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

Part 44:

Integrated generic resources: Product structure configuration

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

Partie 44: Ressources génériques intégrées: Configuration de structure de produits

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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 10303-44 was prepared by Technical Committee ISO TC184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data and global manufacturing languages*.

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 methods: The EXPRESS language reference manual;

— Part 21 Implementation methods: Clear text encoding of the exchange structure;

— Part 22 Implementation methods: Standard data access interface;

— Part 31 Conformance testing methodology and framework: General concepts;

— Part 32 Conformance testing methodology and framework: requirements on testing laboratories and clients;

— Part 41 Integrated generic resources: Fundamentals of product description and support;

— Part 42 Integrated generic resources: Geometric and topological representation;

— Part 43 Integrated generic resources: Representation structures;

— Part 44 Integrated generic resources: Product structure configuration;

— Part 45 Integrated generic resources: Materials;

— Part 46 Integrated generic resources: Visual presentation;

— Part 47 Integrated generic resources: Shape variation tolerances;

— Part 49 Integrated generic resources: Process structure and properties;

— Part 101 Integrated application resources: Draughting;

— Part 104 Integrated application resources: Finite element analysis;

— Part 105 Integrated application resources: Kinematics;

— Part 201 Application protocol: Explicit draughting;

— Part 202 Application protocol: Associative draughting;

— Part 203 Application protocol: Configuration controlled design;

— Part 207 Application protocol: Sheet metal die planning and design;

— Part 210 Application protocol: Printed circuit assembly product design data;

— Part 213 Application protocol: Numerical control process plans for machined parts.

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

— Part 11 specifies the description method;

— Parts 21 and 22 specify the implementation methods;

— Parts 31 and 32 specify the conformance testing methodology and framework;

— Parts 41 to 49 specify the integrated generic resources;

— Parts 101 to 105 specify the integrated application resources;

— Parts 201 to 213 specify the application protocols.

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

Annexes A and B form an integral part of this part of ISO 10303. Annexes C, D, E and F are for information only.

Diskette

Users should note that this part of ISO 10303 comprises a diskette:
— the short names of entities given in annex A are also included on the diskette;
— the EXPRESS listings (annex C) are provided on the diskette only;
— a method to enable users to report errors in the documentation is given. Full details are provided in the file.

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 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 integrated resources series. Major subdivisions of this part of ISO 10303 are:

- the product structure schema;
- the product concept schema;
- the configuration management schema.

The product structure schema:

- defines a product in terms of its composition as a set of constituents or consumed products. A product may be assembled from the constituents or produced by consuming other products, or both;

- defines mechanisms for expressing the composition relationship.

The product concept schema identifies the product concept as a set of specifications for a product derived from analysis of customer needs for the product. It represents the idea of a product based on customer needs and not as it might be designed or built.

The configuration management schema identifies those products participating in the manufacture of another product whose configurations are under the direct control of an organization.

Industrial automation is concerned with the management of the information including the following:

- product structure and its complexity;
- product configuration and its complexity;
- product change.

Product structure is focussed on that aspect of product design defining a product in terms of a nested decomposition into constituents. The product structure schema of this part and the product definition schema of ISO 10303-41 together define the representation of the information that manages the complexity of product structure. An example of the use of the information represented is the generation of bill-of-material reports.

Product configuration is concerned with the specification of manufacturing or assembly plans for specific products. The planning includes specification of the actual constituents of a product which are to be included in a planned unit of production. The configuration management schema and the product structure schema represent the information that manages the configuration of a product. The concept of effectivity is used to manage the configuration of a product.

Change management is involved with the changes over time in a product as new versions of a product are developed. This part of ISO 10303 is concerned with changes that affect the organization of constituents into interrelated structures. The configuration management schema represents information on the structural form of the definition of a product as the product changes and is enhanced during the product life cycle. Representation of information on other aspects of change management is defined in the product definition schema and the change schema of ISO 10303-41.

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Industrial automation systems and integration — Product data representation and exchange — Part 44: Integrated generic resources: Product structure configuration

1 Scope

This part of ISO 10303 specifies the resources to manage the structure and configuration of a product during its life cycle.

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

- the relationship among the components and assemblies of a product;
- the relationship among products and their components as made by modification of other products;

EXAMPLE 1 - The machining of a product from another product.

- the description of a product as defined by customer needs;
- the management of the structure for configuration of assemblies and components as planned for manufacture;
- the decomposition of a product to support different product life cycle activities;

NOTE 1 - An organization may need to decompose a product into one bill of materials that enumerates each component with respect to the number of that component used in an assembly, and into a second bill of materials that decomposes a product with multiple assemblies into the individual components. See annex E for more examples of different product structure reports that are supported.

- multiple versions of a single product which are equivalent with respect to form, fit, and function.

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

- the relationships among different product definitions for the same product;

EXAMPLE 2 - The relationship of a product definition for a component in a preliminary design to a corresponding product definition for the same component in a detailed design;

- administrative activities of the product life cycle including approvals, security classifications, contractual arrangements, and supplier organizations;

– the change process for a product, including the reason for change and what aspect of a product has changed;

– the decisions made, and their reasons, during the product life cycle;

– the physical connections among components of a product;

– the properties that a product constituent may have;

NOTE 2 - A mechanism is defined in ISO 10303-41 to support the association of properties with components. The actual associations are included in various application protocols which are parts of this International Standard. For example, the details of what a material property is and how it is defined are out of scope, as well as the fact that a component has a material property.

– the information for as-built manufacturing, manufacturing planning, and logistical structure and configurations;

– multiple versions of a single product that are not form, fit, and function equivalent.

NOTE 3 - The concept of versions of a product is defined in ISO 10303-41.

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/IEC 8824-1:–[1)], *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 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.*

[1)] To be published.

3 Definitions and abbreviations

3.1 Terms defined in ISO 10303-1

This part of ISO 10303 makes use of the following terms defined in ISO 10303-1.

- assembly;
- component;
- product.

3.2 Other definitions

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

3.2.1 ancestor node: any node that can be reached from a given node, by successive traversals of links in the reverse direction. For a given node, its ancestor nodes include all parent nodes, all parent nodes of these parent nodes, etc.

3.2.2 bill-of-material structure (BOM): a structural description of a product in terms of its nested constituents.

NOTE - See annex E for examples of bill-of-material structures.

3.2.3 child node: the node to which a link is pointing.

3.2.4 constituent: a subdivision of a product, either a component or an assembly.

3.2.5 directed acyclic graph (DAG): a collection of nodes and directed links such that no node is an ancestor (or descendant) of itself.

3.2.6 descendent node: any node that can be reached from a given node, by successive traversals of links. For a given node, its descendent nodes include all children nodes, all children nodes of these children nodes, etc.

3.2.7 effectivity: a characteristic that indicates when a product is allowed, approved or permitted to be used in another product.

3.2.8 form, fit, and function of a product: the form is the shape of the product, the fit is the way the product interfaces with other products, and the function is the purpose that the product serves.

3.2.9 leaf node: a node that has no children.

3.2.10 link: a uni-directional relationship from one node to another node within a directed acyclic graph.

3.2.11 lot: a collection of actual units treated as a single unit.

3.2.12 node: an element of a directed acyclic graph, connected to other such elements by links.

3.2.13 parent node: the node from which a link is initiated.

3.2.14 parts list structure: a structural description of a product in terms of a hierarchy of all distinct usages of its constituents.

NOTE - See annex E for cases of parts list structures.

3.2.15 promissory use: the intention to use a constituent in an assembly.

3.2.16 root node: a node that has no parents.

3.2.17 tree: a restricted type of directed acyclic graph in which there is only one root node, and in which each node has at most one parent.

3.3 Abbreviations

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

BOM bill-of-material.

CM configuration management.

DAG directed acyclic graph.

4 Product structure schema

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

EXPRESS specification:

```
*)
SCHEMA product_structure_schema;

  REFERENCE FROM product_definition_schema
    (product,
     product_definition_relationship,
     acyclic_product_definition_relationship);

  REFERENCE FROM measure_schema
     (measure_with_unit);

  REFERENCE FROM support_resource_schema
     (identifier, label, text);
(*
```

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

product_definition_schema	ISO 10303-41
measure_schema	ISO 10303-41
support_resource_schema	ISO 10303-41

4.1 Introduction

The subject of the **product_structure_schema** is the relationship between the definitions of:

- products which are assembled to make other products;
- products which are changed to make other products.

These relationships are defined as specialisations of relationships among **product_definitions** as specified in the **product_definition_schema** of ISO 10303-41. In addition, any product that is used in a product structure may have alternative products specified for that use. Collectively these relationships are referred to as a product structure.

The product structure defines the different methods by which a product can be represented as being made up of constituents. Product structure relationships are established among the constituents that make up a product. Product structure is an aspect of product definition.

The relationships between product definitions are specializations of the general relationship among product definitions in the **product_definition_schema** of ISO 10303-41. They are represented in this International Standard using a subtype of the **product_definition_relationship** entity as defined in the product definition schema of ISO 10303-41. The subtypes of **product_definition_relationship** defined in this schema establish additional constraints and meanings to the supertype in ISO 10303-41.

The product structure concept applies to multiple definitions of the structure of a single product version. The different definitions correspond to different organization requirements for defining the structure of a product during the life cycle of the product's development.

EXAMPLE 3 - An organization may define a bill-of-material for both a design engineering release life cycle activity, as well as for a manufacturing engineering activity.

This schema supports the concept of making a product from another product. This concept deals with the relationship between a product and the results of a process applied to that product which produces a new product.

The **product_structure_schema** develops the following specific concepts for use in representing the various forms of product structure:

- the **alternate_product_relationship** is used to convey the information that two products have a relationship whereby one product may be used in the place of another product;
- the **make_from_usage_option** represents the fact that any actual unit of one design can be manufactured by consuming or modifying an actual unit of another design;

NOTE 1 - Typically the consumed product is referred to as stock or raw material.

– the **make_from_usage_option_group** is used to represent one specific combination of products that can be made from a single product;

NOTE 2 - Typically the single product is referred to as stock or raw material.

– the **assembly_component_usage** establishes relationships between designs within one of four different subtypes:

a) The **quantified_assembly_component_usage** represents the relationship between a constituent and an assembly. For discrete constituents, several occurrences of the constituent are represented by the single constituent and the quantity representing the number of occurrences of it. For non-discrete constituents the quantity represents a unit of measure other than a unitless number;

b) The **next_assembly_usage_occurrence** represents the relationship between an occurrence of a constituent and its immediate assembly;

c) The **specified_higher_usage_occurrence** represents the relationship between a specific use of a constituent with respect to a non-immediate/non-parent ancestor assembly within the product structure;

d) The **promissory_usage_occurrence** represents the relationship between a constituent and an ancestor assembly within an overall product structure without any specification of the intermediate assemblies being represented.

4.2 Fundamental concepts and assumptions

Product structures are modelled by directed acyclic graphs (DAG). In these models, nodes represent product definitions, and the directed links represent composed-of relationships. In this schema, nodes correspond to **product_definition** entities and the links correspond to **assembly_component_usage** entities.

NOTE 1 - For a detailed discussion of graph theory, see [1].

Many forms of product structure can be represented using this schema. Two product structures of special utility are bill-of-material and parts list structures.

NOTE 2 - Examples and diagrams of the manner in which the entities of this part may be used to represent product structures are included in annex E.

A parts list structure is a specific form of a bill-of-material that can be represented by a tree. A bill-of-material structure may require a more general DAG.

For a general product structure, in order to identify the usage of any constituent within an assembled product, it is necessary to identify the path between the assembled product and the constituent. The **specified_higher_usage_occurrence** entity provides this capability.

4.3 Product structure schema entity definitions

4.3.1 alternate_product_relationship

The alternate product relationship is used to convey the information that two products have a relationship whereby one product, the **alternate** product, may be used in the place of another product, the **base** product.

When one product is an alternate for another product it is understood that there is no interest within the organization to keep track of which product, the base or any alternates specified, is used as a particular instance of the base product within a product structure.

NOTE - An organization may track design changes for a base part, and establish effectivity conditions for the use of that base part in various assemblies to be manufactured. The use of an alternate product implies that an organization does not specify any particular version of the alternate product or establish effectivities relating to it.

The two products specified in the entity are equivalent with respect to form, fit, and function, as determined by the organization.

EXAMPLE 4 - Two screws of the same size are products. One screw has a cross head and the other has a straight head. These head shapes are properties of the respective products. Within a particular organization, the two screws are considered equivalent with respect to form, fit, and function: they both have sufficiently close physical shape, they take up the same space when used, and they both serve to fasten two things together. Thus, one of these two screws could be considered to be an alternate part for the other screw. A different organization might consider the forms to be different.

The use of the **alternate_product_relationship** entity shall be defined in the context of the product structure of the base product. The relationship established by the use of **alternate_product_relationship** need not be symmetric. If B is an alternate product for A, it is not required that A is also an alternate product for B.

EXPRESS specification:

```
*)
ENTITY alternate_product_relationship;
  name       : label;
  definition: text;
  alternate : product;
  base       : product;
  basis      : text;
UNIQUE
  UR1: alternate, base;
WHERE
  WR1: alternate :<>: base;
END_ENTITY;
(*
```