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Third edition
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Technical product documentation — Digital product definition data practices

Documentation technique de produits — Pratiques pour les données numériques de la définition d'un produit

Reference number
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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.

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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 10, *Technical product documentation*.

This third edition cancels and replaces the second edition (ISO 16792:2015), which has been technically revised.

The main changes to the previous edition are as follows:

— information on assembly part identification added;

— information on movable parts in assemblies added;

— figures updated to reflect current International Standards,

— content which is authored in other documents removed;

— former practices moved to Annex A;

— Annex C with additional examples of applying this document added.

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

Every effort was made during the preparation of this document, adapted from ASME Y14.41:2012, to apply existing requirements developed for two-dimensional (2D) presentation equally to the output from three-dimensional (3D) models. Where new geometrical product specification (GPS) rules have proved essential, these have been drafted with a view to their being equally applicable to both 2D and 3D. Therefore, in order to maintain the integrity of a single system, these new rules are being incorporated in the relevant existing International Standards for cross-reference. Application examples have been included where, due to the specific requirements of 3D modelling in support of model-based definition (MBD), additional guidance was deemed beneficial.

It is recognized that there is a need to support drawings in conjunction with 3D models now and for the foreseeable future. This need has been addressed in this document through the definition of the two methods for documenting digital models and specification of requirements to ensure that the information in a data set is consistent between the model and the drawing.

The figures in this document are intended only as illustrations to aid the user in understanding the practices elaborated in the text. In some cases, figures show a level of detail as needed for emphasis; in others, they are only complete enough to illustrate a concept or facet thereof, including the associativity of annotations in the design model. The absence of figures has no bearing on the applicability of the specified requirement or practice.

Most figures are illustrations of models in a 3D environment. Figures illustrating drawings in digital format include a drawing sheet border.

This document describes general requirements and practices for digital product definition applied for 3D mechanical engineering (MCAD) but which can be also applied to other disciplines and trades (e.g. ECAD).

For former practices, see Annex A.

Technical product documentation — Digital product definition data practices

1 Scope

This document specifies requirements for the preparation, revision and presentation of digital product definition data, hereafter referred to as data sets, complementing existing standards. It supports two methods of application: 3D model-only and 3D model with 2D drawing in digital format. The structure of this document presents requirements common to both methods followed by clauses providing for any essential, differing requirements for each method. Additionally, its use in conjunction with computer-aided design (CAD) systems can assist in the progression towards improved modelling and annotation practices for CAD and engineering disciplines, as well as serving as a guideline for CAx software developers.

The actual definitions for the interpretation, in particular the ISO TPD and ISO GPS rules, are taken from the original definition standards, e.g. ISO 129-1 and ISO 1101.

When the term model is used in this document it applies to both design models and annotated models.

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

ISO 128-3:2020, *Technical product documentation (TPD) — General principles of representation — Part 3: Views, sections and cuts*

ISO 129-1, *Technical product documentation (TPD) — Presentation of dimensions and tolerances — Part 1: General principles*

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

ISO 2553, *Welding and allied processes — Symbolic representation on drawings — Welded joints*

ISO 3098-1, *Technical product documentation — Lettering — Part 1: General requirements*

ISO 3098-5, *Technical product documentation — Lettering — Part 5: CAD lettering of the Latin alphabet, numerals and marks*

ISO 5457, *Technical product documentation — Sizes and layout of drawing sheets*

ISO 5459, *Geometrical product specifications (GPS) — Geometrical tolerancing — Datums and datum systems*

ISO 7200, *Technical product documentation — Data fields in title blocks and document headers*

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

ISO 10209:2012, *Technical product documentation — Vocabulary — Terms relating to technical drawings, product definition and related documentation*

ISO 11442, *Technical product documentation — Document management*

ISO 21920-1[1)], *Geometrical product specifications (GPS) — Surface texture: Profile —Part 1:Indication of surface texture*

ISO 25178-1, *Geometrical product specifications (GPS) — Surface texture: Areal — Part 1: Indication of surface texture*

ISO 80000-1, *Quantities and units — Part 1: General*

IEC 82045-2, *Document management — Part 2: Metadata elements and information reference model*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10209 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General terms and definitions

3.1.1
absolute coordinate system
initial model coordinate system in the active CAD model used to define the location of digital elements in that CAD model

Note 1 to entry: The active CAD model may be a part, subassembly or assembly.

Note 2 to entry: This absolute coordinate system has absolute origin of 0,0,0.

3.1.2
offset section
stepped cutting plane to include features not located in a straight cutting plane

Note 1 to entry: 2D offset section views are drawn as if the offsets were in one plane, and the offsets are not indicated in any manner in the section views. 3D offset section views are shown by cutting through the part in an offset manner.

3.1.3
product definition data set
data set
collection of one or more computer files that discloses (directly or by reference), by means of graphic or textual presentations, or combinations of both, the physical and functional requirements of a product

3.1.4
user-defined coordinate system
model coordinate system which is created in the CAD model by the user in addition to the absolute coordinate system

3.2 Classification codes for drawings and data sets (see Annex B)

3.2.1
classification code
designation assigned to product definition data that defines what data are included within the drawing, data set or both

Note 1 to entry: A drawing can be in either physical or electronic format.

1) Under preparation. Stage at the time of publication: ISO/DIS 21920-1:2021.

3.2.2
classification code 1
drawing with optional data set

Note 1 to entry: Classification code 1 identifies that the data elements are located on the drawing and the drawing is the original.

3.2.3
classification code 2
data set with design model and drawing containing specifications

Note 1 to entry: Classification code 2 identifies that data elements are located on a drawing and the drawing is the original. A computer is used as a tool to prepare the drawing graphics sheet and the model. Data elements are located in the digital data and the drawing. The model when provided is supplementary to the drawing.

3.2.4
classification code 3
data set with design model or annotated model and simplified drawing

Note 1 to entry: Classification code 3 identifies a model with a simplified drawing used to expedite communication of common part features and to define non-geometric part definitions. The data set is the original. For example, the model and the drawing must be used together to satisfy this requirement.

Note 2 to entry: When used, annotated models under classification code 3 are partially annotated.

3.2.5
classification code 4
data set with annotated model and drawing

Note 1 to entry: Classification code 4 identifies that all data elements are located in both the digital data and the drawing. The data set is the original. For example, the model or the drawing can be used individually to satisfy this requirement.

3.2.6
classification code 5
data set with annotated model

Note 1 to entry: Classification code 5 identifies that all data elements are located in the data set with model. No drawing exists.

4 Data set identification and control

4.1 General

Actual data sets shall meet the requirements of this document.

Data sets for which conformity with this document is claimed shall include a reference to this document either in the data set itself or in a document referenced by the data set (see 5.4.3).

The current revision of the data and the computer application(s) and version(s) used to develop the data set shall be specified with other management data (see 5.4).

The data set identifier shall be unique and shall consist of numeric, alphabetic or special characters in any combination. Spaces are not permitted between any of the characters of the data set identifier.

The length of the data set identifier may be a direct function of the computer system and the operating system. When the part or identifying number is used as the data set identifier, the length shall be compatible with recognized limitations on number length in accordance with ISO 7200 and IEC 82045-2.

Special characters, such as hyphen (-), slash (/) or asterisk (*), shall be selected in a manner that does not hinder data set identification or have an adverse effect on the computer system operation.

A recognizable prefix or suffix may be included as part of the identifier to associate files and sets of related data.

The classification codes given in Annex B can be used to identify the content of the data sets and define the hierarchal relationships when applicable.

4.2 Related data

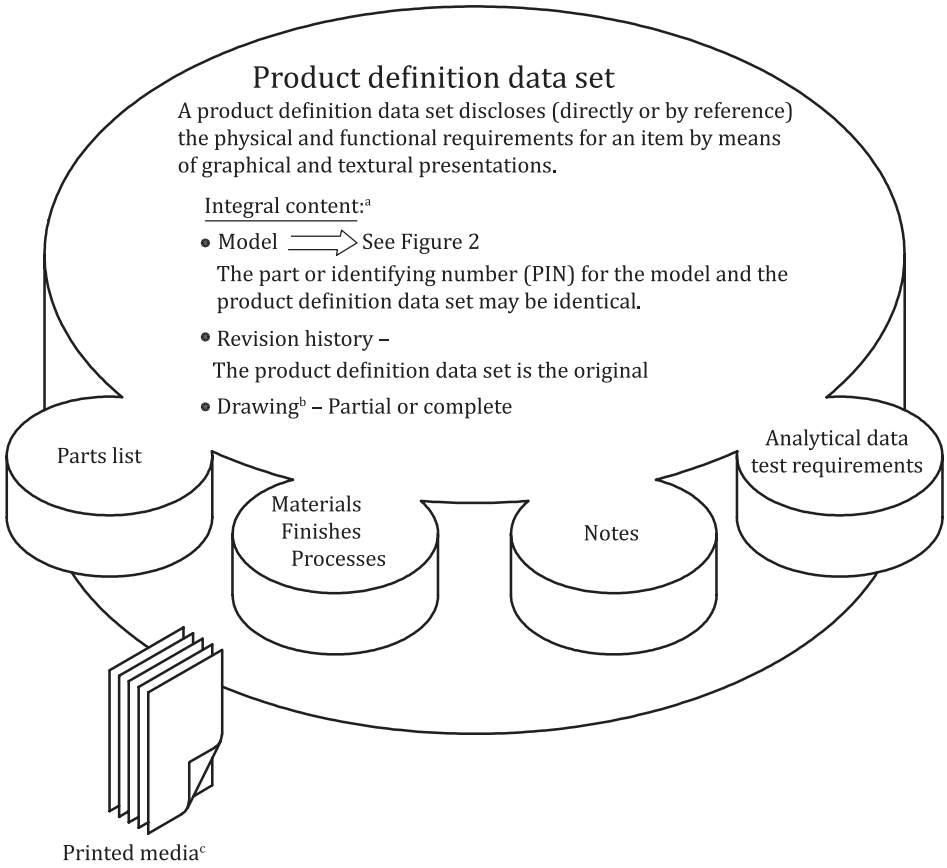
Related data shall be integral to, or referenced in, the data set. Examples of related data include analytical data, parts lists, test requirements, material specifications, process and finish requirements (see Figure 1).

4.3 Data management

The following specifies the structure and control requirements for data management:

a) The data management system shall meet the requirements of ISO 11442, providing information to enable the control and tracking of data sets throughout the life cycle of the product to which each relates. The system may include work in process, data review status, model checked status, release status, design tool and version and libraries.

b) Revision history information in accordance with ISO 11442 shall be contained in the data set.



a Related data (as applicable) required for complete definition may be integral to or referenced in the product definition data set. Data not integral to the product definition data set may be revised independently.

b A drawing is not required for model only data sets.

c Related data may be manually or computer generated.

Figure 1 — Content of a product definition data set

A model in a product definition data set contains annotations, attributes and the CAD design model, which typically comprises model geometry, geometric elements and supplemental geometry (see Figure 2).

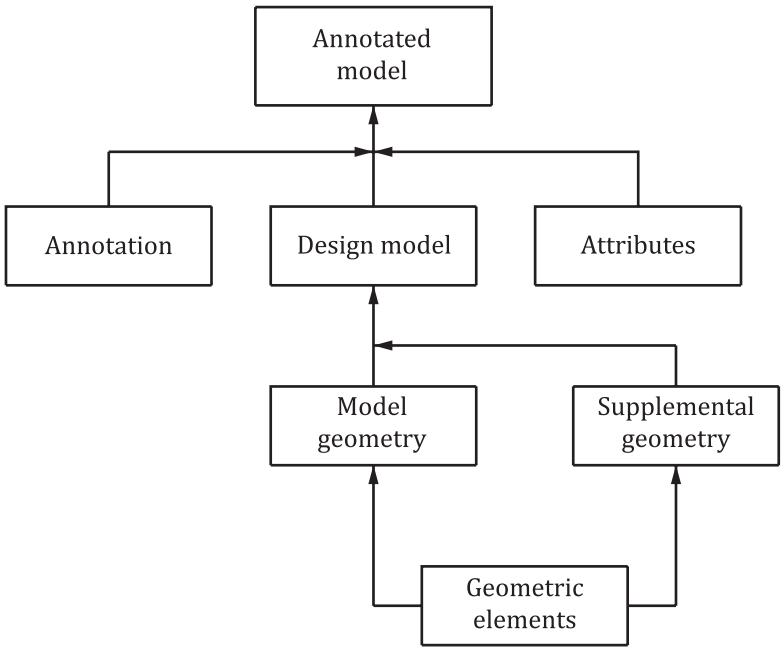


Figure 2 — Content of a model

5 Data set requirements

5.1 General

5.1.1 Introduction

The data set shall provide complete product definition, for example, a design model, its annotation and related documentation.

5.1.2 Fundamental requirements

5.1.2.1 General

The following are the fundamental requirements and other provisions applicable to both annotated models and drawings, specific to annotated models and specific to drawings.

The integrity of product definition data should be ensured at all times, i.e. the information presented shall not be conflicting.

5.1.2.2 Common to annotated models and drawings

— All model values and resolved dimensions shall be obtained from the model.

— Rounding requirements for resolved dimensions shall conform with 9.2.2.

— The ability to query the model shall be available (see 7.3.8).

— All angular values shall be queried from the model (see 9.2). Exceptions to this are model coordinate system(s), planes and axes in a datum system and orthographic views.

— When query is required, a notation stating the requirement for query of the model or associated data shall be added to the drawing or in the general notes. See Figure 26 for an example.

— Values obtained from the model for any feature(s) which are not covered by any tolerance, specify the location of a datum target, or the location and extent of a restricted portion of a feature, shall be auxiliary dimensions.

— The legibility requirements of ISO 3098-1 and ISO 3098-5 shall apply when the annotation is viewed perpendicular to the annotation plane.

— Annotation in any given annotation plane shall not overlap other annotation in the same annotation plane when the model is viewed perpendicular to the annotation plane.

— Annotation text within any given annotation plane shall not be placed over the design model when the model is viewed perpendicular to the annotation plane. Where this is unavoidable the legibility shall not be compromised.

— On spherical surfaces tolerance indicators shall be placed on an annotation plane containing its centre point.

5.1.2.3 Applicable only to models

— An annotation shall be specified in an annotation plane. Several annotations can belong to the same annotation plane. When the model-only method (classification code 5) is used, the CAD software shall support maintenance of annotation plane orientation relative to the model (see 7.3.4).

— The associated entities, annotation and attributes shall be in agreement.

— Resolved dimensions created from queried model values are considered the same as dimensions displayed on a model (see 9.2.2).

— Display of centre lines or centre planes for features of size is optional.

— To ensure that the annotation is readable – the text, for example, can be upside down or backwards following rotation of the model – one of the following techniques shall be used:

  a) ensuring that the reading direction is updated after rotation of a model;

  b) inclusion of means of determining the correct reading direction in each annotation plane applied to a model;

  c) when using saved views, ensuring that the model is orientated in the intended view direction, for example by including a means of determining the correct reading direction in the view;

  d) when the orientation of the annotation is part of the specification, the relationship to the geometry shall be maintained regardless of the viewing direction.

— Dimensions, tolerances and datums to internal features can be shown without the use of a section as long as the specification is unambiguous.

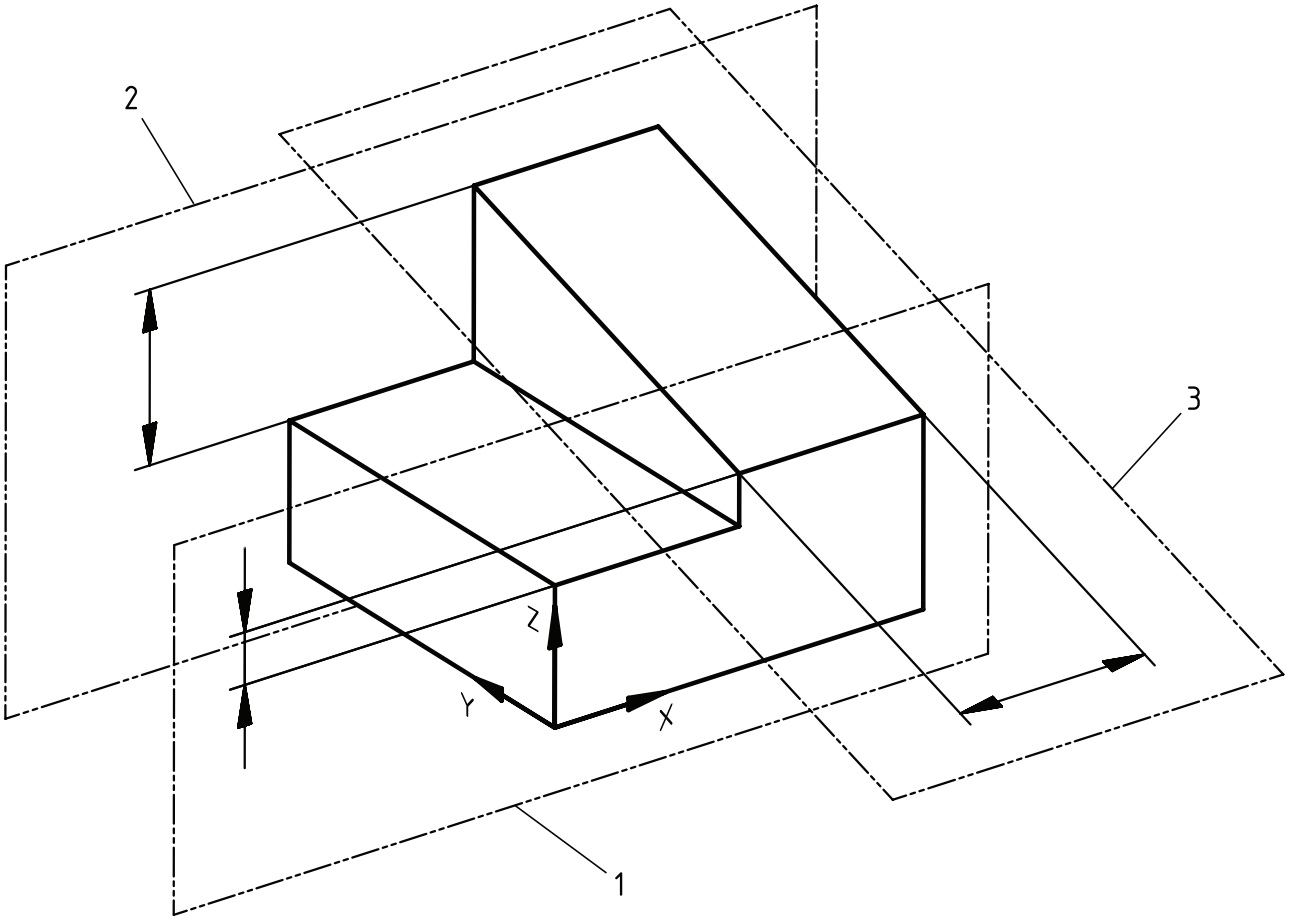
— Utilizing an annotation plane on the design model, the method to indicate annotations is as follows:

  a) The annotation plane shall be parallel to the orthogonal coordinate surface of the absolute coordinate system or a user-defined coordinate system of the 3D model. In addition, it is acceptable to set an annotation plane in a discretionary direction as needed (see Figure 3).

  b) Indicate so that the relationship between the annotation and the design model portion indicating the annotation can be maintained through a dimension line, projection line and leader line.

  c) The colour of the annotation should be set to a colour which can be clearly identified against the colour of the design model, the annotation plane and the background.

d) It is acceptable to be able to switch between displaying and hiding annotations as needed on a computer monitor.



Key

1 front annotation plane in direction of absolute coordinate system
2 back annotation plane in direction of absolute coordinate system
3 annotation plane with a direction which is not parallel to the absolute coordinate system

Figure 3 — Example of displaying annotation plane on design model

5.1.2.4 Applicable only to drawings accompanied by 3D models

— Annotation may be applied to orthographic or axonometric views.

— For axonometric views, the orientation of the annotation shall be parallel to, normal to or coincident with the surface to which it applies. Where legibility is compromised, the annotation shall be orientated to the viewing plane of the drawing. One annotation shall not overlap another or the geometrical representation of the part.

5.1.3 Design model requirement (classification codes 3, 4 and 5)

A design model is required and shall be in accordance with 5.2 and Clause 6.

5.2 General model requirements

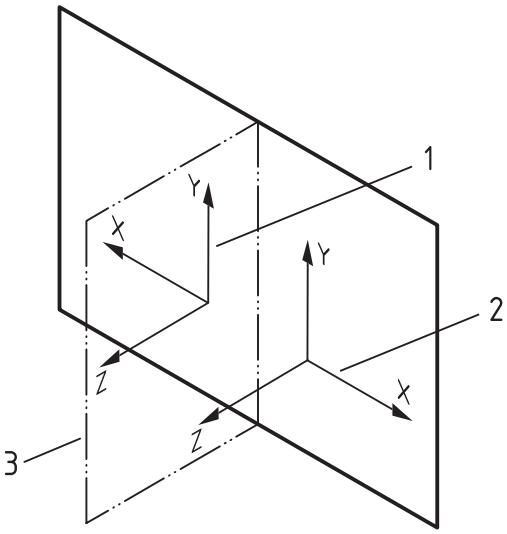
5.2.1 Associativity

The ability to associate digital elements shall be available and maintained. Associativity information shall be electronically accessible.

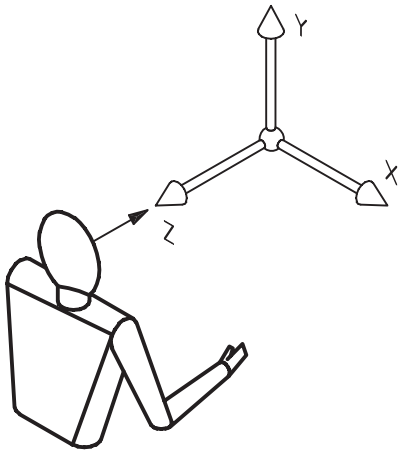
5.2.2 Model coordinate systems

A design model shall contain one or more model coordinate systems. A model coordinate system shall be depicted by three mutually perpendicular line segments with its origin located at the intersection of the three axes. Each axis shall be labelled, and the positive direction shown. Model coordinate systems shall be right-handed unless otherwise specified (see Figure 4).

The CAD model shall establish a link between the absolute coordinate system and the model coordinate system(s). The technical product documentation shall establish a link between the model coordinate system(s) and the datum system(s) for geometrical specifications.



a) Mirror-image relationship



b) Recognizing the right-hand coordinate system

Key

1 left-hand coordinates

2 right-hand coordinates

3 mirror transform

NOTE The right-hand coordinates system when observed in the Z direction, with positive Y ascending, shows positive X is directed to the right-hand side of the observer.

Figure 4 — Left- and right-hand model coordinate systems

5.2.3 Applications of supplemental geometry

When supplemental geometry is used, there shall be a clear distinction between the supplemental geometry and the model geometry.

5.2.4 Part features not fully modelled

A conventional simplified representation of part features such as threads, holes, fillets, rounds and drafts can be shown using partial geometry definition, annotations, attributes or a combination thereof (see Figure 16). Simplification shall be done in an unambiguous manner according to applicable standards.

5.3 General method requirements

5.3.1 Data set methods

The following subclauses cover the following product definition methods. Each different method for specifying product definition is used in support of different industry processes and requirements. The data set is the original for all of the methods: any copy, no matter what the media of presentation, is subordinate.

5.3.2 Model-only method

The following is applicable when there is complete product definition within a model.

a) Items including notes, parts lists, marking requirements, dimensions and tolerances shall be contained or referenced in the data set.

b) The data elements of a drawing format as defined in ISO 5457 and ISO 7200 are not required, except for the following, which shall be contained in the data set:

   — legal owner for the data set;

   — data set title;

   — data set number;

   — approval indicators and approval dates;

   — contract number when required;

   — originator's name and date.

c) When working with a model or assembly model, the first or third angle projection symbol (see ISO 5456-2) is not required.

5.3.3 Model and drawing method

The following is applicable when there is complete product definition within a model and drawing.

a) A complete definition of a product shall contain a model and a drawing that may contain orthographic views, axonometric views or a combination thereof. Annotation may be applied to the model, on the drawing or a combination thereof. Care should be taken to ensure that there is complete product definition.

b) Product definition data created or shown in the model and on the drawing shall not be in conflict (for classification code 3 or 4).

c) Product definition data created and shown on the drawing shall not conflict with product definition data in the model (for classification code 2).

d) The drawing shall contain a drawing border and title block information in accordance with ISO 5457 and ISO 7200.

e) The drawing shall reference all models and data relevant to the product including revision history.

f) Annotation displayed on the drawing shall be interpretable without the use of query, except for model value queries in order to extract TED values,

g) When complete product definition is not contained on the drawing this shall be noted on the drawing.

h) When complete product definition is not contained in the model this shall be noted in the model.

i) The model shall be connected to the drawing by a method that identifies the relationship between the drawing and the model. This may be accomplished by associativity in a CAD system or by providing the information in 5.3.2 b) within the data set.

5.4 Management data

5.4.1 General

Management data that are not placed on a drawing shall be placed on the model or in the data set separate from the model or drawing according to 5.4.2 and 5.4.3.

5.4.2 Management data in the data set

The following management data shall be contained in the data set:

— application data;

— approval;

— data set identification;

— design activity transfer;

— revision history for the data set.

5.4.3 Management data on a model

Management data placed on a model shall be placed on a management data annotation plane or using an equivalent method. The annotation plane shall be available for display with the model. When displayed, the management data annotation plane shall not rotate with the model. Management data placed on a model shall include:

— a reference to this document, i.e. ISO 16792 or ISO 16792:2021;

— CAD-maintained notation;

— design activity identification;

— duplicate original notation;

— part or identifying number;

— unit of measurement (if other than millimetres);

— navigation data;

— a definition of the original data and the content of the full data set; this can be the use of classification codes according to Annex B or any other unambiguous indication.

5.5 Protection marking

5.5.1 General

Protection marking shall be placed in the file(s) or in the referenced document(s) to which it applies (see ISO 16016).

5.5.2 Location on models

Protection marking shall be placed on a protection-marking annotation plane, or equivalent, which shall be available for display with the model. Reproductions of technical data, or any portions thereof, subject to restrictions, shall also reproduce the restrictions. When displayed, the protection-marking annotation plane does not rotate with the model.

NOTE Models containing company intellectual property can include notes to this effect, such as company proprietary notes and competition-sensitive material. In addition, there can be requirements for the inclusion of other information such as government notices, statements and legends. Contractual requirements (e.g. copyright notices, distribution statements, export control notices and rights in data legends) determine precisely what is required.

5.6 Saved views on models

5.6.1 General

See ISO 128-3 for sections and views. This subclause describes exceptions or additions for views on models.

Saved views of a design model may be defined to facilitate presentation of the model and its annotation. A saved view shall have an identifier, be retrievable on demand, contain a model coordinate system that

denotes the direction of the view relative to the model and may contain one or more of the annotation plane(s), a selected set of annotation or a selected set of geometry. A saved view may be zoomed in or out for visual clarification.

5.6.2 Sections

Saved views can be used to retain sections. All sections shall have the same scale as the design model.

A representation of a cutting plane may be used to indicate the location and viewing direction of a section. The edges of the cutting plane shall be continuous [see Figure 6 a)] or long-dashed dotted narrow lines in accordance with ISO 128-2 [see Figure 6 b)]. The image of the section may indicate the view of the section; in these cases the cutting planes can be omitted [see Figure 6 c)].

Cutting planes in the model may be identified with reference arrows, if necessary, for example for readability. In that case a reference arrow or arrows shall be included to show the direction in which the section is viewed [see Figure 5 a) and Figure 5 c)] and a capital letter or letters shall be used for the identification of the cutting plane as indicated in ISO 128-3.

Using only one arrow and letter to identify the cutting plane should only be done on simple sections. Large sections and offset sections will usually require the use of two arrows with their accompanying identification letters.

a) The result of the section cut may be shown either by removing material from the part [see Figure 5 b) and Figure 5 d)] or by display of the curves overlaid on the model that result from intersecting the cutting plane with the part [see Figure 5 c)].

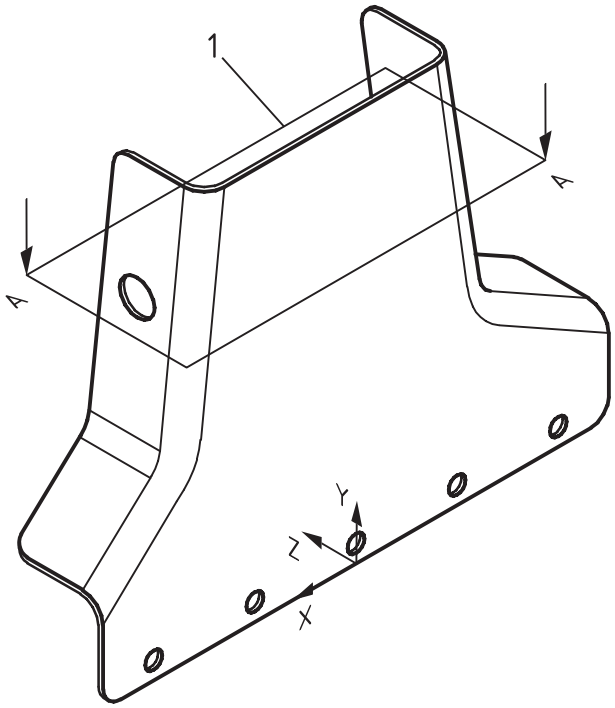
b) Multiple connected cutting planes shall be used for offset sections (see Figure 6).

c) Removed sections and revolved sections, as used in ISO 128-3:2020, 6.3 and D.4, shall not be used on design models.

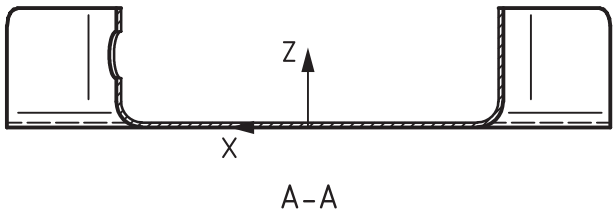
d) Broken-out sections shall be accomplished as offset sections [see 5.6.2 a)].

e) Foreshortened and revolved features shall not be used on design models.

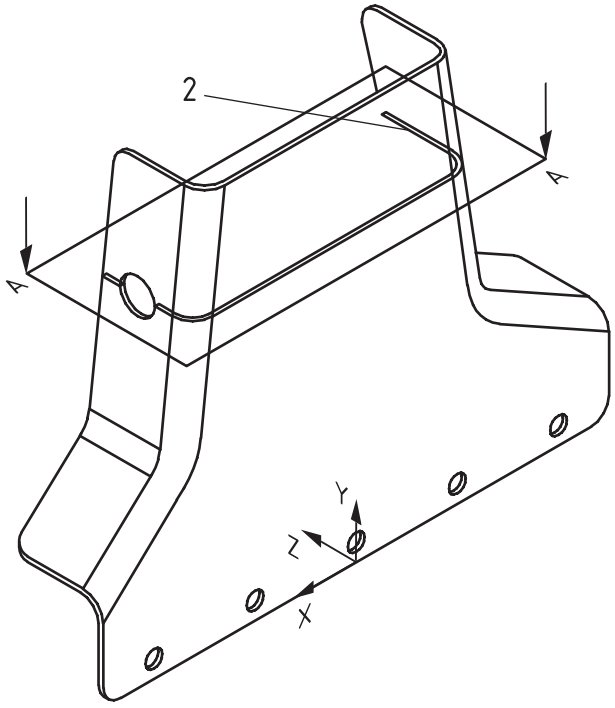
f) Section views shall be derived from the design model. Changes to the design model shall cause section views to be updated accordingly.



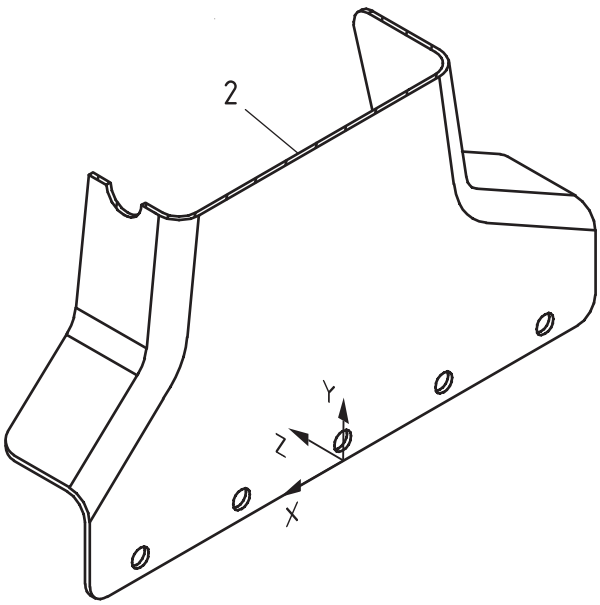
a) Design model cutting plane



b) Resultant section in saved view



c) Resultant section shown on curves on the model



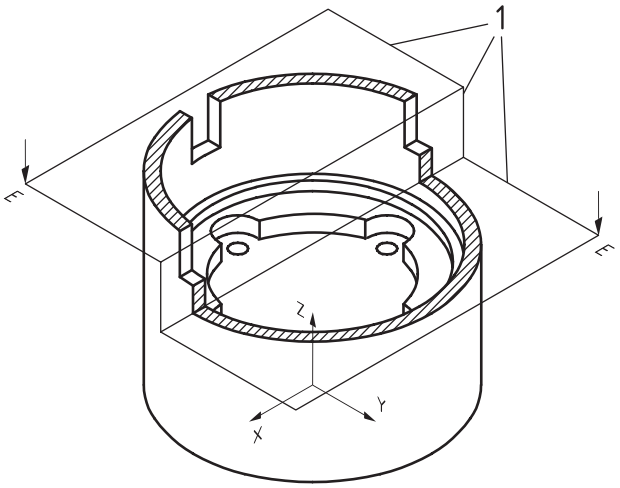
d) Resultant section shown as cutaway

Key

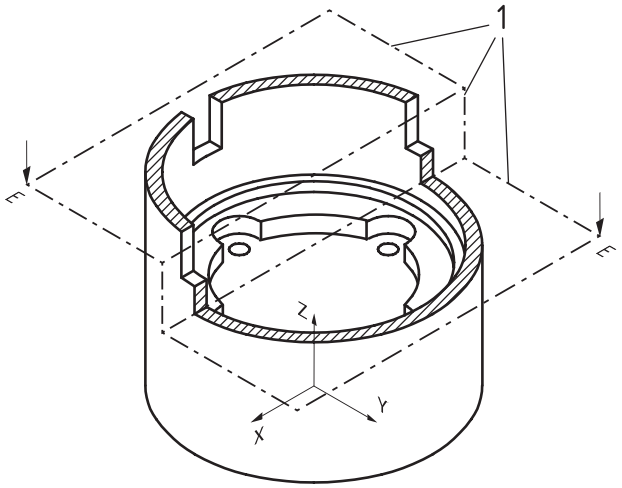
1 query on cutting plane

2 query responses

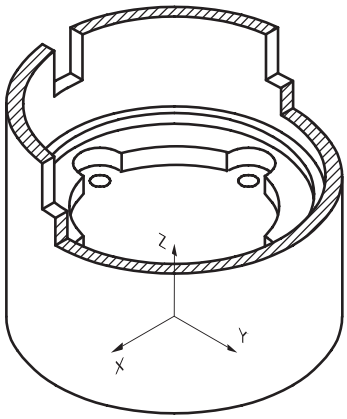
Figure 5 — Design cutting model plane



a) Cutting plane shown as solid continuous line



b) Cutting plane shown as long-dashed dotted narrow lines



c) Section show without cutting planes

Key

1 multiple connected cutting planes

Figure 6 — Design model with offset section

6 Design model requirements

6.1 General

Design models represent a product in ideal geometric form at a specified dimensional condition, for example nominal, minimum, maximum or mean. The condition shall be specified as a general note.

6.2 Geometric scale, units and precision

Design models shall be modelled using a scale of 1:1.

The design model precision indicates the numeric accuracy required in order for it to fulfil the design intent. The number of decimal places of the design model shall be specified in the data set. The number of decimal places required for the design cannot exceed the precision of the design model.

NOTE If the number of decimal places for a model is changed, this can cause dimensional values to change because rounding is applied (see 9.2.2).

6.3 Model completeness

The annotated model shall contain geometry, attributes and annotation as required to provide a complete definition of the part. The annotated model shall be constructed so as to provide a complete definition of the part (geometry, attributes and annotation). The following exceptions are allowed:

— models not fully modelled shall be identified as such, for example a partially modelled symmetrical part;

— features that are not fully modelled, such as threaded holes which are only shown as holes, shall be identified with an annotation similar to what is shown in Figure 7;

— thin parts for which the thickness has not been modelled shall be indicated as shown in Figure 8, using an arrow to indicate material direction in conjunction with the thickness indicator in accordance with ISO 129-1. If the median plane of the geometry has been modelled, opposing arrows can be used. Note that on larger parts arrow indicators can be hard to locate. It is preferable to show the model with its thickness and provide in the general notes the value of the thickness as it is permitted in ISO 129-1.

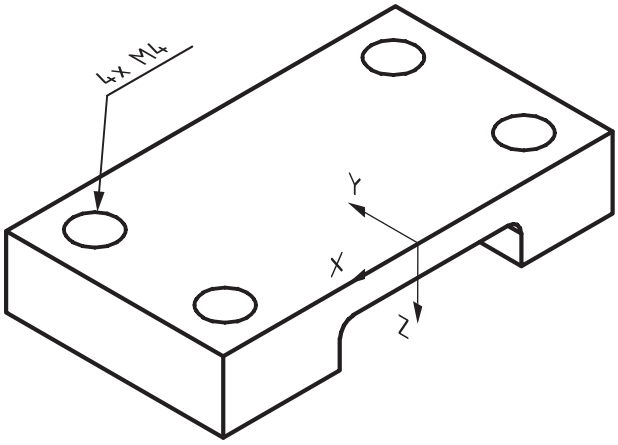


Figure 7 — Threaded holes not fully modelled

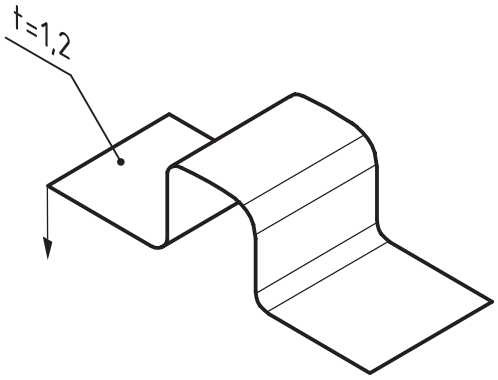


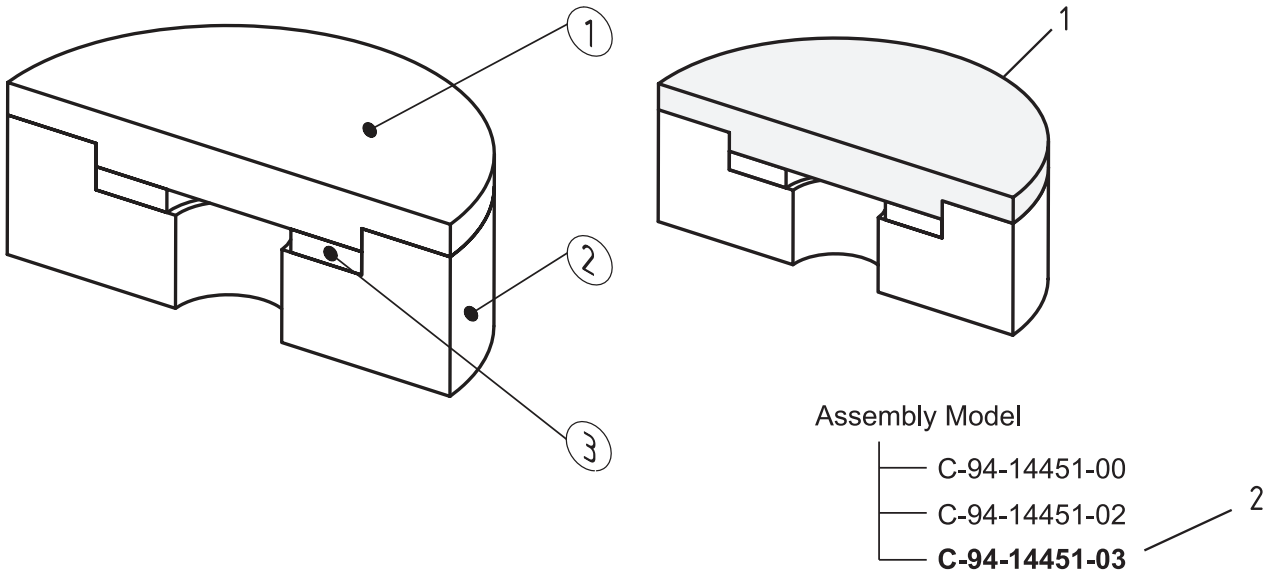
Figure 8 — Thickness indicator for non-modelled thin parts

6.4 Assembly model completeness

Assembly model completeness shall be in accordance with 6.3. Part and sub-assembly models shown in the assembly model need only have sufficient detail shown to ensure correct part identification, orientation and placement. The assembly model can be shown in an exploded, partially assembled or completely assembled state. Location and orientation of parts and assemblies can be shown by geometric definition, annotation or a combination of both.

6.5 Part reference numbers

Part reference numbers may be applied following the rules of ISO 6433. Figure 9 a) shows how to apply ISO 6433 to a 3D model. As an alternative, identifying the part may be shown by querying. The part number may be used instead of the part reference number [see Figure 9 b)].



a) Indirect indication **b) Query of a part reference**

Key

1 query

2 visual response

Figure 9 — Examples of part reference numbers indication

6.6 Identification method

6.6.1 General

The designer shall be responsible for unambiguous visual representation.

If using colour, greyscale, mapping (see 6.6.4), hatching or transparency to clarify a specific location, the meaning of those features shall be clearly described on the drawing or related documentation. For locations that are clearly tied to geometric specifications no further description is necessary.

Examples of when to use colour, greyscale, mapping, hatching or transparency include:

— in cases of indicating an area;

— in cases of identifying nearby parts (see Figure 10);

— in cases of movable areas;

— in cases of describing before and after shape changes;

— in cases of describing before and after processing.

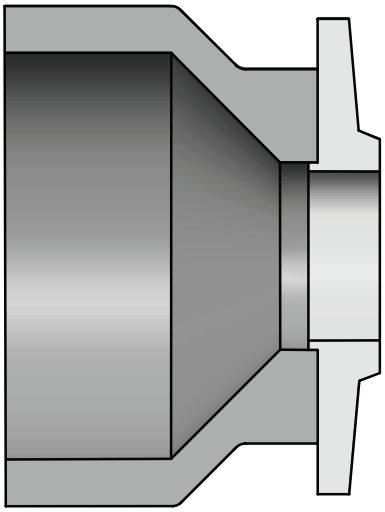


Figure 10 — Example of close proximity of parts

6.6.2 Colour

The colour to use for identification is not prescribed.

6.6.3 Greyscale

If displaying multiple shades of greyscale on a computer monitor, set the gradation so that each greyscale shade is easily identifiable.

6.6.4 Mapping

If showing the characteristics on a design model, such as material, a mapping such as texture mapping may be used.

EXAMPLES Knurling, texture surface, glass, other materials.

6.6.5 Transparency

Transparency may be used in combination with colour, greyscale and mapping.

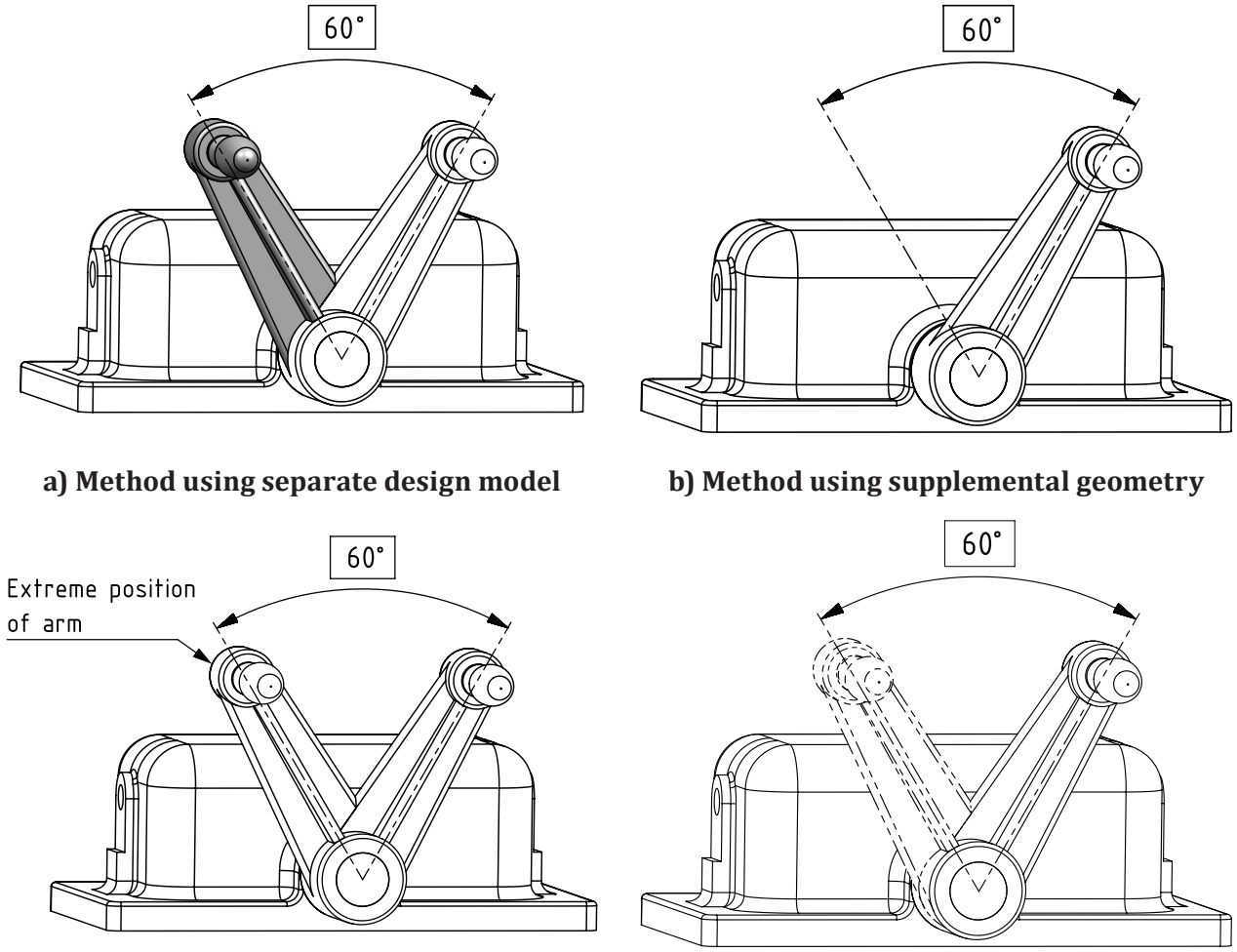
6.7 Installation model completeness

Installation model completeness shall be in accordance with 6.3 and 6.4. Part, subassembly and assembly models shown in the installation model need only be sufficiently detailed to provide installation and space requirements. The maximum envelope for parts and assemblies can be shown using supplemental geometry, annotation or a combination of both. Location and orientation of parts and assemblies can be shown by geometric definition, annotation or a combination of both.

If there is a need to show a movable portion, it should be indicated using one of the following methods:

— Show the movable portion and place it in the specific position [see Figure 11 a) and Figure 11 c)]. It should be clearly identified that this is additional geometry used to indicate movement.

— Use an annotation with supplemental geometry to indicate the movable limit [see Figure 11 b and Figure 11 d)]. It should be clearly identified that this is supplemental geometry use to indicate movement.



a) Method using separate design model

b) Method using supplemental geometry

c) Alternate method using separate design model

d) Alternate method using supplemental geometry

Figure 11 — Movable parts in an installation

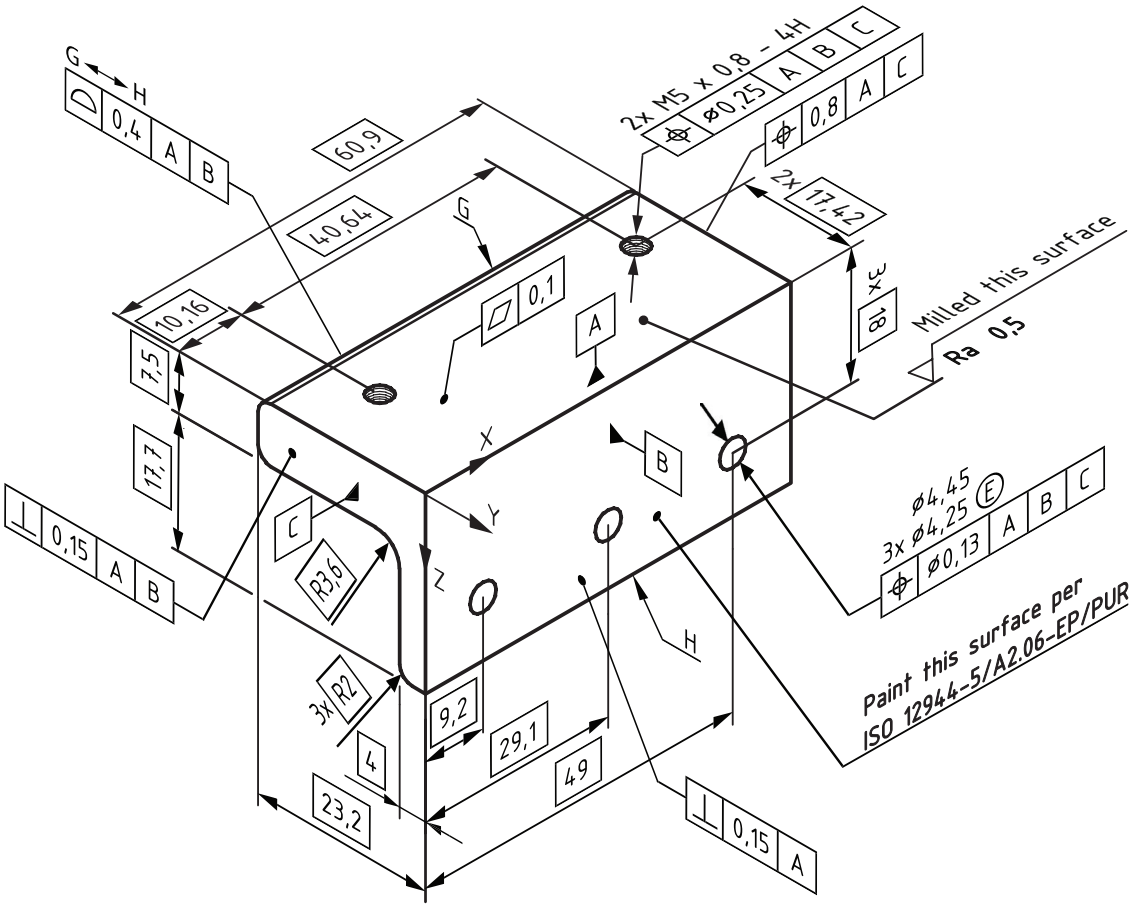
7 Common requirements for product definition data

7.1 General

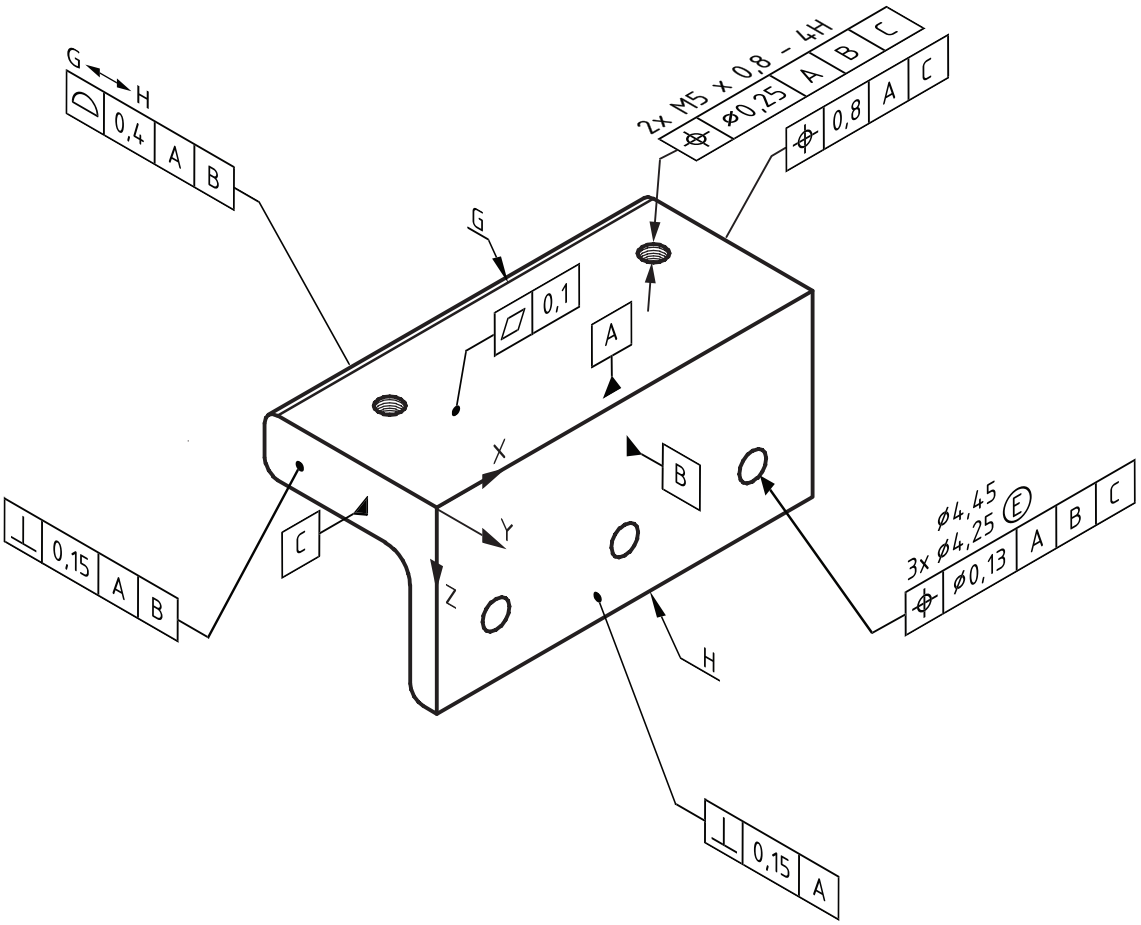
This clause establishes the common requirements for the application, display management and query of product definition data. Specific requirements for particular types of product definition data are given in Clauses 8 to 11.

7.2 Common requirements

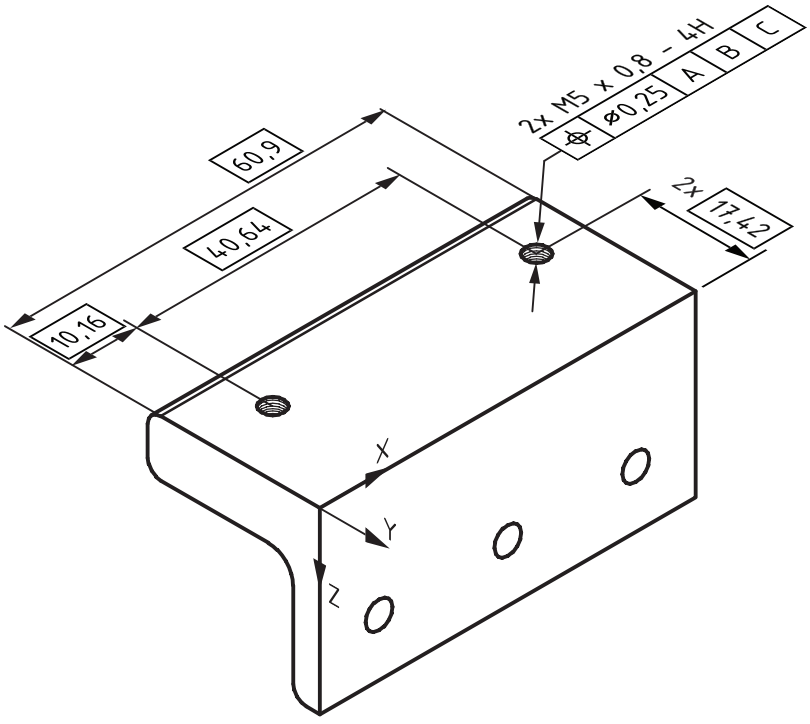
Display management shall include the possibility to enable or disable the display of annotation completely or partially by filtering or selection (see Figure 12).



a) Model with all annotation displayed



b) Model with one filtration of annotation displayed



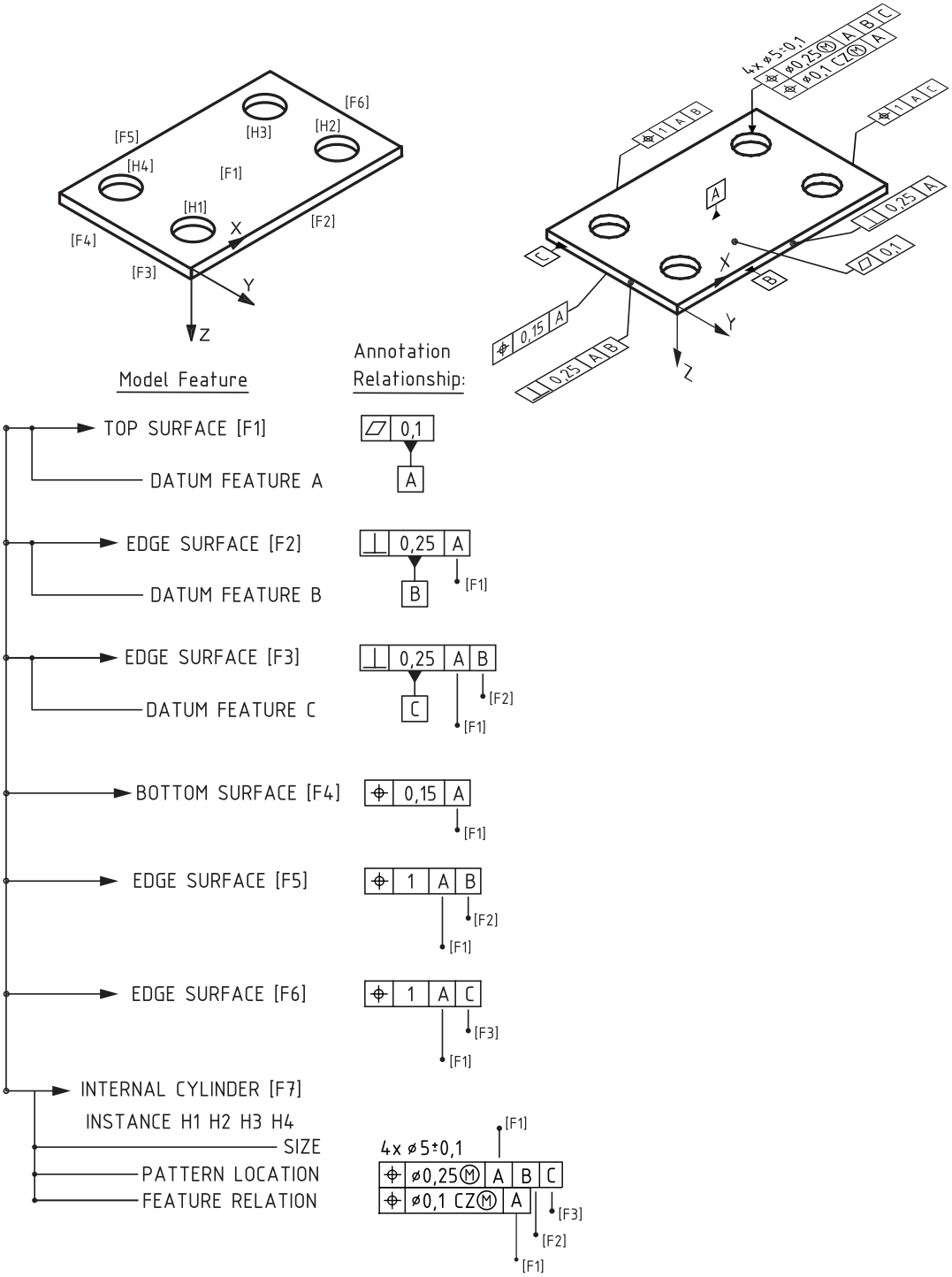
c) Model with selected annotation displayed

Figure 12 — Display management

7.3 Model requirements

7.3.1 General

The following subclauses give requirements for annotation applied to a design model. These are general requirements which apply to all types of annotation. Specific requirements for particular types of annotation are addressed in Clauses 8 to 11. See Figure 13 a) for a diagram showing the relationship between annotation and model feature. Figure 13 b) shows what the annotations view in the model would look like with these relationships applied.



a) Relationship diagram **b) Annotation view in model**

NOTE Numbers in bracket (e.g. [F1], [F3]) are given for the information of the user of this document only, to clarify the meaning and position. They are not included in the annotation within the CAD-system for additional enumeration of features.

Figure 13 — Annotation and model feature relation relationship

7.3.2 Associativity

The following are general provisions for defining an associative relationship between digital elements:

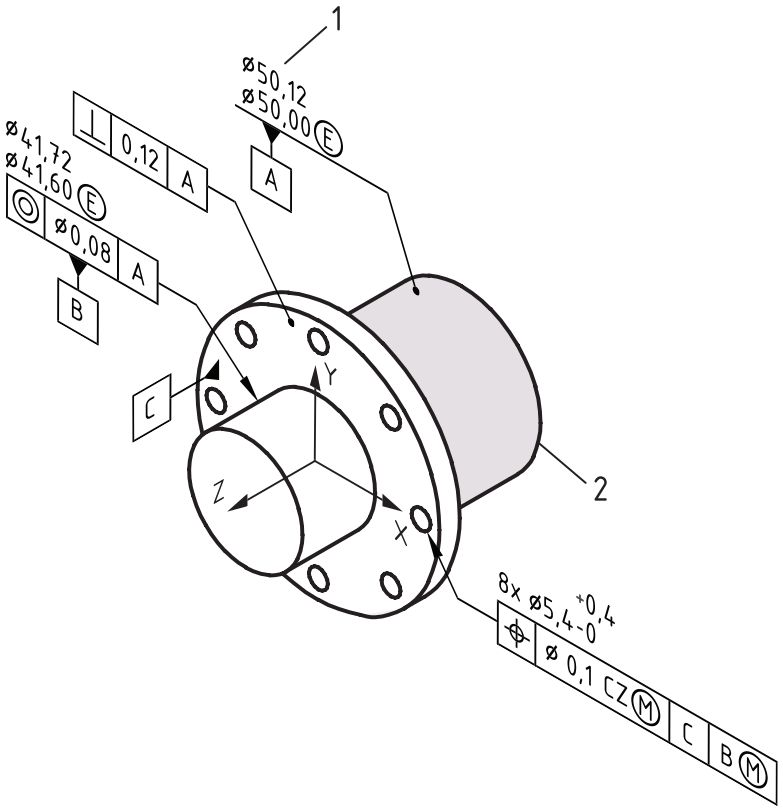
— Annotation can be associated with a model feature, a group of model features or a portion of an applicable model feature. For an example of the associated entities for a dimension, see Figure 14.

— Annotation, model geometry and supplemental geometry can be placed into associated groups to indicate their relationships (see Figure 15).

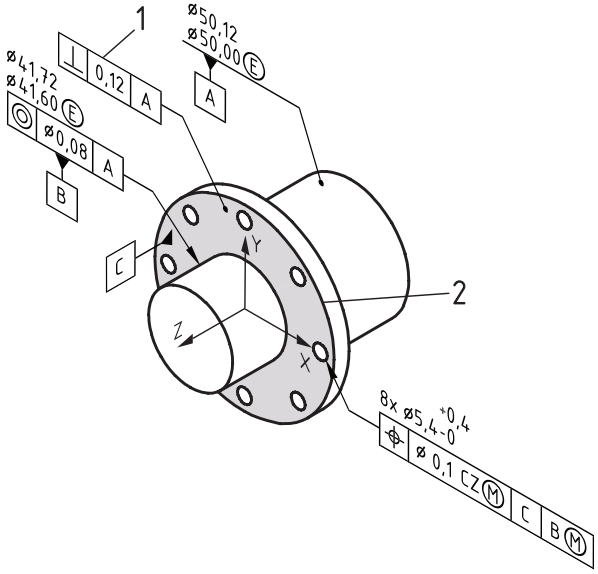
EXAMPLE 1 Supplemental geometry used to define location or further clarify the application of annotation to a model.

EXAMPLE 2 A model coordinate system for datum systems.

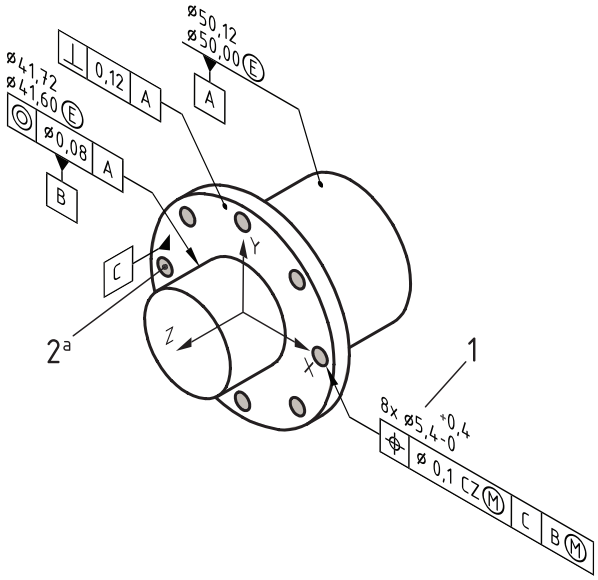
EXAMPLE 3 Other annotation. This can include qualifying notes and size limit indications.



a) Size tolerance query



b) Geometric tolerance query



c) Pattern of features query

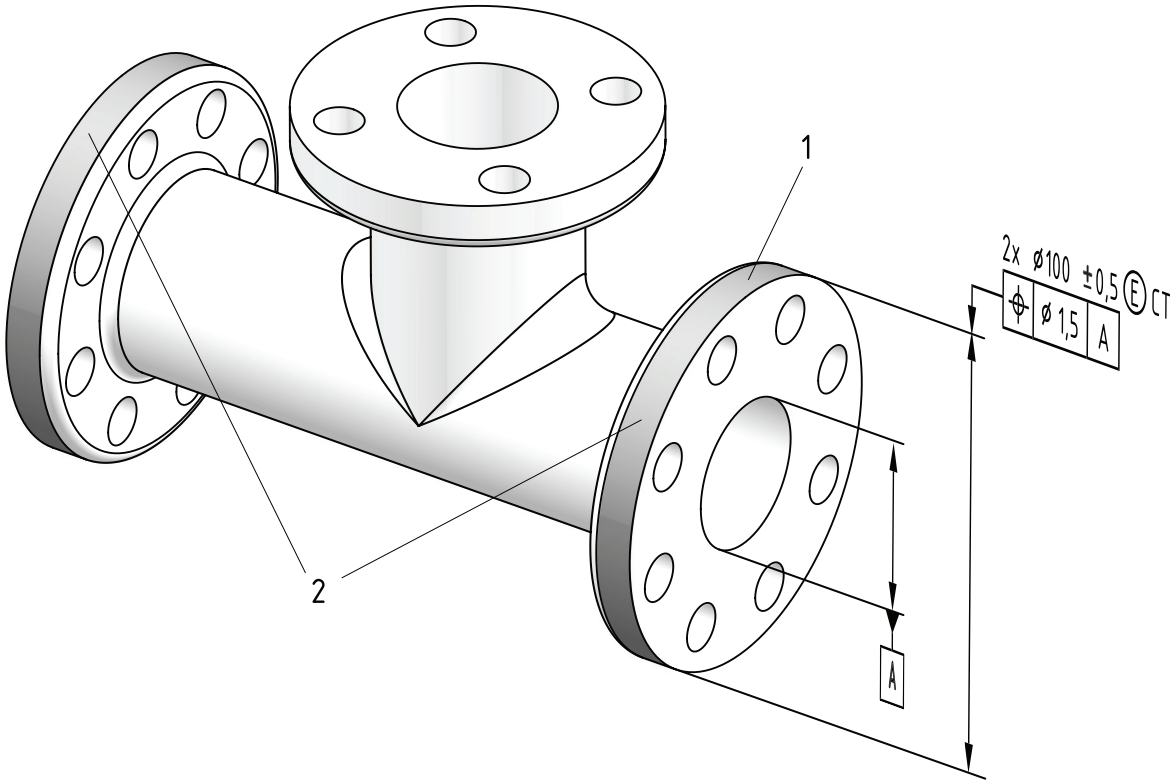
Key

1 query

2 visual response

a All eight associative features.

Figure 14 — Tolerance query associativity



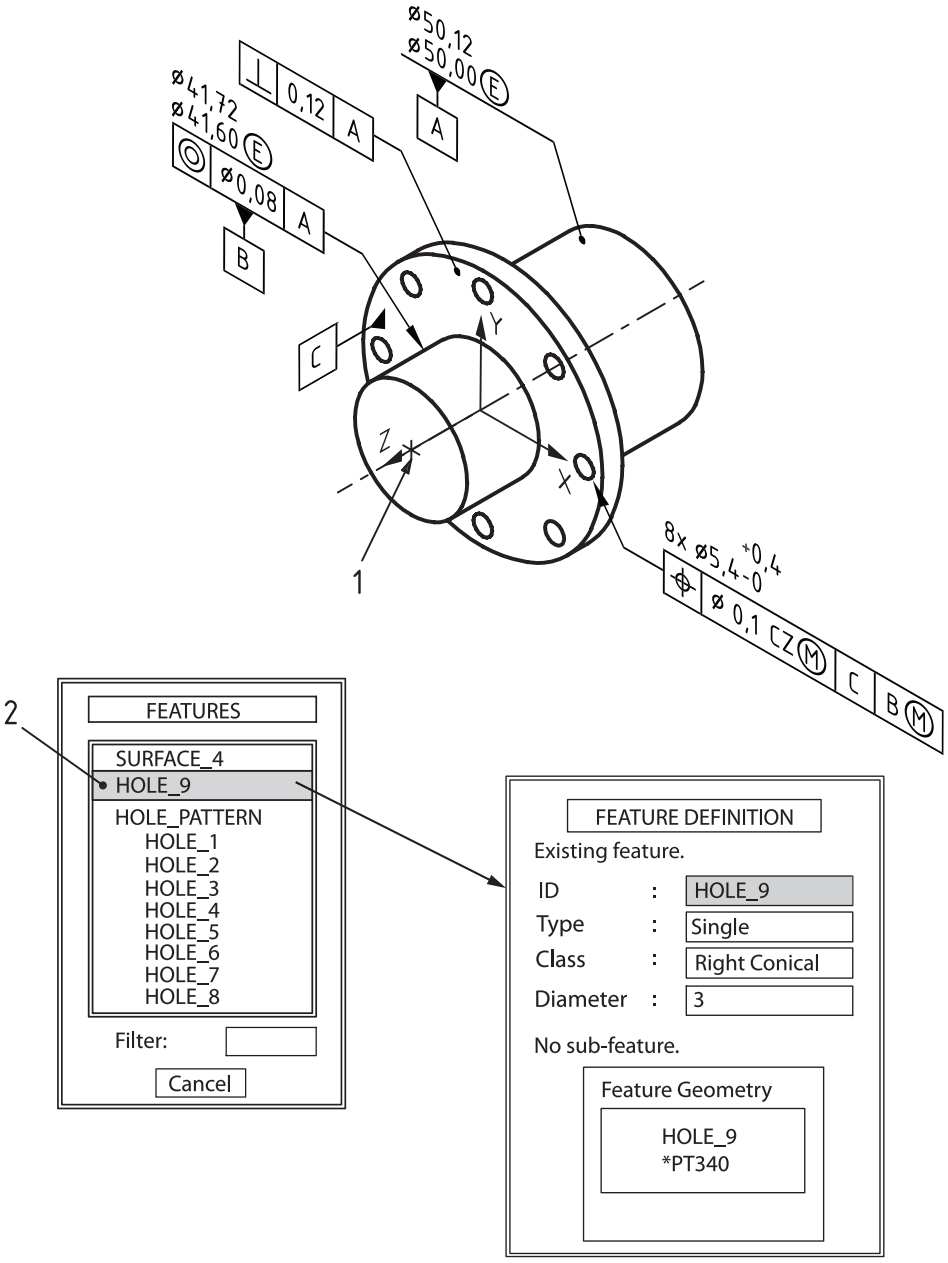
Key

1 query
2 visual response

Figure 15 — Query of associated groups

7.3.3 Attributes

Attributes are used to capture additional information that is not shown using geometry or in the model annotation. Attributes shall be available on demand. Attributes may be presented using text description, forms or other techniques. See Figure 16 for an example of how the attributes of a hole can be represented. Applications of attributes include coatings, knurling, threaded holes and pins.



Key

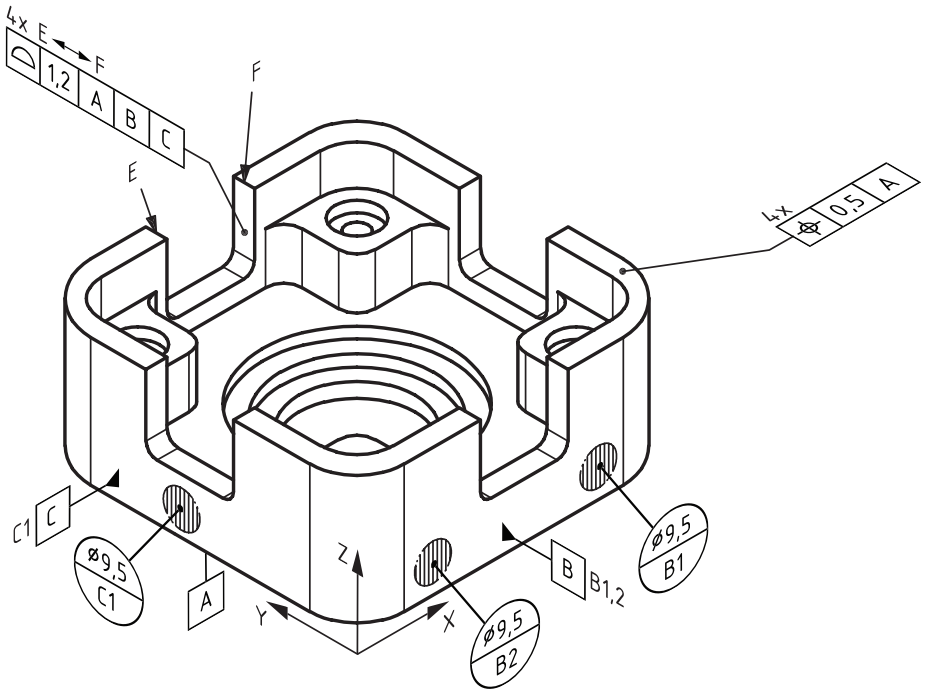
1 query

2 response

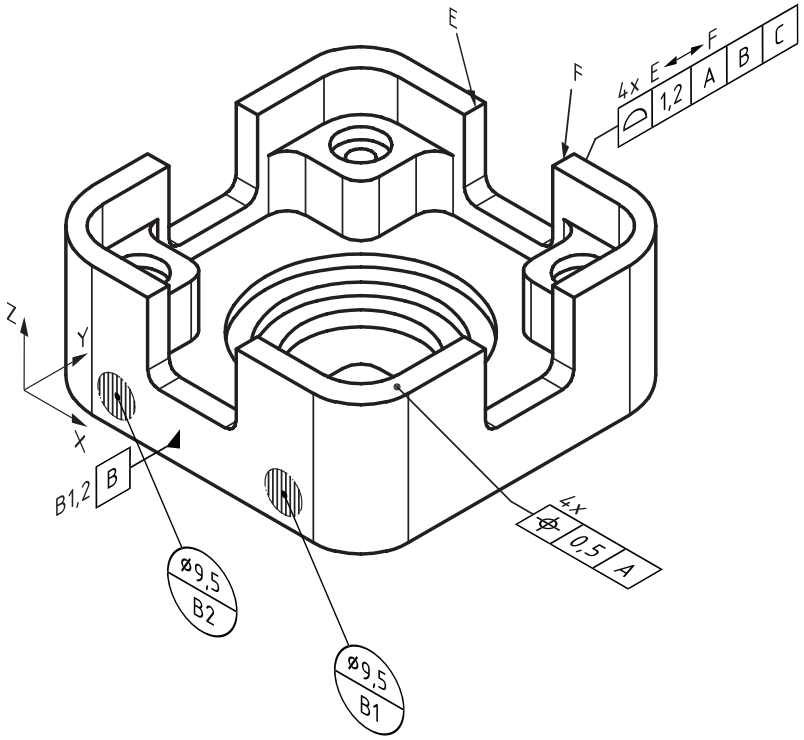
Figure 16 — Simplified feature representation and attributes

7.3.4 Annotation planes

The orientation of the annotation planes shall be maintained relative to the model geometry as the model is manipulated in 3D. For example, as the geometry is rotated, the text rotates correspondingly (see Figure 17).



a) Initial attitude of model geometry and annotation



b) Rotated about the Z axis

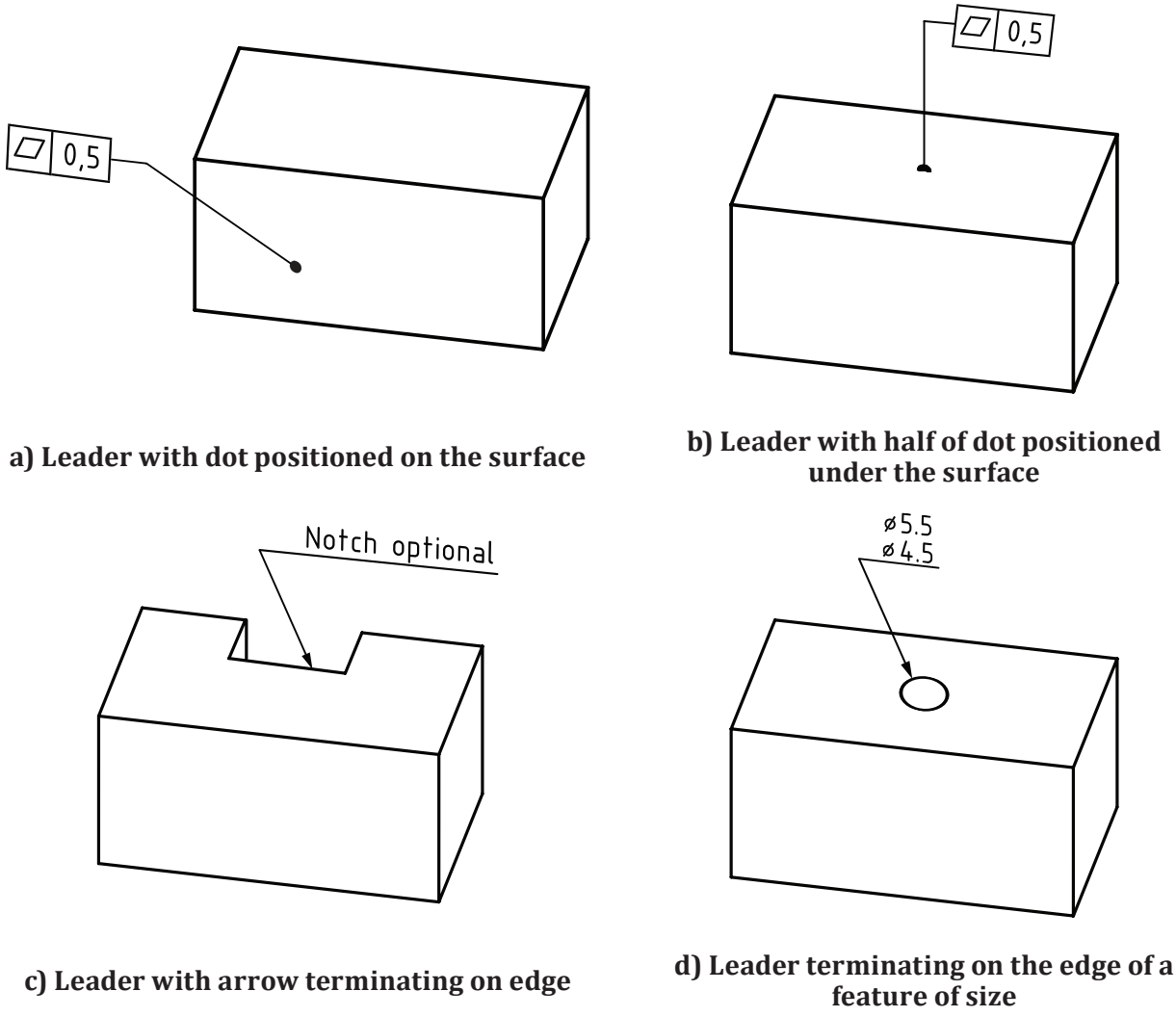
Figure 17 — Part rotated around the Z axis

7.3.5 Leader lines

The rules of leader lines in ISO 129-1 shall apply.

When an indicated element is a surface, the leader line shall terminate with a dot within the bounds of the surface [see Figure 18 a)]. It is acceptable for the dot to be hidden partially under the surface of the model [see Figure 18 b)]. Depending on the direction of perspective for the saved view, it is possible that the dot will not look like a complete sphere.

Leader lines may terminate on the rim or edge of a feature of size when doing so provides a clearer understanding of the intention of the annotation [see Figure 18 c) and Figure 18 d)]. A continuous leader line shall be used to indicate all datum targets in a design model. Leader lines shall be directed to an entity.



a) Leader with dot positioned on the surface

b) Leader with half of dot positioned under the surface

c) Leader with arrow terminating on edge

d) Leader terminating on the edge of a feature of size

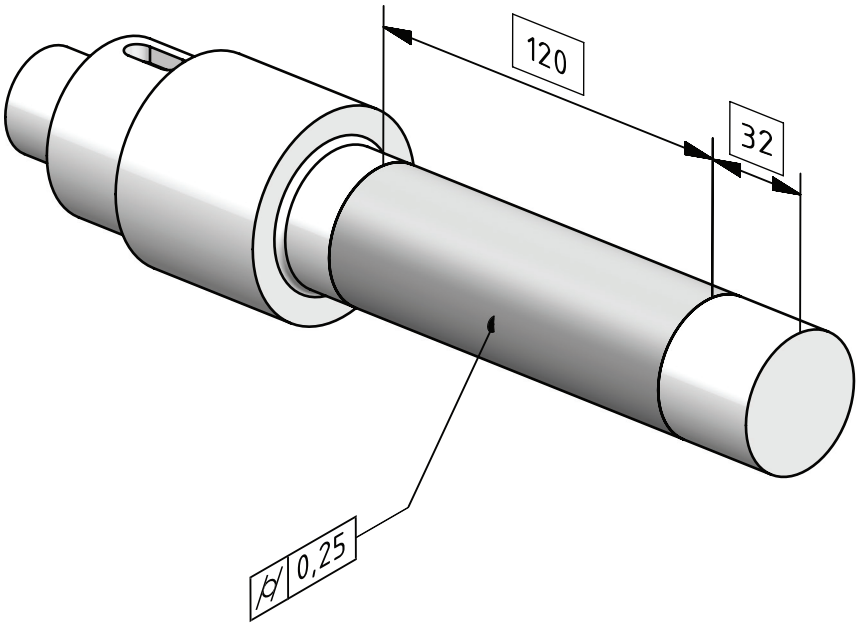
Figure 18 — Leader line application

7.3.6 Direction-dependent specifications

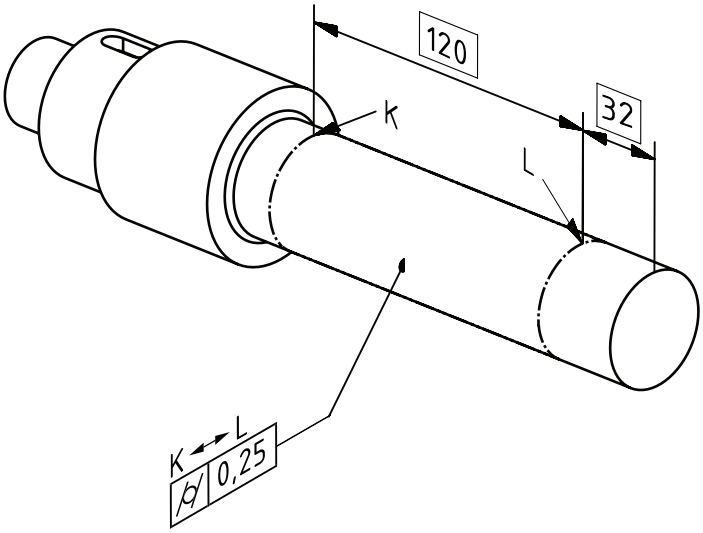
When a direction-dependent specification (e.g. straightness) is applied to a design model, the direction shall be explicitly defined in accordance with ISO 1101 and other ISO GPS standards.

7.3.7 Indicating of restricted area

The applications for restricted areas in International Standards may be applied. Limited length, area and location indicators may include supplemental geometry and associative annotation such as highlighting [see Figure 19 a)]. When supplemental geometry is used, it shall be located on the model geometry [see Figure 19 b)].



a) Using shading to show associativity



b) Using supplemental geometry

Figure 19 — Indication of a portion of the model feature

7.3.8 Query types

Regardless of whether the geometry or the annotation is selected, the relationship between model feature and its annotation shall be maintained, including the following:

— Graphic display of associated model features: the associated model features for a piece of annotation shall be highlighted or otherwise distinguished from other model features on the display, on demand (see Figure 14 and Figure 44).

— Graphic display of associated annotation: all annotations associated with selected geometry or model features shall be highlighted or otherwise distinguished from other annotations, on demand (see Figure 20).

The model shall contain at least the information sufficient to satisfy the following query types:

a) Model values.

b) Digital element identifiers (see Figure 21).

c) Model geometry and model features.

   — Model features shall be identifiable by selecting a geometric element of the model feature.

   — All geometric elements in an associated group of model features shall be identifiable by selecting any geometric element within the group.

   — All model features in a group of model features shall be identifiable by selecting one of the model features.

d) Tolerance indicators, datum target indicators and datum feature indicators.

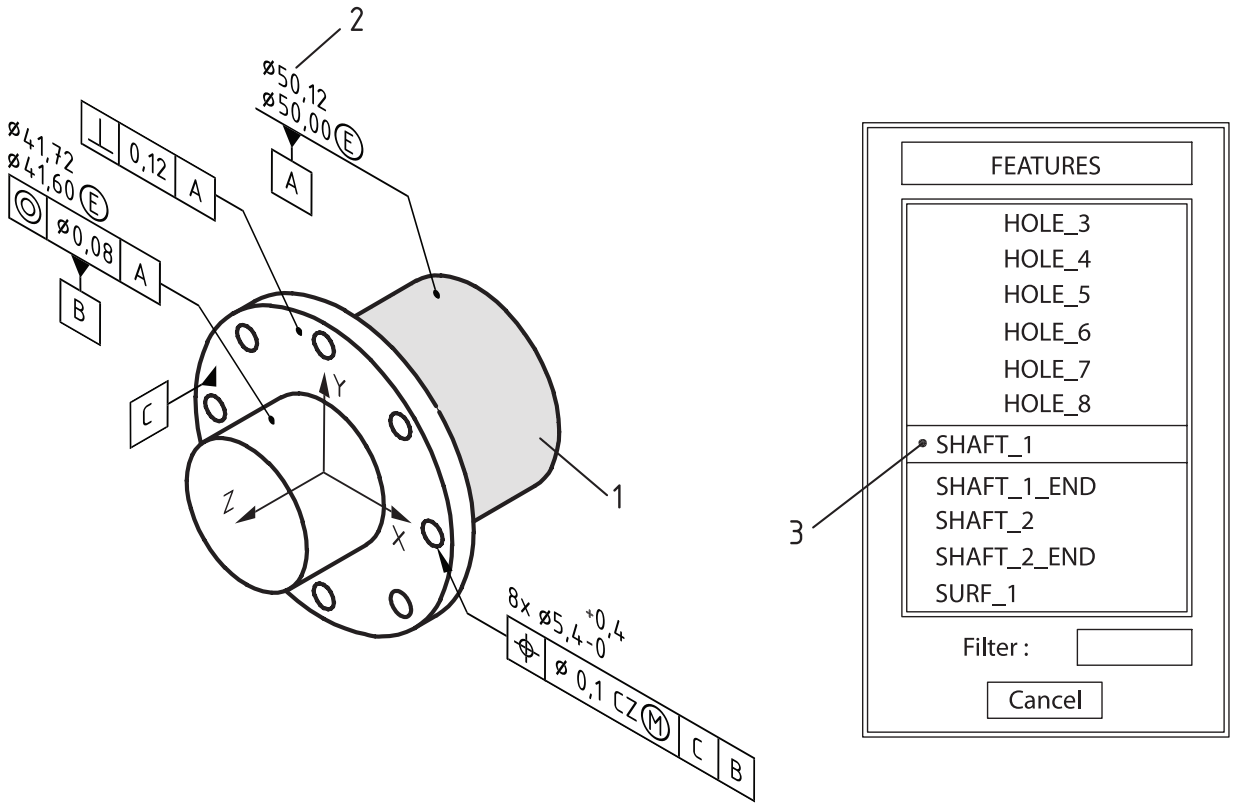
   — Upon selection of a tolerance indicator, the datum feature indicators and datum target indicators that correspond to the datum references shall be highlighted or otherwise distinguished from other datum feature indicators and datum target indicators on the display (see Figure 22).

   — Upon selection of a datum target indicator, all datum target indicators sharing the same letter and the datum feature indicator shall be highlighted or otherwise distinguished from other datum feature indicators and datum target indicators on the display (see Figure 23).

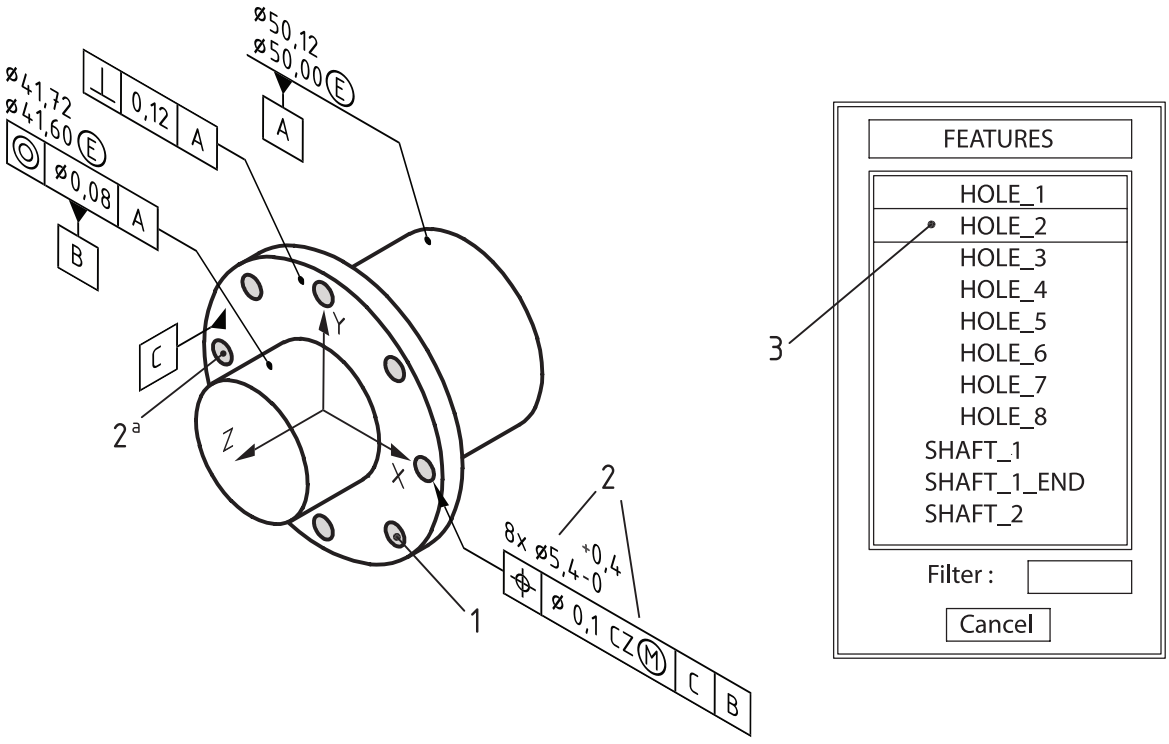
   — Upon selection of a datum feature indicator, the datum target indicators which have the same datum letter shall be highlighted or otherwise distinguished from other entities on the display (see Figure 24).

e) Supplemental geometry used in the definition of annotations, appropriately highlighted or otherwise distinguished from other entities on the display.

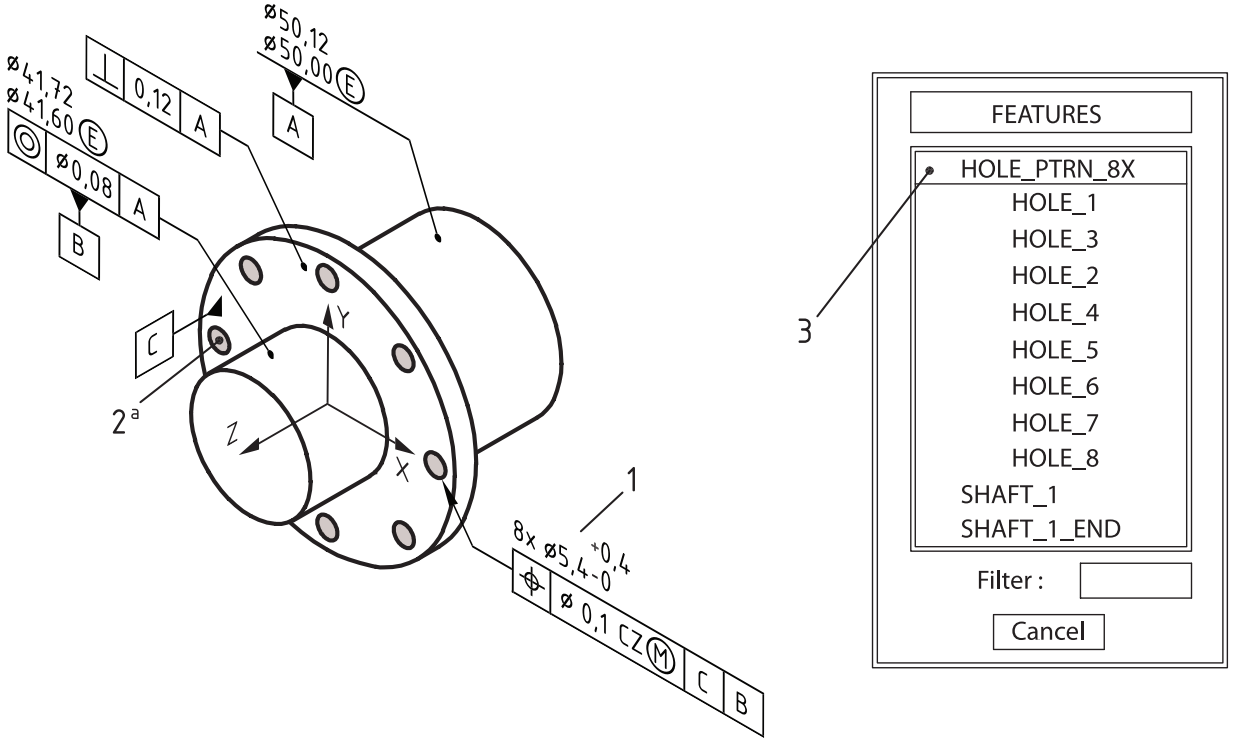
f) Identification of all elements of an associated group, appropriately highlighted or otherwise distinguished from other entities on the display, through the selection of any one element.



a) Individual feature



b) One feature of a pattern



c) Pattern of features

Key

1 query
2 visual response
3 feature name
a All eight associative features.

Figure 20 — Graphic display of associated annotation

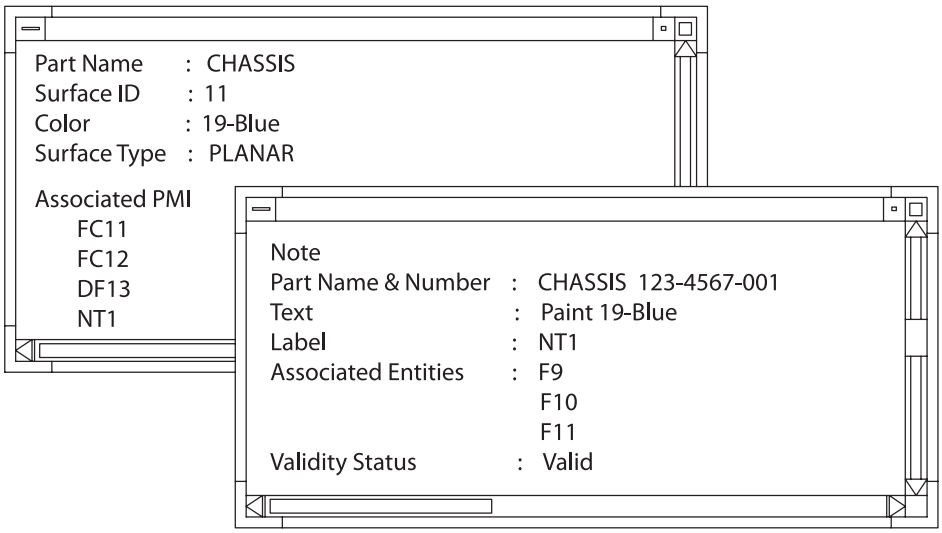
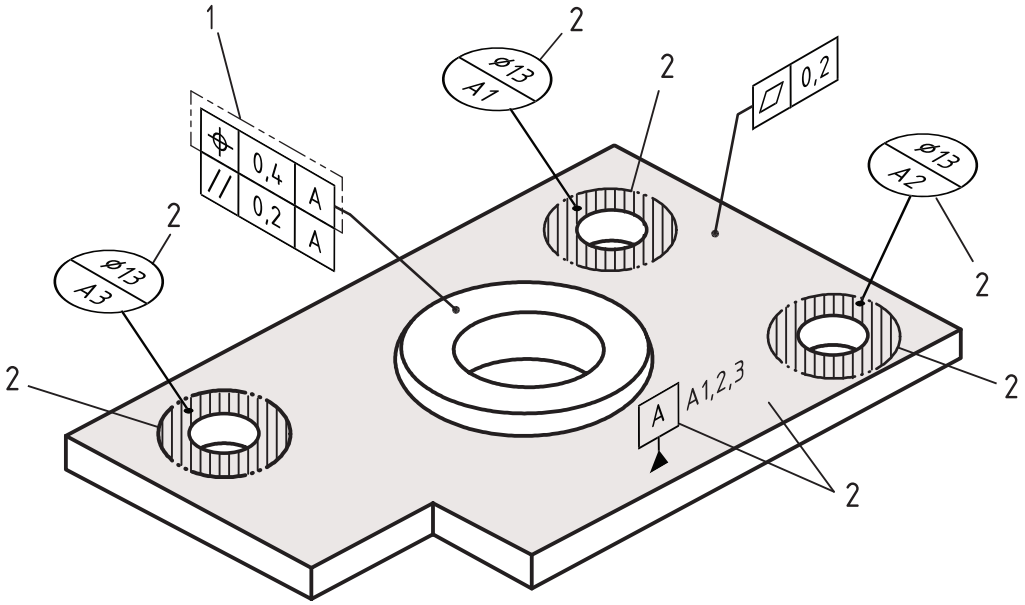


Figure 21 — Listing of digital element identifiers

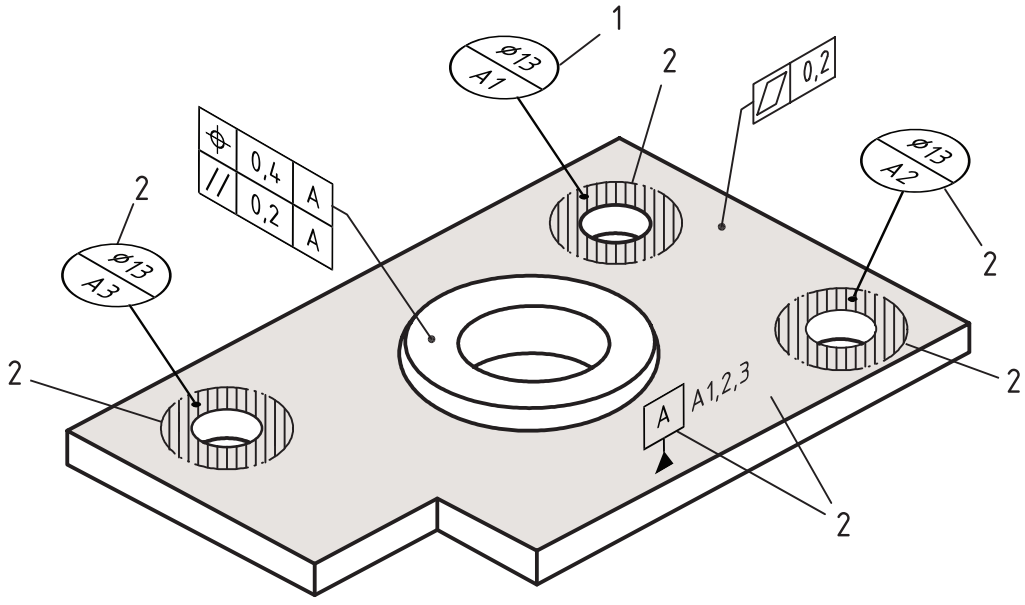


Key

1 query

2 visual response

Figure 22 — Queries of datum feature indicators and datum target indicators

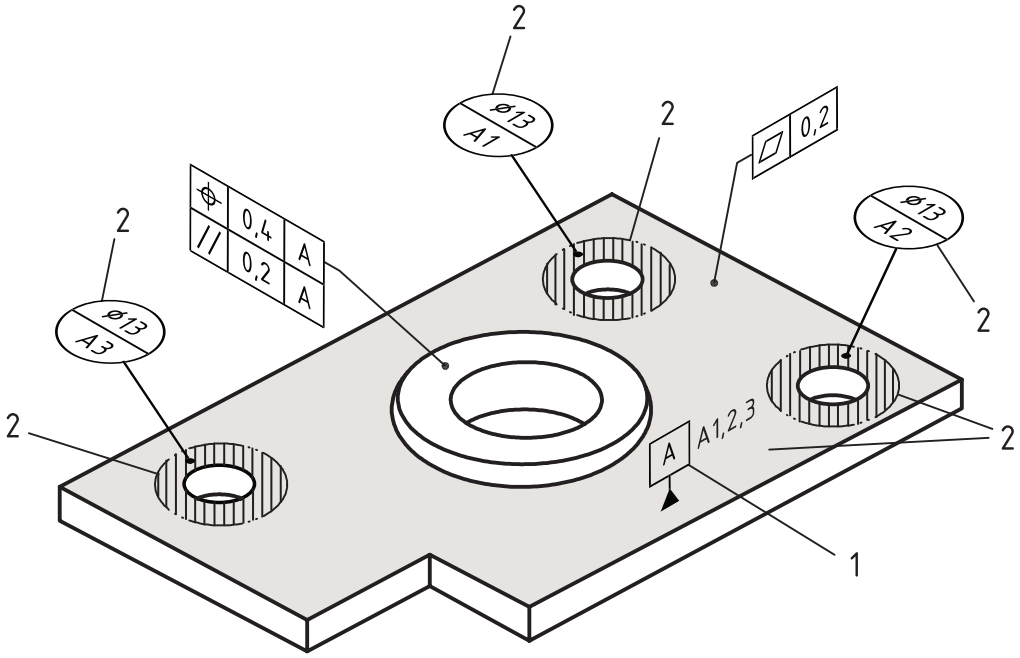


Key

1 query

2 visual response

Figure 23 — Queries for datum targets



Key

1 query

2 visual response

Figure 24 — Queries for datum feature indicators

7.4 Drawing requirements

7.4.1 General

See ISO 128-3 for sections and views. The following subclauses describe exceptions or additions for views on drawings. The following subclauses also describe general requirements for axonometric views on fully or partially defined drawings. Specific requirements for particular types of annotation are addressed in Clauses 8 to 11. The relationship between a model and a drawing is illustrated in Figure 25 and Figure 26.

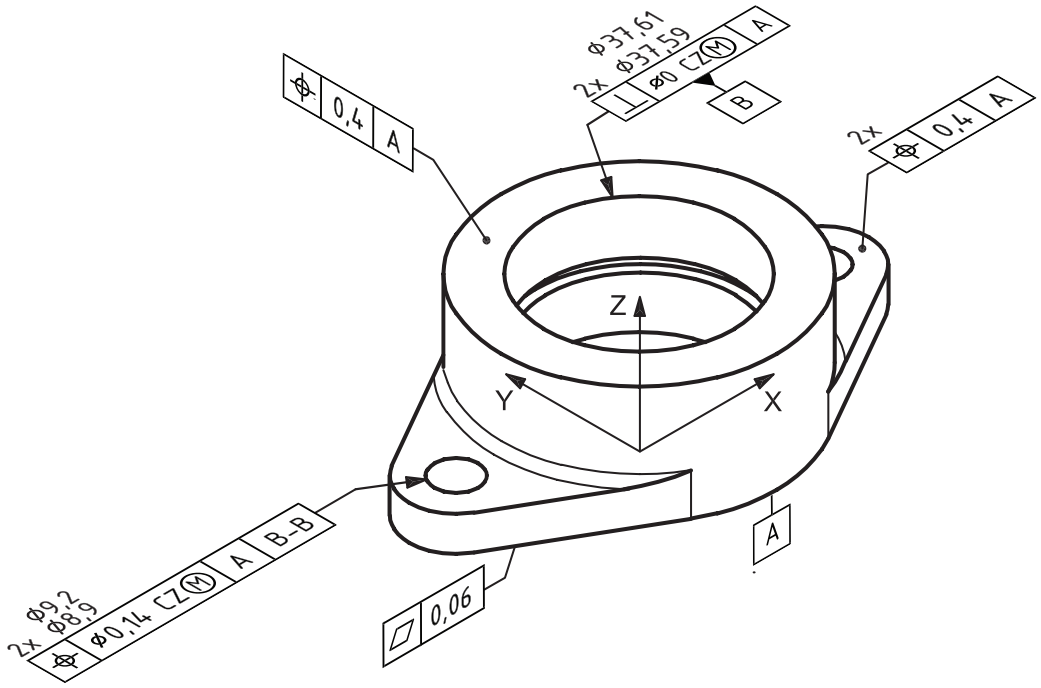
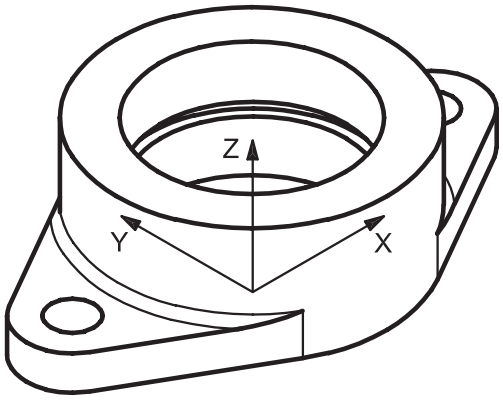


Figure 25 — Annotated model



Design model 123-4567

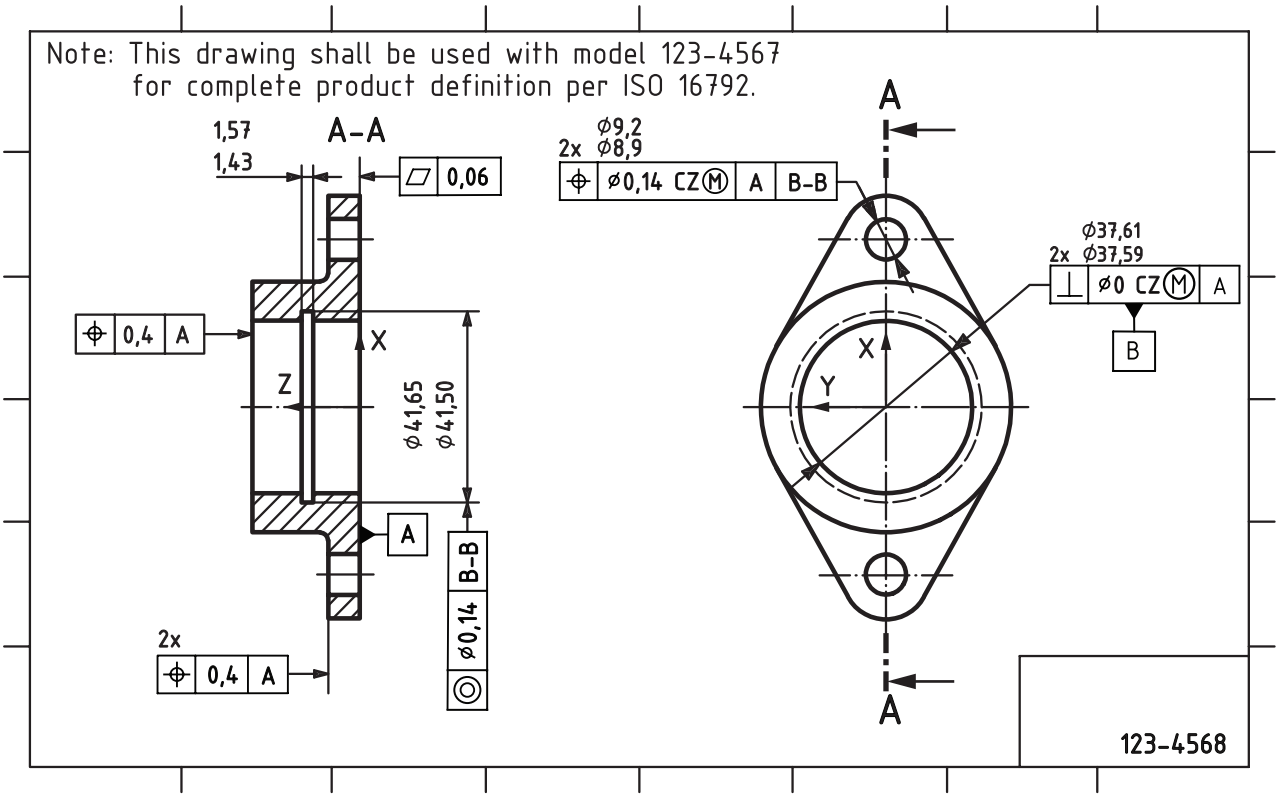


Figure 26 — Design model and drawing

7.4.2 Orthographic views

When orthographic views are used, a model coordinate system may be used to indicate view orientation.

7.4.3 Axonometric views

It is recommended that a model coordinate system be included in each axonometric view to indicate orientation of the view [see Figure 27 a)].

Section views may be created from axonometric views. A section view can be orthographic or axonometric.

For axonometric section views the following shall be applied:

— A representation of a cutting plane shall be used to indicate the location and viewing direction of a section. The edges of the cutting plane shall be continuous or long-dashed dotted lines. A visible viewing arrow or arrows shall be included to show the direction in which the section is viewed [see Figure 27 a), Figure 27 b) and Figure 27 c)]. The cutting plane and the cuts and sections shall be indicated in accordance with ISO 128-3.

— The result of the section cut can be shown either by removing material from the part [see Figure 27 a) and Figure 27 b)] or by display of the curves overlaid on the view that result from intersecting the cutting plane with the part [see Figure 27 c)].

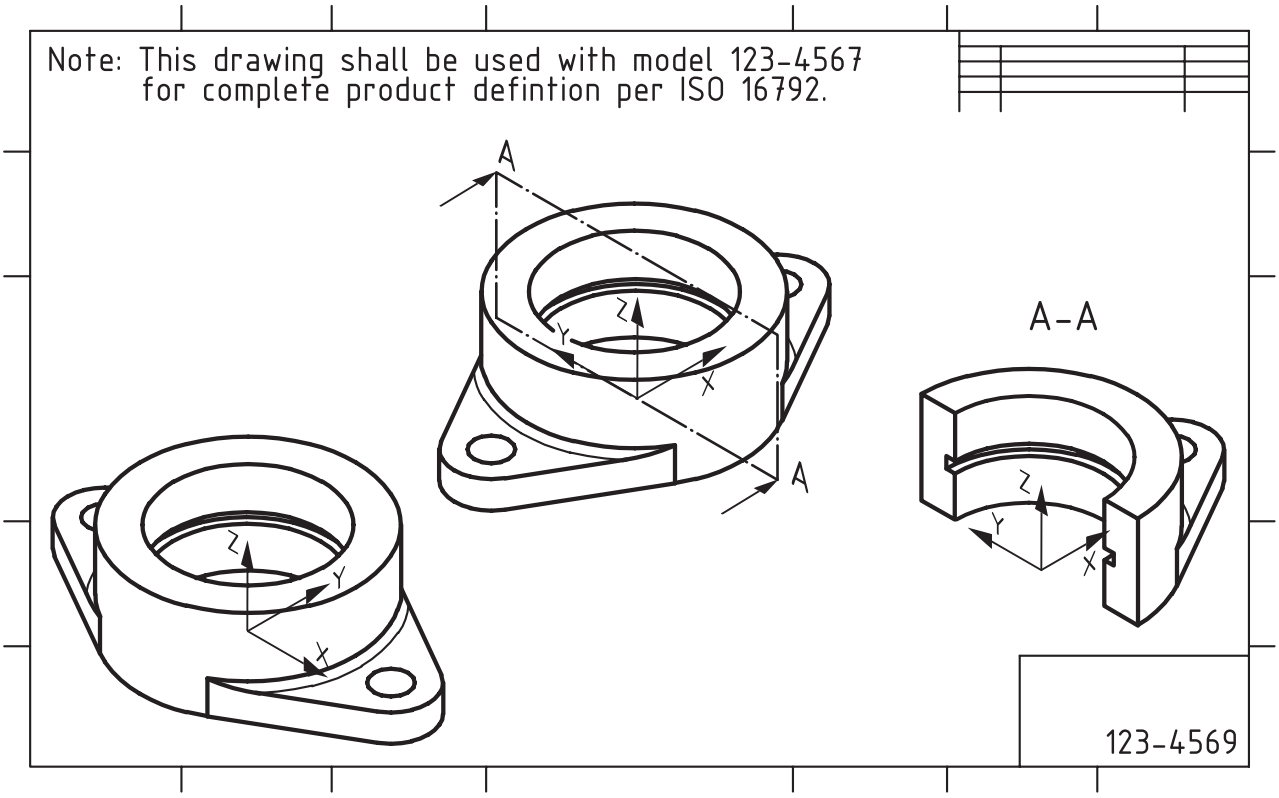
— Sections taken from axonometric views can be presented in the same orientation as the parent view or rotated to present the section in the viewing plane of the drawing.

— The use of a stepped or offset cutting line is supported in axonometric views. The resulting section cut geometry can be shown in its true position on the design model or drawn as if the offsets were in one plane.

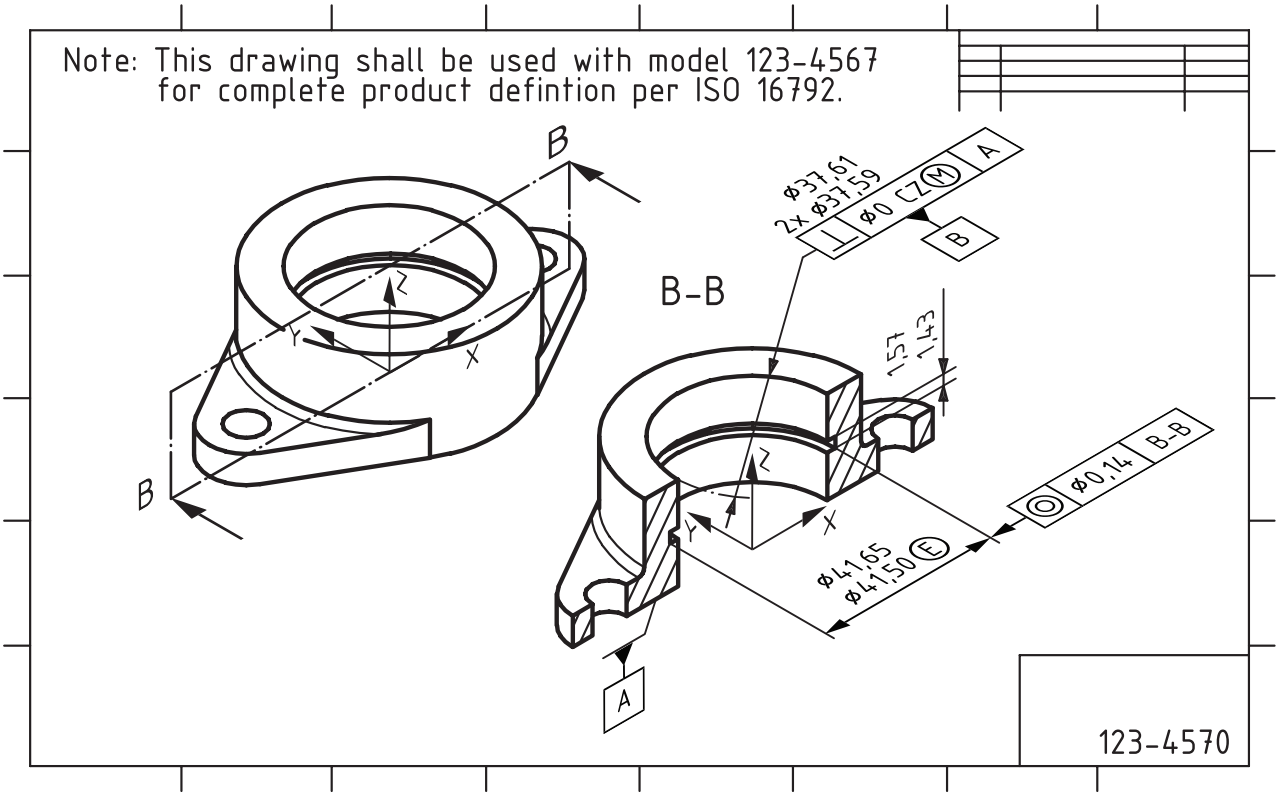
— The use of a cutting plane line containing angular changes is supported in axonometric views. The resulting section can show all features in their true position on the design model or be drawn as if the bent cutting plane and features were rotated into a plane perpendicular to the line of sight of the sectional view.

— Features can be shown in their actual position, without foreshortening or alignment, when the section is made from an axonometric view.

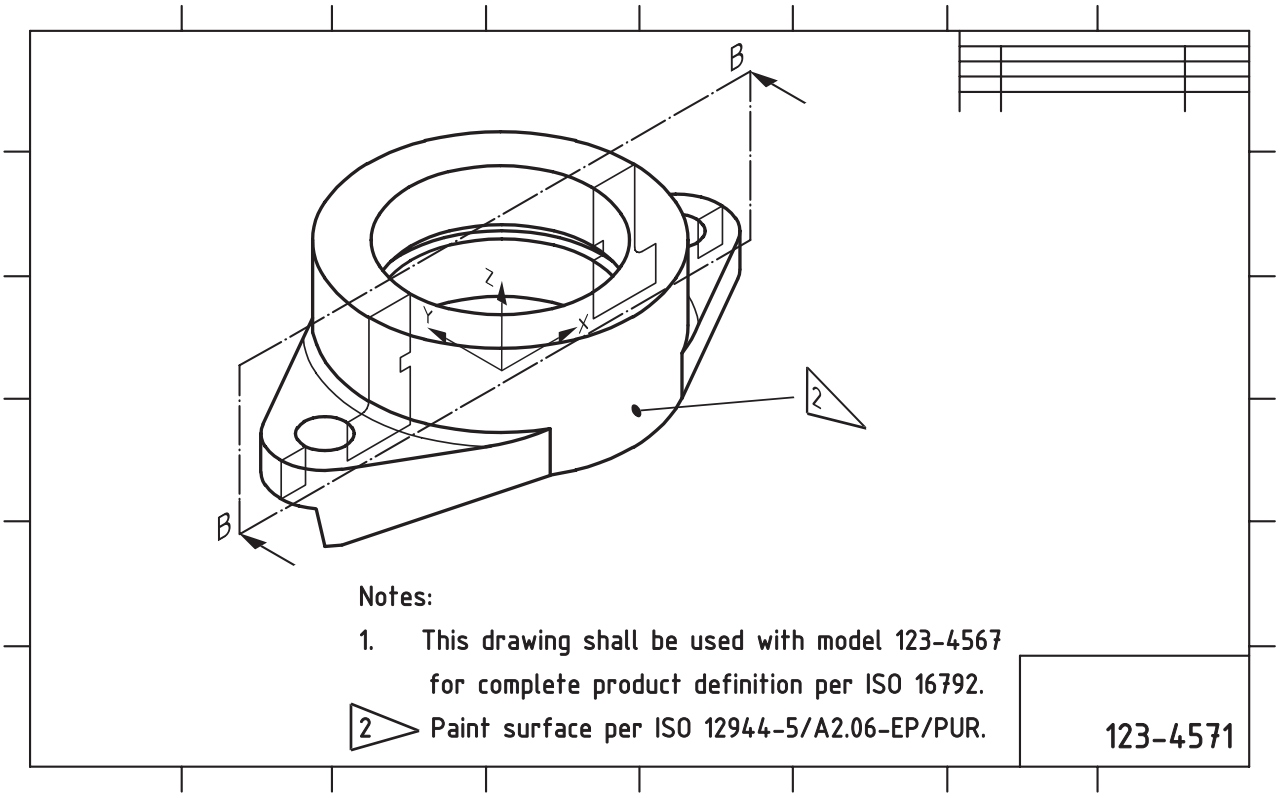
— Features can be shown in their actual location when shown in a section view cut from an axonometric view.



a) Drawing with axonometric view



b) Axonometric section view



c) Section curves and flag notes shown in an axonometric view

Figure 27 — Axonometric views

8 Notes and special notations

8.1 Common requirements

There are no common requirements for notes and special notations.

8.2 Model requirements

When general notes, flagnotes and special notations (see ISO 129-1) are placed in a model, they shall be placed on a single annotation plane that does not rotate with the model. This annotation plane shall be available for display with the annotated model.

General notes can include general tolerance(s) for the entire model. Local notes shall be associative to the applicable digital elements in the model. When a flagnote is placed in a model, the following shall apply:

— the flagnote symbol and text shall be placed on the notes area annotation plane;

— the flagnote symbol and text shall be associative to the digital elements to which it applies;

— the flagnote symbol shall be shown adjacent to the applicable digital elements in the model;

— the flagnote symbol shown adjacent to the digital elements in the model shall rotate with the model.

When special notations are placed in a model, the following shall apply:

— When the special notations are applicable to the entire model, the notation shall be placed on the notes area annotation plane.

— When the special notations are applicable only to a portion of a model, the special notations symbol and its associated text shall be placed on the notes area annotation plane in accordance with 8.2. The special notations symbol shall be shown adjacent to the applicable digital elements in the model. The special notation symbol shall be associative to the digital elements to which it applies.

The use of flag notes and special notation symbols on classification 5 data sets is not practical and the use of local notes is recommended instead.

8.3 Drawing requirements

For drawing axonometric views, the 2D rules of ISO 129-1 apply. See Figure 27.

9 Model values and dimensions

9.1 General

This clause establishes the requirements for the data set with respect to model value query, resolved theoretically exact dimensions (TEDs) as well as size and geometrical specifications. This clause also defines the common requirements for associativity on a model or drawing.

9.2 Common requirements

9.2.1 Model value queries

The following model value queries shall always be conducted in relation to the absolute or a user-defined model coordinate system of the design model:

— determination of location and orientation of surfaces;

— determination of distance or angle between two surfaces;

— determination of relations of features within a pattern or a group.

Direct query of the model surface or model feature of size is conducted for:

— determining the shape (curvature) of surfaces;

— determining the size value for a feature of size or a pattern of features of size.

9.2.2 Resolved dimensions

Dimensions displayed on a model are resolved dimensions. The requirements for resolved dimensions are as follows:

a) To obtain a resolved dimension, a model value shall be rounded to the number of decimal places specified in the design model precision. A general statement on decimal places may be given for the entire data set or may be controlled for specific dimensions. All resolved dimensions shall be displayed as values in accordance with ISO 129-1 and ISO 8015.

b) Rounding shall be in accordance with ISO 80000-1 method A or method B. The method used shall be stated in the data set.

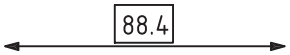
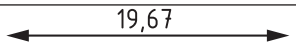
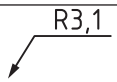
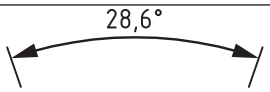
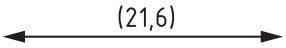
c) Resolved dimension preservation and association: a direct and permanent association to the originating model value shall be established and maintained for every resolved dimension.

d) Utilization of model or resolved dimensions: the use of model values or resolved dimensions for analyses and other processes shall be defined in appropriate documentation.

The values obtained from a digital nominal geometrical model can only be an approximation of the true nominal value, due to technical boundaries in digital modelling (numerical approximation).

Resolved dimensions may be used as TEDs. As resolved dimensions are rounded from the actual model values, the rounding can affect the outcome of the design process and downstream processes, e.g. manufacturing and verification. For examples of resolving model values to displayed dimensions, see Table 1.

Table 1 — Resolved dimension examples

Topic	ISO 16792		
	Model value[a]	Resolved model value[a]	Application example
Linear theoretically exact dimension (linear TED) (ISO 1101)	88,410 000 0...	88,4	
Angular theoretically exact dimension (angular TED) (ISO 1101)	28,591 827 3...	28,592	
Size (ISO 14405-1)	7,000 000 0...	7	
Linear distance	19,666 666 6...	19,67	
Radial distance (ISO 14405-2)	3,140 000 0...	3,1	
Angular dimension	28,591 827 3...	28,6	
Auxiliary dimension (ISO 129-1)	21,601 804 3...	21,6	

[a] The values shown are examples. Actual values reflect the defined precision of the model and the rounding requirements of each particular application as determined by the requirements in the data set. Refer to the decimal principle in ISO 8015.

9.3 Model requirements

9.3.1 General

Requirements for attaching and displaying TEDs, size values and plus and minus tolerances on a model are defined in the following subclauses.

9.3.2 Theoretically exact dimensions (TEDs)

When using geometrical specification to constrain a feature, TEDs, when needed, may be queried from the 3D model or explicitly displayed as annotations. Displayed TEDs shall be enclosed in a frame in accordance with ISO 1101 and ISO 129-1.

When applicable, the following rules apply:

a) Querying of the model for the profile, location and orientation of a feature shall occur within the model coordinate system associated with the datum indication (see 9.2 and 10.2.1).

b) The display of TEDs may be mandatory in defining some model relationships. For example, two features that can appear to be at an angle of 90° to each other but for which the actual model angle is something else.

c) TEDs defining surface curvature or extent, such as fillets, rounds or chamfers, shall be directed to the model feature surface by a leader line in accordance with ISO 129-1 (see Figure 28).

d) Explicitly displayed TEDs defining linear distance or angular relation shall be shown using dimension and extension lines in accordance with ISO 129-1 (see Figure 28).

When applicable, TEDs may be placed in annotation planes that are parallel with one of the planes of the absolute or a user-defined coordinate system. Examples of exceptions are the 6,35 and 19,05 TEDs shown in Figure 28, which are defined based on the geometry.

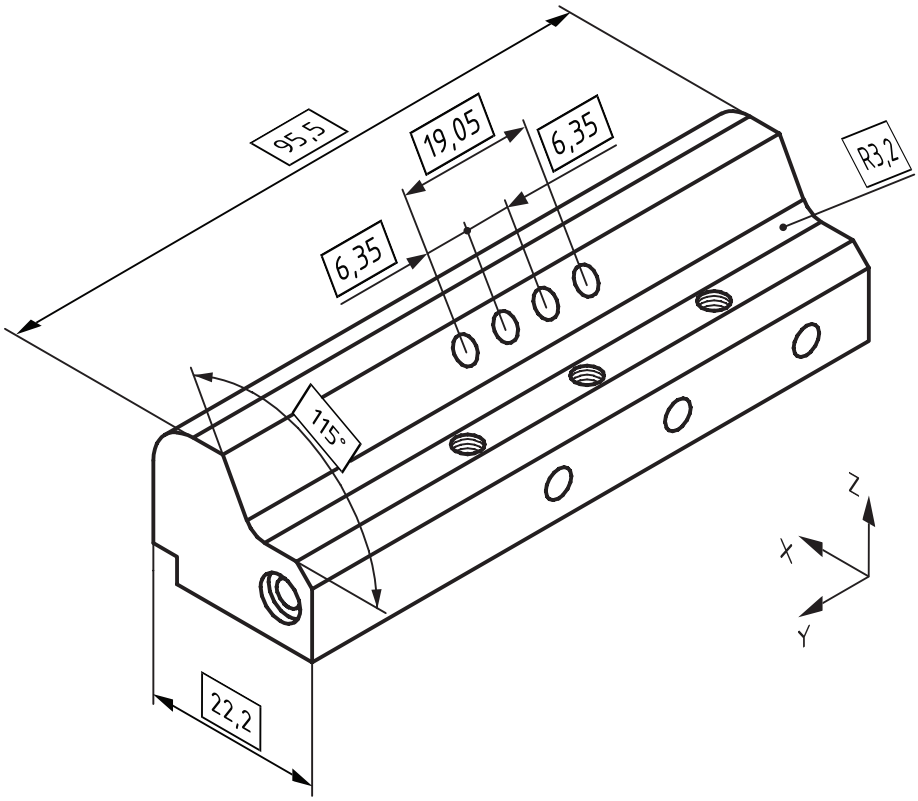


Figure 28 — Placement and attachment for TEDs

9.3.3 Size values

A size value shall not conflict with the queried model value for the same feature when the model value is rounded to the same number of decimal places.

For the most common size values, the placement and attachment methods for size values are as follows:

— spherical surface: the size value, dimension and extension lines shall be placed on an annotation plane containing the model feature centre-point;

— cylindrical surface: the size value, dimension and extension lines shall be placed on an annotation plane perpendicular to the model feature axis or containing the model feature axis.

— set of two opposed parallel surfaces (a width): the size value, dimension and extension lines shall be placed on an annotation plane perpendicular to the model feature centre plane (the extension lines shall clearly indicate the surfaces comprising the width, see Figure 29 for examples).

Size tolerances can be specified using the ISO system of coded size tolerances as specified in ISO 286-1. This method should be used with caution as it can cause the nominal size value and the nominal cad geometry to conflict.

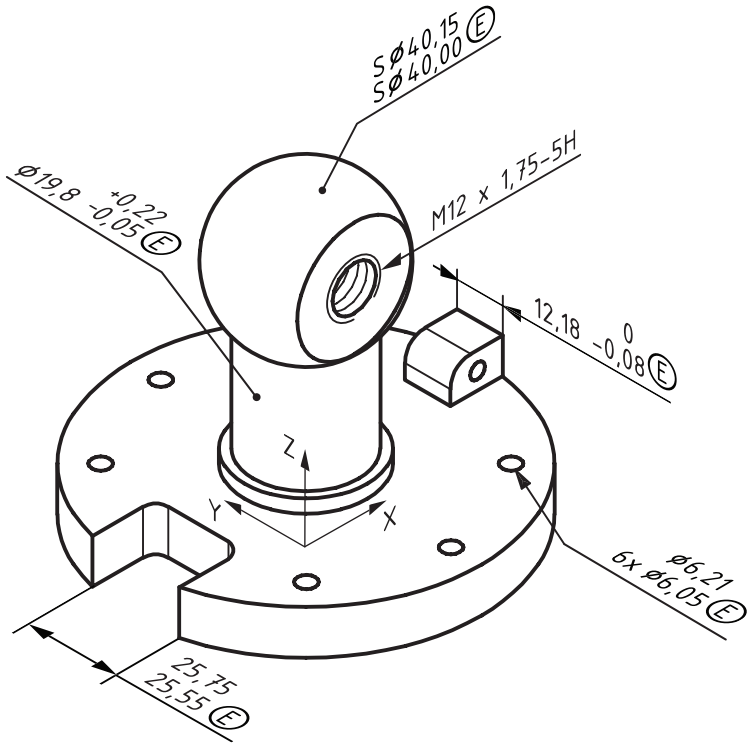


Figure 29 — Placement and attachment for linear dimensions

9.3.4 Examples of general applications

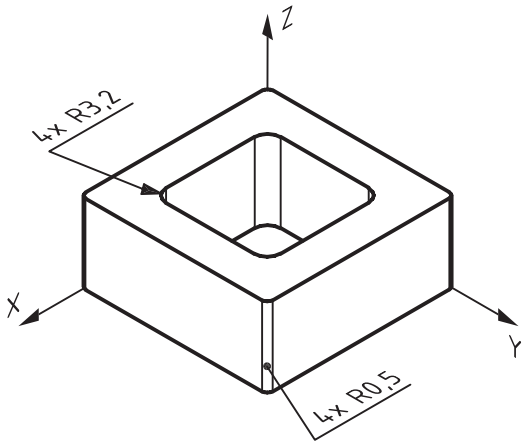
Examples of the attachment methods most commonly used are given in Table 2.

9.3.5 Chamfers

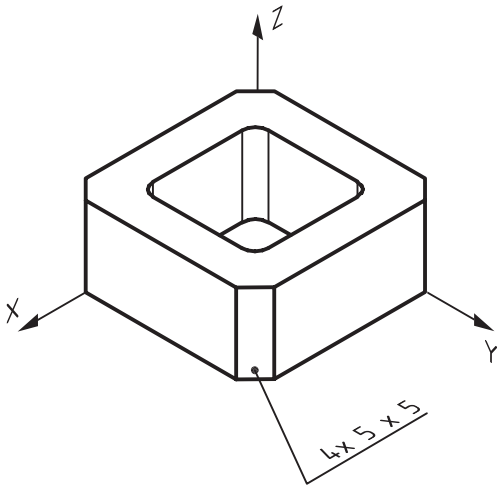
Attachment for 90° surface intersections with an equally disposed chamfer is indicated in Table 2. Oblique surface intersections, unequally disposed extents or chamfers defined using a linear and angular dimension require the use of dimension and extension lines (see Figure 30 and Figure 32). The value shall be located and oriented in a manner that is clear.

Table 2 — Examples of attachment techniques

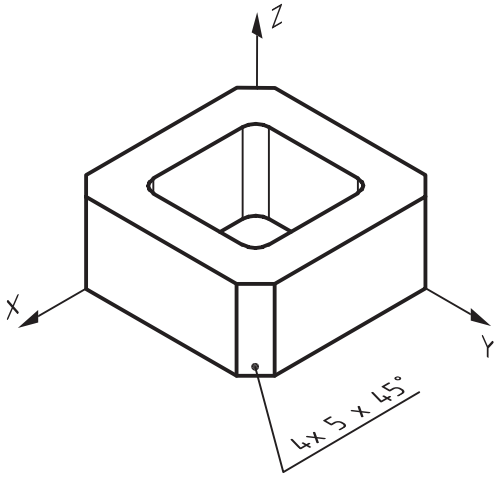
General application	Attachment technique			Figure
	Dimension indication	Directed leader line	Extension lines	
Fillets, round, chamfers		X		Figure 30 a) to f)
Reliefs, step surface			X	Figure 31 a) and b)
Countersinks	X			Figure 32 a)
Oblique surfaces			X	Figure 32 b)
Threaded holes	X			Figure 33 a)
Counterbore	X			Figure 33 b)
Remaining thickness			X	Figure 33 c)
Notches, flats and pin height			X	Figure 34 a) to d)



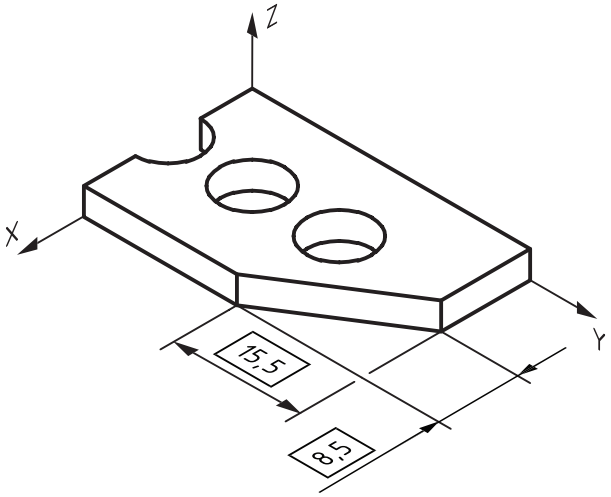
a) Fillets and rounds



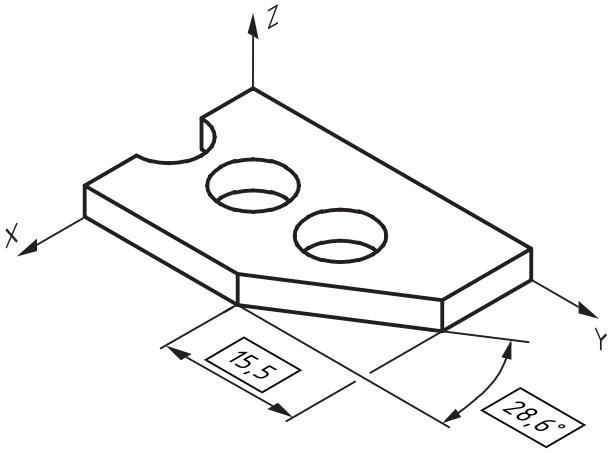
b) Chamfer — Equal offsets



c) Chamfer — Offset and 45° angle

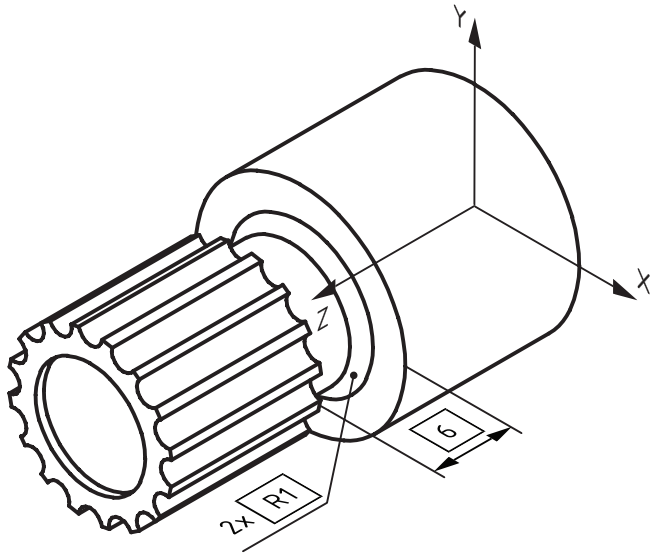


d) Chamfer — Unequal offsets

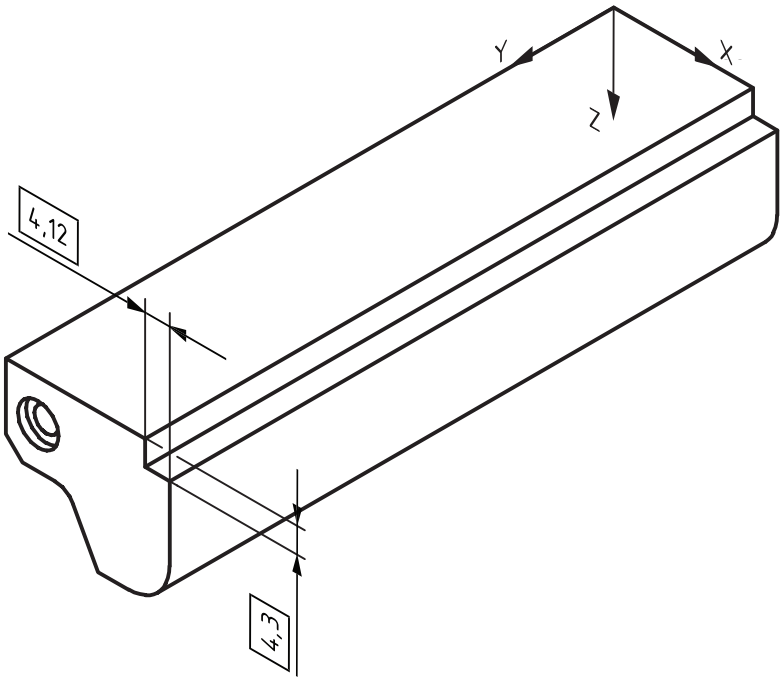


e) Chamfer — Offset and angle

Figure 30 — Attachment techniques — Fillets, rounds and chamfers

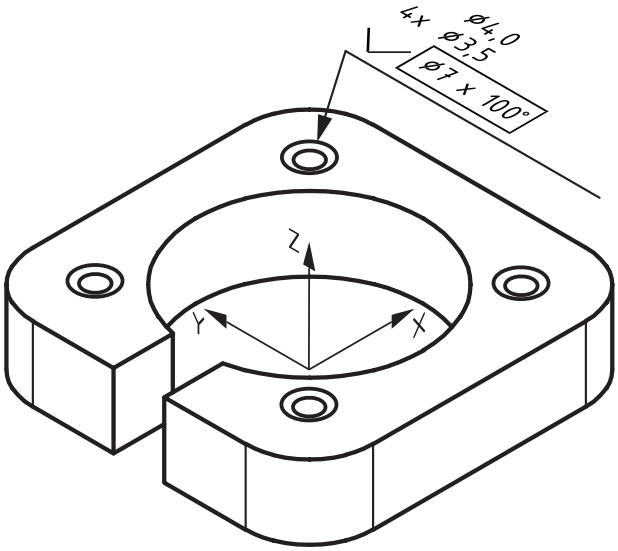


a) Relief

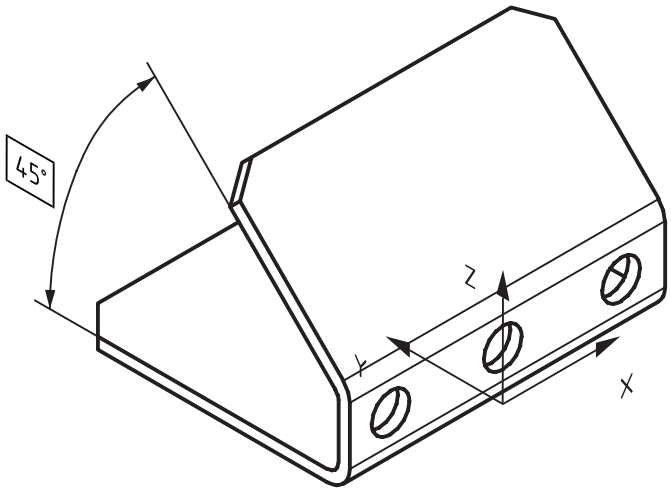


b) Step surfaces

Figure 31 — Attachment techniques — Reliefs and step surfaces



a) Countersinks

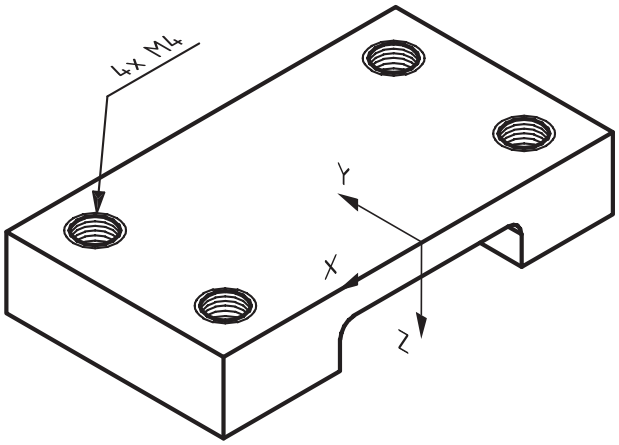


b) Oblique surfaces

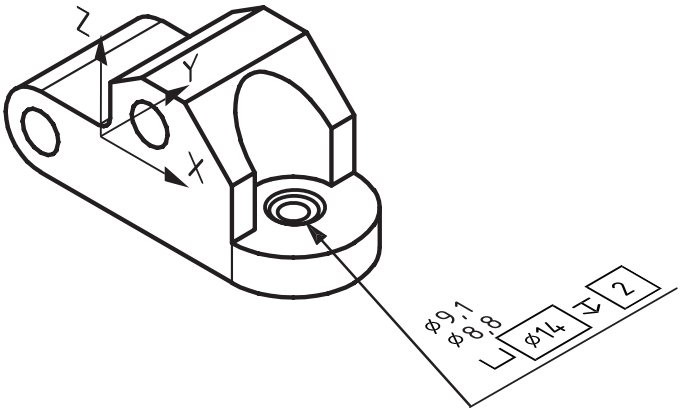
Figure 32 — Attachment techniques — Countersinks and oblique surfaces

9.3.6 Depth specification

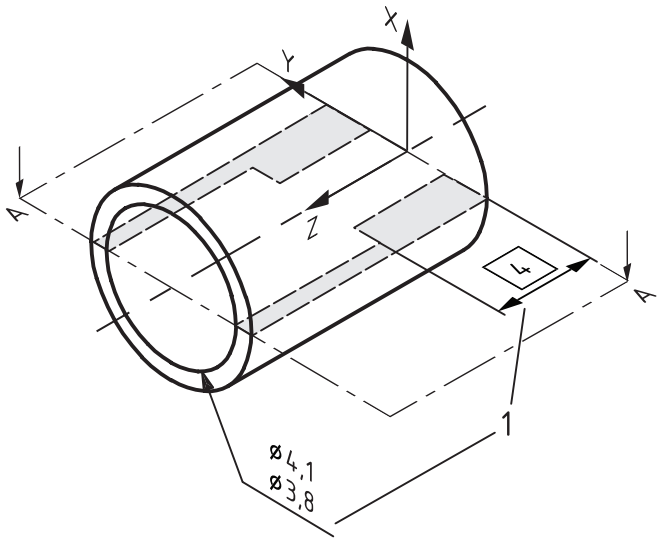
When a feature depth is governed by a remaining thickness tolerance, the feature tolerance and the remaining thickness requirement should be an associated group [see Figure 33 c)].



a) Threaded holes



b) Counterbore

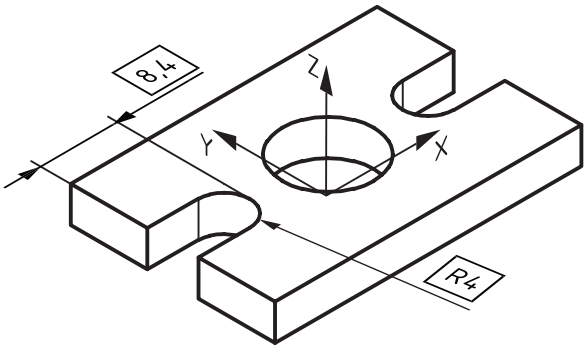


c) Remaining thickness

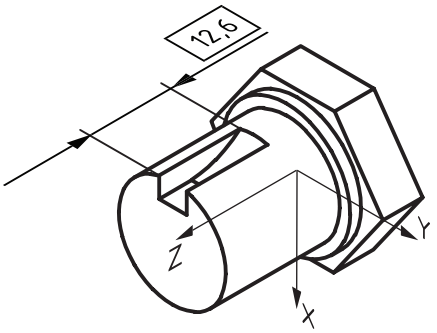
Key

1 associative group

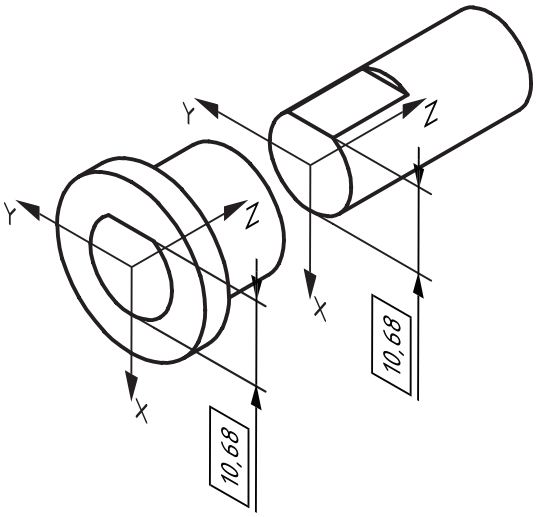
Figure 33 — Attachment techniques — Depth, spotface, remaining thickness



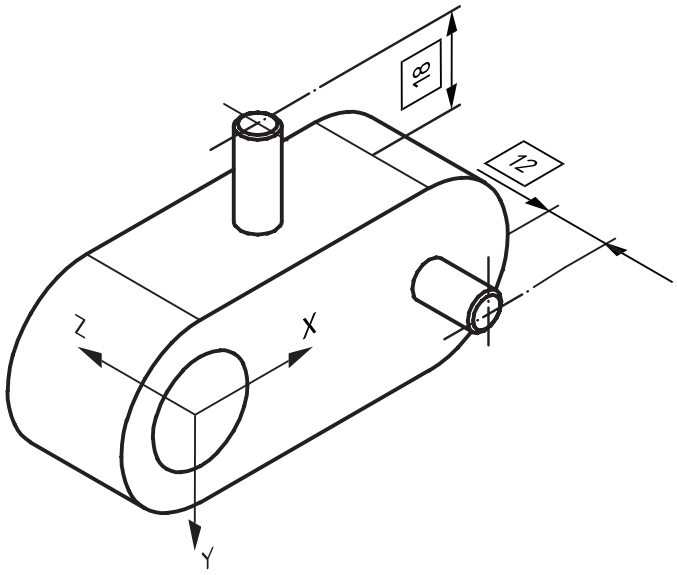
a) Notches example 1



b) Notches example 2



c) Flats on cylinders



d) Pin heights

Figure 34 — Attachment techniques — Notches, flats and pin heights

9.4 Drawing requirements for axonometric views

Requirements for dimensions on axonometric views of a drawing are as follows:

— Displayed dimensions in views are true dimensions. Dimensions shown in an axonometric view shall be actual values (not out of scale).

— Displayed TEDs shall be enclosed in a frame in accordance with ISO 1101.

— Leader lines shall terminate with an arrowhead.

10 Datum applications

10.1 General

This clause establishes practices for organizing, attaching and displaying datum feature indicators, datum target indicators and related information associative with models. Requirements and recommendations for correlating datum features to the coordinate axes of the model space are given.

10.2 Model requirements

10.2.1 Datum systems and model coordinate systems

10.2.1.1 Introduction

The following requirements apply to the relationship between the datum systems on the model and the model coordinate systems.

10.2.1.2 Datum system and coordinate system correspondence

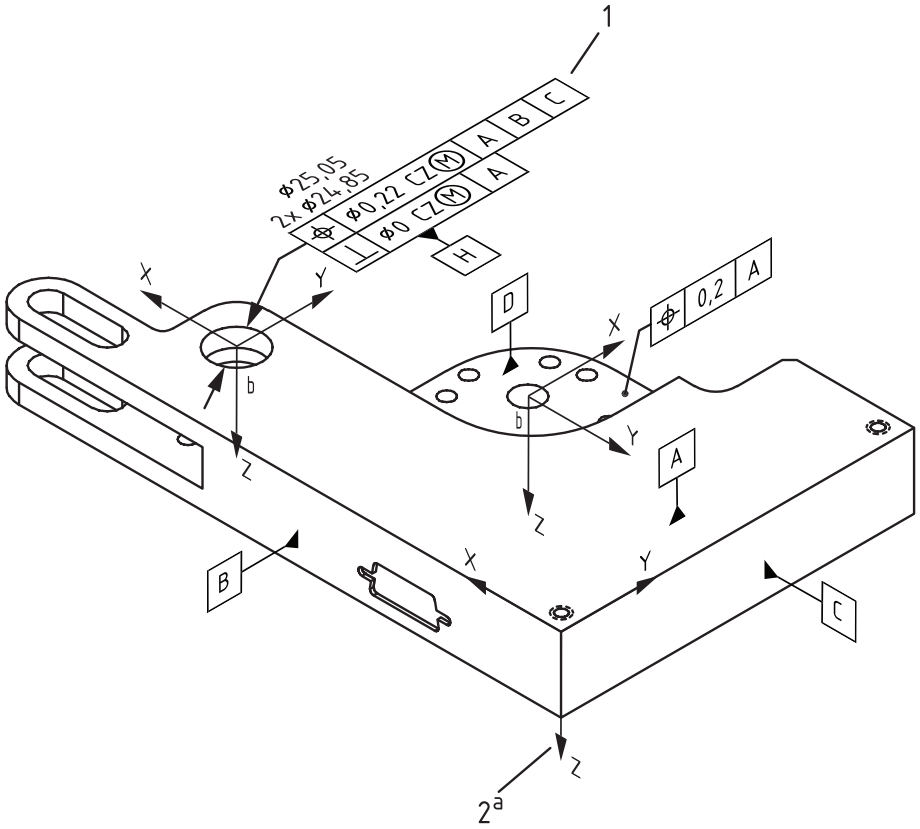
For geometrical product specifications all datum systems shall have a corresponding cartesian coordinate system and this coordinate system shall be associated with its specific datum system.

10.2.1.3 Display link between datum system and coordinate system

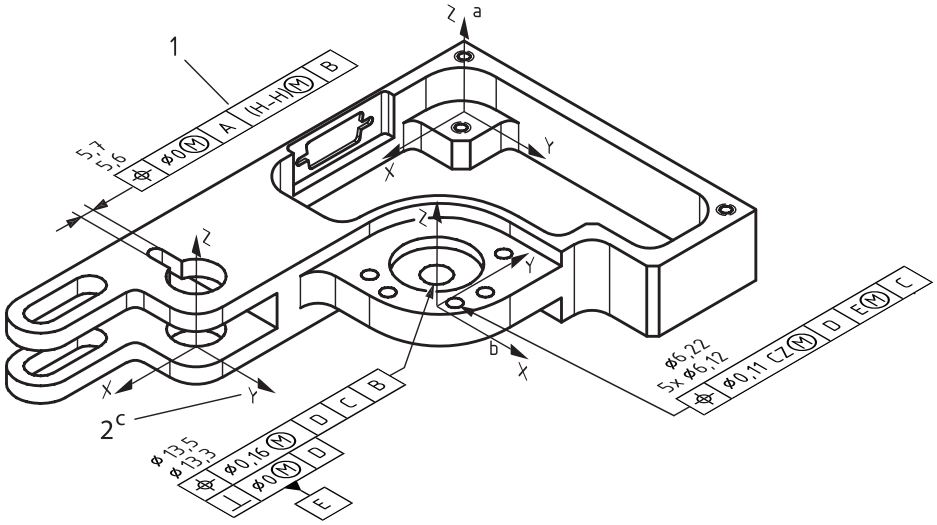
A definite visual relationship between any datum system presented in a datum section and the corresponding coordinate system shall be preserved throughout navigation and query of the presented design data.

If more than one datum system exists, then more than one cartesian coordinate system may be presented (see Figure 35).

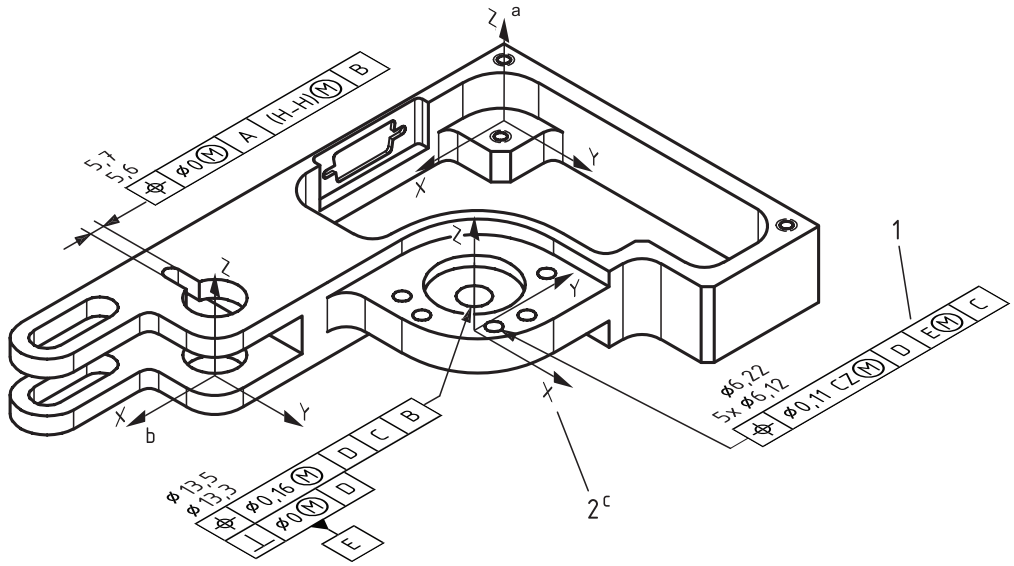
When a coordinate system (e.g. CS2) is defined from another coordinate system (e.g. CS1), a link shall be created between them and the parameters (origin changing and orientation changing) shall be defined as TEDs.



a) Absolute coordinates corresponding to a datum system



b) User-defined coordinates corresponding to a datum system



c) Multiple user-defined coordinate systems

Key

1 datum reference query

2 visual response

a Absolutes.

b User-defined.

c User-defined coordinate system is the only result of this query.

Figure 35 — Datum systems and coordinates relationship

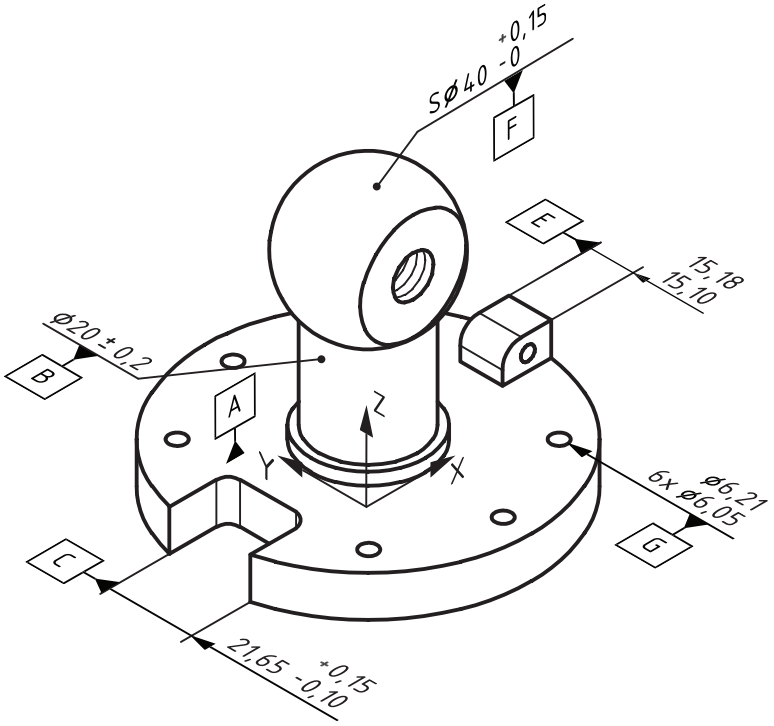
10.2.2 Identification of datums

Figure 36 demonstrates symbol attachment methods for identifying datums on a model. The datum feature indicator should be attached to the surface representing the datum feature. Single extension lines of model feature outlines should not be used for attachment of datum feature indicators. Particular requirements and the preferred attachment methods for datum feature indicators are as follows:

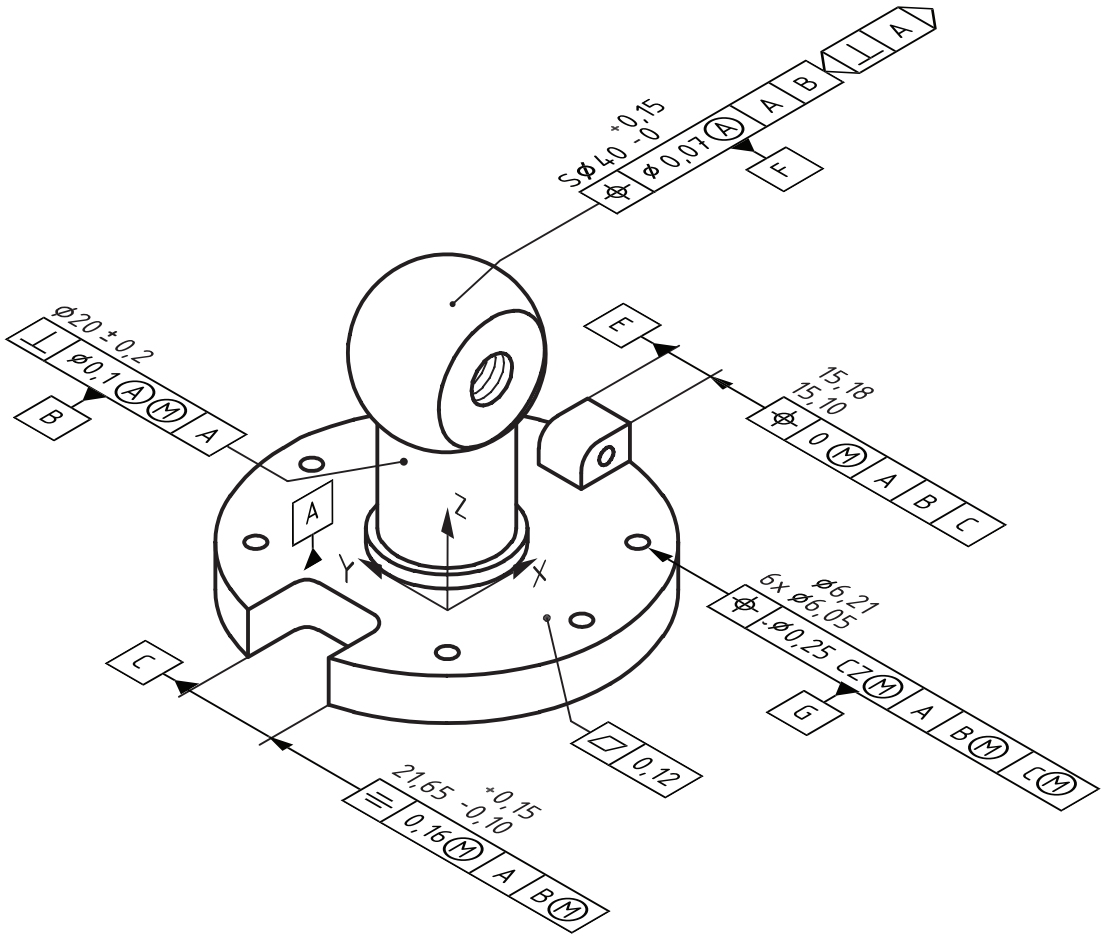
— Place the datum feature indicator on an annotation plane perpendicular to the integral surface [see datum A in Figure 36 a)].

— Place the datum feature indicator on the same plane as the tolerance indicator [see Figure 36 b)].

NOTE For specific rules on creating datums see ISO 5459.



a) Direct attachment



b) Tolerance indicators

Figure 36 — Datum feature indicator attachments

10.2.3 Identification of restricted area application

When the surface containing a datum feature also contains an area of limited application of a geometric tolerance, represent the restricted area of application on the model using supplemental geometry (see Figure 37).

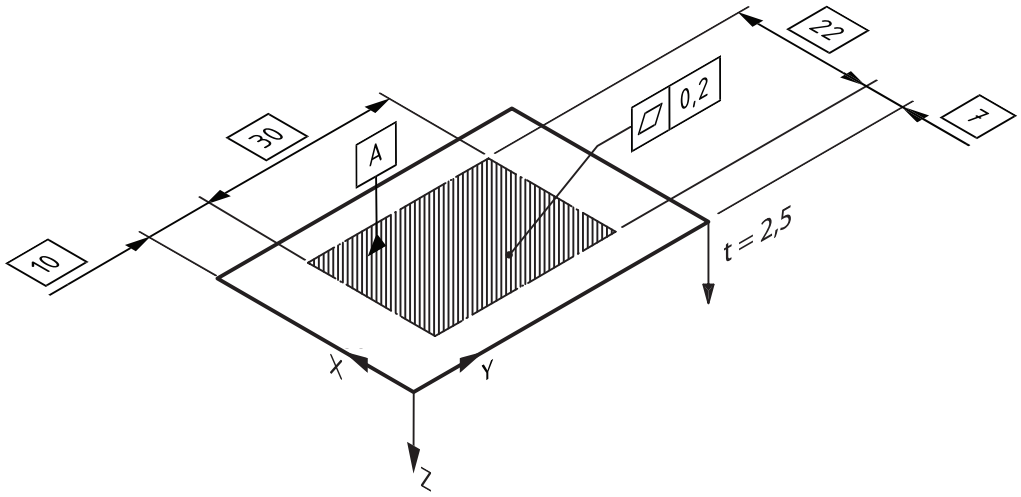


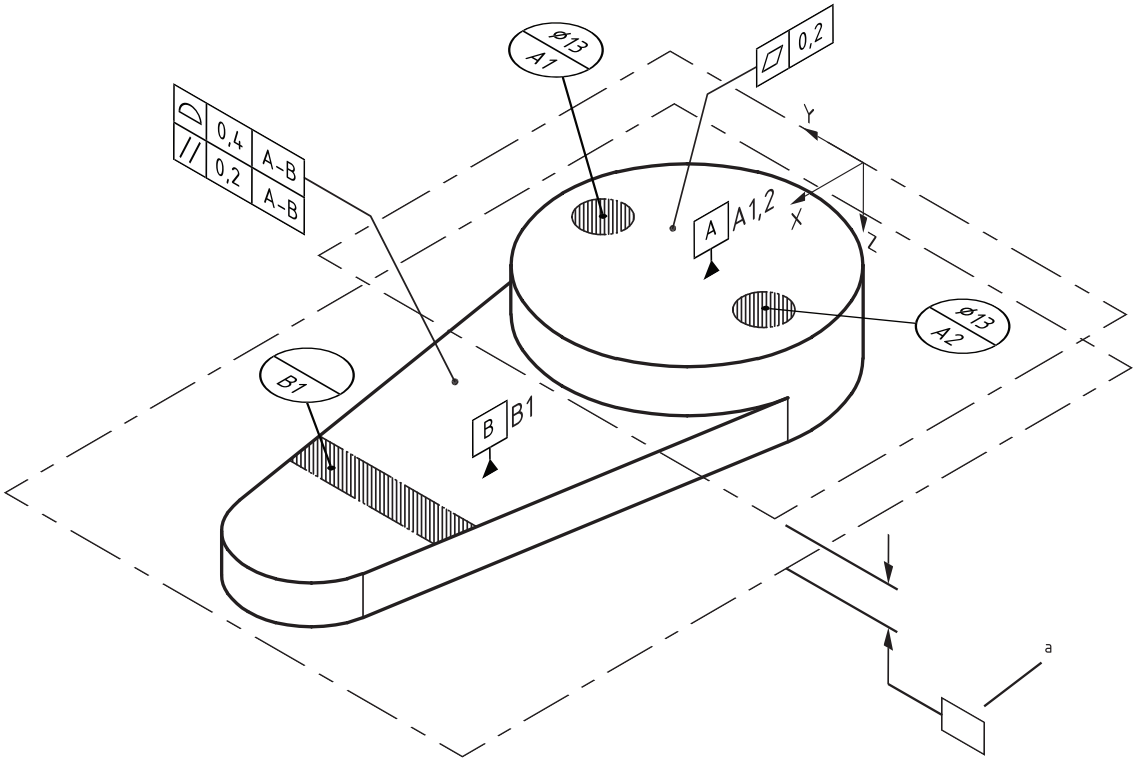
Figure 37 — Partial surface as a datum feature

10.2.4 Associativity of datum features and design data

A query of any datum feature shall permit access to all relevant information for the datum feature. This includes the datum feature indicator, the size limits (if applicable), any applied geometric tolerance and the relevant coordinate system.

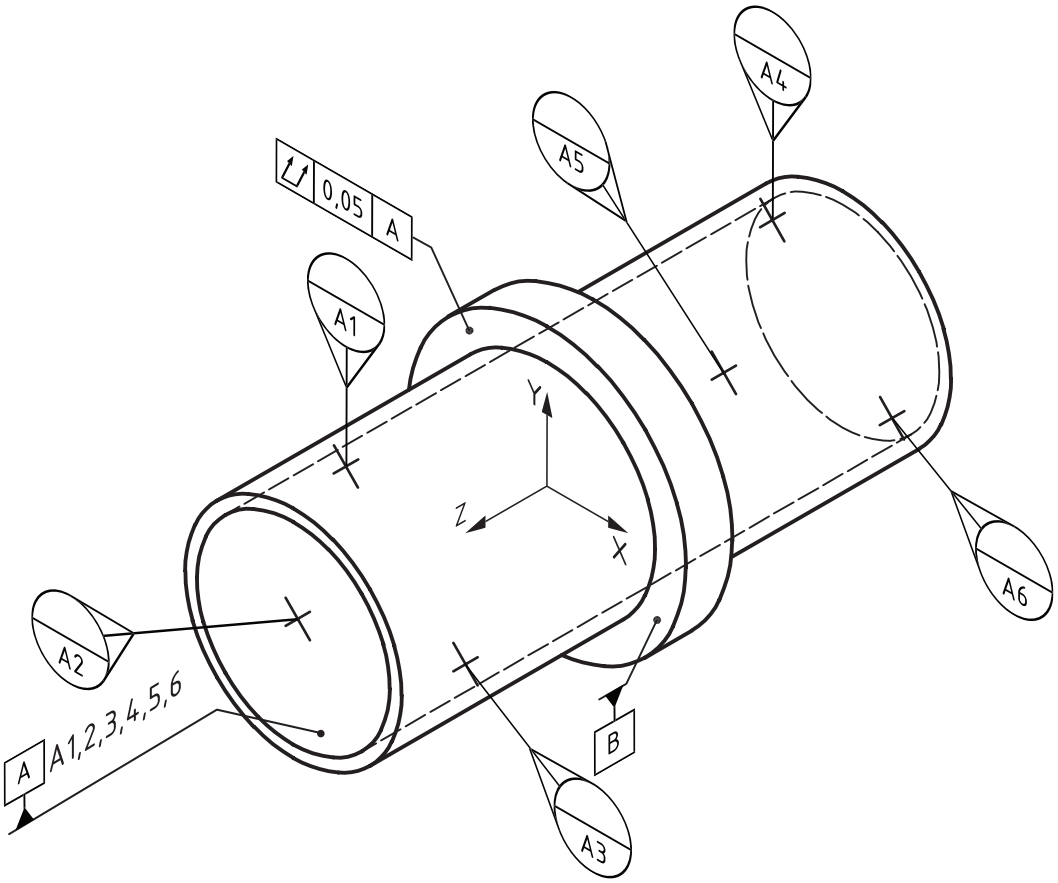
10.2.5 Datum target identification and attachment

Datum target indicators shall follow the rules of ISO 5459 (see Figure 38, Figure 39 and Figure 40).



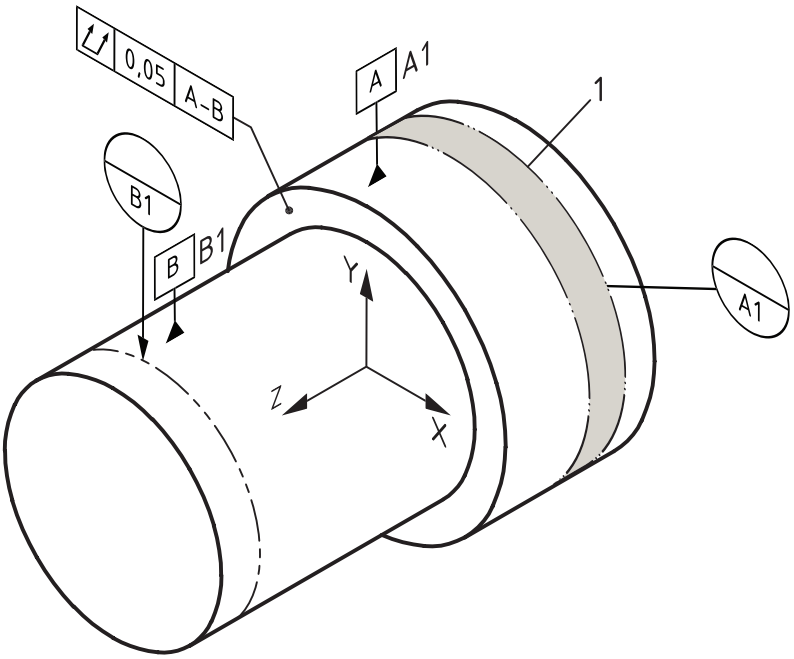
[a] The TED for the height distance between datum A and B is queried in this model instead of being shown as an annotation. The annotation planes are coplanar with the datum targets.

Figure 38 — Datum target identification and attachment



NOTE This figure shows a special display of the model to allow the termination of the leaders on internal surfaces of the model to be seen. This figure does not show the exact location of the datum targets, which is done by showing annotations or by a separate query function.

Figure 39 — Target points establishing a datum on an internal cylindrical surface



Key

1 cylindrical datum target

NOTE This figure does not show the exact location of the datum targets, which is done by showing annotations or by a separate query function.

Figure 40 — Two cylindrical features establish a datum axis

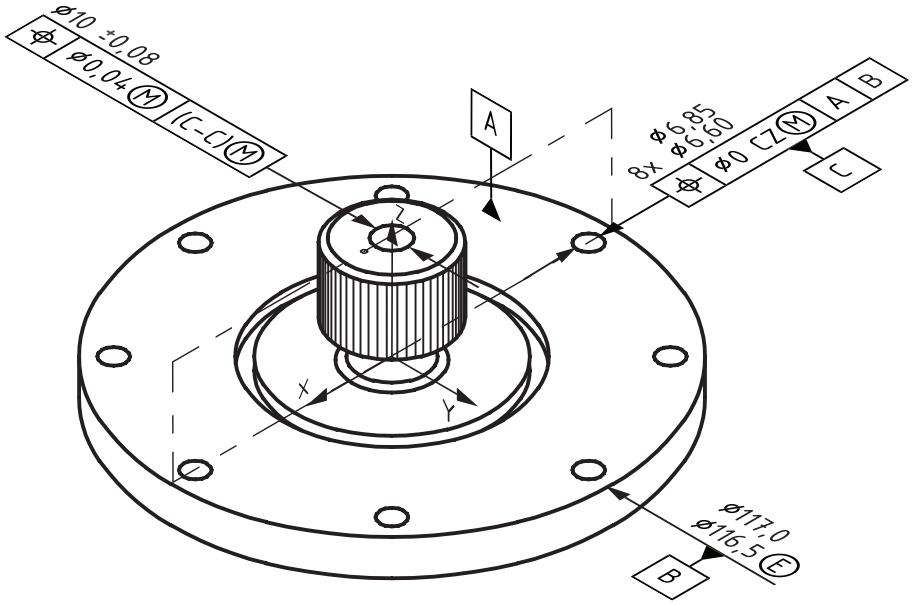
10.2.6 Multiple features establishing a datum

When two or more features are combined to establish a datum, associativity shall be established in the design presentation. For several common instances, the following display and associativity requirements apply.

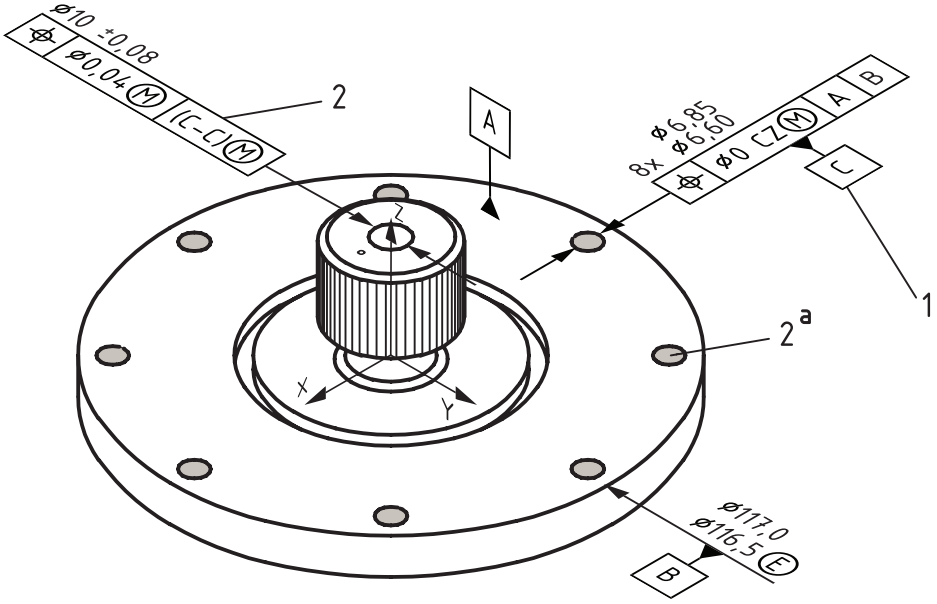
a) When a pattern of features of size is used to establish a datum axis, the involved model features and any applied tolerance for these model features shall be organized as an associated group (see Figure 41).

b) When two or more coaxial and cylindrical datum features are used to establish a single, common datum axis, the involved model features and any applied tolerance for these model features shall be organized as an associated group (Figure 42).

c) When two or more coplanar surface features are used to establish a datum plane, the involved model surfaces and any applied tolerance for these surfaces shall be organized as an associated group (see Figure 43 and Figure 44).



a) Placement and attachment



b) Datum feature indicator associativity

Key

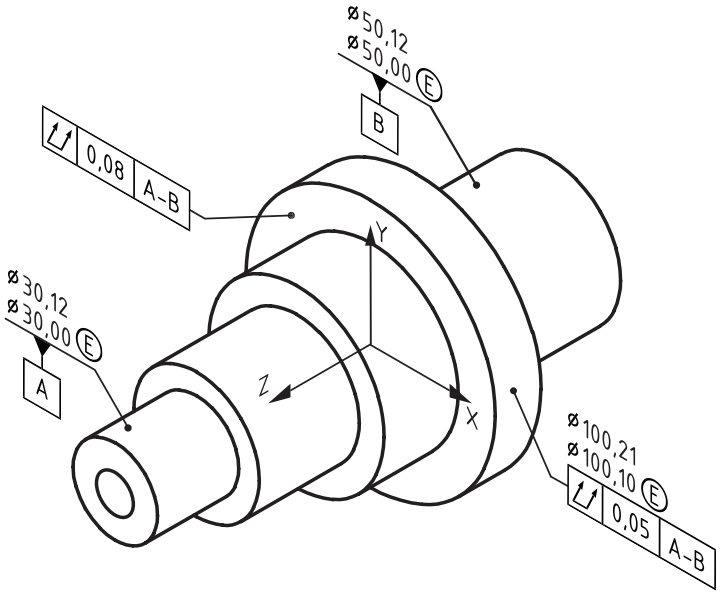
1 query

2 visual response

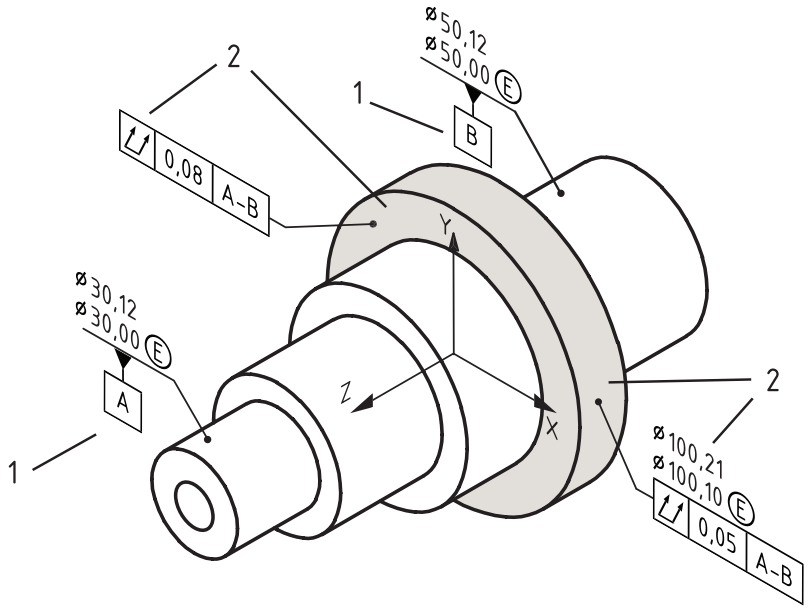
a All eight holes included in visual response.

NOTE This figure does not show location of the holes, which is done by showing annotations or by a separate query function.

Figure 41 — Pattern of features establish a datum axis



a) Placement and attachment

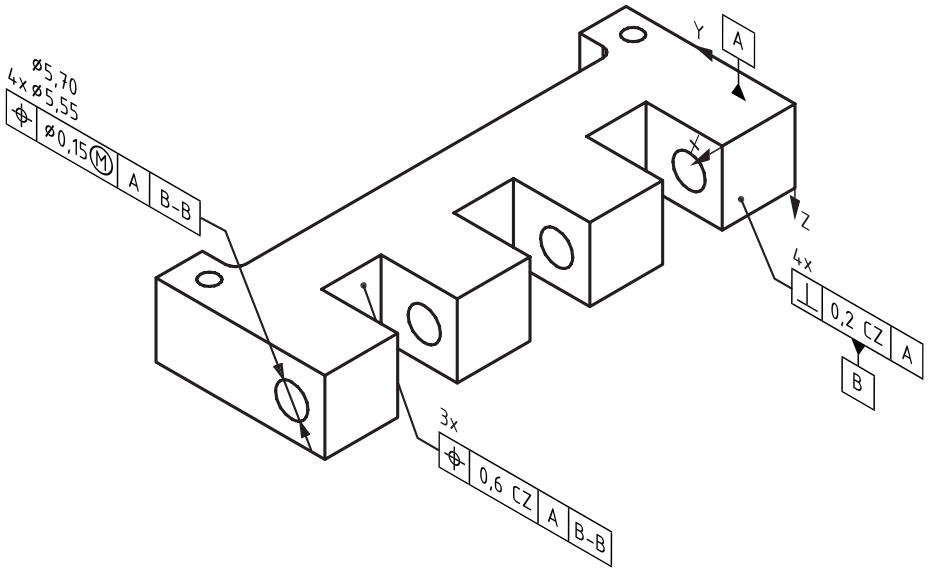


b) Datum feature indicator associativity

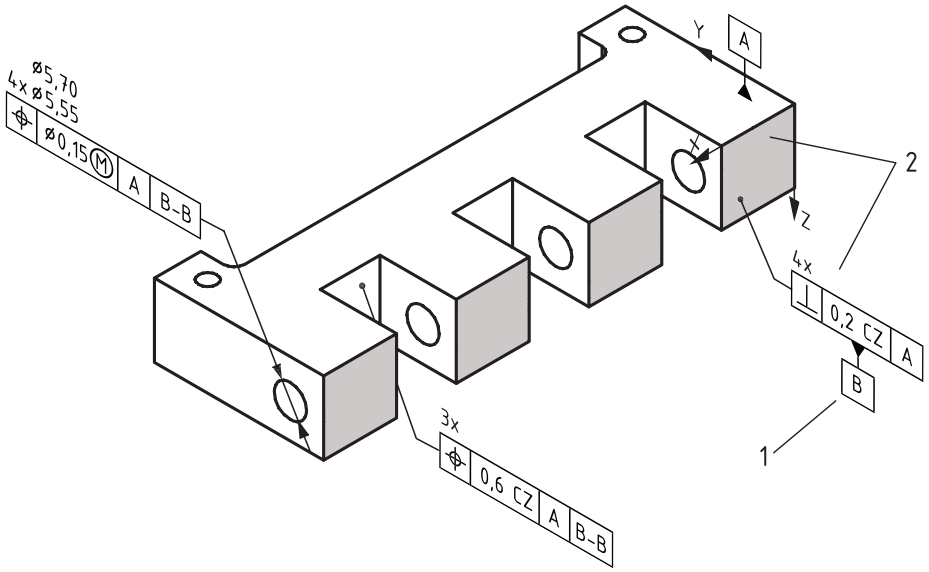
Key

1 query
2 visual response

Figure 42 — Two coaxial features establish a datum axis



a) Placement and attachment



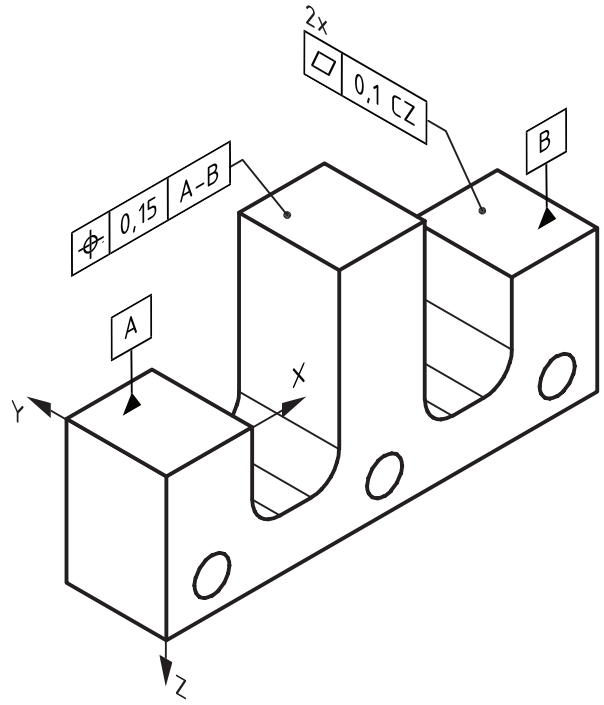
b) Datum feature indicator associativity

Key

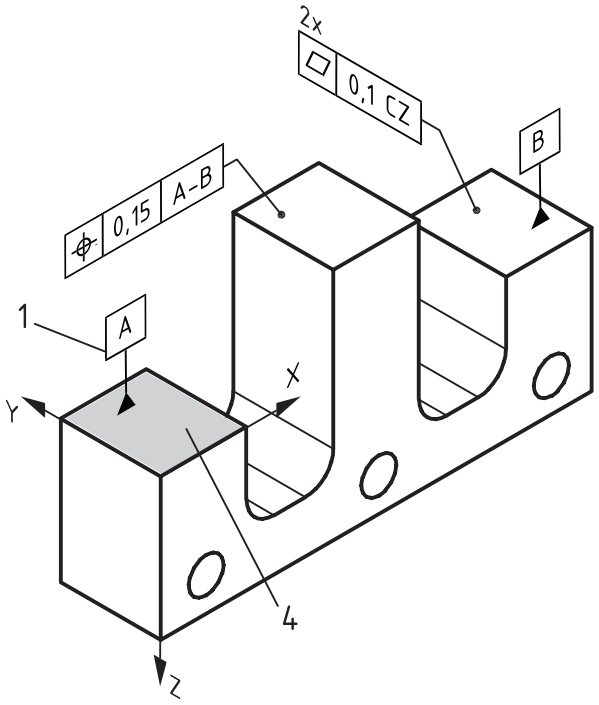
1 query

2 visual response

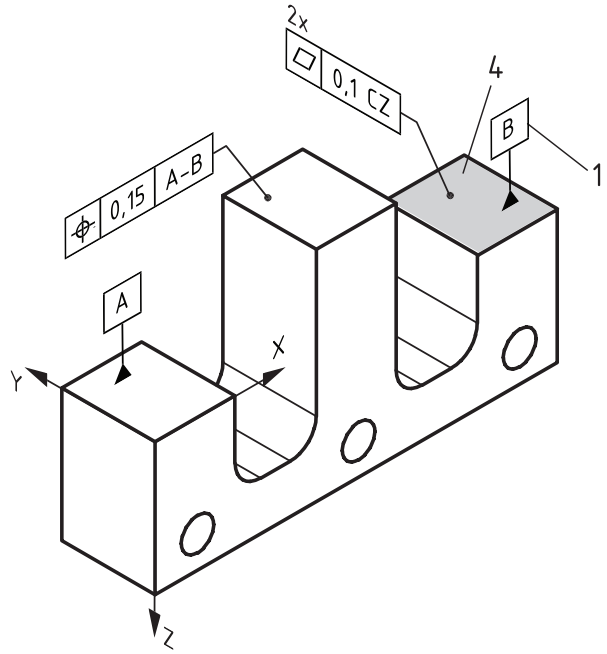
Figure 43 — Coplanar surfaces establish a datum plane

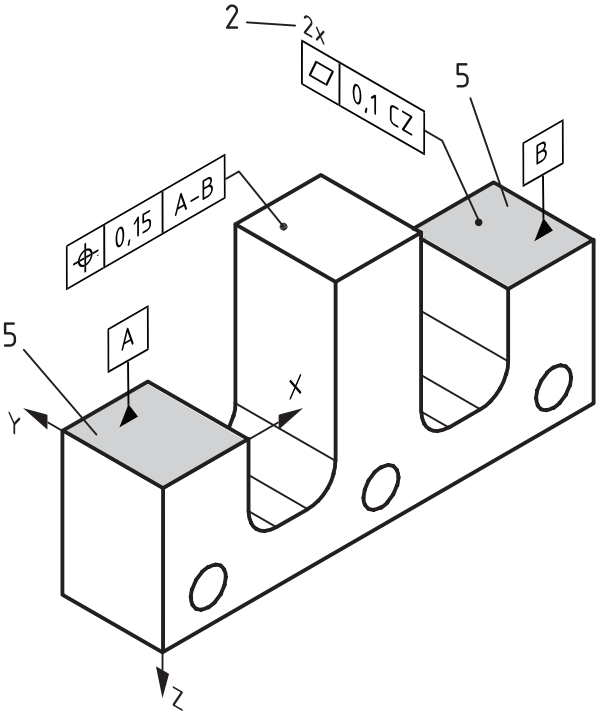


a) Placement and attachment



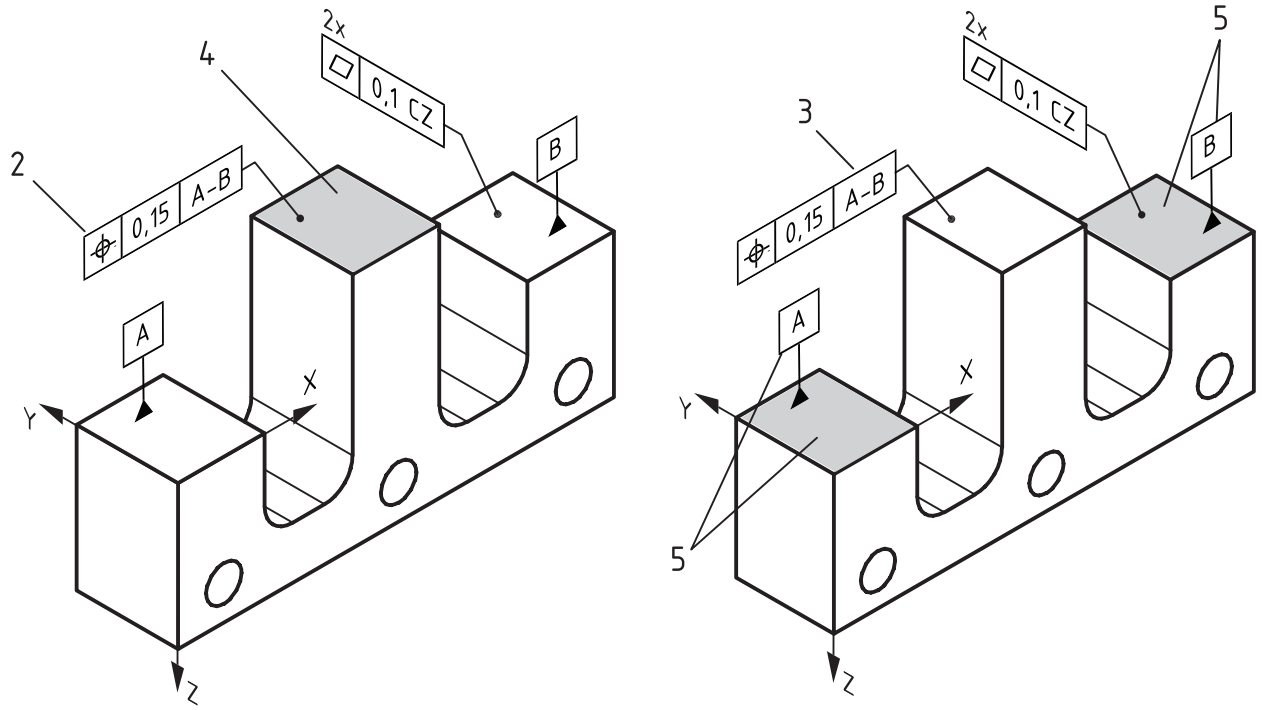
b) Datum feature indicator associativity





c) Datum feature indicator associativity

d) Tolerance indicator associativity



e) Tolerance indicator associativity

f) Datum reference associativity

Key

1 datum feature indicator query
2 tolerance indicator query
3 datum reference query
4 visual response with TEDs not shown
5 visual response of associated group

Figure 44 — Separated surfaces establish a datum plane

10.3 Drawing requirements

The following is a list of requirements and other provisions for datum features in axonometric views in addition to the requirements from ISO 5459.

a) The corresponding model coordinate system shall be displayed in each axonometric view in which a datum system is cited.

b) The datum feature indicator should be attached to the surface of the represented object. A single extension line of a model feature outline should not be used for attachment of datum feature indicators in an axonometric view (see Figure 45).

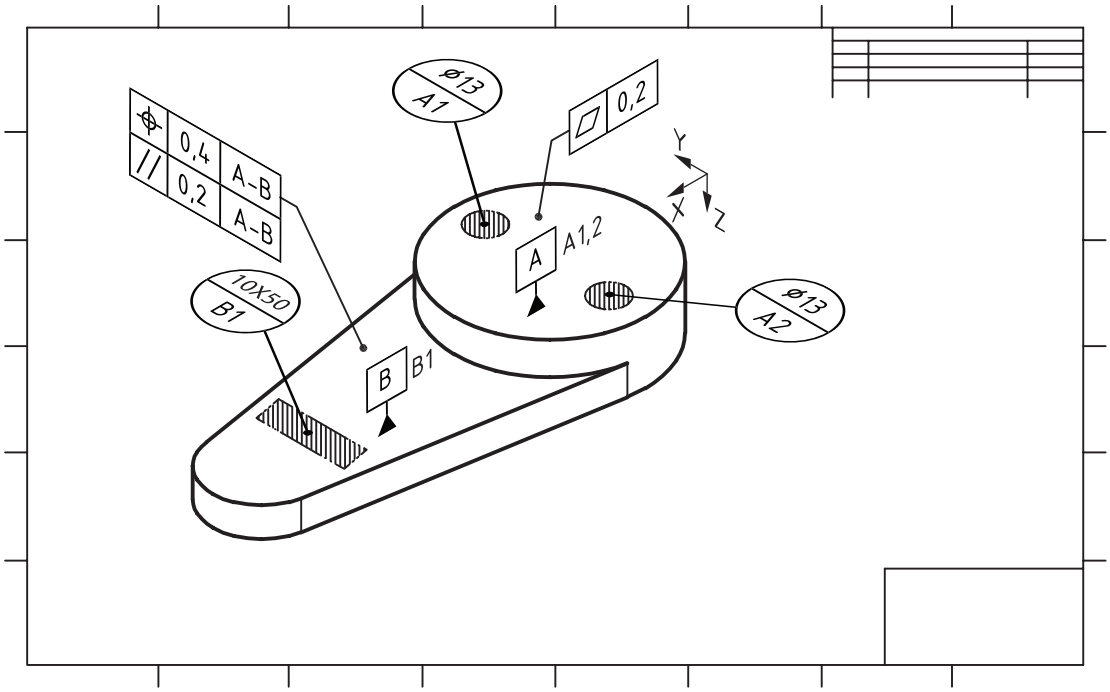


Figure 45 — Datum targets and indicators in an axonometric view

11 Geometric tolerances

11.1 General

The rule for the ISO GPS system along with the rules of this document apply when specifying geometrical tolerances for data sets. See Annex C for examples.

11.2 Drawing requirements

11.2.1 General

11.2.1.1 When using orthographic views, geometric tolerances shall be specified in accordance with ISO 1101, ISO 5459 and other applicable International Standards.

11.2.1.2 When axonometric views are used, the following provides exceptions, recommendations and additional requirements:

a) For axonometric views it is recommended that a portion of the specified feature is visible in the view in which the specification is applied. If a specification is applied to multiple features, some of the features may not be visible.

b) When a tolerance indicator is applied to a restricted area in axonometric views, the restricted area of application shall be represented using supplemental geometry (see Figure 46).

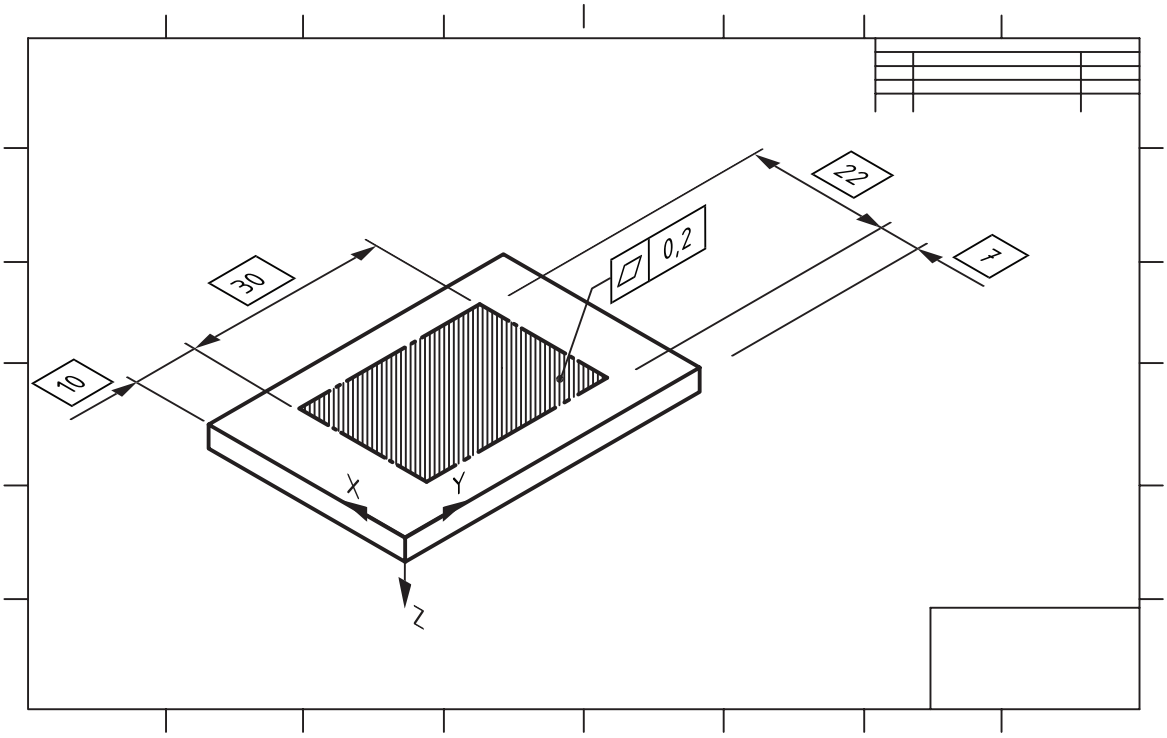


Figure 46 — Axonometric views — Restricted area application

12 Welds

12.1 General

Welding symbols shall be in accordance with ISO 2553. This clause establishes the placement, attachment and display requirements and other provisions for welds.

12.2 Common requirements

12.2.1 Application of supplemental geometry

Supplemental geometry can be used to indicate the path of the weld.

12.2.2 Arrow lines

Welding symbols are drawn using an arrow line:

— the arrow line shall terminate with an arrowhead;

— the arrow line shall terminate on the joint or on supplemental geometry when a supplemental geometry is used to indicate the path of the weld (see Figure 47).

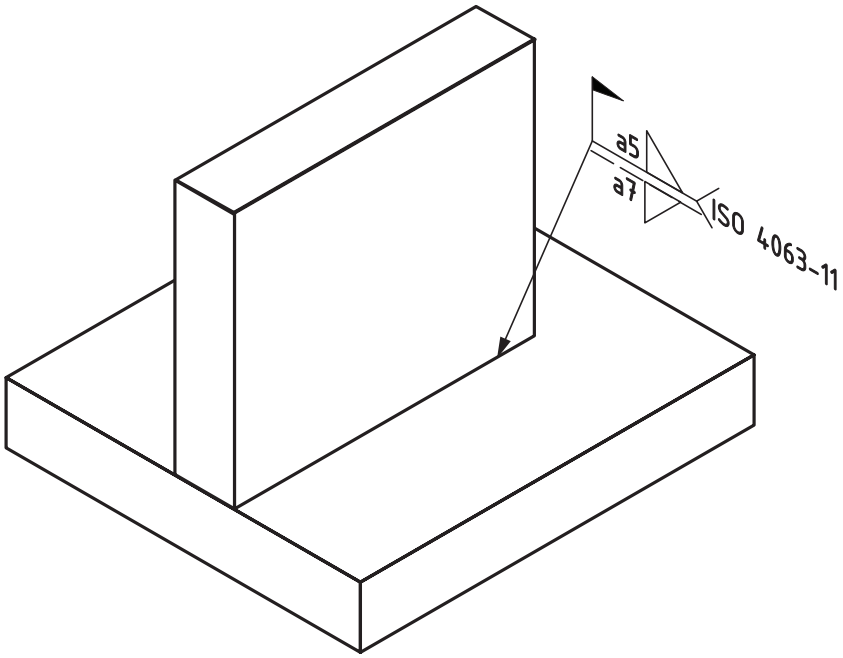


Figure 47 — Placement of a weld

12.3 Model requirements

12.3.1 Annotation plane

The welding symbol shall be placed in an annotation plane that is perpendicular to or coplanar with the joint or the supplemental geometry indicating the path of the weld (see Figure 47).

12.3.2 Associativity

The portions of the model which are being welded together shall be the associated geometry for the weld.

12.3.3 Indicating extents of the weld

When the associated geometry and the indicated weld path are not sufficient to indicate the area of application, the following techniques may be used as appropriate.

The extent of the weld may be further clarified by defining the extent of the weld or its placement.

When the weld applies to a limited length of the indicated weld path, the extents of the weld may be indicated using the between symbol and the limits of the application labelled as shown in Figure 48.

When the exact location of the weld is to be defined, a dimension may be applied to indicate the start of the weld (see Figure 49).

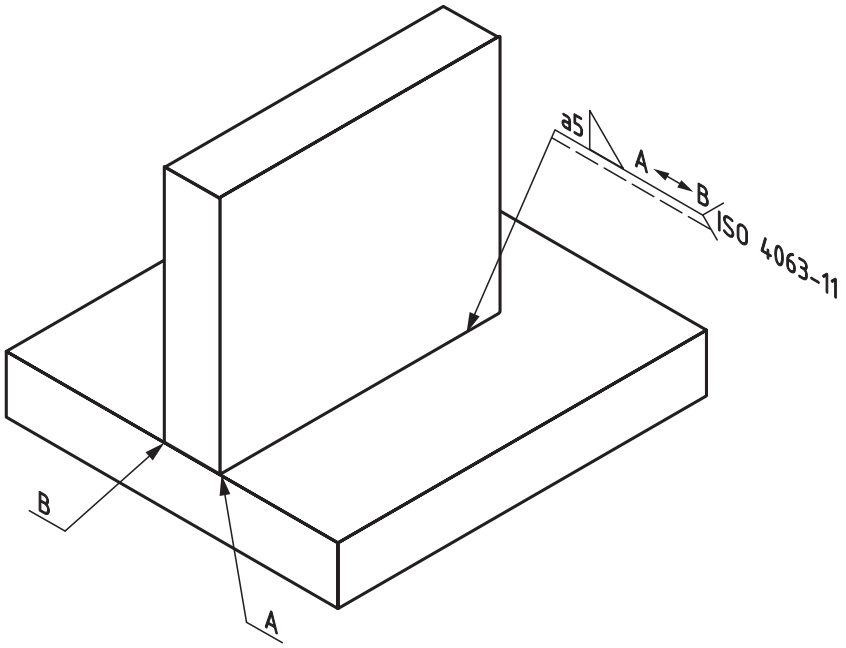
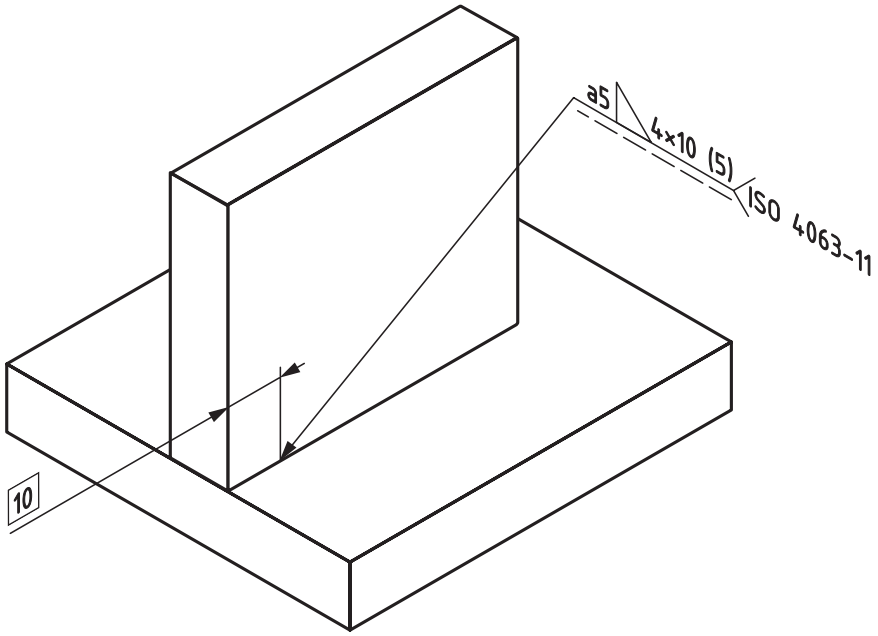
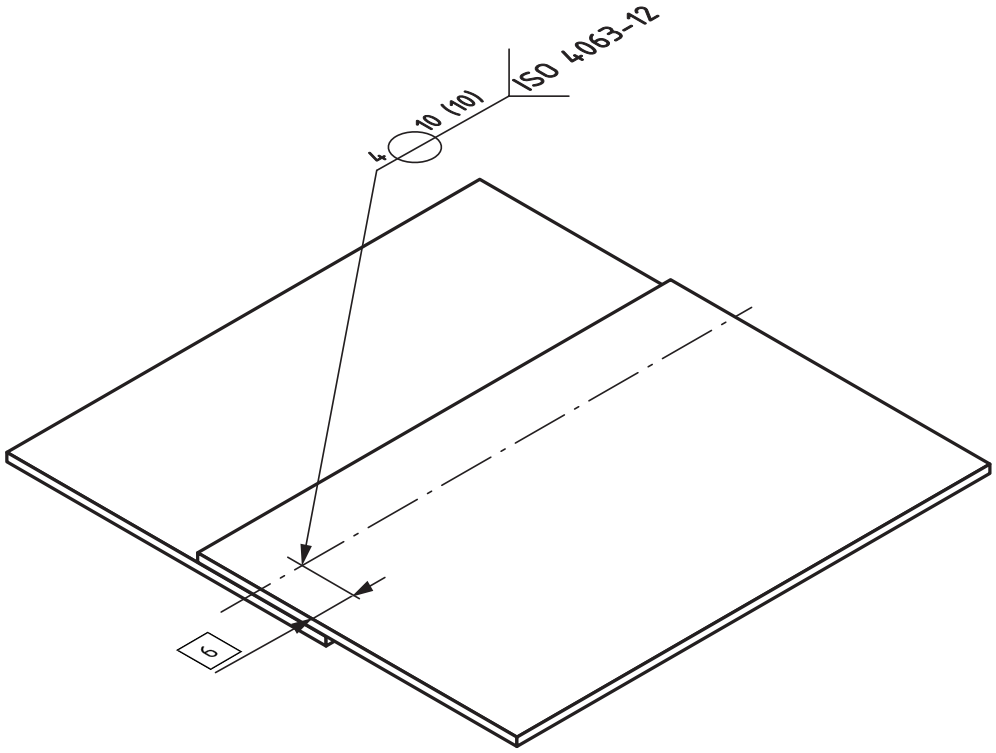


Figure 48 — Extent of a weld using the between symbol



a) Fillet weld

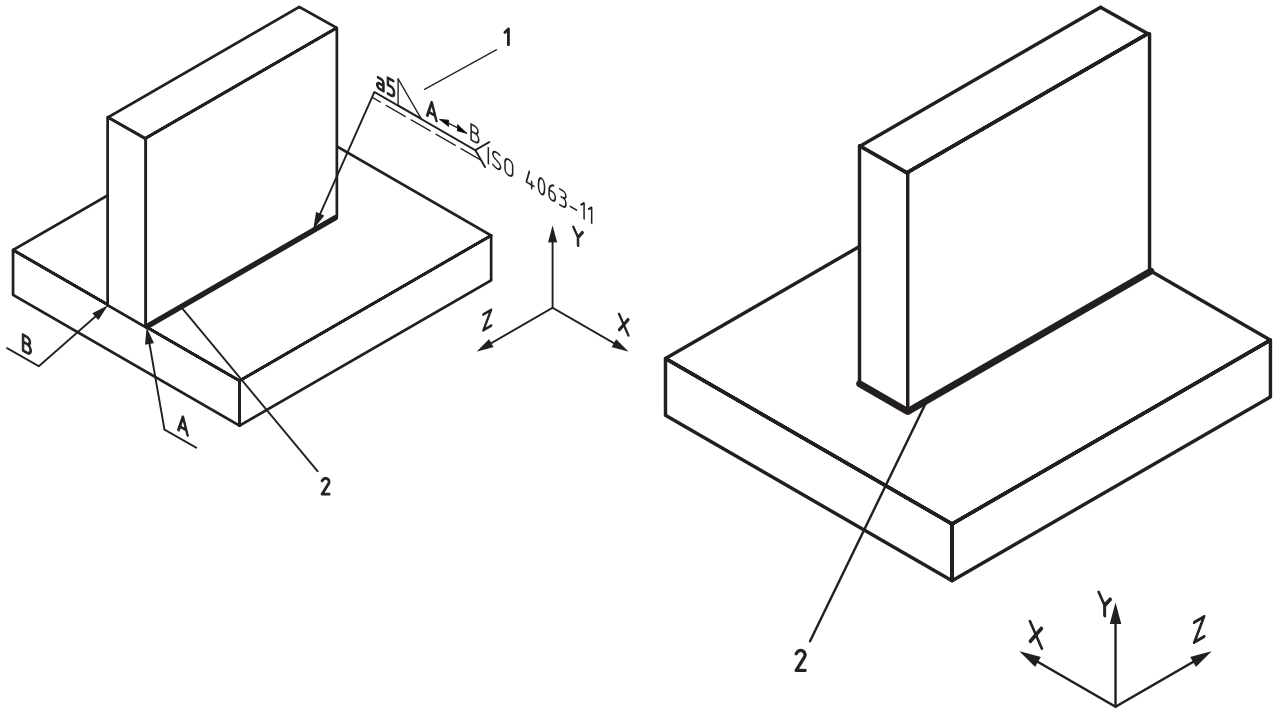


b) Spot welds

Figure 49 — Indication of location of welds

12.3.4 Query of weld path

Upon selection of a weld, the geometry representing the weld path shall be highlighted or otherwise distinguished from other entities on the display (see Figure 50).



a) Query **b) Visual response**

Key

1 query

2 visual response

Figure 50 — Indication of weld paths

12.4 Drawing requirements

In axonometric views, the extents of the weld can be indicated as they are on models (see 12.3.3).

13 Surface texture

13.1 General

Surface texture symbols shall be in accordance with ISO 21920-1[2)] or ISO 25178-1. This clause establishes the placement, attachment and display requirements and other provisions for surface texture symbols.

13.2 Common requirements

There are no common exceptions or additions between models and drawings.

13.3 Model requirements

13.3.1 Display techniques

All attachment methods shown in ISO 21920-1 and ISO 25178-1 are allowed. For readability and ease of interpretation of the 3D model, the preferred method for display is by an attachment to a reference line with a leader (see Figure 51). When a leader is used, it shall terminate with a dot on the surface.

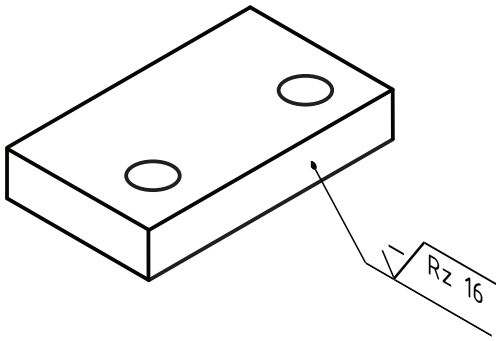


Figure 51 — Surface texture attached with a leader to a surface

13.3.2 Associativity

The portions of the model to which the surface texture applies shall be the associated geometry for the surface texture symbol.

2) Under preparation. Stage at the time of publication: ISO/DIS 21920-1:2021.

Annex A
(informative)

Former practices

A.1 General

The following drawing indications were described in the previous edition of this document. Their use in practice has shown that their interpretation was ambiguous. Therefore, these drawing indications should no longer be used.

A.2 Direction-dependant tolerances

A.2.1 General

It was a former practice to use supplemental geometry to communicate the orientation of a direction-dependant tolerance.

A.2.2 Represented line element

Formerly, the line element was used to identify the orientation of the line requirements, e.g. straightness of a line in a plane, line profile, orientation of a line element of a feature (see Figure A.1). Since the publication of ISO 1101 the intersection plane indicator has been used for this purpose.

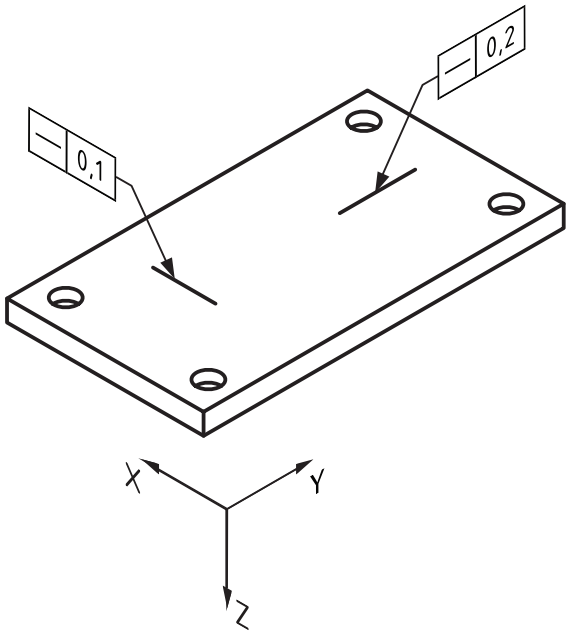
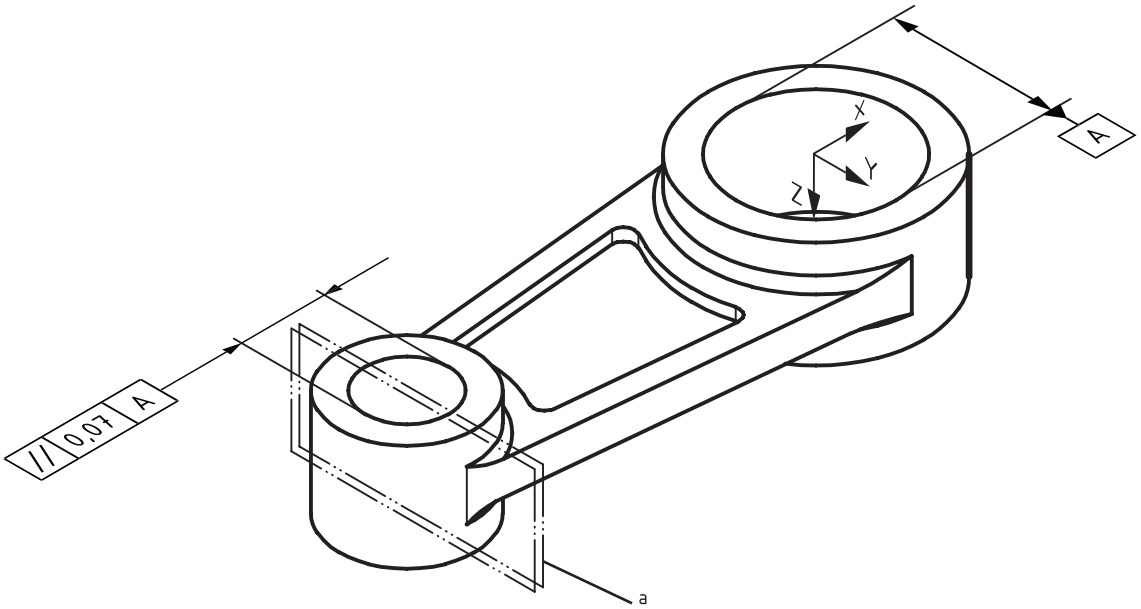


Figure A.1 — Straightness — Directed by line element

A.3 Orientation tolerances

It was former practice in the case of a specification for a centre point or a median line in one direction that the arrow of the leader line defined the orientation of the tolerance zone (see Figure A.2). Since the publication of ISO 1101 the orientation plane indicator has been used for this purpose.



a The tolerance zones shown here are for clarification only and are not part of an actual presentation.

Figure A.2 — Orientation of axis with parallel plane's tolerance zone

Annex B
(informative)

Classification codes for drawings and data sets

B.1 General

This annex establishes the requirements for classification codes for defining what data are included within the drawing, data set or both. When using the principles in this document it is recommended that this annex be invoked for better communication.

B.2 Application

The classification code can be used to indicate how the product documentation is organized within the product definition data set. When both a model and a drawing are provided, the classification code defines whether the model, the drawing or both provide the complete definition of the product. The indication of the classification code should appear on the model if one is included, on the drawing if used and in the associated list(s) if used. See B.4.2 for the location of the classification code.

B.3 Definitions

See 3.2 for the terms and definitions related to classification codes for drawings and data sets.

B.4 Classification code requirements

B.4.1 General

Identify classification codes as specified herein.

B.4.2 Classification code location

On a model, the classification code shall be placed on an annotation plane or in the header of the model.

On a drawing, the classification code shall be displayed on a drawing.

The classification code shall be placed on the associated list(s).

When the production definition data set can communicate the classification code clearly for its contents (see Figure 1) the code shall be placed at the data set level and not as described previously.

B.4.3 Classification code 1

The following applies to classification code 1, drawing with data set, without model:

a) the data set shall be stored in a repository;

b) the drawing shall be released and is the original.

B.4.4 Classification code 2

The following applies to classification code 2, data set with design model and drawing:

a) the data set shall be stored in a repository;

b) the drawing and related data shall provide complete product definition;

c) the drawing is released and is the original.

B.4.5 Classification code 3

The following applies to classification code 3, data set with design model and simplified drawing:

a) the data set shall be stored in a repository;

b) the design model, simplified drawing and related data shall be used to provide complete product definition;

c) the design model, simplified drawing and related data are the originals.

B.4.6 Classification code 4

The following applies to classification code 4, data set with annotated model and complete drawing:

a) the data set shall be stored in a repository;

b) the annotated model and related data shall be used to provide complete product definition and the complete drawing and related data shall be used to provide complete product definition;

c) the annotated model and related data are the originals;

d) the complete drawing and related data are the originals.

B.4.7 Classification code 5

The following applies to classification code 5, data set with an annotated model without a drawing:

a) the data set shall be stored in a repository;

b) the annotated model and related data shall be used to provide complete product definition;

c) the annotated model and related data are the originals.

Annex C
(informative)

Examples

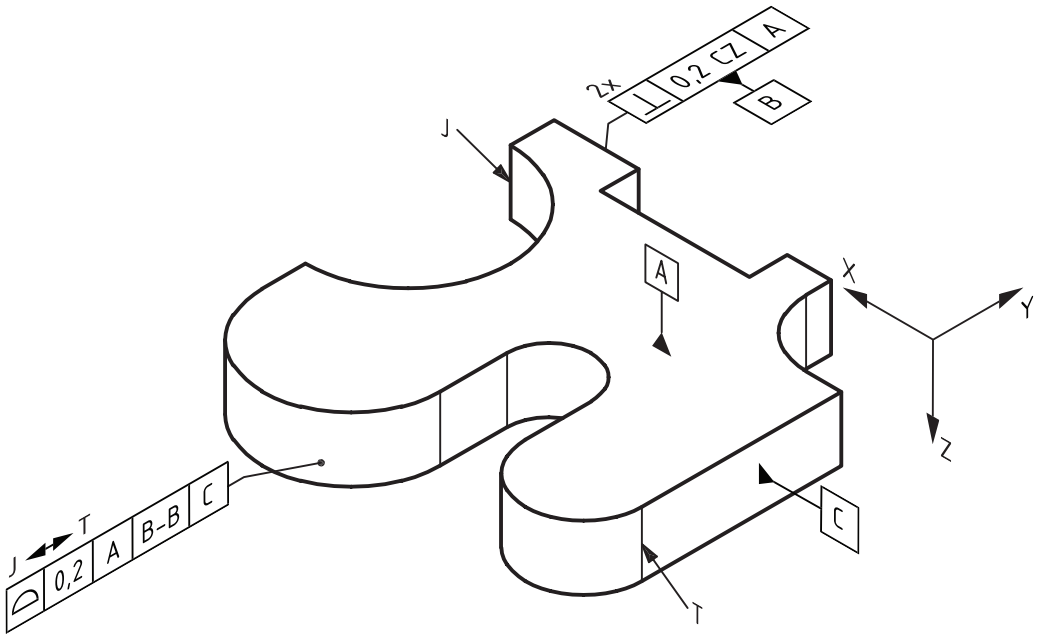
C.1 General

This annex is provided to show examples of attaching specifications to 3D models and to show examples of query and response behaviour.

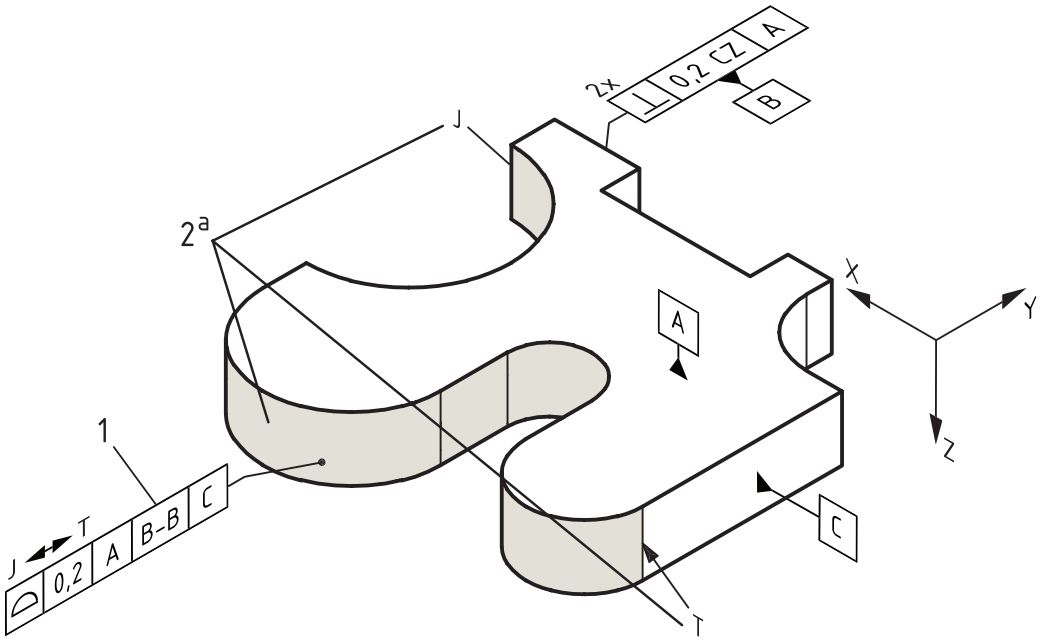
C.2 Examples

C.2.1 Usage of "between" symbol

In Figure C.1 a) the symbol "between" is used to apply a specification to multiple features. See Figure C.1 b) for query and response.



a) Placement and attachment



b) Tolerance associativity

Key

1 query

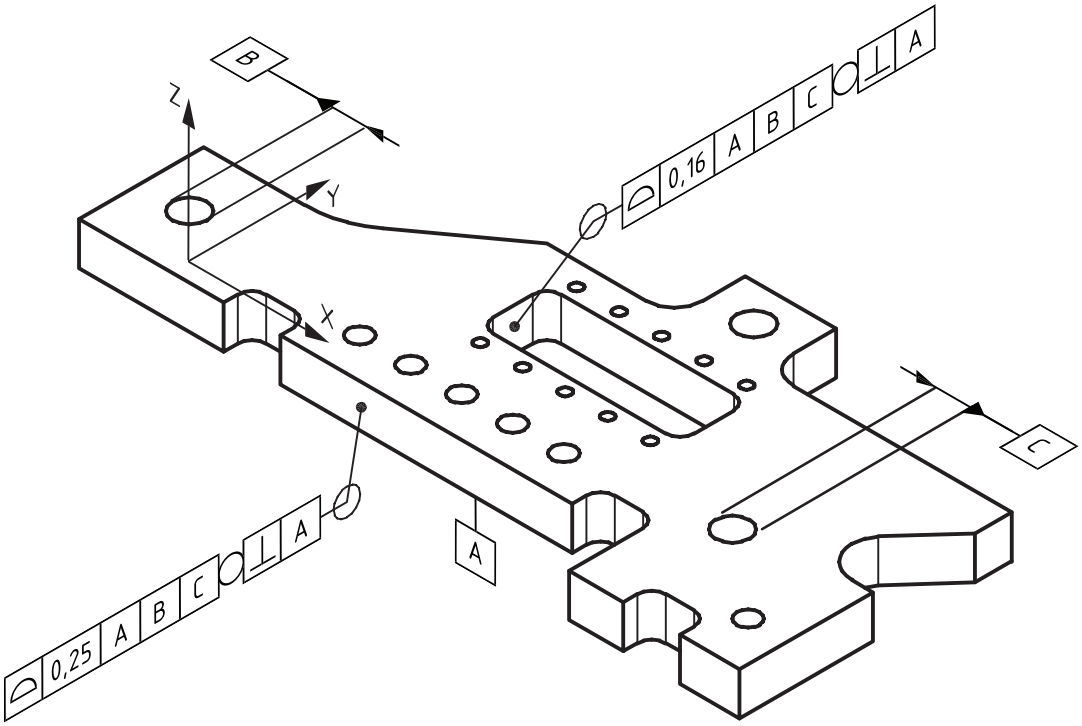
2 visual response

a All surfaces residing between lines J and T.

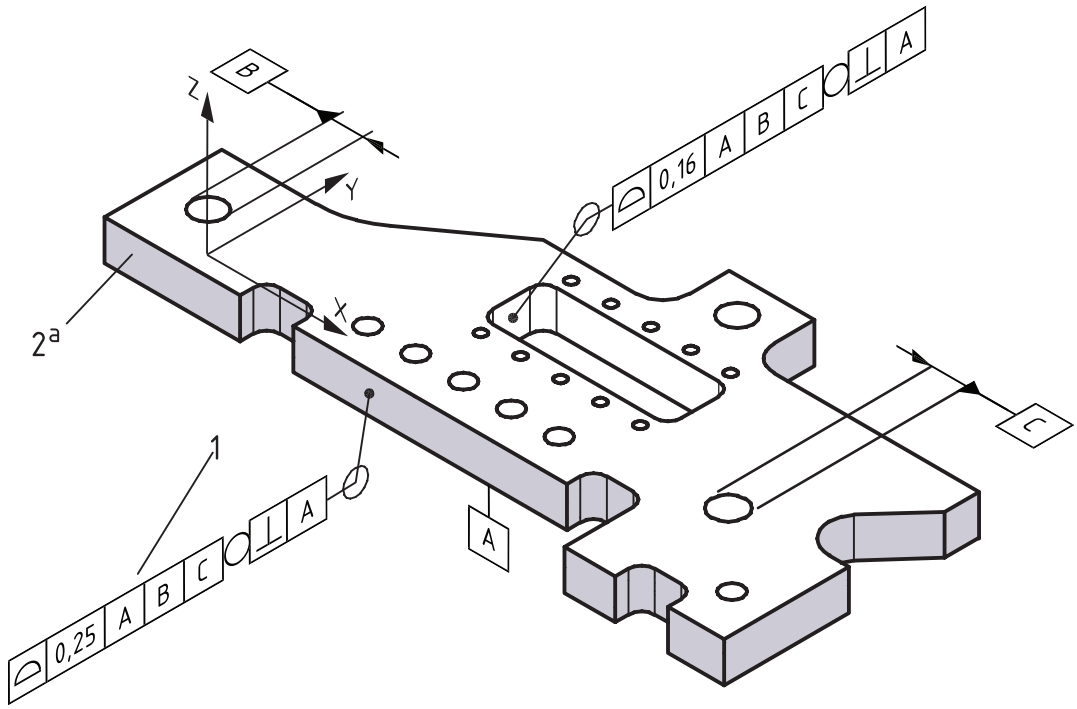
Figure C.1 — Profile — Between basis

C.2.2 All-around application

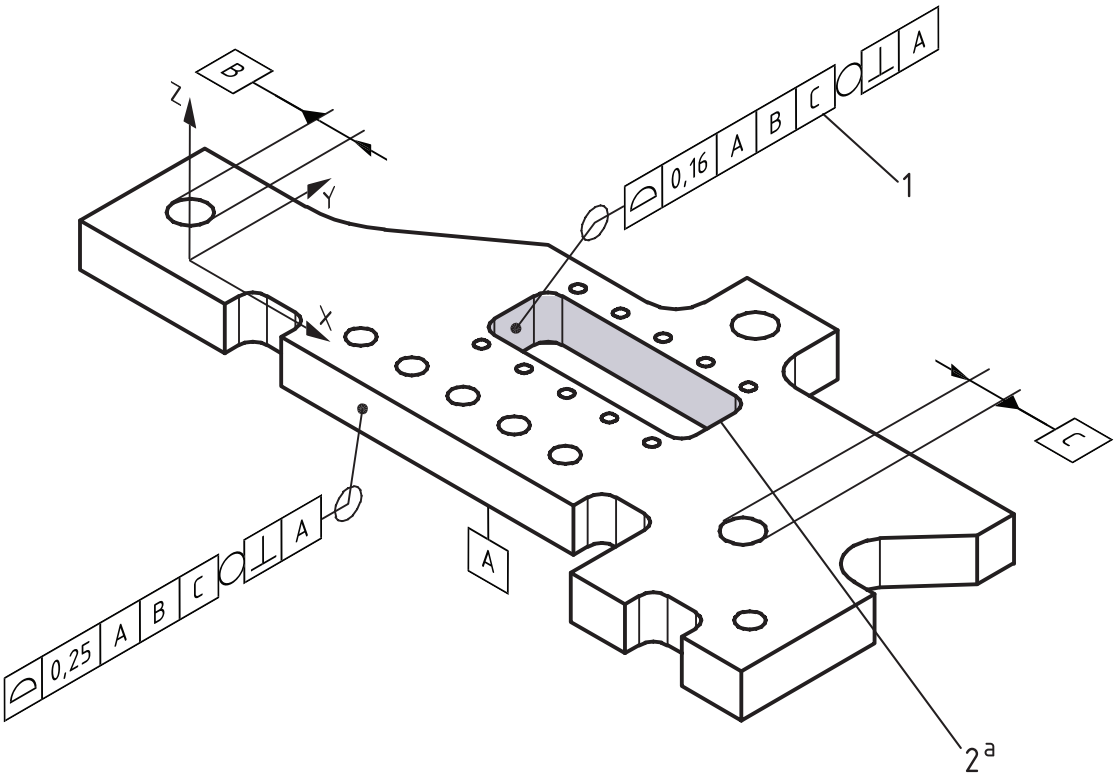
In Figure C.2 a) the symbol “all around” and the collection plane indicator are used to apply a specification to multiple features. Figure C.2 b) and Figure C.2 c) illustrate the response when the specifications are queried.



a) Placement and attachment



b) Tolerance associativity



c) Tolerance associativity

Key

1 query
2 visual response
a All contiguous surfaces in the closed path.

Figure C.2 — Profile — All-around application

C.2.3 Conical surface and surface of revolution

In Figure C.3 the direction feature indicator is used to define the direction of width of the tolerance zone.

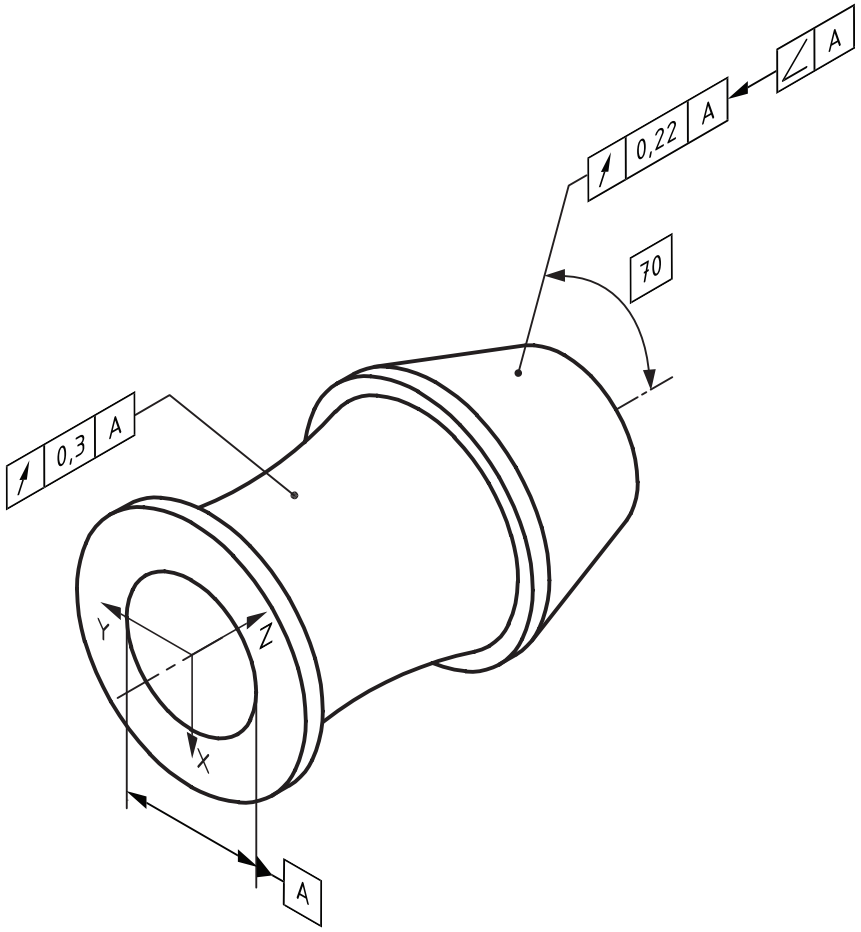


Figure C.3 — Conical surface and surface of revolution — Leader attachment

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[5] ISO 14405-2, *Geometrical product specifications (GPS) — Dimensional tolerancing — Part 2: Dimensions other than linear or angular sizes*

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[7] ASME Y14.41:2012, *Digital Product Definition Data Practices*

[8] ASME Y14.100, *Engineering Drawing Practices*

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