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 inhomogeneities 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 of:

• 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
**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.

**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 adaptator

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.
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 mandreill 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.
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 discreet 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 ...

Programming of a measurement sequence

Probe meter, oscilloscope and FFT analysis for correct measurement setup
HEAD OFFICE
IBS PRECISION ENGINEERING BV
Esp 201, 5633 AD Eindhoven, The Netherlands
Telephone: +31 (0)40 290 12 70
Fax: +31 (0)40 290 12 79
E-mail: info@ibspe.com, Internet: www.ibspe.com

GERMANY
IBS PRECISION ENGINEERING DEUTSCHLAND GMBH
Leitzstraße 45, 70469 Stuttgart, Germany
Telephone: +49 (0)711 490 66 230
Fax: +49 (0)711 490 66 232
E-mail: info@ibspe.de, Internet: www.ibspe.de

FRANCE
IBS PRECISION ENGINEERING SARL
Le Magellan, 7 rue Montespan, 91024 Evry Cedex, France
Telephone: +33 (0)1 69 47 60 53
Fax: +33 (0)1 69 47 60 70
E-mail: info@ibspe.fr, Internet: www.ibspe.fr