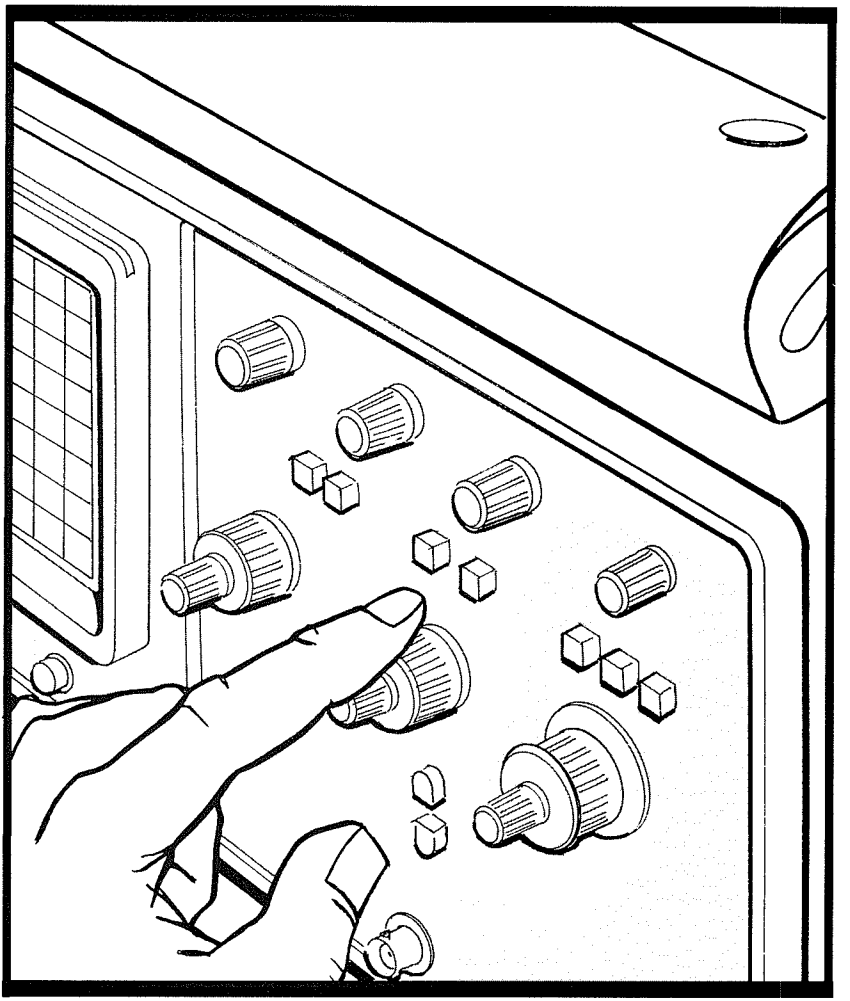
SECTION 5

Controls, Connectors, and Indicators



Controls, Connectors and Indicators

Introduction

The following descriptions are intended to familiarize the operator with the location and function of the instrument's controls, connectors, and indicators.

All continuously variable controls, except FOCUS, TRACE ROTATION, ASTIGMATISM, and SCALE ILLUMINATION have fine resolution for a portion of their rotation after each reversal. Continued rotation in the same direction gives progressively coarser resolution.

Power And Display

Refer to Figure 5-1 for the location of items 1 through 10.

1 **INTENSITY Control** — Adjusts the brightness of the waveform. The 2467B automatically limits both waveform intensity and readout intensity to protect the CRT from excessive aging, after a time of inactivity of the instrument controls. Operating any control except FOCUS, SCALE ILLUM, TRACE ROTATION, or ASTIGMATISM restores waveform and readout intensity levels and resets the CRT protection timer

2 **BEAM FIND Button** — Limits the CRT deflection both vertically and horizontally to within the graticule. Display intensity is not affected by the BEAM FIND button, except to restore automatically limited waveform and readout intensity levels.

3 **FOCUS Control** — Adjusts the CRT writing beam for optimum display definition.

4 **TRACE ROTATION Control** — Aligns the no-signal trace with the horizontal graticule lines. Relocating the instrument to a different magnetic ambient may result in slight misalignment of the trace and graticule, indicating a need to readjust the TRACE ROTATION control, using a screwdriver.

5 READOUT INTENSITY Control

Adjusts the intensity of the CRT readout display and either enables or disables the display of scale factors. Digital measurements, Save/Recall readouts, the "50 Ω OVERLOAD" message, the available Counter/Timer/Trigger *(CTT)* menu, Television/Video *(TV)*, and High Definition Television/Video *(HDTV)* function indicators are always enabled.

Various functions generate displays in the upper row. The most recently selected function displaces any previous readout. If delta or delay readouts displace displays generated by the available *TV* or *HDTV* enhancement or *CTT*, the *TV, HDTV* or *CTT* displays shift to the upper left corner, in lieu of the trigger level readout.

Minimum intensity occurs at the control's midrange, OFF position. Clockwise rotation from midrange increases the intensity and enables all displays. Counterclockwise rotation from midrange increases the intensity and disables the scale-factor and control-status displays.

6 ASTIG Control

Adjusts the CRT beam shape to obtain a well-defined display over the entire graticule area, in conjunction with the FOCUS control. Once adjusted with a screwdriver, it normally does not require readjustment.

7 SCALE ILLUM Control

Adjusts the level of graticule illumination.

8 POWER Switch

Turns instrument power on and off. Press in for ON; press again for OFF. An indicator in the switch shows green when the switch is on and black when it is off. Front-panel settings are returned when power is reapplied to the instrument, unless saved setup number 1 is selected by EXER 06, described in Appendix A.

9 CRT

Has a 68-mm vertical by 985-mm horizontal display area. Internal graticule lines eliminate parallax-viewing error between the trace and the graticule lines. The graticule includes 0%, 10%, 90%, and 100% marks for rise-time measurements.

10 GPIB STATUS Indicators

Included only with the available IEEE-Standard-488 interface *(GPIB)*; show key interactions with a GPIB system. LOCK lights when the instrument controls are disabled by a local lockout message from the system controller. SRQ lights when the instrument requests a service response from the system controller. REM lights when the system controller assumes control of the instrument. See *24X5B/2467B Option 10 Instrument Interfacing Guide* for detailed information on using the instrument in a GPIB system.

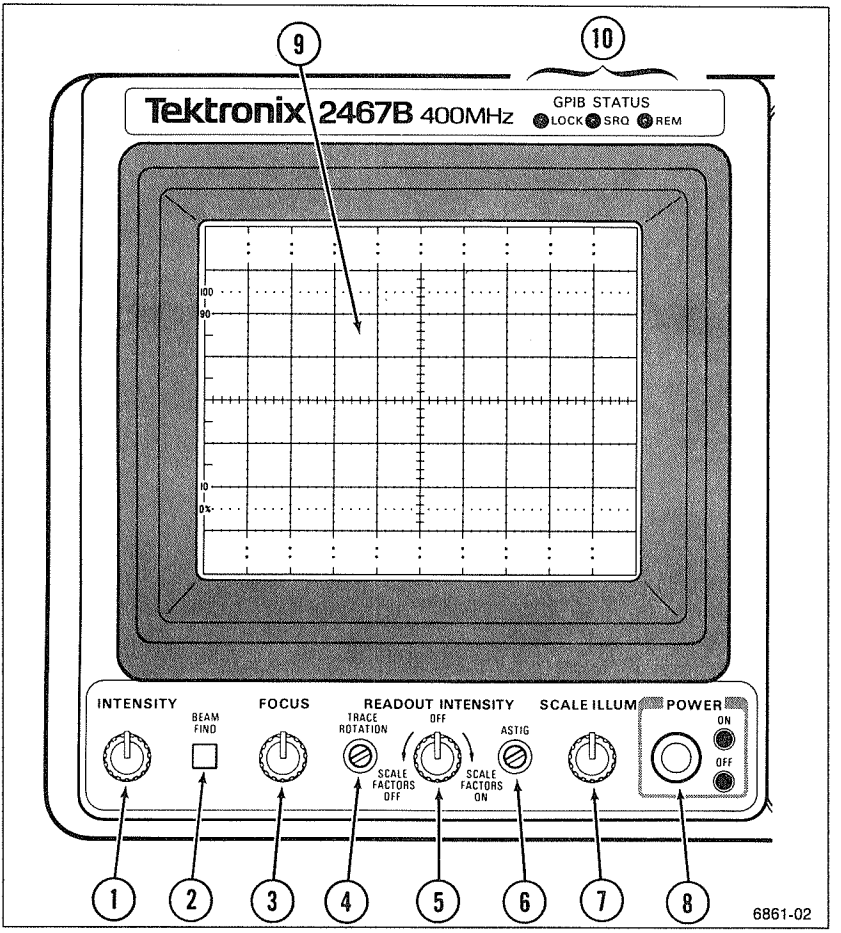


Figure 5–1. Power and display controls.

Setup and Vertical

Refer to Figure 5-2 for the location of items 11 through 18.

(11) STEP/AUTO Button

Recalls the next step in a stored sequence of setups, if the STEP indicator is illuminated. If the STEP indicator is not illuminated, the oscilloscope automatically establishes triggering and scales the waveform display vertically and horizontally (AUTO). HDTV will set up triggering in the video mode for TV signals.

(12) SAVE/HELP Button

Saves the current oscilloscope control settings in a numbered setup when followed by one of the setup-number buttons, 1 through 8, which are also the Vertical MODE buttons. Pushing the SAVE/HELP button replaces the top and bottom rows of the normal readout display with prompting and help messages. These help messages may be cycled through by repeatedly pushing the SAVE/HELP button. Additional setups are accessible by using Δ and STEP. For operational information, see the "Operation" section and Appendix B.

(13) RECALL/HELP Button

Restores previous oscilloscope control settings saved in a numbered setup when followed by one of the setup-number buttons. Pushing the RECALL/HELP button replaces the top and bottom rows of the normal readout with the user defined menu. Repeated operation of the HELP button produces a cycle of help messages.

Additional setups are accessible by using Δ and STEP. For operational information, see the "Operation" section and Appendix B.

Each setup carries a name with one to seven characters. The name of a setup can be defined when it is saved or redefined at any time. The names of setups one through eight appear on the screen as a user-defined menu when RECALL is pressed. The names appear on the screen in the same relative positions as the corresponding setup number buttons, also used as a Vertical MODE button. When a steup is recalled, the setup number and name appear in the upper left of the readout until a control is moved or a measurement changes the readout.

For instruments with serial numbers B049999 and below with firmware version 11 and above or for instruments with serial numbers B050000 and above with firmware version 2 and above, pressing the RECALL/HELP button following an auto setup or parameteric measurement will restore the instrument to the mode of operation prior to the parametric measurement.

14 MEASURE Button

Activates the Parametric Measurements menu. Selections from the menu are made using the VERTICAL MODE buttons. Repeated activation of the MEASURE button will cycle through a series of explanatory text in the lower CRT readout.

15 POSITION Controls

Set vertical position of the Channel 1 and Channel 2 signal displays. Clockwise rotation of a control moves the associated trace upward. When the X-Y display feature is in use, Channel 1 POSITION control moves the display horizontally; clockwise moves it to the right. The Channel 2, Channel 3, and Channel 4 vertical POSITION controls move the associated X-Y display vertically.

16 MODE Buttons

Select the indicated channel(s) for display. Any combination of the five possible signal selections can be displayed by pressing the appropriate buttons. The Channel 1 signal will be displayed if none of the displays are selected. Each button has an associated indicator to show when the respective display or characteristic is active. Pressing a button toggles the display or characteristic on or off. When pressed after pressing SAVE or RECALL, these buttons select setup memories (1) through (8).

HDTV allows TV presets to be accessed (see EXER 64).

These buttons also select the various entries in the displayed menu when the buttons are pressed after pressing the MEASURE button.

When multiple channels are selected, they are displayed sequentially in order of priority. The established priority order is: CH 1, CH 2, ADD, CH 3, then CH 4.

The algebraic sum of Channel 1 and Channel 2 is displayed when the Add display is selected. When both Add and Invert displays are selected, the waveform displayed is the difference between the Channel 1 and Channel 2 signals. The INVERT button also inverts the polarity of the signal output at the CH 2 SIG OUT connector on the rear panel. At the same time, the Channel 2 trigger-signal polarity is inverted so that if CH 2 is selected as the TRIGGER SOURCE, the displayed slope will agree with the TRIGGER SLOPE setting.

(17) **CHOP/ALT Button**

Selects the vertical display mode for multiple-channel displays.

CHOP/ALT has no effect on the switching rate of X-Y function displays. If more than one vertical display is selected for X-Y, the display switches at 2.5 MHz.

CHOP

When more than one channel is selected, the vertical display switches sequentially through the selected channels at the chop-switching rate.

When more than one channel is selected, if the SEC/DIV setting for the displayed sweep is in the range of 20 µs/div to 2 µs/div, each channel is displayed for 400 ns. Otherwise, each channel is displayed for 1 µs. The chop switching rate is desynchronized from sweep repetitions to minimize waveform breaks when viewing repetitive signals.

ALT

When more than one channel is selected, the vertical display switches sequentially through the selected channels. Alternate switching occurs during sweep-retrace times. If both A and B Sweeps are displayed, in Alt horizontal mode, vertical switching occurs at the completion of the B Sweep.

The Alt vertical mode enables a slaved delta-time mode for measuring time intervals between two channels. In the slaved delta-time mode, the first selected display in the sequence is displayed with the delta reference delay and the second selected display in the sequence is displayed with the delta delay. Any additional channels are displayed with both delays. The slaved delta-time mode also requires the following control conditions: either Δt or $1/\Delta t$ selected, Inten, Alt, or B horizontal display with the dual delays and not cursors, multiple vertical displays, and a single A-Sweep trigger source.

(18) **20 MHz BW LIMIT Button (50 MHz BW LIMIT Button for HDTV)**

Limits the bandwidth of the vertical deflection system to 20 MHz (50 MHz). Full vertical bandwidth is available when the bandwidth limit function is off. Neither the trigger signals nor the output from the CH 2 SIG OUT connector is affected by the 20 MHz (50 MHz) BW LIMIT.

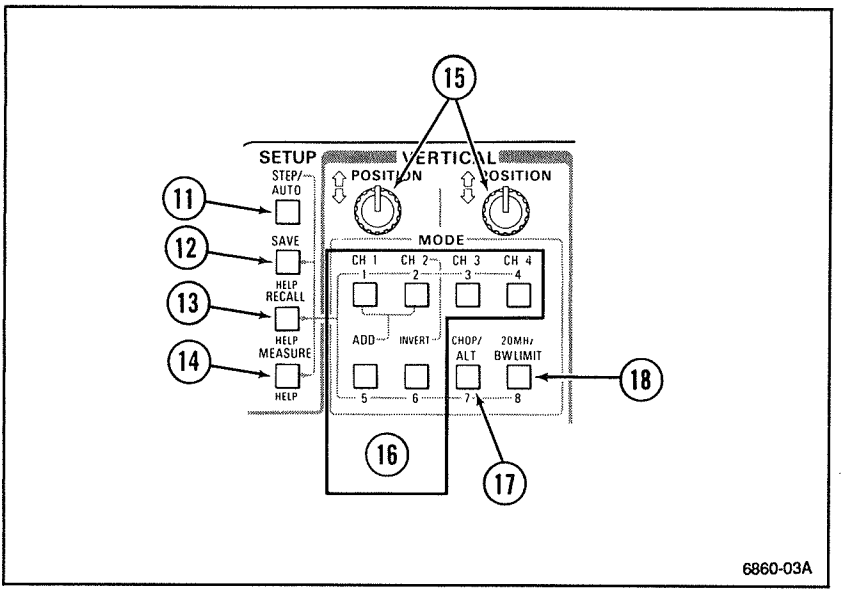


Figure 5–2. SETUP and MODE buttons, and CH 1 and CH 2 POSITION controls.

Refer to Figure 5-3 for the location of items 19 through 22.

19 VAR Controls Provide continuously variable, uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switches. These controls vary the deflection factors from calibrated (fully clockwise detent position) to at least 2.5 times the calibrated deflection factor (fully counterclockwise position). When out of the calibrated detent, a greater than (>) sign appears in front of the associated VOLTS/DIV readout display.

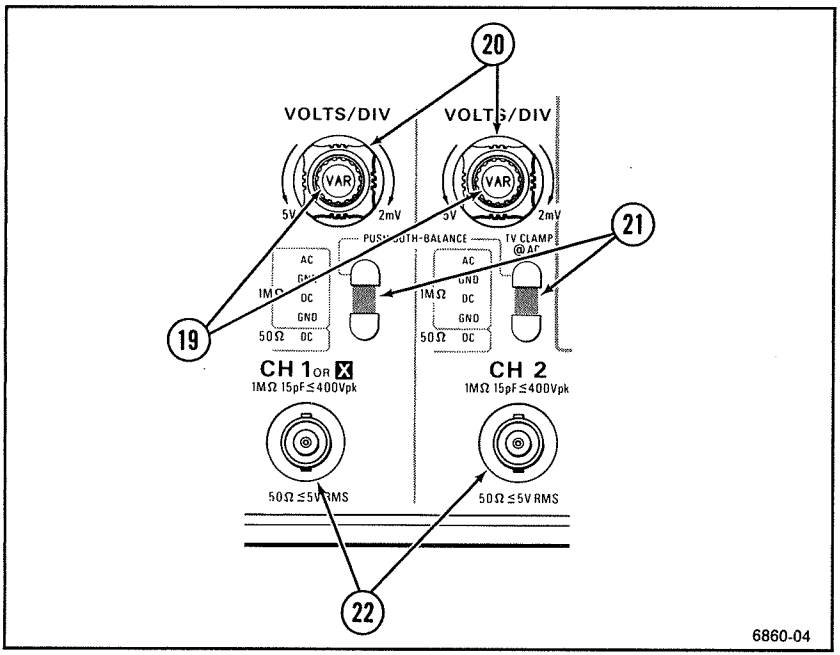


Figure 5-3. Channel 1 and Channel 2 controls and connectors.

(20) VOLTS/DIV Switches

Select vertical deflection factor settings in a 1-2-5 sequence with 11 positions. The VAR control must be in the detent (fully clockwise) position to obtain a calibrated deflection factor. Basic deflection factors are from 2 mV per division to 5 mV per division. The switches can rotate continuously, but have no effect beyond the extreme settings. Deflection factors shown in the CRT readout reflect actual deflection factors when Tektronix attenuation-coded probes are connected to the inputs.

(21) Input Coupling Buttons and Indicators

Select the method of coupling input signals to Channel 1 and Channel 2 and indicate the selection made. If the upper Channel 1 and Channel 2 Input Coupling buttons are both pressed together, the instrument automatically performs a dc balance of Channel 1 and Channel 2 vertical circuitry.

1 MΩ AC

Input signal is capacitively coupled to the vertical attenuator. The dc component of the input signal is blocked. The low-frequency limit (-3 dB point) is 10 Hz or less when using either a 1X probe or a coaxial cable and is 1 Hz or less when using a properly compensated 10X probe.

Only with the available Television/Video *(TV)* and High Definition Television/Video *(HDTV)* enhancements, the CH 2 input has a back porch clamp for composite video signals.

NOTE

TV CAL 61 can be used to adjust the back porch reference level.

When the input coupling is AC, pressing the upper button activates the clamp and displays "TVC" in the readout. The clamp locks the back porch feature of the video signal to a constant level and eliminates drift, hum, and tilt, despite changes in signal amplitude and average luminance levels. Pressing the lower button restores AC coupling and turns off the clamp.

1 MΩ GND (2 identical positions)

The input of the vertical amplifier is grounded to provide a zero (ground) reference-voltage display. Input resistance is 1 MΩ to ground. This input selection allows precharging of the input-coupling capacitor to prevent a sudden shift of the trace if AC input coupling is selected later. The input signal is not grounded. If the input coupling of a channel selected as an A-Trigger source is set at GND, the A Sweep free runs. However, when A TRIGGER SOURCE is set to VERT and the Add vertical display is selected, the sweep free runs only if both Channel 1 and the Channel 2 input couplings are set to GND. While power is off, coupling is at 1 MΩ GND.

1 MΩ DC

All frequency components of the input signal are coupled to the vertical. Input resistance is 1 MΩ to ground.

50 Ω DC

All frequency components of the input signal are coupled to the vertical, with the input terminated by 50 Ω to ground. If excessive signal is applied to either the CH 1 or the CH 2 input connector while 50 Ω DC input coupling is selected, input coupling will revert to 1 MΩ GND and a CRT readout will indicate the overloaded condition. Changing the input coupling of the affected channel removes the overload message.

CH 1 OR X and CH 2 Input Connectors

Conduct external signals to the Channel 1 and Channel 2 vertical inputs. A signal applied to the CH 1 OR X connector provides the horizontal deflection for an X-Y display. Each connector includes a coding-ring contact for Tektronix-coded probes.

Refer to Figure 5-4 for the location of items 23 through 27.

23 CH 3 and CH 4 Input Connectors

Conduct external signals to the Channel 3 and Channel 4 vertical inputs. Each connector includes a coding-ring contact for Tektronix-coded probes. Input coupling from these connectors is DC only. Channel 3 and Channel 4 are most useful as digital-signal and trigger-signal input channels, given their limited choice of deflection factors.

24 POSITION Controls

Set vertical position of the Channel 3 and Channel 4 signal displays. The controls operate identically to the Channel 2 POSITION control, but with less range on their associated traces.

25 VOLTS/DIV Switches

Toggle between 0.1 V and 0.5 V per division deflection factors for Channel 3 and Channel 4.

26 CALIBRATOR Connector

Provides a 0.4-V p-p square-wave into a 1 MΩ load, 0.2-V p-p into a 50 Ω dc-coupled load, or 8-mA p-p into a short circuit. The signal is useful for checking sweeps, delay-times, and vertical deflection accuracies, as well as compensating voltage probes and checking the accuracy of current probes. The repetition rate of the square wave changes with A-Sweep SEC/DIV changes. From 100 ms per division to 100 ns per division, the A Sweep of the instrument supplying the CALIBRATOR signal displays five cycles per 10 divisions. At 100 ms per division and slower, the CALIBRATOR frequency is 5 Hz; at 100 ns per division and faster, the frequency is 5 MHz. The signal amplitude at 5 MHz is at least 50% of the signal amplitude obtained when the sweep speed is set to 1 ms per division.

NOTE

The calibrator signal changes phase during trigger holdoff. This does not affect the accuracy of the calibrator signal that is present during a sweep. However, if the CALIBRATOR signal is used with other instruments, the sweep of the instrument must be shut off. If it is not, the signal will appear to jitter and will give false (low) frequency counts. The sweep of the instrument is easily shut off by setting TRIGGER MODE to SGL SEQ.

27 Auxiliary Ground Jack

Provides an auxiliary signal ground. The jack is compatible with standard banana plugs. A standard accessory binding post plugged into the jack provides a probe ground when probing the CALIBRATOR output and provides a versatile ground connection.

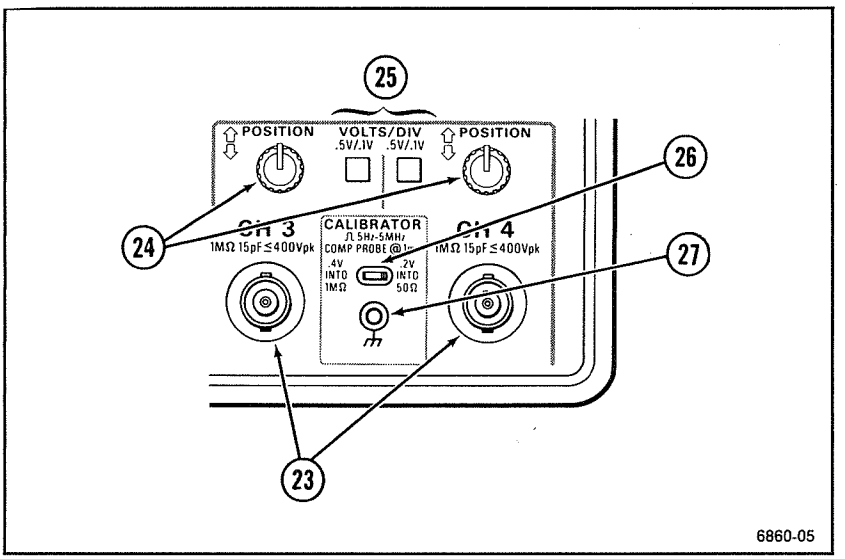


Figure 5-4. CH 3 and CH 4 controls, connectors and CALIBRATOR output.

Horizontal

Refer to Figure 5-5 for the location of items 28 through 37.

28 SEC/DIV Switch and Indicators — Selects A-Sweep speeds, B-Sweep speeds, Delay Time ranges, horizontal display mode, and CH 2 Delay Matching mode. The SEC/DIV switch can be rotated continuously in either direction, but further rotation has no effect when either extreme setting has been reached. The A SWP and B SWP indicators show which sweep or sweeps are displayed.

A SEC/DIV — When the A Sweep is displayed without the B Sweep, SEC/DIV selects 25 calibrated A-Sweep speeds from 500 ms/div to 5 ns/div in a 1-2-5 sequence. Full counterclockwise rotation of the SEC/DIV switch selects the X-Y display feature. In X-Y, the CH 1 OR X input drives the horizontal deflection system.

B SEC/DIV — When the B Sweep is displayed, SEC/DIV selects B-Sweep speeds in 22 calibrated steps from 50 ms/div to 5 ns/div in a 1-2-5 sequence.

Horizontal Display Mode Selection (PULL-INTEN TURN-ALT PUSH-B):

A — When the SEC/DIV knob is in, the A Sweep is displayed, unless the B Sweep has been displayed and the B Sec/Div setting remains faster than the A Sec/Div setting. The exception is that Channel 1 is displayed in the horizontal at the extreme counterclockwise setting of SEC/DIV.

PULL-INTEN Pulling the SEC/DIV knob out while the A Sweep is displayed selects the Intensified horizontal display mode and cancels the Delta Volts function if it is active. The A-Sweep display intensifies during the B Sweep. The B Sweep is not displayed, but it runs either 100 times faster than the

A Sweep or at 5 ns per division, whichever is slower. In Alt horizontal display mode, setting B Sec/Div equal to A Sec/Div also selects the Intensified horizontal display mode. With Δt or $1/\Delta t$, a pair of intensified zones appears. With multiple vertical displays, Alt vertical mode, and a single A-Trigger source (CH 1, CH 2, ADD, CH 3, or CH 4), the pair of intensified zones appear as follows:

1. The reference zone appears on the first selected trace in the display sequence: CH 1, CH 2, ADD, CH 3, CH 4.

2. The delta zone appears on the second selected trace.

3. Both zones appear on additional traces when more than two traces are selected.

Both zones appear on all traces with Chop vertical mode or multiple A-Trigger sources.

Pulling the SEC/DIV switch knob out at the fastest A Sec/Div rate selects the CH 2 delay offset adjustment. The readout displays one of two messages: "CH 2 DLY-TURN Δ"or "CH 2 DLY DISABLED." If the adjustment is enabled, the Δ control or the Δ REF control can adjust the apparent delay between the Channel 1 signal and the Channel 2 signal. The adjustment range is sufficient to compensate for propagation delay variations up to $\pm$500 ps. Adjusting the delay offset between Channel 1 and Channel 2 signals has no effect on the common-mode rejection between Channel 1 and Channel 2.

TURN-ALT

When the SEC/DIV knob is out, clockwise rotation activates the Alternate Horizontal Display mode. The Alt mode presents the intensified A Sweep alternating with the delayed B Sweep. The position of the intensified zone on the A Sweep indicates the B-Sweep duration. A separate B Sweep runs for each intensified zone.

In the Alt horizontal display mode, pushing in the SEC/DIV knob displays only B Sweeps. When the B-Sweep speed is set equal to the A-Sweep speed in Alt or B display mode, the mode changes from A to B or from Inten to Alt.

29 **VAR Control**

Continuously varies the sweep speed between SEC/DIV switch settings, for either the A Sweep or B Sweep. The detent position (full clockwise rotation) produces the basic sweep speed selected by the SEC/DIV switch. The fully counterclockwise position slows the sweep by a nominal factor of three. The CRT readout displays the actual time-per-division scale factor for all settings of the VAR control. When the Intensified A Sweep or the B Sweep is displayed, VAR affects only the B-Sweep scale factor.

30 **TRACE SEP Control**

Positions the B trace downward from the A trace in Alt horizontal display mode. In the B horizontal display mode, with Δt or $1/\Delta t$, TRACE SEP positions the trace associated with the Δ control downward. Fully clockwise rotation eliminates separation between the traces.

31 **POSITION Control**

Horizontally positions the sweep displays.

32 **X10 MAG Button**

Horizontally magnifies the portion of the sweep display positioned at the center vertical graticule line by a factor of 10. When in Alt or B horizontal display mode, only the B Sweep is affected.

Delay and Delta Controls

The ΔV, Δt, and TRACK/INDEP buttons, with the Δ REF OR DLY POS and Δ rotary controls, are used to make voltage, time, frequency, ratio, and phase measurements. These controls also affect the SAVE and RECALL functions and the CH 2 DLY matching function. With the available *TV* and *HDTV* enhancements, Δ also serves as a line number selector and "FLD LINE #" nomenclature is added. With the available *CTT*, Δ REF and Δ serve as menu selectors and as delaying-event-count controls. With the available *WR*, they serve as word definition controls.

ΔV Button

Activates the Delta Volts measurement function and cancels the Δt or 1/Δt measurement function. When the ΔV function is active, two horizontal cursors are superimposed on the display. The CRT readout shows the equivalent voltage between the two cursors. Cursors are positioned by the Δ REF OR DLY POS control and the Δ control. With multiple vertical displays, the deflection factor of the first selected channel in the display sequence determines the cursor scale factor. The cursor readout is displayed as a percent RATIO under either of the following conditions:

1. When the VOLTS/DIV VAR control of the channel determining the scale factor is out of the detent position;

2. When the Add vertical display mode is selected alone and the Channel 1 and Channel 2 VOLTS/DIV settings are not the same.

Pressing the Δ V button when the function is active cancels ΔV. Pulling SEC/DIV out also cancels the Delta Volts function.

34 **Δt Button**

Activates the Delta Time measurement function and cancels the ΔV or 1/Δt measurement functions. When Δt is selected with Inten or Alt horizontal display modes, two delay times are defined. When Δt is selected with either A-Sweep or B-Sweep horizontal display, two vertical cursors are established. One delay time or cursor position is controlled by the Δ REF OR DLY POS control, and the other is controlled by the Δ control. The CRT readout displays either the difference between the two delay times or the equivalent time between the vertical cursors.

If SEC/DIV VAR is not in the detent position, and either the A-Sweep or the B-Sweep horizontal display mode is selected, the CRT readout displays delta-time as a ratio, where five divisions correspond to 100% ratio.

When Δt is active, pressing the Δt button deactivates the function.

1/Δt Function

Momentarily pressing the Δt and ΔV buttons together activates the 1/Delta-Time function and cancels any other Delta measurement function. The waveform display and the Delta controls operate the same as for Δt, but the readout shows the reciprocal of the time in Hz (frequency).

If the SEC/DIV VAR control is not in the detent position (full clockwise rotation), and the A-Sweep or B-Sweep horizontal display mode is selected, the readout displays the time between cursors as degrees of phase, where five divisions are equal to 360 degrees.

When the 1/Delta Time function is active, pressing the Δt and ΔV buttons together deactivates the function.

DLY, ΔV, Δt, and 1/Δt Readouts

Each of these readouts includes a function name, a signed, floating-point numeral, and the appropriate unit symbol. Numerals are displayed with larger sized characters. A numeral immediately following "ΔV" indicates which channel provides the delta voltage scaling, the lowest numbered of the displayed channels. Sweep Delay Time (DLY) is displayed for the Inten, Alt, and B horizontal display modes when none of the delta functions are selected. Except for DLY, these readouts are enabled with Readout Intensity set for Scale Factors On or Scale Factors Off.

A question mark appears after the ΔV function label when the function applies to CH 3 or CH 4, indicating poorer accuracy than is available with CH 1 or CH 2.

A question mark appears in a DLY readout or in a Δt or 1/Δt readout with a pair of sweep delays, when one or both of the sweep delay settings is less than 1% of maximum delay (full scale) setting or when the B-Trigger mode is TRIG AFT DLY (or, with *CTT*, TRIG Δ DLY). With the *CTT*, these question marks disappear when a direct measurement is complete. A question mark also appears when the difference between the pair of delays in 1/Δt is less than 1% of full scale, and the *CTT* does not remove it.

For the lowest 0.5% of the range of DLY settings, the reading is zero. This offset lends accuracy to delay time settings. It is related to the circuit offset that makes the A-Sweep triggering event viewable at minimum delay.

(35) **ΔREF OR DLY POS Control**

Sets the B-Sweep Delay Position. It sets the reference B-Sweep delay when Δt or 1/Δt is active with two delays. When any cursor mode is active, the Δ REF OR DLY POS control positions the reference cursor (dotted line) and has no effect on B-Sweep delay.

When TRACK mode is selected, Δ REF moves both the reference and delta cursors or delays, equally.

When a Save mode is active, Δ REF selects character positions in a setup name or attribute fields in a sequence step definition.

When MEASURE is active, Δ REF selects items or item groups in the Time Interval Configure menu and selects character positions in event-count definition displays. With the *WR*, Δ REF selects character positions in word-definition displays.

(36) **ΔControl**

Positions the delta B-Sweep delay or time cursor (dashed vertical line) when either Δt or 1/Δt is active. When ΔV is active, the Δ control positions the delta cursor (dashed horizontal line).

When a Save mode is active, Δ defines each character in a setup name definition and each attribute field in a sequence step definition.

When MEASURE is active, Δ selects items in the menu and defines characters in event-count definition displays. With the *WR*, Δ defines characters in word-definition displays.

With the available *TV* and HDTV enhancements, the control nomenclature includes "FLD LINE #." The control selects specific line numbers within a video field for triggering the A Sweep when trigger Coupling is set to FLD 1, FLD 2, or alternate FLD 1-FLD 2. Possible line numbers range from 1 to the maximum number of lines per frame in the television signal. Rotating the control clockwise increases the line number; rotating it counterclockwise decreases the line number. Increasing the line number above the number of lines in a field or decreasing the number below the minimum automatically sets the line number to the minimum or the maximum in the other field and selects the opposite FLD 1 or FLD 2 coupling. In ALT, the coupling does not change and line numbers are limited to the numbers shared by both fields. See EXER 61 and EXER 62 in Appendix A to define the desired line number format. For example, the lines in a 525-line, interlaced-scan signal can be numbered (HDTV provides automatic line number format selection - see option to HD EXER 61):

... | 1 2 . . . 262 263 | 1 2 . . . 261 262 | ...

or

... | 1 2 . . . 262 263 | 264 265 . . . 524 525 | ...

With FLD 1 or FLD 2 trigger coupling, the readout displays the selected line number. The line number readout is followed by a Δ symbol if the Δ FLD LINE # control is directed to line number selection. If the Δ symbol is not present, the control is directed to another function and the line number is fixed. The control is redirected to line-number selection or back to a Δ function by pressing a Trigger Coupling button or the respective Δ button(s).

37 TRACK/INDEP Button

Selects either the Tracking or Independent mode for the Δ REF OR DLY POS control. In the Tracking mode, rotating the Δ REF OR DLY POS control changes both delays or both cursors equally until the limit of either is reached.

In the Indep mode, Δ REF OR DLY POS affects only the reference delay or cursor. In either Tracking or Independent mode, the Δ control moves only the Δ cursor.

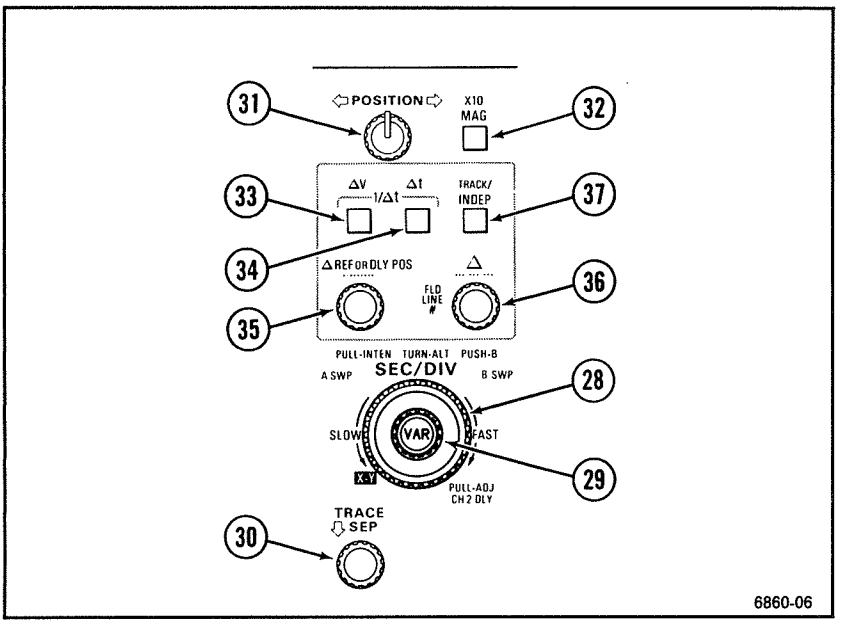


Figure 5-5. Horizontal and delta measurement controls.

Trigger

Refer to Figure 5-6 for the location of items 38 through 47.

(38) **MODE Buttons and Indicators**

Select the mode of either the A Trigger or the B Trigger. Pressing a button steps the MODE selection once; holding the button causes the MODE selection to step repeatedly. Indicators show the selected mode of either the A Trigger or the B Trigger according to the selected horizontal display mode and as directed by the A/B TRIG button.

A-Trigger Modes:

AUTO LVL

Automatically establishes the trigger level on a triggering signal and free runs the sweep in the absence of a triggering signal.

In Auto Lvl mode, LEVEL covers the range between the positive and negative peaks of repetitive triggering signals. If the triggering signal amplitude changes, the trigger level does not change unless a trigger is no longer produced at the established level. The signal peaks are measured and the trigger level is redefined when triggering ceases, when the LEVEL control is turned to either extreme, or when the upper MODE button is pressed. If the LEVEL control is set near either end position, the trigger level is set near the corresponding signal peak. If LEVEL is in the midrange between either end, the trigger level set by AUTO LVL is near the midpoint between the trigger signal peaks. When INIT@50% is pressed, the trigger level is set near the midpoint of the signal, regardless of the setting of LEVEL. The established trigger level remains in effect when switching to Auto trigger mode.

To obtain triggered sweeps, the triggering signal repetition rate must be greater than a nominal limit, depending on the selected sweep speed.

With Auto Lvl mode and Vert trigger source, the lowest numbered channel displayed, or Add if it is displayed, provides the trigger signal. When the trigger mode is changed from Auto Lvl to Auto while more than one channel is displayed, the single channel trigger source is retained and the VERT indicator is turned off unless Add is being displayed. When Add is displayed, Vert source is retained when trigger mode changes to Auto.

AUTO Sweep free runs in the absence of triggered signal. The trigger level changes only the when the LEVEL control is adjusted to a new position or when INIT@50% is pressed.

NORM Sweep is triggered and runs when an adequate triggering signal is applied. In the absence of an adequate triggering signal, the A Sweep does not run, except when the input coupling of the trigger-source channel is set to GND. If the selected source is Vert, and the Add vertical display is selected, the A Sweep free runs if Channel 1 and Channel 2 input coupling are both set to GND.

SGL SEQ When armed by pushing the lower MODE button, the sweep runs once for each of the traces defined by the following controls: Vertical MODE, A and B SEC/DIV, and Δt or $1/\Delta t$. Each sweep requires a distinct A-Sweep triggering event. The READY indicator remains illuminated until the final trace in the sequence is completed. At the end of the display sequence, scale-illumination flashes and the readout display is written once to present the scale factors and other readout data.

B-Trigger Modes:

RUN AFT DLY The B Sweep runs immediately after the delay time set by A SEC/DIV, Δ REF OR DLY POS, and, if Δt or 1/Δt is active, Δ.

TRIG AFT DLY The B Sweep runs when triggered after the set delay, determined by the same controls as for RUN AFT DLY, provided the A Sweep has not terminated.

TRIG Δ DLY Only with the available *CTT*, and with Δt or 1/Δt active, the B-Trigger Slope and Level for the Δ delay can be set separately from those for the REFerence delay. If both TRIG AFT DLY and TRIG Δ DLY indicators are on, the B-Trigger Slope and Level are common for the two delays. TRIG Δ DLY should normally be used with VERT trigger source for B Trigger. Pressing the lower trigger Mode button alternates between TRIG AFT DLY and TRIG Δ DLY and the controls are alternately directed to the two triggers.

(39) **SOURCE Buttons and Indicators** — Select the trigger-signal source for either A Sweep or B Sweep.

VERT — The sweep triggers on the displayed channel when only one channel is selected. If multiple vertical displays are selected, both the trigger Mode and the Chop/Alt selection affect the triggering source. With Alt vertical mode and with A-Trigger modes other than Auto Lvl, each displayed channel in turn provides the triggering signal and the respective LED indicator for each displayed channel is illuminated. With Auto Lvl trigger mode or with Chop vertical mode, the lowest-numbered channel, or ADD if it is displayed, is the triggering-signal source. The Source indicators show the source of the triggering signal in any case. When ADD is selected, both the CH 1 and the CH 2 indicators are illuminated.

CH1, CH 2, CH 3, or CH 4 — A triggering signal is obtained from the corresponding vertical channel.

LINE (A-Trigger Only) — A triggering signal is obtained from a sample of the ac power-source waveform. This trigger source is useful when vertical input signals are related (multiple or submultiple) to the frequency of the ac power-source voltage.

(40) **COUPLING Buttons and Indicators** — Select the method of coupling the triggering signal to the trigger generator.

DC — All frequency components of the signal are coupled to the trigger. This coupling is preferred for most signals.

NOISE REJ — All frequency components of the input signal are coupled to the trigger. This coupling improves trigger stability with signals accompanied by low-level noise

HF REJ — Attenuates high-frequency triggering-signal components above 50 kHz. This coupling eliminates radio-frequency interference and high-frequency noise components from the signal applied to the trigger. It allows triggering on the low-frequency components of a complex waveform.

LF REJ — Signals are capacitively coupled, blocking the dc component of the triggering signal and attenuating the low-frequency signal components below 50 kHz. This coupling allows triggering on the high-frequency components of a complex waveform.

AC — Signals are capacitively coupled. Frequency components below 60 Hz are attenuated, and the dc component of the input signal is blocked. This coupling works for signals that are superimposed on slowly changing dc voltages. This method will work for most signals when trigger-level readout is not desired.

For instruments with serial numbers B049999 and below with firmware versions 11 and above or for instruments with serial numbers B050000 and above with firmware versions 2 and above , the trigger level readout is displayed in AC trigger coupling modes (HF REJ, LF REJ, AC, LINES, FLD1, FLD2, or ALT) or AC input coupling. The trigger level readout is displayed with a "V?" mark, to indicate the setting is only of value to allow the operator to obtain the same setting again.

Only with the available *TV* and HDTV enhancements, the trigger Coupling buttons and indicators select four additional trigger couplings. The readout shows which of these couplings and which line number are selected, in the upper right corner of the CRT. If that corner is occupied, the *TV* information is displayed in the upper left corner.

LINES — The A Sweep triggers at TV horizontal line-sync pulses. AUTO trigger mode is automatically selected.

HDTV allows an Active Video trigger mode. This mode of operaton disables triggering during the vertical interval and only allows triggering to occur on active video lines. NORM trigger mode is automatically selected

FLD 1 — The A Sweep triggers on a selected line in the first field of a TV signal. NORM trigger mode is automatically selected.

FLD 2 — The A Sweep triggers on a selected line in the second field of a TV signal. NORM trigger mode is automatically selected.

ALT

The A Sweep alternately triggers on the same selected line in both TV fields. Both the FLD 1 and the FLD 2 indicators light. NORM trigger mode is automatically selected.

With CHOP vertical mode, all channels are displayed with both the FLD 1 and the FLD 2 triggers. With Alt vertical mode and more than one channel displayed, field 1 of the video signal triggers the sweep with the first displayed channel and field 2 triggers the sweep with the next displayed channel. With more than two channels, each additional channel is displayed with triggers from both fields.

(41) **A/B TRIG Button**

The MODE, SOURCE, COUPLING, SLOPE, LEVEL, and INIT@50% controls are normally directed to the A Trigger. They are directed to the B Trigger with Inten, Alt, or B-Sweep horizontal displays, if B mode is TRIG AFT DLY (or, with the *CTT*, TRIG Δ DLY). The trigger controls are directed to the opposite trigger while the A/B TRIG button is pressed. With Inten, Alt, or B-Sweep horizontal displays, and with B-Trigger mode set to RUN AFT DLY or with A-Trigger mode set to Sgl Seq, the trigger controls are alternately directed to the A Trigger or to the B Trigger each time the button is pushed.

(42) **LEVEL Control**

Sets the amplitude point on the triggering signal at which A-Sweep or B-Sweep triggering occurs. When the A-Trigger mode is set to Auto Lvl, the effect of the LEVEL control is spread over the peak to peak amplitude of the triggering signal. When the control is rotated to either extreme, the peak values are measured, and the control range is redefined to correspond to the peak values. If LEVEL is fully clockwise, the initial level is near the positive peak. If LEVEL is fully counterclockwise, the initial level is near the negative peak. With the available *TV* and HDTV enhancements, the LEVEL control adjusts the trigger point relative to the 50% point of horizontal sync.

(43) **SLOPE Button and Indicators**

Determines whether the A Trigger or B Trigger respond to the positive-going or the negative-going slope of a signal. With the available *TV* and *HDTV* enhancements, Slope selects positive or negative sync polarity. With the available *CTT*, in Logic Trigger modes, Slope determines whether the high (+) or low (-) state of the signal is the true input to the logic function.

44 **A SWP TRIG'D Indicator**

Illuminates when the A Sweep is triggered. It extinguishes a short time after completion of a sweep unless a triggering signal is received.

45 **READY Indicator**

Illuminates when Sgl Seq mode is selected and the A Sweep is armed and waiting for a triggering event to occur. It extinguishes following the completion of all the traces selected for the Sgl Seq display.

46 **HOLDOFF Control**

Varies the time from the end of an A Sweep to enabling the next sweep to be initiated by the triggering signal. This control can be set to stabilize some aperiodic signals. In the B ENDS A position (fully clockwise) trigger holdoff time is minimum, and A Sweep terminates immediately at the end of the B Sweep. This enables the fastest possible sweep-repetition rate at slow A-Sweep speeds.

47 **INIT@50% Button**

Initializes the trigger level at the midpoint between peaks, for either the A Trigger or B Trigger, in any mode.

If Vert trigger source is selected and more than one channel is displayed, INIT@50% automatically sets the trigger source to the lowest numbered of the displayed channels. However, with the available *CTT*, with a "slaved delta-time" display and separate B-Trigger settings for reference and delta delays, INIT@50% sets the level for each of the first two channels separately and does not change the trigger source. If Sgl Seq mode is selected, the A-Trigger mode changes to Norm. With the available *TV* and HDTV enhancements, the INIT@50% control resets the trigger level to approximately 50% of sync.

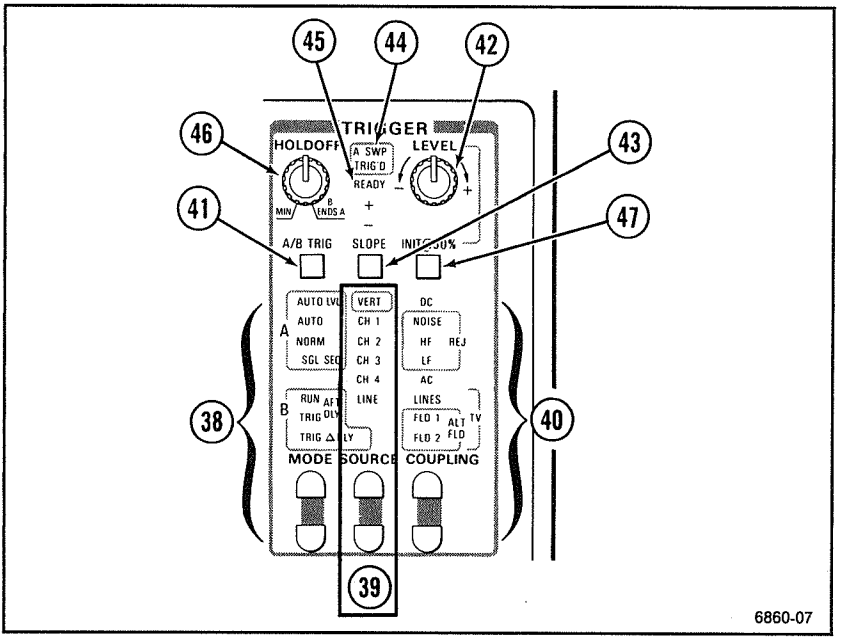


Figure 5–6. Trigger controls and indicators.

Rear Panel

Refer to Figure 5–7 for the location of items 48 through 58.

49 **Line Voltage Selector Switch** — Selects either 115 V or 230 V nominal ac-power-source voltage.

50 **EXT Z-AXIS IN Connector** — Provides an input for external signals to modulate the display intensity.

51 **Fuse Holder** — Contains the ac power-source fuse.

52	**Detachable Power Cord Receptacle**	Connects the ac power source to the instrument.
53	**CH 2 SIGNAL OUT Connector**	Supplies a normalized signal that represents the Channel 2 input signal.
54	**Mod Slots**	Contain identification of any installed instrument modifications.
55	**STEP/AUTO EXT Switch Connector**	A connector on the rear panel accepts a standard, 2.5-mm, micro-phono plug, compatible with some commonly available remote-control switches for audio recorders. A contact closure or TTL-low at this input produces the same effect as operating the STEP/AUTO button.
56	**Word Recognizer Probe Connector or Probe Power Connector**	Connects the 17-Bit Word Recognizer Probe to the instrument, only with the available *WR* (Option 09), or supplies conditioned dc voltages to active probes, only with Option 11.
57	**WORD RECOG OUT Connector or Probe Power Connector**	Provides an LSTTL-compatible, positive-going pulse when the Word Recognizer detects the selected word, only with the available *WR* (Option 09), or supplies conditioned dc voltages to active probes, only with Option 11.
58	**GPIB Connector**	Provides the IEEE Std 488-1978 compatible electrical and mechanical connection to the GPIB.

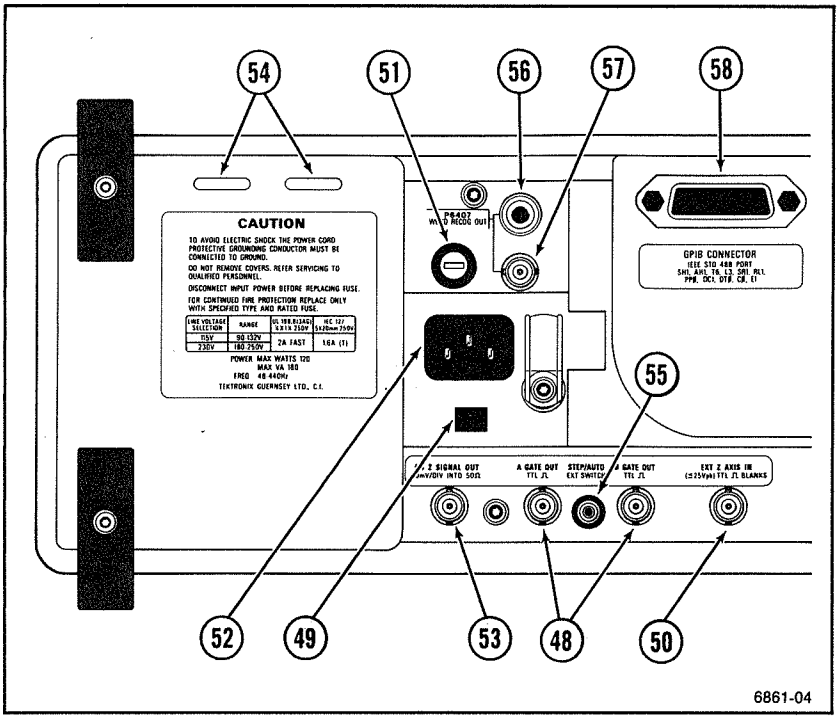
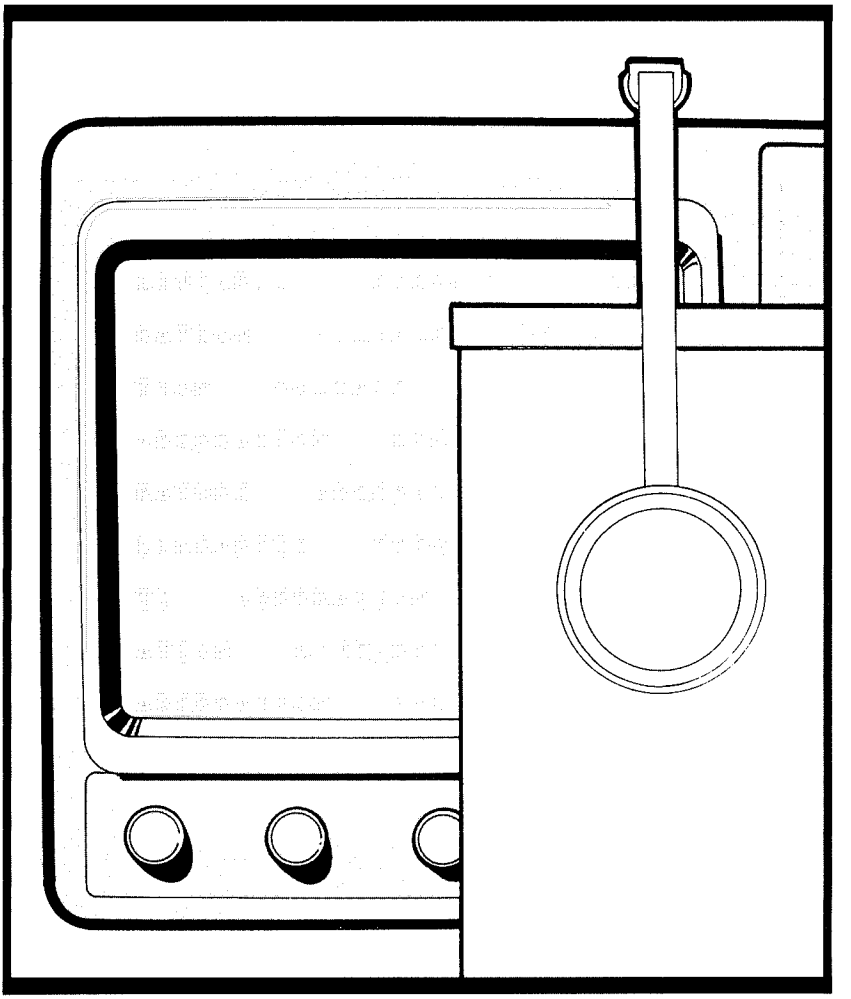


Figure 5–7. Rear panel controls and connectors.

SECTION 6

Performance Characteristics



Performance Conditions

The following electrical characteristics (Tables 6-1 through 6-5) are valid for the instrument when it has been adjusted at an ambient temperature between +20°C and +30°C, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between −15°C and +55°C (unless otherwise noted). As a general rule, this instrument should be adjusted every 2,000 hours of operation or once a year if used infrequently.

Items listed in the "Performance Requirements" column define the measurement capabilities of the instruments. Supplementary measurement conditions may also be listed in the "Performance Requirement" column.

Mechanical characteristics are listed in Table 6-6.

Environmental characteristics are given in Table 6-7. The oscilloscope meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment, with the humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4.

Table 6-1
2467B Electrical Characteristics

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM—CHANNEL 1 AND CHANNEL 2	
Deflection Factor	
Range	2 mV/division to 5 V/division in a 1-2-5 sequence of 11 steps.
Accuracy	1 MΩ input, noninverted.
+15°C to +35°C	
On-Graticule Accuracy	Within ±2% at any VOLTS/DIV setting for a four or five-division signal centered on the screen.
ΔV Accuracy (using cursors over entire graticule area)	±(1.25% of reading +0.03 div + signal aberrations).
−15°C to +15°C and +35°C to +55°C	Add ±2% of reading.
50 Ω Coupling	Add ±1% of reading.
CH 2 Inverted	Add ±1% of reading.
ΔV Range	±8 × VOLTS/DIV setting.
V/DIV VARiable, noninverted	Continuously variable between VOLTS/DIV settings. Extends deflection factor to >12.5 V/division.

Table 6-1 (cont)

Characteristics	Performance Requirements
−3 dB Bandwidth	Using standard accessory probe or internal 50-Ω termination.
2465B	
+15°C to +35°C	⩾5 mV/DIV:Dc to 400 MHz.[a] 2 mV/DIV:Dc to 350 MHz.[a]
−15°C to +15°C and +35°C to +55°C	⩾5 mV/DIV: Dc to 350 MHz. 2 mV/DIV: Dc to 300 MHz.
2455B	
+15°C to +35°C	Dc to 250 MHz.[a]
−15°C to +15°C and +35°C to +55°C	Dc to 200 MHz.
2445B	Dc to 150 MHz.
−4.7 dB Bandwidth	Using 50-Ω external termination on 1-MΩ input.
2465B	
−15°C to +35°C	⩾5 mV/DIV: Dc to 400 MHz.[a] 2 mV/DIV: Dc to 350 MHz.[a]
+35°C to +55°C	Dc to 300 MHz.
2455B	
−15°C to +35°C	Dc to 250 MHz.[a]
+35°C to +55°C	Dc to 200 MHz.
2445B	Dc to 150 MHz.
AC Coupled, Lower −3 dB Frequency	10 Hz or less.
With Standard Accessory Probe	1 Hz or less.
Step Response Rise Time	Calculated from $T_r = 0.35/BW$.
2465B	⩾5 mV/DIV: ⩽.875 ns. 2 mV/DIV: ⩽1 ns.
2455B	⩽1.4 ns.
2445B	⩽2.33 ns.

[a]If instrument is subjected to "greater than" 85% relative humidity, bandwidth is reduced by 50 MHz. After instrument is subjected to "greater than" 85% relative humidity, it requires more than 50 hours of operation at "less than" 60% relative humidity before full bandwidth is restored.

Table 6-1 (cont)

Characteristics	Performance Requirement
Displayed Channel 2 Signal Delay with Respect to Channel 1 Signal	Adjustable through a range of at least −500 ps to +500 ps.
Input R and C (1 MΩ)	
Resistance	1 MΩ ±0.5%.
Capacitance	15 pF ±2 pF.
Maximum Input Voltage DC, AC, or GND Coupled ⚠	400 V (dc + peak ac). 800 V p-p ac at 10 kHz or less.
Input R (50 Ω)	
Resistance	50Ω ±1%.
VSWR	
Dc to 300 MHz	≤ 1.45:1.
300 to 400 MHz	≤ 1.6:1.
Maximum Input Voltage ⚠	5 V rms, averaged for 1 second; ±50 V peak.
Cascaded Operation	Channel 2 Vertical Signal Output into Channel 1 input; DC coupled using 50-Ω RG-58C/U coaxial, 1 MΩ DC or 1 MΩ AC Channel 1 input coupling; Channel 1 and Channel 2 VOLTS/DIV set at 2 mV; 20 MHz bandwidth limit on.
Deflection Factor	200 μV per division ±10%.
CMRR (ADD Mode with Channel 2 inverted)	At least 20:1 at 50 MHz for common-mode signals of eight divisions or less, with VAR VOLTS/DIV control adjusted for best CMRR at 50 kHz, at any VOLTS/DIV setting.
Deflection Factors	
Values	100 mV and 500 mV per division.
Accuracy	Within ± 10%.

Table 6-1 (cont)

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM—CHANNEL 3 AND CHANNEL 4	
Frequency Response	Bandwidth is measured with a leveled, low distortion, 50-Ω source, sine-wave generator, terminated in 50 Ω. The reference signal amplitude is set at the lesser of 6 divisions or the maximum leveled amplitude. Bandwidth with external termination is checked with a 4 division reference signal amplitude. Bandwidth with probe is checked using a BNC-to-probe-tip (013-0227-00) adapter. Bandwidth with external termination is checked using a BNC 50-Ω feed through terminator (011-0049-01).
−3 dB Bandwidth	Using standard accessory probe.
+15°C to +35°C	Dc to 400 MHz.[a]
−15°C to +15°C and +35°C to +55°C	Dc to 350 MHz.
−4.7 dB Bandwidth	Using 50-Ω external termination.
+15°C to +35°C	Dc to 400 MHz.
−15°C to +15°C and +35°C to +55°C	Dc to 300 MHz.
Step Response Rise Time	≤1 ns (calculated from $T_r = 0.35/BW$).
Channel Isolation	≥50:1 attenuation of deselected channel at 100 MHz with an 8-division input signal.
Signal Delay Between Channel 1 and Either Channel 3 or Channel 4	Within ±1.0 ns, measured at the 50% points.
Input Resistance	1 MΩ ±1%.
Input Capacitance	15 pF ±3 pF.
Maximum Input Voltage ⚠	400 V (dc + peak ac). 800 V p-p ac at 10 kHz or less.

[a]If instrument is subjected to "greater than" 85% relative humidity, bandwidth is reduced by 50 MHz. After instrument is subjected to "greater than" 85% relative humidity, it requires more than 50 hours of operation at "less than" 60% relative humidity before full bandwidth is restored.

Table 6-1 (cont)

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM-ALL CHANNELS	
Low-frequency Linearity	0.1 division or less compression or expansion of a two-division, center-screen signal when positioned anywhere wthin the graticule area.
Bandwidth Limiter	Reduces upper 3 dB bandpass to a limit of 13 MHz to 24 MHz.
Option 5H	50 MHz BW limit. 3 dB bandpass to a limit of 43 MHz to 54 MHz.
Vertical Signal Delay	At least 30 ns of the sweep is displayed before the triggering event is displayed at any SEC/DIV $\geq$10 ns/div. At 5 ns/div, at least 10 ns of the sweep is displayed before the triggering event.
Chopped Mode Switching Rate	With displayed SEC/DIV in the 20 µs to 2 µs/div range, the switching rate is 2.5 MHz $\pm$0.2%. Otherwise, the switching rate is 1 MHz $\pm$0.2%. The display cycle rate equals the chop switching rate divided by the number of channels displayed. The chop switching rate is modulated slightly to minimize waveform breaks with repetitive signals.
TRIGGERING	
Minimum P-P Signal Amplitude for Stable Triggering from Channel 1 or Channel 2 Source	
DC Coupled	0.35 division from dc to 50 MHz; increasing to 1.0 division at 300 MHz and 1.5 divisions at 500 MHz.
NOISE REJ Coupled	$\leq$1.2 divisions from dc to 50 MHz; increasing to 3 divisions at 300 MHz and 4.5 divisions at 500 MHz.
AC Coupled	0.35 division from 60 Hz to 50 MHz; increasing to 1.0 division at 300 MHz and 1.5 divisions at 500 MHz. Attenuates signals below 60 Hz.
HF REJ Coupled	0.5 division from dc to 30 kHz.
LF REJ Coupled	0.5 division from 80 kHz to 50 MHz; increasing to 1.0 division at 300 MHz and 1.5 divisions at 500 MHz.

Table 6-1 (cont)

Characteristics	Performance Requirements
Minimum P-P Signal Amplitude for Stable Triggering from ADD Source	Add 0.5 division to CH 1 or CH 2 requirement at 300 MHz and 500 MHz.
Minimum P-P Signal Amplitude for Stable Triggering from CH 3 or CH 4 Source	0.5 × CH 1 or CH 2 requirement.
Minimum P-P Signal Amplitude for Stable Triggering from Composite, Multiple Channel Source, ALT Vertical Mode	Checked at 50 mV per division. Add 1 division to the single-channel source specification.
Maximum P-P Signal Rejected by NOISE REJ COUPLING Signals Within the Vertical Bandwidth	
CH 1 or CH 2 SOURCE	⩾0.4 division for VOLTS/DIV settings of 10 mV/div and higher. Maximum noise amplitude rejected is reduced at 2 mV/div and 5 mV/div.
CH 3 or CH 4 SOURCE	⩾0.2 division.
Jitter	⩽100 ps with 5 divisions of 300 MHz at 500 ps/division.
LEVEL Control Range	
CH 1 or CH 2 SOURCE	±18 × VOLTS/DIV setting.
CH 3 or CH 4 SOURCE	±9 × VOLTS/DIV setting.
AUTO LVL Mode Maximum Triggering Signal Period	
A SEC/DIV Setting	
<10 ms	At least 20 ms.
10 ms to 50 ms	At least four times the A-SEC/DIV setting.
>50 ms	At least 200 ms.
AUTO LVL Mode Trigger Acquisition Time	Eight to 100 times the AUTO LVL Mode maximum triggering signal period, depending on the triggering signal period and waveform.

Table 6-1 (cont)

Characteristics	Performance Requirements
AUTO Mode Maximum Triggering Signal Period	
A-SEC/DIV Setting	
<10 ms	At least 80 ms.
10 ms to 50 ms	At least 16 times the A-SEC/DIV setting.
>50 ms	At least 800 ms.
LEVEL Readout Accuracy	For triggering signals with transition times greater than 20 ns.
CH 1 or CH 2 SOURCE	
+15°C to +35°C	Within ±[3% of reading + 3% of p-p signal + 0.2 division + 0.5 mV + (0.5 mV × probe attenuation factor)] with Vertical Input at 1 MΩ DC, CH 2 Source Not Inverted, and Trigger DC Coupled.
−15°C to +35°C and +35°C to +55°C	Add 1.5 mV × probe attenuation to +15°C to +35°C specification.
50 Ω Input	Add ±1% to 1 MΩ input specification.
CH 2 Inverted	Add ±1% of reading to non-inverted specification.
NOISE REJ Coupled	Add ±0.6 division to DC Coupled specifications.
CH 3 or CH 4 SOURCE	Within ±[3% of reading + 4% of p-p signal + 0.1 division + (0.5 mV × probe attenuation factor)] and Trigger DC Coupled.
NOISE REJ Coupled	Add ±0.3 division to the DC Coupled specification.
Trigger Holdoff	
Minimum	The greater of the A-SEC/DIV reading value or 1 μs, within +33% +500 ns to −10%.
Variable	Increases trigger holdoff time to 10 to 25 times the minimum holdoff.
SLOPE Selection	Conforms to trigger-source waveform or ac power-source waveform.

Table 6-1 (cont)

Characteristics	Performance Requirements
HORIZONTAL DEFLECTION SYSTEM	
A Sweep Time Base Range	500 ms/div to 5 ns/div in a 1-2-5 sequence of 25 steps. X10 MAG extends maximum sweep rate to 500 ps/div.
B Sweep Time Base Range	50 ms/div to 5 ns/div in a 1-2-5 sequence of 22 steps. X10 MAG extends maximum sweep rate to 500 ps/div.
Timing Accuracy	+15°C to +35°C, A Sweep, with SEC/DIV at 100 ms/div or faster.
Sweep Accuracy Unmagnified	±(0.7% of time interval + 0.6% of full scale).
Δt Accuracy With Cursors, Unmagnified	±(0.5% of time interval + 0.3% of full scale).
Δt Accuracy with Sweep Delay	±(0.3% of time interval + 0.1% of full scale + 200 ps.)
Delay Accuracy, A Sweep Trigger to Start of B Sweep	±(0.3% of delay setting + 0.6% of full scale) +0 to −25 ns.
B-Sweep Accuracy and Δt Accuracy with Cursors on B Sweep	Add ±0.3% of time interval to A-Sweep specifications.
X10 MAG Accuracy	Add ±0.5% of time interval to unmagnified Sweep and Δt Cursors specifications. Exclude the first 0.5 division after the sweep starts (the first 0.5% of the full 100 division sweep).
500 ms or 200 ms/div Timing Accuracy (A Sweep only)	Add ±0.5% of interval to specifications for A SEC/DIV at 100 ms or faster.
SEC/DIV VAR Timing Accuracy	Add 2% of time interval to sweep accuracy specifications when VAR is out of detent.
Timing Accuracy (−15°C to +15°C and +35°C to +55°C)	Add ±0.2% of time interval to all Δt and delay specifications. Add ±0.5% of interval to sweep accuracy specification.
Δt Readout Resolution	Greater of either 10 ps or 0.025% of full scale.

Table 6-1 (cont)

Characteristics	Performance Requirements
Δt Range	±10 times A-SEC/DIV setting with Cursors, ±9.95 times A-SEC/DIV setting with Sweep Delay.
Sweep Delay Range	0 to 9.95 times the A SEC/DIV setting, from 500 ms to 10 ns. A-Sweep triggering event is observable on B Sweep with zero delay setting for A SEC/DIV settings 10 μs or faster.
Delay Jitter	Within 0.01% (one part or less in 10,000) of the maximum available delay, plus 100 ps.
X10 MAG Registration	Within 0.5 division from graticule center at 1 ms SEC/DIV setting (X10 MAG on to X10 MAG off).
Horizontal POSITION Range	Start of 1 ms per division sweep can be positioned from right of graticule center to at least 10 divisions left of graticule center. Some portion of 1 ms per division sweep is always visible with X10 MAG off.
X-Y Operation	
X-Axis Deflection Factor Range, Variable, and Input Characteristics	Same as Channel 1.
Deflection Factor Accuracy	Same as Channel 1.
X-Axis Bandwidth	Dc to 3 MHz.
Phase Difference Between X and Y with BW Limit Off	≤1° from dc to 1 MHz; ≤3° from 1 MHz to 2 MHz.
X-Axis Low-frequency Linearity	0.1 division or less compression or expansion of a two-division, center-screen signal when positioned within the graticule area.

Table 6-1 (cont)

Characteristics	Performance Requirements
	DISPLAY
Cursor Position Range	
Delta Volts (ΔV)	At least the center 7.6 vertical divisions.
Delta Time (Δt)	At least the center 9.6 horizontal divisions.
Graticule	
Size	68 mm X 85 mm.
Markings	8 major divisions vertically and 10 major divisions horizontally, with auxiliary markings.
Trace Rotation Range	Adequate to align trace with the center horizontal graticule line.
Standard Phosphor	P31.
Visual Writing Speed with 20 Foot-Candles Illumination, Normal to the Crt Faceplate	Using the standard-accessory, color filter, no more than 5 bright spots will be visible at maximum intensity and no bright-spot halo will be visible within the center 7 X 9 divisions. Additional bright spots may be visible after displaying a high-intensity trace. These added spots will extinguish when intensity is set to minimum.
	⩾4 divisions/ns.
Photographic Writing Speed with C30B Camera at F1.9 with ASA 3000 Film, not Prefogged	⩾10 divisions/ns.
Display Intensity Limitation	Control settings and trigger rate are monitored to limit the display intensity after a time of no control activity.

Table 6-1 (cont)

Characteristics	Performance Requirement
Z-AXIS INPUT	
Sensitivity	
Dc to 2 MHz	Positive voltage decreases intensity; +2 V blanks a maximum intensity trace.
2 MHz to 20 MHz	+2 V modulates a normal intensity trace.
Input Impedance	10 kΩ ±10%.
Maximum Input Voltage ⚠	± 25 V peak; 25 V p-p ac at 10 kHz or less.
SIGNAL OUTPUTS	
CALIBRATOR	With A SEC/DIV set to 1 ms.
Output Voltage and Current	0.4 V ±1% into a 1-MΩ load, 0.2 V ±1.5% into a 50-Ω load, or 8 mA ± 1.5% into a short circuit.
Repetition Period	Two times the A SEC/DIV setting for SEC/DIV from 100 ns to 100 ms.
Accuracy	± 0.1%, during sweep time.
CH 2 SIGNAL OUT	
Output Voltage	20 mV/division ± 10% into 1 MΩ, 10 mV/division ±10% into 50 Ω.
Offset	±20 mV into 1 MΩ, when dc balance has been performed within ± 5°C of the operating temperature.
A GATE OUT and B GATE OUT	
Output Voltage	2.4 V to 5 V positive-going pulse, starting at 0 V to 400 mV.
Output Drive	Will supply 400 μA during HI state; will sink 2 mA during LO state.

Table 6-1 (cont)

Characteristics	Performance Requirements
AC POWER SOURCE	
Source Voltage Nominal Ranges 115 V	90 V to 132 V.
230 V	180 V to 250 V.
Source Frequency	48 Hz to 440 Hz.
Fuse Rating	2 A, 250 V, AGC/3AG, Fast blow; or 1.6 A, 250 V, 5 × 20 mm Quick-acting.
Maximum Power Consumption (fully optioned instrument)	120 watts (180 VA).
Primary Circuit Dielectric Voltage Withstand Test	1500 V rms, 60 Hz for 10 seconds without breakdown.
Primary Grounding	Type test to 0.1 Ω maximum. Routine test to check grounding continuity between chassis ground and protective earth ground.

Table 6-1 (cont)

Characteristics	Performance Requirements
PARAMETRIC MEASUREMENTS	
Period	
Accuracy	
+15°C to +35°C	0.9% + 0.5 ns + Jitter Error.
-15 to +15°C and +35°C to +55°C	Add 0.3%.
Minimum Period	⩽ 2 ns.
Maximum Period	⩾100 ms (MINFREQ=10Hz).
Minimum Signal Amplitude	⩽ (60 mV * probe attenuation factor) p-p. If DC coupling is used, the DC offset voltage must meet the following criteria: at a VOLTS/DIV setting which gives a p-p signal ⩾ 4 divisions, the peak signal + offset must be ⩽12 divisions.
Frequency	Calculated as 1/period.
Volts	
+Peak, −Peak, Peak-to-Peak, and Average	
Accuracy	
+15°C to +35°C	5% of reading + 5 mV + (0.5 mV * probe attenuation) + signal aberrations + 1 Least Significant Digit (LSD).
−15°C to +15°C and +35°C to +55°C	Add (1.5 mV * probe attenuation).
Minimum Width at Peak Amplitude	⩽ 10 ns.
Maximum Sine Wave Frequency	
+15°C to +35°C	⩾ 1 MHz.
−15°C to +15°C and +35°C to +55°C	Add 2%. Volts measurements depend on peak signal measurements. Noise on the input signal, even if at a low repetition rate that makes it difficult to see, will be detected and will affect the measurements.

Table 6-1 (cont)

Characteristics	Performance Requirements	
PARAMETRIC MEASUREMENTS (cont)		
Pulse Width (High or Low)		
Accuracy		
+15°C to +35°C	0.9% of reading + 1.0 ns + jitter error + 2 × offset error.	
−15°C to +15°C and 35°C to +55°C	Add 0.3%.	
Minimum Pulse Width	⩽ 5 ns.	
Minimum Repetition Rate	⩽ 10 Hz (with MINFREQ = 10 Hz).	
Duty Cycle	Calculated from Pulse Width and Period.	
Rise Time, Fall Time, and Time Interval		
Accuracy		
+15°C to +35°C	**Rise/Fall Time**	**Time Interval**
	5% of reading + 3.0 ns + jitter error + offset error.	0.5% of reading + 5% of start event transition time + 5% of stop event transition time + 3.0 ns + jitter error + offset error.
	Add 0.5 ns if measurement is made between CH1 and CH2. Rise and Fall time measurement is made at 20% and 80% points of transition and linearly extrapolated to the 10% and 90% points. Accuracy is relative to time interval as measured on screen using cursors. Measurement is made using peak-to-peak transition for measurement points in percent.	
−15 to +15°C and 35°C to +55°C	Add 2%.	
Minimum Time	⩽ 5 ns.	
Minimum Repetition Rate	⩽ 10 Hz (with MINFREQ = 10 Hz).	

Table 6-1 (cont)

<table>
<tr><th>Characteristics</th><th>Performance Requirements</th></tr>
<tr><td colspan="2">PARAMETRIC MEASUREMENTS (cont)</td></tr>
<tr><td>Jitter Error</td><td>Noise on the input signal causes jitter which introduces errors in the measurements. The amount of jitter depends on the noise amplitude and the slew rate of the input signals.

The amount of jitter can be calculated as:

$\text{jitter} = \frac{\text{input noise amplitude (peak)}}{\text{input slew rate in div/sec}}$

Input slew rate should be measured at 2 Volts/div settings more sensitive than the setting at the end of the measurements or at 5 mV/div, whichever is less sensitive.

The slew rate must be measured at the same points at which the measurement will be taken. The points for the various measurements are:

Measurement Points
<table><tr><th>Measurement</th><th>First Measurement point</th><th>Second Measurement point</th></tr><tr><td>Frequency</td><td>50% amplitude</td><td>50% amplitude</td></tr><tr><td>Width</td><td>50% amplitude</td><td>50% amplitude</td></tr><tr><td>Rise, Fall Time</td><td>10% amplitude</td><td>90% amplitude</td></tr><tr><td>Time interval</td><td>Specified by Time Interval Configuration</td><td>Specified by Time Interval Configuration</td></tr></table>The algorithms used for the measurements result in the following equation for the total jitter error that must be applied to the accuracy specifications.

Jitter Error = 2 * first point jitter
+ 2 * second point jitter.</td></tr>
</table>

Table 6-1 (cont)

Characteristics	Performance Requirements
PARAMETRIC MEASUREMENTS (cont)	
Offset Error	Offset error is introduced when the trigger level is not set exactly at the expected points. This misplacement of the trigger level applied to any non-infinite slew rate produces a timing error. The magnitude of the error is given by: $$\text{Offset Error} = \frac{\text{offset}}{\text{input slew rate}}$$ Frequency measurements do not suffer from offset errors since measurements are made with the same trigger level and slope, so no offset is introduced. All other timing measurements suffer from offset errors. The slew rates used to calculate offset errors must be measured at the first and second measurement points given in the Measurement Points table. Offset error is calculated as: $$\text{Offset Error} = \frac{0.2\ \text{div}}{\text{First Point slew rate}} + \frac{0.2\ \text{div}}{\text{Second Point slew rate}}$$ If a time interval measurement is made using Volts mode, the offset at each measurement point is: 0.2 div + 5% of measurement point voltage converted to divisions.

Table 6-2
Option 05 (TV) Electrical Characteristics

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM–CHANNEL 1 AND CHANNEL 2	
Frequency Response	For VOLTS/DIV settings between 5 mV and 0.2 mV with VAR control in calibrated detent. Five-divison, 50-kHz reference signal from a 50-Ω system. With external 50-Ω termination on 1 MΩ input.
Full Bandwidth	
50 kHz to 5 MHz	Within ±1%.
>5 MHz to 10 MHz	Within +1%, −2%.
>10 MHz to 30 MHz	Within ±2%, −3%.
Bandwith Limit	
50 kHz to 5 MHz	Within +1%, −4%.
Square Wave Flatness	With fast-rise step (rise time ≤1 ns), 1 MΩ dc input coupling, an external 50 Ω termination, and VAR VOLTS/DIV control in calibrated detent. Exclude the first 50 ns following the step transition. For signals with rise times ≤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.

Table 6-2 (cont)

Characteristics	Performance Requirements
TV (Back-Porch) Clamp (CH 2 only)	For VOLTS/DIV settings between 5 mV and 0.2 V with VAR control in calibrated detent. Six-division reference signal.
60 Hz Attenuation	≥18 dB.
Back-Porch Reference	Within 1.0 division of ground reference (adjustable).
TRIGGERING	
Bi-level 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 system. For noninterlaced scale systems, the video signal source must start and end with full lines of video for correct line identification in the field trigger modes.
Line Selection Range in FLD1, FLD2, or Both Coupling Modes	The lesser of 1280 or the number of lines in the field.
Input Signal Amplitude for Stable Triggering	
Channel 1 or Channel 2	Minimum sync-pulse amplitude within 18 divisions of input ground reference.
Composite Video	1 division.
Composite Sync	0.3 division.
Channel 3 or Channel 4	Minimum sync-pulse amplitude within 9 divisions of input ground reference.
Composite Video	0.5 division.
Composite Sync	0.25 division.

Table 6-3
Option 5H (HDTV) Electrical Characteristics

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM–CHANNEL 1 AND CHANNEL 2	
Frequency Response	For VOLTS/DIV settings between 5 mV and 0.2 mV with VAR control in calibrated detent. Five-divison, 50-kHz reference signal from a 50-Ω system. With external 50-Ω termination on 1 MΩ input.
Full Bandwidth	
50 kHz to 10 MHz	Within ±1%.
>10 MHz to 20 MHz	Within +1%, −2%.
>20 MHz to 30 MHz	Within ±2%.
Bandwith Limit	
50 kHz to 10 MHz	Within +1%, −4%.
>10 MHz to 20 MHz	Within +1%, −8%.
>20 MHz to 30 MHz	Within +1%, −12%.
Square Wave Flatness	With fast-rise step (rise time ≤1 ns), 1 MΩ dc input coupling, an external 50 Ω termination, and VAR VOLTS/DIV control in calibrated detent. Exclude the first 50 ns following the step transition. For signals with rise times ≤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.

Table 6-3 (cont)

Characteristics	Performance Requirements
TV (Back-Porch) Clamp (CH 2 only)	For VOLTS/DIV settings between 5 mV and 0.2 V with VAR control in calibrated detent. Six-division reference signal.
60 Hz Attenuation	≥18 dB.
Back-Porch Reference	Within 1.0 division of ground reference (adjustable).
TRIGGERING	
Bi-level 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 system. For noninterlaced scale systems, the video signal source must start and end with full lines of video for correct line identification in the field trigger modes.
Tri-level Sync Separation	Stable video rejection and sync separation from tri-level component (GBR and Y) and composite video systems, 525 to 1280 lines, 50 Hz or 60 Hz, interlaced or non-interlaced systems.
Line Selection Range in FLD1, FLD2, or Both Coupling Modes	The lesser of 1280 or the number of lines in the field.
Input Signal Amplitude for Stable Triggering	
Channel 1 or Channel 2	Minimum sync-pulse amplitude within 18 divisions of input ground reference.
Composite Video	1 division.
Composite Sync	0.3 division.
Channel 3 or Channel 4	Minimum sync-pulse amplitude within 9 divisions of input ground reference.
Composite Video	0.5 division.
Composite Sync	0.25 division.

Table 6–4

Option 06 (C/T/T) Electrical Characteristics

Characteristics	Performance Requirements
SIGNAL INPUT	
	With DC Coupling of A Trigger and B Trigger.
Maximum Input Frequency for Count and Delay by Events	≥150 MHz.
Minimum Width of High or Low State of Input Signal for Count and Delay by Events	≤3.3 ns.
Sensitivity	For Count, Delay by Events, and Logic Trigger Functions Excluding Word Recognizer.
Dc to 50 MHz (0.5 Hz to 50 MHz for Frequency and Period)	
CH 1 and CH 2	1.5 divisions.
CH 3 and CH 4	0.75 division.
50 MHz to 150 MHz	
CH 1 and CH 2	4.0 divisions.
CH 3 and CH 4	2.0 divisions.
FREQUENCY	
Ranges	**RANGE / LSD INTERNAL REFERENCE / LSD EXTERNAL REFERENCE[a]** 1 Hz / 100 nHz / 10 nHz 10 Hz / 1 µHz / 100 nHz 100 Hz / 10 µHz / 1 µHz 1 kHz / 100 µHz / 10 µHz 10 kHz / 1 mHz / 100 µHz 100 kHz / 10 mHz / 1 mHz 1 MHz / 100 mHz / 10 mHz 10 MHz / 1 Hz / 100 mHz 100 MHz / 10 Hz / 1 Hz 150 MHz / 100 Hz / 10 Hz
Automatic Ranging	Upranges at 100% of full scale; downranges at 9% of full scale. Downrange occurs at 90 MHz on 150 MHz range. Full scale corresponds to the value given in the Range column. Maximum displayed value for any range is Range value LSD value.[a]

[a]Refers to LSD reading with Option 1E installed.

Table 6-4 (cont)

Characteristics	Performance Requirements
Accuracy	±[Resolution + (Frequency × TBE)] Hz.
Time Base Error (TBE)	
Internal Reference	10 ppm with less than 5 ppm per year drift.
External Reference	Determined by external reference.
Resolution	$\frac{1.4 \times \text{Frequency}^2 \times \text{TJE}}{N} + \text{LSD}.$
Display Update Rate	
Internal Reference	Twice per second or twice the period of the input signal, whichever is slower.
External Reference[a]	Twice per 1.5 seconds or twice the period of the input signal, whichever is slower.
PERIOD	
Ranges	**RANGE** / **LSD** 10 ns / 1 fs 100 ns / 10 fs 1 µs / 100 fs 10 µs / 1 ps 100 µs / 10 ps 1 ms / 100 ps 10 ms / 1 ns 100 ms / 10 ns 1 s / 100 ns 2 s / 1 µs
Minimum Period	≤6.7 ns.
Automatic Ranging	Upranges at 100% of full scale; downranges at 9% of full scale. Full scale corresponds to the value given in the Range column. The maximum displayed value for any range is the Range value minus the LSD value.

[a]Refers to instruments with Option 1E installed.

Table 6-4 (cont)

Characteristics	Performance Requirements
Accuracy	±[Resolution + (TBE × Period)].
Resolution	±[LSD + (1.4 × TJE)/N].
Display Update Rate	Twice per second or twice the period of the input signal, whichever is slower.
TOTALIZE	
Maximum Count	9999999.
Display Update Rate	Twice per second or once per event, whichever is slower.
DELAY BY EVENTS	
Maximum Event Count	4194303.
Minimum Time from Start Signal to Any Delay Event	4 ns.
LOGIC TRIGGER	
Minimum Function-True Time	4 ns.
Minimum Function-False Time	4 ns.

Table 6-4 (cont)

Characteristics	Performance Requirements
ADDED DELAY TIME CHARACTERISTICS WITH C/T/T	
Run After Delay	
Accuracy	LSD[b] + [0.0012 × (A SEC/DIV)] + [0.03 × (B Time/Div)[c]] + A Trigger Level Error + 50 ns. When the A Sweep is triggered by the Word Recognizer in synchronous mode, add 100 ns for probe delay; in asynchronous mode, add 200 ns for probe delay.
Triggerable After Delay	
Accuracy	For intervals within 70 ns to 10 times the A-SEC/DIV Setting.
	LSD[b] + [10 ppm × (measured interval)] + TJE + A-Trigger Level Error + B-Trigger Level Error + 0.5 ns. If the A and B Sweeps are triggered from different channels, add 0.5 ns for channel-to-channel mismatch. When the A Sweep is triggered by the Word Recognizer in synchronous mode, add 100 ns for probe delay; in asynchronous mode, add 200 ns for probe delay.
Minimum Measurable Delay Time	≤70 ns.
Display Update Rate	In Auto Resolution, twice per second or once for every sweep, whichever is slower. In 1 ns, 100 ps, and 10 ps resolution modes, the update rate depends on the A SEC/DIV setting and the trigger repetition rate.

[b]See Tables 2-1 and 2-2.

[c]B Time/Div includes SEC/DIV, X10 MAG, and VAR.

Table 6-4 (cont)

Characteristics	Performance Requirements
ADDED DELTA-DELAY-TIME CHARACTERISTICS WITH C/T/T	
Run After Delay	
Accuracy	LSD[b] + [0.0008 × (A SEC/DIV)] + [0.01 × (B Time/Div)[c]] + 83 ps. When the A Sweep is triggered by the Word Recognizer in synchronous mode, add 1 ns for probe jitter; in asynchronous mode, add 20 ns for probe jitter.
Triggerable After Delay	
Accuracy	Both delays are within 70 ns to 10 times the A-SEC/DIV setting.
Superimposed Delta Time	LSD[b] + [0.01 × (B Time/Div)[c]] + [10 ppm × (A SEC/DIV)] + [10 ppm × (measured interval)] + 50 ps + TJE. If CH 3 or CH 4 is one channel of a two-channel measurement, add 0.5 ns for channel-to-channel delay mismatch.
Nonsuperimposed Delta Time	LSD[b] + $\lvert t_{REF} - t_{DELT} \rvert$[d] + TJE + [(0.0005 div) × ($1/SR_{REF}$ + $1/SR_{DELT}$)] + [10 ppm × (A SEC/DIV)] + [10 ppm × (measured interval)] + 50 ps. If A and B sweeps are triggered from different channels, add 0.5 ns for channel-to-channel mismatch + [0.5 div × ($1/S_{REF}$ + $1/SR_{DELT}$)] for trigger offset.
Display Update Rate	In Auto Resolution, twice per second or once for every four sweeps, whichever is slower. In 1 ns, 100 ps, and 10 ps resolution modes, the update rate depends on the A SEC/DIV setting and the trigger repetition rate.

bSee Tables 2-1 and 2-2.
cB Time/Div includes SEC/DIV, X10 MAG, and VAR.
dThis term assumes the trigger points are between the 10% and 90% points of the waveforms. Fall time is expressed as a negative risetime.

Table 6-4 (cont)

Characteristics	Performance Requirements
DEFINITIONS	

A Trigger Level Error = (A Trigger Level Readout Error)/SR_A.

B Trigger Level Error = (B Trigger Level Readout Error)/SR_B.

$t_{r_{REF}}$ = rise time, reference trigger signal.

$t_{r_{DELT}}$ = risetime, Delta trigger signal.

SR_A = slew rate at trigger point, A Sweep trigger signal in div/sec.

SR_B = slew rate at trigger point, B Sweep trigger signal in div/sec.

SR_{REF} = slew rate at trigger point, reference trigger signal in div/sec.

SR_{DELT} = slew rate at trigger point, delta trigger signal in div/sec.

TJE = trigger jitter error.

For delay or delta time, disregarding noise in the signal, this term contributes <1 LSD if the slew rate is greater than 0.03 vertical div/ns or if the slew rate is greater than 30000 vertical div/horizontal div.

Trigger Jitter = [(Reference Trigger Signal Jitter)^2 + (Delta Trigger Signal Jitter)^2 + (A Sweep Trigger Signal Jitter)^2]$^{1/2}$.

Reference Trigger Signal Jitter = $(e_{n_s} + e_{n_{REF}})/SR_{REF}$.

= 0 for Frequency mode.

e_{n_s} = scope noise in div.

= 0.05 div for HF REJ trigger coupling.

= 0.1 div for DC trigger coupling, 5 mV to 5 V sensitivity.

= 0.15 div for DC trigger coupling, 2 mV sensitivity.

$e_{n_{REF}}$ = reference signal rms noise in div.

Table 6-4 (cont)

Characteristics	Performance Requirements

Delta Trigger Signal Jitter = $(e_{ns} + e_{n_{DELT}})/SR_{DELT}$.

= 0 for Frequency or Delay mode.

$e_{n_{DELT}}$ = Delta signal rms noise in div.

A Trigger Signal Sweep Jitter = $(e_{ns} + e_{n_A})/SR_A$.

e_{n_A} = A sweep trigger signal rms noise in div.

When the Word Recognizer supplies a trigger in synchronous mode, the trigger jitter of the associated trigger signal is < 1 ns; in asynchronous mode, the associated trigger signal jitter is < 20 ns.

N = number of averages during measurement interval.

= see Table 2-1 for Delay or Delta Time.

= (measured frequency) × (measurement interval) for Frequency or Period.

Measurement Interval = 0.5 s or two periods of measured signal, whichever is greater.

Table 6-5
Option 09 (WR) Electrical Characteristics

Characteristics	Performance Requirements
SYNCHRONOUS MODE	
Data Setup Time D_0-D_{15} and Q	25 ns.
Data Hold Time D_0-D_{15} and Q	0 ns.
Minimum Clock Pulse Width	
High	20 ns.
Low	20 ns.
Minimum Clock Period	50 ns.
Delay from Selected Clock Edge to Word Out from C/T/T	$\leq$55 ns.
ASYNCHRONOUS MODE	
Maximum Trigger Frequency	10 MHz.
Minimum Coincidence Between Data Inputs (D_0-D_{15} & Q) Resulting in a Trigger	<85 ns.
Maximum Coincidence Between Data Inputs (D_0-D_{15} & Q) Without Producing a Trigger	>20 ns.
Delay from Input Word Coincidence to Word Out	$\leq$140 ns.

Table 6-5 (cont)

Characteristics	Performance Requirements
INPUTS AND OUTPUTS	
Input Voltages	
Minimum Input Voltage ⚠	—0.5 V.
Maximum Input Voltage ⚠	—5.5 V.
Maximum Input Low Voltage	0.6 V.
Minimum Input High Voltage	2.0 V.
WORD RECOG OUT	
High	> 2.5 V LSTTL output.
Low	< 0.5 V LSTTL output.
Input High Current	≤20 µA.
Input Low Current	≥—0.6 mA source.

Table 6–6

Option 10 (GPIB) Electrical Characteristics 2

Characteristics	Performance Requirements
Vertical Position Accuracy	Position accuracy is only valid when: 1. Positioning occurs after a BALance command is invoked at the ambient temperature in which the instrument is operating. 2. The VOLTS/DIV VAR control is in the calibrated detent.
CH 1, CH 2 (noninverted)	
+15°C to +35°C	±(0.3 div + 3% of distance from center screen in div + 0.5 mV/V/DIV setting.)
CH 2 Inverted	Add 0.2 div.
—15°C to +15°C and +35°C to +55°C	Add 1.5 mV/DIV setting.
CH 3 and CH 4	±(0.7 div + 3% of distance from center screen in div.)
IEEE 488 Outputs	
Volts Out for True (I_{OT} = 48 mA)	Max 0.5 V.
Volts Out for False (I_{OF} = —5.2 mA)	Min 2.5 V.
Volts Out with Output Disabled	Max 3.7 V, Min 2.5 V.
Output Leakage Current with Power OFF (0 V < V_{IN} < 2.5 V)	Max 40 µA.
IEEE 488 Inputs	
Volts In for True	Max 0.8 V, Min 0 V.
Volts In for False	Max 5.5 V, Min 2.0 V.
Current In for True (V_{IT} = 0.5 V)	Max —0.1 mA.
Current In for False (V_{IT} = 2.7 V)	Max 20 µA.

Table 6–7

Mechanical Characteristics

Characteristics	Description
Weight	
With Accessories and Pouch	10.9 kg (24.0 lb).
With Option 05, 5H, 06 and 09, or 10	12.0 kg (26.44 lb).
Without Accessories and Pouch	9.3 kg (20.5 lb).
Domestic Shipping Weight	
2467B	14.6 kg (32.1 lb).
With Option 05, 5H, 06 and 09, or 10	19.4 kg (42.7 lb).
Height	
Without Accessories Pouch	
2467B with or without Options 05, 5H, 06 and 09, and 10	160 mm (6.29 in).
With Feet and Accessories Pouch	
2467B with or without Options 05, 5H, 06 and 09, and 10	202 mm ± 25.4 mm (7.94 in ± 1.0 in).
Width (with handle)	338 mm (13.31 in).
Depth	
With Front Panel Cover	472 mm (18.6 in).
With Handle Extended	533 mm (21.0 in).
Cooling	Forced-air circulation.
Finish	Tek Blue vinyl clad material on aluminum cabinet.
Construction	Aluminum-alloy chassis (sheet metal). Plastic-laminate front panel. Glass-laminate circuit boards.

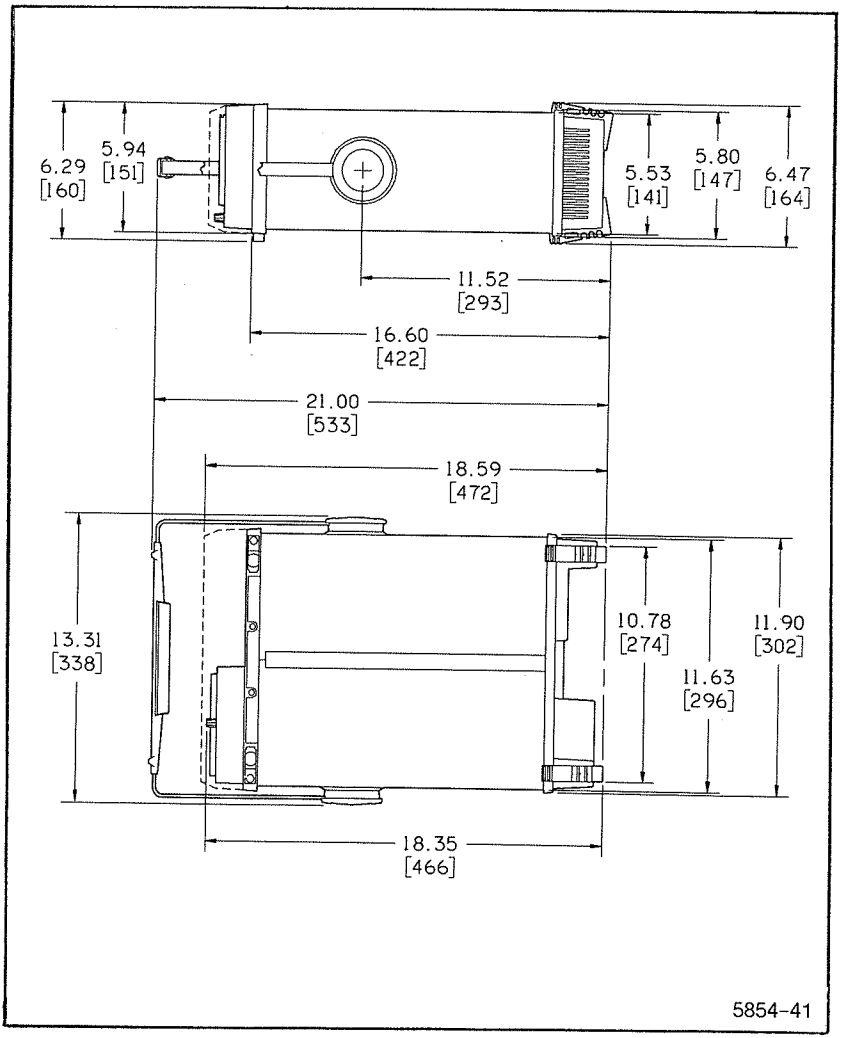


Figure 6-1. Dimensional drawing.

Table 6–8

Environmental Requirements

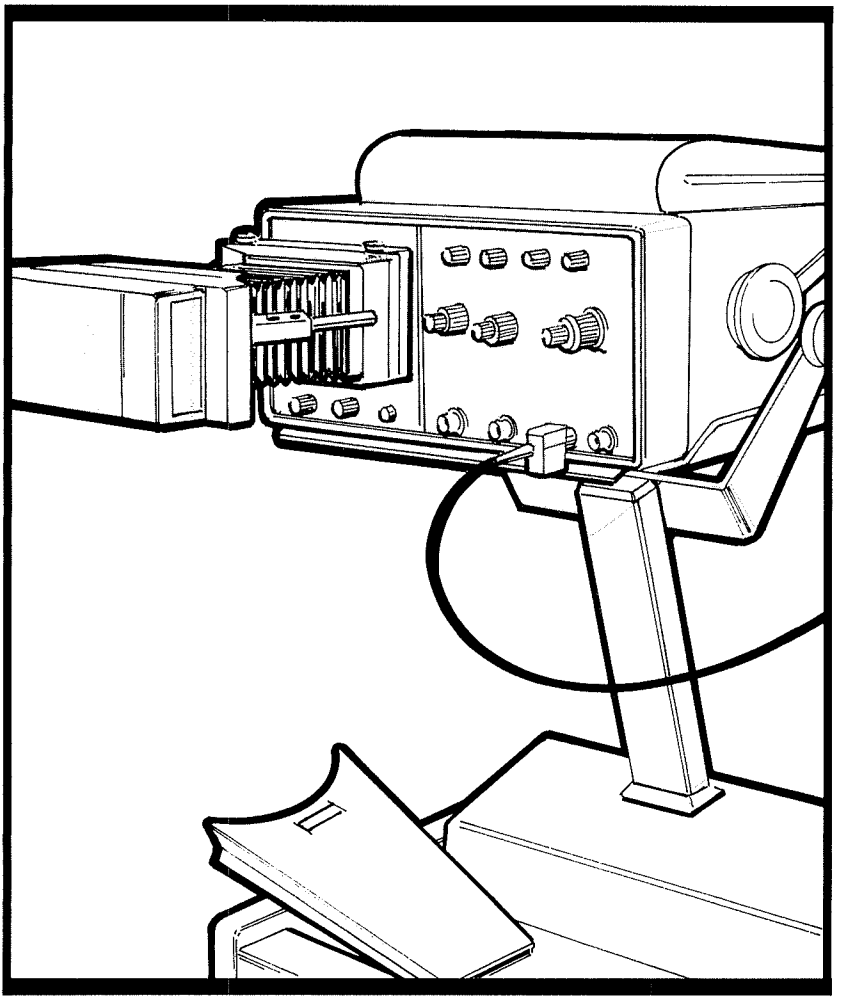
Characteristics	Performance Requirements
	Environmmental requirements qualify the electrical and mechanical specifications. When not rack mounted, the instrument meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment, with the humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4. Rack mounting changes the temperature, vibration, and shock capabilities. The rack mounted instruments meet or exceed the requirements of MIL-T-28800C with respect to Type III, Class 5, Style C equipment with the rack-mounting rear-support kit installed. Rack mounted instruments will be capable of meeting or exceeding the requirements of Tektronix Standard 062-2853-00, class 5.
Temperature	
Operating	−15°C to +55°C.
	For a rack mounted instrument, ambient temperature should be measured at the instrument's air inlet. Fan exhaust temperature should not exceed +65°C.
Nonoperating (Storage)	−62°C to +85°C.
Altitude	
Operating	To 15,000 feet. Maximum operating temperature decreases 1°C for each 1000 feet above 5000 feet.
Nonoperating (Storage)	To 50,000 feet.
Humidity	
Operating and Storage	Stored at 95% relative humidity for five cycles (120 hours) from 30°C to 60°C, with operational performance checks at 30°C and 55°C.
Vibration (operating)	
Not Rack Mounted	15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one minute sweeps. Hold 10 minutes at each major resonance or, if none exists, hold 10 minutes at 55 Hz (75 minutes total test time).
Rack Mounted	Change displacement to 0.015 inch p-p (2.3 g at 55 Hz).

Table 6–8 (cont)

Characteristics	Performance Requirements
Shock (operating and nonoperating)	
Not Rack Mounted	50 g, half sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.
Rack Mounted	30 g.
Transit Drop (not in shipping package)	8-inch drop on each corner and each face (MIL-T-28800C, para. 4.5.5.4.2).
Bench Handling (cabinet on and cabinet off)	MIL-STD-810C, Method 516.2, Procedure V (MIL-T-28800C, para. 4.5.5.4.3).
Topple (operating with cabinet installed)	Set on rear feet and allow to topple over onto each of four adjacent faces (Tektronix Standard 062-2858-00).
Packaged Transportation Drop	Meets the limits of the National Safe Transit Assn., test procedure 1A-B-2; 10 drops of 36 inches (Tektronix Standard 062-2858-00).
Packaged Transportation (Vibration)	Meets the limits of the National Safe Transit Assn., test procedure 1A-B-1; excursion of 1 inch p-p at 4.63 Hz (1.1 g) for 30 minutes (Tektronix Standard 062-2858-00).
EMI (Electro-magnetic Interference)	Meets MIL-T-28800C; MIL-STD-461B, part 4 (CE-03 and CS-02), part 5 (CS-06 and RS-02), and part 7 (CS-01, RE-02, and RS-03) – limited to 1 GHz; VDE 0871, Category B; Part 15 of FCC Rules and Regulations, Subpart J, Class A; and Tektronix Standard 062-2866-00.
Electrostatic Discharge Susceptibility	Meets Tektronix Standard 062-2862-00. The instrument will not change control states with discharges of less than 10 kV.
X-Ray Radiation	Meets requirements of Tektronix Standard 062-1860-00.

SECTION 7

Options and Accessories



Options and Accessories

Introduction

This section contains a general description of instrument options available at the time of publication of this manual. Also included is a complete list (with Tektronix part numbers) of standard accessories included with the instrument and a partial list of optional accessories. Additional information about instrument options, option availability, and other accessories can be obtained either by consulting the current Tektronix Product Catalog or by contacting your local Tektronix Field Office or representative.

Option 11

Option 11 provides two probe-power connectors on the rear panel of the instrument. Voltages supplied at these connectors meet the power requirements of standard Tektronix active oscilloscope probes.

Option 1R

When the oscilloscope is ordered with Option 1R, it is shipped in a configuration that permits easy installation into a 19-inch-wide electronic-equipment rack.

An optional rear-support kit also is available for use when rackmounting the instrument. Using this optional rear-support kit enables the rackmounted instrument to meet appropriate electrical and environmental specifications.

Connector-mounting holes are provided in the front panel of the rackmounted instrument. These enable convenient accessing of the four bnc connectors (CH 2 SIGNAL OUT, A GATE OUT, B GATE OUT, and EXT Z AXIS IN) and the two PROBE POWER connectors located on the rear panel. Additional cabling and connectors required to implement any front-panel access to the rear-panel connectors are supplied by the user; however, these items can be separately ordered from Tektronix.

Complete rackmounting instructions are provided in a separate document shipped with Option 1R. These instructions also contain appropriate procedures to convert a standard instrument into the Option 1R configuration by using the rackmounting conversion kit.

Power Cord Options

Instruments are shipped with the detachable power-cord configuration ordered by the customer. Descriptive information about the international power-cord options is provided in Section 1, "Preparation for Use." The following list identifies the Tektronix part numbers for the available power cords and associated fuses.

Universal Euro - OPTION A1

Power cord (2.5 m)	161-0104-06
Fuse (1.6 A, 250 V, 5 x 20 mm, Quick-acting)	159-0098-00

UK - OPTION A2

Power cord (2.5 m)	161-0104-07
Fuse (1.6 A, 250 V, 5 x 20 mm, Quick-acting)	159-0098-00

Australian - OPTION A3

Power Cord (2.5 m)	161-0104-05
Fuse (1.6 A, 250V, 5 x 20 mm, Quick-acting)	159-0098-00

North American - OPTION A4

Power Cord (2.5 m)	161-0104-08
Fuse (2 A, 250 V, AGC/3AG, Fast-blow)	159-0021-00

Switzerland - OPTION A5

Power Cord (2.5 m)	161-0167-00
Fuse (1.6 A, 250 V, 5 x 20 mm, Quick-acting)	159-0098-00

Standard Accessories

The following standard accessories are provided with each instrument:

Qty	Description	Part Number
2	Probes (10X, 1.3 m) with Accessories	P6137
1	Banana Plug/Binding Post Adaptor	134-0016-01
1	Accessory Pouch, Snap Fastener	016-0692-00
1	Accessory Pouch, Zip-lock Fastener	016-0537-00
1	Operators Manual	070-6861-01
1	Fuse (2 A, 250 V, AGC/3AG)	159-0021-00
1	CRT Filter, Blue Plastic (installed)	378-0270-00
1	CRT Filter, Blue Plastic (installed)	378-0270-00
1	Front Cover	200-3199-01

The following standard accessories are provided with instruments containing Option 5 (TV):

Qty	Description	Part Number
1	CCIR Graticule	378-0270-01
1	NTSC Graticule	378-0270-02
1	Polarized Viewing Hood	016-0180-00

The following standard accessories are provided with instruments containing Option 5H (HDTV):

Qty	Description	Part Number
1	CCIR Graticule	378-0270-01
1	NTSC Graticule	378-0270-02
1	Polarized Viewing Hood	016-0180-00
3	75 Ω Terminators	011-0055-00

The following standard accessories are provided with instruments containing Option 09 (WR):

Qty	Description	Part Number
1	P6407 Word Recognizer Probe	010-6407-01
2	10-wide comb, 10-inch leads (without grabbers)	012-0747-00
20	Grabber Tips	206-0222-01

Optional Accessories

The following optional accessories are recommended for use with the instrument:

Description	Part Number
Protective Cover, Waterproof, Blue Vinyl	016-0720-00
Probe Package (for use with Channels 3 and 4)	P6137
Rackmounting Conversion Kit	016-0691-00
Rear-Support Kit (for use with rackmounted instruments)	016-0096-00
Polarized Collapsible Viewing Hood	016-0180-00
Folding Viewing Hood, Light-shielding	016-0592-00
Collapsible Viewing Hood, Binocular	016-0566-00
Oscilloscope Camera	See C30B Series
SCOPE-MOBILE Cart	K212
Carrying Strap	346-0199-00
2467B/2465B Service Manual	070-6863-00
24X5B/2467B Options Service Manual (SN B050000 and Above) [covers Option 05 (TV), Option 5H (HDTV), Option 06 (CTT), Option 09 (WR), and Option 10 (GPIB)]	070-6864-02
24X5B/2467B Options Service Manual (SN B049999 and Below) [covers Option 05 (TV), Option 06 (CTT), Option 09 (WR), and Option 10 (GPIB)]	070-6864-00

Appendix

A

Extended Functions with Diagnostic Exercisers

Diagnostic exercisers provide access to an operating-time log and they control instrument setup modes and the viewing-time display. The available GPIB interface adds exercisers to establish system parameters of the instrument and to transfer the set of thirty saved setups from one instrument to one or more other instruments. With the available Television/Video *(TV)* enhancement, added exercisers control video line numbering. The Service Manual describes EXER01 through 04 in more detail.

Information Exercises

	EXER 01	Pots and Switches
	EXER 02	Calibration RAM Examine
	EXER 03	Cycle Error Clear
	EXER 04	Display ROM Headers

Setup Exercises

	EXER 05	Display Operating Time and Power Cycle Count
	EXER 06	Select Setup to Use at Power Up
	EXER 07	Enable/Disable Setup SAVE and Sequence Definition
	EXER 08	Initialize Setups
	EXER 09	Program Viewing Time Display
GP	**EXER 11**	Program GPIB Address
GP	**EXER 12**	Program GPIB Message Terminator and Talk/Listen
GP	**EXER 13**	Receive-Setups Mode
GP	**EXER 14**	Send-Setups Mode
TV	**EXER 61**	(HD EXER 61) Select TV system-M, non-system-M, 1050/1250 or Autoformat selection
TV	**EXER 62**	(HD EXER 62) Select TV line numbering format
TV	**EXER 63**	(HD EXER 63) Select TV sync polarity default
HD	**EXER 64**	Restore HDTV presets

To operate these features:

1. Enter the Diagnostic Monitor mode by pressing and holding both ΔV and Δt, then pressing Trigger SLOPE while holding ΔV and Δt. The readout will display "DIAGNSTIC. PUSH A/B TRIG TO EXIT," indicating the Diagnostic Monitor mode.

2. Repeatedly press the upper or lower Trigger MODE button to sequence through the TEST and EXER routine labels and select the one you want to run.

3. Press the upper Trigger COUPLING button to execute the selected Exerciser. In all listed exercisers except EXER 05, EXER 09, and the GP EXER's, repeatedly pressing the upper Trigger COUPLING button cycles through the available selections.

4. To exit an exerciser, press the lower Trigger COUPLING button.

5. To return to normal instrument operation, press A/B/TRIG.

In the descriptions below, the lines marked with " > " show what is displayed in the top row of the readout.

Information Exercises

EXER 01 Pots and Switches

> AA BB CC DEEE FF GG HI JJ KL

AA = the code of the most-recently-activated poteniometer.
BB = the current value (in hexadecimal) of pot AA.
CC = the previous value (in hexidecimal) of pot AA.
D = the DAC Multiplexer code used to select pot AA.
EEE = the 12-bit DAC value (in hexidecimal) associated with pot AA.
FF = the code of the previously-activated potentiometer.
GG = the row code of the most-recently-activated switch.
H = the switch-position code: 0 for open; C for closed.
I = the column code for the most-recently-activated switch.
JJ = the row for the previously-activated switch
K = the switch-position code: 0 for open; C for closed.
L = the column code for the previously-activated switch.

EXER 02 Calibration Ram Examine

> AA DDDD P

AA = the eight-bit address in hexidecimal notation.
DDD = the 14-bit word stored at the location (13 bits of data and one parity bit).
P = a parity indicator for the data word: X indicates even parity; blank is odd parity.

EXER 03 Cycle Error Clear

This routine provides a way for the operator to clear the cycle-failure data written to the RAM when a CYCLE mode failure occurs.

Clearing the RAM location is done by pressing the following switches in sequence:

TRIGGER COUPLING upper (starts exerciser),
TRIGGER SOURCE lower,
TRIGGER MODE lower, then
TRIGGER COUPLING lower (exits the exerciser).

EXER 04 Display ROM Headers

> CCCC PPPP SS AAAA OD

CCCC = a two-byte hexidecimal checksum.
PPPP = the four middle digits of the ROM part number.
SS = the suffix of the ROM part number (version number).
AAAA = the starting address of the ROM (address where the ROM should be installed.
OD = a two-character option designator identifying the option that this particular line of diagnostic refers to (see Options manual for details). For the basic instrument the OD is blank.
FF = the code of the previously-activated potentiometer.
GG = the row code of the most-recently-activated switch.
H = the switch-position code: 0 for open; C for closed.
I = the column code for the most-recently-activated switch.
JJ = the row for the previously-activated switch
K = the switch-position code: 0 for open; C for closed.
L = the column code for the previously-activated switch.

Setup Exercises

EXER 05 Display Operating Time and Power Cycle Count

> HRS ON nnnn OFF/ON CYCLES mmmm

nnnn = Accumulated Number of Hours with Power Applied
mmmm = Accumulated Number of Power Cycles

EXER 06 Select Setup to Use at Power Up

> POWER UP TO POWER DOWN SETUP

Instrument will power up with the setup in effect at power down.

> POWER UP TO SETUP 1

Instrument will power up with the setup stored as setup 1.

EXER 07 Enable/Disable Setup SAVE and Sequence Definition

> ENABLE SAVE AND SEQUENCE-CHANGE

All Save and Sequence functions are enabled.

> DISABLE SAVE AND SEQUENCE-CHANGE

All Save and Sequence-definition functions are disabled.

> ENABLE SAVE 1 - 8, NO SEQ-CHANGE

Only setups 1 through 8 can be changed. BEGIN/STEP/END attributes cannot be changed for any setup.

EXER 08 Initialize Setups

> COUPLING UP CLEARS SAVED SETUPS

Press upper Trigger COUPLING to clear all saved setups.
Press lower Trigger COUPLING to retain saved setups.

EXER 09 Program Viewing Time Display

> SHUTDOWN WARNING AT xx SECONDS

When the remaining time before display intensity reduction is less than xx seconds, a number indicating the time remaining is displayed in the lower, right hand corner of the CRT.

> SHUTDOWN WARNING DISABLED

xx = 0 inhibits timer display.

> SHUTDOWN WARNING ENABLED

xx > 90 gives continuous timer display.

GP EXER 11 Program GPIB Address

> GPIB ADDRESS nn

nn = a primary address within 0 to 31. Turn the D control to select the appropriate address. With address 31, bus data has no effect on the instrument and is unaffected by the instrument. The instrument does not have secondary addressing.

GP EXER 12 Program GPIB Message Terminator and Talk/Listen

Press the upper MODE button to select EOI or LF as message terminator. Press the upper SOURCE button to select TALK/LISTEN or LISTEN operation.

> TERMINATOR EOI MODE TALK LISTEN

The instrument accepts only the EOI bus message as the end of a string of received bytes. The instrument asserts EOI at the end of a string of transmitted bytes. The instrument can be addressed either as a talker to send settings and readings or as a listener to receive control information.

> TERMINATOR LF MODE TALK LISTEN

The instrument accepts either the EOI bus message or an LF (line feed) character as the end of a string of received bytes. The instrument asserts CR (carriage return) then LF with EOI at the end of a string of transmitted bytes.

> TERMINATOR EOI MODE LISTEN ONLY

The instrument will not operate as a bus talker. It will receive control information. The listen-only mode allows the instrument to share a GPIB address with another instrument that talks.

> TERMINATOR LF MODE LISTEN ONLY

GP EXER 13 Receive-Setups Mode

> READY TO RECEIVE SETUPS

1. Connect the instrument to another instrument of the same model and with the same options by a GPIB cable. If the instrument is a different model in the following list: 2445B, 2455B, 2465B, 2465B CT, 2465B DM, 2465B DV, and 2467B, or one with a different set of options, most setups will be valid, but some will give unpredictable results.
2. Select GP EXER 14 in the other instrument.

> RECEIVING SETUPS

When the transfer is complete, the instrument will exit EXER 13 automatically.

GP EXER 14 Send-Setups Mode

Before executing this exerciser, make sure the instrument is connected to another by a GPIB cable and be sure the other instrument is in the "READY TO RECEIVE SETUPS" state initiated by GP EXER 13.

> SENDING SETUPS

When the transfer is complete, the instrument will exit EXER 14 automatically.

TV EXER 61 (HD EXER 61) Select TV system-M, non-system-M, 1050/1250, or Autoformat selection

> LINE 1 OCCURS PRIOR TO FLD SYNC

System-M protocol is selected and the line count begins three lines before the field-sync pulse.

> LINE 1 OCCURS COINCIDENT WITH FLD SYNC

Non-system-M protocol is selected and the line count begins coincident with the field-sync pulse.

> LINE 1 OCCURS AFTER FLD SYNC

1050/60 and 1250/50 HDTV format is selected and line count begins one line after field-sync pulse.

> LINE 1 AUTO FORMATS TO FLD SYNC

Instrument automatically selects the format required depending on the input signal.

NOTE

The previous two selections are only available with Option 5H.

TV EXER 62 (HD EXER 62) Select TV line numbering format

> LINE NO RESETS ON EACH FIELD

Line numbering begins with the first line of both field 1 and field 2.

> LINE NO RESETS ON FLD 1 ONLY

Line numbering begins at the first line of field 1 and continues through field 2.

TV EXER 63 (HD EXER 63) Select TV sync polarity default

> TVSYNC:SLOPE DEFAULT

Trigger Slope, which corresponds to sync polarity, does not change when LINES Coupling is selected.

> TVSYNC:POSITIVE

Trigger Slope is initialized to + when Coupling is changed from AC to LINES.

> TVSYNC:NEGATIVE

Trigger Slope is initialized to - when Coupling is changed from AC to LINES.

HD EXER 64 Restore TV Setups

> COUPLING UP RESTORES TV PRESETS

This exercisor restores the new HDTV presets to stored setup locations 1-9. The presets are as follows:

```
> 1       2       3       4
  LINE    FIELD   FRAME   LINESEL

> 5       6       7       8
  ACTVID  H-BLANK V-BLANK PIXEL
```

LINE to FIELD quick switch sequence. Press RECALL - STEP - STEP to toggle between LINE and FIELD modes with the STEP switch. Press RECALL to exit this mode.

> 9 TSGTRIG

This setup is for use with Tektronix TSG1000 range of HDTV signal generators.

Appendix

B

Sequence Programming and Operation

As many as thirty stored setups can be organized into one or more sequences to be sequentially recalled by the STEP/AUTO button. Unless otherwise defined, all thirty setups can be recalled in one sequence.

A sequence is defined as a contiguous group of saved setups, where the first setup includes the BEGIN attribute and the last setup includes the END attribute. The Sequence-Save mode provides access to the BEGIN/END attributes and provides sequence editing facilities to REPLACE, INSERT, and DELETE setups.

Pressing SAVE establishes the Direct-Save mode, as described in the "Operation" section. Pressing STEP then establishes the Sequence-Save mode. The readout shows a definition mode, a step attribute, a setup number, the "NAME:" prompt, and the name argument in the top row and a HELP message in the bottom row. (If the Direct-Save mode displays "SAVE FUNCTIONS DISABLED" or if the Sequence-Save mode displays "SEQUENCE DEFINITION DISABLED," refer to EXER 07, described in Appendix A.)

Top Row	--	REPLACE STEP :nn	NAME:xxxxxxx
or	--	REPLACE BEGIN :nn	NAME:xxxxxxx
or	--	REPLACE END :nn	NAME:xxxxxxx
Bottom Rows	--	PUSH STEP TO REPLACE SETUP. PUSH SAVE FOR HELP.	

Δ REF moves a cursor to the definition mode field, the step attribute field, the setup number field, or any character in the NAME argument. The Δ control selects a definition mode, REPLACE, INSERT, or DELETE; a step attribute, STEP, BEGIN, or END; a setup number, 1-30; or a character for each position of the setup name.

The initial definition mode is REPLACE. Initial values of the step attribute and setup NAME are the values previously stored at the selected setup number, unless NAME was changed in the Direct-Save mode. The initial value of the setup number is one more than the previously defined or selected setup. The cursor initially remains in the NAME argument, as it was in the Direct-Save mode.

When STEP is pressed in the REPLACE definition mode, the current instrument setup, with the displayed step attribute and the displayed NAME, if the NAME has been changed, replaces setup "nn."

A step with the BEGIN attribute begins a sequence of setups. END defines a step that ends a sequence.

While REPLACE is selected, repeated operation of SAVE presents this cycle of HELP messages in the bottom rows.

Top Row	--	REPLACE STEP :nn NAME:xxxxxxx
or	--	REPLACE BEGIN :nn NAME:xxxxxxx
or	--	REPLACE END :nn NAME:xxxxxxx
Bottom Rows	--	PUSH STEP TO REPLACE SETUP. PUSH SAVE FOR HELP.
or	--	TURN Δ REF TO FIELD, THEN- - - TURN Δ TO DESIRED SETTING.
or	--	PUSH MEASURE TO SAVE A MEASUREMENT. PUSH RECALL TO CANCEL THIS MODE.

When STEP is pressed in the INSERT definition mode, the numbers attached to the currently selected setup and each higher-numbered setup are increased by one and setup 30 is discarded. The current instrument setup, the displayed step attribute, and the displayed NAME are then stored in the selected memory location.

While INSERT is selected, repeated operation of SAVE presents this cycle of HELP messages in the bottom rows.

Top Row	--	INSERT STEP :nn NAME:xxxxxxx
or	--	INSERT BEGIN :nn NAME:xxxxxxx
or	--	INSERT END :nn NAME:xxxxxxx
Bottom Rows	--	INSERT WILL DESTROY STEP 30. PUSH SAVE FOR HELP.
or	--	PUSH STEP TO INSERT SETUP. PUSH MEASURE TO SAVE A MEASUREMENT.
or	--	TURN Δ REF TO FIELD, THEN- - - TURN Δ TO DESIRED SETTING.
or	--	PUSH RECALL TO CANCEL THIS MODE.

In the DELETE definition mode, the attribute and NAME fields cannot be changed. When STEP is pressed, the currently selected setup is moved to Step 30 and the numbers associated with each higher-numbered setup decrease by one.

While DELETE is selected, repeated operation of SAVE presents this cycle of HELP messages in the bottom row.

Top Row	--	DELETE STEP :nn NAME:xxxxxxx
or	--	DELETE BEGIN :nn NAME:xxxxxxx
or	--	DELETE END :nn NAME:xxxxxxx
Bottom Rows	--	PUSH STEP TO DELETE SETUP (or MEASUREMENT).
		PUSH SAVE FOR HELP.
or	--	TURN Δ REF TO FIELD, THEN - - -
		TURN Δ TO DESIRED SETTING.
or	--	PUSH RECALL TO CANCEL THIS MODE.

Executing Sequences

Pressing RECALL establishes the Direct-Recall mode, as described in the Operation section. Then pressing STEP in the Direct-Recall mode enables the Sequence-Recall mode. The top row of the readout shows the names of the first four defined BEGIN steps. If no BEGIN steps are defined, step 1 is the beginning of a sequence, by default. Pressing a setup-number button initiates the corresponding sequence and illuminates the STEP indicator. The position of each button among the others corresponds to the position of a sequence name among the others on the screen. Pressing STEP initiates the first defined sequence and illuminates the STEP indicator.

Repeatedly pressing RECALL presents this cycle of HELP messages. In message 1, "−n" is blank, "−2," "−3," or "−4," depending on how many sequences are defined.

Bottom Rows	--	PUSH 1−n OR STEP TO START SEQ.
		PUSH RECALL FOR HELP.
or	--	TURN Δ TO SELECT ANY STEP.
		PUSH SAVE TO CANCEL THIS MODE.

Turning Δ REF or Δ while in the Sequence-Recall mode allows access to any setup.

STEP recalls any selected setup, initiates sequential setups, and illuminates the STEP indicator. If the step number is decremented below 1, the Direct-Recall mode is reestablished.

Top Row	--	nn xxxxxxx TURN Δ TO SELECT.
Bottom Rows	--	PUSH STEP TO BEGIN SEQ HERE.
		PUSH SAVE TO CANCEL THIS MODE.

Repeated operation of STEP/AUTO sequentially steps through the sequentially stored setups. When an END step or step 30 is encountered, the sequence reverts to the previous BEGIN step, or to step 1, if no previous BEGIN step exists.

With the available *GPIB*, all setups can be transferred from one instrument to another. See GP EXER 13 and GP EXER 14 in Appendix A.

Appendix

C

Power Up Tests

Power-up tests are automatically performed each time the instrument is turned on. These tests provide the user with the highest possible Confidence that the instrument is operational. They include a Kernel test and Confidence tests.

Kernel Test

A Kernel test failure is considered "fatal" to the operation of the instrument. A Kernel test failure causes the TRIG'D indicator to flash and displays a binary code pattern on other front panel indicators. If a Kernel test fails, the user can attempt to operate the instrument normally by pressing the A/B TRIG button. Operation is unpredictable; it depends on the nature of the failure.

Confidence Tests

Confidence tests are performed after the processor Kernel has been found operational. These tests check a portion of the instrument for correct operation.

If a Confidence test fails, the readout will indicate the nature of the failure by a coded message in this format:

TEST XX FAIL YY

where XX is a two-digit test number and YY is a failure code. Table C-1 shows the function affected by detected failures.

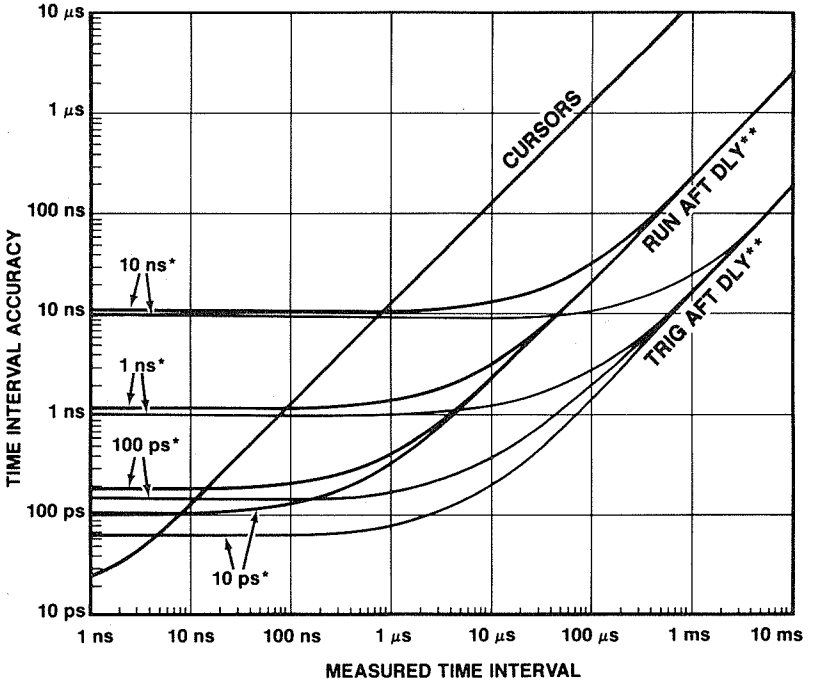
Table C-1
Confidence Test Numbers and Affected Functions

Test Number	Description
01	Interrupt Request Missing or Wrong Period
02	Momentary Switch Stuck
03	Readout Interface or Memory Failure
04	Calibration Data Parity or Checksum Error
05	Main Board Failure Detected by Auto Level Trigger on LINE Source
06	Memory-Battery Voltage Too High or Too Low
GP 11	GPIB Interface Failure Detected
CT 81 - 87	Counter-Timer-Trigger Failure Detected

Appendix

D

Delta-Time and Delta-Delay-Time Accuracy under Noted Conditions for the C/T/T Option



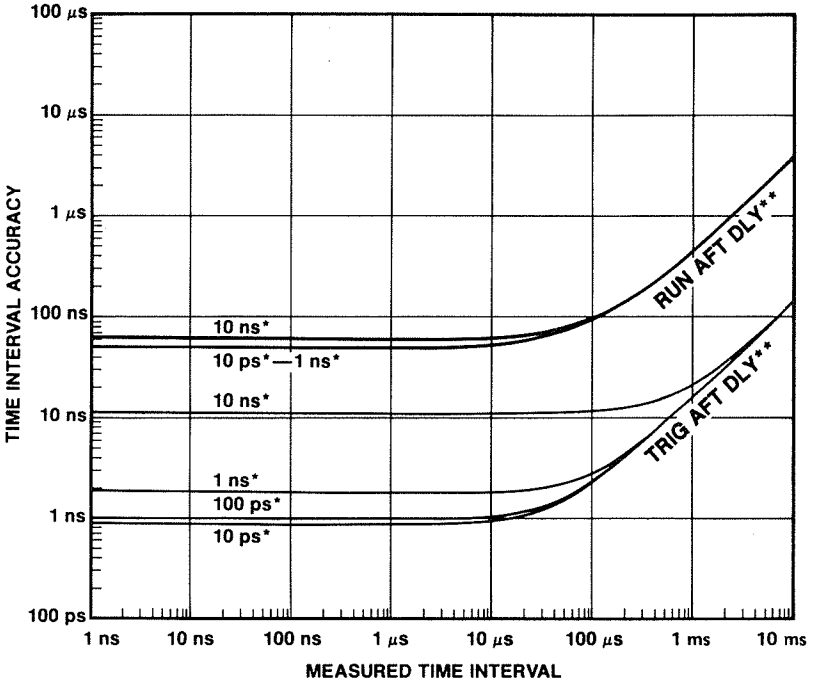
CONDITIONS:

1) Input signal is 5 vertical divisions with a 2 ns rise time.
2) Measured times are 4 horizontal divisions.
3) TJE is negligible for slew rates greater than 0.1/div ns.
4) For all B-Trigger modes, the beginning and end of the measured interval are visually superimposed.
5) RUN and TRIG accuracies are with RUN AFT DLY and TRIG AFT DLY B-Trigger Modes.

* Selected resolution. See "Resolution Selections" table for resolutions corresponding to trigger rates with AUTO resolution.

**B-Trigger Modes

Delay-Time Accuracy under Noted Conditions for the C/T/T Option



CONDITIONS:
1) Input signal is 5 vertical divisions with a 2 ns rise time.
2) Measured times are 4 horizontal divisions.
3) TJE is negligible for slew rates greater than 0.1 div/ns.
4) RUN and TRIG accuracies are with RUN AFT DLY and TRIG AFT DLY B-Trigger Modes.

* Selected resolution. See "Resolution Selections" table for resolutions corresponding to trigger rates with AUTO resolution.

**B-Trigger Modes

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