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Geometrical product specifications (GPS) — Dimensional tolerancing

Part 1:  
Linear sizes

*Spécification géométrique des produits (GPS) — Tolérancement dimensionnel*

*Partie 1: Tailles linéaires*

ISO/FDIS 14405-1

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## Foreword

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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 document 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](http://www.iso.org/directives)).

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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](http://www.iso.org/iso/foreword.html). This document was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 290, *Dimensional and geometrical product specification and verification*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 14405-1:2016), which has been technically revised.

The main changes are as follows:

- the use of linear size specifications for cones, torus and two opposite circles is now reduced to the cases described in Annexes D, E and F;
- the syntax is changed, and is now defined with several indication areas, and a sequence of specification elements in each area;
- linear size specifications can be stacked upon each other and the rules for stacked specifications are defined;
- the indication  $k \times / n \times$  is now possible, in order to facilitate stacking with geometrical specifications;
- the graphical rules are modified;
- the specification element “/0” to mean “any restricted portion whose length is equal to zero” has been removed to use the modifier “ACS”;

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- ~~when~~ different specification operators applied for the upper and the lower specification limits of size characteristic, the new rule is to indicate two different size specifications;
- ~~the~~ indication of several linear size specifications on the same dimension line or reference line with brackets is removed;
- it is now ~~mandatory~~required to use the “between” symbol to indicate that a linear size specification applies to a fixed restricted portion of a feature of linear size;
- it is now ~~mandatory~~required to indicate “SCS” with the identifier of the section for a specific cross-section;
- ~~the~~ rank-order size specification is now called statistical size specification.

A list of all parts in the ISO 14405 series can be found on the ISO website.

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](http://www.iso.org/members.html).

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## Introduction

This document is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO 14638). It influences chain links A to C of the chain of standards on size.

The ISO GPS matrix model given in ISO 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 the specifications made in accordance with this document, unless otherwise indicated.

For more detailed information on the relationship of this document to other standards and the GPS matrix model, see [Annex I](#).

This document deals with linear size specifications on the following features of linear size:

- cylinders;
- spheres;
- two parallel opposite planes.

It also deals with the following cases:

- circles as sections of a cone;
- circles as sections of a torus;
- parallel opposite lines as longitudinal sections of cylindrical tubes.

Different specification elements allow specifying local linear sizes or global linear sizes of different types, and, for example, specifications on several features of linear size, specifications in sections and specifications on portions. The many specification elements allow for specifying a variety of functional needs.

[Annex D](#) provides the definition of a size for a circle as section of a cone. [Annex E](#) provides the definition of sizes for circles as sections of a torus. [Annex F](#) provides the definition of sizes for parallel opposite lines as longitudinal sections of cylindrical tubes in half planes containing a specified axis. [Annex H](#) gives an overview of the sequence of specification elements for linear size specifications.

[ISO 14405-2](#) gives the difference between linear size, angular size and dimensions other than linear or angular sizes. [ISO 14405-2](#) relies on this document for the rules about indication.





# Geometrical product specifications (GPS) — Dimensional tolerancing

## Part 1: Linear sizes




**IMPORTANT** — The ~~illustrations~~figures included in this document are intended to ~~either~~ illustrate the text ~~and/or~~ to provide examples of the related technical drawing specification, ~~or both~~. These ~~illustrations~~figures are not fully specified, showing only the relevant general principles. As a consequence, the ~~illustrations~~figures are not a representation of a complete workpiece and are not of a quality that is required for use in industry ~~(in terms of full conformity with the standards prepared by ISO/TC 10 and ISO/TC 213)~~ and, as such, are not suitable for projection for teaching purposes. Figures are simplified 2D representations and show features that are unlikely (e.g. a minimum circumscribed cylinder with three contact points in the same section).

### 1 Scope

This document ~~establishes the rules to indicate~~specifies requirements for indicating linear sizes.

This document establishes the default specification operator (see ISO 17450-2) and defines a special specification operator for linear sizes.

This document is applicable to the following features of linear size (see ISO 17450-1):

-  cylinders;
-  spheres;
-  two parallel opposite planes.

~~Annex D provides the definition of a size for a circle as section of a cone. Annex E provides the definition of sizes for circles as sections of a torus. Annex F provides the definition of sizes for parallel opposite lines as longitudinal sections of cylindrical tubes in half planes containing a specified axis.~~

This document provides a set of tools to express several types of linear size characteristics. It does not present any information on the relationship between a function or a use and a linear size characteristic.

~~ISO 14405-2 gives the difference between linear size, angular size and dimensions other than linear or angular sizes. ISO 14405-2 relies on this document for the rules about indication.~~

### 32 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 286-1, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 1: Basis of tolerances, deviations and fits*

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

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

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

ISO 17450-3, *Geometrical product specifications (GPS) — General concepts — Part 3: Toleranced features*

ISO 81714-1, *Design of graphical symbols for use in the technical documentation of products — Part 1: Basic rules*

### **4.3 Terms and definitions**

For the purposes of this document, the terms and definitions given in ISO 286-1, ISO 8015, ISO 17450-1, ISO 17450-2, ISO 17450-3 and the following apply.

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

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

#### **4.13.1 ~~3.1~~ size**

dimensional parameter considered variable for a feature of size that can be defined on a nominal feature or on an associated feature

Note 1 to entry: A size is angular (e.g. angle of a cone) or linear (e.g. diameter of a cylinder). This document only ~~deals with~~ **applies to** linear sizes ~~(3.2(3.2)-1)~~. See ISO 14405-3 for angular sizes.

Note 2 to entry: Depending on the type of feature of linear size, the terms “diameter”, “width, and “thickness” are synonyms for size.

#### **4.23.2 ~~3.2~~ linear size**

dimension in length units characterizing a feature of size

[SOURCE: ISO 14405-2:2018, 3.2]

#### **4.33.3 ~~3.3~~ size characteristic**

characteristic relative to a size ~~(3.1(3.1)-1)~~ and defined from an extracted integral feature

Note 1 to entry: A size can be evaluated by more than one size characteristic (e.g. the two-point diameter or the diameter of the associated feature).

#### **4.43.4 ~~3.4~~ upper specification limit of size characteristic**

largest permissible value for a size characteristic ~~(3.3(3.3)-1)~~

#### **4.53.5 ~~3.5~~ lower specification limit of size characteristic**

smallest permissible value for a size characteristic ~~(3.3(3.3)-1)~~

#### 4.6.3.6

##### 3.6

##### local linear size

size characteristic (3.3(3.3)) having by definition a non-unique result of evaluation either along and/or around, or both, a feature of linear size (3.2).

Note 1 to entry: For a given feature of linear size, an infinity of local linear sizes exists.

Note 2 to entry: In Figure 3, examples of local linear sizes are shown. These examples do not take into account the statistical size (3.7.6(3.7.6)).

#### 4.6.13.6.1 3.6.1

##### two-point size

<local linear size> distance between two opposite points on an extracted integral feature of linear size (3.2)

Note 1 to entry: A two-point size on a cylinder can be called a "two-point diameter".

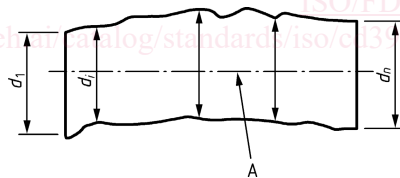
Note 2 to entry: A two-point size on two parallel opposite planes can be called a "two-point thickness" or a "two-point width".

Note 3 to entry: The method establishing a two-point size from any kind of features of linear size is given in ISO 17450-3.

Note 4 to entry: See Figure 1.

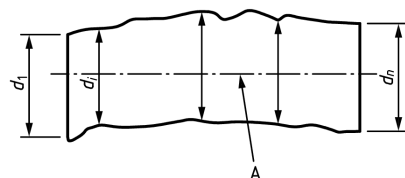


for examples of two-point sizes. Figure 1 a) Extracted shows an extracted feature under consideration: a cylinder which could be either internal or external.



a) Extracted feature under consideration

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b) Two-point sizes (see ISO 17450-3)

Key

$d$  size

A axis of the least-squares associated cylinder with the extracted integral feature

Figure 1 — Examples of two-point sizes

4.6.23.6.2 3.6.2

spherical size

<local linear size> diameter of the maximum inscribed sphere

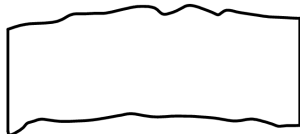
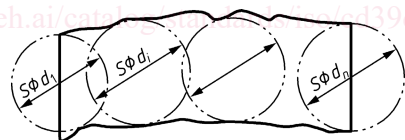
Note 1 to entry: The maximum inscribed sphere is used when defining the spherical size of both internal and external features of linear size (3.2).

Note 2 to entry: The spherical size does not apply to spheres.

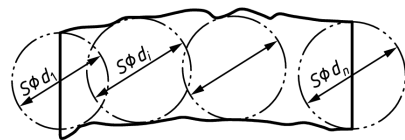
Note 3 to entry: See Figure 2 for examples of spherical sizes. Figure 2 a) Figure 2.



a) Extracted feature under consideration: a cylinder which could be either internal or external.



a) Extracted feature under consideration



b) Spherical sizes

**Key**

*Sed* diameter of the maximum inscribed sphere

*Sed* diameter of the maximum inscribed sphere

**Figure 2 — Examples of spherical sizes**

**4.6.33.6.3 3.6.3**

**linear section size**

global linear size (3.7(3.7)) for a given section of the extracted integral feature of linear size (3.2)

Note 1 to entry: A linear section size is a global linear size (3.7) for a given section and is a local linear size (3.6(3.6)) for the entire feature of linear size because it has by definition different results of evaluation along the feature of linear size.

Note 2 to entry: On an extracted feature of linear size, which is a cylindrical surface, it is possible to define an infinite number of cross-sections in which the diameter of the associated circle can be defined (with a specific association criterion). This is a linear section size.

Note 3 to entry: See Figure 3 for an example of linear section size. Figure 3 a) Figure 3.



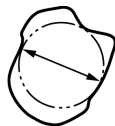
a) Extracted feature under consideration, a cylinder which could be either internal or external. Figure 3 b)



b) Linear section size obtained from a global linear size with maximum inscribed criterion (other criteria are possible).



a) Extracted feature under consideration



b) Linear section size obtained from a global linear size

NOTE The linear section size of Figure 3 b) in each cross-section is given by the diameter of the maximum inscribed circle defined in that cross-section.

Figure 3 — Example of linear section size

4.6.4.3.6.4 3.6.4

#### linear portion size

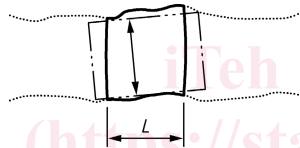
global linear size (3.7(3.7)) for a given portion of the extracted feature of linear size (3.2)

Note 1 to entry: A linear portion size is a global linear size (3.7) for a given portion and is a local linear size (3.6(3.6)) for the entire feature of linear size because it has by definition different results of evaluation along the feature of linear size.

Note 2 to entry: See Figure 4 for an example of linear portion size. Figure 4 a) Figure 4.



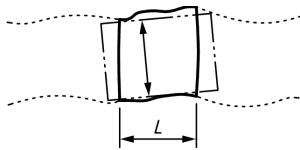
a) Extracted) shows an extracted feature under consideration: a cylinder which could can be either internal or external. Figure 4 b



b) Linear) shows a linear portion size obtained from a global linear size with maximum inscribed criterion (other criteria are possible)).



a) Extracted feature under consideration



b) Linear Key

$L$  — considered length of the portion of the cylinder size obtained from a global linear size

Key

$L$  considered length of the portion of the cylinder

NOTE Only a portion of length  $L$  of the extracted feature is considered.

Figure 4 — Example of linear portion size