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Automation systems and integration — Core vocabulary for industrial data

Systèmes d'automatisation et intégration — Vocabulaire de base pour les données industrielles

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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.

Introduction

The terms and definitions in this document are applicable to all ISO/TC 184/SC 4 standards. Depending upon the standard, these terms can be implemented as classes, relationships, properties or other types of model or ontology element. The core terms can be used in the documentation of the links between the different standardized data models, ontologies and software applications that need to work together to produce a digital twin for an industrial activity. The terms in the set can also help with data integrity by making sure we are talking about the same thing.

This document:

— provides a vocabulary that is not only understandable by ISO/TC 184/SC 4 experts, but also by domain engineers and by business decision makers;

NOTE 1 Many of the terms and definitions can already exist in the Oxford English Dictionary or in standards, but the definition of an integration layer requires their selection and so even these terms are included.

— enables the development of reference data that are equally applicable to all ISO/TC 184/SC 4 standards;

NOTE 2 Domain experts will produce detailed taxonomies that specialise generic items identified by terms in the set. The domain experts will not need detailed knowledge of any particular ISO/TC 184/SC 4 standard or of any particular top-level ontology.

— defines an interface to reference data developed outside ISO/TC 184/SC 4, and thereby enables its use by all ISO/TC 184/SC 4 standards.

NOTE 3 This document is intended to be analogous in the industrial domain to the Dublin Core in the document management domain. The original Dublin Core metadata set consisted of only 15 terms. This initial set has since been expanded to 55 terms. This document is of a similar size.

The role of this document in the development of reference data libraries is shown informally in Figure 1.

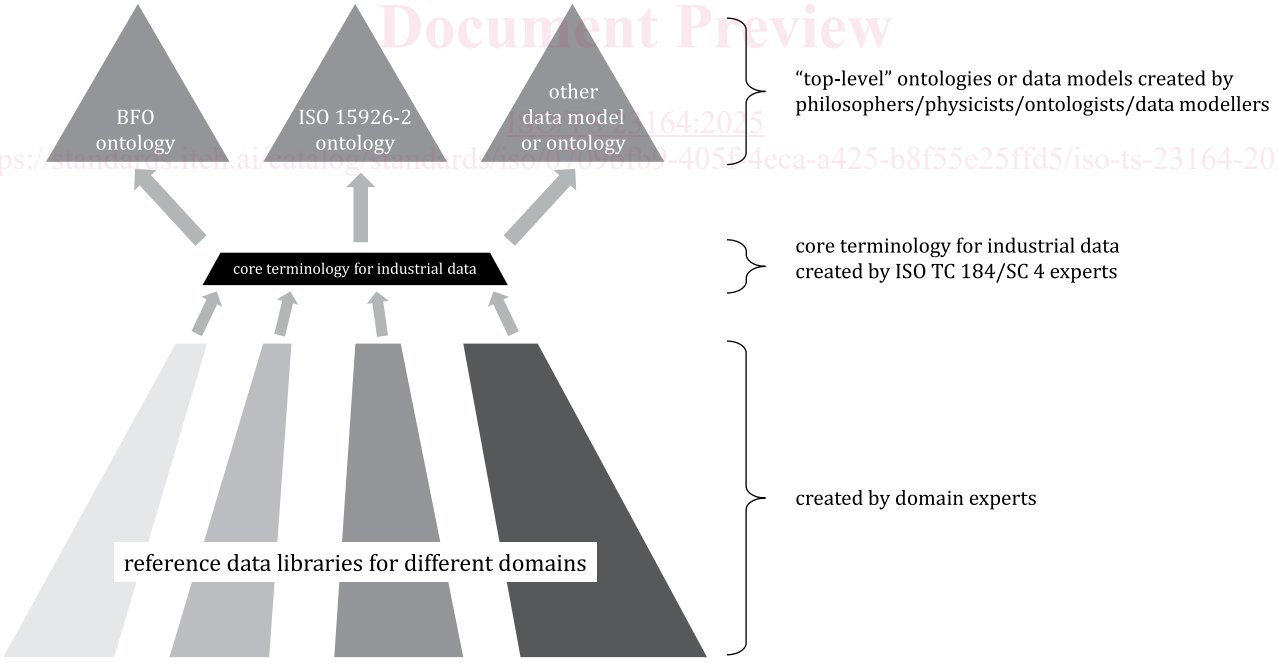

Figure 1 — Role of this document in the development of reference data libraries

A top-level ontology in Figure 1 addresses generic issues such as the representation of whole-part relationships, change over time, and the distinction between actual objects, requirements and plans.

At present ISO 10303 does not contain a top-level ontology. However, the Integrated Resource data models can be regarded as containing an informal top-level ontology. ISO 15926-2 is a top-level ontology.

The reference data libraries for different domains in Figure 1 are shown as independent. In practice there are large overlaps. This document shows which reference data items are specialisations of the same generic item, and therefore make the overlaps easier to manage.

The approach used to develop the content of this document and to define its scope is described in Annex A "Development methodology".

The guidance on groups of terms and their motivation is contained in Annex B "Guidance on groups of terms".

NOTE 1 The methodology followed in the development of this document has been to:

a) define a thing about which industrial data is held using natural language;

b) assign a preferred term consisting of one or more English language words to the thing.

Because the things and their definitions are primary with terms assigned to them, this document can also be called a "thesaurus".

NOTE 2 In this document the preferred terms are unique. In some cases, admitted terms are also given, which are not necessarily unique.

NOTE 3 Where possible the terms are taken from international standards.

NOTE 4 The terms can be used in the text definitions and descriptions of entities and attributes in industrial data models, and of classes and relationships in industrial ontologies. The terms can be used in the text definitions and descriptions of items within industrial data libraries for particular industrial domains.

Automation systems and integration — Core vocabulary for industrial data

1 Scope

This document specifies a vocabulary for industrial data that defines generic terms for things that exist in more than one industrial domain.

The following are within the scope of this document:

— definition of terms for generic types of industrial thing;

EXAMPLE 1 Definitions of the terms "material object", "artefact" and "product" are within the vocabulary.

— definition of terms relevant to assemblies, systems and their breakdown structures;

— definition of terms relevant to activities and participation in activities;

— definition of terms relevant to positions and roles in organizations;

— definition of terms relevant to behaviour, capability and function;

— definition of terms relevant to state and condition;

— definition of terms relevant to specifications, designs and plans;

— definition of terms relevant to versions, alternatives and configurations for specifications, designs and plans;

— definition of terms relevant to signals and other carriers of information and to devices that process signals and information;

— definition of terms relevant to physical quantities and properties.

The following are outside the scope of this document:

— definition of terms that are relevant to data themselves, rather than the things that data are about;

EXAMPLE 2 Definitions of the terms "data" and "information" are not within the vocabulary.

— definition of terms that are relevant to representations.

EXAMPLE 3 Definitions of the terms "representation" and "model" are not within the vocabulary.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.2 Terms related to particular and kind

3.2.1
particular
individual
thing existing in space and time

EXAMPLE 1 The pump with serial number “X12345”, which was supplied by Fred Bloggs and Co. to UGE Inc. on 2019-09-27, is a *particular* pump.

EXAMPLE 2 The computer file http://www.uge.com/annual-report/2019.docx is a *particular* computer file. It was created at a *particular* time and may be deleted in the future. It exists on a *particular* server somewhere.

Note 1 to entry: The term “individual” is used in ISO/TS 10303-1164:2023, 4.3.1, and ISO 15926-2:2003, 3.1.6.

Note 2 to entry: IEC 81346-1:2022, 3.16 defines the term “product individual” with the same meaning as particular *product* (3.3.3).

Note 3 to entry: The term *particular* is used as a qualifier of another term.

Note 4 to entry: In this document, the term *particular* is not used on its own, except where the qualified term is understood.

Note 5 to entry: “Realized” is a natural term where qualified term is *product* (3.3.3), but less natural where the qualified term is *person* (3.10.2).

Note 6 to entry: The term “individual” is used on its own in OWL to mean an object within the domain. In OWL DL (OWL statements following specified syntactic restrictions that are interpreted using the OWL 2 Direct Semantics) an OWL individual cannot also be an OWL class. In OWL-Full (which need not follow the above semantic restrictions and is interpreted using the OWL 2 RDF-Based Semantics) an OWL individual can also be an OWL class.

Note 7 to entry: The space and time within which a *particular* thing exists can be unknown.

Note 8 to entry: Some ontological approaches describe plans for the future or scenarios in terms of *particular* things that exist in possible worlds. The vocabulary defined here neither prescribes nor precludes such approaches.

Note 9 to entry: ISO 10303 allows a *particular* thing to be either actually existing or planned for the future. A *particular* thing that is actually existing is also called “realized”.

Note 10 to entry: In ISO/TS 10303-4000:2023 and in the Application Reference Model of ISO 10303-242:2022, term “product” is replaced by “part” so that the following terms are used: “individual part”, “planned individual part” and “realized individual part”.

3.2.2
kind
class
type
things that have something in common

EXAMPLE 1 Pump is a *kind* of *material object* (3.3.2). Each *particular* (3.2.1) *material object* of this *kind* is intended to add mechanical energy to a fluid. This is a generic *kind* of *material object*.

EXAMPLE 2 The “Fred Bloggs and Co. model A-101 pump” is a *kind* of *material object*. Each *particular* pump of this *kind* has a rated power of 1 kW. There are many other quantitative properties possessed by each *particular* pump of this *kind*. This is a specific *kind* of *material object*.

Note 1 to entry: The term “class” is used in ISO 15926-2:2003, 3.1.1, and ISO/TS 10303-54:2005, 3.2.1.

Note 2 to entry: The terms “type” and “class” are used in IEC 81346-1:2022, 3.17 and 3.20, with meanings which are both similar to *kind*.

Note 3 to entry: The term *kind* is a qualifier of another term, usually in the form “kind of”. In this document, the term *kind* is not used on its own as a noun, except where the qualified term is understood.

Note 4 to entry: Depending on the what all things of a *kind* have in common, a *kind* can be "generic" or "specific". A generic *kind* is one that is defined in sources used throughout industry, such as standards. A specific *kind* is often defined by an *organization* as part of a *specification*.

Note 5 to entry: What things of the same *kind* have in common can be specified.

Note 6 to entry: "Class" and "type" are possible synonyms for *kind*. "Class" is used in ISO 15926-2:2003, 3.1.1 with a meaning that is close to "set" in mathematics. The uses of these terms in ontologies or data modelling languages is not necessarily consistent with the less formal use here.

Note 7 to entry: ISO 10303 mostly uses the term "class". The usage of this term is defined in ISO/TS 10303-1114:2019, 4.3.1 defines the entity Classification_assignment to be "the assignment of a Class to product or activity data for their classification".

Within ISO 10303, a "part" can be a *kind* of thing. ISO/TS 10303-1022:2014, 3.1.2.2 defines a *part* to be "discrete object that can come into existence as a consequence of a manufacturing process".

Within ISO 10303, a "concept" is a *kind* of thing. ISO/TS 10303-1060:2004, 4.1.2 defines the entity Product_concept to be "an identification of a set of similar products that were, are or will be proposed to customers".

Within ISO 10303 the term "type" is used in some circumstances. ISO/TS 10303-1240:2004, 4.2.2 defines the entity Organization_type to be a "recognized kind of organization". ISO/TS 10303-1245:2004, 4.3.1 defines the entity Type_of_person to be a "type of person".

3.3 Terms related to artefact, product and material object

3.3.1
artefact
thing that is a result of human activity

EXAMPLE 1 The noise of vented steam from plant UGE-1 on 2020-03-17 is an *artefact*.

EXAMPLE 2 The footprints of Neil Armstrong on the moon are *artefacts*.

3.3.2
material object
thing that occupies space and possesses rest mass

EXAMPLE 1 A washer is stamped from a sheet of steel. The sheet of steel is a *material object* and a *product* (3.3.3). The stamping process creates two new *material objects* and *products*:

— the washer;

— a disc of waste steel that is removed to make the hole in the washer.

The original sheet of steel continues to exist but now has a hole in it. The washer is a *product* intended for sale or use, whilst the disc of waste steel and the steel sheet with hole in it may be waste *products*.

EXAMPLE 2 The batch of liquid B-101 is stored in tank A. The batch B-101 is a *material object*. The contents of tank A are then divided so that some goes into tank B and some into tank C. The contents of tanks B and C are two different *material objects*. We can say that the contents of tanks B and C came from *batch* B-101 for traceability, but it is an administrative decision whether the *material objects* in tanks B and C are regarded as parts of *material object* B-101 which continues but now as two separate parts, or whether the *material object* B-101 ceased to exist when it was transferred out of tank A and divided.

Note 1 to entry: A *material object* can be a discrete solid quantity of material, or a part of a larger quantity of solid material. A *material object* can be a quantity of fluid material, or a part of a large quantity of fluid material.

Note 2 to entry: The beginning or end of the life or existence of a *material object* can be an arbitrary administrative decision. A *material object* can be deemed to come into existence at a stage of a manufacturing process. A *material object* can be deemed to have ended its life at a stage of a dismantling or recycling process.

Note 3 to entry: The matter that a *material object* consists of can exist before the *material object* begins. This matter is other *material objects*. Similarly, the matter a *material object* consists of can continue to exist after the *material object* ends. This matter is also another *material object*.

3.3.3
product
thing that is intended to be either sold, or delivered, or used as input to another human activity, or transferred to the environment as waste

Note 1 to entry: This definition encompasses the following:

— sales product: This is something produced or extracted for sale. It is not necessarily an *artefact* (3.3.1), because it can be raw material or agricultural produce. It is not necessarily a *material object* (3.3.2), because it can be software.

— intermediate product: This is something that has been produced and that is intended for further processing before end use.

— waste product: This is something that has been produced, but is unwanted by its producer. It can be input to other processes or transferred to the environment.

Note 2 to entry: A *product* is distinguished from a *service* (3.11.2) in this document. The term "product and service" is used for things that are a combination of the two.

Note 3 to entry: A *product* can be raw material extracted from the ground, timber from a forest, or agricultural produce.

Note 4 to entry: A *product* can be intangible, such as software or a product design.

Note 5 to entry: A *product* can be energy, such as a supply of electricity or heat.

3.3.4
material product
product (3.3.3) that is a *material object* (3.3.2)

Note 1 to entry: A *material product* can be an unfinished *product* that is produced by a materials supplier, and that is input to other manufacturing *processes* (3.11.1).

3.4 Terms related to part and component

3.4.1
part

thing that is a part of a whole

EXAMPLE 1 The front offside wheel of the vehicle with registration "DV 58 HUK" is a *part* of the vehicle. It is not arbitrary, but an *assembly element* (3.5.3). It is also a *material object* (3.3.2). The material that is the front offside wheel can change from time to time during the life of the vehicle.

EXAMPLE 2 The compartment "P-13" of the ship Arctic Queen is a *part* of the ship. It is not arbitrary, but a *breakdown element* (3.7.4) of a spatial breakdown of the ship.

Note 1 to entry: Each thing is always a *part* of many other things. Therefore, calling a thing a "part" conveys no information other than that there is a part-whole relationship of interest.

Note 2 to entry: A *part* can be an arbitrary division of the whole. A *part* can also be not arbitrary. A *part* that is not arbitrary can be an *assembly element*, a *system element* (3.5.8), a *network element* (3.5.12), or a *breakdown element*.

Note 3 to entry: If the whole is a material object, then each *part* is also a *material object*. However, a *part* can be different material at different times.

Note 4 to entry: A *part* can be identified solely by the place where it is. A *part* is not necessarily a serial numbered *material product* (3.3.4).

Note 5 to entry: If a *part* is a material object which can be replaced, then the identity of the *part* is derived from its relationship with the whole that it is part of.

Note 6 to entry: A *part* can be a *shape feature* (3.4.2).

Note 7 to entry: A *part* can be empty space. In a process plant, an access route can be an important and identified *part*.

3.4.2
shape feature
part (3.4.1) that is distinguished from a whole by its shape

Note 1 to entry: A *shape feature* is not usually a *component* (3.4.2) for an *assembly* (3.5.2). A *shape feature* is not usually separable from the whole.

Note 2 to entry: A *shape feature* can be formed by the addition or removal of material. A *shape feature* can be a hole.

Note 3 to entry: A *shape feature* can be classified according to its shape. Such classifications include thread, groove, slot, and stud.

Note 4 to entry: A *shape feature* can be classified according to its engineering purpose. Such classifications include lifting lug and drain hole.

Note 5 to entry: The boundary of a *shape feature* can be incompletely defined. Hence the boundary between a lifting lug and the *material object* (3.3.4) to which it is fixed can be vague. It can be somewhere in the region of the weld.

3.4.3
component
product (3.3.3) that was created with the intention that it be part of an *assembly* (3.5.2), *system* (3.5.6) or *network* (3.5.11)

EXAMPLE 1 Nut is a generic *kind* (3.2.2) of *component*.

EXAMPLE 2 Flange nut is a generic *kind* of *component*.

EXAMPLE 3 "Flange nut to specification N-DEF" is a specific *kind* of *component*.

Note 1 to entry: A *component* is usually a *material object* (3.3.2), but can be a non-material thing such as software.

Note 2 to entry: A *component* can be an *assembly*.

Note 3 to entry: A *component* can have different statuses during its life, such as:

— not assembled: available for use in an *assembly*;

— assembled and replaceable: can be removed from its *assembly* and replaced by a *component* with similar form, fit or function;

— assembled and not replaceable: cannot be removed from its *assembly*.

In a factory that makes circuit boards, a bare board is a *component*, which initially has the status of not assembled. Once it is part of a completed circuit board, it has the status of assembled and not replaceable. A completed circuit board is itself a *component*. In a distribution centre, a complete circuit board has the status of not assembled.

Note 4 to entry: In ISO/TS 10303-4000:2023 and in the Application Reference Model of ISO 10303-242:2022, the term "product" is replaced by "part". With this usage, it can be a *component* that is being referred to.

3.5 Terms related to things that are aggregations of parts

3.5.1
collection
aggregation
two or more *particular* (3.2.1) things together as a whole, where the relationships between the things are unimportant

EXAMPLE 1 The load of bricks delivered to site UGE-1 on 2020-03-17 is a *particular collection* of bricks. The load of bricks is also an *artefact* (3.3.1), *material object* (3.3.2) and *product* (3.3.3).

EXAMPLE 2 The paintings in the UK National Gallery are a *collection*. The paintings in the *collection* change from time to time.

Note 1 to entry: A *collection* is not a *set*. If the things in a *collection* are *material objects*, then the *collection* is itself also a *material object*.

Note 2 to entry: A *collection* can be arbitrary, non-contiguous or both.

Note 3 to entry: The *parts* (3.4.1) of a *collection* can change during the life of the *collection*.

3.5.2
assembly
two or more things, where each is a *material object* (3.3.2), assembled together into a contiguous whole

Note 1 to entry: A distinct *part* (3.4.1) within an *assembly* is an *assembly element* (3.4.3).

3.5.3
assembly element
material object (3.3.2) that is assembled with others to create an *assembly* (3.5.2)

EXAMPLE 1 The building with site identifier "B-101" is a *particular* (3.2.1) *assembly*. Some of its *assembly elements*, such as doors and windows, are *components* (3.4.3) which are brought to the site. Other *assembly elements*, such as the walls, are made in-place.

Each wall of building "B-101" is a *particular assembly*. A wall has bricks as *assembly elements*. The bricks are *components.*

EXAMPLE 2 The motor car with registration number "DV 58 HUK" is a *particular assembly*. All of its assembly elements are *components*, such as the body shell, engine, and transmission. The engine is usually regarded as replaceable, whilst the body shell is not.

EXAMPLE 3 The engine design "E-ABC" is or defines (according to ontological view) a *kind* (3.2.2) of *assembly*. The arrangement of the head nuts for the engine design "E-ABC" is shown in Figure 2.

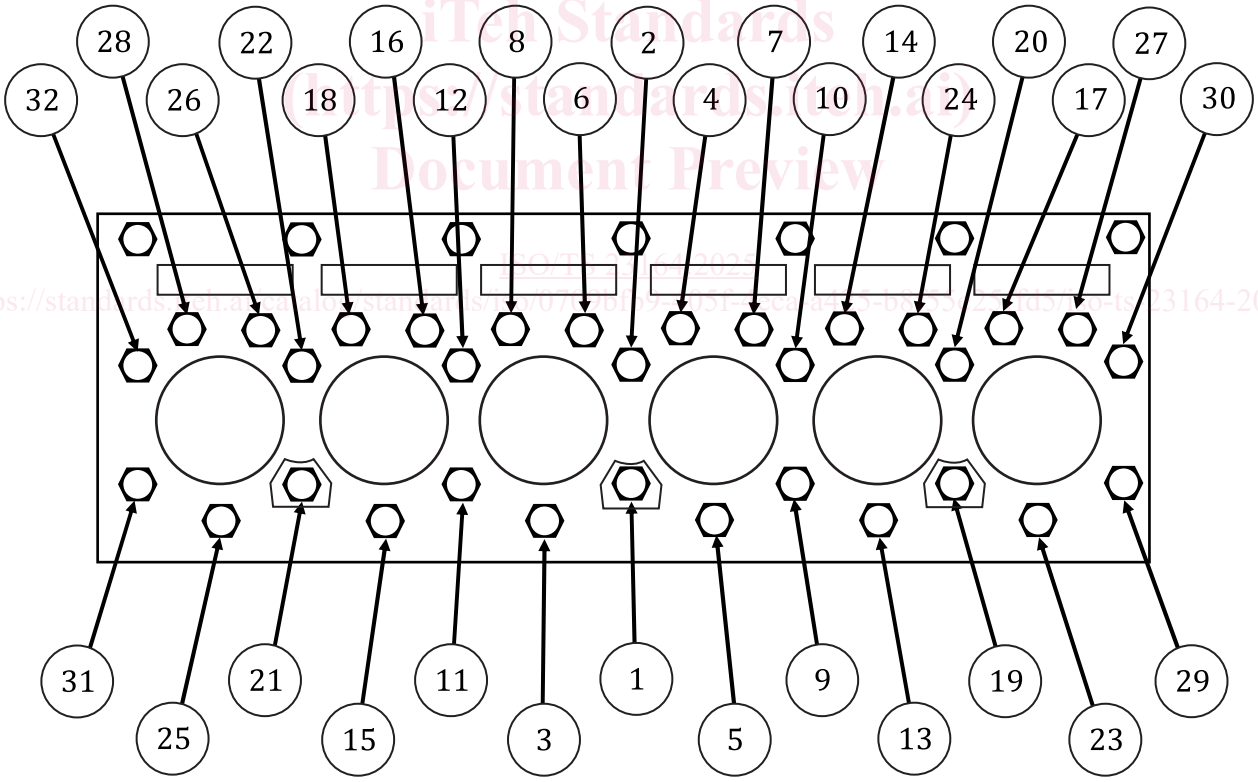

Figure 2 — Head nut arrangement for engine design "E-ABC"

EXAMPLE 4 The material of the cylinder head directly under head nut 27 of the engine with serial number "98/12345" is a *particular part*. This is not a *particular assembly element* but an arbitrary *particular part* (3.4.1). The material could change if that material were ground out and new material welded in.

EXAMPLE 5 The material of the cylinder head directly under head nut 27 of the *kind* of engine to design E-ABC is a *kind* of *part*. This is not a *kind* of *assembly element* but an arbitrary *kind* of *part*.