LOAD CELL SYSTEM

FAULT FINDING GUIDE

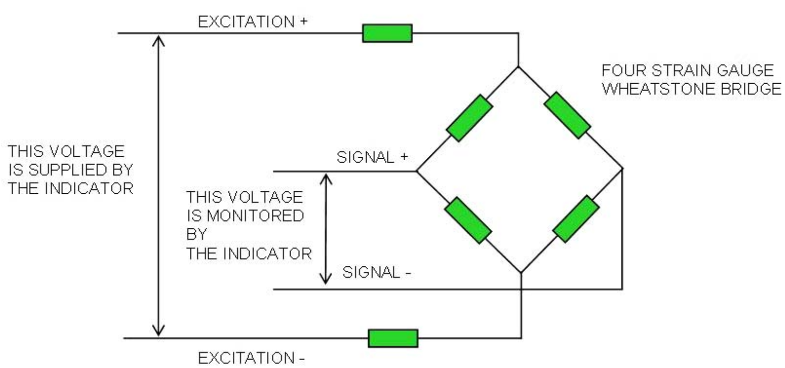
1. BASIC CHECKS

This first chapter is intended to aid in fault finding in load cell systems using Wheatstone bridge type load cells. The items covered are designed to assist in checking connection of the load cell and obtaining a display from a load cell monitor. Since only a load cell and monitor are being checked the main purpose is to isolate whether any problems seen arise from the load cell or the monitor. For other load cell system requirements such as alarm setting and retransmission outputs consult the instruction manual of the load cell monitor being used.

Equipment required: A multimeter capable of measuring Ohms, Volts and mV. To test the monitor independently a load cell simulator will be required.

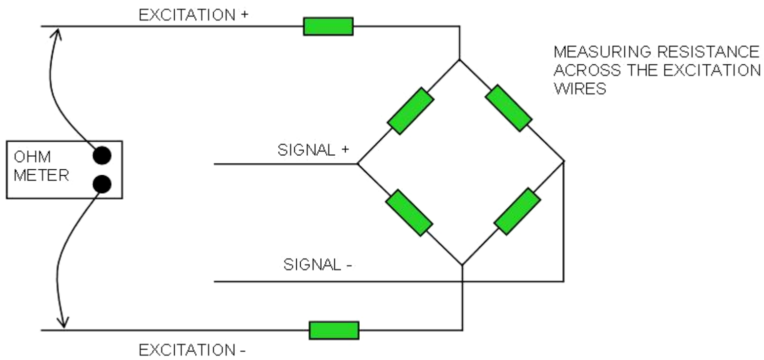
1.1 Basic load cell system

The basic load cell system consists of a 4 wire load cell connected to a load cell monitor. The monitor supplies a voltage called the excitation voltage to the load cell and the load cell returns a millivolt (mV) signal back to the monitor. The mV signal changes with the load experienced by the load cell and this mV signal is used to determine the display value on the monitor.



1.2 Basic load cell resistance checks

Unfortunately there is no standard wiring colour code for load cells so you will need to know from data supplied with the cell which wires are the excitation wires and which wires are the signal wires (see section 2.6 for colour code examples). If you do not have this information then as shown in the diagram above in addition to the 4 resistance elements which make up the Wheatstone bridge there are commonly one or two resistors in the excitation lines. This means that the resistance across the excitation wires is usually the highest resistance measured across any two wires. The resistances also vary between manufacturers and load cell types, input and output resistance values are often provided in the data supplied with the load cell.



To test the cell obtain a meter capable of measuring Ohms, measure across each pair of wires in turn and record the results (space provided in the table which follows). The load cell must be completely disconnected from the monitor and at no load when these tests are made.

The table which follows gives measurements taken with a sample 350 Ω load cell with one resistor in its Ex+ line i.e. these readings show lowest values between signal lines and Ex-. For a load cell with two resistors in its excitation lines (one in Ex+ and one in Ex-) you would expect the Ex+ and Ex- to S+ and S- measured values to be roughly the same. In a typical load cell the S+ to S- should be close to the specified output resistance of the cell i.e. within one or two Ohms, other values are nominal.

Resistance check	Typical 350 Ω	Record your readings	Record your readings	Record your readings
Ex+ to Ex -	410 Ω approx			
S+ to S-	350 Ω approx			
Ex + to S+	315 Ω approx			
Ex+ to S-	315 Ω approx			
Ex- to S+	280 Ω approx			
Ex- to S-	280 Ω approx			

If the resistance readings appear to be correct move on to section 1.3. If the resistance readings appear to be incorrect e.g. outside expected range, open circuit or short circuit across any two wires then the likely cause is a damaged or faulty load cell or incorrect/faulty wiring.

1.3 Checks when load cell is connected to monitor

When installing a load cell system the usual installation procedure would be:

1. Install load cell in position
2. Connect excitation and signal wires to monitor
3. Calibrate monitor to read the load in the units required e.g. kg or Tonnes (consult monitor instruction manual for calibration procedures
4. Check monitor is reading correctly over a range of values

If you wish to check the system prior to installation or if the load cell will not calibrate or the monitor can not be made to read correctly or is giving unstable readings make the following measurements.

1. Using a voltmeter measure and record the excitation voltage
2. Using a mV meter measure and record the signal voltage at the lowest load you can apply
3. Using a mV meter measure and record the signal voltage at a load as close to the rating of the load cell as possible
4. Obtain the mV/V output figure from the load cell data supplied with the load cell and compare the signal changes seen with the theoretical values from the load cell data.

1.4 Other common system problems

Some common problems which may cause difficulty when installing a system:

1. **Incorrect wiring of load cell to monitor** - i.e. signal & excitation wires crossed at one or more points. In AIC monitors this is likely to show an error message of ¯¯¯¯ or ¯***or*** ¯ on the display.

2. **Friction or restriction of load cell movement** - If the load cell is prevented from moving freely due to friction or is prevented from moving to its full deflection due to an obstacle the output from the load cell will not be correct. Typical display reading indications are that the display is slow to respond to load changes and/or that the display does not always return to zero when expected and/or that the display is not linear. Check that there are no obstructions to free movement and that the load cell is mounted correctly.

3. **Over stressed load cell** - If the load cell becomes over stressed sufficiently it will take on a permanent deformation. This will lead to a high offset voltage which may make it impossible to calibrate successfully and may also lead to non linearity over its operating range.

4. **Moisture in the load cell or wiring** - if moisture is allowed to enter the electrical circuit of the load cell or wiring the display reading will change due to current flowing through both the load cell bridge and the new current paths created by moisture. Ensure that cells of the correct environmental protection (IP) rating are used for the application and that moisture cannot enter the cable through cuts, cable joins and exposed cables.

5. **High resistance cable joins** - When a load cell cable is extended it is important that the joins made are electrically sound and free from moisture. A damp or corroded join will lead to unreliable readings.

6. **Incorrect mounting of the load cell -** Load cells are manufactured in many types e.g. shear beam, "S" type etc. Each type requires a particular form of mounting for correct operation. Check the load cell type and mounting requirements if in doubt.

7. **Electrical damage to load cells** - Electrical damage can often occur due to lightning strikes, welding on the structure to which the load cell is attached and other causes. Surge suppression devices for load cell systems are available from suppliers such as MTL. Welding currents will destroy the cell. If welding on the structure is likely and the load cell is not insulated from the current flow, copper or stainless steel braids should be used to connect each end of the load cells to ground to help prevent electrical damage.

8. **Non linearity of display reading -** Friction & restriction as described in 2. above could be the cause of non linearity. With some load cell designs, particularly those designed for high loads e.g. Tonnes the output of the cell may be non linear over parts of its measurement range, typically the low load end of the curve may not be quite linear. Some load cell monitors allow extra calibration points to correct this non linear output from the cell. It is also worth checking in instruments with this feature that the linearising functions have been turned off if they are not required i.e. if it is turned on and the cell output is linear the linearising functions may make it appear non linear.

1.5 Technical assistance

To save time when seeking assistance, as much as possible of the information below should be obtained before contacting the monitor or load cell manufacturer for technical assistance. Photocopy this page and fill in as much information as you can.

Question	Record your answer
Model number of monitor	
Model number of load cell	
Capacity of load cell	
mV/V output of load cell	mV/V
Load cell resistance Ex+ to Ex-	Ω
Load cell resistance S+ to S-	Ω
Load cell resistance Ex+ to S+	Ω
Load cell resistance Ex+ to S-	Ω
Load cell resistance Ex- to S+	Ω
Load cell resistance Ex- to S-	Ω
Excitation voltage measured	V
mV signal at low load & load value	mV at load
mV signal at high load & load value	mV at load
Monitor mV/V input range setting	mV/V

APPENDIX

2.1 mV/V explained

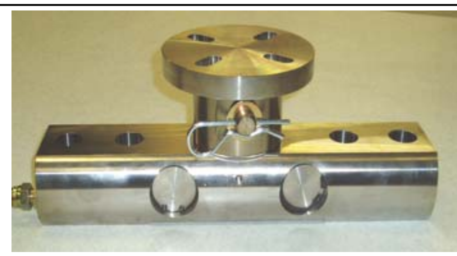
When a load cell is obtained it is usually accompanied by a certificate which details the specifications for the load cell including the signal output span per volt of excitation or mV/V output.

Usually the output from a load cell will be approximately 0mV at zero load though typically there may be a small offset voltage at zero load. Over the full rated capacity of the load cell the mV output will change. The amount by which it changes depends on the resistance change in the cell and on the excitation voltage applied. Since the load cell manufacturer does not know what excitation voltage will be applied to the cell rather than quote the mV output overfull range they will quote the millivolt output per volt of excitation or in its short form mV/V.

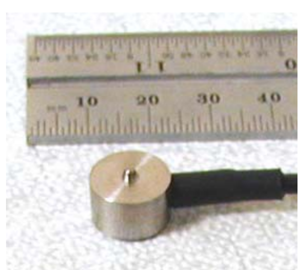
For example a 250kg load cell may be quoted as having a 2.357mV/V output. If the excitation voltage is 1 0V they you could expect a mV output of 0mV at zero load and 23.57mV at 250kg load. Again the actual voltages seen could be affected by a usually small offset voltage.

2.2 Load cell types



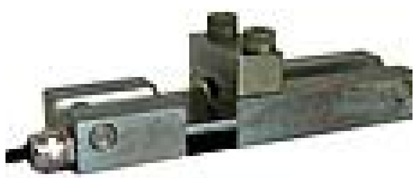


Shear beam - the shear beam load cell is fixed rigidly at one end with the force being applied to the other end. These can be used singly or in groups e.g. a platform scale using one cell in each corner.
Double ended shear beam type cells are of different construction and are fixed rigidly at each end with the force being applied to the centre of the beam.
Single point load cells are of similar design

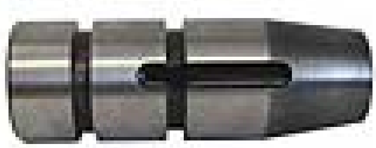



Compression - the compression load cell is designed to operate in compression only. Some designs require load to be applied at one end only, other designs can be compressed by force at both ends.

S type - the S type load cell can be used in tension and compression. The signal voltage output will reverse in polarity when the force changes from tension to compression i.e. the display value may change from. **Tension** load cells and **Load links** are designed to operate under tension only.



Rope clamp - the rope clamp load cell is popular in hoist and crane applications due to it ease of installation. The rope passes through the cell and when tension is applied to the rope due to a weight being lifted the tension produces a bending force on the cell.
The mounting position of this type of load cell is very important. Most of these type of cells are mounted at the dead end of the rope allowing enough rope at each end for flexing i.e. ensure that the attachment is not so close to the dead end that the rope is rigid and cannot flex.
Since these cells are designed to operate over a very wide range of loads and rope sizes, and because the rope system often goes through a series of "drops", it is often the case that the mV output from these cells is at the low end of the range. The sensitivity of the monitor may need to be increased by lowering the mV range to compensate.

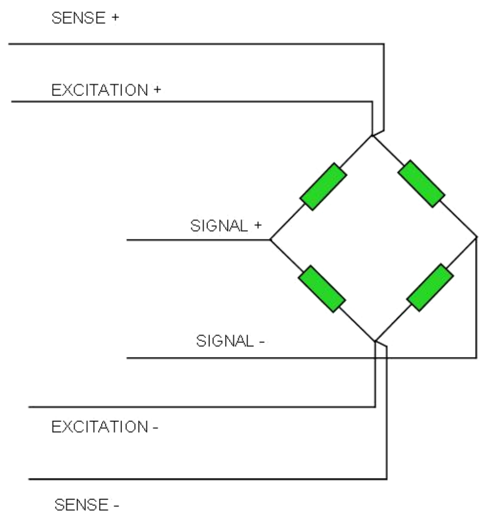


Load pin - load pin cells are designed to be installed in the axis of a sheave, shackle etc. through which force is applied. Most common load pins will measure force in one direction only. The direction of force is often marked with an arrow at one end of the pin or instructions for alignment may be given in the load cell certificate. If the load is off axis, the output will be reduced. At 90 degrees off axis the output will not change with a change in load.

2.3 Six wire load cells

Six wire load cells use two extra wires known as sense or reference wires. These sense wires connect to the excitation wires at the load cell as shown below. Monitors which will accept 6 wire load cells measure the current passing down the Ex+ to SEN+ and Ex- to SEN- wires. This measurement allows the monitor to compensate for any resistance changes in the wiring to the load cell due to changes in temperature.

As can be seen below the sense wiring can be tested using an Ohm meter. The resistance between Ex+ & SEN+ and Ex- & SEN- should be no more than a few Ohms.



2.4 Single & multi-point weighing

Single point weighing - single point type load cells can be used with single load cell platform designs, usually in fairly low capacity systems. S type, tension type, rope clamp & load pins load cells are also used in single point systems.

Two point weighing - can be used for longer thin platforms, beams and girders e.g. load cell near each end.

Three point weighing - often used in weighing vertical cylinders. Using 3 points gives less complicated leveling than when more load cells are used.

Four point weighing -typically used with high capacity platform scales and rectangular containers

More than 4 points -typically used in very high capacity and/or very large container/platform measurement systems

Using pivots and load cells - savings in load cell costs are often made by using pivots e.g. instead of using two load cells the load on a beam can be measured by using a load cell at one end and a pivot on the other. The use of a pivot is not recommended unless accuracy is not important. If a pivot is used instead of an extra cell it must be taken into account that the mechanical design must allow adequate and linear transference of load to the load cells in the system. Any friction in the pivot will result in slow response, inaccurate and non repeatable measurements