

Technical product documentation (TPD) — Digital product definition data practices

ICS 01.110

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee TDW/4, Technical product documentation — Methodology, presentation and verification, upon which the following bodies were represented:

- Ball and Roller Bearing Manufacturers' Association
- British Engineers Cutting Tools Association
- British Foundry Association
- British Metal Casting Association
- British Standards Society
- Castings Development Centre
- City of Birmingham Polytechnic
- Drawing Office Material Manufacturers' Association
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Foreword

This Draft for Development is equivalent to a draft standard, currently under development within ISO/TC 10/WG 16, that in turn has been based on a provisional draft developed in the USA. The project has been the subject of considerable invested effort, over several years, by "The American Society of Mechanical Engineers (ASME)", with participation by a number of the major 3D modelling, software developers.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature, because the concepts it embodies are relatively new and it is believed that a period of practical application will be beneficial to its final development. It should be applied, therefore, on this provisional basis, so that information and experience as to its practicality and particularly the appropriateness of its output, may be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the International Standards Committee responsible for its future development. A review of the experience gained in the use of this draft, will be initiated within 2 years of its publication so that the technical content of the United Kingdoms input to the ISO Committee's deliberations, on to the future direction of the International Standard, can be determined. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards*.

On the basis of the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the progression of this draft to a full International Standard, implemented as a European Standard and in turn a British Standard, or to withdraw it. Comments should be sent in writing to the Secretary of BSI Technical Committee TDW/4, Technical product specification — Methodology, presentation and verification, at 389 Chiswick High Road, London W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

A list of organizations represented on this committee can be obtained on request to its secretary.

Compliance with a Draft for Development does not of itself confer immunity from legal obligations.

Introduction

The figures in this Standard are intended only as illustrations to aid the user in understanding the practices described in the text. In some cases, figures show a level of detail as needed for emphasis; in other cases, figures are only complete enough to illustrate a concept or facet thereof. The absence of figures has no bearing on the applicability of the specified requirement or practice. To comply with the requirements of this Standard, actual data sets shall meet the content requirements set forth in the text.

Most figures are illustrations of models in a three-dimensional environment. Figures illustrating drawings in digital format have a border included.

Text in uppercase letters used in the figures are intended to appear in data sets. Text in lower case letters are explanatory of the figures only and are not intended to appear in data sets.

The concepts in this standard apply equally to individual parts, items or assemblies. The term "part" has been used, throughout, to simplify the text.

1 Scope

This Draft for Development specifies requirements for, and references documents applicable to, the preparation and revision of digital product definition data, hereafter referred to as data sets. The draft defines exceptions and additional requirements to existing ISO standards for using product definition digital data sets or drawings in digital format. Where no exception or additional requirements are identified, existing ISO standards apply.

This draft supports two methods of application: model only, and model and drawing in digital format. The structure starts with requirements common to both methods, and then addresses the sections that have differing requirements for each method. Guidelines for best practices have been developed to aid in the continuity of the life cycle process of design through release, and to support design, manufacture, and inspection. In addition, it provides a guide for the many CAD software packages to develop better modelling and annotation practices for computer aided design and engineering disciplines.

2 Normative references

The following referenced documents are indispensable for the application 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.

BS EN ISO 3098-0, *Technical product documentation (TPD) — Lettering — General requirements*.

BS EN ISO 3098-5, *Technical product documentation (TPD) — Lettering — CAD lettering of the Latin alphabet, numerals and marks*.

BS EN ISO 5456-2, *Technical drawings — Projection methods — Orthographic representations*.

BS EN ISO 5456-3, *Technical drawings — Projection methods — Axonometric representations*.

BS EN ISO 5456-4, *Technical drawings — Projection methods — Central projection*.

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

BS EN ISO 11442-1, *Technical product documentation — Handling of computer based technical information — Security requirements*.

BS ISO 128-30, *Technical drawings — General principles of presentation — Basic conventions for views*.

BS ISO 128-34, *Technical drawings — General principles of presentation — Views on mechanical engineering drawings*.

BS ISO 128-40, *Technical drawings — General principles of presentation — Basic conventions for cuts and sections*.

BS ISO 128-44, *Technical drawings — General principles of presentation — Sections on mechanical engineering drawings*.

BS ISO 128-50, *Technical drawings — General principles of presentation — Basic conventions for representing areas on cuts and sections*.

BS ISO 129, *Technical drawings — Dimensioning — General principles, definitions, methods of execution and special indications*.

BS ISO 406, *Technical drawings — Tolerancing of linear and angular dimensions*.

BS ISO 1101, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run out — Generalities, definitions, symbols and indications on drawings*.

BS ISO 7200, *Technical drawings — Title blocks*.

BS ISO 10578, *Technical drawings — Tolerancing of orientation and location — Projected tolerance zone*.

ISO 31-0:1992, *Specification for quantities, units and symbols — General principles*.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1

annotation

dimensions, tolerances, notes, text, or symbols visible without any manual or external manipulation

3.2

annotation plane

conceptual plane containing annotation that either perpendicularly intersects, or is coincident with one or more surfaces of a feature of the model

3.3

assembly model

model in which the product described is an assembly of two or more items

3.4

associated entities

portion of a product definition to which annotation pertains

3.5

associated group

user-defined set of related digital elements

3.6

associativity

established relationship between digital elements

3.7

attribute

dimension, tolerance, note, text or symbol required to complete the product definition or feature of the product that is not visible but available upon interrogating the model

3.8

data

information represented in a formal manner suitable for communication, interpretation, or processing by human beings or computers

3.9

datum system

partial or complete datum reference frame

3.10

derivative

data duplicated or extracted from the original

NOTE A copy of a derivative is also a derivative.

3.11

design model

portion of the data set that contains the model geometry

3.12

digital element

geometric element, feature of the model, group of features of the model, annotation, associated group or, attribute that exists in a data set

3.13

digital element identifier

label or name used to specify a unique digital element

3.14

direction dependent tolerance

tolerance that invokes a zone of parallel lines or curves

3.15

geometric element

graphic entity used in a data set, e.g. point, line, plane, surface, solid, model co-ordinate system or, cross-hatching

3.16

hard copy

printed or plotted copy of a displayed image on a medium such as paper or polyester film

3.17

installation model

model in which the product described is an installation, showing parts or assemblies and a partial or complete representation of the installation site

3.18

management data

data required for the release, control, and storage of product definition data as well as other relevant engineering data

3.19

model

combination of design model, annotation and attributes that describes a product

3.20

model co-ordinate system

representation of a Cartesian co-ordinate system in a product definition data set

3.21

model geometry

geometric elements in product definition data which represent designed product

3.22

model value

numerical value derived by interrogating the model that quantifies the form and spatial relationships of the geometry composing a design model or assembly of models to the precision (number of decimal places) of the computer system

3.23

product definition data

totality of data elements required to completely define a product

3.24**product definition data set**

collection of one or more computer file(s) that discloses (directly or by reference), by means of graphic or textual presentations, or combinations of both, the physical and functional requirements of an item

3.25**query**

means of interrogating a digital element or the relationship between digital elements

3.26**represented line element**

supplemental geometry line or curve segment indicating the orientation of a direction dependent tolerance

3.27**resolved dimension**

model value that is rounded off to the number of decimal places required for the design

3.28**saved view**

stored and retrievable specific orientation and a magnification factor of a model

3.29**special character**

character not included in the set of letters A-Z, a-z, numerals and punctuation symbols

3.30**supplemental geometry**

geometric elements included in product definition data to communicate design requirements but not intended to represent a portion of the manufactured product

4 Product definition data set identification and control

4.1 General

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 clause 5.4.

The data set identifier shall be unique and consist of numeric, alpha 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 BS EN ISO 11442-1.

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

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

The BS EN ISO 11442 series of standards provides descriptions and specifies the relationships between drawings and drawing numbers, including part or identifying numbers.

4.2 Related data

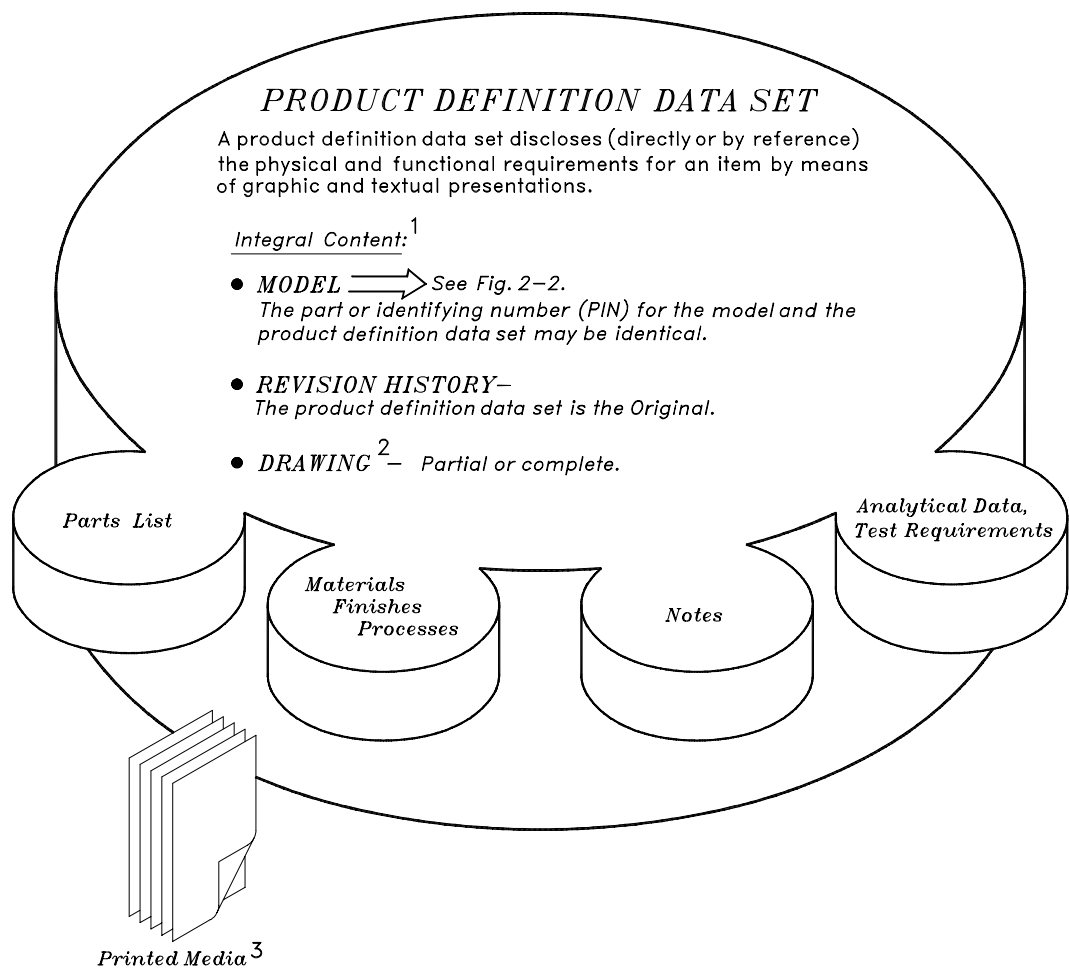
Related data shall be integral to or referenced in the data set. Related data consists of, but is not limited to the following: analytical data, parts lists, test requirements, material specifications, process and finish requirements in accordance with figure 1.

4.3 Data management

The structure and control requirements for data management shall include the following.

- a) Control and tracking information of the data sets. This system may include work in process, data review status, model checked status, release status, design tool and version, libraries etc.
- b) Approval of data sets, in accordance with BS EN ISO 11442-1.
- c) Ongoing control and availability, throughout the life cycle of a product.
- d) Revision history information, maintained within the data set.

NOTE ISO 11442-6, Technical product documentation – Handling of computer-based technical information- Part 6: Rules for revision, currently in development, will provide assistance with this, when published.



1. 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.
2. A drawing is not required for Model Only data sets.
3. Related data may be manually or computer generated.

Figure 1 — Contents of a product definition data set

5 Data set requirements

5.1 General

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

5.1.1 Fundamental dimensioning and tolerancing requirements

The following define the fundamental dimensioning and tolerancing requirements that are applicable to both models and drawings (5.1.1.1), that are specific to models (5.1.1.2), and that are specific to drawings only (5.1.1.3).

5.1.1.1 Common to annotated models and drawings

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

The ability to query the model shall be available, see clause 7.2.

There is no implied 90° basic angle rule for a model. All angular values shall be queried from the model, see clause 9.3. Exceptions to this are the model co-ordinate system(s) and planes associated with a datum reference frame(s) and orthographic views.

Direct tolerancing methods, as defined in BS ISO 406, should only be used to define the size of a feature. Geometric tolerancing is the preferred method.

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.

Rounding requirements for resolved dimensions shall comply with clause 9.2.

When tolerancing features, alignment of the annotation plane to the true profile is not required.

Values queried from the model for any feature(s) without limit, plus or minus, or, geometric tolerance(s) shall be reference dimensions.

Legibility requirements of BS EN ISO 3098-0 and BS EN 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.

5.1.1.2 Applicable to models only

All annotation shall be specified in one or more annotation planes. When a CAD system does not support maintenance of annotation plane orientation relative to the model, the model only method shall not be used, see clause 7.2.

The associated entities, annotation, and attributes shall be in agreement, see clause 7.2.

Resolved dimensions created from queried model values are considered the same as values specified in BS ISO 129 as expressed dimensions, see clause 9.2.1.

The term TRUE, when used with a dimension, shall not be used on models.

Display of centre lines or centre planes for features of size are optional.

To ensure the annotation is being interpreted as intended, for example the text could be upside down or backwards following rotation of the model, one of the following techniques shall be used:

Ensure the reading direction is updated after rotation of a model;

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

When using saved views, ensure the model is orientated in the intended view direction. For example, this may be accomplished by including a means of determining the correct reading direction in the view.

Dimensions and tolerances may be shown to internal features without the use of a section, see figure 27 c).

5.1.1.3 Applicable to drawings only:

Dimensions, tolerances, datum specifications and, notes shall be shown in true profile views and refer to visible outlines, or appear in 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. Annotation shall not overlap other annotation. Annotation shall not overlap the part.

5.1.2 Design model requirement

A design model is required and shall be in accordance with clauses 5.2 and 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 co-ordinate systems

A design model shall contain one or more model co-ordinate systems. A model co-ordinate system shall be depicted by three mutually perpendicular lines with its origin located at the intersection of the three axes. Each axis shall be labelled and the positive direction shown. Model co-ordinate systems shall be right-handed unless otherwise specified, see figure 2.

5.2.3 Applications of supplemental geometry

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

5.2.3.1 The following geometric tolerances may use a represented line element to clarify the directionality of a two-dimensional tolerance zone of parallel lines. When a represented line element is used to indicate the direction of a geometric tolerance application, the leader from the feature control frame shall terminate on the represented line element in an arrowhead, see figure 44.

For straightness applied to the line elements of a planar surface, see table 3 and figure 44.

For orientation tolerance applied on an each element basis, see clause 12.2.2.1 and figure 49.

For line profile. See clause 12.2.3 7) and figure 60.

5.2.3.2 The represented line element, the feature control frame and, the controlled feature of the model should be organized as an associated group, see figures 44, 49, and 60.

5.2.4 Part features not fully modelled

A simplified representation of part features such as threads, holes, fillets, rounds and, drafts may be shown using partial geometry definition, annotations, attributes or a combination thereof, see figure 11.

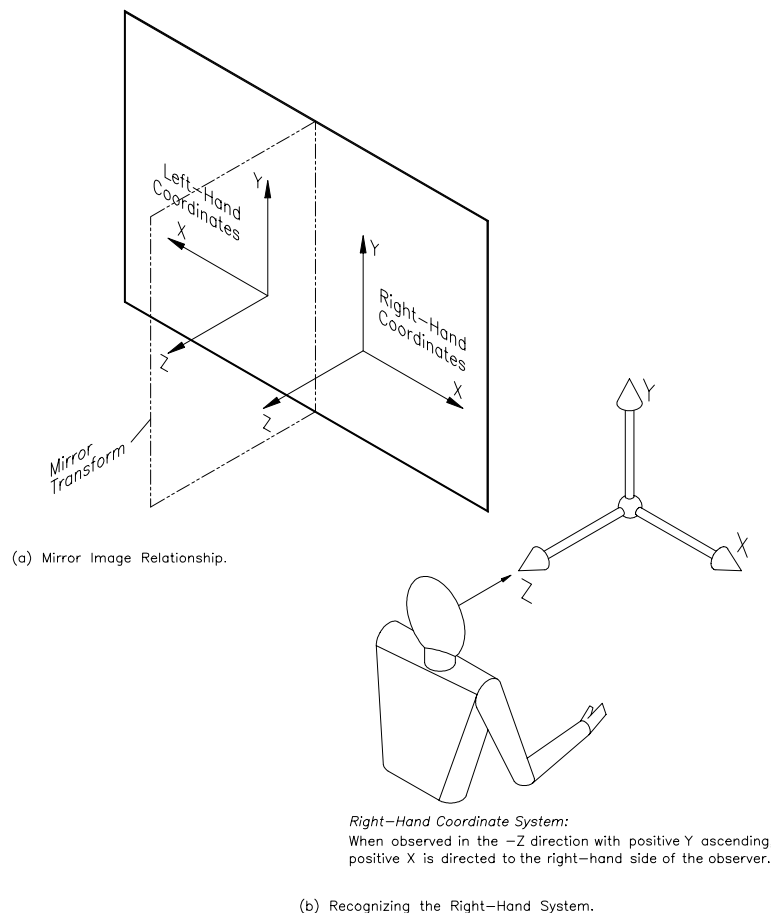


Figure 2 — Left-hand and right-hand model co-ordinate systems

5.3 General method requirements

5.3.1 Data set

The following paragraphs cover the product definition methods listed below. 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, and any hard copy output is a derivative.

5.3.2 Model only

The following describes requirements when complete product definition is contained in the model.

5.3.2.1 Product definition data, including but not limited to notes, parts lists, marking requirements, dimensions and, tolerances shall be contained or referenced in the data set.

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

- Name and address of the company or design activity for the data set
- Data set title
- Data set number
- Approval indicators and approval dates
- Contract number when required
- Originator's name and date
- Issue identifier

5.3.2.3 When working with a model, the first or third angle projection symbol in accordance with BS EN ISO 5456-2 is not required.

5.3.3 Model and drawing

The following describes requirements when complete product definition is contained in the model and drawing.

5.3.3.1 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, or on the drawing or, a combination thereof.

NOTE The development of a drawing that provides a complete product definition is allowed.

5.3.3.2 Product definition data created or shown in the model and subsequently shown on the drawing shall be in agreement.

5.3.3.3 Product definition data created and shown on the drawing shall not conflict with product definition data in the model.

5.3.3.4 The drawing shall contain a drawing border and title block information in accordance with BS EN ISO 5457 and BS ISO 7200.

5.3.3.5 The drawing shall reference all applicable models and data for the product specified on the drawing.

5.3.3.6 Minimum drawing hard copy output capability shall be in accordance with BS EN ISO 5456-3 and BS EN ISO 5456-4, BS EN ISO 5457, BS ISO 7200 and BS ISO 128-40, BS ISO 128-44 and BS ISO 128-50.

5.3.3.7 Annotation displayed on the drawing shall be interpretable without the use of query.

5.3.3.8 When complete product definition is not contained on the drawing, it shall be noted.

5.3.3.9 When complete product definition is not contained in the model, it shall be noted.

5.4 Management data

5.4.1 Location

Management data which is not placed on a drawing, shall be placed on the model or in the data set separate from the model or drawing as indicated in 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 (see Annex C for explanation of terms):

- Application data;
- Approval;
- Data set identification;
- Design activity transfer;
- Revision history for the data set;
- Design stage identifier.

5.4.3 Management data on a model

Management data placed on a model shall be placed on a management data annotation plane or an equivalent method. The annotation plane shall be available for display with the model. When displayed, the management data annotation plane does not rotate with the model. Management data placed on a model includes, but is not limited to the following (see Annex C for explanation of terms):

- Reference to this standard;
- CAD maintained notation;
- Design activity identification;
- Duplicate original notation;
- Item identification;
- Metric notation;
- Navigation data.

5.5 Security marking

5.5.1 General

Security marking shall be placed in the file(s) or in the referenced document(s) to which it applies. The following requirements pertain to models.

5.5.2 Location on models

Security marking shall be placed on an annotation plane, or equivalent. The annotation plane or equivalent, containing this information, shall be available for display with the model. Reproductions of

technical data, or any portions thereof, subject to asserted restrictions shall also reproduce the asserted restrictions. When displayed, the security data annotation does not rotate with the model.

5.5.3 Enhanced security

Models containing classified information shall contain the applicable security markings and shall be controlled in accordance with the applicable security level. The applicable security markings shall be constantly displayed for all mediums of viewing.

5.5.4 Company intellectual property

Company Security Marking Models containing company intellectual property may include notes to this effect. These include but are not limited to company proprietary notes and competition sensitive. The display and control shall be in accordance with company policy.

5.5.5 Government notices, statements and legends

Models may require government notices, statements and, legends. Contractual requirements determine which are applicable. These include, but are not limited to copyright notices, distribution statements, export control notices and rights in data legends.

5.6 Views on models

5.6.1 General

BS ISO 128-30, BS ISO 128-34, BS ISO 128-40, BS ISO 128-44 and BS ISO 128-50 apply. The following clauses describe exceptions or additions to views on models.

5.6.2 Saved views

5.6.2.1 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 co-ordinate system and may contain one or more of the annotation plane, a selected set of annotation, or a selected set of geometry

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

5.6.3 Cutting planes

5.6.3.1 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 solid or phantom lines. A means to identify all cutting planes in a model shall be available. A visible viewing arrow or arrows drawn to the plane shall be included to show the direction in which the section is viewed, see figure 3a. The indication of views and sections shall be in accordance with BS ISO 128-30, BS ISO 128-34, BS ISO 128-40, BS ISO 128-44 and BS ISO 128-50. To relate the cutting plane to its section view, upper case letters such as A, B, C, etc., shall be placed near the viewing arrow or arrows. The corresponding section views are identified as SECTION A, or SECTION A-A when two viewing arrows are used. Section letters should be used in alphabetical order excluding I, O, Q, S, X, Y and, Z. When the alphabet is exhausted, additional sections shall be indicated using double letters in alphabetical order, as in AA, AB, AC, etc., or AA-AA, AB-AB etc., when two viewing arrows are used.

5.6.3.2 The result of the section cut may be shown either by removing material from the part, see figure 3b, or by display of the curves overlaid on the model that result from intersecting the cutting plane with the part, see figure 3c.

5.6.3.3 Multiple, connected cutting planes shall be used for offset sections, see figure 4.

5.6.3.4 Aligned sections, removed sections and revolved sections shall not be used on design models.

5.6.3.5 Broken-out sections shall be accomplished as offset sections, see also 5.6.3.2.

5.6.3.6 Foreshortened and aligned features as well as rotation of features shall not be used on design models.

5.6.3.7 Section views shall be derivatives of the design model. Changes to the design model shall cause section views to be updated accordingly.

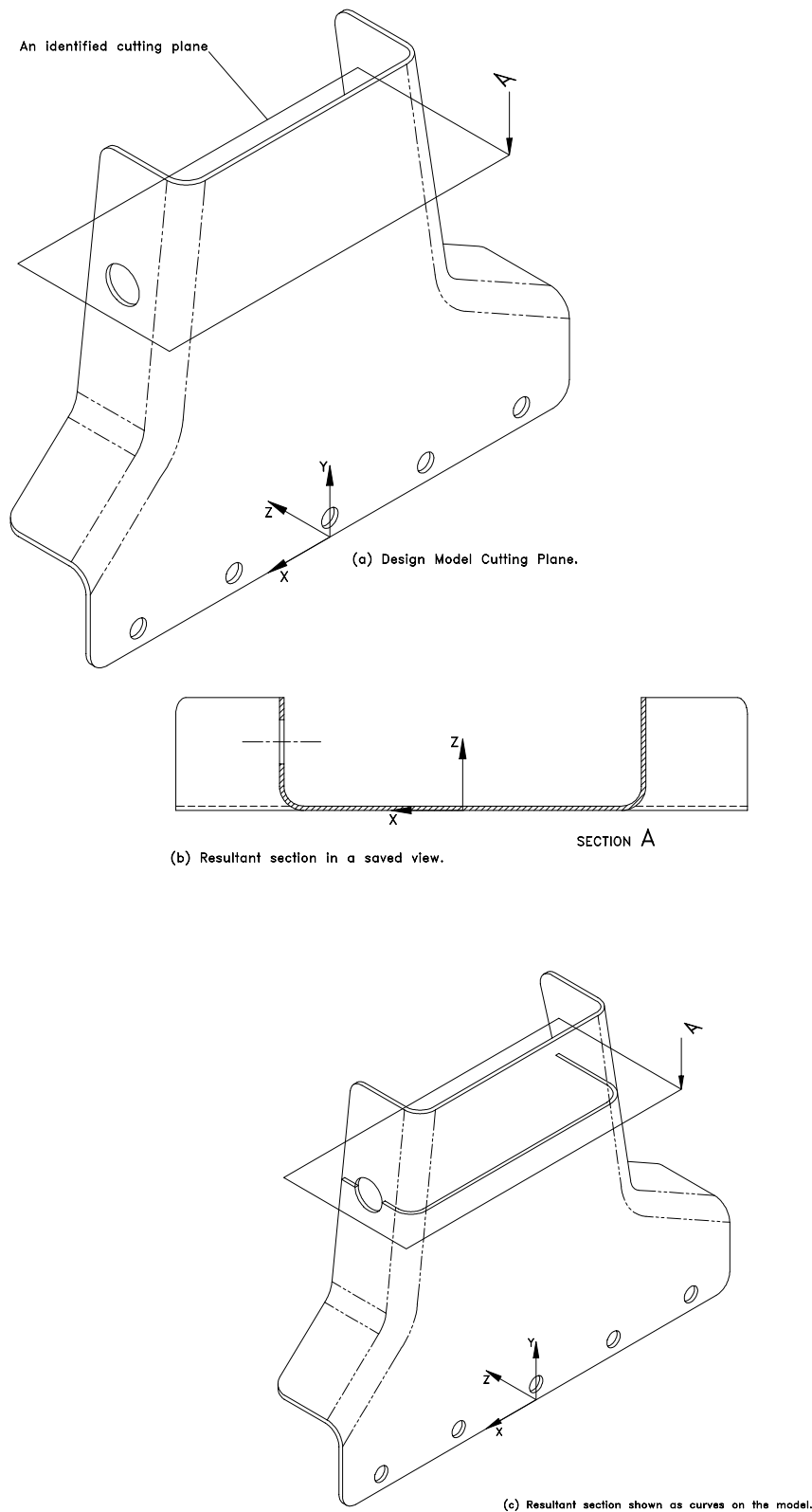


Figure 3 — Design model cutting plane

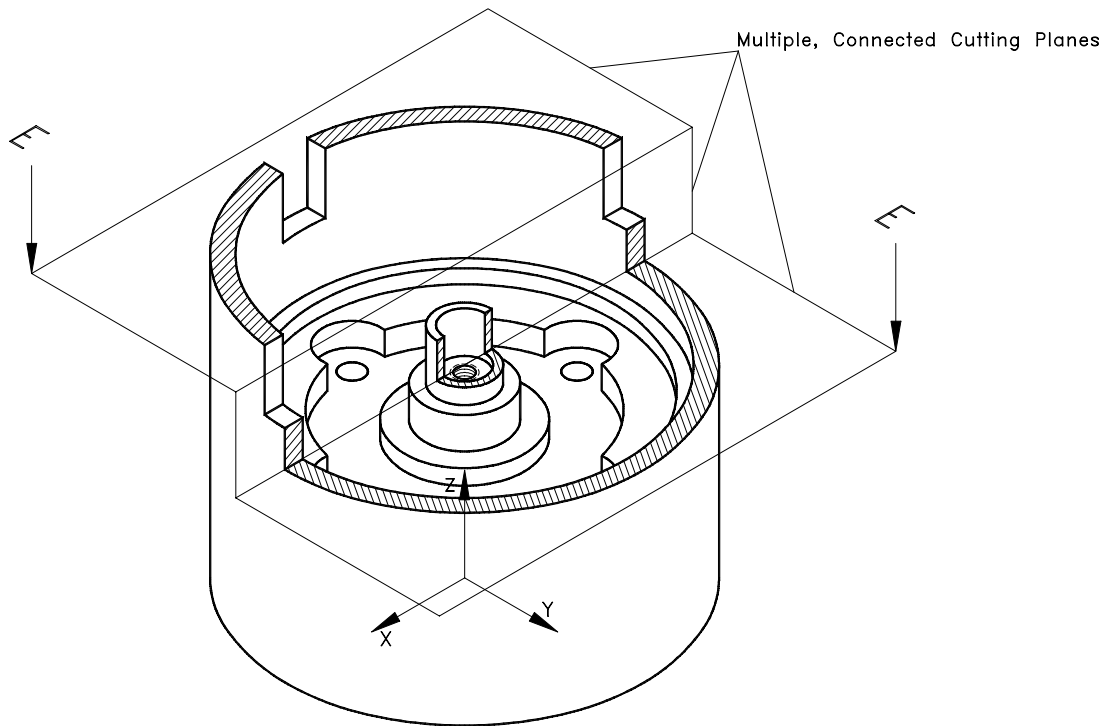


Figure 4 — Design model with offset section

6 Model requirements

6.1 General

This clause establishes the requirements for a design model. Design models represent ideal geometric constructs; that is, perfect dimensionality and shape aspect of the part geometry are assumed. Parts shall be modelled at a specified dimensional condition, for example minimum, maximum, nominal or mean. The dimensional condition shall be specified as a general note.

6.2 Geometric scale, units and precision

The following are the requirements concerning the scale, units and precision of a design model.

- Design models shall be modelled at a scale of 1:1.
- The units of measure at which the design model is created shall be specified within the data set.
- The design model precision indicates the numeric accuracy required in the production of the part in order for it to fulfil the design intent. The number of significant digits 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.

6.3 Model completeness

The model shall contain geometry, attributes and annotation as required to provide a complete definition of the part (see figure 5).

- Models not fully modelled shall be identified as such; e.g. partially modelled symmetrical part.

- Features that are not fully modelled shall be identified as such; e.g. threaded holes that are only shown as holes.

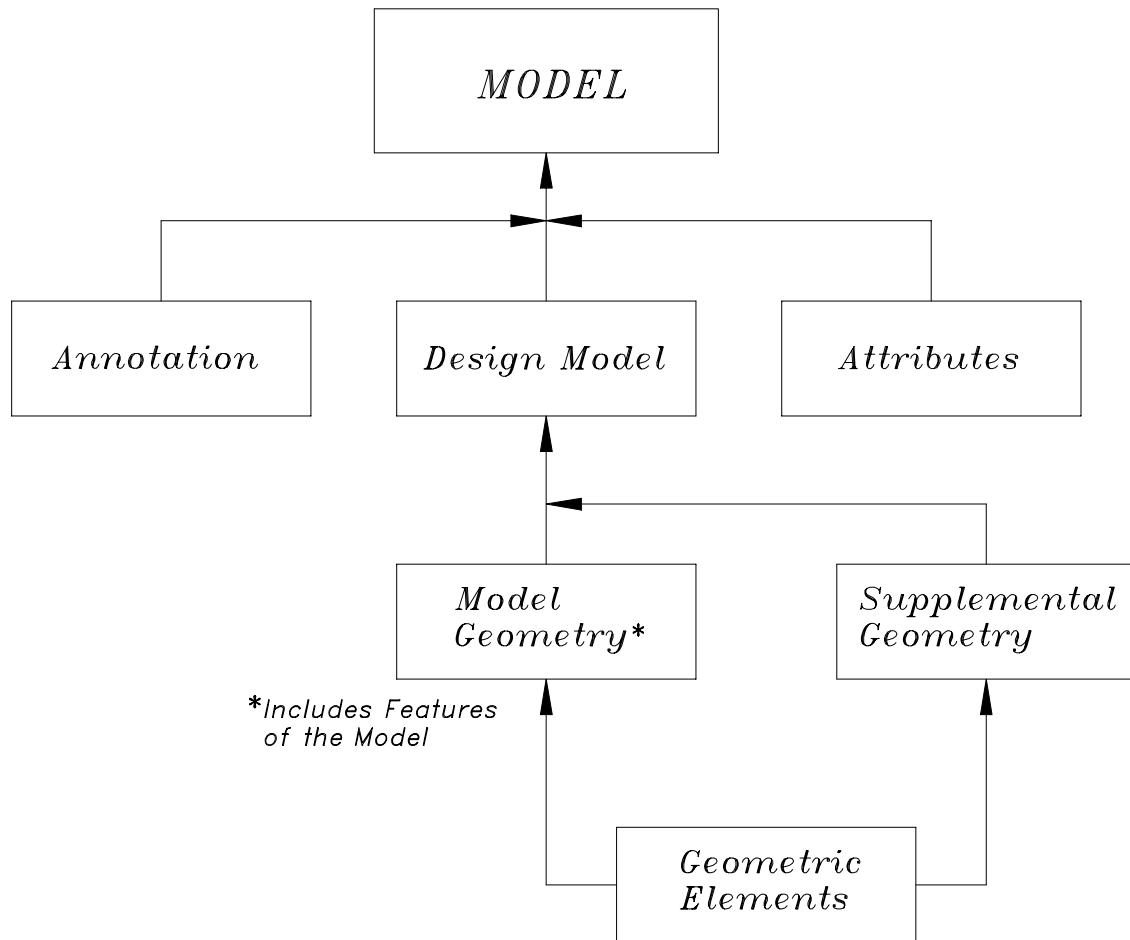


Figure 5 — Content of a model

6.4 Assembly model completeness

Assembly model completeness shall be in accordance with clause 6.3 except part and sub-assembly models shown in the assembly model need only have sufficient detail shown to ensure correct identification, orientation and placement. The assembly model may be shown in an exploded, partially assembled or, completely assembled state. The placement of parts and sub-assemblies within the assembly may alternatively be defined via annotation, or a combination of annotation and pictorial representation of the model.

6.5 Installation model completeness

Installation completeness shall be in accordance with clauses 6.3 and 6.4 except part 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 may be shown using supplemental geometry, annotation or a combination of both. Location and orientation of parts and assemblies may be shown by geometric definition, annotation or a combination of both.

7 Common requirements for product definition data

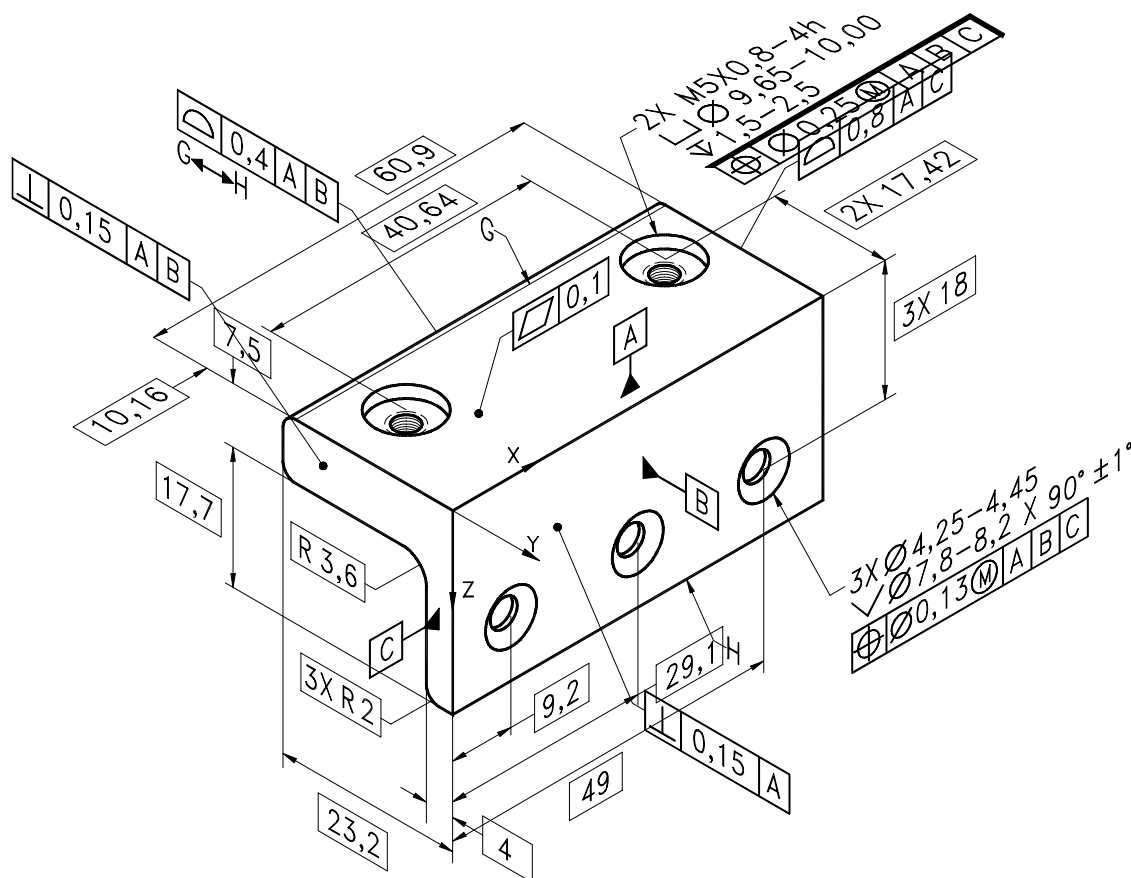
This Section establishes the common requirements for the application, display management, and query of product definition data. Specific requirements for particular types of product definition data are described in clauses 6 through 10.

7.1 Common requirements

The following paragraphs describe requirements common to models and drawings.

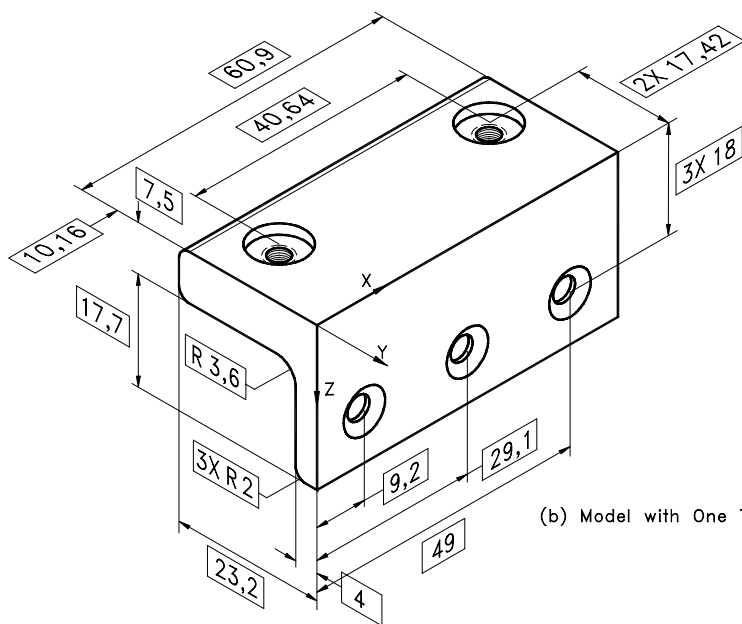
7.1.1 Display management

Display management shall include the ability to enable or disable the display of all annotation, annotation by type or selected annotation, see figure 6 and 7.

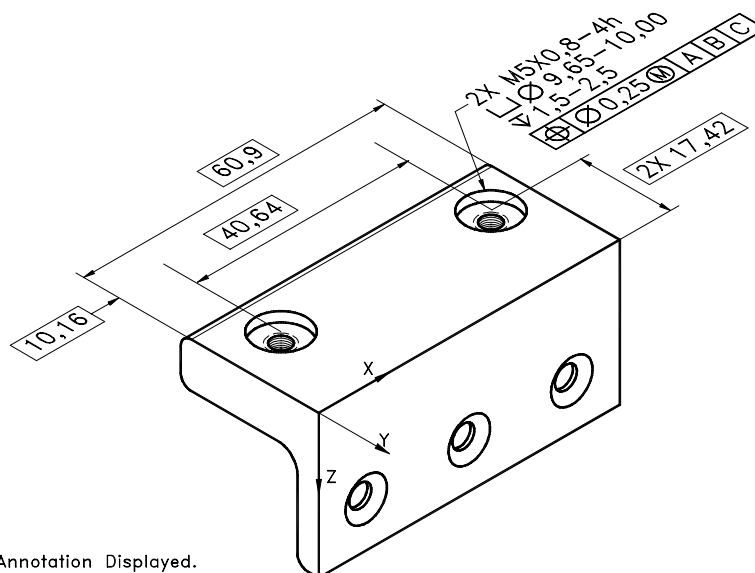


(a) Model With All Annotation Displayed.

Figure 6 — Display management



(b) Model with One Type of Annotation Displayed.



(c) Model with Selected Annotation Displayed.

Figure 7 — Display management (continued)

7.1.2 Hard copy

A hard copy of any given visual display shall be available on demand. When a hard copy is intended to be used as an engineering drawing it shall meet applicable drawing standards.

7.2 Model requirements

The following paragraphs describe 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 12, see figure 8 for a diagram showing the relationship between annotation and model geometry.

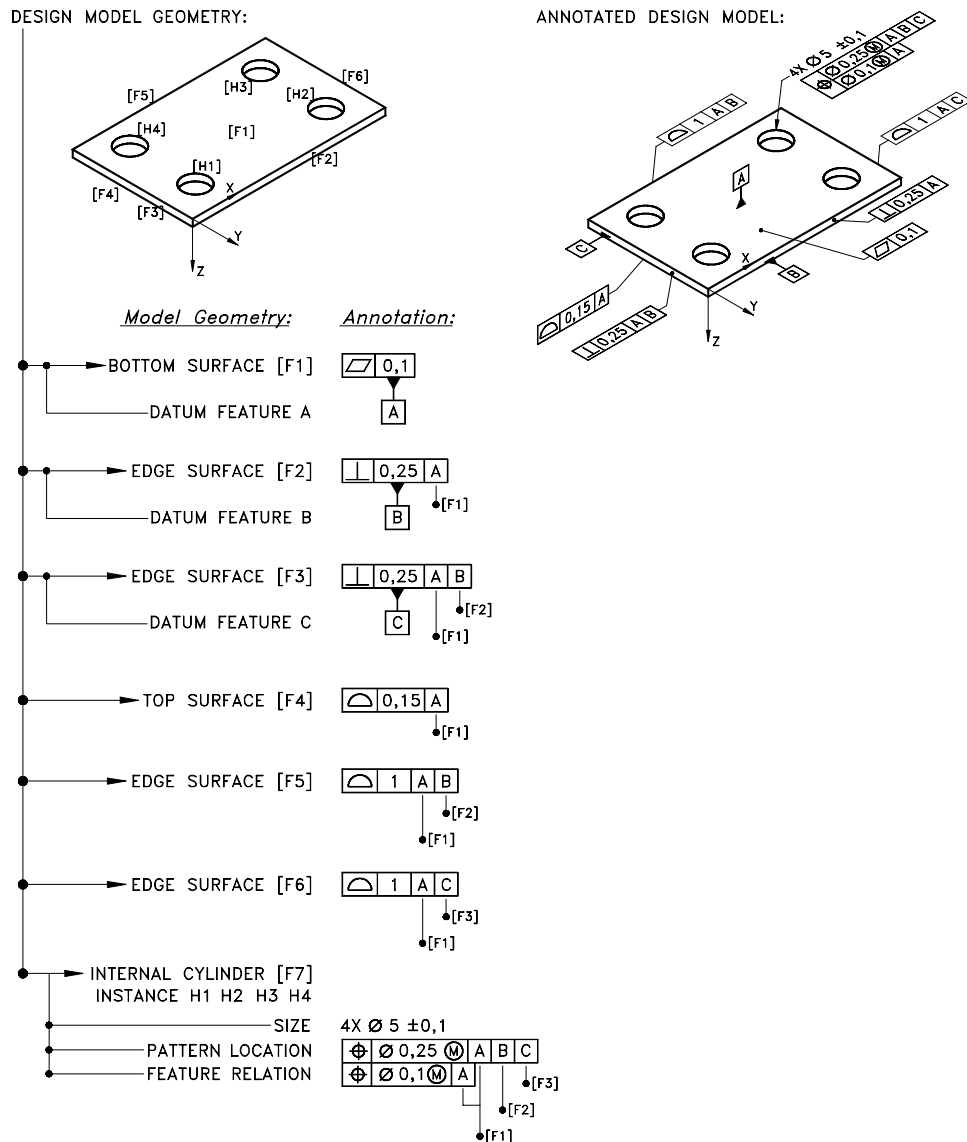


Figure 8 — Annotation and model geometry relationship

7.2.1 Associativity

The following are general requirements for defining an associative relationship between digital elements.

Annotation may be associated by selecting a feature of the model, a group of features of the model, or a portion of an applicable feature of the model. For an example of the associated features of the model for a dimension, see Fig. 9 and 10.

Annotation, model geometry, and supplemental geometry may be placed into associated groups to indicate their relationships.

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

EXAMPLE 2 A model co-ordinate system for datum symbols and datum targets

EXAMPLE 3 Other annotation. This could include qualifying notes and size limits indications

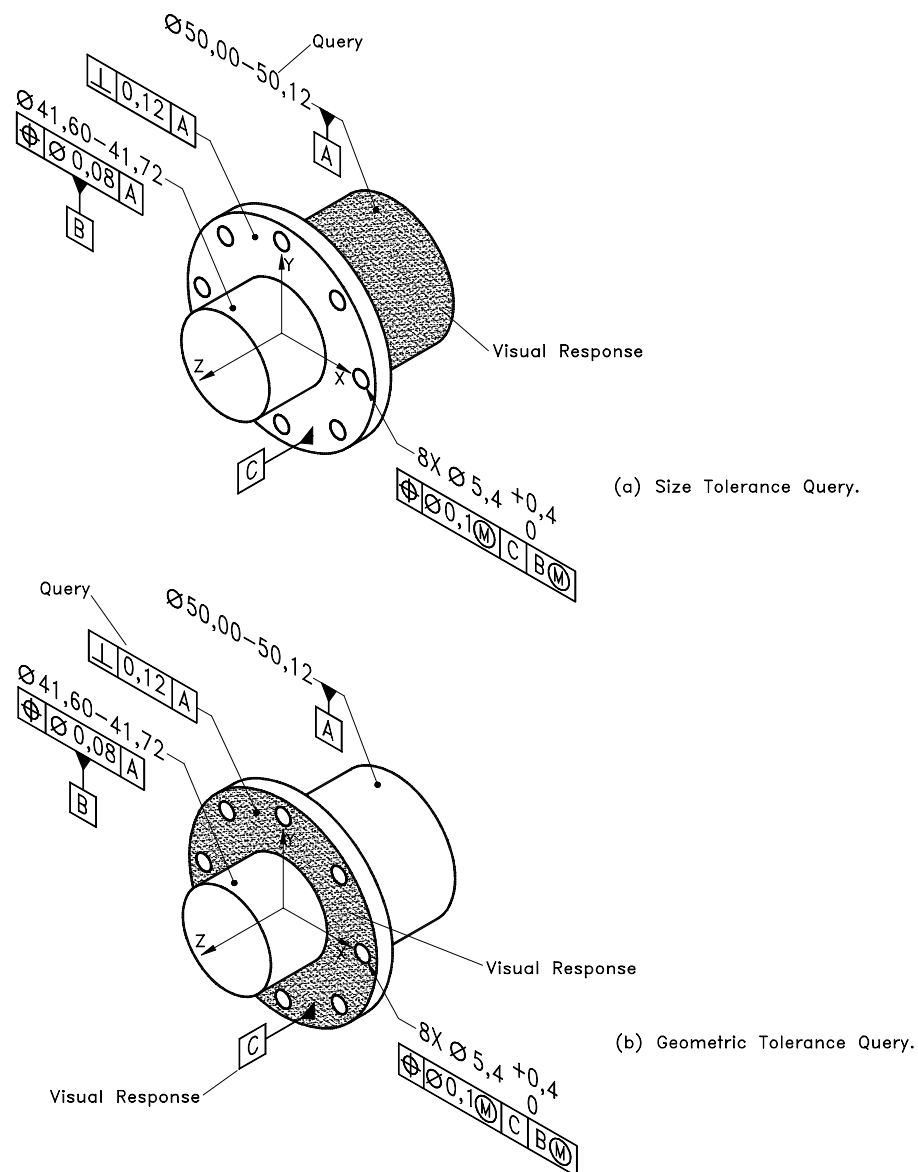


Figure 9 — Tolerance query associativity

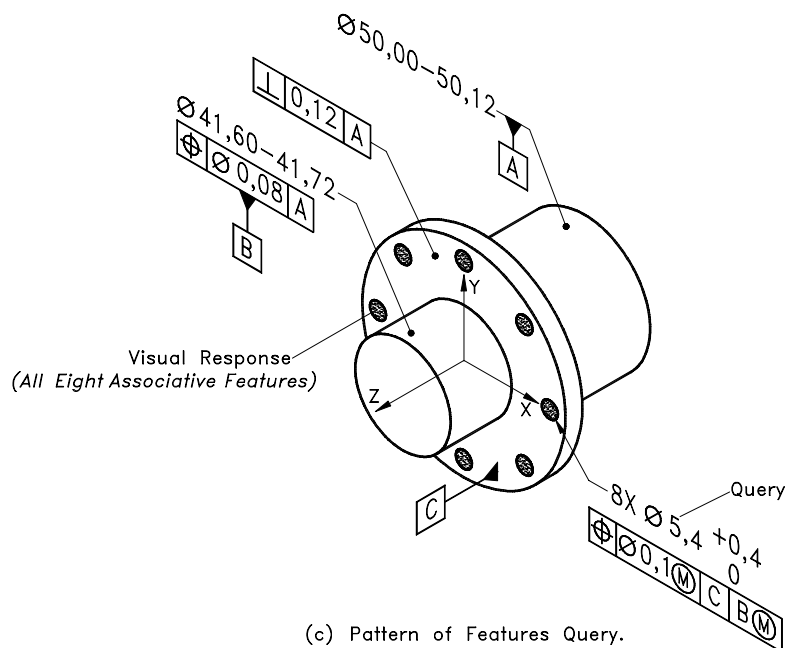


Figure 10 — Tolerance query associativity (continued)

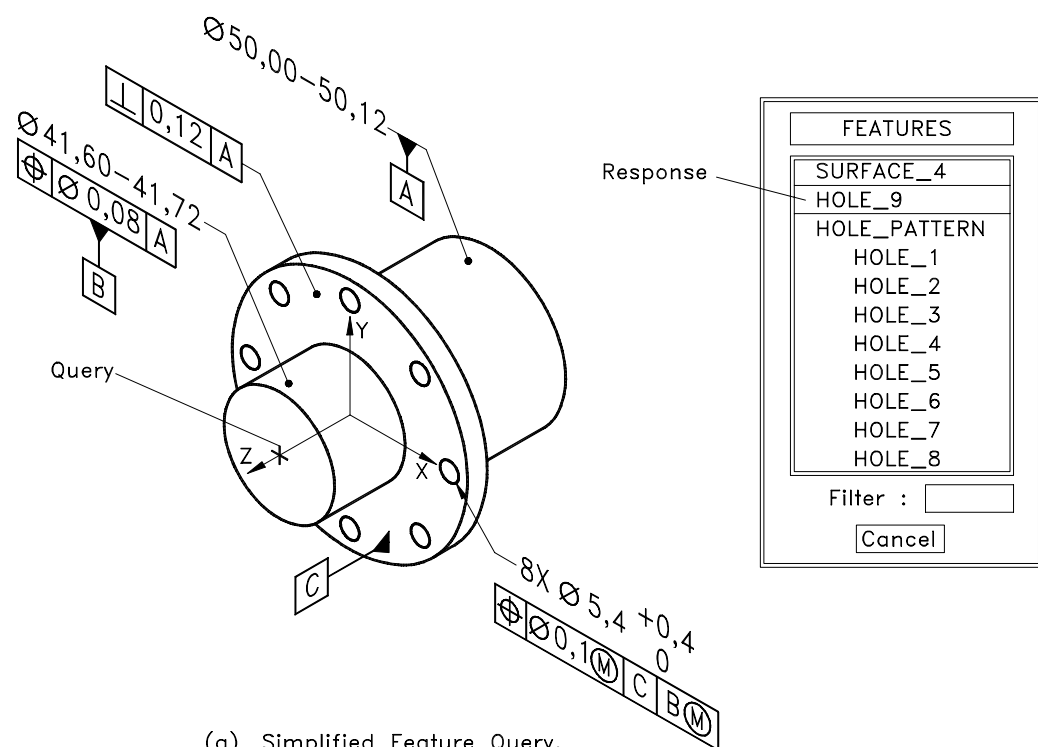
7.2.2 Attributes

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 11 for an example of how the attributes of a hole could be represented. Applications of attributes include, but are not limited to, coatings, knurling, threaded holes, and pins.

7.2.3 Annotation planes

The orientation of the annotation plane 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 12. When a CAD system does not support maintenance of annotation plane orientation relative to the model, annotation planes shall not be used.

Note: For the special cases of general notes annotation, management data and security data, the annotation planes do not rotate with the model. See clauses 5.4.2, 5.5.1 and 8.2.

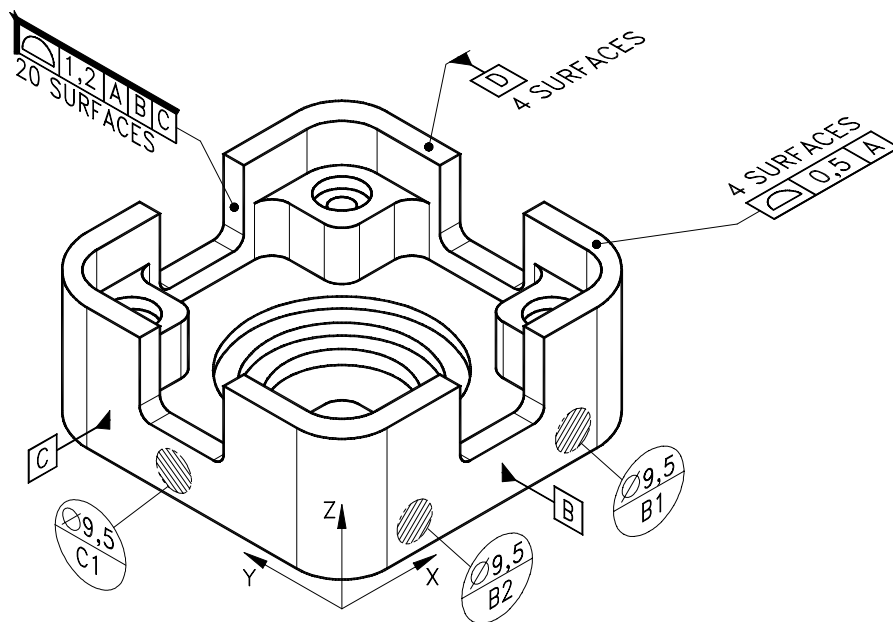


(a) Simplified Feature Query.

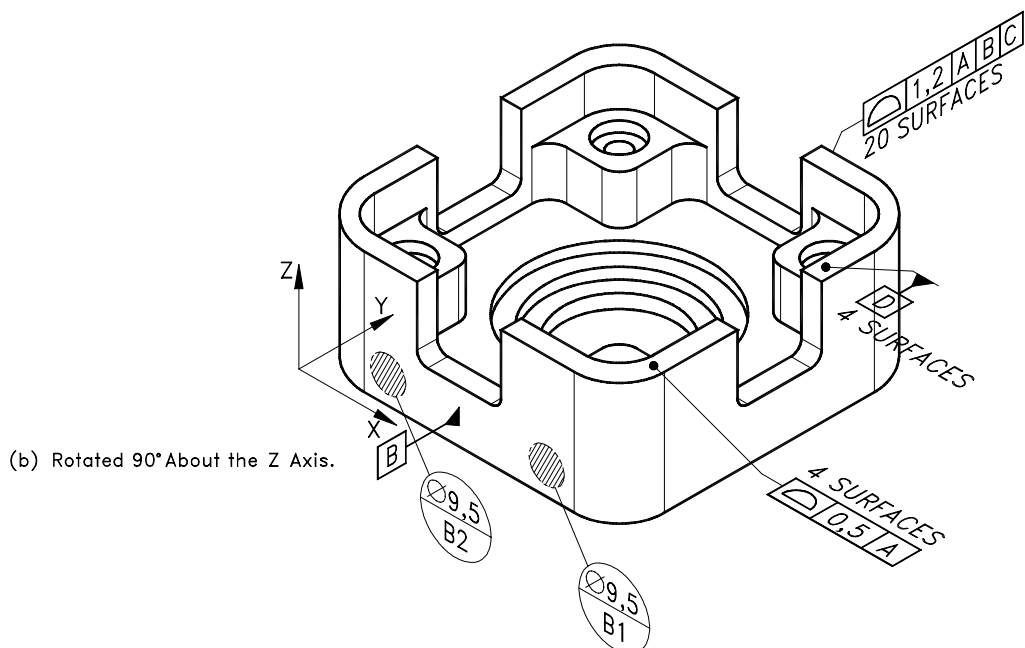
FEATURE DEFINITION	
Existing feature.	
ID :	HOLE_9
Comment :	mach_center
Type :	Single
Class :	Right Conical
Diameter	3 $\pm 0,1$
No sub-feature.	
Feature Geometry	
HOLE_9 *PT340	

(b) Feature Attributes.

Figure 11 — Simplified feature representation and attributes



(a) Initial Attitude of Model Geometry and Annotation.



(b) Rotated 90° About the Z Axis.

Figure 12 — Annotation planes relative to model geometry

7.2.4 Leader lines

Leader lines directed to represented line elements shall terminate with an arrowhead, see figure 44. When an indicated element is a surface, the leader shall terminate with a dot within the bounds of the surface (see figure 12). 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. A solid leader line shall be used to indicate all datum targets in a design model, see clause 5.1.1.2. Leader lines shall be directed to an associated entity.

7.2.5 Direction dependent tolerances

When a direction dependent tolerance (e.g. straightness) is applied to a design model, the direction shall be explicitly defined as follows.

- Supplemental geometry is added to the model to show the direction of application. The model geometry to which the tolerance applies shall be defined as the associated geometry for the annotation, see figures 44, 49 and 60 and clause 5.2.3.1.
- Direction dependent tolerances may use a model co-ordinate system vector to define the direction of application. The model co-ordinate system vector, associated feature of the model and tolerance shall be organized as an associated group, see figures 45, 50 and 61.

7.2.6 Indicating limited application of a tolerance

Limited length, area and location indicators may consist of, but are not limited to, supplemental geometry and associative annotation. When supplemental geometry is used, it shall be located on the model geometry, see figures 32 and 40.

7.2.7 Query

The model shall contain information needed to enable the following types of queries.

7.2.7.1 Model values shall be obtainable from the model.

7.2.7.2 The ability to traverse the relationship between model geometry and annotation in either order shall be available within the model. This includes:

- Graphic display of associated entities. The associated entities for a piece of annotation shall be highlighted, or otherwise distinguished from other entities on the display, on demand, see figures 9a, 10 and 13c.
- Graphic display of associated annotation. All annotations associated with selected geometry or features of the model shall be highlighted, or otherwise distinguished from other entities, on demand, see figures 9b and 13 (a) and (b).

7.2.7.3 Digital element identifiers shall be obtainable from the model, see figure 14.

7.2.7.4 Model geometry and features of the model shall be identifiable as follows:

- A feature of the model shall be identifiable by selecting a geometric element of that feature.
- All geometric elements in an associated group of features of the model shall be identifiable by selecting any geometric element within the group of one of the model features.
- All features of the model in a group of features of the model shall be identifiable by selecting one of the features of the model.

7.2.7.5 Feature control frames, datum feature symbols and datum targets shall be highlighted as follows:

- Upon selection of a feature control frame, the datum feature symbols and datum target symbols that correspond to the datum references shall be highlighted or otherwise distinguished from other entities on the display, see figure 15.
- Upon selection of a datum target symbol, all datum target symbols sharing the same letter shall be highlighted or otherwise distinguished from other entities on the display, see figure 16 (a).

- Upon selection of a datum target symbol or a datum feature symbol, other datum target symbols and datum feature symbols which have the same datum letter shall be highlighted or otherwise distinguished from other entities on the display, see figure 16 (b).
- Upon selection of a feature control frame, the portion of the corresponding co-ordinate system representing the partial or complete datum reference frame referenced in the feature control frame shall be highlighted or otherwise distinguished from other entities on the display, see figure 17 (a).

7.2.7.6 Upon selection of annotation, the supplemental geometry used in the definition of the annotation shall be highlighted or otherwise distinguished from other entities on the display, see figure 17 (b).

7.2.7.7 Upon selection of one of the digital elements in an associated group, the members of the associated group shall be highlighted or otherwise distinguished from other entities on the display.

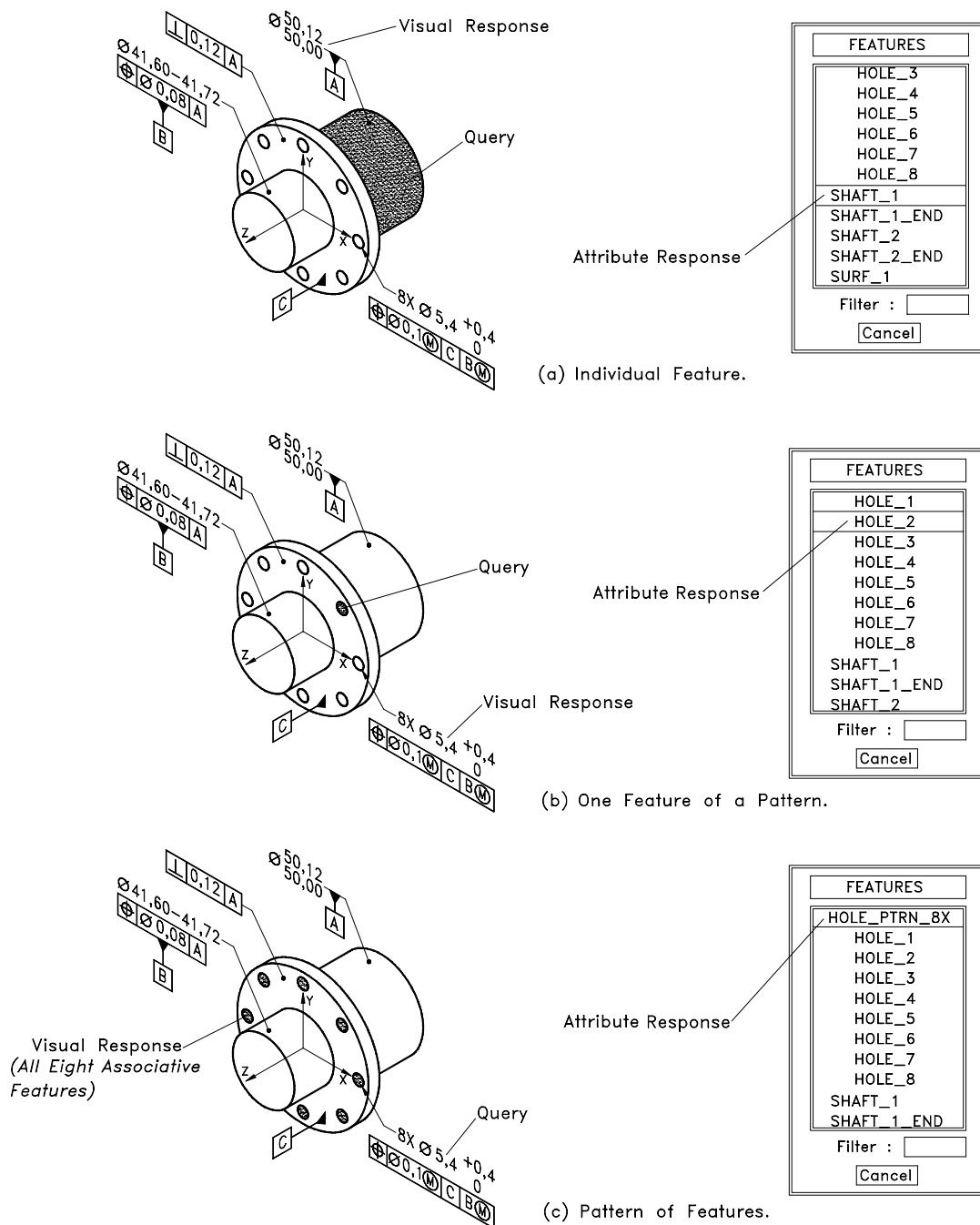


Figure 13 — Graphic display of associated annotation

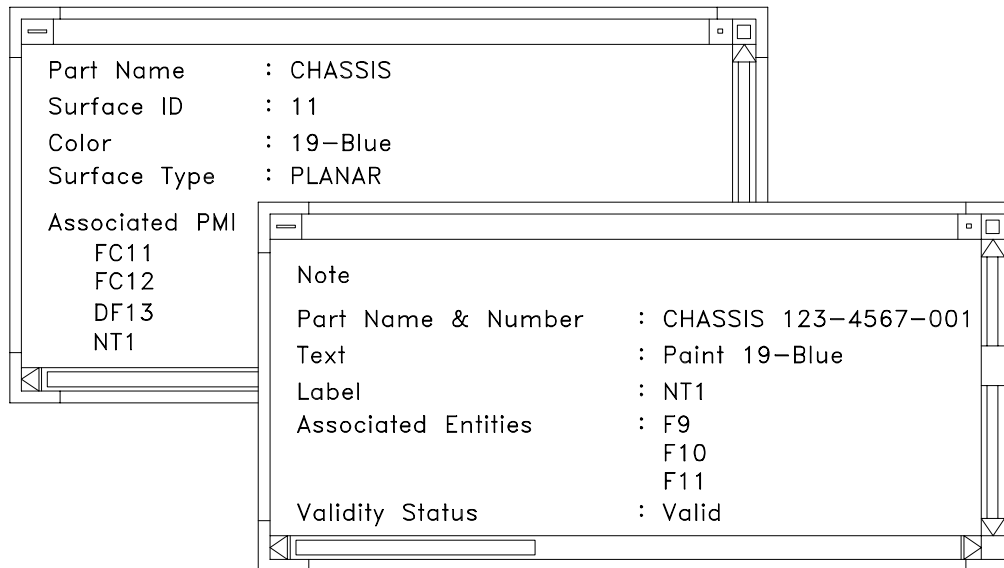


Figure 14 — Listing of digital element identifiers

Visual Response: All Datum Feature Symbols and Datum Target Symbols respond.

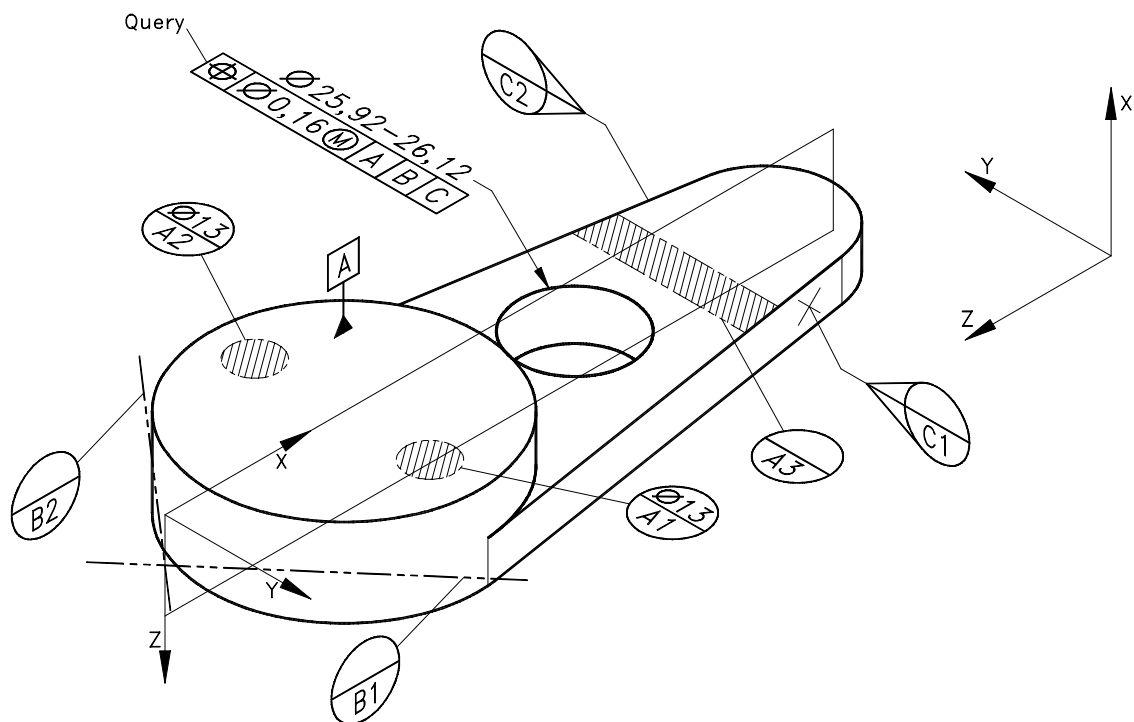


Figure 15 — Queries of datum feature symbols and datum target symbols

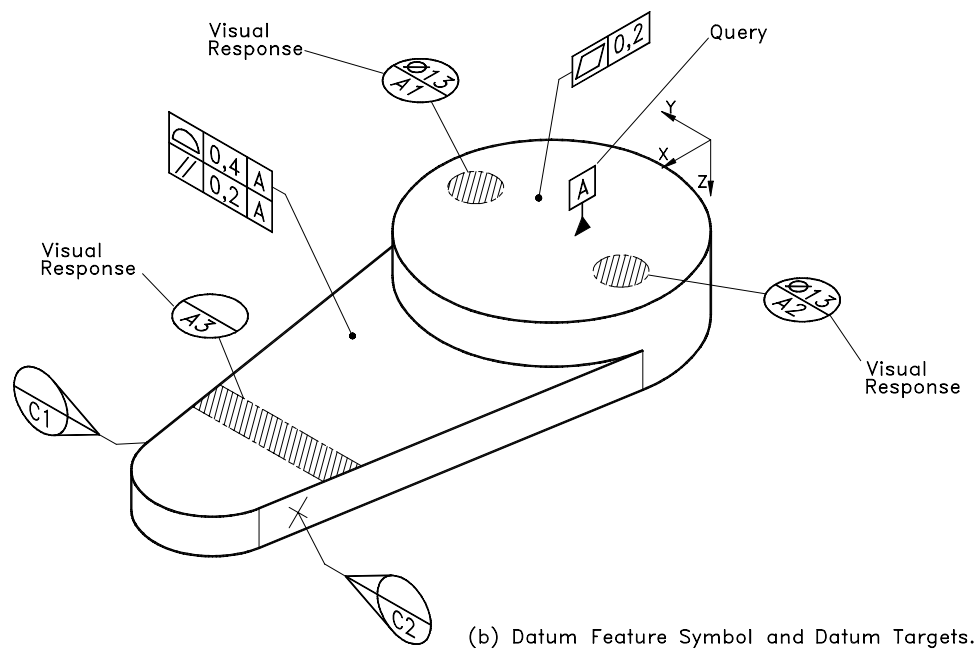
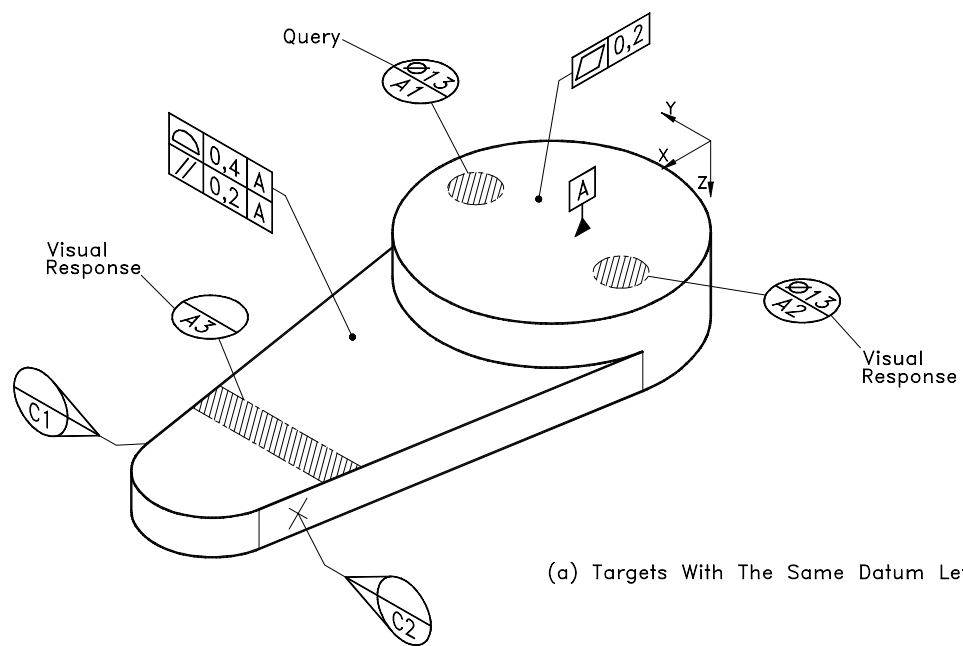


Figure 16 — Queries for datum targets