INTERNATIONAL STANDARD

ISO 14405-2

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Geometrical product specifications (GPS) — Dimensional tolerancing —

Part 2: Dimensions other than linear sizes

Spécification géométrique des produits (GPS) — Tolérancement dimensionnel —

Partie 2: Dimensions autres que tailles linéaires

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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.

ISO 14405-2 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

This first edition of ISO 14405-2 cancels and replaces ISO 406:1987.

ISO 14405 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Dimensional tolerancing*:

— *Part 1: Linear sizes*

— *Part 2: Dimensions other than linear sizes*

Introduction

This part of ISO 14405 is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). In the general GPS matrix, it influences chain link 1 in the distance and radius chains of standards and chain links 1, 2 and 3 in the angle chain of standards.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this document is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated.

For dimensions other than linear sizes, the requirement is ambiguous when applied to the real workpiece. It is the presence of form and angular deviations on all real workpieces that makes these requirements ambiguous, i.e. there is a specification ambiguity.

It has to be realized that this specification ambiguity can only be avoided for features of size toleranced in accordance with ISO 14405-1. For all other dimensions, geometrical tolerancing should be used in order to control the specification ambiguity.

For more detailed information on the relation of this part of ISO 14405 to other standards and to the GPS matrix model, see Annex B.

Geometrical product specifications (GPS) — Dimensional tolerancing —

Part 2: Dimensions other than linear sizes

1 Scope

This part of ISO 14405 illustrates the use of geometrical tolerancing for dimensions that are not linear sizes to avoid the ambiguity that the use of ± tolerances on these dimensions causes. Both linear and angular dimensions, except size of features of size are covered.

Dimensional tolerancing can be indicated by ± tolerancing or geometrical tolerancing.

The ambiguity caused by using ± tolerances for dimensions other than linear sizes (for individual tolerances and general tolerances according to, e.g. ISO 2768-1 and ISO 8062-3) is explained in Annex A.

NOTE 1 The figures, as shown in this part of ISO 14405, merely illustrate the text and are not intended to reflect actual usage. The figures are consequently simplified to indicate only the relevant principles.

NOTE 2 For indications of size tolerances, see the following:

— ISO 14405-1 for linear size;

— ISO 2538 for wedges;

— ISO 3040 for cones.

NOTE 3 The rules for geometrical tolerancing are given in ISO 1101.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the cited editions apply. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 129-1:—[1], *Technical drawings — Indication of dimensions and tolerances — Part 1: General principles*

ISO 286-1:2010, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 1: Basis of tolerances, deviations and fits*

ISO 2538:1998, *Geometrical Product Specifications (GPS) — Series of angles and slopes on prisms*

ISO 1101:—[2], *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

1) To be published. (Revision of ISO 129-1:2004)

2) To be published. (Revision of ISO 1101:2004)

ISO 8015:2011, *Geometrical product specifications (GPS) — Fundamentals — Concepts, principles and rules*

ISO 13715:2000, *Technical drawings — Edges of undefined shape — Vocabulary and indications*

ISO 14405-1:2010, *Geometrical product specifications (GPS) — Dimensional tolerancing — Linear sizes*

ISO 14660-1:1999, *Geometrical Product Specifications (GPS) — Geometrical features — Part 1: General terms and definitions*

ISO 14660-2:1999, *Geometrical Product Specifications (GPS) — Geometrical features — Part 2: Extracted median line of a cylinder and a cone, extracted median surface, local size of an extracted feature*

ISO 17450-1:— [3], *Geometrical product specifications (GPS) — General concepts — Part 1: Model for geometrical specification and verification*

ISO 17450-2:— [4], *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators, uncertainties and ambiguities*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 129-1, ISO 1101, ISO 8015, ISO 13715, ISO 14405-1, ISO 14660-1, ISO 14660-2, ISO 17450-1, ISO 17450-2 and the following apply.

The term “drawing” is used in this part of ISO 14405 as a synonym for the 2D drawing, the 3D model and other representations of the workpiece.

3.1
± tolerancing
tolerancing using dimension and indication of limit deviations, dimension limit values or unilateral dimension limit

NOTE The sign ± should not be understood in a way that the limit deviations are always symmetrical to the nominal size.

3.2
linear size
dimension in length units characterizing a feature of size

3.3
angular size
dimension in angle units characterizing a feature of size

3.4
distance
dimension between two geometrical features which are not considered as a feature of size

NOTE 1 Distance can be between two integral features or an integral feature and a derived feature or two derived features.

NOTE 2 Linear distance and angular distance exist.

3.4.1
linear distance
distance in length units

3) To be published. (Revision of ISO/TS 17450-1:2005)

4) To be published. (Revision of ISO/TS 17450-2:2002)

3.4.2
angular distance
distance in angle units

4 Principles and rules for indication of dimensions and related tolerances

The general rules and principles for indicating ± tolerances given in ISO 14405-1 apply to this part of ISO 14405 and are the basis for tolerancing on mechanical engineering drawings. In all other cases, special rules apply.

For rules on the indication of units, see Clause 5.

For dimensions other than linear sizes, a requirement with ± tolerancing is ambiguous (specification ambiguity) when applied to a real workpiece. This type of specification is not recommended; see Annex A.

Specification ambiguity can only be avoided for linear sizes toleranced in accordance with ISO 14405-1. In order to control specification ambiguity, geometrical tolerancing shall be used.

Unless otherwise specified, e.g. by using CZ according to ISO 1101 or Ⓜ according to ISO 2692, tolerances on mechanical engineering drawings are independent requirements without any relationships to other requirements for the same feature(s). This is the independency principle (see ISO 8015).

Several types of dimensions exist in the nominal model of the workpiece (see Table 1).

Table 1 — Types of dimensions

		Characterization, type and number of features			Type of dimension	Details in
Dimension	Linear dimension (length units)	One feature	Integral – only features of size		Linear size	ISO 14405-1
			Integral or derived		Radius dimension	7.5, A.6, A.7
			Integral or derived		Arc length	A.12
		Two features	Integral – integral	Facing the same direction	Linear distance or step height	7.2, A.2
				Facing the opposite direction	Linear distance	7.2, 7.6, A.3, A.8
			Integral – derived		Linear distance	7.3, 7.7, A.4, A.9
			Derived – derived		Linear distance	7.4, A.5
		Edge (transition region between two integral features)	Integral	Chamfer shape	Chamfer height and angle	A.11
				Rounding shape	Edge radius	A.11
	Angular dimension (angle units)	One feature	Integral – only features of size		Angular size, cones	ISO 3040
		Two features	Integral – integral		Angular distance	8.1, 8.2, ISO 2538
			Integral – derived		Angular distance	8.3, A.10
			Derived – derived		Angular distance	—

5 Units used in drawings for dimensions

The default units for dimensions are the following.

— For linear dimensions and associated tolerance limits, the unit is the millimetre (mm).

— For angular dimensions and associated tolerance limits, the unit is the degree (360°). Decimal degrees or degrees, minutes and seconds can be used.

For a linear dimension, the unit is not indicated; it is implied.

For an angular dimension, the unit shall be indicated for the nominal value and for the tolerance limit indication.

If a unit other than the default is used, the unit shall be indicated in or near the title block of the drawing.

6 Indication of tolerances for linear and angular dimensions

Indication of tolerances for linear dimensions shall be in accordance with the indication rules in ISO 14405-1.

For the indication of tolerances for angular dimensions, the same indication rules apply with the addition that the angle unit shall be specified on both the dimension value and the tolerance value.

7 Illustrations of ambiguous ± tolerancing vs. unambiguous geometrical tolerancing

7.1 General

This clause shows examples of the use of geometrical tolerances for dimensions which are not linear sizes. Geometrical tolerances can be used to avoid the ambiguity of dimensions with ± tolerances. Generally, requirements based on geometrical tolerances have no, or a very small, specification ambiguity.

The ambiguity caused by using ± tolerances is described in Annex A.

If geometrical tolerances are used, several different solutions are normally possible. The examples in this clause show some of these possibilities.

Each example is accompanied by a figure illustrating the use of ± tolerancing, which is ambiguous and therefore can give high specification ambiguity. (See Annex A for explanations and examples of the ambiguity associated with ± tolerancing for dimensions other than linear size.)

For more details about geometrical tolerances, see ISO 1101.

7.2 Linear distance between two integral features

See Figure 1.

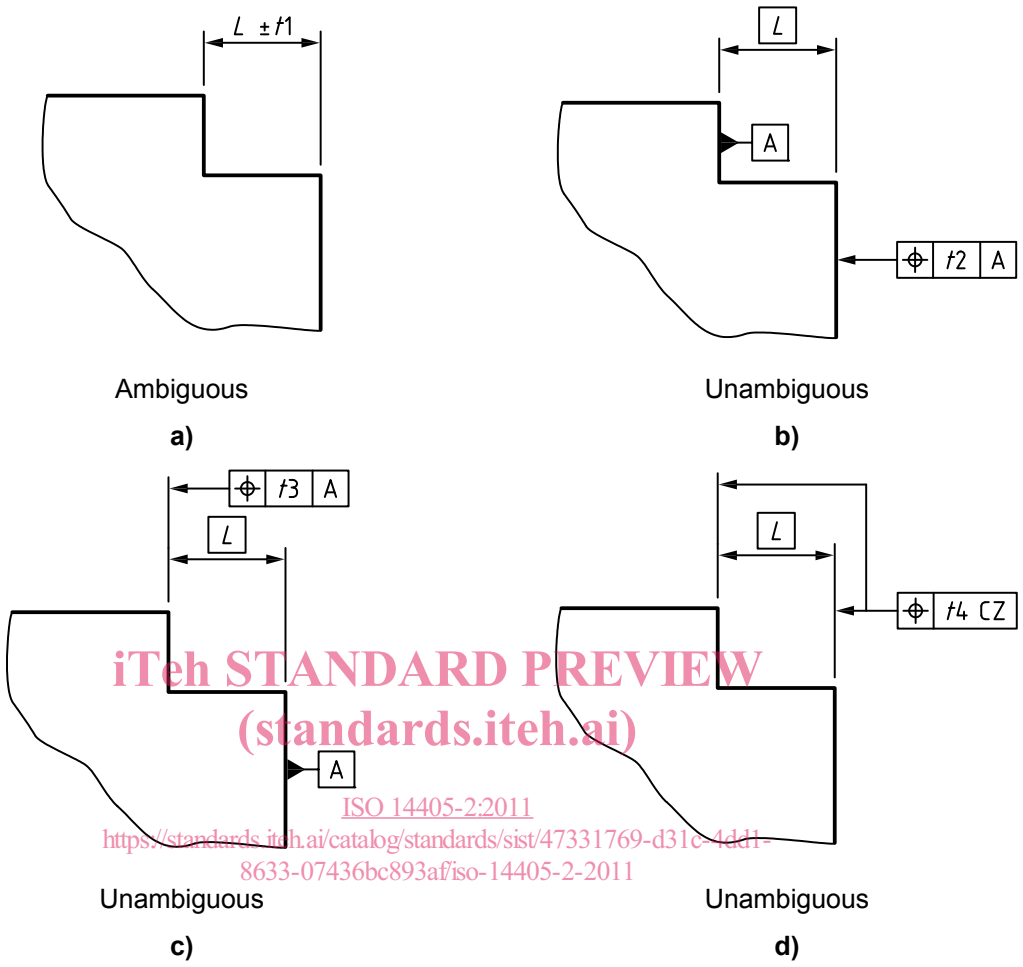

Figure 1 — Example of a linear step dimension (a) and three different solutions using geometrical tolerances (b, c and d)

NOTE 1 Figure 1 a) shows an example of the use of ± tolerances for a dimension. This is ambiguous and can result in high specification ambiguity; see Annex A.

NOTE 2 Figures 1 b), 1 c) and 1 d) show different solutions using geometrical tolerances. This is unambiguous and can result in no, or a very low, specification ambiguity.

NOTE 3 In Figure 1 b), a datum plane A is established on datum feature A, the left-hand vertical nominal flat surface. Datum A aligns the workpiece in space. The right-hand vertical flat surface is toleranced by a position tolerance zone at a TED (Theoretically Exact Dimension) distance L.

NOTE 4 In Figure 1 c), a datum plane A is established on datum feature A, the right-hand vertical nominal flat surface. Datum A aligns the workpiece in space. The left-hand vertical flat surface is toleranced by a position tolerance zone at a TED distance L.

NOTE 5 In Figure 1 d), no datum is indicated. The workpiece is aligned in space considering simultaneously the two vertical flat surfaces. The two flat surfaces are toleranced in relation to each other by position tolerance zones the distance L apart.

Figure 2 shows an example with two integral features facing opposite directions. However, the principle is the same as in Figure 1.

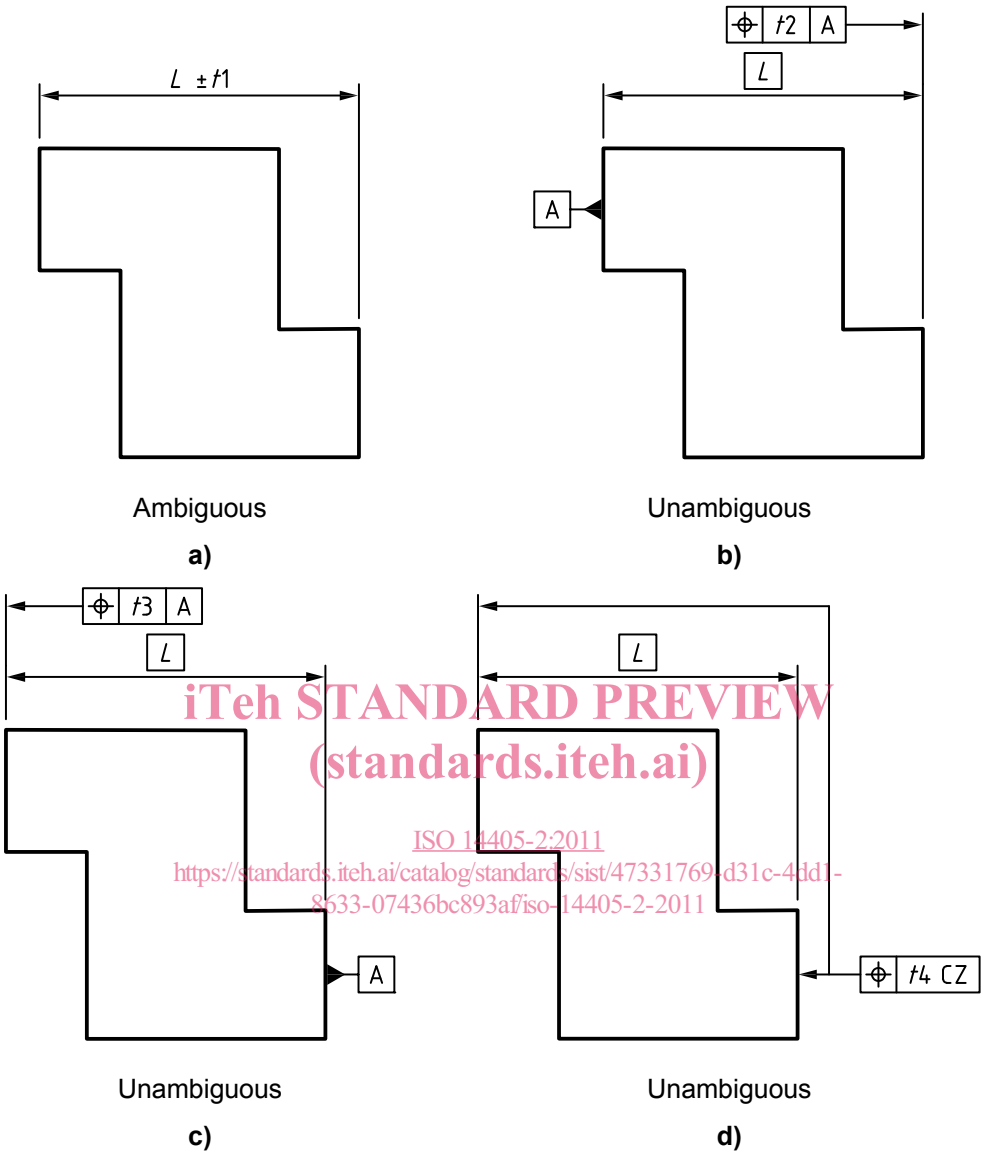

Figure 2 — Example of a linear distance between two integral features facing opposite directions (a), not a feature of size, and three different solutions using geometrical tolerances (b, c and d)