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GUIDE PRODUCT GROUP 41

USING THE
2211
Oscilloscope

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INTRODUCTION

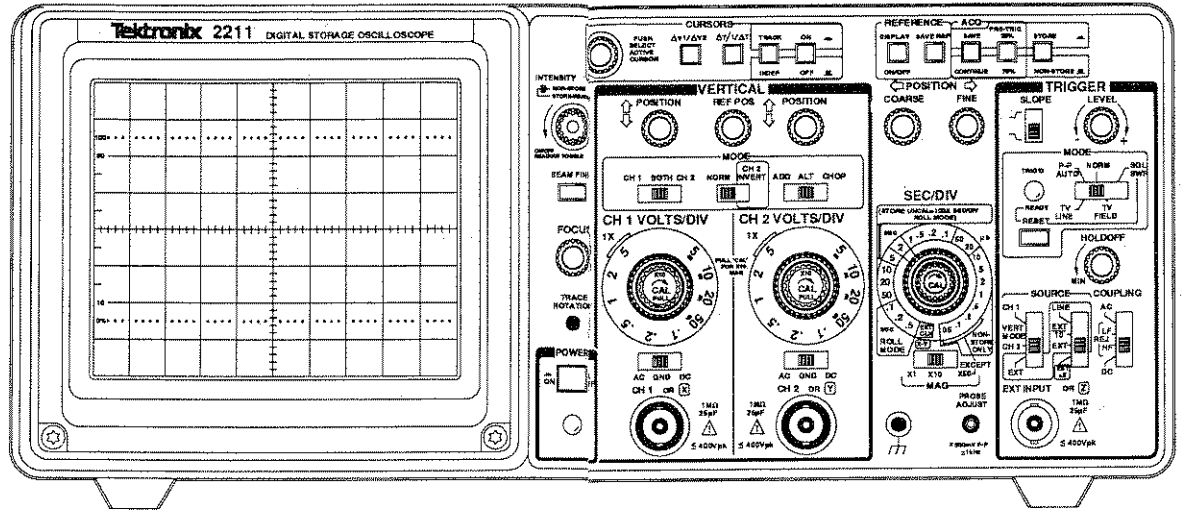
The 2211 is not only a powerful digital storage oscilloscope but also provides the analog capabilities of a conventional non-storage instrument.

In the digital storage mode, the instrument is capable of sampling up to 20 MS/s. The acquisition is 4K points per channel, all displayed on screen. Waveform "acquisition" is the digitizing and storing of the digital values that represent the analog waveform applied to the vertical inputs. Save reference memory provides the user with the capability of storing either one 4K record or two 4K records, one for each channel.

For flexibility in viewing events both before and after the trigger event, two trigger points can be selected, 25% and 75%. Save reference memory can be simultaneously viewed on-screen with the current acquisition for waveform comparison.

In non-storage mode, the instrument behaves as a conventional 50 MHz analog oscilloscope. The 2211 offers versatility in triggering, high accuracy in both vertical and horizontal systems, and excellent display quality.

In both store and non-store modes, the 2211 offers a cursor readout display to aid the user in making measurements.



OSCILLOSCOPE CONTROLS

CRT CONTROLS:

INTENSITY—Adjusts the brightness of all NON-STORE displayed waveforms.

READOUT/STORE INTENSITY—Adjusts the brightness of all STORE waveforms, the CRT readout and the cursor displays. This control is also used to either enable or disable the CRT readout and cursor display.

BEAM FIND—Compresses the vertical and horizontal deflection to within the graticule area. The traces are intensified to aid the user in locating traces that are over-scanned or deflected outside of the crt viewing area.

FOCUS—Adjusts for optimum display definition. Once set, proper focusing is maintained over a wide range of display intensity.

TRACE ROTATION—Permits alignment of the trace with the horizontal graticule lines. This control is a screw-driver adjustment that, once set, should require little attention during normal operation.

POWER ON/OFF—Turns instrument power on or off. An LED indicator lights when power is on.

VERTICAL SYSTEM CONTROLS:

POSITION—Control the vertical display position of the input signals. In STORE mode, the controls set the vertical position of the signals being acquired. The POSITION controls do not reposition the SAVE mode waveforms, but a POSITION control change is seen upon returning to CONTINUE mode. In the NON-STORE X-Y display mode the CH 2 POSITION control moves the X-Y display vertically.

CH 1-BOTH-CH 2—Selects the vertical channel(s) for display in both NON-STORE and STORE.

CH 1—Selects only the Channel 1 input signal for display.

BOTH—Selects a combination of Channel 1 and Channel 2 signals for display (CH 1-BOTH-CH 2 switch must be in the BOTH position for ADD, ALT and CHOP operation).

CH 2—Selects only the Channel 2 input signal for display.

NORM/CH 2 INVERT—Inverts the Channel 2 display when in the CH 2 INVERT position. With channel 2 inverted, the oscilloscope may be operated as a differential amplifier when the BOTH-ADD Vertical Mode is selected. In NORM, the Channel 2 display and trigger signals are non-inverted. An invert symbol (↓) is displayed with the CH 2 VOLTS/DIV readout when CH 2 is inverted.

ADD-ALT-CHOP—Selects the display mode for the two input signals when the CH 1-BOTH-CH 2 switch is set to BOTH.

ADD—Displays the sum of Channel 1 and Channel 2 input signals when BOTH is also selected. The difference of the Channel 1 and Channel 2 input signals is displayed when the Channel 2 signal is inverted. In STORE mode ADD, the sum of CH 1 and CH 2 is acquired by Channel 1.

ALT—Alternately displays the NON-STORE Channel 1 and Channel 2 input signals. Switching between channels occurs during retrace at the end of each sweep. ALT Vertical Mode is most useful for viewing both channel input signals at sweep rates of 0.5 ms per division or faster.

CHOP—Switches the display between Channel 1 and Channel 2 vertical input signals during the sweep. The chopped switching rate (CHOP frequency) is approximately 500 kHz.

In STORE mode both signals are acquired simultaneously. There is no functional difference between ALT and CHOP except when VERT MODE trigger is selected. When VERT MODE trigger is selected, each channel is acquired alternately.

CH 1 and CH 2 VOLTS/DIV—Select the vertical channel deflection factors from 5 mV to 5 V per division in a 1-2-5 sequence. The VOLTS/DIV switch setting for both channels is displayed in the crt readout.

1X—Front-panel marking that indicates the deflection factor set by the VOLTS/DIV switch when a 1X probe or a coaxial cable is attached to the channel input connector.

Variable VOLTS/DIV (CAL)—Provide uncalibrated variable deflection factors between the calibrated settings of the VOLTS/DIV controls. The VOLTS/DIV sensitivity is reduced by at least 2.5 times at the fully counter-clockwise rotation of the variable knob. The switch detent at full clockwise rotation is the CAL position of the variable knob. The uncalibrated condition is indicated by a greater-than symbol (>) in front of the affected VOLTS/DIV readout.

Pulling the Variable VOLTS/DIV control multiplies the vertical gain by X10 and limits the bandwidth. This latter condition is indicated in the readout display by the letters BL.

AC-GND-DC (Input Coupling)—Selects the method of coupling the input signal from the CH 1 and CH 2 vertical input connectors to the vertical amplifiers.

AC—Capacitively couples the input signal to the vertical amplifier. The dc component of the input signal is blocked. The lower -3 dB bandpass is 10 Hz or less. Selection of AC input coupling is indicated in the readout by a tilde symbol (~) in the associated channel's VOLTS/DIV readout.

GND—Grounds the input of the vertical amplifier, providing a zero (ground) reference voltage display. In GND, the input coupling capacitor charges to the average dc voltage level of the amplifier's input signal.

DC—All frequency components of the input signal are coupled to the vertical amplifiers.

Table 1
Storage Modes

HORIZONTAL SYSTEM CONTROLS:

POSITION (Coarse and Fine)—Position all the waveforms horizontally over a one-sweep-length range in X1, X10 or X50 Magnification. In STORE mode with Δt cursors selected, operation of the Horizontal Position controls also moves the cursors as they are attached to the waveform(s).

SEC/DIV—Selects calibrated sweep rates from 0.5 s to 0.05 μ s per division in a 1–2–5 sequence of 22 positions. The X–Y position selects the X–Y display in NON–STORE Mode. The CH 1 input signal provides horizontal deflection for X–Y displays, and the CH 2 input signal produces vertical deflection.

In STORE mode, the SEC/DIV switch determines the acquisition and display modes, sets the sampling rate, and establishes the time scale factor of the displayed waveforms. There are two storage modes with respect to the SEC/DIV switch setting (see Table 1).

RECORD Mode—Updates a full record of the acquired waveform each time a trigger event is recognized.

ROLL Mode—Continuously acquires and displays signals. The waveform display overwrites the previous acquisition from right to left. Triggers are disabled except in SGL SWP.

SEC/DIV Switch Setting	SEC/DIV Variable	
	CAL	UNCAL
X–Y (EXTERNAL CLOCK)	RECORD Clock: dc to 10 MHz	ROLL Clock: dc to 4 kHz
0.05 μ s to 10 μ s	Error Indication ^b	Error Indication ^b
20 μ s to 5 ms ^a	RECORD	RECORD
10 ms to 50 ms	RECORD	ROLL (100X) 1 s/div to 5 s/div
0.1 s to 0.5 s	ROLL (1X)	ROLL (100X) 10 s/div to 50 s/div

^aThe Variable SEC/DIV control has no effect in this range. If a SEC/DIV range above 20 μ s is selected while in STORE mode, Sec/Div? is displayed, indicating that an illegal control setting has been selected. The acquisition continues at the 20 μ s rate.

^bSec/Div? is displayed in the crt readout.

At SEC/DIV settings of 10 ms and below, when the Variable SEC/DIV control is moved from the CAL position, the selected SEC/DIV setting is multiplied by 100 and the display mode is ROLL.

In STORE mode, X-Y on the SEC/DIV switch selects external clock. In this mode the acquisition rate is controlled by a signal applied to the EXTERNAL CLOCK connector located on the right hand side of the instrument.

The SEC/DIV switch setting is displayed in the crt readout.

Variable SEC/DIV (CAL)—Continuously varies the uncalibrated NON-STORE sweep time per division to at least 2.5 times the calibrated time per division set by the SEC/DIV switch. Full counter-clockwise rotation increases the slowest sweep time per division to at least 2 s. The uncalibrated condition is indicated by a greater than symbol (>) in front of the SEC/DIV readout.

In STORE mode (10 ms per division to 0.5 s per division), if the Variable control is switched out of CAL detent, the SEC/DIV switch setting is multiplied by 100 times (see Table 2). The control has no effect in STORE mode at SEC/DIV switch settings faster than 10 ms. When the SEC/DIV switch is set to EXT CLK, the Variable SEC/DIV control selects the display mode. In the CAL position, RECORD mode is selected, EXT CLK range DC to 10 MHz. Out of CAL detent, ROLL mode is selected, EXT CLK range DC to 4 kHz, and ROLL is displayed on the crt.

MAG—Selects the amount of horizontal magnification: X1, X10 or X50. Magnification occurs around the center vertical graticule division in both NON-STORE and STORE. The crt SEC/DIV readout will reflect the setting of both the SEC/DIV switch and the magnification factor. In STORE mode, with Δ t cursors selected, operation of the Horizontal MAG switch will also magnify the cursors as they are attached to the waveform(s).

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Table 2
Extended SEC/DIV Ranges

SEC/DIV Variable	
CAL	UNCAL
10 ms/div	1 s/div
20 ms/div	2 s/div
50 ms/div	5 s/div
0.1 s/div	10 s/div
0.2 s/div	20 s/div
0.5 s/div	50 s/div

PROBE ADJUST—Provides an approximately 0.5 V, negative-going, square-wave voltage (at approximately 1 kHz) for use in compensating voltage probes and checking the vertical deflection system. The PROBE ADJUST output is not intended as a reference in checking either the vertical or horizontal accuracy of the instrument.

TRIGGER SYSTEM CONTROLS:

Trigger SLOPE Switch—Selects either the positive or negative slope of the trigger signal to start the sweep.

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Trigger LEVEL Control—Selects the dc level that the Trigger signal must pass through to produce triggering. The Trigger point is displayed as a voltage readout in the display field unless any of the following are selected:

Trigger Source CH 1 and CH 1 is AC coupled, or uncalibrated

Trigger Source CH 2 and CH 2 is AC coupled, or uncalibrated

Trigger Source VERT and Vertical Mode is CHOP

Trigger Source VERT and CH 1 is AC coupled or uncalibrated, or CH 2 is AC coupled or uncalibrated, or CH 1 VOLTS/DIV and MAG are not equal to CH 2 VOLTS/DIV and MAG

Trigger Source EXT

Trigger Coupling is not set to DC

Trigger Mode TV

TRIG'D/READY Indicator—A dual-function, light-emitting diode (LED) indicator. In P-P AUTO, NORM, and TV FIELD Trigger modes, the indicator turns on when triggering occurs.

In NON-STORE, for SGL SWP Trigger mode the indicator turns on when the trigger circuit is armed awaiting a triggering event. The indicator turns off again as soon as the single sweep completes.

In STORE mode, selecting SGL SWP and pressing the RESET button starts the sampling to fill the pretrigger portion of the waveform RECORD. The TRIG'D/READY indicator does not come on until the pretrigger part of the RECORD is full. When the indicator comes on, the storage acquisition system is ready to accept a trigger

event. Filling the remaining portion of the RECORD begins when that trigger occurs, and the indicator turns off when the RECORD is full. The time needed to fill the pretrigger and post-trigger portions of the RECORD depends on two things: the sampling rate, and the setting of the PRE-TRIG 25%/75% switch. Until a trigger occurs, the pretrigger data is continually updated, but the RECORD display is not updated until a complete new waveform is acquired.

MODE Switch—Determines the NON-STORE sweep and STORE acquisition triggering mode. STORE mode triggering operation also depends on the position of the SEC/DIV switch.

P-P AUTO/TV LINE—In NON-STORE mode, the Trigger LEVEL control range is set to the peak-to-peak limits of the input trigger signal. Triggered operation occurs when the trigger signal has enough amplitude and occurs often enough (20 Hz and faster repetition rate) for the peak detectors to determine the signal peaks. If the trigger signal does not meet the requirements to produce a trigger event, an autotrigger is generated, and the sweep free runs.

In STORE mode, in the absence of a trigger signal an autotrigger is generated. The trigger point annunciator (intensified dot) is visible on the autotrigger generated trace when selected by the 25%/75% pretrigger button. At SEC/DIV settings faster than 20 us, triggered acquisitions occur under the same conditions as NON-STORE mode P-P AUTO triggering.

NORM—Permits triggering at all NON-STORE sweep speeds. The Trigger LEVEL control must be set correctly to produce a sweep; an autotrigger is not generated if there is no trigger signal. NORM Trigger Mode is especially useful in obtaining a stable display of low-frequency and low-repetition-rate signals.

In STORE mode RECORD, the display is updated once the acquisition is complete; the last waveform acquired remains displayed until that time.

In ROLL, the trigger signal is ignored for all the Trigger modes except in SGL SWP Trigger mode (see Table 3). In non-triggered ROLL mode, the display is continually updated at the digitization rate.

Table 3
ROLL Trigger Modes

TRIGGER MODE	ROLL MODE Trigger Operation
P-P AUTO	Untriggered ROLL
NORM	Untriggered ROLL
TV TRIG (LINE and FIELD)	Untriggered ROLL
SGL SWP	Triggered ROLL

TV FIELD—Permits stable triggering on a television field (vertical sync) signal. In the absence of an adequate trigger signal, the sweep (or acquisition) free runs. The instrument otherwise behaves as in P-P AUTO. When TV FIELD is selected, "TV" is displayed in the crt readout.

SGL SWP—Selects single sweep operation.

In RECORD mode, upon entering SGL SWP the last waveform acquired remains displayed. Pressing the RESET button rearms the trigger circuitry to accept the next triggering event. When a trigger event is recognized, the full record is acquired and the display updates. If BOTH-ALT Vertical Mode is selected along with VERT MODE Trigger SOURCE, the triggered channel behaves as just described. The non-triggered channel display is not updated. Pressing the RESET button again causes the second channel to update.

If the display mode is ROLL when SGL SWP is selected, the display continues to roll because the trigger circuit is not armed. When the RESET button is pushed to arm the trigger circuit the display continues rolling until the pretrigger portion of the RECORD is full. The trigger point indicator (intensified dot) then appears on the waveform, and the TRIG'D/READY indicator lights. The display continues to roll as data is acquired to fill the post-trigger portion of the RECORD. The amount of pretrigger information in a RECORD is set by the 25%/75% PRETRIG button. In SGL SWP, if BOTH-ALT Vertical mode is selected along with VERT MODE Trigger Source the triggered channel behaves just as described; the non-triggered

channel is blanked. The triggered and non-triggered channel alternates with each press of the RESET button.

RESET—Arms the trigger circuit either for a single sweep in NON-STORE SGL SWP or a single acquisition in STORE SGL SWP. Triggering requirements are the same as in NORM Trigger Mode. After the completion of a triggered NON-STORE sweep or a STORE SGL SWP acquisition, pressing in the RESET button rearms the trigger circuitry. In NON-STORE mode, the next trigger event can then be accepted to start the sweep. For STORE mode, the pretrigger acquisition is started when the RESET button is pressed.

Variable HOLDOFF Control—Adjusts the NON-STORE variable holdoff time. NON-STORE variable holdoff starts at the end of the sweep. STORE mode holdoff starts at the end of the acquisition cycle; it ends when the waveform data has been transferred from the acquisition memory to the display memory and the pretrigger portion of the RECORD has been filled. After STORE mode holdoff ends, the next acquisition can be triggered after the next (or current, if one is in progress) NON-STORE holdoff ends. STORE mode holdoff can be much longer than the sweep time so that several NON-STORE holdoff periods may have occurred during STORE holdoff time. This ensures that STORE mode triggering is controllable by the Variable HOLDOFF control and will be stable if the NON-STORE display is stable.

Trigger SOURCE Switches—Determine the source of the internal and external trigger signal for the trigger generator circuits.

CH 1—Trigger signal is obtained from the channel 1 input and "CH 1" is displayed in the crt readout.

VERT MODE—Trigger signals are obtained alternately from the CH 1 and CH 2 input signals in ALT Vertical Mode. In CHOP Vertical Mode, the trigger signal source is the sum of the CH 1 and CH 2 input signal. When VERT MODE is selected, "VERT" is displayed in the crt readout.

CH 2—Trigger signal is obtained from the channel 2 input. The NORM/CH 2 INVERT switch also inverts the polarity of the internal CH 2 trigger signal when the CH 2 display is inverted. When CH 2 is selected, "CH 2" is displayed in the crt readout.

EXT—Selects external triggers. The actual form these triggers take is selected by the second SOURCE switch. When EXT is selected, "EXT" is displayed in the crt readout.

LINE—Routes a sample of the ac power line signal to the trigger circuit.

EXT/10—Attenuates the external signal applied to the EXT INPUT or Z connector by a factor of 10 before applying it to the trigger circuit.

EXT—Routes an external signal applied to the EXT INPUT or Z connector to the trigger circuit.

EXT = Z—Routes the signal from the EXT INPUT or Z connector to the Z-axis amplifier rather than the trigger circuit. If EXT and EXT = Z are both selected, the signal applied to the EXT INPUT or Z connector is routed to both the trigger circuit and the Z-axis amplifier.

COUPLING Switch—Determines the method of coupling for the signal applied to the trigger circuit.

AC—Input signal is capacitively coupled, and the dc component (below 10 Hz) from the trigger circuit is blocked. "AC" is displayed in the crt readout.

HF REJECT—Rejects (attenuates) the high-frequency components (above 30 kHz) from the trigger circuit. "HF rej" is displayed in the crt readout.

LF REJECT—Rejects (attenuates) the low-frequency components (below 30 kHz) from the trigger circuit. "LF rej" is displayed in the crt readout.

DC—Couples all frequency components of the external signal to the trigger circuit (DC to full bandwidth).

STORAGE CONTROLS:

STORE/NON-STORE Switch—Selects either the NON-STORE or the STORE waveforms for display. The STORE acquisition system is turned off while NON-STORE is selected so that the last waveform acquired in STORE mode remains in memory. NON-STORE is selected when the button is out; STORE mode when pressed in.

PRE-TRIG 25%/75% Switch—Selects either 25% or 75% pretrigger. If either RECORD mode or SGL SWP ROLL mode is selected, the trigger position is shown on the display by an intensified dot. Selects 75% pretrigger when out; 25% when pressed in.

ACQ SAVE/CONTINUE Switch—Stops the display from being updated when pressed in. If the display mode is ROLL, the current acquisition is stopped immediately upon pressing the button. Releasing the button causes the acquisition to continue. If the display mode is RECORD, the current display is held immediately upon pressing the button. When the button is released the display is updated with the acquisition that was in progress when the SAVE button was pushed. On returning to the CONTINUE mode, previously acquired waveforms are no longer valid if the control settings were changed while in SAVE mode. The next waveform acquired in CONTINUE mode will reflect any changes made. When SAVE is selected, "SAVE" appears at the bottom of the readout display.

Reference SAVE REF Switch—Saves the displayed STORE mode waveform(s) into the reference memory.

The saved Reference waveform is displayed on the crt. When the SAVE REF button is pressed, previously saved waveform(s) are over-written by the displayed acquisition waveform(s). The Reference waveform(s) remain in memory when the instrument is switched between STORE and NON-STORE modes. Reference waveforms are NOT saved when the oscilloscope is turned off.

Reference DISPLAY ON/OFF Switch—Turns the stored reference waveform display on and off when in STORE mode.

Reference POSITION Control—Allows vertical positioning of the saved Reference waveforms. The Reference waveforms may only be positioned in the positive region from the level at which they were saved; they cannot be positioned below that level.

NOTE

Any portions of the STORE waveform that are out of the display area will not be saved correctly in the Reference memory when SAVE REF is pressed. The off-screen portion will be clipped. The clipping effect is seen when saving a waveform that is partially off the bottom of the crt display. When the Reference waveform is positioned upward to bring it on-screen, the bottom of the display will be clipped. The effect cannot be seen on the Reference waveforms clipped at the top because they cannot be positioned downwards.

CURSOR:

DELTA V Switch—Activates the Delta Volts (ΔV) measurement function and cancels any other Delta measurement function when momentarily pressed. The CRT readout displays the equivalent voltage represented by the separation between the two cursors with VOLTS/DIV scaling defined by the setting of the selected vertical channel's VOLTS/DIV switch. The selection of the VOLTS/DIV switch is defined by the operation of the ΔV switch such that, when the ΔV function is inactive, depressing the ΔV switch selects the VOLTS/DIV switch previously selected for ΔV measurement mode (CH 1 is selected after switch-on), and, when the ΔV function is active and Vertical MODE is set to BOTH, subsequent depressions of the ΔV button will toggle VOLTS/DIV scaling between CH 1 and CH 2 VOLTS/DIV switches. If CH 1 is not displayed, $\Delta V1$ will not be enabled. Likewise, if CH 2 is not displayed, $\Delta V2$ will not be enabled. Each

channel has its own independent cursors and channel selection is indicated in the Readout field. The position of the cursors on the display are set by the Cursor Position control. The DELTA Volts readout is displayed as a percentage ratio (with five divisions corresponding to a 100% ratio) if either one of the following conditions exist:

- (1) The selected vertical channel is uncalibrated (VOLTS/DIV CAL control out of detent), or
- (2) ADD is selected when the CH 1 and CH 2 deflection factors are not the same (VOLTS/DIV switches are at different settings or at least one is uncalibrated). The setting of the VOLTS/DIV switch must take account of the X10 PULL function.

When the 2211 is in NON-STORE X-Y Mode, the Delta VX and Delta VY cursors can be enabled via the Delta V switch. The $\Delta V1$ cursors become the ΔVX cursors and the $\Delta V2$ cursors become the ΔVY cursors, and pressing the Delta V switch toggles between them. The ΔVX cursors present a voltage measurement dependent upon the difference between the position of the cursors and the CH 1 VOLTS/DIV setting. Likewise, the ΔVY cursors present a voltage measurement dependent upon the difference between the position of the cursors and the CH 2 VOLTS/DIV setting. The ΔVX cursors are similar in appearance to the time cursors, i.e. vertical lines on the crt, whereas the ΔVY cursors are similar in appearance to the voltage ($\Delta V1$, $\Delta V2$) cursors. If the channel VOLTS/DIV switches are in UNCAL, ΔVX and ΔVY measurements will be displayed as ratios with 5 screen divisions equal to 100%.

DELTA t 1/DELTA t Switch—Activates the Delta Time (Δt) measurement function and cancels any other Delta measurement functions when momentarily pressed in. When the Δt function is active, momentarily pressing in the Δt button selects the $1/\Delta t$ ($1/\Delta t$) function. Subsequent operation of this button toggles between the Δt and $1/\Delta t$ functions. The CRT Readout displays the time difference (Δt), or its reciprocal ($1/\Delta t$), between the two vertical cursors with SEC/DIV scaling defined by the positions of the SEC/DIV and MAG switches. When the SEC/DIV switch selects the EXT CLK function, the Δt function displays the difference between the two cursors in graticule divisions, and the $1/\Delta t$ function displays its reciprocal. The positions of the cursors on the display are set by the Cursor Position control. In NON-STORE, if the SEC/DIV CAL control is not in the detent position, Δt cursor difference is expressed as a ratio with five divisions corresponding to a 100% ratio, and $1/\Delta t$ as phase with five divisions corresponding to 360 degrees. In STORE, if the SEC/DIV CAL control is not in the detent position, the SEC/DIV switch setting is multiplied by 100 times, except at SEC/DIV switch settings faster than 10 ms, when the SEC/DIV CAL control has no effect.

In STORE mode, Delta t cursors are attached to the waveform(s) (waveform based cursors). Once on the required measurement points, operation of both the Horizontal POSITION control and/or the Horizontal MAG switch will result in the cursors moving with the waveform rather than independent of it.

TRACK/INDEP switch—Selects either the tracking or independent mode for the Cursor Position control. When in the TRACK mode, the difference between cursors

does not change with rotation of the Cursor Position control. When the Cursor Position control is rotated, both cursors move equally until the limit of either is reached. If INDEP is selected, the cursors are independently movable using the Cursor Position control.

Cursor Position Control—Positions the Delta time cursors (vertical line) when either the Δt or $1/\Delta t$ Measurement Mode is active. When the ΔV Measurement Mode is active, the control positions the Delta Voltage cursors (horizontal line). Rotating the control clockwise moves the ΔV cursors upwards or the Δt cursors to the right. Pushing the Cursor Position control will toggle the selection of the active cursor.

ON/OFF Control—When Cursor Measurement mode is active, depressing this button cancels the cursor measurement mode, extinguishing the cursors and the cursor measurement display. When the Cursor Measurement mode is inactive, depressing this button enables the cursor measurement mode, enabling the cursors and the cursor measurement display. When the instrument is first switched on, the Readout display will indicate the current switch settings, and $\Delta V1$ will be operative: if CH 1 or BOTH is selected, or, if CH 2 is selected, $\Delta V2$ will be operative.

REAR PANEL

Fuse Holder—Contains the ac-power-source fuse. See the rear panel nomenclature for fuse rating and line voltage range.

Detachable Power Cord Receptacle—Provides the connection point for the ac power source to the instrument.

Line Voltage Selector (Mains switch)—Selects the line voltage range either 115 V or 230 V.

SIDE PANEL

EXT CLOCK—Provides a TTL compatible input for external clock signals to the storage acquisition circuit. The EXT CLOCK input signal is selected when the SEC/DIV switch is in the EXT CLK position. The maximum input frequency permitted depends on the display mode (RECORD or ROLL). The mode is selected with the Variable SEC/DIV control. The frequency ranges are dc to 10 MHz in RECORD mode (Variable SEC/DIV control in CAL detent) and dc to 4 kHz in ROLL mode (Variable SEC/DIV control out of the CAL detent position).

CRT READOUT

The Readout system provides an alphanumeric display of information on the crt along with the waveform displays. The readout is displayed in two rows of characters. One row is within the top graticule division, the other within the bottom graticule division.

Cursor Type—Indicates which Δ function has been selected. Possible values are: $\Delta V1$, $\Delta V2$, ΔT , $1/\Delta T$, Ratio, Phase, ΔVX , and ΔVY .

Cursor Delta Value—Indicates the distance between the two cursors. Units will depend upon the cursor type.

Trig—Indicates that the following information relates to the Trigger point. This field is used for information only.

Trigger Value—Indicates the value of the Trigger level. This field is disabled in X-Y mode and a number of other trigger modes as described on page 12.

Trigger Source—Indicates the current Trigger Source. Possible values are: CH 1, CH 2, VERT and EXT.

CH 1 Vertical Deflection—Indicates the current CH 1 VOLTS/DIV switch setting. A > sign appears before the value if the switch is in the UNCAL position, a ~ sign appears after the value if the input is AC coupled, and B_L appears if the channel bandwidth is limited.

ADD—If the instrument is set for ADD Mode, a + sign appears in this field, otherwise the field is blank.

CH 2 Vertical Deflection—Indicates the current CH 2 VOLTS/DIV switch setting. A > sign appears before the value if the switch is in the UNCAL position, a ~ sign appears after the value if the input is AC coupled, B_L appears if the CH 2 bandwidth is limited, and a down arrow (\downarrow) is displayed if CH 2 is inverted.

Horizontal Deflection—Indicates the current value of the SEC/DIV switch. A > sign appears before the value if the switch is in the UNCAL position.

Acquisition Status—Indicates whether the instrument is in SAVE or ROLL mode. This field is only active in STORE mode.

The ΔT , $1/\Delta T$, ΔV_X , and associated Phase and Ratio cursors are displayed as vertical lines on the crt. The ΔV_1 , ΔV_2 , ΔV_Y and associated Ratio cursors are displayed as horizontal lines on the crt.

MAKING MEASUREMENTS

RECORD MODE ACQUISITION:

With the signal or signals to be measured applied to the vertical inputs:

SET: STORE/NON-STORE to STORE (in).

SET: ACQ SAVE/CONTINUE to CONTINUE (out).

SET: Vertical MODE switches to display either CH 1, CH 2, or BOTH (CH 1 and CH 2) as you require for the applied signals.

SET: Trigger MODE and SOURCE to the appropriate setting for the desired triggering operation.

SET: 25%/75% PRE-TRIG to the desired amount of pretrigger to be acquired.

SET: SEC/DIV to the desired setting. The switch setting must be in the range 20 ms/div to 20 μ s/div for RECORD mode; SEC/DIV settings faster than 20 μ s are not permitted in STORE mode.

ADJUST: Trigger LEVEL and SLOPE for a stable display.

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SET: SAVE/CONTINUE to SAVE when the signals are acquired.

ROLL MODE ACQUISITION:

SET: PRETRIG 25%/75% to 25%.

SET: STORE/NON-STORE to STORE (in).

SET: SAVE/CONTINUE to the CONTINUE position (out).

SET: Vertical MODE switches to display either CH 1, CH 2 or BOTH (CH 1 and CH 2).

SET: The SEC/DIV switch to between 0.5 s and 10 ms.

SET: The SAVE/CONTINUE switch to SAVE when the waveform you want to measure has been acquired.

ACQUISITION SAVE REF:

REPEAT: the ROLL or RECORD mode acquisition procedure.

PRESS: Reference SAVE REF. The signal(s) that had been acquired and displayed are now copied into the reference memory and the reference waveforms are displayed.

ROTATE: The Reference POSITION control to vertically position the SAVE REF waveform apart from the original acquisition. Subsequent acquisitions can then be compared to the reference waveform.

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PRESS: The Reference DISPLAY ON/OFF button to turn reference waveforms display on or off. Reference waveforms remain in memory upon selecting NON-STORE mode.