



**MACHINE TOOL INSPECTION
& ANALYZER SOLUTIONS**



INTRODUCTION

IBS Precision Engineering machine tool inspection series offers a range of products to provide peace of mind and control to machine operators by guaranteeing your machine is within specification. Machine-integrated, workshop robust INSPECTOR systems provide rapid qualification of cutting position, rotary table characteristics or spindle behaviour.

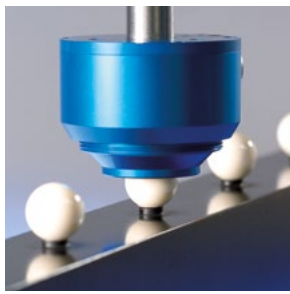
Simple go/no-go testing supports machine management and reduces out-of-tolerance products; data tracking makes essential maintenance planning easy.

For machine tool builders, maintenance providers and other advanced users ANALYZER systems offer fully calibrated, in-depth measurement and feedback capability. Machine acceptance qualification, compensation and diagnostics are at your fingertips.

DESIDERIUS ERASMUS

DUTCH HUMANIST (1469 – 1536)

Desiderius was the greatest humanist scholar of his age. He developed a biblical-humanist approach to theology that attached little value to dogma and to ecclesiastical ceremony.



MACHINE TOOL CALIBRATION AND INSPECTION SOLUTIONS

POSITION INSPECTOR

Quick health check of your machine tool linear axis

POSITION ANALYZER

In-depth analysis & diagnostics of your machine tool linear axis

ROTARY AXIS INSPECTOR

Quick health check of your machine tool rotary axis

ROTARY AXIS ANALYZER

In-depth analysis & diagnostics of your machine tool rotary axis

SPINDLE INSPECTOR

Quick health check of your spindle accuracy & performance

SPINDLE ANALYZER

In-depth analysis & diagnostics of your spindle accuracy & performance



	Linear axis	Rotary axis	Spindle
Inspection / Quick health check	<p>Position Inspector</p> 	<p>Rotary Axis Inspector</p> 	<p>Spindle Inspector</p> 
Analysis & Diagnostics	<p>Position Analyzer</p> 	<p>Rotary Axis Analyzer</p> 	<p>Spindle Analyzer</p> 

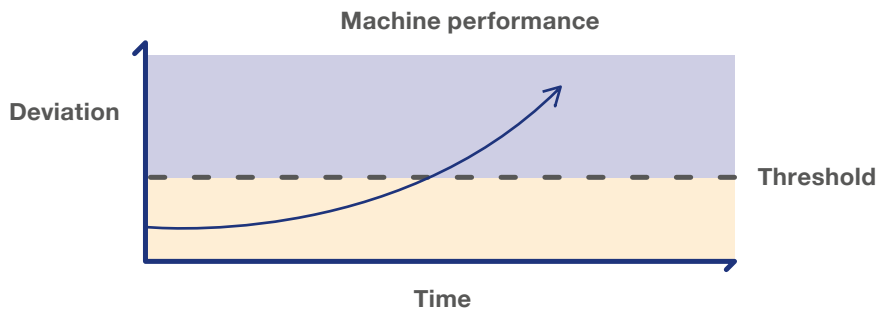
POSITION INSPECTOR



The positioning accuracy of any machine tool is of vital importance. It governs how and when your end product is within tolerance and defines your productivity. Over time accuracy falls off and with it your effective output.

The position INSPECTOR delivers rapid and reliable measurement of the positioning accuracy of your machine. Designed to integrate into the machine, it puts an instant 'health check' at hand during normal production.

The position INSPECTOR measures X-, Y- and Z- errors simultaneously, speeding the assessment process.



Interface & Network	Measurement	System Status	Results							
Ball:	1	2	3	4	5	6	7	8	9	10
X	0.002	0.001	0.006	0.008	0.010	0.004	0.007	0.007	0.005	0.001
Y	0.005	0.008	0.003	0.007	0.005	0.002	0.011	0.008	0.006	0.009
Z	0.007	0.004	0.009	0.001	0.009	0.008	0.003	0.000	0.003	0.009
<input type="button" value="Probe awake..."/>										Elapsed Sleep [min] 5.37

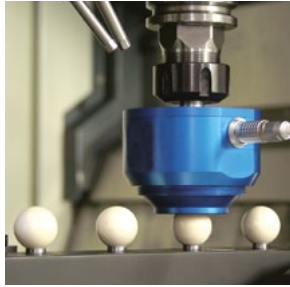
The Position Inspector will measure when the machine positioning accuracy exceeds a certain threshold and (if required) stop production to avoid scrap.

UNIQUE STRENGTHS OF THE POSITION INSPECTOR:

- Instantaneous qualification of tool positioning accuracy (for end product conformity)
- High performance measurement with 0,2 µm resolution
- Machine check with 10 positions within 1 minute
- Data tracking for predictive maintenance scheduling
- Automated process including simple go/no go options

The position INSPECTOR comes with the wireless (Trinity) probe. For specifications see pages 8 & 9.

All tests in compliance with the ISO 230 standard. All sensors are calibrated and supplied with a traceable certificate.



POSITION ANALYZER

For machine tool builders, maintenance providers and other advanced users the position ANALYZER meets the need for more comprehensive diagnostic capability, absolute calibration and data feedback for on-line compensation.

Absolute geometric conformity measurements are achieved using a calibrated ball beam. A large probe range enables simple set-up without the need for complex alignment procedures. Ball beam measurement is completed in minutes and shows the positioning accuracy and straightness deviations directly.

UNIQUE STRENGTHS OF OUR POSITION ANALYZER:

- Rapid and comprehensive machine volumetric positioning accuracy determination
- Simultaneous measurement of position and straightness errors
- Absolute measurements for machine acceptance test qualification
- In-depth machine characterization (e.g. reversal error, backlash assessment)
- Simple automated set-up delivers accuracy comparable to a laser interferometer
- Measurement according to ISO 230 standards



POSITION ANALYZER BALL BEAM

The ball beam provides a reference object allowing absolute calibration of your machine tool. Constructed from 22 mm diameter precision balls, the relative position of the ball centre points are calibrated in X, Y and Z and may be compared to the coordinate system of the machine tool.

The number and spacing of the precision balls can be chosen according to the application.

Standard available ball beams

Ball beam	Nominal length	Nr. of balls	Ball distance	Beam material*
MTB-500SC	500 mm	11	50 mm	Silicon Carbide
MTB-1000SC	1000 mm	21	50 mm	Silicon Carbide
MTB-1500SC	1500 mm	16	100 mm	Silicon Carbide

* Silicon carbide (carbon fibre available on request)

The position ANALYZER is available incorporating a wireless (TRINITY) or wired (TRITON) probe format. See pages 8 & 9.

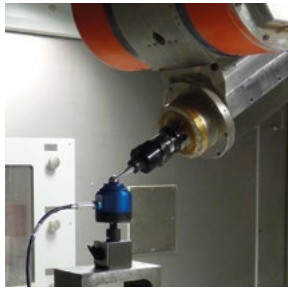


ROTARY AXIS INSPECTOR

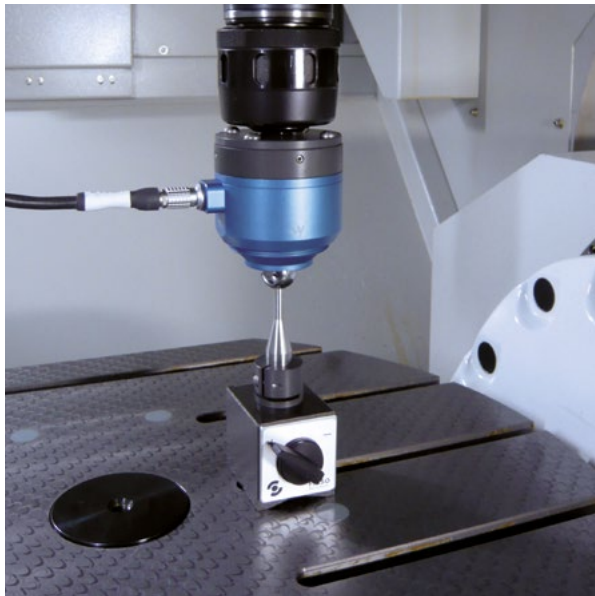
Providing rapid confirmation of current performance against desired specification, the rotary axis INSPECTOR provides a key part of your maintenance routine. Ideally your rotary axis should be centred about a precisely known point; in reality offsets occur as a result of normal operation that lead to distortion in cutting tool paths which superimpose onto the final product form. As product tolerances increase, the impact of such errors becomes critical.

The rotary axis INSPECTOR provides instant confirmation of the conformity of your machines rotary axes to guarantee product quality. Measurements can be conducted against a fixed protocol for go/no go operation control. Data is provided in an easily accessible form for quantifiable error correction and maintenance.





ROTARY AXIS ANALYZER



For users who require more comprehensive analysis and diagnostics, the rotary axis ANALYZER, places full capability in your hands. Machine tool developers and professional maintenance providers can quantify machine performance in real time with both static and dynamic measurement possible.

Unique probe configuration allows high accuracy 3D measurement to determine both the location and the squareness of the rotary table.

MACHINE ACCEPTANCE TESTS

Multi axis operations can be completed in minutes. Rapid verification of the rotary axis correctness can be confirmed on all machine configurations: swivel head, rotating table, trunnion or combined configurations. Meets all ISO 10791-6 requirements.

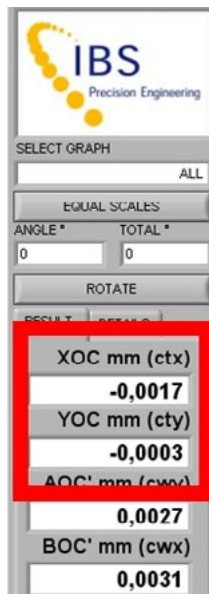
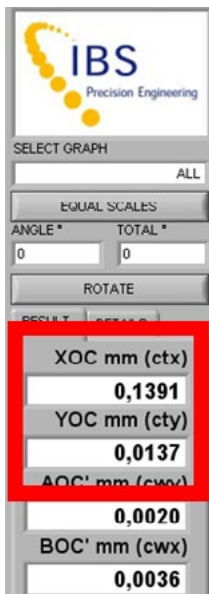
DYNAMIC ANALYSIS

Users can measure the true tool path under two or more linear and rotary axis movements.

EXACT ERROR CORRECTION AND COMPENSATION

No more guesswork based on static measurements - with real dynamic data at hand

The rotary axis ANALYZER is available with both wireless (Trinity) and wired (Triton) probe configurations. See pages 8 & 9.



Static measurement
C-Axis position before
and after compensation





PROBES



The position and rotary INSPECTOR and ANALYZER series employ IBS Precision Engineering's patented probe systems. Unlike other systems, their unique design means that X, Y and Z measurements are made simultaneously and with equal precision- so exceptional measurement speed and accuracy are delivered hand in hand.

Measurements are based on master ball(s) mounted on the machine tool. Moving the probe on to the master ball, three highly accurate sensors in the probe head are used to determine its centre point position with sub-micron accuracy.

Available in two configurations: the TRITON wired probe delivers a smaller measurement range with higher precision whilst the TRINITY probe provides the flexibility of wireless.



WIRELESS PROBE: TRINITY

The Trinity probe system consists of:

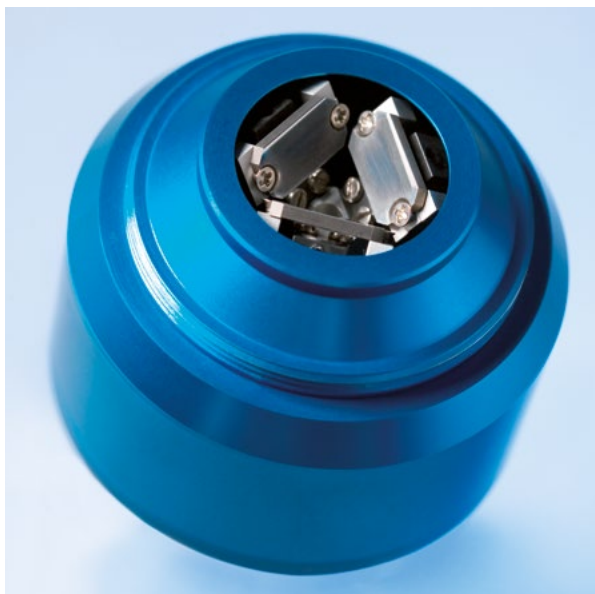
- Calibrated Trinity probe
- Wireless access point
- Wireless USB receiver
- 22mm diameter masterball
- Mounting accessories
- Travel case (optional)
- Manual
- 4 batteries (3100 mAh), including charger & adapter

SPECIFICATIONS PROBE

Measuring range	3,50 mm
Resolution	0,2 μ m
Sampling rate	2 kHz
Measuring uncertainty	U1 < 1,0 μ m (within 1 mm range)
Power consumption	> 24 hrs mixed operation
	1,3 W (=17 hrs) when measuring
	0,52 W (=42 hrs) when in sleep mode
Wireless details PSK	2,4 GHz frequency, 802.11b/g/n standard, WPA2 - security
Probe mounting shaft	\varnothing = 16 mm
Dimensions	Length: 135 mm; Diameter: 80 mm; Weight: 770 grams

SPECIFICATIONS MASTERBALL

Roundness error	< 0,6 μ m
Diameter (nominal)	22 mm
Length	75 mm



WIRED PROBE: TRITON

Measuring range	1 mm
Resolution	0,1 μ m
Sampling rate	6,5 kHz
Measuring uncertainty	U1 < 0,6 μ m (k=2)
Probe mounting shaft	\varnothing = 16 mm
Dimensions	Length: 56 mm; Diameter: 75 mm; Weight: 375 grams

SPECIFICATIONS PROBE

Roundness error	< 0,25 μ m
Diameter (nominal)	22 mm
Length	75 mm

SPECIFICATIONS MASTERBALL



SPINDLE INSPECTOR

Spindles represent a key part of any machine tool. Not only does their performance represent a key parameter in product quality, they can represent a significant fraction of the machine cost.

The IBS Precision Engineering spindle INSPECTOR delivers a simple but highly accurate system which may be integrated seamlessly into production systems. Automated measurement at a range of user defined speeds reduces spindle performance to a set of simple parameters with definable tolerances*. A 'green light' system allows your machines to continue performing uninterrupted until a tolerance run out is spotted; system interface options cease operation when tolerance is exceeded. Spindle replacement can be precisely predicted; product failure and sampling reduced.

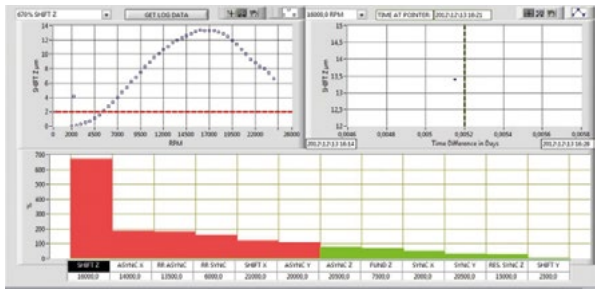
Unique strengths of the spindle INSPECTOR

- High performance non-contact measurement at 75 nm resolution
- Measurement of dynamic spindle performance from 250 to 40,000 rpm
- In process axis shift measurement
- Data logging for spindle performance monitoring over time

List of parameters

- Synchronous radial error in X
- Asynchronous radial error in X
- Synchronous radial error in Y
- Asynchronous radial error in Y
- Synchronous rotating radial error
- Asynchronous rotating radial error
- Fundamental axial error in Z
- Residual axial error in Z
- Asynchronous axial error in Z
- Axis shift in X
- Axis shift in Y
- Axis shift in Z

*Tolerance values can be predefined by IBS Precision Engineering based on product specifications.

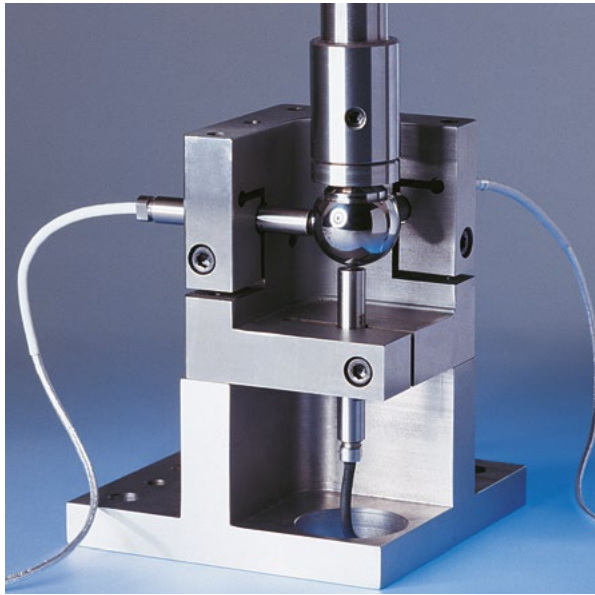
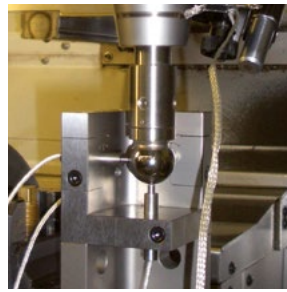
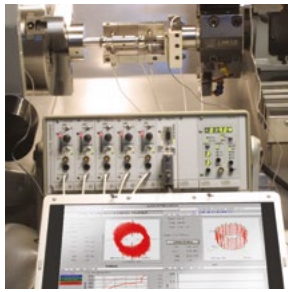


Measurement takes place in a probe nest permanently positioned in the machine. The target is a high precision cylinder with a maximum roundness error of 1 μm , accommodated in the tool magazine. Three sensors in the probe nest measure simultaneously allowing a real-time dynamic radial and axial measurement.

All data is acquired by an industrial real-time system and stored locally. The spindle INSPECTOR is supplied with Windows software to analyse and present the data. Multiple inspectors can be networked remotely for total factory control.

SPECIFICATIONS

Range	625 μm
Resolution	< 0,075 μm
Input	110-230 VAC
Output	TCP/IP network communication / 24 V output to machine tool
Measurement time	30 seconds per rpm test
RPM range	250 - 40.000 rpm
Software	Monitor spindle performance over time with up to 500 measurements in log file
Target roundness	< 1 μm (calibrated)



SPINDLE (ERROR) ANALYZER

UNLOCKING THE MYSTERY OF SPINDLE PERFORMANCE

Spindles represent a key part of any machine tool. They determine the quality of the final product produced and the overall productivity and efficiency of the machine tool itself. In state of the art machine tools the spindle takes up a considerable part of the total cost of your machine. The Spindle Error Analyzer (SEA) is developed specifically for machine tool metrology, giving you clear and noncompromising results.

WHY SHOULD YOU USE A SPINDLE ANALYZER ?

Spindle manufacturer:

- Optimization of your spindle design
- Understanding complex spindle problems
- Demonstration of your spindle performance
- Clear machine commissioning with ISO standard measurements

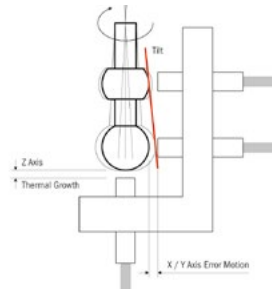
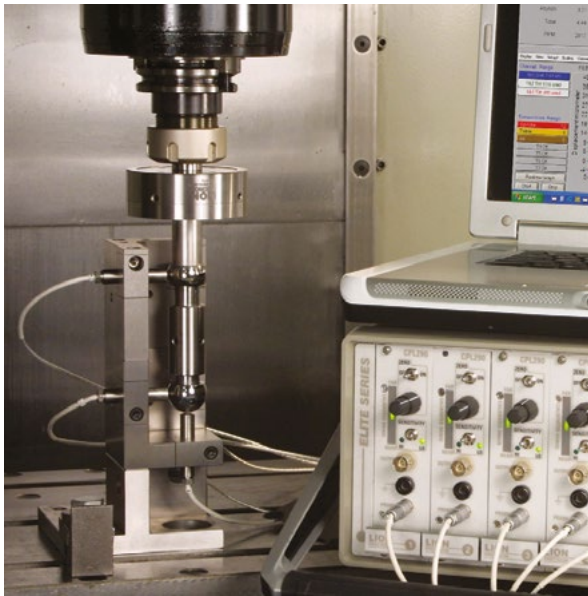
Spindle end user:

- Money saving predictive maintenance
- Higher and better work piece quality
- Recognition of warranty claims
- Machine acceptance
- Working order checking following crashes

The Lion Precision Spindle Error Analyzer is a complete system for spindle metrology that measures and analyses the accuracy of machine tool spindles. The system works by installing a precision Master-Ball target with a maximum roundness error of 50 nm* in the tool holder. The spindle motion is measured with non-contact probes mounted in a precision fixture.

These readings are then analysed by state-of-the-art algorithms and the results presented in easy to read charts and graphs.

**with reversal techniques the roundness error of the master ball can be eliminated*



CLEAR AND NON-COMPROMISING RESULTS

The purpose of the SEA system:

- High performance non-contact measurement with nanometre resolution
- Measurement of dynamic spindle performance
- Measurement of thermal drift

The Spindle Error Analyzer performs tests in compliance with the latest ISO 230 standards

Applications:

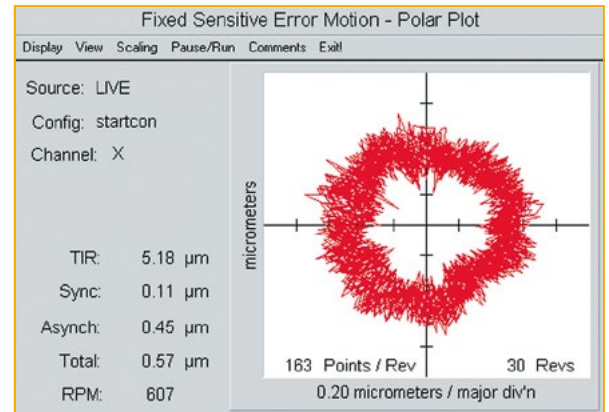
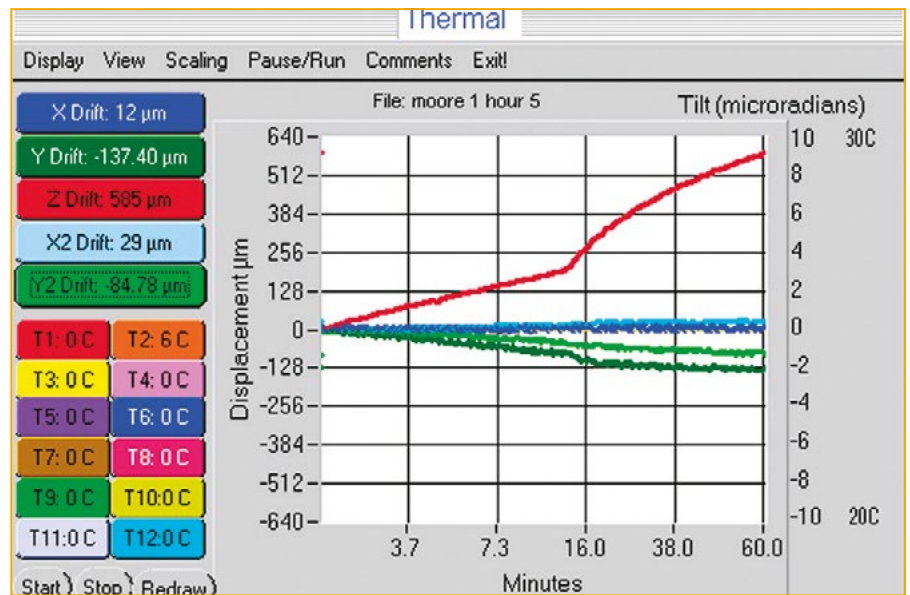
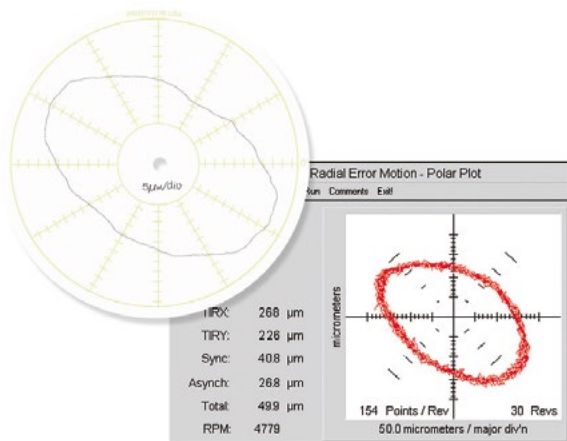
- Wide range of spindles and rotary tables
- Ultra precision and high speed spindles
- Real-time measurement & analysis
- Measurement according to ISO 230-3 and 230-7 standard
- Complete and portable system

Measurement setup & principle

Non-contact precision sensors are applied to measure the dynamic displacement of master ball targets. The applied capacitance sensors are best suited because of the high bandwidth and they are not influenced by material properties or inhomogenities like inductive sensors.

A standard setup consists of 3 sensors mounted in X-, Y- and Z-direction respectively. The sensors measure simultaneously the master ball allowing a real-time dynamic radial and axial measurement. With 5 sensors also the tilt of the spindle can be determined in X- and Y-direction.

The high performance software collects the readings from the probe while the spindle is turning, analyses the results and reports them on screen with polar and linear plots and discreet measurement values.



EFFECT OF SPINDLE ERROR MOTION

Feature location errors

Thermal growth is the largest single error source in your machine tool. As the machine heats up, it will grow and bend. That will change your tool position and tilt resulting in a different feature size, feature location and/or hole depth.

With the Spindle Error Analyzer you measure this drift according to the latest ISO 230-3 standard. This enables you to characterise the machine, do an acceptance test or compensate for the errors.

Roundness quality

The synchronous error motion is the "out of roundness" of your spindle rotation. It predicts your ability to cut a round hole or to turn a round product. The measured synchronous error will match the roundness measurement plot of your product. Measuring the synchronous error motion will enable you to characterise all your spindles so you know which one to use for the critical parts. It also lets you test a spindle for maintenance or after a crash to see if its ability to make good parts has been affected.

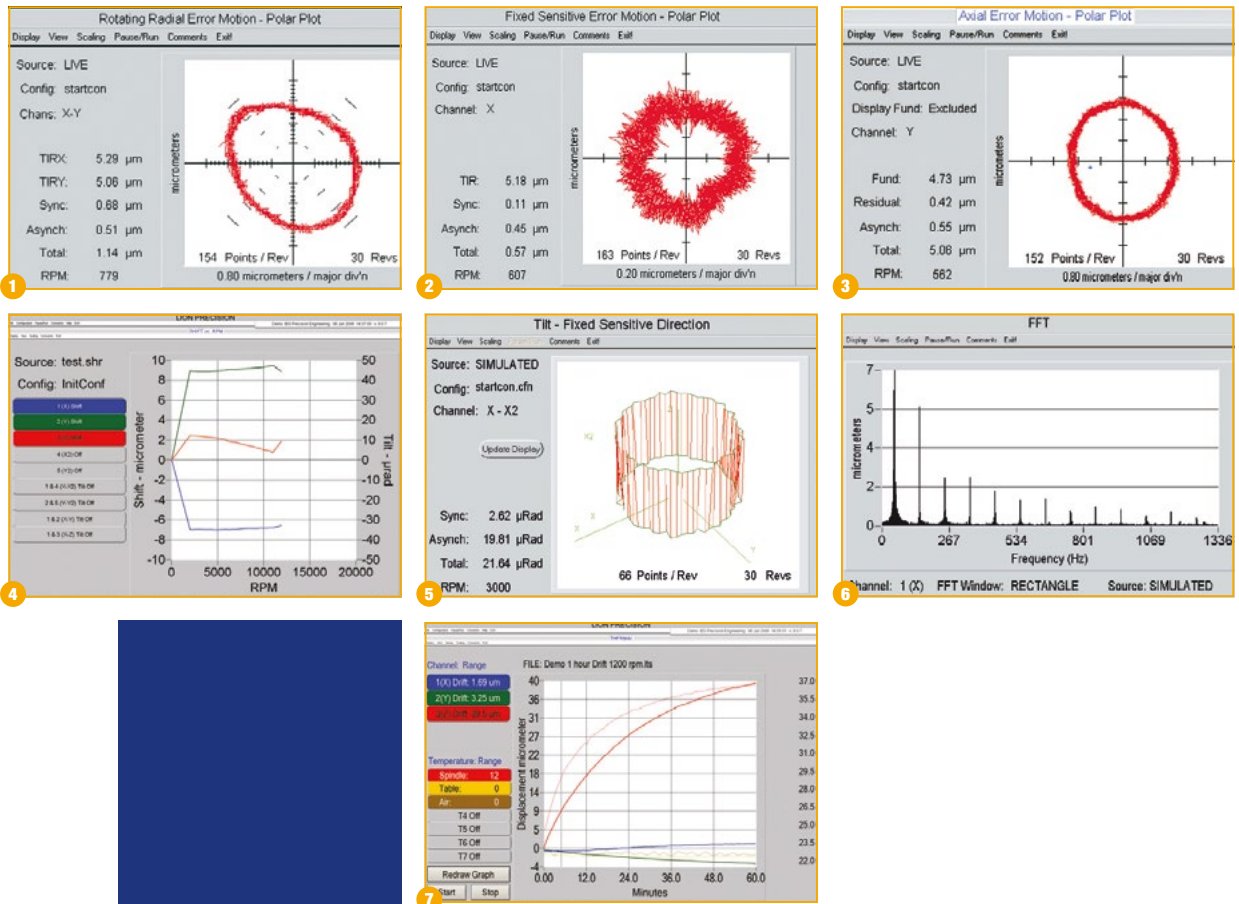
Surface finish

The asynchronous error motion is the non-repeating change in position of your spindle on successive rotations. It is directly responsible for surface finish. Measurements of the asynchronous error motion enables you to select your spindles so you know which one to use for best surface quality. With the asynchronous error you can see the quality of your spindle after a crash.

Main features of the Spindle Analyzer software

The software is designed for easy use. The display area is divided into four quadrants and each quadrant runs independently. Any test, setup, or display function can be activated in any quadrant. realtime displays can run while other quadrants display full analysed output charts from the current tests. Tests can be archived for later retrieval or comparison. Sensors are read through the data acquisition system. The data is analyzed in real time and presented in a selection of plots: cartesian, polar, or 3-D. The software performs many different tests of error motions in all three axes with up to five channels of displacement measurement and seven channels of temperature measurement.

The SEA software is available with multiple language modules: English, German, French, Chinese and Japanese.



Other features of the Spindle Error Analyzer are:

- 1 Rotating sensitive radial measurement
- 2 Fixed sensitive radial measurement
- 3 Axial measurement
- 4 Spindle shift as function of its speed
- 5 Tilt measurement with fixed sensitive direction
- 6 FFT analysis
- 7 Thermal behaviour



SPINDLE ERROR ANALYZER HARDWARE

State of the art capacitive Elite measurement system measures the motion of the master ball targets. The System can be Single range (CPL190) or dual range (CPL290) and are housed in a multiple channel Eurocard enclosure. The enclosure includes a multipin connector for data acquisition equipment.

The Spindle Error Analyzer measurement system is consisting off:

- 3 single or dual range drivers for X-Y-Z measurement or,
- 5 drivers to measure X-Y-Z and tilt
- Each driver is provided with a 8mm probe
- A high speed USB 2.0 data acquisition device
- Powerful analysis software



AVAILABLE OPTIONS:

TMP190: Seven channel temperature sensor and encoder/index module

The TMP190 is used primarily with the Lion Precision Spindle Error Analyzer. In this application it monitors temperature in various locations of a machine tool while the spindle is tested for error motions. Inputs for encoder pulses and index pulses are processed on board and used by a computer to synchronize readings to specific angular locations.

- Up to seven temperature sensors
- Index pulse input
- Rotary encoder input differential or single-ended
- Index/encoder activity indicators
- Computer controlled



MM190: Meter and signal processing module

- Bright display of dimensional units
- Inch or mm display selection
- Two-channel signal summing
- Peak capture
 - Maximum
 - Minimum
 - TIR
 - Tracking TIR
- Processed signal voltage output





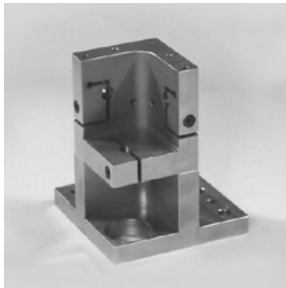
Master ball targets

Master targets are manufactured to exacting standards. Our master ball targets boast a roundness spec of better than 50 nanometre. The targets feature adjustable eccentricity to induce a fixed runout when necessary for testing. The dual master ball is required for tilt measurement with a five channel systems. A precision gage pin is also available.

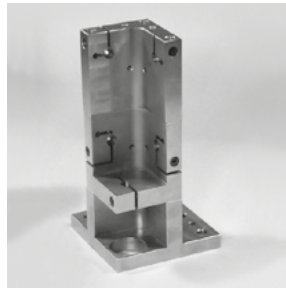
3 Probe nest

5 Probe nest

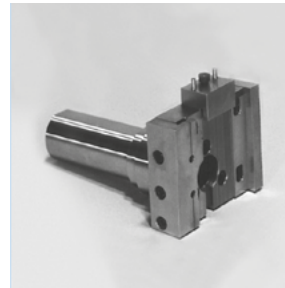
Lathe adaptor



X, Y, and Z axes measurements with a three channel system.



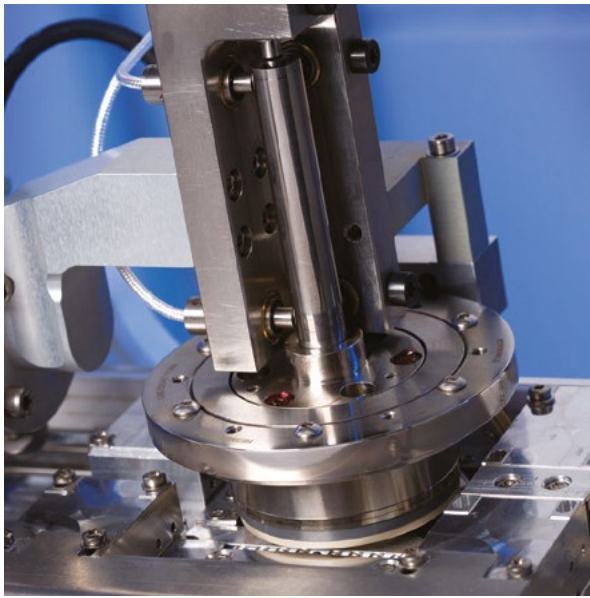
2X, 2Y, and Z measurements for tilt and error motion with 5 channel systems.



Fits in lathe tool holder and holds a standard three probe nest.

Probe mounts

Precision probe holders are designed to maintain perfect perpendicularity required for accurate measurement of high-resolution error motion. Also available are more generic adjustable probe holders for single channel measurements.



STATIC SPINDLE ERROR ANALYZER

(Measurement system for precision rotary tables)

Measurement system

In modern machine designs the application of a rotary table becomes increasingly common. In order to realize sufficient accuracy, the geometrical errors of a rotary axis must be well known. Most common is the application of an angular measurement checking the positional accuracy of the rotary table. Other measurements still rely on the Schlesinger method from 1927 measuring with dial gauges and mandrell but not revealing the errors of the rotary table.

At IBS Precision Engineering an innovative measurement system has been developed with which the errors of a rotary axis can be determined with a high level of accuracy, The Static Spindle Error Analyzer.

System description

The Static Spindle Error Analyzer is the measurement system for rotary tables and performs tests in compliance to the latest ISO 230-7 standard.

The static Spindle Analyzer uses the same hardware as the 3- or 5 channel Spindle Analyzer (see pages 16 and 17).

System configuration:

- 3- or 5 channel Elite capacitive system
- Single or dual master ball
- TMP 190 module for trigger signal
- USB 2.0 interface
- Static SEA software

Measurement procedure

Non contact capacitive probes are mounted in the probe nest. They measure the displacement of the high precision master ball at discrete positions of the rotary table. The measurement can be done over the full 360° of a rotary table, but also partial measurements are possible. This enables also the measurement of goniometers. All measurement sequences can be programmed at any angles and can be repeated and/or bidirectional.



CREATE MEASUREMENT LIST

Create Initial List

Partial Circle
 Full Circle

Start Angle:

Stop Angle:

Increment Angle:

This section is used to create an initial measurement list by choosing:
A partial or full circle, then fill in the desired start-, stop- and increment angle in degrees.
By pressing the 'CREATE LIST' button the initial measurement list is created in the 'Resulting List' box on the right side of the screen.
Pressing the 'CLEAR LIST' button resets the entire list.

Edit Resulting List

Item(s) to add:

X

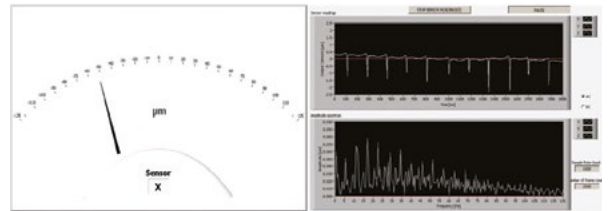
This section is used to edit the resulting measurement list:
->Items can be added the following way:
- Select the position where the item(s) must be added by simply clicking on the item in the resulting list on the right side. Fill in the item(s) to be added in the 'Item(s) to add' list located above. By pressing the 'ADD ITEM(S) TO LIST' button, the item(s) will be added to the resulting list ABOVE the selected location.
->Items can be deleted from the resulting list the following way:
- By holding down the 'CTRL'-key and select the item(s) to be removed.
- By selecting a start item and then hold down the 'SHIFT'-key and then select a stop item, all items between the start and stop item are now selected. When the selection is made press the 'DELETE SELECTED ITEM(S) FROM LIST' button to remove the selection.
->Repeats are performed on the ENTIRE resulting list.

Resulting List

Angle [°]	0.000
	10.000
	20.000
	30.000
	40.000
	50.000
	60.000
	70.000
	80.000
	90.000
	100.000
	110.000
	120.000
	130.000
	140.000
	150.000
	160.000
	170.000
	180.000
	190.000
	200.000
	210.000
	220.000
	230.000
	240.000
	250.000
	260.000
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	310.000
	320.000
	330.000
	340.000
	350.000
	0.000

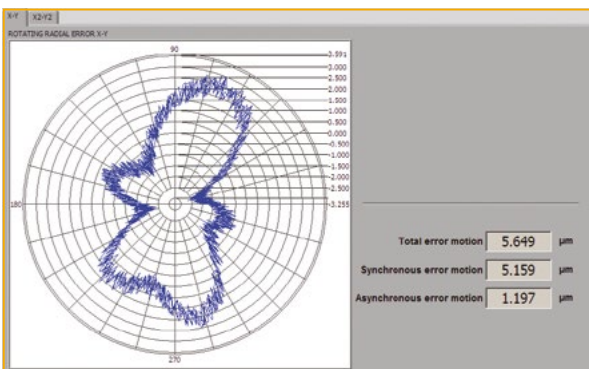
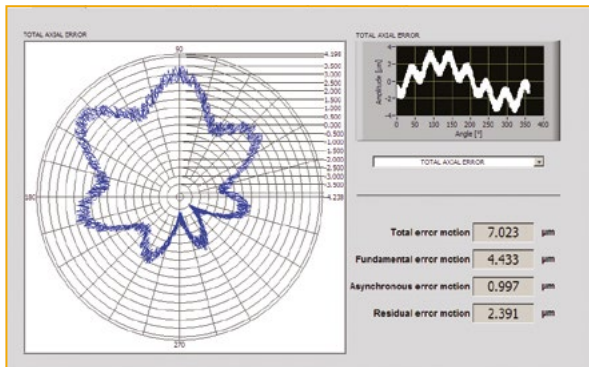
Uni-directional
 Bi-directional

Measurement Positions



2 Probe meter, oscilloscope and FFT analysis for correct measurement setup

1 Programming of a measurement sequence



Analysis and display

Proprietary software collects readings from the probes at the programmed angle. The data acquisition can be triggered by either keyboard or a TTL signal provided to the TMP module. After completion of the measurement the software analyzes the results and reports them on screen with polar and linear plots and with discrete measurement values.

Tests include:

- Rotating sensitive radial error motion
- Fixed sensitive radial error motion
- Radial tilt error motion
- Axial error motion

Listed values include:

- Synchronous error
- Asynchronous error
- TIR
- More ...



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