

**Implementation of
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**



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Committees responsible for this British Standard

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Construction Industry Computing Association
Department of Trade and Industry (Services Management Division (IMS))
GKN Technology Ltd.
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* S *

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

Part 41:

Integrated generic resources: Fundamentals
of product description and support

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

*Partie 41: Ressources génériques intégrées: Principes de description et
de support de produits*



Contents	Page
Section 1 : General	1
1.1 Scope	1
1.1.1 Generic product description resources	1
1.1.2 Generic management resources	2
1.1.3 Support resources	2
1.2 Normative references	2
1.3 Definitions and abbreviations	3
1.3.1 Terms defined in ISO 10303-1	3
1.3.2 Terms defined in ISO 8601	3
1.3.3 Abbreviations defined in ISO 1000	4
Section 2 : Generic product description resources	5
2.1 Introduction	5
2.2 application_context_schema	5
2.2.1 Introduction	6
2.2.2 Fundamental concepts and assumptions	6
2.2.3 application_context_schema entity definitions	6
2.2.3.1 application_context	6
2.2.3.2 application_protocol_definition	7
2.2.3.3 application_context_element	8
2.2.3.4 product_context	8
2.2.3.5 product_definition_context	9
2.2.3.6 product_concept_context	9
2.2.3.7 library_context	10
2.3 product_definition_schema	11
2.3.1 Introduction	11
2.3.2 Fundamental concepts and assumptions	12

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2.3.3	product_definition_schema type definition:	
	source	12
2.3.4	product_definition_schema entity definitions	13
2.3.4.1	product	13
2.3.4.2	product_category	14
2.3.4.3	product_related_product_category	14
2.3.4.4	product_category_relationship	14
2.3.4.5	product_definition_formation	16
2.3.4.6	product_definition_formation_relationship	16
2.3.4.7	product_definition_formation_with_specified_source	17
2.3.4.8	product_definition	18
2.3.4.9	product_definition_with_associated_documents	18
2.3.4.10	product_definition_relationship	19
2.3.4.11	product_definition_substitute	20
2.3.4.12	product_definition_effectivity	21
2.3.5	product_definition_schema function definitions	21
2.3.5.1	acyclic_product_definition_formation_relationship	21
2.3.5.2	acyclic_product_definition_relationship	23
2.3.5.3	acyclic_product_category_relationship	24
2.4	product_property_definition_schema	25
2.4.1	Introduction	26
2.4.2	Fundamental concepts and assumptions	26
2.4.3	product_property_definition_schema type definitions	26
2.4.3.1	characterized_definition	26
2.4.3.2	characterized_product_definition	27
2.4.3.3	shape_definition	27
2.4.4	product_property_definition_schema entity definitions	28
2.4.4.1	characterized_object	28
2.4.4.2	property_definition	28
2.4.4.3	product_definition_shape	29
2.4.4.4	shape_aspect	30
2.4.4.5	shape_aspect_relationship	30
2.4.5	product_property_definition_schema function definition:	
	acyclic_shape_aspect_relationship	32
2.5	product_property_representation_schema	33
2.5.1	Introduction	34
2.5.2	Fundamental concepts and assumptions	34
2.5.3	product_property_representation_schema entity definitions	35
2.5.3.1	shape_representation	35
2.5.3.2	property_definition_representation	35
2.5.3.3	shape_representation_relationship	35
2.5.3.4	context_dependent_shape_representation	36
2.5.3.5	shape_definition_representation	37
2.5.4	product_property_representation_schema function definitions	37

ISO 10303-41:1994(E)

2.5.4.1	relatives_of_product_definitions	37
2.5.4.2	relatives_of_shape_representations	39
Section 3 : Management resources		41
3.1	Introduction	41
3.2	management_resources_schema	41
3.2.1	Introduction	42
3.2.2	Fundamental concepts and assumptions	42
3.2.3	management_resources_schema entity definitions	42
3.2.3.1	name_assignment	42
3.2.3.2	external_referent_assignment	43
3.2.3.3	library_assignment	43
3.2.3.4	document_reference	44
3.2.3.5	action_request_assignment	44
3.2.3.6	action_assignment	45
3.2.3.7	certification_assignment	45
3.2.3.8	approval_assignment	45
3.2.3.9	contract_assignment	46
3.2.3.10	security_classification_assignment	46
3.2.3.11	person_assignment	46
3.2.3.12	organization_assignment	47
3.2.3.13	person_and_organization_assignment	47
3.2.3.14	date_assignment	48
3.2.3.15	time_assignment	48
3.2.3.16	date_and_time_assignment	49
3.2.3.17	group_assignment	49
3.2.3.18	effectivity_assignment	49
Section 4 : Support resources		51
4.1	Introduction	51
4.2	document_schema	52
4.2.1	Introduction	52
4.2.2	Fundamental concepts and assumptions	53
4.2.3	document_schema entity definitions	53
4.2.3.1	document_type	53
4.2.3.2	document	53
4.2.3.3	document_with_class	54
4.2.3.4	document_usage_constraint	54
4.2.3.5	document_relationship	55
4.2.4	document_schema function definition: acyclic_document_relationship	56
4.3	action_schema	57



Documents

Document Sharing Hub

4.3.1	Introduction	57
4.3.2	Fundamental concepts and assumptions	58
4.3.3	action_schema type definition:	
	supported_item	58
4.3.4	action_schema entity definitions	58
4.3.4.1	action	58
4.3.4.2	executed_action	59
4.3.4.3	directed_action	59
4.3.4.4	action_status	59
4.3.4.5	action_request_status	59
4.3.4.6	action_relationship	60
4.3.4.7	action_method	60
4.3.4.8	action_request_solution	61
4.3.4.9	action_method_relationship	61
4.3.4.10	versioned_action_request	62
4.3.4.11	action_directive	62
4.3.4.12	action_resource	63
4.3.4.13	action_resource_relationship	63
4.3.4.14	action_resource_type	64
4.3.5	action_schema function definitions	64
4.3.5.1	acyclic_action_relationship	64
4.3.5.2	acyclic_action_resource_relationship	65
4.3.5.3	acyclic_action_method_relationship	67
4.4	certification_schema	68
4.4.1	Introduction	69
4.4.2	Fundamental concepts and assumptions	69
4.4.3	certification_schema entity definitions	69
4.4.3.1	certification_type	69
4.4.3.2	certification	69
4.5	approval_schema	70
4.5.1	Introduction	71
4.5.2	Fundamental concepts and assumptions	71
4.5.3	approval_schema entity definitions	71
4.5.3.1	approval_status	71
4.5.3.2	approval	71
4.5.3.3	approval_date_time	72
4.5.3.4	approval_person_organization	72
4.5.3.5	approval_role	73
4.5.3.6	approval_relationship	73
4.5.4	approval_schema function definition:	
	acyclic_approval_relationship	73
4.6	contract_schema	75
4.6.1	Introduction	75
4.6.2	Fundamental concepts and assumptions	75

ISO 10303-41:1994(E)

4.6.3	contract_schema entity definitions	76
4.6.3.1	contract_type	76
4.6.3.2	contract	76
4.7	security_classification_schema	76
4.7.1	Introduction	77
4.7.2	Fundamental concepts and assumptions	77
4.7.3	security_classification_schema entity definitions	77
4.7.3.1	security_classification_level	77
4.7.3.2	security_classification	78
4.8	person_organization_schema	78
4.8.1	Introduction	79
4.8.2	Fundamental concepts and assumptions	79
4.8.3	person_organization_schema type definition: person_organization_select	79
4.8.4	person_organization_schema entity definitions	80
4.8.4.1	address	80
4.8.4.2	personal_address	81
4.8.4.3	organizational_address	81
4.8.4.4	person	82
4.8.4.5	organization	82
4.8.4.6	organizational_project	83
4.8.4.7	person_and_organization	83
4.8.4.8	organization_relationship	84
4.8.4.9	person_and_organization_role	84
4.8.4.10	person_role	85
4.8.4.11	organization_role	85
4.8.5	person_organization_schema function definition: acyclic_organization_relationship	85
4.9	date_time_schema	87
4.9.1	Introduction	87
4.9.2	Fundamental concepts and assumptions	87
4.9.3	date_time_schema type definitions	87
4.9.3.1	date_time_select	87
4.9.3.2	year_number	88
4.9.3.3	month_in_year_number	88
4.9.3.4	week_in_year_number	88
4.9.3.5	day_in_week_number	89
4.9.3.6	day_in_month_number	89
4.9.3.7	day_in_year_number	90
4.9.3.8	ahead_or_behind	90
4.9.3.9	hour_in_day	90
4.9.3.10	minute_in_hour	91
4.9.3.11	second_in_minute	91
4.9.4	date_time_schema entity definitions	91



4.9.4.1	date	91
4.9.4.2	calendar_date	92
4.9.4.3	ordinal_date	92
4.9.4.4	week_of_year_and_day_date	93
4.9.4.5	coordinated_universal_time_offset	93
4.9.4.6	local_time	94
4.9.4.7	date_and_time	94
4.9.4.8	date_time_role	95
4.9.4.9	date_role	95
4.9.4.10	time_role	95
4.9.5	date_time_schema function definitions	96
4.9.5.1	leap_year	96
4.9.5.2	valid_calendar_date	96
4.9.5.3	valid_time	97
4.10	group_schema	99
4.10.1	Introduction	99
4.10.2	Fundamental concepts and assumptions	99
4.10.3	group_schema entity definitions	100
4.10.3.1	group	100
4.10.3.2	group_relationship	100
4.10.4	group_schema function definition:	
	acyclic_group_relationship	101
4.11	effectivity_schema	102
4.11.1	Introduction	103
4.11.2	Fundamental concepts and assumptions	103
4.11.3	effectivity_schema entity definitions	103
4.11.3.1	effectivity	103
4.11.3.2	serial_numbered_effectivity	104
4.11.3.3	dated_effectivity	104
4.11.3.4	lot_effectivity	105
4.12	external_reference_schema	105
4.12.1	Introduction	106
4.12.2	Fundamental concepts and assumptions	106
4.12.3	external_reference_schema type definitions	106
4.12.3.1	message	106
4.12.3.2	reference	107
4.12.4	external_reference_schema entity definitions	107
4.12.4.1	external_source	107
4.12.4.2	external_source_relationship	107
4.12.4.3	pre_defined_item	108
4.12.4.4	externally_defined_item	108
4.12.5	external_reference_schema function definition:	
	acyclic_external_source_relationship	109
4.12.6	End of schema declaration	110

ISO 10303-41:1994(E)

4.13	support_resource_schema	110
4.13.1	Introduction	111
4.13.2	Fundamental concepts and assumptions	111
4.13.3	support_resource_schema type definitions	111
4.13.3.1	identifier	111
4.13.3.2	label	111
4.13.3.3	text	112
4.13.4	support_resource_schema function definition:	
	bag_to_set	112
4.14	measure_schema	113
4.14.1	Introduction	113
4.14.2	Fundamental concepts and assumptions	114
4.14.3	measure_schema type definitions	114
4.14.3.1	measure_value	114
4.14.3.2	length_measure	115
4.14.3.3	mass_measure	115
4.14.3.4	time_measure	115
4.14.3.5	electric_current_measure	115
4.14.3.6	thermodynamic_temperature_measure	116
4.14.3.7	amount_of_substance_measure	116
4.14.3.8	luminous_intensity_measure	116
4.14.3.9	plane_angle_measure	116
4.14.3.10	solid_angle_measure	116
4.14.3.11	area_measure	117
4.14.3.12	volume_measure	117
4.14.3.13	ratio_measure	117
4.14.3.14	parameter_value	117
4.14.3.15	numeric_measure	118
4.14.3.16	positive_length_measure	118
4.14.3.17	positive_plane_angle_measure	118
4.14.3.18	positive_ratio_measure	118
4.14.3.19	context_dependent_measure	119
4.14.3.20	descriptive_measure	119
4.14.3.21	count_measure	119
4.14.3.22	unit	119
4.14.3.23	si_unit_name	120
4.14.3.24	si_prefix	122
4.14.4	measure_schema entity definitions	123
4.14.4.1	named_unit	123
4.14.4.2	si_unit	123
4.14.4.3	conversion_based_unit	124
4.14.4.4	context_dependent_unit	124
4.14.4.5	length_unit	125
4.14.4.6	mass_unit	125
4.14.4.7	time_unit	126

4.14.4.8	electric_current_unit	126
4.14.4.9	thermodynamic_temperature_unit	127
4.14.4.10	amount_of_substance_unit	127
4.14.4.11	luminous_intensity_unit	128
4.14.4.12	plane_angle_unit	128
4.14.4.13	solid_angle_unit	129
4.14.4.14	area_unit	129
4.14.4.15	volume_unit	130
4.14.4.16	ratio_unit	130
4.14.4.17	dimensional_exponents	131
4.14.4.18	derived_unit_element	132
4.14.4.19	derived_unit	132
4.14.4.20	global_unit_assigned_context	133
4.14.4.21	measure_with_unit	133
4.14.4.22	length_measure_with_unit	134
4.14.4.23	mass_measure_with_unit	134
4.14.4.24	time_measure_with_unit	135
4.14.4.25	electric_current_measure_with_unit	135
4.14.4.26	thermodynamic_temperature_measure_with_unit	135
4.14.4.27	amount_of_substance_measure_with_unit	136
4.14.4.28	luminous_intensity_measure_with_unit	136
4.14.4.29	plane_angle_measure_with_unit	137
4.14.4.30	solid_angle_measure_with_unit	137
4.14.4.31	area_measure_with_unit	137
4.14.4.32	volume_measure_with_unit	138
4.14.4.33	ratio_measure_with_unit	138
4.14.5	measure_schema function definitions	139
4.14.5.1	dimensions_for_si_unit	139
4.14.5.2	derive_dimensional_exponents	140
4.14.5.3	valid_units	141

Annexes

A	Short names of entities	145
B	Information object registration	151
B.1	Document identification	151
B.2	Schema identification	151
B.2.1	application_context_schema identification	151
B.2.2	product_definition_schema identification	151
B.2.3	product_property_definition_schema identification	151
B.2.4	product_property_representation_schema identification	151
B.2.5	management_resources_schema identification	152
B.2.6	document_schema identification	152
B.2.7	action_schema identification	152
B.2.8	certification_schema identification	152
B.2.9	approval_schema identification	152

ISO 10303-41:1994(E)

B.2.10	contract_schema identification	152
B.2.11	security_classification_schema identification	152
B.2.12	person_organization_schema identification	152
B.2.13	date_time_schema identification	153
B.2.14	group_schema identification	153
B.2.15	effectivity_schema identification	153
B.2.16	external_reference_schema identification	153
B.2.17	support_resource_schema identification	153
B.2.18	measure_schema identification	153
C	Computer-interpretable listings	154
D	Technical discussions	155
D.1	Generic product description resource structure	155
D.2	Acyclicity avoidance function template	155
D.2.1	acyclic_object_relationship	155
D.3	Relationship template	157
D.3.1	object_relationship	157
E	Examples	159
E.1	Use of the product_definition_schema	159
E.2	Use of the generic management resource constructs	159
F	EXPRESS-G diagrams	161
G	Bibliography	177

Figures

1	The groupings of resource schemas into generic product description resources, generic management resources, and support resources	xv
D.1	The structure of the generic product description resource	156
F.1	application_context_schema - EXPRESS-G diagram 1 of 1	162
F.2	product_definition_schema - EXPRESS-G diagram 1 of 1	163
F.3	product_property_definition_schema - EXPRESS-G diagram 1 of 1	164
F.4	product_property_representation_schema - EXPRESS-G diagram 1 of 1	165
F.5	management_resources_schema - EXPRESS-G diagram 1 of 1	166
F.6	document_schema - EXPRESS-G diagram 1 of 1	167
F.7	action_schema - EXPRESS-G diagram 1 of 1	168
F.8	certification_schema - EXPRESS-G diagram 1 of 1	168
F.9	approval_schema - EXPRESS-G diagram 1 of 1	169
F.10	contract_schema - EXPRESS-G diagram 1 of 1	169



F.11 security_classification schema - EXPRESS-G diagram 1 of 1	170
F.12 person_organization_schema - EXPRESS-G diagram 1 of 1	170
F.13 date_time_schema - EXPRESS-G diagram 1 of 1	171
F.14 group_schema - EXPRESS-G diagram 1 of 1	172
F.15 effectivity_schema - EXPRESS-G diagram 1 of 1	173
F.16 external_reference_schema - EXPRESS-G diagram 1 of 1	174
F.17 support_resource_schema - EXPRESS-G diagram 1 of 1	175
F.18 measure_schema - EXPRESS-G diagram 1 of 3	175
F.19 measure_schema - EXPRESS-G diagram 2 of 3	176
F.20 measure_schema - EXPRESS-G diagram 3 of 3	176

Tables

A.1 Short names of entities	145
---------------------------------------	-----



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 10303-41 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data and global manufacturing programming 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 specification;
- 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 methods;
- 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 International Standard are:

- generic product description resources;
- generic management resources;
- support resources.

The groupings of resource schemas into these major subdivisions are shown in figure 1.

The generic product description resources provide an overall organization for the integrated resources that are documented in other parts of ISO 10303. They support the description of application-independent facts that are common to all products. In this part the combination of the generic product description resources and the ISO 10303 integrated resources that are defined in the other parts that belong to the integrated resources class is referred to as the "integrated product description resources".

The generic management resources support the description of information that is used to manage and control product data. Together, the integrated product description resources and the generic management resources are the foundations upon which application interpreted models, the normative conceptual schemas of application protocols, are built. Application interpreted models apply selected generic management resources to elements of the integrated product description resources to satisfy the requirements that are specified in the appropriate application reference model.

The support resources are a set of shared resource constructs that are used by the ISO 10303 integrated resources. They provide an underlying consistency across the resources of ISO 10303.

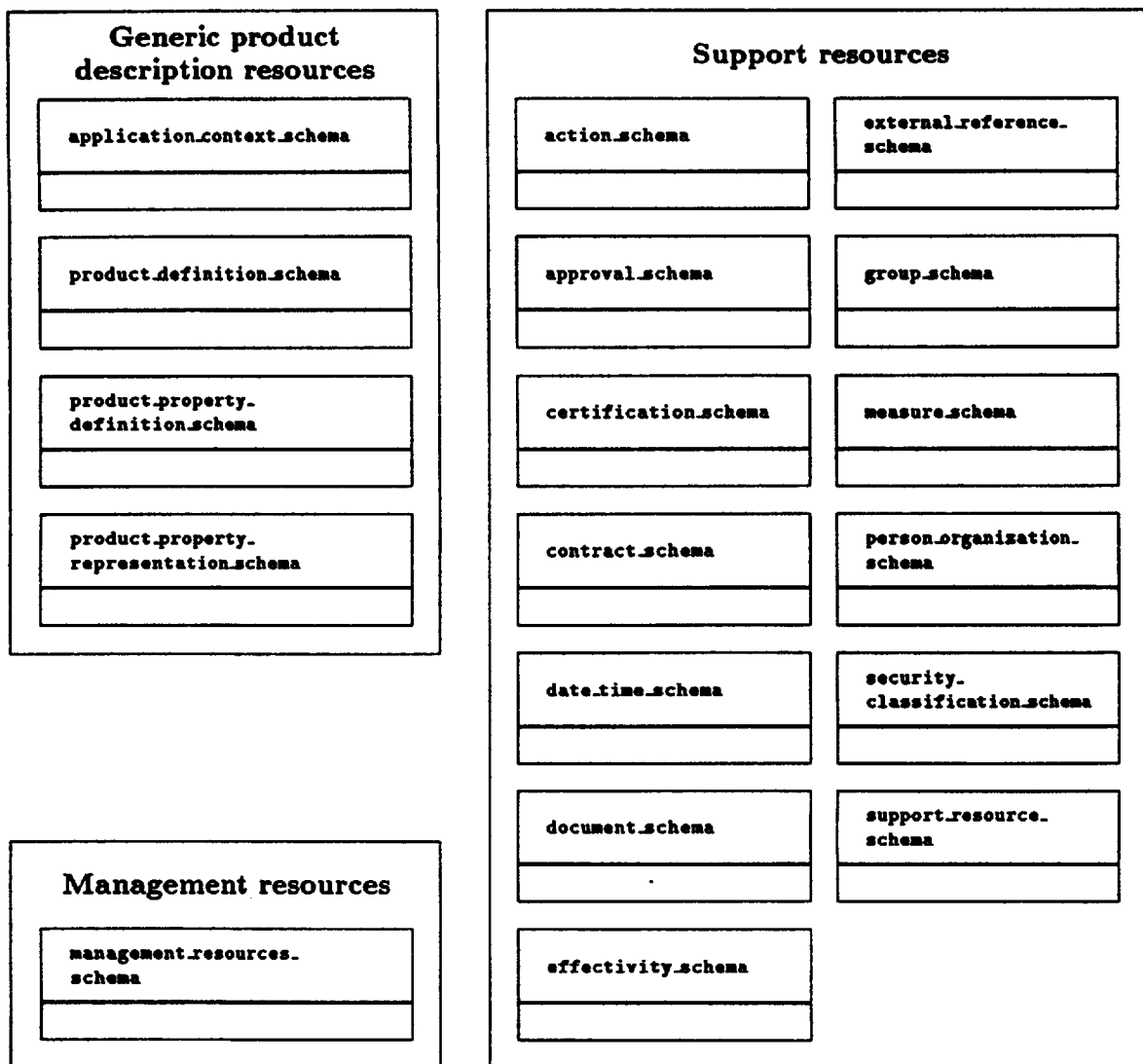


Figure 1 – The groupings of resource schemas into generic product description resources, generic management resources, and support resources

**Industrial automation systems and integration —
Product data representation and exchange —
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Integrated generic resources:
Fundamentals of product description and support**

Section 1 : General

1.1 Scope

This part of ISO 10303 specifies the following:

- generic product description resources (section 2);
- generic management resources (section 3);
- support resources (section 4).

The schemas which are specified in this part of ISO 10303 are organized according to these sections.

1.1.1 Generic product description resources

This section of ISO 10303-41 specifies the resource constructs for the high level structure for the representation of products and their properties. It also specifies ISO 10303 integrated resources for the description of generic aspects of product usage, categorization of products and associations between products.

The following are within scope in this section:

- the identification of a product;
- the categorization of products;
- the specification of definitions of, relationships among, and allowable substitutions for a product;
- the specification of the representation of the shape of a product;
- the specification of the representation of the properties of a product;
- the description of the application context for which product data is defined.

ISO 10303-41:1994(E)

1.1.2 Generic management resources

This section of ISO 10303-41 specifies the resource constructs for the structures that are used to associate administrative data with product data.

The following are within scope in this section:

- the structure for connecting product data within an application context to related administrative data.

1.1.3 Support resources

This section of ISO 10303-41 specifies the resource constructs for administrative data, physical quantities and their units, and basic data types.

The following are within scope in this section:

- the description of references to documents;
- the descriptions of actions, action requests, and the status of actions;
- the descriptions of certification, approvals, security classifications, and effectivities;
- the identification of contracts;
- the identification of people and organizations;
- the specification of dates and times;
- the provision of mechanisms for grouping items and referring to information that is defined outside an exchange;
- the definition of physical quantities and their units.

1.2 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 31-0:1992, *Quantities and units*.

ISO 1000:1981, *SI units and recommendations for the use of their multiples and of certain other units*.

ISO 8601:1988, *Date elements and interchange formats - Information interchange - Representations of dates and times.*

ISO 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: EXPRESS language reference manual.*

ISO 10303-43:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 43: Integrated resources: Representation structures.*

ISO 10303-44:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 44: Integrated resources: Product structure configuration.*

1.3 Definitions and abbreviations

1.3.1 Terms defined in ISO 10303-1

This Part of ISO 10303 makes use of the following terms defined in ISO 10303-1:

- application;
- application context;
- application interpreted model;
- application protocol;
- application reference model;
- interpretation;
- product.

1.3.2 Terms defined in ISO 8601

This part of ISO 10303 makes use of the following terms defined in ISO 8601:

- calendar date;

¹⁾To be published.

ISO 10303-41:1994(E)

- ordinal date;
- second;
- minute;
- hour;
- day;
- week;
- calendar week;
- month;
- year;
- calendar year;
- common year;
- leap year;
- local time;
- Coordinated Universal Time;
- Gregorian Calendar.

1.3.3 Abbreviations defined in ISO 1000

This part of ISO 10303 makes use of the following abbreviation defined in ISO 1000:

- SI International System of Units.

Section 2 : Generic product description resources

2.1 Introduction

This section specifies the ISO 10303 integrated resources used for the high-level description of a product. The following schemas are included:

- **application_context_schema;**
- **product_definition_schema;**
- **product_property_definition_schema;**
- **product_property_representation_schema.**

The **application_context_schema** supports the description of the applicable usage of product data.

The **product_definition_schema** supports the description of the identification of products, the categorization of products, and the relationships among the definitions of products.

The **product_property_definition_schema** supports the description of the characteristics of a product.

The **product_property_representation_schema** describes the structure for representing the shape characteristics of a product.

NOTE 1 – This part is not limited to the domain of a specific application context. The reader should not be misled by the deliberately limited scope of the examples.

NOTE 2 – The way in which the support resources are associated with the generic product description resources is described in annex E.

2.2 application_context_schema

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

EXPRESS specification:

*)

SCHEMA application_context_schema;

REFERENCE FROM support_resource_schema

(label,
text);

ISO 10303-41:1994(E)

REFERENCE FROM `date_time_schema`
(`year_number`);
(*

NOTES

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

support_resource_schema	clause 4.13 of this part of ISO 10303
date_time_schema	clause 4.9 of this part of ISO 10303
- 2 – See annex F, figure F.1, for a graphical presentation of this schema.
- 3 – This schema is one of the generic product description resource schemas. The relationships between the generic product description resource schemas are given in annex D.

2.2.1 Introduction

This clause defines requirements for the **application_context_schema**. This schema defines a mechanism for application protocols to define a frame of reference or context that applies to particular sets of product data. An overall application context has several context elements. Each context element may be referenced by a different aspect of product data.

A means is provided for users of product data to identify the application interpreted model in terms of which that product data is defined.

2.2.2 Fundamental concepts and assumptions

The meaningful exchange of product data requires the identification of the application context in which that product data is defined. One element of an application context is the application interpreted model which is used. Each application interpreted model belongs to one, and only one, application protocol. Since all application interpreted models in ISO 10303 have unique names, identification of an application interpreted model schema name also uniquely identifies an application protocol. Applications which use product data require information that identifies the application interpreted model that defines the content and logical structure of the product data.

2.2.3 application_context_schema entity definitions

2.2.3.1 application_context

An **application_context** is a context in which product data is defined. An **application_context** represents various types of information which relate to product data and may affect the meaning and usage of that data.

EXPRESS specification:

*)
ENTITY `application_context`;

```

    application      : text;
INVERSE
    context_elements : SET [1:?] OF application_context_element
                        FOR frame_of_reference;
END_ENTITY;
(*)

```

Attribute definitions:

application: a description of the usage of the product data.

context_elements: there shall be at least one **application_context_element** associated with the **application_context**.

2.2.3.2 application_protocol_definition

An **application_protocol_definition** is a definition of an application protocol.

EXPRESS specification:

```

(*)
ENTITY application_protocol_definition;
    status                    : label;
    application_interpreted_model_schema_name : label;
    application_protocol_year  : year_number;
    application                : application_context;
END_ENTITY;
(*)

```

Attribute definitions:

status: a classification of an application protocol with regard to its acceptance by some approving body.

NOTES

1 – Legal values for this attribute are specified in application interpreted models which use this entity.

2 – The fundamental assumption (see clause 2.2.2) that an application interpreted model schema name uniquely identifies an application protocol is only valid for ISO 10303 application protocols.

application_interpreted_model_schema_name: the EXPRESS schema name of the the application interpreted model.

application_protocol_year: the year when the application protocol attained the status given by the **status** attribute.

application: the application context of the application protocol.

2.2.3.3 application_context_element

An **application_context_element** is an aspect of the application context in which product data is defined. **Application_context_elements** may represent several different aspects of an application context. An application protocol may specify the context of data using the subtypes of the **application_context_element** entity:

- **product_context**;
- **product_definition_context**;
- **product_concept_context**;
- **library_context**.

NOTE - In using this entity, it is the responsibility of an application protocol to properly constrain the values of these attributes based on their applicable usage.

EXAMPLE 1 - A **product_definition_context** could have "design" as its **product_life_cycle_stage** and "detailed design" as its **application_context_element.name**.

EXPRESS specification:

```
*)
ENTITY application_context_element
  SUPERTYPE OF (ONEOF (product_context,
                        product_definition_context,
                        product_concept_context,
                        library_context));
  name : label;
  frame_of_reference : application_context;
END_ENTITY;
(*
```

Attribute definitions:

name: an identification of the detailed context in which product data exists.

EXAMPLE 2 - "Detailed design" and "preliminary design" are examples of **application_context_element.names**.

frame_of_reference: the overall context of which this **application_context_element** is a part.

2.2.3.4 product_context

A **product_context** is that aspect of an **application_context** which defines a context for a product.

NOTE 1 - The **product** entity is defined in clause 2.3.4.1 in this part of ISO 10303.



A **product_context** represents information about the engineering or manufacturing perspective for product data that may affect its meaning and usage.

EXPRESS specification:

```
*)
ENTITY product_context
  SUBTYPE OF (application_context_element);
  discipline_type : label;
END_ENTITY;
(*
```

Attribute definitions:

discipline_type: an identification of the engineering or manufacturing category to which the product belongs.

EXAMPLE 3 – “Electrical”, “mechanical”, and “architectural” are examples of **discipline_types**.

NOTE 2 – Legal values for this attribute are specified in application interpreted models which use this entity.

2.2.3.5 product_definition_context

A **product_definition_context** is that aspect of an **application_context** which defines a context for a **product_definition**.

NOTE 1 – The **product_definition** entity is defined in clause 2.3.4.8 of this part of ISO 10303.

This context represents information about the stage in the product life cycle to which the product data belongs. Such information may affect the meaning and usage of the product data.

EXPRESS specification:

```
*)
ENTITY product_definition_context
  SUBTYPE OF (application_context_element);
  life_cycle_stage : label;
END_ENTITY;
(*
```

Attribute definitions:

life_cycle_stage: an identification of the general stage in the product life cycle to which the product data belongs.

NOTE 2 – Legal values for this attribute are specified in application interpreted models which use this entity.

EXAMPLE 4 – Terms such as “as designed” and “as specified” are examples of **life_cycle_stages**.

2.2.3.6 product_concept_context

A **product_concept_context** is that aspect of an **application_context** which defines a context for a **product_concept**.

ISO 10303-41:1994(E)

NOTE – The **product_concept** entity is defined in ISO 10303-44.

A **product_concept_context** represents information that relates to the characterization of potential purchasers of a product. Such information may affect the meaning and usage of the product data.

EXPRESS specification:

```
*)  
ENTITY product_concept_context  
  SUBTYPE OF (application_context_element);  
  market_segment_type : label;  
END_ENTITY;  
(*
```

market_segment_type: an identification of the category that characterizes potential purchasers of a product.

EXAMPLE 5 – “Luxury automobiles”, “laptop personal computers”, and “budget personal stereos” are all examples of **market_segment_types**.

2.2.3.7 library_context

A **library_context** is that aspect of an **application_context** which defines a context for elements of a library. A **library_context** represents information that may affect the meaning and usage of the product data in the library.

EXPRESS specification:

```
*)  
ENTITY library_context  
  SUBTYPE OF (application_context_element);  
  library_reference : label;  
END_ENTITY;  
(*
```

Attribute definitions:

library_reference: an identification of the library which provides a context for the elements of the library.

EXAMPLE 6 – “Smith’s Pens (UK) Standard Pen Tops” is an example of a **library_reference**.

EXPRESS specification:

```
*)  
END_SCHEMA; -- application_context_schema  
(*
```

2.3 product_definition_schema

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

EXPRESS specification:

```

*)
SCHEMA product_definition_schema;

REFERENCE FROM application_context_schema
  (product_context,
   product_definition_context);

REFERENCE FROM document_schema
  (document);

REFERENCE FROM effectivity_schema
  (effectivity);

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

```

NOTES

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

application_context_schema	clause 2.2 of this part of ISO 10303
document_schema	clause 4.2 of this part of ISO 10303
effectivity_schema	clause 4.11 of this part of ISO 10303
support_resource_schema	clause 4.13 of this part of ISO 10303

2 - See annex F, figure F.2, for a graphical presentation of this schema.

3 - This schema is one of the generic product description resource schemas. The relationships between the generic product description resource schemas are given in annex D.

2.3.1 Introduction

This clause defines requirements for the **product_definition_schema**. This schema provides for the generic aspects of product definition.

EXAMPLE 7 - The identification of products and definitions of products, the grouping of products according to classification schemes and the definition of various kinds of relationship between products are all examples of generic aspects of product definition.

The generic aspects of product definition are realized by means of a set of resource constructs that may be used to specify generic product definition facts.

EXAMPLE 8 – The fact that a product definition is related to other product definitions is an example of generic product definition fact. It is not specific to a particular application context.

Product definition facts are independent of properties. The ways in which these facts may be combined are prescribed by the relationships that are defined in this schema. Each generic fact can be interpreted in any application context; the ways in which generic facts are to be interpreted are stipulated in application protocols.

NOTE – An example of the way in which this schema may be used is given in annex E.

2.3.2 Fundamental concepts and assumptions

A single product may have multiple groups of definitions associated with it; each group is valid in a given application context.

EXAMPLE 9 – An application context may be the manufacture of ball-point pens. A particular ball-point pen has multiple versions. Each version is described through a group of product definitions. An older version has a solid cap whereas a more recent version has a hole in the cap to prevent people from choking if they swallow it. The characteristics of the two versions would be different from each other because the later version would have a hole in the cap whereas the earlier version would not. This schema could be used to define the ball-point pen with a solid cap as one product and the one with a hole in the cap as another. On the other hand it could also be used to define both pens as two versions of a single product. The approach taken would depend upon the requirements of the application context.

The definition of a product includes the properties that are required to characterize it.

EXAMPLE 10 – An integrated circuit product will have a functional definition represented by a circuit schematic diagram and a physical definition represented by a circuit layout diagram.

Definitions of products may be related to each other in various ways. It is necessary to be able to identify the relationships between products and to be able to characterize those relationships.

EXAMPLE 11 – The ball-point pen cap would be related in an assembly relationship to the ball-point pen itself and one of the caps could be substituted for the other in some circumstances.

2.3.3 product_definition_schema type definition: source

The **source** type represents whether a **product_definition_formation** is to be manufactured within an organization or bought-in. Possible values are constrained to represent these two possibilities, or the fact that this information is not known.

EXPRESS specification:

```
*)
TYPE source = ENUMERATION OF
  (made,
   bought,
   not_known);
END_TYPE;
(*)
```

2.3.4 product_definition_schema entity definitions

2.3.4.1 product

A **product** is the identification and description, in an application context, of a physically realizable object that is produced by a process.

NOTES

1 – A physically realizable object may, but need not, be physically realized.

2 – The term “product” is defined in ISO 10303-1.

EXAMPLE 12 – Production, construction, manufacture, and fabrication are all examples of processes.

EXAMPLE 13 – The ball-point pen, its cap, and the assembly of the cap and the ball-point pen are all objects that may be produced by a manufacturing process.

EXAMPLE 14 – The end-product that an organization produces and intends to sell, the raw material from which such products are manufactured, and the tooling and other facilities that are used to transform the raw material into the end-product may all be examples of physically realizable objects.

EXPRESS specification:

```
*)
ENTITY product;
    id                : identifier;
    name              : label;
    description       : text;
    frame_of_reference : SET [1:?] OF product_context;
UNIQUE
    UR1: id;
END_ENTITY;
(*)
```

Attribute definitions:

id: the identification of the **product**.

EXAMPLE 15 – Part numbers, stock item numbers and serial numbers are examples of **product** identifiers.

name: the word or group of words by which the **product** is referred to.

EXAMPLE 16 – “Ball-point pen”, “cap”, and “nib” are examples of **product** names.

description: text that relates the nature of the **product**.

frame_of_reference: the contexts within which the **product** was defined.

Formal propositions:

UR1: every **product**’s identification shall be unique.

2.3.4.2 product_category

A **product_category** identifies a category to which **products** and other **product_category**s may belong.

EXAMPLE 17 – In an application protocol whose context includes manufactured parts, “mechanical part”, “electrical part”, “structural part”, “piping part”, “water pipe”, and “hot water pipe” are all examples of **product_category**s.

EXPRESS specification:

```
*)  
ENTITY product_category;  
    name      : label;  
    description : OPTIONAL text;  
END_ENTITY;  
(*
```

Attribute definitions:

name: the word or group of words by which the **product_category** is referred to.

description: text that relates the nature of the **product_category**.

Informal propositions:

IP1: when a **product_category** participates in a **product_category_relationship**, the value of the **name** attribute shall be unique within its parent **product_category**s.

2.3.4.3 product_related_product_category

A **product_related_product_category** is a **product_category** that contains **products**.

EXPRESS specification:

```
*)  
ENTITY product_related_product_category  
    SUBTYPE OF (product_category);  
    products : SET [1:?] OF product;  
END_ENTITY;  
(*
```

Attribute definitions:

products: the **products** that belong to the **product_related_product_category**.

2.3.4.4 product_category_relationship

A **product_category_relationship** is an association between two categories. A **product_category** may be identified as a sub-category in its relationship with other **product_category**s.

EXAMPLE 18 – The **product_category** called “piping part” could be used to relate two other **product_category**s, “cold water pipe” and “hot water pipe”, to each other.

Networks of **product_category**s may be defined using this entity.

EXAMPLE 19 – A **product_category** called “piping part” may be the parent category of sub-categories called “cold water pipe” and “hot water pipe”. The **product_category** called “hot water pipe” may be a sub-category of another **product_category** called “boiler output pipe”. This is an example of a **product_category** network because the **product_category** called “hot water pipe” has two parents.

If a **product** is within a **product_category**, it is also within all of the parent **product_category**s of that **product_category**.

NOTE – This entity, in conjunction with the **product_category** entity, is based on the relationship template that is described in annex D.

EXPRESS specification:

```
*)
ENTITY product_category_relationship;
    name          : label;
    description    : text;
    category       : product_category;
    sub_category   : product_category;
WHERE
    WR1: acyclic_product_category_relationship (SELF, [SELF.sub_category]);
END_ENTITY;
(*)
```

Attribute definitions:

name: the word or group of words by which the **product_category_relationship** is referred to.

description: text that relates the nature of the **product_category_relationship**.

category: the parent of the **sub_category**.

EXAMPLE 20 – In the previous example, “piping part” would be the **category** for “cold water pipe” and “hot water pipe”.

sub_category: a child of the **category**.

EXAMPLE 21 – In the previous example “cold water pipe” would be the **sub_category** for “piping part” in one case and “hot water pipe” would be the **sub_category** in the other.

Within a single category and sub-category relationship hierarchy, a given **product** shall only be referenced once.

Formal propositions:

WR1: a network of **product_category**s shall not be cyclic.

Informal propositions:

IP1: a given **product** may only be referenced once within a given **product_category_relationship** structure.

2.3.4.5 product_definition_formation

A **product_definition_formation** is an identified group of **product_definitions** for a **product**. Each of the **product_definitions** in the group has a distinct **frame_of_reference** (and therefore **life_cycle_stage**) or includes some variation in its properties.

NOTE – The purpose of the **product_definition_formation** is defined in application interpreted models that use this entity.

EXAMPLE 22 – An application interpreted model could use this entity to support the identification of different versions of a single **product**. Each version would be described by a unique group of **product_definitions** and each group, identified by a **product_definition_formation**, would be associated with the same **product**.

EXPRESS specification:

```
*)  
ENTITY product_definition_formation;  
  id      : identifier;  
  description : text;  
  of_product : product;  
UNIQUE  
  UR1: id, of_product;  
END_ENTITY;  
(*
```

Attribute definitions:

id: the unique identification of the **product_definition_formation** in the context of the **product** to which it relates.

EXAMPLE 23 – Part version number is an example of a **product_definition_formation** identifier.

description: text that relates the nature of the **product_definition_formation**.

NOTE 1 – The descriptions of different formations of a single **product** could identify differences in the purpose and function of each formation.

of_product: the **product** of which the **product_definition_formation** is a version.

NOTE 2 – A **product** is associated with one or more **product_definition_formation**s through the implicit inverse of this relationship.

Formal propositions:

UR1: the **id** of each **product_definition_formation** that is related to a single **product** (through their **of_product** attributes) shall be unique within the collection of **product_definition_formation**s which are related to that **product**.

2.3.4.6 product_definition_formation_relationship

A **product_definition_formation_relationship** is an association between two **product_definition_formation**s. An association may exist between **product_definition_formation**s

that relate to different **products** or between different formations of the same **product**. The meaning of the relationship for a particular context is defined in specializations of this entity.

NOTES

1 – Relationships captured using this entity may be parent child relationships. Specializations of this entity state this fact if it is true for the particular specialization.

2 – This entity, in conjunction with the **product_definition_formation** entity, is based on the relationship template that is described in annex D.

EXPRESS specification:

```
*)
ENTITY product_definition_formation_relationship;
  id                      : identifier;
  name                    : label;
  description              : text;
  relating_product_definition_formation : product_definition_formation;
  related_product_definition_formation : product_definition_formation;
END_ENTITY;
(*
```

Attribute definitions:

id: the identification of the **product_definition_formation_relationship**.

name: the word or group of words by which the **product_definition_formation_relationship** is referred to.

description: text that relates the nature of the **product_definition_formation_relationship**.

relating_product_definition_formation: one of the **product_definition_formation**s which is a part of the relationship.

NOTE 3 – The role of this attribute is defined in the application protocol or the ISO 10303 integrated resource that uses or specializes this entity.

related_product_definition_formation: the other **product_definition_formation** which is a part of the relationship. If one element of the relationship is dependent upon the other then this attribute shall be the dependent one.

NOTE 4 – The role of this attribute is defined in the application protocol or the ISO 10303 integrated resource that uses or specializes this entity.

2.3.4.7 **product_definition_formation_with_specified_source**

A **product_definition_formation_with_specified_source** is a **product_definition_formation** with a specified source.

EXPRESS specification:

```
*)
ENTITY product_definition_formation_with_specified_source
```

ISO 10303-41:1994(E)

```
SUBTYPE OF (product_definition_formation);  
make_or_buy : source;  
END_ENTITY;  
(*
```

Attribute definitions:

make_or_buy: the source of the **product_definition_formation**.

2.3.4.8 product_definition

A **product_definition** is the identification of a characterization of a product in a particular application context.

NOTE – A **product_definition** is characterized by properties which refer to it.

EXAMPLE 24 – A product's physical design may be one **product_definition** while the functional design of the same product may be a different **product_definition**. Both **product_definitions** would be related to the same **product_definition_formation** but could be used in different application contexts.

EXPRESS specification:

```
*)  
ENTITY product_definition;  
  id : identifier;  
  description : text;  
  formation : product_definition_formation;  
  frame_of_reference : product_definition_context;  
END_ENTITY;  
(*
```

Attribute definitions:

id: the identification of the **product_definition**.

description: text that relates the nature of the **product_definition**.

formation: the **product_definition_formation** to which the **product_definition** relates.

frame_of_reference: the **product_definition_context** in which the **product_definition** or **product_definition** data is used.

2.3.4.9 product_definition_with_associated_documents

A **product_definition_with_associated_documents** is a **product_definition** which is related to one or more documents.

EXPRESS specification:

```
*)  
ENTITY product_definition_with_associated_documents  
  SUBTYPE OF (product_definition);
```

```

documentation_ids : SET[1:?] OF document;
END_ENTITY;
(*)

```

Attribute definitions:

documentation_ids: the set of documents that are associated with the **product_definition**.

2.3.4.10 product_definition_relationship

A **product_definition_relationship** is an association between two **product_definitions**. An association may exist between **product_definitions** that relate to different products or between different definitions of the same product.

EXAMPLE 25 – The relationships within a bill-of-materials structure are examples of **product_definition_relationships** that associate different products. The relationship between a sketch and a detailed design is an example of a **product_definition_relationship** that associates different definitions of a single product.

A single **product_definition** may be used more than once within the description of a product.

NOTE 1 – The same component could be used more than once in the same assembly. Each usage of the component would be specified as an instance of the **product_definition_relationship** entity.

The meaning of the relationship for a particular context is defined in specializations of this entity.

NOTES

2 – Relationships captured using this entity may be parent-child relationships. Specializations of this entity state this fact if it is true for the particular specialization.

3 – This entity, in conjunction with the **product_definition** entity, is based on the relationship template that is described in annex D.

EXPRESS specification:

```

*)
ENTITY product_definition_relationship;
    id                : identifier;
    name              : label;
    description       : text;
    relating_product_definition : product_definition;
    related_product_definition  : product_definition;
END_ENTITY;
(*)

```

Attribute definitions:

id: the identification of the **product_definition_relationship**.

name: the word or group of words by which the **product_definition_relationship** is referred to.

description: text that relates the nature of the **product_definition_relationship**.



5*



Documents

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relating_product_definition: one of the **product_definitions** which is a part of the relationship.

NOTE 4 – The role of this attribute is defined in the application protocol or the ISO 10303 integrated resource that uses or specializes this entity.

EXAMPLE 26 – If the **product_definition_relationship** is an assembly component relationship, the **relating_product_definition** may be the assembly.

related_product_definition: the other **product_definition** which is a part of the relationship. If one element of the relationship is dependent upon the other, this attribute shall be the dependent one.

NOTE 5 – The role of this attribute is defined in the application protocol or the ISO 10303 integrated resource that uses or specializes this entity.

EXAMPLE 27 – In an assembly, the **related_product_definition** may be the **product_definition** that is an element of the assembly.

2.3.4.11 product_definition_substitute

A **product_definition_substitute** is an association between three **product_definitions** where one **product_definition** acts as a substitute for another **product_definition** in the context of a third **product_definition**.

NOTE – If a **product_definition_relationship** exists between a component part and its assembly, a **product_definition_substitute** could be used to capture an allowable substitute, that is, a different component part that may be used as a replacement in the same assembly.

EXAMPLE 28 – Two kinds of ball-point pen may be manufactured: a standard model and a deluxe model. Each model of the pen would be specified as a separate **product_definition** related to a particular kind of nib: a standard nib and a deluxe nib, respectively. The fact that the deluxe nib and the standard nib are interchangeable only in the context of the standard model of ball-point pen can be established with this construct.

EXPRESS specification:

```
*)
ENTITY product_definition_substitute;
    description          : text;
    context_relationship : product_definition_relationship;
    substitute_definition : product_definition;
WHERE
    WR1: context_relationship.related_product_definition :<>: substitute_definition;
END_ENTITY;
(*
```

Attribute definitions:

description: text that relates the nature of the **product_definition_substitute**.

context_relationship: the relationship whose **related_definition** may be replaced by the **substitute_definition**. The **relating_product_definition** attribute of this attribute specifies the context within which the replacement is made.

EXAMPLE 29 – The relating `product_definition` of a `product_definition_relationship` identified as a `context_relationship` would be the standard model of the ball-point pen and the related `product_definition` would be the standard nib.

substitute_definition: the `product_definition` which may act as a replacement for the related `product_definition` of the `context_relationship`.

EXAMPLE 30 – This attribute would be the deluxe nib in the previous examples.

Formal propositions:

WR1: a `product_definition` shall not be defined as a substitute for itself.

2.3.4.12 `product_definition_effectivity`

A `product_definition_effectivity` is an `effectivity` that may be applied for a particular `product_definition` participating in a given `product_definition_relationship`.

EXAMPLE 31 – The fact that a particular `product_definition`'s shape was effective for a certain period of time within the context of an assembly could be defined using this entity. The `product_definition_effectivity` and `dated_effectivity` entities would be associated with the `product_definition_shape` entity during interpretation. The usage attribute of the `product_definition_effectivity` entity would represent the assembly.

EXPRESS specification:

```
*)
ENTITY product_definition_effectivity
  SUBTYPE OF (effectivity);
  usage : product_definition_relationship;
  UNIQUE
    UR1: usage, SELF\effectivity.id;
END_ENTITY;
(*)
```

Attribute definitions:

usage: the `product_definition_relationship` that initiates the `effectivity`.

Formal propositions:

UR1: the identification of the `effectivity` shall be unique.

2.3.5 `product_definition_schema` function definitions

2.3.5.1 `acyclic_product_definition_formation_relationship`

The `acyclic_product_definition_formation_relationship` function determines whether or not the given `product_definition_formation`s have been self-defined. The associations made

ISO 10303-41:1994(E)

in the specified **product_definition_formation_relationship**. This function may be used to evaluate either a **product_definition_formation_relationship** or any of its subtypes.

NOTE 1 – A specified type of the **product_definition_formation_relationship** entity is either a **product_definition_formation_relationship** or one of its subtypes.

The function returns a value of TRUE if none of the elements of the **relatives** argument occur in the **relation** argument of the type which is given in the **specific_relation** argument. Otherwise it returns a value of FALSE.

NOTE 2 – This function is not used in this schema. It is defined here because other ISO 10303 integrated resources and application protocols that use the **product_definition_formation_relationship** entity include rules that use this function.

EXPRESS specification:

```
*)
FUNCTION acyclic_product_definition_formation_relationship
(relation      : product_definition_formation_relationship;
 relatives     : SET OF product_definition_formation;
 specific_relation : STRING) : LOGICAL;

LOCAL
  x      : SET OF product_definition_formation_relationship;
  i      : INTEGER;
  local_relatives : SET OF product_definition_formation;
END_LOCAL;

REPEAT i := 1 TO HIINDEX(relatives);
  IF relation.relying_product_definition_formation == relatives[i] THEN
    RETURN(FALSE);
  END_IF;
END_REPEAT;
x := bag_to_set(USEDIN (relation.relying_product_definition_formation, specific_relation));
local_relatives := relatives + relation.relying_product_definition_formation;
IF SIZEOF(x) > 0 THEN
  REPEAT i := 1 TO HIINDEX(x);
    IF NOT acyclic_product_definition_formation_relationship
      (x[i], local_relatives, specific_relation) THEN
      RETURN(FALSE);
    END_IF;
  END_REPEAT;
END_IF;
RETURN(TRUE);
END_FUNCTION;
(*)
```

Argument definitions:

relation: (input) the candidate **product_definition_formation_relationship** to be checked.

relatives: (input) the set of **product_definition_formation**s which the function is searching for in the **relating_product_definition_formation** parameter of the **relation** argument.

specific_relation: (input) the fully qualified name of a subtype of the **product_definition_formation_relationship** entity.

2.3.5.2 acyclic_product_definition_relationship

The **acyclic_product_definition_relationship** function determines whether or not the given **product_definitions** have been self-defined by the associations made in the specified **product_definition_relationship**. This function may be used to evaluate either a **product_definition_relationship** or any of its subtypes.

NOTE 1 – A specified type of the **product_definition_relationship** entity is either a **product_definition_relationship** or one of its subtypes.

The function returns a value of TRUE if none of the elements of the **relatives** argument occur in the **relation** argument of the type which is given in the **specific_relation** argument. Otherwise it returns a value of FALSE.

NOTE 2 – This function is not used in this schema. It is defined here because other ISO 10303 integrated resources and application protocols that use the **product_definition_relationship** entity include rules that use this function.

EXPRESS specification:

*)

FUNCTION **acyclic_product_definition_relationship**

(**relation** : **product_definition_relationship**;
relatives : SET OF **product_definition**;
specific_relation : **STRING**) : **LOGICAL**;

LOCAL

x : SET OF **product_definition_relationship**;
i : **INTEGER**;
local_relatives : SET OF **product_definition**;
END_LOCAL;

REPEAT **i** := 1 **TO** **HIINDEX**(**relatives**);

IF **relation.relying_product_definition** := **relatives**[**i**] **THEN**
RETURN(**FALSE**);

END_IF;

END_REPEAT;

x := **bag_to_set**(**USEDIN** (**relation.relying_product_definition**, **specific_relation**));
local_relatives := **relatives** + **relation.relying_product_definition**;

IF **SIZEOF**(**x**) > 0 **THEN**

REPEAT **i** := 1 **TO** **HIINDEX**(**x**);

IF NOT **acyclic_product_definition_relationship**
(**x**[**i**], **local_relatives**, **specific_relation**) **THEN**
RETURN(**FALSE**);

END_IF;

```
END_REPEAT;  
END_IF;  
RETURN(TRUE);  
END_FUNCTION;  
(*
```

Argument definitions:

relation: (input) the candidate **product_definition_relationship** to be checked.

relatives: (input) the set of **product_definitions** which the function is searching for in the **relating-product_definition** parameter of the **relation** argument.

specific_relation: (input) the fully qualified name of a subtype of the **product_definition_relationship** entity.

2.3.5.3 acyclic_product_category_relationship

The **acyclic_product_category_relationship** function determines whether or not the given **product_category**s have been self-defined by the associations made in the specified **product_category_relationship**.

The function returns a value of TRUE if none of the elements of the **children** argument occur in the **relation** argument. Otherwise it returns a value of FALSE.

NOTE - This function is based on the cyclicity avoidance template that is described in annex D. It performs its task by ensuring that the **children** argument is not the **category** field of either the **relation** argument or, recursively, any other **product_category_relationship** entities in which the **relation** plays the role of **category**.

EXPRESS specification:

*)

```
FUNCTION acyclic_product_category_relationship  
  (relation : product_category_relationship;  
   children : SET of product_category): LOGICAL;
```

```
LOCAL
```

```
  x          : SET OF product_category_relationship;  
  i          : INTEGER;  
  local_children : SET OF product_category;  
END_LOCAL;
```

```
REPEAT i := 1 to HIINDEX(children);  
  If relation.category :=: children [i] THEN  
    RETURN(FALSE);  
  END_IF;  
END_REPEAT;  
x := bag_to_set(USEDIN (relation.category,
```

```

        'PRODUCT_DEFINITION_SCHEMA.' +
        'PRODUCT_CATEGORY_RELATIONSHIP.SUB_CATEGORY'));
local_children := children + relation.category;
IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 to HIINDEX(x);
        IF NOT acyclic_product_category_relationship(x[i], local_children) THEN
            RETURN(FALSE);
        END_IF;
    END_REPEAT;
END_IF;
RETURN(TRUE);
END_FUNCTION;
(*)

```

Argument definitions:

relation: (input) the candidate **product_category_relationship** to be checked.

children: (input) the set of **product_category** which the function is searching for in the **category** field of the relation argument.

EXPRESS specification:

```

*)
END_SCHEMA; -- product_definition_schema
(*)

```

2.4 product_property_definition_schema

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

EXPRESS specification:

```

*)
SCHEMA product_property_definition_schema;

REFERENCE FROM product_definition_schema
    (product_definition,
     product_definition_relationship);

REFERENCE FROM support_resource_schema
    (bag_to_set,
     label,
     text);
(*)

```

NOTES

1 – The schemas referenced above can be found in the following parts of ISO 10303:

product_definition_schema clause 2.3 of this part of ISO 10303
support_resource_schema clause 4.13 of this part of ISO 10303

2 – See annex F, figure F.3, for a graphical presentation of this schema.

3 – This schema is one of the generic product description resource schemas. The relationships between the generic product description resource schemas are given in annex D.

2.4.1 Introduction

This clause defines requirements for the **product_property_definition_schema**. This schema brings together groups of characteristics. These characteristics may be associated with a single **product_definition** or with one **product_definition** in the context of another. Each characteristic is independent of the number or types of representations of that characteristic. These characteristics may also be associated with the shape of a product, an element of the shape of a product, or sometimes the relationship between elements of the shape of a product.

2.4.2 Fundamental concepts and assumptions

Products are characterized by their properties. This schema allow these properties to be captured and to be associated to the identification of a **product_definition**, **product_definition-relationship** or a **shape_definition**. The properties are identifiable concepts which are independent of how, or even if, they are represented.

EXAMPLE 32 – The definition of the surface finish of a shape is independent of the way in which the shape or the surface finish are represented.

NOTE – In the previous example, both the defined surface finish and the shape could have multiple representations.

It is appropriate to specify entities which carry the idea of properties as concepts that are independent of their representation.

2.4.3 **product_property_definition_schema** type definitions

2.4.3.1 **characterized_definition**

The **characterized_definition** type is the means by which the various properties that pertain to a **characterized_object**, **product_definition** or **shape_definition** are aggregated. This type is used to allow properties to be associated with such entities.

EXPRESS specification:

*)

```
TYPE characterized_definition = SELECT  
  (characterized_object,
```

```

        characterized_product_definition,
        shape_definition);
END_TYPE;
(*)

```

2.4.3.2 characterized_product_definition

The **characterized_product_definition** type is the means by which the various properties that pertain to a specific **product_definition** are aggregated. This type is used to allow properties to be associated with such entities.

There is a special meaning in the selection of a **product_definition_relationship**; a property which is related to a **product_definition_relationship** is applied to the **related_product_definition** attribute in the context of its **relating_product_definition** attribute.

NOTE 1 – This allows product properties which change when the product is a part of the relationship to be represented.

EXAMPLE 33 – The shape of a gasket depends upon whether or not it is a part of an assembly and, if it is an element of an assembly, it depends upon the assembly that it participates in.

NOTE 2 – A **characterized_product_definition** refers to a **product_definition** either directly or in the context of another **product_definition** through a **product_definition_relationship**.

EXPRESS specification:

```

*)
TYPE characterized_product_definition = SELECT
    (product_definition,
     product_definition_relationship);
END_TYPE;
(*)

```

2.4.3.3 shape_definition

The **shape_definition** type provides a mechanism by which either the entire shape of a **product**, a limited portion of the shape of a **product**, or an association between portions of the shapes of **products** can be referenced.

NOTE – Unlike the **characterized_product_definition** type, references to a **shape_aspect_relationship** are references to the association itself and not one of the associated **shape_aspects**.

EXPRESS specification:

```
*)  
TYPE shape_definition = SELECT  
  (product_definition_shape,  
   shape_aspect,  
   shape_aspect_relationship);  
END_TYPE;  
(*
```

2.4.4 product_property_definition_schema entity definitions

2.4.4.1 characterized_object

A **characterized_object** is the identification of an item that has associated property information.

NOTES

1 - A **characterized_object** is characterized by properties which refer to it.

2 - The properties of a **characterized_object** may be used as an environmental condition under which the properties of a product are measured.

EXAMPLE 34 - If a product has a set of properties that are measured within a room or an atmosphere, the properties of the room or atmosphere, such as temperature, are specified with the attribute that references this entity. The name and description of the room or the atmosphere are captured through the **characterized_object** entity.

EXPRESS specification:

```
*)  
ENTITY characterized_object;  
  name      : label;  
  description : text;  
END_ENTITY;  
(*
```

Attribute definitions:

name: the word or group of words by which the **characterized_object** is referred to.

description: text that relates the nature of the **characterized_object**.

2.4.4.2 property_definition

A **property_definition** is a property that characterizes a product. It applies to either a product, a product in the context of another product, the shape of a product, an element of the shape of a product, or an element of the shape in the context of another element of the shape of a product.

EXPRESS specification:

```

*)
ENTITY property_definition;
    name      : label;
    description : text;
    definition  : characterized_definition;
END_ENTITY;
(*)

```

Attribute definitions:

name: the word or group of words by which the **property_definition** is referred to.

description: text that relates the nature of the **property_definition**.

definition: the **product_definition**, **shape_aspect** or **shape_aspect_relationship** whose property is identified.

NOTE – A **property_definition** cannot exist unless it is related to either a **product_definition** or a **shape_definition**. This attribute establishes this relationship.

2.4.4.3 product_definition_shape

A **product_definition_shape** is a type of **property_definition**. It is the shape of a product. This shape may be a conceptual shape for which a specific geometric representation is not required.

NOTE – Early in the design of a **product** there may not be a specific idea about the form of the **product** but there may be certain characteristics of the form that are to be captured. Those **product** shape characteristics can be attached to the **product** shape using this entity.

EXAMPLE 35 – A geometric representation of shape is not needed to assert facts such as, “a shape must fit within a 5 centimetre cube”.

EXPRESS specification:

```

*)
ENTITY product_definition_shape
    SUBTYPE OF (property_definition);
UNIQUE
    UR1: SELF\property_definition.definition;
WHERE
    WR1: 'PRODUCT_PROPERTY_DEFINITION_SCHEMA.CHARACTERIZED_PRODUCT_DEFINITION'
        IN TYPEOF (SELF\property_definition.definition);
END_ENTITY;
(*)

```

Formal propositions:

UR1: each **characterized_product_definition** shall be related to **one** **product_definition_shape**.

WR1: the **definition** attribute shall be a **characterized_product_definition**.

2.4.4.4 **shape_aspect**

A **shape_aspect** is an identifiable element of the shape of a product.

EXAMPLE 36 – Consider the **product_definition_shape** of a bolt. One might distinguish, as an element of this shape, the concept of the threaded portion of its shank. This portion of the shape could be specified using a **shape_aspect** entity so that other properties, such as surface finish, may be associated with it.

EXPRESS specification:

```
*)  
ENTITY shape_aspect;  
  name : label;  
  description : text;  
  of_shape : product_definition_shape;  
  product_definitional : LOGICAL;  
END_ENTITY;  
(*
```

Attribute definitions:

name: the word or group of words by which the **shape_aspect** is referred to.

description: text that relates the nature of the **shape_aspect**.

of_shape: the **product_definition_shape** of which this entity is an aspect.

EXAMPLE 37 – If the identified aspect were the threaded portion of a bolt's shank, this attribute would be the **product_definition_shape** of the bolt.

product_definitional: an indication that the **shape_aspect** is on the physical boundary of the **product_definition_shape**. If the value of this attribute is TRUE, it is asserted that the **shape_aspect** being identified is on such a boundary. If the value is FALSE, it shall be asserted that the **shape_aspect** being identified is not on such a boundary. If the value is UNKNOWN, it shall be asserted that it is not known whether or not the **shape_aspect** being identified is on such a boundary.

EXAMPLE 38 – If the identified **shape_aspect** were the threaded portion of a bolt's shank, the value of this attribute would be TRUE. However, if it were the centre-line, the value would be FALSE.

2.4.4.5 **shape_aspect_relationship**

A **shape_aspect_relationship** is an association between two **shape_aspects**.

EXAMPLE 39 – If one **shape_aspect** is part of another, this entity could be used to associate the two **shape_aspects**.

NOTES

1 – The intention is to capture distinct properties of shapes as they exist in their own right and as they participate in the relationship. The **shape_aspect_relationship** entity is not a representation