

USB-3100 Series

USB Voltage and Current Output Devices

Features

- 4, 8, or 16 analog outputs
- 16-bit resolution
- Update rates from 100 S/s to 100 kS/s
- 4, 8, or 16 analog current outputs available
- High-drive output capability available
- Digital I/O, counter/timer available
- Synchronous update available

Software

- TracerDAQ® software included for acquiring and displaying data and generating signals
- Universal Library includes support for Visual Studio® and Visual Studio® .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET
- Comprehensive drivers for DASyLab® and NI LabVIEW™
- Supported by MATLAB® Data Acquisition Toolbox™
- InstaCal software utility for installing, calibrating, and testing
- Supported Operating Systems: Windows 7/Vista/XPSP2, 32- or 64-bit

Overview

USB-3100 Series are voltage and current output USB 2.0 full-speed devices. Each device provides four, eight, or 16 voltage outputs. The USB-3102/3104/3106 also provide four, eight, or 16 current outputs. All devices provide synchronous and concurrent voltage updates.

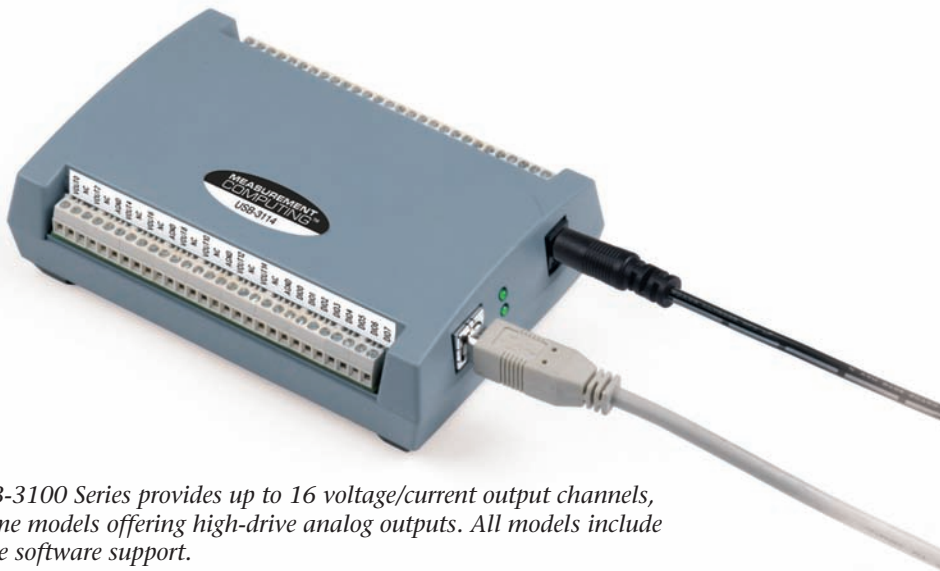
All USB-3100 Series devices except the USB-3101FS provide eight digital I/O lines and one 32-bit event counter.

The USB-3110/3112/3114 are powered by an external AC adapter. All other devices in the Series are powered by the +5 V USB supply from the computer.

The USB-3101FS has 250 V_{rms} channel-to-ground isolation that protects the device and computer from ground spikes and ensures a reliable data stream, making it suitable for high-voltage applications.

Analog Output

All USB-3100 Series devices provide either four, eight, or 16 channels of 16-bit analog output.



The USB-3100 Series provides up to 16 voltage/current output channels, with some models offering high-drive analog outputs. All models include extensive software support.

USB-3100 Series Selection Chart						
Model	Voltage Output	Update Rate	Current Output	DIO	Counter/Timer	Isolation
USB-3101	4	100 S/s	—	8	1	—
USB-3102	4	100 S/s	4	8	1	—
USB-3103	8	100 S/s	—	8	1	—
USB-3104	8	100 S/s	8	8	1	—
USB-3105	16	100 S/s	—	8	1	—
USB-3106	16	100 S/s	16	8	1	—
USB-3110	4 high-drive	100 S/s	—	8	1	—
USB-3112	8 high-drive	100 S/s	—	8	1	—
USB-3114	16 high-drive	100 S/s	—	8	1	—
USB-3101FS	4	100 kS/s	—	—	—	250 V _{rms} channel-to-ground

USB-3101FS: Each channel has a fixed ± 10 V voltage output range. Channel outputs can be updated individually or simultaneously.

Each channel has a D/A converter (DAC) that produces a voltage signal. Each channel also has ± 30 V overvoltage and indefinite short-circuit protection.

For high-voltage applications, use the USB-3101FS with the ACC-107 backshell accessory to ensure that the terminals are not accessible. The backshell also provides strain relief to protect the screw terminals.

All Other USB-3100 Series Devices: Each channel is software-selectable for either a bipolar voltage output range of ± 10 V or a unipolar range of 0V to 10V. Channel outputs can be updated individually or simultaneously.



The USB-3101FS includes four simultaneously-updating analog output channels with 250 V_{rms} channel-to-ground isolation.

USB-3100 Series

General Information and Specifications



Current Output (USB-3102/3104/3106 Only)

These devices provide 0 mA to 20 mA of current output. Each DAC controls a voltage/current channel pair simultaneously. Each channel pair can be updated individually or simultaneously.

Synchronous DAC Updates

All USB-3100 Series devices except for the USB-3101FS have a synchronous DAC load connection pin (SYNCLD) that simultaneously updates DAC outputs on multiple devices. You can configure this with software as an input (slave mode) or as an output (master mode).

In slave mode, the SYNCLD pin receives the D/A LOAD signal from an external source. When the SYNCLD pin receives the trigger signal, the analog outputs are updated simultaneously.

In master mode, the internal D/A LOAD signal is sent to the SYNCLD pin. You can then synchronize with a second device of the same type and simultaneously update the DAC outputs on each device.

On power up and reset, the SYNCLD pin is set to slave mode (input).

Digital I/O

All USB-3100 Series devices except for the USB-3101FS have eight bidirectional digital I/O connections. The DIO lines can be independently programmed for input or output. All digital pins are floating by default. A screw terminal connection is provided to configure for pull-up (+5 V) or pull-down (0 V).

Counter Input

Each USB-3100 Series device except for the USB-3101FS has a 32-bit event counter for counting TTL pulses. The counter increments when the TTL levels transition from low to high. The counter accepts frequency inputs of up to 1 MHz.

Specifications

All USB-3100 Series Devices
Except for the USB-3101FS

General

Environment

Operating Temperature

USB-3101/3103/3105: 0 °C to 70 °C

All Other Devices: 0 °C to 50 °C

Storage Temperature: -40 °C to 85 °C

Relative Humidity (RH): 0% to 90% RH, noncondensing

Communications: USB 2.0 full-speed mode (12 Mbps)

Signal I/O Connector: Screw terminals

Power

Supply Current (USB Enumeration): <100 mA

Supply Current (Quiescent): Total quiescent current requirement includes up to 10 mA for the status LED. This does not include any potential loading of the digital I/O bits, +5 V user terminal, or the VOUTx outputs.

USB-3101/3102: 140 mA typ

USB-3103/3104/3110: 160 mA typ

USB-3105/3106: 200 mA typ

USB-3112: 225 mA max

USB-3114: 355 mA max

+5 V User Output Voltage Range: 4.5 V to 5.25 V (assumes USB power supply is within specified limits)

+5 V User Output Current: 10 mA max (refers to the total amount of current that can be sourced from the +5 V user terminal for general use; also includes any additional contribution due to DIO loading)

USB-3102/3104/3106

ITEST Output Voltage Range: 13 V, ±1% typ

ITEST Output Current: 30 mA max

Refers to the total maximum amount of current that can be sourced from the ITEST user terminal, which should only be used for biasing individual IOUTx outputs to facilitate functional testing. Place a load resistor of 100 Ω between the ITEST pin and the IOUTx pin for proper operation)

External Power (USB-3110/3112/3114 Only)

Output Voltage: 5 V, ±5%

Output Wattage: 10 W

Power Jack Configuration: Two conductor

Power Jack Barrel Diameter: 6.3 mm

Power Jack Pin Diameter: 2.0 mm

Power Jack Polarity: Center positive

Dimensions (L × W × H): 127.0 × 88.9 × 35.6 mm (5.0 × 3.5 × 1.4 in.)

Analog Voltage Output

D/A Converter: DAC8554

Number of Channels

USB-3101/3102/3110: 4

USB-3103/3104/3112: 8

USB-3105/3106/3114: 16

On the USB-3102/3104/3106, each DAC8554 output controls a voltage and current output channel-pair simultaneously. For example, writing to voltage output channel 0 also updates current output channel 0; conversely, writing to current output channel 0 also updates voltage output channel 0. Disconnect unused voltage and current output channels.

Resolution: 16 bits

Output Ranges (Software-Selectable)

Calibrated: ±10 V, 0 V to 10 V

Uncalibrated: ±10.2 V, -0.04 V to 10.08 V

Output Transient

±10 V to (0 V to 10 V) or (0 V to 10 V) to ±10 V

Range Selection: The output voltage level defaults to 0 V when the output voltage range is reconfigured, the host computer is reset, shut down, or suspended, or a reset command is issued to the device.

Duration: 5 μs typ

Amplitude: 5 V p-p typ

Host Computer is Reset, Powered On, Suspended, or a Reset Command is Issued to Device

The duration of this output transient is depends highly on the enumeration process of the host computer. Typically, the output is stable after two seconds.

Duration: 2 s typ

Amplitude: 2 V p-p typ

Initial Power On

Duration: 50 ms typ

Amplitude: 5 V peak typ

Differential Nonlinearity: The maximum differential nonlinearity specification applies to the entire operating temperature range. This specification also accounts for the maximum errors due to the software calibration algorithm (in Calibrated mode only) and the DAC8554 nonlinearities)

Calibrated: ±1.25 LSB typ, -2 LSB to +1 LSB max

Uncalibrated: ±0.25 LSB typ, ±1 LSB max

Output Current

VOUTx Pins

USB-3101 Through USB-3106: ±3.5 mA typ

USB-3110: ±40 mA max

USB-3112/3114: ±40 mA max single channel, ±180 mA total load current

Output Short-Circuit Protection

VOUTx Connected to AGND

USB-3101 Through USB-3106: Indefinite

USB-3110/3112/3114: ±100 ms max

Do not keep voltage outputs in a short-circuit condition for longer than the specified limit of 100 ms. For applications that may exceed the 40 mA maximum current limit or the 100 ms short-circuit condition, use external current limiting to prevent potential damage to the device.

Output Coupling: DC

Power On and Reset State

DACs Cleared to Zero-Scale: 0 V, ±50 mV typ

Output Range: 0 V to 10 V

Output Noise

0 V to 10 V Range: 14.95 μVrms typ

±10 V Range: 31.67 μVrms typ

Settling Time

To 1 LSB Accuracy: 25 μs typ

Slew Rate

USB-3101 Through USB-3106

0 V to 10 V Range: 1.20 V/μs typ

±10 V Range: 1.20 V/μs typ

USB-3110/3112/3114

0 V to 10 V Range: 2.0 V/μs typ

±10 V Range: 4.0 V/μs typ

Throughput

Single-Channel: 100 S/s max, system-dependent

Multichannel: 100 S/s/#ch max, system-dependent

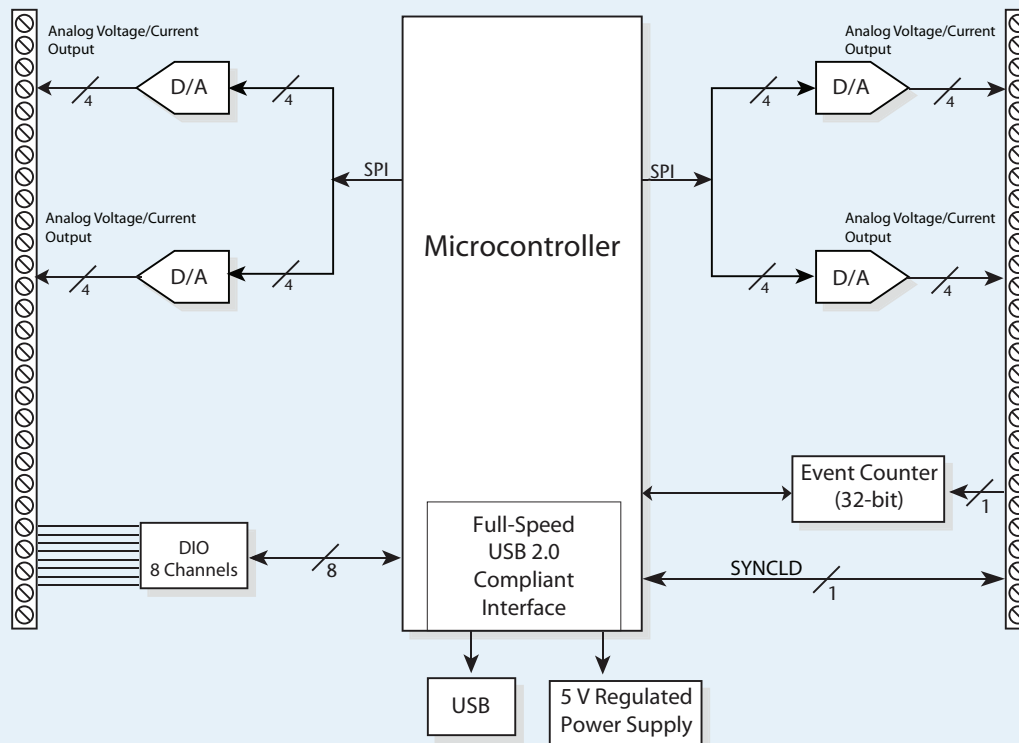
USB-3100 Series

Specifications

USB-3106 Block Diagram

With 16 channels of analog voltage/current output, the USB-3106 contains a superset of the analog output features of these USB-3100 Series devices:

- The USB-3101 provides four channels of analog voltage output
- The USB-3102 provides four channels of analog voltage/current output
- The USB-3103 provides eight channels of analog voltage output
- The USB-3104 provides eight channels of analog voltage/current output
- The USB-3105 provides 16 channels of analog voltage output



Absolute Accuracy Components – Calibrated Output

Range	% of Reading	Offset	Temperature Drift (%/°C)	Absolute Accuracy at FS
±10 V	±0.0183	±1.831 mV	0.00055	±3.661 mV
0 V to 10 V	±0.0183	±0.915 mV	0.00055	±2.746 mV

Absolute Accuracy – Calibrated Output

±10 V: ±4.0 LSB
 0 V to 10 V: ±22.0 LSB
Relative Accuracy (±LSB)
 ±10 V, 0 V to 10 V: 4.0 typ, 12.0 max

Analog Current Output (USB-3102/3104/3106)

Number of Channels

USB-3102: 4
 USB-3104: 8
 USB-3106: 16

Each DAC8554 output controls a voltage and current output channel-pair simultaneously. For example, writing to voltage output channel 0 also updates current output channel 0; conversely, writing to current output channel 0 also updates voltage output channel 0. Disconnect unused voltage and current output channels.

Resolution: 16 bits
Output Ranges

Calibrated: 0 mA to 20 mA typ
 Uncalibrated: 0 mA to 25 mA typ

Compliance Voltage Range

Calibrated Output: 8 V to 36 V

The following formulas calculate the maximum load resistance for correct current output circuit operation. The compliance voltage applied should not exceed the compliance voltage range limits.

Calibrated output

$Load\ Resistance = (compliance\ voltage - 6\ V) / 0.020\ A$

Uncalibrated output

$Load\ resistance = (compliance\ voltage - 6\ V) / 0.025\ A$

Differential Nonlinearity

Calibrated: ±1.25 LSB typ, -2 LSB to 1 LSB max

Uncalibrated: ±0.25 LSB typ, -1 LSB to 1 LSB max

The maximum differential nonlinearity specification applies to the entire operating temperature range. This specification also accounts for the maximum errors due to the software calibration algorithm (in calibrated mode only) and the DAC8554 nonlinearities.

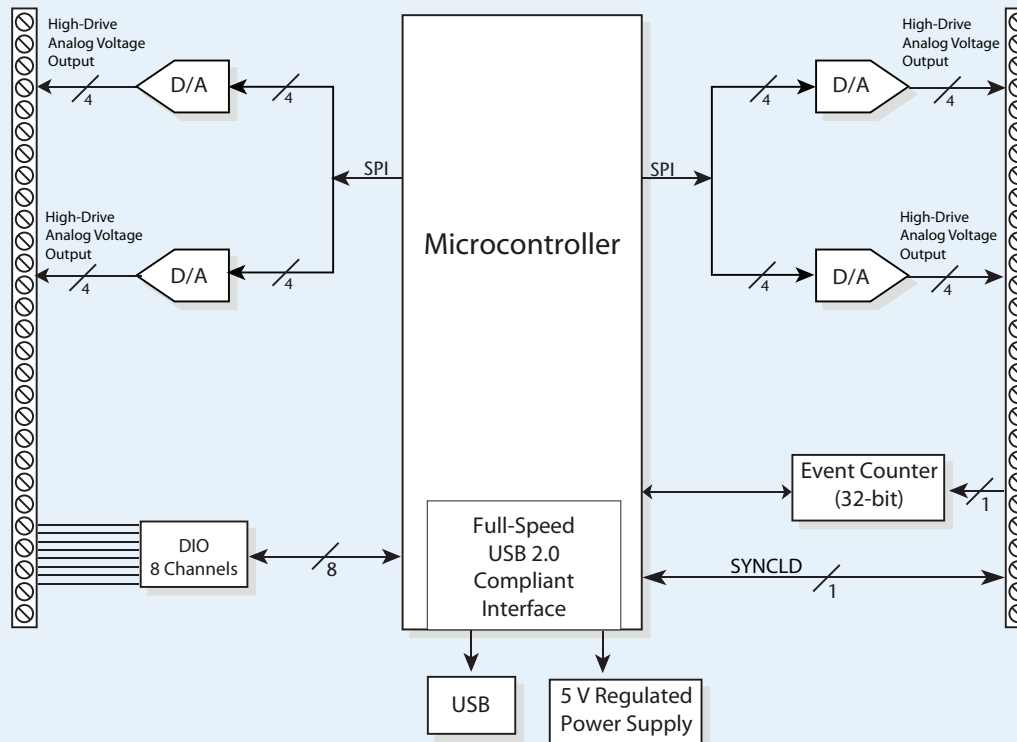
USB-3100 Series

Specifications

USB-3114 Block Diagram

With 16 channels of high-drive analog voltage output, the USB-3114 contains a superset of the analog output features of these USB-3100 Series devices:

- ° The USB-3110 provides four channels of analog voltage output
- ° The USB-3112 provides eight channels of analog voltage output



Absolute Accuracy: $\pm 0.05\%$ of full-scale range
(compliance voltage = 13 V, load resistance = 100 Ω)

IOUTx Leakage Current: 100 nA typ for each individual IOUT channel (all zeros written to IOUTx channel)

Settling Time: 25 μ s typ (full scale step to 1 LSB accuracy; compliance voltage = 12 V, load resistance = 500 Ω)

Throughput

Single-Channel: 100 Hz max, system-dependent
Multichannel: 100 Hz/#ch max, system-dependent

Analog Output Calibration

Recommended Warm-Up Time: 15 minutes min

Onboard Precision Reference

DC Level: 5.000 V ± 1 mV max.

Tempco: ± 10 ppm/ $^{\circ}$ C max.

Long-Term Stability: ± 10 ppm/SQRT(1000 hrs)

Calibration Method

USB-3101 Through USB-3106: Software calibration

USB-3110/3112/3114: Software calibration (V_{outx}
 $R_{load} = 20$ mA fixed resistive load)

Calibration Interval: 1 year

Digital I/O

Digital Logic Type: CMOS

Number of I/O: 8

Configuration: Independently-configured for input or output

Pull-Up/Pull-Down Configuration: Software-selectable; all pins floating (default)

For pull-down, connect the DIO CTL pin to a DGND pin. For pull-up, connect the DIO CTL pin to the +5 V pin.

Digital I/O Input Loading: TTL (default); 47 K Ω (pull-up/pull down configurations)

Digital I/O Transfer Rate (System-Paced): System-dependent, 33 to 1000 port reads/writes or single bit reads/writes per second.

Input High Voltage: 2.0 V min, 5.5 V absolute max

Input Low Voltage: 0.8 V max, -0.5 V absolute min

Output High Voltage (IOH = -2.5 mA): 3.8 V min

Output Low Voltage (IOL = 2.5 mA): 0.7 V max

Power On and Reset State: Input

Synchronous DAC Load

Pin Name: SYNCLD (terminal block pin 49)

Power On and Reset State: Input

Pin Type: Bidirectional

Termination: Internal 100 K pull-down

Software-Selectable Direction

Output: Outputs internal D/A LOAD signal

Input: Receives D/A LOAD signal from external source

Input Clock Rate: 100 Hz max

Clock Pulse Width

Input: 1 μ s min

Output: 5 μ s min

Input Leakage Current: ± 1.0 μ A typ

Input High Voltage: 4.0 V min, 5.5 V absolute max

Input Low Voltage: 1.0 V max, -0.5 V absolute min

Output High Voltage

IOH = -2.5 mA: 3.3 V min

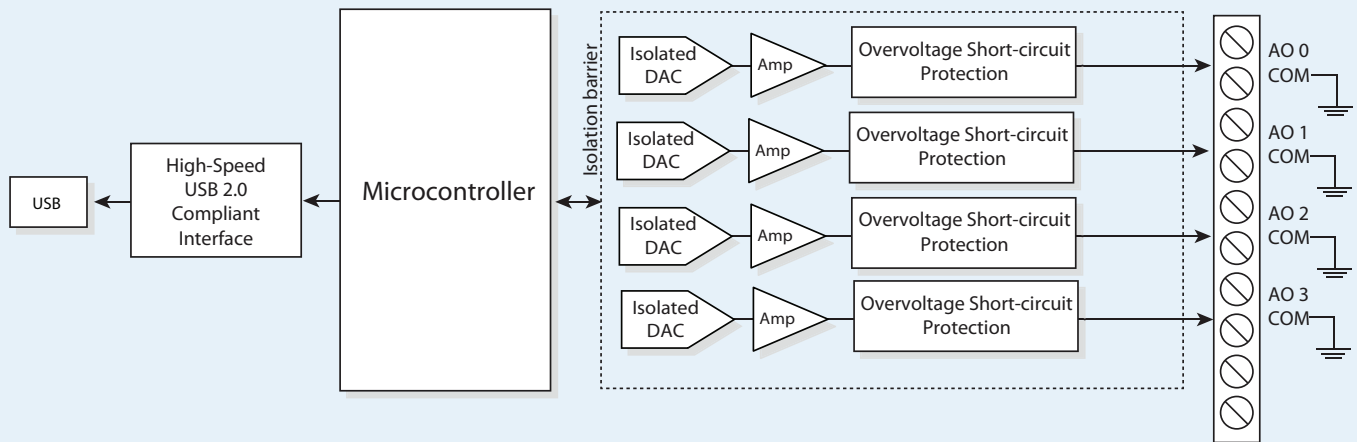
No Load: 3.8 V min

SYNCLD is a Schmitt trigger input and is over-current protected with a 200 Ω series resistor.

USB-3100 Series

Specifications

USB-3101FS Block Diagram



Output Low Voltage

IOL = 2.5 mA: 1.1 V max

No Load: 0.6 V max

When SYNCLD is in input mode, the analog outputs may either be updated immediately or when a positive edge is seen on the SYNCLD pin (this is under software control.) However, the pin must be at a low logic level in order for the DAC outputs to be updated immediately. If an external source is pulling the pin high, no update occurs.

Counter

Pin Name: CTR

Number of Channels: 1

Resolution: 32-bits

Counter Type: Event counter

Input Type: TTL, rising edge triggered

Counter Read/Write Rates (Software-Paced)

Counter Read: System dependent, 33 to 1000 reads per second

Counter Write: System-dependent, 33 to 1000 reads per second

Schmidt Trigger Hysteresis: 20 mV to 100 mV

Input Leakage Current: $\pm 1.0 \mu\text{A}$ typ

Input Frequency: 1 MHz max

High Pulse Width: 500 ns min

Low Pulse Width: 500 ns min

Input High Voltage: 4.0 V min, 5.5 V absolute max

Input Low Voltage: 1.0 V max, -0.5 V absolute min

Memory

EEPROM: 256 bytes

EEPROM Configuration

Address Range: 0x000-0x0FF

Access: Read/write

Description: 256 bytes user data

Microcontroller

Type: High performance 8-bit RISC microcontroller

Program Memory: 16,384 words

Data Memory: 2,048 bytes

Specifications

USB-3101FS

General

Environment

Operating Temperature: -40 °C to 70 °C

Storage Temperature: -40 °C to 85 °C

Relative Humidity (RH)

Operating Humidity: 10% to 90% RH non-condensing

Storage Humidity: 5% to 95% RH non-condensing

Communications: USB 2.0 high-speed (480 Mbps)

Signal I/O Connector: One bank of detachable screw terminals

Power

Power Consumption: 625 mW max

Thermal Dissipation at 70 °C: 625 mW max

Dimensions (L x W x H): 114.3 x 139.7 x 38.1 mm (4.5 x 5.5 x 1.5 in.)

Weight: 544 g (1.2 lb)

Analog Voltage Output

Number of Channels: 4

D/A Converter Resolution: 16 bit

D/A Converter Type: String

Output Range: ± 10 V

Power On Voltage: 0 V

Operating Voltage: ± 10.7 V nominal, ± 10.3 V min, ± 11 V max

Current Drive: ± 1 mA per channel max

Output Impedance: 0.1 Ω

Stability:

Offset Drift: $\pm 80 \mu\text{V}/^\circ\text{C}$

Gain Drift: 6 ppm/ °C

Protection

Overvoltage: ± 30 V

Short-Circuit: Indefinitely

Update Time

One Channel: 3 μs

Two Channels: 5 μs

Three Channels: 7.5 μs

Four Channels: 9.5 μs

Update Rate: 100 kS/s per channel max

Noise: 260 μVrms

Slew Rate: 4 V/ μs

Crosstalk: 76 dB

Settling Time:

100 pF Load to 1 LSB

FS Step: 20 μs

3 V Step: 10 μs

0.1 V Step: 8 μs

Glitch Energy

256 Steps, Worst Case: 2 mV for 2 μs

Capacitive Drive: 1,500 pF min

Monotonicity: 16 bits

Differential Nonlinearity: -1 to 2 LSBs max

Integral Nonlinearity (Endpoint): 16 LSBs max

Accuracy		
Measurement Conditions	% of Reading	% of Range (Range is Equal to ± 10.7 V)
Calibrated, max (-40 to 70 °C)	0.35%	0.75%
Calibrated, typ (25 °C, ± 5 °C)	0.01%	0.1%
Uncalibrated, max (-40 to 70 °C)	2.2%	1.7%
Uncalibrated, typ (25 °C, ± 5 °C)	0.3%	0.25%

USB-3100 Series

Ordering Information

Ordering Information

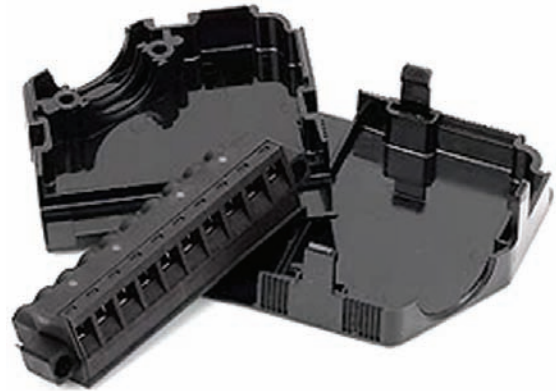
Description	Part No.
USB-based four-channel, 16-bit, 100 kS/s, simultaneously updating analog output device with USB cable	USB-3101FS
USB-based four-channel, 16-bit, analog voltage output device with one 32-bit counter, eight DIO lines, and USB cable	USB-3101
USB-based four-channel, 16-bit, analog voltage/current output device with one 32-bit counter, eight DIO lines, and USB cable	USB-3102
USB-based eight-channel, 16-bit analog voltage output device with one 32-bit counter, eight DIO lines, and USB cable	USB-3103
USB-based eight-channel, 16-bit analog voltage/current output device with one 32-bit counter, eight DIO lines, and USB cable	USB-3104
USB-based 16-channel, 16-bit voltage output device with one 32-bit counter, eight DIO lines, and USB cable	USB-3105
USB-based 16-channel, 16-bit voltage/current output device with one 32-bit counter, eight DIO lines, and USB cable	USB-3106
USB-based four-channel, 16-bit high-drive analog output device with one 32-bit counter, eight DIO lines, USB cable, and PS-5V2AEPS power supply	USB-3110
USB-based eight-channel, 16-bit high-drive analog output device with one 32-bit counter, eight DIO lines, USB cable, and PS-5V2AEPS power supply	USB-3112
USB-based 16-channel, 16-bit high-drive analog output device with one 32-bit counter, eight DIO lines, USB cable, and PS-5V2AEPS power supply	USB-3114

Accessories & Cables

USB-3101FS Backshell with 10-position connector block (quantity 1)	ACC-107
10-position detachable screw terminal connector blocks (quantity 10)	ACC-121

Software

Icon-based data acquisition, graphics, control, and analysis software	DASYLab
Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator	TracerDAQ Pro



ACC-107



ACC-121