Clip. Measure. Control.

Preventing 3 Errors in Signal Conditioning to Reach Accurate Test Results

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The more precisely measurands can be acquired, the fewer rejects are generated, which leads to more economical processes. High-precision sensors and amplifiers are important because of this, especially in industrial production and test benches, where they represent an opportunity to achieve significant gains in productivity with modest investments. In this article, we show you which factors can negatively affect the accuracy of industrial amplifiers, what impact this has on your measurement results, and how you can avoid these errors.

It should be clear to all machine operators that the entire measurement chain is only as precise as its weakest link. Often, however, high-quality sensors (for example with an accuracy class of 0.02) are used with less precise amplifiers (for example with an accuracy class of 0.1). The resulting overall accuracy will then be worse than 0.1.

What affects the measurement accuracy of industrial amplifiers?

ClipX from HBM has an accuracy class of 0.01 and an integrated calibration certificate. Together with modern sensors (such as HBM's S9), an optimum measurement chain is formed, since the accuracy of the sensors can be fully used, and at very economical costs!

But how is this high accuracy achieved and what factors affect it? High accuracy can only be achieved if the latest electronic components such as analog-to-digital converters are used and all the individual rated outputs of the amplifier are finely adjusted to each other. Less is more in this case: The number of analog electronic components is reduced and consistently digitized.

The following error groups are distinguished for amplifiers used to measure electrical signals based on physical quantities such as force, pressure, torque, temperature, voltage and current: full scale value-related errors and actual value-related errors.

Error 1: Full scale value-related errors

Errors generating a specific output signal independent of the measurement signals applied, for example the effect of temperature on zero point (temperature coefficient of zero signal) or non-linearity.

Error 2: Actual value-related errors

Errors whose magnitude is proportional to the measurement signal applied at the time of evaluation (full-scale drift).

Fig. 1: Effect of full scale value-related errors for measurements in the lower measuring range

Zero drift and linearity

Zero drift and linearity are often of vital importance. A component of measurement inaccuracy of this kind has a specific value regardless of the magnitude of the measurement signal that is being measured.

When measurements are taken in the upper measuring range of the sensor and amplifier, i.e. for large signals (forces, etc.), an error relative to the full scale value is uncritical, since its relative proportion is small compared to the high output signal.

The situation looks quite different when a small force is measured using the same force measurement chain. In this case, the effect of an error relative to the full scale value is significantly greater: Although the absolute error is the same, it needs to be related to a smaller force, which increases the relative proportion. This is illustrated by the diagram.

Linearity and the zero point's dependency on temperature (zero drift) are major error influences relative to full scale. Every improvement in these rated outputs makes it possible to use the amplifier – assuming given accuracy requirements – forever smaller signals.

Full scale value-related errors (full-scale drift) determine the measuring range within which the measurement chain can be used. Small errors relative to full scale expand the possibility of measuring in the partial load range.

Errors relative to the actual value always take effect relative to the measurement signal currently being measured. When small signals are measured, the effect of these error quantities is therefore quite small.

For example: When the amplifier is used at 5% of its measurement range, the error caused by linearity and/or zero drift relative to the measurement signal applied is only 0.2% (0.01% full scale value error relative to 5% of the measurement range value). With these properties, the ClipX amplifier opens up new fields of application that were previously only possible with the use of elaborate and expensive measurement technology. This expanded range of measurements and applications delivers benefits to users and saves expenses in plant engineering and machine building.

Prevent electromagnetic interference (EMI) from distorting the measurement result

Error 3: Electromagnetic interferences

Digital measurement chains are used in practical applications in an industrial environment. They work next to large motors, generators and inverters that generate powerful electromagnetic and electrostatic fields and interference. These malfunctions have a direct effect on the amplifiers and must be considered as full scale value-related errors, which is especially critical.

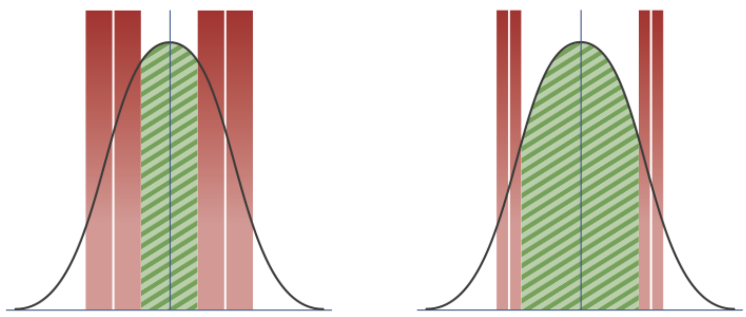
Because of this, amplifiers must be fitted with suitable interference suppression elements to ensure that measurement accuracy is retained even in case of malfunctions. These properties should always be documented in the specifications of industrial measuring amplifiers, as HBM does for all its devices.

Efficient production through precision

In addition to the expanded field of application, precise industrial amplifiers also have a positive impact on the cost-effectiveness of production processes, as illustrated by the diagram: The lower the measurement uncertainty, shown here with red stripes, the fewer rejects, which means greater efficiency or quality for the process.

The measurement accuracy of the measurement chain needs to be assessed to be able to evaluate the process. To implement a good/bad evaluation, the components may only be evaluated as OK when they lie within the set-point range less the measurement tolerance – shown in the diagrams by the green hatched area.

It is easy to see that the number of parts that can be tolerated increases with increasing measurement accuracy. To put it differently: The number of OK parts depends greatly on the measurement accuracy of the measurement chain.



Process monitoring with conventional signal conditioners, high reject rate due to measurement inaccuracies

Increased efficiency with ClipX, optimum yield through precise measurement results

Figure 2:

- Higher accuracy enables more accurate measurement of manufacturing tolerances.
- The components are precisely tested and manufactured with the necessary tolerance.
- Waste is reduced, resources are saved and yields maximized.

Opening up new application fields with precise measurement results

Today's measurement technology works more precisely than just a few years ago and has also become more suited to industry. This opens up new fields of application in industrial process control.

Field 1: Conventional production monitoring

High-quality products are produced due to greater precision. Errors are detected somewhat earlier and rejects can be avoided. Thanks to digitization, which involves the use of modern fieldbus interfaces and management of all parameters of the measurement chain in parameter sets, which can be implemented in the millisecond times, flexible implementation is possible from small batch sizes to mass production.

Field 2: Applications in test bench manufacturing

This includes test benches used in the automotive sector, aerospace and energy production. Components and parts in these areas, for example motors, are constantly being improved and cost-optimized. The increased measurement accuracy and digitization in these areas has enabled the development of more efficient machines and systems.

Field 3: Test benches for materials testing – end-of-line

The focus here is on testing and optimizing components. Lighter, faster, more resilient and resource-conserving components are tested to ensure reliable function. These tests are conducted in-line (during production) or at end-of-line (EOL, after production is complete). Faster and more reliable processes enable 100% quality control here as well.

Conclusion

There are a number of accuracy errors in signal conditioning that can be reduced with the help of modern measurement instruments. The higher the accuracy class of the signal conditioner and the matching sensor, the higher the output or quality of products and processes.

In the future, efficient production or development without precise measurement technology will no longer be possible. Today, HBM already offers the appropriate sensors and measuring technology in order to be prepared for future requirements. Contact us so we can find the right solution for your production together.