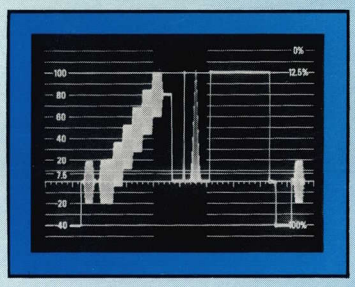
Television  Products

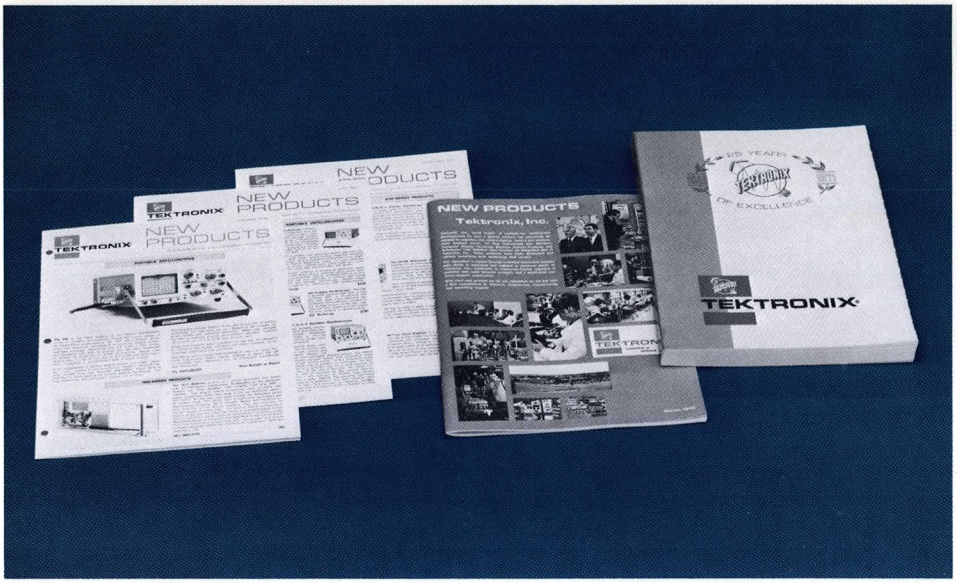
- Picture Monitors
- Test Signal Generators
- Oscilloscopes
- Vectorscopes
- Sync Generators
- Waveform Monitors
- Spectrum Analyzers

Tektronix, Inc.

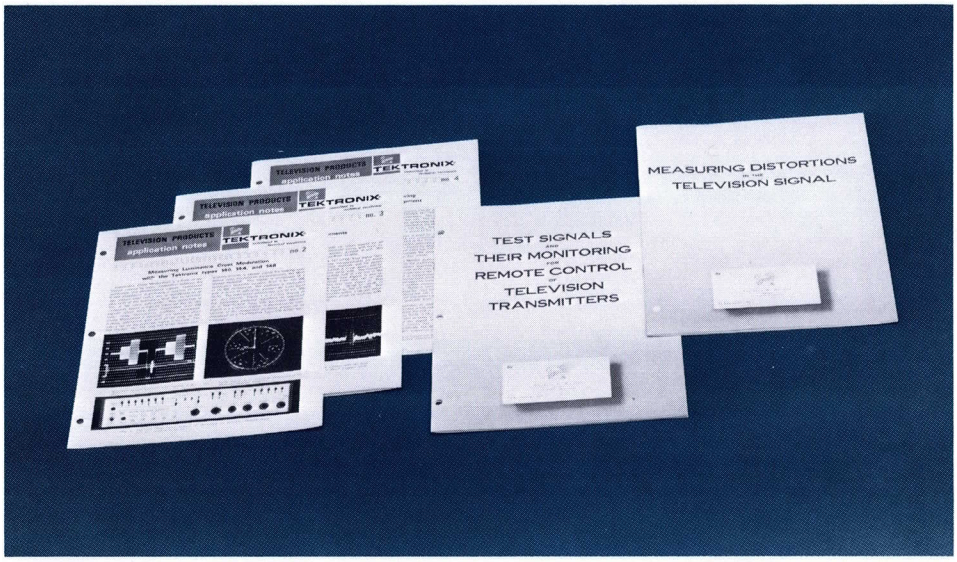
March, 1972

ITEMS MAILED TO THE TELEVISION AND CATV MAILING LISTS

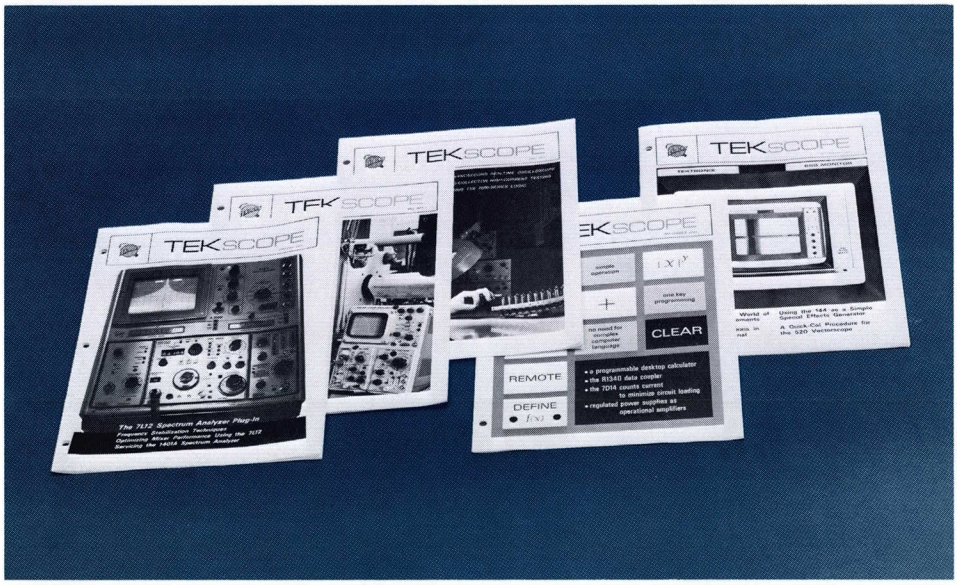
TEKTRONIX Television Products catalog. Full TEKTRONIX Catalog plus New Product Supplements.



Application Notes — How-to-do-it information about measurements and operation.



TEKSCOPE — A periodical containing articles describing instruments, measurements and techniques across the whole TEKTRONIX technology.



INFORMATION ABOUT PRODUCTS OF INTEREST TO YOU

TV CATALOG PURPOSE

The purpose of this catalog is to communicate the important details about TEKTRONIX products useful to people concerned with engineering, operating and maintenance of any television system. CATV, ETV, CCTV and *broadcasters* are served by the products included in this publication.

HOW TO USE THIS CATALOG

This catalog is organized by basic product function:

Within each functional section, most products are grouped by standard or system. Reference charts are provided to guide the user quickly to the product best serving his needs. When a product is known by type or model number, use the index for page location.

ORDERING INFORMATION

A complete index and price list of all products in this TV Products Catalog will be found on the last page of this catalog. General terms of sale and warranty information are contained in our March, 1971, full catalog.

OTHER PRODUCT INFORMATION

There are many TEKTRONIX products not included here. Most users of this catalog will occasionally need information about those products. Most, but not all, of this information will be found in the full TEKTRONIX catalog. Your local TEKTRONIX people can provide information about any product. Please contact them; they will be glad to help you.

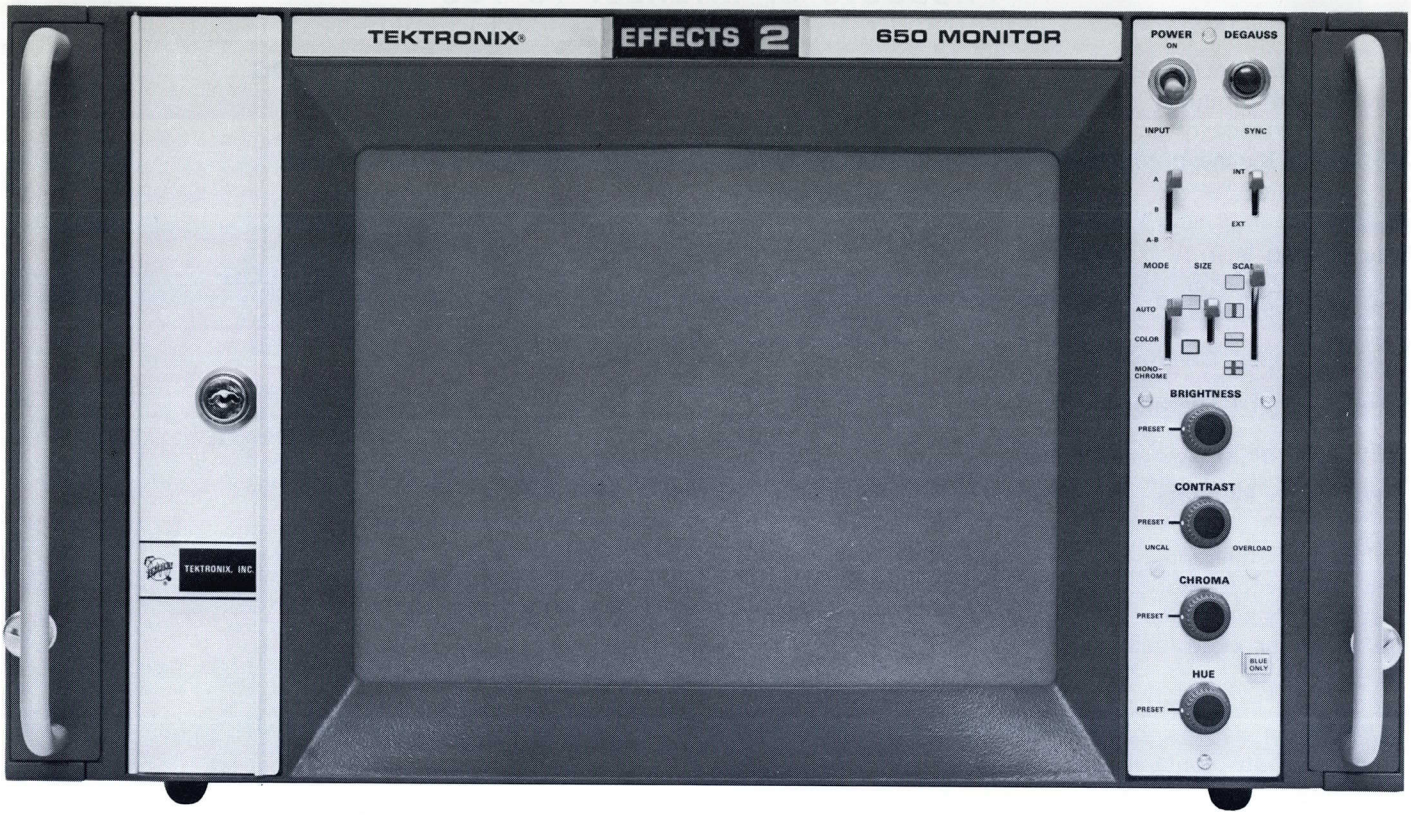
MAILING LISTS

In the United States and Canada, Tektronix, Inc. maintains several mailing lists. This catalog and other material related to your interests in television are mailed periodically to our *Television Mailing List.* We also have a *CATV* Mailing List that receives most of the same items, plus any items of special interest to CATV people (see inside front cover).

TEKTRONIX AND TELEVISION SIGNAL QUALITY

For more than twenty years, Tektronix, Inc. has produced products used in detecting and measuring television signal distortions. Only a few years ago, these distortions were large enough that they could easily be measured, usually after or before the broadcast day. Today, nearly all measurements are on an "in-service" basis using the vertical interval test signals (VITS). TEKTRONIX Television Products have helped lead the way to better signal quality with our television instruments, waveform monitors, vectorscopes, test transmission and synchronizing generators, and picture monitors in use at almost every point in world-wide television broadcasting systems.

In addition to manufacturing television measurement products used in nearly every country in the world, Tektronix, Inc. plays an active part within the television engineering community developing measurements and techniques that help make the color picture a quality color picture. The television picture signal presents a constant challenge to the state-of-the-art in origination, transmission and measurement capability. We are proud to be one of the leaders in advancing the state-of-the art.



- 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

650 NTSC
650-1 NTSC plus RGB
651 PAL
651-1 PAL plus RGB
652 PAL M
652-1 PAL M plus RGB
654 RGB
654-1 RGB plus RGB
655 NTSC plus PAL
655-1 NTSC plus PAL plus RGB
658 PAL M plus NTSC
658-1 PAL M plus NTSC plus RGB
659 PAL M plus PAL
659-1 PAL M plus PAL plus RGB

PAL monitors are for systems using 625/50 and 4.43 MHz.

PAL M monitors are for systems using 525/60 and 3.575 MHz.

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.

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.**

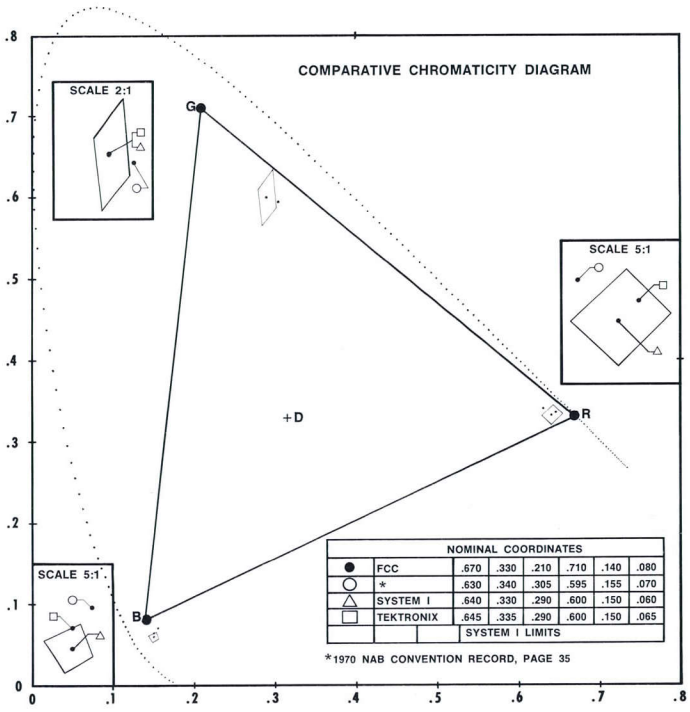
The grille structure used in Sony Trinitron picture tubes is inherently free of this moire problem, hence the same Trinitron may be used on both 525 line and 625 line standards without compromise. This fundamental property of the Trinitron and the provisions for two decoders within the monitor make it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



The TEKTRONIX pioneered phosphors used in the 650 Series with results shown in this chromaticity chart.

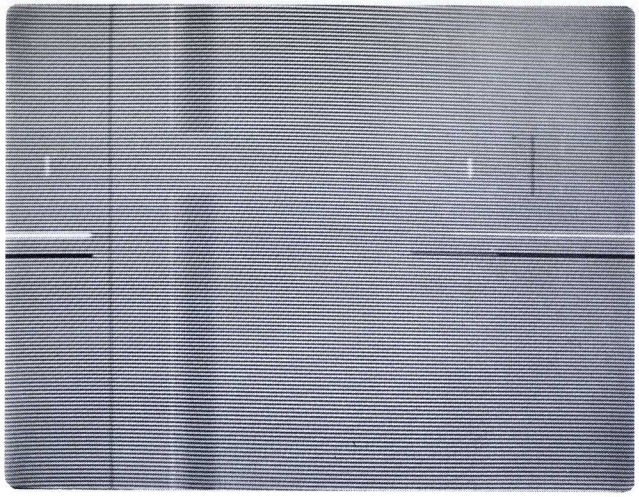
*Registered Trademark Sony Corporation.

** 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.

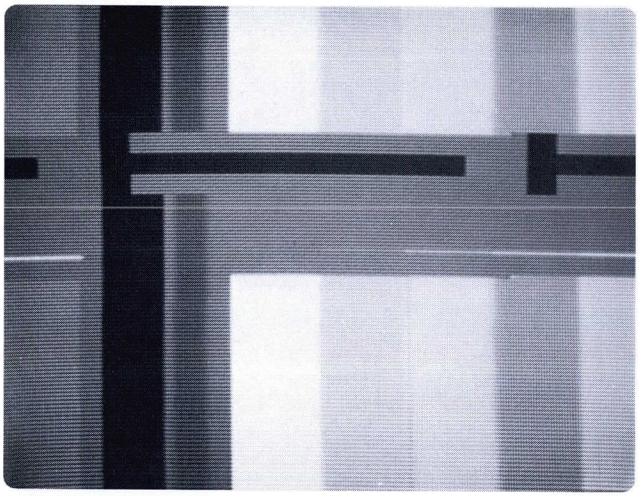
***CCIR Doc X1/136 (United Kingdom) 1966-1969. Also in Report 407-1 (Part B, Section 9).

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

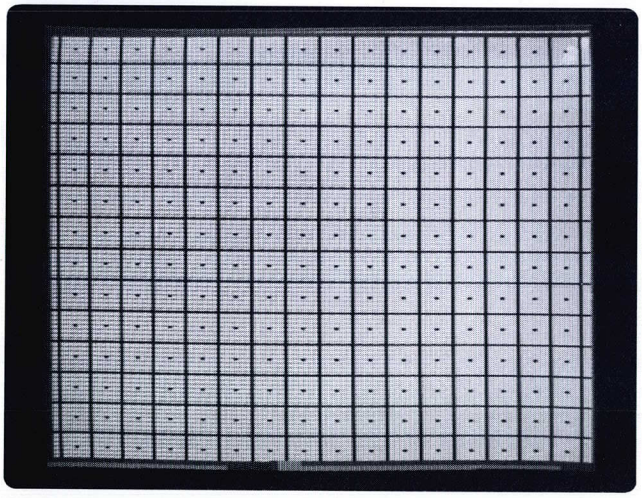
*Extremely High Tension



An A-B display of an expanded pulse-cross display. Note the excellent cancellation of the two signals except for portions visible because of slight differences between cable length.



Here is the unique pulse-cross display that shows details of the vertical interval by expanding the V axis.



The entire frame area is visible in this underscan display. Exceptionally rapid retrace makes this display possible.

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.

The video inputs may be used differentially (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.

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 intended 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.

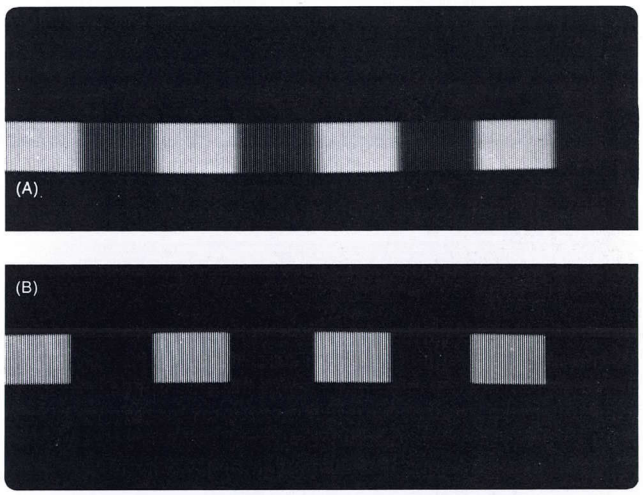
Those two standard color monitors with Option 2 will provide color difference signals from whichever decoder is in use so that not only is the color monitor multistandard, but so is the vector display.

Option 2 provides a *vector only* display and is not well suited for transmission measurements of nonlinear distortions.

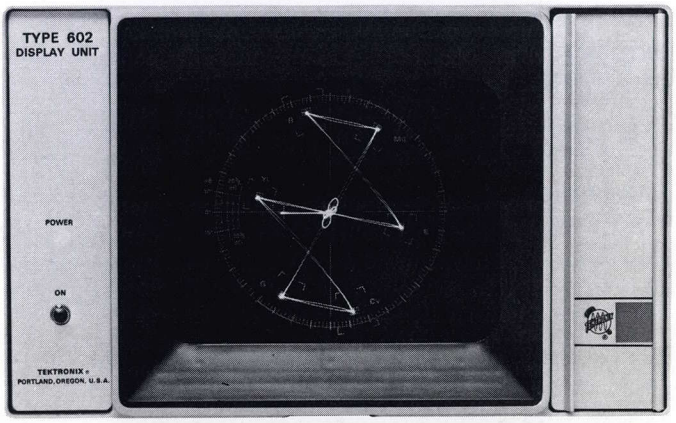
RGB VERSIONS FOR UNENCODED VIDEO AND INFORMATION DISPLAY

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.



Bias adjustment for each beam is facilitated by a 10-to-1 raster compression. In this case blue bars are displayed (A) with bias adjusted for just-visible blue between the bars and (B) with bias setup for no visible blue between the bars.



Precise decoding allows the Monitors to be used with a X-Y oscilloscope for Vector displays. Shown is a TEKTRONIX 602 MOD 174V.

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 4 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 4 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 4 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%.

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 ; 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 expanded 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% (207 VAC to 253 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)

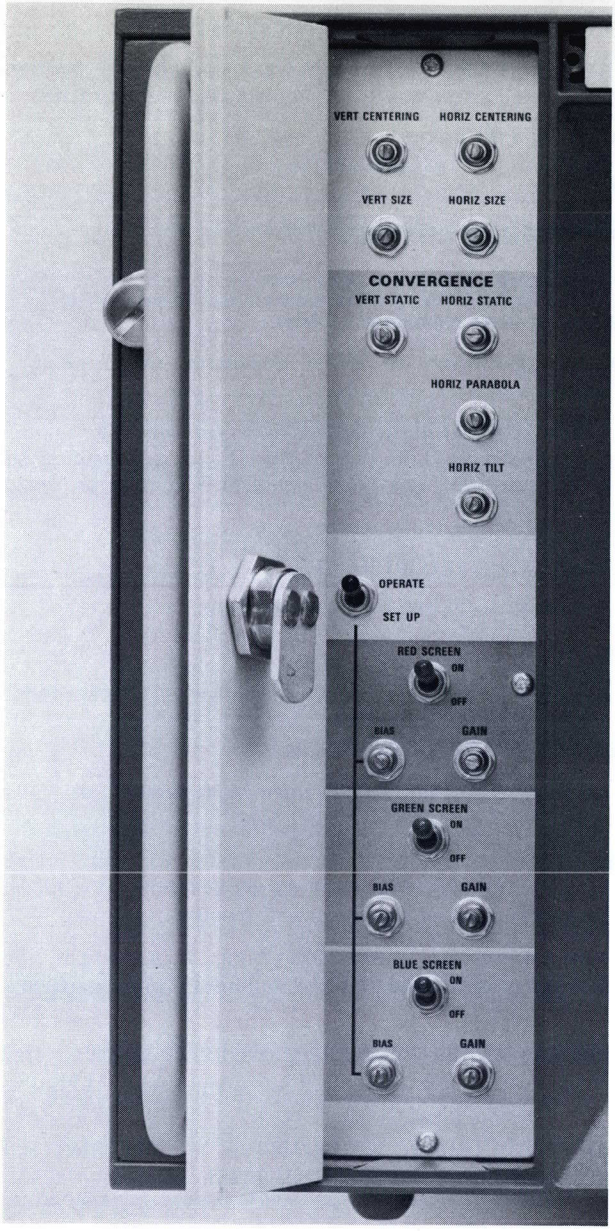
CABINET VERSION—Width is 16.75 inches or 42.545 cm.
Height is 11 inches or 27.940 cm.
Length is 16.5 inches or 41.910 cm.

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.

Order 650 NTSC
Order 650-1 NTSC plus RGB
Order 651 PAL
Order 651-1 PAL plus RGB
Order 652 PAL M
Order 652-1 PAL M plus RGB
Order 654 RGB



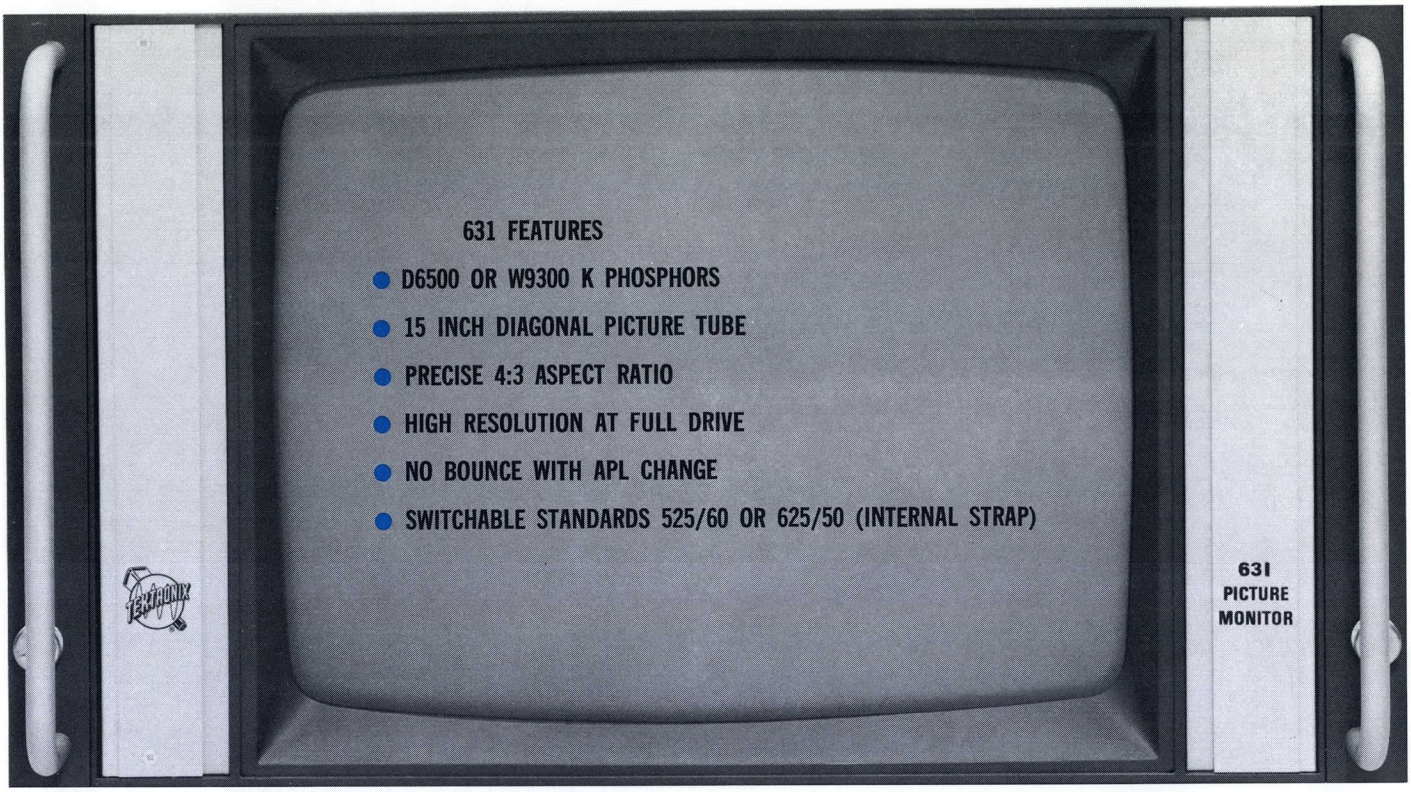
These are the simple controls behind the lockable front-panel door. These controls will not be adjusted during the 650 Series use. Inherently stable design results in precise performance over extended periods.

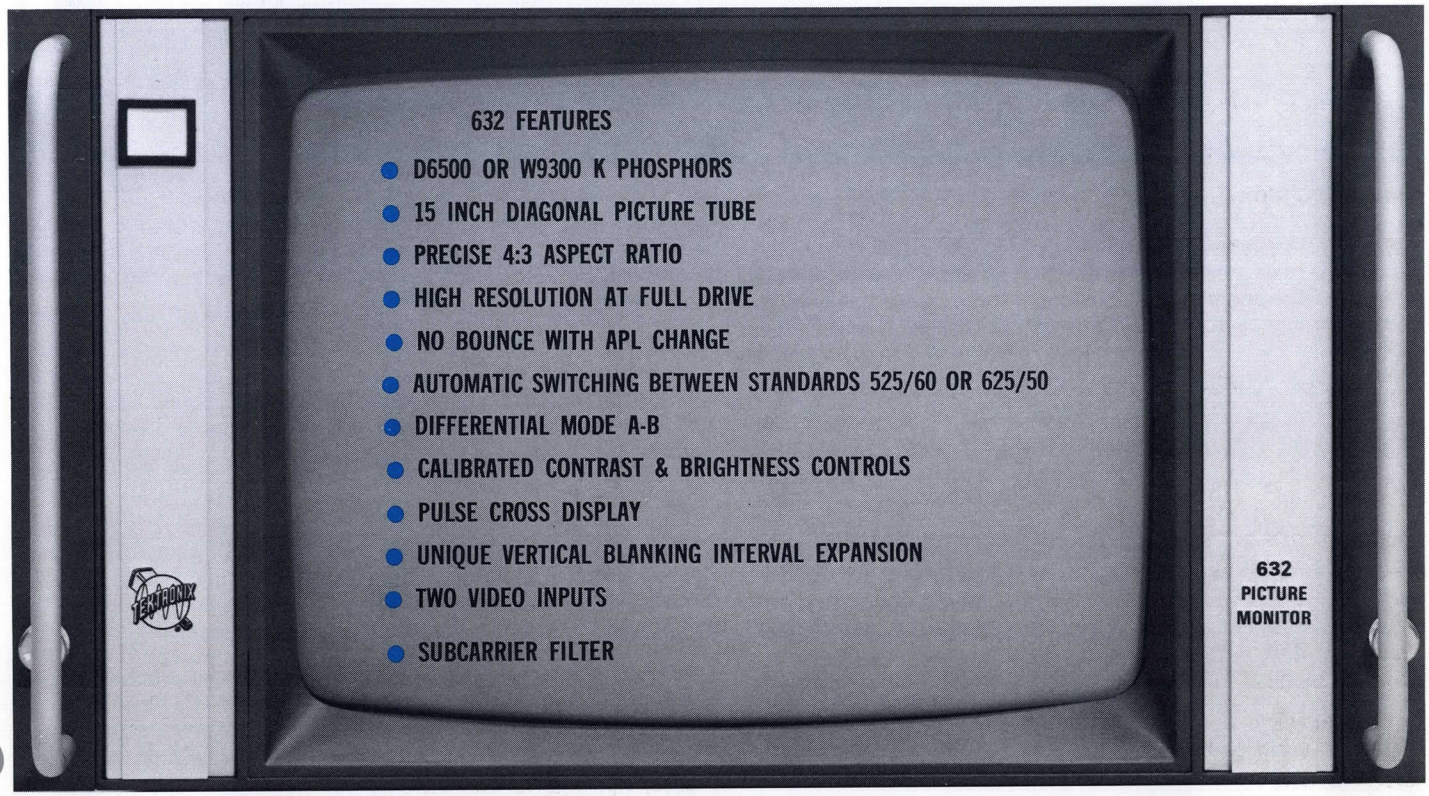
Order 654-1 RGB plus RGB
Order 655 NTSC plus PAL
Order 655-1 NTSC plus PAL plus RGB
Order 658 PAL M plus NTSC
Order 658-1 PAL M plus NTSC plus RGB
Order 659 PAL M plus PAL
Order 659-1 PAL M plus PAL plus RGB

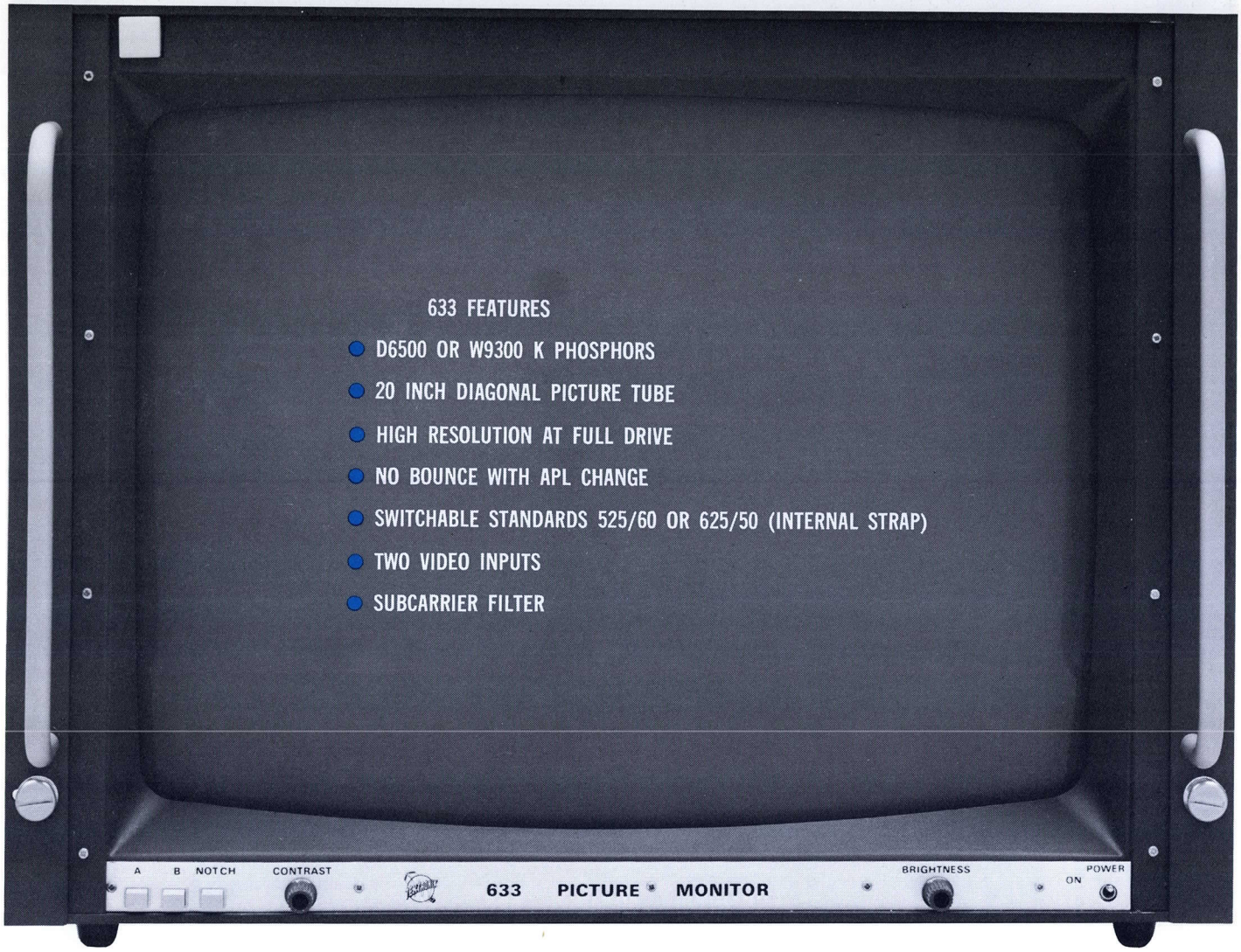
For Vector Display Option

Order Option 2 for single standard (for each 650 Monitor)
Order Option 2 for dual standard (for each 650 Monitor)
Order 602 MOD 174V
Order 604 MOD 174V

For further ordering information see last page.


631 FEATURES
D6500 OR W9300 K PHOSPHORS
15 INCH DIAGONAL PICTURE TUBE
PRECISE 4:3 ASPECT RATIO
HIGH RESOLUTION AT FULL DRIVE
NO BOUNCE WITH APL CHANGE
SWITCHABLE STANDARDS 525/60 OR 625/50 (INTERNAL STRAP)
631
PICTURE
MONITOR


632 FEATURES
D6500 OR W9300 K PHOSPHORS
15 INCH DIAGONAL PICTURE TUBE
PRECISE 4:3 ASPECT RATIO
HIGH RESOLUTION AT FULL DRIVE
NO BOUNCE WITH APL CHANGE
AUTOMATIC SWITCHING BETWEEN STANDARDS 525/60 OR 625/50
DIFFERENTIAL MODE A-B
CALIBRATED CONTRAST & BRIGHTNESS CONTROLS
PULSE CROSS DISPLAY
UNIQUE VERTICAL BLANKING INTERVAL EXPANSION
TWO VIDEO INPUTS
SUBCARRIER FILTER
632
PICTURE
MONITOR



The 631, 632 and 633 Monochrome Picture Monitors are designed for measurement and qualitative evaluation of 525/60 and 625/50 standards. The monitors have many features in common such as a choice of D6500 or W9300 K phosphors. High resolution is maintained at full drive. Bandwidth is 6 MHz within 0.5 dB with 100% white amplitude.

The TEKTRONIX Monochrome Picture Monitors are designed to display 50 fields/second 625-line or 60 fields/second 525-line television pictures. The switching between the 50 fields/second 625-line and 60 fields/second 525-line system is automatic in the 632.

The monitors are all solid-state (except kinescope) and require only 10½ inches (14 inches for 633) of rack space. They can easily be changed into a rackmount version. A rectangular kinescope with a polished screen face (centered horizontally), rimband implosion protection and 3:4 aspect ratio is used.

Easily removable doors on the 631 and 632 provide access to the display and signal selection controls. The monitors have front-panel selection of signal inputs, or the difference signal (632 only) between the two input channels. The rear-panel video input connector grounds are isolated from the chassis. Center connector and braid of the coaxial input cable drive differential input amplifiers to provide rejection of common-mode signals for nondifferential input signals.

The 632 and 633 have a subcarrier filter that may be selected to reduce the effects of subcarrier on the picture. In the 632 the subcarrier frequency automatically shifts from 3.58 MHz to 4.43 MHz. When switching systems, the setup is also changed.

In the 632 contrast (white level) and brightness (black level) can be either calibrated (for a 1.0 V P-P signal) or variable. The calibrated mode can be internally preset for a given video signal. The black level is stabilized (DC restoration) by a back porch sampling system, independent of varying video or sync amplitudes.

The monitors have both internal (displayed video) sync capability and external sync capability. The external sync input connector grounds are isolated from the chassis. Center connector and braid of the coaxial cable drive a differential input amplifier to provide rejection of common-mode signals in the signal path. All **inputs** to the monitor are high impedance loop-through connected, compensated for optimum return loss when terminated into 75 ohms.

Remote operation of 633 controls is provided through a rear-panel 12-way multicon plug and modification instructions are provided for the following: Remote Contrast, Remote Brightness, Remote Video and Tally Light.

CHARACTERISTICS

PICTURE TUBE 631, 632 and 633

Phosphor—Standard Illuminant D6500 K. Colorimetry within 2 jnd. X = 0.313, Y = 0.344. Optional: W9300 K.

Resolution— 650 lines.

Light Output— 50 ft lambert.

EHT— 16 kV stabilized.

Filament—DC regulated.

Diagonal Size—631 and 632, 15 inch diagonal; 633, 20 inch diagonal. Square corners, implosion protection provided.

DISPLAY

Normal Size— 631 and 632, 8.8 inches or 224 mm height; 11.7 inches or 298 mm width. 633, 11.4 inches or 290 mm height; 15.5 inches or 386 mm width.

Under Scan (.85) 632 Only— 15% reduction of picture size.

Aspect Ratio— 4.3.

Linearity Vertical and Horizontal— 2%.

Geometry— 2%.

System—525/60 and 625/50 — 631 and 633 requires simple internal change. 632 — automatic switching from one system to another. Subcarrier Filter and setup is also changed at the same time in the 632.

Calibrated Contrast (632 Only)—1 V for full contrast.

Variable Contrast—631 and 632, 0.25 V to 2.0 V video input for full contrast of the picture. 633, 0.5 V to 2.0 V.

Brightness Calibrated (632 Only)—Contrast normal range is normal for 1 V video.

Brightness Variable—Range is extended to be able to make picture black at full contrast.

DISPLAY SHIFT MODES—632 ONLY

Vertical—Displays vertical blanking interval at midscreen.

Horizontal—Displays all sync pulse detail.

Pulse Cross—Shifts both vertical and horizontal.

Vertical Blanking Interval Expansion is provided.

VIDEO INPUTS

631 has a single input; 632 and 633 have two switchable inputs. BNC connectors are standard*.

Return Loss—46 dB to MHz with respect to 75 ohms.

Ground—Normally floating, can be easily grounded where RF interference is encountered.

MAINS HUM Rejection, Input Floating—The input and floating round drive a differential amplifier to reject mains hum, ground current induced. Rejection 50 to 60 Hz 7 V P-P; 60 dB.

Differential Input Mode (632 Only) A-B Rejection—46 dB to 4.43 MHz with up to 2 V P-P input signal.

*Other connectors optional, special order.

Video Performance Bandwidth—Up to 6 MHz, 50 V drive at CRT cathode, —0.5 dB; 10 MHz, 25 V —0.5 dB; 15 MHz 15 V P-P, —3 dB. Line time, field time distortion Nil.

Pulse Response—Pulse to bar ratio 0.98 — 1.02.

Relative Chroma Delay—Less than 5 ns. Gain—Less than 0.1 dB.

Subcarrier Filter (632 and 633)—More than 20 dB rejection at carrier frequency. Automatic switched between 625/525 systems in 632.

Differential Gain Distortion—2% or less at 45 V P-P CRT drive.

Dynamic Gain Distortion—Less than 1%, 10 — 90% APL.

DC Restoration—Keyed back porch clamp, no observable black level shift. 10 — 90% APL, burst present or absent. CRT heater voltage is regulated.

SYNC

External Input—Loopthrough, floating ground. BNC connectors are standard.

Input Characteristics Unterminated—25 K ohms/25 pF.

Input Sensitivity—1 to 8 V P-P composite sync (can internally be changed to positive going composite sync).

Horizontal Pull-In Range—>500 Hertz.

Horizontal Hold-In Range—>1000 Hertz.

Horizontal Pull-In Time—Fast or slow internally changeable.

Internal Sync—Video A, Sync A (631 & 632). Video B, Sync B (632 only). Video A-B, Sync A (632 only).

OTHER CHARACTERISTICS 631, 632 & 633

POWER

Input Voltages— 115, 220, 240 ±10%, 48 to 66 Hertz.

Power— 631 and 632, 80 watts maximum; 633, 85 watts maximum.

Dimensions of Cabinet— 631 and 632, 10½ inches height; 16½ inches depth; 19 inches width (RM). Can be used as a 19 inch rack or cabinet model. 633, 14 inches height; 16½ inches depth; 19 inches width (RM). It too can be used in 19 inch rack or cabinet model.

Weight— 631 and 632, 35 lb, 15.8 kg, cabinet. 40.8 lb, 18.5 kg rackmount. 633, 45 lb, 20.5 kg, cabinet. 48.5 lb, 22 kg, rackmount.

NOTE: Various options are available upon request.

INCLUDED ACCESSORIES

Power cord (161-0036-00); tally light connector plug (134-0132-00) and clamp (343-0309-00); indication symbols for tally light; instruction manual.

Order 631 15 INCH PICTURE MONITOR
Order 632 15 INCH PICTURE MONITOR
Order 633 20 INCH PICTURE MONITOR

For further ordering information see last page.

NTSC SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

NTSC TEST SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

SIGNAL	140	144	146	147	149	1430
FCC Color Bars	X*	X*	X*		X*	
FCC Composite Test Signal[3]				X*	X*	
FCC Multiburst				X*	X*	
Gen-Lock			X	X	X	
EIA Color Bar	X	X	X			
Color Bar Luminance Scale		[7]	X			
Full-Field Color Bar	X*	X*	X*		X*	
Modulated 5 Step Staircase[1]	X*	X*	X*	X*	X*	
Modulated 10 Step Staircase[1]	X*	X*	X*	X*	X*	
Modulated Ramp[1]				X*	X*	
Modulated Pedestal	X*	X*	X*		X*[2]	
STOC Composite Test Signal (No. 1)				X*[4]	X*[5]	
Convergence Pattern	X	X	X			
Full Amplitude Multiburst[6]				X*	X*	
Sin² Pulse & Bar				X*	X*	
Sin² Pulse & Window				X	X	
Field Square Wave				X	X	
Noise Measuring Capability				X*		X*
Vertical Interval Reference Signal (VIRS)				VITS only	VITS only	
Flat Field (Variable Level)	X*	X*	X*	X	X	
Flat-Field Bouncing APL				X	X	

A few signals may require reprogramming and some signals may not be available simultaneously.

X Full-Field Signal

* May be programmed as a VITS.

[1] Modulation may be turned off.

[2] Modulated pedestal meets requirements of Satellite Technical Operation Commission (STOC). Signal I.

[3] 5 step staircase, 2T, 12.5T White Bar. STOC I.

[4] Standard programmed for STOC Signal I; Option 1 programmed for FCC 73.699.

[5] Standard programmed for FCC 73.699; Option programmed for STOC II.

[6] Reduced amplitude M.B. on 147 Option 1/149 meets FCC 73.699.

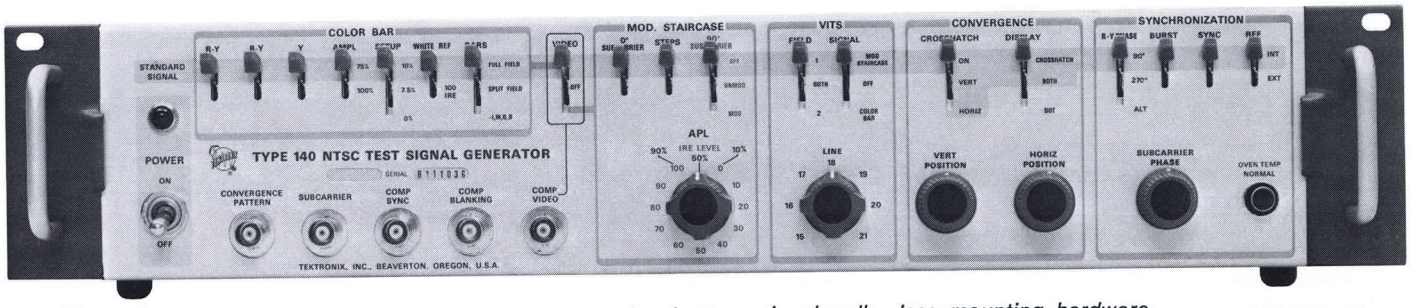
[7] In Multiple Mode Only.

NTSC SYNC & TIMING SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

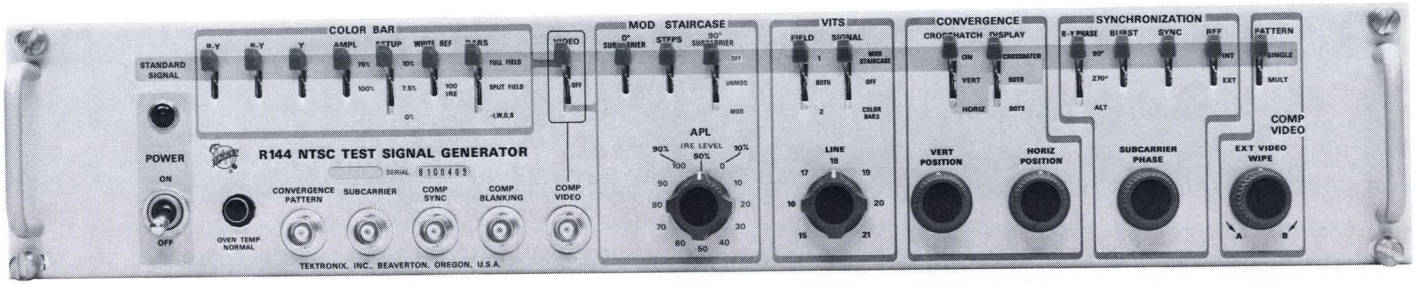
	140	144	146
Gen-Lock Input			X
Comp Sync	X	X	X
Subcarrier	X	X	X
Comp Blanking	X	X	X
Burst Flag	X	X	X
H Drive	X	X	X
V Drive	X	X	X
External Comp Sync Input	X	X	X
External Subcarrier Input	X	X	X

- MASTER SYNC GENERATOR AND COLOR STANDARD
  CONFORMS WITH EIA STANDARD RS 170
- PROPORTIONAL CONTROL COLOR STANDARD
- COLOR GEN-LOCK (146 ONLY)
- TIMING JITTER LESS THAN 4 ns
- NTSC ENCODED COLOR BARS
  CONFORMS TO EIA STANDARD RS 189
  FULL-FIELD OR SPLIT-FIELD BARS
  75% OR 100% AMPLITUDE
  7½%, 10%, or 0% SETUP
- CONVERGENCE CROSSHATCH PATTERN
- VERTICAL INTERVAL TEST SIGNALS
  MODULATED PEDESTAL, STAIRCASE OR COLOR BARS
  LINES 15 THROUGH 21, EITHER OR BOTH FIELDS
- MODULATED STAIRCASE
  CONFORMS TO IEEE STANDARD IEEE 206
  VARIABLE APL, 10% to 90%—FIXED
  APL, 50%
  5 OR 10 STEPS
  SUBCARRIER PHASE-LOCKED TO BURST

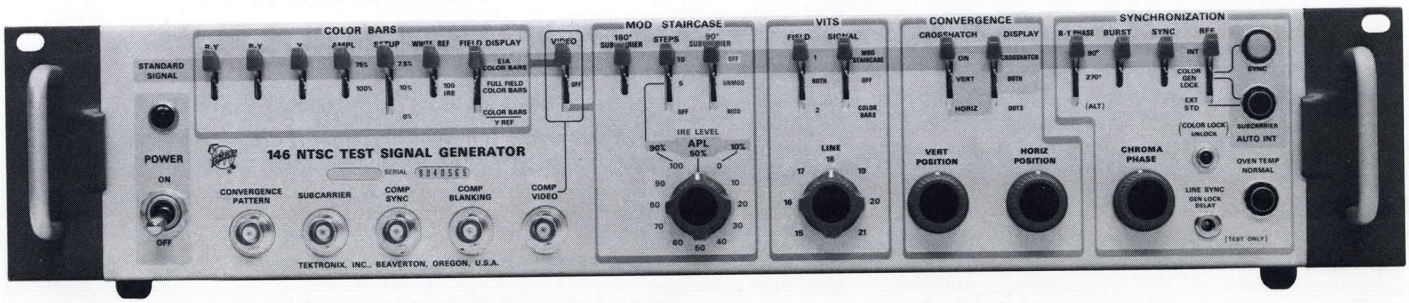
The 140-Series NTSC Signal Generators are a compact, solid-state source of high-quality television test, sync and color sync burst signals for 525-line, 60-Hz field standard NTSC color TV systems. Combined in one compact unit are the test signals needed to accurately test, evaluate, and adjust laboratory and standard broadcast color video equipment. Each test signal conforms with industry standards, and provides additional refinements to enhance both the accuracy and range of measurements which can be made. The 140 Series offers a sync generator with a proportional control constant-temperature oscillator that has excellent short term frequency stability.



Rackmount version; cabinet version has carrying handle, less mounting hardware.



R144 rackmount shown above. 144 cabinet style available.



Rackmount version; cabinet version has carrying handle, less mounting hardware.

SYNC PULSE GENERATION FUNCTIONS

SYNC GENERATOR AND COLOR STANDARD

The EIA sync generator circuitry is largely digital, using integrated circuitry for counting functions. The usual frequency multiplier circuits and their attendant problems have been avoided resulting in exceptional time stability. Internal adjustments permit some variation of widths, including burst flag timing. These adjustments are preset to conform to FCC standards.

Color Gen-Lock, External Subcarrier, and Internal Subcarrier can be selected for color standard reference. The 146 NTSC Signal Generator can synchronize the time of occurrence of field, frame, line, and subcarrier from composite video input. Front-panel lamps indicate loss of gen-lock H sync and/or subcarrier due to excessive noise and/or low amplitude.

The color standard has a proportional control oven for the quartz crystal and the entire oscillator circuit. The frequency stability achieved is well within FCC specifications. A front-panel lamp indicates proper operation of the oven. When the internal color standard is used, the phase of the color subcarrier output is variable over a 360° range with respect to the phase of the burst contained in the video output. When an external color standard is used the phase of the burst (and all other subcarrier frequency components of the test signal outputs) may be varied 360° with respect to the external subcarrier source.

Phase-lock between the color subcarrier and the master sync clock can be interrupted by front-panel push button. The subcarrier frequency remains within specifications, but chroma appears as an "envelope" because of phase-lock interruption. This envelope facilitates measuring chroma to luminance delay and other measurements.

Subcarrier—Frequency is 3.579545 MHz within 5 Hz. Outputs are provided on the front and rear panels. Output impedance is 75 Ω within 5%. Isolation is at least 30 dB. Output level is 2 V P-P within 0.2 V into 75 Ω. Input requires 1 V to 4 V. Return loss is at least 46 dB at 3.58 MHz.

GEN-LOCK (146 only)

Input—Can be composite video or black burst, sync negative.

Input Level Range— 0.5 V to 3 V (1 V nominal).

Input Return Loss— 46 dB to 5 MHz when terminated in 75 Ω.

Phase Accuracy—Within 1° input burst variations + or —10 Hz of 3.579545 MHz.

Within 5° with ambient temperature variation from 0°C to 50°C; within 1° for any 10°C variation within 0° to 50°. Burst must be 3.579545 MHz within 1 Hz and oven temperature normal.

Within 1° with input signal + or —3 dB from 1 V. Within 3° with burst/sync ratio variation —6 dB to +10 dB. Burst must be 3.579545 within 1 Hz, ambient temperature 20°C and oven temperature normal. Dynamic burst phase stability is within 0.1° with APL variation 10% to 90%; within 1° with —24 dB white noise.

Delay Range—Adjustable between 3 μs before input sync to 1 μs after. Delay is stable within 70 ns. Factory-set to coincidence.

Pull-In Time— 200 ms maximum.

Field/Frame Sync—Direct acting within one field.

COMPOSITE SYNC

OUTPUT

Independent, front- and rear-panel outputs are provided with the two outputs isolated by at least 40 dB.

Output Level— 4 V within 0.2 V.

Return Loss—At least 30 dB to 5 MHz.

Risetime— 115 ns within 10%.

INPUT*

Required Amplitude— 2 V to 8 V, negative-going.

Return Loss—At least 46 dB using loop-through input on rear panel.

COMPOSITE BLANKING

Independent, front- and rear-panel outputs are provided with the two outputs isolated by at least 40 dB.

Output Level— 4 V within 0.2 V.

Risetime— 115 ns.

Return Loss—At least 30 dB.

VERTICAL DRIVE

One rear-panel output provides 4 V within 0.2 V.

Risetime— 115 ns.

Return Loss— At least 30 dB.

HORIZONTAL DRIVE

One rear-panel output provides 4 V within 0.2 V.

Risetime— 115 ns.

Return Loss—At least 30 dB.

BURST FLAG

One rear-panel output provides 4 V within 0.2 V.

HORIZONTAL BLANKING

11.1 μs (digitally determined from 3.579545 MHz).

VERTICAL BLANKING

21 lines (digitally determined from 3.579545 MHz).

COMPOSITE VIDEO OUTPUT

Composite video consists of composite sync and video test signals as selected by front-panel controls. Independent front- and rear-panel outputs are provided with the two inputs isolated by at least 40 dB.

Output Level— 1 V P-P.

Return Loss— 30 dB from DC to 5 MHz.

*Inputs are optional and only required for synchronizing with another NTSC sync generator.

NTSC COLOR BARS

NTSC color bars are provided. The composition of these signals is in accord with EIA color bar signal specifications RS 189. In addition to basic signal requirements, these 100% saturated color bars are provided in either 75% or 100% amplitude with a choice of 0%, 7½%, or 10% setup. The white bar amplitude may be independently selected at 75% or 100% for 75% amplitude bars. The 100% white bar amplitude level permits a convenient check of relative chrominance/luminance gain by comparing the peak amplitudes of the yellow and cyan to the white bar. An additional refinement to the full-field color bar is a black reference bar following the blue bar.

A new, split-field signal, COLOR BARS/Y REF (146 only), provides a picture monitor display and a waveform suitable for detecting the effects of rectified subcarrier on luminance (luminance cross-modulation). Standard color bars and the luminance component only of standard color bars are combined in a split-field, a combination that can clearly reveal the effects of luminance/chrominance time delay.

Luminance and Chrominance Component Amplitude Accuracies Amplitudes comply with the NTSC signal requirements as defined by the FCC. Absolute amplitudes of luminance signal, setup, and sync are within 1% or 1.5 mV, whichever is greater. Absolute amplitudes of all subcarrier frequency components (chroma and burst) are within 3%. Relative amplitudes of all subcarrier frequency components (chroma and burst) are within 1% or 1.5 mV whichever is greater.

White Reference— 75% amplitude or 100% amplitude.

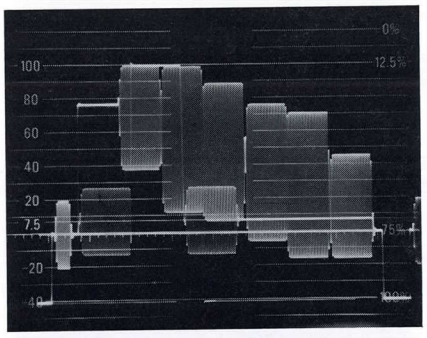
Chrominance Envelope Risetime and Falltime— 375 ns within 15%.

Setup— 10%, 7½% or 0%.

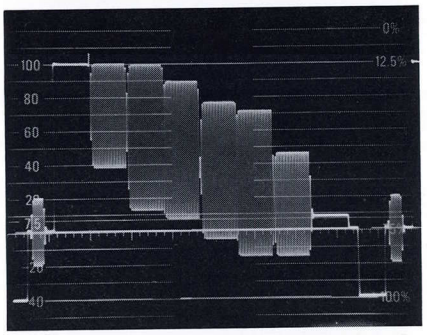
Blanking to Peak White Amplitude— 714 mV (independent of setup).

Luminance Risetime and Falltime— 115 ns within 15%.

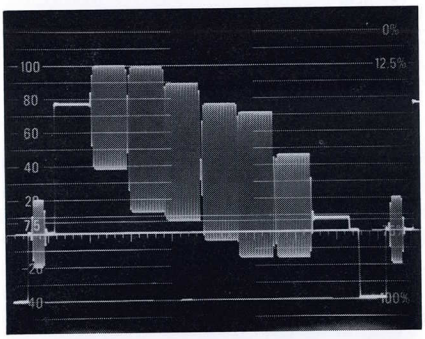
—**I and Q Chrominance Signal Width**— 9.4 μs on the same lines as black and white references, amplitude of each within 1% of burst amplitude.



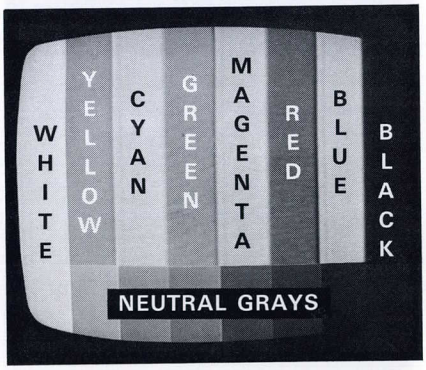
Standard EIA Color Bar Signal defined in RS-189. Setup can be conveniently changed to 10% or 0.



Full-field color bars. 75% or 100% selectable. Black bar follows blue bar.



Full-field color bars. 75% amplitude with 100% or 75% white bar amplitude.



Split-field signal on color picture monitor. Color bars 100% and 0% saturation. Useful to show gray-scale tracking.

STAIRCASE

The modulated staircase signal is provided with a selection of APL from 10% to 90% (0 to 100 IRE) in eleven equal levels, or at a fixed APL of 50%.

The staircase luminance component is either 10 equal, 10 IRE steps; 5 equal, 20 IRE steps; or OFF as selected by front-panel switch. The subcarrier component is phase-locked to color burst. The signal is in strict conformity with IEEE 206 and the definition of APL is rigorously observed. Applications include measurements of differential gain and phase, dynamic gain, luminance signal linearity and burst phase errors.

See video staircase differentiator in the accessory section.

Luminance Component—Peak amplitude with 5 or 10 step, 714 mV within 1%. Each step is 143 mV within 1% in 5 step and 71.5 mV in 10 step. Step risetime is 260 ns within 15% and aberrations are within 2%. Step duration at blanking level and at white level is 13.2 μs within 5%. Intermediate step durations are 6.6 μs within 5%.

Chrominance Component—Amplitude is 143 mV P-P within 3% and in phase with burst.

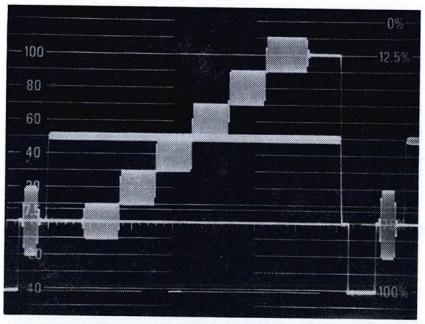
Differential Phase— 0.1° or less.

Differential Gain— 0.5% or less.

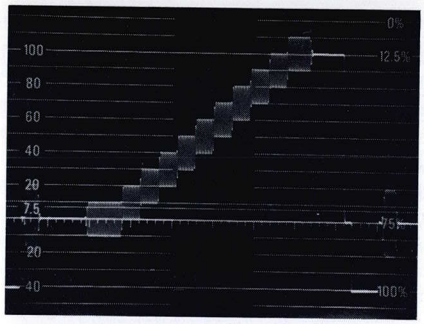
Subcarrier Envelope—Risetime is 375 ns within 15% and duration is 40 μs within 5%. Envelope delay from horizontal sync is 16.1 μs within 5%.

50% Fixed APL—Each active line carries the modulated staircase signal. APL is 50% per IEEE standard, IEEE 206.

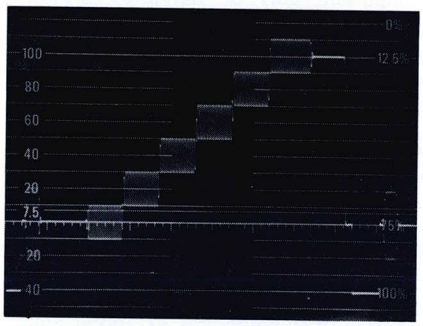
Variable APL—Staircase signal is on every 5th line and on the same lines each frame. The variable amplitude pedestal signal is on the remaining 4 out of 5 lines. APL range is 10% to 90% with lines without staircase having eleven selectable pedestal levels from 0 IRE to 100 IRE. 0 IRE position provides 10% APL, 50 IRE position provides 50% APL, and 100 IRE position provides 90% APL.



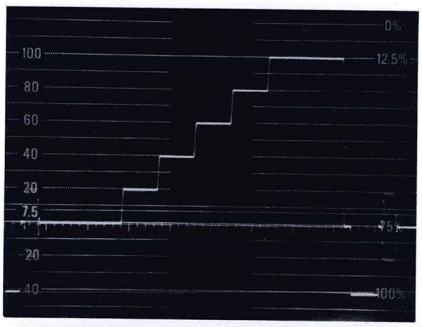
5-step modulated staircase with APL pedestal at 50 IRE. Subcarrier component on pedestal provides phase markers when measuring differential phase, ±12° for 20 IRE modulation.



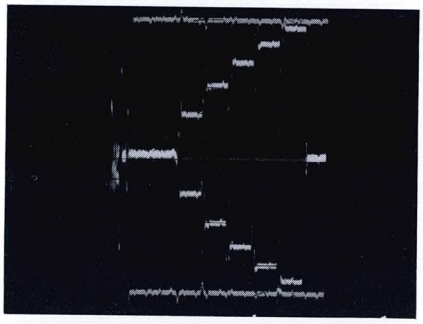
10-step modulated staircase. Subcarrier is precisely in phase with burst.



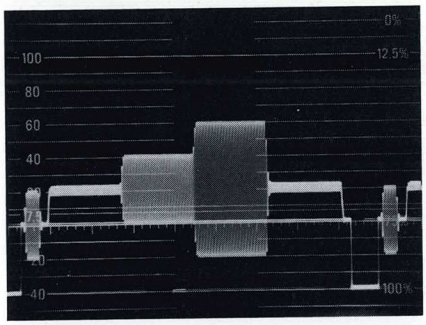
5-step modulated staircase. Subcarrier amplitude may be increased to 40 IRE by internal adjustment.



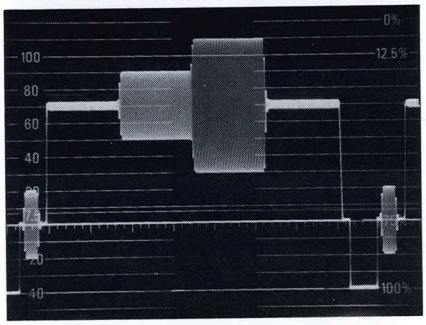
5-step unmodulated staircase.



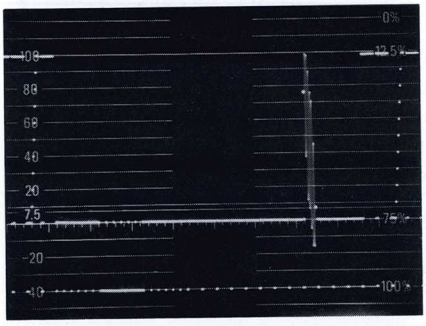
Using a 146, 144, or 140 as a signal source, 90° unmodulated subcarrier on APL pedestal lines provides 12° phase markers in measuring phase difference. Using 40 IRE subcarrier on staircase, phase markers are ±6°. While this method is only approximate, it proves highly useful.



Modulated 90° subcarrier test signal, luminance of 20 IRE shown, variable 0 to 100 IRE in 11 equal steps.



Modulated 90° subcarrier test signal at 70 IRE luminance level. Available as full field or as a VIT signal.



Vertical interval test signal. Color bars or staircase signal may be added to program signals.

MODULATED PEDESTAL

A unique, TEKTRONIX-developed, chroma-step signal provides a means to check luminance signal distortion caused by rectification of the subcarrier signal chrominance-luminance intermodulation. When a variable APL mode is selected, subcarrier, phased to lead burst by 90°, may be added to the pedestal lines either as a constant 30-mV signal or amplitude modulated to produce 30-mV, 286-mV (40 IRE), and 572-mV (80 IRE) amplitudes.

The amplitude modulated subcarrier is used to determine the effects of subcarrier rectification upon luminance signals at all APL's through the entire TV system. The constant 30-mV subcarrier signal is used to eliminate unnecessary portions of the display when making differential phase measurements. The modulated pedestal signal is also useful when checking video tape recorders for "chroma banding".

Subcarrier Component—A three-position switch controls the insertion of subcarrier on the pedestal lines. Pedestal positions are: subcarrier off, unmodulated subcarrier, and modulated subcarrier.

The unmodulated 90° subcarrier provides 30 mV P-P (approx 5 IRE at 90°) during active line time of 52.3 μs.

Subcarrier is precisely 90° from color burst, i.e., R-Y phase. As such, it can be used to check correct phasing of both VTR playbacks (when prerecorded on tape) or color picture monitors. Chroma amplitudes are 5 IRE, 40 IRE and 80 IRE.

VERTICAL INTERVAL TEST SIGNALS

The modulated staircase or the color bar can be added on any line from 15 through 21 of either or both fields. The phase of the burst together with all other subcarrier frequency components of the test signal outputs may be varied 360° with respect to an external subcarrier frequency source.

It is possible to test an entire video system during programming, including transmitters, with the 75% amplitude, full-field color bar signal or the modulated staircase signal inserted on line 18 or 19.

CONVERGENCE PATTERN

The convergence pattern signal is provided separate and independent from the other test signals. It is useful for measuring picture monitor or camera scanning linearity, aspect ratio, and geometeric distortion. It conforms to IEEE standard 202.

Display Available—White crosshatch, vertical lines only, horizontal lines only, white dots only, and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern).

Convergence Pattern Signal Characteristics—The P-P amplitude is 1 V within 5%. Pulse amplitude is 77 IRE. Sync amplitude is 40 IRE. Setup is 7½ %.

COMPOSITE COLOR TEST PATTERN (144 ONLY)

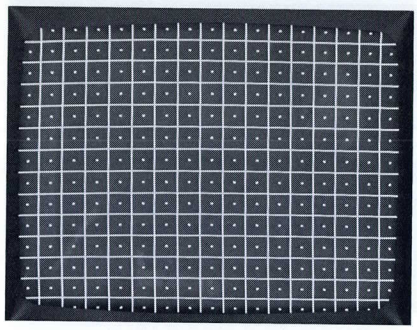
This operating mode provides a convergence pattern (crosshatch lines and/or dots) with two inserts areas. Each insert is digitally controlled from the sync generator. The user may select the lines to be included in each insert area by proper placement of insulated color-coded jumpers within the instrument.

The first insert consists of either the staircase test signal or color bar signal. When the color bar is selected, the luminance portion of the color bars, is located directly above the first insert. The second insert can be controlled by the operator in the same manner as the first. Generally, the second insert will be below the center of the screen, as the center should carry the convergence pattern to permit proper converging of color receivers. This insert does not normally carry test signals since it is intended for message service.

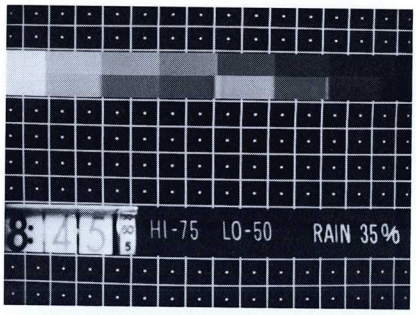
Two video inputs are provided at the rear panel. Video input signals may be derived from TV cameras which are driven by the sync generator in the 144. A horizontal wipe control provides for smooth transition between the two signals, or allows them to be displayed simultaneously, sharing the selected insert area.

External Video Input—Two AC-coupled, 75-Ω, loop-through input connections are provided on the rear panel. Input requires 1.0 V P-P of composite video or 0.714 V P-P of non-composite video. Return loss is at least 30 dB to 5 MHz. External sync is stripped and sync from the 144 is inserted.

Composite Video Ouput—Composite video consists of composite sync and video test signals as selected by front-panel controls. Independent front- and rear-panel outputs are provided with the two inputs isolated by at least 40 dB. Output level is 140 IRE units with the exception of the crosshatch lines and dots which are set for 75 IRE units.



CONVERGENCE PATTERN



COMPOSITE COLOR TEST PATTERN

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.

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

Dimensions and Weights

	Cabinet		Rack	
	in	cm	in	cm
Height	3 1/2	8.9	3 1/2	8.9
Width	16 3/4	42.6	19	48.3
Depth	18 1/2	47.1	18 1/2	47.1
	lb	kg	lb	kg
Net weight	17 3/4	8.0	18 1/2	8.4
Domestic shipping weight	≈34	≈15.4	≈35	≈15.9
Export-packed weight	≈54	≈24.4	≈55	≈25

INCLUDED ACCESSORIES

75-Ω, through-line termination (011-0103-02); 3-conductor power cord (161-0036-00); instruction manual (070-1111-00).

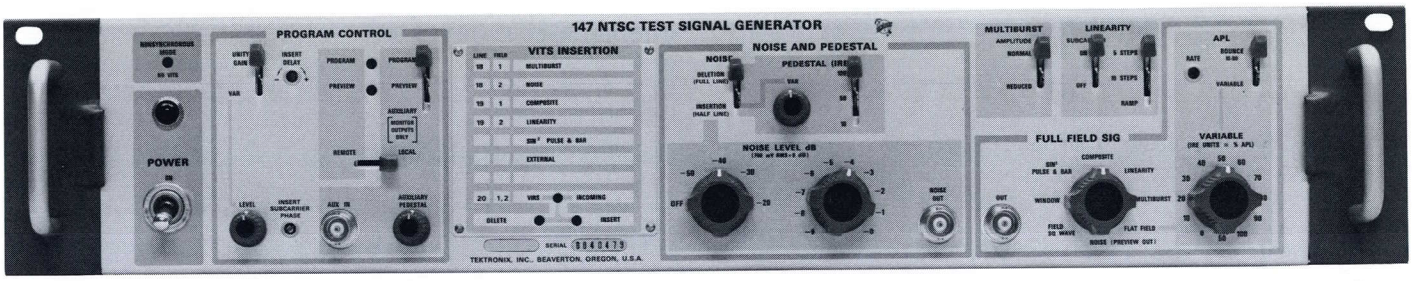
All R140 Series also include rackmounting hardware.

Order 140 NTSC SIGNAL GENERATOR
Order R140 SIGNAL GENERATOR (rackmount)
Order 144 NTSC SIGNAL GENERATOR
Order R144 NTSC SIGNAL GENERATOR (rackmount)
Order 146 NTSC SIGNAL GENERATOR
Order R146 SIGNAL GENERATOR (rackmount)

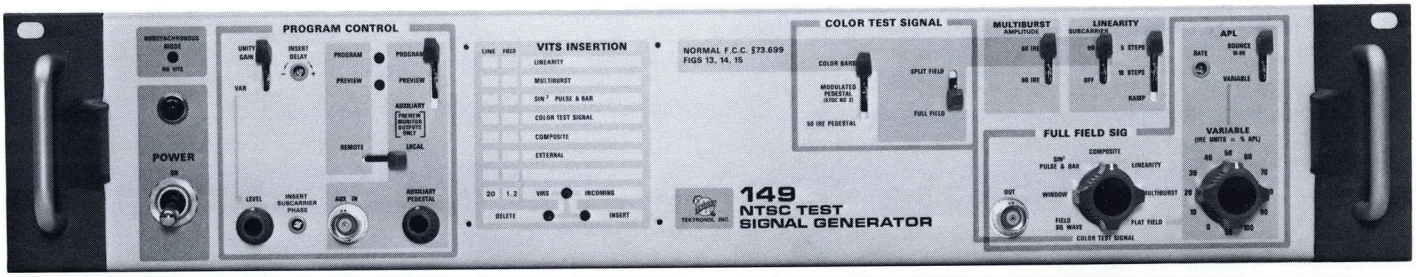
For additional Ordering Information see last page.

NTSC GENERATORS

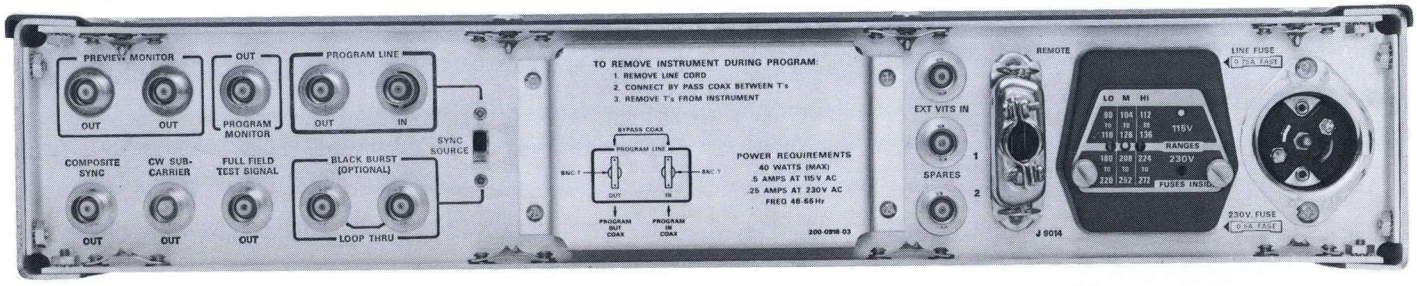
- VERTICAL, INTERVAL TEST SIGNALS, GENERATION
  INSERTION
  DELETION
- FULL-FIELD TEST SIGNALS
- EASILY REPROGRAMMED
- REMOTE TRANSMITTER MONITORING SIGNALS
- SATELLITE TECHNICAL OPERATION COMMISSION (STOC) I, II
- NOISE TEST SIGNAL (147 ONLY)
- VERTICAL INTERVAL REFERENCE SIGNAL
- ONE UNIT SOURCE OF SIGNALS REQUIRED BY FCC § 73-676 (f) FOR TRANSMITTER REMOTING (149 ONLY).
- COLOR BARS (149 ONLY)



Rackmount version; cabinet version has carrying handle less mounting hardware.



Rackmount version; cabinet version has carrying handle less mounting hardware.



Rear panel of 147 and 149 are similar.

The 147 and 149 are similar NTSC television signal generators that supply 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 generators will operate in the full-field test signal mode, deriving timing information from its own internal oscillator (clock).

TRANSMITTER REMOTING

The 149 is a single unit that supplies all the monitoring signal requirements of FCC § 73-676 (f) with all the features of the 147 except the noise test signal. The 147 Option 1 is also available for insertion and deletion of FCC § 73-676 (f) required signals. These signals are described on a later page.

VERTICAL INTERVAL INSERTION/DELETION and PROGRAM CONTROL

When, and only when, the generator 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 generator, 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 generator. 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.

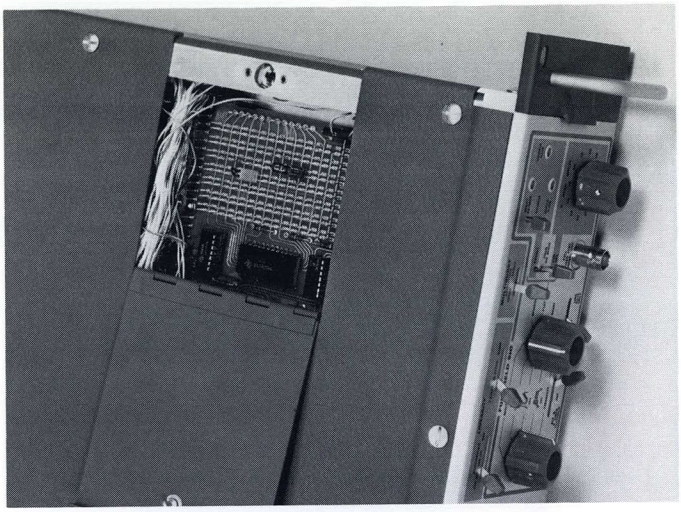
Crosstalk into Program Channel from Internal Signals—2 T pulse less than −70 dB, subcarrier (color bars) −60 dB.

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

Jitter—Less than 5 ns.

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

NTSC GENERATORS



Access is provided to the signal programming area. The generator is easy to reprogram when necessary for your signal needs.

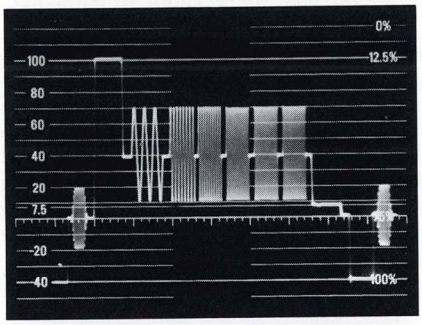
GENERATION, INSERTION and DELETION of SIGNALS REQUIRED for REMOTE OPERATION of TRANSMITTERS

- **REDUCED AMPLITUDE MULTIBURST — 149 and 147 Option 1**
- **COLOR TEST SIGNAL**
  149 generates, inserts and/or deletes.
  147 Option 1 inserts and/or deletes, but requires external source of color test signal (140, 144 or 146).
- **COMPOSITE TEST SIGNAL — 149 and 147 Option 1**

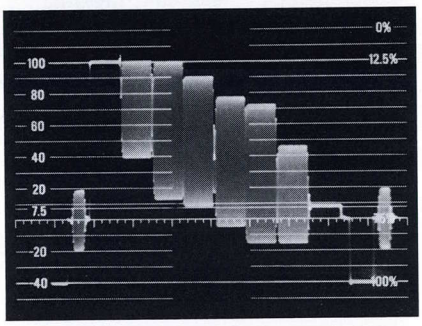
The 149 is an excellent, one unit source of the signals required for transmitter remote operation. The 149 recognizes monochrome transmissions (no burst) and includes facilities which may be used to squelch the chrominance components of the color bar signal as required. The 149 has all the features of the 147, except Noise Test Signal. Modulated Pedestal (STOC No. 2) is available as a VIT, and Full-Field Color bars are available both as VIT Line 18, Field II and Full-Field signals.

Split-field color bars with a unique luminance only/color bar signal are selectable by a front panel switch. This split-field signal is useful to show gray scale tracking and consists of the luminance component of color bars on all active lines. The chrominance component is added to lines 66 through 218.

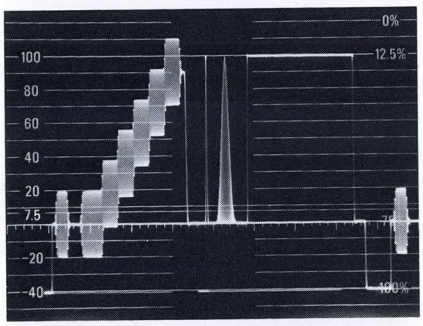
The 147 Option 1 NTSC Test Signal Generator is programmed to generate, insert and delete test signals as required by FCC § 73.676 (f) for transmitter remote control. Multiburst and the composite test signal are generated by the 147. Color bars are externally generated. TEKTRONIX 140 is a recommended source. 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 transmission 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.



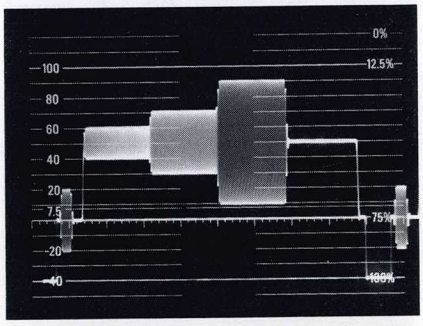
Line 18 Field I Multiburst Per FCC § 73.699



Line 18 Field II Color Bars Per FCC §73.699



Line 19 Field I, II Composite Test Signal Per FCC §73.699



Modulated Pedestal, STOC 2

VERTICAL INTERVAL REFERENCE SIGNAL

The proposed VIR Signal is generated by the generator 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 generator 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.

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.

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.

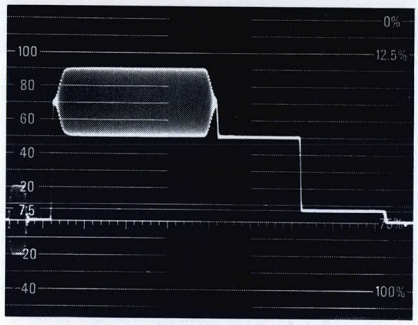
White Reference Amplitude—100 IRE ±1 IRE

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

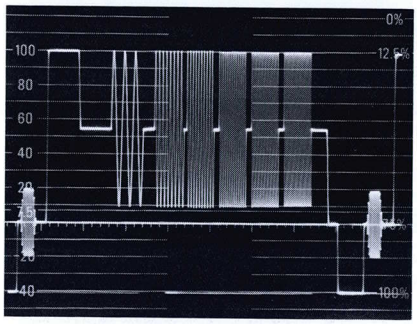
Average Burst Level—55 ±1 IRE with 10% setup; reduced, 40 ±1 IRE.

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

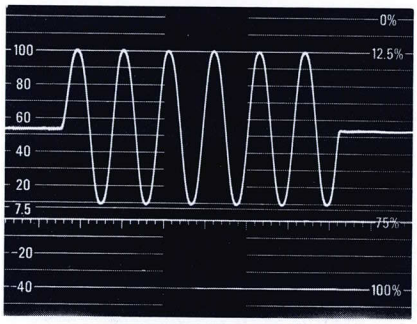
Timing—Each burst starts at 0° of the first cycle and ends at 360° of the last cycle.



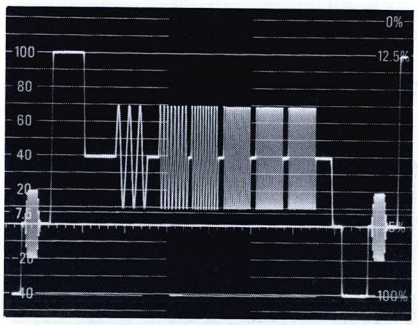
The Vertical Interval Reference Signal.



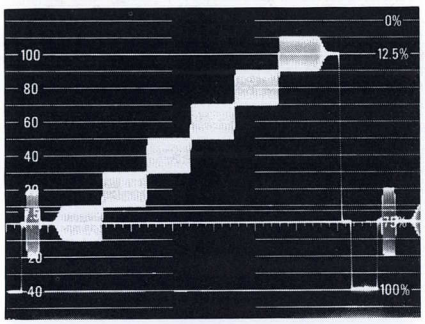
Full Amplitude Multiburst with white and black flags.



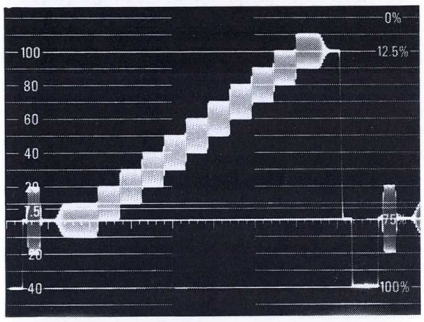
Digital programming produces jitter-free, whole number of cycles for each burst.



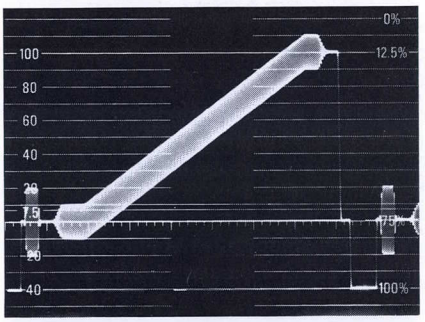
50% Amplitude Multiburst for use where 100% tests are invalidated by nonlinear distortions; e.g., transmitters.



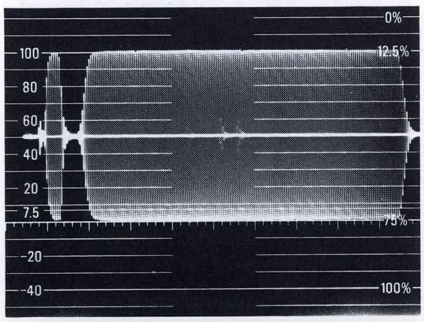
Linearity Test Signal 5 step, 20 IRE subcarrier at burst phase.



Linearity Test Signal 10 step with 20 IRE subcarrier at burst phase.



Linearity Test Signal Ramp 0 to 100 IRE with 20 IRE subcarrier in phase with burst.



40 IRE, subcarrier, 5 step linearity test signal displayed in high-pass mode. Note the lack of significant transients at step transitions.

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 20-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 in approximately 230 ns and aberrations 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 vertical 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.

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 generator 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 12.5 T modulated $\sin^2$ pulse is extremely sensitive to delay distortion and easily utilized as delay distortion equals 10 d, where d equals baseline sinusoidal ripple in percent. The 20 T pulse is also available.

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 generator, 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%.

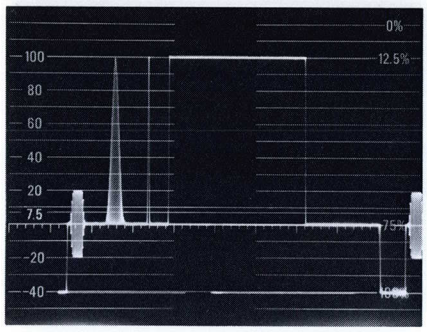
T Bar Time Location—Start and Stop internally programmable in 2-μs increments.

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

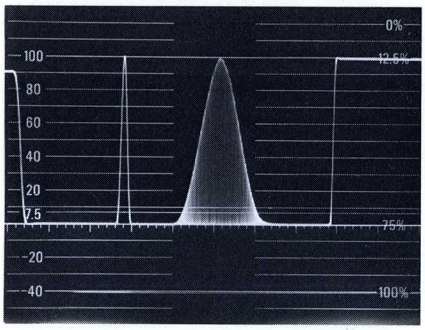
12.5 T Modulated Pulse HAD— 2.50μs or can be internally set to 2.5 μs (20 T if desired).

T Modulated $\sin^2$ Pulse Residual Subcarrier—Less than 0.5 IRE on insertion line.

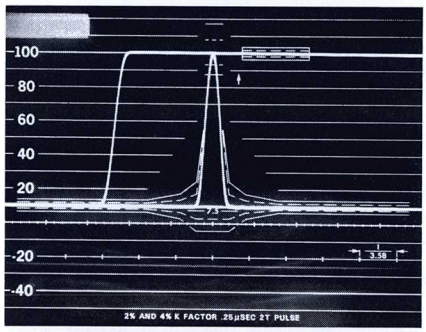
T Modulated $\sin^2$ Pulse Relative Chroma-Luminance Time Delay—Less than 10 ns.



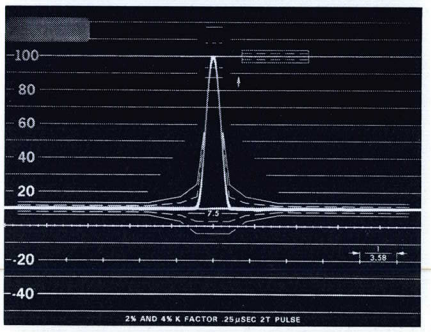
2 T pulse wth 12.5 T modulated pulse and bar.



2 T pulse with 12.5 T modulated pulse and bar. Subcarrier is phase modulated at field rate.



2 T pulse with T Bar double exposed.



T pulse.

NTSC GENERATORS

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 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 TEST SIGNAL (147 only)

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.

Important—see 1430 page for noise weighting filters needed.

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.)

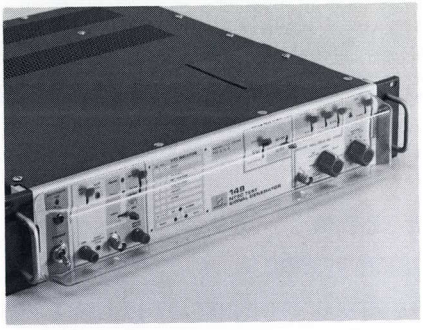
Output Impedance— 75 Ω.

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

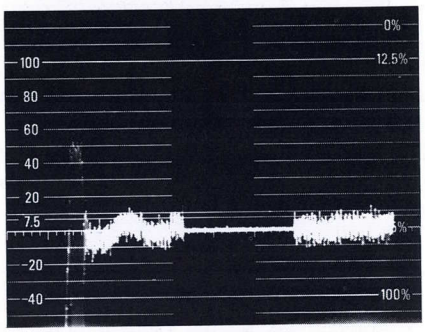
OTHER CHARACTERISTICS

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.



A removable clear plastic cover that prevents accidental use of controls is shipped installed on the 149 (200-1328-00).



Noise test with inserted noise in center of line. Inserted noise is adjusted low for identification of time location. 147 only.

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 or 149 Cabinet		147 or 149 Rack	
	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

INCLUDED ACCESSORIES

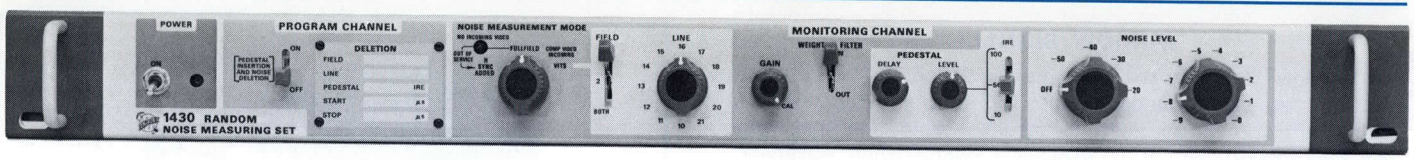
75 Ω, BNC termination (011-0103-02); 2 each BNC-T adapters (103-0030-00); 7½ ft power cable, three wire (161-0036-00); VIT program front-panel cover plate (200-1246-00); instruction manual (070-1169-00). R147 and R149 includes rackmounting hardware.

Order 147 NTSC SIGNAL GENERATOR
Order R147 NTSC SIGNAL GENERATOR (rackmount)
Order 147 OPTION 1 NTSC SIGNAL GENERATOR
Order R147 OPTION 1 NTSC SIGNAL GENERATOR (rackmount)
Order 149 NTSC SIGNAL GENERATOR
Order R149 NTSC SIGNAL GENERATOR (rackmount)
Order 149 OPTION 1 NTSC GENERATOR
Order R149 OPTION 1 NTSC SIGNAL GENERATOR (rackmount)

For further ordering information see last page.

1430

RANDOM NOISE MEASURING



- **IN-SERVICE TESTING**
- **OUT-OF-SERVICE TESTING**
- **PROGRAM MATERIAL PROTECTED BY FAIL-SAFE PROVISIONS**

The 1430 Random Noise Measuring Set provides random noise measurement capabilities on an in-service basis using the spatially adjacent noise matching technique with a waveform monitor as described in References 1 and 2. A program channel is provided for deletion of VITS and/or on selected lines in the vertical blanking interval and a monitor channel is provided for making measurements with a waveform monitor. The 1430 consists of two sections. One permanently mounted in the rack contains inputs and outputs and provisions for protecting program material. The second section, only 1¾ inches high, contains circuitry and controls which are easily removed without cable disconnection.

PROGRAM CHANNEL

The program channel has a 75 Ω input impedance, unity gain and output impedance of 75 Ω. No program impairment is introduced. A relay provides program signal continuity if the 1430 loses power. All deletion parameters are controlled by internal programming readily changeable within the 1430. Deletion of up to any three lines between 10 to 21 in either or both fields (as well as full-field deletion) is provided. The deletion may be varied between the first half, second half or full active portion of the video line. A pedestal may be inserted in the deleted portion of a line at 10, 50, or 100 IRE levels.

MONITOR CHANNEL

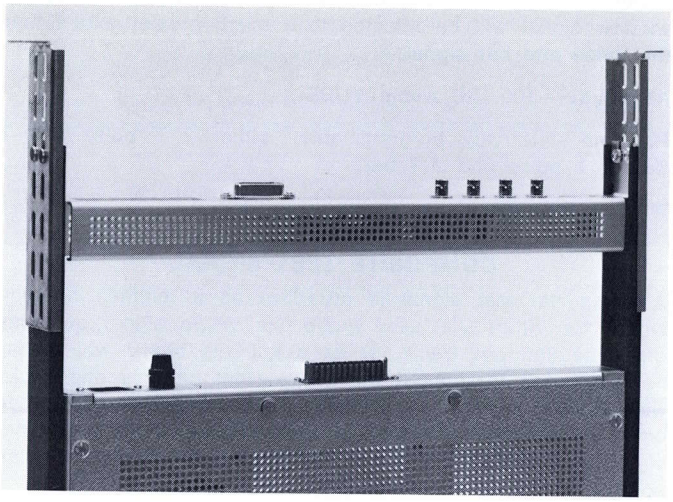
The monitor channel has an output independent from program for comparing the noise on the incoming signal against the noise from the internal noise generator on a waveform monitor. Monitor channel parameters are determined by front-panel controls. Three operating modes are provided: VITS, Full Field and Out-of-Service.

In the VITS mode, any line between lines 10 and 21 in either or both fields may be selected for insertion of the reference noise. The Full-Field mode provides insertion on all active lines.

The Out-of-Service mode is intended for making measurements on sources that do not have composite sync, in particular, transmission circuits not carrying signals at the time this test is conducted. Horizontal sync is added for synchronization of the waveform monitor with the insertion time in the Out-of-Service mode. The insertion width is internally at 26 μs. Delay between insertion and sync is controlled by Delay adjustment in all modes. The insertion pedestal level is controlled by a switch and a potentiometer covering a range of 0 - 100 IRE.

References (Available at request):

1. Charles W. Rhodes, "In-Service Noise Measurements on a CATV system", 20th Annual NCTA Convention and Exposition, Washington, D.C., July 6-9, 1971.
2. Charles W. Rhodes, "Measuring Distortions in the Television Signal", November, 1971.



Cabling to loop-through connectors remains undisturbed when the 1430 is removed. Program material is protected.

Monitor Channel Gain control, with a ±3 dB range, allows normalizing the signal for 1 V P-P signal so that noise measurement relative to 1 V may be made. The internal noise-weighting filter may be switched in or out from the front panel for evaluation of the spectral content of the incoming noise. Weighting filter is in the monitor channel and does not affect the program output.

The output of the monitor channel passes through an internal low-pass filter to the internal weighting filter monitor. Both the noise-weighting filter and the low-pass filter are on separate etched circuit boards and can easily be changed for different television systems, e.g., 625/50 and 525/60 standards require different filters, the 1430 will operate (with appropriate filters) on both standards. The 1430 is shipped equipped for NTSC. Filters appropriate for PAL systems will be available later.

PERFORMANCE

1. Repeatable measurements can be made within 2 dB on a VITS basis and to within 0.5 dB on a Full-Field signal.
2. Noise Range —20 to —59 dB below 700 mV RMS noise amplitude.

Order 1430 RANDOM NOISE MEASURING SET

NOISE MEASUREMENT FILTERS

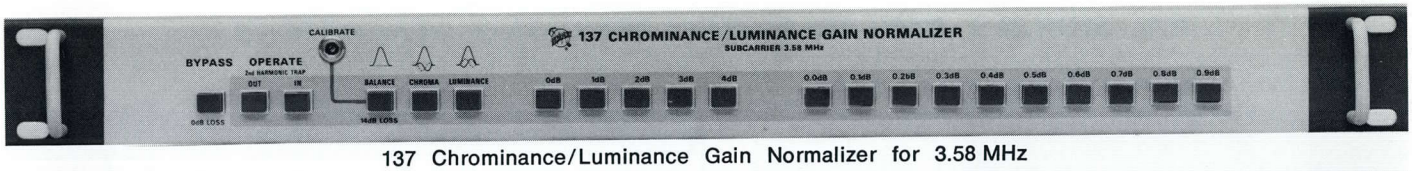
External filters are required with the 147 or 148 Generators when making noise measurements.

For systems using 525/60 standards order 015-0212-00 Low Pass Filter and 015-0214-00 Noise Weighting Filter.

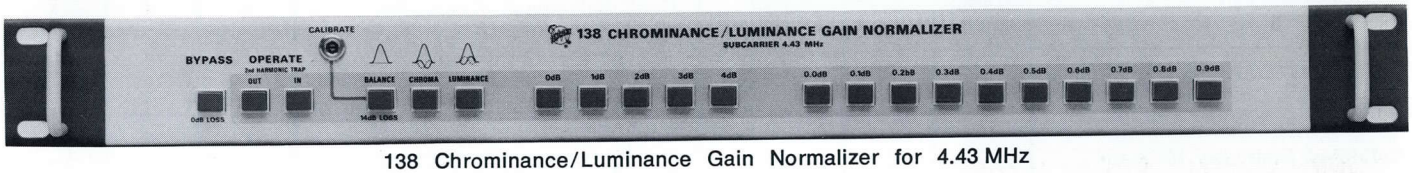
For systems using 625/50 standards order 015-0213-00 Low Pass Filter and 015-0215-00 Noise Weighting Filter.

Order 015-0212-00 Low-Pass 4.2 MHz 525/60
Order 015-0213-00 Low-Pass 5.0 MHz 625/50
Order 015-0214-00 Noise-Weighting 4.2 MHz 525/60
Order 015-0215-00 Noise-Weighting 5.0 MHz 625/50

CHROMINANCE/LUMINANCE GAIN NORMALIZER



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

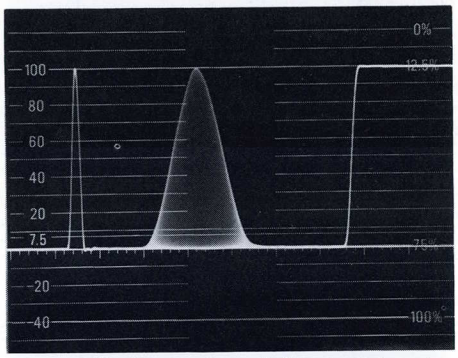


Fig. 1. Undistorted modulated $\sin^2$ pulse.

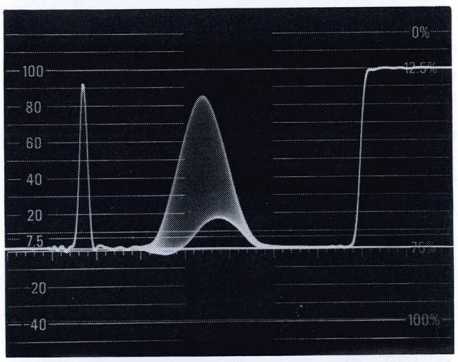


Fig 2. Modulated $\sin^2$ pulse with chrominance/luminance gain and delay distortions. Display 1 volt full scale.

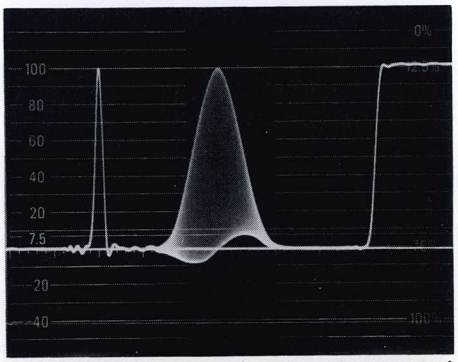


Fig. 3. Modulated $\sin^2$ pulse after normalization. Display 0.2 volt full scale.

For further ordering information see last page.

PAL SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

PAL TEST SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

SIGNAL	141A	142	148
EBU Colour Bars	FF I	FF I	
Colour Bars/Luminance Reference		FF	
Modulated Staircase 5 Step[1]	FF I	FF I	FF I
Modulated Staircase 10 Step[1]			FF I
Modulated Ramp[1]			FF I
Modulated Pedestal[1]		FF I	
Composite Test Signal[2]			FF I
Sin² Pulse and Bar			FF I
Sin² Pulse and Window			FF I
Field Square Wave			FF
Flat Field			FF
APL Bounce			FF
Noise Measuring Capability			FF I
Convergence Signal	Order Mod 703Z	FF	
ITS, International Per EBU			
Line 17			FF** I
Line 18			FF** I
Line 330			FF** I
Line 331			FF** I

Signals are not necessarily simultaneous and a few require simple reprogramming.

FF Full Field

I ITS

1 Modulation may be turned off

2 5 step staircase plus 2 T, 12.5 T & Bar

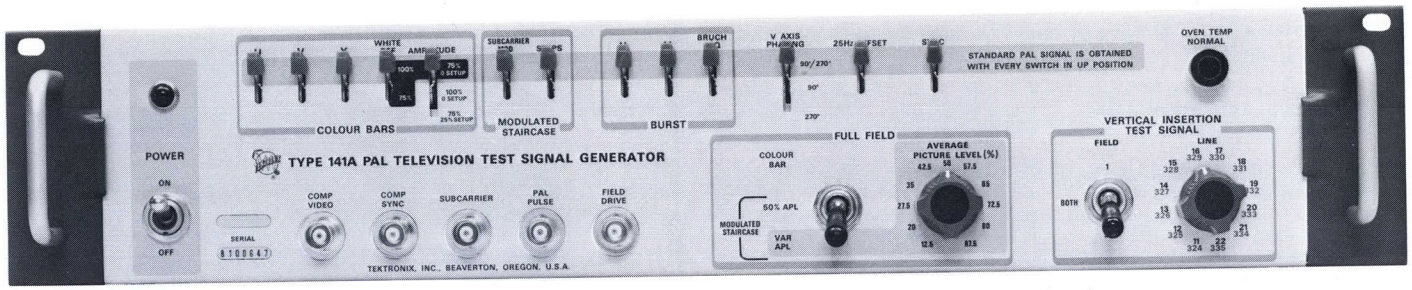
** Any two of these may be time shared with 6 lines of flat field to set APL

PAL SYNC & TIMING

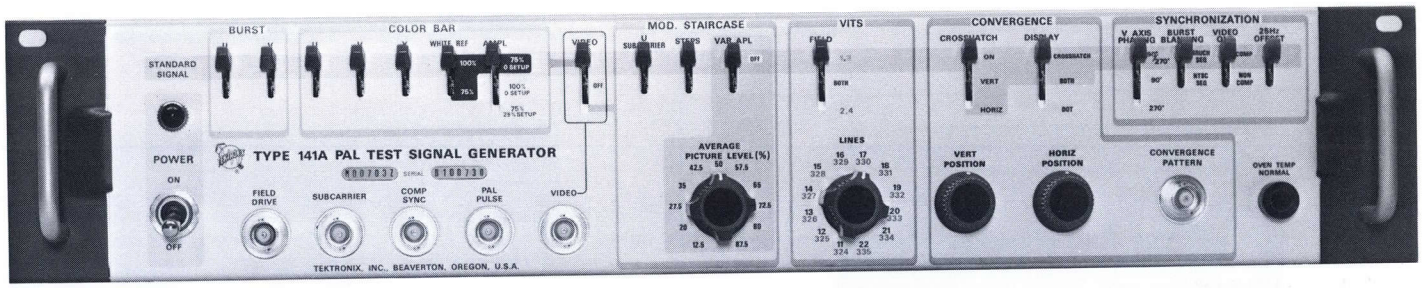
SIGNAL OUTPUTS	141A	142	148
Composite Sync	X	X	X
Composite Blanking	X	X	
Subcarrier	X	X	X
Burst Flag	X	X	
PAL Pulse	X	X	
Line Drive	X	X	
Field Drive	X	X	
1 MHz Reference	X		
25 Hz	X		
12.5 Hz	X		
SIGNAL INPUTS			
Gen-Lock Input			X
External Sync Input		X	X
External Subcarrier Input		X	X

PAL GENERATORS

- 625-LINE, 50-CYCLE FIELD 4.433618 MHz SUBCARRIER
- PAL COLOUR BARS
- STAIRCASE
- PAL SYNC GENERATOR
- INSERTION TEST SIGNAL
- CONVERGENCE SIGNAL (141A Mod 703Z only)



Rackmount version; cabinet version has carrying handle, less mounting hardware.



The 141A MOD 703Z (with convergence signal).

The 141A PAL Television Test Signal Generator is a source of high-quality television test signals for 625-line, 50-cycle field standard PAL colour TV Systems. Digital Integrated Circuits are used to achieve stability, accuracy and reliability.

Three operating modes provide PAL Colour Bars, a 5-Step Staircase with fixed Average Picture Level (APL), and the same Staircase with variable APL. The colour bar output is a full-field test signal appearing on every active line and consists of 75% amplitude colour bars in descending luminance order with 0% setup. The white reference can be set at 75% or at 100% (for standard EBU bars). Two other versions of colour bar signal can be selected: 75% amplitude, 100% white reference with 25% setup (BBC 95% bars) and 100% white reference, 0% setup (100% bars). Any component of the composite video colour signal may be turned off. This includes Y, U, V, the entire colour bar signal, sync, burst (either U or V component only or both), and the 25-Hz offset of colour subcarrier which drives the sync generator.

The staircase signal is particularly useful with a TEKTRONIX Vectorscope to measure differential phase and differential gain. Luminance channel linearity may also be measured using the TEKTRONIX video staircase differentiator part #015-0154-00 (the transient response of the staircase signal component is determined by a $\sin^2$ filter whose cutoff frequency limits the energy content in the region of the colour subcarrier frequency).

The PAL subcarrier (140 mV P-P) is accurately phased at 180° (it lies along the —U PAL axis and is at the same phase on alternate lines). Subcarrier may be switched off when desired.

To provide ITS (Insertion Test Signal) the staircase signal is keyed on during a selected line of the vertical blanking interval, either or both fields (line 11-22 on Field 1 and line 324-325 on Field 2).

Normal PAL colour burst is provided on the staircase and colour bar signals. The complex four-field Bruch blanking sequence during vertical interval is provided and may be switched off if desired.

A 1-MHz reference signal which is frequency "locked" to the 4.43361875-MHz PAL subcarrier oscillator is provided at the rear of the instrument. The accuracy of the internal subcarrier oscillator may be conveniently verified by comparing the 1-MHz reference with known frequencies, such as the Droitwich 200-kHz radio transmission in Europe.

PAL COLOUR BARS

Luminance And Chrominance Amplitude Accuracies—(25°C reference) Component amplitudes comply with the CCIR signal requirements as defined by CCIR, 11th Plenary Assembly, 1966, Vol. 5, p. 281. Absolute amplitudes of luminance signal, setup and sync are within 1% or 1.5 mV, whichever is greater. Absolute amplitudes of all subcarrier frequency components (chrominance, U and V) are within 3%. Relative amplitudes of all subcarrier frequency components (chrominance and burst) are within 1% or residual subcarrier plus 1 mV whichever is greater, of the red chrominance bar.

Bar Width— 6.5 μs within 5%.

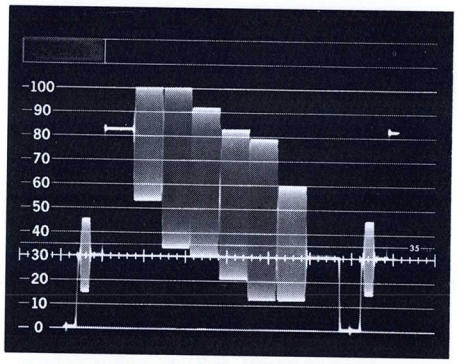
White Reference— 100% amplitude (normal); or 75% amplitude.

Chrominance—Time difference between luminance and chrominance channels is 20 ns or less. Risetime is 260 ns within 10%. U, V quadrature error is 0.5° or less, V axis phase-switcher error is 0.5° or less.

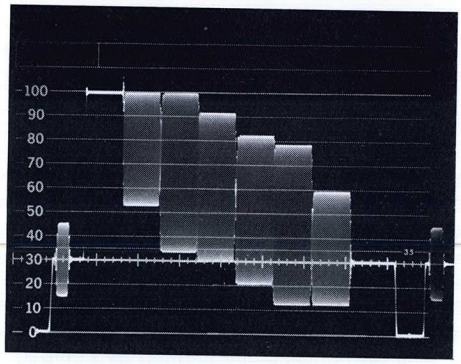
Residual Subcarrier—At least 52 dB below 1 V except 30 dB at end of H blanking.

Aberrations—Within 4% of 1 V P-P.

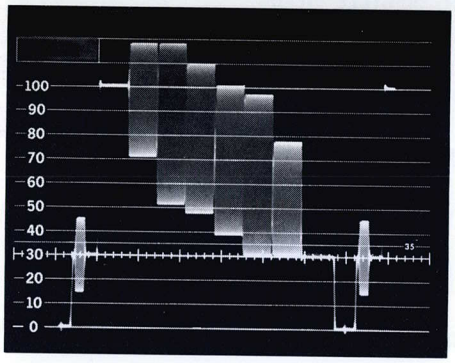
Spurious Subcarrier—At least 52 dB below 1 V when viewed on a 529 Waveform Monitor. Other spurious outputs are at least 52 dB below 1 V also.



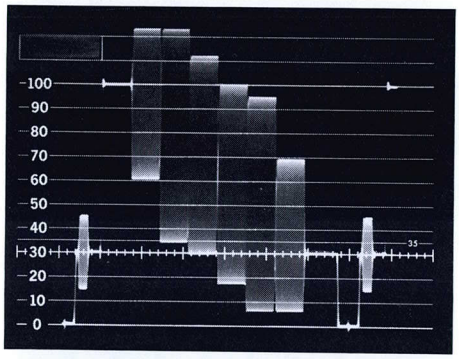
EBU colour bars—75% amplitude, 100% saturation, 0% setup and 75% white reference.



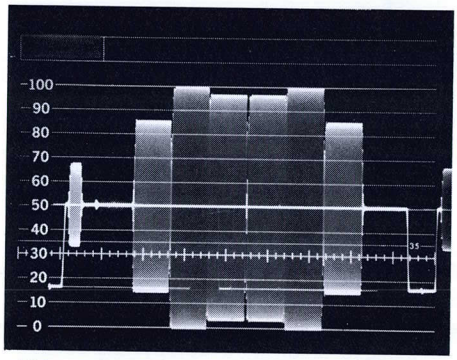
EBU colour bars—75% amplitude, 100% saturation, 0% setup and 100% white reference.



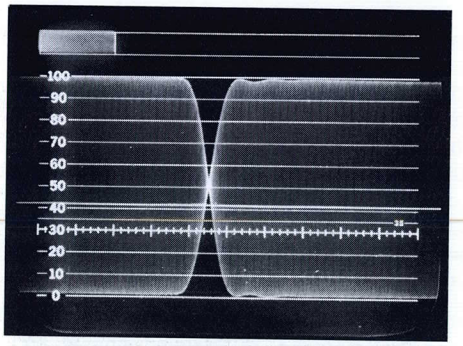
BBC 95% colour bars—75% amplitude, 100% saturation, 25% setup and 100% white reference.



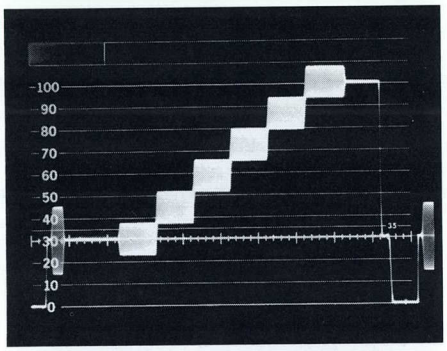
100% colour bars—100% amplitude, 100% saturation, 0% setup, 100% white reference.



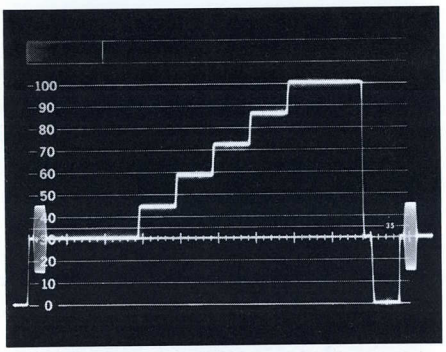
PAL colour bars, luminance component switched off (vertical gain of waveform monitor increased).



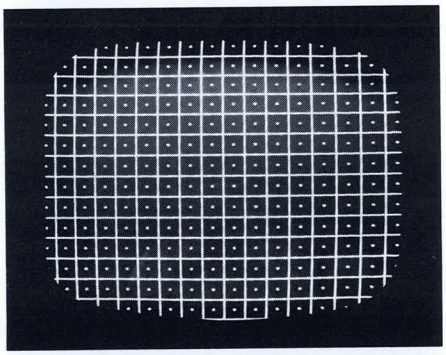
Chrominance signal, green-magenta transition, 250 ns/cm time base.



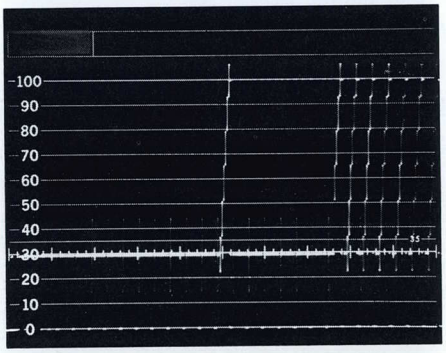
5-step staircase waveform with PAL subcarrier along -U axis. PAL burst is provided. Note white reference level following the modulation.



5-step staircase waveform, luminance only. Note double width black and white steps. Luminance transitions are $\sin^2$ shaped of approx 260-ns risetime.



Convergence pattern, suitable for convergence, scanning linearity, and aspect ratio adjustments of monitors. Available with the 141A MOD 703Z. Shown on conventional monitor.



Vertical Insertion Test Signal, 5-step staircase with PAL subcarrier on line 16, field 1.

STAIRCASE

Luminance Component—5-step amplitude is 700 mV within 1%. Single-step amplitude is 140 mV within 1%. Step risetime is 260 ns within 15%. Step duration at blanking level and white level is 13 μs within 5%. Intermediate step durations are 6.5 μs within 5%. Aberrations are within 2% of step amplitude.

Chrominance Component—Amplitude is 140 mV P-P within 3%. Phase is 180°.

Differential Phase— 0.1° or less.

Differential Gain— 0.5% or less at 0%, 50% and 100% APL.

Subcarrier Envelope—Risetime is 260 ns within 15% and duration is 39 μs within 5%.

50% FIXED APL—Each active line carries the modulated staircase signal. APL is 50%.

Variable APL—Staircase signal is on every 4th line and the same line every frame. Luminance level range is 700 mV in 10 equal increments, within 2%. The 90°/270° subcarrier modulation on the variable APL lines is 30 mV within 20%.

Convergence Pattern—The 141A MOD 703Z provides a convergence pattern signal separate and independent from the other test signals. It is useful for measuring picture monitor or camera scanning linearity, aspect ratio, and geometric distortion. Displays available are: cross hatch, vertical lines only, horizontal lines only, and cross hatch plus dots (dots appear centered in the rectangles formed by the cross-hatch pattern). The 141A MOD 703Z retains all the features of the standard 141A.

INSERTION TEST SIGNAL

The staircase signal may be keyed on during a selected line of the vertical blanking interval, either or both fields (line 11-22 on Field 1 and line 324-335 on Field 2).

SYNC GENERATOR

ALL AMPLITUDES ARE SPECIFIED WITH 75-Ω LOAD IMPEDANCE. ALL CONNECTORS ARE BNC TYPE. RETURN LOSS (WHERE APPLICABLE) IS ALWAYS GREATER THAN 30 dB. ISOLATION BETWEEN ALL OUTPUTS IS ALWAYS GREATER THAN 40 dB.

Subcarrier—Frequency is 4.43361875 MHz (long term drift) within 1 Hz/2 week period. Outputs—Three outputs (one front panel and two rear panel). Output level is 2 V P-P within 0.2 V. Output frequency is unaffected by position of 25-Hz offset switch on front panel.

Composite Sync—A front-panel and a rear-panel output is provided. Output level is 4 V within 0.2 V. Risetime is 260 ns within 15%.

PAL Pulse—Two outputs (one front, one rear panel). Amplitude and phasing are internally selected to be either of the following: 1) Squarewave—1 V P-P within 0.05 V with transitions occurring with each horizontal sync pulse. Either positive or negative transition is coincident with leading edge of line sync pulse with 135° or 225° burst phasing, (as internally selected). 2) Pulse—4 V P-P within 0.2 V, duration 4.7 μs within 0.2 μs with negative transition coincident with leading edge of line sync pulse on lines with 135° or 225° burst phasing, (as internally selected).

Composite Blanking—One rear-panel output provides 4 V within 0.2 V. Risetime is 260 ns.

Line Drive—One output (on rear panel). Output level is 4 V within 0.2 V. Risetime is 260 ns.

Field Drive—Two outputs (one front panel, one rear panel). Output level is 4 V within 0.2 V. Risetime is 260 ns.

Burst Flag—One rear-panel output provides 4 V within 0.4 V. Duration is 2.2 μs within 5%, delay from horizontal sync is 5.5 μs within 5%.

1-MHz Reference Frequency—One rear-panel output. Frequency is 1.000000 MHz when subcarrier is 4.43361875 MHz with 25 Hz offset. Amplitude is 1 V P-P within 0.2 V.

25 Mz—One rear-panel output. Output level is 1 V within 0.2 V.

12.5 Hz—One rear-panel output. Output level is 1 V within 0.2 V.

Line Period—64 μs (derived from PAL subcarrier frequency).

Burst—Half amplitude duration of envelope is 2.2 μs within 5% (approximately 10 cycles). Burst delay is 5.5 μs within 0.2 μs. Burst component is 300 mV P-P within 3%. V component is 212 mV P-P within 3%. U component is 212 mV P-P within 3%. Amplitude ratio of U/V is 1.00 within 1%. Amplitude on successive lines—smaller is between 97% and 100% of the larger. Phasing—135° within 1° and 225° within 1° on successive lines. Phasing between successive bursts is 90° within 1°.

Line Blanking—11.8 μs to 12.2 μs.

Front Porch—1.8 μs within 5%.

Line Sync Pulse—Width is 4.7 μs within 0.2 μs; risetime is 260 ns within 15%.

Field Period—20 ms (digitally derived from 4.43361875 MHz).

Field Blanking—25 lines, 1600 μs (digitally derived from 4.43361875 MHz).

Equalization Pulse Sequence Duration—First sequence, 2.5 H (lines); second sequence, 2.5 H (lines).

Field Sync Pulse—Duration 27.3 μs within 0.2 μs.

Interval Between Field Sync Pulses—47 μs within 0.2 μs.

The 141A will not colour Gen-Lock.

OTHER CHARACTERISTICS

COMPOSITE VIDEO OUTPUT

Two outputs are provided through BNC type connectors, one front panel and one rear panel. Composite video consists of composite sync and video test signals as selected by front-panel controls. Amplitude is 1 V P-P into 75 Ω. Return loss is at least 30 dB. Isolation is at least 40 dB.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz. 55 W max at 230 VAC, 50 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

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

Dimensions And Weights

Cabinet	Height	3½ in	8.9 cm
	Width	16¾ in	42.6 cm
	Depth	18½ in	47.1 cm
	Net weight	17¾ lb	8.0 kg
Rack	Height	3½ in	8.9 kg
	Width	19 in	48.3 cm
	Depth	18½ in	47.1 cm
	Net weight	18½ lb	8.4 kg

INCLUDED ACCESSORIES

75-Ω through-line termination (011-0103-02); 7½-foot 3-wire power cord (161-0036-00); instruction manual (070-1008-00). R141A also includes rackmounting hardware.

Order 141A PAL SIGNAL GENERATOR

Order 141A MOD 703Z PAL SIGNAL GENERATOR

Order R141A PAL SIGNAL GENERATOR (rackmount)

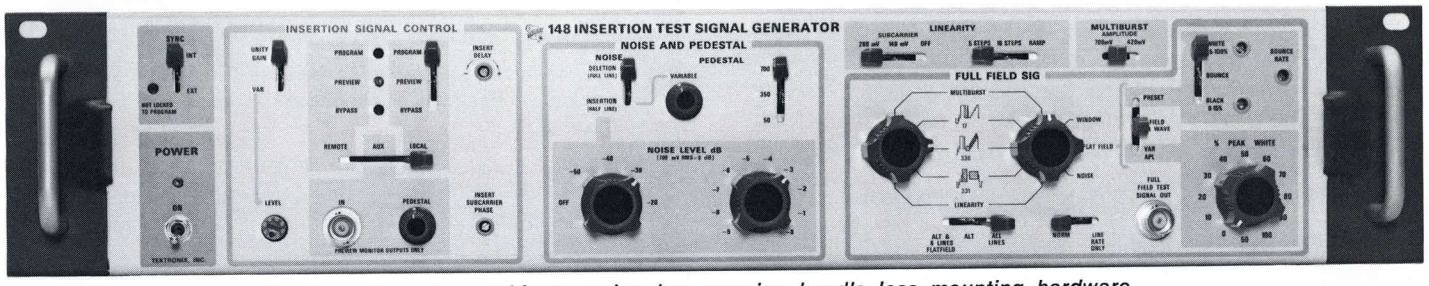
Order R141A MOD 703Z PAL SIGNAL GENERATOR (rackmount)

For additional ordering information see last page.

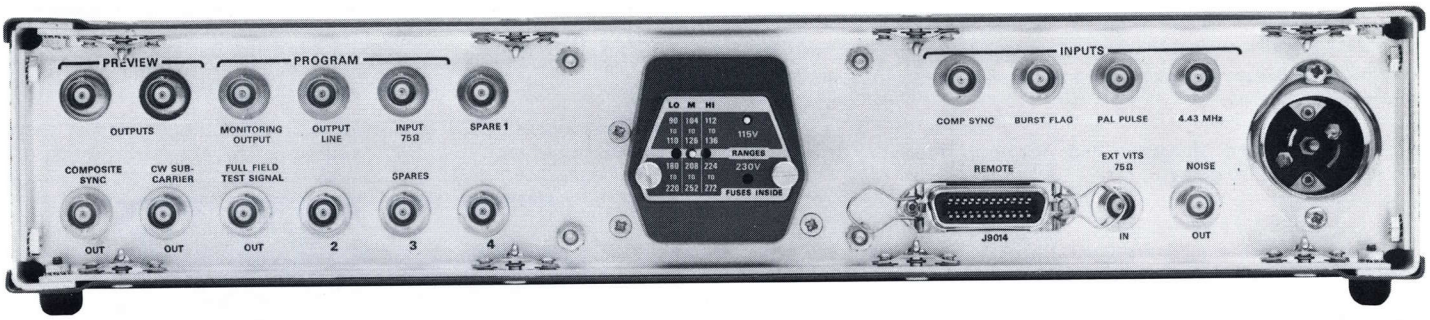
INSERTION TEST SIGNAL GENERATOR

148

- INSERTION TEST SIGNALS
- FULL-FIELD TEST SIGNALS
- EASILY REPROGRAMMABLE
- SAFE IN-SERVICE VITS INSERTION
- NOISE MEASUREMENT
- APL BOUNCE SIGNAL
- SOURCE IDENTIFICATION CODE
- OPERATES WITH SOUND IN SYNCS
- LOCKS WITH MIXED SYNCS
  - SUBCARRIER
  - PAL PULSE
  - BURST FLAG



Rackmount version; cabinet version has carrying handle less mounting hardware.



The 148 is a PAL television signal generator supplying all 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 Insertion Test Signals 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 ITS. As a ITS 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 ITS signals are readily made by removing and/or moving color-coded jumpers within the 148. Any signal may be eliminated or moved. Externally generated ITS 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 ITS deletion or insertion is automatically discontinued. An internal synchronization is derived from incoming program video. In external, it is derived from four internal signals: mixed syncs, subcarrier, PAL pulse and burst flag.

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-ITS inserted on program line output according to internal selection of test signals and their time address. Preview-ITS 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 noncomposite 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.

ITS 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—At least 30 dB to 7 MHz.

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

Isolation Between Program Preview Outputs—At least 46 dB to 5 MHz.

Isolation Between Program and Program Monitor Outputs—At least 34 dB to 5 MHz.

Inserted Signal Level—Within ±1% of nominal.

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—Within 0.25%.

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— 0.7 mV or less.

Hum, Transients on Noninserted Lines—At least 60 dB down.

Spurious Signals During Blanking Time—Inactive line time at least 40 dB down; active ITS lines at 60 dB down.

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 ITS Insertion—Program and Preview Channel: Less than 5 mV.

Line Timing Adjustment Range with External Sync—±0.5 μs front panel.

FULL-FIELD OPERATION

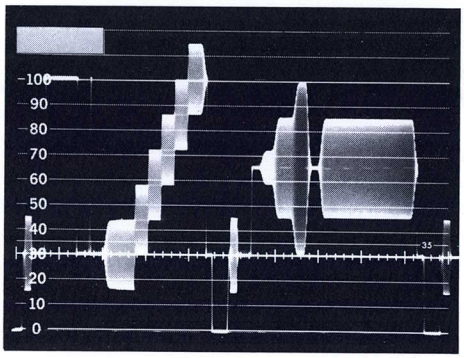
A major function of the 148 is to provide full-field test signals separate from program. Full-field signals are generated with or without external synchronizing information. Therefore, there are two modes of full-field operation: Free running or synchronized (locked).

Eight full-field signals can be selected: Multiburst, Linearity, Flat Field, Window, Noise, Line 17, Line 330, and Line 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 switches. This permits any one of the eight signals to be produced on all active lines or any two signals can be alternated on all active lines or any two signals can be paired on two successive lines and alternated with six lines of adjustable flat field.

Full-Field signals are available with or without vertical sync and blanking selectable by front panel.



Full-field alternation of two signals on all active lines.

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 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 ≈200 ns.

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 reprogrammed to produce different spacings of 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 by a 9 pole Kastelein filter. This filter is on a separate plug-in circuit board so that other pulse durations may be obtained with the use of other filters.

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 μs HAD. Greater sensitivity to chrominance-luminance delay errors may be had by using reduced 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.

Luminance Bar Amplitude—700 mV ±1%.

T Bar Risetime—100 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 3 mV.

20 T Modulated Pulse HAD—2.0 μs.

20 T Modulated Pulse Residual Subcarrier—Less than 3 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.

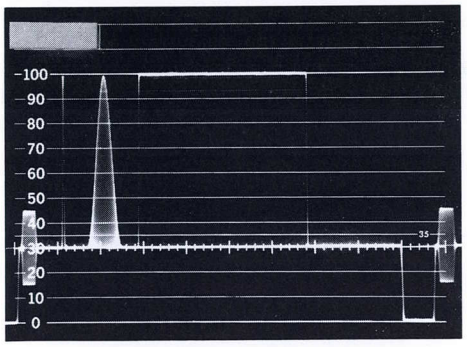
Risetime—Shaped by $\sin^2$ filter with first zero in frequency domain at 4.3 MHz.

WINDOW SIGNAL

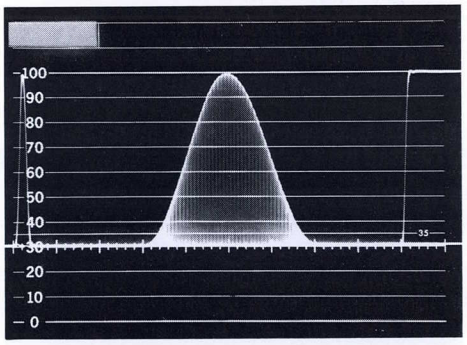
The Window Signal is the same as the Pulse and Bar except that the "Window" occupies the center 205 lines of each field. A window signal can be used to measure both line time and field time distortions. It is especially useful when observing picture monitors. Where field rate distortion is present, the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

Amplitude— 700 mV.

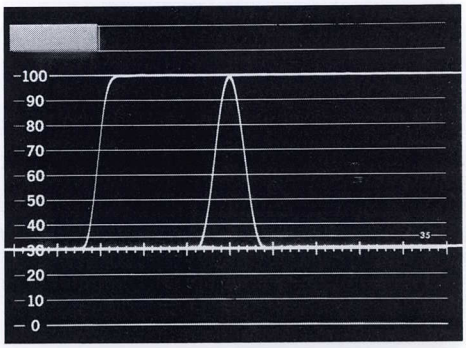
Risetime—Internally programmable: either 2 T pulse and T window or T pulse and 2 T window.



Window signal with 2 T and modulated 20 T $\sin^2$ pulses.



Modulated 20 T pulse magnified.



2 T $\sin^2$ pulse superimposed on bar by double exposure.

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. Important—see 1430 page for noise weighting filters.

Noise Pedestal Amplitude—Selectable 0 mV, 50 mV, or 100 mV. within 2%.

Variable Pedestal— ±5% variation provided for half line insertion in order to exactly match pedestal level of incoming signal.

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—At least 30 dB.

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.

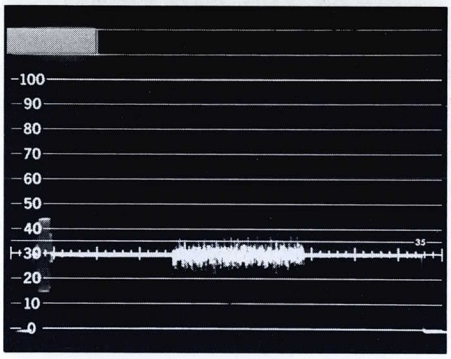
Chrominance Component—Amplitude is selectable: 0 mV, 140 mV, 280 mV.

Differential Phase— 0.2° or less.

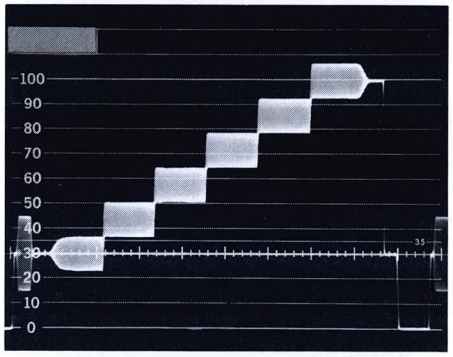
Differential Gain—0.5% or less.

Ramp Luminance Amplitude— 700 mV.

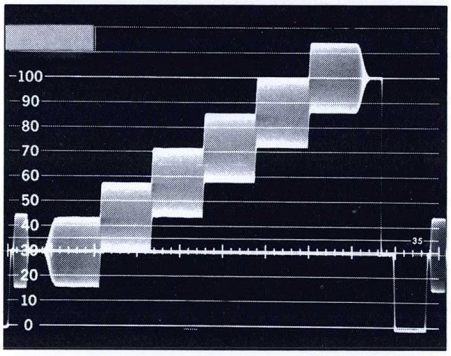
Ramp Linearity— Within 1%.



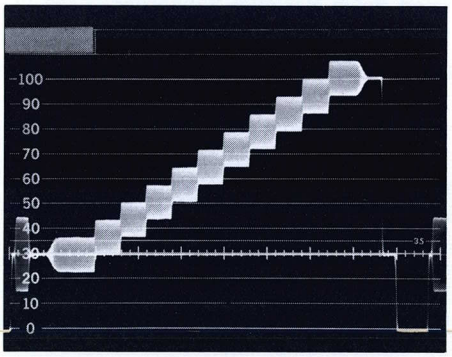
Half line adjustable noise comparison signal inserted on a full line.



Linearity signal, 5 step, 140 mV subcarrier.



Linearity signal, 5 step, 280 mV subcarrier.



Linearity signal, 10 step, 140 mV subcarrier.

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% and 420 μV ±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, 4.0, 4.8 and 5.8 MHz within 3%. Each burst frequency independently adjustable (internal).

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

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.

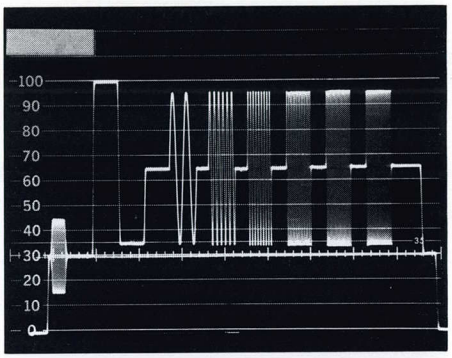
Superimposed Subcarrier Frequency and Phase— 4.43361875 MHz ±10 Hz; 60° ±5° to the B-Y axis, referred to the burst (when present).

Rise and Fall Times of Subcarrier Superimposed on Staircase— 1 μs approximately.

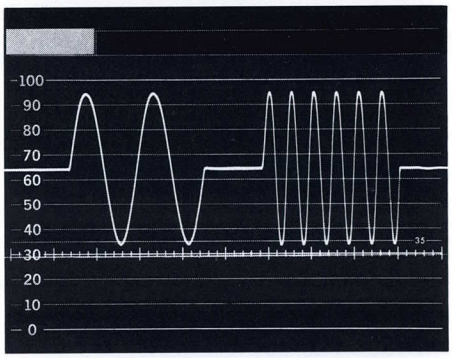
Inherent Differential Gain—Less than 0.5%.

Inherent Differential Phase—Less than 0.2°.

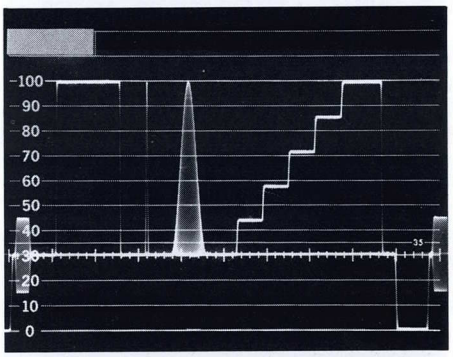
Amplitude of Superimposed Subcarrier— 0.28 V peak-to-peak ±2% of luminance-bar amplitude.



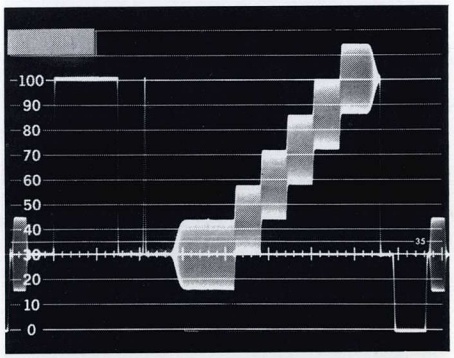
420 mV Multiburst—Note burst starts and stops precisely at the same level.



Multiburst magnified to show start and stop transitions.



Line 17



Line 330

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.

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

Harmonic Content of Subcarrier—Less than —40 dB.

Chroma Phase—60° (internally adjustable to any phase).

CHROMINANCE BAR

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

Pedestal— 0.35 V ±1%.

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.

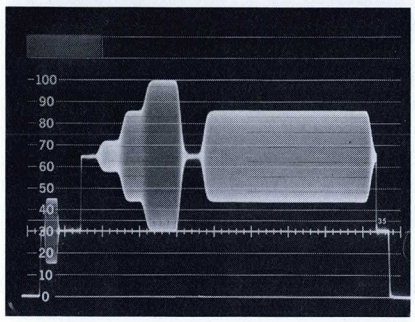
SOURCE IDENTIFICATION CODE

The 148 is a source identification code generator with up to 25 pulses in any combination on line 16 or 329.

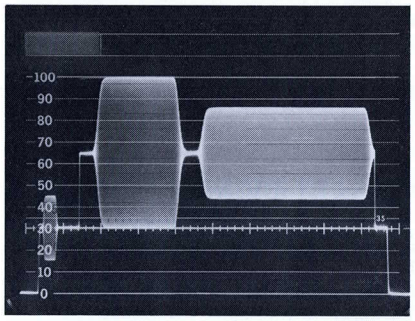
Pulse Width—1 μs.

One Level—630 to 700 mV above blanking.

Zero Level—Within 25 mV of blanking.



Line 331



Line 331 with single level chrominance bar.

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 ITS 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

7½-ft power cable, three wire (161-0036-00); 75 Ω, BNC termination (011-0103-02); 2 each BNC-T adapters (103-0030-00). R148 includes rackmounting hardware (351-0195-00).

Order 148 TEST SIGNAL GENERATOR

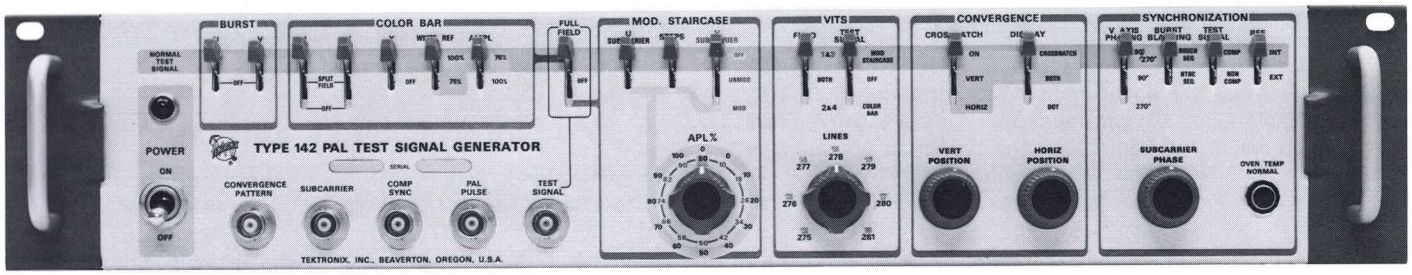
Order R148 TEST SIGNAL GENERATOR (rackmount)

For further ordering information see last page.

PAL M GENERATOR

142

- COLOR BARS
- STAIRCASE
- SYNC PULSE GENERATOR
- VERTICAL INSERTION TEST SIGNAL
- CONVERGENCE



Rackmount version shown; cabinet version has carrying handle, less mounting hardware.

The TEKTRONIX 142 PAL Test Signal Generators are a compact, solid-state source of high-quality television test signals for 525-line, 60-Hz field-standard PAL color TV systems. Combined in one compact unit are the test signals needed to accurately test, evaluate, and adjust laboratory and standard broadcast color video equipment. Each test signal not only strictly adheres to industry standards, but also provides additional refinements to enhance the accuracy and range of measurements which can be made. The self-contained sync generator includes a temperature controlled color standard with excellent frequency stability. Digital integrated circuits are extensively used to achieve stability, accuracy and reliability.

Three operating modes provide PAL color bars, 5 step staircase with APL and a 5 step staircase variable APL. A convergence pattern signal is available independent of and separate from other test signals.

PAL COLOR BARS

The standard color bar output is a full-field test signal appearing on every active line, and consists of 75% or 100% amplitude color bars in descending luminance order with 50 millivolts setup. With 75% amplitude, the white reference amplitude, which precedes the yellow bar, may be selected at 75% or 100% levels. The 100% white bar amplitude level permits a convenient check of relative chrominance/luminance gain by comparing the peak amplitudes of the yellow, cyan and white bars.

CHARACTERISTICS

Luminance and Chrominance Accuracy—Absolute amplitudes of luminance signal, setup and sync are within 1% or 1.5 millivolts, whichever is greater, with respect to blanking. Absolute amplitudes of all subcarrier frequency components (Chrominance, U and V) are within 3%. Relative amplitudes of all subcarrier frequency components are within 1% or 1.5 millivolts, whichever is greater, of the red chrominance bar.

Bar Width—6.6 μs within 5%.

White Bar Risetime—115 ns within 15%.

White Reference—100% amplitude normal; or 75%.

Chrominance—Time difference between luminance and chrominance is 20 ns or less.

Risetime—375 ns within 15%. U, V Quadrature error is 0.5° or less. V axis phase switcher is 0.5° or less.

Residual Subcarrier—At least 52 dB below 1 volt on white or black.

Aberrations—Within 4% peak to peak of 1 volt.

Spurious Subcarrier (between burst and white)—At least 52 dB below 1 volt when viewed on a TEKTRONIX 529 except 30 dB during sync and at the end of H blanking.

Other Spurious Subcarrier (at center of line blanking pulse)—At least 52 dB below 1 volt except 30 dB during sync and at the end of H blanking.

STAIRCASE

The staircase signal is particularly useful with a TEKTRONIX 522 Vectorscope to measure differential phase and differential gain, as the transient response of the staircase signal component is determined by a filter whose cut-off frequency limits the energy content in the region of the color subcarrier frequency. Staircase signal may also be used to measure luminance signal linearity with a TEKTRONIX video staircase differentiator part number 015-0075-00. The PAL subcarrier (140 mV P-P) is accurately phased at 0°, (it lies along the +U PAL axis and is at the same phase on alternate lines). Subcarrier may be switched off when desired. The last step (at white level) is double width so it can be viewed with and without subcarrier to detect clipping in the white direction. To provide VITS (Vertical Insertion Test Signal) information, the staircase signal is keyed on during a selected line of the vertical blanking interval in one or both pairs of fields, depending on the settings of the FIELD and LINE SWITCHED.

CHARACTERISTICS

Luminance Component—Step amplitude is 140 millivolts within 1%. 5 step amplitude is 700 millivolts within 1%. Step risetime is 260 ns within 15%. Aberrations are within 2% of step amplitude.

Chrominance Component—Amplitude is 140 millivolts within 3%. Phase is 0°.

Differential Phase—0.1° or less.

Differential Gain—0.5% or less.

Subcarrier Envelope—Duration is 39 μs within 5%. Risetime is 375 ns within 15%.

Variable APL—Staircase signal on every fifth line, and the same line each frame. Luminance level range is 0 to 700 millivolts in 10 equal increments within 2%.

VERTICAL INSERTION TEST SIGNALS

Provision is made for insertion of either the staircase or the color bar, as a vertical insertion test signal, on any line from 12 through 18 of fields 1 and 3, or any line from 275 through 281 in fields 2 and 4. The phase of the burst (and all other subcarrier frequency components of the test signal outputs) may be varied 360° with respect to the subcarrier frequency source (internal or external).

With the 75% amplitude full-field color bar signal or the modulated staircase signal inserted on an appropriate line of both fields, it is possible to test an entire video system including transmitters for differential phase and gain.

CONVERGENCE PATTERN

The convergence pattern signal is provided separately and independent from the other test signals. It is useful for measuring picture monitor or camera scanning linearity, aspect ratio and geometric distortion. Displays available include crosshatch, vertical lines only, horizontal lines only, dots only and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern).

Convergence Pattern—Setup is 50 mV within 5%. Sync amplitude is 300 mV within 5%. Pulse amplitude is 700 mV within 5%. Amplitude is 1 volt peak-to-peak within 5% (overall). Return loss is at least 30 dB. Risetime is 115 ns within 10%. Crosshatch vertical lines and repetition rate is 315 kHz. Pulse time position range is at least 3.2 μs. Pulse polarity is positive. Number of unblanked pulses is 16 or 17 (depending on setting of POSITION control). Crosshatch pulse duration is 225 ns within 15%. Dot pulse duration is 350 ns within 15%.

Crosshatch Horizontal Lines—Repetition rate is 900 Hz. Pulse time position range is at least 1.1 ms. Pulse polarity is positive. Number of unblanked pulses is 13 to 14 (depending on setting of POSITION control). Crosshatch pulse duration is 1 line at field rate. Dot pulse duration is 3 lines per frame.

SYNC GENERATOR AND COLOR STANDARD

The EIA sync generator circuitry is largely digital, using integrated circuit counting functions. The usual frequency multiplier circuits and their attendant problems have been avoided, resulting in exceptional time stability. Internal controls permit some variation of widths, including burst flag timing.

The color standard has a proportional control oven for the quartz crystal and the entire oscillator circuit. A front-panel lamp indicates proper operation of the oven. When the internal color standard is used, the phase of the color subcarrier output is variable over a 360° range with respect to the phase of the burst contained in the video output. When an external color standard is used, the phase of the burst (and all other subcarrier frequency components of the test signal outputs) may be varied 360° to the external subcarrier source.

Composite Sync—Output amplitude is 4 volts peak-to-peak within 0.2 volts into 75 ohms. Return loss is at least 30 dB to 5 MHz. Rise and falltime is 115 ns within 10%. Line sync duration is 4.71 μs within 0.05 μs measured at 10% from blanking level. Line period is 63.56 μs. Equalizing pulse duration is 2.33 μs within 0.5 μs measured at 10% from blanking level. Sequence duration is first, 3 lines and second, 3 lines. Field sync pulse duration is 27.3 μs within 0.2 μs measured at 10%. Sequence duration is 3 lines. Internal between 3 is 4.5 μs within 0.2 μs measured at 10% from blanking level. Field period is 262.5 lines. Input (loop-through) amplitude is at least 2 volts peak-to-peak. Return loss is at least 46 dB.

Subcarrier—Output amplitude is 2 volts peak-to-peak within 0.2 volts into 75 ohms. Return loss is at least 30 dB. Frequency is 3.575611 MHz within 5 Hz. Input (loop-through) amplitude is at least 1 volt peak-to-peak. Return loss is at least 46 dB.

Horizontal Drive—Amplitude is 4 volts peak-to-peak within 5% into 75 ohms. Pulse duration is 6.35 μs within 5%. Rise and falltime is 115 ns within 10%. Return loss is at least 30 dB.

TEST SIGNAL OUTPUT CHARACTERISTICS

Return Loss—At least 30 dB.

Isolation Passive—Either open or short of one output will cause an output level change at the other connector of less than 1%; i.e., 40 dB for all other components of the signal.

Active (Noncoherent Crosstalk)—A signal introduced to one output connector will be attenuated by at least 40 dB at the other connector for signals between +0.5 and —4.0 volts, at or below color subcarrier frequency.

Front Porch—1.54 μs within 0.05 μs measured at 10% from blanking.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz. 55 W max at 230 VAC, 50 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

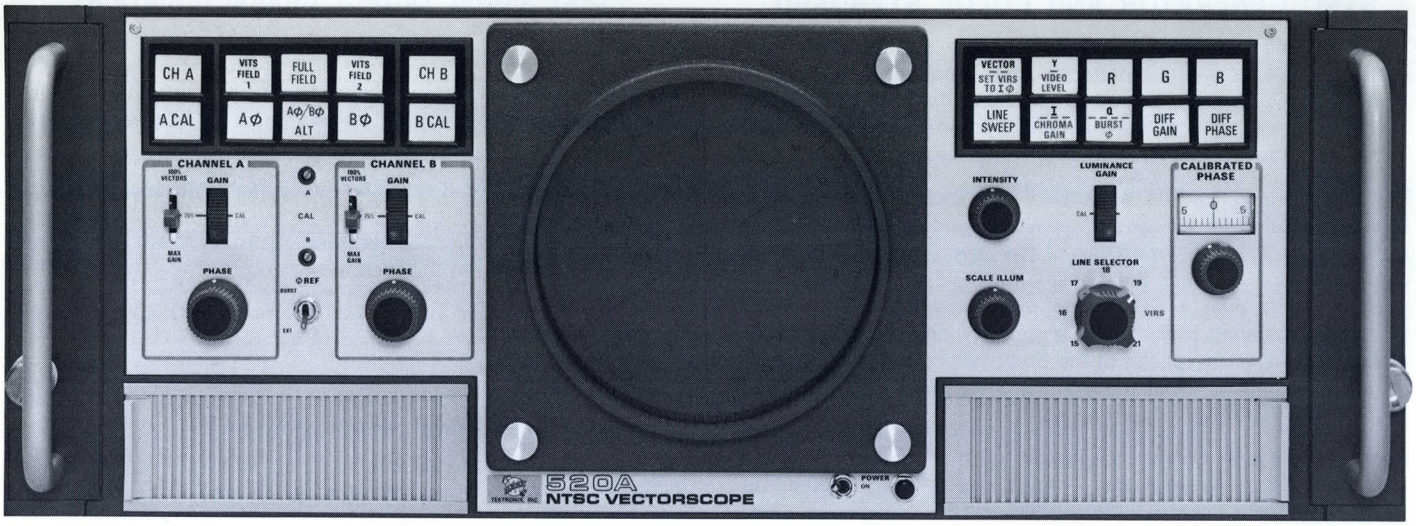
Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

INCLUDED ACCESSORIES

75-Ω through-line termination (011-0103-02); 7½ foot 3-wire power cord (161-0036-00); instruction manual (070-1008-00). R142 is shipped with rackmounting hardware.

Order 142 PAL M SIGNAL GENERATOR
Order R142 PAL M SIGNAL GENERATOR

For additional ordering information see last page.



R520A NTSC (525/60 3.58 MHz)

MEASUREMENTS

- **LUMINANCE AMPLITUDE**
- **CHROMINANCE PHASE AND AMPLITUDE**
- **DIFFERENTIAL PHASE**
- **DIFFERENTIAL GAIN**

VECTOR DISPLAYS

The vector presentation graphically displays the relative phase and amplitude of the chrominance signal on polar coordinates. To identify these coordinates the graticule (see fig 1) has points which correspond to the proper phase and amplitude of the primary and complementary colors: R (Red), B (Blue), G (Green); Cy (Cyan), Y_L (Yellow) and M_G (Magenta).

Any errors in the color encoding, video tape recording or transmission processes which change these phase and/or amplitude relationships cause color errors in the television receiver picture. The polar coordinate type of display such as that obtained on the 520A CRT has proved to be the best method for portraying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Saturation is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits per FCC requirements (±10°, ±20%). The inner boxes indicate ±2.5° and 2.5 IRE units and correspond to phase and amplitude error limits per EIA specification RS-189, amended for 7.5% setup.

An internally generated test circle matched with the vector graticule verifies quadrature accuracy, horizontal to vertical gain balance and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase-shift are provided. Large phase-shifts can be accurately read from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase-shifts.

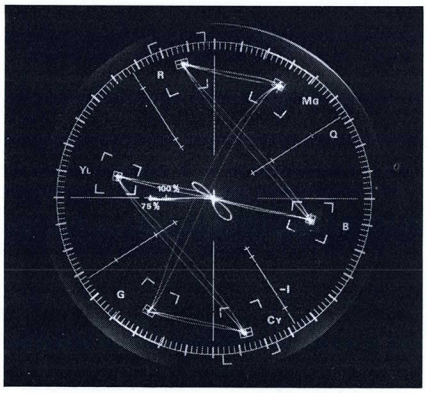


Fig 1—Vector display—full-field color bars, 75% amplitude, 100% white reference, 10% set-up. Conforms to EIA standard RS189. 140 NTSC Test Signal Generator used as a signal source.

DUAL VECTOR DISPLAY

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync and switching transients are blanked. Input-output signals from video equipment can be conveniently compared on channel A and B for phase and/or amplitude distortion. The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° CALIBRATED PHASE shifter. While viewing channel A or B, either of the uncalibrated phase-shifters, Aϕ or Bϕ, can be switched into the subcarrier processing channel. Aϕ and Bϕ will lock to channel A and B respectively, when A and B channel are time-shared, permitting independent phase control of channel A and B displays. Phase shifts caused by unequal signal paths are easily canceled, leaving only phase and amplitude distortion caused by equipment deficiencies. Video cable lengths can be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference. Accurate amplitude measurements of chrominance and luminance are provided from the CRT. An internal 1-V luminance amplitude calibration test signal is provided to check the gain accuracy of channel A and B amplifiers and the luminance channel.

LINEAR-SWEEP PRESENTATION

The linear time base operates at the line rate. Color signals are demodulated along any desired axis, I, Q, R-Y, B-Y, etc. and displayed at the line rate on a linear time base.

RED (R), GREEN (G), BLUE (B) AND LUMINANCE (Y)

The 520A provides a luminance channel which permits the separation and display of the luminance (Y) component from the composite color signal (fig 2). The Y component can also be combined with the output of the chrominance demodulators for R, G and B displays at a line rate (fig 3, 4, 5). Amplitude measurements of color signal components can be made with an accuracy of 3%.

DIFFERENTIAL GAIN AND DIFFERENTIAL PHASE MEASUREMENTS

The two main chrominance-signal distortions are differential gain and differential phase. Both can be measured on the 520A Vectorscope. Differential gain (fig 6) is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, the saturation will be distorted in the areas between the light and dark portions of the scene. The IRE graticule major divisions represent % of voltage gain or loss when making a differential gain measurement. The 520A permits differential gain measurements with accuracy to better than 1%.

Differential phase (fig 7) is a phase modulation of the chrominance signal by the luminance signal. In the reproduced color picture, the hue will vary with scene brightness. Differential gain and differential phase may occur separately or together. Differential phase is read from the precision calibrated phase shift control or directly from the differential phase markings on the graticule. Dial resolution is excellent with 1° phase shift represented by approximately 1 inch of dial movement. The vertical deflection of the display is greatly magnified and inverted on alternate lines allowing the use of a trace overlay technique and the slide-back method for measuring small phase changes. The CALIBRATED PHASE control provides direct readout of differential phase. Using the standard linearity test signal, differential phase of 0.2° can be measured. Reference burst is selectable, internal or external.

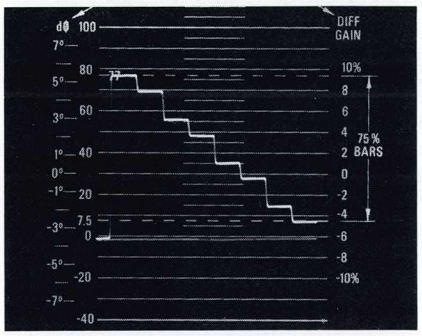


Fig 2

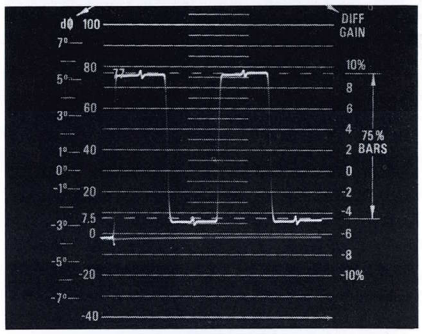


Fig 3

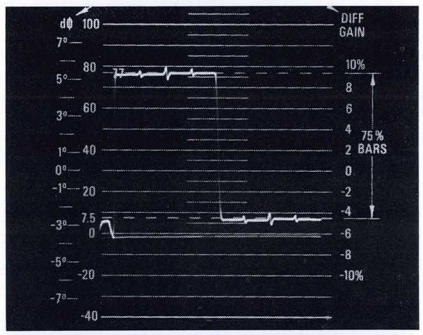


Fig 4

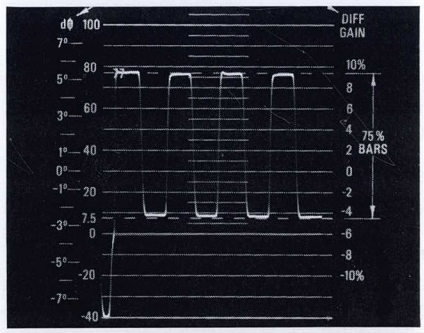


Fig 5

75% amplitude Color Bar Signal. Line-sweep displays of Luminance (fig 2), decoded Red (fig 3), decoded Green (fig 4), and decoded Blue (fig 5). Displays photographed with a TEKTRONIX C-27-549 Camera, using a TEKTRONIX 140 NTSC Test Signal Generator as a source.

VERTICAL INTERVAL TEST SIGNAL OBSERVATION

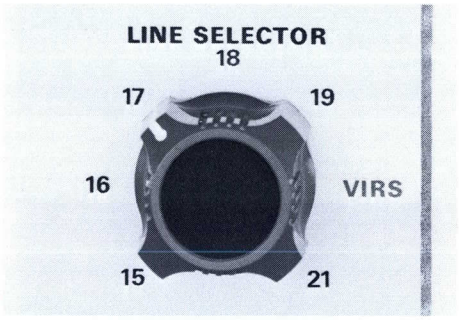
Vertical Interval Test Signals from front-panel selected lines of either field 1 or field 2 can be displayed on the 520A Vectorscope.

Binary counters operate in conjunction with the field selector to select lines in either field that may carry suitable test signals. These circuits enable the Vectorscope to be used for measuring differential gain and differential phase from test signals transmitted in the vertical blanking interval of color broadcasts.

TWO METHODS OF MEASURING DIFFERENTIAL PHASE

Small differential phase distortions such as those found in studio systems, laboratory or on individual equipment is most accurately measured by the two-trace overlay method as shown in fig. 7. This method is independent of differential gain distortion.

A second direct-reading method is better suited for larger differential phase measurements such as found in video tape recorders and microwave links. Accuracy is limited by differential gain distortion.



VITS Line Selector

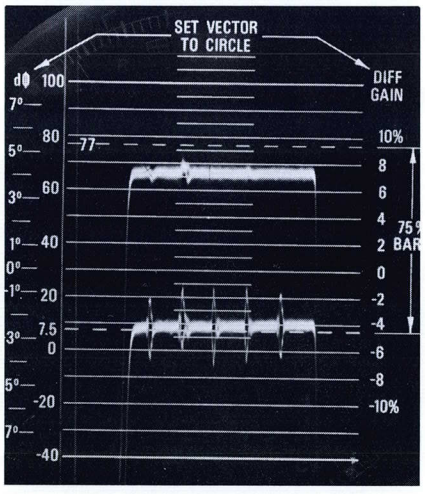
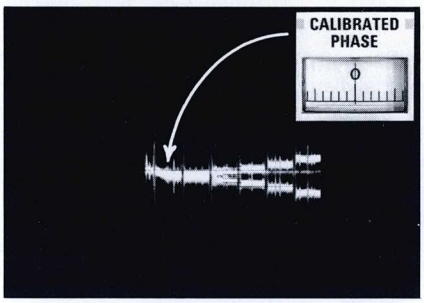


Fig 6—Differential Gain display from the 520A using the 140 NTSC Test Signal Generator. Lower trace, luminance is on. Upper trace, luminance is off. Minor divisions of graticule indicate 1% Differential Gain. Double exposure.



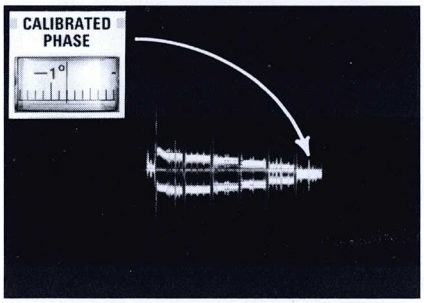


Fig 7—Differential Phase presentation using a modulated staircase signal. A trace overlay technique provides excellent resolution for measuring small phase changes. From reference point in top photo (1st step of staircase signal overlayed) to point of measure in bottom photo (6th step overlayed) represents 1.2° differential phase distortion.

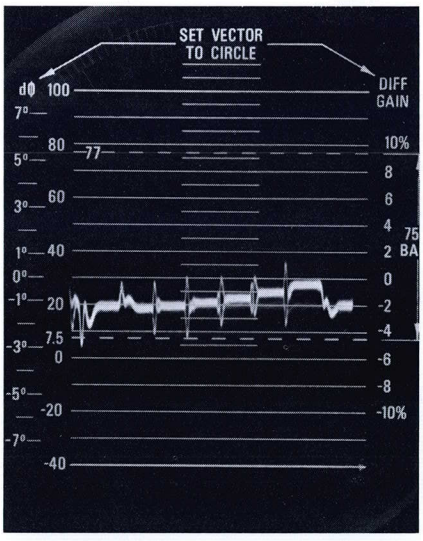


Fig. 8. The new direct-reading display of differential phase distortion using a single trace employs a new graticule.

Graticule—Two separate graticules provide references for vector and line sweep displays. The parallax-free vector graticule, or the luminance graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

Z Axis Input—The Z-AXIS INPUT connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest. A 1-V negative-going pulse is required.

Video Inputs—Dual BNC input connectors for each channel permit 75-Ω loop-through operation with a return loss greater than 46 dB* to 5 MHz. Amplitude range is 0.7 V to 1.4 V VIDEO (sync tip to peak white).

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 47 to 63 Hz, 95 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Environmental Capabilities—Listed instrument characteristics are valid over a temperature range of 0°C to +50°C ambient.

Mechanical Characteristics—The Vectorscope is available in two mechanical configurations, a cabinet model and a rackmount model. Both instruments are electrically identical. The rackmount model mounts in a 19-inch rack and is provided with a slide-out assembly for convenient access to internal components.

DIMENSIONS AND WEIGHTS

Cabinet	Height	7 in	17.8 cm
	Width	16⅞ in	42.9 cm
	Depth	19⅛ in	48.7 cm
	Net weight	33 lb	15 kg
Rackmount	Width	7 in	17.8 cm
	Height	19 in	48.3 cm
	Depth	19¾ in	50.2 cm
	Net Weight	33 lb	15 kg
Domestic shipping weight		≈61 lb	≈27.7 kg
Export-packed weight		≈82 lb	≈37.3 kg

INCLUDED ACCESSORIES

Smoke-gray filter, installed (378-0581-00); camera gasket and mounting screws (016-0114-00); power cord (161-0036-00); instruction manual (070-0639-01).

Rackmount. Same as cabinet but includes rackmounting hardware, and slide-out assembly (351-0195-00).

Order 520A NTSC VECTORSCOPE
Order R520A NTSC VECTORSCOPE (rackmount)

For further ordering information see last page.

*Exceeds CCIR recommendation 451-2, paragraph 3.1 and 3.2

OPTIONAL ACCESSORIES

75-Ω Voltage Step-Up Termination—The 75-Ω Voltage Step-Up Termination provides a X5 increase in chrominance amplitude and permits Differential Gain and Differential Phase measurements to be made to a higher degree of accuracy when used with a TEKTRONIX Vectorscope. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the Vectorscope.

For use with 520A Vectorscope
UHF connectors, order 011-0100-00
BNC connectors, order 011-0100-01

Single Sideband Chroma Amplitude Corrector—The Single Sideband Chroma Amplitude Corrector is designed for use with a TEKTRONIX Vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides a X2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

For use with 520A Vectorscope
UHF connectors, order 011-0107-00
BNC connectors, order 011-0107-01

C-27 Trace Recording Camera—f/1.9, 1:0.5 lens; Polaroid Land* Pack-Film back.

Order C-27-549
520A to C-27 Adapter, order 016-0225-02

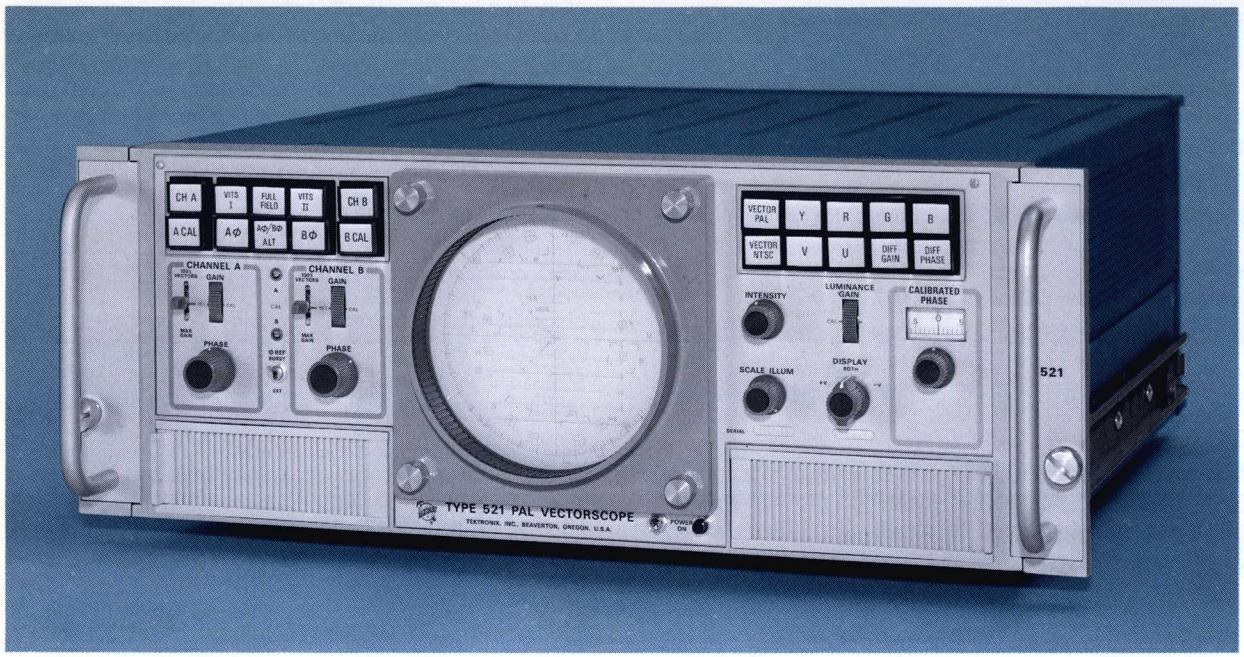
R520A Cradle Assembly—For mounting the 520A in a WECO backless rack.

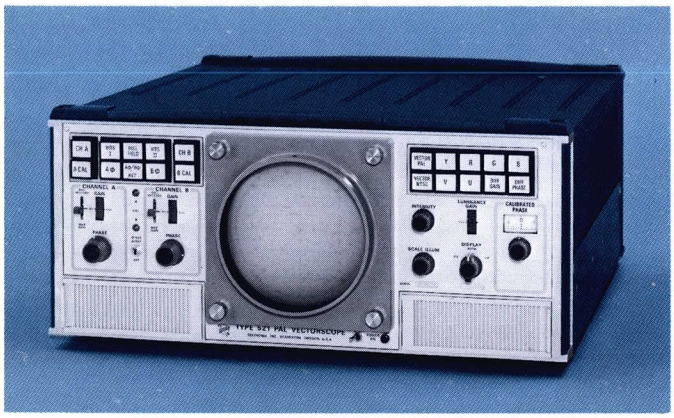
Order 426-0667-00

*Registered Trademark Polaroid Corporation

521 and 522*

PAL Vectorscopes





- ***PUSH-BUTTON OPERATING CONVENIENCE***
- ***AMPLITUDE CALIBRATED DISPLAYS***
- ***LUMINANCE AMPLITUDE, CHROMINANCE PHASE AND AMPLITUDE, DIFFERENTIAL PHASE AND DIFFERENTIAL GAIN MEASUREMENTS***
- ***THE LUMINANCE CHANNEL AND THE LINE-RATE TIME BASE PERMIT DECODED R, G, B and Y DISPLAYS***
- ***ALL SOLID-STATE, COOL, QUIET OPERATION***

The Tektronix Type 521 PAL Vectorscope is designed to measure luminance amplitude, and chrominance phase and amplitude of the PAL composite color television signal. It is designed for 625 line 50 field PAL Color TV signals utilizing a color subcarrier frequency of 4.43361875 MHz and is calibrated to observe video signals with 0 set-up level. Self-canceling push-button switches permit rapid selection of displays for quick analysis of television signal characteristics, and to check Vectorscope calibration. All solid-state circuitry provides low power consumption and cool, quiet operation.

Dual inputs are provided permitting time-shared displays for comparison of input-output signal phase and gain distortion. A chrominance channel is provided which demodulates the chrominance signal to obtain color information from the composite video signal for use in VECTOR PAL, VECTOR NTSC, R, G, B, U, V, Differential Gain and Differential Phase displays. A luminance channel separates and displays the luminance (Y) component of the composite color signal. The Y component is combined with the output of the chrominance demodulators for R, G and B displays at a line rate.

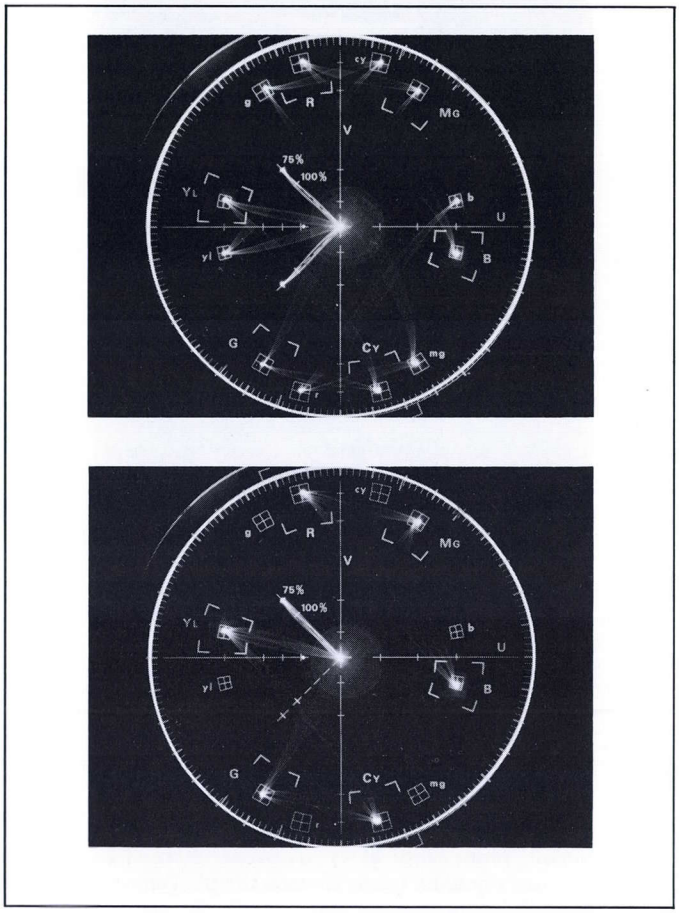
A digital line selector permits the display of a single line Vertical Insertion Test Signal from a selected line of either field 1 or field 2.

*For 525-line 60-cycle field, 3.575611 MHz subcarrier (Brazilian system)

521 and 522
PAL Vectorscopes

VECTOR PRESENTATION

The vector presentation graphically displays the relative phase and amplitude of the chrominance signal on polar coordinates. To identify these coordinates the graticule (see fig 1) has points which correspond to the proper phase and amplitude of the primary, complementary and conjugate chrominance vectors: Red (R) (r), Green (G) (g), Blue (B) (b), Cyan (Cy) (cy), Magenta (Mg) (mg) and Yellow (Yl) (yl).



Any errors in the color encoding, video tape recording or transmission processes which change these phase and/or amplitude relationships cause color errors in the television receiver picture. The polar coordinate type of display such as that obtained on a vectorscope has proved to be the best method for portraying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Saturation is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits (±10°, ±20%). The inner boxes indicate ±3° phase angle and ±5% amplitude.

(+V), (+V and —V) and (—V) vector displays are provided, permitting observation of the 135° and 235° burst-related color information, individually or combined.

An internally generated test circle matched with the vector graticule verifies quadrature accuracy, horizontal to vertical gain balance and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase-shift are provided. Large phase-shifts can be accurately read from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase-shifts.

LINEAR-SWEEP PRESENTATION

The linear time base operates at the line rate. Color signals are demodulated along any desired axis, U, V, etc. and displayed at the line rate on a linear time base.

DUAL DISPLAY

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync and switching transients are blanked. Input-output signals from video equipment can be conveniently compared on channel A and B for phase and/or amplitude distortion. The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° CALIBRATED PHASE shifter. While viewing channel A or B, either of the uncalibrated phase-shifters, Aϕ or Bϕ, can be switched into the subcarrier processing channel. Aϕ or Bϕ will lock to channel A and B respectively, when A and B channel are time-shared, permitting independent phase control of channel A and B displays. Phase shifts caused by unequal signal paths are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies. Video cable lengths can be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference. Accurate amplitude measurements of chrominance and luminance are provided from the CRT. An internal 1-V luminance amplitude calibration test signal is provided to check the gain accuracy of channel A and B amplifiers and the luminance channel.

DIFFERENTIAL GAIN AND DIFFERENTIAL PHASE MEASUREMENTS

The two main chrominance-signal distortions are differential gain and differential phase. Both can be measured on the Type 521 PAL Vectorscope. Differential gain (fig 2) is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, the saturation will be distorted in the areas between the light and dark portions of the scene. The luminance graticule major divisions represent percent of voltage gain or loss when making a differential gain measurement. The 521 PAL Vectorscope permits differential gain measurements with accuracy to better than 1%.

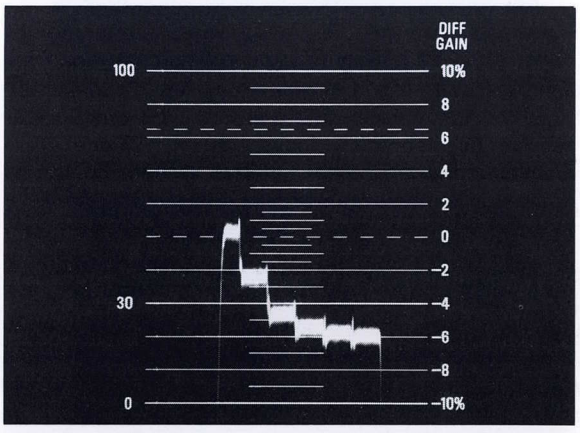
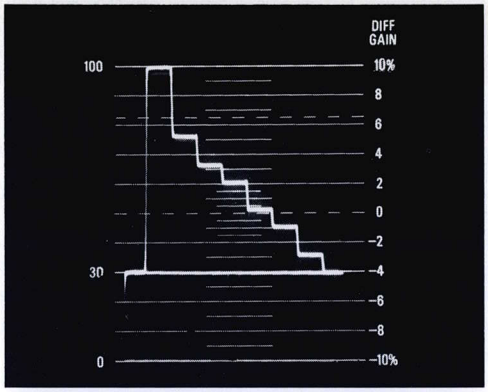
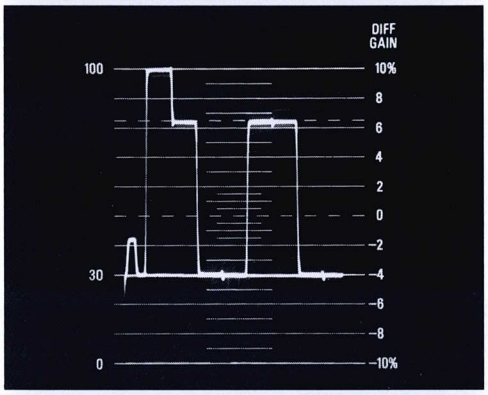


Fig 2—Type 521 PAL and Type 141A system being used to measure differential gain of a typical cascade of video amplifiers. Indicated differential gain is 6½%.

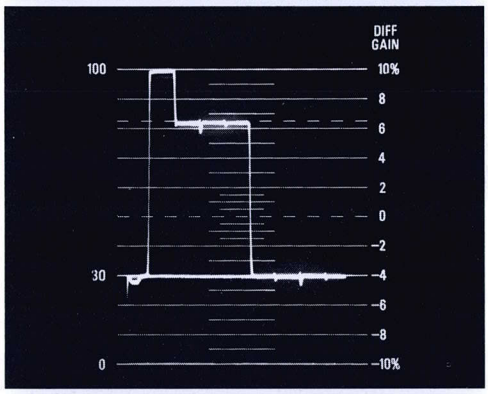
3



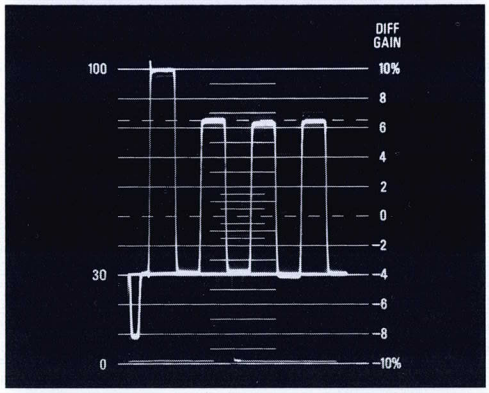
4



5



6



Line sweep presentations of Luminance (signal sequence; white, yellow, cyan, green, magenta, red, blue, and black, fig 3), decoded Red (fig 4), decoded Green (fig 5), and decoded Blue (fig 6), components of the PAL color bar signal. Photos were taken using a Type 141A PAL Television Test Signal Generator, a Type 521 PAL Vectorscope, and a C-27-549 Camera.

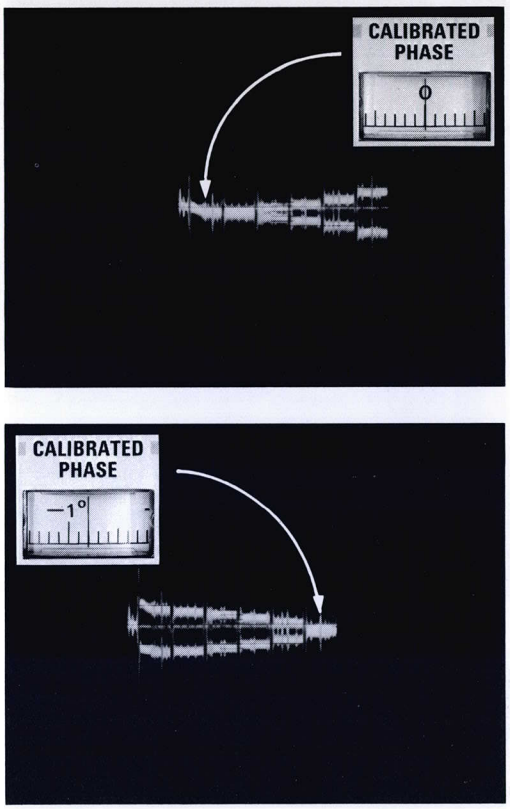


Fig 8—Differential Phase presentation using a modulated staircase signal. A trace overlay technique provides excellent resolution for measuring small phase changes. From reference point in top photo (1st step of staircase signal overlayed) to point of measure in bottom photo (6th step overlayed) represents 1.2° differential phase distortion.

Differential phase (fig 8) is a phase modulation of the chrominance signal by the luminance signal. Differential phase may result in picture impairment.

Differential gain and differential phase may occur separately or together. The causes of these distortions are amplitude non-linearity and time delay that are not independent of the signal level. Differential phase is read from the precision calibrated phase shift control. Dial resolution is excellent with 1° phase shift represented by approximately 1 inch of dial movement. The vertical deflection of the display is greatly magnified and inverted on alternate lines allowing the use of a trace overlay technique and the slide-back method for measuring small phase changes. The CALIBRATED PHASE control provides direct readout of differential phase. Using the standard linearity test signal, differential phase of 0.2° can be measured. Reference phase is selectable, from an internal subcarrier regenerator or an external CW source.

RED (R), GREEN (G), BLUE (B) AND LUMINANCE (Y) OBSERVATIONS

The Type 521 PAL Vectorscope provides a luminance channel which permits the separation and display of the luminance (Y) component from the composite color signal (fig 3). The Y component can also be combined with the output of the chrominance demodulators for R, G and B displays at a line rate (fig 4, 5, 6). Amplitude measurements of color signal components can be made with an accuracy of 3%.

VERTICAL INSERTION TEST SIGNAL OBSERVATION

Vertical Insertion Test Signal from preselected lines of either field 1 and 3 or field 2 and 4 can be displayed.

Binary counters operate in conjunction with the field selector to select lines in either field that may carry suitable test signals. These circuits enable the Vectorscope to be used for measuring differential gain and differential phase from test signals transmitted in the vertical blanking interval of color broadcasts.

Specific lines are selected by means of the VITS I and VITS II push buttons. Vectorscopes normally are shipped from the factory with the following lines selected by these switches:

	(VITS I) FIELDS 1 and 3	(VITS II) FIELDS 2 and 4
Type 521/R521	lines 17 and 18	lines 330 and 331

Internal quick-disconnect jumper wires permit selecting any line from 4 through 22 or 316 through 335. Intensity and focus are automatically adjusted for optimum viewing of VITS.

GRATICULE

Two separate graticules provide references for vector and line sweep displays. The parallax-free PAL vector graticule, or the luminance graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

Z AXIS INPUT

The Z-AXIS INPUT connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest. A 1-V negative-going pulse is required.

VIDEO INPUTS

Dual BNC input connectors (fig 9) for each channel permit 75-Ω loop through operation with a return loss greater than 46 dB* to 5 MHz. Amplitude range is 0.7 V to 1.4 V VIDEO (sync tip to peak white).

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 47 to 63 Hz, 95 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

ENVIRONMENTAL CAPABILITIES

Listed instrument characteristics are valid over a temperature range of 0°C to +50°C ambient.

MECHANICAL CHARACTERISTICS

The Type 521 PAL Vectorscope is available in two mechanical configurations, a cabinet model and a rackmount model. Both instruments are electrically identical. The Type R521 mounts in a 19-inch rack and is provided with a slide-out assembly for convenient access to internal components.

DIMENSIONS AND WEIGHTS

Type 521	Height	7 in	17.8 cm
	Width	16⅞ in	42.9 cm
	Depth	19⅛ in	48.7 cm
	Net weight	33 lb	15 kg
Type R521	Height	7 in	17.8 cm
	Width	19 in	48.3 cm
	Depth	19¾ in	50.2 cm
	Net weight	33 lb	15 kg

*Exceeds CCIR recommendation 451-2, paragraph 3.1 and 3.2

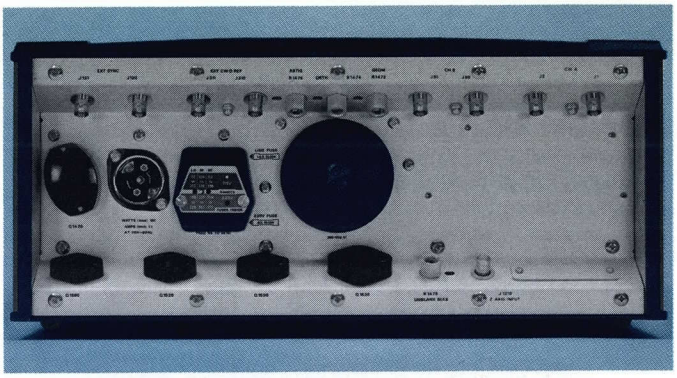


Fig 9—Rear view of Type 521 PAL Vectorscope.

INCLUDED STANDARD ACCESSORIES

Smoke-gray filter (378-0581-00); camera gasket and mounting screws (016-0114-00); power cord (161-0036-00); instruction manual 521/R521 (070-1027-00).

Type R521 same as Type 521 but includes rackmounting hardware, and slide-out assembly (351-0195-00).

ORDERING INFORMATION

Cabinet model, order
TYPE 521 PAL VECTORSCOPE
Rackmount model, order
TYPE R521 PAL VECTORSCOPE

For 525-line, 60-cycle field, 3.575611 MHz subcarrier (Brazilian system):

TYPE 522 PAL VECTORSCOPE
TYPE R522 PAL VECTORSCOPE

UHF connectors are optional and may be specified without additional cost.

OPTIONAL ACCESSORIES

R521 CRADLE ASSEMBLY

For mounting the Type R521 in a WECO backless rack.
Order 426-0667-00

C-27 TRACE RECORDING CAMERA

f/1.9, 1:0.5 lens; Polaroid Land* Pack-Film back.
Order C-27-549
Type 521 to C-27 Camera Adapter.
Order 016-0225-02

75-Ω VOLTAGE STEP-UP TERMINATION

The 75-Ω Voltage Step-Up Termination provides a ×5 increase in chrominance amplitude and permits Differential Gain and Differential Phase measurements to be made to a higher degree of accuracy when used with a Tektronix Vectorscope. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the vectorscope.

FOR USE WITH TYPE 521 VECTORSCOPE
BNC connectors, order 011-0109-00

SINGLE SIDEBAND CHROMA AMPLITUDE CORRECTOR

The Single Sideband Chroma Amplitude Corrector is designed for use with a Tektronix Vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides a ×2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

FOR USE WITH TYPE 521 VECTORSCOPE
UHF connectors, order 011-0108-00
BNC connectors, order 011-0108-01

*Registered Trademark Polaroid Corporation

For further ordering information see last page.

WAVEFORM MONITORS, OSCILLOSCOPES AND TELEVISION

The oscilloscope is, perhaps, the most versatile test and measurement instrument that has ever been built. Versatile in that it can be used in almost any technical field and for almost any measurement involving voltages. Many television measurements require oscilloscopes and it is important that factors unique to this dynamic industry be considered before making a scope purchase. The waveform monitors, a specialized oscilloscope designed for the needs of television, along with several general-purpose instruments of interest to the industry, are included on the following pages.

Since an oscilloscope is most often used to plot a graph of changing voltage in the vertical axis and time in the horizontal axis, sensitivity and bandwidth must be considered along with an ability to lock (trigger) on a time reference in your signal. This time reference is typically sync. You must also consider how the signal is to be acquired and how it is affected by the acquisition technique.

First consider deflection factor. Deflection factor is the amount of CRT deflection caused by a value of voltage. It is expressed as a ratio such as 10 millivolts per division. The deflection factor is always a peak-to-peak value not RMS. If your signal to be displayed has a frequency close to the stated bandwidth of a general-purpose scope, it is unlikely that the apparent amplitude will be "correct". For example, one volt peak-to-peak of 3.58-MHz subcarrier displayed on an ordinary 5-MHz bandwidth scope will not "read" one volt. Bandwidth specs can be misleading since they indicate only where a —3 dB may be reached. There usually is a significant "roll-off" below the specified —3 dB point, therefore amplitude readings are to be suspected below the specified bandwidth frequency. A good rule of thumb is to suspect the amplitude reading of any waveform that does not have a flat top and that has a frequency of more than 50% of the upper bandwidth specification of a general-purpose oscilloscope.

An oscilloscope, such as the 453A, with a bandwidth of DC to 60 MHz can handle any signal at baseband and beyond with complete fidelity. The 7A15 Amplifier in a 7403N Oscilloscope is another instrument with a "safe" margin of bandwidth.

Specialized oscilloscopes called waveform monitors, such as the 528 and 529, have more detailed bandwidth specs that define the 1% down point (usually 6 MHz). Waveform monitors use vertical amplifiers with very carefully controlled responses in order to preserve the signal fidelity demanded of video systems. Waveform monitors also have special switchable filters to insert defined responses to measure chroma (subcarrier), luminance with chroma eliminated, and full composite video.

Triggering from composite video can be difficult since most scope trigger circuits are designed to recognize amplitude levels and slope polarity and do not **recognize** the duration difference between vertical and horizontal sync pulses. A simple, external resistor/capacitor integrator can often help your scope trigger better, but an oscilloscope with built-in separator circuitry usually works best. The 453A Mod 127C and the 7000-Series Oscilloscope Time Base Plug-In 7B53A or 7B53AN Option 5 feature television sync recognition triggering. All TEKTRONIX waveform monitors have this feature. If separate vertical and horizontal sync pulses are available for external triggering, almost any scope will trigger well. Line selection through the use of delaying sweep, or sweep magnifiers requires very solid triggering on sync for proper operation. This is a major feature of the 529 Waveform Monitor.

Signal acquisition can be as simple as connecting a cable, but the acquisition method always affects the signal being measured. The effects are minimal with proper methods. Use of precision 75-Ω terminations are an obvious precaution in 75-Ω systems; less obvious is the loading effects of probes and loop-through inputs. Tektronix, Inc. specifies return loss for all television instruments. All probes from Tektronix, Inc. have specified impedances for your consideration in evaluated loading effects on your system. We also have available a return loss measuring system for evaluating your system (see Accessory pages).

Plug-in oscilloscopes, such as the 7000 Series, offer outstanding flexibility through the availability of a choice of real-time amplifiers and time bases or special purpose units for spectrum analyzers, time domain reflectometry, counter applications, digital voltmeter use, semiconductor curve tracing, etc.

Storage oscilloscopes are essentially the same as conventional scopes with the added benefit of long term retention (storage) of displays, a feature very useful in sweeper work. Tektronix, Inc. offers a number of storage instruments. The newly introduced 434 fits the needs of the CATV industry since it is a portable scope of high quality, featuring both stored and nonstored operation.

The oscilloscope is basically a simple device with widely varied applications. Precision in these applications is only achieved by the precision features that distinguish the quality instrument from the ordinary. Your TEKTRONIX Field Engineer or Representative is prepared to help you select the best instrument for your needs. Call him for some suggestions and information.

STANDARD	MONITOR
525/60	528
625/50	528 MOD 188G

FEATURES

- PRECISE RESPONSE
- LARGE 8 x 10-cm DISPLAY AREA
- ½ RACK SIZE
- TWO VIDEO INPUTS
- PICTURE MONITOR OUTPUT
- SELECTABLE 1-VOLT AND 4-VOLT FULL SCALE DEFLECTION FACTORS
- YRGB AND RGB INPUTS

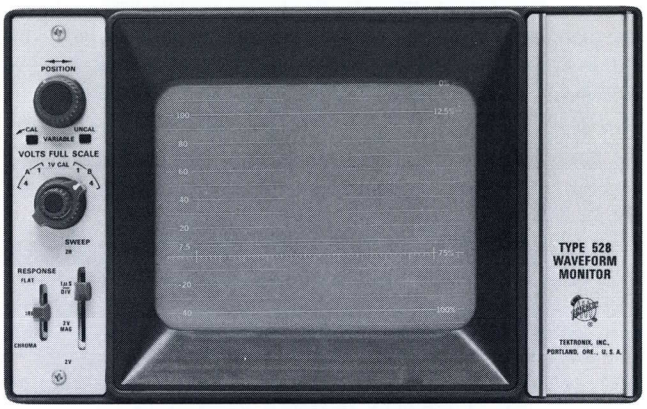
The solid-state 528 Waveform Monitor provides bright, easy-to-read video waveform displays on a 5-inch CRT, yet requires only 5¼-inch vertical height and ½-rack width mounting space. This compact instrument is especially well suited for monitoring signals from camera outputs, video system output lines, transmitter video input lines, closed-circuit TV systems and educational TV systems. A portable version is also available (see MOD 147B).

Either of two video inputs, selectable from the front panel, may be displayed. The displayed video signal is also provided at a video output jack for viewing on a picture monitor. Calibrated, 1-volt and 4-volt full scale (140 IRE unit) sensitivities are provided for displaying common video and sync signal levels. A variable sensitivity control permits uncalibrated displays from 0.25-volt to 4.0-volt full scale. The built-in 1-volt calibration signal may be switched on to check vertical sensitivity calibration. Flat, IRE, Chroma, and Diff Gain frequency response positions permit observation of various signal characteristics.

Horizontal Sweep selection provides 2 H (two line), 1 μs/div (expanded two line), 2 V (two field) and 2 V MAG (expanded two field). Displays of RGB and YRGB waveforms from color processing amplifiers are provided for the interconnection through a rear-panel 9-pin receptacle.

A DC Restorer maintains the back porch at an essentially constant level despite changes in signal amplitude, APL and color burst. May be turned off when not needed.

All solid-state circuitry provides low power consumption, and long-term reliability.



VIDEO FEATURES

Inputs—Rear-panel BNC connectors provide two unbalanced inputs (A & B) which may be used with either 75-Ω loop-through or bridging connection. Maximum return loss for A and B video inputs, terminated in 75 Ω, operating or nonoperating is 46 dB or greater to 5 MHz. Normally AC coupled but may be easily modified by user for DC coupling.

Deflection Factor—Calibrated 1-volt and 4-volt (for 140 IRE unit deflection) positions are provided for video inputs A or B with accuracy within 1% for the 1-volt positions and 3% for the 4-volt positions. A variable sensitivity control permits uncalibrated displays from 0.25-volt to 4.0-volt full scale.

Frequency Response— 4 response positions are provided: FLAT— 25 Hz to 3.6 MHz within 1% of response at 50 kHz, 3.6 MHz to 5 MHz +1%, −3% of response at 50 kHz, and +1%, −3% of response at 3.58 MHz; IRE—per IEEE Standard IEEE 205. Response at 4.43 MHz attenuated at least 22 dB; CHROMA— 30% down between 3.1 MHz and 3.4 MHz, 30% down between 3.8 MHz and 4.1 MHz. Response at 3.58 MHz does not vary between FLAT and CHROMA by more than 1%. DIFF GAIN—same as CHROMA response with additional gain for displaying 100 IRE units of 90 mV to 143 mV subcarrier levels.

528 MOD 188G Chroma—30% down between 3.83 MHz and 4.23 MHz, 30% down between 4.59 MHz and 5.07 MHz, response at 4.43 MHz does not vary between FLAT and CHROMA by more than 1%.

Differential Gain— 1% or less with 10 to 90% APL changes using DIFF GAIN operating mode with modulated staircase signal, baseline adjusted to 50 IRE units position, and signal adjusted to 100 IRE units P-P.

Transient Response— 1-volt or 4-volt calibrated deflection factor, FLAT response position, using 125-ns HAD $\sin^2$ pulse and bar test signal: preshoot is not more than 1 IRE unit, overshoot not more than 2 IRE units, ringing not more than 2 IRE units and pulse to bar ratio within 0.99:1 to 1.01:1.

Low Frequency Tilt— 1% or less tilt on the vertical window or 60 Hz squarewave (DC Restorer off).

Maximum Input Level

Maximum DC Input— 5 volts‡ for all response positions using AC coupling.

MAXIMUM AC INPUT

FLAT and IRE Response—Signal levels should be limited to produce displays not exceeding 200 IRE units.

Chroma Response—Chroma levels up to 140 IRE units may be displayed, provided the chroma plus luminance level does not exceed 200 IRE units when viewed in the FLAT response mode.

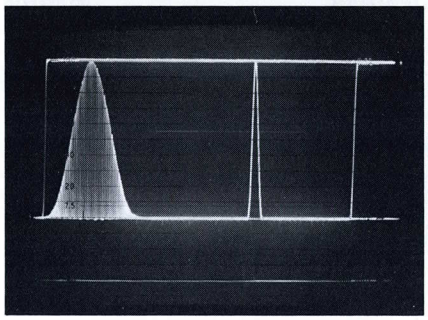
Diff Gain—Subcarrier signal levels of 90 mV to 143 mV peak to peak may be expanded, using the variable gain control, to 100 IRE units for measurement of differential gain with 10 to 90% APL.

DC Restorer—Slow acting back porch DC restoration. Blanking level shift due to presence or absence of burst or changes in APL from 10% to 90% will not exceed 2 IRE units. May be disabled when desired.

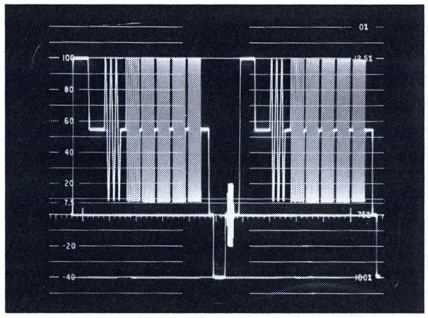
Video Output—The displayed signal is provided at a rear-panel BNC connector. Frequency response is 25 Hz to 5 MHz within 3%. Output signal amplitude is 1 volt within 15% for 140 IRE unit display using the FLAT response mode. DC level is 2 volts‡ or less into 75-Ω load. Nominal output impedance is 75 Ω.

Infrequently used operating controls are conveniently located behind a front-panel hinged door.

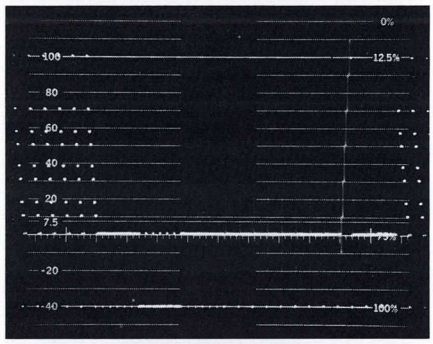
‡Exceeds CCIR recommendation 451-2 paragraph 3.2.



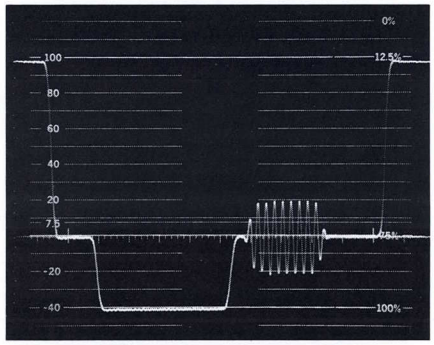
.250 μs HAD Sin^2 Pulse (right) 12.5 T Modulated Sin^2 Pulse (left) 125 ns risetime bar (1T) also with bar superimposed.



Multiburst signal. 2-H SWEEP, FLAT response.



Vertical Blanking Interval. 2-V MAG SWEEP. 20X magnification permits convenient vertical blanking interval observation.



Horizontal Blanking Interval. 1-μs/div calibrated sweep.

TIME-BASE FEATURES

Synchronization—Internal or external sync is provided and is selectable by a switch behind the front panel hinged door. Internal sync is derived from composite video input. External sync is via a rear panel BNC loop-through connector and requires 1.5 to 4.5 volts composite sync input. The unterminated sync input impedance is approximately 15 kΩ paralleled by approximately 5 pF and maximum input voltage is 20 volts.‡

Sweep Modes — 528 and 528 MOD 188G

4 sweep modes are provided: 2-V SWEEP—repetition rate equal to frame rate of applied video or external sync; 2-V MAG SWEEP—expands the vertical blanking interval (approximately 20X magnification of 2 V); 2-H SWEEP—repetition rate equal to half-line rate of applied video or external sync; 1-μs/div SWEEP—calibrated sweep with accuracy within 3% for center 10 div of 12-div sweep, and linearity within 3% throughout horizontal POSITION range, excluding first and last div.

YRGB AND RGB DISPLAYS

The 528 can be used with color camera processing amplifiers which provide the necessary sequential signal switching and staircase signals. A rear panel 9-pin receptacle provides the necessary interconnections. Factory wired for RGB (3 step) input.

Stairstep Amplitude—A 10-volt amplitude stairstep signal will produce a 9-div display length within 15%.

Stairstep DC Level—Peak AC plus DC signal levels shall not exceed limits of −12 to +12 volts. Maximum AC signal level is 12 volts peak-to-peak.

Control Signals—The RGB or YRGB modes may be initiated through the use of external voltage. (12 volts to 15 volts) or ground connection at the rear panel 9-pin receptacle. A 9-pin plug is supplied with the included standard accessories.

‡Exceeds CCIR recommendation 451-2, paragraph 3.2

OTHER FEATURES

Regulated Power Supply—Operates on 99 volts AC to 132 volts AC and 198 volts AC to 264 volts AC, 48 Hz to 66 Hz line frequency. Operates on 115 volts ±10% or 230 volts ±10% at line frequencies from 66 Hz to 440 Hz. POWER CONSUMPTION: approx 48 watts at 115 volts AC, 60 Hz.

TEKTRONIX Cathode-Ray Tube—Flat-faced 5-inch rectangular CRT providing an 8 x 10-cm display area. P31 phosphor supplied. External graticule with variable illumination.

Calibrator—An internal calibration signal provides a convenient reference for verifying deflection factor. Amplitude is 1.0 volt within 1%.

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

Dimensions And Weights

Height	5¼ in	13.3 cm
Width	8½ in	21.6 cm
Depth	18½ in	47.0 cm
Net weight	15 lb	6.8 kg

INCLUDED ACCESSORIES

9-pin connector (136-0099-00), connector cover (200-0249-00), instruction manual (070-0800-00).

528 WAVEFORM MONITOR (for 525 line)

528 MOD 146B WAVEFORM MONITOR (as above less cover)

528 MOD 147B WAVEFORM MONITOR (with blue protective cabinet)

528 MOD 188G WAVEFORM MONIITOR (for 625 line)

For additional ordering information see last page.

OPTIONAL ACCESSORIES

MOUNTING CRADLES

Two different cradle assemblies, with associated bezels and mounting brackets, allow the 528 Waveform Monitor to be mounted alongside an 8-inch or 9-inch Conrac† Picture Monitor, in a standard 19-inch rack.

FOR MOUNTING 8-INCH CNB-8 PICTURE MONITOR (REQUIRES 10½ INCHES RACK SPACE)

Description	Part Number
Cradle Assembly	014-0021-00
Bezel and brackets for mounting 528 on operator's left	014-0035-00
Bezels and brackets for mounting 528 on operator's right	014-0036-00

FOR MOUNTING 9-INCH RND-9 PICTURE MONITOR (REQUIRES 8¾ INCHES RACK SPACE)

Cradle Assembly	014-0020-00
Bezel and brackets for mounting 528 on operator's left	014-0038-00
Bezel and brackets for mounting 528 on operator's right	014-0037-00

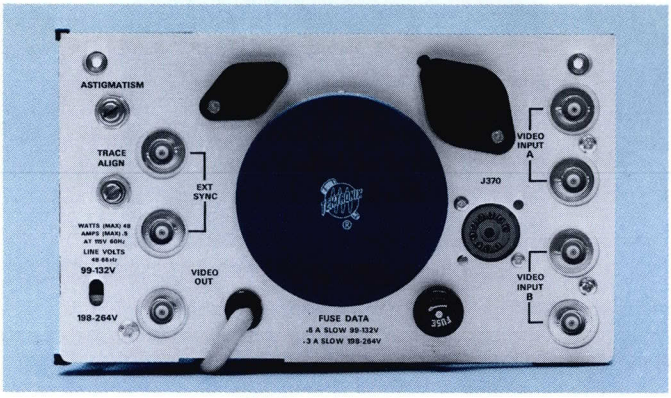
TEKTRONIX 14-INCH MONOCHROME AND COLOR PICTURE MONITORS ARE AVAILABLE

†Registered Trademark Conrac Corporation, Conrac Division

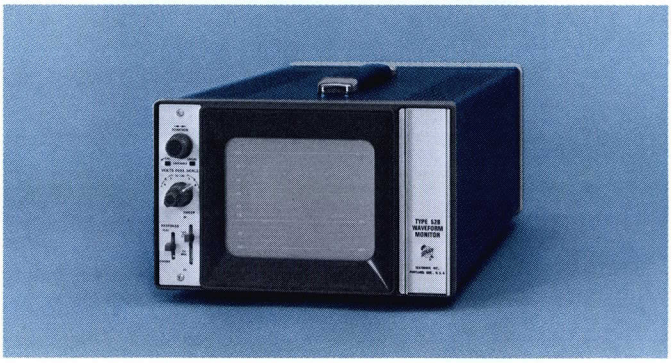
For further ordering information see last page.

Panel Assembly—For covering ½ of rack adapter when only one 528 is rackmounted, order 016-0116-00

C-27 Camera—f/1.9, 1:85 lens, Polaroid Land* Pack-Film back.
Order C-27 CAMERA
528 to C-27 camera adapter, Order 016-0249-03

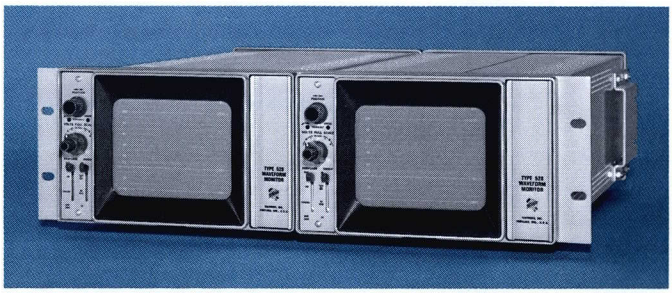


Rear panel of 528 Waveform Monitor.



528 WITH PROTECTIVE CABINET

The 528 MOD 147B is a standard 528 provided with a protective cabinet for table-top use or portable applications. Cabinet is aluminum construction, blue vinyl finish.



Rack Adapter—For mounting two 528's side-by-side in a standard 19-inch rack. Included are rim clamps which allow fastening or removing instruments from the front.
Order 016-0115-02

*Registered Trademark Polaroid Corporation

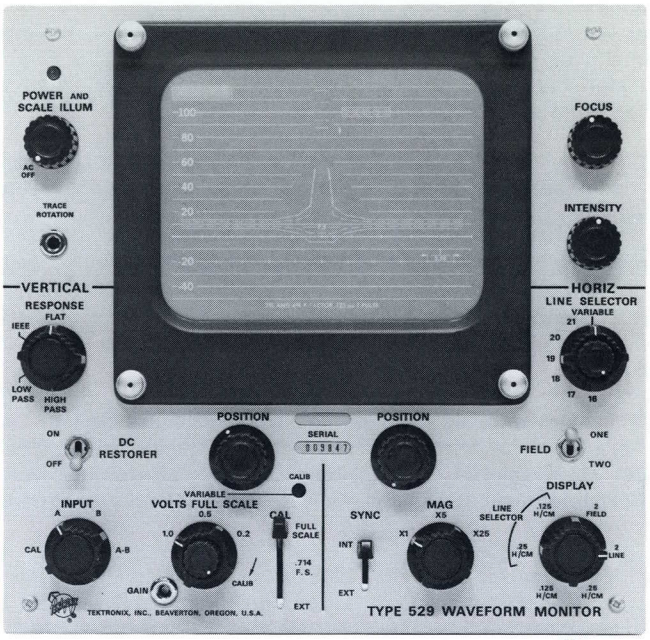
For further ordering information see last page.

529
RM529

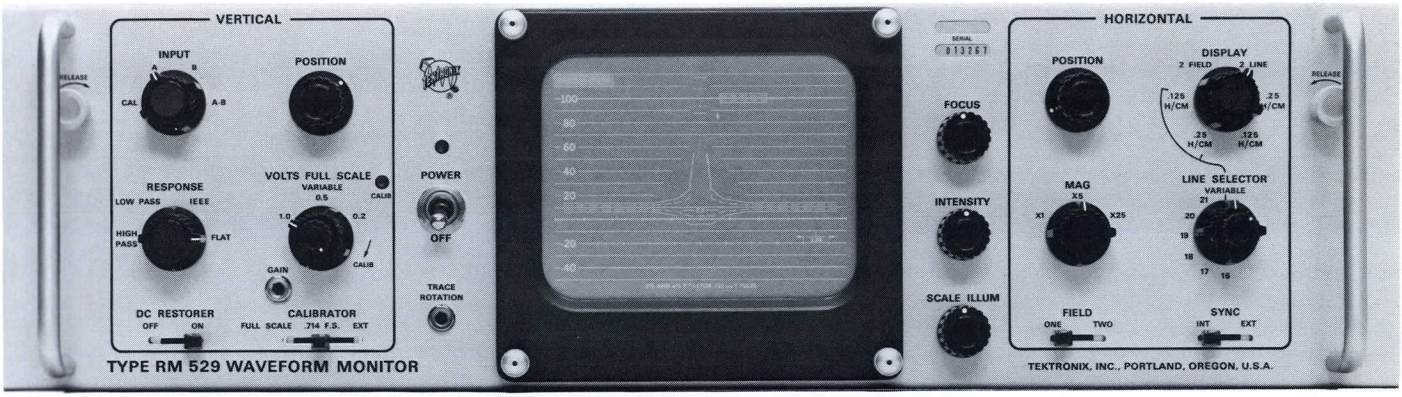
STANDARD	MONITOR
525/60	529 and RM529
625/50, 405/50, 819/50	529 MOD 188D and RM529 MOD 188D

FEATURES

- LINE SELECTION
- PRECISE RESPONSE
- FLEXIBLE
- TWO CONFIGURATIONS



529 half rack width



RM529 (rackmount) full rack width

The 529 and RM529 bring to the industry a flexibility in waveform monitoring: signal-level monitoring, bandwidth and differential gain measurements, sin²-pulse and bar testing, monitoring Vertical Interval Test Signals, transmitter percent-of-modulation measurements, YRGB displays (in conjunction with color-processing amplifiers) and others. Included are four video response characteristics, HIGH-PASS, LOW-PASS, IEEE, and FLAT. Both instruments feature FLAT RESPONSE to 8 MHz, assuring excellent waveform fidelity for sine-squared testing with 2T, T and ½T pulses.

DC RESTORATION maintains the back porch at an essentially constant level despite changes in signal amplitude, APL, and color burst, and may be turned off for reviewing other than video signals. The circuit can easily be modified for sync-tip restoration.

Sensitivity range is 0.12 volts to 1.5 volts for full-scale deflection. Full-scale calibration at 0.714 V or 1.00 V is provided.

BRIGHT WAVEFORM DISPLAYS in line selector operation are obtained with a highly-efficient 5-inch aluminized CRT. The instrument uses the best of both solid-state and vacuum-tube circuitry resulting in improved stability and reliability. These instruments do not require a fan, resulting in cleaner operation and complete freedom from noise.

HORIZONTAL SELECTION provides 2-field or 2-line displays, plus calibrated sweep rates of 0.125 H/cm or 0.25 H/cm. Either calibrated rate may be delayed for line selection. SWEEP MAGNIFICATION extends the sweep rate by X5 or X25, offering calibrated sweep rates from 0.250 H/cm to 0.005 H/cm. POSITIVE FIELD SELECTION assures stable displays in the presence of random noise bursts and video switching. The LINE SELECTOR permits detailed study of any portion of any desired line(s), and a front panel switch selects lines 16 through 21 for viewing VIT signals. A VIDEO-OUTPUT AMPLIFIER supplies video and a brightening pulse to the associated picture monitor, intensifying the same line, or lines, displayed on the instrument when using the LINE SELECTOR.

VIDEO FEATURES

Inputs—Two unbalanced inputs through rear-panel BNC connectors may be used with either 75-Ω loop-through or bridging connection (input R & C is 1 MΩ and 24 pF). Return loss is greater than 46 dB to 5 MHz using 75-Ω loop-through. Alternatively, one balanced, differential input may be used.

Deflection Factor— 120 mV to 1.5 V full scale. Continuously variable between ranges. Calibrated full scale: 1.0, 0.50 and 0.20 V.

Frequency Response— 4 response characteristics provide: FLAT: +0.0 — 1% to 6 MHz; +0.0 — 3% to 8 MHz. IEEE: IEEE Standard IEEE 205. HIGH-PASS: 3.58 MHz ±400 kHz at 15% to 30% down. LOW-PASS: At least 80% down at 500 kHz.

DC Restorer—Keyed back porch* type eliminates drift in DC-coupled vertical amplifier. Does not distort color burst. Waveform will remain on screen if there is a loss of sync pulses for DC restorer keying. DC restorer may be disabled by front-panel switch.

Vertical Amplifier—May be DC-coupled, to diode demodulator as in % Video Modulation Monitoring. Details are available in manual.

Video Output—Signal is provided for driving a picture or line monitor with amplitude into 75 ohms approx equal to input signal to 529/RM529.

Calibrator—Two internal calibration voltages of 0.714 V and 1.00 V on 1-volt full-scale range of VERTICAL GAIN switch. An external calibration signal may be used. Internal calibration pulse amplitude ±1% over ambient temperature range and line-voltage range. Reference is a Zener diode.

*Sync tip restoration available by simple modification .

TIME BASE FEATURES

Calibrated Time Base—0.125 H/cm. Magnifier extends calibrated time base to 0.025 H/cm and 0.005 H/cm within 3%. Rep rate is ½ of the TV line rate. The time base can be calibrated using TV signals. Color burst is displayed without phase interlace.

Uncalibrated Time Base— *2 Line:* Triggered time base with rep rate of ⅓ TV line frequency. Provides complete 2-line display with horizontal blanking centered on the screen.

2 Field: Synchronized time base with rep rate the same as the TV frame rate. Entire frame of video is displayed with the vertical blanking centered on the screen. Time base will free-run in the absence of signal, indicating loss of incoming signal.

Time-Base Magnifier—X5 and X25. Accuracy is within 3%. Magnifier expands the center of the display, convenient for monitoring equalizing or serrated pulses.

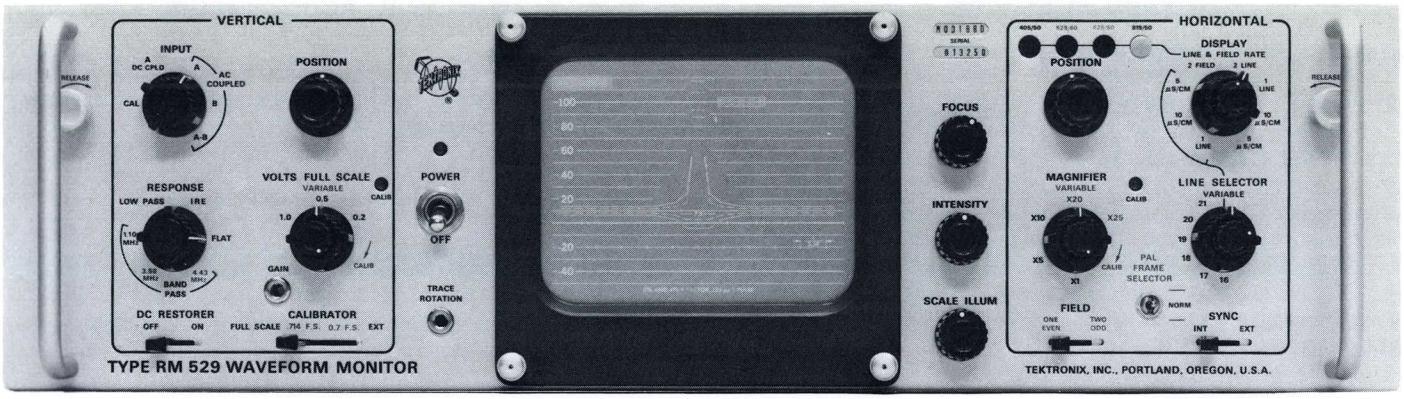
Color Camera YRGB Displays—Can be used with color camera processing amplifiers providing these sequential signals and the staircase signal. To provide YRGB display directly, switching is done in the color processing amplifier. Receptacle to interconnect color processing amplifier (relay control, staircase signal input, and ground) is provided on rear panel.

VIT Selector—Front-panel switch selects lines 16 through 21. Knob position indicates line selected for viewing.

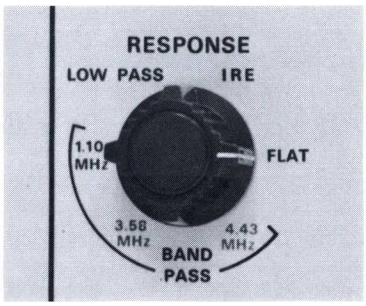
Line Selector—Variable delay allows any line of either field to be viewed.

Field Selector—Positive-acting field selection.

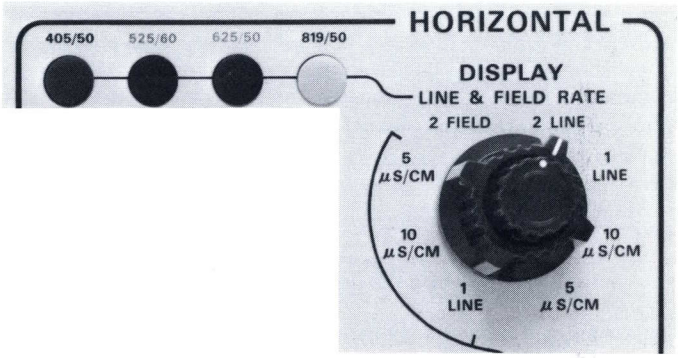
Trigger Selection—Stable triggering on composite video signals. INTERNAL: 200 mV to 1 V or more, peak-to-peak. EXTERNAL: 400 mV to 1 V or more, peak-to-peak.



- **HALF WIDTH 529 MOD 188D**
- **RACKMOUNT RM529 MOD 188D (above)**



Multi-Standard Response



Multi-Standard Time Base

529 or RM529 MOD 188D

The 529 Mod 188D and RM529 Mod 188D Waveform Monitors are adapted for use with 405-line 50-Hz field rate, 525-line 60-Hz field, 625-line 50-Hz field, and 819-line 50-Hz field standard television systems. Added Vertical RESPONSE switch positions, added MAGNIFIER steps and VARIABLE control, 5 and 10 μs/cm sweep rates in addition to line and field rates, and a PAL FRAME SELECTOR permit quick setup for use on any of four systems without internal adjustments. Panel marking, color-coordinated with Line/Field indicator light colors, identifies control positions associated with the selected system.

The added PAL FRAME SELECTOR permits normal display from all frames or selection of either frame of the four-field PAL color system cycle.

The Vertical system features selectable DC coupling for Video Input A, and added 1.1 MHz and 4.43 MHz Bandpass positions of the RESPONSE switch. The CALIBRATOR switch has an added 0.70 F.S. position for proper calibration for systems based on a 30-unit (of 100) blanking level. Sweep rates based on line and field intervals are supplemented by fixed 5 μs/cm and 10 μs/cm rates. Extra X10 and X20 MAGNIFIER positions and a VARIABLE MAGNIFIER provide maximum flexibility of adjustment for various test signals.

Vertical System—Response Switch: Added positions of 1.1-MHz Bandpass (—18 dB at 0.2 MHz) and 4.43-MHz Bandpass (—3 dB bandwidth ≥800 kHz) at double sensitivity.

Calibrator: 0.70 F.S. position added for CCIR standards.
Input Switch: Added DC-coupled position for Input A.

Horizontal System—Line/Field Rate Selection: 405/50, 525/60, 625/50, 819/50.

Sweep Rates: 2 Field, 2 Line, 1 Line, 5 μs/cm, and 10 μs/cm.

Line Selector Sweep Rates: 1 Line, 5 μs/cm, 10 μs/cm. Discrete line selection provided for 525/60 and 625/50 systems; for 405/50 and 819/50 systems, continuously-variable line selection only.

Accuracy: All sweep rates (except 2 Field, an uncalibrated rate are accurate within 3% (MAG X1).

Magnifier: X1, X5, X10, X20, X25, plus VARIABLE (±20% from selected step).

Field Switch: Added Even/Odd marking for PAL standards. Positive field selection provided except for CCIR System E (change-of-field only).

PAL Frame Selector: 3-position switch for viewing all frames or selecting alternate frames.

General—Line Voltage: +10%, —8% accommodation range at 105, 110, 115, 120, 210, 220, 230, or 240-V center voltage, 48 to 66 Hz. Normally wired and fused for 240 V. Multi-tap transformer can be changed for use with any of the listed nominal line voltages.

OTHER FEATURES

Regulated Power Supply—Operates on 115 V or 230 V line ± 10% RMS. LINE FREQUENCY: 48-66 Hz. POWER CONSUMPTION: Approx 100 W at 115 V, 60 Hz.

TEKTRONIX Cathode-Ray Tube—Flat-faced, 5-inch rectangular CRT, operating at 6.4 kV accelerating potential. Calibrated viewing area, 7 x 10 cm. Electrical beam rotator provides trace alignment. P31 phosphor is normally supplied. External graticule, variable illumination.

Ventilation—Convection air-cooled. Operating Temperature Range: 0°C to +50°C.

Dimensions And Weights

529:	Height	8¼ in	21 cm
	Width	8½ in	21.6 cm
	Depth	19½ in	49.7 cm
	Net weight	27 lb	12.2 kg
	Domestic shipping weight	≈34 lb	≈15.5 kg
	Export-packed weight	≈47 lb	≈21.4 kg

Two 529 Waveform Monitors can be mounted side-by-side, or one mounted alongside an associated picture monitor in a standard 19-inch rack or console.

RM529:	Height	5¼ in	13.3 cm
	Width	19 in	48.2 cm
	Rack depth	18¼ in	46.4 cm
	Net weight	30½ lb	13.9 kg
	Domestic shipping weight	≈59 lb	≈26.8 kg
	Export-packed weight	≈81 lb	≈36.8 kg

Instrument fits standard 19-inch rack, can be tilted 90°.

INCLUDED ACCESSORIES

529: Smoke-gray light filter (378-0560-00); composite graticule, shown lower center (331-0156-01); noncomposite graticule, shown top left (331-0077-01); dual scale graticule, shown top center (331-0157-00); $\sin^2$, K factor, and IRE graticule, shown top right, lower left, lower right (331-0161-02); 75-ohm termination resistor (011-0102-00); instruction manual (070-0509-01); graticule light insert (377-0064-00). RM529: same as 529 but includes four retainer bars (381-0187-00); one pr tracks (351-0040-02); instruction manual (070-0466-01).

MOD 188D: The following graticules are furnished in addition to the standard 529/RM529 complement: 0-100 unit composite CCIR Video, 30-unit blanking level, PN 331-0184-00. 0-100 unit composite CCIR Video, with $\sin^2$ & K factor ruling for 0.1 μs T and 0.2 μs 2T pulses, 2% and 4% K factor, timing line for 4.43 MHz, PN 331-0185-00 (installed).

Order 529 WAVEFORM MONITOR

Order 529 MOD 147B WAVEFORM MONITOR (installed in field case)

Order 529 MOD 188D MULTI-STANDARD WAVEFORM MONITOR

Order RM529 WAVEFORM MONITOR

Order RM529 MOD 188D MULTI-STANDARD WAVEFORM MONITOR

For additional ordering information see last page.

OPTIONAL ACCESSORIES

529 Field Case
Provides cabinet protection for the 529 when used for applications outside of the rack. Aluminum construction, blue vinyl finish; order 016-0084-00

C-27 Camera
f/1.9-1:0.85 lens, Polaroid Land* Pack-Film back,
Order C-27

529 or RM529 to C-27 Camera Adapter, Order 016-0224-00

Mesh Filter
For improving display contrast when viewing under high-ambient light conditions; includes special graticule cover.
Order 378-0575-00

9-Pin Connector
Used with color processing amplifiers for RGB, etc. displays.
Order 134-0049-00

See the catalog accessory pages for additional information on other accessory items not listed.

529 MOUNTING CRADLES
Two different cradle assemblies, with associated bezels, allow the 529 Waveform Monitor to be mounted alongside an 8-inch or 9-inch Conrac* Picture Monitor, in a standard 19-inch rack. A cradle and bezel are also available for mounting two 529's side-by-side.

FOR MOUNTING 8-INCH CNB-8 PICTURE MONITOR (REQUIRES 10½ INCHES RACK SPACE)

Description	Part Number
Cradle Assembly	014-0021-00
Bezel, for mounting 529 on operator's left	014-0027-00
Bezel, for mounting 529 on operator's right	014-0028-00

FOR MOUNTING 8-INCH CZB-8 PICTURE MONITOR (REQUIRES 10½ INCHES RACK SPACE)

Description	Part Number
Cradle Assembly	014-0021-00
Bezel, for mounting 529 on operator's left	014-0025-00
Bezel, for mounting 529 on operator's right	014-0026-00

FOR MOUNTING 9-INCH RNB-9 PICTURE MONITOR (REQUIRES 8¾ INCHES RACK SPACE)

Cradle Assembly	014-0020-00
Bezel, for mounting 529 on operator's left	014-0023-00
Bezel, for mounting 529 on operator's right	014-0024-00

FOR MOUNTING TWO 529 WAVEFORM MONITORS SIDE-BY-SIDE (REQUIRES 8¾ INCHES RACK SPACE)

Cradle Assembly	014-0020-00
Bezel	014-0022-00

RM529 Cradle Assembly
For mounting the RM529 in a WECO backless rack,
Order 426-0309-00

TEKTRONIX 14-inch monochrome and color picture monitors are available.

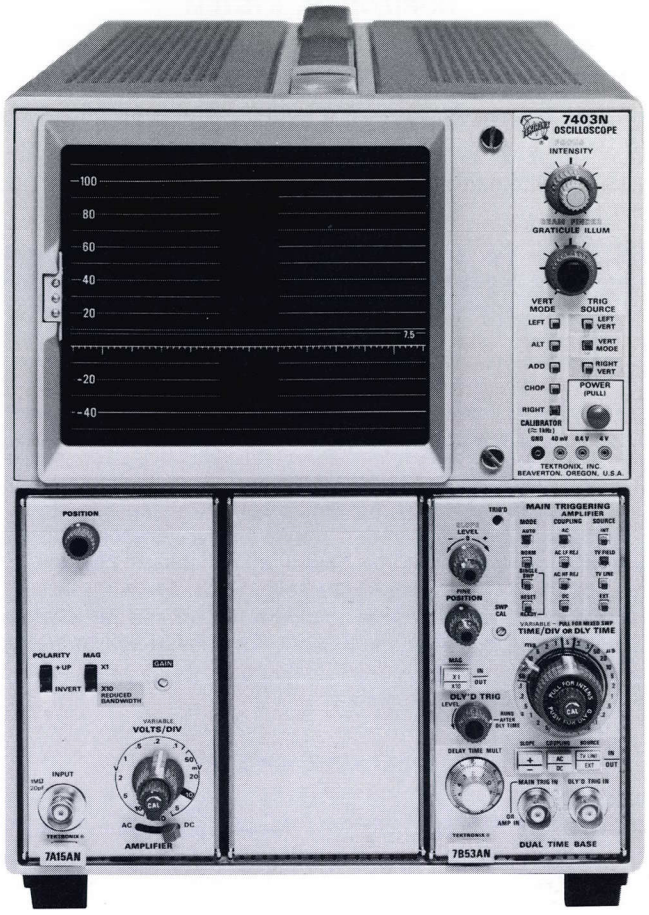
*Registered Trademark Conrac Corporation, Conrac Division

*Registered Trademark Polaroid Corporation.

For further ordering information see last page.

7403N
7A15AN/7B53AN Opt 5

- SYNC SEPARATION
- THREE-PLUG-IN FLEXIBILITY
- 6-1/2-INCH CRT
- VERSATILE TRIGGER SOURCE SELECTION
- VERTICAL MODE SWITCHING
- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING



A 50 MHz, 5 mV sensitivity scope featuring sync separation for individual line-by-line display.

An excellent general-purpose oscilloscope to use around the plant is the 7403N with one or two 7A15AN Amplifiers and 7B53AN Option 5 Time Base. Many more mainframes and plug-ins are available. Your TEKTRONIX Field Engineer or Representative can supply details.

The 7403N and R7403N (5¼-inch rackmount) Oscilloscopes provide a wide performance range through mainframe and plug-in versatility. They are designed to accept all 7000-Series amplifiers and time bases. The R7403N with 7L12 Spectrum Analyzer plug-in is shown on Page 62.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series Plug-Ins (7D13 and 7D14 excluded).

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

7A15AN AMPLIFIER

The 7A15AN is a wideband plug-in amplifier for all 7000-Series mainframes. The two vertical mainframe channels allow the 7A15AN to be used alone, or with another vertical unit for dual-trace operation. Polarity of the display is selectable. The 7A15AN does not incorporate CRT READOUT.

Probes are not supplied with the 7A15AN and are ordered separately to fit the application. The P6061 (10X) probe is recommended for use with the 7A15AN.

Bandwidth—50 MHz in 7403N; 10 Hz or less (lower −3 dB) AC coupled.

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

Input R and C—1 MΩ within 2%; 20 pF within 1.5 pF.

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

HORIZONTAL SYSTEM

Channels—One right-hand plug-in compartment; compatible with all 7000-Series Plug-Ins (7D13 and 7D14 excluded).

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

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

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

7B53AN OPTION 5 DUAL TIME BASE

The 7B53AN Option 5 Dual Time Base features four sweep display modes: normal, intensified delaying, delayed and mixed.

Option 5, TV Sync Separator Triggering—Permits stable internal Line or Field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or overseas, with up to 1201-line, 60-Hz field rates. Individual lines can be displayed with the delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame color-burst observations in the PAL color system.

DELAYING SWEEP

Sweep Rate—0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div. The variable control is internally switchable between main, delayed sweep and variable main sweep holdoff.

Sweep Accuracy—Measured over the center 8 div.

TIME/DIV	UNMAGNIFIED		MAGNIFIED	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

Delay Time Multiplier Range—0 to 10 times the TIME/DIV setting.

Delay Time Multiplier Incremental Linearity—Within 0.2% of full scale.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial divisions for 1 μs to 0.5 s delay times. Within 2% and 2 minor dial divisions for 1 s to 5s delay times. Measurements were made over center 8 div.

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

Triggering

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

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

DELAYED SWEEP

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

Triggering

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV

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

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

POWER REQUIREMENTS

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

Line Frequency—48 Hz to 440 Hz (7403N), 48 Hz to 66 Hz (R7403N). The R7403N may be ordered for 360-440 Hz, 48-66 Hz operation by ordering R7403N Option 5.

Max Power Consumption—160 Watts, 2.0 Amps at 115 V line, 60 Hz (7403N); 168 Watts, 2.1 Amps at 115 line, 60 Hz (R7403N).

DIMENSIONS AND WEIGHTS

	7403N		R7403N	
	in	cm	in	cm
Height	11.4	28.9	5.25	13.3
Width	8.7	22.1	19.0	48.2
Length	24.0	60.9	24.7	62.9
	lb	kg	lb	kg
Net weight	30.0	13.6	30.0	13.6

Order 7403N OSCILLOSCOPE
Order 7A15AN AMPLIFIER
Order 7B53AN Opt. 5 DUAL TIME BASE

For further ordering information see last page.

TELEVISION OSCILLOSCOPE

453A MOD 127C

- TV SYNC SEPARATION
- 5 mV/DIV TO 10 V/DIV CALIBRATED DEFLECTION FACTORS
- 60-MHz BANDWIDTH AT 20 mV/DIV
- CALIBRATED MIXED SWEEP
- CALIBRATED SWEEP DELAY
- DESIGNED FOR SEVERE ENVIRONMENTS

Increased bandwidth, larger, brighter displays, calibrated mixed sweep, color-coded front panel, and easy-to-use X-Y capabilities are some of the features of the 453A, the new version of the world's most widely used oscilloscope. The rugged, field proven design of the 453 is retained in the 453A, so is laboratory accuracy, and ease of maintenance.

With the MOD 127C, an internal TV Sync Separator circuit permits stable internal line or Field-Rate triggering from displayed composite video or composite sync waveforms. External ÷ 10 trigger sources are replaced by internal TV Sync positions providing Line sync pulses to the B Sweep circuit and either Field or Line sync pulses to the A sweep circuit.

Individual lines can be selected with the delayed sweep features in the 453A. The wide range of delayed sweeps permits accurate alternate-frame color-burst observations in the PAL color system.

Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or overseas, with up to 1201-line, 60 Hz field rates. A parallax-free, 8 x 10 div, illuminated graticule is standard. Two additional snap-in TV graticules are supplied, but may not be illuminated. Other characteristics are the same as 453A and R453A.

Included Accessories—Two P6061 6-foot Probes with accessories (010-6061-03); 50-Ω 18-inch BNC cable (012-0076-00); BNC jack post (012-0092-00); two 6-32 adapters (103-0051-01); snap-in light filter/TV graticule (NTSC) (378-0664-01); snap-in light filter/TV graticule (CCIR) (378-0664-02); blue light filter (378-0664-00) and CRT ornamental ring (354-0248-00), both installed; instruction manual (070-1089-00) with MOD 127C insert; operator's manual (070-1105-00); five fuses, assorted spares. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

Order 453A MOD 127C OSCILLOSCOPE
Order R453A MOD 127C OSCILLOSCOPE (rackmount)

For further ordering information see last page.

CHARACTERISTIC SUMMARY

VERTICAL
(2 Identical Channels)

Bandwidth and Risetime—DC to 60 MHz (5.8 ns) from 20 mV/div to 10 V/div, DC to 50 MHz (7 ns) at 10 mV/div, DC to 40 MHz (8.75 ns) at 5 mV/div.

Calibrated Deflection Factor— 20 mV/div to 10 V/div at full bandwidth, 5 mV/div and 10 mV/div at reduced bandwidth.

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

HORIZONTAL

Calibrated Time Base— 0.1 μs/div to 5 s/div.

X10 Magnifier—Operates over full time base, increases fastest rate to 10 ns/div.

Calibrated X-Y Operation— 5 mV/div to 10 V/div in 11 steps.

Delay Range— 0.2 μs to 50 s.

External Input— 270 mV/div or 2.7 V/div dual trace, 5 mV/div to 10 V/div single trace.

CRT

Display Area— 8 x 10 divisions (0.8 cm/div)

Accelerating Voltage—14 kV

Phosphor—P31

OTHER

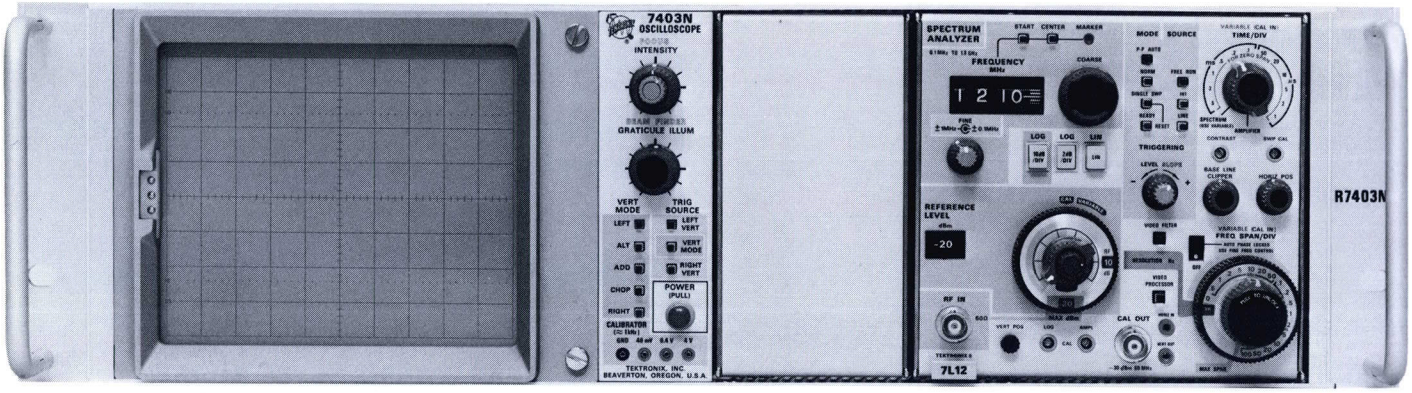
Amplitude and Time Calibrator—1 V or 0.1 V output, 5 mA output, 1-kHz squarewave.

Power Requirements—90 to 136 V or 180 to 272 V, 48 to 62 Hz, 92 W at 115 VAC.

7L12
R7403N

SPECTRUM ANALYZER

- CONVERTS ANY 7000-SERIES OSCILLOSCOPE TO AN EXCELLENT SPECTRUM ANALYZER
- 0 Hz to 1800 MHz IN ONE DISPLAY
- FULLY CALIBRATED DISPLAYS
- 300 Hz to 3 MHz RESOLUTION
- 4:1 RESOLUTION BANDWIDTH SHAPE FACTOR
- 70 dB DYNAMIC RANGE
- INTERMODULATION DISTORTION 70 dB BELOW FULL SCREEN
- SPURIOUS FREE OPERATION
- AUTOMATIC PHASE LOCK
- —110 dBm SENSITIVITY



5¼-inch rackmount R7403N with 7L12 installed.

The 7L12 Spectrum Analyzer Plug-In converts the R7403N Oscilloscope into a high-performance spectrum analyzer. This rackmount system is only 5¼ inches high and is useful in transmitter monitoring and elsewhere in TV spectra measurements.

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.

SPECTRUM ANALYZER

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; —108 dBm at 3 kHz Resolution; —100 dBm at 30 kHz Resolution; —90 dBm at 300 kHz Resolution; —80 dBm at 3 MHz Resolution.

Internal Spurious Responses—Less than —100 dBm referred to 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: 20 kHz (P-P) maximum.

Display Flatness—±1.5 dB, with respect to 50 MHz.

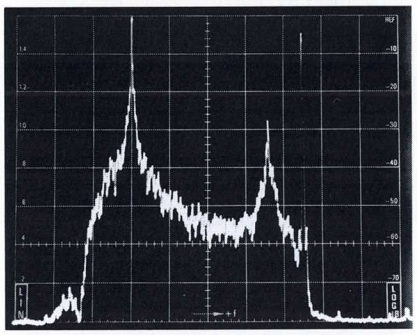
Maximum Safe Input Power—RF Attenuation 0 dB: +13 dBm. (—30 dBm linear operating limit) RF Attenuation 60 dB: +30 dBm (Power rating of attenuator).

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.

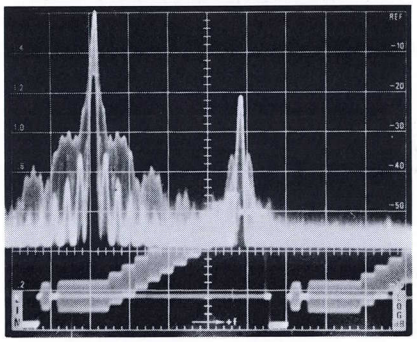
Triggering Modes—Normal, Peak-to-Peak Auto, Single.

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



This is the RF spectrum of a television transmitter showing output filter characteristics (pedestal shape) and video, color burst and audio. Frequency span is 1 MHz/div in this display on a 7403N Oscilloscope. Resolution is 30 kHz and the log mode provides 10 dB per div.



The upper display is the RF spectrum resulting from a modulated staircase plus sync and color burst. The lower display is a time base display of the modulated staircase. The simultaneous displays were plotted with a 7A18 Amplifier and a 7B53AN Time Base plus the 7L12 in a 7504 Oscilloscope.

Included Accessories—6-ft BNC cable (012-0113-00); adapter BNC male to N female (103-0058-00); special spectrum analyzer graticules (implosion shields 337-1439-01 for 7403N or R7403N, 337-1159-02 for other 7000 Series); Amber light filter (378-0684-01.

Order 7L12 SPECTRUM ANALYZER
Order R7403N OSCILLOSCOPE

For P7 phosphor and an internal spectrum analyzer graticule.
Order R7403N MOD 08 P7SA

For additional ordering information see last page.

1401A
1401A-1

SPECTRUM ANALYZER

- **GATED MODE for PULSED R.F. and TELEVISION**
- **75-OHM INPUT (1401A-1)**
- **50-OHM INPUT (1401A)**
- **AC, DC or BATTERY POWERED**
- **UP to 500 MHz in ONE DISPLAY**
- **FREQUENCY and AMPLITUDE CALIBRATOR**
- **60-dB LOG DYNAMIC RANGE**
- **INTERMODULATION DISTORTION MORE THAN 60-dB DOWN**
- **FLAT WITHIN 1.5 dB OVER 200 MHz**

1401A/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. Statements about the 1401A apply also to the 1401A-1 unless indicated.

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

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

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

ANALYZER CHARACTERISTICS

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

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

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

Resolution Bandwidth— 3, 100, and 1000 kHz.

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

Incidental FM— 20 kHz or less.

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

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

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

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

If Gain Control—At least 30 dB range.

Vertical Display—Linear and log.

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

SWEEP CHARACTERISTICS

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

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

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

CALIBRATOR

Frequency— 50 MHz within 0.01%.

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

SPECTRUM ANALYZER

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

For further ordering information see last page.

SPECTRUM ANALYZER SYSTEM

1401A/324 (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 (324); instruction manual (324).

Order 1401A/324P7
Order 1401A-1/324P7

OSCILLOSCOPE SUMMARY

CHARACTERISTIC	323	324
Bandwidth	DC to 4 MHz	DC to 10 MHz
Risetime	90 ns	36 ns
	10 mV/div to 20 V/div at full bandwidth	
Deflection Factor	1 mV/div at 2.75 MHz	2 mV/div at 8 MHz
Input R and C	1 megohm paralleled by approx 47 pF	
Time Base	5 μs/div to 1 s/div	1 μs/div to 0.2 s/div
Magnifier	X10	X5
CRT Display Area	6 x 10 divisions (1/4-inch divisions)	
Phosphor	P7 supplied when ordered with 1401A or 1401A-1	
Amplitude Calibrator	Internal, 0.5 V at external jack	
Power Sources	Internal batteries	Internal batteries
	External 6 to 16 VDC	External 6.5 to 16 VDC
	90 to 136 VAC	115 VAC ±10%
	180 to 272 VAC	230 VAC ±10%
	48 to 440 Hz	48 to 440 Hz
	14 W at 115 VAC	20 W at 126 VAC

The SONY/TEKTRONIX Type 323 and 324 are manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, they are available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the 1401A or 1401A-1 can be used during transport or storage, and is constructed of waterproof blue vinyl.

Order 016-0112-00

Power Pack—Extra power pack, in addition to the one supplied with the 1401A or 1401A-1, allows one power pack to charge while the other is powering the analyzer. An identical power pack is used in the 323. Pack contains six size "C" NiCd cells and battery charger.

Order 016-0119-02

Adapter—BNC 75 Ω to 50 Ω minimum loss attenuator.

Order 011-0112-00

Battery Set—Set of six NiCd cells.

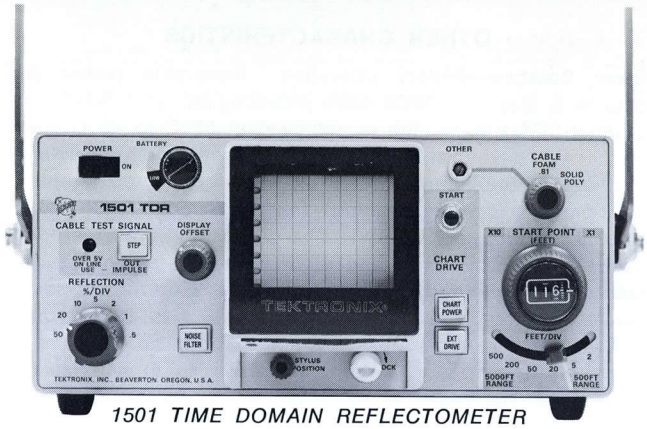
Order 146-0012-01

For further ordering information see last page.

1501

TIME DOMAIN REFLECTOMETRY

- DETECTS AND LOCATES CABLE FAULTS TO 10,000 FEET
- ACCURATE TO INCHES FOR SHORT RANGES
- SELF-CONTAINED RECHARGEABLE BATTERY
- AC OPERATED WHILE BATTERY CHARGES
- LESS THAN EIGHT POUNDS
- 50-OHM OR 75-OHM SOURCE IMPEDANCE
- PLUG-IN STRIP CHART RECORDER
- EASY TO OPERATE
- USE WITH OSCILLOSCOPE OPTIONAL



1501 TIME DOMAIN REFLECTOMETER

The 1501 is a portable, battery-operated Time Domain Reflectometer (TDR) used to detect and locate faults and to measure impedance variations in transmission cables through the use of test pulses. Resultant reflections from any discontinuities indicate the seriousness and character of the faults. The 1501 TDR is designed for use wherever communication or power transmission cable systems are used.

Two types of test signals and operating modes are provided . . . narrow pulses (IMPULSE mode) or fast rise long duration step signals (STEP mode). The step mode is usually preferred for analytical work; the impulse mode is especially for operating in the presence of noise signals or power voltage on the line. Test pulses are generated within the 1501 and drive the cable under test through a type "F" connector on the side panel. Adapters are available to mate with other connector types. Reflected signals return to the same connector and are terminated by the source impedance, either 50 ohms or 75 ohms—selectable with an internal switch. The input circuits are automatically protected from voltage on the line up to ±100 volts for frequencies up to 440 Hz. Voltages over 5 volts automatically AC couple the input, blocking DC and low frequency voltages, and causing a front panel light to indicate the presence of voltage on the line.

The 1501 is designed to be a complete measurement package when the Chart Recorder (016-0506-00) is plugged in. A strip chart 5 CM wide by 32.5 CM long can be made in about 20 seconds for about 10 cents per chart. For convenience in previewing each chart or as a substitute for graphic records a separate oscilloscope may be easily connected to the Vertical and Horizontal outputs of the 1501. The 323 or 324 SONY/TEKTRONIX Oscilloscopes are recommended for a size and style match with the 1501. The TEKTRONIX 211 Oscilloscope is also recommended. Most any oscilloscope with DC coupled vertical and horizontal amplifiers having a vertical sensitivity of 0.2 volts per division and a horizontal sensitivity of 0.5 volts per division is suitable.

The recorded portion of each chart has ten major horizontal divisions spaced 2.5 CM apart (about 1 inch) and eight major vertical divisions spaced 0.5 CM apart. The long (25 CM) horizontal scale provides distance resolution down to an inch or two for the 500 foot range at 2 feet per division. A direct reading, ten turn, start point delay dial provides the means for precise distance measurements using an oscilloscope display. Each chart is 7.5 centimeters longer than the recorded portion to provide space for handwritten data.

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

CHARACTERISTICS

Test Signal Amplitudes—Step 1 V, Impulse 10 V.

Displayed Risetime—1.3 ns (from reflection).

Displayed Impulse Width—1.3 ns (at 50% amplitude).

Displayed Aberrations—+4%, −4%, total not to exceed 8% of test signal amplitude within first ten feet, much less thereafter.

Vertical Deflection Factors— 0.5, 1, 2, 5, 10, 20 and 50% (of test signal amplitude) per division. One division on scope is equal to one 0.5 centimeter division on chart. Accuracy is 3%.

Displayed Noise (Tangentially measured)—Less than 0.2% using noise filter mode, or recorded on chart.

Source Impedance—75 ohms within 2% or 50 ohms within 2 percent. Selectable with internal slide switch.

Maximum Safe Input Voltage—±100 volts (DC + peak AC) for AC frequencies to 440 Hz.

Horizontal Scale Factors—2, 5, 20, 50, 200, 500 feet per division. Accuracy within 3%.

Start Point (Delay) Ranges—500 feet and 5000 feet, continuously variable. Direct distance readout on dial. Accuracy within 2% of dial setting.

Distance Ranges—0-520 feet at 2 feet/div
0-550 feet at 5 feet/div
0-5200 feet at 20 feet/div
0-5500 feet at 50 feet/div
0-7000 feet at 200 feet/div
0-10,000 feet at 500 feet/div

Cable Dielectric—Three choices. Either solid polyethylene, foam polyethylene with progration velocity of 0.81, or one other, adjustable to your choice.

Sweep Rate—Changes from about 40 per second (flicker free) to 4 per second when noise filter mode is selected. Approximately 20 seconds when a chart recording is made. Front panel push button starts the recording. Paper automatically stops when record is complete.

Sweep Output—0 to +5 volt ramp within 2%.
Vertical Output—0.2 V per chart division. Range limited to +2 V to −2 V.

External Pen Drive Input—0.2 V per chart division, 1.6 V P-P.

ENVIRONMENTAL CAPABILITIES

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

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

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

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

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

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

POWER SOURCES

External DC Source—Operates from an external DC source of 6 V to 16 V, requires 5 W.

External AC Source—Operates from an external AC source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 15 W maximum at 115 VAC.

Battery Operation—Removable power pack contains a battery of 6 size C NiCd cells providing at least 8 hours of operation with 30 recordings at 20° to 25°C. Power packs may be removed and plugged into AC to recharge the cells or may be left in the 1501 for recharge. The cells completely recharge in 16 hours. The 1501 may be operated from AC while the cells recharge or turned off except for recharge.

DIMENSIONS AND WEIGHTS

	1501	
	in	cm
Height	3½	8.9
Width w/handle	8½	21.6
Depth w/panel cover	10⅝	27.0
Depth w/handle	13	33.0
	lb	kg
Weight w/Recorder and Accessories	≈8	≈3.6
Net weight w/o Recorder and Accessories	≈6.5	≈3
Domestic shipping weight w/Recorder	≈13	≈5.9
Export-packed weight w/Recorder	≈21	≈9.5

TIME DOMAIN REFLECTOMETER MODULE

1501 Included Accessories—Chart recorder (016-0506-00); two rolls chart paper (006-1658-00); "F" male to male adapter (103-0157-00); "F" female to female adapter (103-0159-00); "F" male to BNC female adapter (103-0158-00); 8-ft power cable assembly (161-0043-02); cover plate, chart recorder blank (016-0509-00); TDR concept book (062-1244-00); instruction manual (070-1206-00).

Order 1501 (with recorder)
Order 1501 Option 1 (without recorder)
Order 1501 Option 2 (Metric version)
Order 1501 Option 3 (Metric version without recorder)

OPTIONAL ACCESSORIES

Chart Recorder, Order 016-0506-00

323 Oscilloscope with P7 Phosphor—The 323 with high persistance P7 phosphor is highly recommended.
Order 323 (with P7 phosphor)

1501 Convenience Accessory Group—Panel cover (200-0812-00); neck strap (346-0051-00); accessory pouch (016-0113-00); protective cover (016-0112-00); **Order 020-0053-00**

Protective Cover—Waterproof blue vinyl, **Order 016-0112-00**

Handle Conversion Kit (for two instruments)—For combining an existing 323 or 324 Oscilloscope with 1501 TDR, for a system as shown, **Order 040-0563-00**

Handle Conversion Kit (for three instruments)—For combining an existing 323 or 324/1401A or 1401A-1 and 1501 TDR.
Order 040-0596-00

Chart Paper—One roll, **Order 006-1658-00**

Power Pack—Extra power pack, identical to the one supplied with the 1501, allows one power pack to charge while the other is powering the 1501. **Order 016-0119-02**

Battery Set—Set of 6 NiCd cells, **Order 146-0012-01**

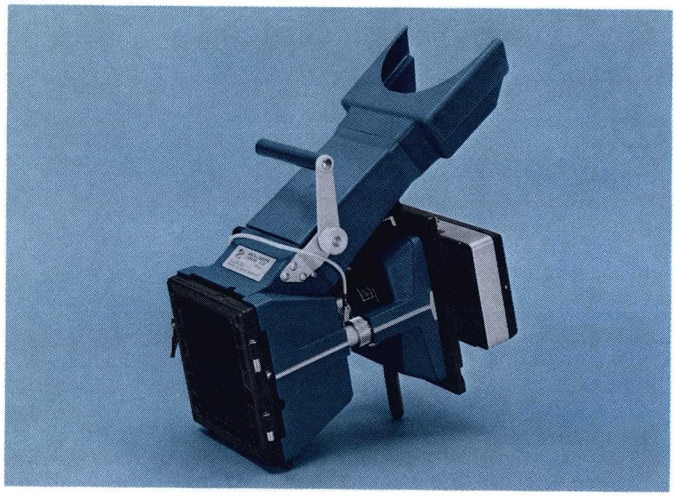
Adapters
Adapter "F" male to BNC female, **Order 103-0158-00**
Adapter "F" female to BNC male, **Order 013-0126-00**
Adapter "F" female to GR 874*, **Order 015-0089-00**

*Registered Trademark General Radio Company

For further ordering information see last page.

Recommended Trace Recording Cameras

INSTRUMENT	CAMERA	ADAPTER
520A	C-27-549	016-0295-00
521	C-27-549	016-0295-00
522	C-27-549	016-0295-00
528	C-27	016-0249-03
529	C-27	016-0224-00
453A MOD 127C	C-30A	integral
7403N	C-59	integral



C-27 and C-27-549 CAMERAS

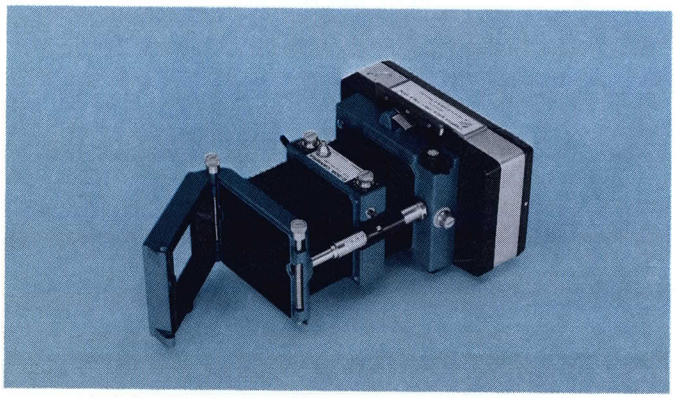
The C-27-P Camera is recommended for the 528 and 529 Waveform Monitors. The C-27-549-P Camera is recommended for the 520A, 521 and 522 Vectorscopes. The C-27-P and C-27-529-P differ only in their lens system. The C-27-P has an f/1.9 lens with a 0.85 magnification and the C-27-549-P has an f/1.9 lens with 0.5 magnification. Both have shutter speeds from 1 to 1/50 second (mechanically actuated). Both feature a removable viewing tunnel for compact stacking on rack-mount instruments, and the camera frame can be rotated, positioning the viewing tunnel at either side or at the bottom of the camera. Both cameras require mounting adapters as described in the ordering information.

Order C-27-P CAMERA, Pack-Film Back
Order C-27-549-P CAMERA, Pack-Film Back

Mounting Adapters

For 520A, 521 and 522 Order 016-0295-00
For 528, Order 016-0249-03
For 529, Order 016-0224-00

For further ordering information see last page.

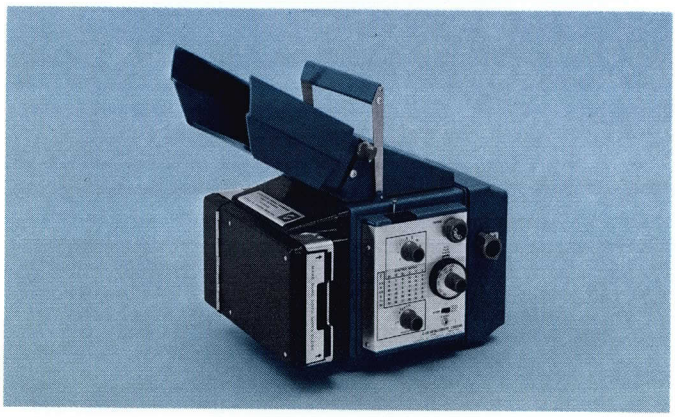


C-30A CAMERA

The C-30A-P Camera is recommended for the 453A MOD 127C Television Oscilloscope. It features a variable magnification with 10 indexed steps from 1.5 to 0.7. It has a f/1.9 lens with a mechanically actuated shutter with speeds from 4 to 1/50 second. The camera mounts directly to the oscilloscope (no additional adapter required) and can be quickly lifted off when not needed, or swing open from left or right as desired.

Order C-30A-P CAMERA, Pack-Film Back

For further ordering information see last page.



C-59 CAMERA

The C-59-P Camera is recommended for the 7403N Oscilloscope. Its features include • accurate exposure control • trace-brightness photometer • range-finder focusing. The shutter is mechanically actuated with speeds from 1 to 1/50 second. A magnification of 0.67 and aperture settings from f/2.8 to f/16 optimize this camera for general-purpose trace recording. The camera mounts directly to the oscilloscope (no additional adapter required) and can be quickly lifted off when not needed.

Order C-59-P CAMERA, Pack-Film Back

For further ordering information see last page.

BNC ATTENUATORS—TERMINATIONS

DESCRIPTION	PART NUMBER
75-Ω feedthrough termination	011-0055-00
75-Ω 10X attenuator	011-0061-00
50-Ω to 75-Ω min loss attenuator	011-0057-00
75-Ω to 50-Ω min loss attenuator (AC coupled)	011-0112-00

CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is ±2% at DC.

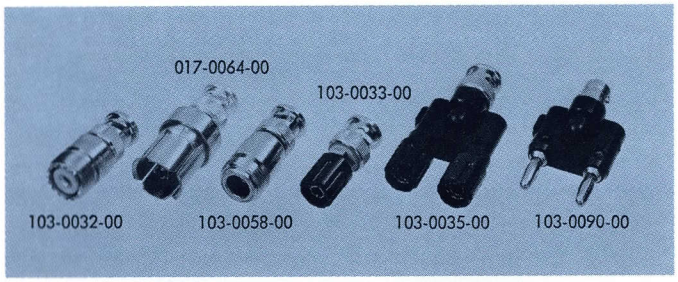
Power Rating of attenuators is ½ watt and terminations 1 watt.

Voltage Standing Wave Ratio (VSWR) not specified.

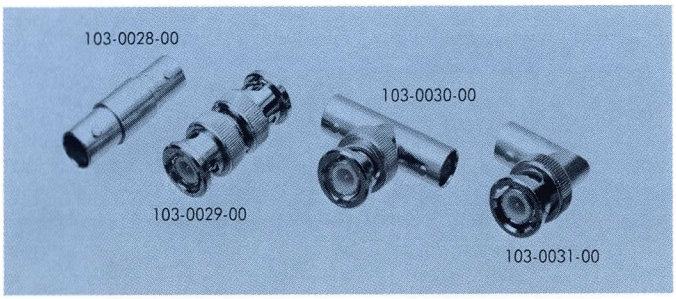
BNC CABLES

Coaxial, 50 Ω, 18 in	012-0076-00
Coaxial, 50 Ω, 42 in	012-0057-01
Coaxial, 75 Ω, 42 in	012-0074-00
Coaxial, 93 Ω, 42 in	012-0075-00

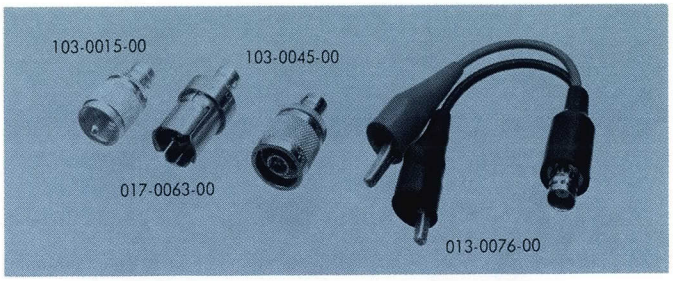
ADAPTERS



BNC Male to GR	017-0064-00
BNC Male to N Female	103-0058-00
BNC Male to Binding Post	103-0033-00
BNC Male to Dual Binding Post	103-0035-00
BNC Female to Dual Banana	103-0090-00
BNC Male to UHF Female	103-0032-00



BNC Female to BNC Female	103-0028-00
BNC Male to BNC Male	103-0029-00
BNC T	103-0030-00
BNC Elbow Male to Female	103-0031-00



BNC Female to UHF Male	103-0015-00
BNC Female to GR	017-0063-00
BNC Female to N Male	103-0045-00
BNC Female to clip leads	013-0076-00

CAMERA CARRYING CASES

C-30A/C-31/C-32 CARRYING CASE—The carrying case holds the C-30A, C-31 or C-32 Camera and all standard accessories including up to three Film Backs, extra bezels and extra film. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are $7\frac{3}{16}$ x $13\frac{3}{16}$ x $15\frac{3}{16}$ inches, net weight is approx $6\frac{1}{2}$ lb.

Order 016-0126-00

C-12/C-27 CARRYING CASE—C-12/C-27 Camera Carrying Case holds either the C-12 or C-27 Camera and all the standard accessories plus extra film. The case is constructed of heavy-gage, high-impact plastic and has a foam-rubber liner. Dimensions are $20\frac{1}{2}$ by 20 by 8 inches. Net weight is $15\frac{1}{2}$ lb; domestic shipping weight is ≈22 lb.

Order 016-0208-01

C-50 Series/C-70 CARRYING CASE—The carrying case will hold a C-50, C-51, C-52, or C-70 Camera and all standard accessories including a battery pack, extra film, and adapters. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are 16 3/4 x 23 2/3 x 10 1/10 inches. Net weight is approx 8 pounds.

Order 016-0177-00

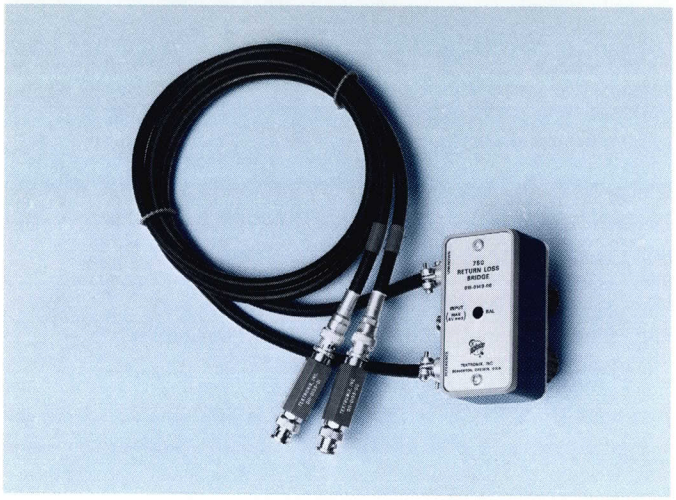
For further ordering information see last page.

SCOPE-MOBILE® CART MODELS — USAGE CHART

MODEL	PLUG-IN CARRIER & STORAGE DRAWER	TOP TRAY DIMENSIONS	BOTTOM SHELF DIMENSIONS	TRAY DESIGNED FOR OSCILLOSCOPE	SCOPE LOCK-DOWN	NET WEIGHT APPROXIMATE
200-1	None	$11\frac{1}{2}$ x $16\frac{1}{2}$ in	12 x 12 x ¾ in deep	453A, 454A, 491, 432, 434	No	19 lb
203-2	Holds four 5 or 7 Series plug-ins	$11\frac{1}{4}$ x 21 in	$14\frac{3}{4}$ x $26\frac{3}{4}$ in	7503, 7403N, 5100 Series	Yes	$38\frac{1}{2}$ lb

Television Accessories

75 Ω RETURN LOSS BRIDGE



The Tektronix Return Loss Bridge is a compact and rugged device featuring passive components and simple construction. It is designed to measure impedance errors in a 75-Ω system in terms of return loss, using a wideband, high-gain differential amplifier and oscilloscope (TEKTRONIX Type 1A5/547 or 7A13/7000-Series) as the error detector. The TEKTRONIX 011-0103-00 and 011-0103-01 are 75 Ω, 0.2% double-ended termination resistors supplied as removable bridge arms. Two matched coax cables extend the bridge arms and are permanently attached to the bridge. The ability to disconnect either or both bridge arms provides for a maximum degree of flexibility, during both calibration and in making measurements.

The bridge can be driven by a number of different sources such as VIT test signals, squarewaves, sinewaves, sine-squared pulses, multiburst, and swept-frequency sinewaves. With the Return Loss Bridge coupled to the differential amplifier and oscilloscope, a television test signal such as the multiburst can be used to measure impedance errors over the complete video spectrum with a single measurement.

CHARACTERISTICS

RETURN LOSS—At least 54 dB, DC to 10 MHz.

MAXIMUM INPUT VOLTAGE—6 V RMS (6 V RMS, DC to 1.2 MHz decreasing to 0.7 V RMS at 10 MHz when used with Type 1A5 or 7A13).

RETURN LOSS BRIDGE, order 015-0149-00
Includes instruction manual (070-1024-00).

TERMINATIONS

75-ohm termination. 75 ohms within 0.5% (at DC). Return loss is at least 52 dB, DC to 10 MHz, maximum input voltage is 5 V RMS, center conductor to ground.

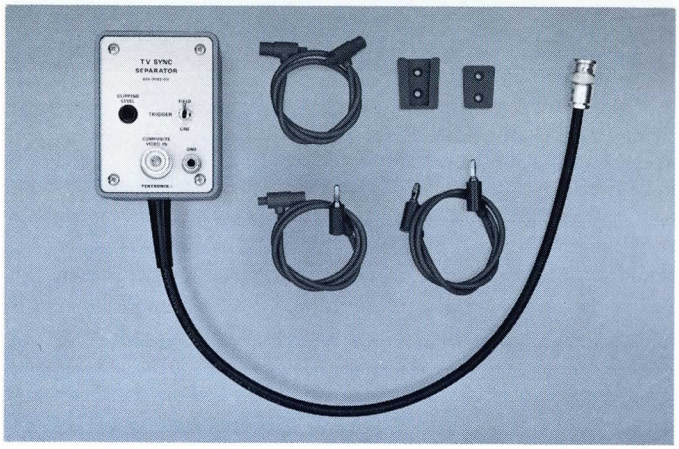
BNC, order 011-0102-00

UHF, order 011-0104-00

75 ohm feed through termination. 75 ohms within 0.2% (at DC). Return loss is at least 52 dB, DC to 10 MHz, maximum input voltage is 3 V RMS, center conductor to ground.

BNC, order 011-0103-02

TV SYNC SEPARATOR



The TV Sync Separator provides the trigger facilities for viewing composite video signals on a conventional oscilloscope. It can be used with Tektronix general-purpose oscilloscopes that have a 100-volt calibrator output. When used with other instruments, a separate 100-V source is required to power the unit.

A front panel switch selects field- or line-rate triggers, and a separate output jack supplies field triggers continuously. The unit has a clipping level control, allowing it to be used with signals ranging from 0.5 V to 8.5 V in amplitude.

POWER REQUIREMENTS—7 mA; operates on 100-V DC, or from the output of an oscilloscope calibrator with a frequency near 1 kHz.

INPUT—Composite video signal from signal source or from Vert Sig Out jack on front panel of oscilloscope.

OUTPUT— ≈8-V negative-going composite sync for line rate triggering or ≈6-V negative-going field-rate triggers. Selected by toggle switch. Also second output for field-rate triggers.

TV SYNC SEPARATOR, with illustrated accessories
Order 015-0062-00

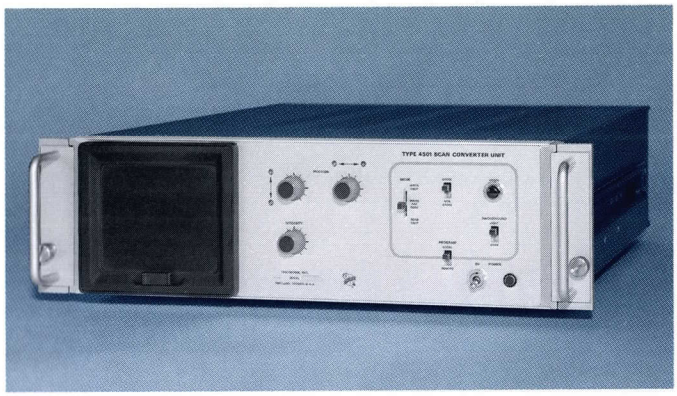
VIDEO STAIRCASE DIFFERENTIATOR

The Video Staircase Differentiator permits the use of a general-purpose oscilloscope for measuring amplitude linearity in TV systems.

The staircase differentiator is a filter which differentiates the steps of an unmodulated, linearity staircase (VIT signal) into spikes. The spikes appear on a common-reference level. Amplitude linearity is checked by comparing the amplitude of the spikes on the oscilloscope display. The generator used must supply a staircase having equal risetime, for the output amplitude of the differentiator is proportional to the rate of rise. Input impedance of the differentiator is 75 ohms. Return loss is at least 36 dB.

VIDEO STAIRCASE DIFFERENTIATOR
UHF, order 015-0075-00
BNC, order 015-0154-00

For further ordering information see last page.



- LINKS DATA AND SIGNAL SOURCES TO LARGE-SCREEN TV MONITORS OR RECEIVERS
- CONFORMS TO EIA OR CCIR STANDARDS
- OUTPUT DRIVES SEVERAL MONITORS
- DC-TO-10 MHz X AND Y AMPLIFIERS
- REMOTELY PROGRAMMABLE

The 4501 Scan Converter accepts alphanumeric and graphic data—in the form of analog inputs—and converts it to displays on TV receivers and monitors. The hi-contrast TV displays are ideal for individual or group viewing—even under bright light conditions. The displays may be viewed as light data on a dark background or as dark data on a light background, selected from the 4501 front panel.

The 4501 uses a Tektronix bistable storage CRT. Data may be written once on the storage CRT and retained for an hour *without refreshing*. The results are: call for your data once, then view it as long as one hour on a TV-size display. The 4501 also transfers continuously written data to your TV display.

The output video signal is internally switchable to either EIA 525-line, 60-field or CCIR 625-line, 50-field standards. Selected displays may be light on a dark background or dark on a light background. Outputs provide composite video output for monitor use or modulated RF (channel 2, 3 or 4) for TV receivers.

Order R4501 SCAN CONVERTER

- POINT, DRAW, WRITE, MAGNIFY ON TV MONITORS AND RECEIVERS
- USE IN BROADCASTING, TEACHING, COMPUTER-AIDED INSTRUCTION
- ANALOG AND DIGITAL OUTPUTS

The 4551 Light Pen Unit, when used in any 525/60 or 625/50 line TV system, produces a visible location indicator (cursor) on all TV displays in the system. The cursor may appear as a crosshair ⊢, a rectanglar box ▭, or the crosshair may be enclosed by the box ⊟. Size of the cursor is variable by a front-panel control. Conventional video mixing techniques are used to insert the cursor into the TV display system. The cursor tracks the position of a pen as the user moves it across the screen of the TV display.

The cursor calls the attention of the TV audience to any point of the display; the user reduces distractions by removing himself and physical pointers from the display.

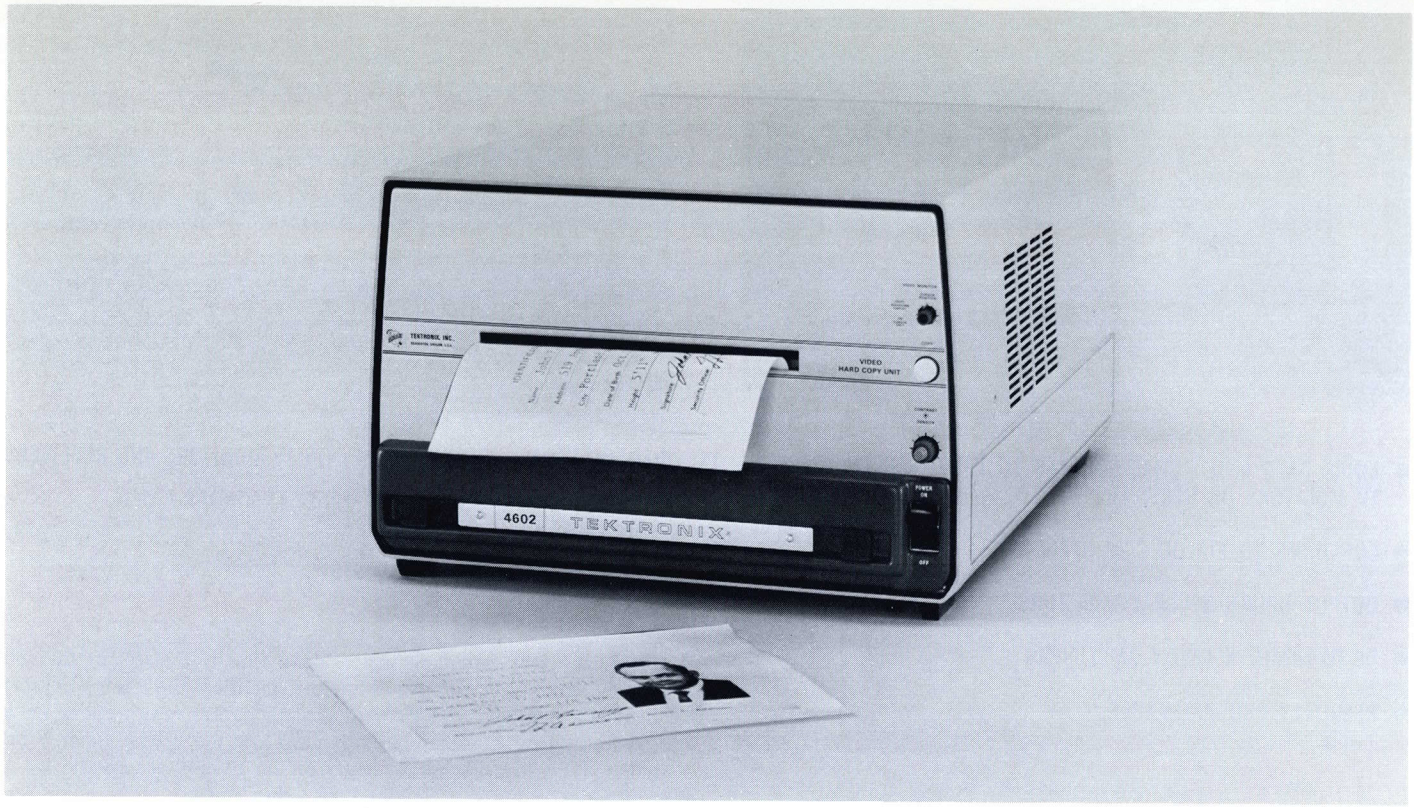
To write or draw on the display, the 4551 is used in conjunction with the 4501 Scan Converter. As the pen is moved, its movements are converted to stored images in the 4501. The 4501 then displays the written image on the monitor or receiver appearing as if it is written directly on the TV screen. To remove written data from the 4501, the user pushes Erase, a Light Pen Unit front panel control. This erases all stored data from the 4501 and readies it to store new data.

To magnify, a cursor is placed over that portion of the display which is to be enlarged. With the Light Pen Unit operating in the MAG mode, the area enclosed by the cursor is stored on the 4501 and scanned, magnified up to five times. In the MIXED mode, the area enclosed by the cursor is displayed alternately as a magnified and then a non-magnified area. The user views this as superimposed displays.

Order 4551 LIGHT PEN

For further ordering information see last page.

4602 Video Hard Copy



The 4602 Video Hard Copy Unit provides a convenient means of making permanent facsimile copies from static television signals. The 4602 produces dry copies on 3M Dry-Silver Paper providing an accurate gray scale representation of the television inputs. The easy-to-handle 8½ x 11-inch dry copies are convenient for communication, documentation, recording and filing uses in banking, finance, law enforcement, medical and education applications. Of course, the 4602 also copies alphanumeric and graphic displays from refreshed video computer display terminals.

Since the 4602 is completely self-contained, installation consists merely of connection to the power line and to the video information to be copied. Front-panel controls allow the user to standardize the copy video signals in the range of 0.2 V p-p to 3 V p-p. Copy command is initiated by pressing a front-panel control, or by supplying an external command. Contrast and Density are adjusted by the operator with simple to use front-panel controls.

CHARACTERISTICS

VIDEO INPUT—Two rear-panel BNC connectors arrayed for loop-through connection of 75 ohm coax video cable. Response is within 3 dB from 50 Hz to 30 MHz. Common-mode rejection ratio is 40 dB at 50 to 60 Hz with a common-mode signal range up to 5 V p-p. Return loss is greater than 46 dB from 50 Hz to 5 MHz.

Video Monitor Output—Composite video output with 75 Ω source impedance allows use of a video picture monitor as a setup aid. Output amplitude is 1 V p-p when video gain is properly adjusted for copy.

Copy Size—Adjusted to 8½ x 11 inches at factory.

Copy Time— 40 seconds for first copy. Additional copies of the same display take about 20 seconds each.

Warm up Time—20 minutes.

Remote Copy Command—Closure to ground for at least 5 μs.

Ambient Temperature—Between 0°C to +35°C is recommended.

Power Source (factory-wired options)—90 to 136 VAC, 115 V nominal, 50 to 60 Hz. Maximum power consumption at 115 V, 60 Hz is 1450 W for first 40 s after turn on. 220 to 520 W for normal operation, 100 W standby.

Dimension (height, width, length)—11 x 17 x 24 inches; 27.9 x 42.7 x 61 cm.

Weight—Approximately 69 pounds; approximately 31 kg.

Order 4602 VIDEO HARD COPY UNIT Option One
525 Line/60 Hz Field
Line rate may be set to conform with other video systems
110 V 50-60 Hz power
40 second copy time

Order 4602 VIDEO HARD COPY UNIT Option Two
625 Line/50 Hz Field
Line rate may be set to conform with other video systems
220 V 50-60 Hz power
49 second copy time

Order 4602 VIDEO HARD COPY UNIT Option Three
1029 Line/60 Hz Field
Line rate may be set to conform with other video systems
110 V 50-60 Hz power
82 second copy time

Paper—The roll shipped with the 4602 is 3M Type 777 Dry-Silver Paper. Refills may be purchased from Tektronix, Inc., or 3M Co. service centers.
For one roll, order 006-1603-00
For one carton of 4 rolls, order 006-1603-01

For further ordering information see last page.

INDEX and PRICE LIST

PART NUMBER	PRICE	PAGE
016-1603-00	$ 40.00	72
006-1603-01	143.00	72
006-1658-00	6.85	67
011-0055-00	10.00	69
011-0057-00	13.25	69
011-0061-00	12.00	69
011-0100-00	27.50	45
011-0100-01	27.50	45
011-0102-00	9.70	70
011-0103-02	9.70	70
011-0104-00	9.70	70
011-0107-00	27.50	45
011-0107-01	27.50	45
011-0108-00	27.50	49
011-0108-01	27.50	49
011-0109-00	27.50	49
011-0112-00	25.00	65, 69
012-0057-01	6.00	69
012-0074-00	6.00	69
012-0075-00	6.00	69
012-0076-00	6.00	69
013-0076-00	$ 5.50	69
013-0126-00	6.25	67
014-0020-00	35.00	54, 58
014-0021-00	35.00	54, 58
014-0022-00	40.00	58
014-0023-00	40.00	58
014-0024-00	40.00	58
014-0025-00	50.00	58
014-0026-00	50.00	58
014-0027-00	50.00	58
014-0028-00	50.00	58
014-0035-00	40.00	54
014-0036-00	40.00	54
014-0037-00	40.00	54
014-0038-00	40.00	54
015-0062-00	95.00	70
015-0075-00	25.00	70
015-0089-00	10.00	67
015-0149-00	100.00	70
015-0154-00	25.00	70
015-0212-00	60.00	26
015-0213-00	$ 60.00	26
015-0214-00	35.00	26
015-0215-00	35.00	26
016-0084-00	35.00	58
016-0112-00	10.00	65, 67
016-0115-02	95.00	54
016-0116-00	8.00	54
016-0119-02	98.00	65, 67
016-0126-00	38.00	69
016-0177-00	80.00	69
016-0208-01	85.00	69
016-0224-00	16.00	58, 68
016-0225-02	16.00	45, 49
016-0249-03	16.00	54, 68
016-0295-00	16.00	68
016-0506-00	475.00	67
017-0063-00	7.50	69
017-0064-00	10.50	69
020-0053-00	25.00	67
040-0563-00	30.00	67
040-0596-00	50.00	67
103-0015-00	$ 2.25	69
103-0028-00	2.10	69
103-0029-00	4.00	69
103-0030-00	3.70	69
103-0031-00	3.00	69
103-0032-00	2.00	69
103-0033-00	2.20	69
103-0035-00	6.50	69
103-0045-00	2.40	69
103-0058-00	2.75	69
103-0090-00	3.50	69
103-0158-00	6.25	67
134-0049-00	6.00	58
146-0012-01	23.00	65, 67
200-1328-00	.75	25
378-0575-00	18.00	58
426-0309-00	9.50	58
426-0667-00	8.50	45, 49

Tektronix, Inc.

P. O. Box 500, Beaverton, Oregon 97005

Telephone: (503) 644-0161 Telex: 36-0485 Cable: TEKTRONIX

FIELD ENGINEERING OFFICES

ALABAMA

***Huntsville** 35801
Suite 51, 3322 S. Memorial Parkway
Phone (205)881-2912, Telex 59-4422

ARIZONA

Phoenix
7045 E. Camelback Road
Scottsdale 85251
Phone (602)946-4273, Telex 66-7401
Tucson Area: ENterprise 383

CALIFORNIA

Alhambra 91801
Suite D, 1525 S. Garfield Avenue
Phone (213)576-1601, Telex 6-74397
From L.A. call: 283-0501

***Concord** 94520
2339A Stanwell Circle
Phone (415)687-8350, Telex 335-344
From Oakland, Berkeley, Richmond, Albany and San Leandro: 254-5353

***Orange** 92667
1722 E. Rose Avenue
Phone (714)633-3450, Telex 6-78432

Palo Alto 94303
3750 Fabian Way
Phone (415)326-8500, Telex 34-8411
(Info. Disp. Prod. 415-321-7728)

†**Mountain View Service Center**
2133B Leghorn Street
Mountain View 94040
Phone (415)967-2863

***San Diego 92111**
6841 Convoy Court
Phone (714)292-7330, Telex 69-5025

San Jose
Suite 1B, 1725 De La Cruz Blvd.
Santa Clara 95050
Phone (408)296-3010, Telex 34-6439

***Van Nuys** 91406
16930 Sherman Way
Phone (213)987-2600, Telex 65-1426
From L.A. call: 873-6868

COLORADO

***Denver**
6801 So. Yosemite St.
Englewood 80110
Phone (303)771-8012, Telex 4-5798

CONNECTICUT

***Hartford**
809 Main Street
East Hartford 06108
Phone (203)289-8695, Telex 9-9338

Stamford 06902
125 Strawberry Hill Avenue
Phone (203)325-3817, Telex 96-5917

FLORIDA

Fort Lauderdale 33311
1871 West Oakland Park Blvd.
Phone (305)731-1220, Telex 51-4474
Also serves Puerto Rico and U.S. Virgin Islands

***Orlando** 32803
Suite 185, 1010 Executive Center Dr.
Phone (305)894-3911, Telex 56-4465
From The Cape Kennedy Area: 636-0343

Pensacola 32503
Suite 130, 4900 Bayou Blvd.
Phone (904)476-1897, Telex 70-2430

GEORGIA

***Atlanta** 30329
Suite 106, 1680 Tullie Circle, N.E.
Phone (404)633-0344, Telex 54-2233
(Info. Disp. Prod. 404-634-9744)

ILLINOIS

Chicago
Suite 104, 2590 E. Devon
Des Plaines 60018
Phone (312)298-6666, Telex 72-6347

†**Chicago Service Center**
Unit E
175 Randall Street
Elk Grove Village 60007
Phone (312)956-1774

INDIANA

***Indianapolis** 46219
6121 East 30th Street
Phone (317)546-2408, Telex 27-348

KANSAS

Kansas City
Suite 101, 6025 Lamar
Mission 66202
Phone (913)432-1003, Telex 4-2321

MARYLAND

***Baltimore**
1526 York Road
Lutherville 21093
Phone (301)825-9000, Telex 87-804
From Harrisburg, Lancaster and York Area call: ENterprise 1-0631
(Info. Disp. Prod. 301-821-9390)

***Rockville** 20852
1500 East Jefferson Street
Phone (301)881-6133, Telex 89-2337

MASSACHUSETTS

***Boston**
244 Second Avenue
Waltham 02154
Phone (617)890-4550, Telex 92-3446
(Info. Disp. Prod. 617-890-5950)

Methuen 01844
240 Pleasant Street
Phone (617)685-1511, Telex 94-7458

Natick 01760
209 West Central Street, Room 6
Phone (617)237-4890, Telex 94-8400
From Boston call: 235-8233

MICHIGAN

***Detroit**
22132 West Nine Mile Road
Southfield 48075
Phone (313)358-3122, Telex 23-0692

MINNESOTA

***St. Paul** 55112
3775 North Dunlap Street
Phone (612)484-7255, Telex 29-7095

MISSOURI

***St. Louis**
11331 Natural Bridge Road
Bridgeton 63044
Phone (314)731-4696, 7, Telex 44-851

NEVADA

Las Vegas 89102
5128 West Charleston Blvd.
Phone (702)870-8201, Telex 68-4419

NEW JERSEY

Cherry Hill 08034
905 Kings Highway, North
Phone (609)667-4333, Telex 84-5338

Morris Plains 07950
520 Speedwell Avenue
Phone (201)540-0330, Telex 13-6479

***Springfield** 07081
964 South Springfield Avenue
Phone (201)379-1670, Telex 13-8259

NEW MEXICO

***Albuquerque** 87108
1258 Ortiz Drive, S.E.
Phone (505)268-3373, Telex 66-0421
Southern N.M. Area: ENterprise 678

NEW YORK

Albany
678 Troy Road
Latham 12110
Phone (518)785-3353, Telex 145-402

Buffalo 14225
965 Maryvale Drive
Phone (716)633-7861, Telex 91-385

***Endicott**
3214 Watson Blvd.
Endwell 13763
Phone (607)748-8291, Telex 932-421

***Long Island**
125 Mineola Avenue
Roslyn Heights, L.I. 11577
Phone (516)484-2300, Telex 96-1328

***Poughkeepsie** 12603
One Old Mill Road
Phone (914)462-4670, Telex 96-8414

***Syracuse** 13211
Room #112
5858 E. Molloy Road
Phone (315)455-6666, Telex 937-239

NORTH CAROLINA

***Greensboro** 27405
1011 Homeland Avenue
P.O. Box 6242
Phone (919)274-4647, Telex 57-4416

OHIO

***Cleveland** 44129
5562 Pearl Road
Phone (216)884-6558, Telex 98-5217

***Columbus**
Suite 5, 12 West Selby Blvd.
Worthington 43085
Phone (614)888-4040, Telex 24-5497

Dayton 45439
3309 Office Park Drive, Suite 103
Phone (513)293-4175, Telex 2-88225

OKLAHOMA

***Oklahoma City** 73105
901 Office Park Plaza
Phone (405)848-3361, Telex 7-1459

OREGON

Portland
8845 S.W. Center Court
Tigard 97223
Phone (503)639-7691, Telex 36-0205

†**Factory Service Center**
TEKTRONIX Industrial Park
Beaverton 97005
Phone (503)644-0161, Telex 36-0485

PENNSYLVANIA

Ft. Washington 19034
165 Indiana Avenue
Phone (215) 643-4935

†**Philadelphia Service Center**
1030 W. Germantown Pike
Norristown 19401
Phone (215)539-5540, Telex 84-6482

***Pittsburgh**
3834 Northern Pike
Monroeville 15146
Phone (412)351-3345, Telex 86-761

Valley Forge 19481
Suite 108
Davis Road and Oakwood Road
Phone (215) 783-7711

RHODE ISLAND

Providence
2845 Post Road
Warwick 02886
Phone (401)739-4771, Telex 92-7662

TEXAS

***Dallas** 75240
4315 Alpha Road
Phone (214)233-7791, Telex 73-0570
From Austin Area: ENterprise 9915

***Houston** 77027
Suite H, 3723 Westheimer
Phone (713)622-8141, Telex 77-494

San Antonio 78209
8031 Broadway
Phone (512)826-0686, Telex 76-7456

UTAH

***Salt Lake City** 84115
65 West 2950 South
Phone (801)484-8501, Telex 388-365

VIRGINIA

Alexandria 22304
Suite 11, 5249 Duke Street
Phone (703)751-6096, Telex 8-9406

Hampton 23366
1310 Todds Lane
Phone (703)826-4020, Telex 82-3409

WASHINGTON

Seattle 98188
410 Baker Blvd.
Andover Industrial Park
Phone (206)243-2494, Telex 32-488

WISCONSIN

Milwaukee 53226
Mayfair Plaza
2421 North Mayfair Road
Phone (414)476-6850, Telex 2-6604

***Field Office/Service Center**

†**Service Center**