TEKTRONIX®

7B80 TIME BASE WITH OPTIONS

OPERATORS

INSTRUCTION MANUAL

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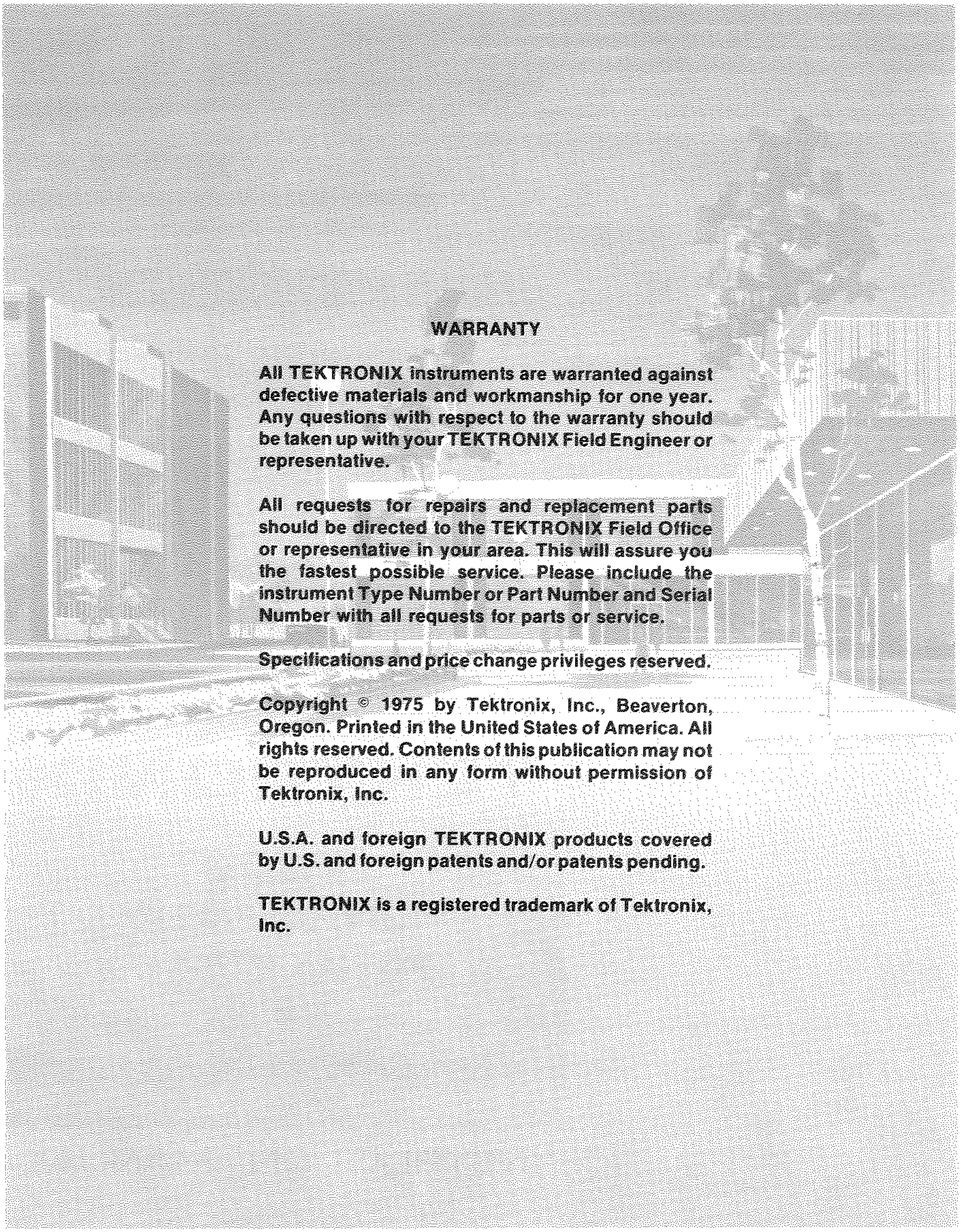

WARRANTY

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

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

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SAFETY SUMMARY

This manual contains safety information which the user must follow 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.

WARNING

Ground the Instrument

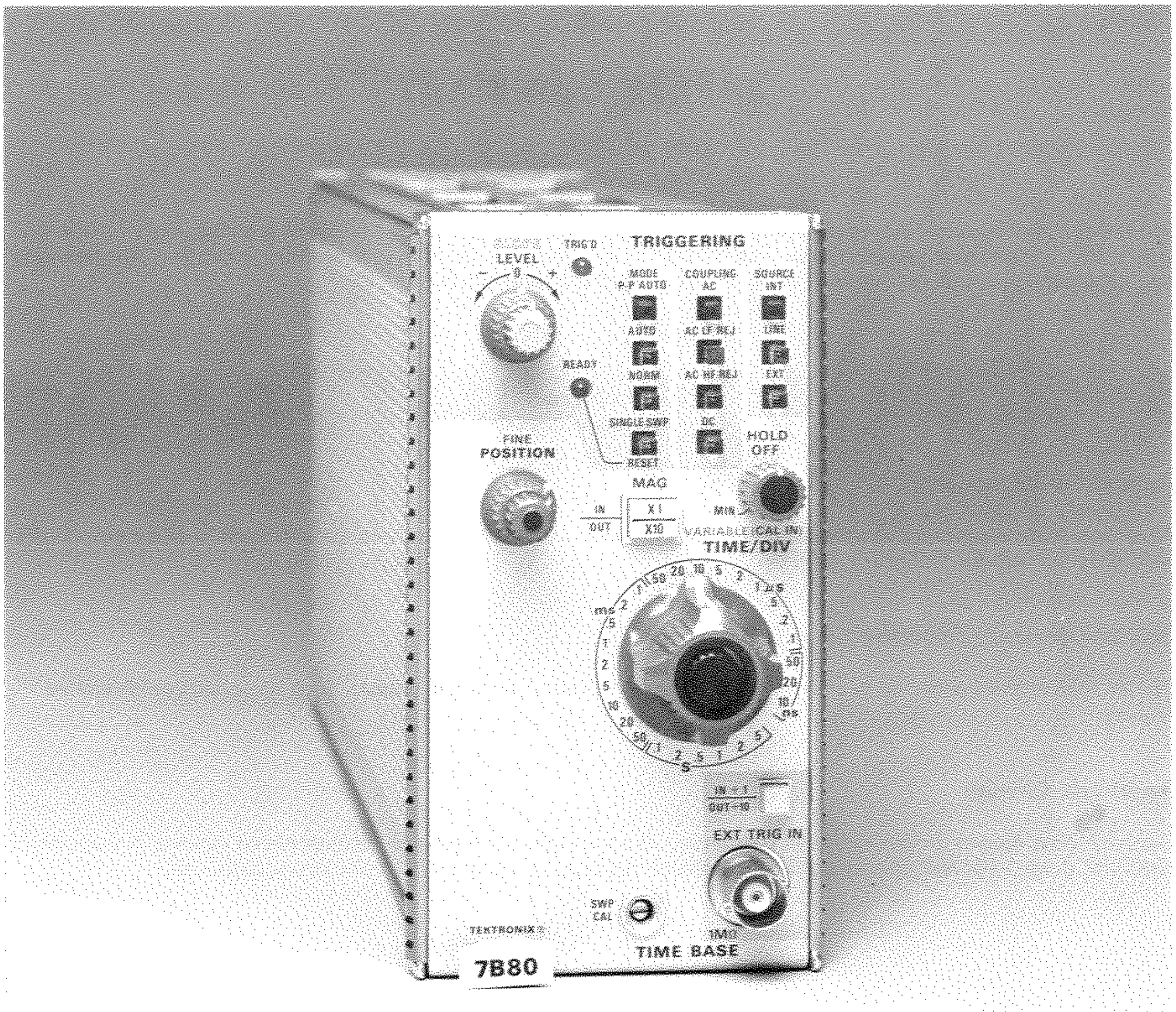
To reduce electrical-shock hazard, the mainframe (oscilloscope) chassis must be properly grounded. Refer to the mainframe manual for grounding information.

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.



7B80 Features

The 7B80 Time-Base unit provides calibrated sweep rates from 5 seconds to 10 nanoseconds and triggering to 400 megahertz for 7700-, 7800-, and 7900-series oscilloscopes. A X10 Magnifier increases each sweep rate by a factor of 10 and a VARIABLE TIME/DIV control provides continuously variable sweep rates between calibrated steps. Variable hold off and alphanumeric readout are provided. Also, when operating in the AUTO TRIGGERING MODE, a bright baseline trace is displayed in the absence of a trigger signal. The 7B80 can be operated as an independent time base or as a delayed-sweep unit with a companion delaying time-base unit.

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OPERATING INSTRUCTIONS

The 7B80 Time-Base unit operates with a Tektronix 7700-, 7800-, and 7900-series oscilloscope mainframes and a 7A-series amplifier unit to form a complete oscilloscope system. This section describes the operation of the front-panel controls and connectors, provides general operating information, a functional check procedure, and basic applications for this instrument.

INSTALLATION

The time-base unit is designed to operate in the horizontal plug-in compartment of the mainframe. This instrument can also be installed in a vertical plug-in compartment to provide a vertical sweep on the crt. However, when used in this manner, there are no internal triggering or retrace blanking provisions, and the unit may not meet the specifications given in Section 2.

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

To remove the unit, pull the release latch (see Figure 1-1) to disengage the unit from the mainframe, and pull it out of the plug-in compartment.

CONTROLS, CONNECTORS, AND INDICATORS

All controls, connectors, and indicators required for the operation of the time-base unit are located on the front panel. Figure 1-2 shows and provides a brief description of all front-panel controls, connectors, and indicators. More detailed information is given in the General Operating Instructions.

FUNCTIONAL CHECK

The following procedures are provided for checking basic instrument functions. Refer to the description of the controls, connectors, and indicators while performing this procedure. If performing the functional check procedure reveals a malfunction or possible improper adjustment, first check the operation of the associated plug-in units, then refer to the instruction manual for maintenance and adjustment procedures.

Setup Procedure

1. Install the time-base unit being checked in the A horizontal compartment of the mainframe.

2. Install an amplifier plug-in unit in a vertical compartment.

3. Set the time-base unit controls as follows:

SLOPE	(+)
MODE	P-P AUTO
COUPLING	AC
SOURCE	INT
POSITION	Midrange
TIME/DIV	1 ms
VARIABLE (CAL IN)	Calibrated (Pushed in)
HOLD OFF	MIN (fully counter-clockwise)
MAG	X1 (pushed in)

4. Turn on the mainframe and allow at least 20 minutes warmup.

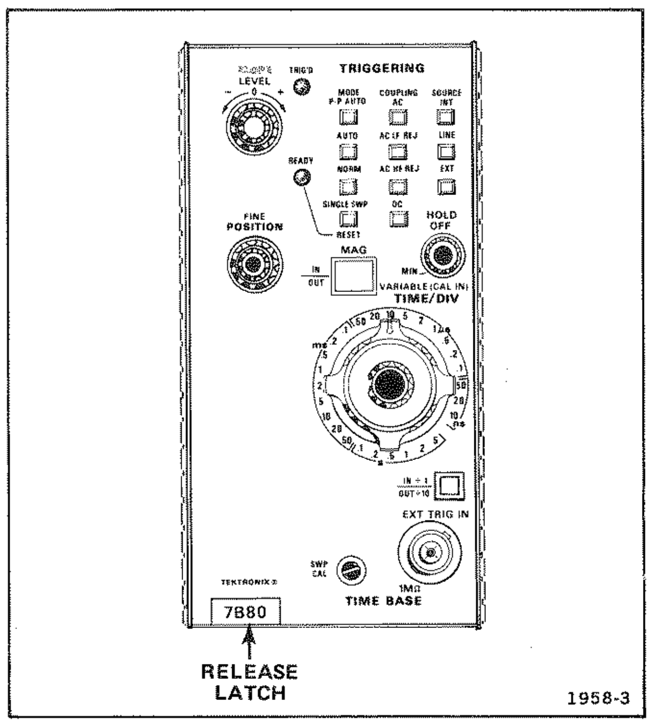

Fig. 1-1. Location of release latch.

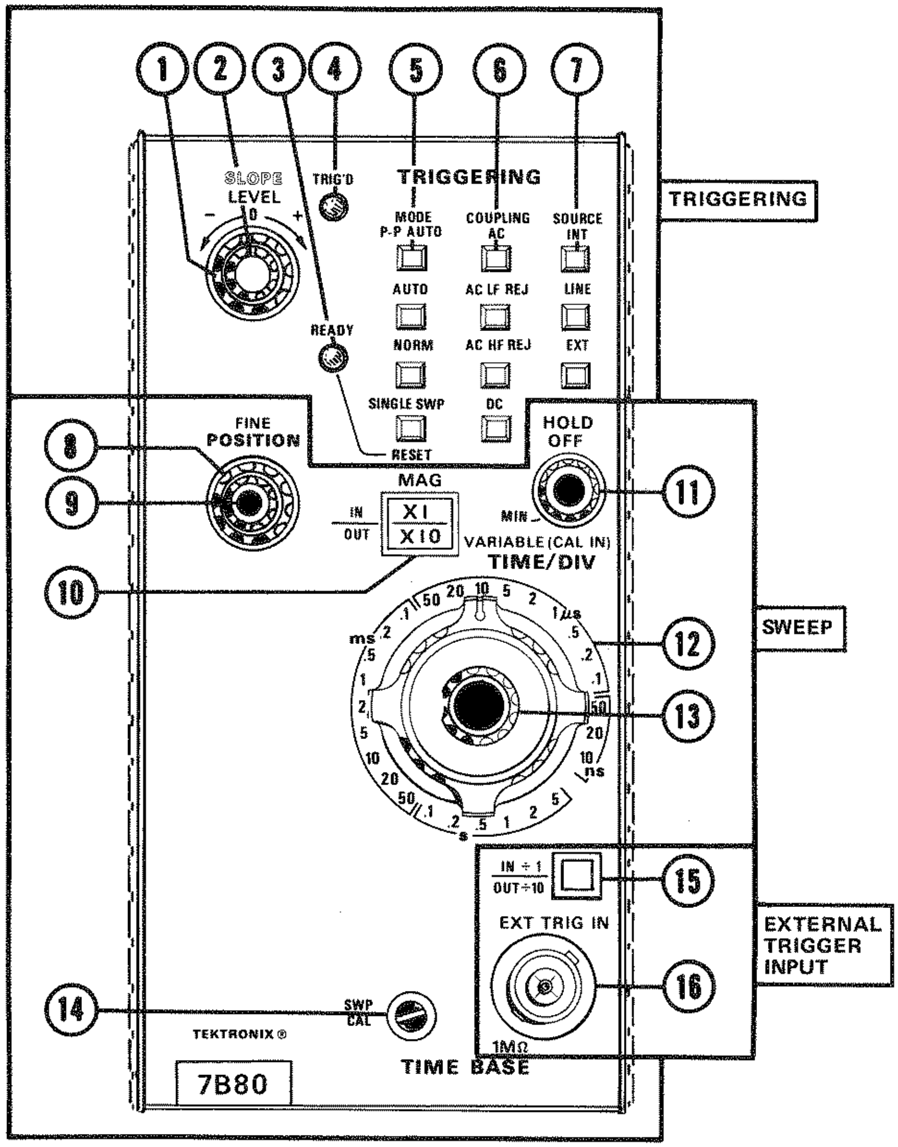

Fig. 1-2. Front-panel controls, connectors, and indicators.

TRIGGERING

(1) LEVEL Control—Selects a point on the trigger signal where triggering occurs.

(2) SLOPE Switch—Permits sweep to be triggered on negative or positive-going portions of the trigger signal.

(3) READY Indicator—Illuminates when sweep circuit is armed (SINGLE SWEEP Mode).

(4) TRIG'D Indicator—Illuminates when the display is triggered.

(5) MODE Pushbuttons—Selects the operating mode of the triggering circuit.

(6) COUPLING Pushbuttons—Selects the method of coupling the trigger signal to triggering circuit.

(7) SOURCE Pushbuttons—Selects source of the trigger signal.

SWEEP

(8) POSITION Control—Provides horizontal positioning.

(9) FINE Control—Provides precise horizontal positioning.

(10) MAG Pushbutton—Selects magnified X10 or unmagnified sweep.

(11) HOLD OFF Control—Permits hold off period to be varied to improve trigger stability on repetitive complex waveforms.

(12) TIME/DIV Selector—Selects the sweep rate of the sweep generator.

(13) VARIABLE Control and CAL Switch—Selects calibrated or uncalibrated sweep rates. Uncalibrated sweep rates can be continuously reduced to at least the sweep rate of the next slower position.

(14) SWP CAL Adjustment—Compensates for basic timing changes due to the differences in sensitivity of mainframes

EXTERNAL TRIGGER INPUT

(15) EXT TRIG ATTENUATOR—Selects attenuation factor for external trigger signals.

(16) EXT TRIG IN Connector—Connector (BNC type) provides input for external trigger signals.

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Fig. 1-2. Front-panel controls, connectors, and indicators (cont.).

5. Set the mainframe vertical and horizontal modes to display the plug-in units used and adjust the intensity and focus for a well-defined display. See the oscilloscope mainframe and amplifier unit instruction manuals for detailed operating instructions.

Sweep Functions

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

1. Perform the preceding Setup Procedure.

2. Connect a 0.4-volt, 1-kilohertz signal from the mainframe calibrator to the amplifier unit input.

3. Set the amplifier unit deflection factor for 4 divisions of display.

4. Adjust the LEVEL control for a stable display.

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

6. Turn the FINE control and note that the display can be precisely positioned horizontally.

7. Check the display for one complete cycle per division. If necessary, adjust the front-panel SWP CAL screwdriver adjustment for one complete cycle per division over the center 8 graticule divisions. Be sure that the timing of the mainframe calibrator signal is accurate to within 0.25% (+20 to +30° C).

8. Press to release the VARIABLE (CAL IN) control. Turn the VARIABLE (CAL IN) control fully counterclockwise and note that the displayed sweep rate changes to at least the next slower TIME/DIV switch setting (i.e., 2 milliseconds/division). Press the VARIABLE (CAL IN) knob in to the calibrated position.

MAGNIFIED SWEEP. Perform the following procedure to obtain a X10 magnified display and to demonstrate the function of the related controls:

1. Obtain a one cycle per division display as described in the preceding Normal Sweep procedure.

2. Press to release the MAG button (X10). Note that the unmagnified display within the center division of the graticule is magnified to about 10 divisions.

3. Press the MAG button (X1).

Triggering Functions

Perform the following procedure to obtain a triggered sweep and to demonstrate the functions of the related controls:

1. Obtain a display as described in the preceding Normal Sweep procedure.

2. Press the AUTO MODE button and turn the LEVEL control fully counterclockwise to obtain a free-running sweep.

3. Slowly turn the HOLD OFF control clockwise and note that a stable display can be obtained at several positions of the HOLD OFF control. Return the HOLD OFF control to the fully counterclockwise (MIN) position.

NOTE

The HOLD OFF control varies the sweep hold-off time which effectively changes the repetition-rate of the horizontal sweep signal. However, its primary function is to obtain a stable display of complex waveforms which are otherwise difficult to trigger.

4. Press the AC, AC HF REJ, and DC COUPLING buttons for both the + and – positions of the SLOPE switch and check for a stable display (LEVEL control may be adjusted, if necessary, to obtain a stable display).

5. Apply the 0.4-volt, 1 kilohertz signal from the mainframe calibrator to the amplifier unit and to the EXT TRIG IN connector.

6. Press the EXT SOURCE button and set the amplifier unit deflection factor for a 4-division display.

7. Press the AC, AC HF REJ, and DC COUPLING buttons for both the + and – positions of the SLOPE switch and check for a stable display (LEVEL control may be adjusted, if necessary, for a stable display).

8. Press the AC COUPLING, INT SOURCE, and NORM MODE buttons. Adjust the LEVEL control for a stable display.

9. Press the AUTO MODE button and adjust the LEVEL control for a free-running display.

10. Press the NORM MODE button and check for no display.

11. Adjust the LEVEL control for a stable display and press the SINGLE SWP MODE button.

12. Note that one trace occurs when the RESET MODE button is pressed.

13. Disconnect the mainframe calibrator signal from the amplifier unit input and press the RESET MODE button. Check for no display and note that the READY indicator is lit.

14. Note that one trace occurs and that the READY indicator extinguishes when the mainframe calibrator signal is reconnected to the amplifier unit input.

GENERAL OPERATING INFORMATION

Triggering Switch Logic

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

Triggering Modes

The MODE push-button switches select the mode in which the sweep is triggered.

P-P AUTO. The P-P AUTO MODE provides a triggered display at any setting of the LEVEL control whenever an adequate trigger signal is applied. The range of the LEVEL control in the P-P AUTO MODE is between approximately 10% and 90% of the peak-to-peak amplitude of the trigger signal. The LEVEL control can be set so that the displayed waveform starts at any point within this range on either slope. The trigger circuits automatically compensate for a change in trigger-signal amplitude. Therefore, if the LEVEL control is set to start the waveform display at a certain percentage point on the leading edge of a low-amplitude signal, it triggers at the same percentage point on the leading edge of a high-amplitude signal if the LEVEL control is not changed. When the trigger repetition rate is outside the parameter given in the Specification section, or when the trigger signal is inadequate, the sweep free runs at the rate indicated by the TIME/DIV switch to produce a bright base-line reference trace (TRIG'D light off). When an adequate trigger signal is again applied, the free-running condition ends and a triggered display is presented.

The P-P AUTO MODE is particularly useful when observing a series of waveforms, since it is not necessary to reset the LEVEL control for each observation. The P-P AUTO MODE is used for most applications because of the ease of obtaining a triggered display. The AUTO, NORM, and SINGLE-SWP MODE settings may be used for special applications.

AUTO. The AUTO MODE provides a triggered display with the correct setting of the LEVEL control whenever an adequate trigger signal is applied (see Trigger Level discussions). The TRIG'D light indicates when the display is triggered.

When the trigger repetition rate is outside the frequency range selected by the COUPLING switch or the trigger signal is inadequate, the sweep free runs at the rate indicated by the TIME/DIV switch (TRIG'D indicator off). An adequate trigger signal ends the free-running condition and a triggered display is presented. The sweep also free runs at the rate indicated by the TIME/DIV switch when the LEVEL control is at a setting outside the amplitude range of the trigger signal. This type of free-running display is useful when it is desired to measure only the peak-to-peak amplitude of a signal without observing the waveshape (such as bandwidth measurements).

NORMAL. The NORM MODE provides a triggered display with the correct setting of the LEVEL control whenever an adequate trigger signal is applied. The TRIG'D light indicates when the display is triggered.

The normal trigger mode must be used to produce triggered displays with trigger repetition rates below about 30 hertz. When the TRIG'D light is off, no trace is displayed.

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

To obtain a single-sweep display of a repetitive signal, first obtain the best possible display in the NORM MODE. Then, without changing the other TRIGGERING controls, press the SINGLE SWP RESET button. A single trace is presented each time this button is pressed. Further sweeps cannot be presented until the SINGLE SWP RESET button is pressed again. If the displayed signal is a complex waveform composed of varying amplitude pulses, successive single-sweep displays may not start at the same point on the waveform. To avoid confusion due to the crt persistence, allow the display to disappear before pressing the SINGLE SWP RESET button again. At fast sweep rates, it may be difficult to view the single-sweep display. The apparent trace intensity can be increased by reducing the ambient light level or by using a viewing hood as recommended in the mainframe instruction manual.

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

Trigger Coupling

The TRIGGERING COUPLING push buttons select the method in which the trigger signal is connected to the trigger circuits. Each position permits selection or rejection of some frequency components of the signal which triggers the sweep.

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

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

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

DC. DC COUPLING can be used to provide stable triggering from low-frequency signals which would be attenuated in the other COUPLING switch positions. DC COUPLING can be used to trigger the sweep when the trigger signal reaches a dc level set by the LEVEL control. When using internal triggering, the setting of the vertical unit position control affects the triggering point.

Trigger Source

The TRIGGERING SOURCE push buttons select the source of the trigger signal which is connected to the trigger circuits.

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

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

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

The ÷10 push button attenuates the external trigger signal by a factor of 10. Attenuation of high amplitude external trigger signals is desirable to increase the effective range of the LEVEL control.

Trigger Slope

The TRIGGERING SLOPE switch (concentric with the TRIGGERING LEVEL control) determines whether the trigger circuit responds on the positive- or negative-going portion of the trigger signal. When the SLOPE switch is in the (+) (positive-going) position, the display starts on the positive-going portion of the waveform (see Figure 1-3). When several cycles of a signal appear in the display, the setting of the SLOPE switch is often unimportant. However, if only a certain portion of a cycle is to be displayed, correct setting of the SLOPE switch is important to provide a display that starts on the desired slope of the input signal.

Trigger Level

The TRIGGERING LEVEL control determines the voltage level on the trigger signal at which the sweep is triggered. When the LEVEL control is set in the + region, the trigger circuit responds at a more positive point on the trigger signal. When the LEVEL control is set in the – region, the trigger circuit responds at a more negative point on the trigger signal. Figure 1-3 illustrates this effect with different settings of the SLOPE switch.

To set the LEVEL control, first select the TRIGGERING MODE, COUPLING, SOURCE, and SLOPE. Then set the LEVEL control fully counterclockwise and rotate it clockwise until the display starts at the desired point.

Horizontal Sweep Rates

The TIME/DIV switch provides calibrated sweep rates from 5 seconds/division to 10 nanoseconds/division in a 1-2-5 sequence. The VARIABLE TIME/DIV control must be in the calibrated position and the MAG switch set to X1 to obtain the sweep rate indicated by the TIME/DIV switch. However, the mainframe crt readout will display the appropriate sweep rate.

The VARIABLE TIME/DIV control includes a two-position switch to determine if the sweep rate is calibrated, or uncalibrated. When the VARIABLE control is pressed in, it is inoperative and the sweep rate is calibrated. When pressed and released outward, the VARIABLE control is activated for uncalibrated sweep rates, to at least the sweep rate of the next slower position.

A calibrated sweep rate can be obtained in any position of the VARIABLE control by pressing in the VARIABLE control. This feature is particularly useful when a specific uncalibrated sweep rate has been obtained and it is desired to switch between calibrated and uncalibrated displays.

Time Measurement

When making time measurements from the graticule, the area between the second and tenth vertical lines of the graticule provides the most linear time measurements (see Figure 1-4). Position the start of the timing area to the second vertical line and adjust the TIME/DIV switch so the end of the timing area falls between the second and tenth vertical lines.

Sweep Magnification

The sweep magnifier can be used to expand the display by a factor of 10. The center division of the unmagnified display is the portion visible on the crt in the magnified form (see Figure 1-5). The equivalent length of the magnified sweep is more than 100 divisions; any 10 division portion can be viewed by adjusting the POSITION and FINE POSITION controls to bring the desired portion into the viewing area. When the MAG switch is set to X10 (OUT) the equivalent magnified sweep rate can be determined by dividing the TIME/DIV setting by 10; the equivalent magnified sweep rate is displayed on the crt readout.

Variable Hold Off

The HOLD OFF control improves triggering stability on repetitive complex waveforms by effectively changing the repetition rate of the horizontal sweep signal. The HOLD OFF control should normally be set to its minimum setting. When a stable display cannot be obtained with the TRIGGERING LEVEL control, the HOLD OFF control can be varied for an improved display. If a stable display cannot be obtained at any setting of the LEVEL and HOLD OFF controls, check the TRIGGERING COUPLING and SOURCE switch settings.

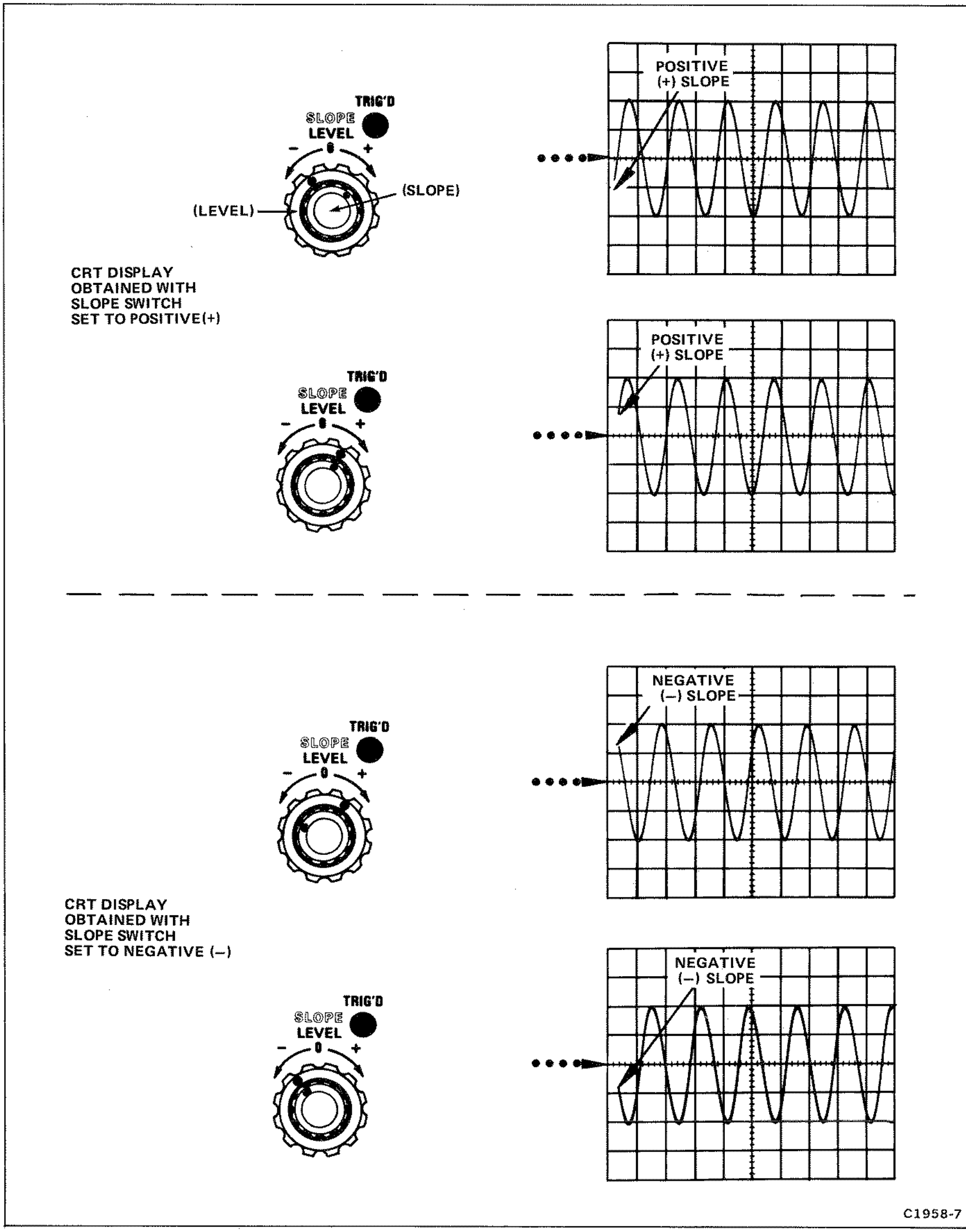

Fig. 1-3. Effect of LEVEL control and SLOPE switch on crt display.

Mainframe Operating Modes

The time-base unit can be operated either as an independent time base in any Tektronix 7700-, 7800-, or 7900-series oscilloscope mainframe, or as a delayed-sweep unit in those mainframes that have two horizontal compartments. A companion delaying time-base unit is required for delayed-sweep operation. Refer to the delaying time-base unit instruction manual for additional information.

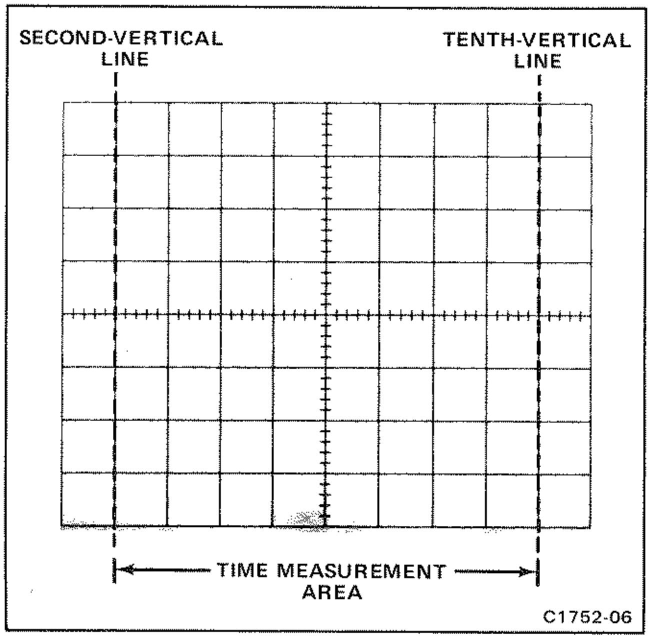

Fig. 1-4. Area of graticule used for most accurate time measurements.

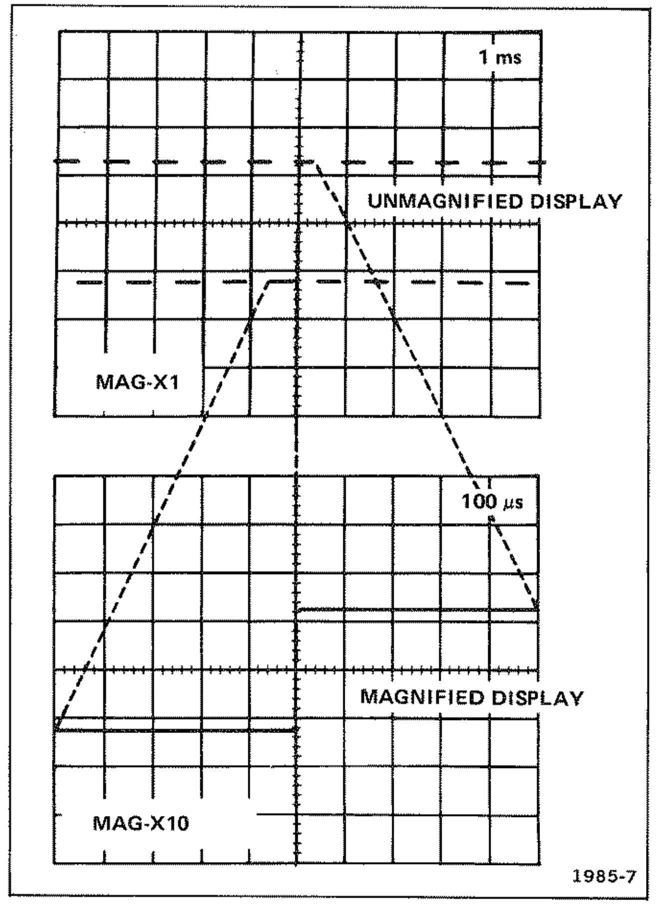

Fig. 1-5. Operation of sweep magnifier.

REPACKAGING FOR SHIPMENT

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

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument, on all sides. Seal carton with shipping tape or industrial stapler.

The carton test strength for your instrument is 200 pounds.

APPLICATIONS

The following information describes procedures and techniques for making basic time measurements with the time-base unit installed in a Tektronix 7700-, 7800-, or 7900-series oscilloscope. These procedures provide enough detail to enable the operator to adapt them to other related time measurements. Contact your Tektronix Field Office or representative for assistance in making measurements that are not described in this manual.

TIME-INTERVAL MEASUREMENTS

Since time is a function of the sweep rate and the horizontal distance (in divisions) that the sweep travels across the graticule in a calibrated-sweep oscilloscope system, the time interval between any two points on a waveform can be accurately measured. The following procedures provide methods to measure some of the more common time-related definable characteristics of a waveform such as period, frequency, rise time, fall time, and pulse width. The procedure for each of these measurements is essentially the same, except for the points between which the measurements are made. The time interval between any two selected points on a displayed waveform can be measured with basically the same technique.

Period and Frequency Measurements

Perform the following procedure to measure the period and determine the frequency of a displayed waveform:

1. Install the time-base unit in a mainframe horizontal compartment (either A or B horizontal in a four-compartment mainframe).

2. Connect the signal to be measured to the vertical unit input.

3. Set the mainframe horizontal- and vertical-mode switches to display the time base and vertical units. (Check that the time base VARIABLE (CAL IN) control is pushed in and the HOLD OFF control is in the MIN position.)

4. Set the TRIGGERING switches and LEVEL control for a stable display (see General Operating Information for selecting proper triggering).

5. Set the vertical deflection factor and position control for about a 5-division display, vertically centered on the graticule.

6. Set the TIME/DIV switch and POSITION control for 1 complete cycle displayed within the center 8 graticule divisions as shown in Figure 1-6.

7. Measure the horizontal distance in divisions over 1 complete cycle of the displayed waveform (see Figure 1-6).

8. Multiply the horizontal distance measured in Step 7 by the TIME/DIV switch setting. (Divide the answer by 10 if sweep magnification is used.)

Example: Assume that the horizontal distance over 1 complete cycle is 7 divisions, and the TIME/DIV switch setting is .1 ms (see Figure 1-6).

Using the formula:

$$\text{Period} = \frac{\text{Horizontal distance X TIME/DIV setting}}{\text{Magnification}}$$

Substituting values:

$$\text{Period} = \frac{7 \text{ X } 0.1 \text{ ms}}{1} = 0.7 \text{ millisecond}$$

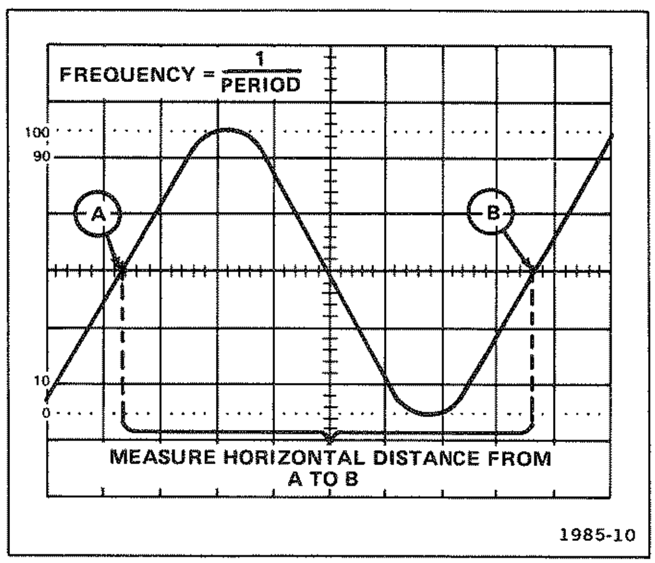

Fig. 1-6. Measuring the period and determining the frequency of a displayed waveform.

9. Determine the frequency of the displayed waveform obtained in steps 1 through 8 by taking the reciprocal of the period of 1 cycle.

Example: Assume that the period of the displayed waveform is 0.7 millisecond.

Using the formula:

$$\text{Frequency} = \frac{1}{\text{Period}}$$

Substituting values:

$$\text{Frequency} = \frac{1}{0.7\text{ ms}} = 1.43 \text{ kilohertz}$$

Rise-Time and Fall-Time Measurements

Perform the following procedure to measure the rise time and fall time of a displayed waveform:

1. Install the time-base unit in a mainframe horizontal compartment (either A or B horizontal in a four-compartment mainframe).

2. Connect the signal to be measured to the vertical unit input.

3. Set the mainframe horizontal- and vertical-mode switches to display the time base and the vertical unit. (Check that the time base VARIABLE (CAL IN) control is pushed in and the HOLD OFF control is in the MIN position.)

4. Set the TRIGGERING switches and LEVEL control for a stable display (see General Operating Information for selecting proper triggering).

5. Set the vertical deflection factor and position control for a vertically-centered display with an exact number of divisions of amplitude.

6. Set the TIME/DIV switch and POSITION control to display the rising or falling portion of the waveform within the center 8 graticule divisions as shown in Figure 1-7 (see General Operating Information in this section for discussion of timing measurement accuracy).

7. Determine rise time or fall time by measuring the horizontal distance in divisions between the point on the rising or falling portion of the waveform that is 10% and the point that is 90% of the total display amplitude (see Figure 1-7).

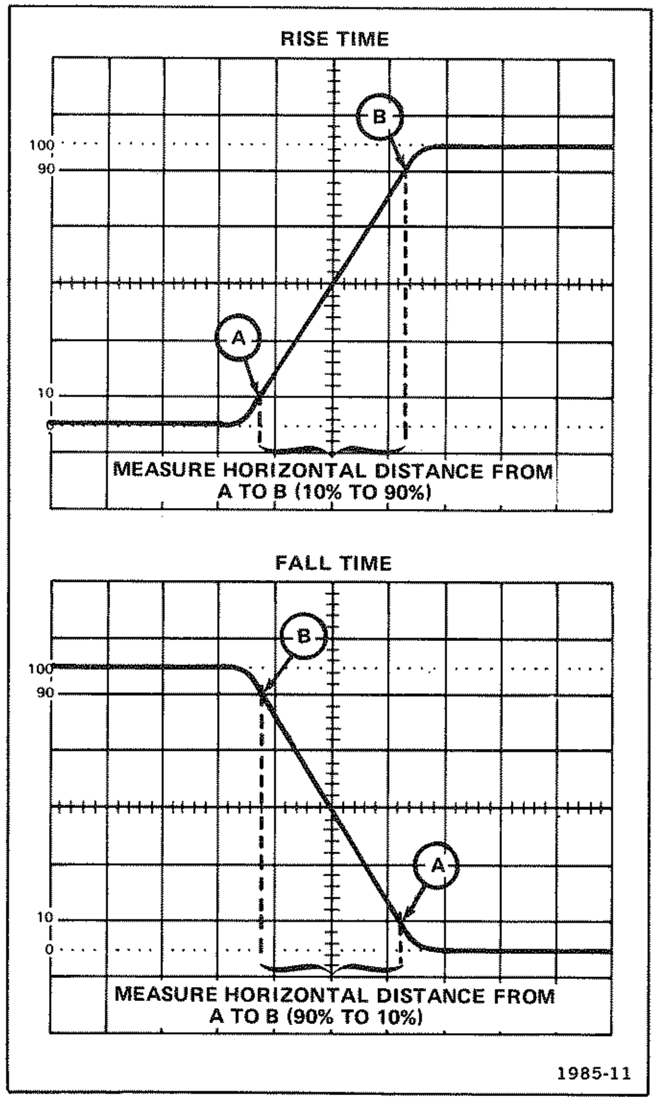

Fig. 1-7. Measuring the rise time and fall time of a displayed waveform.

NOTE

The left edge of the oscilloscope graticule is scribed with 0, 10, 90, and 100% lines for convenience when measuring rise time or fall time. To use this feature, adjust the vertical deflection factor and position control to fit the display between the 0 and 100% graticule lines. Then measure the horizontal distance between the points where the waveform crosses the 10% and 90% graticule lines.

8. Multiply the horizontal distance measured in step 7 by the TIME/DIV switch setting. (Divide the answer by 10 if sweep magnification is used.)

Example: Assume that the horizontal distance from the 10 to 90% points is 2.5 divisions and the TIME/DIV switch setting is .1 μs (see Figure 1-7).

Using the formula:

$$\text{Rise Time} = \frac{\text{Horizontal distance (divisions)} \times \text{TIME/DIV setting}}{\text{Magnification}}$$

Substituting values:

$$\text{Rise Time} = \frac{2.5 \times 0.1\ \mu s}{1} = 0.25 \text{ microsecond}$$

Pulse Width Measurements

Perform the following procedure to measure the pulse width of a displayed waveform:

1. Install the time-base unit in a mainframe horizontal compartment (either A or B horizontal in a four-compartment mainframe).

2. Connect the signal to be measured to the vertical unit input.

3. Set the mainframe horizontal- and vertical-mode switches to display the time base and vertical unit. (Check that the time base VARIABLE (CAL IN) control is pushed in and the HOLD OFF control is in the MIN position.)

4. Set the TRIGGERING switches and LEVEL control for a stable display (see General Operating Information for selecting proper triggering).

5. Set the vertical deflection factor and position control for about a 5-division pulse vertically centered on the graticule.

6. Set the TIME/DIV switch and POSITION control for 1 complete pulse displayed within the center 8 graticule divisions as shown in Figure 1-8.

7. Measure the horizontal distance in divisions between the 50% amplitude points of the displayed pulse (see Figure 1-8).

8. Multiply the horizonal distance measured in step 7 by the TIME/DIV switch setting. (Divide the answer by 10 if sweep magnification is used.)

Example: Assume that the horizontal distance between the 50% amplitude points is 3 divisions, and the TIME/DIV switch setting is .1 ms (see Figure 1-8).

Using the formula:

$$\text{Pulse Width} = \frac{\text{Horizontal distance} \times \text{TIME/DIV setting}}{\text{Magnification}}$$

Substituting values:

$$\text{Pulse Width} = \frac{3 \times 0.1 \text{ ms}}{1} = 0.3 \text{ millisecond}$$

DELAYED-SWEEP MEASUREMENTS

The time-base unit may be used with a delaying time-base unit in a mainframe with two horizontal compartments to make delayed-sweep measurements. See the Tektronix Products Catalog for compatible delaying time-base plug-in units. If a compatible delaying time-base unit is available, refer to the instruction manual for that unit for detailed delayed-sweep measurement procedures.

X-Y PHASE MEASUREMENTS

The phase difference between two signals with the same frequency can be measured with a 7B80 Option 2 and amplifier plug-in units. Refer to the Instrument Options section of this manual for detailed procedures.

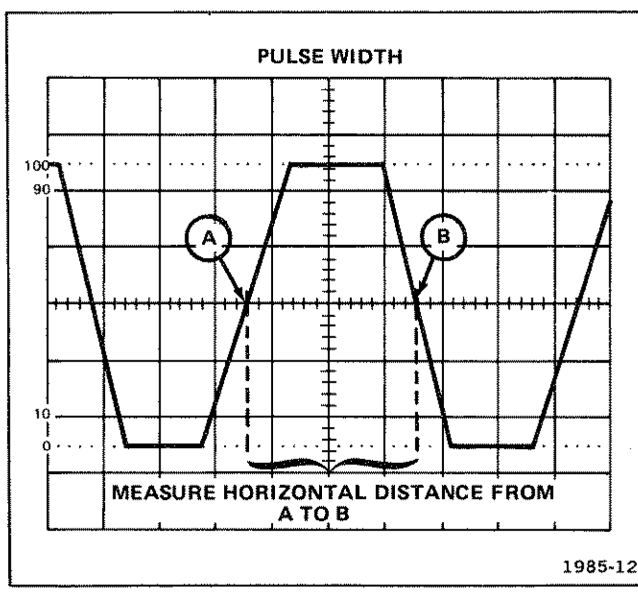

Fig. 1-8. Measuring the pulse width of a displayed waveform.

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SPECIFICATION

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

TABLE 2-1
Electrical Characteristics

Characteristic	Performance Requirement			
SWEEP GENERATOR				
Sweep Rates				
Calibrated Range	5 s/div to 10 ns/div in 27 steps. X10 Magnifier extends fastest calibrated sweep rate to 1 ns/div.			
Variable Range	Continuously variable uncalibrated sweep rate to at least 2.5 times the calibrated sweep rate setting.			
Sweep Accuracy[1] (With 7700, 7800, or 7900-Series Mainframes)	With SWP CAL adjusted at 1 ms/div within the temperature range of +20° to +30° C to a timing reference of 0.25% or better.			
Over Center 8 Div	+15° to +35° C		0° to +50° C	
	Unmag	Mag	Unmag	Mag
5 s/Div to 1 s/Div	4.0%	5.0%	5.0%	6.0%
0.5 s/Div to 0.1 μs/Div	1.5%	2.5%	2.5%	3.5%
50 ns/Div to 10 ns/Div	2.5%	4.0%	3.5%	5.0%
Excluded Portions of Sweep				
Start of Sweep	First 10 ns in 7800, 7900-series mainframes. First 20 ns in 7700-series mainframes. First 50 ns in all other 7000-series mainframes.			
End of Sweep	Beyond 10th div unmagnified. Beyond 100th div magnified.			
Sweep Length (Unmagnified)	At least 10.2 div at all sweep rates.			
MAG Registration	0.5 div or less from graticule center when changing from MAG X10 to MAG X1.			
Position Range				
POSITION Controls Fully Clockwise	Start of sweep must be to the right of graticule center at 1 ms/div.			
POSITION Controls Fully Counterclockwise	End of sweep must be to the left of graticule center at 1 ms/div.			

[1] The fastest calibrated sweep rate is limited by some mainframes.

TABLE 2-1 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
Trigger Holdoff Time	
Minimum Holdoff Setting	
5 s/Div to 1 μs/Div	2 times TIME/DIV setting or less.
0.5 μs/Div to 10 ns/Div	2.0 μs or less.
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster.

TRIGGERING

Characteristic	Triggering Frequency Range[2]	Minimum Triggering Signal Required	
Triggering Sensitivity from Repetitive Signal (Auto, Norm and Single Sweep Modes)		Internal	External
Coupling			
AC	30 Hz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV
AC LF REJ[3]	30 kHz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV
AC HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
DC[4]	Dc to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV

Characteristic	Performance Requirement
Internal Trigger Jitter	0.1 ns or less at 400 MHz.
External Trigger Input	
Maximum Input Voltage	250 V (dc plus peak ac).
Input R and C	1 MΩ within 5%, 20 pF within 10%.
Level Range (Excluding P-P AUTO)	(Checked on 1 kHz sine wave.)
EXT ÷ 1	At least + and −1.5 volts.
EXT ÷ 10	At least + and −15 volts.

Characteristic	Triggering Frequency Range	Minimum Triggering Signal Required	
P-P AUTO Operation Sensitivity (Ac or Dc Coupling)		Internal	External
	200 Hz to 50 MHz	0.5 div	125 mV
	50 MHz to 400 MHz	1.5 div	375 mV
Low Frequency Response	At least 50 Hz	2.0 div	500 mV

[2] The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system (mainframe and amplifier unit) when operating from an internal source.
[3] Will not trigger on sine waves at or below 60 Hz when amplitudes are less than 8 divisions internal or 3 volts external.
[4] The Triggering Frequency Range for DC COUPLING applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

TABLE 2-2
Environmental Characteristics

Refer to the Specification section of the associated mainframe manual.

TABLE 2-3
Physical Characteristics

Net Weight	Approximately 2.1 pounds (1 kilogram).
Dimensions	See Figure 2-1, dimensional drawing.

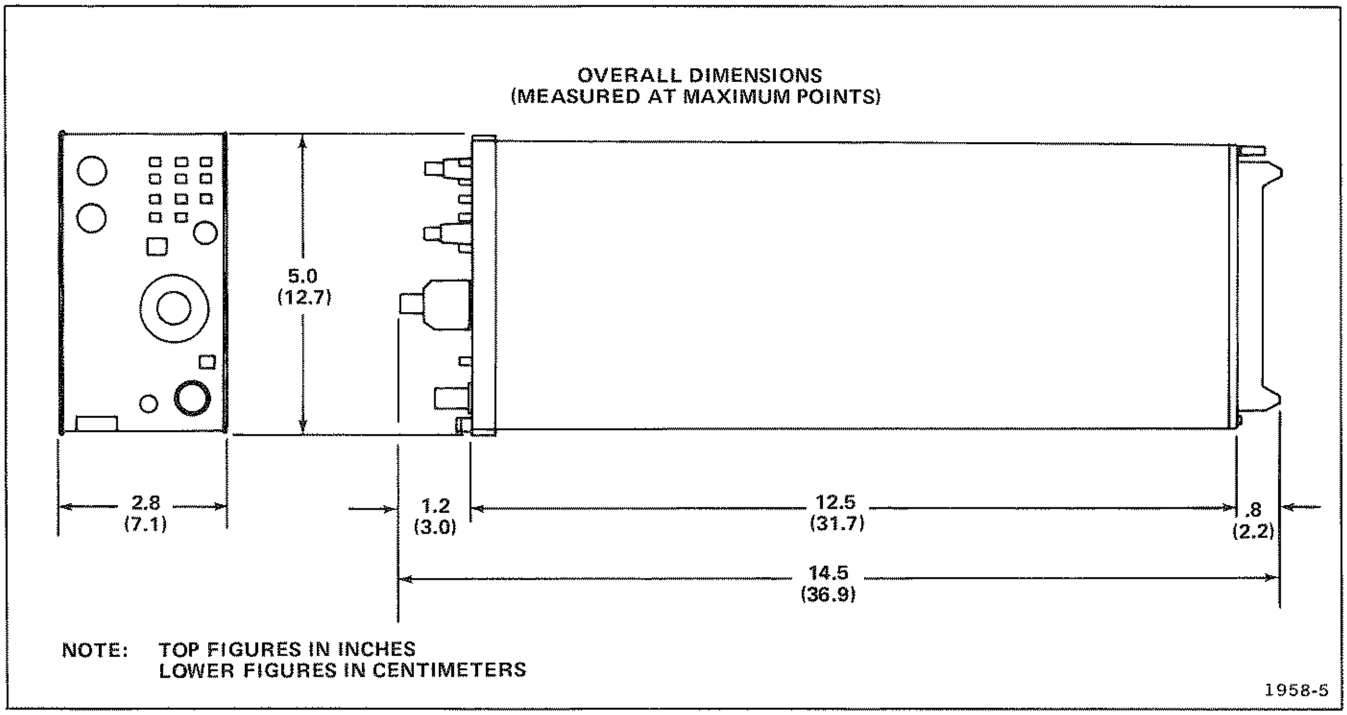

Fig. 2-1. 7B80 dimensional drawing.

STANDARD ACCESSORIES

1 ea . . . . Operators Manual

1 ea . . . . Instruction Manual

INSTRUMENT OPTIONS

Your instrument may be equipped with one or more instrument options. A brief description of each option is given in the following discussion.

Conversion kits, for most options, are available and can be installed at a later time. For further information on instrument options, see your Tektronix Catalog or contact your Tektronix Field Office.

OPTION 2

This option provides an X-Y display feature. Horizontal (X) and vertical (Y) deflection signals are applied to the inputs of either a dual-trace amplifier or two single amplifier units; the horizontal signal is then routed through the amplifier and main frame trigger paths to the Option 2 instrument. A push-button control (DISPLAY MODE) is provided on the Option 2 instrument front panel to select either normal sweep or X-Y display.

OPTION 2

This option provides a means to obtain an X-Y display. The horizontal and vertical (X-Y) signals are applied to the inputs of a dual-trace amplifier unit, or two single amplifier units. The horizontal signal is then routed through the amplifier and mainframe trigger paths to the Option 2 instrument. The front-panel DISPLAY MODE switch selects either normal sweep displays or X-Y displays. A functional description of the X-Y display feature will follow.

OPERATING INSTRUCTIONS

To make full use of the capabilities of this instrument, the operator should be familiar with the use of the front-panel DISPLAY MODE push-button switch. A brief description of the DISPLAY MODE switch is given here. More detailed information is given under the topic General Operating Information (later in this section).

DISPLAY MODE CONTROL

Figure 1 shows the location of the front-panel DISPLAY MODE switch relative to the standard front-panel controls. Only the functions of the Option 2 instrument DISPLAY MODE switch are explained here; see Section 1, Operating Instructions in this manual for a description of the standard instrument controls.

FUNCTIONAL CHECK

The following procedure checks the basic operation of the X-Y functions and is intended to supplement the Functional Check procedure given in Section 1 of this manual.

Setup Procedure

1. Install the Option 2 instrument in a horizontal compartment of the mainframe.

2. Install a dual-trace amplifier unit in the desired vertical compartment, or install single amplifier units in each vertical compartment of the mainframe.

3. Turn on the mainframe power.

X-Y Display

1. Set the DISPLAY MODE push button to X-Y. Set the mainframe intensity control for convenient brightness of the displayed spot.

2. Any available vertical channels may be used for the X and Y signal inputs.

DUAL-TRACE AMPLIFIERS. Set the vertical display mode controls of both the amplifier and mainframe to select the Y (vertical) signal; set the trigger source controls of both the amplifier and mainframe to select the X (horizontal) signal.

SINGLE-TRACE AMPLIFIERS. Set the vertical display mode of the mainframe to select the Y (vertical) signal. Set the mainframe trigger source to select the X (horizontal) signal.

3. Set each amplifier unit input coupling switch to dc, and set the position controls of the selected X and Y channels for a spot display at graticule center. Notice that the position control of the Y channel controls Y-axis (vertical) spot movement and that the position control of the X channel controls X-axis (horizontal) spot movement.

4. Connect a low-frequency sine-wave signal to the selected X and Y inputs.

5. Adjust the mainframe intensity control until the display is at the desired viewing level. Adjust the signal amplitude for a convenient display size with the X and Y amplifiers set for the same deflection factor.

6. If one signal source is connected to both the X and Y amplifier units, the resultant display should be a diagonal line on the mainframe crt.

7. Disconnect the X and Y signals, set the Option 2 instrument DISPLAY MODE control to TIME BASE, and set the mainframe vertical mode and trigger source for normal sweep operation.

GENERAL OPERATING INFORMATION

The following information is provided to aid in fully understanding the functions associated with the DISPLAY MODE control.

Internal Sweep Operation

When the DISPLAY MODE push button is pressed and latched to the IN: TIME BASE position, all functions and controls of the instrument operate as described (in Section 1—Operating Instructions) for the standard instrument. Operation in an X-Y mode is not possible until the DISPLAY MODE push button is pressed and released to the OUT: X-Y position.

X-Y Operation

In some applications, it is desirable to display one signal versus another (X-Y), rather than against the internal sweep. When the DISPLAY MODE push button is pressed and released to the OUT: X-Y position, all other front-panel controls, the sweep, and readout functions of the Option 2 instrument are disabled. An X-Y mode of operation is now provided. An external X signal can now be connected to any vertical amplifier unit and coupled through the internal triggering system of the vertical amplifier unit, the mainframe, and the Option 2 Time Base to provide the horizontal deflection on the mainframe display. The external Y signal is connected to the remaining amplifier channel to provide the vertical deflection on the mainframe display.

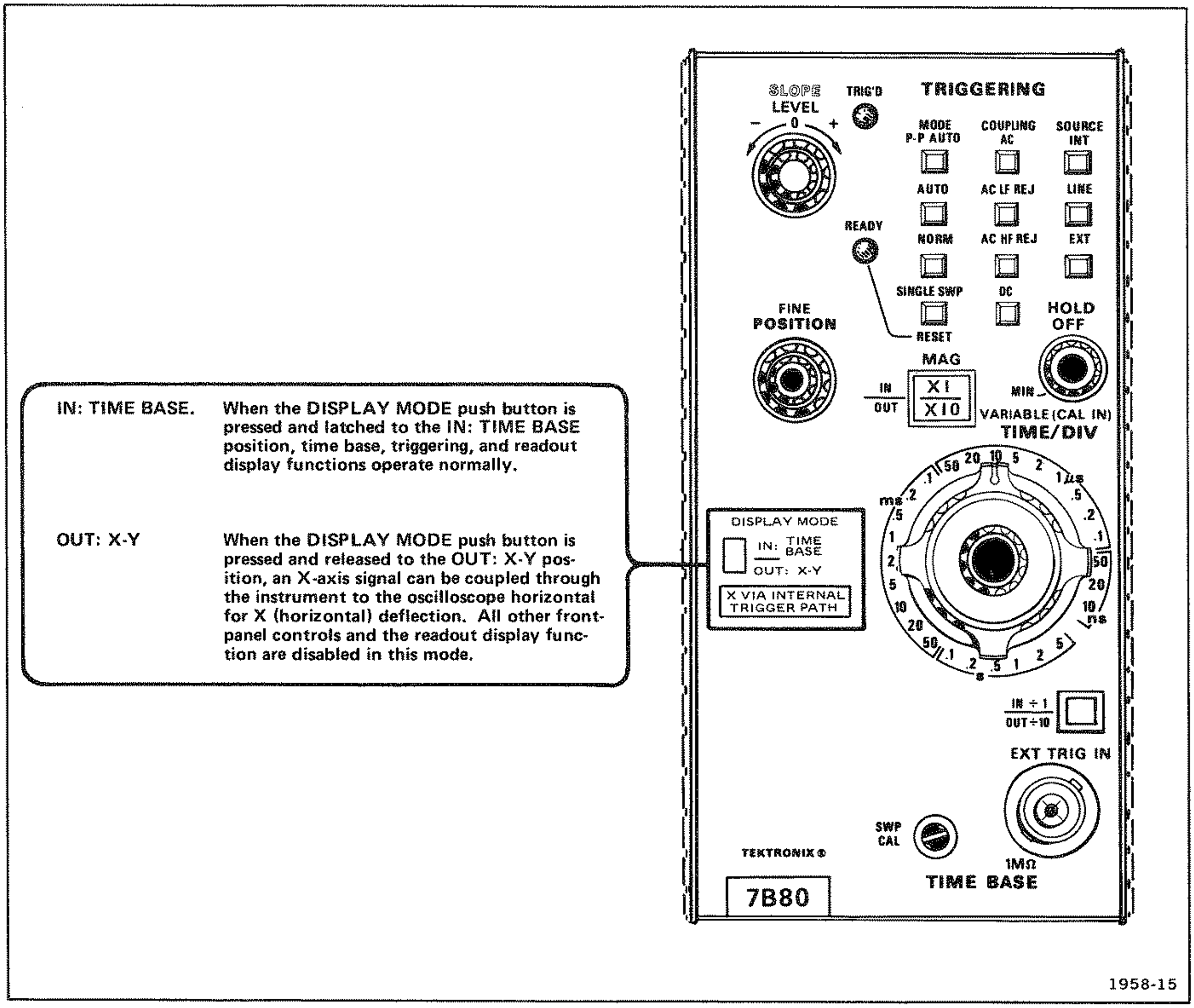

Figure 1. Option 2 Display Mode switch.

The advantages of using the internal triggering system to provide the X signal are:

1. X-Y operation is possible with one dual-trace amplifier in a mainframe vertical compartment.

2. X-Y operation is possible without having to remove a time-base unit from the horizontal compartment of the mainframe to substitute an amplifier unit.

3. The attenuator switch of the vertical channel in the horizontal signal path provides many deflection-factor settings to allow full-range amplitude control.

OPERATION WITH DUAL-TRACE AMPLIFIERS. When dual-trace amplifier units are used with the Option 2 Time-Base unit, any vertical channel may be used for X or Y signal inputs. Set the display mode controls of both the amplifier and mainframe to select the channel that provides the vertical signal; set the trigger source controls of both the amplifier and mainframe to select the channel that provides the horizontal signal.

OPERATION WITH SINGLE-TRACE AMPLIFIERS. If single-trace amplifier units are used with the Option 2 Time-Base unit, set the mainframe trigger source control to select the amplifier unit that provides the horizontal signal; set the mainframe vertical mode control to select the amplifier unit that provides the vertical signal.

APPLICATIONS

The following information describes a procedure or technique for making X-Y phase measurements with the Option 2 Time-Base unit. The measurements are described in a detailed example, but each user application must be adapted to the requirements of the individual measurement. The following X-Y phase measurement method can be used to measure the phase angle between two signals of the same frequency.

Preliminary Setup

1. Set the DISPLAY MODE push button to the OUT: X-Y position. Set the mainframe intensity control for convenient brightness of the spot display.

2. Set the controls of the mainframe and the amplifier units as directed in the following setup procedure for the amplifier units to be used.

DUAL-TRACE AMPLIFIERS. Set the vertical display mode controls of both the amplifier and mainframe to select the input of the Y (vertical) signal; set the trigger source controls of both the amplifier and mainframe to select the input of the X (horizontal) signal.

SINGLE-TRACE AMPLIFIERS. Set the vertical display mode control of the mainframe to select the input of the Y (vertical) signal; set the trigger source control of the mainframe to select the input of the X (horizontal) signal.

3. Set each amplifier unit input coupling switch to dc, and set the position controls of the selected X and Y channels for a spot display at graticule center.

4. Connect low-frequency sine-wave signals of the same frequency to the selected X and Y inputs.

5. Advance the mainframe intensity control until the display is at the desired viewing level. Set the amplifier deflection factors and variable volts/division controls for eight divisions of vertical and horizontal deflection, and set the position controls to center the display on the graticule as shown in Figure 2.

6. Measure and record the overall horizontal deflection (B) and the opening of the Lissajous display (A), measuring horizontally at the graticule horizontal center line (see Figure 2).

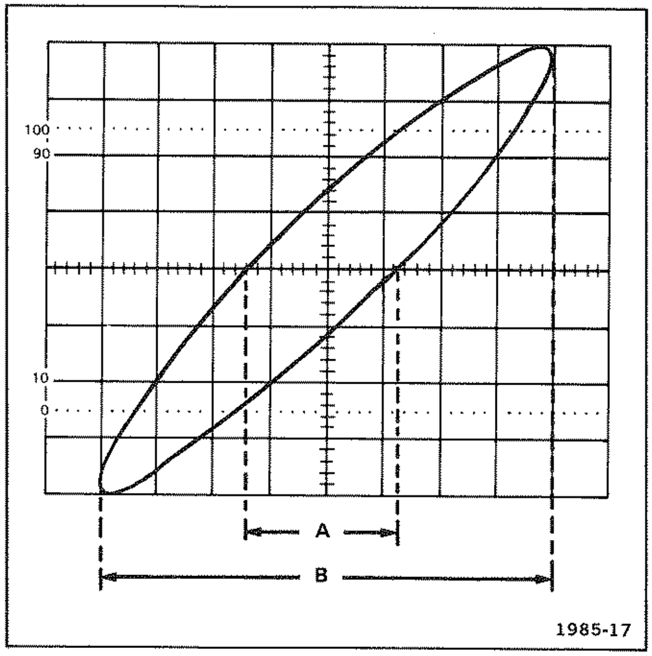

Figure 2. Measurement of phase angle difference from an X-Y display.

7. Divide A by B to obtain the trigonometric sine of the phase angle difference between the two signals. Obtain the phase angle from a trigonometric table to determine the phase angle between the X and Y signals.

Example: Assume that the horizontal distance measured at the center opening of the display (A) is 2.7 divisions (see Figure 2) and the overall horizontal distance of the display (B) is eight divisions.

Using the formula:

$$\sin(\text{Phase Angle}) = \frac{\text{center opening distance (A)}}{\text{overall distance (B)}}$$

Substituting values:

$$\sin(\text{Phase Angle}) = \frac{2.7 \text{ divisions}}{8 \text{ divisions}} = 0.3375$$

Obtaining the angle from a trigonometric table:

$$\text{Phase Angle} = \sin^{-1} 0.3375 = 19.7^\circ$$

The phase angle difference between the X and Y signals is 19.7°.

SPECIFICATION

The following information applies to the Option 2 Time-Base unit only, operating in the X-Y display mode. Any electrical characteristics listed here apply when the instrument is operating in an oscilloscope system within an ambient temperature range of 0° to +50° C. Warmup time of the oscilloscope system must be 20 minutes or more.

X BANDWIDTH

In most cases, the typical X bandwidth is equal to the horizontal bandwidth of the mainframe alone. (Example: In the Tektronix 7904 mainframe, the horizontal bandwidth is 1 MHz.)

When the amplifier unit in the X-signal path is lower in trigger bandwidth than the horizontal bandwidth of the mainframe (an unusual case), the X bandwidth is this lower value.

X-Y PHASE SHIFT

X-Y Phase Shift is determined by the circuitry in the mainframe. For mainframes without X-Y horizontal compensation, the mainframe phase shift specification is retained for frequencies of 50 kHz and below. (Example: In the Tektronix 7904 mainframe, the X-Y phase shift specification of 2° or less to 35 kHz is retained.)

Supplemental Information

For mainframes with optional X-Y horizontal compensation, the extra delay of the mainframe trigger path adds to the phase shift error above 50 kHz. (Example: In the Tektronix 7904 Option 2 mainframe, the trigger path adds about 2° of error at 1 MHz, which increases its X-Y phase shift specification of 2°, to a typical 4° error at 1 MHz.)

Refer to the manuals on associated instruments for X-Y phase shift and frequency information. Apply signals to the vertical and horizontal systems within the X-Y frequency range specified for the instruments.

X DEFLECTION FACTOR ACCURACY

X deflection factor accuracy is determined by the gain accuracy in the trigger paths of the amplifier unit and the mainframe.

Supplemental Information

The typical X deflection factor is within 20% of the amplifier unit deflection factor.

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.
111	PG 501 - Risetime less than 3.5 ns; 8 ns Pretrigger pulse delay.	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger Pulse delay.
114	PG 501 - ±5 V output.	114 - ±10 V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, or Delayed pulse mode; ±5 V dc Offset. Has ±5 V output.	115 - Paired, Burst, Gated, and Delayed pulse mode; ±10 V output. Short-proof output.
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.
114	PG 502 - ±5 V output	114 - ±10 V output. Short proof output.
115	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; Has ±5 V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ±10 V output. Short-proof output.
2101	PG 502 - Does not have Paired or Delayed pulse. Has ±5 V output.	2101 - Paired and Delayed pulse; 10 V output.
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	SG 503 - Frequency range 250 kHz to 250 MHz.	191 - Frequency range 350 kHz to 100 MHz.
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180,		
180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Marker outputs, 5 sec to 1 μs. Sinewave available at 20, 10, and 2 ns. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000 μs, plus 10 ns sinewave.
184	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Marker outputs, 5 sec to 2 ns. Sinewave available at 50, 20, 10, 5, and 2 ns. Separate trigger pulses of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs. Marker amplifier provides positive or negative time marks of 25 V min. Marker intervals of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Marker outputs, 5 sec to 0.1 μs. Sinewave available to 50, 10, and 5 ns. 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.