USB-1608G Series
USB Multifunction Devices

Features
- **16-bit high-speed USB devices**
- **Acquisition rates ranging from 250 kS/s to 500 kS/s**
- **8 differential (DIFF) or 16 single-ended (SE) analog inputs (software-selectable)**
- **Up to 2 analog outputs**
- **8 digital I/O lines**
- **Two 32-bit counter input channels**
- **One timer output channel**

Software
- **TracerDAQ® software included for acquiring and displaying data and generating signals**
- **Universal Library includes support for Visual Studio® and Visual Studio® .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET**
- **DAQFlex open-source software framework; compatible with Windows® 7/Vista®/XP SP2, 32-bit or 64-bit, Linux®, and Mac® platforms**
- **Comprehensive drivers for DASYLab® and NI LabVIEW™**
- **InstaCal software utility for installing, calibrating, and testing**
- **Supported Operating Systems: Windows® 7/Vista®/XP SP2, 32-bit or 64-bit; Linux®, and Mac®**

All USB-1608G Series devices offer 16 singled-ended or eight differential analog inputs, 8 digital I/O, and one counter input. The USB-1608GX-2AO (shown here) also offers two analog outputs.

USB-1608G Series Selection Chart					
Model	**Analog Inputs**	**Sampling Rate**	**Analog Outputs**	**Digital I/O**	**Counters**
USB-1608G	16 SE/8 DIFF	Up to 250 kS/s	0	8	2
USB-1608GX	16 SE/8 DIFF	Up to 500 kS/s	0	8	2
USB-1608GX-2AO	16 SE/8 DIFF	Up to 500 kS/s	2	8	2

Overview
USB-1608G Series devices are low-cost, high-speed, analog and digital I/O USB devices. All of these devices offer up to eight DIFF or 16 SE analog inputs, up to eight digital I/O channels, two counter inputs, and one timer output.

The USB-1608GX-2AO offers two, 16-bit analog output channels with DAC rates up to 500 kS/s.

Everything you need to begin acquiring, viewing, and storing data is included with each USB-1608G Series device, including comprehensive software support.

Analog Input
USB-1608G Series devices provide 16-bit analog inputs that are software-selectable as 16 SE or eight DIFF inputs. These devices also support input ranges of ±10 V, ±5 V, ±2 V, and ±1 V that are software-selectable per channel.

Analog Output
(USB-1608GX-2AO only)
The USB-1608GX-2AO has two 16-bit analog outputs. Both outputs can be updated at a rate of 250 kS/s per channel; one output can be updated at a rate of 500 kS/s. The output range is fixed at ±10 V. The outputs default to 0 V when the host PC is shut down or suspended, or when a reset command is issued to the device.

Trigger Input
USB-1608G Series devices have an external digital trigger input. The trigger mode is software-selectable for edge- or level-sensitive mode.

You can configure edge-sensitive mode for either rising or falling edge. In level-sensitive mod, you can configure for either high or low level. The default setting at power up is edge-sensitive, rising edge.

Retrigger mode: In retrigger mode, you can set up repetitive analog input trigger events. The trigger is automatically re-armed after it is activated. Use software to set the A/D trigger count (the number of samples you want per trigger).

USB-1608G Series
General Information & Specifications

Digital I/O

Eight bidirectional digital I/O connections are included with USB-1608G Series devices. Each digital channel is individually configurable for input or output. The digital I/O terminals can detect the state of any TTL-level input. You can configure for pull-up (+5 V) or pull-down (0 V) through a jumper.

Counter Input

Each USB-1608G Series device includes two 32-bit event counters for counting TTL pulses. The counters accept frequency inputs of up to 20 MHz.

Timer Output

USB-1608G Series devices have a PWM timer output that can generate a pulse output with a programmable frequency in the range of 0.0149 Hz to 32 MHz. The timer output parameters are software-selectable.

External Clock I/O

USB-1608G Series devices provide one external clock input and one external clock output for the analog inputs.

The USB-1608GX-2AO also has one external clock input and one external clock output for the analog outputs.

Software

Each USB-1608G Series device includes TracerDAQ, an out-of-the-box application that generates, acquires, analyzes, displays, and exports data within seconds of installing Measurement Computing data acquisition hardware. TracerDAQ includes a Strip Chart, Oscilloscope, Function Generator, and Rate Generator, all of which are accessed through a common, easy-to-use menu page.

Also included is a complete set of drivers and detailed example programs for the most popular programming languages and software packages. Driver support includes Universal Library programming libraries for Microsoft® Visual Studio® programming languages, and other languages, DASYLab® support, and ULx for NI LabVIEW®.
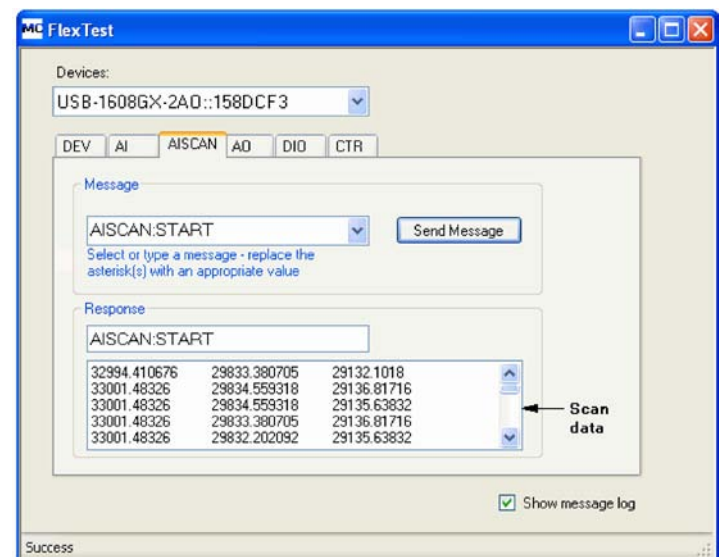
DAQFlex

For DAQ programming in virtually any OS, USB-1608G Series devices include DAQFlex, a framework that combines a small footprint driver with a message-based command protocol. The simplicity of the driver is enabled with a message-based protocol that offers an efficient yet powerful interface to DAQ devices and a common command set that simplifies application development.

Specifications

Analog Input

A/D Converter Type: Successive approximation
ADC Resolution: 16 bits
Number of Channels: 8 DIFF, 16 SE; software-selectable
Input Voltage Range: ±10 V, ±5 V, ±2 V, ±1 V; software-selectable per channel
Absolute Maximum Input Voltage
    CHx Relative to AGND: ±25 V max (power on); ±15 V max (power off)
Input Impedance: 1 GΩ (power on); 820 Ω (power off)
Input Bias Current: ±10 nA
Input Bandwidth
    All Input Ranges, Small Signal (–3 dB)
        USB-1608G: 750 kHz
        USB-1608GX/1608GX-2AO: 870 kHz
Input Capacitance: 60 pf
Maximum Working Voltage (Signal + Common Mode): ±10.2 V max relative to AGND
Common Mode Rejection Ratio
    f_{IN} = 60 Hz, All Input Ranges: 86 dB
Crosstalk
    Adjacent Differential Mode Channels, DC to 100 kHz: –75 dB
Input Coupling: DC
Sampling Rate (Software-Selectable)
    USB-1608G: 0.0149 Hz to 250 kHz
    USB-1608GX/1608GX-2AO: 0.0149 Hz to 500 kHz
Trigger Source: TRIG (refer to *External Trigger* section)
Sample Clock Source: Internal A/D clock or external A/D clock (AICKI terminal)
Burst Mode: Software-selectable using the internal A/D clock; always enabled when using the external clock (AICKI terminal)
    USB-1608G: 4 µs
    USB-1608GX/1608GX-2AO: 2 µs
Throughput
    Software Paced: 33 to 4000 S/s typ, system dependent
    Hardware Paced
        USB-1608G: 250 kS/s max
        USB-1608GX/1608GX-2AO: 500 kS/s max
Channel Gain Queue: Up to 16 elements; software-selectable range for each channel
Warm-up Time: 15 minutes min

FlexTest is an interactive GUI-based utility that demonstrates how to communicate with a device using the DAQFlex communication protocol and software.

USB-1608G Series
Specifications

Analog Input DC Voltage Measurement All Values are (±)						
Range	Gain error (% of Reading)	Offset Error (µV)	INL Error (% of Range)	Absolute accuracy at Full Scale (µV)	Gain Temperature coefficient (% reading/°C)	Offset Temperature Coefficient (µV/°C)
±10 V	0.024	915	0.0076	4075	0.0014	47
±5 V	0.024	686	0.0076	2266	0.0014	24
±2 V	0.024	336	0.0076	968	0.0014	10
±1 V	0.024	245	0.0076	561	0.0014	5

Noise Performance*		
Range	Counts	LSBrms
±10 V	6	0.91
±5 V	6	0.91
±2 V	7	1.06
±1 V	9	1.36

* 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.

Settling Time**			
USB-1608G			
Range	4 µS settling accuracy (% FSR)	6 µS settling accuracy (% FSR)	10 µS settling accuracy (% FSR)
±10 V	0.0061	0.0031	0.0015
±5 V	0.0061	0.0031	0.0015
±2 V	0.0061	0.0031	0.0015
±1 V	0.0061	0.0031	0.0015
USB-1608GX/1608GX-2AO			
Range	2 µS settling accuracy (% FSR)	4 µS settling accuracy (% FSR)	9 µS settling accuracy (% FSR)
±10 V	0.1251	0.0031	0.0015
±5 V	0.0687	0.0031	0.0015
±2 V	0.0687	0.0031	0.0015
±1 V	0.0687	0.0031	0.0015

** Settling time is defined as the expected accuracy after one conversion when switching from a channel with a DC input at one extreme of full scale to another channel with a DC input at the other extreme of full scale. Both input channels are configured for the same input range.

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

Number of Channels: 2 (leave unused AOUTx output channels disconnected)
Resolution: 16 bits
Output Range: ±10 V (calibrated)
Output Transient
Host computer is reset, powered on, suspended, or a reset command is issued to the device.
  Duration: 500 µs
  Amplitude: 2 V pk-pk
Powered Off
  Duration: 10 ms
  Amplitude: 7 V peak
Differential Non-Linearity: ±0.25 LSB typ; ±1 LSB max
Output Current
  AOUTx : ±3.5 mA max
Output Short-Circuit Protection
  AOUTx Connected to AGND: Unlimited duration

Analog Output Absolute Accuracy	
Range	Absolute accuracy (± LSB)
±10 V	16.0

Analog Output Calibrated Absolute Accuracy Components				
Range	% of Reading	Offset (±mV)	Offset Tempco	Gain Tempco (ppm of Range/°C)
±10 V	±0.0183	1.831	12.7	13

Analog Output Relative Accuracy	
Range	Relative Accuracy (INL)
±10 V	4.0 typ

Output Coupling: DC
Power On and Reset State
  DACs Cleared to Zero-Scale: 0 V, ±50 mV (AOUTx defaults to 0 V whenever the host computer is reset, powered on, suspended, or a reset command is issued to the device)
Output Noise: 30 µVrms
Sample Clock Source: Internal D/A clock or external D/A clock (AOCKI terminal)
Output Update Rate: 500 kHz/number of channels in scan
Settling Time
  To Rated Accuracy, 10 V Step: 40 µs
Slew Rate: 9 V/µs
Throughput
  Software Paced: 33 S/s to 4000 S/s typ, system-dependent
  Hardware Pacedl: 500 kS/s max, system-dependent

Analog Input/Output Calibration

Recommended Warm-Up Time: 15 minutes min
Calibration Method: Self-calibration (firmware)
Calibration Interval: 1 year (factory calibration)
AI Calibration Reference
  +5 V, ±2.5 mV max (actual measured values stored in EEPROM)
  Tempco: 5 ppm/°C max
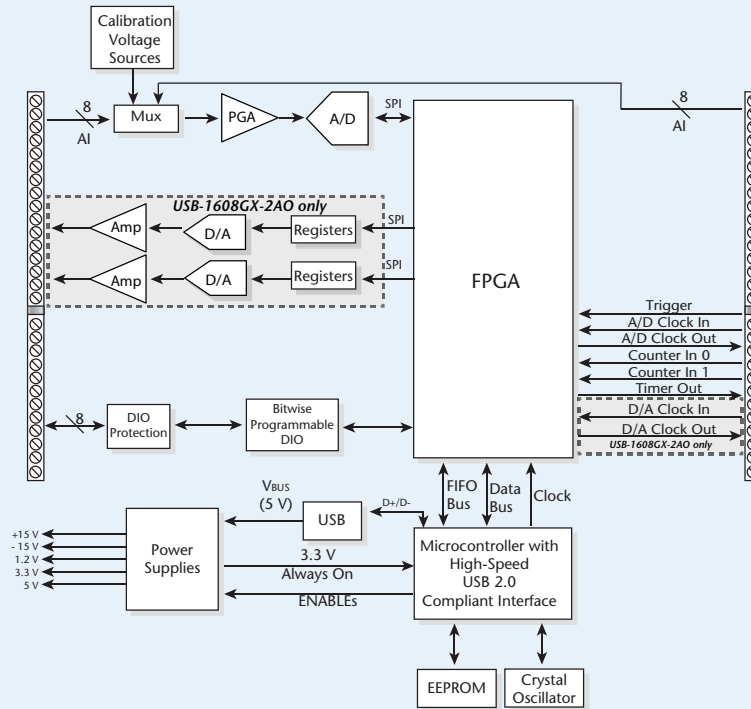 **Long Term Stability:** 15 ppm/1000 hours
AOUTx Calibration Procedure (USB-1608GX-2AO Only)
  The analog output terminals are internally routed to the analog input circuit. For best calibration results, disconnect any AOUTx connections at the terminal block prior to performing AOUT calibration.

USB-1608G Series Block Diagram

Digital Input/Output

Digital Type: CMOS
Number of I/O: 8
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-ups or pull-downs (default) via internal jumper (W1).
Digital I/O Transfer Rate (System-Paced): 33 to 8000 port reads/writes or single bit reads/writes per second typ, system dependent.
Input High Voltage: 2.0 V min, 5.5 V absolute max
Input Low Voltage: 0.8 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: TRIG input
Trigger Mode: Software configurable 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 min
Input Type: Schmitt trigger, 33 Ω series resistor and 49.9 kΩ pull-down to ground
Schmitt Trigger Hysteresis: 0.4 V to 1.2 V
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

External Clock Input/Output

Terminal Names
   AICKI, AICKO,
   AOCKI, AOCKO (USB-1608GX-2AO only)
Terminal Types
   AxCKI: Input, active on rising edge
   AxCKO: Output, power on default is 0 V, active on rising edge

Terminal Descriptions
   AxCKI: Receives sampling clock from external source
   AxCKO: Outputs the internal sampling clock (D/A or A/D clock) or the pulse generated from AxCKI when in external clock mode.
Input Clock Rate
   USB-1608G: 250 kHz max
   USB-1608GX/1608GX-2AO: 500 kHz max
Clock Pulse Width
   AxCKI: 400 ns min
   AxCKO: 400 ns min
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: 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

Counter

Terminal Names: CTR0, CTR1
Number of Channels: 2 channels
Resolution: 32-bit
Counter Type: Event counter
Input Type: Schmitt trigger, 33 Ω series resistor, 47 kΩ pull-down to ground
Input Source:
   CTR0 (terminal 52)
   CTR1 (terminal 51)
Counter Read/Writes Rates (Software-Paced) : 33 to 8000 reads/writes per second typ, system dependent
Input High Voltage: 2.2 V min, 5.5 V max
Input Low Voltage: 1.5 V max, –0.5 V min
Schmitt Trigger Hysteresis: 0.4 V min, 1.2 V max
Input Frequency: 20 MHz, max
High Pulse Width: 25 ns, min
Low Pulse Width: 25 ns, min

TimerOutput

Timer Terminal Name: TMR
Timer Type: PWM output with count, period, delay, and pulse width registers
Output Value: Default state is idle low with pulses high, software-selectable output invert
Internal Clock Frequency: 64 MHz
Register Widths: 32-bit
High Pulse Width: 15.625 ns min
Low Pulse Width: 15.625 ns 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

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
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, +5 V terminal, or the AOUTx outputs (USB-1608GX-2AO only).
    Quiescent Current
        USB-1608G/1608GX: 230 mA
        USB-1608GX-2AO: 260 mA
    +5 V User Output Voltage Range (Available at Terminal 42): 4.9 V min to 5.1 V max
    +5 V User Output Current (Available at Terminal 42): 10 mA 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

Dimensions (L × W × H): 127 × 89.9 × 35.6 mm (5.00 × 3.53 × 1.40 in.)
User Connection Length: 3 m (9.84 ft) max

Ordering Information

Description	Part No.
16-channel, 250 kS/s device with two 32-bit counter inputs, one timer output, eight DIO lines, and USB cable	USB-1608G
16-channel, 500 kS/s device with two 32-bit counter inputs, one timer output, eight DIO lines, and USB cable	USB-1608GX
16-channel, 500 kS/s device with two analog outputs, two 32-bit counter inputs, one timer output, eight DIO lines, and USB cable	USB-1608GX-2AO

Software

Icon-based data acquisition, graphics, control, and analysis software	DASYLab
Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator – professional version	TracerDAQ Pro