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OM-USB-TC-AI
8 Channel Thermocouple/Voltage Input USB Data Acquisition Module

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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-TC-AI so that you get the most out of its USB-based thermocouple and voltage measurement 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-TC-AI

Overview: OM-USB-TC-AI features

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

The OM-USB-TC-AI is a USB 2.0 full-speed, thermocouple input module that is supported under popular Microsoft® Windows® operating systems. The OM-USB-TC-AI is fully compatible with both USB 1.1 and USB 2.0 ports.

The OM-USB-TC-AI provides eight analog input channels that are configured as four differential temperature inputs and four differential or single-ended voltage inputs. A 24-bit analog-to-digital (A/D) converter is provided for each pair of analog inputs. 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.

The temperature channels are software programmable for different thermocouple types. You can take measurements from type J, K, R, S, T, N, E, and B thermocouples.

The voltage input range is software programmable for ±10 V, ±5 V, ±2.5 V, ±1.25 V.

The OM-USB-TC-AI provides a integrated cold junction compensation (CJC) sensor for thermocouple measurements. An open thermocouple detection feature lets you detect a broken thermocouple.

An on-board microprocessor automatically linearizes the measurement data.

The OM-USB-TC-AI is a standalone plug-and-play module which draws power from the USB cable. No external power supply is required. All configurable options are software programmable.

The OM-USB-TC-AI is fully software calibrated.

OM-USB-TC-AI block diagram

OM-USB-TC-AI functions are illustrated in the block diagram shown here.

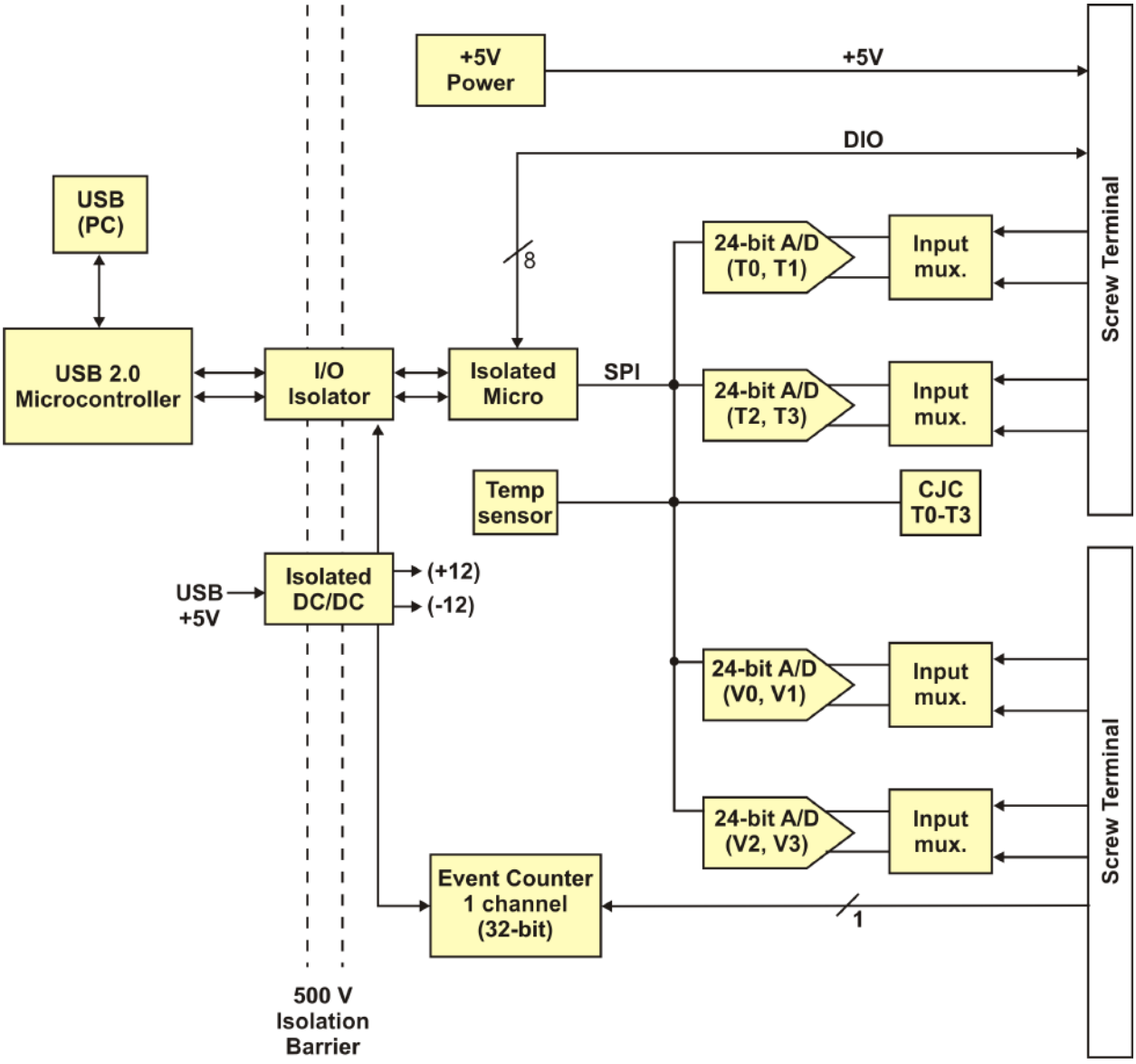

Figure 1. OM-USB-TC-AI functional block diagram

Software features

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

Connecting a OM-USB-TC-AI to your computer is easy

Installing a data acquisition device has never been easier.

- The OM-USB-TC-AI 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-TC-AI. No third-party device driver is required.
- The OM-USB-TC-AI is plug-and-play. There are no jumpers to position, DIP switches to set, or interrupts to configure.
- You can connect the OM-USB-TC-AI 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 USB 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 module. The USB automatically delivers the electrical power required by each peripheral connected to your system.
- Data can flow two ways between a computer and peripheral over USB connections.

Installing the OM-USB-TC-AI

What comes with your OM-USB-TC-AI shipment?

The following items are shipped with the OM-USB-TC-AI.

Hardware

- OM-USB-TC-AI

- USB cable (2 meter length)

Additional documentation

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

Unpacking the OM-USB-TC-AI

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the OM-USB-TC-AI 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 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.

We recommend that you download the latest Windows Update onto your computer before installing and operating the OM-USB-TC-AI.

Installing the OM-USB-TC-AI

To connect the OM-USB-TC-AI 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-TC-AI.

When you connect the OM-USB-TC-AI for the first time, a notification message opens as the OM-USB-TC-AI is detected. When this message closes, the installation is complete. The **USB LED** should flash and then remain lit. This indicates that communication is established between the OM-USB-TC-AI and your computer.

If the LED turns off

If the LED is lit but then turns off, the computer has lost communication with the OM-USB-TC-AI. 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-TC-AI

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

Use *Insta*Cal to set the thermocouple type for each for each pair of temperature channels, and the range and input configuration of each voltage channel. Any channel you don't intend to use should be left disabled.

Configuration options are stored on the OM-USB-TC-AI 's isolated microcontroller in EEPROM, which is non-volatile memory on the OM-USB-TC-AI module. Configuration options are loaded on power up. The factory default configuration is *Type J* thermocouple.

Default configuration

The factory default configuration for the voltage inputs is *Disabled*. The Disabled mode disconnects the analog inputs from the terminal blocks and internally grounds all of the A/D inputs.

Warm up

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

Calibrating the OM-USB-TC-AI

The OM-USB-TC-AI is fully calibrated via *Insta*Cal. Allow the OM-USB-TC-AI to operate for at least 30 minutes before calibrating. This warm up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

Signal I/O Connections

Screw terminal pin out

The OM-USB-TC-AI 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 screw terminals 10 and 11 is the integrated CJC sensor used for thermocouple measurements. Signals are identified in Figure 2.

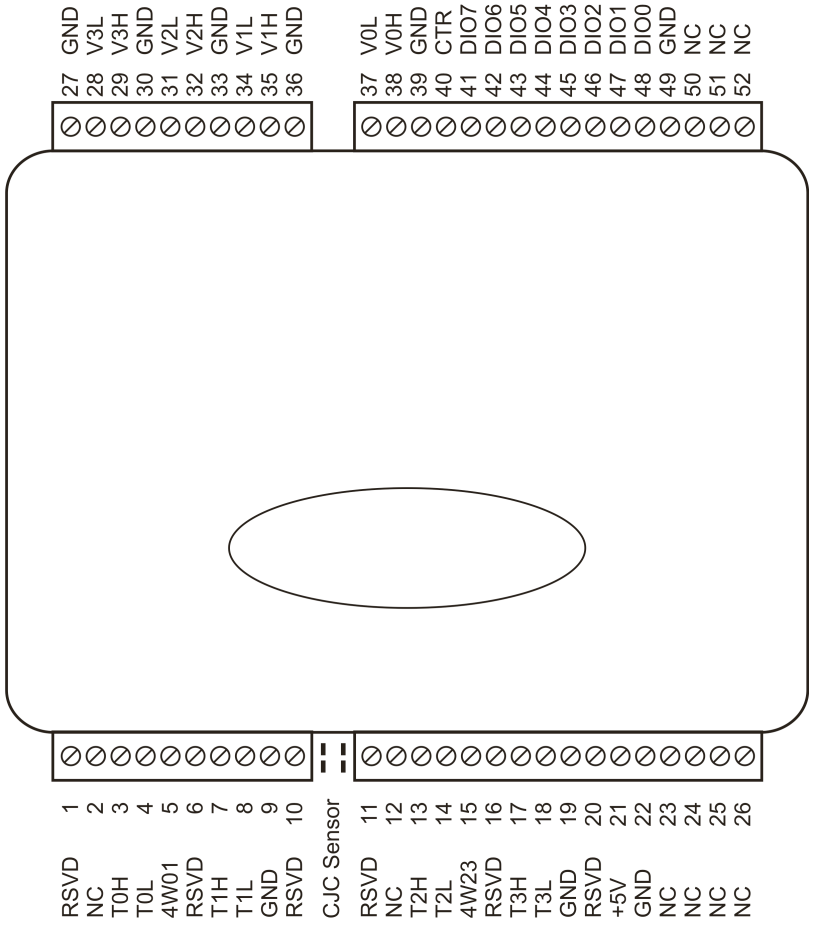

Figure 2. OM-USB-TC-AI screw terminal pin numbers

OM-USB-TC-AI screw terminal descriptions

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	RSVD	Reserved, Do Not Use	27	GND	
2	NC		28	V3L	V3 voltage input (-)
3	T0H	T0 sensor input (+)	29	V3H	V3 voltage input (+)
4	T0L	T0 sensor input (-)	30	GND	
5	4W01	T0/T1 4-wire, 2 sensor common	31	V2L	V2 voltage input (-)
6	RSVD	Reserved, Do Not Use	32	V2H	V2 voltage input (+)
7	T1H	T1 sensor input (+)	33	GND	
8	T1L	T1 sensor input (-)	34	V1L	V1 voltage input (-)
9	GND		35	V1H	V1 voltage input (+)
10	RSVD	Reserved, Do Not Use	36	GND	
	CJC sensor				
11	RSVD	Reserved, Do Not Use	37	V0L	V0 voltage input (-)
12	NC		38	V0H	V0 voltage input (+)
13	T2H	T2 sensor input (+)	39	GND	
14	T2L	T2 sensor input (-)	40	CTR	Counter Input
15	4W23	T2/T3 4-wire, 2 sensor common	41	DIO7	Digital Input/Output
16	RSVD	Reserved, Do Not Use	42	DIO6	Digital Input/Output
17	T3H	T3 sensor input (+)	43	DIO5	Digital Input/Output
18	T3L	T3 sensor input (-)	44	DIO4	Digital Input/Output
19	GND		45	DIO3	Digital Input/Output
20	RSVD	Reserved, Do Not Use	46	DIO2	Digital Input/Output
21	+5V	+5V output	47	DIO1	Digital Input/Output
22	GND		48	DIO0	Digital Input/Output
23	NC		49	GND	
24	NC		50	NC	
25	NC		51	NC	
26	NC		52	NC	

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

Tighten screw terminal connections

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

Voltage input terminals (±V0H/V0L to ±V3H/V3L)

You can connect up to four voltage inputs to the voltage channels (V0H/V0L to V3H/V3L). The input range is software programmable for ±10 V, ±5 V, ±2.5 V, or ±1.25 V. Each voltage channel is software configurable for differential or single-ended mode.

When connecting differential inputs to floating input sources, you must provide a DC return path from each differential input to ground. One way to do this is to connect a resistor from one side of each of the differential inputs to GND. A value of approximately 100 k_ can be used for most applications.

All ground pins on the OM-USB-TC-AI (pins 9, 19, 22, 27, 30, 33, 36, 39, 49) 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.

Thermocouple input terminals (T0H/T0L to T3H/T3L)

You can connect up to four thermocouples to the differential sensor inputs (T0H/T0L to T3H/T3L). The OM-USB-TC-AI supports type J, K, R, S, T, N, E, and B thermocouples. You can mix thermocouple types (J, K, R, S, T, N, E, and B).

Thermocouple selection

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

Ground terminals (GND)

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

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.

Counter terminal (CTR)

The **CTR** terminal (pin 40) is the input to the 32-bit event counter. The internal counter increments when the TTL level transitions from low to high. The counter can count events at frequencies of up to 1 MHz.

Caution! All ground pins on the OM-USB-TC-AI (pins 9, 19, 22, 27, 30, 33, 36, 39, 49) 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.

CJC sensor

The OM-USB-TC-AI has one built-in high-resolution temperature sensor. The CJC sensor measures the ambient temperature at the terminal block so that the cold junction voltage can be calculated.

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-TC-AI 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 thermocouple 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) on one or more sensor input channels to connect the thermocouple.

Wiring configuration

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

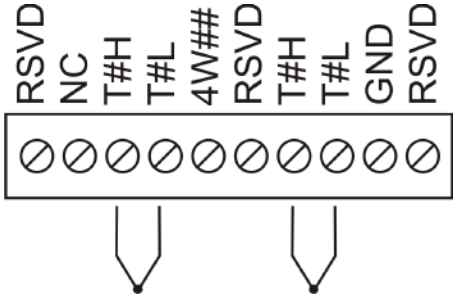

Figure 3. Typical thermocouple connection

Connect thermocouples to the OM-USB-TC-AI such that they are floating with respect to GND (pins 9, 19, 28, 38). The OM-USB-TC-AI **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-TC-AI is powered on, and ±40 VDC when the OM-USB-TC-AI 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.

Digital I/O connections

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

When you configure the digital bits for input, you can use the OM-USB-TC-AI digital I/O terminals to detect the state of a TTL-compatible device. Refer to the schematic shown in Figure 4. If you set the switch to the +5V input, DIO0 reads *TRUE* (1). If you move the switch to GND, DIO0 reads *FALSE* (0).

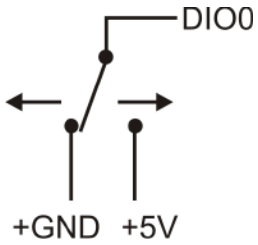

Figure 4. Schematic showing switch detection by digital channel DIO0

All ground pins on the OM-USB-TC-AI (pins 9, 19, 22, 27, 30, 33, 36, 39, 49) 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).

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-TC-AI 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-TC-AI 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-TC-AI terminal blocks produce two additional thermocouple junctions. 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-TC-AI subtracts the *cold junction* voltage from the thermocouple voltage.

The OM-USB-TC-AI has one high-resolution temperature sensor integrated into the design. The CJC sensor measures the average temperature at the terminal block 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-TC-AI is equipped with 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.

USB connector

The USB connector provides +5V power and communication. No external power supply is required.

LED

The LED indicates the communication status of the OM-USB-TC-AI. It uses up to 5 mA of current. The table below defines the function of the OM-USB-TC-AI LED.

LED Illumination

LED Illumination	**Indication**
Steady green	The OM-USB-TC-AI is connected to a computer or external USB hub.
Pulsing green	Data is being transferred. Upon connection, the LED should flash three times and then remain lit (indicates a successful installation).

Power

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

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

Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.
All specifications apply to all temperature and voltage input channels unless otherwise specified.
Specifications in *italic* text are guaranteed by design.

Analog input

Table 1. Generic analog input specifications

Parameter	Conditions	Specification
A/D converter type	T0x-T3x, V0x-V3x	AD42_321 Dual 24-bit Sigma-Delta
Number of channels	Voltage input V0x-V3x	4 differential 4 single-ended
	Temperature input T0x-T3x	4 differential
Input isolation		*500 VDC minimum between field wiring and USB interface*
Channel configuration	T0x-T3x	Temperature input. Software programmable to match sensor type
	V0x-V3x	Voltage input
Analog input modes	Power up and reset state	Factory default configuration is Disabled mode. Once configured, each channel reverts to the mode previously set by the user.
	Single-ended	Vx_H inputs are connected directly to their screw terminal pins. Vx_L inputs are disconnected from their screw terminal pins and internally connected to GND.
	Differential	Vx_H and Vx_L inputs are connected directly to their screw terminal pins.
		Tx_H and Tx_L inputs are connected directly to their screw terminal pins.
Input ranges	Thermocouple T0x-T3x	±0.080 V
	Voltage V0x-V3x	±10 V, ±5 V, ±2.5 V, ±1.25 V software selectable
Absolute maximum input voltage	*T0x-T3x relative to GND (pins 9, 19, 22, 27, 30, 33, 36, 39, 49)*	*±25 V maximum (power on)* *±40 V maximum (power off)*
	V0x-V3x relative to GND (pins 9, 19, 22, 27, 30, 33, 36, 39, 49)	*±25 V maximum (power on)* *±15 V maximum (power off)*
Input impedance	*T0x-T3x*	*5 Gigohm (power on)* *1Mohm (power off)*
	V0x-V3x	*10 Gigohm (power on)* *2.49 kohm (power off)*
Input leakage current	*T0x-T3x, with open thermocouple detect disabled.*	*30 nA maximum*
	T0x-T3x, with open thermocouple detect enabled.	*105 nA maximum*
	V0x-V3x	*±1.5 nA typical., ±25 nA maximum*

Parameter	Conditions	Specification
Input bandwidth (-3 dB)	T0x-T3x	50 Hz
	V0x-V3x	3 kHz
Maximum working voltage (signal + common mode)	V0x-V3x	±10.25 V maximum
Common mode rejection ratio	*T0x-T3x, f_{IN} = 60 Hz*	*100 dB*
	V0x-V3x, f_{IN} = 60 Hz, all input ranges	*83 dB*
ADC Resolution		24 bits
ADC No missing codes		*24 bits*
Input coupling		DC
Warm-up time		30 minutes minimum
Open thermocouple detect	T0x-T3x	Automatically enabled when the channel pair is configured for thermocouple sensor. The maximum open detection time is 3 seconds.
CJC sensor accuracy	T0x-T3x, *15 °C to 35 °C*	*±0.25 °C typical,±0.5 °C maximum*
	T0x-T3x, *0°C to 70 °C*	*–1.0 to +0.75 °C maximum*

Channel configurations

Table 2. Channel configuration specifications

Channel	Category	Conditions	Specification
T0x-T3x	Disabled	All temperature input channels are disconnected from screw terminals and internally connected to GND.	See Note 4
T0x-T3x	Thermocouple Note 1		4 differential channels
V0x-V3x	Disabled	All voltage input channels are disconnected from screw terminals and internally connected to GND.	See Note 4
V0x-V3x	Differential Note 2		4 differential channels
V0x-V3x	Single-ended		4 single-ended channels

Note 1: Internally, the OM-USB-TC-AI has four, dual-channel, fully differential A/Ds providing a total of eight input channels.

Note 2: When connecting differential inputs to floating input sources, you must provide a DC return path from each differential input to ground. To do this, connect a resistor from each of the differential inputs to GND. A value of approximately 1Meg ohm can be used for most applications.

Note 3: 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 4: The factory default configuration is **Disabled**. The Disabled mode will disconnect the temperature and voltage inputs from the terminal blocks and internally connect ground (GND) to all of the A/D inputs.

Compatible sensors: T0x-T3x

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

Accuracy

Thermocouple measurement accuracy: T0x-T3x

Table 4. Thermocouple accuracy specifications, including CJC measurement error. All specifications are (±)

Sensor Type	Sensor temperature range	Accuracy error maximum (°C)	Accuracy error typical (°C)	Tempco (°C/°C)
J	-210 °C	2.028	0.707	0.031
	0 °C	0.835	0.278	
	1200 °C	0.783	0.288	
K	-210 °C	2.137	0.762	0.035
	0 °C	0.842	0.280	
	1372 °C	0.931	0.389	
S	-50 °C	1.225	0.435	0.021
	250 °C	0.554	0.195	
	1768 °C	0.480	0.157	
R	-50 °C	1.301	0.458	0.019
	250 °C	0.549	0.190	
	1768 °C	0.400	0.134	
B	250 °C	2.193	2.185	0.001
	700 °C	0.822	0.819	
	1820 °C	0.469	0.468	
E	-200 °C	1.976	0.684	0.030
	0 °C	0.954	0.321	
	1000 °C	0.653	0.240	
T	-200 °C	2.082	0.744	0.035
	0 °C	0.870	0.290	
	400 °C	0.568	0.208	
N	-200 °C	2.197	0.760	0.028
	0 °C	0.848	0.283	
	1300 °C	0.653	0.245	

Note 5: Thermocouple measurement accuracy specifications include polynomial 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 OM-USB-TC-AI between 15 °C and 35 °C. There is a CJC sensor on the temperature sensor input 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. Contact your thermocouple supplier for details on the actual thermocouple accuracy error.

Note 6: Thermocouples must be connected to the OM-USB-TC-AI such that they are floating with respect to GND (pins 9, 19, 22, 27, 30, 33, 36, 39, 49). The OM-USB-TC-AI GND pins are isolated from earth ground. You can connect thermocouple sensors to voltages referenced to earth ground as long as the isolation between the GND pins and earth ground is maintained.

Note 7: When thermocouples are attached to conductive surfaces, the voltage differential between multiple thermocouples must remain within ±1.4 V. For best results, we recommend using insulated or ungrounded thermocouples when possible.

Absolute Accuracy: V0x-V3x

Table 5. Calibrated absolute accuracy specifications

Range	Absolute Accuracy (mV)
±10 V	±2.779
±5 V	±1.398
±2.5 V	±0.707
±1.25 V	±0.362

Note 8: When connecting differential inputs to floating input sources, the user must provide a ground return path from each differential input to ground. To do this, simply connect a resistor from each of the differential inputs to GND. A value of approximately 1Meg ohm can be used for most applications.

Note 9: All ground pins on the OM-USB-TC-AI (pins 9, 19, 22, 27, 30, 33, 36, 39, 49) are common and are isolated from earth ground. If a connection is made to earth ground when using both voltage inputs 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

Note 10: Unused voltage inputs should not be left floating. These inputs should be placed in the Disabled mode or connected to GND.

Table 6. Accuracy components. All values are (±)

Range	Gain error (% of reading)	Offset error (µV)	INL error (% of range)	Gain Temperature Coefficient (ppm/°C)	Offset Temperature Coefficient (µV/°C)
±10 V	0.0246	16.75	0.0015	3.68	0.42
±5 V	0.0246	16.75	0.0015	3.68	0.42
±2.5 V	0.0246	16.75	0.0015	3.68	0.42
±1.25 V	0.0246	16.75	0.0015	3.68	0.42

Table 7. Noise performance specifications

Range	Peak to peak noise (µV)	RMS noise (µVrms)	*Noise-Free resolution (bits)*
±10 V	41.13	6.23	*19.09*
±5 V	30.85	4.67	*18.51*
±2.5 V	17.14	2.60	*18.36*
±1.25 V	11.14	1.69	*17.98*

Table 7 summarizes the noise performance for the OM-USB-TC-AI. Noise distribution is determined by gathering 1000 samples with inputs tied to ground at the user connector. Samples are gathered at the maximum specified sample rate of 2 S/s.

Settling time: V0x-V3x

Table 8. Settling time specifications

Range	Accuracy
	±0.0004% (seconds)
±10 V	15.0
±5 V	0.40
±2.5 V	0.40
±1.25 V	0.40

Settling time is defined as the time required for a channel to settle within a specified accuracy in response to a full-scale (FS) step input.

Analog input calibration

Table 9. Analog input calibration specifications

Parameter	Specifications
Recommended warm-up time	30 minutes minimum
Calibration	Firmware calibration
Calibration interval	1 year
Calibration reference	+10.000 V, ±5 mV maximum. Actual measured values stored in EEPROM
	Tempco: 5 ppm/°C maximum
	Long term stability: 30 ppm/1000 h

Throughput rate

Table 10. 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 11: 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 voltage/temperature data is provided by the USB unit is approximately 0.4 seconds.

Digital input/output

Table 11. Digital input/output specifications

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

Note 12: All ground pins on the OM-USB-TC-AI (pins 9, 19, 22, 27, 30, 33, 36, 39, 49) 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.

Counter

Table 12. CTR I/O specifications

Parameter	Conditions	Specification
Pin name		CTR
Number of channels		1
Resolution		32-bits
Counter type		Event counter
Input type		TTL, rising edge triggered
Input source		CTR screw terminal
Counter read/writes rates (software paced)	Counter read	System dependent, 33 to 1000 reads per second.
	Counter write	System dependent, 33 to 1000 reads per second.
Schmidt trigger hysteresis		20 mV to 100 mV
Input leakage current		*±1.0 µA typ.*
Input frequency		1 MHz max.
High pulse width		*500 nS min.*
Low pulse width		*500 ns min.*
Input high voltage		4.0 V min, 5.5 V absolute max
Input low voltage		1.0 V max, –0.5 V absolute min

Note 13: All ground pins on the OM-USB-TC-AI (pins 9, 19, 22, 27, 30, 33, 36, 39, 49) are common and are isolated from earth ground. If a connection is made to earth ground with both the counter (CTR) 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.

Memory

Table 13. Memory specifications

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

Microcontroller

Table 14. Microcontroller specifications

Type	Two high-performance 8-bit RISC microcontrollers

USB +5V voltage

Table 15. USB +5V voltage specifications

Parameter	Specification
USB +5V (VBUS) input voltage range	4.75 V minimum to 5.25 V maximum

Power

Table 16. Power specifications

Parameter	Conditions	Specification
Supply current	USB enumeration	<100 mA
Supply current (Note 14)	Continuous mode with all inputs configured for Disabled mode.	270 mA typical
User +5V output voltage range (terminal block pin 21)		4.9 V minimum to 5.1 V maximum
User +5V output current (terminal block pin 21)	Bus-powered and connected to a self-powered hub. (Note 14)	5 mA maximum
Isolation	Measurement system to PC	500 VDC minimum

Note 14: This is the total current requirement for the OM-USB-TC-AI which includes up to 10 mA for the status LED.

USB specifications

Table 17. USB specifications

USB device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0
Device power capability	Self-powered
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 maximum

Environmental

Table 18. Environmental specifications

Operating temperature range	0 to 55 ° C maximum
Storage temperature range	-40 to 85 ° C maximum
Humidity	0 to 90% non-condensing maximum

Mechanical

Table 19. Mechanical specifications

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

Screw terminal connector type and pin out

Table 20. Screw terminal connector specifications

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

Table 21. Screw terminal pin out

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	RSVD	Reserved, Do Not Use	27	GND	
2	NC		28	V3L	V3 voltage input (-)
3	T0H	T0 sensor input (+)	29	V3H	V3 voltage input (+)
4	T0L	T0 sensor input (-)	30	GND	
5	NC		31	V2L	V2 voltage input (-)
6	RSVD	Reserved, Do Not Use	32	V2H	V2 voltage input (+)
7	T1H	T1 sensor input (+)	33	GND	
8	T1L	T1 sensor input (-)	34	V1L	V1 voltage input (-)
9	GND		35	V1H	V1 voltage input (+)
10	RSVD	Reserved, Do Not Use	36	GND	
	CJC sensor				
11	RSVD	Reserved, Do Not Use	37	V0L	V0 voltage input (-)
12	NC		38	V0H	V0 voltage input (+)
13	T2H	T2 sensor input (+)	39	GND	
14	T2L	T2 sensor input (-)	40	CTR	Counter Input
15	NC		41	DIO7	Digital Input/Output
16	RSVD	Reserved, Do Not Use	42	DIO6	Digital Input/Output
17	T3H	T3 sensor input (+)	43	DIO5	Digital Input/Output
18	T3L	T3 sensor input (-)	44	DIO4	Digital Input/Output
19	GND		45	DIO3	Digital Input/Output
20	RSVD	Reserved, Do Not Use	46	DIO2	Digital Input/Output
21	+5V	+5V output	47	DIO1	Digital Input/Output
22	GND		48	DIO0	Digital Input/Output
23	NC		49	GND	
24	NC		50	NC	
25	NC		51	NC	
26	NC		52	NC	

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