

# USB-1608G-OEM

High-speed Multifunction DAQ

## 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-1608G-OEM data acquisition devices and lists device specifications.

### Conventions in this user's guide

**For more information about ...**

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.

**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-1608G-OEM hardware is available on our website at [www.mccdaq.com](http://www.mccdaq.com). You can also contact Measurement Computing Corporation by phone, fax, or email with specific questions.

- Knowledgebase: [kb.mccdaq.com](http://kb.mccdaq.com)
- Tech support form: [www.mccdaq.com/support/support\\_form.aspx](http://www.mccdaq.com/support/support_form.aspx)
- Email: [techsupport@mccdaq.com](mailto: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](http://www.mccdaq.com/International).

## Introducing the USB-1608G-OEM

The USB-1608G-OEM is a USB 2.0 high-speed device provides the following features:

- 16 single-ended (SE) or eight differential (DIFF) analog input channels
- Eight individually configurable digital I/O channels
- Two counter channels (32-bit) that count TTL pulses
- One timer output channel (32-bit)
- Header connectors for field wiring connections

The USB-1608G-OEM device is compatible with both USB 1.1 and USB 2.0 ports. The speed of the device may be limited when using a USB 1.1 port due to the difference in transfer rates on the USB 1.1 versions of the protocol (low-speed and full-speed).

The USB-1608G-OEM is powered by the +5 volt USB supply from your computer, and requires no external power.

**Caution!** There are no product safety, electromagnetic compatibility (EMC), or CE marking compliance claims made for the USB-1608G-OEM. The USB-1608G-OEM is intended for use as a component of a larger system. MCC can help developers meet their compliance requirements. The end product supplier, however, is responsible for conforming to any and all compliance requirements.

### Functional block diagram

USB-1608G-OEM functions are illustrated in the block diagram shown here.

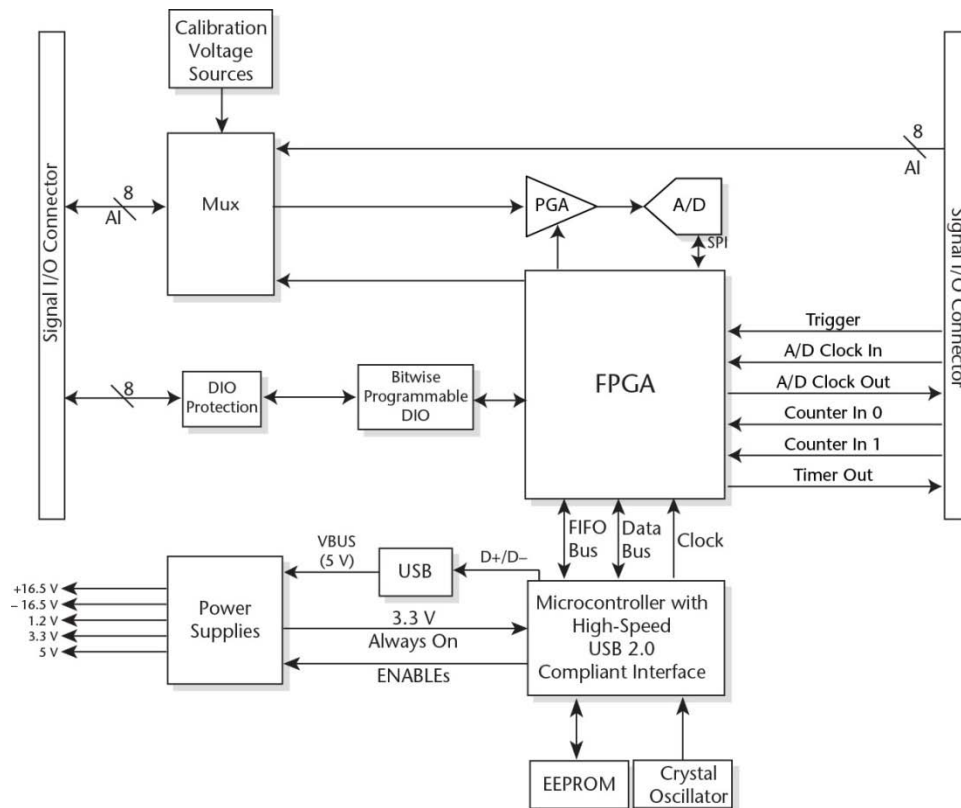


Figure 1. Functional block diagram

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# Installing the USB-1608G-OEM

## Unpacking

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

## Downloading the software

Refer to the USB-1608G-OEM product page on the Measurement Computing website for information about the supported software you can download.

### Install the software before you install the hardware

The driver needed to run the 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.

## Installing the hardware

### Installing on a Windows platform

#### Install the software before you install your device

A driver needed to run the USB-1608G-OEM 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-1608G-OEM to your system, turn on your computer and 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 USB cable to the USB connector on the device. No external power is required.

When you connect the device for the first time to a computer running Windows, a **Found New Hardware** dialog opens when the operating system detects the device. The dialog closes after the device is installed.

A green **Status** LED indicates the device status. When the Status LED is on, the device is powered and ready for operation. When the Status LED is off, the device is not powered or did not initialize. Figure 3 on page 10 shows the location of the **Status** LED.

**Caution!** Do not disconnect any device from the USB bus while the computer is communicating with USB-1608G-OEM hardware, or you may lose data and/or your ability to communicate with the device.

#### If the Status LED is off

If the **Status** LED is on but then turns off, the computer has lost communication with the USB-1608G-OEM. To restore communication, disconnect the USB cable from the computer and then reconnect it. This should restore communication, and the LED should turn on.

### Installing on an Android platform

Many Android devices include a standard A-type USB port to connect to the USB-1608G-OEM. If your device does not have a USB port, you may need a USB OTG cable in order for your Android device to host a USB device. Refer to your Android device documentation for more information.

## Calibrating the hardware

### Factory calibration

The Measurement Computing Manufacturing Test department performs the initial factory calibration. Contact Measurement Computing for details about how to return your device and have it calibrated to the factory specifications.

### Field calibration

The USB-1608G-OEM supports field calibration. Calibrate the device using InstaCal whenever the ambient temperature changes by more than  $\pm 10$  °C from the last field calibration.

## Firmware updates

Your DAQ device contains firmware that can be updated in the field if required. Firmware is available for download at [www.mccdaq.com/firmware.aspx](http://www.mccdaq.com/firmware.aspx). We recommend that you check this page periodically to see if an update to your device firmware is available.



## Functional Details

### Analog input modes

The USB-1608G-OEM can acquire analog input data in two basic modes – software paced and hardware paced.

#### Software paced

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 data and returned to the computer. Repeat this procedure until you have the total number of samples that you want.

The sample rate in software paced mode is system-dependent and can range from 33 S/s to 4000 S/s.

#### Hardware paced

You can acquire data from up to 16 channels in hardware paced mode. The analog data is continuously acquired, converted to digital values, and written into the FIFO buffer on the device until you stop the scan. The FIFO buffer is serviced in blocks as the data is transferred from the FIFO buffer to the computer memory buffer. You start a hardware-paced scan with either a software command or with an external hardware trigger event.

The maximum sampling rate in hardware paced mode from one to 16 channels is 250 kS/s aggregate.

### Burst mode

When using the onboard pacer, you can enable burst mode for more precise timing between samples. When burst mode is enabled, each successive channel in a scan is sampled at the maximum A/D rate. This ensures that samples from each channel are taken as close as possible to the same absolute point in time. When burst mode is disabled, data is sampled at evenly spaced intervals, allowing maximum settling time and best amplitude accuracy. Multi-channel scanning with burst mode enabled and disabled is shown in Figure 2.

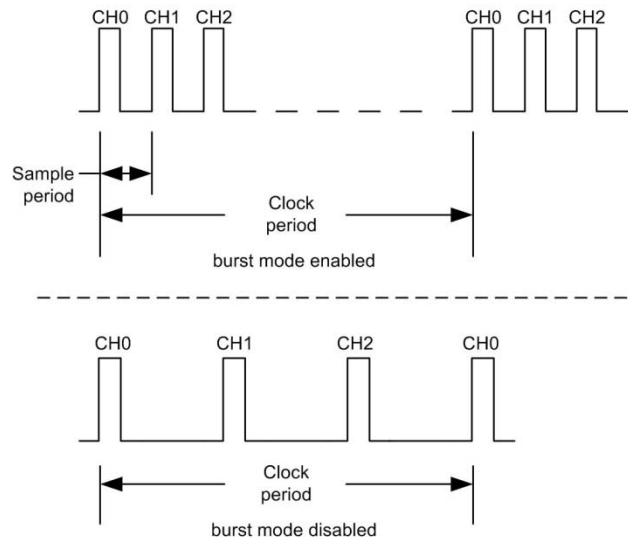


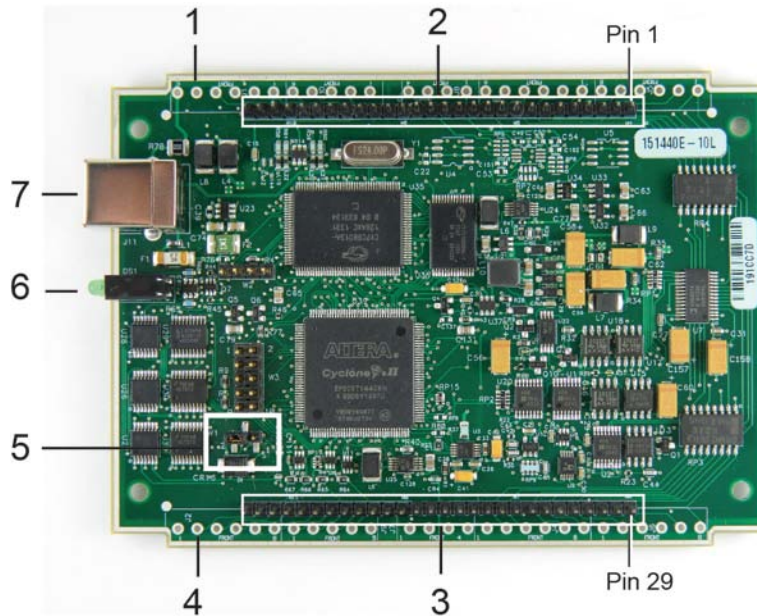
Figure 2. Multi-channel scan with burst mode enabled and disabled

The burst mode sample period is 4  $\mu$ s.

You can trigger the acquisition with the external trigger, and control the clock period with the internal or external A/D pacer clock. Pacing from the external clock always operates with burst mode enabled.

## Board components

Board components are shown in Figure 3. Note that each screw terminal location is unpopulated.



- |   |                              |   |  |
|---|------------------------------|---|--|
| 1 | Screw terminal (unpopulated) | 5 | Pull-up/down jumper W1                     |
| 2 | Header connector W4          | 6 | Status LED (top) and Activity LED (bottom) |
| 3 | Header connector W6          | 7 | USB connector                              |
| 4 | Screw terminal (unpopulated) |   |  |

Figure 3. Board components

### USB connector

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

### LEDs

The device has two LEDs – **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.

### Header connectors

The header connectors provide the following connections:

- 16 SE (**CH0** to **CH15**) or eight DIFF (**CH0H/CH0L** to **CH7H/CH7L**) analog input connections
- Eight digital I/O connections (**DIO0** to **DIO7**)
- One external clock input (**AICKI**) and one external clock output (**AICKO**) for analog inputs
- One digital trigger input (**TRIG**)
- Two counter inputs (**CTR0**, **CTR1**)
- One timer output (**TMR**)
- One power output (**+5V**)
- 13 analog ground (**AGND**) and five digital ground (**GND**) connections

The differential mode pinout is shown on page 11. The single-ended mode pinout is shown on page 12.

## Differential mode pinout

Pin	Signal Name	Description	Pin	Signal Name	Description
1	CH0H	Channel 0 HI	29	CH7L	Channel 7 LO
2	CH0L	Channel 0 LO	30	CH7H	Channel 7 HI
3	AGND	Analog ground	31	AGND	Analog ground
4	CH1H	Channel 1 HI	32	CH6L	Channel 6 LO
5	CH1L	Channel 1 LO	33	CH6H	Channel 6 HI
6	AGND	Analog ground	34	AGND	Analog ground
7	CH2H	Channel 2 HI	35	CH5L	Channel 5 LO
8	CH2L	Channel 2 LO	36	CH5H	Channel 5 HI
9	AGND	Analog ground	37	AGND	Analog ground
10	CH3H	Channel 3 HI	38	CH4L	Channel 4 LO
11	CH3L	Channel 3 LO	39	CH4H	Channel 4 HI
12	AGND	Analog ground	40	AGND	Analog ground
13	NC	No connection	41	AGND	Analog ground
14	AGND	Analog ground	42	AGND	Analog ground
15	NC	No connection	43	+5V	+5V output
16	AGND	Analog ground	44	AGND	Analog ground
17	NC	No connection	45	NC	No connection
18	GND	Digital ground	46	GND	Digital ground
19	DIO0	Digital input/output 0	47	AICKI	AI clock input
20	DIO1	Digital input/output 1	48	AICKO	AI clock output
21	DIO2	Digital input/output 2	49	NC	No connection
22	DIO3	Digital input/output 3	50	NC	No connection
23	DIO4	Digital input/output 4	51	TRIG	Trigger input
24	DIO5	Digital input/output 5	52	GND	Digital ground
25	DIO6	Digital input/output 6	53	CTR1	Counter 1
26	DIO7	Digital input/output 7	54	CTR0	Counter 0
27	GND	Digital ground	55	TMR	Timer output
28	GND	Chassis ground	56	GND	Digital ground

Do not connect anything to pins labeled "NC".

## Single-ended mode pinout

Pin	Signal Name	Description	Pin	Signal Name	Description
1	CH0	Channel 0	29	CH15	Channel 15
2	CH8	Channel 8	30	CH7	Channel 7
3	AGND	Analog ground	31	AGND	Analog ground
4	CH1	Channel 1	32	CH14	Channel 14
5	CH9	Channel 9	33	CH6	Channel 6
6	AGND	Analog ground	34	AGND	Analog ground
7	CH2	Channel 2	35	CH13	Channel 13
8	CH10	Channel 10	36	CH5	Channel 5
9	AGND	Analog ground	37	AGND	Analog ground
10	CH3	Channel 3	38	CH12	Channel 12
11	CH11	Channel 11	39	CH4	Channel 4
12	AGND	Analog ground	40	AGND	Analog ground
13	NC	No connection	41	AGND	Analog ground
14	AGND	Analog ground	42	AGND	Analog ground
15	NC	No connection	43	+5V	+5V output
16	AGND	Analog ground	44	AGND	Analog ground
17	NC	No connection	45	NC	No connection
18	GND	Digital ground	46	GND	Digital ground
19	DIO0	Digital input/output 0	47	AICKI	AI clock input
20	DIO1	Digital input/output 1	48	AICKO	AI clock output
21	DIO2	Digital input/output 2	49	NC	No connection
22	DIO3	Digital input/output 3	50	NC	No connection
23	DIO4	Digital input/output 4	51	TRIG	Trigger input
24	DIO5	Digital input/output 5	52	GND	Digital ground
25	DIO6	Digital input/output 6	53	CTR1	Counter 1
26	DIO7	Digital input/output 7	54	CTR0	Counter 0
27	GND	Digital ground	55	TMR	Timer output
28	GND	Chassis ground	56	GND	Digital ground

Do not connect anything to pins labeled "NC".

## Signal connections

### Analog input

You can configure the analog inputs for SE or DIFF mode. The input voltage range is software selectable for  $\pm 10$  V,  $\pm 5$  V,  $\pm 2$  V, or  $\pm 1$  V.

With SE mode, connect up to 16 inputs to **CH0** to **CH15**. SE mode requires two wires:

- Connect one wire to the signal you want to measure (**CHx**).
- Connect one wire to the analog ground reference (**AGND**).

With DIFF mode, connect up to eight differential inputs to **CH0H/CH0L** to **CH7H/CH7L**. DIFF mode requires two wires plus a ground reference:

- Connect one wire to the high/positive signal (**CHxH**).
- Connect one wire to the low/negative signal (**CHxL**).
- Connect one wire to the analog ground reference (**AGND**).

### Floating voltage source

When connecting DIFF voltage inputs to a "floating" voltage source, make sure the DIFF input channel has a DC return path to ground. To create this path, connect a resistor from each low channel input to an AGND pin. A value of approximately 100 k $\Omega$  can be used for most applications.

Leave unused input channels either floating or tied to an AGND terminal. Source impedances should be kept as small as possible to avoid settling time and accuracy errors.

Figure 4 shows DIFF channels 0-3 connected to a ground path resistor.

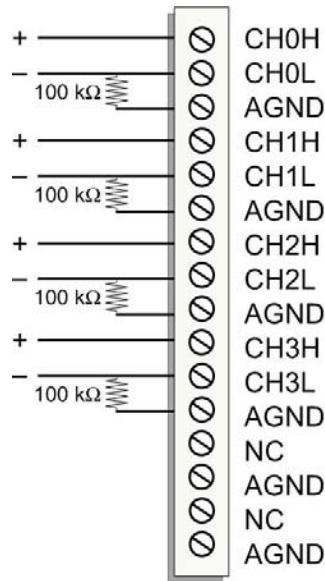


Figure 4. DIFF connections with ground path resistor

### Channel-Gain queue

The channel-gain queue feature allows you to configure a list of channels, modes, and gains for each scan. The settings are stored in a channel-gain queue list that is written to local memory on the device.

The channel-gain queue list contains one or more channel numbers, modes, and range settings. You can configure up to 16 elements. The channels can be listed in any order, and can include duplicate channels for sampling at different ranges.

An example of a 4-element list is shown in the table below.

Sample channel gain queue list

Element	Channel	Range	Mode
0	CH5	BIP5V	SE
1	CH1	BIP10V	SE
2	CH15	BIP1V	SE
3	CH5	BIP5V	SE

Carefully match the gain to the expected voltage range on the associated channel or an over range condition may occur. Although this condition does not damage the device, it does produce a useless full-scale reading, and can introduce a long recovery time due to saturation of the input channel.

#### For more information about analog signal connections

For more information about analog input connections, refer to the *Guide to Signal Connections* (this document is available on our web site at [www.mccdaq.com/pdfs/DAQ-Signal-Connections.pdf](http://www.mccdaq.com/pdfs/DAQ-Signal-Connections.pdf)).

### External clock I/O

The USB-1608G-OEM provides one external clock input (**AICKI**) and one external clock output (**AICKO**) for analog inputs. You can connect an external clock signal to **AICKI** and/or **AOCKI**.

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

## Digital I/O

You can connect up to eight digital I/O lines to **DIO0** through **DIO7**. Each digital channel is individually configurable for input or output. The digital I/O terminals can detect the state of any TTL-level input. Refer to the schematic shown in Figure 5.

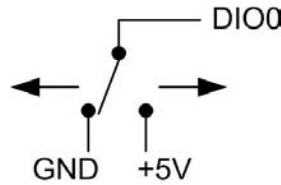


Figure 5. Schematic showing switch detection by digital channel DIO0

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 configuration

Unconnected inputs are pulled low by default to 0 V through 47 kΩ resistors via jumper **W1** on the circuit board (see Figure 6).

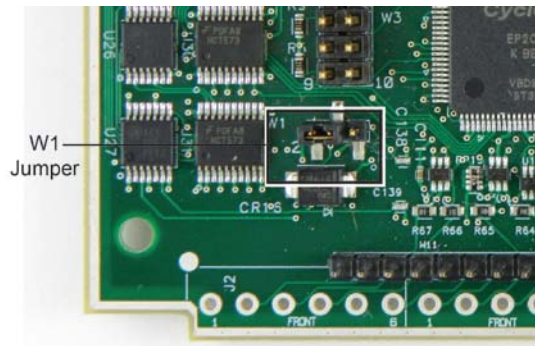


Figure 6. W1 jumper location

The pull-up/pull-down voltage is common to all 47 kΩ resistors. Jumper W1 is configured by default for pull-down. Figure 7 shows the jumper configured for pull-up and pull-down.

**Caution!** The discharge of static electricity can damage some electronic components. Before touching the board, ground yourself using a wrist strap or touch the computer chassis or other grounded object to eliminate any stored static charge.



Figure 7. W1 jumper configurations

### For more information about digital signal connections

For general information about digital signal connections and digital I/O techniques, refer to the *Guide to Signal Connections* (available on our web site at <http://www.mccdaq.com/pdfs/DAQ-Signal-Connections.pdf>).

## Trigger input

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

- Edge sensitive mode is configurable for rising or falling edge.
- Level sensitive mode is configurable for high or low level.

The default setting at power up is edge sensitive, rising edge.

## Retrigger mode

Retrigger mode lets you set up repetitive analog input or output trigger events. The trigger is automatically re-armed after it is activated. Use software to set the A/D or D/A trigger count (the number of samples you want per trigger).

## Counter input

The **CTR0** and **CTR1** terminals are 32-bit event counters that can accept frequency inputs up to 20 MHz. The internal counter increments when the TTL levels transition from low to high.

## Timer output

The **TMR** terminal is a pulse width modulation (PWM) timer output that can generate a pulse output with a programmable frequency in the range of 0.0149 Hz to 32 MHz. The timer output parameters are software selectable. Figure 8 shows the timer output schematic.

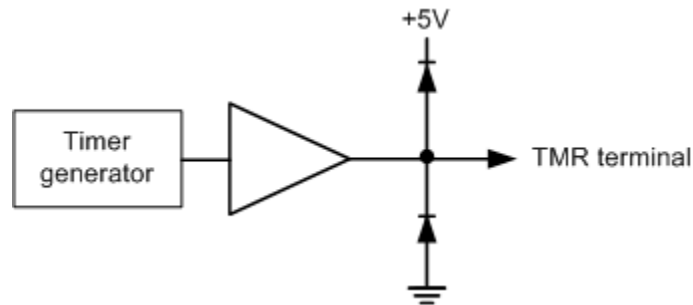


Figure 8. Timer output schematic

## Power output

The **+5V** terminal can output up to 10 mA maximum. You can use this terminal to supply power to external devices or circuitry.

**Caution!** The **+5V** 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, timer, and clock channels and the power terminal.

## Mechanical drawings

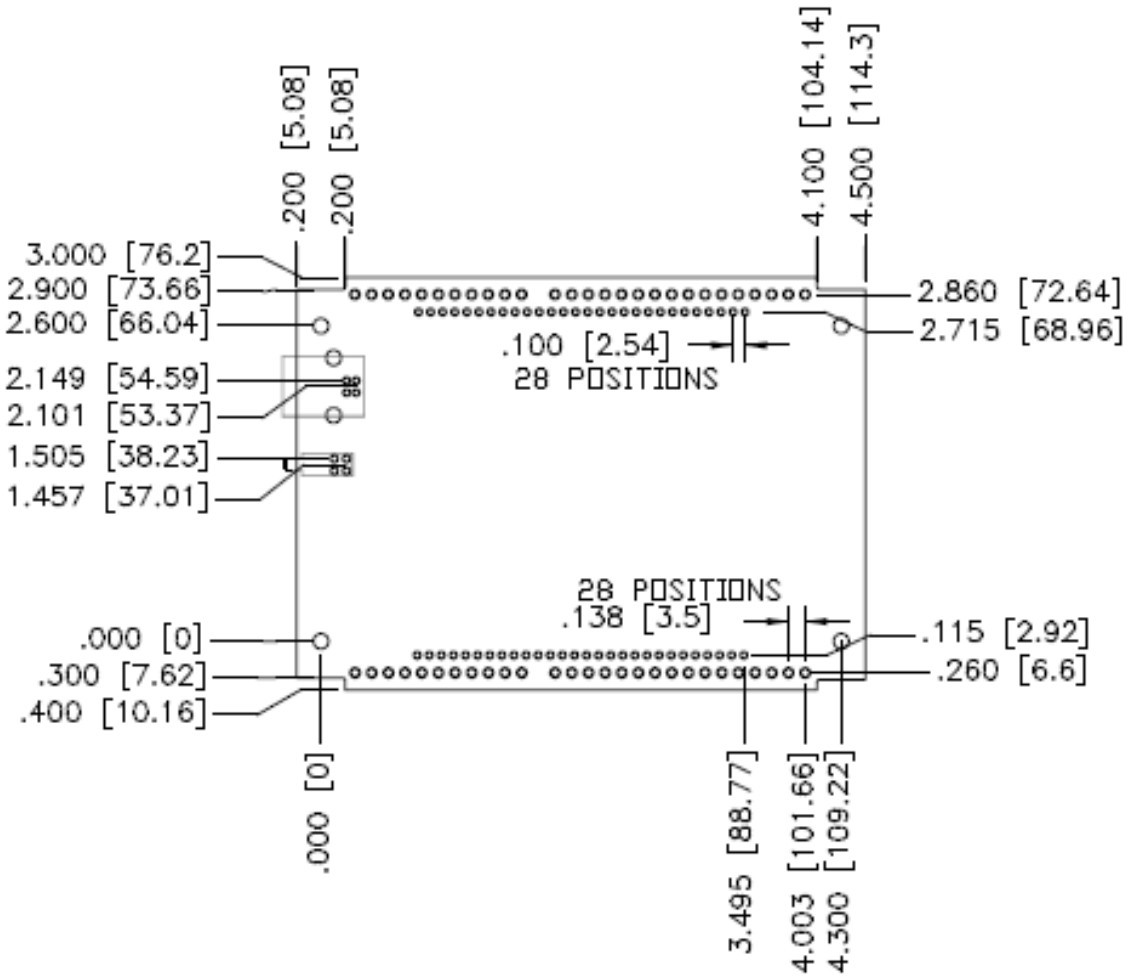


Figure 9. USB-1608G-OEM circuit board dimensions



## 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		16 bits
Number of channels		8 differential, 16 single-ended Software-selectable
Input voltage range		$\pm 10$ V, $\pm 5$ V, $\pm 2$ V, $\pm 1$ V Software-selectable per channel
<i>Absolute max 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 15</math> V max (power off)</li> </ul>
<i>Input impedance</i>		<ul style="list-style-type: none"> <li>■ 1 G<math>\Omega</math> (power on)</li> <li>■ 820 <math>\Omega</math> (power off)</li> </ul>
<i>Input bias current</i>		$\pm 10$ nA
Input bandwidth	All input ranges, small signal ( $-3$ dB)	750 kHz
<i>Input capacitance</i>		60 pF
Max working voltage (signal + common mode)	$\pm 10$ V range	$\pm 10.2$ V max relative to AGND
	$\pm 5$ V range	$\pm 10.2$ V max relative to AGND
	$\pm 2$ V range	$\pm 9.5$ V max relative to AGND
	$\pm 1$ V range	$\pm 9.0$ V max relative to AGND
Common mode rejection ratio	( $f_{IN} = 60$ Hz, all input ranges)	86 dB
Crosstalk	Adjacent differential mode channels, DC to 100 kHz	$-75$ dB
Input coupling		DC
Sampling rate		0.0149 Hz to 250 kHz; software-selectable
Trigger source		TRIG (see <i>External trigger</i> on page 19)
Sample clock source		Internal A/D clock or external A/D clock (AICKI pin)
Burst mode		4 $\mu$ s Software-selectable using the internal A/D clock; always enabled when using the external clock (AICKI pin).
Throughput	Software paced	33 to 4000 S/s typ, system dependent
	Hardware paced	250 kS/s max
Channel gain queue	Up to 16 elements	Software-selectable range for each channel
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 ( $\mu$ V)	INL error (% of range)	Absolute accuracy at Full Scale ( $\mu$ V)	Gain temperature coefficient (% reading/ $^{\circ}$ C)	Offset temperature coefficient ( $\mu$ V/ $^{\circ}$ C)
$\pm 10$ V	0.024	915	0.0076	4075	0.0014	47
$\pm 5$ V	0.024	686	0.0076	2266	0.0014	24
$\pm 2$ V	0.024	336	0.0076	968	0.0014	10
$\pm 1$ V	0.024	245	0.0076	561	0.0014	5

### Noise performance

For the peak-to-peak noise distribution test, a differential input channel is connected to AGND at the input terminal block, and 32,000 samples are acquired at the maximum rate available at each setting.

Table 3. Noise performance specifications

Range	Counts	LSB <sub>rms</sub>
$\pm 10$ V	6	0.91
$\pm 5$ V	6	0.91
$\pm 2$ V	7	1.06
$\pm 1$ V	9	1.36

### Settling time

Settling time is defined as the accuracy that can be expected after one conversion when switching from a channel with a DC input at one extreme of full scale to another channel with a DC input at the other extreme of full scale. Both input channels are configured for the same input range.

Table 4. Input settling time specifications in  $\mu$ S, typical

Range	4 $\mu$ S settling accuracy (% FSR)	6 $\mu$ S settling accuracy (% FSR)	$\pm 10$ $\mu$ S settling accuracy (% FSR)
$\pm 10$ V	0.0061	0.0031	0.0015
$\pm 5$ V	0.0061	0.0031	0.0015
$\pm 2$ V	0.0061	0.0031	0.0015
$\pm 1$ V	0.0061	0.0031	0.0015

## Analog input calibration

Table 5. Analog input/output calibration specifications

Parameter	Specification
Recommended warm-up time	15 minutes min
Calibration method	Self-calibration (firmware)
Calibration interval	1 year (factory calibration)
AI calibration reference	+5 V, $\pm 2.5$ mV max. Actual measured values stored in EEPROM.
	Tempco: 5 ppm/ $^{\circ}$ C max
	Long term stability: 15 ppm/1000 hours

## Digital input/output

Table 6. Digital input/output specifications

Parameter	Specification
Digital type	CMOS
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 k $\Omega$ resistors configurable as pull-ups or pull-downs (default) via internal jumper (W1).
Digital I/O transfer rate (system-paced)	33 to 8000 port reads/writes or single bit reads/writes per second typ, system dependent.
Input high voltage	2.0 V min 5.5 V absolute max
Input low voltage	0.8 V max -0.5 V absolute min 0 V recommended min
Output high voltage	4.4 V min (IOH = -50 $\mu$ A) 3.76 V min (IOH = -2.5 mA)
Output low voltage	0.1 V max (IOL = 50 $\mu$ A) 0.44 V max (IOL = 2.5 mA)
Output current	$\pm$ 2.5 mA max

## External trigger

Table 7. External trigger specifications

Parameter	Specification
Trigger source	TRIG input
Trigger mode	Software programmable 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 clock cycle max
Trigger pulse width	100 ns min
Input type	Schmitt trigger, 33 $\Omega$ series resistor and 49.9 k $\Omega$ pull-down to ground
Schmitt trigger hysteresis	0.4 V to 1.2 V
Input high voltage	2.2 V min 5.5 V absolute max
Input low voltage	1.5 V max -0.5 V absolute min 0 V recommended min

## External clock input/output

Table 8. External clock 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 sampling clock from external source AICKO: Outputs the internal sampling clock (D/A or A/D clock) or the pulse generated from AICKI when in external clock mode.
Input clock rate	250 kHz max
Clock pulse width	AICKI: 400 ns min AICKO: 400 ns min
Input type	Schmitt trigger, 33 $\Omega$ series resistor, 47 k $\Omega$ pull-down to ground
Schmitt trigger hysteresis	0.4 V to 1.2 V
Input high voltage	2.2 V min 5.5 V absolute max
Input low voltage	1.5 V max -0.5 V absolute min 0 V recommended min
Output high voltage	4.4 V min (IOH = -50 $\mu$ A) 3.76 V min (IOH = -2.5 mA)
Output low voltage	0.1 V max (IOL = 50 $\mu$ A) 0.44 V max (IOL = 2.5 mA)
Output current	$\pm$ 2.5 mA max

## Counter

Table 9. Counter specifications

Parameter	Specification
Terminal names	CTR0, CTR1
Number of channels	2 channels
Resolution	32-bit
Counter type	Event counter
Input type	Schmitt trigger, 33 $\Omega$ series resistor, 47 k $\Omega$ pull-down to ground
Input source	CTR0 (pin 52) CTR1 (pin 51)
Counter read/writes rates (software paced)	33 to 8000 reads/writes per second typ, system dependent
Input high voltage	2.2 V min, 5.5 V max
Input low voltage	1.5 V max, -0.5 V min
Schmitt trigger hysteresis	0.4 V min, 1.2 V max
Input frequency	20 MHz, max
High pulse width	25 ns, min
Low pulse width	25 ns, min

## Timer

Table 10. Timer specifications

Parameter	Specification
Terminal name	TMR
Timer type	PWM output with count, period, delay, and pulse width registers
Output value	Default state is idle low with pulses high, Software-selectable output invert
Internal clock frequency	64 MHz
Register widths	32-bit
High pulse width	15.625 ns min
Low pulse width	15.625 ns min
Output high voltage	4.4 V min (IOH = -50 $\mu$ A) 3.76 V min (IOH = -2.5 mA)
Output low voltage	0.1 V max (IOL = 50 $\mu$ A) 0.44 V max (IOL = 2.5 mA)
Output current	$\pm$ 2.5 mA max

## Memory

Table 11. Memory specifications

Parameter	Specification
Data FIFO	4 kS analog input
Non-volatile memory	32 KB (28 KB firmware storage, 4 KB calibration/user data)

## Power

Table 12. Power specifications

Parameter	Condition	Specification
Supply current (Note 3)	Quiescent current	230 mA
+5 V user output voltage range	Available at terminal block pin 43	4.5 V min to 5.25 V max
+5 V user output current	Available at terminal block pin 43	10 mA max

**Note 1:** This is the total quiescent current requirement for the device that includes up to 10 mA for the Status LED. This does not include any potential loading of the digital I/O bits or the +5V terminal.

## USB

Table 13. USB specifications

Parameter	Specification
USB device type	USB 2.0 (high-speed)
Device compatibility	USB 1.1, USB 2.0
USB cable type	A-B cable, UL type AWM 2527 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D-)
USB cable length	3 m (9.84 ft) max

## Environmental

Table 14. 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 15. Mechanical specifications

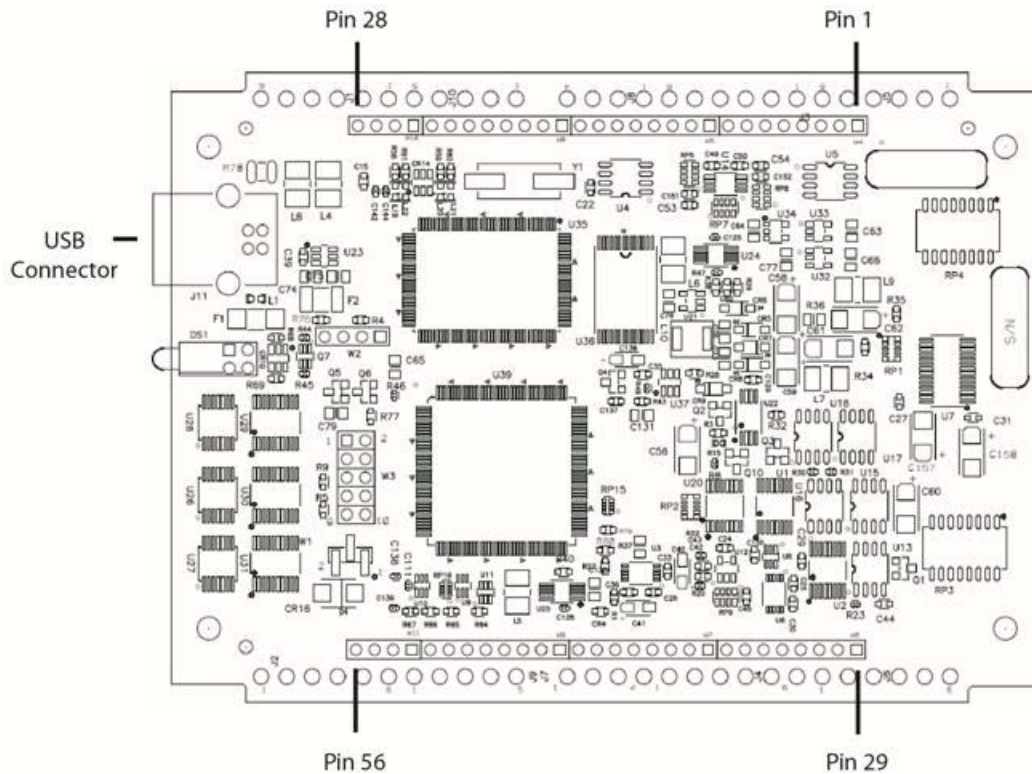
Parameter	Specification
Dimensions (L × W × H)	121.92 × 86.36 × 15.24 (4.80 × 3.40 × 0.60 in.)

## Header connector

Table 16. Header connector specifications

Parameter	Specification
Connector type	Two 1 × 28 pin 0.1 in. pitch headers

### Pin orientation



## Differential mode pinout

Table 17. 8-channel differential mode pinout

Pin	Signal Name	Description	Pin	Signal Name	Description
1	CH0H	Channel 0 HI	29	CH7L	Channel 7 LO
2	CH0L	Channel 0 LO	30	CH7H	Channel 7 HI
3	AGND	Analog ground	31	AGND	Analog ground
4	CH1H	Channel 1 HI	32	CH6L	Channel 6 LO
5	CH1L	Channel 1 LO	33	CH6H	Channel 6 HI
6	AGND	Analog ground	34	AGND	Analog ground
7	CH2H	Channel 2 HI	35	CH5L	Channel 5 LO
8	CH2L	Channel 2 LO	36	CH5H	Channel 5 HI
9	AGND	Analog ground	37	AGND	Analog ground
10	CH3H	Channel 3 HI	38	CH4L	Channel 4 LO
11	CH3L	Channel 3 LO	39	CH4H	Channel 4 HI
12	AGND	Analog ground	40	AGND	Analog ground
13	NC	No connection	41	AGND	Analog ground
14	AGND	Analog ground	42	AGND	Analog ground
15	NC	No connection	43	+VO	+5V voltage output
16	AGND	Analog ground	44	AGND	Analog ground
17	NC	No connection	45	NC	No connection
18	GND	Digital ground	46	GND	Digital ground
19	DIO0	DIO channel 0	47	AICKI	AI clock input
20	DIO1	DIO channel 1	48	AICKO	AI clock output
21	DIO2	DIO channel 2	49	NC	No connection
22	DIO3	DIO channel 3	50	NC	No connection
23	DIO4	DIO channel 4	51	TRIG	Trigger input
24	DIO5	DIO channel 5	52	GND	Digital ground
25	DIO6	DIO channel 6	53	CTR1	Counter 1
26	DIO7	DIO channel 7	54	CTR0	Counter 0
27	GND	Digital ground	55	TMR	Timer output
28	GND	Chassis ground	56	GND	Digital ground

## Single-ended mode pinout

Table 18. 16-channel single-ended mode pinout

Pin	Signal Name	Description	Pin	Signal Name	Description
1	CH0	Channel 0	29	CH15	Channel 15
2	CH8	Channel 8	30	CH7	Channel 7
3	AGND	Analog ground	31	AGND	Analog ground
4	CH1	Channel 1	32	CH14	Channel 14
5	CH9	Channel 9	33	CH6	Channel 6
6	AGND	Analog ground	34	AGND	Analog ground
7	CH2	Channel 2	35	CH13	Channel 13
8	CH10	Channel 10	36	CH5	Channel 5
9	AGND	Analog ground	37	AGND	Analog ground
10	CH3	Channel 3	38	CH12	Channel 12
11	CH11	Channel 11	39	CH4	Channel 4
12	AGND	Analog ground	40	AGND	Analog ground
13	NC	No connection	41	AGND	Analog ground
14	AGND	Analog ground	42	AGND	Analog ground
15	NC	No connection	43	+VO	+5V voltage output
16	AGND	Analog ground	44	AGND	Analog ground
17	NC	No connection	45	NC	No connection
18	GND	Digital ground	46	GND	Digital ground
19	DIO0	DIO channel 0	47	AICKI	AI clock input
20	DIO1	DIO channel 1	48	AICKO	AI clock output
21	DIO2	DIO channel 2	49	NC	No connection
22	DIO3	DIO channel 3	50	NC	No connection
23	DIO4	DIO channel 4	51	TRIG	Trigger input
24	DIO5	DIO channel 5	52	GND	Digital ground
25	DIO6	DIO channel 6	53	CTR1	Counter 1
26	DIO7	DIO channel 7	54	CTR0	Counter 0
27	GND	Digital ground	55	TMR	Timer output
28	GND	Chassis ground	56	GND	Digital ground



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