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**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*



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## Foreword

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

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](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.

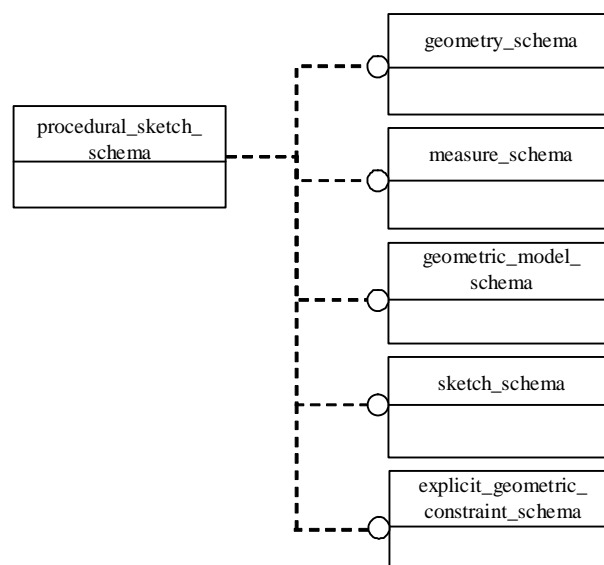
This part of ISO 10303 is a member of the integrated application resources series. This part of ISO 10303 specifies the **procedural\_sketch** schema.

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

ISO/DIS 10303-239

<https://standards.iteh.ai/catalog/standards/sist/a06fe7b8-ae27-4110-b740-77aa6139f058/iso-10303-112-2006-1>  
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(SELF);
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(SELF);
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**.

### 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.

EXPRESS specification:

```

*)
TYPE ps_sketch_element_select = SELECT BASED_ON sketch_element_select WITH
  (sketch_create_curve_element,
   sketch_create_pattern_element,
   sketch_operate_transform);
END_TYPE;
( *

```

**4.4 procedural\_sketch entity definitions****4.4.1 sketch\_command**

A **sketch\_command** represents the creation of a new sketch element or the transformation of an existing sketch element.

EXPRESS specification:

```

*)
ENTITY sketch_command
  ABSTRACT SUPERTYPE OF (ONEOF (sketch_create_curve_element,
  sketch_create_pattern_element, sketch_operate_transform));
END_ENTITY;
( *

```

**4.4.2 sketch\_create\_curve\_element**

A **sketch\_create\_curve\_element** is a type of **sketch\_command** and **geometric\_representation\_item** that specifies types of curve creation.

EXPRESS specification:

```

*)
ENTITY sketch_create_curve_element
  ABSTRACT SUPERTYPE OF (ONEOF (create_line_segment, create_centreline,
  create_polyline, create_rectangle, create_polygon, create_circular_arc,
  create_circle, create_ellipse, create_spline, create_parabolic_arc,
  create_fillet, create_chamfer, create_divided_curve))
  SUBTYPE OF (sketch_command, geometric_representation_item);
WHERE
  WR1: SELF\geometric_representation_item.dim = 2;
END_ENTITY;
( *

```

Formal propositions:

**WR1:** The dimension of this entity shall be 2D.

**4.4.3 create\_line\_segment**

A **create\_line\_segment** is a type of **sketch\_create\_curve\_element** that specifies types of line segment creation.

EXPRESS specification:

```

*)
ENTITY create_line_segment
  ABSTRACT SUPERTYPE OF (ONEOF (create_line_segment_2_points,

```