TN 15.867 Load Cell Evaluation

Technical Support

Often when faced with the situation of an unreliable load cell installation, the service technician is unable to directly identify the cause of the problem. Suspecting a load cell fault the only alternative previously available to him has been to return the load cells to the manufacturer for testing. As this can be time consuming and expensive we have gathered a series of tests which may help the technician in evaluating load cell condition.

Check visually first.

When assessing the condition of a load cell the first check should be visual as visual points can sometimes lead to a quick diagnosis of the fault.

- Is corrosion evident? This may result in a ground fault if sufficiently advanced. Steel filings or grinding dust can cause holes in stainless bellows.
- Check for cracks, possibly from stress and corrosion.
- Check for signs of moisture or liquids.
- Check for chemical residues that could cause corrosion or deterioration. Some common chemicals will permeate encapulation.
- Is the cable nicked or worn and are all connectors properly fitted.
- Is there welding splatter that could indicate welding that may have caused circuit damage.
- Has the load cell suffered physical damage such as bashing or bending indicating that the load cell may have been overloaded? Quickly check this with a straight edge.

All these points give an indication of the working environment and may help with fault diagnosis at a later date.

Take measurements.

Following a visual check electrical measurements should be taken.

- Resistance readings should be accurate to 0.1 ohms when measuring leg (side of the Wheatstone bridge) resistance and can be taken with a 4 1/2 digit multimeter.
- Voltage measurements are excitation (usually in the range 5-15V) to 0.1V and signal voltage (usually in the range 0-20mV) to 0.01mV
- Ground insulation tests should not be taken with a megger as the voltage can sometimes cause damage. A DMM usually has insufficient voltage to provide an accurate test and a resistance meter with 50 volt maximum signal, current limited to 5mA or less and capable of measuring to 5 G ohm (i.e. 5000 M ohm) should be used.
- A digital load cell indicator with auto zero tracking turned off, set to display 0 at 0mV/V input and a minimum of 2000 x 1 displayed counts at 2mv/V input, is used to take load cell signal readings.

The form at the end of the document should prove useful for recording readings.

Interpret readings.

Interpretation of the results will in most cases lead to a good indication of the fault. Sometimes for full confirmation it is necessary to return the load cell to the factory where it may be necessary to disassemble the load cell to prove beyond a doubt the cause of the fault. In some case disassembly will render the load cell non-repairable and it is only recommended for instances where replacement of the load cell was already deemed necessary or liability for fault is important.

Referring to the test form:-

Check readings.

- If reading R1 is greater than 10% of the rated load cell output but not over-range and is stable, it is probable that the load cell has been over loaded. For these readings the load cell should be supported as it would normally be in an installation but with the live end free of any load or fittings. Note that sometimes the load cell can be overloaded in a negative direction which may result in a high negative zero.
- If the reading is unstable a ground fault may be present, to be checked with the insulation test.
- If the reading is either +O/R or -O/R (over-range) or erratic the load cell may be grossly overloaded or have an open circuit, to be identified by the resistance tests. Plugs and leads should be checked before testing the load cell.
- If V2 is outside the range -0.5mV ~ 0.5mV with no load then the load cell may be over loaded.
- If the reading at R4 is negative then the load cell has been connected in reverse and may only

require re-installation with the signal wire connection reversed.

Check resistances and voltages.

- If any figures R18 through R20 are less than 5000M ohm then it is possible that a ground fault exists. This can be caused by moisture or a pinched cable and may or may not be salvageable at the factory. The resistance checks will reveal problems such as an open circuit.
- For single bridge load cells resistance R5 should be 350Ω ± 5 from trimmed input load cells or 400Ω to 520Ω for most PT products. For dual bridge load cells this figure may be 750Ω to 1050Ω. If resistance R5 is open circuit there may be a break in one of the excitation leads. If R5 is short circuit check for a short in the sense wires or alternatively verify that load cell lead identification is correct.
- Resistance R6 should be 350Ω ± 3 or 700Ω ± 5 for most PT load cells.
- Resistances R7 and R8 should be close to short circuit (They are internally connected). If open circuit there may be an internal fault and if a resistance of a few hundred OHMS shows check the load cell lead identification as the sense or excitation wires may not be correctly identified..
- Resistances R10, R12, R14, R16 should all be similar and between 275 and 320 or between 550 and 650. If three values are around 300 say and one is three times the others then an internal fault is indicated and the load cell should be returned to the factory for evaluation.
- A comparison of the differences between resistances (R9, R11, R13, R16) indicates if a possible overload has occurred.
- Normally R9 and R17 should be less than 0.5 ohm.
- Also R13 should be less than 0.1 Ohm. Remember to take account of the accuracy of the readings.
- The bridge unbalance can be approximated from the value of R13 as follows:-
    - mV/V = R13/R5 * 1000
    - or % offset = R13/R5 * 1000 / (mv/V at rated output) * 100
- V3 and V4 should be approximately half of V1.

Check for overloading

If the % offset is over 20% then the load cell is most probably over loaded. If between 10% and 20% it is possibly overloaded. The test readings at R1 will verify this. If the load cell has been overloaded it is most likely that the load cell material has been stretched to a point where accurate operation of the load cell is not possible and the load cell should be replaced or returned to the factory if verification is required. If the load cell seems grossly overloaded (V2 > 3*V1 in mV) some bending may be noticed by holding a straight edge along the load cell.

Often many faults can be rectified by PT at their factory and for cases other than severe over load it is recommended that the load cell be returned for factory evaluation. Factory evaluation is required for all warranty claims and will establish a cost of repair for non-warranty claims, if repair is possible.

IDENTIFYING LOAD CELL LEADS

EQUIPMENT

Resistance meter on 2000 ohm range.
Load cells generally have either six or four wires plus a screen (shield).

SIX CORE LEADS

Test all wires to find two pairs of wires with a virtual short between them. These pairs of wires connect internally. One pair (E1) of wires with a virtual short will be excitation +ve (positive) and sense +ve (positive), the other pair (E2) will be excitation -ve (negative) and sense -ve (negative).
The remaining pair of wires will be signal +ve (positive) and signal -ve (negative).

- Connect the load cell to an indicator, connect both wires from the E1 pair to excitation -ve, sense -ve and connect both wires from the E2 pair to excitation +ve and sense +ve input. If the indicator has only 4 wire connection, connect the respective excitation and sense wires of the load cell together to the corresponding excitation of the indicator.
- Connect the other two wires to signal input of the indicator and apply load to the load cell.
- If the indicator goes -ve with load then reverse the polarity of the signal wires and check that the indicator goes +ve with load.
- Mark the leads as now connected to the indicator as the correct lead identification.

FOUR CORE LEADS

These are more difficult than six core leads.
Measure resistances between all wires identified here as 1-4.
Typical resistances could be:

Wire	**1-2**	**1-3**	**1-4**	**2-3**	**2-4**	**3-4**
CASE A	350	280	280	300	300	400
CASE B	350	280	280	280	280	350

Note: Four sets of similar readings. Values may vary slightly.

CASE A.
There is only one pair at 350 ohms and only one pair at 400 ohms. While there are four pairs at the lower resistance of 280 ohms. This indicates a 350 ohm bridge. Some load cells will have bridge resistances from 120 ohms to 1000 ohms or more. Readings will follow the same pattern with two higher values and four lower values.

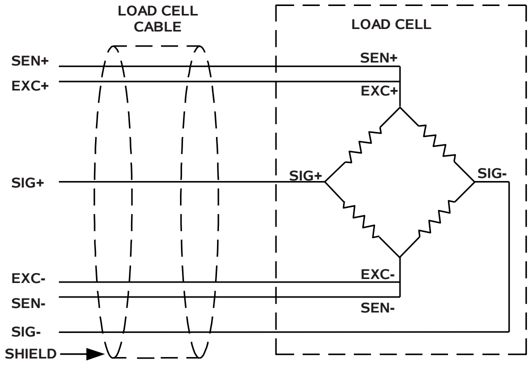
- Leads 1 and 2 are signal wires, leads 3 and 4 are excitation wires.
- Connect 3 and 4 to excitation +ve and -ve respectively in the indicator, connect 1 and 2 to signal +ve and -ve respectively in the indicator.
- If the output goes negative then reverse 1 and 2.
- Correct load cell lead identification should be as now connected to the indicator.

CASE B.
Note there are two pairs at 350 ohm and four pairs at 280 ohms. These resistance's may vary as in Case A between 120 ohms and 1000 ohms.
Here 1 and 2 may be signal (C1) or excitation (C2) and 3 and 4 may be excitation (C1) or signal (C2).
To identify which pair is signal and which pair is excitation:

<table>
<tr>
<td>CONNECTION (C1)
Connect 1 and 2 to excitation +ve and -ve.
Connect 3 and 4 to signal +ve and -ve.
If the indicator shows -ve with load then reverse 3 and 4.
Apply a known load to the load cell and take the reading, say reading D1.</td>
<td>CONNECTION (C2)
Swap the leads signal +ve for excitation +ve and signal -ve for excitation -ve.
If the indicator shows -ve with load then reverse signal +ve and -ve.
Apply the same load and note reading D2.
If reading D1 is greater than reading D2 then the correct connection is connection C2.
If reading D2 is greater than reading D1 then connection C1 is correct.</td>
</tr>
</table>

Mark the leads when the correct connection is established. This method may be used to verify connections in Case A.

LOAD CELL TEST FORM



LOAD CELL MAKE/MODEL:
CAPACITY: SERIAL NO:

Point	*Connection*	*Diagram*
A	excitation +ve	(EXC+)
B	sense +ve	(SEN+)
C	excitation -ve	(EXC-)
D	sense -ve	(SEN-)
E	signal +ve	(SIG+)
F	signal -ve	(SIG-)

Using a Digital load cell indicator with auto zero off, set to 0 at 0mV/V and a minimum of 2000 x 1 counts at 2mv/V input, take the following readings. (Note: If the reading goes -ve and the indicator will not read signals in this direction, reverse the load cell signal wires and enter these readings (now +ve) but with a -ve sign in front.) Take the readings with no load on the load cell.

Excitation Voltage(V) (Between A and C) : ....V1 (Excitation source connected)

Signal voltage (mV) (Between E and F) : ....V2 (Wires disconnected)

Leg Voltage (mV) (C to E) : V3

Leg Voltage (V) (C to F) : V4

Load cell reading at zero load (include ± over range) :..........................R1

Is the reading stable (Y/N) : R2

Apply some load to the load cell in the direction it would be applied when in use.

Load cell reading with load :..........................R3

SUBTRACT (R3 - R1) :..........................R4

Using a Digital Multimeter Set to ohms measure the following values and enter them:-

Input Impedance (Between A and C) :..........................R5

Output Impedance (Between E and F) :..........................R6

Leg Resistance (A to B) :..........................R7

Leg Resistance (C to D) :..........................R8

SUBTRACT (R14-R10) :..........................R9

Leg Resistance (A to E) :..........................R10

SUBTRACT (R12-R10) :..........................R11

Leg Resistance (C to E) :..........................R12

SUBTRACT (R15-R11) :..........................R13

Leg Resistance (A to F) :..........................R14

SUBTRACT (R16-R14) :..........................R15

Leg Resistance (C to F) :..........................R16

SUBTRACT (R16-R12) :..........................R17

Using a Ground Insulation Tester, connecting A+B+C+D+E+F together (A-F) measure the following values and enter them:-

Between (A-F) and Load cell body : R18

Between cable screen and load cell body :..........................R19

Between cable screen (shield) and (A-F) :..........................R20