USB-1808 Series
High-Speed, High-Precision, Simultaneous USB Devices

Overview
USB-1808 Series devices are high-performance, simultaneous-sampling DAQ devices. All devices provide synchronous and concurrent voltage I/O, waveform output, counter input, quadrature encoder input, timer output, and digital I/O. USB-1808X models offer synchronous I/O operations at rates up to 200 kS/s per channel, while USB-1808 models offer the same features at rates up to 50 kS/s per channel.

Analog Input
USB-1808 Series devices provide eight, 18-bit simultaneous-sampling analog inputs that are software-selectable per channel for DIFF or SE mode. USB-1808X models support sample rates up to 200 kS/s per channel, while USB-1808 models support sample rates up to 50 kS/s per channel. All devices support voltage ranges of ±10 V, ±5 V, 0 V to 10 V, and 0 V to 5 V.

Channel-Gain Queue
Use the channel-gain queue feature to configure a list of channels and gains for each scan. Each channel can have a different gain setting, and the settings are stored in a list that is written to local memory on the device. The channel-gain queue list on USB-1808 Series devices can contain up to eight unique channels that must be listed in increasing order.

Features
- Eight 18-bit differential (DIFF) or single-ended (SE) analog inputs
- Simultaneous sampling (up to 200 kS/s per channel)
- Two analog outputs
- Four digital I/O
- Two general-purpose counters and two quadrature encoders
- Two timer outputs
- Synchronous AI, AO, DIO operations (up to 200 kS/s per channel)
- External clock I/O, external digital triggering, and pattern triggering
- Board-only OEM available

Supported Operating Systems
- Windows® 10/8/7/Vista®/XP 32/64-bit
- Linux®

Analog Output
USB-1808 Series devices offer two 16-bit analog outputs. USB-1808X models can be updated at a rate of 500 kS/s per channel, while USB-1808 models can be updated at a rate of 125 kS/s. The output range is fixed at ±10 V.

Digital I/O
Four digital I/O lines are individually configurable for input or output. The DIO terminals can detect the state of any TTL-level input. Users can configure for pull-up (+5 V) or pull-down (0 V) with an onboard jumper.

USB-1808 Series Selection Chart

<table>
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<tr>
<th>Model</th>
<th>Analog Inputs</th>
<th>Sample Rate (max/channel)</th>
<th>Analog Outputs</th>
<th>Update Rate (max/channel)</th>
<th>Digital I/O</th>
<th>Counter Inputs</th>
<th>Encoder Inputs</th>
<th>Timer Outputs</th>
<th>Signal I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB-1808</td>
<td>8 DIFF/8 SE</td>
<td>50 kS/s</td>
<td>2</td>
<td>125 kS/s</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>Screw Terminal</td>
</tr>
<tr>
<td>USB-1808X</td>
<td>8 DIFF/8 SE</td>
<td>200 kS/s</td>
<td>2</td>
<td>500 kS/s</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>Screw Terminal</td>
</tr>
<tr>
<td>USB-1808-OEM</td>
<td>8 DIFF/8 SE</td>
<td>50 kS/s</td>
<td>2</td>
<td>125 kS/s</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>Header</td>
</tr>
<tr>
<td>USB-1808X-OEM</td>
<td>8 DIFF/8 SE</td>
<td>200 kS/s</td>
<td>2</td>
<td>500 kS/s</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>Header</td>
</tr>
</tbody>
</table>

US-1808 Series devices provide eight simultaneously-sampling analog inputs that are configurable per channel as differential or single-ended, two analog outputs, four digital I/O, two general-purpose counters, two quadrature encoders, and two timer outputs.
USB-1808 Series

Features

Counter Input
USB-1808 Series devices have two 32-bit general-purpose counter inputs that can be read asynchronously under program control, or synchronously as part of a digital scan group.

Each counter can accept frequency inputs up to 50 MHz and supports the following software-selectable counter input modes:

- **Totalize** – High-speed pulse counter for general counting applications. The internal counter increments when the TTL levels transition from low to high or from high to low.
- **Period measurement** – Measure the period of a signal at a counter channel input. Users can measure x1, x10, x100 or x1000 periods for 32-bit values. Four resolutions are available — 20 ns, 200 ns, 2000 ns, or 20,000 ns
- **Pulse-width measurement** – Measure the time from the rising edge to the falling edge, or vice versa, on a signal on a counter input. Four resolutions are available — 20 ns, 200 ns, 2000 ns, or 20,000 ns

Each mode supports additional counter options. When counter options are set, the counters can concurrently monitor time periods, frequencies, pulses, and other event-driven incremental occurrences directly from pulse-generators, limit switches, proximity switches, and magnetic pick-ups.

Quadrature Encoder Input
USB-1808 Series devices can simultaneously decode signals from up to two quadrature encoders. Encoders with a 50 MHz maximum pulse frequency and X1, X2, and X4 count modes are supported.

Each device provides A, B, and Z inputs for each connected encoder. A typical encoder generates the A and B signals at a 90° phase shift with respect to each other. These signals are used to determine system position (counts), velocity (counts per second), and direction of travel or rotation.

Timer Output
Two timers can generate pulse rates of up to 50 MHz each, with programmable pulse widths down to 10 ns. The timer output rate and pulse width can be updated asynchronously at any time, however doing so results in a pulse stream that is not seamless.

Timer output operations can be paced by the internal clock or by an external clock, and can be initiated by a digital trigger.

Synchronous I/O – Mixing Analog, Digital, and Counter Scanning
USB-1808 Series devices can read analog, digital, counter, and encoder inputs, and generate up to two analog outputs and one digital pattern output at the same time. Digital, counter, and encoder inputs do not affect the overall A/D rate because these inputs use no time slot in the scanning sequencer.

For example, one analog input channel can be scanned at the maximum A/D rate along with digital, counter, and encoder input channels.

Each analog channel can have a different gain, and digital, counter, and encoder channels do not need additional scanning bandwidth as long as there is at least one analog channel in the scan group.

Digital input channel sampling is done during the dead time of the scan period when no analog sampling is being done.

Clock I/O
USB-1808 Series devices provide two external clock inputs – one for pacing input scan and the other to pace output scans.

These devices also include two clock outputs – one to output the internal or external clock used for input scans, and the other to output the internal or external clock used for output scans.

Triggering
USB-1808 Series devices support digital triggering and pattern triggering.

The ITRIG and OTRIG pins are used for external TTL-level triggering – ITRIG can trigger input scans, and OTRIG can trigger output scans. The trigger mode is software-selectable for edge or level sensitive, rising or falling edge, high or low level.

USB-1808 Series devices can also start an input or output scan with a digital pattern trigger using any of the four DIO ports. A scan is triggered when a specified pattern is detected. Specific bits can be masked or ignored. A digital pattern can be input or output under the timing control of a clock signal.

Calibration
The USB-1808 Series devices are factory-calibrated using a NIST-traceable calibration process. Specifications are guaranteed for one year. For calibration beyond one year, return the device to the factory for recalibration.

USB-1808 Series OEM Versions
OEM versions have board-only form factors 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.
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Software Support
USB-1808 Series devices are supported by the software in the table below.

<table>
<thead>
<tr>
<th>Ready-to-Run Applications</th>
</tr>
</thead>
</table>
| **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. |

<table>
<thead>
<tr>
<th>General-Purpose Programming Support</th>
</tr>
</thead>
</table>

| **UL for Linux®** | Library for developing applications in C, C++, and Python on Linux. UL for Linux is available on GitHub (https://github.com/mccdaq/uldaq). Open-source, third-party Linux drivers are also available for supported MCC devices. |

<table>
<thead>
<tr>
<th>Application-Specific Programming Support</th>
</tr>
</thead>
</table>
| **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. |
USB-1808 Series
Specifications

These specifications apply to both standard and OEM versions unless noted. All specifications are subject to change without notice. Typical for 25 °C unless otherwise specified.

**Analog Input**
A/D converter type: Simultaneous
ADC resolution: 18 bits
Number of channels: 8 differential (DIFF), 8 single-ended (SE); software-selectable per-channel for SE or DIFF
Input voltage range: ±10 V, ±5 V, 0 V to 10 V, 0 V to 5 V; software-selectable per channel
Absolute max input voltage (CHx relative to AGND): ±25 V max (power on); ±15 V max (power off)
Input impedance: >1 GΩ (power on); 1000 Ω (power off)
Input bias current: ±50 pA
Input bandwidth, all input ranges, small signal (–3 dB): 2.0 MHz
Input capacitance: 50 pf

Common mode voltage range
±10 V range: ±10.1 V
±5 V range: ±10.1 V
0 V to 10 V range: ±10.1 V
0 V to 5 V range: ±10.1 V
Common mode rejection ratio (\(f_i \leq 1\) kHz, all input ranges): 90 dB
Crosstalk (±10 V, adjacent channels, DC to 100 kHz): –95 dB
Input coupling: DC
Sample rate
USB-1808: 0.023 Hz to 50 kHz; software-selectable
USB-1808X: 0.023 Hz to 200 kHz; software-selectable
Scan clock source: Internal input scan clock or external input scan clock (ICLKI pin)
Trigger source
ITRIG (see External Trigger on page 6)
Digital pattern detection (see Pattern Trigger on page 6)
Channel gain queue (up to 8 elements): Software-selectable. Queue list may contain up to eight elements of unique, consecutive channels paired with any valid range.
Warm-up time: 15 minutes min

<table>
<thead>
<tr>
<th>Range</th>
<th>Gain Error (% of Reading)</th>
<th>Offset Error (mV)</th>
<th>INL Error (% of range)</th>
<th>Absolute Accuracy at Full Scale (mV)</th>
<th>Gain Temperature Coefficient (% reading/°C)</th>
<th>Offset Temperature Coefficient (µV/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>0.020</td>
<td>1.5</td>
<td>0.00076</td>
<td>3.576</td>
<td>0.00023</td>
<td>4</td>
</tr>
<tr>
<td>±5 V</td>
<td>0.020</td>
<td>1.0</td>
<td>0.00057</td>
<td>2.028</td>
<td>0.00023</td>
<td>4</td>
</tr>
<tr>
<td>0 V to 10 V</td>
<td>0.020</td>
<td>1.5</td>
<td>0.00028</td>
<td>3.528</td>
<td>0.00023</td>
<td>4</td>
</tr>
<tr>
<td>0 V to 5 V</td>
<td>0.020</td>
<td>1.0</td>
<td>0.00014</td>
<td>2.007</td>
<td>0.00023</td>
<td>4</td>
</tr>
</tbody>
</table>

Dynamic Performance
±10 V range
Signal-to-noise ratio (SNR): 94 dB
Signal-to-noise-and-distortion ratio (SINAD): 94 dB
Total harmonic distortion (THD): –108 dB
Spurious free dynamic range (SFDR): 112 dB
Effective number of bits (ENOB): 15.3 bits

±5 V range
SNR: 91 dB
SINAD: 91 dB
THD: –105 dB
SFDR: 107 dB
ENOB: 14.8 bits

0 V to 10 V range
SNR: 87 dB
SINAD: 87 dB
THD: –104 dB
SFDR: 109 dB
ENOB: 14.5 bits

0 V to 5 V range
SNR: 83 dB
SINAD: 83 dB
THD: –103 dB
SFDR: 103 dB
ENOB: 13.6 bits
**USB-1808 Series**

**Specifications**

### Noise Performance

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

<table>
<thead>
<tr>
<th>Range</th>
<th>Counts</th>
<th>LSBrms</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V</td>
<td>11.6</td>
<td>1.77</td>
</tr>
<tr>
<td>±5 V</td>
<td>18.0</td>
<td>2.73</td>
</tr>
<tr>
<td>0 V to 10 V</td>
<td>23.3</td>
<td>3.54</td>
</tr>
<tr>
<td>0 V to 5 V</td>
<td>36.1</td>
<td>5.47</td>
</tr>
</tbody>
</table>

### Analog Output

- **Number of channels:** 2
- **Resolution:** 16 bits
- **Output transient**
  - Host computer is reset, powered on, suspended, or a reset command is issued to the device
  - Duration: 5 ms
  - Amplitude: 2 V p-p
  - Powered off from 0 V output
  - Duration: 20 ms
  - Amplitude: 5 V p-p
- **Differential nonlinearity:** ±0.25 LSB typ, ±1 LSB max
- **Output current (AOUTx pins):** ±3.5 mA max
- **Output short-circuit protection (single AOUTx channel connected to AGND):** Unlimited duration
- **Output coupling:** DC
- **Power on and reset state (DACs cleared to zero-scale):** 0 V, ±50 mV
- **Output noise:** 100 μVrms

### Trigger source

- OTRIG (see **External Trigger on page 6**)
- Digital pattern detection (see **Pattern Trigger on page 6**)
- Scan clock source: Internal input scan clock or external input scan clock (ICLKI pin)

### Analog Input/Output Calibration

- **Warm-up time:** 15 minutes recommended min
- **Calibration method:** Factory calibration
- **Calibration interval:** 1 year

### Digital Input/Output

- **Digital type:** CMOS
- **Number of I/O:** 4
- **Configuration:** Each bit may be configured as input (power on default) or output
- **Pull-up configuration:** The port has 47 kΩ resistors configurable as pull-up or pull-down (default) via internal jumper (DIO).
- **Digital I/O transfer rate (system paced, asynchronous):** 33 to 8,000 port reads/writes or single bit reads/writes per second typ, system dependent.
- **Digital I/O transfer rate (synchronous):**
  - USB-1808: 0.023 Hz to 50 kHz input, 125 kHz output, based on the internal clock speed of 100 MHz
  - USB-1808X: 0.023 Hz to 200 kHz input, 500 kHz output, based on the internal clock speed of 100 MHz

### Scan clock source

- Internal input scan clock or external input scan clock (ICLKI pin)

### Counter

- **Terminal names:** CTR0, CTR1
- **Number of channels:** 2 channels
- **Resolution:** 32-bit
- **Counter type:** FPGA
- **Counter input modes:** Totalize, Pulse width, Period
- **Input type:** Schmitt trigger, 33 Ω series resistor, 47 kΩ pull-down to ground
- **Input source:** CTR0, CTR1

### Quadrature Inputs

- **Terminal names:** ENC0A, ENC0B, ENC0Z; ENC1A, ENC1B, ENC1Z
- **Number of encoders:** 2
- **Signals per encoder:** A, B and Z
- **Resolution:** 20 ns
- **Maximum frequency:** 50 MHz
- **Minimum pulse width:** 10 ns
- **De-bounce function:** None

### Timer

- **Terminal name:** TM0R, TM1R
- **Timer type:** PWM output with count, period, delay, and pulse width registers

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**Measurement Computing**

(508) 946-5100

info@mccdaq.com  mccdaq.com
USB-1808 Series

Ordering

External Clock Input/Output
Terminal names: ICLKI, ICLKO, OCLKI, OCLKO
Terminal types
- xCLKI: Input, active on rising edge
- xCLKO: Output, power on default is 0 V, active on rising edge
Terminal descriptions
- xCLKI: Receives sampling clock from external source
- xCLKO: Outputs the internal input scan or internal output scan clock, or the pulse generated from xCLKI when in external clock mode.

Input clock rate
USB-1808: 125 kHz
USB-1808X: 500 kHz
Clock pulse width
- xCLKI: 400 ns
- xCLKO: 400 ns

Input high voltage: 2.2 V min, 5.5 V absolute max
Input low voltage: 1.5 V max, –0.5 V absolute min, 0 V recommended min
Output high voltage: 4.4 V min (IOH = –50 µA); 3.76 V min (IOH = –2.5 mA)
Output low voltage: 0.1 V max (IOL = 50 µA); 0.44 V max (IOL = 2.5 mA)

Output current: ±2.5 mA max

External Trigger
Trigger source: ITRIG for inputs, OTRIG for outputs
Trigger mode: Software programmable for edge or level sensitive, rising or falling edge, high or low level. Power on default is edge sensitive, rising edge.
Trigger latency: 1 µs + 1 clock cycle max
Trigger pulse width: 100 ns

Input type: Schmitt trigger, 33 Ω series resistor, 47 kΩ pull-down to ground
Schmitt trigger hysteresis: 0.4 V to 1.2 V

Input high voltage: 1.5 V max, –0.5 V absolute max
Input low voltage: 0.4 V max, –1.2 V absolute max

Pattern Trigger
Trigger source: DIO0 – DIO3
Trigger types: Above pattern, Below pattern, Equal pattern, or Not equal pattern
Trigger stability: Digital port must be stable for 50 ns to be recognized as a pattern
Trigger bit width: Up to 4, adjustable through bitmask
Trigger latency: Up to 1 scan period

Order Information

Hardware

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB-1808</td>
<td>18-bit, eight-channel, 50 kS/s per channel simultaneous-sampling DAQ device with two analog outputs, four digital I/O lines, two 32-bit counter inputs, two quadrature encoder inputs, and two timer outputs. Includes a USB cable.</td>
</tr>
<tr>
<td>USB-1808X</td>
<td>18-bit, eight-channel, 200 kS/s per channel simultaneous-sampling DAQ device with two analog outputs, four digital I/O lines, two 32-bit counter inputs, two quadrature encoder inputs, and two timer outputs. Includes a USB cable.</td>
</tr>
<tr>
<td>USB-1808-OEM</td>
<td>Board-only 18-bit, eight-channel, 50 kS/s per channel simultaneous-sampling DAQ device with two analog outputs, four digital I/O lines, two 32-bit counter inputs, two quadrature encoder inputs, and two timer outputs.</td>
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<td>USB-1808X-OEM</td>
<td>Board-only 18-bit, eight-channel, 200 kS/s per channel simultaneous-sampling DAQ device with two analog outputs, four digital I/O lines, two 32-bit counter inputs, two quadrature encoder inputs, and two timer outputs.</td>
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</table>

Memory
Data FIFO: 4 kS analog input/2 kS analog output
Non-volatile memory: 32 KB (28 KB firmware storage, 4 KB calibration/user data)

Power
Supply current (quiescent current): 305 mA
This is the total quiescent current requirement for the device that includes up to 10 mA for the status LED. This does not include any potential loading of the digital I/O bits, +VO terminal, or the AOUTx outputs.
+VO user output voltage range: 4.5 V min to 5.25 V max
The +4.5 V min limit includes the +VO 10 mA load, it does not include any potential loading of the digital I/O bits or the AOUTx outputs
+VO user output current: 10 mA max

USB
USB device type: USB 2.0 (high-speed)
Device compatibility: USB 1.1, USB 2.0, USB 3.0
USB cable type: A-B cable, UL type AWM 2725 or equivalent
USB cable length: 3 m (9.84 ft) max

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 max

Mechanical
Signal I/O Connector
- Standard: 2 banks of screw-terminals (wire gauge range 16 AWG to 30 AWG)
- OEM: Two 1 x 28 pin 0.1 in. pitch headers
Dimensions (L x W x H)
- Standard: 127 x 89.9 x 35.6 mm (5.00 x 3.53 x 1.40 in.)
- OEM: 119.38 x 86.36 x 35.6 mm (4.7 x 3.4 x 1.40 in.)
User connection length: 3 m (9.84 ft) max

Software also Available from MCC

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<td>DAQami</td>
<td>Data acquisition companion software for acquiring data and generating signals</td>
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<tr>
<td>TracerDAQ Pro</td>
<td>Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator – professional version</td>
</tr>
<tr>
<td>DASYLab</td>
<td>Icon-based data acquisition, graphics, control, and analysis software</td>
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