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OMB-NET6224

12-Channel Ethernet-Based Strain Gauge Input Module

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Table of Contents

About this User's Guide

What you will learn from this user's guide

This user's guide describes the Omega Engineering OMB-NET6224 data acquisition device and lists device specifications.

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.

bold text — **Bold** text is used for the names of objects on the 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-NET6224 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: info@omega.com

Introducing the OMB-NET6224

Overview: OMB-NET6224 features

The OMB-NET6224 is a 24-bit resolution strain measurement device that connects to an Ethernet port on a host computer. The device is used to measure half-bridge and full-bridge sensors and can be synchronized with other OMB-NET6000 Series devices.

The OMB-NET6224 provides the following features:

- Up to 12 strain RJ50 input jacks
- Up to eight lines of digital I/O and four 32-bit counters
- Supports quarter-bridge I, quarter-bridge II, half-bridge I, half-bridge II, full-bridge I, full-bridge II, and full-bridge III

Software requirements

- Windows 7 (32- or 64-bit)
- Windows Vista (32- or 64-bit)
- Windows XP SP2 (32-bit)
- Windows 2000 SP4
- Encore Software for OMB-NET6000 Series CD

Hardware requirements

Verify that you have the following items and meet or exceed the minimum requirements listed.

- OMB-NET6224
- OMB-NET-TR-60U power supply and cable
- Ethernet crossover cable

  Use the provided Ethernet crossover cable when connecting an OMB-NET6000 Series device directly to the PC. Use a standard Ethernet cable when connecting via a hub/switch. Use a gigabit switch when connecting multiple devices.
- PC requirements:

  Minimum:
  - CPU: Intel® Pentium® 4, 3.0 GHz or equivalent
  - RAM: 1 GB
  - Monitor: 1024 × 768 screen resolution

  Recommended:
  - CPU: Intel® Core™ 2 Duo family
  - RAM: at least 2 GB
  - Monitor: 1024 × 768 screen resolution

OMB-NET6224 block diagram

The 12 strain measurement channels on the OMB-NET6224 are set up in three distinct isolated sections. Channels 1 through 4 share 'section 1 common' and an isolator; channels 5 through 8 share 'section 2 common' and an isolator; and channels.9 through 12 share 'section 3 common' and an isolator.

OMB-NET6224 functions are illustrated in Figure 1.

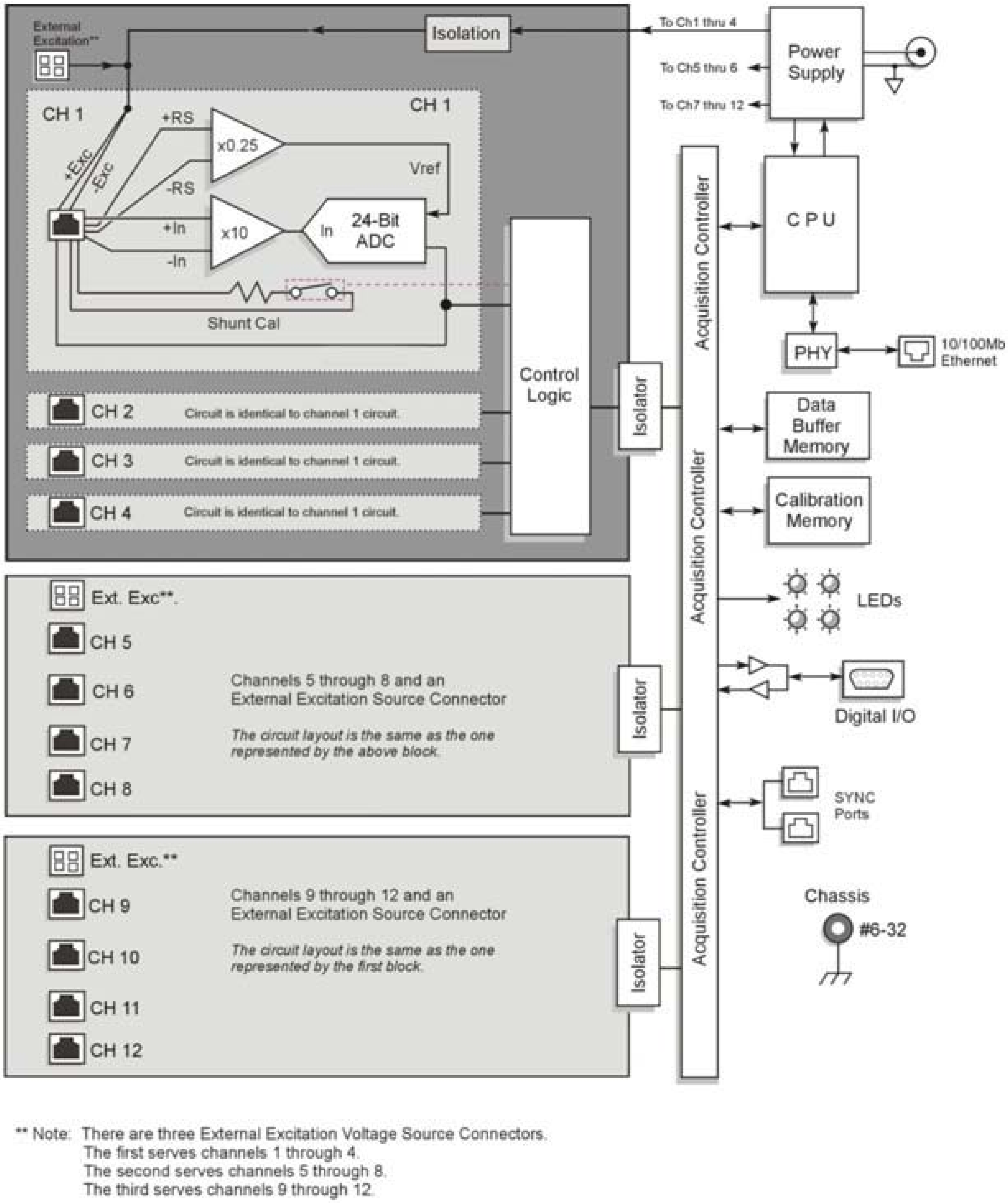


Figure 1. OMB-NET6224 functional block diagram

What comes with your OMB-NET6224 shipment?

The following items are shipped with the OMB-NET6224.

Hardware

- OMB-NET6224

- OMB-NET-TR-60U external power supply, 90 VAC to 264 VAC
- Either a OMB-CA-1 cable (U.S. version) or a OMB-CA-216 cable (European version) for use with OMB-OMB-NET-TR-60U
- OMB-CA-192-7C Ethernet crossover cables

Software

Encore Software for OMB-NET6000 Series installation CD

Documentation

In addition to this hardware user's guide, a *Quick Start* booklet is included with the OMB-NET6224 shipment. This booklet explains how to install and connect the OMB-NET6224 and install the Encore software.

Unpacking the OMB-NET6224

As with any electronic device, take care while handling to avoid damage from static electricity. Before removing the OMB-NET6224 device 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 hardware and software

Refer to the *OMB-NET6224 Quick Start* for instructions on connecting your OMB-NET6224 and configuring it using the Encore software.

Maintenance guidelines

OMB-NET6000 Series devices are essentially maintenance-free and need only a minimal amount of care. They should be treated much like any other high-tech piece of equipment. In general:

- Operate the units in ventilated and relatively dust-free environments.
- Keep the units clear of harsh chemicals and abrasive elements.
- Avoid exposing the products to extreme heat – for example, avoid placing the units near boilers and furnaces.
- Avoid extreme shock and vibration.
- Avoid subjecting the device to liquids and extremely fine air particulate, such as silica dust.
- Never open the device. The device should only be opened by qualified service technicians.
- Use lint-free rags and rubbing alcohol to clean the outer surfaces of an OMB-NET6000 Series device.

Functional Details

Front panel RJ50 jacks

The front panel houses twelve channel signal input jacks and three excitation voltage source connectors—one for each set of four channels. The input channel jacks are type RJ50 (10p10c) and are labeled CH1 through CH12. Refer to the RJ50 (10p10c) modular plug and jack pinout table on page 15 for the 10-connector pinout for the RJ50 connectors.

Refer to the External excitation voltage sources section on page 19 for information on the optional external voltage source connectors that are available.

Caution! Do not connect an RJ45 plug to an RJ50 jack. Using RJ45 plugs can cause permanent damage to RJ50 pins 1 and 10, thus disabling shunt calibration.

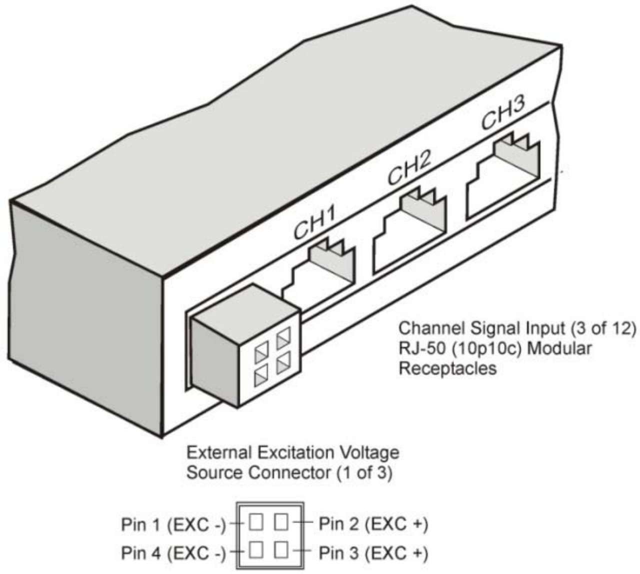


Figure 2. OMB-NET6224 front panel jacks (CH0 through CH4)

Rear panel components

OMB-NET6224 devices have the rear panel components shown in Figure 3.

1	Cable tie mounts	4	Chassis ground	7	Power input connector
2	Ethernet connector	5	Status LEDs	8	Power switch
3	Digital I/O D-SUB connector	6	SYNC ports		

Figure 3. OMB-NET6224 rear panel components

Cable tie mounts

Use the two cable tie mounts for cable strain relief.

Ethernet connector

Connect the 10/100BaseT Ethernet port to the Ethernet port of the host computer or to an Ethernet network. The Ethernet connector has two built in LEDs that indicate traffic flow on the network.
Refer to *Accessories* in the *Specifications* chapter for Ethernet cables available from Omega Engineering.

When connecting the OMB-NET6224 directly to a computer (not to a network hub), use an Ethernet crossover cable. The Ethernet cable length must be less than 3 m (9.8 ft) long in order for the system to be CE compliant.

Digital I/O D-SUB connector

Eight digital I/O lines are accessible via a 9-pin, female D-SUB connector (refer to the Digital input/output specifications on page 29 for more information).

Chassis ground

Provides a connection point for chassis ground through a #6-32 machine screw.

Status LEDs

Power—LED is *on* when the device is connected to a sufficient power source, and the power switch is in the **I** (on) position.

Boot— When you power on the device, the **Boot** LED turns on to indicate the first stage of the boot process. When this process completes successfully, the **Boot** LED turns off. If an internal error occurs during this first stage boot process, this LED blinks. Contact Omega Engineering to arrange repair service.

Active—When you power on the device, the **Active** LED is off while the device boots, including network configuration. This LED blinks quickly when the boot process is complete, and then remains on.

When both the **Power** and **Active** are on, the OMB-NET6224 is in the *ready* state. When the **Active** LED blinks slowly, it indicates communication with a host computer.

Data—The **Data** LED turns on any time the device is acquiring channel data that is available to the host computer control software.

When you power on the OMB-NET6224, the device can take up to two minutes to reach ready state, depending on network settings. Use the following LED sequence to determine when the device is ready:

1. **Power** LED turns on and remains on
2. **Boot** LED turns on, then off
3. **Active** LED blinks, then remains on
4. Device is ready

SYNC connectors

The two synchronization ports can synchronize the pre-trigger data and post-trigger scanning of up to nine OMB-NET6000 Series devices. Use Encore to designate any OMB-NET6000 Series device as a *master unit*, *slave unit*, or *terminating slave unit*.

Up to nine OMB-NET6000 Series devices can be synchronized. The total combined length of the SYNC cables cannot exceed 2.438 m (8 ft).

Refer to the following section, *Synchronization*, for details. Refer to *Accessories* in the *Specifications* chapter for SYNC cables available from Omega Engineering.

Power input connector

Connect to 19 VDC to 30 VDC power supply, such as the OMB-NET-TR-60U, 24VDC universal power supply.

Power switch

Switch to power on (**|** and power off (**0**) the device.

Synchronization

To synchronize up to nine OMB-NET6000 Series devices, connect them with synchronization cables as shown in Figure 4. The first device added to the synchronization group is the master, and the last device added is the terminating slave.

Unplug sync cables from devices that are not intended to be part of a Synchronized Device Group. Leaving a sync cable connected to an independent device can lead to errors.

Channel-to-channel phase relationships in a multi-device configuration are not necessarily fixed.

Figure 4. OMB-NET6000 Series devices connected for synchronization

After connecting the devices with the sync cables, configure them as a *synchronized device group* using Encore. Each synchronized group consists of one master device and at least one slave device.

The sampled data phase relationship among channels among multiple devices depends on the Channel Sync Skew specification for each device. When using different models in a multi-device system, any differences in the ADC filter delay (*input delay*) should be added (refer to the Input delay specifications on page 27).

Refer to the *Synchronizing Devices* topic of the OMB-NET6000 Series *Encore Help* for more information on synchronizing devices.

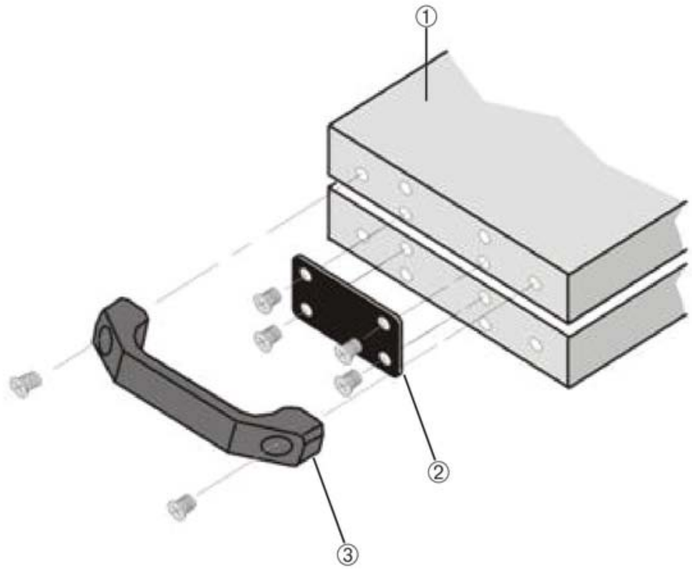
Caution! Leaving an un-terminated sync cable on a synchronized device can lead to errors.

Stacking plate and handle options

Each OMB-NET6000 Series device chassis is equipped with feet on the lower panel and dimples on the upper panel for quick stacking of units.

To secure units together, use the optional stacking plate kits (OMB-NET-SPK). Each kit contains two stacking plates and eight screws (8-32 × .500 in., Phillips Flat, 82 Degree).

An optional handle kit (OMB-NET-HK) is available to provide a convenient way of carrying a single OMB-NET6000 Series device or a secured stacked set of devices. Each handle kit includes one black molded plastic handle and two mounting screws (1/4-20 x 7/8 in., Phillips Pan Head).



1 OMB-NET6000 Series devices 2 Stacking plate 3 Handle

Figure 5. OMB-NET6224 stacking plate assembly

To attach OMB-NET6000 Series devices to each other using stacking plates, complete the following steps:

5. With the hole tapers facing out, align the bottom two holes of a plate with the top two center holes of the lower
6. Secure the plate with the two #8-32 × .500 in. Phillips screws (provided). Tighten the screws snug, but do not over-tighten.
7. Repeat steps 1 and 2 for the second plate on the other side of the OMB-NET6000 Series device.
4. Attach the second device using the remaining four screws.
5. Repeat steps 1 through 4for each additional device and stacking plate kit and device.

To mount a handle to an OMB-NET6000 Series device, attach the handle to adevice using the two outer holes on the device and the two 1/4-20 ×7/8 in. Phillips pan head screws (provided). Tighten the screws snug, but do not over-tighten.

Installing quarter-bridge completion accessories

The OMB-NET-CN-269 and OMB-NET-CN-270 are quarter-bridge completion kits. Each kit consists of four components, and a single component (each member of its respective four-pack) can be used to add a quarter-bridge completion resistor to a channel on the OMB-NET6224.

The OMB-NET-CN-269 components each house a 120 Ω resistor. The OMB-NET-CN-270 components each house a 350 Ω resistor.

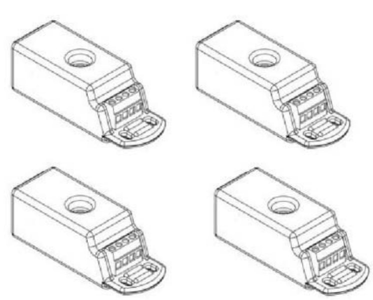


Figure 6. OMB-NET6224 quarter-bridge completion kit

You need an RJ50 M/M cable to use any of the quarter-bridge components with an OMB-NET6224. Omega Engineering offers a pack of four RJ50 M/M, 1 meter (3.28ft) cables (refer to the Connecting components with RJ50 cables section on page 15).

As shown in Figure 7, OMB-CN-269 and OMB-CN-270 components each have two holes that you can use to loop a plastic tie-strap through in order to add strain relief for the wire connections to the screw terminals.

To mount a component, use a M4x20 screw (or similar hardware) that can fit into the 8.89 mm (0.350 in.) outer clearance/4.57 mm (0.180 in.) inner clearance hole.

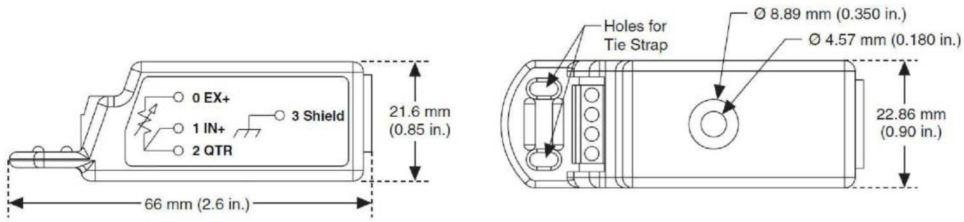


Figure 7. OMB-NET6224 quarter-bridge component diagrams

Installing half-bridge and full-bridge completion accessories

The OMB-NET-CN-268 is a half-bridge or full-bridge completion kit. Because bridge completion is built into the OMB-NET6224, you only need connectivity accessories.

The OMB–NET-CN-268 is a set of four female RJ50-to-12-pin screw terminal adapters. You need an RJ50 M/M cable to use a OMB-NET-CN-268 component with an OMB-NET6224. Omega Engineering offers a pack of four RJ50 M/M, 1 meter (3.28ft) cables (refer to the *Connecting components with RJ50* cables section on page 15).

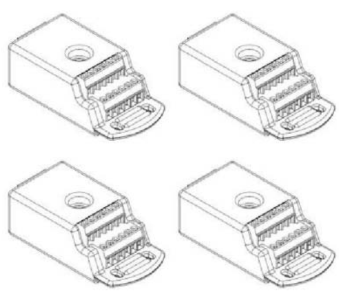


Figure 8. OMB-NET6224 half-bridge and full-bridge completion kit

As shown in Figure 9, OMB-NET-CN-268 components each have two holes that you can use to loop a plastic tie-strap through in order to add strain relief for the wire connections to the screw terminals.

If you want to mount an OMB-NET-CN-268 component, use an M4x20 screw (or similar hardware) that can fit into the 8.89 mm (0.350 in.) outer clearance/4.57 mm (0.180 in.) inner clearance hole. Refer to Figure 9.

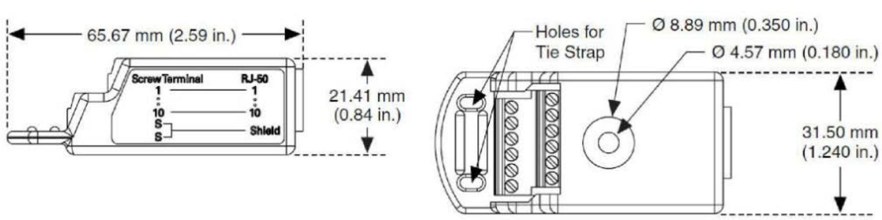


Figure 9. OMB-NET6224 half-bridge/full-bridge component diagrams

Connecting components with RJ50 cables

When connecting a cable from an OMB-NET6224 RJ50 jack to a bridge completion accessory (OMB-NET-CN-268, OMB-NET-CN-269, or OMB-NET-CN-270), only use RJ50 M/M cables (OMB-NET-CA-272-01). Using another cable type can damage RJ50 pins.

The OMB-NET-CA-272-01includes four RJ50 to RJ50 M/M, 1 meter (3.28ft) cables.

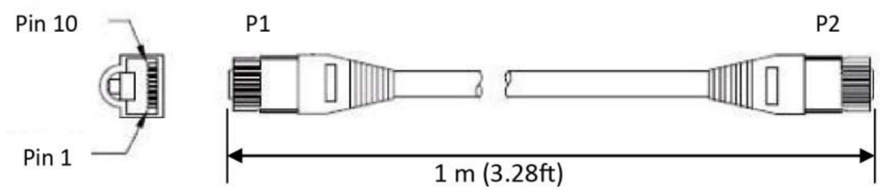


Figure 10. OMB-NET6224 RJ50 to RJ50 M/M cable diagram

Strain channels, RJ50 pinout

The twelve RJ50 jacks each have 10 pins with signal designations as indicated in the following table.

RJ50 modular plug and jack pinout

Pin #	Signal name	Signal description
1	SC	Shunt calibration
2	AI+	Positive input signal
3	AI-	Negative input signal
4	RS+	Positive remote sense signal
5	RS-	Negative remote sense signal
6	EX+	Positive excitation signal*
7	EX-	Negative excitation signal*
8	T+	No connection
9	T-	No connection
10	SC	Shunt calibration

* The three channel blocks each share three signals within their block, as follows:

- For CH1, CH2, CH3, and CH4, the signal values of pins 6, 7, and 9 are shared.
- For CH5, CH6, CH7, and CH8, the signal values of pins 6, 7, and 9 are shared.
- For CH9, CH10, CH11, and CH12, the signal values of pins 6, 7, and 9 are shared

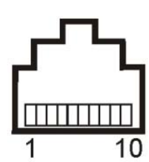


Figure 11. OMB-NET6224 RJ50 connector front view

Caution! Do not connect an RJ45 plug to an RJ50 jack. Using RJ45 plugs can cause permanent damage to RJ50 pins 1 and 10, thus disabling shunt calibration.

Bridge connections

Figure 12 shows how to connect bridges to an OMB-NET6224. The manner in which these signals correspond to the RJ50 connector is shown in the *RJ50 modular plug and jack pinout* table above.

- When connecting a bridge to the OMB-NET6224, the RS+, RS-, SC, T+, and T-.connections are optional.
- For the half-bridge and quarter-bridge, there is no AI- signal to connect.
- To create a quarter-bridge, place an external resistor across the two SC lines of a half-bridge. Omega Engineering offers two external quarter-bridge accessories, OMB-NET-CN-269 (120 Ω) and OMB-NET-CN-270 (350 Ω).

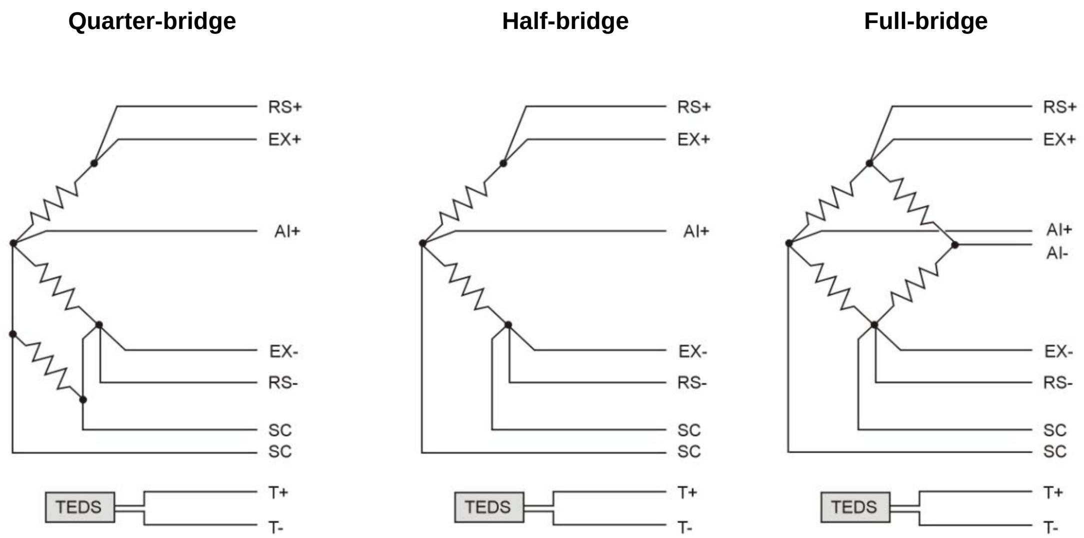


Figure 12. OMB-NET6224 Quarter-bridge, half-bridge, and full-bridge connection diagrams

Analog circuitry

The OMB-NET6224 is isolated from earth ground. However, individual channels within their four-channel group are not isolated from each other. The EX+, EX–, and T– signals are common among the four channels in their group as indicated by the block diagram (Figure 1 on page 7).

You can connect the OMB-NET6224 to a device that is biased at any voltage within the range of earth ground (refer to Common-mode rejection ratio (CMRR)).

If you connect floating signals to the OMB-NET6224, connecting the **EX–** signal to the earth ground or shield results in better noise rejection.

Each of the twelve analog channels has its own 24-bit ADC and input amplifier, so you can simultaneously sample signals from all twelve channels.

The OMB-NET6224 includes anti-aliasing filters. Filtering is based on the sampling rate.

Filtering

The OMB-NET6224 uses a combination of analog and digital filtering to accurately represent desirable signals while rejecting out-of-band signals. The filters discriminate between signals based on the frequency range (bandwidth) of the signal.

The three bandwidths to consider are the passband, the stopband, and the alias-free bandwidth.

Passband bandwidth

The OMB-NET6224 represents signals within the passband as quantified primarily by passband flatness and phase nonlinearity. The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with frequency is called the passband flatness.

The OMB-NET6224 filters adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate. The following figure shows typical passband flatness for a range of data rates.

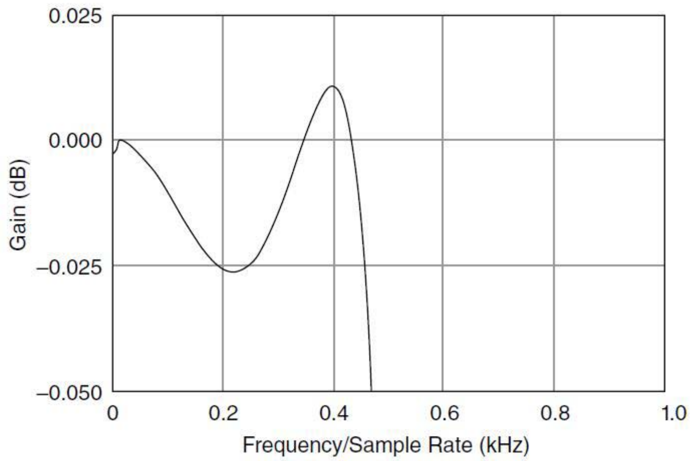


Figure 13. Passband flatness for a range of data rates

Stopband bandwidth

The OMB-NET6224 filters reject frequencies within the stopband as quantified by stopband rejection. The filter significantly attenuates all signals above the stopband frequency. The primary goal of the filter is to prevent aliasing. Therefore, the stopband frequency scales precisely with the data rate.

Stopband rejection is the minimum amount of attenuation applied by the filter to all signals with frequencies that would be aliased into the alias-free bandwidth.

Alias-Free bandwidth

All signals that appear in the alias-free bandwidth of the OMB-NET6224 are either unaliased signals or signals filtered by at least the amount of the stopband rejection. The alias-free bandwidth is defined by the ability of the filter to reject frequencies above the stopband frequency and equals the data rate minus the stopband frequency.

Correcting errors in bridge circuits

Wire resistance can create errors in bridge circuits. The OMB-NET6224 can correct for these errors using *remote sensing* and *shunt calibration*.

Remote sensing

Remote sensing continuously and automatically corrects for errors in excitation leads, and generally is best-suited for full-bridge and half-bridge sensors.

Long wire and smaller gage wire have greater resistance, which can result in gain error. The voltage drop caused by wire resistance in the wires which connect the excitation voltage to the bridge is a source of gain error. The OMB-NET6224 includes remote sensing to compensate for this error. Remote sense (RS) wires are connected to the point where the excitation voltage wires connect to the bridge circuit.

In Figure 14, the actual bridge excitation voltage is smaller than the voltage at the **EX+** and **EX–** leads.

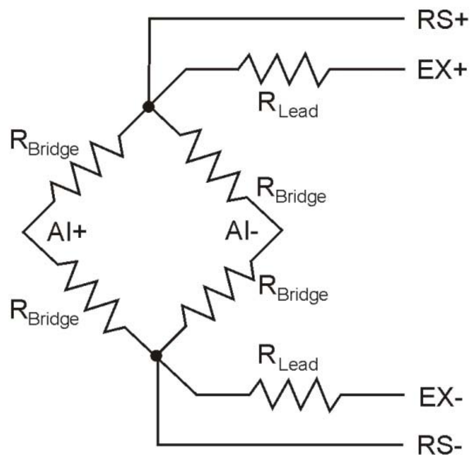


Figure 14. Remote sensing connection diagram

If remote sensing of the actual bridge voltage is not used, the resulting gain error is as follows:

Error in full-bridge sensors = $2R_{\text{Lead}}/R_{\text{Bridge}}$

Error in half-bridge sensors = $R_{\text{Lead}}/R_{\text{Bridge}}$

If the remote sense (RS) signals are connected directly to the bridge resistors, then the OMB-NET6224 senses the actual bridge voltage sense and eliminates the gain errors caused by the resistance of the EX+ and EX– leads.

Shunt calibration

Shunt calibration involves simulating the input of strain by changing the resistance of an arm in the bridge. This is accomplished by shunting, or connecting, a large resistor of known value across one arm of the bridge, creating a known strain-induced change in resistance. The output of the bridge can then be measured and compared to the expected voltage. The results are used to correct gain errors in the entire measurement path, or to simply verify general operation to gain confidence in the setup.

Use shunt calibration to correct for errors from the resistance of both the excitation wiring and wiring in the individual resistors of the bridge. Shunt calibration is most critical when measurements are made on quarter-bridge sensors because there is no means to remotely sense around any IR drops in the connection wiring.

The OMB-NET6224 includes a precision 100 kΩ resistor and a software-controlled switch for each channel. You can leave the shunt calibration terminals connected to the sensor, and then apply or remove the shunt calibration resistance in software.

While remote sensing corrects for resistances from the EX terminals on the OMB-NET6224 to the sensor, shunt calibration corrects for these errors and for errors caused by wire resistance within an arm of the bridge.

A stable signal – typically the unloaded state of the sensor – is used first with the shunt calibration switched *off*, and then again switched *on*. The difference in these two measurements indicates the gain errors from wiring resistances and corrections for offset errors.

Internal excitation voltage sources

The OMB-NET6224 houses three internal voltage sources, with each source serving four channels.

The first source applies excitation voltage to CH1 through CH4, the second to CH5 through CH8, and the third to CH9 through CH12.

The sensor industry does not recognize a single standard excitation voltage level. However, excitation voltage levels residing in the range of 2.5 V to 10 V are common. Encore's selections for internal excitation are 2.5V, 3.3V, 5V, and 10V, and each of the three internal voltage sources can provide up to 150 mW of excitation power. The OMB-NET6224 automatically reduces internal excitation voltages, as needed, to stay below 150mW.

Since channels are associated by groups of four, the excitation setting applied to one channel in a group are also applied to the other channels in that group. For example, if channel 1 is set to have an internal excitation of 3.3 V, then channels 2, 3, and 4 also have 3.3 V excitation.

The OMB-NET6224 measures the ratio of bridge output to bridge excitation, and does not require accurate excitation voltage. For this reason, the excitation voltage is not precisely regulated and may vary as much as 10% from the requested voltage, while still achieving accurate measurements.

The power consumed by a single bridge is V_{ex}^2/R.

Where V_{ex} is the excitation voltage and R is the total resistance of the bridge.

For a full bridge, *R* equal to the resistance of each element. For a half or quarter bridge, R is equal to two times the resistance of each element.

For each of the three voltage sources, the 150 mW limit allows you to power full and half bridges as follows:

- Four 350 Ω half bridges at 5.0 V
- Four 350 Ω full bridges at 3.3 V
- Four 120 Ω half bridges at 2.5 V

If you need an excitation voltage greater than 150 mW, use the four-position external excitation voltage connectors (refer to the External excitation voltage sources section below). Each of the three external connectors can be used to provide external excitation to four channels of the OMB-NET6224; thus all twelve channels can receive external excitation.

External excitation voltage sources

The OMB-NET6224 front panel includes three 4-pin connectors which provide connections to external excitation voltage sources.

Each external voltage source serves 4 channels, as follows:

- the first source applies excitation voltage to CH1 through CH4
- the second source applies excitation voltage to CH5 through CH8
- the third source applies excitation voltage to CH9 through CH12

Since channels are associated by groups of four, what you set for one channel in a group is also applied to other channels of that group. For example: if you set channel 1 for 10 V external excitation, channels, 2, 3, and 4 also have 10 V external excitation.

The sensor industry does not recognize a single standard excitation voltage level. However, excitation voltage levels residing in the range of 2.5V to 10 V are common.

Caution! Unless you supply external excitation voltage, Omega Engineering recommends that you set the excitation voltage to a value that keeps the total power below 150 mW.

Figure 15 shows the pinout for the external excitation voltage source connector. Also, refer to the Internal excitation voltage sources section above

Figure 15. OMB-NET6224 external excitation voltage source pinout

Mounting and securing connections

For a strain measurement system, *mechanical noise* should also be a consideration. Movement in the connection system could translate to errors in the measurement.

Make sure the OMB-NET6224, RJ50 cables, and dongles are physically secured to prevent relative movement.

Counter input

The OMB-NET6224 has four 32-bit counter inputs that accept frequency inputs up to 20 MHz. The counter inputs are software-configurable for counter or encoder measurements.

Use Encore to configure the following counter settings:

- **Counter Source**—Select **Internal Clock**, **Timer 1**, **Timer 2**, or **Digital Line 0** through **Digital Line 7** as the source used for the counter. One source can be used in multiple counters.
- **Counter Gate**—Select **Unused** (do not gate the counter), **Internal Clock**, **Timer 1**, **Timer 2**, or **Digital Line 0** through **Digital Line 7** as the gate used for the counter. One gate can be used in multiple counters.
- **Count**—Select from the following settings:
  - **Clear on Read**—The counter counts up and is cleared after each read. By default, the counter counts up and only clears the counter at the start of a new scan command. The value of the counter before it is cleared is latched and returned.
  - **Totalize**—The counter counts up and is cleared at the start of a new scan.
  - **Start Count**–The value used to start counting. The default is *zero*.
  - **Stop Count**—The value used to stop counting. The default is *65535*.
  - **Rollover**—The count rolls over upon reaching the start or stop value.
- **Direction**—Select either **Increment** (count up) or **Decrement** (count down).
- **Detection**—Select **Rising Edge** to detect the count when the signal goes from low to high, or **Falling Edge** to detect the count when the signal goes from high to low.

Encoder settings

Select **Encoder** from the **Measurement Type** list to configure the following encoder settings:

- **Resolution**—Select the encoder resolution—the number of full quadrature cycles per full shaft revolution (360 mechanical degrees) —from the following options:
  - **X1** —One count per cycle (default)
  - **X2**—Two counts per cycle
  - **X4**— Four counts per cycle
- **Sources**—Select one of the digital lines—**Digital Line 0** through **Digital Line 7**— for encoder **Source A**, **Source B**, and **Source C**.

When configured for encoder measurements, the OMB-NET6224 can count *negative* values. When counting down, the encoder continues counting down below 0. This feature is useful to calculate the position of an encoder.

Overview of strain gage types

This section uses simple schematics to represent axial and/or bending strain to indicate the type(s) of strain that applies to a given bridge type.

For each type of bridge, supplemental information shows two equations:

- the first equation is to convert voltage to strain
- the second equation is to simulate the effect on strain by applying a shunt resistor across R3

Figures and equations in this section use the following acronyms, formulas, and variables:

ε Measured strain

$+\varepsilon$ Tensile strain

$-\varepsilon$ Compressive strain

ε_S Simulated strain

GF Gage factor (usually specified by the gage manufacturer)

R_g Nominal gage resistance (usually specified by the gage manufacturer)

R_L Lead resistance (if lead lengths are long, R_L can significantly impact measurement accuracy)

R_s Shunt calibration resistor value.

U Ratio of expected signal voltage to excitation voltage with the shunt calibration circuit engaged. Parameter *U* appears in the equations for simulated strain and is defined by the following equation

$$U = \frac{-R_g}{4R_s + 2R_g}$$

ν Poisson's ratio, defined as the negative ratio of transverse strain to axial strain (longitudinal) strain

V_{CH} Measured signal voltage

V_{EX} Excitation voltage.

V_r Ratio used in the voltage-to-strain conversion equations that is defined by the following equation:

$$V_r = \left(\frac{V_{CH\,(strained)} - V_{CH\,(unstrained)}}{V_{EX}}\right)$$

Quarter-bridge type I

Quarter-bridge type I measures either axial or bending strain. The following symbols apply to the circuit diagram in Figure 16 and to the following equation that converts data from strain channels to strain units:

$$\mu\varepsilon = 10^6 \cdot \left[\frac{-4 \cdot V_r}{GF \cdot (1+2 \cdot V_r)} \cdot \left(1+\frac{R_L}{R_g}\right)\right]$$

- R1 and R2 are the half-bridge completion resistors.
- R3 is the quarter-bridge completion resistor (dummy resistor).
- R4 is the active strain-gage element measuring tensile strain (+ε).

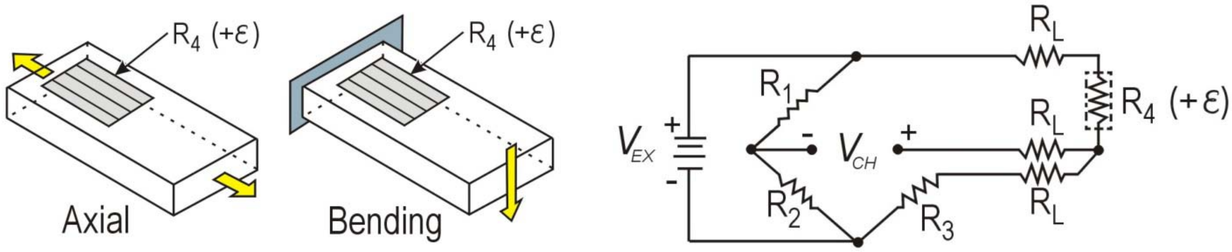


Figure 16. Quarter-bridge type I measurement examples and circuit

Quarter-bridge type I has the following characteristics:

- A single active strain-gage element is mounted in the principle direction of axial or bending strain.
- A passive quarter-bridge completion resistor (dummy resistor) is required in addition to half-bridge completion.
- Temperature variation in specimen decreases the accuracy of the measurements.
- Sensitivity at 1000 με is ~ 0.5 mV_{out}/V_{EX} input.

The following symbols apply to the above circuit diagram and to the equations provided in the supplemental

Quarter-bridge type II

Quarter-bridge type II measures either axial or bending strain. The following symbols apply to the circuit diagram in Figure 17 and to the following equation that converts data from strain channels to strain units:

$$\mu\varepsilon = 10^6 \cdot \left[\frac{-4 \cdot V_r}{GF \cdot (1+2 \cdot V_r)} \cdot \left(1+\frac{R_L}{R_g}\right)\right]$$

- R1 and R2 are half-bridge completion resistors.
- R3 is the quarter-bridge temperature-sensing element (dummy gage).
- R4 is the active strain-gage element measuring tensile strain (+ε).

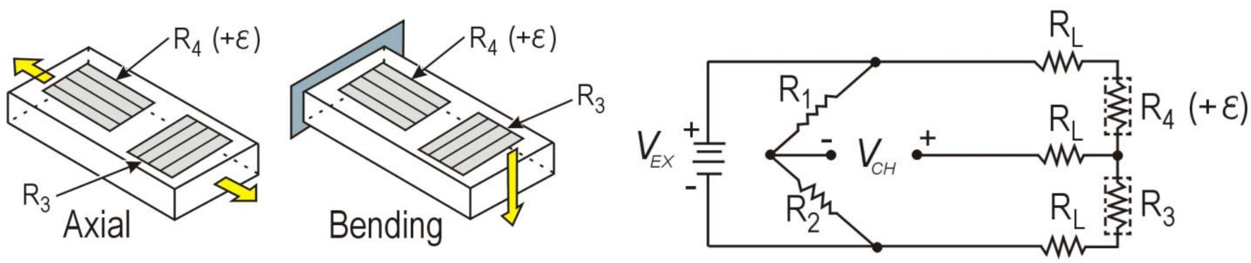


Figure 17. Quarter-bridge type II measurement examples and circuit

Quarter-bridge type II has the following characteristics:

- One active strain-gage element and one passive, temperature-sensing quarter-bridge element (dummy gage). The active element is mounted in the direction of axial or bending strain. The dummy gage is mounted in close thermal contact with the strain specimen but not bonded to the specimen, and is usually mounted transverse (perpendicular) to the principle axis of strain.
- This configuration is often confused with the half-bridge type I configuration. In the half-bridge type I configuration, the R3 element is active and bonded to the strain specimen to measure the effect of Poisson's ratio.
- Completion resistors provide half bridge completion.
- Compensates for temperature.
- Sensitivity at 1000 με is ~ 0.5 mV_{out}/V_{EX} input.

Half-bridge type I

Half-bridge type I measures either axial or bending strain. The following symbols apply to the circuit diagram in Figure 18 and to the following equation that converts data from strain channels to strain units:

$$\mu\varepsilon = 10^6 \cdot \left[\frac{-4 \cdot V_r}{GF \cdot (1+2 \cdot V_r)} \cdot \left(1+\frac{R_L}{R_g}\right)\right]$$

- R1 and R2 are half-bridge completion resistors.
- R3 is the active strain-gauge element measuring compression from Poisson effect (–νε).
- R4 is the active strain-gauge element measuring tensile strain (+ε).

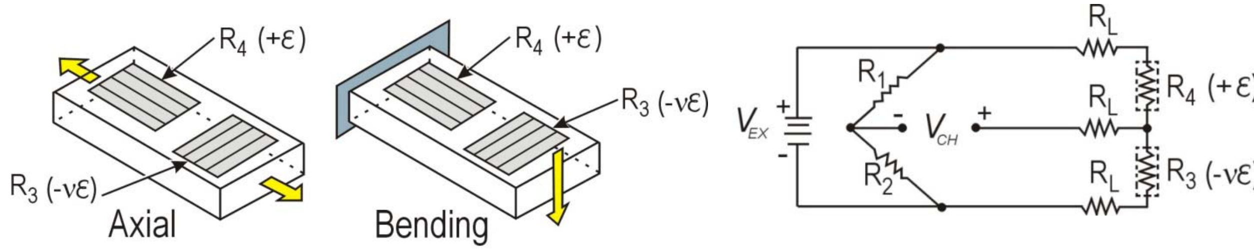


Figure 18. Half-bridge type I measurement examples and circuit

Half-bridge type I has the following characteristics:

- Two active strain-gage elements, with ones mounted in the direction of axial strain, and the other (acting as a Poisson gage) mounted transverse (perpendicular) to the principal axis of strain.
- Completion resistors provide half bridge completion.
- Sensitive to both axial and bending strain.
- Compensates for temperature.
- Compensates for the aggregate effect on the principle strain measurement due to the Poisson's ratio of the specimen material.
- Sensitivity at 1000 με is ~ 0.65 mV_{out}/V_{EX} input.

Half-bridge type II

Half-bridge type II only measures bending strain. The following symbols apply to the circuit diagram in Figure 19 and to the following equation that converts data from strain channels to strain units:

$$\mu\varepsilon = 10^6 \cdot\left[\frac{-2\cdot V_r}{GF}\cdot\left(1+\frac{R_L}{R_g}\right)\right]$$

- R1 and R2 are half-bridge completion resistors.
- R3 is the active strain-gauge element measuring compressive strain (–ε).
- R4 is the active strain-gauge element measuring tensile strain (+ε).

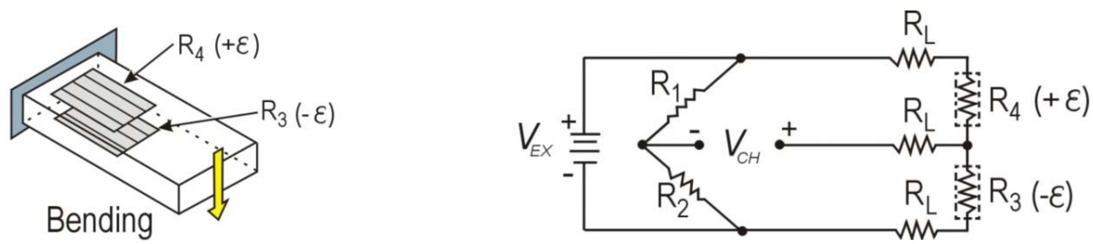


Figure 19. Half-bridge type II measurement example and circuit

Half-bridge type II has the following characteristics:

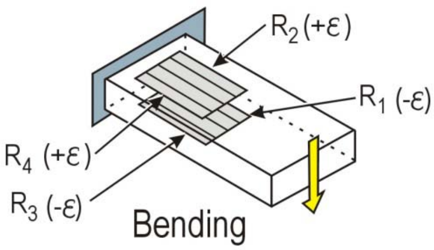
- Two active strain-gage elements, with one mounted in the direction of bending strain on one side of the strain specimen (top), and the other mounted in the direction of bending strain on the opposite side (bottom).
- Completion resistors provide half bridge completion.
- Sensitive to bending strain.
- Rejects axial strain.
- Compensates for temperature.
- Sensitivity at 1000 με is ~ 1 mV_{out}/V_{EX} input.

Full-bridge type I

The Full-bridge type I only measures bending strain. The following symbols apply to the circuit diagram in Figure 20 and to the following equation that converts data from strain channels to strain units:

$$\mu\varepsilon = 10^6 \cdot \left[\frac{(-V_r)}{GF}\right]$$

- R1 is an active strain-gage element measuring compressive strain (–ε).
- R2 is an active strain-gage element measuring tensile strain (+ε).
- R3 is an active strain-gage element measuring compressive strain (–ε).
- R4 is an active strain-gage element measuring tensile strain (+ε).



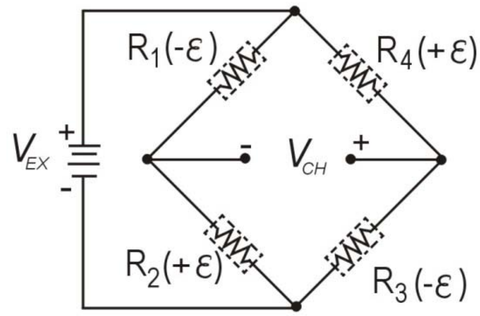


Figure 20. Full-bridge type I measurement example and circuit

Full-bridge type I configuration has the following characteristics:

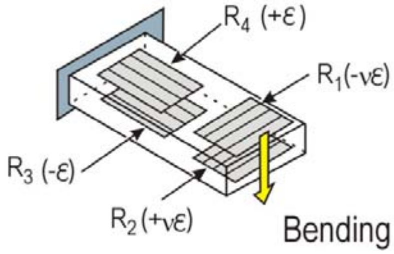
- Four active strain-gage elements, with two mounted in the direction of bending strain on one side of the strain specimen (top), and the other two mounted in the direction of bending strain on the opposite side (bottom).
- Highly sensitive to bending strain.
- Rejects axial strain.
- Compensates for temperature.
- Compensates for lead resistance.
- Sensitivity at 1000 με is ~ 2.0 mV_{out}/V_{EX} input.

Full-bridge type II

Full-bridge type II only measures bending strain. The following symbols apply to the circuit diagram in Figure 21 and to the following equation that converts data from strain channels to strain units:

$$\mu\varepsilon = 10^6 \cdot \left[\frac{(-2 \cdot V_r)}{GF \cdot (1+\nu)}\right]$$

- R1 is an active strain-gage element measuring compressive Poisson effect (–νε).
- R2 is an active strain-gage element measuring tensile Poisson effect (+νε).
- R3 is an active strain-gage element measuring compressive strain (–ε).
- R4 is an active strain-gage element measuring tensile strain (+ε).



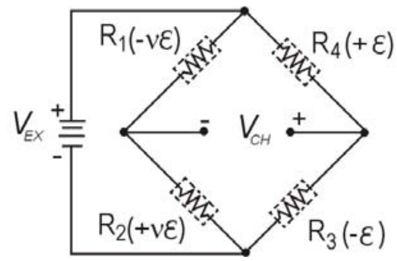


Figure 21. Full-bridge type II measurement example and circuit

Full-bridge type II configuration has the following characteristics:

- Four active strain-gage elements, with two mounted in the direction of bending strain with one on one side of the strain specimen (top), the other on the opposite side (bottom). The other two act together as a Poisson gage and are mounted transverse (perpendicular) to the principal axis of strain with one on one side of the strain specimen (top), and the other on the opposite side (bottom).
- Rejects axial strain.
- Compensates for temperature.
- Compensates for the aggregate effect on the principle strain measurement due to the Poisson's ratio of the specimen material.
- Compensates for lead resistance.
- Sensitivity at 1000 με is ~ 1.3 mV_{out}/V_{EX} input.

Full-bridge type III

Full-bridge type III only measures axial strain. The following symbols apply to the circuit diagram in Figure 22 and to the following equation that converts data from strain channels to strain units:

$$\mu\varepsilon = 10^6 \cdot \left[\frac{-2 \cdot V_r}{GF \cdot [(1+\nu) - V_r\,(\nu - 1)]}\right]$$

- R1 is an active strain-gauge element measuring compressive Poisson effect (–νε).
- R2 is an active strain-gauge element measuring tensile strain (+ε).
- R3 is an active strain-gauge element measuring compressive Poisson effect (–νε).

R4 is an active strain-gauge element measuring the tensile strain (+ε).

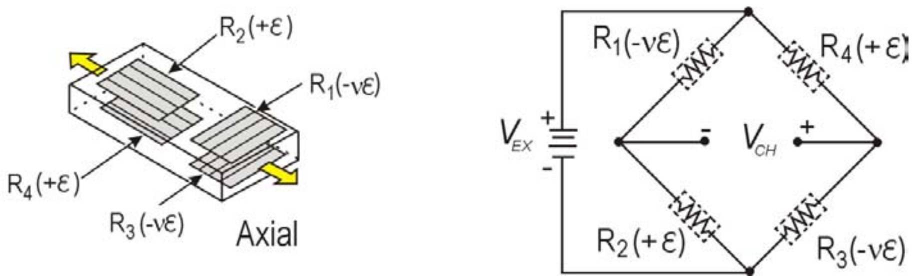


Figure 22. Full-bridge type III measurement example and circuit

Full-bridge type III configuration has the following characteristics:

- Four active strain-gage elements, with two mounted in the direction of axial strain with one on one side of the strain specimen (top), the other on the opposite side (bottom). The other two act together as a Poisson gage and are mounted transverse (perpendicular) to the principal axis of strain with one on one side of the strain specimen (top), the other on the opposite side (bottom).
- Compensates for temperature.
- Rejects bending strain.
- Compensates for the aggregate effect on the principle strain measurement due to the Poisson's ratio of the specimen material.
- Compensates for lead resistance.
- Sensitivity at 1000 με is ~ 1.3 mV_{out}/V_{EX} input.

Pressure/force

Pressure is defined as force per unit area that a fluid exerts on its surroundings. For example, pressure, P, is a function of force, F, and area, A.

$$P = {}^{F}\!/_{A}$$

Data from pressure/force channels is converted using the following equation:

$$P = \left[\frac{O_{fs}}{S}\left(\frac{V_m}{V_{EX}}\right)\right]$$

where *P* represents pressure

S represents the sensitivity of the gage in mV/V

O_{fs} represents the Full Scale output

V_m represents the measured voltage

V_{EX} represents the excitation voltage

Specifications

All specifications are subject to change without notice.
Typical for –40 °C to 50 °C unless otherwise specified.

Analog input

Table 1. Analog input specifications

Parameter	Specification
A/D converter type	Delta-Sigma (with analog pre-filtering)
Number of analog channels	12
A/D resolution	24 bits
Sampling mode	Simultaneous
Bridge completion	Full and half: Internal Quarter: External
Single device, channel-to-channel matching (calibrated)	350 ns max
Data rate (*fs*)	(50 kS/s)/*n* , *n* = 1, 2, ... 31.
Multiple device, channel sync skew	1 sample period
Master timebase (internal)	Frequency: 12.8 MHz Accuracy: 100 ppm max
Nominal full-scale range	±25 mV/V
Scaling coefficient	2.9802 nV/V per LSB
Overvoltage protection	±30 V between any two terminals
Phase nonlinearity	▪ 0 kHz to 1 kHz: <0.001° ▪ 0 kHz o 20 kHz: ±0.1°
Input delay	4.8 µs + 38.4/fs
Passband	Frequency: 0.45 • f_s Flatness: 0.1 dB max
Stopband	Frequency: 0.55 • f_s Attenuation: 100 dB
Alias-free bandwidth	0.45 • f_s
Oversample rate	64 • f_s
Attenuation at oversample rate (Note 1)	▪ 50 kS/s: 90 dB @ 3.2 MHz ▪ 10 kS/s: 60 dB @ 640 kHz
Common-mode voltage	All signals to earth ground: ±60 VDC
Common-mode rejection ratio (CMRR)	▪ Relative to earth ground (Note 2): –140 dB @ 0 Hz to 60 Hz ▪ Relative to EX–: –85 dB @ 0 kHz to 1 kHz

Note 1: Rejection by analog pre-filter of signal frequencies at oversample rate.

Note 2: Measured with a balanced cable. Shielded cables may be significantly unbalanced.

Accuracy

Table 2. Accuracy specifications

Measurement conditions (excludes offset null or shunt calibration)	**Percent of reading**	**Offset**
Calibrated, max (–40 °C to 50 °C)	0.20%	0.0625 mV/V
Calibrated, typ (25 °C, ±5 °C)	0.05%	0.0125 mV/V
Parameter	**Specification**	
Gain drift	10 ppm/°C max	
Offset drift	▪ 2.5 V excitation: 0.6 µV/V per °C ▪ 3.3 V excitation: 0.5 µV/V per °C ▪ 5 V excitation: 0.3 µV/V per °C ▪ 10 V excitation: 0.2 µV/V per °C	

Channel-to-channel matching (calibrated)

Table 3. Channel-to-channel matching (calibrated) specifications

Input signal frequency (f_{in})	**Gain**	
	Typical	**Maximum**
0 kHz to 1 kHz	0.15%	0.3%
1 kHz to 20 kHz	0.4%	1.1%

Input noise

Table 4. Input noise specifications

Excitation voltage	**Density (nV/Vrms per $\sqrt{Hz}$)**	**Total (50 kS/s)(µV/Vrms)**	**0 kHz to 1 kHz (nV/Vrms)**
2.5 V	8	1.3	250
3.3 V	6	1.0	190
5.0 V	4	0.6	130
10.0 V	2	0.3	65
Parameter		**Specification**	
Spurious-free dynamic range (SFDR)		106 dB, (1KHz, –60 dBFS)	
Total harmonic distortion (fundamental @ –20 dBFS)		▪ 1 kHz: –100 dB ▪ 8 kHz: –90 dB	
Excitation noise		0.1 mV/Vrms	
Crosstalk		▪ 1 kHz: --110 dB ▪ 10 kHz: –100 dB	
Shunt calibration		▪ Resistance: 100 kΩ ▪ Resistor accuracy 25°C: ±110 Ω –40 °C to 50 °C: ±200 Ω	
Excitation		▪ Internal voltage: 2.5 V, 3.3 V, 5.0 V, 10.0 V ▪ Internal power: 450 mW max ▪ External voltage: 2 V to 10 V	

Digital input/output

Table 5. Digital I/O specifications

Parameter	Specification
Number of I/O	8 channels programmable as a single port or as individual lines
Power on mode	Inputs pulled low
Connector	DB-9 female (see Figure 23)
Programmable input scanning modes	▪ Asynchronous: Under program control at any time relative to analog scanning. ▪ Synchronous: Data captured synchronously with the analog channels.
Input levels	▪ Low: 0 V to 0.8 V ▪ High: 2.0 V to 5.0 V
Input voltage range without damage	–0.6 V to 5.6 V max
Input pull-down resistor	10 kΩ
Output voltage range	0 V to +3.0 V Can be externally pulled up to 5.6 V without damage
Output resistance	40 Ω
Output levels	See Figure 24 below
Sampling	1 MHz max continuous
Output timing	Outputs are always written asynchronously

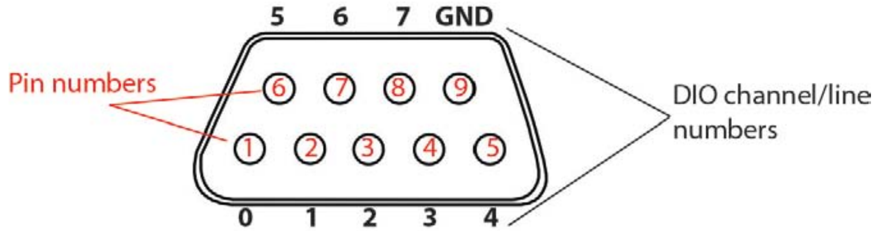


Figure 23. DB9 connector as viewed from the rear panel

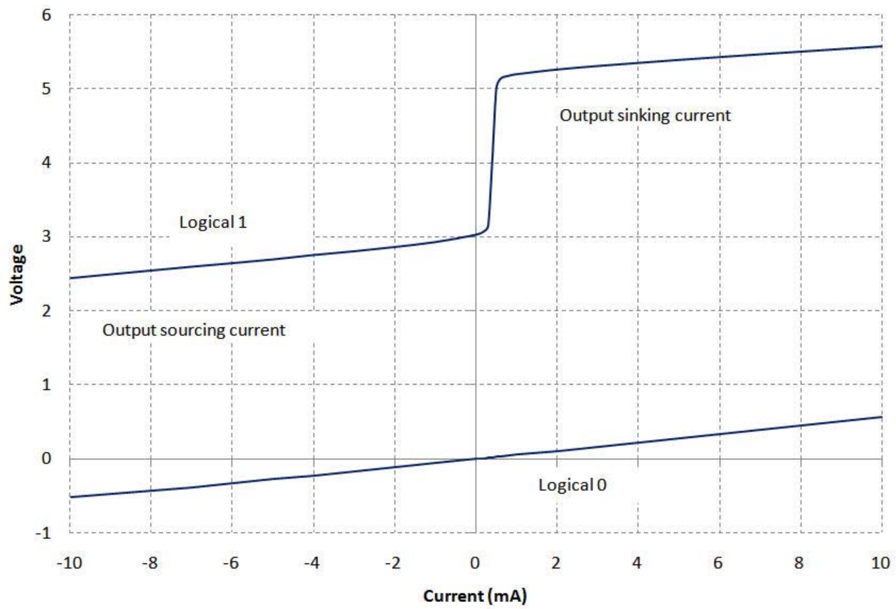


Figure 24. OMB-NET6224 digital output

Counter input

Table 6. Counter input specifications

Parameter	Specification
Channels	Up to 4 independent
Resolution	32-bit
Input frequency	20 MHz max
Input characteristics	10 kΩ pull-down
Trigger level	TTL
Minimum pulse width	25 ns high, 25 ns low
Programmable modes	Counter, Encoder
Encoder resolution	x1 (default), x2, and x4
Encoder sources	A, B, and Z; can be assigned to any digital pin x.
Counter source	Internal Clock, Timer 1, Timer 2, and digital pin x. One source can be used in multiple counters.
Counter mode options	Totalize, Clear on Read, Rollover, Stop at the Top, Increment, Decrement, Rising Edge, Falling Edge
Counter gate options	Unused, Internal Clock, Timer 1, Timer 2, and Digital pin x. One gate can be used in multiple counters.

Power

Table 7. Power specifications

Parameter	Specification
Power consumption	6.3 W typ, 6.6 W max
Power jack	Barrel type: 5.5 mm O.D.; 2.1 mm I.D.

Mechanical

Table 8. Mechanical specifications

Parameter	Specification
Weight	1.3 Kg (2.88 lb)
Dimensions (L × W × H)	276.9 × 169.8 × 30.5 mm (10.9 × 6.685 ×1.2 in.)

Environmental

The OMB-NET6224 is intended for indoor use only, but can be used outdoors if installed in a suitable enclosure.

Table 9. Counter input specifications

Parameter	Specification
Operating temperature	–40 °C to 50 °C
Storage temperature	–40 °C to 75 °C
Ingress protection	IP 40
Operating humidity	10% to 90% RH, noncondensing
Storage humidity	5% to 95% RH, noncondensing
Maximum altitude	2,000 m (6562 ft)
Pollution degree	2

Calibration

The following calibration information applies to hardware calibration, not to be confused with *user* or *software* calibration. When calibrating the OMB-NET6224 with Encore, keep in mind that sample rate affects both the gain and offset of the device, and therefore the device should be software-calibrated at the same sample rate that is intended for measurements.

Table 10. Calibration specifications

Parameter	**Specification**
Calibration interval	1 year

Contact Omega Engineering for information regarding calibration service.

Accessories

Table 11. OMB-NET6224 accessories

Accessory	**Description**
OMB-NET-TR-60U	24 VDC @ 0.8 A (max) universal power supply
OMB-CA-1	120 V IEC AC Mains cable (US)
OMB-CA-216	220 V IEC Mains Cable (EU)
OMB-NET-CN-268	RJ50, 12 pin screw terminal, 4pk
OMB-NET-CN-269	RJ50, 120 Ω quarter bridge, 4pk
OMB-NET-CN-270	RJ50, 350 Ω quarter bridge, 4pk
OMB-NET-CA-272-01	RJ50 to RJ50 M/M, 1 meter (3.28ft) cable, 4pk
OMB-CA-74-1	RJ12 shielded cable, 6-conductor, sync, 0.3 m (1 ft); refer to Note 3
OMB-NET-SPK	Stacking plate kit; includes: ▪ 2 stacking plates ▪ 8 screws (#8-32x0.5 in, Phillips Flat, 82 degree)
OMB-NET-CN-271	Backshell connector kit; includes: ▪ 1 plastic backshell connector ▪ 1 screw-terminal connector
OMB-NET-HK	Handle kit; Includes: ▪ A molded black plastic handle ▪ Two screws (#1/4-20x7/8 in, Phillips Pan Head)
OMB-CA-192-7C	Ethernet crossover cable, 2.133 m (7 ft); refer to Notes 5 and 6
OMB-CA-242	Ethernet patch cable, 0.457 m (1.5 ft); refer to Note 5
OMB-CA-242-7	Ethernet patch cable, 2.133 m (7 ft); refer to Note 6

Note 3: Up to nine units can be synchronized. The total combined length of the SYNC cables cannot exceed 2.438 m (8 ft).

Note 4: Ethernet cable length must be <3 m (9.8 ft) in order for the system to be CE Compliant.

Note 5: Ethernet crossover cables should only be used for direct network connections. In particular, attempting to connect a device to a Hub using a crossover cable may prevent that network link from functioning. Some modern routers have become an exception by including logic to detect the crossover cable and allow the network link to function.

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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