.1 YEAR WARRANTY

OMEGA CARE℠ Extended Warranty Program

CE

OMEGA®

User's Guide

Shop online at omega.com®

e-mail: info@omega.com
For latest product manuals:
www.omegamanual.info

OM-USB-1608FS-PLUS
8-Channel 16-Bit Multifunction USB Data Acquisition Module

omega.com info@omega.com

Servicing North America:

U.S.A.: Omega Engineering, Inc., One Omega Drive, P.O. Box 4047
Stamford, CT 06907-0047 USA
Toll-Free: 1-800-826-6342 (USA & Canada only)
Customer Service: 1-800-622-2378 (USA & Canada only)
Engineering Service: 1-800-872-9436 (USA & Canada only)
Tel: (203) 359-1660 Fax: (203) 359-7700
e-mail: info@omega.com

For Other Locations Visit omega.com/worldwide

Table of Contents

About this User's Guide

What you will learn from this user's guide

This user's guide describes the Omega Engineering OM-USB-1608FS-Plus data acquisition device and lists device specifications.

Conventions in this user's guide

For more information

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 OM-USB-1608FS-Plus hardware is available on our website at www.omega.com. You can also contact Omega Engineering by phone, fax, or email with specific questions.

- Phone: (203) 359-1660
- Fax: (203) 359-7700
- Email: das@omega.com

Introducing the OM-USB-1608FS-Plus

The OM-USB-1608FS-Plus is an analog input and digital I/O data acquisition device providing the following features:

- Eight 16-bit single-ended (SE) analog input channels
  Each input channel has a dedicated A/D converter for simultaneous sampling.
  Software-selectable analog input ranges of ±10 V, ±5 V, ±2 V, and ±1 V
- Eight individually configurable digital I/O channels
- One 32-bit event counter
- One external digital trigger input
- Bidirectional external clock for synchronous operation with more than one device.
- Screw terminals for field wiring connections

The device is powered by the +5V USB supply from the computer, requiring no external power.

The OM-USB-1608FS-Plus 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).

Functional block diagram

OM-USB-1608FS-Plus functions are illustrated in the block diagram shown here.

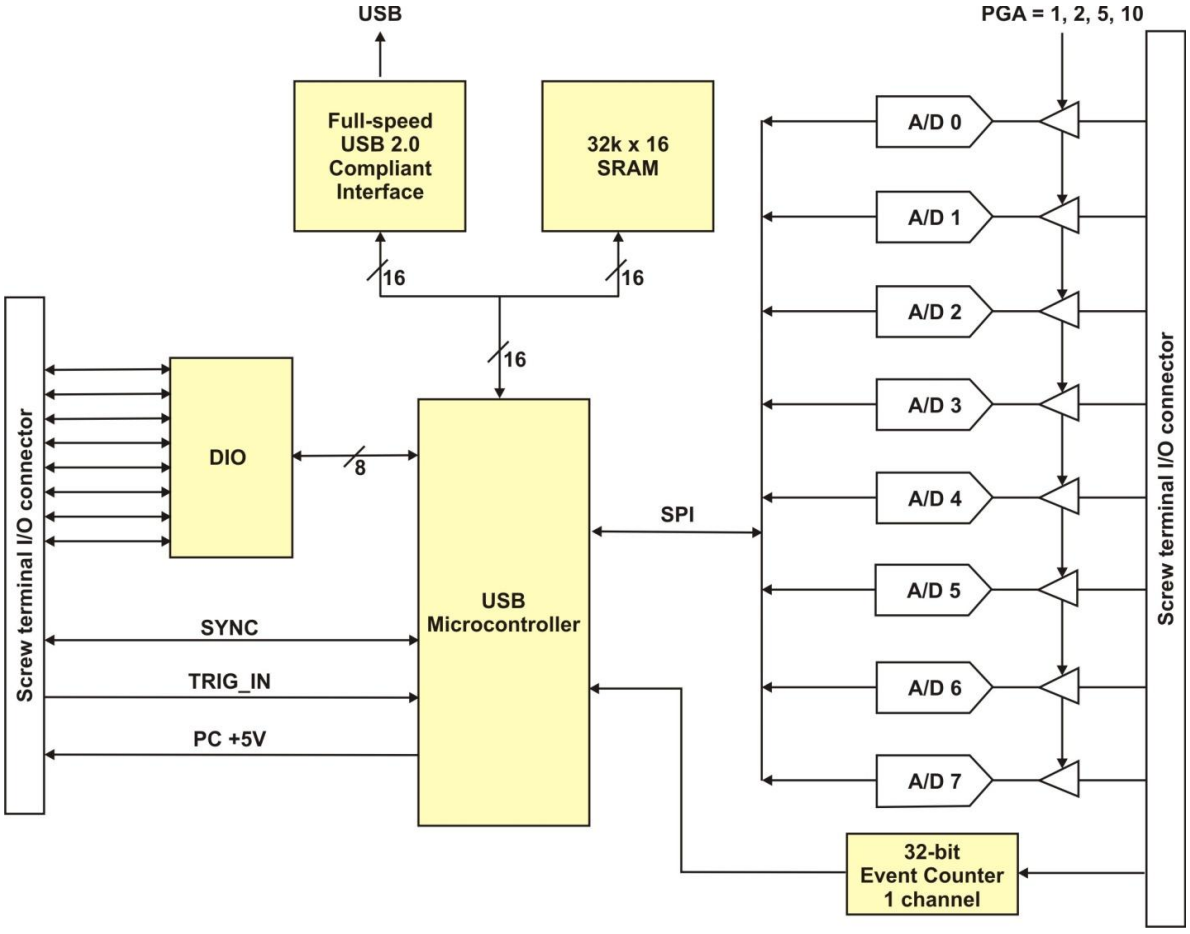


Figure 1. Functional block diagram

Installing a OM-USB-1608FS-Plus

What comes with your shipment?

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

Hardware

- OM-USB-1608FS-Plus
- USB cable

Software

- Software for OMB-DAQ-2400, OM-USB, OM-WEB, and OM-WLS Series Data Acquisition Modules CD

Documentation

In addition to this hardware user's guide, you should also receive the *OMB-DAQ-2400, OM-USB, OM-WEB, and OM-WLS Series Data Acquisition Software User's Guide*. This booklet provides an overview of the software you received with the device, and includes information about installing the software.

Unpacking

As with any electronic device, 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, notify Omega Engineering immediately by phone, fax, or e-mail.

- Phone: (203) 359-1660
- Fax: (203) 359-7700
- Email: das@omega.com

Installing the software

Refer to the *Software User's Guide* for instructions on installing the software. This booklet ships with the hardware, and is available in PDF at http://www.omega.com/manuals/manualpdf/M4803.pdf.

Installing the hardware

Install the software before you install your device

The driver needed to run the OM-USB-1608FS-Plus is installed when you install the software. Therefore, you need to install the software before you install the hardware.

To connect the OM-USB-1608FS-Plus 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 USB 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 LED on the OM-USB-1608FS-Plus turns on after the device is successfully installed.

If the LED turns off

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

Calibrating the hardware

Omega Engineering performs the initial factory calibration. Return the device to Omega Engineering when calibration is required. The recommended calibration interval is one year.

The OM-USB-1608FS-Plus does not support field calibration.

Functional Details

Analog input modes

The OM-USB-1608FS-Plus can acquire analog input data in three modes – software paced, hardware paced, and burst scan.

Software paced

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

The typical throughput sample rate in software paced mode is 500 S/s (system-dependent).

Hardware paced

You can acquire data from up to eight channels simultaneously in hardware paced mode. The analog data is continuously acquired, converted to digital values, and written to an on-board FIFO buffer on the device until you stop the scan. The FIFO buffer is serviced in blocks as the data is transferred from the device FIFO buffer to the memory buffer on your computer. Data is transferred in blocks from the device to the memory buffer on your computer.

The maximum sampling rate is an aggregate rate. The total sample rate using hardware paced mode is 400 kS/s divided by the number of channels, with a maximum rate of 100 kS/s for any channel. You can acquire data from one to four channels at 100 kS/s each, six channels at 66.7 kS/s each, and so on, up to eight channels at 50 kS/s each. You can start a hardware paced scan with a software command or an external hardware trigger event.

Burst scan

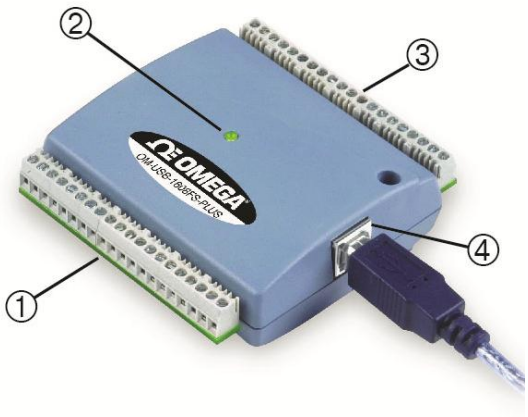
In burst scan mode (BURSTIO), you can acquire data from the OM-USB-1608FS-Plus using the full capacity of the 32 k sample FIFO. The acquired data is read from the FIFO and transferred to a user buffer in the computer. You can initiate a single acquisition sequence of one to eight channels with either a software command or an external hardware trigger event.

Burst scans are limited to the depth of the on-board memory, as the data is acquired at a rate faster than it can be transferred to the computer. The maximum sampling rate is an aggregate rate. The total sample rate using burst scan mode is 100 kS/s per channel for any or all channels. A data overrun may occur if you exceed the FIFO capacity and sample >32,768 samples.

External components

The OM-USB-1608FS-Plus has the following external components, as shown in Figure 2.

- Screw terminals
- LED
- USB connector



1	Screw terminal pins 21 to 40	3	Screw terminal pins 1 to 20
2	LED	4	USB connector

Figure 2. OM-USB-1608FS-Plus components

USB connector

The USB connector receives the supplied USB cable. When connected to a computer or USB hub, the cable provides +5 V power and communication. No external power supply is required.

LED

The LED indicates the communication status; it cannot be disabled.

LED behavior

LED state	Indication
On – steady green	The device is connected to a computer or external USB hub.
Blinks once	A USB command is received.
Blinks continuously	An analog input scan is in progress.

Screw terminals

The screw terminals provide the following connections:

- Eight analog inputs (**CH0 IN** to **CH7 IN**)
- Eight digital I/O lines(**DIO0** to **DIO7**)
- One external event counter input (**CTR**)
- One SYNC I/O terminal for external clocking and multi-unit synchronization (**SYNC**)
- One external trigger input (**TRIG_IN**)
- One power output (**PC+5 V**)
- 11 analog ground (**AGND**) and eight digital ground (**GND**) connections

Use 16 AWG to 30 AWG wire when making connections to the screw terminals. Pinout locations are shown in Figure 3.

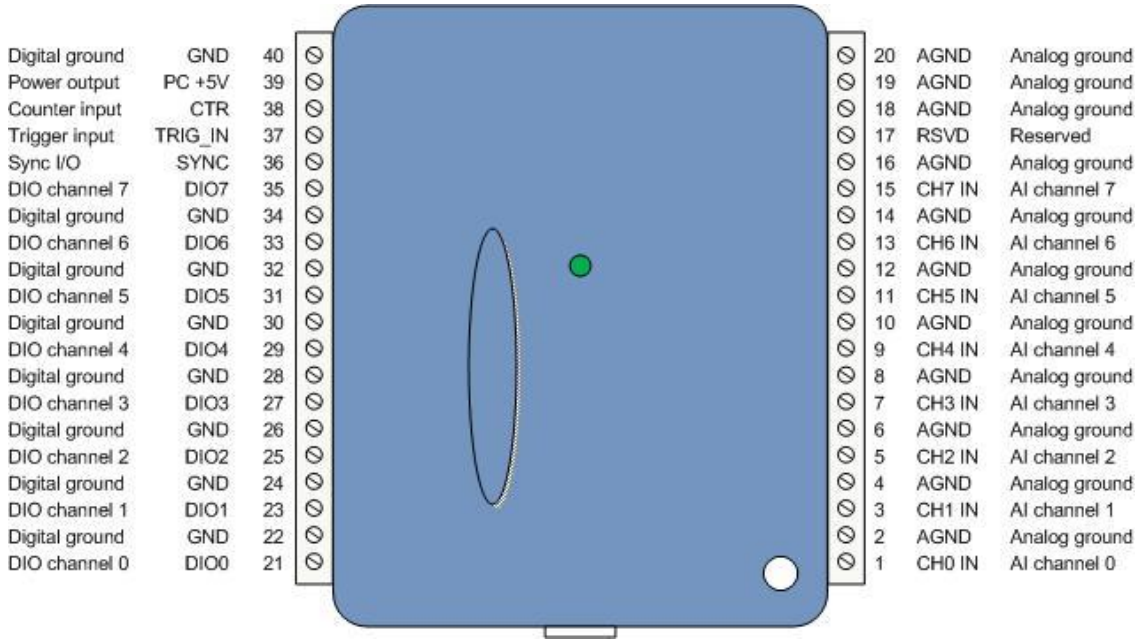


Figure 3. Screw terminal pinout

Signal connections

Analog input

You can connect up to eight analog input connections to the screw terminal containing pins 1 to 20 (**CH0 IN** through **CH7 IN**.) Connect unused analog input terminals to ground terminals during operation. For example, if you are not using terminal 15 (**CH7 IN**), connect this terminal to terminal 16 (**AGND**).

All analog input channels are configured for single-ended input mode. All analog input signals are referenced to ground (**AGND**):

- Connect the wire carrying the signal to be measured to **CH# IN**.
- Connect the second wire to **AGND**.

The input voltage ranges are ±10 V, ±5 V, ±2.0 V, ±1.0 V.

For more information about analog signal connections

For more information about analog input connections, refer to the *OMB-DAQ-2400, OM-USB, OM-WEB, and OM-WLS Series General Guide to Signal Connections* (available on our web site at www.omega.com/manuals/manualpdf/M4830.pdf).

Channel-Gain queue

The channel-gain queue feature allows you to configure a different gain setting for each channel. The gain settings are stored in a channel-gain queue list that is written to local memory on the device.

The channel-gain queue list can contain up to eight unique elements. The channel list must be in increasing order. An example of a five element list is shown in the table below.

Sample channel-gain queue list

Element	Channel	Range
0	CH0	BIP1V
1	CH2	BIP2V
2	CH4	BIP10V
3	CH6	BIP1V
4	CH7	BIP5V

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.

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. During initial power on or reset the digital pins are set for input.

The digital I/O terminals can detect the state of any TTL-level input. Refer to the schematic shown in Figure 4.

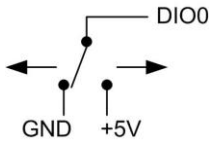


Figure 4. Schematic showing switch detection by digital channel DIO0

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

Pull-up/down configuration

All digital I/O lines are pulled up to USB +5V (HI) with a 47 kΩ resistor (default). You can change the pull-up/down configuration using the internal jumper labeled **DIO**. You must remove the device housing to access the jumper on the circuit board.

To set the jumper for pull-up or pull-down, complete the following steps.

1. Unplug the device from the computer.
2. Turn the device over and rest the top of the housing on a flat, stable surface.

Caution! The discharge of static electricity can damage some electronic components. Before removing the OM-USB-1608FS-Plus from its housing, ground yourself using a wrist strap or touch the computer chassis or other grounded object to eliminate any stored static charge.

3. Remove the three screws from the bottom of the device using a #1 Philips head screwdriver.
4. Hold both the top and bottom sections together, turn the device over and rest it on the surface, then carefully remove the top section of the case to expose the circuit board.

   Figure 5 shows the location of the **DIO** jumper on the circuit board.

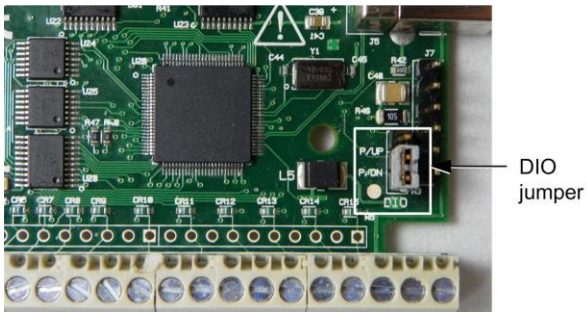


Figure 5. Pull-up/down jumper location

5. Configure the jumper for pull-up or pull-down, as shown in Figure 6.

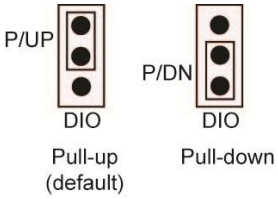


Figure 6. Pull-up/down jumper configuration

6. Replace the top section of the housing, and fasten it to the bottom section with the three screws.

For more information about digital signal connections

For general information about digital signal connections and digital I/O techniques, refer to the *OMB-DAQ-2400, OM-USB, OM-WEB, and OM-WLS Series General Guide to Signal Connections* (available on our web site at www.omega.com/manuals/manualpdf/M4830.pdf).

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.

SYNC I/O

The **SYNC** terminal is a bidirectional I/O signal that can be configured as an input (default) or an output.

- Configure as an external clock input to pace the A/D conversions from an external source. The SYNC terminal supports TTL-level input signals of up to 100 kHz.
- Configure as an output that may be used to pace conversions on a second device and acquire data from 16 channels. Refer to page 15 for more information about synchronized operations.

Trigger input

The **TRIG_IN** terminal is an external digital trigger input. The trigger mode is software-selectable for edge or level sensitive. Edge sensitive mode is selectable for rising or falling. Level sensitive mode is selectable for high or low.

Reserved

The **RSVD** terminal is reserved for future use.

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, trigger, counter, and sync channels and the power terminal.

Power output

The **PC +5V** output terminal can output up to 200 mA maximum. You can use this terminal to supply power to external devices or circuitry.

Caution! The PC +5V terminal is an output. Do not connect it to an external power supply or you may damage the device and possibly the computer.

The maximum output current that can be drawn by the OM-USB-1608FS-Plus is 500 mA. This maximum applies to most personal computers and self-powered USB hubs. Bus-powered hubs and notebook computers may limit the maximum available output current to 100 mA. If the current requirement of the device exceeds the current available from the computer, connect to a self-powered hub or power the computer with an external power adapter.

When running applications with the device, each DIO bit can source up to 24 mA. The total amount of current that can be sourced from the PC +5V, SYNC, and digital outputs is 200 mA max.

Accuracy

The overall accuracy of any instrument is limited by the error components within the system. Resolution is often used incorrectly to quantify the performance of a measurement product. While "16-bits" or "1 part in 65,536" does indicate what can be resolved, it provides little insight into the quality, or accuracy, of an absolute measurement. Accuracy specifications describe the actual measurement achievable with a OM-USB-1608FS-Plus. Accuracy specifications are listed on page 17.

There are three types of errors which affect the accuracy of a measurement system:

- offset
- gain
- nonlinearity

The primary error sources in a OM-USB-1608FS-Plus are offset and gain. Nonlinearity is small, and is not significant as an error source with respect to offset and gain.

Figure 7 shows an ideal, error-free transfer function. The typical calibrated accuracy of a OM-USB-1608FS-Plus is range-dependent. We use a ±10 V range as an example of what you can expect when performing a measurement in this range.

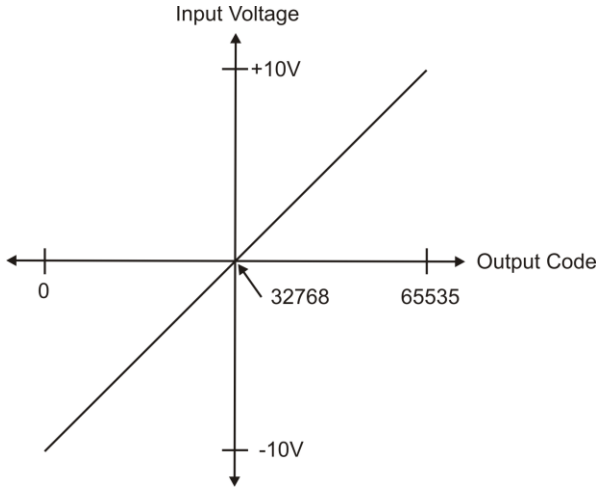


Figure 7. Ideal ADC transfer function

The offset error is measured at mid-scale. Ideally, a zero volt input should produce an output code of 32,768. Any deviation from this is an offset error. Figure 8 shows the transfer function with an offset error. The typical offset error specification for a OM-USB-1608FS-Plus on the ±10 V range is ±1.66 mV. Offset error affects all codes equally by shifting the entire transfer function up or down along the input voltage axis.

The accuracy plots in Figure 8 are drawn for clarity and are not drawn to scale.

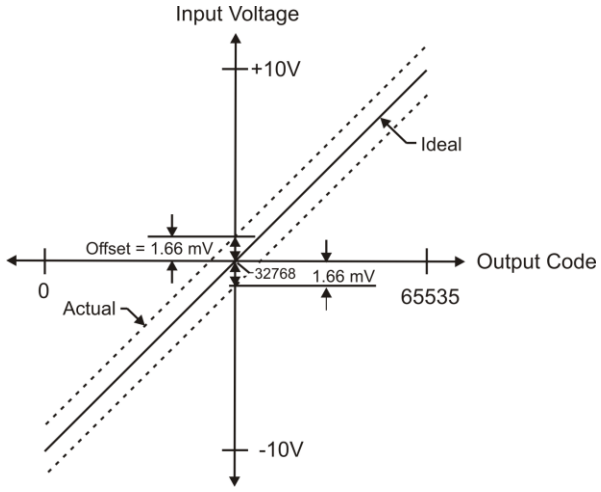


Figure 8. ADC transfer function with offset error

Gain error is a change in the slope of the transfer function from the ideal, and is typically expressed as a percentage of full-scale. Figure 9 shows the OM-USB-1608FS-Plustransfer function with gain error. Gain error is easily converted to voltage by multiplying the full-scale input (±10 V) by the error.

The accuracy plots in Figure 9 are drawn for clarity and are not drawn to scale.

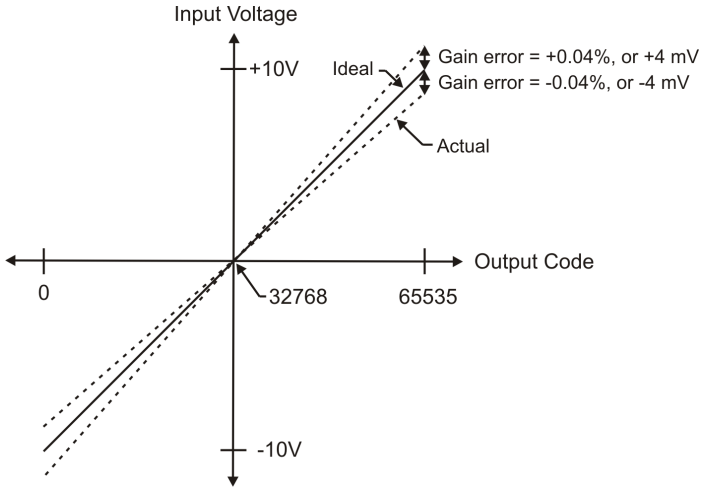


Figure 9. ADC Transfer function with gain error

For example, a OM-USB-1608FS-Plus exhibits a typical calibrated gain error of ±0.04% on all ranges. For the ±10 V range, this would yield 10 V × ±0.0002 = ±4 mV. This means that at full scale, neglecting the effect of offset for the moment, the measurement would be within 4 mV of the actual value. Note that gain error is expressed as a ratio. Values near ±FS (±10 V) are more affected from an absolute voltage standpoint than are values near mid-scale, which see little or no voltage error.

Combining these two error sources in Figure 10, we have a plot of the error band at ±full scale (±10 V). This plot is a graphical version of the typical accuracy specification of the product.

The accuracy plots in Figure 10 are drawn for clarity and are not drawn to scale.

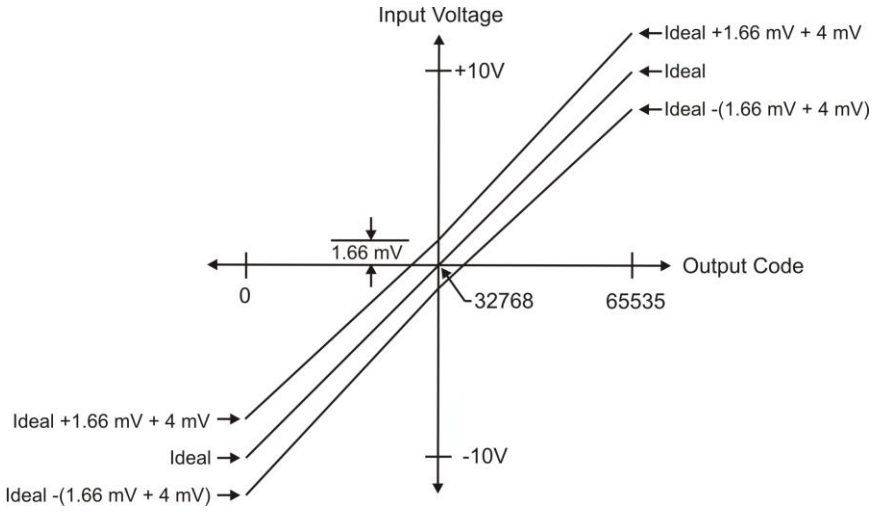


Figure 10. Error band plot

Synchronized operations

You can connect the SYNC pin of multiple devices together in a master/slave configuration and acquire data from the analog inputs of all devices using one clock.

When the SYNC pin is configured as an output, the internal A/D pacer clock signal is sent to the screw terminal. You can output the clock to the SYNC pin of another device that is configured for A/D pacer input.

Mechanical drawings

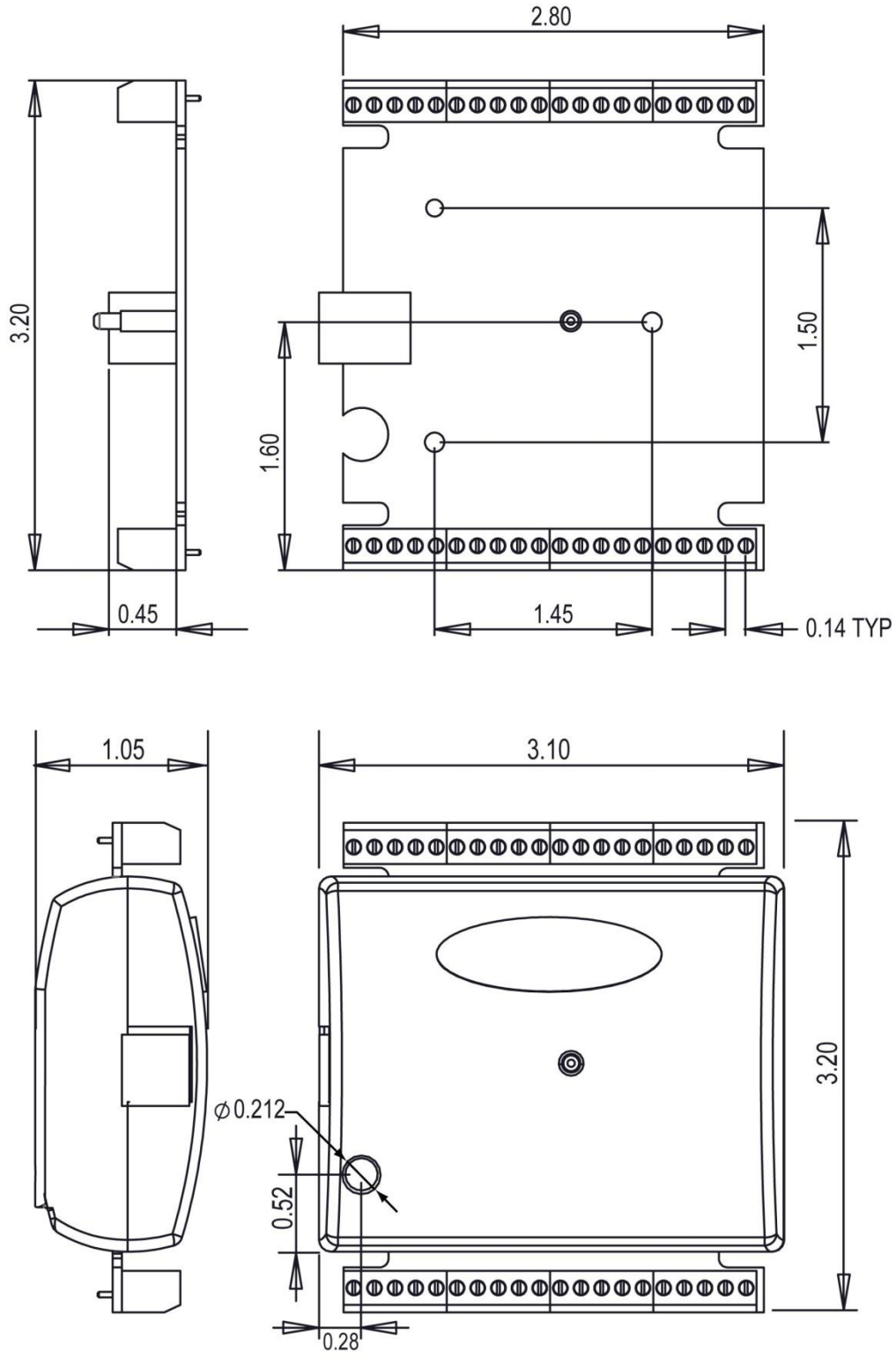


Figure 11. OM-USB-1608FS-Plus circuit board (top) and enclosure dimensions

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		16-bit successive approximation type
Number of channels		8 single-ended
Input configuration		Individual A/D per channel
Sampling method		Simultaneous
Absolute maximum input voltage	*CHx IN relative to GND*	*±15 V max*
Input impedance		100 MΩ min
Input ranges	Software-selectable per channel	±10 V, ±5 V, ±2 V, ±1 V
Sampling rate	Hardware paced	0.01 S/s to 100 kS/s, software-selectable
Throughput	Software paced	500 S/s all channels
	Hardware paced (Note 1)	(400 kS/s) / (# of channels) max, 100 kS/s max for any channel
	Burst scan ≤ 32,768 total samples (uses onboard FIFO)	(800 kS/s) / (# of channels) max, 100 kS/s max for any channel
Gain queue		Software configurable. Up to eight elements – one gain element per unique, ordered channel.
Resolution		16 bits
No missing codes		*16 bits*
Crosstalk	Signal DC to 25 kHz	–80 dB
Trigger source	Software-selectable	External digital: TRIG_IN

Note 1: Maximum throughput when scanning in hardware paced mode is machine dependent.

Accuracy

Analog input DC voltage measurement accuracy

Table 2. Calibrated absolute accuracy

Range	Accuracy (mV)
±10 V	5.66
±5 V	2.98
±2 V	1.31
±1 V	0.68

Table 3. Accuracy components - All values are (±)

Range	Gain error (% of Reading)	Gain error at FS (mV)	Offset (mV)
±10 V	0.04	4.00	1.66
±5 V	0.04	2.00	0.98
±2 V	0.04	0.80	0.51
±1 V	0.04	0.40	0.28

Noise performance

Table 4. Noise performance

Range	Typical counts	LSBrms
±10 V	10	1.52
±5 V	10	1.52
±2 V	11	1.67
±1 V	14	2.12

Table 4 summarizes the noise performance for the OM-USB-1608FS-Plus. Noise distribution is determined by gathering 50 K samples with inputs tied to ground at the user connector. Samples are gathered at the maximum specified sampling rate of 100 kS/s.

Digital input/output

Table 5. Digital I/O specifications

Parameter	Specification
Digital type	5V TTL
Number of I/O	8 (DIO0 through DIO7)
Configuration	Independently configured for input or output
Pull-up/pull-down configuration	All pins pulled up to 5V via 47 K resistors (default). May be changed to pull-down using an internal jumper.
Input high voltage threshold	2.0 V min
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	0.8 V max
Input low voltage limit	–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)
Power on and reset state	Input

External trigger

Table 6. External trigger specifications

Parameter	Condition	Specification
Trigger source	External digital	TRIG_IN
Trigger mode	Software-selectable	Edge or level sensitive: user configurable for CMOS compatible rising or falling edge, high or low level.
Trigger latency		2 µs + 1 pacer clock cycle max
Trigger pulse width		1µs 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 3.1V max
Input high voltage limit		5.5 V absolute max
Input low voltage threshold		1.42 V typ 1.0 V min 2.0 V max
Input low voltage limit		-0.5 V absolute min 0 V recommended min

External clock input/output

Table 7. External clock I/O specifications

Parameter	Condition	Specification
Pin name		SYNC
Pin type		Bidirectional
Direction, software-selectable	Input	Receives A/D pacer clock from external source
	Output	Outputs internal A/D pacer clock
Input clock rate		100 kHz, max
Clock pulse width	Input	1 µs min
	Output	4 µs min
Input clock mode		Edge sensitive, rising
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 3.1V max
Input high voltage limit		5.5 V absolute max
Input low voltage threshold		1.42 V typ 1.0 V min 2.0 V max
Input low voltage limit		-0.5 V absolute min 0 V 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)

Counter section

Table 8. Counter specifications

Parameter	Specification
Pin name	CTR
Counter type	Event counter
Number of channels	1
Input type	Schmitt trigger, 47 kΩ pull-down to ground
Input source	CTR screw terminal
Resolution	32 bits
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 3.1V max
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	1.42 V typ 1.0 V min 2.0 V max
Input low voltage limit	-0.5 V absolute min 0 V recommended min
Input frequency	1 MHz max
High pulse width	*500 ns min*
Low pulse width	*500 ns min*

Memory

Table 9. Memory specifications

Parameter	Specification
Data FIFO	32,768 samples, 65,536 bytes
EEPROM	2,048 bytes (768 bytes calibration, 256 bytes user, 1,024 bytes DAQFlex)

Microcontroller

Table 10. Microcontroller specifications

Parameter	Specification
Type	*High performance 32-bit RISC microcontroller*

Power

Table 11. Power specifications

Parameter	Condition	Specification
Supply current	USB enumeration	< 100 mA
Supply current	Including DIO and SYNC output loading	< 500 mA
+5V power available (Note 2)	Connected to externally-powered root port hub or a self-powered hub	4.5 V min, 5.25 V max
Output current (Note 3)		200 mA max

Note 2: "Self-powered hub" refers to a USB hub with an external power supply. Self-powered hubs allow a connected USB device to draw up to 500 mA. "Root port hubs" reside in the PC USB host Controller. The USB port(s) on your PC are root port hubs. All externally-powered root port hubs, such as a desktop PC, provide up to 500 mA of current for a USB device. Battery-powered root port hubs provide 100 mA or 500 mA, depending upon the manufacturer. A laptop PC that is not connected to an external power adapter is an example of a battery-powered root port hub. If your laptop PC is constrained to the 100 mA maximum, you need to purchase a self-powered hub.

Note 3: Output current is the total amount of current that can be sourced from the PC +5V, SYNC, and digital outputs.

General

Table 12. General specifications

Parameter	Specification
Device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0

Environmental

Table 13. Environmental specifications

Parameter	Specification
Operating temperature range	0 °C to 70 °C
Storage temperature range	–40 °C to 70 °C
Humidity	0% to 90% non-condensing

Mechanical

Table 14. Mechanical specifications

Parameter	Specification
Dimensions (L × W × H)	79 × 82 × 27 mm (3.10 × 3.20 × 1.05 in.)
USB cable length	3 m (9.84 ft) max
User connection length	3 m (9.84 ft) max

Screw terminal connector and pinout

Table 15. Connector specifications

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

Table 16. Connector pinout

Pin	Signal Name	Pin	Signal Name
1	CH0 IN	21	DIO0
2	AGND	22	GND
3	CH1 IN	23	DIO1
4	AGND	24	GND
5	CH2 IN	25	DIO2
6	AGND	26	GND
7	CH3 IN	27	DIO3
8	AGND	28	GND
9	CH4 IN	29	DIO4
10	AGND	30	GND
11	CH5 IN	31	DIO5
12	AGND	32	GND
13	CH6 IN	33	DIO6
14	AGND	34	GND
15	CH7 IN	35	DIO7
16	AGND	36	SYNC
17	RSVD	37	TRIG_IN
18	AGND	38	CTR
19	AGND	39	PC +5V
20	AGND	40	GND

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

Where Do I Find Everything I Need for Process Measurement and Control? OMEGA...Of Course!

*Shop online at omega.com*SM

TEMPERATURE

- ☑ Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- ☑ Wire: Thermocouple, RTD & Thermistor
- ☑ Calibrators & Ice Point References
- ☑ Recorders, Controllers & Process Monitors
- ☑ Infrared Pyrometers

PRESSURE, STRAIN AND FORCE

- ☑ Transducers & Strain Gages
- ☑ Load Cells & Pressure Gages
- ☑ Displacement Transducers
- ☑ Instrumentation & Accessories

FLOW/LEVEL

- ☑ Rotameters, Gas Mass Flowmeters & Flow Computers
- ☑ Air Velocity Indicators
- ☑ Turbine/Paddlewheel Systems
- ☑ Totalizers & Batch Controllers

pH/CONDUCTIVITY

- ☑ pH Electrodes, Testers & Accessories
- ☑ Benchtop/Laboratory Meters
- ☑ Controllers, Calibrators, Simulators & Pumps
- ☑ Industrial pH & Conductivity Equipment

DATA ACQUISITION

- ☑ Data Acquisition & Engineering Software
- ☑ Communications-Based Acquisition Systems
- ☑ Plug-in Cards for Apple, IBM & Compatibles
- ☑ Data Logging Systems
- ☑ Recorders, Printers & Plotters

HEATERS

- ☑ Heating Cable
- ☑ Cartridge & Strip Heaters
- ☑ Immersion & Band Heaters
- ☑ Flexible Heaters
- ☑ Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- ☑ Metering & Control Instrumentation
- ☑ Refractometers
- ☑ Pumps & Tubing
- ☑ Air, Soil & Water Monitors
- ☑ Industrial Water & Wastewater Treatment
- ☑ pH, Conductivity & Dissolved Oxygen Instruments