USB-1608FS Series

16-Bit, Simultaneous Sampling, Multifunction DAQ

The USB-1608FS-Plus offers 8 simultaneous analog inputs at up to 100 kS/s per channel (400 kS/s overall), 8 digital I/O, and one event counter input.

Features

- Eight 16-bit single-ended analog inputs
- Simultaneous sampling
- 400 kS/s overall throughput (100 kS/s max for any channel)
- Eight digital I/O and one event counter
- External clock I/O and external digital trigger input
- Available with enclosure and as a board-only OEM version
- **Supported Operating Systems**
- Windows® 10/8/7/Vista®/XP 32/64-bit
- Android™
- Linux®

Overview

USB-1608FS Series devices are low-cost, analog input and digital I/O USB devices. All devices in this series can acquire data from up to eight 16-bit single-ended (SE) analog inputs simultaneously. These devices also offer eight digital I/O channels, an external digital trigger input, an event counter, a bidirectional external clock, and a channel-gain queue feature for configuring a list of channels and gains for each scan.

USB-1608FS Series Selection Chart

Specification	USB-1608FS	USB-1608FS-Plus, USB-1608FS-Plus-OEM†
Analog Input	8 Single-ended	8 Single-ended
Sample Rate	(100 kS/s)/(# of channels); 50 kS/s max for any channel	(400 kS/s)/(# of channels); 100 kS/s max for any channel
Channel-Gain Queue	Up to 8 unique, consecutive elements	Up to 8 unique, ordered elements; consecutive not required
Digital Output Current	±2.5 mA per pin	±24 mA per pin
Calibration	Factory and field calibration	Factory calibration only
External Clock Input	50 kHz max	100 kHz max
Trigger Sensitivity	Edge sensitive	Edge or level sensitive
Event Counter	One 32-bit; 1 MHz input frequency max	One 32-bit; 1 MHz input frequency max
DAQami Support	✔	✔
UL for Android Support	✔	✔
Linux Support	✔	✔
MATLab® Support	✔	✔

† The USB-1608FS-Plus-OEM provides header connectors instead of screw terminals for signal I/O.

Analog Input

All USB-1608FS Series devices have a dedicated A/D converter per analog channel for simultaneous sampling. The devices offer software-selectable analog input ranges for ±10 V, ±5 V, ±2 V, and ±1 V.

Sample Rate

USB-1608FS Series devices offer the following sample rates when scanning continuously to computer memory (hardware-paced mode):

- USB-1608FS-Plus/USB-1608FS-Plus-OEM - Total rate of 400 kS/s divided by the number of channels sampled; maximum rate of 100 kS/s per channel.
- USB-1608FS - Total rate of 100 kS/s divided by the number of channels sampled; maximum rate of 50 kS/s per channel.

Simultaneous Sampling

In hardware-paced mode, all devices can acquire data from up to eight channels simultaneously. The analog data is continuously acquired, converted to digital values, temporarily stored in the onboard FIFO buffer, and periodically uploaded to the computer.

USB-1608FS Series

General Information

Channel-Gain Queue

The channel-gain queue lets you configure a list of channels and gains for each scan. Each channel can have a different gain setting. 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 for both devices can contain up to eight unique channels.

On the USB-1608FS, the channels must be consecutive and listed in increasing order.

On the USB-1608FS-Plus/USB-1608FS-Plus-OEM, the channels can be non-consecutive, but still must be listed in increasing order.

Digital I/O

Both devices provide eight digital I/O connections. Each digital channel is individually-configurable for input or output. When configured for input, you can use the digital I/O terminals to detect the state of any TTL-level input.

On the USB-1608FS-Plus, the digital I/O channels are high-drive (24 mA) connections.

Pull-Up/Down Configuration

USB-1608FS Series devices have a user-configurable internal jumper to configure the digital bits for pull-up (default) or pull-down.

Counter Input

USB-1608FS Series devices have a 32-bit event counter that can accept a signal up to 1 MHz. The internal counter increments when the TTL levels transition from low to high.

External Clock I/O

Each USB-1608FS Series device has a bidirectional external clock terminal. When configured for input, A/D conversions can be paced by an external source.

The USB-1608FS supports TTL-level input signals up to 50 kHz.

The USB-1608FS-Plus/USB-1608FS-Plus-OEM supports TTL-level input signals up to 100 kHz.

When configured for output, both devices can pace A/D conversions on a second device and acquire data from all input channels simultaneously.

Trigger Input

USB-1608FS Series devices provide an external digital trigger input.

The USB-1608FS trigger mode is edge sensitive and software-selectable for rising or falling edge

The USB-1608FS-Plus/USB-1608FS-Plus-OEM trigger mode is edge or level sensitive. Edge sensitive is software-selectable for rising or falling edge. Level sensitive is software-selectable for high or low level.

Calibration

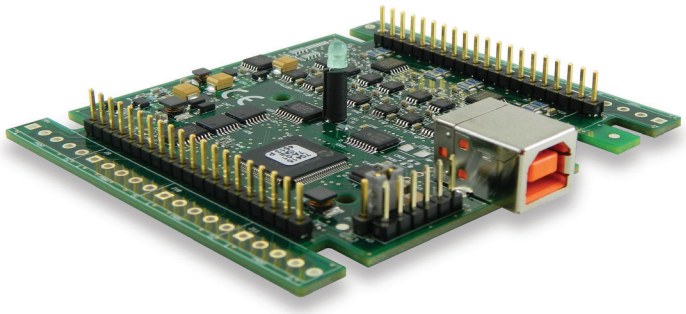
The USB-1608FS supports field calibration with InstaCal. Perform calibration whenever the ambient temperature changes by more than ±10 °C from the last calibration.

The USB-1608FS-Plus/USB-1608FS-Plus-OEM do not support field calibration.

All USB-1608FS Series devices are factory-calibrated. Specifications are guaranteed for one year. For calibration beyond one year, return the device to the factory for recalibration.

USB-1608FS-Plus-OEM Version

The USB-1608FS-Plus-OEM has a board-only form factor with header connectors for OEM and embedded applications (no case, CD, or USB cable included). All devices can be further customized to meet customer needs.



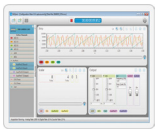
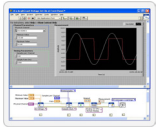
The USB-1608FS-Plus-OEM has the same specifications as the USB-1608FS-Plus, but comes in a board-only form factor with header connectors instead of screw terminals.

USB-1608FS Series

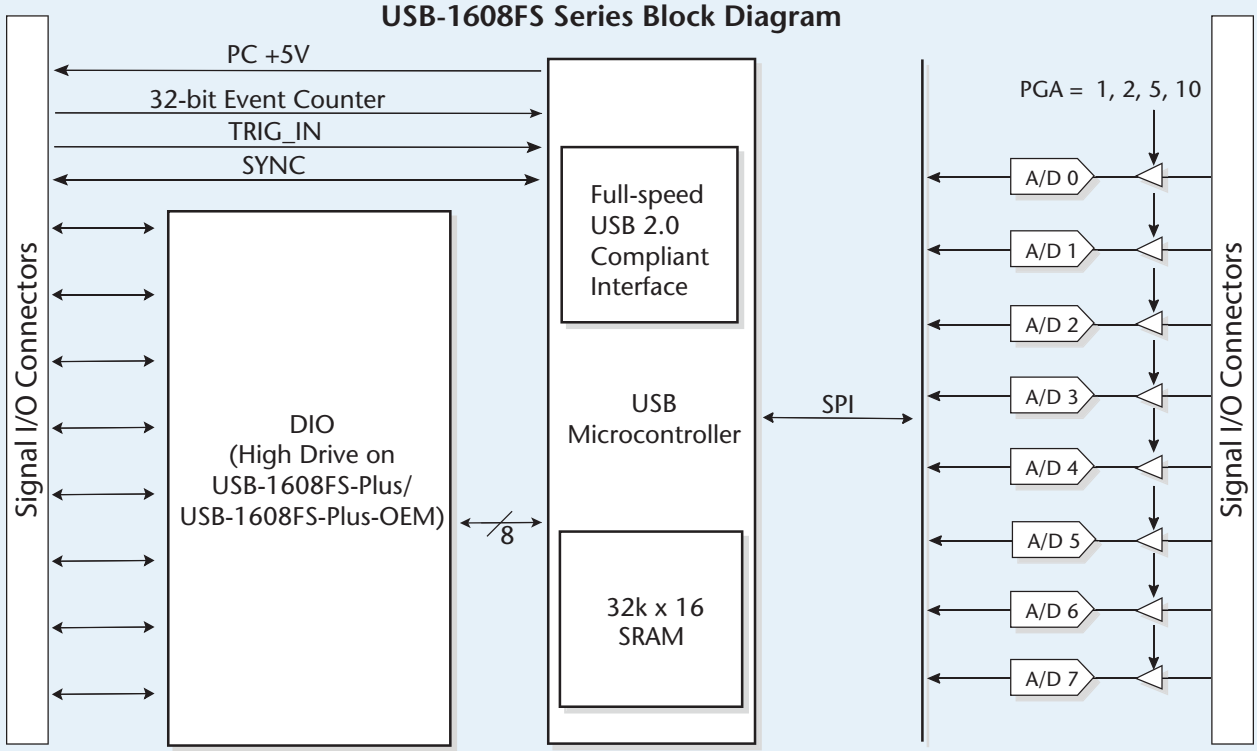
Software

Software Support

USB-1608FS Series devices are supported by the software in the table below.

Ready-to-Run Applications		
DAQami™		Data acquisition companion software with drag-and-drop interface that is used to acquire, view, and log data, and generate signals. DAQami can be configured to log analog, digital, and counter channels, and to view that data in real-time or post-acquisition on user-configurable displays. Logged data can be exported for use in Excel® or MATLAB®. Windows OS DAQami is included with the free MCC DAQ Software bundle (CD/download). Install DAQami and try the fully-functional software for 30 days. After 30 days, all features except for data logging and data export will continue to be available – data logging and data export features can be unlocked by purchasing the software.
InstaCal™		An interactive installation, configuration, and test utility for MCC hardware. Windows OS InstaCal is included with the free MCC DAQ Software bundle (CD/download).
TracerDAQ™ and TracerDAQ Pro		Virtual strip chart, oscilloscope, function generator, and rate generator applications used to generate, acquire, analyze, display, and export data. Supported features may vary by hardware. The Pro version provides enhanced features. Windows OS TracerDAQ is included with the free MCC DAQ Software bundle (CD/download). TracerDAQ Pro is available as a purchased software download.
General-Purpose Programming Support		
Universal Library™ (UL)		Programming library of function calls for C, C++, VB, C# .Net, and VB .Net using Visual Studio and other IDEs. Windows OS The UL is included with the free MCC DAQ Software bundle (CD/download).
UL for Android™		Programming library of Java classes for programmers who develop apps for Android-based tablets and phones. UL for Android communicates with select MCC DAQ devices. Supports Android project development on Windows, Linux, Mac OS X UL for Android is included with the free MCC DAQ Software bundle (CD/download).
Linux® driver		Open-source Linux drivers are available for most MCC devices. Example programs are also provided.
Application-Specific Programming Support		
ULx for NI LabVIEW™		A comprehensive library of VIs and example programs for NI LabVIEW that is used to develop custom applications that interact with most MCC devices. Windows OS ULx for NI LabVIEW is included with the free MCC DAQ Software bundle (CD/download).
DASYLab®		Icon-based data acquisition, graphics, control, and analysis software that allows users to create complex applications in minimal time without text-based programming. Windows OS DASYLab is available as a purchased software download. An evaluation version is available for 28 days.
MATLAB® driver		High-level language and interactive environment for numerical computation, visualization, and programming. The Mathworks Data Acquisition Toolbox™ allows users to acquire data from most MCC PCI and USB devices. Visit www.MathWorks.com for more information about the Data Acquisition Toolbox.

USB-1608FS Series Block Diagram



Specifications

Specifications apply to all USB-1608FS Series devices unless noted otherwise. USB-1608FS-Plus specifications apply to the USB-1608FS-Plus-OEM unless noted otherwise.

Analog Input

A/D converter Type: 16-bit successive approximation type
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: ±10 V, ±5 V, ±2 V, ±1 V; software-selectable per channel
Sample rate (Hardware Paced)
  USB-1608FS: 0.6 S/s to 50 kS/s, software-selectable
  USB-1608FS-Plus: 0.01 S/s to 100 kS/s, software-selectable
Throughput
  Software paced: 500 S/s all channels
  Hardware paced (system-dependent)
    USB-1608FS: (100 kS/s)/(# of channels) max, 50 kS/s max for any channel
    USB-1608FS-Plus: (400 kS/s)/(# of channels) max, 100 kS/s max for any channel
  Burst scan ≤ 32,768 total samples (uses onboard FIFO)
    USB-1608FS: (200 kS/s)/(# of channels) max, 50 kS/s max for any channel
    USB-1608FS-Plus: (800 kS/s)/(# of channels) max, 100 kS/s max for any channel
Gain queue
  USB-1608FS: Up to eight elements; one gain element per unique, consecutive channel; software-selectable
  USB-1608FS-Plus: Up to eight elements; one gain element per unique, ordered channel; software-selectable
  Resolution: 16 bits
No missing codes
  USB-1608FS: 15 bits
  USB-1608FS-Plus: 16 bits
Crosstalk
  Signal DC to 25 kHz: –80 dB
CAL output (USB-1608FS only): 0.625 V, 1.25 V, 2.5 V, 5 V
CAL output accuracy (USB-1608FS only): 0.5% typ, 1.0% max (actual values used for calibration are measured and stored in EEPROM)
CAL current (USB-1608FS Only): ±5 mA max
Trigger source (software-selectable)
  External digital: TRIG_IN

Accuracy

Analog Input DC Voltage Measurement Accuracy

Calibrated Absolute Accuracy	
Range	**Accuracy**
±10 V	5.66 mV
±5 V	2.98 mV
±2 V	1.31 mV
±1 V	0.68 mV

Accuracy Components All values are (±)			
Range	**Gain Error (% of Reading)**	**Gain Error at Full Scale**	**Offset**
±10 V	0.04	4.00 mV	1.66 mV
±5 V	0.04	2.00 mV	0.98 mV
±2 V	0.04	0.80 mV	0.51 mV
±1 V	0.04	0.40 mV	0.28 mV

Noise Performance*		
Range	**Typical Counts**	**Least Significant Bit Root Mean Square (LSB_{RMS})**
±10 V	10	1.52
±5 V	10	1.52
±2 V	11	1.67
±1 V	14	2.12

* Summarizes the noise performance for USB-1608FS Series devices. Noise distribution is determined by gathering 50 kS with inputs tied to ground at the user connector. Samples are gathered at the maximum specified sample rates of 50 kS/s (USB-1608FS) and 100 kS/s (USB-1608FS-Plus).

Digital Input/Output

Digital type
- **USB-1608FS:** CMOS
- **USB-1608FS-Plus:** 5 V 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 5 V via 47 kΩ 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
- **USB-1608FS (IOH = –2.5 mA):** 3.8 V min
- **USB-1608FS-Plus:** 4.4 V min (IOH = –50 µA); 3.76 V min (IOH = –24 mA)

Output low voltage
- **USB-1608FS (IOL = 2.5 mA):** 0.44 V max
- **USB-1608FS-Plus:** 0.1 V max (IOL = 50 µA); 0.44 V max (IOL = 24 mA)

Power on and reset state: Input

External Trigger

Trigger source
- **External digital:** TRIG_IN

Trigger mode (software-selectable)
- **USB-1608FS:** Edge sensitive: user configurable for CMOS compatible rising or falling edge
- **USB-1608FS-Plus:** Edge sensitive or level sensitive: user configurable for CMOS compatible rising or falling edge, high or low level.

Trigger latency
- **USB-1608FS:** 10 µs max
- **USB-1608FS-Plus:** 2 µs + 1 pacer clock cycle max

Trigger pulse width: 1 µs min
Input type: Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input high voltage threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input 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 I/O

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
- **USB-1608FS:** 50 kHz max
- **USB-1608FS-Plus:** 100 kHz max

Clock pulse width
- **Input:** 1 µs min
- **Output**
  - **USB-1608FS:** 5 µs min
  - **USB-1608FS-Plus:** 4 µs min

* **USB-1608FS** hardware revisions E and later may be changed to pull-down using an internal user-configurable jumper. Previous revisions can be configured for pull-down at the factory.

Input clock mode: Edge sensitive, rising edge
Input type: Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input high voltage threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input 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

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, 3.1 V 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

Power

Supply Current
- **USB enumeration:** < 100 mA
- **Including DIO and SYNC output loading:** < 500 mA

+5 V USB power available (connected to externally-powered root port hub or a self-powered hub): 4.5 V min, 5.25 V max
Output current (total amount of current that can be sourced from the USB +5 V and digital outputs): 300 mA max

Memory

Data FIFO: 32,768 samples, 65,536 bytes
USB-1608FS
- **EEPROM:** 1,024 bytes
- **EEPROM configuration**
- **Address 0x000 to 0x07F:** Reserved access,128 bytes system data
- **Address 0x080 to 0x1FF:** Read/write access, 84 bytes cal data
- **Address 0x200 to 0x3FF:** Read/write access, 512 bytes user area

USB-1608FS-Plus
- **EEPROM:** 2,048 bytes (768 bytes calibration, 256 bytes user, 1,024 bytes reserved)

General

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

Environmental

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

Mechanical

Dimensions (L × W × H)
- **USB-1608FS, USB-1608FS-Plus:** 79 × 82 × 27 mm (3.10 × 3.20 × 1.05 in.)
- **USB-1608FS-Plus-OEM:** 73.66 × 81.28 × 13.72 mm (2.90 × 3.20 × 0.54 in.)
- **USB Cable Length:** 3 m (9.84 ft) max

User connection length: 3 m (9.84 ft) max

Microcontroller

Type: High performance 32-bit RISC

Signal I/O Connector Type

USB-1608FS, USB-1608FS-Plus: Screw terminal
USB-1608FS-Plus-OEM: Two 20-pin, 0.1 in. pitch headers

USB-1608FS Series

Ordering

Order Information

Part No.	Description
USB-1608FS	USB-based DAQ device with 8 simultaneous 16-bit 100 kS/s analog inputs and 8 digital I/O (includes USB cable and MCC DAQ software CD)
USB-1608FS-Plus	USB-based DAQ device with 8 simultaneous 16-bit 100 kS/s analog inputs, and 8 high-current digital I/O (includes USB cable and MCC DAQ software CD)
USB-1608FS-Plus-OEM	Board-only DAQ device with 8 simultaneous 16-bit 100 kS/s analog inputs and 8 high-current digital I/O

Software also Available from MCC

Part No.	Description
DAQami	Data acquisition companion software for acquiring data and generating signals
TracerDAQ Pro	Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator – professional version
DASYLab	Icon-based data acquisition, graphics, control, and analysis software

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