

MAHR | AUTOMOTIVE INDUSTRY



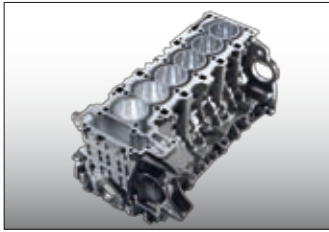
METROLOGY FOR ENGINE COMPONENTS

$$-0+$$

Mahr

EXACTLY

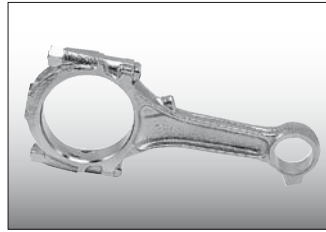
CYLINDER BLOCK



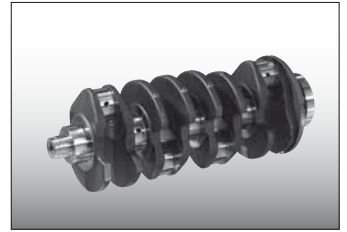
PISTON



CONNECTING ROD



CRANKSHAFT



MORE ABOUT MAHR: THE COMPETENCE

► | **Mahr knows the metrology requirements for combustion engines.** Combustion engines are today, and will remain so in the foreseeable future, the principal power source for motor vehicles. Ongoing developments in the materials for individual components as well as the continual improvement in production processes have led to engines that are 20% lighter than those produced in the 1980's but with significantly longer service lives. The maintenance intervals have increased by a factor of 2 to 3 during this same period. Improvements in injection technology as well as optimization of the combustion chamber have led to an improvement in performance while reducing fuel consumption.

The requirements and challenges for metrology have grown right along with all these new developments.

When you make the choice for Mahr metrology you can rest assured that you are on the road to success with **one** partner you can count on.

Decades of experience are reflected in the instruments and can be seen in the excellent metrology solutions and developments. Many set the standard for world class excellence. Mahr stands for quality and innovation.

From the caliper to the coordinate measuring machine you get everything from one single partner for all products and services.

Mahr delivers your metrology solutions for engine block, cylinder head, crankshaft, camshaft, connecting rod, piston, valve, etc. with products from length metrology, form metrology, surface and contour metrology, shaft metrology, and gear metrology.



Further information is available on our Website:

www.mahr.com

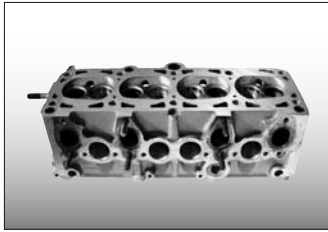
WebCode 331

The Mahr WebCode enables you to directly access the corresponding contents of our web portal.

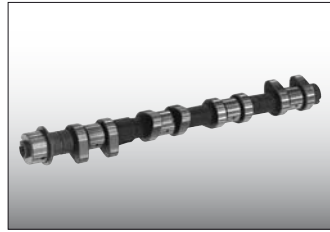
Simply visit www.mahr.com and enter the desired webcode in the left column.



CYLINDER HEAD



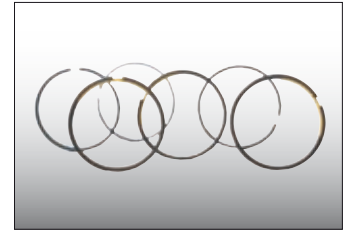
CAMSHAFT



VALVE



PISTON RING



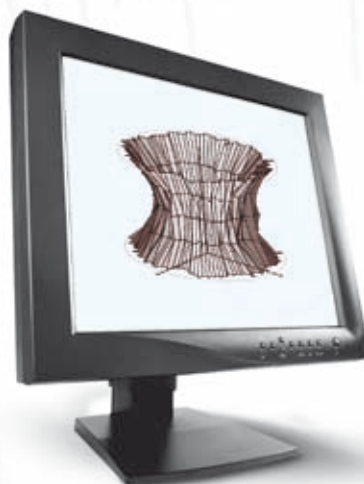
MORE ABOUT MAHR: THE FUTURE

► | **Always one step ahead with Mahr.** Technology development in combustion engines places ever increasing demands on the quality of the engine components. Better fuel mileage, lower emissions and reduced noise are only a few of the required characteristics. These developments in engine technology create the need to develop suitable metrology solutions to meet the requirements of producing these components.

Mahr has been meeting these challenges head-on for decades. The products have been recognized with many patents and awards. The continuously increasing population of our machines on the market also demonstrates the confidence of our customers. Mahr has kept up with the trend of metrology moving from the laboratory onto the shop floor with many innovative solutions. CNC-based contour and surface measuring stations are used by many well-known customers on the shop floor. Robust and high precision are not contradictions but rather demands of the marketplace. Mahr form measuring systems already set the world class reference with tactile sensors. Now with the use of optical sensors, these systems, which already had a resolution in the nanometer range, have been further optimized.

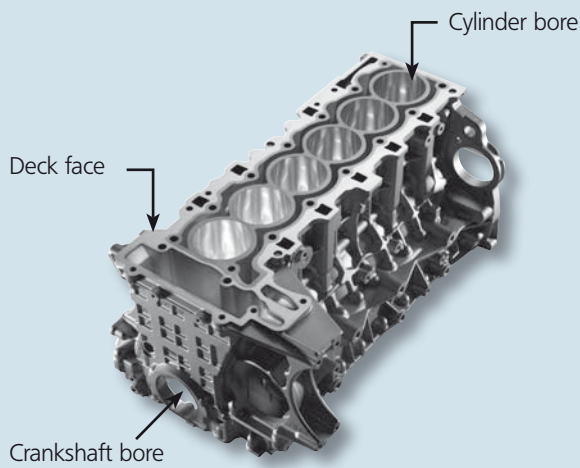
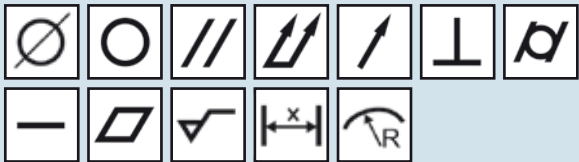
Mahr invests about 7% of sales in research and development. New technologies and trends are constantly becoming part of new products. Optical sensor systems and the wireless connections (Bluetooth) are current examples of this.

Choose the innovative and confident partner; choose Mahr Metrology to measure your engine parts.



Measuring task

Cylinder crankcase



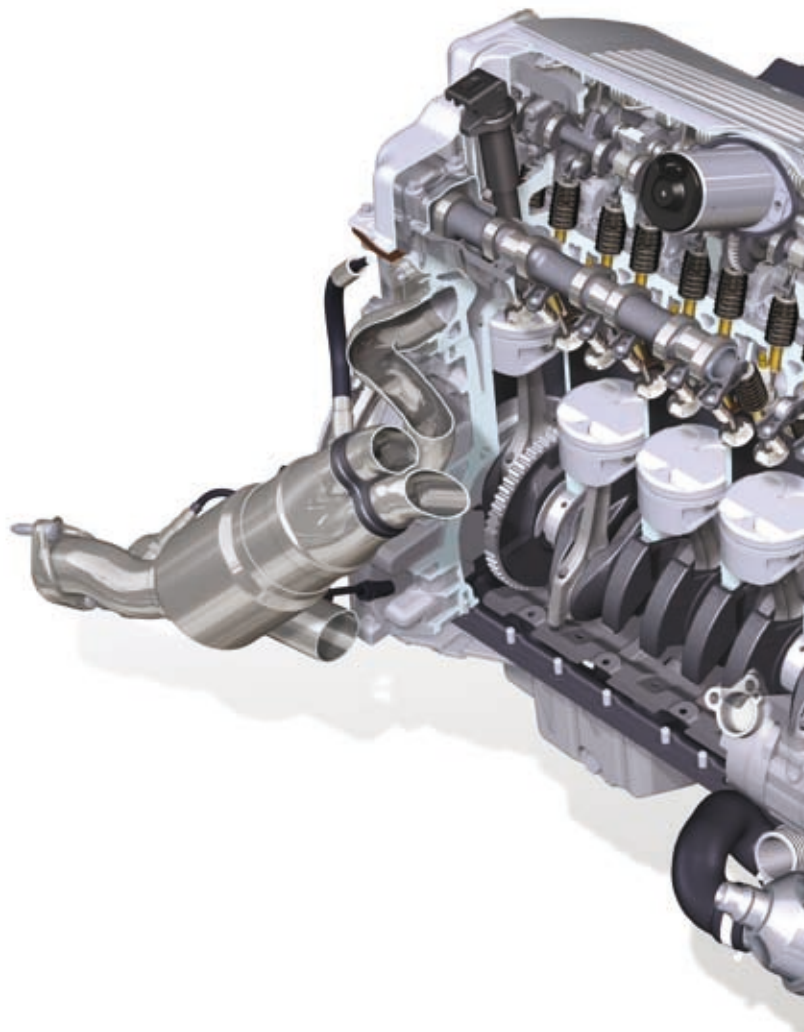
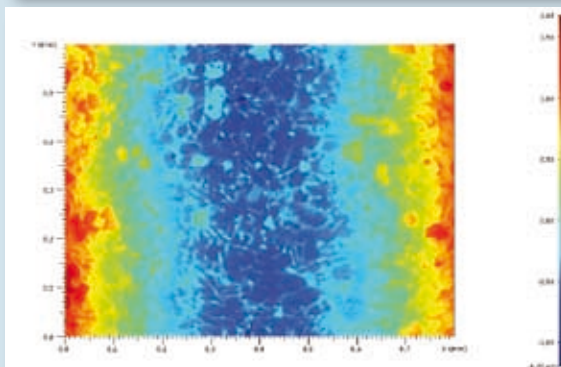
Measuring tasks on engine blocks

This is the heart of the combustion engine drivetrain. Optimal performance of the piston in the cylinder and the associated demands on the **dimensional accuracy, form and surface quality of the cylinder bore** are of critical importance in order to meet the steadily increasing demands on fuel consumption and emissions.

The quality of the **dimensional characteristics, form, and surface quality** in the crankshaft bore are essential contributors to the performance of the crankshaft at dynamic load in engine speeds of 0 to about 5000 rpm.

The **flatness and surface quality of the deck face** are further critical inspection characteristics.

Surface structure cylinder surface



Measuring tasks on cylinder heads

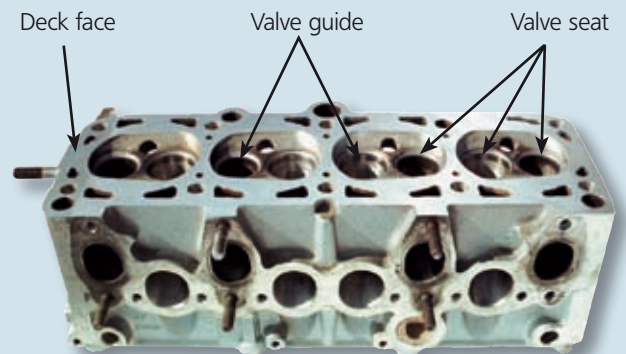
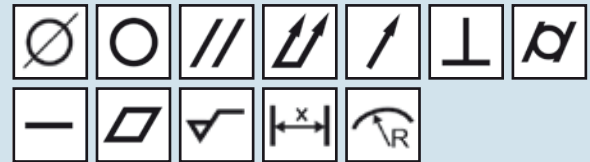
The valves need to be guided perfectly in the **valve guide bore**. **Diameter, roundness and surface condition** in master gage quality have to be assured.

The **contour, roundness and surface quality of the valve seat** guarantee the necessary sealing in the operation of the valve.

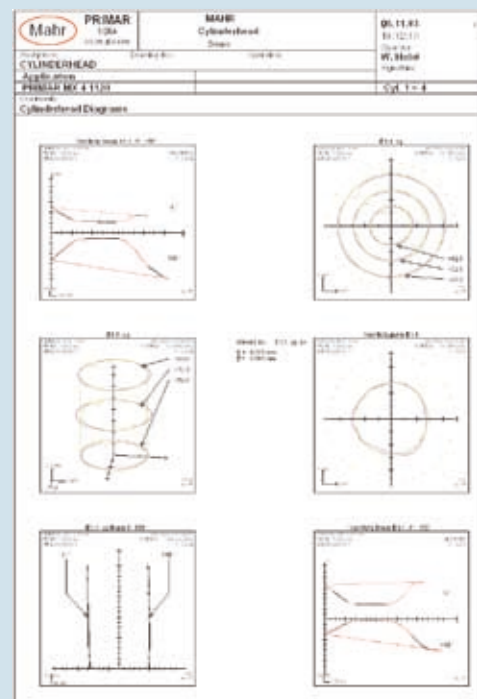
Similar to the **crankshaft bore**, the **dimensional characteristics, form, and surface quality** of the camshaft bore in the cylinder head need to be verified.

The **flatness and surface quality of the deck face** are further critical inspection characteristics.

Cylinder head

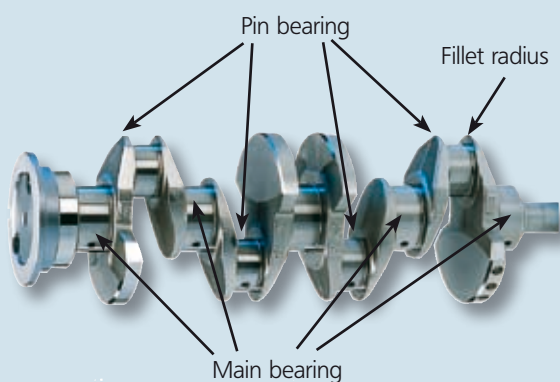
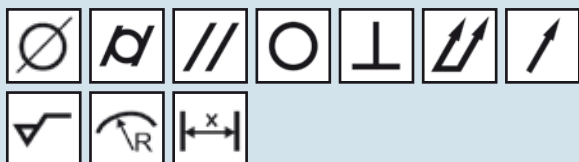


Cylinder form of valve seat



Measuring tasks

Crankshaft



Measuring tasks on crankshafts

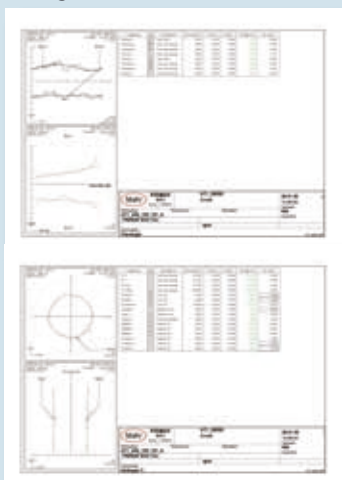
The most important element in the dynamic conversion of linear motion into rotary motion is the crankshaft. Because of high dynamic forces the accuracy of critical geometries such as keyways and counterweights must be checked.

Dimensional accuracy, form, location, and surface quality of the pin and main bearings are essential requirements.

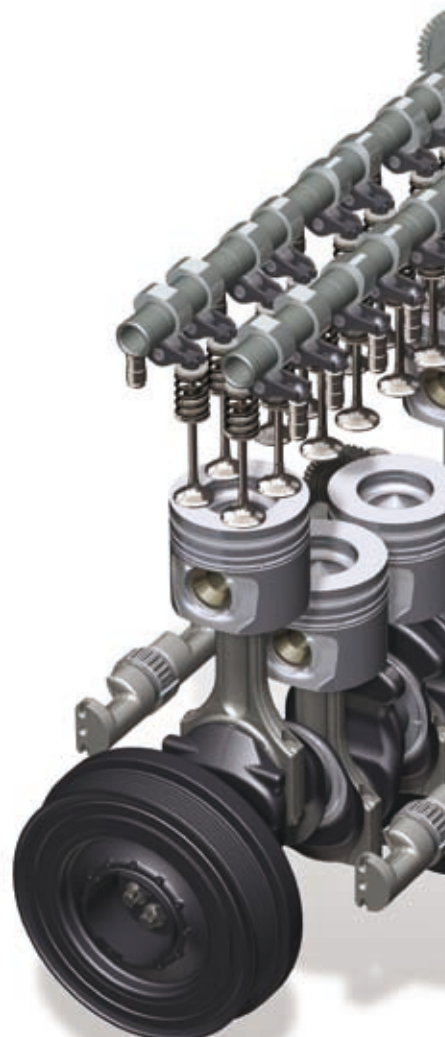
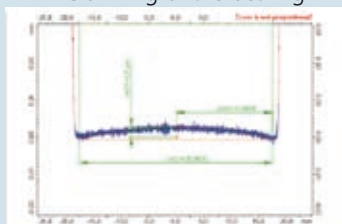
The **dimensional accuracy of the fillet radii** between the **thrust face and pin bearing** ensure operation without failure due to the high forces generated by the eccentric design. **Contour and surface quality** must be controlled.

Roundness and straightness of the main and pin bearings

Straightness and roundness record



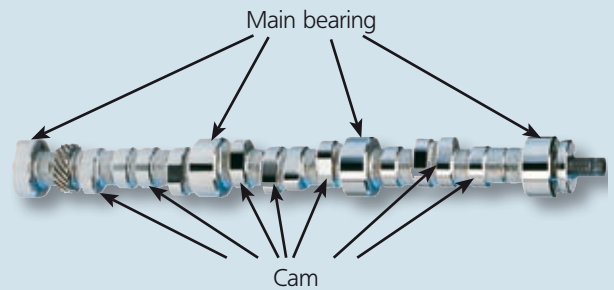
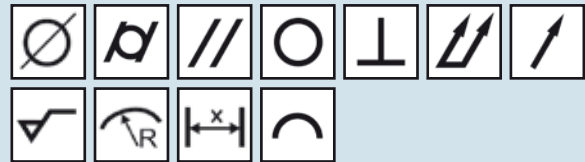
Crowning of the bearing



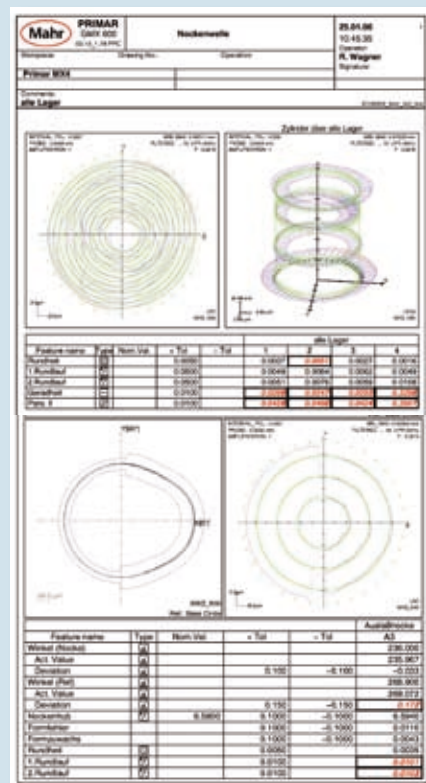
Measuring of the **gear geometry of the drive gear**



Camshaft

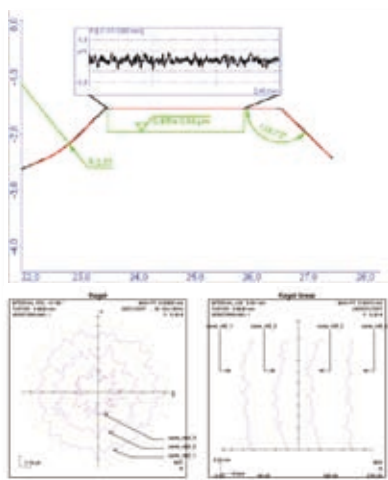
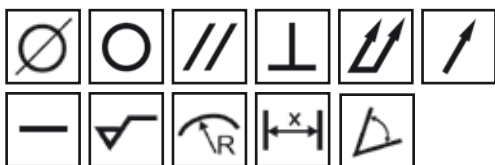


Camshaft form



Measuring tasks

Valve



The valve is inserted in the valve bore of the cylinder head. The stroke of the valve is controlled by the camshaft to control the timing of the inlet and outlet valves.

Valve head / seal face:

Roughness/contour Parameter Rz, Wt, Rk, Rpk, Rvk
Angle, fillet radius

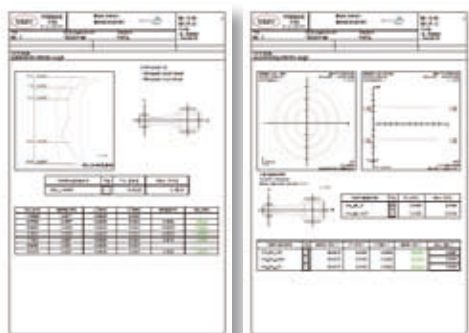
Shaft

Roughness Parameter Rz, Wt, Rk, Rpk, Rvk
Form Straightness, roundness, cylindrical form
Length Diameter

Valve seat

Roughness/contour Parameter: Pt, Rz
Apex angle, fillet radius
Form Roundness, radial run-out, angle, coaxiality, cone form

Connecting rod



The connecting rod is the mechanical linkage between the piston and the crankshaft. It transforms the linear motion of the piston into the rotational motion of the crankshaft.

The connecting rod undergoes enormous dynamic forces. The quality of the large and small "eyes" is of critical importance.

Important characteristics are: **diameter, eye-to-eye axis center distance, form and location of the bore as well as the surface finish of the bearing.** In some cases the thread geometry of the assembly of the end cap is verified as well.

Roughness/contour Parameter Rz, Wt, Rk, Rpk, Rvk
Thread geometry
Form Roundness, straightness, parallelism, perpendicularity, sector roundness, bend and twist
Length Diameter, axial center distance between bores

Measuring tasks

Piston

Several areas must be measured and several characteristics evaluated on the piston:

Skirt profile

Roughness/contour Parameter Rz, Wt, Rk, Rpk, Rvk
Combustion chamber, outline

Form Measurement of ovality
Measurement of meridian form

Ring groove

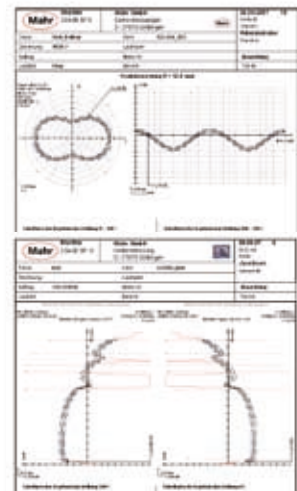
Roughness Parameter Rz, Ra, Rk, Rpk, Rvk

Form Angle to the profile and the reference point
Total angle of the upper and lower edge
Straightness of the groove edges

Wrist pin bore

Roughness Parameter Rz, Wt, Rk, Rpk, Rvk

Form Measurement of bore form (linear and radial)
Alignment / squareness



Piston ring

Piston rings are metallic gaskets which seal the combustion chamber from the crank case and support the heat conduction from the piston to the cylinder wall. They also regulate the oil consumption of the engine especially through the oil control ring.

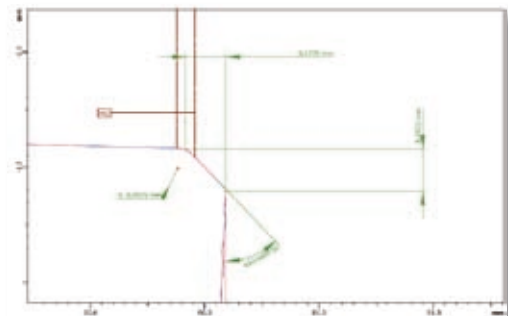
The piston rings are the contact elements between piston and cylinder. They are located in the ring groove.

The following features are measured on piston rings:

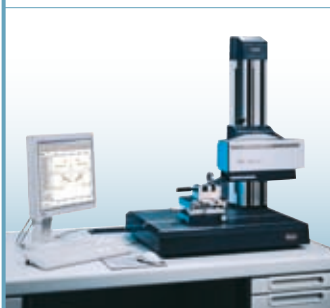
Roughness/contour Parameter Rz, Ra
Angle, radii, distances of the piston ring contour

Length Diameter, radial section thickness, axial height of the ring, groove width

Form Roundness



Mahr Metrology In Use



MarSurf XCR 20

The ideal possibility to combine contour and roughness, or use with mobile roughness devices, optimized for your application.

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WebCode 2564

MarForm MMQ 400

The newest generation of high-precision form measuring units. Generous measuring volume despite compact dimensions. For highest precision even in the production environment.

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WebCode 1258



Formtester MFK 500

Especially suited for checking motor blocks, cylinder heads, transmission cases, elements of hydraulics, crankshafts and camshafts.

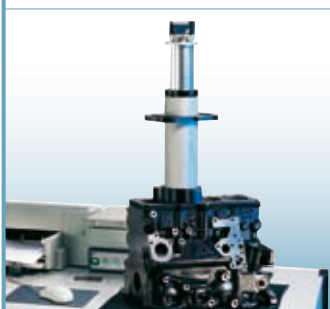
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MarShaft SCOPE

Optical shaft measuring unit

Flexible optical measuring unit to measure round and/or turned parts. Highest precision directly on the shop floor.

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MarSurf XR 20 with PMB-S

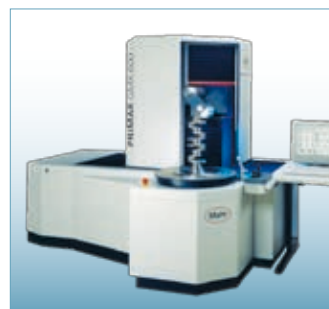
is the solution for fast and uncomplicated measurements of cylinder bores from 75 mm to 100 mm up to a depth of 200 mm.

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MarGear GMX 600

This measuring unit provides the perfect combination of gear measuring unit and formtester with perfect solutions for crankshafts and camshafts as well as connection rods.

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Hand tools, pneumatic metrology

Their easy handling makes them the most versatile devices for daily inspection use.

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Customer solutions

Measuring units for production metrology. Millimar length metrology provides reliable measuring devices in different grades of automation.

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WebCode 1576



Service

Machine training, Mahr application center, Mahr Academy

- Training, expert seminars and workshops
- Capability testing for new and demanding measuring tasks
- Creation of customer-specific measuring programs
- Measurement service in a fully air-conditioned environment with precision measuring room qualities.
- Extensive selection of current Mahr measuring machines available in our application center for your measuring task.

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Maintenance / calibration agreements and software maintenance

- Maximum operational readiness of your measuring station
- Early detection of trouble due to wear, therefore less down time and ensuing costs
- Continual improvement and upgrade of your measuring station due to software maintenance agreement

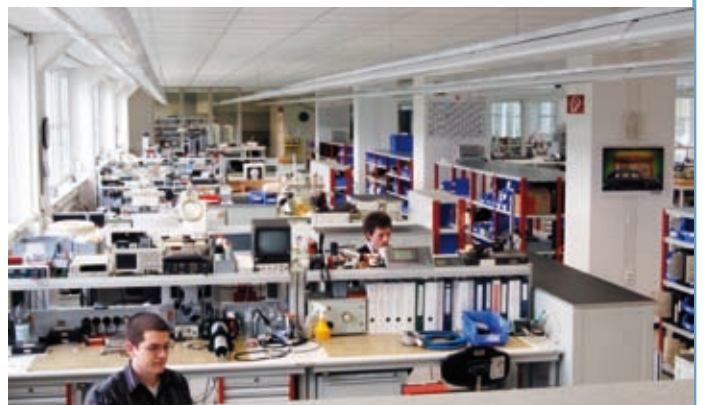
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- Only at Mahr do all OEM warranties remain.
- Special tools and diagnostic units ensure your equipments meets original specifications.
- Continual training and further education of Mahr technicians ensures the highest quality for your repairs

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Calibrations. The DKD laboratory at Mahr

- DKD and manufacturer calibrations from Mahr
- Mahr reference and working standards for surface, form and contour
- Calibration service as a measurement service
- Process monitoring close to the production site with calibrated standards
- High-precision standards and comparison specimens

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Mahr

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