Digital Phosphor Oscilloscopes
MSO2000 Series • DPO2000 Series

The Power to Solve Problems Quickly - The MSO2000 and DPO2000 Series digital phosphor oscilloscopes (DPOs) deliver the performance and tools you need to visualize your signals and find answers quickly. The DPO2000 Series are the first oscilloscopes to provide 1 M points of usable record length on all channels, serial trigger and decode analysis options, a variable low-pass filter that also allows you to see signal details to the oscilloscope’s full bandwidth and all in a compact form factor. The MSO2000 Series adds 16 integrated digital channels, enabling you to visualize and time correlate analog and digital signals on a single instrument. This integration extends triggering functionality across all 20 channels - which is ideal for debugging mixed analog and digital designs.

Designed to Make Your Work Easier
Wave Inspector® Navigation and Search
Imagine trying to efficiently use the Internet if search engines such as Google and Yahoo didn’t exist and Web browser features such as Favorites and Links didn’t exist. Now you know how most modern oscilloscope users feel when trying to use the long record length in their digital oscilloscope. Record length, one of the key specifications of an oscilloscope, is the number of samples it can digitize and store in a single acquisition. The longer the record length, the longer the time window you can capture with high timing resolution (high sample rate). The first digital oscilloscopes could capture and store only 500 points, which made it very difficult to acquire all relevant information around the event being investigated. Over the years, oscilloscope vendors have provided longer and longer record lengths to meet market demands for long capture windows with high resolution. These mega-point record lengths often represent thousands of screens worth of signal activity. While standard record lengths have increased greatly over

Features & Benefits
Key Performance Specifications
- 100 MHz and 200 MHz bandwidth models
- 2 or 4 analog channels
- 16 digital channels (MSO2000 Series)
- Sample rates up to 1 GS/s on all channels
- 1 Mega sample record length on all channels
- 5,000 wfm/s maximum waveform capture rate
- Suite of advanced triggers

Serial Bus Trigger and Decode
- I^2C, SPI, CAN, LIN, and RS-232/422/485/UART serial triggering, decode, and analysis options

Ease of Use Features
- Wave Inspector® Navigation and Search provides unprecedented efficiency in waveform analysis
- FilterVu™ variable low-pass filter allows for removal of unwanted signal noise while still capturing high-frequency events
- 7 in (180 mm) bright, widescreen, TFT-LCD color display
- USB 2.0 on front panel for quick and easy data storage
- USB 2.0 device port on rear panel for direct PC control of oscilloscope using USBTMC or direct printing to any PictBridge® compatible printer
- Plug ‘n’ Play PC connectivity and analysis software solutions
- TekVPI® Probe Interface supports active, differential, and current probes for automatic scaling and units
- Small footprint and light weight - only 5.3 in (134 mm) deep and 7 lb 14 oz (3.6 kg)

Mixed Signal Design and Analysis (MSO2000 Series)
- Ability to time correlate up to 4 analog and 16 digital channels
- Parallel bus trigger and analysis
- Multichannel setup and hold triggering
- Next-generation digital waveform display

Applications
- Embedded design and debug
- Mixed signal design and debug
- Power measurements
- Automotive electronics
- Education and training
- Video design and debug

Tektronix MSO2000 and DPO2000 Series Digital Phosphor Oscilloscopes

Digital phosphor technology enables 5,000 waveforms/second waveform capture and real-time intensity grading on the MSO2000 and DPO2000 Series.
# Digital Phosphor Oscilloscopes

**MSO2000 Series • DPO2000 Series**

## Characteristics

### Vertical System - Analog Channels

<table>
<thead>
<tr>
<th>Vertical System Analog Channels</th>
<th>MSO2012</th>
<th>MSO2014</th>
<th>MSO2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Channels</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Analog Bandwidth (if activated)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardware Bandwidth Limits</td>
<td>100 MHz</td>
<td>200 MHz</td>
<td></td>
</tr>
<tr>
<td>Calculated Rise Time</td>
<td>3.5 ns</td>
<td>3.5 ns</td>
<td>2.1 ns</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>AC, DC, GND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Sensitivity Range</td>
<td>8 bits</td>
<td>8 bits</td>
<td>8 bits</td>
</tr>
<tr>
<td>Vertical Resolution</td>
<td>±25 ppm</td>
<td>±25 ppm</td>
<td>±25 ppm</td>
</tr>
<tr>
<td>Max Input Voltage</td>
<td>300 Vrms with peaks ≤450 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC Gain Accuracy (with offset set to 0 V)</td>
<td>±3% for 10 mV/div to 5 V/div, ±4% for 2 mV/div to 5 mV/div</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offset Range</td>
<td>2 mV/div to 200 mV/div</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel-to-Channel Skew</td>
<td>±1 V</td>
<td>±25 V</td>
<td></td>
</tr>
</tbody>
</table>

### Vertical System - Digital Channels

<table>
<thead>
<tr>
<th>Vertical System Digital Channels</th>
<th>MSO2012</th>
<th>MSO2014</th>
<th>MSO2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Channels</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Thresholds Per Set of 8 Channels</td>
<td>±20 V</td>
<td>±20 V</td>
<td>±20 V</td>
</tr>
<tr>
<td>Threshold Accuracy</td>
<td>±100 mV + 3% of threshold setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Input Voltage</td>
<td>101 kΩ</td>
<td>101 kΩ</td>
<td>101 kΩ</td>
</tr>
<tr>
<td>Probe Loading</td>
<td>15 pF</td>
<td>15 pF</td>
<td>20 pF</td>
</tr>
<tr>
<td>Vertical Resolution</td>
<td>1 bit</td>
<td>1 bit</td>
<td>1 bit</td>
</tr>
</tbody>
</table>

### Horizontal System - Analog Channels

<table>
<thead>
<tr>
<th>Horizontal System Analog Channels</th>
<th>MSO2012</th>
<th>MSO2014</th>
<th>MSO2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Sample Rate (all channels)</td>
<td>1 GS/s</td>
<td>1 GS/s</td>
<td>1 GS/s</td>
</tr>
<tr>
<td>Minimum Peak Detect Pulse Width</td>
<td>7.0 ns</td>
<td>3.5 ns</td>
<td></td>
</tr>
<tr>
<td>Maximum Record Length (all channels)</td>
<td>1 M points</td>
<td>1 M points</td>
<td>1 M points</td>
</tr>
<tr>
<td>Maximum Duration of Time Captured at Highest Sample Rate (all channels)</td>
<td>1 ms</td>
<td>1 ms</td>
<td>1 ms</td>
</tr>
<tr>
<td>Timebase Range</td>
<td>4 ns to 100 s</td>
<td>2 ns to 100 s</td>
<td>2 ns to 100 s</td>
</tr>
<tr>
<td>Timebase Delay Time Range</td>
<td>-100 div to 5000 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel-to-Channel Skew</td>
<td>±100 ns</td>
<td>±25 ppm</td>
<td></td>
</tr>
</tbody>
</table>

### Horizontal System - Digital Channels

<table>
<thead>
<tr>
<th>Horizontal System Digital Channels</th>
<th>MSO2012</th>
<th>MSO2014</th>
<th>MSO2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Sample Rate (when using any of channels D7-D0)</td>
<td>1 GS/s (1 ns resolution)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Sample Rate (when using any of channels D15-D8)</td>
<td>500 MS/s (2 ns resolution)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Record Length</td>
<td>1 M points</td>
<td>1 M points</td>
<td>1 M points</td>
</tr>
<tr>
<td>Minimum Detectable Pulse Width</td>
<td>5 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel-to-Channel Skew</td>
<td>2 ns typical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Acquisition Modes
Sample – Acquires sampled values.
Peak Detect – Captures glitches as narrow as 3.5 ns at all sweep speeds.
Averaging – From 2 to 512 waveforms included in average.
Roll – Scrolls waveforms right to left across screen at sweep speeds slower than or equal to 40 ms/div.

Trigger System
Main Trigger Modes – Auto, Normal and Single.
Trigger Coupling – DC, HF reject (attenuates >65 kHz), LF reject (attenuates <65 kHz), noise reject (reduces sensitivity).
Trigger Holdoff Range – 20 ns to 8 s.
Trigger Signal Frequency Counter – Provides a higher accuracy means of identifying the frequency of trigger signals. Trigger Signal Frequency counter resolution is 6 digits.

Trigger Level Range
Any Channel – ±4.92 divisions from center of screen.
External (auxiliary input) – ±6.25V, 1x attenuation; ±12.5V, 10x attenuation.

Sensitivity
Internal DC Coupled
Trigger Source | Sensitivity
--- | ---
Analog Inputs | 0.4 division from DC to 50 MHz
6 divisions >50 MHz to 100 MHz
0.8 divisions >100 MHz to 200 MHz

External
(Auxiliary input) | 200 mV from DC to 100 MHz, 1x attenuation

Trigger Modes
Edge – Positive or negative slope on any channel or front-panel auxiliary input. Coupling includes DC, HF reject, LF reject, and noise reject.
Pulse Width – Trigger on width of positive or negative pulses that are >, <, =, or ≠ to a specified period of time.
Runt – Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again.
Logic – Trigger when any logical pattern of channels goes false or stays true for a specified period of time. Any input can be used as a clock to look for the pattern on a clock edge. Pattern (AND, NAND) specified for all analog and digital input channels defined as High, Low, or Don’t Care.
Setup and Hold – Trigger on violations of both setup time and hold time between clock and data present on any of the input channels.
Rise/Fall Time – Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative, or either.
Video – Trigger on line number, all lines, odd, even, or all fields on NTSC, PAL and SECAM video signals.
I²C (Optional) – Trigger on Start, Repeated Start, Stop, Missing ACK, Address (7 or 10 bit), Data, or Address and Data on I²C buses up to 3.4 Mb/s.
CAN (Optional) – Trigger on Start of Frame, Frame Type (data, remote, error, overload), Identifier (standard or extended), Data, Identifier and Data, End of Frame, Missing ACK, or Bit Stuffing Errors on CAN signals up to 1 Mb/s. Data can be further specified to trigger on ≤, ≥, <, >, =, ≠, or a specific data value. User-adjustable sample point is set to 50% by default. RS-232/422/485/UART (Optional) – Trigger on Tx start bit, Rx start bit, Tx end of packet, Rx end of packet, Tx data, Rx data, Tx Parity Error, and Rx Parity Error.
LIN (Optional) – Trigger on Sync, Identifier, Data, Identifier and Data, Wakeup Frame, Sleep Frame, or Errors such as Sync Parity or Checksum Errors. Parallel (available on MSO models only) – Trigger on a parallel bus data value.

Waveform Measurements
Cursors – Waveform and Screen Automatic Measurements – 29, of which up to four can be displayed on screen at any one time. Measurements include Frequency, Period, Delay, Rise Time, Fall Time, Positive Duty Cycle, Negative Duty Cycle, Positive Pulse Width, Negative Pulse Width, Burst Width, Phase, Positive Overshoot, Negative Overshoot, Peak-to-Peak, Amplitude, High, Low, Max, Min, Mean, Cycle Mean, RMS, Cycle RMS, Positive Pulse Count, Negative Pulse Count, Rising Edge Count, Falling Edge Count, Area and Cycle Area.
Gating – Isolate the specific occurrence within an acquisition to take measurements, using either the screen or waveform cursors.

Waveform Math
Arithmetic – Add, subtract, and multiply waveforms.

Software
NI LabVIEW SignalExpress™ Tektronix Edition LE – A fully interactive measurement software environment optimized for the MSO2000/DPO2000 Series, enables you to instantly acquire, generate, analyze, compare, import, and save measurement data and signals using an intuitive drag-and-drop user interface that does not require any programming. Standard MSO2000/DPO2000 Series support for acquiring, controlling, viewing and exporting your live signal data is permanently available through the software.
The full version (SIGEXPTE) adds additional signal processing, advanced analysis, mixed signal, sweeping, limit testing, and user-defined step capabilities and is available for a 30-day trial period standard with each instrument.
OpenChoice® Desktop – Enables fast and easy communication between a Windows PC and the MSO2000/DPO2000 Series, using USB or LAN. Transfer and save settings, waveforms, measurements and screen images.
IVI Driver – Provides a standard instrument programming interface for common applications such as LabVIEW, LabWindows/CVI, Microsoft .NET and MATLAB.
**Display Characteristics**

Display Type – 7 in (180 mm) liquid crystal TFT color display.
Display Resolution – 480 horizontal x 234 vertical pixels (WQVGA).
Graticules – Full, Grid, Cross Hair, Frame.
Format – YT and XY.
Waveform Capture Rate – Up to 5,000 wfms/sec.

**Input/Output Ports**

USB 2.0 High-Speed Host Port – Supports USB data storage devices and keyboards.
USB 2.0 High-Speed Device Port – Rear-panel port supports communication/control of oscilloscope by PC and all PictBridge® compatible printers.
LAN Port – RJ-45 connector, supports 10/100Base-T (requires DPO2CONN).
GPIB – Adapt USB 2.0 device port to a GPIB port (requires TEK-USB-488).
Video Out Port – DB-15 female connector, connect to show the oscilloscope display on an external monitor or projector (requires DPO2CONN).
Auxiliary Input – Front-panel BNC connector. Input Impedance 1 MΩ ±2%. Max input 300 VRMS with peaks ±450 V.
Probe Compensator Output – Front-panel pins, Amplitude 5.0 V, Frequency 1 kHz.
Kensington Lock – Rear-panel security slot connects to standard Kensington style lock.

**Physical Characteristics**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>mm</th>
<th>in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>380</td>
<td>15.0</td>
</tr>
<tr>
<td>Width</td>
<td>377</td>
<td>14.9</td>
</tr>
<tr>
<td>Depth</td>
<td>134</td>
<td>5.3</td>
</tr>
<tr>
<td>Weight</td>
<td>3.6</td>
<td>7.9</td>
</tr>
</tbody>
</table>

**Power Source**

Power Source Voltage – 100 to 240 V ±10%.
Power Source Frequency – 45 to 65 Hz (90 to 264 V), 360 to 440 Hz (100 to 132 V).

**Environmental Characteristics**

Temperature
Operating – 0 ºC to +50 ºC.
Nonoperating – -40 ºC to +71 ºC.

Humidity
Operating – High: 30 ºC to 50 ºC, 5% to 60% Relative Humidity. Low: 0 ºC to 30 ºC, 5% to 95% Relative Humidity.
Nonoperating – High: 30 ºC to 55 ºC, 5% to 60% Relative Humidity. Low: 0 ºC to 30 ºC, 5% to 95% Relative Humidity.

Altitude
Operating – 3,000 meters (9,843 feet).
Nonoperating – 12,000 meters (39,370 feet).

Random Vibration
Operating – 0.31 Gmax from 5 to 500 Hz, 10 minutes each axis, 3 axes, 30 minutes total.
Nonoperating – 2.46 Gmax from 5 to 500 Hz, 10 minutes each axis, 3 axes, 30 minutes total.

**Regulatory**

Electromagnetic Compatibility – 2004/108/EC.

**MSO2000 Models**

MSO2012– 100 MHz, 1 GS/s, 1 M record length, 2+16 channel mixed signal oscilloscope.
MSO2014– 100 MHz, 1 GS/s, 1 M record length, 4+16 channel mixed signal oscilloscope.
MSO2024– 200 MHz, 1 GS/s, 1 M record length, 4+16 channel mixed signal oscilloscope.

**DPO2000 Models**

DPO2012– 100 MHz, 1 GS/s, 1 M record length, 2-channel digital phosphor oscilloscope.
DPO2014– 100 MHz, 1 GS/s, 1 M record length, 4-channel digital phosphor oscilloscope.
DPO2024– 200 MHz, 1 GS/s, 1 M record length, 4-channel digital phosphor oscilloscope.

All models include: One P2221 200 MHz, 1x/10x Passive Probe per Analog Channel, User Manual and Translated Front-Panel Overlay, Documentation CD (063-4118-xx), OpenChoice® Desktop Software, NI LabVIEW Sigmascope™ Tektronix Edition LE Software, Calibration certificates document measurement traceability to National Metrology Institute(s) and ISO9001 Quality System Registration, Power Cord, and a three-year warranty. MSO models also include one P6316 16-channel logic probe and accessory kit, and accessory bag (016-2008-xx).

Please specify power plug and manual version when ordering.
For Further Information
Tektronix maintains a comprehensive, constantly expanding collection of
application notes, technical briefs and other resources to help engineers
working on the cutting edge of technology.

Product(s) are manufactured in ISO registered facilities.
Product(s) comply with IEEE Standard 488.1-1987, RS-232-C, and with
Tektronix Standard Codes and Formats.

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