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IEEE Standard for Utility Industry Metering Communication Protocol Application Layer (End Device Data Tables)

Sponsored by the

IEEE Standards Coordinating Committee 31 on Automatic Meter Reading and Energy Management

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(Revision of
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Abstract: Common structures are provided in this standard for encoding data in communication between End Devices (meters, home appliances, IEEE 1703 Nodes) and Utility enterprise collection and control systems using binary codes and Extensible Markup Language (XML) content. The Advanced Metering Infrastructure (AMI) and SmartGrid requirements are addressed as identified by the Office of Electricity Delivery and Energy Reliability of the U.S. Department of Energy and by the Smart Metering Initiative of the Ontario Ministry of Energy (Canada) and of Measurement Canada. Sets of tables are exposed that are grouped together into sections that pertain to a particular feature-set and related function such as Time-of-use, Load Profile, Security, Power Quality, and more. Each standard Table Set (Data Model) can be expanded or restricted by the Manufacturer of the IEEE 1377 Device or home appliance using XML/TDL descriptive registered syntax (XML-based Table Definition Language) and enterprise data-value management using EDL (Exchange Data Language) in a manner that is machine readable. Published jointly with NEMA and Measurement Canada, Tables are provided in support of Gas, Water, and Electric sensors and related appliances. Tables are also provided for network configuration and management by referencing its companion standard IEEE Std 1703™-2012. IEEE Std 1377-2012 is co-published as ANSI C12.19 and MC12.19.

Keywords: ANSI C12.19, End Device, IEEE 1377, Utility Tables

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Introduction

This introduction is not part of IEEE Std 1377-2012, IEEE Standard for Utility Industry Metering Communication Protocol Application Layer (End Device Data Tables).

The body of this standard was developed jointly with ANSI C12.19 and MC12.19. The joint agreement calls for the standards and regulatory organizations IEEE, ANSI, and MC to maintain the body of this standard in step and congruent as they publish versions and revisions of the standard. A number of editorial errors and error of omission were discovered since the publication of ANSI C12.19-2008, just before the acceptance of IEEE Std 1377-2012. These errors are listed in Annex N, "(normative) Listing of editorial errors and errors of omission in ANSI C12.19-2008". All reported errors were identified in the body of this standard and highlighted to indicate that the text was in error and was corrected. Errors of omission were corrected in the body of this document and similarly highlighted. Other minor editorial changes have been made to this standard, but they have not been highlighted.

The second version of this standard was developed under the auspices of the secretariat of ANSI ASC 12 SC17 WG2. For that reason, the document contains references to ANSI standards, which in a number of them are cross published by the IEEE. These standard references can be interchangeably replaced with the corresponding IEEE standards (or MC reference numbers) as follows:

ANSI Standard	IEEE Standard	MC Reference
ANSI C12.18	IEEE Std 1701™	MC12.18
ANSI C12.19	IEEE Std 1377™	MC12.19
ANSI C12.21	IEEE Std 1702™	MC12.21
ANSI C12.22	IEEE Std 1703™	MC12.22

All communications to Measurement Canada (MC) in regard to MC referenced Standard should be directed to:

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IEEE Std 1377-2012 provides a common data structure for use in transferring data to and from utility End Devices, typically meters. It has been approved after considerable cooperative effort among utilities, meter manufacturers, automated meter reading service companies, ANSI, Measurement Canada (for Industry Canada), NEMA, IEEE, Utilimetrics, and other interested parties.

The standard data structure is defined as sets of tables. The tables are grouped together into sections called decades. Each Decade pertains to a particular feature-set and related function such as Time-of-use, Load Profile, and so on. Table data is transferred from or to the End Device by reading from or writing to a particular table or portion of a table. Specific actions may be requested to be executed by the End Device through Procedure invocations.

The second release of the standard represents a philosophical departure from the first release in 1997. This release of the 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 covers a broader range of functionality relative to its previous version; however, it does not follow that implementations of this broader range of functionality need to be large or complex. Implementers are encouraged to choose an appropriate 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 are encouraged to deploy their desired functionalities using complete and consistent suites of standard tables from standard decades to the largest extent practical.

Readers who are acquainted with IEEE Std 1377-1997 will discover that the new version contains many changes. The changes may be categorized as follows:

- Additions of new features or new functionality through the introduction of new tables, decades, or syntax.
- Extensions or improvements to preexisting functionality in support of contemporary and anticipated industry needs.
- Corrections of errors and provision of clarifications that address known deficiencies and documentation of the accepted or anticipated industry practice.
- Introduction of XML-based table description language (TDL/EDL) and documentation of services supporting the needs expressed by initiatives such as Smart Metering, Advanced Metering Infrastructure, and the like.
- Removal of features that were found undesirable.
- Provision of guidelines for implementers of this standard and developers of future versions of the standard on backward compatibility and planned phase-out of obsolete features.

Some of the many new features introduced in this revision of the standard include:

- Addition of new data types in support of high-precision sub-second time stamps, such as HTIME_DATE and HTIME.
- Creation of new syntax for the aggregation of transmitted characters into strings, STRING.
- Creation of new syntax for the aggregation of transmitted Octets into opaque blobs, BINARY.
- Addition of new Decade 9, Telephone tables. This Decade imports and supersedes the tables and syntax defined in ANSI C12.21/MC12.21/IEEE 1702.
- Creation of new Decade 11, Load Control and Pricing Tables. This Decade provides for demand-side management capabilities, including load control, demand response, prepayment, and direct customer billing functions.
- Creation of Decade 14, Extended User-defined Tables. This Decade provides capability for transmitting and receiving a contiguous stream of element and subelement data. The data are referenced methodically to the legitimate and formal IEEE 1377 data element.
- Creation of Decade 15, Quality-of-service Tables. This Decade provides control, capture, and logging of high-precision Quality-of-service performance indicators, such as power quality, and the inclusion of detailed waveforms, power spectra, and related information.
- Creation of Decade 16, One-way Devices Tables. This Decade provides control and management tables in support of one-way (talk-only) End Devices.

Some extensions or improvements to preexisting functionality include:

- Table 0, General Configuration Table, retains its original form and it is backward compatible with IEEE Std 1377-1997. However, a few notable control elements were modified:
  1) Extended CHAR_FORMAT to support UTF-8.
  2) Replaced MANUFACTURER element with DEVICE_CLASS element to facilitate a more dynamic End Device data model recognition.
  3) Extended TM_FORMAT in support of high-precision, sub-second, time stamps.
- Changed all data source selections in all tables (e.g., Table 22) from UINT8 to SOURCE_SELECT_RCD. This form is backward and forward compatible with IEEE Std 1377-1997 when MODEL_SELECT is 0.
- Table 3, End Device Mode Status Table, incorporates the changes proposed in ANSI C12.21/MC12.21/IEEE 1702.
- Table 7, Procedure Initiate Table, and Table 8, Procedure Response Table, were updated and extended to provide procedures in support of new functionality that is needed by:
  1) Decade 7, History and Event Log Tables.
  2) Decade 9, Telephone Control Tables.
  3) Decade 11, Load Control and Pricing Tables.
  4) Decade 12, Network Control Tables.
  5) Decade 15 Quality-of-service Tables.
- Table 12, Unit of Measure Entry table, was expanded with new Units of Measure (UOMs).
- Table 17, Transformer Loss Compensation, was added to Decade 1.
- Extended the event log tables to provide a new capability to manage and detect program changes through the life of the End Device.
- Extended the event log tables to provide a new capability to manage, authenticate, and verify the integrity of data read from an End Device service point by any receiving client application that may reside across any communication system.
- Extended the table type that can be transmitted to include up to 2040 Extended-user-defined tables via TABLE_IDA_BFLD. Also introduced a new Decade 14, Extended User-defined Tables, to manage the collation of table elements, down to the bit level, into extended-user-defined tables.

Corrections of errors and clarifications include:

- Section 7.0, Compliance, was updated to reduce variations in the implementation of the standard.
- Section 8.0, Table Transportation Issues, was updated to include the “Errata to ANSI Standard C12.19-1997, Utility Industry Data Tables” published in 2001. It also was updated to harmonize this standard with ANSI C12.18/MC12.18/IEEE 1701, ANSI C12.21/MC12.21/IEEE 1702, and ANSI C12.22/MC12.22/IEEE 1703.
- Table 7, Procedure Initiate Table, and Table 8, Procedure Response Table, indices calculations were completely rewritten to eliminate a fatal error in the production of unique indices for procedure parameters when using index/count access methods.

Removal of features that were considered undesirable:

— Section 5.0, Syntax, no longer supports two-dimensional arrays. Appropriate corrections were applied wherever this syntax was used. This does not impact the offset/count data access methods.

The reader is encouraged to review the descriptive text as it brings significant clarifications and examples of use where appropriate.

Contents

IEEE Standard for Utility Industry Metering Communication Protocol Application Layer (End Device Data Tables)

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 1377-1997 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.