

# USB-201

Analog and Digital I/O

## User's Guide

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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-201 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-201 hardware is available on our website at [www.mccdaq.com](http://www.mccdaq.com). You can also contact Measurement Computing Corporation with specific questions.

- Knowledgebase: [kb.mccdaq.com](http://kb.mccdaq.com)
- 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](mailto:techsupport@mccdaq.com)

## Introducing the USB-201

The USB-201 is a USB 2.0 full-speed device supported under the following operating systems:

- Microsoft Windows 8, 7, Vista, XP (32-bit or 64-bit)
- Macintosh (32-bit or 64-bit)
- Linux (32-bit or 64-bit)

The device is also compatible with USB 1.1 ports.

### Device features

The USB-201 provides the following features:

- Eight single-ended 12-bit analog inputs
- 100 kS/s max sample rate
- 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-201 is powered by the +5 V USB supply from your computer; no external power is required.

### Functional block diagram

Device functions are illustrated in the block diagram shown here.

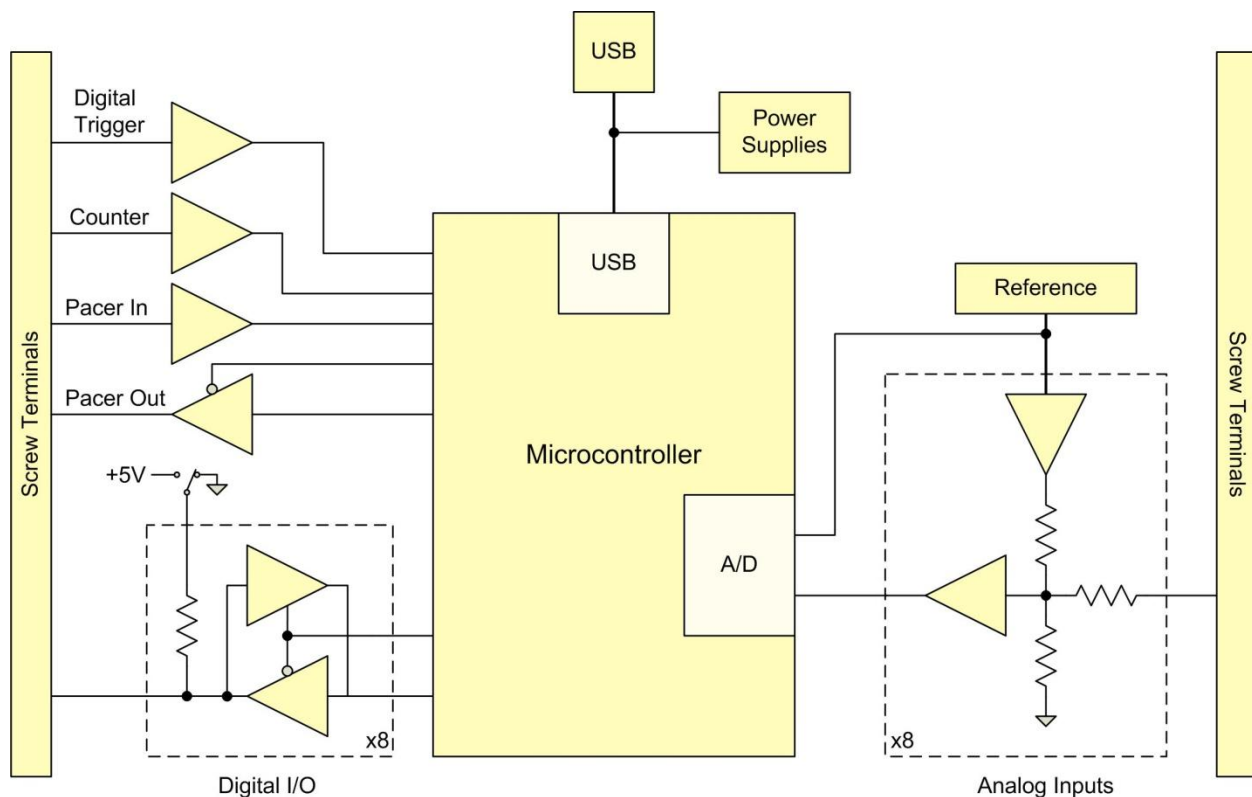


Figure 1. USB-201 functional block diagram

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# Installing the USB-201

## What comes with your shipment?

Verify that the following hardware components are included in the shipment:

### Hardware

- USB-201
- USB cable

### Software

- MCC DAQ CD

### Documentation

#### MCC DAQ Quick Start Guide

The Quick Start Guide booklet provides an overview of the MCC DAQ software you received with the device, and includes information about installing the software. Please read this booklet completely before installing any software or hardware.

#### DAQFlex Insert

The DAQFlex insert ships with all hardware that supports the DAQFlex Open-Source Software Framework. The insert lists supporting operating systems, the internet location where you can download DAQFlex software, and the locations where you can learn more about DAQFlex and MCC DAQ software.

## 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.

If any components are missing or damaged, contact us immediately using one of the following methods:

- Knowledgebase: [kb.mccdaq.com](http://kb.mccdaq.com)
- 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](mailto:techsupport@mccdaq.com)

For international customers, contact your local distributor. Refer to the International Distributors section on our website at [www.mccdaq.com/International](http://www.mccdaq.com/International).

## Installing the software

**Note:** Before installing the USB-201, first install the software you plan to use with the device.

The USB-201 is supported by Universal Library software and DAQFlex software. You can install both software packages on your computer. However, you cannot run both software packages simultaneously with one USB-201 device.

### DAQFlex

Install the DAQFlex Open-Source Software Framework when you want to develop data acquisition applications that can be deployed across multiple operating systems and custom embedded systems.

DAQFlex software for each supported operating system is available from the DAQFlex download page at [www.mccdaq.com/DAQFlexDL](http://www.mccdaq.com/DAQFlexDL). Refer to the *DAQFlex Software User's Guide* at [www.mccdaq.com/pdfs/manuals/DAQFlex%20Software.pdf](http://www.mccdaq.com/pdfs/manuals/DAQFlex%20Software.pdf) for instructions about installing DAQFlex software.

## Universal Library and InstaCal

Install Universal Library and InstaCal when you want to develop data acquisition applications using Windows programming languages.

Universal Library and InstaCal software are included on the CD that ships with the device. Refer to the *Quick Start Guide* booklet for instructions about installing Universal Library and InstaCal software.

## Installing the hardware

### Install the software before you install your device

The driver needed to run the USB-201 device is installed when you install the software. Therefore, you need to install the software package you plan to use before you install the hardware.

For operation on a Windows operating system, we recommend that you run Windows Update to update your operating system with the latest USB drivers.

To connect the USB-201 to your system, 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-201 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-201 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-204 external components

## Screw terminals

The screw terminals provide the following connections:

- Eight single-ended analog inputs (**CH0** to **CH7**)
- 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**)

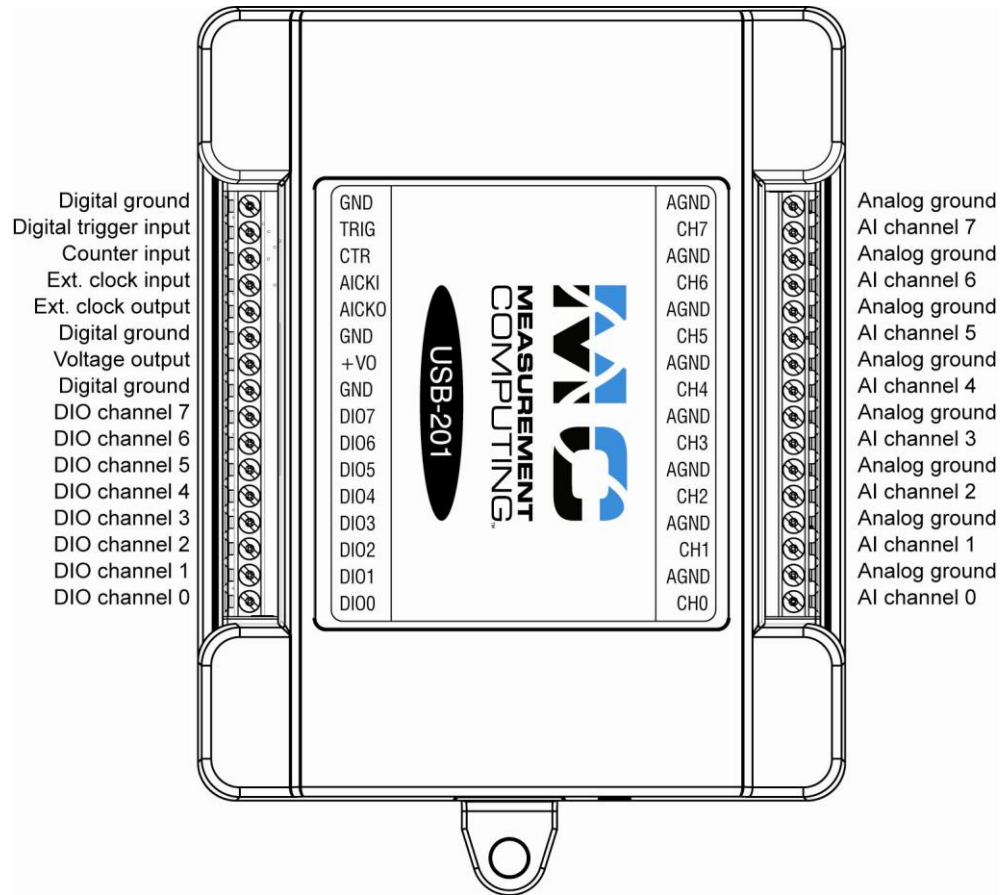


Figure 3. USB-201 pinout

## 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 9 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  $\pm 10$  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 pacer I/O

The USB-201 provides one external clock input (**AICKI**) and one clock output (**AICKO**) for the analog input pacer. You can connect an external clock signal to **AICKI**.

When using the internal clock, **AICKO** outputs the ADC sample clock.

### 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.

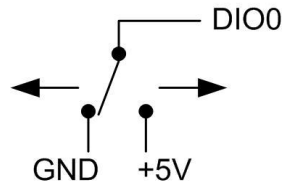


Figure 4. Schematic showing switch detection by digital channel DIO0

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).

### Internal pull-up/down configuration

The digital port has 47 k $\Omega$  resistors that you can configure as pull-up or pull-down with an internal jumper. Unconnected inputs are pulled low by default to 0 V through 47 k $\Omega$  resistors. The pull-up/pull-down voltage is common to all 47 k $\Omega$  resistors.

You can change the configuration with an internal jumper. 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 the pull-up/down jumper in relation to the USB connector.

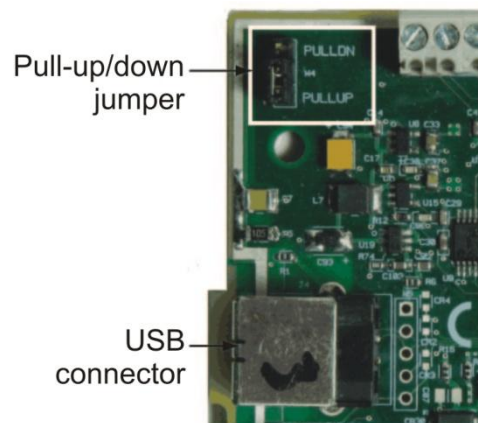


Figure 5. Pull-up/down jumper location

Figure 6 shows the jumper configured for pull-down.

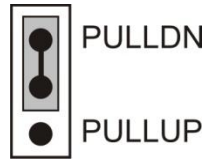


Figure 6. Pull-down jumper

Configure the jumper for pull-up to pull the digital inputs high (+5V).

#### 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 Signal Connections* at [www.mccdaq.com/pdfs/DAQ-Signal-Connections.pdf](http://www.mccdaq.com/pdfs/DAQ-Signal-Connections.pdf).

### Mechanical drawings

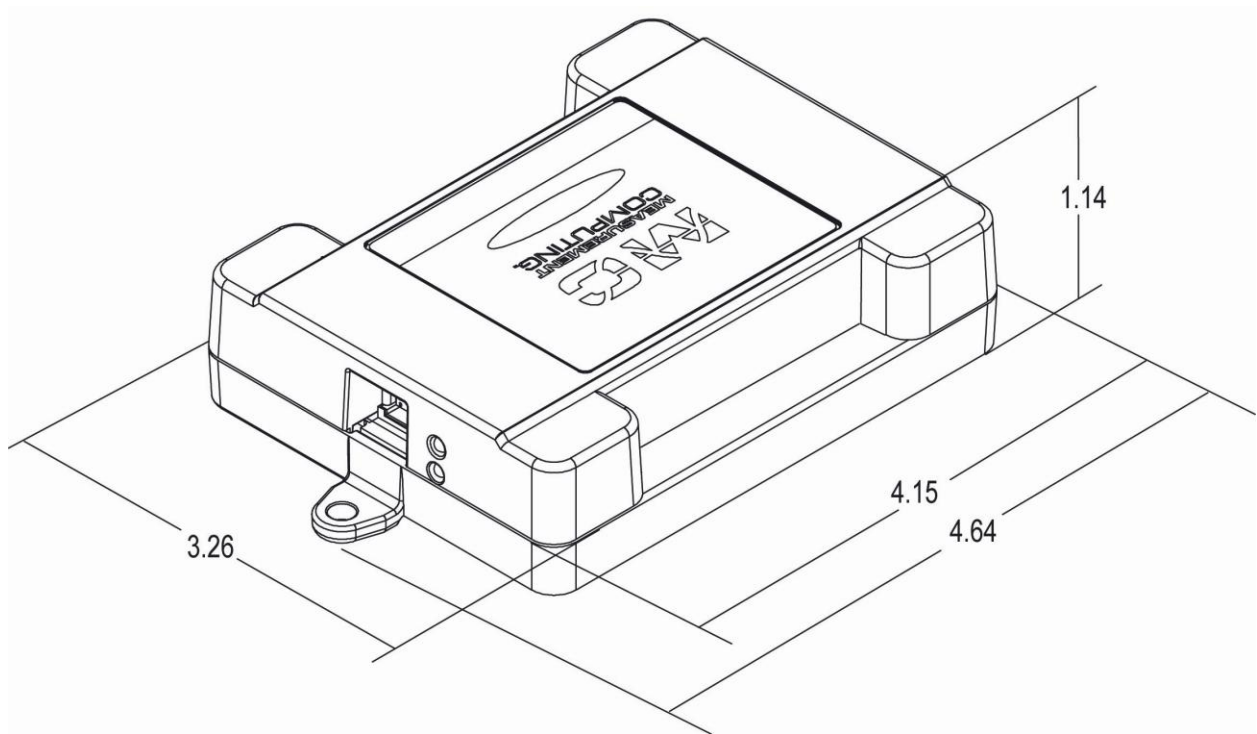
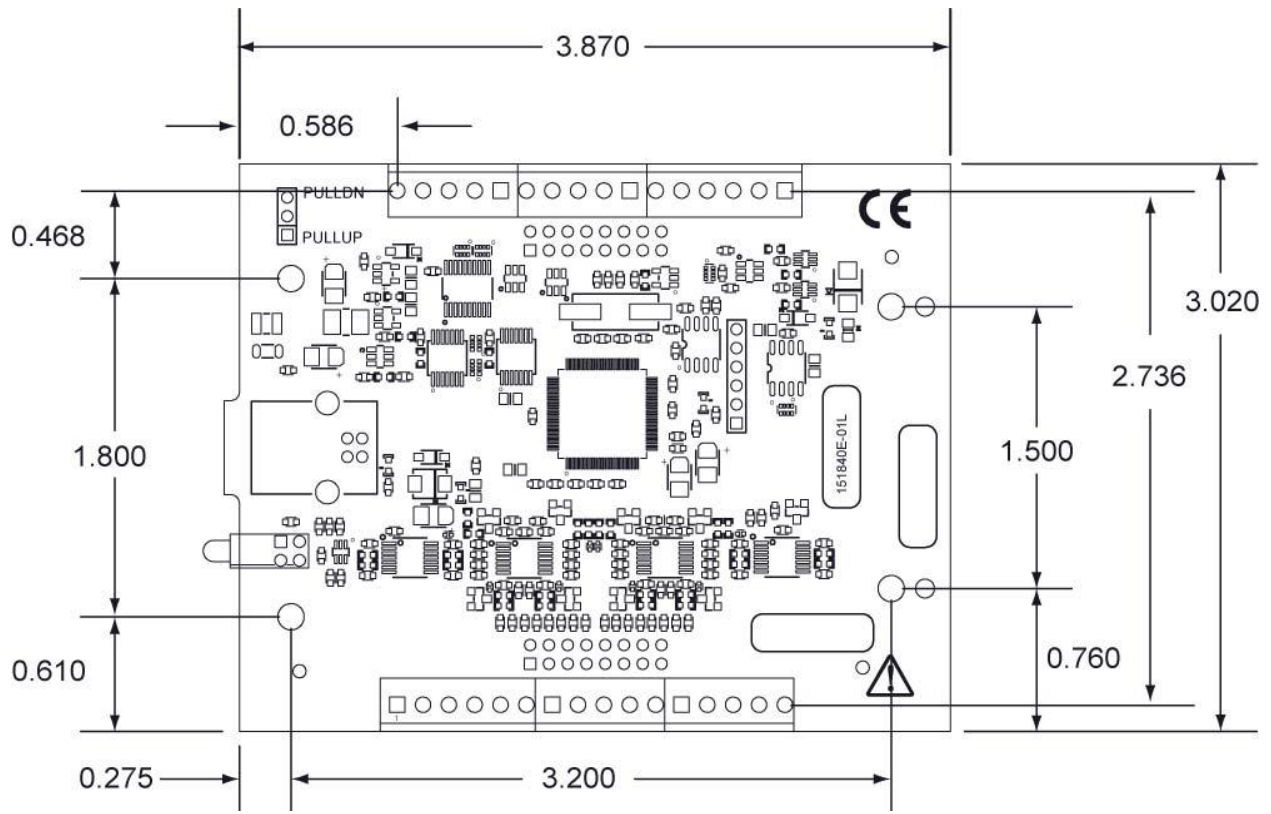


Figure 7. Circuit board (top) and housing dimensions

## 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	Conditions	Specification
A/D converter type		Successive approximation
ADC resolution		12 bits
Number of channels		8 single-ended
Input voltage range		$\pm 10$ V
<i>Absolute maximum input voltage</i>	<i>CHx relative to AGND</i>	<ul style="list-style-type: none"> <li>▪ <math>\pm 25</math> V max (power on)</li> <li>▪ <math>\pm 25</math> V max (power off)</li> </ul>
<i>Input impedance</i>		<ul style="list-style-type: none"> <li>▪ <math>1\text{ M}\Omega</math> (power on)</li> <li>▪ <math>1\text{ M}\Omega</math> (power off)</li> </ul>
<i>Input bias current</i>	<i>10 V input</i>	$-12\ \mu\text{A}$
	<i>0 V input</i>	$2\ \mu\text{A}$
	<i>-10 V input</i>	$12\ \mu\text{A}$
Input bandwidth	Small signal ( $-3$ dB)	200 kHz
Maximum working voltage	Input range relative to AGND	$\pm 10.1$ 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		<ul style="list-style-type: none"> <li>▪ Internal A/D clock</li> <li>▪ Pacer input terminal AICKI</li> </ul>
Channel queue		Up to eight unique, ascending channels
Throughput	Software paced	33 to 4000 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 ( $\pm$ )

Range	Gain error (% of reading)	Offset error (mV)	Absolute accuracy at Full Scale (mV)	Gain temperature coefficient (% reading/ $^{\circ}\text{C}$ )	Offset temperature coefficient (mV/ $^{\circ}\text{C}$ )
$\pm 10\text{V}$	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

## Digital input/output

Table 5. 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 typical, 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 $\mu$ s + 1 pacer clock cycle max
Trigger pulse width	125 ns min
Input type	Schmitt trigger, 47 k $\Omega$ 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 AOCKO: 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 k $\Omega$ 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 $\mu$ A) 3.80 V min (IOH = -8 mA)
Output low voltage	0.1 V max (IOL = 50 $\mu$ A) 0.44 V max (IOL = 8 mA)
Output current	$\pm$ 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 k $\Omega$ 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	5.5V absolute max -0.5V absolute min 0V 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	Conditions	Specification
Supply current	Typical (Note 1)	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 1:** 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	CH7	Channel 7
3	CTR	Counter input	19	AGND	Analog ground
4	AICKI	External clock pacer input	20	CH6	Channel 6
5	AICKO	External clock pacer output	21	AGND	Analog ground
6	GND	Digital ground	22	CH5	Channel 5
7	+VO	User voltage output	23	AGND	Analog ground
8	GND	Digital ground	24	CH4	Channel 4
9	DIO7	DIO channel 7	25	AGND	Analog ground
10	DIO6	DIO channel 6	26	CH3	Channel 3
11	DIO5	DIO channel 5	27	AGND	Analog ground
12	DIO4	DIO channel 4	28	CH2	Channel 2
13	DIO3	DIO channel 3	29	AGND	Analog ground
14	DIO2	DIO channel 2	30	CH1	Channel 1
15	DIO1	DIO channel 1	31	AGND	Analog ground
16	DIO0	DIO channel 0	32	CH0	Channel 0

# CE Declaration of Conformity

Manufacturer: Measurement Computing Corporation  
Address: 10 Commerce Way  
Suite 1008  
Norton, MA 02766  
USA  
Category: Electrical equipment for measurement, control and laboratory use.  
Date of Issue: October 11, 2012

Measurement Computing Corporation declares under sole responsibility that the product

## USB-201

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

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

Emissions:

- EN 55011 (2007) / CISPR 11(2003): Radiated emissions: Group 1, Class A
- EN 55011 (2007) / CISPR 11(2003): Conducted emissions: Group 1, Class A

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

- IEC 61000-4-2 (2001): Electrostatic Discharge immunity.
- IEC 61000-4-3 (2002): Radiated Electromagnetic Field immunity.
- 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.
- The host computer must be USB 2.0 compliant.
- Equipment must be operated in a controlled electromagnetic environment as defined by Standards EN 61326-1:2006, or IEC 61326-1:2005.

**Note:** Data acquisition equipment may exhibit noise or increased offsets when exposed to high RF fields (>1V/m) or transients.

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in September, 2012. Test records are outlined in Chomerics Test Report #EMI6206.12.

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



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