TEK 100-MHz, 60-MHz DIGITAL-STORAGE OSCILLOSCOPES

2200 SERIES

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 M$	ext{S/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—analog and digital—with the 2200 series of digital storage oscilloscopes. In analog 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 MSa/s at 5 μs/div and faster to 20 samples at 5 s/div. CHOP/ALT modes effectively halve the digitizing rate waveform. The effective sampling rate in Repetitive Storage mode is 2 GSa/s.

Useful Storage Bandwidth—SingleShot: Useful storage bandwidth is the maximum sampling rate (20 MSa/s) divided by the desired point/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/Preload Mode—Simple, Peak Detect, Average (2220, 2221) Accumulated Peak Detect.

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

Average Mode—(2230) Normalized Average weight is selectable from 1/3, 1/5, 1/7, 1/9, 1/11, 1/15, 1/21, 1/27. 1/30. Number of sweeps averaged adjustable from 1 to 998,000 or to an unlimited number (2220, 2221). Normalized weight of average is 1/3 for 2220, 1/9 for 2221. (2220 Average mode used for 2 μs/div and faster sweep settings.)

Pre/Posttrigger—(2230) 1/4 (Pretrig) or 1/4 (Posttrig) of waveform acquisition is prior to the trigger event. Trigger position menu selectable over the entire record. (2220, 2221) 1/2 (Pretrig), 1/2 (Midtrig) or 1/2 (Posttrig) of waveform acquisition window prior to trigger event.

Record Length—(2230) 4K or 1K record length, selectable. (2220, 2221) 1K 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: ±3% of delta voltage reading. Time difference: 5s to 5 μs/div, ±1 sample display interval (+1 if in Peak or ACC Peak); 2 μs to 0.05 μs/div ±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 divider.

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 m/s/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 m/s/div and outside 0 to +35°C.

Bandwidth Limit—(2230) 20 MHz ±10%. (2220, 2221) 10 MHz ±15%.

Deflection Factor and Accuracy (Store/Nonstore)—2 mV to 5 V/div in 1:2-5 sequence. Accuracy: 15:38°C: 2%; 0-50°C: 3% Uncalibrated: Continuous variable between steps by at least 2.5:1.

Vertical System Operating Modes—CH1, CH 2, CH2 invert, ADD, ALT, CHOP (500 kHz nonstore).

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

Input R and C—1 MΩ, 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—±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 μs to 0.5 s/div in 1:2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ms/div. In Store mode, lower sweep speed is extended to 5 s/div.

B Time Base—(2230) 0.05 μs to 50 ms/div in 1:2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ms/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—±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 ±2% ±3%

Magnified ±3%* ±4%*2

* 4% at 0.05 μs/div.

* 6% at 0.05 μs/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—±1% (+18 to +35°C); ±2% (0 to +50°C).

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

TRIGGERING

2230 Internal External

10 MHz 0.35 div 40 mV

100 MHz 1.5 div 200 mV

2220/2221 Internal External

10 MHz 0.35 div 40 mV

60 MHz 1.0 div 120 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 attenugates 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) ≤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 ±2% ±3%

0 to +50°C ±3% ±4%

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

Storage-Bandwidth Y-axis same as scope’s vertical system, X-axis: 2.5 MHz.

Storage Phase Difference—Between X and Y amplifiers: ±3° 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 ±3° 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: ±3° from dc to 150 kHz.

Storage-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 ±3° referenced to a 10-division signal period.
CRT AND DISPLAY FEATURES
CRT—8 x 10 cm display; internal graticule, nonilluminated, accelerating potential is 14 kV, GH (P3) phosphor standard.
Controls—Beam finder, focus, trace rotation, (2230). Storage/Readout intensity (2221). Separate A and B sweep intensity (2230).
Z-Axis—Sensitivity: 5 V causes noticeable modulation, positive voltage decreases intensity. Usable frequency range is dc to 20 MHz.
Maximum safe input voltage is 30 V (dc + peak ac) or 10 V ac p-p at 1 kHz or less. Input resistance is approximately 10 kΩ.

OTHER CHARACTERISTICS
Probe Adjustment Signal—0.5 V ±5% square wave at 1 kHz ±20%.

POWER REQUIREMENTS
Line-Voltage Range—90 to 250 V ac.
Line Frequency—48 to 440 Hz.
Maximum Power Consumption—85 W, 2.0 A, at 250 V (slow blow line fuse).

ENVIRONMENTAL
Temperature—Operating: 0 to +50 °C; Non-operating: −55 to +70 °C.
Altitude—Operating: to 4,500 meters (15,000 ft), maximum operating temperature decreased 1 °C per 1,000 ft above 5,000 ft. Non-operating: to 15,000 m (50,000 ft).
Humidity—Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C, for Type III, Class 5 instruments.
Radiated and Conducted Emissions—Requirements per VDE-0871. Meets Class B.
Vibration—Operating: 15 minutes along each of three axes at a total displacement of 0.016-inch p-p (2.4 g's at 55 Hz) with frequency varied from 10 to 55 Hz in one-minute sweeps; hold for 10 minutes at 55 Hz in each axis; all major resonances must be above 55 Hz.
Shock—Operating and Nonoperating: 30 g's, half-sine, 11-ms duration, 3 shocks per axis for a total of 18 shocks.

PHYSICAL CHARACTERISTICS

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Option 10 GPIB Interface
Option 12 RS-232C Interface

GPIB (Option 10) and RS-232C (Option 12) interfaces are available for the 2230, 2221, and 2220. Either interface can transmit and receive waveform data. Most front-panel settings can be queried and many functions can be controlled via the interface; e.g., single-sweep reset. 2230 and 2221 Option 10 or 12 interfaces also allow messages or computed results to be displayed on screen. Both options for the 2230 include a battery-backed reference memory (minimum lifetime 3 years) for storage of up to 26 additional waveform sets.

The Option 10 GPIB interface conforms to IEEE Standard 488.1-1987. It is fully compatible with Tektronix Standard Codes and Formats. Primary address (0-30), message terminator (EOI or LF/EOL), and talk/listen mode are selected by a switch on the oscilloscope side panel. Maskable interrupts for RQS and OPC can be programmed.

IEEE Standard 488.1-1987 Interface Function Subsets Implemented—SHI, AHI, T6, L3, SRI, RL2, PPO, DCI, DT0, C0.
SOFTWARE

- RS-232-C Software Utilities
- GPIB Software Utilities
- Advanced Data Analysis and Controller

Tektronix offers a variety of software packages to help you transform your 2200 DSO into a highly capable system component. By equipping your scope with either GPIB or RS-232 interface options, you can send and receive digitized waveform data to and from external devices such as controllers and computers. With RS-232, data can even be sent over phone lines, offering excellent potential for remote-site monitoring via modem and phone linkages.

IBM PC Utility Software (S49Z200 Series)—The S49Z201/202/203 Utility Software packages consist of a set of subroutines intended to speed application development for users of Tek's 2230, 2221, 2220 digital scopes with RS-232 or GPIB interface options.

This software is capable of being used directly for essential data handling functions, including transmitting and receiving waveforms, displaying waveforms using PC graphics, and storing and retrieving waveforms from disk storage. With these capabilities, you can create a library of reference waveforms, or maintain a record of previous acquisitions for later review or analysis.

The 2200 DSO's also support limited command sets for changing select front panel and menu settings, such as acquisition mode and single sweep trigger reset, thereby enabling remote babysitting applications.

In addition, you can utilize the subroutines for integrating essential data handling and instrument communication protocols into your own developed application programs. Applications such as automated data analysis, waveform comparison, or data logging can be created more easily with less development time.

S49Z121/122 Tek 4041 Software—These programs include subroutines written in 4041 BASIC to perform many necessary instrument control functions and data handling procedures with the Tek 4041 controller. S49Z122 further enables you to perform complex mathematical and statistical analysis on retrieved waveforms.

GURU II, SPD, and ASYST—There are several other advanced software packages offered by Tektronix that are easily integrated with the 2230. They include: GURU II (GPIB User's Resource Utility) Software, which provides subroutines written in BASIC to support application environment work; SPD (Signal Processing and Display) Software for performing complex waveform analysis on acquired waveforms; and ASYST Drivers, consisting of instrument control subroutines.

For more information on utility and application software, see the Test and Measurement Software Section or consult your local sales or applications engineer.

TECHNICAL ASSISTANCE SERVICES

When you need technical assistance to supplement your own resources, Tektronix can arrange the services of an application engineer skilled in meeting your needs. For more information, see Total Solution/New Product section, page 35 or consult your local sales engineer.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center. Toll free: 1-800-426-2200, Ext. 99.
ORDERING INFORMATION

2220—60 MHz Single Time-Base
Digital Storage Oscilloscope $2,995
Includes: Two P6109 10X Voltage Probes, front- panel cover (200-2520-00), Accessory Pouch (016-0677-02), Operator Manual (070-5301-01), User Reference Card (070-5681-00),
 2221—60 MHz Single Time-Base
Digital Storage Oscilloscope $3,995
Includes: Two P6109 10X Voltage Probes, front- panel cover (200-2520-00), Accessory Pouch (016-0677-02), Operators Manual (070-6530-00), Users Reference Card (070-5370-00),
 2230—100 MHz Dual Time-Base
Digital Storage Oscilloscope $4,995
Includes: Two P6109 10X Voltage Probes, front- panel cover (200-2520-00), Accessory Pouch (016-0677-02), Operators Manual (070-4998-02), Users Reference Card (070-5370-00),

OPTIONS
Option 10—(2230) GPIB IEEE-488 Interface includes 26K battery backed memory $750
Option 10—(2220/2221) GPIB IEEE-488 Interface $500
Option 15—(2230) RS232C Interface includes 26K battery backed memory $750
Option 12—(2220/2221) RS232C Interface $500
Option 1C—C-5C Option 04 Camera $495
Option 1K—K212 Portable Instrument Cart $350
Option 1T—Transit Case $215
Option 1R—Rackmount* $500

FIELD RETRIFT KITS
2230F10—Field Retrofit kit for Option 10 $750
2230F12—Field Retrofit kit for Option 12 $750
2221F10—Field Retrofit kit for Option 10 $500
2221F12—Field Retrofit kit for Option 12 $500
2220F10—Field Retrofit kit for Option 10 $500
2220F12—Field Retrofit kit for Option 12 $500
** Contact your local sales office.

SOFTWARE
S492201—RS-232 Utility Software $50
Includes: Software diskettes (5.25 inch); User's Manual. Required equipment and software: 2230, 2221, or 2220 Digital Oscilloscope with Option 12 (RS-232 Interface); IBM PC or fully compatible (384k bytes of RAM, 2 diskette drives, color monitor, color graphics card, DOS V2.1 or later); BASICSA Interpreter (V3.0 or later); Microsoft QuickBasic Compiler (V2.0 or V3.0); and RS-232 Cable (straight-through).
S492202—GPIB/Turbo Pascal Utility Software $50
Includes: Software diskettes (5.25 inch); User's Manual. Required equipment and software: 2230, 2221, or 2220 Digital Oscilloscope with Option 10 (GPIB Interface); IBM PC or fully compatible (512k bytes of RAM, 2 diskette drives, color monitor, color graphics card, DOS V2.1 or later); Borland's Turbo Pascal (V3.0 or above); National Instruments PC/PC2A GPIB Card, or Tektronix GURU card (or equivalent); GPIB Cable.
S492203—GPIB/BASICA Utility Software $50
Includes: Software diskettes (5.25 inch); User's Manual. Required equipment and software: 2230, 2221, or 2220 Digital Oscilloscope with Option 10 (GPIB Interface); IBM PC or fully compatible (512K bytes of RAM, 2 diskette drives, color monitor, color graphics card, DOS V2.1 or later); BASICA Interpreter or QuickBASIC Compiler; National Instruments PC/PC2A GPIB Card, or Tektronix GURU card (or equivalent); GPIB Cable.

INTERNATIONAL POWER PLUG OPTIONS
Option A1—Universal Euro 220 V, 50 Hz $229
Option A2—UK 240 V, 50 Hz $229
Option A3—Australian 240 V, 50 Hz $229
Option A4—North American 240 V, 60 Hz $229
Option A5—Switzerland 220 V, 50 Hz $229

WARRANTY PLUS SERVICE PLANS
M1—(2230) 2 Calibrations + $229
M1—(2220) 2 Calibrations + $229
M2—(2230) 2 Calibrations + $229
M2—(2220) + 2 Years Service + $338
M2—(2221) + 2 Years Service + $338
M3—(2230) 2 Calibrations & 2 Years Service + $796
M3—(2220) 4 Calibrations & 2 Years Service + $785
M3—(2221) 4 Calibrations & 2 Years Service + $785
M4—(2230) 5 Calibrations + $547
M4—(2221) 5 Calibrations + $547
M5—(2230) 9 Calibrations & 2 Years Service + $1,318
M5—(2221) 9 Calibrations & 2 Years Service + $1,307
M5—(2220) 9 Calibrations & 2 Years Service + $1,298

OPTIONAL ACCESSORIES

HC100—Color Pen Plotter $825
Option 01—GPIB Cable $140
Service Manuals—(2230) Order 070-4999-00 $25
(2220) Order 070-6531-00 $30
(2220) Order 070-4999-00* $25
(2210) Order 070-7684-00* $25
(2201) Order 070-7819-00* $25
Rackmount Conversion Kit—(2220/2230) Order 016-1003-00 $140
(2201/2200) Order 016-0819-00 $190
Padded Suitcase—Order 016-0792-01 $225
Carrying Strap—Order 346-0199-00 $17.50
Rain Cover—Order 016-0848-00 $16.25

VIEWING HOODS
(Collapsible) 016-0562-00 $15
(Polarized) 016-0180-00 $60
(Binocular) 016-0566-00 $21

CERT LIGHT FILTER, CLEAR—Order 337-2775-01 $1.95
PORTABLE POWER SUPPLY—See page 315. $2,090
BATTERY PACK—See page 316. $1,580
DC INVERTER—See page 316. $1,175
DC INVERTER MOUNTING KIT—Order 016-0785-00. $60

ISOLATORS—(Ground Isolation Monitor) A6901 $760
(Isolation Amplifier) A6902B $1,980

RECOMMENDED PROBES
Passive Voltage Probes P6008—10X Probe $260
P6062B—Switchable 1X/10X $175
P6101A—Non Attenuating 1X $53
P6121—Modular 10X $100
P6122—Modular 10X $58
High Voltage Probes P6009—1.5 KV 100X Probe $205
P6015—20 KV 1000X Probe $725

ACTIVE VOLTAGE PROBES P6201—1X FET Probe $1,280
P6202A—10X FET Probe $735
P6230—10X Bias/Offset Probe $420
P6045—Differential Probe $1,895

CURRENT PROBES P6021—AC Current Probe $450
P6022—AC Current Probe $495

A6302—DC/AC 20 A Current Probe (Requires TM500 Mainframe and AM503 Current Amplifier $625
A6303—DC/AC 100 A Current Probe (Requires TM500 Mainframe and AM503 Current Amplifier $1,320
CT—A1—1000 A Current Transformer $1,320

RECOMMENDED CARTS
K212—Portable Instrument Cart $350

RECOMMENDED CAMERAS
See Instrumentation Documentation Devices section.
C-1C—Option 04 $495
C-7—Option 02 $610
* Contact your local sales office.

TRAINING
Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. See Customer Training Section for information. For further information, or to enroll, call us at 1-800-835-9433 ext. 430.