Tektronix®
COMMITTED TO EXCELLENCE

7D11
DIGITAL DELAY

OPERATORS

INSTRUCTION MANUAL

TEKTRONIX®

7D11
DIGITAL DELAY

OPERATORS

INSTRUCTION MANUAL

Tektronix, Inc. P.O. Box 500 Beaverton, Oregon 97005
070-1329-00 772

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.

TABLE OF CONTENTS

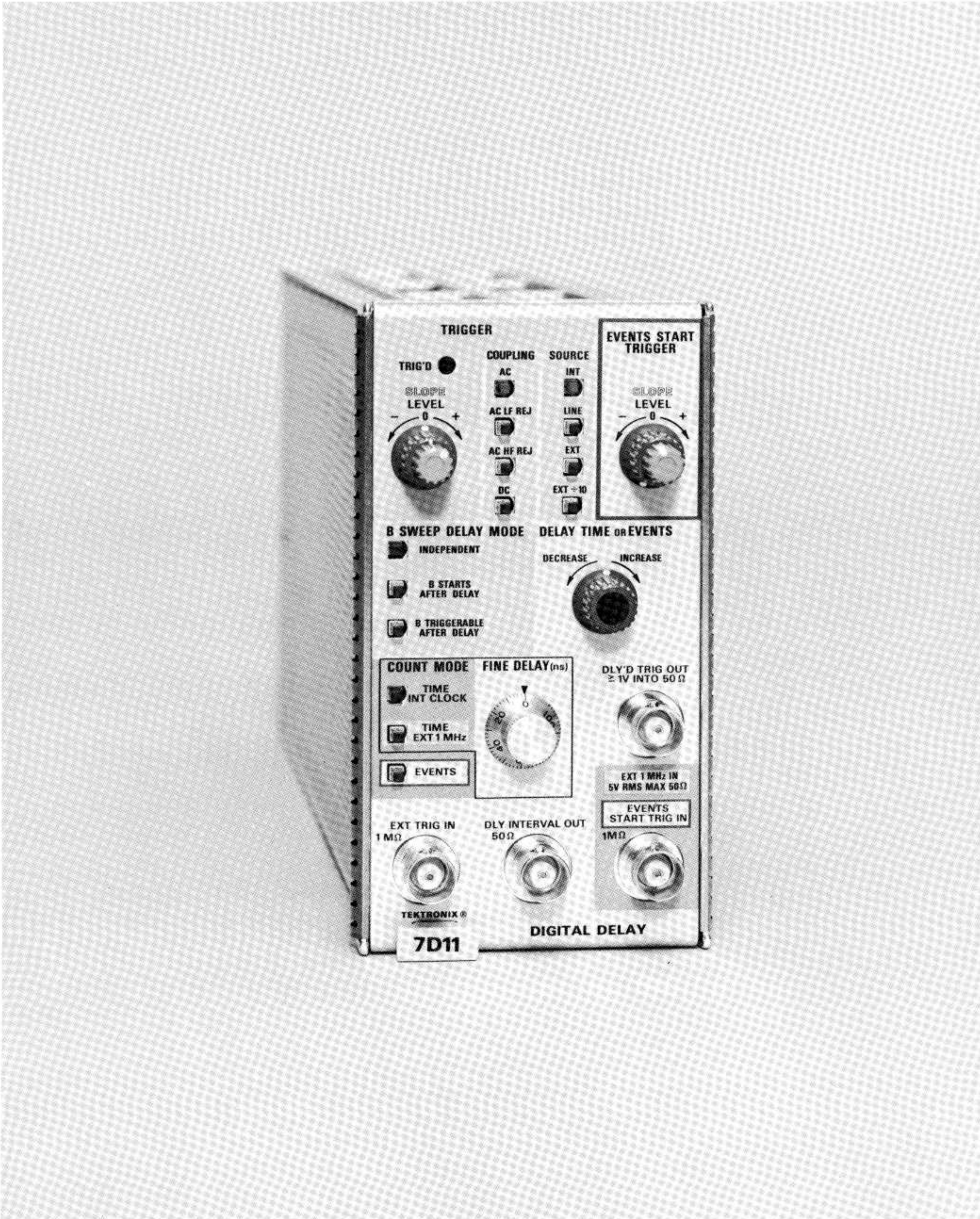


Fig. 1-1. 7D11 Digital Delay.

OPERATING INSTRUCTIONS

7D11 Features

The 7D11 Digital Delay plug-in unit is designed for use with TEKTRONIX 7000-Series Oscilloscope mainframes equipped with a readout system. The 7D11 uses the readout system to display the selected delay count on the CRT. A delayed trigger output is generated by counting time or events. Digital delay time to one second is read out in 100-nanosecond increments. Additional analog delay time from zero to 100 nanoseconds selected from a calibrated front-panel dial provides added resolution. An "echo" time-delay mode provides a divide-by-two scaler to read out the "one-way trip" time up to two seconds for radar ranging and TDR applications. Delay time accuracy is controlled by an internal crystal oscillator; greater accuracy can be obtained by the use of an external one-megahertz standard. In the Count by Events mode, the CRT readout displays the integer number of events from one to 10^7 events at count rates up to 50 megahertz.

The 7D11 can be used to delay a 7B-series time-base unit in either a runs-after or triggerable-after delay time mode. Other 7D11 features include on-screen display of delay interval by vertical signal or display blanking, trigger pickoff from vertical amplifier unit, and blanking of all zeros to the left of the most significant digit (Count by Time mode only).

PRELIMINARY INFORMATION

Installation

The 7D11 is designed to operate in any plug-in compartment of TEKTRONIX 7000-series mainframes. However, certain modes of operation require the 7D11 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. The 7D11 must be operated in the A Horizontal compartment to control the delay mode of a time-base unit in the B Horizontal compartment. Operation in a vertical compartment is necessary to view the Delay Interval Pedestal without the use of external cables.

To install the 7D11 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 7D11. Continue to pull the release latch to remove the unit from the mainframe.

Display

The 7D11' readout display is presented on the CRT of the mainframe, along with information encoded by the other plug-in units. Digital delay time (in milliseconds) is displayed in four to eight digits. All zeros to the left of the most significant digit are blanked out. The + symbol to the right of the digital display reminds the operator to add any analog delay time selected by the FINE DELAY (ns) dial to the delay time. The number of events being counted is presented in a seven-digit display.

The 7D11 readout display appears on the CRT in a location corresponding to the plug-in compartment used. The delay time or number of events will be displayed in the top division of the CRT graticule. The delay-time measurement unit (ms) will be displayed in the bottom division. It is not necessary to select the 7D11 with the mainframe Vertical or Horizontal Mode switches to view the digital display. In order to view the Delay Interval Pedestal waveform, selection with the Vertical Mode switch is required.

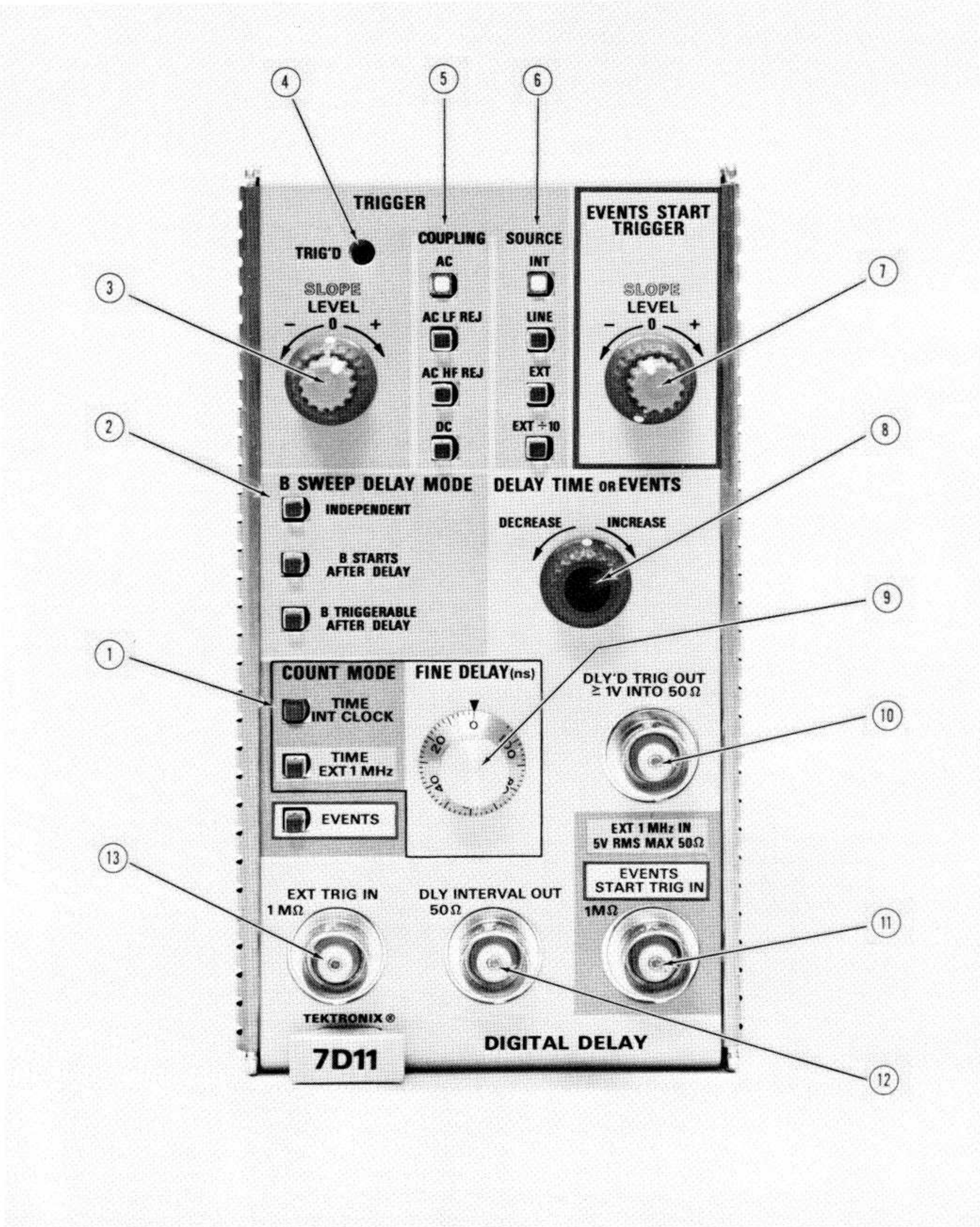


Fig. 1-2. 7D11 front-panel controls and connectors.

CONTROLS AND CONNECTORS

The major controls and connectors for operation of the 7D11 are located on the front panel of the unit. Two controls located inside the unit for auxiliary functions are described in the General Operating Information section. The front-panel controls and connectors are identified in Fig. 1-2; their functions are as follows:

(1) COUNT MODE Switch

Selects mode of operation and clock-signal source for Time count mode.

(2) B SWEEP DELAY MODE Switch

Selects the delay mode logic for time-base unit in B Horizontal compartment of mainframe.

(3) TRIGGER SLOPE/LEVEL Controls

Select slope and amplitude point of input signal where the delay is initiated.

(4) TRIG'D Indicator

Lights when a trigger is produced.

(5) COUPLING Switch

Selects the method of coupling the input signal to the Trigger circuit.

(6) SOURCE Switch

Selects Trigger input signal source.

(7) EVENTS START TRIGGER SLOPE/LEVEL Controls

Select slope and amplitude point of input signal where the Events Start count is initiated.

(8) DELAY TIME OR EVENTS Control

Selects delay time or number of events counted. Direction of rotation selects increase or decrease in delay time or number of events.

(9) FINE DELAY (ns) Dial

Selects analog delay time added to digital delay time selected by DELAY TIME OR EVENTS control.

(10) DLY'D TRIG OUT

BNC connector for Delayed Trigger output signal.

(11) EXT 1 MHz IN or EVENTS START TRIG IN

BNC connector for input of external 1 MHz time-reference signal or input of Events Start Trigger input signal. Connector function is determined by setting of COUNT MODE switch.

(12) DLY INTERVAL OUT

BNC connector for Delay Interval output signal.

(13) EXT TRIG IN

BNC connector for external input to Trigger circuit (selected by SOURCE switch in the external positions).

RESET
Resets the DELAY TIME OR EVENTS to 0000001 (EFF SN B030000 and up).

GENERAL OPERATING INFORMATION

Signal Connection

In general, probes offer the most convenient means of connecting signals to the 7D11 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 7D11 and the associated equipment. The common ground provided by 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 7D11 through an amplifier unit via the internal trigger circuitry of the mainframe (7D11 installed in a horizontal compartment). This method of signal connection minimizes circuit loading, especially when triggering a time-base unit in parallel with the 7D11. (NOTE: Only external signals can be used with the Events Start Trigger.)

The front-panel output signals, DLY'D TRIG OUT and DLY INTERVAL OUT, should be connected to other equipment with 50-ohm coaxial cables. The cables should be terminated in 50 ohms to maintain the rise and falltime characteristics of these signals.

Count Mode

General. Two basic count modes, Time and Events, can be performed by the 7D11, as selected by the COUNT MODE switch. The delay interval in both modes is selected by the DELAY TIME OR EVENTS control and is read out on the CRT.

TIME INT CLOCK. The 7D11 counts precise increments of time after the receipt of a trigger. The TRIGGER controls select and condition the signal to start the time delay. Accuracy in this mode is determined by an internal, crystal-controlled oscillator.

TIME EXT 1 MHz. This count mode is the same as TIME INT CLOCK except the accuracy is derived from an external, one-megahertz standard.

EVENTS. The 7D11 counts events, periodic or aperiodic, at count rates to 50 megahertz. The EVENTS START TRIGGER provides a means of discriminating between the event that starts the delay and the events to be counted. The events to be counted are selected and conditioned by the TRIGGER controls.

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.

NOTE

When the 7D11 is used in the EVENTS count mode, the EVENTS START TRIGGER affects the output of the Trigger circuit but has no effect on the TRIG'D light.

Trigger Coupling

The TRIGGER pushbuttons located below the COUPLING title select the method in 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 delay start.

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 delay start; 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 delay 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 input 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 delay 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 delay 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 7D11 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 delay 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 delay 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 (towards + 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 delay starts from the desired point.

Events Start Trigger

The Events Start Trigger is used in the EVENTS count mode to differentiate between the event that starts the delay and the events being counted.

The EVENTS START TRIG IN connector provides the input to 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 is triggered.

Generally, the best point on a waveform for triggering the delay 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 (towards + or — symbols on panel).

Delay Time or Events

The DELAY TIME OR EVENTS control selects the digital delay time in the TIME count mode, and the number of events counted in the EVENTS count mode. The delay time in milliseconds, or 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 count at which 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 delay time is increased above 1000.0000 ms (one second), the count will go to 0.0001 ms. Conversely, if the delay time is decreased past 0.0001 ms, the count will go to 1000.0000 ms.

Fine Delay

The FINE DELAY (ns) dial selects analog delay time from zero to 100 nanoseconds in the TIME count mode. This one-turn control provides added resolution to the digital delay time selected by the DELAY TIME OR EVENTS control. The delay time selected by the FINE DELAY (ns) dial is read from the calibrated knob as the analog delay time is not read out on the CRT. Each minor division on the dial represents two nanoseconds.

B Sweep Delay Mode

The B SWEEP DELAY MODE switch permits the 7D11, under specific conditions, to select the delay mode of a compatible time-base unit. To use this feature, the 7D11 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 7D11 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 7D11.

OUTPUT SIGNALS

Front-Panel Output Signals

General. 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 falltime 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. In time mode DLY INTERVAL OUT is approximately 20-30 ns shorter than indicated delay time because of internal propagation delays and trigger recognition time. In the event mode, the DLY INTERVAL OUT is within 30 ns of actual delay, usually ≤ 10 ns.

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 Fig 1-3, along with the input signal. The input signal, Fig. 1-3(A), is comprised of one- and ten-microsecond time markers. The 7D11 is set for a 0.0038-millisecond delay time after triggering on the ten-microsecond markers. The resultant Delay Interval and Delayed Trigger outputs are shown in Fig. 1-3(B) and (C), respectively. The characteristics of these output signals are given in the Specification section.

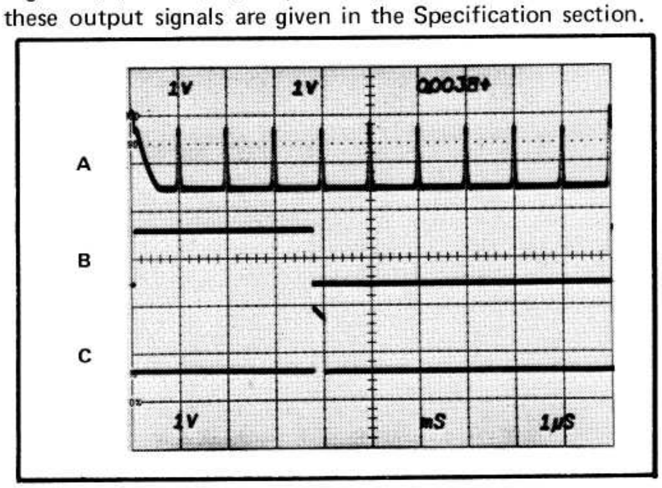


Fig. 1-3. Display showing time relationship of: (A) Input signal to the front-panel, (B) Delay Interval, and (C) Delayed Trigger outputs.

Output Signals to Mainframe

General. 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 7D11 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 Fig. 1-4 (A). The input signal, shown in Fig. 1-4 (B), is comprised of one- and ten-microsecond time markers. The 7D11 is set to trigger on the ten-microsecond markers, and to generate a 0.0038-millisecond delay time.

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 7D11 is in a vertical compartment. To use this output, the 7D11 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 7D11 installed in any plug-in compartment. The Z-axis blanking display is selected by a slide switch located inside the unit (on the left side; see Fig. 1-6).

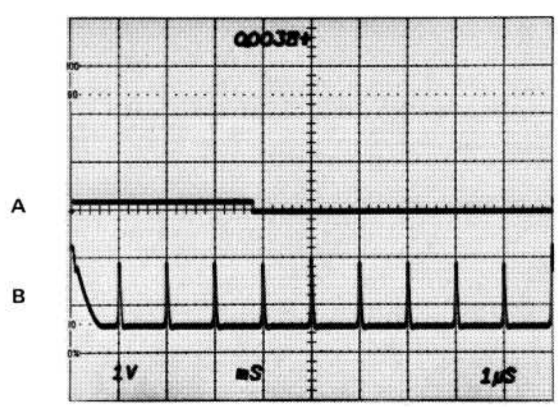
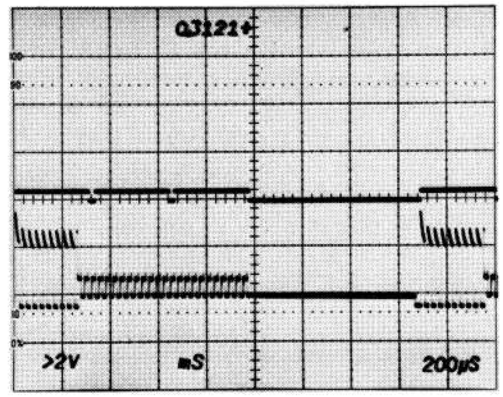
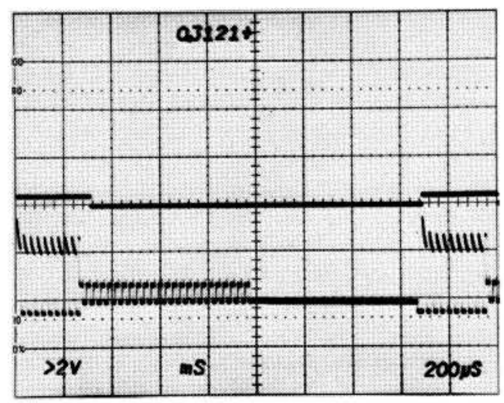


Fig. 1-4. Waveform display of: (A) Delay Interval Pedestal; (B) input signal.



A. 7D11 triggered incorrectly.



B. 7D11 triggered correctly.

Fig. 1-5. Use of Delay-Interval Pedestal display to indicate: (A) Incorrect triggering, and; (B) correct triggering.

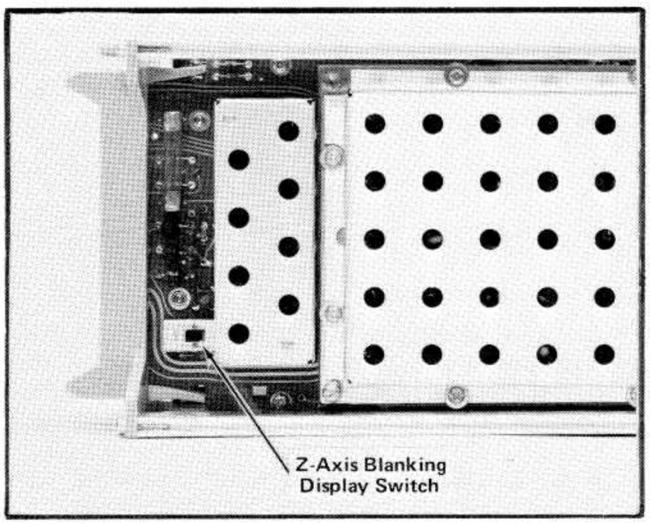


Fig. 1-6. Location of Z-Axis Blanking Display switch (on left side of unit). The switch position towards the rear of the unit selects Z-axis blanking.

NOTE

At faster sweep speeds (100 ns/div or faster) care must be taken when interpreting CRT display because relative propagation delays through the 7D11 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 7D11 and the signal(s) viewed through a vertical amplifier on the CRT. Changing the TRIG SOURCE between INT and EXT or EXT ÷ 10 will vary this apparent time shift due to differences in propagation delays of the signal path.

OPERATING MODES

Sweep Delay

The 7D11 can be used to delay the start of a sweep for a selected time interval following the receipt of a trigger. Low-jitter sweep delay can be used for accurate time, jitter, and stability measurements. 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 7D11, rather than from the signal to be displayed. Several methods of coupling the Delayed Trigger to the sweep are possible, depending on the application. These methods are described in the following discussions.

B Sweep Delay Mode Switch. The sweep produced by a time-base unit can be controlled and delayed by a 7D11 via the mainframe interface and the B SWEEP DELAY MODE switch. To use this mode of sweep delay, the 7D11 must be installed in the A Horizontal compartment and the time-base unit in the B Horizontal compartment of a four-plug-in mainframe. For further information, see B Sweep Delay Mode.

NOTE

The logic levels provided to the 7D11 from the mainframe are designed to control a time-base unit delaying sweep. For this reason, the 7D11 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 7D11, 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 7D11 in a vertical compartment. To use this sweep delay mode, the 7D11 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.

Echo Delay Time Mode

The Echo delay time mode provides a CRT readout of the "one-way-trip" time, or one-half of the generated delay time. This mode of operation is selected for use by an internal switch (on left side of unit, see Fig. 1-7). In the Echo mode, the delay time is selected by the DELAY TIME OR EVENTS control in 200-nanosecond increments. An insertion delay of about 160 nanoseconds in this mode requires adding analog delay time to the first delay increment to obtain a 200-nanosecond delay interval. This can be accomplished by displaying the DELAY INTERVAL OUT and setting the FINE DELAY dial for a total delay interval of 200 nanoseconds as measured on the graticule.

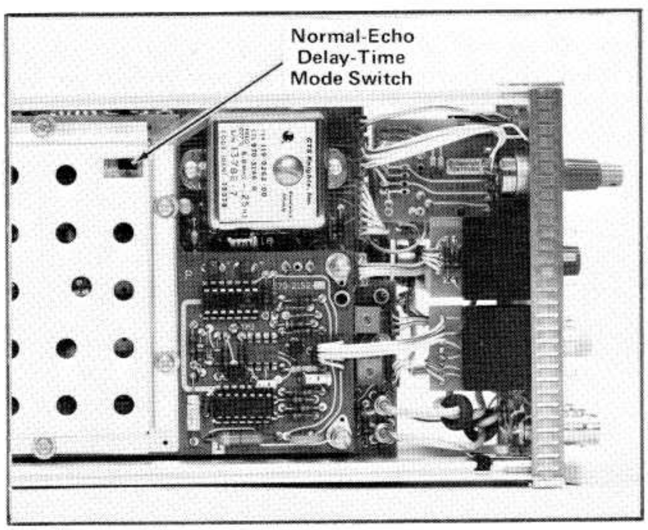


Fig. 1-7. Location of Normal-Echo Delay Time Mode switch (on left side of unit). Set the switch towards the front of the unit to select Normal Mode.

APPLICATIONS

General

The following information describes the procedures and techniques for making measurements using a 7D11 Digital Delay unit. 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 which are not described in this manual. Contact your local TEKTRONIX Field Office or representative for assistance in making specific measurements with this instrument.

Delayed-Sweep Time Measurements

The 7D11 can be used to delay the start of a sweep to make accurate time measurements. The following procedure describes one method of determining the time difference between two pulses displayed on the same trace. This application can also be used to measure time difference between two signal sources or to measure the time duration of a single pulse. Other methods of delayed-sweep time measurements with the 7D11 are described under General Operating Information.

1. Within the 7D11, set the Z-Axis switch to Z to select the Z-Axis Blanking display.

2. Install the 7D11, time-base unit, and amplifier unit in the A Horizontal, B Horizontal, and vertical compartments respectively of a four-plug-in mainframe.

3. Connect the signal to be measured to the amplifier unit.

4. Set both the 7D11 and time-base unit to trigger from the signal source.

5. Set the 7D11 for TIME INT CLOCK operation in the INDEPENDENT mode.

6. Set the time-base unit sweep rate to view several cycles of the applied signal.

7. Set the 7D11 TRIGGER controls to trigger the delay start. The TRIG'D indicator will light when a trigger is being produced.

8. Turn the DELAY TIME OR EVENTS control clockwise to produce a blanked display. Set this control to position the blanked portion to the left of the first pulse.

9. Set the 7D11 B SWEEP DELAY MODE switch to B STARTS AFTER DELAY.

10. Set the time-base unit for a sweep rate 100 times faster than its original sweep rate.

11. Set the DELAY TIME OR EVENTS and FINE DELAY controls to move the first pulse to the center vertical line. Note the total delay time read out on the CRT and the FINE DELAY dial.

12. Set the DELAY TIME OR EVENTS and FINE DELAY controls to position the second pulse to the same point. Again note the total delay time.

13. Subtract the first delay time reading from the second. This gives the time interval between pulses.

Displaying Complex Signals With Delayed Sweep

Complex signals often consist of a number of individual events of differing amplitudes. Since the time-base trigger circuits are sensitive only 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 event which follows the triggering event. The 7D11 provides a means of delaying the start of the sweep by a selected amount following the event which triggers the 7D11. Then, the part of the waveform which contains the information of interest can be displayed. The following procedure describes one method of using the 7D11 to display complex signals.

1. Within the 7D11, set the Z-Axis switch to Z to select the Z-Axis Blanking display.

2. Install the 7D11, time-base unit, and amplifier unit in the A Horizontal, B Horizontal, and vertical compartments respectively of a four-plug-in mainframe.

3. Connect the signal to be measured to the amplifier unit.

4. Set the 7D11 and the time-base unit to trigger from the signal source.

5. Set the 7D11 for TIME INT CLOCK operation in the INDEPENDENT mode.

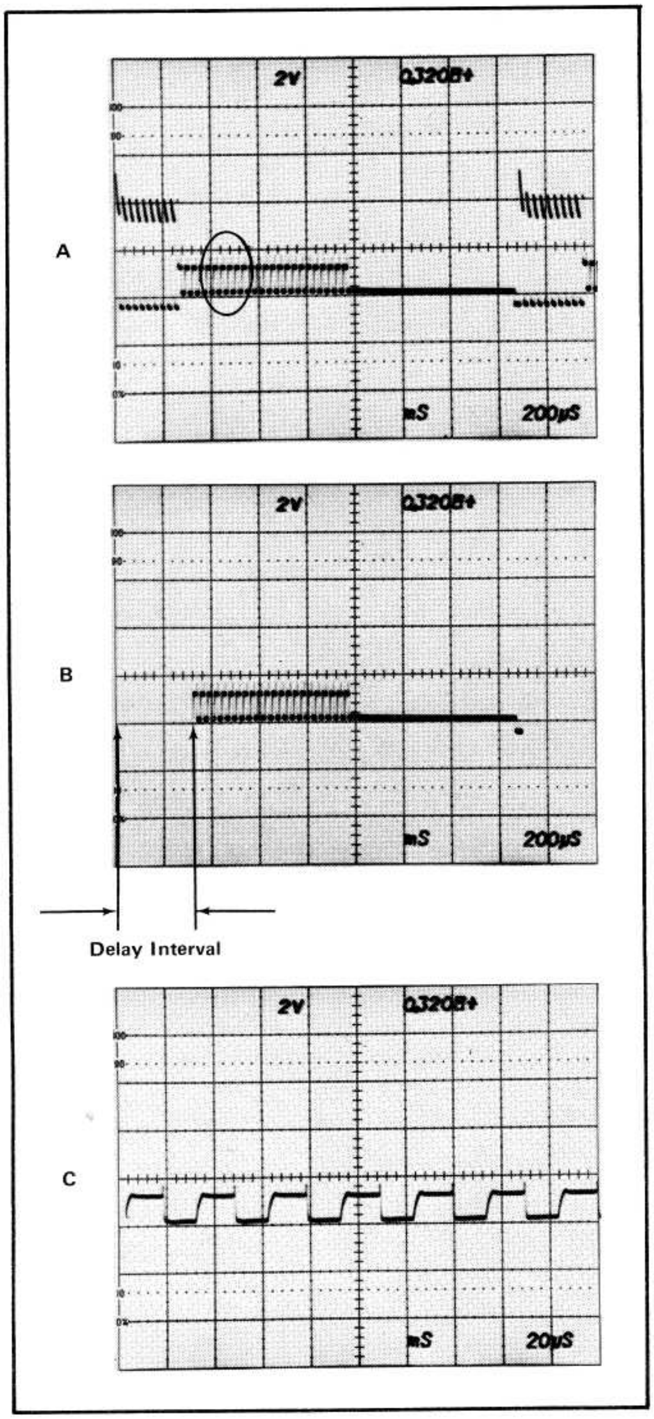


Fig. 1-8. (A) The circled portion of this display cannot be viewed at a faster sweep rate; (B) Display blanked during delay interval; (C) Area of interest displayed at faster sweep rate.

6. Set the time-base unit to view several cycles of the applied signal.

7. Set the 7D11 TRIGGER controls to trigger the delay start. The TRIG'D indicator will light when a trigger is being produced.

8. Turn the DELAY TIME OR EVENTS control clockwise to blank that portion of the display preceding the area of interest. The blanked portion of the display represents the delay interval.

9. Set the B SWEEP DELAY MODE switch to B STARTS AFTER DELAY. Set the time-base to a sweep rate which displays the area of interest.

Example. Fig. 1-8(A) 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; a faster sweep rate moves this area of the waveform off the viewing area. Fig. 1-8(B) shows the display blanked out during the delay interval (delay interval is area between the arrows). Fig. 1-8(C) shows the sweep triggered after the delay at a faster sweep rate to display 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.

Use the following procedure:

1. Install an amplifier unit and the 7D11 in the vertical compartments of a mainframe. Install a time-base unit in a horizontal compartment.

2. Set the mainframe for a dual-trace vertical display mode.

3. Connect the signal to the amplifier unit and to the 7D11 EXT TRIG IN connector.

4. Set the time-base unit to trigger on the applied signal at a sweep rate which displays the complete waveform.

5. Set the 7D11 for TIME INT CLOCK count mode. Set the TRIGGER SOURCE to EXT. Set the TRIGGER LEVEL control for a triggered condition as indicated by the TRIG'D indicator light.

6. Set the DELAY TIME OR EVENTS control to select a delay interval which ends just before the pulse to be measured.

7. Connect the DLY'D TRIG OUT to the time-base external trigger input. Set the time-base to trigger from the external source.

8. Set the time-base unit for a sweep rate which displays just the pulse or leading edge to be measured.

9. Pulse jitter is shown by horizontal movement of the pulse (take into account inherent jitter of 7D11). Measure the amount of horizontal movement directly from the CRT graticule.

Example. Assume the horizontal movement is 0.2 division at a 200-nanosecond sweep rate (see Fig. 1-9). The amount of pulse jitter is then 0.2 X 200 nanoseconds = 40 nanoseconds.

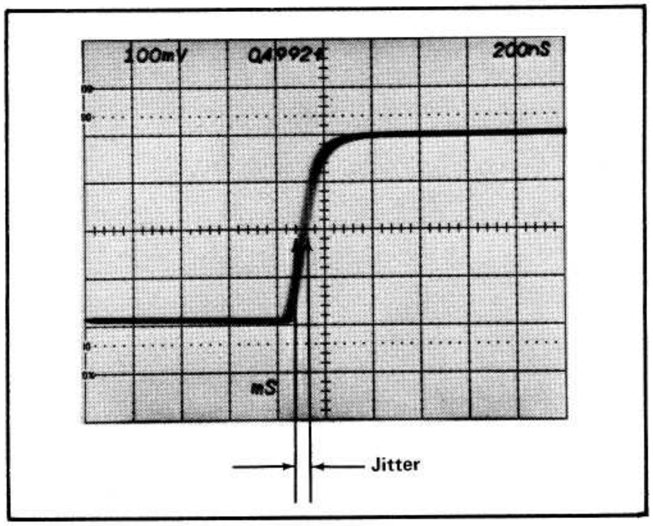


Fig. 1-9. Measuring pulse jitter.

SPECIFICATION

Introduction

The electrical characteristics listed in Table 2-1 are valid over the stated environmental range for instruments calibrated at an ambient temperature of +20°C to +30°C, and after a 20-minute warmup unless otherwise stated.

TABLE 2-1
ELECTRICAL

TIME DELAY

Digital Delay—Selected by front-panel DELAY TIME OR EVENTS control. Range is 100 nanoseconds to one second in 100-nanosecond increments in Normal mode; 200 nanoseconds to two seconds in 200-nanosecond increments in Echo mode. Normal/Echo modes are selected by internal Mode switch.

Analog Delay—Selected by front-panel FINE DELAY (ns) control. Range is continuously variable from zero to at least 100 nanoseconds; accuracy is within two nanoseconds of indicated delay time; resolution is one nanosecond or less.

Jitter with Internal Clock—2.2 nanoseconds or (delay time X 10^{-7}), whichever is greater.

Insertion Delay in Normal Mode—Zero within two nanoseconds.

Insertion Delay in Echo Mode—Less than 160 nanoseconds, adjustable to 200 nanoseconds within four nanoseconds with FINE DELAY dial.

Recycle Time—Not greater than 575 nanoseconds.

Time Base—500-megahertz oscillator, phase locked to internal or external clock, as selected by COUNT MODE switch. Internal clock (TIME INT CLOCK) is a five-megahertz crystal oscillator. Accuracy is within 0.5 part per million from 0°C to +50°C; long-term drift is one part or less in 10^7 per month.

External clock (TIME EXT 1 MHz) requires a one-megahertz signal applied to EXT 1 MHz IN connector. Input requirements are: Frequency, one megahertz within 1% to insure phase lock of 500-megahertz oscillator; amplitude, at least 400 millivolts RMS sinewave or pulse with 10% to 90% duty cycle. AC input coupling. Input impedance is 50 ohms ±2%. Maximum input voltage is 5 volts RMS (DC + peak AC must not exceed 500 volts).

TRIGGERING

Source—Selected by front-panel SOURCE switch.

INT—Internal from associated vertical unit (7D11 installed in horizontal compartment).

LINE—Internal from power source (AC).

TRIGGERING (cont)

EXT—External from front-panel EXT TRIG IN connector.

EXT ÷ 10—External divide by ten (10X input signal attenuation).

Coupling—Selected by front-panel COUPLING switch.

AC—Capacitive coupling.

AC LF REJ—Capacitive coupling, low-frequency reject.

AC HF REJ—Capacitive coupling, high-frequency reject.

DC—Direct coupling.

Polarity—Selected by front-panel TRIGGER LEVEL/SLOPE control. Time delay can be triggered from positive-going or negative-going portion of trigger signal.

Internal Trigger Sensitivity[1]

AC—0.3 division of deflection, minimum, 30 hertz to 10 megahertz; increasing to 1.0 division at 50 megahertz.

AC LF REJ—0.3 division of deflection, minimum, 30 kilohertz to 10 megahertz; increasing to 1.0 division at 50 megahertz. Will not trigger on sinewaves of three divisions or less below 120 hertz.

AC HF REJ—0.3 division of deflection, minimum, 30 hertz to 50 kilohertz.

DC—0.3 division of deflection, minimum, DC to 10 megahertz; increasing to 1.0 division at 50 megahertz.

Slope—0.5 volt/nanosecond or greater for specified jitter and accuracy; slower risetime signals will trigger the instrument with reduced accuracy and increased jitter.

External Trigger Sensitivity (SOURCE switch set to EXT; triggering signal requirements increased 10 times for EXT ÷ 10 position).

AC—150 millivolts, minimum, 30 hertz to 10 megahertz; increasing to 500 millivolts at 50 megahertz.

AC LF REJ—150 millivolts, minimum, 150 kilohertz to 10 megahertz; increasing to 500 millivolts at 50 megahertz.

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

TABLE 2-1 (cont)

TRIGGERING (cont)

AC HF REJ—150 millivolts, minimum, 30 hertz to 50 kilohertz.

DC—150 millivolts, minimum, DC to 10 megahertz; increasing to 500 millivolts at 50 megahertz.

External Trigger Input

Maximum Input Voltage—500 volts (DC + peak AC), 500 volts peak-to-peak AC at 1 kHz or less.

Input Resistance—One megohm within 2%.

Input Capacitance—20 picofarads within two picofarads.

LEVEL Range—At least +1.75 volts to −1.75 volts in EXT, at least +17.5 volts to −17.5 volts in EXT ÷ 10.

EVENTS DELAY

Delay Range—One to 10^7 events.

Delay Increment—One event.

Insertion Delay—35 nanoseconds ± five nanoseconds.

Recycle Time—500 nanoseconds or less.

Maximum Events Frequency—50 megahertz or greater.

Events Start Triggering

Source—External only from EVENTS START TRIG IN connector.

Coupling—DC.

Maximum Input Voltage—150 volts (DC + peak AC).

Sensitivity—40 millivolts, minimum, 30 hertz to four megahertz; increasing to 100 millivolts, four megahertz to 20 megahertz; increasing to 250 millivolts, 20 megahertz to 50 megahertz.

Input Resistance—Approximately one megohm

EVENTS DELAY (cont)

Input Capacitance—Approximately 20 picofarads

LEVEL Range—At least + three volts to − three volts.

OUTPUT SIGNALS

Delayed Trigger—Positive-going, rectangular pulse available at front-panel DLY'D TRIG OUT connector.

Amplitude—Two volts or greater into open circuit; one volt or greater into 50-ohm load.

Risetime with 50-Ohm Load—Two nanoseconds or less.

Falltime with 50-Ohm Load—Five nanoseconds or less.

Pulse Width—200 to 250 nanoseconds.

Delay Interval—Positive-going, rectangular waveform available at front-panel DLY INTERVAL OUT connector.

Amplitude—Two volts or greater into open circuit; one volt or greater into 50-ohm load.

Rise and Falltime with 50-Ohm Load—Five nanoseconds or less.

Accuracy—Delay interval pulse width is equal to the generated Events Delay within 30 nanoseconds and equal to the generated Time Delay less 20 to 30 nanoseconds.

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 two nanoseconds.

Pedestal Display—CRT analog display of the delay interval, available when 7D11 is used in vertical compartment. (Pedestal Display pulse ends coincident with Delayed Trigger start.)

De-Intensified Display—Signal to dim CRT display during delay interval. (De-Intensified Display selected by internal switch.)

TABLE 2-2

ENVIRONMENTAL CHARACTERISTICS

Refer to the Specification for the associated oscilloscope.

TABLE 2-3

PHYSICAL

Size	Fits all 7000-series plug-in compartments.
Weight	2 Pounds 11 Ounces (1219 grams)