

# HOERBIGER:

## Multi-component transducers for a transmission test rig

Our physical environment is three-dimensional and this is also the way that mechanical loads act. If the moments around the three coordinates are included this makes the model six-dimensional.

In industrial plants, usually only one load component is measured. Then extensive mechanical decoupling of the parasitic influences may be necessary. If real service conditions have to be simulated and measured for the parts to be tested or if incorrect loadings are to be avoided, multi-component transducers are needed. HBM provides customized multi-component transducers, which can be developed and produced in the shortest possible time.

Various transducer designs with different nominal (rated) measuring ranges and nominal measuring range conditions are used for the components.

HBM has developed a 2-component transducer for the synchronization process simulating test benches made by HOERBIGER, the transmission manufacturer and the associated components. This has been designed in such a way that axial force and friction moment are acquired simultaneously. The transducer also had to fit in the tight mounting clearance of existing test benches and needed the input shaft to run through a central hole. The oil mist environment and the presence of hot oil surrounding the lower half of the test benches were major challenges for which HBM found a good solution.



Fig. 2: Transmission test rig with integrated multi-component transducer

The transducer achieves extremely good accuracy, with a composite error of  $\leq 0.05\%$  f.s. and an equally low reversibility error. Temperature sensitivity during operation, when the oil reaches temperatures of up to  $110^{\circ}\text{C}$ , is also extremely low. Very good stability is certified during the entire service life test of several thousand cycles.

The crosstalk, that generally limits the accuracy of multi-component transducers, has been minimized in all phases of development and manufacture. In order to further reduce measurement error during operation, an individual compensation matrix is needed for each multi-component transducer. This is included in the scope of supply, together with the sensitivity and the crosstalk as a percentage.

The output basis for the compensation matrix is the straight lines determined from the measured values, in accordance with the best-fit method.



Fig. 1: Synchronization process simulating transmission test rigs

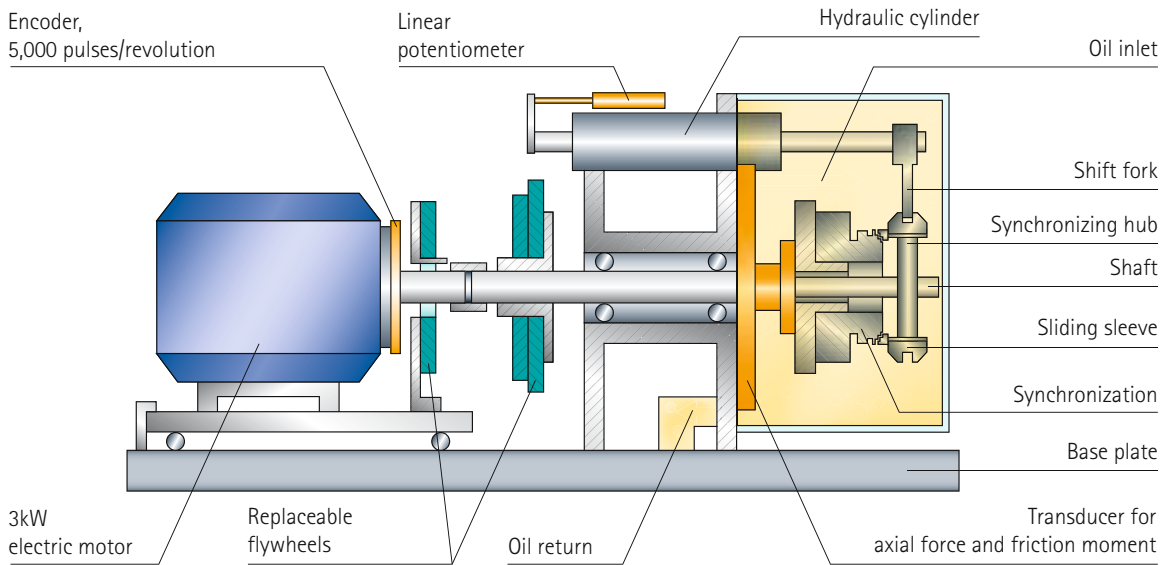


Fig. 3:  
Test bench  
function chart

Equations for all the directions of measurement taken together make up a system of equations of the first order:

$$\begin{pmatrix} U_{Fx} \\ U_{Md} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \cdot \begin{pmatrix} Fx \\ Md \end{pmatrix}$$

If you resolve the equation in accordance with the force vector, you get:

$$\begin{pmatrix} Fx \\ Md \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \cdot \begin{pmatrix} U_{Fx} \\ U_{Md} \end{pmatrix}$$

where ...

$$\begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix}$$

...is the compensation matrix.

As the  $b_{ij}$  coefficients of the compensation matrix are taken from the test certificate, the following equations can be used to compensate the crosstalk by computation and thus increase the accuracy of the transducer still further.

Thus:

$$\begin{aligned} Fx &= b_{11} \cdot U_{Fx} + b_{12} \cdot U_{Md} \\ Md &= b_{21} \cdot U_{Fx} + b_{22} \cdot U_{Md} \end{aligned}$$

This calculation is a component part of the catman®Professional software.

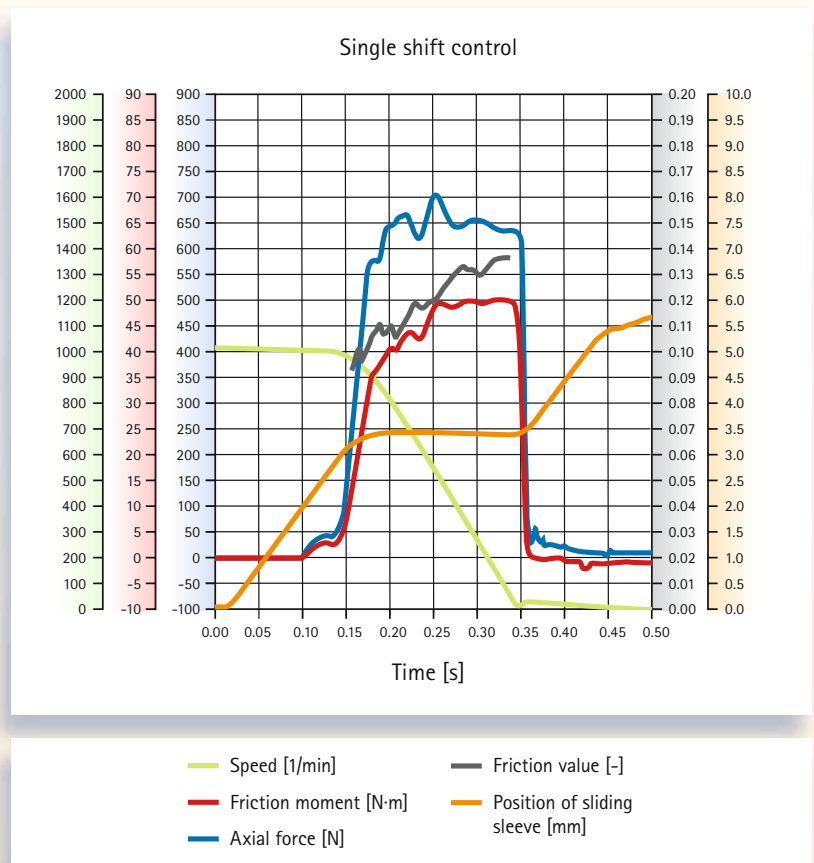


Fig. 4: Single shift control on the  $\mu$ -comp test bench

More information at...  
[www.hbm.com/customized](http://www.hbm.com/customized)