

INTERNATIONAL
STANDARD

ISO
10303-201

First edition
1994-12-15

**Industrial automation systems and
integration — Product data representation
and exchange —**

Part 201:

Application protocol: Explicit draughting

*Systèmes d'automatisation industrielle et intégration — Représentation
et échange de données de produits —*

Partie 201: Protocole d'application: Dessin technique explicite



Reference number
ISO 10303-201:1994(E)

AVA Documents
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Foreword

The International Organization for Standardization (ISO) 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.

Draft International Standards adopted by technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

International Standard ISO 10303-201 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data and global manufacturing programming languages*.

ISO 10303 consists of the following parts under the general title *Industrial automation systems and integration – Product data representation and exchange*:

- Part 1, Overview and fundamental principles;
- Part 11, Description methods: The *EXPRESS* language reference manual;
- Part 21, Implementation methods: Clear text encoding of the exchange structure;
- Part 22, Implementation methods: Standard data access interface specification;
- Part 31, Conformance testing methodology and framework: General concepts;
- Part 32, Conformance testing methodology and framework: Requirements on testing laboratories and clients;
- Part 41, Integrated generic resources: Fundamentals of product description and support;
- Part 42, Integrated generic resources: Geometric and topological representation;
- Part 43, Integrated generic resources: Representation structures;
- Part 44, Integrated generic resources: Product structure configuration;
- Part 45, Integrated generic resources: Materials;
- Part 46, Integrated generic resources: Visual presentation;
- Part 47, Integrated generic resources: Shape variation tolerances;

- Part 49, Integrated generic resources: Process structure and properties;
- Part 101, Integrated application resources: Draughting;
- Part 104, Integrated application resources: Finite element analysis;
- Part 105, Integrated application resources: Kinematics;
- Part 201, Application protocol: Explicit draughting;
- Part 202, Application protocol: Associative draughting;
- Part 203, Application protocol: Configuration controlled design;
- Part 207, Application protocol: Sheet metal die planning and design;
- Part 210, Application protocol: Printed circuit assembly product design data;
- Part 213, Application protocol: Numerical control process plans for machined parts.

The structure of this International Standard is described in ISO 10303-1. The numbering of the parts of this International Standard reflects its structure:

- Part 11 specifies the description methods;
- Parts 21 and 22 specify the implementation methods;
- Parts 31 and 32 specify the conformance testing methodology and framework;
- Parts 41 to 49 specify the integrated generic resources;
- Parts 101 to 105 specify the integrated application resources;
- Parts 201 to 213 specify the application protocols.

Should further parts be published, they will follow the same numbering pattern.

Annexes A, B, C, D and E form an integral part of this part of ISO 10303. Annexes F, G, H, J and K are for information only.

Diskette

Users should note that this part of ISO 10303 comprises a diskette:

- the short names of entities given in annex B are also included on the diskette;
- the EXPRESS listings (annex A) are provided on the diskette only;
- a method to enable users to report errors in the documentation is given. Full details are provided in the file.

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

This International Standard is organized as a series of parts, each published separately. The parts of ISO 10303 fall into one of the following series: description methods, integrated resources, application protocols, abstract test suites, implementation methods, and conformance testing. The series are described in ISO 10303-1. This part of ISO 10303 is a member of the application protocols series.

This part of ISO 10303 specifies an application protocol (AP) for the exchange of technical CAD drawings consisting of two-dimensional geometry and two-dimensional annotation. This part satisfies the need for the exchange of such drawings within and between organizations, especially those operating in the mechanical engineering and architectural, engineering, and construction industrial sectors.

The exchange of such drawings enables the communication of product data during all stages of the lifecycle of a product for any product type. This product data, in the form of a CAD drawing, may be interpreted by people according to accepted international, national, or organization draughting standards. The use of CAD drawings for the purposes of the communication of product data is common practice in many industries. This product data may also be interpreted by appropriate CAx systems for use in applications other than draughting.

The nominal shape of a product is represented by geometry defined in two dimensions. Such representations may be the result of the application of a projection transformation on a three-dimensional shape representation; such three-dimensional shape representations, and the projection transformations that may be applied to produce a two-dimensional representation, lie outside the scope of this part of ISO 10303.

This application protocol makes use of two fundamental concepts which relate to the creation, revision, storage, and use of drawings produced using CAD systems.

A CAD drawing is a digital representation of a drawing and may include the following, in addition to lines and text presented on the face of the drawing:

- representations of the shape(s) of the product(s) depicted by the drawing;
- information used in administering drawings for purposes of configuration control, audit trails, etc.

The use of the shape representation present in the CAD drawing depends on the interpretation of a draughtsman or engineer viewing the drawing. For this reason the concept of a draughting shape model is included. A draughting shape model is a representation of the shape of a product

whose interpretation is determined through visual inspection of the drawings that depict the product.

EXAMPLE 1 – An architectural drawing may contain both isometric and perspective views of a building. The use of the two-dimensional representations depicted in these views depends on the knowledge, in the mind of a designer, that the lengths of lines may be measured or calculated in the isometric view but not in the perspective view.

This draughting shape model is also a nominal shape model; no information regarding tolerances is included in the draughting shape model.

Figure 1 contains the data planning model that provides a high-level description of the general structure of this application protocol, as well as the relationships between the basic data components.

The data planning model illustrates that a product may be described by a draughting shape model. The draughting shape model is a two-dimensional model generated by a CAD system. This CAD model is composed of geometry which represents the shape of the product and may also include annotation. The product is documented by a drawing.

The drawing is composed of drawing sheets that contain annotation and drawing views. The drawing views are two-dimensional views of the draughting shape model that may include additional annotation. Therefore, the drawing is a presentation of the draughting shape model.

Annotation, in the form of text and symbology, provides additional product data that is needed to fully define the product or interpret the drawing. The scope of this application protocol constrains the dimensionality of all data found within it to be two-dimensional only.

This application protocol defines the context, scope, and information requirements for exchange of geometrically explicit two-dimensional technical CAD drawings with explicit annotation and specifies the integrated resources necessary to satisfy these requirements.

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of the application protocol and summarizes the functionality and data covered by the AP. An application activity model that is the basis for the definition of the scope is provided in annex F. The information requirements of the application are specified in clause 4 using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model, is given in annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. The expanded listing given in annex A contains the complete EXPRESS for the AIM without annotation. A graphical representation of the AIM is given in annex H. Additional requirements for specific

implementation methods are given in annex C.

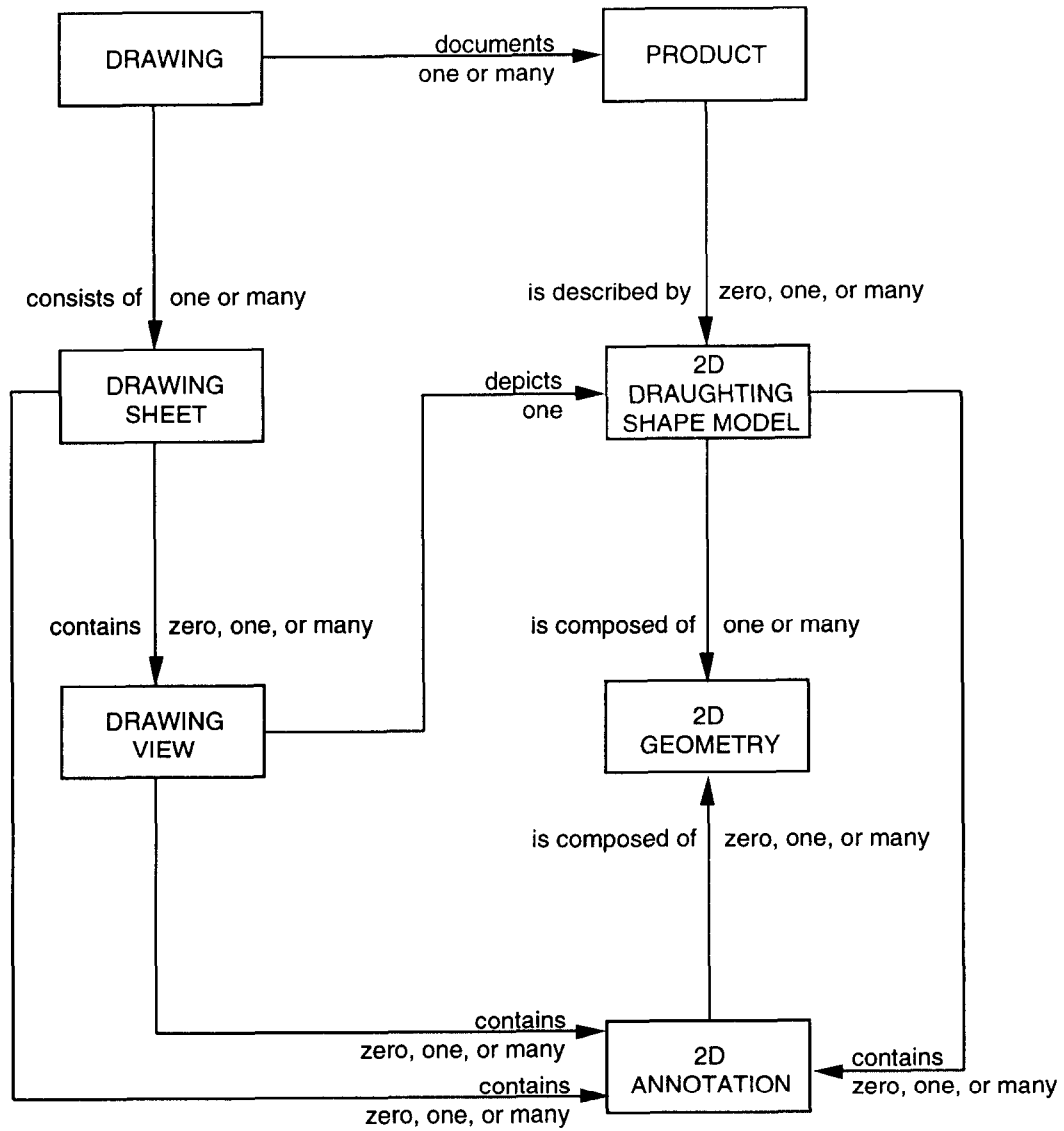


Figure 1 – Data planning model

Industrial automation systems and integration — Product data representation and exchange — Part 201 : Application protocol: Explicit draughting

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for explicit draughting.

NOTE – The application activity model in annex F provides a graphical representation of the processes and information flows which are the basis for the definition of the scope of this part of ISO 10303.

This part of ISO 10303 is applicable to the inter-organization exchange of computer-interpretable drawing information and product definition data.

The following are within the scope of this part of ISO 10303:

- the representation of drawings for the purpose of exchange, especially for mechanical engineering, architectural engineering, and construction applications;
- the representation of the real size of a product depicted in a drawing to enable use by applications where true geometric equivalence is required;

EXAMPLE 2 – The representation of the shape of the product is required to support not only visual equivalence of exchanged drawings but also where true geometric equivalence is required by the receiving system. Such uses include the calculations of distances or areas and the generation of numerical control tool paths.

- the representation of a drawing that depicts any phase of the design;
- the representation of individual drawing revisions;
- the representation of the two-dimensional draughting shape model depicting the product shape and the transformations used for the generation of the drawing views;
- the presentation of non-shape product definition data depicted in a drawing by two-dimensional annotation;
- the hierarchical structure of drawings, drawing sheets, and views of the draughting shape

model;

- mechanisms for the grouping of the elements depicted on a drawing;
- the administrative data used for the purpose of drawing management;
- the administrative data identifying the product versions being documented by the drawing.

The following are outside the scope of this part of ISO 10303:

- the representation of the shape of a product using three-dimensional geometry;
- the representation of the shape of a product that is not depicted in a drawing;
- the representation of drawings that are not related to a product;
- the exchange of drawing history;
- the definition of annotation in three-dimensional coordinate systems;
- the presentation of dimensions and annotation that are associated to viewed geometry and annotation;
- a computer-interpretable bill of material structure except as conveyed by annotation on the drawing;
- strict enforcement of draughting standards;
- drawings containing non-displayable attribute data other than that required as administrative data;

EXAMPLE 3 – Non-displayable attribute data could be density, mass, or moment of inertia.

- the automatic generation of drawings including views, dimensions, and annotation.
- the exchange of data used exclusively for the creation of paper or or hardcopy versions of the drawing.

EXAMPLE 4 – Printer or plotter data could be pen designations, plot scale, or plot color specifications.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10303. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10303 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3098-1:1974, *Technical drawings – Lettering – Part 1: Currently used characters*.

ISO/IEC 8824-1:—¹⁾, *Information technology – Open Systems Interconnection – Abstract Syntax Notation One (ASN.1) – Part 1: Specification of Basic Notation*.

ISO 10303-1:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 1: Overview and fundamental principles*.

ISO 10303-11:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 11: Description methods: The EXPRESS language reference manual*.

ISO 10303-21:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 21: Implementation methods: Clear text encoding of the exchange structure*.

ISO 10303-31:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 31: Conformance testing methodology and framework: General concepts*.

ISO 10303-41:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 41: Integrated generic resources: Fundamentals of product description and support*.

ISO 10303-42:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 42: Integrated generic resources: Geometric and topological representation*.

ISO 10303-43:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 43: Integrated generic resources: Representation structures*.

ISO 10303-46:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 46: Integrated generic resources: Visual presentation*.

ISO 10303-101:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 101: Integrated application resources: Draughting*.

¹⁾To be published.

3 Definitions and abbreviations

3.1 Terms defined in ISO 10303-1

This part of ISO 10303 makes use of the following terms defined in ISO 10303-1:

- application;
- application activity model (AAM);
- application interpreted model (AIM);
- application protocol (AP);
- application reference model (ARM);
- conformance testing;
- implementation method;
- integrated resource;
- model;
- product;
- product data;
- unit of functionality (UoF).

3.2 Terms defined in ISO 10303-42

This part of ISO 10303 makes use of the following terms defined in ISO 10303-42:

- curve.

3.3 Terms defined in ISO 10303-46

This part of ISO 10303 makes use of the following terms defined in ISO 10303-46:

- annotation;
- picture.

3.4 Terms defined in ISO 10303-101

This part of ISO 10303 makes use of the following terms defined in ISO 10303-101:

- callout;
- draughting;
- drawing.

3.5 Other definitions

For the purpose of this part of ISO 10303, the following definitions apply.

3.5.1 text baseline : a theoretical line on which the lowest points of the text characters, excluding descenders, rest.

3.5.2 CAD drawing : a digital representation of a drawing that includes pictures, text, or combinations of both that are presented in the drawing; information used in administering the drawing; and possibly representations of the shapes of the products depicted in the drawing.

3.5.3 cartesian coordinate system : a set of mutually perpendicular axes divided into known segments, each of whose length is a specified unit of measure. In the case of a two-dimensional coordinate system there are two axes and in the case of a three-dimensional coordinate system there are three. The point of intersection of the axes is referred to as the origin.

3.5.4 chain dimension sequence : a sequence of two or more dimensions in which the terminus of one dimension initializes the next dimension in the sequence.

3.5.5 dimension value : a representation of the numerical value for a dimension that describes its magnitude.

3.5.6 draughting shape model : a graphical representation of a product shape composed of geometric and annotation elements that are all defined in the same coordinate system. It is created and used specifically for generating a drawing of a product.

3.5.7 externally defined : an element in which an explicit description of its use and physical representation are given within another source. This source shall provide all the information necessary to unambiguously recreate the element. This information shall be referenceable by identification of the source and the element within that source.

3.5.8 independently instantiable : an entity for which instances can be created that are not referenced by instances of other entity data types.

3.5.9 parallel dimension sequence : a collection of two or more dimensions where all the dimensions are of the same type, their dimension lines are parallel to one another and/or they

share a common origin or datum.

3.5.10 predefined : an element which has an explicit description of its use and physical representation given within an annex of this part of ISO 10303. The explicit description shall provide all the information necessary to unambiguously recreate the element.

3.5.11 scale : the ratio of the linear size of a representation of a product in a drawing to the linear size of the product itself.

3.5.12 subfigure : a combination of geometric and annotation elements that are all defined in the same coordinate system.

NOTE -- This combination of elements may be duplicated multiple times into the drawing or draughting shape model.

3.5.13 symbol : a combination of annotation elements which, as a collection, represents a distinct concept.

NOTE – This combination of elements may be defined externally to the drawing or draughting shape model and may be duplicated multiple times into the drawing or draughting shape model.

3.6 Abbreviations

For the purpose of this part of ISO 10303, the following abbreviations apply.

AIC	application interpreted construct.
ANSI	American National Standards Institute.
CAD	computer aided design.
CAX	computer aided technologies.

4 Information requirements

This clause specifies the information required for explicit draughting.

The information requirements are specified as a set of units of functionality, application objects, and application assertions. These assertions pertain to individual application objects and to relationships between application objects. The information requirements are defined using the terminology of the subject area of this application protocol.

NOTES

- 1 – A graphical representation of the information requirements is given in annex G.
- 2 – The information requirements correspond to those of the activities identified as being in the scope of this application protocol in annex F.
- 3 – The mapping table specified in 5.1 shows how the information requirements are met using the integrated resources of this International Standard. The use of the integrated resources introduces additional requirements that are common to application protocols.

The following are high-level information requirements:

- a draughting shape model shall be presented in at least one view;
- each exchange shall contain at least one drawing;
- all draughting shape models depicting the shape of a product shall be defined using one-to-one scale geometry;
- the exchange of two-dimensional draughting shape models and the information that defines the views of those models shall be supported. Two-dimensional geometry created as a result of applying the view definition will not be exchanged;
- annotation may be applied to the draughting shape model, a drawing view, or a drawing sheet without being part of a drawing view;
- all elements in a CAD model or a drawing shall be assigned to one or more layers.

4.1 Units of functionality

This subclause specifies the units of functionality for the explicit draughting application protocol. This part of ISO 10303 specifies the following units of functionality:

- 2D_draughting_shape_model;
- 2D_elements_of_appearance;
- 2D_model_viewing;
- drawing_structure_and_administration;
- elements_of_annotation;
- elements_of_draughting_annotation;
- grouping;
- product_relation.

The units of functionality and a description of the functions that each UoF supports are given below. The application objects included in the UoF's are defined in 4.2.

4.1.1 2D_draughting_shape_model

The 2D_draughting_shape_model UoF contains the application objects which represent the two-dimensional shape of a product. This representation is composed of geometric elements and may include annotation elements. This representation may be structured through the use of sub-models.

The following application objects are used by 2D_draughting_shape_model UoF:

- 2D_cartesian_coordinate_space;
- 2D_draughting_shape_model;
- 2D_geometric_element;
- Cartesian_coordinate_space;
- Model_placed_annotation;
- Sub_model;
- Sub_model_definition.

4.1.2 2D_elements_of_appearance

The 2D_elements_of_appearance UoF contains information about the presentation characteristics of two-dimensional geometric and annotation elements. It contains the information required for visual display of the drawing elements.

The following application objects are used by 2D_elements_of_appearance UoF:

- Appearance;
- Colour;
- Curve_appearance;
- Externally_defined_hatching;
- Externally_defined_line_font;
- Externally_defined_text_font;

- Externally_defined_tile;
- Externally_defined_tiling;
- Fill_area_appearance;
- Hatching_pattern;
- Line_font;
- Predefined_colour;
- Predefined_line_font;
- Predefined_text_font;
- Solid_fill_area;
- Text_appearance;
- Text_font;
- Tile;
- User_defined_colour;
- User_defined_hatching;
- User_defined_line_font;
- User_defined_tile;
- User_defined_tiling;
- Visibility.

4.1.3 2D_model_viewing

The 2D_model_viewing UoF contains the information necessary to depict a two-dimensional draughting shape model in a view on a sheet of the drawing. It establishes a relationship between the draughting shape model and the drawing view. It provides the assignment of appearance characteristics to all geometric elements and annotation that are displayed in a view of the draughting shape model.

The following application objects are used by 2D_model_viewing UoF:

- 2D_drawing_view_definition;
- View_displayed_geometry;
- View_displayed_model_annotation.

4.1.4 drawing_structure_and_administration

The drawing_structure_and_administration UoF contains information about the hierarchical organization of drawings, drawing sheets, and drawing views, together with the administrative information necessary to manage drawings and drawing sheets. Drawing sheets and drawing views are defined in their specific coordinate space. Annotation may be assigned to each drawing sheet and drawing view. The administrative information supports the exchange of drawings between environments in which configuration management of drawings is used.

The following application objects are used by drawing_structure_and_administration UoF:

- 2D_cartesian_coordinate_space;
- Approval;
- Cartesian_coordinate_space;
- Drawing;
- Drawing_sheet;
- Drawing_view;
- Organization;
- Sheet_placed_annotation;
- View_placed_annotation.

4.1.5 elements_of_annotation

The elements_of_annotation UoF contains the application objects used to compose all annotation, along with the ability to create nested annotation. Annotation may be used either in a drawing sheet, a drawing view, or a draughting shape model to present drawing elements without a specific meaning in the context of a drawing.

EXAMPLE 5 – Figure 2 shows a linear dimension and identifies within it a text object as an example of an annotation element.

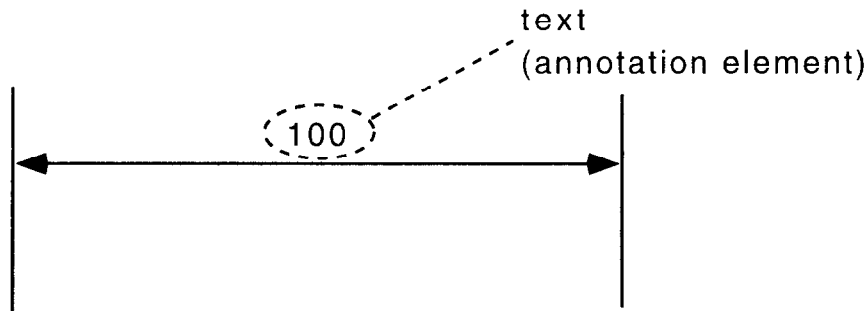


Figure 2 – Example of elements_of_annotation UoF

The following application objects are used by elements_of_annotation UoF:

- 2D_cartesian_coordinate_space;
- Annotation_curve;
- Annotation_element;
- Annotation_subfigure;
- Annotation_subfigure_definition;
- Annotation_subfigure_definition_element;
- Annotation_symbol;
- Cartesian_coordinate_space;
- Externally_defined_symbol;
- Fill_area;
- Fill_area_boundary;
- Point_marker_symbol;
- Predefined_symbol;
- Text;
- Text_string;
- User_defined_symbol;

- User_defined_symbol_definition.

4.1.6 elements_of_draughting_annotation

The elements_of_draughting_annotation UoF contains the application objects used for the creation of annotation, presented on a drawing, that has a specific meaning or purpose within the scope of draughting.

EXAMPLE 6 – Figure 3 shows a linear dimension as an example of draughting annotation. This is built from a number of components – projection lines, dimension line, dimension value – and has a known meaning: the dimensioned part or feature has a length of 100 units.

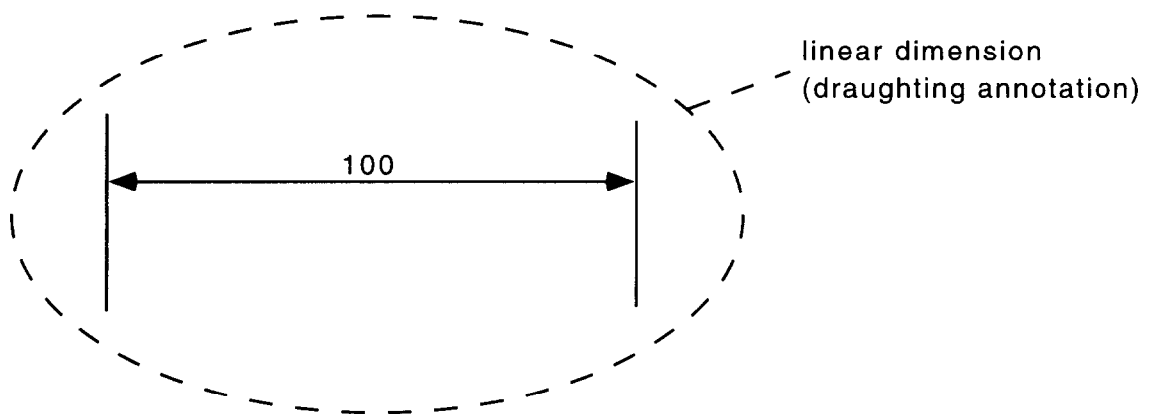


Figure 3 – Example of elements_of_draughting_annotation UoF

The following application objects are used by elements_of_draughting_annotation UoF:

- Angular_dimension;
- Chained_dimension_pair;
- Curve_dimension;
- Datum_feature_callout;
- Datum_target_callout;
- Diameter_dimension;
- Dimension;
- Dimension_callout;
- Dimension_line;

- Dimension_sequence_pair;
- Dimension_symbol;
- Directed_curve;
- Draughting_annotation;
- Draughting_callout;
- Drawing_sheet_layout;
- Geometrical_tolerance;
- Geometrical_tolerance_symbol;
- Leader;
- Leader_directed_dimension;
- Linear_dimension;
- Ordinate_dimension;
- Parallel_dimension_pair;
- Projection_line;
- Radius_dimension;
- Structured_dimension_callout;
- Terminator_symbol;
- Unstructured_dimension_callout.

4.1.7 grouping

The grouping UoF contains information about the organizational structures defined in a draughting shape model or a drawing. It includes the user capabilities to collect geometric or drawing elements for a specific discipline or viewpoint. Different mechanisms can be applied to group these elements. The primary use of grouping mechanisms is to increase efficiency during shape model design or modification by manipulation of more than one element at a time. Grouping mechanisms are not physical characteristics of the drawing, but their structure is preserved to aid in the future modification of the shape model or drawing.

The following application objects are used by grouping UoF:

- Group;
- Group_annotation_element;
- Group_element;
- Group_geometric_element;
- Layer;
- Sub_group.

4.1.8 product_relation

The product_relation UoF contains the administrative information necessary to relate a product to a drawing. The administrative data consists of the information to uniquely identify the product which is documented by the drawing.

The following application objects are used by product_relation UoF:

- Organization;
- Product_version.

4.2 Application objects

This subclause specifies the application objects for the explicit draughting application protocol. Each application object is an atomic element that embodies a unique application concept and contains attributes specifying the data elements of the object. The application objects and their definitions are given below.

4.2.1 2D_cartesian_coordinate_space

A 2D_cartesian_coordinate_space is a type of Cartesian_coordinate_space (see 4.2.14) that is defined by two mutually perpendicular axes.

4.2.2 2D_draughting_shape_model

A 2D_draughting_shape_model is a representation of a product or a portion of a product. This representation consists of points and curves defined in a two-dimensional coordinate space, and

may also contain annotation placed in the same coordinate space, or Sub_model objects. Each 2D_draughting_shape_model contains at least one 2D_geometric_element (see 4.2.4) or Sub_model (see 4.2.71). Each 2D_draughting_shape_model may be a Sub_model_definition (see 4.2.72). The data associated with a 2D_draughting_shape_model are the following:

- Model_id.

The Model_id specifies the identification of a particular draughting shape model.

4.2.3 2D_drawing_view_definition

A 2D_drawing_view_definition is the specification of a plane, within the coordinate system of a draughting shape model, to which the elements of the draughting shape model are projected. Additionally, clipping boundaries are specified to limit the content of the projection, and a scale is specified to define the size of the projected elements in the view. The data associated with a 2D_drawing_view_definition are the following:

- Clipping;
- Scale;
- Translation.

NOTE – A 2D_drawing_view_definition may be placed multiple times on a drawing, but each is a separate drawing view. The placement within a particular sheet makes each drawing view unique to that drawing sheet.

4.2.3.1 Clipping

The Clipping specifies the mathematical information necessary to define a two-dimensional area that encloses all viewable geometric and annotation elements of a draughting shape model. Only those elements, or portions of any elements, that fall within this boundary will be displayed.

4.2.3.2 Scale

The Scale specifies the ratio between the size of the elements as defined in the draughting shape model and the size of the elements as presented in the drawing view.

4.2.3.3 Translation

The Translation specifies the mathematical values that define the non-rotational displacement between elements located in the coordinate system of the draughting shape model and their location in the coordinate system of the drawing view.

4.2.4 2D_geometric_element

A 2D_geometric_element is a specified type of individual geometry that is used in the representation of the shape of a product. A 2D_geometric_element is defined in a two-dimensional coordinate space. The types of 2D_geometric_element that may be specified are: cartesian point, point on curve, straight line, composite curve, b-spline curve, offset curve, polyline, circle, ellipse, and trimmed conic.

4.2.5 Angular_dimension

An Angular_dimension is a type of Dimension (see 4.2.22) that is the graphical presentation of a value of angular distance measure where the distance is between two elements converging on a common point.

NOTE – Figure 4 illustrates three angular dimensions depicting angular distance. The figure also illustrates a radius dimension.

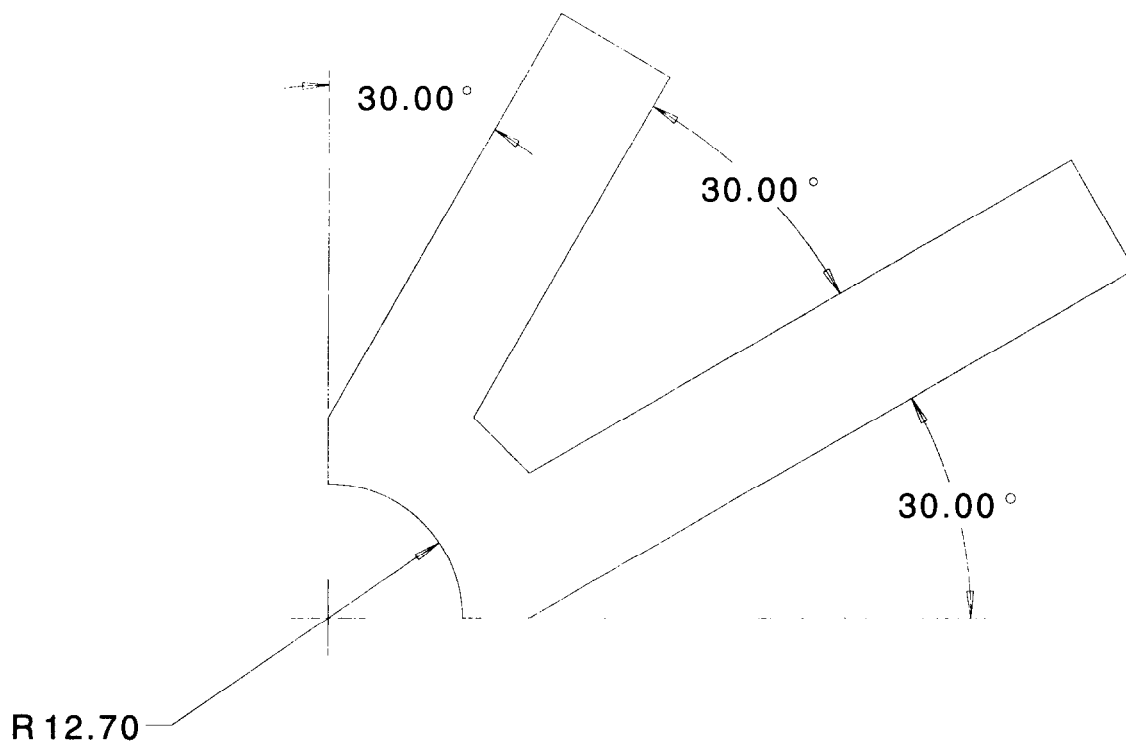


Figure 4 – Angular and radius dimensions

4.2.6 Annotation_curve

An `Annotation_curve` is a type of `Annotation_element` (see 4.2.7) that is a two-dimensional trimmed curve used only to annotate a drawing or a draughting shape model and which is defined in the coordinate system in which it is used. Each `Annotation_curve` may be a `Directed_curve` (see 4.2.27).

4.2.7 Annotation_element

An `Annotation_element` is a type of `Draughting_annotation` (see 4.2.28) that is the lowest level discrete element that can either serve as annotation itself, or be used as a constituent of other annotation. Each `Annotation_element` is either an `Annotation_curve` (see 4.2.6), an `Annotation_subfigure` (see 4.2.8), an `Annotation_symbol` (see 4.2.11), a `Fill_area` (see 4.2.40), or a `Text` (see 4.2.74).

4.2.8 Annotation_subfigure

An `Annotation_subfigure` is a type of `Annotation_element` (see 4.2.7) that is the presentation of an `Annotation_subfigure_definition` (see 4.2.9) located within the coordinate system of a drawing sheet, a drawing view, a draughting shape model, or another subfigure. The data associated with an `Annotation_subfigure` are the following:

- Location;
- Rotation;
- Scale.

4.2.8.1 Location

The `Location` specifies the position of the origin of the coordinate system in which the subfigure is defined relative to the origin of the coordinate system into which the subfigure is being placed.

4.2.8.2 Rotation

The `Rotation` specifies the angle, measured counter-clockwise, between the horizontal axis of the coordinate system in which the subfigure is defined and the horizontal axis of the coordinate system into which the subfigure is being placed.

4.2.8.3 Scale

The Scale specifies the ratio between the size of the subfigure as defined and the size of the subfigure as presented. The scale in the x-coordinate need not equal the scale in the y-coordinate.

4.2.9 Annotation_subfigure_definition

An Annotation_subfigure_definition is a collection of defined annotation elements, along with their placements, in a definitional coordinate space. The data associated with an Annotation_subfigure_definition are the following:

- Name.

The Name specifies the identification of a particular subfigure definition. The Name need not be specified for a particular Annotation_subfigure_definition.

4.2.10 Annotation_subfigure_definition_element

An Annotation_subfigure_definition_element is annotation that is used as a constituent of a subfigure definition.

4.2.11 Annotation_symbol

An Annotation_symbol is a type of Annotation_element (see 4.2.7) that is a combination of text and annotation curves which, as a collection, represent a recognized concept. Each Annotation_symbol is either an Externally_defined_symbol (see 4.2.36), a Predefined_symbol (see 4.2.62), or a User_defined_symbol (see 4.2.83).

The data associated with an Annotation_symbol are the following:

- Location;
- Rotation;
- Scale.

4.2.11.1 Location

The Location specifies the position of the origin of the coordinate system in which the symbol is defined, relative to the origin of the coordinate system into which the symbol is being placed.

4.2.11.2 Rotation

The Rotation specifies the angle, measured counter-clockwise, between the horizontal axis of the coordinate system in which the symbol is defined and the horizontal axis of the coordinate system into which the symbol is being placed.

4.2.11.3 Scale

The Scale specifies the ratio between the size of the symbol as defined and the size of the symbol as presented. The scale in the x-coordinate need not equal the scale in the y-coordinate.

4.2.12 Appearance

An Appearance is a collection of visual characteristics that govern the presentation of geometric elements or annotation elements. Each Appearance may be one of the following: a Fill_area_appearance (see 4.2.41), a Curve_appearance (see 4.2.17), or a Text_appearance (see 4.2.75).

4.2.13 Approval

An Approval is information that indicates the drawing, drawing sheet, or both have been reviewed for data content and for correctness of the presentation of that data and has been found to be acceptable. The data associated with an Approval are the following:

- Date;
- Description.

4.2.13.1 Date

The Date specifies the date on which the approval was assigned.

4.2.13.2 Description

The Description specifies the organization-specific release status or the authorized modifications for the revision of the drawing, drawing sheet, or both.

EXAMPLE 7 – A Description could be “manufacturing release”, “see engineering change notice 423 for a description of the changes”, or “zone C-8, dimension 8.00 was 8.25”

4.2.14 Cartesian_coordinate_space

A `Cartesian_coordinate_space` is a two-dimensional or three-dimensional space defined by a cartesian coordinate system. Each `Cartesian_coordinate_space` is a `2D_cartesian_coordinate_space` (see 4.2.1). Each `Cartesian_coordinate_space` is the coordinate space of either an `Annotation_subfigure_definition` (see 4.2.9), a `Drawing_sheet` (see 4.2.31), a `Drawing_view` (see 4.2.33), a `User_defined_symbol_definition` (see 4.2.84), or multiple `2D_draughting_shape_model` (see 4.2.2) objects. The data associated with a `Cartesian_coordinate_space` are the following:

- `Length_measure_unit`;
- `Plane_angle_measure_unit`.

4.2.14.1 Length_measure_unit

The `Length_measure_unit` specifies the increments used to define linear distances or sizes within a cartesian coordinate space.

4.2.14.2 Plane_angle_measure_unit

The `Plane_angle_measure_unit` specifies the increments used to define angular distances within a cartesian coordinate space.

4.2.15 Chained_dimension_pair

A `Chained_dimension_pair` is a type of `Dimension_sequence_pair` (see 4.2.25) that is the relationship between two dimensions in which the terminus of one dimension initializes the next dimension in the sequence.

NOTE – Figure 5 illustrates four horizontal linear dimensions in a chain dimension sequence. Each set of two dimensions sharing a projection line is a chained dimension pair. Additionally, the figure illustrates a single vertical linear dimension.

4.2.16 Colour

A `Colour` defines a basic appearance property of an element with respect to the light reflected by it. Each `Colour` is either a `Predefined_colour` (see 4.2.60) or a `User_defined_colour` (see 4.2.80).

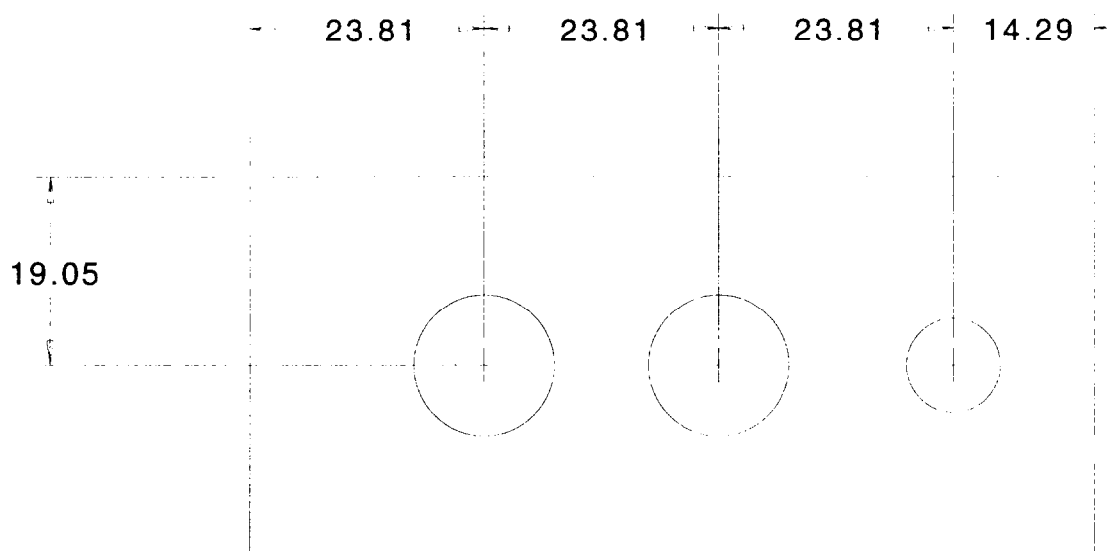


Figure 5 – Chain dimension sequence

4.2.17 Curve_appearance

A **Curve_appearance** is a type of **Appearance** (see 4.2.12) that governs the visual presentation of geometric curves and annotation curves. The data associated with a **Curve_appearance** are the following:

- **Draughting_role**;
- **Width**.

4.2.17.1 Draughting_role

The **Draughting_role** specifies the purpose within draughting for a particular curve appearance. The **Draughting_role** need not be specified for a particular **Curve_appearance**.

EXAMPLE 8 – A **Draughting_role** could be a centreline or section line.

4.2.17.2 Width

The **Width** specifies the thickness of the curve measured perpendicular to the direction of the curve. The **Width** of a curve is not affected by scaling.

4.2.18 Curve_dimension

A Curve_dimension is a type of Dimension (see 4.2.22) that is the graphical presentation of a value of the distance between two elements, measured along a curved path, or the length of a curved element.

NOTE – Figure 6 illustrates two curve dimensions. The dimension with a value of 36.91 depicts the distance between two elements along a path defined by a third element of geometry or annotation. The dimension with a value of 76.64 depicts the length of a curve, measured along the entire path of the curve.

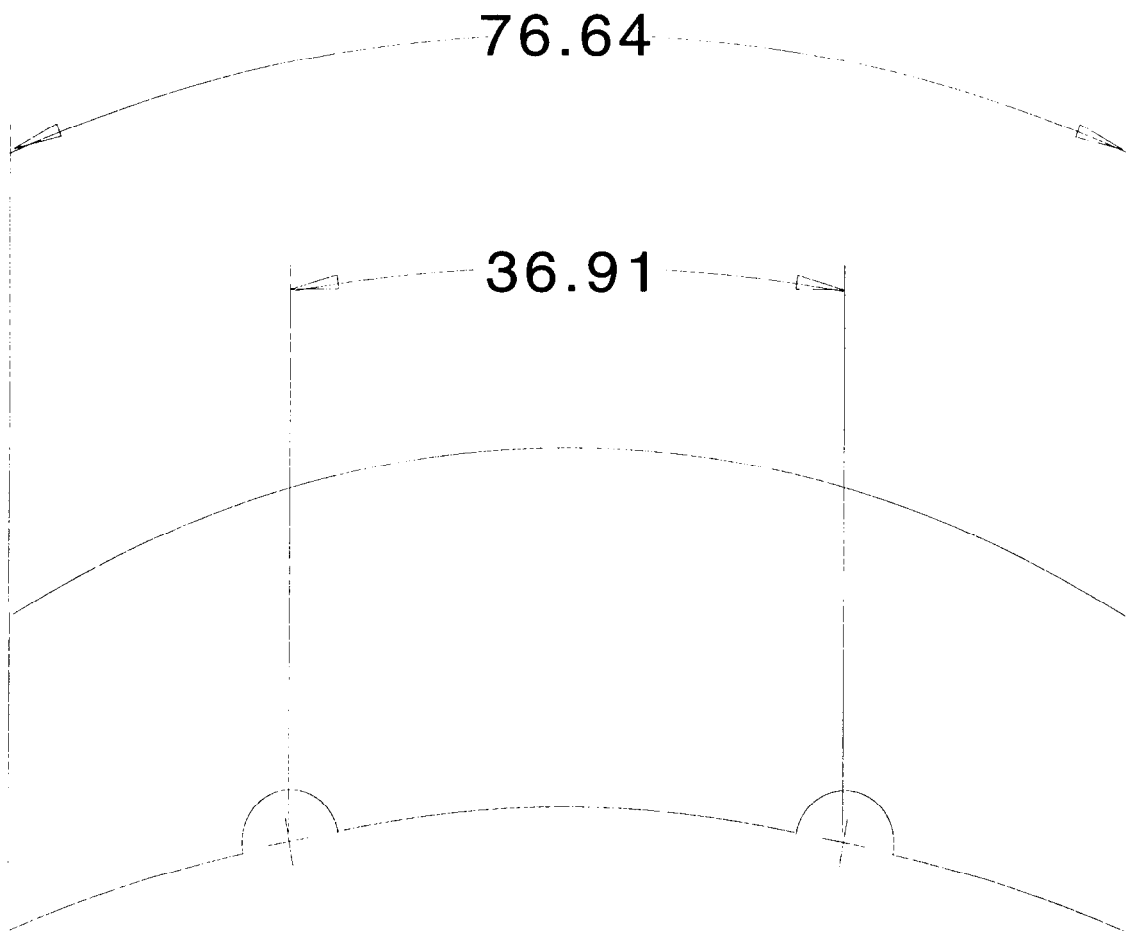


Figure 6 – Curve dimension

4.2.19 Datum_feature_callout

A Datum_feature_callout is a type of Draughting_callout (see 4.2.29) used to denote a point, line, or plane as a datum and which specifies the designation to be used as identification of that datum.

4.2.20 Datum_target_callout

A Datum_target_callout is a type of Draughting_callout (see 4.2.29) used to denote points, lines, and surfaces of contact which are used in establishing a reference datum on a product. The callout contains an alphanumeric designation and, where applicable, a specification of the diametrical size of the target area.

4.2.21 Diameter_dimension

A Diameter_dimension is a type of Dimension (see 4.2.22) that is the graphical presentation of a value of the diametrical size of a circular element.

NOTE – Projection lines may be used to clarify the extent of a dimension of diametrical size as illustrated in Figure 7.

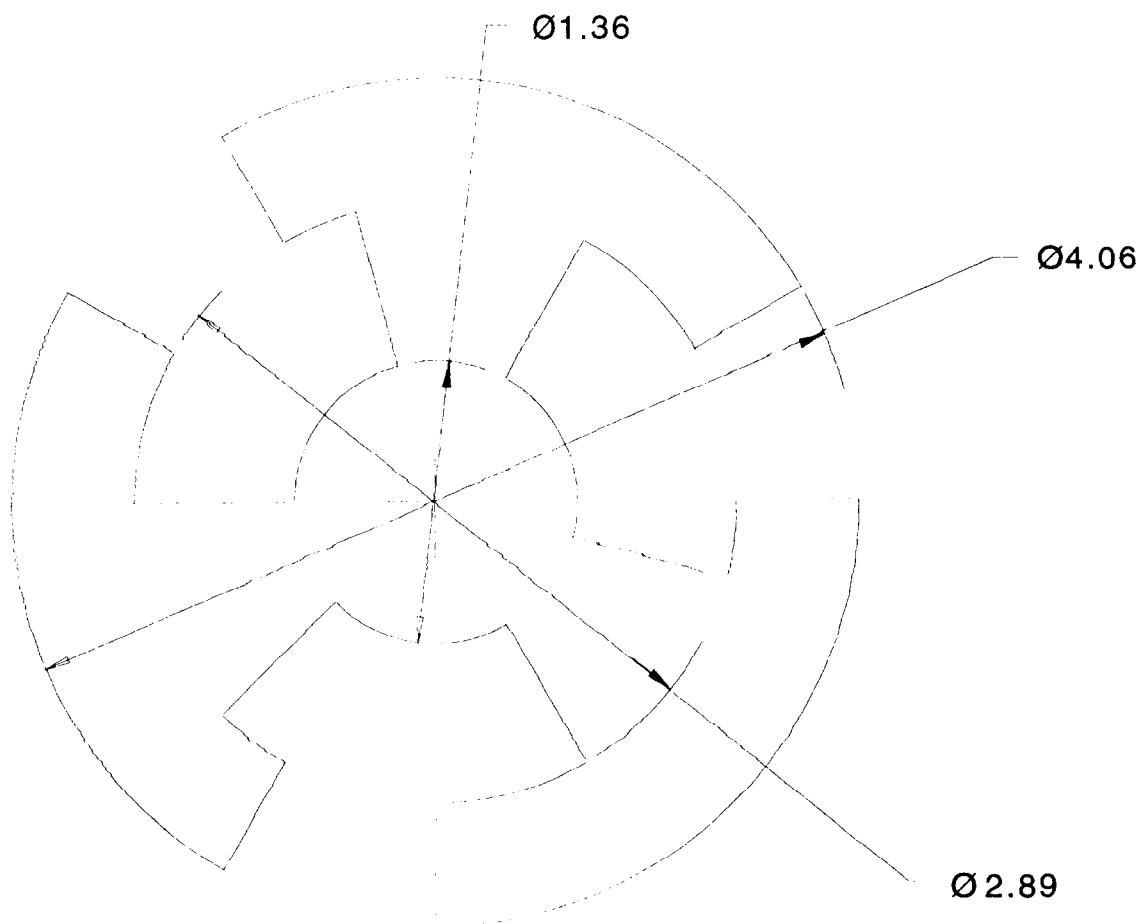


Figure 7 – Diameter dimension

4.2.22 Dimension

A Dimension is a type of Draughting_annotation (see 4.2.28) that is the graphical presentation of the dimension value, associated information, and the necessary symbology to accurately depict its area of application. Each Dimension is either an Angular_dimension (see 4.2.5), a Curve_dimension (see 4.2.18), a Diameter_dimension (see 4.2.21), a Leader_directed_dimension (see 4.2.52), a Linear_dimension (see 4.2.54), an Ordinate_dimension (see 4.2.56), or a Radius_dimension (see 4.2.66).

4.2.23 Dimension_callout

A Dimension_callout is the text and symbols in the presentation of a dimension that represent the dimension value, dimension units, tolerance information and any related notes. Each Dimension_callout is either a Structured_dimension_callout (see 4.2.69) or an Unstructured_dimension_callout (see 4.2.79). Each Dimension_callout is either primary or secondary for one dimension.

4.2.24 Dimension_line

A Dimension_line is a type of Directed_curve (see 4.2.27) used in the graphical presentation of a dimension value along with other symbology, if necessary, to show the extent of the application of the value.

EXAMPLE 9 – Terminator symbols may be associated with a Dimension_line.

4.2.25 Dimension_sequence_pair

A Dimension_sequence_pair is the relationship between two adjacent dimensions that share a projection line. Each Dimension_sequence_pair is either a Chained_dimension_pair (see 4.2.15) or a Parallel_dimension_pair (see 4.2.58).

4.2.26 Dimension_symbol

A Dimension_symbol is a type of Predefined_symbol (see 4.2.62) that is used in conjunction with a dimension value to convey the context of the dimension value.

EXAMPLE 10 – A diameter symbol may be used in conjunction with a dimension value to denote a diameter dimension.

NOTE – See 5.2.2.1.36 for a description of the dimension symbols supported by this part of ISO 10303.

4.2.27 Directed_curve

A **Directed_curve** is a type of **Annotation_curve** (see 4.2.6) that is used to guide annotation to a specific feature or area of a draughting shape model, drawing view, or drawing sheet. Each **Directed_curve** is either a **Dimension_line** (see 4.2.24), a **Leader** (see 4.2.51), or a **Projection_line** (see 4.2.65).

4.2.28 Draughting_annotation

A **Draughting_annotation** is text and symbology applied to either a drawing sheet, drawing view, another piece of annotation, or a draughting shape model, for the purpose of communicating product data and drawing interpretation information. Each **Draughting_annotation** is either an **Annotation_element** (see 4.2.7), a **Dimension** (see 4.2.22), or a **Draughting_callout** (see 4.2.29). Each **Draughting_annotation** may be one of the following: a **Model_placed_annotation** (see 4.2.55), a **Sheet_placed_annotation** (see 4.2.67), or a **View_placed_annotation** (see 4.2.89).

4.2.29 Draughting_callout

A **Draughting_callout** is a type of **Draughting_annotation** (see 4.2.28) that is a combination of text, annotation curves, and symbology which conveys information about a specific feature or area. Each **Draughting_callout** may be one of the following: a **Datum_feature_callout** (see 4.2.19), a **Datum_target_callout** (see 4.2.20), or a **Geometrical_tolerance** (see 4.2.43).

NOTE – Figure 8 illustrates the dimensioning and annotation of specific features of a product. The top view illustrates the specification of datums E and F and the specification of the diameter dimension with an associated geometrical tolerance. The centre view illustrates another datum specification and a draughting callout, in this case, a geometrical tolerance related by a projection line. The bottom view illustrates three datum target points and their associated datum target symbols.

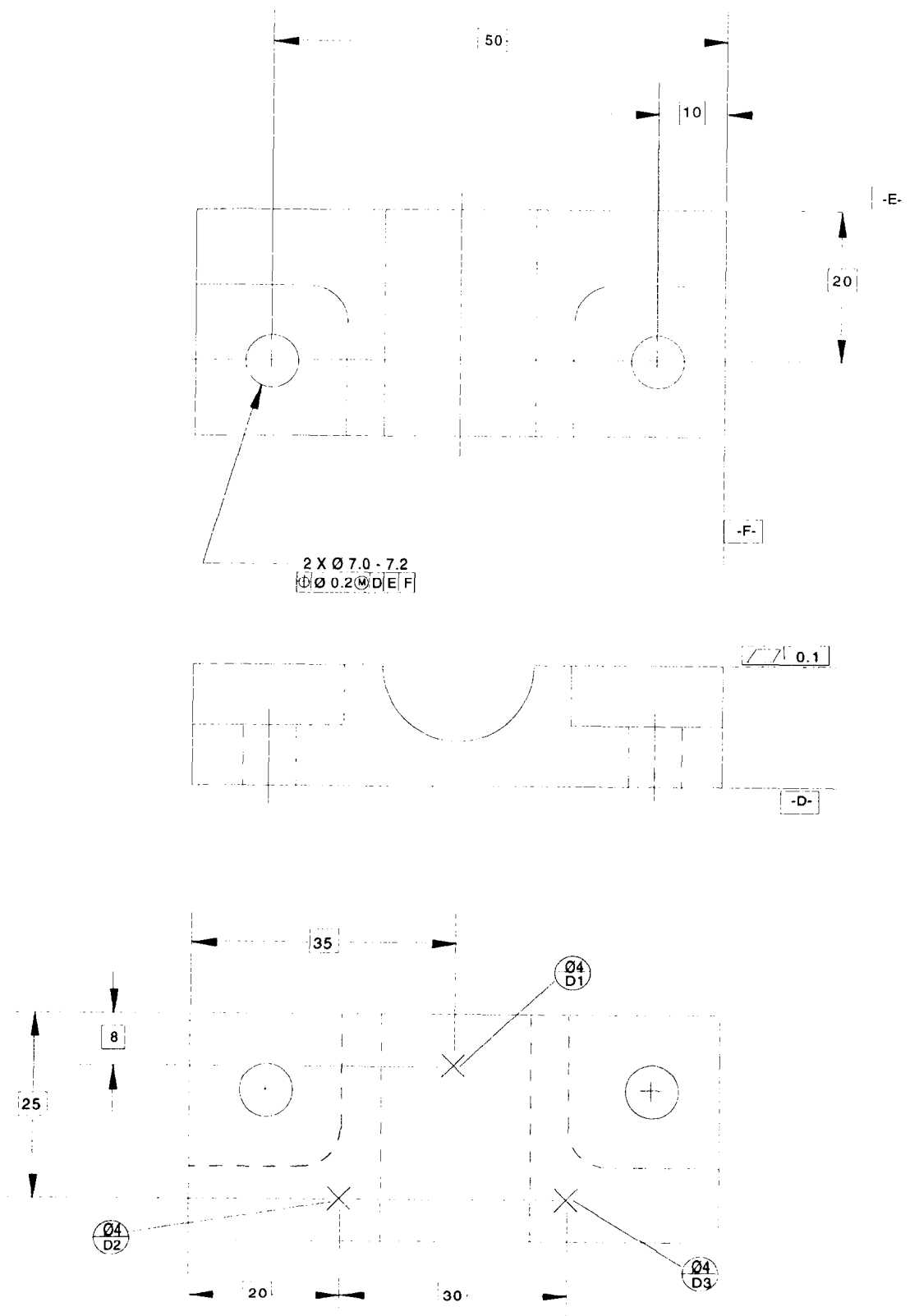


Figure 8 – Draughting callouts

4.2.30 Drawing

A Drawing is the presentation of product data in a human-interpretable form wherein the physical and functional requirements for that product are presented pictorially and textually. The data associated with a Drawing are the following:

- Contract_reference;
- Drawing_number;
- Drawing_revision_id;
- Drawing_specification;
- Dawing_type;
- Security_classification;
- Title.

4.2.30.1 Contract_reference

The Contract_reference specifies the identification of a legally enforceable agreement, between two or more parties, that defines activities related to the drawing. The Contract_reference need not be specified for a particular Drawing. There may be more than one Contract_reference for a Drawing.

4.2.30.2 Drawing_number

The Drawing_number specifies the identification of a particular drawing by an organization.

4.2.30.3 Drawing_revision_id

The Drawing_revision_id specifies the identification of a particular version of the drawing.

4.2.30.4 Drawing_specification

The Drawing_specification specifies the identification of a standard to which the drawing conforms. This standard specifies the presentation forms used in the drawing. The Drawing_specification need not be specified for a particular Drawing. There may be more than one Drawing_specification for a Drawing.

EXAMPLE 11 – A Drawing_specification may be ISO 129, Technical drawings - Dimensioning.

4.2.30.5 Drawing_type

The Drawing_type specifies the category of the drawing and may indicate the information content. The Drawing_type need not be specified for a particular Drawing.

EXAMPLE 12 – A Drawing_type may be an assembly drawing, casting drawing, elevation drawing, or a land title drawing.

4.2.30.6 Security_classification

The Security_classification specifies the organization and external designation of the level of protection from unauthorized access to the drawing. The Security_classification need not be specified for a particular Drawing. There may be more than one Security_classification for a Drawing.

4.2.30.7 Title

The Title specifies a description of the content or subject matter of the drawing. The Title may or may not be specified for a particular Drawing.

4.2.31 Drawing_sheet

A Drawing_sheet is a logical division of a drawing into a two-dimensional area for the presentation of product data. These divisions correspond to sheet paper sizes for plotting. A Drawing_sheet contains at least one Drawing_view (see 4.2.33) or one Draughting_annotation (see 4.2.28). The data associated with a Drawing_sheet are the following:

- Security_classification;
- Sheet_number;
- Sheet_revision_id;
- Size;
- Title.

4.2.31.1 Security_classification

The Security_classification specifies the organization and external designation of the level of protection from unauthorized access to the drawing sheet. The Security_classification need not be specified for a particular Drawing_sheet. There may be more than one Security_classification for a Drawing_sheet.

4.2.31.2 Sheet_number

The Sheet_number specifies the page number for a particular drawing sheet and its location in relation to other sheets of the drawing.

4.2.31.3 Sheet_revision_id

The Sheet_revision_id specifies the identification of a particular version of the drawing sheet.

4.2.31.4 Size

The Size specifies the physical size of the presentation area of the drawing sheet. This physical size also corresponds to the physical size of a sheet of paper on which the drawing sheet may be placed. The physical size is defined by the length and width of the sheet in specified units of measure.

NOTE – The standard sheet size designators for a specified draughting standard, such as ANSI Y14.2M-1979 or ISO STD HDBK 12, can be derived from these values.

4.2.31.5 Title

The Title specifies the contents or subject matter of the drawing sheet. The Title need not be specified for a particular Drawing_sheet.

4.2.32 Drawing_sheet_layout

A Drawing_sheet_layout is a type of User_defined_symbol_definition (see 4.2.84) that specifies the layout, or format, of a sheet of a drawing.

4.2.33 Drawing_view

A Drawing_view is a presentation on a drawing sheet of 2d projection of a draughting shape model, together with any annotation that refers to, or is relevant to, the view. The data

associated with a `Drawing_view` are the following:

- `Location`;
- `Name`;
- `Rotation`.

NOTE – Note that the 2d projection is specified by a `2D_drawing_view_definition` (see 4.2.3).

4.2.33.1 Location

The `Location` specifies the position of the origin of the coordinate system of the drawing view relative to the origin of the coordinate system of the drawing sheet where it is placed.

4.2.33.2 Name

The `Name` specifies the identification of a particular drawing view. The `Name` need not be specified for a particular `Drawing_view`.

4.2.33.3 Rotation

The `Rotation` specifies the angle, measured counter-clockwise, between the horizontal axis of the coordinate system of the drawing view and the horizontal axis of the coordinate system of the drawing sheet where it is placed.

4.2.34 Externally_defined_hatching

An `Externally_defined_hatching` is a type of `Fill_area_appearance` (see 4.2.41) that has an explicit physical description defining the hatching and is found in a known source. This known source is agreed to by all parties involved in the exchange of the drawings on which the hatching pattern appears. An `Externally_defined_hatching` consists of one or more uniformly spaced geometric patterns. For each pattern, an `Externally_defined_hatching` shall include the specification of the curve appearance, the angle of the curves in the pattern relative to the horizontal axis of the coordinate system into which it is placed, and the displacement between adjacent curves in the pattern. The data associated with an `Externally_defined_hatching` are the following:

- `Hatching_name`;
- `Hatching_reference`.

4.2.34.1 Hatching_name

The Hatching_name specifies the identification of a particular hatching pattern within the known source.

4.2.34.2 Hatching_reference

The Hatching_reference specifies the known source that contains a set of patterns from which the hatching pattern is selected.

4.2.35 Externally_defined_line_font

An Externally_defined_line_font is a type of Line_font (see 4.2.53) that has an explicit physical description defining the line font and is found in a known source. This known source is agreed to by all parties involved in the exchange of the drawings on which the line font appears. An Externally_defined_line_font shall include a set of values which represent the length of the visible and invisible segments of the line font. The set of values is sufficient to define all elements which constitute a single portion of the curve. This portion is then repeated over the length of the curve. The data associated with an Externally_defined_line_font are the following:

- Font_name;
- Font_reference.

4.2.35.1 Font_name

The Font_name specifies the identification of a particular line font within the known source.

4.2.35.2 Font_reference

The Font_reference specifies the known source that contains a set of line fonts from which the line font is be selected.

4.2.36 Externally_defined_symbol

An Externally_defined_symbol is a type of Annotation_symbol (see 4.2.11) that has an explicit physical description defining the symbol and is found in a known source. This known source is agreed to by all parties involved in the exchange of the drawings on which the symbol appears. An Externally_defined_symbol shall include the specification of all the constituent components of the symbol, their size, and relative location, together with the origin or reference point of the symbol. The data associated with an Externally_defined_symbol are the following:

- Symbol_name;
- Symbol_reference.

4.2.36.1 Symbol_name

The Symbol_name specifies the identification of a particular symbol within the known source.

4.2.36.2 Symbol_reference

The Symbol_reference specifies the known source that contains a set of symbols from which the symbol is selected.

4.2.37 Externally_defined_text_font

An Externally_defined_text_font is a type of Text_font (see 4.2.76) that has an explicit physical description defining the text font and is found in a known source. This known source is agreed to by all parties involved in the exchange of the drawings on which the text font appears. An Externally_defined_text_font shall include the specification of the physical form of the characters of the font, together with the origin or reference point of each character. The data associated with an Externally_defined_text_font are the following:

- Font_name;
- Font_reference.

4.2.37.1 Font_name

The Font_name specifies the identification of a particular text font in the known source.

4.2.37.2 Font_reference

The Font_reference specifies the known source that contains a set of text fonts from which the text font is selected.

4.2.38 Externally_defined_tile

An Externally_defined_tile is a type of Tile (see 4.2.78) that has an explicit physical description defining the tile and is found in a known source. This known source is agreed to by all parties

involved in the exchange of the drawings on which the tile appears. An `Externally_defined_tile` shall include the specification of all the constituent components of the tile. The data associated with an `Externally_defined_tile` are the following:

- `Tile_name`;
- `Tile_reference`.

4.2.38.1 `Tile_name`

The `Tile_name` specifies the identification of a particular tile in the known source.

4.2.38.2 `Tile_reference`

The `Tile_reference` specifies the known source that contains a set of tiles from which the tile is selected.

4.2.39 `Externally_defined_tiling`

An `Externally_defined_tiling` is a type of `Fill_area_appearance` (see 4.2.41) that has an explicit physical description defining the tiling pattern and is found in a known source. This known source is agreed to by all parties involved in the exchange of the drawings on which the tiling appears. An `Externally_defined_tiling` specification shall include the repeat vectors used to define the relative positioning of tiles, the angle of the horizontal axis of the tile relative to the horizontal axis of the coordinate system into which it is placed, and the scale of the tile as presented to the tile as defined. The data associated with an `Externally_defined_tiling` are the following:

- `Tiling_name`;
- `Tiling_reference`.

4.2.39.1 `Tiling_name`

The `Tiling_name` specifies the identification of a particular tiling pattern in the known source.

4.2.39.2 `Tiling_reference`

The `Tiling_reference` specifies the known source that contains a set of patterns from which the tiling pattern is selected.

4.2.40 Fill_area

A Fill_area is a type of Annotation_element (see 4.2.7) that is a bounded area containing coloring, hatching, or tiling that indicate its extent and content. A Fill_area communicates some aspect of a physical part characteristic or distinguishes it from its surroundings. The data associated with a Fill_area are the following:

- Reference_point.

The Reference_point specifies a point within the fill area used in the placement and initiation of the fill area appearance. The Reference_point establishes a point through which a line of a hatching pattern passes or at which the origin of a tile is located. The Reference_point also establishes the point at which the first visible segment of a line font used as the curve appearance for a hatching pattern starts. The Reference_point need not be specified for a particular Fill_area.

4.2.41 Fill_area_appearance

A Fill_area_appearance is a type of Appearance (see 4.2.12) that governs the visual presentation of a fill area. Each Fill_area_appearance is either an Externally_defined_hatching (see 4.2.34), an Externally_defined_tiling (see 4.2.39), a Solid_fill_area (see 4.2.68), a User_defined_hatching (see 4.2.81), or a User_defined_tiling (see 4.2.86). The data associated with a Fill_area_appearance are the following:

- Draughting_role.

The Draughting_role specifies the purpose within draughting for a particular fill area appearance. The Draughting_role need not be specified for a particular Fill_area_appearance.

4.2.42 Fill_area_boundary

A Fill_area_boundary is an annotation curve in the same coordinate space that defines the limits of a fill area. The curve is closed and not self-intersecting.

4.2.43 Geometrical_tolerance

A Geometrical_tolerance is a type of Draughting_callout (see 4.2.29) that is the human-interpretable presentation of tolerance information. This presentation is a combination of geometric characteristic symbols, tolerance values, and datum reference designations, where applicable, to express the permissible variation from the theoretically exact size, profile, orientation, or location of a feature or datum target.

NOTE – Computer interpretable geometric tolerances are not within the scope of this application protocol.