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

**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

**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

**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

**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

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**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

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**MACHINE SELECTION & ANALYSIS**

**ENVIRONMENTAL EFFECTS**
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**
**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.

SEA / SCA / SCI

**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 / SCI

**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 / SCI

**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
**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

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**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

**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

**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

**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 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, 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**
- 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)
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<tr>
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<th>SEA Spindle Error Analyzer</th>
<th>SCA Spindle Check Analyzer</th>
<th>SCI Spindle Error Inspector</th>
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* 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.

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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 (#{ number 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:**

- MFG3-1906 MASTERBALL 1” SINGLE & DOUBLE ADJUSTABLE ECCENTRICITY 20MM SHANK
- 4900-0001 & 4900-0002 PROBE NEST 3 PROBES & PROBE NEST 5 PROBE ADAPTOR
- P016-6002 PROBES
- P014-2451 PROBE CAP
## Accessories

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<th>Spindle &amp; Application</th>
<th>Number of Probes</th>
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### Features:

- P014-2292 CALIBRATION CHECK FIXTURE
- 4900-0108 HEX KEY
- P017-8900 USB WITH SEA 9.0 SOFTWARE
- P017-0100 TRAVEL CASE

<table>
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<th>Accessories</th>
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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

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**

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<thead>
<tr>
<th>Region</th>
<th>Precision</th>
<th>Target Pin Size</th>
<th>Part #</th>
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[Velocity Shipping Product]

FEATURES:

- ![Feature Icon]
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**P017-7480**
PROBE SET

**A017-7560**
INDEX PROBE SPACER

**P017-8766**
USB WITH SCA SOFTWARE

**P017-7490**
TRAVEL CASE
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
**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 separately. Often it is helpful to have multiple pin sizes if you are checking a wide variety of machines.

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**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

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- Velocity Shipping Product
ACCESSORIES

P017-6061  8 MM TARGET PIN
P017-6091  20 MM TARGET PIN
P017-6570  XYZ ADJUSTABLE STAGE

B017-3911  ADAPTOR 1.00” DIAMETER WITH FLATS
B017-3901  ADAPTOR 1.00” DIAMETER WITHOUT FLATS
B017-3912  ADAPTOR 1.25” DIAMETER WITH FLATS
B017-3902  ADAPTOR 1.25” DIAMETER WITHOUT FLATS
B017-3905  20 MM DIAMETER WITHOUT FLATS
B017-3906  25 MM DIAMETER WITHOUT FLATS
B017-3910  3/4” DIAMETER WITH FLATS
B017-3900  3/4” DIAMETER WITHOUT FLATS

4900-0026  MASTERBALL 1” DOUBLE ADJUSTABLE ECCENTRICITY 20MM SHANK
P017-7331  CAPACITIVE DRIVE PROBE REPLACEMENT

4900-6203  MASTERBALL 1” SINGLE ADJUSTABLE ECCENTRICITY 20MM SHANK
P015-4658  - SCA INDEX PROBE REPLACEMENT
P017-7072  - SCI INDEX PROBE REPLACEMENT
P016-6700  - SCA INDEX DRIVER REPLACEMENT
P016-6701  - SCI INDEX DRIVER REPLACEMENT

MF05-1250  DEMO STAND

4900-0026  MASTERBALL 1” DOUBLE ADJUSTABLE ECCENTRICITY 20MM SHANK
P017-7331  CAPACITIVE DRIVE PROBE REPLACEMENT

4900-6203  MASTERBALL 1” SINGLE ADJUSTABLE ECCENTRICITY 20MM SHANK
P015-4658  - SCA INDEX PROBE REPLACEMENT
P017-7072  - SCI INDEX PROBE REPLACEMENT
P016-6700  - SCA INDEX DRIVER REPLACEMENT
P016-6701  - SCI INDEX DRIVER REPLACEMENT

MF05-1250  DEMO STAND

ACCESSORIES

P017-6061  8 MM TARGET PIN
P017-6091  20 MM TARGET PIN
P017-6570  XYZ ADJUSTABLE STAGE

B017-3911  ADAPTOR 1.00” DIAMETER WITH FLATS
B017-3901  ADAPTOR 1.00” DIAMETER WITHOUT FLATS
B017-3912  ADAPTOR 1.25” DIAMETER WITH FLATS
B017-3902  ADAPTOR 1.25” DIAMETER WITHOUT FLATS
B017-3905  20 MM DIAMETER WITHOUT FLATS
B017-3906  25 MM DIAMETER WITHOUT FLATS
B017-3910  3/4” DIAMETER WITH FLATS
B017-3900  3/4” DIAMETER WITHOUT FLATS

4900-0026  MASTERBALL 1” DOUBLE ADJUSTABLE ECCENTRICITY 20MM SHANK
P017-7331  CAPACITIVE DRIVE PROBE REPLACEMENT

4900-6203  MASTERBALL 1” SINGLE ADJUSTABLE ECCENTRICITY 20MM SHANK
P015-4658  - SCA INDEX PROBE REPLACEMENT
P017-7072  - SCI INDEX PROBE REPLACEMENT
P016-6700  - SCA INDEX DRIVER REPLACEMENT
P016-6701  - SCI INDEX DRIVER REPLACEMENT

MF05-1250  DEMO STAND