

MACHINE TOOL MEASUREMENTS

BE CONFIDENT: KNOW YOUR SPINDLE

LION
PRECISION
An Amphenol **CTI** Brand

Intelligent Machining

Interpret quickly. Save time. Increase profitability.

Production Engineer, Machinist, or Maintenance Professional

Imagine if you could:

- » Quickly prove with data the overall condition of a spindle
- » Determine a machine's best & worst operating speeds
- » Identify potential root causes of issues

Plant Manager, Production Supervisor, or Engineering Lead

Lion Precision's Machine Tool Products will allow you to:

- » Define the best machine for the job
- » Minimize unnecessary spindle rebuilds or replacements
- » Better manage your machine tools

Researcher, Professor, Scientist, or Metrologist

Our Technology provides you with data that will help you:

- » Expand your knowledge of a machine's performance
- » Allow you to advance a machine to a higher level of precision
- » All while speeding up your research process & improving lab capabilities



Solve Problems For:

- » Production/Machine Shops
- » OEM Design Centers
- » Maintenance/Calibration
- » Universities
- » National Labs

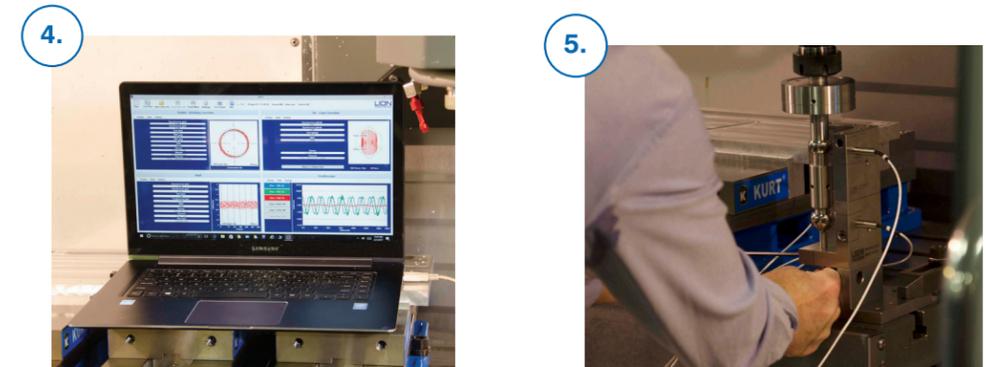
How It Works



1. Mount Target in Spindle

2. Place Electronics

3. Set Up Probe Nest

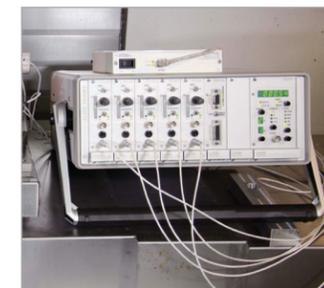


4. Start Up Software

5. Align and Test

Machine Measurement Tools

Spindle Error Analyzer (SEA)



Flexible configuration for sophisticated measurements and highest precision spindles. Best analysis device available.

SpindleCheck Analyzer (SCA)



Detailed analysis of machine performance with high resolution.

Intelligent Machining

Setup & Operation



Configuration

Each measurement device comes with a configuration interface which includes the choice of multiple languages, targets, diagnostic, and analytic settings that can be adjusted to any application.

SEA/SCA



Oscilloscope

The Oscilloscope is a utility display that emulates a basic Oscilloscope, allowing a time-based view of the data acquired on any probe channels.

SEA/SCA

Thermal Management



Thermal

Thermal testing allows for rotating or non-rotating spindle measurement to analyze the effect temperature changes have on the machine tool. It is often used in troubleshooting environmental conditions or determining thermal stability.

SEA/SCA



Warm Up

When a cold spindle begins to rotate, friction heating of the bearings causes the spindle to expand (primarily in the Z axis). Knowing the time until a machine stabilizes allows for more precise scheduling/planning, less scrap, and may expose machine frame distortions.

SEA/SCA



Temp & Encoder Input Module

Uses sensors for monitoring temperature change. Also includes an encoder and index input for triggering the measurement.

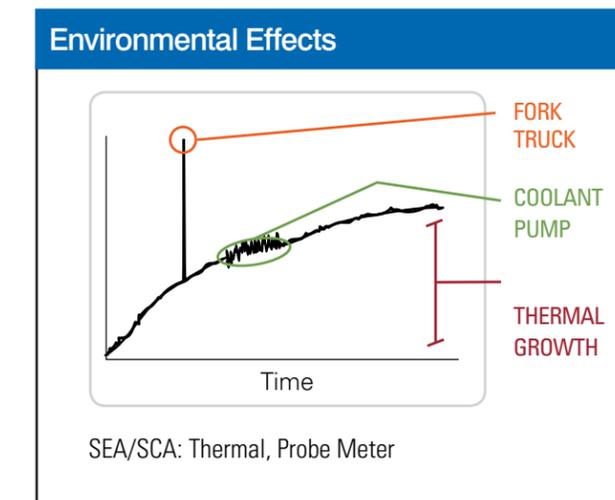
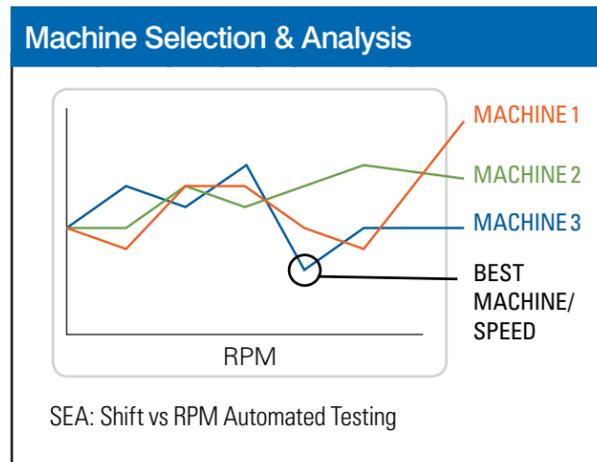
SEA



Probe Meter

The Probe Meter is an analog meter indicating the current probe/target gap of the selected probe. It is often used as a tool for setup and troubleshooting.

SEA/SCA



Position Measurement



FFT

The FFT analysis test acquires data from a single probe and displays the relative amplitude of its frequency components. A graph of amplitude vs. frequency is produced. FFT data is used in identifying bearing frequencies, resonant frequencies, harmonics, RPM, and structural vibration.

SEA/SCA



Position Shift

The axis of rotation of the spindle may shift location with changes in RPM. Charting any changes in position of the axis of rotation of the spindle against RPM allows the operator the ability to adjust RPM or offsets to correct any errors.

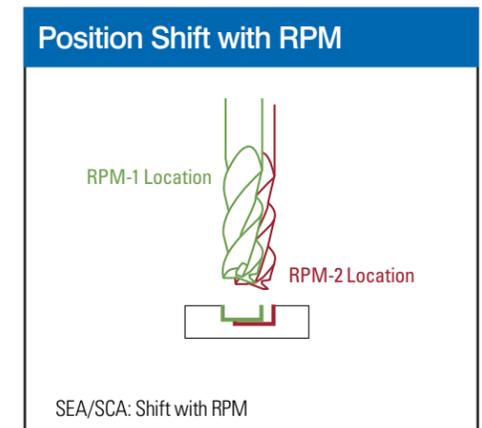
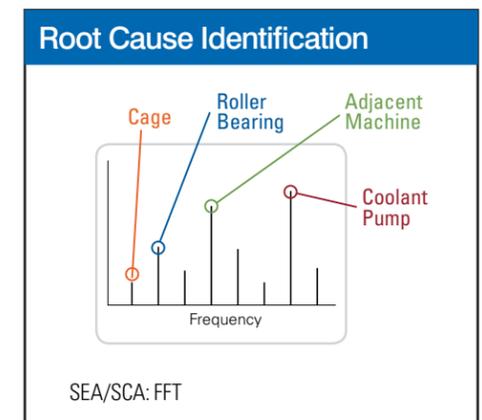
SEA/SCA



Meter Module

Provides a digital display of the displacement.

SEA



Dynamic Measurement



Total Error

While the individual components of the "Total Rotation Error" provide insight into specific part errors, the Total Rotation Error (total error motion) gives a general condition of a spindle and a quick comparison of the condition of spindles on multiple machines.

SEA/SCA



Runout/TIR

Often used in manufacturing, Runout will affect the diameter of holes and straightness of cuts. It should not change dramatically with changes in speed. Changes in Runout are a potential sign of significant wear causing the system to shift or bend as the spindle turns faster.

SEA/SCA



Synchronous Error/ Roundness Capability

The portion of the total error motion that repeats every revolution and relates to the ability of the machine to produce round features when drilling or boring in a milling operation or when doing longitudinal turning on a lathe.

SEA/SCA



Asynchronous Error/ Surface Roughness

The portion of the total error motion that does not repeat from revolution to revolution. These are caused by machine vibrations and in ideal cutting conditions with a single point tool would be a reasonable indicator of the surface roughness (Ra) of the finished part.

SEA/SCA



Radial Fixed Sensitive/Turning

Radial Fixed Sensitive acquires displacement in one axis relative to spindle angular location and displays the data in a polar plot. Most often used in lathe applications.

SEA/SCA

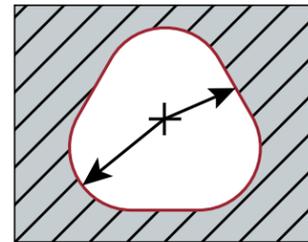


Radial Rotating Sensitive/Milling

Radial Rotating Sensitive acquires displacement data from two probes positioned 90° apart. The probes measure the X and Y displacement of the axis of rotation to generate a polar plot. Most often used when measuring mills.

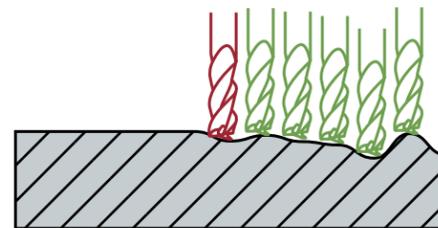
SEA/SCA

Roundness Capability



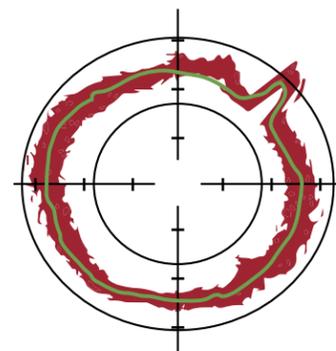
SEA/SCA: Radial Synchronous Error Motion

Roughness Capability



SEA/SCA: Radial and Axial Asynchronous Error Motion

Polar Plots



SEA/SCA: Asynchronous & Synchronous Error



Axial

Axial Error Motion utilizes displacement data from one probe in the Z axis. The probe measures the axial displacement of the spindle. In addition to a polar plot, axial error motion can also be displayed in a linear, oscilloscope type display.

SEA/SCA



Tilt Thermal

Using two probes in either the X or Y direction, thermal tilt can determine if there is a distortion of the machine frame which will cause a much larger error than simple thermal expansion.

SEA



Tilt Dynamic

Using two probes in either the X or Y direction, dynamic tilt is measured to determine how much worse the synchronous error (related to roundness) and asynchronous error (related to surface roughness) are as the distance from the spindle nose increases. Results are displayed as polar plots or 3D plots.

SEA



Donaldson Reversal

Donaldson Reversal displays data from two Radial – Fixed Sensitive tests combined in such a way that form errors in the target (out of roundness) are separated from the synchronous error motion of the spindle.

SEA

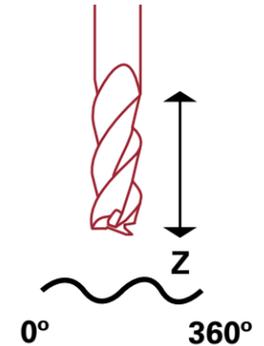
Hardware



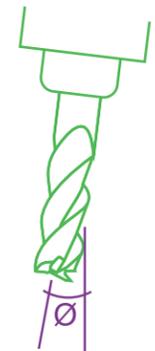
Travel Case

SEA/SCA

Axial Error Motion



Tilt



SEA: Tilt, Thermal

Select a Product Family

To find the right product, determine the following criteria:

1. **Spindle Speed (RPM)**
Determine which product you need based on the maximum and minimum RPMs needed for your application.
2. **Distance to the End of Tool**
If you have a long distance from spindle nose to tool end, you may want to measure tilt. The longer this distance, the more error that occurs at the point of machining as the machine distorts with temperature changes and the spindle tilts at different points of rotation at different speeds.
3. **Hardware**
Select the hardware components you need for your system. Often your decision will be based on where the product will be used such as a lab environment where items will often be setup and left in a location versus a production environment where items will move around the shop.
4. **Features**
Products were designed with specific types of users in mind. SEA was built for scientists and R&D centers or high end machine testing.
5. **Tilt**
Tilt measurements require five probes.
6. **Select Product**
The final outcome of these selections should give you the product that is right for you.
7. **Proceed to Product Page**
With the product now determined, go to the bottom of the column and find the associated product page to order the correct part number.

Standards & References

- ISO230: Test Code for Machine Tools, Part 3: Determination of Thermal Effects (SEA/SCA) Part 7: Geometric Accuracy of Axes of Rotation (SEA/ SCA) Part 2: Determination of Accuracy & Repeatability of Positioning Numerically Controlled Axes (SCA).
- ANSI/ASME Standard B5.54-2005, Methods for Performance Evaluation of CNC Machining Centers (SEA/SCA)
- ANSI/ASME B5.57-2012, Methods for Performance Evaluation of CNC Turning Centers (SEA/SCA)
- ANSI/ASME B89.3.4-2010, Axes of Rotation, Methods for Specifying, & Testing (SEA/SCA)
- JIS B 6190-7, Test Code for Machine Tools Part 7, Geometric Accuracy of Axes of Rotation (SEA/SCA)



		SEA Spindle Error Analyzer	SCA SpindleCheck Analyzer
PERFORMANCE	Max RPM	No Limit*	120000
	Min RPM	< 1	12
	Using Long Tool (>300mm)	✓	
	Using Short Tool (<300mm)	✓	✓
	Channels/Package	1-5	3
	EAR99 Version (No Export License Req.)		
HARDWARE	Meter Module	✓	
	Encoder Input	✓	
	Temperature Module (7 sensors)	✓	
	Carrying Case	✓	✓
	Lathe/Swiss Adapters	✓	✓
	Wireless		
	Battery Powered		
OPERATION	Probe Meter	✓	✓
	Oscilloscope	✓	✓
	Automated Testing	✓	
	Analysis Configuration	✓	
	Guided Measurement Process Reporting		
DYNAMIC / ROTATING	Total Error	✓	✓
	Fixed Sensitive Radial	✓	✓
	Axial	✓	✓
	Runout/TIR	✓	✓
	Rotating Sensitive Radial	✓	✓
	Roughness/Asynchronous	✓	✓
	Roundness/Synchronous	✓	✓
	Donaldson Reversal	✓	
	Tilt Dynamic	✓	
POSITION	Position Shift (Shift vs. RPM)	✓	✓
	Vibration	✓	✓
	FFT	✓	✓
	Repeatability		
THERMAL	Thermal Drift (Non-Rotating)	✓	✓
	Warm-Up (Rotating)	✓	✓
	Tilt Thermal	✓	
Brochure Page »		10	12

* Limited by DAQ speed and number of channels.
Export License – Because of high resolutions, export of some systems to some countries requires an export license.



SPINDLE ERROR ANALYZER

Expand your capabilities with the ultimate analyzer for precision and analysis.

Selection Steps

- 1. Spindle Application**
Air Bearing Nanometer precision, often with two measurement ranges (10 & 50 micrometers).
Oil Bearing Spindle Applications with precision requirements in the tens of nanometers that need a larger range of 50 micrometers plus thermal growth ranges of 250 micrometers.
Rolling Element Bearings (Hybrid) Sub-micrometer precision hybrid spindles with higher speed and accuracy needing a 50 micrometer range for dynamic measurements and up to 250 micrometer ranges for the thermal measurements.
Rolling Element Bearings (Conventional) High quality production spindles with micrometer precision requirements capable of testing dynamic performance plus thermal growth measurements of 50 and 250 micrometer ranges.
- 2. Number of Probes Required**
 The number of probes required will be based on the measurement requirements you have. The numbers of probes was determined on the product selection table on page 3.
- 3. Accessories**
Temp Encoder Module Select this accessory if you want to use sensors for monitoring temperature change. Also includes an encoder input for triggering the measurement.
Meter Module Provides a digital display of the displacement.
- 4. Enclosures Slots**
 Selected based on the number of channels required (# of probes + accessories + any future expansion)
- 5. Probe & Calibration Range**
 While there are standard calibrations, Lion Precision can customize calibration ranges to fit your specific needs.

Spindle & Application	Number of Probes	Accessories		Enclosure Slots			Range		
		TMP190	MM190	3	6	8	10 μ m	50 μ m	250 μ m
Air Bearing (Thermal) Oil-Bearing Rolling Element (Hybrid)	3	✓		MSSF-2343	MSSF-2346	MSSF-2348	✓	✓	
					MSSF-2356	MSSF-2358	✓	✓	
			✓		MSSF-2366	MSSF-2368	✓	✓	
	5	✓	✓		MSSF-2376	MSSF-2378	✓	✓	
					MSSF-2546	MSSF-2548	✓	✓	
		✓	✓			MSSF-2556	MSSF-2558	✓	✓
Rolling Element (Conventional)	3			MSSS-2343	MSSS-2346	MSSS-2348		✓	✓
		✓			MSSS-2356	MSSS-2358		✓	✓
			✓		MSSS-2366	MSSS-2368		✓	✓
	5	✓	✓		MSSS-2376	MSSS-2378		✓	✓
					MSSS-2546	MSSS-2548		✓	✓
		✓			MSSS-2556	MSSS-2558		✓	✓
	✓			MSSS-2568		✓	✓		
	✓	✓			MSSS-2578		✓	✓	

FEATURES:



INCLUDED WITH SEA ELECTRONICS:



MFG3-1906
MASTERBALL 1" SINGLE & DOUBLE
ADJUSTABLE ECCENTRICITY 20MM SHANK



4900-0001 & 4900-0002
PROBE NEST 3 PROBES &
PROBE NEST 5 PROBE ADAPTER



P016-6002
PROBES



P014-2451
PROBE CAP



P014-2292
CALIBRATION CHECK FIXTURE



4900-0108
HEX KEY



P017-8900
USB WITH
SEA 9.0
SOFTWARE



P017-0100
TRAVEL CASE

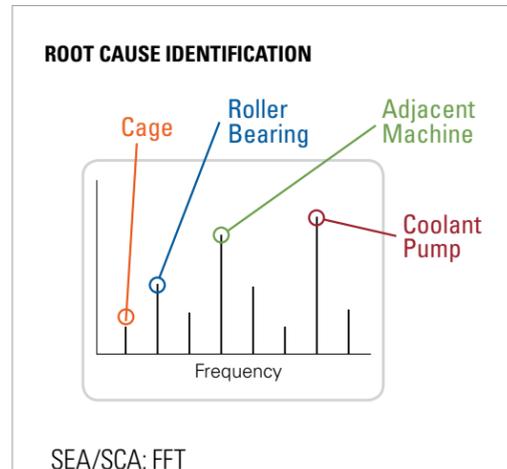


SpindleCheck ANALYZER

Analyze machine performance for detailed analysis and troubleshooting

Benefits include:

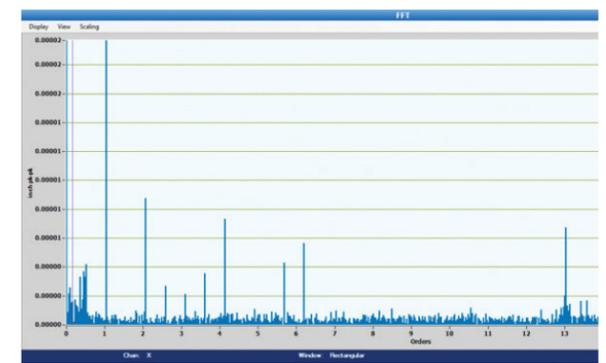
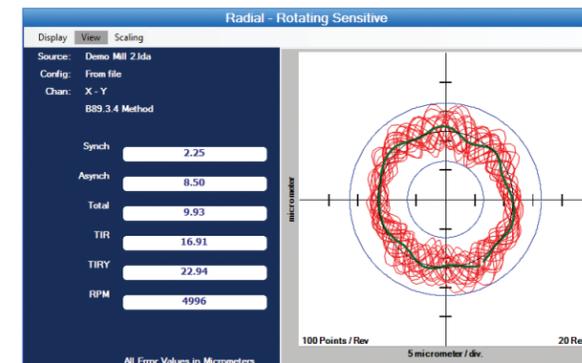
- Portable hardware & easy set-up
- Important data clearly displayed – including Polar Plots, Oscilloscope, & FFT graphs
- Ideal for the technical user that wants to link error motions to possible root causes



SELECTION STEPS:

1. Target Pin Size

Region	Precision	Target Pin Size	Part #
WORLD	Standard	8mm	MFG5-0235
		20mm	MFG5-0233



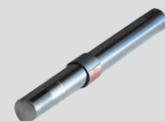
FEATURES:



INCLUDED WITH SCA ELECTRONICS



P017-6107
MAGNETIC BASE WITH PROBE NEST



P017-6061
8 MM PRECISION TARGET PIN



P014-8250
GROUNDING KIT



4490-0515
FIVE METER USB CABLE



P017-7480
PROBE SET



A017-7560
INDEX PROBE SPACER



P017-8766
USB WITH SCA SOFTWARE



P017-7490
TRAVEL CASE

Accessories

SCA



P017-6061
8 MM TARGET PIN

P017-6091
20 MM TARGET PIN

SEA/SCA



P017-6570
XYZ ADJUSTABLE STAGE

SEA



4900-6203
MASTERBALL 1" SINGLE
ADJUSTABLE ECCENTRICITY
20MM SHANK

SCA



P015-4658
INDEX PROBE REPLACEMENT

P017-7072
INDEX PROBE REPLACEMENT



P017-6661 ADAPTER 1.00" DIAMETER
WITH FLATS

P017-6651 ADAPTER 1.00" DIAMETER
WITHOUT FLATS

P017-6662 ADAPTER 1.25" DIAMETER
WITH FLATS

P017-6652 ADAPTER 1.25" DIAMETER
WITHOUT FLATS

P017-6653 20 MM DIAMETER
WITHOUT FLATS

P017-6654 25 MM DIAMETER
WITHOUT FLATS

P017-6660 3/4" DIAMETER
WITH FLATS

P017-6650 3/4" DIAMETER
WITHOUT FLATS

SEA



4900-0026
MASTERBALL 1" DOUBLE
ADJUSTABLE ECCENTRICITY
20MM SHANK

SCA



P017-7331
CAPACITIVE DRIVE PROBE
REPLACEMENT

SCA



P016-6700
INDEX DRIVER REPLACEMENT

P016-6701
INDEX DRIVER REPLACEMENT



MFG5-1250
DEMO STAND



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