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**Geometrical product specification (GPS) - Geometrical
tolerancing - Tolerances of form, orientation, location
and run-out**

产品几何技术规范（GPS）几何公差 形状、方向、位置和跳动公差
标注
(ISO 1101:2017, MOD)

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Geometrical product specification (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out

1 Scope

This standard defines the symbols and description rules, for the geometrical tolerance specifications of workpieces.

This standard gives the basic principles of geometrical tolerance specifications.

The legends in this standard are intended to illustrate how to use visual annotations (including annotations, such as TED), to fully interpret technical specifications.

Note 1: The other national/international standards, which are cited in Chapter 2, Table 2, Table 3, provide more detailed information, on the marking of geometrical tolerance.

Note 2: This standard gives clear and direct rules, for marking the geometrical tolerance specification. As an alternative, the same specification can be marked on the 3D CAD model, according to ISO 16792. At this time, the technical specification features can be obtained, through the query function of the 3D CAD model OR the query of other 3D CAD model information, instead of using visual annotations.

This standard applies to the marking of the form, orientation, location, runout tolerance, in the geometric tolerancing of the geometric product specifications (GPS).

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB/T 4249-2018 Geometrical product specifications (GPS) - Fundamentals - Concepts, principles and rules (ISO 8015:2011, MOD)

GB/T 4457.4-2002 Mechanical drawings - General principles of presentation - Lines (ISO 128-24:1999, MOD)

parts), GB/Z 24637.1, GB/Z 24637.2, ISO 17450-3, ISO 22432, ISO 25378:2011, as well as the following terms and definitions, apply to this document.

3.1

Tolerance zone

The area, which is defined by one or two ideal geometric line features or area features AND represented by one or more linear dimensions.

Note: See also 4.4.

3.2

Intersection plane

The plane, which is established by the extraction features of the workpiece. It is used to identify the line features (component features or central features) on the extraction surface OR to identify the point features on the extraction line.

Note 1: The use of intersection planes does not depend on the view, to define the measured feature.

Note 2: For the regional surface structure, the intersection plane can be used, to define the orientation, in which the area is evaluated, see ISO 25178-1.

3.3

Orientation plane

The plane, which is established by the extracted features of the workpiece. It is used to identify the orientation of the tolerance zone.

Note 1: The use of the orientation plane does not depend on the TED (location) or datum (orientation), to define the plane of the tolerance zone OR the direction of the cylinder. Only when the measured feature is a central feature (center point, center line) AND the tolerance zone is defined by two parallel straight lines or parallel planes, OR when the measured feature is a central point or a cylinder, the orientation plane can be used.

Note 2: The orientation plane can be used, to define the orientation of the rectangular local area.

3.4

Direction feature

The ideal features, which are established by the extracted features of the workpiece. They are used to identify the width direction of the tolerance zone (local deviation).

Note 1: The direction feature can be a plane, a cylindrical surface, or a conical surface.

Note 2: The use of direction feature can change the width direction of the tolerance zone, of the line feature, on the area feature.

Note 3: When the tolerance value is applied in the specified direction, rather than the normal direction of the specified geometric form, it may use the direction feature.

Note 4: Direction features can be constructed, by the use of the datum, which is marked in the second grid of the direction feature grid. The geometric form of the measured feature can be used, to determine the geometric form of the direction feature.

3.5

Compound continuous feature

A single feature, that is seamlessly combined by multiple single features.

Note 1: The compound continuous feature can be closed or non-closed.

Note 2: Non-closed compound continuous features can be defined by the "interval" symbol (see 9.1.4) and the UF modifier (if applicable).

Note 3: The closed compound continuous features can be defined by the "full circumference" symbol (see 9.1.2) and the UF modifier. At this time, it is a group of single feature; the intersection with any plane, which is parallel to the collection plane, forms a line feature or a point feature.

Note 4: The closed compound continuous features can be defined by the "full surface" symbol (see 9.1.2) and the UF modifier.

3.6

Collection plane

The plane, which is established by the features on the workpiece. It is used to define a closed compound continuous features.

Note: When using the "full circumference" symbol, always use the collection plane.

3.7

Theoretically exact dimension

TED

In GPS operation, the linear or angular size, which is used to define the theoretically exact geometric form, range, location, orientation of the features.

Note 1: The term "theoretically exact dimension" is abbreviated as TED, in this standard.

Note 2: TED definition can be used:

- Nominal shape and size of the feature;
- Theoretical exact feature (TEF);
- The local location and size of the feature, including the local measured feature;
- The extension length of the measured feature;
- The relative location and direction of two or more tolerance zones;
- The relative location and direction of the reference target, including the movable reference target;
- The location and direction of the tolerance zone, as relative to the datum and datum system;
- The width direction of the tolerance zone.

Note 3: TED can be clearly marked or defaulted. When marking, a clear TED can be marked by a rectangular box, that contains a value, as well as related symbols, such as ϕ or R. In the 3D model, the clear TED can be obtained by query.

Note 4: The default TED may not be marked. The default TED may include: 0 mm, 0°, 90°, 180°, 270°, the angular distance between features, which are evenly distributed on a complete circle.

Note 5: TED is not affected by a single or general specification.

3.8

Theoretically exact feature

TEF

Nominal features, which have ideal form, ideal dimension, orientation, location.

Note 1: The theoretically exact feature (TEF) can have any form. It can be defined by the theoretically exact dimension, that is clearly marked or defined by default, in the CAD data.

Note 2: If applicable, the theoretical exact location and orientation are relative to the marked datum system, which is used for the specification of the corresponding actual features.

Note 3: See also ISO 25378.

Example 1: The spherical surface, which is shown in Figure 110, is a theoretically exact feature, for a given sphere radius AND a given location and direction, as relative to the datum A.

Example 2: Valid condition, for example: According to GB/T 16671-2018, Maximum material valid condition (MMVC) is the theoretically exact feature.

3.9

United feature

A feature, which is composed of continuous or discontinuous constituent features AND treated as a single feature.

Note 1: Derived features can be obtained from united features.

Note 2: The definition of united features can be very broad, so as not to miss any useful applications. However, the purpose of using united features is not to define multiple naturally separated features together. For example, do not construct two parallel cylindrical features with different axis OR two parallel square tubes with different axis (each composed of two sets of parallel planes perpendicular to each other), as a united feature.

Example 1: Cylindrical features, which are defined by a group of arc features, such as the outer diameter profile of a spline. They are one of the purposes of using united features, as shown in Figure 48.

Example 2: Two complete coaxial cylinders, which have different nominal diameters, cannot be regarded as a united feature.

4 Basic concepts

4.1 Geometrical tolerances shall be specified, in accordance with functional requirements. The manufacturing and testing requirements will also affect the marking of geometrical tolerances.

Note: For the marking of geometrical tolerance, it does not need to specify the specific

processing, measurement or inspection method, which are used.

4.2 The geometrical tolerances, which are applied to the features, define the tolerance zone, which is constructed relative to the reference feature. The measured feature shall be limited within the tolerance zone.

Note 1: In some cases, that is, when using the feature parameter modifiers, which are introduced in this standard, see Figure 13. The geometrical tolerance specifications can define features, rather than tolerance zones.

Note 2: All dimensions, which are given in the drawings of this standard, are in millimeters.

4.3 Features are specific parts on the workpiece, such as point features, line features or area features. These features can be either component features (such as the outer surface of a cylinder) or derived features (such as centerline or center surface), as shown in GB/ Z 24637.1.

4.4 According to the specified characteristics (items) and their specifications, the main forms of the tolerance zone are as follows:

- The area within a circle;
- The area between two concentric circles;
- The area between two parallel circles, on a conical surface;
- The area between two parallel circles, which have the same diameter;
- The area between two equidistant curves OR two parallel straight lines;
- The area between two non-equidistant curves OR two non-parallel straight lines;
- The area within a cylindrical surface;
- The area between two coaxial cylindrical surfaces;
- The area within a conical surface;
- The area within a single curved surface;
- The area between two equidistant curved surfaces or two parallel planes;
- The area within a sphere;
- The area between two non-equidistant curved surfaces OR two non-parallel planes.

Note: The tolerance zone can be defined in the CAD model.

4.5 Unless there are further restrictions, such as marked with additional instructions, the measured feature may have any form, orientation, and/or location, within the tolerance zone.

4.6 Unless otherwise specified (see Chapter 11 and Chapter 12), the tolerance shall apply to the entire measured feature.

At present, the detailed separation rules (defining the boundaries of the measured features) have not been formulated in the GPS standards. This can lead to ambiguity in the specification.

4.7 The geometrical tolerance given, as relative to the datum, does not limit the form error of the datum feature itself.

4.8 For functional considerations, one or more features can be used, to define the geometric deviation of a feature. Certain forms of specifications can not only limit the geometric deviation of the measured feature, but also limit other forms of deviation of the same element:

- The location specification can control the location deviation, direction deviation, form deviation of the measured feature.
- The direction specification can control the direction and form deviation of the measured feature, BUT it cannot control its location.
- The shape specification only controls the form deviation of the measured feature.

5 Symbols

The symbol definitions, which are used in the symbol part of the tolerance grid, are as shown in Table 1.

The definitions of symbols, which are used in tolerance zones, features, characteristics, in the tolerance grid, are as shown in Table 2. Appendix C defines the meaning of the filter symbols. Appendix D defines the meaning of fitting symbols and (characteristic) parameter symbols.

Some symbols, which are defined in other standards AND used in GB/T 1182, are as shown in Table 3, for reference.

For filter symbols, see Table C.1. For nesting index, see Table C.2. For fitting symbols, see Table D.1. For parameter symbols, see Table D.2.

Note: See ISO 7083 and Appendix F, for the proportions of related symbols.

feature). The role of OZ, in a single plane and a single straight line, is the same as the direction-only symbol.

8.2.3.2 Specification features of the measured element

8.2.3.2.1 Specification features of the filter

GB/Z 26958.1-2011 defines all terms related to filtering. The specific filter is defined in other parts of GB/Z 26958, as shown in Chapter 2.

Currently, there is no default filter defined in the GPS standard. Therefore, if no specification features or other methods are used, to give a clear definition, THEN, the filter is undefined. See also C.3. This increases the ambiguity of the specification, as shown in GB/Z 24637.2.

Note: See A.3.7 for the marking method of the abolished filtering.

The filter specification is an optional specification feature. The filtering, which is specified by the measured feature, shall be marked by the combination of two standard features, wherein one marks the specified filter type, and the other marks the nesting index of the filter.

The symbol of the standard filter is given in Table C.1. For detailed information about the utility of filters AND examples of filter marking, see Appendix E.

The nesting index of each filter type AND its meaning are as given in Table C.2. "-" shall be added after the exponent of the long-wave pass filter. "-" shall be added before the exponent of the short-wave pass filter. If both sides of the band-pass filter use the same filter type, it shall give the long-pass filter index first, then the short-pass filter index. The exponents shall be separated by "-".

Only for the Fourier filter, which is marked with F (Fourier), when it is applicable to a single harmonic (wavelength or number of UPR), it shall mark a single value. If the applicable filter feature contains a series of harmonics, the marking shall follow the rules given above.

If the filter types, which are used by the band-pass filter, are not the same, the long-pass filter shall be marked in front of the short-pass filter.

In the standard operation set of the band pass filter, the long-pass filter shall be applied before the short-pass filter.

Short-wave pass filters and band-pass filters are only used for form specifications, that is, they do not refer to datum specifications, because these filters will remove the location and direction attributes of the measured features.

Straight, planar, axial cylinders are open features; their nesting index shall be

marked in millimeters. Cylinders, rings, spheres in the circumferential direction are closed features; their nesting index shall be marked with UPR (wave number/revolution), instead of unit.

If the features are open in both directions, two different filters shall be used. For example, the plane shall use the intersection plane grid, to mark the direction in which the first filter applies. It shall use "x" to separate the markings of the two filters. The direction, to which the second filter is applicable, shall be perpendicular to the direction of the first filter.

If the feature is open in one direction AND closed in the other direction, such as a cylinder, the filter in the open direction shall be marked in front of the filter in the closed direction. The markings of the two filters shall be separated by "x".

If the two filters are of the same type, regardless of whether both directions are open (e.g., plane), or both are closed (e.g., sphere) or one of them is open (e.g., cylinder), the filter type must not be marked twice.

When the measured feature is a derived feature or a fitting feature, the filter shall be applied to the component feature, before the derivation or fitting operation.

For an example of marking of filter specification, see E.2.

8.2.3.2.2 Fitted specification features of the measured features

The specification is applied, by default, to the actual extracted component features marked OR the derived features themselves. The fitted measured feature is an optional specification feature. It can be used to indicate that the specification does not apply to the marked feature itself, but applies to the features fitted to it. If the filter is marked, the fitting shall be the filter feature.

Fitted measured features can only be used for datum-related specifications, such as direction and location specifications.

If the fitted measured feature is used together with the filter, the fitted filter feature shall be the non-ideal feature.

When the measured feature is a derived feature, the fitted feature shall be an indirect fitted feature, as shown in ISO 22432.

The range of the fitted measured feature shall be equal to the range of the fitted feature.

The fitting measured features shall not be used together with the following specification features: the fitted specification features, which are used to evaluate the reference features, are as shown in 8.2.3.3.1; for parameters, see

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