USB-1608HS Series

16-Bit Simultaneous Sampling DAQ Devices

MC MEASUREMENT COMPUTING™

Features
- **Simultaneous analog sampling**
- **Sample rates up to 250 kS/s per channel**
- **Eight SE or DIFF analog inputs**
- **Up to two analog outputs**
- **8 digital inputs and 8 digital outputs**
- **One trigger input**
- **One event counter**
- **External 5 V power adapter and DIN rail clips included**

Supported Operating Systems
- **Windows® 10/8/7/Vista®/XP 32/64-bit**
- **Linux®**
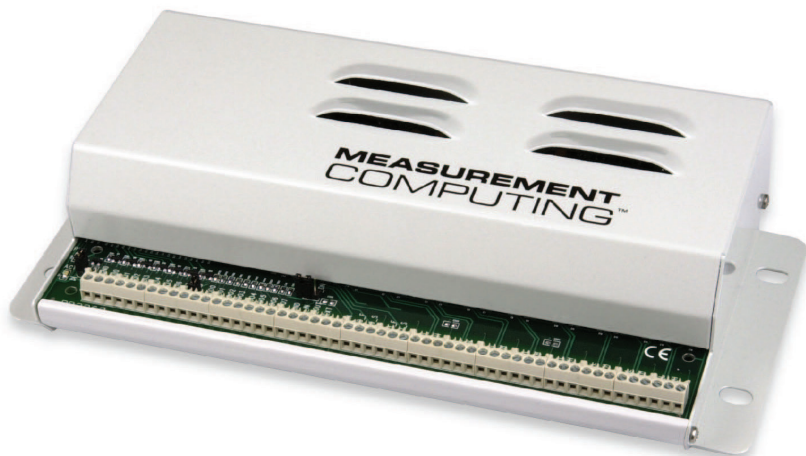
The USB-1608HS Series provides simultaneous sampling at rates up to 250 kS/s per channel.

Overview

With one A/D converter per channel, the USB-1608HS Series offers true simultaneous sampling of up to eight 16-bit analog inputs at 250 kHz per channel.

The USB-1608HS Series is housed in a heavy-duty chassis with integrated mounting slots, ensuring that the hardware is rugged enough for any DAQ application. A required external power supply is included.

Analog Input

The USB-1608HS Series provides eight single-ended or eight differential analog inputs. Users can mix SE and DIFF channels. Each input has a dedicated 16-bit A/D converter for true simultaneous sampling per channel. The input range is software-selectable, and the sample rate is 250 kS/s per channel. Users can pace operations with an internal or external clock.

Analog Output

The USB-1608HS-2AO provides two independent, 16-bit analog voltage outputs. The throughput rate is 70 kS/s for one channel, and 35 kS/s for two channels. Users can clock output operations with the onboard scan clock.

Users can enable remote sensing for each output to compensate for any voltage drop error that may occur.

Digital I/O

The 16 digital I/O lines are configured as 8 inputs and 8 outputs. The digital I/O transfer rate is up to 8000 port or single bit reads/writes per second, system-dependent.

Users can configure the pull-up/down configuration with onboard jumpers. Each DIO pin has an associated LED to indicate the digital input/output state.

Trigger Input

An analog trigger input can be used to start an acquisition. The trigger threshold range is ±10 V. The threshold resolution 12 bits. Users can set the following trigger options:

- Positive or negative slope
- Edge or level sensitive
- Retrigger on or off

The trigger is automatically rearmed after acquiring a specified number of samples.

Counter Input

The counter channel is a TTL-level input to a 32-bit event counter. The counter increments when the TTL level transitions from low to high. The counter can count frequencies of up to 1 MHz.

Clock I/O

Users can pace operations with the internal clock or with an external source. Two terminals are provided for external clocking and multi-unit synchronization:

- **SYNC_IN** externally paces A/D conversions. TTL-level input signals of up to 250 kHz are supported.
- **SYNC_OUT** outputs the clock for A/D conversions.

Users can connect the **SYNC_OUT** pin on one device to the **SYNC_IN** pin of a second device and acquire data synchronously from 16 analog input channels.

USB-1608HS Series Selection Chart						
Model	Analog Input	Sample Rate per Channel (max)	Analog Output	Digital I/O	Counter Input	Clock Source
USB-1608HS	8 SE/ 8 DIFF	250 kS/s	0	8 input 8 output	1	Internal, external input and output
USB-1608HS-2AO	8 SE/ 8 DIFF	250 kS/s	2	8 input 8 output	1	Internal, external input and output

USB-1608HS Series

Features

Power

The USB-1608HS Series requires external power. A 5 V power adapter (PS-5V2AEPS) is included with each shipment.

Calibration

The USB-1608HS Series is factory-calibrated using a NIST-traceable calibration process. Specifications are guaranteed for one year.

The USB-1608HS Series also supports field calibration for users to calibrate the device locally with the InstaCal utility.
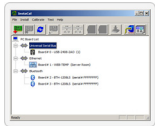
USB-1608HS Series Block Diagram
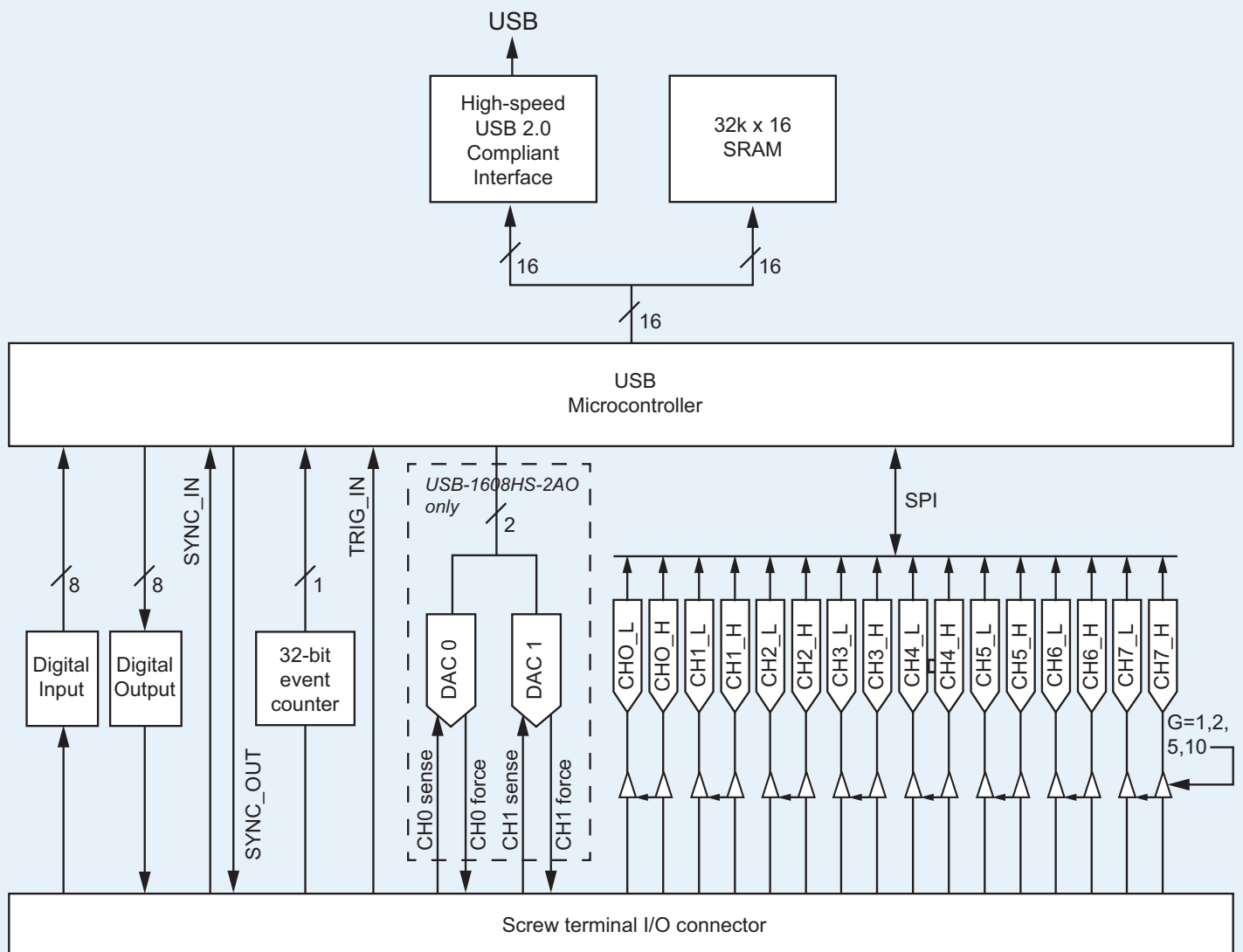
USB-1608HS Series

Software

Software Support

The USB-1608HS Series is 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. 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.
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. TracerDAQ Pro is available as a purchased software download.
General-Purpose Programming Support	
Universal Library™ (UL) for Windows	Library for developing applications in C, C++, VB, C# .Net, VB .Net, and Python on Windows. The UL for Windows is included with the free MCC DAQ Software bundle. The UL Python API for Windows is available on GitHub (github.com/mccdaq/mcculw).
UL for Linux®	Library for developing applications in C, C++, and Python on Linux. UL for Linux is available on GitHub (github.com/mccdaq/uldaq). Open-source, third-party Linux drivers are also available for supported MCC devices.
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.
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.

Specifications

All specifications are subject to change without notice.
These specifications apply to both standard and OEM versions unless noted.

Analog Input

A/D converter type: 16-bit successive approximation type
Number of channels: Eight differential or eight single-ended
Input configuration: Individual A/D per channel
Sampling method: Simultaneous
Analog input modes
  Power up and reset state: CHx_H and CHx_L inputs are disconnected from their screw terminal pins and internally connected to GND; recommended configuration for unused inputs.
  Single-ended: CHx_H inputs are connected directly to their screw terminal pins. CHx_L inputs are disconnected from their screw terminal pins and internally connected to GND.
  Differential: CHx_H and CHx_L inputs are connected directly to their screw terminal pins.
Absolute maximum input voltage:
  CHx IN to GND: ±25 V max (power on)
  TRIG_IN to GND: ±15 V max (power off)
Input impedance (CHx IN): 1 GΩ (power on), 1.5 kΩ (power off)
Input bandwidth (–3 dB) (all input ranges): 330 kHz
Input leakage current: ±25 pA
Input capacitance: 50 pf
Input ranges (software-selectable per channel): ±10 V, ±5 V, ±2 V, ±1 V
A/D pacing: Onboard A/D clock, external source (**SYNC_IN**). Refer to "External Clock Input/Output" on page 5.
A/D trigger source: TRIG_IN input. Refer to "External Trigger" on page 5.
A/D trigger modes: External analog. Refer to "External Trigger" on page 5.
Maximum working voltage (signal + common mode): FSR ±0.05% FSR max
Sampling rate: 0.009 S/s to 250 kS/s, software-selectable
Throughput
  Software paced: 33 to 8000 S/s all channels, system dependent
  Scan to PC memory: 250 kS/s per channel max (limited on USB 1.1 ports)
  Resolution: 16 bits
Differential non-linearity
  Calibrated: ±2.0
  Uncalibrated: ± 0.5 LSB typ, ±1.0 LSB max (applies to the entire 0 °C to 55 °C temperature range)
CMRR (60 Hz)
  ±10 V: 81 dB min
  ±5 V: 81 dB min
  ±2 V: 92 dB min
  ±1 V: 92 dB min

Calibrated Absolute Accuracy	
Range (V)	Accuracy (mV)
±10	±7.019
±5	±3.509
±2	±1.403
±1	±0.702

Accuracy Components					
Range (V)	Integral Non-Linearity (% FSR)	Gain Error at FS (mV)	Offset (mV)	Gain Tempco (ppm/°C)	Offset Tempco (µV/°C)
±10	0.00915	4.578	1.526	3.8	19.5
±5	0.00915	2.289	0.763	7.0	19.5
±2	0.00915	0.916	0.305	16.5	24.3
±1	0.00915	0.458	0.153	40.1	29.2

All values are ±. When connecting differential inputs to floating input sources, the user must provide a DC return path from each differential input to ground by connecting a resistor from each differential input to **AGND**. A value of approximately 100 kΩ can be used for most applications.

Noise Performance		
Range (V)	Peak to Peak Noise (Counts)	RMS Noise (LSBrms)
±10	8	1.21
±5	8	1.21
±2	8	1.21
±1	8	1.21

All values are ±. Noise distribution is determined by gathering 50 kS with inputs tied to ground at the user connector. Samples are gathered at the maximum specified sampling rate of 250 kS/s.

Analog Output (USB-1608HS-2AO only)

Number of channels: Two independent
Resolution: 16 bits
Output range: ±10 V
Throughput
  Single channel: 70 kS/s
  Two channel: 35 kS/s
Pacer source: Onboard D/A clock
Monotonicity: *16 bits*
Glitch energy: 200 nV/s
Current output: ±10 mA max single channel, ±20 mA max two channels.
  The maximum load that the analog output can drive is calculated by dividing the full scale output voltage by the current output specification or (10 V/10 mA) = 1000 Ω. This calculation is valid whether the remote sense feature is enabled or disabled.
Output short-circuit protection (Output connect to GND): 100 ms max
Output coupling: DC
Power up and reset state: DACs clear to midscale, (0 V, ±20 mV). Remote sense is disabled.
Remote sense configuration: Enabled or disabled through software control.
Remote sense compliance voltage (Note 4): ±10.75 V max
  The remote sense feature can compensate for any series resistance up to 75 Ω between its force terminal pins and its output load.
Remote sense compensation range (Note 5): 0 to 75 Ω max
  R_{load} should not exceed the specified 1000 Ω, and R_{series} should not exceed its specified limit of 75 Ω.
Output noise: 100 nV/Hz
Settling time (to 0.003%):
  20 V output step, (RL = 5 kΩ, CL = 200 pf): *5 µS max*
Slew rate: 10 V/µs
Absolute accuracy: ±0.25% of FSR max
Offset error drift: ±4 ppm/°C
Gain error drift: ±10 ppm/°C

Analog Input Calibration

Recommended warm-up time: 15 minutes min
Calibration method: Software calibration
Calibration interval: 1 year
Calibration reference: +10.000 V, ±5 mV max. Actual measured values stored in EEPROM
  Tempco: 5 ppm/°C max
  Long term stability: 30 ppm/1000 h

Digital Input/Output

Digital type: 5 V CMOS
Number of I/O: 16
Configuration: Eight input, eight output
Pull-up/down configuration: The eight input pins have 47 kΩ resistors that may be configured to either pull-up or pull-down with a jumper.
Digital I/O transfer rate: System dependent, 33 to 8000 port reads/writes or single bit reads/writes per second.
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: (IOH = –2.5 mA): 3.8 V min
Output low voltage: (IOL = 2.5 mA): 0.7 V max
Power on and reset state: Outputs: driven low
LED indicators: Each I/O pin has an associated LED status indicator. A high state turns the LED on. The LEDs may be disabled with jumpers **JP1** (input LEDs) and **JP2** (output LEDs).

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Ordering

External Trigger

Trigger source: TRIG_IN input
Trigger input range: ±10 V max
Absolute maximum input voltage
 TRIG_IN to GND: ±25 V max (power on), ±15 V max (power off)
Trigger threshold levels: ±10 V/4096; software-selectable.
Input impedance: 1 MΩ (power on), 1.5 kΩ (power off)
Trigger modes: Positive/negative slope, edge/level sensitive, retrigger on/off
Threshold resolution: 12 bits, 1 in 4096
Threshold accuracy: ±0.25% FSR
Hysteresis: ±5 mV
Full power bandwidth (–3 dB): 640 kHz

External Clock Input/Output

Pin names: SYNC_IN, SYNC_OUT
Pin type
 SYNC_IN: Input; receives the A/D pacer clock signal from an external source; rising edge sensitive.
 SYNC_OUT: Output; outputs the A/D pacer clock signal. Over-current protected with a 200 Ω series resistor.
Input clock rate: 250 kHz max
Clock pulse width
 SYNC_IN: 1 µs min
 SYNC_OUT: 2 µs min
Input leakage current: ±2.0 µA
Input high voltage: 3.5 V min, 6.5 V absolute max
Input low voltage: 1.5 V max, –0.5 V absolute min
Output high voltage
 IOH = –2.5 mA: 3.3 V min
 No load: 3.8 V min
Output low voltage
 IOL = 2.5 mA: 1.1 V max
 No load: 0.6 V max

Counter

Pin name: CTR
Counter type: Event counter; Schmitt trigger input protected with a 1 kΩ series resistor.
Number of channels: 1
Input type: TTL, rising edge triggered
Input source: CTR screw terminal
Resolution: 32 bits
Schmidt trigger hysteresis: 0.58 V to 0.93 V
Input leakage current: ±5 µA
Maximum input frequency: 1 MHz
High pulse width: 500 ns min
Low pulse width: 500 ns min
Input high voltage: 2.4 V min, 6.5 V absolute max
Input low voltage: 2.19 V max, –0.5 V absolute min

Power

Supply current
 Continuous mode: 920 mA. This is the total current requirement, and does not include any additional contribution due to the power output pin current, analog output source current, or DIO loading.
+5V EXT pin output voltage range: 4.5 V min, 5.25 V max. Output voltage range assumes that the input power supply is within specified limits.
+5V EXT pin output current: +10 mA max. This is the total amount of current that can be sourced for general use from the power output pin.
External power input: +5.0 VDC
External power adapter: +5 V, ±5% @ 2 A (MCC p/n PS-5V2AEPS included)

Environmental

Operating temperature range: 0 °C to 55 °C max
Storage temperature range: –40 °C to 85 °C max
Humidity: 0% to 90% non-condensing

Mechanical

Dimensions (L × W × H)
 Board: 203.2 × 121.9 × 15.2 mm (8.0 × 4.8 × 0.6 in.)
 Enclosure: 241.3 × 125.7 × 58.9 mm (9.50 × 4.95 × 2.32 in.)

Order Information

Hardware

Part No.	Description
USB-1608HS	16-bit, 250 kS/s device with eight SE and eight DIFF simultaneous sampling analog inputs, one counter, and 16 DIO lines. Includes USB cable, external power supply (PS-5V2AEPS), and DIN rail mounting clips.
USB-1608HS-2AO	16-bit, 250 kS/s device with eight SE and eight DIFF simultaneous sampling analog inputs, two analog outputs, one counter, and 16 DIO lines. Includes USB cable, external power supply (PS-5V2AEPS), and DIN rail mounting clips.
PS-5V2AEPS	Replacement power supply; interchangeable plugs are available separately.

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