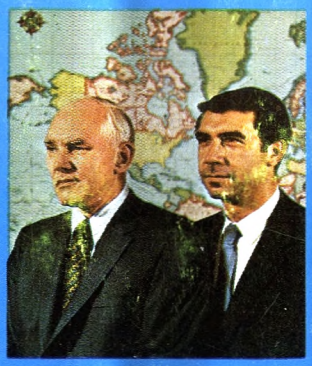
NEW PRODUCTS

Tektronix, Inc.



Tektronix, Inc., world leader of cathode-ray oscilloscope developments for over a quarter century has selectively expanded its expertise into related display, control and measurement product areas. TV Test Instruments and Monitors, Computer Display Terminals, Machine Control Products, and Automated Test Systems have become an integrated part of Tektronix, Inc. These products have been developed and refined, benefiting both technology and society.

Our reputation is earned through technical leadership coupled with ability to anticipate and respond to customer needs. At Tektronix, Inc., leadership in electronic-display expertise is matched with solid financial strength, and a world-wide customer-support organization.

With each new product we lay our reputation on the line with a firm commitment to research, engineering, manufacturing and marketing support.

TEKTRONIX®

committed to technical excellence

March, 1972

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To Our Readers

This New Products Catalog presents in one booklet all instruments and products introduced by Tektronix, Inc. since publication of our general catalog in March of 1971. We will continue to announce new products in our bimonthly New Product Supplement.

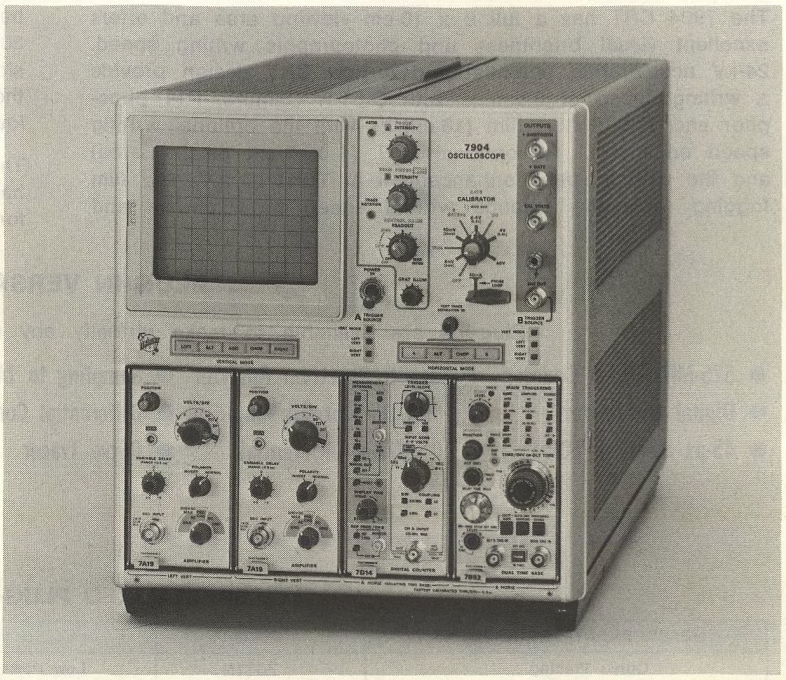
The 1971 catalog, along with this New Product Catalog and the forthcoming New Product Supplements, will provide you with current information on all TEKTRONIX products. A new catalog will be distributed to everyone on our mail list about September 1, 1972.

Information in this publication supersedes all previously published material. Specification and price change privileges reserved.

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
- CHOOSE FROM 24 COMPATIBLE 7000-SERIES PLUG-INS
- 16 cm/ns ENHANCED WRITING SPEED
- CRT READOUT
- VERTICAL AND HORIZONTAL MODE SWITCHING
- VERSATILE TRIGGER SOURCE SELECTION
- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING



The 7900 Family is the world's most advanced oscilloscope measurement system. It is the latest extension of the versatile TEKTRONIX 7000 Series. Coupled with the broad functional versatility of the established 7000-Series plug-ins, the 7900 Family offers the highest mainframe and CRT bandwidth available today in a general-purpose oscilloscope system.

500 MHz FAMILY VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	Tr	SIG OUT BW	ACCURACY*	
						WITHOUT PROBE	WITH PROBE
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	250 MHz	1.4 ns	140 MHz	2% (Integral)	
7A12	Dual-Channel Amplifier	5 mV/div	120 MHz	2.9 ns	110 MHz	2%	3% (P6053)
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	105 MHz	3.4 ns	100 MHz	1.5%	1.5% (P6053) 1.5% (P6055)
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	55 MHz (P6021) 120 MHz (P6022)	6.4 ns (P6021) 2.9 ns (P6022)	50 MHz (P6021) 100 MHz (P6022)	———	2% (P6021) 2% (P6022)
7A15	Low-Cost Conventional Input Amplifier	5 mV/div	80 MHz	4.4 ns	70 MHz	2%	3% (P6053) 3% (P6054) 3% (P6061)
7A16	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	225 MHz	1.6 ns	140 MHz	2%	3% (P6053)
7A17	Low-Cost, Easy to Customize Amplifier	50 mV/div	150 MHz	2.4 ns	15 MHz	Adjustable	
7A18 7A18N	Dual-Channel Amplifier	5 mV/div	80 MHz	4.4 ns	70 MHz	2%	3% (P6053) 3% (P6054) 3% (P6061)
7A19	Wide-Bandwidth 50-ohm Input Amplifier	10 mV/div	500 MHz	0.8 ns	300 MHz	3%	3% (P6056) 3% (P6057)
7A21N	Direct CRT Access	<4 V/div	1 GHz	350 ps	———	———	———
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	2% (ANY)

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

*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%.

7904

500-MHz Oscilloscope

The 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 8 cm/ns with C-51-R Camera, P11 phosphor and 10,000 ASA film (16 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 25 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.

The 7904 has an auto-focus circuit. After the focus control has been initially set, the auto-focus circuit reduces the need for additional manual focusing with changes in intensity.

PLUG-IN VERSATILITY

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

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

SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PERFORMANCE FEATURE	
Curve Tracing	7CT1N	Low Power Semiconductor Curve Tracer	
Digital Multimeter	7D13	Digital Multimeter Plus a Unique Temperature Probe	
Digital Counting	7D14	Directly Gated Counter to 525 MHz	
Spectrum Analysis	7L12	1 MHz to 1.8 GHz Spectrum Analyzer	
Delay Line	7M11	High Quality Dual 50-Ω Delay Line	
Sampling	7S11	1 MΩ/350 MHz to 50 Ω/14 GHz Sampling Unit	
TDR and Sampling	7S12	TDR and Sampling Applications	
Sampling Sweep	7T11	Random or Sequential, Equivalent or Real-Time Sampling	

Use these versatile plug-ins in all the Families of our 7000 Series. For specific performance features see:

50 MHz — 7400 Family — 7403N, R7403N
90 MHz — 7500 Family — 7503, 7504, 7514
150 MHz — 7700 Family — 7704, R7704

7904 OSCILLOSCOPE

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.

Trace 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.

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) between vertical and horizontal channels. Bandwidth is DC to at least 1 MHz.

CRT

Standard (T7900)—8 x 10 cm with P31 phosphor (P11 optional at no charge). For general purpose use.

Optional Max Brightness CRT (T7901)—4 x 5 cm with P31 phosphor (P11 optional at no charge). Provides extremely high photographic and information writing speed and increases the visibility of low rep rate high speed signals. **Order option 4.**

Accelerating Potential—24 kV.

Graticule—Internal with variable illumination.

Phosphor—P31 standard, P11 optional at no additional cost.

Minimum Photographic Writing Speed—Using Polaroid* film without film fogging and the standard 8 x 10 cm CRT.

WRITING SPEED		CAMERA	LENS	FILM
P31	P11			
4.0 cm/ns	8.0 cm/ns	C-51-R	f/1.2 1:0.5	10,000 ASA
1.7 cm/ns	3.4 cm/ns	C-52-R	f/1.4 1:1	
2.0 cm/ns	4.0 cm/ns	C-51-P/R	f/1.2 1:0.5	3,000 ASA
0.8 cm/ns	1.7 cm/ns	C-52-P/R	f/1.4 1:1	

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.

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

*Registered Trademark Polaroid Corporation

+Gate—Positive-going rectangular waveform derived from A, B, or DELAYED gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 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 (±10%) into 50 Ω, 0.5 V/div (±10%) into an open circuit. The bandwidth depends upon vertical plug-in. See the **500-MHz 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—For 7904 mainframe and single-width plug-ins.

	MAINFRAME		PLUG-INS	
DIMENSIONS	in	cm	in	cm
HEIGHT	13.5	34.2	5.0	12.7
WIDTH	12.0	30.5	2.8	7.1
LENGTH	23.3	59.0	14.5	36.9
WEIGHTS (approx)	**lb**	**kg**	**lb**	**kg**
NET	32.0	14.5	2.0	0.9
DOMESTIC SHIPPING	52.0	23.5	5.0	2.3
EXPORT-PACKED	63.0	28.6	10.0	4.5

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

Order 7904 OSCILLOSCOPE, without plug-in units

INSTRUMENT OPTIONS

Order 7904 OSCILLOSCOPE, without readout, Option 1

CRT READOUT CONVERSION KIT, Order 040-0605-00

Order X-Y HORIZONTAL COMPENSATION, Option 2

X-Y CONVERSION KIT, Order 040-0606-00

Order EMI MODIFICATION, Option 3

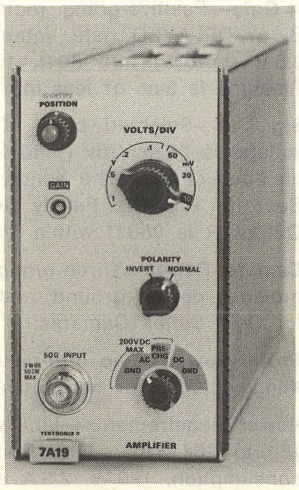
EMI CONVERSION KIT, Order 040-0570-00

Order 7904 OSCILLOSCOPE, with maximum brightness CRT (4 x 5 cm), Option 4

7A17 and 7A19 Single-Trace Amplifiers
7A21N Direct Access

7A19 AMPLIFIER

- DC-to-500 MHz BANDWIDTH
- 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-Family mainframes, but is compatible with all 7000-Series mainframes. The polarity of the display is selectable, either normal or inverted. As an option the 7A19 is available with a variable (front-panel) delay line to permit matching the transit time of two preamps and probes to better than 50 ps. The range of this variable delay is ±500 ps.

Probes are not supplied with the 7A19 and should be ordered separately according to the application.

The P6056 (10X) or P6057 (100X) Probe is recommended for use with the 7A19 for optimum frequency response and CRT READOUT compatibility. Both of these probes are compatible with 50 Ω systems.

The P6051 FET Probe is recommended when your measurement requirement dictates a high input impedance. With this 1 MΩ probe the system bandwidth of the 7904/7A19 is 450 MHz.

Bandwidth—DC to 500 MHz; 1 kHz (lower —3 dB) AC coupled.

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.

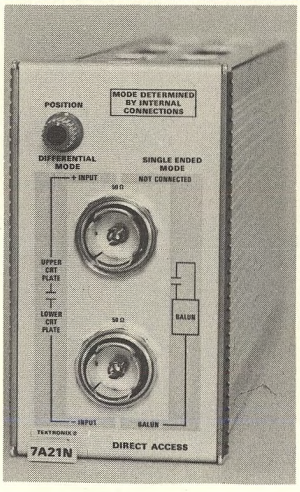
Max Input—2 watts RMS or 50 div Peak in both the AC and DC coupled mode. 200 V (DC + Peak AC) in the AC coupled mode.

Order 7A19 AMPLIFIER

Order 7A19, with variable delay, Option 1

7A21N DIRECT ACCESS

- BANDWIDTH TO 1 GHz
- 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 the wide bandwidth CRT of the 7904 Oscilloscope. Two front panel input connectors allow either single-ended or differential operation (internally selected). Vertical trace positioning is accomplished by a front panel control.

The direct access feature of this plug-in dictates by-passing the 7904 vertical amplifier. 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.

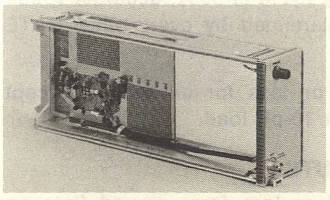
Max Input Voltage— 25 V DC, 100 V pulsed AC.

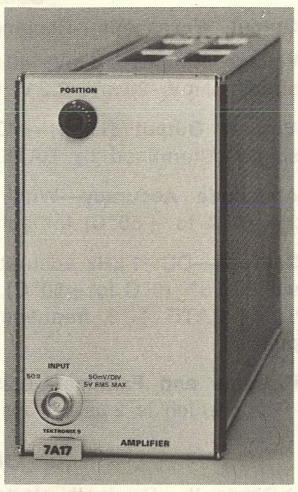
Order 7A21N DIRECT ACCESS

Included Accessories—Interconnecting board assembly.

7A17 AMPLIFIER

- LOW COST
- 50 mV/DIV CALIBRATED DEFLECTION FACTOR
- DC-to-150 MHz BANDWIDTH
- EASY-TO-CUSTOMIZE





The 7A17 is a unique wideband, plug-in amplifier for all 7000-Series mainframes. It is optimized electrically and mechanically for "do it yourself" design and modification.

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

Probes are not supplied with the 7A17. If the application requires probes see the P6056 or P6057 on accessories page for more details.

Bandwidth—DC to 150 MHz.

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

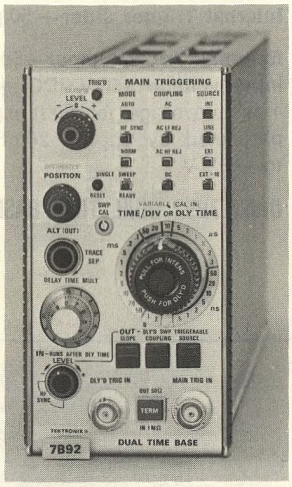
Input Z—50 Ω.

Max Input Voltage—5 V RMS.

Order 7A17 AMPLIFIER

7B92
DUAL TIME BASE

- **0.5 ns/DIV to 0.2 s/DIV CALIBRATED TIME BASE**
- **TRIGGERING to 600 MHz**
- **DISPLAY SWITCHING—ALTERNATE DISPLAY OF INTENSIFIED DELAYING & DELAYED SWEEPS**



The exceptionally fast sweep (500 picosecond/cm) of the 7B92 ideally matches the ultra-high bandwidth of the 7904 mainframe. The 7B92 features four display modes: normal, intensified delaying sweep (controllable 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 SEPARATION 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.

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.

Delay Time Multiplier Incremental Linearity—Within 0.2% of full scale over center 8 divisions. Within 1% of full scale in the first division.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial divisions for 10 ns to 0.1 s delay times. Within 2% and 2 minor dial divisions for 0.2 s delay time.

Jitter—1 part in 50,000 of maximum available delay time or 500 ps whichever is greater. (Not applicable for first 2% of available delay range.)

Triggering

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 20 MHz	0.5 div	100 mV
	20 MHz - 600 MHz	1.0 div	500 mV
AC LF REJ	30 kHz - 20 MHz	0.5 div	100 mV
	20 MHz - 600 MHz	1.0 div	500 mV
AC HF REJ	30 Hz - 50 kHz	0.5 div	100 mV
DC	DC - 20 MHz	0.5 div	100 mV
	20 MHz - 600 MHz	1.0 div	500 mV

HF Sync—Triggering frequency range is from 100 MHz to 600 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 600 MHz.

External Trigger Input—Selectable 50 Ω or 1 MΩ inputs. Max input voltage 250 V (DC + peak AC) for 1 MΩ input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 MΩ paralleled by approx 20 pF. LEVEL range is at least +3.5 V to −3.5 V in EXT, at least +35 V to −35 V in EXT ÷ 10.

DELAYED SWEEP

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

Sweep Accuracy—Measured over the center 8 div in the 7900-Family Oscilloscope mainframe.

TIME/DIV	+15°C to +35°C	0°C to +50°C
0.1 s/div to 50 ns/div	within 3%	within 4%
0.2 s/div and 20 ns/div to 1 ns/div	within 4%	within 5%
0.5 ns/div	within 5%	within 6%

7B92 Dual Time Base

7L12 Spectrum Analyzer

Triggering

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 20 MHz	0.5 div	100 mV
	20 MHz - 600 MHz	1.0 div	500 mV
DC	DC - 20 MHz	0.5 div	100 mV
	20 MHz - 600 MHz	1.0 div	500 mV

HF Sync—Triggering frequency range is from 100 MHz to 600 MHz with increased sensitivity.

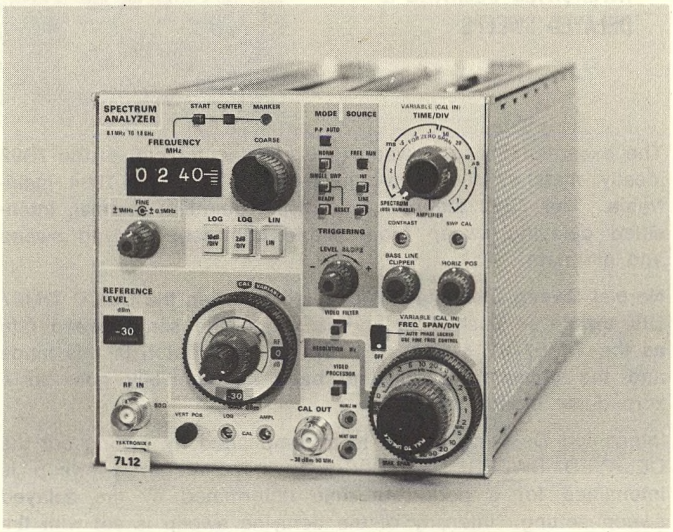
Internal Trigger Jitter— 50 ps or less at 600 MHz.

External Trigger Input—Selectable 50 Ω or 1 MΩ inputs. Max input voltage 250 V (DC + peak AC) for 1 MΩ input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 MΩ paralleled by approx 20 pF. LEVEL range is at least +3.5 V to −3.5 V.

Order 7B92 DUAL TIME BASE

7L12 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
- −110 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 to 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 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.

CHARACTERISTICS

Frequency Tuning Range—100 kHz to 1.8 GHz continuously variable; accuracy ± (10 MHz + 1% of dial indication).

Frequency Span—500 Hz/div to 100 MHz/div in 1-2-5 sequence. 0 Hz (analyzer, not swept) and maximum span (1.8 GHz over 10 div), modes are also selectable. A continuously variable span control is provided.

Calibrator— 50 MHz ±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, a 10 dB variable control is also provided.

Log Display Mode Dynamic Range—70 dB at 10 dB/div; 14 dB at 2 dB/div; log scale accuracy ±0.1 dB/dB, ±1.5 dB maximum over the full dynamic range.

RF Attenuation— 0 dB to 60 dB in 10 dB steps ± (0.2 dB + 1% of setting).

Resolution Bandwidth (6 dB down)— 300 Hz to 3 MHz in decade steps ±20%.

Resolution Shape Factor— 4:1, 60 dB to 6 dB.

Video Filter Bandwidth—Automatically selected by the resolution control.

CW Sensitivity— —110 dBm at 300 Hz Resolution; —100 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 input.

Intermodulation Distortion—Third order: 70 dB down from two —30 dBm signals. Second order: 70 dB down from two —40 dBm signals (at any frequency span).

Incidental FM—Phase locked Mode: 200 Hz (P-P) maximum; not phase locked: 10 kHz (P-P) maximum.

Display Flatness—±1.5 dB, with respect to 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 μs/div to 10 ms/div in 1-2-5 sequence continuously variable between steps. Variable control has 100:1 range in 10 ms/div to decrease sweep rate to approximately 1 s/div.

Triggering Modes—Normal, Peak-to-Peak Auto, Single.

Triggering Sources—Vertical Amplifier channels, Power frequency and free run.

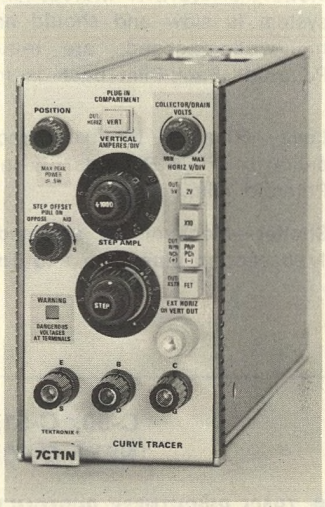
DIMENSIONS	in	cm	WEIGHTS (approx)	lb	kg
HEIGHT	5.0	12.7	NET	10	4.5
WIDTH	5.5	14.0	DOMESTIC SHIPPING	13	5.9
LENGTH	14.5	36.9	EXPORT-PACKED	18	8.2

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/R7403N, 337-1159-02 for other 7000-Series).

Order 7L12 SPECTRUM ANALYZER

7CT1N CURVE TRACER

- 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
- COMPATIBLE WITH ALL 7000-SERIES MAINFRAMES
- LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT
- EASY TO OPERATE



The 7CT1N Curve Tracer is a plug-in unit used in TEKTRONIX 7000-Series Oscilloscope Systems for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts.

A variable collector/drain sweep produces a maximum peak voltage of at least 250 volts; a base/gate step generator produces up to 10 calibrated current or voltage steps. Ranges of step amplitudes are 1 μA/step to 1 mA/step for current and 1 mV/step to 1 V/step for voltage. In addition the unit has a vertical display amplifier with deflection factors ranging from 10 nA/div to 20 mA/div and a horizontal amplifier output compatible with other 7000-Series Plug-ins. See page 40 for more details.

Order 7CT1N CURVE TRACER

C-5 and C-53 (Including C-50, C-51 and C-52) Cameras

C-5 CAMERA

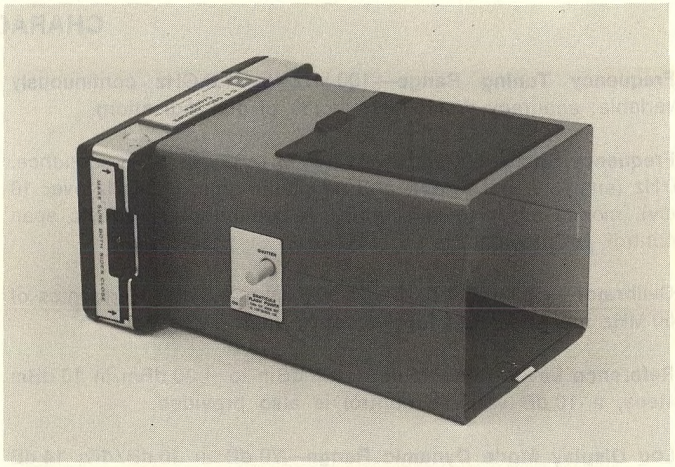
- EASY TO USE
- FIXED FOCUS
- LIGHTWEIGHT
- LOW COST

The C-5 Camera is specifically designed for use with TEKTRONIX 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 variable-intensity (brightness) battery-powered graticule illuminator for oscilloscopes with non-illuminated graticules. A hinged door in the camera top allows viewing of the CRT without removing the camera. The C-5 lens system is slow and should not be used where moderate- to high-writing speeds are required. A permanently attached Polaroid[1] Pack-Film back is mounted to the camera housing.

Lens— 60 mm, f/16 (fixed) trace-recording lens with a magnification of 0.68. Records 6½-inch CRTs on standard 3¼ x 4¼ Polaroid Film.

Shutter—Mechanically actuated with speeds of 1/5, 1/10 and 1/25 second plus Bulb and Time.



Film Back—Permanently attached Polaroid 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

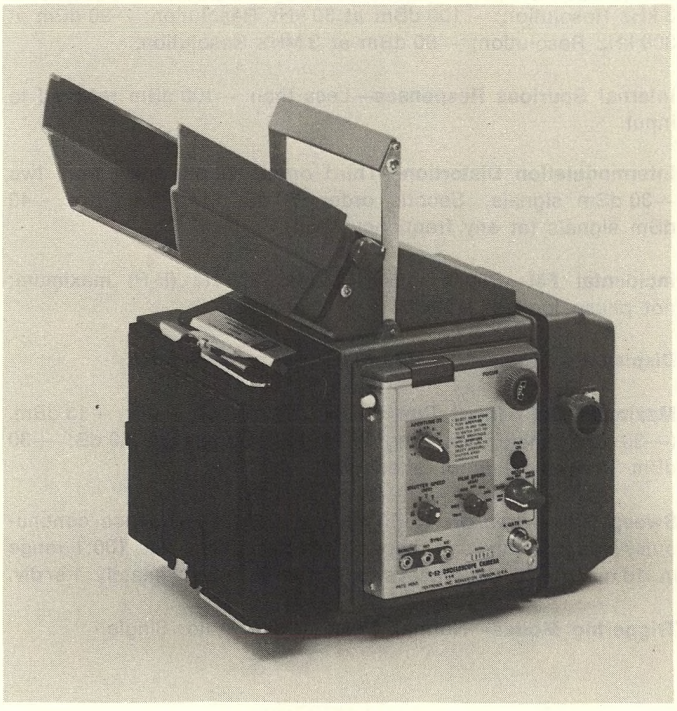
Order C-5 CAMERA

C-50, C-51, C-52 AND NEW C-53 CAMERAS

- TRACE-BRIGHTNESS PHOTOMETER
- ELECTRICALLY-CONTROLLED SHUTTER
- RANGE-FINDER FOCUSING
- ACCURATE EXPOSURE CONTROL
- COMPACT, LIGHTWEIGHT

The C-50, C-51, C-52 and new C-53 are compact, light-weight, trace-recording cameras designed primarily for use with all TEKTRONIX 7000-Series Oscilloscopes (no additional adapter required). With optional battery pack and appropriate mounting adapter, they may be used with most other full-size oscilloscopes. Differing only in the lens systems, these cameras feature a trace-brightness photometer, range-finder focusing and accurate exposure control. The shutter is electrically actuated either remotely or by a push button on the control panel.

All cameras may be ordered with either a Polaroid[1] Pack-Film or Roll-Film Back, a Graflok[2] 4 x 5 Back or no back. Optional film backs can be rapidly interchanged without refocusing the camera.



C-52-G Shown

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.

[1]Registered Trademark Polaroid Corporation
[2]Registered Trademark Graflex, Inc.

Exposure—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 thumbwheel 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 the 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.

Shutter—The shutter is electrically 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 externally connected to the oscilloscope plus gate. When connected to the plus gate, the shutter is electronically closed approximately five seconds after the end of 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.

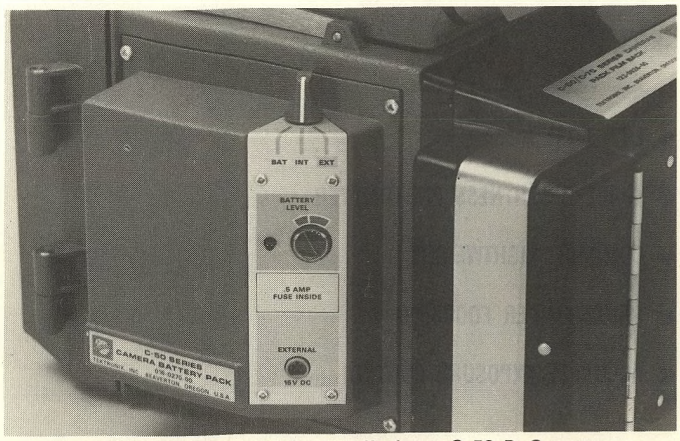
SPECIFICATIONS

CAMERA	C-50	C-51	C-52	NEW C-53
PERFORMANCE FEATURE	General Purpose	Highest-Writing Speed	Full Size Image	**General Purpose Large Image
LENS	57.6 mm	57.6 mm	60.0 mm	57.6 mm
f/STOP	f/1.9 to f/16	f/1.2 to f/11	f/1.4 to f/16	f/1.9 to f/16
MAGNIFICATION	0.7	0.5	1.0	0.85
*RELATIVE LENS SPEED	1.2 (f/1.9)	3.6 (f/1.2)	1.5 (f/1.4)	1.0 Reference (f/1.9)
SHUTTER RANGE	Electrically actuated, 4 to 1/60 s, plus Bulb and Time			
TIMING ACCURACY	Within 10% (+20°C to +30°C) Within 20% (0°C to +50°C)			

*This is a comparative figure of the relative speeds (i.e. their light gathering power) of different camera lens systems. The C-53, f/1.9 lens is the reference.
**The new C-53 lens projects the largest practical image of an 8 x 10 cm graticule on Polaroid 3¼ x 4¼ film.

Dimensions and Weights—With standard back and viewing tunnel installed.

DIMENSIONS	C-50-P and C-53-P		C-51-R		C-52-G	
	in	cm	in	cm	in	cm
HEIGHT	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
LENGTH	10.8	27.3	10.8	27.3	10.8	27.3
WEIGHT (approx)	lb	kg	lb	kg	lb	kg
NET	7.5	3.4	9.5	4.3	8.0	3.6
DOMESTIC SHIPPING	12.0	5.4	15.0	6.8	15.0	6.8
EXPORT-PACKED	24.0	10.9	27.0	12.2	27.0	12.2



Optional battery pack installed on C-53-P Camera

ORDERING INFORMATION

C-50

Order C-50-P CAMERA, Pack-Film Back
Order C-50-R CAMERA, Roll-Film Back
Order C-50-G CAMERA, 4 x 5 Graflok Back
Order C-50-N CAMERA, No Back

C-51

Order C-51-R CAMERA, Roll-Film Back (Recommended)
Order C-51-P CAMERA, Pack-Film Back
Order C-51-G CAMERA, 4 x 5 Graflok Back
Order C-51-N CAMERA, No Back

C-52

Order C-52-G CAMERA, 4 x 5 Graflok Back (Recommended)
Order C-52-R* CAMERA, Roll-Film Back
Order C-52-P* CAMERA, Pack-Film Back
Order C-52-N CAMERA, No Back

C-53

Order C-53-P CAMERA, Pack-Film Back
Order C-53-R CAMERA, Roll-Film Back
Order C-53-G CAMERA, 4 x 5 Graflok Back
Order C-53-N CAMERA, No Back

OPTIONAL ACCESSORIES

Battery Pack—Provides an auxiliary power source for the C-50-Series Cameras (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 the oscilloscope camera power or an external DC voltage source. Net weight of pack, including batteries, is 1.2 pounds. **Order 016-0270-00**

Carrying Case—Holds a C-50-Series or C-70 Camera. **Order 016-0177-00**

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 3¼ x 4¼ 3000-speed pack film. **Order 122-0926-00**

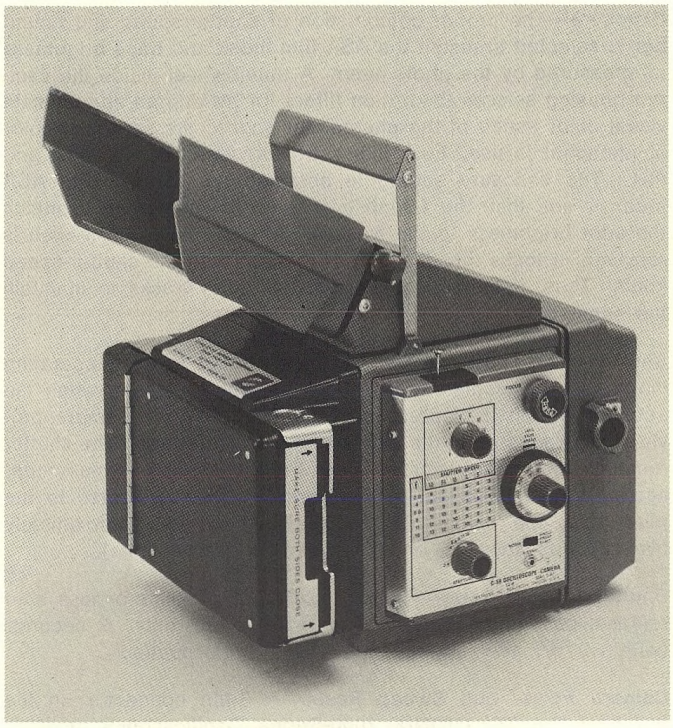
Roll-Film Back—Accepts Polaroid 3¼ x 4¼ 10,000 or 3000-speed roll film. **Order 122-0929-00**

Graflok Back, 4 x 5—Accepts Polaroid Land 4 x 5 film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders. **Order 122-0931-01**

Polaroid Land 4 x 5 Film Holder, 1 Exp. **Order 016-0201-01.**

*These cameras use 3¼ x 4¼ film and will not record a full 8 x 10 cm graticule.

C-59
Camera



- LOW COST
- TRACE BRIGHTNESS PHOTOMETER
- COMPACT, LIGHTWEIGHT
- RANGE-FINDER FOCUSING
- ACCURATE EXPOSURE CONTROL

The C-59 trace-recording camera 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.

The C-59 may be ordered with either a Polaroid[1] Pack-Film or Roll-Film Back, a Graflok[2] 4 x 5 Back or no back. Optional film backs can be rapidly interchanged without refocusing the camera.

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.

Exposure—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 on top of the ASA setting control. The photometer light spot brightness and trace brightness are matched. The push-on 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.

*Can only be used with 5100-Series Oscilloscopes when in the store mode.
[1]Registered Trademark Polaroid Corporation
[2]Registered Trademark Graflex, Inc.

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 opened and closed. Whenever the camera is attached to a 7000-Series Oscilloscope the internal batteries in the camera are disconnected.

SPECIFICATIONS

Lens—55.33 mm, f/2.8 trace-recording lens, stops down to f/16. Magnification 0.67.

Shutter—Mechanically actuated with speeds from 1 to 1/50 second plus Bulb and Time.

Dimensions and Weights—With pack back and viewing tunnel installed.

DIMENSIONS	in	cm	WEIGHTS (approx)	lb	kg
HEIGHT	11.5	29.2	NET	7.0	3.2
WIDTH	7.7	19.3	DOMESTIC SHIPPING	11.0	5.0
LENGTH	10.8	27.3	EXPORT-PACKED	23.0	10.4

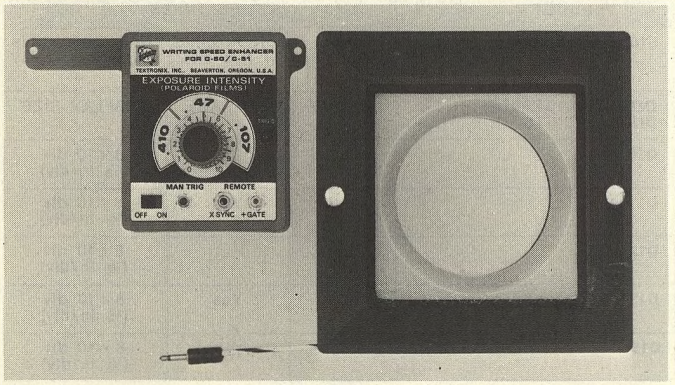
Order C-59-P CAMERA, Pack-Film Back
Order C-59-R CAMERA, Roll-Film Back
Order C-59-G CAMERA, 4 x 5 Graflok Back
Order C-59-N CAMERA, No Back

Eight AA alkaline cells (006-0513-00) are included with each camera.

TEKTRONIX Writing Speed Enhancer

This camera accessory increases photographic writing speed by accurate and repeatable film fogging. The writing speed increase for 3000 ASA film and 10,000 ASA film is ≈4 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.



Control box and light diffuser for C-50 Series

The following table lists the approximate relative writing-speed factors of three Polaroid* Film types, and the effect of controlled fogging.

Polaroid Film Type	Relative Film Speed**		
	No Enhancement		
	With Front Illumination of Print for Viewing	With Back Illumination of Print for Viewing	With Fogging by Writing Speed Enhancer
107 (3,000 pack)	1.0 (Reference)	Print Base Is Opaque	4.0
47 (3,000 roll)	1.0	1.7	4.0
410 (10,000 roll)	2.0	3.9	8.0

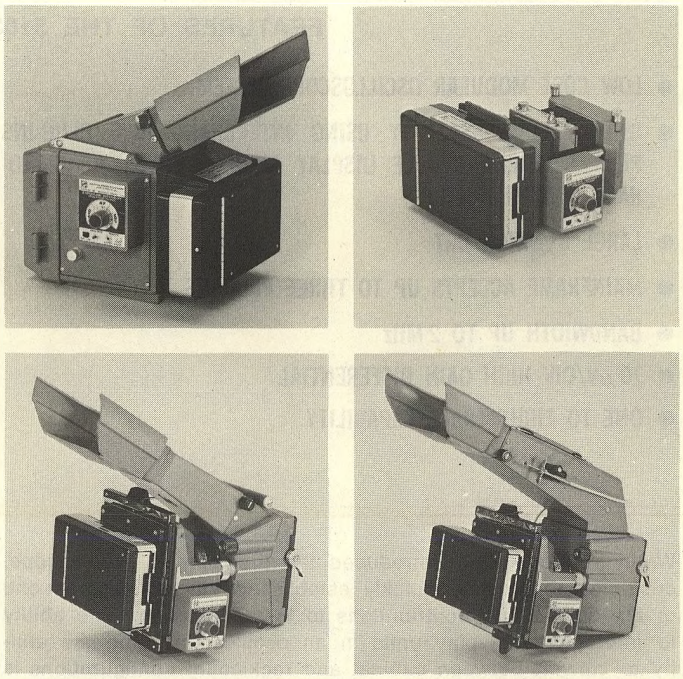
The following table lists the approximate relative light-gathering power of most TEKTRONIX camera lenses.

Cameras and Lenses			Relative Lens Speeds
C-12†	f/1.9 f/1.4 f/1.3	1:0.85 1:1 1:0.5	0.65 1.0 (Reference) 1.7
C-27	f/1.9 f/1.4 f/1.3	1:0.85 1:1 1:0.5	1.0 (Reference) 1.5 2.6
C-30A	f/1.9	1:0.7	1.0 (Reference)
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 (Reference)
C-59	f/2.8	1:0.67	0.65

*Registered Trademark Polaroid Corporation

**Although these average values are based upon the analysis of many photographs, they are considered tentative.

†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 ≅ Relative Writing Speed**
Example:
1.2 (C-50) X 4.0 (107 Enhanced) ≅4.8

CHARACTERISTICS

Triggering—Manual push button or automatic when connected to camera X-sync, or oscilloscope + gate.

Exposure Time—Approximately 0.5 seconds.

Repeatability—Within 5%.

Illumination—Four 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°C.

DIMENSIONS	in	cm	WEIGHTS (approx)	lb	kg
HEIGHT	3.0	7.6	NET	0.6	0.27
WIDTH	1.3	8.3	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.

ORDERING INFORMATION

WRITING SPEED ENHANCER for:

C-12 and C-27 Cameras, Order 016-0280-00

C-30A and C-31 Cameras, Order 016-0284-00

C-50 Camera, Order 016-0278-00

C-51 Camera, Order 016-0279-00

C-53 Camera, Order 016-0300-00

C-59 Camera, Order 016-0290-00

FEATURES OF THE 5103N OSCILLOSCOPE SYSTEM

- LOW COST MODULAR OSCILLOSCOPE SYSTEM
- UNEQUALED VERSATILITY USING INTERCHANGEABLE PLUG-INS PLUS INTERCHANGEABLE DISPLAY MODULES PLUS BENCH-TO-RACK CONVERTIBILITY
- LARGE 6½-INCH CRT
- MAINFRAME ACCEPTS UP TO THREE PLUG-INS
- BANDWIDTH UP TO 2 MHz
- 10 μV/DIV HIGH GAIN DIFFERENTIAL
- ONE TO EIGHT TRACE CAPABILITY
- SIMULTANEOUS DISPLAY OF TWO INDEPENDENT TIME BASES OR DELAYED SWEEP
- Y-T OR X-Y OPERATION
- NEW IMPROVED STORAGE CAPABILITY
- SIMPLIFIED CONSTRUCTION, EASY TO MAINTAIN, RELIABLE
- COLOR CODED FRONT PANELS FOR EASY OPERATION
- LIGHT WEIGHT, EASY TO CARRY
- LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT
- SOLID STATE STABILITY

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. These features are expected to represent the same significance to oscilloscopes as did the plug-in.

These exclusive 5103N Oscilloscope System features support the TEKTRONIX commitment to progress in waveform measurement. This oscilloscope system will provide present and future measurement capabilities at a sound price/performance ratio, and the customer 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 the user to choose an instrument for his immediate individual requirements and have unequaled ability to change the configuration when his applications change.

Currently the 5103N Oscilloscope System consists of five interchangeable display modules, eleven amplifier plug-ins, three time base plug-ins and one 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. Chopped and alternate modes are selected from a push-button on time base plug-ins.

MAINFRAME AND INTERCHANGEABLE DISPLAY UNITS

PRODUCT	FEATURES		
5103N MAINFRAME	Power Supply/Amplifier Unit compatible with each of five interchangeable display units •		
INTERCHANGEABLE DISPLAY UNITS	**BEAMS**	**STORAGE**	**DISPLAY SIZE**
D10	Single		8 x 10 div (½ in/div)
D11	Single	Yes	8 x 10 div (½ in/div)
D12	Dual		8 x 10 div (½ in/div)
D13	Dual	Yes	8 x 10 div (½ in/div)
D15 New	Single	Yes	8 x 10 div (½ in/div)

AMPLIFIER PLUG-INS

PRODUCT		TRACES	MINIMUM DEFLECTION FACTOR	BANDWIDTH —3 dB	CMRR
5A13N	New	Single	1 mV	2 MHz	10,000:1
5A14N	New	Four	1 mV	2 MHz	
5A15N		Single	1 mV	2 MHz	
5A18N		Dual	1 mV	2 MHz	
5A19N	New	Single	1 mV	2 MHz	1,000:1
5A20N		Single	50 μV	1 MHz	100,000:1
5A21N		Single (Voltage and Current)	50 μV 0.5 mA	1 MHz	100,000:1
5A22N	New	Single	10 μV	1 MHz	100,000:1
5A23N		Single	10 mV/div	2 MHz	
5A24N		Single	50 mV/div	2 MHz	
5CT1N	New	Semiconductor Curve Tracer			

TIME BASE PLUG-INS

PRODUCT	DUAL and DELAYED SWEEP	SWEEP RATE	MAG	SINGLE SWEEP	VOLTS/DIV EXT MODE
5B10N		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	Yes	1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B13N		1 μs to 100 ms			50 mV

The five display modules presently available include a single beam unit, a dual beam unit, single beam storage units and a dual beam storage unit. Each unit features a large CRT with 8 x 10 divisions (½ in/div). All five modules have a 3.5 kV accelerating potential and internal graticules. P31 phosphor is standard for the non-storage 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, the controls related to the CRT display, and the Z-axis input. Each is powered from the 5103N mainframe.

In addition to large, bright displays the D10 Single Beam Display Unit has a front panel output which provides current, voltage and timing calibration sources. A Beam Finder positions the beam on screen regardless of vertical and horizontal control settings. A DC coupled Z-axis input requires only 5 V to modulate the writing beam.

The D11 and D15 Single Beam Storage Units have bistable, split-screen storage CRTs with increased light output, especially in the stored mode. A brightness control allows the user to vary the stored brightness level to retain information for as long as several 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 only the same operating care as a conventional CRT. The stored brightness control used in conjunction with the other storage controls also allows "integration" to increase the effective writing rate.

The D12 Dual Beam Display Unit is the same as the D10 Single Beam Unit except the CRT has 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. The D13 Dual Beam Storage Unit has all of the storage features of the D11 Single Beam Storage Unit plus the dual beam capability of the D12.

All plug-ins in the 5103N Oscilloscope System stress simplicity of design and operating ease. Logical grouping of controls and the use of color-coded panel markings by function is used extensively. Ten vertical amplifiers and three time bases are currently available.

Scale 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.

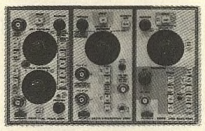
Oscilloscope Dimensions and Weights

	CABINET		RACKMOUNT	
Dimensions	In	cm	In	cm
Height	11.5	29.5	5.25	13.5
Width	8.5	21.5	19.0	48.0
Length	20.0	50.9	19.0	50.9
Weights (approx)	lb	kg	lb	kg
Net	23.0	10.5	23.0	10.5
Domestic Shipping	32.0	14.5	42.0	19.0
Export Packed	44.0	20.0	59.0	24.5

The 5103N is a low frequency oscilloscope system with interchangeable display units with 6½-inch CRTs. The cabinet model converts to and from a rackmount configuration.

SELECT FROM THESE UNITS

The 5103N Mainframe (Shown With Plug-Ins)



Add The D10 Single Beam CRT Unit

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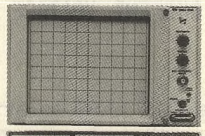

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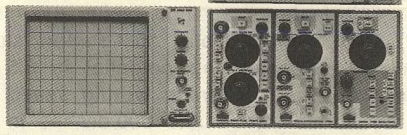

OR

Add The D11 OR D15 Single Beam Storage Unit

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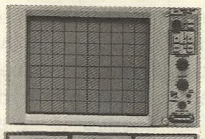

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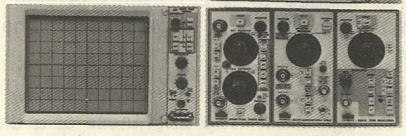

OR

Add The D12 Dual-Beam Unit

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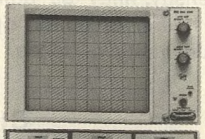

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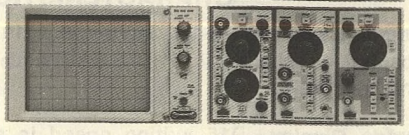

OR

Add The D13 Dual-Beam Storage Unit

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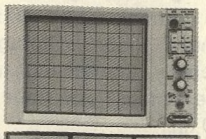

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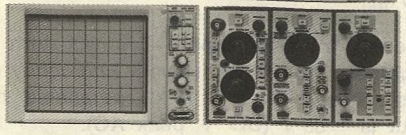


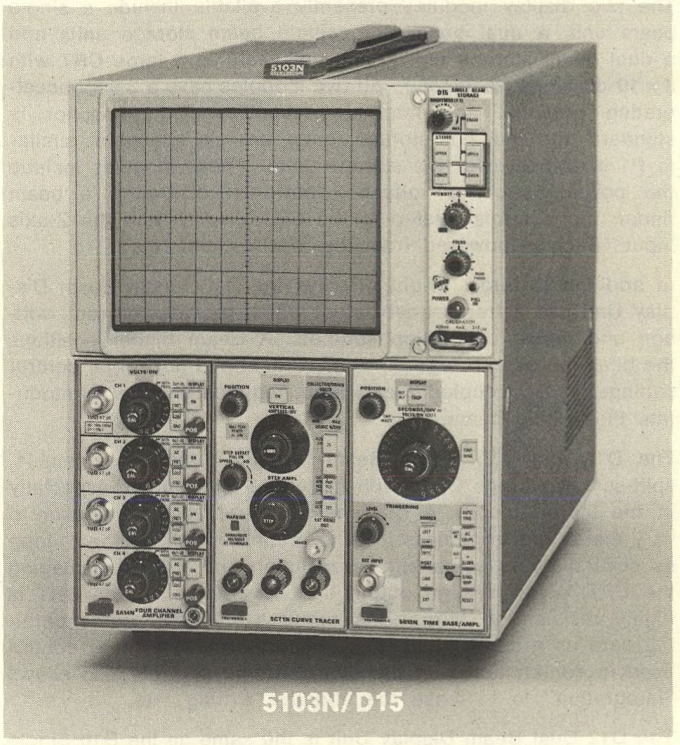
5100 Series Plug-in Dimensions and Weights

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

D15 Single-Beam Storage Display Unit

5103N Mainframe

- 8 x 10 DIV CRT (½ IN/DIV)
- BISTABLE SPLIT-SCREEN STORAGE
- VARIABLE STORED BRIGHTNESS
- STORE FOR HOURS
- VIEW FOR EXTENDED PERIODS
- CABINET OR 5¼-INCH RACKMOUNT
- BEAM FINDER
- DC COUPLED Z-AXIS INPUT
- CURRENT, VOLTAGE AND TIME CALIBRATOR



The D15 provides storage displays for the 5103N Mainframe. The unit features a single-beam, 6½-inch 8 x 10 div (½ in/div) CRT with bistable, split-screen storage and an internal graticule. Accelerating potential is 3.5 kV and the phosphor is similar to P1. Storage writing speed is at least 200 div/ms in the normal mode and 800 div/ms in the enhanced mode.

Simplified storage operation, a characteristic of TEKTRONIX bistable storage, lets the user leave the oscilloscope unattended and still retain transient events in a view mode. This frees the user to concentrate on the test point, confident that the only action needed to retain events is setting the display to store and the time base to single sweep. The oscilloscope does the rest.

A Variable Brightness control adds new versatility to the bistable storage tube. The brightness of a display, stored at normal intensity, may be adjusted to extend storage time to at least 10 hours, to obtain optimum photographic results and to integrate multiple traces.

CHARACTERISTICS

Cathode-Ray Tube—6-1/2 inches, 8 x 10 divisions (1/2 in/div). Phosphor is similar to P1. 3.5 kV accelerating potential. Internal graticule.

Storage Display—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 time is at least one hour at normal intensity, increasing to ten hours at reduced intensity. View time at least one hour at normal intensity. Erase time is approx 250 ms.

External Intensity Input— 5 V will turn the beam on to full brightness from an off level. Frequency range is DC to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (DC + peak AC).

Calibrator—Voltage output is 400 mV within 1%. Current output (loop) is 4 mA within 1%. Frequency is 2X line.

Beam Finder—When pressed, the beam is positioned on screen, regardless of vertical and horizontal position control settings.

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

Power Requirements—Quick-change line voltage selector allows operation from 110 V ±10% or 120 V ±10%, 60 and 400 Hz. Specify option 1 (no extra charge) for operation from 100, 110, 120, 200, 220, and 240 V (±10% on each range), 50 to 60 Hz and 400 Hz. Quick-change selector is factory connected for 220-V operation on option 1 instruments.

ORDER INFORMATION

Cabinet—The 5103N Mainframe Unit and Display Unit may be ordered as a cabinet model oscilloscope equipped with a tilt bail and the instruction manual for each unit.

5103N/D15 STORAGE OSCILLOSCOPE (without plug-ins)

Rackmount—The 5103N Mainframe Unit and Display Unit may be ordered as a 5¼-inch rackmount oscilloscope equipped with a slide-out assembly and the instruction manual for each unit.

R5103N/D15 STORAGE OSCILLOSCOPE (without plug-ins)

The Mainframe and Display Unit may be ordered separately as follows:

D15 SINGLE BEAM STORAGE DISPLAY UNIT
Powered from the 5103N Mainframe. Includes instruction manual.

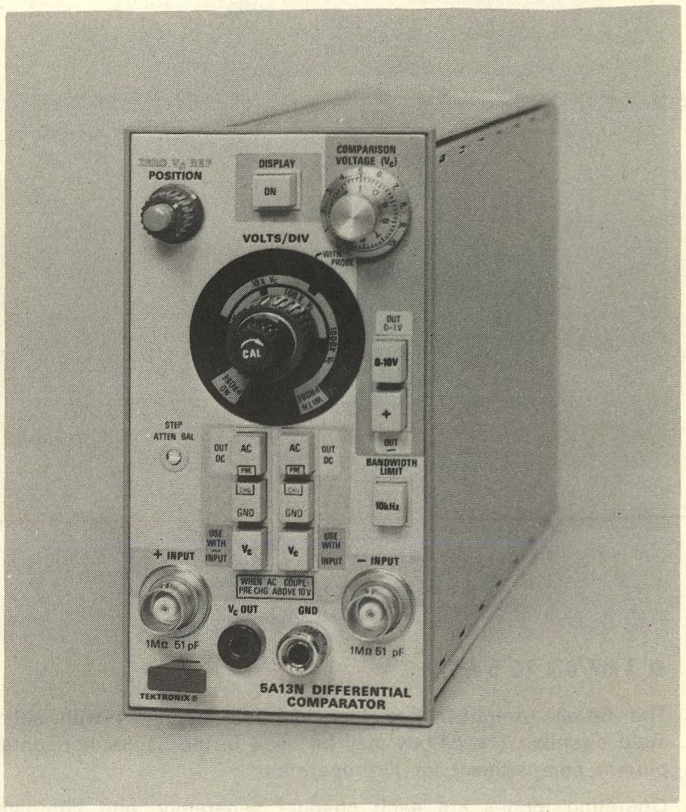
5103N MAINFRAME (without plug-ins or display unit)
Includes instruction manual.

The D15 may be converted from one configuration to the other as applications change.

CONVERSION KITS

Cabinet-to-rackmount conversion kit order 040-0583-00
Rackmount-to-cabinet conversion kit order 040-0584-00

- 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 ± 10 V may be applied to an input (plus or minus) at a deflection factor setting of 1 mV/div and viewed in 10,000 divisions by offsetting the signal with the opposing comparison voltage. A ±1 V comparison voltage is also available for application requiring maximum resolution. The offset voltage may be externally monitored through a front panel output.

CHARACTERISTICS

Bandwidth—DC to 2 MHz. Bandwidth Limit Mode, DC to 10 kHz within 2 kHz. AC Coupled, 2 Hz or less at the lower —3 dB point.

Deflection Factor— 1 mV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Input R and C—1 MΩ within 0.15%, approximately 51 pF.

Signal Range

DEFLECTION FACTOR SETTINGS	1 mV to 50 mV/div	0.1 V to 5 V/div
COMMON-MODE SIGNAL RANGE	±15 V	±350 V
MAX DC COUPLED INPUT (DC + PEAK AC at 1 kHz or less)	±350 V	±350 V
MAX AC COUPLED INPUT (DC VOLTAGE)	±350 V	

Max Input Gate Current— 0.1 nA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Overdrive Recovery— 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after the removal of an overdrive signal between +15 V and —15 V, regardless of overdrive signal duration.

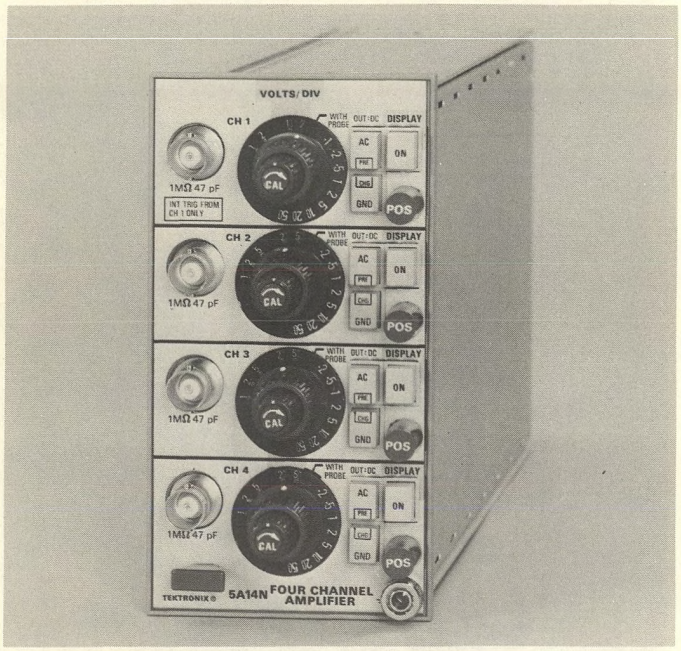
Internal Comparison Voltage—Range, 0 V to ±10 V and 0 V to ±1 V; accuracy, ± (0.2% + 0.05% of full scale); electrical zero, 0.5 mV or less; Vc output R, approximately 15 kΩ.

Common-Mode Rejection Ratio—At least 10,000:1, DC to 10 kHz at 1 mV/div to 50 mV/div DC coupled, with up to 20-volt peak-to-peak sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, DC to 10 kHz at 0.1 V/div to 5 V/div DC coupled, with up to 100-volt peak-to-peak sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz AC coupled, CMRR is the same as stated for DC coupled. Below 5 kHz AC coupled, CMRR decreases to 400:1 at 10 Hz. CMRR with two P6060 probes is at least 400:1 at any deflection factor.

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

5A13N DIFFERENTIAL COMPARATOR AMPLIFIER

5A14N 1 MHz Four Trace Amplifier
5A19N Differential Amplifier



● 1 mV/DIV TO 5 V/DIV

The 5A14N Amplifier has four identical channels with solid state circuits. The 5A14N may be used in the 5103N horizontal plug-in compartment for X-Y operation.

Operating modes are each channel separately, and alternate or chop between any combination of channels. Internal trigger is available from channel one only or from each displayed trace.

Scale factors are readout (automatically corrected for recommended 10X probe) by back lighted volts/div skirt.

CHARACTERISTICS

Bandwidth—DC coupled, DC to at least 1 MHz at all deflection factors. AC coupled, 2 Hz or less to at least 1 MHz at all deflection factors.

Deflection Factor— 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C— 1 MΩ within 1% paralleled by approximately 47 pF.

Maximum Input—DC coupled, 350 V (DC + peak AC). AC coupled, 350 VDC.

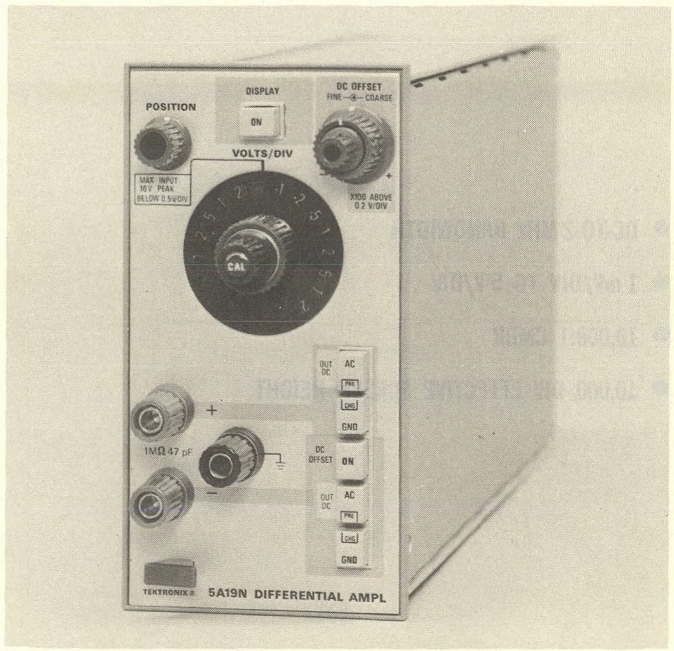
Chopping Rate— 50 kHz or 100 kHz depending upon plug-in combinations and number of traces displayed.

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

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

Order 5A14N FOUR-TRACE AMPLIFIER
Includes instruction manual.



● 1 mV/DIV TO 20 V/DIV ● DC OFFSET

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.

Bandwidth—DC coupled, DC to at least 2 MHz at all deflection factors. AC coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factors—1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 50 V/div.

Input R and C—1 MΩ within 0.30% paralleled by approximately 47 pF.

Signal and Offset Range

Deflection Factor Settings	1 mV/div to 200 mV/div	500 mV/div to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Max DC Coupled Input (DC + Peak AC at 1 kHz or less)	±350 V	
Max AC Coupled Input (AC Voltage)	±350 V	
DC Offset Range	+15 V to −15 V	+350 V to −350 V

Common-Mode Rejection Ratio—DC coupled, 1 mV/div to 200 mV/div, at least 1000:1; decreasing to 100:1 at 500 mV/div to 20 V/div.

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

Weights

Net Weight	1.8 lb	0.82 kg
Domestic Shipping	4.0 lb	1.82 kg
Export Packed	9.0 lb	4.1 kg

Order 5A19N DIFFERENTIAL AMPLIFIER
Includes instruction manual

- DC-TO-1 MHz BANDWIDTH
- 10 μV/DIV TO 5 V/DIV
- 100,000:1 CMRR
- SELECTABLE UPPER AND LOWER —3 dB POINTS
- DC OFFSET

The 5A22N is a differential amplifier for the 5103N Oscilloscope System. Significant performance features are 10 μV/div to 5 V/div deflection factors, DC-to-1 MHz bandwidth, selectable HF and LF —3 dB points, common-mode rejection ratio of 100,000:1 at 10 μV/div DC coupled, and a DC offset feature with ±0.5 V range from 10 μV/div to 50 mV/div and ±50 V range from 100 mV/div to 5 V/div.

There are many factors which contribute to the usability and performance of this high-gain, wideband differential amplifier. Displayed noise (grounded inputs) is held to 20 μV or less at 10 μV/div, tangentially measured at full bandwidth. Since noise is related to bandwidth, the displayed noise can be greatly reduced with the HF —3 dB point selector. Low amplitude signals often ride a small DC component, perhaps a few millivolts, which would place a DC-coupled display offscreen at 10 μV/div. Or, DC drift may be present in the signal to be measured. Low frequency drift is minimized by using AC coupled inputs for frequencies above 2 Hz or by using DC coupled inputs and low frequency limits selectable by a front panel switch. The same techniques are used to cancel a DC component from the signal being measured. Adding a DC voltage opposite in polarity to the polarity of the disturbing DC component is a third method. This is done by using the plug-in's variable DC offset. Full bandwidth is retained in this mode of operation. These and other factors make the 5A22N well suited for measurements in difficult, low-amplitude, low-frequency areas.

CHARACTERISTICS

Bandwidth—HF —3 dB point: selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 20% of selected frequency. LF —3 dB point: selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 20% of selected frequency. AC coupled, 2 Hz or less.

Deflection Factor— 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Input R and C— 1 MΩ within 0.15%, approximately 47 pF.

Drift With Temperature— 100 μV/°C or less.

Max Input Gate Current— 200 pA or less.

Signal and Offset Range

DEFLECTION FACTOR SETTINGS	10 μV to 50 mV/div	0.1 V to 5 V/div
COMMON-MODE SIGNAL RANGE	±10 V	±350 V
MAX DC COUPLED INPUT (DC + PEAK AC AT 1 kHz OR LESS)	±12 V	±350 V
MAX AC COUPLED INPUT (DC VOLTAGE)	±350 V DC rejection, at least 4×10^5:1	
DC OFFSET RANGE	+0.5 V to −0.5 V	+50 V to −50 V

Displayed Noise— 20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

Overdrive Recovery— 10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

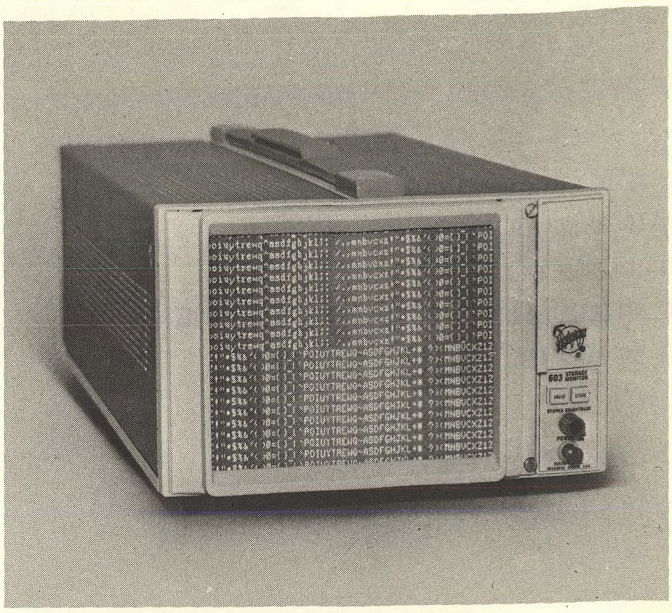
Common-Mode Rejection Ratio—AC coupled, 10 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. DC coupled, at least 100,000:1, DC to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V P-P sinewave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V P-P sinewave. CMRR with two P6060 probes is at least 400:1 at any deflection factor.

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

5A22N DIFFERENTIAL AMPLIFIER

603
Storage Display Monitor

- LOW-COST X-Y MONITOR
- 6-1/2-INCH STORAGE CRT
- 1 MILLION DOTS/SEC WRITING SPEED
- VARIABLE STORED BRIGHTNESS
- VIEW FOR EXTENDED PERIODS
- DIFFERENTIAL INPUTS



The 603 is an X-Y monitor for displaying alphanumeric and graphic data in either a refreshed or stored mode on a 6½-inch CRT. It is well suited for applications such as ultrasonic detection systems, electron microscope systems, radiation and thermal scanning systems, speech therapy, mechanical pressure, volume and vibration analysis, medical and biophysical systems.

The TEKTRONIX-developed bistable storage CRT used in the 603 eliminates the need for costly memory devices to refresh the display. Brightness of stored displays may be adjusted to obtain optimum photographic results, to integrate multiple traces and extend storage time to at least ten hours. Permanent records of the 603 display can be obtained on Polaroid* prints using the TEKTRONIX C-5 Camera.

Operating functions are remotely programmable through a rear panel connector which interfaces directly with TTL systems. X-Y-Z differential inputs are available via BNC connectors. A remote program connector is also available for positive inputs.

CRT DISPLAY AND STORAGE

Cathode-Ray Tube—6½-inch flat-faced bistable storage tube. Phosphor is similar to P1. 3.5-kV accelerating potential. Two storage tubes are available (standard CRT for a brighter stored display or Option 2 for a faster writing speed). When used in the nonstore mode, both tubes exhibit characteristics of a conventional CRT.

*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 1 inch deflection at any point on the CRT will not vary more than 5%.

Viewing Time—At least one hour at normal intensity without loss of resolution. Viewing time can be extended to ten hours by utilizing the variable brightness control.

Erase Time—Approximately 250 ms.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—DC to 2 MHz at 3-dB down (80% full screen scan).

Polarity—Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor—Vertical and horizontal: ≈50 mV/div to 250 mV/div, internally adjustable, 5:1 fixed internal attenuator extends range to at least 1.25 V/div.

603

Storage Display Monitor

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

X-Y Phase Difference—1° or less to at least 500 kHz.

Beam Position—Front panel position controls permit setting zero to any point on screen. Position shift is 1 mm/h or less after 20-min warm-up.

Settling Time—0.2 μsec or less for distances of 1 div or less. 1 μsec or less from any point on the CRT to within one spot diameter of final position.

Maximum Input Voltage—±100 V DC plus peak AC.

Linear Common-Mode Signal Range—±3 V, ±15 V in 5X fixed attenuator position.

Common-Mode Rejection Ratio—At least 100:1 to at least 100 kHz.

Recommended Source Impedance—10 kΩ or less.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam in nonstored mode. Positive input to + input increases the display intensity.

To insure storage of each written dot the Z-axis on-time should be at least 4 μs with the standard CRT and at least 0.5 μs with option 2 CRT. The Z-axis pulse should be timed so that the system settling time is completed before unblanking occurs.

Bandwidth—DC to 5 MHz over usable range. Sensitivity is adjustable from 1 to 5 V.

Differential Input—CMRR at least 100:1 and common-mode range at least ±5 V.

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

Maximum Input Voltage—±100 V DC plus peak AC.

OTHER CHARACTERISTICS

Power Requirements—Line voltage selector allows operation from 100, 110, 120, 200, 220 and 240 V (±10% on each range), 50 to 60 Hz and 400 Hz. 75 watts maximum at nominal line voltage.

Dimensions and Weights—See page 20.

Included Accessories—Program connector, connector cover and instruction manual.

Optional Accessories—5¼-inch rack conversion kit, C-5 Camera.

ORDER INFORMATION

603 STORAGE MONITOR
Standard instrument is without graticule. (External 8 x 10 div graticule provided for test purposes.)

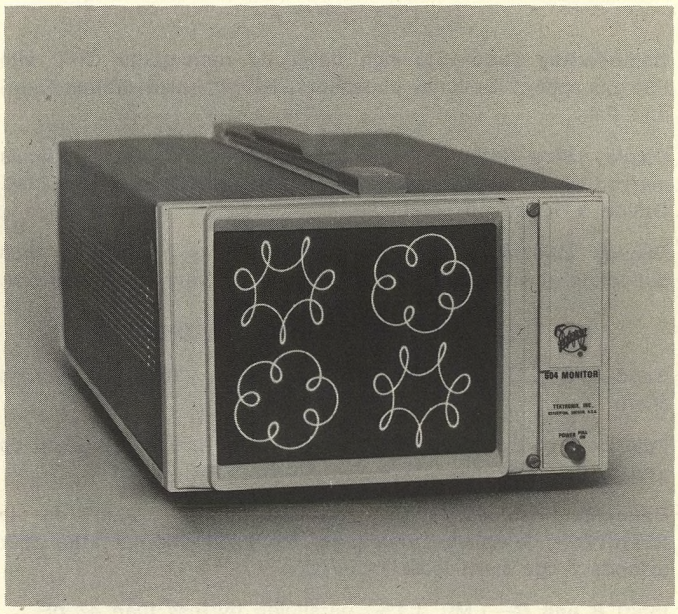
OPTION 1
Standard instrument with internal nonilluminated graticule. (8 x 10 div, 0.5 inch per division.)

OPTION 2
Standard instrument with fast-writing CRT.

OPTION 3
Standard instrument without handle and feet.

604

Display Monitor



- LOW-COST MONITOR
- 6½-INCH, EASY VIEWING CRT
- 2 MHz X AND Y BANDWIDTH
- DC-COUPLED 5 MHz Z AXIS
- X-Y PHASE DIFFERENCE WITHIN 1° TO 500 kHz
- DIFFERENTIAL INPUTS

The 604, with a 6½-inch CRT, ideally meets the display and space requirements of system designers in such applications as pulse height analysis, infrared detection, data communications systems testing, component and logic testing, vibration analysis and medical instrumentation. The 604 is also well suited for many other applications including: phase shifts and frequency ratios using Lissajous figures, raster displays with intensity modulation and apparent dynamic three-dimensional illustrations. 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.

*Registered Trademark Polaroid Corporation

604
Display Monitor

CRT DISPLAY

Cathode-Ray Tube—6½-inch flat-faced rectangular CRT with P31 phosphor. Optional phosphors; P7 (includes orange filter) and P4.

Display Size—Internal parallax-free, nonilluminated graticule marked in 8 vertical and 10 horizontal divisions (½ in/div). Option 1 is without graticule.

Display Linearity—The voltage required to produce 1 inch deflection at any point on the CRT will not vary more than 5%.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—DC to 2 MHz at 3-dB down (80% full screen scan).

Polarity—Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor—Vertical and horizontal: ≈50 mV/div to 250 mV/div, internally adjustable, 5:1 fixed internal attenuator extends range to at least 1.25 V/div.

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

X-Y Phase Difference—Not more than 1° to at least 500 kHz.

Beam Position—Front panel position controls permit setting zero to any point on screen. Position shift is 1 mm/h or less after 20-min warm-up.

Maximum Input Voltage—±100 V DC plus peak AC.

Linear Common-Mode Signal Range— ±3 V, ±15 V in 5X fixed attenuator position.

Common-Mode Rejection Ratio—At least 100:1 to at least 100 kHz, 50:1 to 100 kHz with 5X attenuator.

Recommended Source Impedance—10 kΩ or less.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth—DC to 5 MHz over usable range, sensitivity is adjustable from 1 to 5 V.

Differential Input—CMRR at least 100:1 and common-mode range at least ±5 V.

Input R and C—1 MΩ ±1% paralleled by less than 47 pF.

Maximum Input Voltage—±100 V DC plus peak AC.

OTHER CHARACTERISTICS

Power Requirements—Line voltage selector allows operation from 100, 110, 120, 200, 220 and 240 V (±10% on each range), 50 to 60 Hz and 400 Hz, 56 watts maximum at nominal line voltage.

Included Accessories—25 pin connector, connector cover and instruction manual.

Optional Accessories—5¼-inch rack conversion kit, C-5 Camera.

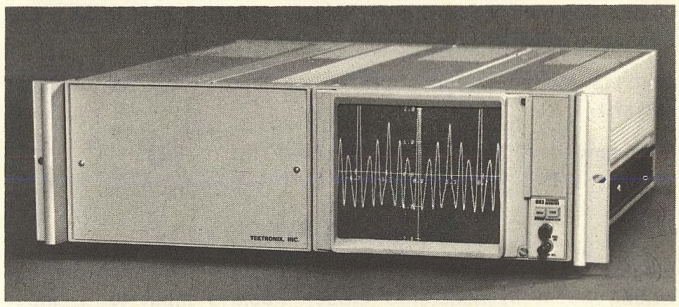
ORDER INFORMATION

604 MONITOR
Standard instrument with internal nonilluminated graticule.

OPTION 1
Standard instrument without graticule.

OPTION 2
Standard instrument without handle or feet.

RACKMOUNTING FOR 603 AND 604



Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a 603 Option 3 or 604 Option 2 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized. Order 040-0601-00

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two 603 Option 3s or two 604 Option 2s side-by-side in a standard rack width. Order 040-0600-00

Rackmount-to-cabinet conversion kit required to convert a rackmount 603 or 604 to a cabinet style. Order 040-0602-00

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

PORTABLE OSCILLOSCOPE REFERENCE

PRODUCT	STORAGE	BW	MINIMUM DEFLECTION FACTOR	DUAL TRACE	DELAYED SWEEP	SWEEP RATE (WITH MAG)	MAG	BATTERY POWER	DISPLAY SIZE
211		500 kHz	10 mV/div			1 μs/div	X5	Yes	6 x 10 div 0.2 in/div
321A		6 MHz	10 mV/div			0.1 μs/div	X5	Yes	6 x 10 div ¼ in/div
323		4 MHz	10 mV/div			0.5 μs/div	X10	Yes	6 x 10 div ¼ in/div
324		10 MHz	10 mV/div			0.2 μs/div	X5	Yes	6 x 10 div ¼ in/div
326 New		10 MHz	10 mV/div	Yes		0.1 μs/div	X10	Yes	8 x 10 div ¼ in/div
422/ R422		15 MHz	10 mV/div	Yes		50 ns/div	X10	Yes	8 x 10 div 0.8 cm/div
432/ R432 New		25 MHz	10 mV/div	Yes		20 ns/div	6 steps to X50		8 x 10 cm
434/ R434 New	Yes	25 MHz	10 mV/div	Yes		20 ns/div	6 steps to X50		8 x 10 div 0.98 cm/div
453A/ R453A New		60 MHz	20 mV/div	Yes	Yes	10 ns/div	X10		8 x 10 div 0.8 cm/div
454A R454A		150 MHz	10 mV/div	Yes	Yes	2 ns/div	X10		8 x 10 div 0.8 cm/div
485 New		350 MHz	5 mV/div	Yes	Yes	1 ns/div			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 MΩ), 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.

453A/R453A Customer preference made the 50-MHz 453 a widely used service and laboratory oscilloscope in virtually an unlimited range of applications throughout the world. The reasons are many and include 453 features such as delayed sweep, which is easy to use, simplified full-range triggering and other straightforward functions which remove the guesswork from oscilloscope operation. The 453 is durable, reliable and easy to maintain which keeps down time to a minimum and on-site operating time to a maximum. The new 453A dual-trace 60-MHz solid-state oscilloscope retains these features of the 453 and offers many new ones. For instance, the CRT of the 453A is expanded to 8 x 10 div (each division is 0.8 cm), providing 33% more viewing area. A carefully designed front panel provides space for this large, high-resolution CRT. Properly spaced, logically arranged controls let the user easily understand the 453A operating modes and quickly switch among these to obtain positive solutions to even his most complex measurement problems.

The majority of laboratory problems are solved by high-performance, dual-trace oscilloscopes. These are the laboratory measurements which the 453A will solve. The 453A price-performance value offers sound solutions to the majority of laboratory measurements.

324/326 The new 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-

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 new 211 miniscope is optimized for field maintenance and other applications where space and portability are primary considerations. Though small, 3 lb, 3 x 5¼ 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 new dual-trace oscilloscopes with bandwidth to 25 MHz, sweep rates to 20 ns/div, deflection factors to 1 mV/div and large CRTs 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 new 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°C to +55°C and be stored for long periods from −55°C to +75°C. For those instruments including batteries, the storage temperatures are −40°C to +60°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 c/s) 10 to 55 to 10 c/s in one-minute cycles, while operating. They will also withstand shock of 30 g's, (20 g's for the 321A) 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. All 400-Series portables have been subjected to tests as specified in MIL-1-6181D 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.

BATTERY OPERATION

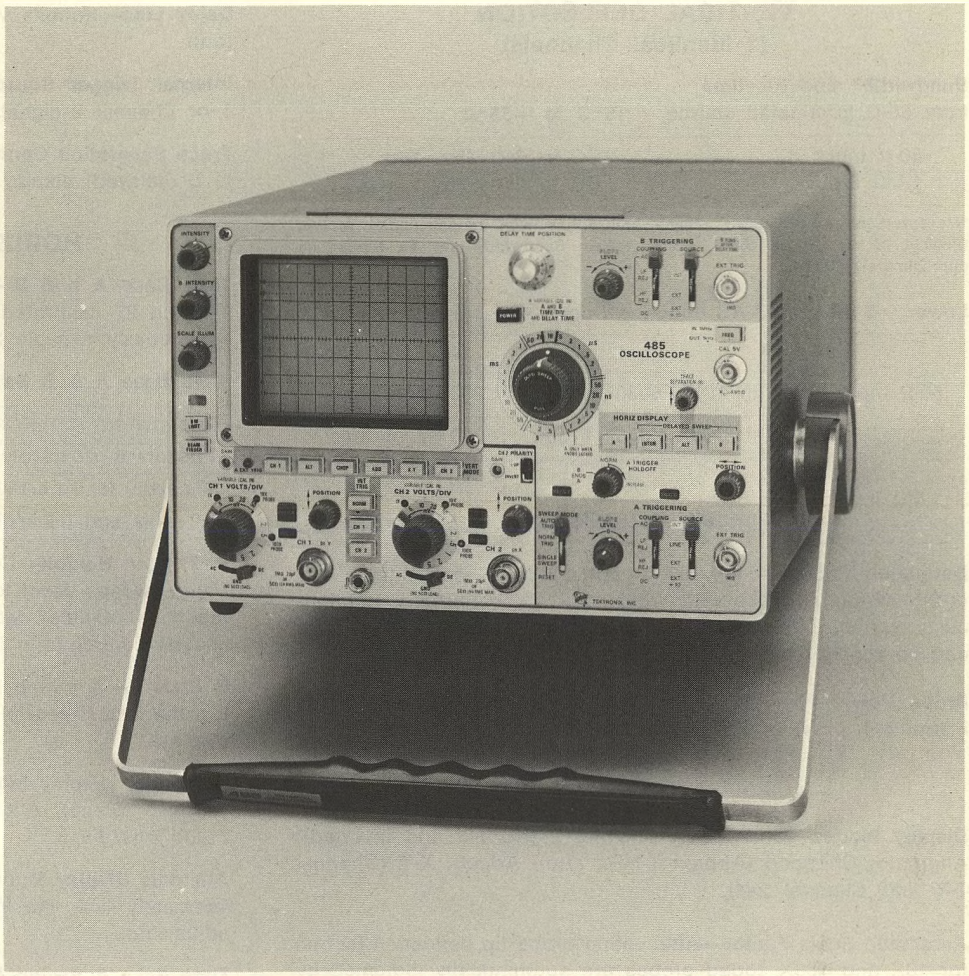
Six portables (Types 211, 321A, 323, 324, 326 and 422) are battery operated. With battery operation, the user moves from one remote location to another without concern for power connections. Battery powered instruments are especially suited for maintenance at sites such as remote microwave installations, 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.

485

350-MHz Dual-Trace Oscilloscope



- 350 MHz AT 5 mV/DIV
- 1 ns/DIV SWEEP RATE
- 7.2 DIV/ns WRITING SPEED
- ALTERNATE SWITCHING BETWEEN INTENSIFIED AND DELAYED SWEEPS
- 1 MΩ AND 50 Ω INPUT IMPEDANCES
- 50 Ω INTERNAL INPUT PROTECTION
- LIGHTED KNOB SKIRTS FOR VOLTS/DIV READOUT, AUTOMATICALLY CORRECTS FOR 10X AND 100X PROBES
- AUTO FOCUS
- ADJUSTABLE TRIGGER HOLDOFF
- PUSH BUTTON EXT TRIGGER DISPLAY
- 20½ LB

The 485 is a 350 MHz, 1 ns/div portable dual-trace oscilloscope weighing 20½ 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 MΩ), 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. Internal detection circuitry automatically protects the 50 Ω input by disconnecting the amplifier when the signal exceeds 5 V RMS or 0.5 watt and 0.1 watt-second.

Automatic vertical scale-factor readout is provided by three LEDs located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen volts/div any time 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 1 ns/div without magnifier. 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. Trace separation between the main and delayed sweeps and intensity control of the delayed sweep are also additional new features.

The external trigger signal may be easily viewed on the 485 without disconnecting leads and resetting controls. A front panel push button automatically routes an external signal used to trigger Time Base A to the vertical deflection amplifier. In this way, relative timing between the trigger signal and the signal of interest can be quickly and easily determined.

Full bandwidth triggering (without HF sync) and "Trigger Holdoff" provide stable triggering on bursts of repetitive waveforms.

An auto-focus circuit makes it unnecessary to readjust the focus each time the intensity is changed. This means that the focus will always be correct in single shot photography. A beam current limit circuit protects the CRT phosphor from high intensity burns.

485
350-MHz Dual-Trace Oscilloscope

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Risetime from 50-Ω terminated source, +15°C to +35°C

50 Ω input	DC to 350 MHz, 1 ns
1 MΩ input	DC to 250 MHz, 1.4 ns

*Measured at —3 dB down. Same bandwidths with recommended probes (P6053A 10 MΩ, P6056 500 Ω, P6057 5 kΩ). Bandwidth may be limited to approximately 20 MHz.

Lower —3 dB point. AC coupling from 50-Ω source.

50 Ω input	1X	1 kHz or less
	With 10X P6056 Probe	200 Hz or less
	With 100X P6057 Probe	20 Hz or less
1 MΩ input	1X	10 Hz or less
	With 10X P6053A Probe	1 Hz or less

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 10 V/div. Gain can be recalibrated at the front panel.

Probe Power—Two Lemo 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—Attenuating probe tip deflection factors for 10X and 100X coded probes are automatically indicated by three readout diodes at the edge of the knob skirts. All diodes are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

Maximum Input Voltage—

50 Ω input	150 V peak Power not to exceed 0.5 W (5 V RMS)** Single pulses above 5 V not to exceed 0.1 watt-sec**
1 MΩ input	500 V (DC + peak AC) 500 V P-P to 1 kHz

**50 Ω Internal Input protection—Signals to 100 V (DC + peak AC) 50 Ω source, that exceed 0.5 watt and 0.1 watt-second are automatically disconnected. Overload is indicated and has manual reset.

Selectable Input R and C—50-Ω input within 0.5%, VSWR typically less than 1.25:1 to 350 MHz at 5 and 10 mV/div, less than 1.15:1 from 20 mV/div to 5 V/div. 1 MΩ input paralleled by approx 20 pF.

Selectable Input Coupling—AC; DC; GND (provides zero reference, precharges coupling capacitor, disconnects 50-Ω load in 50-Ω mode).

Delay Line—Permits viewing leading edge of displayed waveform.

Internal Trigger Source—Normal (displayed signals), Channel 1 or Channel 2 signal.

Trace Separation Control—Provides additive vertical positioning to B (delayed) display in the alternate horizontal display mode.

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 & 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—Continuously variable control of time between sweeps down to 0.2 s/div enables stable presentation of repetitive complex waveforms (retriggerable period has continuous control from 0.5 μs to 2 sec).

B Ends A—A sweep is reset at the end of the B sweep to allow the fastest possible sweep repetition rate for delayed sweep displays.

Horizontal Display Modes—A, Intensified (A), Alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2 and 5 ns/div.

Alternate Display Mode—Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation is adjustable.

Time Base A Sweep Modes—Auto Trigger (sweep free runs in absence of triggering signal), Single Sweep, Normal Trigger. Lights indicate when sweep is triggered and when single sweep is ready.

Time Base B Sweep Modes—B triggerable after delay time. B starts after delay time.

CALIBRATED SWEEP DELAY

Delay Time Range—0 to 10 times Delay Time/Div setting of 10 ns/div to 0.5 s/div.

Differential Delay Time Measurement Accuracy.

Delay Time Setting	+15° to +35°C
10 ns/div and 20 ns/div	2% + 0.4 ns
50 ns/div to 0.1 s/div	0.9% + 0.1% full scale
0.2 s/div to 0.5 s/div	1.9% + 0.1% 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

Modes—Automatic or Normal on Time Base A. Automatic operation useful between 20 Hz and 350 MHz. 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. Normal triggering only on Time Base B.

Time Base A & B Trigger Sensitivity

Trigger Mode		To 50 MHz	To 350 MHz
DC	Internal	0.3 div deflection	1.5 div deflection
	External	20 mV	100 mV
AC		Signals below 16 Hz are attenuated	
AC LF Reject		Signals below 16 kHz are attenuated	
AC HF Reject		Signals below 16 Hz and above 50 kHz are attenuated	

A External Trigger Display—Provides a momentary push button selector as an additional vertical mode which overrides other controls and displays the external signal being used for A sweep triggering. This feature is useful for easily establishing a timing reference from this external trigger source. The deflection factor is approximately 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Sources—Internal, Line on A only, External, External ÷ 10. Input R and C approx 1 MΩ paralleled by approx 15 pF. 500 V (DC + peak AC) maximum input 500 V P-P AC (1 kHz or less). Level adjustment through at least ±0.5 V in External, through at least ±5 V in External ÷ 10.

Jitter—0.1 ns or less at 350 MHz and 1 ns/div.

X-Y OPERATION

Full Sensitivity X-Y (CH 1-Y, CH 2-X)— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 2%. Y-axis bandwidth identical to Channel 1. X-axis bandwidth is DC to at least 5 MHz (—3 dB). Phase difference between amplifiers is 3° or less.

PHOTOGRAPHIC WRITING SPEED (without Film Fogging Techniques)

Camera and Phosphor				Minimum Photographic Writing Speed
Camera Lens	Object-to-image ratio	Polaroid* film type	CRT Phosphor	
C-31-R f/1.2	1:0.5	410 (10,000 ASA)	P31	4 div/ns
			P11	7.2 div/ns

*Registered Trademark Polaroid Corporation

CRT

TEKTRONIX CRT— 4-inch rectangular tube; 8 x 10-div display area, each div in 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.

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—DC coupled to CRT grid. +2 volts blanks the trace. Risetime approx 15 ns. Sensitivity 2 V P-P for full intensity range. Useful input voltage versus repetition frequency 2 V P-P, DC to 2 MHz reducing to 0.4 V P-P at 10 MHz. Input R is approx 500 Ω.

Beam Current Limit—Automatically limits the average beam current to protect the CRT phosphor .

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: —15°C to +55°C. Filtered forced air ventilation is provided. Storage: —35°C to +75°C.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three 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

Amplitude and Time Calibrator—Output resistance is 450 Ω with a risetime into 50 Ω of 1 ns or less. 1-kHz duty cycle 49.8% to 50.2%.

Amplitude and Time Calibrator		Accuracy	
		+15° to +35°	—15°C to +55°C
Output Voltage	5 V Open Ckt	0.5%	1.0%
	0.5 V Into 50 Ω ±0.5%	1.0%	1.5%
50 mA amplitude to optional BNC accessory current loop		1.0%	1.5%
1 kHz & 1 MHz Repetition Rate		0.25%	0.5%

A Sweep Output—Open circuit, approximately 10 V positive-going sawtooth; into 50 Ω, approx 0.5 V.

A and B Gate Outputs—Open circuit, approximately 4 V positive-going rectangular pulse; into 50 Ω, approx 0.5 V.

Power Requirements—Recessed slide switch selects nominal operating line range. Line voltage range is 90 V to 136 V and 180 V to 272 V. 60 watts maximum power consumption at 115 V. Line frequency 48 to 440 Hz.

485

350-MHz Dual-Trace Oscilloscope

485 Dimensions and Weights

Height	6-9/16 in	16.7 cm
Width	12 in	30.5 cm
Depth		
handle extended	20-5/8 in	52.4 cm
handle not extended	18-1/2 in	46.9 cm
Net Weight		
with accessories	23 lb	10.4 kg
without accessories	20-1/2 lb	9.3 kg
Domestic Shipping Weight	≈35 lb	≈15.9 kg
Export Packed Weight	≈49 lb	≈22.2 kg

Included Standard Accessories—50 Ω 18-inch BNC cable (012-0076-00); two BNC jack posts (012-0092-00); 50 Ω terminator (011-0049-01); accessory pouch (016-0535-00); instruction manual; operator's handbook.

485 OSCILLOSCOPE

485-1 OSCILLOSCOPE, without A EXT TRIG Display

485-2 OSCILLOSCOPE, without A EXT TRIG Display and with 50-Ω input only instead of selectable input impedance

PROBES

Probes are not supplied with the 485 and should be ordered separately, according to the application.

Probes—

P6056 10X 500 Ω Probe Package, for use with 50 Ω systems, order 010-6056-03—6 ft.
010-6056-05—9 ft.

P6057 100X 5 kΩ Probe Package, for use with 50 Ω systems, order 010-6057-03—6 ft.
010-6057-05—9 ft.

P6053A 10X 10 MΩ Probe Package, for use with 1 MΩ systems, order 010-6053-00—3.5 ft.
010-6053-03—6 ft.
010-6053-05—9 ft.

Contact your Field Engineer for further information on these or active probes.

OPTIONAL ACCESSORIES

Optional Accessories increase measurement capability and provide added convenience.

Current Loop Adapter—The adapter provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is approximately 25 ns.
Order 012-0341-00

50 Ω 5X Pad—Provides reverse termination for the calibrator.
Order 011-0060-01

Folding Viewing Hoods—Improve viewing in high ambient-light conditions.
Folds to 7/16 x 4-1/4 x 7-1/2 inches
Order 016-0274-00

Folds to 9/16 x 6-3/4 x 13-3/4 inches
Order 016-0082-00

C30A Compact Camera—f/1.9 lens, magnification variable from 1:1.5 to 1:0.7, Polaroid Land* Pack-Film back for 3000-speed film. Order C-30A-P

C31-R High Speed Camera—f/1.2, 1:0.5 lens with Roll-Film back for 10,000 or 3000-speed film
Order C-31-R

C-32 High Speed Camera—f/1.4 lens, magnification variable from 1:1.5 to 1:0.7, Polaroid Land* Pack-Film back for 3000-speed film. Order C-32-P

Scope-Mobile® Cart—Occupies less than 18 inches aisle space, has storage area in base. Requires adapter (see below) for use with the 485 Oscilloscope.
Order 200-1

Adapter—Allows the 485 to be used with the 200-1 Scope-Mobile® Cart. Order 014-0042-00

OPTION 1

Electromagnetic Interference (EMI) Modification

The 485 may be ordered to meet the interference specification of MIL-1-6181D 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).

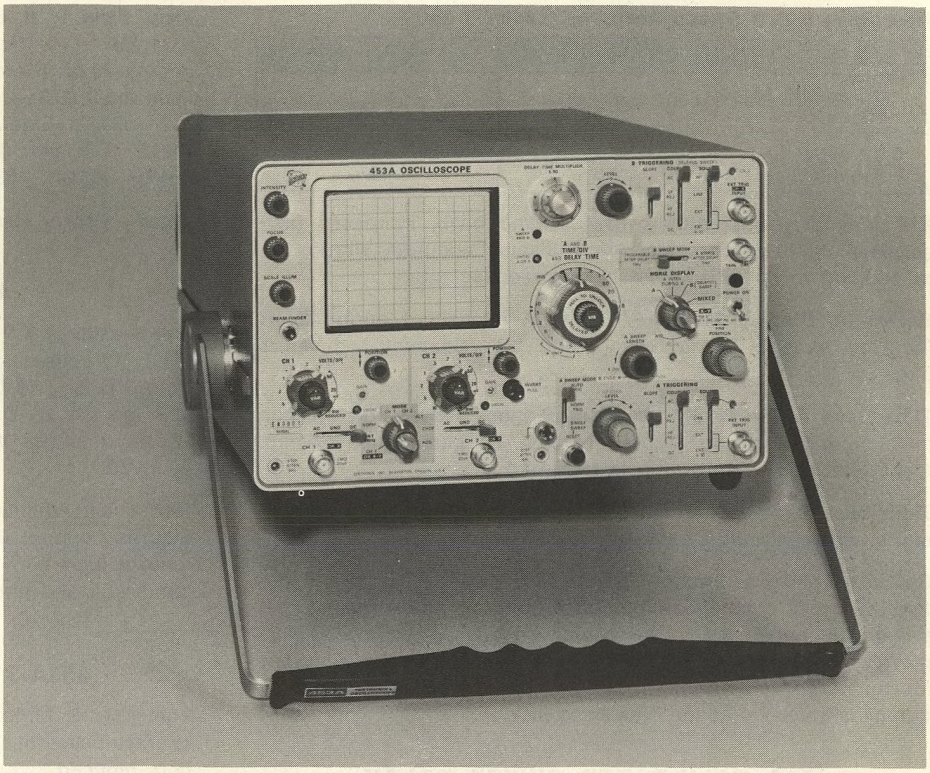
EMI MODIFICATION, Option 1

*Registered Trademark Polaroid Corporation

453A Series

60-MHz Dual-Trace Oscilloscope

- 5 mV/DIV TO 10 V/DIV
- 60 MHz AT 20 mV/DIV
- 25 MHz AT 1 mV/DIV (single trace)
- 8 x 10 DIV CRT
- BRIGHT, HIGH RESOLUTION DISPLAYS
- FULL BANDWIDTH TRIGGERING
- DESIGNED FOR SEVERE ENVIRONMENTS



Most laboratory measurements are solved by high gain dual trace oscilloscopes. With the larger CRT and increased light output, 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. Other field and laboratory measurements involve resolving pulses with nanosecond periods, a problem which the 453A Series' larger CRT lets the user solve easily and quickly.

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. Note comparison chart at the right.

VERTICAL DEFLECTION
(2 Identical Channels, Common to Entire 453A Series)

Bandwidth* and Risetime from 50-Ω terminated source, with† or without P6061 Probe‡
DC to at least 60 MHz, 5.9 ns at 20 mV/div to 10 V/div
DC to at least 50 MHz, 7.0 ns at 10 mV/div
DC to at least 40 MHz, 8.8 ns at 5 mV/div
DC to at least 25 MHz, 14 ns at 1 mV/div single trace, cascaded

Deflection Factor— 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 25 V/div. Warning lights indicate uncalibrated settings.

*Measured at —3 dB down. Lower —3 dB point, AC coupled, is 1.6 Hz or less (0.16 Hz or less with included 10X probe).
†Stated deflection factors are without 10X probe.
‡With included 3 1/2-foot or optional 6-foot probe.

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approx 500-kHz rate); Added.

Input R and C— 1 megohm within 2% paralleled by approx 20 pF.

Maximum Input Voltage— 600 V (DC + peak AC), AC component to 1 kHz.

Signal Output—Channel 1 vertical signal is DC to at least 25 MHz, 14 ns, terminated in 50 Ω. At least 25 mV/div into 1 megohm.

Delay Line—Permits viewing leading edge of displayed waveform.

Internal Trigger Source—Normal (displayed signal) or Channel 1 signal only.

HORIZONTAL DISPLAY MODES	453A	453A-1	453A-2	453A-3	453A-4
NORMAL SWEEP	●	●	●	●	●
UNCAL DLY'D SWP		●			
CAL DLY'D SWP	●		●	●	
MIXED SWEEP	●			●	
5 mV X-Y	●				

453A HORIZONTAL DEFLECTION

Time Base A— 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 12.5 s/div. Warning light indicates uncalibrated setting. Sweep length continuously variable from 4 div or less to at least 10 div.

Time Base B— 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

453A Series

60-MHz Dual-Trace Oscilloscope

Time Base A & B Sweep Accuracy (center 8 div)

SWEEP RATE	0°C to +40°C	−15°C to +55°C
0.1 μs/div to 50 ms/div	±3%	±4%
0.1 s/div to 5 s/div	±3%	±5%

X10 Magnifier—Operates over full time base, increases fastest rate to 10 ns/div. Magnified display accurate within 1% in addition to specified time base sweep accuracy.

Horizontal Display Modes—A only, A intensified during B, B (delayed sweep), Mixed Sweep, and X-Y (Channel 1 drives X axis).

Time Base A Sweep Modes—Auto Trigger (sweep free runs in absence of triggering signal); Normal Trigger; Single Sweep. Light indicates when sweep is triggered.

Time Base B Sweep Modes—B Triggerable after delay time; B starts after delay time.

Calibrated Mixed Sweep—Displays A sweep for period determined by delay-time multiplier control, then displays B sweep for remainder of horizontal sweep. Mixed sweep displays are accurate within 2% plus specified A sweep accuracy for the A portion of the display; B portion of the display accuracy is the same as for Time Base B.

453A CALIBRATED SWEEP DELAY

Delay Range— 0.2 μs to 50 s after delaying sweep start.

Delay Accuracy (center 8 div)

DELAY TIME SETTING	0°C to +40°C	−15°C to +55°C
1 μs to 50 ms 0.1 s to 5 s	Within 1.5% Within 2.5%	Within 2.0% Within 3.5%
MULTIPLIER LINEARITY	Within 0.2% of full scale (2 minor dial divisions)	Within 0.3% of full scale (3 minor dial divisions)
DIFFERENTIAL TIME MEASUREMENT		
1 μs to 50 ms	Within 1.5% and 4 minor dial divisions	
0.1 s to 5 s	Within 2.5% and 4 minor dial divisions	

Jitter— 1 part or less in 20,000 of 10X the time/div setting.

TRIGGER

Modes—Automatic or Normal on Time Base A. Automatic operation useful between 20 Hz and 60 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. Normal triggering only on Time Base B.

Time Base A & B Trigger Sensitivity

TRIGGER MODE	TO 10 MHz	AT 60 MHz
DC INTERNAL EXTERNAL	0.3 div deflection 50 mV	1.5 div deflection 200 mV
AC	Requirements increase below 30 Hz	
AC LF REJECT	Requirements increase below 30 kHz	
AC HF REJECT	Requirements increase below 30 Hz and above 50 kHz	

Time Base A & B Trigger Sources—Internal, Line, External, External ÷ 10. Input R and C approx 1 megohm paralleled by approx 20 pF (except in AC LF Reject mode). 600 volts maximum input (DC + peak AC). Level adjustment through at least ±2 volts in External, through at least ±20 volts in External ÷ 10. B Trigger Source is preselected for internal AC coupling on the 453A-1, 453A-2, 453A-3. The 453A-4 has no B sweep.

Jitter— 1 ns or less at 60 MHz and 10 ns/div.

453A X-Y OPERATION

Full-Sensitivity X-Y (CH 1 Horiz, CH 2 Vert)— 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 5% from 0°C to +40°C, within 8% from −15°C to +55°C; no variable on Ch 1. Bandwidth is DC to at least 5 MHz (−3 dB). Phase difference between amplifiers is 3° or less at 50 kHz at 20 mV/div.

Horizontal Amplifier (External Input)—Approx 270 mV/div in External, approx 2.7 V/div in External ÷ 10. 600 V maximum input voltage (DC + peak AC), AC component to 1 kHz. Same bandwidth and phase difference as previously described.

453A-3 HORIZONTAL DEFLECTION

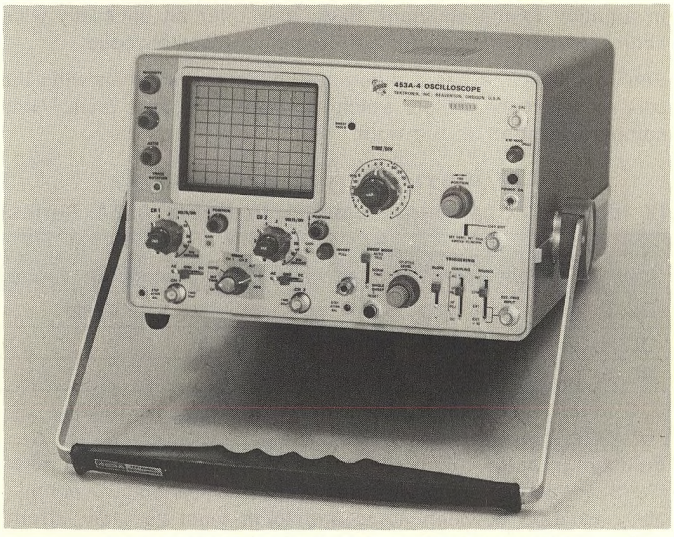
The 453A-3 horizontal deflection system includes all of the characteristics of the 453A horizontal system except X-Y operation, reduced sweep rates for Time Base A and B (to 0.5 s/div and 50 ms/div respectively), and calibrated delay range (to 5 s).

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.

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. 14-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, no parallax; variable edge lighting on 453A. Non-illuminated in 453A-1, 453A-2, 453A-3, 453A-4.

Beam Finder (453A Only)—Compresses trace 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.

ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating: −15°C to +55°C. Storage: −55°C to +75°C. Filtered forced air ventilation is provided.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three 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 shocks.

Electromagnetic Interference (453A Mod 163D and R453A Mod 163D only)—Meets interference requirements of MIL-1-6181D, 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-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER 453A CHARACTERISTICS

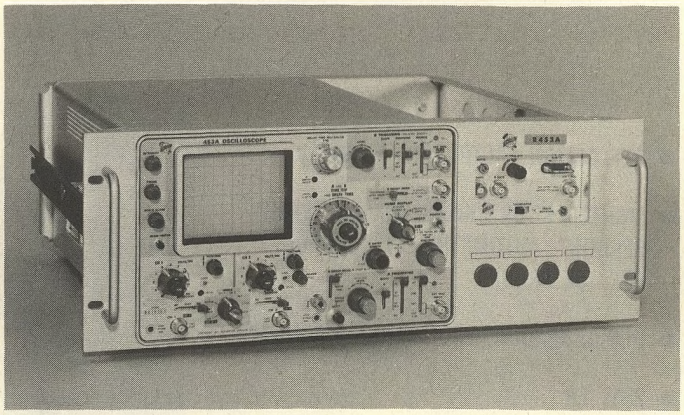
Amplitude and Time Calibrator— 1 V, 0.1 V and 5 mA at external jacks; accurate within 1% from 0°C to +40°C, and within 1.5% from −15°C to +55°C. 1-kHz repetition rate accurate within 0.5% from 0°C to +40°C, and within 1% from −15°C to +55°C.

Signal Outputs—Positive gates from both time bases (approx 12 V).

Power Requirements—Quick-change line voltage selector provides six ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. 48 to 62 Hz, 92 watts maximum at 115 V and 60 Hz.

453A Dimensions and Weights

Height	7-1/8 in	18.2 cm
Width (with handle)	12-1/2 in	30.8 cm
Depth (incl. panel cover)	20-1/2 in	52.0 cm
Depth (handle extended)	22-3/8 in	56.8 cm
Net weight (w/o panel cover)	29-1/4 lb	12.7 kg
Net weight (with panel cover and accessories)	31-1/4 lb	13.6 kg
Domestic shipping weight	≈43 lb	≈18.7 kg
Export-packed weight	≈57 lb	≈24.8 kg



R453A Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth (behind front panel)	18 in	45.7 cm
Net weight	33-1/2 lb	14.5 kg
Domestic shipping weight	≈65 lb	≈28.2 kg
Export-packed weight	≈86 lb	≈37.4 kg

Standard Accessories—Two P6061 Probes with accessories (010-6061-01); 50-Ω 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; instruction manual; operator's manual; five fuses, assorted spares. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

OTHER 453A-1, 453A-2, 453A-3, 453A-4 CHARACTERISTICS

Amplitude Calibrator—1 V at external jacks; accurate within 1% from 0°C to +40°C, and within 1.5% from −15°C to +55°C. ≈1-kHz repetition rate.

Power Requirements—Quick change line voltage selector provides operation at 100 to 130 V or 200 to 260 V. 48 to 62 Hz, 92 watts maximum at 115 V and 60 Hz.

Dimensions and Weights—Same as cabinet model 453A.

Standard Accessories—Includes two P6061 Probes with accessories (010-6061-01); instruction manual and operator's manual.

ORDERING INFORMATION

453A OSCILLOSCOPE*

R453A OSCILLOSCOPE* (Rack Model)

453A-1 OSCILLOSCOPE, with normal and uncalibrated delayed sweep

453A-2 OSCILLOSCOPE, with normal and calibrated delayed sweep

453A-3 OSCILLOSCOPE, with normal, calibrated delayed sweep and calibrated mixed sweep

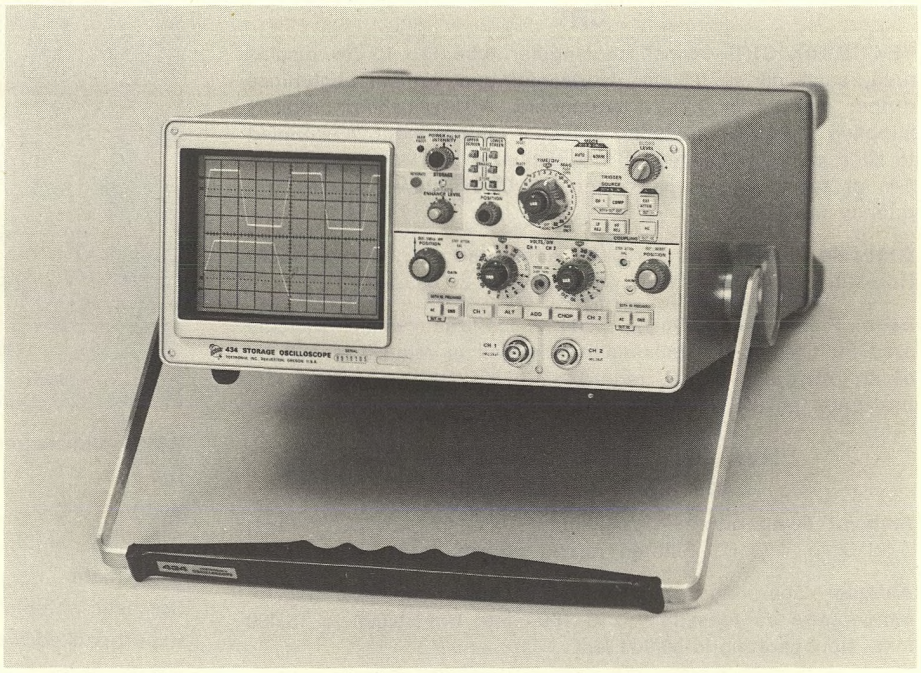
453A-4 OSCILLOSCOPE, with normal sweep

*with normal, calibrated delayed sweep, calibrated mixed sweep and 5 mV X-Y.

432 25-MHz Dual-Trace Oscilloscope

434 25-MHz Dual-Trace 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
- 20¾ LB
- 5¼-INCH RACKMOUNT



The 432 and 434 have identical performance characteristics, except the 434 has a bistable storage CRT. These new dual-trace oscilloscopes with bandwidth to 25 MHz, sweep rates to 20 ns/div, deflection factors to 1 mV/div and large CRTs cover a wide range of laboratory and field applications. Both instruments are small and light. Cabinet height is 5¾ inches including the feet, (rackmount height is 5¼ inches) and weight is 20¾ pounds. Applications include field maintenance areas where conventional AND storage capability are needed. 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: full-screen storage, or upper (or lower) screen storage with the other half in a conventional mode. Events stored on the upper (or lower) area are stable reference points for events displayed in a conventional mode on the other half of the CRT.

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

Comparison of changing phenomena is easily made using the TEKTRONIX unique split-screen storage CRT. In measurement of pulse response as a function of temperature, for example, a reference display can be stored on the upper screen area, then compared with subsequent displays stored on the lower screen area. The effect of the temperature change is easily seen. After studying the pulse changes, the user can erase either half of the screen and store a third display under still different conditions. This procedure can be repeated as often as needed. The operator presses one button to erase the upper half of the CRT and a second button to erase the lower half. Pressing both buttons simultaneously erases the full screen.

The writing speed of the bistable storage CRT is variable from 100 div/ms to 400 div/ms on the 434. Option 1 increases the normal writing speed to 500 div/ms and to 5000 div/ms in enhanced operation. This allows the user to choose the writing rate best suited for his requirements.

The design of the TEKTRONIX storage CRT makes it highly resistant to burns. It requires only the same operating care as a conventional CRT.

Vertical scale-factor readout is provided by lighted knob skirts which automatically indicate the correct reading, even when using the recommended 10X probes. This feature saves time and reduces errors by freeing the user from having to calculate the scale factor each time a measurement is made with the 10X probes.

434 STORAGE

TEKTRONIX Storage CRT— 5-inch rectangular tube, 8 x 10 div (1 div = 0.98 cm) display area. Phosphor is similar to P1. 4-kV accelerating potential.

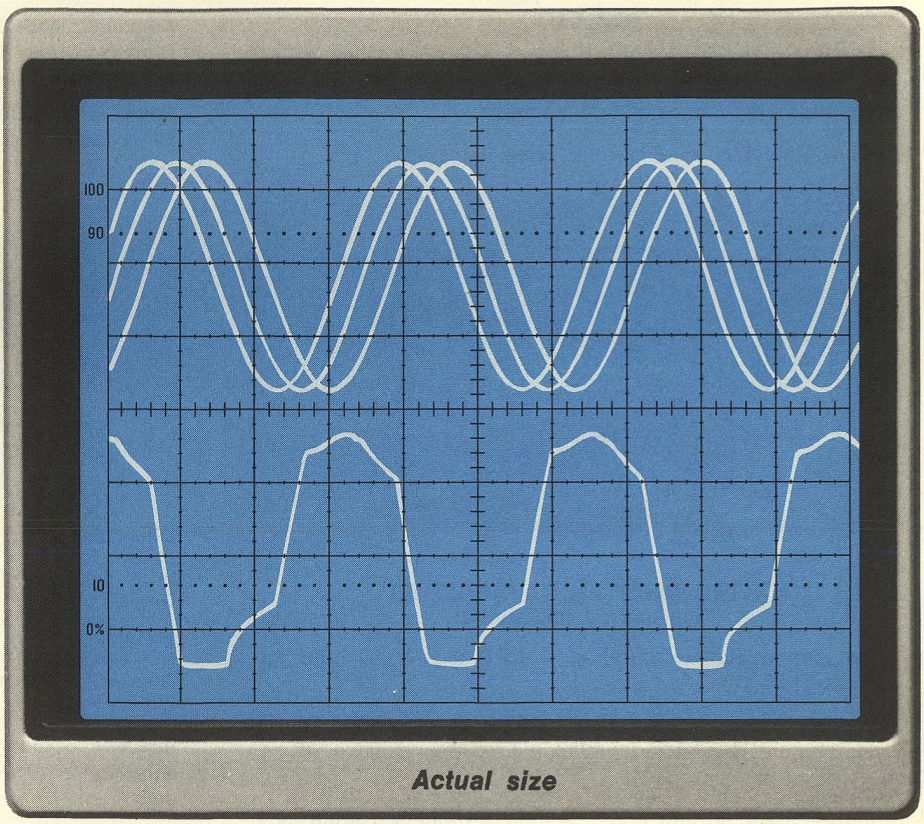
Graticule—Internal, parallax-free, nonilluminated.

Split-Screen Storage— 3 Display Modes: Storage on either upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display on entire screen. Independent operation of both halves.

Writing Speed (Center 8 div)—Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 1, 500 div/ms, normal; to 5000 div/ms, enhanced).

Storage Viewing Time—Up to four hours.

Erase Time—300 ms or less.



Actual size

CHARACTERISTICS

The following characteristics apply to both the 432 Oscilloscope and 434 Storage Oscilloscope, except where noted:

VERTICAL DEFLECTION
(2 Identical Channels)

Deflection Factor— 1 mV/div to 10 V/div in 13 calibrated steps (1-2-5 sequence), accurate within 3%. Lighted knob skirts indicate correct deflection factor for either 1X or 10X probes. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Bandwidth and Risetime—(from 50-Ω terminated source, with or without 10X probe) DC to at least 25 MHz at 3-dB down*, 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 ±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.

HORIZONTAL DEFLECTION

Time Base— 0.2 μs/div to 5 s/div in 23 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to 12.5 s/div. Accurate within 3% unmagnified and 4% magnified from +20°C to +30°C, within 4% unmagnified and 5% magnified from −15°C to +55°C.

Direct Reading Magnifier—Six-position, push-to-turn, 50X maximum. Extends fastest sweep rate to 20 ns/div.

Time Base Sweep Modes—Auto Trigger, (sweep free runs in absence of triggering signal and provides bright baseline at all sweep rates), Normal Trigger, Single Sweep.

External Horizontal Input—Deflection factor is approx 0.5 V/div. Input resistance is approx 50 kΩ.

TRIGGER

COUPLING		TO 5 MHz	AT 25 MHz
DC	INTERNAL	0.3 div deflection	1 div deflection
	EXTERNAL	50 mV	175 mV
AC		Same as DC at 20 Hz and above, requirements increase below 20 Hz	
AC LF REJECT		Same as AC at 50 kHz and above, requirements increase below 50 kHz	
AC HF REJECT		Same as AC at 50 kHz and below, requirements increase above 50 kHz	

Sources—Channel 1 only, composite, line, external and external ÷ 10. Input R approximately 1 megohm. Maximum external input, 250 Volts (DC + peak AC). External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

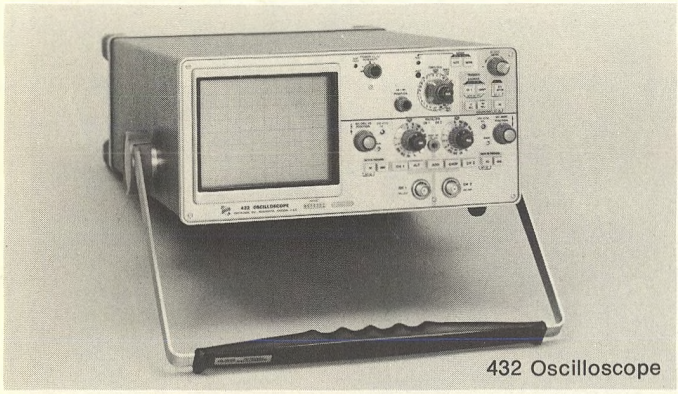
*Bandwidth derating to 22 MHz at temperatures above +30°C.

432 25-MHz Dual-Trace Oscilloscope
434 25-MHz Dual-Trace Storage Oscilloscope

432 CRT

TEKTRONIX CRT— 5-inch rectangular tube, 8 x 10 cm display area. P31 phosphor normally supplied. P7 is optional without extra charge. 4-kV accelerating potential.

Graticule—Internal, parallax-free, nonilluminated.



432 Oscilloscope

ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating, −15°C to +55°C. Storage, −55°C to +75°C.

Altitude—Operating, 15,000 feet. Maximum allowable operating temperature decreases 1°C/1000 feet from 5,000 to 15,000 feet.

Vibration—Operating and non-operating, 15 minutes along each of the three major axes at a total displacement of 0.025 inch P-P (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute 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-1-6181D. Conducted, 150 kHz to 25 MHz. Radiated, 150 kHz to 1 GHz.

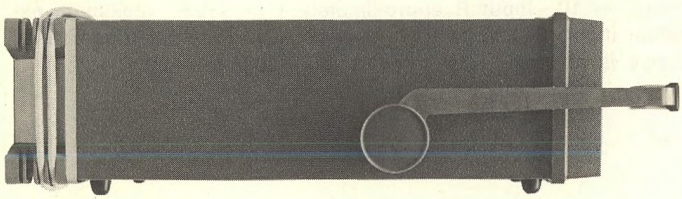
Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

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.

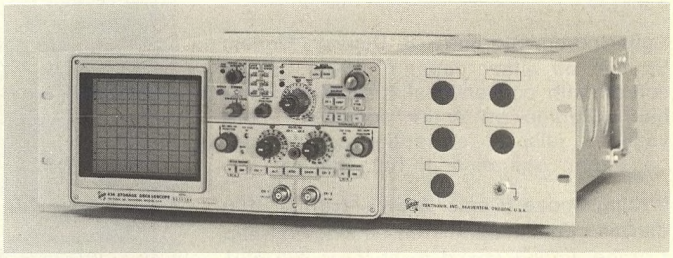
Beam Finder—Compresses display to within graticule area independent of position controls or input signal amplitude, for ease in determining the location of an off-screen signal.

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 0.5%. Repetition rate is adjustable to 1 kHz within 0.25% (+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	**in**	**cm**	**in**	**cm**
Height	5.6	14.5	5.25	13.5
Width with handle	13	33	19	48.3
Depth	18.7	47.5	18	46
Weight (approx)	**lb**	**kg**	**lb**	**kg**
Net weight	20.8	9.4	23.1	10.5
Domestic shipping	30	13.7	42.6	19.4
Export-packed	35	15.9	62.6	28.5

Included Standard Accessories—Two P6061 3.5-ft probes with accessories (010-6061-01); instruction manual, operator's manual.

Order 432 OSCILLOSCOPE
Order 434 STORAGE OSCILLOSCOPE
Order 434 STORAGE OSCILLOSCOPE (Option 1)
Order R432 OSCILLOSCOPE (Rackmount model)
Order R434 STORAGE OSCILLOSCOPE (Rackmount model)
Order R434 STORAGE OSCILLOSCOPE (Rackmount model, option 1)

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**

Accessory Pouch—Attaches to top of oscilloscope, constructed of durable blue vinyl, sufficient space for probes, manuals, viewing hood, mesh filter. **Order 016-0165-00**

Folding Polarized Viewing Hood—Order 016-0180-00

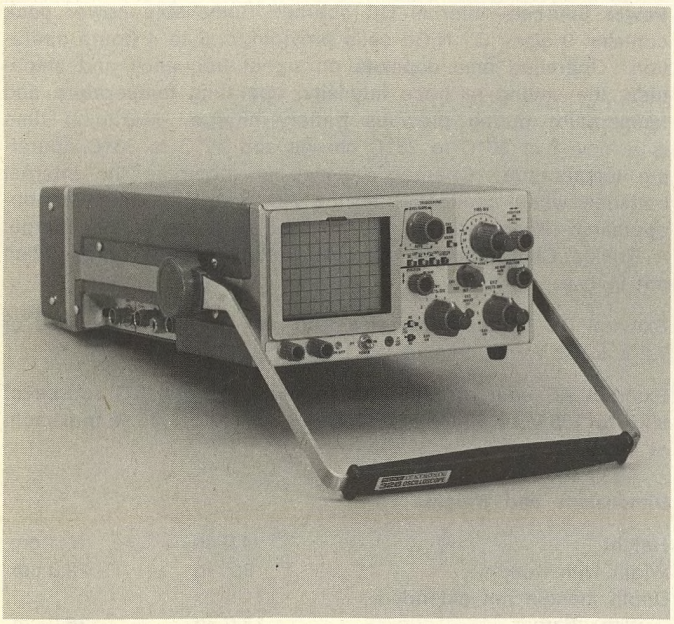
Clear Plastic CRT Filter—Order 378-0677-00

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base. Requires adapter (see below) for use with the 432 or 434 Oscilloscopes. **Order 200-1**

Camera Adapter—Mounts C-30 Series Camera to the 432 & 434 Oscilloscope. **Order 016-0269-00**

Adapter—Allows the 432 or 434 to be used with the 200-1 SCOPE-MOBILE Cart. **Order 014-0042-00**

10-MHz Dual-Trace Oscilloscope



- **1 mV/DIV TO 10 V/DIV CALIBRATED DEFLECTION FACTORS**
- **AC, DC OR BATTERY POWERED**
- **COMPACT SIZE — WEIGHT <12 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 13.9 inches, width is 8.7 inches, height is 4.0 inches, and weight is less than 12 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.

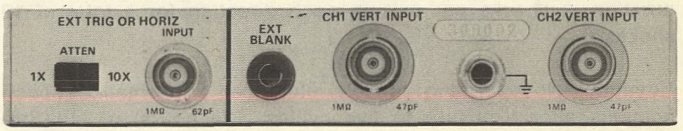
Internal Trigger Source—Normal (displayed signal) or Channel 1 signal only.

HORIZONTAL DEFLECTION

Time Base— 1 μs/div to 1 s/div in 19 calibrated steps (1-2-5 sequence); accurate within 3% over the center 8 divisions from 1 μs/div to 0.2 s/div; accurate within 4% at 0.5 s/div and 1 s/div. Uncalibrated, continuously variable between steps and to approx 2.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest sweep rate to 0.1 μs/div. Accuracy of magnified display is within 4% over the center 8 divisions from 0.5 μs/div to 20 ms/div, within 5% at 0.1 μs/div, 0.2 μs/div, 50 ms/div and 0.1 s/div.

External Input—Continuously variable from approx 25 mV/div to approx 1.5 V/div. AC or DC coupled. DC to at least 200 kHz at 3-dB down.



Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

Amplitude Requirements— 0.3-div deflection or 150 mV external to 1 MHz, increasing to 1.0-div deflection or 500 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 50 kHz with AC LF REJ coupling.

CRT

CRT— 8 x 10-div display area; each div is ¼ inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your field engineer, representative or distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 50 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, nonilluminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼-inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Nonoperating: 55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 15,000 feet maximum; maximum ambient temperature must be decreased by 1°C/1000 feet from 5,000 feet to 15,000 feet. Nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Nonoperating: Meets electrical performance specifications after exposure to five cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— 0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probes—The P6049A is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: Removable power pack contains 9 size "C" NiCd cells providing 1.5 to 4 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Charger provides for charging the internal batteries when connected to the AC line, operating or nonoperating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: Operates from an external DC source of 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 100 VAC.

Dimensions and Weights

Height	4.0 in	10.1 cm
Width with handle	8.7 in	22.0 cm
Depth, handle not extended		
With charger	15.0 in	38.0 cm
Without charger	12.2 in	31.0 cm
Depth, handle extended		
With charger	18.2 in	46.0 cm
Without charger	15.8 in	40.0 cm
Net weight without accessories		
With charger	≈13 lb	≈5.8 kg
Without charger	≈10 lb	≈4.5 kg
Domestic shipping weight	≈21 lb	≈9.5 kg
Export-packed weight	≈29 lb	≈13.1 kg

Included Standard Accessories—Two P6049A 10X probes (010-6049-01); carrying case (016-0532-00); strap assembly (346-0098-00); viewing hood (016-0297-00); blue light filter (426-0871-00); external DC cable assembly (012-0406-00); 326 operator's handbook, 326 instruction manual.

Order 326 OSCILLOSCOPE, including power pack

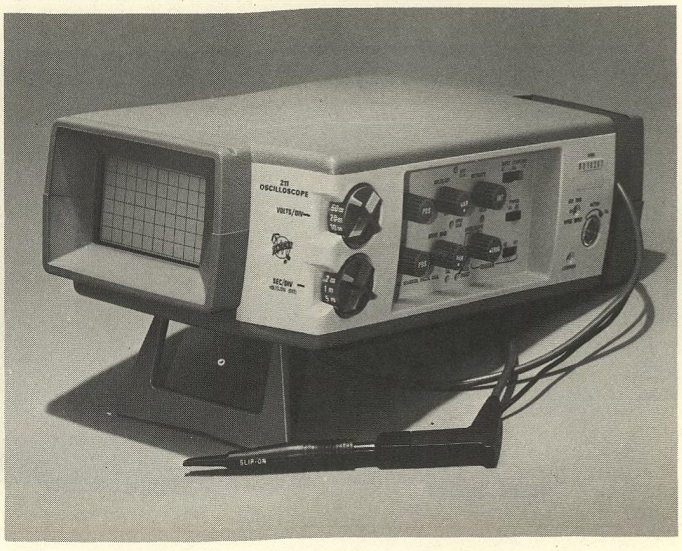
The SONY®/TEKTRONIX® 326 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 326 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Battery Set—Set of 9 NiCd cells, order 146-0018-00
Battery Pack—Includes 146-0018-00 in battery housing, order 016-0296-00

500-kHz Oscilloscope

- 3 LB, 3 x 5¼ 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 MΩ 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

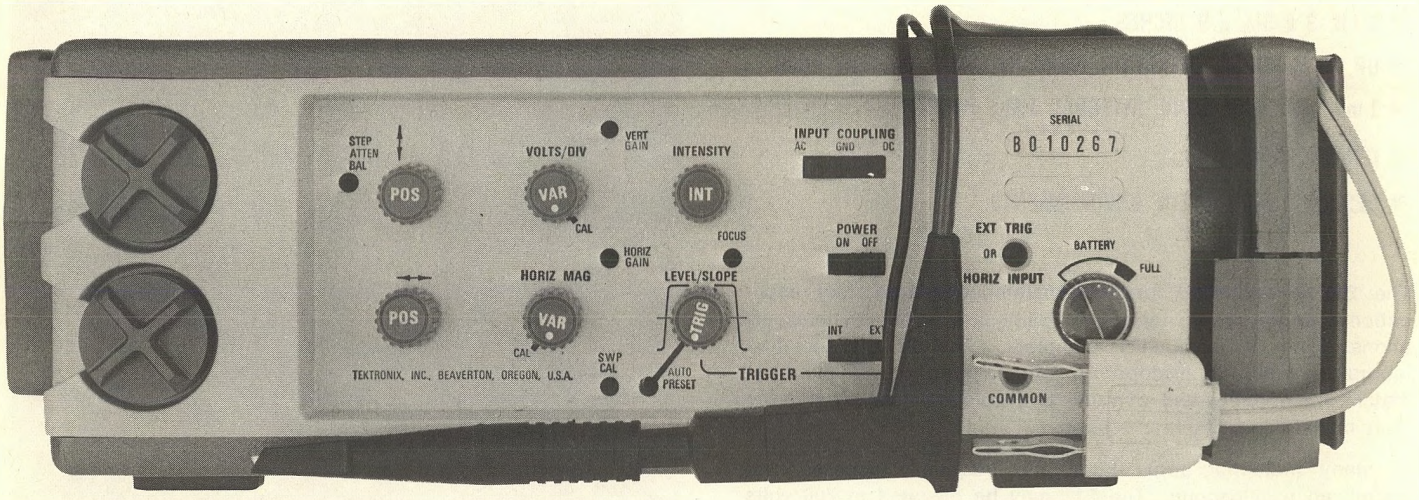
Time Base— 5 μs/div to 200 ms/div in 15 calibrated steps (1-2-5 sequence); accurate within 5% over center 8 divisions.

Variable Magnifier—Increases each sweep rate by at least 5 times. Continuously variable magnification extends the maximum sweep rate to at least 1 μs/div.

External Horizontal Input— 1 and 10 V/div within 10%; DC to 75 kHz. Approx 0.5 MΩ paralleled by approx 30 pF. Maximum input voltage, 200 V (DC + peak AC), 200 V P-P AC, referenced to probe common.

211

500-kHz Oscilloscope



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°C to +30°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	5.25 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	3.4 kg
Export-packed weight	12.0 lb	5.4 kg

Standard Accessories—Viewing hood (016-0199-00); instruction manual, operator's manual, carrying case (016-0512-00).

Order 211 OSCILLOSCOPE, includes batteries

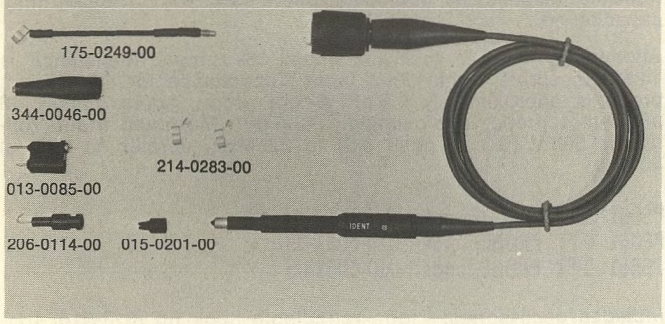
POWER OPTIONS

Option 1 for 220 to 250 V, 50 Hz, includes batteries

Option 2 for 90 to 110 V, 50 Hz includes batteries

Option 3 for 110 to 126 V, 400 Hz, includes batteries

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, such as the 3S1 plug-in, or the S1 and S2 sampling heads, with a BNC male to GR adapter (017-0063-00).

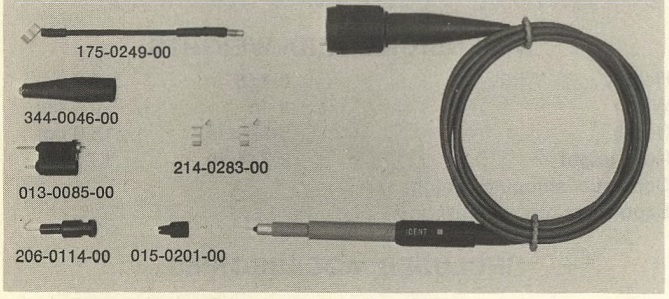
The P6056 is equipped with a special BNC connector that provides trace identification and CRT readout information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function. The probe is factory compensated, and will not require adjustment, unless the setting of the compensating mechanism is disturbed.

Attenuation is 10X within 3% including ±2% input resistance of oscilloscope. **Input Resistance** is 500 Ω within 2% at DC and approx 300 Ω at 1 GHz. **Input Capacitance** is 1.0 pF within 0.1 pF. **Risetime** is less than 100 ps. **Typical Risetime** with 7904 Oscilloscope and 7A19 Amplifier is 0.7 ns. **Bandwidth** is 3.5 GHz when direct coupled. **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
P6056 9-FT PROBE, order 010-6056-05

Included accessories: Probe hook tip (206-0114-00); 25-inch ground lead (175-0249-00); probe tip grounding adapter (013-0085-00); two each ground contact springs (214-0283-00); miniature alligator clip (344-0046-00); insulated tip guard (015-0201-00); instruction manual (070-1224-00).

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, such as the 3S1 plug-in, or the S1 and S2 sampling heads, with a BNC male to GR adapter (017-0063-00).

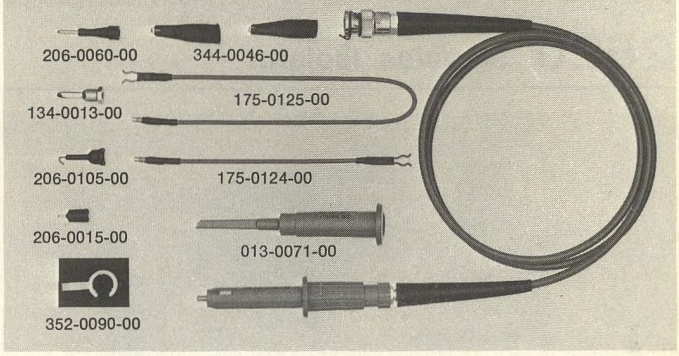
The P6057 is equipped with a special BNC connector that provides trace identification and CRT readout information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function. The probe is factory compensated, and will not require adjustment, unless the setting of the compensating mechanism is disturbed.

Attenuation is 100X within 3% including ±2% input resistance of oscilloscope. **Input Resistance** is 5000 Ω within 2% at DC and approx 1500 Ω at 1 GHz. **Input Capacitance** is 1.0 pF within 0.1 pF. **Risetime** is less than 200 ps. **Typical Risetime** with 7904 Oscilloscope and 7A19 Amplifier is 0.7 ns. **Bandwidth** is 1.7 GHz when direct coupled. **Maximum Input Voltage** RF (CW) 70 volts DC 50 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.

P6057 6-FT PROBE, order 010-6057-03
P6057 9-FT PROBE, order 010-6057-05

Included accessories: same as P6056.

P6060 DC to 40 MHz 10X



The P6060 is a precision passive probe with 10X attenuation, for use with TEKTRONIX low- and mid-frequency oscilloscopes used in differential applications. The precise attenuation also provides greater accuracy for single-ended input applications, such as amplitude measurements with a differential comparator. The probe can be compensated for use with any amplifier input having a nominal input capacitance of 15 to 55 pF and input resistance of 1 MΩ.

The BNC-type connector utilizes a special grounding clip to shift the deflection factor indicator to 10X normal reading in 5000-Series Oscilloscopes. The connector is also compatible with all previously used TEKTRONIX BNC connectors.

Attenuation is 10X. Accuracy when used with a 1 MΩ ±0.15% input will be within ±0.4%. When used with a 1 MΩ ±2% input the accuracy will be within ±2%. **Input Resistance** is 10 MΩ within ±0.25% with a 1 MΩ ±0.15% input; 10 MΩ within ±0.4% when used with a 1 MΩ ±2% input. **Input Capacitance** for 15 pF instruments is approximately 6.0 pF with 3.5-ft probe and ≈7.7 pF with 6 ft. On 55 pF we have ≈9.5 pF with the 3.5 ft, ≈11.5 pF for the 6 ft. **CMRR (Probe Pair)**—At least 400:1 (with 5A20N or 5A21N) DC to 30 kHz. **Bandwidth**— 3.5-foot probe at least 40 MHz (with 453A; 20 mV/div to 10 V/div). 6-foot probe at least 30 MHz (with 453A; 20 mV/div to 10 V/div. **Maximum Input Voltage**— 600 V (DC + Peak AC). **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).

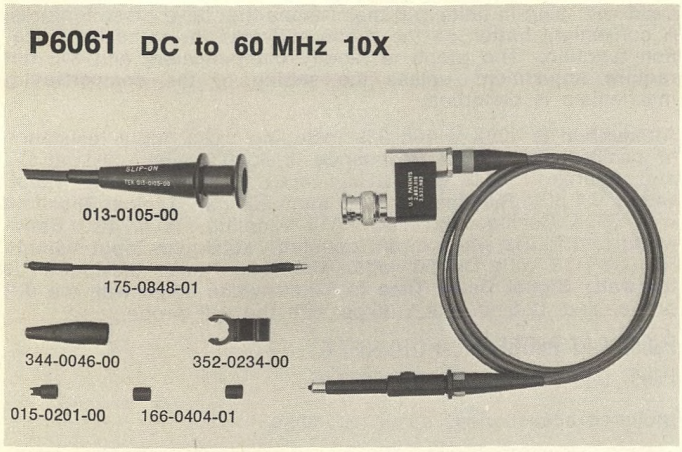
P6060 3.5-FT PROBE, order 010-6060-01
P6060 6-FT PROBE, order 010-6060-03

Included accessories: 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); probe holder (352-0090-00); probe straight tip (206-0015-00); probe hook tip (206-0105-00); probe retractable hook tip (013-0071-00); probe spring tip (206-0060-00); banana plug (134-0013-00); miniature alligator clip (344-0046-00); instruction manual (070-1171-00).

P6061 Voltage Probe

2620 Stimulus Isolator

P6061 DC to 60 MHz 10X



The P6061 is a miniature 10X attenuation probe designed specifically for use with the 453A Oscilloscope and the 7A18 Dual-Trace Amplifier when used in the 7403N Oscilloscope.

The probe is terminated with a BNC connector, and does not incorporate CRT readout/trace-identify functions.

The P6061 can be compensated for use with instruments having a nominal input capacitance of 15 to 24 pF, although transient response is optimized when used with a 20 pF input capacitance.

Attenuation is 10X, accurate within 3%. **Input Resistance** is 10 MΩ, accurate within 2%. **Input Capacitance** for the 3.5-foot probe is approximately 9.5 pF; 6-foot probe, approximately 12 pF; 9-foot 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
P6061 6-FT PROBE, order 010-6061-03
P6061 9-FT PROBE, order 010-6061-05

Included accessories: Probe retractable hook tip (013-0107-01); miniature alligator clip (344-0046-00); 5-inch ground lead (175-0848-01); two insulated sleeves (166-0404-01); probe holder (352-0234-00); insulated tip guard (015-0201-00); instruction manual (070-1182-00).

2620 Stimulus Isolator

- **PHYSIOLOGICAL STIMULUS ISOLATION**
  True differential stimulation
- **CONSTANT CURRENT OUTPUT**
- **BIPHASIC or MONOPHASIC OUTPUT**
- **UP to 30 mA with 100 V COMPLIANCE**

$1925

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, 1×10^{10} Ω or greater, shunted by 10 pF or less. Voltage, 500 V maximum.

Ranges—0 to ±300 μA, 0 to ±3 mA, or to ±30 mA. +current and − current are independently variable and continuously calibrated.

Output impedance is greater than 10 MΩ shunted by approximately 25 pF.

Accuracy—30 mA range, within 3% if indicated current ±600 μA. 3 mA range, within 3% of indicated current ±60 μA. 300 μA range, within 4% of indicated current ±6 μA.

Voltage Compliance—At least 100 V.

Indicator—Lamp indicates the presence of an output signal.

Risetime, Falltime—Less than 2 μs when load resistance is 3.3 kΩ or less.

DIMENSIONS AND WEIGHTS

Height	3-1/8 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
Domestic shipping weight		
Export-packed weight		

INCLUDED ACCESSORIES

Dual banana plug (103-0142-00); two nickel-cadmium cells (146-0005-00); instruction manual (070-1118-00).

Order 2620 STIMULUS ISOLATOR

Extra Batteries, 146-0005-00

- 100-to-100,000 GAIN
- 50,000:1 CMRR
- SELECTABLE UPPER AND LOWER —3 dB POINTS
- DC-to-1-MHz BANDWIDTH AT ALL GAIN SETTINGS

The 26A2 is a DC-coupled differential amplifier designed for use in the 2600-Series modular instrument system. Excellent common-mode rejection, high gain, and selectable high- and low-frequency —3 dB points, make the 26A2 suitable for low-frequency, low-level applications.

There are many factors which affect the usability of high-gain, wideband differential amplifiers. Noise (if excessive) can make the high-gain positions unusable. Since noise is related to bandwidth, noise can be greatly reduced with a HF —3 dB POINT selector when the application allows. DC drift can also hinder measurements causing the trace to move offscreen rapidly. A small signal DC component, perhaps a few millivolts, would also place a DC-coupled display offscreen at 10 μV/div. There are three ways to reject this DC voltage: (1) AC coupling the input if the signal frequency is high enough to be unaffected (2 Hz, LOWER —3 dB POINT). (2) AC coupling with the LF —3 dB POINT selector which allows lower bandwidth selection down to 0.1 Hz. (3) DC OFFSET which supplies an internal DC voltage to offset, or reject, the DC signal component.

A guard signal derived from the common-mode signal within the amplifier is available on the front panel for driving cable shields. ±15 volts DC is also available to permit use of special active probes, transducer adapters, etc.

A front-panel lamp and a coincident logic signal output indicates most over-range conditions of excessive input signal (either differential or common-mode), excessive gain, or excessive offset.

All front-panel output connections are duplicated at a rear connector for interconnecting with other modules via the 2601 Mainframe.

AMPLIFIER

Gain— 100 to 100,000 in 10 steps in a 1-2-5 sequence, accuracy within 2%. Uncalibrated variable gain between steps.

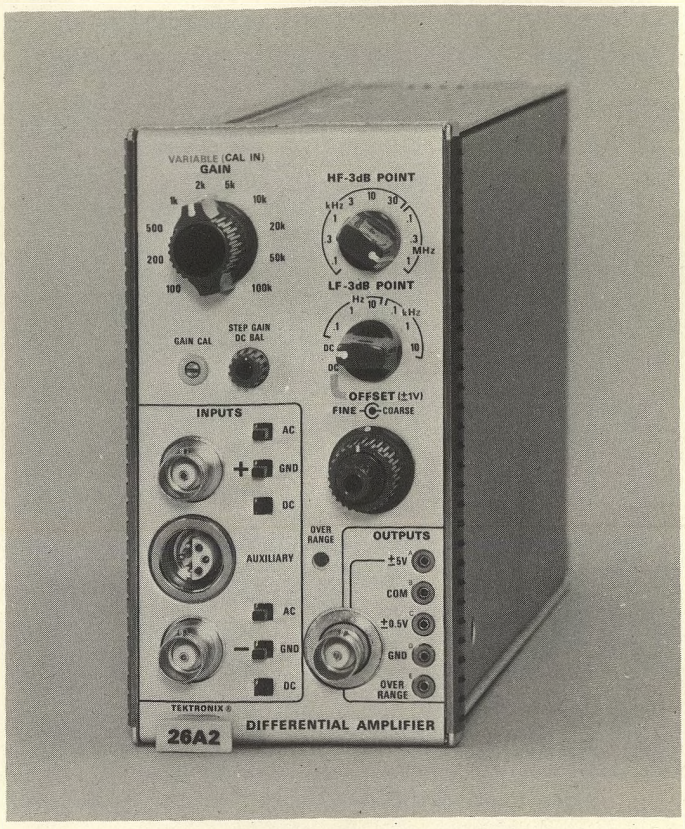
Frequency Response—DC-to-1 MHz within 15%, direct-coupled. 2 Hz or less (low-frequency —3 dB point) with input AC-coupled.

HF —3 dB POINT—Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 15% of selected frequency.

LF —3 dB POINT—Selectable in 6 decade steps from 0.1 Hz to 10 kHz, accurate within 20% of selected frequency.

DC Offset—At least plus or minus one volt to offset signal DC component.

Common-Mode Rejection Ratio— 50,000:1 or greater, DC to 50 kHz. Range, ±5 V (DC-coupled input).



Maximum Safe Inputs—Direct coupled, 15 V (DC + peak AC); AC-coupled, 500 V DC plus 15 V peak AC.

Input R and C— 1 MΩ paralleled by approximately 20 pF.

Differential Signal Range— 50 μV at 100,000 gain, increasing to —50 mV to +50 mV at 100 gain.

OUTPUT

High-Amplitude Output— ±5 V, ±20 mA maximum, short-proof to ground or ±15 V. Output resistance 5 Ω or less.

Low-Amplitude Output— ±0.5 V maximum. Output resistance 50 Ω within 2%.

Maximum Voltage Drift— 10 μV P-P per minute; 20 μV P-P per hour; 100 μV per °C.

Maximum Noise— 25 μV or less (tangentially measured).

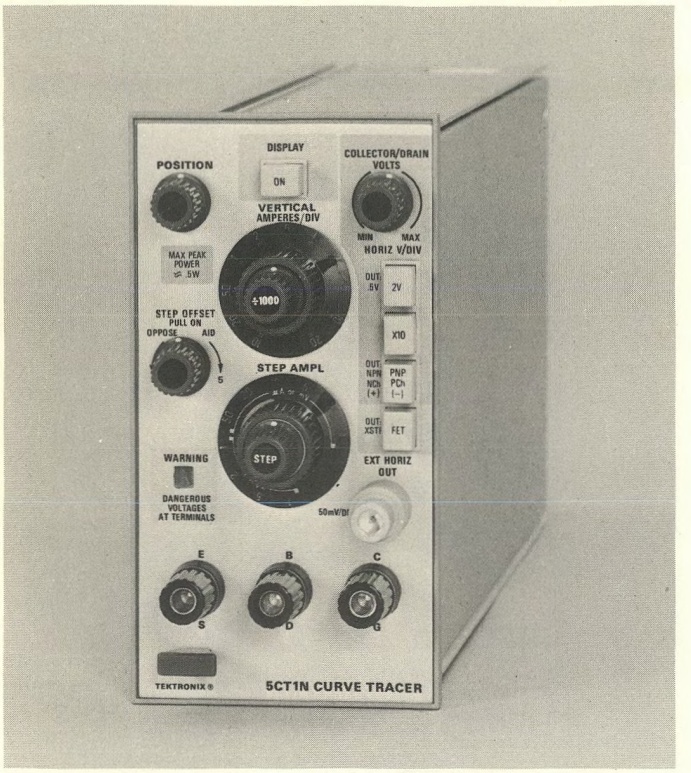
Overrange—Lamp and coincident logic signal indicates most overrange conditions.

WEIGHTS

Net Weight	1 3/4 lb	0.8 kg
Domestic Shipping Weight	≈ 5 lb	≈2.3 kg
Export-Packed Weight	≈12 lb	≈5.4 kg

26A2 Differential Amplifier
Includes instruction manual (070-1119-00).

5CT1N
7CT1N
Plug-In Curve Tracers



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

The 7CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 7000-Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 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 following discussion and characteristics apply to both units.

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

A front panel button switches the base/gate step generator output from current steps of the same polarity as the collector/drain sweep for checking transistors, to voltage steps of the opposite polarity of the collector/drain sweep for checking FETs in the depletion region. This button also internally switches the test fixture leads so that one test socket can be 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	0.5	2
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Maximum Open Circuit Voltage—Within ±20%. Maximum short circuit current, within 30%.

Series Resistance—Automatically selected with horizontal volts/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning—When the horizontal volts/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

STEP GENERATOR

Transistor Mode—Step amplitude range is 1 μA/step to 1 mA/step, 1-2-5 sequence. Maximum current (steps plus aiding offset) is X15 amplitude setting. Maximum voltage (steps plus aiding offset) is at least 13 V. Maximum opposing offset current is at least X5 amplitude setting.

FET Mode—Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is X15 amplitude setting, 13 V maximum. Source impedance is 1 kΩ ± 1%.

Accuracy—Incremental; within 3% between steps. Absolute; within ± (3% + X0.3 amplitude setting).

Step Polarity—The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps—Selectable in one step increments between 0 and 10.

Offset—Selectable from 0 to 5 steps. Polarity aid(s) or oppose(s) the step polarity.

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

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

Horizontal Deflection Factors—Selectable: 0.5 V, 2 V, 5 V, or 20 V, when driving an amplifier with a deflection factor of 50 mV/div and an input R of at least 50 kΩ.

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 compartment of the 7000-Series Oscilloscope mainframe.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

	5CT1N		7CT1N	
Dimensions	**in**	**cm**	**in**	**cm**
Length	12	30.5	14.5	36.9
Width	2.6	6.7	2.8	7.1
Height	5	12.7	5	12.7
Weight	**lb**	**kg**	**lb**	**kg**
Net	1.8	0.8	2.5	1.1
Domestic Shipping	4	1.8	6	2.7
Export Packed	9	4.1	11	5

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

Order 5CT1N CURVE TRACER

Order 7CT1N CURVE TRACER

OPTIONAL ACCESSORIES

Adapters—For transistors with long leads.
Order 013-0069-00

For transistors with TO-3 or TO-66 basing.
Order 013-0070-01

Diode Test Fixture—Holds axial-lead diodes.
Order 013-0072-00

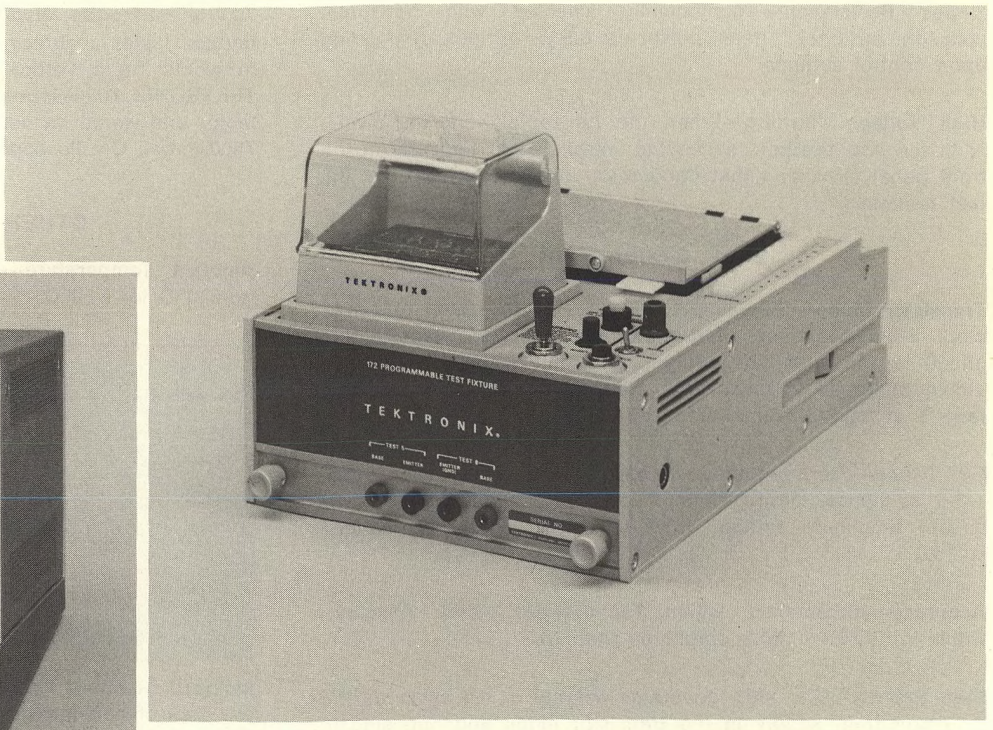
Adapter Box—Allows mounting of additional semiconductor sockets. **Order 013-0073-00**

Power Transistor Socket—For power transistors with hook leads. **Order 013-0074-00**

Diode Test Adapter—Production test fixture for rapid handling.
Order 013-0079-00

172
Programmable Test Fixture

- **PROGRAMS TESTS ON FETs, TRANSISTORS AND DIODES**
- **UP TO 11 PROGRAM TESTS**



576 with 172 inserted

The 172 Programmable Test Fixture, when used with the TEKTRONIX 576 Curve Tracer, permits the operator to program up to eleven sequential tests on 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 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.

When testing several different devices, plastic cards may be programmed in advance. Then the operator simply exchanges cards each time a different device is tested.

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.

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.

CHARACTERISTICS

VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies—As a percentage of the highest on-screen value.

NORM DISPLAY MODES	NORMAL (UNMAGNIFIED)	OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
		100 - 40 div	35 - 15 div	10 - 0 div
Vert Current	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
Horiz Volts	3%	2%	3%	4%
LEAKAGE DISPLAY MODE Vert Current				
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			
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 (norm, unmagnified mode)	NOT APPLICABLE		
200, 20 or 2 nA/div	3% + 0.050 V/vert div (norm, unmagnified mode)			
500, 50, 5 nA/div	3% + 0.125 V/vert div (norm, unmagnified mode)			

PERFORM TESTS ON:				PROGRAMMABLE CAPABILITIES
TEST	XSTR	FETs	DIODES	
1*	H_{FE}, $V_{CE(sat)}$†	V_p†	V_F†	PEAK VOLTS up to 350 V
2	V_{BE}			Horiz range is 100 mV/div to 2 V/div (Other conditions same as Test 1)
3	H_{FE}, $V_{CE(sat)}$	I_{DSS}, $R_{DS(on)}$		Base Drive: 100 nA to 110 mA Collector Sweep: 2 V to 20 V peak Vert range is 1 μA/div to 0.5 A/div Horiz range is 0.1 V/div to 2 V/div
4	Same as #3			
5	I_{CEO} or I_{CES}, I_{CER} with external short or 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}		Same as #5
7	I_{EBO}		I_R	Same as #5
8	$V_{(BR)CEO}$ or $V_{(BR)CER}$ with external resistor		V_F	Current Supply: 100 nA to 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	$V_{(BR)CES}$			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 μA to 2 A/div in 20 steps. Test 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1 μA to 0.5 A/div in 18 steps. Test 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1, 2, 5 sequence.

Horizontal Deflection Factor—Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for test 2, at least 100 MΩ at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Test 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1, 2, 5 sequence.

Collector Sweep Voltage—At least 2 V open circuit, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

Current Supply Accuracy— 0.1 μA to 1 μA, accurate within 3% ±30 nA with up to 500 V compliance. 1 μA to 11 mA, accurate within 2% ±30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% ± 30 nA with up to 50 V compliance. Increments of current are: 0.1 μA (from 0.1 μA to 11 μA), 1 μA (from 10 μA to 110 μA), 10 μA (from 100 μA to 1.1 mA) 100 μA (from 1 mA to 11 mA) and 1 mA (from 10 mA to 110 mA).

Voltage Supply Accuracy— 1 V to 500 V, accurate within 3% ±300 mV with at least 0.5 mA compliance.

Test Display Time Range (Automatic)— 300 ms or less to at least 2 s continuously variable. Manual operation from a front-panel switch or optional foot switch.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

Dimensions and Weights

Height w/cover	6 1/2 in	16.6 cm
Width	7 3/4 in	19.8 cm
Depth	12 3/8 in	31.5 cm
Net weight	11.5 lb	5.3 kg
Shipping weight	16 lb	7.2 kg
Export weight	23 lb	10.5 kg

Included Standard Accessories—One instruction manual, one protective cover, five programming cards, 250 programming card pins, five limit cards (CRT overlay).

Order 172 PROGRAMMABLE TEST FIXTURE

Foot Switch—for manually sequencing the programmed test. **Order 260-1189-01**

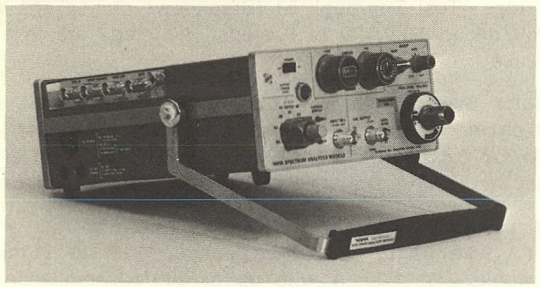
†These are the *usual* tests performed because of the higher current capability and pulse mode operation. However, other tests could be performed as well.

*All of the test conditions for Test 1 are controlled by the Type 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.

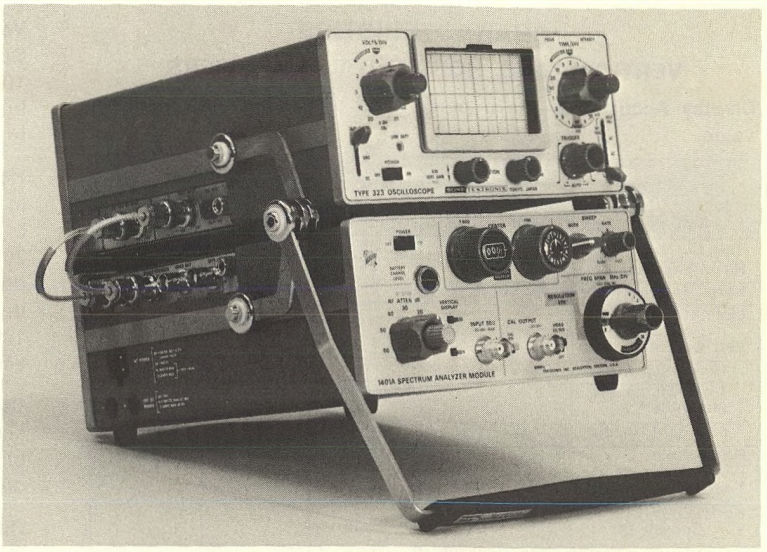
For the remaining tests the only Type 576 controls that are functional are the Polarity and CRT controls such as INTENSITY, FOCUS, DISPLAY OFFSET.

1401A
1401A-1 1 MHz-to-500 MHz Spectrum Analyzer Modules

- 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
- GATED MODE FOR PULSED R.F. and TELEVISION



1401A Spectrum Analyzer Module



1401A/323 Spectrum Analyzer System

The 1401A and 1401A-1 Spectrum Analyzer Modules are an expansion of the plug-in concept of using an oscilloscope for spectrum analysis. These modules, used with the SONY/TEKTRONIX 323, 324, or other oscilloscopes, provide measurement facilities in the 1 MHz to 500 MHz frequency range. The 1401A is designed for 50 Ω systems; the 1401A-1 is for use with 75 Ω systems.

The 1401A and 1401A-1 are compatible with any oscilloscope having 0.5 V/div horizontal deflection factor (adjustable ±10%) and 1.2 V full-screen vertical deflection.

One of the unique features of the 1401A is automatic center frequency positioning in the search mode. At 50 MHz/div frequency span (dispersion), the center frequency automatically becomes 250 MHz, preventing a possible erroneous display. in the search mode, the center frequency control positions a negative marker to indicate that part of the spectrum which will appear at center screen when the frequency span is reduced to less than 50 MHz/div.

Design of the 1401A/323 provides for easy carrying and convenient viewing and access. Power may be obtained from the normal AC line, 6 to 16 VDC, or internal rechargeable batteries.

ANALYZER CHARACTERISTICS

Center Frequency—Continuously selectable with 10-turn digital frequency readout control over the range of 1 to 500 MHz. Absolute accuracy within ± (5 MHz +5% of dial reading). Fine control provides a calibrated variation of up to plus or minus 1 MHz, within 10%.

CW Sensitivity	1401A	1401A-1
3 kHz Resolution	at least −100 dBm	at least −45 dBmV
100 kHz Resolution	at least −85 dBm	at least −30 dBmV
1000 kHz Resolution	at least −78 dBm	at least −23 dBmV

Frequency Span (dispersion)— 50 MHz/div to 100 kHz/div in 9 steps (1-2-5 sequence), accurate within 10% over a 10 div display, plus 0 Hz span. Frequency span can be continuously varied (uncalibrated) from any calibrated value toward zero.

Resolution Bandwidth— 3, 100, and 1000 kHz.

Display Flatness—Amplitude variations are within 1.5 dB to 200 MHz and 3 dB to 500 MHz.

Incidental FM— 20 kHz or less.

Intermodulation Distortion— 1401A at least 55 dB down with two signals at −30 dBm (+25 dBm 1401A-1), one MHz apart; 60 dB down with signals at −40 dBm (+15 dBm 1401A-1).

Frequency Stability—Within 50 kHz over any 5 minute interval after 20 minute warm-up and measurement at +20°C to +30°C ambient. Temperature coefficient = 0.5 MHz/°C or less.

Maximum Input Power	1401A	1401A-1
With RF attenuation	+30 dBm	+80 dBmV
Without RF attenuation	−30 dBm	+25 dBmV

RF Attenuator— 0 to 60 dB in 10 dB steps accurate within ± (0.2 dB + 1% of dB reading).

If Gain Control—At least 30 dB range.

Vertical Display—Linear and log.

Dynamic Range—At least 60 dB in log mode at 10 dB/div.

SWEEP CHARACTERISTICS

Free Run—Sweep rate continuously variable from one sweep per second or less to at least 100 sweeps per second.

External Trigger—Accepts an external positive pulse of 1 to 10 V, at least 100 ns width, 1 MHz or less.

External Horizontal—Input accepts signal of 0 to +5 V. 0 V corresponds to approximately 0 frequency and +5 V corresponds to approximately 500 MHz in Search Mode. 10 V maximum input.

CALIBRATOR

Frequency— 50 MHz within 0.1%.

Amplitude of the fundamental— 1401A, −30 dBm; 1401A-1, +25 dBmV. Accuracy, within 0.3 dB at 25°C and within 0.5 dB from −15°C to +55°C.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C; Nonoperating: −55°C to +75°C (without batteries), −40°C to +60°C (with batteries); Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; Nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Electromagnetic Interference—Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

OTHER CHARACTERISTICS

Power Sources—Battery operation: removable power pack contains 6 size "C" NiCd cells providing at least 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.

	1401A 1401A-1		323 324		1401A/323 1401A/324	1401A-1/323 1401A-1/324
	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′ power cable assembly; panel cover; blue filter; amber filter; three 5-1/2″, 50 Ω BNC to BNC cable assemblies; 6′ 50 Ω BNC to BNC cable assembly; screwdriver; strap assembly; operator's handbook (1401A); instruction manual (1401A).

Order 1401A

SPECTRUM ANALYZER MODULE

1401A-1 Included Accessories—Same as for 1401A except: Insert for instruction manual; two BNC to F adapters; change 6′, 50 Ω BNC to BNC cable assembly to 6′ 75 Ω BNC to BNC cable assembly.

Order 1401A-1

SPECTRUM ANALYZER SYSTEM

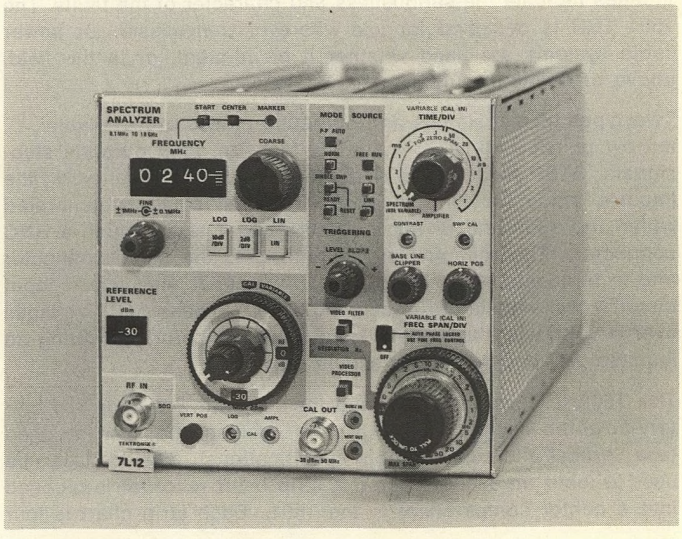
1401A/323 (P7 Phosphor) Included Accessories—Two 8′ power cable assemblies; two panel covers; blue filter; amber filter; smoke gray filter; three 5-1/2″, 50 Ω BNC to BNC cable assemblies; 6′, 50 Ω BNC to BNC cable assembly; two strap assemblies; viewing hood; probe package P6049; BNC to banana post patch cord; BNC to binding post adapter; screwdriver; accessory pack; operator's handbook (1401A); instruction manual (1401A); operator's handbook (323); instruction manual (323).

Order 1401A/323P7

Order 1401A-1/323P7

7L12 SPECTRUM ANALYZER

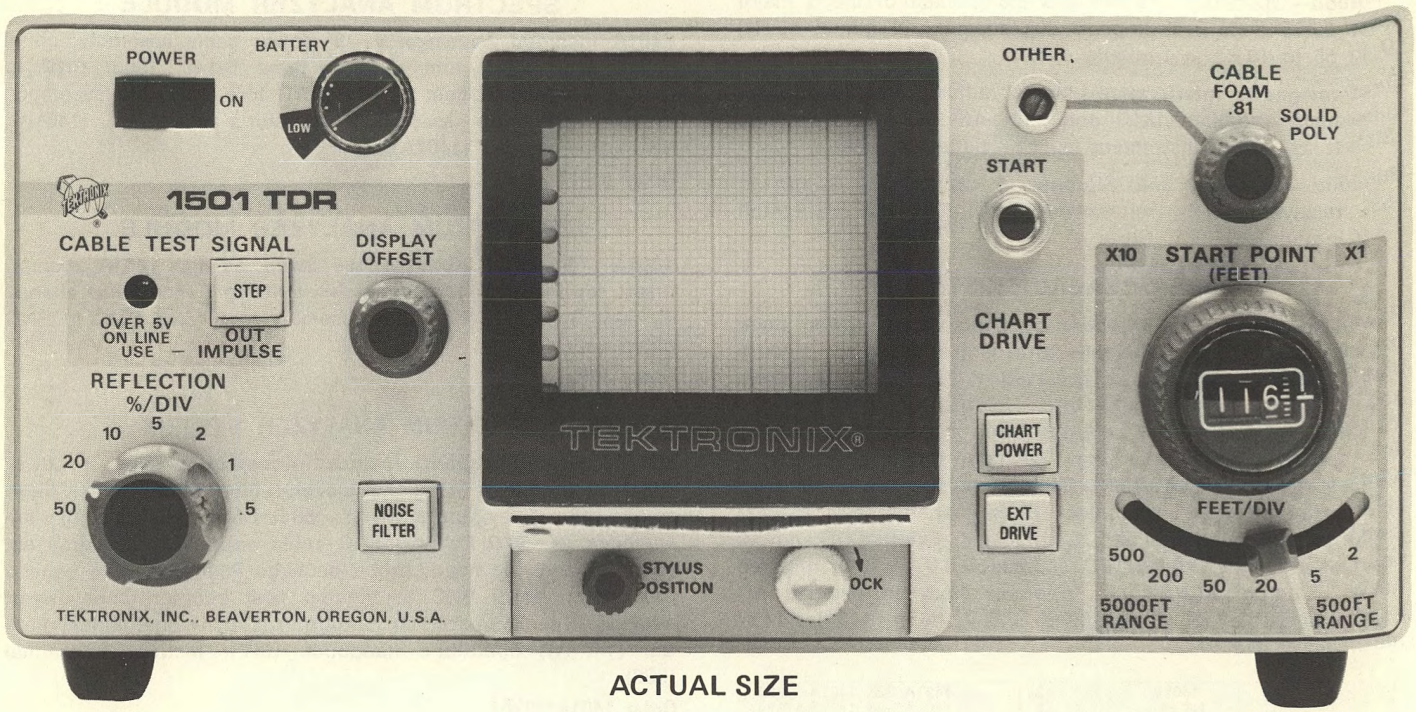
- 0 Hz to 1800 MHz IN ONE DISPLAY
- FULLY CALIBRATED DISPLAYS
- 300 Hz to 3 MHz RESOLUTION
- 4:1 RESOLUTION BANDWIDTH SHAPE FACTOR
- 70 dB DYNAMIC RANGE
- INTERMODULATION DISTORTION 70 dB BELOW FULL SCREEN
- SPURIOUS FREE OPERATION
- AUTOMATIC PHASE LOCK
- —110 dBm SENSITIVITY



7L12 Spectrum Analyzer
The 7L12 double-width 7000-Series Plug-in is covered on page 6.

1501

Time Domain Reflectometer



ACTUAL SIZE

- **DETECTS AND MEASURES DISCONTINUITIES TO 10,000 FEET**
- **BATTERY, AC OR DC OPERATED**
- **WEIGHS LESS THAN EIGHT POUNDS**
- **PLUG-IN CHART RECORDER AVAILABLE**
- **CAN BE USED WITH MOST OSCILLOSCOPES**

The 1501 is a portable, battery-operated Time Domain Reflectometer (TDR). A TDR is 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 transmission or power cable systems are used whether it be in-plant, or in the field, above or below ground.

Two types of test signals and operating modes are available . . . narrow pulses (IMPULSE mode) or fast-rise, long duration step-signals (STEP mode). The step mode is for analytical work; the impulse mode for fault location. The test pulse is generated within the 1501 and drives the cable under test through a BNC connector. The reflected signal returns to the same connector and is terminated in a selectable 50 Ω or 75 Ω resistance. Input circuitry will withstand up to ±100 V (DC + peak AC). Voltages over 5 volts will illuminate a front panel indicator, indicating an impulse, AC coupled mode should be used.

The 1501 is especially designed for use with a 323 or 324 battery-powered oscilloscope, but other oscilloscopes can be used (see vertical and sweep output specifications). 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 twenty-five centimeters long to allow permanent, inexpensive, high-resolution TDR plots of entire cables, or any particular portion of a cable. Notes may be hand-written on each chart (7.5 centimeters are available at the beginning of the chart).

The chart recorder in the 1501 can be driven by the 1401A or 1401A-1 Spectrum Analyzer but works especially well when coupled with a 323 to make a measurement and then make a 10-inch chart of the 323 display. The 1401A has a 50 Ω input and the 1401A-1 has a 75 Ω input especially suited for CATV.

CHARACTERISTICS

Output Pulse Amplitudes—Step pulse 1 V, impulse 10 V.

System Step Pulse Reflection Risetime—1.3 ns.

System Reflected Impulse Width— 1.3 ns at 50% amplitude.

System Aberrations— +4%, —4%, total not to exceed 8% with first 10 feet in step mode. +4%, —4% total not to exceed 8% from baseline referenced to impulse amplitude in impulse mode.

Pulse Repetition Rate—More than 10 kHz.

Display Deflection Factors—0.5% to 50% per div in 7 steps. One division on 323 or 324 Oscilloscope represents a 5 cm division on the strip chart.

Deflection Factory Acuracy—Within 3%.

Display Offset— +2.5 V to —2.5 V for viewing small signals in the presence of DC voltages.

Display Noise (Tangentially Measured)—Less than 0.5%, less than 0.2% with noise filter or in chart mode.

Line Reverse Termination— 75 Ω within 2% or 50 Ω within 2%.

Transmission Line Coupling—DC or AC.

Maximum Safe Input Voltage— 100 V (DC + peak AC) AC frequency 440 Hz maximum.

Horizontal Deflection— 2 ft/div and 5 ft/div, in 500 ft start point range: 20 ft/div, 50 ft/div, 200 ft/div and 500 ft/div, in 500 ft start point range.

Start Point—Display Start Point is continuously variable over the two ranges (500 ft and 5000 ft). Control accuracy is within 2% of dial setting. With Start Point control set at 5000 ft and Horizontal Deflection set at 500 ft/div, line discontinuities up to 10,000 ft can be detected.

Dielectric Selector—Solid polyethylene, foam or other dielectric cables can be measured directly without use of correction factor for propagation constant.

Sweep Rate—For use with oscilloscopes approximately 40 per second. When the noise filter is selected, the rate becomes approximately 4 per second.

Chart Recording—When a chart drive mode is selected, the sweep rate becomes 1 per 20 seconds approximately. Recording is initiated by a front panel button. Approximately two recordings can be made in one minute and a total of 60 recordings can be made on one loading of chart paper.

X-Axis (Sweep) Output—0 to 5 V ramp within 2%.

Y-Axis (Vertical) Output—0.2 V per chart division, +2 V and −2 V Peak to Peak.

Y-Axis Input Deflection Factor—0.2 V/div, 1.6 V Peak to Peak.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C; Nonoperating: −55° to +75°C (without batteries), −40°C to +60°C (with batteries); Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock (operating and nonoperating)—30 g's ½ sine, 11 ms duration. Two guillotine-type shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

POWER SOURCES

Battery Operation—Removable power pack contains 6 size "C" NiCd cells providing at least 8 hours operation with 30 recordings. 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 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 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.

DIMENSIONS AND WEIGHTS

	1501		1501/323 or 324		1501/323 or 324/ 1401A or 1401A-1	
	In	cm	in	cm	in	cm
Height	3½	8.9	7	17.9	10½	26.7
Width w/handle	8½	21.6	9⅜	23.9	9⅜	23.9
Depth w/panel cover	10⅝	27.0	10⅝	27.0	10⅝	27.0
Depth w/handle	13	33.0	14⅝	37.2	14⅝	37.2
	lb	kg	lb	kg	lb	kg
Weight w/Recorder and Accessories	≈8	≈3.6	≈16	≈7.2	≈24	≈10.9
Net weight w/o Recorder and Accessories	≈6.5	≈3	≈14.5	≈6.6	≈22.5	≈10.2
Domestic shipping weight w/Recorder	≈13	≈5.9	≈23	≈10.4	≈40	≈18.1
Export-packed weight w/Recorder	≈21	≈9.5	≈31	≈14.0	≈51	≈23.1

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); instruction manual (070-1206-00).

Order 1501 (with recorder)

TIME DOMAIN REFLECTOMETER MODULE

1501 Included Accessories—"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); instruction manual (070-1206-00).

Order 1501 (without recorder)

TIME DOMAIN REFLECTOMETER SYSTEM

1501/323 (P7 Phosphor) 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); cover plate, chart recorder blank (016-0509-00); TDR concept book (062-1244-00); instruction manual (070-1206-00); blue filter (378-0670-01); amber filter (378-0670-02); two 8-ft power cable assemblies (161-0043-02); two panel covers (200-0812-00); strap assembly (346-0051-00); viewing hood (016-0247-01); P6049A probe package (010-0223-00); BNC to binding post patch cord (012-0089-00); two 5.5 inch, 50 Ω BNC to BNC cable assemblies (012-0214-00); accessory pack (016-0113-00); 323 operator's handbook (070-1155-00); 323 instruction manual (070-0750-00).

Order 1501 (with recorder)/323P7

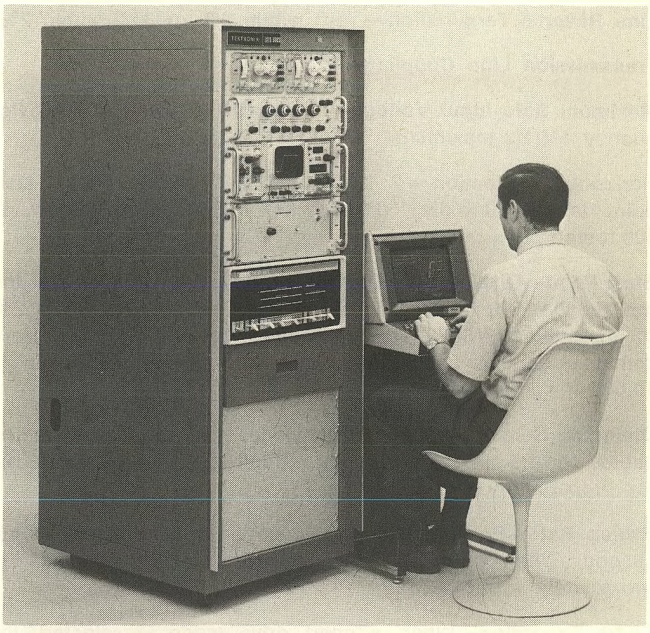
S-3003
S-3260 Automated Testing Systems

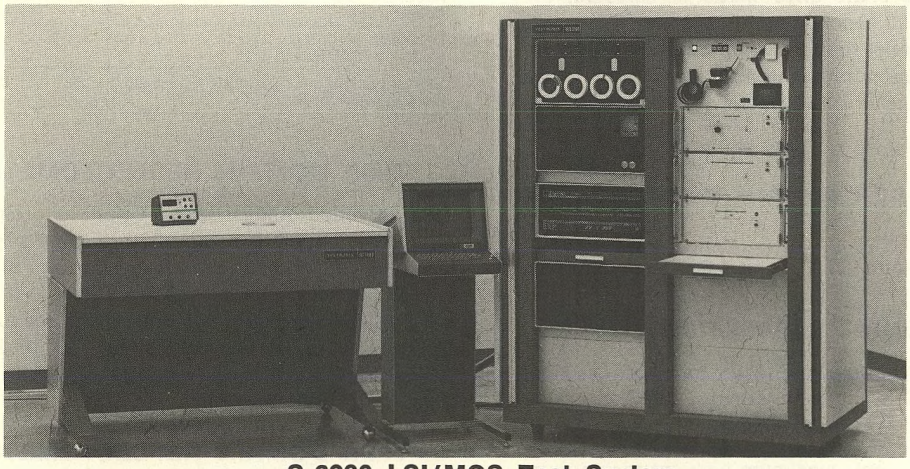
S-3003 Computer Operated Waveform Digitizer

Waveform analysis by computer offers measurement capability unattainable by hardware oriented devices. Its potential is limited only by the imagination of the system's programmer and the capabilities of the computer system. In addition to such traditional measurements as risetime, falltime, pulse width, period and amplitude, the system's programmer has the ability to measure slew rate, overshoot, preshoot, droop, etc. Also he may differentiate or integrate the waveform and/or perform a fast-Fourier transform on a waveform.

The basic S-3003 consists of a programmable sampling oscilloscope, a data coupler, interface cards, input/output panel and a WAFORM I Software Package. WAFORM I is a FORTRAN-based system capable of running a Digital Equipment Corporation PDP-11 Disc Operating System or the H-P 2100-Series Computers.

Hardware options available include interfaces to a Hewlett-Packard 9213A Automatic Instrument System, a multiple sampling head system (up to 16), pulse generators, automatic self-calibration (Auto-CAL), DEC PDP-11 Computer System and a 4010 Graphic Display Terminal.





S-3260 LSI/MOS Test System

The S-3260 LSI/MOS Test System 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 Display Terminal and Test Station(s).

Devices with up to 64 pins may be tested with combined input-output electronics. Devices with up to 128 pins may be tested by splitting the input-output connections.

FUNCTIONAL TESTS are conducted with a high-speed driver and dual, strobed comparators for each pin. A four-phase clock serves four selected pins. Clock-cycle repetition rate is 500 Hz to 20 MHz (two ranges). Clock transitions are independently programmed in 5-ns increments. Comparator and data strobes are positioned throughout the clock-cycle in 1-ns increments.

A 20-MHz shift register at each pin stores data patterns and address sequences for input forcing, as well as mask and expected data patterns for output comparison. Direct output data or errors may be stored on-the-fly for subsequent analysis or display. 1024 bits per pin may be recirculated or chained at adjacent pins for greater pattern length. More change microinstructions issue directly from computer memory during run time.

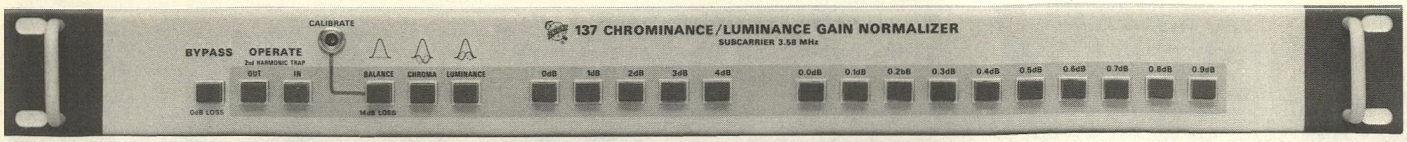
DYNAMIC TESTS including risetime, propagation delay and access time are performed in a separate subsystem. There are five time ranges, ± 100 ns to ± 1 ms, with 100-ps resolution and 1% accuracy. Dynamic test rates are up to 250 per second.

PARAMETRIC (DC) TESTS such as stress, leakage, breakdown, resistance, I_{out}, V_{out}, I_{in} and V_{in} are performed in a separate parametric test subsystem. Measurements can also be made with forcing function and dual, strobed comparators at each pin. The DUT may be functionally initialized with programmable clock, data and strobe signals and dc stimuli. Parametric test rates are up to 250 per second.

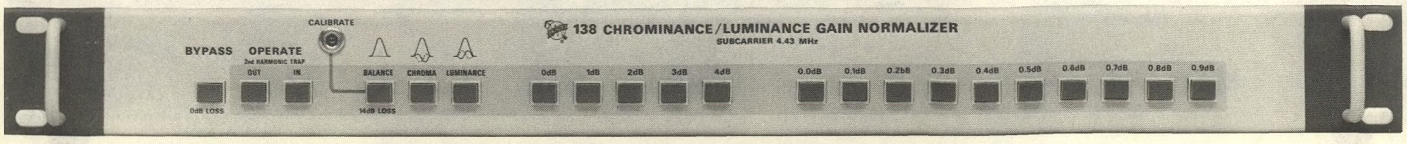
The S-3260 is controlled by a Digital Equipment Corporation PDP-11 with 16-bit word length. Memory includes an 8k core and a 65K disc.

Software includes pattern generator, translator/editor and executive programs. A procedure-oriented, interactive English-language source is used. An English-language executive is used for test-sequence control.

Auto-handlers, manual insertion, environmental handlers, wafer probers or EC-board test stations are all served by the same test circuitry.



137 Chrominance/Luminance Gain Normalizer for 3.58 MHz



138 Chrominance/Luminance Gain Normalizer for 4.43 MHz

- **Simplifies Chrominance/Luminance Gain Measurements**
- **Simplifies Chrominance/Luminance Delay Calculations**

A TEKTRONIX 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 overcomes the inherent inaccuracies of the Nomograph techniques. 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. No Power is required for operation.

The Normalizer is installed in the video line to a waveform monitor. When measurements are to be made, an OPERATE (measurement) mode is used. The Normalizer is used to balance chrominance deviation around the base line of the waveform monitor display by inserting calibrated luminance or chrominance attenuation until deviation symmetry is achieved. After symmetry is achieved, the luminance or chrominance gain distortion is read directly from the attenuator controls. Delay distortion is calculated from the waveform monitor display. The Normalizer can be used with modulated $\sin^2$ pulses of any duration. A BYPASS mode is available when no measurements are to be made.

137/138 CHARACTERISTICS

Input Return Loss—BYPASS Mode is 46 dB to 6 MHz, OPERATE Mode is 34 dB, 0 Hz to subcarrier frequency.

Insertion Loss—BYPASS Mode is 0 dB, OPERATE Mode is 14 dB within 0.2 dB.

Attenuation— 0 to 4.9 dB in 0.1 dB steps within 0.1 dB of indicated attenuation.

Dimensions and Weights—Height, 1¾ in, 4.5 cm; Width, 19 in, 48.3 cm; Depth, 7½ in, 19.1 cm; Net Weight, 3¼ lbs, 1.5 Kg; Domestic shipping weight, 6¼ lbs, 2.8 Kg.

The 137 Chrominance/Luminance Gain Normalizer is designed for systems using 3.58 MHz subcarrier. The recommended modulated $\sin^2$ pulse source for systems with 3.58 MHz subcarrier is the TEKTRONIX 147 NTSC Test Signal Generator. The optimum waveform monitor for the system is a TEKTRONIX 529 or R529.

Included Accessories: Instruction manual, rackmounting hardware.

Order 137 Chrominance/Luminance Gain Normalizer 3.58 MHz

The 138 Chrominance/Luminance Gain Normalizer is designed for systems using 4.43 MHz subcarrier. The recommended modulated $\sin^2$ pulse source for systems with 4.43 MHz subcarrier is the TEKTRONIX 148 Insertion Test Signal Generator. The optimum waveform monitor for the system is a TEKTRONIX 529 MOD 188D or R529 MOD 188D.

Included Accessories: Instruction manual, rackmounting hardware.

Order 138 Chrominance/Luminance Gain Normalizer 4.43 MHz

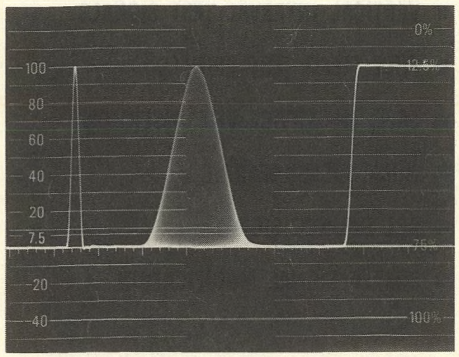


Fig. 1. Undistorted modulated $\sin^2$ pulse.

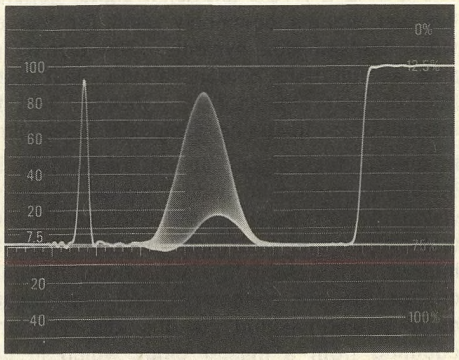


Fig 2. Modulated $\sin^2$ pulse with chrominance/luminance gain and delay distortions. Display 1 volt full scale.

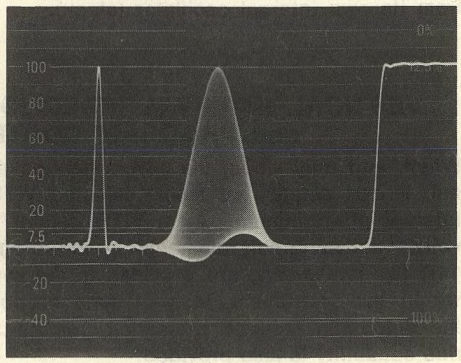
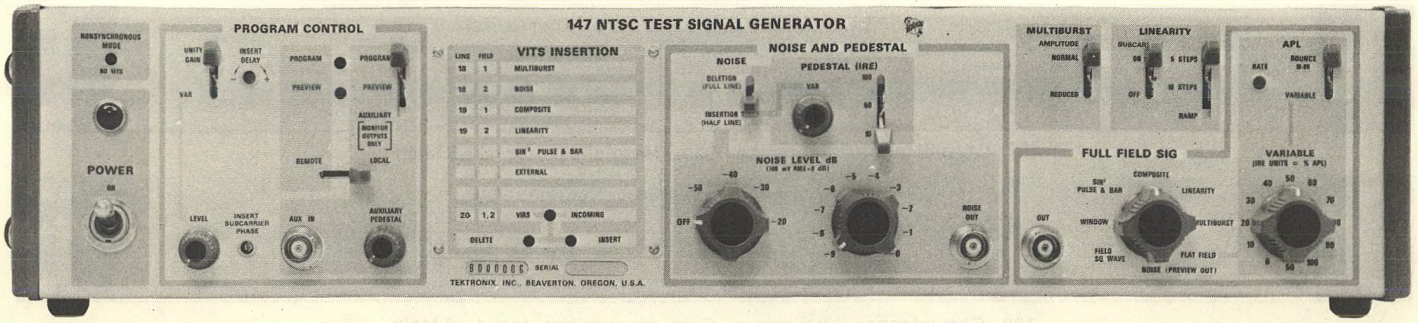


Fig. 3. Modulated $\sin^2$ pulse after normalization. Display 0.2 volt full scale.

147
NTSC Signal Generator



- VERTICAL INTERVAL REFERENCE SIGNAL
- VERTICAL INTERVAL TEST SIGNALS
- FULL FIELD TEST SIGNALS
- SAFE, IN-SERVICE VITS INSERTION
- NOISE MEASUREMENT
- APL BOUNCE SIGNAL
- SIMPLE SIGNAL MODIFICATION

The 147 is a NTSC television signal generator that supplies all the test signals commonly used for test and measurement of video transmission systems. The signals generated are available as full field composite-video test signals and as Vertical Interval Test Signals (VITS) inserted into the vertical blanking interval of an incoming composite video signal.

In-service test signal timing information is derived from the incoming composite video signal. There are extensive provisions within the instrument to modify the parameters of the test signals and their time location within the vertical blanking interval. This flexibility is provided through the use of easily-changeable pin connectors. All time locations of test signals as to position within the line and field are derived by digital counting from a master clock which in turn is gen-locked to the incoming synchronizing pulses; however, in the absence of incoming composite video (or sync), the 147 will operate in the full field test signal mode, deriving timing information from its own internal oscillator (clock).

VERTICAL INTERVAL INSERTION/DELETION and PROGRAM CONTROL

When, and only when, the 147 is gen-locked to a program signal, it can delete and insert selected VITS as determined by internal programming. As a VITS deleter/inserter function involves active circuit elements in the program line within the 147, fail-safe means are provided in the event of a malfunction within the instrument, loss of sync or power. In addition to the automatic fail-safe protection, remote-control manual override capability is also provided.

A preview function allows observation of exactly what lines will be deleted and exactly what signals and levels will be inserted on the program signal before anything is done to the program signal itself. The preview/program function can be remotely controlled.

Changes in the time location of VIT signals are readily made by removing and/or moving color-coded jumpers within the 147. Any signal may be eliminated or moved. The front panel provides a means of indicating the actual VITS and their line and field location. Externally generated VITS may be added to the program line if desired.

PROGRAM CONTROL FEATURES

Nonsynchronous Operation—Warning Light indicates absence of incoming synchronizing information without which VITS deletion or insertion is automatically discontinued.

Program Level—Switch selects whether a preset gain, normally adjusted for unity gain between program input and program output, is used or whether a front panel level adjustment is available to normalize incoming signal to provide 1 volt at the program output.

Local-Remote Control of Program or Preview—Switch shifts control of program or preview modes from front panel (local) to a remote position, controllable by connection of a remote switching circuit to a rear panel connector. When operating under local or remote control, a light indicates preview or program status, since the switch position may not indicate the actual operating mode.

Program-Preview-Auxiliary—This switch selects one of three modes: Program—VITS inserted on program line output according to internal selection of test signals and their time address. Preview—VITS inserted only on program as viewed on the preview monitor output; used for verification prior to impressing these signals on program output. Auxiliary—Permits the use of a noncomposite video signal at the auxiliary input (such as a sweep generator). This signal then appears at the monitor output connector, with composite blanking and with sync added. This mode is not available by remote control.

Auxiliary Pedestal—This control provides a DC offset so that the auxiliary signal excursion may be positioned between the black and white limits of the resulting composite video signal.

VITS Subcarrier Phase—This control adjusts phase of color subcarrier on internally generated signals to be correct in relation to the phase of incoming burst

VIRS Incoming Indicator—Light indicates the presence of a Vertical Interval Reference Signal on incoming composite video. In this case, the generation of an internal VIRS is inhibited (inhibition may be disabled by remote control. Incoming VIRS can be observed on a suitable waveform monitor* connected to the preview monitor output while internally-generated VIRS are added to the opposite field. Such displays easily detect small errors in the incoming VIRS.

PROGRAM CONTROL SYSTEM SPECIFICATIONS

Input Level—Adjusted to Unity Gain.

Variable Input Level— ±30%.

Input Return Loss—Less than 46 dB to 5 MHz. Power on, 40 dB to 5 MHz in bypass.

Output DC Level—Less than 50 mV (no signal).

Isolation between Program and Program Monitor Outputs—Greater than 34 dB.

Inserted Signal Level—714 mV (100 IRE) ±1%.

Frequency Response, Program and Preview Channels—±1%, 50 kHz to 5 MHz; +1%, −5%, 5 MHz to 8 MHz.

2 T Pulse to Bar Ratio— 100% ±0.5%.

Field Rate Squarewave Tilt—Less than 0.5%.

Line Tilt—Less than 0.5%.

Differential Phase at any APL, Standard Input—Program output less than 0.15%. Preview output less than 0.3%.

Differential Gain at any APL, Standard Input—Program output less than 0.2%. Preview output less than 0.4%.

Line Time Amplitude Nonlinearity—Less than 0.5%.

Random Noise Output Program Channel—Less than −75 dB RMS.

Residual Subcarrier on Noninserted Lines—Less than −60 dB P-P.

Hum, Transients on Noninserted Lines—Less than −60 dB.

Spurious Signals During Blanking Time—Less than −40 dB.

Signal Attenuation in "Delete" Mode— 2 T pulse greater than −70 dB; subcarrier (color bars) greater than −60 dB.

Crosstalk into Program Channel from Internal Signals—2 T pulse less than −70 dB, subcarrier (color bars) −60 dB.

Unwanted Pedestal at Time of VIT Insertion—Program and Preview Channel: Less than ±1.7 IRE.

Line Timing Adjustment Range with External Sync—±3 μs.

Jitter—Less than 5 ns.

VERTICAL INTERVAL REFERENCE SIGNAL

The proposed VIR Signal is generated by the 147 and can be inserted on line 20 of either or both fields. Standard operational practices regarding the proposed VIR signal have not yet been worked out. Therefore the 147 has been designed to be programmable for a number of possible operating modes which in turn depend upon the presence or absence of a VIR signal on the incoming program line.

Indicator lamps indicate the presence of an incoming VIR signal, whether an incoming VIR is being deleted and whether a local VIR is being inserted. Remote control of the VIR signal functions is also available, with the indicators showing the actual operating mode. In the absence of burst, no VIR signal will be inserted.

MULTIBURST SIGNAL

Multiburst is generated by a function generator controlled by the digital programmer. The function generator approach eliminates the need for individual start-stop oscillators for each burst and individual amplitude and AC axis adjustments for each burst. Thus each burst start time is completely stable and each burst consists of an exact integer number of cycles, regardless of the frequency. Each burst starts at 0° of the first cycle and ends at 360° of the last cycle. Location of the white flag may be programmed with relation to the bursts as a means of source identification.

White Reference Amplitude—100 IRE ±1 IRE

Burst Amplitude—Normal amplitude: 90 IRE plus 10 IRE setup. Reduced amplitude: 60 IRE plus 10 IRE setup or 50 IRE plus no setup.

Average Burst Level—55 ±1 IRE with 10% setup; reduced, 40 ±1 IRE.

Burst Frequencies— 0.5, 1.5, 2.0, 3.0, 3.58, +3% and 4.2 MHz ±2%. Each independently adjustable.

Timing—Each burst starts at 0° of the first cycle and ends at 360° of the last cycle.

LINEARITY SIGNAL

Linearity—Three linearity test signals are front panel selectable: 5 step, 10 step and ramp either modulated or unmodulated. Luminance component is either 10 equal 10-IRE steps; 5 equal 16-IRE steps or a 100-IRE ramp, selected by front-panel switch. Each of these is front-panel adjustable from 80-100-IRE peak amplitude. The subcarrier component is phase-locked to color burst. Applications include measurements of differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal nonlinearity, and burst-phase errors.

Measurements of differential phase and gain can be made more easily with 40-IRE subcarrier to override noise than with 20-IRE subcarrier. Subcarrier amplitude can be varied from 20 to 40 IRE by internal selection. Since this level of subcarrier should not be used together with full amplitude staircase or ramp where the test signal may be radiated, luminance amplitude of modulated linearity signals can be reduced to 80 IRE by internal adjustment.

Luminance Component—Peak amplitude 100 IRE within 1%. Each step is 20 IRE, within 1%, in 5 step and 10 IRE in 10 step. Step risetime is approximately 230 ns and aberations are within 2%. Step durations are 6 μs for 5 steps and 3 μs for 10 steps.

Chrominance Component—Amplitude is 286 mV P-P (40 IRE) within 5% and in phase with burst (can be 143 mV (20 IRE) with internal jumper change.

Differential Phase— 0.2° or less.

Differential Gain— 0.5% or less.

Subcarrier Envelope—Risetime is approximately 375 ns.

Ramp Luminance Amplitude— 714 mV, 100 IRE ±1%.

Ramp Linearity—Within 1%.

Ramp Duration— 30 μs.

FLAT FIELD SIGNAL

The Flat Field Signal is used primarily for variable average picture level (APL) vertical interval testing. The Flat Field Signal is a composite video signal which during the active portion of each field has a constant luminance level. During the ver-

*529 with −25 V lead disconnected from the field selector switch to disable field selection.

tical interval there will be present each test signal which has been programmed for insertion as described in the Vertical Interval Insertion/Deletion section.

The luminance level of the Flat Field Signal is selectable in 10 IRE unit increments from 0 to 100 IRE. An alternate selection provides a "bounce" between 10 and 90 IRE at a 0.1 to 1.0 Hz rate. Thus the use of the Flat Field Signal permits the use of the several test signals in the presence of a selectable APL. This technique is useful in the measurement of APL-dependent distortions.

Luminance Level of the Flat Field Signal—Within 2% of the indicated level except the 100 IRE level which is within 1%.

Risetime—Shaped by $\sin^2$ filter with first zero in the frequency domain at 4 MHz.

FIELD SQUAREWAVE

A sensitive measurement of field time distortion can be made with this signal. In this mode, the 147 provides a composite video signal with 170 active lines at 100 IRE, which approximates a 60 Hz squarewave. A composite video signal such as this reveals low-frequency phase and gain distortions much as a simple 60 Hz squarewave will do, but unlike the latter, it can pass through clamper amplifiers.

Amplitude—Within ±1 IRE of white reference.

Number of White Lines—57 through 227 on each field, all remaining active lines are black.

Risetime—Shaped by $\sin^2$ filter with first zero in frequency domain at 4 MHz.

PULSE AND BAR SIGNAL

2 T, T pulses are generated to high precision by two 9-pole Kastelein Filters. The digital programmer provides the high degree of timing accuracy required in these pulses to eliminate jitter and long term drift. The programmer also exactly determines pulse-to-pulse spacing and bar duration. However, the programmer may be readily reprogrammed to produce different spacings or bar widths in 2 μs increments.

The $\sin^2$ pulse may be either 2 T (0.25 μs HAD) or T (0.125 μs HAD). The transitions of the bar are controlled by either of two Kastelein filters so that frequency spectrum is limited to 4 MHz or 8 MHz. Shape of these transitions is integrated $\sin^2$.

For a specific application, the user may elect to program the 147 for any combination of T or 2 T pulse and T or 2 T bar. As shipped, the pulse is 2 T, the bar is formed by the T filter. This provides for K factor measurements of short time distortion. Thus the pulse and bar test signal is useful to measure line time and short time distortions.

The envelope of the modulated $\sin^2$ pulse is formed in the function generator rather than in a filter. The function generator can be readily programmed for any desired pulse width from 1.5 to 2.5 μs. Thus the 147 offers unique modulated $\sin^2$ pulse generator flexibility.

Modulated $\sin^2$ pulse (20 T) is used in measuring relative gain and delay errors between chrominance and luminance signals. The 20 T modulated $\sin^2$ pulse has a 2.5 μs HAD and hence, its frequency spectrum cuts off at 4.0 MHz. Greater sensitivity to chrominance-luminance delay errors may be had by reducing the pulse width (HAD).

As a full-field test signal, the subcarrier component of the modulated $\sin^2$ pulse is phase modulated. The subcarrier could be free running, however, it could slowly drift in frequency in a manner annoying to the user. The frequency locked, phase modulated approach assures a stable display.

When used as a VIT signal, neither field rate phase modulation or frequency offsetting has utility. In the 147, a programmable phase offset between burst and the subcarrier component of the modulated $\sin^2$ pulse is provided. This conveniently source-codes the point in the system where the VIT signals are inserted. This subcarrier component may be viewed on either a vectorscope display or on most color monitors.

2 T Pulse Amplitude—Within 1 IRE of T Bar.

2 T HAD— 250 ns within 7.5 ns.

2 T Ringing—Amplitude less than 0.5 IRE; duration less than 4 cycles.

Time Location—Internally programmable in 2-μs increments.

T Bar Amplitude— 714 mV (100 IRE) ±1%.

T Bar Risetime—115 ns ±15%.

T Bar Time Location—Start and Stop internally programmable in 2-μs increments.

20 T Modulated Pulse Peak Chrominance to Peak Luminance Amplitude Difference—Less than 0.5 IRE.

20 T Modulated Pulse HAD— 2.50 μs or can be internally set to 1.57 μs.

20 T Modulated Pulse Residual Subcarrier—Less than 0.5 IRE on insertion line.

2O T Modulated Pulse Relative Chroma-Luminance Time Delay—Less than 10 ns.

WINDOW SIGNAL

The Window Signal is the same as the Pulse and Bar except that the "Window" occupies lines 66 through 218 only. A window signal can be used to measure both line time and field time distortions. It is especially useful when observing picture monitors. Where field rate distortion is present, the window signal will be affected to a much greater extent than the pulse and bar signal.

Amplitude— 100 IRE within 1 IRE.

Risetime—Internally programmable: either 2 T pulse and T Bar or T pulse and 2 T bar.

Window Duration—Lines 66 through 218.

COMPOSITE TEST SIGNAL

A composite test signal (fig. 18) is attractive as a multiple function signal for either VIT use, where the whole signal occupies only one line per frame, or as a full field signal which may be distributed throughout the entire plant on only one cable, with obvious economic advantage. The composite signal can be programmed in a variety of ways. Phase of the subcarrier of the modulated 20 T pulse may identify the signal insertion point.

NOISE

The 147 offers a unique signal-to-noise measuring technique for "in-service" testing during the vertical interval. The noise present in the middle portion of a line is deleted and noise generated in a calibrated source is inserted for measurement by comparison. The user varies a calibrated attenuator until inserted noise and incoming noise appear the same on a waveform monitor. The noise values measured are independent of operator interpretation errors to within 2 dB.

Where transmission noise is to be measured, the noise may be deleted on an entire line at the point from which the noise is to be measured using one 147. Further down the transmission system, a second 147 will match the noise level in the manner described previously. This process may be repeated and the transmission noise level determined for several sections of the transmission system, or its overall performance evaluated.

Noise may be measured at 10, 50 or 100 IRE luminance levels. The calibrated noise generator provides "flat" (white) noise.

Noise Pedestal Amplitude—Selectable 10, 50, or 100 IRE within 0.2 dB.

Variable Pedestal—Provided.

Noise Levels— —20 dB to —59 dB in 1 dB steps (0 dB = 700 mV RMS).

Flat Noise Spectrum—Energy unit bandwidth: 15 kHz to 5 MHz ±6 dB. (Spectrum extends well beyond 5 MHz.)

Output Impedance— 75 Ω.

Return Loss—Less than —30 dB to 5 MHz.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz, 40 watts maximum at 115 VAC and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

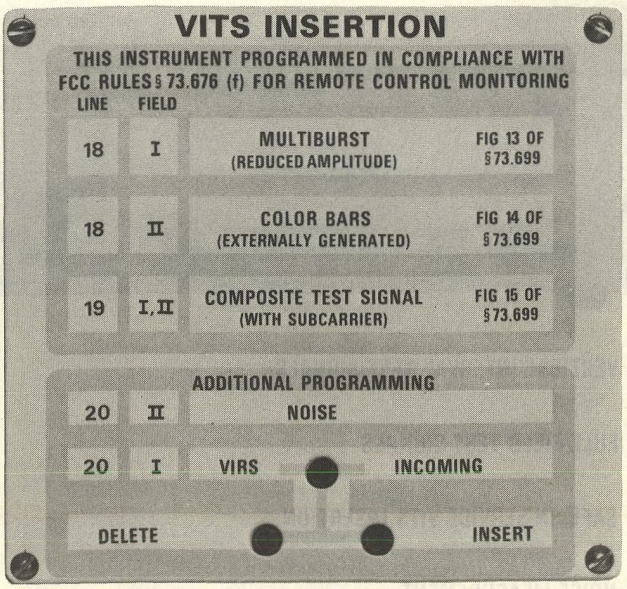
Inputs—External VITS Input, Program Input, Auxiliary Input, Composite Sync and Subcarrier.

Outputs—Program, Program Monitor, Preview Monitor (two each) and Full Field.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0° to +50°C.

Dimensions and Weights

	147		R147	
	in	cm	in	cm
Height	3-7/8	9.9	3-1/2	8.9
Width	17-7/8	45.5	19	48.3
Depth	17-1/8	43.6	19-5/8	49.9
	lb	kg	lb	kg
Net weight	19	8.6	20	9.1
Domestic shipping weight	≈35	≈15.9	≈36	≈16.3
Export-packed weight	≈55	≈25	≈56	≈25.4



OPTION 1 VITS Program

The 147 Option 1 NTSC Test Signal Generator is programmed to insert and delete test signals as required by FCC §73.676 (f) for transmitter remote control (See Waveforms). The 147 recognizes monochrome transmissions (no burst) and includes facilities which may be used to squelch the chrominance components of the color bar signal as required. In addition, other signals commonly used for test and measurement of video transmision systems are available from the 147 as full-field composite-video test signals. Other vertical interval test signals (VITS) may be inserted in the vertical blanking interval of an incoming composite video signal by reprogramming. All 147 Generators can be easily reprogrammed by the user.

INCLUDED ACCESSORIES

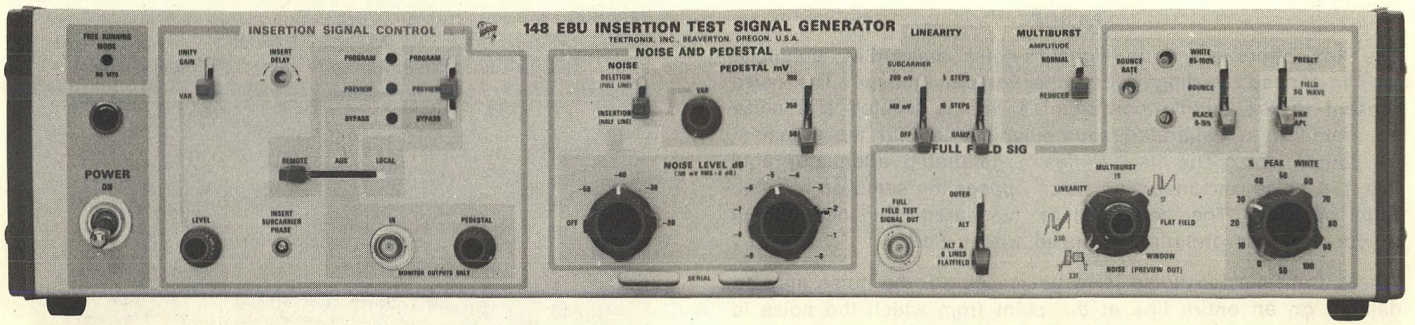
75 Ω, BNC termination (011-0103-02); 2 each BNC-T adapters (103-0030-00); 7½ ft power cable, three wire (161-0036-00); VIT program front-panel cover plate (200-1246-00); instruction manual (070-1169-00); R147 also includes rackmounting hardware.

Order 147 NTSC SIGNAL GENERATOR
Order 147 Option 1 NTSC Test Signal Generator
Order R147 NTSC SIGNAL GENERATOR (rackmount)
Order R147 Option 1 NTSC Test Signal Generator (rackmount)

OPTIONAL ACCESSORIES

Filters
4.2 MHz low pass **((015-0212-00)**
5 MHz low pass **(015-0213-00)**
4.2 MHz weighting **(015-0214-00)**
5 MHz weighting **(015-0215-00)**

148
Test Signal Generator



- **VERTICAL INTERVAL TEST SIGNALS**
- **FULL FIELD TEST SIGNALS**
- **SAFE, IN-SERVICE VITS INSERTION**
- **NOISE MEASUREMENT**
- **APL BOUNCE SIGNAL**

The 148 is a PAL television signal generator supplying all test signals commonly used for test and measurment of video transmission systems. The signals generated are available as full field composite video test signals and as Vertical Interval Test Signals (VITS) inserted into the vertical blanking interval of an incoming composite video signal.

In-service test signal timing information is derived from the incoming composite video signal. There are extensive provisions within the instrument to modify the parameters of the test signals and their time location on a line or within the vertical blanking interval. This flexibility is provided through the use of easily-changeable pin connectors. All time locations of test signals as to position within the line and field are derived by digital counting from a master clock which in turn is gen-locked to the incoming synchronizing pulses; however, in the absence of incoming composite video (or sync), the 148 will continue to operate in the full field test signal mode, deriving time information from its own internal oscillator (clock).

VERTICAL INTERVAL INSERTION/DELETION AND PROGRAM CONTROL

When, and only when, the 148 is gen-locked to a program signal, it can delete and insert internally programmed VITS. As a VITS deleter/inserter function involves active circuit elements in the program line within the 148, fail-safe means are provided in the event of a malfunction within the instrument, loss of sync, or power. In addition to the automatic fail-safe protection, remote-control manual override capability is also provided.

A preview function allows observation of exactly what lines will be deleted and exactly what signals and levels will be inserted on the program signal before anything is done to the program signal itself. The preview/program function can be remotely controlled.

Changes in the time location of VIT signals are readily made by removing and/or moving color-coded jumpers within the 148. Any signal may be eliminated or moved. Externally generated VITS may be added to the program line if desired.

INSERTION SIGNAL CONTROL FEATURES

Free Running Operation — A warning light indicates absence of incoming synchronizing information without which VITS deletion or insertion is automatically discontinued.

Program Level — A switch selects whether a preset gain, normally adjusted for unity gain between program input and program output, is used or whether a front panel level adjustment is available to normalize incoming signal to provide 1 volt at the program output.

Local-Remote Control of Program and Preview — A switch can shift control of program or preview modes from front panel (local) to a position remote from the 148. When operating under either local or remote control, a light indicates whether a preview, program or bypass mode is in use.

Program-Preview-Bypass — A switch selects one of three modes: Program-VITS inserted on program line output according to internal selection of test signals and their time address. Preview-VITS inserted only on program as viewed on the preview monitor output; used for verification prior to inserting these signals on program output. Bypass-Incoming program material bypasses 148 functions and is outputted unchanged.

Auxiliary — A non-composite video signal at the auxiliary input (such as a sweep generator) appears at the preview monitor output connector with composite blanking and sync added. This mode is not available by remote control. A pedestal control provides a DC offset so that the auxiliary signal excursion may be positioned between the black and white limits of the resulting composite video signal.

VITS Subcarrier Phase — A recessed, front-panel control adjusts phase of color subcarrier on internally generated signals to be correct in relation to the phase of incoming burst.

Insertion Delay — A recessed, front-panel control provides a fine adjustment for inserted signals.

INSERTION CONTROL SPECIFICATIONS

Input Level — Adjusted to Unity Gain.

Variable Input Level — ±30%

Input Return Loss — Better than 34 dB to 5 MHz.

Output DC Level — Less than 50 mV (no signal).

Isolation Between Program and Program Monitor Outputs — Greater than 34 dB.

Inserted Signal Level — 700 mV ±1% with 700 mV reference from APL generator.

Frequency Response, Program and Preview Channels — ±1%, 50 kHz to 5 MHz; +1%, −5%, 5 MHz to 8 MHz.

2 T Pulse to Bar Ratio — 100% ±0.5%.

Field Rate Squarewave Tilt — Less than 0.5%.

Line Tilt — Less than 0.5%.

Differential Phase at Any APL, Standard Input — Program output less than 0.15°. Preview output less than 0.15°.

Differential Gain at Any APL, Standard Input — Program output less than 0.2%. Preview output less than 0.4%.

Line Time Amplitude Nonlinearity — Less than 0.5%.

Random Noise Output Program Channel — Less than −75 dB RMS.

Residual Subcarrier on Non-Inserted Lines — Less than −60 dB P-P.

Hum, Transients on Non-Inserted Lines — Less than −60 dB.

Spurious Signals During Blanking Time — Less than −40 dB.

Signal Attenuation in "Delete" Mode — 2 T pulse greater than −70 dB; subcarrier (color bars) greater than −60 dB.

Crosstalk into Program Channel from Internal Signals — 2 T pulse less than −70 dB, subcarrier (color bars) −60 dB.

Unwanted Pedestal at Time of VIT Insertion — Program and Preview Channel: Less than 7 mV.

Line Timing Adjustment Range with External Sync — ±3 μs internal, ±1 μs front panel.

Jitter — Less than 5 ns.

FULL FIELD OPERATION

A major function of the 148 is to provide full field test signals separate from program. Full field signals are generated with or without external synchronizing information. Therefore, there are two modes of full field operation: Free running or synchronized (locked).

Eight full field signals can be selected: Multiburst, Linearity, Flat Field, Window, Noise, VIT 17, VIT 330, and VIT 331. When operating in a flat field mode, a white level, preset between 85% and 100%, or a black level, preset between 0% and 15% may be chosen. An automatic change between white and black is available for testing convenience. This change (bounce), when selected, occurs at an adjustable period from 1.0 seconds to 10.0 seconds.

Eleven APL levels between 0% and 100% of white can be selected for use in the flat field or alternation mode in which flat field lines are alternated with other selected test signals such as multiburst, linearity, etc.

The eight full field signals are selected by two concentric switches. This permits any one of the eight signals to be produced on all active lines or any two signals (except window) can be alternated on all active lines or any two signals (except window) can be paired on two successive lines and alternated with six lines of adjustable flat field.

MULTIBURST SIGNAL

Multiburst is generated by a function generator controlled by a digital programmer. The function generator approach eliminates the need for individual start-stop oscillators for each burst and individual amplitude and AC axis adjustments for each burst. Thus each burst start time is completely stable and each burst consists of an exact integer number of cycles, regardless of the frequency. Each burst starts at 0° of the first cycle and ends at 360° of the last cycle. Location of the white flag may be programmed with relation to the bursts as a means of source identification.

White Reference Amplitude — 700 mV ±1.

Burst Amplitude — Two amplitudes, Normal or Reduced, are front panel selectable. Internal adjustment presets normal amplitude value.

Burst Frequencies — 0.5, 1.5, 2.5-2.8, 4.0-4.3, 4.8 and 5.8 MHz within 3%. Each burst frequency independently adjustable.

Timing — Each burst starts at 0° of the first cycle and ends at 360° of the last cycle.

LINEARITY SIGNAL

Linearity — Three linearity test signals are front panel selectable: 5 step, 10 step and ramp either modulated or unmodulated. The subcarrier component is phase-locked to color burst. Applications include measurements of differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal nonlinearity, and burst phase errors.

Luminance Component — Peak amplitude 700 mV within 1%, 5 step, 10 step or ramp.

Riser Shape — Determined by filter with first zero at 4.43 MHz.

Chrominance Component — Amplitude is selectable: 0 mV, 140 mV, 280 mV.

Differential Phase — 0.2° or less.

Differential Gain — 0.5% or less.

Subcarrier Envelope — Risetime is 375 ns within 15%.

Ramp Luminance Amplitude — 700 mV.

Ramp Linearity — Within 1%.

PULSE AND BAR SIGNAL

2 T and T pulses are generated to high precision by two 9-pole Kastelein Filters. The digital programmer provides the high degree of timing accuracy required in these pulses to eliminate jitter and long term drift. The programmer also exactly determines pulse-to-pulse spacing and bar duration. However, the programmer may be readily re-programmed to produce different spacings or bar widths in 2 μs increments.

The $\sin^2$ pulse may be either 2 T (200 ns HAD) or T (100 ns HAD). The transitions of the bar are controlled by either of two Kastelein Filters so that frequency spectrum is limited to 4.3 MHz or 8.6 MHz. Shape of these transitions is integrated $\sin^2$.

For a specific application, the user may elect to program the 148 for any combination of T or 2 T pulse and T or 2 T bar. As shipped, the pulse is 2 T, the bar is formed by the T filter. This provides for K factor measurements of short time distortion. Thus the pulse and bar test signal is useful to measure line time and short time distortions.

The envelope of the modulated $\sin^2$ pulse is formed in the function generator rather than in a filter. The function generator can be readily programmed for any desired pulse width from 1.5 to 2.5 μs. Thus the 148 offers unique modulated $\sin^2$ pulse generator flexibility.

Modulated $\sin^2$ pulse (20 T) is used in measuring relative gain and delay errors between chrominance and luminance signals. The 20 T modulated $\sin^2$ pulse has a 2.0 HAD. Greater sensitivity to chrominance-luminance delay errors may be had by reducing the pulse width.

2 T Pulse Amplitude — Within 1% of luminance bar.

2 T HAD — 200 ns.

2 T Ringing — Amplitude less than 0.5%; duration less than 2 cycles.

Time Location — Internally programmable in 2-μs increments.

Test Signal Generator

Luminance Bar Amplitude — 700 mV ±1%.

T Bar Risetime — 185 ns ±15%.

T Bar Time Location — Start and Stop internally programmable in 2-μs increments.

20 T Modulated Pulse Peak Chrominance to Peak Luminance Amplitude Difference — Less than 0.5 IRE.

20 T Modulated Pulse HAD — 2.0 μs.

20 T Modulated Pulse Residual Subcarrier — Less than 0.5 mV on insertion line.

20 T Modulated Pulse Relative Chroma-Luminance Time Delay — Less than 5 ns.

FIELD SQUAREWAVE

A sensitive measurement of field time distortion can be made with this signal. In this mode, the 148 provides a composite video signal with 205 active lines at 700 mV, which approximates a 50 Hz squarewave. A composite video signal such as this reveals low-frequency phase and gain distortions much as a simple 50 Hz squarewave will do, but unlike the latter, it can pass through clamper amplifiers.

Amplitude — Within ±1 mV of white reference.

Number of White Lines — 65 through 270 and 377 through 582, all remaining active lines are black.

Risetime — Shaped by $\sin^2$ filter with first zero in frequency domain at 4.3 MHz.

WINDOW SIGNAL

The Window Signal is the same as the Pulse and Bar except that the "Window" occupies the center 205 lines of each field. A window signal can be used to measure both line time and field time distortions. It is especially useful when observing picture monitors. Where field rate distortion is present, the window signal will be affected to a much greater extent than the pulse and bar signal.

Amplitude — 700 mV.

Risetime — Internally programmable: either 2 T pulse and T window or T pulse and 2 T window.

NOISE

The 148 offers a unique signal-to-noise measuring technique for "in-service" testing during the vertical interval. The noise present in the middle portion of an internally selected line is deleted and noise generated in a calibrated source is inserted for measurement by comparison. The user varies a calibrated attenuator until inserted noise and incoming noise appear the same on a waveform monitor. The noise values measured are independent of operator interpretation errors to within 2 dB.

Where transmission noise is to be measured, the noise may be deleted on an entire line at the point from which the noise is to be measured using one 148. Further down the transmission system, a second 148 will match the noise level in the manner described previously. This process may be repeated and the transmission noise level determined for several sections of the transmission system, or its overall performance evaluated.

Noise may be measured at 50 mV, 350 mV or 700 mV luminance levels. The calibrated noise generator provides "flat" (white) noise.

Noise Pedestal Amplitude — Selectable 0 mV, 50 mV, or 100 mV. within 0.2 dB.

Variable Pedestal — Provided for half line insertion.

Noise Levels — −20 dB to −59 dB in 1 dB steps (0 dB = 700 mV RMS).

Flat Noise Spectrum — Energy unit bandwidth: 15 kHz to 5 MHz ±6 dB. (Spectrum extends well beyond 5 MHz.)

Output Impedance — 75 Ω.

Return Loss — Less than 30 dB to 5 MHz.

FLAT FIELD SIGNAL

The Flat Field Signal is used primarily for variable average picture level (APL), vertical interval testing. The Flat Field Signal is a composite video signal which during the active portion of each field has a constant luminance level. During the vertical interval there will be present each test signal which has been programmed for insertion as described in the Vertical Insertion/Deletion section.

The luminance level of the Flat Field Signal is selectable in eleven increments from 0% to 100% of white. An alternate selection provides a "bounce" between black and white with a variable period from 1 to 10 seconds. Thus the use of the Flat Field Signal permits the use of the several test signals in the presence of a selectable APL. This technique is useful in the measurement of APL-dependent distortions.

Luminance Level of the Flat Field Signal — Within 2% of the indicated level except the 100% level which is within 1%.

Risetime — Shaped by $\sin^2$ filter with first zero in the frequency domain at 4.43 MHz.

INSERTION TEST SIGNALS LINE 17, LINE 330 AND LINE 331

The signals used as vertical interval test signals on line 17, 330 and 331 are also available full field. The elements of these signals are specified as follows:

LUMINANCE BAR

Amplitude — 0.7 V ± 1%.

Shape and Time of Rise and Fall — Approximately 100 ns (or may be derived from the shaping network of the sine-squared pulse or of the staircase waveform).

Tilt — Less than 0.5% for 10 μs.

STAIRCASE SIGNAL

Level of the Uppermost Tread of Staircase — Within ±1% of luminance-bar amplitude.

Number of Risers — 5.

Shape of Risers — Determined by a filter with a first zero at 4.43 MHz.

Line-Time Nonlinearity — The difference in amplitude between the largest and smallest risers is less than 0.5% of the largest amplitude.

Superposed Sub-Carrier Frequency and Phase — 4.43361875 MHz ±10 Hz; 60° ±5° to the B-Y axis, referred to the burst (when present).

Rise and Fall Times of Sub-Carrier Superposed on Staircase — 1 μs approximately.

Inherent Differential Gain — Less than 0.5%.

Inherent Differential Phase — Less than 0.2°.

Amplitude of Superposed Sub-Carrier — 0.28 V peak-to-peak ±2% of luminance-bar amplitude.

2 T PULSE

Amplitude — ± 1% of luminance-bar amplitude.

Half-Amplitude Duration — 200 ±6 ns.

20 T COMPOSITE PULSE

Amplitude — Within ± 1% of luminance-bar amplitude.

Half-Amplitude Duration — 2 ±0.06 μs.

Inherent Chrominance / Luminance Gain Inequality — Less than 0.5%.

Inherent Chrominance/Luminance Delay Inequality — Less than 10 ns.

Sub-Carrier Leak — Less than 3.5 mV peak-to-peak on insertion lines.

Harmonic Content of Sub-Carrier — Less than −40 dB.

CHROMINANCE BAR

Peak-To-Peak Amplitude — Within ± 1% of luminance-bar amplitude.

Pedestal — 0.35 V ±1%. Risetime: as in sub-para 7.2.1.b.

Inherent Chrominance/Luminance Cross Modulation — 0.5% of pedestal amplitude.

Envelope Risetime — 1 μs approximately.

THREE-LEVEL CHROMINANCE BAR

Position of Transitions — 7H/32, 9H/32, 11H/32 and 14H/32.

Peak-To-Peak Amplitudes — 1st section, within ±1% of 1/5 of the luminance bar (nominal value: 0.14 V). 2nd section, within ± 1% of 3/5 of the luminance bar (nominal value: 0.42 V). 3rd section, within ± 1% of the luminance bar (nominal value: 0.7 V).

Pedestal — 0.35 V ±1%.

Chrominance/Luminance Cross Modulation — Less than 0.5% of pedestal amplitude.

Envelope Risetime — 1 μs approximately.

CHROMINANCE REFERENCE

Peak-To-Peak Amplitude — 0.42 V ±1% of luminance-bar amplitude.

Pedestal — As in sub-para 7.2.5.b.

Envelope Risetime — 1 μs approximately.

OTHER CHARACTERISTICS

Power Requirements — 90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz, 55 watts maximum at 115 VAC and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

Inputs — External VITS Input, Program Input, Auxiliary Input, Composite Sync and Subcarrier.

Outputs — Program, Program Monitor, Preview Monitor (two each) and Full Field.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0° to +50° C.

Dimensions and Weights

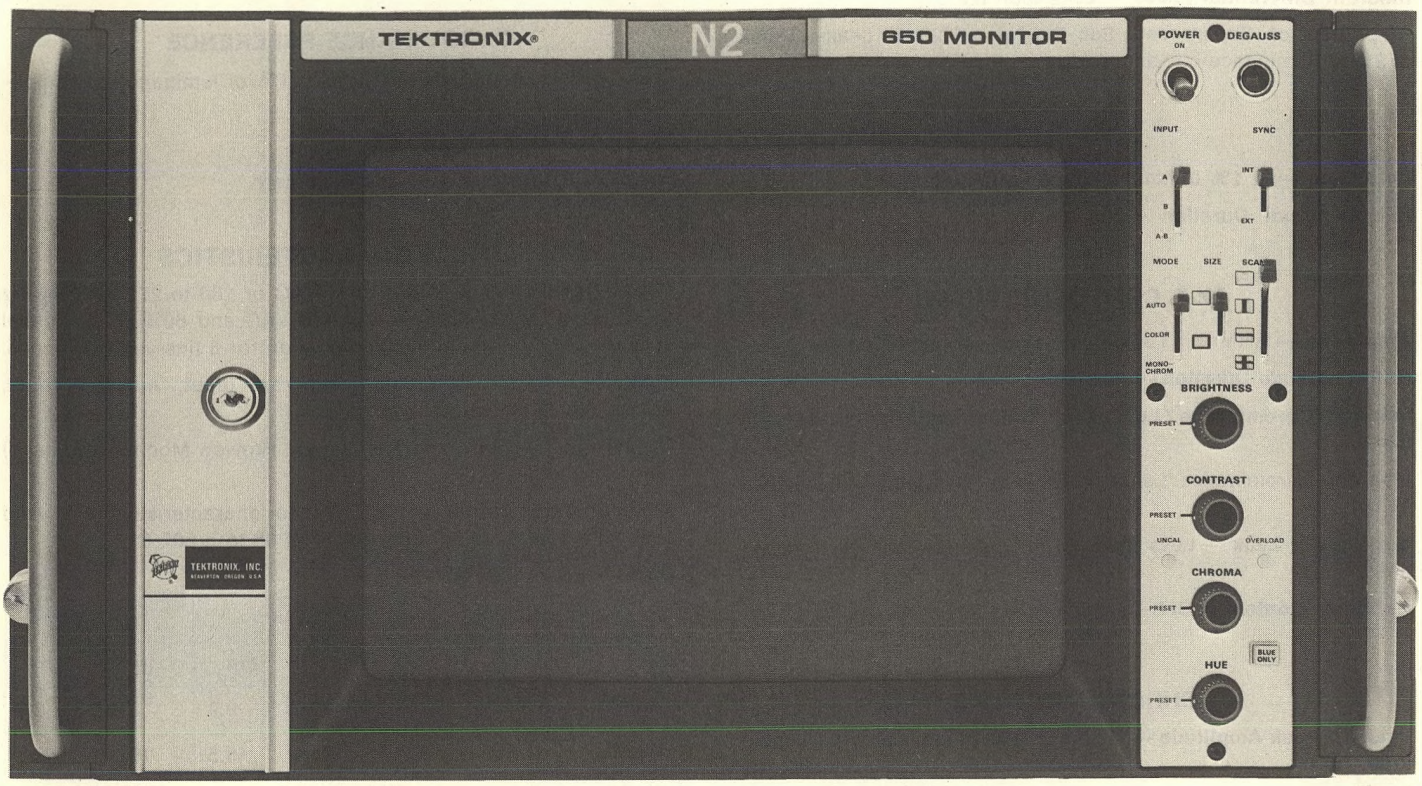
	148		R148	
	in	cm	in	cm
Height	3⅞	9.9	3½	8.9
Width	17⅞	45.5	19	48.
Depth	17⅛	43.6	19⅝	49.9
	lb	kg	lb	kg
Net Weight	≈19	≈ 8.6	≈20	≈ 9.1
Domestic shipping weight	≈35	≈15.9	≈36	≈16.3
Export-packed weight	≈55	≈25	≈56	≈25.4

INCLUDED ACCESSORIES

75-Ω, through-line termination; 3-conductor power cord; instruction manual. Includes rackmounting hardware for all 148's.

Order 148 TEST SIGNAL GENERATOR

650-Series
Color Picture Monitors



- Controlled phosphors traceable to an international standard.
- Preset operating controls to enable matching
- Precise color tracking over brightness and contrast ranges.
- Black level set for linear kinescope operation.
- Such precise phasing (hue) that it can be used for adjusting system encoding quadrature.
- Expanded V in pulse cross and V delay modes.
- Differential (A-B input) for sync timing, burst timing and phase adjustments.
- Retrace so rapid that the entire active picture area can be displayed.
- Two switchable inputs isolated from ground for hum rejection.
- External sync switching capability.
- Optional multistandard and/or RGB capability.
- Such precise decoding that R-Y, B-Y outputs are optional for use in vector display on oscilloscopes.

The 650-Series Color Picture Monitors are *measurement quality* monitors. *Measurement quality* means having the features and accuracy required to reliably assess signal quality.

A specially-manufactured twelve-inch Sony Trinitron*, with its simplicity of convergence and its adaptability to multistandard usage, is the heart of each monitor. 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.

PICTURE TUBE

The Sony Corporation Trinitron kinescope has many advantages over currently available shadow-mask color picture tubes. Outstanding among them is the simplicity of its convergence adjustment. After the yoke has been positioned properly, convergence is adjusted by means of four front-panel controls located behind a lockable door. Not only are there far fewer controls, but their adjustment is straightforward.

Basic to the Trinitron gun is the arrangement of the red and blue cathodes on the same (horizontal) plane as the green cathode which is located on the kinescope axis between the red and blue cathodes. Thus, convergence is primarily a matter of modulating the horizontal deflection component of the red and blue beams in opposite manner, but nearly equal amounts. The green beam, being on an axis, is not affected by convergence adjustments. Since the eye perceives green best, the green cathode is located in the center, which affords it the best focus of all three beams.

*Registered Trademark Sony Corporation.

Moire patterns may be displayed on shadow-mask color picture tubes due to interference effects between the scanning line structure and the dot structure. This is minimized by careful design of the shadow mask for the line structure the tube is designed for; e.g., 625 lines or 525 lines.*

The grille structure used in Sony Trinitron picture tubes is inherently free of this moire problem, hence the same Trinitron may be used on both 525 line and 625 line standards without compromise. This fundamental property of the Trinitron and the provisions for two decoders within the monitor make it universally usable on multiple standards.

Chromaticity of the TEKTRONIX 650-Series Monitors falls within the range of that currently specified by CCIR recommendations for PAL** and by the Canadian Television Practices Committee***. The Trinitron supplied in the 650-Series Monitors uses selected phosphors.

Reference white for the monitor is factory set to match illuminant D, whose color temperature is approximately 6500° K. Control range is adequate to permit readjustment to higher color temperatures where they are standard. The monitor is calibrated at the time of manufacture using a commercially available illuminant D white comparator. The screen color temperature is highly critical in accurate color reproduction and does vary with aging of the picture tube, regardless of design. Slight differences in color temperature between various monitors in a given broadcasting facility are far more serious than an absolute error in color temperature of all monitors at that facility. Thus, each facility will desire to maintain all monitors to match the reference white standard at the facility.

Two controls for each beam are provided to set up the color balance. The circuit arrangement permits one (bias) to set low level balance, the other (drive) to set high light color balance. These controls have minimal interaction, speeding correct adjustment. By compressing the raster 10:1 vertically, a very accurate bias adjustment is rapidly established. The setup switch and all color balance controls are under the lockable door.

The kinescope operates at 19 kV from a regulated EHT**** supply which is interlocked with the horizontal and vertical deflection circuits to avoid possible damage to the picture tube in the event of a deflection failure. During an EHT current overload condition, to avoid "blooming", certain characteristics of the monitor are altered; therefore, a front-panel OVERLOAD indicator is provided. An internal indicator of EHT failure is also provided.

DISPLAYS

Two inputs are provided for encoded video signals. Each input can be isolated from the chassis to prevent ground current-induced hum. Each input is also isolated from all others. Hum is at least 50 dB down for mains hum up to 4 V RMS.

*Recent Developments in Shadow-Mask Tubes for Color Television By W. W. Wright from the Royal Television Society Journal Volume 13 #10, July, August, 1971, Pages 221 through 230.

**CCIR Doc X1/136 (United Kingdom) 1966-1969. Also in Report 407-1 (Part B, Section 9).

***CTP 5: The Specifications of Colorimetric Characteristics in the Ideal Color Telecine by Lloyd C. Harrop, September, 1970 Journal SMPTE, Volume 179, page 808.

****Extremely High Tension

The video inputs may be used differently (A-B) to display the difference between two video signals. While using the differential mode, the hum rejection feature is still available, even in the typical case of unequal hum levels. This is especially useful when timing two signal sources relative to each other. The pulse cross display may be used to observe sync blanking and burst. The differential input performance is excellent throughout the entire frequency band. Thus, it is also possible to accurately observe the relative phase and timing, e.g., breezeway the duration of two color bursts. This is a logical extension of the usual pulse cross capability of picture monitors.

The picture may be shifted either horizontally or vertically or both together (pulse cross). This permits monitoring sync, burst, blanking, vertical interval test and reference signals. When the monitor is operating in any of these display modes, brightness is automatically advanced to permit observation of the sync pulses and burst. Expansion of the vertical scan is provided in pulse cross and vertical delay modes to view individual lines in the vertical blanking interval.

In the 650 Series, horizontal retrace is less than 10 microseconds. This is less than any horizontal blanking interval. The rapid retrace enables viewing (in reduced size mode) of the entire active video (picture) area. During this rapid retrace these monitors clamp video to the preadjusted black level. Time constants are chosen so that any hum component of the video signal will be displayed, alerting the video operator.

RGB VERSIONS FOR UNENCODED VIDEO AND INFORMATION DISPLAY

RGB Versions are designed for monitoring unencoded video signals. RGB inputs permit monitoring the camera signal before the encoding process. Thus colorimetric errors may be readily isolated to either camera or encoder. Small errors in the unencoded signal can readily be observed. This may be of particular value in accurate camera matching.

RGB Versions are excellent for display of data from computers, process control systems, electron microscopes and other systems requiring precise, multicolor displays. RGB inputs may be used to observe color television signals decoded from any standard. In these monitors, reliance can be placed upon their stable and accurate RGB tracking. A simple demonstration is highly convincing. The RGB inputs are normally isolated from each other and the chassis. One model having RGB input only is available, and another has dual RGB inputs.

CALIBRATED MEASUREMENT INSTRUMENT

The 650-Series Color Monitors are calibrated measuring instruments. The chrominance gain and phase controls and the video gain and brightness controls are provided with preset calibrated positions. In these detented positions the instrument produces a picture in accordance with system standards. In addition the monitors exhibit precise color tracking over brightness and contrast ranges.

The color subcarrier is regenerated from burst with great accuracy, despite the many possible errors which may occur in burst itself with regard to timing, amplitude or transients (quadrature components). Burst itself is often regenerated in TV transmission; hence, this instrument should not exhibit any sensitivity to the peculiarities of the color burst component of the picture signal.

The phasing (Hue) of the 650 Series is stable enough to confirm the phase accuracy of encoders, processing amplifiers, VTRs, etc. A "Blue Only" button on the operational panel (right side) is used for this function.

Residual color subcarrier, present as a CW signal component of the encoded signal, causes a change in the colorimetry of the reproduced picture on home receivers. This occurs because the CW subcarrier is present on neutral shades of gray and white. Even subcarrier amplitudes too small to be easily noticed on the waveform monitor or vectorscope can change the observed color. The 650-Series Monitor is designed to detect residual subcarrier signal under these conditions and will display a significantly different color picture in certain cases than other monitors. This feature may be eliminated if desired. However, as a measuring instrument, it is inteded to display the true signal, and not compensate for signal errors.

When monitoring encoded signals, it is essential that the chrominance subcarrier does not reach the kinescope. If it does, the effects are: (1) Objectionable dot structure crawling vertically. (2) Gamma characteristics of the display will be altered by the chrominance subcarrier. The result is that highly saturated colors, especially in dark areas, will be substantially increased in brightness with a consequent decrease in saturation and contrast. A practical solution is to reduce the luminance amplifier frequency response in the vicinity of the color subcarrier. A luminance channel low-pass filter with *phase equalization* is provided to accomplish this objective.

The MODE switch controls whether or not the chrominance channel is activated. In the AUTO mode, the chrominance channel is activated by the presence of burst. In the COLOR mode, the chrominance channel is activated whether burst is present or not; in MONOCHROME mode, the channel is deactivated despite the presence of burst.

VECTOR DISPLAY OPTION

The decoder design uses equiband decoding in the 650-Series Monitors and is highly stable and accurate in phase and gain. Thus the color difference signals from the decoder may be used to provide a very accurate vectorscope display (comparable to the present state-of-the-art) on any suitable X-Y oscilloscope. By ordering Option 2, your color monitor is fitted with X and Y outputs at the correct levels to drive TEKTRONIX 602 and 604 X-Y Oscilloscopes. These are available with an internal vectorscope graticule suitable for both NTSC and PAL when ordered with Mod 174V.

Those two standard color monitors with Option 2 will provide color difference signals from whichever decoder is in use so that not only is the color monitor multistandard, but so is the vector display.

Option 2 provides a *vector only* display and is not well suited for transmission measurements of nonlinear distortions.

GENERAL INFORMATION

All signal connections to the picture monitor are made through BNC coaxial connectors located on the sloping rear panel of the instrument. Two connectors for each input provide compensated loop-through connections so that the instrument may be connected into any part of a system.

Two external composite sync inputs are provided with the capability of automatically switching between two external sync signal sources as the video input is switched, or for obtaining sync for both video inputs from one sync source as desired. The sync inputs are also isolated from each other and the chassis.

All components in the instrument are solid state except for the kinescope. All transistors and diodes are silicon devices. Most transistors, and integrated circuits are socketed for ease in servicing. Semimodular construction is used with the glass-epoxy etched circuit boards readily removable for repair or replacement.

Remote Control

All instruments are capable of being modified for remote control. Certain circuits within the monitor, normally controlled by the right front-panel controls, can be remotely controlled through potentiometers, ground closures or TTL circuitry. This requires special quotes.

Other Features

Manual degaussing facilities are provided. The 650 is available in either a 10½ inch rackmount form or cabinet form. A 24-volt tally lamp is provided with a set of characters for the tally window.

NTSC PERFORMANCE

CONNECTORS—BNC.

SIGNAL LEVEL—0.5 V P-P minimum composite video; 2 V P-P maximum.

IMPEDANCE

UNTERMINATED—High Z bridging inputs loop-through compensated for 75 ohms (not internally terminated).

RETURN LOSS—At least 46 dB to 5 MHz, power on or off, input in use or not.

MAXIMUM SAFE INPUT—Exceeds CCIR Recommendation 451-2 (±5 V peak).

HUM REJECTION—Hum is at least 50 dB down when 5 V maximum RMS mains hum signal is applied to the monitor in floating ground mode.

DIFFERENTIAL A-B MODE COMMON MODE REJECTION—46 dB, or greater, up to 4.43 MHz.

LUMINANCE CHANNEL

DC RESTORATION—Back porch type; not affected by burst. Mains hum reduction due to DC restorer is less than 6 dB.

AMPLITUDE LINEARITY—Within 2%.

BANDPASS—Limited to approximately 3 MHz.

CHROMINANCE CHANNEL

DEMODULATION AXIS—R-Y, B-Y.

BANDPASS—0.6 MHz equiband.

GAIN RANGE—Preset at 0 dB; adjustable from —6 dB to +10 dB.

RESIDUAL SUBCARRIER DETECTION (on applied signal)—Color of displayed picture will shift due to any residual subcarrier. This feature can be inhibited by a jumper on the decoder board.

CHROMINANCE/LUMINANCE

TIME ERROR—Less than 30 nanoseconds.

GAIN ERROR—Less than 3%.

DELAY—Red to green to blue is less than 30 nanoseconds.

SUBCARRIER REGENERATION

PHASE ERROR—Within 1° with input burst variation of ±10 Hz from 3.579545 MHz, nominal burst level.

WITH TEMPERATURE VARIATION—Within 5° with ambient temperature variation from 0°C to 50°C; within 1°, for any 10°C increment within the range of 0°C to 50°C.

WITH INPUT SIGNAL VARIATION—Within 1° with input signal variation of ±3 dB from 1.0 V. Within 3° with variation of burst/sync ratio of —6 dB to +10 dB.

BREEZEWAY STABILITY—0.2° or less for burst timing errors including burst width variance (8-11 cycles), and breezeway variance ±0.28 μs.

PHASE ERROR DUE TO NOISE—Within 1° with RMS white noise at —24 dB (0 dB = 700 mV RMS).

PAL PERFORMANCE

CONNECTORS—BNC.

SIGNAL LEVEL—0.5 V P-P minimum composite video; 2 V P-P maximum.

IMPEDANCE

UNTERMINATED—High Z bridging inputs loop-through compensated for 75 ohms (not internally terminated).

RETURN LOSS—At least 46 dB to 5 MHz, power on or off, input in use or not.

MAXIMUM SAFE INPUT—Exceeds CCIR recommendation 451-2 (±5 V peak).

HUM REJECTION—Hum is at least 50 dB down when 5 V maximum RMS mains hum signal is applied to the monitor in floating ground mode.

DIFFERENTIAL A-B MODE COMMON MODE REJECTION—46 dB, or greater, up to 4.43 MHz.

LUMINANCE CHANNEL

DC RESTORATION—Back porch type; not affected by burst. Mains hum reduction due to DC restorer is less than 6 dB.

AMPLITUDE LINEARITY—Within 2%

BANDPASS—Limited to approximately 3 MHz.

CHROMINANCE CHANNEL

DEMODULATION AXIS—U, V.

BANDPASS—Approximately 1.2 MHz.

GAIN RANGE—Preset at 0 dB; adjustable from —6 dB to ±10 dB.

RESIDUAL SUBCARRIER DETECTION (on applied signal)—Color or displayed picture will shift due to any residual subcarrier. This feature can be inhibited by a jumper on the decoder board.

CHROMINANCE/LUMINANCE

TIME ERROR—Less than 30 nanoseconds.

GAIN ERROR—Less than 3%.

DELAY—Red to green to blue in less than 30 nanoseconds.

SUBCARRIER REGENERATION

PHASE ERROR—Within 1° with input burst variation of ±10 Hz from 4.433619 MHz, nominal burst level.

WITH TEMPERATURE VARIATION—Within 5° with ambient temperature variation from 0°C to 50°C; within 1°, for any 10°C increment within the range 0°C to 50°C.

WITH INPUT SIGNAL VARIATION—Within 1° with input signal variation of ±3 dB from 1.0 V. Within 3° with variation of burst/sync ratio of —6 dB to +10 dB.

BREEZEWAY STABILITY—0.2° or less for burst timing errors including burst width variance (8-11 cycles), and breezeway variance ±0.28 μs.

PHASE ERROR DUE TO NOISE—Within 1° with RMS white noise at —24 dB (0 dB + 700 mV RMS).

RGB PERFORMANCE

CONNECTORS—BNC.

SIGNAL LEVEL—0.5 V to 2 V P-P.

IMPEDANCE

UNTERMINATED—High Z bridging inputs loop-through compensated for 75 ohms (not internally terminated).

RETURN LOSS—At least 46 dB to 5 MHz, power on or off, input in use or not.

MAXIMUM SAFE INPUT—Exceeds CCIR Recommendation 451-2 (±5 V peak).

HUM REJECTION—Hum is at least 50 dB down when 5 V maximum RMS mains hum signal is applied to the monitor in floating ground mode.

INTERNAL SYNC—Obtained from green channel composite signal.

LUMINANCE CHANNEL

DC RESTORATION—Back porch type; not affected by burst. Mains hum reduction due to DC restorer is less than 6 dB. Shift in blanking level due to APL variations from 10% to 90% is less than 2 IRE.

AMPLITUDE LINEARITY—Within 2%.

650-Series
Color Picture Monitors

PICTURE

HEIGHT—7.23 inches or 184 mm.

WIDTH—9.64 inches or 214 mm.

UNDERSCAN—Approximately 20% reduction in both height and width.

ASPECT RATIO— 3:4.

DEFLECTION LINEARITY Vertical and Horizontal—±1% within a central area bounded by a circle whose diameter equals picture height; ±2% outside of the central area.

CONVERGENCE ERROR—Less than 1 mm within the central area. Outside of the central area, color separation (misconvergence) is less than 2 mm.

UNBLANKING—All active picture elements are displayed. (Horizontal retrace is accomplished within 10 μs).

COLORIMETRY—Falls within the range of PAL System 1; color temperature is adjustable to 6500°K. Nominal RGB coordinates: Red ($X = 0.645$, $Y = 0.335$); Green ($X = 0.290$, $Y = 0.600$); Blue ($X = 0.150$, $Y = 0.065$).

COLOR TEMPERATURE—6500°K. Adjustable to other standards.

CALIBRATED CONTRAST—30 foot lamberts at peak white of standard 1 V signal.

CALIBRATED BRIGHTNESS—Displayed black may be adjusted to black level of input signal.

E.H.T. (Extremely High Tension)—19 kV nominal, regulated. Load variations cause less than 1% picture height variation. Monitor conforms to Department of Health, Education and Welfare regulation 42 CFR, Part 78, applicable at date instrument was manufactured.

KINESCOPE PROTECTION—Failure of horizontal and vertical scanning shuts off the E.H.T. Failure of H.V. Regulator circuit does not cause E.H.T. to soar excessively. E.H.T. supply is current limited.

HEATER VOLTAGE—Regulated DC.

SYNC & TIMING

CONNECTORS—BNC.

SIGNAL RANGE—Composite sync 0.5 V P-P to 8 V P-P or composite video 0.5 V to P-P to 2 V P-P.

IMPEDANCE

UNTERMINATED—High Z bridging inputs loop-through compensated for 75 ohms (not internally terminated).

TERMINATED—75 ohms.

RETURN LOSS—At least 46 dB to 5 MHz with respect to 75 ohms.

HUM REJECTION—Hum is at least 50 dB down when 5 V maximum RMS mains hum signal is applied to the monitor in floating ground mode.

SYNCHRONIZATION—Stable subcarrier regeneration, limited by line sync performance. Line sync white noise immunity is 20 dB. Field sync white noise immunity is 20 dB. Field sync stable with tilt equal to 100% of sync amplitude in vertical blanking. Stable with 20 IRE mains hum.

AFC—Two-loop AFC type.

PHASE CORRECTOR—Corrects for phase errors due to side pin cushion correction and other effects within the monitor.

SLOW AFC—Displays timing errors of incoming sync; particularly, 60 Hz or 240 Hz timing errors. Bandwidth is approximately 25 Hz.

FAST AFC—Largely corrects for incoming errors; approximately 2 kHz bandwidth.

SCAN DELAY

HORIZONTAL DELAY—Approximately ¼ line; displays burst.

VERTICAL DELAY—Approximately one-half field; vertical scan is expended unless underscan is activated.

PULSE CROSS—Displays horizontal and vertical blanking intervals; vertical blanking is expanded unless underscan is activated. All equalizing pulses are displayed.

POWER INPUT

LINE VOLTAGE RANGE

115 V—Within 10% (104 VAC to 126 VAC).

230 V—Within 10% (198 VAC to 242 VAC).

CREST FACTOR—At least 1.3.

LINE CURRENT—1.5 A RMS maximum at 115 V, 60 Hz. 0.75 A maximum at 230 V, 50 Hz. Current is substantially higher during degaussing.

DEGAUSSING SURGE CURRENT—5 A RMS.

POWER CONSUMPTION—150 W maximum, 110 W typical.

LINE FREQUENCY—48 Hz to 66 Hz.

DIMENSIONS (Overall)

CABINET VERSION—Width is 16.75 inches or 42.545 cm.
Height is 11 inches or 27.940 cm.
Length is 16.5 inches or 41.910 cm.

RACKMOUNT VERSION—Width is 19 inches or 48.260 cm.
Height is 10.46 inches or 26.568 cm.
Length is 18.25 inches or 46.355 cm.

Included accessories: 7½-ft power cable, three wire (161-0036-00); indicator symbol film for tally indicator (334-1935-00); four cabinet feet and mounting screws (348-0080-01); instruction manual (070-1161-00).

All 650 Monitors are shipped with rackmounting hardware.

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Order 650-1 **NTSC plus RGB**
Order 651 **PAL**
Order 651-1 **PAL plus RGB**
Order 654 **RGB**
Order 654-1 **RGB/RGB**
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For Vector Display Option
Order Option 2 (for each 650 Monitor)

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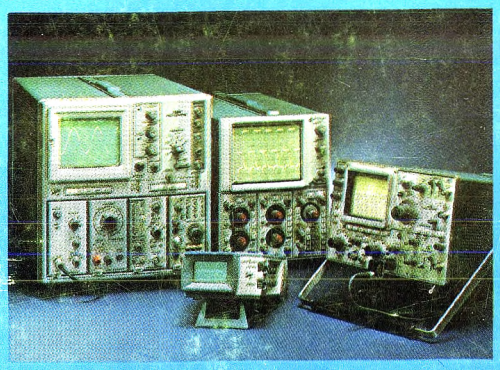

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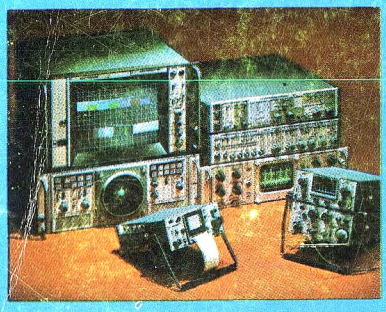
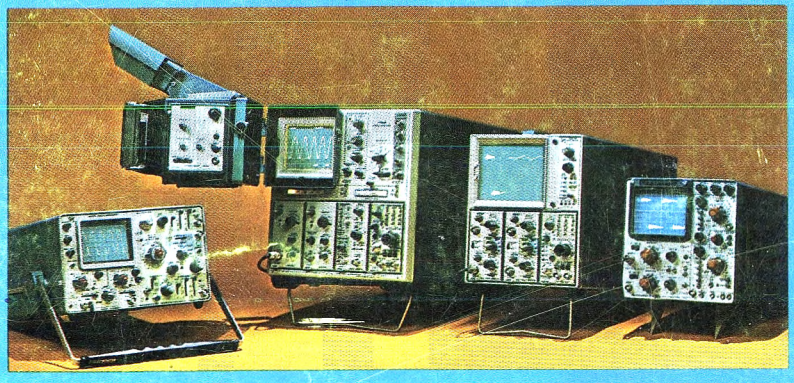


TELEVISION INSTRUMENTS—Television broadcasters use TEKTRONIX waveform monitors and vectorscopes to detect, display and measure signal aberations in every television picture you see at home. We also provide the television industry with precise test signals and timing signals. Picture monitors of unique precision and with new measurement features are our most recent contribution to picture quality.



THE OSCILLOSCOPE DISPLAY—Wherever the oscilloscope is used, on the engineer's bench, in complex experiments or servicing sophisticated devices, people make measurements and decisions based on its visual display. The center of action displayed in the world of science, engineering, manufacturing and servicing is the oscilloscope display.

AUTOMATIC TESTING SYSTEMS—Automatic testing is an economical way to determine and maintain product quality. Tektronix, Inc. makes Functional, DC and Dynamic Testing Systems with features such as computer control, waveform digitizing, 20 MHz testing, instant graphing of results and hard copy option.

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