TEKTRONIX®

7B53A/7B53AN
DUAL TIME BASE
OPERATORS

INSTRUCTION MANUAL

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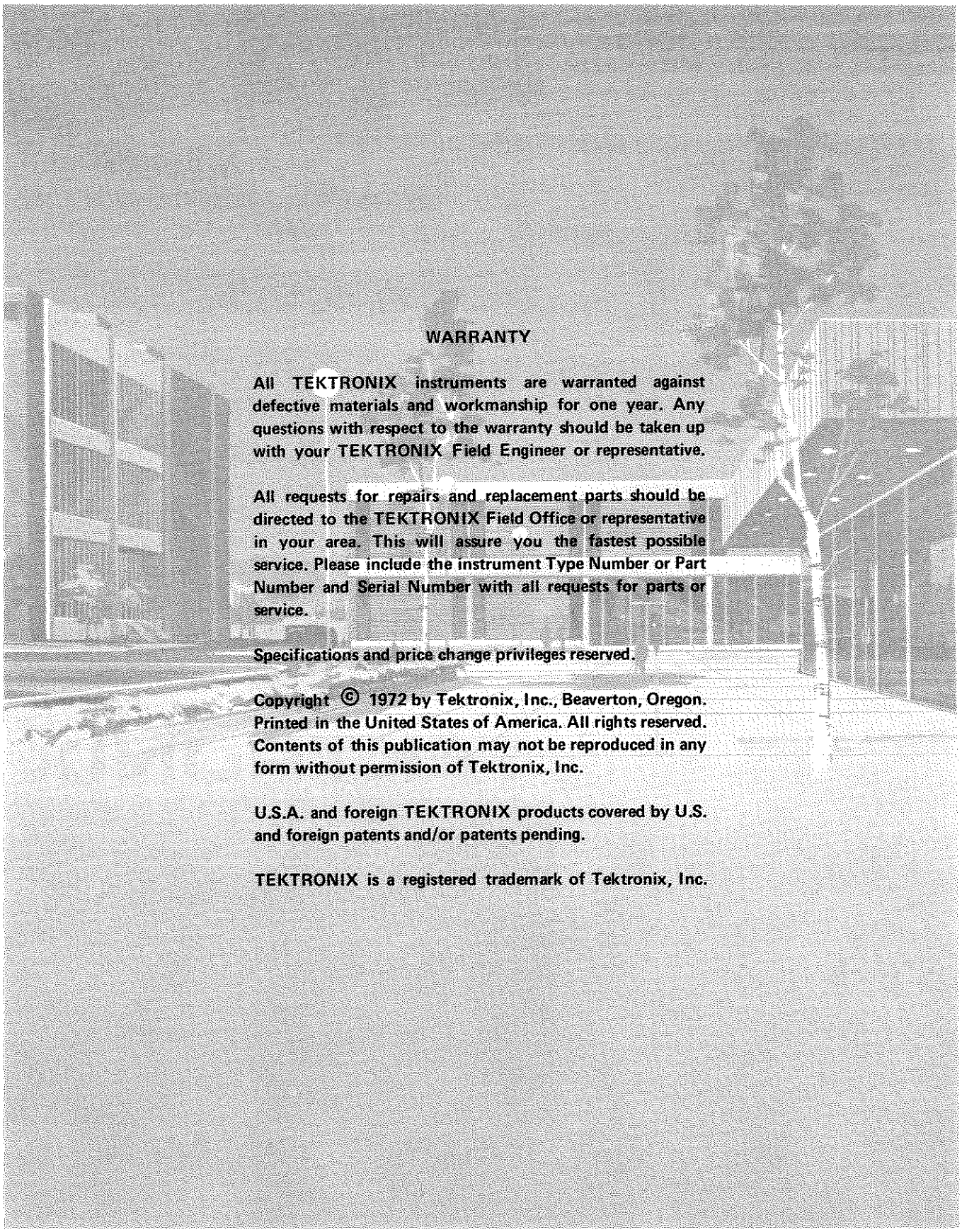

WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

Specifications and price change privileges reserved.

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NOTE

Refer to the 7B53A/7B53AN Service Manual for circuit description, maintenance, calibration, diagrams, and parts replacement information.

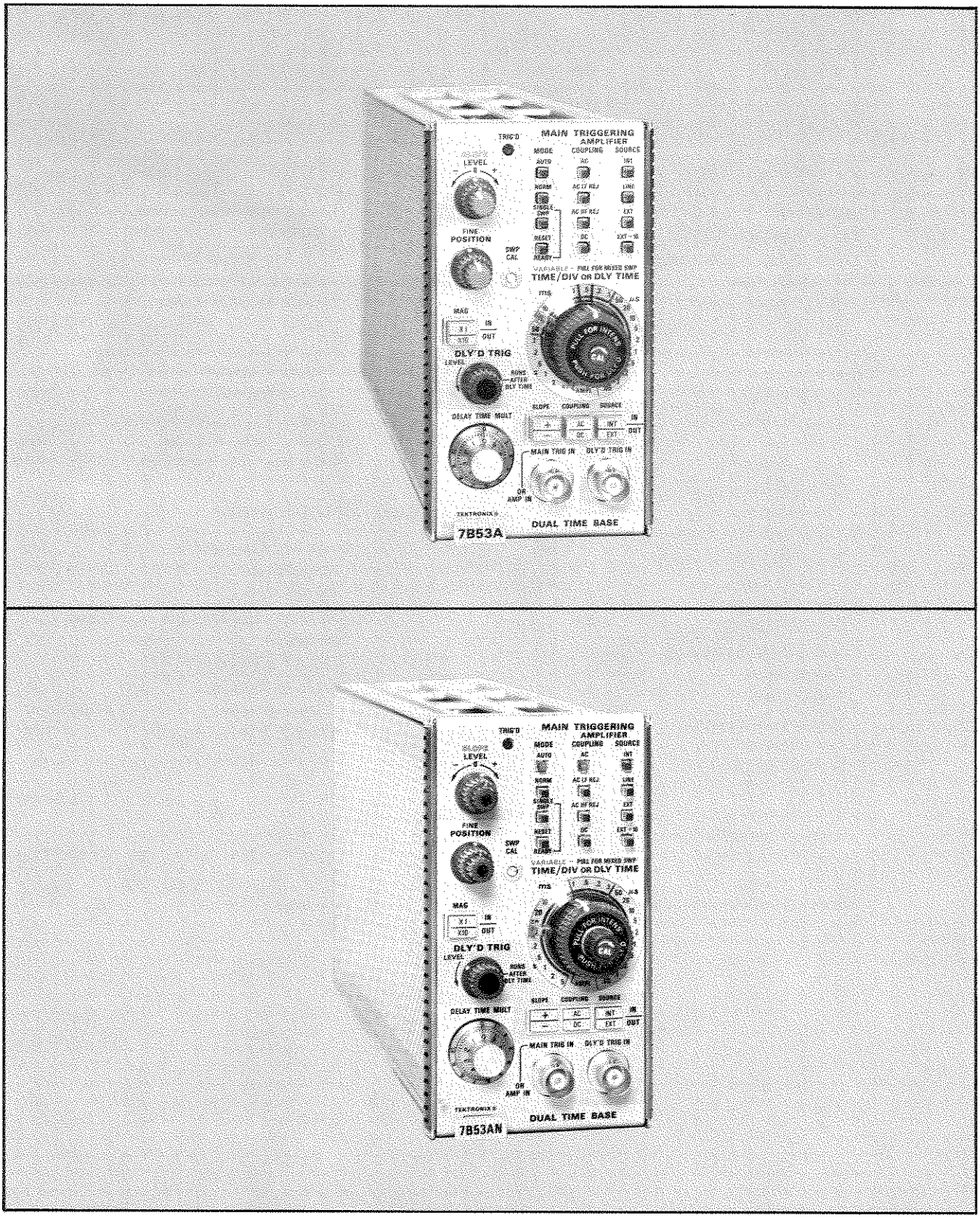


Fig. 1-1. 7B53A and 7B53AN Dual Time Base Units.

OPERATING INSTRUCTIONS

7B53A/7B53AN Features

The 7B53A and 7B53AN Dual Time Base units provide Main, Intensified, Delayed, and Mixed sweep operation for TEKTRONIX 7000-Series Oscilloscopes. Calibrated sweep rates from 5 s/DIV to 50 ns/DIV (5 nanoseconds with X10 magnification) and triggering to 100 megahertz are provided. The 7B53A and 7B53AN are electrically identical except that only the 7B53A is compatible with the alphanumeric readout system provided for 7000-Series Oscilloscopes.

Other features include 0 to 10 times continuous sweep delay, variable main and delayed sweep rates, and variable main sweep holdoff. Separate triggering controls are provided for main and delayed sweep triggering, and when operating in the AUTO MAIN TRIGGERING MODE, a bright base line is displayed in the absence of a trigger signal. The 7B53A/7B53AN can also be used as an amplifier for X-Y operation.

General

The 7B53A/7B53AN operates with a TEKTRONIX 7000-Series Oscilloscope and a 7A-Series Amplifier unit to form a complete oscilloscope system. To effectively use the 7B53A/7B53AN its operation and capabilities should be known. This section describes the operation of the front-panel controls and connectors, provides an Operating Checkout procedure, gives general operating information, and basic applications for this instrument.

Installation

The 7B53A/7B53AN is designed to operate in the horizontal compartment of the indicator oscilloscope. This instrument can also be installed in the Vertical plug-in compartment to provide a sweep that runs vertically on the CRT. However, when used in this manner, there are no retrace blanking or internal triggering provisions, and the unit may not meet the specifications given in Section 2. The instructions in this manual are written for use of the 7B53A/7B53AN in the horizontal plug-in compartment.

Before proceeding with installation it is necessary to check the settings of the Variable Selector multi-pin connector (P140) and the Delayed Sweep Gate Out multi-pin connector (P613). The Variable Selector multi-pin connector (P140) determines whether the front-panel VARIABLE control varies main sweep rates, delayed sweep rates, or main sweep holdoff; the Delayed Sweep) Gate Out multi-pin connector (P613) determines whether the Delayed Sweep Gate Out signal is connected to the front-panel DLY'D TRIG IN connector (see Fig. 1-3). Refer to General Operating Instructions in this section for VARIABLE control and DLY'D GATE OUT information.

To install the 7B53A/7B53AN in a plug-in compartment, push it in until it fits firmly into the compartment. The front panel of the 7B53A/7B53AN should be flush with the front panel of the indicator oscilloscope. Even though the gain of the indicator oscilloscope is standardized to minimize adjustment when inserting plug-in units, the sweep calibration of the 7B53A/7B53AN should be checked when installed. The procedure for checking the unit is given under Sweep Calibration in the Operating Checkout procedure in this section.

To remove the 7B53A/7B53AN, pull the release latch (see Fig. 1-2) to disengage the unit from the indicator oscilloscope and pull it out of the plug-in compartment.

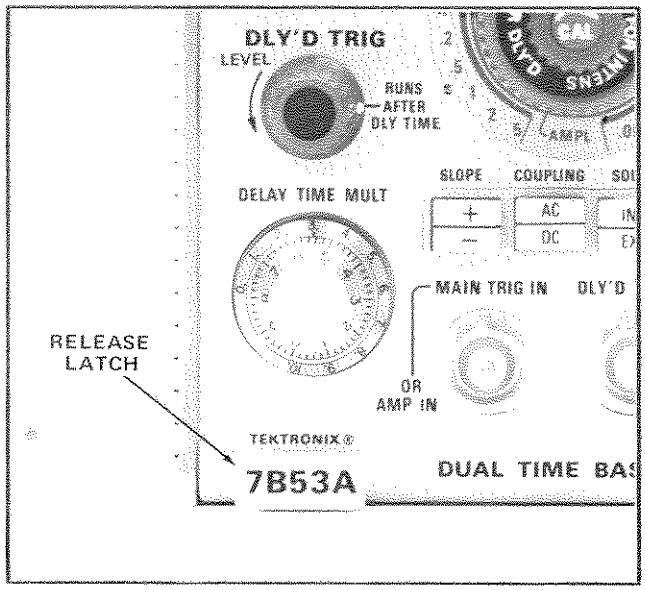


Fig. 1-2. Location of release latch.

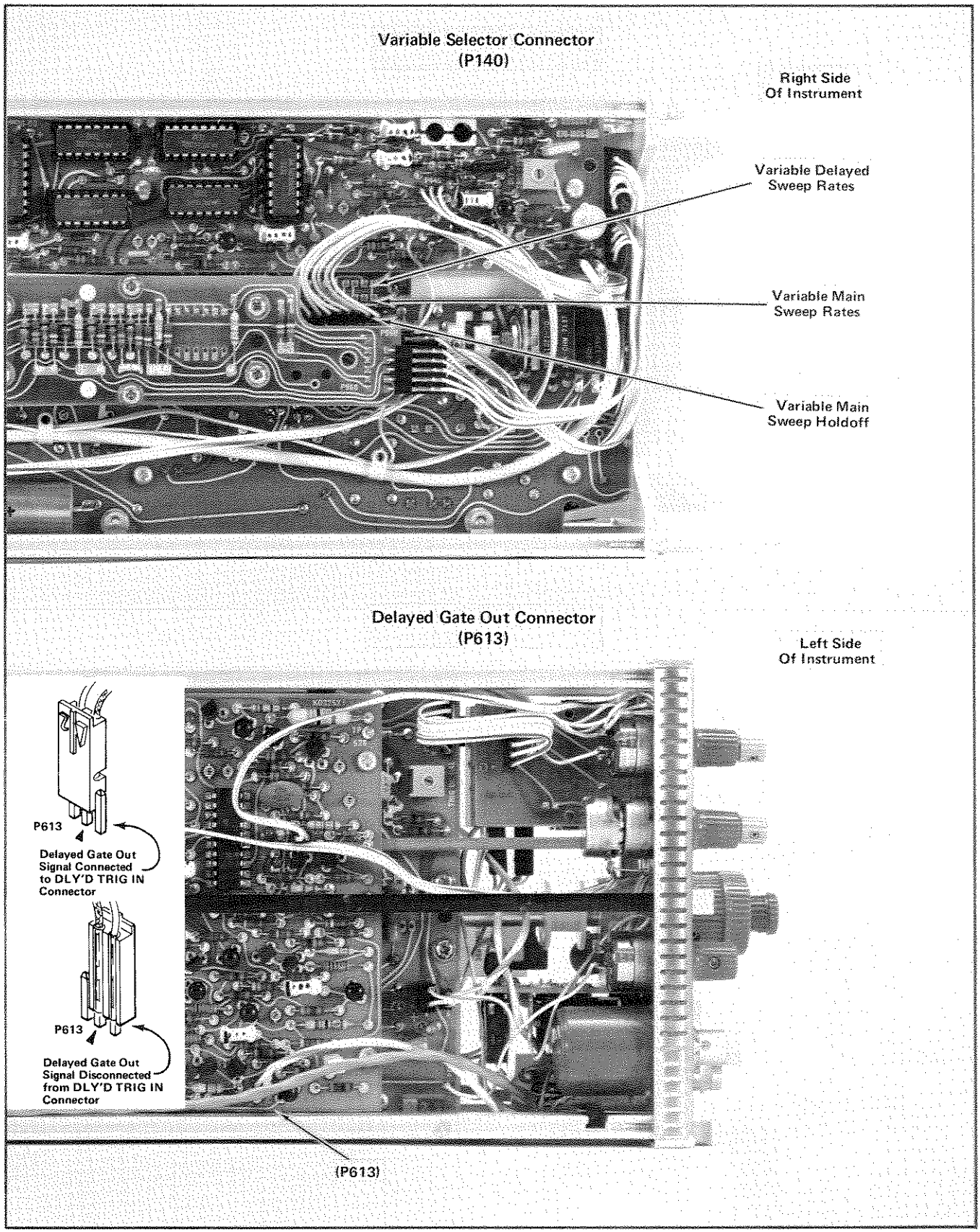


Fig. 1-3. Location of Delayed Gate Out and Variable Selector multi-pin connectors.

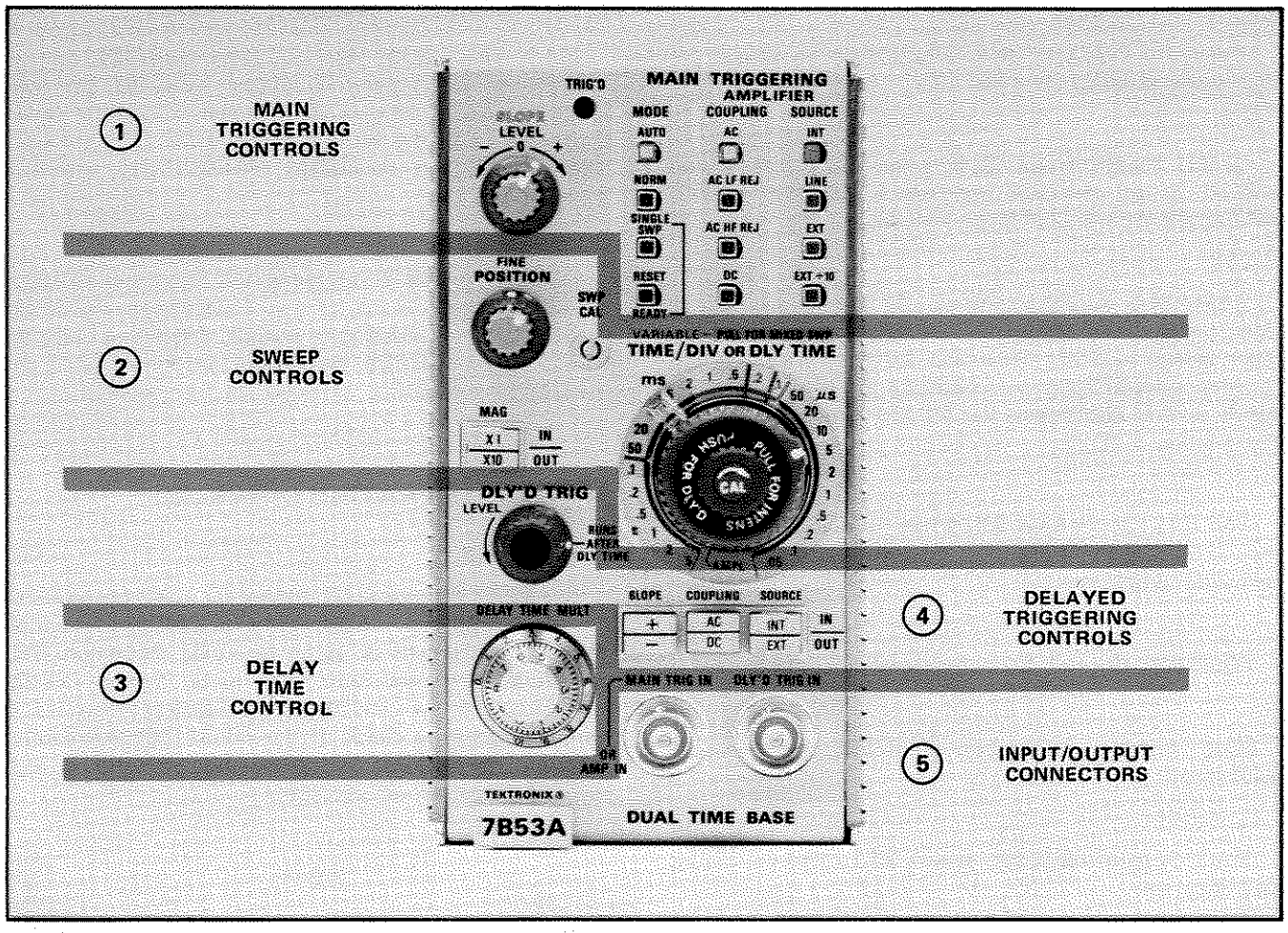


Fig. 1-4. Front-panel controls and connectors.

CONTROLS AND CONNECTORS

General

All controls required for the operation of the 7B53A/7B53AN, except the Variable Selector and the Dly'd Sweep Gate Out connector (see Fig. 1-3), are located on the front panel of the instrument. To make full use of the capabilities of this instrument, the operator should be familiar with the function and use of each control. A brief description of the front-panel controls and connectors is given here. More detailed information is given under General Operating Information. Fig. 1-4 shows the front panel and external controls and connectors of the 7B53A/7B53AN.

1. Main Triggering Controls

LEVEL. Selects the amplitude point on the trigger signal where sweep triggering occurs.

SLOPE. Two-position switch permits triggering on the positive-going or negative-going portion of the main triggering signal.

TRIG'D. Light indicates that the main sweep is triggered and will produce a display.

MODE. Pushbutton switches select the operating mode for the main triggering circuits.

COUPLING. Pushbutton switches select the method of coupling the triggering signal to the main triggering circuits.

SOURCE. Pushbutton switches select the source of the main triggering signal.

2. Sweep Controls

TIME/DIV OR DLY TIME. Selects the sweep rate of the main sweep generator (see Fig. 1-7).

DLY'D Time/Division. Selects the sweep rate of the delayed sweep generator and selects the MAIN SWP, INTEN, and DLY'D SWP Display Modes (see Fig. 1-7).

VARIABLE. Provides continuously variable main sweep rates, continuously variable delayed sweep rates, or variable main sweep holdoff; depending on the setting of the Variable Selector multi-pin connector (P140). The VARIABLE control also selects the MIXED Display Mode (see Fig. 1-3, Fig. 1-7).

SWP CAL. Screwdriver adjustment to match the gain of the 7B53A/7B53AN to the indicator oscilloscope for calibrated sweep rates.

POSITION. Controls horizontal position of display.

FINE. Provides precise control of horizontal position adjustment.

MAG. Pushbutton switch selects X1 or X10 horizontal magnification.

3. Delay Time Control

DELAY TIME MULT. Provides variable sweep delay between 0.00 and 10.0 times the delay time indicated by the TIME/DIV OR DLY TIME switch.

4. Delayed Triggering Controls

LEVEL. Selects the RUNS AFTER DLY TIME or Triggerable After Dly Time Modes, and the amplitude point at which the delayed sweep is triggered.

SLOPE. Two-position switch permits triggering on the positive-going or negative-going portion of the delayed triggering signal.

COUPLING. Two-position switch selects the method of coupling the triggering signal to the delayed triggering circuits.

SOURCE. Two-position switch to select the source of the delayed triggering signal.

5. Input/Output Connectors

MAIN TRIG IN OR AMP IN. Front-panel BNC connector serving as an external trigger input for the main triggering circuit or as an external horizontal input, depending upon the setting of the TIME/DIV OR DLY TIME switch and the MAIN TRIGGERING SOURCE switch.

DLY'D TRIG IN. Front-panel BNC connector serving as an external trigger input for the delayed triggering circuits or as a delayed sweep gate output; depending upon the DLY'D TRIG SOURCE switch, the position of P613, and the DISPLAY MODE.

OPERATING CHECKOUT

Introduction

The following procedure checks the basic operation of the 7B53A/7B53AN. It may also be used for familiarization with this instrument or as an incoming inspection. This procedure is divided into two parts, Sweep Control Functions, and Main and Delayed Triggering Functions. A complete operating check of the 7B53A/7B53AN control functions can be made by performing both parts, or each part may be performed separately.

NOTE

For optimum performance, the 7B53A/7B53AN should be installed in an oscilloscope system with similar frequency and sweep rate capabilities.

Setup Procedure

1. Install the 7B53A/7B53AN in the right horizontal compartment of the indicator oscilloscope.

2. Install a Vertical Amplifier unit in the left vertical compartment.

3. Turn on the indicator oscilloscope and allow at least 20 minutes warmup.

4. Set the 7B53A/7B53AN controls as follows:

MAIN TRIGGERING	
SLOPE	(+)
MODE	AUTO
COUPLING	AC
SOURCE	INT

DLY'D TRIG	
LEVEL	RUNS AFTER DLY TIME (fully clockwise)
SLOPE	(+)
COUPLING	AC
SOURCE	INT
Sweep Controls	
POSITION	Midrange
MAG	X1-IN
TIME/DIV OR DLY TIME	1 ms
DLY'D Time/Division	1 ms
VARIABLE	CAL (fully clockwise)
Variable Selector	Main Variable
DELAY TIME MULT	1.00

5. Set the indicator oscilloscope to display the plug-in units and adjust for a well defined display. See indicator oscilloscope and vertical unit instruction manuals for detailed operating instructions.

Sweep Control Functions

The following procedure checks the operation of the sweep controls and checks the Display Modes.

Normal Sweep

1. Perform steps one through five of the Setup Procedure.

NOTE

The Time/Division switch selects main sweep rates, delayed sweep rates, and Display Modes (MAIN SWP, INTEN, DLY'D SWP, and MIXED). Refer to Selecting Sweep Rates and Display Modes discussions in the General Operating Instructions for further information.

2. To select the MAIN SWP Display Mode, press in the DLY'D Time/Division knob, and set the TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switch to the same sweep rate (1 ms).

3. Connect the one-kilohertz calibrator signal from the indicator oscilloscope to the vertical amplifier unit Input. Adjust the Calibrator and the vertical Volts/Division switch for four divisions of display.

4. Rotate the MAIN TRIGGERING LEVEL control for a stable MAIN SWP display (non-delayed). Rotate the DELAY TIME MULT dial and note that it has no effect on the display.

5. Rotate the POSITION control and note that it horizontally positions the trace. Rotate the FINE control and note that it provides precise horizontal positioning. Disconnect the calibrator signal.

Sweep Calibration

NOTE

For accurate sweep timing, apply a signal of known frequency or time period (time-mark signal, calibrator square wave, 60 hertz line etc.) to the associated vertical amplifier unit and adjust the TIME/DIV OR DLY TIME switch and the SWP CAL control to calibrate the signal to the oscilloscope graticule. Be sure that the sweep timing signal is accurate within 0.5%. The following sweep calibration procedure uses a TEKTRONIX Time-Mark Generator.

6. Connect a 1 millisecond time-mark signal from the Time-Mark Generator with a 50-ohm BNC coaxial cable and 50-ohm BNC termination to the Input of the associated vertical unit. Adjust the vertical Volts/Div switch for about four divisions of display and rotate the MAIN TRIGGERING LEVEL control for a stable display. Check the CRT display for one complete time-mark per division (position as necessary). If necessary, adjust the SWP CAL screwdriver adjustment for one complete time-mark per division over the center eight divisions of display. Disconnect the Time-Mark Generator.

Intensified, Delayed, and Mixed Sweep

7. Reconnect the oscilloscope Calibrator signal to the vertical unit and adjust for about four divisions of vertical display. Pull out the DLY'D Time/Division knob and rotate clockwise to .1 ms/DIV for the INTEN Display Mode (TIME/DIV OR DLY TIME switch remains at 1 ms/DIV). Note that a delaying sweep with an intensified portion (delayed sweep) is displayed on the CRT (the oscilloscope Intensity may need to be varied to view the intensified display).

8. Rotate the DELAY TIME MULT dial and note that the amount of delay time before the intensified portion of display is controlled by the DELAY TIME MULT dial.

9. Rotate the VARIABLE control counterclockwise out of switch detent and note that the sweep rate indicated by the TIME/DIV OR DLY TIME switch can be varied to at least the sweep rate of the next adjacent position (2 ms/DIV). The internal Variable Selector connector must be set for variable main sweep rates. Return the VARIABLE control to the CAL position.

10. Press the DLY'D Time/Division switch to the inner position for the DLY'D SWP Display Mode. Note the magnified display with sweep rate determined by the DLY'D Time/Division switch. The oscilloscope Intensity may need to be increased to view the delayed sweep display.

11. Pull out the VARIABLE Time/Division knob for the MIXED Display Mode (MIXED Display Mode can be selected when operating in the DLY'D SWP Display Mode only). Note that the main sweep is displayed at a rate determined by the TIME/DIV OR DLY TIME switch followed by a delayed sweep display at the rate determined by the DLY'D Time/Division switch. Rotate the DELAY TIME MULT dial and note that the amount of display allocated to each sweep is determined by the DELAY TIME MULT dial.

Main and Delayed Sweep Triggering Functions

The following procedure checks the operation of the main and delayed triggering controls:

Partial Procedure. To begin the Operating Checkout with triggering, perform steps 1 through 5 of the Setup Procedure provided at the beginning of the Operating Checkout. Connect the 1-kilohertz calibrator signal from the indicator oscilloscope to the vertical unit Input and adjust for about four divisions of vertical display.

12. Set the TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switch to 1 ms and press in the DLY'D Time/Division switch and the Variable control. CHECK—that a stable display can be obtained with the COUPLING switch for MAIN TRIGGERING set to AC, AC HF REJ, and DC for both the positive and negative positions of the SLOPE switch (MAIN TRIGGERING LEVEL control may be adjusted as necessary to obtain a stable main sweep display). Remove all connections from the oscilloscope system.

13. Connect a 60 hertz signal (line voltage, etc.) with a 50-ohm cable or voltage probe to the vertical unit Input and adjust the Volts/Div switch for about four divisions of display. Set the MAIN TRIGGERING COUPLING switch to AC LF REJ and set the TIME/DIV OR DLY TIME switch to 10 ms. Rotate the MAIN TRIGGERING LEVEL control throughout its range and check that a stable display cannot be obtained (TRIG'D light off).

14. Change the MAIN TRIGGERING SOURCE switch to LINE and the COUPLING switch to AC. Check that a stable main sweep display can be obtained with the MAIN TRIGGERING COUPLING switch set to AC, AC HF REJ, and DC (MAIN TRIGGERING LEVEL control may be adjusted as necessary). Remove all connections from the oscilloscope system.

15. Connect the indicator oscilloscope Calibrator signal to the vertical unit Input connector and to the MAIN TRIG IN connector. Set the Calibrator for a 0.4 volt, 1 kilohertz signal and adjust the vertical unit Volts/Div switch for about four divisions of display. Set the TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switch to 1 ms. Set the MAIN TRIGGERING SOURCE switch to EXT and check that a stable display can be obtained with the COUPLING switch for MAIN TRIGGERING set to AC, AC HF REJ, and DC, for both the positive and negative positions of the SLOPE switch (MAIN TRIGGERING LEVEL control may be adjusted as necessary for a stable display).

16. Change the MAIN TRIGGERING SOURCE switch to EXT ÷ 10. Set the oscilloscope Calibrator for 4 volts at 1 kilohertz and adjust the vertical unit Volts/Div switch for about 4 divisions of display. Check that a stable display can be obtained with the COUPLING switch for MAIN TRIGGERING set to AC, AC HF REJ, and DC, for both the positive and negative positions of the SLOPE switch (MAIN TRIGGERING LEVEL control may be adjusted as necessary to obtain a stable delaying sweep display). Remove the Calibrator signal from the MAIN TRIG IN connector.

17. Set the MAIN TRIGGERING COUPLING switch to AC and the SOURCE switch to INT. Adjust the MAIN TRIGGERING LEVEL control for a stable display. Set the MODE switch to NORM and check for a stable display. Change the MODE switch to AUTO and adjust the LEVEL control for a free-running display. Change the MODE switch to NORM and check for no display.

18. Adjust the MAIN TRIGGERING LEVEL control for a stable display. Change the MAIN TRIGGERING MODE switch to SINGLE SWP. Press the RESET button and check for one sweep. Remove the 1 kilohertz signal from the vertical unit and press the RESET button. CHECK for no display and that the READY light is on. Connect the 1 kilohertz signal to the vertical unit and check for one sweep as the signal is applied.

19. Set the MAIN TRIGGERING MODE switch to AUTO. With the TIME/DIV OR DLY TIME switch at 1 ms, pull out the DLY'D Time/Division switch and rotate to .2 ms (Intensified Display Mode). Rotate the MAIN TRIGGERING LEVEL control for a stable display (oscilloscope Intensity may need to be varied to view the intensified display). Rotate the DELAY TIME MULT dial and note that the intensified portion of display is continuously variable.

20. Rotate the DLY'D TRIG LEVEL control counterclockwise out of switch detent for a triggered delayed sweep. With the DLY'D TRIG SLOPE, COUPLING, and SOURCE switches set to (+), AC, and INT; rotate the DLY'D TRIG LEVEL control for a stable intensified portion of display. Rotate the DELAY TIME MULT dial and note that the intensified portion of display does not start at the completion of the delay time (determined by the settings of the TIME/DIV OR DLY TIME switch and the DELAY TIME MULT dial), but waits for the next trigger pulse.

21. Press the DLY'D Time/Division switch in for the DLY'D SWP Display Mode. Rotate the DLY'D TRIG LEVEL control for a stable delayed sweep display (oscilloscope Intensity may need to be varied). Check that a stable delayed sweep display can be obtained with the DLY'D TRIG COUPLING switch set to AC and DC for both + and − positions of the SLOPE switch (DLY'D TRIG LEVEL control may be adjusted as necessary for a stable delayed sweep display).

22. Change the DLY'D TRIG SOURCE switch to EXT. Connect the indicator oscilloscope Calibrator signal to the DLY'D TRIG IN connector. Set the oscilloscope Calibrator for 0.4 volt at 1 kilohertz and adjust the vertical Volts/Division switch for about 4 divisions of display. Check that a stable delayed sweep display can be obtained with the DLY'D TRIG COUPLING switch set to AC and DC for both the + and − positions of the SLOPE switch (DLY'D TRIG LEVEL control may be adjusted as necessary for a stable delayed sweep display).

GENERAL OPERATING INSTRUCTIONS

Pushbutton Switch Logic

The MODE, COUPLING, and SOURCE pushbuttons of the MAIN TRIGGERING switches are arranged in a sequence which places the most-often used position at the top of each series of pushbuttons. With this arrangement, a stable display can usually be obtained by pressing the top pushbuttons: AUTO, AC, and INT. When an adequate trigger signal is applied, the unit is triggered as indicated by the illuminated TRIG'D light, with the correct setting of the LEVEL control and SLOPE switch. If the TRIG'D light is not on, the LEVEL control is at a setting outside the range of the trigger signal applied to this unit from the vertical unit, the trigger signal is inadequate, or its frequency is below the lower frequency limit of the AC COUPLING switch position. If the desired display is not obtained with these buttons pushed in, other selections must be made. Refer to the following discussions or the instruction manuals for the associated oscilloscope and vertical unit for more information.

Triggered Light

The TRIG'D light conveniently indicates the condition of the triggering circuits. If the MAIN TRIGGERING controls are correctly set and an adequate trigger signal is applied, the TRIG'D light is on. Under certain conditions, the TRIG'D light may be off, indicating that the sweep is not triggered. The cause could be a misadjusted LEVEL control, incorrectly set COUPLING or SOURCE switches, low trigger signal amplitude, or a triggering signal repetition rate outside the acceptable frequency range. This light can be used as a general indication of correct triggering. It is particularly useful when setting up the trigger circuits when a triggering signal is available without a display on the CRT.

Main Trigger Mode

The pushbuttons located under the MODE title select the mode in which the main sweep is triggered.

AUTO. When the AUTO pushbutton is pressed, a triggered display is presented whenever an adequate trigger signal is applied and the LEVEL control and SLOPE switch are correctly set. The TRIG'D light indicates when the display is triggered.

When the trigger repetition rate is below about 30 hertz, outside the frequency range selected by the COUPLING switch, or when the trigger signal is inadequate, the sweep free-runs at the sweep rate indicated by the TIME/DIV or DLY TIME switch (TRIG'D light off). When an adequate trigger signal is again applied, the free-running condition ends and a triggered display is presented. The sweep also free-runs when the LEVEL control is at a setting outside the amplitude range of the trigger signal. This type of free-running display can be useful when it is desired to measure only the maximum peak-to-peak amplitude of a signal without observing the waveshape (such as in bandwidth measurements). When the display is of a much greater amplitude than can be displayed on the CRT, the sweep will be triggered in all positions of the LEVEL control and will not free-run.

NORM. When the NORM pushbutton is pressed, a triggered display is presented with the correct setting of the LEVEL control and SLOPE switch whenever an adequate trigger signal is applied. The TRIG'D light indicates when the display is triggered.

The NORM trigger mode must be used to produce triggered displays with trigger repetition rates below about 30 hertz. When the LEVEL control is at a setting outside the amplitude range of the trigger signal, when the trigger repetition rate is outside the frequency range selected by the COUPLING switch, or when the trigger signal is inadequate, there is no trace (TRIG'D light is off).

SINGLE SWEEP, RESET-READY. When the signal to be displayed is not repetitive or varies in amplitude, waveshape, or repetition rate, a conventional repetitive type display may produce an unstable presentation. A stable display can often be obtained under these circumstances by using the SINGLE SWP feature of this unit. The SINGLE SWP MODE is also useful to photograph non-repetitive or unstable displays.

To obtain a single-sweep display of a repetition signal, first obtain the best possible display in the NORM MODE. Then without changing the other MAIN TRIGGERING switches, press the SINGLE SWEEP pushbutton. When ready to view the single-sweep display, press the RESET-READY pushbutton. A single trace is presented each time the RESET-READY pushbutton is pressed (as long as the repetitive signal remains connected to the system and MAIN TRIGGERING switches are correctly set); further sweeps cannot be presented until the RESET-READY pushbutton is pressed again. If the display signal is a complex waveform composed of varying amplitude, successive single-sweep displays may not start at the same point on the waveform. To avoid confusion due to the CRT persistence, allow the display to disappear before pressing the RESET-READY pushbutton again. At fast sweep rates, it may be difficult to view the single-sweep display. The apparent trace intensity can be increased by reducing the ambient light level or using a viewing hood as recommended in the indicator oscilloscope instruction manual.

Non-repetitive, random signals can be displayed in the SINGLE SWP MODE by first obtaining the best possible display in the NORM MODE with a signal which is about the same amplitude and frequency as the random signal. Then without changing the other MAIN TRIGGERING controls, press the SINGLE SWP pushbutton. When ready for the random signal, press the RESET-READY pushbutton. The RESET-READY pushbutton remains illuminated to indicate that the unit has been reset and is ready to produce a sweep. The light goes out after the single sweep has been displayed. To prepare the unit for another single-sweep display, press the RESET-READY pushbutton.

When using the SINGLE SWP MODE to photograph waveforms, turn off the graticule illumination while the trace is being photographed. Then the graticule can be photographed later to produce a double-exposure picture showing complete information. Further information on photographic technique is given in the appropriate camera instruction manual.

Main Triggering Coupling

The MAIN TRIGGERING pushbuttons located below the COUPLING title select the method in which the trigger signal is connected to the trigger circuits. Each position permits selection or rejection of the frequency components of the trigger signal which trigger the sweep. Fig. 1-5 graphically illustrates the band of frequencies covered by each position of the COUPLING switch.

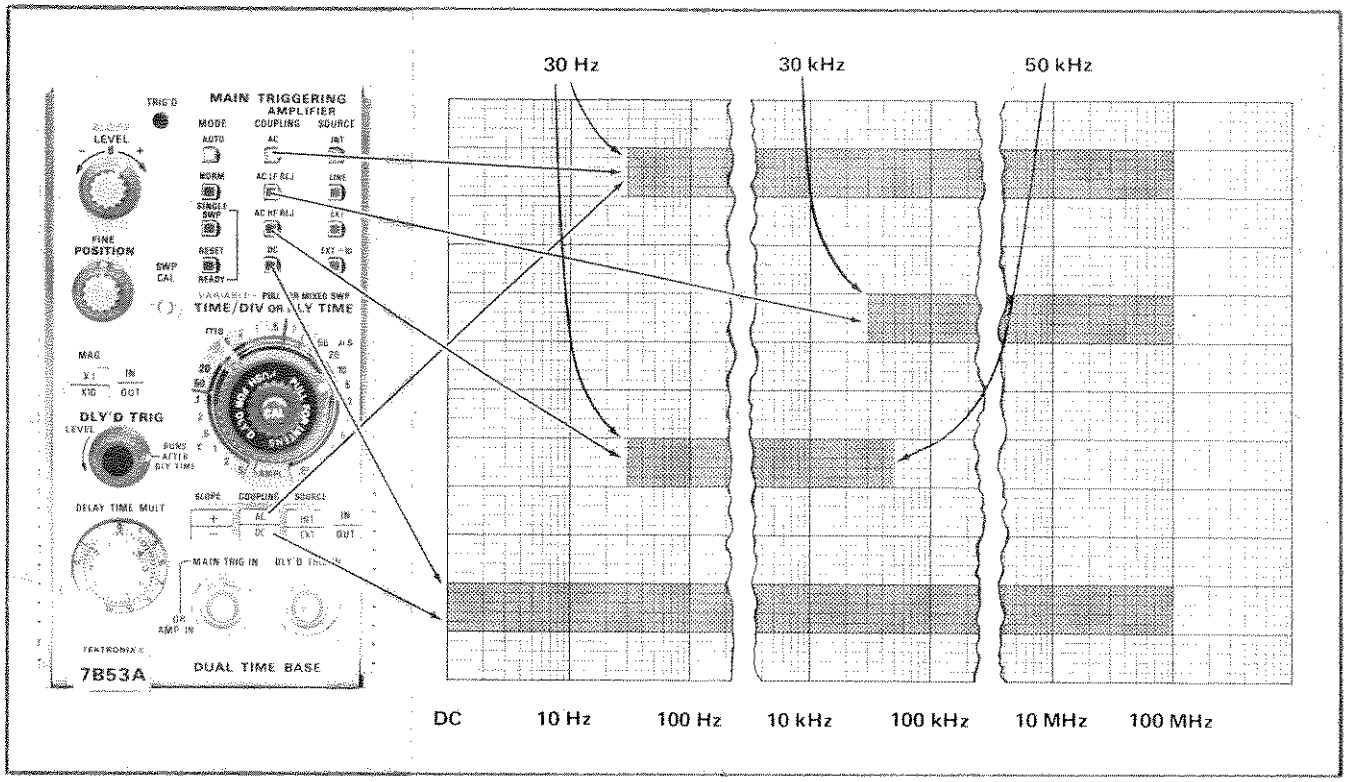


Fig. 1-5. Frequency range of each COUPLING switch position.

AC. In the AC position of the COUPLING switch, the DC component of the trigger signal is blocked. Signals with low-frequency components below about 30 hertz are attenuated. In general, AC COUPLING can be used for most applications. However, if the signal contains unwanted frequency components or if the sweep is to be triggered at a low repetition rate or DC level, one of the remaining COUPLING switch positions will provide a better display.

The triggering point in the AC position of the COUPLING switch depends upon the average voltage level of the trigger signal. If the trigger signal occurs randomly, the average voltage level will vary, causing the triggering point to vary also. This shift of the triggering point may make it impossible to maintain a stable display. In such cases, use DC COUPLING.

AC LF REJ. In the AC LF REJ position of the COUPLING switch, DC is rejected and low-frequency trigger signals below about 30 kilohertz are attenuated. Therefore, the sweep is triggered only by the higher-frequency components of the trigger signal. This position is particularly useful for providing stable triggering if the trigger signal contains line-frequency components. Also, the AC LF REJ position provides the best alternate vertical displays at fast sweep rates when comparing two or more unrelated signals.

AC HF REJ. The AC HF REJ position of the COUPLING switch passes all low-frequency signals between about 30 hertz and 50 kilohertz. DC is rejected and signals outside the above range are attenuated. When triggering from complex waveforms, this position is useful to provide a stable display of the low-frequency components.

DC. The DC position of the COUPLING switch can be used to provide stable triggering with low-frequency signals which would be attenuated in the other modes, or with low-repetition rate signals. It can also be used to trigger the sweep when the trigger signal reaches a DC level selected by the setting of the LEVEL control. When using internal triggering, the setting of the vertical unit position control affects the DC triggering point.

Main Triggering Source

The MAIN TRIGGERING pushbutton located below the SOURCE title select the source of the trigger signal which is connected to the main triggering circuits.

INT. In the INT position of the SOURCE switch, the trigger signal is derived from the associated vertical unit. Further selection of the internal trigger signal may be provided by the associated vertical unit or indicator oscilloscope; see the instruction manuals for these instruments for information. For most applications, the INT position of the SOURCE switch can be used. However, some applications require special triggering which cannot be obtained in the INT position of the SOURCE switch. In such cases the LINE or EXT positions of the SOURCE switch must be used.

LINE. The LINE position of the SOURCE switch connects a sample of the power-line voltage from the indicator oscilloscope to the trigger circuit. Line triggering is useful when the input signal is time-related (multiple or submultiple) to the line frequency. It is also useful for providing a stable display of a line-frequency component in a complex waveform.

EXT. An external signal connected to the MAIN TRIG IN connector can be used to trigger the sweep in the EXT position of the SOURCE switch. The external signal must be time-related to the displayed waveform for a stable display. An external trigger signal can provide a triggered display when the internal signal is too low in amplitude for correct triggering, or contains signal components on which it is not desired to trigger. It is also useful when signal tracing in amplifiers, phase shift networks, waveshaping circuits, etc. The signal from a single point in the circuit under test can be connected to the EXT TRIG IN connector with a probe or cable. The sweep is then triggered by the same signal at all times and allows amplitude, time relationship, or waveshape changes of signals at various points in the circuit to be examined without resetting the MAIN TRIGGERING controls.

EXT ÷ 10. Operation in the EXT ÷ 10 position of the SOURCE switch is the same as described for EXT except that the external signal is attenuated 10 times. Attenuation of high-amplitude external trigger signals is desirable to broaden the range of the LEVEL control.

Trigger Slope

The MAIN TRIGGERING SLOPE switch (concentric with the MAIN TRIGGERING LEVEL control) determines whether the trigger circuit responds on the positive-going or negative-going portion of the trigger signal. When the SLOPE switch is in the + position, the display starts on the positive-going portion of the waveform; in the – position, the display starts with the negative-going portion of the waveform (see Fig. 1-6). When several cycles of a signal appear in a display, the setting of the SLOPE switch is often unimportant. However, if only a certain portion of a cycle is to be displayed, correct setting of the SLOPE switch is important to provide a display which starts on the desired slope of the input signal.

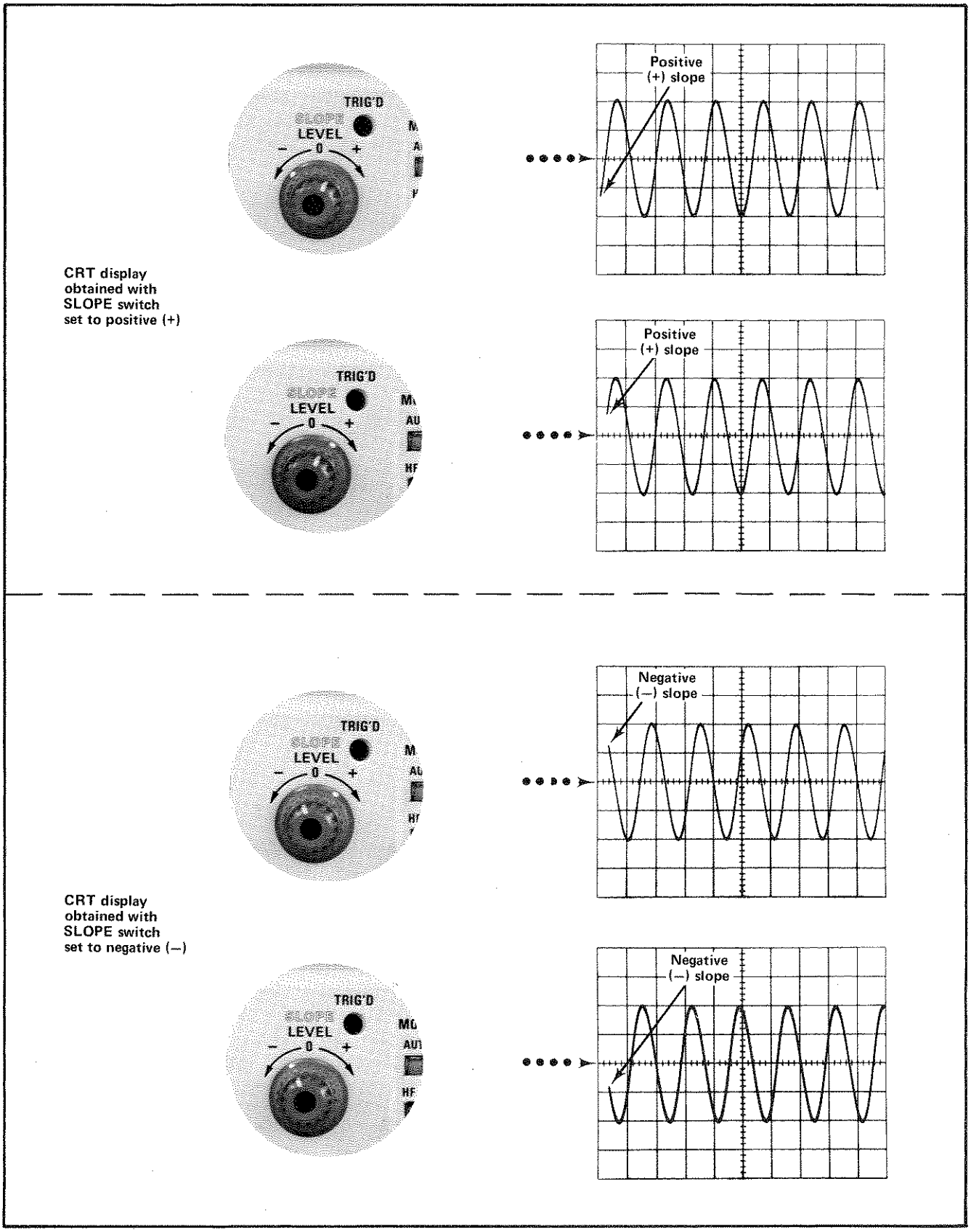


Fig. 1-6. Effect of LEVEL control and SLOPE switch on CRT display.

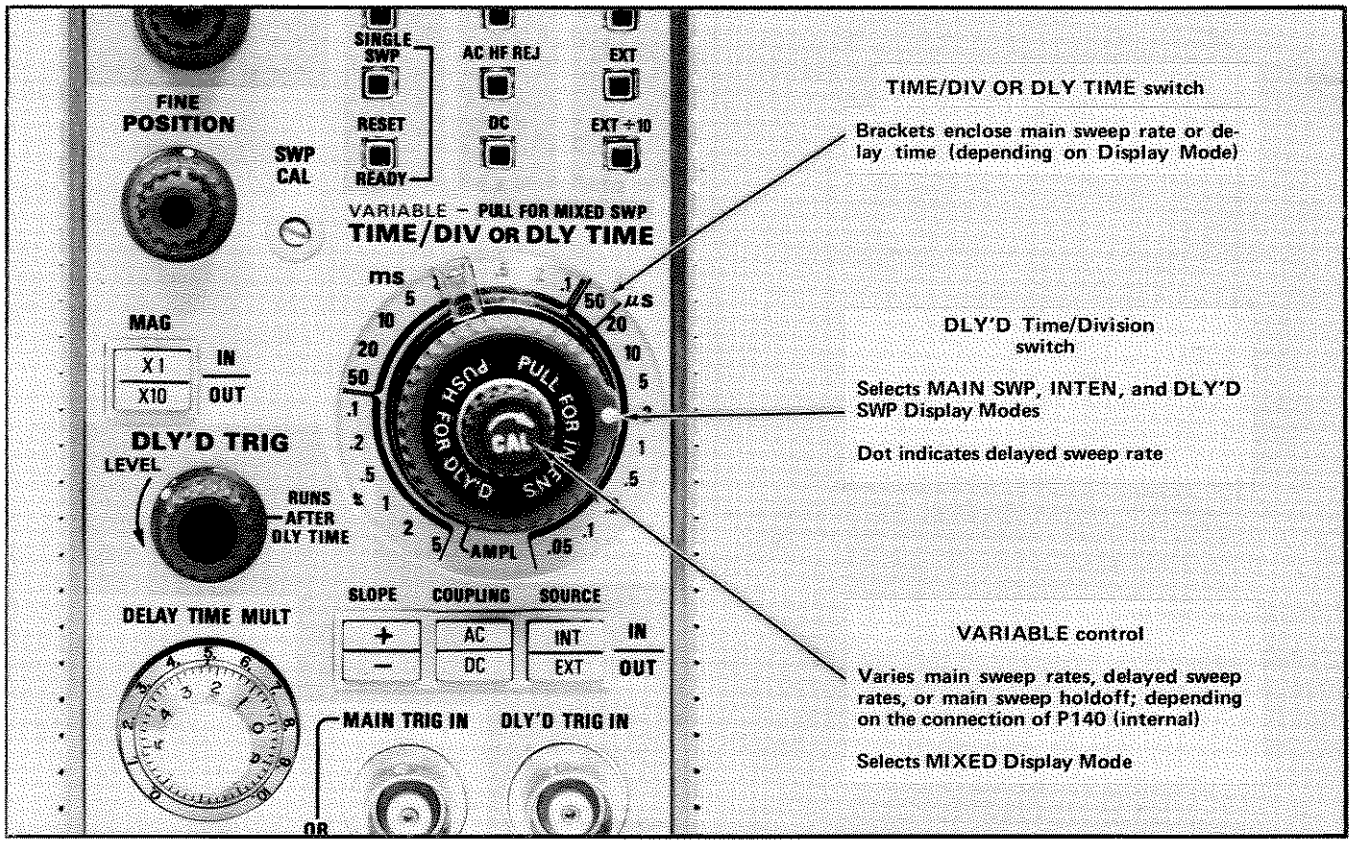


Fig. 1-7. Composite Time/Division switch.

Trigger Level

The MAIN TRIGGER LEVEL control determines the voltage level on the trigger signal at which the sweep is triggered. When the LEVEL control is set in the + region, the trigger circuit responds at a more positive point on the trigger signal. When the LEVEL control is set in the – region, the trigger circuit responds at a more negative point on the trigger signal. Fig. 1-6 illustrates this effect with different settings of the SLOPE switch.

Before setting the MAIN TRIGGERING LEVEL, set the desired SLOPE, MODE, COUPLING, and SOURCE. Set the LEVEL control fully counterclockwise and then rotate clockwise until the display starts at the desired point.

Selecting Sweep Rates

The TIME/DIV OR DLY TIME switch selects calibrated sweep rates for the main sweep generator and the DLY'D Time/Division switch selects calibrated sweep rates for the delayed sweep generator. The sweep rate of the main sweep generator is bracketed by the black lines on the clear plastic flange of the TIME/DIV OR DLY TIME switch (see Fig. 1-7). The sweep rate of the delayed sweep generator is indicated by the white line on the DLY'D Time/Division knob. When the TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switch are set to the same sweep rate, the switches lock together and the sweep rate of both generators are changed at the same time. However, when the DLY'D Time/Division knob is pulled outward, the clear plastic flange is disengaged and only the delayed sweep generator sweep rate is changed. This allows changing the delayed sweep rate without changing the delay time determined by the main sweep generator. The DLY'D Time/Division switch also selects Display Modes. See Display Mode discussion in this section for further information.

A VARIABLE control is provided concentric with the TIME/DIV OR DLY TIME and the DLY'D Time/Division switches (see Fig. 1-7). When the VARIABLE control is rotated clockwise to the CAL position (into switch detent) the variable function is inoperative and the VARIABLE knob can be used only to select the MIXED Display Mode (see Display Mode discussion in this section for more information). However, when rotated counterclockwise (out of switch detent), the VARIABLE control is activated for variable (uncalibrated) main sweep rates, delayed sweep rates, or main sweep holdoff; depending upon the setting of the Variable Selector multi-pin connector (see Fig. 1-3). The VARIABLE control allows the sweep rate in each Time/Division switch position (main or delayed) to be reduced to at least the next adjacent switch position and the holdoff time to be increased 2:1.

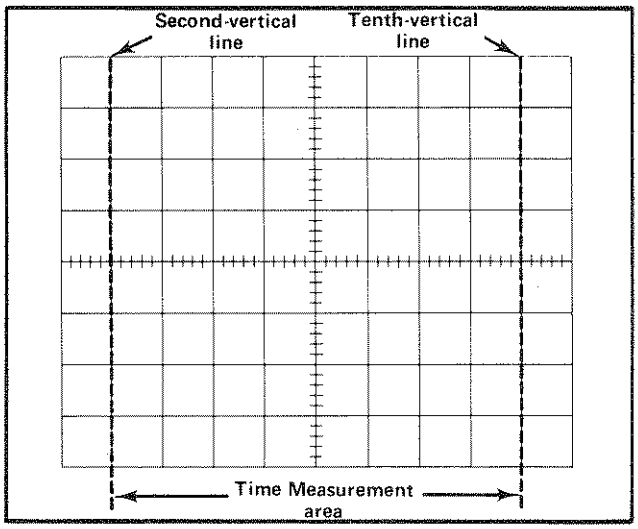


Fig. 1-8. Area of graticule used for accurate time measurements.

Time Measurement

When making time measurements from the graticule, the center eight divisions provide the most linear time measurements (see Fig. 1-8). Position the start of the timing area to the second vertical line and adjust the TIME/DIV OR DLY TIME switch so the end of the timing area falls between the second and tenth vertical lines.

Sweep Magnifier

The sweep magnifier can be used to expand the display ten times. The center division of the unmagnified display is the portion visible on the CRT in the magnified form (see Fig. 1-9). Equivalent length of the magnified sweep is more than 100 divisions; any 10 division portion can be viewed by adjusting the POSITION control to bring the desired portion onto the viewing area.

To use the MAG switch, first move the portion of the display which is to be expanded to the center of the graticule. Then press and release the MAG switch to the OUT – X10 position. When the MAG switch is in the X10 position, the equivalent magnified sweep rate can be determined by dividing the Time/Division setting by 10. For example, if the TIME/DIV OR DLY TIME switch is set to 1 ms the equivalent sweep rate is 100 μs. When operating in the INTEN, DLY'D SWP, or MIXED Display Modes the delayed sweep rate as well as the main sweep rate is increased 10 times.

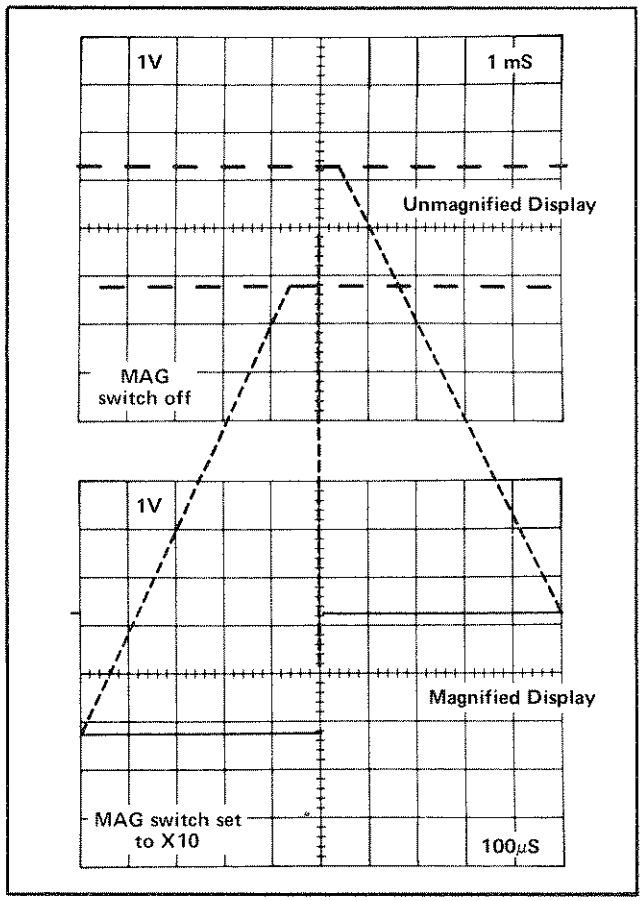


Fig. 1-9. Operation of Sweep Magnifier.

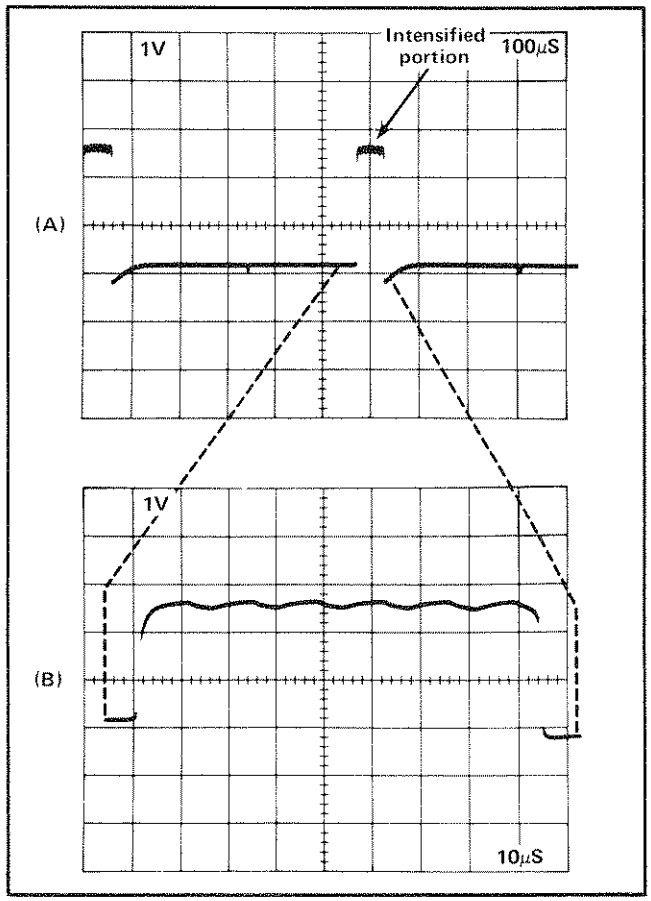


Fig. 1-10. (A) Intensified Sweep display; (B) Delayed Sweep display.

Display Modes

Four Display Modes can be selected by appropriate settings of the Time/Division switches (see Fig. 1-7).

Main Sweep Operation. To select the MAIN SWP Display Mode (non-delayed sweep) set the TIME/DIV OR DLY TIME and DLY'D Time/Division switches to the same sweep rate and press in the DLY'D Time/Division switch. Calibrated sweep rates in the MAIN SWP Display Mode are available from 5 s/DIV to 0.05 μs/DIV (5 ns/DIV with X10 magnification). The VARIABLE control (Variable Selector connector set to Main Variable) can be used to obtain uncalibrated sweep rates to 12.5 seconds/division. Triggering in the MAIN SWP Display Mode is controlled by the MAIN TRIGGER controls.

Intensified Sweep Display. To select the INTEN Display Mode, pull out the DLY'D Time/Division knob and rotate it to a desired sweep rate faster than the TIME/DIV OR DLY TIME switch setting. The INTEN Display Mode provides an intensified portion of the main sweep during the time the delayed sweep is in operation (see Fig. 1-10A). The time that the delayed sweep runs is determined by the DLY'D Time/Division switch. The amount of delay time between the start of the delaying sweep and the intensified portion is determined by the TIME/DIV OR DLY TIME switch and the DELAY TIME MULT dial. Triggering for the delaying sweep portion of display is controlled by the MAIN TRIGGERING controls; triggering for the intensified portion of display is controlled by the DLY'D TRIG controls.

Delayed Sweep Display. The DLY'D SWP Display Mode is selected when the DLY'D Time/Division switch is pulled out, rotated in the INTEN Mode for the desired sweep rate, and then pushed in. In this mode, the intensified portion of display, as viewed in the INTEN Display Mode, is displayed on the CRT at the sweep rate indicated by the DLY'D Time/Division switch (see Fig. 1-10B). Calibrated sweep rates in the DLY'D SWP Display Mode are available from .5 s/DIV to 0.05 μs/DIV. Uncalibrated delayed sweep rates to 1.25 seconds/division can be obtained by using the VARIABLE control (Variable Selector connector set to Dly'd Variable position). Triggering for the DLY'D SWP display is controlled by the DLY'D TRIG controls.

Mixed Sweep Operation. The MIXED Display Mode is selected when the DLY'D SWP Display Mode is selected and the VARIABLE knob is pulled out. In this mode, the main sweep is displayed on the CRT to a point determined by the DELAY TIME MULT dial; the remainder of the sweep is at a rate determined by the delayed sweep. Triggering for the main sweep portion of display is controlled by the MAIN TRIGGERING controls; and triggering for the delayed sweep portion of display is controlled by the DLY'D TRIG controls. A typical mixed sweep display is shown in Fig. 1-11.

Delay Time Multiplier

The DELAY TIME MULT dial (functional in the INTEN, DLY'D SWP, and MIXED Display Modes) provides 0 to 10 times continuous sweep delay. The time that the main sweep runs before the start of the delayed sweep is determined by the settings of the TIME/DIV OR DLY TIME switch and the DELAY TIME MULT dial.

For example, the delay time indicated by the DELAY TIME MULT dial in Fig. 1-12 is 3.55; this corresponds to 3.55 CRT divisions of main sweep. Thus 3.55 multiplied by the delaying sweep rate, indicated by the TIME/DIV OR DLY TIME switch, gives the calibrated delay time before the start of the delayed sweep.

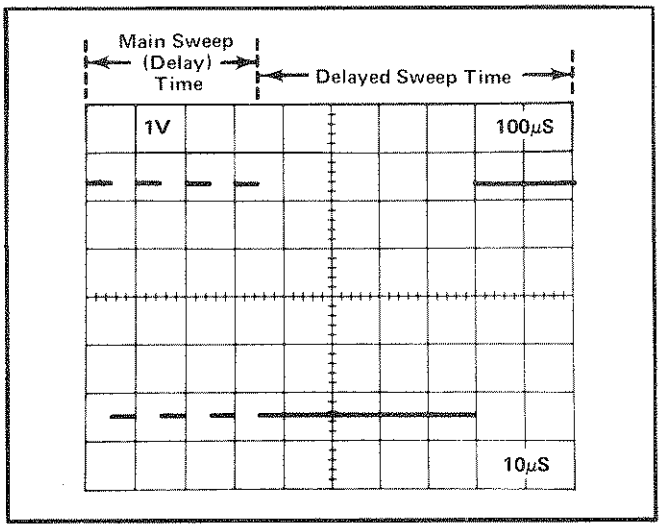


Fig. 1-11. Typical Mixed Sweep display (DELAY TIME MULT dial set to 3.55).

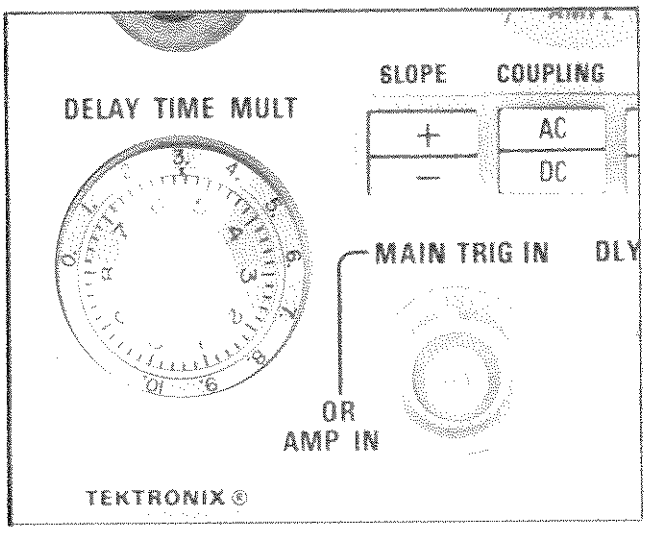


Fig. 1-12. DELAY TIME MULT dial. Reading shown: 3.55.

Delayed Sweep Triggering

A LEVEL control and SLOPE, COUPLING, and SOURCE switches are provided for delayed sweep triggering. When the LEVEL control is rotated to the RUNS AFTER DLY TIME position the delayed sweep starts immediately after the delay time. The DLY'D TRIG LEVEL control and the SLOPE, COUPLING, and SOURCE switches are inoperative. This mode permits the selection of continuously variable delay times (by varying the DELAY TIME MULT dial).

When the DLY'D TRIG LEVEL control is rotated counterclockwise (out of switch detent), the delayed sweep is triggerable. The delayed sweep does not start at the completion of the delay time but, waits until a trigger pulse is received by the delayed sweep triggering circuit. The delay time in this mode is dependent not only on the settings of the delay-time controls, but on the delayed sweep triggering controls and the occurrence of the delayed sweep triggering signal. The primary purpose of this mode is to eliminate jitter from the display delayed sweep waveform. Since the delayed sweep is triggered by the input waveform, jitter is eliminated from the delayed sweep display even though it may be inherent in the input waveform.

When the delayed sweep is triggerable, the LEVEL control can be rotated to select the amplitude point on the trigger signal at which the delayed sweep is triggered. The DLY'D TRIG SLOPE, COUPLING, and SOURCE switches are activated and their functions are the same for delayed triggering as functions with the same title are for MAIN TRIGGERING (see Main Triggering Level, Slope, Coupling, and Source discussions in this section).

Input/Output Connectors

Two dual-function BNC connectors are provided on the instrument front-panel.

MAIN TRIG IN OR AMP IN. This connector is an external trigger input for the main triggering circuit when the MAIN TRIGGERING SOURCE switch is set to EXT or EXT ÷ 10 and the TIME/DIV OR DLY TIME switch is set to any position except AMPL. When the TIME/DIV OR DLY TIME switch is set to AMPL and the MAIN TRIGGERING SOURCE switch is set to EXT or EXT ÷ 10, this connector serves as an external horizontal input (see X-Y Operation).

DLY'D TRIG IN. This connector is an external input for the delayed triggering circuit when the DLY'D TRIG SOURCE switch is set to EXT. When the DLY'D TRIG SOURCE switch is set to INT and P613 is properly connected (see Fig. 1-3), the DLY'D TRIG IN connector serves as a Delayed Sweep Gate Out connector (not labeled). The Delayed Sweep Gate signal is a rectangular positive-going pulse with approximately 3.0 volts amplitude and pulse width coincident with the delayed sweep.

X-Y Operation

Some applications require one signal displayed versus another rather than against time (internal sweep). The amplifier function of the 7B53A/7B53AN allows an external signal to be applied to the horizontal deflection system either externally via the MAIN TRIG IN OR AMP IN connector or internally by way of the triggering system.

To apply an external signal (X-signal) to the horizontal system, set the 7B53A/7B53AN TIME/DIV OR DLY TIME switch to AMPL and the MAIN TRIGGERING SOURCE switch to EXT. The MAIN TRIGGERING COUPLING selected affects the frequency response of the X-signal. Apply the external signal to the MAIN TRIG IN OR AMP IN connector. Deflection factor of the X-signal is provided in multiples of 10 as shown in Table 1-1. The Y-signal can be applied to the plug-in unit installed in the vertical compartment.

TABLE 1-1

MAIN TRIGGERING COUPLING	MAG	DEFLECTION FACTOR (within 10%)
EXT	X 10	10 mV/div
EXT	X1	100 mV/div
EXT ÷ 10	X 1	1 V/div

To apply the X-signal internally via the triggering system set the TIME/DIV OR DLY TIME switch to AMPL and the MAIN TRIGGERING SOURCE switch to INT. Apply the external signal to the Amplifier unit installed in the vertical compartment. The attenuator switch of the Amplifier unit determines the horizontal deflection factor.

For information on X-Y applications see the oscilloscope manual. Also, the reference books listed under Applications provide information on X-Y measurements and interpreting the resultant lissajous displays.

Mainframe Operating Modes

The 7B53A/7B53AN can be operated in a 7000-Series Oscilloscope which has four plug-in compartments, either independently, in the Alternate or Chopped Horizontal Modes, or as a delayed sweep unit. However, when the 7B53A/7B53AN is operated as a delayed sweep unit, it must be triggered for a CRT display. It cannot delay another time base unit but it can delay its own internal delayed sweep. Refer to the appropriate oscilloscope manual for additional mainframe horizontal operating information.

APPLICATIONS

General

The following information describes the procedure and techniques for making basic measurements with a 7B53A/7B53AN installed in a 7000-Series Oscilloscope. These applications are not described in detail, since each application must be adapted to the requirements of the individual measurement. This instrument can also be used for many applications not described in this manual. Contact your local TEKTRONIX Field Office or representative for assistance in making specific measurements. The following books describe oscilloscope measurement techniques which can be adapted for use with this instrument.

J. Czech, "Oscilloscope Measuring Techniques", Phillips Technical Library, Springer-Verlag, New York, 1965.

John D. Lenk, "Handbook of Oscilloscope Theory and Applications", Prentice-Hall, Inc. Englewood Cliffs, N.J., 1968.

Charles H. Roth, Jr., "Use of the Oscilloscope", Programmed Text, Prentice-Hall, Inc., Englewood Cliffs, N.J. 1970.

J. H. Golding, "Measuring Oscilloscope", Transatlantic, 1971.

Comparison Measurement Techniques

Sweep Rates. To establish an arbitrary horizontal sweep rate based upon a specific reference frequency proceed as follows:

1. Connect the reference signal to the input of the vertical unit. Set the Volts/Division switch of the vertical unit for four or five divisions of vertical deflection. Obtain a triggered display.

2. Set the TIME/DIV OR DL'Y TIME switch and the VARIABLE control (Variable Selector connector set to Main Variable) so one cycle of the signal covers an exact number of horizontal divisions. Do not change the VARIABLE control after obtaining the desired deflection. This display can be used as a reference for frequency comparison measurements.

3. To establish an arbitrary sweep rate so the period (time for one complete cycle) of an unknown signal can be measured accurately at any setting of the TIME/DIV OR DLY TIME switch, the period of the reference signal must be known. If it is not known, it can be measured before the VARIABLE switch is set in step 2.

4. Divide the period of the reference signal (seconds) by the product of the horizontal deflection established in step 2 (division) and the setting of the TIME/DIV OR DLY TIME switch. This is the horizontal conversion factor:

$$\text{Horizontal Conversion Factor} = \frac{\text{reference signal period (seconds)}}{\text{horizontal deflection (divisions)} \times \text{TIME/DIV OR DLY TIME switch setting}}$$

5. To measure the period of an unknown signal disconnect the reference signal and connect the unknown signal to the vertical unit. Set the TIME/DIV OR DLY TIME switch to a setting that provides sufficient horizontal deflection to make an accurate measurement. Do not readjust the VARIABLE control.

6. Measure the horizontal deflection in divisions and calculate the period of the unknown signal using the following formula:

$$\text{Period (Seconds)} = \text{TIME/DIV OR DLY TIME setting} \times \text{horizontal conversion factor} \times \text{horizontal deflection (divisions)}$$

Example. Assume a reference signal frequency of 455 hertz (period 2.19 milliseconds), a TIME/DIV OR DLY TIME switch setting of .2 ms, and the VARIABLE control adjusted to provide a horizontal deflection of eight divisions. Substituting these values in the horizontal conversion factor formula (step 4):

$$\text{Horizontal Conversion Factor} = \frac{2.19 \text{ milliseconds}}{.2 \text{ ms} \times 8} = 1.37$$

Then, with a TIME/DIV OR DLY TIME switch setting of 50 μs, the period of an unknown signal which completes one cycle in seven horizontal divisions can be determined by using the period formula (step 6):

$$\text{Period (Seconds)} = 50\,\mu s \times 1.37 \times 7 = 480\,\mu s$$

This answer can be converted to frequency by taking the reciprocal of the period in seconds (see application on Determining Frequency Measurements).

Time Duration Measurements

To measure time between two points on a waveform, use the following procedure:

1. Connect the signal to be displayed to the input of the vertical unit.

2. Set the Vertical and Horizontal Mode switches on the indicator oscilloscope to display the plug-in units used.

3. Set the Volts/Division switch of the vertical unit to display about four divisions of waveform.

4. Set the MAIN TRIGGERING controls to obtain a stable display.

5. Set the TIME/DIV OR DLY TIME switch to the fastest sweep rate that displays less than eight divisions between the time measurement points (see topic entitled "Time Measurements" and Fig. 1-8).

6. Adjust the vertical unit position control to move the points between which the time measurement is made to the center horizontal line.

7. Adjust the horizontal POSITION control to position the time-measurement points within the center eight divisions of the graticule.

8. Measure the horizontal distance between the time measurement points. Be sure the VARIABLE control is set to CAL.

9. Multiply the distance measured in step 8 by the setting of the TIME/DIV OR DLY TIME switch.

Example. Assume that the distance between the time measurement points is five divisions (see Fig. 1-13), and the TIME/DIV OR DLY TIME switch is set to .1 ms.

Using the formula:

$$\text{Time Duration} = \text{horizontal distance (divisions)} \times \text{TIME/DIV OR DLY TIME setting}$$

Substituting the given values:

$$\text{Time Duration} = 5 \times 0.1 \text{ ms}$$

The time duration is 0.5 millisecond.

Determining Frequency

The time measurement technique can also be used to determine the frequency of a signal. The frequency of a periodically recurrent signal is the reciprocal of the time duration (period) of one complete cycle.

Use the following procedure:

1. Measure the time duration of one complete cycle of the waveform as described in the previous application.

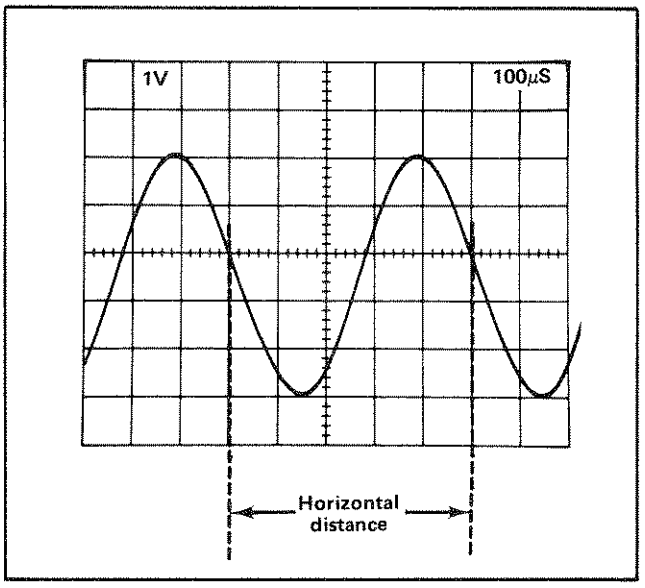


Fig. 1-13. Measuring the time duration between points on a waveform.

2. Take the reciprocal of the time duration to determine the frequency.

Example. The frequency of the signal shown in Fig. 1-13 which has a time period of 0.5 millisecond is:

Frequency =

$$\frac{1}{\text{time period}} \times \frac{1}{0.5 \text{ millisecond}} = 2 \text{ kilohertz}$$

Risetime Measurements

Risetime measurements employ basically the same techniques as time-duration measurements. The main difference is the points between which the measurement is made. The following procedure gives the basic method of measuring risetime between the 10% and 90% points of the waveform. Falltime can be measured in the same manner on the trailing edge of the waveform.

1. Connect the signal to be displayed to the input of the vertical unit.

2. Set the Vertical and Horizontal Mode switches on the indicator oscilloscope to display the plug-in unit used.

3. Set the Volts/Division switch and the Variable Volts/Division control of the vertical unit to produce a signal an exact number of divisions in amplitude.

4. Center the display about the center horizontal graticule line with the vertical unit Position control.

5. Set the MAIN TRIGGERING controls to obtain a stable display.

6. Set the TIME/DIV OR DLY TIME switch to the fastest sweep rate that displays less than eight divisions between the 10% and 90% points on the waveform.

7. Determine the 10% and 90% points on the rising portion of the waveform. The figures given in Table 1-2 are for the points 10% up from the start of the rising portion and 10% down from the top of the rising portion (90% point).

TABLE 1-2

Risetime Measurements

Vertical display (divisions)	10% and 90% points	Divisions vertically between 10% and 90% points
4	0.4 and 3.6 divisions	3.2
5	0.5 and 4.5 divisions	4.0
6	0.6 and 5.4 divisions	4.8
7	0.7 and 6.3 divisions	5.6
8	0.8 and 7.2 divisions	6.4

8. Adjust the horizontal POSITION control to move the 10% point of the waveform to the second vertical line of the graticule. For example, with a five-division display as shown in Fig. 1-14, the 10% point is 0.5 division up from the start of the rising portion.

9. Measure the horizontal distance between the 10% and 90% points. Be sure the VARIABLE control is set to CAL.

10. Multiply the distance measured in step 9 by the setting of the TIME/DIV OR DLY TIME switch.

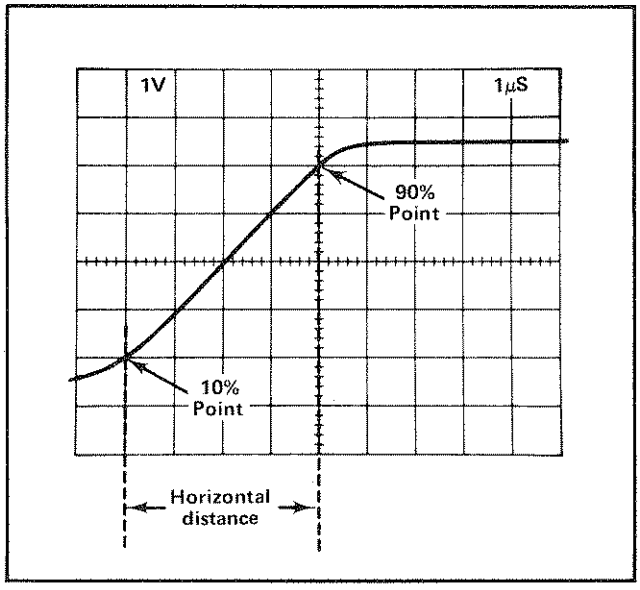


Fig. 1-14. Measuring risetime.

Example. Assume that the horizontal distance between the 10% and 90% points is four divisions (see Fig. 1-14) and the TIME/DIV OR DLY TIME switch is set to 1 μs. Applying the time duration formula to risetime:

Time Duration (Risetime)	=	horizontal distance (divisions)	X	TIME/DIV OR DLY TIME setting

Substitute the given values:

Risetime = 4 X 1 microsecond.

The risetime is 4.0 microseconds.

Delayed Sweep Measurement

The delayed sweep mode can be used to make accurate time measurements. The following measurement determines the time difference between two pulses displayed on the same trace. This application may also be used to measure time difference from two different sources (dual-trace) or to measure time duration of a single pulse. See Section 2 for measurement accuracy.

1. Connect the signal to be displayed to the input of the vertical unit.

2. Set the vertical and horizontal Mode switches on the indicator oscilloscope to display the plug-in units used.

3. Set the Volts/Division switch of the vertical unit to produce a display about 4 divisions in amplitude.

4. Adjust the MAIN TRIGGERING controls for a stable display.

5. If possible, set the TIME/DIV OR DLY TIME switch to a sweep rate which displays about eight divisions between pulses.

6. Set the DLY'D Time/Division switch to a setting 1/100 of the TIME/DIV OR DLY TIME switch setting and pull out the DLY'D Time/Division switch for the INTEN Display Mode. This produces an intensified portion approximately 0.1 division in length.

NOTE

Measurement accuracy will be affected if the LEVEL control setting for MAIN TRIGGERING or horizontal POSITION control setting is changed.

7. Rotate the DELAY TIME MULT dial to move the intensified portion of the trace to the first pulse.

8. Press in the DLY'D Time/Division switch for the DLY'D SWP Display Mode.

9. Adjust the DELAY TIME MULT dial to move the pulse (or the rising portion) to the center vertical graticule line. Note the exact setting of the dials.

10. Turn the DELAY TIME MULT dial clockwise until the second pulse is positioned to the same point as the first pulse. (If several pulses are displayed, return to the INTEN DISPLAY MODE to locate the correct pulse). Again note the exact dial setting.

11. Subtract the first dial setting from the second and multiply by the delay time shown by the TIME/DIV OR DLY TIME switch. This figure is the time interval between pulses.

Example. Assume the first dial setting is 1.31 and the second dial setting is 8.81 with the TIME/DIV OR DLY TIME switch set to 2 microsecond (see Fig. 1-15).

$$\text{Time Difference (Delayed Sweep)} = \left(\begin{matrix}\text{second}\\ \text{dial}\\ \text{setting}\end{matrix}\right) - \left(\begin{matrix}\text{first}\\ \text{dial}\\ \text{setting}\end{matrix}\right) \times \text{delay time (TIME/DIV OR DLY TIME switch setting)}$$

Substituting the given values:

Time Difference = (8.81 − 1.31) X 2 μs

The time difference is 15 μs

Delayed Sweep Magnification

The delayed sweep feature of the 7B53A/7B53AN provides apparent magnification of the displayed waveform. The sweep rate of the delayed sweep is not actually increased; the apparent magnification is the result of delaying the Delayed Sweep an amount of time selected by the TIME/DIV OR DLY TIME switch and the DELAY TIME MULT dial before the display is presented at the sweep rate selected by the DLY'D Time/Division switch. The following method uses the RUNS AFTER DLY TIME DLY'D TRIG Mode to allow the delayed portion of the display to be positioned with the DELAY TIME MULT dial. If there is too much jitter in the delayed sweep display, use the Triggered delayed sweep magnification procedure which follows this procedure.

1. Connect the signal to be displayed to the input connector of the vertical unit. Set the Vertical and Horizontal Mode switches on the indicator oscilloscope to display the plug-in units used.

2. Set the Volts/Division switch of the vertical unit to produce a display about 4 divisions in amplitude.

3. Adjust the MAIN TRIGGERING controls for a stable display.

4. Set the TIME/DIV OR DLY TIME switch to a sweep rate which displays the complete waveform (see Fig. 1-16A).

5. Pull out the DLY'D Time/Division switch for the INTEN Display Mode. Rotate the DLY'D TRIG LEVEL control clockwise to RUNS AFTER DLY TIME.

6. Position the start of the intensified portion with the DELAY TIME MULT dial to the part of the display to be magnified.

7. Set the DLY'D Time/Division switch to a setting which intensifies the full portion of the display to be magnified. The start of the intensified trace will remain as positioned in Step 6.

8. Press in the DLY'D Time/Division switch for the DLY'D SWP Display Mode.

9. Time Measurements can be made from the display in the conventional manner. Sweep rate is determined by the setting of the DLY'D Time/Division switch.

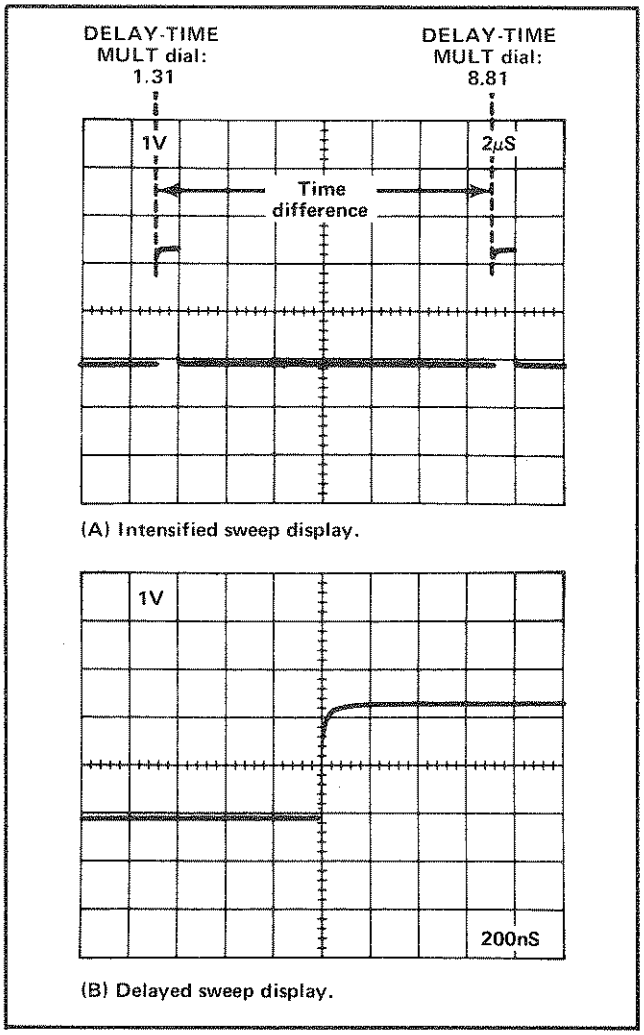


Fig. 1-15. Measuring time difference using delayed sweep.

10. The apparent sweep magnification can be calculated by dividing the TIME/DIV OR DLY TIME switch setting by the DLY'D Time/Division switch setting.

Example. The apparent magnification of the display shown in Fig. 1-16 with a TIME/DIV OR DLY TIME setting of .1 ms and a DLY'D Time/Division switch setting of 10 microsecond is:

$$\text{Apparent Magnification} = \frac{\text{TIME/DIV OR DLY TIME setting}}{\text{DLY'D Time/Division setting}}$$

Substituting the given values:

$$\text{Apparent Magnification} = \frac{1 \times 10^{-4}}{1 \times 10^{-5}}$$

The apparent magnification is 10 times.

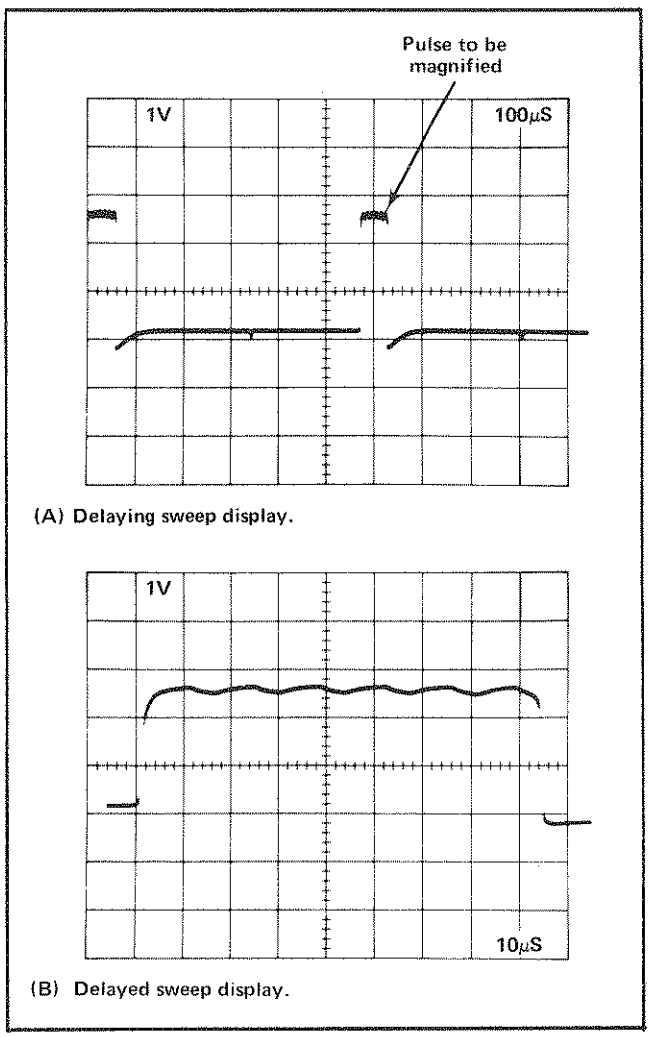


Fig. 1-16. Using delayed sweep for magnification.

Triggered Delayed Sweep Magnification

The delayed sweep magnification method just described may produce too much jitter at high apparent magnification ranges. The Triggered Delayed Sweep Mode (DLY'D TRIG LEVEL control rotated out of switch detent) provides a more stable display, since the delayed sweep display is triggered at the same point each time.

1. Set up the display as instructed in steps 1 through 7 in the Delayed Sweep Magnification procedure.

2. Rotate the DLY'D TRIG LEVEL control in a counterclockwise direction but out of switch detent for a triggerable delayed sweep. Select the desired DLY'D TRIG SLOPE, COUPLING, and SOURCE.

3. Adjust the DLY'D TRIG LEVEL control to produce an intensified portion on the display.

4. Inability to produce an intensified portion on the display indicates that the DLY'D TRIG controls are incorrectly set, or that the signal does not meet triggering requirements. If the condition cannot be remedied with the DLY'D TRIG controls or by increasing the display amplitude (lower Volts/Division setting), externally trigger the delayed sweep.

5. When the correct portion of the display is intensified, press in the DLY'D Time/Division switch for the DLY'D SWP Display Mode, slight readjustment of the DLY'D TRIG LEVEL control may be necessary to produce a stable delayed sweep display.

6. Measurement and magnification are as described above in Delayed Sweep Magnification discussion.

Displaying Complex Signals Using Delayed Sweep

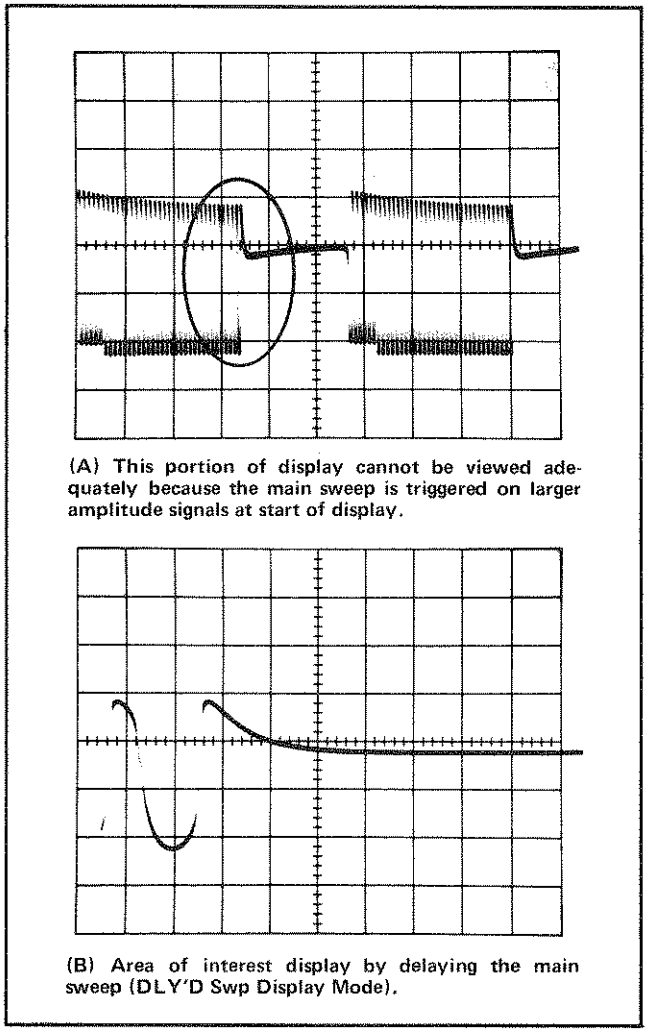
Complex signals often consist of a number of individual events of differing amplitudes. Since the trigger circuits are sensitive to changes in signal amplitude, a stable display can normally be obtained only when the sweep is triggered by the event(s) having the greatest amplitude. However, this may not produce the desired display of a lower-amplitude portion which follows the triggering event. The delayed sweep feature provides a means of delaying the start of the delayed sweep by a selected time following the event which triggers the main sweep generator. Then, the part of the waveform which contains the information of interest can be displayed at the delayed sweep rate.

Use the following procedure:

1. Set up the display as given in Steps 1 through 8 of Delayed Sweep Magnification.

2. Time measurements can be made from the display in the conventional manner. Sweep rate is determined by the setting of the DLY'D Time/Division switch.

Example. Fig. 1-17 shows a complex waveform as displayed on the CRT. The circled portion of the waveform cannot be viewed in any greater detail because the sweep is triggered by the larger amplitude pulses at the start of the display and a faster sweep rate moves this area of the waveform off the viewing area. The second waveform shows the area of interest magnified 10 times using Delayed Sweep. The DELAY TIME MULT dial has been adjusted so the delayed sweep starts just before the area of interest.



(A) This portion of display cannot be viewed adequately because the main sweep is triggered on larger amplitude signals at start of display.

(B) Area of interest display by delaying the main sweep (DLY'D Swp Display Mode).

Fig. 1-17. Displaying a complex signal using delayed sweep.

Pulse Jitter Measurements

In some applications it is necessary to measure the amount of jitter on the leading edge of a pulse or jitter between pulses.

1. Connect the signal to be displayed to the input connector of the vertical unit. Set the Vertical and Horizontal Mode switches on the indicator oscilloscope to display the plug-in units used.

2. Set the Volts/Division switch on the vertical unit to produce a display about 4 divisions in amplitude.

3. Adjust the MAIN TRIGGERING controls for a stable display.

4. Set the TIME/DIV OR DL Y TIME switch to a sweep rate which displays the complete waveform (see Fig. 1-16A).

5. Pull out the DLY'D Time/Division switch for the INTEN Display Mode.

6. Position the start of the intensified portion with DELAY TIME MULT dial to the part of the display to be magnified.

7. Set the DLY'D Time/Division switch to a setting which intensifies the full portion of the display to be magnified. The start of the intensified trace will remain as positioned in Step 6.

8. Press in the DLY'D Time/Division switch for the DLY'D SWP Display Mode.

9. Slight readjustment of the MAIN TRIGGERING LEVEL control may be necessary to produce as stable a display as possible.

10. Pulse jitter is shown by horizontal movement on the pulse (take into account inherent jitter of delayed sweep). Measure the amount of horizontal movement. Be sure that both vertical and horizontal VARIABLE controls are set to CAL.

11. Multiply the distance measured in Step 10 by the DLY'D Time/Division switch setting to obtain pulse jitter in time.

Example. Assume that the horizontal movement is 0.5 division (see Fig. 1-18) and the DLY'D Time/Division switch is .5 microsecond.

Using the formula:

$$\text{Pulse Jitter} = \begin{matrix}\text{horizontal} \\ \text{jitter} \\ \text{(divisions)}\end{matrix} \times \begin{matrix}\text{DLY'D} \\ \text{Time/Division} \\ \text{setting}\end{matrix}$$

Substituting the given values:

Pulse Jitter = 0.5 X 0.5 microsecond

The pulse jitter is 0.25 microsecond.

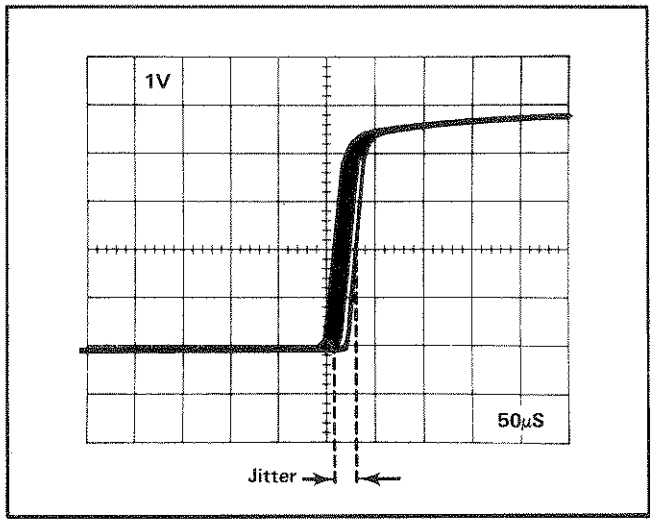


Fig. 1-18. Measuring pulse jitter.

SPECIFICATION

General

This instrument will meet the electrical characteristics listed under Performance Requirement in Table 2-1, following complete calibration. The following electrical characteristics apply over an ambient temperature range of 0°C to +50°C, except as otherwise indicated. Warmup time for given accuracy is 20 minutes.

TABLE 2-1

ELECTRICAL

Characteristics	Performance Requirement				Supplemental Information
MAIN SWEEP					
Sweep Rates	0.05 μs/DIV to 5 s/DIV in 25 calibrated steps.				
Sweep Accuracy	Measured in 7000-Series Oscilloscopes.				
	+15°C to +35°C		0°C to +50°C		
Over Center Eight Divisions	Unmag	Mag	Unmag	Mag	
50 ms/div to 0.5 μs/div	Within 2%	Within 2.5%	Within 3%	Within 4%	
5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	Within 3%	Within 3.5%	Within 4%	Within 5%	
Over any 2 div portion within center eight div (all sweep rates)	Within 5%		Within 7%		
Variable Sweep Rates	Continuously variable between calibrated sweep rates. Extends sweep rate to at least 12.5 s/div.				Variable to at least 2.5:1. VARIABLE control internally switchable between variable main sweep rates, variable delayed sweep rates, and variable main sweep holdoff.
Sweep Hold-Off	Hold-off time may be varied by front-panel VARIABLE control when Variable Selector connector (P140) is connected for variable holdoff.				
DELAYED SWEEP					
Sweep Rates	0.05 μs/DIV to .5 s/DIV in 22 calibrated steps.				
Sweep Accuracy	Measured in 7000-Series Oscilloscopes.				
	+15°C to +35°C		0°C to +50°C		
Over Center 8 Divisions	Unmag	Mag	Unmag	Mag	
50 ms/div to 0.5 μs/div	Within 3%	Within 3.5%	Within 4%	Within 5%	Exclude the first 10 and beyond the 90th division of the magnified sweep when measuring magnified accuracy.
0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	Within 4%	Within 4.5%	Within 5%	Within 6%	
Over any 2 div portion within center eight div (all sweep rates)	Within 6%		Within 8%		

TABLE 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	DELAYED SWEEP (cont)	
Variable Sweep Rate	Continuously variable between calibrated sweep rates. Extends sweep rate to at least 1.25 s/div.	Variable to at least 2.5:1. VARIABLE control switchable between variable main sweep rates, variable delayed sweep rates, and variable main sweep holdoff.
	MIXED SWEEP, VARIABLE TIME DELAY	
Mixed Sweep Accuracy		Exclude the following portions of the mixed sweep: First 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.
Main Sweep	Within 2% plus main sweep error.	
Delayed Sweep	Unchanged.	
Variable Time Delay		Full scale is 10 times the TIME/DIV OR DLY TIME setting. Accuracy applies over the center eight major DELAY TIME MULT dial divisions.
Delay Time Range	0 to 10 times DLY TIME/DIV settings from 5 s/div to 1 μs/div.	
Differential Delay Time Measurement Accuracy (+15°C to +35°C)		
5 s/div to 1 s/div	Within 1.4% of measurement plus 0.3% of full scale.	
0.5 s/div to 1 μs/div	Within 0.7% of measurement plus 0.3% of full scale.	
Delay Time Jitter	Less than 1 part in 20,000 of the maximum available delay time.	
	AMPLIFIER	
Deflection Factor		
EXT, MAG X10	10 mV/div within 10%.	
EXT, MAG X1	100 mV/div within 10%.	
EXT ÷ 10, MAG X1	1 V/div within 10%.	
Nominal Frequency Response	System −3 dB points in 7000-Series Oscilloscope.	

	Lower −3 dB	Upper −3 dB
AC	40 Hz	2 MHz
AC LF REJ	16 kHz	2 MHz
AC HF REJ	40 Hz	100 kHz
DC	DC	2 MHz

TABLE 2-1 (cont)

Characteristic	Performance Requirement			Supplemental Information
MAIN TRIGGERING				
Trigger Sensitivity				
COUPLING	Triggering Frequency Range	Minimum Trigger Signal Required		
		INT[1] (div)	EXT (mV)	
AC	30 Hz to 10 MHz	0.3	100	
	10 MHz to 100 MHz	1.5	500	
AC LF REJ	30 kHz to 10 MHz	0.3	- - -	
	150 kHz to 10 MHz	- - -	100	
	10 MHz to 100 MHz	1.5	500	
AC HF REJ	30 Hz to 50 kHz	0.3	100	
DC	DC to 10 MHz	0.3	100	
	10 MHz to 100 MHz	1.5	500	
				Triggering signal amplitude requirements increased 10 times for EXT ÷ 10 operation.
External Trigger Input				
Input R and C				Approximately 1 MΩ paralleled by 20 pF.
Maximum Safe Input Voltage				500 V (DC + Peak AC). 500 V peak-to-peak AC at 1 kHz or less.
Level Range				
EXT	At least + and − 1.5 V.			
EXT ÷ 10	At least + and − 15 V.			
Internal Trigger Jitter	1 ns or less at 75 MHz.			

[1] For Internal Triggering only, the specified −3 dB frequency of the vertical system replaces any frequencies in the above table when the number in the table is greater than the −3 dB frequency of the vertical system.

TABLE 2-1 (cont)

Characteristic	Performance Requirement			Supplemental Information
DELAYED TRIGGERING				
Trigger Sensitivity	Triggering Frequency Range	Minimum Trigger Signal Required		
Coupling		INT[1] (div)	EXT (mV)	
AC	30 Hz to 10 MHz	0.3	100	
	10 MHz to 100 MHz	1.5	500	
DC	DC to 10 MHz	0.3	100	
	10 MHz to 100 MHz	1.5	500	
External Trigger Input				
Maximum Safe Input Voltage				500 V (DC + peak AC). 500 V peak-to-peak AC at 1 kHz or less.
Input R and C				1 MΩ paralleled by 20 pF.
Level Range	At least + and − 1.5 V.			
Internal Trigger Jitter	1 ns or less at 75 MHz.			
OUTPUT SIGNALS				
Delayed Sweep Gate				
Maximum Safe Input Voltage				±10 volts (DC + Peak AC). 20 volts peak-to-peak AC at 1 kHz or less.
Waveshape	Rectangular pulse.			Available at front-panel DLY'D TRIG IN connector when operating in the INTEN, DLY'D SWP, or MIXED Display Modes. The DLY'D TRIG SOURCE switch must be set to INT and P613 must be connected for Delayed Sweep Gate Out.
Amplitude (into open circuit)	⩾3.0 V with baseline at −0.2 to −1 V.			
Output Resistance				Approximately 1 kΩ.
Loading				At least 10 kΩ shunted by 100 pF or less.
Polarity	Positive-going.			

[1] For Internal Triggering only, the specified −3 dB frequency of the vertical system replaces any frequencies in the above table when the number in the table is greater than the −3 dB frequency of the vertical system.

TABLE 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	OUTPUT SIGNALS (cont)	
Duration		
DISPLAY MODE		
INTEN, DLY'D SWP	For the time that the delayed sweep runs.	
MIXED	Composite gate signal with timing determined by the setting of the TIME/DIV OR DLY TIME switch during the main sweep portion of the display, and by the setting of the DLY'D Time/Division switch during the delayed sweep portion of the display.	
Sweep Gate	Refer to associated oscilloscope manual.	
Duration		
DISPLAY MODE		
MAIN SWEEP, INTEN	Coincident with the main sweep interval.	
DLY'D SWP	Coincident with the delayed sweep interval.	
MIXED	Coincident with the main sweep interval plus the delayed sweep interval.	
Main Sweep Gate	Refer to associated oscilloscope manual.	
Duration	Coincident with the main sweep (all Display Modes).	
Sawtooth	Refer to associated oscilloscope manual.	
Waveshape		
DISPLAY MODE		
MAIN SWP, INTEN	Sawtooth signal with slope determined by setting of the TIME/DIV OR DLY TIME switch.	
DLY'D SWP	Sawtooth signal with slope determined by the setting of the DLY'D Time/Division switch.	
MIXED	Composite sawtooth signal with slope determined by the setting of the TIME/DIV OR DLY TIME switch during the main sweep portion of display, and by the setting of the DLY'D Time/Division switch during the delayed sweep portion of display.	
Duration	Coincident with the time that each sweep is displayed.	

TABLE 2-2

ENVIRONMENTAL
Refer to the Specification for the associated oscilloscope.

TABLE 2-3

	PHYSICAL
Size	Fits all 7000-series plug-in compartments.
Weight	3.3 pounds (1.5 kilograms).

MANUAL CHANGE INFORMATION

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

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

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.