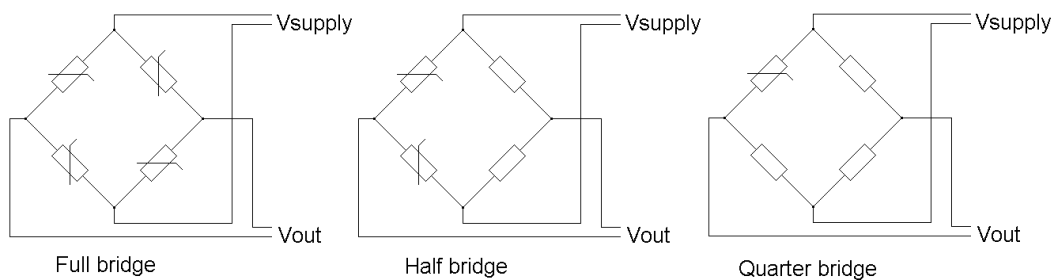
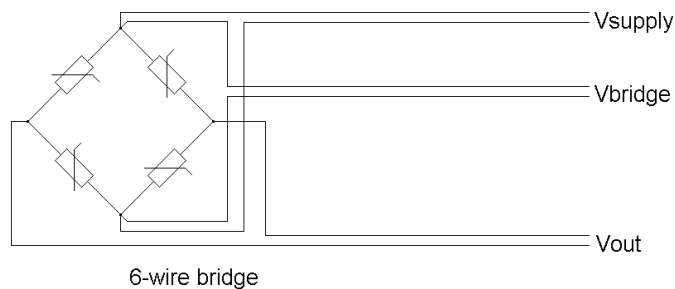


# Connecting Bridge Sensors to the OM-SQ2020/SQ2040 Series Loggers

Bridge sensors include strain gauges, pressure sensors and load cells. A bridge sensor consists of four resistive elements of which one or more change their resistance with a change in the input parameter being measured. In a full bridge all four elements change their resistance, in a half bridge two elements change their resistance and two are fixed and in a quarter bridge only one element changes its resistance and the other three are fixed. Note that the fixed resistors must be precision, low temperature coefficient types for the greatest accuracy. The three types of bridge are shown below.



All of the above have four wires connected to the bridge and so they are known as 4-wire bridges. In a 4-wire system the voltage drop in the power supply leads is assumed to be small so the bridge input voltage is measured at the power supply. However, if there is a significant resistance in the supply wires then the voltage measured at the supply and bridge ends of the supply wires will be different which could lead to measurement errors. In this case it is necessary to use a 6-wire bridge system where two wires supply power to the bridge, two wires measure the voltage actually present at the bridge (thus removing any voltage drops in the power supply leads) and two wires measure the bridge output as shown below.



The OM-SQ20XX range of loggers can be used to measure all of the above types of bridge sensor with the total number of inputs being dependant on the logger type and the type of connection made. For example, a 6-wire bridge requires two differential voltage inputs for each

using a half or quarter bridge in 4-wire connection could be done with one single-ended voltage input to measure the bridge supply voltage, one single-ended voltage input to measure the fixed half bridge output voltage and then one single-ended voltage input to measure for each sensor (although this would give the worst accuracy). Thus an OM-SQ2020 2F8 could measure four 6-wire bridges fully differentially or sixteen half or quarter bridges using single-ended inputs including the two high voltage inputs. The best compromise would be to use one differential voltage input to measure the common bridge supply voltage at the logger and then use a differential voltage input for each bridge.

The logger's sensor power output can be used to power the bridge sensor so long as care is taken to ensure that it is not overloaded as bridge sensors are often quite low impedance. For example, a 330 Ohm bridge running from the 5V sensor supply draws about 15mA. The 5V supply can only give 50mA maximum and so it could only have three full bridges connected to it although this can easily be increased by using an external power supply.

#### Making the measurement

Strain gauges change resistance when stretched or compressed and the strain-resistance relationship is given by:

$$\text{Strain} = \frac{\Delta L}{L} = \frac{1}{G} * \frac{\Delta R}{R}$$

Where:

L is the initial length

$\Delta L$  is the change in length

G is the gauge coefficient (given by the gauge manufacturer)

R is the initial resistance

$\Delta R$  is the change in resistance

However, it is difficult for the logger to actually measure the small resistance changes so it is much better to use the formula re-arranged in terms of voltage which is:

$$\text{Strain} = \frac{4}{G * N} * \frac{V_{\text{out}}}{V_{\text{bridge}}}$$

Where:

G is the gauge coefficient as before

N is the number of active bridge elements (1 for quarter, 2 for half and 4 for full)

$V_{\text{out}}$  is the bridge output voltage

$V_{\text{bridge}}$  is the bridge supply voltage

The following example shows how to set up a OM-SQ2020 2F8 to measure two 4-wire full bridge strain gauges for gauges with a gauge coefficient of 2.0. The equation required to calculate the strain is:

$$\text{Strain} = \frac{4}{G * N} * \frac{V_{\text{out}}}{V_{\text{bridge}}} = \frac{4}{2.0 * 4} * \frac{V_{\text{out}}}{V_{\text{bridge}}} = 0.5 * \frac{V_{\text{out}}}{V_{\text{bridge}}}$$

Whilst it is possible to get the logger to re-calculate the constant part of the expression ( $4 / G * N$ ) it uses up more equation space in the logger and so it is better to calculate it beforehand as shown above.

Before entering the equations in the calculated channels the differential input voltages need to be selected and named in the Logger Setup window with the 5V sensor power supply turned on as shown below. Only one Vbridge measurement is required as the bridges are 4-wire and so the bridge supply voltage is measured at the logger and the voltage drop along the wires is assumed to be negligible.

Sensor Type	Description	Block	Connections	Log Method
Voltage - Differential : -6 to 6 V	vbridge	A	1(+ve) to 2(-ve)	Sample Interval: A (00:00:01) Logging Interval: (00:00:01) Mo
Not Set	Not Set	A		Not Set
Voltage - Differential : -0.075 to 0.075 V	Vout1	A	3(+ve) to 4(-ve)	Sample Interval: A (00:00:01) Logging Interval: (00:00:01) Mo
Not Set	Not Set	A		Not Set
Voltage - Differential : -0.075 to 0.075 V	Vout2	B	1(+ve) to 2(-ve)	Sample Interval: A (00:00:01) Logging Interval: (00:00:01) Mo
Not Set	Not Set	B		Not Set
Not Set	Not Set	B		Not Set
Not Set	Not Set	B		Not Set
Not Set	Not Set	C		Not Set
Not Set	Not Set	C		Not Set
Not Set	Not Set	C		Not Set

**Logger Control**

Logger Date / Time: Set Logger Time Manually, Set Logger Time to PC Time, PC Time: 04/09/2008 16:22:32

Logger Identification: Logger ID (This text is used to identify the logger), Job Description

Memory Mode: Stop when full, Max Memory Allocated to this Job: All Free Mem

Sensor Power Timers: A (Supply) 00:00:00, B (SV) 00:00:00, Continuous

Delayed Start: Enable, Real Time, Elapsed, Start Logging At: 04/09/2008 16:21:45

The channels are set to Sample Only as it is only the resultant strain output that is of interest. The strain is obtained by using calculated channels as shown below. First enter the equation as described above.

Calculated Channel Wizard

Stage 1 of 3 - Create Channel Equation

Create an equation for the Calculated Channel

0.5 \* ( Vout1 / Vbridge )

1 2 3 / ( ) <-- --> <-- Del

4 5 6 x Channels

7 8 9 - Vbridge

. 0 +/- + Vout1

Vout2

Next →

Then set the units, the correct number of decimal places and ensure that the “Log” box is ticked.

Calculated Channel Wizard

Stage 2 of 3 - Calculated Channel Settings

Complete the following parameters for the Calculated Channel

Description Strain1

Units Strain

Decimal Places 6

Log ☒

← Back Next →

Finally, check that everything has been entered correctly.



Repeat the above procedure for the second channel. After sending the setup to the logger it will now be able to log and display the strain imposed on the strain gauge bridge.