Rotary Inspector
5-Axis Metrology
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Our expertise

Everything we do…is built on unique metrology expertise
IBS Precision Engineering

Inspection & Qualification Tools
Custom product measurement solutions
IBS Precision Engineering

Metrology products
Measurement systems to nanometer accuracy
Engineered solutions
Customer specific modules for next generation precision
Our Markets

Helping our customers to achieve the next level of precision.....

for their most challenging processes.

Semiconductor | Aerospace | Machine Tool

Disk Drive | Scientific Instruments | Printing & Processing
5-Axis Benefits

- Reduced tools & fixturing
- Higher cutting speeds
- Shorter tools
- Improved accuracy
- Complex shapes
- Less time & waste
Introduction

• Great benefits with 5-axis machining
  – especially in high tech market, aviation, SemiCon and medical
• Increased importance for traceability and certification production process.
• How do I manage this in an Industry 4.0 manner?
Kinematic tests

5-axis machine qualification

- Measurements against fixed protocol (ISO 10791)
- Trinity wireless measurement head
  - Non-contact measurement in 3D
  - Sub-micron accuracy
- Precision master ball
- Robust, integrated design for production environments
  - Erowa mounting option
- Optional automatic compensation
  - Rotary table pivot point & squareness
Rotary Inspector

5-axis dynamic measurement (ISO 10791-6)

Q-value: Geometrical error
P-value: Surface and form error

< 1 minute
How does it work?

Top View

Offset in X direction: XOC

Masterball (workpiece)
Probe (tool)
How does it work?

Front view

Offset in X direction: XOC

Probe (tool)

Masterball (workpiece)
How does it work?

Front view with tilted table

Probe (tool)  Masterball (workpiece)
What does it reveal?

- True tool path revealed in 3D
- Pivot point & squareness
- Dynamic effects
- Controller parameters
Q value: geometrical error

Span max. to min. across X, Y and Z errors

Work piece dimensional error
P value: dynamic error

Work piece surface finish error

Span max. dynamic peak X, Y and Z
Link to ISO

ISO Measurement

\[-k1\]
2 axes follow 1 rotary axis

\[-k2\]

\[-k4\]
3 axes follow 2 rotary axes (5 axis)
Rotary Inspector measurement

BK1 Measurement
A-axis with Y & Z

BK2 Measurement
B-axis with X & Z

BK4 Measurement
A & B with X, Y & Z
Milling workpiece & kinematic tests

RI accurately predicts work piece error
RI vs work piece error

Q value 36 μm
Torus error 35.5 μm
Rotary Inspector

Industry 4.0 data management

• Central data base
  – Multiple Rotary Inspector systems
  – Different locations, factories, even countries

• Instant feedback on installed 5-axis machine base

• Analysis for
  – Actual machine performance
  – Improved scheduling
  – Reduced errors
  – Customer compliance
  – Predictive maintenance

• Machine certification
Automatic compensation

BK1 Measurement
A-axis with Y & Z

BK2 Measurement
B-axis with X & Z

BK4 Measurement
A & B with X, Y & Z
Automatic compensation

A-axis: Position 0.0282 → 0.0001 mm. Angles 0.0005 → 0.0001°

B-axis: Position 0.0219 → 0.0002 mm. Angles 0.0014 → 0.0000°
Automatic compensation

Total performance: BK4 measurement
A & B with X, Y & Z

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<th>End (mm)</th>
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Conclusions

• Market trend
  – 5-axis machining process
  – Increased need for certification

• Metrology system
  – Rotary Inspector for 5-axis machines
  – ISO 10791-6
  – True tool path: as your work piece

• Industry 4.0
  – Central data management & analysis
  – Actual performance
  – Improvement by compensation