Application Description AG/266calib-EN Rev. B

2600T Series Pressure Transmitters
Calibration Frequency Determination

Pressure Measurement
Engineered solutions for all applications

Mantaining desired performances in real operating condition
Get the maximum out of your pressure transmitters by programming maintenance at the right time.

Smart Maintenance
How to avoid unnecessary recalibration.

Time-saving operation for the 2600T trasmitter
How to dramatically reduce recalibration time using 2600T pressure transmitters.

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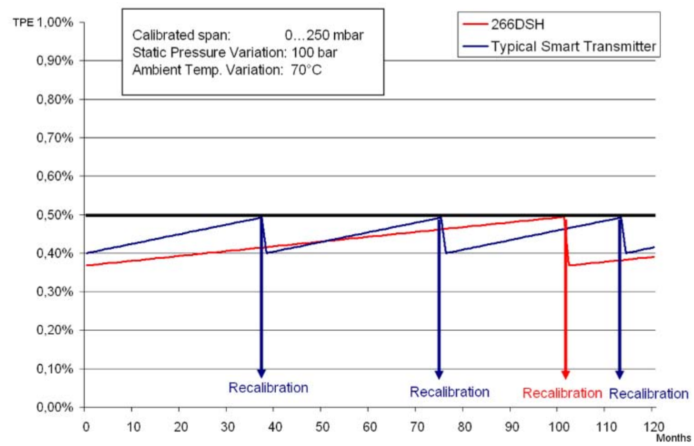
General description and introduction
Getting the best levels of performance from pressure transmitter equipment is a more involved process than many manufacturers would have you believe.
Pressure transmitters are now ubiquitous throughout industry, measuring everything from pressure to flow rate and levels of liquids in tanks. In applications such as petrochemical plants, in particular, there may be thousands of pressure transmitters installed on just one site.
Of course, users of pressure transmitters want them to be accurate, particularly in safety critical applications. For a variety of reasons, no device will remain accurate indefinitely and eventually will need to be re-calibrated to make it give a true reading of actual conditions. Yet, calibration of pressure transmitters is a skilled job requiring specialist equipment and is something that companies don't want to do to too often, particularly if it means interrupting revenue earning plant operations.
This is why so many pressure transmitter users are increasingly being attracted to devices which their vendors claim to have zero drift or only to require recalibration every ten years. On the face of it, such devices offer a convenient fit with the five year plant maintenance cycles operated by many companies.

How often the transmitter calibration has to be checked
How often you check your pressure transmitter calibration depends on how critical it is to the process. If high performance and accuracy is crucial to production operations or health and safety, then the transmitter should be checked regularly.
Some applications will have a financial implication, for instance measuring the flow rates of materials in the petrochemical industry for fiscal purposes. In safety critical applications, companies may need to have their pressure transmitters checked typically every 12 months in a SIL1 application or every three months in a SIL3 application: the frequency is determined by the target reliability required.
Can manufacturers' figures for calibration frequency really be believed? The answer has to be possibly. The figures quoted are based on a specific set of conditions for temperature and pressure that may have little to do with the conditions in a real plant.
Depending on the application, the accuracy needed, the ambient and process conditions along with a range of other factors, the actual calibration frequency of a device may differ markedly from that quoted by its maker. It could be shorter. It could be a lot longer. The user will only know for sure if he takes his particular conditions into account and calculates the calibration frequency himself.

Finding the real calibration frequency
The calibration frequency of any pressure transmitter depends on three things: the application of the device, the performance the user needs from it and the operating conditions.



When calculating calibration frequency, the following five stage process should be followed:

1. Determine the performance required for the application
Application is an important factor because it affects the accuracy needed. Some applications have a direct bearing on safety or plant efficiency and therefore accurate readings are extremely important and will lead to the user setting a high performance figure, in the order of 0.5 % of span or less. This will normally increase the required calibration frequency.
Other applications may not demand a very high performance, for example measuring the level in a water tank. If all that is needed is to indicate that the water level is approximately in the center of the tank a good enough performance figure could be something around 10% of span. An accuracy of this order could lead to calibration frequencies of hundreds of years, suggesting that the device need never be calibrated at all.

2. Determine the operating conditions
Operating conditions such as static pressure and the ambient temperature are another vital aspect. For each pressure transmitter, these conditions will each have an associated error figure.

3. Calculate the TPE (Total Probable Error or Total Performance)
This is determined by a formula which incorporates terms for the quoted base accuracy of the device and the likely effects of static pressure and temperature errors on performance accuracy.

E_{perf} = TPE (total probable error)
$E_{\Delta Tz}$ = Effect of the ambient temperature on zero
$E_{\Delta TS}$ = Effect of the ambient temperature on span
$E_{\Delta Pz}$ = Effect of the static pressure on zero
$E_{\Delta Ps}$ = Effect of the static pressure on span
E_{lin} = Base accuracy

$$E_{perf} = \sqrt{(E_{\Delta Tz} + E_{\Delta TS})^2 + E_{\Delta Pz}^2 + E_{\Delta Ps}^2 + E_{lin}^2}$$

Example:
Let's say we need to calculate the TPE of a 266 differential pressure transmitter calibrated from 0 to 250 mbar working on a flow measurement in a pipe which sees a static pressure variation from 20 to 50 bar. The environment has an ambient temperature variation from –10°C to 60°C.

– Calibrated span:	250 mbar
– Ambient temperature variation:	70°C
– Static pressure variation:	30 bar

From the product data sheet we identity the performance specification for the instrument.
E_{lin} = ± 0,025% of cal span
$E_{\Delta Tz}$ = 0,06% of URL for 70°C variation
$E_{\Delta TS}$ = 0,05% of cal span for 70°C variation
$E_{\Delta Pz}$ = 0,05% of URL for 100 bar variation
$E_{\Delta Ps}$ = 0,05% of reading

In the example the ambient temperature variation is 70°C so we do need to add the datasheets ambient temperature errors. Conversely the published errors for static pressure refer to a variation of 100 bar but in our example we only have a variation of 30 bar. In this case the stated errors have to be divided by 100 and multiplied by 30 to obtain the correct result. To simplify all the calculations we may want to convert all the errors into pressure units (mbar).
This bring us to the following:
E_{lin} = ± 0,025% of cal span
= 0,025% x 250mbar
= 0,0625 mbar
$E_{\Delta Tz}$ = 0,06% of URL for 70°C variation
= 0,06% x 400 mbar
= 0,24 mbar
$E_{\Delta TS}$ = 0,05% of cal span for 70°C variation
= 0,05% x 250 mbar
= 0,125 mbar
$E_{\Delta Pz}$ = 0,05% of URL for 100 bar variation
= 0,05% / 100 bar x 30 bar x 400 mbar
= 0,06 mbar
$E_{\Delta Ps}$ = 0,05% of reading
= 0,05% x 250 mbar (reading considered = span)
= 0,125 mbar

$$E_{perf} = \sqrt{(0{,}24 + 0{,}125)^2 + 0{,}06^2 + 0{,}125^2 + 0{,}0625^2}$$

E_{perf} = 0,3955 mbar

E_{perf} = 0,3955/250 = 0,158% of calibrated span

4. Determine the stability for a month

This data should be provided by the vendor for the particular model to be used. Normally the stability will be expressed for a given time period e.g. 36 or 60 or 120 months.
Example:
For our 266 differential pressure transmitter the stability is expressed under the performance specification of our datasheet and is:
± 0,15% over a ten years period
E_{SM} = ± 0,15% / 120 months (stability per month)
E_{SM} = 0,00125% of URL

5. Calculate the calibration frequency

The calibration frequency is given by desired performance minus the Total Probable Error, divided by the stability per month. This determines the frequency with which the calibration needs to be checked in order to maintain the desired accuracy.
Example:
Considering the data calculated in the previous examples and considering a requested (accepted) total performance in the plant of 0,3% (E_{EXP})
CF = Calibration Frequency = (E_{EXP} - E_{perf})/ E_{SM}
CF = (0,3% - 0,158%) / (0,00125%) = 113,46 months

6. Results evaluation

The calibration frequency result is telling how often a device should theoretically be recalibrated to be sure that it will perform better or in line with the desired performance (E_{EXP}). Special attention should be given to the fact that all the theory above could be made in vain in case the transmitter will work infrequently outside its functional limits. If the calibration frequency intervals are too high, this may be impractical for standard plant operations when you consider preventive maintenance schedules, hazardous area approvals and required equipment, as well as the necessary mounting accessories such as cable glands and valve manifolds that may require replacement to conform to plant safety rules and standards.

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Asking the right questions

Above all, a customer must not rely solely on the assurances of a manufacturer, as different models in a manufacturer's range will have differing performances.

Making a purchasing decision based only on 'headline' statements in literature can result in over specified instrumentation or a poorly performing pressure transmitter.

In either case, inefficiencies in process control result in poor product quality, lost production and more frequent maintenance. Checking pressure transmitter calibration and installation at the right intervals will avoid these problems, while keeping the cost of ownership to a minimum.

Note

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