

USB-2408 Series

24-Bit Multifunction Temperature & Voltage Devices



Features

- Measure thermocouples (TCs) or voltage
- Up to 16 analog inputs
- 24-bit resolution
- Up to 1 kS/s sampling
- 8 digital I/O
- Two counters
- Up to 2 analog outputs
- 500 VDC isolation between field wiring and the USB interface

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)
- DASyLab®

Overview

The USB-2408 Series are multifunction DAQ devices designed for highly-accurate voltage or temperature measurements. Each device features up to 16 single-ended (SE)/8 differential (DIFF) analog inputs. Each device includes 8 digital I/O and two counter inputs.

The USB-2408-2AO also features two analog outputs. Each device in the series offers 24-bit resolution for ultra-accurate voltage or TC measurements.



USB-2408 Series devices offer high-resolution voltage or thermocouple measurements along with digital I/O and counter inputs. The USB-2408-2AO (shown here) includes analog output functionality.

USB-2408 Series Selection Chart					
Model	Analog Inputs	Throughput Rate	Analog Outputs	Digital I/O	Counters
USB-2408	16 SE/8 DIFF	Up to 1 kS/s	—	8	2
USB-2408-2AO	16 SE/8 DIFF	Up to 1 kS/s	2	8	2

Analog Input

Each device includes 16 SE/8 DIFF analog inputs which you can configure for voltage or TC input on a per-channel basis. Eight software-selectable voltage input ranges are provided. You can configure these ranges on a per-channel basis from ± 10 V to ± 0.078 V. When measuring TCs, configure analog inputs in DIFF mode. All devices also include open TC detection to identify improperly working thermocouples.

Sample Rate

USB-2408 Series devices can sample analog input channels at up to a 1 kS/s.*

Analog Output (USB-2408-2AO only)

The USB-2408-2AO includes two 16-bit analog outputs. Each output has a ± 10 V range. Both outputs can be updated at a rate of up to 500 S/s per channel; one output can be updated at a rate of 1 kS/s.

Digital I/O

Eight digital I/O channels are included with each USB-2408 Series device, and you can read from or write to each individual bit.

Counter Input

Two 32-bit counters are included with USB-2408 Series devices. The TTL level inputs are capable of read/write rates of up to 500 Hz and an input frequency of up to 1 MHz.

Calibration

USB-2408 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 InstaCal is also supported.

* Refer to the [USB-2408 Series User's Guide](#) to learn how the noise filtering feature affects the throughput rate for analog inputs.





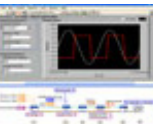

USB-2408 Series

Software Information



Software Support

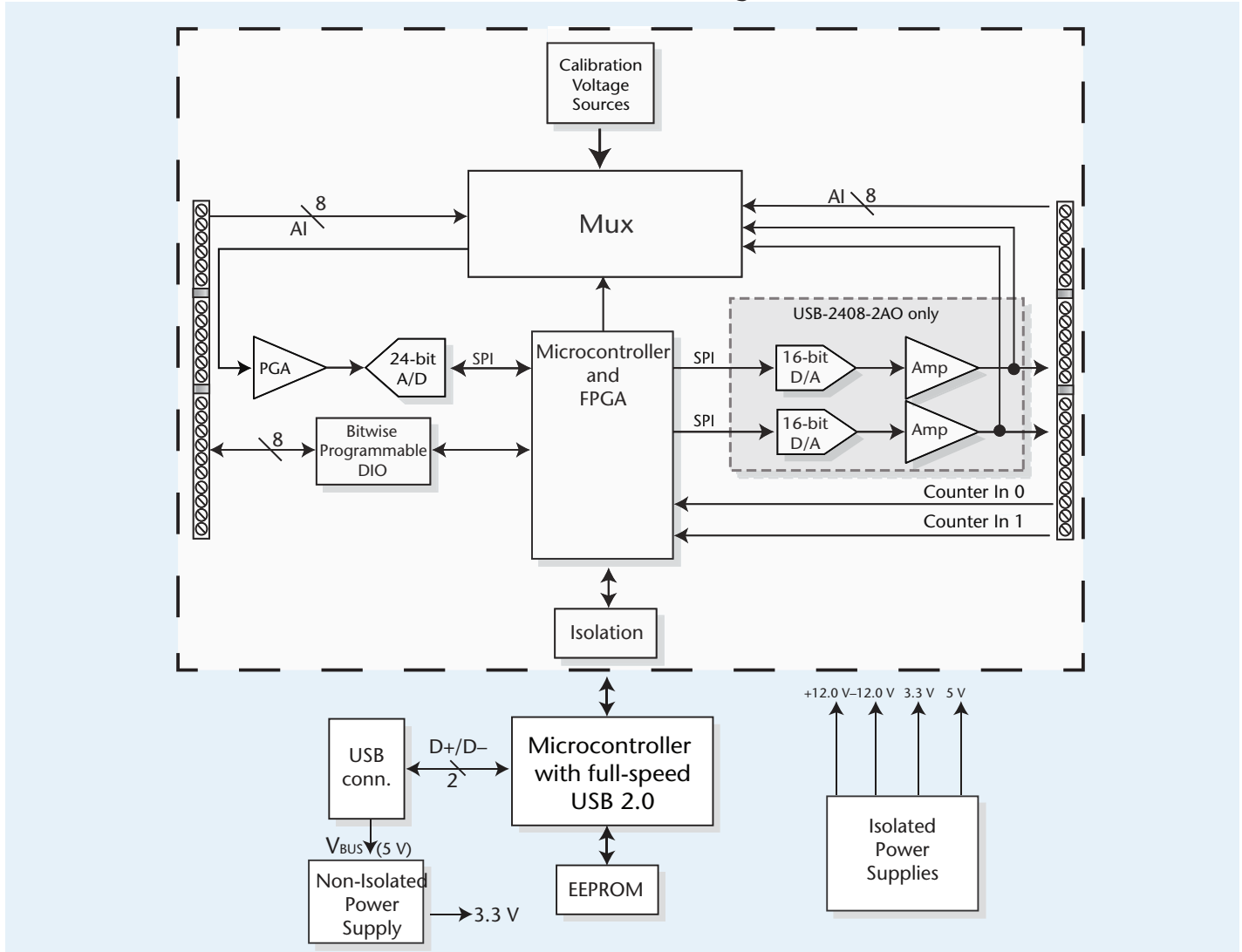
USB-2408 Series devices are supported by the software in the table below.

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

USB-2408 Series

Specifications

USB-2408 Series Block Diagram



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 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 (Software-Selectable for Single Channel and Multiple Channels)
Single Channel: 2.5 S/s to 1102.94 S/s
Multiple Channels: 0.16 Hz to 1102.94 Hz
Number of Channels: Up to 16 channels individually software-selectable as SE or DIFF; TCs require differential mode; for each channel configured as differential, you lose one single-ended channel

Input Isolation: 500 VDC min between field wiring and USB interface

Channel Configurations: Temperature sensor input, software-selectable to match sensor type; voltage input

Input Voltage Range

Thermocouple Mode: ± 0.078125 V
Voltage Mode* (Software-Selectable): ± 10 V, ± 5 V, ± 2.5 V, ± 1.25 V, ± 0.625 V, ± 0.3125 V, ± 0.15625 V, ± 0.078125 V

Absolute Maximum Input Voltage

CxH-CxL relative to GND: ± 22 V max (power on), ± 10 V max (power off)

Input Impedance: 10 M Ω (power on), 390 Ω (power off)

Input Leakage Current

± 20 nA
Input Voltage $> \pm 22$ V (Power On/Off): ± 1 μ A max
Input Capacitance: 590 pF

Maximum Working Voltage (Signal + Common Mode)

Voltage Mode: ± 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-selectable channel and range

Warm-Up Time: 45 minutes min

Open Thermocouple Detect: Software-selectable for each channel

CJC Sensor Accuracy

15 °C to 35 °C: ± 0.5 °C typ

0 °C to 55 °C: ± 1.0 °C max

USB-2408 Series

Specifications



Channel Configurations

CxH/CxL

Thermocouple: 8 DIFF channels

Voltage: 16 individually configurable channels that can be configured as either 16 SE or 8 DIFF

Compatible Sensors (Thermocouple)

J: -210 °C to 1200 °C

R: -50 °C to 1768 °C

T: -270 °C to 400 °C

E: -270 °C to 1000 °C

K: -270 °C to 1372 °C

S: -50 °C to 1768 °C

N: -270 °C to 1300 °C

B: 0 °C to 1820 °C

Thermocouple Accuracy Specifications*				
Includes CJC Measurement Error and Polynomial Linearization Error				
Specifications Valid for One Year or 3000 Operating Hours, Whichever Comes First				
Thermocouple	Sensor temperature range	Accuracy error, maximum	Accuracy error, typical	Tempco (°C/°C)
J	-210 °C	±2.572 °C	±1.416 °C	±0.022
	0 °C	±0.935 °C	±0.469 °C	
	1200 °C	±1.869 °C	±1.456 °C	
K	-210 °C	±2.917 °C	±1.699 °C	±0.029
	0 °C	±1.017 °C	±0.526 °C	
	1372 °C	±2.478 °C	±2.022 °C	
N	-200 °C	±3.480 °C	±2.030 °C	±0.029
	0 °C	±1.201 °C	±0.659 °C	
	1300 °C	±1.991 °C	±1.600 °C	
R	-50 °C	±4.826 °C	±3.133 °C	±0.082
	250 °C	±2.117 °C	±1.424 °C	
	1768 °C	±2.842 °C	±2.347 °C	
S	-50 °C	±4.510 °C	±2.930 °C	±0.089
	250 °C	±2.165 °C	±1.468 °C	
	1768 °C	±3.187 °C	±2.597 °C	
B	250 °C	±5.489 °C	±3.956 °C	±0.14
	700 °C	±2.283 °C	±1.743 °C	
	1820 °C	±2.202 °C	±1.842 °C	
E	-200 °C	±2.413 °C	±1.352 °C	±0.017
	0 °C	±1.069 °C	±0.551 °C	
	1000 °C	±1.575 °C	±1.211 °C	
T	-200 °C	±2.821 °C	±1.676 °C	±0.027
	0 °C	±1.050 °C	±0.558 °C	
	400 °C	±0.957 °C	±0.595 °C	

* Each terminal block has a CJC sensor. The accuracy listed above assumes the screw terminals are at the same temperature as the CJC sensor. The accuracy errors do not include the inherent accuracy error of the TC sensor. Ask your TC supplier about the actual TC sensor accuracy limitations. Connect TCs to the USB-2408 Series device so that they float with respect to AGND. When configuring TC sensors, keep any stray capacitance relative to AGND as small as possible to avoid settling time and accuracy errors. AGND and DGND pins are isolated from earth ground. To connect TC sensors to voltages referenced to earth ground, maintain isolation between the AGND/DGND pins and earth ground. To achieve the TC accuracies listed above, warm up the USB-2408 Series device for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the device is housed in the plastic enclosure.

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Specifications



Analog Input DC Voltage Measurement Accuracy						
Range	Gain error (% of reading)	Offset error	INL error (% of range)	Absolute accuracy	Gain temperature coefficient (% reading/°C)	Offset temperature coefficient (µV/°C)
±10 V	±0.0037	50 µV	±0.0008	500 µV	±0.0006	3
±5 V	±0.0047	25 µV	±0.0008	300 µV	±0.0006	2
±2.5 V	±0.0059	20 µV	±0.0008	200 µV	±0.0006	1
±1.25 V	±0.0056	20 µV	±0.0008	100 µV	±0.0006	1
±0.625 V	±0.0068	15 µV	±0.0005	60 µV	±0.0006	1
±0.3125 V	±0.0104	15 µV	±0.0006	50 µV	±0.0006	1
±0.15625 V	±0.0184	10 µV	±0.0005	40 µV	±0.0006	1
±0.078125 V	±0.0384	10 µV	±0.0009	40 µV	±0.0006	1

Input Bandwidth	
A/D Data Rate	-3 db Bandwidth (Hz)
3750 S/s	1615
2000 S/s	878
1000 S/s	441
500 S/s	221
100 S/s	44.2
60 S/s	26.5
50 S/s	22.1
25 S/s	11.1
10 S/s	4.42
5 S/s	2.21
2.5 S/s	1.1

Noise Performance

Refer to the *USB-2408 Series User's Guide* for noise performance specifications

Channel Switching Error

Refer to the *USB-2408 Series User's Guide* for channel switching error specifications

Throughput Rate

The maximum throughput of a USB-2408 Series device is 1.1 kS/s aggregate. The USB-2408 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 for each channel.

Refer to the *USB-2408 Series User's Guide* for tables and formulas that explain the many options for single- and multichannel throughputs.

Analog Voltage Output (USB-2408-2AO only)

Unused AOUTx output channels should be left disconnected.

The USB-2408-2AO 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 computer. Typically, the output of the USB-2408-2AO is stable after two seconds.

Digital to Analog Converter: DAC8552

Number of Channels: 2

Resolution: 16 bits

Output Ranges

Calibrated: ±10 V

Uncalibrated: ±10.05 V, software-selectable

Output Transient

Host computer 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 typ, ±1 LSB max

Output Current: AOUTx pins, ±5.0 mA max

Output Short-Circuit Protection

AOUTx connected to AGND: Unlimited duration

Output Coupling: DC

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

Output Noise: 60 µVrms (BW=1.5 KHz)

Settling Time: To rated accuracy, 10 V step, 75 µs

Slew Rate: 1.0 V/µs

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 (±LSB): 16.0

Calibrated Absolute Accuracy Components

Range: ±10 V

% of Reading: ±0.0183

Offset: ±1.831 mV

Temp Drift (%/°C): 0.00055

Absolute Accuracy at FS: ±3.661 mV

Relative Accuracy

Range: ±10 V

Relative Accuracy: ±4.0 LSB typ

Analog Input/Output Calibration

Warm-Up Time: 45 minutes min

Calibration: Firmware calibration

Calibration Interval: 1 year

AI 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

AO Calibration Procedure (USB-2408-2AO Only):

The analog output pin is internally routed to the analog input pin.

AOUTx Readback (USB-2408-2AO Only, Software-Selectable): Each AOUTx output can be independently measured by the onboard A/D converter

Digital Input/Output

Digital Input

Number of I/O: 8 channels

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

Input Voltage Range: 0 to 15 V

Input Type: CMOS (Schmitt trigger)

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

Maximum Input Voltage Range: 0 V to 20 V max (power on/off, relative to DGND)

Pull-Up/Pull-Down Configuration: All pins pulled up to 5 V through individual 47 kΩ resistors (the J6 shorting block default position is pins 1 and 2)

Pull-down capability is available by placing the J6 shorting block across pins 2 and 3

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

Input High Voltage: 1.3 V to 2.2 V

Input Low Voltage: 1.5 V to 0.6 V

Schmitt Trigger Hysteresis: 0.4 V to 1.2

Digital Output

Number of I/O: 8 channels

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

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

Each DMOS transistor source pin is internally connected to DGND

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Specifications & Ordering



Pull-Up Configuration: All pins pulled up to 5 V through individual 47 k Ω resistors (the J6 shorting block default position is pins 1 and 2).
Transfer Rate (Software Paced)
Digital Output: 500 port writes or single bit writes per second typ
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: 1.0 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

Pin Names: CTRO, CTR1
Number of Channels: 2 channels
Resolution: 32-bits
Counter Type: Event counter
Input Type: Schmitt trigger, rising edge triggered
Input Source: CTRO (pin 44), CTR1 (pin 42)
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 has 562 k Ω resistor pulled up to 5 V and a 10 k Ω series resistor
Input Voltage Range: ± 15 V max
Maximum Input Voltage Range: CTRO, CTR1 relative to GND and DGND, ± 20 V max (power on/off)
Input High Voltage: 1.3 V to 2.2 V
Input Low Voltage: 1.5 V to 0.6 V
Schmitt Trigger Hysteresis: 0.4 V to 1.2
Input Bandwidth (-3 dB): 1 MHz
Input Capacitance: 25 pF
Input Leakage Current: ± 120 nA @5 V, ± 1.6 mA @ ± 15 V
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

Supply Current: Quiescent current, 275 mA
This is the total quiescent current requirement for the USB-2408 Series which includes up to 10 mA for the status LED. This does not include any potential loading of the digital I/O bits, +5 V user terminal or the AOUTx outputs.
Voltage Supervisor Limits: 4.5 V > V_{ext} or V_{ext} > 5.5 V, PWR 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 40, 4.75 V to 5.25 V
+5 V User Output Current: Available at terminal block pin 40, 10 mA max
Isolation: Measurement system to computer, 500 VDC min

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: 3 meters max

Environmental

Operating Temperature Range: 0 $^{\circ}$ C to 50 $^{\circ}$ C
Storage Temperature Range: -40 $^{\circ}$ C to 85 $^{\circ}$ C
Humidity: 0% to 90% non-condensing

Mechanical

Dimensions (L x W x H): 127 x 89.9 x 35.6 mm (5.00 x 3.53 x 1.40 in.)
User Connection Length: 3 meters max

Screw Terminal Connector

Connector Type: Fixed screw terminal
Wire Gauge Range: 16 AWG to 30 AWG

Ordering Information

Part No.	Description
USB-2408	USB-based 24-bit, isolated, 16 SE/8 DIFF temperature and voltage measurement device with 8 digital I/O, and 2 counter inputs
USB-2408-2AO	USB-based 24-bit, isolated, 16 SE/8 DIFF temperature and voltage measurement device with 8 digital I/O, 2 counter inputs, and 2 analog outputs

Accessories

745690-E001	E-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ F), 1 m
745690-E002	E-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ F), 2 m
745690-J001	J-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ F), 1 m
745690-J002	J-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ F), 2 m
745690-K001	K-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ F), 1 m
745690-K002	K-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ F), 2 m
745690-T001	T-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ F), 1 m
745690-T002	T-type thermocouples wire, fiberglass (0 $^{\circ}$ C to 482 $^{\circ}$ C, 32 $^{\circ}$ F to 900 $^{\circ}$ 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