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Test code for machine tools —

Part 10:

Determination of the measuring performance of probing systems of numerically controlled machine tools

AMENDMENT 1: Measuring performance with scanning probes

Code d'essai des machines-outils —

Partie 10: Détermination des performances de mesure des systèmes de palpage des machines-outils à commande numérique

AMENDEMENT 1: Performances de mesure avec palpeurs de scanning

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 230-10 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO 230 consists of the following parts, under the general title *Test code for machine tools*:

- *Part 10: Determination of measuring performance of numerically controlled machine tools*
- *Part [n]:*
- *Part [n+1]:*

Test code for machine tools — Part 10: Determination of measuring performance of numerically controlled machine tools

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Annex A
(informative)
Alphabetical cross reference and short descriptions of symbols

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Annex B (informative)

Measuring performance with scanning probes

B.1 Scope

This Annex to ISO 230-10 specifies test procedures to evaluate the scanning performance of contacting probing systems, integrated with a numerically controlled machine tool, and used in a pre-defined path scanning mode (see B 2.9).

These tests are supplementary to the discrete point tests that are specified in clauses 6 and 7 of this International Standard. Contacting probing systems that do not support discrete point measurement are not covered by this Annex.

Clauses 1 through 5 are applicable to this Annex.

The test procedures are not intended to distinguish between the various causes of errors. They are intended to demonstrate the combined influence of the environment, machine tool, probing system and probing software on the measuring performance.

The tests in this Annex are applicable to both acceptance testing and re-verification testing, and should be run periodically, after a crash of the probe or machine, or if any of the following are changed:

- Measurement feed speed;
- Stylus configuration (in particular stylus length);
- Feed speed during qualification or measurement;
- Probe orientation during measurement;
- Probe module (e.g. the probe itself);
- Nominal deflection;
- Measurement range.

B.2 Terms and definitions

For the purpose of this Annex, the following additional terms and definitions apply.

B.2.1

rest position

the position of the probe's stylus tip when it is stationary and not deflected by contact with a surface

NOTE This is a nominal position that is established during qualification. The actual rest position at any time will typically vary slightly from this value.

B.2.2

maximum scanning deflection

the maximum deflection that can be applied to the probe stylus tip during a scanning measurement specified by the manufacturer

NOTE This may vary with direction of deflection (x, y, z) .

B.2.3

probe over-travel limit

the maximum deflection of the probe stylus from the rest position that can be applied without causing damage to the probe stylus assembly

B.2.4

minimum scanning deflection

the minimum deflection of the centre of the stylus tip from its rest position that is allowed during a scanning measurement

NOTE Deflection is programmed to be large enough to ensure that the stylus tip maintains contact with the surface throughout the measurement.

B.2.5

scanning measurement range

maximum allowed distance between the nominal scan line and the actual scan line, as specified by the manufacturer/supplier. [RO1]

NOTE 1 This distance may be expressed separately for the different axes of the probe, e.g., $\pm 0.3\text{mm}$ in X and Y, $\pm 0.2\text{mm}$ in Z.

NOTE 2 The scanning measurement range is less than the difference between the maximum scanning deflection and the minimum scanning deflection for a number of reasons, some examples being:

- Deviation from the pre-defined tool-path caused by machine tool path following errors;
- Approximations during tool-path generation (e.g. approximating a curve by straight line segments);
- Additional probe deflection caused by movement along the surface (e.g. friction, local surface normal deviations, surface finish).

B.2.6

stylus tip normal acceleration

acceleration of the stylus tip relative to the surface being measured, normal to the target surface

NOTE Stylus tip normal acceleration is sometimes considered to limit the scanning feed speed for features that have sharp scanning path variations, and would therefore demand high rates of acceleration from the machine tool axes. Scanning performance is affected mostly by acceleration normal to the surface being measured, as machine position errors in the direction of the target scan line do not usually lead to significant measurement errors.

B.2.7

Indicated tip centre point

indicated position of the centre of the stylus tip during a measurement

NOTE This is also known as an "indicated measured point" (see ISO 10360-1, Clause 2.12).

B.2.8

scanning sphere position reproducibility error

reproducibility of sphere centre position measurement when varying the nominal position of the sphere, and hence the scanning tool path with respect to the actual sphere position

B.2.9

pre-defined path scanning

method of scanning in which the motion of the probing system between two defined end points is directed by a target scan line.

[ISO 10360-1, definition 7.5]

NOTE In this method of scanning, feedback from the probing system is not used to direct the motion of the probing system.

B.3 General considerations

The sources of measurement error in continuous scanning systems on machine tools are different from those on a CMM. The main differences are:

- A machine tool typically does not control probe deflection while scanning. This means that the positional uncertainty of the work-piece is more likely to affect measurement uncertainty on a machine tool.
- Machine tools are optimised for cutting, not measurement. Machine position reporting errors during qualification and subsequent measurements typically create differences between the measurement accuracy of inside and outside features, for example bores and bosses.

The following tests should be performed using the feed speed and the measurement range specified for the probing system or agreed between manufacturer/supplier and user.

The tests in this Annex are sensitive to stylus configuration; especially stylus length and stylus tip diameter. For acceptance testing the stylus configuration should be agreed between manufacturer/supplier and user. For verification testing the tests should be run whenever a new stylus configuration is used.

For probing systems that control probe deflection using real-time feedback to adjust the measurement path, the less comprehensive but shorter test specified in ISO 10360-4 may be appropriate. For this type of system, if agreed between manufacturer/supplier and user, the Scanning 3D performance test (see B.5) could be replaced by the test specified in ISO 10360-4. If this is done it is nevertheless recommended that the scanning 2D performance test (see B.6) is still performed.

NOTE 1 Scanning 3D performance test contains the measurements required for ISO10360-4. If required, the measurement data from the Scanning 3D performance test can also be analysed to produce ISO10360-4 results.

NOTE 2 The 3D scanning performance test is performed on an external surface, whereas the 2D scanning performance test is performed on an internal surface. The two tests have been designed to be complimentary to each other as scanning systems on machine tools may have significantly different uncertainties when scanning internal and external surfaces. It is recommended that both tests are performed.

The probe should be tool changed and, where applicable, the tool change indexer moved by at least one index position after qualification and between each test.

B.4 Filtering parameters

The filtering algorithms and parameters used during these tests will affect the results, and should be agreed between manufacturer/supplier and user, and stated in the test report.

B.5 Scanning 3D performance test; $E_{SC,3D,POS}$, $E_{SC,3D,DIA}$, $E_{SC,3D,FORM}$, $T_{SC,3D}$, ($Error_{scanning,3D,POSition}$, $Error_{scanning,3D,DIAmeter}$, $Error_{scanning,3D,FORM}$ and $Time_{scanning,3D}$)

B.5.1 General

This test determines the ability of the probing system to measure a test sphere when the measurement tool-path is not exactly aligned with the test sphere. This test applies to probing systems that can measure a sphere in continuous scanning mode, and simulates the deviation of work-piece position during in process measurement.

The probe is operated over its full 3D measurement range in this test. This test does not include the effects of temperature variation on positional uncertainty. The user of a contact scanning system is advised to consider the effect of temperature variations on their measurement range requirements.