

USB-2416 Series

24-Bit Multifunction Temperature & Voltage Devices



Features

- Measure thermocouples or voltage
- 32 analog inputs expandable to 64
- 24-bit resolution
- 1 kS/s sampling
- 4 analog outputs
- 8 digital I/O
- Two counters
- Includes regulated power supply that provides the required 5 VDC, 2 A external power to device

Software

Supported Operating Systems

- Windows® 8/7/Vista®/XP 32/64-bit
 - Universal library (UL), ULx for NI LabVIEW™
- Linux®
 - Third-party support
- Android™
 - UL for Android

Ready-to-Run Applications

- InstaCal™ (install, configure, and test)
- DAQami™ Advanced Data Logging Application (acquire, view, and log)
- TracerDAQ® (acquire, view, log, and generate)

Supported Programming Environments

- Visual Studio® and Visual Studio .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic .NET, and other IDEs
- Java® (Android only) including examples and demo apps
- LabVIEW (Windows only)
- DASLab®
- MATLAB® (Data Acquisition Toolbox™)

Overview

The USB-2416 Series are multifunction DAQ devices designed for highly-accurate voltage or temperature measurements. Each device features 32 single-ended (SE)/16 differential (DIFF) analog inputs, expandable to 64 SE/32 DIFF inputs.

Analog inputs are user-configurable for voltage or thermocouple input on a per-channel basis. Also included with each device are 8 digital I/O (expandable to 24 channels) and two counter inputs.



The USB-2416 Series offers high-resolution voltage or thermocouple measurements along with digital I/O. Analog output functionality is available with the USB-2416-4AO.

USB-2416 Series Selection Chart					
Model	Analog Inputs	Throughput Rate	Analog Outputs	Digital I/O	Counters
USB-2416	32 SE/16 DIFF	Up to 1 kS/s	—	8	2
USB-2416-4AO	32 SE/16 DIFF	Up to 1 kS/s	4	8	2
USB-2416 with AI-EXP32	64 SE/32 DIFF	Up to 1 kS/s	—	24	2
USB-2416-4AO with AI-EXP32	64 SE/32 DIFF	Up to 1 kS/s	4	24	2

The USB-2416-4AO also features four analog outputs.

Each device in the series offers 24-bit resolution for ultra-accurate voltage or thermocouple measurements.

Analog Input

Each device includes 32 SE/ 16 DIFF analog inputs, expandable to 64 SE/32 DIFF inputs. Software-selectable voltage input ranges of ± 20 V, ± 10 V, ± 5 V, ± 2.5 V, ± 1.25 V, ± 0.625 V, ± 0.312 V, ± 0.156 V, ± 0.078 V are configurable per-channel.

When measuring thermocouples, analog inputs must be configured in DIFF mode. All devices include open thermocouple detection to identify improperly working thermocouples.

Sample Rate

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

Analog Output (USB-2416-4AO Only)

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

Digital I/O

Eight digital I/O channels are included with each USB-2416 Series device, and you can read from or write to each individual bit. The AI-EXP32 expansion device adds 16 additional digital I/O to the system.

USB-2416 Series

General Information & Specifications

Counter Input

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

Channel Expansion with the AI-EXP32

The AI-EXP32 is an expansion device that can double the analog input count of either the USB-2416 or USB-2416-4AO. It provides up to 32 SE/16 DIFF analog inputs with a 1 kS/s aggregate throughput.

Each channel can be individually configured for SE or DIFF input, and offers the same software-selectable analog input ranges (± 0.078 V to ± 20 V).

The analog inputs can be configured as thermocouple inputs (up to 16 DIFF). 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.

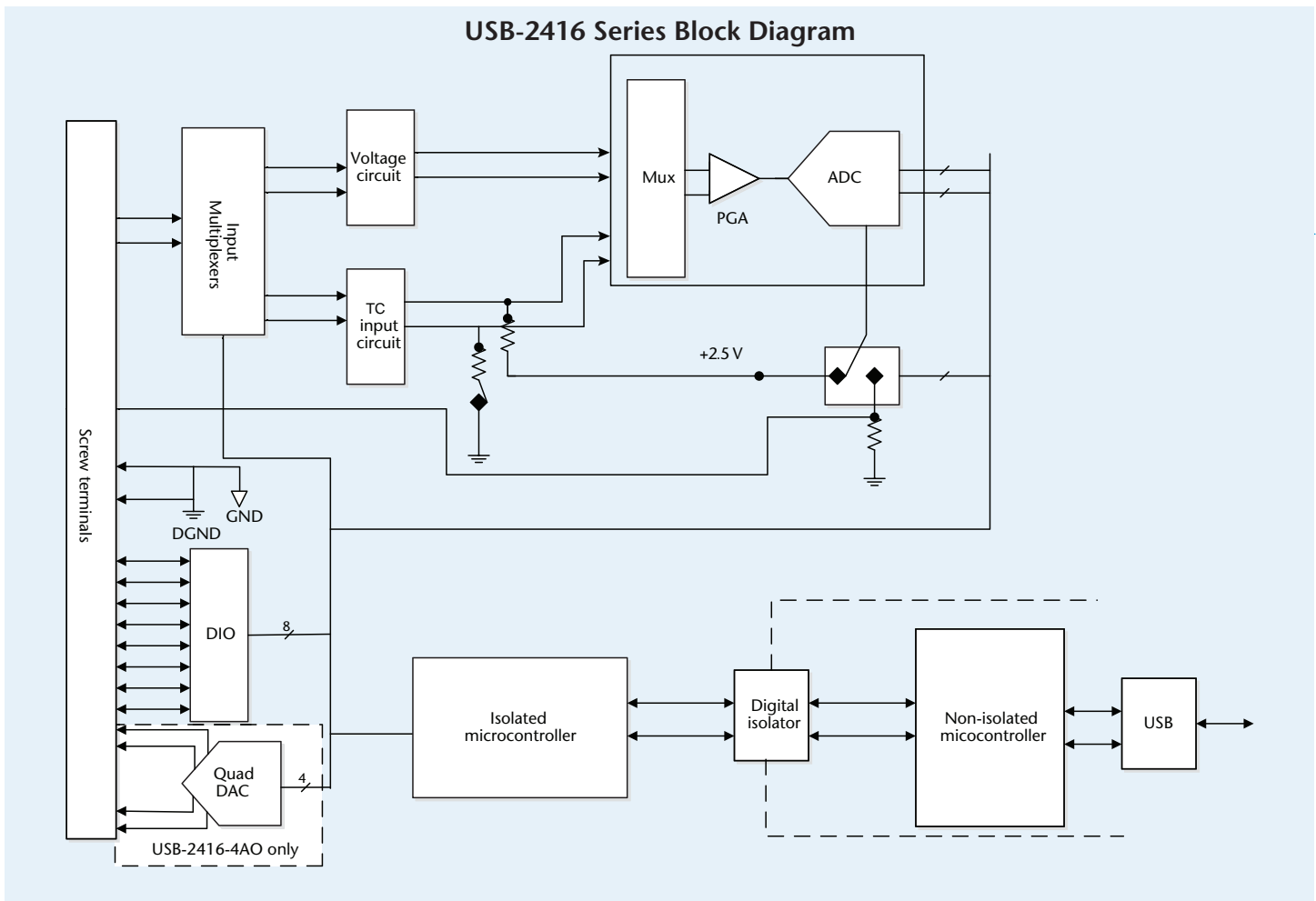
The AI-EXP32 is connected to the USB-2416 Series device with the 37-pin expansion connector. The AI-EXP32 supports all of the analog/thermocouple input and digital I/O features of the USB-2416 Series devices to which it is connected.

Power for the AI-EXP32 comes from the USB-2416 Series device.

Calibration

USB-2416 Series devices are factory-calibrated. Specifications are guaranteed for one year. For calibration beyond one year, return the device to the factory for recalibration.

Field calibration with InstCal is also supported.







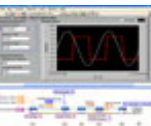


USB-2416 Series

Software Information



Software Support

USB-2416 Series devices are supported by the software in the table below.

Ready-to-Run Applications		
InstaCal		An interactive utility that configures and tests MCC hardware. Windows® OS InstaCal is included with the free MCC DAQ Software bundle (CD/download).
DAQami		Advanced data logging application with drag-and-drop software interface that is used to acquire, view, and log data. DAQami can be configured to log analog channels and to view that data in real-time or post-acquisition on user-configurable displays. Windows OS DAQami is available as a purchased software download.
TracerDAQ and TracerDAQ Pro		A virtual strip chart, oscilloscope, function generator, and rate generator applications used to generate, acquire, analyze, display, and export data. 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).
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 is included with the free MCC DAQ Software bundle (CD/download).
DASYLab Driver		Icon-based data acquisition, graphics, control, and analysis software that allows users to create complex applications in minimal time without text-based programming. DASYLab is available as a purchased software download. Windows OS
MATLAB Driver		High-level language and interactive environment for numerical computation, visualization, and programming. The Data Acquisition Toolbox, provided by The Mathworks, allows users to acquire data from most MCC PCI and USB devices. Visit www.MathWorks.com for more information on MATLAB Data Acquisition Toolbox support.

USB-2416 Series

Specifications



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 (fIN = 60 Hz): 110 dB

Voltage Mode (fIN = 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 typ; 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 T: -270 °C to 400 °C

K: -270 °C to 1372 °C N: -270 °C to 1300 °C

R: -50 °C to 1768 °C E: -270 °C to 1000 °C

S: -50 °C to 1768 °C B: 0 °C to 1820 °C

Accuracy

Refer to the [USB-2416 User's Guide](#) or [USB-2416-4AO User's Guide](#) for thermocouple and voltage measurement accuracy.

Throughput Rate

The maximum throughput of USB-2416 Series devices is 1.1 kS/s aggregate.

The USB-2416 Series 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.

Refer to the [USB-2416 User's Guide](#) or [USB-2416-4AO User's Guide](#) for tables and formulas that describe the many options for single- and multi-channel throughputs.

Analog Voltage Output (USB-2416-4AO 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 V 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 V 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 V to 5 V (no external pull up resistor, internal 47 k Ω pull-up resistors connected to 5 V by default); 0 V 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

USB-2416 Series

Specifications & Ordering Information



Counter Input

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

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: MCC p/n PS-5V2AEPS (included), +5 VDC, 10 W, 5% regulation
Voltage Supervisor Limits: $4.5 \text{ V} > V_{\text{ext}}$ or $V_{\text{ext}} > 5.5 \text{ V}$ PWR LED = Off, (power fault); $4.5 \text{ V} < V_{\text{ext}} < 5.5 \text{ V}$, 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 Series devices and not to the AC power adapter.
Operating Temperature Range: 0 $^{\circ}\text{C}$ to 50 $^{\circ}\text{C}$ max
Storage Temperature Range: -40 to 85 $^{\circ}\text{C}$ max
Humidity: 0 to 90% non-condensing max

Mechanical

Dimensions (L \times W \times H): 245 \times 146 \times 50 mm (9.65 \times 5.75 \times 1.97 in.)
User Connection Length: 5 m 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

Part No.	Description
USB-2416	USB-based 24-bit, isolated, high-channel-count DAQ device
USB-2416-4AO	USB-based 24-bit, isolated, high-channel-count, multifunction DAQ device with 4 analog outputs
AI-EXP32	Analog input expansion module for USB-2416 Series

Accessories

ACC-202	DIN-rail kit for USB-2416 Series	
ACC-216	DST kit with 6 detachable screw terminals	
745690-E001	E-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 1 m	
745690-E002	E-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 2 m	
745690-J001	J-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 1 m	
745690-J002	J-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 2 m	
745690-K001	K-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 1 m	
745690-K002	K-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 2 m	
745690-T001	T-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 1 m	
745690-T002	T-type thermocouples wire, fiberglass (0 $^{\circ}\text{C}$ to 482 $^{\circ}\text{C}$, 32 $^{\circ}\text{F}$ to 900 $^{\circ}\text{F}$), 2 m	

Software also Available from MCC

DAQami	Easy-to-use advanced data logging software to acquire, view, and log data
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