INSTRUCTION MANUAL

7B92
DUAL TIME BASE

OPERATORS

Serial Number _____

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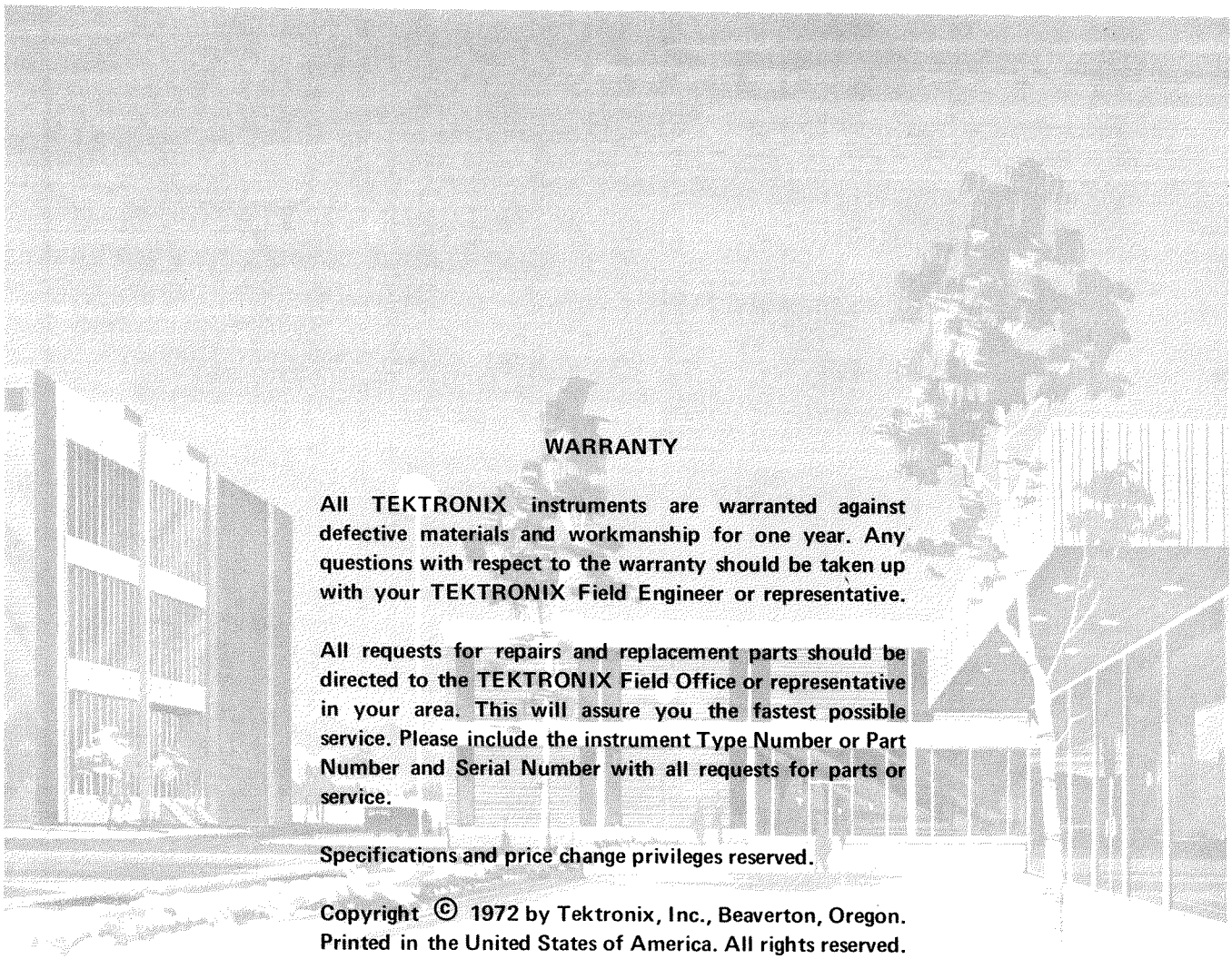

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NOTE

Refer to the 7B92 Service Manual for maintenance, calibration, diagrams, and parts replacement information. Refer to the 7B92 Circuit Description supplement for circuit description information.

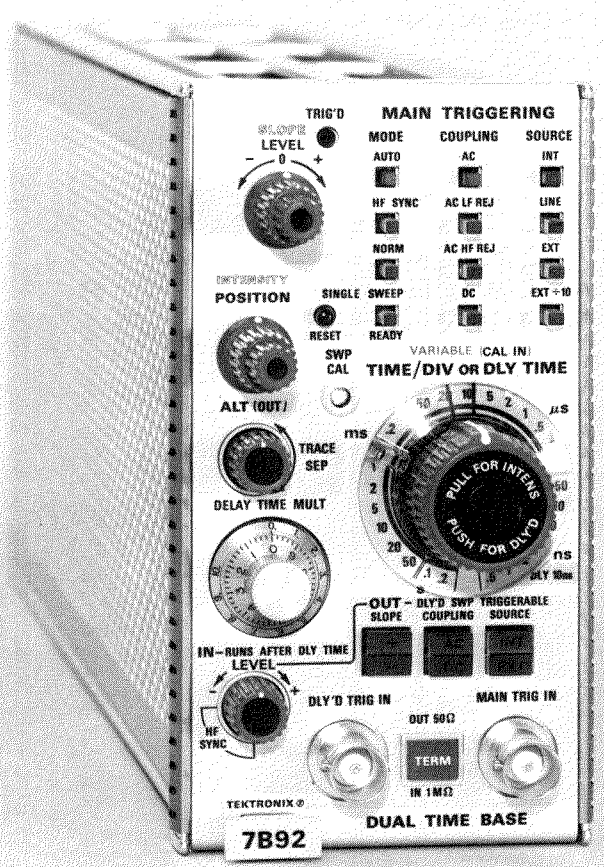

Fig. 1-1. 7B92 Dual Time Base.

SPECIFICATIONS

7B92 Features

The 7B92 Dual Time Base unit provides normal, delayed, and alternate sweep operation for Tektronix 7000-Series Oscilloscopes. Calibrated sweep rates from 0.2 second to 0.5 nanosecond and triggering to 500 megahertz are provided. The 7B92 is intended for use with high-frequency 7000-Series Oscilloscope systems; however, most 7B92 functions are compatible with all 7000-Series Oscilloscopes.

Other features include lighted pushbutton switches, compatibility with indicator oscilloscopes having an alpha-numeric readout system, and 0 to 9.9 times continuous sweep delay. A VARIABLE control allows continuously variable sweep rates between calibrated steps. Also, when operating in the AUTO MAIN TRIGGERING MODE, a bright base line is displayed in the absence of a trigger signal.

This instrument will meet the electrical characteristics listed under Performance Requirement in Table 1-1, 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 1-1

ELECTRICAL

Characteristic	Performance Requirement	Supplemental Information	
	MAIN TRIGGERING		
Trigger Sensitivity	Triggering Frequency Range	Minimum Triggering Signal Required	
Operating in AUTO, NORM, or SINGLE SWEEP MODE		INT (divisions)	EXT[3] (millivolts)
COUPLING[1]			
AC	30 hertz to 20 megahertz	0.5	100
	20 to 500 megahertz	1.0	500
AC LF REJ[2]	30 kilohertz to 20 megahertz	0.5	100
	20 to 500 megahertz	1.0	500
AC HF REJ	30 hertz to 50 kilohertz	0.5	100
DC	DC to 20 megahertz	0.5	100
	20 to 500 megahertz	1.0	500
Operating in the HF SYNC MODE			
AC			
AC LF REJ[2]	100 to 500 megahertz	0.5	100
DC			

[1] On 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.

[2] Will not trigger on sinewaves of 8 divisions or less internal or 3 volts or less external signal at 60 hertz or below.

[3] External signal requirements increased 10 times for EXT ÷ 10 operation.

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TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
MAIN TRIGGERING (cont)		
AC HF REJ	Not a recommended mode of operation	
Trigger Jitter		
Internal or External	50 picoseconds or less at 500 megahertz	
External Trigger Input		
Level Range		
EXT	At least + and −3.5 volts	Not applicable in HF SYNC MAIN TRIGGERING MODE
EXT ÷ 10	At least + and −35 volts	
Maximum Safe Input Voltage		
One Megohm Input		250 volts (DC + peak AC)
50 Ohm Input		1 watt average
Input R and C		
One Megohm Input		Approximately one megohm paralleled by approximately 20 picofarads.
50 Ohm Input		
Resistance		50 ohms ±7%
Reflection Coefficient (Time Domain)		0.1 peak to peak (using 1 gigahertz Reflectometer)

DELAYED TRIGGERING

Trigger Sensitivity	Triggering Frequency Range	Minimum Triggering Signal Required	
Operating in the normal DLY'D SWP TRIGGERABLE mode		INT (divisions)	EXT (millivolts)
COUPLING[1]			
AC	30 hertz to 20 megahertz	0.5	100
	20 to 500 megahertz	1.0	500
DC	DC to 20 megahertz	0.5	100
	20 to 500 megahertz	1.0	500

[1]On 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 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information	
DELAYED TRIGGERING (cont)			
Operating in HF SYNC mode AC DC	100 to 500 megahertz	0.5	100
Trigger Jitter Internal or External	50 picoseconds or less at 500 megahertz		
External Trigger Input Level Range EXT		At least + and −2.5 volts	
Maximum Safe Input Voltage One Megohm Input		250 volts (DC + peak AC)	
50 Ohm Input		1 watt average	
Input R and C One Megohm Input		Approximately one megohm paralleled by approximately 20 picofarads	
50 Ohm Input Resistance		50 ohms ±7%	
Reflection Coefficient (Time Domain)		0.1 peak to paek (using 1 gigahertz Reflectometer)	
INTENSIFIED (DELAYING) SWEEP			
Sweep Rates	10 nanoseconds/division to 0.2 second/division in 23 calibrated steps	Selected by TIME/DIV or DLY TIME switch. Steps in a 1-2-5 sequence	
Sweep Accuracy	Measured in 7900-Series Indicator Oscilloscope		
Over Center 8 Divisions	+15°C to +35°C	0°C to +50°C	
.2 s/DIV	Within 4%	Within 5%	
All Other Sweep Rates	Within 3%	Within 4%	

TABLE 1-1 (cont)

Characteristics	Performance Requirement		Supplemental Information
DELAYING SWEEP GENERATOR (cont)			
Over Any Two Division Portion Within Center 8 Divisions	+15 C to +35 C	0° to 50°C	
	Within 5%	Within 7%	
Variable Sweep Rate	Continuously variable between calibrated sweep rates		Extends sweep rate at least 0.5 second. VARIABLE control internally switchable between Delaying and Delayed Sweeps
NORMAL and DELAYED SWEEP			
Sweep Rates	0.5 nanosecond/division to 0.2 second/division in 27 calibrated steps		Selected by DELAYED Time/Div switch. Steps in a 1-2-5 sequence
Sweep Accuracy	Measured in 7900-Series Oscilloscope		
Over Center Eight Divisions	+15°C to +35°C	0°C to +50°C	
.2 s/DIV	Within 4%	Within 5%	
.1 s/DIV to 50 ns/DIV	Within 3%	Within 4%	
20 ns/DIV to 2 ns/DIV	Within 4% (Exclude the first 2 div of sweep)	Within 5%	
1 ns/DIV	Within 4% (Exclude the first 5 div of sweep)	Within 5%	
.5 ns/DIV	Within 5% (Exclude the first 10 div of sweep)	Within 6%	
Over Any Two Division Portion Within Center Eight Division			
.2 s/DIV to 50 ns/DIV	Within 5%	Within 7%	
20 ns/DIV to 2 ns/DIV	Within 10% (Exclude the first 2 div of sweep)	Within 10%	
1 ns/DIV	Within 10% (Exclude the first 5 div of sweep)	Within 10%	
.5 ns/DIV	Within 10% (Exclude the first 10 div of sweep)	Within 10%	
Variable Sweep Rate	Continuously variable between calibrated sweep rates		Extends sweep rate to at least 0.5 second. VARIABLE control internally switchable between Delaying and Delayed Sweeps

TABLE 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
	VARIABLE TIME DELAY	
Delay Time Range DLY TIME/DIV Settings .2 s/DIV to 10 ns/DIV	0 to 9.9 times the DLY TIME/DIV switch setting (0 to 1.98 seconds)	
Differential Delay Time Measurement Accuracy (+15°C to +35°C) 0.2 s/DIV	±(1.4% of measurement +0.3% of full scale)	
0.1 s/DIV to 0.1 μs/DIV	±(0.7% of measurement of +0.3% of full scale)	
50 ns/DIV to 10 ns/DIV	±(1.5% of measurement +0.5% of full scale) Full scale is 10 times the DELAY TIME/DIV setting: Accuracy applies over the center 8 major DELAY TIME MULT dial divisions	
Absolute Time Measurement Accuracy (Measurement From Start of Delaying Sweep) .2 s/DIV to 1 μs/DIV	±1% of full scale plus differential time measurement accuracy	
.5 μs/DIV to .1 μs/DIV	±1% of full scale plus differential time measurement plus 0.1 microsecond	
50 ns/DIV to 10 ns/DIV	±1% of full scale plus differential time measurement accuracy plus 20 nanoseconds	
Delay Time Jitter	One part or less in 50,000 of the maximum available delay time (10 times the TIME/DIV OR DLY TIME switch setting) or 0.5 nanosecond, whichever is greater	Jitter specification does not apply to the first 2% of the maximum available delay time (0.2 major DELAY TIME MULT dial divisions)

TABLE 1-2

ENVIRONMENTAL

Refer to the Specification for the associated oscilloscope.

TABLE 1-3

PHYSICAL

Size:	Fits all 7000-Series plug-in compartments
Weight:	3.3 pounds (1.5 kilograms)

OPERATING INSTRUCTIONS

General

The 7B92 Dual Time Base Plug-In Unit operates with a Tektronix 7900-Series Indicator Oscilloscope and a 7A-Series vertical plug-in unit to form a complete high-frequency oscilloscope system. To effectively use the 7B92, its operation and capabilities should be known. This section describes the operation of the front-panel controls and connectors, gives general operating information, provides an Operating Checkout procedure, and gives basic applications for this instrument.

Installation

The 7B92 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 1. The instructions in this manual are written for use of the 7B92 in the horizontal plug-in compartment.

Before proceeding with installation, it is necessary to check the settings of the Variable Selector multi-pin connector and the Mainframe Selector multi-pin connector (see Fig. 2-1). The Variable Selector determines whether the front-panel VARIABLE control operates in conjunction with the Delaying or Delayed Sweeps. The Mainframe Selector determines the indicator oscilloscope in which the 7B92 is to be operated. The two mainframe selections are:

1. 7900-Series Oscilloscopes.

2. All other 7000-Series Oscilloscopes.

To install the 7B92 in a plug-in compartment, push it in until it fits firmly into the compartment. The front panel of the 7B92 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 7B92 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 7B92, pull the release latch (see Fig. 2-2) to disengage the unit from the indicator oscilloscope, and pull it out of the plug-in compartment.

CONTROLS AND CONNECTORS

General

All controls required for the operation of the 7B92, except the Variable Time/Division Selector and Mainframe Selector, 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. 2-3 shows the front panel and external controls and connectors of the 7B92.

Main Triggering Controls

LEVEL	Selects amplitude point on trigger signal where sweep triggering occurs when operating in the AUTO, NORM, or SINGLE SWEEP MAIN TRIGGERING MODE. When operating in HF SYNC MAIN TRIGGERING MODE, the LEVEL control adjusts the frequency of the trigger generator to sychronize with the frequency (or subharmonic) of the triggering signal frequency to provide a stable display.
SLOPE	Permits triggering on the positive or negative-going portion of the trigger signal in all positions of the MAIN TRIGGERING MODE switch except HF SYNC.
TRIG'D Light	Indicates that the sweep is triggered and will produce a display with correct setting of the POSITION control and the controls on the associated vertical units and indicator oscilloscope.
MODE	Four pushbutton switches to select the desired trigger mode. Selected mode is indicated by lighted pushbutton.

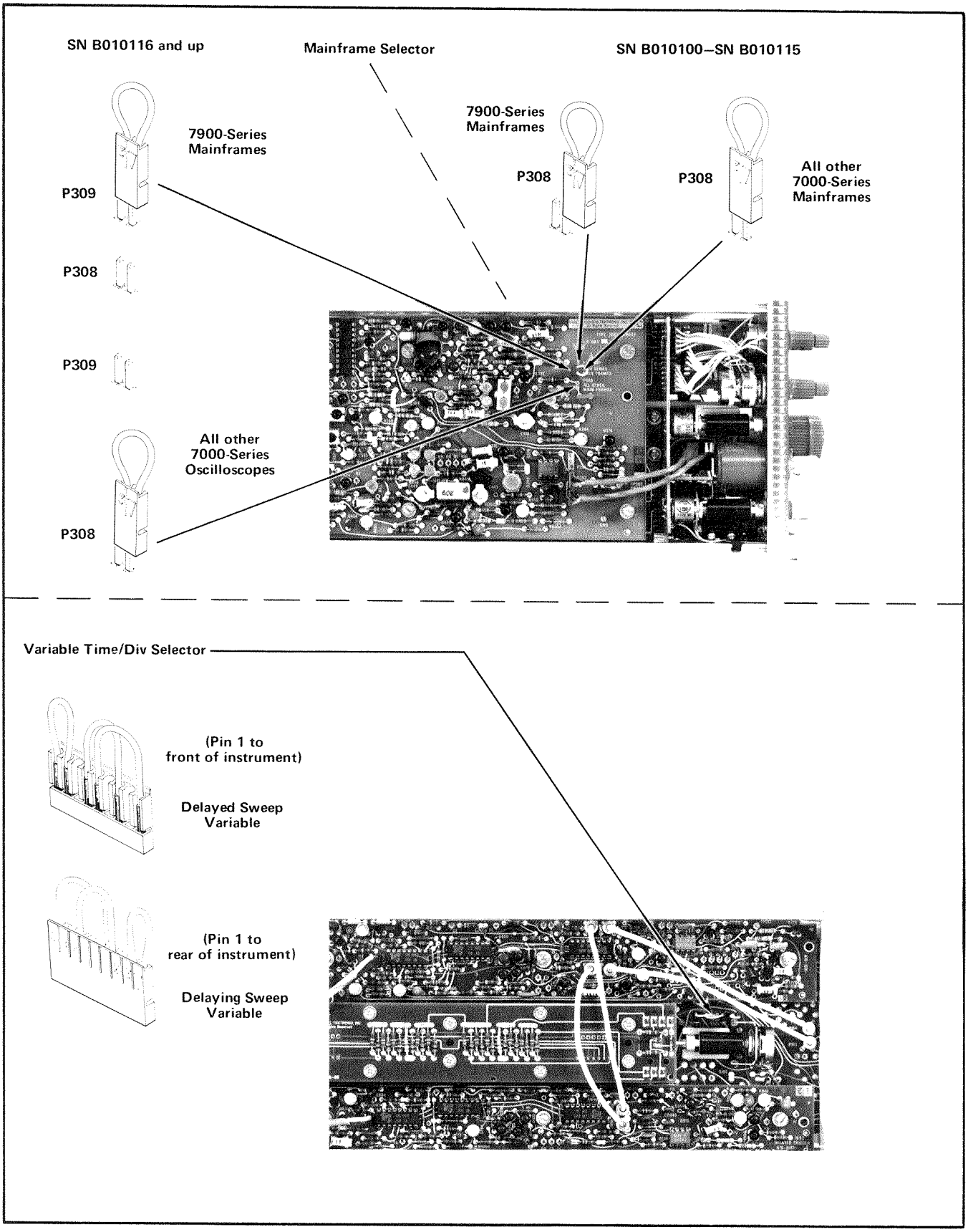


Fig. 2-1. Location of Variable Selector and Mainframe Selector multi-pin connectors.

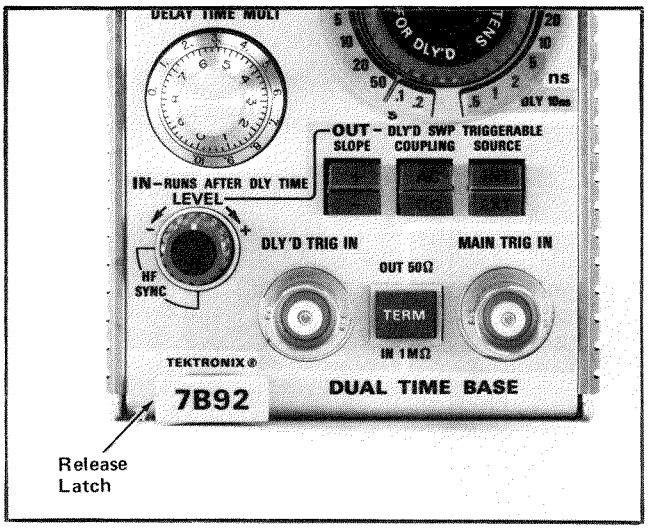


Fig. 2-2. Location of release latch.

AUTO: Triggered sweep initiated by the applied trigger signal at a point selected by the LEVEL control and SLOPE switch when the trigger signal repetition rate is above about 30 hertz and within the frequency range selected by the COUPLING switch. When the LEVEL control is outside the amplitude range, the trigger repetition rate is outside the frequency range selected by the COUPLING switch, or the trigger signal is inadequate, the sweep free-runs to provide a reference trace.

HF SYNC: Sweep initiated by trigger signals with repetition rates above 100 megahertz and within the range selected by the COUPLING switch. Stable display can be obtained when the LEVEL control adjusts the frequency of the trigger generator to the frequency (or subharmonic) of the trigger signal frequency. When the LEVEL control is adjusted to frequencies between subharmonics, the sweep free-runs.

NORM: Sweep initiated by the applied trigger signal at point selected by the LEVEL control and SLOPE switch over the frequency range selected by the COUPLING switch. Triggered sweep can be obtained only over the amplitude range of the applied trigger signal. When the LEVEL control is outside the amplitude range, the trigger repetition rate is outside the frequency range selected by the COUPLING switch, or the trigger signal is inadequate, there is no trace.

SINGLE SWEEP READY: After a sweep is displayed, further sweeps cannot be presented until the RESET button is pressed. Display is triggered as for NORM operation using the MAIN TRIGGERING controls. The SINGLE SWEEP-READY light is illuminated when the RESET pushubtton is pressed, and remains on until a trigger is received and the sweep is completed.

RESET: When the RESET pushbutton is pressed (SINGLE SWEEP MODE) a single display will be presented (with proper triggering) when the next trigger pulse is received. The SINGLE SWEEP-READY light remains on until a trigger is received and the sweep is completed. RESET pushbutton must be pressed again before another sweep can be presented.

COUPLING

Four pushbutton switches to select trigger coupling. Selected coupling is indicated by lighted pushbutton.

AC: Rejects DC and attenuates AC signals below about 30 hertz. Accepts signals between 30 hertz and 500 megahertz.

AC LF REJ: Rejects DC and attenuates signals below about 30 kilohertz. Accepts signals between 30 kilohertz and 500 megahertz.

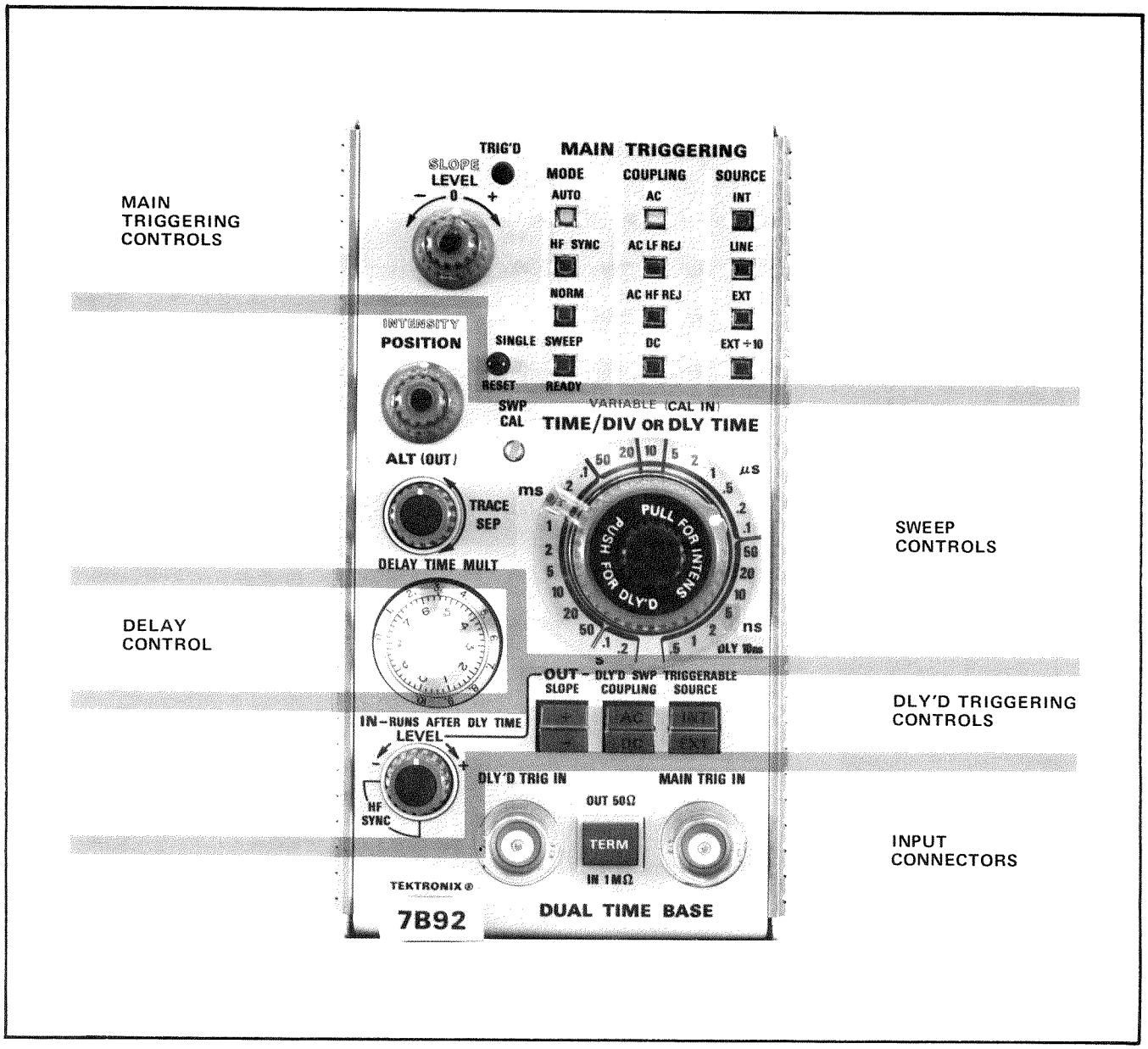


Fig. 2-3. Front-Panel controls and connectors.

AC HF REJ: Rejects DC and attenuates signals above 50 kilohertz. Accepts signals from 30 hertz to 50 kilohertz.

DC: Accepts all signals from DC to 500 megahertz.

SOURCE

Four pushbutton switches to select the triggering source. Selected source is indicated by lighted pushbutton.

INT: Trigger signal obtained internally from vertical unit by way of associated indicator oscilloscope.

LINE: Trigger signal obtained internally from a sample of the line voltage applied to the associated indicator oscilloscope.

EXT: Trigger signal obtained from an external signal applied to the MAIN TRIG IN connector.

EXT ÷ 10: Trigger signal obtained from an external signal applied to the MAIN TRIG IN connector. In this position the external signal is attenuated 10 times before it is applied to the trigger circuit.

Sweep Controls

TIME/DIV OR DLY TIME — Selects the basic sweep rate for Normal and ALT sweep operation and selects the delay time (to be multiplied by the DELAY TIME MULT dial setting) when operating in the INTEN or DLY'D sweep mode. The VARIABLE control must be in the CAL position for indicated sweep rate.

DLY'D Time/Division — Selects the sweep rate of the delayed sweep generator for operation in DLY'D, INTEN, and ALT sweep Display Modes. The VARIABLE control must be in CAL position for indicated sweep rate.

VARIABLE — Two position switch actuated by the VARIABLE control to select calibrated or uncalibrated sweep rates. In the CAL position (pressed inward) the VARIABLE control is inoperative and the sweep rate is calibrated. When pressed and released, the knob moves out to activate the VARIABLE control for-uncalibrated sweep rates. The sweep rate in each TIME/DIV switch position can be reduced at least to the sweep rate of the next slower position. The VARIABLE control can be switched to operate with either the delaying or delayed sweep by means of the internal Variable Selector connector.

DISPLAY MODES — Four display modes can be selected by the following switch settings:

NORMAL Sweep: A Normal Sweep (non-delayed) is selected when the TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switch are locked together at the same sweep rate. The DLY'D Time/Division switch and the Delayed Triggering LEVEL control must be pressed in for the Normal Sweep mode. Calibrated sweep rates from 0.2 second/division to .5 nanoseconds/division can be selected.

INTEN: The INTEN mode, a function of the delaying and delayed sweeps, is selected when the DLY'D SWEEP Time/Division switch is pulled out and rotated clockwise. In this mode, a portion of the delaying sweep is intensified during the time that the delayed sweep runs.

DLY'D Sweep: The DLY'D Sweep mode is selected when the DLY'D Time/Division switch is pulled out, rotated in the INTEN MODE for the desired delayed sweep rate, and then pushed in. In this mode, the delayed sweep is displayed at a rate determined by the DLY'D Time/Division switch at the end of each delay period, as selected by the TIME/DIV OR DLY TIME switch and the DELAY TIME MULT dial settings.

ALT Sweep: When the ALT switch is pressed in and released to the OUT position, sweeps from both the delaying sweep generator (intensified sweep) and delayed sweep generator (delayed sweep) are displayed. The alternate sweep switches between generators at the end of each sweep. The TRACE SEP control is activated in this mode.

TRACE SEP — When the ALT switch is OUT (ALT display mode) it serves as a trace separation control. This control vertically positions the trace produced by the delaying sweep generator up to four divisions with respect to the trace produced by the delayed sweep generator.

DELAY TIME MULT — Provides variable delay of 0 to 9.9 times the basic delay time selected by the TIME/DIV OR DLY TIME switch.

INTENSITY — Controls the intensity of the delaying sweep display only when operating in the INTEN or ALT Display Modes.

SWP CAL — Screwdriver adjustment to set horizontal gain of unit. Used to set the basic timing of the 7B92 and to compensate for differences in input sensitivity when changing indicator oscilloscopes.

Delayed Triggering Controls

LEVEL — Control determines delayed sweep mode, delayed trigger mode, and delayed trigger level.

IN-RUNS AFTER DL'Y TIME: The delayed sweep runs immediately following the delay time selected by the TIME/DIV OR DL'Y TIME switch and the DELAY TIME MULT dial. Delayed SLOPE, COUPLING, SOURCE, and HF SYNC functions are inoperative.

OUT-DLY'D SWP TRIGGERABLE: When the Delayed Triggering LEVEL control is pressed and released, the delayed sweep is triggerable. The Delayed Triggering LEVEL control can now be rotated to select the amplitude point on the trigger signal at which the delayed sweep is triggered or it can be rotated counterclockwise (as marked on the instrument front panel) to select the HF SYNC Delayed triggering Mode. In the OUT-DLY'D SWP TRIGGERABLE mode, the delayed SLOPE, COUPLING, and SOURCE functions are activated.

HF SYNC: The HF SYNC Delayed Triggering mode is selected when the Delayed Triggering LEVEL control is pressed in and released to the OUT-DLY'D SWP TRIGGERABLE position and rotated counterclockwise to HF SYNC as marked on the instrument front panel. Sweep is initiated by trigger signals with repetition rates above 100 megahertz and within the range selected by the COUPLING switch. Stable display can be obtained when the LEVEL control adjusts the frequency of the trigger generator to the frequency (or subharmonic) of the trigger signal frequency. When the LEVEL control is adjusted to frequencies between subharmonics, the sweep free-runs.

SLOPE — Two-position switch to select the portion of trigger signal which starts the delayed sweep.

+ : The delayed sweep can be triggered from the positive slope of the trigger signal.

– : The delayed sweep can be triggered from the negative slope of the trigger signal.

COUPLING — Two-position switch to determine the method of coupling delayed trigger signal to the delayed trigger circuit.

AC: Rejects DC and attenuates signals below about 30 hertz. Accepts delayed trigger signals from 30 hertz to 500 megahertz.

DC: Accepts trigger signals from DC to 500 megahertz.

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

INT: The delayed trigger signal is obtained from the vertical amplifier unit by way of associated indicator oscilloscope.

EXT: The delayed trigger signal is obtained from an external source by way of the DLY'D TRIG IN connector.

Front-Panel Inputs

MAIN TRIG IN	When the SOURCE switch for MAIN TRIGGERING is set to EXT or EXT ÷ 10, this connector serves as an external trigger input for the main triggering circuit.
DLY'D TRIG IN	When the Delayed Triggering SOURCE switch is set to EXT, this connector serves as an external trigger input for the delayed triggering circuit.
TERM 50 Ω - 1 MΩ	Two-position switch to select 50-ohms or 1 megohm input impedance for the MAIN TRIG IN and DLY'D TRIG IN connectors.

OPERATING CHECKOUT

Introduction

The following procedure checks the basic operation of the 7B92. It may also be used for familiarization with this instrument or as an incoming inspection. The procedure is divided into two parts, Sweep Control Functions and Main and Delayed Triggering Functions. A complete operating check of the 7B92 control functions can be made by performing both parts, or each part may be performed separately.

NOTE

For optimum high-frequency performance, the 7B92 should be installed in an oscilloscope system with similar frequency and sweep rate capabilities.

Setup Procedure

1. Install the 7B92 in the right horizontal compartment of the indicator oscilloscope.

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

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

4. Set the 7B92 controls as follows:

Main Triggering	
SLOPE	(+)
MODE	AUTO
COUPLING	AC
SOURCE	INT
Delayed Triggering	
LEVEL	IN-RUNS AFTER DLY TIME
SLOPE	(+)
COUPLING	AC
SOURCE	INT
Sweep Controls	
POSITION	Midrange
Intensity	As desired
TIME/DIV OR DLY TIME	1 ms
DLY'D Time/Division	1 ms
VARIABLE	CAL
ALT	IN
Variable Selector (Internal)	Delaying Sweep Time/Division 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.

2. To select the Normal Sweep Display Mode, press the Delayed Triggering LEVEL control to the IN-RUNS AFTER DLY TIME position, 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).

NOTE

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

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 Normal Sweep 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.

Sweep Calibration

6. Check the CRT display for one complete cycle per division. If necessary, adjust the SWP CAL screwdriver adjustment for one complete cycle per division over the center eight divisions of display. Be sure that the horizontal timing of the Calibrator signal is accurate within 0.5%.

Intensified Sweep

7. Pull out the DLY'D-INTENS knob and rotate clockwise to .1 ms/DIV for the Intensified Sweep Display Mode. Note that a delaying sweep with an intensified portion (delayed sweep) is displayed on the CRT.

8. Rotate the INTENSITY control and note that it varies the intensity of the delaying sweep (non-intensified portion).

9. 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.

10. Press and release the VARIABLE control. Rotate the VARIABLE control 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 must be set to Delaying Time/Division Variable position. Return VARIABLE control to the CAL position.

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

Alternate Sweep

12. Set the Vertical unit for about two divisions of vertical display. Press and release the ALT switch to the OUT position for the ALT Display Mode. Note both an intensified trace and a delayed sweep trace displayed on the CRT. The intensified trace provides an intensified portion on the delaying sweep (delaying sweep rate determined by TIME/DIV OR DLY TIME switch) during the time that the delayed sweep runs (delayed sweep rate determined by the DLY'D Time/Division switch). The delayed sweep trace displays the intensified portion as viewed on the intensified trace at the sweep rate indicated by the DLY'D Time/Division switch.

13. Rotate the TRACE SEP control to vertically position the delaying sweep trace with respect to the delayed sweep trace.

14. Rotate the INTENSITY control and note that it varies the intensity of the delaying sweep trace.

Main and Delayed Sweep Triggering

The following procedure checks the operation of the Main and Delayed Sweep Triggering controls.

Partial Procedure. To begin the Operation Check with Triggering, set the MAIN TRIGGERING MODE, COUPLING, and SOURCE switches to AUTO, AC and INT. Connect the one-kilohertz calibrator signal from the indicator oscilloscope to the vertical unit Input and adjust for about four divisions of vertical display.

Main Sweep Triggering

15. Press the ALT switch to the IN position. Set the DLY'D Time/Division switch and the TIME/DIV OR DLY TIME switch to 1 ms, and press in the DLY'D Time/Division switch and the Delayed Triggering LEVEL control (Normal Sweep Display Mode). Rotate the MAIN TRIGGERING LEVEL control for a stable display (TRIG'D light on).

16. 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.

NOTE

To check the AC LF REJ position of the MAIN TRIGGERING COUPLING switch (step 17), a signal source with 60 hertz frequency and amplitude between 0.1 and 3 volts is required.

17. Connect the 60 hertz signal source to the vertical unit Input with a 50-ohm BNC cable and BNC T-connector. Connect the output of the T-connector to the MAIN TRIG IN connector with a BNC patch cord. Set the MAIN TRIGGERING COUPLING switch to AC LF REJ and press

the TERM switch to IN-1 MΩ. Set the TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switch to 10 ms. Adjust the vertical unit Volt/Div switch for about four divisions of display. Rotate the MAIN TRIGGERING LEVEL control throughout its range and check that a stable display cannot be obtained (TRIG'D light off). Change the MAIN TRIGGERING SOURCE switch to EXT. Rotate the MAIN TRIGGERING LEVEL control throughout its range and check that a stable display cannot be obtained. Remove all connections from the oscilloscope system.

18. Connect a BNC patch cord from the indicator oscilloscope calibrator to the vertical unit Input connector and a patch cord from the indicator oscilloscope Calibrator to the MAIN TRIG IN connector. Set the Calibrator for a 0.4 volt one 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. 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).

19. 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 all connections from the oscilloscope system.

20. Change the MAIN TRIGGERING SOURCE switch to LINE, the TIME/DIV OR DLY TIME switch to 5 ms, and the DLY'D Time/Division switch to 5 ms. Connect a 10X probe to the vertical unit Input connector, then connect the probe tip to the same line voltage source which is connected to the indicator oscilloscope. Set the vertical unit for approximately four divisions of vertical deflection. Check for stable CRT display triggered on the correct slope (MAIN TRIGGERING LEVEL control may be adjusted as necessary). Remove all connections from the oscilloscope system.

21. Set the MAIN TRIGGERING COUPLING switch to AC and the SOURCE switch to INT. Connect the one-kilohertz calibrator signal from the indicator oscilloscope to the vertical Input and adjust for about four divisions of vertical display. Set the TIME/DIV OR DLY TIME and DLY'D Time/Division switches to 1 ms. 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.

22. Adjust the MAIN TRIGGERING LEVEL control for a stable display. Change the MAIN TRIGGERING MODE switch to SINGLE SWEEP. Press the RESET button and check for one sweep as the RESET button is pressed. Remove the 1 kilohertz signal from the vertical unit and press the RESET button. CHECK for no display and READY light on. Connect the one kilohertz signal to the vertical unit Input and check for one sweep as the signal is applied. Remove all connections from the oscilloscope system.

NOTE

To check HF SYNC operation, a signal source with frequency between 100 megahertz and 500 megahertz is required.

23. Change the MAIN TRIGGERING MODE switch to HF SYNC. Connect the high frequency signal source (100 to 600 megahertz) to the vertical unit Input and adjust for four divisions of vertical deflection. Adjust the TIME/DIV OR DLY TIME switch and DLY'D Time/Division switch for about six cycles of display. Rotate the MAIN TRIGGERING control through a complete rotation and note that the sweep is stable, then free-running, several times during the rotation (triggering display indicates that the trigger generator frequency is adjusted to a sub-harmonic of the trigger signal frequency). Check that a stable display can be obtained with the COUPLING switch for MAIN TRIGGERING set to AC, AC LF REJ, and DC (MAIN TRIGGERING LEVEL control may be adjusted as necessary for a stable display).

Delayed Sweep Triggering

24. Pull out the DLY'D Time/Division switch, rotate it to one sweep rate faster than the setting of the TIME/DIV OR DLY TIME switch, and press it in (Delayed Sweep Display Mode). Press and release the Delayed Triggering LEVEL control to the OUT-DLY'D SWP TRIGGERABLE position and rotate counterclockwise into the HF SYNC Delayed Triggering mode (HF SYNC range marked on instrument front-panel). Rotate the Delayed Triggering LEVEL control throughout the HF SYNC range for an optimum display. CHECK that a stable CRT display can be obtained with the Delayed Triggering COUPLING switch set to AC and DC. Disconnect the high-frequency signal from the oscilloscope system.

25. Set the MAIN TRIGGERING MODE switch to AUTO, the SOURCE switch to AC, and press the Delayed

Triggering LEVEL control to the IN-RUNS AFTER DLY TIME position. Set the TIME/DIV OR DLY TIME switch to 1 ms and pull out the DLY'D Time/Division switch and rotate to .2 ms (Intensified Display Mode). Connect the one-kilohertz calibrator signal from the indicator oscilloscope to the vertical Input and adjust for about four divisions of display. Rotate the MAIN TRIGGERING LEVEL control for a stable intensified display. The INTENSITY control may need to be adjusted to view the intensified display. Rotate the DELAY TIME MULT control and note that the delay time before the intensified portion of display is continuously variable.

26. Press and release the Delayed Triggering LEVEL control to OUT-DLY'D SWP TRIGGERABLE. Set the Delayed Triggering SLOPE, COUPLING, and SOURCE switches to (+), AC, and INT; and rotate the LEVEL control for a stable intensified display. Rotate the DELAY TIME MULT dial and note that the intensified sweep 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.

27. Press the DLY'D Time/Division switch in for the Delayed Sweep Display Mode. Check that a stable delayed sweep display can be obtained with the COUPLING switch for Delayed Triggering set to AC and DC for both the (+) and (−) positions of the SLOPE switch (Delayed Triggering LEVEL control may be adjusted as necessary for a stable delayed sweep display).

28. Change the Delayed Triggering SOURCE switch to EXT. Connect a BNC patch cord from the indicator oscilloscope Calibrator output to the DLY'D TRIG IN connector. Set the oscilloscope Calibrator for 0.4 volt at 1 kilohertz. Check that a stable delayed sweep display can be obtained with the COUPLING switch for Delayed Triggering set to AC and DC, for both the (+) and (−) positions of the SLOPE switch (Delayed Triggering 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, 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. 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 pushbuttons pushed in, other selections must be made. Refer to the following discussions or the instruction manuals for the associated indicator oscilloscope and vertical unit for more information.

Triggered Light

The TRIG'D light provides a convenient indication of 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 might be a misadjusted LEVEL control, incorrectly set COUPLING or SOURCE switches, low trigger signal amplitude, or a trigger 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 trigger 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. In the AUTO MAIN TRIGGERING MODE, a triggered display is presented with the correct setting of the LEVEL control (see Trigger Level discussion) whenever an adequate trigger signal is applied. The TRIG'D light indicates when the display is triggered.

When the trigger repetition rate is below about 30 hertz (or 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. When the LEVEL control is at a setting outside the amplitude range of the trigger signal, the sweep also free runs at the sweep rate indicated by the TIME/DIV OR DLY TIME switch. 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).

HF SYNC. The HF SYNC MAIN TRIGGERING MODE permits stable displays of repetitive signals with no more than 0.5 division of internal trigger signal required (100 millivolts external signal) for trigger signal frequencies

between 100 megahertz and 500 megahertz. TRIG'D light indicates when display is triggered.

Triggered display is obtained when the LEVEL control adjusts the frequency of the trigger generator to the frequency or subharmonic of the trigger signal frequency. Stable display may be obtained several times in one rotation of the LEVEL control, depending on the amplitude and frequency of the trigger signal. The LEVEL control should be rotated for optimum display.

When the LEVEL control is adjusted between subharmonics of the trigger signal frequency, the trigger repetition rate is below 100 megahertz or outside the frequency range selected by the COUPLING switch, or the trigger signal amplitude is inadequate, the sweep free-runs at the sweep rate determined by the TIME/DIV OR DLY TIME switch

NORM. When the NORM MAIN TRIGGERING MODE is selected a triggered display is presented with the correct setting of the LEVEL control 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. 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-sweep feature of this unit. The single-sweep mode is also useful to photograph non-repetitive or unstable displays.

To obtain a single-sweep display of a repetitive signal, first obtain the best possible display in the NORM MODE. Then without changing the other MAIN TRIGGERING switches, press the SINGLE SWP pushbutton. When ready to view the single-sweep display, press the RESET pushbutton. A single trace is presented each time the RESET 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 pushbutton is pressed again. If the displayed signal is a complex waveform composed of pulses of varying amplitude, successive single-sweep displays may not start at the same point of the waveform. To avoid confusion due to the CRT persistence, allow the display to disappear before pressing the RESET 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.

When using the single-sweep mode to photograph waveforms, the graticule must be photographed separately in the normal manner to prevent over-exposing the film. Be sure the camera system is well protected against stray light, or operate the system in a darkened room. For repetitive waveforms, press the RESET pushbutton only once for each waveform unless the signal is completely symmetrical. Otherwise, multiple waveforms may appear on the film. For random signals, the lens can be left open until the random signal triggers the unit (SINGLE SWEEP-READY pushbutton illuminated). Further information on photographic technique is given in the appropriate camera instruction manual.

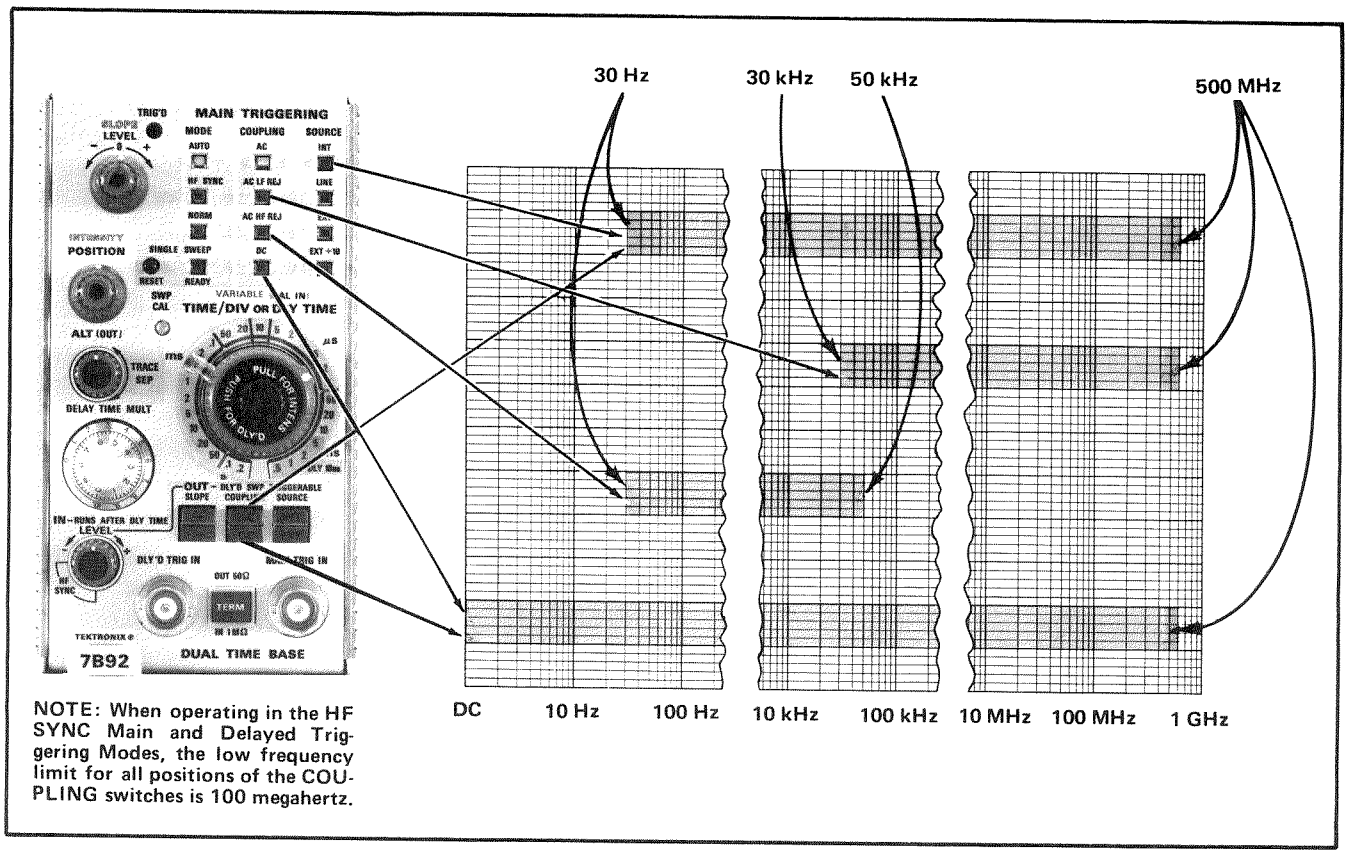
RESET. The RESET pushbutton resets the main sweep generator for the next sweep when operating in the SINGLE SWP MODE. See the preceding Single Sweep discussion for more information.

Main Trigger 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. 2-4 graphically illustrates the band of frequencies covered by each position of the COUPLING switch.

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.

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-mode vertical displays at fast sweep rates when comparing two or more unrelated signals.



NOTE: When operating in the HF SYNC Main and Delayed Triggering Modes, the low frequency limit for all positions of the COUPLING switches is 100 megahertz.

Fig. 2-4. Frequency range of each COUPLING switch position.

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. AC HF REJ COUPLING cannot be used when operating in the HF SYNC MAIN TRIGGERING MODE.

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 controls affects the DC triggering point.

Main Trigger Source

The MAIN TRIGGERING pushbuttons located below the SOURCE title select the source of the trigger signal which is connected to the main trigger 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 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. Line triggering cannot be used when operating in the HF SYNC MAIN TRIGGERING MODE.

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 be used to provide a triggered display when the internal signal is too low in amplitude for correct triggering, or contains signal components on which is is not desired to trigger. It is also useful when signal tracing in amplifiers, phase-shift networks, wave-shaping circuits, etc. The signal from a single point in the circuit under test can be connected to the MAIN TRIG IN connector through 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.

TERM Switch

The input impedance of the MAIN TRIG IN and DLY'D TRIG IN connectors may be selected by the front-panel TERM switch.

IN-1 MΩ. The IN-1 MΩ position is suitable for most low and medium frequency applications. The 1 MΩ position provides a high input impedance for minimum loading on the trigger signal source.

OUT-50 Ω. The OUT-50 Ω TERM switch position is recommended for high frequency applications requiring maximum overall bandwidth. The 50-ohm termination should be used when externally triggering from a 50-ohm system.

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. The trigger slope can be selected only when operating in the AUTO, NORM, or SINGLE SWEEP MAIN TRIGGERING Modes. When the SLOPE switch is in the (+) (positive-going) position, the display starts with the positive-going protion of the waveform; in the (–) (negative-going) position, the display starts with the negative-going portion of the waveform (see Fig. 2-5). When several cycles of a signal appear in the 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.

Trigger Level

The MAIN TRIGGERING LEVEL control determines the voltage level on the trigger signal at which the sweep is triggered when operating in the AUTO, NORM, or SINGLE SWEEP Main Triggering Modes. 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. 2-5 illustrates this effect with different settings of the SLOPE switch.

To set the LEVEL control, first select the MAIN TRIGGERING MODE, COUPLING, SOURCE, and SLOPE. Then set the LEVEL control fully counterclockwise and rotate it clockwise until the display starts at the desired point. Less selection of the triggering level is available as the trigger signal frequency exceeds 150 megahertz.

When operating in the HF SYNC MAIN TRIGGERING MODE, the LEVEL control synchronizes the trigger generator frequency to the frequency or subharmonic of the trigger signal frequency. Trigger slope and level cannot be selected.

Selecting Sweep Rates

The TIME/DIV OR DLY TIME switch selects calibrated sweep rates for the Delaying Sweep Generator and the DLY'D Time/Division switch selects calibrated sweep rates for the Delayed Sweep Generator. The sweep rate for the Delaying Sweep Generator is bracketed by the black lines on the clear plastic flange of the TIME/DIV OR DLY TIME switch (see Fig. 2-6). Sweep rate of the Delayed Sweep Generator is indicated by the white line on the DLY'D Time/Division knob. When the white line on the outer knob is set to the same position as the lines on the inner knob, the two knobs lock together and the sweep rate of both generators is 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 Delaying Sweep Generator. The TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switch also select 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 DLY'D Time/Division switches (see Fig. 2-6). This control can be used with either the Delaying or Delayed Sweep Generators as determined by the setting of the Variable Selector mulit-pin connector (internal, see Fig. 2-1 for location). The VARIABLE control also incorporates a two-position switch to determine if the applicable sweep rate is calibrated or uncalibrated. When the VARIABLE control is pressed in, it is inoperative. However, when pressed and released, the VARIABLE control is activated for uncalibrated sweep rates. The sweep rate can be returned to the calibrated position by pressing the VARIABLE control. This feature is useful when a specific uncalibrated sweep rate has been obtained and it is desired to switch between calibrated and uncalibrated sweep rates. Switching from uncalibrated to calibrated and vice-versa does not affect the setting of the VARIABLE control. The VARIABLE control allows the sweep rate in each Time/Division switch position to be reduced to at least the next adjacent switch position.

Time Measurement

When making time measurements from the graticule, the area between the second and tenth vertical lines of the graticule provides the most linear time measurements (see Fig. 2-7). Position the start of the timing area to the second

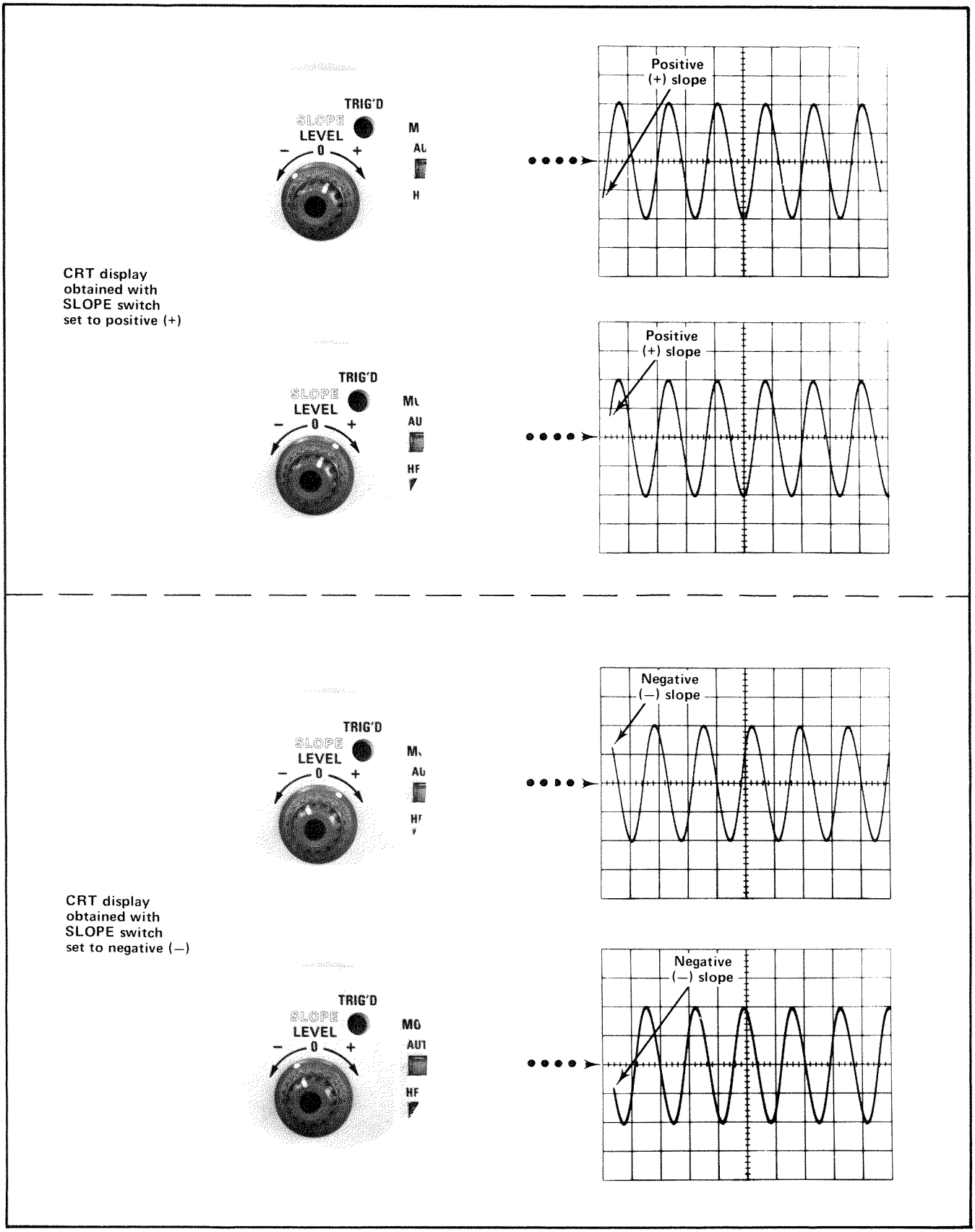


Fig. 2-5. Effect of LEVEL control and SLOPE switch on CRT display (AUTO, NORM, and SINGLE SWEEP MODE).

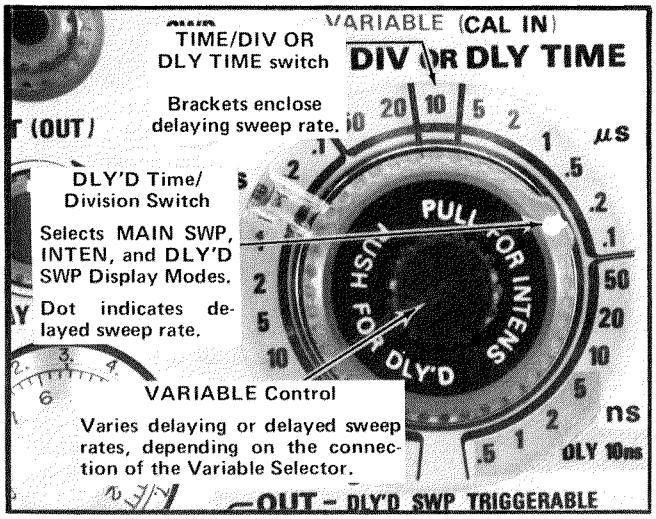


Fig. 2-6. Delaying and Delayed Time/Division switch.

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.

Display Modes

Four Display Modes can be selected by appropriate settings of the TIME/DIV OR DLY TIME, DLY'D Time/Division, and ALT switches.

Normal Sweep Operation. To select the Normal Sweep Display Mode (non-delayed sweep) press in the DLY'D Time/Division switch and set it to the same sweep rate as the TIME/DIV OR DLY TIME switch. Press the Delayed Triggering LEVEL control to the IN-RUNS AFTER DLY TIME position.

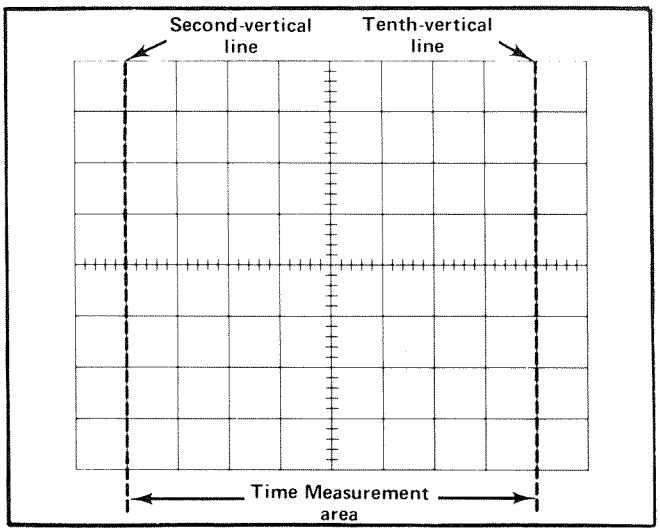


Fig. 2-7. Area of graticule used for accurate time measurements.

Calibrated sweep rates in the Normal Sweep Display Mode are available from 0.2 s/DIV to .5 ns/DIV. By using the VARIABLE control (Variable Selector connector set for variable Delayed Sweep rates) uncalibrated sweep rates to 0.5 s/DIV are available. Triggering in the Normal Sweep Display Mode is controlled by the MAIN TRIGGERING 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 on the delaying sweep during the time the delayed sweep is in operation (see Fig 2-8A). 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. The time that the delayed sweep runs is determined by the DLY'D Time/Division switch. 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 Delayed Triggering controls.

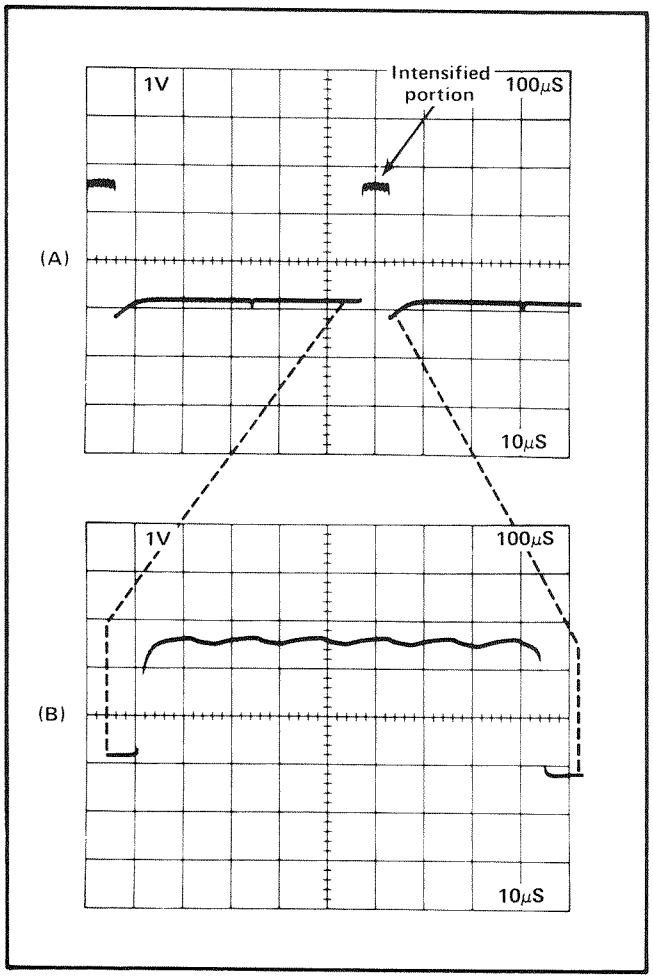


Fig. 2-8. (A) Intensified Sweep display; (B) Delayed Sweep display.

Delayed Sweep Display. The DLY'D Sweep 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 mode, is displayed on the CRT at the sweep rate indicated by the DLY'D Time/Division switch (see Fig. 2-8B).

Calibrated sweep rates in the DLY'D Sweep mode are available from .2 s/DIV to 0.5 ns/DIV. By using the VARIABLE control (Variable Selector connector set for variable delayed sweep rates), uncalibrated delayed sweep rates to .5 s/DIV are available. Triggering for the DLY'D Sweep Display Mode is controlled by the Delayed Triggering controls.

Alternate Sweep Display. The ALT Display Mode is effective when the ALT switch is pressed and released to the OUT position and the DLY'D Time/Division switch is set to a sweep rate faster than the TIME/DIV OR DLY TIME switch setting. In this Display Mode, both an intensified sweep and a delayed sweep are displayed (see Fig. 2-9).

The intensified trace of the Alternate Sweep display provides an intensified portion on the delaying sweep display during the time that the delayed sweep is in operation. 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. For the delayed sweep trace of the Alternate Sweep display, the intensified portion, as viewed on the intensified trace is displayed at the sweep rate indicated by the DLY'D Time/Division switch at the end of the delay time as determined by the settings of the TIME/DIV OR DLY TIME switch and the DELAY TIME MULT dial. Triggering for the delaying sweep portion of the intensified trace is controlled by the MAIN TRIGGERING controls; triggering for the intensified portion of the intensified trace and the delayed sweep trace is controlled by the Delayed Triggering controls.

The TRACE SEP control vertically positions the intensified trace approximately four divisions with respect to the delayed sweep trace. The brightness of the delaying sweep portion of the intensified trace may be varied by the INTENSITY control.

Delay Time Multiplier

The DELAY TIME MULT dial (functional in the INTEN, DLY'D SWP, ALT, or Mainframe Delaying modes) provides 0 to 9.9 times continuous sweep delay. The amount of time that the delaying 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. 2-10 is 3.55; this corresponds to 3.55 CRT divisions of delaying 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.

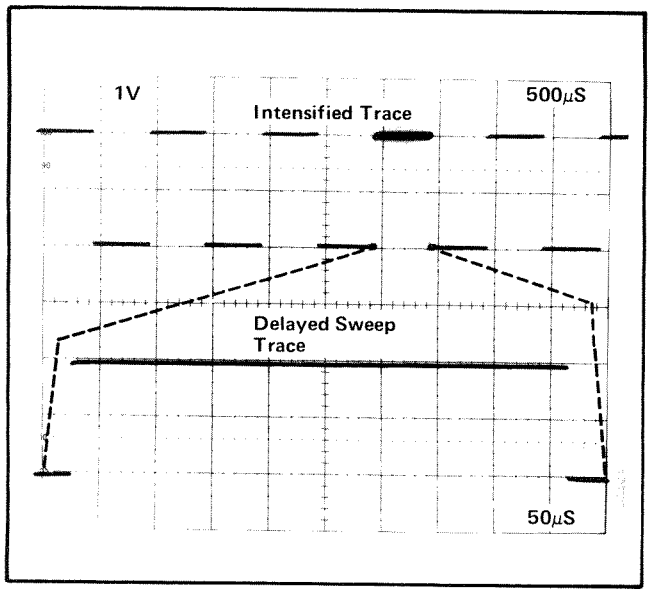


Fig. 2-9. Typical Alternate Sweep display.

Delayed Sweep Triggering

A LEVEL control and SLOPE, COUPLING, and SOURCE switches are provided for delayed sweep triggering. The Delayed Triggering LEVEL control determines the delayed sweep mode, delayed triggering mode, and delayed triggering level. When the LEVEL control is pressed to the IN-RUNS AFTER DLY TIME position the delayed sweep starts immediately after the delay time determined by the TIME/DIV OR DLY TIME switch and DELAY TIME MULT dial. The delayed triggering LEVEL and HF SYNC control and the SLOPE, COUPLING, and SOURCE switches are inoperative. This mode permits selection of continuously variable delay times by rotating the DELAY TIME MULT dial.

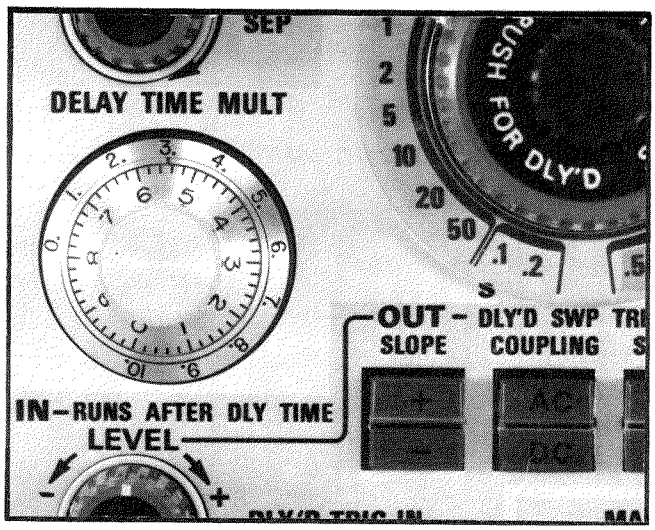


Fig. 2-10. DELAY TIME MULT dial. Reading shown: 3.55.

When the Delayed Triggering LEVEL control is pressed in and released to the OUT-DLY'D SWP TRIGGERABLE position, the delayed sweep does not start at the completion of the delay time. Instead, it waits until a trigger pulse is received by the delayed triggering circuits. The delay time in this mode is dependent not only on the settings of the delay time controls but on the delayed triggering controls and the occurence of the delayed sweep triggering signal as well. The primary purpose of this mode is to eliminate jitter from the displayed delayed sweep waveform. Since the delayed sweep is triggered by the input waveform, jitter is eliminated from the delayed sweep display even through it may be inherent in the input waveform. When jitter in the delayed sweep display is not a problem, the IN-RUNS AFTER DLY TIME Delayed Triggering mode should be used.

In the DLY'D SWP TRIGGERABLE mode, the Delayed Triggering LEVEL control can be rotated to select the amplitude point on the trigger signal at which the delayed sweep is triggered or it can be rotated counterclockwise to select the HF SYNC Delayed Triggering mode. The Delayed Triggering SLOPE, COUPLING, and SOURCE pushbuttons are activated (selected position indicated by lighted portion of pushbutton). The HF SYNC Delayed Triggering mode and the SLOPE, COUPLING, and SOURCE functions are the same for delayed triggering as functions with the same title are for MAIN TRIGGERING (see Main Triggering HF SYNC, SLOPE COUPLING, SOURCE, and TERM Switch discussions in this section).

Mainframe Operating Modes

The 7B92 may be operated in a 7000-Series Oscilloscope with two horizontal compartments as an independent time base or as a delayed sweep unit in the Runs After Delay Time or Triggerable After Delay Time modes. The instrument can be operated independently in either plug-in compartment or as a delayed sweep unit in the B Horizontal compartment. Refer to the appropriate indicator oscilloscope manual for additional mainframe horizontal operating information.

APPLICATIONS

General

The following information describes the procedure and techniques for making basic measurements with a 7B92 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. Also, the following books describe oscilloscope measurement techniques which can be adapted for use with this instrument:

Harley Carter, "An Introduction to the Cathode Ray Oscilloscope", Philips Technical Library, Cleaver-Hume Press Ltd., London, 1960.

J. Czech, "Oscilloscope Measuring Technique", Philips Technical Library, Springer-Verlag, New York, 1965.

Robert G. Middleton and L. Donald Payne, "Using the Oscilloscope in Industrial Electronics", Howard W. Sams & Co. Inc., The Bobbs-Merril Company Inc., Indianapolis, 1961.

John F. Rider and Seymour D. Uslan, "Encylopedia of Cathode-Ray Oscilloscopes and Their Uses", John F. Rider Inc., New York, 1959.

John F. Rider, "Obtaining and Interpreting Test Scope Traces", John F. Rider Publisher Inc., New York, 1959.

Rufus P. Turner, "Practical Oscilloscope Handbook", Volumes 1 and 2, John F. Rider Publisher Inc., New York, 1964.

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.

2. Set the TIME/DIV OR DL'Y TIME switch and the VARIABLE control 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 DL'Y 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 DL'Y TIME switch. This is the horizontal conversion factor:

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

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 DL'Y 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:

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

Example. Assume a reference signal frequency of 455 hertz (period 2.19 milliseconds), a TIME/DIV OR DL'Y 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 DL'Y 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):

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

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 DL'Y 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. 2-7).

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 DL'Y TIME switch.

Example. Assume that the distance between the time measurement points is five divisions (see Fig. 2-11), and the TIME/DIV OR DL'Y TIME switch is set to .1 ms.

Using the formula:

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

Substituting the given values:

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

The time duration is 0.5 millisecond.

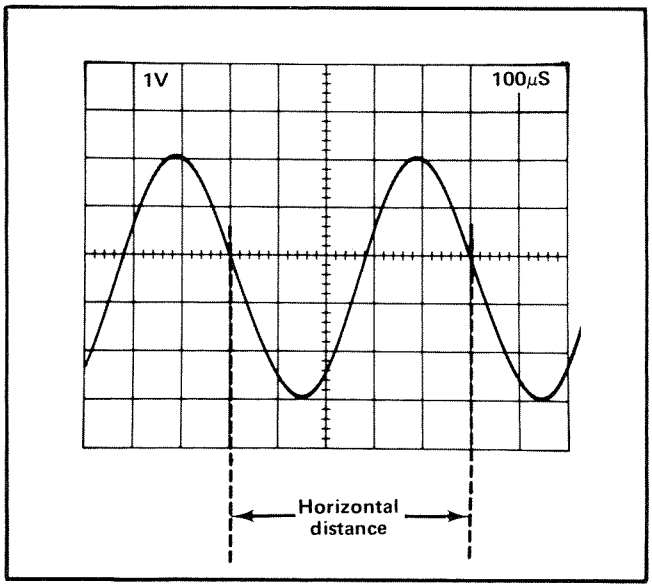


Fig. 2-11. Measuring the time duration between points on a waveform.

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.

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

Example. The frequency of the signal shown in Fig. 2-11 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 DL'Y 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 2-1 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 2-1

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. 2-12, 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 DL'Y TIME switch.

Example. Assume that the horizontal distance between the 10% and 90% points is four divisions (see Fig. 2-12) and the TIME/DIV OR DL'Y TIME switch is set to 1 μs. Applying the time duration formula to risetime:

Time Duration (Risetime)	=	horizontal distance (divisions)	X	TIME/DIV OR DL'Y TIME setting

Substitute the given values:

Risetime = 4 X 1 microsecond.

The risetime is 4.0 microseconds.

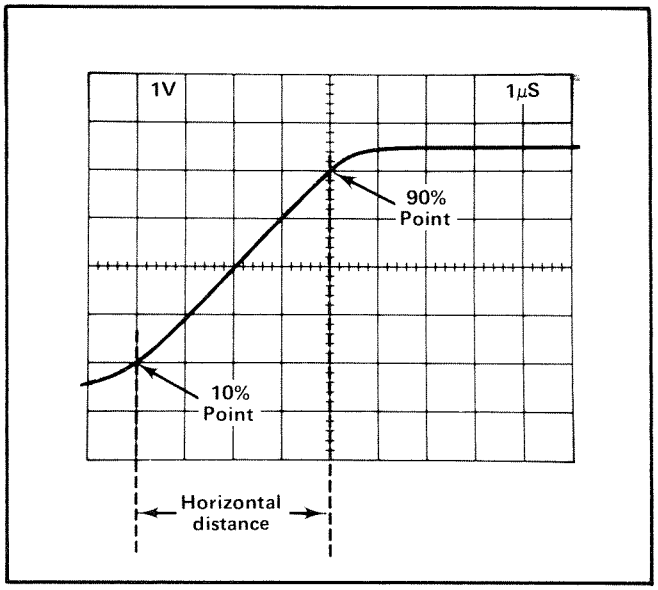


Fig. 2-12. Measuring risetime.

Delayed Sweep Measurements

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 1 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 DL'Y 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 DL'Y TIME switch. This figure is the time interval between pulses.

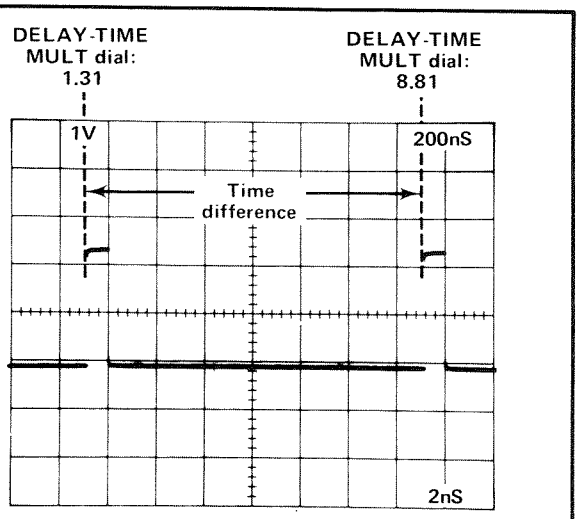
Example. Assume the first dial setting is 1.31 and the second dial setting is 8.81 with the TIME/DIV OR DL'Y TIME switch set to 0.2 microsecond (see Fig. 2-13).

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

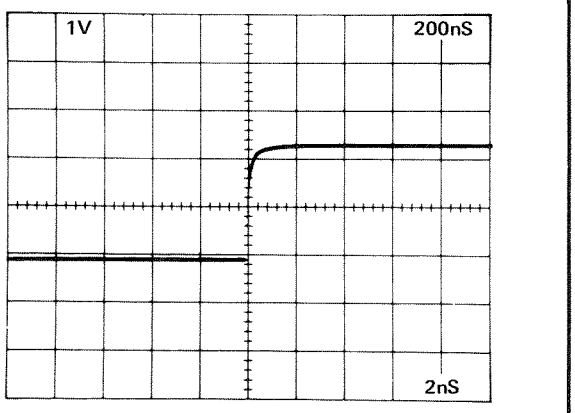
Substituting the given values:

Time Difference = (8.81 − 1.31) X 0.2 μs

The time difference is 1.5 μs



(A) Intensified sweep display.



(B) Delayed sweep display.

Fig. 2-13. Measuring time difference using delayed sweep.

Delayed Sweep Magnification

The delayed sweep feature of the 7B92 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 DL'Y TIME switch and the DELAY TIME MULT dial before the display is presented at the sweep rate selected by the DLY'D SWEEP Time/Division switch. The following method uses the IN-RUNS AFTER DL'Y TIME Delayed Trigger 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. 2-14A).

5. Pull out the DLY'D Time/Division switch for the INTEN Display Mode. Press the Delayed Triggering LEVEL control to IN-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 setting of the DLY'D Time/Division switch.

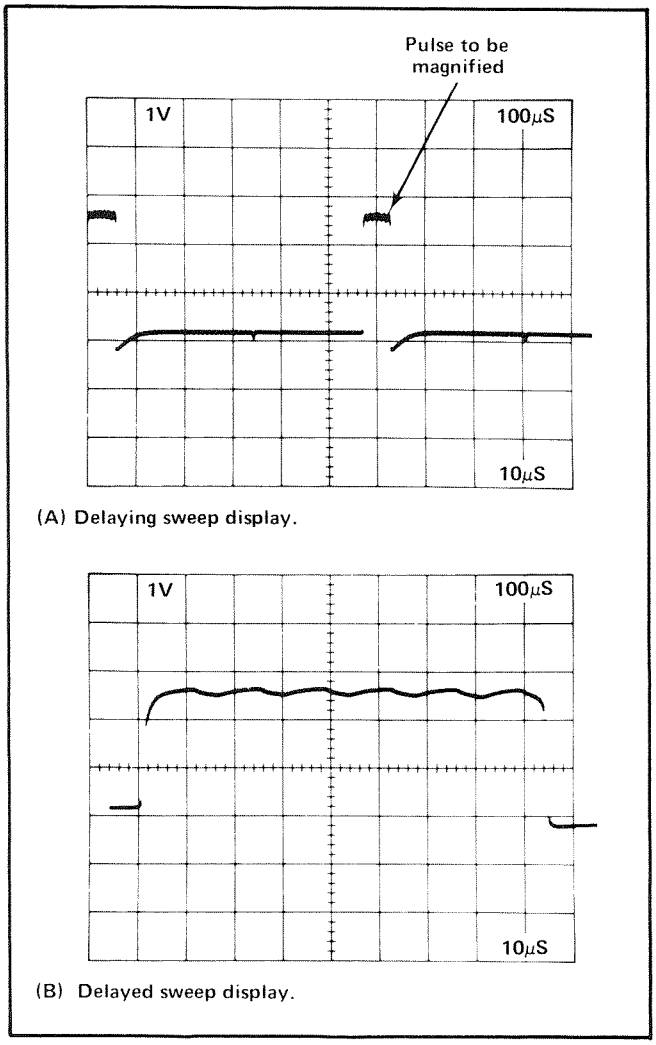


Fig. 2-14. Using delayed sweep for magnification.

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

Example. The apparent magnification of the display shown in Fig. 2-14 with a TIME/DIV OR DL'Y TIME setting of .1 ms and a DLY'D SWEEP Time/Divisions switch setting of 10 microsecond is:

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

Substituting the given values:

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

The apparent magnification is 10 times.

Triggered Delayed Sweep Magnification

The delayed sweep magnification method just described may produce too much jitter at high apparent magnification ranges. The OUT-DLY'D SWP TRIGGERABLE mode provides a more stable display, since the delayed sweep display is triggered at the same point each time.

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

2. Press in and release the Delayed Triggering LEVEL control to the OUT-DLY'D SWP TRIGGERABLE position. Select the desired Delayed Triggering SLOPE, COUPLING, and SOURCE.

3. Adjust the Delayed Triggering LEVEL control to produce an intensified portion on the display.

4. Inability to produce an intensified zone on the display indicates that the Delayed Triggering controls are incorrectly set, or that the signal does not meet triggering requirements. If the condition cannot be remedied with the Delayed Triggering 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 Delayed Triggering 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

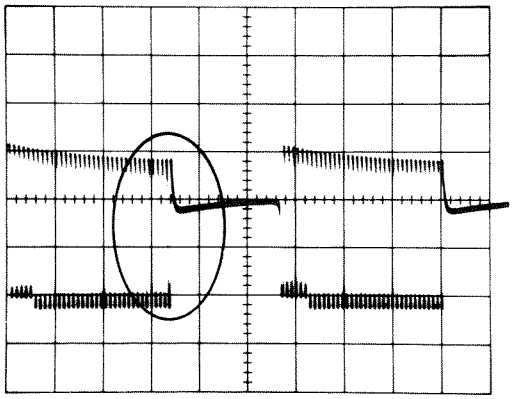
Complex signals often consist of a number of individual events of differing amplitudes. Since the trigger circuits are sensitive to changes in signal amplitude, a stable display can normally be obtained only when the sweep is triggered by the event(s) having the greatest amplitude. However, this may 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 amount 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:

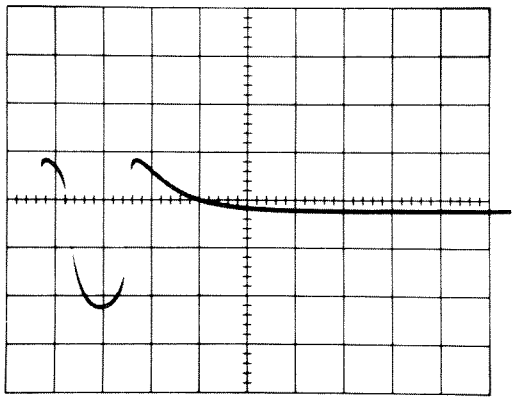
1. Set up the display as given in Steps 1 through 8 of Delayed Sweep Magnification.

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. 2-15 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 the start of display.



(B) Area of interest displayed by delaying the main sweep (DLY'D SWP mode).

Fig. 2-15. 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 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 DL'Y TIME switch to a sweep rate which displays the complete waveform (see Fig. 2-14A).

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 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. 2-16) and the DLY'D Time/Division switch is .5 microsecond.

Using the formula:

Pulse Jitter	=	horizontal jitter (divisions)	X	DLY'D SWEEP Time/Division setting

Substituting the given values: Pulse Jitter = 0.5 X 0.5 microsecond

The pulse jitter is 0.25 microsecond.

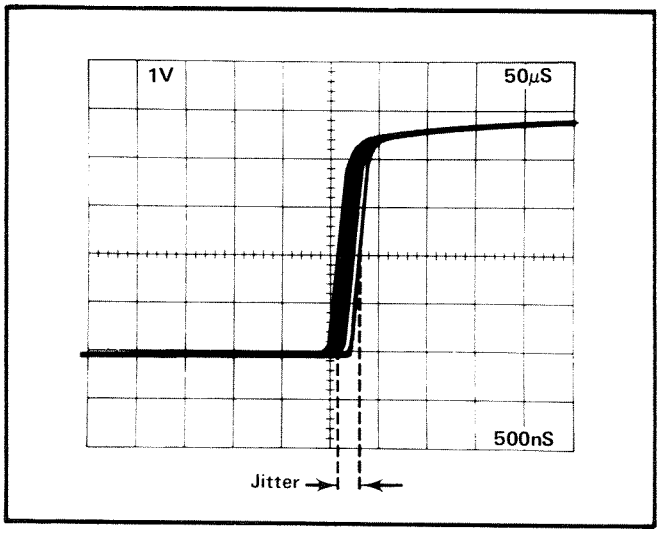


Fig. 2-16. Measuring pulse jitter.

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.