TN 15.605 Direct mV/V Entry Calibration

Technical Support

Calibration of weighing systems by direct mV/V entry is convenient and has good application where it is impractical to place calibrated weights on to the scale vessel or platform. There are however some drawbacks, many of which can be overcome.

Direct mV/V calibration refers to entering the load cell signal directly into the indicator at calibration to avoid the need to apply calibration loads. Many of the PT indicators have this function. Most indicators allow setting of zero point and span independently so that it is possible to set zero in the standard way (accept the current empty weight as zero) and set span (or range) by direct entry.

Direct zero calibration allows for setting of a zero point. This requires calculation of an expected signal for the calculated dead weight of the empty structure. If possible, standard zero setting should be used as it is simpler and more accurate. Direct zero entry could be used where load cells are fitted to an existing system that cannot be emptied during installation to set the zero.

Direct span calibration allows for setting of the span or range of the scale by directly entering the signal from the load cells. The signal expected for a specific load must be calculated from the number of load cells and the signals (load cell sensitivity, full load output) from the load cell calibration.

Direct mV/V calibration is not as accurate as calibration with known weights or loads, there are a number of factors that affect accuracy.

Direct mV/V calibration can be tuned as operation continues to obtain a weighing system more accurate than at initial calibration.

There are a number of factors affecting the accuracy of calibration by mV/V direct entry because they affect the signal from the load cell causing it to differ from the signal determined at factory calibration, these factors are explained below.

Cable. If the cable length is altered the signal is affected and the calibration will be inaccurate.

Calibration. There is a limitation to the accuracy of the load cell output calibration at manufacture. The calibration is usually performed adequately to ensure matching within the tolerance specified for the load cell. The relative accuracy of the load cells will be good, 0.05% or better, but the absolute accuracy could be much less.

Summing box. If the load cells connect through a summing box with adjusting resistors for corner matching then these resistors alter the signal. A summing box with corner adjustment can cause large inaccuracies, 6% to 20% could be possible. A summing box without corner adjustment can be used or subsequent tuning performed to reduce these errors.

Indicator accuracy. The indicator or display has some limited accuracy in regards its calibration to direct mV/V signal. Some indicators specify typical accuracies of 1%, some are much better

Mechanicals. The mechanical aspects of the installation (foundation, flexing, support area, load application devices, pipework, cables, etc.) can affect the signal from the load cells causing inaccuracies. These can typically be up to 1% in worst cases, but could conceivably be more.

Gravity. The acceleration due to gravity (g) and hence the force produced by a certain mass varies from location to location and can result in the output signal varying from the value at calibration, this effect can be 0.1% or more. Some examples of g from Wikipedia are below.

Amsterdam 9.813 m/s²	Frankfurt 9.810 m/s²	Manila 9.784 m/s²	Singapore 9.781 m/s²
Athens 9.807 m/s²	Havana 9.788 m/s²	Mexico City 9.779 m/s²	Stockholm 9.818 m/s²
Auckland, NZ 9.799 m/s²	Helsinki 9.819 m/s²	New York 9.802 m/s²	Sydney 9.797 m/s²
Bangkok 9.783 m/s²	Istanbul 9.808 m/s²	Nicosia 9.797 m/s²	Taipei 9.790 m/s²
Brussels 9.811 m/s²	Jakarta 9.781 m/s²	Oslo 9.819 m/s²	Tokyo 9.798 m/s²
Buenos Aires 9.797 m/s²	Kuwait 9.793 m/s²	Ottawa 9.806 m/s²	Vancouver, BC 9.809 m/s²
Calcutta 9.788 m/s²	Lisbon 9.801 m/s²	Paris 9.809 m/s²	Washington, DC 9.801 m/s²
Cape Town 9.796 m/s²	London 9.812 m/s²	Rio de Janeiro 9.788 m/s²	Wellington, NZ 9.803 m/s²
Chicago 9.803 m/s²	Los Angeles 9.796 m/s²	Rome 9.803 m/s²	Zurich 9.807 m/s²
Copenhagen 9.815 m/s²	Madrid 9.800 m/s²	San Francisco 9.800 m/s²	

Drift. Load cells exhibit long term drift, the longer the time from manufacture the greater the uncertainty of the calibrated values. Zero could drift up to 2% of capacity and span (output) up to 0.03% of range per year

Calibration.

Before performing the calibration it is necessary to calculate the values required for entry into the indicator. The loadcell parameters can be found on the calibration certificates. When multiple load cells are used (i.e. 4 on a silo) the values are averaged. To calculate the zero value for mV/V the dead load of the vessel is required, to calculate the span entry value for mV/V the indicator capacity is required.
Calculate the average offset and the average output from the information on the PT load cell certificates shipped with each load cell. On the PT certificate the zero offset is a % of full load output.
For a 3 load cell silo this would be Zero = (zero1 + zero2 + zero3)/3 and Span = (output1 + output2 + output3)/3. Calculate zero and output as required for the number of load cells.

Zero.
Calculate the zero mV/V value where;
DL = the dead load (empty weight) of the vessel or scale.
Zero = the average zero load output of the load cells calculated above.
Span = the average full load output signal calculated above in mV/V.
CapL = the total capacity of the load cells (number of loadcells x load cell capacity)

zero mV/V = Zero / 100 x Span + DL / CapL x Span

Span.
Calculate the span mV/V value at full capacity of the indicator where;
Span = the average full load output signal calculated above in mV/V.
CapL = the total capacity of the load cells (number of loadcells x load cell capacity)
CapI = the capacity of the indicator set during the indicator build configuration.

span mV/V = Span x CapI / CapL

If the indicator prompts for a load and a direct mV/V value during calibration, use the scale capacity, CapI, for the load.

Perform load cell calibration as detailed in the specific indicator manual, using the values above. Where possible use standard zero calibration with an empty vessel.

Check that the calibration seems correct, in case an error with decimal place or similar has occurred. This can be performed by applying an approximately known load (a person or volume of material). This is a check for gross inaccuracies before commissioning the project.

Record the values entered for use later to fine tune the calibration.

Tuning.

The initial calibration by direct mV/V span can be fine tuned by checking and adjusting the scale by comparing the load added to or discharged from the scale against another device or scale. For instance a large silo could fill a truck and the load on the truck is checked on a weigh bridge or a flow meter may be used to fill a large vat. The initial span calibration mV/V recorded above during calibration is adjusted and span calibration performed again. This is the importance of recording the values entered.

Calculate the new_span mV/V where;
span mV/V = the value of the calibration currently in the indicator (from records)
OW = the original weight observed on the scale to be tuned
MW = the weight measured on a reference scale (weigh bridge, etc.)
new_span mV/V = the new value of span mV/V to be entered with direct mV/V span calibration

new_span mV/V = span mV/V x OW / MW

Recalibrate the indicator span, check and continue to observe any variations in case further tuning is required.
Record the values for future use.