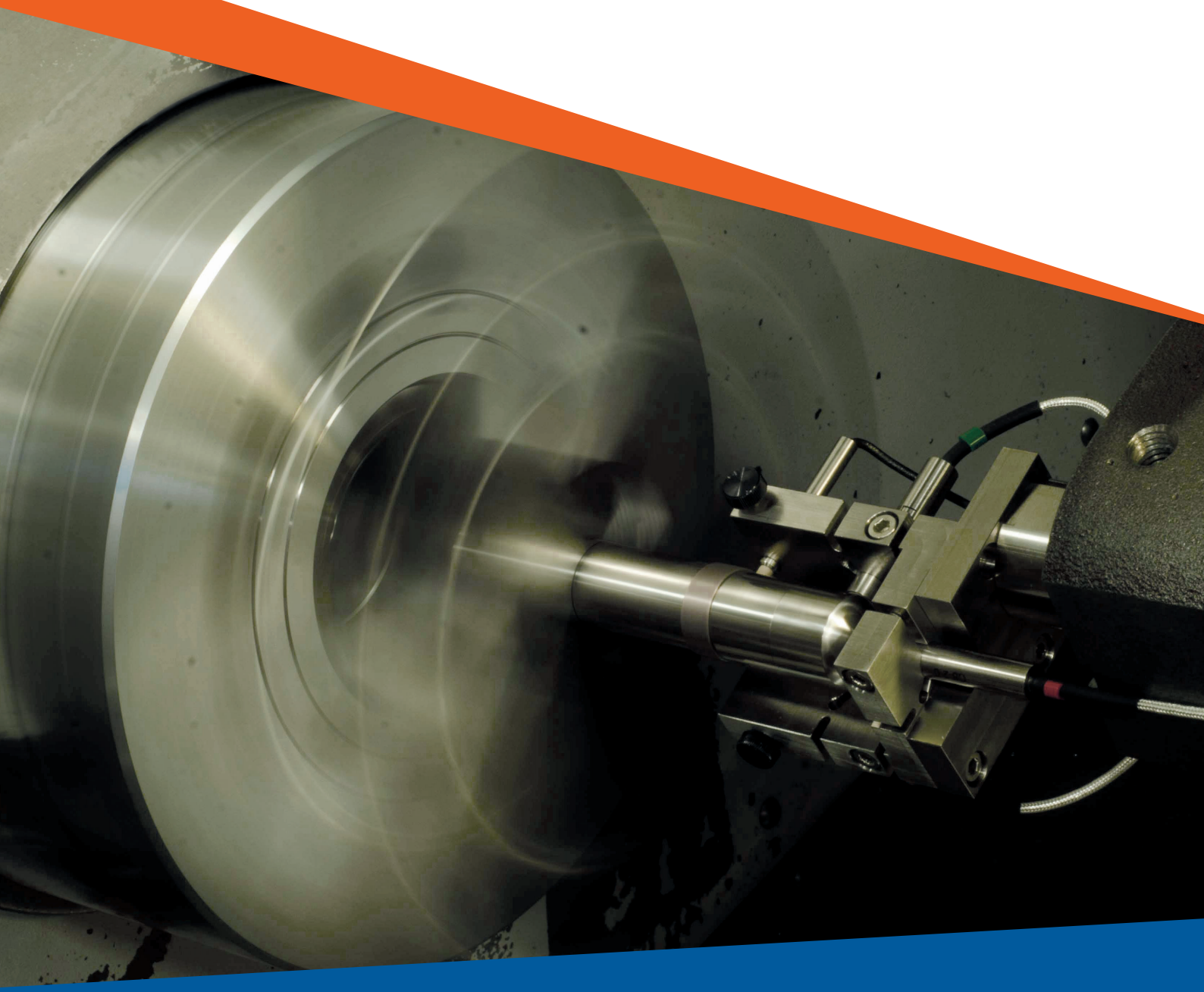
LION PRECISION

MACHINE TOOL MEASUREMENTS

BE CONFIDENT: KNOW YOUR SPINDLE



INTELLIGENT MACHINING

QUICKLY UNDERSTAND – 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 and 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 and 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

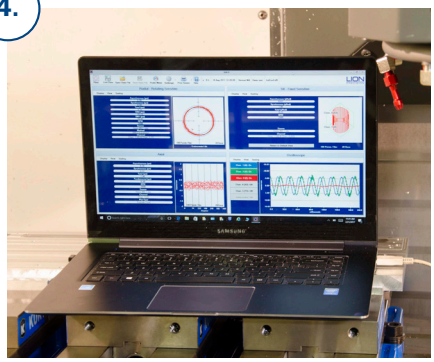
2.

Place Electronics

3.

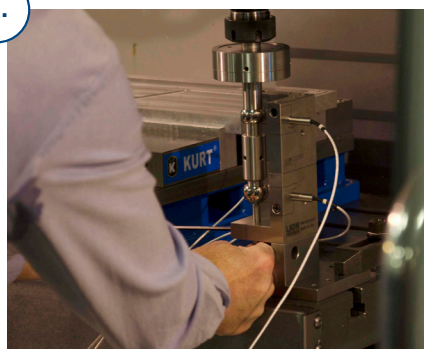
Set Up Probe Nest

4.



Start Up Software

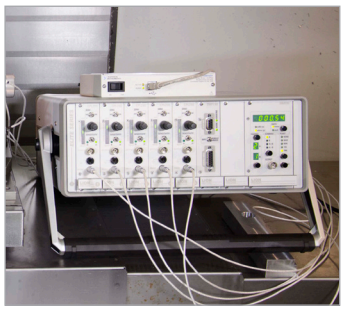
5.



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.

SpindleCheck Inspector (SCI)

Maintenance and test measurements compared across speeds and across machines.

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 / SCI

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 / SCI

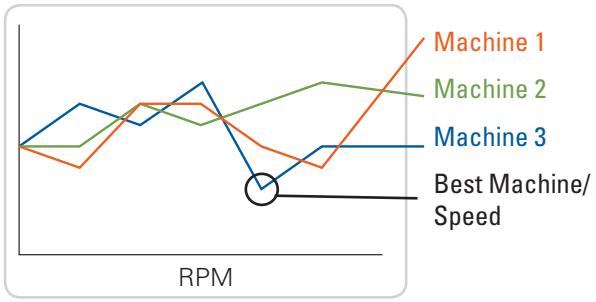
Machine Capability Report
With a Machine Capability Report operators, programmers and management can quickly understand the machine's best performance characteristics which helps select the right machine and settings.
SCI

Tutorials
There are a number of step-by-step instruction guides that take the guess work out of setting up, measuring, and evaluating a machine. These tutorials equip even the most novice user.
SCI

Shop Capability Report
The Shop Capability Report provides a complete assessment of a filtered set of machinery across any size organization. This determines which site and machine will be the optimal one to run a job.
SCI

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

MACHINE SELECTION & ANALYSIS



SCI: Reports SEA / SCI: Shift vs RPM Automated Testing

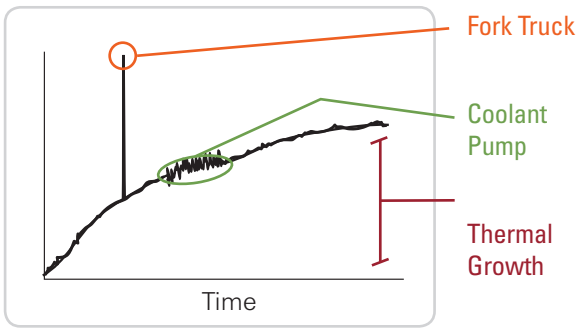
THERMAL MEASUREMENT

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 / SCI

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 / SCI

Temp & Encoder Input Module
Uses sensors for monitoring temperature change. Also includes an encoder and index input for triggering the measurement.
SEA

ENVIRONMENTAL EFFECTS



SCI: Warm-Up, Vibration, Thermal
SCA/SEA: Thermal, Probe Meter

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 / SCI

Vibration

Vibration impacts the surface finish capabilities of the machine. By studying the affects of vibration over time, any external factors that are impacting the performance of the tool can be identified. Vibration from a fork lift or coolant pump can often cause a part to fail if it occurs during a critical cut.

SCI

Repeatability

As the mechanics of a machine wear, backlash and other issues will reduce its ability to accurately locate the cutting tool relative the workpiece. Performing this test allows the operator to better predict the machine's ability to hold tolerance of a feature location. Troubleshooting is simplified by determining which axis has the problem.

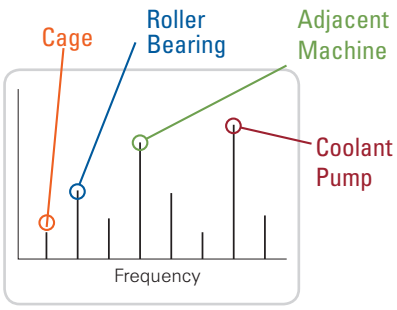
SCI

Meter Module

Provides a digital display of the displacement.

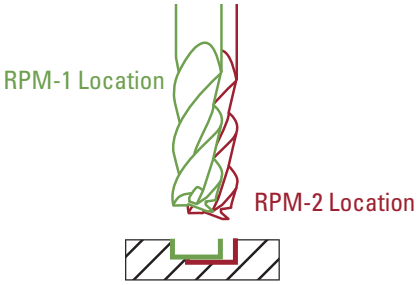
SEA

ROOT CAUSE IDENTIFICATION



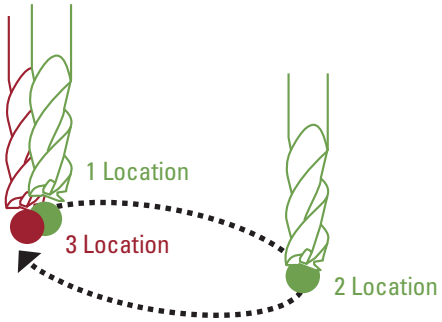
SEA/SCA: FFT

POSITION SHIFT WITH RPM



SCI: Position Shift
SEA/SCA: Shift with RPM

REPEATABILITY



SCI: Repeatability

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 / SCI

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 / SCI

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.

SCI / 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.

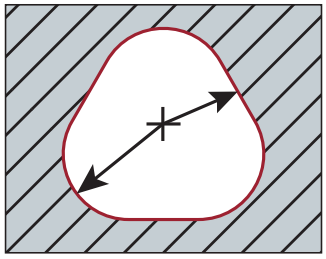
SEA / SCA

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

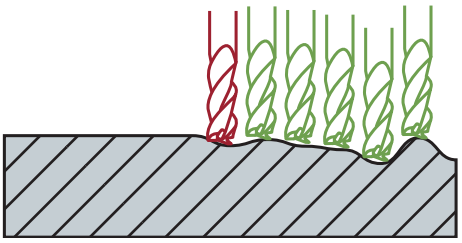
ROUNDNESS CAPABILITY



SCI: Roundness Capability

SCA/SEA: Radial Synchronous Error Motion

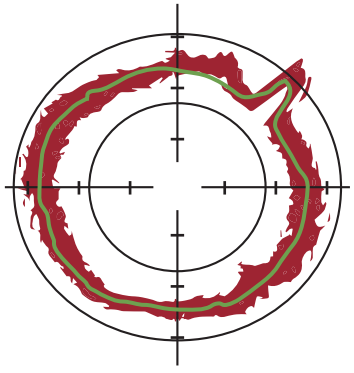
ROUGHNESS CAPABILITY



SCI: Roughness Capability

SCA/SEA: 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 / SCI

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.

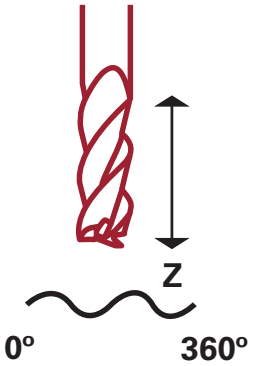
SEA

Donaldson Reversal

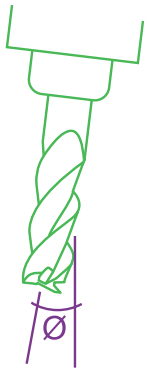
Donaldson Reversal displays data from two Radial – Fixed Sensitive tests combined in such a way that form errors in the target (out of roundness) are separated from the synchronous error motion of the spindle.

SEA

AXIAL ERROR MOTION



TILT



SEA: Tilt, Thermal

HARDWARE

Wireless

WiFi system allows you to have the device sensing electronics inside the machine tool with the doors closed while operating the software from outside the machine.

SCI

No Export License Required

Export licenses are required for most measurement devices to export controlled countries. No Export License Required means that those devices do not need a license to be used.

SCI

Battery Powered

In combination with WiFi capabilities the battery powered module removes the need for any cables or cords leaving outside the machines safety enclosure.

SCI

Travel Case

SEA / SCA / SCI

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 environement 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, where SCI was developed for the quick check of machines in a production environment.

5. ***Tilt***
Tilt measurements require five probes.

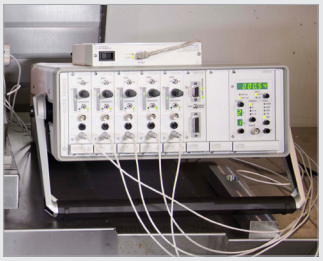
6. ***Select Product***
The final outcome of these selections should give you the product that is right for you.

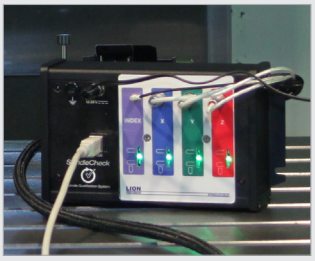
7. ***Proceed to Product Page***
With the product now determined go to the bottom of the column and find the associated product page to order the correct part number.

Velocity Shipping Product
Product ships within 24 hours

STANDARDS & REFERENCES

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

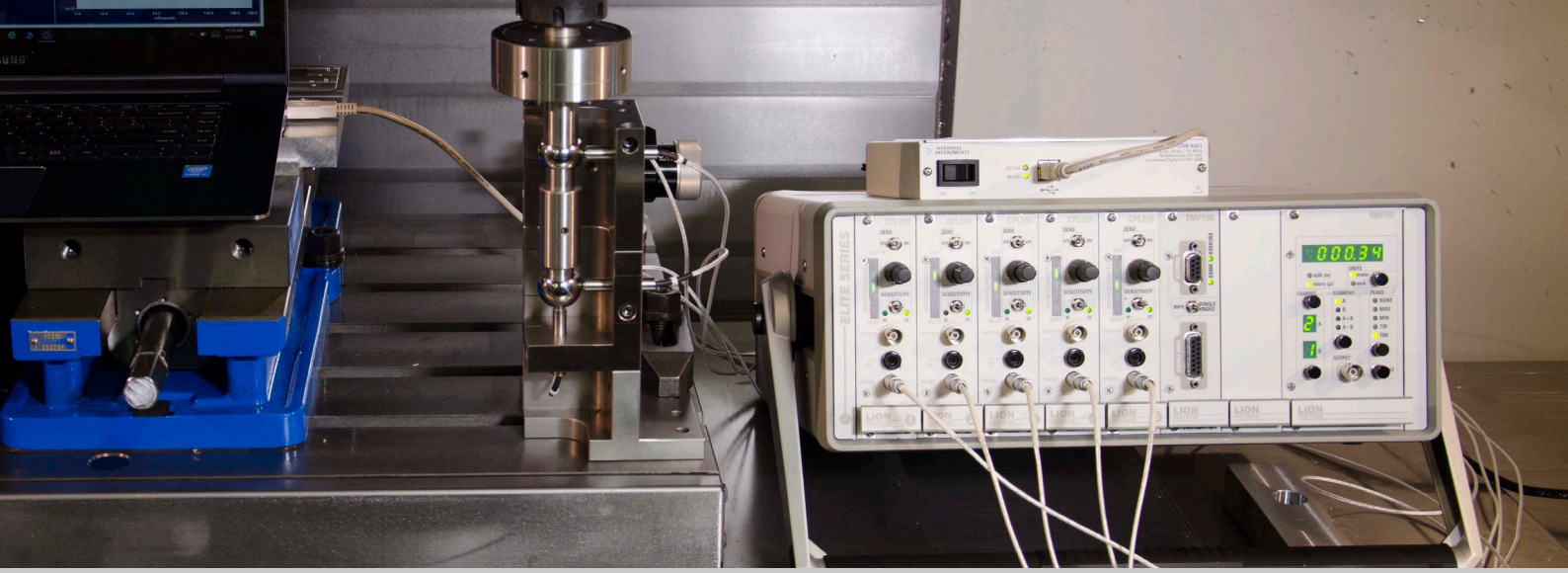




		SEA Spindle Error Analyzer	SCA Spindle Check Analyzer	SCI Spindle Error Inspector
PERFORMANCE	Max RPM	No Limit*	120000	120000
	Min RPM	< 1	12	100
	Using Long Tool (>300mm)	✔		
	Using Short Tool (<300mm)	✔	✔	✔
	Channels/Package	1-5	3	3
	EAR99 Version (No Export License Req.)			✔
HARDWARE	Meter Module	✔		
	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)	✔	✔	✔
	FFT	✔	✔	
	Repeatability			✔
	Vibration	✔	✔	✔
THERMAL	Thermal Drift (Non-Rotating)	✔	✔	✔
	Warm-Up (Rotating)	✔	✔	✔
	Tilt Thermal	✔		
	Brochure Page »	10	12	14

** 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 in 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 micrometer.

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 wanting to test dynamic performance plus thermal growth measurements of 50 and 250 micrometer range.

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.

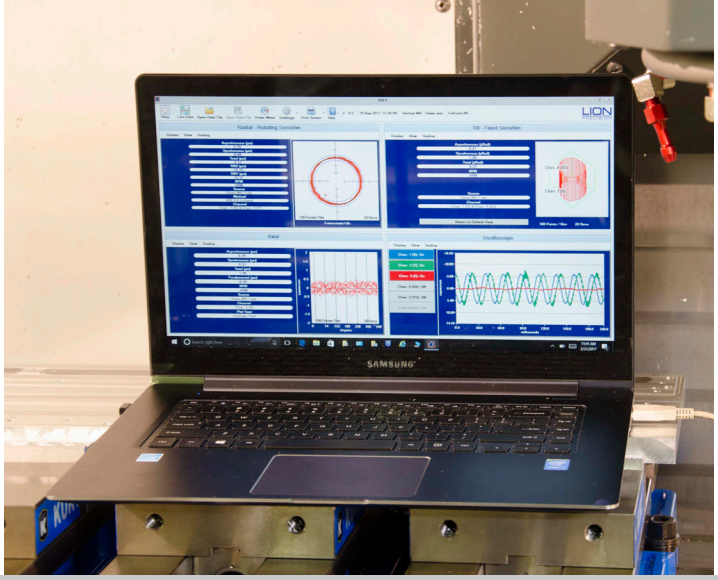
INCLUDED WITH SEA ELECTRONICS:

MFG3-1905
MASTERBALL 1" SINGLE & DOUBLE FIXED ECCENTRICITY 20MM SHANK

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

P017-6207
PROBES

P014-2451
PROBE CAP



Spindle & Application	Number of Probes	Accessories: TMP190	Accessories: MM190	Enclosure Slots: 3	Enclosure Slots: 6	Enclosure Slots: 8	Range: 50 µm	Range: 250 µm
Air Bearing (Thermal) Oil-Bearing Rolling Element (Hybrid)	3			MSSF-2343	MSSF-2346	MSSF-2348	✔	✔
		✔			MSSF-2356	MSSF-2358	✔	✔
			✔		MSSF-2366	MSSF-2368	✔	✔
		✔	✔		MSSF-2376	MSSF-2378	✔	✔
	5				MSSF-2546	MSSF-2548	✔	✔
		✔			MSSF-2556	MSSF-2558	✔	✔
			✔			MSSF-2568	✔	✔
		✔	✔			MSSF-2578	✔	✔
Rolling Element (Conventional)	3			MSSS-1343	MSSS-1346	MSSS-1348		✔
		✔			MSSS-1356	MSSS-1358		✔
			✔		MSSS-1366	MSSS-1368		✔
		✔	✔		MSSS-1376	MSSS-1378		✔
	5				MSSS-1546	MSSS-1548		✔
		✔			MSSS-1556	MSSS-1558		✔
			✔			MSSS-1568		✔
		✔	✔			MSSS-1578		✔

Velocity Shipping Product

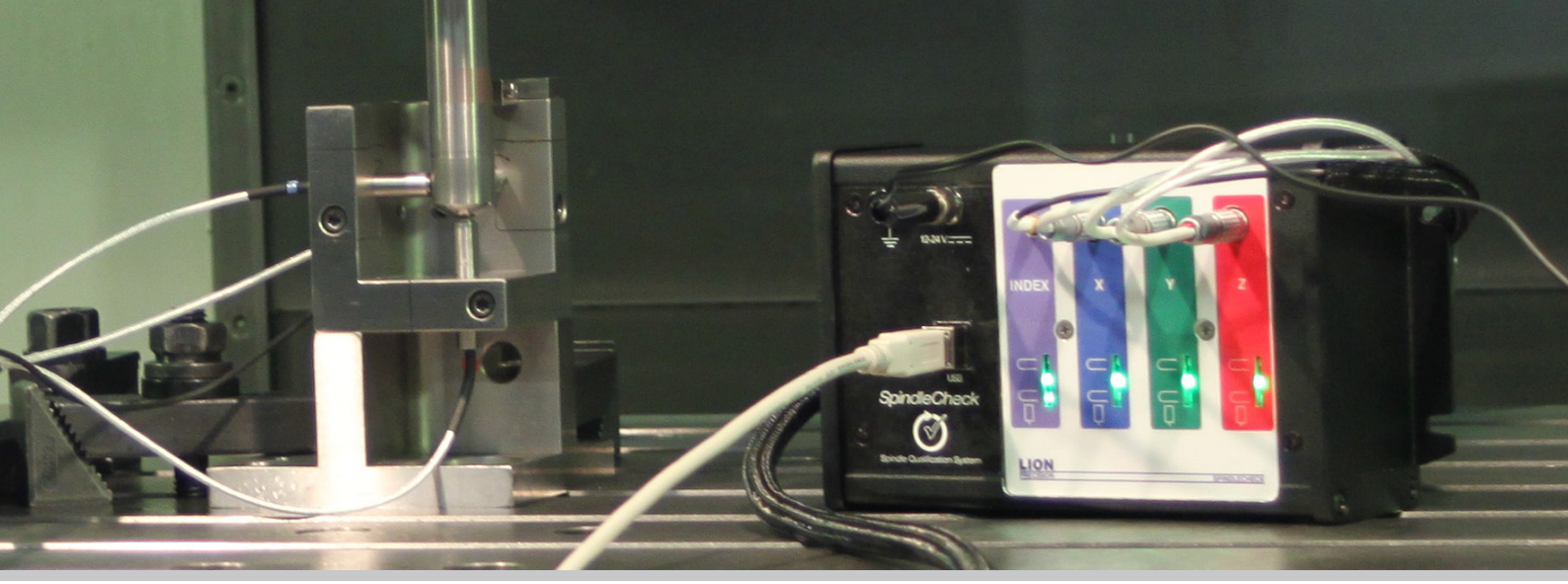
FEATURES:

P014-2292
CALIBATION CHECK FIXTURE

4900-0108
HEX KEY

P017-8900
USB WITH
SEA 9.0 SOFTWARE

P017-0100
TRAVEL CASE



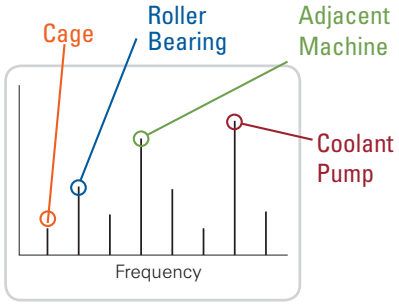
SpindleCheck ANALYZER

Analyze machine performance for detailed analysis and troubleshooting

Benefits include:

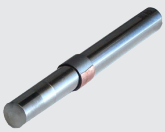
- Portable hardware & easy set-up
- Important data clearly displayed – including Polar Plots, Oscilloscope & FFT graphs
- Ideal for the technical user that wants to link error motions to possible root causes

ROOT CAUSE IDENTIFICATION



INCLUDED WITH SCA ELECTRONICS

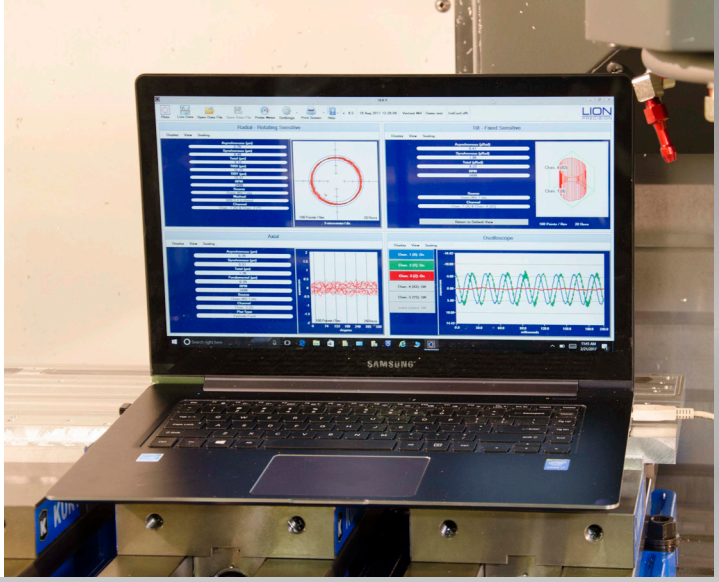
P017-6207
MAGNETIC BASE WITH PROBE NEST



MFG5-1240
PRECISION TARGET PIN

P014-8250
GROUNDING KIT

4490-0515
FIVE METER USB CABLE

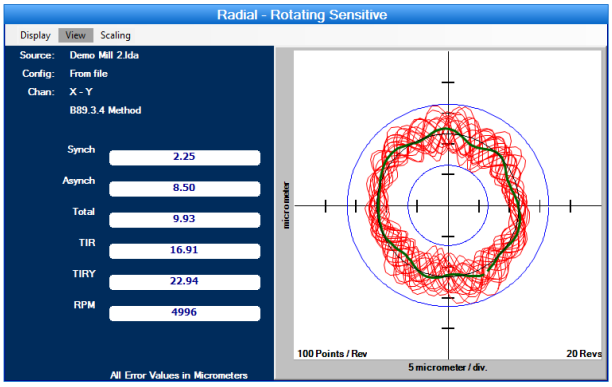


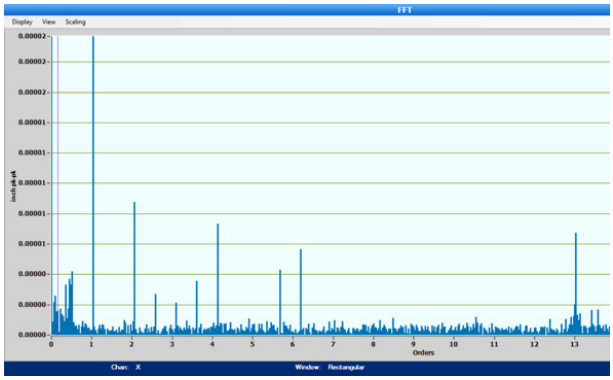
SELECTION STEPS:

1. *Target Pin Size*

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

Velocity Shipping Product





FEATURES:

P017-7485
PROBE SET

A017-7560
INDEX PROBE SPACER

P017-8766
USB WITH SCA SOFTWARE

P017-7490
TRAVEL CASE

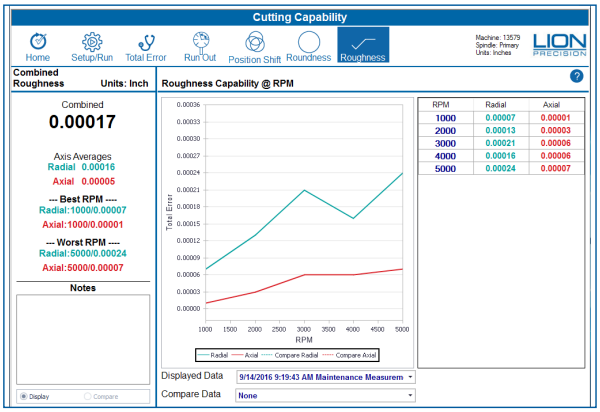
SpindleCheck INSPECTOR

Know your machines' best performance parameters quickly and easily.

The Cost of a Spindle is Approximately 10% of the Total Cost of the Machine Tool

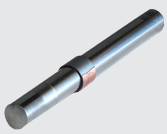
Measuring a Spindle Allows You To:

- Confirm or eliminate the root cause of a problem
- Avoid unnecessary spindle repair or replacement
- Minimize downtime and increase machine tool utilization
- Reduce scrap / identify best and worst speeds
- Better PM planning and scheduling
- Set baselines for machine tools and track performance over time
- Compare machines to better assign jobs
- Measure a spindle after a crash, before doing PM
- Qualify new machine tools



INCLUDED WITH SCI ELECTRONICS

P017-6207
MAGNETIC BASE WITH PROBE NEST



MFG5-1240
PRECISION TARGET PIN

P014-8250
GROUNDING KIT

4490-0515
FIVE METER USB CABLE

P017-7570
BATTERY

SELECTION STEPS:

1. ### *Region*
China specific units require a different router package to be used on the WiFi networks.

2. ### *Precision Requirements*
Standard The standard hardware comes with resolution of 125 nm and requires an export license to ship to certain countries.

Ear99 The EAR99 hardware comes with a precision level of 250 nm has no export license requirements.

3. ### *Target Pin Size*
Target pin sizes can vary based on the typical machines being measured. No matter which system you select, additional pins can be purchased seperately. Often it is helpful to have multiple pin sizes if you are checking a wide variety of machines.

Region	Precision	Target Pin Size	Part #
CHINA	EAR99	8mm	MFG5-1265
		20mm	MFG5-1263
	Standard	8mm	MFG5-1365
		20mm	MFG5-1363
THE REST OF THE WORLD	EAR99	8mm	MFG5-1235
		20mm	MFG5-1233
	Standard	8mm	MFG5-1335
		20mm	MFG5-1333

Velocity Shipping Product

FEATURES:

MFG5-1230
BATTERY CHARGER, POWER SUPPLY & POWER CABLE

P017-7485
PROBE SET

A017-7560
INDEX PROBE SPACER

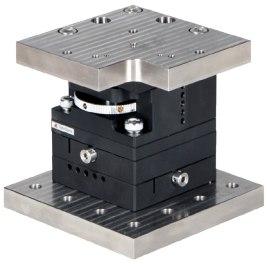
P017-8770
USB WITH SCI SOFTWARE

P017-7191
TRAVEL CASE

ACCESSORIES

MFG5-1240
8 MM TARGET PIN

MFG5-1241
20 MM TARGET PIN



P017-6570
XYZ ADJUSTABLE STAGE

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

8017-3911	ADAPTOR 1.00" DIAMETER WITH FLATS
8017-3901	ADAPTOR 1.00" DIAMETER WITHOUT FLATS
8017-3912	ADAPTOR 1.25" DIAMETER WITH FLATS
8017-3902	ADAPTOR 1.25" DIAMETER WITH FLATS
8017-3905	20 MM DIAMETER WITHOUT FLATS
8017-3906	25 MM DIAMETER WITHOUT FLATS
8017-3910	3/4" DIAMETER WITH FLATS
8017-3900	3/4" DIAMETER WITHOUT FLATS

P017-7980
DEMO STAND

LION PRECISION