JENOPTIK

FORMLINE.

Form Metrology

hommel
etamic

Flexible and efficient form measurement

We deliver solutions that help you optimize your manufacturing process regarding qualitative and economic objectives.

We, the Industrial Metrology Division of the Jenoptik Group, are one of the leading international specialists in high-precision, tactile and non-tactile production metrology.

Our services range from complete solutions for different measuring tasks such as the inspection of surface and form as well as determining dimensions, throughout every phase of the production process including final inspection or in the metrology lab.
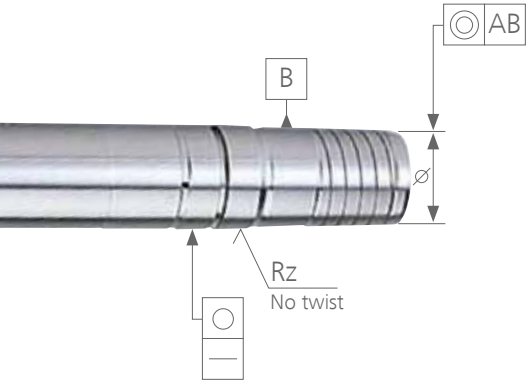
Our decades of experience in tactile, optical and pneumatic measurement combined with our global sales and service support network brings us close to you, our customers, enabling us to provide optimal support as a reliable partner.

Our team is looking forward to your inquiry!

Jenoptik – Sharing Excellence
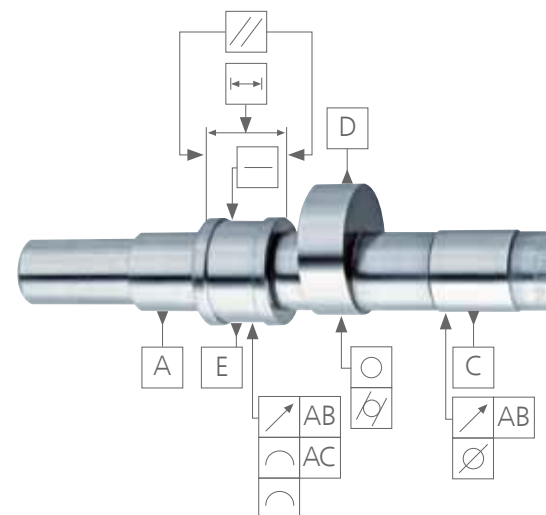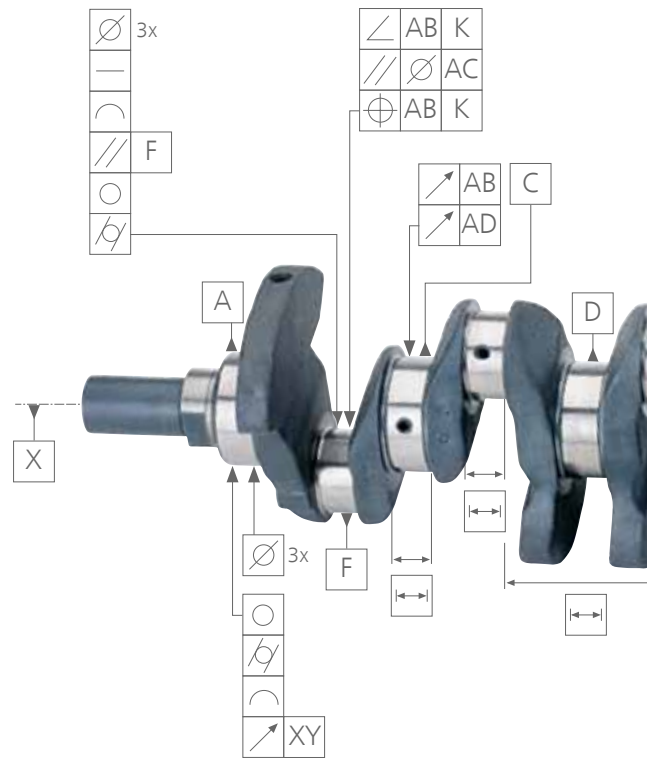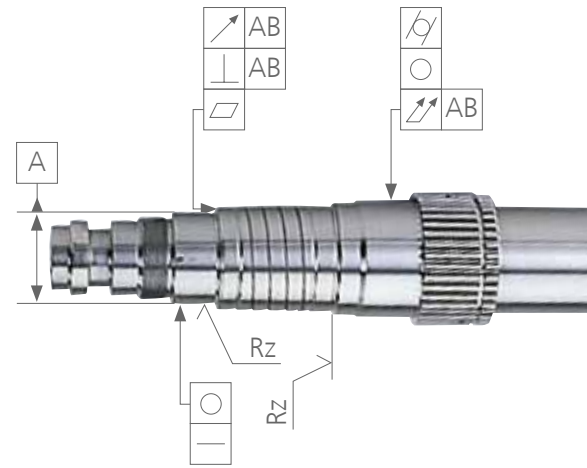
Measuring solutions for your applications

Measuring systems of our FORMLINE series offer you extensive evaluation possibilities for shaft type and cubic workpieces (depending on the system):

Form tolerances

- Straightness
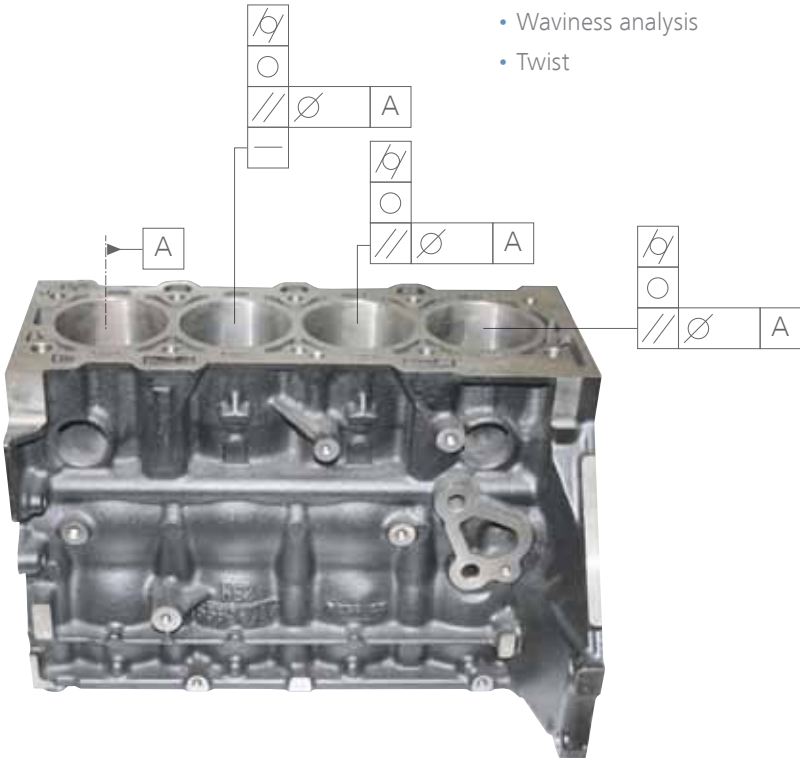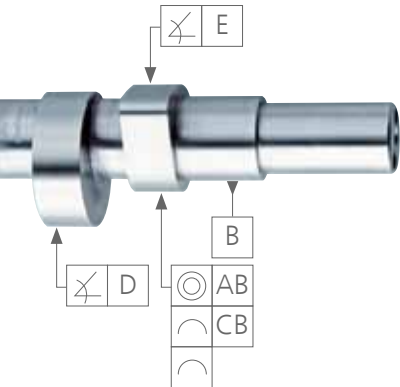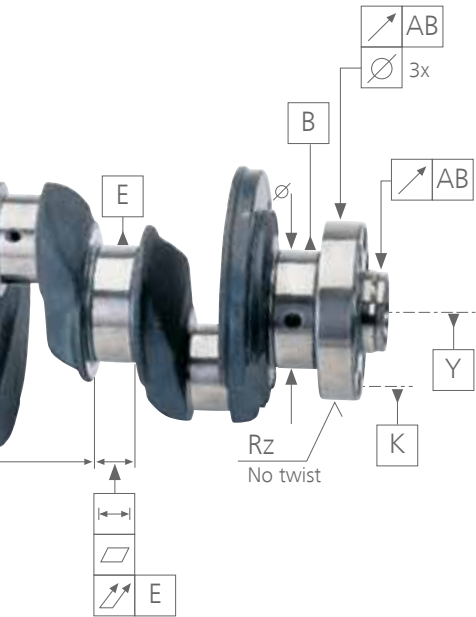- Roundness
- Flatness
- Cylindricity

Run-out tolerances

- Radial run-out
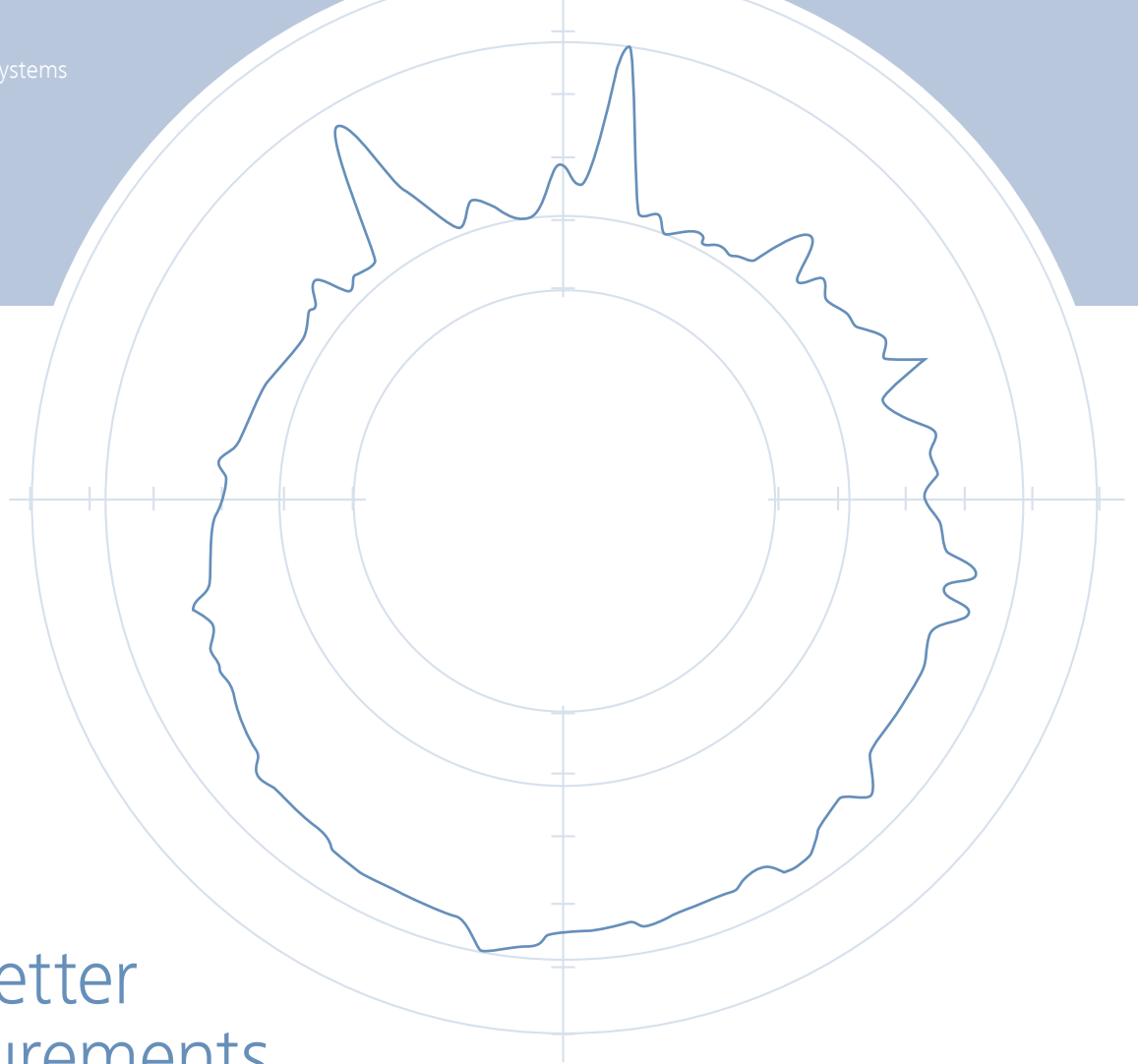- Axial run-out
- Total radial run-out
- Total axial run-out

Position tolerances

- Parallelism
- Perpendicularity
- Angularity
- Coaxiality, concentricity

Specific parameters

- Diameter
- Conicity
- Position deviation
- Length
- Stroke radius
- Crowning
- Angle deviation
- Waviness analysis
- Twist

Get better measurements

… with versatility

The modular design of our FORMLINE solutions guarantees maximum flexibility for a wide range of applications. Our product line includes compact roundness measuring devices, standard and custom CNC measuring systems for the determination of all form and positional tolerances as well as combined form and surface roughness measuring systems. You also get solutions for large, heavy and cubic work-pieces or specific crank shaft and cam shaft measure-ments or form measurement in cylinder bores.

… with professional metrology

FORMLINE solutions are the result of our decades of experience and extensive know-how in form metro-logy. They boast explicit measurements according to standards, easy operation and professional evaluation of the measured values.

… in day-to-day operations

FORMLINE solutions measure with high accuracy in the measuring lab or in the shop floor. With a user-friendly evaluation software, they are easy to use and can be easily adapted to numerous measuring tasks thanks to an extensive range of accessories.

… with speed

Time is money. That's why we focus on automated measuring runs and FORMLINE solutions, that offer optimized processes, adapted to the measuring tasks.

… with customized solutions

For your specific requirements, we develop measuring systems, that are adapted to your needs. You can rely on our experience in the development of customized solutions, for example for break disks, pistons, valves, conrods or injection parts.

Form measuring systems

Crank shaft and cam shaft measuring machines

Measuring systems for cylinder bores

Model	Brief description	Page
F50, F135, F155	Compact and ergonomic form measuring systems	6–7
F435, F455	Fully automatic measurement of all form and positional tolerances, roughness and twist measurement as an option	8–9
roundscan	Combined form and roughness measuring systems with optional twist measurement	10–11
FMS8200	Spindle measuring machines for heavy workpieces with a large measuring volume	12–13
TURBO FORM	Evaluation software for F series, roundscan and FMS	14–18
CFM, shaftscan, CCM	Measuring machines for crank shafts and cam shafts	25–27
TURBO SHAFT	Evaluation software for CFM, shaftscan and CCM	30–31
incometer	Measuring systems for form and roundness in cylinder bores	32–35
INCOWIN	Evaluation software for incometer	36–39

HOMMEL-ETAMIC F50

Accurate and cost-efficient roundness measurements

With the compact F50 form measuring system you perform roundness measurements quickly and accurately.

System features

- Highly accurate air bearing rotary table with a diameter of 150 mm
- Menu-guided manual centering and leveling
- Measuring probe with adjustable measurement force and large measuring range
- Continuously adjustable measurement speed
- Manual Z and R axes
- Simplified software user interface with all the key functions in one view
- Optional tilt arm FS1 for variable probing positions

Your benefits

- Universal roundness measuring system with extensive evaluation possibilities
- Professional print reports for documentation of your production quality
- Secure and simple operation via the Windows-based evaluation software
- Fast and efficient measurements
- High-quality, maintenance-free air bearing for maximum precision at all times
- Compact and robust desktop device, which is ideal for flexible use during production

Model	Workpiece weight	Distance C/Z axis	ø measurable	Measuring height	Centering/ leveling	Measuring axes	Option roughness
F50	25 kg	195 mm	300 mm	320 (560[1]) mm	manual	C	no

1) Probe in upward position

HOMMEL-ETAMIC F135

Form measurement of precision parts made easy

The F135 and F155 measurement systems are the best choice for measuring the roundness and cylindricity of your precision parts.

System features

• Highly accurate air bearing rotary table with a diameter of 150 mm
• Menu-guided manual centering and leveling
• Measuring Z axis for cylinder form and straightness measurements
• Probe protected against collisions
• New generation of probes with magnetic coupling for fast probe arm changes
• Tilt arm FS1 for variable probing positions, even on complex workpieces

Your benefits

• Universal system for cylinder form measurements with extensive evaluation functions
• Automated measurement runs
• Professional print reports for documentation of your production quality
• Two models to choose from, depending on the workpiece length
• Extensive range of probes for numerous measuring applications
• Capable assistant for easy creation of test plans
• Optional measuring R axis for flatness measurements

Model	Workpiece weight	Distance C/Z axis	ø measurable	Measuring height	Centering/ leveling	Measuring axes	Option roughness
F135	25 kg	275 mm	340 mm	350 mm	manual	C, Z	no
F155	25 kg	275 mm	340 mm	550 mm	manual	C, Z	no

Fully automatic measuring of all form and positional tolerances

The F435 and F455 form measurement systems allow you to determine all form and positional tolerances in a precise and reliable manner.

System features

- Highly accurate air bearing rotary table (250 mm) with automatic centering and leveling of the workpiece
- Three motorized measuring axes
- Vertical measuring axis with a measurement range of either 350 mm or 550 mm
- New generation of probes with magnetic coupling for fast probe arm changes
- Tilt arm FS1 for perfect probe positioning, even on complex workpieces
- Available as a desktop device or as an ergonomic measuring station
- Optional instrument table with air damping or spring elements

Your benefits

- Precise measurement of roundness, cylinder form and flatness
- High degree of automation thanks to automatic centering and leveling of the workpiece and CNC controlled measuring axes
- Easy CNC programming and workpiece-specific measurement documentation
- Capable evaluation software for determination of all form and positional tolerances
- For demanding measuring tasks in series production or for frequently changing tasks in the metrology lab
- Optional roughness and waviness measurement with free probing system in Z-direction
- Optional twist measurement according to MBN 31007-07 V02
- Magnetic probe arm coupling for fast changing of the probe arm and protection in case of collisions

HOMMEL-ETAMIC F435,
ergonomic measuring station

Model	Workpiece weight	Distance C/Z axis	ø measurable	Measuring height	Centering/ leveling	Measuring axes	Option roughness
F435/F455 desktop	40 kg	400 mm	430 mm	350/550 mm	automatic	C, Z, R	no
F435/F455 station form	40 kg	400 mm	430 mm	350/550 mm	automatic	C, Z, R	no
F435/F455 station roughness	40 kg	400 mm	430 mm	350/550 mm	automatic	C, Z, R	yes, Z axis

Measurement of roughness and form
with double-tipped probing system and
magnetic coupling

Motorized tilt and rotation module MDS

Optional roughness and waviness measurement

Thanks to the new FT1.1 probe generation and a
double-tipped probing system, roughness and waviness
measurements can be performed in addition to form
measurements. And all this in a single clamping opera-
tion, saving you both time and money.

Fully automatic measurements

Thanks to the optional motorized tilt and rotation
module MDS, the probe is always positioned in the
optimum probing position on the workpiece, thus
allowing for the measuring of complex workpiece geo-
metries without interrupting the CNC run.
The module has one motorized axis for tilting (90°) and
one for rotating (270°) the probe for reaching measure-
ment positions that are hard to access.

Compact desktop device

Depending on requirements, the F435 and F455
measurement systems are available either as a com-
pact desktop device or integrated into an ergonomic
measuring station.

HOMMEL-ETAMIC F435,
desktop device with optional instrument table

9

Highly efficient solution for combined form and roughness measurements

Depending on the measurement task, the combined form and roughness measurement systems from the roundscan series can be configured to create the measurement situation that best suits your requirements.

System features

- Highly accurate air bearing rotary table with impressive rigidity for consistently high precision
- Vertical measuring axis available in three different heights, depending on requirements
- Basic version for form measurement with 1 µm resolution of the R/Z axis and 20,000 points in the C axis
- High Resolution version (HR) for combined form and roughness measurements with 0.1 µm resolution in the R/Z axis and 720,000 points in the C axis, as well as integrated linear scale and air damping with active level control

Your benefits

- Saving of time: very fast, fully automatic centering and leveling and CNC controlled measuring axes for save measuring, even on complex workpieces
- Flexibility: combined form, roughness and twist measurements in a single clamping operation with no probe arm changes; small parts such as valves can be measured with a small measuring circle
- Ergonomics: optimized design for convenient standing or sitting operation of the measuring system

HOMMEL-ETAMIC roundscan 555 with optional printer container

MDS3 with double-tipped probing system
FT3 with collision protection

Fully automatic measurements with innovative probe system for efficient measurement of form, roughness and twist

- CNC controlled tilt and rotation module MDS3 for measurements at any position on the workpiece
- Double-tipped probing system for measurements with two different probe tips for form and roughness
- Adjustable and switchable probe force for measurements in accordance with standards
- Probing system can be switched from form to roughness during the CNC run
- High resolution of the axes for a minimal measuring point distance for roughness measurements
- Low measurement speed from 0.2 mm/s can be run
- Only very low basic interference of the measuring axes, even at maximum resolution
- Form and roughness measurements can be programmed fully automatically; no retooling times for fast and reproducible measurements
- Magnetic probe arm coupling for fast changing of the probe arm and protection in case of collisions

Ergonomic measuring station

- Height-adjustable, tiltable evaluation unit
- Convenient standing and sitting workstation
- Lockable cabinets for safe storage of evaluation computer and printer
- Control panel for performing key operations while maintaining a view of the workpiece and probe
- Integrated probe arm rest

Height-adjustable evaluation unit

Model	Workpiece weight	Distance C/Z axis	ø measurable	Measuring height	Centering/ leveling	Measuring axes	Option roughness (HR models)
roundscan 535	60 kg	370 (420)* mm	430 (530)* mm	350 mm	automatic	C, Z, R, X, Y	yes, C, Z, R axes
roundscan 555	60 kg	370 (420)* mm	430 (530)* mm	550 mm	automatic	C, Z, R, X, Y	yes, C, Z, R axes
roundscan 590	60 kg	370 (420)* mm	430 (530)* mm	900 mm	automatic	C, Z, R, X, Y	yes, C, Z, R axes

Spindle measuring machines for large and heavy workpieces

The specific machine design of the FMS8200 spindle measuring machine with a rotating probing system and five measuring axes offers you a flexible solution for the automated measurement of all form and positional tolerances on large and heavy workpieces.

System features
• Rotating probing system with automatic weight balance
• Automatically movable air bearing X-Y table with large support area
• In X-Y table integrated axes (A, B) for automatic workpiece alignment
• X, Y and Z axes with straightness measuring function
• Five measuring axes, two alignment axes as well as optional movement axis for the measurement of V motor blocks
• Automatic setting of the probing system to the workpiece diameter

Your benefits
• Fully automated measuring runs with extensive evaluation possibilities
• Especially suited for cylinder heads, motor blocks, large liners, gear boxes, crank shafts, large-bore pistons, etc.
• Freely movable operator terminal for the entire machine control
• Comprehensive collision protection for a long service life and increased productivity
• Automatic changeover of the probing direction for different measurements in a single clamping operation
• Easy changing of the workpiece thanks to large measuring and travel ranges of the axes

HOMMEL-ETAMIC FMS8200
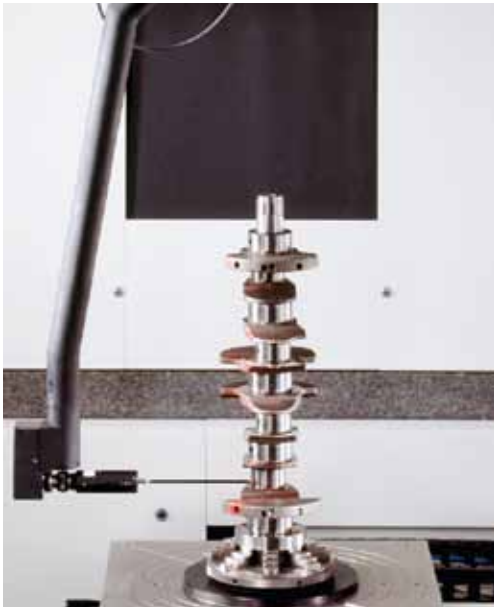
Crank shaft measurement with specific probe arm

Crank shaft measurement

The crank shaft measurement arm is used for axial and radial measurements on main bearings and pin bearings with no probe changes. The measurement arm is available with either an automatically or manually rotating probe.
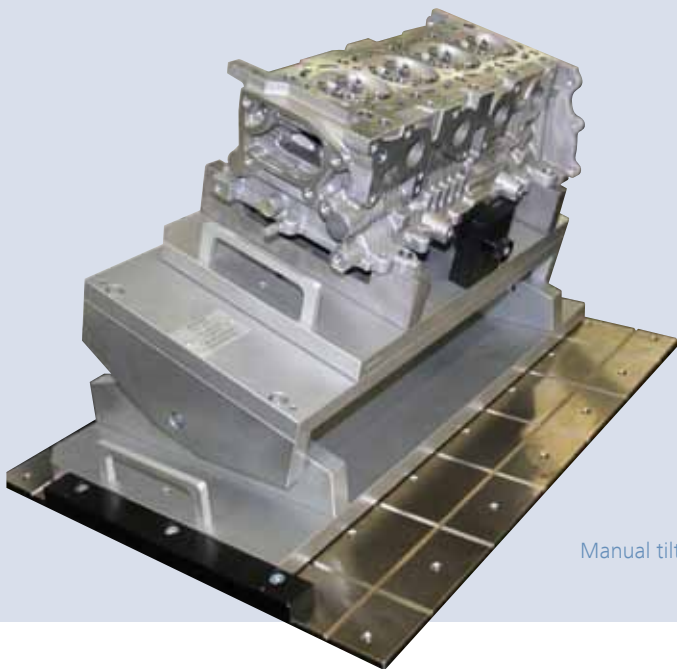
Manual tilt module

Tilt module

The tilt module enables manual or automatic positioning of cylinder heads or motor blocks (depending on version). Valve seats and cylinder bores of V motor blocks can be completely CNC measured.

Model	Workpiece weight	X axis	Y axis	Measuring height	Workpiece alignment	Measuring axes
FMS8200	300 kg	800 mm	300 mmm	1300 mmm	automatic	C, Z, R, X, Y

Software with clear user guidance for reliable measurement evaluation

The graphical, function-oriented TURBO FORM user interface ensures simple operation, even when performing complex measurement tasks:
- User-friendly interface with clear icons
- Simple definition of measurement positions and axis references
- Direct transfer of positions via teach-in
- Simple CNC programming using pictograms
- Fully automatic alignment and measurement of workpieces
- Comprehensive profile analysis and complete documentation of the measurement results

Performance features
- Clear program flow
- Evaluation in accordance with standards
- Convenient test plan management
- User-defined presentation of measuring reports
- Numerous options for special applications
- Fast evaluation algorithms for prompt results
- CNC modules, Fourier analysis and 3D analyses included in the standard scope of delivery
- Automatic saving of PDF reports

Creating test plans
By clicking the mouse you select the required characteristic. The wizard guides you simply and safely through all the necessary steps.
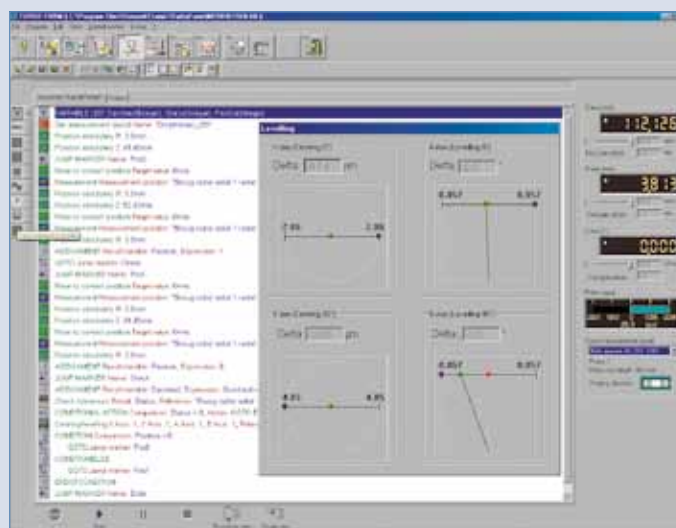
Automatic alignment
Alignment is semi-automatic or fully automatic (depending on the device version) and is supported by the software to optimum effect.

Automatic measurement runs: CNC

A CNC run is quicker than a manual measurement sequence and provides user-independent, reproducible results. CNC programs are created by single steps in the teach-in mode and can then be changed step by step, either as a total measurement run or in single steps.

Fourier analysis

The measured profile is deconstructed into its spectral components and displayed as a graphic. Tolerance limits are defined with a limiting curve and a warning limit in order to detect recurring, high-frequency profile parts, such as chattermarks.
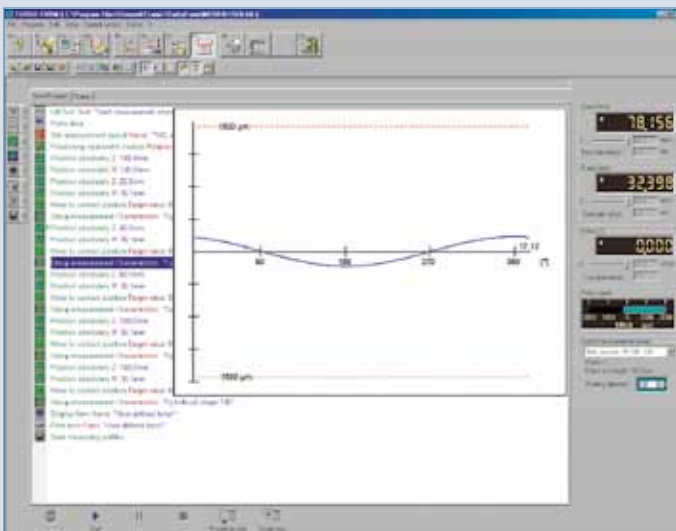
Measuring

Depending on the device type, measuring is performed manually or fully automatically via a CNC measuring program. The aligned workpiece is (automatically) measured at the measuring positions defined in the test plan. The measuring profile can be viewed, allowing an evaluation to be performed while the measuring process is still underway.
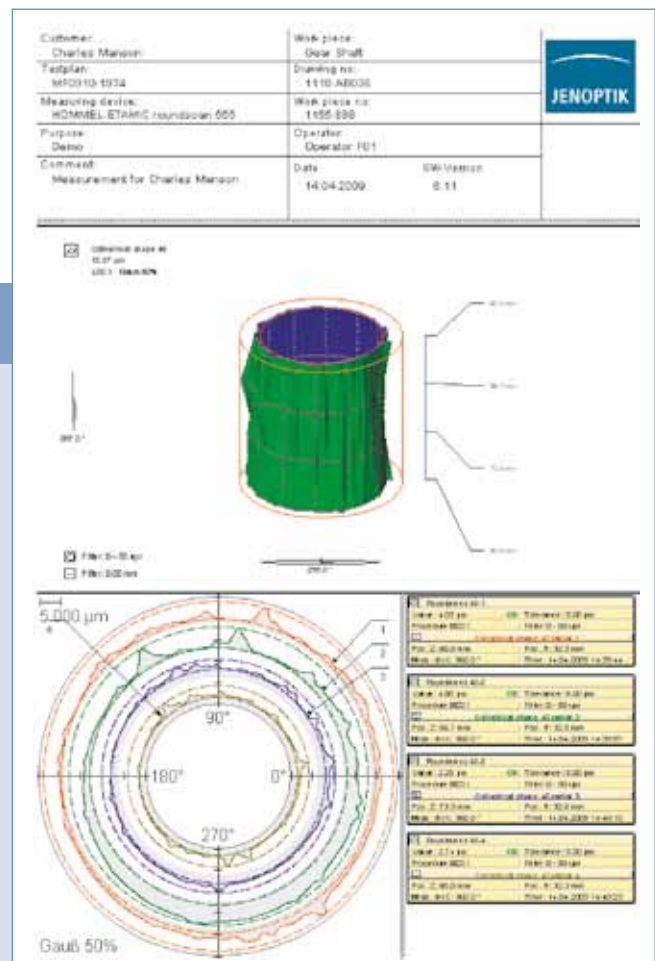
Analysis and documentation

After scanning the workpiece, the measuring profiles are displayed clearly and in accordance with standards in (3D) diagrams. Printing and saving of the reports can be integrated directly into the automatic run. Measurement data can also be exported via an optional interface.

Software options for the evaluation of special measuring tasks

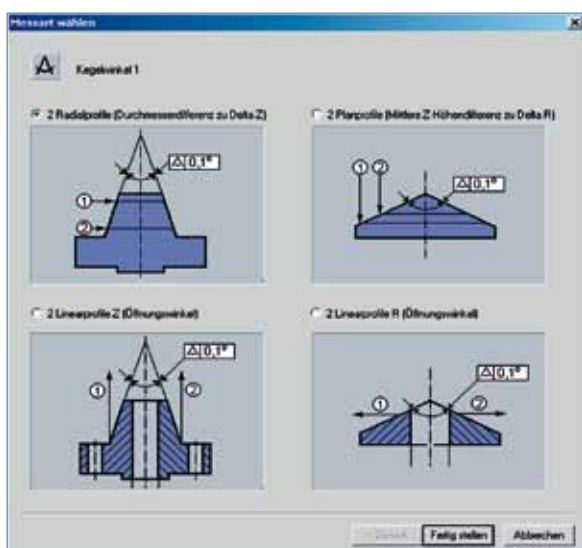Line form

Cone

Linear form piston
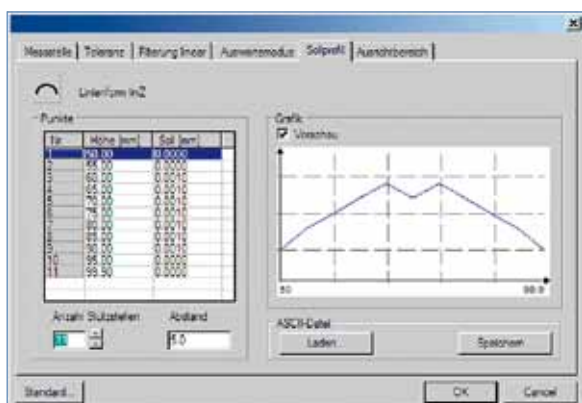
Line form
Evaluation of the line form by a nominal curve with even tolerance band.

Angular sector
Determination of the greatest roundness error within a defined angle segment.

Fourier synthesis
Extraction of individual frequency ranges. Characteristics, which are then formed, no longer contain these waves.

Cone
Calculation of the cone angle from two polar or two linear profiles. Determination and clear 3D display of conical form and run.

qs-STAT® interface
Certified according to AQDEF. Transfer of the measuring data to the statistics package qs-STAT® for process data analysis.

ASCII export interface
Export of calculated characteristics and their measured values in ASCII format for further processing in other software programs such as Excel.
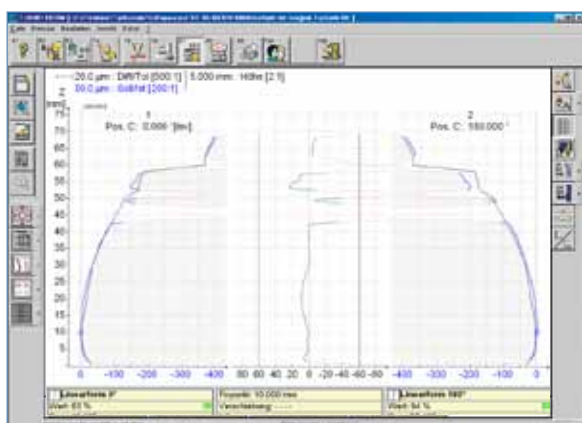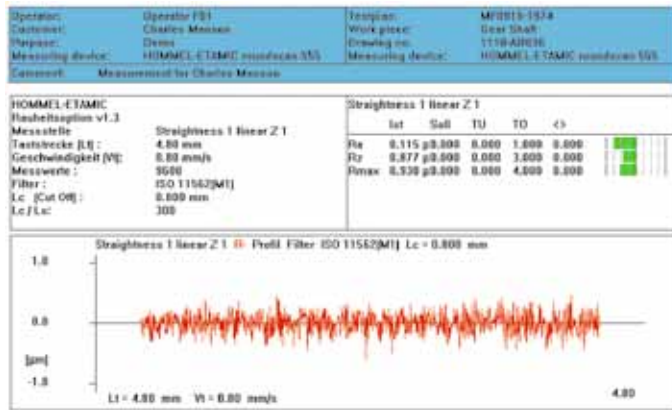
Piston measurement
Evaluation of non-standardized characteristic types on pistons, e.g. evaluation of the ovality, reference bolt axis or linear form.
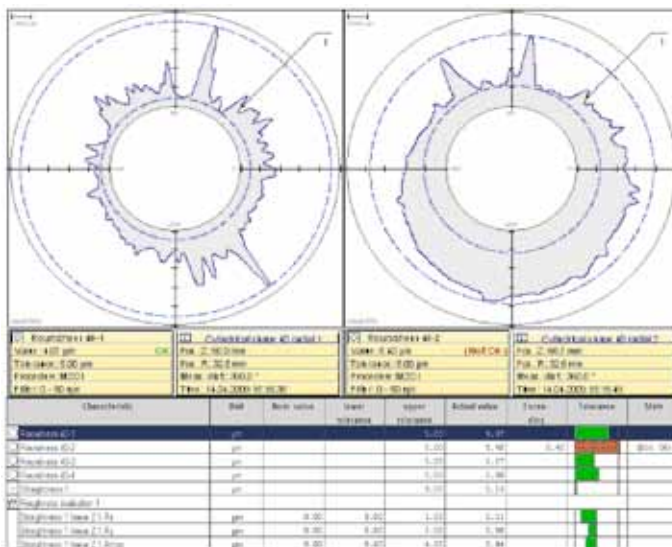
Brake disk measurement
Evaluation of certain important properties of brake disks such as wobble, thickness difference, waviness and wear measurement.

Evaluation of roughness, waviness and profile

Roughness parameters and roughness profile

Measurement report

This optional module for the F435 and F455 models, as well as the High Resolution (HR) versions of the roundscan, enable fast, simple calculation, evaluation and graphical representation of all standard roughness, profile and waviness parameters in accordance with DIN/EN/ISO/JIS standards.

Performance features

- Various standard forms for evaluation
- Simple, clear configuration of measurement conditions
- Individual combination of parameters depending on the measurement task
- A wide range of display options simplifies profile analysis, e.g. superposition of several profiles, zoom, filter or fault extraction
- Free and individual design of screen and print forms
- Clear display of all form and roughness parameters in a characteristics table
- The key information is visible at a glance via the tolerance output and the status display

Automatic roughness evaluation (CNC)

Roughness measurement positions are integrated into the CNC run by the appropriate program button. Measurement conditions such as probing force are adapted automatically. The results are displayed directly in the automatic measurement run and printed as required. They can also be saved as a PDF file or exported via the ASCII or qs-STAT® interface (optional).

Twist measurement according to MBN 31007-7

Twist refers to periodic structures which are comparable with the course of a thread. Magnified many times, it is visible as a micro-grinding structure. Twist structures at the sealing surfaces of shafts occur during grinding and impair the sealing function between the shaft and the sealing ring.

The most important properties of these structures can be determined with a 3D evaluation of the surface. The contact zone of the shaft is measured as a 3D area with a roughness stylus tip over a series of envelope line profiles. This allows a graphic representation of the twist structure as well as calculation of the twist parameters.

Twist parameters

The F435, F455 and roundscan systems support the current version of the Daimler standard MBN 31007-7 from 2009. This means that all parameters such as Number of threads DG, Twist depth Dt [µm], Period length DP [mm], Feed cross section DF [µm²], Feed cross section per revolution DFu [µm²/r], Contact length in percent DLu [%] and Twist angle Dγ [°] can be determined. Due to the optimized evaluation algorithms, the measurement results are much more stable. The reduction of the standard evaluation length from 5 mm to 2 mm reduces time considerably.
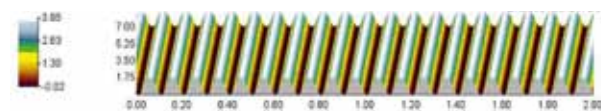
TwistLive® analysis method

With this modern analysis method for all roundscan systems, the normal measurement time may be reduced by 75 %. During the measuring progress, a results forecast of the twist parameters is already possible – live!

Display of unfiltered primary surface structure

Display of twist structure in detailed scaling

Display of original profile (green) and twist profile (blue)

Twist measurement with a roughness stylus tip

Chucks, instrument tables and tilt modules for F series and roundscan

We offer a wide range of standard and custom accessories for handling even the most complex workpieces.

Chucks

With three, six or eight hardened clamping jaws for secure clamping of the workpieces on the rotary table.

Chuck FX70

Chuck range
Internal 18–62 mm
External 2–68 mm
Art. 232 036

Chuck FX100

Chuck range
Internal 28–95 mm
External 2–95 mm
Art. 232 357

Chuck FX150

For 250 mm rotary table
Chuck range
Internal 46–140 mm
External 2–140 mm
Art. 232 359

Chuck FX150

For 150 mm rotary table
Chuck range
Internal 46–140 mm
External 2–140 mm
Art. 507 001

Motorized tilt and rotation module for F435 and F455

With this module the probe is always positioned in the optimum probing position on the workpiece. Thus complex workpiece geometries can also be measured fully automatically.
Art. 1006 0796

Instrument tables

For F series desktop devices

GTS with drawers	Art. 232 900
GTS-K	Art. 232 901

For F435 and F455

GTF-3 with spring elements	Art. 1006 3184
GTF-3 with air damping	Art. 1006 3185

Probe arms – basis for high-precision measurement

Probe arm set FTS1 for F50

To cover the most common measurement tasks.

Art. 230 580

The components of the probe arm set may also be ordered separately:

Extension L030
L = 30 mm (2x); M2 thread   Art. 051 210

Probe tip M2 KU500/R L20
L = 20 mm; 1 mm ruby ball;
M2 thread   Art. 051 209

Probe tip FO KE300/90H L10 D2/10
L = 10 mm; 2 conical tips   Art. 519 520

Probe tip FO KU1500/R L20 D2/18,5
L = 18,5 mm;
3 mm ruby ball   Art. 243 877

Probe tip FO KE300/90H L35 D2/35
L = 35 mm; 2 conical tips   Art. 241 712

Probe tip FO TO250-8000/60H L40 D2/40
L = 40 mm; axe probe tip with
0.25 mm and 8 mm radius   Art. 243 681

Key for changing the probe tip M2 Art. 051 215
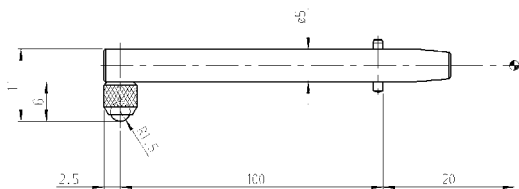
Probe arm FT-R-L100-KU 1,5
L = 100 mm, 3 mm probe ball   Art. 230 615
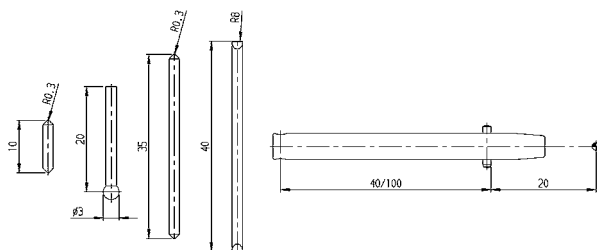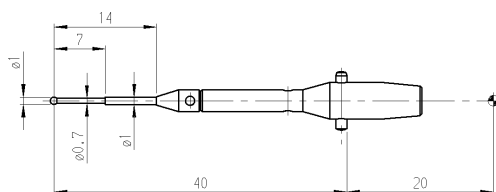
Probe arm FT-HR-L040/L100-D2
2 mm bore for inserting probe tips
L = 40 mm   Art. 230 630
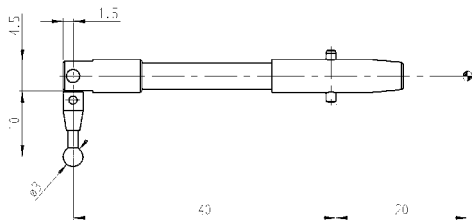L = 100 mm   Art. 230 634

Probe arm FT-HA-L020-M2
M2 thread for screwing on probe tips
L = 20 mm   Art. 230 561

Ceramic probe arms for F50

Available in standard and custom sizes, which can be quickly and easily adapted to a variety of measurement situations. Below are examples of different types of probe arms.
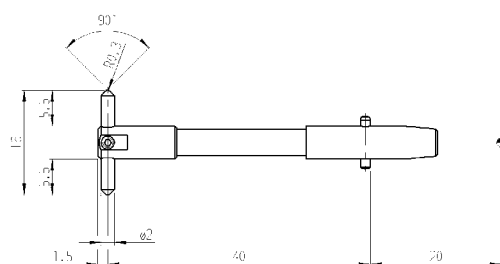

Probe arm FT-HR-L040/L100-M2

2 mm thread for screwing on probe tips

L = 40 mm	Art. 244 940
L = 100 mm	Art. 244 941

Probe tip with
3 mm ruby ball   Art. 063 935

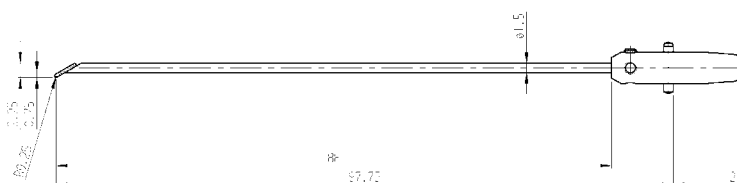### Probe arm FT-HR-L404/L100-D2

for inserting 2 mm probe tips

L = 40 mm	Art. 256 720
L = 100 mm	Art. 1000 1880

Probe tip with
2 conical tips   Art. 243 938

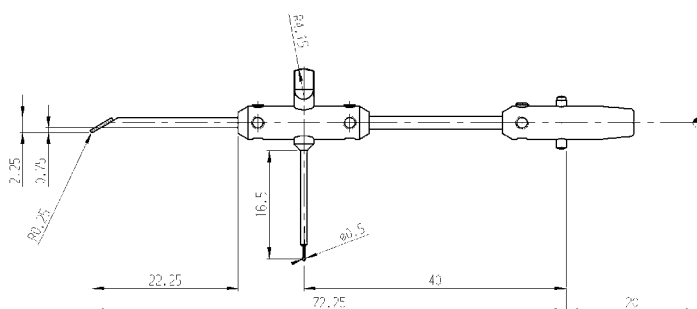For measurements on ground and slightly soiled measurement positions

Probe arm FT-R-L097,75-KU0,15

with tip contacting at an angle
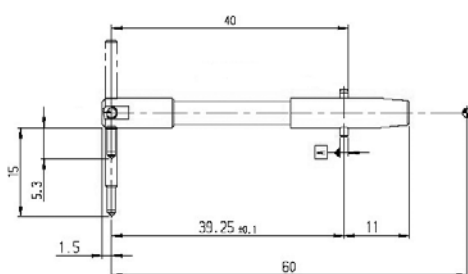
Art. 241 561

For measurements on envelope lines

Probe arm FT-AR-L040/072,25

Special version

With cross pin   Art. 256 729

For measurements on end surfaces, in bores above 3 mm and on the bottom surfaces of bores

Probe arm FT-A-L040-KE5

L = 40 mm, diamond Tipp with 90°, 5 µm

Art. 513 140

For twist measurement

Probe arms for individual measuring tasks

Probe arm set FTS3 for F135/F155, F435/F455 and roundscan

To cover the most frequent measurement tasks.

Art. 1002 9224

The parts of the probe arm set can also be ordered individually.

Probe tip FO KE300/90H L10 D2/10
L = 10 mm; 2 cone tips   Art. 519 520

Probe tip FO KE300/90H L35 D2/35
L = 35 mm; 2 cone tips   Art. 241 712

Probe tip FO KE300/90H L10,4 D4-2
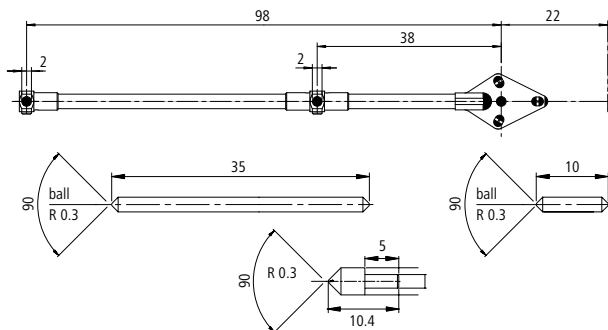L = 10,4 mm; cone tips   Art. 243 519

Pin wrench M2   Art. 051 215

Extension L060
L = 60 mm; M2 thread   Art. 1003 4259
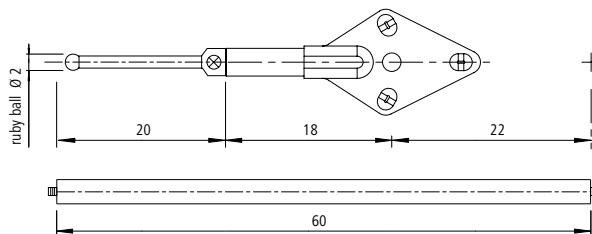
Probe tip M2 KU1000/R L20
L = 20 mm; 2 mm ruby ball;
M2 thread   Art. 051 207

Probe arm FTM-HR-L038*098 - D2*D2
Two 2 mm bores for inserting stylus tips. The probe tip at 38 mm is suitable for the outside measurement; the probe tip at 98 mm is used for measurements in bores.
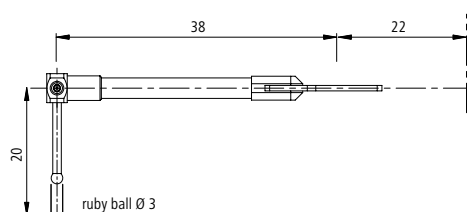L = 38 mm + 98 mm   Art. 1003 0456

Probe arm FTM-HA-L018-M2
M2 thread for screwing on probe tips.
L = 18 mm   Art. 1000 3942

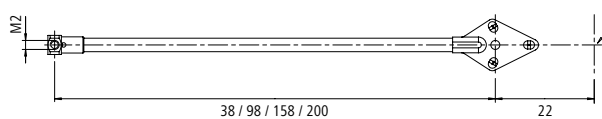Standard probe arm with probe tip
Delivered with every device.

Probe arm FTM-HR-L038-D2
L = 38 mm   Art. 1000 3955

Probe arm FO KU1500/R L20 D2
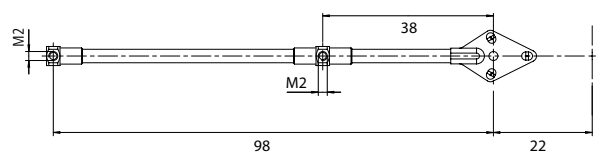L = 20 mm; 3 mm ruby ball   Art. 243 877

Probe arms with M2 thread and matching probe tips for F135/F155, F435/F455 and roundscan

Probe arm FTM-HR-Lxxx-M2

Lateral M2 thread for screwing on probe tips.

L = 38 mm	Art. 1000 3938
L = 98 mm	Art. 1000 9711
L = 158 mm	Art. 1000 9714
L = 200 mm	Art. 1003 8257

Probe arm FTM-HR-L038*098 – M2*M2

Two lateral M2 threads for screwing on probe tips.

L = 98 mm + 38 mm   Art. 1002 4596

Probe tips M2 with ruby ball

Standard stylus tips for precise form measurement.

Probe tip M2 KU1000/L10,0 D1,0
L = 10 mm; 2 mm ruby ball;
Art. 051 208

Probe tip M2 KU1000/L15,0 D1,0
L = 15 mm; 2 mm ruby ball;
Art. 1002 9794

Probe tip M2 KU1000/L20,0 D1,0
L = 20 mm; 2 mm ruby ball;
Art. 051 207

Probe tips M2 with diamond tip

For the exact determination of the surface parameters.

Probe tip M2 KE5 / 90GD L05,0
L = 5 mm; diamond tip 90° / 5 µm;
Art. 1002 9793

Probe tip M2 KE5 / 90GD L15,0
L = 15 mm; diamond tip 90° / 5 µm;
Art. 1002 5091

Probe tips M2 with cone

For measurements on ground and lightly soiled measuring points.

Probe tip M2 KE300/90H L5,0
L = 5 mm; cone tip 90° / R 0,3 mm;
Art. 1004 4157

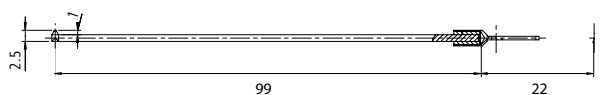**Probe tip M2 KE300/90H L10,0**
L = 10 mm; cone tip 90° / R 0,3 mm;
Art. 1004 4188

Probe tip M2 KE300/90H L15,0
L = 15 mm; cone tip 90° / R 0,3 mm;
Art. 1004 4189

Special probe arms for measurements in small bores from 3 mm
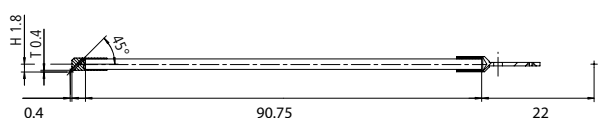

Probe arm FTM-R-L099-KE0,3-60H

For form measurement.
L = 99 mm; cone tip 60° / R 0,3 mm;
Art. 1001 1703

Probe arm FTM-R-L098-KE0,005/ 60D

For roughness measurement.
L = 98 mm; diamond tip 60° / 5 µm; 45° mounting;
Art. 1004 0375
L = 98 mm; diamond tip 60° / 5 µm; 45° mounting;
Art. 1004 0389

Permanent measurement accuracy

DAkkS-DKD calibration laboratory

Continuous monitoring of optimum measurement accuracy is necessary to ensure perfect functioning of the measuring instruments. This is because changes in function can occur over the course of normal use, especially due to wear and tear, and these types of changes can go unnoticed. We calibrate the standards you send us in our ISO/IEC 17025 accredited DAkkS-DKD calibration laboratory. This ensures direct tracing of the gaging components to the Federal Physical-Technical Institute (PTB) and guarantees measurements and calibrations at the highest technical standard for measuring.

If a standard cannot be calibrated, a new one can be obtained directly from any of our manufacturing facilities. Simple factory calibration certificates and test reports for non-accredited parameters are also available. We also carry out capability tests for demanding measurement tasks.

Our range of calibration services:

Our DAkkS-DKD accreditation includes the measurement of variables such as roughness, profile depth, roundness, straightness, and parallelism as well as contour standards and roughness measurement instruments. Within this scope we offer:
- DAkkS-DKD calibration certificates for form standards
- DAkkS-DKD calibration certificates for contour standards
- DAkkS-DKD calibration certificates for roughness standards
- DAkkS-DKD calibration certificates for roughness measurement systems

DAkkS-DKD calibration certificate for form standards

Calibration is carried out on our DAkkS-DKD measuring station in an air-conditioned, vibration-insulated measuring room. All common form characteristic values can be determined.

Magnification standard FN101

For inspecting the amplification of the probing system.
With test report   Art. 521 809
With DAkkS-DKD calibration certificate   Art. 532 528

Roundness standard FN111

Made of ceramic. For inspecting the radial roundness deviation of the rotational axis.
With test report   Art. 521 799
With DAkkS-DKD calibration certificate   Art. 532 529

Roughness standard
RNDX2 with standard holder FNR

Geometry standard RNDX2 made of nickel with an extra hard protective coating and triangular/sinusoidal grooves. For inspecting the roughness measurement of the Z and R axis.
Delivered with test report and standard holder FNR for one or two geometry standards of the RNDH or RNDX type.
Ra: approx. 1.0 μm;
Rz: approx. 3.3 μm
Art. 1003 4205

Set of twist standards

With 10 and 30-turn left twist. For inspecting the accuracy of the measuring systems.
Delivered with test report.
Art. 1001 6265

DAkkS
Deutsche
Akkreditierungsstelle
D-K-15030-01-00

Comprehensive competence for crank shafts, gear shafts and cam shafts

Measure your crank shafts and cam shafts quickly and accurately with the fully automatic, CNC controlled CFM3010 measuring machine.

System features

- Gaging component capability: measuring accuracy with repeatability of up to 0.3 µm
- Distance between tips: 1250 or 1500 mm
- Fast measurement value recording
- Choice of manual or automatic loading
- Wear-free air bearing measuring slides
- Capable evaluation software TURBO SHAFT for cam shafts and crank shafts

Your benefits

- Secure measurement results, as there are no mechanical transverse forces
- Excellent basic accuracy thanks to high-resolution measurement systems
- Robust construction with vibration decoupling for use in the measuring room or in the laboratory
- Optimized CNC runs in conjunction with high measurement and travel speeds
- Can be used flexibly for a variety of workpieces

HOMMEL-ETAMIC CFM3010

Model	Workpiece weight	Test diameter	Measuring height
CFM3010	150 kg	300 mm	1250 or 1500 mm

High-End solution for crank shaft and cam shaft measurements

Thanks to its sophisticated and intelligent hardware and software components, the shaftscan 1030 offers highly accurate top-of-the-range crank shaft and cam shaft measurements.

System features

- Robust construction, as well as dual vibration decoupling, for use in the measuring room and in production
- Optimized machine concept with ergonomic design, height-adjustable evaluation unit and easy loading
- Evaluation of form and positioning, lengths and diameters, and all cam form deviations and chattermarks
- Pneumatic lifting of the tailstock with position indicator and automatic clamping for distinct clamping position
- Integrated storage compartment for gaging components and accessories
- Wear-free air bearing measuring slides
- Capable evaluation software TURBO SHAFT for cam shafts and crank shafts

Your benefits

- Fast, simple program setup
- Excellent cost-efficiency and service life thanks to fast measurement and travel speeds and the use of wear-free components
- Maximum accuracy with flexible use for different shafts
- Short travel distances and measuring times thanks to arbitrary order of repeat measurements of selected measuring points
- Two measuring heads as an option for reduction of cycle times

HOMMEL-ETAMIC shaftscan 1030

Model	Workpiece weight	Test diameter	Measuring height
shaftscan 1030	150 kg	300 mm	1000 mm

Specialist for cam shaft and cam form deviation measurements

Maximum mechanical accuracy and production-oriented robustness coupled with proven evaluation software are just some of the outstanding features of this CNC controlled cam shaft measuring machines.

System features

- Continuous zero-point inspection of the measurement systems for optimum intrinsic machine safety
- Robust construction and dual vibration decoupling for use in the metrology lab or in production
- High-resolution measurement systems for excellent basic accuracy
- Wear-free thanks to pneumatic tailstock lifting for positioning

Your benefits

- Horizontal structure for optimum handling of workpieces
- Measurement of all cam form deviations using suitable cam fitting processes
- Two measuring heads used in parallel ensure fast measurement runs
- Optimized CNC runs in conjunction with high measurement and travel speeds
- PTB certified evaluation algorithms

HOMMEL-ETAMIC CCM2010

Model	Workpiece weight	Test diameter	Workpiece length
CCM2010	50 kg	120 mm	1100 mm
CCM2020	50 kg	120 mm	1000 mm

Accessories for CFM, shaftscan and CCM

We offer a wide range of standard and custom accessories for easy handling of the workpiece. Our decades of experience in the field of crank shaft and cam shaft measurement ensure that you get the perfect solution even for complex measurement tasks.

Measuring followers

Universal measuring followers for different measuring tasks.

Flat measuring follower for crank shafts and convex cam shafts

Round measuring follower made of different materials for cam shaft diameters

Workpiece drivers

Universal standard workpiece drivers for the measurement of all common workpiece types.
Application-specific drivers are also available.

Universal driver for cam shafts, gear shafts and crank shafts

Workpiece-specific axial driver for cam shafts and crank shafts for angle indexing in axial bores

Workpiece-specific radial driver for cam shafts for angle indexing in grooves

Cam form deviation measurements at PTB* level

Thanks to the cam shaft standard and the validated evaluation algorithms of the TURBO SHAFT software, traceable cam form deviation measurements can be performed for the first time.

- DAkkS-DKD certified evaluation software for cam shafts
- Calibrated cam shaft standard
- Practice-oriented, reliable, traceable and therefore comparable status reports and status evaluations of cam shaft measurement systems
- Evaluation of form and dimensional deviations in all the main characteristics
- Comparability of evaluation strategies and detached consideration of the influence of the software from a purely mechanical measurement process
- Evidence of gaging machine capability (Cg, Cgk)
- For all CFM, shaftscan and CCM measuring machines

Characteristics measured

- Cam form
- Cam pitch
- Cam height
- Cam width
- Cam base circle radius
- Cam base circle run-out
- Cam angle position
- Diameter
- Circularity
- Straightness
- Parallelism

Certified evaluation software TURBO SHAFT

- Validation of evaluation algorithms
- Definition of measuring uncertainty on the basis of synthetic reference information
- Certified measuring uncertainty of the software <±0.1 µm (cam form) or ±0.1″ (angle)

* Federal Physical-Technical Institute – Physikalisch-Technische Bundesanstalt (PTB)

Convenient measurement and evaluation according to standards

The Windows software TURBO SHAFT sets standards with its convenient operation and functionality:

- Fast and simple program creation thanks to standardized input assistance
- Extensive help functions
- Automatic creation of a CNC program with the input data
- Grouping functions support the clarity of complex CNC programs
- Entering of positions via teach-in
- „Copy & Paste" for recurring characteristics, tolerances and nominal values

Performance features

- Definition of all measurement positions by entering a constant bearing and measurement track distance
- All measured values can be displayed for direct evaluation during the CNC run
- Automatic evaluation and determination of characteristics
- Documentation of measurement results using clear screen and print forms
- Export in ASCII format
- Saves and exports source data, result data and reports
- Offline programming
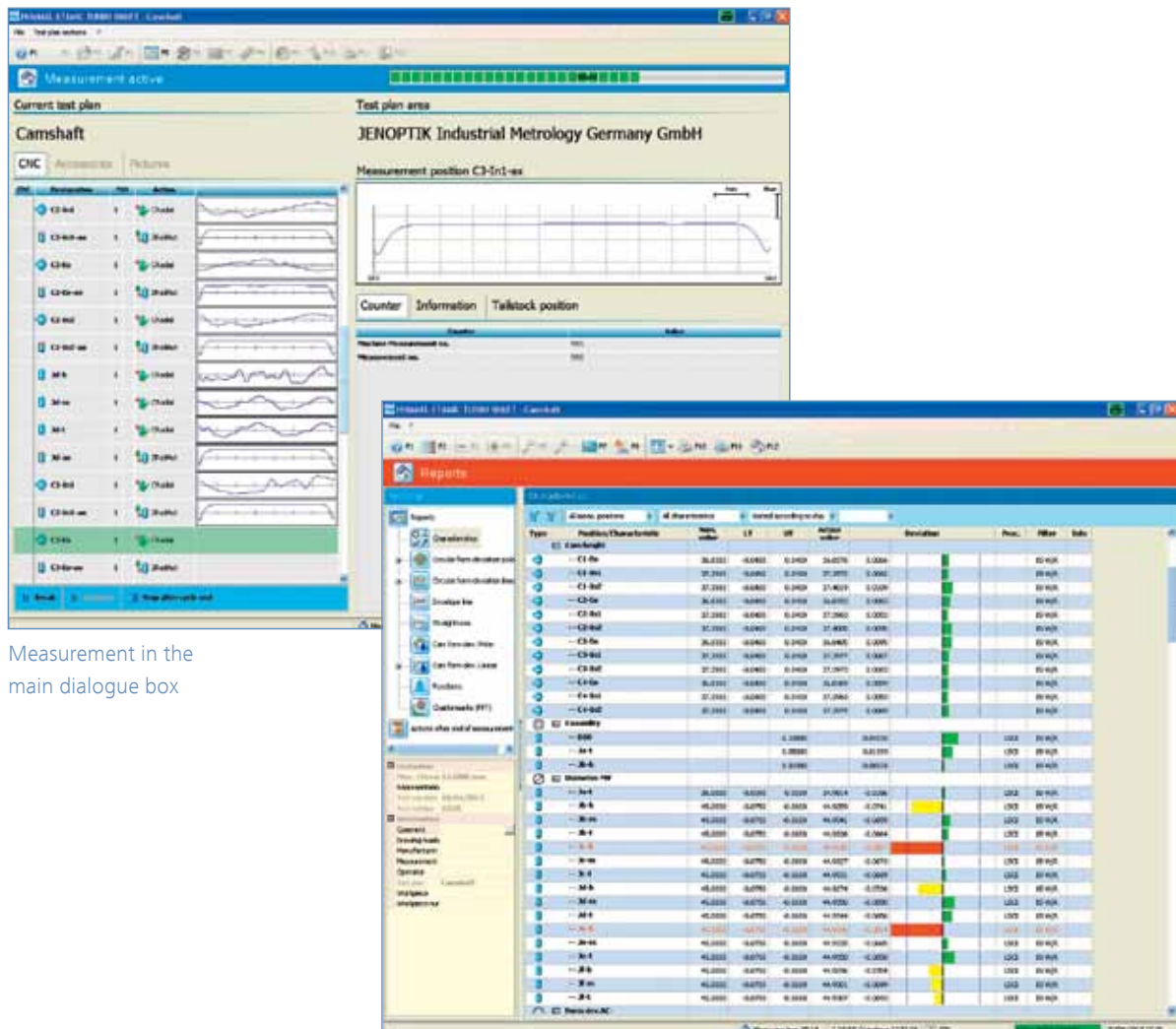
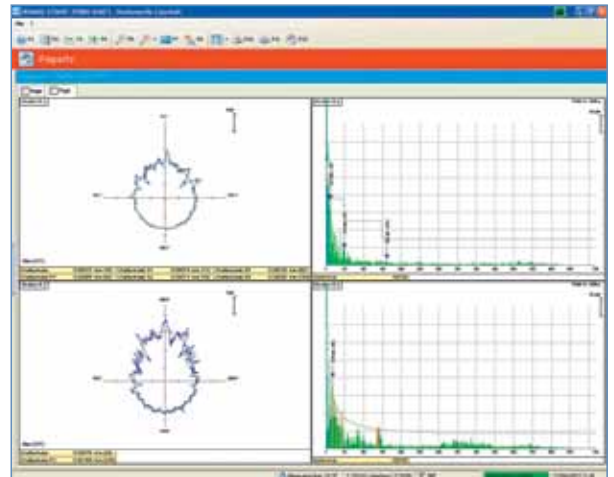Measurement in the main dialogue box

Numeric output

Evaluation of specific measurement tasks

Cam form profile over 360°
The cam form profile deviation can be detected in the area of the pre-cams, main cams or post-cams as well as on the base circle.

Chattermarks
Chattermarks are detected thanks to a frictionless measurement system with no reverse tension. As the measured values are recorded in the regular cam form measurement, there is no additional time outlay.

Axis parallelism of crank shaft pin bearings
Display of the direction and amount of the axis parallelism to a reference axis for each main bearing and pin bearing via vectors.
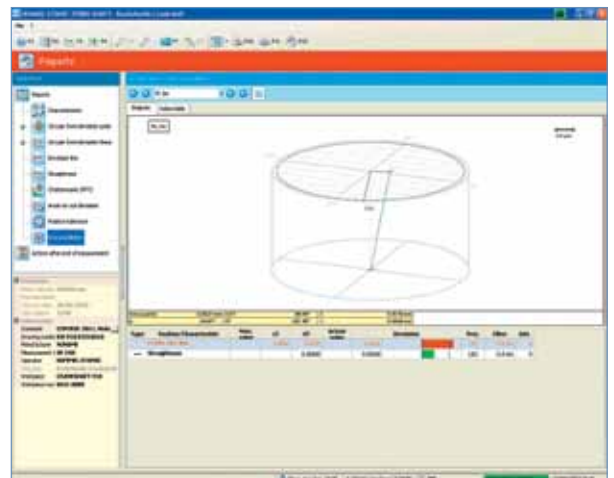
Wear evaluation for cam shafts
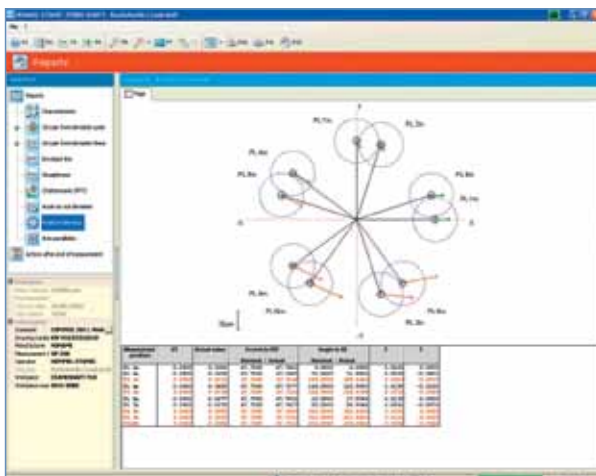Determination of the material wear between two measurements. The form deviation difference is identified as the maximum wear with the amount and angle position.

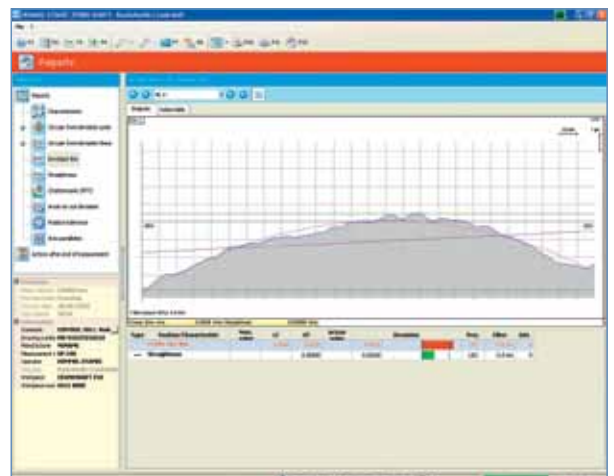### Crowning evaluation
Either from the polar or the linear measurement.
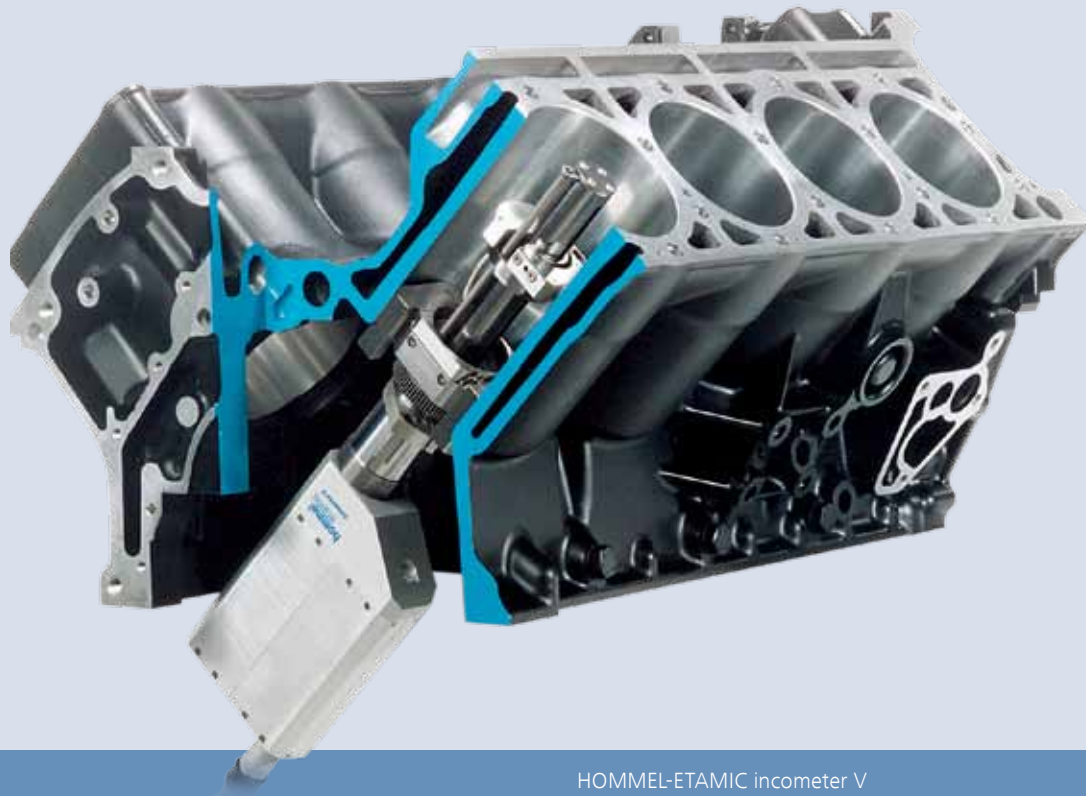
Certified qs-STAT® interface
ASCII transfer format for local or central data storage.

Chattermarks on cams

Axis parallelism

Position deviation

Crowning envelope line

HOMMEL-ETAMIC incometer V

Flexible measuring systems for form and roundness in cylinder bores

The incometer V measuring systems offer fast, reliable and highly accurate measurements for analytic examination of cylinder-piston configurations in engine block development.

- Measurement of cylinder distortion and wear, also under temperature influences
- Assistance for the dimensioning of piston rings
- Measurement with mounted cylinder head possible

System features

- Compact, robust measuring probe
- Scanning measuring method
- Simple operation via Windows software with pre-defined measuring routines
- By changing measuring tips and clamping jaws, the probe easily adjusts to different diameters

Your benefits

- Flexible and mobile use during development and testing
- Resistant to vibrations, making it ideal for measurements during production
- Easily adapted to different cylinder dimensions thanks to the clamping mechanism
- The probe's self-adjustment eliminates time-consuming alignments
- Automatic correction of any eccentricities or inclined positions of the cylinder axes to the measuring probe via the software
- Shortest measuring times on the market

External plate for fixing the probe

Measuring cylinder distortions

• Measurement and evaluation of the influence of cylinder heads and gaskets on bore distortion
• Thanks to its extremely compact design, the incometer probe can be installed on the crank shaft side in order to measure inside cylinder bores with the cylinder head mounted
• In the case of long-term testing, wear rates and cylinder distortion can also be monitored

Temperature distortion

• Simple fixturing and high speed allow for measurement of engine blocks, even under high temperature conditions
• Distortion-specific analysis of the critical warm-up phase with extreme differences in temperature between the cylinder head and the engine block
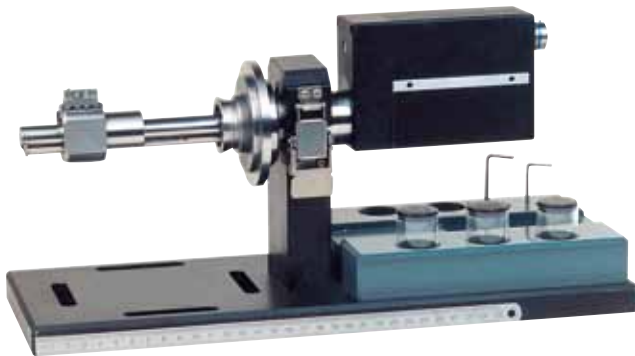
incometer VS for small engines

Analysis of cylinder distortions in small motors, e.g. for:
• Motorcycles
• Agricultural and forestry equipment
• Compressors of cooling systems

incometer V110 for flat engines

Analytical testing of the cylinder-piston configuration in engines with particularly difficult installation requirements, e.g. extremely flat V engines.

HOMMEL-ETAMIC incometer VS

HOMMEL-ETAMIC incometer V110
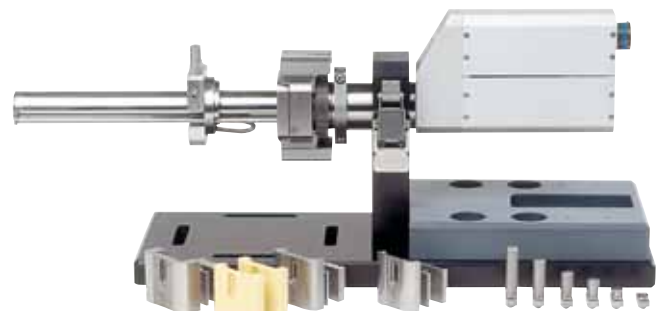
Mounting device and accessories for incometer V

Model	Test diameter	Axial measuring range	Radial measuring range
incometer V	65 – 155 mm	80 – 200 mm (depending on model)	±400 µm
incometer V110	65 – 155 mm	110 mm	±400 µm
incometer VS120	39 – 100 mm	120 mm	±500 µm

Fast form measurement in cylinder bores
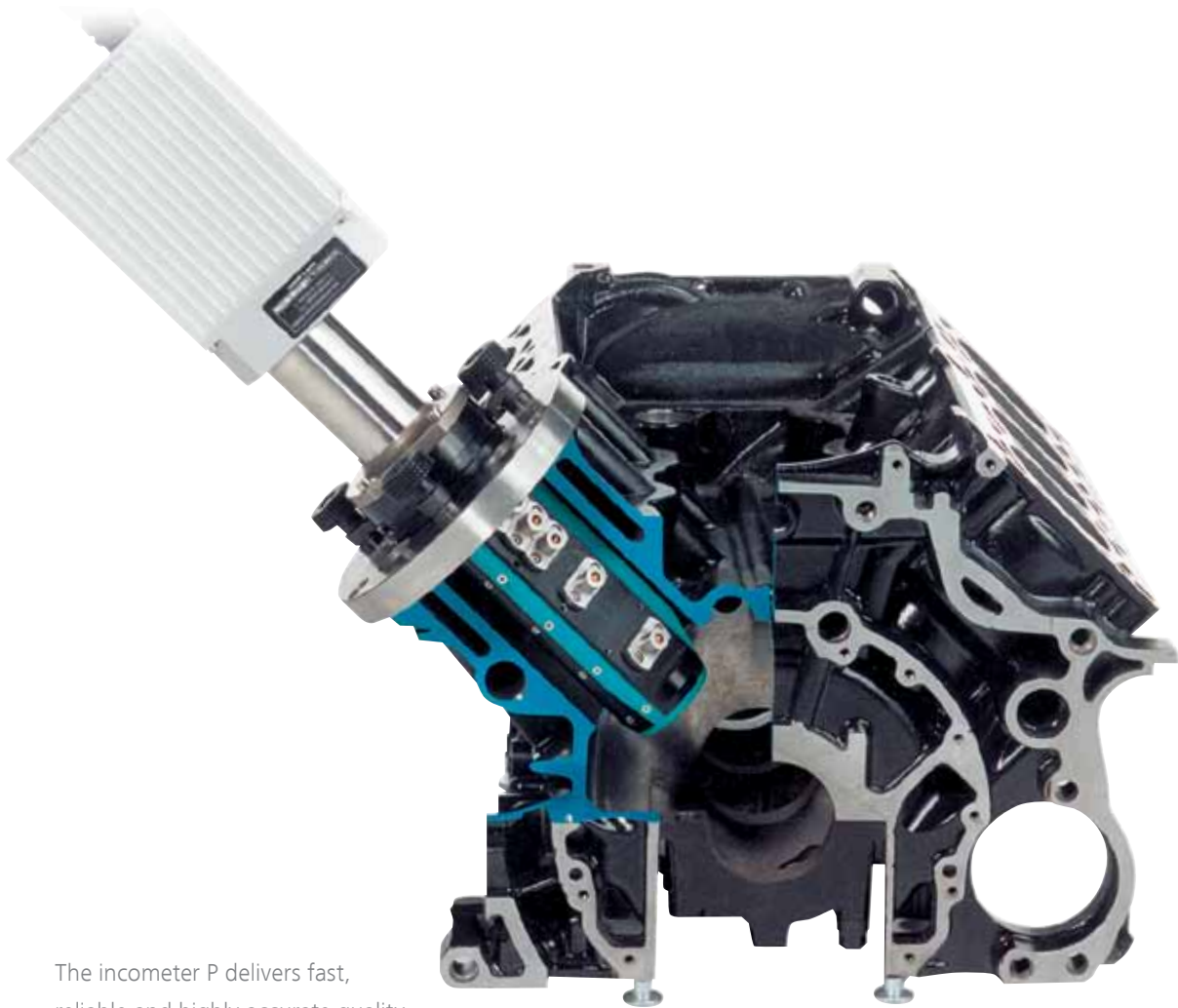
The incometer P delivers fast, reliable and highly accurate quality data during production.

HOMMEL-ETAMIC incometer P

System features

- Compact and robust design for mobile use during production
- Minimization of disruptive vibrations thanks to direct mechanical connection between the measuring probe and the workpiece
- Automatic correction of inclinations and eccentricities by the software
- Precision measurements of roundness and form in seconds during engine production

Your benefits

- Fast measurement readiness, as no manual alignment is required
- Measurement of the cylinder bore in just a few seconds
- Fast adaptation to different bore diameters thanks to interchangeable measuring tips
- Ideally suited for flexible production lines
- Simple operation, even without previous experience
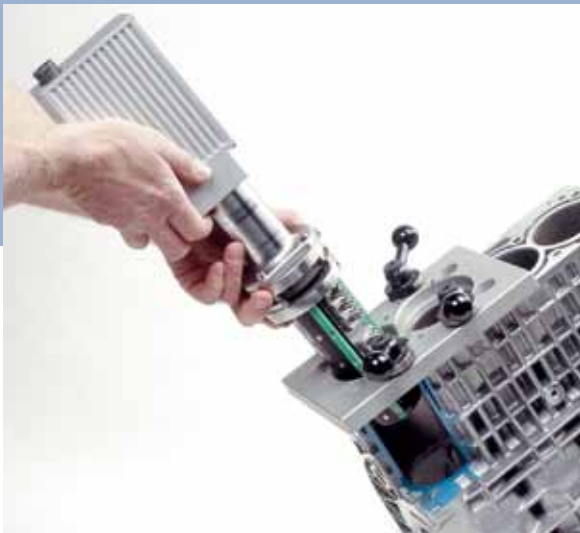
Inserting of the probe

Fixing of the probe

Easy handling and fast measurement

Measuring a cylinder bore with the incometer P takes only a few seconds:

• Insertion of the probe into the cylinder
• Plastic guide rails protect the cylinder wall
• Adjustment of the probe to the bore via a fixture plate
• Simply attaching the clamping levers connects the incometer P to the engine block

• Start of the measurement and 360° rotation of the measuring head
• Scanning, dynamic recording of the measurement values of all previously positioned sensors at a constant speed
• Measurement values are available immediately
• Choice of up to 7 sensors per measuring head
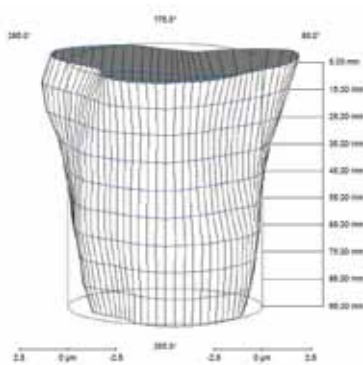
Isometric plot of a cylinder measurement
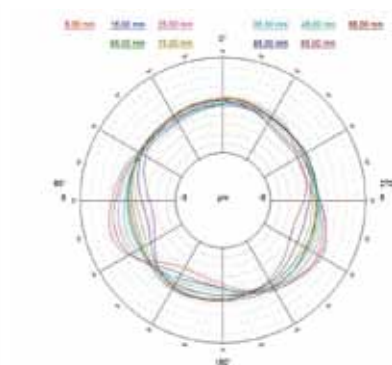
Radial plot of a cylinder bore
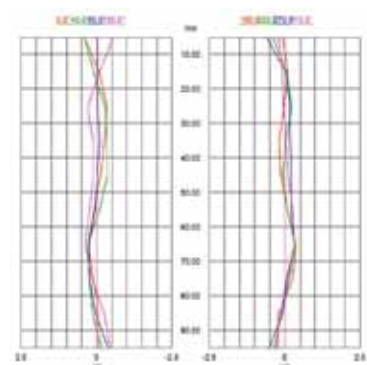
Axial plot of a cylinder bore

Model	Test diameter	Axial measuring range	Radial measuring range
incometer P100	60 – 110 mm	max. 300 mm	±500/1000 µm (depending on the diameter)

Clearly structured evaluation and control software
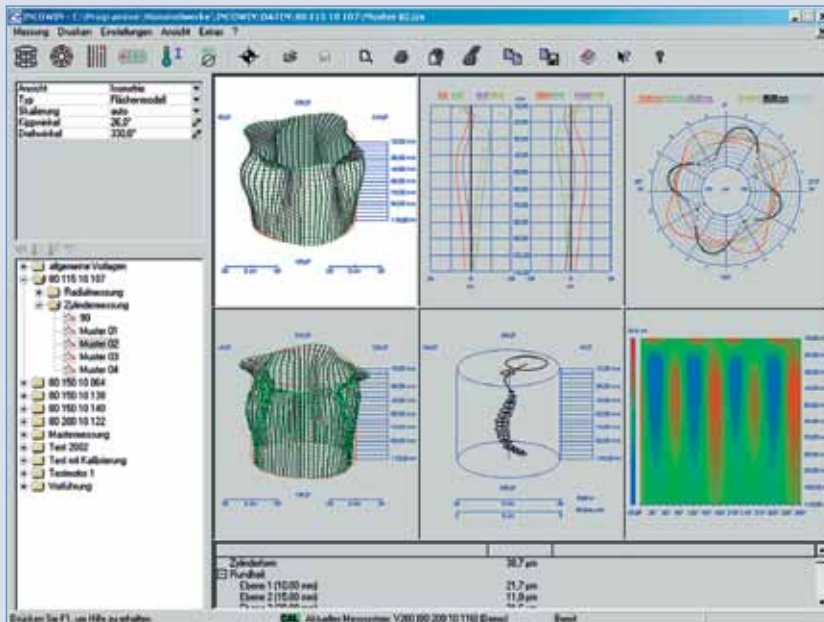
Clearly arranged desktop

The clearly structured INCOWIN software ensures that operating the measuring systems is easy, even with no previous experience. Once the measurements have been taken, all procedures, such as saving and printing the measurement results and statistically evaluating them, can be performed automatically. The advanced user administration (optional) allows hierarchical access to the individual functions of the INCOWIN software.

Performance features

- Optimal mobility with a notebook
- Clear and easy-to-understand user interface for intuitive operation
- Central data backup possible via network operation
- Rapid set-up of all user-specific requirements
- Multiple display options for easy analysis of the measurement results
- Easy creation of new measurement reports
- Customization of screen and print forms
- Language selection (English, German, French) during operation
- Simple project management
- Comfortable menu guidance
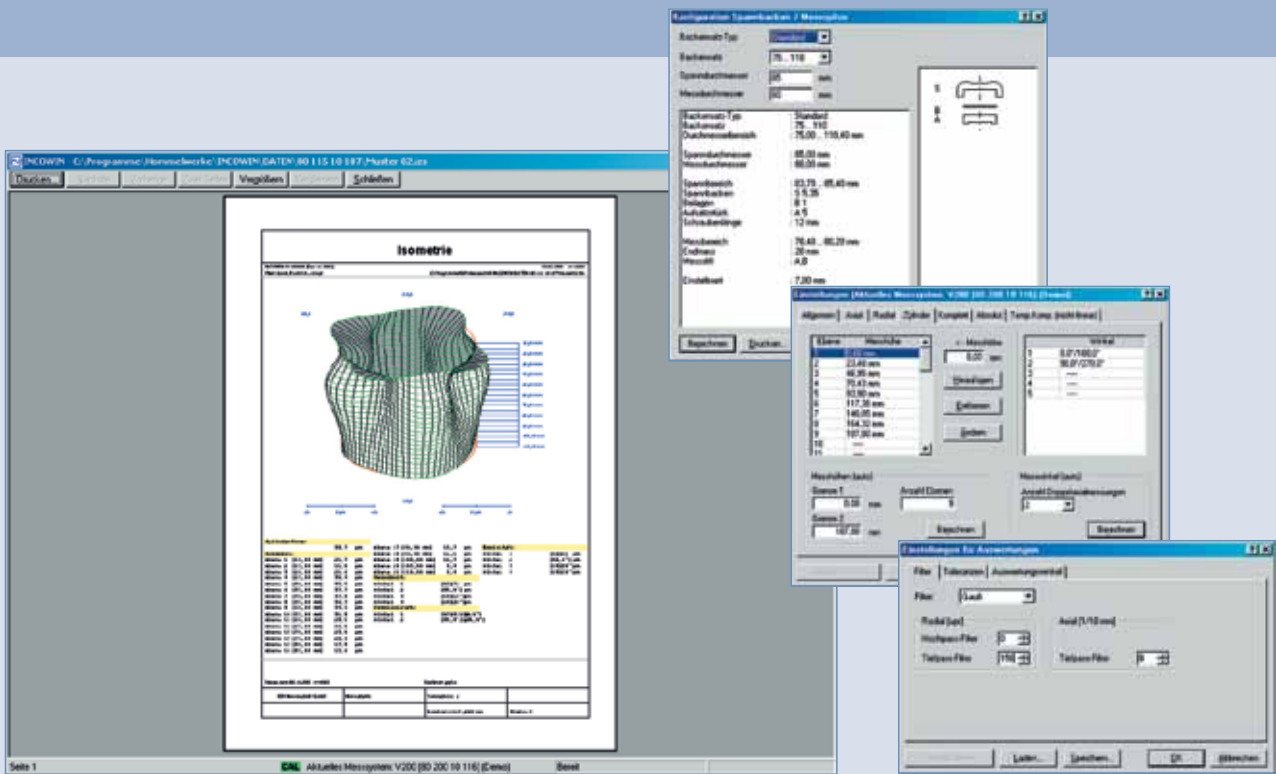
Print preview

Numerous support tools

Dynamic measurement

INCOWIN offers extensive measuring functions and is equipped with a standardized high-resolution scanner. This ensures a very high resolution and a detailed display of the actual geometry of the cylinder bore. The high data density allows standardized filter methods to be used (e.g. Fourier and Gauss filters or median filter for eliminating individual outliers).

Optimum mobility

The incometer systems are operated with a notebook for mobile use. The overall logic is generated on an interface card, which is installed in the electronics unit. The connection to the computer consists of a serial interface cable.

Unrestricted upgrade capability

Measurement systems can be retrofitted at any time. The cost will vary depending on the age and technological status of the system, and must be determined on a case-by-case basis.

Customizable range of functions

INCOWIN can be extended by software options and the range of functions can be customized, thereby ensuring maximum clarity.

Optional offline software

This module enables external (offline) evaluation and analysis of the measurement data from the incometer form measuring system on a separate computer.

hommel
etamic *INCOWIN*

Software options for research and development

Wear measurement

In order to measure the liner wear in previously used cylinder bores, the cylinder bore is measured in high resolution with axial scans equally distributed around the circumference.

Measuring temperature distortion

Due to the very fast complete cylinder measurement, the incometer systems are also able to measure hot engines (up to over 120°C), allowing temperature distortion to be identified on a „living" object.

Fourier analysis

Distortions are calculated using the Fourier analysis method for a more precise description of the cylinder form.

„Copy & Paste"/Data export

Both the graphics and the parameter list can be exported to another format or to other Windows applications.

Differentiation

For analyzing distortion changes with different configurations of the cylinder head, the cylinder head seal and the crankcase, or for hot distortion evaluations. A difference is generated based on measurements that have been carried out at different times in order to draw a direct comparison between them.

Data import

External data (polar, Cartesian or as Fourier coefficients) can be imported into the INCOWIN software, evaluated with the same algorithms as „normal" measurements, and compared with the incometer measurements.
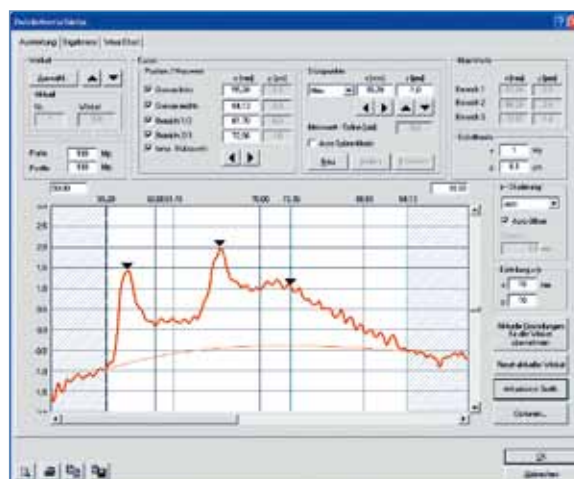
Wear measurement
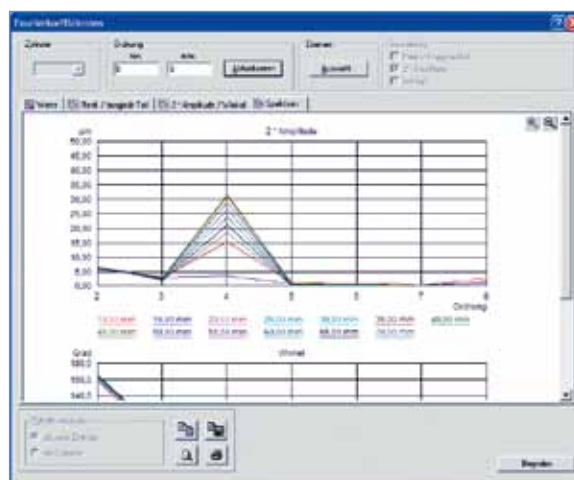
Fourier analysis
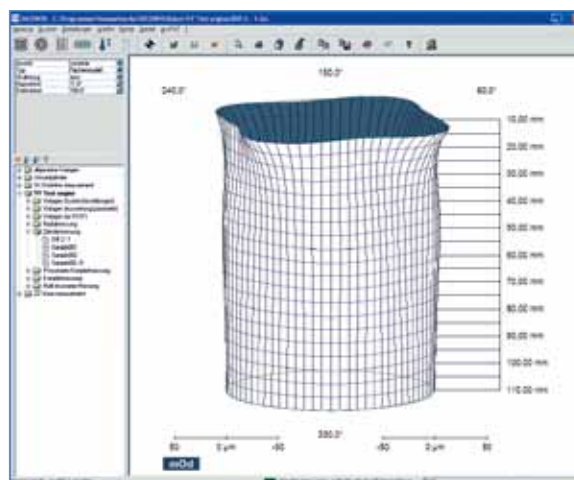
Differentiation

Software options for the production

Block measurement and complete evaluation

For measuring a complete crankcase with one-time input of the reference data. The user is guided through the entire measuring procedure via diagrams. All cylinder measurements of a crankcase are saved in a single file. The evaluation contains the printout of the form parameters for all cylinders in a table and provides a graphic display of the radial and axial measurement and the isometries for all cylinders on one page.

Data transfer to qs-STAT®

The qs-STAT® interface certified by Q-DAS allows the measurement results to be transferred to a statistics package for further process data analysis.

Determining the absolute diameter

For determining the absolute diameter of the cylinder of a crankcase. To this end, the incometer is calibrated to the nominal dimension of the cylinder diameter before each measurement.

Advanced user administration

For creating different users and user groups with their own profiles. The individual users can each be assigned to a specific group and given a personal password.

Automatic functions

For automating processes, such as saving, printing etc., in order to reduce errors resulting from incorrect inputs or user mistakes.
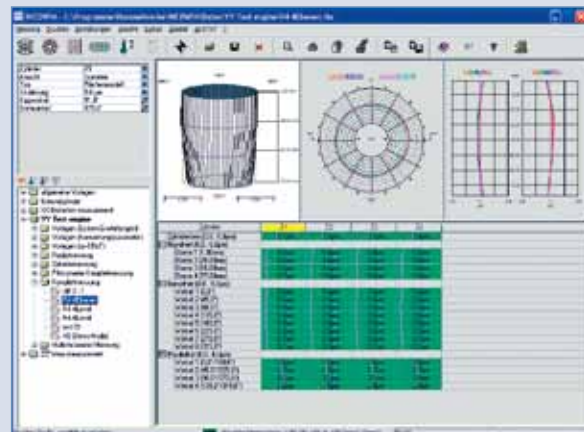
Block measurement

qs-STAT® interface

User administration

Technical data

HOMMEL-ETAMIC F series and roundscan

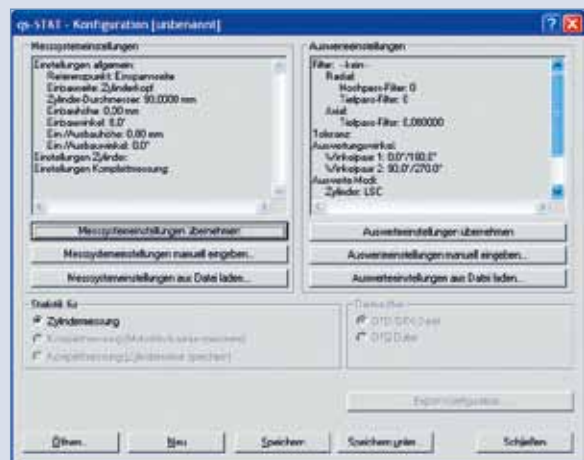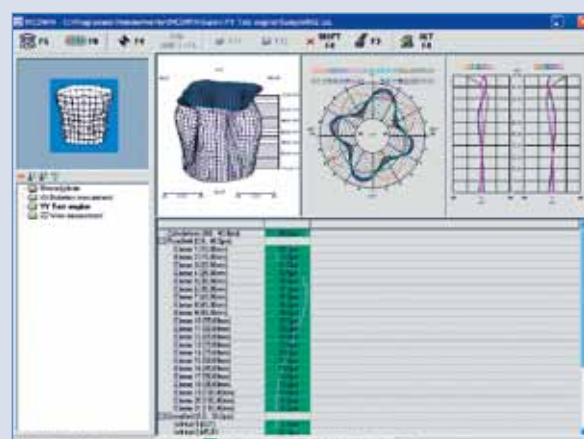| Model	F50	F135 / F155	F435 / F455	roundscan 535 / 555 / 590
Measuring range				
Distance C/Z axis	195 mm	275 mm	325 mm	370 (420)* mm
Max. test diameter	300 mm	340 mm	430 mm	430 (530)* mm
Max. measuring height	320 (560) mm	350 / 550 mm	350 / 550 mm	350 / 550 / 900 mm
Rotation axis (C axis)				
Table diameter	150 mm	150 mm	250 mm	330 mm
Workpiece alignment	manual	manual	automatic	automatic
Roundness error µm+µm/mm measuring height	0.05+0.0005 µm	0.03+0.0005 µm	0.02+0.0005 µm	0.02+0.0005 µm
Roundness error µm+µm/mm measuring height**	0.025+0.00025 µm	0.015+0.00025 µm	0.01+0.00025 µm	0.01+0.00025 µm
Axial run-out error µm+µm/mm radius	0.05+0.0005 µm	0.04+0.0005 µm	0.03+0.0005 µm	0.03+0.0005 µm
Axial run-out error µm+µm/mm radius**	0.025+0.00025 µm	0.02+0.00025 µm	0.015+0.00025 µm	0.015+0.00025 µm
Centering range	±2 mm	±2 mm	±2 mm	±5 mm
Leveling range	±0.6°	±0.6°	±0,6°	±1°
Measuring and positioning speed	1–10 1/min.	1–10 1/min.	1–12 1/min.	0,2–30 1/min.
Bearing	air	air	air	air
Max. charge	250 N	250 N	400 N	600 (1000)* N
Vertical axis (Z axis)				
Traverse distance	320 mm	–	–	–
Measuring distance	–	350 / 550 mm	350 / 550 mm	350 / 550 / 900 mm
Straightness error/100 mm	–	0.15 µm	0.15 µm	0.15 / 0.15 / 0.25 µm
Straightness error/measuring distance	–	0.3/0.4 µm	0.3/0.4 µm	0.3 / 0.45 / 1.5 µm
Parallel C-Z/measuring distance	–	0.8/1.3 µm	0.8/1.3 µm	0.5 / 0.8 / 2.5 µm
Measuring and positioning speed	–	0.2–23 mm/s	0.2–23 mm/s	0.2–50 mm/s
Collision protection	–	yes	yes	yes
Horizontal axis (R axis)				
Traverse distance	160 mm	–	–	–
Measuring distance	–	220 mm	220 mm	220 mm
Straightness error/100 mm	–	–	0.3 µm	0.25 µm
Straightness error/measuring distance	–	–	0.6 µm	0.5 µm
Squareness C-R	–	–	1.2 µm	0.8 µm
Measuring and positioning speed	–	0.2–14 mm/s	0.2–14 mm/s	0.2–50 mm/s
Dimensions/weight				
Length	475 (635) mm	700 (910)*** mm	790 (1010)*** mm	1990 mm
Width	285 mm	410 (550)**** mm	510 (650)**** mm	750 mm
Height	710 mm	950 / 1150 mm	960 / 1160 mm	1760 / 1960 / 2310 mm
Weight (approx.)	60 kg	185 / 200 kg	290 / 300 kg	650 / 665 / 685 kg

All accuracy data according to EN ISO 1101 at 20°C ±1°C in vibration neutral environment. Filter 0–15 rpm LSCI, or 2.5 mm LSLI; 6 rpm, or 4 mm/s.
All proof on standard under inclusion of the compensation method.

* On request
** Values as maximum deviation from the reference circle LSCI, filter 0-15 rpm LSC, 6 rpm
*** R axis extended
**** With servo box

HOMMEL-ETAMIC FMS

Model	FMS8200
Measuring range	
Max. test diameter	300 mm
Max. measuring height	1250 (1500)* mm
Max. traverse distance radial	210 mm
Rotation axis (C axis)	
Dimensions table	600 x 450 mm
Workpiece alignment	automatic
Roundness error radial µm+µm/mm measuring height	0.1+0.0008 µm
Axial run-out error µm+µm/mm radius	0.1+0.0008 µm
Bearing	air
Max. charge	3000 N
Traversing speed	max. 12 rpm
Resolution	0.01°
Positioning accuracy	0.1°
Vertical axis (Z axis)	
Measuring distance	1300 mm
Straightness error/100 mm	0.3 µm
Straightness error/measuring distance	2,6 µm
Measuring speed	16 mm/s
Positioning speed	25 mm/s
Positioning error/measuring distance	15 µm/1300 mm
Horizontal axis (R axis)	
Measuring distance	150 mm + 100 mm rel.
Straightness error/150 mm	1.5 µm
Measuring speed	16 mm/s
Positioning speed	25 mm/s
Positioning error/measuring distance	5 µm/150 mm
Straightness axis (X axis)	measuring
Measuring distance	800 mm
Straightness error/100 mm	0.3 µm
Straightness error/measuring distance	1.6/800 mm
Measuring speed	16 mm/s
Positioning speed	25 mm/s
Positioning error/measuring distance	10 µm/800 mm
Straightness axis (Y axis)	measuring
Measuring distance	300 mm
Straightness error/100 mm	0.3 µm
Straightness error/measuring distance	0.9 µm/300 mm
Measuring speed	16 mm/s
Positioning speed	25 mm/s
Positioning error/measuring distance	6 µm/300 mm
Dimensions/weight	
Length	1704 mm
Width	2250 mm
Height	3316 mm
Weight (approx.)	7500 kg

HOMMEL-ETAMIC CFM, shaftscan and CCM

Model	CFM3010	shaftscan 1030	CCM2010/CCM2020
Measuring range			
Max. workpiece diameter	205 mm	205 mm	175 mm
Max. test diameter	300 mm	300 mm	118 mm
Max. measuring height	1250 (1500) mm	1000 mm	1100/1000 mm
Max. traverse distance radial	210 mm	210 mm	60 mm
Rotation axis (C axis)			
Face plate	196 mm	196 mm	157 mm
Workpiece alignment	tips	tips	tips
Measuring speed	2–40 1/min.	2–40 1/min.	2–40 1/min.
Bearing	mechanical	mechanical	mechanical
Max. charge	1500 N	1500 N	500 N
Traversing speed	2–40 1/min.	2–40 1/min.	2–40 1/min.
Resolution	0.00005°	0.00005°	0.0001°
Positioning accuracy	0.1°	0.1°	0.1°
Accuracy	±0.00028	±0.00028°	0.00139°
Run-out accuracy of the roller bearing	0.25 µm	0.25 µm	< 0.5 µm
Vertical axis (Z axis)			
Travel distance	1290 (1590)* mm	1250 mm	1200/1000 mm
Measuring distance	1250 (1500)* mm	1000 mm	1170/935[1) mm
Collision protection	yes	yes	optional
Positioning speed	5–150 mm/s	5–150 mm/s	5–200 mm/s
Positioning error/measuring distance	0.05 mm	0.05 mm	0.1 mm
Measuring and positioning speed	5–150 mm/s	5–150 mm/s	200 mm/s
Resolution of the Z scale	0.1 µm	0.1 µm	0.1 µm
Accuracy	±3 µm	±3 µm	±3 µm
Straigtness axis (X axis)			
Measuring distance	210 mm	210 mm	60 mm
Resolution	0.02 µm	0.02 µm	0.1 µm
Accuracy	±0.2 µm	±0.2 µm	±0.5 µm
Setting range of measurement force	1, 2, 3 and 4 N	1, 2, 3 and 4 N	1, 2, 3 and 4 N
Travel in X direction			
Measuring point distance	0.1/0.2/0.5/1	0.1/0.2/0.5/1	0.1/0.2/0.5/1
Resolution radial	0.02 µm	0.02 µm	0.1 µm
Resolution axial	0.1 µm	0.1 µm	0.1 µm
Dimensions/weight			
Length	1240 mm	1650 mm	2000 mm
Width	1360 mm	1130 mm	1000 mm
Height	2450 mm	2300 mm	1150 mm
Weight (approx.)	2400 kg	2100 kg	1500 kg

* On request

[1)] CCM2020: 935 per measuring slide

Technical data

HOMMEL-ETAMIC incometer

Model	incometer V					incometer VS	incometer P
	V80	V115	V150	V200	V110	VS120	P100
Diameter of the cylinder*	65 – 155 mm					39 – 100 mm	60 – 110 mm
Clamping length min.	20 mm	20 mm	25 mm	30 mm	40 mm	ext. fixture	ext. fixture
Axial measuring range	80 mm	115 mm	150 mm	200 mm	110 mm	120 mm	max. 300 mm
Measuring path on the circumference	360°					360°	360°
Radial measuring range	± 400 µm					± 500 µm	± 500/1000 µm***
Resolution	0.1 µm					0.1 µm	0.1 µm
Number of measured values per rotation	14,400/1,024					14,400/1,024	14,400/1,024
Number of sensors	1					1	max. 7
Repeating accuracy Roundness Cylinder form Parallelism	≤ 1.0 µm ≤ 1.5 µm ≤ 1.5 µm					≤ 1.0 µm ≤ 1.5 µm ≤ 1.5 µm	≤ 1.0 µm ≤ 1.0 µm –
Measuring accuracy Roundness Cylinder form Parallelism	≤ 1.0 µm ≤ 1.5 µm ≤ 1.5 µm					≤ 2.0 µm ≤ 2.0 µm ≤ 2.0 µm	≤ 1.0 µm ≤ 1.5 µm –
Temperature range of use**	20 – 40 °C					20 – 40 °C	20 – 40 °C
Power supply	230 V / 50 Hz 115 V / 60 Hz					230 V / 50 Hz 115 V / 60 Hz	230 V / 50 Hz 115 V / 60 Hz
Power consumption	150 W					150 W	150 W
Weight of the sensor	2.9 kg					1.9 kg	8 kg***

* Further diameters on demand
** Measuring of the warm distortion on demand (up to 130°C)
*** Dependent on diameter

Product range for incometer	ø min/max	Height / Depth	Width of part	Laboratory	Offline
Cylinder bore	39 – 155 mm	≤ 200 mm	≤ 200 mm	incometer VS incometer V	incometer P
Cylinder liners	39 – 155 mm	≤ 200 mm	≤ 200 mm	incometer VS incometer V	incometer P

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