USB-5200 Series

24-Bit Stand-Alone USB Temperature Data Loggers

Features

- 24-bit temperature data loggers with 8 differential channels
- Measures thermocouples, RTDs, thermistors, or semiconductors
- Internal measurement electronics accuracy exceeds accuracy specifications of supported temperature sensors
- Supports 512 MB, 1 GB, and 2 GB CompactFlash® memory cards
- 8 digital I/O for software-selectable high/low alarms
- Convert data to .csv or .txt format
- Includes a 512 MB memory card (collects up to 128 million measurements), USB power adapter, and software CD

Software

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

Ready-to-Run Applications
- InstaCal™ (install, configure, and test)
- DAQami™* (acquire, view, and log) available for purchase
- 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
- LabVIEW*
- DASYLab®*

* Supports USB-to-PC connection only

The USB-5200 Series offers 24-bit resolution on eight thermocouple inputs. The USB-5203 (shown above) also measures temperature from RTD, thermistor, and semiconductor sensor inputs.

USB-5200 Series Selection Chart

Model	Channels	Thermocouple Inputs	RTD, Thermistor, Semiconductor Sensor Inputs	Stand-Alone Logging to CF Card
USB-5201	8	✔	—	✔
USB-5203	8	✔	✔	✔

Overview

The USB-5200 Series provides temperature measurement flexibility and convenience in devices that can be moved and installed anywhere temperature measurements are needed, without the need for a dedicated host computer.

Temperature Input

USB-5200 Series devices offer eight thermocouple inputs. The USB-5203 also supports RTD, thermistor, and semiconductor sensors.

The inputs are configured to run continuously at 2 S/s. The maximum latency between when a sample is acquired and when the temperature data is provided by the USB unit is approximately 0.5 seconds.

USB-5200 Series devices provide the most accurate temperature measurement possible because the accuracy of their internal measurement electronics exceeds the accuracy specifications of the temperature sensors.

Data Logging

USB-5200 Series devices can store temperature data on the included Compact Flash (CF) card. The data can then be read from a CF reader or by connecting the device directly to a USB port on a PC.

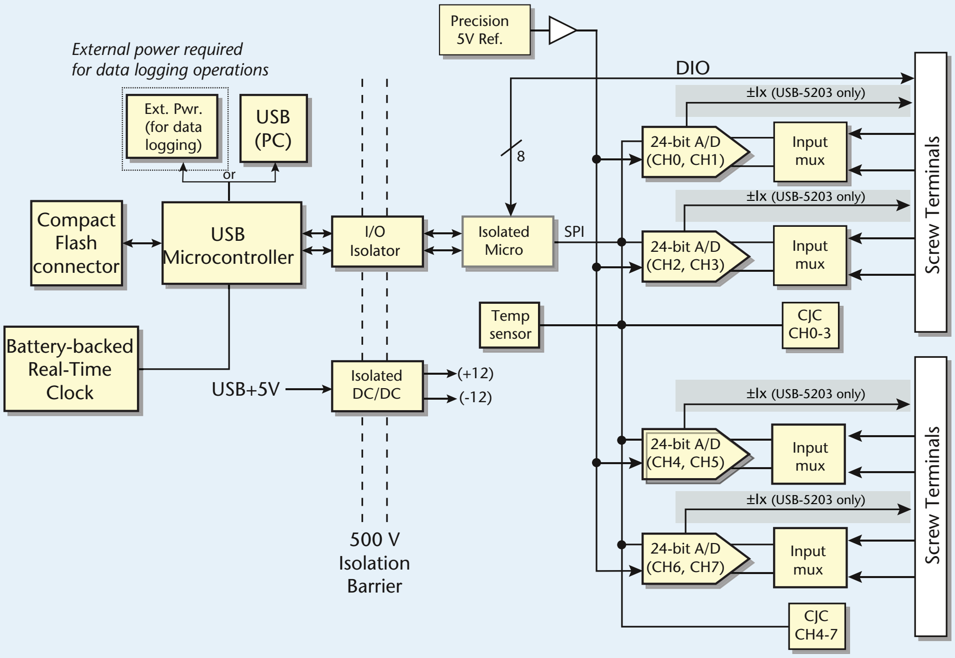
Both devices can be configured to log the following types of data:

- temperature (°C) or raw data from selected input channels
- timestamp data
- CJC sensor readings

Users can set the number of seconds between samples, and control when logging begins – at power up, when the logging button is pressed, or at a specific date and time.

Logged data is stored on the memory card in binary files and then can be transferred to the computer. Use InstaCal to convert the files to .csv format for use in Microsoft® Excel® files, or to .txt format for use in other applications.

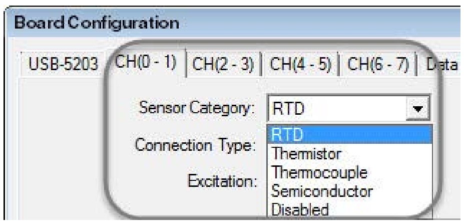
USB-5200 Series Block Diagram



Configuring a USB-5200 Series Device for Logging with InstaCal

After you connect and install a USB-5200 Series device and add the device to the InstaCal configuration, right-click on the device in the InstaCal window and select **Configure** from the context menu to open the **Board Configuration** dialog box.

The **Board Configuration** dialog box includes four tabs for configuring sensor settings for each differential channel pair, and a **Data Logger** tab for configuring logging and alarm settings.



Channel pair tabs and the Sensor Category list on the Board Configuration dialog box in InstaCal.

Configuring Differential Channel Pairs

For each channel pair, select the type of connected sensor from the **Sensor Category** list, and configure the available settings for the selected sensor.

Sensor Category	Settings
RTD (USB-5203 only)	**Connection Types** – Select **2-wire (1-sensor)**, **2-wire (2-sensors)**, **3-wire**, or **4-wire**. Click **Show Connections** to display a diagram of the selected connection type. **Callendar-Van Dusen Coefficients** – Configure these settings for each connected sensor.
Thermistor (USB-5203 only)	**Connection Types** – Select **2-wire (1-sensor)**, **2-wire (2-sensors)**, **3-wire**, or **4-wire**. Click **Show Connections** to display a diagram of the selected connection type. **Steinhart-Hart Coefficients** – Configure these settings for each connected sensor.
Thermocouple	**Thermocouple** – Select type J, K, R, S, T, N, E, or B.
Semiconductor (USB-5203 only)	**Coefficients** – Configure these settings for the offset voltage, scale (V/°C), and sensor type.
Disabled	The channel pair is not used in the acquisition.

Configuring Data Logger Settings

Click on the **Data Logger** tab to configure settings on the **Logger Data**, **Logger Setup**, and **Alarm Setup** tabs.

Tab	Settings
Logger Data	**Preferences** – Select the **Time Format**, **Time Zone** used for timestamps, and the **Temperature Units** used for logged data. **Files** – Displays the binary files containing logged data. Select a file to perform one of the following operations: • click **Convert** to convert the file to a .csv or .txt file • click **Copy** to create a copy of the file • click **Delete** to delete the file from disk **Storage** – Displays the total amount and free amount of memory on the CF card.
Logger Setup	**Settings** – Select whether to log **CJC Readings** and **Timestamps** in addition to temperature readings. **Interval** – Number of seconds between each logged sample. **Starting file number** – Number to append to the next log file name. **Mode** – Select one of the following logging modes: • **Logging Off** – Logging is disabled • **Start Logging on Power Up** – Start logging 5 seconds after power on to allow hardware to settle. • **Start Logging on Button** – Manually start logging by pressing the logging button to the right of the CF card slot. • **Start Logging at Specified Time** – Start logging based on the time entered in the date and time fields. **Channel Selection and Format** – Select each channel to log and whether data is logged in as temperature value or raw value.

Tab	Settings
Alarm Setup	Configure up to eight independent temperature alarms using the settings on the **Alarm 0** through **Alarm 7** tabs. Each tab corresponds to a digital I/O bit (0 - 7). When an alarm is activated, the associated DIO channel is driven to the output state. **Enable Alarm** – Select this checkbox to enable the alarm. **Input Channel** – Select the temperature channel used as the alarm input. **Output Type** – Select **Active High** or **Active Low** as the alarm output. **Threshold** – Select one of the temperature threshold conditions that activates the alarm.

Saving Data Logger Configurations

Click on the **Saved Configurations** tab to save a configuration to file or to load a previously saved configuration.

Calculating the Logging Time for a Memory Card

The following formula calculates the approximate amount of logging time in seconds that one of the supported memory cards allows. USB-5200 Series devices support 512 MB, 1 GB, and 2 GB CompactFlash memory cards.

$$\text{time} = R \times \frac{N_{Disk}}{N_{TS} + N_{DIO} + (N_{Temp} \times n_{Channels}) + N_{CJC}}$$

where:
- *time* = total disk time in seconds
- N_{Disk} = size of memory card in bytes
- N_{DIO} = 1 byte for digital I/O
- $n_{Channels}$ = number of channels logged
- R = logging rate in seconds
- N_{TS} = 6 bytes for timestamp, if enabled
- N_{Temp} = 4 bytes for a temperature reading (always enabled)
- N_{CJC} = 8 bytes if CJC sensor readings are enabled

For example, if logging from one channel to a 512 MB card with all logging options selected, the calculation is as follows:

- N_{Disk} = 512,000,000 bytes (512 MB)
- $N_{DIO} = 1$
- $n_{Channels} = 1$
- $R = 1$ S/s
- $N_{TS} = 6$ (timestamp enabled)
- $N_{Temp} = 4$ (temperature readings)
- $N_{CJC} = 8$ (CJC sensor readings enabled)

Inserting these values into the formula creates the following equation:

$$\text{time} = 1 \times \frac{512{,}000{,}000}{6 + 1 + (4 \times 1) + 8} = 26947368 \text{ seconds} = 311.9 \text{ days}$$

Changing the number of channels logged from 1 to 8 in the above formula ($n_{Channels} = 8$) yields the following equation:

$$\text{time} = 1 \times \frac{512{,}000{,}000}{6 + 1 + (4 \times 8) + 8} = 10893617 \text{ seconds} = 126 \text{ days}$$

Thermocouple Measurements

USB-5200 Series devices make fully-differential thermocouple measurements without the need of ground-referencing resistors. A 32-bit floating point value in either a voltage or temperature format is returned by software. An open thermocouple detection feature is available for each analog input which automatically detects an open or broken thermocouple.

A thermocouple is created by joining two dissimilar metals. The junction produces a small voltage as a function of the temperature. Supported thermocouple types – J, K, R, S, T, N, E, or B) – are software-selectable on each input channel.

USB-5200 Series devices apply 2.5 V to the low side of the thermocouple input, which level-shifts the thermocouple output voltage into the A/D common mode input range.

Cold-Junction Compensation (CJC)

When the thermocouple sensor leads are connected to the sensor input channel, the dissimilar metals at the terminal blocks produce an additional thermocouple junction. This junction creates a small voltage error term which must be removed from the overall sensor measurement using a cold junction compensation technique. The measured voltage includes both the thermocouple voltage and the cold junction voltage. To compensate for the additional cold junction voltage, the USB-5203 subtracts the cold junction voltage from the thermocouple voltage.

USB-5200 Series devices have two high-resolution temperature sensors integrated into their design. One sensor is located on the right side of the package, and the other sensor is located at the left side. The CJC sensors measure the average temperature at the terminal blocks so that the cold junction voltage can be calculated.

A software algorithm automatically corrects for the additional thermocouples created at the terminal blocks by subtracting the calculated cold junction voltage from the thermocouple voltage measurement.

Data Linearization

After the CJC correction is performed on the measurement data, an onboard microcontroller automatically linearizes the thermocouple measurement data using National Institute of Standards and Technology linearization coefficients for the selected thermocouple type.

The measurement data is then output as a 32-bit floating point value in the configured format (voltage or temperature).

Open-Thermocouple Detection

USB-5200 Series devices are equipped with an open-thermocouple detection (OTD) for each analog input channel. With OTD, any open-circuit or short-circuit condition at the thermocouple sensor is detected by the software. An open channel is detected by driving the input voltage to a negative value outside the range of any thermocouple output. The software recognizes this as an invalid reading and flags the appropriate channel. The software continues to sample all channels when OTD is detected.

Input Leakage Current

With OTD enabled, up to 105 nA of input leakage current is injected into the thermocouple. This current can cause an error voltage to develop across the lead resistance of the thermocouple that is indistinguishable from the thermocouple voltage being measured.

Use the following formula to estimate this error voltage:

error voltage = thermocouple resistance × 105 nA

To reduce the error, reduce the length of the thermocouple to lower its resistance, or lower the AWG of the wire by using a wire with a larger diameter. With open-thermocouple detection disabled, 30 nA (max) of input leakage current is injected into the thermocouple.

RTD and Thermistor Measurements (USB-5203 Only)

A resistance temperature detector (RTD) measures temperature by correlating the resistance of the RTD element with temperature.

A thermistor is a thermally-sensitive resistor that is similar to an RTD in that its resistance changes with temperature – thermistors show a large change in resistance that is proportional to a small change in temperature.

RTDs and thermistors are resistive devices requiring an excitation current to produce a voltage drop that can be measured differentially across the sensor.

The USB-5203 has four built-in current excitation sources (±I1 to ±I4) for measuring resistive-type sensors. Each current excitation terminal is dedicated to one channel pair.

The device measures the sensor resistance by forcing a known excitation current through the sensor and then measuring (differentially) the voltage across the sensor to determine its resistance.

After the device measures the voltage, it calculates the RTD resistance using Ohm's law – divide the measured voltage by the current excitation level (±Ix) source.

The value of the ±Ix source is stored in local memory.

- In RTD mode, the USB-5203 can measure resistance values up to 660 Ω. This limit includes the total resistance across the current excitation (±Ix) pins, which is the sum of the RTD resistance and the lead resistances.
- In thermistor mode, the USB-5203 can measure resistance values up to 180 kΩ. The 180 kΩ resistance limit includes the total resistance across the current excitation (±Ix) pins, which is the sum of the thermistor resistance and the lead resistance.

Data Linearization

Once the resistance value is calculated, an onboard microcontroller automatically performs linearization on RTD and thermistor measurements to convert them to a temperature value. The measurement is returned by software as a 32-bit floating point value in a voltage, resistance, or temperature format.

The main difference between RTD and thermistor measurements is the method used to linearize the sensor data.

RTD measurements are linearized using a Callendar-Van Dusen coefficients algorithm (select DIN, SAMA, or ITS-90).

Thermistor measurements are linearized using a Steinhart-Hart linearization algorithm. This algorithm requires coefficients from the sensor manufacturer data sheet).

The USB-5203 makes two, three, and four-wire measurements of RTDs (100 Ω platinum type) and thermistors.

Two-Wire Configurations

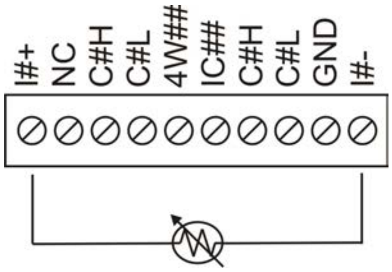
The easiest way to connect an RTD or thermistor to the USB-5203 is with a two-wire configuration, since it requires the fewest connections to the sensor. The two wires that provide the RTD sensor with its excitation current also measure the voltage across the sensor.

Because RTDs exhibit a low nominal resistance, measurement accuracy can be affected due to the lead wire resistance. For example, connecting lead wires that have a resistance of 1 Ω (0.5 Ω each lead) to a 100 Ω platinum RTD results in a 1% measurement error.

With a two-wire configuration, either one sensor per channel pair or two sensors per channel pair can be connected.

Two-Wire, Single-Sensor

When a two-wire single sensor configuration is selected with software (such as InstaCal), connections to C#H and C#L are made internally.

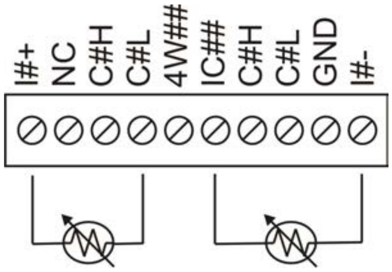


Two-wire, single-sensor measurement configuration

Two-Wire, Two-Sensor

With a two-wire, two-sensor configuration, connections to C#H (first sensor) and C#H/C#L (second sensor) are made internally.

When configured for two-wire mode, both sensors must be connected to obtain proper measurements.

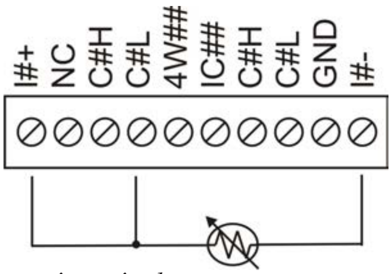


Two-wire, two-sensor measurement configuration

Three-Wire, Single-Sensor Configuration

A three-wire configuration compensates for lead-wire resistance by using a single-voltage sense connection. Only one sensor per channel pair can be connected in a three-wire configuration.

When a three-wire, single-sensor sensor configuration is selected with software, the USB-5203 measures the lead resistance on the first channel (C#H/C#L) and measures the sensor itself using the second channel (C#H/C#L). This configuration compensates for any lead-wire resistance and temperature change in lead-wire resistance. Connections to C#H for the first channel and C#H/C#L of the second channel are made internally.



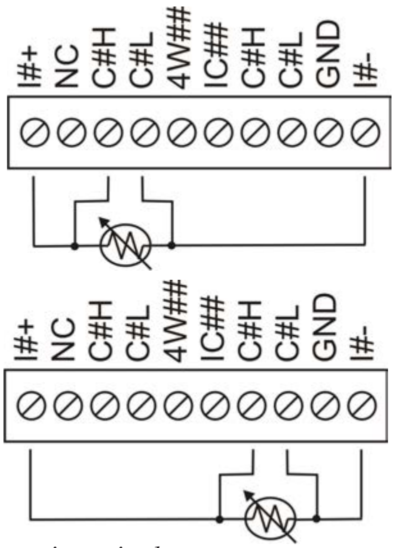
Three-wire, single-sensor measurement configuration

For accurate three-wire compensation, the individual lead resistances connected to the excitation (I#+/I–#) pins must be of equal resistance value.

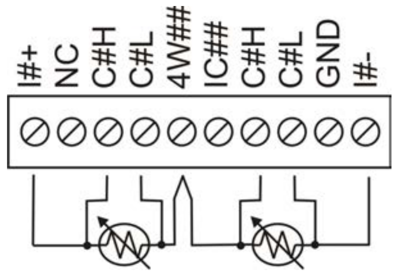
Four-Wire Configurations

With a four-wire configuration, connect two sets of sense/excitation terminals at each end of the RTD or thermistor sensor. This configuration completely compensates for any lead-wire resistance and temperature change in lead-wire resistance.

Use a four-wire configuration when the application requires very high accuracy measurements. The USB-5203 can be configured with either a single-sensor-per-channel or a two-sensor–per-channel pair.



Four-wire, single-sensor measurement configurations



Four-wire, two-sensor measurement configuration

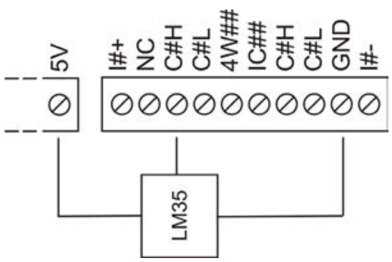
Semiconductor Sensor Measurements (USB-5203 Only)

Semiconductor sensors are suitable over a range of approximately -40 ˚C to 125 ˚C, where an accuracy of ±2 ˚C is adequate. The temperature measurement range of a semiconductor sensor is small when compared to thermocouples and RTDs. However, semiconductor sensors can be accurate, inexpensive and easy to interface with other electronics for display and control.

The USB-5203 makes high-resolution measurements of semiconductor sensors. The software outputs the measurement data as a 32-bit floating point value in either voltage or temperature. Use InstaCal to select the sensor type (LM35, TMP35 or equivalent) and the sensor input channel to connect to the sensor.

Semiconductor Wiring Configuration

Connect the semiconductor sensor to the USB-5203 using a single-ended configuration. The device provides +5 V and GND pins for powering the sensor.



Semiconductor sensor measurement configuration

Trigger Input

USB-5200 Series devices have an external digital trigger input that is software-selectable for edge- or level-sensitive mode.

Configure edge-sensitive mode for either rising or falling edge. Level-sensitive mode can be configured for either high or low level. The default setting at power up is edge-sensitive, rising edge.

Digital I/O

USB-5200 Series devices provide eight digital I/O lines that are pulled up to 5 V with a 47 kΩ resistor (default). Factory reconfiguration of the resistor for pull-down to ground is available by request.

Each digital bit can be configured for either input or output.

When a bit is configured for input, the corresponding DIO terminal can detect the state of any TTL-level input.

Configuring DIO Channels to Generate Alarms

Each DIO bit can also be configured as a temperature alarm with software.

When configured as an alarm, a bit is configured as an output on the next power cycle and assumes the state defined by the alarm configuration.

Each alarm controls an associated digital I/O channel as an alarm output. The input to each alarm is one of the temperature input channels.

Use software to set up the temperature conditions to activate an alarm, and the output state of the channel (active high or low) when activated. When an alarm is activated, its associated DIO channel is driven to the output state specified.

The alarm configurations are stored in non-volatile memory and are loaded on power up. Temperature alarms function both in data logging mode and while attached to the USB port on a PC.

Calibration

USB-5200 Series devices are factory-calibrated. Specifications are guaranteed for one year. For calibration beyond one year, return the device to the factory for recalibration.

Software Support

USB-5200 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 (USB-to-PC connection only)		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 (USB-to-PC connection only)		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 (USB-to-PC connection only)		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 (USB-to-PC connection only)		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

Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.

Analog Input

A/D converters: Four dual 24-bit, Sigma-Delta type
Number of channels: 8 differential
Input isolation: 500 VDC minimum between field wiring and USB interface
Channel configuration: Software-selectable to match sensor type
Differential input voltage range for each supported sensor categories
- **Thermocouple:** ±0.080 V
- **RTD (USB-5203 only):** 0 V to 0.5 V
- **Thermistor (USB-5203 only):** 0 V to 2 V
- **Semiconductor (USB-5203 only):** 0 V to 2.5 V

Absolute maximum input voltage: ±C0x through ±C7x relative to GND; ±25 V power on, ±40 V power off
Input impedance: 5 GΩ, min
Input leakage current
- **Open thermocouple detect disabled:** 30 nA max
- **Open thermocouple detect enabled:** 105 nA max

Normal mode rejection ratio: fIN = 60 Hz: 90 dB min
Common mode rejection ratio: fIN=50 Hz/60 Hz: 100 dB min
Resolution: 24 bits
No missing codes: 24 bits
Input coupling: DC
Warm-up time: 30 minutes min
Open thermocouple detect: Automatically enabled when the channel pair is configured for a thermocouple sensor. The maximum open detection time is 3 seconds.
CJC sensor accuracy
- **15 °C to 35 °C:** ±0.25 °C typ,±0.5 °C max
- **0 °C to 70 °C:** –1.0 °C to +0.5 °C max

Channel Configurations

Sensor Category	Conditions	Max Number of Sensors (All Channels Configured Alike)
Disabled (default)		
Thermocouple	J, K, S, R, B, E, T, or N	8 Differential Channels
Semiconductor (USB-5203 only)		8 Differential Channels
RTD/Thermistor (USB-5203 only)	2-Wire Configuration with a Single Sensor per Channel Pair	4 Differential Channels
	2-Wire Configuration with Two Sensors per Channel Pair	8 Differential Channels
	3-Wire Configuration with a Single Sensor per Channel Pair	4 Differential Channels
	4-Wire Configuration with a Single Sensor per Channel Pair	4 Differential Channels
	4-Wire Input Configuration with Two Sensors per Channel Pair	8 Differential Channels

Internally, the device has four, dual-channel, fully differential A/Ds providing a total of eight differential channels. The analog input channels are therefore configured in four channel pairs with CH0/CH1 sensor inputs, CH2/CH3 sensor inputs, CH4/CH5 sensor inputs, and CH6/CH7 sensor inputs paired together. This channel-pairing requires the analog input channel pairs be configured to monitor the same category of temperature sensor. Mixing different sensor types of the same category (such as a type J thermocouple on channel 0 and a type T thermocouple on channel 1) is valid.
Channel configuration information is stored in the EEPROM of the isolated microcontroller by the firmware whenever any item is modified. Modification is performed by commands issued over USB from an external application, and the configuration is made non-volatile through the use of the EEPROM. The factory default configuration is Disabled. In Disabled mode, analog inputs are disconnected from the terminal blocks and all of the A/D inputs are internally grounded. This mode also disables each of the current excitation sources.

Compatible Sensors

Sensor	Conditions
Thermocouple	J: –210 to 1200
	K: –270 to 1372
	R: –50 to 1768
	S: –50 to 1768
	T: –270 to 400
	N: –270 to 1300
	E: –270 to 1000
	B: 0 to 1820
RTD (USB-5203 only)	100 Ω PT (DIN 43760: 0.00385 ohms/ohm/°C)
	100 Ω PT (SAMA: 0.003911 ohms/ohm/°C)
	100 Ω PT (ITS-90/IEC751: 0.0038505 ohms/ohm/°C)
Thermistor (USB-5203 only)	Standard 2,252 Ω Through 30,000 Ω
Semiconductor/IC (USB-5203 only)	LM35, TMP35 or Equivalent

Accuracy

Thermocouple Measurement Accuracy

Thermocouple measurement accuracy specifications include linearization, cold-junction compensation and system noise. These specs are for one year, or 3000 operating hours, whichever comes first, and for operation of the device between 15 °C and 35 °C. For measurements outside this range, add ±0.5° to the maximum error shown. There are CJC sensors on each side of the module. The accuracy listed above assumes the screw terminals are at the same temperature as the CJC sensor. Errors shown do not include inherent thermocouple error. Please contact the thermocouple supplier for details on the actual thermocouple error.
Thermocouples must be connected to the device such that they are floating with respect to GND. The device GND pins are isolated from earth ground, so connecting thermocouple sensors to voltages referenced to earth ground is permissible as long as the isolation between the GND pins and earth ground is maintained.
When thermocouples are attached to conductive surfaces, the voltage differential between multiple thermocouples must remain within ±1.4 V. For best results, MCC recommends using insulated or ungrounded thermocouples when possible.

USB-5200 Series

Specifications

Sensor Type	Maximum Error (°C)	Typical Error (°C)	Temperature Range (°C)
J	±1.499	±0.507	–210 to 0
	±0.643	±0.312	0 to 1200
K	±1.761	±0.538	–210 to 0
	±0.691	±0.345	0 to 1372
S	±2.491	±0.648	–50 to 250
	±1.841	±0.399	250 to 1768.1
R	±2.653	±0.650	–50 to 250
	±1.070	±0.358	250 to 1768.1
B	±1.779	±0.581	250 to 700
	±0.912	±0.369	700 to 1820
E	±1.471	±0.462	–200 to 0
	±0.639	±0.245	0 to 1000
T	±1.717	±0.514	–200 to 0
	±0.713	±0.256	0 to 600
N	±1.969	±0.502	–200 to 0
	±0.769	±0.272	0 to 1300

Semiconductor Sensor Measurement Accuracy (USB-5203 Only)

The error shown in the table below does not include errors of the sensor itself. These specs are for one year while operating the device between 15 °C and 35 °C. Contact the sensor supplier for details on the actual sensor error limitations.

Sensor Type	Temperature Range (°C)	Maximum Accuracy Error (°C)
LM35, TMP35, or Equivalent	–40 to 150	±0.50

RTD Measurement Accuracy (USB-5203 Only)

The error shown in the table below does not include errors of the sensor itself. Sensor linearization is performed using a Callendar-Van Dusen linearization algorithm. These specs are for one year while operating the device between 15 °C and 35 °C. The specification does not include lead resistance errors for 2-wire RTD connections. Contact the sensor supplier for details on the actual sensor error limitations.

In RTD mode, the device cannot measure resistance values greater than 660 Ω. The 660 Ω resistance limit includes the total resistance across the current excitation (Ix+/Ix–) pins, which is the sum of the RTD resistance and the lead resistances. For accurate three-wire compensation, the individual lead resistances connected to the Ix+/Ix– pins must be of equal value.

RTD	Sensor Temperature (°C)	Accuracy Error (°C) Ix+ = 210 µA	
		Maximum	Typical
PT100, DIN, US, or ITS-90	–200 to –150	±2.85	±2.59
	–150 to –100	±1.24	±0.97
	–100 to 0	±0.58	±0.31
	0 to 100	±0.38	±0.11
	100 to 300	±0.39	±0.12
	300 to 600	±0.40	±0.12

Thermistor Measurement Accuracy (USB-5203 Only)

The error shown in the table below does not include errors of the sensor itself. The sensor linearization is performed using a Steinhart-Hart linearization algorithm. These specs are for one year while operating the device between 15 °C and 35 °C. The specification does not include lead resistance errors for 2-wire thermistor connections. Contact the sensor supplier for details on the actual sensor error limitations.

Total thermistor resistance on any given channel pair must not exceed 180 kΩ.

Thermistor	Temperature Range (°C)	Maximum Accuracy Error (°C) Ix+ = 10 µA
2252 Ω	–40 to 120	±0.05
3000 Ω	–40 to 120	±0.05
5000 Ω	–35 to 120	±0.05
10000 Ω	–25 to 120	±0.05
30000 Ω	–10 to 120	±0.05

Typical Thermistor Resistance

Typical resistance values at various temperatures for supported thermistors are shown in the table below. The USB-5203 cannot measure resistance values greater than 180 kΩ in thermistor mode. The 180 kΩ resistance limit includes the total resistance across the current excitation (Ix+/Ix–) pins, which is the sum of the thermistor resistance and the lead resistances.

For accurate three-wire compensation, the individual lead resistances connected to the Ix+/Ix– pins must be of equal value.

Temp (°C)	Thermistor Resistance				
	2252 Ω	3000 Ω	5 kΩ	10 k Ω	30 kΩ
–40	76 kΩ	101 kΩ	168 kΩ	240 kΩ	885 kΩ
–35	55 kΩ	73 kΩ	121 kΩ	179 kΩ	649 kΩ
–30	40 kΩ	53 kΩ	88 kΩ	135 kΩ	481 kΩ
–25	29 kΩ	39 kΩ	65 kΩ	103 kΩ	360 kΩ
–20	22 kΩ	29 kΩ	49 kΩ	79 kΩ	271 kΩ
–15	16 kΩ	22 kΩ	36 kΩ	61 kΩ	206 kΩ
–10	12 kΩ	17 kΩ	28 kΩ	48 kΩ	158 kΩ
–5	9.5 kΩ	13 kΩ	21 kΩ	37 kΩ	122 kΩ
0	7.4 kΩ	9.8 kΩ	16 kΩ	29 kΩ	95 kΩ

Throughput Rate to PC

The analog inputs are configured to run continuously. Each channel is sampled twice per second. The maximum latency between when a sample is acquired and the temperature data is provided by the USB unit is approximately 0.5 s. The maximum throughput to a CompactFlash® memory card is 1 S/s per channel.

Number of Input Channels	Maximum Throughput
1	2 S/s
2	2 S/s per channel, 4 S/s total
3	2 S/s per channel, 6 S/s total
4	2 S/s per channel, 8 S/s total
5	2 S/s per channel, 10 S/s total
6	2 S/s per channel, 12 S/s total
7	2 S/s per channel, 14 S/s total
8	2 S/s per channel, 16 S/s total

USB-5200 Series

Specifications

Digital Input/Output

All ground pins on the device are common and are isolated from earth ground. If a connection is made to earth ground when using digital I/O and conductive thermocouples, the thermocouples are no longer isolated. In this case, thermocouples must not be connected to any conductive surfaces that may be referenced to earth ground.

Digital type: CMOS
Number of I/O: 8 (DIO0 through DIO7)
Configuration: Independently configured for input or output. Power on reset is input mode unless bit is configured for alarm.
Pull up/pull-down configuration: All pins pulled up to +5 V via 47 K resistors (default). Pull down to ground (GND) also available.
Digital I/O transfer rate (software paced)
Digital input: 50 port reads or single bit reads per second typ
Digital output: 100 port writes or single bit writes per second typ
Input high voltage: 2.0 V min, 5.5 V absolute max
Input low voltage: 0.8 V max, –0.5 V absolute min
Output low voltage (IOL = 2.5 mA): 0.7 V max
Output high voltage (IOH = –2.5 mA): 3.8 V min

Temperature Alarms

Number of alarms: 8 (one per digital I/O line)
Alarm functionality: Each alarm controls its associated digital I/O line as an alarm output. The input to each alarm can be any temperature input channel. When an alarm is enabled, its associated I/O line is set to output (after the device is reset) and driven to the appropriate state based on the alarm options and input temperature. Alarm configurations are stored in non-volatile memory and are loaded at power on. Alarms function both in data logging mode and USB mode.
Alarm input modes
Alarm when input temperature > T1
Alarm when input temperature > T1, reset alarm when input temperature goes below T2
Alarm when input temperature < T1
Alarm when input temperature < T1, reset alarm when input temperature goes above T2
Alarm when input temperature is < T1 or > T2
T1 and T2 may be independently set for each alarm.
Alarm output modes
Disabled: Digital I/O line may be used for normal operation
Enabled: Active high output (digital I/O line goes high when alarm conditions met)
Enabled: Active low output (digital I/O line goes low when alarm conditions met)
Alarm update rate: 1 second

Memory

EEPROM: 1,024 bytes isolated micro reserved for sensor configuration
256 bytes USB micro for external application use
256 bytes USB micro reserved for data logging configuration

Microcontroller

Type: Two high performance 8-bit RISC microcontrollers

Data Logging

Standalone power supply: 2.5 watt USB power adapter with interchangeable plugs (includes plug for USA)
Memory card type: CompactFlash
Supplied memory card: 512 MB CompactFlash card
Memory card host access: USB mass storage device
File systems supported: FAT16, FAT32 (the device only creates 8.3 file names in the root subdirectory)
Log file format: Binary
Logging rate: Min 1 second between entries, max 232 seconds, 1 second granularity
Data items logged: Timestamp, temperature, or raw reading from selected channels, state of DIO lines, CJC sensor readings
Logging start methods (software-selectable)
Start logging on power up: Logging begins 5 seconds after power on to allow hardware to settle.
Start logging on button: Device is idle on power on. Press and hold the button until the LED turns on to begin logging. The first sample is acquired 1 second after the LED turns on unless less than 5 seconds have elapsed since power on.
Start logging at specified time: Device is idle until the real-time clock indicates the time is equal to or greater than the specified time, at which time the LED turns on. The first sample is acquired 1 second after the LED turns on unless less than 5 seconds have elapsed since power on.
Logging stop methods
Stop on button press: To stop logging, press and hold the button until the LED turns off. The device caches logged data in volatile memory prior to writing to memory card. When logging, always use the button to stop logging and ensure data is written to memory card prior to removing power.
Logging status indication: The LED operations when connected to the AC power adapter are different than when connected to USB.
Logging modes
Logging off: The LED is off (disabled).
Start logging on power up: The LED turns on, but blinks off momentarily every time data is captured.
Start logging on button: The LED is initially off. When the button is pressed and held for approximately 1 second, the LED turns on and act the same as Start Logging on Power Up mode.
Start logging at specified time: the LED turns off, with a momentary on flash every second until the specified date/time is reached. At that time, the LED turns on and acts the same as Start Logging on Power Up mode.
Other indication: To stop logging and store the remaining data to memory card, press and hold the button until the LED turns off. It is then safe to remove the memory card.

If the memory card becomes full, the LED blinks rapidly (250 ms period).

If the memory card is removed while logging is in progress, the LED blinks rapidly (250 ms period). Inserting a memory card stops the LED from blinking.

Real-Time Clock

Battery backup: CR-2032 lithium coin cell, replaceable
Accuracy: ±1 minute per month

USB +5V Voltage

USB +5 V (VBUS) input voltage range: 4.75 V min to 5.25 V max

Power

Connected to USB
Supply current
USB enumeration: <100 mA
Continuous mode: 500 mA max (this is the total current requirement for the device which includes up to 10 mA for the status LED.
+5 V output voltage range (connected to a self-powered hub): 4.75 V min to 5.25 V max
+5 V output current connected to a self-powered hub): 10 mA max
Self-powered hub refers to a USB hub with an external power supply. Self-powered hubs allow a connected USB device to draw up to 500 mA. This device may not be used with bus-powered hubs due to the power supply requirements.

Root Port Hubs reside in the PC USB host controller. The USB port(s) on the PC are root port hubs. All externally powered root port hubs (desktop PC) provide up to 500 mA of current for a USB device. Battery-powered root port hubs provide 100 mA or 500 mA, depending upon the manufacturer. A laptop PC that is not connected to an external power adapter is an example of a battery-powered root port hub.
Isolation (measurement system to PC): 500 VDC min
Connected to AC adapter power supply for data logging
Output voltage: 5 V ±5%
Output wattage: 2.5 W
Input voltage: 100 VAC to 240 VAC, 50 Hz to 60 Hz
Input current: 0.2 A

USB Specifications

USB device type: USB 2.0 (full-speed)
Device compatibility: USB 1.1, USB 2.0; self-powered, 500 mA consumption max
USB cable type: A-B cable, UL type AWM 2725 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D–)
USB cable length: 3 m (9.84 ft) max

Current Excitation Outputs (Ix+) (USB-5203 Only)

The device has four current excitation outputs, with I1+/I1– dedicated to the CH0/CH1 analog inputs, I2+/I2– dedicated to CH2/CH3, I3+/I3– dedicated to CH4/CH5, and I4+/I4– dedicated to CH6/CH7. The excitation output currents should always be used in this dedicated configuration.

The current excitation outputs are automatically configured based on the sensor (thermistor or RTD) selected.
Configuration: 4 dedicated pairs

USB-5200 Series

Specifications & Ordering

MEASUREMENT COMPUTING

Current Excitation Output	AI Channel
I1+/I1–	CH0/CH1
I2+/I2–	CH2/CH3
I3+/I3–	CH4/CH5
I4+/I4–	CH6/CH7

Current excitation output ranges
Thermistor: 10 µA typ
RTD: 210 µA typ
Tolerance: ±5% typ
Drift: 200 ppm/°C
Line regulation: 2.1 ppm/V max
Load regulation: 0.3 ppm/V typ
Output compliance voltage (relative to GND): 3.90 V max, –0.03 V min

Environmental

Operating temperature range: 0 °C to 70 °C
Storage temperature range: –40 °C to 85 °C
Humidity: 0% to 90% non-condensing

Mechanical

Dimensions (L × W × H): 128.52 x 88.39 × 35.56 mm (5.06 × 3.48 × 1.43 ft)
User connection length: 3 m (9.84 ft) max

Screw Terminal Connector

Connector type: Screw terminal
Wire gauge range: 16 AWG to 30 AWG

Ordering Information

Part No.	Description
USB-5201	USB-based 8-channel thermocouple input data logger (CompactFlash) with high/low alarms, 8 digital I/O lines. Includes USB cable, USB power adapter, and MCC DAQ software CD.
USB-5203	USB-based 8-channel temperature data logger (CompactFlash) supports 4 sensor types, with high/low alarms, 8 digital I/O lines. Includes USB cable, USB power adapter, and MCC DAQ software CD.

Accessories

Part No.	Description
745690-E001	E-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 1 m
745690-E002	E-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 2 m
745690-J001	J-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 1 m
745690-J002	J-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 2 m
745690-K001	K-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 1 m
745690-K002	K-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 2 m
745690-T001	T-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 1 m
745690-T002	T-type thermocouples wire, fiberglass (0 °C to 482 °C, 32 °F to 900 °F), 2 m
745691-01	3-wire, 100 ohm RTD, sealed with alumina tube, 1 m
745691-02	3-wire, 100 ohm RTD, platinum (ready made), 2 m
512 MB CF Card	CompactFlash card for Measurement Computing data loggers, 512 MB
1 GB CF Card	CompactFlash card for Measurement Computing data loggers, 1 GB
2 GB CF Card	CompactFlash card for Measurement Computing data loggers, 2 GB

Software also Available from MCC

Part No.	Description
DAQami	Easy-to-use advanced data logging application 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