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OMB-DAQ-TC-RACK **32-Channel USB/Ethernet Based** **Thermocouple Input** **Data Acquisition System**



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About this User's Guide

What you will learn from this user's guide

This user's guide describes the Measurement Computing OMB-DAQ-TC-RACK data acquisition device and lists device specifications.

Conventions in this user's guide

For more information

Text presented in a box signifies additional information related to the subject matter.

Caution! Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

bold text **Bold** text is used for the names of objects on a screen, such as buttons, text boxes, and check boxes.

italic text *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase.

Where to find more information

Additional information about OMB-DAQ-TC-RACK hardware is available on our website at www.omega.com. You can also contact Omega Engineering by phone, fax, or email with specific questions.

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

Introducing the OMB-DAQ-TC-RACK

The OMB-DAQ-TC-RACK is a dual-interface data acquisition device that provides the following features:

- 32 differential thermocouple (TC) inputs, expandable to 64 channels with OMB-DAQ-TC-RACK-EXP32 expansion device¹
- Two 24-bit ADCs (one ADC per 16 inputs)
- TC channels field-to-host isolation
- 3 S/s per update rate
- Support for type J, K, R, S, T, N, E, and B thermocouples, software-selectable per channel
- One integrated cold junction compensation (CJC) sensor per TC input
- Open thermocouple detection (OTD) to detect faulty TC connections
- 8 digital inputs, isolated from TC and host
- 32 digital outputs/alarms isolated from TC inputs and host
- DIO connections are made to 50-pin header connector
- USB 2.0 or 10/100 Ethernet interface
- Powered by the included +5 V external power adapter (OMB-DAQ-TC-RACK-PS)

Ethernet interface

The OMB-DAQ-TC-RACK has a built-in 10/100 BASE-T auto-negotiation, high-speed communication port.

With the Ethernet interface, you can remotely access and configure your OMB-DAQ-TC-RACK from anywhere on the network. Only one computer can control the OMB-DAQ-TC-RACK at a time.

A unique *media access control* (MAC) address is assigned to each device at the factory. You configure the Ethernet connection settings through software. The network name uses the format TC-32-xxxxxx, where xxxxxx are the lower six digits of the factory-assigned MAC address.

USB interface

The OMB-DAQ-TC-RACK is a USB 2.0 full-speed device that is compatible with USB 3.0 ports. The device is also compatible with USB 1.1 ports.

¹ 40-pin ribbon cable for the **EXPANSION** connector is included with the OMB-TC-RACK-EXP.

Functional block diagram

Device functions are illustrated in the block diagram shown here:

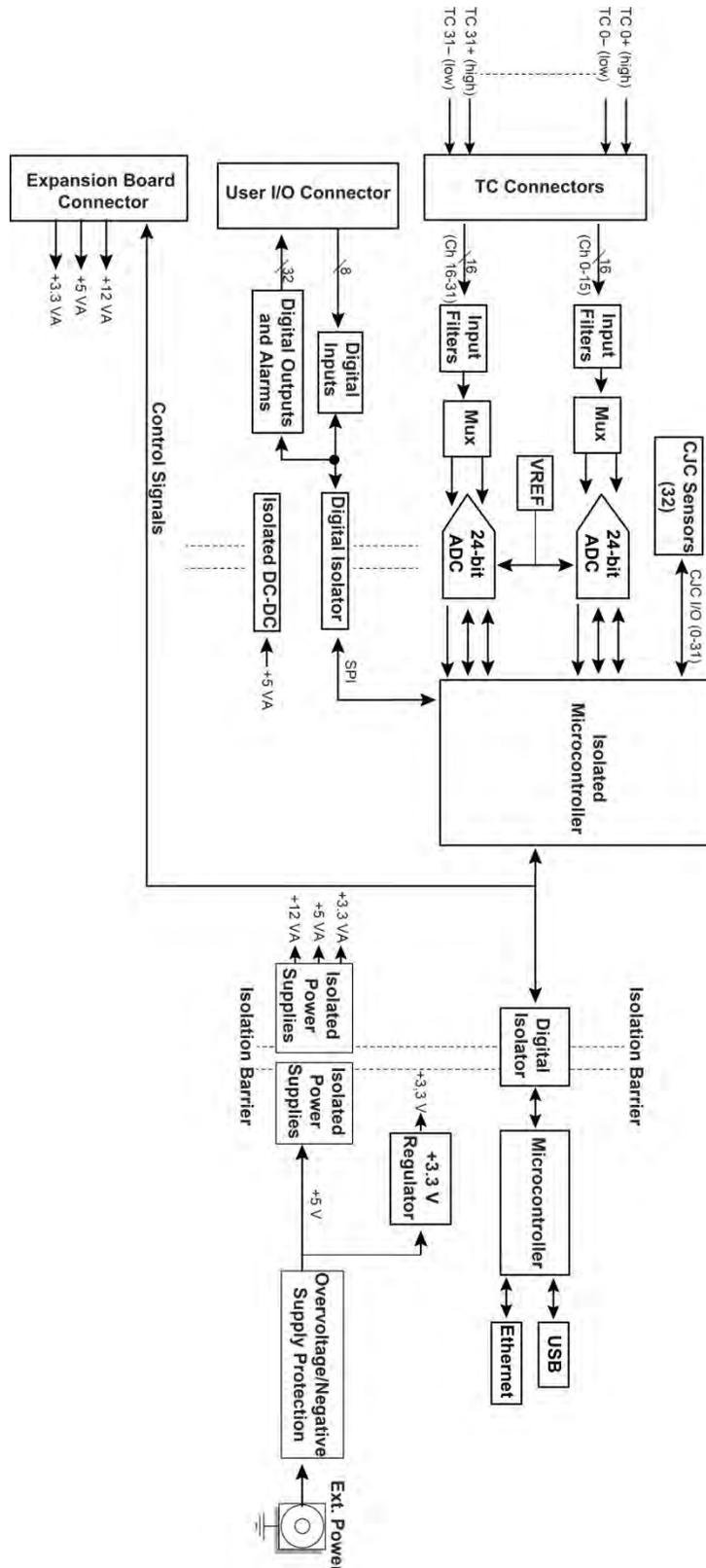


Figure 1. OMB-DAQ-TC-RACK functional block diagram

Installing the OMB-DAQ-TC-RACK

Unpacking

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the board 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.

Installing the software

Refer to the *Software User's Guide* for instructions on installing the software on the CD. This booklet is available in PDF at www.omega.com/manuals/manualpdf/M4803.pdf.

Connecting the external power adapter

Power to the OMB-DAQ-TC-RACK is provided with the 5 V external power adapter (OMB-DAQ-TC-RACK-PS). Connect the adapter cord to the power connector on the OMB-DAQ-TC-RACK device, and plug the AC adapter into an electrical outlet.

The **Power** LED turns on when 5 V power is supplied to the OMB-DAQ-TC-RACK. If the voltage supply is less than 4.0 V or more than 5.75 V, the **POWER** LED does not turn on.

Refer to [Figure 2](#) on page 11 for the location of the **Power** LED.

Installing the hardware

The OMB-DAQ-TC-RACK can run on either a USB or Ethernet interface.

Installing on USB

Connect the OMB-DAQ-TC-RACK using the cable provided to a USB port on a computer running Windows. Windows finds and installs the device driver automatically, and notifies you that the device is ready to use.

Installing on Ethernet

The OMB-DAQ-TC-RACK requires a TCP/IP and UDP connection to a network or computer. Use the standard Ethernet cable provided to connect the OMB-DAQ-TC-RACK to a 10Base-T or 100Base-TX compatible Ethernet port, hub, or switch.

When connecting the OMB-DAQ-TC-RACK for the first time, make sure that you connect to a local network with DHCP enabled.

If you are unsure whether you have access to a local network or that DHCP is enabled on that network, you should use a direct connection to a Windows PC.

It may take a minute or two to detect the device and assign the address. The green **Link/activity** LED on the lower left of the Ethernet connector turns on when there is a valid Ethernet link, and blinks when network activity is detected.

Once the OMB-DAQ-TC-RACK is physically connected to the local network or PC, you can run the software (InstaCal for example) to establish a connection. If a connection cannot be established, make sure the device is using the default configuration by following the instructions in the [Restoring factory default network settings](#) on page 10.

Once a connection is established and you can communicate to the device, you can change the configuration for other network scenarios.

Configuring network settings

The following OMB-DAQ-TC-RACK network settings are software-selectable. Only one user at a time can connect to the OMB-DAQ-TC-RACK to configure network options on the device. For typical local networks, the default settings are recommended.

Address mode settings

The address mode setting determines whether the default IP parameters (IPv4 address, subnet mask, and gateway) are assigned to the OMB-DAQ-TC-RACK or an auto-addressing method is used to assign these parameters.

DHCP or link-local enabled (default)

If connected to a network with a DHCP server, the service automatically assigns IP addresses to the OMB-DAQ-TC-RACK.

If the connected network does not have a DHCP server, the address stored in the default IP address is assigned to the OMB-DAQ-TC-RACK.

If the OMB-DAQ-TC-RACK is directly connected to a Windows PC or other host that supports link-local addressing, a link-local address is assigned to the device. A link-local address is valid only for communications between the OMB-DAQ-TC-RACK and the device to which it is connected

DHCP Only

Enables configuration by a DHCP server if one is available. The OMB-DAQ-TC-RACK is assigned an IP address shortly after it is powered up and attached to the network.

Link Local Only

The OMB-DAQ-TC-RACK is assigned a link-local IP address by the Windows PC or other host that supports link-local addressing. A link-local address is valid only for communications between the OMB-DAQ-TC-RACK and the device to which it is connected.

Static

The default **IPv4 Address** is manually configured on the OMB-DAQ-TC-RACK.

IP address settings

The default settings of the following IP address are assigned to the OMB-DAQ-TC-RACK when automatic addressing is disabled or not available (DHCP or Link Local for example)

- **IPv4 address** – The IP address that is stored on the device. The default IPv4 address is 192.168.0.101.
- **Subnet mask** – The Subnet mask that is stored on the OMB-DAQ-TC-RACK . The subnet mask determines the number of bits of the IP address that is used for the host portion of the address vs. the number of bits used for the network portion. The default subnet mask is 255.255.255.000
- **Gateway** – The gateway IP address that is stored on the OMB-DAQ-TC-RACK. The gateway address of the device that bridges subnets within a network. The default gateway is 192.168.0.1

Connection code

The connection code is a number between 0 (default) and 999999999. You can change this number from its default of 0 to prevent other users from connecting to and configuring the device. The device remains visible to other users on the network, but connection by another user is not allowed.

Setting up the OMB-DAQ-TC-RACK for communication across networks

In order to communicate with the OMB-DAQ-TC-RACK from a computer connected to a different network – such as over the Internet – you must change the network configuration of the network router.

In the following procedure, the OMB-DAQ-TC-RACK is installed on the *host* LAN, the computer is installed on the *client* LAN, and it is assumed that you have successfully connected the device to a local network.

Caution! This procedure should only be performed by a network administrator or computer professional. Incorrect settings can significantly disrupt a network.

1. Determine the IP address of the device. If the address was assigned by DHCP, it is recommended you change it to a static address by setting the default address to the address assigned and setting the device network configuration to static.
2. Configure the firewall/router to forward incoming traffic to the following ports to the IP address assigned to the device:
 - UDP:54211 (discovery)
 - TCP:54211 (commands)
3. On the computer connected to the client LAN, manually enter the WAN address of the host router, and specify the ports that were forwarded to connect to the remote OMB-DAQ-TC-RACK.

Calibrating the hardware

Factory calibration

Omega Engineering performs the initial factory calibration. Return the device to Omega Engineering when calibration is required. The recommended calibration interval is one year.

Field calibration

The OMB-DAQ-TC-RACK supports field calibration. Calibrate the device using InstaCal whenever the ambient temperature changes by more than ± 10 °C from the last calibration.

The following items are required to perform field calibration on a OMB-DAQ-TC-RACK:

- a precision voltage source
- a voltmeter

Each ADC (two ADCs per device) is measured at three points and a linear correction is calculated.

When prompted, enter the voltmeter reading to a precision of three decimal places.

Omega Engineering strongly recommends that you warm up the OMB-DAQ-TC-RACK for at least 20 minutes prior to performing field calibration.

Restoring factory default network settings

To reset the network configuration settings to the factory default values, complete the following steps:

1. Use a ballpoint pen to press and hold in the **Reset** button for at least four seconds until both the **Power** and **Activity** LEDs blink, indicating that the settings have been restored to the factory defaults.
2. Release the button so the device continues startup with the default settings. If the button is released before the two LEDs blink, the settings are not affected and the device starts up normally.

If InstaCal is open when default settings are restored, click the **Refresh Boards** button on the InstaCal toolbar to reflect the changes.

Functional Details

External components

OMB-DAQ-TC-RACK front panel components are shown in Figure 2.

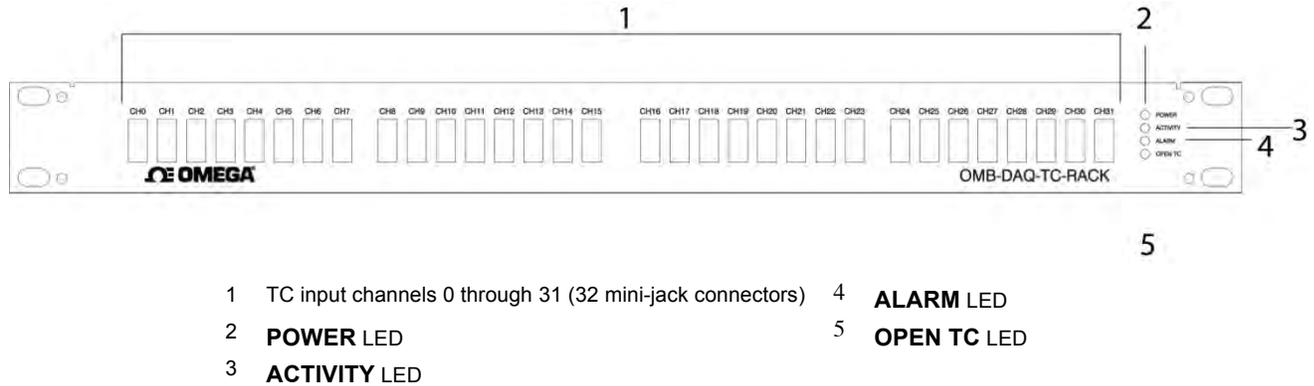


Figure 2. OMB-DAQ-TC-RACK front panel components

OMB-DAQ-TC-RACK rear panel components are shown in Figure 3.

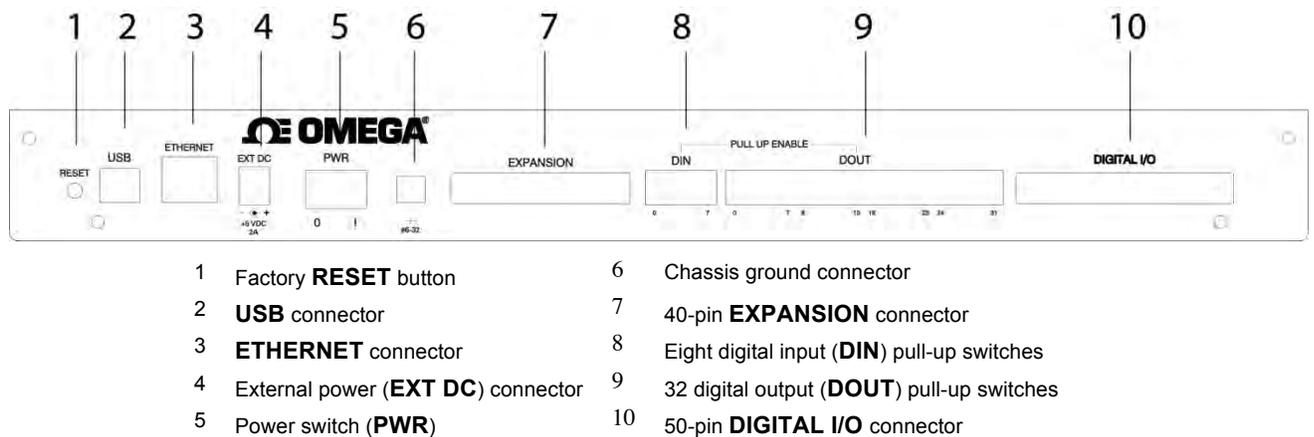


Figure 3. OMB-DAQ-TC-RACK rear panel components

USB connector

The USB connector provides USB communication.

Ethernet connector

The OMB-DAQ-TC-RACK has one 10/100 BASE-T, auto-negotiation, high-speed communication port. The port connector is an RJ-45, eight-position connector. The Ethernet port accepts CAT-5 shielded or unshielded twisted pair cable. The maximum communication distance without using a repeater is 100 meters.

External power connector

Connect the OMB-DAQ-TC-RACK-PS power supply to this connector. The power supply provides 5 VDC, 2 A power to the OMB-DAQ-TC-RACK.

TC input connectors, measurements, and LED

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.

You can add another 32 differential TC input connections to mini-jack connectors labeled CH0 through CH31 (refer to Figure 2).

The device supports type J, K, S, R, B, E, T, N thermocouples.

Caution! Omega Engineering strongly recommends that you ground yourself using a wrist strap before handling the thermocouple sensors.

Connecting TCs to common-mode voltage sources

You can connect a thermocouple to a common voltage source (AC or DC) as long as the magnitude of the voltage is within the common mode voltage range specification of 48V (DC) or 3.5V p-p (AC).

Each applied common mode voltage must be less than or equal to the *average* common mode voltage ± 1.4 V.

For example, in Figure 4, there are three TCs connected to three different common mode voltage sources and two thermocouples that are not connected to anything (floating).

In this example, the average common mode voltage is calculated as follows: $(11.4 \text{ V} + 10 \text{ V} + 8.6 \text{ V})/3 = 10 \text{ V}$

- Each TC channel becomes biased to the average common mode voltage of 10 V.
- Each common mode voltage must then be within the $10 \text{ V} \pm 1.4 \text{ V}$ limits or 8.6 V to 11.4 V.

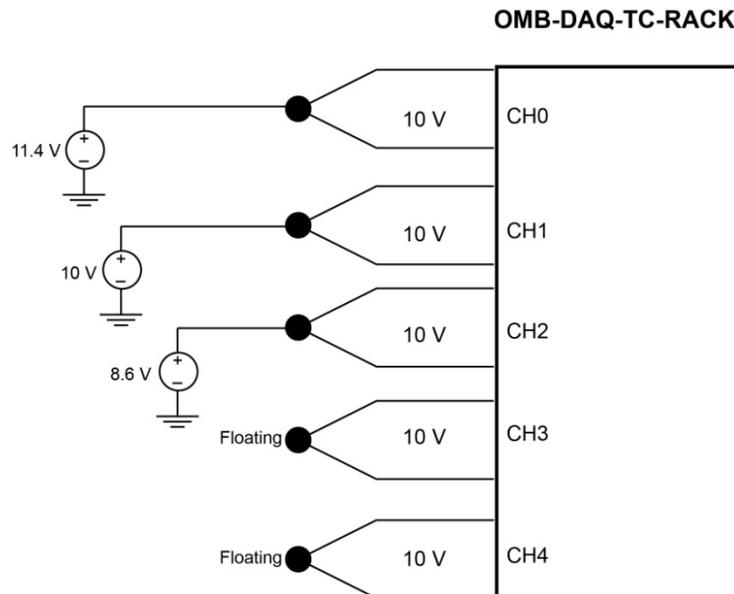


Figure 4. OMB-DAQ-TC-RACK common mode voltage connections example

Cold junction compensation (CJC)

Each TC input on the OMB-DAQ-TC-RACK has a high-resolution CJC sensor. When you connect the thermocouple sensor leads to the sensor input channel, the dissimilar metals at the OMB-DAQ-TC-RACK terminal blocks produce an additional thermocouple junction. This junction creates a small voltage error component which must be removed from the overall sensor measurement using a CJC technique.

The measured voltage includes both the thermocouple voltage and the cold junction voltage. To compensate for the additional cold junction voltage, the OMB-DAQ-TC-RACK subtracts the cold junction voltage from the thermocouple voltage.

Increasing the thermocouple length

If you need to increase the length of your thermocouple, use the same type of TC 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 OMB-DAQ-TC-RACK is equipped with OTD for all analog input channel. With OTD, any open-circuit condition at the TC sensor is detected by the software. An open channel is detected by the use of a pull up and pull down resistors on the thermocouple inputs. An open thermocouple condition forces the input differential voltage outside of the valid thermocouple voltage range. The software recognizes this as an invalid reading and flags the appropriate channel. The software continues to sample all channels when OTD is detected.

Input leakage current

With OTD enabled, 75 nA (max) of input leakage current is injected into the TC. This current can cause an error voltage to develop across the lead resistance of the TC that is indistinguishable from the thermocouple voltage you are measuring. You can estimate this error voltage with the following formula:

$$\text{error voltage} = \text{resistance of the thermocouple} \times 75 \text{ nA}$$

To reduce the error, reduce the length of the TC to lower its resistance, or lower the AWG of the wire by using a wire with a larger diameter. With open-thermocouple detection disabled, 2 nA (max) of input leakage current is injected into the TC.

Digital I/O

The OMB-DAQ-TC-RACK provides eight digital inputs and 32 digital outputs that are electrically isolated from the host computer and from the OMB-DAQ-TC-RACK analog circuits.

All DIO bits have internal pull-up resistors to 5 V that can be disconnected with the rear panel slide switches.

The recommended maximum length of the 50-pin cable used to connect the **DIGITAL I/O** connector to the digital I/O signal source is 1 foot.

Digital inputs

The OMB-DAQ-TC-RACK provides eight digital inputs with rates of 500 port reads or single bit reads per second.

Digital input voltage ranges of 0 V to 15 V are permitted, with thresholds of 0.6 V (low) and 2.2 V (high).

Each digital input has a 100 k Ω pull-up resistor. Use the eight **PULL-UP ENABLE – DIN** slide switches to enable or disable the 5 V pull-up option.

5Digital outputs/temperature alarms

Each digital output is *open-drain*, which can sink up to 100 mA for direct drive applications. Each output has a 100 k Ω pull-up resistor. Use the eight **PULL-UP ENABLE – DOUT** slide switches to enable or disable the 5 V pull-up option.

6Optionally, you can configure each digital output as an alarm for each TC input. When an alarm is enabled, its associated output line is driven to the appropriate state determined by the alarm options and input temperature.

You can also use the alarm outputs to control a device or application that indicates when a temperature threshold has been exceeded.

The alarm configurations are stored in non-volatile memory and loaded at power up.

Alarm settings are applied when changed and at power on. Temperatures are constantly converted on enabled channels and processed for alarm conditions regardless of the communications connectivity.

Each available alarm mode and setting is explained below.

| | |
|--|--|
| Alarm input modes Set independent temperature thresholds T1 and T2 for each alarm. | <ul style="list-style-type: none"> ■ Trigger alarm when input temperature $\geq T1$; reset alarm when input temperature $< T2$ ■ Trigger alarm when input temperature $\leq T1$; reset alarm when input temperature $> T2$ ■ Trigger alarm when input temperature is $< T1$ or $> T2$ |
| Alarm error modes | <ul style="list-style-type: none"> ■ Alarm on temperature reading only ■ Alarm on temperature reading, open thermocouple, or common-mode voltage error ■ Alarm on open thermocouple or common-mode voltage error only |
| Alarm output modes | <ul style="list-style-type: none"> ■ Alarm disabled; digital output line can be used for normal operation ■ Alarm enabled; active low output (output line goes low when alarm condition is met) ■ Alarm enabled; active high output (output line goes high when alarm condition is met) ■ Alarm output may be latched and will not clear unless explicitly cleared by the user |

The OMB-DAQ-TC-RACK provides three alarm indicators – the [ALARM LED](#), the [OPEN TC LED](#) on the front panel and, optionally, the user-configurable digital outputs associated with each channel.

Because the digital alarm outputs are user-configurable, they can be used to supply additional information (visually, if the digital outputs are used to drive LEDs), such as the channel associated with the alarm condition or differentiating between threshold and CMV alarms.

Pull-up configuration

By default, pull-up is enabled for all eight digital inputs and all 32 digital outputs. Slide switches on the rear of the housing can disable pull-up for each digital input bit and digital output bit.

LED indicators

The OMB-DAQ-TC-RACK has four LEDs that indicate the power, communication, alarm, and open TC status

POWER LED²

The **POWER** LED turns on when you plug the power adapter into the OMB-DAQ-TC-RACK. If a Flash LED command is sent from an application, the **Power** LED blinks five times.

ACTIVITY LED²

The **ACTIVITY** LED turns on when there is a valid connection (USB or Ethernet) and blinks when a command is sent to the OMB-DAQ-TC-RACK.

ALARM LED

The **ALARM** LED turns on when an alarm condition occurs.

OPEN TC LED

The **OPEN TC** LED turns on when there is an open thermocouple condition.

EXPANSION connector

Use the **EXPANSION** connector to connect the OMB-DAQ-TC-RACK to an OMB-TC-RACK-EXP32 expansion device (sold separately) for applications that need additional analog/thermocouple input and digital I/O channels. A 40-pin expansion cable is included with the OMB-DAQ-TC-RACK-EXP32.

Chassis ground connector

Provides a connection point (#6-32 screw) for chassis ground. Connect this to an external grounding source.

² Both the **POWER** and **ACTIVITY** LEDs blink in firmware upgrade mode. Refer to [Updating firmware](#) on page 10.

If the OMB-DAQ-TC-RACK is connected by USB or by a shielded Ethernet cable to grounded equipment, connecting to an external grounding source is not needed since the USB/shielded Ethernet connection already grounds the OMB-DAQ-TC-RACK and a connected OMB-DAQ-TC-RACK-EXP32.

RESET button

Press and hold this button to restore the OMB-DAQ-TC-RACK to its factory default network settings. Refer to [Restoring factory default network settings](#) on page 10

Mechanical drawings

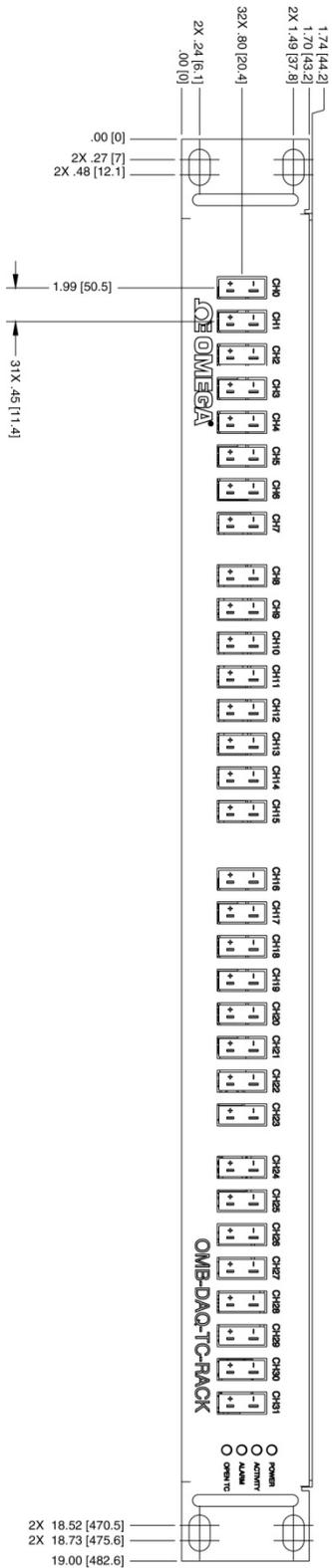


Figure 7. Enclosure dimensions - front

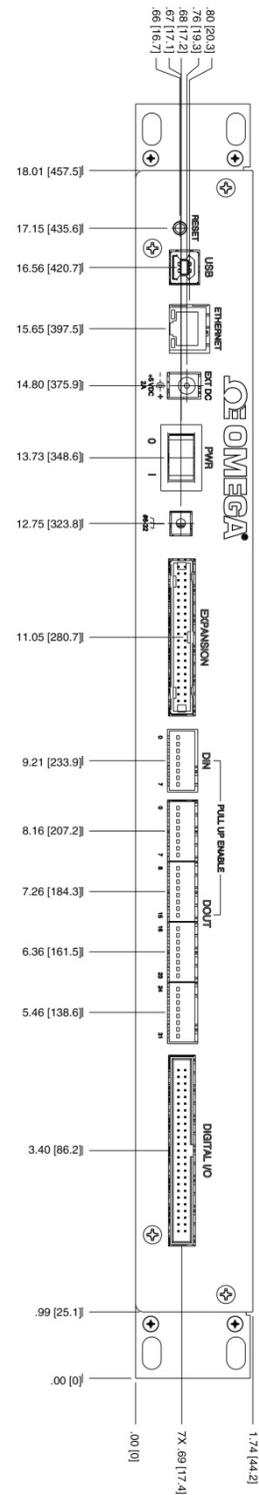


Figure 8. Enclosure dimensions - rear

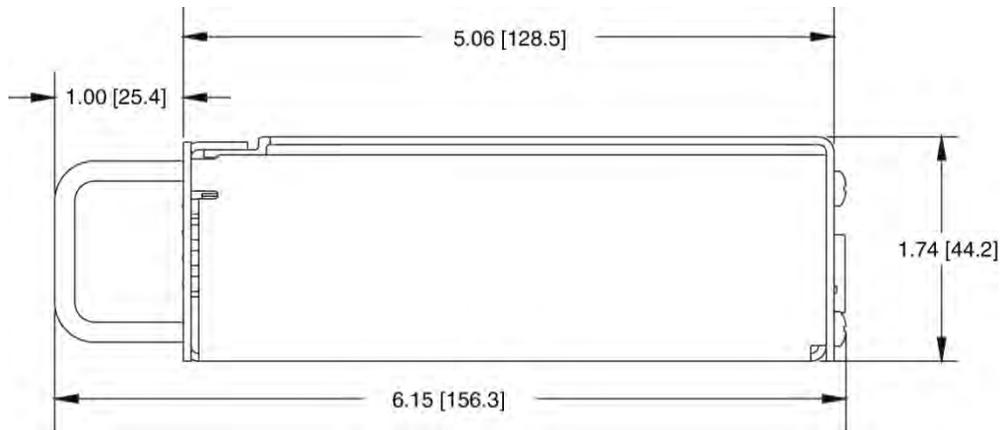


Figure 9. Enclosure dimensions – side

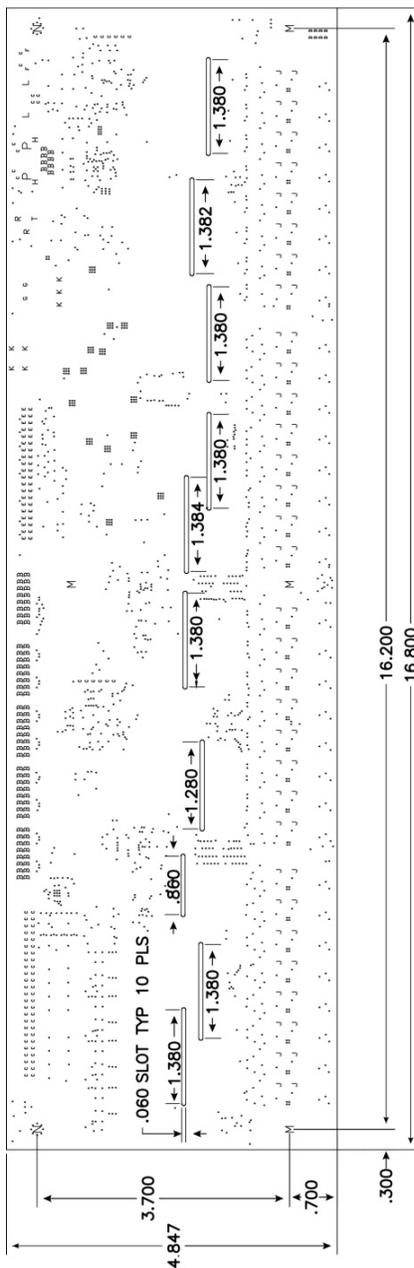


Figure 10. Circuit board dimensions

Specifications

All specifications are subject to change without notice.

Typical for 25°C unless otherwise specified.

Specifications in *italic text* are guaranteed by design.

Thermocouple input

Table 1. Generic analog input specifications

| Parameter | Condition | Specification |
|--|---|--|
| A/D converter type | | Delta-Sigma |
| A/D resolution | | 24-bit |
| Number of channels | | 32 |
| <i>Filtering options</i> | | <i>50 Hz or 60 Hz noise filtering, software-selectable</i> |
| <i>Isolation</i> | <i>Between any TCx channel and chassis ground.</i> | <i>500 VDC absolute max</i> |
| Channel configuration | | Software-selectable to match thermocouple sensor type |
| Differential input voltage range | | ±78.125 mV |
| <i>Absolute maximum input voltage</i> | <i>Between any two TCx inputs</i> | <i>±25 V (power on) ±25 V (power off)</i> |
| <i>Differential input impedance</i> | <i>50 Hz filtering, power on</i> | <i>26 MΩ</i> |
| | <i>60 Hz filtering, power on</i> | <i>20 MΩ</i> |
| <i>Input current</i> | <i>Open thermocouple detect disabled</i> | <i>2 nA</i> |
| | <i>Open thermocouple detect enabled</i> | <i>75 nA</i> |
| <i>Common mode rejection</i> | <i>50 Hz filtering, at DC and $f_{in}=50$ Hz</i> | <i>110 dB</i> |
| | <i>60 Hz filtering at DC and $f_{in}=60$ Hz</i> | <i>110 dB</i> |
| <i>Noise rejection</i> | <i>50 Hz filtering at $f_{in}=50$ Hz</i> | <i>80 dB typ.</i> |
| | <i>60 Hz filtering at $f_{in}=60$ Hz</i> | <i>80 dB typ.</i> |
| Input bandwidth | <i>50 Hz filtering</i> | <i>22 Hz</i> |
| | <i>60 Hz filtering</i> | <i>26 Hz</i> |
| Crosstalk | <i>Between any two TCx inputs</i> | -90 dB |
| Sample rate (Note 1) | | 3 Hz max (per channel) |
| Common mode voltage range (Note 2) | TCx channel to TCx channel | ±1.40 V |
| | TCx channel relative to chassis ground, $f_{in}=60$ Hz | ±3.5 VAC p-p |
| | TCx channel relative to chassis ground | ±48 V DC |
| Input noise | <i>50 Hz or 60 Hz filtering</i> | 510 nV rms |
| Gain error | <i>50 Hz or 60 Hz filtering</i> | 0.004 % FSR |
| Offset error | <i>50 Hz or 60 Hz filtering</i> | 3 μV |
| Measurement sensitivity (Note 3) | Thermocouple type J,K,T,E,N | 0.07°C |
| | Thermocouple type R,S | 0.18°C |
| | Thermocouple type B | 0.60°C |
| Warm-up time | | 20 minutes min |
| Open thermocouple detect response time | | 1 second |
| <i>CJC sensor accuracy</i> | <i>0°C to 45°C</i> | <i>±0.20°C typ ±0.40°C max</i> |

Note 1: The enabled thermocouple inputs are continuously converted at the maximum A/D converter rate.

Note 2: When thermocouple sensors are connected to different common mode voltages, the channels with floating thermocouples sensors will be biased to approximately the average value of the applied common mode voltages. Each of the applied common mode voltages must then be less than or equal to the average common mode voltage ±1.40 V or $[CMV_{applied} \leq (CMV_{average} \pm 1.4 V)]$.

Note 2: When thermocouple sensors are connected to different common mode voltages, the channels with floating thermocouples sensors will be biased to approximately the average value of the applied common mode voltages. Each of the applied common mode voltages must then be less than or equal to the average common mode voltage ± 1.40 V or $[CMV_{\text{applied}} \leq (CMV_{\text{average}} \pm 1.4 \text{ V})]$.

Note 3: Measurement sensitivity is the smallest change in temperature that can be detected.

Channel configuration

Table 2. Channel configuration specification

| Sensor Category | Condition | Specification |
|-----------------|------------------------|--------------------------|
| Thermocouple | J, K, S, R, B, E, T, N | 32 differential channels |

Note 4: Channel configuration is stored on EEPROM external to the isolated microcontroller by the firmware whenever any item is modified. Modification is performed by commands issued from an external application, and the configuration is made non-volatile through the use of the EEPROM.

Compatible thermocouple sensors

Table 3. Compatible sensor type specifications

| Parameter | Specification |
|--------------|---|
| 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

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

| Sensor Type | Sensor Temperature (°C) | Accuracy Error Maximum (°C), 15°C to 35°C | Accuracy Error Typical (°C), 15°C to 35°C | Accuracy Error Maximum (°C), 0°C to 45°C | Accuracy Error Typical (°C), 0°C to 45°C |
|-------------|-------------------------|---|---|--|--|
| J | -210 | 1.965 | 0.910 | 2.167 | 0.989 |
| | 0 | 0.787 | 0.361 | 0.816 | 0.375 |
| | 1200 | 0.752 | 0.371 | 1.148 | 0.508 |
| K | -210 | 2.295 | 1.061 | 2.520 | 1.152 |
| | 0 | 0.821 | 0.376 | 0.852 | 0.392 |
| | 1372 | 1.029 | 0.504 | 1.560 | 0.688 |
| S | -50 | 2.467 | 1.111 | 2.655 | 1.223 |
| | 250 | 1.835 | 0.825 | 1.961 | 0.904 |
| | 1768 | 0.893 | 0.361 | 1.519 | 0.590 |
| R | -50 | 2.609 | 1.174 | 2.810 | 1.293 |
| | 250 | 1.862 | 0.837 | 1.992 | 0.918 |
| | 1768 | 0.754 | 0.305 | 1.346 | 0.520 |
| B | 250 | 2.450 | 1.090 | 2.707 | 1.254 |
| | 700 | 0.937 | 0.424 | 1.136 | 0.520 |
| | 1820 | 0.610 | 0.300 | 1.056 | 0.467 |
| E | -200 | 1.754 | 0.811 | 1.933 | 0.880 |
| | 0 | 0.775 | 0.355 | 0.806 | 0.369 |
| | 1000 | 0.657 | 0.323 | 0.989 | 0.437 |
| T | -200 | 2.005 | 0.923 | 2.207 | 1.005 |
| | 0 | 0.836 | 0.382 | 0.874 | 0.400 |
| | 400 | 0.544 | 0.255 | 0.659 | 0.297 |
| N | -200 | 2.255 | 1.038 | 2.481 | 1.134 |
| | 0 | 0.908 | 0.415 | 0.949 | 0.437 |
| | 1300 | 0.718 | 0.357 | 1.157 | 0.510 |

Thermocouple measurement accuracy specifications include polynomial linearization, cold-junction compensation, and system noise. The accuracy specifications assume the device is operated within its enclosure and with the enclosure in a horizontal, upright orientation. The board should also be warmed up for the recommended 20 minutes. If the maximum digital output load of 3.2 amps is applied, add an additional 0.30°C to the typical and maximum accuracy specifications listed above. Errors shown do not include inherent thermocouple error. Contact your thermocouple supplier for details on the actual thermocouple accuracy error.

Digital input/output

Table 5. Digital input specifications

| Parameter | Specification |
|--------------------------------|--|
| Number of inputs | 8 channels |
| Configuration | Fixed input |
| Input voltage range | 0 V to +15 V |
| Input type | CMOS (Schmitt trigger) |
| Input characteristics | 100 k Ω pull-up resistor, 28.7 k Ω series resistor |
| Maximum input voltage range | 0 V to +20 V max (power on/off, relative to IGND pins) |
| Pull-up configuration | All pins pulled up to +5 V via individual 100 k Ω resistors using slide switch SW5. SW5 default positions are on (pulled up.) |
| Transfer rate (software paced) | 500 port reads per second typ. |
| Input high voltage | 1.3 V min, 2.2 V max |
| Input low voltage | 1.5 V max, 0.6 V min |
| Schmitt trigger hysteresis | 0.4 V min, 1.2 V max |

Table 6. Digital output specifications

| Parameter | Specification |
|---|--|
| Number of outputs | 32 channels, shared with alarms |
| Configuration | Open drain output |
| Output characteristics | 100 k Ω pull-up, open drain (DMOS transistor) |
| Pull-up configuration | All pins pulled up to +5 V via individual 100 k Ω resistors using slide switches SW1-SW4. The default positions for SW1-4 are on (pulled up.) |
| Transfer rate (software-paced) | Digital output – 500 port writes per second typ. |
| Output voltage range | 0 V to +5 V (internal 100 k Ω pull-up resistors connected to +5 V by default) 0 V to +15 V max (using external pull up resistor) |
| Off state leakage current | 0.1 μ A |
| Sink current capability | 100 mA max (continuous) per output pin |
| DMOS transistor on-resistance (drain to source) | 4 Ω |

Note 5: Ground pins labeled IGND are isolated from AGND and chassis ground.

Temperature alarms

Table 7. Temperature alarm specifications

| Parameter | Specification |
|------------------------|---|
| Number of alarms | 32, shared with digital output |
| Alarm functionality | Each alarm controls its associated digital output line as an alarm output. When an alarm is enabled, its associated output line is driven to the appropriate state determined by the alarm options and input temperature. The alarm configurations are stored in non-volatile memory and loaded at power on. |
| Alarm input modes | <ul style="list-style-type: none"> ■ Alarm when input temperature \geq T1, reset alarm when input temperature $<$ T2 ■ Alarm when input temperature \leq T1, reset alarm when input temperature $>$ T2 ■ Alarm when input temperature is $<$ T1 or $>$ T2 Note: T1 and T2 may be independently set for each alarm. |
| Alarm error modes | <ul style="list-style-type: none"> ■ Alarm on temperature reading only ■ Alarm on temperature reading, open thermocouple, or common-mode voltage error ■ Alarm on open thermocouple or common-mode voltage error only |
| Alarm output modes | <ul style="list-style-type: none"> ■ Disabled, digital output line may be used for normal operation ■ Enabled, active high output (output line goes high when alarm condition is met) ■ Enabled, active low output (output line goes low when alarm condition is met) ■ Alarm output may be latched and will not clear unless explicitly cleared by the user |
| Alarm latency (Note 6) | 1 second, max |

Note 6: Alarm settings are applied when changed and at power-on. Temperatures are constantly converted on enabled channels and processed for alarm conditions regardless of the communications connectivity.

Memory

Table 8. Memory specifications

| Parameter | Specification |
|-----------|---------------|
| EEPROM | 8,192 bytes |

Microcontroller

Table 9. Microcontroller specifications

| Parameter | Specification |
|-----------|---|
| Type | One high-performance 32-bit RISC microcontroller (communications) One high-performance 32-bit RISC microcontroller (measurement) |

Power

Table 10. Power specifications

| Parameter | Conditions | Specification |
|--|---|--|
| Supply current | | 330 mA typ, 610 mA max 550 mA typ, 1000 mA max (with OMB-DAQ-TC-RACK-EXP32 connected) |
| External power input (Note 5) | | +5 VDC \pm 5% (+5 VDC power supply provided) |
| Power switch | | Rocker type |
| External power supply (included) | Omega Engineering p/n OMB-DAQ-TC-RACK-PS | +5 VDC, 10 W, 5% regulation |
| External power input voltage supervisor limits | $4.0\text{ V} > V_{\text{ext}} > 5.75\text{ V}$ | PWR LED = Off (power fault) |
| | $4.0\text{ V} < V_{\text{ext}} < 5.75\text{ V}$ | PWR LED = On |
| Chassis ground connection | | 6-32 screw on rear of enclosure |

Note 7: Voltage specification applies at barrel plug power input. The power supply provided with the device meets this specification at the rated total power supply current. If a different power supply is used, small line resistances could cause significant voltage drop between the power supply and the barrel plug input.

USB

Table 11. USB specifications

| Parameter | Specification |
|----------------------|--|
| Device type | USB 2.0 full speed |
| Device compatibility | USB 1.1, USB 2.0, USB 3.0 |
| Connector | Standard B |
| Cable length | 5 meters max |
| Power | Self-powered (no USB current consumed) |

Network

Ethernet connection

Table 12. Ethernet connection specifications

| Parameter | Specification |
|------------------------------|------------------------------|
| <i>Ethernet type</i> | 100 Base-TX 10 Base-T |
| <i>Communication rates</i> | 10/100 Mbps, auto-negotiated |
| <i>Connector</i> | RJ-45, 8 position |
| <i>Cable length</i> | 100 meters max |
| <i>Additional parameters</i> | HP Auto-MDIX support |

Network interface

Table 13. Factory default specifications

| Parameter | Specification |
|--------------------------|---|
| Protocols used | TCP/IP (IPv4 only), UDP |
| Network ports used | UDP:54211 (discovery) TCP:54211 (commands) |
| Network IP configuration | DHCP + link-local, DHCP, static, link-local |
| Network name | TC-32-xxxxxxx, where xxxxxxx are the lower 6 digits of the device MAC address |
| Network name publication | By NBNS (responds to b-node broadcasts, therefore only available on the local subnet) |

Network factory default settings

Table 14. Factory default specifications

| Parameter | Specification |
|------------------------------|---------------------------|
| Factory default IP address | 192.168.0.101 |
| Factory default subnet mask | 255.255.255.0 |
| Factory default gateway | 192.168.0.1 |
| Factory default DHCP setting | DHCP + link-local enabled |

Network security

Table 15. Factory default specifications

| Parameter | Specification |
|-------------------------------|--|
| Security implementation | TCP sockets are not opened unless application sends the correct PIN code (stored in non-volatile memory, may be changed by user, default value 0000) |
| Number of concurrent sessions | 1 |
| Vulnerabilities | TCP Sequence Number Approximation Vulnerability |

LED displays and the factory reset button

Table 16. LED and button configurations

| Parameter | Specification |
|-----------------------------|---|
| POWER LED (top) | Indicates power on. Blinks when blink command is sent. Both the POWER and ACTIVITY LEDs blink in firmware upgrade mode. |
| ACTIVITY LED | On when there is a valid connection and blinks when a command is sent to the OMB-DAQ-TC-RACK. Both the POWER and ACTIVITY LEDs blink in firmware upgrade mode. |
| ALARM LED | Indicates that an alarm condition is met. |
| OPEN TC LED (bottom) | Indicates that there is an open thermocouple condition. |
| Factory reset button | When held for 3 seconds, the LEDs turn off for a short time, indicating a reset is in process. When the LEDs turn back on, reset is complete and the factory-default network settings are restored. |

Environment

Table 17. Environmental specifications

| Parameter | Specification |
|-----------------------------|---------------------------|
| Operating temperature range | 0°C to 45°C |
| Storage temperature range | -40°C to 85°C |
| Humidity | 0°C to 90% non-condensing |

Mechanical

Table 18. Mechanical specifications

| Parameter | Specification |
|------------------------|---|
| Dimensions (L × W × H) | 482.6 × 128.6 × 43.18 mm (19 × 6.15 × 1.74 in.) |

Signal I/O connectors

Table 19. Connector specifications

| Parameter | Specification |
|--|---|
| User accessible I/O connectors (excluding USB and Ethernet) | Thermocouple inputs, digital I/O connector, expansion connector, chassis ground |
| Thermocouple connector type | Thermocouple Mini-Jack (Omega PCC-SMP-V-U-100) |
| Digital I/O connector type | 50-pin IDC header |
| Compatible cable for the 50-pin DIO connector | C50FF-2, C50FF-15 |
| Compatible accessory products with the C50FF-2 and C50FF-15 cables | CIO-MINI50 |
| Expansion connector type | 40-pin IDC header |
| Compatible cables for the 40-pin expansion connector | C40FF-2 |
| Chassis ground connector | 6-32 screw |

Table 20. Thermocouple connector pinout

| Pin | Signal Name | Pin Description | Pin | Signal Name | Pin Description |
|-----|-------------|-----------------------|-----|-------------|-----------------------|
| J1 | TC0(+) | CH0 sensor input (+) | J17 | TC16(+) | CH16 sensor input (+) |
| | TC0(-) | CH0 sensor input (-) | | TC16(-) | CH16 sensor input (-) |
| J2 | TC1(+) | CH1 sensor input (+) | J18 | TC17(+) | CH17 sensor input (+) |
| | TC1(-) | CH1 sensor input (-) | | TC17(-) | CH17 sensor input (-) |
| J3 | TC2(+) | CH2 sensor input (+) | J19 | TC18(+) | CH18 sensor input (+) |
| | TC2(-) | CH2 sensor input (-) | | TC18(-) | CH18 sensor input (-) |
| J4 | TC3(+) | CH3 sensor input (+) | J20 | TC19(+) | CH19 sensor input (+) |
| | TC3(-) | CH3 sensor input (-) | | TC19(-) | CH19 sensor input (-) |
| J5 | TC4(+) | CH4 sensor input (+) | J21 | TC20(+) | CH20 sensor input (+) |
| | TC4(-) | CH4 sensor input (-) | | TC20(-) | CH20 sensor input (-) |
| J6 | TC5(+) | CH5 sensor input (+) | J22 | TC21(+) | CH21 sensor input (+) |
| | TC5(-) | CH5 sensor input (-) | | TC21(-) | CH21 sensor input (-) |
| J7 | TC6(+) | CH6 sensor input (+) | J23 | TC22(+) | CH22 sensor input (+) |
| | TC6(-) | CH6 sensor input (-) | | TC22(-) | CH22 sensor input (-) |
| J8 | TC7(+) | CH7 sensor input (+) | J24 | TC23(+) | CH23 sensor input (+) |
| | TC7(-) | CH7 sensor input (-) | | TC23(-) | CH23 sensor input (-) |
| J9 | TC8(+) | CH8 sensor input (+) | J25 | TC24(+) | CH24 sensor input (+) |
| | TC8(-) | CH8 sensor input (-) | | TC24(-) | CH24 sensor input (-) |
| J10 | TC9(+) | CH9 sensor input (+) | J26 | TC25(+) | CH25 sensor input (+) |
| | TC9(-) | CH9 sensor input (-) | | TC25(-) | CH25 sensor input (-) |
| J11 | TC10(+) | CH10 sensor input (+) | J27 | TC26(+) | CH26 sensor input (+) |
| | TC10(-) | CH10 sensor input (-) | | TC26(-) | CH26 sensor input (-) |
| J12 | TC11(+) | CH11 sensor input (+) | J28 | TC27(+) | CH27 sensor input (+) |
| | TC11(-) | CH11 sensor input (-) | | TC27(-) | CH27 sensor input (-) |
| J13 | TC12(+) | CH12 sensor input (+) | J29 | TC28(+) | CH28 sensor input (+) |
| | TC12(-) | CH12 sensor input (-) | | TC28(-) | CH28 sensor input (-) |
| J14 | TC13(+) | CH13 sensor input (+) | J30 | TC29(+) | CH29 sensor input (+) |
| | TC13(-) | CH13 sensor input (-) | | TC29(-) | CH29 sensor input (-) |
| J15 | TC14(+) | CH14 sensor input (+) | J31 | TC30(+) | CH30 sensor input (+) |
| | TC14(-) | CH14 sensor input (-) | | TC30(-) | CH30 sensor input (-) |
| J16 | TC15(+) | CH15 sensor input (+) | J32 | TC31(+) | CH31 sensor input (+) |
| | TC15(-) | CH15 sensor input (-) | | TC31(-) | CH31 sensor input (-) |

Table 21. Digital I/O connector (J33) pinout

| Pin | Signal Name | Pin Description | Pin | Signal Name | Pin Description |
|-----|-------------|------------------------------------|-----|-------------|-------------------------------------|
| 1 | DOUT0 | Digital Output 0/ Alarm Output 0 | 2 | DOUT1 | Digital Output 1/ Alarm Output 1 |
| 3 | DOUT2 | Digital Output 2/ Alarm Output 2 | 4 | DOUT3 | Digital Output 3/ Alarm Output 3 |
| 5 | DOUT4 | Digital Output 4/ Alarm Output 4 | 6 | DOUT5 | Digital Output 5/ Alarm Output 5 |
| 7 | DOUT6 | Digital Output 6/ Alarm Output 6 | 8 | DOUT7 | Digital Output 7/ Alarm Output 7 |
| 9 | DOUT8 | Digital Output 8/ Alarm Output 8 | 10 | DOUT9 | Digital Output 9/ Alarm Output 9 |
| 11 | DOUT10 | Digital Output 10/ Alarm Output 10 | 12 | DOUT11 | Digital Output 11/ Alarm Output 11 |
| 13 | DOUT12 | Digital Output 12/ Alarm Output 12 | 14 | DOUT13 | Digital Output 13/ Alarm Output 13 |
| 15 | DOUT14 | Digital Output 14/ Alarm Output 14 | 16 | DOUT15 | Digital Output 15/ Alarm Output 15 |
| 17 | IGND | Isolated Digital GND | 18 | IGND | Isolated Digital GND |
| 19 | IGND | Isolated Digital GND | 20 | IGND | Isolated Digital GND |
| 21 | DOUT16 | Digital Output 16/ Alarm Output 16 | 22 | DOUT17 | Digital Output 17 / Alarm Output 17 |
| 23 | DOUT18 | Digital Output 18/ Alarm Output 18 | 24 | DOUT19 | Digital Output 19/ Alarm Output 19 |
| 25 | DOUT20 | Digital Output 20/ Alarm Output 20 | 26 | DOUT21 | Digital Output 21/ Alarm Output 21 |
| 27 | DOUT22 | Digital Output 22/ Alarm Output 22 | 28 | DOUT23 | Digital Output 23/ Alarm Output 23 |
| 29 | DOUT24 | Digital Output 24/ Alarm Output 24 | 30 | DOUT25 | Digital Output 25 / Alarm Output 25 |
| 31 | DOUT26 | Digital Output 26/ Alarm Output 26 | 32 | DOUT27 | Digital Output 27/ Alarm Output 27 |
| 33 | DOUT28 | Digital Output 28/ Alarm Output 28 | 34 | DOUT29 | Digital Output 29/ Alarm Output 29 |
| 35 | DOUT30 | Digital Output 30/ Alarm Output 30 | 36 | DOUT31 | Digital Output 31/ Alarm Output 31 |
| 37 | IGND | Isolated Digital GND | 38 | IGND | Isolated Digital GND |
| 39 | IGND | Isolated Digital GND | 40 | IGND | Isolated Digital GND |
| 41 | DIN0 | Digital Input 0 | 42 | DIN1 | Digital Input 1 |
| 43 | DIN2 | Digital Input 2 | 44 | DIN3 | Digital Input 3 |
| 45 | DIN4 | Digital Input 4 | 46 | DIN5 | Digital Input 5 |
| 47 | DIN6 | Digital Input 6 | 48 | DIN7 | Digital Input 7 |
| 49 | IGND | Isolated Digital GND | 50 | IGND | Isolated Digital GND |

Table 22. Expansion connector (J34) pinout

| Pin | Signal Name | Pin Description | Pin | Signal Name | Pin Description | |
|-----|--------------|----------------------|--------|-------------|---------------------|---------------------|
| 1 | +12VA (Note) | +12 VA power output | Note 8 | 2 | AGND | Isolated Analog GND |
| 3 | +12VA | +12 VA power output | | 4 | AGND | Isolated Analog GND |
| 5 | +5VA | +5 VA power output | | 6 | AGND | Isolated Analog GND |
| 7 | +5VA | +5 VA power output | | 8 | AGND | Isolated Analog GND |
| 9 | +5VA | +5 VA power output | | 10 | AGND | Isolated Analog GND |
| 11 | +5VA | +5 VA power output | | 12 | AGND | Isolated Analog GND |
| 13 | +3.3VA | +3.3 VA power output | | 14 | AGND | Isolated Analog GND |
| 15 | +3.3VA | +3.3 VA power output | | 16 | AGND | Isolated Analog GND |
| 17 | +3.3VA | +3.3 VA power output | | 18 | AGND | Isolated Analog GND |
| 19 | +3.3VA | +3.3 VA power output | | 20 | AGND | Isolated Analog GND |
| 21 | CS | Chip select | 22 | AGND | Isolated Analog GND | |
| 23 | SCK | Serial clock | 24 | AGND | Isolated Analog GND | |
| 25 | MOSI | Master output data | 26 | AGND | Isolated Analog GND | |
| 27 | MISO | Master input data | 28 | AGND | Isolated Analog GND | |
| 29 | IRQ | Interrupt request | 30 | AGND | Isolated Analog GND | |
| 31 | RSVD | Reserved | 32 | AGND | Isolated Analog GND | |
| 33 | RSVD | Reserved | 34 | AGND | Isolated Analog GND | |
| 35 | RSVD | Reserved | 36 | AGND | Isolated Analog GND | |
| 37 | RSVD | Reserved | 38 | AGND | Isolated Analog GND | |
| 39 | EXP_DETECT | EXP detection | 40 | AGND | Isolated Analog GND | |

Note 8: Power supplies (+12 VA, +5 VA, 3.3 VA) located at connector J34 are intended for use with the OMB-DAQ-TC-RACK-EXP32 expansion device only.

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