

# USB-3100 Series

## USB Voltage and Current Output



The USB-3100 Series provides up to 16 voltage/current output channels, with some devices offering high-drive analog outputs.



The USB-3101FS includes 4 simultaneous output channels with 250 Vrms channel-to-ground isolation.

### 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 available
- Digital I/O, counter/timer available
- Synchronous update available

### Supported Operating Systems

- Windows® 11/10/8/7/Vista®XP 32/64-bit
- Linux® (except for USB-3101FS)

### Overview

The 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.

### Analog Output

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

**USB-3101FS:** Each channel has a fixed  $\pm 10$  V voltage output range. Outputs can be updated individually or simultaneously. Each channel has a D/A converter (DAC) that produces a voltage signal. Each channel also has  $\pm 30$  V overvoltage and indefinite short-circuit protection. The USB-3101FS has 250 Vrms 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.

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

### 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 the USB-3101FS have a synchronous DAC load connection pin 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).

### Digital I/O

All USB-3100 Series devices except the USB-3101FS have eight bidirectional DIO lines. 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.

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 Vrms ch-to-gnd

### Software Support

The USB-3100 Series is supported by the software in the table below.

#### Ready-to-Run Applications

##### [DAQami™](#)



Data acquisition companion software with drag-and-drop interface that is used to acquire, view, and log data, and generate signals. DAQami can be configured to log analog, digital, and counter channels, and to view that data in real-time or post-acquisition on user-configurable displays. Logged data can be exported for use in Excel® or MATLAB®. Windows OS

DAQami is included with the free MCC DAQ Software bundle.

##### [InstaCal™](#)



An interactive installation, configuration, and test utility for MCC hardware. Windows OS

InstaCal is included with the free MCC DAQ Software bundle.

##### [TracerDAQ™ and TracerDAQ Pro](#)



Virtual strip chart, oscilloscope, function generator, and rate generator applications used to generate, acquire, analyze, display, and export data. Supported features may vary by hardware. The Pro version provides enhanced features. Windows OS

TracerDAQ is included with the free MCC DAQ Software bundle.

TracerDAQ Pro is available as a purchased software download.

#### General-Purpose Programming Support

##### [Universal Library™ \(UL\) for Windows](#)



Library for developing applications in C, C++, VB, C# .Net, VB .Net, and Python on Windows.

The UL for Windows is included with the free MCC DAQ Software bundle.

The UL Python API for Windows is available on GitHub ([github.com/mccdaq/mcculw](https://github.com/mccdaq/mcculw)).

##### [UL for Linux® \(except for the USB-3101FS\)](#)



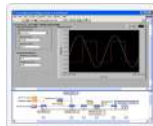
Library for developing applications in C, C++, and Python on Linux.

UL for Linux is available on GitHub ([github.com/mccdaq/uldaq](https://github.com/mccdaq/uldaq)).

Open-source, third-party Linux drivers are also available for supported MCC devices.

#### Application-Specific Programming Support

##### [ULx for NI LabVIEW™](#)



A comprehensive library of VIs and example programs for NI LabVIEW that is used to develop custom applications that interact with most MCC devices. Windows OS

ULx for NI LabVIEW is included with the free MCC DAQ Software bundle.

##### [DASYLab®](#)



Icon-based data acquisition, graphics, control, and analysis software that allows users to create complex applications in minimal time without text-based programming. Windows OS

DASYLab is available as a purchased software download. An evaluation version is available for 28 days.

##### [MATLAB® driver \(except for the USB-3101FS\)](#)



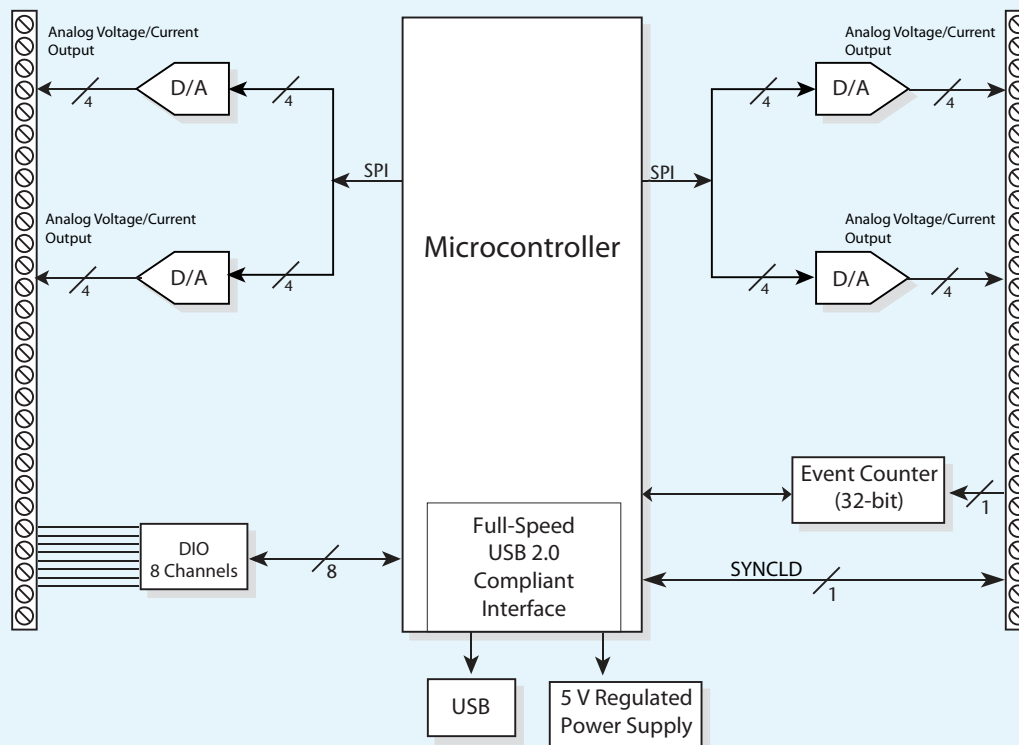
High-level language and interactive environment for numerical computation, visualization, and programming. The Mathworks Data Acquisition Toolbox™ allows users to acquire data from most MCC PCI and USB devices.

Visit [www.MathWorks.com](http://www.MathWorks.com) for more information about the Data Acquisition Toolbox.

### 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:

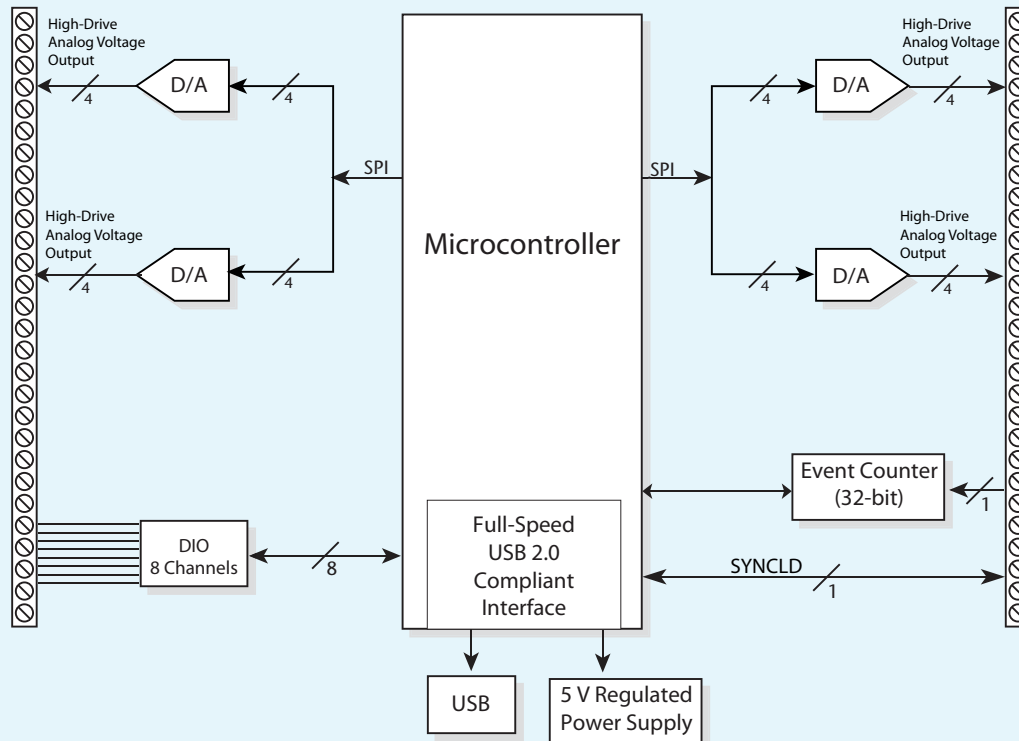
- USB-3101: 4 voltage output channels
- USB-3102: 4 voltage/current output channels
- USB-3103: 8 voltage output channels
- USB-3104: 8 voltage/current output channels
- USB-3105: 16 voltage output channels



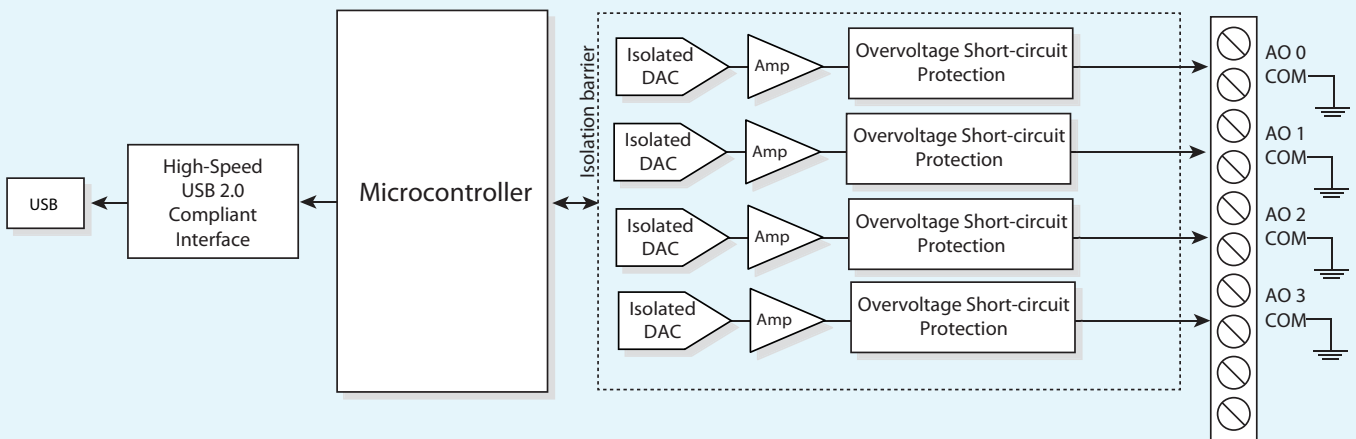
### USB-3114 Block Diagram

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:

- USB-3110: 4 voltage output channels
- USB-3112: 8 voltage output channels



### USB-3101FS Block Diagram



# USB-3100 Series

## Specifications



### Specifications – all devices except USB-3101FS

#### 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. Writing to voltage channel 0 also updates current channel 0; conversely, writing to current channel 0 also updates voltage channel 0. Disconnect unused voltage and current output channels.

Resolution: 16 bits

Output Ranges (Software-Selectable)

Calibrated:  $\pm 10$  V, 0 V to 10 V

Uncalibrated:  $\pm 10.2$  V,  $-0.04$  V to 10.08 V

Output Transient

$\pm 10$  V to (0 V to 10 V) or (0 V to 10 V) to  $\pm 10$  V Range Selection: The output 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  $\mu$ s typ

Amplitude: 5 V p-p typ

Host Computer is Reset, Powered On, Suspended, or a Reset Command is Issued to Device: The duration depends 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 max specification applies to the operating temperature range, and accounts for max errors due to the software calibration algorithm (Cal mode) and DAC8554 nonlinearities

Calibrated:  $\pm 1.25$  LSB typ,  $-2$  LSB to  $+1$  LSB max

Uncalibrated:  $\pm 0.25$  LSB typ,  $\pm 1$  LSB max

Output Current

VOUTx Pins

USB-3101 through USB-3106:  $\pm 3.5$  mA typ

USB-3110:  $\pm 40$  mA max

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

Output Short-Circuit Protection

VOUTx Connected to AGND

USB-3101 through USB-3106: Indefinite

USB-3110/3112/3114:  $\pm 100$  ms max

Output Coupling: DC

Power On and Reset State

DACs Cleared to Zero-Scale: 0 V,  $\pm 50$  mV typ

Output Range: 0 V to 10 V

Output Noise

0 V to 10 V Range: 14.95  $\mu$ Vrms typ

$\pm 10$  V Range: 31.67  $\mu$ Vrms typ

Settling Time

To 1 LSB Accuracy: 25  $\mu$ s typ

Slew Rate

USB-3101 Through USB-3106

0 V to 10 V Range: 1.20 V/ $\mu$ s typ

$\pm 10$  V Range: 1.20 V/ $\mu$ s typ

USB-3110/3112/3114

0 V to 10 V Range: 2.0 V/ $\mu$ s typ

$\pm 10$  V Range: 4.0 V/ $\mu$ s typ

Throughput

Single-channel: 100 Hz max, system-dependent

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

Absolute Accuracy Components – Calibrated Output				
Range (V)	% of Reading	Offset (mV)	Temp. Drift (%/°C)	Absolute Accuracy at FS
$\pm 10$	$\pm 0.0183$	$\pm 1.831$	0.00055	$\pm 3.661$ mV
0 to 10	$\pm 0.0183$	$\pm 0.915$	0.00055	$\pm 2.746$ mV

Absolute Accuracy – Calibrated Output

$\pm 10$  V:  $\pm 4.0$  LSB

0 V to 10 V:  $\pm 22.0$  LSB

Relative Accuracy ( $\pm$ LSB)

$\pm 10$  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. Writing to voltage channel 0 also updates current channel 0; conversely, writing to current channel 0 also updates voltage 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 min, 36 V max. Formulas to calculate the max load resistance for current output circuit operation:

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:  $\pm 1.25$  LSB typ,  $-2$  LSB to 1 LSB max

Uncalibrated:  $\pm 0.25$  LSB typ,  $-1$  LSB to 1 LSB max

The max specification applies to the entire operating temperature range, and accounts for max errors due to the software calibration algorithm (in calibrated mode only) and the DAC8554 nonlinearities.

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

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

Settling time: 25  $\mu$ s typ (full scale step to 1 LSB accuracy; compliance voltage = 12 V, load resistance = 500  $\Omega$ )

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  $\pm 1$  mV max.

Tempco:  $\pm 10$  ppm/°C max.

Long-Term Stability:  $\pm 10$  ppm/SQRT(1000 hrs)

Calibration Method

USB-3101 Through USB-3106: Software calibration

USB-3110/3112/3114: SW calibration (Voutx Rload = 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 $\Omega$  (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, Schmitt trigger input, over-current protected with a 200  $\Omega$  series resistor.

Power On and Reset State: Input

Pin Type: Bidirectional; output the internal D/A LOAD signal, or receive the D/A LOAD signal from an external source.

Termination: Internal 100 k $\Omega$  pull-down

Input Clock Rate: 100 Hz max

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## Specifications



### Clock Pulse Width

**Input:** 1  $\mu$ s min  
**Output:** 5  $\mu$ s min  
**Input Leakage Current:**  $\pm 1.0$   $\mu$ 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

### Output Low Voltage

**IOL = 2.5 mA:** 1.1 V max  
**No Load:** 0.6 V max

When set for input, the analog outputs can be updated immediately or when a positive edge is detected with software. SYNCLD must be at a low logic level for 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/Write:** System dependent, 33 to 1000 reads per second  
**Schmidt Trigger Hysteresis:** 20 mV to 100 mV  
**Input Leakage Current:**  $\pm 1.0$   $\mu$ 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

## Specifications – USB-3101FS

### Analog Voltage Output

**Number of Channels:** 4  
**D/A Converter Resolution:** 16 bit  
**D/A Converter Type:** String  
**Output Range:**  $\pm 10$  V  
**Power On Voltage:** 0 V  
**Operating Voltage:**  $\pm 10.7$  V nominal,  $\pm 10.3$  V min,  $\pm 11$  V max  
**Current Drive:**  $\pm 1$  mA per channel max  
**Output Impedance:** 0.1  $\Omega$   
**Stability:**  
**Offset Drift:**  $\pm 80$   $\mu$ V/ $^{\circ}$ C  
**Gain Drift:** 6 ppm/ $^{\circ}$ C  
**Protection**  
**Overvoltage:**  $\pm 30$  V  
**Short-Circuit:** Indefinitely  
**Update Time**  
**One Channel:** 3  $\mu$ s  
**Two Channels:** 5  $\mu$ s  
**Three Channels:** 7.5  $\mu$ s  
**Four Channels:** 9.5  $\mu$ s  
**Update Rate:** 100 kS/s per channel max  
**Noise:** 260  $\mu$ Vrms  
**Slew Rate:** 4 V/ $\mu$ s  
**Crosstalk:** 76 dB  
**Settling Time:**  
**100 pF Load to 1 LSB**  
**FS Step:** 20  $\mu$ s  
**3 V Step:** 10  $\mu$ s  
**0.1 V Step:** 8  $\mu$ s  
**Glitch Energy**  
**256 Steps, Worst Case:** 2 mV for 2  $\mu$ s  
**Capacitive Drive:** 1,500 pF min

### Environmental

**Operating temperature**  
USB-3101/3103/3105: 0  $^{\circ}$ C to 70  $^{\circ}$ C  
All other devices: 0  $^{\circ}$ C to 50  $^{\circ}$ C  
**Storage temperature:** -40  $^{\circ}$ C to 85  $^{\circ}$ C  
**Relative humidity (RH):** 0% to 90% RH, noncondensing

### 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 (USB power is within specified limits)  
**+5 V user output current:** 10 mA max (total current sourced from the +5V for general use; includes any additional contribution due to DIO loading).  
USB-3102/3104/3106  
**ITEST output voltage range:** 13 V,  $\pm 1\%$  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  $\Omega$  between the ITEST pin and the IOUTx pin for proper operation)  
**External power (USB-3110/3112/3114 only)**  
**Output voltage:** 5 V,  $\pm 5\%$   
**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

### Mechanical

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

**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 $\pm 10.7$ V)
Calibrated, max (-40 to 70 $^{\circ}$ C)	0.35%	0.75%
Calibrated, typ (25 $^{\circ}$ C, $\pm 5$ $^{\circ}$ C)	0.01%	0.1%
Uncalibrated, max (-40 to 70 $^{\circ}$ C)	2.2%	1.7%
Uncalibrated, typ (25 $^{\circ}$ C, $\pm 5$ $^{\circ}$ C)	0.3%	0.25%

### Environmental

**Operating temperature:** -40  $^{\circ}$ C to 70  $^{\circ}$ C  
**Storage temperature:** -40  $^{\circ}$ C to 85  $^{\circ}$ C  
**Operating humidity:** 10% to 90% RH non-condensing  
**Storage humidity:** 5% to 95% RH non-condensing

### Power

**Power consumption:** 625 mW max  
**Thermal dissipation at 70  $^{\circ}$ C:** 625 mW max

### Mechanical

**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)



# USB-3100 Series

## Ordering



### Ordering Information

#### Hardware

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

#### Accessories and Cables (for USB-3101FS only)

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

#### Software also Available from MCC

Part No.	Description
TracerDAQ Pro	Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator – professional version
DASYLab	Icon-based data acquisition, graphics, control, and analysis software