Machine axis squareness inspection plan

machine-axis-squareness

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Application template; not a claim of a completed customer project.

Scope

Evaluate the right-angle relation between mean motion-axis directions. Distinguish it from full-surface perpendicularity to a datum.

Equipment and configuration guidance

• Autocollimator and stable reflector base

• Calibrated optical square or suitable right-angle reference

• Coordinate records and reference corrections

Principle and calculation

Determine deviation from 90° using the defined directions. Correct reference errors or include them in uncertainty. Do not remove all tilt independently before comparing directions.

On-site checklist

• Traceable reference direction

• Relative directions retained

• Reference error addressed

Suggested records

• Setup and coordinate diagram

• Axis profiles and directions

• Squareness and repeated measurements

Limitations

Near-90° fitted lines do not prove complete surface perpendicularity. Use the applicable machine test and drawing definition.

Detailed teaching example

Axis squareness: include the reference correction in the measurement model

Scenario and task

Teaching demonstration, not a real customer project. A reference with a known actual turning angle transfers the first direction, after which the second-axis residual is measured. The explicit model $\alpha=\beta_{ref}+r$ prevents indiscriminate addition or subtraction of reference corrections.

Workflow overview

Define axis directions → Read reference calibration → Transfer and define signs → Calculate corrected angle → Separate direction and form → Repeat and document

Preparation and measurement steps

01. Define first-axis direction A, second-axis direction B and their common measurement plane. Establish mean directions as required while retaining original tilt information for both lines.

02. Read the reference calibration and confirm its actual turning angle in this setup as βref=90°+0.60″. Recheck signs if the reference is reversed.

03. Transfer direction A through the reference and compare B with the turned direction. Define residual r as positive when B is farther in the increasing-angle direction.

04. Repeat residual readings and check reference stability. Use the illustrative mean residual r=+2.80″ and calculate the axis angle with α=βref+r.

05. Report δ=α−90° and, if helpful, its directional effect over 500 mm. Keep each axis straightness result separately instead of replacing it with the included angle.

06. Repeat after reinstallation or reversal and report reference correction, sign diagram, span, repeatability and uncertainty. Do not claim acceptance when no tolerance is specified.

Teaching example readings

• Actual calibrated reference turning angle βref=90°+0.60″.

• Second-direction residual relative to the transferred reference: mean r=+2.80″.

• Model α=βref+r; length conversion uses L=500 mm.

Calculation procedure

α=(90°+0.60″)+2.80″=90°+3.40″, so δ=+3.40″. Directional length effect e=500000×tan(3.4π/648000)≈8.241833 μm. Reversing the reference requires a newly verified sign model for βref and r.

Example result and interpretation

The illustrated axis-direction error is +3.40″, corresponding to approximately +8.241833 μm over 500 mm. It does not evaluate full-surface perpendicularity, all axis geometry or machining capability.

Example verification checklist

• Do not independently remove all tilt from both lines before trying to recover their relative directions.

• A certificate error and correction may have opposite signs; map them to the actual measurement model.

• Document changes in reference reversal, optical turns and coordinate directions rather than reusing unverified signs.

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