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TEKTRONIX®

7B92A
DUAL TIME BASE
WITH OPTIONS
OPERATORS

INSTRUCTION MANUAL

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

Serial Number _____

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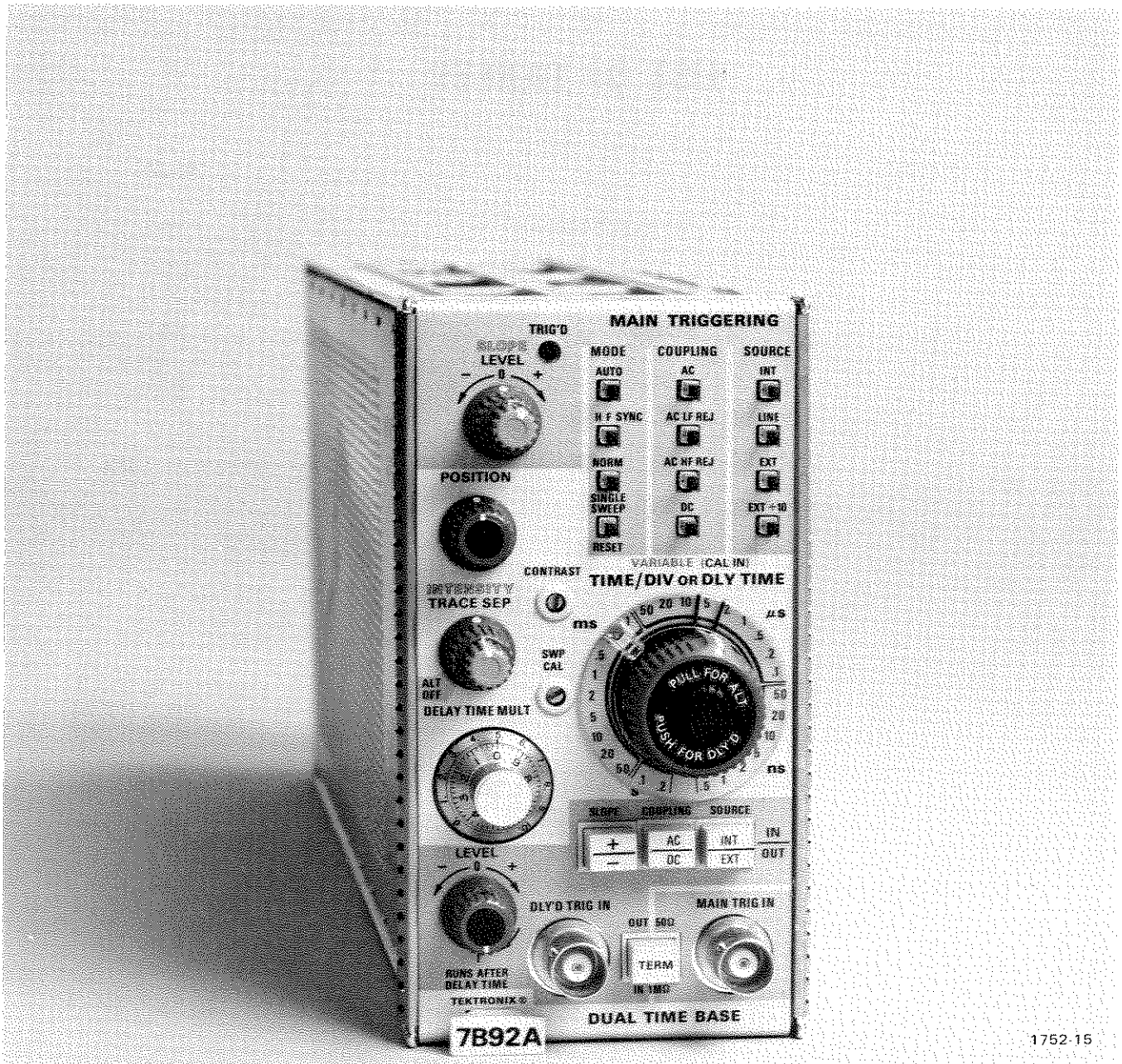
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7B92A Features

The 7B92A Dual Time Base unit provides normal, delayed, intensified, 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 7B92A is intended for use with high-frequency 7000-Series Oscilloscope systems; however, most 7B92A functions are compatible with all 7000-Series Oscilloscopes.

Other features include lighted pushbutton switches, compatibility with indicator oscilloscopes having an alphanumeric readout system, and 0 to 9.8 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.

Fig. 1-1. 7B92A Dual Time Base.

SPECIFICATION

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 Characteristics

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[2] (div)	EXT[3] (mV)	
COUPLING				
AC	30 Hz to 20 MHz 20 MHz to 500 MHz	0.5 1.0	100 500	
AC LF REJ[1]	30 Hz to 20 MHz 20 MHz to 500 MHz	0.5 1.0	100 500	
AC HF REJ	30 Hz to 50 Hz	0.5	100	
DC	Dc to 20 MHz 20 MHz to 500 MHz	0.5 1.0	100 500	
Operating in HF SYNC MODE				
AC AC LF REJ DC	100 MHz to 500 MHz	0.5	100	Use NORM or SINGLE SWEEP MODE for signals below about 30 Hz
AC HF REJ	Not recommended for HF SYNC mode			
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				
1 MΩ Input				250 V (dc + peak ac)
50Ω Input				1 W average (7 V rms)

[1] Will not trigger on the sine waves of 8 div amplitude or less (internal), or 3 V or less (external) at 60 Hz or below.

[2] 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.

[3] Triggering signal amplitude requirements increased by factor of 10 for EXT ÷ 10 operation.

TABLE 1-1 (cont.)
Electrical Characteristics

Characteristic	Performance Requirement			Supplemental Information
MAIN TRIGGERING (cont.)				
Input R and C				
1 MΩ Input				Approximately 1 MΩ paralleled by approximately 20 pF
50 Ω Input				
Resistance				50 Ω within 7%
Reflection Coefficient (Time Domain)				0.1 p-p (using 1 GHz Reflectometer)
Trigger Jitter				
Internal or External	50 ps or less at 500 MHz			
DELAYED TRIGGERING				
Trigger Sensitivity	Triggering Frequency Range	Minimum Triggering Signal Required		
		INT[4] (div)	EXT (mV)	
COUPLING				
AC	30 Hz to 20 MHz	0.5	100	
	20 MHz to 500 MHz	1.0	500	
DC	Dc to 20 MHz	0.5	100	
	20 MHz to 500 MHz	1.0	500	
Trigger Jitter				
Internal or External	50 ps or less at 500 MHz			
External Trigger Input				
Level Range				
EXT	At least +3.5 V to −3.5 V			
Maximum Safe Input				
1 MΩ Input				250 V (dc + peak ac)
50 Ω Input				1 W average (7 V rms)
Input R and C				
1 MΩ Input				Approximately 1 MΩ paralleled by approximately 20 pF

[4] 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.)
Electrical Characteristics

Characteristic	Performance Requirement		Supplemental Information
DELAYED TRIGGERING (cont.)			
Input R and C (cont.)			
50 Ω Input			
Resistance			50 Ω within 7%
Reflection Coefficient (Time Domain)			0.1 p-p (using 1 GHz Reflectometer)
NORMAL, ALT (Delayed Sweep Trace) and DLY'D SWEEP			
Sweep Rates	0.2 s/div to 0.5 ns/div in 27 calibrated steps		Selected by TIME/DIV switch. Steps in a 1-2-5 sequence
Sweep Accuracy	Measured in 7900-Series Oscilloscope		
Over Center 8 Div	+15°C to +35°C	0°C to +50°C	
.2 s/Div to 20 ns/Div	Within 2%	Within 3%	
10 ns/Div to 5 ns/Div	Within 3%	Within 4%	
2 ns/Div to 1 ns/Div	Within 4%	Within 5%	
.5 ns/Div	Within 5%	Within 6%	
Over Any 2 Div Portion Within Center 8 Div			
.2 s/Div to 10 ns/Div	Within 5%	Within 5%	
5 ns/Div to .5 ns/Div	Within 10%	Within 10%	
Variable Sweep Rate	Continuously variable between calibrated sweep rates.		Extends sweep rate to at least 0.5 s. VARIABLE control internally switchable between Delaying and Delayed Sweeps
INTENSIFIED SWEEP (Delaying Sweep Trace of ALT Sweep Display)			Selected by TIME/DIV OR DLY TIME switch. Steps in a 1-2-5 sequence
Sweep Rates	0.2 s/div to 10 ns/div in 23 calibrated steps		
Sweep Accuracy	Measured in 7900-Series Oscilloscope		
Over Center 8 Div	+15°C to +35°C	0°C to +50°C	
.2 s/Div to 20 ns/Div	Within 2%	Within 3%	
10 ns/Div	Within 3%	Within 4%	
Over Any 2 Div Portion Within 8 Div	Within 5%	Within 5%	

TABLE 1-1 (cont.)
Electrical Characteristics

Characteristic	Performance Requirement	Supplemental Information
INTENSIFIED SWEEP (Delaying Sweep Trace of ALT Sweep Display) (cont.)		
Variable Sweep Rate	Continuously variable between calibrated sweep rates	Extends sweep rate to at least 0.5 s. Variable control internally switchable between Delaying and Delayed Sweeps
Trace Separation	Intensified sweep can be positioned at least 3.5 div above the delayed sweep	
Alt Off	Intensified sweep of the delaying sweep is displayed when the TIME/DIV switch is pulled out and rotated clockwise, and the TRACE SEP control is in ALT OFF position	Allow Intensified Mode of operation
VARIABLE TIME DELAY		
Delay Time Range		
DLY TIME/DIV Settings		
.2 s/Div to 10 ns/Div	0 to 9.8 times the DLY TIME switch setting (0 to 1.96 s)	
Differential Delay Time Measurement Accuracy		
+15°C to +35°C		
.2 s/Div to .1 μs/Div		
Both DELAY TIME MULT dial settings at 0.50 or greater	Within 0.75% of measurement +0.25% of full scale	Full scale is 10 times the TIME/DIV OR DLY TIME setting
One or Both DELAY TIME MULT dial settings less than 0.50	Within 0.75% of measurement +0.5% of full scale + 5 ns	
50 ns/Div to 10 ns/Div		
Both delay times equal to or greater than 25 ns	Within 1.0% of measurement +0.5% of full scale	
One of both delay times less than 25 ns	Within 1.0% of measurement +1.0% of full scale + 5 ns	
Delay Time Jitter		Jitter specification does not apply to the first 2% of the maximum available delay time (DELAY TIME MULT dial setting less than 0.20)
0.2 s/Div to 50 μs/Div	1 part or less in 50,000 of the maximum available delay time (10 times the TIME/DIV OR DLY TIME switch setting)	
20 μs/Div to 10 ns/Div	1 part or less in 50,000 of the maximum available delay time (10 times the TIME/DIV OR DLY TIME switch setting + 0.5 ns)	

TABLE 1-2

Environmental

Refer to the Specification for the associated oscilloscope.

TABLE 1-3

Physical

Net Weight	3.062 lbs (1.372 Kg)
Dimensions	See Fig. 1-2, Dimensional Drawing

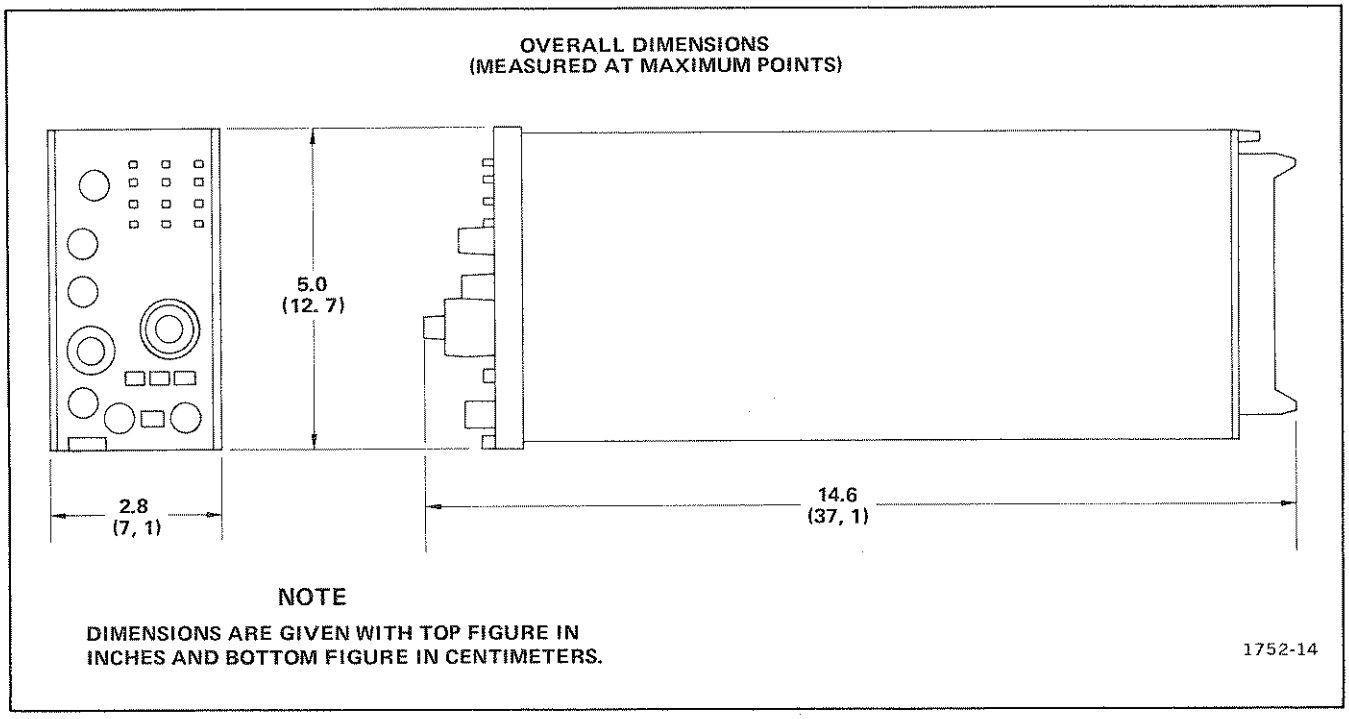
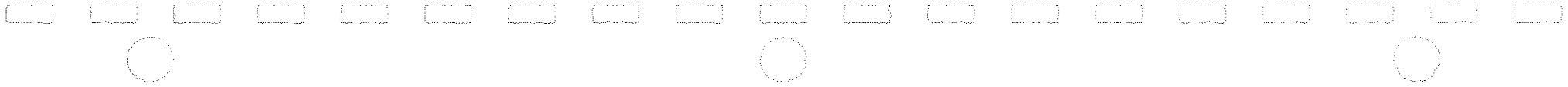


Fig. 1-2. Dimensional drawing.



OPERATING INSTRUCTIONS

The 7B92A Dual Time-Base Plug-In Unit operates with a Tektronix 7000-Series Oscilloscope and a 7A-Series Amplifier plug-in unit to form a complete high-frequency oscilloscope system. This section describes the operation of the front-panel controls and connectors, provides general operating information, an Operating Check-Out procedure, and basic applications for this instrument.

NOTE

The ALT OFF position, which allows the Intensified mode of operation, is applicable to instruments SN B060000 and up.

INSTALLATION

The 7B92A is designed to operate in the horizontal plug-in compartment of the oscilloscope. This instrument can also be installed in a vertical plug-in compartment to provide a vertical sweep on the crt. However, when used in this manner, there are no internal triggering or retrace blanking provisions, and the unit may not meet the specifications given in Section 1.

Before proceeding with installation, check the settings of the Time/Div Variable Selector multi-pin connector and the Mainframe Selector multi-pin connector (see Fig. 2-1). The Time/Div Variable Selector determines whether the front-panel Time/Div VARIABLE control operates in conjunction with the delaying or delayed sweeps. The Mainframe Selector adapts the 7B92A to the oscilloscope mainframe being used. The two mainframe selections are:

(1) 7800 and 7900-Series Oscilloscopes.

(2) All other 7000-Series Oscilloscopes.

NOTE

The 7B71 will not delay the 7B92A for displaying alternating Delaying and Delayed sweeps. Instead, it causes a sweep lock-up to occur under the following conditions; with the 7B71 in the A Horizontal compartment, and the 7B92A in the B Horizontal compartment, the sweep locks up if the 7B92A is in its Alternate mode and the Mainframe Horizontal Mode is Alt. Lock-up can be avoided by changing the Mainframe Horizontal Mode to Chop or B. This allows both 7B92A sweeps to be displayed.

To install the 7B92A in a plug-in compartment, push it in until it fits firmly into the compartment. The front panel of the 7B92A should be flush with the front panel of the oscilloscope. Even though the gain of the oscilloscope is standardized, the sweep calibration of the 7B92A should be checked when installed. The procedure for checking the unit is given under Sweep Calibration in the Operating Checkout procedure in this section.

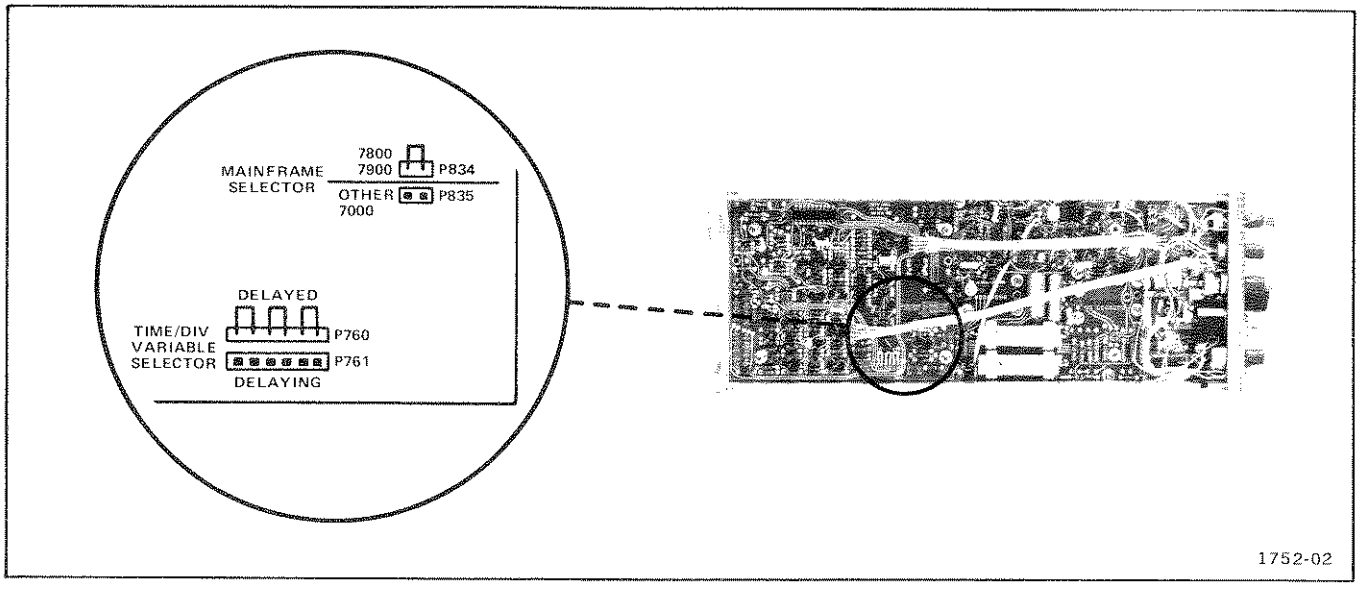


Fig. 2-1. Location of Variable and Mainframe Selector multi-pin connectors.

To remove the 7B92A, pull the release latch (see Fig. 2-2) to disengage the unit from the oscilloscope, and pull it out of the plug-in compartment.

FRONT-PANEL CONTROLS, CONNECTORS, AND INDICATORS

All controls, connectors, and indicators required for the operation of the 7B92A, except the Time/Div Variable and Mainframe Selectors, are located on the front panel. A brief description of the front-panel controls, connectors, and indicators is given here. More detailed information is given under General Operating Information. Fig. 2-1 shows the Time/Div Variable and Mainframe Selectors. Fig. 2-3 shows the front-panel controls, connectors, and indicators.

Main Triggering Controls

(1) LEVEL Control

Selects amplitude point on trigger signal where sweep triggering occurs when the Main Triggering Mode AUTO, NORM, or SINGLE SWEEP switches are pressed. When the Main Triggering Mode HF SYNC switch is pressed, the LEVEL control adjusts the frequency of the trigger generator to synchronize with the frequency (or sub-harmonic) of the triggering signal to provide a stable display.



Fig. 2-2. Location of release latch.

(2) SLOPE Switch

Permits triggering on the positive or negative slope of the trigger signal (except in HF SYNC).

(3) TRIG'D Indicator

When lit, indicates that the sweep is triggered and will produce a display with correct setting of the POSITION control and the controls on the associated Amplifier plug-in unit(s) and oscilloscope.

(4) MODE Switches

Select the desired main triggering mode. Selected mode is indicated by lighted pushbutton.

AUTO: Selects a triggered sweep initiated by the applied trigger signal at a point determined by the LEVEL control and SLOPE switch when the trigger signal repetition rate is above 30 hertz and within the frequency range selected by the COUPLING switches. When the LEVEL control is outside the amplitude range, the trigger repetition rate is outside the frequency range selected by the COUPLING switches, 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. When the LEVEL control is adjusted to frequencies between subharmonics, the sweep free-runs.

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

SINGLE SWEEP-RESET: When the SINGLE SWEEP-RESET pushbutton switch is pressed, a single trace will be presented when the next trigger pulse is received. The SINGLE SWEEP-RESET pushbutton remains lit until a trigger is received and the sweep is completed. The SINGLE SWEEP-RESET pushbutton switch must be pressed again before another sweep can be displayed.

(5) COUPLING Switches

Select trigger signal coupling. Selected coupling is indicated by lighted pushbutton.

AC: Rejects dc and attenuates ac signals below approximately 30 hertz. Accepts signals between 30 hertz and 500 megahertz.

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

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.

(6) SOURCE Switches

Select the triggering source. Selected source is indicated by lighted pushbutton.

INT: Trigger signal obtained internally from Amplifier plug-in unit of oscilloscope.

LINE: Trigger signal obtained internally from the line voltage applied to the oscilloscope.

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

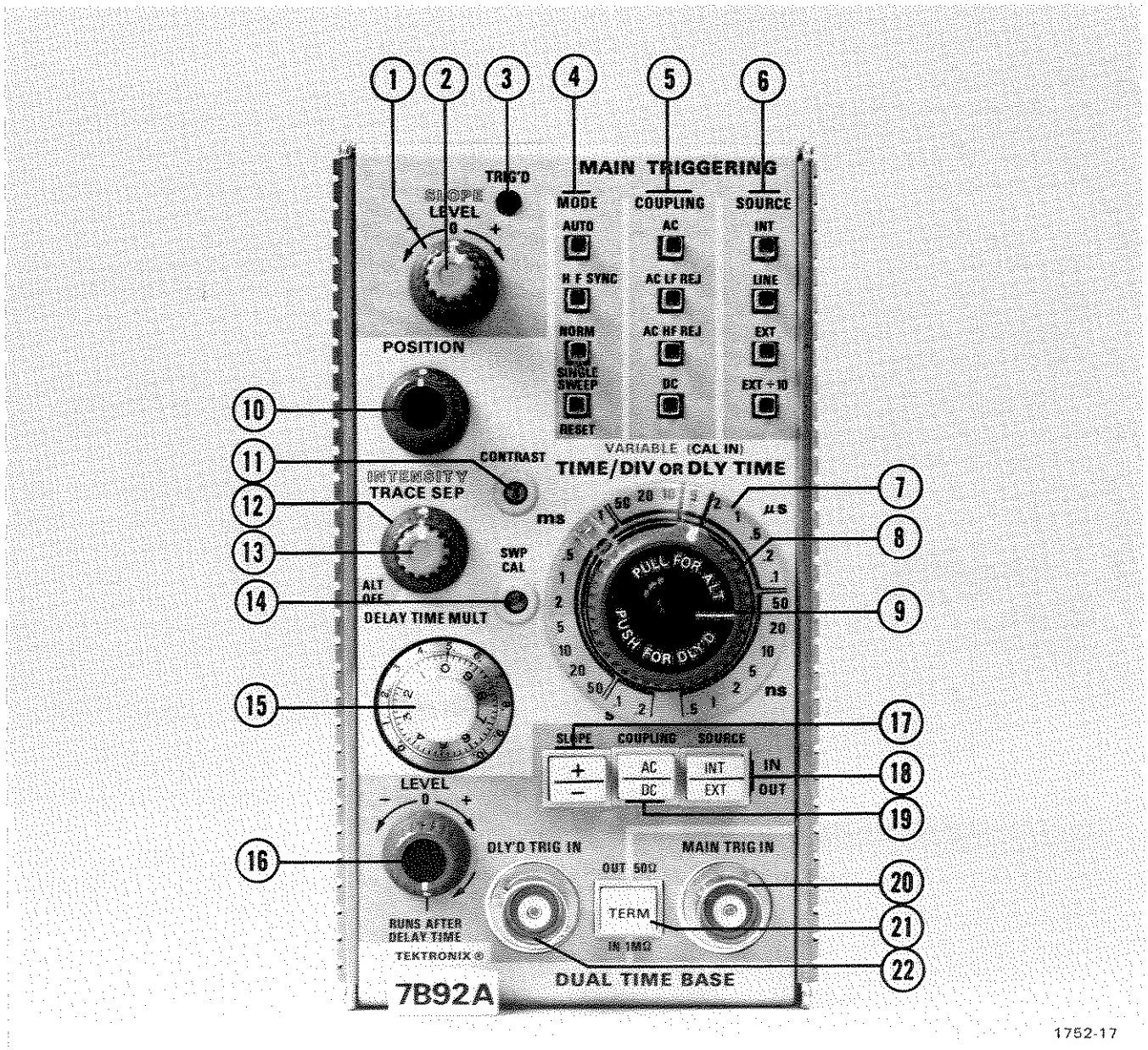


Fig. 2-3. Front-panel controls and connectors.

(6) SOURCE Switches (cont.)

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

Sweep Controls

(7) TIME/DIV OR DLY TIME

Selects the basic sweep rate for normal sweep operation and selects the delay time (multiplied by the DELAY TIME MULT dial setting) when operating in the Alternate or Delayed sweep modes. The VARIABLE control must be in the CAL (knob in) position for calibrated sweep rate.

(8) DLY'D Time/Division

Selects the delayed sweep rate for operation in Delayed and Alternate sweep modes. The VARIABLE control must be in the CAL (knob in) position for calibrated sweep rate.

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

Normal Sweep: A normal sweep is selected when the TIME/DIV OR DLY TIME switch and the DLY'D Time/Division switches are locked together at the same sweep rate. The DLY'D Time/Division knob must be pressed in for normal sweep mode. Calibrated sweep rates from 0.2 second/division to 0.5 nanosecond/division can be selected.

ALT Sweep: The Alternate mode is selected when the DLY'D Time/Division switch is pulled out and rotated clockwise and the TRACE SEP control is turned clockwise from the ALT OFF position. In this mode, the delaying sweep is displayed (with an intensified zone during the time that the delayed sweep runs) alternately with the delayed sweep.

Intensified Sweep: The intensified sweep mode (Intens) is selected when the DLY'D Time/Division switch is pulled out, and rotated to the desired sweep rate faster than the TIME/DIV or DLY TIME switch setting, and the TRACE SEP control is rotated counterclockwise to the ALT OFF position (see Fig. 2-3). In this mode, a portion of the delaying sweep is intensified during the time that the delayed sweep generator runs.

DLY'D Sweep: The delayed sweep mode is selected when the DLY'D Time/Division switch is pulled out, rotated 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 setting.

(9) VARIABLE

Two-position switch actuated by the VARIABLE control to select calibrated or uncalibrated sweep rates. In the CAL position (knob in) 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 to at least the sweep rate of the next slower position. The VARIABLE control will operate with either the delaying or delayed sweep by means of the internal Time/Div Variable Selector.

(10) POSITION Control

Positions the display horizontally on the graticule.

(11) CONTRAST Control

Varies the relative brightness of the intensified portion of the delaying trace when in the Alternate mode.

(12) TRACE SEP/ALT OFF Control

This control vertically positions the delaying sweep display up to 3.5 divisions above the delayed sweep display when in the Alternate mode. The ALT OFF position allows the Intensified sweep mode of operation, permitting the display of an intensified portion of the delaying sweep.

(13) INTENSITY Control

Varies the intensity of the Intensified sweep only when operating in the INTENS or ALT mode.

(14) SWP CAL Adjustment

Screwdriver adjustment sets the basic timing of the 7B92A to compensate for slight differences in input sensitivity when changing indicator oscilloscopes.

(15) DELAY TIME MULT Dial

Provides variable delay of 0 to 9.8 times the basic delay time selected by the TIME/DIV OR DLY TIME switch.

Delayed Triggering Controls

(16) LEVEL Control

Determines the delayed trigger mode and the delayed trigger level.

RUNS AFTER DELAY TIME (LEVEL control turned fully clockwise into detent): Delayed sweep runs immediately following the delay time selected by the TIME/DIV OR DLY TIME switch and the DELAY TIME MULT dial. Delayed SLOPE, COUPLING, and SOURCE functions are inoperative.

Delayed Sweep Triggerable: When the Delayed Triggering LEVEL control is turned counter-clockwise out of detent, the delayed sweep is triggerable. The Delayed Triggering LEVEL control can now be rota-

(16) LEVEL Control (cont.)

ted to select the amplitude point on the trigger signal at which the delayed sweep is triggered. In the Delayed Sweep Triggerable mode, the delayed SLOPE, COUPLING, and SOURCE functions are activated.

(17) SLOPE Switch

Two-position switch to select the slope of the trigger signal which starts the delayed sweep.

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

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

(18) SOURCE Switch

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

INT: The delayed trigger signal is obtained from the vertical amplifier of the oscilloscope.

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

(19) COUPLING Switch

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

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

DC: Accepts trigger signals from dc to 500 megahertz.

Front-Panel Inputs

(20) MAIN TRIG IN Connector

Serves as an external trigger input for the main triggering circuit when the Main Triggering Source EXT or EXT ÷ 10 pushbutton switches are pressed.

(21) TERM Switch

Two-position pushbutton switch to select 50 ohms (out position) or 1 megohm (in position) input impedance for the MAIN TRIG IN and DLY'D TRIG IN connectors.

(22) DLY'D TRIG IN Connector

Serves as an external trigger input for the delayed triggering circuit when the Delayed Triggering SOURCE switch is set to EXT.

CAUTION

Do not exceed 7 volts (rms) of external signal when 50 Ω termination is selected.

FAMILIARIZATION PROCEDURE

The following procedure may be used for familiarization or as a check of basic instrument operation. The procedure is divided into two parts, Sweep Functions and Triggering Functions. A complete operating check of the 7B92A functions can be made by performing both parts, or each part may be performed separately. If performing the Familiarization Procedure reveals a malfunction or improper calibration, first check the operation of the associated plug-in units; then refer to the 7B92A Service manual.

NOTE

For optimum high-frequency performance, the 7B92A should be installed in an oscilloscope system with similar frequency and sweep-rate capabilities.

Setup Procedure

1. Install the 7B92A in a horizontal compartment of the oscilloscope.

2. Install the Amplifier plug-in unit in a vertical compartment.

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

4. Set the 7B92A controls as follows:

Main Triggering

SLOPE	(+)
MODE	AUTO
COUPLING	AC
SOURCE	INT

Delayed Triggering

LEVEL	RUNS AFTER DELAY TIME

Delayed Triggering (cont.)

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 (knob in)
VARIBLE	CAL
Time/Div Variable Selector (Internal)	Delayed Sweep
DELAY TIME MULT	1.00
TRACE SEP	Midrange

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

Sweep Functions

NORMAL SWEEP. Perform the following procedure to obtain a normal sweep and demonstrate the function of the related sweep controls:

1. Perform the Setup Procedure.

2. Connect a 4 volt, 1 kilohertz signal from the oscilloscope Calibrator to the Amplifier plug-in unit Input.

3. Adjust the Amplifier plug-in unit Volts/Division switch for two divisions of display.

4. Rotate the Main Triggering LEVEL control for a stable display.

5. Rotate the POSITION control and note that the trace moves horizontally.

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 8 graticule divisions. Be sure that the timing of the Calibrator signal is accurate within 0.5%.

ALTERNATE AND DELAYED SWEEP. Perform the following procedure to obtain alternate-delayed sweeps and demonstrate the function of the related sweep controls:

7. Pull out the DLY'D Time/Division knob and rotate clockwise to 0.1 ms for the Alternate sweep mode. Note both an intensified trace and a normal-intensity delayed sweep trace on the crt. Increased oscilloscope intensity may be required for viewing the delayed sweep.

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

9. Rotate the CONTRAST adjustment for adequate identification of the intensified portion of the delaying sweep when alternating with delayed sweep.

NOTE

When operating in the Intensified Mode, the intensified zone is controlled by the intensity of the test oscilloscope, instead of the 7B92A Contrast and Intensity controls.

10. Rotate the TRACE SEP control to vertically position the delaying sweep trace with respect to the delayed sweep trace. With the TRACE SEP control in the ALT OFF position, only the Intensified sweep will be displayed.

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

12. Press the DLY'D Time/Division switch in for the Delayed sweep mode. Note the delayed display with sweep rate determined by the DLY'D Time/Division switch.

13. Press and release the VARIABLE control. Rotate the VARIABLE control and note that the sweep rate indicated by the DLY'D Time/Division switch can be varied to at least the sweep rate of the next adjacent position (0.2 ms). The internal Time/Div Variable Selector must be set to Delayed Sweep position. Return the VARIABLE control to the CAL position (knob in).

Triggering Functions

MAIN AND DELAYED TRIGGERING. Perform the following procedure to obtain a triggered alternate, normal, or delayed sweep and demonstrate the function of the related controls:

14. Perform the Set Up Procedure. Connect the 1 kilohertz Calibrator signal from the oscilloscope to the Amplifier plug-in unit Input and adjust for about 4 divisions of vertical display.

15. 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 knob (Normal sweep mode). Rotate the Main Triggering LEVEL control for a stable display.

16. Check that a stable display can be obtained with the Main Triggering COUPLING switch 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 display). Remove all connections from the oscilloscope system.

17. Connect a 0.4 volt, 1 kilohertz signal from the oscilloscope Calibrator to the Amplifier plug-in unit and to the MAIN TRIG IN connector. Set the Main Triggering SOURCE switch to EXT. Set the Amplifier plug-in unit Volts/Div switch for about 4 divisions of display. Check that a stable

display can be obtained with the Main Triggering COUPLING switch 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).

18. Change the Main Triggering SOURCE switch to EXT ÷ 10. Set the oscilloscope Calibrator for 4 volts at 1 kilohertz and adjust the Amplifier plug-in unit Volts/Div switch for about 4 divisions of display. Check that a stable display can be obtained with the Main Triggering COUPLING switch 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 display). Remove all connections from the oscilloscope system.

19. Set the Main Triggering COUPLING switch to AC and SOURCE switch to INT. Connect a 1 kilohertz Calibrator signal from the oscilloscope to the Amplifier plug-in unit Input and adjust for about 4 divisions of display amplitude. 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.

20. 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 Amplifier plug-in unit and press the RESET button. Check for no display and READY light on. Connect the 1 kilohertz signal to the Amplifier plug-in unit Input and check for one sweep as the signal is applied. Remove all connections from the oscilloscope system.

21. Set the Main Triggering MODE switch to AUTO and SOURCE switch to AC. Turn the Delayed Triggering LEVEL control fully clockwise to the RUNS AFTER DLY TIME position. Pull out the DLY'D Time/Division switch and rotate to 0.2 ms (Alternate mode). Connect a 0.4 volt, 1 kilohertz signal from the oscilloscope Calibrator to the Amplifier plug-in unit Input and adjust for about 2 divisions of display amplitude. 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 dial and note that the delay time before the intensified portion of display is continuously variable.

22. Set the Delayed Triggering SLOPE, COUPLING, and SOURCE switches to (+), AC, and INT. Rotate the Delayed Triggering LEVEL control counterclockwise out of the detent and adjust for a stable display. Rotate the DELAY TIME MULT dial and note that the intensified sweep does not start at the completion of the delay time but waits for the next trigger pulse.

23. Check that a stable display can be obtained with the Delayed Triggering COUPLING switch 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 display).

24. Change the Delayed Triggering SOURCE switch to EXT. Connect a 0.4 volt, 1 kilohertz signal from the oscilloscope Calibrator to the DLY'D TRIG IN connector. Check that a stable display can be obtained with the Delayed Triggering COUPLING switch 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).

HIGH-FREQUENCY SYNCHRONIZATION. Perform the following procedure to obtain a triggered alternate, normal, or delayed sweep with a 100 megahertz to 500 megahertz input signal:

NOTE

To check HF SYNC operation, a signal source frequency between 100 megahertz and 500 megahertz is required. If a 100 to 500 megahertz signal source is not desired to check the HF SYNC operation, the last two steps of this procedure may be deleted.

25. Change the Main Triggering MODE switch to HF SYNC. Connect a high-frequency signal source (100 to 500 megahertz) to the Amplifier plug-in unit Input and adjust for 4 divisions of vertical deflection. Adjust the TIME/DIV OR DLY TIME switch and DLY'D Time/Division switch for about 6 cycles of display. Rotate the Main Triggering LEVEL control throughout its range and note that the sweep is alternately stable, then free-running, several times during the rotation (stable display indicates that the trigger-generator frequency is adjusted to a subharmonic of the trigger signal frequency). Check that stable displays can also be obtained with the Main Triggering COUPLING switch set to AC, AC LF REJ, and DC (Main Triggering LEVEL control may be adjusted, as necessary for a stable display).

26. Pull out the DLY'D Time/Division switch, rotate it to the next fastest sweep rate from the setting of the TIME/DIV OR DLY TIME switch (Alternate mode). When the LEVEL control is in the detent (RUNS AFTER DELAY TIME) the display should be stable. Rotate the LEVEL control counterclockwise out of the detent and adjust for a stable display. Check that stable crt displays can be obtained with the Delayed Triggering COUPLING switch set to AC and DC. Disconnect the high-frequency signal from the oscilloscope system.

GENERAL OPERATING INFORMATION

Main Triggering

The Main Triggering MODE, COUPLING, and SOURCE pushbutton 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 and the LEVEL control is set correctly, the TRIG'D indicator will light. If the TRIG'D indicator is not lit: (1) the LEVEL control is at a setting outside the range of the trigger signal from the Amplifier plug-in unit, (2) the trigger signal is inadequate, or (3) the trigger-signal frequency is below the lower frequency limit of the COUPLING switch position. If the desired display is not obtained with these pushbuttons, other selections must be made. Refer to the following discussions or the instruction manuals for the oscilloscope and Amplifier plug-in unit for more information.

Main Trigger Modes

The MODE pushbutton switch selects the mode in which the main sweep is triggered.

AUTO. The AUTO pushbutton provides a triggered display with the correct setting of the LEVEL control (see Trigger Level discussion) whenever an adequate trigger signal is applied. The TRIG'D indicator lights when the display is triggered.

When the trigger repetition rate is outside the frequency range selected by the COUPLING switch or the trigger signal is inadequate, the sweep free-runs at the sweep rate indicated by the TIME/DIV OR DLY TIME switch (TRIG'D indicator off). An adequate trigger signal ends the free-running condition 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 pushbutton permits stable displays of repetitive signals with only 0.5 division of internal trigger signal (100 millivolts external signal) required for frequencies between 100 megahertz and 500 megahertz.

A triggered display is obtained when the LEVEL control adjusts the frequency of the trigger generator to the frequency or subharmonic of the trigger signal. Stable displays may be obtained several times between the limits of the LEVEL control, depending on the amplitude and frequency of the trigger signal. The LEVEL control should be set for optimum display. (In the High-Frequency Synchronization mode, the display is not necessarily stable when the TRIG'D indicator is lit.)

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. The NORM pushbutton provides a triggered display with the correct setting of the LEVEL control whenever an adequate trigger signal is applied. The TRIG'D indicator lights 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 TRIG'D indicator is off, no trace will be displayed.

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 controls, press the SINGLE SWEEP RESET pushbutton. A single trace is presented each time the pushbutton is pressed. Further sweeps cannot be presented until the SINGLE SWEEP-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 on the waveform. To avoid confusion due to the crt persistence, allow the display to disappear before pressing the SINGLE SWEEP-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 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 SINGLE SWEEP-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 signal triggers the unit. Further information on photographic techniques is given in the appropriate camera instruction manual.

Main Trigger Coupling

The Main Triggering COUPLING switches select the method in which the trigger signal is connected to the trigger circuits. Each position permits selection or rejection of some frequency components of the trigger signal which trigger the sweep.

AC. The AC pushbutton blocks the dc component of the trigger signal. 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 other COUPLING switch positions will provide a better display.

AC LF REJ. The AC LF REJ pushbutton rejects dc, and attenuates low-frequency trigger signals below about 30 kilohertz. 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.

AC HF REJ. The AC HF REJ pushbutton 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 should not be used when operating in the HF SYNC triggering mode.

DC. The DC pushbutton can be used to provide stable triggering from low-frequency signals which would be attenuated in the other modes. It can also be used to trigger the sweep when the trigger signal reaches a dc level set by the LEVEL control. When using internal triggering, the setting of the Amplifier plug-in unit Position control affects the triggering point.

Main Trigger Source

The Main Triggering SOURCE pushbutton switches select the source of the trigger signal which is connected to the main trigger circuits.

INT. The INT pushbutton connects the trigger signal from the Amplifier plug-in unit. Further selection of the internal trigger signal may be provided by the Amplifier plug-in unit or oscilloscope; see the instruction manuals for these instruments for more information. For most applications, the internal source can be used. However, some applications require special triggering which cannot be obtained in the INT position. In such cases, the LINE or EXT positions of the SOURCE switches must be used.

LINE. The LINE pushbutton connects a sample of the power-line voltage from the 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 triggering mode.

EXT. The EXT pushbutton connects the signal from the MAIN TRIG IN connector to the trigger circuit. 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 triggering is not desired. 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 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. The EXT ÷ 10 pushbutton operates the same as described for EXT except that the external signal is attenuated. Attenuation of high-amplitude external trigger signals is desirable to increase the effective range of the LEVEL control.

Input Impedance

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 1 MΩ position is suitable for most low- and medium-frequency applications or when using a 10X probe. The 1 MΩ position provide a high input impedance for minimum loading on the trigger signal source.

OUT — 50 Ω. The 50Ω 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 cannot be selected when operating in the high-frequency synchronization mode. When the SLOPE switch is in the (+) (positive-going) position, the display start on the positive-going portion of the waveform; in the (—) (negative-going) position, the display starts on the negative-going portion of the waveform (see Fig. 2-4). 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

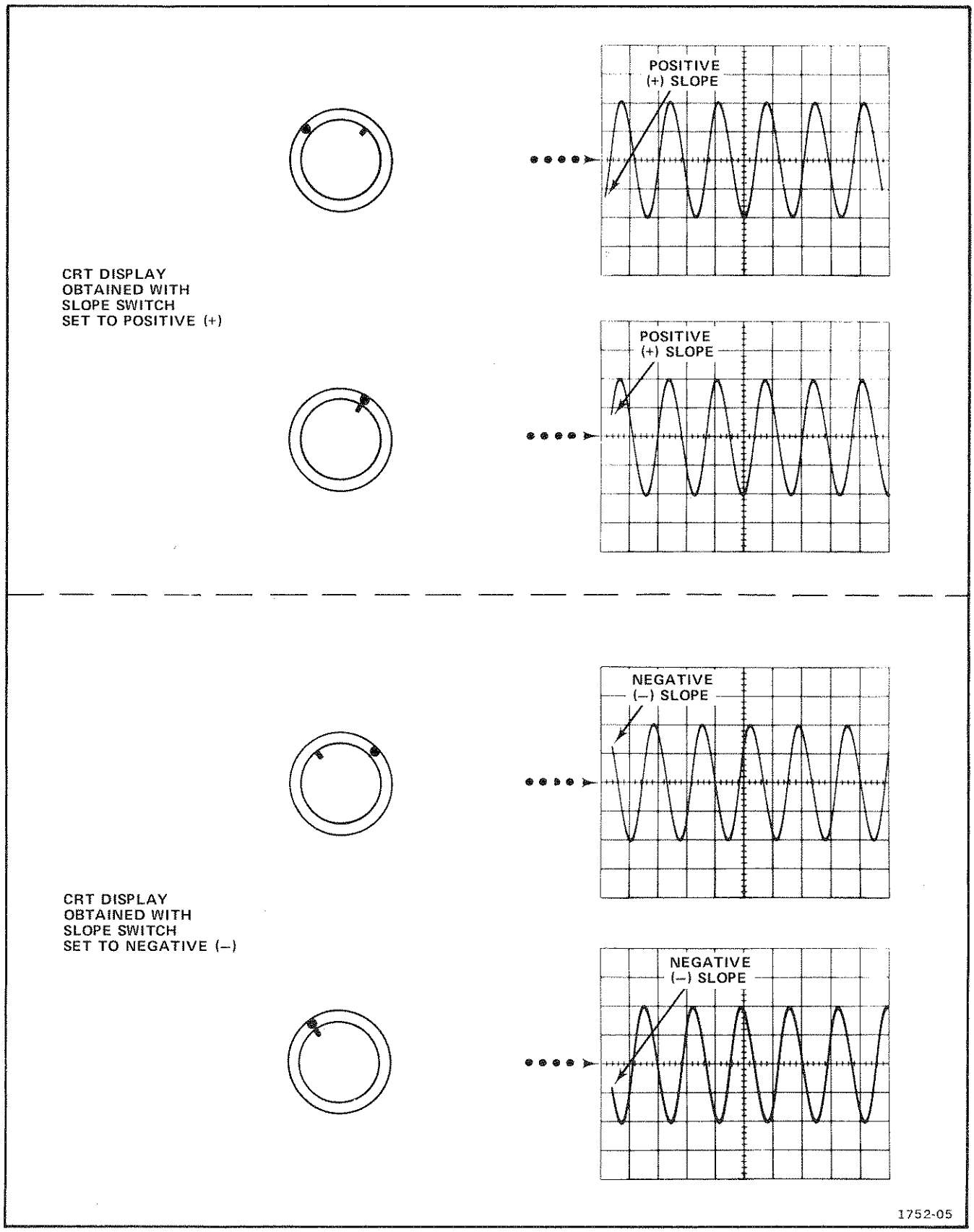


Fig. 2-4. Effect of LEVEL control and SLOPE switch on crt display.

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 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. 2-4 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 Main Triggering HF SYNC Mode, the LEVEL control synchronizes the trigger generator frequency to a 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. The DLY'D Time/Division switch selects calibrated sweep rates for the delayed sweep. The sweep rate for the delaying sweep is bracketed by the black lines on the clear plastic flange of the TIME/DIV OR DLY TIME switch. Sweep rate of the delayed sweep 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 rate is changed. This allows changing the delayed sweep rate without changing the delaying sweep rate. 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. 2-3). This control can be used with either the delaying or delayed sweeps as determined by the Time/Div Variable Selector multi-pin connector (internal, see Fig. 2-1 for location). The VARIABLE control also incorporates a two-position switch to determine if the applicable sweep 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 knob in. 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 decreased 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. 2-5). 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 fourth and tenth vertical lines.

Display Modes

Four display modes can be selected by appropriate settings of the TIME/DIV OR DLY TIME and DLY'D Time/Division switches.

NORMAL SWEEP OPERATION. To select the Normal sweep display mode, press in the DLY'D Time/Division switch and set it to the same sweep rate as the TIME/DIV OR DLY TIME switch. Rotate the Delayed Triggering LEVEL control clockwise into the RUNS AFTER DELAY TIME position.

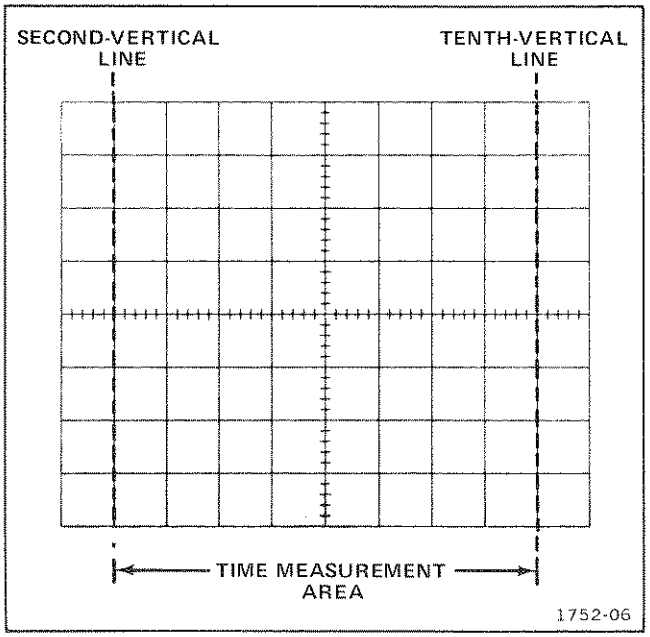


Fig. 2-5. Area of graticule used for most accurate time measurements.

Calibrated sweep rates in the Normal sweep display mode are 0.2 s/Div to 0.5 ns/Div. By using the VARIABLE control (Time/Div 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.

ALTERNATE SWEEP DISPLAY. To select the Alternate 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. In this mode, both an intensified sweep and a delayed sweep are displayed (see Fig. 2-6).

The intensified trace of the Alternate sweep display provides an intensified portion on the delaying sweep during the time the delayed sweep is running. 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 the intensified trace is controlled by the MAIN TRIGGERING controls; triggering for the intensified portion and the delayed sweep trace is controlled by the Delayed Triggering controls.

The TRACE SEP control vertically positions the intensified trace up to 3.5 divisions above the delayed sweep trace. The brightness of the intensified zone may be varied by the CONTRAST control. The brightness of the intensified sweep may be varied by the 7B92A INTENSITY control.

INTENSIFIED SWEEP MODE. The intensified sweep mode (Intens) is selected when the DLY'D Time/Division switch is pulled out, rotated to the desired sweep rate faster than the TIME/DIV or DLY TIME switch setting, and the TRACE SEP control is rotated counterclockwise to the ALT OFF position.

DELAYED SWEEP DISPLAY. The Delayed sweep display mode is selected when the DLY'D Time/Division switch is pulled out, rotated to the desired sweep rate, and then pushed in. In this mode, only the delayed sweep is displayed.

Calibrated sweep rates in the Delayed sweep mode are available from 0.2 s/Div to 0.5 ns/Div. By using the VARIABLE control (Time/Div Variable Selector connector set for variable delayed sweep rates), uncalibrated delayed sweep rates to 0.5 s/Div are available. Triggering for the delayed sweep is controlled by the Delayed Triggering controls.

Delay Time Multiplier

The DELAY TIME MULT dial (functional in the Delayed, Alternate, or Mainframe Delaying modes) provides 0 to 9.8 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, a DELAY TIME MULT dial setting of 3.55 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.

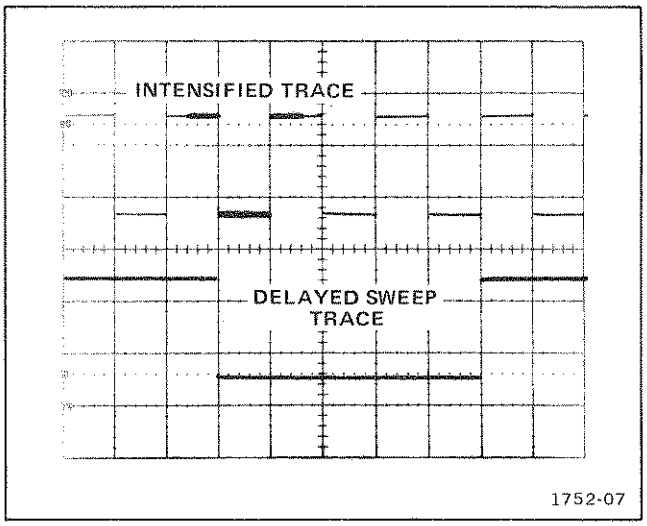


Fig. 2-6. Typical alternate sweep display.

Delayed Sweep Triggering

The Delayed Triggering LEVEL control determines the delayed triggering mode, and delayed triggering level. When the LEVEL control is in the RUNS AFTER DLY TIME detent position (fully clockwise), the delayed sweep starts immediately after the delay time (determined by the TIME/DIV OR DLY TIME switch and DELAY TIME MULT dial). This mode permits selection of continuously variable delay times by rotating the DELAY TIME MULT dial. The Delayed Triggering LEVEL control and SLOPE, COUPLING, and SOURCE switches are inoperative.

When the delayed sweep is triggerable (Delayed Triggering LEVEL out of the RUNS AFTER DELAY detent), 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 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 jitter in the delayed sweep display is not a problem, the RUNS AFTER DLY TIME mode should be used.

In the Delayed Sweep Triggerable mode, the Delayed Triggering LEVEL control is rotated to select the amplitude point on the trigger signal at which the delayed sweep is triggered. The SLOPE, COUPLING, and SOURCE functions are the same for delayed triggering as for MAIN TRIGGERING (see Main Triggering SLOPE, COUPLING, SOURCE and TERM switch discussions in this section).

Mainframe Operating Modes

The 7B92A 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 Horizontal plug-in compartment or as a Delayed Sweep plug-in unit in the B Horizontal compartment. Refer to the appropriate oscilloscope manual for additional mainframe horizontal operating information.

APPLICATIONS

The following information describes the procedures and techniques for making basic measurements with a 7B92A 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.

Time Duration Measurements

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

1. Connect the signal to be displayed to the input of the Amplifier plug-in unit.

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

3. Set the Volts/Division switch of the Amplifier plug-in unit to display about 4 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 8 divisions between the time measurement points (see Time Measurement discussion and Fig. 2-7).

6. Adjust the Amplifier plug-in Position control to move the points between which the time measurement is made to the center horizontal graticule line.

7. Adjust the horizontal POSITION control to position the time-measurement points within the center 8 divisions of the graticule.

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

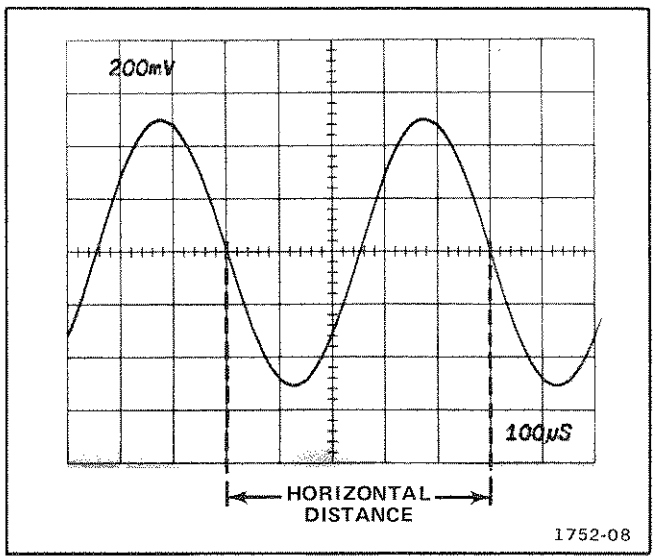


Fig. 2-7. Measuring the time duration between points on a waveform.

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 5 divisions (see Fig. 2-7), 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:

$$\text{Time Duration} = 5 \times 0.1 \text{ millisecond} = 0.5 \text{ millisecond}$$

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.

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

Example: The frequency of the signal shown in Fig. 2-7 which has a time period of 0.5 millisecond is:

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

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 Amplifier plug-in unit.

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

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

4. Center the display about the center horizontal graticule line with the Amplifier plug-in 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 8 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)	Divisions vertically between 10% and 90% points
4	0.4 and 3.6	3.2
5	0.5 and 4.5	4.0
6	0.6 and 5.4	4.8
7	0.7 and 6.3	5.6
8	0.8 and 7.2	6.4

8. Measure the horizontal distance between the 10% and 90% 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 horizontal distance between the 10% and 90% points is 4 divisions (see Fig. 2-8) and the TIME/DIV OR DLY TIME switch is set to 20 ns. Applying the time duration formula to risetime:

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

Substitute the given values:

$$\text{Risetime} = 4 \times 20 \text{ nanoseconds} = 80 \text{ nanoseconds}$$

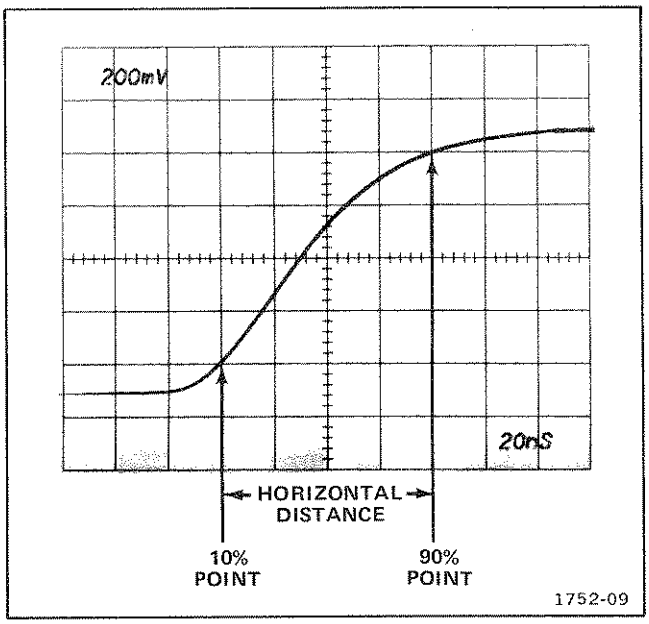


Fig. 2-8. Measuring risetime.

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.

1. Connect the signal to be displayed to the Amplifier plug-in unit.

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

3. Set the Volts/Division switch of the Amplifier plug-in 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 8 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 Alternate display mode. Rotate the TRACE SEP control clockwise from the ALT OFF position. This produces an intensified portion approximately 0.1 division in length.

NOTE

Measurement accuracy will be affected if the LEVEL or POSITION control settings are 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 dial.

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 ALT 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 2.60 and the second dial setting is 6.80 with the TIME/DIV OR DLY TIME switch set to 1 μs (see Fig. 2-9).

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

Substituting the given values:

$$\text{Time Difference} = (6.80 - 2.60) \times 1 \text{ millisecond} = 4.2 \text{ milliseconds}$$

Delayed Sweep Magnification

The delayed sweep feature of the 7B92A provides apparent magnification of the displayed waveform. The following method uses the RUNS AFTER DLY TIME 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.

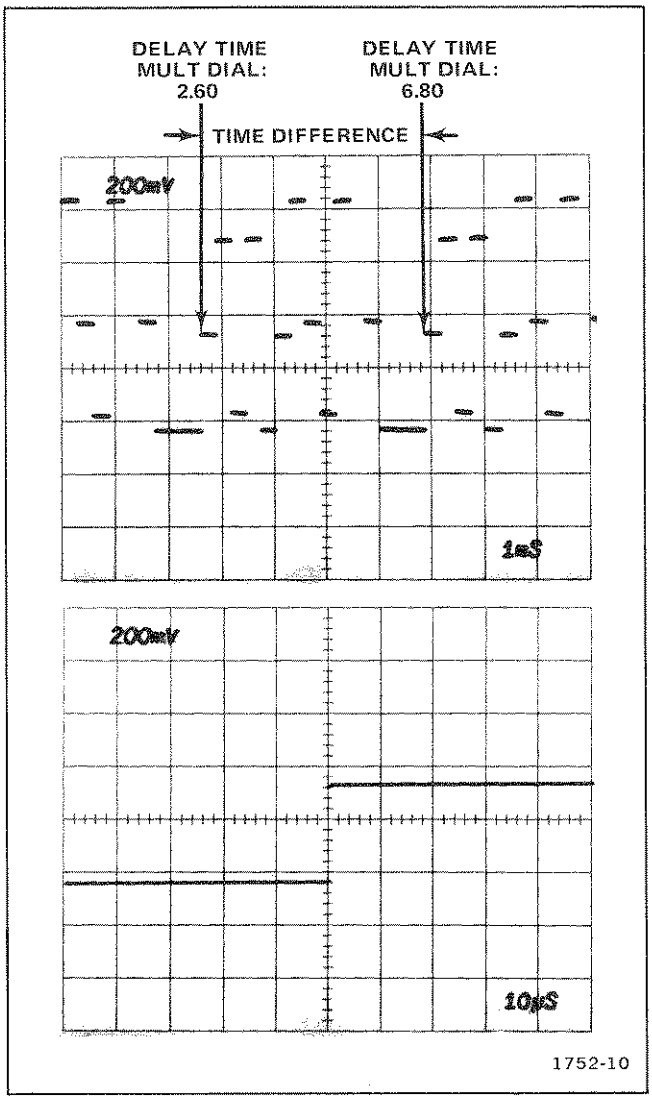


Fig. 2-9. Measuring time difference using delayed sweep.

1. Connect the signal to be displayed to the Amplifier plug-in unit. Set the Vertical and Horizontal Mode switches on the oscilloscope to display the plug-in units used.

2. Set the Volts/Division switch of the Amplifier plug-in unit to produce about 4 divisions of display 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. 2-10).

5. Pull out the DLY'D Time/Division switch for the Alternate display mode. Turn the Delayed Triggering LEVEL control clockwise into the RUNS AFTER DLY TIME detent. Rotate the TRACE SEP control clockwise from the ALT OFF position.

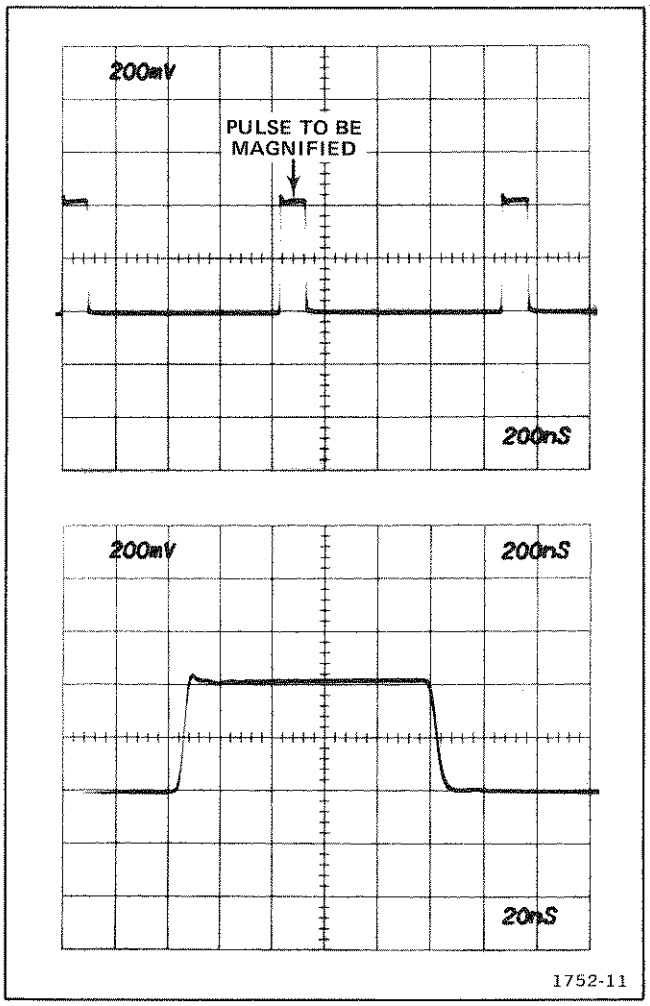


Fig. 2-10. Using delayed sweep for magnification.

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 Delayed Sweep mode.

9. Time measurements can be made from the display in the conventional manner. Sweep rate is set by the DLY'D Time/Division switch.

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. 2-10 with a TIME/DIV OR DLY TIME setting of 200 ns and a DLY'D Time/Division switch setting of 20 ns is:

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

Substituting the given values:

$$\text{Apparent Magnification} = \frac{200 \text{ nanoseconds}}{20 \text{ nanoseconds}} = 10$$

Triggered Delayed Sweep Magnification

The delayed sweep magnification method just described, may produce too much jitter at high apparent magnification. The Delayed Sweep 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. Rotate the Delayed Triggering LEVEL control counterclockwise out of the RUNS AFTER DELAY TIME detent. 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. 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 Delayed Sweep 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 in the 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 under Delayed Sweep Magnification.

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

Example: Fig. 2-11 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 graticule. The second waveform shows the area of interest magnified 4 times using the Delayed Sweep. The DELAY TIME MULT dial has been adjusted so the delayed sweep starts just before the area of interest.

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. (See Fig. 2-12.)

1. Connect the signal to be displayed to the Amplifier plug-in unit. Set the Vertical and Horizontal Mode switches on the oscilloscope to display the plug-in units used.

2. Set the Volts/Division switch of the Amplifier plug-in unit to produce about 4 divisions of display amplitude.

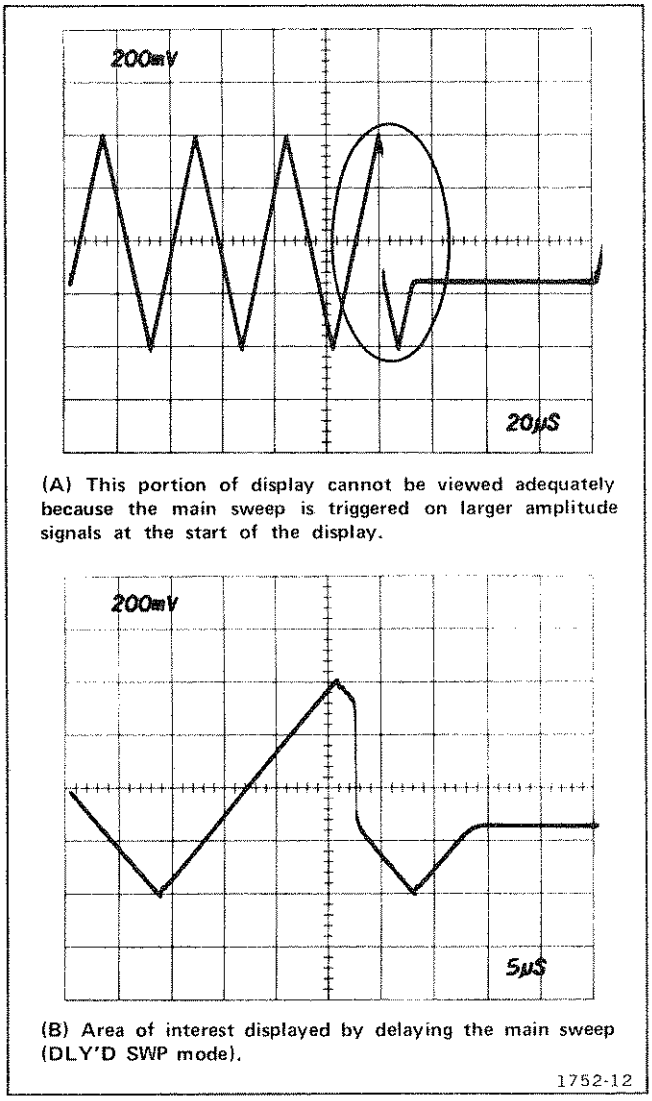
3. Adjust the MAIN TRIGGERING controls for a stable display.

4. Set the TIME/DIV OR DLY TIME switch to a sweep rate which displays the complete waveform.

5. Pull out the DLY'D Time/Division switch for the Alternate Display Mode. Rotate the TRACE SEP control clockwise from the ALT OFF position.

6. Position the start of the intensified portion with the DELAY TIME MULT dial to the part of the display to be magnified. (Delayed Trigger LEVEL control must be in the RUNS AFTER DELAY TIME detent.)

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.



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

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

Fig. 2-11. Displaying a complex signal using delayed sweep.

8. Press in the DLY'D Time/Division switch for the Delayed Sweep mode.

9. Slight re-adjustment of the Main Triggering LEVEL control may be necessary to produce a stable display.

10. Pulse jitter is shown by horizontal movement on the pulse (take into account inherent jitter of the Delayed Sweep).

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

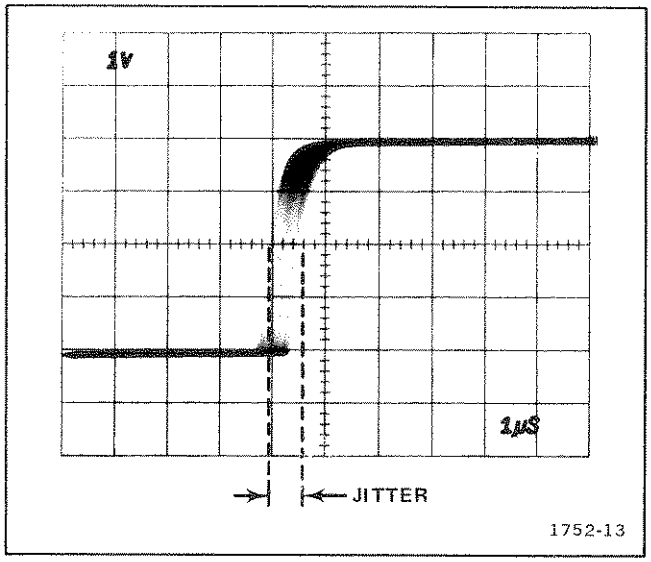


Fig. 2-12. Measuring pulse jitter.

Example: Assume that the horizontal movement is 0.6 division (see Fig. 2-12) and the DLY'D Time/Division switch setting is 1 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 = 0.6 x 1 microsecond = 0.6 microsecond

OPTIONS

No Options available at the time of this printing. Refer to the CHANGE INFORMATION in the back of this manual for Options available after this printing.

MANUAL CHANGE INFORMATION

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

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

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

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω.	107 - Risetime less than 3.0 ns into 50 Ω.
108	PG 501 - 5 V output pulse; 3.5 ns Risetime	108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114	Performance of replacement equipment is the same or better than equipment being replaced.	
115		
2101		
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191		
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181		181 - Multiple time-marks
184	TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

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