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Geometrical Products Specifications (GPS) — Geometrical tolerancing: Datums and datum systems —

Part 2:
Explanations and indications in technical product documentation

Spécification géométrique des produits (GPS) — Tolérancement géométrique: Références spécifiées et systèmes de références spécifiées —

Partie 2: Explications et indication dans la documentation technique de produits

ICS 01.100.20; 17.040.10

ISO/CEN PARALLEL ENQUIRY

The CEN Secretary-General has advised the ISO Secretary-General that this ISO/DIS covers a subject of interest to European standardization. **In accordance with the ISO-lead mode of collaboration as defined in the Vienna Agreement, consultation on this ISO/DIS has the same effect for CEN members as would a CEN enquiry on a draft European Standard.** Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month FDIS vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

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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 3.

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.

ISO 5459 was prepared by the technical committee ISO/TC 213 *Dimensional and geometrical product specifications and verification* and consists of the following parts under the general title *Geometrical product specifications (GPS) – Geometrical tolerancing: Datums and datum-systems* :

— Part 1 : *Vocabulary*

— Part 2 : *Explanations and indication on technical product documentation*

— Part 3 : *Association methods*

Together with ISO 5459-1, this part of ISO 5459 cancels and replaces ISO 5459:1981 which has been technically revised.

Annexes A to E are for information only.

Introduction

This part of ISO 5459 is a Geometrical Product Specification standard and is to be regarded as a General GPS standard (see ISO/TR 14638). It influences the chain links 1 and 2 of the chain of standards on datums.

For more detailed information of the relation of this standard to the GPS matrix model see annex E.

For the definitive presentation (proportions and dimensions) of symbols for geometrical tolerancing, see ISO 7083:1983.

The previous version of ISO 5459 dealt only with planes, cylinders and spheres. There is a need to consider all types of surfaces which are more and more used in industry. The definitions of classes of surfaces as given in annex A are a way to be exhaustive and unambiguous.

NOTE Any needed addition identified during the elaboration of ISO 5459-3 and ISO 5459-4 will be added in a technical corrigendum. In particular, the drawing indication corresponding to the modifiers for non default rules and the corresponding definition will be developped at this stage.

Geometrical Products Specifications (GPS) — Geometrical tolerancing: Datums and datum systems —

Part 2:
Explanations and indications in technical product documentation

1 Scope

This part of ISO 5459 describes the rules, explanations and manner in which datums and datum-systems are indicated in technical product documentation.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 128-24: 1999, *Technical drawings — General principles of presentation — Part 24: Lines on mechanical engineering drawings.*

ISO 1101: - [1], *Technical drawings - Geometrical tolerancing - Tolerances of form, orientation, location and run-out - Generalities, definitions, symbols, indications on drawings.*

ISO 2692:-[1)], *Geometrical Product Specifications (GPS) – Geometrical tolerancing - Maximum material requirement (MMR) and least material requirement (LMR).*

ISO 5459-1:-[1)], *Geometrical Product Specifications (GPS) – Geometrical tolerancing: Datums and datum-systems – Part 1: Vocabulary* .

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

ISO/TS 17450-1: - [2)] , *Geometrical Product Specifications (GPS) – General concepts – Part 1: Model for geometrical specification and verification.*

3 Terms and definitions

For the purposes of this International Standard, the definitions of ISO 1101, ISO 2692, ISO 5459-1, ISO 14660-1 and ISO/TS 17450-1 apply.

NOTE For the purpose of this standard, the term “theorectically exact dimension” has been abbreviated TED.

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[1] Under revision

[2)] Under preparation

4 Role of datums

Tolerancing of geometrical features consists in the limitation of the geometrical deviations in relation to their nominal form, orientation and/or location. This limitation is achieved by defining zones in which toleranced features shall be located. According to the function, two cases may exist:

— zones are oriented and located between each others,

— zones are oriented and located by other features called datums.

Datum(s) or datum-system(s) is (are) theoretically exact geometric features (point, straight line, plane) which situate (orientate and/or locate):

— virtual conditions in the case of complementary requirements , e.g maximum material requirement, by using TEDs; or

— tolerance zones for toleranced features by using TEDs.

These datum(s) or datum-system(s) consist of one or more situation feature(s) of surfaces associated to the features used for establishing datums (see Table A.1).

Therefore it is necessary:

— to designate features (surfaces, lines or points) to be used for establishing these datums,

— to specify datum(s) or datum-system(s) to be taken into account for each geometrical tolerance.

NOTE Datums and datum-systems are features and not coordinate systems. Coordinate systems can be built on the datums.

5 Basic concepts

5.1 General

Datums can be established on complete surfaces or on portions of surfaces.

The geometric type of these surfaces belongs to one of the following invariance classes (see Annex A):

— complex (e.g. a hyperbolic paraboloid)

— prismatic (e.g. a prism)

— revolute (e.g. a cone, a torus)

— cylindrical (i.e. a cylinder)

— planar (i.e. a plane)

— spherical (i.e. a sphere).

NOTE Helical surfaces are not considered in this standard. In most functional cases where threads are involved, the combined rotation and translation of the helix is not needed for datum purposes. In these cases, the pitch cylindrical surface is used for datum ; the major or minor cylindrical surface can also be considered and specified.

5.2 Intrinsic characteristics of associated surfaces

Intrinsic characteristics of associated surfaces can be theoretically exact or variable according to the following cases:

— for virtual conditions, the intrinsic characteristics of the considered feature are theoretically exact: defined by virtual sizes corresponding to maximum or least material conditions,

— for tolerance zones, unless otherwise specified, an intrinsic characteristic is considered as

  — theoretically exact when for at least one possible value of this characteristic, the invariance class of the considered feature has changed,

  — variable when for all possible value of this characteristic (0 mm, 0°, 180°, ...), the invariance class of the considered feature is the same.

NOTE 1 This approach has some restrictions in relation to some practices (see annex B).

NOTE 2 A cylinder (invariance class: cylindrical) has only one intrinsic characteristic : its diameter. When varying, its value can be 0 (zero). Then the cylinder becomes a straight line. This straight line belongs also to the cylindrical invariance class. Therefore the diameter is considered as variable.

NOTE 3 A feature constituted of two parallel cylinders (invariance class : prismatic) has five intrinsic characteristics :

  — the two angles that define the parallelism : if the two axes are no more parallel, then the invariance class of the feature changes (complex). Therefore the two angles shall be considered as theoretically exact.

  — the two diameters of the cylinders : According to NOTE 2, the two diameters are considered as variable.

  — the distance between the two axes : when varying, the value of this distance can be 0 (zero). Then the surface becomes two coaxial cylinders. This surface belongs to the cylindrical invariance class. As the invariance class has changed, this distance shall be considered as theoretically exact.

5.3 Single datums, common datums and datum-systems

5.3.1 Single datums

A single datum is characterized by one or more situation feature(s) based on one surface considered alone.

The feature associated to the surface (or to the portions of the surface) used for establishing the datums is obtained without external orientation or location constraints.

The intrinsic characteristics of associated surfaces shall be considered as variable or theoretically exact as given in 5.2.

When a single datum used alone fully constrains the situation of the tolerance zone, it is not allowed to use datum-systems.

5.3.2 Common datums

A common datum is characterized by one or more situation features resulting from the collection of the considered surfaces.

In order to determine the situation feature(s) which characterize the collection surface, the invariance class of this collection surface shall be found by considering all the surfaces together and by observing the invariance degrees for which the collection surface is invariant.

NOTE 1 Table A.1 gives the invariance classes as a function of these invariance degrees and the corresponding situation features.

The collection surface associated to the surfaces (or to the portions of the surfaces) used for establishing the datums, is obtained without external orientation or location constraints; therefore the association is global and the surfaces (constituting the collection surface) are not associated individually.

The intrinsic characteristics of associated surfaces shall be considered as variable or theoretically exact as given in 5.2.

When a common datum used alone fully constrains the situation of the tolerance zone, it is not allowed to use datum-systems.

5.3.3 Datum-systems

A datum-system is constituted by an ordered list of two or three datums. These datums are single or common. A datum-system is characterized by two or three situation features resulting from the collection of the considered surfaces.

In order to determine the situation feature(s) which characterize(s) the collection surface, the invariance class of this collection surface shall be found by considering all the surfaces together and by observing the invariance degrees for which the collection surface is invariant.

NOTE Table A.1 gives the invariance classes as a function of these invariance degrees and the corresponding situation features.

The association of the surfaces, corresponding to each datum, associated to the surfaces (or to the portions of the surfaces) used for establishing the datums, is made one after the other, in the order defined by the system. The relative orientation between the datums is theoretically exact but the relative location is not.

The first datum in the list is called "primary datum"; the second, is called "secondary datum", and the third, is called "tertiary datum". This order defines the orientation constraints for the association operation : the primary datum imposes orientation constraints to the secondary and tertiary datums; the secondary datum imposes orientation constraints to the tertiary datum.

When two datums are sufficient to fully constrain the situation of the tolerance zone, a third datum cannot be meaningfully applied, and shall not be specified to modify the result of the 2 previous datums.

The secondary datum can not modify the situation constraints of the tolerance zone given by the primary datum.

The tertiary datum can not modify the situation constraints of the tolerance zone given by the primary or secondary datums.

6 Graphical language

6.1 General

To express on the drawing geometrical tolerance with datum(s), it is necessary to:

— designate the complete surface(s) of the workpiece which will be taken as datum; when complete surface is not required, designate the considered portion(s) (surfaces, lines or points) and the corresponding dimensions and locations;

— specify single datum(s), common datum(s) or datum-system(s);

— indicate orientation and location constraints in relation to the corresponding datums;

— indicate the objective of the association;

— indicate the use of maximum or minimum material requirement.

6.2 Designation of the surface(s)

6.2.1 Datum indicator

Those surfaces to be used for establishing datums are indicated by a rectangle linked to a filled or an open triangle by a leader line (see Figure 1).

NOTE There is no difference in the meaning between a filled and an open triangle.

Figure 1

FAST COMMENT: All the figures given in this standard are not completely according to ISO/TC 10 rules. They will be redrawn properly during the DIS enquiry.

6.2.2 Datum letter

A surface used for establishing datums is identified by a capital letter placed in the datum indicator.

NOTE 1 It is recommended not to use the letters I, O, Q, and X which can be misinterpreted.

NOTE 2 If a large drawing has exhausted the alphabet, or if it seems useful for the comprehension of the drawing, it is recommended to continue using the same letter repeatingly eg. two times, three times etc. eg. BB, CCC etc. In order to facilitate the reading of the standard, only one letter is used in the rest of the standard.

6.2.3 Datum targets

When the complete surface is not used, it is necessary to indicate the considered portion(s) lying on the surface (surfaces, lines or points) and the corresponding dimensions and locations. These portions are called datum targets.

The datum targets to be used for datums are indicated by a leader line terminated by

— a cross, if the datum target is a point (see Figure 2);

— two crosses connected by a long-dashed double-dotted narrow line (type 05.1 of ISO 128-24) if the datum target is a line (see Figure 3); this line can be a straight line or a line of any shape, which can be closed, in that case the two crosses are omitted;

— a hatched area surrounded by a long-dashed double-dotted narrow line (type 05.1 of ISO 128-24) if the datum target is an area (see Figure 4).

Figure 2

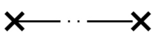


Figure 3

Figure 4

A datum target is indicated by datum target indicator divided into two compartments by a horizontal line, linked to an arrow (see Figure 5).

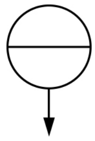


Figure 5

The lower compartment is reserved for a letter and a number (from 1 to *n*) which designate the datum target.

The upper compartment is reserved for additional information, such as dimensions of the datum target area.

FAST COMMENT: Examples of datum targets should be added to Annex C.

6.3 Specification of datums or datum-systems

The datum (or datum-system) is specified through the third (and if necessary fourth and if necessary fifth) compartment of the tolerance frame (see Figure 6) as described in 6.1 of ISO 1101.

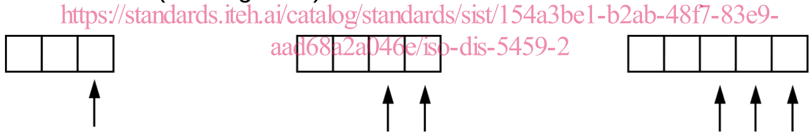


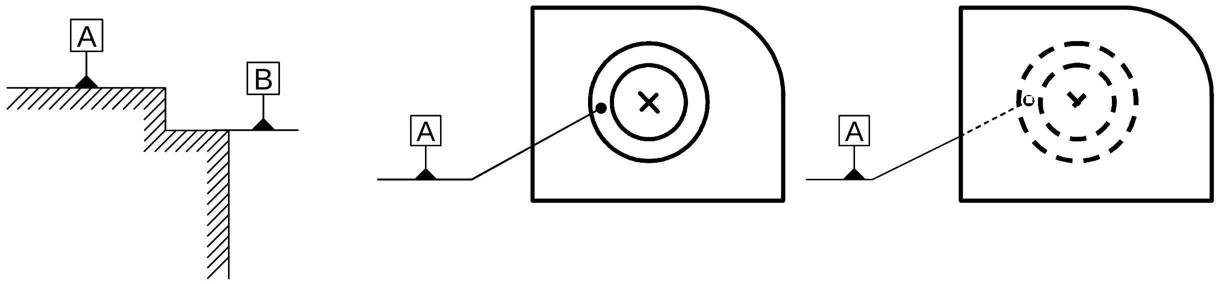
Figure 6

6.4 Writing and reading rules

6.4.1 Writing rules

Rule W1: if the surface used for establishing the datum has no intrinsic characteristic or no intrinsic characteristic considered as variable, then this surface is designated by one datum indicator placed either on the outline of the surface, or on an extension line of the surface (see Figure 7a), or on a reference line with a leader line pointing to the surface (see Figure 7b) or by a leader line only pointing to the surface.

NOTE When the surface is hidden, the hidden part of the leader line or reference line shall be dashed and terminate by an open dot (see Figure 7c).



a) **b)** **c)**

Figure 7

Rule W2: if a surface used for establishing the datum has an intrinsic characteristic considered as variable, then this surface is designated by one datum indicator placed as an extension of a dimension line, which may have or may not have a size indication, see Figure 8.

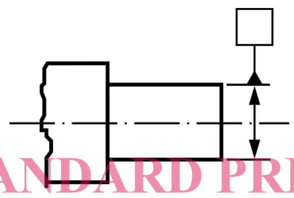


Figure 8

Rule W3: if the intrinsic characteristic(s) of a surface(s) used for establishing datum(s) is(are) considered as theoretically exact for the association, then their value(s) is (are) identified either by a TED(s) or by an implicit TED(s).

NOTE 1 The values of 0 mm, 0°, 90° and 180° are implicit TEDs and are not indicated.

NOTE 2 See C.1.3 for an example.

Rule W4: if an intrinsic characteristic(s) of surface(s) used for establishing datum(s) is(are) considered as variable for the association, then their value (s) is (are) indicated by a plus-minus tolerance following the dimension.

Rule W5: if the datum target is a point, then the datum target indicator is linked to a cross placed on the surface.

NOTE The location of the point shall be defined by dimensions without tolerances.

Rule W6: if the datum target is a line, then the datum target indicator is linked to a line placed on the surface.

NOTE The length and the location of the line shall be defined by dimensions without tolerances.

Rule W7: if the datum target is any line on the considered surface, then the drawing indication « AL » is added on the right side of the datum target indicator (see Figure 9).

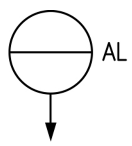


Figure 9

Rule W8: if the datum target is an area, then the datum target indicator is linked to a hatched area placed on the surface.

NOTE The extent and the location of this area shall be defined by dimensions without tolerances. The dimensions of the area are indicated either,

- when this area is circular (see Figure 10) or square (see Figure 11), in the upper compartment of the datum target indicator, or placed outside and connected to the appropriate compartment by either a leader line or by leader lines and reference lines when there is not sufficient space within the compartment, or

- when the area is neither square nor circular, directly on the drawing.

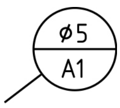


Figure 10

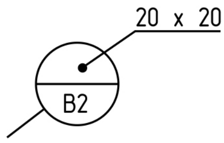


Figure 11

Rule W9: if the datum is established from datum targets, then the letter identifying the surface is repeated on the right side of the datum indicator followed by the list of numbers identifying the targets (separated by comas) (see Figure 12).

NOTE When several datum targets on the same surface are used, their relative location shall be defined by dimensions without tolerances.

Figure 12

Rule W10: If the datum is a single datum, then it is indicated only by one letter in one compartment of the tolerance frame.

NOTE The letter given in the tolerance frame shall be the same as the letter given in the datum indicator.

Rule W11: If the datum is a single datum used alone, then the tolerance frame has only three compartments and the datum letter is indicated in the third compartment (see Figure 14a).

NOTE The letter given in the tolerance frame shall be the same as the letter given in the datum indicator.

Rule W12: If the datum is a common datum, then it is indicated through a list of letters separated by a hyphen(s) in one compartment of the tolerance frame.

NOTE 1 There is in principle as many letters as surfaces used for establishing the common datum.

NOTE 2 The letters are the same as the letters given in the datum indicators.

NOTE 3 There is no difference in the meaning whatever the order of the letters in the list is.

NOTE 4 When the number of surfaces is more than 2, and when not ambiguous, it is possible to simplify the drawing indication by :

— using only one datum indicator,

— using only one doubled letter separated by a hyphen in the list,

— adding the complementary indication of x times corresponding to the number of surfaces in the collection (e.g 6x) on the right side of a datum indicator, pointing one of the surfaces (see Figure 13).

NOTE 5 When a collection of surfaces is used to establish a common datum and when it is identified by only one datum indicator accompanied by x times, then it is possible to use this indication to establish a single datum on each of the surfaces considered individually. In this case, each single datum is indicated by a single letter in the tolerance frame.

NOTE 6 See C.2.7 for an example.

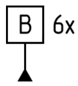
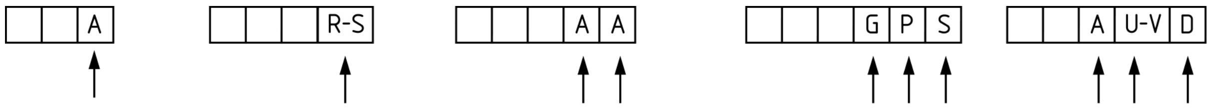


Figure 13

Rule W13: if the datum is a common datum used alone, then the tolerance frame has only three compartments and the list of datum letters separated by a hyphen(s) is indicated in the third compartment of the tolerance frame (see Figure 14b).



a) b) c) d) e)

a) single datum used alone

b) common datum used alone

c) single datums used in a system

d) single datums used in a system

e) single datums and common datums used in a system

Figure 14

Rule W14: If the datums (single or common) consist of all the situation features, which are all needed, then no complementary indication (PL, SL, PT) is added to the letter(s) in the tolerance frame.

Rule W15: If the datums (single or common) consist of two or three situation features, which are not all needed, then a complementary indication is added to the letter(s) in the tolerance frame:

— indication (PL) if only the plane is needed (see Figure 15),

— indication (SL) if only the straight line is needed (see Figure 16),

— indication (PT) if only the point is needed (see Figure 17).

NOTE When it is obvious which situation feature is to be used according to the specification, the indication (PL), (SL) or (PT) can be omitted (see example on Figure C.4)

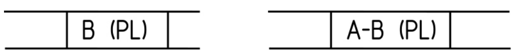


Figure 15