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

Part 112:

Integrated application resource:

**Modelling commands for the exchange of
procedurally represented 2D CAD models**

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

*Partie 112: Ressources d'application intégrée: Commandes de
modélisation pour l'échange de modèles 2D CAD représentés en
modes opératoires*

<https://standards.iteh.ai/catalog/standards/iso/81161/6ab-b0b3-4422-bf9f-0d6f4e6e2de2/iso-10303-112-2006>



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 10303-112:2006](https://standards.iteh.ai/catalog/standards/iso/811d16ab-b0b3-4422-bf9f-0d6f4e6e2de2/iso-10303-112-2006)

<https://standards.iteh.ai/catalog/standards/iso/811d16ab-b0b3-4422-bf9f-0d6f4e6e2de2/iso-10303-112-2006>

© ISO 2006

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 either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents	Page
1 Scope.....	1
2 Normative references.....	1
3 Terms, definitions, and abbreviations.....	2
3.1 Terms defined in ISO 10303-1.....	2
3.2 Terms defined in ISO 10303-11.....	2
3.3 Terms defined in ISO 10303-55.....	2
3.4 Terms defined in ISO 10303-108.....	2
3.5 Other terms and definitions.....	3
3.6 Abbreviations.....	3
4 Procedural sketch.....	3
4.1 Introduction.....	3
4.2 Fundamental concepts and assumptions.....	4
4.2.1 Identification of selected entities.....	4
4.2.2 Representation of construction history.....	4
4.2.3 Representation of explicit constraints in a 2D sketch.....	5
4.3 Procedural sketch type definitions.....	5
4.3.1 polygon_circle_type.....	5
4.3.2 circle_or_circular_arc.....	5
4.3.3 line_or_trimmed_line.....	6
4.3.4 rotation_direction.....	6
4.3.5 ps_sketch_element_select.....	6
4.4 procedural_sketch entity definitions.....	7
4.4.1 sketch_command.....	7
4.4.2 sketch_create_curve_element.....	7
4.4.3 create_line_segment.....	7
4.4.4 create_line_segment_2_points.....	8
4.4.5 create_line_segment_point_tangent.....	8
4.4.6 create_line_segment_2_tangents.....	9
4.4.7 create_centreline.....	10
4.4.8 create_polyline.....	11
4.4.9 create_rectangle.....	11
4.4.10 create_polygon.....	12
4.4.11 create_circular_arc.....	13
4.4.12 create_circular_arc_concentric.....	13
4.4.13 create_circular_arc_3_tangents.....	14
4.4.14 create_circular_arc_centre_ends.....	16
4.4.15 create_circular_arc_start_centre_angle.....	17
4.4.16 create_circular_arc_start_centre_length.....	18
4.4.17 create_circular_arc_start_end_angle.....	19
4.4.18 create_circular_arc_start_end_direction.....	19
4.4.19 create_circular_arc_start_end_radius.....	20
4.4.20 create_circular_arc_3_points.....	20
4.4.21 create_circular_arc_angles.....	21
4.4.22 create_circle.....	22
4.4.23 create_circle_centre_point.....	23
4.4.24 create_circle_concentric.....	23
4.4.25 create_circle_3_tangents.....	24
4.4.26 create_circle_2_points.....	25

4.4.27	create_circle_3_points	26
4.4.28	create_ellipse	27
4.4.29	create_ellipse_3_points	27
4.4.30	create_ellipse_centre_point	28
4.4.31	create_spline	29
4.4.32	create_parabolic_arc	30
4.4.33	create_fillet	31
4.4.34	create_chamfer	32
4.4.35	create_divided_curve	34
4.4.36	sketch_operate_transform	35
4.4.37	sketch_transform_translate	36
4.4.38	sketch_transform_rotate	36
4.4.39	sketch_transform_mirror	37
4.4.40	sketch_transform_scale	38
4.4.41	sketch_create_pattern_element	39
4.4.42	create_pattern_rectangular	39
4.4.43	create_pattern_circular	40
4.5	procedural_sketch function definitions	42
4.5.1	distance_between_cartesian_points	42
4.5.2	non_collinear_2d_points	42
4.5.3	midpoint	43
4.5.4	distinct_points	43
4.5.5	circular_type	44
4.5.6	linear_type	44
4.5.7	centre_of_circle_or_circular_arc	45
4.5.8	have_pattern_elements_in_geometric_curve_set	45
4.5.9	three_distinct_points	45
Annex A (normative) Short names of entities		47
Annex B (normative) Information object registration		49
B.1	Document identification	49
B.2	Schema identification	49
Annex C (informative) Computer interpretable listings		50
Annex D (informative) EXPRESS-G diagrams		51
Annex E (informative) Example of intended usage of this part of ISO 10303		68
E.1	Example	68
Index		70

Figures

Figure 1	— Schema level diagram of relationships between the ISO 10303-112 schemas and other resource schemas	vii
Figure 2	— create_line_segment_2_points	8
Figure 3	— create_centrelines	10
Figure 4	— create_polyline	11
Figure 5	— create_rectangle	12
Figure 6	— create_circular_arc_concentric	14
Figure 7	— create_circular_arc_3_tangents	16
Figure 8	— create_circular_arc_centre_ends	17
Figure 9	— create_circular_arc_start_centre_angle	18

Figure 10 — create_circular_arc_3_points	21
Figure 11 — create_circular_arc_angles.....	22
Figure 12 — create_circle_centre_point	23
Figure 13 — create_circle_concentric.....	24
Figure 14 — create_circle_3_tangents.....	25
Figure 15 — create_circle_3_points	27
Figure 16 — create_ellipse_3_points.....	28
Figure 17 — create_ellipse_centre_point.....	29
Figure 18 — create_spline	30
Figure 19 — create_parabolic_arc	31
Figure 20 — create_fillet	32
Figure 21 — create_chamfer	34
Figure 22 — sketch_divided_curve	35
Figure 23 — sketch_transform_translate	36
Figure 24 — sketch_transform_rotate.....	37
Figure 25 — sketch_transform_mirror.....	38
Figure 26 — sketch_transform_scale.....	39
Figure 27 — create_pattern_rectangular	40
Figure 28 — create_pattern_circular.....	42
Figure D. 1 — procedural_sketch_schema EXPRESS-G diagram 1 of 16.....	52
Figure D. 2 — procedural_sketch_schema EXPRESS-G diagram 2 of 16.....	53
Figure D. 3 — procedural_sketch_schema EXPRESS-G diagram 3 of 16.....	54
Figure D. 4 — procedural_sketch_schema EXPRESS-G diagram 4 of 16.....	55
Figure D. 5 — procedural_sketch_schema EXPRESS-G diagram 5 of 16.....	56
Figure D. 6 — procedural_sketch_schema EXPRESS-G diagram 6 of 16.....	57
Figure D. 7 — procedural_sketch_schema EXPRESS-G diagram 7 of 16.....	58
Figure D. 8 — procedural_sketch_schema EXPRESS-G diagram 8 of 16.....	59
Figure D. 9 — procedural_sketch_schema EXPRESS-G diagram 9 of 16.....	60
Figure D. 10 — procedural_sketch_schema EXPRESS-G diagram 10 of 16.....	61
Figure D. 11 — procedural_sketch_schema EXPRESS-G diagram 11 of 16.....	62
Figure D. 12 — procedural_sketch_schema EXPRESS-G diagram 12 of 16.....	63
Figure D. 13 — procedural_sketch_schema EXPRESS-G diagram 13 of 16.....	64
Figure D. 14 — procedural_sketch_schema EXPRESS-G diagram 14 of 16.....	65
Figure D. 15 — procedural_sketch_schema EXPRESS-G diagram 15 of 16.....	66
Figure D. 16 — procedural_sketch_schema EXPRESS-G diagram 16 of 16.....	67
Figure E. 1 — Example.....	68

Tables

Table A. 1 — Short names of entities	47
--	----

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the 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.

Attention is drawn to the possibility that some of the elements of this part of ISO 10303 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10303-112 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

ISO 10303 consists of a series of parts, under the general title *Industrial automation systems and integration — Product data representation and exchange*. The structure of ISO 10303 is described in ISO 10303-1.

Each part of ISO 10303 is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs, and application modules. This part is a member of the integrated application resources series. The integrated generic resources and the integrated application resources specify a single conceptual product data model.

A complete list of parts of ISO 10303 is available from the following URL:

http://www.tc184-sc4.org/titles/STEP_Titles.htm

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation of product information and for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

This part of ISO 10303 is a member of the integrated application resources series. This part of ISO 10303 specifies the **procedural_sketch** schema.

This part of ISO 10303 provides general resources for the representation of modelling commands for the exchange of procedurally represented 2D CAD models. Procedural models have the advantage of being easy to edit, simply by changing values of parameters used as arguments of their constructional operations. Such models are said to embody design intent, in the sense that modifications to them conform to the method of creation used by their original creator, and they also comply with any constraints implied by the particular constructional operations used.

ISO 10303-55 specifies the resource constructs for the representation of models of the procedural or construction history type, defined in terms of the sequence of constructional operations used to build them. The mechanisms provided in ISO 10303-55 allow the use of entity data types specified in this part of ISO 10303 for representations of the operations.

The relationships of the schema in this part of ISO 10303 to other schemas that define the integrated resources of ISO 10303 are illustrated in Figure 1 using EXPRESS-G notation. EXPRESS-G is defined in ISO 10303-11:2004, Annex D. The schemas occurring in Figure 1 are components of ISO 10303 integrated resources, and they are specified in the following resource parts:

measure_schema	ISO 10303-41
geometry_schema	ISO 10303-42
geometric_model_schema	ISO 10303-42
sketch_schema	ISO 10303-108
explicit_geometric_constraint_schema	ISO 10303-108

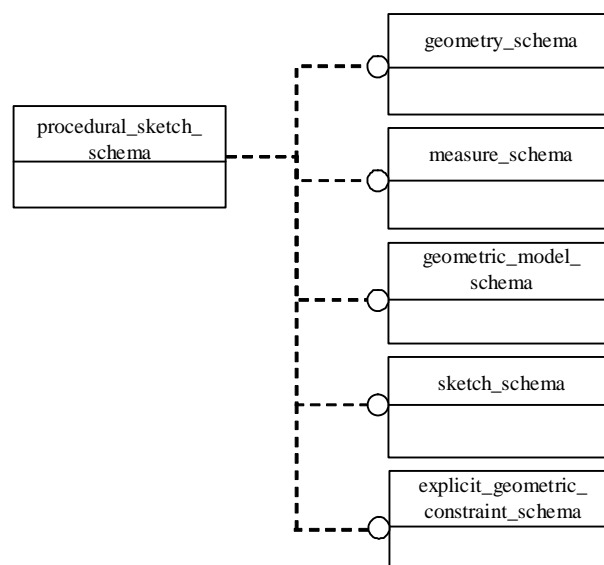


Figure 1 — Schema level diagram of relationships between the ISO 10303-112 schemas and other resource schemas

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

Part 112:

Integrated application resource: Modelling commands for the exchange of procedurally represented 2D CAD models

1 Scope

This part of ISO 10303 specifies the resource constructs for the representation of 2D modelling commands for use in the exchange of procedurally represented 2D CAD models. A procedural model is defined in terms of the sequence of 2D modelling operations used to build it.

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

- entities representing creation commands for geometric elements such as lines, arcs, chamfers and fillets;
- entities representing transformation operations such as rotations and translations.

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

- the identification of selected entities by interactive picking in a procedural model;
- the specification of sequences of modelling commands;
- query, deletion and modification commands (except in the case where the modification is a transformation);
- dimensioning and constraining commands for 2D modelling.

The first and second capabilities in the out of scope list above are provided by ISO 10303-55, and the fourth by ISO 10303-108. This part of ISO 10303 is designed to be used in conjunction with those parts of ISO 10303.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For updated references, the latest edition of the referenced document (including any amendments) applies

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

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

ISO 10303-11:2004, *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual.*

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

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

ISO 10303-55, *Industrial automation systems and integration — Product data representation and exchange — Part 55: Integrated generic resource: Procedural and hybrid representation.*

ISO 10303-108, *Industrial automation systems and integration — Product data representation and exchange — Part 108: Integrated application resource: Parameterization and constraints for explicit geometric product models.*

3 Terms, definitions, and abbreviations

3.1 Terms defined in ISO 10303-1

For the purposes of this document, the following term defined in ISO 10303-1 applies.

- application.

3.2 Terms defined in ISO 10303-11

For the purposes of this document, the following terms defined in ISO 10303-11 apply.

- entity;
- entity data type;
- instance.

3.3 Terms defined in ISO 10303-55

For the purposes of this document, the following terms defined in ISO 10303-55 apply.

- explicit selected elements;
- procedural model.

3.4 Terms defined in ISO 10303-108

For the purposes of this document, the following terms defined in ISO 10303-108 apply.

- constraint;
- explicit constraint;

— sketch.

3.5 Other terms and definitions

For the purposes of this document, the following definition applies.

3.5.1

sketch command

command for the creation of one or more sketch elements.

3.6 Abbreviations

For the purposes of this part of ISO 10303 the following abbreviations apply:

CAD computer aided design

IR integrated resource (of ISO 10303)

4 Procedural sketch

4.1 Introduction

The following EXPRESS declaration begins the procedural sketch schema and identifies the necessary external references.

EXPRESS specification:

*)

```
SCHEMA procedural_sketch_schema;
```

```
REFERENCE FROM measure_schema -- ISO 10303-41
(count_measure,
 length_measure,
 plane_angle_measure,
 positive_length_measure,
 positive_plane_angle_measure,
 positive_ratio_measure);
```

```
REFERENCE FROM geometry_schema -- ISO 10303-42
(cartesian_point,
 circle,
 conic,
 cross_product,
 curve,
 direction,
 geometric_representation_item,
 line,
 point_on_curve,
 trimmed_curve);
```

```
REFERENCE FROM geometric_model_schema -- ISO 10303-42
(geometric_curve_set
 geometric_set);
```

```
REFERENCE FROM sketch_schema -- ISO 10303-108
(sketch_element_select);
```

```
REFERENCE FROM explicit_geometric_constraint_schema          -- ISO 10303-108
(near_point_relationship,
 non_negative_length_measure);
(*
```

NOTE 1 The schemas referenced above are specified in the following part of ISO 10303:

measure_schema	ISO 10303-41
geometry_schema	ISO 10303-42
geometric_model_schema	ISO 10303-42
sketch_schema	ISO 10303-108
explicit_geometric_constraint_schema	ISO 10303-108

NOTE 2 See annex D, Figures D.1 – D.16, for a graphical presentation of this schema.

4.2 Fundamental concepts and assumptions

The procedural sketch schema defines representations for a set of 2D modelling commands for the creation of a sketch. The intention is to provide a means for the exchange of procedural representations of sketches and other 2D geometric models.

NOTE 1 A common application of such a sketch is extrusion or rotation to generate a 3D model.

NOTE 2 The commands specified in this part of ISO 10303 are concerned purely with geometry. However, the capabilities of ISO 10303-108 may be used to parameterize or constrain elements of the created geometry.

4.2.1 Identification of selected entities

It is intended that **selected_items_in_procedural_shape_rep** as defined in ISO 10303-55 shall be used for the identification of elements selected by the user from the CAD system screen.

4.2.2 Representation of construction history

The sequence of operations used to create a 2D sketch model is referred to as a construction history or a procedural model. This part of ISO 10303 is intended to be used in conjunction with ISO 10303-55, which provides the mechanisms to capture the sequence of operations.

EXAMPLE To represent a construction history, **procedural_shape_representation_sequence** from ISO 10303-55 is used as follows.

```
#10=PROCEDURAL_SHAPE_REPRESENTATION_SEQUENCE('Example',(#33,#34,#13,#14,
#12),$, 'sketch1');
#12=SKETCH_OPERATE_FILLET('Fillet1',#17,#18,2,..T.);
#13=USER_SELECTED_SHAPE_ELEMENTS(",(#17));
#14=USER_SELECTED_SHAPE_ELEMENTS(",(#18));
#17=TRIMMED_CURVE(",#21,(#37),(#38),.T.,.CARTESIAN.);
#18=TRIMMED_CURVE(",#22,(#39),(#40),.T.,.CARTESIAN.);
#33=CREATE_LINE_SEGMENT_2_POINTS('line1',#37,#38);
#34=CREATE_LINE_SEGMENT_2_POINTS('line2',#39,#40);
```

NOTE 1 In the above example, the instance of **procedural_shape_representation_sequence** uses instances of the entity **geometric_representation_item** (defined in ISO 10303-42) as arguments. Because the entities of this part of ISO 10303 are subtypes of **geometric_representation_item**, they can be used for this purpose.

NOTE 2 The above example is a part of the example in clause E.1 of Annex E. Some instances such as #21, #22 are omitted.

4.2.3 Representation of explicit constraints in a 2D sketch

This part of ISO 10303 is intended to be used in conjunction with ISO 10303-108 to represent explicit constraints among sketch elements.

EXAMPLE To represent explicit constraints, resources of ISO 10303-108 are used as shown in the following example

```
#10=PROCEDURAL_SHAPE_REPRESENTATION_SEQUENCE('Example',(#35,#36,#15,#16,#11),$, 'sketch
1');
#11=PARALLEL_GEOMETRIC_CONSTRAINT('constraint1',(#23),(#24));
#15=USER_SELECTED_SHAPE_ELEMENTS(",(#19));
#16=USER_SELECTED_SHAPE_ELEMENTS(",(#20));
#19=TRIMMED_CURVE(",#23,(#41),(#42),.T.,.CARTESIAN.);
#20=TRIMMED_CURVE(",#24,(#43),( #44),.T.,.CARTESIAN.);
#23=LINE(",#41,#27);
#24=LINE(",#43,#28);
#35=CREATE_LINE_SEGMENT_2_POINTS('line3',#41,#42);
#36=CREATE_LINE_SEGMENT_2_POINTS('line4',#43,#44);
```

NOTE 1 In the above example, the instance of **parallel_geometric_constraint** from ISO 10303-108 uses two instances of line (as defined in ISO 10303-42) as arguments. According to the mechanism of ISO 10303-55, these instances represent the explicit geometry of instances #35 and #36. As a result, the instance of **parallel_geometric_constraint** effectively constrains the geometry created by instances #35 and #36.

NOTE 2 The above example is a part of the example in clause E.1 of Annex E. Some instances such as #41, #43 are omitted.

4.3 Procedural sketch type definitions

4.3.1 polygon_circle_type

A **polygon_circle_type** specifies the relationship between the polygon and the circle used to create it.

EXPRESS specification:

```
*)
TYPE polygon_circle_type = ENUMERATION OF
  (inscribed,
   circumscribed);
END_TYPE;
(*
```

Enumerated item definitions:

inscribed: the polygon to be created is inscribed in the circle.

circumscribed: the polygon to be created is circumscribed about the circle.

4.3.2 circle_or_circular_arc

A **circle_or_circular_arc** selects a circle or circular arc. A circular arc is represented by the **trimmed_curve** entity from ISO 10303-42, with the restriction that its basis curve shall be of type **circle** as defined in ISO 10303-42.

EXPRESS specification:

```
*)
TYPE circle_or_circular_arc = SELECT
  (circle,
   trimmed_curve);
WHERE
  WR1: circular_type(SELFC);
END_TYPE;
(*
```

Formal propositions:

WR1: If the type of the selected instance is **trimmed_curve** then its attribute **basis_curve** shall be of type **circle**.

4.3.3 line_or_trimmed_line

A **line_or_trimmed_line** selects a line or trimmed line. A trimmed line is represented by the **trimmed_curve** entity from ISO 10303-42, with the restriction that its basis curve shall be of type **line** as defined in ISO 10303-42.

EXPRESS specification:

```
*)
TYPE line_or_trimmed_line = SELECT
  (line,
   trimmed_curve);
WHERE
  WR1: linear_type(SELFC);
END_TYPE;
(*
```

Formal propositions:

WR1: If the type of the selected instance is **trimmed_curve** then its attribute **basis_curve** shall be of type **line**.

<https://standards.iteh.ai/catalog/standards/iso/811d16ab-b0b3-4422-bf9f-0d6f4e6e2de2/iso-10303-112-2006>

4.3.4 rotation_direction

A **rotation_direction** specifies the sense of rotation.

EXPRESS specification:

```
*)
TYPE rotation_direction = ENUMERATION OF
  (cw,
   ccw);
END_TYPE;
(*
```

Enumerated item definitions:

cw: the sense of rotation is clockwise.

ccw: the sense of rotation is counterclockwise.

4.3.5 ps_sketch_element_select

A **ps_sketch_element_select** selects a type of sketch or sketch transformation.