

INTERNATIONAL STANDARD

ISO
10303-202

First edition
1996-12-15

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

Part 202:

Application protocol: Associative draughting

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

Partie 202: Protocole d'application: Dessin technique associatif



Reference number
ISO 10303-202:1996(E)

AVA Documents
Document Sharing Hub

Contents	Page
1 Scope	1
2 Normative references	3
3 Definitions and abbreviations	4
3.1 Terms defined in ISO 5459	4
3.2 Terms defined in ISO 10209-1	5
3.3 Terms defined in ISO 10303-1	5
3.4 Terms defined in ISO 10303-42	5
3.5 Terms defined in ISO 10303-46	6
3.6 Terms defined in ISO 10303-101	6
3.7 Other definitions	6
3.7.1 application interpreted construct (AIC)	6
3.7.2 baseline	6
3.7.3 cartesian coordinate system	6
3.7.4 draughting shape model	6
3.7.5 externally defined	6
3.7.6 geometric basis	6
3.7.7 geometric target	7
3.7.8 model	7
3.7.9 predefined	7
3.7.10 subfigure	7
3.7.11 symbol	7
3.8 Abbreviations	7
4 Information requirements	8
4.1 Units of functionality	9
4.1.1 associative_dimensions	9
4.1.2 draughting_shape_model	10
4.1.3 drawing_structure_and_administration	11
4.1.4 elements_of_annotation	11
4.1.5 elements_of_appearance	12
4.1.6 elements_of_draughting_annotation	14
4.1.7 grouping	15
4.1.8 model_viewing	15
4.1.9 product_relation	16
4.2 Application objects	16

© ISO 1996
All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Organization for Standardization
Case Postale 56 - CH-2111 Geneve 20 - Switzerland

Printed in Switzerland

4.3 Application assertions 61

5 Application interpreted model 77

5.1 Mapping table 77

5.2 AIM EXPRESS short listing 185

6 Conformance requirements 281

Annexes

A AIM EXPRESS expanded listing 297

B AIM short names of entities 420

C Implementation method specific requirements 433

D Protocol implementation conformance statement (PICS) proforma 434

E Information object registration 436

E.1 Document identification 436

E.2 Schema identification 436

F Application interpreted constructs for this part of ISO 10303 437

G Application activity model 558

G.1 Application activity model definitions 558

G.2 Application activity model diagrams 561

H Application reference model 566

J AIM EXPRESS-G 583

K AIM EXPRESS listing 647

L Technical discussions 648

L.1 Draughting of the product shape 648

L.2 Draughting of dimensions 652

M Bibliography 659

Index 660

Figures

Figure 1 - Data planning model	xvi
Figure 2 - Angular and radius dimensions	19
Figure 3 - Chain dimension sequence	23
Figure 4 - Curve dimension	24
Figure 5 - Diameter dimension	26
Figure 6 - Direction vector	28
Figure 7 - Draughting callouts	29
Figure 8 - Drawing sheet layout	34
Figure 9 - Leader directed dimension	43
Figure 10 - Linear dimensions depicting a radius size dimension and a diameter size dimension . .	44
Figure 11 - Ordinate dimension	45
Figure 12 - Parallel dimension sequence	46
Figure 13 - Structured dimension callout	49
Figure 14 - Text characteristics	51
Figure 15 - Mirror angle	53
Figure 16 - Text appearance and rotation of text	54
Figure 17 - Character alignment	56
Figure 18 - User defined tiling	61
Figure 19 - Viewed surface appearance	62
Figure 20 - Predefined curve fonts	196
Figure 21 - Predefined dimension symbols	203
Figure 22 - Predefined geometrical tolerance symbols	206
Figure 23 - Predefined point marker symbols	210
Figure 24 - Predefined terminator symbols	212
Figure F.1 - Angular and radius dimensions	484
Figure F.2 - Curve dimension	485
Figure F.3 - Draughting callouts	486
Figure F.4 - Diameter dimension	487
Figure F.5 - Chain dimension pair	491
Figure F.6 - Parallel dimension pair	491
Figure F.7 - Leader directed dimension	494
Figure F.8 - Ordinate dimension	496
Figure F.9 - Structured dimension callout	497
Figure G.1 - IDEF0 basic notation	558
Figure G.2 - A0: document product	562
Figure G.3 - A0: document product decomposition	563
Figure G.4 - A1: configure drawing view	564
Figure G.5 - A2: configure drawing sheet	565
Figure H.1 - ARM diagram 1 of 16 in IDEF1X	567
Figure H.2 - ARM diagram 2 of 16 in IDEF1X	568
Figure H.3 - ARM diagram 3 of 16 in IDEF1X	569
Figure H.4 - ARM diagram 4 of 16 in IDEF1X	570
Figure H.5 - ARM diagram 5 of 16 in IDEF1X	571
Figure H.6 - ARM diagram 6 of 16 in IDEF1X	572

Figure H.7 - ARM diagram 7 of 16 in IDEF1X	573
Figure H.8 - ARM diagram 8 of 16 in IDEF1X	574
Figure H.9 - ARM diagram 9 of 16 in IDEF1X	575
Figure H.10 - ARM diagram 10 of 16 in IDEF1X	576
Figure H.11 - ARM diagram 11 of 16 in IDEF1X	577
Figure H.12 - ARM diagram 12 of 16 in IDEF1X	578
Figure H.13 - ARM diagram 13 of 16 in IDEF1X	579
Figure H.14 - ARM diagram 14 of 16 in IDEF1X	580
Figure H.15 - ARM diagram 15 of 16 in IDEF1X	581
Figure H.16 - ARM diagram 16 of 16 in IDEF1X	582
Figure J.1 - AIM EXPRESS-G diagram 1 of 64	584
Figure J.2 - AIM EXPRESS-G diagram 2 of 64	585
Figure J.3 - AIM EXPRESS-G diagram 3 of 64	586
Figure J.4 - AIM EXPRESS-G diagram 4 of 64	586
Figure J.5 - AIM EXPRESS-G diagram 5 of 64	587
Figure J.6 - AIM EXPRESS-G diagram 6 of 64	588
Figure J.7 - AIM EXPRESS-G diagram 7 of 64	589
Figure J.8 - AIM EXPRESS-G diagram 8 of 64	590
Figure J.9 - AIM EXPRESS-G diagram 9 of 64	591
Figure J.10 - AIM EXPRESS-G diagram 10 of 64	592
Figure J.11 - AIM EXPRESS-G diagram 11 of 64	593
Figure J.12 - AIM EXPRESS-G diagram 12 of 64	594
Figure J.13 - AIM EXPRESS-G diagram 13 of 64	595
Figure J.14 - AIM EXPRESS-G diagram 14 of 64	596
Figure J.15 - AIM EXPRESS-G diagram 15 of 64	597
Figure J.16 - AIM EXPRESS-G diagram 16 of 64	598
Figure J.17 - AIM EXPRESS-G diagram 17 of 64	599
Figure J.18 - AIM EXPRESS-G diagram 18 of 64	600
Figure J.19 - AIM EXPRESS-G diagram 19 of 64	601
Figure J.20 - AIM EXPRESS-G diagram 20 of 64	602
Figure J.21 - AIM EXPRESS-G diagram 21 of 64	603
Figure J.22 - AIM EXPRESS-G diagram 22 of 64	604
Figure J.23 - AIM EXPRESS-G diagram 23 of 64	605
Figure J.24 - AIM EXPRESS-G diagram 24 of 64	606
Figure J.25 - AIM EXPRESS-G diagram 25 of 64	607
Figure J.26 - AIM EXPRESS-G diagram 26 of 64	608
Figure J.27 - AIM EXPRESS-G diagram 27 of 64	609
Figure J.28 - AIM EXPRESS-G diagram 28 of 64	610
Figure J.29 - AIM EXPRESS-G diagram 29 of 64	611
Figure J.30 - AIM EXPRESS-G diagram 30 of 64	612
Figure J.31 - AIM EXPRESS-G diagram 31 of 64	613
Figure J.32 - AIM EXPRESS-G diagram 32 of 64	614
Figure J.33 - AIM EXPRESS-G diagram 33 of 64	615
Figure J.34 - AIM EXPRESS-G diagram 34 of 64	616
Figure J.35 - AIM EXPRESS-G diagram 35 of 64	617
Figure J.36 - AIM EXPRESS-G diagram 36 of 64	618

Figure J.37 - AIM EXPRESS-G diagram 37 of 64	619
Figure J.38 - AIM EXPRESS-G diagram 38 of 64	620
Figure J.39 - AIM EXPRESS-G diagram 39 of 64	621
Figure J.40 - AIM EXPRESS-G diagram 40 of 64	622
Figure J.41 - AIM EXPRESS-G diagram 41 of 64	623
Figure J.42 - AIM EXPRESS-G diagram 42 of 64	624
Figure J.43 - AIM EXPRESS-G diagram 43 of 64	625
Figure J.44 - AIM EXPRESS-G diagram 44 of 64	626
Figure J.45 - AIM EXPRESS-G diagram 45 of 64	627
Figure J.46 - AIM EXPRESS-G diagram 46 of 64	628
Figure J.47 - AIM EXPRESS-G diagram 47 of 64	629
Figure J.48 - AIM EXPRESS-G diagram 48 of 64	630
Figure J.49 - AIM EXPRESS-G diagram 49 of 64	631
Figure J.50 - AIM EXPRESS-G diagram 50 of 64	632
Figure J.51 - AIM EXPRESS-G diagram 51 of 64	633
Figure J.52 - AIM EXPRESS-G diagram 52 of 64	634
Figure J.53 - AIM EXPRESS-G diagram 53 of 64	635
Figure J.54 - AIM EXPRESS-G diagram 54 of 64	636
Figure J.55 - AIM EXPRESS-G diagram 55 of 64	637
Figure J.56 - AIM EXPRESS-G diagram 56 of 64	638
Figure J.57 - AIM EXPRESS-G diagram 57 of 64	639
Figure J.58 - AIM EXPRESS-G diagram 58 of 64	640
Figure J.59 - AIM EXPRESS-G diagram 59 of 64	641
Figure J.60 - AIM EXPRESS-G diagram 60 of 64	642
Figure J.61 - AIM EXPRESS-G diagram 61 of 64	643
Figure J.62 - AIM EXPRESS-G diagram 62 of 64	644
Figure J.63 - AIM EXPRESS-G diagram 63 of 64	645
Figure J.64 - AIM EXPRESS-G diagram 64 of 64	646
Figure L.1 - 2D annotation geometry on drawing sheet	650
Figure L.2 - 2D view projections of the product shape	652
Figure L.3 - Placement of 2D view projections	653
Figure L.4 - 2D or 3D shape with information to derive view projections	654
Figure L.5 - 2D or 3D geometric model	655
Figure L.6 - Linear dimension interpreted as a diameter dimension	656
Figure L.7 - Diameter dimension interpreted as a leader directed dimension	657
Figure L.8 - Diameter dimension displaying entire dimension line	657

Tables

Table 1 - Mapping table for associative_dimensions UoF	80
Table 2 - Mapping table for draughting_shape_model UoF	91
Table 3 - Mapping table for drawing_structure_and_administration UoF	100
Table 4 - Mapping table for elements_of_annotation UoF	115
Table 5 - Mapping table for elements_of_appearance UoF	140
Table 6 - Mapping table for elements_of_draughting_annotation UoF	153

Table 7 - Mapping table for grouping UoF 171

Table 8 - Mapping table for model_viewing UoF 173

Table 9 - Mapping table for product_relation UoF 181

Table 10 - RGB values for predefined colours 194

Table 11 - Line segment and space lengths for predefined curve fonts 195

Table 12 - Conformance classes 282

Table 13 - Conformance class elements 283

Table B.1 - AIM short names 420

Table C.1 - Display of an annotation curve on a drawing 433

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 10303-202 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

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 method: EXPRESS language reference manual;
- Part 12, Description method: EXPRESS-I language reference manual;
- Part 13, Description method: Architecture and methodology reference manual;
- Part 21, Implementation method: Clear text encoding of the exchange structure;
- Part 22, Implementation method: Standard data access interface specification;
- Part 23, Implementation method: C++ language binding to the standard data access interface;
- Part 24, Implementation method: C language binding to the standard data access interface;
- Part 26, Implementation method: Interface definition language binding to the standard data access;
- Part 31, Conformance testing methodology and framework: General concepts;
- Part 32, Conformance testing methodology and framework: Requirements on testing laboratories and clients;

- Part 33, Conformance testing methodology and framework: Structure and use of abstract test suites;
- Part 34, Conformance testing methodology and framework: Abstract test methods;
- Part 35, Conformance testing methodology and framework: Abstract test methods for SDAI implementations;
- Part 41, Integrated generic resource: Fundamentals of product description and support;
- Part 42, Integrated generic resource: Geometric and topological representation;
- Part 43, Integrated generic resource: Representation structures;
- Part 44, Integrated generic resource: Product structure configuration;
- Part 45, Integrated generic resource: Materials;
- Part 46, Integrated generic resource: Visual presentation;
- Part 47, Integrated generic resource: Shape variation tolerances;
- Part 49, Integrated generic resource: Process structure and properties;
- Part 101, Integrated application resource: Draughting;
- Part 104, Integrated application resource: Finite element analysis;
- Part 105, Integrated application resource: Kinematics;
- Part 106, Integrated application resource: Building construction core model;
- Part 201, Application protocol: Explicit draughting;
- Part 202, Application protocol: Associative draughting;
- Part 203, Application protocol: Configuration controlled design;
- Part 204, Application protocol: Mechanical design using boundary representation;
- Part 205, Application protocol: Mechanical design using surface representation;
- Part 207, Application protocol: Sheet metal die planning and design;
- Part 208, Application protocol: Life cycle management - Change process;

- Part 209, Application protocol: Composite and metallic structural analysis and related design;
- Part 210, Application protocol: Design of layered electronic products;
- Part 211, Application protocol: Electronics test diagnostics and remanufacture;
- Part 212, Application protocol: Electrotechnical design and installation;
- Part 213, Application protocol: Numerical control process plans for machined parts;
- Part 214, Application protocol: Core data for automotive mechanical design;
- Part 215, Application protocol: Ship arrangement;
- Part 216, Application protocol: Ship moulded forms;
- Part 217, Application protocol: Ship piping;
- Part 218, Application protocol: Ship structures;
- Part 220, Application protocol: Process planning, manufacture, and assembly of layered electronic products;
- Part 221, Application protocol: Functional data and their schematic representation for process plant;
- Part 222, Application protocol: Exchange of product data for composite structures;
- Part 223, Application protocol: Exchange of design and manufacturing product information for cast parts;
- Part 224, Application protocol: Mechanical product definition for process plans using mechanical feature;
- Part 225, Application protocol: Building elements using explicit shape representation;
- Part 226, Application protocol: Ship mechanical systems;
- Part 227, Application protocol: Plant spatial configuration;
- Part 228, Application protocol: Building services: Heating, ventilation, and air conditioning;
- Part 229, Application protocol: Exchange of design and manufacturing product information for forged parts;
- Part 230, Application protocol: Building structural frame: Steelwork;

- Part 231, Application protocol: Process engineering data: Process design and process specification of major equipment;
- Part 232, Application protocol: Technical data package;
- Part 301, Abstract test suite: Explicit draughting;
- Part 302, Abstract test suite: Associative draughting;
- Part 303, Abstract test suite: Configuration controlled design;
- Part 304, Abstract test suite: Mechanical design using boundary representation;
- Part 305, Abstract test suite: Mechanical design using surface representation;
- Part 307, Abstract test suite: Sheet metal die planning and design;
- Part 308, Abstract test suite: Life cycle management - Change process;
- Part 309, Abstract test suite: Composite and metallic structural analysis and related design;
- Part 310, Abstract test suite: Design of layered electronic products;
- Part 311, Abstract test suite: Electronics test diagnostics and remanufacture;
- Part 312, Abstract test suite: Electrotechnical design and installation;
- Part 313, Abstract test suite: Numerical control process plans for machined parts;
- Part 314, Abstract test suite: Core data for automotive mechanical design;
- Part 315, Abstract test suite: Ship arrangement;
- Part 316, Abstract test suite: Ship moulded forms;
- Part 317, Abstract test suite: Ship piping;
- Part 318, Abstract test suite: Ship structures;
- Part 320, Abstract test suite: Process planning, manufacture, and assembly of layered electronic products;
- Part 321, Abstract test suite: Functional data and their schematic representation for process plant;
- Part 322, Abstract test suite: Exchange of product data for composite structures;

- Part 323, Abstract test suite: Exchange of design and manufacturing product information for cast parts;
- Part 324, Abstract test suite: Mechanical product definition for process plans using mechanical features;
- Part 325, Abstract test suite: Building elements using explicit shape representation;
- Part 326, Abstract test suite: Ship mechanical systems;
- Part 327, Abstract test suite: Plant spatial configuration;
- Part 328, Abstract test suite: Building services: Heating, ventilation, and air conditioning;
- Part 329, Abstract test suite: Exchange of design and manufacturing product information for forged parts;
- Part 330, Abstract test suite: Building structural frame: Steelwork;
- Part 331, Abstract test suite: Process engineering data: Process design and process specification of major equipment;
- Part 332, Abstract test suite: Technical data package;
- Part 501, Application interpreted construct: Edge-based wireframe;
- Part 502, Application interpreted construct: Shell-based wireframe;
- Part 503, Application interpreted construct: Geometrically bounded 2D wireframe;
- Part 504, Application interpreted construct: Draughting annotation;
- Part 505, Application interpreted construct: Drawing structure and administration;
- Part 506, Application interpreted construct: Draughting elements;
- Part 507, Application interpreted construct: Geometrically bounded surface;
- Part 508, Application interpreted construct: Non-manifold surface;
- Part 509, Application interpreted construct: Manifold surface;
- Part 510, Application interpreted construct: Geometrically bounded wireframe;
- Part 511, Application interpreted construct: Topologically bounded surface;

- Part 512, Application interpreted construct: Faceted boundary representation;
- Part 513, Application interpreted construct: Elementary boundary representation;
- Part 514, Application interpreted construct: Advanced boundary representation;
- Part 515, Application interpreted construct: Constructive solid geometry;
- Part 517, Application interpreted construct: Mechanical design geometric presentation;
- Part 518, Application interpreted construct: Mechanical design shaded representation.

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

- Parts 11 to 13 specify the description methods,
- Parts 21 to 26 specify the implementation methods,
- Parts 31 to 35 specify the conformance testing methodology and framework,
- Parts 41 to 49 specify the integrated generic resources,
- Parts 101 to 106 specify the integrated application resources,
- Parts 201 to 232 specify the application protocols,
- Parts 301 to 332 specify the abstract test suites, and
- Parts 501 to 518 specify the application interpreted constructs.

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

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

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 interpreted constructs, 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 protocol series.

This part of ISO 10303 specifies an application protocol (AP) for the exchange of computer-interpretable technical drawings which are generated in a computer-aided design/draughting (CAD) system. These drawings consist of two-dimensional presentations of two-dimensional or three-dimensional geometry and planar annotation defined in a two-dimensional or three-dimensional coordinate space. This part provides the structures for the exchange of such drawings within and among organizations, especially those operating in the mechanical engineering and architectural, engineering, and construction (AEC) industrial sectors.

The exchange of such drawings provides a means of communicating product data during all stages of the life cycle of a product. This product data, in the form of a drawing, may be interpreted by people according to accepted international, national, or organization draughting standards. The use of 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 computer systems for use in applications other than draughting.

This application protocol makes use of four fundamental concepts that relate to the creation, revision, storage, and use of drawings produced using CAD systems. Drawings may include the following:

- representations of the shape of the product, or products, depicted by the drawing;
- information used in administering drawings for purposes of configuration control, audit trails, etc;
- representations of annotations implying suggested machining sequence;
- information on assembly, subassembly, component parts relationship.

The use of the shape representation depicted in the 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 part of ISO 10303 is related to ISO 10303-201 [7], since both support the same basic application domain, draughting. Many of the requirements defined within both application protocols are the same. However, the requirements defined within two basic areas of this part of ISO 10303 have a broader scope. These two areas are the types of draughting shape models that drawings are generated from, and the associativity of annotation to geometric elements and other annotation within the draughting shape model or drawing.

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

The data planning model illustrates that a product is described by a draughting shape model. The draughting shape model is a two-dimensional or three-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, is composed of geometry and presented in the draughting shape model, the drawing views, or on the drawing sheets. Annotation provides additional product data that may be needed to fully define the product or interpret the drawing. This annotation may be associated to geometry or other annotation in the draughting shape model and drawing views. A description of this association is given in annex L.

Constraints on the dimensionality of data have been applied where currently limited by CAD technology. For instance, views of the draughting shape model and annotation applied to a drawing sheet are two-dimensional. All drawings that are produced in paper form are two-dimensional. Therefore, the corresponding electronic data consists of two-dimensional representations.

This application protocol defines the context, scope, and information requirements for exchange of drawings with associative 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.

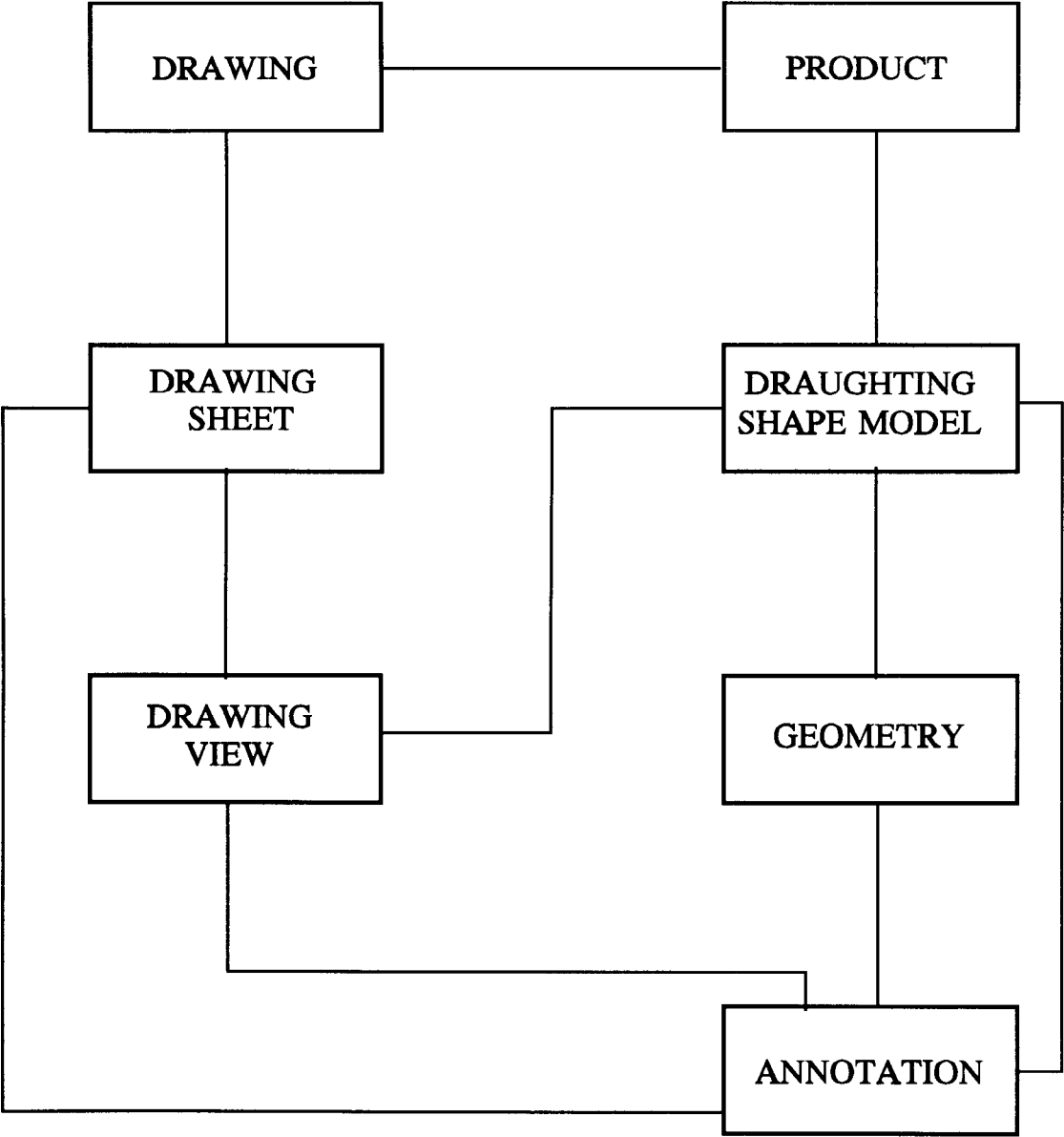


Figure 1 - Data planning model

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 G. 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 H.

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 J. Additional requirements for specific implementation methods are given in annex C.

Industrial automation systems and integration — Product data representation and exchange — Part 202: Application protocol: Associative draughting

1 Scope

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

This part of ISO 10303 provides for the inter-organization exchange of computer-interpretable drawing information and associated product definition data.

NOTE 1 - The application activity model in annex G 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.

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

- the structures for representing drawings for the purpose of exchange, suitable for mechanical engineering and AEC applications;
- the structures for representing a drawing that depicts any phase of the life cycle of a product;
- the structures for representing individual drawing revisions;
- the structures for representing the two-dimensional or three-dimensional product shape;
- the structures for representing the transformations of the shape model used for the generation of the drawing views;
- the hierarchical structure of drawings, drawing sheets, and views of the draughting shape model;
- the presentation of non-shape product definition data depicted in a drawing by two-dimensional annotation or planar annotation defined in a three-dimensional coordinate space;
- 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 structures for representing associations between dimensions or draughting callouts and their respective target product shape geometry or annotation;
- the structures for representing associations between the boundaries of a fill area and the product shape geometry or annotation from which they are derived;
- seven classes of draughting shape models used to represent product shape which include advanced boundary representation, faceted boundary representation, elementary boundary representation, manifold surfaces with topology, surface or wireframe geometry without topology, wireframe geometry with topology, and elementary curve sets;
- the presentation of dimensions and annotation that may be, but need not be, associated with viewed geometry or annotation.

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

- a draughting shape model that is not depicted in a drawing nor used as a constituent of another draughting shape model;
- the structures for representing drawings that are not related to a product;
- the structures for defining the relationships between multiple drawings;

NOTE 2 - Drawings could be related to document the assembly structure of a part or define the history between multiple versions of the same drawing.

- non-planar annotation defined in a three-dimensional coordinate space;
- a bill of materials presented on the drawing by annotation where the information is interpretable to a computer as a bill of materials;
- enforcement of conventions and rules found in draughting standards;

NOTE 3 - This part of ISO 10303 supports the use of draughting standards but does not redefine them.

- the exchange of non-displayable attribute data other than that required as administrative data;

EXAMPLE 2 - 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 hard copy versions of the drawing;

EXAMPLE 3 - Printer or plotter data can be pen designations, plot scale, or plot colour specifications.

- the presentation of the shape of a product in a two-dimensional view using light sources and shading;
- the association between geometric tolerances and related geometric elements;

NOTE 4 - A geometric tolerance as described above is a combination of geometric characteristic symbols, tolerance values, and datum references, where applicable, to express the permissible variation from the theoretically exact size, profile, orientation, or location of a feature or datum target. Each of the three possible components, geometric characteristic symbols, tolerance values, and datum references are computer-identifiable but not computer-interpretable and, therefore, cannot be associated to geometric elements.

- the association between computer-recognizable limit dimensions and shape geometry or annotation.

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 5459:1981, *Technical drawings — Geometric tolerancing — Datums and datum-systems for geometrical tolerances*.

ISO/IEC 8824-1:1995, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation*.

ISO 10209-1:1992, *Technical product documentation — Vocabulary — Part 1: Terms relating to technical drawings: general and types of drawings*.

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 10303-45¹⁾, *Industrial automation systems and integration — Product data representation and exchange — Part 45: Integrated generic resources: Materials.*

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

ISO 10303-47¹⁾, *Industrial automation systems and integration — Product data representation and exchange — Part 47: Integrated generic resources: Shape variation tolerances.*

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

3 Definitions and abbreviations

3.1 Terms defined in ISO 5459

This part of ISO 10303 makes use of the following term defined in ISO 5459:

— datum.

¹⁾ To be published.

3.2 Terms defined in ISO 10209-1

This part of ISO 10303 makes use of the following term defined in ISO 10209-1:

- drawing.

3.3 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 class;
- conformance testing;
- implementation method;
- integrated resource;
- product;
- product data;
- protocol implementation conformance statement (PICS);
- unit of functionality (UoF).

3.4 Terms defined in ISO 10303-42

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

- boundary representation solid model (B-rep);
- closed curve;
- curve;

- self intersect;
- surface.

3.5 Terms defined in ISO 10303-46

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

- annotation;
- presentation.

3.6 Terms defined in ISO 10303-101

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

- callout;
- draughting.

3.7 Other definitions

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

3.7.1 application interpreted construct (AIC): a logical grouping of interpreted constructs that supports a specific function for the usage of product data across multiple application contexts.

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

3.7.3 cartesian coordinate system: a set of mutually perpendicular axes divided into segments 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 axes. The point of intersection of the axes is referred to as the origin.

3.7.4 draughting shape model: a graphical representation of a product shape that is used to create a drawing. A draughting shape model is composed of geometric and annotation elements that are all defined in the same coordinate system.

3.7.5 externally defined: an explicit description of the definition and physical representation given within another source. This source provides all the information necessary to unambiguously recreate the element. This information can be referenced by identification of the source and the element within that source.

3.7.6 geometric basis: an identified point, curve, or surface that is used as the datum from which a geometric dimension is measured.

3.7.7 geometric target: an identified point, curve, or surface that is used as the terminus for the measurement of a geometric dimension.

3.7.8 model: a simplified representation or description, describing only those aspects considered to be relevant in the context of the information domain for draughting applications.

3.7.9 predefined: an explicit description of the definition and physical representation given within a clause of this part of ISO 10303. The explicit description provides all the information necessary to unambiguously recreate the element.

3.7.10 subfigure: a combination of geometric and annotation elements defined in a coordinate system unique to the combination. A subfigure may be duplicated multiple times onto the drawing or draughting shape model.

3.7.11 symbol: a combination of annotation elements which, as a collection, represents a distinct concept. A symbol may be duplicated multiple times onto the drawing or draughting shape model. A symbol may be externally defined or predefined.

3.8 Abbreviations

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

AAM	application activity model
AEC	architectural, engineering, and construction
AIC	application interpreted construct
AIM	application interpreted model
AP	application protocol
ARM	application reference model
CAD	Computer-aided design or computer-aided draughting

NOTE - Within this application domain, CAD is used to mean both design and draughting systems.

PICS	protocol implementation conformance statement
RGB	Red, Green, and Blue colour space
UoF	unit of functionality

4 Information requirements

This clause specifies the information required for associative draughting applications.

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 H.
- 2 - The information requirements correspond to those of the activities identified as being in the scope of this application protocol in annex G.
- 3 - The mapping table is specified in 5.1 which shows how the information requirements are met using the integrated resources and application interpreted constructs of this International Standard. The use of the integrated resources and application interpreted constructs introduces additional requirements which are common to application protocols.

The following are high-level information requirements:

- a draughting shape model shall be presented in at least one view or be a constituent of another draughting shape model;
- 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 or three-dimensional draughting shape models and the information that defines the views of those models is to be supported. Two-dimensional geometry created as a result of applying the view definition is not supported;

NOTE 4 - For a technical discussion concerning the viewing of draughting shape models, see annex L.

- 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 associative draughting application protocol. This part of ISO 10303 specifies the following units of functionality:

- associative_dimensions;
- draughting_shape_model;
- drawing_structure_and_administration;
- elements_of_annotation;
- elements_of_appearance;
- elements_of_draughting_annotation;
- grouping;
- model_viewing;
- 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 UoFs are defined in 4.2.

4.1.1 associative_dimensions

The associative_dimensions UoF contains the objects necessary to determine either the size of an element or the distance between elements. An association is maintained between the calculated value of the size or distance, the presentation of this value, and the element or elements from which this value is calculated. The following application objects are used by the associative_dimensions UoF:

- Angle_distance_dimension;
- Curve_distance_dimension;
- Curve_length_size_dimension;
- Diameter_size_dimension;
- Direction_vector;
- Distance_dimension;

- Geometric_dimension;
- Linear_distance_dimension;
- Radius_size_dimension;
- Size_dimension;
- Tolerance.

4.1.2 draughting_shape_model

The draughting_shape_model UoF contains the application objects that represent the two-dimensional or three-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 the draughting_shape_model UoF:

- 2D_cartesian_coordinate_space;
- 2D_elementary_geometric_curve_set;
- 2D_geometric_curve_set;
- 2D_wireframe_with_topology;
- 3D_cartesian_coordinate_space;
- 3D_non_topological_surface;
- 3D_non_topological_wireframe;
- 3D_wireframe_with_topology;
- Advanced_B_rep;
- Cartesian_coordinate_space;
- Draughting_shape_model;
- Elementary_B_rep;
- Faceted_B_rep;
- Geometric_element;

- Manifold_surface_with_topology;
- Model_placed_annotation;
- Sub_model;
- Sub_model_definition.

4.1.3 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 spaces. Annotation may be assigned to each drawing sheet and drawing view. The administrative information supports the exchange of drawings between environments which apply configuration management to drawings. The following application objects are used by the 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.

4.1.4 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. The following application objects are used by the elements_of_annotation UoF:

- 2D_cartesian_coordinate_space;
- 3D_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.

4.1.5 elements_of_appearance

The elements_of_appearance UoF contains the information about the presentation characteristics of geometric and annotation elements. It contains the information required for the visual display of the drawing elements. The following application objects are used by the 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;
- Invisibility;
- 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;
- Viewed_surface_appearance.

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. The following application objects are used by the 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. Group structure is preserved, even though it is not a physical drawing characteristic, because preservation makes it easier to modify the shape model or drawing in the future. The following application objects are used by the grouping UoF:

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

4.1.8 model_viewing

The model_viewing UoF identifies the information necessary to depict a draughting shape model in a view. 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 which are displayed in a view of the draughting shape model. The following application objects are used by the model_viewing UoF:

- Drawing_view_definition;
- View_displayed_geometry;
- View_displayed_model_annotation.

4.1.9 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 the product_relation UoF:

- Organization;
- Product_definition;
- Product_version.

4.2 Application objects

This subclause specifies the application objects for the associative 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 4.2.20) that is defined by two mutually perpendicular axes.

4.2.2 2D_elementary_geometric_curve_set

A 2D_elementary_geometric_curve_set is a type of Draughting_shape_model (see 4.2.41) that represents the shape of a product or a portion of the shape of a product by a wireframe model without topological information defined by elementary curves in a two-dimensional coordinate system. This representation is formed by the use of points and elementary curves only. All curves are explicitly trimmed unless they are closed. Elementary curves include circles, composite curves, ellipses, lines, parabolas, hyperbolas, polylines, and trimmed curves.

NOTE - Elementary curves exclude b-spline curves, offset curves, curve replicas, surface curves, curves on surfaces, and curves defined within the parameter space of a surface.

4.2.3 2D_geometric_curve_set

A 2D_geometric_curve_set is a type of Draughting_shape_model (see 4.2.41) that represents the shape of a product or a portion of the shape of a product by a wireframe model without topological information

defined in a two-dimensional coordinate system. This representation is formed by the use of points and curves only. All curves are explicitly trimmed unless they are closed.

4.2.4 2D_wireframe_with_topology

A 2D_wireframe_with_topology is a type of Draughting_shape_model (see 4.2.41) that represents the shape of a product or a portion of the shape of a product by a wireframe model defined in a two-dimensional coordinate system. This representation includes topology that consists of a graph of vertices and edges.

4.2.5 3D_cartesian_coordinate_space

A 3D_cartesian_coordinate_space is a type of Cartesian_coordinate_space (see 4.2.20) that is defined by three mutually perpendicular axes. The data associated with a 3D_cartesian_coordinate_space are the following:

— solid_angle_measure_unit.

The solid_angle_measure_unit specifies the increments used to define solid angular distances within a cartesian coordinate system.

EXAMPLE 4 - A solid_angle_measure_unit could be a steradians.

4.2.6 3D_non_topological_surface

A 3D_non_topological_surface is a type of Draughting_shape_model (see 4.2.41) that represents the shape of a product or a portion of the shape of a product using surface geometry defined in a three-dimensional coordinate system. This representation is formed by the use of points, curves, and surfaces. These shape models contain no topological information. All curves and surfaces are explicitly trimmed unless they are closed.

4.2.7 3D_non_topological_wireframe

A 3D_non_topological_wireframe is a type of Draughting_shape_model (see 4.2.41) that represents the shape of a product or a portion of the shape of a product using wireframe geometry defined in a three-dimensional coordinate system. This representation is formed by the use of points and curves. These shape models contain no topological information. All curves are explicitly trimmed unless they are closed.

4.2.8 3D_wireframe_with_topology

A 3D_wireframe_with_topology is a type of Draughting_shape_model (see 4.2.41) that represents the shape of a product or a portion of the shape of a product by a wireframe model defined in a three-dimensional coordinate system. This representation includes topology that consists of a graph of vertices and edges.

4.2.9 Advanced_B_rep

An **Advanced_B_rep** is a type of **Draughting_shape_model** (see 4.2.41) that represents the shape of a product or a portion of the shape of a product by an advanced boundary representation solid model. The geometric shape of this model is represented using elementary surfaces, sculptured surfaces, swept surfaces, or a combination of these surfaces. This representation is defined by curves and surfaces and the topology that relates them. Boundaries are explicitly defined using topology.

4.2.10 Angle_distance_dimension

An **Angle_distance_dimension** is a type of **Distance_dimension** (see 4.2.38) where the distance is calculated between two elements converging on a common point or line, measured in units of angle measure. The data associated with an **Angle_distance_dimension** are the following:

- clockwise;
- orientation.

4.2.10.1 clockwise

The clockwise flag specifies whether or not the dimension is measured in the same direction as the hands of a clock rotate viewed from the front. Counter-clockwise refers to the opposite direction.

4.2.10.2 orientation

The orientation specifies the vector required to determine the direction of measurement specified by the clockwise attribute.

4.2.11 Angular_dimension

An **Angular_dimension** is a type of **Dimension** (see 4.2.31) that is the graphical presentation of a value of the angle between two elements that converge on a common point or line.

NOTE - Figure 2 illustrates three angular dimensions used to depict information about angle distance dimensions. The figure also illustrates a radius dimension.

4.2.12 Annotation_curve

An **Annotation_curve** is a type of **Annotation_element** (see 4.2.13) 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. An **Annotation_curve** does not define the shape of the product. Each **Annotation_curve** may be a **Directed_curve** (see 4.2.36).

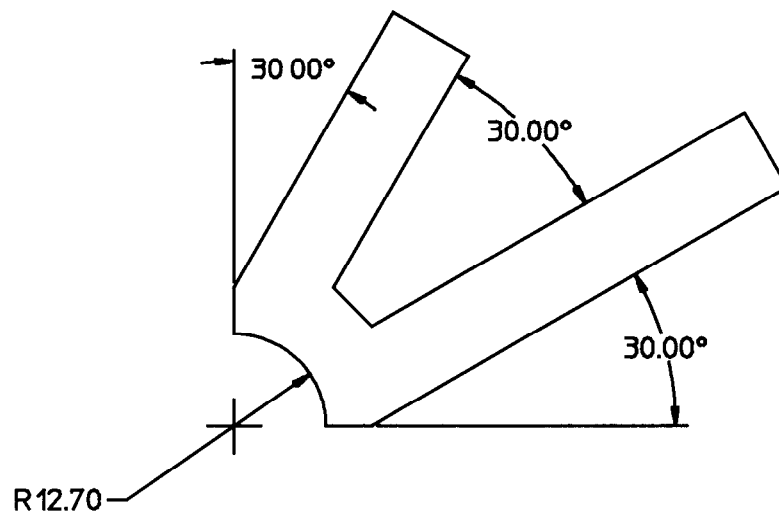


Figure 2 - Angular and radius dimensions

4.2.13 Annotation_element

An `Annotation_element` is a type of `Draughting_annotation` (see 4.2.39) 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 4.2.12), an `Annotation_subfigure` (see 4.2.14), an `Annotation_symbol` (see 4.2.17), a `Fill_area` (see 4.2.55), or a `Text` (see 4.2.97).

4.2.14 Annotation_subfigure

An `Annotation_subfigure` is a type of `Annotation_element` (see 4.2.13) that is the presentation of an `Annotation_subfigure_definition` (see 4.2.15) 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.

4.2.14.1 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.

4.2.14.2 rotation

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

4.2.14.3 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.

4.2.15 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.

4.2.16 Annotation_subfigure_definition_element

An Annotation_subfigure_definition_element is annotation that is used as a constituent of an Annotation_subfigure_definition.

4.2.17 Annotation_symbol

An Annotation_symbol is a type of Annotation_element (see 4.2.13) that is the presentation of a symbol definition that is either externally defined, predefined, or defined explicitly as a combination of annotation elements. The Annotation_symbol is located within the coordinate system of a drawing sheet, drawing view, draughting shape model, or another symbol. Each Annotation_symbol is either an Externally_defined_symbol (see 4.2.50), a Predefined_symbol (see 4.2.82), or a User_defined_symbol (see 4.2.107). The data associated with an Annotation_symbol are the following:

- location;
- rotation;
- scale.

4.2.17.1 location

The location specifies the position of the origin of the coordinate system within which the symbol definition exists relative to the origin of the coordinate system into which the symbol is being placed.

4.2.17.2 rotation

The rotation specifies the angle, measured counter-clockwise, between the x-axis of the coordinate system within which the symbol definition exists and the x-axis of the coordinate system into which the symbol is being placed.

4.2.17.3 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.

4.2.18 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 Curve_appearance (see 4.2.23), a Fill_area_appearance (see 4.2.56), or a Text_appearance (see 4.2.98).

4.2.19 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. The data associated with an Approval are the following:

- date;
- description.

NOTE - The approval does not necessarily indicate that the drawing is complete.

4.2.19.1 date

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

4.2.19.2 description

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

EXAMPLE 5 - A description could be "manufacturing release", "see engineering change notice XXX for a description of the changes", or "zone C-8, dimension 8.00 was 8.25".

4.2.20 Cartesian_coordinate_space

A `Cartesian_coordinate_space` is a two-dimensional or three-dimensional space defined by a right-handed cartesian coordinate system with the same units on each axis. Each `Cartesian_coordinate_space` is either a `2D_cartesian_coordinate_space` (see 4.2.1) or a `3D_cartesian_coordinate_space` (see 4.2.5). Each `Cartesian_coordinate_space` is the coordinate space of either an `Annotation_subfigure_definition` (see 4.2.15), a `Drawing_sheet` (see 4.2.43), a `Drawing_view` (see 4.2.45), a `User_defined_symbol_definition` (see 4.2.108), or multiple `Draughting_shape_model` (see 4.2.41) objects. The data associated with a `Cartesian_coordinate_space` are the following:

- `length_measure_unit`;
- `plane_angle_measure_unit`.

4.2.20.1 length_measure_unit

The `length_measure_unit` specifies the increments used to define linear distances or sizes within a `Cartesian_coordinate_space`.

EXAMPLE 6 - A `length_measure_unit` could be feet or metres.

4.2.20.2 plane_angle_measure_unit

The `plane_angle_measure_unit` specifies the increments used to define angular distances within a `Cartesian_coordinate_space`.

EXAMPLE 7 - A `plane_angle_measure_unit` could be degrees or radians.

4.2.21 Chained_dimension_pair

A `Chained_dimension_pair` is a type of `Dimension_sequence_pair` (see 4.2.34) that is the relationship between two dimensions in which the terminus of one dimension initializes the next dimension in the sequence.

NOTE - Figure 3 illustrates three horizontally-drawn linear dimensions in a series of chain dimension pairs. Each set of two dimensions sharing a projection line is a chained dimension pair. Additionally, the figure illustrates a single vertically-drawn linear dimension.

4.2.22 Colour

A `Colour` is a characteristic of the visual presentation of an element with respect to the light reflected by it. Each `Colour` is either a `Predefined_colour` (see 4.2.80) or a `User_defined_colour` (see 4.2.104).

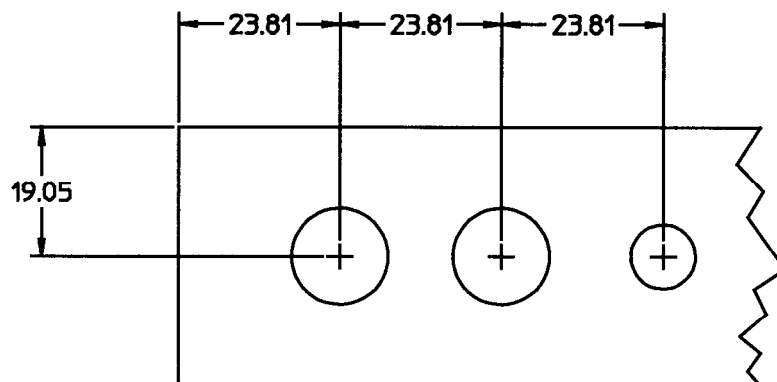


Figure 3 - Chain dimension sequence

4.2.23 Curve_appearance

A *Curve_appearance* is a type of *Appearance* (see 4.2.18) that governs the visual presentation of geometric curves and annotation curves. Each *Curve_appearance* may be a *Viewed_surface_appearance* (see 4.2.114). The data associated with a *Curve_appearance* are the following:

- *draughting_role*;
- *width*.

4.2.23.1 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.

4.2.23.2 width

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

4.2.24 Curve_dimension

A Curve_dimension is a type of Dimension (see 4.2.31) 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 4 illustrates two curve dimensions used to depict information about geometric dimensions. The dimension with a value of "36.91" depicts a curve distance dimension. The dimension with a value of "76.64" depicts a curve length size dimension.

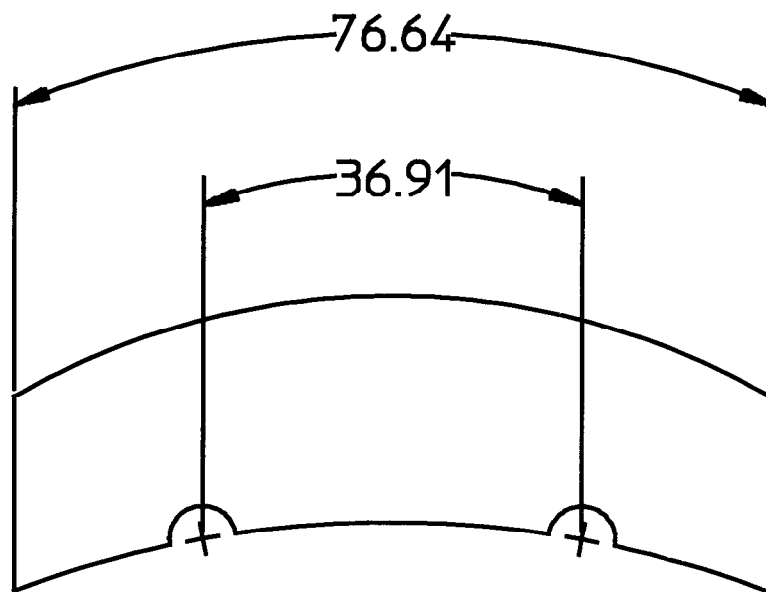


Figure 4 - Curve dimension

4.2.25 Curve_distance_dimension

A Curve_distance_dimension is a type of Distance_dimension (see 4.2.38) where the distance is calculated between two elements along a path defined by a third element of geometry or annotation.

4.2.26 Curve_length_size_dimension

A Curve_length_size_dimension is a type of Size_dimension (see 4.2.90) where the element to be measured is a curve and the measurement is to be along the entire path of the curve.

4.2.27 Datum_feature_callout

A Datum_feature_callout is a type of Draughting_callout (see 4.2.40) used to denote a point, line, or plane as a datum and which specifies the designation to be used as identification of that datum.

NOTE - Figure 7 displays several views. The top view of this figure illustrates the specification of two Datums labelled "E" and "F". The middle view of the same figure illustrates another datum specification.

4.2.28 Datum_target_callout

A Datum_target_callout is a type of Draughting_callout (see 4.2.40) used to denote points, lines, and surfaces of contact, on a product, which are used in establishing a reference datum. The callout contains an alphanumeric designation and, where applicable, a specification of the diametrical size of the target area.

NOTE - Figure 7 displays several views. The bottom view in illustrates three datum target points and their associated datum target symbols.

4.2.29 Diameter_dimension

A Diameter_dimension is a type of Dimension (see 4.2.31) that is the graphical presentation of a value of the diametrical size of a circular element.

NOTE - Figure 5 illustrates how projection lines may be used to clarify the extent of a dimension of diameter size.

4.2.30 Diameter_size_dimension

A Diameter_size_dimension is a type of Size_dimension (see 4.2.90) where the element to be measured is circular in definition and the measurement is the diametrical distance between two points on the element.

4.2.31 Dimension

A Dimension is a type of Draughting_annotation (see 4.2.39) 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 4.2.11), a Curve_dimension (see 4.2.24), a Diameter_dimension (see 4.2.29), a Leader_directed_dimension (see 4.2.70), a Linear_dimension (see 4.2.72), an Ordinate_dimension (see 4.2.76), or a Radius_dimension (see 4.2.87).

4.2.32 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 4.2.92) or an Unstructured_dimension_callout (see 4.2.103).

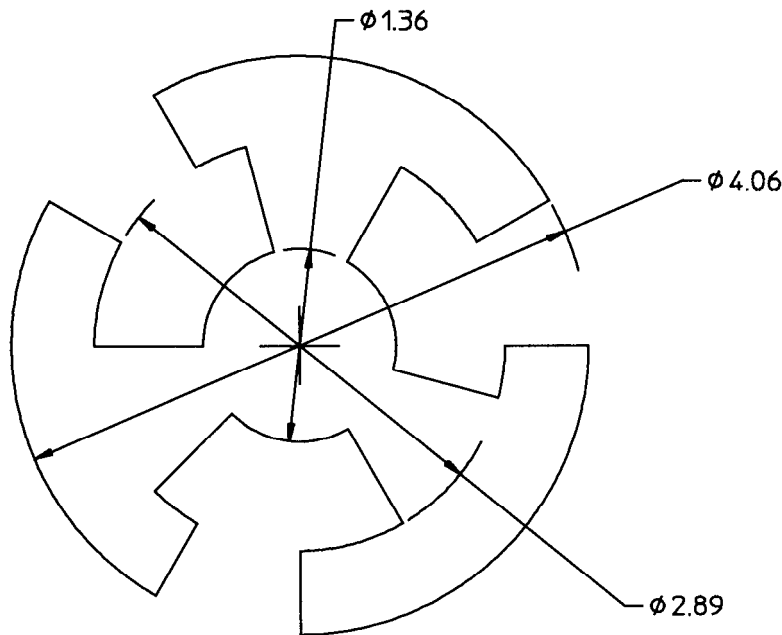


Figure 5 - Diameter dimension

4.2.33 Dimension_line

A **Dimension_line** is a type of **Directed_curve** (see 4.2.36) 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 - Terminators or symbols which indicate a foreshortened line may be associated with a **Dimension_line**.

4.2.34 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 4.2.21) or a **Parallel_dimension_pair** (see 4.2.78).

4.2.35 Dimension_symbol

A **Dimension_symbol** is a type of **Predefined_symbol** (see 4.2.82) that is used in conjunction with a dimension value to convey the context of the dimension value.

NOTE - See 5.2.2.1.13 for a description of the dimension symbols supported by this part of ISO 10303.

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

4.2.36 Directed_curve

A Directed_curve is a type of Annotation_curve (see 4.2.12) 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 4.2.33), a Leader (see 4.2.69), or a Projection_line (see 4.2.86).

4.2.37 Direction_vector

A Direction_vector is a vector that determines the linear course along which to measure a dimension. The vector is defined in the coordinate space of the elements being measured. The magnitude of the vector shall be of unit length one. The magnitude does not affect the measurement of the linear distance dimension.

NOTE - Figure 6 illustrates how a direction vector would define the measurement path from the basis element to the target element.

4.2.38 Distance_dimension

A Distance_dimension is a type of Geometric_dimension (see 4.2.58) that is a calculation of the distance between two elements of geometry or annotation. Each Distance_dimension is either an Angle_distance_dimension (see 4.2.10), a Curve_distance_dimension (see 4.2.25), or a Linear_distance_dimension (see 4.2.73).

4.2.39 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 4.2.13), a Dimension (see 4.2.31), or a Draughting_callout (see 4.2.40). Each Draughting_annotation may be one of the following: a Model_placed_annotation (see 4.2.75), a Sheet_placed_annotation (see 4.2.89), or a View_placed_annotation (see 4.2.113).

4.2.40 Draughting_callout

A Draughting_callout is a type of Draughting_annotation (see 4.2.39) 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 4.2.27), a Datum_target_callout (see 4.2.28), or a Geometrical_tolerance (see 4.2.60).

NOTE - Figure 7 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 a diameter dimension with an associated geometrical tolerance. The middle view illustrates another datum specification and a draughting

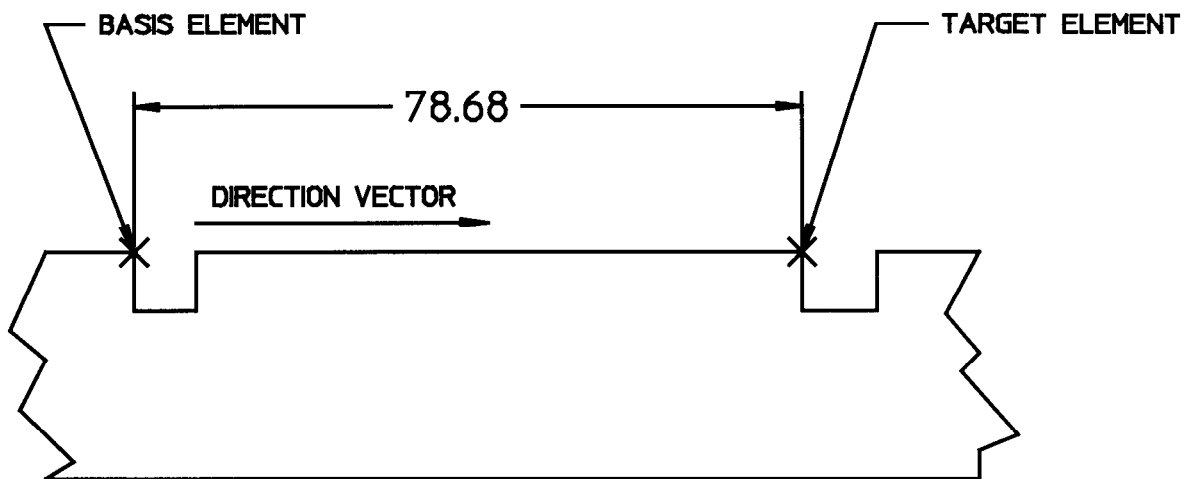


Figure 6 - Direction vector

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.

4.2.41 Draughting_shape_model

A `Draughting_shape_model` is a representation of a product or portion of a product, used to create a drawing. This representation consists of geometric elements defined in a coordinate space, and may also contain annotation placed in the same coordinate space, sub-models, or both. Each `Draughting_shape_model` is either a `2D_elementary_geometric_curve_set` (see 4.2.2), a `2D_geometric_curve_set` (see 4.2.3), a `2D_wireframe_with_topology` (see 4.2.4), a `3D_non_topological_surface` (see 4.2.6), a `3D_non_topological_wireframe` (see 4.2.7), a `3D_wireframe_with_topology` (see 4.2.8), an `Advanced_B_rep` (see 4.2.9), an `Elementary_B_rep` (see 4.2.47), a `Faceted_B_rep` (see 4.2.54), or a `Manifold_surface_with_topology` (see 4.2.74). Each `Draughting_shape_model` may be a `Sub_model_definition` (see 4.2.95). The data associated with a `Draughting_shape_model` are the following:

— `model_id`.

The `model_id` specifies the identification of a particular draughting shape model.

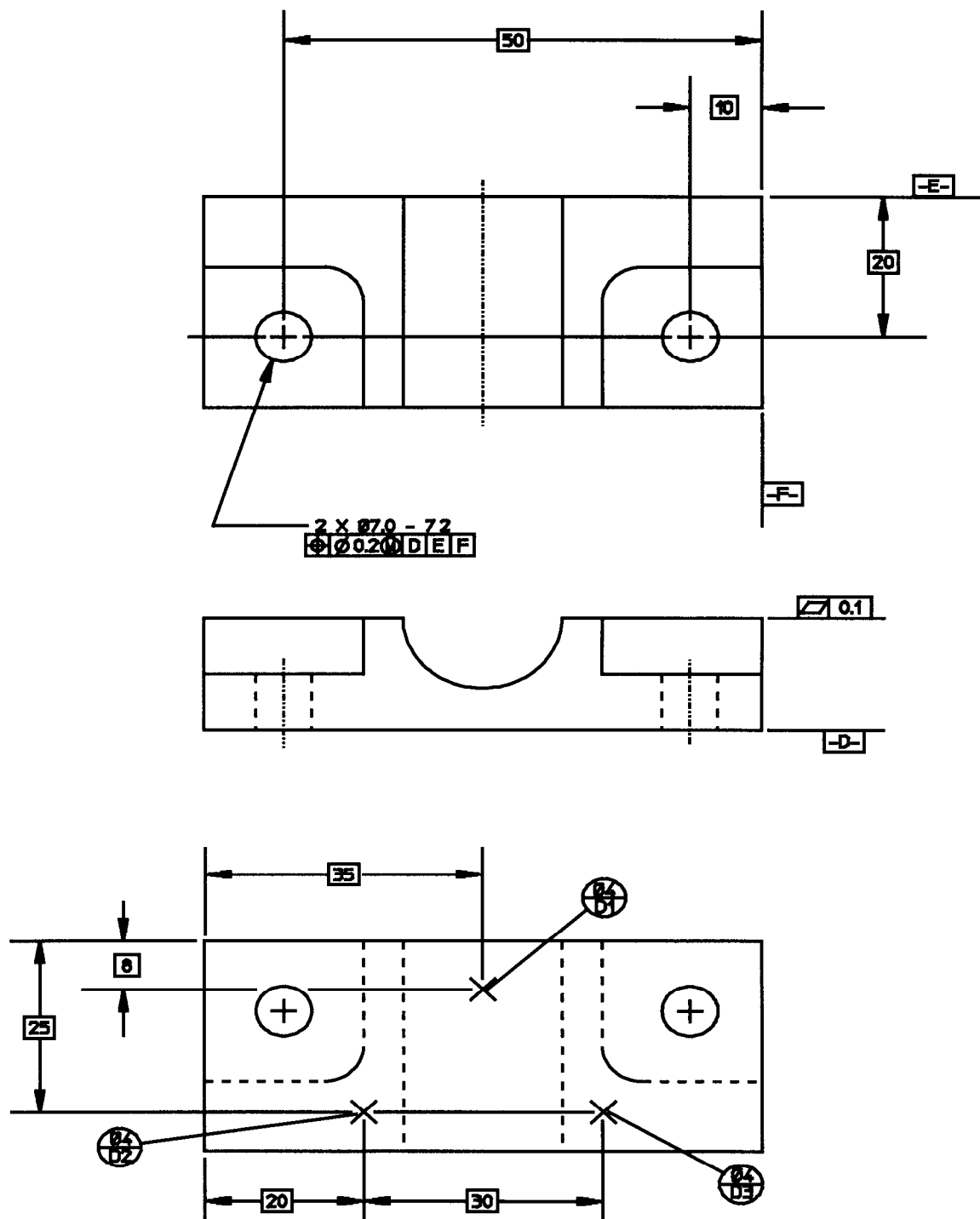


Figure 7 - Draughting callouts

4.2.42 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_version_id;
- drawing_specification;
- drawing_type;
- security_classification;
- title.

4.2.42.1 contract_reference

The contract_reference specifies the identification of an 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.

4.2.42.2 drawing_number

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

4.2.42.3 drawing_version_id

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

4.2.42.4 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 could be ISO 129, Technical drawings - Dimensioning [5].

4.2.42.5 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 could be an assembly drawing, a casting drawing, a piping diagram, an elevation drawing, or a land title drawing.

4.2.42.6 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.

4.2.42.7 title

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

4.2.43 Drawing_sheet

A Drawing_sheet is a logical division of a drawing into a two-dimensional area for the presentation of product data. A Drawing_sheet contains at least one Drawing_view (see 4.2.45) or one Draughting_-annotation (see 4.2.39). The data associated with a Drawing_sheet are the following:

- security_classification;
- sheet_number;
- sheet_version_id;
- size;
- title.

4.2.43.1 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.

4.2.43.2 sheet_number

The sheet_number specifies the page number for a particular drawing sheet.

4.2.43.3 sheet_version_id

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

NOTE - The sheet_version_id is typically taken from a sequential series.

4.2.43.4 size

The size specifies the physical size of the presentation area of the drawing sheet. The physical size is defined by the length and width of the sheet in specified units of measure.

NOTE - The standard sheet size designator for a specified draughting standard, such as ANSI Y14.2 [1] or ISO STD HDBK 12 [9], can be derived from these values.

4.2.43.5 title

The title specifies a description of the content or subject matter of the drawing sheet. The title need not be specified for a particular Drawing_sheet.

4.2.44 Drawing_sheet_layout

A Drawing_sheet_layout is a type of User_defined_symbol_definition (see 4.2.108) that specifies the layout, or format, of a sheet of a drawing.

NOTE - The Drawing_sheet_layout may contain the title block, revision block, drawing zones, and microfilm alignment marks. Figure 8 illustrates a possible drawing sheet layout symbol. The borders of the symbol are shown using foreshortening symbology for the purpose of presentation within this document.

4.2.45 Drawing_view

A Drawing_view is a presentation on a drawing sheet of a two-dimensional 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 - The two-dimensional projection is specified by a Drawing_view_definition (see 4.2.46).