

U2500A Series

USB Modular Simultaneous Sampling Multifunction DAQ Devices

Introduction

The Keysight Technologies, Inc. U2500A Series USB Modular Simultaneous Sampling Multifunction (DAQ) devices are high-performance modules that consist of three models – the U2531A, U2541A and U2542A. The U2500A Series has up to four channels with 14-bit and 16-bit resolutions. The U2531A can sample up to 2 MSa/s for each channel with a resolution of 14 bits, while the U2541A and U2542A can sample up to 250 kSa/s and 500 kSa/s for each channel respectively with a resolution of 16 bits.



Note: The U2531A, U2541A, U2542A USB Modular Simultaneous Sampling Multifunction Data Acquisition will be discontinued on March 1st, 2022. The last day to place an order for this product is February 28th, 2022. Keysight will continue to provide world-class support for this product for the standard period of 5 years.

Features

- Simultaneous sampling with a sampling rate of up to 2 MSa/s for each channel
- Multifunction DAQ solution - AI, AO, DIO, counter
- Dedicated ADC per channel
- 14-bit or 16-bit resolution
- 24-bit programmable digital input/output
- Functions as a standalone or modular unit
- Supports SCPI and IVI-COM
- Compatible with a wide range of Keysight Development Environments (KDEs)
- NEW! Control, automate and simplify with Keysight BenchVue software. Now included.
- USB 2.0 and USBTMC-USB488 standards.

Various features of the U2500A series

- Quick and easy USB setup
- High sampling rate of up to 2 MSa/s for each channel
- Dedicated analog-to-digital (ADC) that allows simultaneous sampling of data
- Flexible standalone or modular capability
- SCPI and IVI-COM supported with a wide range of KDE compatibility that minimizes work time and increases software choices
- Easy-to-use KMM application software and command logger function for easy SCPI command conversion into snippets of VEE, VB, C++, and C# code

High sampling rate of up to 2 MSa/s

The U2500A Series provides a high analog input sampling rate coverage of up to 2 MSa/s for each channel. The high sampling rate coverage offered is ideal for transient signal applications such as sonar analysis.

Simultaneous sampling of data

The U2500A Series has dedicated ADCs that enable simultaneous signals acquisition, which makes the U2500A Series suitable for your phase-sensitive applications



U2500A Series

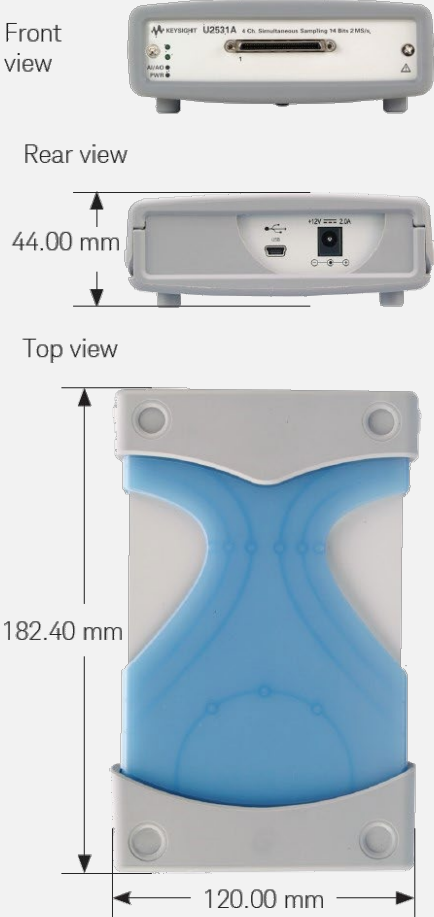
U2500A Series USB Modular Simultaneous Sampling Multifunction (DAQ) devices are high-performance modules that consist of three models:

- U2531A
- U2541A
- U2542A

Product Characteristics and General Specifications

| Product characteristics and general specifications | |
|--|---|
| Remote interface | <ul style="list-style-type: none"> • USBTMC-USB488 ¹ • Hi-Speed USB 2.0 |
| Power requirement | <ul style="list-style-type: none"> • +12 VDC (TYPICAL) • 2 A (MAX) input rated current • Installation Category II |
| Power consumption | +12 VDC, 480 mA maximum |
| Operating environment | <ul style="list-style-type: none"> • Operating temperature from 0 °C to +55 °C • Relative humidity at 15% to 85% RH (non-condensing) • Altitude up to 2000 meters • Pollution Degree 2 • For indoor use only |
| Storage compliant | -20 °C to 70 °C |
| Safety & EMC compliance | Refer to Declaration of Conformity for the latest revisions of regulatory compliance at: www.keysight.com/go/conformity |
| Shock and vibration | Tested to IEC/EN 60068-2 |
| IO connector | 68-pin female VHDCI Type |
| Dimension (W × D × H) | Module dimension: <ul style="list-style-type: none"> • 120.00 mm × 182.40 mm × 44.00 mm (with plastic casing) • 105.00 mm × 174.54 mm × 25.00 mm (without plastic casing) Terminal block dimension: <ul style="list-style-type: none"> • 103.00 mm × 85.20 mm × 42.96 mm |
| Weight | <ul style="list-style-type: none"> • 565 g (with plastic casing) • 400 g (without plastic casing) |
| Note: 1. Compatible with Microsoft Windows operating systems only. Requires a direct USB connection to the PC so the appropriate driver can be installed in the USB DAQ module. | |

Product Outlook and Dimensions



Product Specifications

| Model number | U2531A | U2541A | U2542A |
|---|--|-----------|-----------|
| Analog input | | | |
| Resolution | 14 bits | 16 bits | |
| Number of channels | 4 differential input channels (software selectable/channel) | | |
| Maximum sampling rate | 2 MSa/s | 250 kSa/s | 500 kSa/s |
| Programmable bipolar input range ¹ | ± 10 V, ± 5 V, ± 2.5 V, ± 1.25 V | | |
| Programmable unipolar input range | 0 to 10 V, 0 to 5 V, 0 to 2.5 V, 0 to 1.25 V | | |
| Input coupling | DC | | |
| Input impedance | 1 GΩ/100 pF | | |
| Operational common mode voltage range | ± 8.0 V maximum | | |
| Overtolerance range | Power-on: Continuous ± 30 V, Power-off: Continuous ± 15 V | | |
| Trigger sources | External analog/digital trigger, SSI/star trigger ² | | |
| Trigger modes | Pre-trigger, delay-trigger, post-trigger, and middle-trigger | | |
| FIFO buffer size | Up to 8 MSa | | |
| Analog output | | | |
| Resolution | 12 Bits | | |
| Number of channels | 2 | | |
| Maximum update rate | 1 MSa/s | | |
| Output ranges | 0 to 10 V, ±10 V, 0 to AO_EXT_REF, ±AO_EXT_REF ³ | | |
| Output coupling | DC | | |
| Output impedance | 0.1 Ω Typical | | |
| Stability | Any passive load up to 1500 pF | | |
| Power-on state | 0 V steady state | | |
| Trigger sources | External analog/digital trigger, SSI/star trigger ² | | |
| Trigger modes | Delay trigger, post trigger | | |
| FIFO buffer size | 1 Channel used: Maximum 8 MSa 4 Channels used: Maximum 2 MSa/ch | | |
| Glitch energy | 5 ns-V (Typical), 80 ns-V (Maximum) | | |
| Driving capability | 5 mA | | |
| Function generation mode | Sine, square, triangle, sawtooth, and noise waveforms | | |
| Digital input/output | | | |
| Number of bits | 24-bit programmable input/output | | |
| Compatibility | TTL | | |

| Model number | U2531A | U2541A | U2542A |
|--|--|----------------|--------|
| Input voltage | VIL = 0.7 V maximum; IIL = 10 μ A maximum VIH = 2.0 V minimum; IIH = 10 μ A maximum | | |
| Input voltage range | -0.5 V to +5.5 V | | |
| Output voltage | VOL = 0.45 V maximum; IOL = 8 mA maximum VOH = 2.4 V minimum; IOH = 400 μ A maximum | | |
| General purpose digital timer/counter | | | |
| Maximum count | (231 - 1) bits | | |
| Number of channels | 2 Independent up/down counter | | |
| Compatibility | TTL | | |
| Clock source | Internal or external | | |
| Base clock available | 48 MHz | | |
| Maximum clock source frequency | 12 MHz | | |
| Input frequency range ⁴ | 0.1 Hz to 6 MHz at 50% duty cycle | | |
| Pulse width measurement range | 0.167 μ s to 178.956 s \pm 0.0833 μ s | | |
| Analog input | | | |
| Trigger source | All analog input channels, External analog trigger (EXTA_TRIG) | | |
| Trigger level | \pm Full scale for internal \pm 10 V for external | | |
| Trigger conditions | Above high, below low, and window (software selectable) | | |
| Trigger level resolution | 8 bits | | |
| Bandwidth | 400 kHz | | |
| Input impedance for EXTA_TRIG | 20 k Ω | | |
| Coupling | DC | | |
| Overvoltage protection | Continuous for \pm 35 V maximum | | |
| Digital trigger | | | |
| Compatibility | TTL/CMOS | | |
| Response | Rising or falling edge | | |
| Pulse width | 20 ns minimum | | |
| Calibration ⁵ | | | |
| On board reference voltage | 5 V | | |
| Temperature drift | \pm 2 ppm/ $^{\circ}$ C | | |
| Stability | \pm 6 ppm/1000 hours | | |
| Power consumption | | | |
| Input voltage (DC) | +12 VDC | | |
| Input current | 480 mA maximum | 390 mA maximum | |

| Model number | U2531A | U2541A | U2542A |
|---|--|--------|--------|
| Physical attributes | | | |
| Dimensions (W × D × H) | 120.00 mm × 182.40 mm × 44 mm (with plastic casing) 105.00 mm × 174.54 mm × 25.00 mm (without plastic casing) | | |
| IO connector | 68-pin female VHDCI type | | |
| Weight | 565 g with plastic casing 400 g without plastic casing | | |
| Environmental condition | | | |
| Operating temperature | 0 to 55 °C | | |
| Storage temperature | –20 °C to 70 °C | | |
| Relative humidity | 15% to 85% RH (non-condensing) | | |
| General | | | |
| Remote interface | Hi-Speed USB 2.0 | | |
| Device class | USBTMC-USB488 | | |
| Programmable interface | SCPI and IVI-COM | | |
| Notes: | | | |
| 1. Maximum input voltage for analog input is ± 10 V. | | | |
| 2. System Synchronous Interface (SSI) and star trigger commands are applicable when modular devices are used in modular product chassis (U2781A). | | | |
| 3. Maximum external reference voltage for analog output (AO_EXT_REF) is ± 10 V. | | | |
| 4. Measurement frequency's resolution: | | | |
| • = 12 MHz/n, n = 2, 3, 4, 5, ..., 120 M | | | |
| • = 6 MHz, 4 MHz, 3 MHz, 2.4 MHz, 2.0 MHz, ..., 0.1 Hz (up to six decimal points) | | | |
| 5. Recommended for 20 minutes warm-up time. | | | |

Electrical Specifications and Characteristics

Analog input characteristics ¹

| Model number | U2531A | | U2541A | | U2542A | |
|------------------------------------|--------------|---------------------------------|--------------|---------------------------------|--------------|---------------------------------|
| | 23 °C ± 5 °C | 0 °C to 18 °C 28 °C to 55 °C | 23 °C ± 5 °C | 0 °C to 18 °C 28 °C to 55 °C | 23 °C ± 5 °C | 0 °C to 18 °C 28 °C to 55 °C |
| Offset error ² | ± 2 mV | ± 2 mV | ± 1 mV | ± 1 mV | ± 1 mV | ± 1 mV |
| Gain error ² | ± 6 mV | ± 6 mV | ± 2 mV | ± 2.5 mV | ± 2 mV | ± 2.5 mV |
| –3 dB Small signal bandwidth | 1.2 MHz | | 600 kHz | | 1.0 MHz | |
| 1% THD Large signal bandwidth | 400 kHz | | 400 kHz | | 400 kHz | |
| System noise ³ | 2.0 mVrms | | 0.5 mVrms | | 0.5 mVrms | |
| CMRR (DC to 60 Hz) | 64 dB | | 80 dB | | 80 dB | |
| Spurious-Free Dynamic Range (SFDR) | 76 dB | | 88 dB | | 86 dB | |

| Model number | U2531A | | U2541A | | U2542A | |
|--|--------------|---------------------------------|--------------|---------------------------------|--------------|---------------------------------|
| | 23 °C ± 5 °C | 0 °C to 18 °C 28 °C to 55 °C | 23 °C ± 5 °C | 0 °C to 18 °C 28 °C to 55 °C | 23 °C ± 5 °C | 0 °C to 18 °C 28 °C to 55 °C |
| Signal-to-Noise and Distortion Ratio (SINAD) | 70 dB | | 82 dB | | 80 dB | |
| Total Harmonic Distortion (THD) | -72 dB | | -86 dB | | -84 dB | |
| Signal-to-Noise Ratio (SNR) | 72 dB | | 84 dB | | 82 dB | |
| Effective Number of Bits (ENOB) | 11.3-bit | | 13.3-bit | | 13.0-bit | |
| Channels crosstalk ⁴ | 66 dB | | 84 dB | | 80 dB | |

Notes:

1. Specifications are based on 20 minutes warm-up, self-calibration temperature at 23 °C, and bipolar input range of ± 10 V.
2. The measurements are calculated with 100 points averaging of data.
3. The noise rms value is the standard deviation of 20000 points.
4. The crosstalk measurements are tested up to input frequency of $F_{in} = \text{MaxSamplingRate}/2$.

Analog output characteristics ¹

| Model number | U2531A | | U2541A | | U2542A | |
|-------------------------------------|--------------|----------------|--------------|----------------|--------------|----------------|
| | 23 °C ± 5 °C | 28 °C to 55 °C | 23 °C ± 5 °C | 28 °C to 55 °C | 23 °C ± 5 °C | 28 °C to 55 °C |
| Offset error | ± 1 mV | ± 3 mV | ± 1 mV | ± 3 mV | ± 1 mV | ± 3 mV |
| Gain error | ± 3 mV | ± 4 mV | ± 2 mV | ± 4 mV | ± 2 mV | ± 4 mV |
| Slew rate | 15 V/μs | | 15 V/μs | | 15 V/μs | |
| Rise time | 1.1 μs | 1.2 μs | 1.1 μs | 1.2 μs | 1.1 μs | 1.2 μs |
| Fall time | 1.1 μs | 1.2 μs | 1.1 μs | 1.2 μs | 1.1 μs | 1.2 μs |
| Settling time(s) to 1% output error | 2 μs | | 2 μs | | 2 μs | |

Notes:

1. Specifications are based on 20 minutes warm-up, self-calibration temperature at 23 °C, and bipolar input range of ± 10 V.

Test Condition

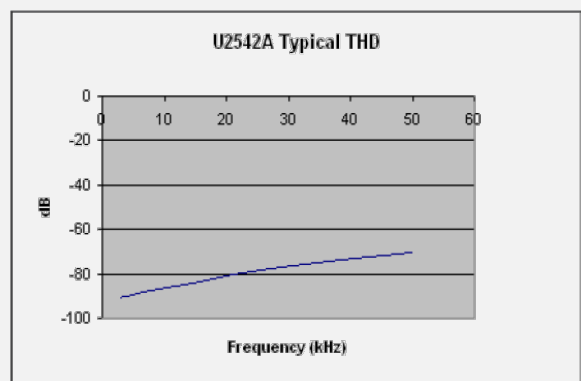
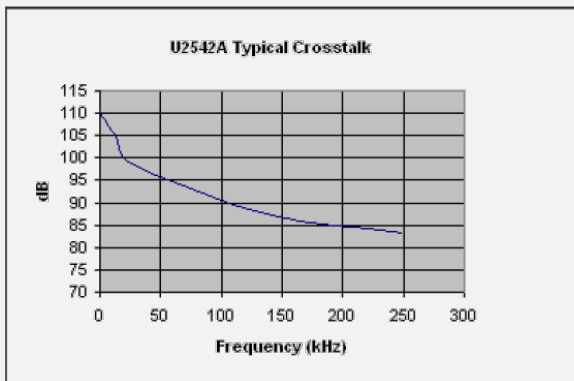
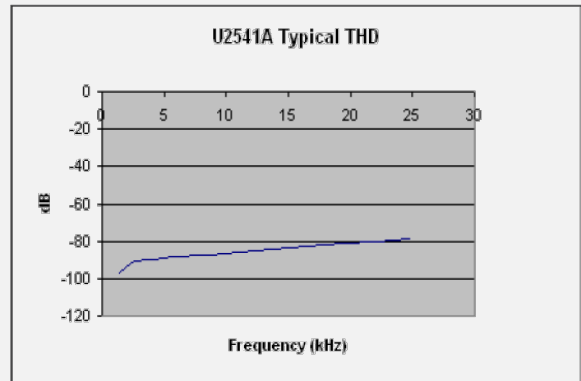
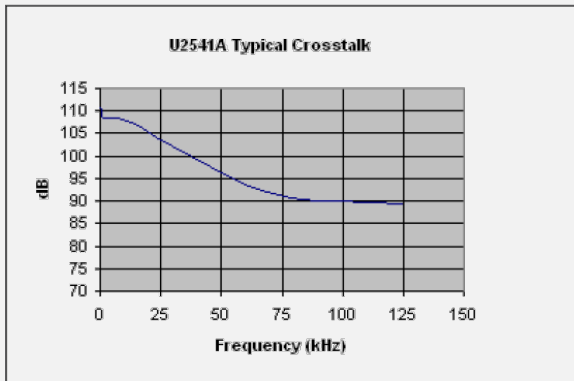
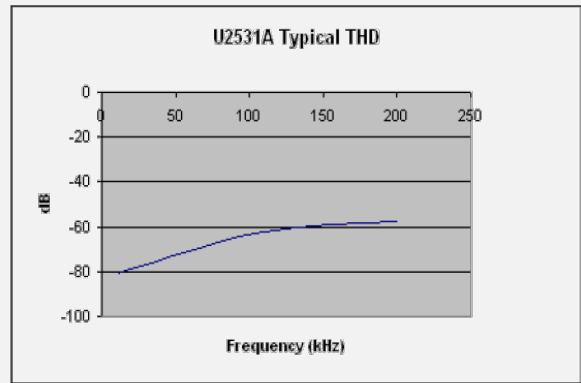
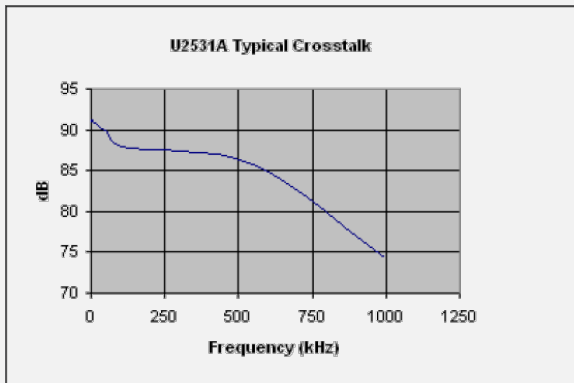
Dynamic range test for U2500A Series DAQ devices

| Dynamic range test | Model | Test conditions (DUT setting at ± 10 V bipolar) | |
|-----------------------------|--------|---|---|
| SFDR, THD, SINAD, SNR, ENOB | U2531A | Sampling rate: Fundamental frequency: Number of points: Fundamental input voltage: | 2 MSa/s 19.927 kHz 65536 FSR – 1 dB FS |
| | U2541A | Sampling rate: Fundamental frequency: Number of points: Fundamental input voltage: | 250 kSa/s 2.4109 kHz 8192 FSR – 1 dBFS |
| | U2542A | Sampling rate: Fundamental frequency: Number of points: Fundamental input voltage: | 500 kSa/s 4.974 kHz 16384 FSR – 1 dBFS |

Bandwidth test for U2500A Series DAQ devices

| Bandwidth test | Model | Test conditions (DUT setting at ± 10 V bipolar) | |
|---|--------|--|--|
| –3 dB Small signal bandwidth: 1% THD Large signal bandwidth: | U2531A | Sampling rate: Input voltage –3 dB Small signal bandwidth: 1% THD Large signal bandwidth: | 2 MSa/s 10% FSR FSR – 1 dBFS |
| | U2541A | Sampling rate: Input voltage –3 dB Small signal bandwidth: 1% THD Large signal bandwidth: | 250 kSa/s 10% FSR FSR – 1 dBFS |
| | U2542A | Sampling rate: Input voltage –3 dB Small signal bandwidth: 1% THD Large signal bandwidth: | 500 kSa/s 10% FSR FSR – 1 dBFS |

Typical Performance



DC Characteristics

Accuracy specifications ¹

| Model | U2541A, U2542A | | |
|--------------------|--------------------------------|-----------------|---|
| Analog input | | | |
| Unipolar range (V) | Offset error (mV) ² | Gain error (mV) | Accuracy (% of reading + offset error) ³ |
| 10 | 1.0 | 1.0 | 0.02% + 1.0 mV |
| 5 | 1.0 | 1.0 | 0.04% + 1.0 mV |
| 2.5 | 1.0 | 1.0 | 0.08% + 1.0 mV |
| 1.25 | 1.0 | 1.0 | 0.16% + 1.0 mV |
| Bipolar range (V) | | | |
| 10 | 1.0 | 2.0 | 0.02% + 1.0 mV |
| 5 | 1.0 | 1.0 | 0.02% + 1.0 mV |
| 2.5 | 1.0 | 1.0 | 0.04% + 1.0 mV |
| 1.25 | 1.0 | 1.0 | 0.08% + 1.0 mV |

| Model | U2531A | | |
|--------------------|--------------------------------|-----------------|---|
| Unipolar range (V) | Offset error (mV) ² | Gain error (mV) | Accuracy (% of reading + offset error) ³ |
| 10 | 2.0 | 3.0 | 0.06% + 2.0 mV |
| 5 | 1.5 | 1.5 | 0.06% + 1.5 mV |
| 2.5 | 1.0 | 1.0 | 0.08% + 1.0 mV |
| 1.25 | 1.0 | 1.0 | 0.16% + 1.0 mV |
| Bipolar range (V) | | | |
| 10 | 2.0 | 6.0 | 0.06% + 2.0 mV |
| 5 | 1.5 | 3.0 | 0.06% + 1.5 mV |
| 2.5 | 1.0 | 2.0 | 0.08% + 1.0 mV |
| 1.25 | 1.0 | 1.0 | 0.08% + 1.0 mV |

| Model | U2541A, U2542A | | |
|--------------------|--------------------------------|-----------------|---|
| Analog output | | | |
| Unipolar range (V) | Offset error (mV) ² | Gain error (mV) | Accuracy (% of reading + offset error) ⁴ |
| 10 | 1.0 | 2.0 | 0.02% + 1.0 mV |
| Bipolar range (V) | | | |
| 10 | 1.0 | 2.0 | 0.02% + 1.0 mV |

| Model | U2531A | | |
|--------------------|--------------------------------|-----------------|---|
| Unipolar range (V) | Offset error (mV) ² | Gain error (mV) | Accuracy (% of reading + offset error) ⁴ |
| 10 | 1.0 | 3.0 | 0.03% + 1.0 mV |
| Bipolar range (V) | | | |
| 10 | 1.0 | 3.0 | 0.03% + 1.0 mV |

Notes:

- Specifications are based on 20 minutes warm-up, and self-calibration temperature at 23 °C.
- Offset error is measured at 0 V.
- Accuracy = ± % of Gain error/(Measured value – Midscale) + Offset error
- Accuracy = ± (% of Gain error/Output value + Offset error)

USB Modular DAQ App within BenchVue

BenchVue software for the PC makes it simple to connect, control, capture and view multiple Keysight instruments simultaneously with no additional programming. You can derive answers faster than ever by easily viewing, logging and exporting measurement data and screen images with a few clicks from a single environment.

- Visualize multiple measurements simultaneously
- Easily log data, screen shots and system state
- Rapidly prototype custom test sequences
- Recall past states of your USB Modular DAQ device
- Export measurement data in the desired format fast
- Quickly access manuals, drivers, FAQs and videos



Figure 1. View measurements across USB DAQ, modular and bench instruments all on one BenchVue interface.

The USB Modular DAQ App within BenchVue allows you to quickly configure and control any of the USB DAQ devices to perform data logging and visualize measurements. With six different display options, including grids and strip charts, zooming in to details the way you want is so much easier—so you can nail that measurement error in no time. In just a few clicks, you can also record measurements and export results to popular PC-friendly applications such as Microsoft Excel and Microsoft Word for further analysis.



Figure 2. Configure and visualize measurements flexibly and easily on BenchVue’s modern interface.

Optional Accessories

U2901A/U2902A -Terminal block and SCSI-II 68-pin connector with 1-meter/ 2-meter cable

The U2901A/U2902A is a terminal block and SCSI-II 68-pin connector with 1 meter cable or 2-meter cable that can be used conjunction with the U2300A Series and U2500A Series

Terminal block overview

Front view



Side view



Other Products in The Keysight USB Modular Data Acquisition (DAQ) Family

| | |
|---|---|
|  | <p>U2300A Series USB Modular Multifunction DAQ</p> <p>Features:</p> <ul style="list-style-type: none">• High analog input sampling rate coverage of up to 3 MSa/s for a single channel• High analog input up to 64 channels• High speed USB 2.0• Multifunction capabilities — analog input (AI), analog output (AO), digital input output (DIO), and counter <p>For more information: http://www.keysight.com/find/U2300A</p> |
|  | <p>U2600A Series USB Modular Isolated Digital I/O</p> <p>Features:</p> <ul style="list-style-type: none">• 64 opto-isolated lines that can meet demand up to 24 V• High speed USB 2.0• Isolation voltage of 1250 Vrms for protection from transient voltage spikes <p>For more information: http://www.keysight.com/find/U2600A</p> |
|  | <p>U2781A USB modular product chassis</p> <p>Features:</p> <ul style="list-style-type: none">• Expansion of channels for each modular product• Multiple instrument synchronization• Internal and external 10 MHz reference clock• High-speed USB 2.0• SSI/Star trigger bus synchronization between external trigger source and modules <p>For more information: http://www.keysight.com/find/U2781A</p> |

Ordering Information

| Model | Description |
|--------|---|
| U2541A | 250 kSa/s USB modular simultaneous sampling multifunction DAQ |
| U2542A | 500 kSa/s USB modular simultaneous sampling multifunction DAQ |
| U2531A | 2 MSa/s USB modular simultaneous sampling multifunction DAQ |

Optional accessories

| Model | Description |
|--------|--|
| U2901A | Terminal block and SCSI-II 68-pin connector with 1-meter cable |
| U2902A | Terminal block and SCSI-II 68-pin connector with 2-meter cable |

Web Resources

Learn more about U2500A at: www.keysight.com/find/U2500A

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications, or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

