PD ISO/TS 10303-16:2021

BSI Standards Publication

Industrial automation systems and integration — Product data representation and exchange

Part 16: Description methods: SysML XMI to EXPRESS transformation

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The UK participation in its preparation was entrusted to Technical Committee AMT/4, Industrial data and manufacturing interfaces.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2022

ISBN 978 0 539 03807 1

ICS 25.040.40

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 August 2022.

Amendments/corrigenda issued since publication

Date	Text affected

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TECHNICAL SPECIFICATION

ISO/TS 10303-16

First edition
2021-07

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

Part 16: Description methods: SysML XMI to EXPRESS transformation

Reference number
ISO/TS 10303-16:2021(E)

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Foreword

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This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data.*

A list of all parts in the ISO 10303 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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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 and 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.

10303-16 is a member of the description methods series. This document specifies a mapping of SysML XMI to the EXPRESS language.

The STEP APs Domain models and the STEP Core Model are information model layer components that are part of the STEP Extended Architecture. These components are developed using SysML. In the past STEP information models were developed using the EXPRESS language. For legacy reasons it is therefore required to provide an EXPRESS schema derived from the SysML domain model. It is mandatory that the transformation from the SysML model to the EXPRESS schema is defined by a reference standard and guarantee a repeatable process applicable to future application protocols developments.

The Object Management Group (OMG) has standardized the XML Metadata Interchange specification (XMI) that integrates the OMG Systems Modeling Language (SysML), the OMG Unified Modeling Language (UML), the OMG Meta-Object Facility (MOF) and the World Wide Web Consortium (W3C) Extensible Markup Language (XML) standards. SysML inherits the XMI interchange capability from UML. XMI is a mechanism for the interchange of metadata between UML-based modeling tools and MOF-based metadata repositories. OMG has also standardized an XMI compliant interchange format for the SysML thus specifying a lexical representation of SysML models based on a standardized metamodel of the SysML. That lexical representation includes, among other things, the ability to interchange data type information, class information (or entities), groupings of classes providing namespaces for the classes (or schemas), associations between classes and inheritance between classes (or subtypes).

ISO has standardized the EXPRESS language (ISO 10303-11:2004). It is used to specify information requirements in ISO 10303.

10303-16 specifies a description method of the STEP Parts family, which defines the transformation of SysML constructs to the EXPRESS elements. Because the XMI standard specifies the XML representation of SysML metamodel constructs, standardizing the binding of SysML constructs into EXPRESS elements supports the representation of SysML models as EXPRESS schemas. SysML metamodel concepts that appear in SysML Block Diagrams are mapped into data specifications defined by EXPRESS schemas. This document does not map all SysML metamodel constructs to EXPRESS elements, because 10303 SysML models do not use all SysML metamodel constructs.

The EXPRESS schemas are derived from the domain model by applying the implementation bindings on the SysML XMI. The EXPRESS binding is realized with XSL transformations, which transforms the SysML model into an EXPRESS Schema. The specified binding is a one-way transformation from SysML information model represented in XMI into an EXPRESS schema. Due to this limitation 10303-16 does not define the transformation of arbitrary SysML models to EXPRESS.

Readers of 10303-16 require detailed knowledge of the EXPRESS language, and SysML.

The structure, conventions and concepts of the EXPRESS language are defined in ISO 10303-11:2004.

The main component of this standard is:

— the specification of the transformation from SysML XMI to EXPRESS for each STEP element modelled in SysML.

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

Part 16: Description methods: SysML XMI to EXPRESS transformation

1 Scope

This document specifies a mapping of SysML (ISO/IEC 19514:2017) constructs to EXPRESS (ISO 10303-11:2004) elements for the purpose of representing SysML model represented in XMI (ISO/IEC 19509:2014) as EXPRESS (ISO 10303-11:2004) schemas. The specified mapping is a one-way transformation from SysML information model represented in XMI into an EXPRESS schema.

NOTE Due to this limitation 10303-16 does not define the transformation of arbitrary SysML models to EXPRESS.

The following are within the scope of this document:

— the transformation of SysML metamodel constructs represented in XMI to EXPRESS elements for the purpose of representing SysML information models as EXPRESS schemas.

The following are outside the scope of this document:

— the transformation of SysML metamodel constructs into EXPRESS elements that are not used in the STEP Extended Architecture.

NOTE The STEP Extended Architecture is defined in References [8], [9] and [10].

— the transformation of SysML metamodel constructs into EXPRESS elements for other purposes than representing SysML constructs as STEP concepts;

— codes and scripts to transform SysML XMI to EXPRESS schema;

— the transformation of SysML constraints (OCL[5]) into EXPRESS global and local rules;

— the transformation of EXPRESS elements into SysML constructs.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *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/IEC 19505-1:2012, *Information technology — Object Management Group Unified Modeling Language (OMG UML) — Part 1: Infrastructure*

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ISO/IEC 19509:2014, *Information technology — Object Management Group XML Metadata Interchange (XMI)*

ISO/IEC 19514:2017, *Information technology — Object management group systems modeling language (OMG SysML)*

W3C Recommendation: Extensible Markup Language (XML) 1.0 (Fifth Edition)

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10303-11, ISO/IEC 19505-1, ISO/IEC 19514 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1 Terms and definitions for generic concepts

3.1.1.1
data
representation of information in a formal manner suitable for communication, interpretation, or processing by human beings or computers

[SOURCE: ISO 10303-1:2021, 3.1.29]

3.1.1.2
data model
description of the organization of data in the management information system of an enterprise

[SOURCE: ISO/IEC 2382:2015, 2121422]

3.1.1.3
EXPRESS
language by which aspects of product data can be defined

[SOURCE: ISO/TS 10303-15:2021, 3.1.1.1]

3.1.1.4
information
facts, concepts, or instructions

[SOURCE: ISO 10303-1:2021, 3.1.41]

3.1.1.5
information model
conceptual model of product data

Note 1 to entry: In ISO 10303, an information model is based on the object-relationship modeling technique that organizes the product data as represented in different system aspects.

Note 2 to entry: In ISO 10303, information models may be developed using EXPRESS modeling language.

EXAMPLE Application resource model for ISO 10303-242 managed model-based 3D engineering.

[SOURCE: ISO 10303-1:2021, 3.1.42, modified — In the definition, "formal" has been replaced with "conceptual"; in Note 2 to entry, "are" has been replaced with "may be"; the Example has been changed.]

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3.1.2 Terms and definitions for SysML constructs

3.1.2.1
association
association classifies a set of tuples representing links between typed model elements

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, 11.5.

3.1.2.2
auxiliary
stereotype applied to an abstract block that has no properties

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, Clause 22.

3.1.2.3
block
modular construct used for defining an entity.

Note 1 to entry: Application activity model concepts, application data planning objects, application domain model business objects, core model objects and ARM in SysML Entities. They can include reference, part, value properties, and constraints. They can be specializations of other blocks.

Note 2 to entry: The full definition is provided in ISO/IEC 19514:2017, Clause 8.

3.1.2.4
canonical XMI
specific constrained format of XMI that minimizes variability and provides more predictable identification and ordering

Note 1 to entry: A canonical XMI file is itself a valid XMI file.

Note 2 to entry: The full definition is provided in ISO/IEC 19509:2014, Annex B.

3.1.2.5
composite aggregation
responsibility for the existence of the composed object

Note 1 to entry: If a composite object is deleted, all of its part instances that are objects are deleted with it.

Note 2 to entry: The full definition is provided in ISO/IEC 19505-1:2012, 11.4.1.

3.1.2.6
connector
link between two or more instances playing owned or inherited roles within a StructuredClassifier

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, 11.2.3.3.

3.1.2.7
enumeration
value type whose values are enumerated in the model as enumeration literals

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, 10.2.3.3.

3.1.2.8
enumeration literal
user defined data value for an enumeration

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, 10.2.3.3.

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3.1.2.9
data type
type whose instances are identified only by their value

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, 10.2.3.1.

3.1.2.10
generalization
directed relationship between a more general supertype and a more specific subtype

Note 1 to entry: Each generalization relates a specific classifier to a more general classifier. Given a classifier, the transitive closure of its general classifiers is often called its generalizations, and the transitive closure of its specific classifiers is called its specializations. The immediate generalizations are also called the classifier's subtype, and where the classifier is a class, its supertype.

Note 2 to entry: The full definition is provided in ISO/IEC 19505-1:2012, C.1.1.

3.1.2.11
part property
property that specifies a part with strong ownership and coincidental lifetime of its containing block

Note 1 to entry: It describes a local usage or a role of the typing block in the context of the containing block. Every part property has composite aggregation and is typed by a block.

Note 2 to entry: The full definition is provided in ISO/IEC 19514:2017, 8.3.2.3, paragraph 6.

3.1.2.12
primitive type
definition of a predefined data type, without any substructure

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, Clause 21.

3.1.2.13
reference property
property that specifies a reference of its containing block to another block

Note 1 to entry: The full definition is provided in ISO/IEC 19514:2017, 8.3.2.3, paragraph 6.

3.1.2.14
stereotype
limited kind of metaclass that cannot be used by itself but must always be used in conjunction with one of the metaclasses it extends

Note 1 to entry: The full definition is provided in ISO/IEC 19505-1:2012, 12.3.3.4.

3.1.2.15
value property
property of a block that is typed with a value type

Note 1 to entry: The full definition is provided in ISO/IEC 19514:2017, 8.3.2.3, paragraph 6.

3.1.2.16
value type
a stereotype of UML data type that is used to define types of values that may be used to express information but cannot be identified as the target of any reference

Note 1 to entry: The full definition is provided in ISO/IEC 19514:2017, 8.3.2.14.

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3.2 Abbreviated terms

CXMI	canonical XMI
ID	identifier
OCL	object constraint language
OMG	object management group
STEP	standard for the exchange of product model data
SysML	systems modeling language
UML	unified modeling language
UUID	universal unique identifier
XMI	XML meta-data interchange
XML	extensible markup language

4 SysML XMI to EXPRESS

4.1 General

This clause describes the concepts and rules for the transformation mapping from a STEP SysML model stored as a CXMI file to an EXPRESS Schema.

This document shall be unambiguously identified in an open information system by the code defined in Annex A.

4.2 Presentation conventions

For ease of identification, separate boxes are used for the fragments of SysML, CXMI and EXPRESS.

The items significant to the section are usually in **bold**, but more than text effects may be used where needed to support the explanation. Triple dots ("...") are used to hide content not relevant to an extract.

Curly brackets "{xxx}" are used to contain descriptive words of the content in the resulting CXMI.

4.3 Common mapping conventions

4.3.1 Reference to external files

All the references in the SysML Canonical XMI fragments are given as *xmi:idref* which assumes that the referenced element is contained in the same XMI file. When the referenced element is in a different XMI file the *href* is used instead. This will be the case for all reference to primitives and may be case for other references.

Canonical XMI: *type href* relative reference to element in DataTypes.xmi

```
CXMI:
<ownedAttribute xmi:id="{...}" xmi:uuid="{...}" xmi:type="uml:Property">
   <name>Text</name>
   <type href="../../../DataTypes.xmi#STRING"/>
   ...other tags...
</ownedAttribute>
```

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