



**International
Standard**

ISO 5459

**Geometrical product specifications
(GPS) — Geometrical tolerancing —
Datums and datum systems**

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

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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).

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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.

This document was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*, 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 5459:2011), which has been technically revised.

The main changes are as follows:

- update of the Normative references and Bibliography;
- addition of definitions [3.20](#), [3.20.1](#) and [3.20.2](#);
- in [Table 1](#), update of the symbol of the datum feature indicator;
- in [Table 1](#), addition of the symbol of single datum target indicator, moveable datum target indicator, restricted datum feature, indication of a situation feature and datum coordinate system indicator, and addition of a note;
- in [Table 2](#), addition of [SV], [SF] and [SFxx], and addition of a note;
- in [Clause 6](#), addition of a paragraph before the example in [6.1](#), update of [6.2.1](#) and [6.2.2](#), replacement of the first paragraph in [6.2.3](#) and [6.2.4](#), addition of the last paragraph in [6.3.2](#) and table titles added in [6.3.2](#) and subsequent tables renumbered;
- in [Clause 7](#), addition of a note in [7.1](#), update of [7.2.1](#), [7.3](#), [7.4.2.1](#) and [7.4.2.2](#), update of the text and figures in [7.4.2.4](#) up to [Figure 22](#), update of the first paragraph of [7.4.2.6](#), update of [Figure 39](#), addition of a new rule 11 in [7.4.2.11](#) and a new rule 12 in [7.4.2.12](#);
- addition of a new [Clause 8](#);
- in [Annex A](#), update of the text between [Figures A.1](#) and [A.2](#), update of the first paragraph in [A.2.1](#) and of [Figure A.4](#), addition of Notes 1 and 2 in [A.2.2.3](#), and update of the row for the plane in [Table A.2](#);

- addition of a new [Clause D.4](#);
- update of [Annex E](#), addition of new [Annexes G](#) to [J](#), update of [Annex K](#) giving the relation to the GPS matrix model.

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.

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 chains of standards on datums.

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 K](#).

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

The previous version of this document dealt only with planes, cylinders and spheres being used as datums. There is a need to consider all types of surfaces, which are increasingly used in industry. The definitions of classes of surfaces as given in [Annex B](#) are exhaustive and unambiguous.

This document applies new concepts and terms that have not been used in previous ISO GPS standards. These concepts are described in detail in ISO 14638, ISO 17450-1 and ISO 17450-2; therefore, it is recommended to refer to these standards when using this document.

This document provides tools to express location or orientation constraints, or both, for a tolerance zone. It does not provide information about the relationship between datums or datum systems and functional requirements or applications.

Geometrical product specifications (GPS) — Geometrical tolerancing — Datums and datum systems

1 Scope

This document specifies terminology, rules and methodology for the indication and understanding of datums and datum systems in technical product documentation. This document also provides explanations to assist the user in understanding the concepts involved.

This document defines the specification operator (see ISO 17450-2) used to establish a datum or datum system. The verification operator (see ISO 17450-2) can take different forms (physically or mathematically) and is not the subject of this document.

NOTE The detailed rules for maximum and least material requirements for datums are given in ISO 2692.

2 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 128-2:2022, *Technical product documentation (TPD) — General principles of representation — Part 2: Basic conventions for lines*

ISO 1101, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 2692, *Geometrical product specifications (GPS) — Geometrical tolerancing — Maximum material requirement (MMR), least material requirement (LMR) and reciprocity requirement (RPR)*

ISO 4351, *Geometrical product specifications (GPS) — Association*

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1101, ISO 2692, ISO 4351, ISO 17450-1, ISO 17450-2 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/>

3.1 situation feature

point, straight line, plane or helix from which the location and orientation of features, or both, can be defined

3.2

datum feature

real (non-ideal) integral feature used for establishing a datum

Note 1 to entry: A datum feature can be a complete surface, a portion of a complete surface, or a feature of size.

Note 2 to entry: An illustration showing the relations between datum feature, associated feature and datum is given in [Figure 4](#).

3.3

associated feature

associated feature for establishing a datum

ideal feature which is fitted to the datum feature with a specific association criterion

Note 1 to entry: The type of the associated feature is by default the same as the type of the nominal integral feature used to establish the datum (for an exception, see [7.4.2.5](#)).

Note 2 to entry: The associated feature for establishing a datum simulates the contact between the real surface of the workpiece and other components.

Note 3 to entry: An illustration showing the relations between datum feature, associated feature and datum is given in [Figure 4](#).

3.4

datum

one or more situation features of one or more features associated with one or more real integral features selected to define the location or orientation, or both, of a tolerance zone or an ideal feature representing for instance a virtual condition

Note 1 to entry: A datum is a theoretically exact reference; it is defined by a plane, a straight line or a point, or a combination thereof.

Note 2 to entry: The concept of datums is inherently reliant upon the invariance class concept (see [Annexes A](#) and [B](#)).

Note 3 to entry: Datums with maximum material condition (MMC) or least material condition (LMC) are not covered in this document (see ISO 2692).

Note 4 to entry: When a datum is established, for example, on a complex surface, the datum consists of a plane, a straight line or a point, or a combination thereof. The modifier [SL], [PL] or [PT], or a combination thereof, can be attached to the datum identifier to limit the situation feature(s) taken into account relative to the surface.

Note 5 to entry: An illustration showing the relation between datum feature, associated feature and datum is given in [Figure 4](#).

3.5

primary datum

datum that is not influenced by constraints from other datums

3.6

secondary datum

datum, in a datum system, that is influenced by an orientation constraint from the primary datum in the datum system

3.7

tertiary datum

datum, in a datum system, that is influenced by constraints from the primary datum and the secondary datum in the datum system

3.8

single datum

datum established from one datum feature taken from a single surface or from one feature of size

Note 1 to entry: The invariance class of a single surface can be complex, prismatic, helical, cylindrical, revolute, planar or spherical. A set of situation features defining the datum (see [Table B.1](#)) corresponds to each type of single surface.

3.9**common datum**

datum established from two or more datum features considered simultaneously

Note 1 to entry: To define a common datum, it is necessary to consider the collection surface created by the considered datum features. The invariance class of a collection surface can be complex, prismatic, helical, cylindrical, revolute, planar or spherical (see [Table B.1](#)).

3.10**datum system**

set of two or more situation features established in a specific order from two or more datum features

Note 1 to entry: To define a datum system, it is necessary to consider the collection surface created by the considered datum features. The invariance class of a collection surface can be complex, prismatic, helical, cylindrical, revolute, planar or spherical (see [Table B.1](#)).

3.11**datum target**

portion of a datum feature which can nominally be a point, a line segment or an area

Note 1 to entry: Where the datum target is a point, a line or an area, it is indicated as a datum target point, a datum target line or a datum target area, respectively.

3.12**moveable datum target**

datum target with a controlled motion

3.13**collection surface**

two or more surfaces considered simultaneously as a single surface

Note 1 to entry: [Table B.1](#) is used to determine the invariance class of a datum or datum systems when using a collection of surfaces.

Note 2 to entry: Two intersecting planes may be considered together or separately. When the two intersecting planes are considered simultaneously as a single surface, that surface is a collection surface.

3.14**objective function**

<association> formula that describes the goal of association from the datum feature and the ideal feature (associated feature)

Note 1 to entry: In this document, the term “objective function” refers to “objective function for association”.

Note 2 to entry: The objective functions are usually named and mathematically described: maximum inscribed, minimum zone, etc.

[SOURCE: ISO 4351:2023, 3.6, modified — “datum feature” replaced “input feature”. Notes to entry added.]

3.15**constraint**

set of restrictions on variability of the mathematical parameters describing an *associated feature* ([3.3](#)) in the optimization process

EXAMPLE Orientation constraint, location constraint, material constraint or intrinsic characteristic constraint are the different types of constraint.

[SOURCE: ISO 4351:2023, 3.9, modified — “constraint” replaced “association constraint” as the term and in the example. “intrinsic characteristic constraint” replaced “size constraint” in the example.]

3.15.1

orientation constraint

constraint (3.15) related to one or more rotational degrees of freedom of *associated feature* (3.3)

[SOURCE: ISO 4351:2023, 3.10, modified — “constraint” replaced “association constraint”.]

3.15.2

location constraint

constraint (3.15) related to one or more translational degrees of freedom of *associated feature* (3.3)

[SOURCE: ISO 4351:2023, 3.11, modified — “constraint” replaced “association constraint”.]

3.15.3

material constraint

constraint (3.15) on the *associated feature* (3.3), in relation to the material boundary of the *datum feature* (3.2)

EXAMPLE The outside material constraint implies that all distances between the associated feature and the datum feature are negative or equal to zero.

[SOURCE: ISO 4351:2023, 3.12, modified — “constraint” replaced “association constraint” and “datum feature” replaced “input feature”.]

3.15.4

intrinsic characteristic constraint

size constraint

association constraint (3.15) on an intrinsic characteristic of *associated feature* (3.3) whether it is considered fixed or variable

Note 1 to entry: The intrinsic characteristic of a cylinder is its diameter which is a size.

Note 2 to entry: In the collection surface, constituted by two parallel and not coaxial cylinders, there are more than one intrinsic characteristic (two diameters, the distance between their axes and the angle of 0°).

3.16

association criterion

objective function with or without constraints, defined for an association

Note 1 to entry: Several constraints may be defined for an association.

Note 2 to entry: Association results (associated features) may differ, depending upon the choice of association criterion.

Note 3 to entry: Default association criteria are defined in [Annex A](#).

3.17

integral feature

surface or line on a surface

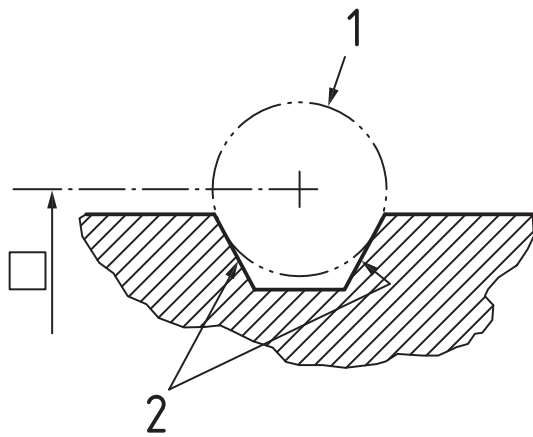
Note 1 to entry: An integral feature is intrinsically defined.

3.18

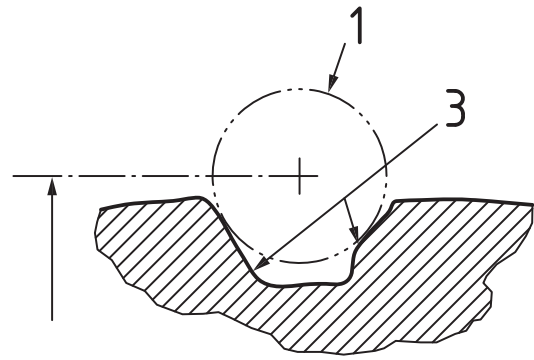
contacting feature

ideal feature of any type which is different from the nominal feature under consideration and is associated with the corresponding datum feature

Note 1 to entry: See [Figure 1](#).



a) Contacting feature on nominal model



b) Contacting feature on real workpiece

Key

- 1 contacting feature: ideal sphere in contact with the datum feature or the feature under consideration
- 2 features under consideration: nominal trapezoidal slot (collection of two non-parallel surfaces)
- 3 datum feature: real feature corresponding to the trapezoidal slot (collection of two non-parallel surfaces)

Figure 1 — Example of a contacting feature**3.19****invariance class**

group of ideal features for which the nominal surface is invariant for the same degrees of freedom

Note 1 to entry: There are seven invariance classes (see [Annex B](#)).

3.20**datum coordinate system**

coordinate system established from a single datum, a common datum or a datum system

Note 1 to entry: Using a datum coordinate system is optional.

3.20.1**datum coordinate system indicator**

indication defining a coordinate system

3.20.2**datum coordinate system identifier**

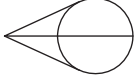
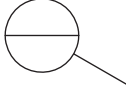
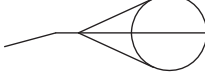
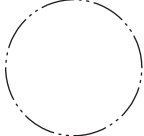
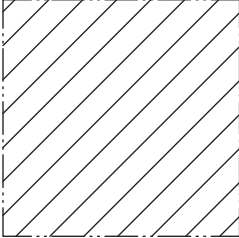
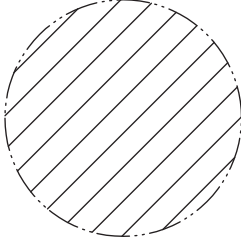
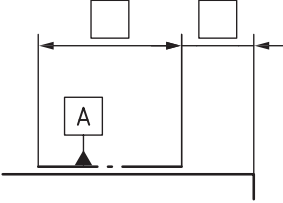
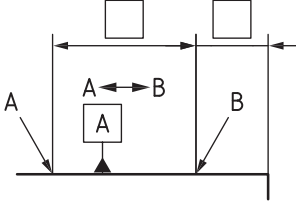
label identifying a coordinate system

4 Symbols

[Table 1](#) gives symbols to identify the datum feature and datum target used to establish a datum.

[Table 2](#) gives the list of modifier symbols, which can be associated the datum identifier.

Table 1 — Datum features and datum target symbols

Description	Symbol	Sub-clause
Datum feature indicator	 	7.2.1
Datum feature identifier	Capital letter (A, B, C, AA, etc.)	7.2.2
Single datum target frame		7.2.3.2
Moveable datum target frame		7.2.3.2
Single datum target indicator ^a		7.2.3
Moveable datum target indicator ^a		7.2.3
Datum target point		7.2.3.3
Closed datum target line		7.2.3.3
Non-closed datum target line		7.2.3.3
Datum target area	 	7.2.3.3
Restricted datum feature	 	7.4.2.4

^a The terminator of the leader line is dependent of the type of datum target.

Table 1 (continued)

Description	Symbol	Sub-clause
Indication of a situation feature of a single datum, a common datum or a datum system	For single datum For datum system	7.4.2.12
Datum coordinate system indicator		Annex G

^a The terminator of the leader line is dependent of the type of datum target.

Table 2 — Modifier symbols

Symbol	Description	Subclause
[PD]	Pitch diameter	7.4.2.1
[MD]	Major diameter	7.4.2.1
[LD]	Minor diameter	7.4.2.1
[ACS]	Any cross-section	7.4.2.4
[ALS]	Any longitudinal section	7.4.2.4
[CF]	Contacting feature	7.4.2.5
[SV]	Size, variable	7.4.2.2
[SF]	Size, fixed	7.4.2.2
[SFxx]	Size, fixed with specified value xx	7.4.2.2
[DV]	Distance, variable (for common datum)	7.4.2.7
[PT]	(situation feature of type) point	7.4.2.8
[SL]	(situation feature of type) straight line	7.4.2.8
[PL]	(situation feature of type) plane	7.4.2.8
><	For orientation constraint only	7.4.2.8
Ⓟ	Projected (for secondary or tertiary datum)	7.4.2.10
Ⓛ	Least material requirement	See ISO 2692
Ⓜ	Maximum material requirement	See ISO 2692

NOTE Other symbols related to filtration and association are presented in [Tables 8 to 10](#) and in [Table H.1](#).

5 Role of datums

Datums form part of a geometrical specification (see ISO 1101).

Datums are established from real surfaces identified on a workpiece.

Datums allow tolerance zones to be located or orientated (see Examples 1 and 2) and virtual conditions to be defined (for example maximum material virtual condition $\textcircled{M}$ according to ISO 2692). The datums can be seen as a means to lock degrees of freedom of a tolerance zone. The number of degrees of freedom of the tolerance zone which are locked depends on the nominal shape of the features utilized to establish the datum or datum system; whether the datum is primary, secondary or tertiary; and on the tolerated characteristic indicated in the geometrical tolerance frame.

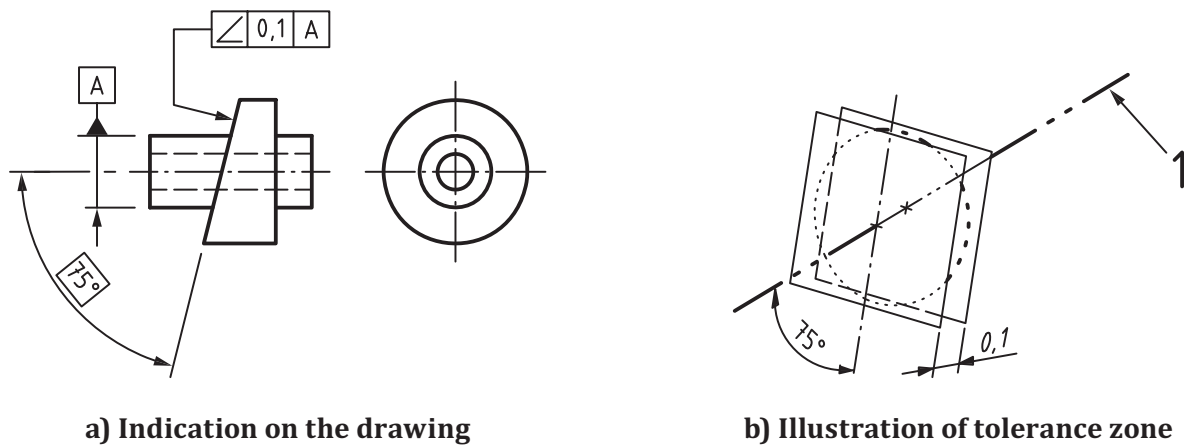
By default, a datum locks all the degrees of freedom of the tolerance zone that it can lock given its shape and which

- are required by the geometrical characteristic indicated in the tolerance frame, and
- have not already been locked by the preceding datum(s) in the datum system.

When a datum locks only orientation degrees of freedom, this shall be indicated by the modifier $><$.

EXAMPLE 1 The tolerance zone, which is the space between two parallel planes 0,1 mm apart, is constrained in orientation by a 75° theoretically exact angle from the datum. Here, the datum is the situation feature of a cylinder (axis of associated cylinder). See [Figure 2](#).

Dimensions in millimetres

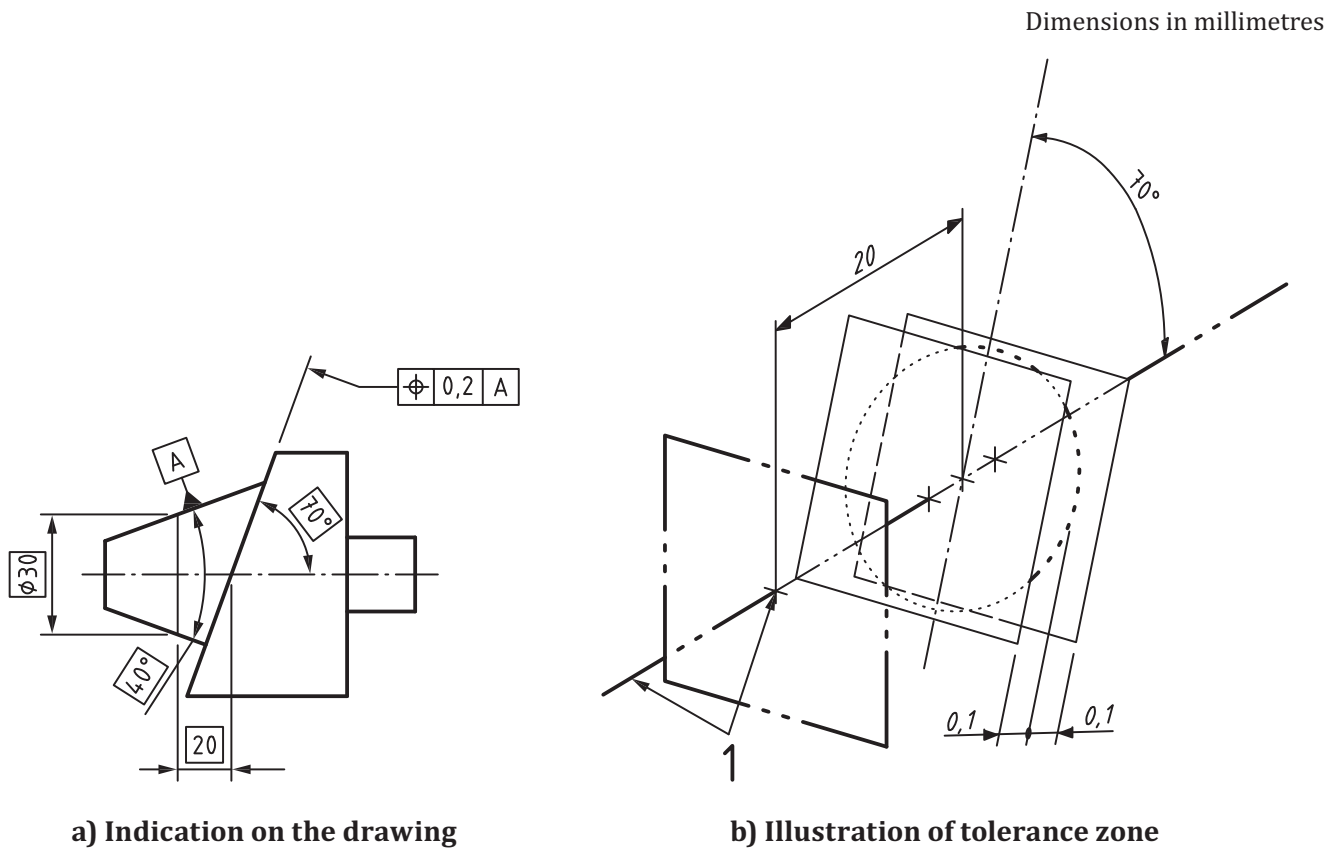


Key

- 1 datum A constituted by the axis of the associated cylinder

Figure 2 — Example of tolerance zone constrained in orientation from a datum

EXAMPLE 2 The tolerance zone, which is the space between two parallel planes 0,2 mm apart, is constrained in orientation by a 70° angle from a datum, and in location by the distance 20 mm from the gauge plane positioned perpendicular to the axis of 40° cone where its local diameter is 30 mm. Here, the datum consists of the set of situation features of the cone with a fixed angle of 40° , i.e. the cone axis and the point of intersection between the gauge plane and that axis. See [Figure 3](#).

**Key**

- 1 datum A constituted by the axis of the associated cone, the point of intersection of the gauging plane and this axis

Figure 3 — Example of a tolerance zone constrained in location from a datum

6 General concepts

6.1 General

Datums and datum systems are theoretically exact geometric features used together with implicit or explicit TEDs to locate or orientate

- a) tolerance zones for toleranced features, or
- b) virtual conditions, e.g. in the case of maximum material requirement (see ISO 2692).

A datum consists of a set of situation features for an ideal feature (feature of perfect form). This ideal feature is an associated feature which is established from the identified datum features of a workpiece. Datum features can be complete features, or identified portions thereof (see [Clause 7](#)).

A datum system consists of more than one datum.

The geometrical type of these associated features belongs to one of the following invariance classes:

- spherical (i.e. a sphere);
- planar (i.e. a plane);
- cylindrical (i.e. a cylinder);

- helical (e.g. a threaded surface)¹⁾;
- revolute (e.g. a cone or a torus);
- prismatic (e.g. a prism);
- complex (e.g. a free-form surface).

Each single or collection feature belongs to one invariance class (for an explanation of invariance classes, invariance degree, and degree of freedom, see [Annex B](#)).

Associated features are established from the real or extracted single features used for the datum. The associated feature can be defined by an operation of association including constraints coming from the feature itself or from one or more other features. The situation features that make up the datum are defined from these associated features. The default association methods are given in [Annex A](#).

One or more single features can be used to establish a datum. If only one single feature is used, it establishes a single datum. If more than one single feature is used, they can either be considered simultaneously to establish a common datum or in a predefined order to establish a datum system (see [6.3](#)).

The datum feature(s) to be used for establishing each datum shall be designated and identified.

The single datums (see [6.3.2](#)), common datums (see [6.3.3](#)) or datum systems (see [6.3.4](#)), as applicable, shall be specified for each geometrical specification.

When applicable, any additional constraints shall be defined for the association.

Datums and datum systems are situation features, not coordinate systems. The set of situation feature is established in a process including associations, but can also include some other geometrical operations (e.g. intersection, translation, rotation). A complete datum system (allowing to lock all six degrees of freedom) is a set of one point, one straight line and one plane (the point on the straight line in the plane). Coordinate systems can be established from a datum or a datum system that locks all six degrees of freedom. In this case, it shall be indicated in accordance with [Annex G](#).

EXAMPLE In [Figure 4](#), the datum is indicated as a single datum derived from a nominal feature, a cylinder, used to orientate or locate a tolerance zone. In order to derive the datum, the following sequence of operations is performed:

- a partition to define the real integral surface corresponding to the nominal feature [see [Figure 4 b](#)];
- an extraction to provide the extracted integral feature [see [Figure 4 c](#)];
- a filtration (see [Annex A](#));
- an association (see [Annex A](#) for association method) to define the associated feature. (In this case, its type is the same as the nominal feature.) The associated feature [see [Figure 4 d](#)] is established from the non-ideal surface (in the specification process) or from the extracted feature (in the verification process).

The datum is defined as the situation feature (the axis) of the associated cylinder [see [Figure 4 e](#)].

6.2 Intrinsic characteristics of surfaces associated with datum features

6.2.1 General

The default status (variable or fixed) of the intrinsic characteristics is described in [6.2.2](#), [6.2.3](#) or [6.2.4](#). For rules, see also rule 2 (2A to 2D) in [7.4.2.2](#).

For datums with virtual conditions, see ISO 2692.

Issues of orientation and location constraints in datum systems are presented in [Annex I](#).

1) Helical surfaces as such are not considered in this document. They are regarded as cylindrical surfaces because, in most functional cases where helical surfaces (threads, helical slope, endless screw, etc.) are involved, the combined rotation and translation of the helix is not needed for datum purposes. In these cases, the pitch cylinder surface is used to establish the datum. The major or minor cylindrical surface can also be considered and specified.

6.2.2 Single datum established from a single feature

The default status of the intrinsic characteristics for a single feature is:

- variable for the linear size of a feature of size (see [Table 3](#));
- fixed for the angular size of a feature of size (see [Table 3](#));
- fixed for an intrinsic characteristic which is not the linear size of a feature of size.

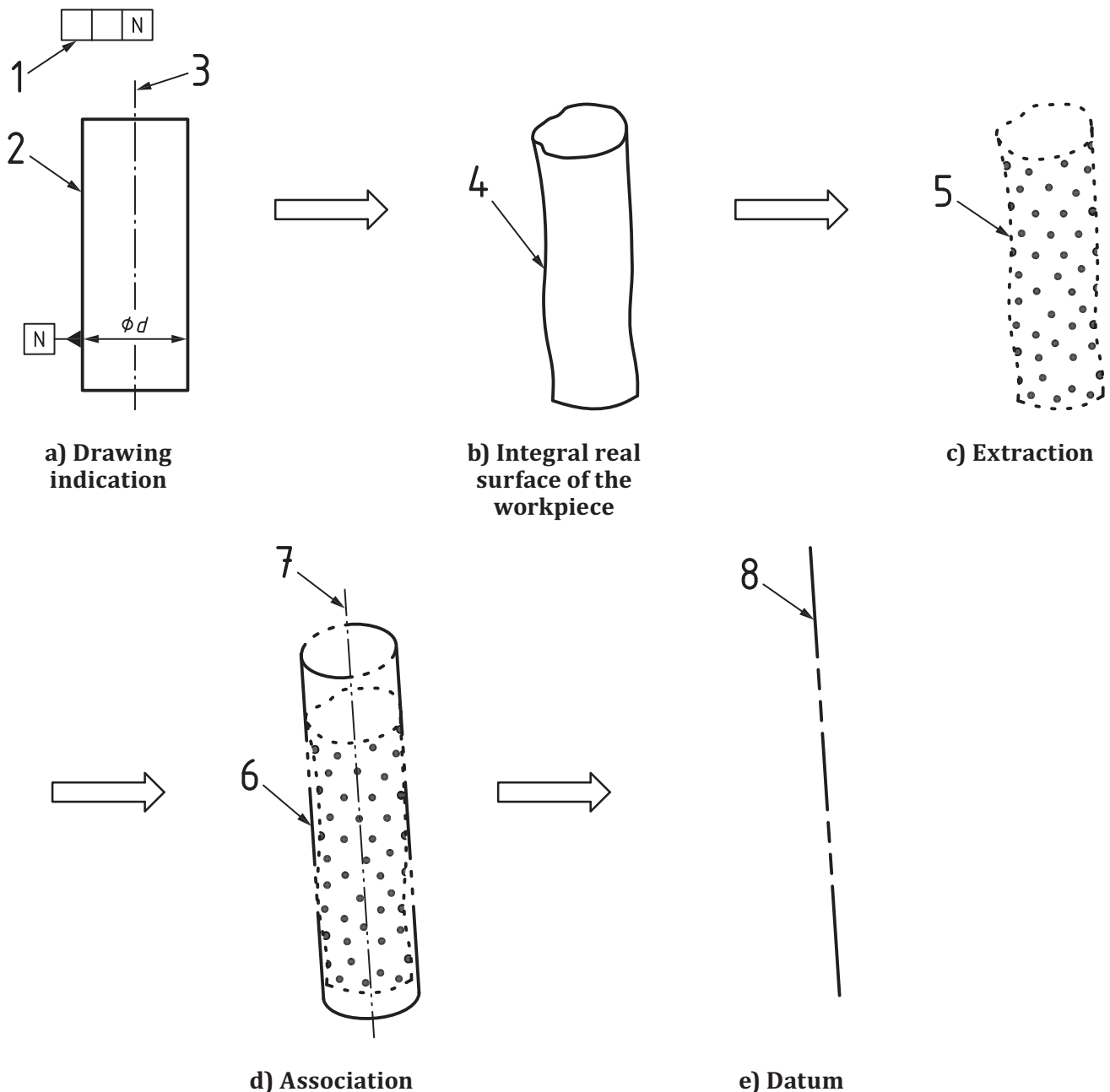
Table 3 — Default status of intrinsic characteristics of features of size

Feature of size	Invariance class	Intrinsic characteristic	Default status
Cylinder	Cylindrical	Diameter	Variable See example in C.2.2
Sphere	Spherical	Diameter	Variable See example in C.2.4
Two parallel opposite planes	Planar	Distance between the two planes	Variable See example in C.2.10
Cone	Revolute	Angle	Fixed See example in C.2.3
Wedge	Prismatic	Angle	Fixed See example in C.2.9

6.2.3 Common datum established from two or more single features simultaneously

The default status (variable or fixed) of the intrinsic characteristics of each associated feature establishing the common datum is as in [6.2.2](#).

Intrinsic characteristics introduced by the collection of features (defining the relation between the associated features) shall by default be considered theoretically exact for both linear and angular dimensions.

**Key**

- | | | | |
|---|---|---|--|
| 1 | tolerance frame to be linked to a tolerated feature | 5 | extracted integral feature (optional) |
| 2 | nominal integral feature (which is a feature of size) | 6 | associated integral feature |
| 3 | nominal derived feature | 7 | derived feature of associated integral feature |
| 4 | real integral feature (datum feature in this case) | 8 | single datum (situation feature of the associated surface) |

In the example shown in [Figure 4 e](#)), the derived feature (key 7) and the situation feature (key 8) are the same as each other; however, this is not always the case.

Figure 4 — Illustration of features used for establishing a single datum from a cylinder

EXAMPLE A common datum is established from two parallel non-coaxial cylinders (invariance class: prismatic). Each individual cylinder has an intrinsic characteristic, its diameter. The collection of features also has intrinsic characteristics: an angle, defined by the fact that two axes restrict the twist of the datum, and the distance between the two axes (see [C.3.4](#)). The two diameters of the cylinders are considered by default variable and the twist angle and the distance between the two are considered theoretically exact.

NOTE See also [6.3.3](#), [7.4.2.7](#) and [7.4.2.9](#) for the special case where the linear dimensions between features included in the collection can be considered variable by using the modifier [DV].

6.2.4 Datum systems established in a defined sequence from two or more single features

The default status (variable or fixed) of the intrinsic characteristics of each associated feature establishing the datum system is as in [6.2.2](#) for a single datum and as in [6.2.3](#) for a common datum.

The intrinsic characteristics introduced by the collection of features (defining the relation between the associated features) shall be considered variable for linear dimensions but theoretically exact for the angular dimensions.

6.3 Single datums, common datums and datum systems

6.3.1 General

When a single surface or a collection surface is identified as a datum feature, the invariance degrees for which the surface is invariant shall be identified and compared with [Table B.1](#) in order to determine the set of situation features (point, straight line, plane or helix, or a combination thereof) that constitutes the datum.

[Annex C](#) gives examples of single datums, common datums and datum systems.

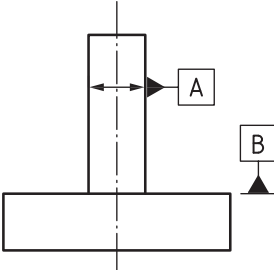
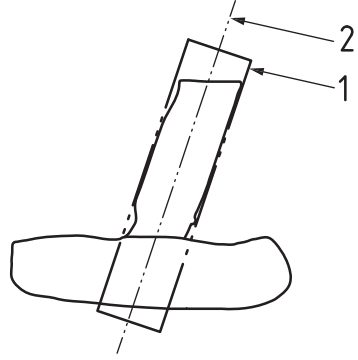
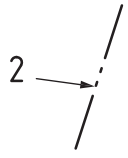
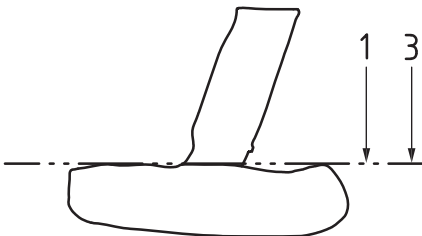
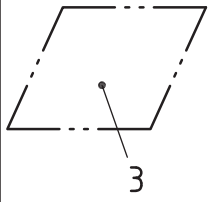
6.3.2 Single datums

A single datum consists of one or more situation features based on one single feature or a portion thereof.

NOTE A single datum taken from a cone has two situation features: its axis and a point on that axis.

For an example, see [Table 4](#).

Table 4 — Example single datum taken from a cylinder or a plane

Indication of datum feature	Indication of datum in tolerance frame	Illustration of the meaning	Invariance class and situation feature (see Annex B)	Datum
			Cylindrical Axis of associated cylinder	
			Planar Associated plane	
Key 1 associated feature (without orientation constraint) 2 straight line which is the situation feature of the associated cylinder (its axis) 3 plane which is the situation feature of the associated plane (the associated plane itself) NOTE Association for single datums is described in Annex A .				

If a single datum is used as the only datum in a tolerance frame, or if it is the primary datum in a datum system, the associated feature to the real integral feature (or to the portions of it) used for establishing the datum is obtained without external orientation constraints or location constraints.

For the constraints that are applied, when a single datum is used as a “secondary datum” or a “tertiary datum”, see [6.3.4](#).

Additional examples of single datums are given in [Clause C.2](#).

For a feature of size made up of two opposite parallel planes, the collection surface associated with the surfaces (or to the portions of the surfaces) used for establishing the datum is obtained with an internal orientation constraint; the associated surfaces (constituting the collection surface) are individually defined with an internal parallelism constraint and a variable intrinsic characteristic constraint (see [C.2.10](#)).

A secondary datum shall not be specified when it does not constrain more degrees of freedom of the tolerance zone than the primary datum.

A tertiary datum shall not be specified when it does not constrain more degrees of freedom of the tolerance zone than the primary and the secondary datums.

6.3.3 Common datums

A common datum consists of one or more situation features established by taking into account the collection surface.

If the common datum is used as the only datum in a tolerance frame, or if it is the primary datum in a datum system, the collection of associated features used for establishing the datums, is established without

external orientation constraints or location constraints; therefore, the surfaces (constituting the collection surface) are associated together, simultaneously. For the constraints that are applied when a common datum is used as a “secondary datum” or a “tertiary datum”, see [6.3.4](#).

A secondary datum shall not be specified when it does not constrain more degrees of freedom of the tolerance zone than the primary datum.

A tertiary datum shall not be specified when it does not constrain more degrees of freedom of the tolerance zone than the primary and the secondary datums.

Examples of common datums are given in [6.3.4](#) (Examples 1 and 2 illustrate the difference between a datum system and a common datum) and [Clause C.3](#).

The complementary indication [DV] (meaning “distance variable”) following the letters indicating a common datum in a tolerance frame means that the linear dimensions between the situation features are variable. See also [7.4.2.9](#) and [Clause E.4](#).

6.3.4 Datum systems

A datum system is constituted by an ordered sequence of two or three single or common datums. A datum system consists of two or three situation features resulting from the collection of the considered surfaces.

The associated features used to establish the datum system are derived sequentially, in the order defined by the geometrical specification. The relative orientation of the associated surfaces is theoretically exact but their relative location is variable.

This order defines the orientation constraints for the association operation: the primary datum imposes orientation constraints on the secondary datum and tertiary datum; the secondary datum imposes orientation constraints on the tertiary datum.

A secondary datum shall be specified when it is necessary to constrain more degrees of freedom of the tolerance zone than are constrained by the primary datum.

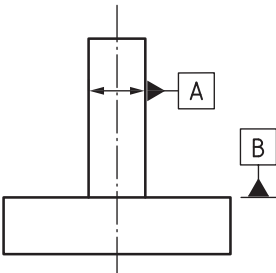
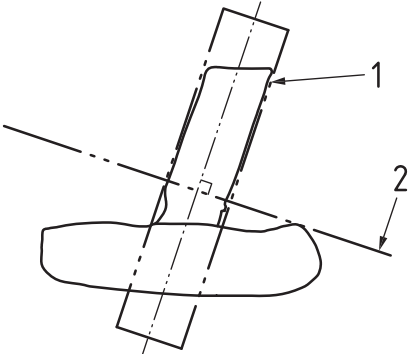
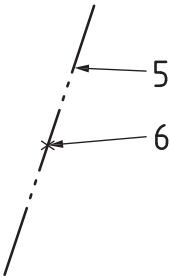
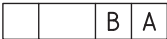
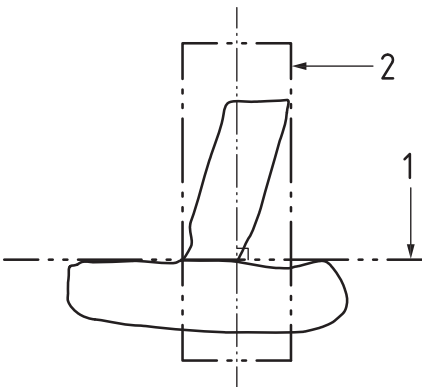
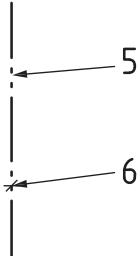
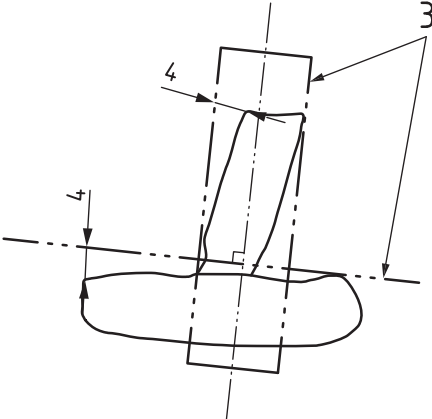
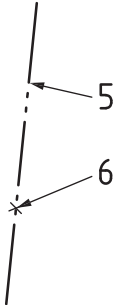
A tertiary datum shall be specified when it is necessary to constrain more degrees of freedom of the tolerance zone than are constrained by the primary and the secondary datums.

A secondary or tertiary datum shall not be specified when it does not constrain more degrees of freedom of the tolerance zone than are constrained by the primary datum and in the case of a tertiary datum also by the secondary datums.

Additional examples of datum systems are given in [Clause C.4](#).

For examples, see [Tables 5, 6 and 7](#).

Table 5 — Example common datum or datum system taken from a cylinder and a plane

Indication of datum feature	Indication of datum in tolerance frame	Meaning on workpiece	Resulting common datum or datum system
			
			
			

Key

- 1 first associated feature without orientation constraint
- 2 second associated feature with orientation constraint from the first associated feature
- 3 simultaneously associated features with orientation constraint and location constraint
- 4 maximum distance balanced between the associated features and datum features
- 5 straight line which is the situation feature of the associated cylinder (its axis)
- 6 point of intersection between the straight line and the plane

NOTE 1 The orientation and location of datums are different depending on the datum indications in the tolerance frame.

NOTE 2 The association for datum systems is described in [A.2.4](#).

Table 6 — Example common datum or datum system taken from two cylinders

Indication of datum feature	Indication of datums in tolerance frame	Meaning on workpiece	Resulting datum or datum system

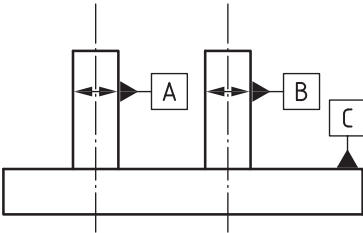
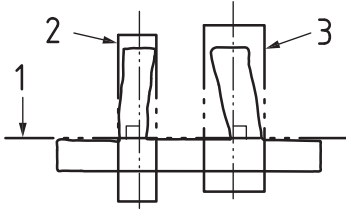
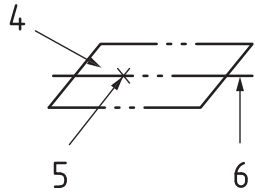
Key

- 1 first associated cylinder without constraint
- 2 second associated cylinder with parallelism constraint from the first associated feature
- 3 simultaneously associated cylinders with parallelism constraint and location constraint
- 4 maximum distance balanced between the associated cylinders and datum features
- 5 straight line which is the axis of the first associated cylinder
- 6 plane including the axes of the two associated cylinders
- 7 median straight line of the axes of the two simultaneously associated cylinders

NOTE 1 The orientation and location of datums are different depending on the datum indication in the tolerance frame. Not all possibilities for establishing the datums are covered.

NOTE 2 For the association method, see [Annex A](#).

Table 7 — Example datum system taken from two cylinders and a plane

Indication of datum feature	Indication of datums in tolerance frame	Meaning on workpiece	Resulting datum or datum system
			
Key 1 first associated feature without a constraint 2 second associated feature with a perpendicularity constraint from the first associated feature 3 third associated feature with a perpendicularity constraint from the first associated feature (and parallelism constraint from the second one) 4 plane which is the first associated feature 5 point of intersection between the plane and the axis of the second associated feature 6 straight line which is the intersection between the associated plane and the plane containing the two axes NOTE For the association method, see Annex A .			

7 Graphical language

7.1 General

The expression of geometrical tolerances with datums in geometrical specifications on drawings includes the following steps:

- Indicate the integral surfaces of the workpiece which are to be used as datum features. When a complete integral surface is not required for a datum feature, the considered portion(s) [area(s), line(s) or point(s)] and the corresponding dimensions and locations shall be indicated (see [7.2](#)).
- Indicate individual single datums, individual common datums or datum systems (see [7.3](#)).
- Indicate the orientation constraints and/or location constraints for the tolerance zones in relation to the indicated datums (see [7.4](#)).
- Indicate the association criteria. This document defines the default association criteria in [Annex A](#). If a different association criterion is required, it shall be indicated (see [Clause 8](#)).
- Indicate, where necessary, the use of the maximum or least material requirement (see ISO 2692) or projected datum (see [7.4.2.10](#)).

NOTE [Annex D](#) presents former practices in relation to ISO 5459:1981²⁾ and ISO 5459:2011³⁾.

7.2 Indication of datum features

7.2.1 Datum feature indicator

A single integral feature to be used as a datum feature shall be indicated by a datum feature indicator. The datum feature indicator consists of a rectangular frame, which contains the datum feature identifier, connected to a leader line terminating with a filled or open datum feature triangle. The datum feature

2) Cancelled and replaced by ISO 5459:2011.

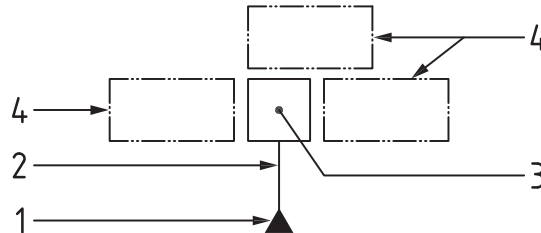
3) Cancelled and replaced by this document.

triangle shall be attached to an integral feature directly or indirectly via a reference line and a leader line, see 7.4.2.1. Optional complementary indications shall be stated in the adjacent indication area, see Figure 5.

NOTE 1 If a datum feature indicator is repeated in several views or sheets of drawing, it can introduce specification ambiguity/interpretation, for instance if some complementary indications are not repeated.

NOTE 2 There is no difference in meaning between a filled and an open datum triangle.

NOTE 3 The width of the rectangular frame is dependent of the length of the datum feature identifier.



Key

- 1 datum feature triangle
- 2 leader line
- 3 area where the datum feature identifier is indicated
- 4 adjacent indication area

Figure 5 — Datum feature indicator without datum feature identifier

7.2.2 Datum feature identifier

Single features used for establishing datum features shall be identified by a datum feature identifier placed in the datum feature indicator. A datum feature identifier consists of one or more capital letters which are not to be separated by hyphens.

The letters I, O, Q and X (which can be misinterpreted) should not be used.

If a drawing has exhausted the alphabet, or if it is useful for the comprehension of the drawing, it is recommended that an unambiguous coding system be defined; for example by repeating the same letter, e.g. two times, three times, etc. (e.g. BB, CCC, etc.). In order to facilitate the reading of this document, only one letter is used in the rest of the document.

7.2.3 Datum targets

7.2.3.1 General

When it is not desirable to use a complete integral feature to establish a datum feature, it is possible to indicate portions of the single feature (areas, lines or points) and their dimensions and locations. These portions are called datum targets. They usually simulate the interface between the considered single feature of the workpiece and one or more contacting ideal features (assembly interface features or fixture features).

A datum target is indicated by a datum target indicator. This indicator is constructed from a datum target frame, a datum target symbol and a leader line linking the two symbols (directly, or through a reference line).

It can be necessary to indicate the same datum target on several appropriate views in order to have an unambiguous definition (see Figures 27, 28 and 29).

7.2.3.2 Datum target frame

The datum target frame is a circle, divided into two compartments by a horizontal line (see [Figure 6](#)). The lower compartment is reserved for the datum feature identifier followed by a digit (from 1 to n), corresponding to the datum target number.

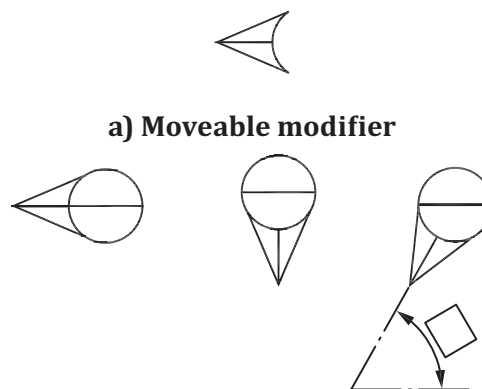
The upper compartment is reserved for additional information, such as dimensions of the target area.



Figure 6 — Single datum target frame

The moveable modifier is constituted by two tangential lines from the circle of the datum target frame to the median segment (see [Figure 7](#)). The direction of the median segment of the moveable modifier is important. It specifies the movement direction where the distance between the moveable datum target and other datums or datum targets is not specified.

The moveable modifier is used to indicate the direction of movement of a physical feature or component simulating the datum or the datum system.



b) Moveable datum target (horizontal, vertical or inclined motion)

Figure 7 — Moveable modifier and examples of datum target frame with the moveable modifier

7.2.3.3 Datum target symbol

The datum target symbol indicates the type of datum target: point, line, or area, identifying a datum target point, a datum target line or a datum target area, respectively:

- a cross (see [Figure 8](#));
- a long-dashed double-dotted narrow line (type 05.1 of ISO 128-2:2022), which, when this line is not closed, is terminated by two crosses (see [Figures 9](#) and [10](#)). This line may be straight, circular or a line of any shape;
- a hatched area surrounded by a long-dashed double-dotted narrow line (type 05.1 of ISO 128-2:2022) (see [Figure 11](#)).



Figure 8 — Datum target point

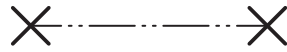


Figure 9 — Non-closed datum target line

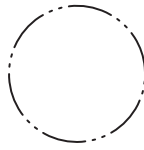


Figure 10 — Closed datum target line

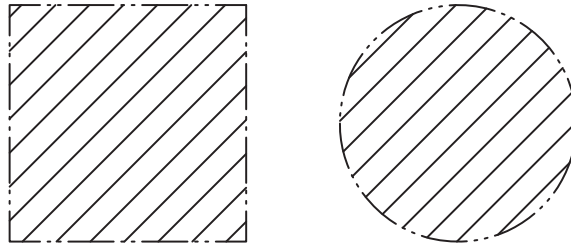


Figure 11 — Datum target area

7.2.3.4 Leader line

The datum target frame is connected directly, or through a reference line, to the datum target symbol by a leader line terminated with or without an arrow or a dot (see [Figures 12, 13 and 14](#)).

When the datum target point or the datum target line is not hidden, the leader line shall be continuous and shall be terminated with or without an arrow (see [Figures 12 and 13](#)).

When the datum target area is shown as an area in the relevant view and is not hidden, the leader line shall be continuous and shall be terminated with a dot [see [Figure 15 b](#)].

When the considered surface is hidden, the leader line shall be dashed and terminated by an open circle for a datum target area [see [Figure 15 a](#)] or without terminator for a datum target point or a datum target line.

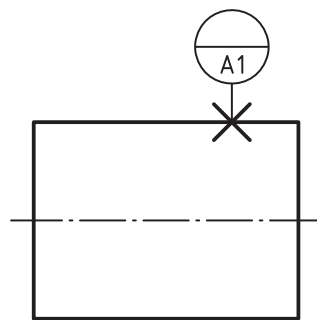


Figure 12 — Indicator for single datum target point

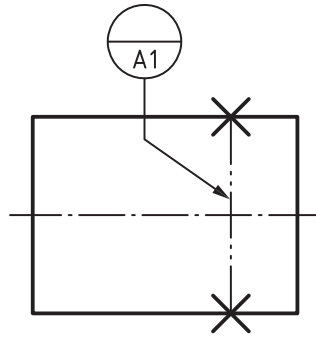


Figure 13 — Indicator for single datum target line

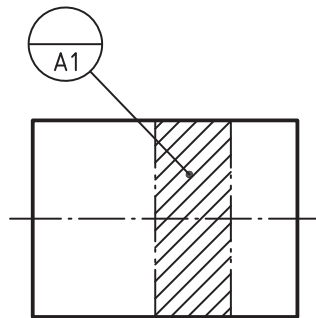
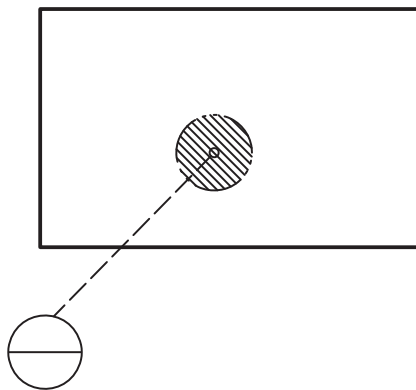
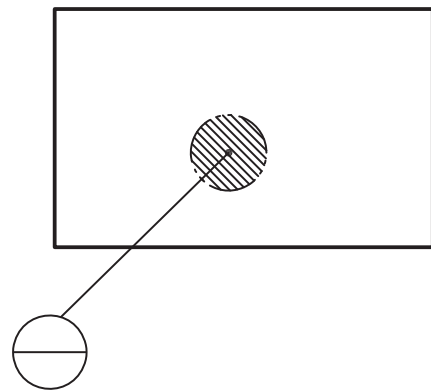


Figure 14 — Indicator for single datum target surface

The orientation of the leader line connecting the frame with the datum target symbol is unimportant. A datum target should be indicated on a view where it is not hidden if possible (see [Figure 15](#)).



a) Indication of a hidden datum target

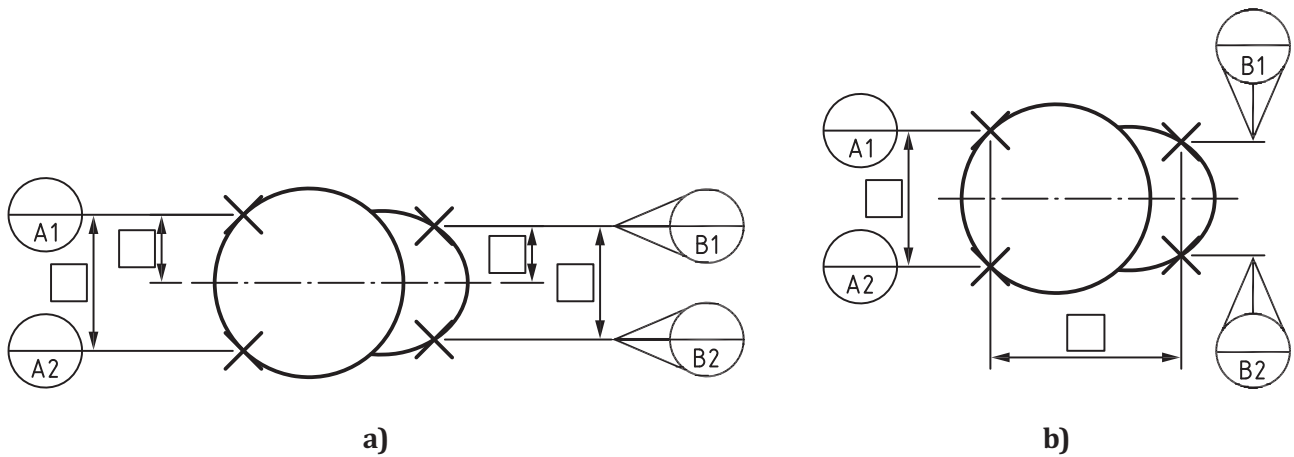


b) Indication of a visible datum target

Figure 15 — Example of indication of datum target

The moveable datum target modifier is used to define the direction in which the location of the datum target is not fixed.

The direction of the motion is indicated by the direction given by the moveable modifier and not by the leader line (see [Figure 16](#)).



NOTE 1 For a), the motion of the moveable datum target, which is given by the direction of the moveable modifier, is perpendicular to a line going through the datum targets A1 and A2.

NOTE 2 For b), the motion of moveable datum target, which is given by the direction of the modifier moveable, is parallel to a line going through the datum targets A1 and A2.

Figure 16 — Example of moveable datum targets

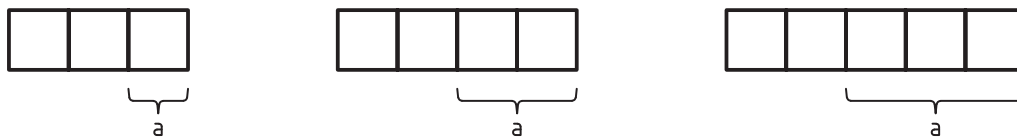
7.3 Specification of datums and datum systems

A datum (single or common) or the datum system is specified in the datum section of:

- a tolerance indicator (see [Figure 17](#) and ISO 1101:2017, 8.2);
- an intersection plane indicator (see ISO 1101:2017, Clause 13);
- an orientation plane indicator (see ISO 1101:2017, Clause 14);
- a direction feature indicator (see ISO 1101:2017, Clause 15);
- a collection plane indicator (see ISO 1101:2017, Clause 16).

A datum section is specified by one, two or three datum indicators.

For more details, see rule 6 in [7.4.2.6](#).



^a Datum section, indicated by one, two or three datum indicators.

Figure 17 — Datum section in a tolerance indicator

7.4 Indication and meaning of rules

7.4.1 General

7.4.1.1 Humans interact with technical product documentation in two ways:

- designers encode the datum requirements into graphical language;
- other users decode the datum requirements from the graphical language.

The necessary rules are given in [7.4.2](#).

7.4.1.2 To encode the location constraints or orientation constraints, or both, for the tolerance zone from features on the workpiece, the following steps shall be performed.

- Indicate and identify all datum features used to establish the datum features with datum feature indicators (see rule 1) and, if necessary, define datum target(s) (see rules 1, 3 and 4).
- Consider how the datums are established from the datum features by defining the manner of association, relevant constraints and types of features (see rules 2, 5, 6, 7, 8, 9 and 10, and [Clause 8](#)).

7.4.1.3 If more than one associated feature is used to establish a datum or datum system, the associations shall be realized sequentially or simultaneously (see rules 6 and 7).

7.4.1.4 For the datum or each datum comprising the datum system, see the applicable rule as indicated below.

- If the type of associated feature is not the same as the datum feature (contacting feature), see rule 5.
- If the size of a feature of size is considered fixed or variable, see rule 2.
- If the constraint given by a datum needs to be reduced, see rules 8 and 9.
- If a geometrical modifier ($\textcircled{M}$, $\textcircled{L}$ or $\textcircled{P}$) is required for a datum, see rule 10.

7.4.1.5 To decode the meaning of a datum or datum system, the following steps shall be performed.

- Read the tolerance frame to determine whether datums are used. If the tolerance frame contains more than two compartments, then at least one datum is used (see rule 6).
- Read all datum feature identifiers corresponding to single datums or common datum components (see rule 7).
- Identify the datum feature corresponding to these datum feature identifiers (see rule 1).
- Determine the datum feature is the complete integral feature (see rule 3). If not, it is necessary to read the datum target(s) and its (their) definition(s) (consider TEDs: see rule 4).
- Consider how the associations shall be processed to establish the datum (see rules 2, 5, 6, 7, 8, 9 and 10).

7.4.2 Rules

7.4.2.1 Rule 1 — Datum features (established from a single feature)

Where the single feature used for establishing a datum is a feature of size, the surface shall be designated by a datum feature indicator placed either:

- as an extension of a dimension line [see [Figure 18 a\)](#) and [Figure 18 b\)](#)];
- on the reference line of a dimension [see [Figure 18 c\)](#)];

- on a tolerance frame linked to a reference line with a dimension and pointing to the surface [see [Figure 18 d](#)]);
- on a tolerance indicator pointing to an extension of a dimension line [see [Figure 18 e](#)) and [Figure 18 f](#))).

If the single feature is a helical surface (e.g. a screw) or a complex surface (e.g. a cylindrical gear), it is considered a cylindrical surface. To establish the datum, the datum feature indicator shall be designated as indicated in [7.2.1](#). If there is no complementary indicator, the datum is established from a pitch cylinder having the pitch diameter of the single feature and the modifier [PD] can be omitted. When the datum is established from a major cylinder (having the major diameter of the single feature) or a minor cylinder (having the minor diameter of the single feature), the symbol [MD] or [LD], respectively, is placed in the adjacent indication area of the datum feature indicator.

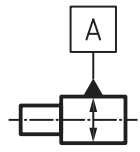
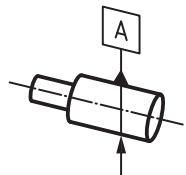
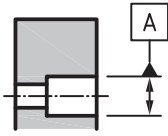
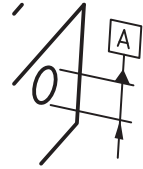
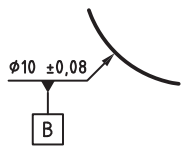
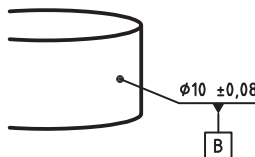
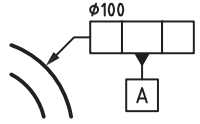
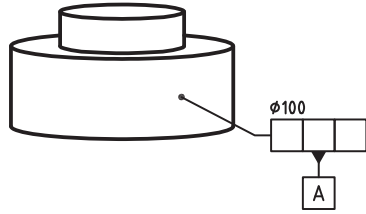
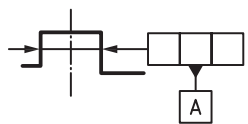
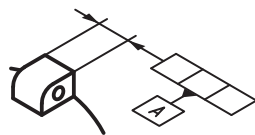
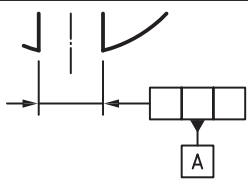
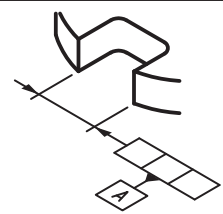
a)		
b)		
c)		
d)		
e)		
f)		
	For 2D representation	For 3D representation

Figure 18 — Attachment of a datum feature indicator for a single datum feature that is treated as a feature of size (linear or angular)

Where the single feature used for establishing a datum is not a feature of size, the surface shall be designated by a datum feature indicator placed either

- on the outline of the surface [see [Figure 19 a](#)]);

- on an extension line of the surface [see [Figure 19 b](#)];
- on a reference line with a leader line having as terminator a dot [see [Figure 19 c](#)] for hidden surface and [Figure 19 d](#)] for visible surface];
- on a tolerance indicator pointing directly to the surface [see [Figure 19 e](#)];
- on a tolerance indicator pointing to an extension line of the surface [see [Figure 19 f](#)];
- on a tolerance indicator pointing to a reference line with a leader line having as terminator a dot [see [Figure 19 g](#)].

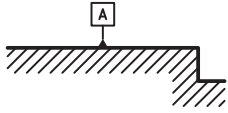
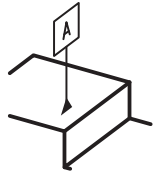
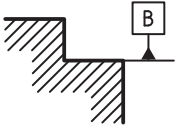
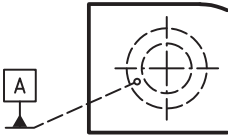
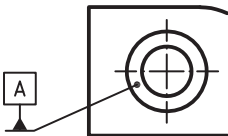
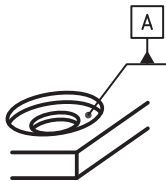
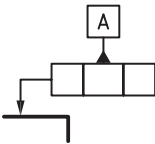
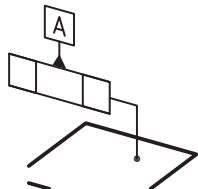
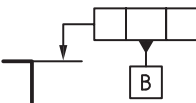
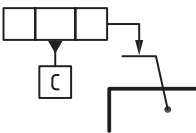
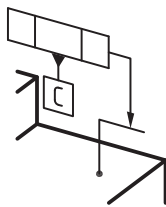
a)		
b)		Non-applicable
c)		Non-applicable
d)		
e)		
f)		Non-applicable
g)		
	For 2D representation	For 3D representation

Figure 19 — Attachment of a datum feature indicator for a single datum feature that is not treated as a feature of size

It is recommended to indicate the datum feature indicator on a view where the surface is not hidden.

NOTE 1 A datum feature indicator can be placed on the top [see [Figures 19 e\)](#) and [19 g\)](#)] or on the bottom of a tolerance indicator [see [Figure 19 g\)](#)].

When the surface is hidden, the leader line or reference line shall be dashed and terminated by an open circle [see [Figure 19 c\)](#)].

NOTE 2 The meaning of a datum feature indicator attached to a tolerance frame for a single feature that is a feature of size is identical to that of a datum feature indicator identifying a feature of size placed in any other permitted manner (see [Figure 18\)](#).

NOTE 3 See example [C.2.1](#) for a feature which is not a feature of size and example [C.2.2](#) for a feature which is a feature of size.

7.4.2.2 Rule 2 — Size status for associated features of size

7.4.2.2.1 General

The size of an associated feature of size can be variable or fixed. This status can be defined explicitly or implicitly, in accordance with rules 2A, 2B, 2C and 2D. Examples of their applications are given for feature of linear size in [Table 8](#) and for feature of angular size in [Table 9](#). An explicit indication of size shall always take precedence over an implicit size status.

NOTE Implicit rules are retained in this document, as in many cases they correspond to established practice. Explicit indications reduce the risk of misinterpretation.

Table 8 — Examples illustrating the status of size of the associated feature of linear size, in link with the indications

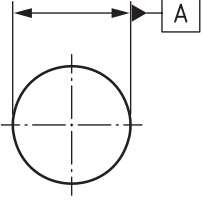
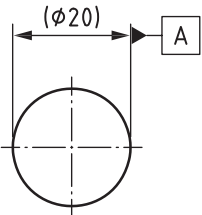
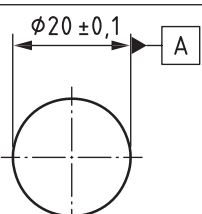
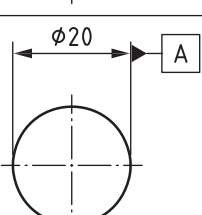
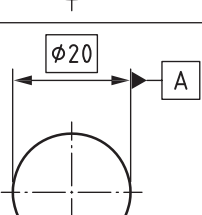
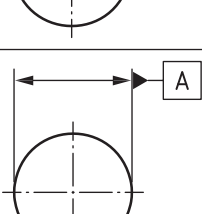
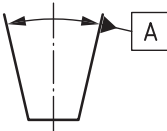
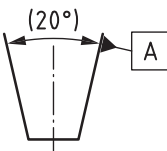
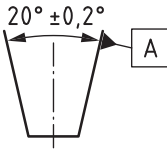
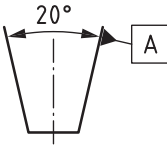
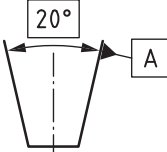
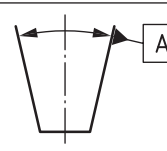
		Datum indicator			
		without [SV] or [SF] A	with [SV] A[SV]	with [SFxx] A[Sf20]	with [SF] A[Sf]
Indication of size value in line with the datum feature indicator (see rule 1)		Variable	Variable	Fixed with size value equal to 20 mm	Incomplete specification (fixed, however with an undefined size value)
					
					
					
		Fixed with size value equal to 20 mm			Fixed with size value equal to 20 mm
		Fixed with size value equal to CAD value			Fixed with size value equal to CAD value
TEDs according to CAD model 007a					

Table 9 — Examples illustrating the status of size of the associated feature of angular size, in link with the indications

		Datum indicator			
		without [SV] or [SF] A	with [SV] A[SV]	with [SFxx] A[SF20]	with [SF] A[SF]
Indication of size value in line with the datum feature indicator (see rule 1)		Incomplete specification (fixed, however with an undefined size value)	Variable	Fixed with size value equal to 20°	Incomplete specification (fixed, however with an undefined size value)
					
		Variable			
					
		Fixed with size value equal to 20°			Fixed with size value equal to 20°
	 TEDs according to CAD model 007a	Fixed with size value equal to CAD value			Fixed with size value equal to CAD value

7.4.2.2.2 Associated feature of size with variable size**7.4.2.2.2.1 General**

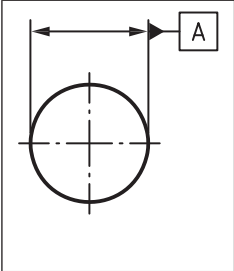
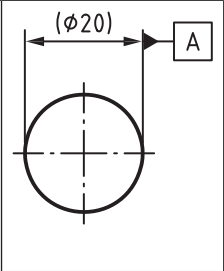
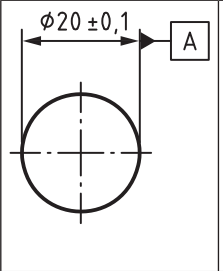
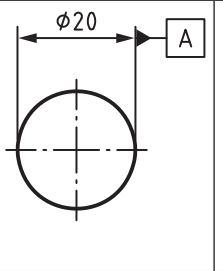
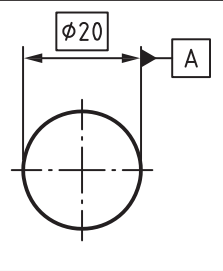
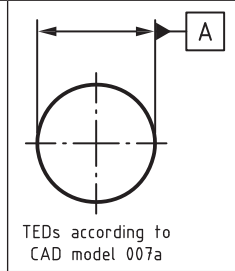
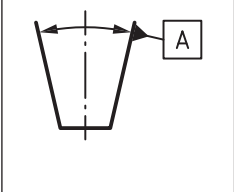
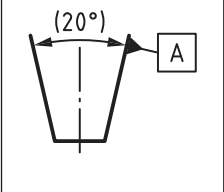
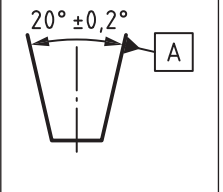
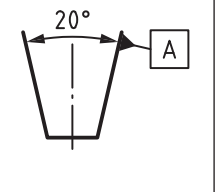
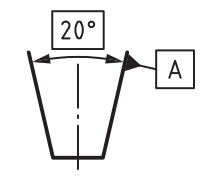
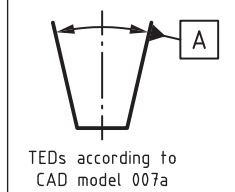
The associated feature of size shall have a variable size (linear or angular) when this is defined explicitly or implicitly, in accordance with rules 2A and 2B.

7.4.2.2.2.2 Rule 2A — Implicit definition of variable size

The associated feature shall have a variable size when:

- the datum feature indicator is attached to a dimension with a tolerance value, applied directly or indirectly as a general tolerance value [see [Figure 20](#) c), d), i) and j)]; or
- the datum feature indicator is attached to an auxiliary dimension for a feature of linear size [see [Figure 20](#) b)]; or

- the datum feature indicator is attached to a dimension without a dimension value for a feature of linear size [see [Figure 20 a\)](#)], and there is no indirect indication that the dimension value is a TED (e.g. with a reference to the CAD model with a statement such as “TEDs in accordance with CAD model 007a”).

					
a)	b)	c)	d)	e)	f)
					
g)	h)	i)	j)	k)	l)

NOTE Other indications of size in line with datum feature indicator are available, see rule 1.

Figure 20 — Illustration of datum feature indicator attached to a dimension line, of size (linear or angular)

7.4.2.2.2.3 Rule 2B — Explicit indication of variable size

The associated feature shall have a variable size when the modifier [SV] is placed immediately after the datum identifier in a datum indicator of the datum section. There shall be no space between the datum identifier and the modifier [SV].

NOTE The [SV] modifier can be used with features of linear size and features of angular size.

7.4.2.2.3 Associated feature of size with fixed size

7.4.2.2.3.1 General

The associated feature of size shall have a fixed size when this is defined explicitly or implicitly, in accordance with rules 2C and 2D.

7.4.2.2.3.2 Rule 2C — Implicit definition of fixed size

The associated feature shall have a fixed size when the datum feature identifier is attached to a dimension line:

- with a TED indicated directly, or defined indirectly by a reference to a CAD model, with a statement such as ‘TEDs in accordance with CAD model 007a’ [see [Figure 20 e\)](#), [f\)](#), [k\)](#) and [l\)](#)]; or
- with an auxiliary dimension for a feature of angular size [see [Figure 20 h\)](#)]; or
- without a dimension value for a feature of angular size [see [Figure 20 g\)](#)].

7.4.2.2.3.3 Rule 2D — Explicit indication of fixed size

The associated feature shall have a fixed size when the modifier [SF] or [SFxx] (where “xx” is the fixed size value) is placed immediately after the datum identifier in a datum indicator of the datum section. There