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

Part 219:

**Application protocol: Dimensional
inspection information exchange**

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

*Partie 219: Protocole d'application: Échange d'information par
vérification dimensionnelle*

ISO 10303-219:2007

<https://standards.iteh.ai/catalog/standards/iso/722d8fe6-5894-4945-b4eb-d4cc86ec3665/iso-10303-219-2007>



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 10303-219:2007](https://standards.iteh.ai/catalog/standards/iso/722d8fe6-5894-4945-b4eb-d4cc86ec3665/iso-10303-219-2007)

<https://standards.iteh.ai/catalog/standards/iso/722d8fe6-5894-4945-b4eb-d4cc86ec3665/iso-10303-219-2007>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2007

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

1 Scope.....	1
2 Normative references.....	2
3 Terms, definitions and abbreviations.....	3
3.1 Terms defined in ISO 1101.....	3
3.2 Terms defined in ISO 5459.....	3
3.3 Terms defined in ISO 10303-1.....	3
3.4 Terms defined in ISO 10303-42.....	4
3.5 Other definitions.....	4
3.6 Abbreviations.....	4
4 Information requirements.....	5
4.1 Units of functionality.....	5
4.1.1 administrative_data.....	6
4.1.2 dimensional_measurement_analysis.....	6
4.1.3 dimensional_measurement_documentation.....	7
4.1.4 dimensional_measurement_execution.....	7
4.1.5 dimensional_measurement_features.....	8
4.1.6 dimensional_measurement_part.....	9
4.1.7 dimensional_measurement_parameters.....	9
4.1.8 feature_definition_items.....	9
4.1.9 feature_profile.....	11
4.1.10 manufacturing_feature.....	12
4.1.11 functional_limitations.....	15
4.1.12 part_properties.....	17
4.1.13 program_run.....	18
4.1.14 shape_representation_for_machining.....	18
4.2 Application objects.....	19
4.3 Application assertions.....	257
5 Application interpreted model.....	311
5.1 Mapping specification.....	311
5.1.1 administrative_data UoF.....	312
5.1.2 dimensional_measurement_analysis UoF.....	318
5.1.3 dimensional_measurement_documentation UoF.....	330
5.1.4 dimensional_measurement_execution UoF.....	332
5.1.5 dimensional_measurement_features UoF.....	337
5.1.6 dimensional_measurement_part UoF.....	443
5.1.7 dimensional_measurement_parameters UoF.....	446
5.1.8 feature_definition_items UoF.....	455
5.1.9 feature_profile UoF.....	501
5.1.10 manufacturing_feature UoF.....	539
5.1.11 functional_limitations UoF.....	746
5.1.12 part_properties UoF.....	797
5.1.13 program_run UoF.....	799
5.1.14 shape_representation_for_machining UoF.....	809
5.2 AIM EXPRESS short listing.....	828
5.2.1 Fundamental concepts and assumptions.....	832
5.2.2 Dimensional inspection schema types.....	832
5.2.3 Dimensional inspection schema entities.....	834

5.2.4 Dimensional inspection schema rules	940
6 Conformance requirements	959
Annex A (normative) AIM EXPRESS expanded listing	960
Annex B (normative) AIM short names	1191
Annex C (normative) Implementation method specific requirements	1204
Annex D (normative) Protocol Implementation Conformance Statement (PICS) proforma	1205
Annex E (normative) Information object registration	1206
Annex F (informative) Application activity model	1207
Annex G (informative) Application reference model	1234
Annex H (informative) AIM EXPRESS-G	1269
Annex I (informative) Computer interpretable listings	1299
Annex J (informative) Application protocol usage guide	1300
Bibliography	1525
Index	1526

Figures

Figure 1 — Data planning model	xii
Figure 2 — Angle_taper	22
Figure 3 — Angular_dimension_tolerance	23
Figure 4 — Angular_size_dimension_tolerance	25
Figure 5 — Angularity_tolerance for a plane surface	26
Figure 6 — Angularity_tolerance for an axis	26
Figure 7 — Bevel_gear	27
Figure 8 — Bevel_gear with shaft_angle and pitch_angle	28
Figure 9 — Bevel_gear with tip_angle and root_angle	28
Figure 10 — Block_base_shape	30
Figure 11 — Catalogue_gear	35
Figure 12 — Catalogue_knurl	36
Figure 13 — Catalogue_marking	37
Figure 14 — Catalogue_thread	37
Figure 15 — Chamfer	39
Figure 16 — Circular_boss	40
Figure 17 — Circular_boss with taper	41
Figure 18 — Circular_closed_profile	42
Figure 19 — Circular_offset_pattern	43
Figure 20 — Circular_omit_pattern	45
Figure 21 — Circular_pattern without rotation	46
Figure 22 — Circular_pattern with rotation of a base feature	46
Figure 23 — Circular_runout_tolerance	48
Figure 24 — Circularity_tolerance	49
Figure 25 — Complete_circular_path	50
Figure 26 — Compound_feature	51
Figure 27 — Concentricity_tolerance	53
Figure 28 — Conical_hole_bottom	54
Figure 29 — Constant_radius_edge_round	55
Figure 30 — Constant_radius_fillet	56
Figure 31 — Counterbore_hole	59
Figure 32 — Countersunk_hole	60
Figure 33 — Curved_dimension_tolerance	60
Figure 34 — Cutout	61

Figure 35 — Cylindrical_base_shape	62
Figure 36 — Cylindricity_tolerance	63
Figure 37 — Defined_marking	66
Figure 38 — Defined_thread	68
Figure 39 — Diagonal_knurl	70
Figure 40 — Diameter_dimension_tolerance	71
Figure 41 — Diameter_taper	72
Figure 42 — Diamond_knurl	73
Figure 43 — Distance_along_curve_tolerance	76
Figure 44 — Dmf_arc	93
Figure 45 — Dmf_circle	95
Figure 46 — Dmf_cone	96
Figure 47 — Dmf_cylinder	99
Figure 48 — Dmf_edge_point	100
Figure 49 — Dmf_ellipse	102
Figure 50 — Dmf_generic_feature	104
Figure 51 — Dmf_geometric_curve	105
Figure 52 — Dmf_geometric_surface	106
Figure 53 — Dmf_line_bounded	107
Figure 54 — Dmf_line_closed_parallel	109
Figure 55 — Dmf_line_unbounded	111
Figure 56 — Dmf_pattern	112
Figure 57 — Dmf_plane	113
Figure 58 — Dmf_plane_closed_parallel	115
Figure 59 — Dmf_plane_symmetric	117
Figure 60 — Dmf_point	118
Figure 61 — Dmf_sphere	120
Figure 62 — Dmf_surface_of_revolution_dml	122
Figure 63 — Dmf_torus	123
Figure 64 — Edge_round	126
Figure 65 — Fillet	130
Figure 66 — Flat_hole_bottom_types	131
Figure 67 — Flat_slot_end_type	132
Figure 68 — Flatness_tolerance	134
Figure 69 — Gear_face_width	135
Figure 70 — Gear_nominal_tooth_depth	136
Figure 71 — Gear_profile_shift	137
Figure 72 — Gear_reference_pressure_angle	137
Figure 73 — Gear_root_fillet_radius	138
Figure 74 — Gear_tip_diameter	138
Figure 75 — General_boss	139
Figure 76 — General_closed_profile	140
Figure 77 — General_open_profile	141
Figure 78 — General_outside_profile	142
Figure 79 — General_path	143
Figure 80 — General_pattern	144
Figure 81 — General_pocket	145
Figure 82 — General_removal_volume	147
Figure 83 — General_revolution_for_outer_shape	148
Figure 84 — General_revolution_for_volume_removal	149
Figure 85 — Groove	154

Figure 86 — Helical_gear	156
Figure 87 — Helical_gear left_or_right_tooth	156
Figure 88 — Helical_gear reference_helix_angle	157
Figure 89 — Implicit_base_shape	158
Figure 90 — Knurl and types of Turned_knurl	160
Figure 91 — Linear_path	162
Figure 92 — Linear_profile	162
Figure 93 — Linear_profile_tolerance	163
Figure 94 — Location_dimension_tolerance	164
Figure 95 — Ngon_base_shape	170
Figure 96 — Ngon_profile	172
Figure 97 — Open_slot_end_type	175
Figure 98 — Outer_diameter	177
Figure 99 — Outer_diameter_to_shoulder	179
Figure 100 — Parallelism_tolerance for an axis	181
Figure 101 — Parallelism_tolerance for a plane	181
Figure 102 — Partial_circular_path	185
Figure 103 — Partial_circular_profile	186
Figure 104 — Perpendicularity_tolerance	188
Figure 105 — Perpendicularity_tolerance for an axis	189
Figure 106 — Planar_face	192
Figure 107 — Pocket_bottom_condition	198
Figure 108 — Position_tolerance	198
Figure 109 — Protrusion	202
Figure 110 — Radial_dimension_tolerance	203
Figure 111 — Radiused_slot_end_type	203
Figure 112 — Recess	204
Figure 113 — Rectangular_boss	205
Figure 114 — Rectangular_closed_pocket	207
Figure 115 — Rectangular_closed_profile	208
Figure 116 — Rectangular_offset_pattern	209
Figure 117 — Rectangular_omit_pattern	210
Figure 118 — Rectangular_open_pocket	212
Figure 119 — Rectangular_pattern	213
Figure 120 — Revolved_flat	216
Figure 121 — Revolved_round	217
Figure 122 — Rib_top	218
Figure 123 — Round_hole	220
Figure 124 — Rounded_end	221
Figure 125 — Rounded_U_profile	222
Figure 126 — Shape_profile	226
Figure 127 — Slot	228
Figure 128 — Spherical_cap	231
Figure 129 — Spherical_hole_bottom	232
Figure 130 — Spur_gear	232
Figure 131 — Square_U_profile	233
Figure 132 — Step	235
Figure 133 — Straight_knurl	236
Figure 134 — Straightness_tolerance	237
Figure 135 — Surface_profile_tolerance	238
Figure 136 — Symmetry_tolerance	239

Figure 137 — Tee_profile	242
Figure 138 — Thread.....	244
Figure 139 — Through_bottom_condition	247
Figure 140 — Total_runout_tolerance.....	251
Figure 141 — Turned_knurl.....	254
Figure 142 — Vee_profile.....	255
Figure 143 — Woodroff_slot_end_type.....	256
Figure F.1 — IDEF0 Basic notation.....	1207
Figure F.2 – A0 Manage dimensional inspection	1218
Figure F.3 - A0 Manage dimensional inspection.....	1219
Figure F.4 - A2 Perform Inspection Planning.....	1220
Figure F.5 - A21 Identify inspection scope and accuracy requirements.....	1221
Figure F.6 - A23 Select DME, tools, fixtures and functions.....	1222
Figure F.7 – A24 Develop inspection process plan	1223
Figure F.8 – A241 Determine setup.....	1224
Figure F.9 - A242 Specify inspection plan	1225
Figure F.10 - A243 Validate and approve the inspection plan	1226
Figure F.11 - A3 Execute inspection	1227
Figure F.12 - A31 Setup for inspection.....	1228
Figure F.13 - A4 Perform analysis of inspection.....	1229
Figure F.14 - A1 Perform inspection administration and archiving	1230
Figure F.15 - A2 Perform inspection planning	1231
Figure F.16 - A3 Execute inspection	1232
Figure F.17 - A4 Perform analysis of dimensional inspection.....	1233
Figure G.1 — ARM EXPRESS-G diagram 1 of 34.....	1235
Figure G.2 — ARM EXPRESS-G diagram 2 of 34.....	1236
Figure G.3 — ARM EXPRESS-G diagram 3 of 34.....	1237
Figure G.4 — ARM EXPRESS-G diagram 4 of 34.....	1238
Figure G.5 — ARM EXPRESS-G diagram 5 of 34.....	1239
Figure G.6 — ARM EXPRESS-G diagram 6 of 34.....	1240
Figure G.7 — ARM EXPRESS-G diagram 7 of 34.....	1241
Figure G.8 — ARM EXPRESS-G diagram 8 of 34.....	1242
Figure G.9 — ARM EXPRESS-G diagram 9 of 34.....	1243
Figure G.10 — ARM EXPRESS-G diagram 10 of 34.....	1244
Figure G.11 — ARM EXPRESS-G diagram 11 of 34.....	1245
Figure G.12 — ARM EXPRESS-G diagram 12 of 34.....	1246
Figure G.13 — ARM EXPRESS-G diagram 13 of 34.....	1247
Figure G.14 — ARM EXPRESS-G diagram 14 of 34.....	1248
Figure G.15 — ARM EXPRESS-G diagram 15 of 34.....	1249
Figure G.16 — ARM EXPRESS-G diagram 16 of 34.....	1250
Figure G.17 — ARM EXPRESS-G diagram 17 of 34.....	1251
Figure G.18 — ARM EXPRESS-G diagram 18 of 34.....	1252
Figure G.19 — ARM EXPRESS-G diagram 19 of 34.....	1253
Figure G.20 — ARM EXPRESS-G diagram 20 of 34.....	1254
Figure G.21 — ARM EXPRESS-G diagram 21 of 34.....	1255
Figure G.22 — ARM EXPRESS-G diagram 22 of 34.....	1256
Figure G.23 — ARM EXPRESS-G diagram 23 of 34.....	1257
Figure G.24 — ARM EXPRESS-G diagram 24 of 34.....	1258
Figure G.25 — ARM EXPRESS-G diagram 25 of 34.....	1259
Figure G.26 — ARM EXPRESS-G diagram 26 of 34.....	1260
Figure G.27 — ARM EXPRESS-G diagram 27 of 34.....	1261

Figure G.28 — ARM EXPRESS-G diagram 28 of 34.....	1262
Figure G.29 — ARM EXPRESS-G diagram 29 of 34.....	1263
Figure G.30 — ARM EXPRESS-G diagram 30 of 34.....	1264
Figure G.31 — ARM EXPRESS-G diagram 31 of 34.....	1265
Figure G.32 — ARM EXPRESS-G diagram 32 of 34.....	1266
Figure G.33 — ARM EXPRESS-G diagram 33 of 34.....	1267
Figure G.34 — ARM EXPRESS-G diagram 34 of 34.....	1268
Figure H.1 — AIM EXPRESS-G diagram 1 of 29.....	1270
Figure H.2 — AIM EXPRESS-G diagram 2 of 29.....	1271
Figure H.3 — AIM EXPRESS-G diagram 3 of 29.....	1272
Figure H.4 — AIM EXPRESS-G diagram 4 of 29.....	1273
Figure H.5 — AIM EXPRESS-G diagram 5 of 29.....	1274
Figure H.6 — AIM EXPRESS-G diagram 6 of 29.....	1275
Figure H.7 — AIM EXPRESS-G diagram 7 of 29.....	1276
Figure H.8 — AIM EXPRESS-G diagram 8 of 29.....	1277
Figure H.9 — AIM EXPRESS-G diagram 9 of 29.....	1278
Figure H.10 — AIM EXPRESS-G diagram 10 of 29.....	1279
Figure H.11 — AIM EXPRESS-G diagram 11 of 29.....	1280
Figure H.12 — AIM EXPRESS-G diagram 12 of 29.....	1281
Figure H.13 — AIM EXPRESS-G diagram 13 of 29.....	1282
Figure H.14 — AIM EXPRESS-G diagram 14 of 29.....	1283
Figure H.15 — AIM EXPRESS-G diagram 15 of 29.....	1284
Figure H.16 — AIM EXPRESS-G diagram 16 of 29.....	1285
Figure H.17 — AIM EXPRESS-G diagram 17 of 29.....	1286
Figure H.18 — AIM EXPRESS-G diagram 18 of 29.....	1287
Figure H.19 — AIM EXPRESS-G diagram 19 of 29.....	1288
Figure H.20 — AIM EXPRESS-G diagram 20 of 29.....	1289
Figure H.21 — AIM EXPRESS-G diagram 21 of 29.....	1290
Figure H.22 — AIM EXPRESS-G diagram 22 of 29.....	1291
Figure H.23 — AIM EXPRESS-G diagram 23 of 29.....	1292
Figure H.24 — AIM EXPRESS-G diagram 24 of 29.....	1293
Figure H.25 — AIM EXPRESS-G diagram 25 of 29.....	1294
Figure H.26 — AIM EXPRESS-G diagram 26 of 29.....	1295
Figure H.27 — AIM EXPRESS-G diagram 27 of 29.....	1296
Figure H.28 — AIM EXPRESS-G diagram 28 of 29.....	1297
Figure H.29 — AIM EXPRESS-G diagram 29 of 29.....	1298
Figure J.1 — Manufacturing suite test case test part drawing.....	1353
Figure J.2 — Manufacturing suite test case part.....	1354

Tables

Table B.1 — AIM short names of entities.....	1191
--	------

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 10303-219 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

ISO 10303 is organized as a series of parts, each published separately. The structure of ISO 10303 is described in ISO 10303-1.

Each part of ISO 10303 is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs, and application modules. This part of ISO 10303 is a member of the application protocol series.

A complete list of parts of ISO 10303 is available from the Internet:

<<http://www.tc184-sc4.org/titles/>>

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation production information 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 part of ISO 10303 is a member of the application protocol series. This part of ISO 10303 specifies an application protocol (AP) for the exchange of information resulting from the dimensional inspection of solid parts. Industry is faced with numerous proprietary inspection languages and interfaces. This causes overhead problems associated with maintaining multiple systems or locks users to one vendor. In particular, there are no adequate standard systems for linking coordinate measurement machines and other types of automated inspection systems with systems that analyze and track dimensional inspection results. During the course of four workshops held on dimensional inspection information exchange, industry representatives indicated that a standard or a specification for dimensional inspection information exchange is critical to their future operations. The focus of the proposed standard is the analysis and reporting activity for dimensional inspection. The measurement process itself is not within the scope of this part of ISO 10303. The primary benefit will be a link between dimensional inspection programs, provided by ISO 22093 (DMIS 4.0), Web-based analysis and reporting practices, aimed for in the Metrology Interoperability Project (MIP), and standard information models for manufacturing provided for example, by ISO 10303-224 and ISO 10303-238. The information provided by the DMIS and the MIP will be mappable into entities of this part of ISO 10303 and transportable into other ISO 10303 based implementations.

In addition this part of ISO 10303 captures the digital representation of dimensioning and tolerancing information requirements in standards ISO 1101, and ISO 5459 developed by ISO TC 213 on Geometrical Product Specifications and Verification.

This application protocol defines the context, scope, and information requirements for analyzing and reporting the information and results of dimensional inspection and specifies the integrated resources necessary to satisfy these requirements.

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of the application protocol and summarizes the functionality and data covered by the AP. Clause 3 lists the words defined in this part of ISO 10303 and gives pointers to words defined elsewhere. An application activity model that is the basis for the definition of the scope is provided in Annex F. The information requirements of the application are specified in clause 4 using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model, is given in Annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. The expanded listing given in Annex A contains the complete EXPRESS for

the AIM without annotation. A graphical representation of the AIM is given in Annex H. Additional requirements for specific implementation methods are given in Annex C.

Figure 1 contains the data planning model that provides a high level description of the requirements for this application protocol. This planning model was created from the in-scope data from the activities of the application activity model (AAM) and grouped into logical units of functionality. This planning model is used as a guide in developing the application reference model (ARM).

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 10303-219:2007](https://standards.iteh.ai/catalog/standards/iso/722d8fe6-5894-4945-b4eb-d4cc86ec3665/iso-10303-219-2007)

<https://standards.iteh.ai/catalog/standards/iso/722d8fe6-5894-4945-b4eb-d4cc86ec3665/iso-10303-219-2007>

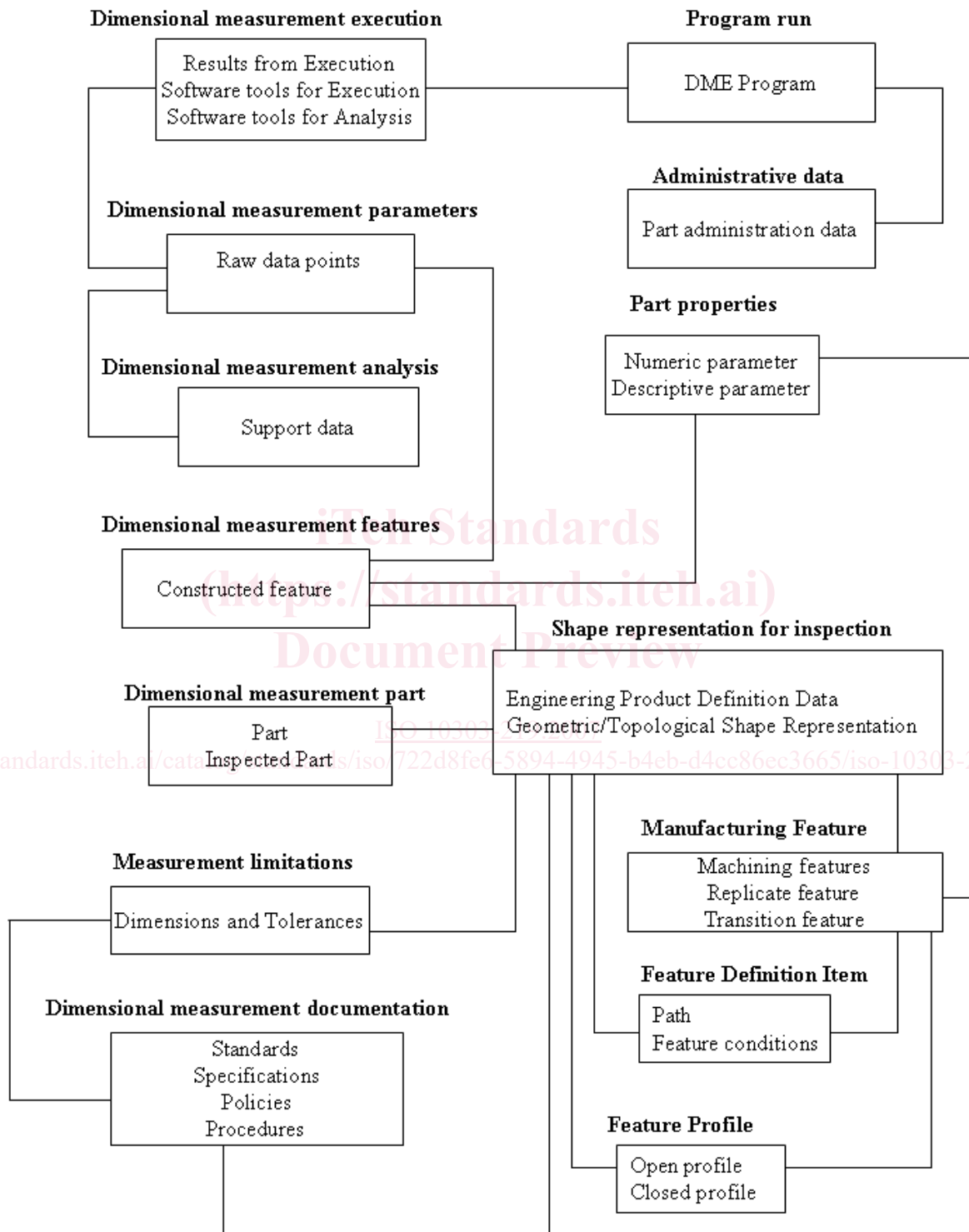


Figure 1 — Data planning model

Industrial automation systems and integration — Product data representation and exchange — Part 219: Application protocol: Dimensional inspection information exchange

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for analyzing the data and reporting the results of dimensional inspections of solid parts or assemblies. Dimensional inspection can occur at any stage of the life cycle of a product where checking for conformance with a design specification is required.

NOTE The application activity model, in Annex F, provides a graphical representation of the processes and information flows which are the basis for the definition of the scope of this part of ISO 10303.

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

- data for administering, planning;
- data for executing dimensional inspection;
- data for archiving the results of a dimensional inspection;
- interface for capturing technical data out of the upstream application protocols;
- machining feature classification structure;
- geometric and dimensional tolerances of the parts being manufactured;
- references to standards and specifications declared in the dimensional inspection.

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

- dimensional inspection of liquid surfaces;
- materials properties of parts;
- manufacturing activities;
- mathematical algorithms to perform the dimensional inspection analysis;
- developing or modifying manufacturing process information;
- generating geometry (creating the CAD model);

ISO 10303-219:2007(E)

- generating tolerance requirements;
- inspection of material properties.

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 286-1, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits.*

ISO 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 1101, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out.*

ISO 5459, *Geometrical product specifications (GPS) — Geometrical tolerancing — Datums and datum-systems.*

ISO/IEC 8824-1, *Information technology — Abstract Syntax Notation One (ASN.1) — Part 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 10303-11:2004, *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual.*

ISO 10303-21, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure.*

ISO 10303-41, *Industrial automation systems and integration — Product data representation and exchange — Part 41: Integrated generic resource: Fundamentals of product description and support.*

ISO 10303-42, *Industrial automation systems and integration — Product data representation and exchange — Part 42: Integrated generic resource: Geometric and topological representation.*

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

ISO 10303-45, *Industrial automation systems and integration — Product data representation and exchange — Part 45: Integrated generic resource: Materials.*

ISO 10303-47, *Industrial automation systems and integration — Product data representation and exchange — Part 47: Integrated generic resource: Shape variation tolerances.*