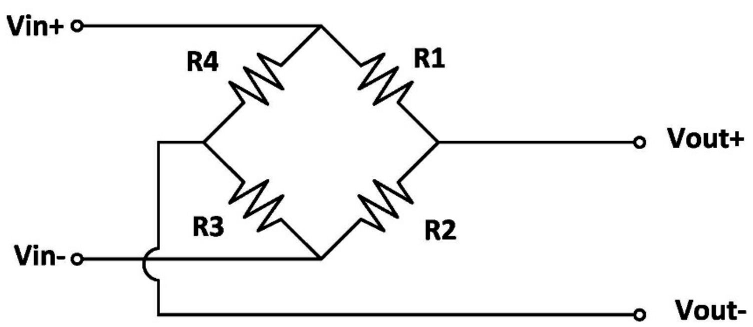
LOAD CELL ELECTRICAL CIRCUIT

The purpose of this technical note is help to the user to know the elements that are part of the electrical circuit of a load cell. First, we will show the basic working circuit of a load cell, based on a Wheatstone bridge and strain gauges; afterwards, we will complete the circuit for a real load cell, where it is necessary an additional circuitry that allows obtaining a high precision sensor.

Basic circuit: the Wheatstone bridge

A load cell is based on an electrical circuit called Wheatstone bridge.



Being Vin the power supply of the bridge or input excitation (V=Volts) and Vout the output signal (mV=milivolts).

This arrangement allows to measure very small changes in the resistance ΔR, which occurs in the strain gauges placed in the arms of the bridge: R1, R2, R3 and R4.

Strain gauges are deformation sensors which are glued to the elastic body of the load cells. Its operation is based on the piezoresistive effect, which is the property of certain materials to change its nominal resistance value when subjected to certain efforts. An effort that deforms the gauge will produce a change ΔR in its nominal resistance value Rg. This small resistance change on each gauge is magnified by the resistive imbalance produced in the Wheatstone bridge and thus obtains an output signal proportional to the applied force.

When the load cell has no load, the four gauges are at rest and have the same ohmic value, the nominal value of the strain gauge Rg:

R1=R2=R3=R4=Rg

Then, the output signal Vout, differential between Vout+ and Vout-, is 0 Volt (zero of the load cell).

Conclusions

The current relatively low cost of the weighing components, as load cells and electronics, compared with the high number of potential advantages makes easy to obtain a fast return of investment of the weighing system for a Silo.

When loading the load cell, the strain gauges changes its resistance value in a very small ratio ΔR:

R1=Rg-ΔR; R2=Rg+ΔR; R3=Rg-ΔR; R4=Rg+ΔR

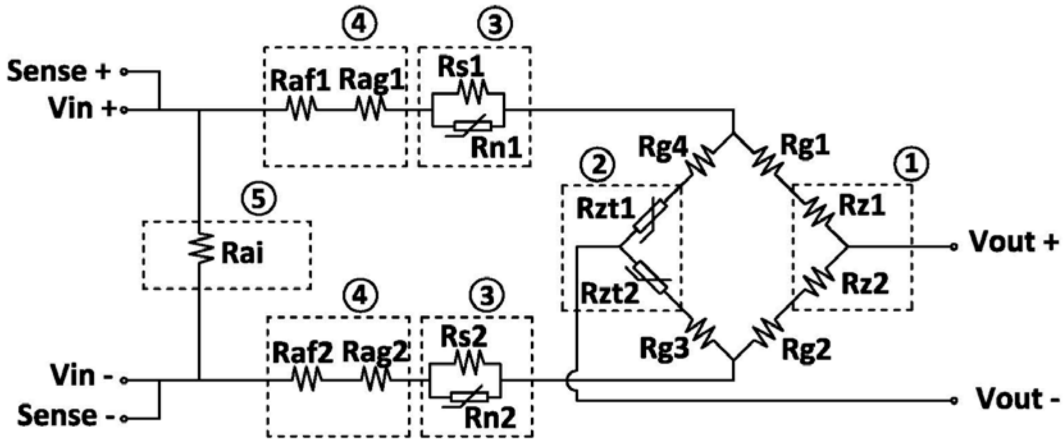
Then, we will obtain an output signal Vout, proportional to the resistance variation of the strain gauges. This is at the same time proportional to the deformation of the elastic body of the cell, which is proportional to the applied force. Thereby obtains a force transducer with an electrical output signal proportional to the applied force.

Should be noted, that this resistive circuit it is also proportional to the input voltage supply, so the output of the load cell it is usually expressed in mV/V, milivolts per volt (supply).

Complete circuit for a high precision load cell

To manufacture a real high precision load cell, it is necessary an additional circuitry to the strain gauges, dedicated to the fine adjustment of the output signal at different loads and to make the necessary individual thermal compensations during the manufacturing process.

The following wiring diagram allows us to identify different stages, described below.



1) Rz1 y Rz2

Zero balance resistors. We perform a fine adjustment of the output signal without load (zero of the cell) to get a value very close to 0mV.

2) Rzt1 y Rzt2

Zero shift temperature compensation resistors. We perform fine adjustments with small thermal compensation resistors to get a stable zero signals with temperature.

3) Rs1, Rn1 y Rs2, Rn2

Sensitivity compensation resistors with temperature. Resistors Rn1 and Rn2, change their nominal resistance value with temperature, Rs1 and Rs2 are used to compensate the changes produced in the mechanical elasticity of the load cell's body to obtain a total gain stable with temperature.

4) Raf1, Rag1 y Raf2, Rag2

Sensitivity adjustment resistors. Rag resistors are used to perform the coarse adjustment and Raf resistors are used for the fine adjustment of the nominal sensibility value (Sn) of each load cell in mV/V.

5) Rai

Input impedance adjustment resistor. It is used to get an input impedance load cell value within the specifications range.

The output signal Vout of a load cell at Nominal Capacity (Ln) is described by the Nominal Sensitivity (Sn) and the power supply (Vin).

Nominal Sensitivity (Sn, in mV/V) is the increase of the output signal (Vout, in mV) when it is applied an increase in force equal to the nominal capacity (Ln, kg), in relation to the supply voltage (Vin, in V).

As an example, we describe a load cell of 100kg Nominal Capacity (Ln) and Nominal Sensitivity (Sn) of 2mV/V. This means that the output signal will increase in 2mV, for each supplied V, when it is applied an increase of load equal to 100kg. Also, this increase is lineal and proportional to the applied load. In the case of a supply voltage of 10V, then we will obtain from 0 to 100kg of load and output from 0mV to 20mV of signal.

From Utilcell, we hope this technical note has been of your help. It is only a guideline and it is not a contractual specification. We reserve the right to change the content of this technical note at any time without notice. We remaining at your disposal for any further information.