

USB-2416 Series

24-Bit Multifunction Temperature & Voltage Modules



Features

- Measure thermocouples or voltage
- 32 analog inputs expandable to 64
- 24-bit resolution
- 1 kS/s sampling
- 8 digital I/O
- Two counters
- Up to 4 analog outputs

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
- Comprehensive drivers for DASyLab® and NI LabVIEW™
- Linux support through third party drivers
- InstaCal software utility for installation, calibration, and testing

Summary

The USB-2416 Series are multifunction DAQ modules designed for highly-accurate voltage or temperature measurements. Each module features 32 SE/16 DE analog inputs, expandable to 64 SE/32 DE inputs. Analog inputs are user-configurable for voltage or thermocouple input on a per-channel basis. Also included with each module are 8 digital I/O, expandable to 24 channels and two counter inputs. The USB-2416-4AO also features four analog outputs. Each module in the series offers 24-bit resolution for ultra-accurate voltage or thermocouple measurements.

Analog Input

Each module includes 32 SE/ 16 DE analog inputs, expandable to 64 SE/32 DE inputs. Nine software selectable voltage input ranges are provided. These are configurable on a per-channel basis from ± 20 V to ± 0.078 V. When measuring thermocouples, analog inputs must be configured in differential (DE) mode. All modules also include open thermocouple detection to identify improperly working thermocouples.



Measurement Computing's USB-2416 Series offers high-resolution voltage or thermocouple measurements along with digital I/O and analog output functionality

USB-2416 Series			
Model	Analog Inputs	Digital I/O	Analog Outputs
USB-2416	32 SE/16 DE	8	—
USB-2416-4AO	32 SE/16 DE	8	4
USB-2416 with AI-EXP32	64 SE/32 DE	24	—
USB-2416-4AO with AI-EXP32	64 SE/32 DE	24	4

Sample Rate

The USB-2416 Series can sample analog input channels at up to a 1 kS/sec rate.

Digital I/O

Eight digital I/O channels are included with each USB-2416 Series module, and each line is individually configurable as an input or output. The AI-EXP32 expansion module adds 16 additional digital I/O to the system.

Counters

Two 32-bit counters are included with USB-2416 Series modules. The TTL level inputs are capable of read/write rates of up to 500 Hz with an input frequency of up to 1 MHz.

Analog Output

Four 16-bit analog outputs are included with the USB-2416-4AO. Each output has a ± 10 V range.

Channel Expansion

The AI-EXP32 is an expansion module used to double analog input count of either the USB-2416 or USB-2416-4AO. It provides up to 32 single-ended/16 differential analog inputs with a 1 kS/s aggregate throughput. Each channel can be individually configured for single-ended or differential input. They offer nine software-selectable analog input ranges (± 20 V, ± 10 V, ± 5 V, ± 2.5 V, ± 1.25 V, ± 0.625 V, ± 0.312 V, ± 0.156 V, ± 0.078 V).

The analog inputs can be configured as thermocouple inputs (up to 16 differential). In thermocouple mode, the AI-EXP32 includes built-in cold-junction compensation and open thermocouple detection. The AI-EXP32 also provides up to 16 additional digital I/O lines.

Four banks of removable screw-terminal blocks provide connectivity to the analog input channels and digital I/O lines. The

USB-2416 Series

General Information & Specifications



AI-EXP32 is connected to the USB-2416 or USB-2416-4AO module with the 37-pin expansion connector. The AI-EXP32 supports all of the analog/thermocouple input and digital I/O features of the USB-2416 series modules to which it is connected. Power for AI-EXP32 comes from the USB-2416 series modules.



The AI-EXP32 connects to a USB-2416 Series module with included hardware

Software

Included with the USB-2416 Series is TracerDAQ, an out-of-the-box application that allows data to be generated, acquired, analyzed, displayed and exported 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 via a common, easy-to-use menu page.



TracerDAQ provides four virtual instrument applications used to graphically display and store input data

Also included with the USB-2416 Series 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 Windows® Visual Studio® programming languages, and other languages, DASYLab® support, and ULx for NI LabVIEW®. Drivers are also available for Linux.

Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.
All specifications apply to all temperature and voltage input channels unless otherwise specified.

Analog Input

A/D Converter Type: ADS1256, 24-bit Sigma Delta
A/D Data Rates: 3750 samples per second (S/s), 2000 S/s, 1000 S/s, 500 S/s, 100 S/s, 60 S/s, 50 S/s, 25 S/s, 10 S/s, 5 S/s, 2.5 S/s

Throughput

Single Channel: 2.5 Hz to 1102.94 Hz, software selectable
Multiple Channels: 0.16 Hz to 1102.94 Hz, software selectable
Number of Channels: Up to 32 channels individually software configurable as single-ended or differential; thermocouples require differential mode; for each channel configured as differential, you lose one single-ended channel; you can add channels by connecting to an AI-EXP32

Input Isolation: 500 VDC min between field wiring and USB interface
Channel Configurations: Temperature sensor input, software programmable to match sensor type; voltage input

Input Voltage Range

Thermocouple Mode: ± 0.078125 V
Voltage Mode: ± 20 V, ± 10 V, ± 5 V, ± 2.5 V, ± 1.25 V, ± 0.625 V, ± 0.3125 V, ± 0.15625 V, ± 0.078125 V, software configurable

Absolute Maximum Input Voltage: CxH-CxL relative to GND, ± 30 V max (power on), ± 10 V max (power off)

Input Impedance: 2 G Ω (power on), 390 Ω (power off)

Input Leakage Current: ± 10.6 nA

Input Capacitance: 590 pF

Maximum Working Voltage (Signal + Common Mode)

Voltage Mode: ± 20 V range, ± 20.01 V max; all other voltage input ranges, ± 10.25 V max

Common Mode Rejection Ratio

Thermocouple Mode (f_{IN} = 60 Hz): 110 dB

Voltage Mode (f_{IN} = 60 Hz, all input ranges): 90 dB

ADC Resolution: 24 bits

Crosstalk: Adjacent channels, 100 dB

Input Coupling: DC

Channel Gain Queue: Up to 64 elements, software configurable channel and range

Warm-Up Time: 45 minutes min

Open Thermocouple Detect: Automatically enabled when the channel is configured for a thermocouple sensor

CJC Sensor Accuracy: 15 °C to 35 °C, ± 0.15 °C typical; 0 °C to 55 °C, ± 0.5 °C max

Channel Configurations

CxH/CxL: Thermocouple, 16 differential channels

CxH/CxL: Voltage, 32 individually configurable channels that can be configured as either single ended or differential

CxH/CxL: Voltage, 32 individually configurable channels that can be configured as either single ended or differential

Compatible Sensors

Thermocouple

J: -210 °C to 1200 °C

K: -270 °C to 1372 °C

R: -50 °C to 1768 °C

S: -50 °C to 1768 °C

T: -270 °C to 400 °C

N: -270 °C to 1300 °C

E: -270 °C to 1000 °C

B: 0 °C to 1820 °C

USB-2416 Series

Specifications



Accuracy

See User's Manual for thermocouple and voltage measurement accuracy.

Throughput Rate

The maximum throughput of the 2416 is 1.1kS/s aggregate. The USB-2416 provides the ability to set conversion rates on a per-channel basis. This feature gives the user flexibility and control over noise averaging on a per-channel basis.

See User's Manual for tables and formulas that describe the many options for single- and multi-channel throughputs.

Analog Voltage Output (4AO only)

Unused VDACx output channels should be left disconnected. The USB-2416-4AO output voltage level defaults to 0 V whenever the host PC is reset, shut down or suspended, or if a reset command is issued to the device. The duration of the output transient depends highly on the enumeration process of the host PC. Typically, the output of the USB-2416-4AO is stable after two seconds.

Digital to Analog Converter: DAC8555

Number of Channels: 4

Resolution: 16 bits

Output Ranges

Calibrated: ± 10 V

Uncalibrated: ± 10.05 V, software configurable

Output Transient

Host PC is reset, powered on, suspended or a reset command is issued to device

Duration: 2 s

Amplitude: 2 V p-p

Initial Power On

Duration: 50 ms

Amplitude: 5 V peak

Differential Non Linearity: ± 0.25 LSB typical, ± 1 LSB max

Output Current: VDACx pins, ± 3.5 mA max

Output Short-Circuit Protection: VDACx connected to AGND, unlimited duration

Output Coupling: DC

VDACx Readback: Each VDACx output can be independently measured by the onboard A/D converter, software selectable

Power on and Reset State: DACs cleared to zero-scale, 0 V, ± 50 mV

Output Noise: 30 μ Vrms

Settling Time: To rated accuracy, 10 V step, 45 μ s

Slew Rate: 1.0 V/ μ s

Throughput

Single-Channel: 1000 S/s max, system-dependent

Multi-Channel: 1000 S/s /#ch max, system-dependent

Calibrated Absolute Accuracy

Range: ± 10 V

Accuracy (\pm LSB): 16.0

Calibrated Absolute Accuracy Components

Range: ± 10 V

% of Reading: ± 0.0183

Offset (\pm mV): 1.831

Temp Drift (%/°C): 0.00055

Absolute Accuracy at FS (\pm mV): 3.661

Relative Accuracy

Range: ± 10 V

Relative Accuracy (\pm LSB): 4.0 typical

Analog Input/Output Calibration

Warm-Up Time: 45 minutes min

Calibration: Firmware 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 hours

Digital Input/Output

Digital Input

Number of I/O: 8 channels

Configuration: Each DIO bit can be independently read from (DIN) or written to (DOUT); the DIN bits can be read at any time whether the DOUT is active or tri-stated

Input Voltage Range: 0 to +15 V

Input Type: CMOS (Schmitt trigger)

Input Characteristics: 47 k Ω pull-up/pull-down resistor, 28 k Ω series resistor

Maximum Input Voltage Range: 0 to +20 V max (power on/off, relative to DGND pins 93 and 94)

Pull-Up/Pull-Down Configuration: All pins pulled up to +5 V via individual 47 k Ω resistors (the JP1 shorting block default position is pins 1 and 2); pull-down capability is available by placing the JP1 shorting block across pins 2 and 3

Transfer Rate (Software Paced): 500 port reads or single bit reads per second typical.

Input High Voltage: 1.3 V min, 2.2 V max

Input Low Voltage: 1.5 V max, 0.6 V min

Schmitt Trigger Hysteresis: 0.4 V min, 1.2 V max

Digital Output

Number of I/O: 8 channels

Configuration: Each DIO bit can be independently read from (DIN) or written to (DOUT); the DIN bits may be read at any time whether the DOUT is active or tri-stated

Output Characteristics: 47 k Ω pull-up, open drain (DMOS transistor)

Pull-Up Configuration: All pins pulled up to +5 V via individual 47 k Ω resistors (the JP1 shorting block default position is pins 1 and 2).

Transfer Rate (Software Paced)

Digital Output: 500 port writes or single bit writes per second typical.

Output Voltage Range: 0 to +5 V (no external pull up resistor, internal 47 k Ω pull-up resistors connected to +5 V by default); 0 to +15 V max

Drain to Source Breakdown Voltage: +50 V min

Off State Leakage Current: 0.1 μ A

Sink Current Capability: 150 mA max (continuous) per output pin, 150 mA max (continuous) for all eight channels

DMOS Transistor On-Resistance (Drain to Source): 4 Ω

Counter

CTR Specifications

Pin Name: CTR0, CTR1

Number of Channels: 2 channels

Resolution: 32-bits

Counter Type: Event counter

Input Type: Schmitt trigger, rising edge triggered

Input Source: CTR0 (pin 43), CTR1 (pin 45)

Counter Read/Writes Rates (Software Paced)

Counter Read: System dependent, 500 reads per second.

Counter Write: System dependent, 500 writes per second.

Input Characteristics: Each CTRx input pin, 562 k Ω pull-up resistor to +5 V, 10 k Ω series resistor

Input Voltage Range: ± 15 V max

Maximum Input Voltage Range: CTR0,CTR1 relative to GND and DGND, ± 20 V max (power on/off)

Input High Voltage: 1.3 V min, 2.2 V max

Input Low Voltage: 1.5 V max, 0.6 V min

Schmitt Trigger Hysteresis: 0.4 V min, 1.2 V max

Input Bandwidth (-3 dB): 1 MHz

Input Capacitance: 25 pF

Input Leakage Current: ± 120 nA

Input Frequency: 1 MHz, max

High Pulse Width: 500 ns, min

Low Pulse Width: 500 ns, min

Memory

EEPROM: 4096 bytes isolated micro reserved for sensor configuration, 256 bytes USB micro for external application use

USB-2416 Series

Specifications & Ordering Information



Microcontroller

Type: One high-performance 8-bit RISC microcontroller with USB interface (non-isolated); one high-performance 16-bit RISC microcontroller for measurements (isolated)

Power

The USB-2416 and USB-2416-4AO include an AC power adapter (PS-5V2AEPS)

Supply Current: Quiescent current, 340 mA

External Power Input: +5 V, $\pm 5\%$

External Power Supply: MCCP/n PS-5V2AEPS (included), +5 VDC, 10 W, 5% regulation
Voltage Supervisor Limits: 4.5 V > V_{ext} or V_{ext} > 5.5 VPWR LED = Off, (power fault); 4.5 V < V_{ext} < 5.5 V, PWR LED = On

+5 V User Output Voltage Range: Available at terminal block pin 35, 4.9 V min to 5.1 V max

User +5V User Output Current: Available at terminal block pin 35, 10 mA max

Isolation: Measurement system to PC, 500 VDC min

AC Power

Output Voltage: +5 V, $\pm 5\%$

Output Wattage: 10 watts

Power Jack Configuration: Two conductor

Power Jack Barrel Diameter: 6.3 mm

Power Jack Pin Diameter: 2.0 mm

Power Jack Polarity: Center positive

USB Specifications

USB Device Type: USB 2.0 (full-speed)

Device Compatibility: USB 1.1, USB 2.0

USB Cable Type: A-B cable, UL type AWM 2527 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D-)

USB Cable Length: 5 meters max

Environmental

The environmental specifications apply to the USB-2416 and USB-2416-4AO and not to the AC power adapter.

Operating Temperature Range: 0 to 50 °C max

Storage Temperature Range: -40 to 85 °C max

Humidity: 0 to 90% non-condensing max

Mechanical

Dimensions: 245 mm (L) x 146 mm (W) x 50 mm (H)

User Connection Length: 5 meters max

Screw Terminal Connector

Connector Type: Detachable screw terminal

Wire Gauge Range: 16 AWG to 30 AWG

Optional AI-EXP32 Expansion Module

Use the AI-EXP32 (sold separately) for applications that need additional analog/thermocouple input and digital I/O channels. See Measurement Computing web site for product details.

The AI-EXP32 expansion port is intended to interface with a USB-2416 series product. Do not try to use any of the expansion port pins for any other purpose.

Ordering Information

Description	Part No.
USB-based 24-bit, isolated, high-channel-count, multifunction DAQ module	USB-2416
USB-based 24-bit, isolated, high-channel-count, multifunction DAQ module with 4 analog outputs	USB-2416-4AO

Signal Conditioning Options

Analog input expansion module for USB-2416 Series	AI-EXP32
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Accessories

DIN-rail kit	ACC-202
DST kit with 6 detachable screw terminals	ACC-216
Replacement power supply for USB-2416 and USB-2416-4AO	PS-5V2AEPS

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