# DS4000E Series
# Digital Oscilloscope

- Bandwidth: 100 MHz, 200 MHz
- Real-time sample rate: up to 2 GSa/s for each channel
- Memory depth (standard): up to 14 Mpts for each channel
- 4 analog channels (standard)
- Waveform capture rate: up to 60,000 waveforms per second
- Waveform record, playback, and analysis functions
  (standard, up to 127,000 frames)
- Innovative "UltraVision" technology
- A variety of trigger and bus decoding functions
- Low noise floor, with the minimum vertical scale 1mV/div
- A variety of interfaces: USB HOST&DEVICE, LAN (LXI-C),
  VGA, AUX, USB-GPIB (optional)
- Novel and sophisticated industrial design, easy for operation
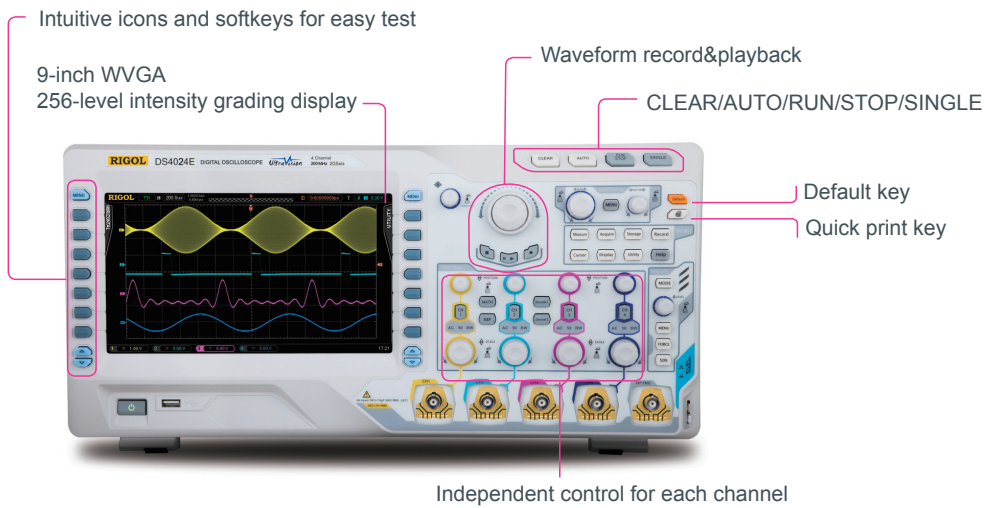- 9-inch WVGA, 256-level intensity grading display

The DS4000E series is a high-performance digital oscilloscope designed to meet the demands of the mainstream market for the design, debugging, and testing purposes. Its 4-channel design and high cost-efficiency will invigorate new vitality to the market of the economical oscilloscopes, offering more choices for the low-cost testing and measurement solutions.

RIGOL TECHNOLOGIES, INC.

# DS4000E Series Digital Oscilloscope

Intuitive icons and softkeys for easy test

9-inch WVGA
256-level intensity grading display

Waveform record&playback

CLEAR/AUTO/RUN/STOP/SINGLE

Default key

Quick print key

Independent control for each channel

*Product Dimensions: Width×Height×Depth = 440.0 mm×218.0 mm×130.0 mm*
*Weight: 4.8 kg±0.2 kg (packaging excluded)*

## ▶ Innovative UltraVision Technology

- Deep memory depth (standard, up to 14 Mpts)
- High waveform capture rate (up to 60,000 wfms/s)
- Real-time waveform record, playback, and analysis (up to 127,000 frames)
- Multi-level intensity grading display (up to 256 levels)

## ▶ Models and Key Specifications

| Model Number | DS4024E | DS4014E |
|---|---|---|
| Analog Bandwidth | 200 MHz | 100 MHz |
| Number of Analog Channels | 4 | 4 |
| Max. Real-time Sample Rate | 2 GSa/s for each channel | |
| Max. Memory Depth | 14 Mpts for each channel | |
| Max. Waveform Capture Rate | 60,000 wfms/s | |
| Hardware Real-time Waveform Record, Playback and Analysis Functions | up to 127,000 frames (standard) | |
| Probe (Standard) | 4 sets of PVP2350 350 MHz BW passive probes for all models | |

## ▶ Design Features

### Up to 60,000 wfms/s waveform capture rate
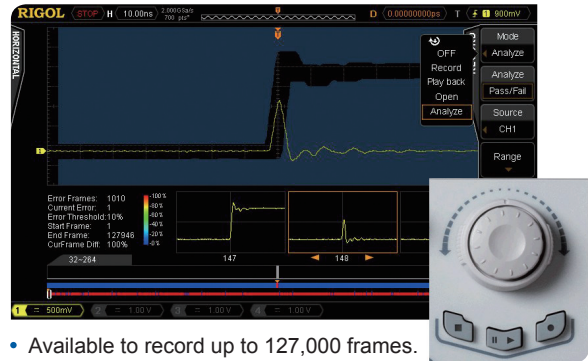


Locate the rare problem easily.
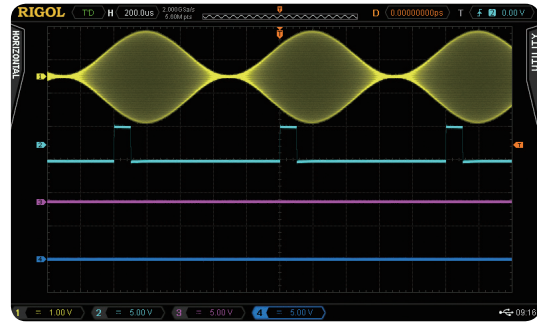
### Up to 2 GSa/s real-time sample rate and 14 Mpts memory depth for each channel



Provide the capability to see both the panorama and detail simultaneously.

### Serial bus triggering (standard) and decoding (optional)



### Advanced math function



Math operation with formula editor, not just limited to the simple operation, such as add, subtract, multiply, and divide.

### 4 analog channels (standard)



### Real-time waveform record, playback, and analysis functions (standard)



• Available to record up to 127,000 frames.
• Play back and analyze the recorded waveforms to locate the problem
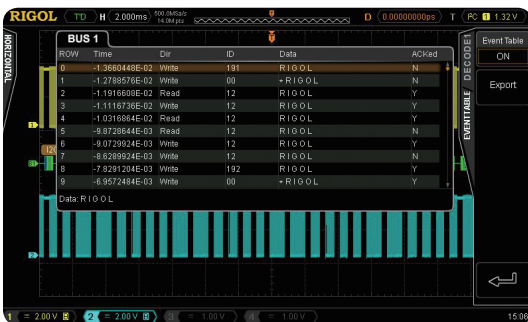
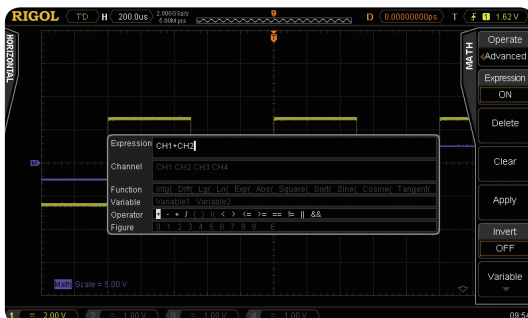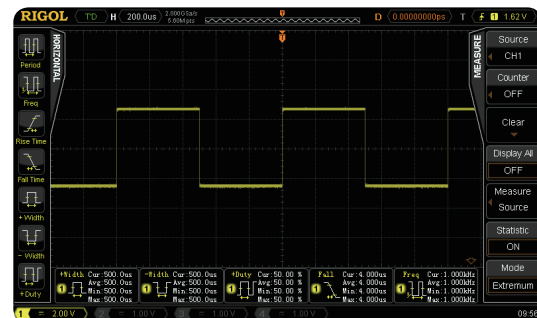### Mask test function (standard)



User-defined mask, Pass/Fail counts, stop on fail, fail alarm

### Automatic measurements with statistics

# RIGOL Probes Supported by DS4000E Series

## ▶ RIGOL Passive Probes

| Model Number | Tpye | Description |
|---|---|---|
| PVP2150 | High Z Probe | 1X: DC to 35 MHz 10X: DC to 150 MHz Compatibility: all **RIGOL** scopes. |
| PVP2350 | High Z Probe | 1X： DC to 35 MHz 10X: DC to 350 MHz Compatibility: all **RIGOL** scopes. |
| RP3500A | High Z Probe | DC to 500 MHz Compatibility: all **RIGOL** scopes. |
| RP5600A | High Z Probe | DC to 600 MHz Compatibility: DS4000E series,MSO/DS4000 series and DS6000 series. |
| RP6150A | Low Z Probe | DC to 1.5 GHz Compatibility: DS4000E series,MSO/DS4000 series and DS6000 series. |
| RP1300H | High Voltage Probe | DC to 300 MHz CAT I 2000 V (DC+AC), CAT II 1500 V (DC+AC) Compatibility: all **RIGOL** scopes. |
| RP1010H | High Voltage Probe | DC to 40 MHz DC: 0 to 10 kV DC, AC: pulse ≤ 20 kVpp, AC: sine wave ≤ 7 kVrms Compatibility: all **RIGOL** scopes. |
| RP1018H | High Voltage Probe | DC to 150 MHz DC+AC Peak: 18 kV AC RMS: 12 kV Compatibility: all **RIGOL** scopes. |

## ▶ RIGOL Active&Current Probes

| Model Number | Tpye | Description |
|---|---|---|
| RP7150 | Differential /Single Eended Probe | BW: DC to 1.5 GHz Max. Input Voltage: 30 V peak, CAT I Compatibility: DS4000E series, MSO/DS4000 series, and DS6000 series. |
| RP1001C | Current Probe | BW: DC to 300 kHz Max. input: DC: ± 100 A AC P–P: 200 A AC RMS: 70 A Compatibility: all **RIGOL** scopes. |
| RP1002C | Current Probe | BW: DC to 1 MHz Max. input: DC: ± 70 A AC P–P: 140 A AC RMS: 50 A Compatibility: all **RIGOL** scopes. |
| RP1003C | Current Probe | BW: DC to 50 MHz Max. input: AC P–P: 50 A (non–continuous) AC RMS: 30 A Compatibility: all **RIGOL** scopes. RP1000P power supply required to be ordered |
| RP1004C | Current Probe | BW: DC to 100 MHz Max. input: AC P–P: 50 A (non–continuous) AC RMS: 30 A Compatibility: all **RIGOL** scopes. RP1000P power supply required to be ordered |
| RP1005C | Current Probe | BW: DC to 10 MHz Max. input: AC P–P: 300 A (non–continuous), 500 A (@ pulse width ≤ 30 us) AC RMS: 150 A Compatibility: all **RIGOL** scopes. RP1000P power supply required to be ordered. |
| RP1000P | Power Supply | Power supply for RP1003C, RP1004C and RP1005C, support 4 channels. |
| RP1025D | High Voltage Differential Probe | BW: 25 MHz Max. voltage: ≤ 1400 Vpp Compatibility: all **RIGOL** scopes. |
| RP1050D | High Voltage Differential Probe | BW: 50 MHz Max. voltage: ≤ 7000 Vpp Compatibility: all **RIGOL** scopes. |
| RP1100D | High Voltage Differential Probe | BW: 100 MHz Max. voltage: ≤ 7000 Vpp Compatibility: all **RIGOL** scopes. |

## ▶ Specifications

All the specifications (except the parameters marked with "Typical") are guaranteed when the instrument has been working for more than 30 minutes under the specified operating temperature.

### Sample

| | |
|---|---|
| Sample Mode | Real-time sample |
| Max. Real-time Sample Rate | 2.0 GSa/s for each channel |
| Max. Memory Depth | 14 Mpts for each channel |
| Peak Detect | 500 ps |
| Averaging | After all the channels finish N times of sampling at the same time, N can be 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, or 8192. |
| High Resolution | 12 bits when ≥10 µs/div @ 2 GSa/s. |

### Input

| | |
|---|---|
| Number of Channels | 4 analog channels |
| Input Coupling | DC, AC, or GND |
| Input Impedance | (1 MΩ±1%) ‖ (15 pF±3 pF) or 50 Ω±1.5% |
| Probe Attenuation Coefficient | 0.01X to 1000X, in 1-2-5 step |
| Maximum Input Voltage (1 MΩ) | CAT I 300 Vrms, CAT II 100 Vrms, transient overvoltage 1000 Vpk |

### Horizontal

| | |
|---|---|
| Time Base Scale | DS4024E: 2 ns/div to 1 ks/div<br>DS4014E: 5 ns/div to 1 ks/div |
| Deviation between Channels | 1 ns (typical), 2 ns (maximum) |
| Max. Recording Length | 14 Mpts for each channel |
| Time Base Accuracy[1] | ≤ ±4 ppm |
| Clock Drift | ≤ ±2 ppm/year |
| Delay Range | Pre-trigger (negative delay): Memory Depth/Sample Rate<br>Post-trigger (positive delay): 1 s to 100 ks |
| Time Base Mode | Y-T, X-Y, Roll, Delayed |
| Number of X-Ys | 2 paths at the same time |
| Waveform Capture Rate[2] | 60,000 wfms/s |
| Zero Offset | ±0.5 div*minimum time base scale |

### Vertical

| | |
|---|---|
| Bandwidth (-3 dB) (50 Ω) | DS4024E: DC to 200 MHz<br>DS4014E: DC to 100 MHz |
| Single Bandwidth (50 Ω) | DS4024E: DC to 200 MHz<br>DS4014E: DC to 100 MHz |
| Vertical Resolution | 8 bits |
| Vertical Scale | 1 MΩ input impedance: 1 mV/div to 5 V/div<br>50 Ω input impedance: 1 mV/div to 1 V/div |
| Offset Range | 1 MΩ input impedance:<br>1 mV/div to 225 mV/div: ±2 V<br>230 mV/div to 5 V/div: ±40 V<br>50 Ω input impedance:<br>1 mV/div to 124 mV/div: ±1.2 V<br>126 mV/div to 1 V/div: ±12 V |
| Dynamic Range | ±5 div |
| Bandwidth Limit[1] | DS4024E: 20 MHz/100 MHz<br>DS4014E: 20 MHz |
| Low Frequency Response (AC coupling, -3 dB) | ≤5 Hz (on BNC) |

| | |
|---|---|
| Calculated Rise Time[1] | DS4024E: 1.8 ns<br>DS4014E: 3.5 ns |
| DC Gain Accuracy | ±2% full scale |
| DC Offset Accuracy | 200 mV/div to 5 V/div: ±0.1 div ± 2 mV ± 0.5% offset<br>1 mV/div to 195 mV/div: ±0.1 div ± 2 mV ± 1.5% offset |
| ESD Tolerance | ±2 kV |
| Channel-to-Channel Isolation | DC to maximum bandwidth: >40 dB |

## Trigger

| | |
|---|---|
| Trigger Level Range | Internal: ±6 div from the center of the screen<br>EXT: ±0.8 V |
| Trigger Mode | Auto, Normal, Single |
| Holdoff Range | 100 ns to 10 s |
| High Frequency Rejection[1] | 50 kHz |
| Low Frequency Rejection[1] | 5 kHz |
| **Edge Trigger** | |
| Edge Type | Rising, Falling, Rising&Falling |
| **Pulse Trigger** | |
| Pulse Condition | Positive Pulse Width (greater than, lower than, within the specific interval);<br>Negative Pulse Width (greater than, lower than, within the specific interval) |
| Pulse Width Range | 4 ns to 4 s |
| **Runt Trigger** | |
| Pulse Polarity | Positive, Negative |
| Qualifier | None, >, <, <> |
| Pulse Width Range | 4 ns to 4 s |
| **Nth Edge Trigger** | |
| Edge Type | Rising, Falling |
| Idle Time | 40 ns to 1 s |
| Number of Edges | 1 to 65535 |
| **Slope Trigger** | |
| Slope Condition | Positive Slope (greater than, lower than, within the specific interval);<br>Negative Slope (greater than, lower than, within the specific interval) |
| Time Setting | 10 ns to 1 s |
| **Video Trigger** | |
| Polarity | Positive, Negative |
| Synchrony | All Lines, Line Num, Odd Field, Even Field |
| Standard | NTSC, PAL/ECAM, 480P, 576P, 720P, 1080P, and 1080I |
| **Pattern Trigger** | |
| Pattern Setting | H, L, X, Rising Edge, Falling Edge |
| **RS232/UART Trigger** | |
| Polarity | Normal, Invert |
| Trigger Condition | Start, Error, Check Error, Data |
| Baud Rate | 2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps,<br>460800 bps, 921600 bps, 1Mbps, User |
| Data Bits | 5 bit, 6 bit, 7 bit, 8 bit |
| **I2C Trigger** | |
| Trigger Condition | Start, Restart, Stop, Missing ACK, Address, Data, A&D |
| Address Bits | 7 bits, 8 bits, 10 bits |
| Address Range | 0 to 127, o to 255, 0 to 1023 |
| Byte Length | 1 to 5 |
| **SPI Trigger** | |
| Trigger Condition | CS, Timeout |

| Timeout Value | 100 ns to 1 s |
|---|---|
| Data Bits | 4 bit to 32 bit |
| Data | H, L, X |
| Clock Edge | Rising Edge, Falling Edge |
| **CAN Trigger** | |
| Signal Type | Rx, Tx, CAN_H, CAN_L, Differential |
| Trigger Condition | SOF, EOF, Frame Type, Frame Error |
| Baud Rate | 10 kb/s, 20 kb/s, 33.3 kb/s, 50 kb/s, 62.5 kb/s, 83.3 kb/s, 100 kb/s, 125 kb/s, 250 kb/s, 500 kb/s, 800 kb/s, 1 Mb/s, User |
| Sample Point | 5% to 95% |
| Frame Type | Data, Remote, Error, OverLoad |
| Error Type | Bit Fill, Answer Error, Check Error, Format Error, Random Error |
| **FlexRay Trigger** | |
| Baud Rate | 2.5 Mb/s, 5 Mb/s, 10 Mb/s |
| Trigger Condition | Frame, Symbol, Error, TSS |
| **USB Trigger** | |
| Signal Speed | Low Speed, Full Speed |
| Trigger condition | SOP, EOP, RC, Suspend, Exit Suspend |
| **LIN Trigger** | |
| Version | 1.X, 2.X, Both |
| Trigger Condition | Sync, Identifier, Data, ID&Data, Wakeup, Sleep, Error |
| ID Range | 0 to 63 |
| Data Comparison | =, ≠, <, >, ≤, ≥ |
| Data Length | 1 to 8 |
| Data Level | H, L |
| Baud Rate | 19200 bps, 10417 bps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, User |
| Error Type | Sync, Even-Odd, Checksum |

## Measure

| | |
|---|---|
| Cursor | Manual mode: Voltage deviation between cursors ($\triangle$V), time deviation between cursors ($\triangle$T), reciprocal of $\triangle$T (Hz) (1/$\triangle$T)<br>Track mode: voltage and time values at the waveform point<br>Auto mode: allow to display cursors during auto measurement |
| Auto Measurement | Maximum, Minimum, Peak-Peak Value, Top Value, Bottom Value, Amplitude, Average, Vrms–N, Vrms-1, Overshoot, Pre-shoot, Area, Period Area, Period, Frequency, Rise Time, Fall Time, Positive Pulse Width, Negative Pulse Width, Positive Duty Cycle, Negative Duty Cycle, Delay A↯→B↯, Delay A↰→B↰, Delay A↯→B↰, Delay A↰→B↯, Phase A↯→B↯, Phase A↰→B↰, Phase A↯→B↰, Phase A↰→B↯ |
| Number of Measurements | Displays 5 measurements at the same time. |
| Measurement Range | Screen Region, Cursor Region |
| Statistic Mode | Extremum, Difference |
| Measurement Statistic | Average, Max, Min, Standard Deviation, Number of Measurements |
| FontSize | Normal, Large, UltraLarge |
| DisItem | ON, OFF |
| Frequency Counter | 6-digit hardware frequency counters |

## Math Operation

| | |
|---|---|
| Waveform Operation | A+B, A-B, A×B, A÷B, FFT, Digital Filter, Editable Advanced Operation, Logic Operation |
| FFT Window | Rectangle, Hanning, Blackman, Hamming |
| FFT Display | Split, Full Screen |
| FFT Vertical Scale | Vrms, dB |
| Logic Operation | AND, OR, NOT, XOR |

| Math Function | Intg, Diff, Lg, Ln, Exp, Abs, Square, Sqrt, Sine, Cosine, Tangent |
|---|---|

## Decoding

| | |
|---|---|
| Number of Buses | 2 |
| Decoding Type | Parallel (standard), RS232/UART (optional), I2C (optional), SPI (optional), CAN (optional), FlexRay (optional), LIN (optional) |
| Parallel | Combines the sample data of the source channel waveforms as a parallel multi-channel bus and displays the data as a single bus value |
| RS232/UART | Displays the input signal(s) of the TX source channel or/and RX source channel as bus |
| I2C | Displays the input signal of the SDA source channel as bus |
| SPI | Displays the input signal(s) of the MISO source channel or/and MOSI source channel as bus |
| CAN | Displays the input signal of the source channel (Rx, Tx, CAN_H, CAN_L, or differential) as bus |
| FlexRay | Displays the input signal of the source channel (BP, BM, or RX/TX) as bus |
| LIN | Displays the input signal of the source channel of LIN as bus |

## Display

| | |
|---|---|
| Display Type | 9-inch (229 mm) TFT LCD display |
| Display Resolution | 800 horizontal×RGB×480 vertical pixel |
| Display Color | 160,000 colors |
| Persistence Time | Min, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, 20 s, Infinite |
| Display Type | Dots, Vectors |
| Real-time Clock | Time and Date (adjustable for users) |

## I/O

| | |
|---|---|
| Standard Ports | Dual USB HOST, USB DEVICE, LAN, VGA Output, 10 MHz Input/Output, Aux Output (TrigOut, Fast, PassFail, GND) |
| Printer Compatibility | PictBridge |

## General Specifications

| | | |
|---|---|---|
| Probe Compensation Output | | |
| Output Voltage[1] | About 3 V, peak-peak | |
| Frequency[1] | 1 kHz | |
| **Power** | | |
| Power Voltage | 100 to 127 V, 45 to 440Hz<br>100 to 240 V, 45 to 65Hz | |
| Power | Maximum 120 W | |
| Fuse | 3 A, T degree, 250 V | |
| **Environment** | | |
| Temperature Range | Operating: 0°C to +50°C | |
| | Non-operating: -40°C to +70°C | |
| Cooling Method | Fan cooled | |
| Humidity Range | 0°C to +30°C: ≤95% RH | |
| | +30°C to +40°C: ≤75% RH | |
| | +40°C to +50°C: ≤45% RH | |
| Altitude | Operating: under 3,000 meters | |
| | Non-operating: under 15,000 meters | |
| **Physical Characteristics** | | |
| Size[3] | Width×Height×Depth = 440.0 mm×218.0 mm×130.0 mm | |
| Weight[4] | Packaging Excluded | 4.8 kg±0.2 kg |
| | Packaging Included | 7.1 kg±1.0 kg |

| Adjustment Interval | |
|---|---|
| The recommended calibration interval is one year. | |
| **Regulatory Information** | |
| EMC | 2014/35/EU<br>Execution standard EN 61326-1:2013 |
| Safety | EN 61010-1:2010<br>EN 61010-2-030:2010<br>IEC 61010-1:2010 (Third Edition)<br>CAN/CSA C22.2 No.61010-1-12<br>UL 61010-1:2012 |

Note[1]: Typical value.
Note[2]: Maximum value. Displayed in dots; a sine signal with 10 ns horizontal time base, 4 div input amplitude, and 10 MHz frequency; Edge trigger.
Note[3]: Supporting legs and handle folded, knob height included, front panel cover excluded.
Note[4]: Standard configuration.

## ▶ Ordering Information

| | Description | Order Number |
|---|---|---|
| Model | DS4014E (100 MHz, 2 GSa/s, 14 Mpts, 4-analog-channel Digital Oscilloscope) | DS4014E |
| | DS4024E (200 MHz, 2 GSa/s, 14 Mpts, 4-analog-channel Digital Oscilloscope) | DS4024E |
| Standard Accessories | Power Cord conforming to the standard of the destination country | - |
| | Front Panel Cover | FPC-DS4000 |
| | USB Data Cable | CB-USBA-USBB-FF-150 |
| | 4 Passive Probes (350 MHz) | PVP2350 |
| | Quick Guide (Hard Copy) | - |
| Optional Accessories | Active Differential Probe (1.5 GHz) | RP7150 |
| | Rack Mount Kit | RM-DS4000 |
| | USB-GPIB Interface Converter | USB-GPIB |
| | TekProbe Interface Adapter | T2R1000 |
| | Calibration Kit for DS6000 | CK-DS6000 |
| Options | RS232/UART Decoding Kit | SD-RS232-DS4000 |
| | I2C/SPI Decoding Kit | SD-I2C/SPI-DS4000 |
| | CAN Decoding/LIN Trigger/LIN Decoding Kit | SD-AUTO-DS4000 |
| | FlexRay Decoding Kit | SD-FlexRay-DS4000 |
| | Optional Kit, including: SD-AUTO-DS4000, SD-FlexRay-DS4000, SD-I2C/SPI-DS4000 and SD-RS232-DS4000 | BND-MSO/DS4000 |

## Warranty Period

Three years for the mainframe, excluding probes and accessories.