

# IEEE Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables

IEEE Standards Coordinating Committee 31

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

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IEEE  
3 Park Avenue  
New York, NY 10016-5997  
USA

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# IEEE Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables

Sponsor

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

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**IEEE-SA Standards Board**

**Abstract:** This standard provides multi-source and “plug and play” environment for the millions of metering devices in the field now and the future using the ANSI Type 2 optical port interface. It solves the problems associated with single source systems and with multi-source systems based upon proprietary communications protocols. Electric, water, and gas utilities and corresponding vendors can realize cost savings which ultimately shall benefit the client consumers of the utilities.

**Keywords:** ANSI C12.18, ANSI Type II, Optical Port, PSEM

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## Introduction

This introduction is not part of IEEE Std 1701-2011, IEEE Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables.

This standard provides an open-platform communications protocol for two-way communication with an End Device (e.g., a meter) through an ANSI Type 2 Optical Port. The protocol is written to conform to the OSI seven-layer stack. Long-time readers of ANSI C12.18-1996 will discover many editing changes in this version of the document. The Working Group chose to improve the clarity of the text as an aid to the reader while retaining the normative elements originally expressed in ANSI C12.18-1996.

The 2006 version to the ANSI publication of ANSI C12.18 was considered in the context of the so-called “protocol suite” of the standards: ANSI C12.18 / MC1218 / IEEE Std 1701, ANSI C12.19 / MC1219 / IEEE Std 1377, ANSI C12.21 / MC1221 / IEEE Std 1702, and ANSI C12.22 / MC1222 / IEEE Std 1703. Changes made were included only after assuring that existing devices implementing ANSI C12.18-1996 would continue to remain compatible with this version of the document.

This document has corrected an error in the original ANSI C12.18-1996 standard: the impossibility of using index-count access methods for table access. Other concepts addressed include compliance, backward and forward compatibility, the use of reserved fields, the Identification Service, packet size, and the toggle bit. Finally, some alignment with the ANSI/MC12.22-2008 standard was performed to meet the goal of producing a coherent suite of protocol standards.

Otherwise, this document is identical to the published ANSI/MC12.18-2006 standards.

## Notice to users

The body of this standard was developed jointly with ANSI C12.18 and MC1218. The joint agreement calls for the standards and regulatory organizations IEEE, ANSI, and MC to maintain the body of this standard in step 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 C12.18-2006, just before the acceptance of IEEE Std 1701. These errors are listed in Annex E. 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**.

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**Aaron F. Snyder**, *Chair*  
**Michael Anderson**, *Vice Chair*  
**Ed Beroet**, *Editor*

Brent Cain  
David Haynes  
Lawrence J. Kotewa

Avygdor Moise  
Vuong Nguyen  
Terry Penn

Richard D. Tucker  
Michel Veillette  
Ginger Zinkowski

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Chris Bagge  
Hugh Barrass  
Ed Beroet  
Brent Cain  
Keith Chow  
Randall Groves  
David Haynes  
Brad Johnson  
Piotr Karocki

Lawrence J. Kotewa  
Jim Kulchisky  
William Lumpkins  
G. Luri  
Faramarz Maghsoodlou  
Gary Michel  
Avygdor Moise  
Jose Morales  
Michael S. Newman  
Vuong Nguyen

Terry Penn  
Bartien Sayogo  
Gil Shultz  
Aaron F. Snyder  
Walter Struppler  
Richard D. Tucker  
Scott Weikel  
Oren Yuen  
Ginger Zinkowski

When the IEEE-SA Standards Board approved this amendment on 2 February 2011, it had the following membership:

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Andy Drozd  
Alexander Gelman  
Jim Hughes

Young Kyun Kim  
Joseph L. Koepfinger\*  
John Kulick  
David J. Law  
Hung Ling  
Oleg Logvinov  
Ted Olsen

Ronald C. Petersen  
Thomas Prevost  
Jon Walter Rosdahl  
Sam Sciacca  
Mike Seavey  
Curtis Siller  
Don Wright

\*Member Emeritus

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Satish Aggarwal, *NRC Representative*  
Richard DeBlasio, *DOE Representative*  
Michael Janezic, *NIST Representative*

Catherine Berger  
*IEEE Standards Project Editor*

Bill Ash  
*IEEE Standards Program Manager, Technical Program Development*

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# IEEE Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables

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## 1. Overview

### 1.1 Scope

This document is identified by three numbers, MC1218, ANSI C12.18-2006, and IEEE Std 1701-2011. The standard details the criteria required for communications with a Utility End Device by another device via an optical port. The other device could be a hand held reader, a laptop or portable computer, a master station system, or some other electronic communications device. It shall provide the optical port lower layers communication protocol for the Utility metering Industry including specifically Water, Gas, and Electric.

The standard provides details for a complete implementation of an OSI 7-layer model in accordance with ISO/IEC 7498-1.

The protocol specified in this document was designed to transport data in Table format. The Table definitions are in ANSI C12.19 (MC1219, IEEE Std 1377) Utility Industry End Device Data Tables.

## 1.2 Purpose

The Utility Industry has need for a standard that provides an operable "plug and play" environment for field metering devices. The purpose of this standard is to define the means to transport the Utility Industry End Device Data Tables via an optical port such that multi-source environment and End Device interchangeability is possible.

## 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.

ANSI C12.19, Utility Industry End Device Data Tables.

ANSI C12.21, Protocol Specification for Telephone Modem Communication.

ISO/IEC 646 (1991), Information Technology—ISO 7-Bit Coded Character Set for Information Interchange.

ISO/IEC 7498-1 (1994), Information Technology—Open Systems Interconnection—Basic Reference Model: The Basic Model.

ISO/IEC 8825-1 (2002), Information Technology—ASN.1 Encoding Rules: Specification Of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) And Distinguished Encoding Rules (DER).

ISO/IEC 13239 (2002), Information Technology—Telecommunications and Information Exchange Between Systems—High-Level Data Link Control (HDLC) Procedures.

## 3. Definitions and syntax

### 3.1 Definitions

For the purposes of this document, the following terms and definitions apply. *The IEEE Standards Dictionary: Glossary of Terms & Definitions* should be referenced for terms not defined in this clause.<sup>1</sup>

**3.1.1. C12.18 Client:** An electronic communication apparatus that attaches to the ANSI Type 2 Optical Port of a C12.18 Device and implements communication according to the protocol specification of this standard.

**3.1.2. C12.18 Device:** An electronic communication apparatus that implements an ANSI Type 2 Optical Port for communication according to the protocol specification of this standard.

**3.1.3. point-to-point communications:** Point-to-point communications is defined as communication between two devices through a single optical interface.

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<sup>1</sup> *The IEEE Standards Dictionary: Glossary of Terms & Definitions* is available at <http://shop.ieee.org/>.

**3.1.4. Table:** Functionally related data elements, grouped together into a single data structure for transport as defined by ANSI C12.19.

### 3.2 Document syntax

Describing data definitions is usually accomplished within the confines of a given language and the grammar rules of that language. Since the data definitions embodied within this standard are meant to be independent of specific language and, hopefully, capable of being implemented within the confines of any language, a method for describing the data definitions must be developed. A modified form of the Backus-Naur Form (BNF) will serve as the basis for building the descriptions used to construct the data definitions.

The modified form of BNF has the following definitions:

| Symbol | Meaning                                                                                                                                                                                                                                                                                                        |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| < >    | A string contained inside angle brackets is called a non-terminal. That is, while it may be viewed as a single unit, it can and should be redefined as consisting of one (1) or more simpler elements.                                                                                                         |
| ::=    | This symbol is read as “is defined as.” The non-terminal that occurs on the left hand side (LHS) of this symbol consists of the elements (non-terminals, terminals, or a combination of the two) found on the right hand side (RHS). A line containing an LHS, :: =, and an RHS is known as a production rule. |
|        | The vertical bar is an “OR” symbol. The OR symbol always occurs on the right hand side of a production where the left hand side can be defined in more than one way. The OR bar separates valid alternative right hand sides.                                                                                  |
| [ ]    | A symbol enclosed in square brackets is optional. The production is valid whether or not it is included.                                                                                                                                                                                                       |
| *      | The superscript asterisk is known as the Kleene star. A symbol followed by the Kleene star may occur zero (0) or more times without violating the grammar.                                                                                                                                                     |
| +      | The superscript plus sign is known as the Kleene cross. A symbol followed by the Kleene cross must occur one (1) or more times.                                                                                                                                                                                |
| +n     | A symbol followed by the Kleene cross and any number “n” represents “n” occurrences of the symbol.                                                                                                                                                                                                             |
| { }    | The curly braces are used to enclose comments within the descriptions. Comments have no impact on the productions.                                                                                                                                                                                             |

### 4. Protocol details

Following the guidelines established by the OSI seven-layer model, the protocol described in this standard provides the following three functions:

- Establishment and modification of the communication channel
- Transport of information to and from the C12.18 Device
- Orderly closure of the communication channel when communications are complete

Three layers are used to provide these communication capabilities. These are the Physical, Data Link, and Application layers.

With the default conditions established by this standard, the communication channel is considered always available once the physical connection has been completed. The required Identification Service is used to obtain the protocol version and revision in use by the C12.18 Device. Certain communication parameters may be modified through the use of the Negotiate Service in the Application Layer. The Negotiate Service is optional and, if not implemented in the C12.18 Device or not used during actual communications, the communication channel parameters shall remain at the default settings specified by this standard. Device implementers are strongly encouraged to implement this service.

Once the C12.18 Device identification and communication parameters have been established, the Application Layer provides Logon, Security, and Logoff services for session activation, access control and deactivation, Read and Write services for issuing data transmission requests, a Terminate service for shutdown of the communication channel, and a response structure that provides information regarding the success or failure of the service requests.

An example of a typical communications session would consist of the following services with appropriate responses, in the order listed: Identification, Negotiate, Logon, Security, Reads or Writes, Logoff and Terminate. Note that this brief example does not detail the packet structure or other aspects of the protocol. Annex A and Annex B contain examples with more detail.

## 4.1 Order of transmission

Within the syntax definitions, multiple parameters shall be transmitted in the order as shown, from left to right.

Service parameters in all layers within the protocol definition are transmitted most significant byte first. The order of transmission of data field parameters within Tables is dictated by the Table structure.

Bytes are transmitted in frames. Each frame consists of a start bit, followed by <byte>, and ending with a stop bit. The start bit is transmitted first.

Bits within each byte are transmitted least significant bit first.

```
<byte>          ::= {An eight-bit quantity.}
<msbyte>        ::= <byte> {most significant byte}
<lsbyte>        ::= <byte> {least significant byte}
<word24>        ::= <msbyte><byte><lsbyte>
<word16>        ::= <msbyte><lsbyte>
```

## 4.2 Layer of application

The Application Layer provides the set of services and data structures required to support C12.18 Devices for purposes of configuration, programming, and information retrieval.

### 4.2.1 Data structure

This protocol shall transport table structures as defined in ANSI C12.19.

## 4.2.2 Protocol Specifications for Electric Metering

This standard defines nine (9) Protocol Specifications for Electric Metering (PSEM) services. Each service consists of a request and a response. Each of these requests and responses is described in the following service sections.

|             |               |                                   |
|-------------|---------------|-----------------------------------|
| <requests>  | ::= <ident>   | {Identification Service request}  |
|             | <read>        | {Read Service request}            |
|             | <write>       | {Write Service request}           |
|             | <logon>       | {Logon Service request}           |
|             | <security>    | {Security Service request}        |
|             | <logoff>      | {Logoff Service request}          |
|             | <negotiate>   | {Negotiate Service request}       |
|             | <wait>        | {Wait Service request}            |
|             | <terminate>   | {Terminate Service request}       |
| <responses> | ::= <ident-r> | {Identification Service response} |
|             | <read-r>      | {Read Service response}           |
|             | <write-r>     | {Write Service response}          |
|             | <logon-r>     | {Logon Service response}          |
|             | <security-r>  | {Security Service response}       |
|             | <logoff-r>    | {Logoff Service response}         |
|             | <negotiate-r> | {Negotiate Service response}      |
|             | <wait-r>      | {Wait Service response}           |
|             | <terminate-r> | {Terminate Service response}      |

### 4.2.2.1 Request codes

PSEM requests always include a one-byte request code. Code numbers are represented in hexadecimal format as follows:

|                                  |                                                                |
|----------------------------------|----------------------------------------------------------------|
| 00 <sub>H</sub> -1F <sub>H</sub> | Codes shall not be used to avoid confusion with response codes |
| 20 <sub>H</sub> -7F <sub>H</sub> | Codes in this range signify request codes                      |
| 80 <sub>H</sub> -FF <sub>H</sub> | Codes shall be reserved for protocol extensions                |

### 4.2.2.2 Response codes

PSEM responses always include a one-byte response code. These codes are listed below in a suggested order of priority. When more than one response code is capable of indicating the error response condition of a C12.18 Device or a C12.18 Client, the response code having the highest priority (from left to right) is as follows:

```
<nok> ::=
<sns> | <iss> | <iar> | <isc> | <onp> | <bsy> | <dlk> | <dnr> | <rno> | <err>
```