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

Part 11: Description methods: The EXPRESS language reference manual

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

Partie 11: Méthodes de description: Manuel de référence du langage EXPRESS

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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.

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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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10303–11 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

This second edition of ISO 10303–11 constitutes a minor revision of the first edition (ISO 10303-11:1994), which is provisionally retained in order 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 second edition also incorporates the Technical Corrigendum ISO 10303–11:1994/Cor.1:1999(E).

ISO 10303 is organized as a series of parts, each published separately. 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 description methods series.

A complete list of parts of ISO 10303 is available from the Internet:
<http://www.tc184-sc4.org/titles/>

0 Introduction

0.1 General

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 elements of the EXPRESS language. Each element of the language is presented in its own context with examples. Simple elements are introduced first, then more complex ideas are presented in an incremental manner.

The changes that lead to this edition were driven by requirements from multi-schema specifications. The new concepts constitute an architecture for extensible data models. The following keywords have been added to this edition:

— BASED_ON;

— END_SUBTYPE_CONSTRAINT;

— EXTENSIBLE;

— GENERIC_ENTITY;

— RENAMED;

— SUBTYPE_CONSTRAINT;

— TOTAL_OVER;

— WITH.

Schemas that contain these words as EXPRESS identifiers become invalid under this edition. Else, the modifications that are incorporated in this edition are upwardly compatible with the previous edition.

0.2 Language overview

EXPRESS is the name of a formal information requirements specification language. It is used to specify the information requirements of other parts of ISO 10303. It is based on a number of design goals among which are:

— the size and complexity of ISO 10303 demands that the language be parsable by both computers and humans. Expressing the information elements of ISO 10303 in a less formal manner would eliminate the possibility of employing computer automation in checking for inconsistencies in presentation or for creating any number of secondary views, including implementation views;

— the language is designed to enable partitioning of the diverse material addressed by ISO 10303. The schema is the basis for partitioning and intercommunication;

— the language focuses on the definition of entities, which represent objects of interest. The definition of an entity is in terms of its properties, which are characterized by specification of a domain and the constraints on that domain;

— the language seeks to avoid, as far as possible, specific implementation views. However, it is possible to manufacture implementation views (such as static file exchange) in an automatic and straightforward manner.

In EXPRESS, entities are defined in terms of attributes: the traits or characteristics considered important for use and understanding. These attributes have a representation which might be a simple data type (such as integer) or another entity type. A geometric point might be defined in terms of three real numbers. Names are given to the attributes which contribute to the definition of an entity. Thus, for a geometric point the three real numbers might be named x, y and z. A relationship is established between the entity being defined and the attributes that define it, and, in a similar manner, between the attribute and its representation.

NOTE 1 A number of languages have contributed to EXPRESS, in particular, Ada, Algol, C, C^{++}, Euler, Modula-2, Pascal, PL/I and SQL. Some facilities have been invented to make EXPRESS more suitable for the job of expressing an information model.

NOTE 2 The examples of EXPRESS usage in this manual do not conform to any particular style rules. Indeed, the examples sometimes use poor style to conserve space or to show flexibility. The examples are not intended to reflect the content of the information models defined in other parts of ISO 10303. They are crafted to show particular features of EXPRESS. Any similarity between the examples and the normative information models specified in other parts of ISO 10303 should be ignored.

Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual

1 Scope

This part of ISO 10303 specifies a language by which aspects of product data can be defined. The language is called EXPRESS.

This part of ISO 10303 also specifies a graphical representation for a subset of the constructs in the EXPRESS language. This graphical representation is called EXPRESS-G.

EXPRESS is a data specification language as defined in ISO 10303-1. It consists of language elements that allow an unambiguous data definition and specification of constraints on the data defined.

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

— data types;

— constraints on instances of the data types.

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

— definition of database formats;

— definition of file formats;

— definition of transfer formats;

— process control;

— information processing;

— exception handling.

EXPRESS is not a programming language.

2 Normative references

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

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

ISO/IEC 8824-1:2002, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO/IEC 10646:2003, *Information technology — Universal Multiple-Octet Coded Character Set (UCS)*

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.

— Conformance requirement;

— Context;

— Data;

— Data specification language;

— Information;

— Information model;

— PICS proforma;

3.2 Terms defined in ISO/IEC 10646

For the purposes of this part of ISO 10303, the following term defined in ISO/IEC 10646 applies.

— Graphic character.

NOTE This definition includes only those characters in ISO/IEC 10646 that have a defined visual representation; this explicitly excludes any cells that are empty or crosshatched.

3.3 Other terms and definitions

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

3.3.1
complex entity data type
a representation of an entity. A complex entity data type establishes a domain of values defined by the common attributes and constraints of an allowed combination of entity data types within a particular subtype/supertype graph.

3.3.2
complex entity (data type) instance
a named complex entity data type value. The name of a complex entity instance is used for referencing the instance.

3.3.3
complex entity (data type) value
a unit of data that represents a unit of information within the class defined by a complex entity data type. It is a member of the domain established by this complex entity data type.

3.3.4
constant
a named unit of data from a specified domain. The value cannot be modified.

3.3.5
data type
a domain of values.

3.3.6
entity
a class of information defined by common properties.

3.3.7
entity data type
a representation of an entity. An entity data type establishes a domain of values defined by common attributes and constraints.

3.3.8
entity (data type) instance
a named entity data type value. The name of an entity instance is used for referencing the instance.

3.3.9
(single) entity (data type) value
a unit of data which represents a unit of information within the class defined by an entity data type. It is a member of the domain established by this entity data type.

3.3.10
instance
a named value.

3.3.11
multi-leaf complex entity (data type)
a complex entity data type that consists of more than one entity data types that do not have further subtypes within this complex entity data type.

3.3.12
multi-leaf complex entity (data type) instance
a named multi-leaf complex entity data type value. The name of a multi-leaf complex entity instance is used for referencing the instance.

3.3.13
multi-leaf complex entity (data type) value
a unit of data that represents a unit of information within the class defined by a multi-leaf complex entity data type. It is a member of the domain established by this multi-leaf complex entity data type.

3.3.14
partial complex entity data type
a potential representation of an entity. A partial complex entity data type is a grouping of entity data types within a subtype/supertype graph which may form part or all of a complex entity data type.

3.3.15
partial complex entity value
a value of a partial complex entity data type. This has no meaning on its own and must be combined with other partial complex entity values and a name to form a complex entity instance.

3.3.16
population
a collection of entity data type instances.

3.3.17
primary schema
a schema in a group of interrelated schemas that form a, possibly cyclic, directed graph. A primary schema is a schema of interest. There can be one or more primary schemas within the graph, where the other schemas in the graph are only there to support the primary schema. The primary schema has a special role in the conversion of a shortform schema into a longform schema (see G).

3.3.18
root schema
a schema in a group of interrelated schemas that form a, possibly cyclic, directed graph. The root schema is not the target of any interface specification, but all the other schemas can be reached from the root schema. The root schema can be considered to be representative of the graph. The root schema has a special role in the conversion of a shortform schema into a longform schema (see G).

3.3.19
simple entity (data type) instance
a named unit of data which represents a unit of information within the class defined by an entity. It is a member of the domain established by a single entity data type.

3.3.20
subtype/supertype graph
a declared collection of entity data types. The entity data types declared within a subtype/supertype graph are related via the subtype statement. A subtype/supertype graph defines one or more complex entity data types.

3.3.21
token
a non-decomposable lexical element of a language.

3.3.22
value
a unit of data.

4 Conformance requirements

4.1 Formal specifications written in EXPRESS

4.1.1 Lexical language

A formal specification written in EXPRESS shall be consistent with a given level as specified below. A formal specification is consistent with a given level when all checks identified for that level and all lower levels are verified for the specification.

Levels of checking

Level 1: Reference checking. This level consists of checking the formal specification to ensure that it is syntactically and referentially valid. A formal specification is syntactically valid if it matches the syntax generated by expanding the primary syntax rule (`syntax`) given in annex A. A formal specification is referentially valid if all references to EXPRESS items are consistent with the scope and visibility rules defined in clauses 10 and 11.

Level 2: Type checking. This level consists of checking the formal specification to ensure that it is consistent with the following:

— expressions shall comply with the rules specified in clause 12;

— assignments shall comply with the rules specified in 13.3;

— inverse attribute declarations shall comply with the rules specified in 9.2.1.3;

— attribute redeclarations shall comply with the rules specified in 9.2.3.4.

Level 3: Value checking. This level consists of checking the formal specification to ensure that it complies with statements of the form 'A shall be greater than B' as specified in clause 7 to clause 16. This is limited to those places where both A and B can be evaluated from literals and/or constants.

Level 4: Complete checking. This level consists of checking a formal specification to ensure that it complies with all statements of requirement as specified in this part of ISO 10303.

EXAMPLE This part of ISO 10303 states that functions shall specify a return statement in each of the possible paths a process may take when that function is invoked. This would have to be checked.

