JENOPTIK

Formline – Form Metrology

Unequivocal measurement of form and positional tolerances using innovative measuring systems. SHARING EXCELLENCE

Your partner for measuring solutions

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

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.

We are one of the leading international specialists in high-precision, tactile and non-tactile production metrology.

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.
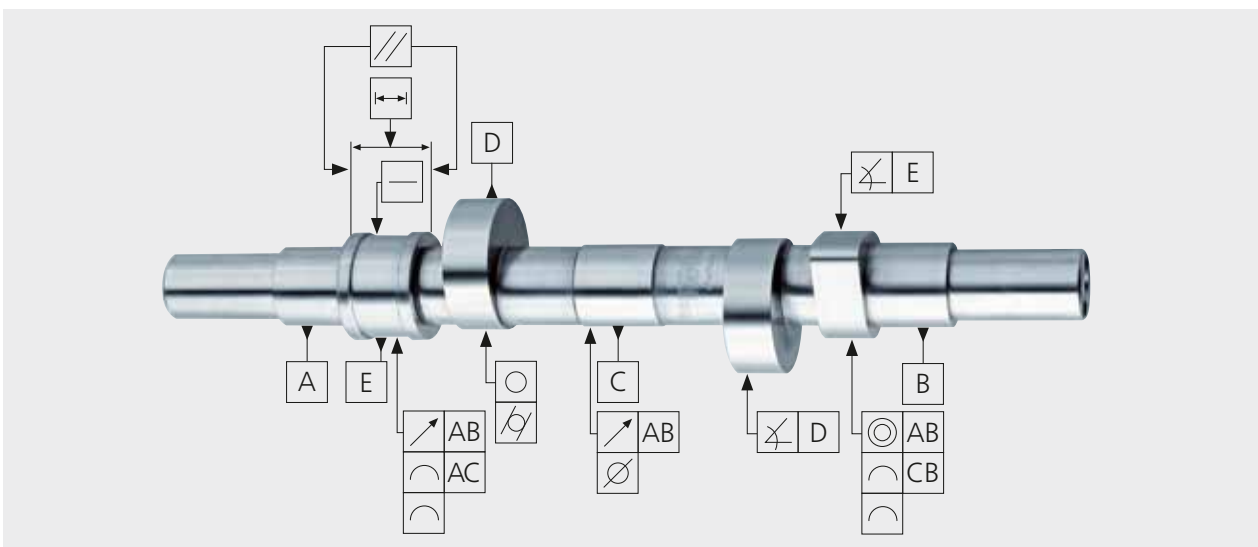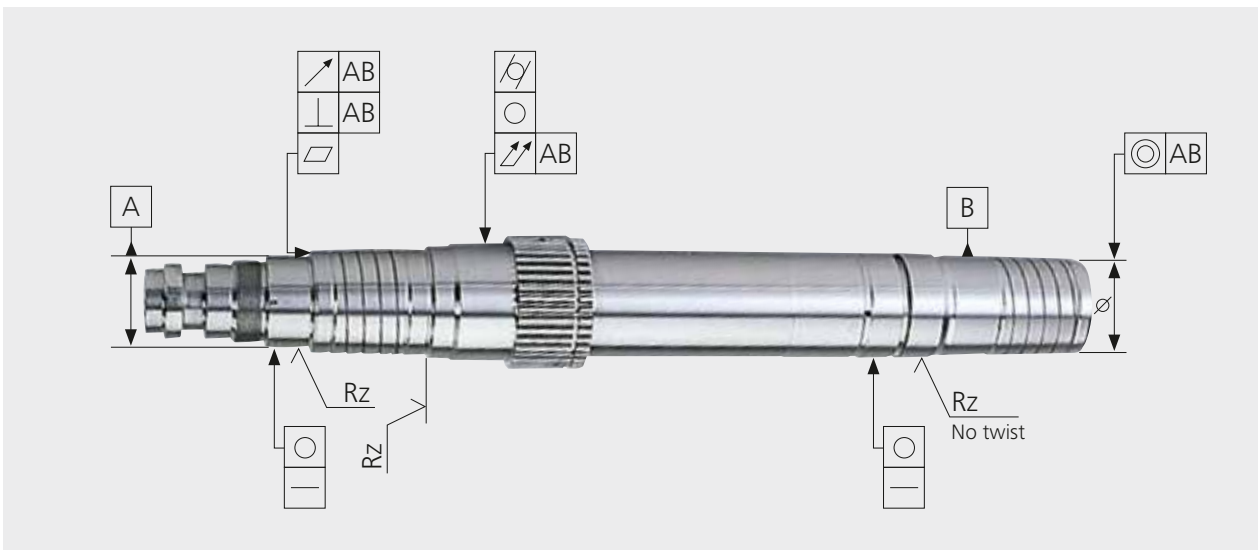
Flexible and efficient form measurement

Measuring systems of our Formline series offer you extensive evaluation possibilities for shaft type and cubic workpieces.

Form tolerances	Position tolerances	Run-out tolerances	Specific parameters
– Straightness	– Parallelism	– Radial run-out	– Conicity
– Roundness	– Perpendicularity	– Axial run-out	– Position deviation
– Flatness	– Angularity	– Total radial run-out	– Length
– Cylindricity	– Coaxiality, concentricity	– Total axial run-out	– Stroke radius
			– Crowning
			– Angle deviation
			– Waviness analysis
			– Twist
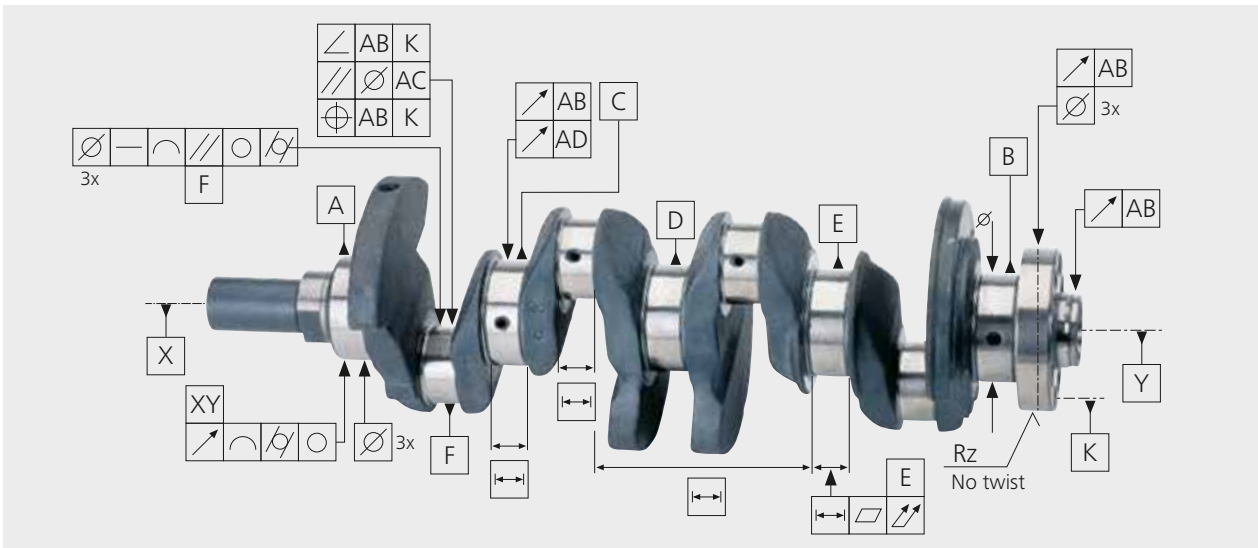
Form measuring systems with rotary table

Crank shaft and cam shaft measuring machines

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 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 specific crank shaft and cam shaft measurements 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 metrology. They boast explicit measurements according to standards, easy operation and professional evaluation of the measured values.
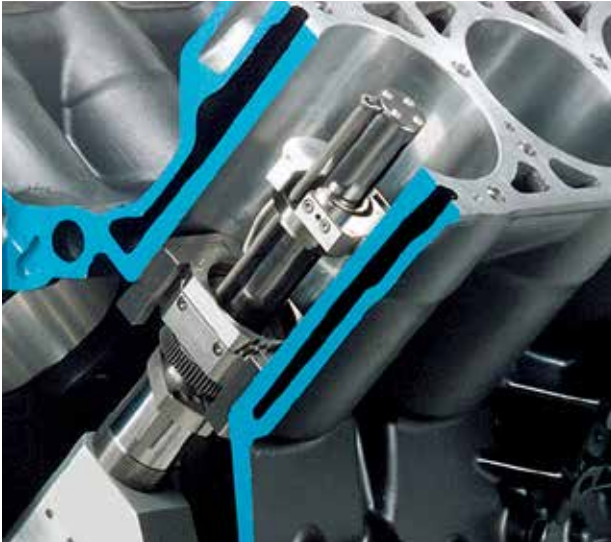
… in day-to-day operations

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.

Measuring systems for cylinder bores

Fully automatic measuring of all form and positional tolerances

The F435 and F455 form measurement systems allow you to determine roundness, cylinder form and flatness in a precise and reliable manner.

Highlights Formline F435 and F455

– 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

System features

– Highly accurate air bearing rotary table (Ø 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 with integrated air damping

Formline F435, ergonomic measuring station

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

Motorized tilt and
rotation module MDS

Formline F435,
desktop device with 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 operation,
saving you both time and money.

Fully automatic measurements

Thanks to the optional motorized tilt and rotation module
MDS with its motorized axes for tilting (90°) and rotating

(270°), the probe is always positioned in the optimum
probing position on the workpiece, thus allowing for
the measuring of complex workpiece geometries without
interrupting the CNC run.

Compact desktop device

Depending on requirements, the F435 and F455 measure-
ment systems are available either as a compact desktop
device or integrated into an ergonomic measuring station
with damping.

Model	Workpiece weight	Distance C/Z axis	ø measurable	Measuring height	Centering/ leveling	Measuring axes	Option roughness
F435/F455 desktop	40 kg	325 mm	430 mm	350/550 mm	automatic	C, Z, R	no
F435/F455 station form	40 kg	325 mm	430 mm	350/550 mm	automatic	C, Z, R	no
F435/F455 station roughness	40 kg	325 mm	430 mm	350/550 mm	automatic	C, Z, R	yes, Z axis

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.

Highlights Formline Roundscan

- Time saving thanks to very fast, fully automatic center-ing and leveling and CNC controlled measuring axes for save measuring, even on complex workpieces
- Flexible use for 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
- Ergonomically optimized design for convenient standing or sitting operation of the measuring system
- Highly accurate air bearing rotary table with impressive rigidity for consistently high precision

System features

- High resolution with 0.1 µm in the R/Z axis 0.1 µm and 720.000 points in the C axis
- Integrated linear scale
- Air damping with active level control
- Vertical measuring axis available in three different heights, depending on requirements: 350, 550 or 900 mm
- Motorized tilt and rotation module for fully automatic measurements at measurement positions that are hard to access

Formline Roundscan 555 with optional printer container

MDS4 with double-tipped probing system FT3 with collision protection

Height-adjustable evaluation unit

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

– CNC controlled tilt and rotation module MDS4 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 repro-ducible 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

Model	Workpiece weight	Distance C/Z axis	ø measurable	Measuring height	Centering/ leveling	Measuring axes	Option roughness
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

* on request

# 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.

Highlights Formline Turbo Form

– 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

System features

– For F435, F455 and Roundscan series
– 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
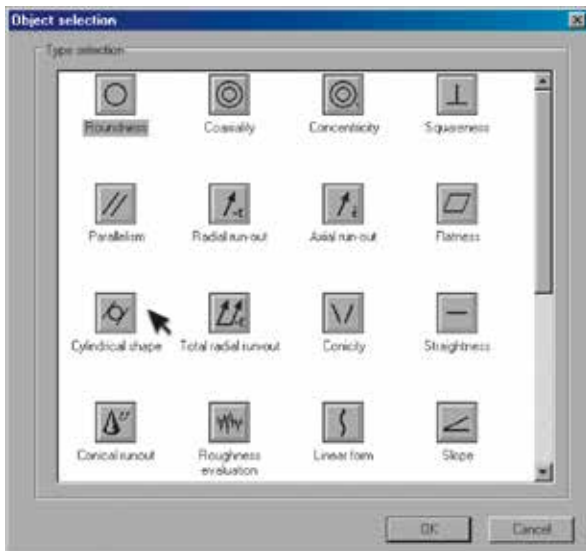
Creating test plans
By clicking the mouse you select the required characteristic. The wizard guides you simply and safely through all the necessary steps.
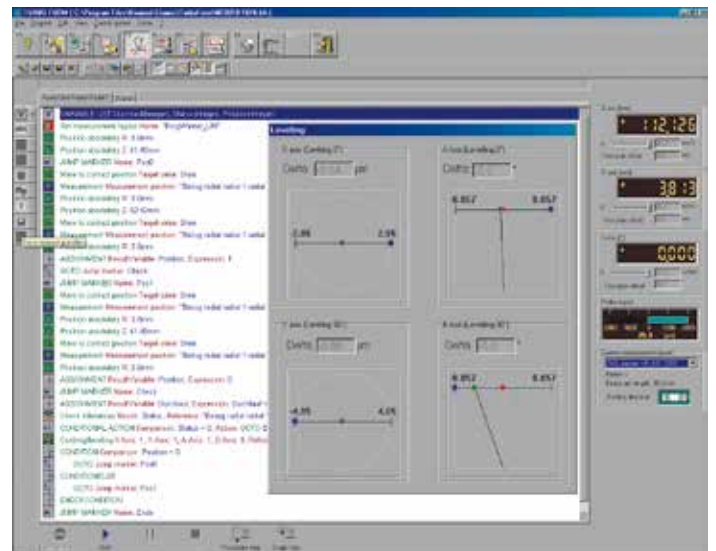
Automatic alignment
Alignment is fully automatic and supported by the software to optimum effect.

Automatic measurement runs: CNC

A CNC run is quicker than a manual measurement sequence and provides user-independent, reproducible results. The aligned workpiece is automatically measured at the measuring positions defined in the test plan. Printing and saving of the reports can be integrated directly into the automatic run.

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.
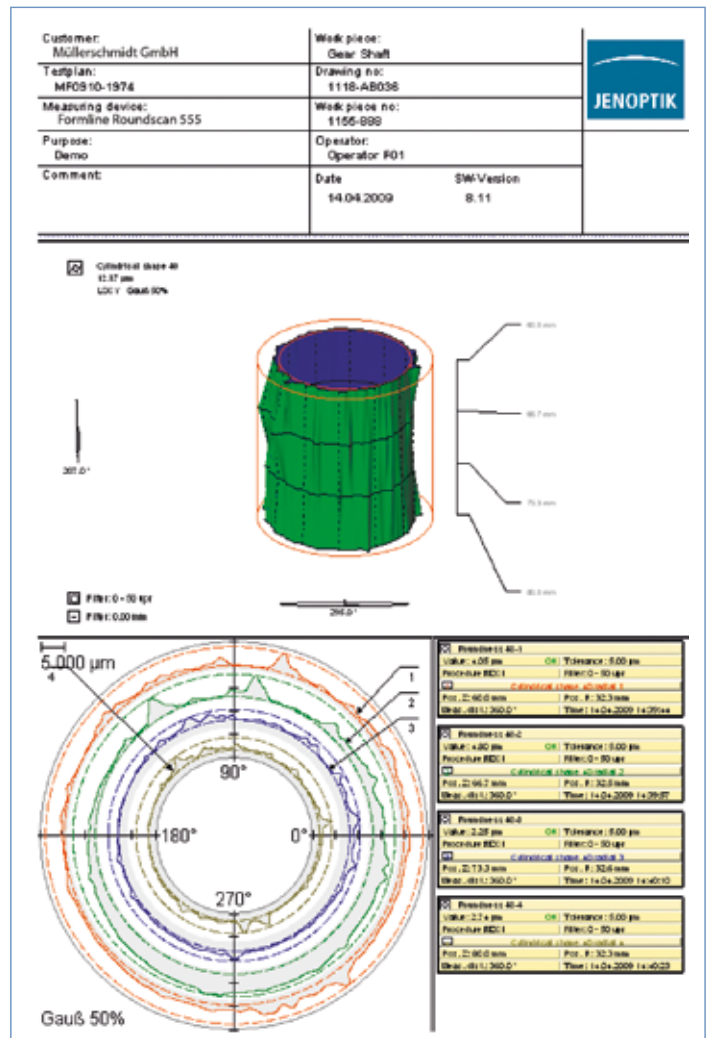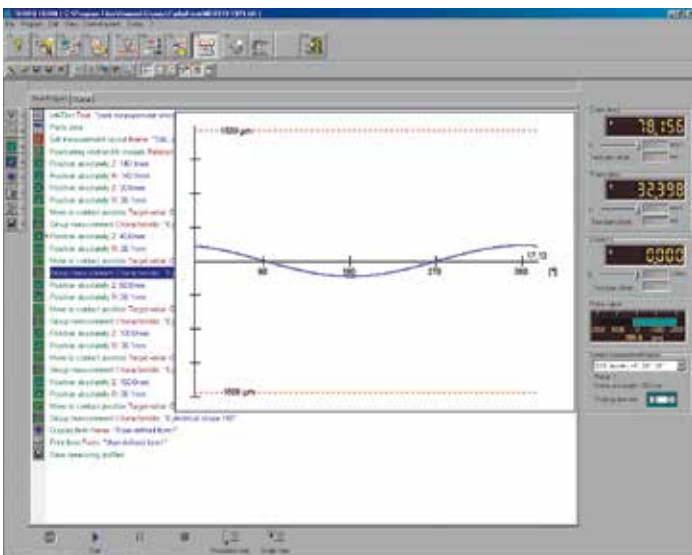
## Workpiece alignment and measuring run

Depending on the device configuration, workpiece alignment and measuring run are performed automatically.

Analysis and documentation

After scanning the workpiece, the measuring profiles are displayed clearly and in accordance with standards in (3D) diagrams. Measurement data can also be exported via an optional interface.

Software options for the evaluation of special measuring tasks

Line form

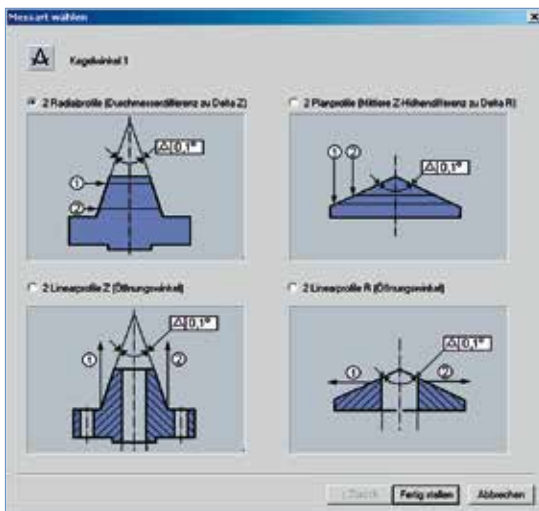Cone

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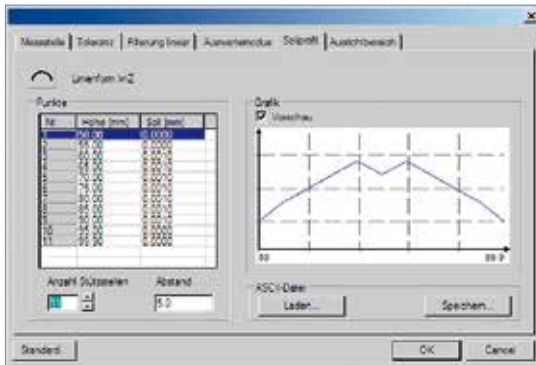
Line form
Evaluation of the line form by a nominal curve with even tolerance band.

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.
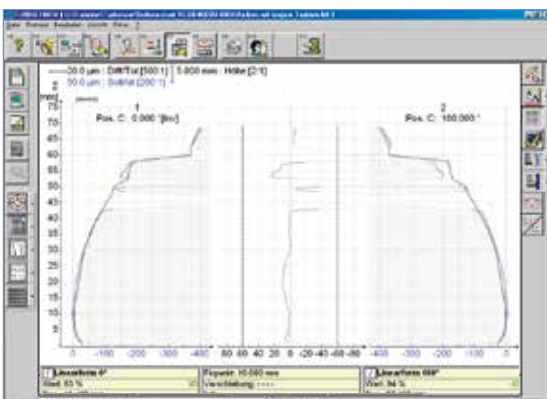
Piston measurement
Evaluation of typical characteristics on the outer surfaces of pistons and hub bores.
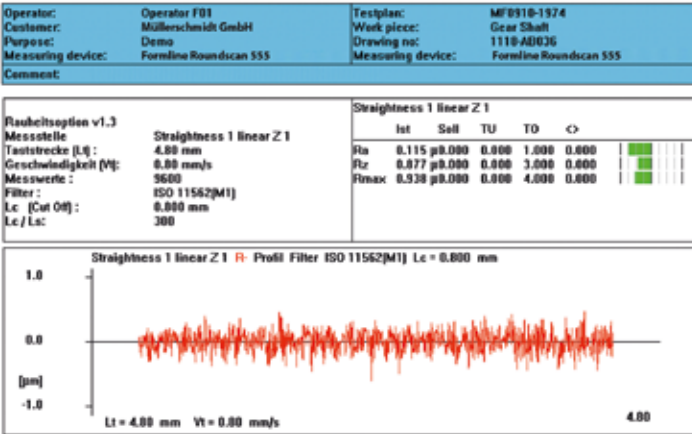
Brake disk measurement
Evaluation of certain important properties of brake disks such as wobble, thickness difference, waviness and wear measurement.

Dominant roundness waviness
Evaluation of the dominant roundness waviness in accordance with Daimler standard MBN 10455.

Evaluation of roughness, waviness and profile

Roughness parameters and roughness profile

This optional module for F435 and F455, as well as the Roundscan series, enables fast, simple calculation, evaluation and graphical representation of all standard roughness, profile and waviness parameters in accordance with DIN/EN/ISO/JIS standards.

Highlights option roughness measurement for Formline Turbo Form

– 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).

Measurement report

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 MBN 31007-7 Daimler standard 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

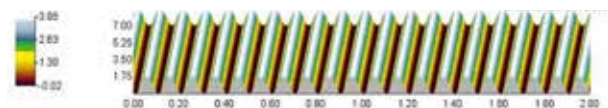With this modern analysis method for all Roundscan systems, the normal measurement time may be reduced by 75 %. During the measuring progress, a results forecast of the twist parameters is already possible – live!
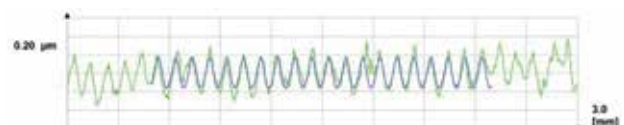
Twist measurement with a roughness stylus tip
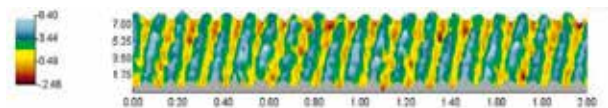
Display of unfiltered primary surface structure

Display of twist structure in detailed scaling

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

Accessories for F435, F455 and Roundscan series

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 MDS 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 F435 and F455

For desktop devices
GTS with drawers   Art. 232 900
GTS-K   Art. 232 901

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

Probe arm set for individual measuring tasks

Probe arm set FTM for F435, F455 and Roundscan series

With the FTM probe arm set you cover the most frequent form measuring tasks. Its components may also be ordered separately.

Probe arm set FTM   Art. 1002 9224

Components included in the probe arm set FTM:

Probe tip M2 pin wrench   Art. IM05 1215
Hexagonal key wrench   Art. IM02 6349
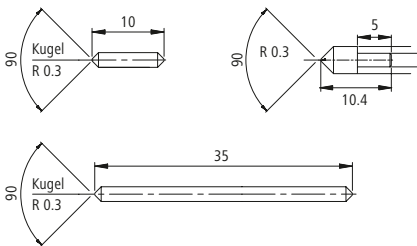
Probe tip FO KE300/90H L10 D2/10
L = 10 mm, 2x carbide tips 300 µm/90°

Art. 519 520

Probe tip FO KE300/90H L10.4 D4-2/5.4-5
L = 10.4 mm, 2x carbide tips 300 µm/90°

Art. 243 519

Probe tip FO KE300/90H L35 D2/35
L = 35 mm, 2x carbide tips 300 µm/90°

Art. 241 712
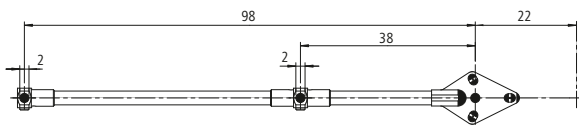
Probe arm FTM-HR-L038*098-D2*D2
The probe tip at 38 mm is suitable for outside measurements; the probe tip at 98 mm is used for measurements in bores.
2x probe tip supports Ø 2 mm, L1 = 38 mm, L2 = 98 mm

Art. 1003 0456
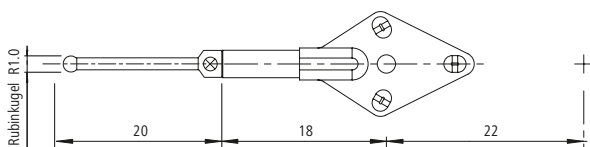
Probe tip M2 KU1000/-R L20 D1.0/14.0
L = 20 mm, 1x ruby ball 1000 µm,
1x M2 thread   Art. IM05 1207

Probe arm FTM-HA-L018-M2
L = 18 mm, axial probe tip, 1x M2 thread,
without probe tip   Art. 1000 3942
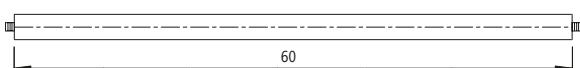
Probe tip extension M2V L60 KE D3.0/60.0
L = 60 mm, 1x M2 thread   Art. 1003 4259

Probe arms for various applications

Standard probe arm and probe tip

To cover the most frequent measurement tasks. Included in the scope of delivery of the form measuring systems F435, F455 and all Roundscan models.
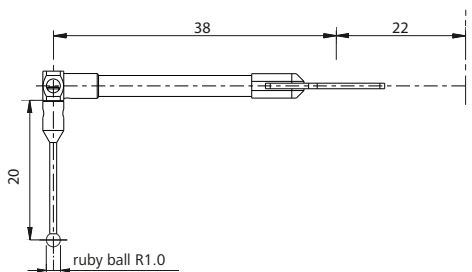
Probe arm FTM-R-L038-KU1.0-R
L probe arm = 38 mm, L probe tip = 20 mm,
radial probe tip, 1x ruby ball 1000 µm
Art. 1006 5094

Special probe arms for measurements in small bores from 3 mm
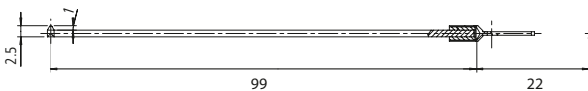
Probe arm FTM-R-L099-KE0.3-60H
For form measurement. L = 99 mm, radial probe tip,
1x carbide tip 300 µm/60°   Art. 1001 1703
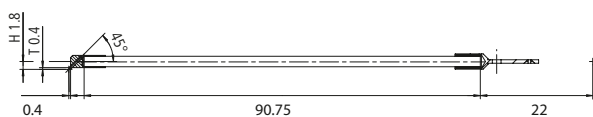
Probe arm FTM-R-L098-KE5/-60D
For roughness measurement. L = 98 mm,
radial probe tip, 1x diamond tip 5 µm/60°,
45° probe tip mounting   Art. 1004 0375
90° probe tip mounting   Art. 1004 0389
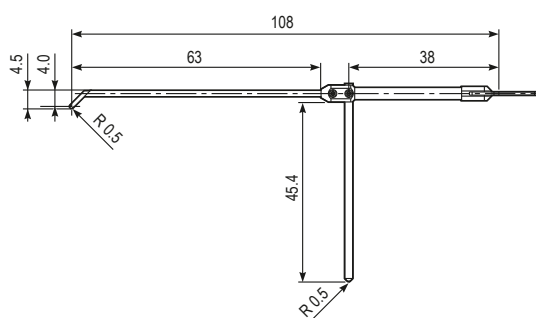
Probe arm FTM-HR-L038*108-KE0.5-90H-KU0.5H
For measurements on end faces, in bores and on the
bottom surfaces of bores. L1 = 38 mm, 1x carbide tip
500 µm/90°; L2 = 108 mm, 1x carbide tip 500 µm
Art. 1005 2509

Probe tip FO KE500/90H L50 D2/50
L = 50 mm,
1x carbide tip 500 µm/90°   Art. 1005 2561

Probe arms and probe tips with thread

For form measuring systems F435, F455 and all Roundscan models

M2

38 / 98 / 158 / 200   22
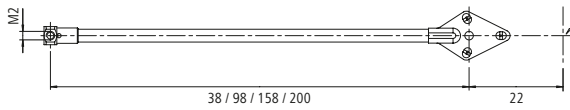
Probe arm FTM-HR-L038-M2
L = 38 mm, 1x radial M2 thread   Art. 1000 3938
Probe arm FTM-HR-L098-M2
L = 98 mm, 1x radial M2 thread   Art. 1000 9711
Probe arm FTM-HR-L158-M2
L = 158 mm, 1x radial M2 thread   Art. 1000 9714
Probe arm FTM-HR-L0200-M2
L = 200 mm, 1x radial M2 thread   Art. 1003 8257

M2

38

M2

98   22
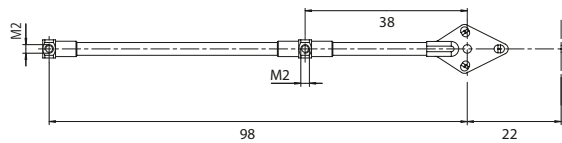
Probe arm FTM-HR-L038*098-M2*M2
L1 = 38 mm, 1x radial M2 thread,
L2 = 98 mm, 1x radial M2 thread   Art. 1002 4596

Probe tips M2 with ruby ball

Standard probe tips for precise form measurement.
Probe tip M2 KU1000/-R L10 D1.0/4.0
L = 10 mm; 1x ruby ball 1000 µm,
1x M2 thread   Art. IM05 1208
Probe tip M2 KU1000/-R L15 D1.0/4.0
L = 15 mm, 1x ruby ball 1000 µm,
1x M2 thread   Art. 1002 9794
Probe tip M2 KU1000/-R L20 D1.0/4.0
L = 20 mm, 1x ruby ball 1000 µm,
1x M2 thread   Art. IM05 1207

Probe tips M2 with diamond tip

For the exact determination of the surface parameters.
Probe tip M2 KE5 / 90GD L5 D3 M2
L = 5 mm, 1x diamond tip 5 µm/90°,
1x M2 thread   Art. 1002 9793
Probe tip M2 KE5 / 90GD L15 D3 M2
L = 15 mm, 1x diamond tip 5 µm/90°,
1x M2 thread   Art. 1002 5091

Probe tips M2 with cone tip

For measurements on ground and lightly soiled measuring points.
Probe tip M2 KE300/90H L5 D3/M2
L = 5 mm, 1x carbide tip 300 µm/90°,
1x M2 thread   Art. 1004 4157
Probe tip M2 KE300/90H L10 D3/M2
L = 10 mm, 1x carbide tip 300 µm/90°,
1x M2 thread   Art. 1004 4188
Probe tip M2 KE300/90H L15 D3/M2
L = 15 mm, 1x carbide tip 300 µm/90°,
1x M2 thread   Art. 1004 4189

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.

Highlights Formline CFM3010

- 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

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
- Wear-free air bearing measuring slides
- Capable evaluation software Tolaris Shaft for cam shafts and crank shafts

Formline CFM3010

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

Accessories for crank shaft and cam shaft measurements

We offer a wide range of standard and custom accessories for easy handling of the workpiece.
Thanks to the cam shaft standard, traceable cam form deviation measurements can be performed.

Measuring drivers and followers for different measuring tasks and workpieces

Universal driver

Workpiece-specific axial driver

Workpiece-specific radial driver

Flat measuring follower for crank
shafts and convex cam shafts

Round measuring follower made of different
materials and diameters for cam shafts

Nockenwellennormal

Cam shaft standard for traceable measurements

- PTB* certified evaluation software Tolaris Shaft for cam shafts
- DAkkS-DKD calibrated cam shaft standard
- Practice-oriented, reliable, traceable and therefore comparable status reports and status evaluations of cam shaft measurement systems
- Comparability of evaluation strategies and detached consideration of the influence of the software from a purely mechanical measurement process
- Definition of measuring uncertainty on the basis of synthetic reference information
- Certified measuring uncertainty of the software $<\pm0.1$ µm (cam form) or ±0.1" (angle)
- Evidence of gaging machine capability (Cg, Cgk)
- Evaluation of form and dimensional deviations in all the main characteristics

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

Characteristics measured

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

Modern evaluation software for reliable process control

The Tolaris Shaft evaluation software for the CFM3010 crank shaft and cam shaft measuring machine is easy to use and takes all key aspects for controlling and optimizing modern production processes for crank shafts and cam shafts into account.

Highlights Formline Tolaris Shaft

– Optimized for the measurement and evaluation of crank shafts and cam shafts
– Intuitive dialogs to support recurring tasks
– Standardized displays to make it easy to familiarize yourself with the software and use it reliably
– Extensive toleration functions
– Clear profile graphics
– Simple print form creation
– Control charts
– Extensive data exports to correct machine tools

System features

– Characteristic-oriented programming
– Offline programming
– Scope for expansion to include specific evaluation functions
– Measuring process management
– Accessories management
– User management
– Windows-compliant operation
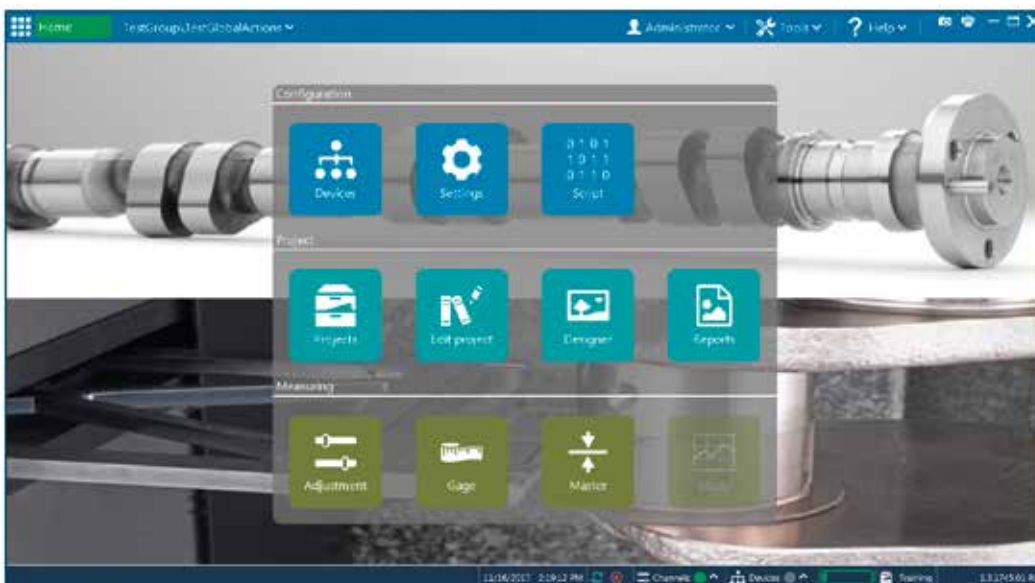
Start screen with easy-to-understand icons

Evaluation of special measurement tasks

Workpiece displays together with characteristics
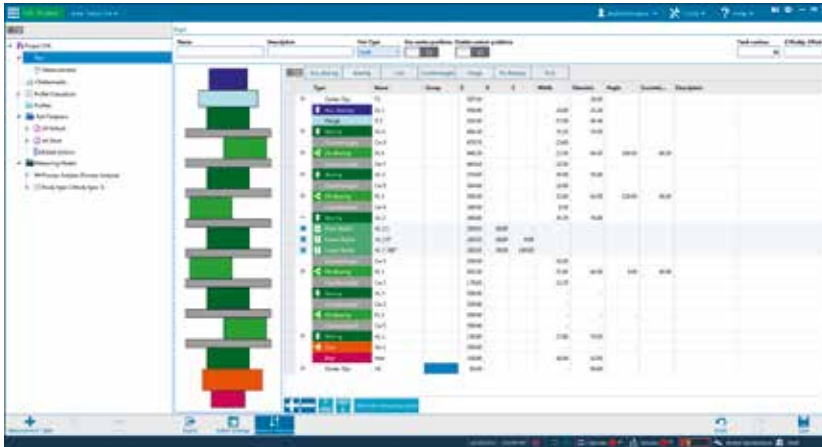
Characteristic-oriented programming

The workpiece is displayed in schematic format together with details of the measuring positions, making it easier to program the characteristics to be measured.

The required test characteristics are selected from an extensive library of measuring characteristics and provided with the relevant references.

Axis control

Machine control and CNC programming

The axis control functions for the machine are clearly arranged in a single view.

– Quick positioning to a specific measurement position for carrying out a single measurement
– Positioning sequences are programmed to create CNC programs

Management of workpiece-specific accessories
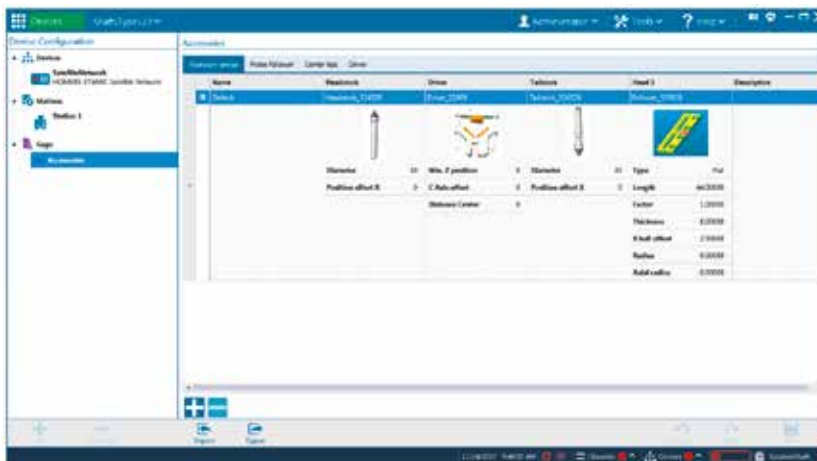
Accessories Management

The accessories management feature makes it easier to organize the clamping equipment and measuring elements required for specific workpieces.

The technical data of the accessory in use is taken into account by the measuring programs. When a clamping device is replaced, the corresponding measuring programs do not need to be changed.

Meaningful profile graphics
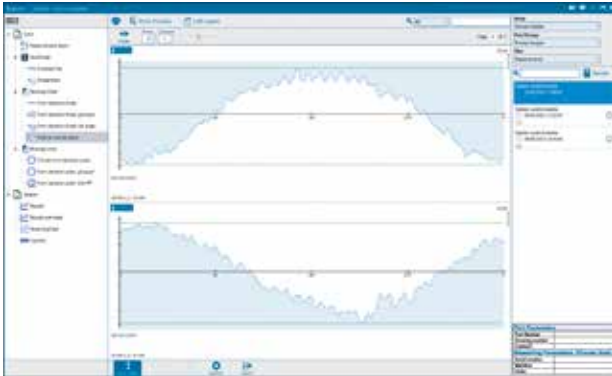
Axial run-out
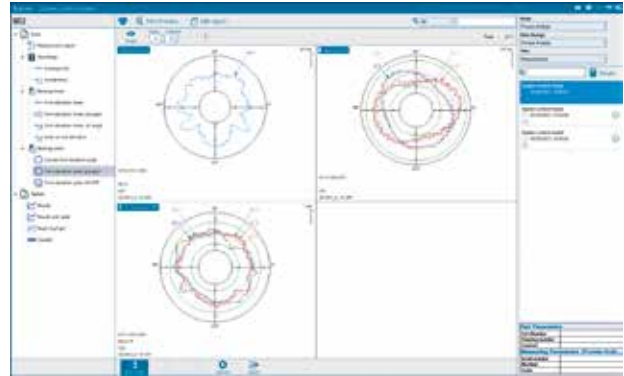
Form deviation on bearings
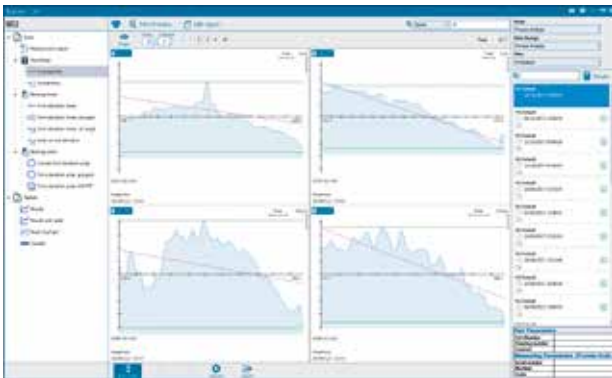
Envelope lines

Overview of results

Software options for Tolaris Shaft

qs-STAT® export

Certified in accordance with AQDEF. Process data is transmitted to the qs-STAT® statistics package for analysis.

Chatter marks

Fourier analysis of the surface waviness. Evaluation of the amplitude values of the harmonic waves with toleration above the limit curve.

Roundness waviness

For measuring and evaluating the dominant round-ness waviness in accordance with Daimler standard MBN 10455.

Cam form

Evaluation of specific characteristics when measuring cam forms.
– Base circle diameter/base circle difference
– Cam height
– Form deviation of cam form (pre-cam, main cam, post-cam)
– Form deviation differences
– Form growth
– Cam angle to reference element

Classification

The classification by tolerance classes allows the characteristics measured to be broken down according to the specified quality grades.

Formline 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.

Highlights Formline Incometer V

– 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

System features

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

Formline Incometer VS
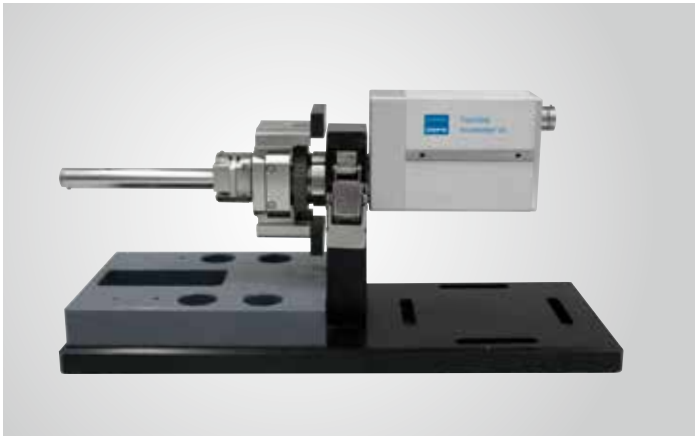
Formline Incometer V110

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.
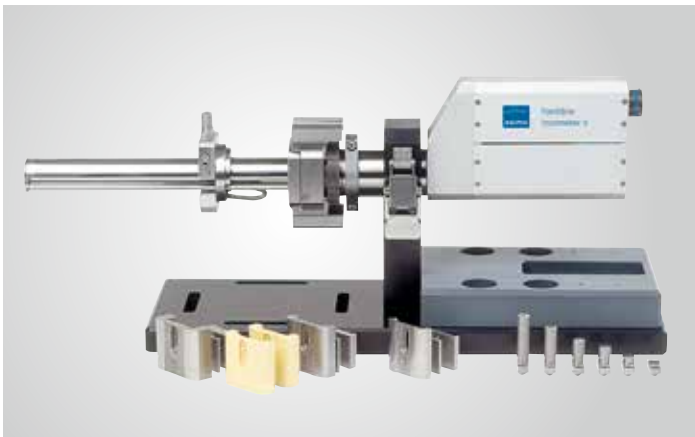
Mounting device and accessories for Incometer V

External plate for fixing the probe

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
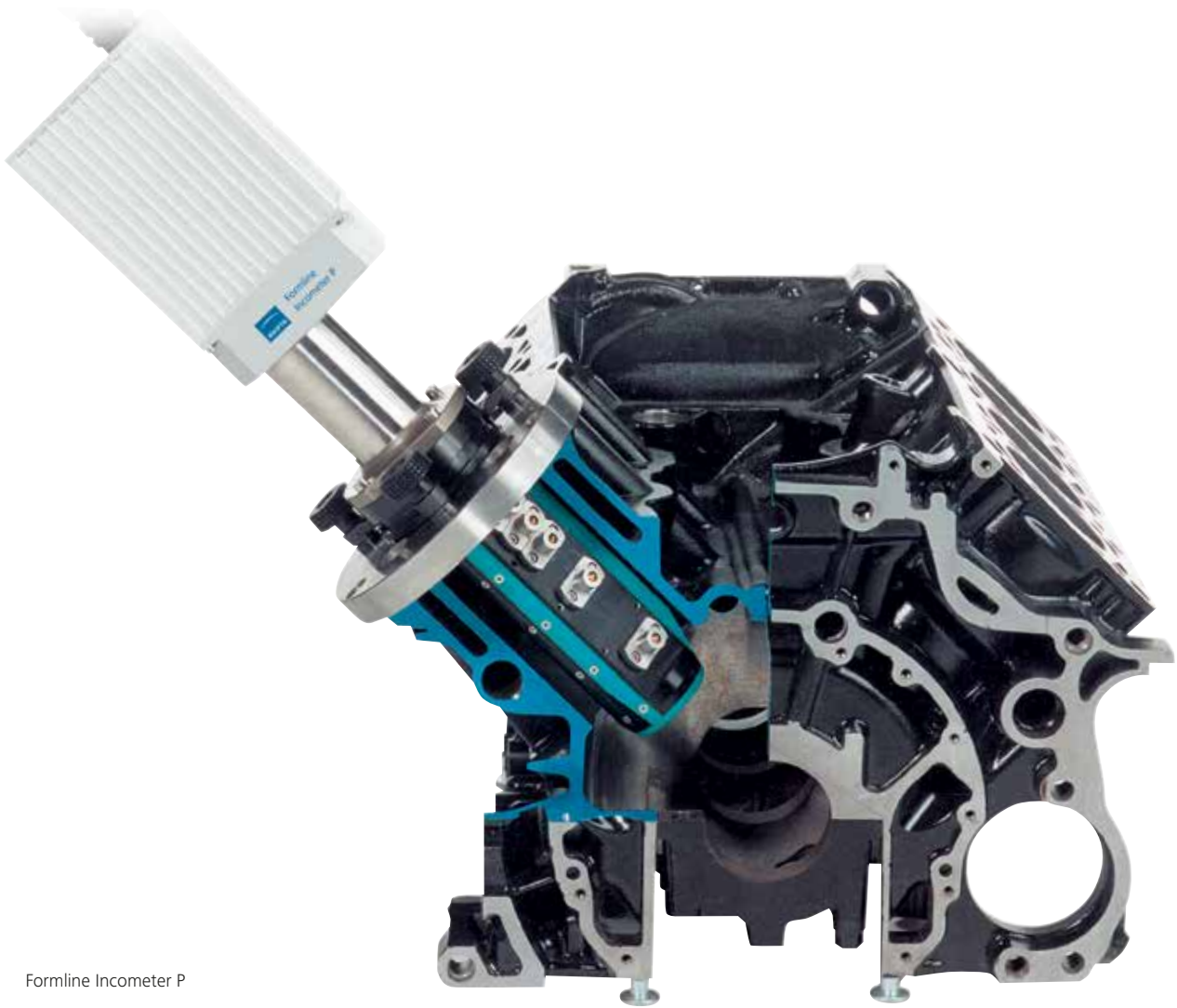
Formline Incometer P

Fast form measurement in cylinder bores

The Incometer P delivers fast, reliable and highly accurate quality data during production.

Highlights Formline Incometer P

- 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

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
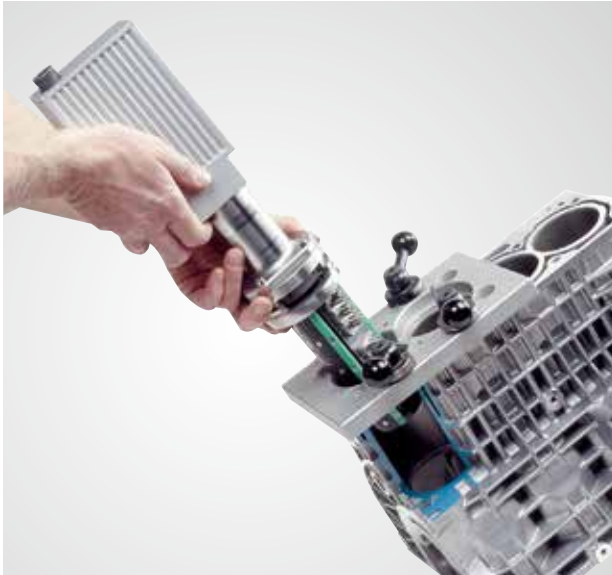
Inserting of the probe
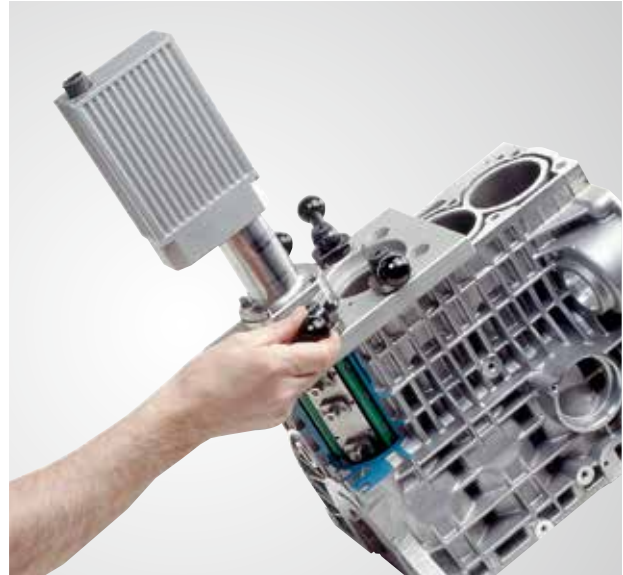
Fixing of the probe

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
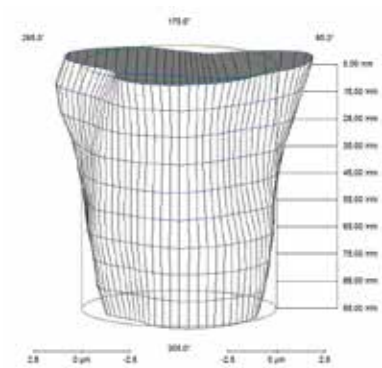
Isometric plot of a cylinder
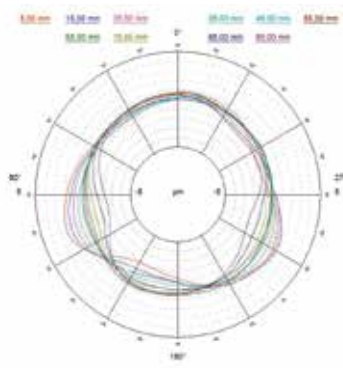
Radial plot of a cylinder bore measurement
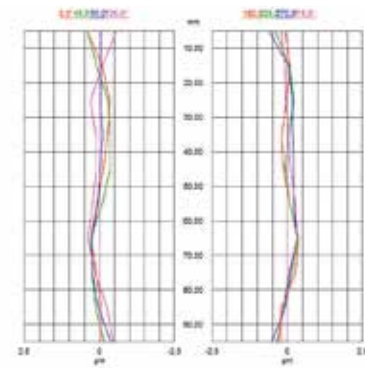
Axial plot of a cylinder bore

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

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.

Highlights Formline Incowin

– Rapid set-up of all user-specific requirements
– Multiple display options for easy analysis of the measurement results
– Easy creation of new measuring programs
– Customization of screen and print forms
– Template language selectable independent from user language

System features

– Optimal mobility with a notebook
– Clear and easy-to-understand user interface for intuitive operation
– Central data backup possible via network operation
– Extensive range of options for engine development and production

Clearly arranged desktop

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.

Print preview

Numerous support tools

Software options for research and development

Wear measurement

Fourier analysis

Differentiation

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 in hot engines, 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.

Software options for production

Block measurement

qs-STAT® interface

User administration

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.
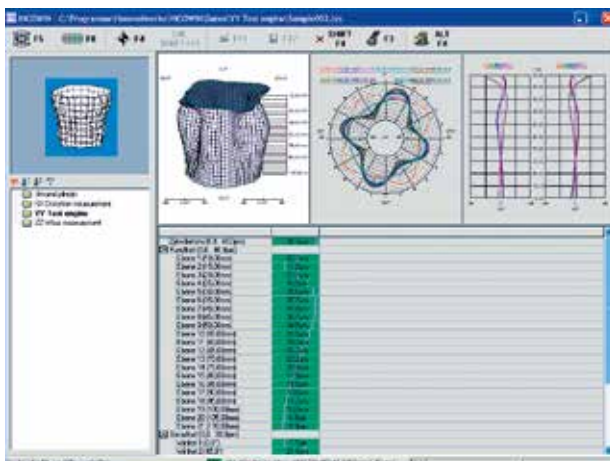
Technical data

Formline F435, F455 and Roundscan series

Model	F435 | F455	Roundscan 535 | 555 | 590
Measuring range		
Distance C/Z axis. max. interfering edge radius	325 mm	370 (420)[1] mm
Max. test diameter	430 mm	430 (530)[1] mm
Max. measuring height	350 | 550 mm	350 | 550 | 900 mm
Rotation axis (C axis)		
Table diameter	250 mm	330 mm
Workpiece alignment	automatic	automatic
Roundness error µm+µm/mm measuring height	0.02+0.0005 µm	0.02+0.0005 µm
Roundness error µm+µm/mm measuring height[2]	0.01+0.00025 µm	0.01+0.00025 µm
Axial run-out error µm+µm/mm radius	0.03+0.0005 µm	0.03+0.0005 µm
Axial run-out error µm+µm/mm radius[2]	0.015+0.00025 µm	0.015+0.00025 µm
Centering range	±2 mm	±5 mm
Leveling range	±0.6°	±1°
Measuring and positioning speed	1 – 12 1/min.	0.2 – 30 1/min.
Bearing	air	air
Max. charge	400 N	600 (1000)[1] N
Vertical axis (Z axis)		
Measuring distance	350 | 550 mm	350 | 550 | 900 mm
Straightness error/100 mm	0.15 µm	0.15 | 0.15 | 0.25 µm
Straightness error/measuring distance	0.3 | 0.4 µm	0.3 | 0.45 | 1.5 µm
Parallel C-Z/measuring distance	0.8 | 1.3 µm	0.5 | 0.8 | 2.5 µm
Measuring and positioning speed	0.2 – 23 mm/s	0.2 – 50 mm/s
Collision protection	yes	yes
Horizontal axis (R axis)		
Measuring distance	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 – 50 mm/s
Dimensions/weight		
Length	790 (1010)[3] mm	1990 mm
Width	510 (650)[4] mm	750 mm
Height	960 | 1160 mm	1760 | 1960 | 2310 mm
Weight (approx.)	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.

[1] On request
[2] Values as maximum deviation from the reference circle LSCI, filter 0-15 rpm LSC, 6 rpm
[3] R axis extended
[4] With servo box

Formline CFM3010

Model	CFM3010
Measuring range	
Distance C/Z axis. interfering edge radius[2]	162 mm
Max. test diameter	300 mm
Max. measuring height	1250 (1500) mm
Max. traverse distance radial	210 mm
Rotation axis (C axis)	
Face plate	196 mm
Workpiece alignment	tips
Measuring speed	2 – 40 1/min.
Bearing	mechanical
Max. charge	1500 N
Traversing speed	2 – 40 1/min.
Resolution	0.00005°
Positioning accuracy	0.1°
Accuracy	±0.00028
Run-out accuracy of the roller bearing	0.25 µm
Vertical axis (Z axis)	
Travel distance	1290 (1590)[1] mm
Measuring distance	1250 (1500)[1] mm
Collision protection	yes
Positioning speed	5 – 150 mm/s
Positioning error/measuring distance	0.05 mm
Measuring and positioning speed	5 – 150 mm/s
Resolution of the Z scale	0.1 µm
Accuracy	±3 µm
Straightness axis (X axis)	
Measuring distance	210 mm
Resolution	0.02 µm
Accuracy	±0.2 µm
Setting range of measurement force	1, 2, 3 and 4 N
Travel in X direction	
Measuring point distance	0.1/0.2/0.5/1
Resolution radial	0.02 µm
Resolution axial	0.1 µm
Dimensions/weight	
Length	1240 mm
Width	1360 mm
Height	2450 mm
Weight (approx.)	2400 kg

[1] On request
[2] Standard flat measuring follower, length 43 mm

Technical data

Formline Incometer systems

Model	Incometer V					Incometer VS	Incometer P
	V80	V115	V150	V200	V110	VS120	P100
Diameter of the cylinder[1]	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[3]	± 400 µm					± 500 µm	± 500/1000 µm[3]
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	≤ 1.0 µm					≤ 1.0 µm	≤ 1.0 µm
Cylinder form	≤ 1.5 µm					≤ 1.5 µm	≤ 1.0 µm
Parallelism	≤ 1.5 µm					≤ 1.5 µm	–
Measuring accuracy							
Roundness	≤ 1.0 µm					≤ 2.0 µm	≤ 1.0 µm
Cylinder form	≤ 1.5 µm					≤ 2.0 µm	≤ 1.5 µm
Parallelism	≤ 1.5 µm					≤ 2.0 µm	–
Temperature range of use[2]	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[3]

[1] Further diameters on demand
[2] Measuring of the warm distortion on demand (up to 130°C)
[3] Cylinder bores diameter 60– 80 mm / 80– 110 mm

Product range for Incometer	Ø min/max	Height / depth	Width of part	Laboratory	Production
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

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
– for cam shaft standards
– for contour standards
– for roughness standards

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

Standard 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

For inspecting the accuracy of the measuring systems.
Calibrated parameters:
Dt, DP, DG and Dγ.
Delivered with test report.
Art. 1001 6265

ilac-MRA

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Industrial Metrology for your applications

Our range of products and services offers solutions for the most demanding measuring tasks: we can work with you to determine the ideal measuring strategy and configure the appropriate system to meet even your most stringent requirements. In doing so, we take all the important considerations into account, such as the required level of automation, or the ability to integrate the measuring process into the production chain.

Waveline –
Roughness and Contour Metrology
Mobile, manual and automated measuring instruments for determining roughness, contour, topography and twist; combined systems for roughness and contour measurements; optical surface inspection for cylinder bores and customized solutions.

Formline –
Form Metrology
CNC-controlled systems for measuring form, position and twist, combined form and roughness instrumentation, form measurement systems for cylinder bores, crank shaft and cam shaft measuring machines and workpiece-specific solutions.

Opticline –
Optical Shaft Metrology
Optical measuring systems for determining dimensions, form, position and geometric elements on concentric workpieces. Can be used offline, or as an automated SPC measuring station within the production chain and as a customized solution for workpiece-specific requirements.

Visionline –
Optical surface inspection & profile measurement
Systems for automatic, optical surface inspection of inner and outer surfaces, optical measuring systems for determining structural elements in cylinder bores, as well as innovative multi-sensor systems for inspecting components in their entirety.

Movoline –
In-Process Metrology
Digital measuring heads, control devices and accessories for tactile in-process measurements of diameter, position and length in machine tools, all aimed at controlling the machining process of machine tools.


Gageline –
Dimensional Metrology
Pre-, in- and post-process measuring systems for measuring dimensions via tactile or pneumatic technologies, including manual, semi and fully automatic systems, final inspection machines as well as individual in-line systems.

Serviceline –
Services Worldwide
Metrological services that help our customers use their measuring systems to optimum effect, ensure the availability of these systems and maximize their performance.
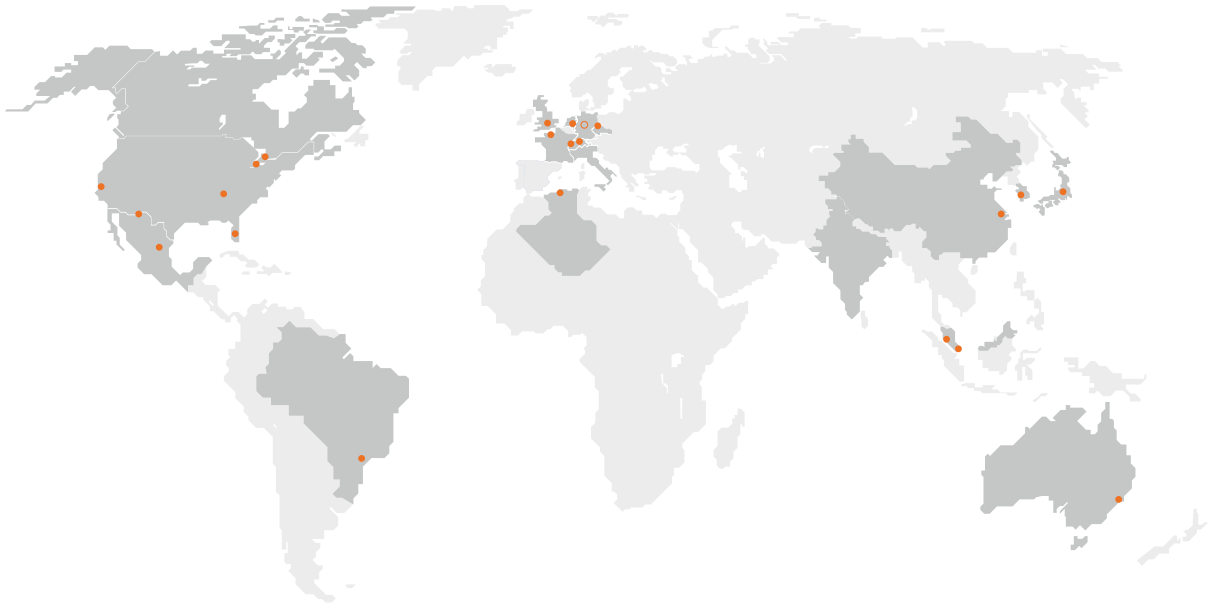
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