User's Guide

OM-USB-5203
8 Channel Temperature Measurement
USB Data Acquisition
Module/Data Logger

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The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.
WARNING: These products are not designed for use in, and should not be used for, human applications.

Table of Contents

About this User's Guide

What you will learn from this user's guide

This user's guide explains how to install, configure, and use the OM-USB-5203 so that you get the most out of its temperature measurement and data logging features.

This user's guide also refers you to related documents available on our web site, and to technical support resources.

Conventions in this user's guide

For more information on …

Text presented in a box signifies additional information and helpful hints related to the subject matter you are reading.

Caution!	Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.
<#:#>	Angle brackets that enclose numbers separated by a colon signify a range of numbers, such as those assigned to registers, bit settings, etc.
bold text	**Bold** text is used for the names of objects on the screen, such as buttons, text boxes, and check boxes. For example: **1.** Insert the disk or CD and click the **OK** button.
italic text	*Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase. For example: *Never* touch the exposed pins or circuit connections on the board.

Where to find more information

For additional information relevant to the operation of your hardware, refer to the *Documents* subdirectory where you installed the software, or search for your device on our website at www.omega.com.

Introducing the OM-USB-5203

Overview: OM-USB-5203 features

This user's guide contains all of the information you need to connect the OM-USB-5203 to your computer and to the signals you want to measure.

The OM-USB-5203 is a USB 2.0 full-speed, temperature measurement device that is supported under popular Microsoft® Windows® operating systems. The OM-USB-5203 is fully compatible with both USB 1.1 and USB 2.0 ports.

The OM-USB-5203 provides eight differential input channels that are software-programmable for different sensor categories including thermocouple, RTDs, thermistors and semiconductor sensors.

Eight independent, TTL-compatible digital I/O channels are provided to monitor TTL-level inputs, communicate with external devices, and to generate alarms. The digital I/O channels are software-programmable for input or output.

With the OM-USB-5203, you can take measurements from four sensor categories:

- Thermocouple – types J, K, R, S, T, N, E, and B
- Resistance temperature detectors (RTDs) – 2, 3, or 4-wire measurements of 100 _ platinum RTDs
- Thermistors – 2, 3, or 4-wire measurements
- Semiconductor temperature sensors – LM36 or equivalent

The OM-USB-5203 provides a 24-bit analog-to-digital (A/D) converter for each pair of differential analog input channels. Each pair of differential inputs constitutes a channel pair.

You can connect a different category of sensor to each channel pair, but you cannot mix categories among the channels that constitute a channel pair (although it is permissible to mix thermocouple types).

The OM-USB-5203 provides two integrated cold junction compensation (CJC) sensors for thermocouple measurements, and built-in current excitation sources for resistive sensor measurements.

An open thermocouple detection feature lets you detect a broken thermocouple. An on-board microprocessor automatically linearizes the measurement data according to the sensor category.

The OM-USB-5203 features eight independent temperature alarms. 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. The output of each alarm is software configurable as active high or low. You set up the temperature threshold conditions to activate each alarm. When an alarm is activated, the associated DIO channel is driven to the output state.

You can log your sensor measurements to a CompactFlash® memory card. CompactFlash is a removable non-volatile storage device. A 512 MB CompactFlash memory card is shipped with the device to store your data. For more information, refer to the section "Logging data with the OM-USB-5203" on page 7.

External power is required for data logging operations

Due to processing limitations, data logging to the memory card is not allowed when the OM-USB-5203 is connected to your computer's active USB bus. When operating as a data logger, disconnect the USB cable from the computer, and connect the external power supply shipped with the device.

The OM-USB-5203 is a standalone plug-and-play device. External power is required for data logging mode only. All configurable options are software programmable. The OM-USB-5203 is fully software calibrated.

Logging data with the OM-USB-5203

The OM-USB-5203 has many software-configurable options for setting up data logging.

You can record:

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

You can also specify the number of seconds between samples. You can begin logging data at power up, when you press the data logging button, or at a specific date and time.

OM-USB-5203 block diagram

OM-USB-5203 functions are illustrated in the block diagram shown here.
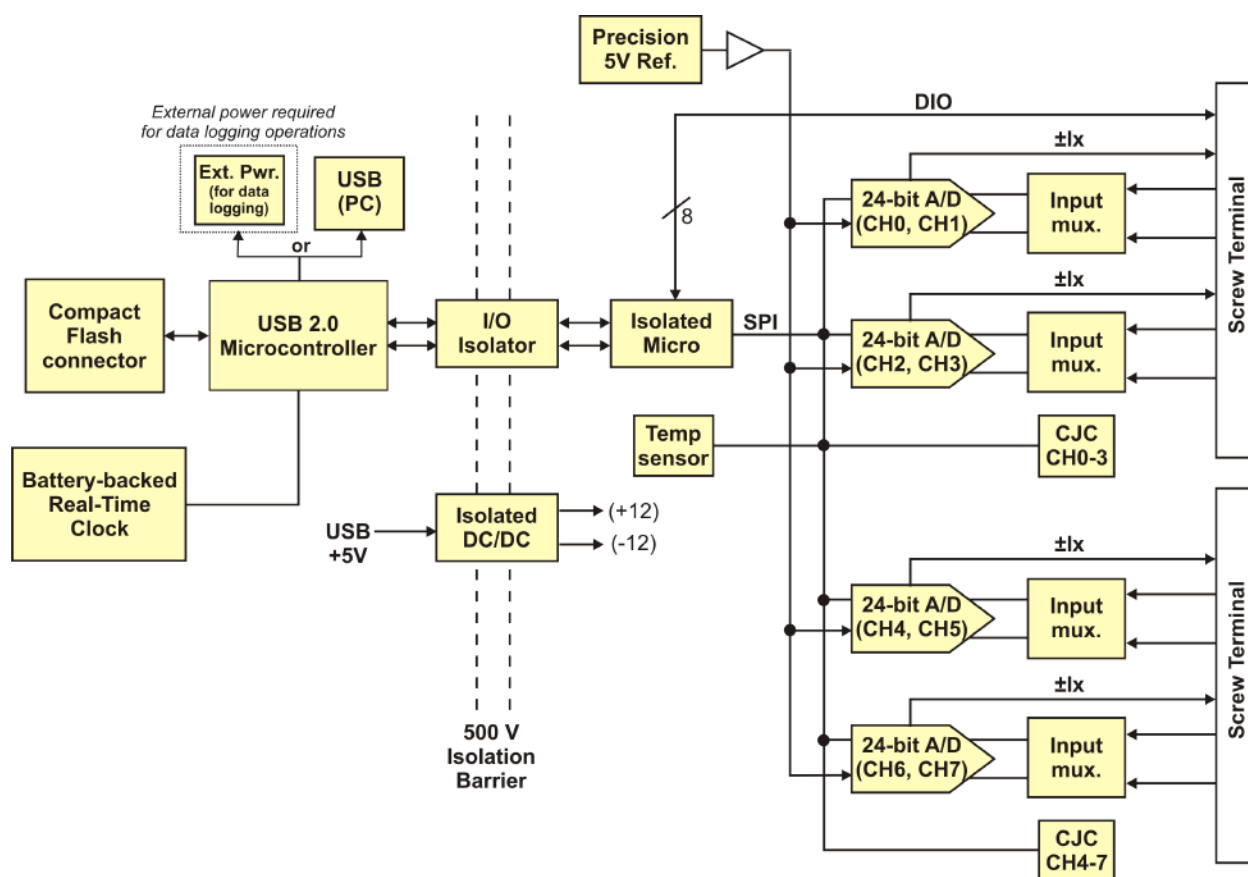
Figure 1. OM-USB-5203 functional block diagram

Software features

For information on the features of *Insta*Cal and the other software included with your OM-USB-5203, refer to the *OMB-DAQ-2416 Series and OM-USB Series Data Acquisition Software User's Guide* that shipped with your device.

Connecting a OM-USB-5203 to your computer is easy

Installing a data acquisition device has never been easier.

- The OM-USB-5203 relies upon the Microsoft Human Interface Device (HID) class drivers. The HID class drivers ship with every copy of Windows that is designed to work with USB ports. We use the Microsoft HID because it is a standard, and its performance delivers full control and maximizes data transfer rates for your OM-USB-5203. No third-party device driver is required.
- In addition to utilizing the HID class drivers, the OM-USB-5203 also utilizes the Mass Storage Device interface to allow the CompactFlash Card adapter to appear as a storage device. This feature allows direct access to data files stored on the OM-USB-5203.
- The OM-USB-5203 is plug-and-play. There are no jumpers to position, DIP switches to set, or interrupts to configure.
- You can connect the OM-USB-5203 before or after you install the software, and without powering down your computer first. When you connect an HID to your system, your computer automatically detects it and configures the necessary software. You can connect and power multiple HID peripherals to your system using a USB hub.
- You can connect your system to various devices using a standard four-wire cable. The USB connector replaces the serial and parallel port connectors with one standardized plug and port combination.
- You do not need a separate power supply device for normal operation. The USB automatically delivers the electrical power required by each peripheral connected to your system. *However, for data logging operations, an external power supply is required.*
- Data can flow two ways between a computer and peripheral over USB connections.

Installing the OM-USB-5203

What comes with your OM-USB-5203 shipment?

The following items are shipped with the OM-USB-5203.

Hardware

The following items should be included with your shipment.

- OM-USB-5203 with memory card

- USB cable (2 meter length)

- External power supply – 2.5 watt USB adapter for data logging operations.
  Omega part number *USB Power Adapter*.

Additional documentation

In addition to this hardware user's guide, you should also receive the *OMB-DAQ-2416 Series and OM-USB Series Data Acquisition Software User's Guide*). This booklet supplies a brief description of the software you received with your OM-USB-5203 and information regarding installation of that software. Please read this booklet completely before installing any software or hardware.

Unpacking the OM-USB-5203

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the OM-USB-5203 from its packaging, ground yourself using a wrist strap or by simply touching the computer chassis or other grounded object to eliminate any stored static charge.

If any components are missing or damaged, notify Omega Engineering immediately by phone, fax, or e-mail.

- Phone: (203) 359-1660
- Fax: (203) 359-7700
- Email: das@omega.com

Installing the software

Refer to the *OMB-DAQ-2416 Series and OM-USB Series Data Acquisition Software User's Guide* for instructions on installing the software on the *OMB-DAQ-2416 Series and OM-USB Series Data Acquisition Software* CD. This booklet is available in PDF at http://omega.com/manuals.

Installing the hardware

To connect the OM-USB-5203 to your system, turn your computer on, and connect the USB cable to a USB port on your computer or to an external USB hub that is connected to your computer. The USB cable provides power and communication to the OM-USB-5203.

Caution!	If you are connecting the OM-USB-5203 to an external self-powered hub, connect the USB hub to the computer *before* you connect the device to the hub. This ensures that the device detects the hub as an active USB port.

The OM-USB-5203 installs as a composite device with separate devices attached. When you connect the OM-USB-5203 for the first time, **Found New Hardware** popup balloons (Windows XP) or dialogs (other Windows version) open as each OM-USB-5203 interface is detected.

It is normal for multiple dialogs to open when you connect the OM-USB-5203 for the first time. For additional information, refer to the "*Notes on installing and using the OM-USB-5201 and OM-USB-5203 data logging devices*" that shipped with the OM-USB-5203.

When the last balloon or dialog closes, the installation is complete. The LED on the OM-USB-5203 should flash and then remain lit. This indicates that communication is established between the OM-USB-5203 and your computer.

Caution!	Do not disconnect **any** device from the USB bus while the computer is communicating with the OM-USB-5203, or you may lose data and/or your ability to communicate with the OM-USB-5203.

If the LED turns off

If the LED is lit but then turns off, the computer has lost communication with the OM-USB-5203. To restore communication, disconnect the USB cable from the computer, and then reconnect it. This should restore communication, and the LED should turn back on.

Configuring the OM-USB-5203

All hardware configuration options on the OM-USB-5203 are programmable with software. Use *Insta*Cal to set the sensor type for each channel.

The configurable options dynamically update according to the selected sensor category. Configuration options are stored on the OM-USB-5203 's isolated microcontroller in EEPROM, which is non-volatile memory on the OM-USB-5203 device. Configuration options are loaded on power up.

Default configuration

The factory default sensor type configuration is *Disabled*. The disabled mode disconnects the analog inputs from the terminal blocks and internally grounds all of the A/D inputs. This mode also disables each of the current excitation sources.

Warm up

Allow the OM-USB-5203 to warm up for 30 minutes before taking measurements. This warm up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

For RTD or thermistor measurements, this warm-up time is also required to stabilize the internal current reference.

Configuring data logging options

The following data logging options are programmable with *Insta*Cal.

- select the input channels to log
- set the data format
- set the start mode
- set up alarm conditions
- copy and convert saved binary files
- delete data files

All data logging options are stored on the OM-USB-5203 in non-volatile memory in EEPROM, and are loaded on power up.

Calibrating the OM-USB-5203

The OM-USB-5203 is fully calibrated with *Insta*Cal. Calibration coefficients are stored in EEPROM. *Insta*Cal prompts you to run its calibration utility when you change from one sensor category to another.

Allow the OM-USB-5203 to operate for at least 30 minutes before calibrating. This warm up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

Sensor Connections

The OM-USB-5203 supports the following temperature sensor types:

- Thermocouple – types J, K, R, S, T, N, E, and B
- Resistance temperature detectors (RTDs) – 2, 3, or 4-wire measurement modes of 100 _ platinum RTDs.
- Thermistors – 2, 3, or 4-wire measurement modes.
- Semiconductor temperature sensors – LM36 or equivalent

Sensor selection

The type of sensor you select will depend on your application needs. Review the temperature ranges and accuracies of each sensor type to determine which is best suited for your application.

Screw terminal pin out

The OM-USB-5203 has four rows of screw terminals — two rows on the top edge of the housing, and two rows on the bottom edge. Each row has 26 connections. Between each bank of screw terminals are two integrated CJC sensors used for thermocouple measurements. Signals are identified in Figure 2.
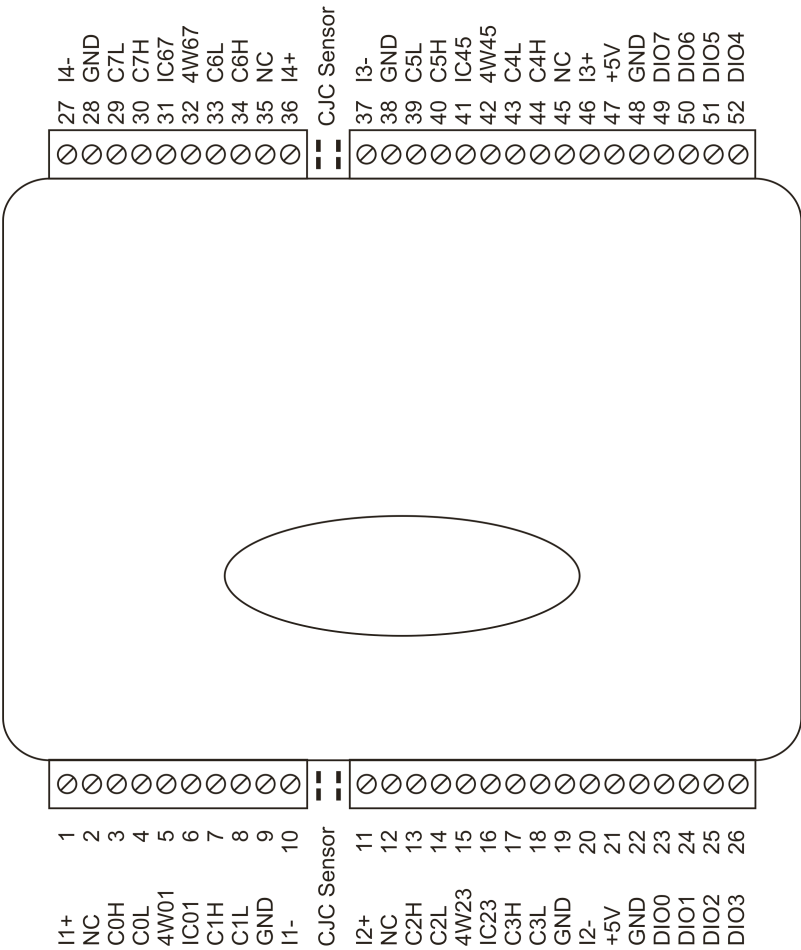
Figure 2. OM-USB-5203 screw terminal pin numbers

OM-USB-5203 screw terminal descriptions

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	I1+	CH0/CH1 current excitation source	27	I4-	CH6/CH7 current excitation return
2	NC	Not connected	28	GND	Ground
3	C0H	CH0 sensor input (+)	29	C7L	CH7 sensor input (-)
4	C0L	CH0 sensor input (-)	30	C7H	CH7 sensor input (+)
5	4W01	CH0/CH1 4-wire, 2 sensor common	31	IC67	CH6/CH7 2 sensor common
6	IC01	CH0/CH1 2-sensor common	32	4W67	CH6/CH7 4-wire, 2 sensor common
7	C1H	CH1 sensor input (+)	33	C6L	CH6 sensor input (-)
8	C1L	CH1 sensor input (-)	34	C6H	CH6 sensor input (+)
9	GND	Ground	35	NC	Not connected
10	I1-	CH0/CH1 current excitation return	36	I4+	CH6/CH7 current excitation source
	CJC sensor			CJC sensor	
11	I2+	CH2/CH3 current excitation source	37	I3-	CH4/CH5 current excitation return
12	NC	Not connected	38	GND	Ground
13	C2H	CH2 sensor input (+)	39	C5L	CH5 sensor input (-)
14	C2L	CH2 sensor input (-)	40	C5H	CH5 sensor input (+)
15	4W23	CH2/CH3 4-wire, 2 sensor common	41	IC45	CH4/CH5 2 sensor common
16	IC23	CH2/CH3 2 sensor common	42	4W45	CH4/CH5 4-wire, 2 sensor common
17	C3H	CH3 sensor input (+)	43	C4L	CH4 sensor input (-)
18	C3L	CH3 sensor input (-)	44	C4H	CH4 sensor input (+)
19	GND	Ground	45	NC	Not connected
20	I2-	CH2/CH3 current excitation return	46	I3+	CH4/CH5 current excitation source
21	+5V	+5V output	47	+5V	+5V output
22	GND	Ground	48	GND	Ground
23	DIO0	Digital Input/output	49	DIO7	Digital Input/output
24	DIO1	Digital Input/output	50	DIO6	Digital Input/output
25	DIO2	Digital Input/output	51	DIO5	Digital Input/output
26	DIO3	Digital Input/output	52	DIO4	Digital Input/output

Use 16 AWG to 30 AWG wire for your signal connections.

Tighten screw terminal connections

When making connections to the screw terminals, fully tighten the screw. Simply touching the top of the screw terminal is not sufficient to make a proper connection.

Sensor input terminals (C0H/C0L to C7H/C7L)

You can connect up to eight temperature sensors to the differential sensor inputs (C0H/C0L to C7H/C7L). Supported sensor categories include thermocouples, RTDs, thermistors, or semiconductor sensors.

Do not mix sensor categories within channel pairs. It is permitted to mix thermocouple types (J, K, R, S, T, N, E, and B) within channel pairs, however.

Do not connect two different sensor categories to the same channel pair

The OM-USB-5203 provides a 24 bit A/D converter for each channel pair. Each channel pair can monitor one sensor category. To monitor a sensor from a different category, connect the sensor to a different channel pair (input terminals).

Current excitation output terminals (±I1 to ±I4)

The OM-USB-5203 has four dedicated pairs of current excitation output terminals (±**I1** to ±**I4**). These terminals have a built-in precision current source to provide excitation for the resistive sensors used for RTD and thermistor measurements.

Each current excitation terminal is dedicated to one pair of sensor input channels:

- I1+ is the current excitation source for channel 0 and channel 1
- I2+ is the current excitation source for channel 2 and channel 3
- I3+ is the current excitation source for channel 4 and channel 5
- I4+ is the current excitation source for channel 6 and channel 7

Four-wire, two sensor common terminals (4W01 to 4W67)

These terminals are used as the common connection for four-wire configurations with two RTD or thermistor sensors.

Two sensor common terminals (IC01 to IC67)

These terminals are used as the common connection for two-wire configurations with two RTD or thermistor sensors.

Ground terminals (GND)

The six ground terminals (**GND**) provide a common ground for the input channels and DIO bits and are isolated (500 VDC) from the USB GND.

Power terminals (+5V)

The two **+5V** output terminals are isolated (500 VDC) from the USB +5V.

Caution!   Each +5V terminal is an output. Do not connect to an external power supply to these terminals or you may damage the OM-USB-5203 and possibly the computer.

Digital terminals (DIO0 to DIO7)

You can connect up to eight digital I/O lines to the screw terminals labeled **DIO0** to **DIO7**. Each terminal is software-configurable for input or output.

If a digital bit is set up as an alarm, the bit is configured for output on power-up, and assumes the state defined by the alarm configuration.

CJC sensors

The OM-USB-5203 has two built in high-resolution temperature sensors. One sensor is located on the right side of the package, and one sensor is located on the left side.

Thermocouple connections

A thermocouple consists of two dissimilar metals that are joined together at one end. When the junction of the metals is heated or cooled, a voltage is produced that correlates to temperature.

The OM-USB-5203 makes 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.

Use *Insta*Cal to select the thermocouple type (J, K, R, S, T, N, E, and B) and one or more sensor input channels to connect the thermocouple.

Wiring configuration

Connect the thermocouple to the OM-USB-5203 using a differential configuration, as shown in Figure 3.
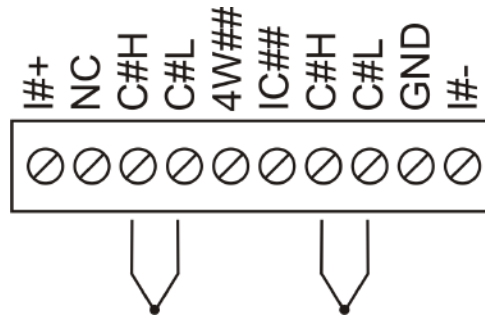

Figure 3. Typical thermocouple connection

The OM-USB-5203 **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 (9, 19, 28, 38) 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, we recommend the use of insulated or ungrounded thermocouples when possible.

Maximum input voltage between analog input and ground

The absolute maximum input voltage between an analog input and the isolated GND pins is ±25 VDC when the OM-USB-5203 is powered on, and ±40 VDC when the OM-USB-5203 is powered off.

If you need to increase the length of your thermocouple, use the same type of thermocouple wires to minimize the error introduced by thermal EMFs.

RTD and thermistor connections

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

RTDs and thermistors are resistive devices that require an excitation current to produce a voltage drop that can be measured differentially across the sensor. The OM-USB-5203 features 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 OM-USB-5203 makes two, three, and four-wire measurements of RTDs (100 _ platinum type) and thermistors.

Use *Insta*Cal to select the sensor type and the wiring configuration. Once the resistance value is calculated, the value is linearized in order to convert it to a temperature value. A 32-bit floating point value in either temperature or resistance is returned by software.

RTD maximum resistance

Resistance values greater than 660 Ω cannot be measured by the OM-USB-5203 in the RTD mode. The 660 Ω resistance limit includes the total resistance across the current excitation (±Ix) pins, which is the sum of the RTD resistance and the lead resistances.

Thermistor maximum resistance

Resistance values greater than 180 kΩ cannot be measured by the OM-USB-5203 in the thermistor mode. 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.

Two-wire configuration

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

Since 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 will result in a 1% measurement error.

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

Two-wire, single-sensor

A two-wire single-sensor measurement configuration is shown in Figure 4.

Figure 4. Two-wire, single RTD or thermistor sensor measurement configuration

When you select a two-wire single sensor configuration with *Insta*Cal, connections to C#H and C#L are made internally.

Two-wire, two sensor

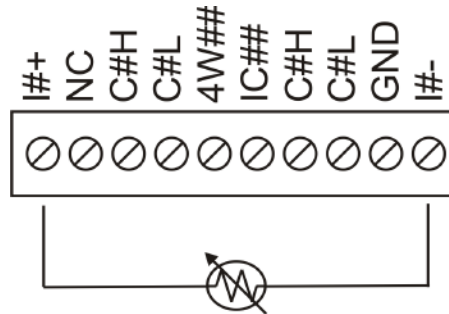A two-wire, two-sensor measurement configuration is shown in Figure 5.
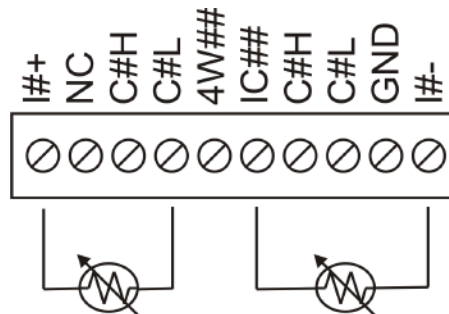

Figure 5. Two-wire, two RTD or thermistor sensors measurement configuration

When you select a two-wire, two sensor configuration with *Insta*Cal, 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.

Three-wire configuration

A three-wire configuration compensates for lead-wire resistance by using a single-voltage sense connection. With a three-wire configuration, you can connect only one sensor per channel pair. A three-wire measurement configuration is shown in Figure 6.
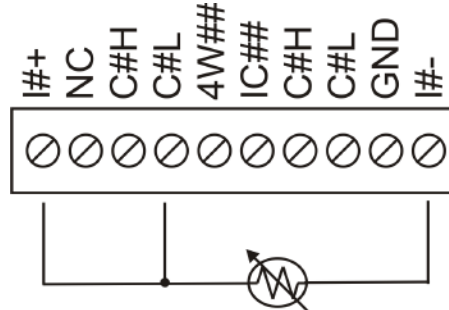
Figure 6. Three-wire RTD or thermistor sensor measurement configuration

When you select a three-wire sensor configuration with *Insta*Cal, the OM-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 compensation

For accurate three wire compensation, the individual lead resistances connected to the ±I# pins must be of equal resistance value.

Four-wire configuration

With a four-wire configuration, connect two sets of sense/excitation wires 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.

Connect your sensor with a four-wire configuration when your application requires very high accuracy measurements. Examples of a four-wire single-sensor measurement configuration are shown in Figure 7 and Figure 8.

You can configure the OM-USB-5203 with either a single-sensor-per-channel, or a two-sensor–per-channel pair.

Four-wire, single-sensor

A four-wire, single-sensor connected to the first channel of a channel pair is shown in Figure 7.
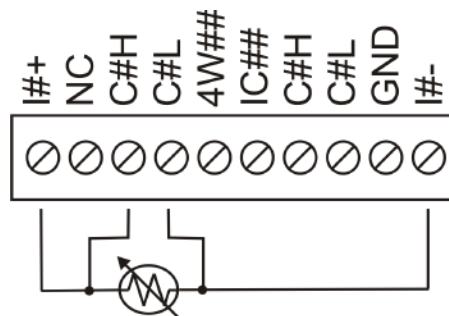
Figure 7. Four-wire, single RTD or thermistor sensor measurement configuration

A four-wire, single-sensor connected to the second channel of a channel pair is shown in Figure 8.
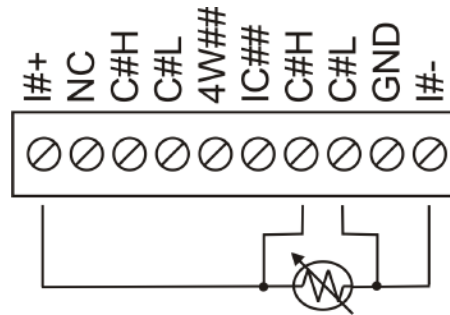
Figure 8. Four-wire, single RTD or thermistor sensor measurement configuration

A four-wire, two-sensor measurement configuration is shown in Figure 9.
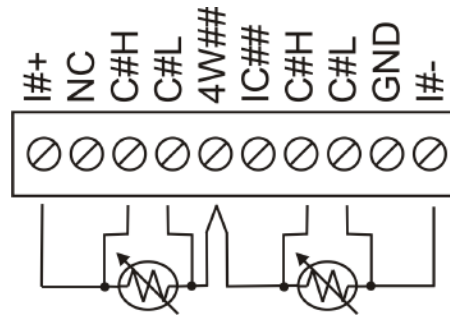
Figure 9. Four-wire, two RTD or thermistor sensors measurement configuration

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

Semiconductor sensor measurements

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 OM-USB-5203 makes high-resolution measurements of semiconductor sensors, such as the LM36 or equivalent, and returns a 32-bit floating point value in either a voltage or temperature format.

Use *Insta*Cal to select the sensor type (TMP36 or equivalent) and the sensor input channel to connect the sensor.

Wiring configuration

You can connect a TMP36 (or equivalent) semiconductor sensor to the OM-USB-5203 using a single-ended configuration, as shown in Figure 10. The OM-USB-5203 also provides **+5V** and **GND** pins for powering the sensor.

Figure 10. Semiconductor sensor measurement configuration

The software outputs the measurement data as a 32-bit floating point value in either voltage or temperature.

Digital I/O connections

You can connect up to eight digital I/O lines to the screw terminals labeled **DIO0** to **DIO7**. All digital I/O lines are pulled up to +5V with a 47 kΩ resistor (default). You can request the factory to configure the resistor for pull-down to ground if desired. You can configure each digital bit for either input or output.

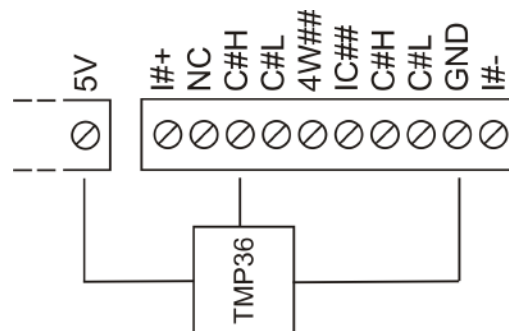|	
Caution!	If a digital bit is set up as an alarm, the bit will be configured for output on power-up, and assume the state defined by the alarm configuration.

When you configure the digital bits for input, you can use the OM-USB-5203 digital I/O terminals to detect the state of any TTL-level input. Refer to the schematic shown in Figure 11. If you set the switch to the +5V input, DIO0 reads *TRUE* (1). If you move the switch to GND, DIO0 reads *FALSE* (0).
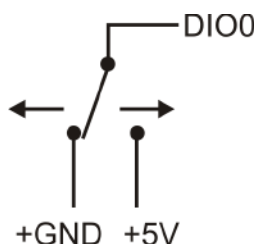
Figure 11. Schematic showing switch detection by digital channel DIO0

Caution!	All ground pins on the OM-USB-5203 (pins 9, 19, 28, 38) 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.

For general information regarding digital signal connections and digital I/O techniques, refer to the *Guide to Signal Connections* (available on our web site at http://www.omega.com/manuals/manualpdf/M4830.pdf).

Configuring the DIO channels to generate alarms

The OM-USB-5203 features eight independent temperature alarms. All alarm options are software configurable.

When a digital bit is configured as an alarm, that bit will be configured as an output on the next power cycle and assume 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. You 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. The temperature alarms function both in data logging mode and while attached to the USB port on a computer.

Functional Details

Thermocouple measurements

A thermocouple consists of two dissimilar metals that are joined together at one end. When the junction of the metals is heated or cooled, a voltage is produced that correlates to temperature.

The OM-USB-5203 hardware level-shifts the thermocouple's output voltage into the A/D's common mode input range by applying +2.5 V to the thermocouple's low side at the C#L input. Always connect thermocouple sensors to the OM-USB-5203 in a floating fashion. Do not attempt to connect the thermocouple low side C#L to GND or to a ground referencing resistor.

Cold junction compensation (CJC)

When you connect the thermocouple sensor leads to the sensor input channel, the dissimilar metals at the OM-USB-5203 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 OM-USB-5203 subtracts the *cold junction* voltage from the thermocouple voltage.

The OM-USB-5203 has two high-resolution temperature sensors that are integrated into the design of the OM-USB-5203. One sensor is located on the right side of the package, and one 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 analog input's thermocouple voltage measurement.

Increasing the thermocouple length

If you need to increase the length of your thermocouple, use the same type of thermocouple wires to minimize the error introduced by thermal EMFs.

Data linearization

After the CJC correction is performed on the measurement data, an on-board microcontroller automatically linearizes the thermocouple measurement data using National Institute of Standards and Technology (NIST) 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 (OTD)

The OM-USB-5203 is equipped with an open-thermocouple detection 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 open-thermocouple detection enabled, 105 nA (max.) 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 you are measuring. You can estimate this error voltage with the following formula:

error voltage = resistance of the thermocouple x 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

RTDs and thermistors are resistive devices that require an excitation current to produce a voltage drop that can be measured differentially across the sensor. The OM-USB-5203 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 voltage measurement is made, the resistance of the RTD is calculated using Ohms law – the sensor resistance is calculated by dividing the measured voltage by the current excitation level ($\pm$**Ix**) source. The value of the $\pm$**Ix** source is stored in local memory.

Once the resistance value is calculated, the value is linearized in order to convert it to a temperature value. The measurement is returned by software as a 32-bit floating point value in a voltage, resistance or temperature format.

Data linearization

An on-board microcontroller automatically performs linearization on RTD and thermistor measurements.

- RTD measurements are linearized using a Callendar-Van Dusen coefficients algorithm (you select DIN, SAMA, or ITS-90).
- Thermistor measurements are linearized using a Steinhart-Hart linearization algorithm (you supply the coefficients from the sensor manufacturer's data sheet).

External components

The OM-USB-5203 has the following external components, as shown in Figure 12.

- Screw terminals
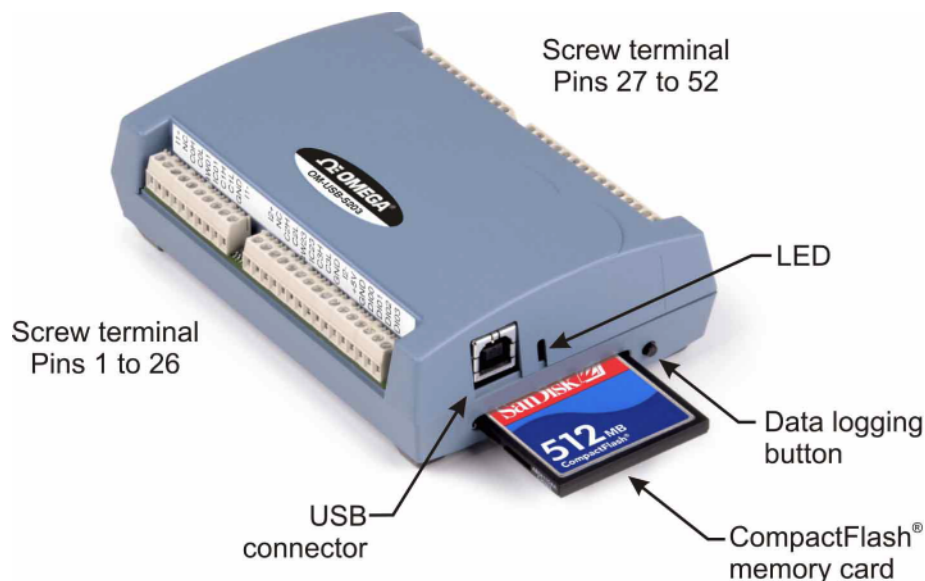- USB connector
- LED
- CompactFlash slot with memory card

Figure 12. OM-USB-5203 component locations

Screw terminals

The device's four banks of screw terminals are for connecting temperature sensors and digital I/O lines. These terminals also provide ground and power output connections. Refer to the "Sensor Connections" chapter for screw terminal descriptions.

USB connector

When not logging data, connect the USB cable to a USB port on your computer or to an external USB hub that is connected to your computer. When connected to an active USB bus, the device's USB connector provides +5 V power and communication. The voltage supplied through the USB connector is system-dependent, and may be less than 5 V. No external power supply is required.

Due to processing limitations, you cannot log data when the device is attached to an active USB bus. For data logging operations, connect the device's USB connector to the external power supply.

LED

The LED uses up to 5 mA of current. The function of the LED varies according to whether the OM-USB-5203 is connected to an active USB port, or when the device is logging data and connected to the external power supply.

The table below lists the function of the LED when the device is connected to an active USB port and not logging data.

LED function when the OM-USB-5203 is connected to an active USB port

LED Illumination	Indication
Steady green	The OM-USB-5203 is connected to a computer or external USB hub.
Blinks continuously	Data is being transferred. Upon connection, the LED should flash a few times and then remain lit (indicates a successful installation).
Blinks several times	Initial communication is established between the OM-USB-5203 and the computer.
Off	The OM-USB-5203 is not connected to an active USB port.

The table below lists the function of the LED when the device is connected to the external supply and is logging data. The function of the LED varies according to the selected logging mode.

LED function when the OM-USB-5203 is logging data

Logging mode	LED Illumination	Indication
Logging off	The LED is off.	The OM-USB-5203 is not logging data, and/or the device is not powered
Start Logging on Power Up	The LED turns on when external power is connected, then blinks each time data is captured.	Blinks when logging data.
Start Logging on Button	The LED stays off until the data logging button is pressed and held for approximately 1 second. At that time, the LED turns on and blinks each time data is captured.	Blinks when logging data.
Start Logging at Specified Time	The LED is off – blinks on once per second until the specified date/time to start logging is reached. At that time, the LED turns on – blinks off each time data is captured.	Blinks on once per second until specified data/time to log data occurs. Then it turns on and blinks each time data is captured.
Any logging mode	Blinks rapidly (250 ms period) and continuously.	▪ The memory card is full. ▪ The memory card was removed during logging. Insert the memory card again to stop the device blinking.

CompactFlash® memory card slot

The CompactFlash slot accepts standard memory cards. A 512 MB memory card is shipped with the device. For extensive data logging, you can insert a higher capacity card of up to 2 GB. You must format the memory card before logging data for the first time.

Data logging button

The data logging button is used to end a data logging session. The data logging button is also used to start recording data when the logging mode is set in *Insta*Cal to *Start Logging on Button*.

- *To begin recording data*, press and hold the button until the LED begins to blink. The first sample is taken one second after the LED illuminates.

  When you first power on the OM-USB-5203, wait at least five seconds before pressing the data logging button. To achieve rated accuracy, allow the OM-USB-5203 to warm up for 30 minutes before logging data.

- *To stop recording data*, press and hold the button again until the LED is off.

Caution!   To prevent loss of data, always use the button to stop logging. Make sure the data is written to the memory card before you disconnect the device from the power source.

The device caches log data in volatile memory prior to writing to the memory card.

Pressing the data logging button has no effect when the OM-USB-5203 is connected to an active USB port and not logging data.

> **External power required for data logging**
>
> Due to processing limitations, data logging is not allowed when the OM-USB-5203 is attached to an active USB bus. The OM-USB-5203 must be connected to the standalone power supply to perform data logging.

External power supply

The external power supply is used to power the OM-USB-5203 during data logging operations. This power supply is a 2.5 W USB power adapter.

Disconnecting the OM-USB-5203 from the computer

You don't need to shut down your computer to disconnect the OM-USB-5203. Refer to the instructions below when disconnecting the OM-USB-5203 from your computer's USB port.

When running Windows XP, use the Unplug or Eject icon on the computer's taskbar to safely stop the OM-USB-5203 before you unplug the device. To do this, right-click on the icon, select the OM-USB-5203 and click **Stop**. Windows will notify you when it is safe to disconnect the device from your computer.

When running Windows 2000, the Unplug or Eject icon does not appear in the taskbar when the OM-USB-5203 is connected to the USB port. Do not disconnect the OM-USB-5203 from the computer when the device's LED is flashing (transferring data), or data may be lost. When you disconnect the device, an Unsafe Removal of Device warning may appear. However, no data is lost on the device when you remove the OM-USB-5203 when the LED is steady green. This information applies to all OM-USB-5203 devices, regardless of the firmware version installed.

Transferring binary data after a logging session

Data is stored on the memory card in binary files. After logging measurements, you can transfer the files to your computer by reconnecting the OM-USB-5203 to a USB port on your computer or by removing the CompactFlash card from the OM-USB-5203 and using a card reader connected to your computer.

Note that when installed with firmware version 3 and later the OM-USB-5203 appears as a Mass Storage Device when connected to a USB port on your computer, so you can copy files using Windows Explorer.

Converting binary data after a logging session

If your OM-USB-5203 is connected to a USB port on your computer, you can use *Insta*Cal or TracerDAQ to convert the files on the CompactFlash card to .CSV format for use in Microsoft Excel files, or to .TXT format for use in other applications.

If you transferred binary files to your computer hard drive or removed the CompactFlash card from your OM-USB-5203 and are using a card reader connected to your computer, use TracerDAQ to import the files and save them as .CSV or.TXT format. *Insta*Cal can only convert files when the CompactFlash card is in a OM-USB-5203 connected to your computer.

Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.
Specifications in *italic* text are guaranteed by design.

Analog input section

Table 1. Generic analog input specifications

Parameter	Conditions	Specification
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 programmable to match sensor type
Differential input voltage range for the various sensor categories	Thermocouple	±0.080 V
	RTD	0 to 0.5 V
	Thermistor	0 to 2 V
	Semiconductor sensor	0 to 2.5 V
Absolute maximum input voltage	*±C0x through ±C7x relative to GND (pins 9, 19, 28, 38)*	±25 V power on, ±40 V power off.
Input impedance		5 Gigohm, min.
Input leakage current	Open thermocouple detect disabled	30 nA max.
	Open thermocouple detect enabled	105 nA max.
Normal mode rejection ratio	$f_{IN} = 60\ Hz$	90 dB min.
Common mode rejection Ratio	$f_{IN} = 50\ Hz/60\ Hz$	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 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 to +0.5°C max*

Channel configurations

Table 2. Channel configuration specifications

Sensor Category	Conditions	Max number of sensors (all channels configured alike)
Disabled		
Thermocouple	J, K, S, R, B, E, T, or N	8 differential channels
Semiconductor sensor		8 differential channels
RTD and thermistor	2-wire input configuration with a single sensor per channel pair	4 differential channels
	2-wire input 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 input configuration with a single sensor per channel pair	4 differential channels
	4-wire input configuration with two sensors per channel pair	8 differential channels

Note 1: 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.

Note 2: 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.

Note 3: The factory default configuration is *Disabled*. The Disabled mode will disconnect the analog inputs from the terminal blocks and internally ground all of the A/D inputs. This mode also disables each of the current excitation sources.

Compatible sensors

Table 3. Compatible sensor type specifications

Parameter	Conditions
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
RTD	100 ohm PT (DIN 43760: 0.00385 ohms/ohm/°C)
	100 ohm PT (SAMA: 0.003911 ohms/ohm/°C)
	100 ohm PT (ITS-90/IEC751:0.0038505 ohms/ohm/°C)
Thermistor	Standard 2,252 ohm through 30,000 ohm
Semiconductor / IC	TMP36 or equivalent

Accuracy

Thermocouple measurement accuracy

Table 4. Thermocouple accuracy specifications, including CJC measurement error

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

Note 4: 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 degree 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 your thermocouple supplier for details on the actual thermocouple error.

Note 5: Thermocouples must be connected to the device such that they are floating with respect to GND (pins 9, 19, 28, 38). 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.

Note 6: When thermocouples are attached to conductive surfaces, the voltage differential between multiple thermocouples must remain within ±1.4 V. For best results we recommend the use of insulated or ungrounded thermocouples when possible.

Semiconductor sensor measurement accuracy

Table 5. Semiconductor sensor accuracy specifications

Sensor Type	Temperature Range (°C)	Maximum Accuracy Error
TMP36 or equivalent	-40 to 150°C	±0.50°C

Note 7: Error shown does not include errors of the sensor itself. These specs are for one year while operation of the device is between 15°C and 35°C. Please contact your sensor supplier for details on the actual sensor error limitations.

RTD measurement accuracy

Table 6. RTD measurement accuracy specifications

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

Note 8: Error shown does not include errors of the sensor itself. The sensor linearization is performed using a Callendar-Van Dusen linearization algorithm. These specs are for one year while operation of the device is between 15 °C and 35 °C. The specification does not include lead resistance errors for 2-wire RTD connections. Please contact your sensor supplier for details on the actual sensor error limitations.

Note 9: Resistance values greater than 660 ohms cannot be measured by the device in the RTD mode. The 660 ohm resistance limit includes the total resistance across the current excitation (±Ix) pins, which is the sum of the RTD resistance and the lead resistances.

Note 10: For accurate three wire compensation, the individual lead resistances connected to the ±Ix pins must be of equal value.

Thermistor measurement accuracy

Table 7. Thermistor measurement accuracy specifications

Thermistor	Temperature Range	Maximum Accuracy Error (°C) I_{x+} = 10 µA
2252 Ω	-40 to 120°C	±0.05
3000 Ω	-40 to 120°C	±0.05
5000 Ω	-35 to 120°C	±0.05
10000 Ω	-25 to 120°C	±0.05
30000 Ω	-10 to 120°C	±0.05

Note 11: Error shown 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 operation of the device is between 15°C and 35°C. The specification does not include lead resistance errors for 2-wire thermistor connections. Please contact your sensor supplier for details on the actual sensor error limitations. Total thermistor resistance on any given channel pair must not exceed 180 k ohms. Typical resistance values at various temperatures for supported thermistors are shown in Table 8.

Table 8. Typical thermistor resistance specifications

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

Note 12: Resistance values greater than 180k ohms cannot be measured by the device in the thermistor mode. The 180 k ohm resistance limit includes the total resistance across the current excitation (±Ix) pins, which is the sum of the thermistor resistance and the lead resistances.

Note 13: For accurate three wire compensation, the individual lead resistances connected to the ±Ix pins must be of equal value.

Throughput rate to PC

Table 9. Throughput rate specifications

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

Note 14: 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 seconds. Throughput to CompactFlash memory card is limited to 1 S/s per channel.

Digital input/output

Table 10. Digital input/output specifications

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.

Note 15: All ground pins on the device (pins 9, 19, 28, 38) 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.

Temperature alarms

Table 11. Temperature alarm specifications

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 may be any of the analog temperature input channels. 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 determined by the alarm options and input temperature. The alarm configurations are stored in non-volatile memory and are loaded at power on. Alarms will function both in data logging mode and while attached to USB.
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 **Note**: 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

Table 12. Memory specifications

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

Table 13. Microcontroller specifications

Type	Two high performance 8-bit RISC microcontrollers

Data Logging

Table 14. Data logging specifications

Standalone power supply	USB power adapter (part number OM-USB-Adapter): 2.5 Watt USB adapter with interchangeable plugs (includes plug for USA)
Memory card type	CompactFlash
Supplied memory card	512 MB CFCard: 512 MB Compact Flash Card for Omega Engineering dataloggers
Memory card host access	USB Mass Storage Device (MSD)
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 2^{32} 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	Configurable: ▪ 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 button until LED comes on to begin logging. The first sample will be taken 1 second after LED comes 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 will come on. The first sample will be taken 1 second after LED comes on unless less than 5 seconds have elapsed since power on. **Note**: Data logging is not allowed when the device is attached to an active USB bus due to processing limitations. The device must be connected to the standalone power supply to perform data logging.
Logging stop methods	Stop on button press – To stop logging, press and hold button until LED turns off. **Note**: The device caches log 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 adapter power supply are different than when connected to USB: Logging modes: ▪ Logging Off mode: the LED is off (disabled). ▪ Start Logging on Power Up mode: the LED is on, with a momentary off flash every time data is captured. ▪ Start Logging on Button mode: the LED is initially off. When the button is pressed and held for approximately 1 second the LED will turn on and act the same as Start Logging on Power Up mode. ▪ Start Logging at Specified Time mode: the LED is off, with a momentary on flash every second until the specified date/time is reached. At that time, the LED will turn on and act 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 will blink rapidly (250 ms period). ▪ If the memory card is removed while logging is in progress the LED will blink rapidly (250 ms period). Inserting a memory card will stop the blinking.

Real time clock

Table 15. Real time clock specifications

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

USB +5V voltage

Table 16. USB +5V voltage specifications

Parameter	Conditions	Specification
USB +5V (VBUS) input voltage range		4.75 V min. to 5.25 V max.

Power

Table 17. Power specifications

Parameter	Conditions	Specification
Connected to USB		
Supply current	USB enumeration	<100 mA
Supply current (Note 16)	Continuous mode	500 mA max.
User +5V output voltage range (terminal block pin 21 and 47)	Connected to a self-powered hub. (Note 17)	4.75 V min. to 5.25 V max.
User +5V output current (terminal block pin 21 and pin 47)	Connected to a self-powered hub. (Note 17)	10 mA max.
Isolation	Measurement system to PC	500 VDC min.
AC Adapter Power Supply (used for data logging operation)		
Output voltage		5V ±5%
Output wattage		2.5W
Input voltage		100 – 240 VAC 50 – 60 Hz
Input current		0.2A

Note 16: This is the total current requirement for the device which includes up to 10 mA for the status LED.

Note 17: 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's USB Host Controller. The USB port(s) on your PC are root port hubs. All externally powered root port hubs (desktop PC's) 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.

USB specifications

Table 18. 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 2527 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D-)*
USB cable length	3 meters max.

Current excitation outputs (Ix+)

Table 19. Current excitation output specifications

Parameter	Conditions	Specification
Configuration		4 dedicated pairs: ±I1 - CH0/CH1 ±I2 - CH2/CH3 ±I3 - CH4/CH5 ±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 pins 9, 19, 28, 38)		3.90 V max. -0.03 V min.

Note 18: The device has four current excitation outputs, with ±I1 dedicated to the CH0/CH1 analog inputs, ±I2 dedicated to CH2/CH3, ±I3 dedicated to CH4/CH5, and ±I4 dedicated to CH6/CH7. The excitation output currents should always be used in this dedicated configuration.

Note 19: The current excitation outputs are automatically configured based on the sensor (thermistor or RTD) selected.

Environmental

Table 20. Environmental specifications

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

Mechanical

Table 21. Mechanical specifications

Dimensions	127 mm (L) x 88.9 mm (W) x 35.56 (H)
User connection length	3 meters max.

Screw terminal connector type and pin out

Table 22. Screw terminal connector specifications

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

Screw terminal pin out

Table 23. Screw terminal pin out

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	I1+	CH0/CH1 current excitation source	27	I4-	CH6/CH7 current excitation return
2	NC		28	GND	
3	C0H	CH0 sensor input (+)	29	C7L	CH7 sensor input (-)
4	C0L	CH0 sensor input (-)	30	C7H	CH7 sensor input (+)
5	4W01	CH0/CH1 4-wire, 2 sensor common	31	IC67	CH6/CH7 2 sensor common
6	IC01	CH0/CH1 2-sensor common	32	4W67	CH6/CH7 4-wire, 2 sensor common
7	C1H	CH1 sensor input (+)	33	C6L	CH6 sensor input (-)
8	C1L	CH1 sensor input (-)	34	C6H	CH6 sensor input (+)
9	GND		35	NC	
10	I1-	CH0/CH1 current excitation return	36	I4+	CH6/CH7 current excitation source
	CJC sensor			CJC sensor	
11	I2+	CH2/CH3 current excitation source	37	I3-	CH4/CH5 current excitation return
12	NC		38	GND	
13	C2H	CH2 sensor input (+)	39	C5L	CH5 sensor input (-)
14	C2L	CH2 sensor input (-)	40	C5H	CH5 sensor input (+)
15	4W23	CH2/CH3 4-wire, 2 sensor common	41	IC45	CH4/CH5 2 sensor common
16	IC23	CH2/CH3 2 sensor common	42	4W45	CH4/CH5 4-wire, 2 sensor common
17	C3H	CH3 sensor input (+)	43	C4L	CH4 sensor input (-)
18	C3L	CH3 sensor input (-)	44	C4H	CH4 sensor input (+)
19	GND		45	NC	
20	I2-	CH2/CH3 current excitation return	46	I3+	CH4/CH5 current excitation source
21	+5V	+5V output	47	+5V	+5V output
22	GND		48	GND	
23	DIO0	Digital Input/Output	49	DIO7	Digital Input/Output
24	DIO1	Digital Input/Output	50	DIO6	Digital Input/Output
25	DIO2	Digital Input/Output	51	DIO5	Digital Input/Output
26	DIO3	Digital Input/Output	52	DIO4	Digital Input/Output

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