



**PLEASE CHECK FOR CHANGE INFORMATION  
AT THE REAR OF THIS MANUAL.**

**2445/2465  
OPTION 05  
TV OPTION  
OPERATORS**

**INSTRUCTION MANUAL**

**Tektronix, Inc.  
P.O. Box 500  
Beaverton, Oregon 97077**

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### INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag,  
or stamped on the chassis. The first number or letter  
designates the country of manufacture. The last five digits  
of the serial number are assigned sequentially and are  
unique to each instrument. Those manufactured in the  
United States have six unique digits. The country of  
manufacture is identified as follows:

B000000	Tektronix, Inc., Beaverton, Oregon, USA
100000	Tektronix Guernsey, Ltd., Channel Islands
200000	Tektronix United Kingdom, Ltd., London
300000	Sony/Tektronix, Japan
700000	Tektronix Holland, NV, Heerenveen, The Netherlands

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# OPERATORS SAFETY SUMMARY

*The general safety summary in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.*

## Terms in This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

## Terms as Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

## Symbols as Marked on Equipment



This symbol indicates where applicable cautionary or other information is to be found.



Protective ground (earth) terminal.



ATTENTION — Refer to manual.

## Power Source

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

## Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

## Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

## Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

## Use the Proper Fuse

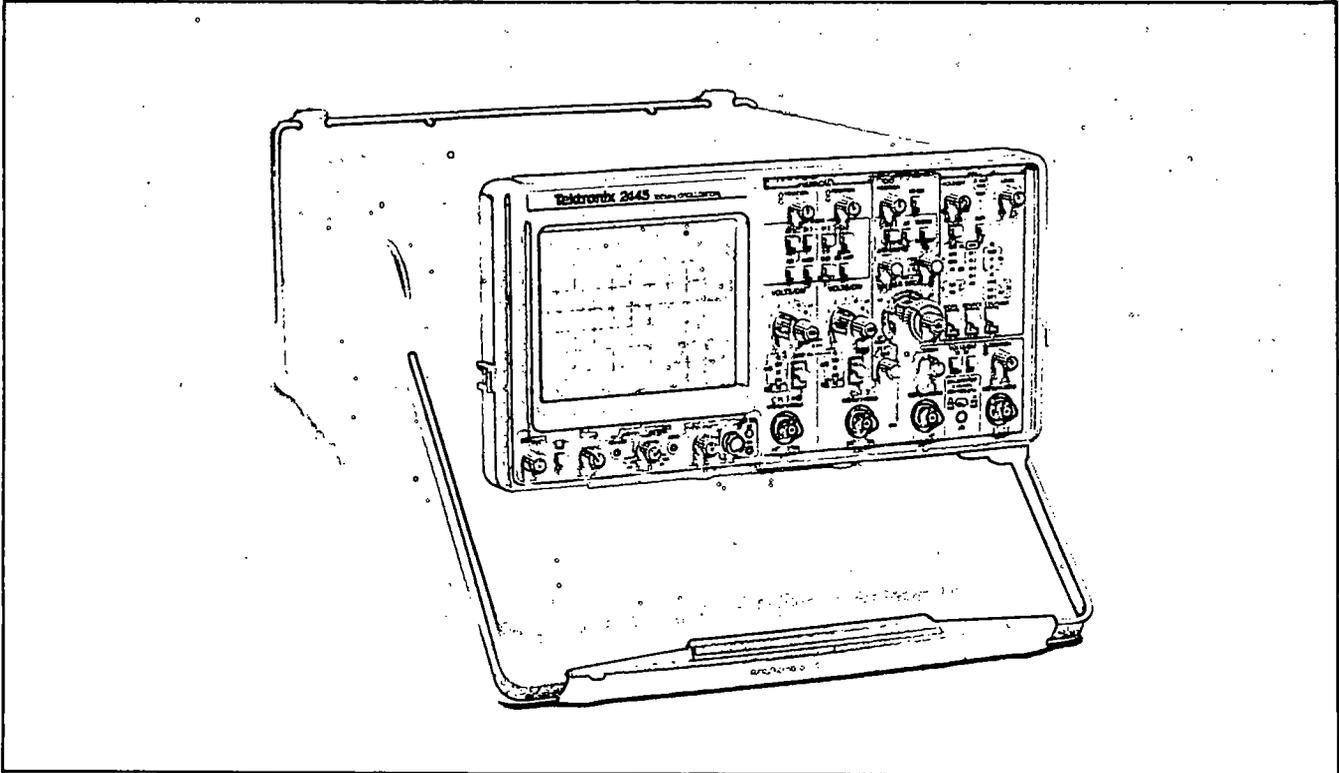
To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified in the parts list for your product.

## Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

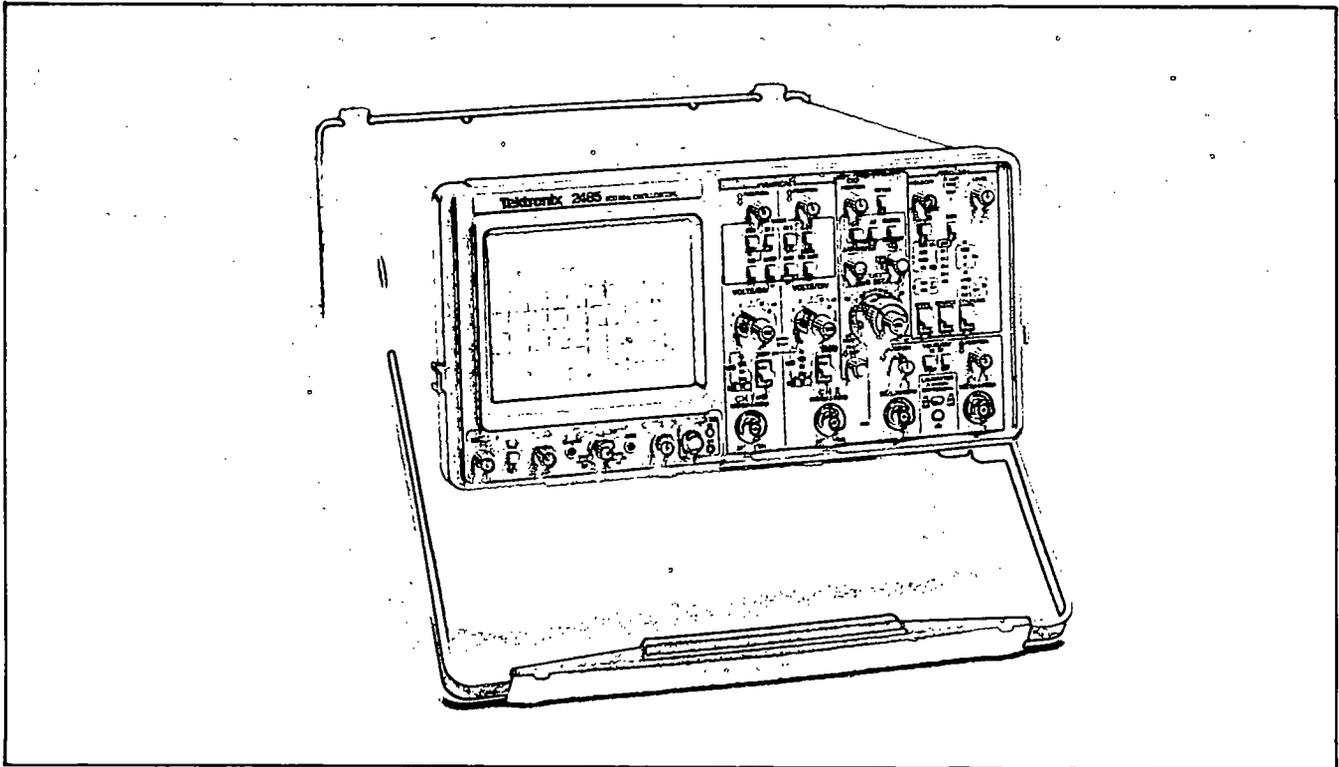
## Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate product without the covers and panels properly installed.



4629-01

The 2445 Option 05 (TV) Oscilloscope.



4629-02

The 2465 Option 05 (TV) Oscilloscope.

# SPECIFICATION

## INTRODUCTION

The TEKTRONIX 2445 and 2465 Oscilloscopes with Option 05 (TV Option) have additional hardware and software features to simplify triggering and viewing of television signals. The option adds TV (back-porch) clamp circuitry to the Channel 2 input and TV trigger coupling modes are provided, allowing a user to select either horizontal or vertical sync pulses to obtain horizontal-line-sync or field-sync pulse triggering. This option permits the user to trigger on a specific line number within a TV field and provides sync polarity switching for either sync-negative or sync-positive composite video signals.

### NOTE

*Composite video is the picture waveform complete with vertical and horizontal blanking and sync. Composite sync is combined vertical and horizontal sync as a single waveform, but without video (picture) waveforms.*

Both system-M and nonsystem-M protocols are available, providing compatibility with most television signal line-numbering protocols. Stable video rejection and sync separation is obtained from sync-positive or sync-negative, interlaced or non-interlaced scan, composite video signals having 525 to 1280 horizontal lines per frame and 50- or 60-Hz field rates.

## STANDARD ACCESSORIES

In addition to the standard accessories listed in the basic oscilloscope manuals, the following TV Option accessories are provided:

Quantity	Description	Part Number
1	2445/2465 Option 05, TV Option, Operators Manual	070-4629-00
1	2445/2465 Option 05, TV Option, Service Manual	070-4630-00
1	CCIR Graticule	378-0199-01
1	NTSC Graticule	378-0199-02
1	Polarized Viewing Hood	016-0180-00

## PERFORMANCE CONDITIONS

Except as noted in Tables 1-1 and 1-2 of this manual, the electrical, environmental, and mechanical characteristics of TV Option instruments are identical to those specified for basic instruments in the respective 2445 and 2465 Oscilloscope manuals.

Table 1-1  
Option 05 Electrical Characteristics

Characteristics	Performance Requirements
<b>VERTICAL DEFLECTION SYSTEM—CHANNEL 1 AND CHANNEL 2</b>	
Frequency Response	For VOLTS/DIV switch settings between 5 mV and 0.2 V/div with VAR control in calibrated detent. Five-division, 50 kHz reference signal from a 50 $\Omega$ system. With external 50 $\Omega$ termination on 1 M $\Omega$ input.
Full Bandwidth	Within $\pm 1\%$ .
50 kHz to 5 MHz	Within +1%, -2%.
>5 MHz to 10 MHz	Within +2%, -3%.
>10 MHz to 30 MHz	
Bandwidth Limit	
50 kHz to 5 MHz	Within +1%, -4%.
Square Wave Flatness	With fast-rise step (rise time $\leq 1$ ns), 1 M $\Omega$ dc input coupling, an external 50 $\Omega$ termination, and VAR VOLTS/DIV control in calibrated detent. Exclude the first 50 ns following the step transition. For signals with rise times $\leq 10$ ns, add 2% p-p between 155 ns and 165 ns after step transition.
Field Rate	
5 mV/div to 10 mV/div	1.5% p-p at 60 Hz with input signal of 0.1 V.
20 mV/div	1% p-p at 60 Hz with input signal of 0.1 V.
50 mV/div	1% p-p at 60 Hz with input signal of 1.0 V.
Line Rate	
5 mV/div to 10 mV/div	1.5% p-p at 15 kHz with input signal of 0.1 V.
20 mV/div	1% p-p at 15 kHz with input signal of 0.1 V.
50 mV/div	1% p-p at 15 kHz with input signal of 1.0 V.
TV (Back-Porch) Clamp (CH 2 only)	For VOLTS/DIV switch settings between 5 mV and 0.2 V with VAR control in calibrated detent. Six-division reference signal.
60 Hz Attenuation	$\geq 18$ dB.
Back-Porch Reference	Within 1.0 division of ground reference.

**Table 1-1 (cont)**

Characteristics	Performance Requirements
<b>TRIGGERING</b>	
Sync Separation	Stable video rejection and sync separation from sync-positive or sync-negative composite video, 525 to 1280 lines, 50 Hz or 60 Hz, interlaced or noninterlaced systems.
Trigger Modes	
Main Sweep	All lines: Field 1, selected line (1 to n); Field 2, selected line (1 to n); Alt fields, selected line (1 to n);  where n is equal to or less than the number of lines in the frame and less than or equal to 1280.
Delayed Sweep	Delayed by time.
Input Signal Amplitude for Stable Triggering	
Channel 1 or Channel 2	Minimum for peak signal amplitude within 18 divisions of input ground reference.
Composite Video	1 division.
Composite Sync	0.3 division.
Channel 3 or Channel 4	Minimum for peak signal amplitude within 9 divisions of input ground reference.
Composite Video	0.5 division.
Composite Sync	0.25 division.

**Table 1-2  
Option 05 Mechanical Characteristics**

Characteristics	Description
Weight	
With Power Cord, Cover, Pouch, Probes, Operators Manual, and Options	≤12.0 kg (26.4 lb).
Domestic Shipping Weight	≤17.6 kg (38.8 lb).

# CONTROLS AND INDICATORS

## FRONT-PANEL CONTROLS

Certain front-panel controls on the oscilloscope have dual modes of operation when the TV Option is installed. When the TV Option is enabled, the controls have the functions as described below. When the TV Option is not enabled, the controls have the functions described in the oscilloscope Operators manual and in other option Operators manuals if other options are installed.

See Figure 2-1 for the location of the TV Option front-panel controls.

- ⑪ **CH 2 Input Coupling Switch**—Selects or deselects the TV (back-porch) clamp function.

**UP:TV CLAMP**—Activates the TV (back-porch) clamp when the switch is pushed up from the 1 MΩ AC position. The AC indicator LED will remain on and the message "TVC" will appear on the top line of the crt. The clamp sets the television signal back-porch amplitude to a constant dc level and eliminates vertical drift, hum, and tilt in the display. A stable display is provided despite changes in signal amplitude and average luminance levels. The TV (back-porch) clamp can be enabled even if TV trigger is deselected.

**AC**—Deactivates the TV (back-porch) clamp when the switch is pushed down once from the UP:TV CLAMP position. The AC indicator LED will remain on and the message "TVC" will be removed from the top of the crt. The television signal's level will then be set by the average signal level and vary with that average level.

- ⑫ **Δ-FLD LINE # Control**—Selects a specific line number within the field for triggering the oscilloscope when the TV Option is enabled and the Trigger COUPLING switch is set to FLD 1, FLD 2, or alternate FLD 1-FLD 2 mode. Possible line numbers range from 1 to the maximum number of lines per frame in the television signal being viewed. Rotating the control clockwise increases the line number; rotating it counterclockwise decreases the line number. See the "Δ-FLD LINE # Control" discussion in

the "Operating Considerations" section of this manual for further information about using this control.

When the line number setting reaches the maximum number of lines in a field and either FLD 1 or FLD 2 coupling is selected, additional clockwise turning of the control changes the line number to the beginning of the following field. If alternate FLD 1-FLD 2 coupling (ALT) is selected, further rotation of the control past the maximum number will only reset the count to 1.

When the line number setting reaches 1 and either FLD 1 or FLD 2 coupling is selected, counterclockwise rotation of the control will move the line number to the maximum line number of the previous field. If ALT coupling is selected, the line number will move to the maximum line number common to both fields.

See the "Line Number Format Selection" discussion in the "Preparation for Use" section of this manual to choose the desired line number format. See the example below for operation with a 525-line interlaced scan signal.

Format 1	..	1 2 ... 263		1 2 ... 262	..
Format 2	..	1 2 ... 263		264 ... 525	..
Field		1		2	
FLD LINE #					
Control Rotation      CCW ← → CW					

- ⑬ **TRIGGER COUPLING Switch and Indicators**—Selects and indicates one of four additional choices for trigger coupling. They are: FLD 1 (field 1), FLD 2 (field 2), ALT (alternate field 1-field 2), and LINES (horizontal TV-line sync triggering). The crt readout will display the trigger coupling mode.

**FLD 1**—Sweep is triggered on the first field of the input TV signal and the FLD 1 LED is illuminated. NORM trigger mode is automatically selected.

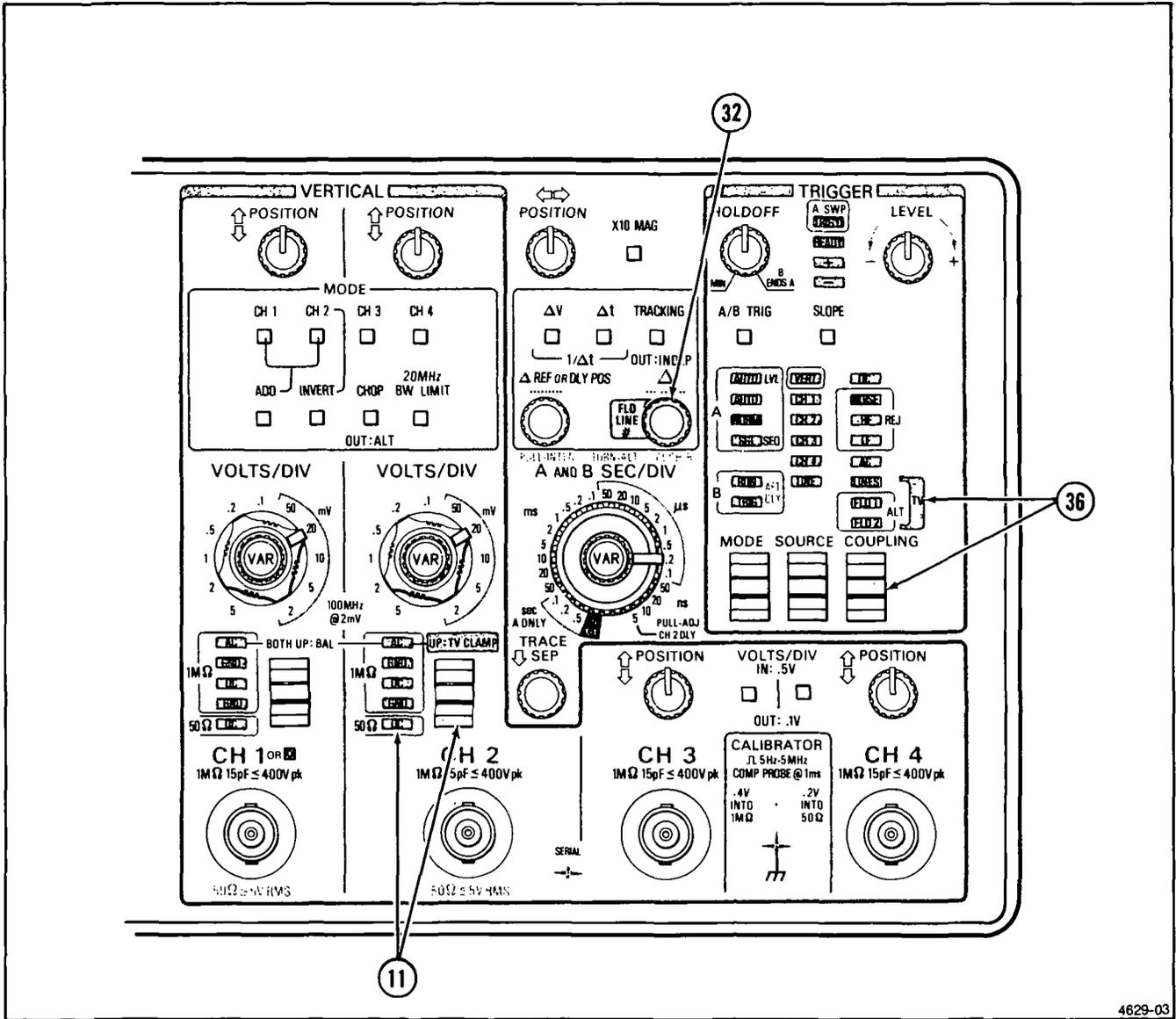


Figure 2-1. TV Option front-panel controls.

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**FLD 2**—Sweep is triggered on the second field of the input TV signal and the FLD 2 LED is illuminated. NORM trigger mode is automatically selected.

**ALT**—Sweep is alternately triggered by the two TV fields and both the FLD 1 and FLD 2 LEDs are illuminated. NORM trigger mode is automatically selected.

When CHOP Vertical Mode is selected, all of the active channels are triggered alternately by field 1 and field 2 of the video signal. The two fields will appear overlaid.

When ALT Vertical Mode is selected and more than one channel is displayed, field 1 of the video signal will trigger the first active channel and field 2 will trigger the next active channel. When more than two channels are displayed, each additional channel will be triggered first by field 1 and then by field 2 of the video trigger signal, and its two fields will be overlaid.

**LINES**—Sweep will trigger when the holdoff time has elapsed and a TV horizontal line-sync pulse is encountered. The LINES LED is illuminated and AUTO trigger mode is automatically selected.

## READOUT DISPLAYS

In addition to the readout displays for oscilloscope operation shown in Sections 3 and 6 in the oscilloscope Operators manual, an instrument equipped with the TV Option will display option status information when in any of the TV modes. Also see the "Operating Considerations" section of this manual for additional information.

The crt readout will display TV Trigger information when the Trigger COUPLING switch is set to any of the TV trigger modes (FLD 1, FLD 2, ALT, or LINES) or when the TV (back-porch) clamp is active. The TV Option utilizes a display area of up to 12 characters that are normally located in the right half of the top display line of the crt readout. If the right half is not available, the TV Option information is displayed in the left half of the top line.

When field triggering is selected, the readout displays the line number selected for triggering the oscilloscope. The line number readout is followed by a delta ( $\Delta$ ) symbol if the FLD LINE # control is controlling the line number selection. If the  $\Delta$  symbol is not present, the FLD LINE # control will not change the line number selection. The crt readout displays the message "TVC" whenever the TV (back-porch) clamp is active.

# PREPARATION FOR USE

This section of the manual contains information related to the power-up of the main instrument containing the TV Option. The power-up sequence of the oscilloscope is described, along with explanations of potential option-related error messages that may occur if the instrument is not functioning properly. Also included is initial setup information for the selection of the TV protocol and line number format parameters.

## POWER-UP SEQUENCE

Before turning on power to the instrument, read Section 2, "Preparation for Use," in the oscilloscope Operators manual and follow the safety and precautionary information described there.

The power-up tests, automatically performed each time the oscilloscope is turned on, test both the standard oscilloscope circuitry and the TV Option circuitry. Tests specifically applicable to the TV Option are integrated into the power-up tests for the host oscilloscope and include the TV Kernel test.

### Kernel Test

Operation of the TV Option memory (ROM) is checked by the standard instrument Kernel test. Kernel test failures will result in an attempt to flash the front-panel A SWP TRIG'D indicator.

#### NOTE

*On some instruments having other options installed, the A/B TRIG button may be labeled A/B/MENU.*

Even with a Kernel failure, pressing in the A/B TRIG switch may still place the instrument in an operating mode. However, if the operating mode is successfully entered, instrument operation may be unpredictable. If the instrument then functions adequately for your particular measurement requirement, it can be used; but refer it to a qualified service technician for repair of the problem as soon as possible.

## Successful Power-Up Sequencing

When the power-up routine is successfully completed without a failure indication, the oscilloscope enters the normal operation state. The oscilloscope parameters are set to correspond with current front-panel switch positions and with switch functions that were established for at least 10 seconds before instrument power was last turned off. The instrument is now ready to make measurements as required.

## POWER-DOWN SEQUENCE

When the POWER switch is set to OFF, the instrument powers down and the instrument front panel settings that were unchanged for at least 10 seconds prior to power off will be stored for use the next time power is applied to the instrument.

## TV PROTOCOL AND LINE-NUMBERING FORMAT SELECTION

The following procedures are used to select a particular protocol or line-numbering format. Both involve access to Diagnostic Monitor routines (EXER 61 and EXER 62) and affect field triggering only (FLD 1, Alternate FLD 1-FLD 2, or FLD 2). TV protocol selection allows the user to choose between system-M and nonsystem-M protocols. Selecting the incorrect system for a given TV protocol will not affect the ability to trigger on a given TV waveform. It will, however, cause the line number displayed to be inaccurate. Line-numbering format selection allows the user to select a preferred line-numbering scheme. Format 1 references line one from the beginning of the field being used for trigger reference. Format 2 always references line one from the first line of Field 1.

Exercise procedure TV EXER 61, accessed via the oscilloscope Diagnostic Monitor, allows the user to select between system-M and nonsystem-M television protocols. When system-M is selected, the line count begins three lines before the field-sync pulse is encountered. If nonsystem-M is selected, the line count begins coincident with the field-sync pulse.

**Preparation For Use  
2445/2465 Option 05 Operators**

Exercise procedure TV EXER 62, accessed via the oscilloscope Diagnostic Monitor, allows the user to select one of two line-number formats as shown below.

Format 1 ..	1 2 ... 263	1 2 ... 262	..
Format 2 ..	1 2 ... 263	264 ... 525	..
Field	1	2	
FLD LINE #			
Control Rotation		CCW ← → CW	

To choose or determine the TV protocol:

1. Hold in both the  $\Delta V$  and  $\Delta t$  buttons and push in the TRIGGER SLOPE button to enter the Diagnostic Monitor.
2. Repeatedly push up and release the TRIGGER MODE switch until the message "TV EXER 61" appears at the bottom-left corner of the crt.
3. Push up and release the COUPLING switch once, and the currently selected protocol will appear at the top of the crt. The message meanings are as follows:

LINE 1 OCCURS PRIOR TO FLD SYNC — System-M protocol is currently selected.

LINE 1 COINCIDENT WITH FLD SYNC — Nonsystem-M protocol is currently selected.

4. If the desired protocol message is not displayed, push up and release the TRIGGER COUPLING switch once. The desired protocol message should now be displayed. Push down once on the TRIGGER COUPLING switch.

To choose or determine the line number format:

5. Push up and release the TRIGGER MODE switch. The message "TV EXER 62" will be displayed at the bottom-left corner of the crt.
6. Push up and release the COUPLING switch once to display the currently selected format at the top of the crt. The message meanings are as follows:
  - LINE NO RESETS ON EACH FIELD—Format 1 is selected.
  - LINE NO RESETS ON FLD 1 ONLY—Format 2 is selected.
7. If the desired line format message is displayed, exit the Diagnostic Monitor by pushing the A/B TRIG button to resume normal oscilloscope operation.
8. If the desired line format message is not displayed, push up and release the TRIGGER COUPLING switch once. The desired line format message should now be displayed.
9. Push the A/B TRIG button to exit the Diagnostic Monitor and resume normal oscilloscope operation.

# OPERATING CONSIDERATIONS

Consult the oscilloscope Operators manual to acquire a thorough understanding of the operation of the basic instrument before trying to use the features of the TV Option. With the TV Option installed, all basic instrument functions (as explained in the respective oscilloscope technical manuals) remain unchanged.

## FRONT-PANEL CONTROL AND SETUP CONSIDERATIONS

The following information is useful when using the oscilloscope in TV applications. To operate properly, observe the oscilloscope front-panel controls and input signal considerations.

### TV Clamp

The TV (back-porch) clamp is used to stabilize ac-coupled TV waveforms and to remove tilt or hum present in the displayed TV waveform. If the Channel 2 signal is not composite video or composite sync or the sweep is not triggered on TV Sync, TV (back-porch) clamp operation is unpredictable.

If the TV (back-porch) clamp is enabled with no TV sync applied to the trigger, the CH 2 trace may drift vertically. This is normal; turning the TV (back-porch) clamp off will restore normal operation.

Use the procedure below to identify the signal type of an input signal to the CH 2 input connector.

1. Turn the TV (back-porch) clamp off and select CH 2 TRIGGER COUPLING.
2. Obtain a stable waveform using the desired TV trigger mode.
3. Determine whether the displayed signal is composite video or composite sync.
4. If necessary, turn the TV (back-porch) clamp on.

### $\Delta$ -FLD LINE # Control

The  $\Delta$ -FLD LINE # control is used for selecting a specific TV line within a field as well as positioning the  $\Delta$  cursor. When it can be used for line number selection, a delta ( $\Delta$ ) symbol appears in the crt readout display following the line number. If a delta symbol is not displayed, the control is used to position the  $\Delta$  cursor for the  $\Delta t$ ,  $1/\Delta t$  or  $\Delta V$  functions. The following two paragraphs describe how to switch the function of the control from one to the other during a series of measurements.

To enable the control to select a TV line when it is currently controlling the  $\Delta$  cursor, press the TRIGGER COUPLING switch once. This will not change the current coupling mode selected and the  $\Delta$  symbol will appear in the crt readout next to the line number.

If the control is currently controlling TV line number selection and it is desired to make a  $\Delta t$ ,  $1/\Delta t$ , or  $\Delta V$  measurement, press in the  $\Delta t$  button to get the  $\Delta t$  function, both the  $\Delta t$  and  $\Delta V$  buttons to get the  $1/\Delta t$  function, or the  $\Delta V$  button to get the  $\Delta V$  function. The control can now be used to position the  $\Delta$  cursor.

### Slope Selection

When using the TV trigger, select the proper slope for triggering on the TV signal. For sync-negative displayed signals, set the SLOPE switch to  $-$ . When triggering on sync-positive displayed signals, set the SLOPE switch to  $+$ .

### Display Considerations

The TV Option circuitry does not detect the color burst phase or Bruch Sequence color burst blanking information. In a four-field Pal Sequence with Bruch Sequence color burst blanking, Fields 1 and 3 will be displayed when Field 1 is selected (odd fields), and fields 2 and 4 will be displayed when Field 2 is selected (even fields). On noninterlaced scan systems the TV Option detects start of field information only. Field 1 and Field 2 are then two consecutive fields of information.

## Operating Considerations 2445/2465 Option 05 Operators

**MULTI-TRACE MODES.** When using the TV trigger and multi-trace operation, the trigger source must not be VERT mode. When only one trace is displayed, the VERT position of the TRIGGER SOURCE switch may be used.

**OVERSCANNED DISPLAYS.** For various video measurements, it may be desirable to magnify the video waveform vertically beyond the limits of the screen. Under these circumstances, the trigger amplifiers or the option circuitry may be overloaded, blocking out some sync pulses in the vicinity of strong video transitions, or losing sync pulses altogether. To avoid overload problems, use one of the other vertical channels to supply a constant amplitude signal to the option circuitry while the overscanned observations are being made.

**RF INTERFERENCE.** Operation in the vicinity of some FM and TV transmitters may contain objectionable amounts of rf signal energy in the input signal, even when coaxial input connections are used. The front-panel 20 MHz BW LIMIT switch will usually eliminate such interference from the display, but will not affect the signal reaching the option circuitry. Where the rf interferes with option operation, external filters will be required.

**MULTIPLE-DISPLAYED WAVEFORMS.** Within a given frame, the color burst alternates phase every line. Since there are an odd number of lines per frame on interlaced scan systems a given line within a frame will alternate color burst phase between frames. This is readily apparent when viewing a specific line within a frame. Understanding this color burst phasing and how A and B sweeps are triggered is important when interpreting multiple-displayed waveforms.

Review the base instrument operators manual parts on horizontal and delta measurements and delayed sweep operation.

In A Alt B mode, the sweeps are displayed as follows: A sweep, delayed (B) sweep, A sweep, delayed (B) sweep. In this mode, if  $\Delta t$  mode is selected and Fld 1 or Fld 2 trigger is selected, sweeps occur in the following order: A sweep, B sweep, A sweep, B sweep. Note that since B sweeps are essentially "interlaced" with the A sweep, each A and B sweep is triggered on every other frame. Since color burst phase alternates on every frame, the A and B displayed waveforms will each show one phase of the color burst information.

If A only or B only sweep mode is selected, sweeps are triggered on every frame and the displayed waveform will show both phases of the color burst.

## Oscilloscope Dc Balance Routine

With the TV Option installed, the main instrument dc balance routine can be accomplished with the CH 2 Input Coupling switch in either the 1 M $\Omega$  AC position or the TV CLAMP position.

## Front-Panel Update

When any front-panel change is made and the TV (back-porch) clamp is enabled, the display may jump vertically. However, the TV (back-porch) clamp will return the back-porch level to its previous position.

## CH 2 SIGNAL OUT Connector

To preserve waveform fidelity of a video signal applied to the CH 2 Input Connector when the TV Clamp is enabled, the CH 2 SIGNAL OUT connector on the instrument rear panel should be unterminated (open). If the connector is terminated into 50  $\Omega$ , there may be a slight shift in the back-porch level between adjacent lines of the video waveform.

## IDENTIFYING FIELDS, FRAMES, AND LINES IN 525/60 AND 625/50 TV SYSTEMS

### NTSC (CCIR System M)

Field 1 is defined as the field whose first equalizing pulse is one full H interval (63.5  $\mu$ s) from the preceding horizontal sync pulse. The field 1 picture starts with a full line of video and its lines are numbered 1 through 263, starting with the leading edge of the first equalizing pulse. The first regular horizontal sync pulse after the second equalizing interval is the start of line 10.

Field 2 starts with an equalizing pulse a half-line interval from the preceding horizontal sync pulse. The field 2 picture starts with a half line of video and its lines are numbered 1 through 262, starting with the leading edge of the second equalizing pulse. After the second equalizing interval, the first full line is line 9.

### CCIR System B and Similar 625/50 Systems (including PAL)

In most 625-line, 50-Hz field-rate systems, identification of parts of the picture relies primarily on continuous line numbering rather than on field-and-line identification, except for PAL systems.

The CCIR frame starts with the first (wide) vertical sync pulse following a field which ends with a half-line of video. The first line after the second equalizing interval is line 6; the

first picture line is line 23 (half-line of video). The first field of the frame contains lines 1 through the first half of line 313, and the picture ends with a full line of video (line 310).

The second field of the frame commences with the leading edge of the first (wide) vertical sync pulse (middle of line 313), and runs through line 625 (end of equalizing interval). The first full line after the equalizing interval is line 318; the picture starts on line 336 (full line).

The first field is referred to as "odd", and the second field as "even". Note that the identification systems for System-M and System-B are reversed.

In the four-field PAL sequence with Bruch Sequence Color-burst blanking, the fields are identified as follows:

**Field 1:** Field that follows a field ending in a half-line of video, when preceding field has color burst on the last full line. Field 1 lines are 1 through 312 and half of line 313. Color burst starts on line 7 of field 1; a half-line of video appears on line 23.

**Field 2:** Field that follows a field ending in a full line which does not carry color burst. Field 2 lines are the last half of line 313 through line 625. Color burst starts on line 319 (one line without burst following the last equalizing pulse); a full line of video appears at line 336.

**Field 3:** Field that follows a field ending in a half line when preceding field has no color burst on its last full line. Field 3 lines are 1 through the first half of line 313. Burst starts on line 6 (immediately following the last equalizing pulse); a half-line of video appears on line 23.

**Field 4:** Field that follows a field ending in a full line carrying color burst. Field 4 lines are the second half of line 313 through line 625. Color burst for field 4 starts on line 320 (two full lines without burst follow the last equalizing pulse); video starts with a full line on line 336.

## **GPIB CONTROLLABLE FUNCTIONS**

If the GPIB Option is installed in the instrument, additional commands to control the TV Option via the GPIB are available. The commands are listed in Table 4-1, and only the upper-case characters of a command are required for recognition. See the GPIB Operators manual for additional information relating to GPIB operation.

When using the GPIB to set the field line number, the option should be stably triggered on a valid composite video or composite sync waveform. If it is not stably triggered, the max line in the option may be set to a low number. An error code may then result on the GPIB controller when an attempt is made to change the line number to what is believed to be a valid line number over the GPIB.

Table 4-1  
GPIB Command Set for the TV Option

Header	Argument	Argument	Comments
ATRigger	COUpling:  SLOpe:	FLD1 FLD2 ALTErnate LINES  PLUs MINUs	Selects TV option trigger mode from list. These commands are in addition to the A trigger commands used by the main instrument.
ATRigger?	COUpling SLOpe		Query returns: ATR COU:string, SLO:string; where string is one of the respective argument parameters.
TVClamp	ON  OFF		Causes the CH 2 input coupling to be switched to AC and the TV (back-porch) clamp to be active.  If the TV (back-porch) clamp is enabled, the CH 2 input coupling is switched to AC and the TV (back-porch) clamp is turned off. Otherwise, no change to the CH 2 input coupling occurs.
TVClamp?			Query returns either TVC ON or TVC OFF.
TVLine	<nrx>		<nrx> is the TV line number chosen to trigger the oscilloscope.
TVLine?			Query returns present line number displayed.
LCNTStart	PREFld  ATFId		Line count begins 3 lines before field-sync pulse (System-M).  Line count begins at field-sync pulse (Nonsystem-M).
LCNTStart?			Query returns Line 1 definition: either LCNTS PREF or LCNTS ATF.
LCNTRreset	F1Only  BOTH		Line count is reset only on field 1 (Format 2).  Both field 1 and field 2 reset the line counter (Format 1).
LCNTRreset?			Query returns Line count reset status: either LCNTR F10 or LCNTR BOT.
ID?			See the GPIB Option manual system commands for details. The string returned for the TV Option is TV:FVz where z is the version number.

# BASIC APPLICATIONS

The basic instrument with the TV Option provides an accurate and flexible measurement system for displaying and analyzing video information. After becoming familiar with the controls, indicators, operating considerations, and capabilities of the instrument, perform the following procedures to become familiar with the oscilloscope functions for making TV-related measurements.

Before proceeding with these instructions, refer to "Preparation for Use" (Section 3).

Verify that the POWER switch is OFF (push button out); then plug the power cord into the power outlet.

## Initial Setup

- a. Press in the POWER switch button (ON).
- b. Set the instrument controls to obtain a baseline trace as follows:

### Vertical

CH 2 POSITION	Midrange
MODE	CH 2
BW LIMIT	Off (button out)
CH 2 VOLTS/DIV	0.2 V
CH 2 VOLTS/DIV VAR	Calibrated detent
CH 2 Input Coupling	GND

### Horizontal

A AND B SEC/DIV	Locked together at 5 ms
SEC/DIV VAR	Calibrated detent
POSITION	Midrange
X10 MAG	Off (button out)

### Trigger

HOLDOFF	MIN (fully ccw)
LEVEL	Midrange
MODE	NORM
SOURCE	CH 2
COUPLING	FLD 1
SLOPE	- for sync-negative displayed signals and + for sync-positive displayed signals

c. Adjust the INTENSITY and READOUT INTENSITY controls for desired display and readout brightness and best trace definition.

d. Adjust the Vertical and Horizontal POSITION controls to position the trace within the graticule area.

## Signal Input Coupling

This procedure demonstrates the appearance of a video signal with the different positions of the CH 2 Input Coupling switch (see Figure 5-1).

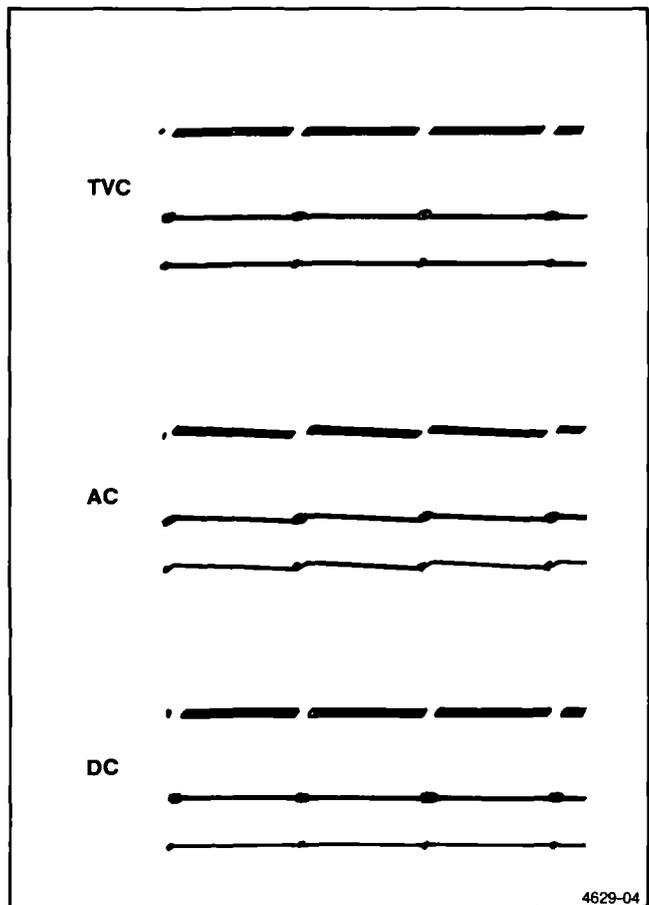


Figure 5-1. Appearance of video signal with CH 2 Input Coupling switch positions.

## Basic Applications

### 2445/2465 Option 05 Operators

a. Connect a composite video signal to the CH 2 input connector and change the CH 2 Input Coupling switch to DC.

b. Obtain a stable baseline trace.

c. With the CH 2 Input Coupling switch in 1 M $\Omega$  DC, note that the signal edges are flat.

d. Set the CH 2 Input Coupling switch to 1 M $\Omega$  AC and note the tilt in the waveform due to the input coupling capacitance.

e. Set the CH 2 Input Coupling switch to TV CLAMP. Notice that the waveform no longer has tilt and has returned to a dc-coupled appearance.

e. Set the TRIGGER COUPLING switch to either FLD 1 or FLD 2, depending on which field the desired line is in. The INTENSITY control may have to be adjusted to increase the trace brightness.

f. Adjust the FLD LINE # control until the desired line number appears in the crt readout. Specific time measurements on that particular line can now be made.

This procedure may also be used to measure the width of a sync pulse.

g. Set the CH 2 VOLTS/DIV, VAR, and POSITION controls so that the sync pulse exactly fills the screen between the 0% and 100% graticule lines. Enable the  $\Delta t$  function, push in the X10 MAG button, and position the sync pulse on screen using the Horizontal POSITION control.

h. Use the  $\Delta$  REF OR DLY control to position one cursor at the 50% point of the leading edge of the sync pulse (at the center horizontal graticule line) and use the  $\Delta$  control to position the other cursor at the 50% point of the trailing edge of the sync pulse. The sync pulse width can now be read directly from the upper-right corner of the crt readout.

## Time Interval Measurements

This procedure demonstrates how to use the  $\Delta t$  cursors to make timing measurements on the video waveform.

a. Set the TRIGGER COUPLING switch to the LINES position and the A AND B SEC/DIV switches to 10  $\mu$ s.

b. Push in the  $\Delta t$  button.

c. Use the  $\Delta$  REF OR DLY control to position one cursor on the rising edge of the first sync pulse and use the  $\Delta$  control to position the other cursor on the rising edge of the next sync pulse. The line interval period can now be read directly from the upper-right corner of the crt readout. On a 525-line/60-Hz interlaced system, the readout should be approximately 63.4  $\mu$ s. A 625-line/50-Hz interlaced system should produce a readout of approximately 64.0  $\mu$ s.

d. Push in both the  $\Delta V$  and  $\Delta t$  buttons simultaneously to get the  $1/\Delta t$  function. The crt readout now contains the line interval frequency. On a 525-line/60-Hz interlaced system, the readout should be approximately 15.8 kHz. A 625-line/50-Hz system should produce a readout of approximately 15.6 kHz.

The preceding procedure measured line intervals on those random lines of the video signal which triggered the oscilloscope sweep. To make a time interval measurement for a particular line within a field:

## Voltage and IRE Measurements

Voltage measurements can be made on the video signal using the  $\Delta V$  cursors and the crt readout. In addition, IRE measurements expressed in percentages can also be made and displayed on the crt as a percent.

a. Push in the  $\Delta V$  button, set the X10 MAG button out for X1 magnification, and return the CH 2 VOLTS/DIV VAR control to its calibrated detent. Waveform voltage measurements can now be made by using the  $\Delta$  REF OR DLY and  $\Delta$  controls to position the  $\Delta V$  cursors at the desired points of the video signal. The crt readout will correspond to the voltage potential between the two points on the waveform.

b. Set the CH 2 VOLTS/DIV, VAR, and POSITION controls so that the back porch and the top of a 100%-modulated video signal exactly fill the screen between the 0% and 100% graticule lines.

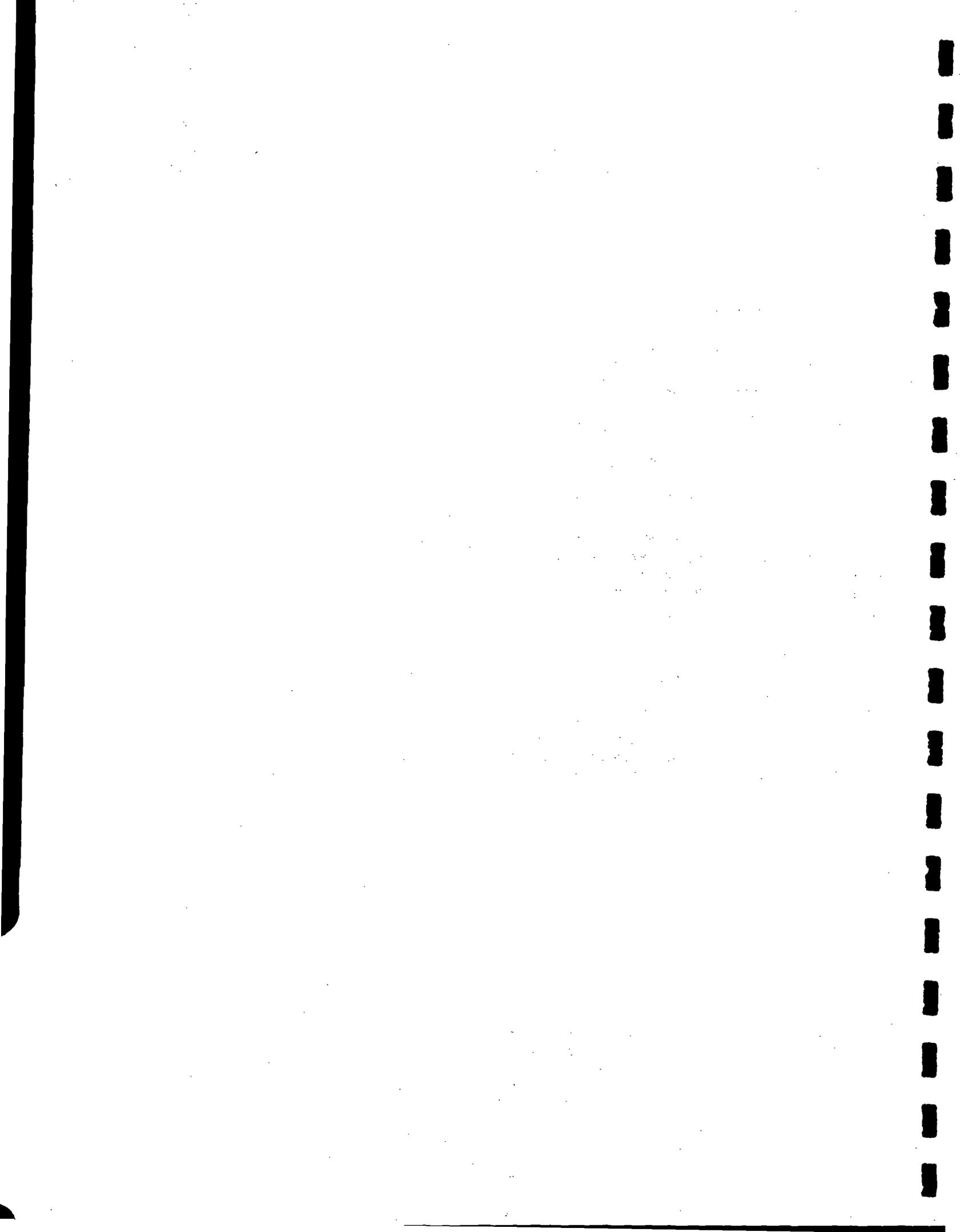
c. Any part of the waveform can now be measured in IRE units by using the  $\Delta$  REF OR DLY and  $\Delta$  controls to position the  $\Delta V$  cursors at the appropriate positions of the waveform. The crt readout will be a percentage which will correspond with the IRE measurement units.

## **MANUAL CHANGE INFORMATION**

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.



## DESCRIPTION

PG 38

**EFFECTIVE ALL SERIAL NUMBERS****TEXT CHANGES****Page 1-3 TRIGGERING****Add the following to the Performance Requirements for Sync Separation.**

For noninterlaced scan systems, the video signal source must start and end with full lines of video for correct line identification in the field trigger modes.

**Page 2-3 READOUT DISPLAYS****In the second paragraph, replace the first sentence with the following.**

The crt readout will display TV Trigger information when the Trigger COUPLING switch is set to any of the TV trigger modes (FLD1, FLD2, ALT, or LINES) and scale factors are on or when the TV (back-porch) clamp is active and scale factors are on.

**Page 3-1****Add the following section.****FILTER/GRATICULE REPLACEMENT**

The plastic filter or graticule over the crt faceplate can be removed by sliding the filter or graticule up until the bottom edge is exposed. Pull the bottom edge out and slide the filter or graticule down.

**Page 3-2****Add the following line to part 8.**

Push down once on the TRIGGER COUPLING switch.

**Page 3-2****Add the following section.****AUTOMATIC SYNC SELECTION**

Automatic sync selection is a feature which allows the user to preselect the polarity of sync used most often. Automatic sync selection will change the sync to the preselected polarity when the user enters a TV trigger coupling selection. Once TV trigger has been activated the user may change the polarity as desired. Changing trigger coupling selections within the TV option area will not cause the sync selection to be changed.

## DESCRIPTION

An exerciser (EXER 63) routine controls this function. The TV option can be set up to automatically select the desired sync when entering the TV trigger. There are three possible selections for exer 63:

POSITIVE: TV option will select sync positive when entering TV trigger.

NEGATIVE: TV option will select sync negative when entering TV trigger.

DEFSLOPE: TV option sync selection will default to the A trigger slope.

(prior to this version MV2 DEFSLOPE has been the only possible selection)

After entering exer 63 the display will read:

TVSYNC:POSITIVE

OR

TVSYNC:NEGATIVE

OR

TVSYNC:SLOPE DEFAULT

Selection is controlled by the trigger coupling switch. An up push when TVSYNC is POSITIVE will change the selection to NEGATIVE, the next up push will change to DEFSLOPE, the next up push will return to POSITIVE. A down push will exit exer 63 and store the last state displayed. Push the A/B TRIG button to exit the diagnostic monitor.

#### Page 4-1 Slope Selection

Replace the Slope Selection paragraph with the following.

When using the TV trigger, the A trigger slope controls the polarity of sync on which the option will trigger. For sync-negative displayed signals, set the slope to -. When triggering on sync-positive displayed signals, set the slope to +.

#### Page 4-4 Table 4-1

Add the following command to the table.

Header	Argument	Argument	Comments
TVSync	POSITIVE		Sync is set to positive when activating the TV trigger.
	NEGATIVE		Sync is set to negative when activating the TV trigger.
	DEFSLOPE		Sync defaults to the present value of the A trigger slope when activating the TV trigger.