USB-1616FS-Plus

Analog Input and Digital I/O

User's Guide

MEASUREMENT COMPUTING™

Table of Contents

About this User's Guide

What you will learn from this user's guide

This user's guide describes the Measurement Computing USB-1616FS-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 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 is used for the names of objects on a screen, such as buttons, text boxes, and check boxes.

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-1616FS-Plus 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-1616FS-Plus

The USB-1616FS-Plus is a USB 2.0 full-speed device supported under popular Microsoft® Windows® operating systems. The USB-1616FS-Plus is compatible with USB 3.0.

The USB-1616FS-Plus provides true simultaneous sampling of up to sixteen 16-bit single-ended analog inputs. Simultaneous input sampling is accomplished using one A/D converter per channel. The device features sampling rates of up to 100 kS/s per channel, and up to 500 kS/s throughput continuously or 1.6 MS/s for a burst of 32kS. You can configure the analog input range of each channel independently via software. An onboard temperature sensor lets you monitor your environment temperature.

Eight digital IO lines are independently selectable as input or output. A 32-bit counter can count TTL pulses. A SYNC (synchronization) control line lets you connect two USB-1616FS-Plus devices and acquire data synchronously from 32 analog inputs.

The USB-1616FS-Plus is powered by an external +9 V unregulated power supply that is shipped with the board. Power and USB connectors let you power and control multiple MCC USB Series products from one external power source and one USB port in a daisy chain fashion.

The USB-1616FS-Plus is enclosed in a rugged housing that you can mount on a DIN rail or on a bench.

Functional block diagram

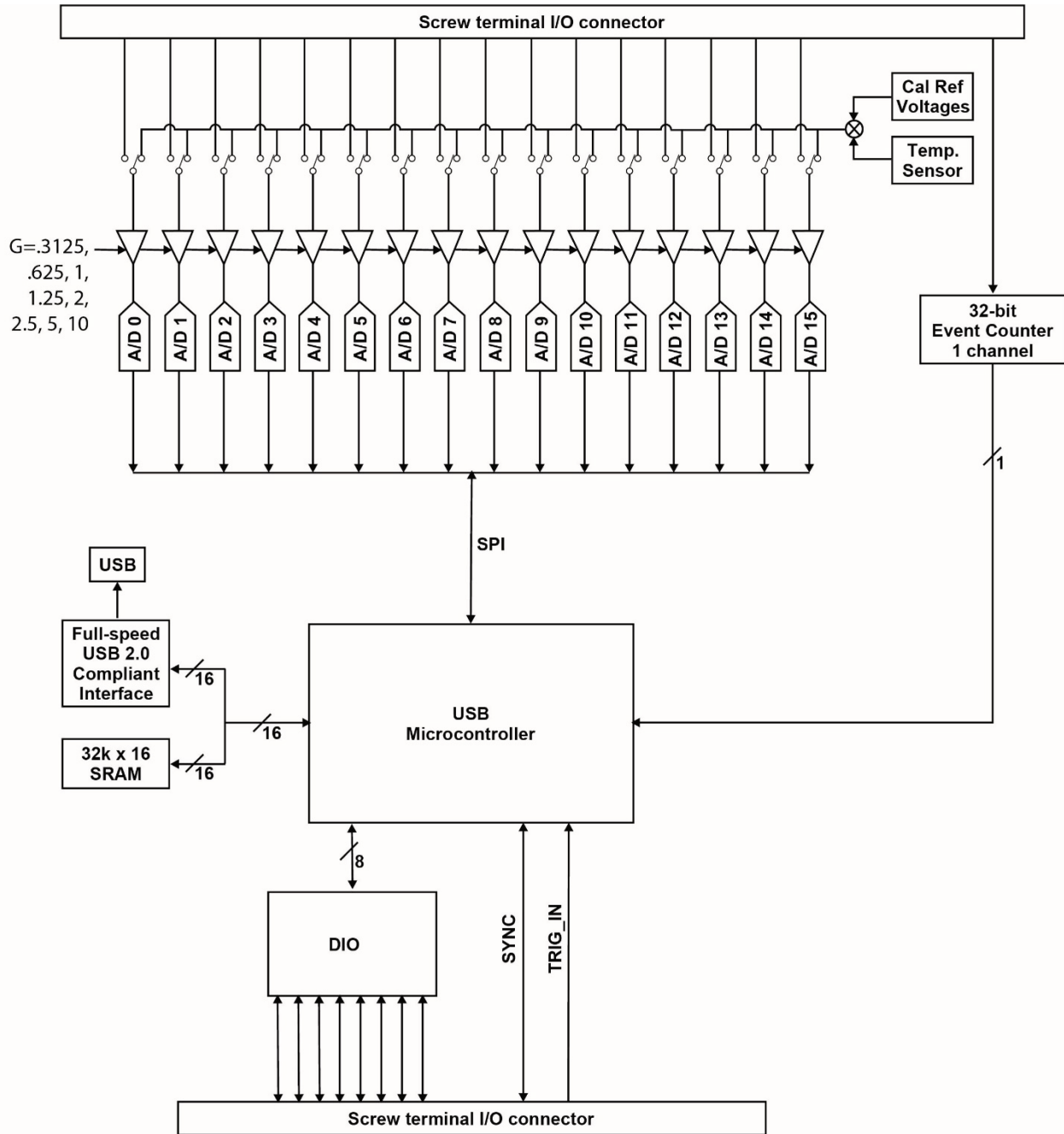USB-1616FS-Plus functions are illustrated in the block diagram shown here.

Figure 1. USB-1616FS-Plus functional block diagram

Installing the USB-1616FS-Plus

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.

Installing the software

Refer to the MCC DAQ Quick Start and the USB-1616FS-Plus product page on our website for information about the available software.

> **Install the software before you install your device**
>
> The driver needed to run the USB-1616FS-Plus 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

Before you connect the USB-1616FS-Plus to your computer, connect the external power supply that was shipped with the device.

You can connect up to four MCC USB Series devices in a daisy chain configuration to a single USB 2.0 port on your computer. If your system has a USB 1.1 port, you can connect up to two MCC USB Series devices.

Connecting the external power supply

Power to the USB-1616FS-Plus is provided with the +9 V external power supply (CB-PWR-9V3A). Connect the external power supply *before* connecting the USB cable to the USB-1616FS-Plus and to the computer.

Complete the following steps to connect the power supply to the USB-1616FS-Plus:

1. Connect the external power cord to the **POWER IN** connector on the rear of the USB-1616FS-Plus enclosure. This connector is labeled **IN** on the board.

2. Plug the power supply into a power outlet.

The **PWR** LED is on (green) when +9 V power is supplied to the USB-1616FS-Plus. If the voltage supply is less than +6.0 V or more than +12.5 V, the **PWR** LED is off.

> **Do not connect external power to the POWER OUT connector**
>
> The power connector labeled **POWER OUT** on the enclosure (**OUT** on the board) provides power to an additional MCC USB Series product. If you connect the external power supply to the **POWER OUT** connector, the USB-1616FS-Plus does not receive power, and the **PWR** LED does not turn on.

Connecting the USB-1616FS-Plus

To connect the USB-1616FS-Plus to your system, do the following.

1. Connect the USB cable that was shipped with the device to the USB connector labeled **USB IN** on the USB-1616FS-Plus.

   The USB cable supplied with the USB-1616FS-Plus has a higher gauge wire than generic USB cables, and is required for proper enumeration of the USB-1616FS-Plus.

2. Connect the other end of the USB cable to a USB port on your computer or to an external USB hub that is connected to your computer. The **PWR LED** turns on (green). The USB cable provides power and communication to the USB-1616FS-Plus.

When you connect the device for the first time, a **Found New Hardware** dialog opens as the device is detected. This is normal. After the device is installed its LED will blink and then remain on. This indicates that communication is established between the USB-1616FS-Plus and your computer.

If you connect the device to a USB 1.1 port, a message may display indicating "**Your USB device can perform faster if you connect to a USB 2.0 port**." You can ignore this message. The USB-1616FS-Plus functions properly when connected to a USB 1.1 port, although USB bandwidth is limited.

If the USB LED turns off

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

If your system does not detect the USB-1616FS-Plus

If a "**USB device not recognized**" message appears when you connect the USB-1616FS-Plus, perform the following procedure.

1. Unplug the USB cable from the USB-1616FS-Plus.
2. Unplug the external power cord from the **POWER IN** connector on the enclosure.
3. Plug the external power cord back into the **POWER IN** connector.
4. Plug the USB cable back into the device.

Your system should now properly detect the USB-1616FS-Plus hardware. Contact technical support if your system still does not detect the device.

Functional Details

Analog input acquisition modes

The USB-1616FS-Plus can acquire analog input data in three basic modes – software paced, continuous scan, and burst scan.

Software paced

With software paced mode you acquire one analog sample at a time. You initiate the A/D conversion by calling 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 from one channel.

The maximum throughput sample rate in software paced mode is about 250 S/s, but may vary depending on your system.

Hardware paced

With hardware paced mode you acquire data from up to 16 channels simultaneously. The analog data is continuously acquired, converted to digital values, and written to the device on-board FIFO buffer 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.

You can acquire data with the USB-1616FS-Plus from one channel at 100 kS/s and up to 16 channels at about 30 kS/s each. You can start a continuous scan with either a software command or with an external hardware trigger event.

Burst scan

With burst scan mode (BURSTIO), you can acquire data using the full capacity of its 32 k sample FIFO on the device. The acquired data is then read from the FIFO and transferred to a user memory buffer on the computer. You can initiate a single acquisition sequence for any number of input channels by either a software command or an external hardware trigger.

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, where the total acquisition rate for all channels is 1.6 MS/s divided by the number of channels. The maximum rate for each channel is 100 kS/s.

Board components

Major components on the USB-1616FS-Plus are shown in Figure 2.

- Two (2) USB connectors
- Two (2) external power connectors
- USB LED
- PWR LED
- Four (4) Screw terminal banks
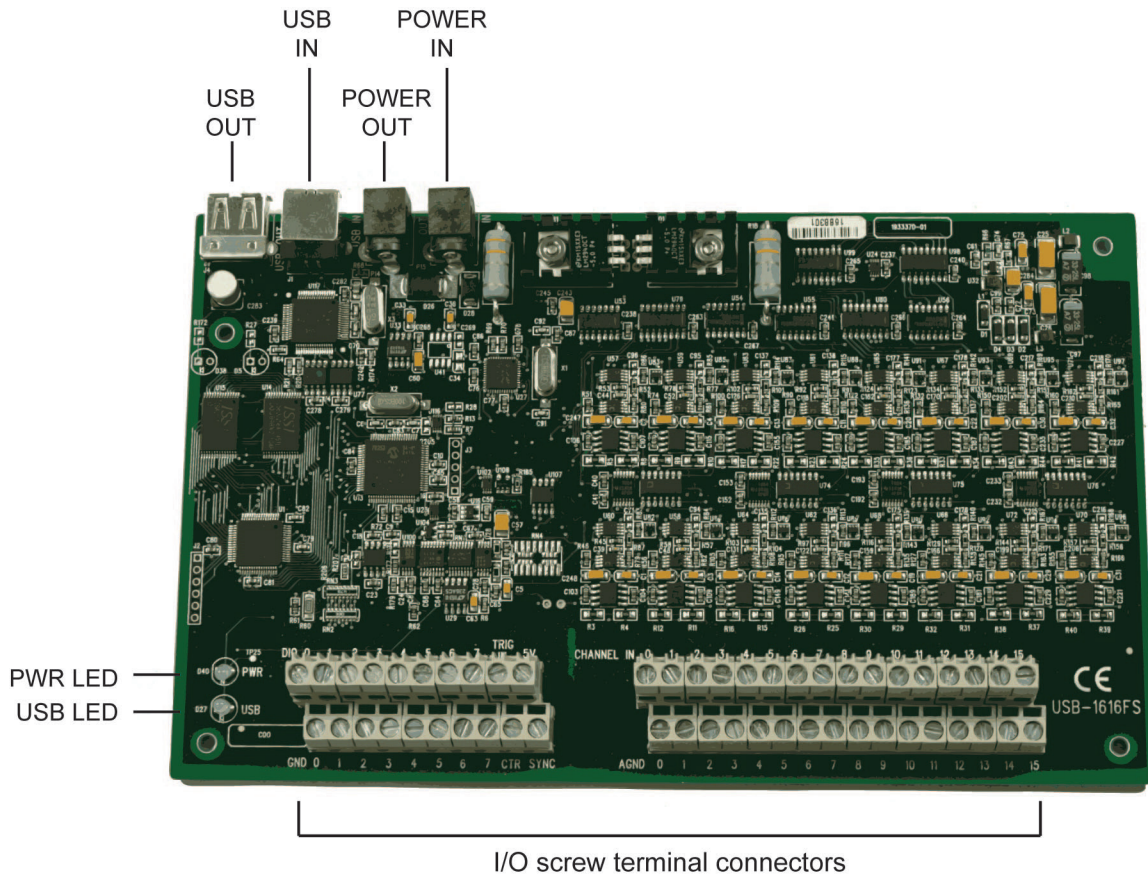
Figure 2. USB-1616FS-Plus internal components

USB OUT connector

The **USB OUT** connector is a downstream hub output port intended for use with other MCC USB Series products only. The USB hub is self-powered, and can provide 100 mA maximum current at 5 V. The USB out connector is labeled USB OUT on the enclosure and on the board.

For information on daisy chaining to other MCC USB Series products, refer to

USB IN connector

Connect the **USB IN** connector to the USB port on your computer (or USB hub connected to your computer). The USB in connector is labeled **USB IN** on the enclosure and on the board.

External power connectors

The USB-1616FS-Plus has two external power connectors labeled **POWER IN** and **POWER OUT** on the enclosure. The **POWER IN** connector is labeled **IN** on the board, and the **POWER OUT** connector is labeled **OUT** on the board.

To supply external power, connect the **POWER IN** connector to the supplied +9 V external power supply (CB-PWR-9V3A).

The **POWER OUT** connector lets you power additional daisy chained MCC USB Series devices from a single external power supply. The C-MAPWR-x cable is available from MCC to connect additional MCC USB Series devices.

USB LED

The **USB** LED indicates the communication status of the USB-1616FS-Plus. This LED uses up to 5 mA of current and cannot be disabled. The table below explains the behavior of the USB LED.

USB LED Illumination

USB LED	Indication
Steady green	The USB-1616FS-Plus is connected to a computer or external USB hub.
Blinks continuously	Initial communication is established between the USB-1616FS-Plus and the computer, or data is being transferred.

PWR LED

An on-board voltage supervisory circuit monitors the USB VBUS (5V) and the external 9 V power supply. If the input voltage falls outside of the specified ranges the **PWR** LED shuts off; refer to the following table.

PWR LED Illumination

PWR LED state	Indication
On - steady green	USB +5 V power or +9 V external power is supplied to the device.
Off	Input power is not supplied, or a power fault has occurred. A power fault occurs when the input power falls outside of the specified voltage range: ■ USB VBUS (+5 V): 4.75 V to 5.25 V ■ External power: (+9 V): 6.0 V to 12.5 V

Screw terminals

The device has two rows of screw terminals. Each row has 26 connections. Signal labels are shown in Figure 3.
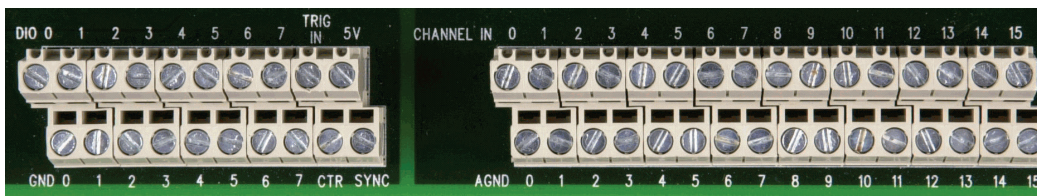
Figure 3. USB-1616FS-Plus screw terminals

The screw terminals provide the following connections:

- eight digital I/O terminals (**DIO 0** to **DIO 7**)
- one external digital trigger terminal (**TRIG IN**)
- one power terminal (**5V**)
- eight ground terminals (**GND 0** to **7**)
- one external event counter terminal (**CTR**)
- one terminal for external clocking and multi-unit synchronization (**SYNC**)
- 16 analog input terminals (**CHANNEL IN 0 to 15**)
- 16 analog ground terminals (**AGND 0 to 15**)

Use 14 AWG to 30 AWG wire for your signal connections.

Caution! Keep the length of stripped wire at a minimum to avoid a short to the enclosure! When connecting your field wiring to the screw terminals, use the strip gage on the terminal strip, or strip to 5.5 mm to 7.0 mm (0.215 in. to 0.275in.) long.

Each screw terminal is identified with a label on the board and on the underside of the enclosure lid. Refer to the table below for the signal name associated with each board label.

Board labels and associated signal names

Board label		Signal name	Board label		Signal name
DIO	0	DIO 0	GND	0	GND 0
	1	DIO 1		1	GND 1
	2	DIO 2		2	GND 2
	3	DIO 3		3	GND 3
	4	DIO 4		4	GND 4
	5	DIO 5		5	GND 5
	6	DIO 6		6	GND 6
	7	DIO 7		7	GND 7
TRIG IN		TRIG IN	CTR		CTR
5V		5V	SYNC		SYNC
CHANNEL IN	0	CH 0	AGND	0	AGND 0
	1	CH 1		1	AGND 1
	2	CH 2		2	AGND 2
	3	CH 3		3	AGND 3
	4	CH 3		4	AGND 4
	5	CH 4		5	AGND 5
	6	CH 5		6	AGND 6
	7	CH 6		7	AGND 7
	8	CH 8		8	AGND 8
	9	CH 9		9	AGND 9
	10	CH 10		10	AGND 10
	11	CH 11		11	AGND 11
	12	CH 12		12	AGND 12
	13	CH 13		13	AGND 13
	14	CH 14		14	AGND 14
	15	CH 15		15	AGND 15

Signal connections

Analog inputs

You can connect up to 16 analog input connections (**CH0 IN** through **CH15 IN**) to the screw terminals labeled **Channel IN 0-15**. We recommend that you connect unused analog input terminals to ground terminals during operation. For example, if you are not using **CH7 IN**, connect this terminal to **AGND 7**.

The analog input channels are configured for single-ended input mode. Each analog signal is referenced to signal ground (AGND), and requires two wires:

- 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, ±2.5 V, ±2.0 V, ±1.25 V, ±1.0 V, ±0.625 V, and ±0.3125 V.

For more information about analog signal connections

For general information about single-ended inputs, refer to the *Guide to DAQ Signal Connections* (available on our web site at www.mccdaq.com/support/DAQ-Signal-Connections.aspx).

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 16 unique elements. The channel list must be contiguous channels in increasing order. An example of an 8-element list is shown in the following table.

Sample channel-gain queue list

Element	Channel	Range
0	CH0	BIP10V
1	CH1	BIP5V
2	CH2	BIP10V
3	CH3	BIP1V
4	CH4	BIP2V
5	CH5	BIP10V
6	CH6	BIP1V
7	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 the screw terminals labeled **DIO 0** to **DIO 7**. 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 4.
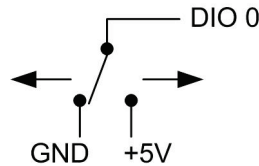
Figure 4. Schematic showing switch detection by digital channel DIO0

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

Pull-up/down configuration

All digital I/O lines are pulled up by default to USB +5V with a 47 kΩ resistor. To configure for pull-down, the board must be modified at the factory.

For more information on digital signal connections

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

Counter input

The CTR terminal (**CTR**) is a TTL level input to a 32-bit event counter. The internal counter increments when the TTL level transitions from low to high. The counter can count frequencies of up to 1 MHz.

Trigger input

The trigger terminal (**TRIG IN**) is an external digital trigger input. You can configure this terminal with software for either rising (default) or falling edge.

SYNC I/O

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

- Configure as an external clock input to externally clock the A/D conversions. The **SYNC** terminal supports TTL-level input signals.
- Configure as an output to synchronize with a second USB-1616FS-Plus and acquire data from 32 channels. For more information about synchronized operations, refer to page 18.

Power output

The **+5V** terminal (labeled **5V**) draws power from either the USB connector VBUS terminal or the external power supply.

Caution! The +5V terminal is an output. Do not connect to an external power supply or you may damage the USB-1616FS-Plus and possibly the computer.

The maximum amount of +5 V current from the +5 V terminal is limited to 50 mA.

Ground terminals

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, sync and power terminals.

Daisy chaining additional devices

Daisy chained MCC USB Series products connect to the USB bus through the high-speed hub on the USB-1616FS-Plus. You can daisy chain a maximum of four MCC USB Series products to a single USB 2.0 port on your computer, or a maximum of two devices to a single USB 1.1 port. Use the supplied cable or an equivalent cable for daisy chaining to additional MCC USB Series products.

MCC USB Series products are USB 2.0 full-speed devices that provide a signaling bit rate of 12 Mb/s. The throughput rate is shared by all devices connected to the USB bus.

Complete the following steps to daisy-chain two or more USB-1616FS-Plus devices. This procedure assumes you already have one USB-1616FS-Plus connected to a computer and to the external power source. The USB-1616FS-Plus already connected to the computer is referred to as the *connected device*. The USB-1616FS-Plus you want to daisy-chain to the connected device is referred to as the *new device*.

1. Connect the **Power OUT** connector on the connected device to the **POWER IN** connector on the new device.
2. Connect the **USB OUT** connector on the connected device to the **USB IN** connector on the new device.
3. For each additional device you want to add, repeat steps 1-2, with the device you just daisy chained now being the *connected device*.

Sample rate limitations

The maximum sample rate when using multiple USB-1616FS-Plus boards is system-dependent. Multiple board performance is limited by an overall aggregate sample rate. The maximum throughput is in number of samples taken per second. The rate is irrespective of the number of channels sampled or the number of boards installed. The maximum sample rate of any one channel is limited to 100 KS/s. Benchmark performance rates are listed in the *Specifications* chapter on page 20.

Power limitations

When daisy chaining additional MCC USB Series products to the USB-1616FS-Plus, you must ensure that you provide adequate power to each board that you connect. The USB-1616FS-Plus is powered with a 9 VDC nominal, 3.0 A external power supply.

Voltage drop

A drop in voltage occurs with each board connected in a daisy chain system. The voltage drop between the power supply input and the daisy chain output is 0.5 V maximum. Factor in this voltage drop when you configure a daisy chain system to ensure that at least 6.0 VDC is provided to the last board in the chain.

Accuracy

The overall accuracy of any instrument is limited by the error components within the system. Quite often, resolution is incorrectly used to quantify the performance of a measurement product. While "16-bits" or "1 part in 65,536" indicates what can be resolved, it provides little insight into the quality, or accuracy, of an absolute measurement. Accuracy specifications describe the actual measurement that can be relied upon with a USB-1616FS-Plus.

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

▪ offset
▪ gain
▪ nonlinearity

The primary error sources in the USB-1616FS-Plus are offset and gain. Nonlinearity is small in the USB-1616FS-Plus, and is not significant as an error source with respect to offset and gain.

Figure 5 shows an ideal, error-free, USB-1616FS-Plus transfer function. The typical calibrated accuracy of the USB-1616FS-Plus is range-dependent, as explained in the "Usage note" in the Specifications chapter. We use a ±10V range as an example of what you can expect when performing a measurement in this range.

The accuracy plot in Figure 5 is drawn for clarity and is not drawn to scale.
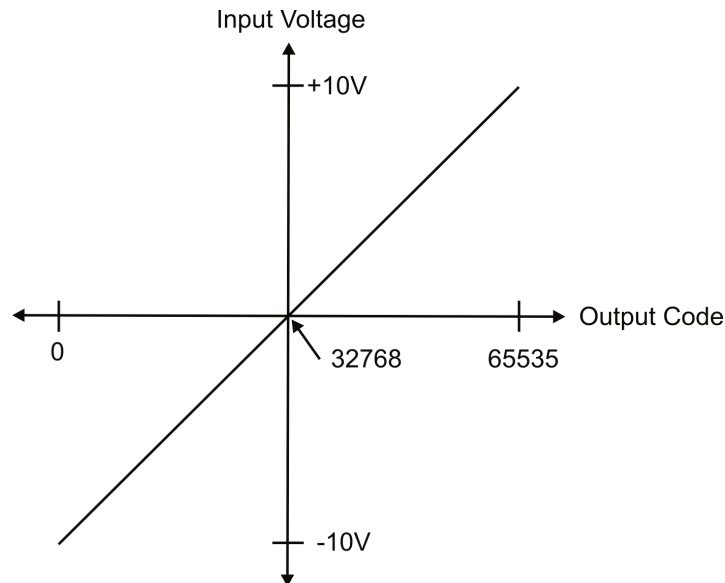
Figure 5. Ideal USB-1616FS-Plus transfer function

The USB-1616FS-Plus 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 6 shows the USB-1616FS-Plus transfer function with an offset error. The typical offset error specification for the USB-1616FS-Plus on the ±10 V range is ±2.25 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 6 are drawn for clarity and are not drawn to scale.
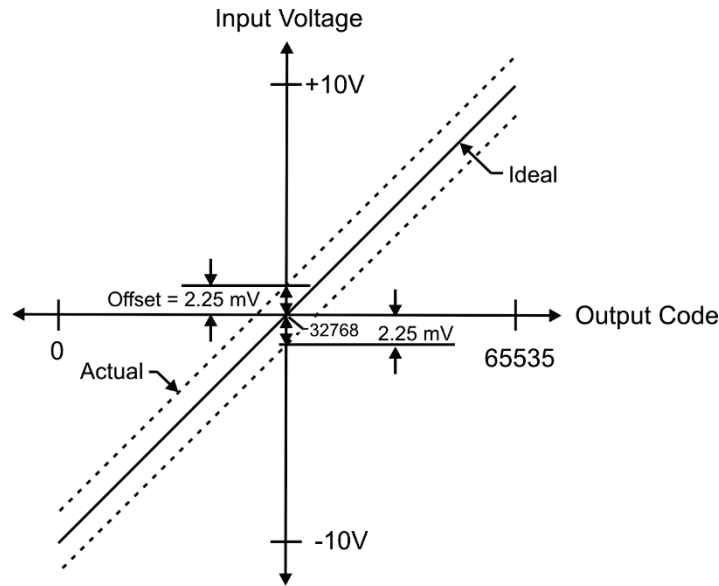
Figure 6. USB-1616FS-Plus transfer function with offset error

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 7 shows the USB-1616FS-Plus transfer 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 7 are drawn for clarity and are not drawn to scale.
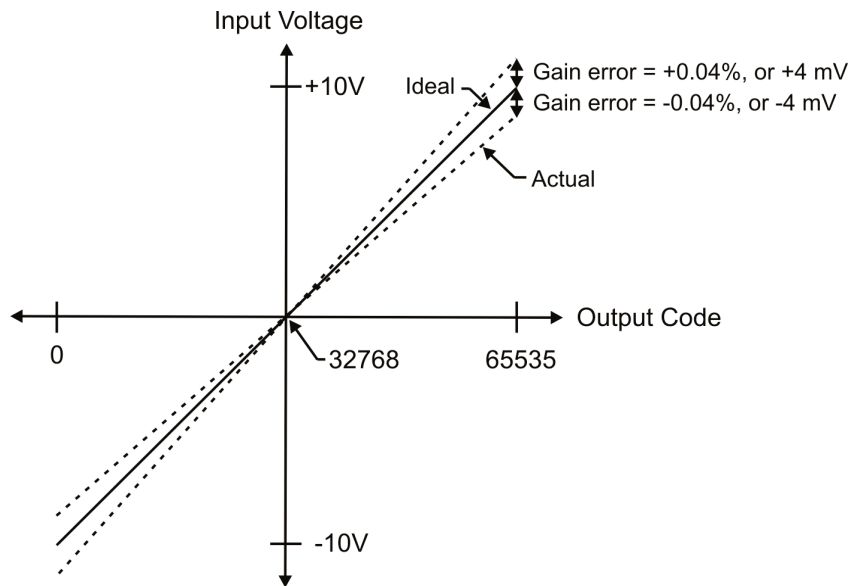
Figure 7. USB-1616FS-Plus transfer function with gain error

For example, the USB-1616FS-Plus exhibits a typical calibrated gain error of ±0.04% on all ranges. For the ±10 V range, this would yield 10 V × ±0.0004 = ±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 8, we have a plot of the error band of the USB-1616FS-Plus at ±full scale (±10 V). This plot is a graphical version of the typical accuracy specification of the product.

The accuracy plots in Figure 8 are drawn for clarity and are not drawn to scale.
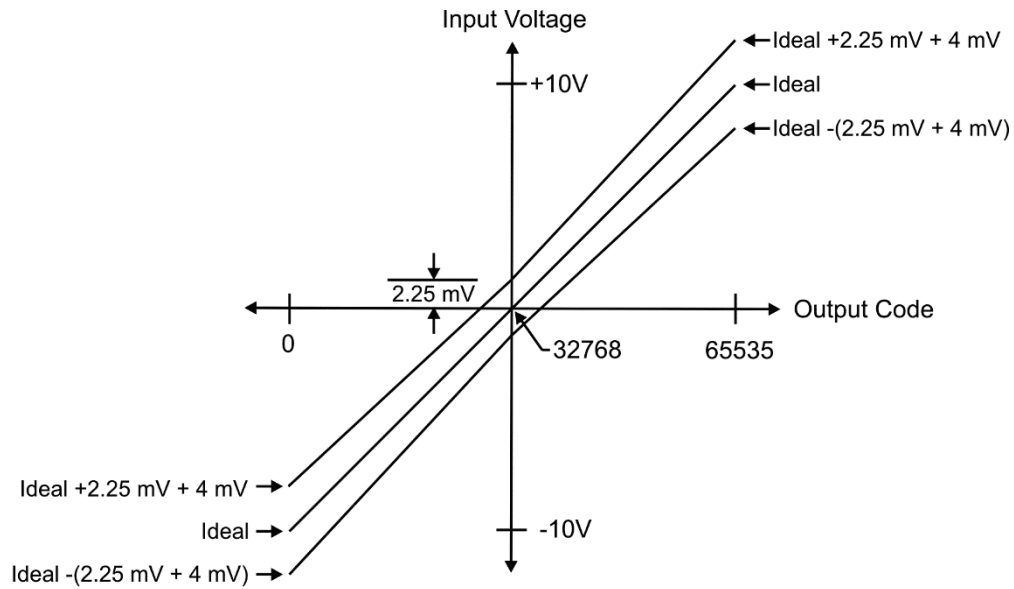
Figure 8. USB-1616FS-Plus error band plot

Synchronized operations

You can connect up to four USB-1616FS-Plus devices to one USB 2.0 port. You can connect up to two devices to a USB 1.1 port.

You can connect the SYNC pin of two USB-1616FS-Plus units together in a master/slave configuration and acquire data synchronously from 32 channels. When the SYNC pin is configured as an output, the internal A/D pacer clock signal is present at the screw terminal. You can output the A/D pacer clock to the SYNC pin of a second USB-1616FS-Plus configured for A/D pacer input.

Mechanical drawings

Figure 9. USB-1616FS-Plus circuit board dimensions
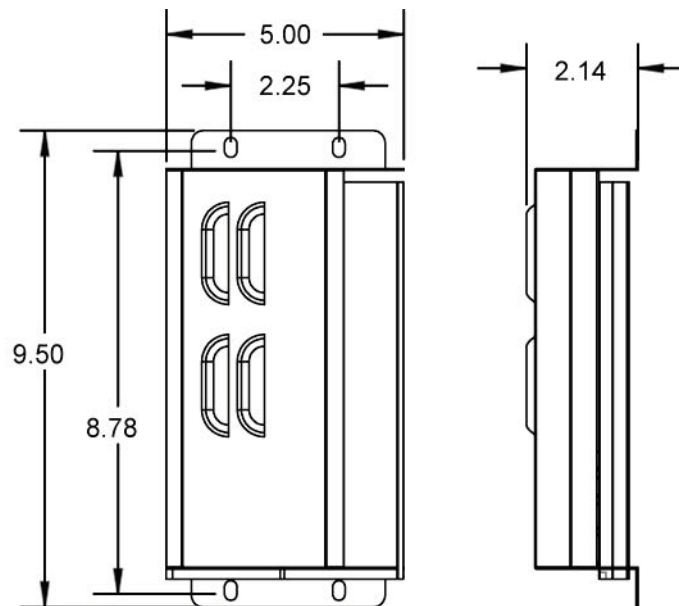
Figure 10. USB-1616FS-Plus enclosure dimensions

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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. Analog input specifications

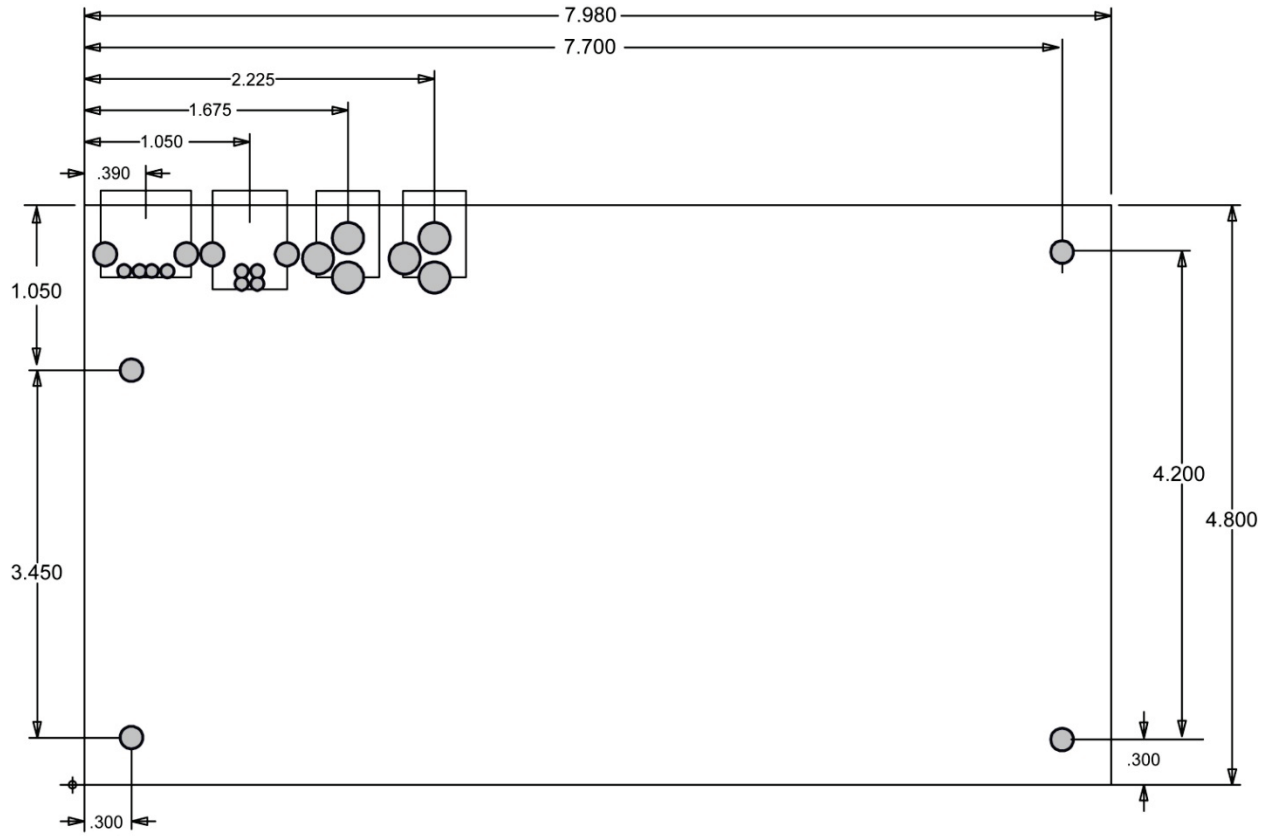| Parameter	Conditions	Specification
A/D converters		16-bit, SAR type
Number of channels		16 single-ended
Input configuration		Individual A/D per channel
Sampling method		Simultaneous
Absolute maximum input voltage	CHx IN to GND	±15 V max
Input impedance		100 MΩ, min
Input bandwidth (–3 dB)		170 kHz typ
Input leakage current		±1 µA typ
Input capacitance		50 pf typ
Offset temperature drift		15 ppm/°C typ
Gain temperature drift	All ranges	35 ppm/°C typ
Input ranges	Software selectable	±10 V, ±5 V, ±2.5 V, ±2 V, ±1.25 V, ±1 V, ±0.625 V, ±0.3125 V
Sample rate	Hardware paced	0.018 S/s to 100 kS/s per channel, software programmable
	Burst scan to 32 kilosample FIFO	0.018 S/s to 100 kS/s per channel, software programmable
Throughput	Software paced	30 S/s to 500 S/s all channels; system dependent
	Hardware paced	Max of 500 kS/s aggregate sample rate (# of channels * per channel rate)
	Burst scan to 32 k sample FIFO	Max of 16 * 100 kS/s
Gain queue		Software configurable. Up to 16 elements – one gain element per unique, ordered channel.
Resolution		16 bits
No missing codes		15 bits
Crosstalk	DC – 25 kHz (sine)	–80 dB min
Trigger source	Software selectable	External digital: TRIG_IN

Table 2. Calibrated absolute accuracy specifications

Range (V)	Accuracy (mV)
±10	±6.25
±5	±3.15
±2.5	±1.55
±2	±1.35
±1.25	±1.02
±1	±0.90
±0.625	±0.75
±0.3125	±0.62

Table 3. Accuracy components specifications – all values are (±)

Range (V)	% of Reading	Gain Error at FS (mV)	Offset (mV)
±10	0.04	4.000	2.25
±5	0.04	2.000	1.15
±2.5	0.04	1.000	0.55
±2	0.04	0.800	0.55
±1.25	0.04	0.500	0.52
±1	0.04	0.400	0.50
±0.625	0.04	0.250	0.50
±0.3125	0.04	0.125	0.50

Table 4. Noise performance specifications

Range (V)	Typical Counts	LSBrms
±10	10	1.52
±5	10	1.52
±2.5	10	1.52
±2	11	1.67
±1.25	12	1.81
±1	14	2.12
±0.625	20	3.03
±0.3125	38	5.75

Noise distribution is determined by gathering 50 kilosamples with analog inputs tied to ground (AGND) at the user connector. Samples are gathered at the maximum specified sample rate of 100 kS/s.

Analog input calibration

Table 5. Analog input calibration specifications

Parameter	Specification
Recommended warm-up time	30 minutes min
Calibration method	Factory
Calibration interval	1 year (factory calibration)

Digital input/output

Table 6. Digital I/O specifications

Parameter	Specification
Digital type	5 V TTL input / CMOS output
Number of I/O	8 (DIO0 through DIO7)
Configuration	Independently configured for input or output
Digital I/O transfer rate (software paced)	System dependent, 33 port reads to 1000 port reads/writes or single bit reads/writes per second, typ
Input high voltage	2.0 V min, 5.5 V absolute max
Input low voltage	0.8 V max, –0.5 V absolute 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

Parameter	Specification
Pull up/pull-down configuration	All pins are configurable via jumper W1 to 5 V or ground via 47 kΩ resistors

External trigger

Table 7. External trigger specifications

Parameter	Conditions	Specification
Trigger source	External digital	TRIG_IN
Trigger mode	Software selectable	Edge sensitive: user configurable for CMOS compatible rising (default) or falling edge
Trigger latency		2 μs max
Trigger pulse width		1 μs min
Input type		Schmitt trigger, 47 kΩ pull-down to ground and 1.5 kΩ series resistor
Schmitt trigger hysteresis		0.6 V min 1.5 V max
Input high voltage threshold		3.1 V max
Input low voltage threshold		1.0 V min

External clock input/output

Table 8. External clock I/O specifications

Parameter	Conditions	Specification
Pin name		SYNC
Pin type		Bidirectional
Software selectable direction	Output	Outputs the internal A/D pacer clock
	Input	Receives the A/D pacer clock from an external source; rising edge sensitive
Input clock rate		100 kHz, max
Clock pulse width	Input	1 μs min
	Output	5 μs min
Input type		Schmitt trigger
Input / output resistance		200 Ω series resistor on output driver 1.5 kΩ series resistor on input buffer 47 kΩ pull-down resistor to ground
Schmitt trigger hysteresis		0.6 V min 1.5 V max
Input high voltage threshold		3.1 V max
Input low voltage threshold		1.0 V min
Output high voltage	IOH = –8 mA	3.8 V min
	No load	4.4 V min
Output low voltage	IOH = 8 mA	0.44 V max
	No load	0.1 V max

Counter

Table 9. Counter specifications

Parameter	Specification
Pin name	CTR
Counter type	Event counter
Number of channels	1
Resolution	32 bits
Maximum input frequency	10 MHz
High pulse width	50 ns min
Low pulse width	50 ns min
Counter/timer read/write rates; software paced	Counter read: system dependent, 33 reads to 1,000 reads per second Counter clear: system dependent, 33 reads to 1,000 writes per second
Input low voltage limit	0 V recommended min −0.5 V absolute min
Input high voltage limit	5.0 V recommended max 5.5 V absolute max
Input type	Schmitt trigger, rising edge triggered, 1.5 kΩ series resistor, 47 kΩ pull-down to ground
Schmitt trigger hysteresis	0.6 V min 1.5 V max
Input high voltage threshold	3.1 V max
Input low voltage threshold	1.0 V min

Memory

Table 10. Memory specifications

Parameter	Specification
Data FIFO	32,768 samples, 65,536 bytes
EEPROM	4,096 bytes

Indicator LEDs

Table 11. Indicator LED specifications

Parameter	Specification
Power LED (top)	On when the device microcontroller has power and is configured. Both LEDs blink together in firmware update
Status LED	On when USB connected; blinks to indicate USB communications.

Power

Table 12. Power specifications

Parameter	Conditions	Specification
Supply current (Note 1)	Continuous mode	350 mA typ
User +5V output voltage range (Note 2)	Available at the 5V screw terminal	4.0 V min, 5.25 V max
User +5V output current (Note 3)	Available at the 5V screw terminal	50 mA max

Note 1: The total current requirement for the device.

Note 2: Output voltage range assumes input power supply voltage is within specified limits

Note 3: The total amount of current that can be sourced from the 5V screw terminal for general use.

External power input

Table 13. External power input specifications

Parameter	Conditions	Specification
External power input		+6.0 VDC to 12.5 VDC 9 VDC power supply included
Voltage supervisor limits – PWR LED (Note 4)	6.0 V > Vext or Vext > 12.5 V	PWR LED = Off (power fault)
	6.0 V < Vext < 12.5 V	PWR LED = On
External power adapter (included)	MCC p/n CB-PWR-9V3A	+9 V ±10%, @ 3 A

Note 4: A voltage supervisory circuit monitors the external +9 V power supply voltage. If this power supply exceeds its specified limit, the PWR LED will turn off indicating a power fault condition.

External power output

Table 14. External power output specifications

Parameter	Conditions	Specification
External power output – current range (Note 5)		4.0 A max
External power output	Voltage drop between power input and daisy chain power output	0.5 V max
Compatible cable(s) for daisy chain	C-MAPWR-x	x = 2, 3 or 6 feet

Note 5: The daisy chain power output option allows multiple MCC USB products to be powered from a single external power source in a daisy chain fashion. The voltage drop between the device power supply input and the daisy chain output is 0.5 V max. Users must plan for this drop to ensure that the last device in the chain will receive at least 6.0 VDC.

USB specifications

Table 15. USB specifications

Parameter	Specification
USB "B" connector	Input
USB device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0, USB 3.0
USB "A" connector	Downstream hub output port
USB hub type	Supports USB 2.0 high-speed, full-speed, and low-speed operating points
	Self-powered, 500 mA max downstream VBUS capability
Compatible products	MCC USB Series devices
USB cable type (upstream and downstream)	A-B cable, UL type AWM 2527 or equivalent (min 24 AWG VBUS/GND, min 28 AWG D+/D–)
USB cable length	3 meters, max (9.84 feet)

Environmental

Table 16. Environmental specifications

Parameter	Specification
Operating temperature range	0 ° C to 70 ° C
Storage temperature range	–40 ° C to 85 ° C
Humidity	0% to 90% non-condensing

Mechanical

Table 17. Mechanical specifications

Parameter	Specification
Card dimensions (L × W × H)	203.2 × 121.9 × 20.0 mm (8.0 × 4.8 × 0.8 in.)
Enclosure dimensions (L × W × H)	241.3 × 125.7 × 58.9 mm (9.50 × 4.95 × 2.32 in.)

Screw terminals

Table 18. Screw terminal specifications

Parameter	Specification
Connector type	Screw terminal
Wire gauge range	14 AWG to 30 AWG

Table 19. Screw terminal pinout

Board label		Signal name	Board label		Signal name
DIO	0	DIO 0	GND	0	GND 0
	1	DIO 1		1	GND 1
	2	DIO 2		2	GND 2
	3	DIO 3		3	GND 3
	4	DIO 4		4	GND 4
	5	DIO 5		5	GND 5
	6	DIO 6		6	GND 6
	7	DIO 7		7	GND 7
TRIG IN		TRIG IN	CTR		CTR
5V		5V	SYNC		SYNC
CHANNEL IN	0	CH 0	AGND	0	AGND 0
	1	CH 1		1	AGND 1
	2	CH 2		2	AGND 2
	3	CH 3		3	AGND 3
	4	CH 3		4	AGND 4
	5	CH 4		5	AGND 5
	6	CH 5		6	AGND 6
	7	CH 6		7	AGND 7
	8	CH 8		8	AGND 8
	9	CH 9		9	AGND 9
	10	CH 10		10	AGND 10
	11	CH 11		11	AGND 11
	12	CH 12		12	AGND 12
	13	CH 13		13	AGND 13
	14	CH 14		14	AGND 14
	15	CH 15		15	AGND 15

$C \in$ **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 13, 2016, Norton, Massachusetts USA
Test Report Number:	EMI4133.05 and Addendum

Measurement Computing Corporation declares under sole responsibility that the product

USB-1616FS-Plus

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)
- EN 61000-4-4 :2012 (IEC61000-4-4:2012)
- EN 61000-4-5 :2014 (IEC61000-4-5:2014)
- EN 61000-4-6 :2013 (IEC61000-4-6:2013)
- EN 61000-4-11:2004 (IEC61000-4-11:2004)

Safety:

- EN 61010-1 (IEC 61010-1)

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

Carl Haapaoja, Director of Quality Assurance