

Engineered Solutions | Customer-Specific Measuring Technology

As modern production techniques develop, bringing with them growing demands in terms of flexibility and quality, conventional measuring technology faces new challenges. With Engineered Solutions, Mahr can offer you custom-made solutions that take into account specific environmental conditions and requirements relating to handling, reliability and speed. Measuring solutions that are as individual as your measuring task: for us your requirements are the benchmark.

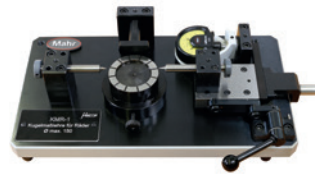
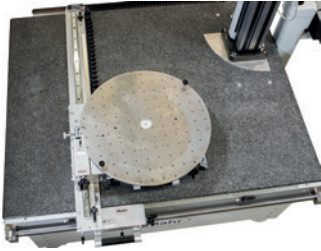


Engineered Solutions. When standardized Solutions are not enough

Individual Solutions according to Customer Requirements

Focusing on modern manufacturing requirements

In many industries, quality control increasingly takes place within the production environment itself, to enable the production process to be controlled and adjusted in an optimal manner. This is giving rise to new, specific demands in measuring technology: challenging environmental conditions, higher speed and simple controls are increasingly relevant. In spite of all this, measuring results still have to be solid and reliable. The measuring machines from Mahr Engineered Solutions are designed precisely with this in mind.



Engineered Solutions

Customized Measuring Technology

DESCRIPTION

Mahr – a full-service Provider for your Measuring System

As your partner from the initial inquiry to commissioning at your site, Engineered Solutions offers a complete solution:

- Project management
- Design and development
- Commissioning
- Instruction and training at the customer's site
- Support from the start of the project right up to the turnkey handover
- After sales service

Experience and international Presence

Many years of experience with a large range of different system solutions makes Engineered Solutions your competent partner for individual measurement tasks worldwide. Together with the companies belonging to the Mahr Group, Mahr MWF GmbH (Großostheim / Germany), SMPR (Grand Couronne / France) and Mahr Inc. (Providence / USA), the team from Engineered Solutions in Goettingen (Germany) offers concentrated expertise. Mahr is also represented in Asia when it comes to customer-specific measuring stations: In Suzhou, China, Mahr has its own office from which customers are comprehensively supported.

The Right Solution for your Application

With Engineered Solutions, Mahr combines the know-how of various product groups and designs customized measuring stations worldwide. These range from manually operated devices to fully automated, robot-loaded solutions for inline measurements.

Individual Clamping Concepts

In the simplest case, these can be individual solutions that are equipped with specially adapted fixtures to securely fix the workpiece with its partially complex geometry. With simple means, the work for measurement technicians and machine operators in production is made simpler and more efficient.

Manual and Semi-Automated Solutions

On the way towards automation, Mahr offers various configurations of manual axes (linear and rotary axes) that can also be integrated into existing measuring stations. This makes it possible to further simplify the often very complex measuring sequences of a standardized measuring station.

With semi-automated measuring stations, measuring processes can be accelerated and measurement reliability increased. These measuring station concepts are characterized by an automated measuring sequence that guarantees reproducible and comparable measurement series. Setting up the measuring station for the respective measurement, however, is still carried out manually by the operator.

CNC Measuring Machines – Fully Automated and Reliable

Our fully automated customer solutions recognize and measure workpieces automatically, with high precision quickly, and therefore highly productively. CNC measuring systems based on the MarSurf LD 130, for example, can check the roughness and contour of small workpieces with a resolution of 0.8 nm – valve needles, nozzle bodies or spindle measurements of steering nuts. At the touch of a button, measurements will be performed fully automated and independent of the operator, resulting in highly reliable measurement results – even when comparing production sites worldwide.



For more information, please visit our website: www.mahr.com

Engineered Solutions

Customized Measuring Technology

Inline Solutions for the Modern Factory

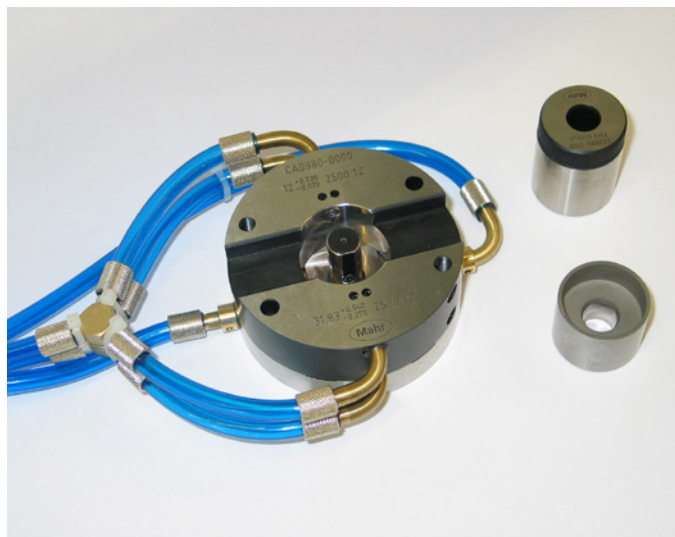
Engineered Solutions also offers production-integrated solutions that can independently capture the relevant measurement data to monitor production machines. According to customer requirements, the measuring devices can be loaded by robots, measure automatically, intervene as required and the measurement results can be cross-linked – for an intelligent production.

Fully automatic measuring rooms with robot loading guarantee an automatic and comprehensive quality inspection 24 hours a day without operator influence. Rejects are minimized, tool wear is detected immediately and costs are saved.



Non-Contact Measurements of Diameters and Lengths Using Air Pressure

Pneumatic metrology records dimensional deviations quickly and accurately. It has proven itself for years in industrial production and in the measuring room. Engineered Solutions offers pneumatic metrology from simple nozzle mandrel to highly complex pneumatic measuring devices, which is characterized by its robust functionality and high accuracy – down to 0.5 µm measurement accuracy.



Measuring Devices – Manual or Integrated in Production

Mahr GmbH and SMPR stand for the development, manufacturing and sale of high-precision special solutions for measuring and testing equipment, special machines and automation technology especially for the automotive industry. The portfolio includes standardized ball gages for gears and shafts, concentricity and axial run-out devices to carry out dimensional testing of workpieces directly in the production environment. This allows rejected parts to be identified more quickly and an immediate reaction to be initiated. The flexible design of the measuring device allows a quick changeover for other workpiece types (different diameters).

In addition to the standardized solutions, Engineered Solutions offers individual solutions adapted to your specific measuring problem in the field of measuring devices: from simple plug gages, to handheld measuring tools in special design, gages and handheld measuring devices, SPC testing devices up to fully automatic measuring machines for 100% testing.

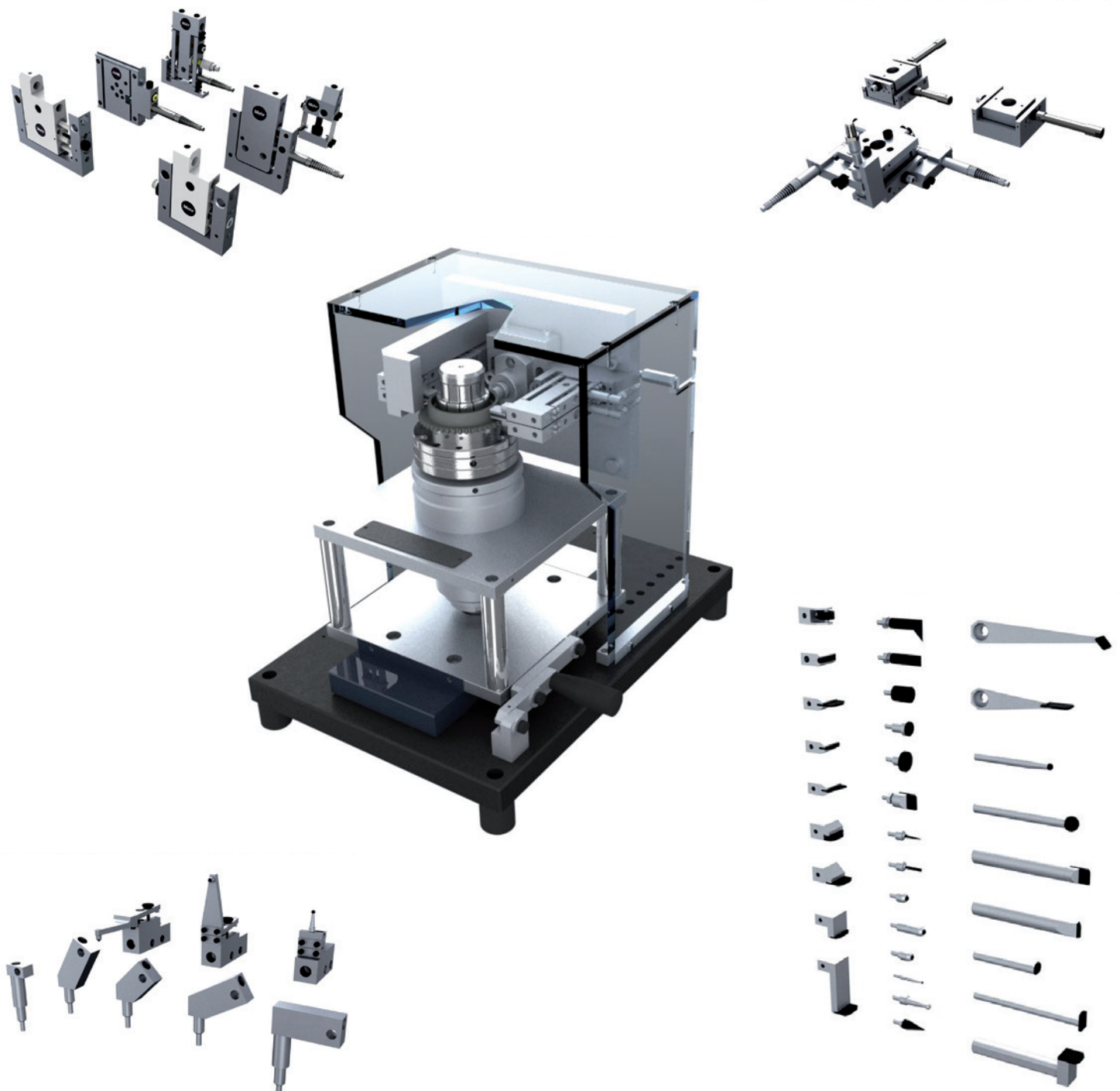
Are you also interested in implementing an intelligent production? Don't hesitate to contact us. Engineered Solutions will be happy to advise you on the way to an individual complete solution that fits your requirements.



For more information, please visit our website: www.mahr.com

Engineered Solutions. Customized Measuring Devices

Millimar standard elements can be used for the flexible design and cost-effective realization of multi-gage measuring devices for a wide range of workpieces, e.g. rotationally symmetrical and non-rotationally symmetrical parts. Rotationally symmetrical workpieces can be mounted between centering tips or on prismatic supports, whereas non-rotationally symmetrical workpieces require a special holder. The extensive range of standard elements includes, for example, vertical and horizontal measuring stands, holders, coordinate measuring tables, block elements, spring parallelograms, swivel elements and a range of measuring anvils.



Engineered Solutions MarSolution

Standardized Measuring Devices

DESCRIPTION

Mahr's "MarSolution" product group offers special customized solutions in dimensional measuring technology – semi and fully automatic measuring systems that work directly in production. Mahr uses its tried and tested standard components (Millimar measuring interface, probes and standard elements) to provide reliable and accurate measuring technology. Always the right solution for your task. Mahr offers solutions for various sectors and industries.

Vertical Measuring Device with Pivoting Workpiece Holder Between Centers

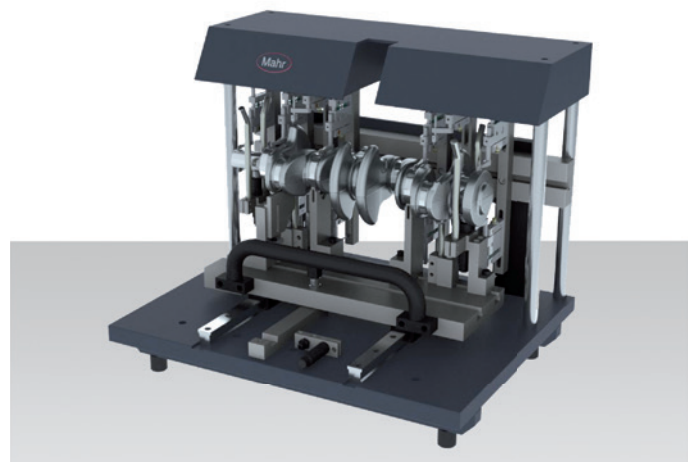
- These measuring devices allow inspection of diameter, length, and radial and axial runout for rotationally symmetrical parts.
- Available with manual or automatic swivel workpiece holder between centers.
- Motorized rotation also allows the option of dynamic workpiece measurement.

Measuring Device with Rotary Table

- Measuring devices with rotary table allow combined external and internal measurements and automatic radial and axial runout testing.
- This measuring device can also be motorized to enable dynamic measurements.

Horizontal Measuring Device

- Workpiece holder on V-blocks or between centers, including workpiece loading table.
- The horizontal measuring devices allow workpieces to be held on V-blocks or between centers. This system is particularly suitable for heavy workpieces.
- The workpiece can be inserted in the workpiece holder outside of the actual measuring station.



For more information, please visit our website: www.mahr.com

Engineered Solutions MarSolution

Measuring Devices based on Millimar Standard Elements

DESCRIPTION

Versatile

- The versatility of the Millimar standard elements means that the right solution can be provided, whatever the measurement task at hand.
- Whether outer, inner or length measurements, the Millimar standard elements can be adapted to the most diverse test requirements, even with difficult to reach workpiece geometries.
- Due to the compact design of the anvils, a large number of measuring points can be inspected within a small area of the testpiece.
- The pneumatic lifting mechanisms integrated in the measuring elements simplify the job of moving the testpiece into the measuring position and reduce wear to the measuring anvils.

Flexible

- The modular concept using Millimar standard elements throughout the whole system and a generous amount of travel in the measuring anvils (up to 20 mm), allow a high degree of flexibility in terms of the variety of testpieces that can be accommodated.

Precise

- The Millimar standard elements are specially designed for use in the workshop and are manufactured using a rigorous process. This guarantees that the measuring devices give stable and reliable measurements.
- For example, using measuring anvils fitted with two ball-bearing guides for supporting the moving part, it is possible to achieve measurement repeatability in the μm range, if this is required due to the tolerances of the feature being measured.

Reliable

- All components are long-lasting and low-maintenance due to the use of rust-proof materials and the selection of appropriate heat treatments. The use of lifting mechanisms to minimize the effects of friction on the measuring anvils when the workpiece is inserted, further reduces component wear.

Economical

- Our systems can either be constructed by the customer from standard catalog elements, or alternatively, we can provide turn-key solutions. Whichever option you choose, you can be sure that you are purchasing a system that is tailored to your specific requirements on the most favorable of terms.
- Below are just a few examples of the many factors that contribute to the cost effectiveness of the Millimar standard elements:
 - Standard elements can be reused: Once manufacture of a particular type of workpiece has ceased, all standard elements used in the test equipment can be reused to create new test equipment for a different type of workpiece
 - A choice of different mechanisms for guiding the moving part of the measuring anvils according to the accuracy requirements of the measuring task (optimum value for money)
 - Reduction in development and implementation time
 - Availability of devices: Our standard elements are manufactured under standard production conditions and are always available off the shelf and ready to use



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Engineered Solutions MarSolution

Customer-specific Measuring Devices

DESCRIPTION

RPM series - commutator shaft measuring device

- The RPM measuring device is a simple and accurate solution for measuring diameters, roundness, radial run-out and bar-to-bar height, for example, of the commutator shaft or precision shaft in the electric motor.
- The RPM offers the following benefits:
 - Simple operation for efficient measuring
 - Fast measurements
 - Powerful functional analysis using the D1200X software



TC series - housing measuring device

- These measuring devices can be used to measure various types of housing, for example turbochargers, pumps, electric motors, housing. The measuring device is available as a standalone solution for close-to-production use or as an integrated version for 100% production control.



CR 240A: Automated measuring devices for connecting rods

- Simple measuring devices can be used to control various work sequences. Automatic solutions can perform all the measuring tasks for the final inspection.
- For example, the CR 240A measuring station can measure the usual dimensional features on a connecting rod and also offers the following functions:
 - Interchangeable measuring heads with pneumatic plug gages and Millimar P2004 inductive probe
 - Laser engraving of connecting rods, the complete housing protects against laser beams
 - Camera for check reading
 - Precise weighing system
 - D1200X measuring software with clear and simple user guide
 - Measurement results can be evaluated online to allow tool adjustments, statistical analysis, etc.



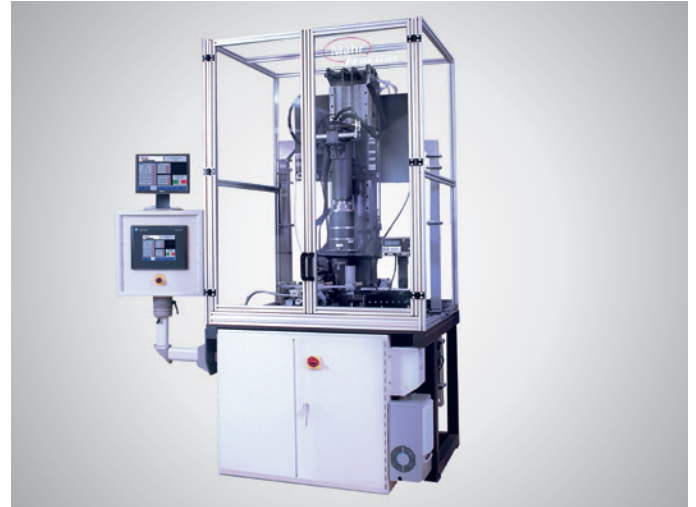
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Engineered Solutions MarSolution

Customer-specific Measuring Devices

Dynamic measurements of the inner diameter of cylinder bores and wall thicknesses

- The cylinder liner measuring machine is a standalone version for automatically measuring the inner diameter of bores and the wall thickness of a diesel cylinder liner.
- A handling device allows fully automatic loading and unloading. The measuring machine is directly integrated in the production line. The cycle time for a complete measurement is less than 2 seconds.
- The measuring instrument consists of three stations:
 - The first station is the charging station where the temperature of the socket is measured.
 - At the second station the inner diameter of the bore is measured using a pneumatic plug gage. The second station also contains the diameter setting master for the pneumatic plug gage; the plug gage is automatically calibrated at regular intervals. This process guarantees maximum measuring accuracy and stability of the measuring results, even in the harshest of manufacturing environments.
 - At the third station a tactile measurement determines the wall thickness of the socket. The probes are automatically positioned at the relevant measuring points after loading. The wall thickness measurement takes just seconds. The probes are parked before the socket is removed from the measuring device to minimize wear to the contacting measuring elements.



Dynamic measuring of deformations in half-bearings

- Type 2152447 is an automatic standalone measuring instrument for measuring dimensional changes caused by pressure to half-bearings (e.g. for connecting rods).
- The half-bearing is automatically conveyed into the measuring machine and inserted into the relevant test chamber (semicircular holder), secured at one side, and a defined pressure is applied to the other free side (e.g. according to the operating mode of the subsequent motor assembly). A tactile probe system simultaneously measures the dimensional change circumferential to the half-bearing. After the measurement, the half-bearing is removed by the handling device.
- To ensure measuring accuracy throughout the process, the measuring device is automatically calibrated at regular intervals using a setting master.
- The entire process is computer-controlled with user-definable force parameters. Measuring records and databases can be created.



Measuring device for checking diameters on large rings

- Large rings (e.g. bearing rings) are subject to the most stringent tolerances. Checking these requires flexible measuring equipment that can cover a range of inner and outer diameters.
- The measuring device for large rings means that inner and outer diameters can be measured with just one device.
- It can measure inner diameters from 63.5 mm up to maximum 825 mm and outer diameters from 76.2 mm up to maximum 831 mm.



For more information, please visit our website: www.mahr.com

Mahr | Services

In addition to its many branches and agencies, Mahr also has a worldwide service network. To find the appropriate contact, visit the Mahr's website at www.mahr.com or refer to the back page of this catalog. Besides product related services, additional services are also available from various Mahr sites, reflecting the available experience and expertise in each case. We are happy to help with all your metrology questions, no matter how specific.



Mahr Academy



The **Mahr Academy** offers application specific product training courses and basic technical seminars. These programs can be held at fixed venues on predetermined dates, or arranged internally within your company. The subjects offered are relevant to all employees who work either directly or indirectly on production tasks. The courses are beneficial to new employees on the shop floor, in the inspection room and in the design department. They are equally valuable to employees who are looking to expand their knowledge.

MahrExpert seminars stand for:

- Trainers with practical experience
- Training concepts based on proven educational techniques
- Extensive, always up-to-date training documents
- Expert advice on all questions relating to the improved quality of technical products

We offer the following seminars:

- Product training at three levels (easy, advanced, professional)
- Basic training and seminars (on length metrology, surface metrology, form measurement, gear and coordinate metrology, AUKOM 1 Basic)
- Professional training to become an authorized measuring instrument representative and gage monitoring, measurement uncertainty, measuring instrument capability and process capability (organized and run in cooperation with the Technical Academy Wuppertal TAW/AfQ)

For more information, please visit our website: www.mahr.com

Application Advice



Do you need help with designing solutions for metrological tasks? Do you need to create measuring programs for complex workpieces? Do your users need some basic product training?

Take advantage of the services offered by our application engineering specialists, with their extensive knowledge and many years of experience in dimensional metrology.

The terms **Precimar**, **MarForm**, **MarSurf**, **Millimar** and **MarShaft** represent core skills in the fields of length metrology, form, contour and roughness metrology and shaft metrology. Our application engineering and technical service specialists also offer:

- Sample measurements
- Help with commissioning equipment
- Program creation
- Product training
- Measuring equipment capability testing
- User training

Technical Service



Mahr quality guidelines set high standards in which **Mahr measuring instruments** are developed and manufactured, using the very latest technology available. This guarantees that consistently, all **Mahr measuring instruments** are of the highest quality.

To assure that your machine/measuring station receives the best possible care, Mahr operates an efficient worldwide service organization. The **Mahr Service Organization**, run by trained specialists, is equipped with cutting edge tools and instruments, many of which have been specially developed, and stocks an extensive range of spare parts.

Mahr works according to progressive, tried-and-tested guidelines and offers a range of complementary services. To ensure the best results from your **Mahr measuring equipment** at all times, we recommend you use only the services offered by the **Mahr Service Organization**. This is the only way of ensuring that only **original Mahr spare parts** and servicing procedures are used, reflecting the stringent **Mahr quality standard**.

Visit Mahr's website at **www.mahr.com** to find your nearest **Mahr Service Center**.



For more information, please visit our website: www.mahr.com

Maintenance for Measuring Systems



The **operational availability** of your measuring equipment is very important. To ensure smooth operation over many years, Mahr recommends your equipment be **regularly inspected**. Regular inspection of your measuring equipment results in **considerable advantages**:

- Unexpected equipment failures are prevented
- Wear parts are exchanged in reasonable time and within the framework of the agreed service intervals
- Keeps your equipment running at peak performance, including incorporation of future product improvements
- Provides the best conditions for your quality assurance system
- With a service agreement you minimize operation costs and optimally retain the value of your machine. Preventative maintenance can be planned and leads to an undisturbed operation of production
- Maximal operational readiness by the setting of all mechanisms, pneumatic and electronic functions as well as the examination of software used
- Complete, intensive examination is conducted only by Mahr specialists
- Calibration certificates are issued
- Early detection of trouble due to wear leads to a decrease in idle time and ensuing costs

Calibration Services Measuring Systems

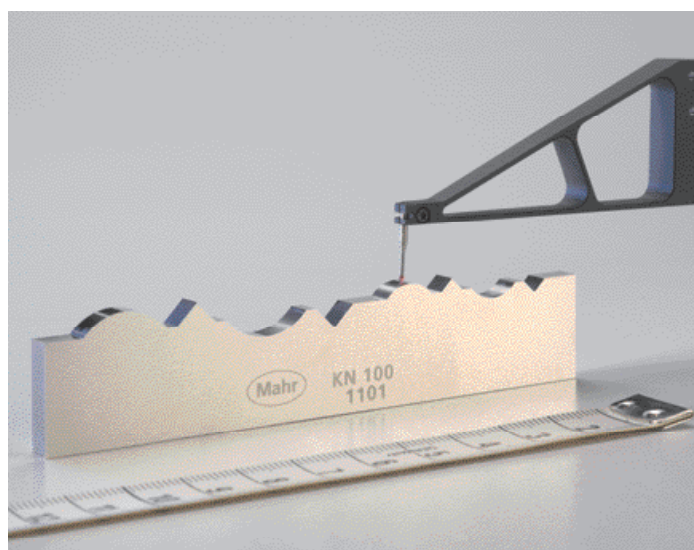


Mahr runs **laboratories** for **various instruments** and **instrument sizes** in the field of **length metrology**. These ensure high dimensional accuracy and **very low measurement uncertainties**. In principle, **all measuring equipment** can be calibrated. We provide the following core services::

- Gage calibration (length) *
- Parallel gage blocks *
- Setting rings / setting plug gages / setting disks / pin gages *
- Geometry and roughness standards *
- Optical flats
- Inductive probes with / without display unit *
- Thread plug gages / thread ring gages *
- Incremental probes *
- Vertical length measuring units / height measuring units *
- Calipers / outside micrometers *
- Dial gages / dial comparators / dial test indicators *
- Setting standards *
- Magnification standards (flicks) *
- Contour standards *
- Stylus instruments / roughness measuring units *
- Testing cylinders / cylinder squares *
- Roundness standards *
- Length measuring units *
- Multi-shaft standards *
- Dial comparator and dial gage testers *
- Super fine roughness standards *
- Custom objects on request

* Calibrations with officially recognized calibration certificates that comply with national and international standards, e.g., DAkkS/DKD (German Calibration Service).

Calibration Services Measuring Systems

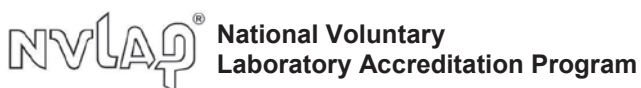


DAKkS/DKD (German Calibration Service) is a signatory of the multilateral agreement by the European cooperation for Accreditation (**EA**) and the International Laboratory Accreditation Cooperation (**ILAC**) concerning the mutual recognition of calibration certificates.

Mahr Inc. offers an inspection and recalibration program for dimensional standards, and calibration and certification services for a wide range of gages. ISO/IEC 17025 Accreditation defines general requirements for the competence of testing and calibration laboratories.

Your **Mahr contact** will provide you with information on national and international recognition, e.g., as part of the multilateral agreements

www.european-accreditation.org and www.ilac.org



CALIBRATION LABORATORIES

NVLAP LAB CODE 200605-0

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005



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