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

Part 43:

**Integrated generic resource:
Representation structures**

*Systemes d'automatisation industrielle et integration — Représentation
et échange de données de produits —*

*Partie 43: Ressources génériques intégrées: Structures de
représentation*

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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 3.

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.

International Standard ISO 10303-43 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

This second edition of ISO 10303-43 constitutes a technical revision of the first edition (ISO 10303-43:1994), which is provisionally retained to support continued use and maintenance of implementations based on the first edition, and to satisfy the normative references of other parts of ISO 10303. This edition incorporates the corrections published in ISO 10303-43:1994/Cor.1:1999 and ISO 10303-43:1994/Cor.2:2000.

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.

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

<<http://www.nist.gov/sc4/editing/step/titles/>>.

This part of ISO 10303 is a member of the integrated resources series. The integrated resources specify a single conceptual product data model.

Annexes A and B form a normative part of this part of ISO 10303. Annexes C and D are for information only.

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 specifies the **representation_schema**. This schema specifies the resource constructs that group elements of product data into collections in order to describe aspects of products, particularly properties of products. The relationships of the schema in this part of ISO 10303 to other schemas that define the integrated resources of this International Standard are illustrated in Figure 1 using the EXPRESS-G notation. EXPRESS-G is defined in annex D of ISO 10303-11. The **application_context_schema**, **product_definition_schema**, **product_property_definition_schema**, and **product_property_representation_schema** are specified in ISO 10303-41. The schemas illustrated in Figure 1 are components of the integrated resources.

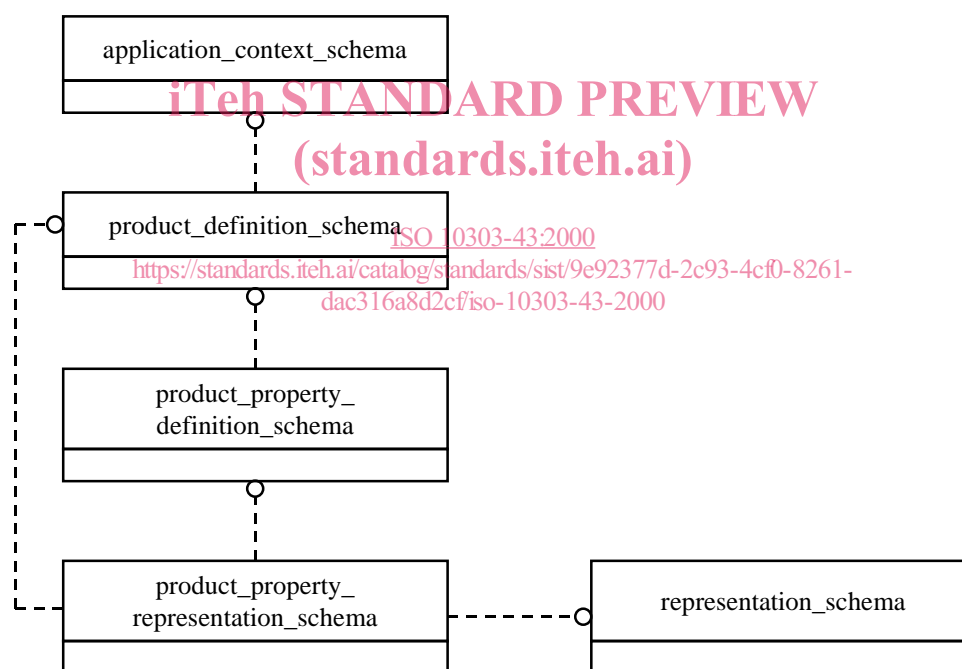


Figure 1 – Relationship of the representation_schema to the ISO 10303 integration architecture

This edition incorporates modifications that are upwardly compatible with the previous edition. Modifications to EXPRESS specifications are upwardly compatible if:

- instances encoded according to ISO 10303-21, and that conform to an ISO 10303 application protocol based on the previous edition of this part, also conform to a revision of that application protocol based on this edition;

- interfaces that conform to ISO 10303-22 and to an ISO 10303 application protocol based on the previous edition of this part, also conform to a revision of that application protocol based on this edition;
- the mapping tables of ISO 10303 application protocols based on the previous edition of this part remain valid in a revision of that application protocol based on this edition.

Technical modifications to ISO 10303-43:1994 are categorized as follows: changes to the EXPRESS declarations, new EXPRESS declarations, and changes to definitions of EXPRESS entity data types.

The following EXPRESS declarations have been modified:

- **acyclic_mapped_representation;**
- **item_in_context;**
- **representation;**
- **uncertainty_measure_with_unit;**
- **using_representations.**

The following EXPRESS declarations have been added:

- **compound_item_definition;**
- **compound_representation_item;**
- **founded_item;**
- **founded_item_select;**
- **list_representation_item;**
- **representation_item_relationship;**
- **set_representation_item;**
- **uncertainty_assigned_representation;**
- **using_items;**
- **valid_measure_value;**
- **value_representation_item.**

The definitions of the following EXPRESS data types have been modified:

- **functionally_defined_transformation;**
- **global_uncertainty_assigned_context;**
- **item_defined_transformation;**
- **mapped_item;**

- **parametric_representation_context;**
- **representation_context;**
- **representation_item;**
- **representation_map;**
- **representation_relationship;**
- **representation_relationship_with_transformation.**

In this International Standard the same English language words may be used to refer to an object in the real world or to a concept, and as the name of an EXPRESS data type that represents this object or concept. The following typographical convention is used to distinguish between these. If a word or phrase occurs in the same typeface as narrative text, the referent is the object or concept. If the word or phrase occurs in a bold typeface, the referent is the EXPRESS data type. Names of EXPRESS schemas also occur in a bold typeface.

The name of an EXPRESS data type may be used to refer to the data type itself, or to an instance of the data type. The distinction between these uses is normally clear from the context. If there is a likelihood of ambiguity, the phrase “entity data type” or “instance(s) of” is included in the text.

Double quotation marks “ ” denote quoted text. Single quotation marks ‘ ’ denote particular text string values.

Numbers in brackets [n] are references to documents listed in the Bibliography.

Several components of this part of ISO 10303 are available in electronic form. This access is provided through the specification of Universal Resource Locators (URLs) that identify the location of these files on the Internet. If there is difficulty accessing these files contact the ISO Central Secretariat, or contact the ISO TC 184/SC4 Secretariat directly at: sc4sec@cme.nist.gov.

Industrial automation systems and integration – Product data representation and exchange – Part 43: Integrated generic resource: Representation structures

1 Scope

This part of ISO 10303 specifies the resource constructs that group elements of product data into collections in order to describe aspects of products. This part of ISO 10303 is applicable to the description of properties of products. The following are within the scope of this part of ISO 10303:

- the specification of contexts for representation;
- the specification of elements of representation;
- the association of elements of representation with one or more contexts in which they are combined to represent a concept;
- the association of elements of representation such that one defines another;
- a structure for relating two representations such that one participates in the definition of the other;
- a structure for relating two representations in which one does not participate in the definition of the other;
- constraints to prevent the recursive definition of instances of an element of representation;
- the specification of the transformation of one element of representation to another by specifying the input and output of the transformation;
- the specification of the transformation of one element of representation to another by specifying the transforming function.

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

- the complete specification of types of representation, types of elements of representation, and types of representation context;
- the specification of the uses of representation;
- the association of representation with any of its possible uses;
- constraints requiring a directed relationship between representations;

NOTE A directed relationship exists between items A and B if the meaning of the relationship of A to B is different from the meaning of B to A. A and B are peers in a non-directed relationship. A directed relationship can be specified in an annotated EXPRESS schema that uses or specializes this schema.

- constraints forbidding cyclic structures of related representations;
- constraints requiring a directed relationship between the contexts in which related representations exist;
- constraints forbidding cyclic structures of relationships between representation contexts.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10303. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10303 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

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

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

ISO 10303-41:—¹⁾, *Industrial automation systems and integration – Product data representation and exchange – Part 41: Integrated generic resource: Fundamentals of product description and support.*

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3 Terms and definitions

3.1 Terms defined in ISO 10303-1

For the purposes of this part of ISO 10303, the following terms defined in ISO 10303-1 apply:

- application;
- application protocol;
- assembly;
- data;
- information;
- integrated resource;
- product;

¹⁾ To be published. (Revision of ISO 10303-41:1994)

- product data;
- structure.

3.2 Terms defined in ISO 10303-41

For the purposes of this part of ISO 10303, the following terms defined in ISO 10303-41 apply:

- agreement of common understanding;
- annotated EXPRESS schema.

3.3 Other terms and definitions

For the purposes of this part of ISO 10303, the following terms and definitions apply:

3.3.1

context of representation

the basis through which elements of a representation are related to each other

3.3.2

element of representation

a data element that participates in the description of a representation, either directly or by describing other elements of representation

3.3.3

founded

the property of an element of representation that results from its association, direct or indirect, with a context of representation

3.3.4

representation

an organized collection of associated data elements, collected together for one or more specific uses

4 Representation

The following EXPRESS declaration begins the **representation_schema** and identifies the necessary external references.

EXPRESS specification:

```
*)
SCHEMA representation_schema;

REFERENCE FROM basic_attribute_schema -- ISO 10303-41
  (get_description_value,
   get_id_value);

REFERENCE FROM measure_schema -- ISO 10303-41
  (measure_value,
   measure_with_unit);
```

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```
REFERENCE FROM support_resource_schema -- ISO 10303-41
  (bag_to_set,
   identifier,
   label,
   text);
```

(*

NOTE 1 The schemas referenced above can be found in the following parts of ISO 10303:

basic_attribute_schema	ISO 10303-41
measure_schema	ISO 10303-41
support_resource_schema	ISO 10303-41

NOTE 2 See annex D for a graphical presentation of this schema using the EXPRESS-G notation.

NOTE 3 A listing of the complete EXPRESS schema specified in this part of ISO 10303, without comments or other explanatory text, is available from the Internet – see annex C.

4.1 Introduction

The subjects of the **representation_schema** are the structures that relate a collection of elements of product data to a context. These structures are representations. Representations are used to describe aspects of products. The associations between representations and the aspects of products they describe are specified in annotated EXPRESS schemas that use or specialize this schema. Representations can be used to:

- describe a property or a relationship between two properties, in which the properties are associated with a complete product or with a part of a product;

NOTE 1 The use of representations to collect elements of product data in order to describe the properties of a product is specified in ISO 10303-41, and can be specified in annotated EXPRESS schemas that use or specialize the constructs specified in this part of ISO 10303 and in ISO 10303-41.

- describe a picture.

NOTE 2 The use of representations to collect elements of product data in order to describe a picture of a product is specified in ISO 10303-46 [6], and can be specified in annotated EXPRESS schemas that use or specialize the constructs specified in this part of ISO 10303 and in ISO 10303-46.

One representation can be part of another representation.

EXAMPLE 1 A collection of lines and points describes the shape of a wall. This representation can be used as part of the description of the shape of the building, of which the wall is a part.

Each representation has a context and a collection of elements specified in that context

EXAMPLE 2 For the representation of geometric elements, the context is a coordinate space.

A context can be related to other contexts.

EXAMPLE 3 Local coordinate spaces can be defined for each building in a factory complex. These coordinate spaces can be related to each other, and to the coordinate space of the factory complex itself.

Transformations between representations can be specified.

4.2 Fundamental concepts and assumptions

4.2.1 Representation

The following concepts and assumptions apply to the portions of this schema that deal with representation.

- a) A representation consists of a collection of elements of representation and a context. A representation corresponds to an instance of the **representation** entity data type. By structuring the elements in this way, relationships between elements can be established. Elements of representation are related if:
- 1) they are elements in the same representation, or
 - 2) they are elements in different representations that have the same context, or
 - 3) they are elements in different representations that have different contexts, if the contexts are related.

EXAMPLE 1 Consider two points with coordinate values of (0,0,0) and (1,0,0). It is not possible to calculate the distance between these points until it is established that they are in the same coordinate space. The specification of a point by itself does not contain enough data to state which coordinate space it is in and what other elements also share that coordinate space. In this part of ISO 10303, a point is an example of an element of representation, and a coordinate space is an example of a context.

- b) A representation can be used more than once. A representation is separate from its use.

EXAMPLE 2 Consider a collection of points and lines in a coordinate space. This collection can be used to describe the shape of a product. The collection can also be used, possibly with some transformation, to describe a drawing or picture of the product. Neither of these uses is part of the definition of the collection itself.

NOTE Representations can be specialized further in annotated EXPRESS schemas that use or specialize this schema.

4.2.2 Context of representation

The following assumptions apply to the portions of this schema that deal with the context of representation.

- A representation has a context. It is the context in which the elements of the representation are related. The context of a representation corresponds to an instance of the **representation_context** entity data type.
- The context of a representation exists only as a basis for the representations that use it. Therefore, representation contexts are related only if representations using the contexts are related.

NOTE Representation contexts can be specialized further in annotated EXPRESS schemas that use or specialize this schema.

EXAMPLE Possible specializations include contexts for geometry, topology, finite element modelling and kinematic modelling.

4.2.3 Elements of representation

The following concepts and assumptions apply to the portions of this schema that deal with elements of representation.

- Elements of representation participate directly in a representation, or support the definition of another element of representation, or both.

EXAMPLE 1 A point could be the only element in the representation of the location of a product, or it could serve as the end point of a line that is the only element in the representation of the edge of a product. In the first case the point itself is an element in a representation directly. In the second case, the point serves only to provide definition for the line entity.

EXAMPLE 2 An element of representation that specifies the presentation of a text string could be part of the description of a drawing. In this case it participates directly in a representation. The same element of representation could, alternatively, be part of a dimension callout. In this second case the text is part of the callout, and participates indirectly in the description of the drawing.

NOTE Elements of representation that describe the presentation of text strings are specified in ISO 10303-46 [6]. Elements of representation that describe dimension callouts are described in ISO 10303-101 [8].

- Elements of representation can refer to each other, thereby forming graphs of such elements in which each graph has an identifiable root. The association of a root element with a context associates all elements in the graph with the context.

EXAMPLE 3 A curve is defined by a number of points. These points are all in the same coordinate space as the curve by virtue of their reference from the curve.

- Elements of representation are collected into representations and associated with contexts as a basis for establishing relationships between elements.
- An element of representation corresponds to an instance of the **representation_item** entity data type.
- An association of one or more elements of representation with a context corresponds to an instance of the **representation_entity** data type.

4.2.4 Association of representations

The following concepts and assumptions apply to the portions of this schema that deal with the association of representations.

- A representation can be related to another representation.
- One representation can be related to another representation such that they both participate in the association, but one does not define the other. This type of association corresponds to the **representation_relationship** entity data type.
- One representation can be related to another representation such that the first is part of the definition of the second. This type of association corresponds to the **mapped_item** and **representation_map** entity data types.
- Two collections of representation elements can be unrelated in two separate contexts, and yet be related in a third context, or be related only as they both participate in a relating structure.

EXAMPLE Two collections of points and lines each represent the shape of a part. Each of those shapes exists in a separate context independent and completely unrelated to the other. A third context can exist for the shape of an assembly of which these parts are components. In this third context, all of the elements are related, either through a direct association of those elements with that context, or through an association of the representations of the parts with the representation of the assembly.

4.2.5 Transformation

The following concepts and assumptions apply to the portions of this schema that deal with transformations.

- a) Elements in different representations can be compared if
 - 1) the representations have the same context, or
 - 2) a transformation is defined that relates the representations to each other.
- b) A transformation can be defined as a function f between a domain A and a range B . The function $f:A \rightarrow B$ takes each element a in A and maps it to an element b in B , i.e., $f(a)=b$. The complete specification of a transformation requires the following:
 - 1) the set of elements a to be transformed;
 - 2) the set of elements b resulting from the transformations;
 - 3) the definition of the context A that is common to the set of elements a ;
 - 4) the definition of the context B that is common to the set of elements b ;
 - 5) the function f .

The domain A and the range B are instances of the **representation_context** entity data type. The elements a and b are instances of the **representation_item** entity data type. The relationships between a and A , and between b and B , are instances of the **representation** entity data type: a is an element in a representation whose context is A , b is an element in a representation whose context is B . <https://standards.iteh.ai/catalog/standards/sist/9e92377d-2c93-4cf0-8261-dac316a8d2cf/iso-10303-43-2000>

- c) Two different approaches are used in this part of ISO 10303 to specify transformations.
 - 1) The function f can be specified. This type of transformation corresponds to the **functionally_defined_transformation** entity data type.

EXAMPLE 1 Two representations are related such that one is rotated and skewed with respect to the other. This transformation can be specified by a matrix.

NOTE 1 The data structures for particular kinds of transformation functions, such as matrices, are not specified in this part of ISO 10303.

EXAMPLE 2 Points on a map are related to points on the surface of the earth by a function that transforms the three dimensional surface to a two dimensional picture, and applies a scaling factor.

- 2) An element a in context A and an element b in context B that are sufficient to derive the function can be specified. This type of transformation corresponds to the **item_defined_transformation** entity data type, or to the mapping defined by the **mapped_item** entity data type.

EXAMPLE 3 A translation between coordinate spaces can be uniquely determined by two instances of **axis2_placement_3d** $a1$ and $b1$ (one in each coordinate space), such that f takes $a1$ and transforms it to $b1$.

NOTE 2 The **axis2_placement_3d** entity data type is defined in ISO 10303-42 [3,4].