TEKTRONIX®

7D10

DIGITAL EVENTS DELAY

WITH OPTIONS

OPERATORS

INSTRUCTION MANUAL

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

Serial Number _____

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WARRANTY

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

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

Specifications and price change privileges reserved.

U.S.A. and foreign Tektronix products covered by U.S. and foreign patents and/or patents pending.

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SAFETY SUMMARY

The following safety information is provided to ensure safe operation of this instrument. WARNING information is intended to protect the operator; CAUTION information is intended to protect the instrument. The following are general safety precautions that must be observed during all phases of operation and maintenance.

WARNING

Ground the Instrument

To reduce electrical-shock hazard, the mainframe (oscilloscope) chassis must be properly grounded. Refer to the mainframe manual for grounding information.

Do Not Operate in Explosive Atmosphere

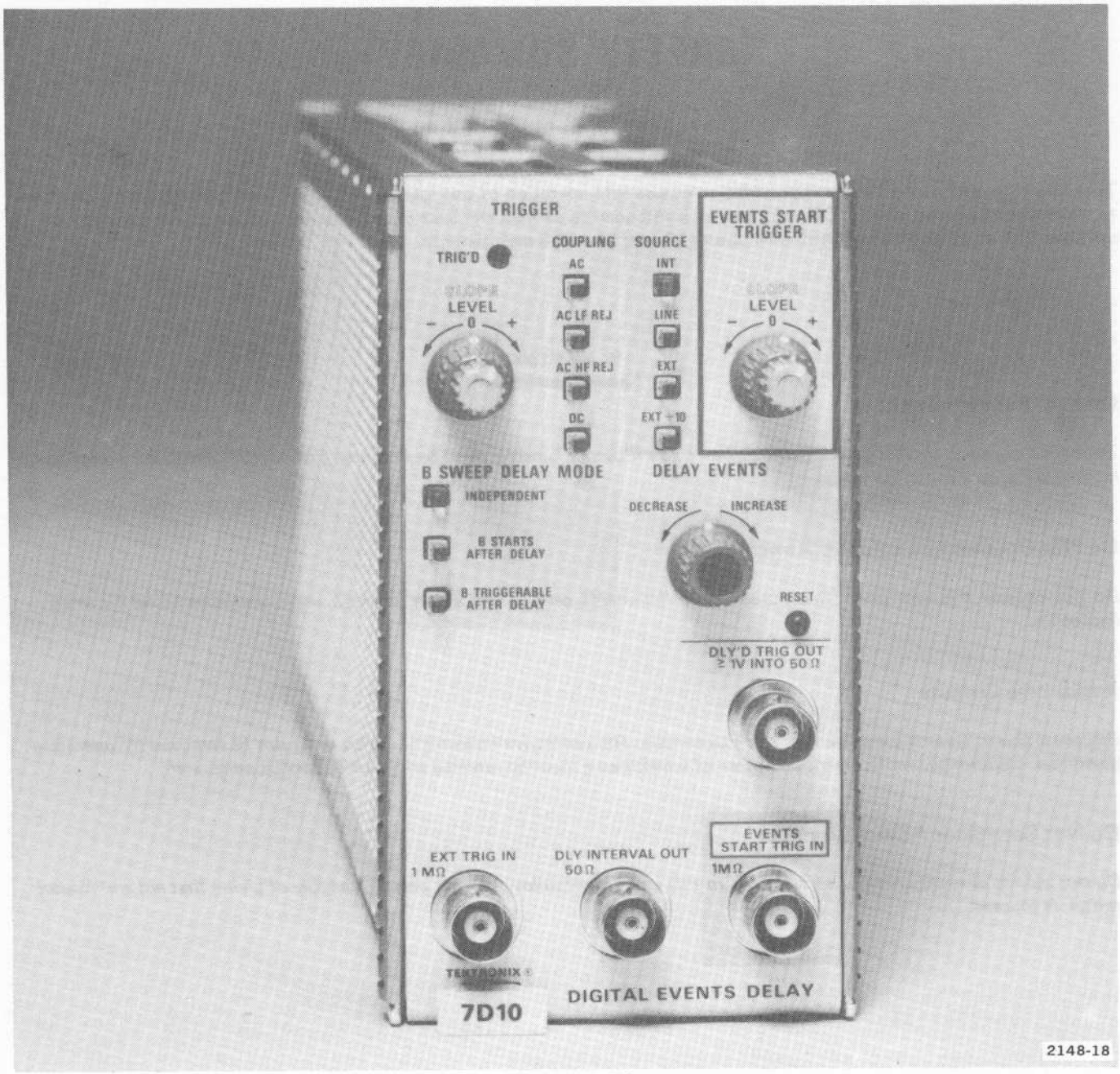
Do not operate this instrument in an area where flammable gases or fumes are present. Such operation could cause an explosion.

Avoid Live Circuits

Electrical-shock hazards are present in this instrument. The protective instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be referred to qualified service personnel.

Do Not Service or Adjust Alone

Do not service or make internal adjustments to this instrument unless another person, capable of giving first aid and resuscitation, is present.



FEATURES

The 7D10 provides delay by events in a plug-in unit for readout-equipped 7000-series oscilloscope mainframes. The operator can, with a single front-panel control, select any desired delay from one to 10^7 events. The 7D10 uses the mainframe readout system to count the selected integral number of events on the crt. When the number of input events reaches the preset count, the 7D10 will output a trigger pulse which can be used to trigger a logic analyzer, oscilloscope sweep, or other equipment. Because the 7D10 creates the delay by counting a number of pulses rather than by analog timing of an interval, jitter is not a problem even when viewing pulses toward the end of a long train.

The 7D10 complements the 7D01 Logic Analyzer. The logic analyzer memory window is easily delayed from the trigger by a selected count using the 7D10. This facilitates bit error detection in pulse trains that are significantly longer than the capacity of the logic analyzer memory.

The 7D10 can be used for selecting a certain time frame for jitter-free analysis of data in mechanically based systems such as disc-file memories. It is also useful for making measurements under complex timing conditions.

GENERAL INFORMATION

INTRODUCTION

The Operator's Manual contains information necessary to effectively operate the 7D10 Digital Events Delay unit and is divided into three sections: Section 1 provides packaging for shipment information, specifications, and a list of standard accessories. Section 2 contains operating information. Information concerning available options for the 7D10 Digital Events Delay unit is in section 3.

The Instruction Manual contains nine sections. Operating information is covered in the first two sections; servicing information is covered in the remaining seven sections. Schematic diagrams are located at the rear of the manual and can be unfolded for reference while reading other parts of the manual. The reference designators and symbols used on the schematic diagrams are defined on the first page of the Diagrams and Circuit Board Illustrations section. Abbreviations used in the manuals, except in the parts list and schematic diagrams, comply with the American National Standards Institute Y1.1-1972 publication. The parts list is a computer printout and uses computer-supplied abbreviations.

INSTRUMENT REPACKAGING

If this instrument is to be shipped for long distances by commercial transportation, it is recommended that the instrument be packaged in the original manner for maximum protection. The carton and packaging material in which your instrument was shipped should be saved and used for this purpose.

Also, if this instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag to the instrument showing the following: Owner of the instrument (with address), the name of an individual at your firm that can be contacted, complete instrument type and serial number, and a description of the service required.

If the original packaging is unfit for use or not available, package the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to Table 1-1 for carton test strength requirements.

2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches on all sides.

4. Seal the carton with shipping tape or with an industrial stapler.

5. Mark the address of the Tektronix Service Center and your return address on the carton in one or more locations.

TABLE 1-1
Shipping Carton Test Strength

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500
140-160	600

SPECIFICATION

The electrical specifications listed in Table 1-2 apply when the following conditions are met: (1) The instrument must have been adjusted at an ambient temperature between +20° and +30° C, (2) the instrument must be fully installed in a calibrated mainframe, and (3) the instrument must have been operating for at least 20 minutes.

TABLE 1-2
Electrical Characteristics

Characteristic	Performance Requirement
TRIGGERING	
Internal Trigger Sensitivity[1]	
Coupling	
AC	0.3 div of deflection, minimum, 30 Hz to 10 MHz; increasing to 1.0 div at 50 MHz.
AC LF REJ	0.3 div of deflection, minimum, 30 kHz to 10 MHz; increasing to 1.0 div at 50 MHz. Will not trigger on sine waves of 3 div or less below 120 Hz.
AC HF REJ	0.3 div of deflection, minimum, 30 Hz to 50 kHz.
DC	0.3 div of deflection, minimum, dc to 10 MHz; increasing to 1.0 div at 50 MHz.
External Trigger Sensitivity	
Coupling	
AC	150 mV, minimum, 30 Hz to 10 MHz; increasing to 500 mV at 50 MHz.
AC LF REJ	150 mV, minimum, 150 kHz to 10 MHz; increasing to 500 mV at 50 MHz.
AC HF REJ	150 mV, minimum, 30 Hz to 50 kHz.
DC	150 mV, minimum, dc to 10 MHz; increasing to 500 mV at 50 MHz.
External Trigger Input	
Maximum Input Voltage	250 V (dc + peak ac), 500 V p-p ac at 1 kHz or less.
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 20 pF.
Input RC Product	One MΩ X 20 pF within 2%.
Level Control Range	At least +1.75 V to −1.75 V in EXT; at least +17.5 V to −17.5 V in EXT ÷ 10.

[1] **Triggering frequency range is also affected by the bandwidth limits of the mainframe and vertical plug-in unit used.**

TABLE 1-2 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
EVENTS DELAY	
Range	One to 10^7 events.
Increment	One event.
Insertion Delay	35 ns within 5 ns.
Recycle Time	500 ns or less.
Maximum Events Frequency	At least 50 MHz.
Minimum Event Width	10 ns.
Events Start Triggering	
Source	External only.
Coupling	Dc.
Maximum Input Voltage	150 V (dc + peak ac).
Sensitivity	100 mV, minimum, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz.
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 20 pF.
Level Control Range	At least +3 V to −3 V.
OUTPUT SIGNALS	
Delayed Trigger	
Waveshape	Positive-going rectangular pulse.
Amplitude	
Into Open Circuit	At least 2 V.
Into 50 Ohms	At least 1 V.
Rise Time (With 50 Ohm Load)	2 ns or less.
Fall Time (With 50 Ohm Load)	5 ns or less.
Pulse Width	200 to 250 ns.

TABLE 1-2 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
OUTPUT SIGNALS (CONT.)	
Delay Interval Waveshape	Positive-going rectangular pulse.
Amplitude	
Into Open Circuit	At least 2 V.
Into 50 Ohms	At least 1 V.
Rise and Fall Times (With 50 Ohm Load)	5 ns or less.
Accuracy	Delay Interval pulse width is equal to the generated Events Delay within 30 ns.
Relative Timing of Delayed Trigger and Delay Interval Output Signals	Leading edge of Delayed Trigger pulse is coincident with falling edge of Delay Interval pulse within 2 ns.

TABLE 1-3
Environmental Characteristics

Characteristic	Performance Requirement
Temperature	
Operating	0° to +40° C.
Non-operating	–40° to +75° C.
Altitude	
Operating	To 15,000 feet.
Non-operating	To 50,000 feet.
Transportation	Qualified under National Safe Transit Committee Test Procedure 1A, Category II.

TABLE 1-4
Physical Characteristics

Characteristic	Description
Finish	Anodized aluminum front panel.
Weight	1.00 Kg (2.20 lbs).
Dimensions	See Figure 1-1, Dimensional Drawing.

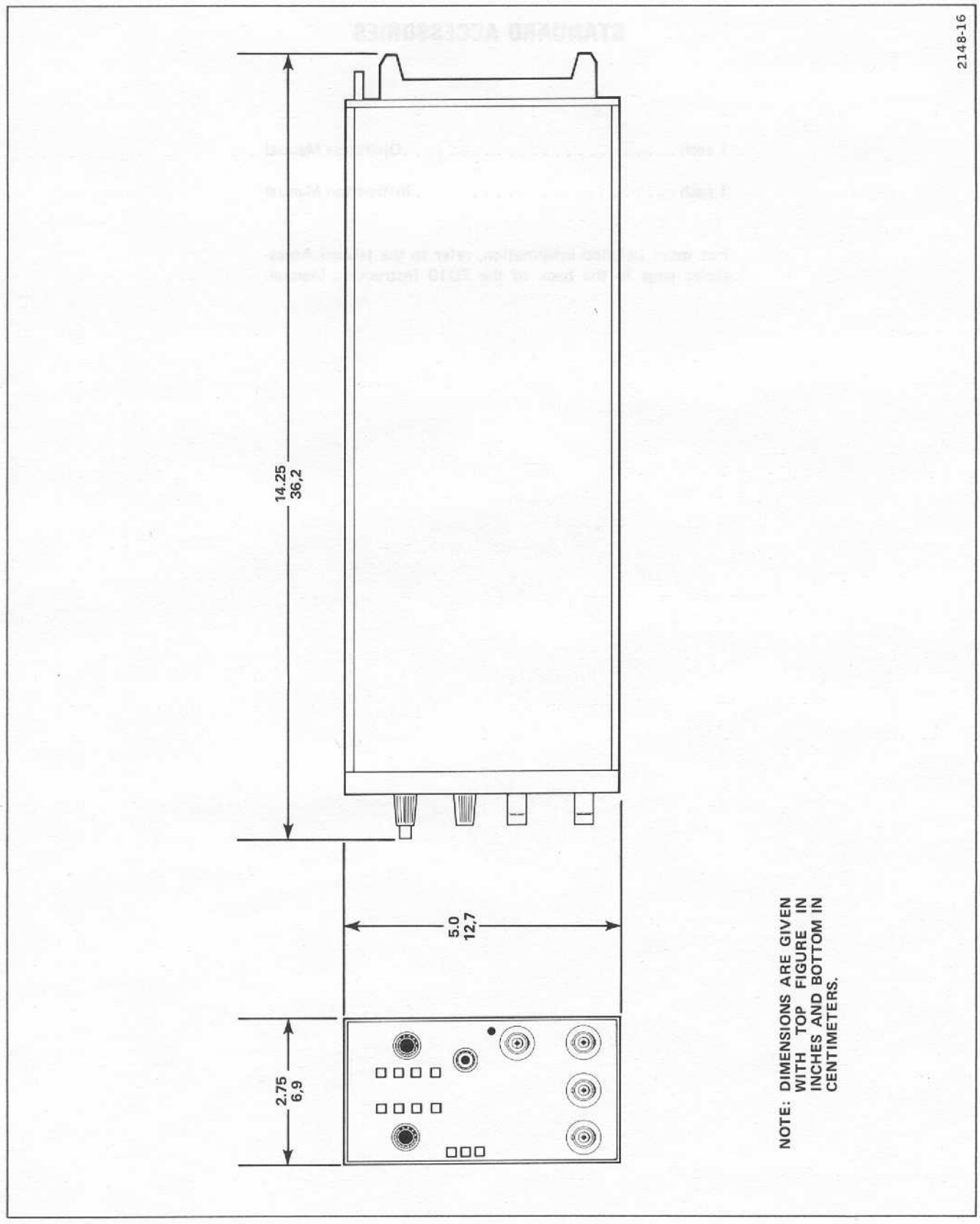


Figure 1-1. Dimensional Drawing.

STANDARD ACCESSORIES

1 each . . . . . .Operators Manual

1 each . . . . . .Instruction Manual

For more detailed information, refer to the tabbed Accessories page in the back of the 7D10 Instruction Manual.

OPERATING INSTRUCTIONS

PRELIMINARY INFORMATION

Installation

The 7D10 is designed to operate in any plug-in compartment of Tektronix 7000-series mainframes. However, certain modes of operation require the 7D10 to be installed in a specific compartment. The unit must be operated in a horizontal compartment to trigger from a signal applied to a vertical amplifier unit. For example, the 7D10 must be operated in the A Horizontal compartment to control the delay mode of a time-base unit in the B Horizontal compartment, or in a vertical compartment to view the Delay Interval Pedestal without the use of external cables.

To install the 7D10 into a plug-in compartment, push the unit in until it is seated flush against the front panel of the mainframe. To remove, pull the release latch to disengage the 7D10. Continue to pull the release latch to remove the unit from the mainframe.

CONTROLS, CONNECTORS, AND INDICATORS

The major controls, connectors, and indicators for operation of the 7D10 are located on the front panel of the unit. One control, located inside the unit, for an auxiliary function is described in Detailed Operating Information. The front-panel controls, connectors, and indicators are located and described in Figure 2-1.

BASIC BLOCK DIAGRAM

The following discussion provides an aid to understanding the overall concept of the 7D10. Figure 2-2 shows a basic block diagram of the 7D10. Each block represents a major circuit within the instrument. The number enclosed within a diamond on each block refers to the schematic diagram of that circuit in the 7D10 Instruction Manual.

The EVENTS DELAY control sets up the desired number of events to be counted in the Events Counter. The number of delay events is encoded by the Readout Encoding circuit, which provides readout data to the mainframe in order to display the number of delay events on the crt.

The Events Start Trigger starts the delay interval and allows the Events Trigger circuit output to be counted by the Events Counter. When the selected number of events has been counted, the Outputs Processing circuit ends the delay interval and outputs the DLY'D TRIG OUT signal.

FUNCTIONAL CHECK

The following procedure may be used as a check of basic instrument operation. The procedure can be used for incoming inspection to verify proper operation, and can also be used by the operator for instrument familiarization. Only instrument functions, and not measurement quantities or specifications, are checked in these procedures. Therefore, a minimum amount of test equipment is required. If performing the Functional Check procedure reveals improper performance or instrument malfunction, first check the operation of associated equipment; then refer to qualified service personnel for repair or adjustment of the instrument.

Test Equipment Required

The following test equipment is used to perform the Functional Check procedure. Other test equipment, which meets these requirements, may be substituted. When other equipment is substituted, the control settings or set-up may need to be altered.

1. Indicator Mainframe

   Description: Any Tektronix 7000-series oscilloscope equipped with a readout system and able to accommodate four plug-in units.

   Type Used: TEKTRONIX 7904 Oscilloscope.

2. Time-Base Plug-In Unit

   Description: Sweep rates, 20 milliseconds/division to magnified or delayed-sweep rate of 20 nanoseconds/division; accuracy, within 5%.

   Type Used: TEKTRONIX 7B80 Time Base.

3. Dual-Trace Wide-Band Vertical Amplifier Unit

   Description: Bandwidth (combined with indicator mainframe), dc to 150 megahertz; deflection factor, variable from 50 millivolts to 5 volts/division; accuracy, within 3%.

   Type Used: TEKTRONIX 7A26 Dual-Trace Amplifier.

4. Time-Mark Generator

   Description: Marker outputs, 1 second to 10 microseconds; trigger output, 1 millisecond; marker accuracy, within 0.1%; marker amplitude, 0.5 volt into 50 ohms; trigger amplitude, 0.5 volt into 50 ohms.

   Type Used: TEKTRONIX TG 501 Time-Mark Generator.[1]

[1] Requires TM 500-series power module.

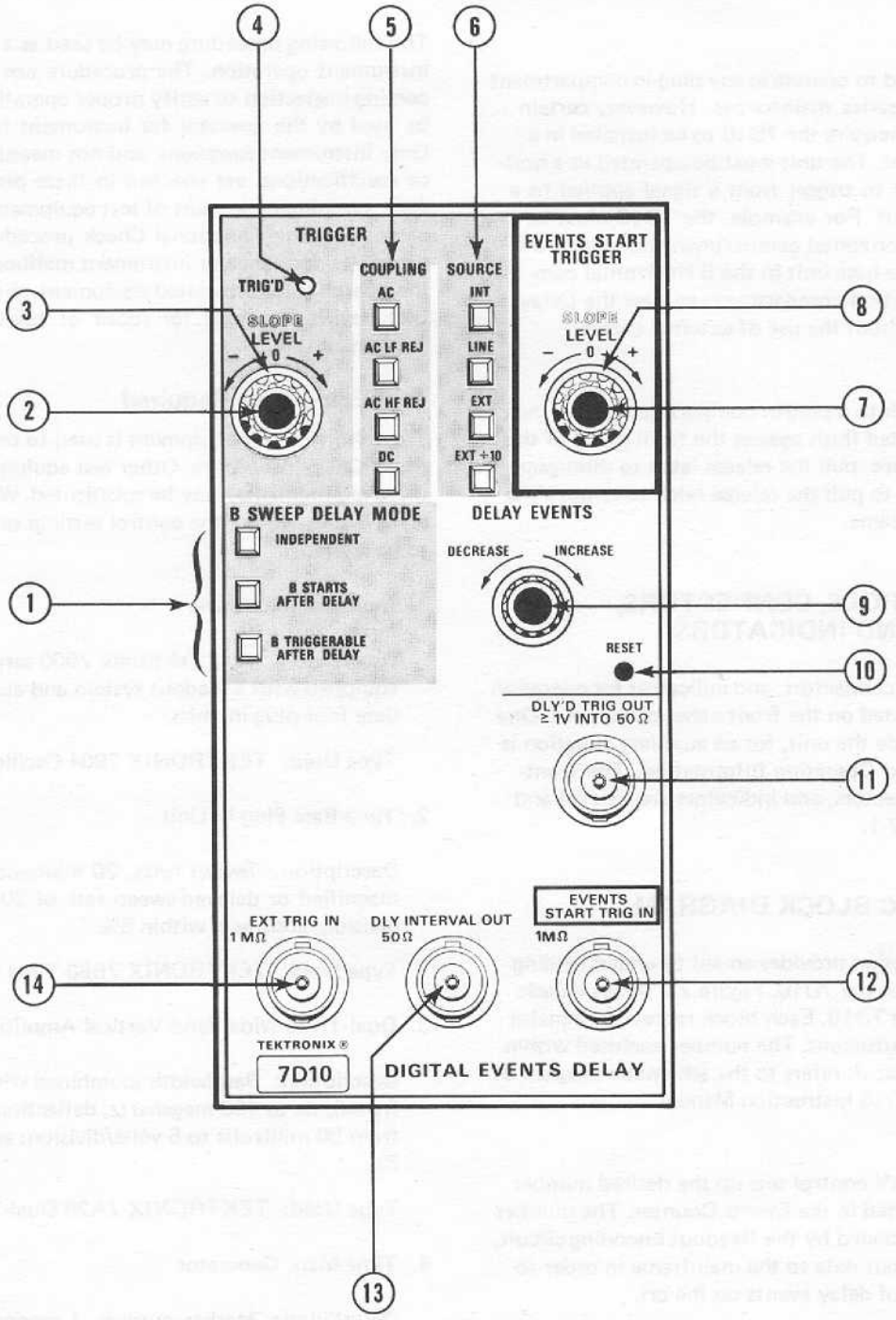


Figure 2-1. Location and function of front-panel controls, indicators, and connectors.

(1) **B SWEEP DELAY MODE Switches**—Self-cancelling pushbutton switches that select the operating mode of the B sweep (time-base) unit for independent or delayed sweep operation.

(2) **TRIGGER SLOPE Switch**—Selects the slope of the trigger signal on which the delay is initiated.

(3) **TRIGGER LEVEL Control**—Selects the amplitude point at which the delay is initiated.

(4) **TRIG'D Indicator**—Lamp that lights when a trigger is being produced.

(5) **COUPLING Switches**—Self-cancelling pushbutton switches that select the following coupling methods for the trigger signal: AC (capacitive coupling), AC LF REJ (capacitive coupling, low frequency rejected), AC HF REJ (capacitive coupling, high frequency rejected), and DC (direct coupling).

(6) **SOURCE Switches**—Self-cancelling pushbutton switches that select the following trigger signal sources: INT (internal from associated vertical unit with 7D10 installed in horizontal compartment), LINE (internal from power source), EXT (external from EXT TRIG IN connector), and EXT ÷ 10 (10X input signal attenuation).

(7) **EVENTS START TRIGGER SLOPE Switch**—Selects slope of trigger signal from which the Events Start is initiated.

(8) **EVENTS START TRIGGER LEVEL Control**—Selects the amplitude point on the trigger signal from which the Events Start is initiated.

(9) **DELAY EVENTS Control**—Spring return to zero (center) control that selects the number of events counted. Direction of rotation increases or decreases the number of events counted.

(10) **RESET Switch**—Pushbutton switch that resets the number of events counted to 0000001.

(11) **DLY'D TRIG OUT Connector**—BNC connector that provides a delayed trigger output signal.

(12) **EVENTS START TRIG IN Connector**—BNC connector that provides an input for the events start trigger signal.

(13) **DLY INTERVAL OUT Connector**—BNC connector that provides a delay interval output signal.

(14) **EXT TRIG IN Connector**—BNC connector that provides an external input for the trigger signal.

Figure 2-1. Location and function of front-panel controls, indicators, and connectors (continued).

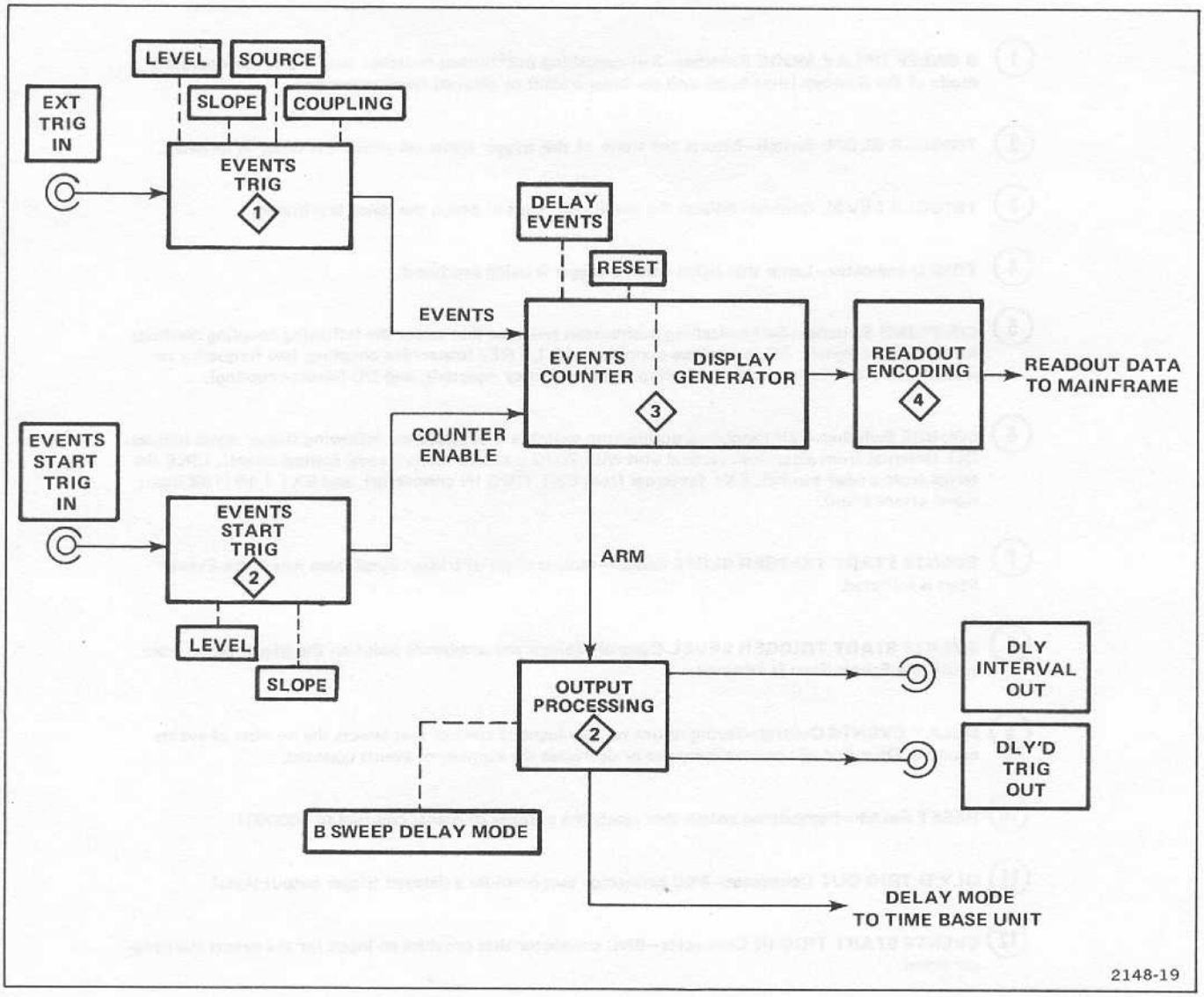


Figure 2-2. 7D10 basic block diagram.

5. 10X Passive Probe

Description: Compatible with amplifier unit.

Type Used: TEKTRONIX P6053B 10X Probe.

6. Termination

Description: Impedance, 50 ohms; accuracy, within 2%; connectors, BNC.

Type Used: Tektronix part 011-0049-01.

7. T Connector

Description: Connectors, BNC.

Type Used: Tektronix part 103-0030-00.

8. Cable (3 required)

Description: Impedance, 50 ohms; type, RG-58/U; length, 18 inches; connectors, BNC.

Type Used: Tektronix part 012-0076-00.

Preliminary Set Up

1. Install a vertical amplifier unit in a vertical compartment and a time-base unit in the B Horizontal compartment of the indicator mainframe. Install the 7D10 in the A Horizontal compartment (see Installation).

2. Set the 7D10 controls as follows:

TRIGGER
SLOPE . . . . . .+
LEVEL. . . . . .Centered
COUPLING . . . .AC
SOURCE. . . . . .INT
EVENTS START
TRIGGER
SLOPE . . . . . .–
LEVEL. . . . . .Centered
B SWEEP
DELAY MODE. . . .INDEPENDENT

3. Turn indicator mainframe power ON and allow at least 5 minutes for warm up.

Trigger Functions

1. Perform the Preliminary Set Up procedure.

2. Attach the T connector to the mainframe calibrator output.

3. Connect the calibrator output signal to the vertical amplifier unit input and to the 7D10 EVENTS START TRIG IN connector.

4. Connect the DLY'D TRIG OUT connector to the time-base unit external trigger input.

5. Set the mainframe calibrator for a 1-kilohertz, 4-volt output.

6. Set the time-base unit triggering for auto mode and external source at a sweep rate of 0.5 millisecond/division.

7. Set the amplifier unit deflection factor for 2 volts/division.

8. Set the indicator mainframe vertical mode to display the amplifier unit input signal and use the vertical signal as the trigger source for the 7D10.

9. Set the 7D10 TRIGGER LEVEL control to light the TRIG'D indicator.

10. Set the EVENTS START TRIGGER LEVEL control approximately midway between fully clockwise and the 0 position.

11. Set the time-base unit triggering for a stable display.

12. Turn the EVENTS START TRIGGER LEVEL control throughout its range and notice that a stable display can be obtained between the 0 and fully clockwise positions.

13. Set the 7D10 TRIGGER SLOPE switch to the + and then to the – position and notice that the display starts on the selected slope of the input signal.

14. Connect the mainframe calibrator signal to the 7D10 EXT TRIG IN connector. (Use a T connector attached to the EVENTS START TRIG IN connector).

15. Set the 7D10 SOURCE switch to EXT.

16. Set the EVENTS START TRIGGER LEVEL control approximately midway between fully clockwise and the 0 position.

17. If necessary, set the 7D10 TRIGGER LEVEL and time-base unit triggering for a stable display.

18. Turn the EVENTS START TRIGGER LEVEL control throughout its range and notice that a stable display can be obtained between the 0 and fully clockwise positions.

19. Set the 7D10 TRIGGER SLOPE switch to the + and then to the – position and notice that the display starts on the selected slope of the input signal.

20. Disconnect the mainframe calibrator signal from the amplifier input.

21. Set the 7D10 TRIGGER SOURCE switch to LINE.

22. Set the time-base unit sweep rate for 5 milliseconds/division and the amplifier unit deflection factor for 2 volts/division.

23. Connect the 10X probe to the amplifier unit input and the probe tip to a line-voltage source.

24. Set the time-base triggering for a stable display.

25. Turn the EVENTS START TRIGGER LEVEL control throughout its range and notice that a stable display can be obtained between the 0 and fully clockwise positions.

26. Set the 7D10 TRIGGER SLOPE switch to the + and then to the – position and notice that the display starts on the selected slope of the input signal.

27. Disconnect the interconnecting cables.

Events Count Functions

1. Install the 7D10 in a vertical compartment of the indicator mainframe and press the RESET button. Notice that an events count readout of 0000001 appears at the upper left side of the graticule vertical center line.

2. Connect the time-mark generator marker output through the T connector and the 50-ohm termination to the vertical amplifier unit input.

3. Set the time-mark generator for a 0.1-millisecond marker output.

4. Connect the time-mark generator marker output from the T connector to the 7D10 EXT TRIG IN connector.

5. Connect the time-mark generator trigger out to EVENTS START TRIG IN connector.

6. Connect the 7D10 DLY'D TRIG OUT connector to the time-base unit external trigger input.

7. Set the indicator mainframe vertical mode to alternately display the amplifier unit and the 7D10.

8. Set the time-base unit sweep rate for 0.1 millisecond/division and the amplifier unit deflection factor for 0.5 volt/division.

9. Set the 7D10 TRIGGER LEVEL control to light the TRIG'D indicator.

10. Set the EVENTS START TRIGGER control and the time-base unit triggering level for a stable time-marker display.

11. Turn the DELAY EVENTS control clockwise to obtain an events count readout of 0000002. Notice that a dual-trace display of positive-going, 0.1-millisecond duration delay-interval pedestals, and 0.1-millisecond time-markers, appear on the crt.

12. Turn the DELAY EVENTS control clockwise and notice that the duration of the delay-interval pedestals increase one marker at a time as indicated by the events count readout.

13. Disconnect the interconnecting cables.

B Sweep Delay Mode Functions

1. Perform the Preliminary Set Up procedure.

2. Connect the time-mark generator marker output to the vertical amplifier input and the generator trigger output to the EVENTS START TRIG IN connector.

3. Set the 7D10 B SWEEP DELAY MODE switch to the B STARTS AFTER DELAY position.

4. Set the time-mark generator for a 10-millisecond marker output.

5. Set the time-base unit for a 10-milliseconds/division sweep rate.

6. Press the RESET button.

7. Set the 7D10 TRIGGER LEVEL and EVENTS START TRIGGER LEVEL controls for a flickering time-mark display.

8. Turn the DELAY EVENTS control clockwise until the events count readout on the crt indicates 0000100 and notice that a displayed sweep occurs once each second, i.e., after each 100 markers (10 milliseconds/marker).

9. Turn the DELAY EVENTS control to increase and decrease the events count readout. Notice that a displayed sweep appears after the selected number of time markers have occurred (indicated by the events count readout).

10. Set the B SWEEP DELAY MODE switch to the B TRIGGERABLE AFTER DELAY position.

11. Set the time-base unit triggering for normal mode, ac coupling, and internal source.

12. Set the 7D10 TRIGGER LEVEL to light the TRIG'D indicator.

13. Set the time-base unit triggering level to light the triggered indicator on the negative-going slope of the input signal.

14. Set the EVENTS START TRIGGER LEVEL control for a time-marker display.

15. Turn the time-base unit triggering level and notice that the sweep can be triggered anywhere on the negative-going slope of the first displayed time-marker at the start of the sweep.

DETAILED OPERATING INFORMATION

Events Readout Display

The events readout display is presented on the mainframe crt, along with information encoded by the other plug-in units. The number of events being counted is presented in a seven to eight digit display.

The 7D10 readout display appears on the crt in a location corresponding to the plug-in compartment used. It is not necessary to select the 7D10 with the mainframe Vertical or Horizontal Mode switches to view the digital display.

Signal Connection

In general, probes offer the most convenient means of connecting signals to the 7D10 external trigger inputs. Tektronix probes are shielded to prevent pickup of electrostatic interference. A 10X attenuation probe offers a high input impedance and allows the circuit under test to perform very close to normal operating conditions. Also, a 10X probe attenuates the input signal ten times.

Tektronix probes are designed to monitor the signal source with minimum circuit loading. The use of a probe will, however, limit the maximum trigger frequency range. To obtain maximum trigger bandwidth when using probes, select a probe capable of compensating the input capacitance; observe the grounding considerations given in the probe manual. The probe-to-connector adapters and the bayonet-ground tip provide the best frequency response.

In high-frequency applications, requiring maximum overall bandwidth, use a coaxial cable terminated at both ends in the characteristic impedance of the cable. To maintain the high-frequency characteristics of the applied signal, use high-quality low-loss cable. Resistive coaxial attenuators can be used to minimize reflection if the applied signal has suitable amplitude.

High-level, low-frequency signals can be connected directly to the external trigger inputs with short, unshielded leads. When this method is used, establish a common ground between the 7D10 and the associated equipment. The common ground provided by the line cords is usually inadequate. If interference is excessive with unshielded leads, use a coaxial cable or probe.

A signal can also be routed to the 7D10 through an amplifier unit via the internal trigger circuitry of the mainframe (7D10 installed in a horizontal compartment). This method of signal connection minimizes circuit loading, especially when triggering a time-base unit in parallel with the 7D10.

NOTE

Only external signals can be used with the Events Start Trigger.

Trigger Controls

The input signal may have a wide variety of shapes and amplitudes, many of which are unsuitable as delay-initiating triggers. For this reason, these signals are first applied to a trigger circuit where they are converted to pulses of uniform amplitude and shape. This makes it possible to start the delay with a pulse that has a constant size, eliminating variations of the delay circuit operation caused by changing input signals. The TRIGGER controls provide a means to select the signal source, filter unwanted frequencies, and start the delay at any voltage level on either slope of the waveform.

Triggered Light

The TRIG'D light provides a convenient indication of the Trigger circuit condition. If the TRIGGER controls are correctly set and an adequate signal is applied, the TRIG'D light is on. If the TRIG'D light is off, no delay interval is started. The cause might be an incorrectly set TRIGGER control, low signal amplitude, or a signal repetition rate outside the usable frequency range. This feature can be used as a general indication of correct triggering when there is no display on the crt. The Delay Interval Pedestal and Z-Axis Blanking displays also aid in obtaining correct TRIGGER control settings. See the discussion of these features under Output Signals to Mainframe for further information.

Trigger Coupling

The TRIGGER pushbuttons located below the COUPLING title select the method by which the input signal is connected to the Trigger circuit. Each position permits selection or rejection of various frequency components of the signal used to trigger the count.

AC. In this position of the COUPLING switch, the dc component of the input 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 delay is to be triggered at a low repetition rate or dc level, one of the other switch positions will provide better results.

The triggering point in the AC position depends upon the average voltage level of the input signal. If the input signal occurs randomly, the average voltage level will vary, causing the triggering point to vary also. This shift of the triggering point may be enough so it is impossible to maintain a stable count; in such cases, use DC coupling.

AC LF REJ. In this position, dc is rejected and low-frequency input signals below about 30 kilohertz are attenuated. Therefore, the count is triggered only by the higher-frequency components of the input signal. The AC LF REJ position is particularly useful for providing stable triggering if the signal contains line-frequency components.

AC HF REJ. This COUPLING switch position passes all low-frequency signals between about 30 hertz and 50 kilohertz. Dc is rejected and signals above 50 kilohertz are attenuated. This position is useful to trigger the count from the low-frequency components of a complex waveform.

DC. The DC position can be used to provide stable triggering from low-frequency or low-repetition-rate signals which would be attenuated in other modes. It can also be used to trigger the count when the input signal reaches a dc level selected by the setting of the SLOPE/LEVEL control. When triggering from the internal source, the setting of the vertical unit position control(s) affects the dc triggering point.

Trigger Source

The TRIGGER pushbuttons located below the SOURCE title select the source of the signal connected to the Trigger circuit.

INT. In this position, the input signal is derived from the associated vertical unit. Therefore, the 7D10 must be installed in a horizontal compartment to use the internal source. Further selection of the internal signal may be provided by the vertical unit and mainframe; see the instruction manuals for these instruments for further information.

LINE. In this SOURCE switch position, a sample of the power-line voltage from the mainframe is connected 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 stable triggering from a line-frequency component in a complex waveform.

EXT. A signal connected to the EXT TRIG IN connector can be used to trigger the count in the EXT position of the SOURCE switch. An external signal can be used to provide a trigger when the internal signal amplitude is too low.

EXT ÷ 10. Operation in this position is the same as described for EXT, except the external signal is attenuated 10 times. Attenuation of high-amplitude signals is desirable to extend the range of the LEVEL control.

Trigger Slope/Level

The TRIGGER SLOPE/LEVEL controls determine the slope and voltage level of the input signal where the Trigger circuit responds. Generally, the best point on a waveform for triggering the count is where the slope is steep, and

therefore usually free of noise. Assuming a sine-wave input waveform, the steepest slope occurs at the zero-crossing point. This is the point selected for triggering when the LEVEL control is set to 0 (center). A more positive or negative point on the waveform is selected as the LEVEL control is rotated clockwise or counterclockwise respectively from 0 (toward + or – symbols on panel).

Before setting the TRIGGER LEVEL, the desired SLOPE, MODE, COUPLING, and SOURCE should be selected. Then, adjust the LEVEL control so the count is triggered from the desired point.

Events Start Trigger

The Events Start Trigger is used to start the delay interval.

The EVENTS START TRIG IN connector provides the input for the events-start signal. The EVENTS START TRIGGER SLOPE and LEVEL controls select the amplitude point and slope on the input signal where the delay interval is triggered.

Delay Events

The DELAY EVENTS control selects the number of events counted. The integer number of events selected is displayed on the crt readout.

This control is a spring-return-to-center control that increases or decreases the number of events counted before a delayed pulse will occur. The direction of rotation determines whether the count is increased or decreased. The rate at which the count increments is determined by the magnitude of rotation. After either extreme of the range is reached, the next count starts from the other end of the range. For example, if the events counted is increased above 10000000, the count will go to 0000001. Conversely, if the delay time is decreased past 0000001, the count will go to 10000000.

Delay Modes

The B SWEEP DELAY MODE switch permits the 7D10, under specific conditions, to select the delay mode of a compatible time-base unit. To use this feature, the 7D10 is installed in the A Horizontal compartment and the time-base in the B Horizontal compartment of a four-plug-in mainframe. With this arrangement, the time-base unit can be controlled through the mainframe interface. Some dual time-base units are not compatible with this feature; see the time-base unit instruction manual for further information.

INDEPENDENT. The 7D10 and the time-base unit operate independently.

B STARTS AFTER DELAY. The time-base unit produces a sweep immediately following the selected delay interval. This provides the same mode of operation as triggering the time-base unit with the delayed trigger output.

B TRIGGERABLE AFTER DELAY. The time-base unit produces a sweep after the first trigger pulse is received following the selected delay interval. This mode of operation provides a stable display of a signal having time jitter. Precision time measurements cannot be made in this mode because the actual delay time is only partially dependent on the delay interval of the 7D10.

Sweep delay can also be used to select a portion of a complex signal for display. A sweep is delayed by triggering the sweep from the Delayed Trigger output of the 7D10, rather than from the signal to be displayed. Several methods of coupling the Delayed Trigger to the sweep are possible, depending on the application.

NOTE

The logic levels provided to the 7D10 from the mainframe are designed to control a time-base unit delaying sweep. For this reason, the 7D10 might become locked out (no output) when the setting of either the B-Sweep unit Time/Division switch or the B SWEEP DELAY MODE switch is changed. If this occurs, a delayed sweep will not be produced. To reset the 7D10, set the B SWEEP DELAY MODE switch first to INDEPENDENT, then select the desired delay mode.

Internal Trigger. The sweep produced by a time-base unit in a horizontal compartment can be internally triggered from a 7D10 in a vertical compartment. To use this sweep delay mode, the 7D10 must be selected by the mainframe trigger source switch. Delaying a time-base sweep from the internal source can be used with the units installed in either a three- or four-plug-in mainframe.

External Trigger Source. A sweep can be delayed by external triggering from the DLY'D TRIG OUT connector. This method can be used with any triggered sweep.

OUTPUT SIGNALS

Front-Panel Output Signals

The Delay Interval and Delayed Trigger outputs are available at the front-panel DLY INTERVAL OUT and DLY'D TRIG OUT connectors respectively. These outputs can be used to control other equipment during or immediately following the delay interval. To maintain the rise- and fall-time characteristics of these signals, connection to other equipment should be made with 50-ohm coaxial cable; the output of the cable should be terminated in 50 ohms.

DLY INTERVAL OUT. This output is a positive-going, rectangular waveform coincident with the generated delay interval. The DLY INTERVAL OUT signal duration is within 30 nanoseconds of actual delay, usually 10 nanoseconds.

DLY'D TRIG OUT. This signal is generated as a positive-going rectangular pulse coincident with the end of the delay interval.

The front-panel output signals are shown in Figure 2-3, along with the input signal. The input signal, Figure 2-3A, is comprised of 10-microsecond time markers. The resultant Delay Interval and Delayed Trigger outputs are shown in Figure 2-3B and 2-3C, respectively.

Output Signals to Mainframe

Signal outputs are provided to the mainframe via the interface connector. The following discussion describes these signals and the operating conditions necessary for their use.

DELAY-INTERVAL PEDESTAL. This output provides an on-screen display of the approximate delay interval. To view the pedestal display, the 7D10 must be installed in a vertical plug-in compartment and be selected by the mainframe Vertical Mode switch. The position of this display is fixed near the vertical center of the graticule area. The Delay-Interval Pedestal display is shown in Figure 2-4A. The input signal, shown in Figure 2-4B, is comprised of 10-microsecond time markers.

DELAYED TRIGGER. The Delayed Trigger output provides an internal Delayed Trigger source for a time-base unit. A time-base unit can be triggered from the Delay Trigger when the 7D10 is in a vertical compartment. To use this output, the 7D10 must be selected by the appropriate trigger source switch (mainframe).

Z-AXIS BLANKING. Z-axis blanking provides an on-screen display of the approximate delay interval. This is accomplished by blanking out the crt display during the delay interval. Z-axis blanking can be obtained with the 7D10 installed in any plug-in compartment. The Z-axis blanking display is selected by a slide switch located inside the unit (see Fig. 8-5, Section 8).

NOTE

At faster sweep rates (100 ns/div or faster), care must be taken when interpreting crt display because relative propagation delays through the 7D10 and vertical amplifier plug-ins are not the same. This appears as a relative time shift between delay interval pedestal or Z-axis blanking generated by the 7D10 and the signal(s) viewed through a vertical amplifier on the crt. Changing the TRIG SOURCE between INT and EXT ÷ 10 will vary this apparent time shift due to differences in propagation delays of the signal path.

APPLICATIONS

The 7D10 counts arbitrary events and delivers an output when a preselected number of events is reached. By counting events rather than delaying by a fixed time, trigger jitter and drift caused by mechanical fluctuations in disc memories or servo control systems is eliminated.

Delay by events provides a convenient method for triggering a time base, after a preselected number of clock pulses, to look at a particular word in a data train without tedious counting. Only two signals are required to operate the 7D10. The events to be counted (clock, line, or mechanical switch pulses) are fed to the EXT TRIG IN connector, and the control (frame or sector) pulse is fed to the EVENTS START TRIG IN connector to tell the 7D10 when to start counting.

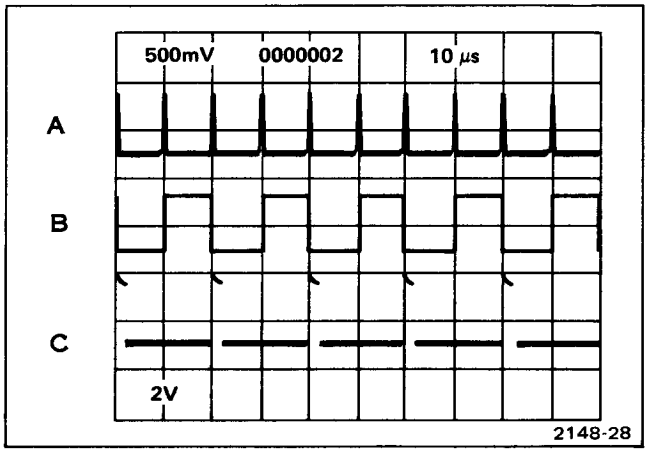


Figure 2-3. Display showing time relationship of (A) input signal at front panel to (B) Delay Interval, and (C) Delayed Trigger outputs.

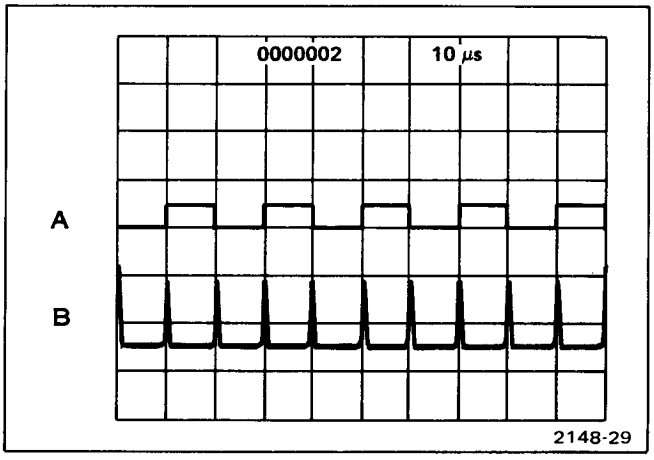


Figure 2-4. Display showing time relationship of (A) Delay Interval Pedestal and (B) input signal.

The 7D10 can be used with companion vertical amplifier and time-base units in a three- or four-hole mainframe to identify transients or incorrect logic state locations on a word or bit that occurs anywhere from 1 event to 10 million events from the start of a data train. Time interval measurements between events can be made with delaying and delayed time base units.

The 7D10 can also be used with a logic analyzer (e.g., TEKTRONIX 7D01 Logic Analyzer) to preselect a binary word or event and examine the data train either before, after, or on both sides of the first to the 10 millionth time that such word or event occurs.

The following procedures describe some specific measurement applications for the 7D10. Contact your local Tektronix Field Office or representative for assistance on applications that are not described in ths manual.

Logic State Identification

The following procedure describes a method for displaying a binary word on a data train in order to determine its logic state:

1. Connect the equipment as shown in Figure 2-5A.

2. Set the mainframe to trigger the time-base unit from the left vertical-amplifier unit and display the time-base unit and both vertical amplifier units in the chopped mode.

3. Set both amplifier units to display channel 1 and 2 in the chopped mode.

4. Set the 7D10 controls as follows:

TRIGGER
COUPLING . . . .AC
SOURCE. . . . . .EXT
SLOPE . . . . . .+
EVENTS START
TRIGGER
SLOPE . . . . . .+
B SWEEP
DELAY MODE. . . .B STARTS AFTER DELAY

5. Set the EVENTS START TRIGGER LEVEL control for a stable display.

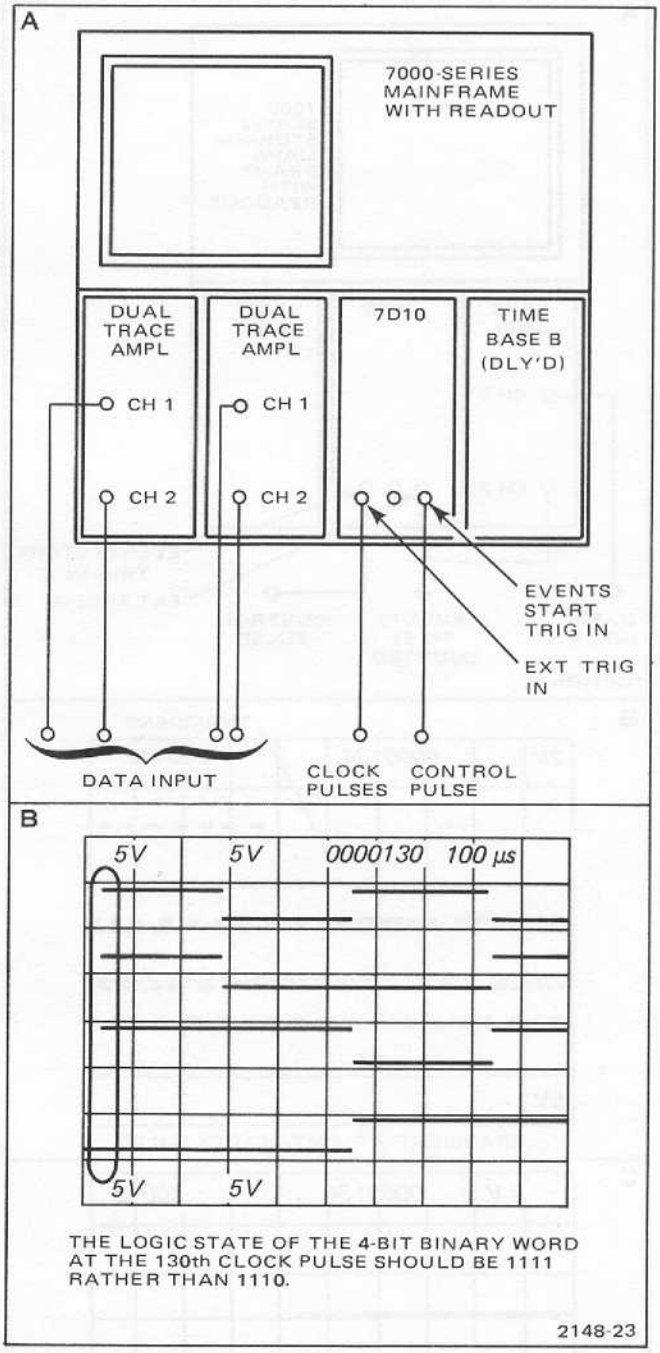


Figure 2-5. Equipment set up and data display for determining the logic state of a 4-bit binary word.

6. Turn the DELAY EVENTS control for the location of the binary word to be examined as indicated by the events count readout.

7. Determine the logic state of the displayed binary word at the left edge of the display (see example in Fig. 2-5B).

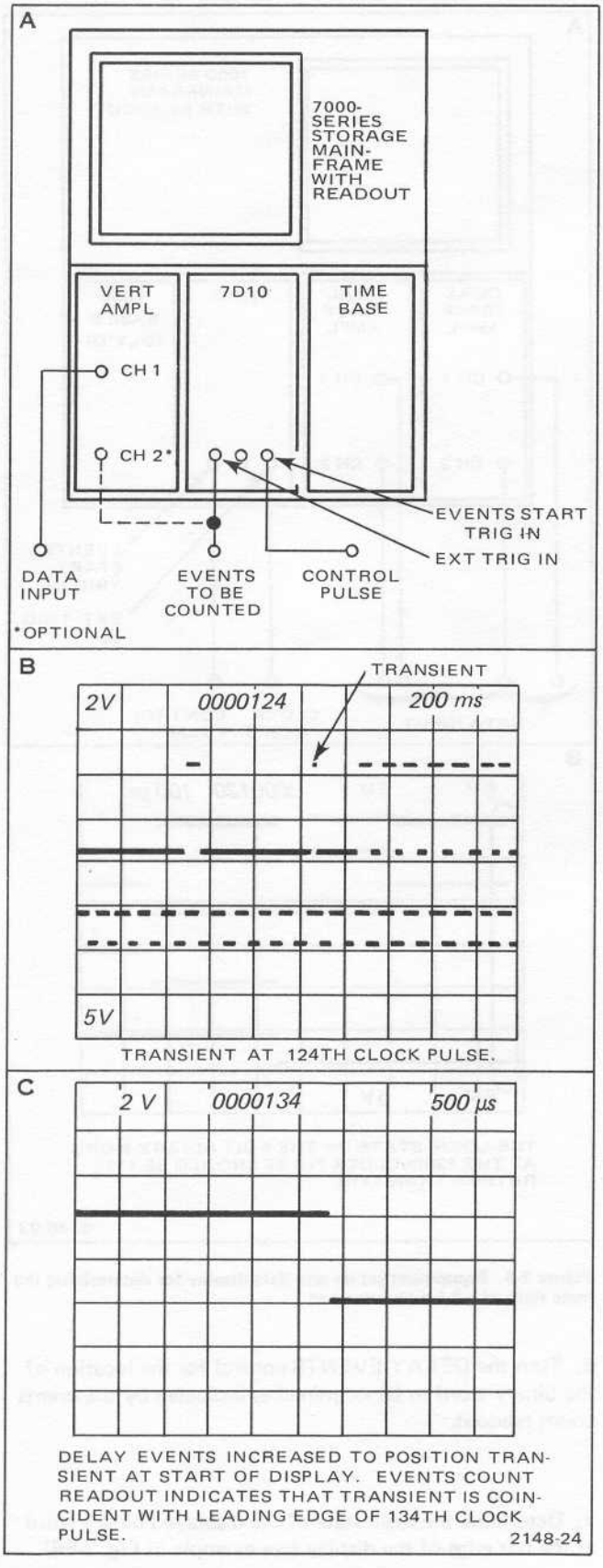


Figure 2-6. Equipment set up and display for finding a transient and determining its location on a data train.

Transient Identification

The following procedure describes a method for locating and examining a transient caused by a timing problem:

1. Connect the equipment as shown in Figure 2-6A.

2. Set the mainframe to trigger the time-base unit from the vertical-amplifier unit and to display the time-base unit and the amplifier unit.

3. Set the time-base unit triggering for normal mode, ac coupling, internal source, and + slope.

4. Set the 7D10 controls as follows:

TRIGGER
COUPLING . . . .AC
SOURCE. . . . . .EXT
SLOPE . . . . . .+
EVENTS START TRIGGER
SLOPE . . . . . .+
B SWEEP
DELAY MODE. . . .INDEPENDENT

5. Set the 7D10 TRIGGER LEVEL control to light the TRIG'D indicator.

6. Set the EVENTS START TRIGGER LEVEL control for a stable display.

7. Turn the DELAY EVENTS control clockwise (INCREASE) to view the data train, bit-by-bit, until the transient is located (see example in Fig. 2-6B).

8. Turn the DELAY EVENTS control to position the transient at the left edge of the display. The events count readout now indicates at which clock pulse the transient occurred.

9. Set the mainframe for storage mode and increase the time-base unit sweep rate to expand the display.

10. Set the time-base unit triggering for single sweep.

11. Press the time-base unit single-sweep reset button to provide the desired single sweep stored display (see example in Fig. 2-6C).

Delay By Words

The following procedure utilizes a 7D10 with a logic analyzer and word recognizer (e.g., TEKTRONIX 7D01 Logic Analyzer) to select a binary word and position the data display window anywhere from the first to the 10 millionth time that such word occurs.

1. Connect the equipment as shown in Figure 2-7A.

2. Set the 7D10 controls as follows:

TRIGGER
COUPLING . . . .AC
SOURCE. . . . . .EXT
SLOPE . . . . . .+
EVENTS START
TRIGGER
SLOPE . . . . . .+
B SWEEP
DELAY MODE. . . .INDEPENDENT

3. Set the logic analyzer for asynchronous operation with the word recognizer as the trigger source.

4. Set the word recognizer for the desired binary word code.

5. Connect the data input to the logic analyzer.

6. Set the mainframe to display the right vertical compartment.

7. Set the 7D10 TRIGGER LEVEL control to light the TRIG'D indicator.

8. Set the EVENTS START TRIGGER LEVEL control for a stable display.

9. Set the DELAY EVENTS control to indicate, on the events count readout, the desired number of times that the preselected binary word is to occur before the 7D10 initiates a data display. For example, if the DELAY EVENTS control is set for an events count readout of 0000025, the word recognizer and 7D10 will initiate a display of the data before, after, or on both sides of the 25th time that the preselected binary word occurs in the data train (see example in Fig. 2-7B).

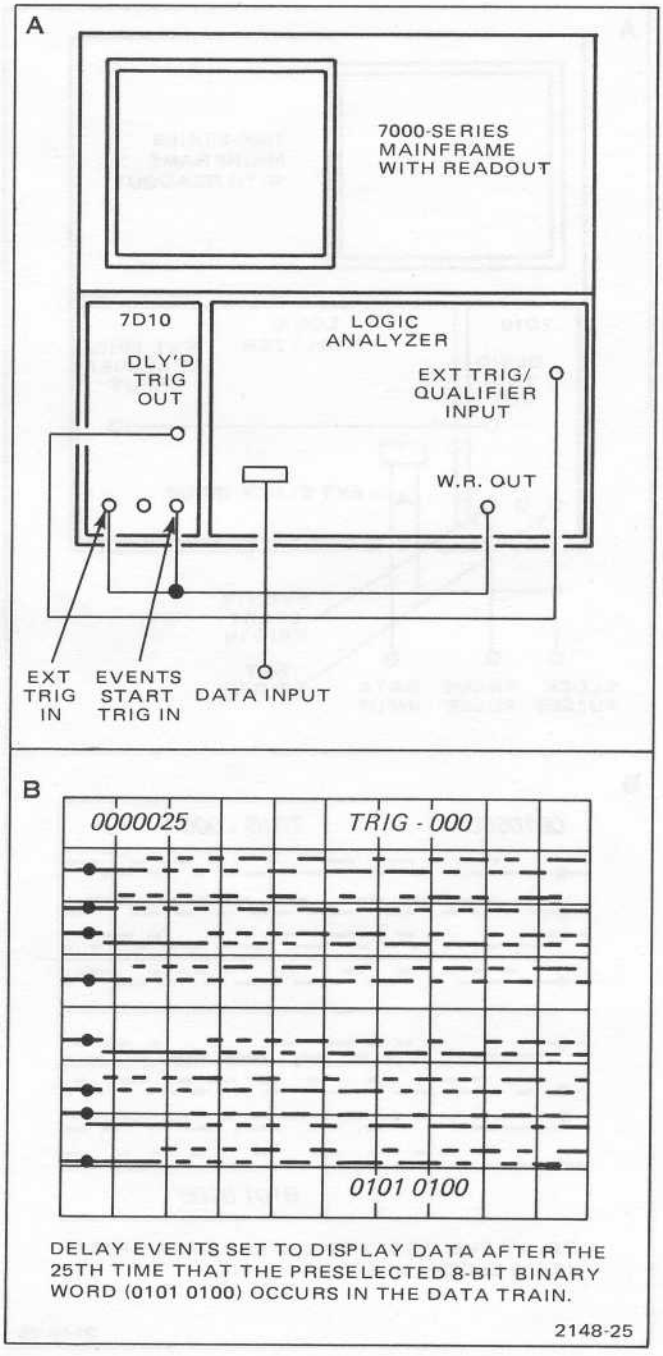


Figure 2-7. Equipment set up and data display window that has been positioned after a selected binary word has occurred 25 times.

Delay By Events

The following procedure utilizes a 7D10 with a logic analyzer (e.g., TEKTRONIX 7D01 Logic Analyzer) to effectively position the data display window to virtually anywhere along a data train:

1. Connect the equipment as shown in Figure 2-8A.

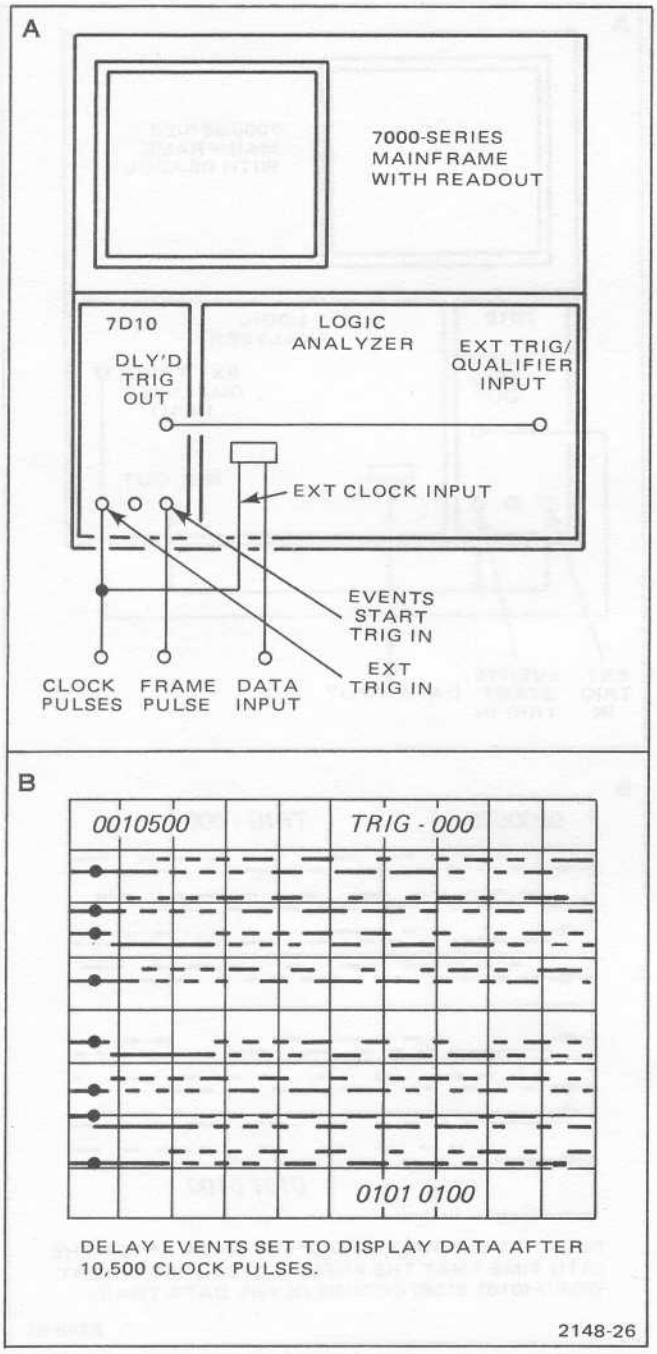


Figure 2-8. Equipment set up and data display window that has been positioned after 10,500 clock pulses have occurred.

2. Set the 7D10 controls as follows:

TRIGGER
COUPLING . . . .AC
SOURCE. . . . . .EXT
SLOPE . . . . . .+
LEVEL. 0
EVENTS START
TRIGGER
SLOPE . . . . . .+

3. Set the logic analyzer to the external clock mode and trigger from the external trigger/qualifier input.

4. Set the mainframe to display the right vertical compartment.

5. Set the EVENTS START TRIGGER LEVEL control for a stable display.

6. Set the DELAY EVENTS control to indicate the desired number of clock pulses, on the events count readout, that the logic analyzer bit-storage window is to be shifted down the data train. For example, if the DELAY EVENTS control is set for an events count readout of 0010500, the logic analyzer and 7D10 will initiate a display of the data before, after, or on both sides of the 10,500th clock pulse (see example in Fig. 2-8B).

Time Interval Measurements

The following procedure describes a method for measuring time intervals either from the display trigger (start of sweep) or between any two points on a displayed data train:

1. Connect the equipment as shown in Figure 2-9A.

2. Set the mainframe to display the left vertical-amplifier unit and both time-base units in the chopped mode.

3. Set the 7D10 controls as follows:

TRIGGER
COUPLING . . . .AC
SOURCE. . . . . .EXT
SLOPE . . . . . .+
EVENTS START
TRIGGER
SLOPE . . . . . .+

4. Set the EVENTS START TRIGGER LEVEL and time-base A triggering level controls for a stable display.

5. Turn the DELAY EVENTS control to display the desired events to be measured.

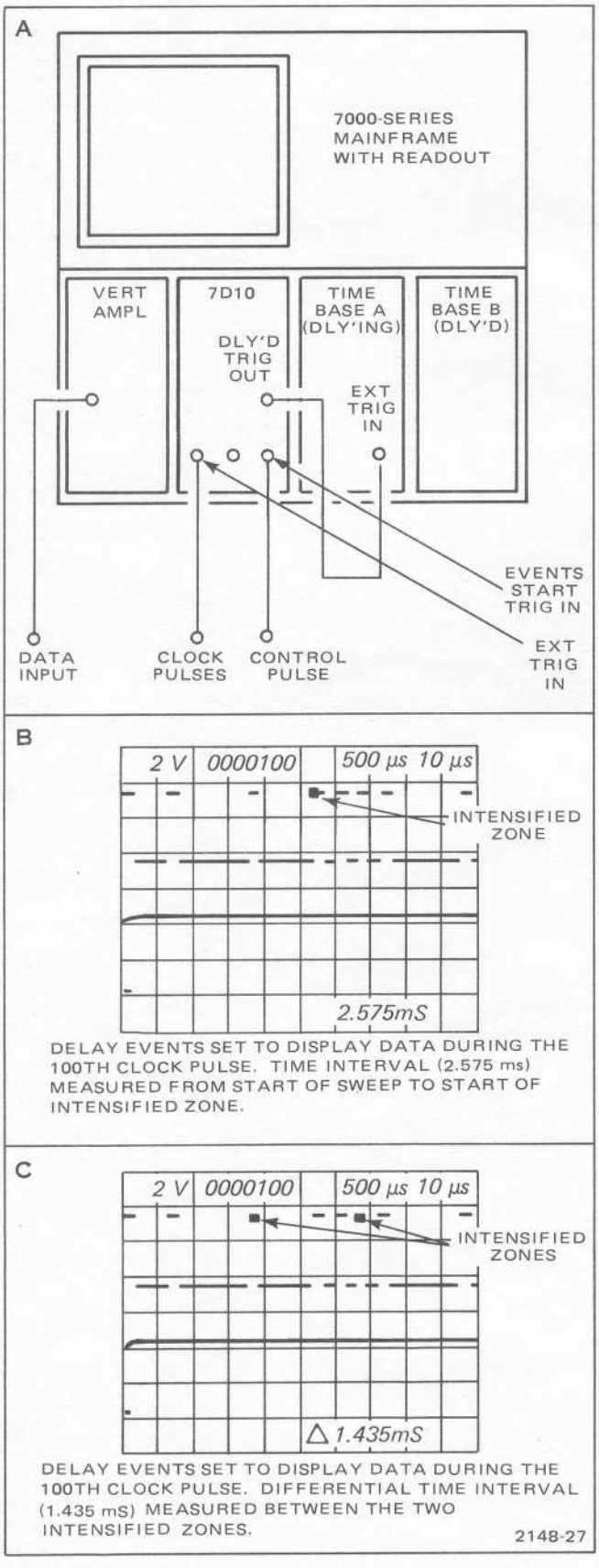


Figure 2-9. Equipment set up and display for time interval measurements from start of sweep or between any two points on a displayed data train.

6. Set time-base A to the delaying mode.

7. Set the time-base A delay time to position the start of the intensified zone to the desired point on the display (see example in Fig. 2-9B). The readout in the bottom right side of the display indicates the time interval from the display trigger (start of sweep) to the start of the intensified zone. (Refer to the delaying time-base unit operator's manual for detailed operating instructions.)

8. For differential time-interval measurements, set time-base A to the differential-time mode.

9. Set the time-base A delay time and differential time to position the start of the two intensified zones at the beginning and end of the time-interval to be measured (see example in Fig. 2-9C). The readout in the bottom right side of the display indicates the time between the start of the two intensified zones. (Refer to the delaying time-base unit operator's manual for detailed operating instructions.)

INSTRUMENT OPTIONS

No options were available for this instrument at the time of this printing.

Information on any subsequent options may be found in the CHANGE INFORMATION section in the back of this manual.

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.