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**Geometrical product specifications (GPS)
— Dimensional tolerancing — Part 1:
Linear sizes**

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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Geometrical product specifications (GPS) — Dimensional tolerancing — Part 1 : Linear sizes

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 14405-1** published in 2010 with some modifications of the technical contents in which the relevant terms having been conventionally established in **JISs** have been partially reviewed.

The portions given dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JB.

1 Scope

This Standard establishes the default specification operator for linear size and defines a number of special specification operators for linear size for feature of size types “cylinder” and “two parallel opposite planes”. It also defines the specification modifiers and the drawing indications for these linear sizes.

This Standard covers the following linear sizes:

- local size
 - two-point size
 - spherical size
 - section size
 - portion size
- global size
 - direct global linear size
 - least-squares size
 - maximum inscribed size
 - minimum circumscribed size
 - indirect global linear size
 - calculated global size (calculated size with volume diameter)
- calculated size
 - circumference diameter
 - area diameter
 - volume diameter

- rank-order size
 - maximum size
 - minimum size
 - average size
 - median size
 - mid-range size
 - range size.

This Standard defines tolerances of linear sizes when there is :

- a + and/or – limit deviation (e.g. 0/–0.019) (see Figure 9);
- an upper limit of size (ULS) and/or lower limit of size (LLS) (e.g. 15.2 max., 12 min) (see Figure 11);
- an ISO tolerance class code in accordance with **JIS B 0401-1** (see Figure 10).

with or without modifier (see Tables 1 and 2).

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

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

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

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent edition (including amendments) shall be applied.

JIS B 0026 *Technical drawings — Dimensioning and tolerancing — Non-rigid parts*

NOTE : Corresponding International Standard : ISO 10579 : 2010 *Geometrical product specifications (GPS) — Dimensioning and tolerancing — Non-rigid parts* (IDT)

JIS B 0401-1 *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 1 : Basis of tolerances, deviations and fits*

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

JIS B 0672-1 *Geometrical Product Specifications (GPS) — Geometrical features — Part 1 : General terms and definitions*

NOTE : Corresponding International Standard : ISO 14660-1 : 1999 *Geometrical Product Specifications (GPS) — Geometrical features — Part 1 : General terms and definitions* (IDT)

JIS B 0672-2 *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*

NOTE : Corresponding International Standard : 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* (IDT)

ISO 17450-1 : 2011 *Geometrical product specifications (GPS) — General concepts — Part 1 : Model for geometrical specification and verification*

ISO 17450-2 : 2012 *Geometrical product specifications (GPS) — General concepts — Part 2 : Basic tenets, specifications, operators, uncertainties and ambiguities*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS B 0672-1**, **JIS B 0672-2**, **ISO 17450-1**, **ISO 17450-2**, and the following apply.

3.1 specification modifier

geometrical product specifications (hereafter referred to as “GPS”) element that changes the default definition of the basic GPS specification when applied

NOTE : Specification modifiers may be defined by **ISO** Standards, **JIS** or by company standards/documents.

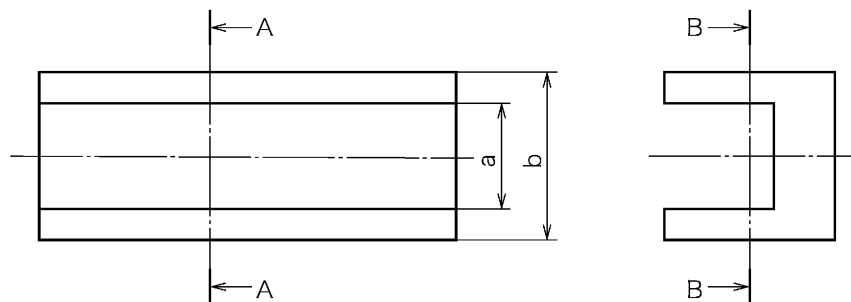
3.2 feature of size

geometrical shape defined by a linear or angular dimension which is a size

NOTE 1 The features of size can be a cylinder, a sphere, two parallel opposite surfaces, etc.

NOTE 2 In **JIS B 0672-1**, the meanings of the terms “plain workpiece” and “single features” are close to that of “feature of size”.

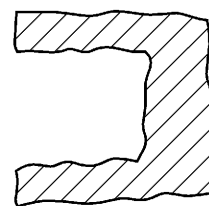
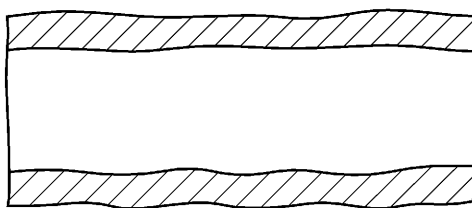
NOTE 3 The types of feature of size covered by this Standard are given in Figures 1 and 2.



a) Nominal features of size (internal and external)

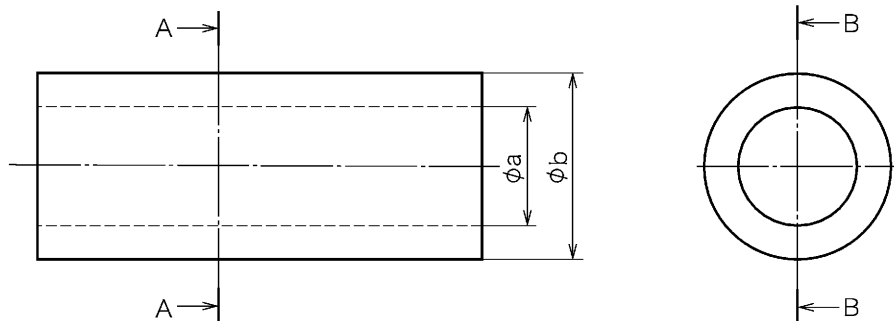
B-B

A-A



b) Extracted feature

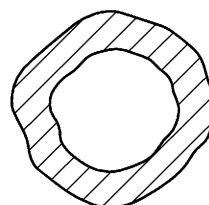
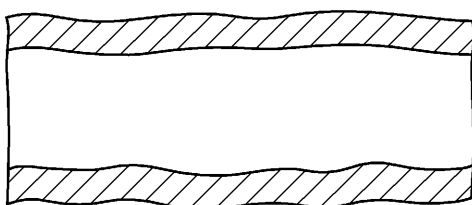
Figure 1 Feature of sizes relative to two opposite planes



a) Nominal features of size (internal and external)

B-B

A-A



b) Extracted feature

Figure 2 Example of feature of size relative to a cylinder

3.3 upper limit of size (ULS)

largest permissible size of a feature of size (3.2)

3.4 lower limit of size (LLS)

smallest permissible size of a feature of size (3.2)

3.5 default specification operator

ordered set of default specification operations only, in the default order

NOTE 1 The default specification operator can be

- an ISO default specification operator specified by **ISO** Standards, or
- a **JIS** default specification operator specified by **JIS**, or
- a company default specification operator specified by company standards/documents, or
- a drawing default specification operator indicated on the drawing according to one of the above.

NOTE 2 The default specification operator applies when the **ISO** basic GPS specification is used on the drawing.

NOTE 3 According to the **ISO** basic GPS specification for size (3.8), the tolerance is indicated by upper and/or lower deviation limits, or upper and/or lower limits of size (see Table 4), or by ISO tolerance codes in accordance with **JIS B 0401-1** with no specification modifiers (3.1).

NOTE 4 The ISO default specification operator for size is given in this Standard (see 5.2).

NOTE 5 Adapted from **ISO 17450-2**. The definition and first NOTE are identical and the original second NOTE and examples are not included here. NOTES 2 to 4 have been added.

3.6 drawing-specific default GPS specification operator

specification operator required by technical documentation, applicable only for the actual specification and containing only default specification operations in the default order

NOTE 1 Default GPS specification can be changed by using drawing-specific default GPS specification or company default GPS specification. The drawing-specific default GPS specification or company default GPS specification is specified either directly or by referring to documents (e.g. regional, national or company standards).

NOTE 2 The drawing-specific default specification operator of size (3.8) is indicated by a specific statement close to the title block (see 5.3).

3.7 special specification operator

specification operator including one or more special specification operations

NOTE 1 The special specification operator is defined by a GPS specification.

NOTE 2 A special specification operator may be a complete specification operator

or an incomplete specification operator.

Example The specification for a shaft of $\phi 30 \pm 0.1 \text{ ⓔ}$ is a special specification operator, because one of the specification operations, the association of the minimum circumscribed cylinder, is not a default specification operation (see 6.2.2).

3.8 size

intrinsic characteristic of a feature of size (3.2) that can be defined on a nominal feature or on an associated feature

NOTE 1 In this Standard, the size corresponds to the diameter of a cylinder, or to the distance between two parallel opposite planes (depending on the type of feature of size, the terms “diameter” and “distance” are synonyms for size).

NOTE 2 A size is angular (e.g. angle of a cone) or linear (e.g. diameter of a cylinder). This Standard only deals with linear size.

3.9 size characteristic

characteristic relative to a size (3.8) and defined on an extracted feature

NOTE 1 A size can be evaluated by more than one size characteristic (e.g. the two-point diameter or the diameter of the associated feature, taken on the extracted feature).

NOTE 2 In this Standard, the term “extracted” means “measured and obtained” and is a synonym for “measured result”.

3.10 local size

local linear size

size characteristic (3.9) having by definition a non-unique result of evaluation along and/or around the feature of size (3.2)

NOTE 1 For a given feature, an infinity of local sizes exists.

NOTE 2 In this Standard, “local size” is used instead of “local linear size”.

NOTE 3 In Figure 3, examples of local size are shown. These examples do not take into account the rank-order size (3.11.2.2).

3.10.1 two-point size

distance between two opposite points taken on the feature of size (3.2)

A type of local size.

NOTE 1 A two-point size taken on cylinder can be called a “two-point diameter”. In **JIS B 0672-2**, this is defined as a local diameter of an extracted cylinder.

NOTE 2 A two-point size taken on two opposite planes can be called a “two-point distance”. In **ISO 14660-2**, this is defined as a local size of two parallel extracted surfaces.

3.10.2 section size

global size for a given cross section of the extracted feature

A type of local size (3.10).

NOTE 1 A section size is a local size (3.10) for the complete tolerated feature of size (3.2).

NOTE 2 The cross section is defined with the same criterion as the one taken to define the direct global size (3.11.1).

NOTE 3 On an extracted feature that corresponds to a cylinder, 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 section size.

3.10.3 portion size

global size for a given portion of the extracted feature

A type of local size (3.10).

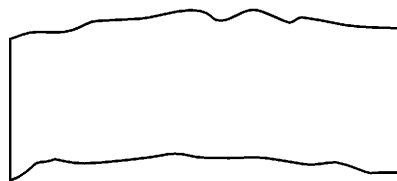
NOTE A portion size is a local size (3.10) for the complete tolerated feature of size (3.2).

3.10.4 spherical size

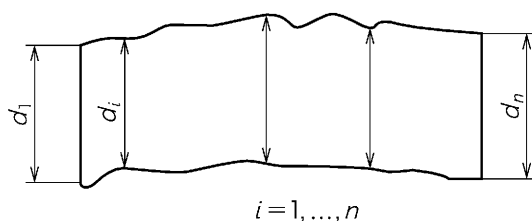
diameter of the maximum inscribed sphere

A type of local size [see Figure 3 c)].

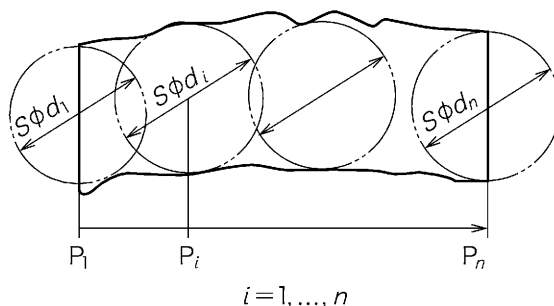
NOTE This local size, defined by a sphere, applies to the feature of size types “cylinder” and “two parallel opposite planes”.



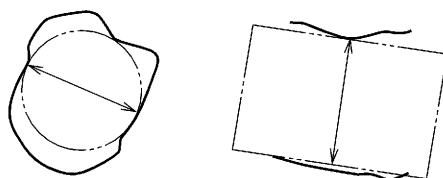
- a) Extracted feature under consideration which could be either an internal or external feature and either a cylinder or two opposite planes



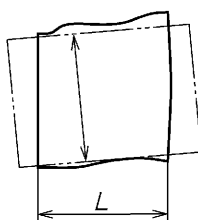
- b) Two-point size



- c) Spherical size



- d) Section size obtained from a direct global size with maximum inscribed criterion (other criteria are possible)



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

- e) Portion size from a direct global size with maximum inscribed criterion (other criteria are possible)

d size [in Figure 3 b)]
 L considered length of the portion of the cylinder
 P position
 $S\phi d$ diameter of the maximum inscribed sphere

Figure 3 Examples of local size

3.11 global size

global linear size

size characteristic (3.9) having by definition a unique result of evaluation along and around the toleranced feature of size (3.2)

3.11.1 direct global size

direct global linear size

size (3.8) of the associated feature, which is of the same geometrical type as the feature of size (3.2)

A type of global size.

NOTE 1 The different direct global linear sizes on the complete toleranced feature are given in Figure 4.

NOTE 2 Different criteria may be used for this operation of association, and different results are obtained depending on the criterion chosen. The association criteria described in this Standard are total least-squares, maximum inscribed and minimum circumscribed.

3.11.1.1 least-squares size

size (3.8) of the associated feature established from the extracted feature(s) with the total least-squares criterion

A type of global size.

NOTE : In this Standard, “total least-squares” is referred to only as “least-squares”. Total least squares method refers to minimizing the sum of squares of deviation in the normal direction to the straight line to be applied. Approximately the same results of application can be obtained by total least squares method and least-squares method, because, in total least squares method, the the direction of the object which has been set intentionally before minimizing is almost parallel to the direction of the straight line.

The least-squares method refers to minimizing the sum of squares of deviation in the direction of longitudinal axis to the straight line to be applied.

3.11.1.2 maximum inscribed size

size (3.8) of the associated feature established from the extracted feature(s) with the maximum inscribed criterion

A type of global size.

3.11.1.3 minimum circumscribed size

size (3.8) of the associated feature established from the extracted feature(s) with the minimum circumscribed criterion

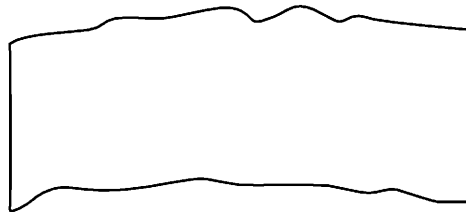
A type of global size.

3.11.2 indirect global size

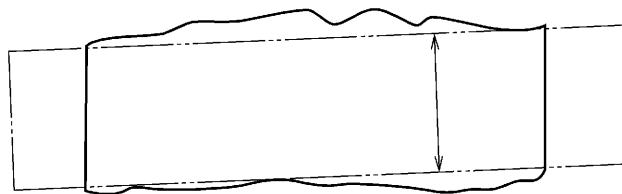
indirect global linear size

rank-order size (3.11.2.2) or calculated global size (3.11.2.1)

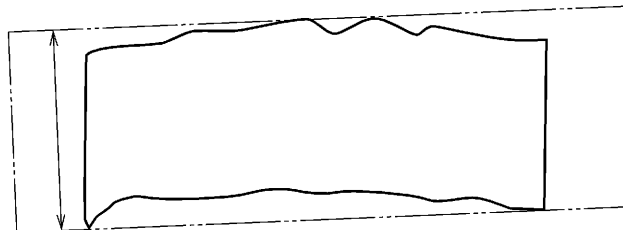
NOTE An indirect global size can be, for example, an average of a set of two-point size values taken on the extracted cylindrical surface.



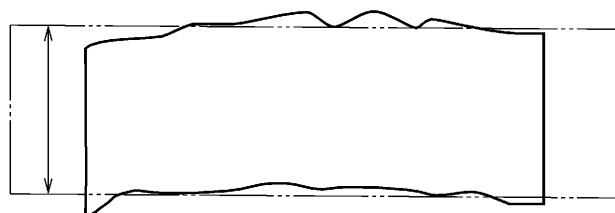
- a) Extracted feature under consideration which could be either an internal or external feature and either a cylinder or two opposite planes



- b) Maximum inscribed size



- c) Minimum circumscribed size



- d) Least-squares size

Figure 4 Illustration of direct global sizes

3.11.2.1 calculated size

size (3.8) obtained by using a mathematical formula that relates the intrinsic characteristic of a feature to one or several other dimensions of the same feature

NOTE : The calculated size can be a local size (3.10) or a global size (3.11).

3.11.2.1.1 circumference diameter

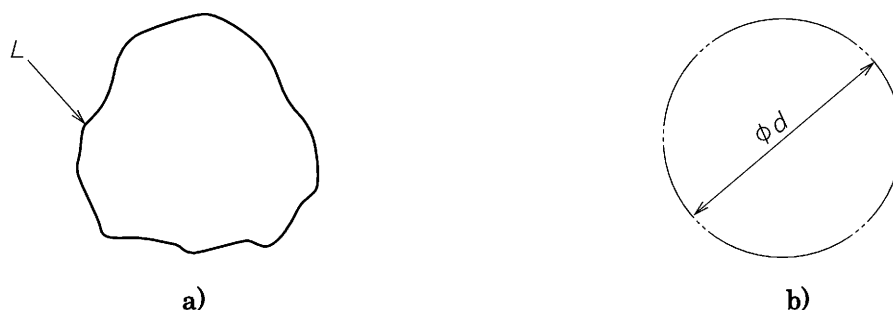
(of an extracted cylinder) calculated size (3.11.2.1), giving the diameter, d , obtained from the following equation :

$$d = \frac{L}{\pi}$$

where, L : length of the integral extracted line in a cross section, normal to the axis of the least-squares associated cylinder (see Figure 5)

NOTE 1 The circumference diameter is defined in a cross section.

NOTE 2 Several criteria can be used for the operation of association to orient the cross section, and different results are obtained according to the chosen criterion. The default criterion is the least-squares associated cylinder of the feature (see JIS B 0672-2, 4.2.1).



L length of the outline (extracted line)

d circumference diameter, equal to L divided by π

Figure 5 Example of circumference diameter

3.11.2.1.2 area diameter

(of an extracted cylinder) calculated size (3.11.2.1), giving the diameter, d , obtained from the following equation:

$$d = \sqrt{\frac{4A}{\pi}}$$

where, A : area limited by the integral extracted line of a cross section, normal to the axis of the least-squares associated cylinder (see Figure 6)

NOTE 1 The area diameter is defined in a cross section.

NOTE 2 Several criteria can be used for the operation of association to orient the cross section, and different results are obtained according to the chosen criterion. The default criterion is the least-squares associated cylinder of the feature (see JIS B 0672-2, 4.2.1).