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

Part 512: Application interpreted construct: Faceted boundary representation

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

Partie 512: Construction interprétée d'application: Représentation délimitée des faces

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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.

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.

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

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

This part of ISO 10303 is a member of the application interpreted constructs series.

Annexes A and B form an integral part of this part of ISO 10303. Annexes C, D and E 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, generic 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 interpreted construct series.

An application interpreted construct (AIC) provides a logical grouping of interpreted constructs that supports a specific functionality for the usage of product data across multiple application contexts. An interpreted construct is a common interpretation of the integrated resources that supports shared information requirements among application protocols.

This document specifies the application interpreted construct for the definition of a boundary representation solid with planar faces and implicit topology. This is the final draft of a 500 series part edition of this AIC.

Industrial automation systems and integration — Product data representation and exchange — Part 512 : Application interpreted construct: Faceted boundary representation

1 Scope

This part of ISO 10303 specifies the interpretation of the generic resources in order to satisfy the following requirements:

— for the description of a three dimensional shape by means of a boundary representation model with planar faces and implicit straight line edges;

— for the composition of one or more such shapes as a **faceted_brep_shape_representation**.

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

— 3D geometry;

— B-reps;

— B-rep models;

— faceted B-reps;

— polyloops;

— unbounded geometry;

— use of topology to bound geometric entities;

— geometric transformations.

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

— 2D geometry;

— curves;

— explicit edge definitions;

— surfaces other than planes;

— offset curves and surfaces.

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 - Open systems interconnection -Abstract syntax notation one (ASN.1) Part 1 : Specification of basic notation.*

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

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

ISO TR 10303-12: 1997, *Industrial automation systems and integration - Product data representation and exchange - Part 12 : Description methods: The* EXPRESS-I *language reference manual.*

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 10303-202: 1995, *Industrial automation systems and integration - Product data representation and exchange - Part 202: Application protocol: Associative draughting*

3 Terms, definitions and abbreviations

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 context;

— application protocol;

— implementation method;

— integrated resource;

— interpretation;

— product data;

3.2 Terms defined in ISO 10303-42

For the purposes of this part of ISO 10303, the following terms defined in ISO 10303-42 apply.

— arcwise connected;

— boundary;

— boundary representation solid model (B-rep);

— bounds;

— coordinate space;

— curve;

— orientable;

— surface;

— topological sense.

3.3 Terms defined in ISO 10303-202

For the purposes of this part of ISO 10303, the following term defined in ISO 10303-202 applies.

3.3.1
application interpreted construct (AIC)
a logical grouping of interpreted constructs that supports a specific functionality for the usage of product data across multiple application contexts.

3.4 Other definitions

3.4.1
faceted B-rep shape representation
a shape representation made up of one or more manifold faceted B-reps. Each constituent B-rep is required to have planar faces and implicitly defined edges.

3.4.2
manifold faceted B-rep
an arcwise connected faceted solid such that, for a very small sphere, centred at any point on the boundary of the solid, the interior of the sphere is divided into precisely two regions. One of these regions is inside the solid, the other is outside.

3.4.3
polyloop
a loop on a planar face consisting of linear segments. The edge geometry and topology is implicitly defined by a list of cartesian points.

3.5 Abbreviations

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

AIC	Application Interpreted Construct
AP	Application Protocol
B-rep	Boundary representation solid model

4 EXPRESS short listing

This clause specifies the EXPRESS schema that uses elements from the integrated resources and contains the types, entity specializations, and functions that are specific to this part of ISO 10303.

NOTE There may be subtypes and items of select lists that appear in the integrated resources that are not imported into the AIC. Constructs are eliminated from the subtype tree or select list through the use of the implicit interface rules of ISO 10303-11. References to eliminated constructs are outside the scope of the AIC. In some cases, all items of the select list are eliminated. Because AICs are intended to be implemented in the context of an application protocol, the items of the select list will be defined by the scope of the application protocol.

This application interpreted construct provides a consistent set of geometric and topological entities for the definition of manifold solid models with planar faces and implicitly defined edges and vertices. The faces of the B-rep models are bounded by **poly_loop**s and each face is required to have an explicit outer bound.

The highest level entity in this AIC is the **faceted_brep_shape_representation.** A **faceted_brep_shape_representation** is a **shape_representation** (see: ISO 10303-41) consisting of **faceted_brep**s and **mapped_item**s defined as transformed copies of **faceted_brep**s.

EXPRESS specification:

```
*)
SCHEMA aic_faceted_brep;

 USE FROM geometry_schema
     (axis2_placement_3d,
      cartesian_point,
      cartesian_transformation_operator_3d,
      elementary_surface,
      plane);

 USE FROM geometric_model_schema
     (brep_with_voids,
      faceted_brep,
      manifold_solid_brep);

 REFERENCE FROM geometric_model_schema(msb_shells);

 USE FROM topology_schema
     (closed_shell,
      connected_face_set,
      face_bound,
      face_outer_bound,
      face_surface,
      oriented_closed_shell,
      poly_loop);

 USE FROM representation_schema(mapped_item);

 USE FROM product_property_representation_schema(shape_representation);

(*
```


NOTE 1 The **connected_face_set** entity is explicitly interfaced (i.e. included in the USE FROM lists) to allow rules in the **faceted_brep_shape_representation** entity to access attributes of this entity. For the use of this AIC this entity shall only be instantiated as one of its subtypes.

NOTE 2 The entity **manifold_solid_brep** is explicitly interfaced to enable compilation of the function **msb_shells**. The entity **elementary_surface** is explicitly interfaced to allow **faceted_brep_shape_representation** to access attributes of this entity. For the use of this AIC, these entities shall only be instantiated as one of their subtypes.

NOTE 3 The schemas referenced above can be found in the following parts of ISO 10303:

geometric_model_schema	ISO 10303-42
geometry_schema	ISO 10303-42
topology_schema	ISO 10303-42
representation_schema	ISO 10303-43
product_property_representation_schema	ISO 10303-41

4.1 Fundamental concepts and assumptions

The following entities are intended to be independently instantiated in the application protocol schemas that use this AIC:

— axis2_placement_3d;

— brep_with_voids;

— cartesian_point;

— cartesian_transformation_operator_3d;

— closed_shell;

— direction;

— face_bound;

— face_outer_bound;

— face_surface;

— faceted_brep;

— mapped_item;

— oriented_closed_shell;

— plane;

— poly_loop;

— representation_map.

An application protocol that uses this AIC shall require that a **shape_representation** entity is instantiated as a **faceted_brep_shape_representation**.

4.2 aic_faceted_brep schema entity definition: faceted_brep_shape_representation

The **faceted_brep_shape_representation** is a type of shape representation in which the representation items are specialisations of faceted brep entities. These differ from the more general B-rep in having only planar faces and implicit edge geometry.

EXPRESS specification:

```
*)
ENTITY faceted_brep_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1 : SIZEOF (QUERY (it <* items |
        NOT (SIZEOF(['AIC_FACETED_BREP.FACETED_BREP',
          'AIC_FACETED_BREP.MAPPED_ITEM',
          'AIC_FACETED_BREP.AXIS2_PLACEMENT_3D'] *
           TYPEOF(it)) = 1))) = 0;
  WR2 : SIZEOF (QUERY (it <* items |
        SIZEOF(['AIC_FACETED_BREP.FACETED_BREP',
        'AIC_FACETED_BREP.MAPPED_ITEM'] * TYPEOF(it)) = 1)) > 0;
  WR3 : SIZEOF (QUERY (fbrep <* QUERY ( it <* items |
        'AIC_FACETED_BREP.FACETED_BREP' IN TYPEOF(it)) |
        NOT (SIZEOF (QUERY (csh <* msb_shells(fbrep) |
        NOT (SIZEOF (QUERY (fcs <* csh\connected_face_set.cfs_faces |
        NOT (('AIC_FACETED_BREP.FACE_SURFACE' IN TYPEOF (fcs)) AND
        (('AIC_FACETED_BREP.PLANE' IN TYPEOF
             (fcs\face_surface.face_geometry)) AND
        ('AIC_FACETED_BREP.CARTESIAN_POINT' IN TYPEOF (
             fcs\face_surface.face_geometry\
                  elementary_surface.position.location))))))
                    = 0))) = 0))) = 0;
  WR4 : SIZEOF (QUERY (fbrep <* QUERY ( it <* items |
        'AIC_FACETED_BREP.FACETED_BREP' IN TYPEOF(it)) |
        NOT (SIZEOF (QUERY (csh <* msb_shells(fbrep) |
        NOT (SIZEOF (QUERY (fcs <* csh\connected_face_set.cfs_faces |
        NOT (SIZEOF (QUERY (bnds <* fcs.bounds |
         'AIC_FACETED_BREP.FACE_OUTER_BOUND' IN TYPEOF(bnds)))
            = 1))) = 0))) = 0))) = 0;
  WR5 : SIZEOF (QUERY (msb <* QUERY (it <* items |
        'AIC_FACETED_BREP.MANIFOLD_SOLID_BREP' IN TYPEOF(it)) |
        'AIC_FACETED_BREP.ORIENTED_CLOSED_SHELL' IN
            TYPEOF (msb\manifold_solid_brep.outer))) = 0;
  WR6 : SIZEOF (QUERY (brv <* QUERY (it <* items |
        'AIC_FACETED_BREP.BREP_WITH_VOIDS' IN TYPEOF(it)) |
        NOT (SIZEOF (QUERY (csh <* brv\brep_with_voids.voids |
         csh\oriented_closed_shell.orientation)) = 0))) = 0;
  WR7 : SIZEOF (QUERY (mi <*  QUERY (it <* items |
                'AIC_FACETED_BREP.MAPPED_ITEM' IN TYPEOF(it)) |
```