High Accuracy is High Efficiency

Why Particularly Accurate Force Transducers Enable New Application Areas

Introduction

The use of highly accurate transducers enables completely new applications in force measurement technology. Because, with products such as the S9M from HBM, measurement chains can be set up for very high overloads without affecting the meaningful outcomes of the measurement results. Yet another advantage: The force transducer can be used flexibly for numerous different measurement tasks. This shows: Highly accurate force transducers are not only technological masterpieces; they also offer solid economic advantages. This becomes obvious if possible, sources of errors during force measurement are looked at in more detail.

Advantages in the use of high accuracy force transducers

Modern force transducers such as the S9M from HBM reach the highest levels of accuracy. Linearity errors, relative reversibility errors and temperature influences are less than 0.02 % relative to the end value. Such values make the use of transducers attractive even when measuring smaller forces:

- The measurement chain can be set up for high overloads, e.g. to prevent damage to the force transducer. Even if the S9M force transducer is only used at 20 % of the nominal (rated) force, the achievable accuracy is high enough under almost all circumstances to deliver meaningful results. You can reckon with an accuracy class of 0.1 % relative to the hypothetical end value.
- Based on the above considerations, the application range can be extended: It is possible to master various measurement tasks without changing the sensors, thus reducing time and outlay. This is because you can cover a wide force spectrum, ranging from small percentages to the full nominal (rated) force, with just one transducer.

Possible sources of error

Why is this the case? In order to understand why, a look at the possible sources of error during force measurement is important. There are two possible error groups in force transducers based on strain gauges, such as the S9M:

- Load-independent error: Errors that generate a specific output signal independent of the applied force
- Actual-value dependent error: Errors whose magnitudes are proportional to the force applied at the time of evaluation

The temperature influence on the zero point is an example of a load-independent error: This measurement deviation outputs a specific value that is independent of the measured force. If such an error is considered relative to the output signal, it can be seen that the influence of the temperature on the zero point (TKZero) is always particularly large when just a small percentage of the nominal (rated) force is used. The absolute value is always the same, but increases due to the small useful signal of the relative percentage in this situation.

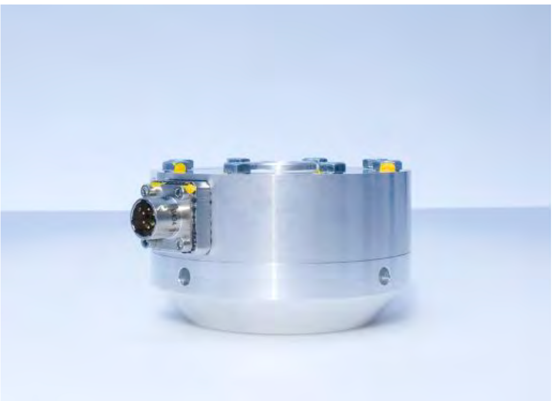
In addition to TKZero, the linearity error is also relative to the end value.

Errors that are relative to the actual value (actual-value dependent error) are calculated relative to the actual applied signal. This includes, for instance, the temperature dependency of sensitivity (TCS), creep or even the tolerance of a calibration that may have been implemented.

When evaluating an error, the individual errors are added geometrically, i.e. a significant improvement in measurement accuracy can only be achieved if the largest individual errors are improved. In numerous cases, TKZero and the linearity are crucially important. As these errors are relative to the end value, i.e. the output signal under full utilization of the nominal (rated) force, any improvement of these parameters is particularly effective, also enabling use of the force transducer in the so-called partial load area, i.e. utilization of a signal partial range of the nominal (rated) force.

S9M from HBM enables new applications in force measurement

The S9M force transducer from HBM offers a TKZero and linearity of just 200 ppm relative to the end value. If such a force transducer is used at 20 % of the nominal (rated) force, the error caused by the linearity or the TKZero relative to the applied force is just 0.1 %. This shows: Measurement chains can also be set up for high overloads, without having to accept major disadvantages regarding the meaningfulness of the results, if force transducers such as the S9M are selected.



U10 force transducer

S9M force transducer

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At higher nominal (rated) forces, load cells such as U10 are an option, as they evidence a relative reversibility error from 300 ppm relative to the nominal (rated) force and TKzero of just 150 ppm/10K due to the extremely favorable SG layout.

Figure 1 shows a further argument for precise force measurement: The force to be measured for quality control purposes is shown on the X axis. The number of produced parts is indicated on the Y axis. The scattering of the produced parts is distributed according to the Gaussian bell curve law. Green lines, indicating the permissible tolerances, are entered in the diagrams, and the measurement uncertainty of the force measurement chain can be seen to the left and right of these limits in red.

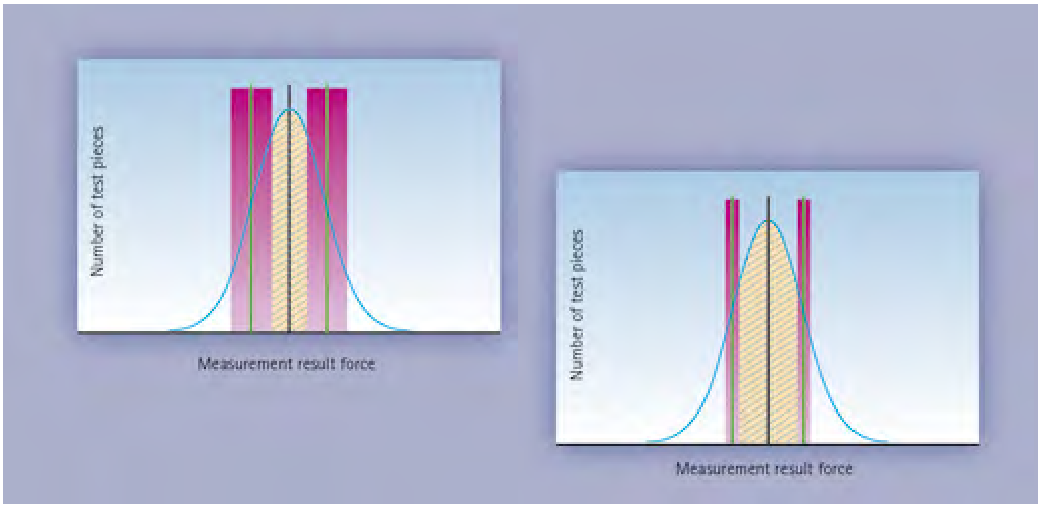

Figure 1 Monitoring a process with a force measurement system with high and low accuracy.

It is necessary to estimate the measurement accuracy of the transducer in order to evaluate the process. To implement a good/bad evaluation, the components may only be evaluated as OK when they lie within the setpoint range less the measurement tolerance (symbolized in the diagrams by the blue hatched lines).

It can be easily recognized that the number of tolerable parts increases when the measurement accuracy also increases. Expressed in a different way, the number of parts to be rejected is also dependent on the measurement accuracy of the force measurement chain.

Modern force transducers such as the S9M or U10M from HBM achieve high accuracies, well over the class standard, above all with regards to the end value-dependent influencing factors on the measurement uncertainty. In addition, there is the possibility of using a measurement chain through operation in a partial load area and thereby significantly increasing the tolerance against overloads. This allows an improved reliability to be achieved. Above all, it is the minimum influence of the temperature on the zero point that makes it possible to use the same sensor for various measurement ranges or to increase the percentage of good parts due to the high precision.