



### Discover Digital Capabilities

With the push of a button, the 2200 series of digital storage oscilloscopes bring the power of digital to your measurement needs. Now you can capture and view events that are difficult or impossible to see on an analog oscilloscope, such as fast transients, single-shot events, elusive glitches, and low-speed phenomena. With pre-trigger capability, you can see what is occurring before a trigger event. And since waveforms can be stored, you can recall them later for analysis or comparison to newly acquired data. For easy documentation, waveforms can be sent to a printer or plotter, or transferred to a PC for subsequent analysis and data storage.

### Capture and Display Narrow Glitches

The 2230/2221/2220 DSO's feature 20 MS/s sampling rates, with repetitive sampling to the full analog bandwidth of the oscilloscope. In addition, each offers Tek's proprietary peak-detect mode, for catching signal extremes or glitches that would otherwise be missed between sample points. Elusive glitches as narrow as 100 ns are always captured, even at the slowest sweep speeds.

### Time-Saving Features

The 2230 and 2221 both offer additional features that save you time and ensure accuracy. Cursors and CRT readout provide for simultaneous voltage and timing measurements for fast, accurate waveform analysis. Weighted signal averaging can be used to remove unwanted noise from a signal. Accumulate Peak Detect mode allows you to capture extremes in signal variations or drift over time.

### Flexibility and High Performance

The 2230 adds benefits that are normally found only on much more expensive products. Features like dual time-base operation, point-selectable trigger positioning, a choice of 1K and 4K record length, and adjustable sweep limits and average weighting. Waveforms can be saved in one of three reference-memory locations, then subsequently repositioned, expanded vertically, and horizontally magnified by a factor of ten. With either the GPIB or RS-232 option, you get an additional 26K of battery-backed memory for storing and retaining up to 26 additional waveform sets for up to three years.

These capabilities, and more, coupled with Tek's proven reliability and support, mean you are assured of outstanding value and long life from your oscilloscope investment.

## 2230/2221/2220

### TYPICAL APPLICATIONS (2230/2221/2220)

- Teleservicing
- Medical Equipment Servicing
- Digital Design and Troubleshooting
- Power Supply Design and Troubleshooting

### BENEFITS

- UL Listed, CSA and VDE Certified
- 3-Year Warranty, 5-Year Optional

### FEATURES

- 100-MHz Analog/Digital Bandwidth (2230); 60 MHz (2221, 2220)
- 100 ns Glitch Capture at Any Speed
- 4K Record Length (1K/4K Selectable 2230)
- Pre/post Triggering (Point Selectable 2230)

- Cursors and Readout (2230, 2221)
- Signal Averaging (2230, 2221)
- Three Save Reference Memory Locations (2230), One location (2220, 2221)
- Expand, Compress, Reposition Stored Waveforms (2230)
- Dual Time Base (2230)
- GPIB or RS-232 Comm Options
- 26K Extended Waveform Storage (with 2230 Comm Options)

### Analog and Digital Versatility

Now get the best of both worlds—analogue and digital—with the 2200 series of digital storage oscilloscopes. In analogue mode, the 2230, 2221, and 2220 operate as conventional oscilloscopes, with the ability to capture complex waveforms with the ease of use and familiarity you expect from Tektronix. Switch to digital operation, and powerful new capabilities are at your command.

## CHARACTERISTICS

The following characteristics are common to the 2230, 2221, and 2220 except where indicated.

### DIGITIZER AND MEMORY

**Speed**—Digitizing rates from 20 MS/s at 5  $\mu$ s/div and faster to 20 samples/s at 5 s/div. CHOP/ALT modes effectively halve the digitizing rate/waveform. The effective sampling rate in Repetitive Storage mode is 2 GS/s.

**Useful Storage Bandwidth**—Single Shot: Useful storage bandwidth is the maximum sampling rate (20 MS/s) divided by the desired points/signal period. Repetitive Storage Mode: DC to 100 MHz (2230); DC to 60 MHz (2220, 2221).

**Resolution**—Vertical: 8 bits, 25 levels/div. Horizontal: 10 bits, 100 points/div.

**Acquisition/Process Modes**—Sample, Peak Detect, Average (2230, 2221) Accumulated Peak Detect.

**Peak Detect (Enhanced Envelope) Mode**—100-ns minimum pulse width for 100% probability of 50% signal amplitude capture. 10 MS/s sampling rate.

**Average Mode**—(2230) Normalized Average weight is selectable from  $1/1$ ,  $1/2$ ,  $1/4$ ,  $1/8$ ,  $1/16$ ,  $1/32$ ,  $1/64$ ,  $1/128$ ,  $1/256$ . Number of sweeps averaged adjustable from 1 to 998,000 or to an unlimited number. (2220, 2221). Normalized weight of average is  $1/4$  for 2220,  $1/16$  for 2221. (2220 Average mode used for 2  $\mu$ s/div and faster sweep settings.)

**Pre/Posttrigger**—(2230)  $7/8$  (Pretrig) or  $1/8$  (Posttrig) of waveform acquisition is prior to the trigger event. Trigger position menu selectable over the entire record. (2220, 2221)  $7/8$  (pretrig),  $1/2$  (midtrig) or  $1/8$  (posttrig) of waveform acquisition window prior to trigger event.

**Record Length**—(2230) 4K or 1K record length, selectable. (2220, 2221) 4K record length. Dual Channel: 2K per channel.

**Save-Reference Memory**—(2230) One 4K or three 1K acquisitions may be saved in reference memory. Options 10 and 12 offer 26K of battery backed reference memory, allowing 26 waveform sets to be saved. (2220, 2221) One 4K acquisition may be saved in reference memory.

**Total Cursor Accuracy**—Voltage:  $\pm 3\%$  of delta voltage reading. Time difference: 5s to 5  $\mu$ s/div.  $\pm 1$  sample display interval (+1 if in Peak or ACC Peak); 2  $\mu$ s to 0.05  $\mu$ s/div  $\pm 2$  sample display intervals (+2 if in ACC Peak).

**X-Y Plotter Output**—Standard on 2230, 2221, and 2220. The oscilloscopes plot all displayed waveform(s) and readout information in either Auto or Manual Plot mode. The plotting of the graticule is selectable on the 2230. Plotter pen lift is adjustable with a relative speed range of 1 to 10 div/s.

**External Clock**—Provides an input for Ext Clock signals, dc to 1 kHz, to the storage acquisition system.

### VERTICAL SYSTEM (2 Identical Channels)

**Bandwidth** (–3 dB) and Rise Time (Nonstore)—(2230) 100 MHz and 3.5 ns, derated to 80 MHz and 4.4 ns at 2 mV/div and outside 0 to +35°C. (2220, 2221) 60 MHz and 5.8 ns, derated to 50 MHz and 7.0 ns at 2 mV/div and outside 0 to +35°C.

**Bandwidth Limit**—(2230) 20 MHz  $\pm 10\%$ . (2220, 2221) 10 MHz  $\pm 15\%$ .

**Deflection Factor and Accuracy (Store/Nonstore)**—2 mV to 5 V/div in 1-2-5 sequence. Accuracy: 15-35°C: 2%; 0-50°C: 3% Uncalibrated: Continuously variable between steps by at least 2.5:1.

**Vertical System Operating Modes**—CH 1, CH 2, CH 2 Invert, ADD, ALT, CHOP (500 kHz nonstore).

**Common-Mode Rejection Ratio**—For signals of 6 div or less, at least 10:1 (at 50 MHz).

**Input R and C**—1 M $\Omega$ , 20 pF.

**Maximum Input Voltage (AC and DC Coupled)**—400 V (dc + peak ac) or 800 V (p-p to 10 kHz).

**Channel 1/Channel 2 Isolation**— $\geq 100:1$  at 50 MHz.

**AC-Coupled Lower Cutoff Frequency**—10 Hz or less at –3 dB.

**Automatic Scale Factor**—(2230, 2221) Probe tip deflection factors for coded probes are automatically indicated in the CRT readout.

### HORIZONTAL SYSTEM

**A Time Base**—0.05  $\mu$ s to 0.5 s/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div. In Store mode, lower sweep speed is extended to 5 s/div.

**B Time Base**—(2230) 0.05  $\mu$ s to 50 ms/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div.

**Variable Sec/Div Control**—In Nonstorage mode, uncalibrated variable extends sweeps by at least 2.5:1. In storage mode, a 4K acquisition is compressed to 1K for on-screen viewing.

**Sweep Linearity**— $\pm 5\%$  over any two of the center eight divisions.

**Time-Base Accuracy**—Storage mode: 0.1% over full 10 cm (or div).

Nonstorage Mode	15 to 35°C	0 to +50°C
Unmagnified	$\pm 2\%$	$\pm 3\%$
Magnified	$\pm 3\%^{*1}$	$\pm 4\%^{*2}$

\*1 4% at 0.05  $\mu$ s/div.

\*2 6% at 0.05  $\mu$ s/div.

**Horizontal Operating Modes**—(2230) Nonstorage: A, Alternate with A intensified by B, and B; Storage: A, A intensified by B, and B.

### DELAYED SWEEP (2230)

**Delayed Sweep Delay Times**—Continuously variable with 10-turn control from less than 0.5 div plus 300 ns to greater than 10 div.

**Differential Delay Time Accuracy**— $\pm 1\%$  (+15 to +35°C);  $\pm 2\%$  (0 to +50°C).

**Delay Jitter**—5,000:1 (0.02%), nonstore mode only.

### TRIGGERING

#### 'A' Trigger Sensitivity

2230	Internal	External
10 MHz	0.35 div	40 mV
100 MHz	1.5 div	200 mV

**B Trigger (2230 Internal Only)**—Sensitivity: 0.35 div at 10 MHz; 1.5 div at 100 MHz.

**Trigger System Operating Modes**—Normal, P-P Automatic, TV Line, TV Field, and Single Sweep. HF Rej triggering attenuates signals above 40 kHz. Lowest usable frequency for P-P Automatic is 20 Hz.

**Trigger Coupling**—Automatic coupling with internal signal sources: AC with P-P Automatic and TV Field; DC with Normal and Single Sweep.

**Trigger Sources**—A trigger: Internal, external, and line. B trigger (2230): Internal only. **External Trigger Input**—Input Coupling: AC, dc, or dc divide by 10. Bandwidth: 100 MHz (2230), 60 MHz (2220, 2221); ac-coupled lower cutoff frequency is 10 Hz or less at –3 dB. Maximum safe input voltage same as scope's vertical channels.

**Variable Hold-Off**—(Non-Store)  $\leq 1:10$ .

### X-Y MEASUREMENTS

**Deflection Factors**—Same as scope's vertical system with the Volts/Div switch in calibrated detent.

**Accuracy**—Storage Mode is same as digital storage vertical-deflection system.

Nonstorage	Y-Axis	X-Axis
+15 to +35°C	$\pm 2\%$	$\pm 3\%$
0 to +50°C	$\pm 3\%$	$\pm 4\%$

**Storage-Mode Bandwidth**—(2230) dc to 100 MHz. (2220, 2221) dc to 60 MHz. Bandwidth changes proportionate to sweep speed.

**Nonstorage Bandwidth**—Y-axis same as scope's vertical system, X-axis: 2.5 MHz.

**Nonstorage Phase Difference**—Between X and Y amplifiers:  $\pm 3^\circ$  from dc to 150 kHz.

**Storage-Mode Phase Difference**—Time difference between Y-axis and X axis is no more than 100 ns. The X-axis is sampled before the Y-axis. Between X and Y amplifiers: Less than  $\pm 2^\circ$  referenced to a 10-division signal period.

**Nonstorage Bandwidth**—Y-axis same as scope's vertical system, X-axis: 2.5 MHz.

**Nonstorage Phase Difference**—Between X and Y amplifiers:  $\pm 3^\circ$  from dc to 150 kHz.

**Storage-Mode Phase Difference**—Time difference between Y-axis and X-axis is no more than 100 ns. The X-axis is sampled before the Y-axis. Between X and Y amplifiers: Less than  $\pm 2^\circ$  referenced to a 10-division signal period.