



ANSI C12.19-2012

American National Standard for Utility Industry End Device Data Tables





ANSI C12.19-2012

*American National Standard
for Utility Industry End Device Data Tables*

Secretariat:

National Electrical Manufacturers Association

IEEE Number: IEEE Std 1377-2012

Measurement Canada Number: MC12.19-2013

Approved October 2, 2014

American National Standards Institute, Inc

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

NEMA standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health- or safety-related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

AMERICAN NATIONAL STANDARD

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

Caution Notice: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

**National Electrical Manufacturers Association
1300 North 17th Street, Suite 900, Rosslyn, Virginia 22209**

© 2015 National Electrical Manufacturers Association. All rights, including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American copyright conventions.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without prior written permission of the publisher.

Printed in the United States of America

Foreword (This Foreword is not part of American National Standard C12.19-2012.)

The ANSI C12.19 Standard provides a common data structure and descriptors for use in transferring data to and from utility End Devices, typically meters and head-ends. It has been developed with consideration of input from utilities, meter vendors, automated meter reading service companies, ANSI, Measurement Canada (for Industry Canada), NEMA, IEEE, Utilimetrics, NIST, SGIP, AEIC, and other interested parties nationally and internationally. This release of the Standard accommodates the concept of an advanced metering infrastructure (AMI), such as that identified by the Office of Electricity Delivery and Energy Reliability of the U.S. Department of Energy; the Smart Metering Initiative of the Ontario Ministry of Energy (Canada); and the stated requirements of Measurement Canada for the approval of a metering device for use in Canada.

ANSI C12.19 Tables are organized into functional groups known as Decades (nominally ten Tables per Decade). The ANSI C12.19 Standard contains up to 2040 “Standard Tables” that are fully described in the Standard. In addition, provisions were made for an additional 2040 “Manufacturers’ Tables” so that future innovations can be implemented utilizing the extension framework and mechanisms specified by the semantic model of this ANSI C12.19 Standard. These mechanisms facilitate the possibility of future inclusion of Manufacturer-defined Tables into future publications of the Standard. The Standard provides the means for the inclusion of Manufacturer-defined Tables into End Devices through designation of new Device Classes.

Another set of 2040 “Extended User-defined Tables” is available for End Devices that have a need for extremely low communications overhead and a high need for compaction of data. The User-defined Tables and the Extended User-defined Tables aggregate Elements of information from other Tables (Standard Tables Elements or Manufacturer Table Elements). These “Formal Elements” can be bundled into “virtual” Tables for transmission.

The Standard defines “Pending” attributes for Standard Tables, Manufacturer Tables, Standard Procedures, Manufacturer Procedures, and Extended User-defined Tables for use in applications such as End Device deferred programming and End Device firmware upgrades with activation and roll-back capabilities. The Pending Tables also facilitate Event-driven and synchronized actionable communication for use by enterprise systems (such as head-end systems) that communicate with a multitude of C12.19 devices in an AMI network of a Smart Grid.

The Standard’s flexibility presents a challenge to system developers, equipment vendors, utilities, and customers alike. System developers must continue to provide the capability of processing multiple data formats from the End Devices. The obvious advantage of ANSI C12.19 is that the semantic rules and semantic model of the Table structures can be published using machine-readable TDL/XML (structure) and EDL/XML (enterprise exchange data) Forms, in addition to the human readable (Standard Document) Forms. TDL/XML and EDL/XML, together with their derivative products (such as the human readable forms), are expected to be accessible through accredited registries via the Internet or other readily available means.

All registration authorities that recognize registrars are governed by ANSI C12 and IEEE SCC31. To be recognized, any registration authority is expected to adhere to the requirements specified in this Standard. See 0 (normative) “Universal Identifier.”

The ANSI C12.19 Standard provides mechanisms and identifies means to access the Table data. For this reason, it is expected that data acquisition AMI products should be capable of processing data from any End Device that follows the access rules defined by ANSI C12.19 and associated communication protocols (such as ANSI C12.18, ANSI C12.21, and ANSI C12.22) and services. The End Device’s Table of Contents is provisioned by ANSI C12.19 Table 0, “General Configuration Table.” Access to Standard Table 0, function limiting Tables (of the Decades), and information found in device control Tables can be combined with ANSI C12.19 Device Class information to gain the necessary information about “End Devices” for improved efficiency and interoperability.

Although this Standard covers a broad range of functionality, it does not follow that implementations of the Standard need to be large or complex. Implementers and users are encouraged to choose an appropriate functionality subset that is suitable for their needs. Therefore, it is very unlikely for any one End Device to embed all Tables or even the majority of the Tables described herein. Implementers and users are encouraged to deploy their desired functionalities using complete and consistent suites of Standard Tables from Standard Decades to the largest extent practical for the desired functionality of the device.

The third release of this Standard is a minor release in that it establishes a new baseline document that includes all of the corrections that were applied in Annex N, "Listing of Editorial Errors and Errors of Omission in ANSI C12.19-2008" of IEEE Std 1377™-2012.

The notable differences and corrections that exist in this release of the Standard relative to its predecessor ANSI C12.19-2008 are listed below:

1. Document is formatted according to IEEE Standards Template (Measurement Canada Version only).
2. New clause 1.1, "Purpose" was introduced to clause 1, "Scope."
3. Introduced new references to clause 2, "Normative Reference":
 - a. AEICGL : 2010—*Smart Grid/AEIC AMI Interoperability Standard Guidelines for ANSI C12.19 / IEEE 1377 / MC12.19 End Device Communications and Supporting Enterprise Devices, Network and Related Accessories*, The Association of Edison Illuminating Companies (AEIC), v2.0, 2010.
 - b. ANSI C12.19, *American National Standard for Utility Industry End Device Data Tables*
 - c. ANSI C12.19-1997, *American National Standard for Utility Industry End Device Data Tables*
 - d. ANSI C12.19-2008, *American National Standard for Utility Industry End Device Data Tables*
 - e. FERC-727-728-2008, Federal Energy Regulatory Commission, *Survey on Demand Response, Time-Based Rate Programs/Tariffs and Advanced Metering Infrastructure Glossary*, FERC-727 and FERC-728, OMB Control Nos. 1902-0214 & 1902-0213
 - f. IEEE Std 1377™-1998, *IEEE Standard for Utility Industry End Device Data Tables*
 - g. MC S-EG-02-2010, *Measurement Canada Specifications for Approval of Physical Sealing Provisions for Electricity and Gas Meters, S-EG-02 (rev. 1)*
 - h. XHTML-2002, *XHTML 1.0 The Extensible HyperText Markup Language (Second Edition)*, W3C Recommendation 26, 2000, revised 2002
 - i. XML-2006, *Extensible Markup Language (XML) 1.1 (Second Edition)*, W3C Recommendation 16
 - j. XMLSchema-2012, *W3C XML Schema Definition Language (XSD) 1.1 Part 1: Structures* W3C Recommendation 5
 - k. XMLSig-2008, *XML Signature Syntax and Processing (Second Edition)*, W3C Recommendation 10
4. Moved references to URLs into page footnotes.
5. Moved clause 2.2, "Other" to Annex M (informative) "Bibliography."
6. Added reference to the "IEEE-SA Standards Definitions Database" in clause 3, "Definitions."
7. Removed numbers from the definitions in clause 3, "Definitions."
8. Replaced Procedure Property "extend" with "type" in clause 4.2.3, "Manufacturer Procedure Properties."
9. Replaced all references to word "byte" with "Octet."
10. Introduced Element-name aliases for backward compatibility with ANSI C12.19-1997, ANSI C12.19-2008, and IEEE Std 1377-1998.
11. Introduced allowance for GEN_CONFIG_TBL.MODEL_SELECT of 1 in clause 6.4.4, "SOURCE_SELECT_RCD".
12. Swapped the terms "target" and "initiating" in clause 8.1.1, "Read Service."

13. Corrected the description of Offset/Octet-count Method in clause 8.1.1, "Read Service."
14. Corrected the description of Offset/Octet-count Method in clause 8.1.2, "Write Service."
15. Corrected the TDL Type Definitions syntax in clause 8.2, "Pending Event Description."
16. Added missing descriptions to TDL Element Descriptions in clause 8.2, "Pending Event Description."
17. Corrected the TDL Element Descriptions true/false and high/low sense in clause 8.2, "List Management Description."
18. Updated MODEL_SELECT in clause 9.1.1, "Table 00 General Configuration Table" to provide reference to the AEIC Guidelines Version 2 [AEICGL : 2010].
19. Updated the description of DEVICE_CLASS in clause 9.1.1, "Table 00 General Configuration Table" to indicate that the last arc tracks the value of MODEL_SELECT.
20. Updated the descriptions of STD_VERSION_NO and STD_REVISION_NO in clause 9.1.1, "Table 00 General Configuration Table."
21. Corrected duplication in syntax of Table 04 Type Definitions in clause 9.1.5, "Table 04 Pending Status Table."
22. Recast and updated descriptions of GPS COORDINATE_1, COORDINATE_2, and COORDINATE_3 in terms of definitely structured STRINGS in clause 9.1.7, "Table 06 Utility Information Table."
23. Corrected and replaced the terms "off/on" with "disconnect/connect" in the definition of NEW_LEVEL in clause 9.1.10.22, "Procedure 21 Direct Load Control."
24. Updated Decade 1 Data Description in clause 9.2, "Decade 1: Data Source Tables" to correctly reflect changes in MODEL_SELECT values.
25. Corrected UOM values above 220 in clause 9.2.3, "Table 12 Units of Measure Entry Table."
26. Corrected ID_RESOURCE values above 23 in clause 9.2.3, "Table 12 Units of Measure Entry Table."
27. Added security best practice recommendation to note in clause 9.5.3, "Table 42 Security Table."
28. Added security best practice recommendation to note in clause 9.5.6, "Table 45 Key Table."
29. Corrected description of TIME_ZONE_OFFSET in clause 9.6.4, "Table 53 Time Offset Table."
30. Introduced SIG_ALGORITHM Element to facilitate the introduction of hash functions that comply with FIPS PUB 180-2 in clause 9.8.1, "Table 70 Log Dimension Limits Table."
31. Introduced SIG_ALGORITHM Element to facilitate the introduction of hash functions that comply with FIPS PUB 180-2 in clause 9.8.2, "Table 70 Actual Log Limiting Table."
32. Revised hash function algorithm descriptions in clause 9.8.9, "Table 78 End Device Program State Table" to reflect the changes made to ACT_LOG_TBL and ACT_LOG_TBL Elements SIG_ALGORITHM.
33. Corrected description of Element LEVEL_SUPPORTED_FLAG in clause 9.12.3, "Table 112 Load Control Status."
34. Added citations IEEE Std 1159-1995 (R2001) and IEEE Std 519-1992 description section of clause 9.16, "Decade 15: Quality-of-service."
35. Corrected Table role and accessibility properties and reorganized descriptions in clause 9.16.4, "Table 153 Quality-of-service Incidents Table."
36. Corrected Table role and accessibility properties in clause 9.16.5, "Table 154 Quality-of-service Log Table."
37. Corrected Table role and accessibility properties in clause 9.17.4, "Table 163 One-way Data Table."
38. Modified unit of measures in COMMODITY_OUTAGE_DUTY_BFLD from seconds to minutes in clause 9.17.4, "Table 163 One-way Data Table."
39. Updated the algorithm description of Element READ_VALUE in clause B.2, "Logger Arguments Implementation Details."
40. Revised BNF definition of constIdentifier in clause G.4, "Identifiers."
41. Corrected BNF definition of Element in clause G.6.1.2, "Container Scopes."
42. Deleted BNF definitions of constType and constMember and associated example from clause G.12, "Constants" to reflect revisions to constIdentifier to clause G.4, "Identifiers."
43. Revised BNF definitions of syntax from clause G.17, "Document Form Starting Production Rule" to reflect revisions to constIdentifier to clause G.4, "Identifiers."

44. Corrected DTD definitions for object and Table in clause I.2.1.7, “<description> Child DTDs.”
45. Inserted missing description for object in clause I.2.1.15, “<object> Attributes.”
46. Inserted missing description for Table in clause I.2.1.16, “<table> Attributes.”
47. Inserted missing descriptions for Table members in clause I.2.1.17, “<caption>, <col>, <thead>, <tfoot> and <tbody> Subelement usage of <table>.”
48. Updated examples in clause I.2.1.18, “<description> Document Form.”
49. Revised DTD definition of enumerator in clause I.2.1.25, “<enumerator> DTD (named)” to reflect revisions to constIdentifier to clause G.4, “Identifiers.”
50. Deleted definition of <positional> in clause I.2.1.27, “<enumerator> DTD (named)” to reflect revisions to constIdentifier to clause G.4, “Identifiers.”
51. Revised clause I.2.1.28, “Constant Enumerated Values DTD.”
52. Revised clause, I.2.1.29, “<enumerator> DTD (Un-named).”
53. Revised clause I.2.1.30, “<enum> DTD.”
54. Revised clause I.2.1.3,1 “<enum> Attributes.”
55. Updated example in clause I.2.1.32, “<enum> Document Form.”
56. Corrected definition of Element in clause I.2.1.39, “<element> DTD.”
57. Corrected definition of else in clause I.2.1.55, “<else> DTD.”
58. Corrected definition of switch in clause I.2.1.58, “<switch> DTD.”
59. Corrected definition of case in clause I.2.1.62, “<case> DTD.”
60. Corrected definitions in clause I.2.1.69, “<bitField> DTD.”
61. Corrected definition of switch in clause I.2.1.84, “<switch> DTD.”
62. Corrected definition of Table in clause I.2.1.108, “<table> DTD definition.”
63. Corrected definition of packedRecord in clause I.2.1.114, “< packedRecord > DTD.”
64. Corrected definition of bitField in clause I.2.1.116, “<bitField> DTD.”
65. Corrected definition of tableName in clause I.3.1.5, “<description> Document Form.”
66. Inserted copyright notice in clause I.3.1.5, “<description> Document Form.”
67. Inserted documentation about schema constraints issues in clause I.3.1.6, “The Schema Constraints Problem.”
68. Corrected type mapping in clause I.4, “EDL XML Form Encoding of Final Element Values.”
69. Updated device class registration information in Annex J, “Universal Identifier.”
70. Corrected section numbering in Annex L, “Registering or Updating DEVICE CLASS OID.”

Members of ASC 12 SC 17 WG2 wish to thank and extend their deepest appreciation for the significant contribution of the balloting members of IEEE P1377, the AEIC AMTIT members, NIST, and SGIP/PAP5 and SGIP/PAP6 members, who provided invaluable input into the making of this revision of the Standard.

Interpretation requests for, questions about, or suggestions for improvement to this Standard are welcome. They should be sent to:

National Electrical Manufacturers Association
 Vice President, Technical Services
 1300 North 17th Street
 Suite 900
 Rosslyn, VA 22209

The Secretariat of the Accredited Standards Committee on Electricity Metering, C12, is held by the National Electrical Manufacturers Association (NEMA) and the National Institute of Standards and Technology (NIST). At the time this Standard was processed and approved, the C12 Committee had the following members:

Tom Nelson, Chairman

Paul Orr, Secretary

<i>Organization Represented:</i>	<i>Name of Representative:</i>
Austin Energy	Herman Millican
Baltimore Gas & Electric Company	Jim Thurber
Center for Neighborhood Technology	Lawrence Kotewa
Duke Energy Company	Tim Morgan
EnerNex	Aaron F. Snyder
Florida Power & Light Co.	Jim DeMars
Future DOS R&D, Inc.	Avygdor Moise
GE Energy	Curt Crittenden
Georgia Power	Larry Barto
Itron, Inc.	Brent Cain
Landis+Gyr	John Voisine
Milbank Manufacturing	Shawn Glasgow
NIST	Tom Nelson
Oncor Group	Brad Johnson
Pacific Gas & Electric Company	D. Young Nguyen
Plexus	Dave Scott
Public Service Electric & Gas	David Ellis
Radian Research, Inc.	Tim Everidge
Schweitzer Engineering Labs, Inc.	Bob Hughes
Sensus Metering	George Steiner
Technology for Energy Corporation	Bill Hardy
Trilliant Networks, Inc.	Michel Veillette
Tucker Engineering Associates Inc.	Richard D. Tucker
Underwriters Laboratories Inc.	Ron Breschini
Watthour Engineering Co.	H.A. Wall
Xcel Energy EMC	Dan Nordell

The following members of Working Group 2 of Subcommittee 17 worked on the development of this revision of the Standard:

Avygdor Moise, Chairman

Aaron Snyder, Co-Vice Chairman
 Kostas Tolios, Co-Vice Chairman
 Michael Anderson, past Vice Chairman
 Terry L. Penn, Editor
 Paul Orr, Secretary

Organizations Represented:

Aclara PLS
 American Electric Power
 Center for Neighborhood Technology
 Consumers Energy
 DTE Energy
 Elster Metering
 Elster Solutions
 EnerNex
 EnerNex
 Future DOS R&D, Inc.
 GE Energy
 Itron, Inc.
 JECARRCO, LLC
 Landis+Gyr
 Landis+Gyr
 Oncor Group
 Sensus Metering
 Silver Springs Networks
 Southern Company
 Trilliant Networks, Inc.
 Tucker Engineering Associates Inc.

Name of Representative:

David Haynes
 Maryam Larijani
 Lawrence Kotewa
 David Jirikovic
 Kostas Tolios
 Jeff Richardson
 Edward J. Beraset
 Aaron F. Snyder
 Erich Gunther
 Avygdor Moise
 Virginia Zinkowski
 Brent Cain
 Jack Carr
 Jeremiah Dole
 Michael Anderson
 Brad Johnson
 Marc Keyes
 Brad Gilbert
 Terry L. Penn
 Michel Veillette
 Richard D. Tucker

Contents

Foreword	ii
1 Overview	1
1.1 SCOPE	1
1.2 PURPOSE	1
2 Normative References	1
3 Definitions	3
4 General	11
4.1 STANDARD TABLES	11
4.1.1 Standard Tables Grouping	11
4.1.2 Standard Tables Properties.....	12
4.1.3 Standard Procedure Properties.....	13
4.2 MANUFACTURER TABLES.....	13
4.2.1 Manufacturer Tables Grouping.....	14
4.2.2 Manufacturer Tables Properties.....	14
4.2.3 Manufacturer Procedure Properties	14
4.3 PACKED RECORD, BIT FIELD, AND ELEMENT PROPERTIES	15
4.4 EXTENDED USER-DEFINED TABLES (EUDT) PROPERTIES.....	15
5 Syntax	15
5.1 DESCRIPTIVE SYNTAX	15
6 Special Data Types.....	16
6.1 CHARACTER SET SELECTION.....	16
6.2 NONINTEGER FORMATS	17
6.2.1 STRING Numbers	17
6.3 DATE AND TIME FORMATS	18
6.3.1 HTIME_DATE, LTIME_DATE, STIME_DATE, TIME, STIME, HTIME Types.....	19
6.3.2 RDATE Type	23
6.3.3 DATE Type	25
6.4 COMMON TABLE OR PROCEDURE IDENTIFIER FORMATS	26
6.4.1 TABLE_IDA_BFLD Bit Field.....	26
6.4.2 TABLE_IDB_BFLD Bit Field.....	27
6.4.3 TABLE_IDC_BFLD Bit Field.....	27
6.4.4 SOURCE_SELECT_RCD	28
7 Compliance and Compatibility	29
7.1 COMPLIANCE	29
7.2 BACKWARD AND FORWARD COMPATIBILITY	30
8 Table Transportation Issues	30
8.1 MINIMUM SERVICES AND PARAMETERS.....	30
8.1.1 Read Service.....	30
8.1.2 Write Service	32
8.1.3 Partial Table Access Using the Index/Element-count Method	33
8.1.4 Partial Table Access Using the Offset/Octet-count Method	35
8.1.5 Index Count Access Method Examples	36
8.2 PENDING EVENT DESCRIPTION.....	36
8.3 LIST MANAGEMENT DESCRIPTION.....	39
9 Tables	41

9.1	DECADE 0: GENERAL CONFIGURATION TABLES	41
9.1.1	Table 00 General Configuration Table	41
9.1.2	Table 01 General Manufacturer Identification Table	47
9.1.3	Table 02 Device Nameplate Table	48
9.1.4	Table 03 End Device Mode Status Table	56
9.1.5	Table 04 Pending Status Table	58
9.1.6	Table 05 Device Identification Table	60
9.1.7	Table 06 Utility Information Table	60
9.1.8	Table 07 Procedure Initiate Table	63
9.1.9	Table 08 Procedure Response Table	68
9.1.10	Standard Procedures	72
9.2	DECADE 1: DATA SOURCE TABLES	89
9.2.1	Table 10 Data Source Dimension Limits Table	90
9.2.2	Table 11 Actual Data Sources Limiting Table	92
9.2.3	Table 12 Units of Measure Entry Table	94
9.2.4	Table 13 Demand Control Table	102
9.2.5	Table 14 Data Control Table	104
9.2.6	Table 15 Constants Table	105
9.2.7	Table 16 Source Definition Table	111
9.2.8	Table 17 Transformer Loss Compensation Table	112
9.3	DECADE 2: REGISTER TABLES	114
9.3.1	Table 20 Register Dimension Limits Table	114
9.3.2	Table 21 Actual Register Limiting Table	117
9.3.3	Table 22 Data Selection Table	119
9.3.4	Table 23 Current Register Data Table	120
9.3.5	Table 24 Previous Season Data Table	122
9.3.6	Table 25 Previous Demand Reset Data Table	123
9.3.7	Table 26 Self-read Data Table	123
9.3.8	Table 27 Present Register Selection Table	125
9.3.9	Table 28 Present Register Data Table	126
9.4	DECADE 3: LOCAL DISPLAY TABLES	127
9.4.1	Table 30 Display Dimension Limits Table	127
9.4.2	Table 31 Actual Display Limiting Table	128
9.4.3	Table 32 Display Source Table	130
9.4.4	Table 33 Primary Display List Table	130
9.4.5	Table 34 Secondary Display List Table	132
9.5	DECADE 4: SECURITY TABLES	133
9.5.1	Table 40 Security Dimension Limits Table	134
9.5.2	Table 41 Actual Security Limiting Table	135
9.5.3	Table 42 Security Table	135
9.5.4	Table 43 Default Access Control Table	137
9.5.5	Table 44 Access Control Table	138
9.5.6	Table 45 Key Table	140
9.5.7	Table 46 Reserved	140
9.5.8	Table 47 Reserved	140
9.6	DECADE 5: TIME AND TIME-OF-USE (TOU) TABLES	140
9.6.1	Table 50 Time and Time-of-use (TOU) Dimension Limits Table	142
9.6.2	Table 51 Actual Time and Time-of-use (TOU) Limiting Table	145
9.6.3	Table 52 Clock Table	148
9.6.4	Table 53 Time Offset Table	149
9.6.5	Table 54 Calendar Table	150
9.6.6	Table 55 Clock State Table	156
9.6.7	Table 56 Time Remaining Table	157
9.6.8	Table 57 Precision Clock State Table	158
9.7	DECADE 6: LOAD PROFILE TABLES	158

9.7.1	Table 60 Load Profile Dimension Limits Table.....	159
9.7.2	Table 61 Actual Load Profile Limiting Table.....	163
9.7.3	Table 62 Load Profile Control Table.....	167
9.7.4	Table 63 Load Profile Status Table.....	170
9.7.5	Table 64 Load Profile Data Set One Table.....	173
9.7.6	Table 65 Load Profile Data Set Two Table.....	177
9.7.7	Table 66 Load Profile Data Set Three Table.....	179
9.7.8	Table 67 Load Profile Data Set Four Table.....	181
9.8	DECADE 7: HISTORY LOG AND EVENT LOG TABLES.....	183
9.8.1	Table 70 Log Dimension Limits Table.....	185
9.8.2	Table 71 Actual Log Limiting Table.....	188
9.8.3	Table 72 Events Identification Table.....	190
9.8.4	Table 73 History Log Control Table.....	191
9.8.5	Table 74 History Log Data Table.....	192
9.8.6	Table 75 Event Log Control Table.....	195
9.8.7	Table 76 Event Log Data Table.....	196
9.8.8	Table 77 Event Log and Signatures Enable Table.....	199
9.8.9	Table 78 End Device Program State Table.....	201
9.8.10	Table 79 Event Counters Table.....	205
9.9	DECADE 8: USER-DEFINED TABLES (UDTs).....	205
9.9.1	Table 80 User-defined Tables (UDTs) Dimension Limits Table.....	206
9.9.2	Table 81 Actual User-defined Tables (UDTs) Limiting Table.....	207
9.9.3	Table 82 User-defined Tables (UDTs) List Table.....	209
9.9.4	Table 83 User-defined Tables (UDTs) Selections Table.....	210
9.9.5	Table 84 User-defined Table (UDT) Zero.....	211
9.9.6	Table 85 User-defined Table (UDT) One.....	211
9.9.7	Table 86 User-defined Table (UDT) Two.....	212
9.9.8	Table 87 User-defined Table (UDT) Three.....	212
9.9.9	Table 88 User-defined Table (UDT) Four.....	213
9.9.10	Table 89 User-defined Table (UDT) Five.....	213
9.10	DECADE 9: TELEPHONE CONTROL TABLES.....	214
9.10.1	Table 90 Telephone Dimension Limits Table.....	214
9.10.2	Table 91 Actual Telephone Limiting Table.....	217
9.10.3	Table 92 Telephone Global Parameters Table.....	219
9.10.4	Table 93 Telephone Call Originate Parameters Table.....	220
9.10.5	Table 94 Telephone Call Originate Schedule Table.....	222
9.10.6	Table 95 Telephone Call Answer Parameters.....	225
9.10.7	Table 96 Originating Telephone Call Purpose.....	226
9.10.8	Table 97 Last Telephone Call Status.....	227
9.10.9	Table 98 Telephone Call Originate Status.....	229
9.11	DECADE 10: UNASSIGNED.....	230
9.12	DECADE 11: LOAD CONTROL AND PRICING TABLES.....	230
9.12.1	Table 110 Load Control Dimension Limits Table.....	231
9.12.2	Table 111 Actual Load Control Limiting Table.....	233
9.12.3	Table 112 Load Control Status.....	235
9.12.4	Table 113 Load Control Configuration.....	237
9.12.5	Table 114 Load Control Schedule.....	238
9.12.6	Table 115 Load Control Conditions.....	241
9.12.7	Table 116 Prepayment Status.....	244
9.12.8	Table 117 Prepayment Control.....	245
9.12.9	Table 118 Billing Control.....	246
9.13	DECADE 12: RESERVED.....	248
9.14	DECADE 13: RESERVED.....	248
9.15	DECADE 14: EXTENDED USER-DEFINED TABLES (EUDTs).....	248
9.15.1	Table 140 Extended User-defined Tables (EUDTs) Function Limiting Table.....	249

9.15.2	Table 141 Extended User-defined Tables (EUDTs) Actual Limits Table	250
9.15.3	Table 142 Extended User-defined Selections Table	251
9.15.4	Table 143 Extended User-defined Constants Table	257
9.16	DECADE 15: QUALITY-OF-SERVICE	258
9.16.1	Table 150 Quality-of-service Dimension Limits Table	261
9.16.2	Table 151 Actual Quality-of-service Limiting Table	269
9.16.3	Table 152 Quality-of-service Control Table	276
9.16.4	Table 153 Quality-of-service Incidents Table	288
9.16.5	Table 154 Quality-of-service Log Table	291
9.16.6	Table 155 Asynchronous Time-domain Waveforms Table	292
9.16.7	Table 156 Asynchronous Frequency-domain Spectrum Table	295
9.16.8	Table 157 Periodic Time-domain Waveforms Table	299
9.16.9	Table 158 Periodic Frequency-domain Spectrum Table	301
9.17	DECADE 16: ONE-WAY DEVICES	304
9.17.1	Table 160 One-way Dimension Limits Table	304
9.17.2	Table 161 Actual One-way Table	307
9.17.3	Table 162 One-way Control Table	310
9.17.4	Table 163 One-way Data Status Table	313
9.17.5	Table 164 One-way Commands/Responses/Extended User-defined Tables (EUDTs) Table 315	
Annex A	(informative) RESERVED DEVICE CLASSES FOR METER EQUIPMENT MANUFACTURERS IMPLEMENTING ANSI C12.19-1997 DEVICES	318
Annex B	(normative) HISTORY AND EVENT LOG CODES	319
B.1	Codes	319
B.2	Logger Arguments Implementation Details	321
B.3	Logger Codes Interpretation Details	324
Annex C	(normative) DEFAULT SETS FOR DECADE TABLES	330
Annex D	(normative) INDICES FOR PARTIAL TABLE READ/WRITE ACCESS	336
Annex E	(informative) EVENT LOGGER IMPLEMENTATION	338
E.1	Background	338
E.2	Signature algorithm	339
Annex F	(informative) TRANSFORMER LOSSES COMPENSATION	341
F.1	Transformer Losses Consideration	341
F.1.1	No-load Loss and Exciting Current	341
F.1.2	Load Loss	341
F.1.3	Transformer Losses Compensation	341
F.2	Transformer Loss Compensation Calculations	342
F.3	Transformer Loss Compensation Calculation Example	343
Annex G	(normative) DOCUMENT-FORM DESCRIPTIVE SYNTAX	344
G.1	General Notes On Symbols, Rules, And Their Meaning	344
G.2	Extended Bnf Symbols And Meaning	344
G.3	Flow Of Information	351
G.4	Identifiers	351
G.5	Basic Data Types	356
G.5.1	Basic Data Type Definitions	359
G.5.2	Data Type Handling	361
G.6	References To Types, Constants, And Values	362
G.6.1	Scoping Rules	363
G.6.2	References to Values	366

G.6.3	Value	369
G.7	Conditionals	371
G.7.1	IF Statements	371
G.7.2	SWITCH Statements	371
G.8	Bit Field Type	372
G.9	Set Type	373
G.10	Array Type	373
G.11	Packed Record Type	374
G.12	Constants	375
G.13	Tables	375
G.14	Procedures	375
G.15	Single-Line (SLM) Math Expressions	377
G.16	Properties	379
G.17	Document Form Starting Production Rule	380
Annex H	(informative) DATE-TIME ELEMENTS CONVERSION ALGORITHM (TM_FORMAT=3 AND TM_FORMAT=4)	381
Annex I	(normative) XML FILE FORMAT OF TDL AND EDL FILES	383
I.1	Overview of the TDL/EDL XML Document Framework	383
I.1.1	TDL/EDL Files and Terminology	383
I.2	TDL XML File Format Of The TDL Document	388
I.2.1	<tdl> Root Element	388
I.2.2	<description> Element	390
I.2.3	<assert> Element	398
I.2.4	<enumerator> Element	399
I.2.5	Constant Enumerated Values of <enumerator> (Named)	403
I.2.6	<enum> Element (Child of <enumerator>)	403
I.2.7	<default> Element (Child of <enumerator> Element)	405
I.2.8	<packedRecord> Element	405
I.2.9	<element> Element (Child of <packedRecord>)	409
I.2.10	<array> Element (Child of <packedRecord>)	412
I.2.11	<set> Element (Child of <packedRecord> Element)	414
I.2.12	<if> Element (Child of <packedRecord>)	416
I.2.13	<else> Element (Child of <packedRecord>/<if>)	417
I.2.14	<switch> Element (Child of <packedRecord>)	419
I.2.15	<bitField> Element	421
I.2.16	<subElement> Element (Child of <bitField>)	425
I.2.17	<if> Element (Child of <bitField>)	427
I.2.18	<then> Element (Child of <bitField>/<if>)	428
I.2.19	<else> Element (Child of <bitField>/<if>)	428
I.2.20	<switch> Element (Child of <bitField>)	429
I.2.21	<case> Element (Child of <bitField>/<switch>)	429
I.2.22	<default> Element (Child of <bitField>/<switch>)	430
I.2.23	<decade> Element (Child of <tdl>)	430
I.2.24	<table> Element (Child of <tdl> or <decade>)	431
I.2.25	<procedure> Element (Child of <tdl> or <decade>)	436
I.2.26	<extend> Element (Child of <procedure>)	439
I.2.27	<qualify> Element (Child of <tdl>)	440
I.2.28	<table> element (Child of <qualify> element)	441
I.2.29	<procedure> Element (Child of <qualify>)	442
I.2.30	<element> Element (Child of <qualify>)	442
I.2.31	<packedRecord> Element (Child of <qualify>)	443
I.2.32	<bitField> Element (Child of <qualify>)	444
I.2.33	<assert> Element (Child of <qualify>)	444

I.3	EDL XML Format	445
I.3.1	Overview	445
I.3.2	<edl> Root Element	445
I.3.3	<description> Element (Child of <edl>)	447
I.3.4	Pseudo Element Names	447
I.3.5	Resolving Second Edition XML Schema Constraints	448
I.3.6	<\${if-switch-clause}> Element	450
I.3.7	<defaultSet> Element (Child of <edl>)	450
I.3.8	<\${limitingTableName}> Element (Child of <defaultSet>)	453
I.3.9	<data> Element (Child of <edl>)	454
I.3.10	<\${tableName}> Element	454
I.3.11	<\${elementName}> Element	455
I.3.12	<entry> Element	456
I.3.13	<pendingHeader> Element	458
I.4	EDL XML Form Encoding of Final Element Values	459
Annex J	(normative) UNIVERSAL IDENTIFIER	461
Annex K	(informative) ALGORITHMS FOR THE CONVERSION OF TABLE ELEMENT VALUES TO ENGINEERING UNITS	462
K.1	Locating Conversion Factors from Decade 1	462
K.2	De-normalizing Interval Data Elements	465
K.3	Converting to Engineering Units at the Point of Metering	466
K.4	Converting to Engineering Units at the Point of Delivery	468
K.5	Assigning Engineering Units	468
K.6	Assigning Fundamental Engineering Units	468
K.7	Table Value to Engineering Units Conversion: An Example	469
Annex L	(informative) REGISTERING OR UPDATING DEVICE CLASS OID	472
L.1	Binding a Device Class to End Device Operating Model	472
L.2	End Devices Referencing the Standard's Device Class	475
L.3	Practical Examples and Use-cases	475
L.3.1	Examples: Initial Registration Condition—An Empty TDL	475
L.3.2	Examples: Initial Registration Conditions—Nonempty TDL	481
Annex M	(informative) BIBLIOGRAPHY	489
Annex N	(informative) HISTORICAL BACKGROUND	490
N.1	Foreword of American National Standard C12.19-1997	490
N.2	Foreword of American National Standard C12.19-2008	493

Table of Figures

Figure 4-1	Possible Combinations of FLC, FLC+1, and Decade Tables	12
Figure 4-2	Default Standard Tables Properties	13
Figure 4-3	Default Standard Tables 7, 8, and Procedures Properties	13
Figure 4-4	Default Manufacturer Tables Properties	14
Figure 4-5	Default Manufacturer Procedures Properties	15
Figure E-1	Detailed Signature Computation Algorithm	340
Figure G-1	Octet Bit Ordering	351
Figure G-2	Multibyte Ordering	351
Figure G-3	Subtypes and Bit Field Bit Ordering	372
Figure G-4	Set Octets and Bit Ordering	373
Figure G-5	Single-dimension Array Ordering	374

Figure I-1 Production of the Document Form (Document Format of Section 9.0, “Tables”) from the TDL XML File 384

Figure I-2 Production of Exchange Data Language (EDL) Validation Schema File from a TDL XML File..... 384

Figure I-3 Production of the Document Form (Document Format of Annex C, “Default Sets for Decade Tables”) from the EDL XML Default Sets File..... 384

Figure I-4 Production of Final Element Indices (Document Format of Annex D, “Indices for Partial Table Read/Write Access”) from a TDL XML File..... 385

Figure I-5 From XML to AMI Application: the Pathways for Using C12.19 Standard- and Manufacturer-defined TDL/XML Tables for Documentation, EDL, and AMI Application Processing 386

Figure K-1 A Typical Electricity Meter Installation..... 467

Figure L-1 A Registered End Device Instance..... 473

Figure L-2 Device Class Re-registration Decision-making Process Flow 474

1 Overview

1.1 SCOPE

This Standard defines a Table structure for utility application data to be passed between an End Device and any other device. It neither defines device design criteria nor specifies the language or protocol used to transport that data. The Tables defined in this Standard represent a data structure that shall be used to transport the data, not necessarily the data storage format used inside the End Device.

1.2 PURPOSE

The Utility Industry has a need for a Standard that provides an interoperable “plug-and-play” environment for field metering devices. The purpose of this Standard is to define the framework and data structures for transporting Utility End Device data to and from End Devices and for use by enterprise systems.

This Standard is intended to accommodate the concept of an advanced metering infrastructure, such as that identified by the Office of Electricity Delivery and Energy Reliability of the U.S. Department of Energy; the Smart Metering Initiative of the Ontario Ministry of Energy (Canada); and the stated requirements of Measurement Canada for the approval of a metering device for use in Canada.

This Standard is to provide a uniform, structured, and adaptive data model, such that Utility End Devices and ancillary devices (e.g., home appliances and communication technology) can operate in a “plug-and-play” and multisource enterprise Advanced Metering Infrastructure (AMI) environment.

This Standard extends the definitions provided by IEEE Std 1377-1998 to include provisions for enterprise-level asset management, data management, and uniform data exchange capability, through the use of common and managed Extensible Markup Language (XML)/Table Definition Language (TDL) and XML/Exchange Data Language (EDL) End Device Class models.

2 Normative References

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

AEICGL-2010, *Smart Grid/AEIC AMI Interoperability Standard Guidelines for ANSI C12.19 / IEEE 1377 / MC12.19 End Device Communications and Supporting Enterprise Devices, Network and Related Accessories*, The Association of Edison Illuminating Companies (AEIC), v2.0, 2010.¹

ANSI C12.10-2011, *American National Standard for Physical Aspects of Watthour Meters—Safety Standard*²

ANSI C12.19, *American National Standard for Utility Industry End Device Data Tables*

ANSI C12.19-1997, *American National Standard for Utility Industry End Device Data Tables*

ANSI C12.19-2008, *American National Standard for Utility Industry End Device Data Tables*

¹ AEIC publications are available from The Association of Edison Illuminating Companies (<http://www.aeic.org/>). This document is available from http://www.aeic.org/meter_service/AEICSmartGridStandardv2-11-19-10.pdf.

² ANSI publications are available from the American National Standards Institute (<http://www.ansi.org/>).