



digiCLIP

More efficient production through reliable measurement

Green light for your production in the digital age

The "digiCLIP" series of products is the new modular system for automation in an industrial environment and for monitoring production processes

Strain gages for structurally integrated measurement

Even as the fiber composites are being made, strain gages are being embedded in the structure



*Gert Gommola
Sales Manager
Central Europe, Eastern Europe
and Scandinavia*

Sales in transition

From index card to virtual sales call

Dear Reader,

state-of-the-art Customer Relationship Management (CRM) systems, a suitable notebook and a pocket-PC are the tools of the trade for today's sales team, replacing the virtually forgotten index card.

As our contact persons and customers, you feel these basic changes in day-to-day working just as much as we do. Nowadays, there is now often far less time available to discuss a project than there used to be. Our partners expect system solutions. The individual measured value is "only" the means to solving the problem and more and more frequently, implementation is to come from a single source.

Over the years, we have responded to increased specialization among our customers' contact persons with relevantly focused sales teams. You can sense this steadily increasing technical competence in direct conversation with your HBM sales contact person and when contacting our equally specialized Technical Support Center in Darmstadt by phone.

Colleagues in international sales and our independent HBM agencies in Eastern Europe or in Scandinavia, for example, were and are becoming more and more involved in this approach.

The Internet is indispensable to our customers as a source of information that is available at any time and anywhere in the world. To make the preliminary selection of relevant information easier for you, the fundamental HBM specializations are also mapped to different portals (such as www.hbm.com/torque) on the HBM pages on the Internet.

But in the foreseeable future, it is not going to be possible to click on to the Internet to buy capital goods and system solutions requiring a great deal of deliberation and advice. Individuals, a personal conversation and mutual trust are still required.

So despite the very latest methods of communication, we are not going to abandon the idea of actual, regional locations in your vicinity – and not just in Germany either. Unlike practically every other comparable company, HBM not only has its three locations in Germany, China and the United States, it also has a global network of branches, sales and service partners.

The exceptionally large number of participants in our "HBM On Tour 2005" series of events proves how valuable this direct contact is. A number of firms are copying this concept. But this tour has again confirmed for us that "you can't beat the original!"

These events have been such a success that that we are increasingly going to run them in other European countries as well.

It is not just the work in sales as such (relationship between customers and sellers), but also the character of measurement that has changed drastically over the years. Whereas special trade fairs have experienced growth, general trade fairs are fighting to keep their visitors interested.

B2B and E-Commerce issues keep you and us equally occupied. Standards must be found here, because HBM cannot implement every single corporate group or company solution.

In general, capital expenditure budgets are not getting any bigger. We have also identified a concept here to break new ground. HBM is the first manufacturer of measurement technology to give you a hardware leasing option on attractive terms (initially only in Germany). The first customers are already seeing the benefit. We will gladly identify such a concept for you too.

Regards, Gert Gommola

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Strain gage technology

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CANbus PROFIBUS

digiCLIP...

Green light for production in the digital age

Controlling core characteristic quantities in production lines is not only essential to the safety of man and machine, it is also important for high productivity and the quality of the end products.

The transfer of I/O signals in junction boxes and on-site, at series terminals in the control cabinet is fraught with errors, which increases commissioning times and thus cost. As the complexity of the input and output tasks increases, so does the required computer power for central machine control. Modern control concepts therefore opt for a central CPU in the control cabinet with distributed intelligent fieldbus terminals.

digiCLIP

The new digiCLIP product series is designed to meet precisely these requirements. It is a modular system for automating industrial test benches and monitoring production processes. Measured quantities such as force, strain, torque, mass or pressure are easily and safely measured with digiCLIP amplifiers.

The modules are available with CAN or ProfibusDPV1 interfaces, via which all the measured values and status information are transferred. Measurement is also possible in potentially explosive atmospheres, when a Zener barrier is connected on the line side. Their functionality, flexibility and design make these modules particularly interesting for industrial plant engineers.

Further advantages include ...

- high stability,
- less drift and noise,
- global use under rough industrial conditions,
- transducer electronic data sheet.



Signal conditioning by digitization

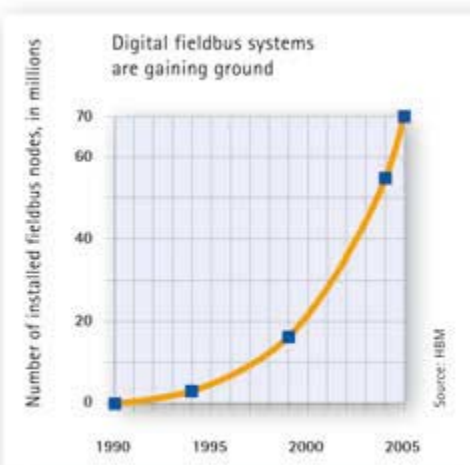
digiCLIP supports TEDS functionality (Transducer Electronic Data Sheet). The characteristics of a sensor can thus be transferred directly to the amplifier in a matter of seconds. A further plus for the service-friendly digiCLIP modules is line continuity detection on all sensor lines and extensive self-monitoring.

digiCLIP displays remarkable accuracy in the 0.05% range and the measured values are highly stable. Carrier frequency technology also makes it highly reliable and there are open interfaces with real-time capability for integration into higher-level control systems.

Advantage of carrier frequency technology

Carrier frequency amplifiers transfer selectively, that is to say, only a narrow frequency band is measured. This makes them far less susceptible to interference signals.

The measured values are digitized via analog/digital conversion (ADC) at 24 bits. The high internal sampling rate of 1.18 kHz allows an extremely stable measured value to be generated from several measured values, subject to the filter setting.



Analog technology is increasingly being replaced by digital technology



digiCLIP combined with PLC control

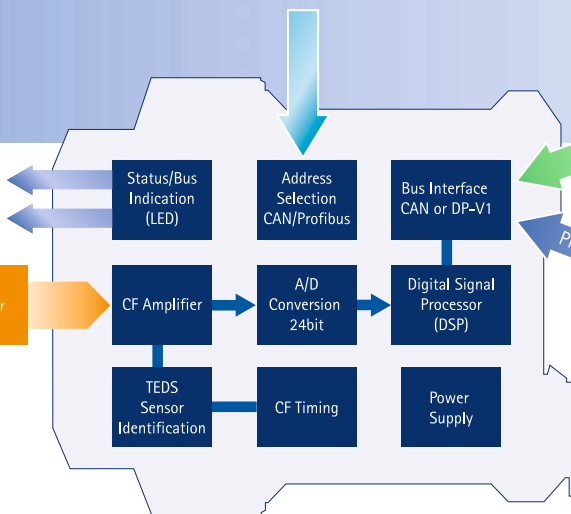


Up to 99 modules can be "CLIPped" together



Setup-Toolkit

Process Connection



Block diagram of the amplifier module



Photo: Schuler S&S

Typical applications in industry



The digital signal processor (DSP) links the measured values to the desired functionality in a matter of milliseconds. If several digiCLIP modules are run in parallel, a synchronization signal ensures that the timing of all the amplifiers is synchronized. A further practical advantage is "hot-plugging", that is to say, the modules can be plugged in or removed during operation.

Intelligent communication

digiCLIP modules have a CANopen interface in compliance with CiA DS301 and DS404. The bus speed can be varied between 20 kbit/s and 1,000 kbit/s; with automatic baud rate detection, the modules "listen" briefly to the bus and then automatically set themselves to the prevailing bus speed. The status of the module and the bus can be read via LEDs.

Parameterization

A new Software Assistant allows the modules to be quickly and easily set via PC or laptop. Device settings can be stored and loaded back into the module, which minimizes service times.

Machine control with distributed intelligence

digiCLIP modules can be used, for example, in automatic placement machines and in PCB production, where extreme accuracy and optimized timing are essential to the production process. The linear motors used for this are controlled by a mini-PLC, together with digiCLIP. Simply plug together and integrate into the control concept of the mini-PLC via the EDS file (electronic data sheet for device functions and documentation).

Communication is via the CAN bus. This makes it possible to compose customized control concepts.

Additional fields of application include engraving and milling machines, as well as printing machines. Measuring and monitoring pressure rollers and positioning are the central measurement tasks of digiCLIP.

The expandable amplifier concept of the digiCLIP product family allows forward-looking machine and automation concepts to become reality. ■

Multi-range torque transduce

...Is it possible to outwit physics?

The answer is short and unmistakable: no!

With multi-range transducers, the case is often argued that it is possible to accurately measure high peak torques and average running torques with one transducer. Unfortunately, it is only after going through data sheets in detail and looking at real proposals and making persistent inquiries that you can understand what is meant by accurate.

The advantages of strain gage (SG) technology [1] have made it a success for high-precision and accurate torque measurement. With this technology, the aim should be to achieve accurate measurements by extracting everything from the measurement signal, down to the absolute physical limit of strain gage technology, i.e. down to the level of the thermal noise [2].

Is there such a thing as a genuine multi-range transducer?

A genuine dual-range transducer would have to have two strain zones, two Wheatstone bridge circuits and two amplifiers. But there is no such transducer on the market and from the technology point of view, virtually no chance of one ever being built. The sensitive measuring point would also have to transfer the maximum torque of the second application point. In practice, this is not feasible and even theoretical possibilities, such as mechanical stops, cannot be implemented for dynamic response and high speeds, if not before. So multi-range transducers only have one strain range and the SG output signal is subsequently processed by two amplifiers.

What is the effect of electrical amplification on errors relative to zero?

Figure 1 shows the basic difference. But if the measurement signal is derived twice from the same measuring body and the same SG bridge circuit, once the 100% signal and once the 10% signal, this only means for the 10% range that all the bridge and input amplifier errors will be amplified more highly, by factor 10. Figure 2 shows this, using the temperature effect on the zero point as an example. A T10FS/1 kN-m torque flange was compared with a 1 kN-m dual-range transducer with a second measuring range of 100 N-m. The results for them both are relative to 100 N-m. Even with other specifications, such as linearity deviation and torsional stiffness, T10FS type torque flanges are superior to multi-range transducers.

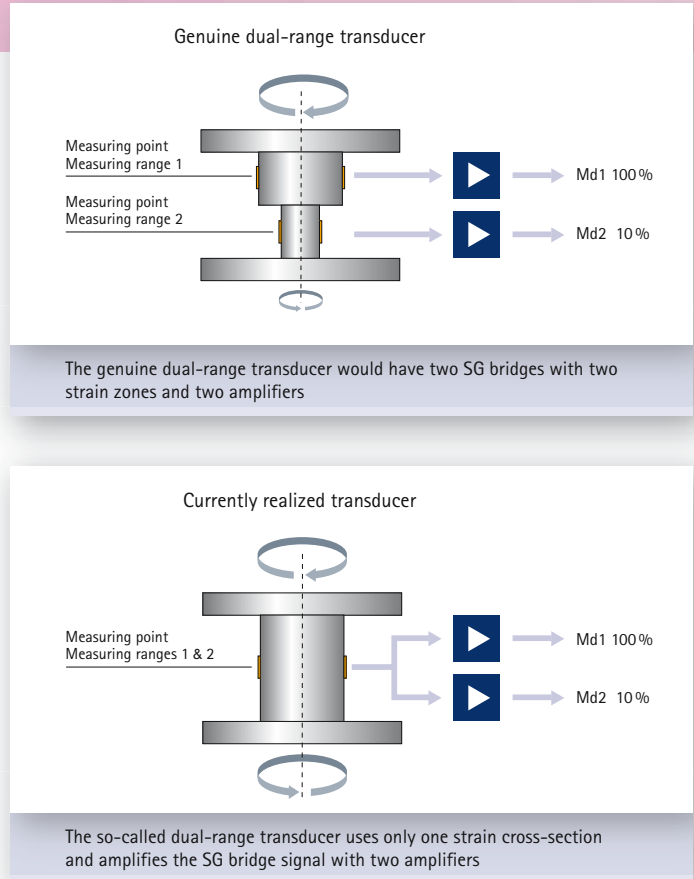


Fig. 1: Basic diagram of dual-range transducers

What difference does the quality of a transducer make?

With multi-range transducers, the signal is only available once, so there is no higher signal resolution. There is a loss of information; all the signals (e.g. the dynamic peaks) that exceed the 10% range are not recorded and this can therefore corrupt the static mean values.

A 10% range then only makes sense, if, for example, the 100% range is non-linear and thus a separate amplification adjustment has to be made in the 10% range or if the measured values are badly corrupted on the transmission path. But the latter is not the case with the frequency modulation method employed by HBM. A very high basic accuracy is absolutely essential, that is to say, a polished measuring body design, minimizing error effects by using optimized components (e.g. SGs) and more than 45 years of relevant torque transducer and strain gage manufacturing know-how from HBM.

rs ...

The measurement chain is important

The argument that HBM torque transducers still only deliver a 500Hz frequency sweep at 10% load, for example and that therefore resolution is low and measurement accuracy unsatisfactory, is not correct. Both with the MGCplus amplifier system and with PME amplifiers, the measurement frequency signals are evaluated in accordance with a special procedure [3] that records the period as well as the frequency, thus obtaining resolutions that are virtually as high as you want. The follower electronics also give you the opportunity to use different parameter sets to adapt the measuring range to meet the particular requirement. This provides far greater flexibility than a fixed, second measuring range in the transducer. ■

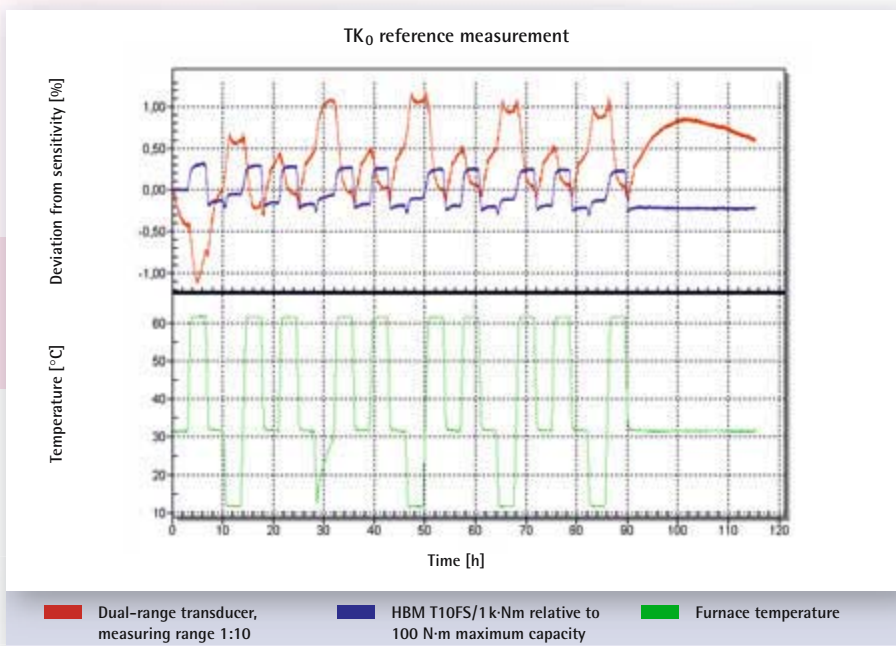


Fig. 2: Typical reference measurement of the temperature effect on the zero point

References:

- [1] Rainer Schicker: Drehmoment-Messflansch nach dem Prinzip der Scherkraftmessung am Doppel-T-Profil; Sensoren, Aufnehmer und Systeme 2000 by b-Quadrat Verlag, 86916 Kaufering, <http://www.hbm.com>
- [2] Manfred Kreuzer: Ein programmierbares Präzisions-Meßgerät der Genauigkeitsklasse 0,0005 und seine Anwendungen, HBM-Instrumentenkurse anlässlich der INTERKAMA 80 Düsseldorf, Notes for course participants
- [3] Rainer Schicker, Georg Wegener: Measuring Torque Correctly, ISBN 3-00-008945-4, Published by Hottinger Baldwin Messtechnik GmbH, Darmstadt

Maximum precision confirmed by accreditation

Two new calibration stations for torque at HBM



Fig. 1: It always was good, but now it's even better:
Torque calibration at HBM

With two new calibration stations for torque, HBM is reinforcing its position of technological leadership in the field of torque measurement. The uncertainties confirmed by the German Metrology Institute, the PTB, in the course of DKD accreditation from the German Calibration Service are the smallest that have ever been achieved anywhere in the world by calibration laboratories outside the national metrological institutes. At the same time, the HBM Calibration Laboratory covers the widest torque range, directly after the PTB.

The stations are used both for calibrating torque transducers for our customers (working standard calibration and DKD calibration) and for the development and ongoing production of high-precision torque transducers.

continued →

continued:

Two new calibration stations for torque at HBM



1 kN·m torque calibration station

- Torque steps from 5 N·m to 1,000 N·m
- Uncertainty of torque representation, 0.01% of the particular torque step
- Lever arm with air bearings to eliminate friction torque almost completely
- Material: Hardstone instead of the usual steel for particularly good dimensional stability
- Binary mass stack, allowing particularly fine spacing even with high torques



25 kN·m torque calibration station

- Torque steps from 100 N·m to 25 kN·m
- Uncertainty of torque representation, 0.008% of the particular torque step
- Binary mass stack, allowing particularly fine spacing even with high torques
- Weight bearing and coupling via flexible links in conjunction with an active control system which ensures that there are no restoring torques to affect the calibration torque
- One of the largest stations in the world with such high precision

Why are high-precision torque calibration stations so sophisticated?

The principle involved is simple: Weights of a defined mass load a lever arm of a defined length and generate torque. But achieving accuracies of fractions of a percentage requires a very high level of sophistication:

- High-precision determination of the length of the lever arm and of the masses
- Taking into account effects such as the air buoyancy of the steel weights, the thermal length changes of the lever arm (despite air conditioning in the calibration laboratory), local differences in the effect of gravity and magnetic interaction
- Minimizing disturbance torques such as friction torques, with sophisticated bearing concepts such as air bearings
- Sophisticated, active control system: to ensure the horizontal alignment of the lever arm and to prevent shocks and vibrations of the active torque. ■

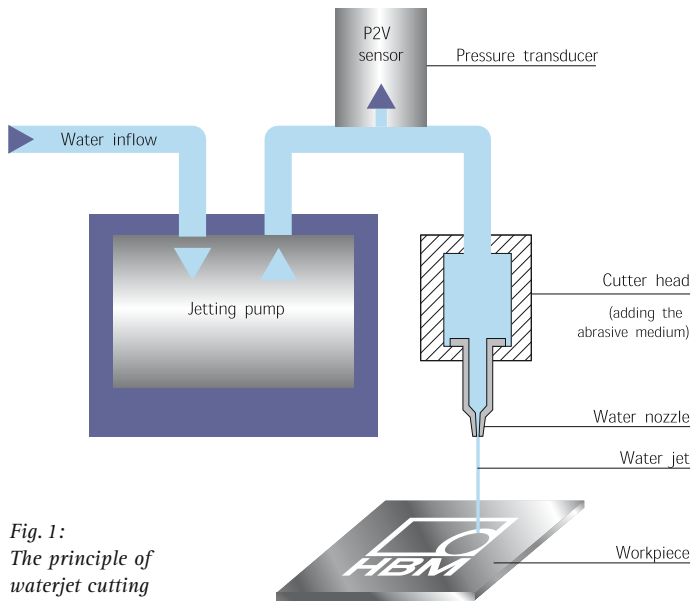


Fig. 1:
The principle of
waterjet cutting



Fig. 2:
Waterjet cutting
machine

Fig. 3: P2V pressure transmitter for
installation in the high-pressure
lines of waterjet cutting machines,
for example

The force of water

Advantages of electrical pressure measurement for waterjet cutting

Waterjet cutting requires extremely high water pressures of 3,000 to 5,000 bar, which have to be measured accurately. HBM provides special pressure transducers and pressure transmitters for this.

In the eighties, the addition of solid particles to the stream improved waterjet cutting so much that the maximum workable material thickness for metals could be increased to 200 mm. Far greater depths of cut are possible with abrasive waterjet cutting than with laser cutting. For example with a laser, it is only possible to cut stainless steel up to a material thickness of 20 mm, but with a waterjet, up to 100 mm is possible. The waterjet cutting method achieves a cutting accuracy of about ± 0.1 mm. It is not necessary to rework the cut edges and there is no pollution burden from toxic gases. The laser method, on the other hand, produces combustion residue. When working with plastics, acrylics, rubber or foams, for example, toxic vapors are produced.

In general, waterjet cutting and deburring methods are sensible alternatives to conventional cutting and removal methods, as, in addition to the advantages listed above, they can also be used in situations where other technologies, such as laser cutting, do not work, for example under water, where explosive substances are involved, or in filled fuel tanks. Waterjet cutting is a cold-cutting method that works

with virtually all materials. This also includes composites, such as laminates or fiber-reinforced plastics. Possible warping of the workpiece from the thermal effect of using a laser, for example, does not happen here.

The purchase price for a waterjet-based method is lower than for the laser method and is therefore highly promising.

Suitable measurement technology for use in waterjet cutting

It used to be scarcely possible to measure maximum pressures accurately. But with the P3MBP BlueLine series of transducers and the new P2V high-pressure transmitters from HBM, this is no longer a problem. The special feature of the patented design, the basis for pressure transducers up to a nominal pressure of 15,000 bar, is the monolithically enclosed pressure chamber. That is to say, the measuring body is made of one piece, without any weld seams and has a very high natural frequency and a previously unheard of service life. ■

New, more economical e

Mahle Powertrain: HBM helps make engines go greener

One of the world's leading automotive consultancies, Mahle Powertrain (formerly Cosworth Technology) of Northampton in the UK, has turned to HBM in its drive to produce cleaner burning engines. Throughout the automotive industry manufacturers are seeking to develop more ecologically friendly – greener – engines by improving engine fuel consumption and simultaneously reducing exhaust emissions.

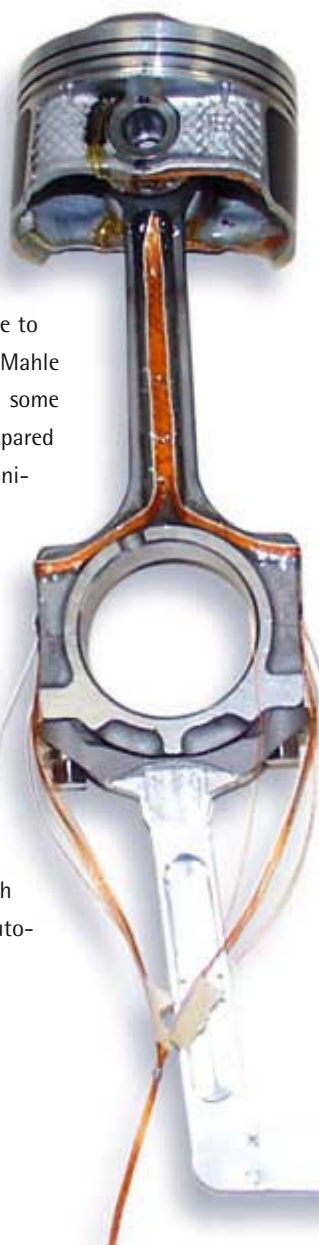
Mahle Powertrain has a well-deserved international reputation for its research that has been directed towards developing a gasoline Controlled Auto-Ignition (CAI) engine to improve fuel economy.

Auto-ignition improves efficiency

The theory behind the CAI engine is that, by invoking auto-ignition in the engine, it is possible to significantly improve thermal efficiency. Mahle Powertrain believes that it is possible to release some 45% of the fuel's energy using this technique compared with the roughly 25% released in a typical spark ignition engine.

Engine technology for the future...

To achieve auto-ignition, Mahle Powertrain needed to change the standard combustion cycle by trapping, or re-cycling, large quantities of burned gases inside the engine cylinder after initial combustion rather than allowing these to exhaust to atmosphere. These gases then heat the next charge of freshly aspirated fuel-air mixture entering the combustion chamber through multiple ports and, after compression, causing auto-ignition.



Adding to the engineering complexity is the challenge that the CAI engine can only be used over a limited operating window. At higher speeds and loads the engine reverts back to conventional spark ignition operation.

...in collaboration with HBM

Working closely with HBM's team in the UK, Mahle Powertrain used their piston telemetry system, comprising a mechanical linkage mechanism from the conrod big end, to route signal wires enabling the acquisition of real-time piston data from a fired engine. By fitting eight thermistors at specific points just below the surface of the piston's combustion bowl and ring lands it was possible to derive the actual temperature measurements within the piston when the engine was running.

Because of the temperatures in the pistons, glass-coated silicon chip thermistors were used of the negative temperature coefficient variety.

Fig. 1: Piston telemetry system with installed thermistors and signal leads

Engines



Fig. 3:
Fully installed piston
telemetry system



Fig. 2:
Eight thermistors are
placed under the combus-
tion recess of the piston

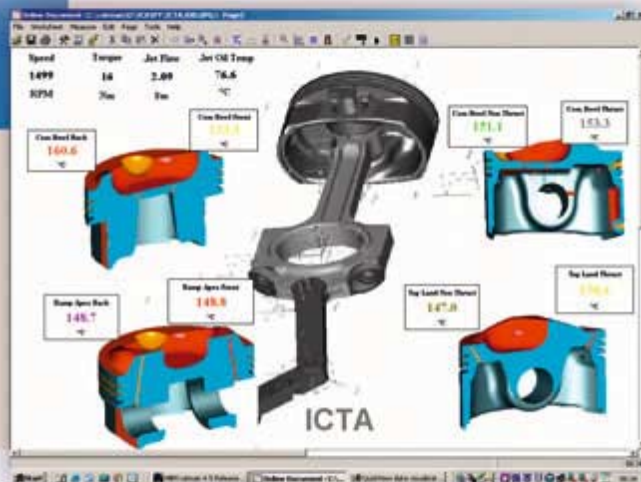


Fig. 4
Position of the eight thermistors in the piston
of the CAI engine

"The challenge with these thermistors is that they produce a non-linear output. However, HBM's catman® software is more than capable of dealing with this aspect."

Carl Godden, senior instrumentation engineer, Mahle Powertrain

Data acquisition with MGCplus and catman®

This set-up produced a twelve-point calibration curve for each sensor at temperatures of up to 350°C. The curves were incorporated into catman® as user scaling files (USC). catman® was configured to perform linear interpolation between the calibration points. To provide a complete picture for Mahle Powertrain, HBM had a number of other inputs into the MGCplus. The oil feed temperature and flow, which is controlled automatically using a heater and valve, were also monitored along with other basic engine parameters such as the torque and speed. The measured data was simply and clearly displayed using catman® real-time graphical tools.

Carl Godden, senior instrumentation engineer at Mahle Powertrain recommends the solution:

"The MGCplus and catman® combination proved to be an excellent solution for our data acquisition requirements. It was particularly rewarding to obtain a multi-point linearization of the thermistor signals that was very simple, and highly effective, to implement."

Carl Godden ■

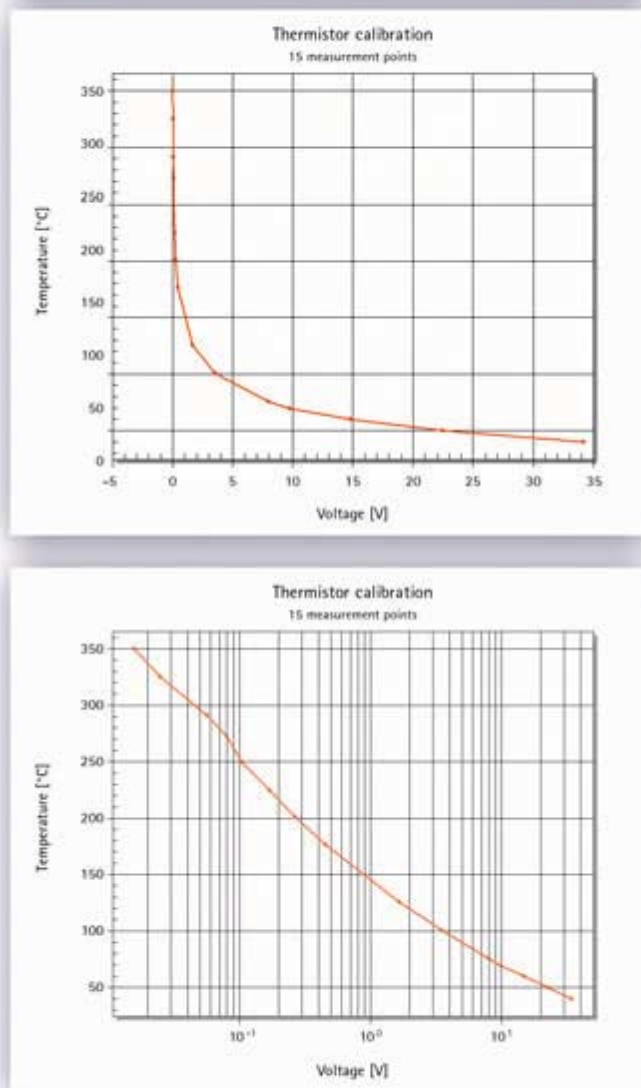


Fig. 5: The MGCplus amplifier system uses catman® software to record the thermistor calibration data, etc.

Road tests ...

Torque measurement on the vehicle under real conditions

The task is to define the torque at the cardan shaft of a truck with great precision, while modifying the drive train as little as possible. The solution must be optimized for cost and be suitable for road testing.

There are two possible ways to measure torque at a cardan shaft:

- Installing strain gages directly on the cardan shaft
- Mounting a customized torque transducer

The following reasons make installing measurement technology with strain gages and a telemetry system on the cardan shaft only the second-best solution:

- The rotor measurement system with SG full bridge, rotor electronics and rotor antenna must be well-protected against mechanical damage and against dirt, humidity and moisture for the road test. This is why the rotor system is fully encapsulated in epoxy resin, for example
- A system constructed in this way cannot be repaired
- When measurement is completed, the cardan shaft only has limited use for follow-up measurements
- After installation, the shaft can only be re-balanced to a limited extent, because of its length
- Measurement accuracy is not very good, as the cardan shaft is not designed in accordance with transducer development criteria.

Customized torque transducers...

So the solution for commercial vehicles is to develop a customized torque transducer, that can be mounted in the vehicle without modification and adaptation. A small part of the length compensation that each cardan shaft has as standard, is used as mount-

ing clearance for the torque transducer and the transducer flange is fitted with the same staggered teeth arrangement as the cardan shaft.

...without restricting driving ability

The height of the transducer must not restrict the mobility of the vehicle axle, even when the road test is "off road". The measuring range of the transducer is either adapted to the transmission range of the cardan shaft or is customized.

The special design of the measuring body minimizes parasitic force influences

The possible parasitic force influences of the cardan shaft on the transducer were taken into account and their effect was minimized when developing the measuring body and the strain gages, as well as their connection. Both the axial forces and the

*Fig. 1:
Torque transducer:
mounted between
the rear axle and
the cardan shaft*



... with HBM



Fig. 2:
Truck rear axle with
torque transducer

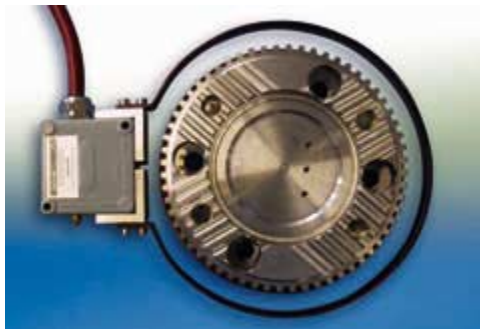


Fig. 3: Torque transducer with stator antenna, the arrangement of the teeth at the circumference is used to measure the speed



Fig. 4: Compact car version of a torque transducer



Fig. 5: To prevent unbalance, the rotor electronics are mounted centrally

bending moments generated by the cardan shaft when compensating for the motion of the axle, only have a minimal effect of the measurement result.

Non-contact data transmission

A telemetry system made by Datatel is used for non-contact transmission of the measurement signal. The supply voltage can be provided by the vehicle electrical system. A measuring bandwidth of more than 1 kHz covers every need. The stator electronics can either be designed as a "standalone" unit or as a connection board for the HBM amplifier system MGCplus. Integration into the MGCplus has the advantage that other measured quantities supported by MGCplus are measured and recorded synchronously.

Robust for use in real life...

To enable road tests to take place whatever the weather, the torque transducer was designed in accordance with protection class IP67 and the temperature range was adapted to suit our climate.

...also in a car version

A solution was also developed for a car, under the same conditions as for a truck. But for the mounting, part of the cardan shaft has to be replaced by the torque transducer. To make sure that the torque transducer fits in the additional space reserved for it, the rotor and the stator antennae were designed as one compact unit on bearings. ■



TEDS is gaining ground

At HBM, the entire measurement chain supports the transducer electronic data sheet

TEDS – the transducer electronic data sheet – has now become established among HBM's transducers and amplifiers as a regular component of metrological system solutions.

Amplifiers equipped in this way can read in the relevant transducer characteristics from the TEDS memory integrated in the transducer and then automatically convert them to the correct settings, so that measurement can start straight away.



catman®Easy – software for TEDS

This philosophy is consistently applied by the catman®Easy measurement data acquisition software, which sets up the channels for visualizing and storing the measurement data from the information read out from the TEDS.

Amplifier modules for TEDS

For some time now, HBM has been offering a series of amplifier modules for various types of transducers (including force, pressure and displacement) with TEDS functionality. New amplifier modules allow more comprehensive and flexible use to be made of these advantages.

One such example is the ML455 multi-channel amplifier module with carrier frequency technology. This amplifier is a push in the right direction for multi-channel technology for transducers.

Although the interference-immune, carrier frequency technology is important, so are the connection types that are standard for transducers. They allow this module to form the basis of many flexible solutions without the need for extensive adjustment and configuration. It is then merely a logical step to fully automatic "Plug & Measure". Of course, the ML455 is fully TEDS compliant.

With the ML38B (the successor to the tried and tested ML38), TEDS has now also arrived in the field of precision amplifiers. In keeping with this field of application, this amplifier also gives you the opportunity to consider the characteristic curve of the transducer not just conventionally, as a straight line, but as a cubic polynomial. This performance feature is given ideal support by the TEDS "Calibration Curve" template.

TEDS transducers

With measurement transducers, it has long been a quite simple matter, even subsequently, to upgrade all transducers with a fixed cable to make them TEDS-compliant. TEDS has also recently been available for transducers with a cable that is attached by plug connections. The TEDS chip must be integrated in the transducer housing for this. ■



Predestined for the measurement chain: U10M force transducers in a double bridge version, the TEDS module is integrated in the transducer housing. Next to this, TEDS-compliant multi-channel modules using carrier frequency technology for the MGCplus amplifier system: ML455 amplifier module with an AP455i connection board



P3MB pressure transducer, fitted with a TEDS module integrated in the transducer plug. This integration is available from HBM both when ordering a new transducer and when upgrading existing transducers



U3 force transducer, fitted with a TEDS module integrated in a metal sleeve in the transducer cable. This integration is available from HBM both when ordering a new transducer and when upgrading existing transducers

Good things come in small packages...

New components for weighing technology

"Good things come in small packages" applies to the performance of our new generation of intelligent FIT® load cells and AED digital transducer electronics. The target markets are chiefly automated and automatic weighing and packing processes.



*Faster than ever and with new interfaces:
AED transducer electronics*

*Trimmed for accuracy:
PW2 single-point load cell*



*Dynamic:
PW22 platform
load cell*

Maximum functionality...

...is provided for users by the single-point properties of the FIT®3 load cells in C3 quality, the integrated primary electronics, the adjustable digital filters and a choice of RS-232, RS-485 (4-wire), CANOpen or DeviceNet interfaces. The flat stainless steel load cell versions even offer protection class IP68. For the first time, a diagnostic channel for on-line parameter modification has been implemented, with the bottling process continuing in the background.

New AED electronics...

...for connecting strain gage full bridge sensors are easily and conveniently controlled and programmed by the included "AED Panel 32" software. With 10,000 legal for trade divisions, they meet the most stringent demands for accuracy and, with protection class IP 67, can also be used under rough conditions.

The PW2 and PW6 single-point load cells,...

...which have proved their worth as mass sensors in counter scales, will in future be available for highly-dynamic requirements, as well as in a C6 precision version. In the C6 version, a more flexible sensor is often required to make it easier to adjust the mechanical stops.

The new PW22 platform load cell...

...is designed specifically for highly-dynamic requirements with optimum distortion resistance and is thus predestined for use in checkweighers or multi-head combination scales in the packaging industry. They are exceptionally robust, thanks to integrated overload protection, which also stops the load cell being destroyed when used under rough industrial conditions. ■

Teamwork: Vehicle test and inspection systems

Siemens: Dynamic truck rear axle transmission test rig for SCANIA

As an automotive industry partner, Siemens A&D, in its vehicle test and inspection systems division provides innovative solutions for testing vehicles and vehicle components throughout the world. By using the latest HBM torque measurement technology new ground was also broken when designing a transmission test rig for SCANIA in Sweden.

A 4-machine test rig was installed at the SCANIA Technical Centre in Södertälje in Sweden to determine data about fatigue, service life and function of truck rear axle transmissions. It was used to develop rear axle transmissions, particularly for heavy goods vehicles with and without a tandem-axle. This is why a total of four electric machines are needed in the test room as drive and loading units.

With a fast control system (CATS_{TC}), robust test rig control and a flexible automation system (CATS_{NT}), the highly functional test rig is able to control a wide variety of different machine configurations (2, 3 or 4 machine operation) and accompanying control modes in the required dynamic response.

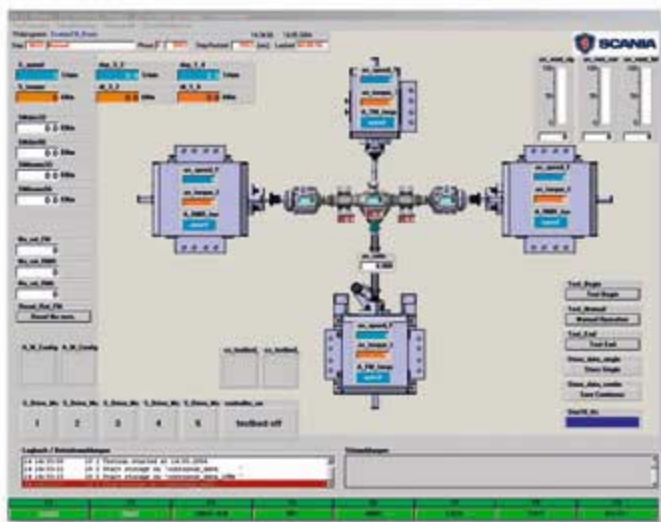


Fig. 1: CATS_{NT} automation system;
all the relevant test rig data at a glance

The drive concept

To ensure that the test rig was readily available, the chosen drive concept had the following advantages:

- No matching gears,
- No adjusting devices,
- High-precision torque measurement:
 - HBM T10FM torque flanges
 - HBM Z4A force transducers
 - HBM PME/MP60DP and MP30DP amplifiers

- Low connection power:

Despite the high power rating for the installed machines of 5,540 kW, it was possible to limit the AFE line-side converter to 2 x 800 kW. This also guarantees dynamic operation.

HBM measurement technology

Four HBM T10FM torque flanges for torques to a maximum of 40 kN·m are used to record the torques at the test specimen. The sensor data is conditioned by HBM's MP60DP amplifiers. These deliver the measurement data to the automation system digitally via an integrated ProfibusDP interface, without additional conversion.

... with HBM



from Siemens A & D ...

Other equipment features

- Control and monitoring:
SIMATIC S7-300 PLC and ET200 distributed I/O stations
- Control system:
Real-time processor system, MATLAB/SIMULINK control system software CATS_{TC} and manual operator control level
- Operator control/automation:
Industrial PC system with the CATS_{NT} automation system
- Measurement technology
To evaluate the sensor signals of the test rig and the test specimen: · HBM PME/MP60DP and MP30DP amplifiers, ET200M distributed I/O stations and PROFIBUS optical fiber cable connection to the CATS_{NT} control system and to the CATS_{NT} automation system



Fig. 2: Test rig with rear axle transmission as a test specimen

Machine specifications

- drive machine (cardan)
1,830 kW, 25 kN·m from 0 to 692 rpm
max. speed 2,320 rpm
- Two wheel machines, each:
1,415 kW, 40 kN·m from 0 to 333 rpm
max. speed 1,200 rpm
- Cardan machine for second axle:
880 kW, 10 kN·m from 0 to 692 rpm
max. speed 2,320 rpm



Fig. 3: Coupling the test specimen

The HBM torque calibration machine...

...is designed as a loading unit with a lever arm and a tension train. A reference measurement chain was provided by a Z4A reference transducer in conjunction with an MP30DP digital amplifier. The calibration machine can be used alternately for all four measuring points.

Conclusion

The test rig is a forward-looking solution, both for fatigue testing and for service life trials, as well as for testing the functionality of rear axles for trucks and coaches.

High-precision and dynamically correct measurement with torque flanges right on the drive train are the optimum conditions for providing a metrological solution. ■

hbm academe

Training and more besides...



On the one hand, the constantly changing world of work, characterized by high cost pressure and rapidly changing markets, demands more universally applicable measurement technology and on the other hand, a user that can do everything. But is this balancing act really to be taken for granted?

Universal and therefore usually rather complex systems require a thorough understanding of the control processes, as well as the requisite basics of metrology. Many users are highly-qualified specialists in their own field, but have no metrological training.

So as manufacturers of complete metrological solutions, we see it as our duty to provide our customers not only with the hardware and software, but also with the necessary qualifications for optimum control of these systems.

The hbm academy ...

...is one of two training areas within HBM. The seminars are geared to product training, learning skills and the requisite theoretical basics. This is achieved by a combination of lectures and practical training in a well-equipped, modern seminar room at our Darmstadt factory.

The wide variety of products offered by HBM is reflected in the diversity of the seminar program.

Topics in overview

DK	The basics of strain gage installation and strain gage measurement technology (Course 1 in accordance with VDI / VDE / ESA 2636)
DM	Strain gage measurement technology in transducer construction and in experimental stress analysis (Course 2 in accordance with VDI / VDE / GESA 2636)
MI	Industrial measurement technology with transducers and devices
MK	The comprehensive seminar for the "metrology administrator". Everything about measurement technology for the electrical measurement of mechanical quantities is dealt with in three blocks of two days each.
MD	Measuring torque correctly
WFT	Production monitoring: Electrical measurement of mechanical quantities in manufacturing and production
BM	Measuring strain, displacement and acceleration in civil engineering
MGCplus	Measuring with the MGCplus amplifier system
catman	Measuring with catman® measurement data acquisition software
CSCT	Working with catman® script language

The contents of training courses and online application can be found in the "hbm academy" catalog or on the Internet under:

www.hbm.com/academy

my



Learn individually...

A major part of the training is directed at practical work. Worksheets are used at a variety of workplaces to give participants independent training in theory. Our team of experts are there to help when required.

...on your own premises too

The second training area is "HBM On Tour – Practical Measurement Techniques". As the name suggests, these are external events staged throughout Europe. The focus here is more on application-specific, practical tips on all aspects of measurement. There is no product presentation or product training. But our aim is still to involve participants as intently as possible, whether installing strain gages or determining characteristic curves.

We are happy to arrange customer-specific seminars or workshops at HBM.

Contact us for a discussion:

E-Mail: seminare@hbm.com
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Fig. 1: Seminar room at HBM in Darmstadt



Fig. 2: "Measuring torque correctly" seminar, workplace no. 1: Mounting a torque flange



Fig. 3: "Basics of practical measurement techniques" workshop in Austria

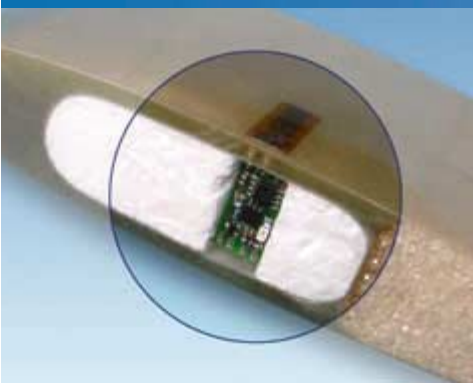


Fig. 4: "Measurement technology in civil engineering" workshop in Gaydon, UK

Strain gage news

HBM develops strain gages (SGs) for structurally integrated measurements

Fiber composites have arrived in many areas of our daily lives and because of their special properties are becoming ever more significant. Nowadays, they are not just found in areas such as aeronautics or motor racing, but also in power engineering and medical technology, in civil engineering and in sports and leisure equipment.



*Fig. 1:
Structurally integrated
measurement technology*



*Fig. 2 – 3:
Focus on composites
in innovations*

The increased use of these materials and the systematic optimization of components presuppose a precise knowledge of the load situation. It is also becoming more and more important, with regard to the manufacturer's warranty responsibility, to have sensor technology specifically adapted to the properties of this material to be used for load analysis and component monitoring during operation.

In many applications, sensor integration is the only way to meet the demand for modern lightweight structures with regard to production control, load monitoring, damage analysis and control signal generation.

HBM has developed a strain gage that is embedded in the structure during the fiber composite production process.

Features of the new strain gage

The most obvious feature of the SG is the two vertically attached contact pins, for contacting the strain gage embedded in the material. The measuring leads are only connected to the gold-plated pins after manufacture, outside the structure, which makes all the handling easier.

The strain gage is of a symmetrical design, with structural strain being applied equally to the measuring grid from both sides. Depending on the requirement, the user can decide whether the pins should be contacted inside the structure or on the outside. Thus, for example, with sandwich structures, the measuring leads or customized electronics can be introduced into the foam core.

The special SG layout is designed in such a way that the measuring grid is outside the fibers running round the pin. Furthermore, special strain relief of the solder terminals prevents the forces working on the pin from being transferred to the measuring grid.

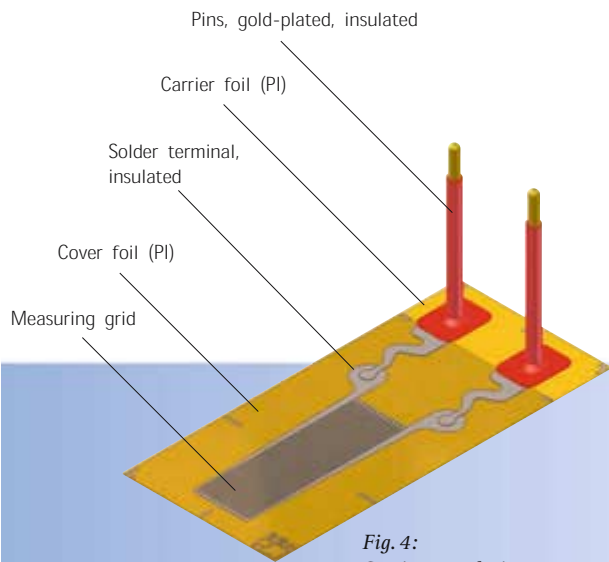


Fig. 4: Strain gage design for structural integration

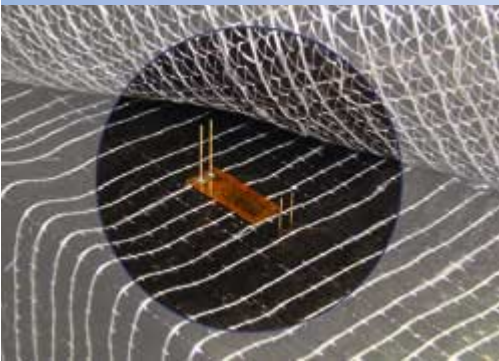


Fig. 5: Embedded sensor

Structural integrity and measurement performance

When the strain gage is integrated, it is cemented to the material via the matrix resin. The point of the pin concept is that it is then not necessary to also embed the measuring leads in the fiber composite.

The measurement performance of integrated strain gages has been verified in countless investigations. Results show that the high level of measurement accuracy that you get from strain gages is retained in full by this integration concept. Secondary, damage analysis investigations indicate that the strain gage is sufficiently sensitive to detect when there are cracks in the resin and delaminations in the fiber composite component.

Application potential

The high strain capability of fiber composites is a problem for the metal strain gage measuring grid and causes premature failure, especially when structures are stressed dynamically, with high numbers of load cycles.

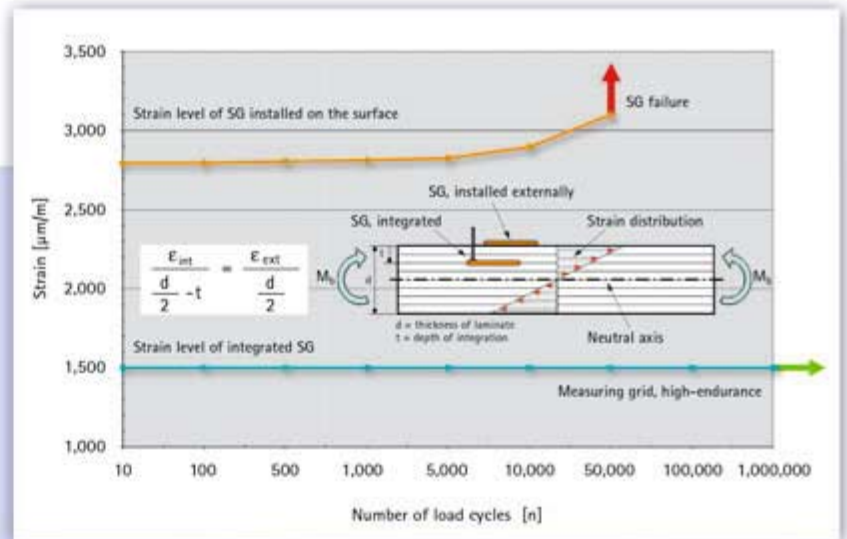


Fig. 6: Improved stability against alternating load when highly strained

For integration...

...in components under bending stress, the level of strain can be adapted to the endurance strength range of the measuring grid by the integration depth. The picture (diagram) shows the vibration endurance performance of strain gages both applied outside and integrated onto or into carbon fiber reinforced plastic (CFRP). This means that the integration makes the strain gage suitable for load monitoring for fiber composite components.

The new possible measuring point positions are of particular interest. Strain gages can be applied during manufacture to places that are later no longer accessible. This integration makes it possible, for example, to take measurements on complex sandwich constructions or structures with hollow spaces.

There are some totally new aspects to consider when monitoring the flow of force between the joints of structural bonds, such as are increasingly being seen in modern lightweight structures. Integrated strain gages could be used, for example, to monitor cemented repair points.

There are also new application possibilities for fluidic measurement tasks. By bringing out the pins on the opposite side to the flow, measurements can be taken without interfering with the motion of the fluid (see Fig. 1). ■

Balancing Wizard

Balancing software based on Spider8 and catman® for balancing machines

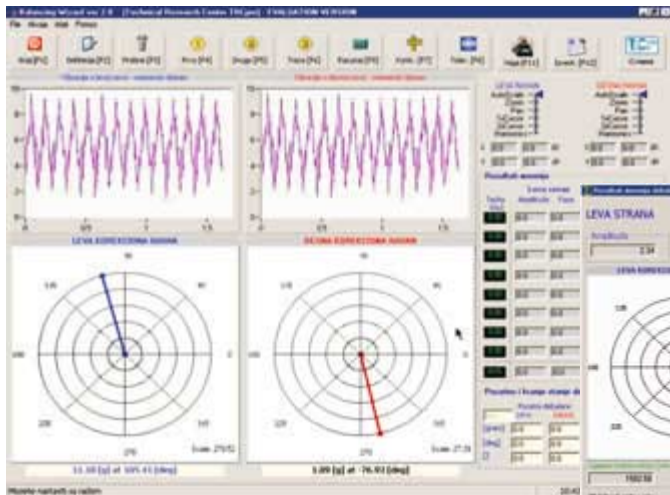


Fig. 1: Balancing Wizard, main user interface



Fig. 2: Repeatability and deviation analysis



Fig. 3: Balancing machine after conversion

As well as its other software packages based on catman® ActiveX and VB6, TRCpro has developed the Software Balancing Wizard for balancing rigid rotors. It works in combination with the HBM amplifier Spider8 and can be used for balancing machines with both rigid and soft suspensions.

Balancing Wizard...

...was developed in MS Visual Basic 6 with ActiveX technology for linking to catman®. catman® acts as an ActiveX server for communication with Spider8 (catman®.I/O interface) and for storing measured values (catman®.DB).

The main user interface...

...(Fig. 1) shows the measurement signal to the machine operator (in rigid machines, inertial force; in soft machines, vibration) in both planes, in the time domain and in the form of a polar diagram. The rigid suspension, where balancing is performed in a single run, is suitable for all types of rotor. The geometry of each rotor is written to the internal rotor database, from where it can be retrieved when required.

With regard to data acquisition and analysis in rotor balancing, it is extremely important to obtain stable amplitude and phase readings at 1X (rotor speed). So the Balancing Wizard uses TRCpro's numerical algorithm for calculating amplitudes and phases. It is absolutely

essential that the results are repeatable. So after each run and before accepting the measurement results, the measured unbalance vectors are represented graphically and the statistical measurement error is calculated (Fig. 2).

As Spider8 is a universal amplifier, a scale for the test and counterbalance weights is part of the measurement chain. Balancing machines measure the speed of the rotor with an absolute value encoder. This allows online phase measurements when attaching test weights and counterbalance weights.

After each balancing process, an electronic report is generated. This can be printed immediately or later, after the process has been retrieved from an internal database.

Use in balancing machines

The Balancing Wizard is used both in soft and hard balancing machines. The same software is installed in each case and is then adapted to meet the needs of the particular customer. Figure 3 shows a balancing machine with rigid suspension. ■

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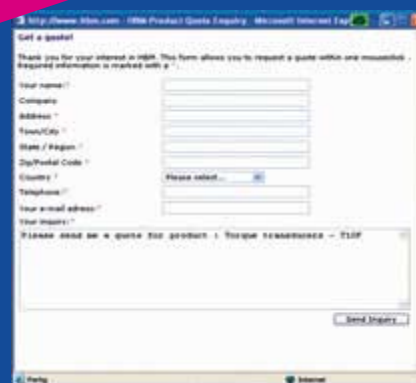
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