
**Test code for machine tools —
Part 3:
Determination of thermal effects**

Code d'essai des machines-outils —

Partie 3: Évaluation des effets thermiques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This third edition cancels and replaces the second edition (ISO 230-3:2007), which has been technically revised. The main changes compared to the previous edition is the addition of [Clause 8](#) for checking thermal effects of machine tool rotating heads and tables.

A list of all parts in the ISO 230 series can be found on the ISO website.

Introduction

The purpose of the ISO 230 series is to standardize methods of testing the accuracy of machine tools, excluding portable power tools.

This document specifies test procedures to determine thermal effects caused by a variety of heat inputs resulting in the distortions of a machine tool structure or the positioning system. It is a recognized fact that the ultimate thermo-elastic deformation of a machine tool is closely linked to the operating conditions. The test conditions described in this document are not intended to simulate the normal operating conditions but are to facilitate performance estimation and to determine the effects of environment on machine tool performance. For example, use of coolants can significantly affect the actual thermal behaviour of the machine tool. Therefore, these tests are considered only as the preliminary tests towards the determination of actual thermo-elastic behaviour of the machine tool if such determination becomes necessary for machine characterization purposes. The tests are designed to measure the relative displacements between the component that holds the tool and the component that holds the workpiece as a result of thermal expansion, contraction, or distortion of relevant structural elements.

The tests described in this document can be used either for testing different types of machine tools (type testing) or testing individual machine tools for acceptance purposes. When the tests are required for acceptance purposes, it is up to the user to choose, in agreement with the supplier/manufacturer, those tests relating to the properties of the components of the machine, which are of interest. A simple reference to this part of the test code for the acceptance tests, without agreement on the tests to be applied and the relevant charges, cannot be considered as binding for any contracting party. One significant feature of this document is its emphasis on environmental thermal effects on all the performance tests described in other parts of the ISO 230 series related to linear displacement measurements (such as linear positioning accuracy, repeatability and the circular tests). The suppliers/manufacturers are expected to provide thermal specifications for the environment in which the machine can be expected to perform with the specified accuracy. The machine user is responsible for providing a suitable test environment by meeting the supplier/manufacturer's thermal guidelines or otherwise accepting reduced performance. An example of environmental thermal guidelines is given in [Annex C](#).

A relaxation in accuracy expectations is required if the thermal environment causes excessive uncertainty or variation in the machine tool performance and does not meet the supplier/manufacturer's thermal guidelines. If the machine does not meet the performance specifications, the analysis of the combined standard thermal uncertainty provides help identifying sources of problems. Combined standard thermal uncertainty is defined in [3.13](#) as well as in ISO/TR 16015.

Test code for machine tools —

Part 3: Determination of thermal effects

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document defines four tests:

- an environmental temperature variation error (ETVE) test;
- a test for thermal distortion caused by rotating spindles;
- a test for thermal distortion caused by moving linear axes;
- a test for thermal distortion caused by rotary motion of components.

The tests for thermal distortion caused by moving linear axes (see [Clause 7](#)) are applicable to numerically controlled (NC) machines only and are designed to quantify the effects of thermal expansion and contraction as well as the angular deformation of structures. For practical reasons, the test methods described in [Clause 7](#) apply to machines with linear axes up to 2 000 mm in length. If they are used for machines with axes longer than 2 000 mm, a representative length of 2 000 mm in the normal range of each axis is chosen for the tests.

The tests correspond to the drift test procedure as described in ISO/TR 16015:2003, A.4.2, applied for machine tools with special consideration of thermal distortion of moving linear components and thermal distortion of moving rotary components. On machine tools equipped with compensation for thermal effects these tests demonstrate any uncertainty in nominal thermal expansion due to uncertainty of coefficient of thermal expansion and any uncertainty of length due to temperature measurement.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 230-1:2012, *Test code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 230-1:2012 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>