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USING THE

**2201**

DIGITAL STORAGE  
OSCILLOSCOPE

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**Tektronix®**  
COMMITTED TO EXCELLENCE

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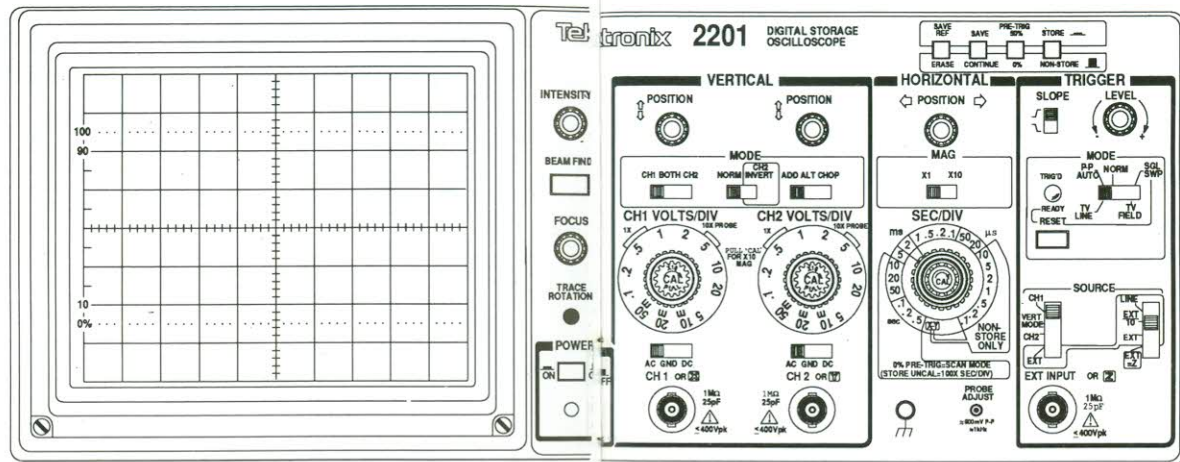
## INTRODUCTION

The 2201 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 10 megasamples per second. The acquisition is 2K 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 2K record or two 2K records, one for each channel.

For flexibility in viewing events both before and after the trigger event, two trigger points can be selected, 0% and 50%. 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 20 MHz analog oscilloscope. The 2201 offers versatility in triggering, high accuracy in both vertical and horizontal systems, and excellent display quality.

## OSCILLOSCOPE CONTROLS

### CRT CONTROLS:

**INTENSITY**—Adjusts the brightness of all displayed waveforms.

**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**—Controls 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.

**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; the record length is 2K.

**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.

**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.

**10X**—Front-panel marking that indicates the deflection factor set by the VOLTS/DIV switch when a 10X probe 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 counterclockwise rotation of the variable knob. The switch detent at full clockwise rotation is the CAL position of the variable knob.

**AC-GND-DC (Input Coupling)**—Select 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.

**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.

## HORIZONTAL SYSTEM CONTROLS:

**POSITION**—Positions all the waveforms horizontally over a one-sweep-length range in X1 or X10 Magnification.

**SEC/DIV**—Selects calibrated sweep rates from 0.5 s to 0.1  $\mu$ s per division in a 1–2–5 sequence of 21 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).

If a SEC/DIV range above 20  $\mu$ s is selected while in STORE mode, the display is flashed at a 4–Hz rate, indicating that an illegal control setting has been selected. The acquisition continues at the 20  $\mu$ s/div rate when the display is flashing.

**Table 1**  
**Storage Modes**

PRETRIGGER 0%/50%	X–Y	0.5 s– 10 ms	20 ms– 20 $\mu$ s	10 $\mu$ s– 0.1 $\mu$ s
0%	CONTROL ERROR	SCAN	RECORD	CONTROL ERROR
50%	CONTROL ERROR	RECORD	RECORD	CONTROL ERROR

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

**SCAN Mode**—Continuously acquires and displays signals. The waveform display overwrites the previous acquisition from left to right. 50% pretrigger is not available in SCAN mode.

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.

**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 counterclockwise rotation increases the slowest sweep time per division to at least 2 s.

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 (see Table 2). The control has no effect in STORE mode at SEC/DIV switch settings faster than 10 ms.

**MAG**—Selects the amount of horizontal magnification: X1 or X10. Magnification occurs around the center vertical graticule division in both NON–STORE and STORE.

**Table 2**  
**Extended SEC/DIV Settings**

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:

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

**LEVEL**—Selects the dc level that the Trigger signal must pass through to produce triggering.

**TRIG'D/READY**—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 0%/50% 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.

**Trigger MODE**—Determines the NON-STORE sweep and STORE acquisition triggering mode. STORE mode triggering operation also depends on the position of the SEC/DIV switch. In STORE, all the triggered modes (including P-P AUTO when an auto trigger is generated) have the trigger-point indicator displayed as an intensified dot in the waveform RECORD at the 50% pretrigger point.



**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 at the 50% position when selected by the 0%/50% pretrigger button.

**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.

**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.

**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.

**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.

**SOURCE**—Determines 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.

**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 signals.



**CH 2**—Trigger signal is obtained from the CH 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.

**EXT**—Selects external triggers. The actual form these triggers take is selected by the second SOURCE switch.

**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.

## STORAGE CONTROLS:

**STORE/NON-STORE**—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 0%/50%**—Selects either post-trigger or 50% pretrigger. When in SEC/DIV settings of 10 ms to 0.5 s, 0% pretrigger selects SCAN mode. When 50% pretrigger is selected, the trigger position is shown on the display as an intensified dot.

**SAVE/CONTINUE**—Stops the display from being updated when pressed in. If the display mode is SCAN, 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.

**Reference SAVE/ERASE**—When in the ERASE position, the stored waveform is superimposed on the reference waveform. When in the SAVE position, the reference waveform is frozen at the current position but the current acquisition display can be moved.

## 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.

## 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: SAVE/CONTINUE to CONTINUE (out).

SET: Vertical MODE switches to display 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: 0%/50% 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  $\mu$ s/div for RECORD mode; SEC/DIV settings faster than 20  $\mu$ s are not permitted in STORE mode.

ADJUST: Trigger LEVEL and SLOPE for a stable display.

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

### SCAN MODE ACQUISITION:

SET: PRETRIG 0%/50% to 0%.

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

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

SET: Vertical MODE switches to display 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 SCAN or RECORD mode acquisition procedure.

PRESS: Reference SAVE/ERASE. The signal(s) that had been acquired and displayed are now copied into the reference memory and the reference waveforms are displayed. Subsequent acquisitions can now be compared to the reference signal(s).