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Building up precision measuring chains with the DMP41 high precision amplifier

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Summary:

DMP41 is the world most precise instrument for strain gauge-based measurements. The DMP series has been used as a reference device in the mechanical laboratories of the national metrology institutes around the world for decades. Characteristics of the newest member are explained for different application cases.

Keywords: DMP41, DMP40, strain gauge, force, torque, pressure, transducers, sensors, calibration system

Introduction

By its nature requirements to precision measuring chains always have been high. However, with the turn of the millennium the requirements, namely by the automotive industry have grown again. New standards and guidelines, such as DIN EN ISO / IEC 17025 and IATF 16949, ensure that industrial processes are more closely linked to the SI system and industrial development and the resulting higher accuracy requirements were also the reason why metrologists consider SI to be essential.

When highest precision of results counts, sensors and measuring amplifiers based on strain gauge technology are first choice for many different mechanical quantities, such as force, torque or pressure [1], [2].

According to Frost & Sullivan mechanical calibration systems are the second largest group of calibration systems at all and have the best growth expectation. The widest range of equipment is offered by our company group “Hottinger Brüel Kjær” (abbreviation HBK), consisting of Hottinger Baldwin Messtechnik GmbH (abbreviation HBM) in Germany and Brüel & Kjær Sound and Vibration A/S (abbreviation BKSV) in Denmark, who both mechanical calibration systems in their portfolio. As a powerful group of specialists, we develop and market mechanical calibration systems for mechanical engineering in the automotive industry.

We now offer a very wide scope from reference force, torque and pressure transducers of HBM, of course the High Precision instruments of HBM, completed by vibration and acoustic calibration systems solutions as well as sound level meter calibration systems of BKSV and we are offering a very wide scope of calibration services as well.

On the Brüel & Kjær side a major milestone is the standardization of vibration calibration systems, which represent the biggest portion at BKSV.

The four standard systems 3629 (versions 3629-A, 3629-B, 3629-C and 3629-D) are made for different frequency ranges and based on comparison calibration of vibration transducers have been launched lately as a standardized calibration system, so they can be delivered of the shelf.

Traceability, its necessities and needs

Even if you are hardly aware of this, the metrological traceability is of great importance for our everyday life. To take again the example of automobile construction, it is unthinkable without correct mechanical parameters. Traceability ensures that a measurement result can be related to a standard or is related to it. A traceable measurement value is based on this recognized standard due to an uninterrupted chain of comparative measurements with a known measurement uncertainty.

Figure 1: TN Torque transfer normal in its new look

It has been mentioned that transducers, which are based on strain gauges (S.G.), have the smallest measurement uncertainties for tracing back force, torque and pressure. For this reason, they are used as reference transducers and transfer standards for inter-comparations.

As a manufacturer of measurement technology solutions, HBM has acquired the necessary special know-how in a decades-long development to offer reference measuring chains.

As an example, HBM's TN reference torque transducers shortly have been optimized for international comparison measurements. The challenge here is that a monolithic design in the form of a shaft is required for comparative measurements. Such shaft type sensors can only be "open" and not, as with the large number of transducers based on strain gauges, hermetically encapsulated. This poses the challenge of making the transducer immune to fluctuations in the relative humidity. This is necessary even though the laboratories are air-conditioned, since the transducer must be sent from laboratory to laboratory. The version used for the reference torque transducer TN shows such a low moisture dependency that "climate adaptation" can take place in a very short time. This means that the total time for such an inter-comparation (meaning the time to run through all laboratories including the transfer time) can be shortened. Several NMIs confirm it is an important issue [3], [4].

DMP41- the most Precise Instrument for strain gauge-based measurements

Since the signal coming from the Wheatstone bridge of a strain gauge-based transducer is very small (usually 2mV/V), a measuring chain must be formed with a “bridge amplifier”, an amplifier based on a Wheatstone bridge, in order to be able to display or process the result. The requirements for these precision measuring amplifiers are even higher than the requirements for the associated transducers.

This is there precision amplifiers come into play. Today the precision amplifier DMP41 from HBM is the most accurate amplifier for measurements based on strain gauges worldwide and thus ideally suited for international comparison measurements [5]. It is the result of more than four decades of further development of the DMP series. DMP39 high precision instrument started in 1980, DMP40 in 1995 and DMP41 in 2013.

Figure 2: DMP 41 high-precision instrument

Conclusions

It has been shown, that with the turn of the millennium requirements, namely by the automotive industry have grown again. New standards and guidelines ensure that industrial processes are more closely linked to the SI system and industrial development and the resulting higher accuracy requirements were also the reason why the metrologists considered a new SI to be essential.

The basis for this development are strain gauge-based reference sensors and high precision amplifiers with ADC, signal conditioning allow a new performance but still a reduction of complexity of measurement. That includes the possibility of reduction of uncertainty by combining analogue signals with digital compensation [6], [7].

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