USB-202

Analog and Digital I/O

User's Guide

MEASUREMENT COMPUTING™

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Notice

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About this User's Guide

What you will learn from this user's guide

This user's guide describes the Measurement Computing USB-202 data acquisition device and lists device specifications.

Conventions in this user's guide

For more information

Text presented in a box signifies additional information related to the subject matter.

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

bold text   **Bold** text is used for the names of objects on a screen, such as buttons, text boxes, and check boxes.

italic text   *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase.

Where to find more information

Additional information about USB-202 hardware is available on our website at www.mccdaq.com. You can also contact Measurement Computing Corporation with specific questions.

- Knowledgebase: kb.mccdaq.com
- Tech support form: www.mccdaq.com/support/support_form.aspx
- Email: techsupport@mccdaq.com
- Phone: 508-946-5100 and follow the instructions for reaching Tech Support

For international customers, contact your local distributor. Refer to the International Distributors section on our website at www.mccdaq.com/International.

Introducing the USB-202

The USB-202 is a USB 2.0 full-speed device that provides the following features:

- Eight single-ended 12-bit analog inputs
- 100 kS/s max sample rate
- Two 12-bit analog outputs
- Eight individually configurable digital I/O channels
- 32-bit counter input
- Digital trigger input
- External pacer clock input
- Internal/external pacer clock output
- User voltage output
- Two screw terminal banks for field wiring connections

The USB-202 is powered by the +5 V USB supply from your computer; no external power is required. A USB cable is shipped with the device.

Functional block diagram

Device functions are illustrated in the block diagram shown here.
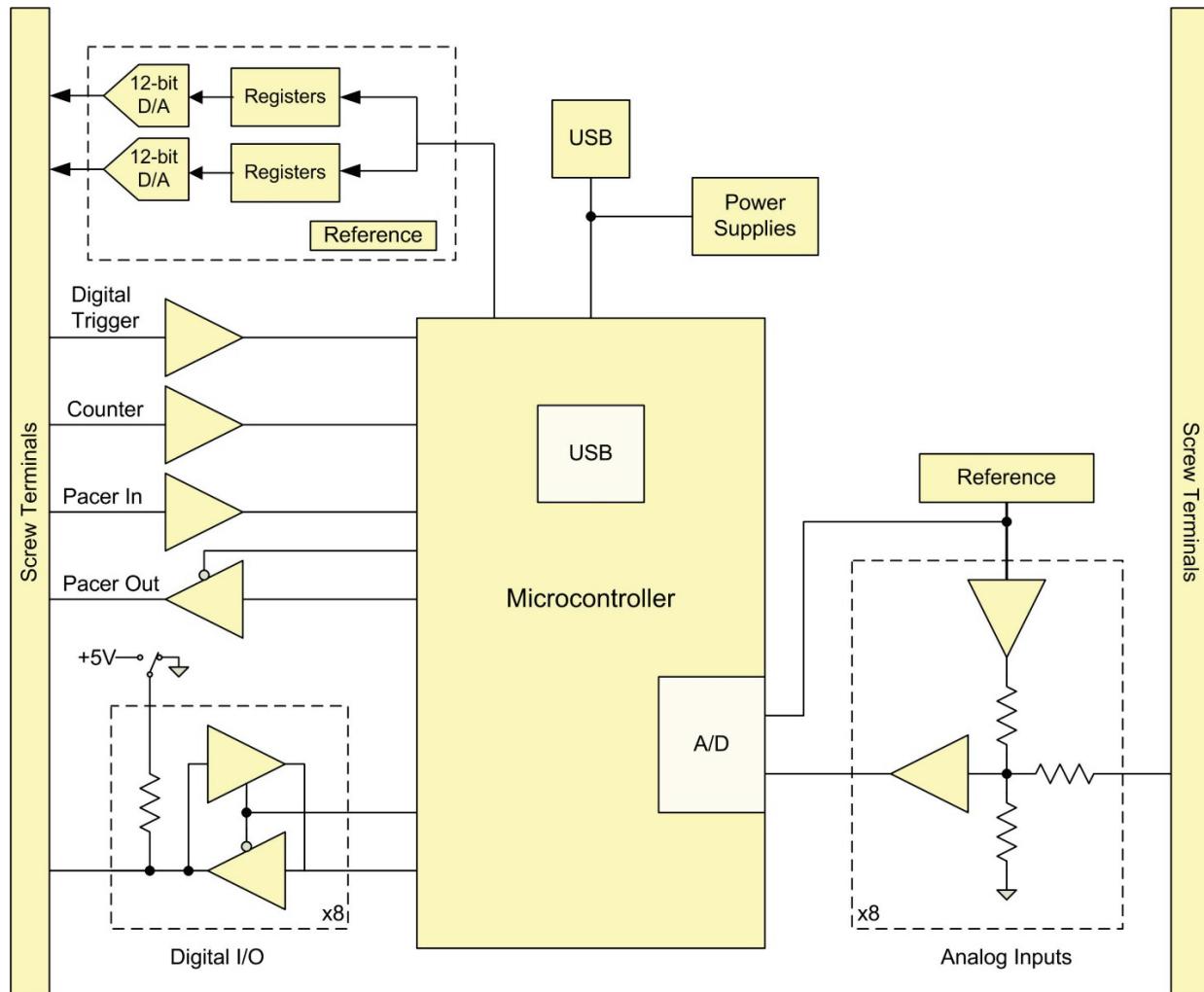
Figure 1. USB-202 functional block diagram

Installing the USB-202

Unpacking

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the device 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.

Contact us immediately if any components are missing or damaged.

Installing the software

Refer to the MCC DAQ Quick Start and the USB-202 product page on our website for information about the software that supports the device.

Install the software before you install your device

The driver needed to run the USB-202 is installed with the software. Therefore, you need to install the software package you plan to use before you install the hardware.

Installing the hardware

Connect the USB cable to an available USB port on the computer or to an external USB hub connected to the computer. Connect the other end of the cable to the USB connector on the device. No external power is required.

When connected for the first time, a **Found New Hardware** dialog opens when the operating system detects the device. When the dialog closes, the installation is complete. The device **Status** LED turns on after the device is successfully installed.

If the Status LED turns off

If communication is lost between the device and the computer, the **Status** LED turns off. To restore communication, disconnect the USB cable from the computer and then reconnect it. This should restore communication, and the **Status** LED should turn on.

Calibrating the hardware

Factory calibration

The Measurement Computing Manufacturing Test department performs the initial factory calibration. Return the device to Measurement Computing Corporation when calibration is required. The recommended calibration interval is one year.

Field calibration

Field calibration is not supported.

Functional Details

Analog input acquisition modes

The USB-202 can acquire analog input data in two different modes – software paced and hardware paced.

Software paced mode

You can acquire one analog sample at a time in software paced mode. You initiate the A/D conversion with a software command. The analog value is converted to digital and returned to the computer. You can repeat this procedure until you have the total number of samples that you want.

The maximum throughput sample rate in software paced mode is system-dependent.

Hardware paced mode

You can acquire data from up to eight channels in hardware paced mode. The analog data is continuously acquired and converted to digital values until you stop the scan. Data is transferred in blocks of 32 samples from the device to the memory buffer on your computer.

The maximum continuous scan rate is an aggregate rate. The total acquisition rate for all channels cannot exceed 100 kS/s. The following table lists the scan rate when scanning from one to eight channels.

Maximum continuous scan rate

# channels scanned	Scan rate (kS/s)
1	100
2	50
3	33.33
4	25
5	20
6	16.67
7	14.29
8	12.50

You can start a hardware paced continuous scan with either a software command or with an external hardware trigger event.

External components

The external components on the USB-202 are shown in Figure 2.

1	Screw terminal pins 1 to 16	4	Activity LED
2	Screw terminal pins 17 to 32	5	USB connector
3	Status LED		

Figure 2. USB-202 external components

Screw terminals

The screw terminals provide the following connections:

- Eight single-ended analog inputs (**CH0** to **CH7**)
- Two analog outputs (**AOUT0** and **AOUT1**)
- Eight digital I/O (**DI00** to **DI07**)
- External pacer clock input (**AICKI**)
- External pacer clock output (**AICKO**)
- Digital trigger input (**TRIG**)
- Counter input (**CTR**)
- User voltage output (**+VO**)
- Analog ground reference (**AGND**) and digital ground reference (**GND**)

Figure 3. USB-202 pinout

USB connector

The USB connector provides +5 V power and communication. No external power supply is required.

LED indicators

The device has two LED indicators – **Status** and **Activity.**

- The **Status** LED turns on when the device is detected and installed on the computer.
- The **Activity** LED blinks when data is transferred, and is off otherwise.

Refer to Figure 2 on page 8 for the location of these LEDs.

Signal connections

Analog input

You can connect up to 8 single-ended inputs to screw terminals **CH0** to **CH7**. The input voltage range is ±10 V. Single-ended mode requires two wires; connect one wire to the signal you want to measure (**CHx**) and connect a second wire to the analog ground reference (**AGND**).

External clock I/O

The USB-202 provides one external clock input (**AICKI**) and one clock output (**AICKO**) for the analog input pacer. Connect the external clock signal to **AICKI**.

▪ When using an external clock, **AICKO** outputs the pulse generated from **AICKI**.
▪ When using the internal clock, **AICKO** outputs the ADC scan clock.

Analog output

The USB-202 has two 12-bit analog outputs (**AOUT0** and **AOUT1**). Both outputs can be updated simultaneously at a rate of 125 S/s per channel. One output can be updated at a rate of 250 S/s. The output range is fixed at 0 V to 5 V. The outputs default to 0 V when the host computer is shut down or suspended, or when a reset command is issued to the device.

Digital I/O

You can connect up to eight digital I/O lines to **DIO0** through **DIO7**. The digital I/O terminals can detect the state of any TTL-level input. Refer to the schematic shown in Figure 4.
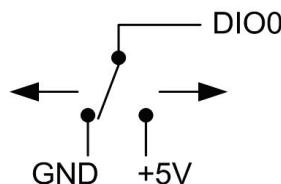
Figure 4. Schematic showing switch detection by digital channel DIO0

If you set the switch to the +5 V input, DIO0 reads *TRUE* (1). If you move the switch to GND, DIO0 reads *FALSE* (0).

Pull-up/down jumper W4

The digital port has 47 kΩ resistors that you can configure as pull-up or pull-down with internal jumper **W4** (see Figure 2 on page 8 for the location of this jumper).

Unconnected inputs are pulled low by default to 0 V through 47 kΩ resistors. The pull-up/pull-down voltage is common to all 47 kΩ resistors.

You must remove the cover from the device in order to access the jumper. To remove the cover, unscrew the four screws on the device bottom.

> **Caution!** The discharge of static electricity can damage some electronic components. Before removing the device from its housing, either ground yourself using a wrist strap or touch the computer chassis or other grounded object to eliminate any stored static charge.

Figure 5 shows the location of jumper W4 in relation to the USB connector.
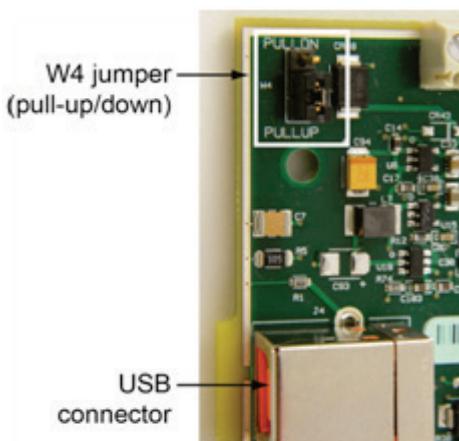
Figure 5. Jumper W4 location

Jumper W4 is configured by default for pull-down; see Figure 6.
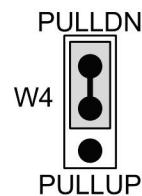
Figure 6. Jumper W4 pull-up/down configuration

To pull the digital inputs high (+5V), configure the jumper for pull-up.

Proper LED alignment

When placing the circuit board within the housing, align the board LEDs with the top of the housing before attaching the housing bottom.

Trigger input

The **TRIG** terminal is an external digital trigger input. The trigger mode is software-selectable for edge- or level-sensitive.

Counter input

The **CTR** terminal is a 32-bit event counter that can accept frequency inputs up to 1 MHz. The internal counter increments when the TTL levels transition from low to high.

Voltage output

The user voltage output **(+VO)** terminal can output up to 100 mA maximum at approximately +5V. You can use this terminal to supply power to external devices or circuitry.

Caution!   The **+VO** terminal is an output. Do not connect to an external power supply or you may damage the device and possibly the computer.

Ground

The analog ground (**AGND**) terminals provide a common ground for all analog channels. The digital ground (**GND**) terminals provide a common ground for the digital, counter, pacer I/O, and power terminal.

For more information about signal connections

For more information about analog and digital signal connections, refer to the *Guide to DAQ Signal Connections* on our website at www.mccdaq.com/support/DAQ-Signal-Connections.aspx.

Mechanical drawings
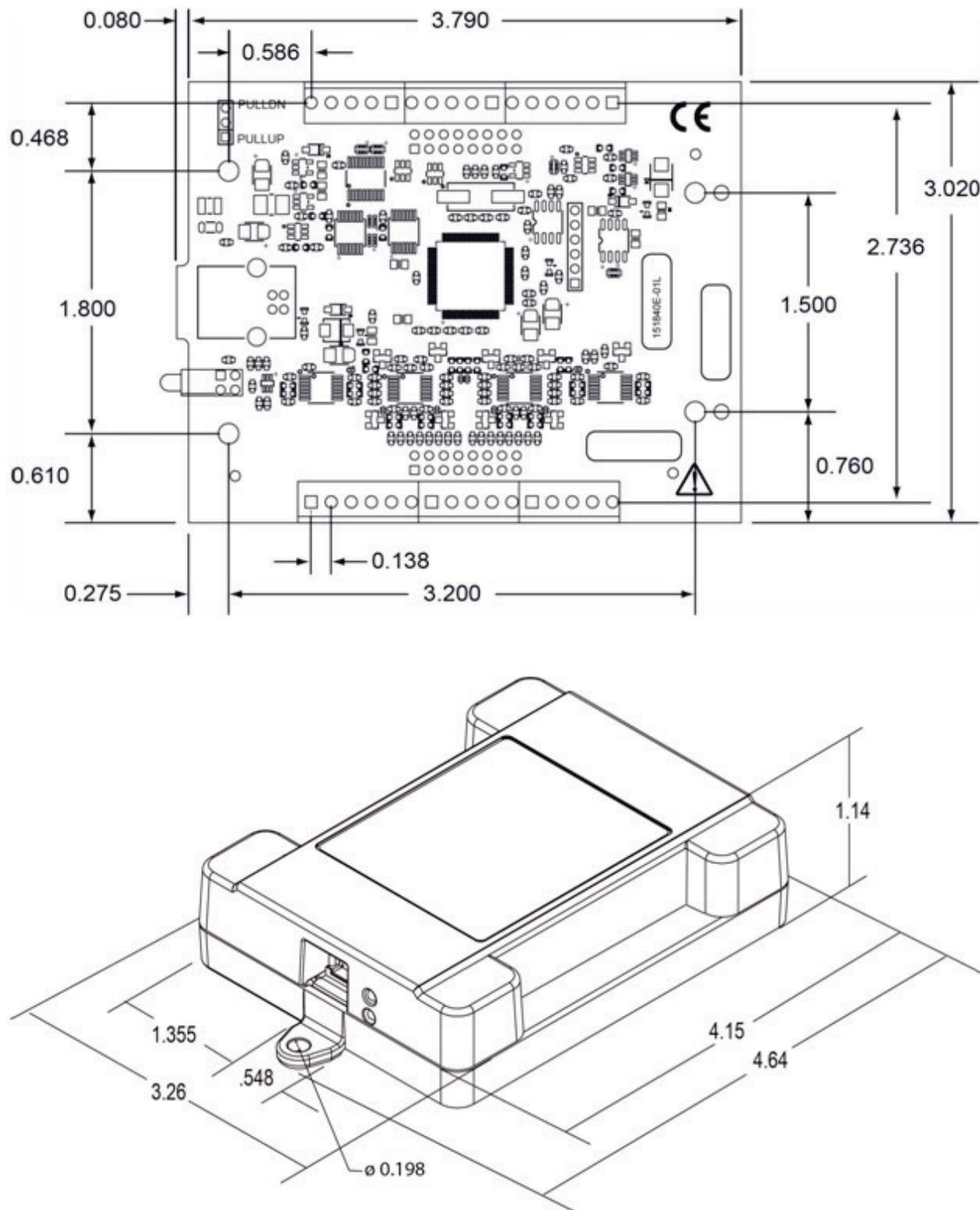
Figure 7. Circuit board (top) and housing dimensions
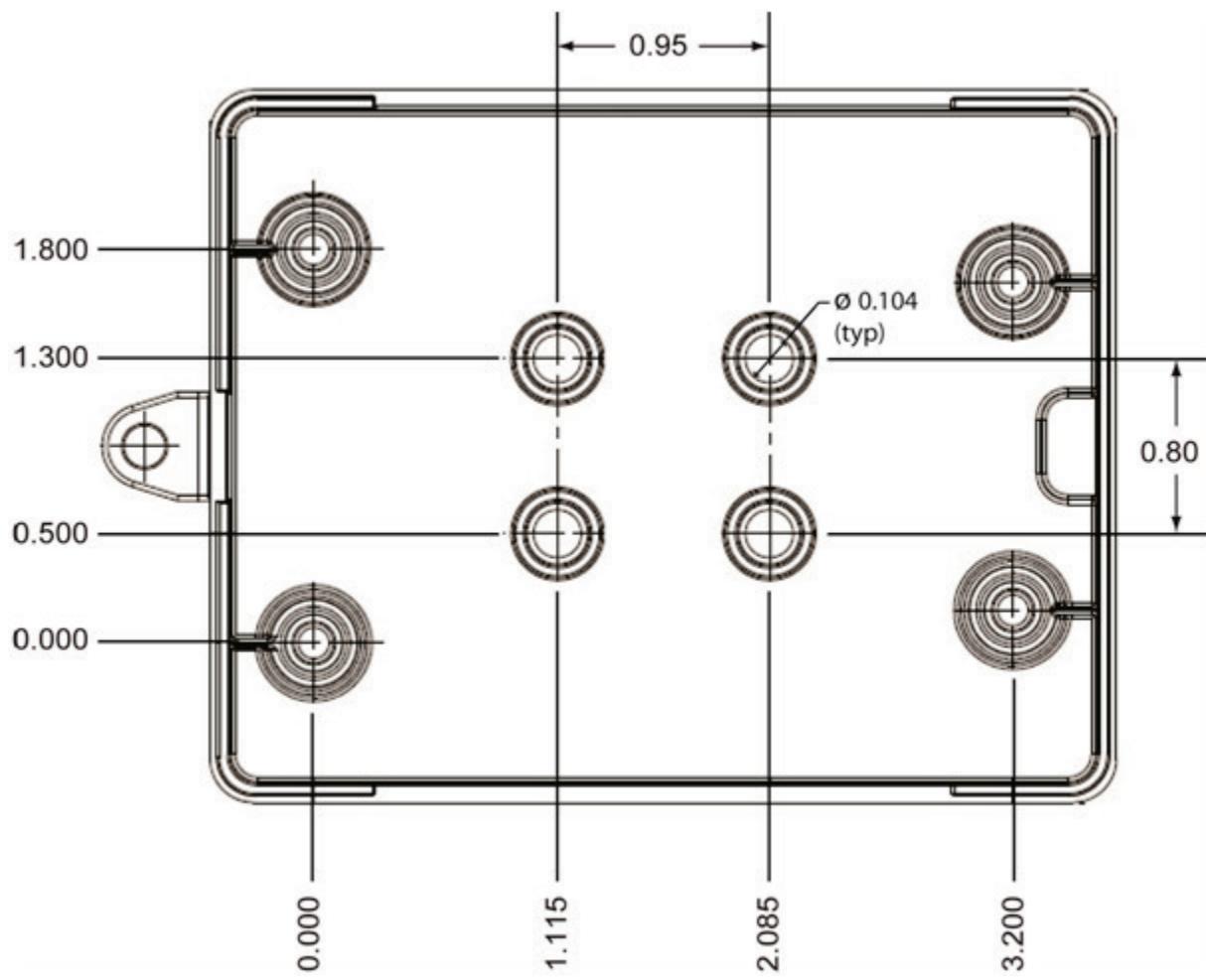
Figure 8. Housing bottom dimensions

Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.
Specifications in *italic* text are guaranteed by design.

Analog input

Table 1. General analog input specifications

| Parameter	Condition	Specification
A/D converter type		Successive approximation
ADC resolution		12 bits
Number of channels		8 single-ended
Input voltage range		±10 V
Absolute maximum input voltage	*CHx relative to AGND*	■ *±25 V max (power on)* ■ *±25 V max (power off)*
Input impedance		■ *1 MΩ (power on)* ■ *1 MΩ (power off)*
Input bias current	*10 V input*	*–12 µA*
	0 V input	*2 µA*
	–10 V input	*12 µA*
Input bandwidth	Small signal (–3 dB)	150 kHz
Maximum working voltage	Input range relative to AGND	±10.1 V max
Crosstalk	Adjacent channels, DC to 10 kHz	–75 dB
Input coupling		DC
Sampling rate	Internal pacer	0.016 S/s to 100 kS/s, software-selectable
	External pacer	100 kS/s max
Sample clock source		■ Internal A/D clock ■ Pacer input terminal AICKI
Channel queue		Up to eight unique, ascending channels
Throughput	Software paced	33S to 4,000 S/s typ, system dependent
	Hardware paced	100 kS/s max, system dependent
Warm-up time		15 minutes min

Accuracy

Analog input DC voltage measurement accuracy

Table 2. DC Accuracy components and specifications; All values are (±)

Range	Gain error (% of reading)	Offset error (mV)	Absolute accuracy at Full Scale (mV)	Gain temperature coefficient (% reading/°C)	Offset temperature coefficient (mV/°C)
±10V	0.098	11	20.8	0.016	0.87

Noise performance

For the peak to peak noise distribution test, the input channel is connected to AGND at the input terminal block, and 12,000 samples are acquired at the maximum throughput.

Table 3. Noise performance specifications

Range	Counts	LSBrms
±10 V	5	0.76

Analog input calibration

Table 4. Analog input calibration specifications

Parameter	Specification
Recommended warm-up time	15 minutes min
Calibration method	Factory
Calibration interval	1 year

Analog output

Table 5. Analog output specifications

Parameter	Condition	Specification
Resolution		12 bits, 1 in 4,096
Output range		*0 V to 5.0 V*
Number of channels		2
Throughput (Note 1)	Software paced	250 S/s single channel typ, PC dependent
Power on and reset voltage	Initializes to 000h code	0 V, ±10 mV
Output drive	Each D/A OUT	5 mA, sourcing
Slew rate		0.8 V/ μs typ

Note 1: Maximum throughput when scanning is machine dependent.

Table 6. Analog output accuracy, all values are (±); accuracy tested at no load

Range	Accuracy (LSB)
0 V to 5.0 V	5.0 typ, 45.0 max

Table 7. Analog output accuracy components, all values are (±)

Range	% of FSR	Gain Error at FS (mV)	Offset (mV) (Note 2)	Accuracy at FS (mV)
0 V to 5.0 V	0.08 typ, 0.72 max	4.0 typ, 36.0 max	1.0 typ, 9.0 max	5.0 typ, 45.0 max

Note 2: Zero-scale offsets may result in a fixed zero-scale error producing a "dead-band" digital input code region. In this case, changes in digital input code at values less than 0x040 may not produce a corresponding change in the output voltage. The offset error is tested and specified at code 0x040.

Digital input/output

Table 8. Digital input specifications

Parameter	Specification
Digital type	TTL
Number of I/O	8
Configuration	Each bit may be configured as input (power on default) or output
Pull-up configuration	The port has 47 kΩ resistors that may be configured as pull-up or pull-down with an internal jumper. The factory configuration is pull-down.
Digital I/O transfer rate (system-paced)	33 to 4000 port reads/writes per second typ, system dependent
Input low voltage threshold	0.8 V max
Input high voltage threshold	2.0 V min
Input voltage limits	5.5 V absolute max –0.5 V absolute min 0 V recommended min
Output high voltage	4.4 V min (IOH = –50 μA) 3.76 V min (IOH = –24 mA)
Output low voltage	0.1 V max (IOL = 50 μA) 0.44 V max (IOL = 24 mA)
Output current	±24 mA max

External digital trigger

Table 6. External digital trigger specifications

Parameter	Specification
Trigger source	TRIG input
Trigger mode	Software configurable for edge or level sensitive, rising or falling edge, high or low level. Power on default is edge sensitive, rising edge.
Trigger latency	1 μs + 1 pacer clock cycle max
Trigger pulse width	125 ns min
Input type	Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis	1.01 V typ 0.6 V min 1.5 V max
Input high voltage threshold	2.43 V typ 1.9 V min 3.1 V max
Input low voltage threshold	1.42 V typ 1.0 V min 2.0 V max
Input voltage limits	5.5 V absolute max –0.5 V absolute min 0 V recommended min

External pacer input/output

Table 7. External pacer I/O specifications

Parameter	Specification	
Terminal names	AICKI, AICKO	
Terminal types	AICKI:	Input, active on rising edge
	AICKO:	Output, power on default is 0 V, active on rising edge
Terminal descriptions	AICKI:	Receives pacer clock from external source
	AICKO:	Outputs internal pacer clock
Input clock rate	100 kHz max	
Clock pulse width	AICKI:	400 ns min
	AICKO:	400 ns min
Input type	Schmitt trigger, 47 kΩ pull-down to ground	
Schmitt trigger hysteresis	1.01 V typ 0.6 V min 1.5 V max	
Input high voltage	2.43 V typ 1.9 V min 3.1 V max	
Input low voltage	1.42 V typ 1.0 V min 2.0 V max	
Input voltage limits	5.5V absolute max -0.5V absolute min 0V recommended min	
Output high voltage	4.4 V min (IOH = –50 μA) 3.80 V min (IOH = –8 mA)	
Output low voltage	0.1 V max (IOL = 50 μA) 0.44 V max (IOL = 8 mA)	
Output current	±8 mA max	

Counter

Table 8. CTR specifications

Parameter	Specification
Pin name	CTR
Number of channels	1 channel
Resolution	32-bit
Counter type	Event counter
Input type	Schmitt trigger, 47 kΩ pull-down to ground
Counter read/write rates (software paced)	33 to 4,000 reads/writes per second typ, system dependent
Schmitt trigger hysteresis	1.01 V typ 0.6 V min 1.5 V max
Input high voltage threshold	2.43 V typ 1.9 V min 3.1 V max
Input low voltage threshold	1.42 V typ 1.0 V min 2.0 V max
Input voltage limits	5.5 V absolute max –0.5 V absolute min 0 V recommended min
Input frequency	1 MHz max
High pulse width	*25 ns min*
Low pulse width	*25 ns min*

Memory

Table 9. Memory specifications

Parameter	Specification
Data FIFO	12 K (12,288) analog input samples
Non-volatile memory	2 KB (768 B calibration storage, 256 B UL user data, 1 KB DAQFlex user data)

Power

Table 10. Power specifications

Parameter	Condition	Specification
Supply current	Typical (Note 3)	150 mA
	Maximum (including user voltage, DIO and AICKO loading)	500 mA
User voltage output terminal (+VO)		4.25 V min, 5.25 V max
User voltage output current		100 mA max

Note 3: This is the total quiescent current requirement for the device which includes up to 10 mA for the Status LED. This value does not include any potential loading of the digital I/O bits, AICKO, or user voltage.

USB specifications

Table 11. USB specifications

Parameter	Specification
USB device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0
USB cable type	A-B cable, UL type AWM 2725 or equivalent. (minimum 24 AWG VBUS/GND, minimum 28 AWG D+/D–)
USB cable length	3 m (9.84 ft) max

Environmental

Table 12. Environmental specifications

Parameter	Specification
Operating temperature range	0 °C to 55 °C max
Storage temperature range	–40 °C to 85 °C max
Humidity	0% to 90% non-condensing max

Mechanical

Table 13. Mechanical specifications

Parameter	Specification
Dimensions (L × W × H)	117.86 × 82.80 × 28.96 mm (4.64 × 3.26 × 1.14 in.) max

Screw terminal connector

Table 14. Screw terminal connector specifications

Parameter	Specification
Connector type	Screw terminal
Wire gauge range	16 AWG to 30 AWG

Table 15. Screw terminal pinout

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	GND	Digital ground	17	AGND	Analog ground
2	TRIG	Digital trigger input	18	AOUT1	Analog output 1
3	CTR	Counter input	19	AGND	Analog ground
4	AICKI	External clock pacer input	20	AOUT0	Analog output 0
5	AICKO	External clock pacer output	21	AGND	Analog ground
6	GND	Digital ground	22	CH7	Channel 7
7	+VO	User voltage output	23	CH6	Channel 6
8	GND	Digital ground	24	AGND	Analog ground
9	DIO7	DIO bit 7	25	CH5	Channel 5
10	DIO6	DIO bit 6	26	CH4	Channel 4
11	DIO5	DIO bit 5	27	AGND	Analog ground
12	DIO4	DIO bit 4	28	CH3	Channel 3
13	DIO3	DIO bit 3	29	CH2	Channel 2
14	DIO2	DIO bit 2	30	AGND	Analog ground
15	DIO1	DIO bit 1	31	CH1	Channel 1
16	DIO0	DIO bit 0	32	CH0	Channel 0

CE EU Declaration of Conformity
According to ISO/IEC 17050-1:2010

Manufacturer: Measurement Computing Corporation
Address: 10 Commerce Way
                          Norton, MA 02766
                          USA
Product Category: Electrical equipment for measurement, control and laboratory use.
Date and Place of Issue: July 20, 2016, Norton, Massachusetts USA
Test Report Number: EMI6206.12

Measurement Computing Corporation declares under sole responsibility that the product

USB-202

is in conformity with the relevant Union Harmonization Legislation and complies with the essential requirements of the following applicable European Directives:

Electromagnetic Compatibility (EMC) Directive 2014/30/EU

Low Voltage Directive 2014/35/EU

RoHS Directive 2011/65/EU

Conformity is assessed in accordance to the following standards:

EMC:

Emissions:

- EN 61326-1:2013 (IEC 61326-1:2012), Class A
- EN 55011: 2009 + A1:2010 (IEC CISPR 11:2009 + A1:2010), Group 1, Class A

Immunity:

- EN 61326-1:2013 (IEC 61326-1:2012), Controlled EM Environments
- EN 61000-4-2:2008 (IEC 61000-4-2:2008)
- EN 61000-4-3 :2010 (IEC61000-4-3:2010)

Safety:

- EN 61010-1:2010 (IEC 61010-1:2010)

Environmental Affairs:

Articles manufactured on or after the Date of Issue of this Declaration of Conformity do not contain any of the restricted substances in concentrations/applications not permitted by the RoHS Directive.

Carl Haapaoja, Director of Quality Assurance