LOAD CELL TROUBLESHOOTING GUIDE

Determining the operational condition of a load cell in the field is a relatively simple task for a qualified service technician with the correct tools and a basic knowledge of what to look for. Interestingly, over half of all load cells returned to SENTRAN for repair exhibit "No Problem Found". The following steps can be used to assist in troubleshooting load cells.

TOOLS REQUIRED:

- Multimeter or similar; Must be able to measure down to 1 micro-volt (.000001-volt) or better; Must be able to measure up to 1 gigaohm (1,000,000,000-ohms) or better; good leads and clips.
- Highly stabilized DC bridge power supply; typical excitation voltages are 5 VDC or 10 VDC; more often than not, the power supply of the companion load cell signal conditioner/digital indicator will serve this purpose.
- Appropriate hand tools generally include: medium-size common screwdriver, medium-size cross point screwdriver, common pliers, electronics technician tweaking (small) driver, electrical wire stripper/crimper tool, utility knife, clean cloth, a light hammer and a flashlight.

Note: Troubleshooting Weigh Modules and Weighing Systems involve more complexity than load cell troubleshooting techniques. Please consult SENTRAN's website or our Applications Engineering Group for technical assistance when troubleshooting weigh modules and weighing systems.

STEP 1: PERFORM A MECHANICAL INSPECTION

Inspect for physical damage. Although many load cells appear to be "a piece of steel with a cable attached", they are in fact very sensitive measurement devices. The most common failure mode for a load cell is damage to the cable. Therefore, carefully inspect the entire length of the load cell cable to determine if any nicks, cuts or abrasions are present. Even if a load cell cable exhibits only modest signs of physical damage, there could be an internal problem or moisture contamination.

Inspect the load cell element carefully. Look for signs of damage, bending of the load cell or severe corrosion. Inspect for distortion or non-symmetry of all metal surfaces. Flexure surfaces, if any, should be parallel to each other and be perpendicular to both end surfaces. Are covers dented, bent or otherwise damaged? Verify the integrity and fit of the mounting bolts, spacers, plates and similar hardware components. Pay particular attention to the load interface mechanisms and alignment. Take notice of any potential binding or interference that could compromise proper load introduction. Is there evidence of moisture ingression into the load cell through the gaging cavity seals or the cable gland fitting or connector? If the load cell element has been physically deformed (permanently bent, for example) it is not repairable.

STEP 2: MEASURE THE ZERO BALANCE

Changes in the load cell's zero balance is most often caused by overloading the cell or from exceeding the fatigue life of the load cell. Other possible causes of *zero shift* include moisture contamination, cable damage, electrical overload and internal subcomponent breakdown. Mechanical overloading of load cells is the second most common load cell failure mode.

Disconnect all load cell leads if they are connected.

Condition One: No Load On The Load Cell

With the rated supply excitation voltage applied to the bridge, use the Multimeter to measure the load cell's voltage output under a proper "no load" condition, (load cell positioned correctly in a rigidly mounted-no weight on the load cell configuration). The output of a correctly "balanced" load cell should typically be within ±1% of the specified Rated Output. Always consult published specifications to obtain the correct tolerance value for any given load cell.

Example: A common load cell output is 2 mV/V; a common load cell signal conditioner/digital indicator power supply output (Bridge Excitation Voltage) to the load cell bridge is 10V; therefore, the full scale output will be 20 mV. If the zero balance of the load cell bridge is within ±1% of the specified Rated Output, the zero reading should then be within ±.2 mV.

If the output is greater than the zero balance tolerance, the cell is likely damaged to some degree, but it may still be useable depending on the amount of *zero shift* beyond the specified tolerance. When the zero reading exceeds the zero balance tolerance but is less than 50% of the full scale output, the load cell can usually be electronically 're- zeroed' if the load cell signal conditioner/digital indicator has the range to accommodate *offsetting* the shift. There is no guarantee that the load cell will provide linear measurement results under conditions of a shift of this magnitude, particularly if the shift was caused by a mechanical phenomenon such as a shock load. Any shift out of specifications warrants load cell replacement or repair. If a load cell has experienced a zero shift greater than 50% of the specified Rated Output, it will likely require a complete overhaul at the factory, or it could be deemed "non-repairable".

Condition Two: Pre-Load (Tare Weight) On The Load Cell

All the same guidelines apply, except that the zero balance can only be fairly estimated by calculating the amount of pre-load (sometimes referred to as "dead weight" or "tare"), and deducting the corresponding voltage this weight would generate, from the measured value.

Example: Assume the following; load cell output is 2 mV/V, bridge excitation voltage is 10V, load cell Rated Capacity is 1,000 lbs., and the pre-load is 100 lbs.

The full scale output will be 20 mV at 1,000 lbs.; 100 lbs. is 10% of 1,000 lbs.; 10% of 20 mV is 2 mV. So, 2 mV must be deducted from the measured value to fairly estimate the actual zero balance of the load cell bridge, which should be within ±1% of the specified Rated Output, or ±.2 mV.

STEP 3: MEASURE THE BRIDGE RESISTANCE

Contemporary industrial load cells employ a fundamentally symmetrical electrical circuit called a "Wheatstone Bridge". In the case of these load cells, a "full bridge" comprised of strain gages and compensating elements is the basis for transmuting the mechanical input into a proportional electrical output. An oversimplification for the sake of explanation would be to say that we use a balanced resistor network that becomes unbalanced (When force is applied to the load cell it elongates two strain gages and compresses the alternate pair, changing the resistive relationship between the pairs), allowing current to flow from the excitation source through the bridge in a very precise manner, thereby generating a measureable change in the voltage output.

An out of tolerance bridge resistance condition can occur as the result of several potential causes including: failure of a compensating element; a broken or intermittent bridge interconnecting wire or trace; damage to a strain gage(s) caused by moisture or excessive current due to power surges, welding in the vicinity of an unprotected load cell, or a nearby lightning strike. Even an excessive overload can cause these values to change modestly. This can be detected by performing a symmetry test (described following).

Measuring the bridge resistance: The basic resistance measurements are made across the pairs of input leads and output leads, respectively. The input resistance (excitation leads) is typically in the range of 350 to 450 ohms for single sensing section load cells, and the output resistance (signal leads) is typically 350 ± 3.5 ohms. Note that there are numerous variations. So-called "double-ended" load cells typical bridge resistance values are approximately double, where the input resistance is typically in the range of 770 ±10 ohms and the output resistance is typically 700 ±5 ohms. These values can vary depending on the load cell type, so the manufacturer's published specifications should be consulted for specific values and tolerances. If the measured values are out of tolerance, it is very probable that the load cell requires factory repair.

Measuring the bridge symmetry resistance: This is a more advanced measurement that in most cases is not required. We are providing it in the event it is required. Measuring the symmetrical characteristic of the load cell bridge can reveal useful information relative to the condition of the bridge zero balance, and the ability of the bridge to reject "noise" influences. Ideally, values will match to within a .1 to .2 ohm variance. There are four measurements between the four load cell cable conductors (two excitation leads and two signal leads) to be made and the values recorded by combination. The combinations are:

+ EXC	+ SIG
+ EXC	- SIG
- EXC	+ SIG
- EXC	- SIG

The results of these measurements should be interpreted by a member of SENTRAN's Applications Engineering Group when necessary.

STEP 4: LEAKAGE RESISTANCE

The insulating resistance between several elements of the load cell should have a very high degree of integrity, measuring on the order of 1 gigaohm or higher. In fact, SENTRAN only ships products that have passed these leakage resistance tests with a reading of greater than 5 gigaohms with a 50-volt potential applied concurrently. A breakdown of this insulating resistance often leads to random drifting of the load cell signal, and can lead to total failure of the load cells ability to measure.

A breakdown in this insulating resistance allows current to flow from the higher potential to the lower potential, thereby influencing the measured value. With the load cell cable disconnected from any connection point, measure the leakage resistance from:

- Bridge (any load cell lead) to ground (load cell body)
- Bridge (any load cell lead) to the cable shield
- Ground (load cell body) to the cable shield

Common causes of a loss of leakage resistance is moisture contamination in the load cell or in the load cell cable, a damaged cable, or damaged subcomponents inside the load cell.

TROUBLESHOOTING WEIGH MODULES AND WEIGHING SYSTEMS

Troubleshooting Weigh Modules and Weighing Systems requires a variety of additional troubleshooting steps, including a complete inspection of the mechanical aspects of the system, proper grounding of the measuring system, knowledge of potential environmental influence factors, and the systematic effects of interfacing instrumentation and equipment, both mechanically and electrically.

Weighing systems must be free and clear of excessive binding, misalignment, force shunts and similar elements. Particular care should be given to verify systems are grounded effectively and to that no ground loops exist.