
**Information technology — Database
languages — SQL —**

**Part 2:
Foundation (SQL/Foundation)**

*Technologies de l'information — Langages de base de données —
SQL —*

Partie 2: Fondations (SQL/Fondations)

Withhold

Withdrawn



COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2016, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword.....	xxi
Introduction.....	xxii
1 Scope.....	1
2 Normative references.....	3
2.1 ISO and IEC standards.....	3
2.2 Other international standards.....	4
3 Definitions, notations, and conventions.....	5
3.1 Definitions.....	5
3.1.1 Definitions taken from [ISO10646].....	5
3.1.2 Definitions taken from [ISO14651].....	5
3.1.3 Definitions taken from [Unicode].....	5
3.1.4 Definitions taken from [ISO8601].....	6
3.1.5 Definitions taken from [ISO9075-1].....	6
3.1.6 Definitions provided in Part 2.....	7
3.2 Notation.....	13
3.3 Conventions.....	13
3.3.1 Use of terms.....	13
3.3.1.1 Other terms.....	14
4 Concepts.....	15
4.1 Data types.....	15
4.1.1 General introduction to data types.....	15
4.1.2 Naming of predefined types.....	16
4.1.3 Host language data types.....	17
4.1.4 Data type terminology.....	17
4.1.5 Properties of distinct.....	19
4.2 Character strings.....	20
4.2.1 Introduction to character strings.....	20
4.2.2 Comparison of character strings.....	21
4.2.3 Operations involving character strings.....	22
4.2.3.1 Regular expression syntaxes.....	22
4.2.3.2 Operators that operate on character strings and return character strings.....	22
4.2.3.3 Other operators involving character strings.....	24
4.2.3.4 Operations involving large object character strings.....	25
4.2.4 Character repertoires.....	26
4.2.5 Character encoding forms.....	27

ISO/IEC 9075-2:2016(E)

4.2.6	Collations.	28
4.2.7	Character sets.	29
4.2.8	Universal character sets.	31
4.3	Binary strings.	31
4.3.1	Introduction to binary strings.	31
4.3.2	Binary string comparison.	31
4.3.3	Operations involving binary strings.	32
4.3.3.1	Operators that operate on binary strings and return binary strings.	32
4.3.3.2	Other operators involving binary strings.	32
4.4	Numbers.	33
4.4.1	Introduction to numbers.	33
4.4.2	Characteristics of numbers.	33
4.4.3	Operations involving numbers.	35
4.5	Boolean types.	36
4.5.1	Introduction to Boolean types.	36
4.5.2	Comparison and assignment of booleans.	36
4.5.3	Operations involving booleans.	37
4.5.3.1	Operations on booleans that return booleans.	37
4.5.3.2	Other operators involving booleans.	37
4.6	Datetimes and intervals.	37
4.6.1	Introduction to datetimes and intervals.	37
4.6.2	Datetimes.	38
4.6.3	Intervals.	40
4.6.4	Operations involving datetimes and intervals.	42
4.7	User-defined types.	43
4.7.1	Introduction to user-defined types.	43
4.7.2	Distinct types.	43
4.7.3	Structured types.	44
4.7.3.1	Introduction to structured types.	44
4.7.3.2	Observer functions and mutator functions.	44
4.7.3.3	Constructors.	44
4.7.3.4	Subtypes and supertypes.	45
4.7.4	Methods.	46
4.7.5	User-defined type comparison and assignment.	47
4.7.6	Transforms for user-defined types.	48
4.7.7	User-defined type descriptor.	48
4.8	Row types.	50
4.9	Reference types.	50
4.9.1	Introduction to reference types.	50
4.9.2	Operations involving references.	51
4.10	Collection types.	52
4.10.1	Introduction to collection types.	52
4.10.2	Arrays.	52
4.10.3	Multisets.	53

4.10.4	Collection comparison and assignment.	53
4.10.5	Operations involving arrays.	53
4.10.5.1	Operators that operate on array values and return array elements.	53
4.10.5.2	Operators that operate on array values and return array values.	54
4.10.5.3	Operators that operate on array values and return numbers.	54
4.10.6	Operations involving multisets.	54
4.10.6.1	Operators that operate on multisets and return multiset elements.	54
4.10.6.2	Operators that operate on multisets and return multisets.	54
4.10.6.3	Operators that operate on multiset values and return numbers.	54
4.11	Data conversions.	55
4.12	Domains.	56
4.13	Columns, fields, and attributes.	56
4.14	Periods.	58
4.14.1	Introduction to periods.	58
4.14.2	Operations involving periods.	59
4.15	Tables.	59
4.15.1	Introduction to tables.	59
4.15.2	Base tables.	60
4.15.2.1	Regular persistent base tables.	60
4.15.2.2	System-versioned tables.	60
4.15.2.3	Temporary tables.	60
4.15.3	Derived tables.	61
4.15.4	Transient tables.	62
4.15.5	Unique identification of tables.	62
4.15.6	Table updatability.	62
4.15.7	Table descriptors.	63
4.15.8	Syntactic analysis of derived tables and cursors.	65
4.15.9	Referenceable tables, subtables, and supertables.	67
4.15.10	Operations involving tables.	68
4.15.11	Range variables.	70
4.15.12	Identity columns.	71
4.15.13	Base columns and generated columns.	72
4.15.14	Grouped tables.	72
4.15.15	Windowed tables.	72
4.16	Data analysis operations (involving tables).	74
4.16.1	Introduction to data analysis operations.	74
4.16.2	Group functions.	74
4.16.3	Window functions.	74
4.16.4	Aggregate functions.	77
4.16.5	Row pattern measures.	79
4.17	Row pattern matching.	80
4.17.1	Matching rows with a pattern.	80
4.17.2	Row pattern matching illustrated.	82
4.17.3	Row pattern partitioning.	85

ISO/IEC 9075-2:2016(E)

4.17.4	Row ordering.....	85
4.17.5	Row pattern measure columns.....	85
4.17.6	Number of rows per match.....	85
4.17.7	Skipping rows after matching.....	86
4.18	Row patterns.....	86
4.19	Unions of row pattern variables.....	88
4.20	Defining Boolean conditions.....	88
4.21	Scalar expressions in row pattern matching.....	89
4.21.1	Running vs. final semantics.....	89
4.21.2	Row pattern navigation operations.....	89
4.21.3	Row pattern classifier function.....	90
4.21.4	Row pattern match number function.....	90
4.22	Determinism.....	90
4.23	Integrity constraints.....	91
4.23.1	Overview of integrity constraints.....	91
4.23.2	Checking of constraints.....	92
4.23.3	Table constraints.....	92
4.23.3.1	Introduction to table constraints.....	92
4.23.3.2	Unique constraints.....	93
4.23.3.3	Referential constraints.....	93
4.23.3.4	Table check constraints.....	96
4.23.4	Domain constraints.....	96
4.23.5	Assertions.....	97
4.24	Functional dependencies.....	97
4.24.1	Overview of functional dependency rules and notations.....	97
4.24.2	General rules and definitions.....	98
4.24.3	Known functional dependencies in a base table.....	99
4.24.4	Known functional dependencies in a viewed table.....	99
4.24.5	Known functional dependencies in a transition table.....	100
4.24.6	Known functional dependencies in <table value constructor>.....	100
4.24.7	Known functional dependencies in a <joined table>.....	100
4.24.8	Known functional dependencies in a <table primary>.....	102
4.24.9	Known functional dependencies in a <table factor>.....	103
4.24.10	Known functional dependencies in a <table reference>.....	103
4.24.11	Known functional dependencies in the result of a <from clause>.....	103
4.24.12	Known functional dependencies in the result of a <where clause>.....	104
4.24.13	Known functional dependencies in the result of a <group by clause>.....	104
4.24.14	Known functional dependencies in the result of a <having clause>.....	105
4.24.15	Known functional dependencies in a <query specification>.....	105
4.24.16	Known functional dependencies in a <query expression>.....	106
4.25	Candidate keys.....	106
4.26	SQL-schemas.....	107
4.27	Sequence generators.....	108
4.27.1	General description of sequence generators.....	108

4.27.2	Operations involving sequence generators.	109
4.28	SQL-client modules.	110
4.29	Embedded syntax.	111
4.30	Dynamic SQL concepts.	111
4.30.1	Introduction to dynamic SQL.	111
4.30.2	Overview of dynamic SQL for constructed SQL-statements.	112
4.30.3	Overview of dynamic SQL for polymorphic table functions.	113
4.30.4	Dynamic SQL statements and descriptor areas.	113
4.31	Direct invocation of SQL.	115
4.32	Externally-invoked procedures.	115
4.33	SQL-invoked routines.	115
4.33.1	Overview of SQL-invoked routines.	115
4.33.2	Characteristics of SQL-invoked routines.	118
4.33.3	Execution of conventional SQL-invoked routines.	120
4.33.4	Invocation of polymorphic table functions.	121
4.33.5	Routine descriptors.	126
4.33.6	Result sets returned by SQL-invoked procedures.	129
4.34	SQL-paths.	130
4.35	Host parameters.	130
4.35.1	Overview of host parameters.	130
4.35.2	Status parameters.	131
4.35.3	Data parameters.	131
4.35.4	Indicator parameters.	131
4.35.5	Locators.	132
4.36	Diagnostics area.	132
4.37	Host languages.	134
4.38	Cursors.	134
4.38.1	General description of cursors.	134
4.38.2	Operations on and using cursors.	138
4.39	SQL-statements.	139
4.39.1	Classes of SQL-statements.	139
4.39.2	SQL-statements classified by function.	141
4.39.2.1	SQL-schema statements.	141
4.39.2.2	SQL-data statements.	142
4.39.2.3	SQL-data change statements.	143
4.39.2.4	SQL-transaction statements.	143
4.39.2.5	SQL-connection statements.	144
4.39.2.6	SQL-control statements.	144
4.39.2.7	SQL-session statements.	144
4.39.2.8	SQL-diagnostics statements.	145
4.39.2.9	SQL-dynamic statements.	145
4.39.2.10	SQL embedded exception declaration.	145
4.39.3	SQL-statements and SQL-data access indication.	146
4.39.4	SQL-statements and transaction states.	146

ISO/IEC 9075-2:2016(E)

4.39.5	SQL-statement atomicity and statement execution contexts	148
4.39.6	Embeddable SQL-statements.	149
4.39.7	Preparable and immediately executable SQL-statements.	151
4.39.8	Directly executable SQL-statements.	153
4.40	Basic security model.	154
4.40.1	Authorization identifiers.	154
4.40.1.1	SQL-session authorization identifiers.	154
4.40.1.2	SQL-client module authorization identifiers.	155
4.40.1.3	SQL-schema authorization identifiers.	155
4.40.2	Privileges.	155
4.40.3	Roles.	158
4.40.4	Security model definitions.	158
4.41	SQL-transactions.	159
4.41.1	General description of SQL-transactions.	159
4.41.2	Savepoints.	160
4.41.3	Properties of SQL-transactions.	160
4.41.4	Isolation levels of SQL-transactions.	161
4.41.5	Implicit rollbacks.	162
4.41.6	Effects of SQL-statements in an SQL-transaction.	163
4.41.7	Encompassing transactions.	163
4.41.7.1	Encompassing transaction belonging to an external agent.	163
4.41.7.2	Encompassing transaction belonging to the SQL-agent.	164
4.42	SQL-connections.	164
4.43	SQL-sessions.	165
4.43.1	General description of SQL-sessions.	165
4.43.2	SQL-session identification.	166
4.43.3	SQL-session properties.	167
4.43.4	SQL-session context management.	169
4.43.5	Execution contexts.	169
4.43.6	Routine execution context.	170
4.44	Triggers	170
4.44.1	General description of triggers.	170
4.44.2	Trigger execution.	172
4.45	Client-server operation.	174
4.46	JSON data handling in SQL.	174
4.46.1	Introduction.	174
4.46.2	Implied JSON data model.	175
4.46.3	SQL/JSON data model.	176
4.46.4	SQL/JSON functions.	177
4.46.5	Overview of SQL/JSON path language.	178
5	Lexical elements.	181
5.1	<SQL terminal character>.	181
5.2	<token> and <separator>.	185

5.3	<literal>.....	195
5.4	Names and identifiers.....	205
6	Scalar expressions.....	217
6.1	<data type>.....	217
6.2	<field definition>.....	230
6.3	<value expression primary>.....	232
6.4	<value specification> and <target specification>.....	234
6.5	<contextually typed value specification>.....	240
6.6	<identifier chain>.....	242
6.7	<column reference>.....	246
6.8	<SQL parameter reference>.....	249
6.9	<set function specification>.....	250
6.10	<window function>.....	253
6.11	<nested window function>.....	262
6.12	<case expression>.....	265
6.13	<cast specification>.....	269
6.14	<next value expression>.....	287
6.15	<field reference>.....	289
6.16	<subtype treatment>.....	290
6.17	<method invocation>.....	292
6.18	<static method invocation>.....	294
6.19	<new specification>.....	296
6.20	<attribute or method reference>.....	298
6.21	<dereference operation>.....	300
6.22	<method reference>.....	301
6.23	<reference resolution>.....	303
6.24	<array element reference>.....	305
6.25	<multiset element reference>.....	306
6.26	<row pattern navigation operation>.....	307
6.27	<JSON value function>.....	311
6.28	<value expression>.....	313
6.29	<numeric value expression>.....	317
6.30	<numeric value function>.....	319
6.31	<string value expression>.....	334
6.32	<string value function>.....	339
6.33	<JSON value constructor>.....	357
6.34	<JSON query>.....	364
6.35	<datetime value expression>.....	366
6.36	<datetime value function>.....	369
6.37	<interval value expression>.....	371
6.38	<interval value function>.....	376
6.39	<boolean value expression>.....	377
6.40	<array value expression>.....	382

ISO/IEC 9075-2:2016(E)

6.41	<array value function>.....	384
6.42	<array value constructor>.....	386
6.43	<multiset value expression>.....	388
6.44	<multiset value function>.....	391
6.45	<multiset value constructor>.....	392
7	Query expressions.....	395
7.1	<row value constructor>.....	395
7.2	<row value expression>.....	398
7.3	<table value constructor>.....	400
7.4	<table expression>.....	402
7.5	<from clause>.....	403
7.6	<table reference>.....	406
7.7	<row pattern recognition clause>.....	425
7.8	<row pattern measures>.....	431
7.9	<row pattern common syntax>.....	433
7.10	<joined table>.....	438
7.11	<JSON table>.....	449
7.12	<where clause>.....	464
7.13	<group by clause>.....	465
7.14	<having clause>.....	474
7.15	<window clause>.....	476
7.16	<query specification>.....	491
7.17	<query expression>.....	502
7.18	<search or cycle clause>.....	520
7.19	<subquery>.....	525
8	Predicates.....	527
8.1	<predicate>.....	527
8.2	<comparison predicate>.....	529
8.3	<between predicate>.....	537
8.4	<in predicate>.....	538
8.5	<like predicate>.....	540
8.6	<similar predicate>.....	546
8.7	<regex like predicate>.....	552
8.8	<null predicate>.....	554
8.9	<quantified comparison predicate>.....	556
8.10	<exists predicate>.....	558
8.11	<unique predicate>.....	559
8.12	<normalized predicate>.....	560
8.13	<match predicate>.....	562
8.14	<overlaps predicate>.....	565
8.15	<distinct predicate>.....	567
8.16	<member predicate>.....	570
8.17	<submultiset predicate>.....	572

8.18	<set predicate>.....	574
8.19	<type predicate>.....	575
8.20	<period predicate>.....	577
8.21	<search condition>.....	582
8.22	<JSON predicate>.....	583
8.23	<JSON exists predicate>.....	585
9	Additional common rules.....	587
9.1	Retrieval assignment.....	587
9.2	Store assignment.....	593
9.3	Passing a value from a host language to the SQL-server.....	599
9.4	Passing a value from the SQL-server to a host language.....	603
9.5	Result of data type combinations.....	607
9.6	Subject routine determination.....	611
9.7	Type precedence list determination.....	613
9.8	Host parameter mode determination.....	617
9.9	Type name determination.....	619
9.10	Determination of identical values.....	621
9.11	Equality operations.....	623
9.12	Grouping operations.....	625
9.13	Multiset element grouping operations.....	627
9.14	Ordering operations.....	629
9.15	Collation determination.....	631
9.16	Execution of array-returning functions.....	633
9.17	Execution of multiset-returning functions.....	637
9.18	Compilation of an invocation of a polymorphic table function.....	638
9.19	Execution of an invocation of a polymorphic table function.....	642
9.20	Signatures of PTF component procedures.....	654
9.21	Invocation of a PTF component procedure.....	657
9.22	XQuery regular expression matching.....	660
9.23	XQuery regular expression replacement.....	663
9.24	Data type identity.....	665
9.25	Determination of a from-sql function.....	667
9.26	Determination of a from-sql function for an overriding method.....	668
9.27	Determination of a to-sql function.....	669
9.28	Determination of a to-sql function for an overriding method.....	670
9.29	Generation of the next value of a sequence generator.....	671
9.30	Creation of a sequence generator.....	673
9.31	Altering a sequence generator.....	676
9.32	Generation of the hierarchical <query expression> of a view.....	679
9.33	Determination of view privileges.....	681
9.34	Determination of view component privileges.....	683
9.35	Row pattern recognition in a sequence of rows.....	687
9.36	Parsing JSON text.....	691

ISO/IEC 9075-2:2016(E)

9.37	Serializing an SQL/JSON item.	694
9.38	SQL/JSON path language: lexical elements.	696
9.39	SQL/JSON path language: syntax and semantics.	700
9.40	Casting an SQL/JSON sequence to an SQL type.	724
9.41	Serializing an SQL/JSON sequence to an SQL string type.	726
9.42	Converting a datetime to a formatted character string.	729
9.43	Converting a formatted character string to a datetime.	733
9.44	Datetime templates.	741
10	Additional common elements.	745
10.1	<interval qualifier>.	745
10.2	<language clause>.	749
10.3	<path specification>.	751
10.4	<routine invocation>.	752
10.5	<character set specification>.	784
10.6	<specific routine designator>.	786
10.7	<collate clause>.	789
10.8	<constraint name definition> and <constraint characteristics>.	790
10.9	<aggregate function>.	792
10.10	<sort specification list>.	809
10.11	<JSON aggregate function>.	812
10.12	<JSON value expression>.	817
10.13	<JSON output clause>.	819
10.14	<JSON API common syntax>.	821
11	Schema definition and manipulation.	823
11.1	<schema definition>.	823
11.2	<drop schema statement>.	826
11.3	<table definition>.	829
11.4	<column definition>.	842
11.5	<default clause>.	848
11.6	<table constraint definition>.	852
11.7	<unique constraint definition>.	854
11.8	<referential constraint definition>.	857
11.9	<check constraint definition>.	863
11.10	<alter table statement>.	865
11.11	<add column definition>.	867
11.12	<alter column definition>.	869
11.13	<set column default clause>.	871
11.14	<drop column default clause>.	872
11.15	<set column not null clause>.	873
11.16	<drop column not null clause>.	874
11.17	<add column scope clause>.	876
11.18	<drop column scope clause>.	877
11.19	<alter column data type clause>.	879

11.20	<alter identity column specification>.....	883
11.21	<drop identity property clause>.....	885
11.22	<drop column generation expression clause>.....	886
11.23	<drop column definition>.....	887
11.24	<add table constraint definition>.....	889
11.25	<alter table constraint definition>.....	890
11.26	<drop table constraint definition>.....	891
11.27	<add table period definition>.....	894
11.28	<drop table period definition>.....	897
11.29	<add system versioning clause>.....	902
11.30	<drop system versioning clause>.....	903
11.31	<drop table statement>.....	905
11.32	<view definition>.....	908
11.33	<drop view statement>.....	920
11.34	<domain definition>.....	923
11.35	<alter domain statement>.....	926
11.36	<set domain default clause>.....	927
11.37	<drop domain default clause>.....	928
11.38	<add domain constraint definition>.....	929
11.39	<drop domain constraint definition>.....	930
11.40	<drop domain statement>.....	931
11.41	<character set definition>.....	933
11.42	<drop character set statement>.....	935
11.43	<collation definition>.....	937
11.44	<drop collation statement>.....	939
11.45	<transliteration definition>.....	941
11.46	<drop transliteration statement>.....	944
11.47	<assertion definition>.....	946
11.48	<drop assertion statement>.....	948
11.49	<trigger definition>.....	951
11.50	<drop trigger statement>.....	957
11.51	<user-defined type definition>.....	960
11.52	<attribute definition>.....	977
11.53	<alter type statement>.....	979
11.54	<add attribute definition>.....	980
11.55	<drop attribute definition>.....	982
11.56	<add original method specification>.....	984
11.57	<add overriding method specification>.....	990
11.58	<drop method specification>.....	995
11.59	<drop data type statement>.....	999
11.60	<SQL-invoked routine>.....	1002
11.61	<alter routine statement>.....	1032
11.62	<drop routine statement>.....	1035
11.63	<user-defined cast definition>.....	1037

ISO/IEC 9075-2:2016(E)

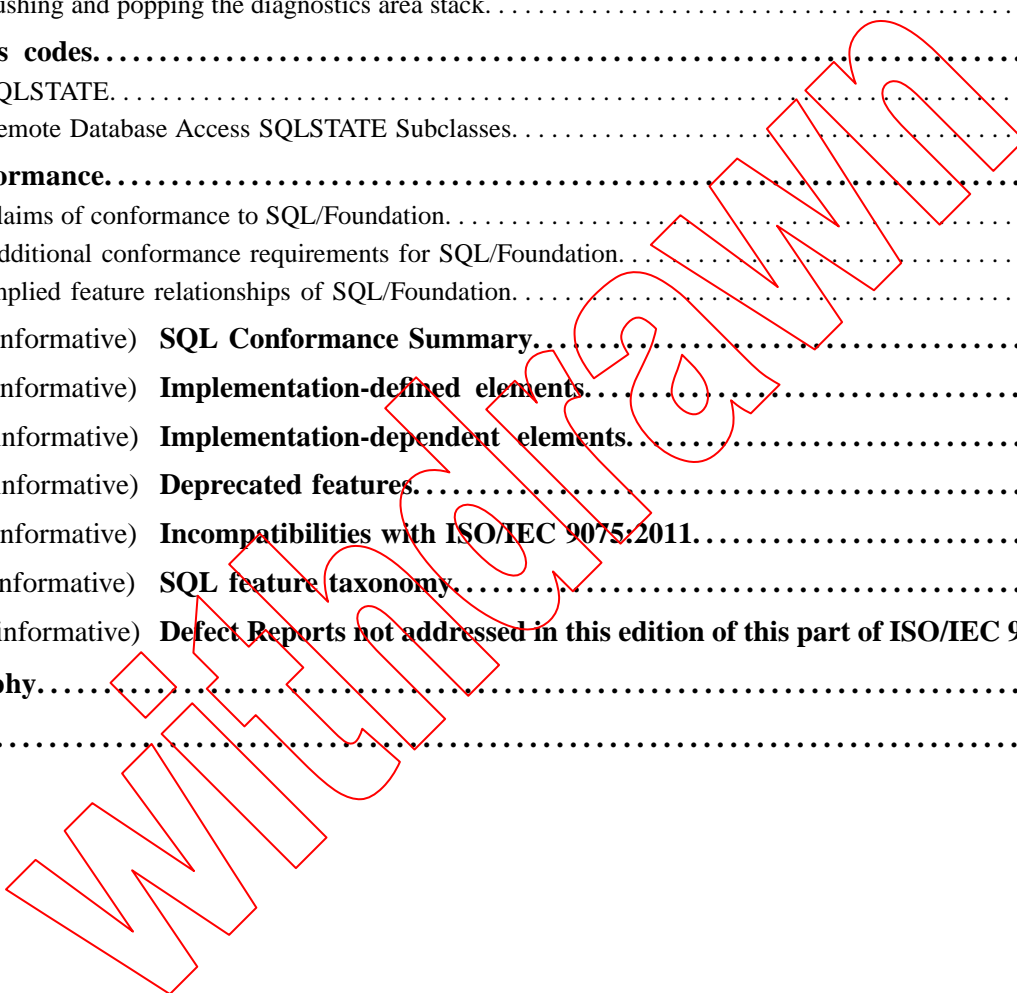
11.64	<drop user-defined cast statement>.....	1039
11.65	<user-defined ordering definition>.....	1041
11.66	<drop user-defined ordering statement>.....	1045
11.67	<transform definition>.....	1047
11.68	<alter transform statement>.....	1050
11.69	<add transform element list>.....	1052
11.70	<drop transform element list>.....	1054
11.71	<drop transform statement>.....	1056
11.72	<sequence generator definition>.....	1059
11.73	<alter sequence generator statement>.....	1061
11.74	<drop sequence generator statement>.....	1063
12	Access control.....	1065
12.1	<grant statement>.....	1065
12.2	<grant privilege statement>.....	1070
12.3	<privileges>.....	1073
12.4	<role definition>.....	1077
12.5	<grant role statement>.....	1078
12.6	<drop role statement>.....	1080
12.7	<revoke statement>.....	1081
12.8	Grantor determination.....	1099
13	SQL-client modules.....	1101
13.1	<SQL-client module definition>.....	1101
13.2	<module name clause>.....	1106
13.3	<externally-invoked procedure>.....	1107
13.4	<SQL procedure statement>.....	1123
13.5	Data type correspondences.....	1130
14	Data manipulation.....	1143
14.1	<declare cursor>.....	1143
14.2	<cursor properties>.....	1145
14.3	<cursor specification>.....	1147
14.4	<open statement>.....	1150
14.5	<fetch statement>.....	1151
14.6	<close statement>.....	1155
14.7	<select statement: single row>.....	1156
14.8	<delete statement: positioned>.....	1160
14.9	<delete statement: searched>.....	1162
14.10	<truncate table statement>.....	1166
14.11	<insert statement>.....	1168
14.12	<merge statement>.....	1174
14.13	<update statement: positioned>.....	1184
14.14	<update statement: searched>.....	1186
14.15	<set clause list>.....	1191
14.16	<temporary table declaration>.....	1196

14.17	<free locator statement>.....	1198
14.18	<hold locator statement>.....	1199
15	Additional data manipulation rules.....	1201
15.1	Effect of opening a cursor.....	1201
15.2	Effect of receiving a result set.....	1204
15.3	Determination of the current row of a cursor.....	1205
15.4	Effect of closing a cursor.....	1208
15.5	Effect of a positioned delete.....	1209
15.6	Effect of a positioned update.....	1211
15.7	Effect of deleting rows from base tables.....	1214
15.8	Effect of deleting some rows from a derived table.....	1217
15.9	Effect of deleting some rows from a viewed table.....	1219
15.10	Effect of inserting tables into base tables.....	1221
15.11	Effect of inserting a table into a derived table.....	1224
15.12	Effect of inserting a table into a viewed table.....	1226
15.13	Effect of replacing rows in base tables.....	1228
15.14	Effect of replacing some rows in a derived table.....	1232
15.15	Effect of replacing some rows in a viewed table.....	1235
15.16	Execution of BEFORE triggers.....	1237
15.17	Execution of referential actions.....	1238
15.18	Execution of AFTER triggers.....	1244
15.19	Execution of triggers.....	1245
16	Control statements.....	1249
16.1	<call statement>.....	1249
16.2	<return statement>.....	1250
17	Transaction management.....	1251
17.1	<start transaction statement>.....	1251
17.2	<set transaction statement>.....	1253
17.3	<transaction characteristics>.....	1255
17.4	<set constraints mode statement>.....	1257
17.5	<savepoint statement>.....	1259
17.6	<release savepoint statement>.....	1260
17.7	<commit statement>.....	1261
17.8	<rollback statement>.....	1263
18	Connection management.....	1267
18.1	<connect statement>.....	1267
18.2	<set connection statement>.....	1270
18.3	<disconnect statement>.....	1272
19	Session management.....	1275
19.1	<set session characteristics statement>.....	1275
19.2	<set session user identifier statement>.....	1277
19.3	<set role statement>.....	1278

ISO/IEC 9075-2:2016(E)

19.4	<set local time zone statement>.....	1279
19.5	<set catalog statement>.....	1280
19.6	<set schema statement>.....	1281
19.7	<set names statement>.....	1283
19.8	<set path statement>.....	1284
19.9	<set transform group statement>.....	1285
19.10	<set session collation statement>.....	1286
20	Dynamic SQL.....	1289
20.1	Description of SQL descriptor areas.....	1289
20.2	<allocate descriptor statement>.....	1300
20.3	<deallocate descriptor statement>.....	1302
20.4	<get descriptor statement>.....	1303
20.5	<set descriptor statement>.....	1307
20.6	<copy descriptor statement>.....	1312
20.7	<prepare statement>.....	1315
20.8	<cursor attributes>.....	1327
20.9	<deallocate prepared statement>.....	1328
20.10	<describe statement>.....	1330
20.11	<input using clause>.....	1337
20.12	<output using clause>.....	1341
20.13	<execute statement>.....	1346
20.14	<execute immediate statement>.....	1348
20.15	<dynamic declare cursor>.....	1349
20.16	<descriptor value constructor>.....	1351
20.17	<allocate extended dynamic cursor statement>.....	1353
20.18	<allocate received cursor statement>.....	1355
20.19	<dynamic open statement>.....	1357
20.20	<dynamic fetch statement>.....	1359
20.21	<dynamic single row select statement>.....	1360
20.22	<dynamic close statement>.....	1361
20.23	<dynamic delete statement: positioned>.....	1362
20.24	<dynamic update statement: positioned>.....	1364
20.25	<preparable dynamic delete statement: positioned>.....	1366
20.26	<preparable dynamic cursor name>.....	1368
20.27	<preparable dynamic update statement: positioned>.....	1370
20.28	<pipe row statement>.....	1372
21	Embedded SQL.....	1375
21.1	<embedded SQL host program>.....	1375
21.2	<embedded exception declaration>.....	1386
21.3	<embedded SQL Ada program>.....	1390
21.4	<embedded SQL C program>.....	1398
21.5	<embedded SQL COBOL program>.....	1407
21.6	<embedded SQL Fortran program>.....	1414

21.7	<embedded SQL MUMPS program>.....	1421
21.8	<embedded SQL Pascal program>.....	1425
21.9	<embedded SQL PL/I program>.....	1432
22	Direct invocation of SQL.....	1439
22.1	<direct SQL statement>.....	1439
22.2	<direct select statement: multiple rows>.....	1443
23	Diagnostics management.....	1445
23.1	<get diagnostics statement>.....	1445
23.2	Pushing and popping the diagnostics area stack.....	1462
24	Status codes.....	1463
24.1	SQLSTATE.....	1463
24.2	Remote Database Access SQLSTATE Subclasses.....	1474
25	Conformance.....	1475
25.1	Claims of conformance to SQL/Foundation.....	1475
25.2	Additional conformance requirements for SQL/Foundation.....	1476
25.3	Implied feature relationships of SQL/Foundation.....	1476
Annex A	(informative) SQL Conformance Summary.....	1483
Annex B	(informative) Implementation-defined elements.....	1567
Annex C	(informative) Implementation-dependent elements.....	1595
Annex D	(informative) Deprecated features.....	1607
Annex E	(informative) Incompatibilities with ISO/IEC 9075:2011.....	1609
Annex F	(informative) SQL feature taxonomy.....	1611
Annex G	(informative) Defect Reports not addressed in this edition of this part of ISO/IEC 9075..	1645
	Bibliography.....	1647
	Index.....	1649



Tables

Table	Page	
1	Overview of character sets.	30
2	Fields in datetime values.	38
3	Datetime data type conversions.	39
4	Fields in year-month INTERVAL values.	41
5	Fields in day-time INTERVAL values.	41
6	Valid values for fields in INTERVAL values.	41
7	Valid operators involving datetimes and intervals.	42
8	Schematic diagram of effective parameter lists of PTF component procedures.	125
9	SQL-transaction isolation levels and the three phenomena.	162
10	Interpretation of datetime components.	201
11	Valid values for datetime fields.	225
12	Valid absolute values for interval fields.	226
13	Truth table for the AND boolean operator.	380
14	Truth table for the OR boolean operator.	380
15	Truth table for the IS boolean operator.	380
16	<null predicate> semantics.	555
17	SQL/JSON and ECMAScript correspondences.	698
18	Standard programming languages.	749
19	Data type correspondences for Ada.	1130
20	Data type correspondences for C.	1132
21	Data type correspondences for COBOL.	1133
22	Data type correspondences for Fortran.	1135
23	Data type correspondences for M.	1136
24	Data type correspondences for Pascal.	1138
25	Data type correspondences for PL/I.	1139
26	Data types of <key word>s used in the header of SQL descriptor areas.	1293
27	Data types of <key word>s used in SQL item descriptor areas.	1293
28	Codes used for SQL data types in Dynamic SQL.	1295
29	Codes associated with datetime data types in Dynamic SQL.	1297
30	Codes used for <interval qualifier>s in Dynamic SQL.	1297
31	Codes used for input/output SQL parameter modes in Dynamic SQL.	1298
32	Codes associated with user-defined types in Dynamic SQL.	1298
33	Codes associated with sort direction.	1298
34	Codes associated with null ordering.	1299
35	<statement information item name>s for use with <get diagnostics statement>.	1447
36	<condition information item name>s for use with <get diagnostics statement>.	1447
37	SQL-statement codes.	1450
38	SQLSTATE class and subclass codes.	1464
39	SQLSTATE class codes for RDA.	1474
40	Implied feature relationships of SQL/Foundation.	1476
41	Syntactic transformations applied before Conformance Rules.	1483
42	Feature definitions outside of Conformance Rules.	1484
43	Feature taxonomy and definition for mandatory features.	1612

44 Feature taxonomy for optional features. 1628

Withdrawn

Figures

Figure	Page
1 Operation of <regular expression substring function>.....	23
2 Illustration of WIDTH_BUCKET Semantics.....	36
3 Illustration of important concepts in example query.....	83
4 Taxonomy of SQL-invoked routines.....	116
5 Flow of information during the invocation of a polymorphic table function.....	124
6 Architecture of SQL/JSON path language usage.....	178
7 Diagram of COLTREE.....	456
8 Diagram of a plan tree.....	457

Withdrawal

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 32, *Data management and interchange*.

This fifth edition of ISO/IEC 9075-2 cancels and replaces the fourth edition (ISO/IEC 9075-2:2011), which has been technically revised. It also incorporates Technical Corrigenda ISO/IEC 9075-2:2011/Cor.1:2013 and ISO/IEC 9075-2:2011/Cor.2:2015.

A list of all parts in the ISO/IEC 9075 series, published under the general title *Information technology — Database languages — SQL*, can be found on the ISO website.

NOTE The individual parts of multi-part standards are not necessarily published together. New editions of one or more parts can be published without publication of new editions of other parts.

Introduction

The organization of this part of ISO/IEC 9075 is as follows:

- 1) Clause 1, “Scope”, specifies the scope of this part of ISO/IEC 9075.
- 2) Clause 2, “Normative references”, identifies additional standards that, through reference in this part of ISO/IEC 9075, constitute provisions of this part of ISO/IEC 9075.
- 3) Clause 3, “Definitions, notations, and conventions”, defines the notations and conventions used in this part of ISO/IEC 9075.
- 4) Clause 4, “Concepts”, presents concepts used in the definition of SQL.
- 5) Clause 5, “Lexical elements”, defines the lexical elements of the language.
- 6) Clause 6, “Scalar expressions”, defines the elements of the language that produce scalar values.
- 7) Clause 7, “Query expressions”, defines the elements of the language that produce rows and tables of data.
- 8) Clause 8, “Predicates”, defines the predicates of the language.
- 9) Clause 9, “Additional common rules”, specifies the rules for assignments that retrieve data from or store data into SQL-data, and formation rules for set operations.
- 10) Clause 10, “Additional common elements”, defines additional language elements that are used in various parts of the language.
- 11) Clause 11, “Schema definition and manipulation”, defines facilities for creating and managing a schema.
- 12) Clause 12, “Access control”, defines facilities for controlling access to SQL-data.
- 13) Clause 13, “SQL-client modules”, defines SQL-client modules and externally-invoked procedures.
- 14) Clause 14, “Data manipulation”, defines the data manipulation statements.
- 15) Clause 15, “Additional data manipulation rules”, defines additional rules for data manipulation.
- 16) Clause 16, “Control statements”, defines the SQL-control statements.
- 17) Clause 17, “Transaction management”, defines the SQL-transaction management statements.
- 18) Clause 18, “Connection management” defines the SQL-connection management statements.
- 19) Clause 19, “Session management”, defines the SQL-session management statements.
- 20) Clause 20, “Dynamic SQL”, defines the SQL dynamic statements.
- 21) Clause 21, “Embedded SQL”, defines the host language embeddings.
- 22) Clause 22, “Direct invocation of SQL”, defines direct invocation of SQL language.
- 23) Clause 23, “Diagnostics management”, defines the diagnostics management facilities.
- 24) Clause 24, “Status codes”, defines values that identify the status of the execution of SQL-statements and the mechanisms by which those values are returned.

- 25) **Clause 25, “Conformance”**, defines the criteria for conformance to this part of ISO/IEC 9075.
- 26) **Annex A, “SQL Conformance Summary”**, is an informative Annex. It summarizes the conformance requirements of the SQL language.
- 27) **Annex B, “Implementation-defined elements”**, is an informative Annex. It lists those features for which the body of this part of ISO/IEC 9075 states that the syntax, the meaning, the returned results, the effect on SQL-data and/or schemas, or any other behavior is partly or wholly implementation-defined.
- 28) **Annex C, “Implementation-dependent elements”**, is an informative Annex. It lists those features for which the body of this part of ISO/IEC 9075 states that the syntax, the meaning, the returned results, the effect on SQL-data and/or schemas, or any other behavior is partly or wholly implementation-dependent.
- 29) **Annex D, “Deprecated features”**, is an informative Annex. It lists features that the responsible Technical Committee intend will not appear in a future revised version of this part of ISO/IEC 9075.
- 30) **Annex E, “Incompatibilities with ISO/IEC 9075:2011”**, is an informative Annex. It lists incompatibilities with the previous version of this part of ISO/IEC 9075.
- 31) **Annex F, “SQL feature taxonomy”**, is an informative Annex. It identifies features of the SQL language specified in this part of ISO/IEC 9075 by an identifier and a short descriptive name. This taxonomy is used to specify conformance.
- 32) **Annex G, “Defect Reports not addressed in this edition of this part of ISO/IEC 9075”**, is an informative Annex. It describes the Defect Reports that were known at the time of publication of this part of this International Standard. Each of these problems is a problem carried forward from the previous edition of ISO/IEC 9075. No new problems have been created in the drafting of this edition of this International Standard.

In the text of this part of ISO/IEC 9075, Clauses and Annexes begin new odd-numbered pages, and in **Clause 5, “Lexical elements”**, through **Clause 24, “Status codes”**, Subclauses begin new pages. Any resulting blank space is not significant.

(Blank page)

Withdrawn

Information technology — Database languages — SQL —

Part 2:

Foundation (SQL/Foundation)

1 Scope

This part of ISO/IEC 9075 defines the data structures and basic operations on SQL-data. It provides functional capabilities for creating, accessing, maintaining, controlling, and protecting SQL-data.

This part of ISO/IEC 9075 specifies the syntax and semantics of a database language:

- For specifying and modifying the structure and the integrity constraints of SQL-data.
- For declaring and invoking operations on SQL-data and cursors.
- For declaring database language procedures.
- For embedding SQL-statements in a compilation unit that is otherwise written in a particular programming language (host language).
- For deriving an equivalent compilation unit in the host language. In that equivalent compilation unit, each embedded SQL-statement has been replaced by one or more statements in the host language, some of which invoke an SQL externally-invoked procedure that, when executed, has an effect equivalent to executing the SQL-statement.
- For direct invocation of SQL-statements.
- To support dynamic preparation and execution of SQL-statements.

This part of ISO/IEC 9075 provides a vehicle for portability of data definitions and compilation units between SQL-implementations.

This part of ISO/IEC 9075 provides a vehicle for interconnection of SQL-implementations.

Implementations of this part of ISO/IEC 9075 can exist in environments that also support application programming languages, end-user query languages, report generator systems, data dictionary systems, program library systems, and distributed communication systems, as well as various tools for database design, data administration, and performance optimization.

(Blank page)

Withdrawn

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.

2.1 ISO and IEC standards

[ISO1539-1] ISO/IEC 1539-1:2004, *Information technology — Programming languages — Fortran — Part 1: Base language*.

[ISO1539-1_Cor1] ISO/IEC 1539-1:2004/Cor 1:2006.

[ISO1539-1_Cor2] ISO/IEC 1539-1:2004/Cor 2:2007.

[ISO1539-1_Cor3] ISO/IEC 1539-1:2004/Cor 3:2008.

[ISO1539-1_Cor4] ISO/IEC 1539-1:2004/Cor 4:2009.

[ISO1989] ISO/IEC 1989:2002, *Information technology — Programming languages — COBOL*.

[ISO1989_Cor1] ISO/IEC 1989:2002/Cor 1:2006.

[ISO1989_Cor2] ISO/IEC 1989:2002/Cor 2:2006.

[ISO1989_Cor3] ISO/IEC 1989:2002/Cor 3:2009.

[ISO6160] ISO 6160:1979, *Programming languages — PL/I* (Endorsement of ANSI X3.53-1976).

[ISO7185] ISO 7185:1990, *Information technology — Programming languages — Pascal*.

[ISO8601] ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*.

[ISO8652] ISO/IEC 8652:1995, *Information technology — Programming languages — Ada*.

[ISO8652_Cor1] ISO/IEC 8652:1995/Cor.1:2001.

[ISO8859-1] ISO/IEC 8859-1, *Information technology — 8-bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1*

[ISO9075-1] ISO/IEC 9075-1:2016, *Information technology — Database languages — SQL — Part 1: Framework (SQL/Framework)*.

[ISO9075-11] ISO/IEC 9075-11:2016, *Information technology — Database languages — SQL — Part 11: Information and Definition Schemas (SQL/Schemata)*.

[ISO9579] ISO/IEC 9579, *Information technology — Remote database access for SQL with security enhancement*.

ISO/IEC 9075-2:2016(E)

2.1 ISO and IEC standards

[ISO9899] ISO/IEC 9899:1999, *Programming languages — C*.

[ISO9899_Cor1] ISO/IEC 9899:1999/Cor 1:2001.

[ISO9899_Cor2] ISO/IEC 9899:1999/Cor 2:2004.

[ISO9899_Cor3] ISO/IEC 9899:1999/Cor 3:2007.

[ISO10206] ISO/IEC 10206:1991, *Information technology — Programming languages — Extended Pascal*.

[ISO10646] ISO/IEC 10646, *Information technology — Universal Multiple-Octet Coded Character Set (UCS)*.

[ISO11756] ISO/IEC 11756:1999, *Information technology — Programming languages — M*.

[ISO14651] ISO/IEC 14651, *Information technology — International string ordering and comparison — Method for comparing character strings and description of the common template tailorable ordering*.

[ECMAScript] ISO/IEC 16262:2011, *Information technology — Programming languages, their environments and system software interfaces — ECMAScript language specification*; also available as *ECMAScript Language Specification*, <http://www.ecma-international.org/ecma-262/5.1/-ECMA-262.pdf>

2.2 Other international standards

[RFC7159] Internet Engineering Task Force, RFC 7159, *The JavaScript Object Notation (JSON) Data Interchange Format*, March 2014; <http://www.ietf.org/rfc/rfc7159>

[Unicode] The Unicode Consortium, *The Unicode Standard*. (Information about the latest version of the Unicode standard can be found by using the "Latest Unicode Version" link on the "Enumerated Versions of The Unicode Standard" page.)

<http://www.unicode.org/versions/enumeratedversions.html>

[Unicode10] Davis, Mark and Whistler, Ken. *Unicode Technical Standard #10, Unicode Collation Algorithm*, The Unicode Consortium.

<http://www.unicode.org/reports/tr10/>

[Unicode15] Davis, Mark and Dürst, Martin, *Unicode Standard Annex #15: Unicode Normalization Forms*, The Unicode Consortium.

<http://www.unicode.org/reports/tr15/>

[Unicode18] Davis, Mark, *Unicode Technical Standard #18: Unicode Regular Expressions*, The Unicode Consortium.

<http://www.unicode.org/reports/tr18/>

[XQueryFO] (W3C Recommendation) XQuery 1.0 and XPath 2.0 Functions and Operators. World Wide Web Consortium.

<http://www.w3.org/TR/xpath-functions/>