USB-2404-10

USB-based Analog Input Device

User's Guide

MC MEASUREMENT COMPUTING™

USB-2404-10

USB-based Analog Input Device

User's Guide

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Table of Contents

Distributed by MicroDAQ.com, Ltd.   **www.MicroDAQ.com**   **(603) 746-5524**

About this User's Guide

What you will learn from this user's guide

This user's guide explains how to install, configure, and use the USB-2404-10, and refers you to related documents available on our web site, and to technical support resources.

Conventions in this user's guide

For more information on …

Text presented in a box signifies additional information and helpful hints related to the subject matter you are reading.

Caution! Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

<#:#> Angle brackets that enclose numbers separated by a colon signify a range of numbers, such as those assigned to registers, bit settings, etc.

bold text **Bold** text is used for the names of objects on the screen, such as buttons, text boxes, and check boxes. For example:
1. Insert the disk or CD and click the **OK** button.

italic text *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase. For example:
The *InstaCal* installation procedure is explained in the Quick Start Guide.
Never touch the exposed pins or circuit connections on the board.

Where to find more information

For additional information relevant to the operation of your hardware, refer to the *Documents* subdirectory where you installed the MCC DAQ software (C:\Program Files\Measurement Computing\DAQ by default), or search for your device on our website at www.mccdaq.com.

Safety guidelines

You can connect hazardous voltages to the USB-2404-10 device's screw terminals. A hazardous voltage is a voltage greater than 42.4 V_{pk} or 60 VDC to earth ground. Take the following precautions if you connect hazardous voltages to the USB-2404-10:

Caution! Ensure that hazardous voltage wiring is performed only by qualified personnel adhering to local electrical standards.

Caution! Do not mix hazardous voltage circuits and human-accessible circuits on the same device.

Caution! Make sure that devices and circuits connected to the USB-2404-10 are properly insulated from human contact.

Caution! When device terminals are hazardous voltage LIVE (>42.4V_{pk}/60 VDC), ensure that devices and circuits connected to the USB-2404-10 are properly insulated from human contact. Use the ACC-160 connector backshell kit to ensure that the terminals are not accessible.

Introducing the USB-2404-10

Overview: USB-2404-10 features

This user's guide contains all of the information you need to connect the USB-2404-10 to your computer and to the signals you want to measure.

The USB-2404-10 is a USB 2.0 high-speed device that is supported under popular Microsoft® Windows® operating systems. The USB-2404-10 is fully compatible with both USB 1.1 and USB 2.0 ports.

The USB-2404-10 provides four channels of 24-bit simultaneous analog inputs.

The maximum sampling rate is 50 kS/s per channel, and the input voltage range is ±10 V, nominal.

An anti-alias filter removes noise that may be present in the signals prior to conversion. A 250 Vrms channel-to-channel and channel-to-ground isolation protects the device and computer from ground spikes, and ensures a reliable data stream. An on-board LED indicates the status of the device.

Field connections are made to four 2-position detachable screw terminals. Ten additional two-position connectors are available with the optional ACC-102 connector kit.

The USB 2.0 high-speed driver transfers data at rates up to 480 Mbps. The USB-2404-10 is powered by the +5 volt USB supply from your computer. No external power is required.

USB-2404-10 block diagram

USB-2404-10 functions are illustrated in the block diagram shown here.

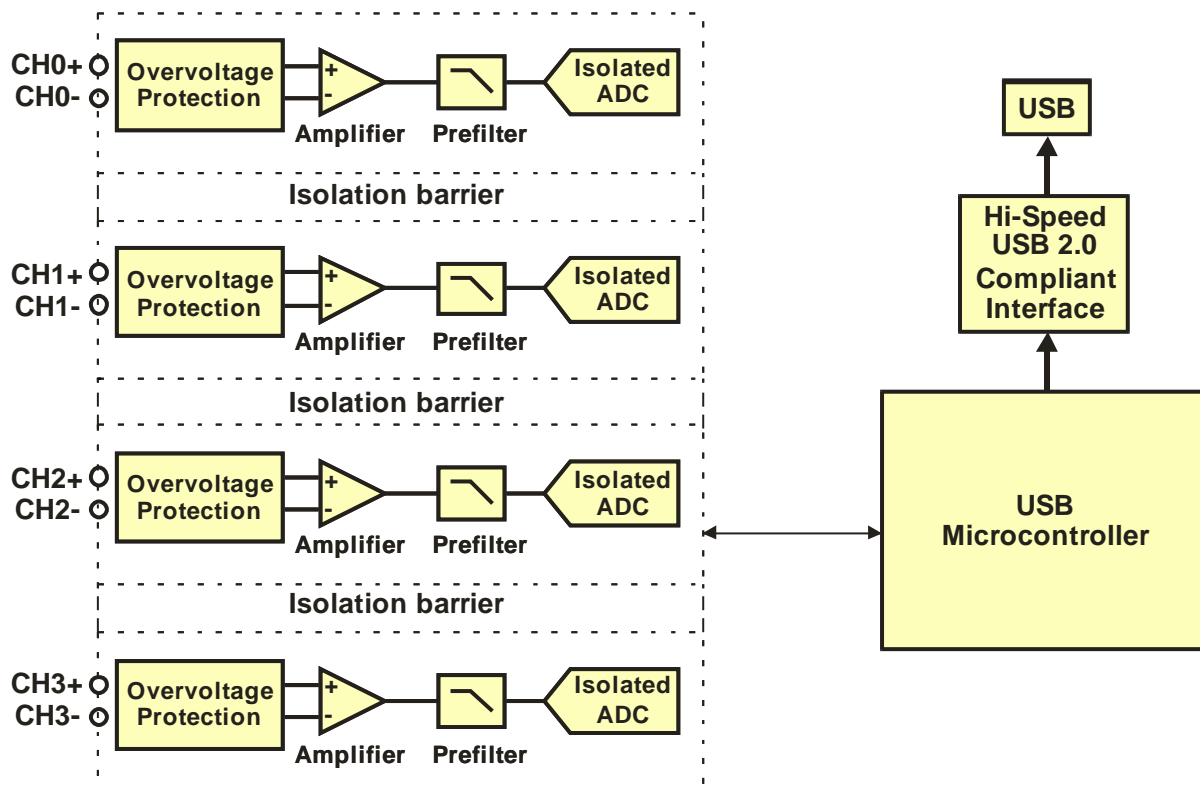Figure 1. USB-2404-10 functional block diagram

Software features

For information on the features of *Insta*Cal and the other software included with your USB-2404-10, refer to the *Quick Start Guide* that shipped with your device. The *Quick Start Guide* is also available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

Check www.mccdaq.com/download.htm for the latest software version.

Installing the USB-2404-10

What comes with your USB-2404-10 shipment?

As you unpack your USB-2404-10, verify that the following components are included.

Hardware

▪ USB-2404-10

▪ USB cable (2 meter length)

Additional documentation

In addition to this hardware user's guide, you should also receive the *Quick Start Guide* (available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf). This booklet supplies a brief description of the software you received with your USB-2404-10 and information regarding installation of that software. Please read this booklet completely before installing any software or hardware.

Optional accessories

▪ ACC-102 — Two-position screw terminal connector blocks (quantity ten). Additional details are available on our web site at www.mccdaq.com/daq-accessory/acc-102.aspx.
▪ ACC-160 — Backshell for use with the ACC-102 two-position screw terminal connector blocks. Provides strain relief and operator protection from high-voltage signals (quantity six). Additional details are available on our web site at www.mccdaq.com/daq-accessory/acc-160.aspx.

Unpacking the USB-2404-10

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the USB-2404-10 from its packaging, ground yourself using a wrist strap or by simply touching the computer chassis or other grounded object to eliminate any stored static charge.

If your USB-2404-10 is damaged, notify Measurement Computing Corporation immediately by phone, fax, or e-mail.

▪ Phone: 508-946-5100 and follow the instructions for reaching Tech Support.
▪ Fax: 508-946-9500 to the attention of Tech Support
▪ Email: techsupport@mccdaq.com

For international customers, contact your local distributor where you purchased the USB-2404-10. Click on this link www.measurementcomputing.com/sales.asp to locate your distributor.

Installing the software

Refer to the *Quick Start Guide* for instructions on installing the software on the *Measurement Computing Data Acquisition Software CD*. This booklet is available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

Installing the hardware

Install the MCC DAQ software before you install your board

The driver needed to run your board is installed with the MCC DAQ software. Therefore, you need to install the MCC DAQ software before you install your board. Refer to the *Quick Start Guide* for instructions on installing the software.

Be sure you are using the latest system software

Before you install your USB-2404-10, run Windows Update to update your operating system with the latest USB drivers.

To connect the USB-2404-10 to your system, turn your computer on, and connect the USB cable to a USB port on your computer or to an external USB hub that is connected to your computer. The USB cable provides power and communication to the USB-2404-10.

When you connect the USB-2404-10 for the first time, a series of **Found New Hardware** popup balloons (Windows XP) or dialogs (other Windows versions) open as the USB-2404-10 is detected by your computer. When the last balloon or dialog closes, the installation is complete. The LED on the USB-2404-10 blinks steadily to indicate that the device is initialized and receiving power.

Caution!   Do not disconnect **any** device from the USB bus while the computer is communicating with the USB-2404-10, or you may lose data and/or your ability to communicate with the device.

Allow the USB-2404-10 to operate for at least 30 minutes before using the device. This warm up time is required to achieve the specified rated accuracy of measurements.

Calibrating the USB-2404-10

The USB-2404-10 is shipped fully calibrated. Calibration coefficients are stored in EEPROM. Return the device to Measurement Computing Corporation when calibration is required. The normal calibration interval is once per year.

Functional Details

Components

The USB-2404-10 has the following external components:

- Screw terminal connectors
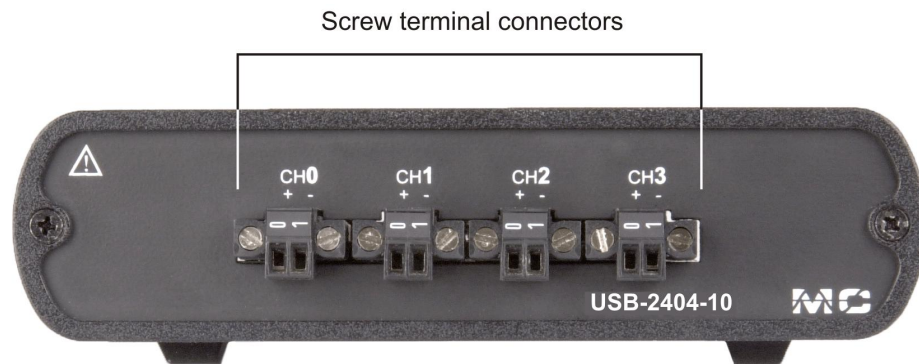- USB port
- LED
- Strain relief slot for USB cable

Screw terminal connectors

Figure 2. Front panel (Screw terminal connections)
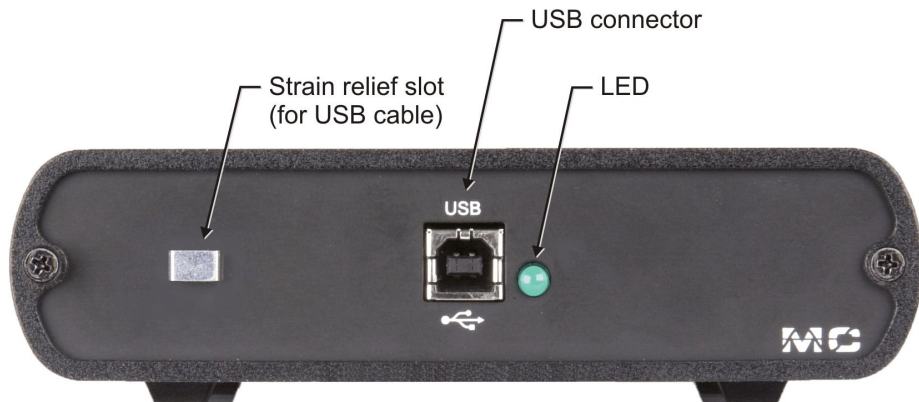
Figure 3. Rear panel (USB connection and LED)

Screw terminals (CH0 to CH3)

The USB-2404-10 has four 2-terminal detachable screw terminals for connection to four isolated analog inputs. The maximum sampling rate is 50 kS/s per channel, and the input voltage range is ±10 V, nominal. The channels may be sampled individually or simultaneously. Signal assignments are listed in the following table.

Screw terminal pin assignments

Screw terminal	Signal
0	CH0+ (CH0 IN HI)
1	CH0– (CH0 IN LO)
0	CH1+ (CH1 IN HI)
1	CH1– (CH1 IN LO)
0	CH2+ (CH2 IN HI)
1	CH2– (CH2 IN LO)
0	CH3+ (CH3 IN HI)
1	CH3– (CH3 IN LO)

Use 16 AWG to 28 AWG wires to connect signals to the device.

USB connector

The USB connector provides +5 V power and communication. The voltage supplied through the USB connector is system-dependent, and may be less than 5 V. No external power supply is required.

LED

The LED indicates the device status. When connected to a USB port, the LED blinks steadily to indicate that the device is initialized and receiving power. Refer to the following table for the possible LED states.

LED States

LED State	device status
Not lit	The device is not connected to a USB port or hub.
Continuous single-blink	The device is operating normally.
Continuous double-blink	The device is connected to a USB 1.1 Full-Speed port or hub, which may affect performance. Optimum performance requires connections to a USB 2.0 Hi-Speed host controller (480 Mbps) and USB 2.0 high-speed hubs.

Strain relief slot for USB cable

Use the strain relief slot to keep the USB cable from disconnecting from the device inadvertently. Feed a tie wrap through the slot and secure to the USB cable when it is connected to the device.

High-voltage applications

For high voltage applications, we recommend using the ACC-160 backshell to ensure that the terminals are not accessible. The backshell also provides strain relief to protect the screw terminals.
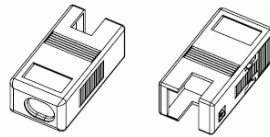
Figure 4. Connector backshell (ACC-160 accessory)

Additional details on this product are available on our web site at www.mccdaq.com/daq-accessory/acc-160.aspx.

Signal source connections

You can connect ground-referenced or floating signal sources to the USB-2404-10.

- Connect the positive signal of the signal source to the CH+ screw terminal.
- Connect the negative signal of the signal source to the CH– screw terminal.

The following figures show the connections between the USB-2404-10 and both a grounded signal source and a floating signal source.

Figure 5. Connecting a grounded signal source

When making a ground-referenced connection between the signal source and the USB-2404-10, make sure the voltage on the CH+ and CH– connections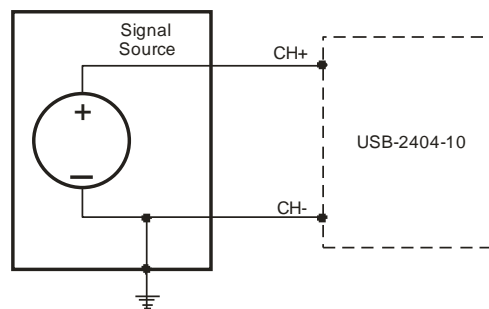 are within the channel-to-earth safety voltage range. Refer to the *Specifications* chapter for information about operating voltages and overvoltage protection.
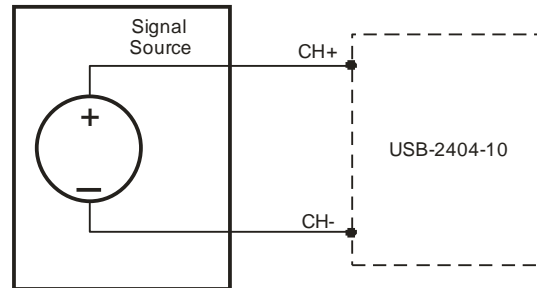

Figure 6. Connecting a floating signal source

Don't connect to signals or use for measurements within category III or IV

Refer to the "*Safety voltages"* section in the *Specifications* chapter for more information about Measurement Categories.

Analog input circuitry

The USB-2404-10 analog input channels are floating with respect to earth ground and to each other. The incoming analog signal on each channel is conditioned, buffered, and then sampled by a 24-bit Delta-Sigma ADC. Each channel provides an independent signal path and ADC, enabling you to sample all four channels simultaneously. Figure 7 shows the circuitry for one analog input channel.
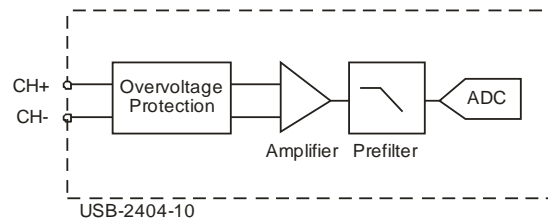

Figure 7. Analog input circuitry for one channel

Filtering

The USB-2404-10 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals while rejecting out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. The passband, stopband, and alias-free bandwidths are important.

The USB-2404-10 represents signals within the passband frequency, as quantified primarily by passband ripple and phase nonlinearity. All signals within the alias-free bandwidth are either unaliased signals or signals that have been filtered by at least the amount of the stopband rejection.

Passband bandwidth

The signals within the passband bandwidth have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the *passband flatness*. The device's digital filters adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the sample rate. Figure 8 shows typical passband flatness for the 50 kS/s sample rate.
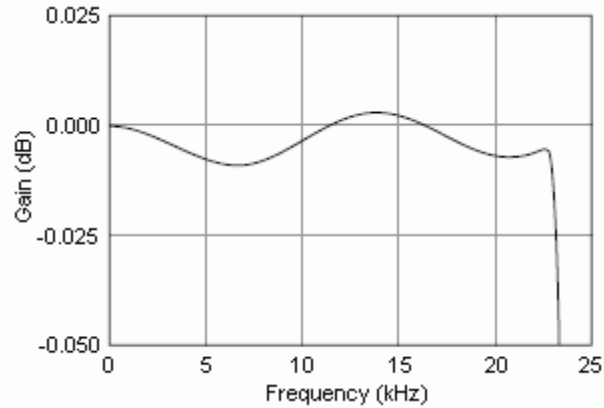
Figure 8. Passband response (typical)

Stopband bandwidth

The filter significantly attenuates all signals above the stopband frequency ($0.547 \cdot f_s$, where f_s is the sample rate). The filter is used primarily to prevent aliasing. Therefore, the stopband frequency scales precisely with the sample rate.

The stopband rejection (100 dB) is the minimum amount of attenuation applied by the filter to all signals with frequencies within the stopband bandwidth.

Alias-free bandwidth

Any signal that appears in the alias-free bandwidth of the USB-2404-10 is not an aliased artifact of signals at a higher frequency. The alias-free bandwidth ($0.453 \cdot f_s$) is defined by the ability of the filter to reject frequencies above the stopband frequency. The alias-free bandwidth equals the sample rate minus the stopband frequency.

Sample rates

A master timebase frequency (f_M) controls the USB-2404-10 sample rate (f_S). The internal master timebase frequency is 12.8 MHz.

The equation below provides the available sample rates of the USB-2404-10:

$$f_S = \frac{(f_M \div 256)}{n}, \text{ where } n \text{ is any integer from 1 to 31.}$$

The sample rate must keep the device within the sample rate range. Refer to the *Specifications* chapter for more information about the sample rate range.

Using the internal master timebase of 12.8 MHz results in sample rates of 50 kS/s, 25 kS/s, 16.67 kS/s and so on down to 1.613 kS/s, depending on the value of *n*.

Specifications

All specifications are subject to change without notice.
Typical for the range 0 to 60 °C unless otherwise noted.
All voltages are relative to the CH– signal on each channel unless otherwise noted.

Analog input

Table 1. Analog input specifications

Parameter	Conditions	Specification
Number of channels		4
A/D converter resolution		24-bit
A/D converter type		Delta-Sigma with analog pre-filtering
Sampling mode		Simultaneous
Sample rate range (f_s)		Minimum: 1.613 kS/s Maximum: 50 kS/s (Note 1)
Sample rates (f_s)		$\dfrac{(f_M \div 256)}{n}, n = 1, 2, \dots 31$
Internal master timebase (f_M)		Frequency: 12.8 MHz Accuracy: ±100 ppm maximum
Input voltage ranges	CH+ to CH–	±10 V, nominal ±10.52 V, typical ±10.3 V, minimum
Overvoltage protection		±100 V
Input coupling		DC
Input impedance	CH+ to CH–	1 MΩ
Input noise		70 μV rms
Gain drift		±5 ppm/°C
Offset drift		±24 μV/°C
Post calibration gain match	channel-to- channel, 20 kHz	0.22 dB maximum
Crosstalk	1 kHz	−130 dB
Phase mismatch	channel-to- channel	0.075°/kHz maximum
Phase nonlinearity	f_s = 50 kS/s	0.11° maximum
Input delay		$38.4/f_s$ +3 μs
Passband frequency		$0.453 \cdot f_s$
Passband flatness	f_s = 50 kS/s	±100 mdB maximum
Stopband frequency		$0.547 \cdot f_s$
Stopband rejection		100 dB
Alias-free bandwidth		$0.453 \cdot f_s$
−3 dB pre-filter bandwidth	f_s = 50 kS/s	24.56 kHz
Common mode rejection ratio (CMRR)	f_{in} = 60 Hz	126 dB
Spurious free dynamic range (SFDR)	1 kHz, –60 dBFS	−128 dBFS
Total harmonic distortion	1 kHz, –1 dBFS	−99 dB
	1 kHz, –20 dBFS	−105 dB

Note 1: Full performance requires connections to a USB 2.0 Hi-Speed host controller and USB 2.0 high-speed hubs.) The maximum sample rate may be lower on USB 1.1 ports.

Accuracy

Table 2. Analog input accuracy

Measurement conditions	Percent of reading (gain error)	Percent of range (offset error) (Note 2)
Calibrated maximum (–0 to 60 ℃)	±0.13%	±0.05%
Calibrated typical (25 ℃, ±5 ℃)	±0.03%	±0.008%
Uncalibrated maximum (–0 to 60 ℃)	±1.4%	±0.67%
Uncalibrated typical (25 ℃, ±5 ℃)	±0.3%	±0.11%

Note 2:   The range is equal to 10.52 V.

Power

Table 3. Power specifications

Parameter	Specification
Current consumption from USB	500 mA, maximum

Bus interface

Table 4. Bus specifications

Parameter	Specification
USB specification	USB 2.0 Hi-Speed mode (480 Mbps) is recommended. Otherwise USB 1.1 Full-Speed mode (12 Mbps)

Environmental

Table 5. Environmental specifications

Parameter	Specification
Operating temperature range	0 to 60 °C
Storage temperature range	–40 to 85 °C
Operating humidity	10 to 90% relative humidity, non-condensing
Storage humidity	5 to 95% relative humidity, non-condensing
Maximum altitude	2000 meters (6561.679 feet)
Pollution degree (IEC60664)	2

Mechanical

Table 6. Mechanical specifications

Parameter	Specification
Dimensions	4.5" L x 5.5" W x 1.5" H
Weight	1.2 lbs. (544 grams)

Safety voltages

Table 7. Safety specifications (Note 3)

Parameter	Conditions	Specification
Channel-to-earth ground isolation	Continuous	250 Vrms, Measurement Category II (Note 4)
	Withstand	2,300 Vrms, verified by a 5 sec dielectric withstand test
Channel-to-channel isolation	Continuous	250 Vrms, Measurement Category II (Note 4)
	Withstand	1390 Vrms, verified by a 5 sec dielectric withstand test

Note 3:   Connect only voltages that are within the limits specified in this table.

Note 4:   Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet, for example 115 V for US or 230 V for Europe.

Caution!   Do not connect the device to signals or use for measurements within Measurement Categories III or IV.

Screw terminal connectors

Table 8. Screw terminal connector specifications

Connector type	Screw terminal
Screw terminal wiring	16 to 28 AWG copper conductor wire with 7 mm (0.28 in.) of insulation stripped from the end.
Torque for screw terminals	0.22 to 0.25 N· m (1.95 to 2.21 lb. · in.)

Table 9. Screw terminal assignments

Screw terminal	Signal
0	CH0+ (CH0 IN HI)
1	CH0– (CH0 IN LO)
0	CH1+ (CH1 IN HI)
1	CH1– (CH1 IN LO)
0	CH2+ (CH2 IN HI)
1	CH2– (CH2 IN LO)
0	CH3+ (CH3 IN HI)
1	CH3– (CH3 IN LO)

Accessory products

Table 10. Screw terminal connector specifications

ACC-102	Two-position detachable screw terminal connector blocks (quantity ten)
ACC-160	Backshell for use with the ACC-102 two-position screw terminal connector blocks. Provides strain relief and operator protection from high-voltage signals (quantity four)

$C\epsilon$ Declaration of Conformity

Manufacturer: Measurement Computing Corporation
Address: 10 Commerce Way
                     Suite 1008
                     Norton, MA 02766
                     USA

Measurement Computing Corporation declares under sole responsibility that the product

USB-2404-10

to which this declaration relates is in conformity with the relevant provisions of the following standards or other documents:

Category: Electrical equipment for measurement, control and laboratory use.

EC EMC Directive 2004/108/EC: General Requirements, EN 61326-1:2006 (IEC 61326-1:2005).

Emissions: IEC 61326-2-1:2005.

- EN 55011 (1990)/CISPR 11 Radiated emissions: Group 1, Class A
- EN 55011 (1990)/CISPR 11 Conducted emissions: Group 1, Class A

Immunity: EN 61326-1:2006, Table 3.

- IEC 61000-4-2 (1995): Electrostatic Discharge immunity, Criteria B.
- IEC 61000-4-3 (1995): Radiated Electromagnetic Field immunity, Criteria A.

To maintain compliance to the standards of this declaration, the following conditions must be met.

- The host computer, peripheral equipment, power sources, and expansion hardware must be CE compliant.
- All I/O cables must be shielded, with the shields connected to ground.
- I/O cables must be less than 3 meters (9.75 feet) in length.
- The host computer must be properly grounded.
- Equipment must be operated in a controlled electromagnetic environment as defined by Standards EN 61326:2006, or IEC 61326:2005.

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in September, 2008. Test records are outlined in Chomerics Test Report #EMI5135.08.

We hereby declare that the equipment specified conforms to the above Directives and Standards.

Carl Haapaoja, Director of Quality Assurance

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