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**Industrial automation systems and  
integration — Process specification  
language —**

**Part 12:  
Outer core**

**iTeh STANDARD PREVIEW**

*Systemes d'automatisation industrielle et integration — Langage de  
specification de procede*  
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*Partie 12: Noyau externe*

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## Foreword

The International Organisation for Standardisation (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 organisations, 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.

International Standards are drafted in accordance with the rules given in ISO/IEC Directives, Part 2.

Draft International Standards (DIS) 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.

Attention is drawn to the possibility that some of the elements of this part of ISO 18629 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18629-12 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Sub-committee SC4, *Industrial data*

A complete list of parts of ISO 18629 is available from the Internet:  
<http://www.iso.org/standards/std18629-12-2005-d9a-4268-8680-b374e90d6784/iso-18629-12-2005>  
<http://www.tc184-sc4.org/titles>

## Introduction

ISO 18629 is an International Standard for the computer-interpretable exchange of information related to manufacturing processes. Taken together, all the parts contained in the ISO 18629 Standard provide a generic language for describing a manufacturing process throughout the entire production process within the same industrial company or across several industrial sectors or companies, independently from any particular representation model. The nature of this language makes it suitable for sharing process information related to manufacturing during all the stages of a production process.

This part provides a description of the core elements of the language defined within the International Standard.

This part of ISO 18629 and all other parts in ISO 18629 are independent of any specific process representation or model proposed in a software application in the domain of manufacturing management. Collectively, they provide a structural framework for improving the interoperability of these applications.

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# Industrial automation systems and integration —

## Process specification language –

### Part 12:

## PSL Outer core

### 1 Scope

This part of ISO 18629 provides a representation of the concepts that belong to the Outer core of the language, through a set of axioms and definitions. These axioms provide an axiomatization of the semantics for terminology in the ISO 18629 Outer core.

The following are within the scope of this part of ISO 18629:

- the aggregation of activities and sub-activities;
  - discrete activities and state;
  - constraints on the occurrence of activities;
  - concurrency for primitive activities;
  - complex activities;
  - occurrences of complex activities.
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### 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/IEC 8824-1, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation*

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

ISO 15531-1: *Industrial automation systems and integration – Industrial manufacturing management data – Part 1: General overview.*

ISO 18629-1: *Industrial automation systems and integration – Process specification language – Part 1: Overview and basic principles*

ISO 18629-11: *Industrial automation systems and integration – Process specification language – Part 11: PSL core*

## 3 Terms, definitions, and abbreviations

### 3.1 Terms and definitions

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

#### 3.1.1

##### **axiom**

well-formed formula in a formal language that provides constraints on the interpretation of symbols in the lexicon of a language

[ISO 18629-1]

#### 3.1.2

##### **conservative definition**

definition that specifies necessary and sufficient conditions that a term shall satisfy and that does not allow new inferences to be drawn from the theory

[ISO 18629-1]

#### 3.1.3

##### **core theory**

set of predicates, function symbols and individual constants, associated with some axioms, the primitive concepts of the ontology

[ISO 18629-1]

#### 3.1.4

##### **data**

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

[ISO 10303-1]

#### 3.1.5

##### **defined lexicon**

set of symbols in the non-logical lexicon which denote defined concepts

NOTE Defined lexicon is divided into constant, function and relation symbols.

EXAMPLE terms with conservative definitions.

[ISO 18629-1]

#### 3.1.6

##### **definitional extension**

extension of PSL-Core that introduces new linguistic items which can be completely defined in terms of the PSL-Core

NOTE: Definitional extensions add no new expressive power to PSL-Core but are used to specify the semantics and terminology in the domain application.

[ISO 18629-1]

**3.1.7  
extension**

augmentation of PSL-Core containing additional axioms

NOTE 1 The PSL-Core is a relatively simple set of axioms that is adequate for expressing a wide range of basic processes. However, more complex processes require expressive resources that exceed those of the PSL-Core. Rather than clutter the PSL-Core itself with every conceivable concept that might prove useful in describing one process or another, a variety of separate, modular extensions need to be developed and added to the PSL-Core as necessary. In this way a user can tailor the language precisely to suit his or her expressive needs.

NOTE 2 All extensions are core theories or definitional extensions.

[ISO 18629-1]

**3.1.8  
grammar**

specification of how logical symbols and lexical terms can be combined to make well-formed formulae

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[ISO 18629-1]

**3.1.9  
idempotent**

element (a) of a set ~~under an internal binary operation (OP) with respect to which:~~  $a \text{ OP } a = a$

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NOTE a function is idempotent when every element of the definition domain is idempotent with respect to it

EXAMPLE set-theoretic intersection and union are idempotent, since  $S \cap S = S$  and  $S \cup S = S$ .

**3.1.10  
information**

facts, concepts, or instructions

[ISO 10303-1]

**3.1.11  
interpretation**

universe of discourse and assignment of truth values (TRUE or FALSE) to all sentences in a theory

NOTE See annex C for an example of an interpretation.

**3.1.12  
language**

combination of a lexicon and a grammar

[ISO 18629-1]

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### 3.1.13

#### **lexicon**

set of symbols and terms

NOTE The lexicon consists of logical symbols (such as Boolean connectives and quantifiers) and non-logical symbols. For ISO 18629, the non logical part of the lexicon consists of expressions (constants, function symbols, and relation symbols) chosen to represent the basic concepts of the ontology.

[ISO 18629-1]

### 3.1.14

#### **manufacturing**

function or act of converting or transforming material from raw material or semi-finished state to a state of further completion

[ISO 15531-1]

### 3.1.15

#### **manufacturing process**

structured set of activities or operations performed upon material to convert it from the raw material or a semifinished state to a state of further completion

NOTE Manufacturing processes may be arranged in process layout, product layout, cellular layout or fixed position layout. Manufacturing processes may be planned to support make-to-stock, make-to-order, assemble-to-order, etc., based on strategic use and placements of inventories.

[ISO 15531-1]

### 3.1.16

#### **model**

combination of a set of elements and a truth assignment that satisfies all well-formed formulae in a theory

NOTE 1 The word "model" is used, in logic, in a way that differs from the way it is used in most scientific and everyday contexts: if a sentence is true in a certain interpretation, it is possible to say that the interpretation is a model of the sentence. The kind of semantics presented here is often called model-theoretical semantics.

NOTE 2 A model is typically represented as a set with some additional structure (partial ordering, lattice, or vector space). The model then defines meanings for the terminology and a notion of truth for sentences of the language in terms of this model. Given a model, the underlying set of axioms of the mathematical structures used in the set of axioms then becomes available as a basis for reasoning about the concepts intended by the terms of the language and their logical relationships, so that the set of models constitutes the formal semantics of the ontology.

[ISO 18629-1]

### 3.1.17

#### **ontology**

a lexicon of specialised terminology along with some specification of the meaning of terms in the lexicon

NOTE 1: structured set of related terms given with a specification of the meaning of the terms in a formal language. The specification of meaning explains why and how the terms are related and conditions how the set is partitioned and structured.

NOTE 2: The primary component of a process specification language such as ISO 18629 is an ontology. The primitive concepts in the ontology according to ISO 18629 are adequate for describing basic manufacturing, engineering, and business processes.

NOTE 3: The focus of an ontology is not only on terms, but also on their meaning. An arbitrary set of terms is included in the ontology, but these terms can only be shared if there is an agreement about their meaning. It is the intended semantics of the terms that is being shared, not simply the terms.

NOTE 4: Any term used without an explicit definition is a possible source of ambiguity and confusion. The challenge for an ontology is that a framework is needed for making explicit the meaning of the terms within it. For the ISO 18629 ontology, it is necessary to provide a rigorous mathematical characterisation of process information as well as a precise expression of the basic logical properties of that information in the ISO 18629 language.

[ISO 18629-1]

### 3.1.18

#### **Outer core**

set of core theories that are extensions of PSL-Core and that are so generic and pervasive in their applicability that they have been put apart

NOTE In practice, extensions incorporate the axioms of the Outer core.

[ISO 18629-1]

### 3.1.19

#### **primitive concept**

lexical term that has no conservative definition

[ISO 18629-1]

### 3.1.20

#### **primitive lexicon**

set of symbols in the non-logical lexicon which denote primitive concepts

NOTE Primitive lexicon is divided into constant, function and relation symbols.

[ISO 18629-1]

### 3.1.21

#### **process**

structured set of activities involving various enterprise entities, that is designed and organised for a given purpose

NOTE The definition provided here is very close to that given in ISO 10303-49. Nevertheless ISO 15531 needs the notion of structured set of activities, without any predefined reference to the time or steps. In addition, from

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the point of view of flow management, some empty processes may be needed for a synchronisation purpose although they are not actually doing anything (ghost task).

[ISO 15531-1]

### 3.1.22

#### **product**

a thing or substance produced by a natural or artificial process

[ISO 10303-1]

### 3.1.23

#### **proof theory**

set of theories and lexical elements necessary for the interpretation of the semantics of the language

NOTE It consists of three components: the PSL-Core, the Outer core and the extensions.

[ISO 18629-1]

### 3.1.24

#### **PSL-Core**

set of axioms for the concepts of activity, activity-occurrence, time-point, and object

NOTE The motivation for PSL-Core is any two process-related applications shall share these axioms in order to exchange process information, and hence is adequate for describing the fundamental concepts of manufacturing processes. Consequently, this characterisation of basic processes makes few assumptions about their nature beyond what is needed for describing those processes, and the PSL-Core is therefore rather weak in terms of logical expressiveness. In particular, PSL-Core is not strong enough to provide definitions of the many auxiliary notions that become necessary to describe all intuitions about manufacturing processes.

[ISO 18629-1]

### 3.1.25

#### **semilattice**

partial ordering in which every two elements have a unique least upper bound

### 3.1.26

#### **theory**

set of axioms and definitions that pertain to a given concept or set of concepts

NOTE this definition reflects the approach of artificial intelligence in which a theory is the set of assumptions on which the meaning of the related concept is based.

[ISO 18629-1]

### 3.1.27

#### **universe of discourse**

the collection of concrete or abstract things that belong to an area of the real world, selected according to its interest for the system to be modelled and for its corresponding environment

[ISO 15531-1]

### 3.2 Abbreviations

— FOL	First-Order Logic;
— BNF	Backus-Naur form;
— KIF	Knowledge Interchange Format;
— PSL	Process Specification Language.

## 4 ISO 18629 general

ISO 18629 specifies a language for the representation of process information, which is a process specification language. It is composed of a lexicon, an ontology, and a grammar for process descriptions.

NOTE 1 PSL is a language for specifying manufacturing processes based on a mathematically well defined vocabulary and grammar. As such, it is different and only different from the other languages used in the standards ISO 10303, ISO 13584, ISO 15531 and ISO 15926. In the context of an exchange of information between two processes, PSL specifies each process independently of its behaviour. For example, an object viewed as a resource within one process can be recognised as the same object even though it is viewed as a product within a second process.

NOTE 2 PSL is based on Mathematical Set Core theory and Situation Calculus (see annex B). As such it follows a significantly different and only different method of description from the method used by existing languages defined in the standard ISO 10303. The meaning of the concepts within PSL follows from a set of axioms and supporting definitions rather than from a formal set of defined terms. A set of supporting notes and examples are provided to aid the understanding of the primitive lexicon of the language.

The 1x series of parts of ISO 18629 specify core theories needed to give precise definitions and the axioms of the primitive concepts of ISO 18629, thus enabling precise semantic translations between different schemes.

The following are within the scope of ISO 18629-1x:

- the representation of the basic elements of the language;
- the provision of standardized sets of axioms that correspond to intuitive semantic primitive concepts adequate to describe basic processes;