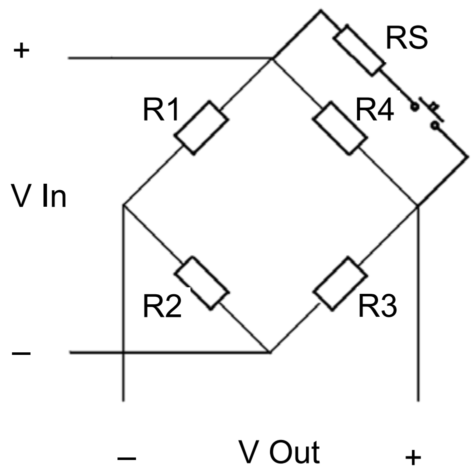
Technical Note # TN06

Shunt Resistor Calibration Process

It is possible to simulate the real function of a Wheatstone Strain Gage Bridge, just simply by connecting a resistor in parallel over one of the arms of the bridge.
This resistor must only be stable versus time and temperature in order to always simulate the same variation.



If R1, R2, R3, R4 are the resistances of the 4 arms bridge, the output voltage V Out of the bridge when any of the 4 resistors varies is given by :

$$V\ Out = (V\ In / 4) \cdot \Sigma\ dR/R = (V\ In / 4) \cdot [\ dR1/R1 - dR2/R2 + dR3/R3 - dR4/R4\ ]$$

The alternation rule of signs, when the 4 gages are located in an appropriate way, allows to get a bridge sensitivity coefficient equal to 4.

If an RS resistor is connected in parallel, when the sensor is not submitted to any physical solicitation, it creates an unbalance as a function of the Rs resistor value connected in parallel on R4 (as shown on the figure).
That unbalance generates a measurable and known output signal Vc perfectly repeatable (if the RS resistor has been selected with a very small temperature coefficient).

From another hand if the bridge sensitivity K has been physically determined by calibration, it is then possible to relate the output signal Vmax, obtained for the Full Scale of the sensor Pmax by :

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$$Pc = K \cdot Pmax \cdot Vc / Vmax$$

Ps, the simulated pressure in this way represents a constant proportion of the Full Scale of the sensor.

So, it is not a simulation obtained by substitution of a known voltage which is a well known method for checking the right function of a measuring chain related to the sensor, but a real check of the sensor itself.

If the sensor is maintained under pressure on a permanent basis, and there is consequently no way to go back to zero, this method is still valid.

In fact, the composition law being linear, an unbalance of the bridge created this way, is added to the signal generated by the pressure applied when the simulation is performed.

In that specific case, it is necessary to measure the value of the output signal created by the pressure, just before making the simulation, and then subtract that value from the value created by simulation, in order to check that it has been remaining equal to the simulation value when no pressure is applied.

The following example illustrates for a series of 5 sensors Type PC18 – 2 bar R, the results obtained by means of this method, for pressure values from 20 % to 100 % of the full scale.

N° 1

P mbar	0	400	800	1200	1600	2000
Simul. (mV)	29.440	29.446	29.447	29.446	29.441	29.440
Δ (P_0 - P_x) Simul (mbar)	---------	0.55	0.65	0.55	0.09	0.00

Delta Max in % of FSO = 0.03

N° 2

P mbar	0	400	800	1200	1600	2000
Simul. (mV)	25.986	25.989	25.978	25.984	25.979	25.974
Δ (P_0 - P_x) Simul (mbar)	---------	0.27	0.72	0.18	0.63	1.08

Delta Max in % of FSO = 0.05

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N° 3

P mbar	0	400	800	1200	1600	2000
Simul. (mV)	28.126	28.122	28.114	28.110	28.106	28.093
Δ (P_0 - P_x) Simul (mbar)	---------	0.37	1.11	1.48	1.85	3.05

Delta Max in % of FSO = 0.15

N° 4

P mbar	0	400	800	1200	1600	2000
Simul. (mV)	27.148	27.139	27.142	27.138	27.136	27.134
Δ (P_0 - P_x) Simul (mbar)	---------	0.85	0.57	0.95	1.14	1.33

Delta Max in % of FSO = 0.07

N° 5

P mbar	0	400	800	1200	1600	2000
Simul. (mV)	28.209	28.205	28.204	28.207	28.203	28.203
Δ (P_0 - P_x) Simul (mbar)	---------	0.37	0.46	0.19	0.56	0.56

Delta Max in % of FSO = 0.03

Those examples demonstrate that the Maximum Delta in % of FSO, met over the 5 sensors under test, do not exceed 0.15 % of the FSO, when the simulation process is performed on each pressure value applied from 20 % to 100 % of the FSO

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