INTERNATIONAL STANDARD

ISO/IEC 9075-15

Second edition
2023-06

Information technology — Database languages SQL —

Part 15: Multidimensional arrays (SQL/MDA)

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

Partie 15: Tableaux multi-dimensionnels (SQL/MDA)

Reference number
ISO/IEC 9075-15:2023(E)

© ISO/IEC 2023



COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, 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
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO/IEC 2023 – All rights reserved

Contents

Page

Foreword . . . vii
Introduction . . . ix
1 Scope . . . 1
2 Normative references . . . 2
3 Terms and definitions . . . 3
4 Concepts . . . 4
4.1 Notations and conventions . . . 4
4.1.1 Notations . . . 4
4.2 Data types . . . 4
4.2.1 General introduction to data types . . . 4
4.2.2 Data type terminology . . . 4
4.3 Numbers . . . 5
4.3.1 Operations involving numbers . . . 5
4.4 User-defined types . . . 5
4.4.1 Distinct types . . . 5
4.5 Collection types . . . 5
4.5.1 Introduction to collection types . . . 5
4.5.2 MD-arrays . . . 6
4.5.3 Collection comparison and assignment . . . 7
4.5.4 Operations involving MD-arrays . . . 7
4.5.4.1 Operators that operate on MD-array values and return MD-array values . . . 7
4.5.4.2 Operators that operate on MD-array values and return tables . . . 8
4.5.4.3 Operators that operate on MD-array values and return numbers . . . 9
4.5.4.4 Operators that operate on MD-array values and return character strings . . . 9
4.5.4.5 Operators that operate on MD-array values and return numbers or Boolean values . . . 9
4.5.4.6 Operators that operate on MD-array values and return character or binary strings . . . 10
4.5.4.7 Operators that construct new MD-array values . . . 10
4.5.4.8 Operators that operate on MD-array values and return MD-array elements . . . 10
4.5.5 MD-axis variables . . . 10
5 Lexical elements . . . 11
5.1 <token> and <separator> . . . 11
5.2 Names and identifiers . . . 12
6 Scalar expressions . . . 13
6.1 <data type> . . . 13
6.2 <value expression primary> . . . 16
6.3 <md-array subset> . . . 18
6.4 <identifier chain> . . . 21
6.5 <md-array aggregation expression> . . . 22

© ISO/IEC 2023 – All rights reserved

6.6 <case expression>. . . . 25
6.7 <cast specification>. . . . 27
6.8 <value expression>. . . . 30
6.9 <numeric value function>. . . . 31
6.10 <string value function>. . . . 34
6.11 <md-array encode function>. . . . 36
6.12 <md-array value expression>. . . . 38
6.13 <md-array value function>. . . . 44
6.14 <md-array value constructor>. . . . 52
6.15 <md-array element reference>. . . . 58
7 Query expressions. . . . 60
7.1 <table reference>. . . . 60
7.2 <query specification>. . . . 63
8 Predicates. . . . 64
8.1 <distinct predicate>. . . . 64
9 Additional common rules. . . . 65
9.1 Retrieval assignment. . . . 65
9.2 Store assignment. . . . 67
9.3 Passing a value from a host language to the SQL-server. . . . 68
9.4 Passing a value from the SQL-server to a host language. . . . 69
9.5 Result of data type combinations. . . . 70
9.6 Type name determination. . . . 71
9.7 Determination of identical values. . . . 72
9.8 Equality operations. . . . 73
9.9 Grouping operations. . . . 74
9.10 Multiset element grouping operations. . . . 75
9.11 Ordering operations. . . . 76
9.12 Potential sources of non-determinism. . . . 77
9.13 Invoking an SQL-invoked routine. . . . 78
9.14 Data type identity. . . . 79
9.15 Indexed name. . . . 80
9.16 MD-array subset. . . . 82
9.17 Canonicalize MD-array element reference. . . . 86
9.18 Execution of MD-array-returning external functions. . . . 88
10 Additional common elements. . . . 92
10.1 <md-extent alternative>. . . . 92
10.2 <md-array md-axis>. . . . 95
11 Schema definition and manipulation. . . . 96
11.1 <column definition>. . . . 96
11.2 <view definition>. . . . 97
11.3 <user-defined type definition>. . . . 98
11.4 <SQL-invoked routine>. . . . 99
12 SQL-client modules. . . . 100
12.1 <externally-invoked procedure>. . . . 100
12.2 Data type correspondences. . . . 102

 © ISO/IEC 2023 – All rights reserved

13 Data manipulation . . . 104
13.1 <set clause list> . . . 104
14 Additional data manipulation rules . . . 106
14.1 Evaluating a <set clause list> . . . 106
15 Dynamic SQL . . . 108
15.1 Description of SQL descriptor areas . . . 108
15.2 <get descriptor statement> . . . 110
15.3 <describe statement> . . . 111
16 Embedded SQL . . . 112
16.1 <embedded SQL Ada program> . . . 112
16.2 <embedded SQL C program> . . . 114
16.3 <embedded SQL COBOL program> . . . 115
16.4 <embedded SQL Fortran program> . . . 116
16.5 <embedded SQL MUMPS program> . . . 117
16.6 <embedded SQL PL/I program> . . . 118
17 Call-Level Interface specifications . . . 119
17.1 SQL/CLI data type correspondences . . . 119
18 Information Schema . . . 121
18.1 Information Schema digital artifact . . . 121
18.2 ELEMENT_TYPES view . . . 121
18.3 MD_EXTENTS view . . . 122
19 Definition Schema . . . 123
19.1 Definition Schema digital artifact . . . 123
19.2 DATA_TYPE_DESCRIPTOR base table . . . 123
19.3 ELEMENT_TYPES base table . . . 125
19.4 MD_EXTENTS base table . . . 126
20 Status codes . . . 128
20.1 SQLSTATE . . . 128
21 Conformance . . . 130
21.1 Claims of conformance to SQL/MDA . . . 130
21.2 Implied feature relationships of SQL/MDA . . . 130
Annex A (informative) **SQL conformance summary** . . . 131
Annex B (informative) **Implementation-defined elements** . . . 135
Annex C (informative) **Implementation-dependent elements** . . . 138
Annex D (informative) **SQL optional feature taxonomy** . . . 139
Annex E (informative) **Deprecated features** . . . 140
Annex F (informative) **Incompatibilities with ISO/IEC 9075:2016** . . . 141
Annex G (informative) **Defect Reports not addressed in this edition of this document** . . . 143
Bibliography . . . 144
Index . . . 145

© ISO/IEC 2023 – All rights reserved

Tables

Table

Page

1 Table aggregation operators. . . . 9
2 Data type correspondences for Ada. . . . 102
3 Data type correspondences for C. . . . 102
4 Data type correspondences for COBOL. . . . 102
5 Data type correspondences for Fortran. . . . 102
6 Data type correspondences for M. . . . 103
7 Data type correspondences for Pascal. . . . 103
8 Data type correspondences for PL/I. . . . 103
9 Data types of <key word>s used in SQL item descriptor areas. . . . 108
10 Codes used for SQL data types in Dynamic SQL. . . . 109
11 SQL/CLI data type correspondences for Ada. . . . 119
12 SQL/CLI data type correspondences for C. . . . 119
13 SQL/CLI data type correspondences for COBOL. . . . 119
14 SQL/CLI data type correspondences for Fortran. . . . 120
15 SQL/CLI data type correspondences for M. . . . 120
16 SQL/CLI data type correspondences for Pascal. . . . 120
17 SQL/CLI data type correspondences for PL/I. . . . 120
18 SQLSTATE class and subclass codes. . . . 128
19 Implied feature relationships of SQL/MDA. . . . 130
D.1 Feature taxonomy for optional features. . . . 139

© ISO/IEC 2023 – All rights reserved

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.

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 or www.iec.ch/members_experts/refdocs).

ISO and IEC draw attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO and IEC take no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO and IEC have not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents and https://patents.iec.ch. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

This second edition cancels and replaces the first edition (ISO/IEC 9075-15:2019), which has been technically revised. It also incorporates the Technical Corrigendum ISO/IEC 9075-15:2019/Cor.1:2022.

The main changes are as follows:

— improve the presentation and accuracy of the summaries of implementation-defined and implementation-dependent aspects of this document;

— introduction of several digital artifacts;

— alignment with updated ISO house style and other guidelines for creating standards.

This second edition of ISO/IEC 9075-15 is designed to be used in conjunction with the following editions of other parts of the ISO/IEC 9075 series, all published in 2023:

— ISO/IEC 9075-1, sixth edition;

— ISO/IEC 9075-2, sixth edition;

— ISO/IEC 9075-3, sixth edition;

© ISO/IEC 2023 – All rights reserved

— ISO/IEC 9075-4, seventh edition;

— ISO/IEC 9075-9, fifth edition;

— ISO/IEC 9075-10, fifth edition;

— ISO/IEC 9075-11, fifth edition;

— ISO/IEC 9075-13, fifth edition;

— ISO/IEC 9075-14, sixth edition;

— ISO/IEC 9075-16, first edition.

A list of all parts in the ISO/IEC 9075 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

© ISO/IEC 2023 – All rights reserved

Introduction

This document was developed in response to industry demand for the ability to store and manipulate data in the form of multidimensional arrays within databases managed using database language SQL.

The organization of this document is as follows:

1) Clause 1, "Scope", specifies the scope of this document.

2) Clause 2, "Normative references", identifies additional standards that, through reference in this document, constitute provisions of this document.

3) Clause 3, "Terms and definitions", defines the notations and conventions used in this document.

4) Clause 4, "Concepts", presents concepts used in the definition of multidimensional arrays.

5) Clause 5, "Lexical elements", defines a number of lexical elements used in the definition of multidimensional arrays.

6) Clause 6, "Scalar expressions", defines a number of scalar expressions used in the definition of multidimensional arrays.

7) Clause 7, "Query expressions", defines the elements of the language that produce rows and tables of data as used in multidimensional arrays.

8) Clause 8, "Predicates", defines the predicates used in the definition of multidimensional arrays.

9) Clause 9, "Additional common rules", specifies the rules for assignments that retrieve multidimensional array data from or store multidimensional array data into SQL-data, and formation rules for set operations.

10) Clause 10, "Additional common elements", defines additional common elements used in the definition of multidimensional arrays.

11) Clause 11, "Schema definition and manipulation", defines facilities for creating and managing a schema.

12) Clause 12, "SQL-client modules", defines SQL-client modules and externally-invoked procedures in the context of multidimensional arrays.

13) Clause 13, "Data manipulation", defines the data manipulation statements.

14) Clause 14, "Additional data manipulation rules", defines additional rules for data manipulation.

15) Clause 15, "Dynamic SQL", defines the facilities for executing SQL-statements dynamically in the context of multidimensional arrays.

16) Clause 16, "Embedded SQL", defines the host language embeddings in the context of multidimensional arrays.

17) Clause 17, "Call-Level Interface specifications", defines facilities for using SQL through a Call-Level Interface.

18) Clause 18, "Information Schema", defines the Information and Definition Schema objects associated with multidimensional arrays.

19) Clause 19, "Definition Schema", defines base tables on which the viewed tables containing schema information depend.

20) Clause 20, "Status codes", defines SQLSTATE values related to multidimensional arrays.

© ISO/IEC 2023 – All rights reserved

21) Clause 21, "Conformance", defines the criteria for conformance to this document.

22) Annex A, "SQL conformance summary", is an informative Annex. It summarizes the conformance requirements of the SQL language.

23) Annex B, "Implementation-defined elements", is an informative Annex. It lists those features for which the body of this document states that the syntax, the meaning, the returned results, the effect on SQL-data and/or schemas, or other aspect is partly or wholly implementation-defined.

24) Annex C, "Implementation-dependent elements", is an informative Annex. It lists those features for which the body of this document states that the syntax, the meaning, the returned results, the effect on SQL-data and/or schemas, or other aspect is partly or wholly implementation-dependent.

25) Annex D, "SQL optional feature taxonomy", is an informative Annex. It identifies the optional features of the SQL language specified in this document by an identifier and a short descriptive name. This taxonomy is used to specify conformance.

26) Annex E, "Deprecated features", is an informative Annex. It lists features that the responsible Technical Committee intends not to include in a future edition of this document.

27) Annex F, "Incompatibilities with ISO/IEC 9075:2016", is an informative Annex. It lists incompatibilities with the previous version of this document.

28) Annex G, "Defect Reports not addressed in this edition of this document", is an informative Annex. It describes the Defect Reports that were known at the time of publication of this document. Each of these problems is a problem carried forward from the previous edition of the ISO/IEC 9075 series. No new problems have been created in the drafting of this edition of this document.

In the text of this document, in Clause 5, "Lexical elements", through Clause 21, "Conformance", Subclauses begin new pages. Any resulting blank space is not significant.

 © ISO/IEC 2023 – All rights reserved

Information technology — Database language SQL —

Part 15:
Multidimensional arrays (SQL/MDA)

1 Scope

This document defines ways in which Database Language SQL can be used in conjunction with multidimensional arrays.

© ISO/IEC 2023 – All rights reserved

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 9075-1, *Information technology — Database languages — SQL — Part 1: Framework (SQL/Framework)*

ISO/IEC 9075-2, *Information technology — Database languages — SQL — Part 2: Foundation (SQL/Foundation)*

ISO/IEC 9075-3, *Information technology — Database languages — SQL — Part 3: Call-Level Interface (SQL/CLI)*

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

Internet Engineering Task Force (IETF) RFC 2046 *Multipurpose Internet Mail Extensions (MIME), Part Two: Media Types*. Edited by: Freed, N. November 1996
Available at: `https://tools.ietf.org/html/rfc2046`

Internet Engineering Task Force (IETF) RFC 8259 *The JavaScript Object Notation (JSON) Data Interchange Format*. Edited by: Miller, Matthew December 2018
Available at: `https://datatracker.ietf.org/doc/rfc8259/`

© ISO/IEC 2023 – All rights reserved