

IEEE Standard for Telephone Modem 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

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

IEEE Std 1702™-2011

2 March 2011

IEEE Standard for Telephone Modem Communication Protocol to Complement the Utility Industry End Device Data Tables

Sponsor

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

Approved 2 February 2011

IEEE-SA Standards Board

Approved 28 June 2011

American National Standards Institute

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

Keywords: ANSI C12.21, IEEE 1702, MODEM, PSEM

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2011 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 2 March 2011. Printed in the United States of America.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-0-7381-6547-9 STD97075
Print: ISBN 978-0-7381-6548-6 STDPD97075

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

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.

The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied “**AS IS**.”

The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation, or every ten years for stabilization. When a document is more than five years old and has not been reaffirmed, or more than ten years old and has not been stabilized, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

In publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon his or her independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration. A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered the official position of IEEE or any of its committees and shall not be considered to be, nor be relied upon as, a formal interpretation of the IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Recommendations to change the status of a stabilized standard should include a rationale as to why a revision or withdrawal is required. Comments and recommendations on standards, and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854
USA

Authorization to photocopy portions of any individual standard for internal or personal use is granted by The Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Introduction

This introduction is not part of IEEE Std 1702-2011, IEEE Standard for Telephone Modem Communication Protocol to Complement the Utility Industry End Device Data Tables.

This standard provides an open-platform communications protocol for two-way communication with a metering device via a telephone modem. The protocol is written to conform to the Open Systems Interconnection (OSI) seven-layer stack. Long-time readers of ANSI C12.21-1999 will discover many editing changes to this version of the standard. The End Device/Telemetry Interface Unit Subcommittee 1701/1702 Working Group chose to improve the clarity of the text as an aid to the reader while retaining the normative elements in the manner of previous publications.

The 2006 revision to ANSI C12.21 was considered in the context of the so-called “protocol suite” of ANSI 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.

It is expected that the Logoff Service will become mandatory in the next revision of this standard. Implementers are strongly encouraged to support this service to comply with this change.

Notice to users

The body of this standard was developed jointly with ANSI C12.21 and MC1221. 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 C12.21-2006, just before the acceptance of IEEE 1702. These errors are listed in Annex J – Listing of Editorial Errors and Errors of Omission in ANSI C12.21-2006. 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**.

Laws and regulations

Users of these documents should consult all applicable laws and regulations. Compliance with the provisions of this standard does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

This document is copyrighted by the IEEE. It is made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making this document available for use and adoption by public authorities and private users, the IEEE does not waive any rights in copyright to this document.

Updating of IEEE documents

Users of IEEE standards should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect. In order to determine whether a given document is the current

edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE Standards Association web site at <http://ieeexplore.ieee.org/xpl/standards.jsp>, or contact the IEEE at the address listed previously.

For more information about the IEEE Standards Association or the IEEE standards development process, visit the IEEE-SA web site at <http://standards.ieee.org>.

Errata

Errata, if any, for this and all other standards can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/updates/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Interpretations

Current interpretations can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/interp/index.html>.

Patents

Attention is called to the possibility that implementation of this may require use of subject matter covered by patent rights. By publication of this, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Participants

At the time this was submitted to the IEEE-SA Standards Board for approval, the End Device/Telemetry Interface Unit Subcommittee 1701/1702 Working Group had the following membership:

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

Brent Cain
David Haynes
Lawrence J. Kotewa

Avygdor Moise
Vuong Nguyen
Terry Penn

Richard D. Tucker
Michel Veillette
Virginia Zinkowski

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

Chris Bagge
Hugh Barrass
Brent Cain
Keith Chow
Randall Groves
David Haynes

Brad Johnson
Piotr Karocki
Lawrence J. Kotewa
Jim Kulchisky
William Lumpkins
Greg 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
Virginia Zinkowski

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

Robert M. Grow, *Chair*
Richard H. Hulett, *Vice Chair*
Steve M. Mills, *Past Chair*
Judith Gorman, *Secretary*

Karen Bartleson
Victor Berman
Ted Burse
Clint Chaplin
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

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

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

Michelle Turner
IEEE Standards Program Manager, Document Development

William Ash
IEEE Standards Program Manager, Technical Program Development

Contents

1. Overview	1
1.1 Scope	1
1.2 Purpose	2
2. Normative references	2
3. Definitions and syntax	2
3.1 Definitions	2
3.2 Document syntax	3
4. Protocol details	3
4.1 Order of transmission	3
4.2 Layer 7 - Application Layer	3
4.3 Layer 6 - Presentation Layer	13
4.4 Layer 5 - Session Layer	14
4.5 Layer 4 - Transport Layer	14
4.6 Layer 3 - Network Layer	14
4.7 Layer 2 - Data Link Layer	14
4.8 Layer 1 - Physical Layer	18
5. Compliance	18
Annex A (informative) Communication example (Layer 7 and Layer 2)	19
Annex B (informative) Packet transmission example	22
Annex C (informative) Service sequence state control	24
Annex D (informative) Modifications and extensions to ANSI C12.19-1997	26
D.1 RDATE type	26
D.2 Table 03, ED_MODE STATUS Table	27
D.3 Table 07, Procedure initiate Table	30
D.4 Decade 90: Telephone control Tables	31
D.5 History and event log codes	43
D.6 Default sets for decade tables	44
D.7 Indices for partial table access	44
Annex E (informative) CRC examples	48
E.1 Trace	48
E.2 C code example	49
Annex F (informative) Error handling	50
Annex G (normative) Data encryption standard (DES)	52
G.1 Usage	52
G.2 —	53
G.3 Implementation	53
G.4 Code example	56
G.5 Trace example	59
Annex H (informative) I command operational description	60
H.1 The problem	60
H.2 The solution	60

Annex I (informative) Compatibility	61
I.1 Backward compatibility with previous versions of the standard	61
I.2 Forward compatibility with next versions of the standard	62
Annex J (normative) Listing of editorial errors and errors of omission in ANSI C12.21-2006	63

IEEE Standard for Telephone Modem Communication Protocol to Complement the Utility Industry End Device Data Tables

IMPORTANT NOTICE: *This standard is not intended to ensure safety, security, health, or environmental protection. Implementers of the standard are responsible for determining appropriate safety, security, environmental, and health practices or regulatory requirements.*

This IEEE document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading “Important Notice” or “Important Notices and Disclaimers Concerning IEEE Documents.” They can also be obtained on request from IEEE or viewed at <http://standards.ieee.org/TPR/disclaimers.html>.

1. Overview

1.1 Scope

This standard details the criteria required for communication between a C12.21 Device and a C12.21 Client via a modem connected to the switched telephone network. The C12.21 Client could be a laptop or portable computer, a master station system, or some other electronic communications device.

This standard does not specify the implementation requirements of the telephone switched network to the modem, nor does it include definitions for the establishment of the communication channel.

This document provides details for an implementation of the Open Systems Interconnection (OSI) seven-layer model **in accordance with ISO/IEC 7498-1**.¹

The protocol specified in this standard was designed to transport data in Table format. The Table definitions are in ANSI C12.19 and in Annex D of this document.

This standard specifies the differences between ANSI C12.18-2006 and ANSI C12.19-1997 and the features and services required to describe a protocol specification for telephone modem communications.

¹ Information on references can be found in Clause 2.

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 a telephone modem so that multisource 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; therefore, 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 referenced, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI C12.18, Protocol Specification for ANSI Type 2 Optical Port.²

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

ANSI INCITS 92-1981 (R2003), Data Encryption Algorithm.

ISO/IEC 7498-1 (1994), Information Technology — Open Systems Interconnection — Basic Reference Model: The Basic Model.³

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. For other terms, refer to *The IEEE Standards Dictionary: Glossary of Terms & Definitions*.⁴

C12.21 Client: An electronic communication apparatus that connects to a C12.21 Device via a modem and implements communication according to the protocol specification of this standard.

NOTE—This concept was implicitly defined in previous versions of this standard as “utility host.”⁵

C12.21 Device: An electronic communication apparatus (e.g., a meter plus an internal or external modem) that implements communication according to the protocol specification of this standard.

NOTE—This concept was implicitly defined in previous versions of this standard as “meter.”

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

² ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

³ ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Geneva 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO/IEC publications are also available in the United States from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>). Electronic copies are available in the United States from the American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁴ *The IEEE Standards Dictionary: Glossary of Terms & Definitions* is available at <http://shop.ieee.org/>.

⁵ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement the standard.

3.2 Document syntax

Document syntax is identical to that of ANSI C12.18.

4. Protocol details

Following the guidelines established by the OSI seven-layer model, the protocol described in this standard provides three (3) functions:

- a) Establishment and modification of the communication channel
- b) The transport of information to and from the C12.21 Device
- c) Orderly closure of the communication channel when communications are complete

Three (3) layers are used to provide these communication capabilities: the Physical, Data Link, and Application layers.

This standard does not specify the implementation requirements of the telephone switched network to the modem, nor does it include definitions for the establishment of the communication channel. The communication channel is considered available once the telephone connection has been successfully established and modems have synchronized. The protocol specification for electric metering (PSEM) Identification Service is required to establish the protocol version and revision in use. Certain communication parameters may be modified through the use of the PSEM Negotiate and Timing Setup services in the Application Layer. These services are optional, and if not implemented in the C12.21 Device or not used during actual communications, the communication channel parameters will remain at the default settings specified by this standard. Implementers are strongly encouraged to implement these optional Application Layer services.

Once the data link is established, the Application Layer provides

- Logon, Security, and Logoff services for session activation, access control, and deactivation
- Read Service and Write Service for issuing data transmission requests
- Authenticate Service for two-way authentication with playback rejection
- Terminate Service for returning to the Base State
- Disconnect Service for shutdown of the communication channel
- 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, Authenticate, Security, Reads or Writes, Logoff, and Disconnect. Note that this brief example does not detail the packet structure or other aspects of the protocol. A more detailed example of a typical communications session is given in Annex A.

4.1 Order of transmission

Order of transmission is identical to that specified in ANSI C12.18.

4.2 Layer 7 - Application Layer

The Application Layer provides a minimal set of services and data structures required to support C12.21 Devices for purposes of configuration, programming, and information retrieval.

Layer 7 shall be defined as in ANSI C12.18 except for the specific items defined in 4.2.1 and 4.2.2.

4.2.1 Data structure

This protocol shall transport Table structures. The Table specifications this standard was designed to transport are referenced in Clause 2 and Annex D of this document.

4.2.2 Protocol specification for electric metering (PSEM)

This standard defines twelve (12) PSEM services. Each service consists of a request and a response. Each of these requests and responses is described in the following service sections (i.e., 4.2.2.1 through 4.2.2.14).

```

<requests>      ::= <ident> |      { Identification Service request}
                  <read> |         { Read Service request}
                  <write> |        { Write Service request}
                  <logon> |        { Logon Service request}
                  <security> |     { Security Service request}
                  <logout> |       { * Logout Service request}
                  <negotiate> |    { Negotiate Service request}
                  <wait> |         { Wait Service request}
                  <terminate> |    { * Terminate Service request}
                  <timing-setup> | { ** Timing Setup Service request}
                  <disconnect> |  { ** Disconnect Service request}
                  <authenticate> | { ** Authenticate 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}
                  <logout-r> |     { * Logout Service response}
                  <negotiate-r> |  { Negotiate Service response}
                  <wait-r> |       { Wait Service response}
                  <terminate-r> |  { * Terminate Service response}
                  <timing-setup-r> | { ** Timing Setup Service response}
                  <disconnect-r> | { ** Disconnect Service response}
                  <authenticate-r> | { ** Authenticate Service response}

```

Note: * Definition or content revised from ANSI C12.18.
 ** New in ANSI C12.21.

4.2.2.1 Request codes

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

```

00H-1FH   Codes shall not be used to avoid confusion with response codes

20H-7FH   Codes in this range signify request codes

80H-FFH   Codes shall be reserved for protocol extensions

```

4.2.2.2 Response codes

PSEM responses always include a one-byte response code. Response codes are identical to those specified in ANSI C12.18. These codes are listed below in a suggested order of priority. When more than one (1) response code is

capable of indicating the error response condition of a C12.21 Device or a C12.21 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>`

For example, if Standard Table 05 of a C12.21 Device is read-only and it is encoded in nonvolatile memory, then a Write Service request to Table 05 would fail. The C12.21 Device may consider the following codes as suitable responses: `<err>` to indicate an error condition or `<dlk>` to indicate that the data is locked in memory and cannot be changed, `<iar>` to indicate that the action requested was not appropriate for this device design or `<isc>` to indicate that the table access permission are “read-only” under the current security policy. The correct response would be `<iar>` as it is the highest priority among `<iar>`, `<isc>`, `<dlk>`, and `<err>`. However, if there is a mechanism for providing write access to Table 05, then `<iar>` should not be considered. Therefore, the response code becomes `<isc>`.

<code><ok></code>	<code>::=</code>	<code>00_H</code>	{Acknowledge Application Layer response indicating no problems, request accepted.}
<code><err></code>	<code>::=</code>	<code>01_H</code>	{Error This Application Layer error code is used to indicate rejection of the received service request. The reason for the rejection is not provided.}
<code><sns></code>	<code>::=</code>	<code>02_H</code>	{Service Not Supported This Application Layer error response will be sent to the device when the requested service is not supported. This error indicates that the message was valid, but the request could not be honored.}
<code><isc></code>	<code>::=</code>	<code>03_H</code>	{Insufficient Security Clearance This Application Layer error indicates that the current authorization level is insufficient to complete the request.}
<code><onp></code>	<code>::=</code>	<code>04_H</code>	{Operation Not Possible This Application Layer error will be sent to the device which requested an action that is not possible. This error indicates that the message was valid, but the message could not be processed. Covers conditions such as: invalid length, invalid offset}
<code><iar></code>	<code>::=</code>	<code>05_H</code>	{Inappropriate Action Requested This Application Layer error indicates that the action requested was inappropriate. Covers conditions such as write request to

			a read-only table or an invalid table id.}
<bsy>	::=	06 _H	{Device Busy This Application Layer error indicates that the request was not acted upon because the device was busy doing something else.}
<dnr>	::=	07 _H	{Data Not Ready This Application Layer error indicates that request was unsuccessful because the requested data is not ready to be accessed.}
<dlk>	::=	08 _H	{Data Locked This Application Layer error indicates that the request was unsuccessful because the data cannot be accessed.}
<rno>	::=	09 _H	{Renegotiate Request This Application Layer error indicates that the responding device wishes to return to the ID or base state and renegotiate communication parameters.}
<isss>	::=	0A _H	{Invalid Service Sequence State This Application Layer error indicates that the request is not accepted at the current service sequence state. For more information on service sequence states, see Annex C – Service Sequence State Control.}
0B _H –1F _H			{Undefined response codes.}
20 _H –7F _H			{Codes shall not be used to avoid confusion with request codes}
80 _H –FF _H			{Codes shall be reserved for protocol extensions}

4.2.2.3 Identification Service

The Identification Service shall be the first service issued upon C12.21 Device power-up, following a PSEM Terminate Service response, or Channel Traffic Timeout. The Identification Service returns a code identifying the reference standard, the version and revision of the reference standard implemented, and an optional feature list. Since the Identification Service is always issued prior to the Negotiate Service, the size of the returned response shall never exceed the default packet size.

The Identification Service is a required service.

The Identification Service shall be initiated only by a C12.21 Client.

Request:

$$\langle \text{ident} \rangle ::= 20_{\text{H}}$$

Response:

The responses <iss>, <bsy>, and <err> indicate a problem with the received service request.

The response <ok> indicates the identification service request was accepted and the standard, version, revision, and optional feature list are included in the response.

```

<ident-r> ::= <isss> | <bsy> | <err> |
               <ok><std><ver><rev><feature>*<end-of-list>

<std> ::= <byte> {Code identifying reference
                  standard. The codes are defined as
                  follows:
                      00H = ANSI C12.18
                      01H = Reserved
                      02H = ANSI C12.21
                      03H = ANSI C12.22
                      04H-FFH = Reserved
                  A C12.21 Device shall return 02H.}

<ver> ::= <byte> {Binary representation of the
                  referenced standard version number.
                  Previous versions shall be Version
                  1. This version shall be Version
                  2.}

<rev> ::= <byte> {Binary representation of the
                  referenced standard version number
                  to the right of the decimal point.
                  This value shall be 0.}

<feature> ::= <auth-ser> | <auth-ser-ticket> | <device-class> |
               <device-identity>
               {Features available.}

<end-of-list> ::= 00H {End of list indicator.}

<auth-ser> ::= 01H <auth-type><auth-alg-id>
               {If present in the feature list,
                authentication is supported by the
                C12.21 Device.}

<auth-ser-ticket> ::= 02H <auth-type><auth-alg-id><ticket-length><ticket>

<auth-type> ::= <byte> {Authentication type identifier.
                        Bit 0: SESSION_LEVEL_AUTHENTICATION
                        If true, Authenticate Service is
                        supported.
                        Bits 1..7 are reserved, shall be
                        zero (0).}

```

`<auth-alg-id> ::= <byte>` {The authentication algorithm used.
00_H = ANSI INCITS 92
01_H-FF_H = Reserved.}

`<ticket-length> ::= <byte>` {Length of <ticket>, in bytes.}

`<ticket> ::= <byte>+` {Value use by the authentication algorithm.}

`<device-class> ::= 06H <universal-id>`
{A Universal Identifier that uniquely identifies a C12.19 Device Class object for early detection of the device class as per MANUFACTURER as defined in Table 00 of ANSI C12.19-1997 or the DEVICE_CLASS as defined by version 2 of ANSI C12.19. The C12.19 Device Class shall be supplied when the C12.19 Device Table 00, GEN_CONFIG_TBL, is readable immediately following the Logon Service. When C12.19 Device Class is provided it shall not preceded features with codes that are less than 06_H.}

`<universal-id> ::= <relative-uid-element> | <absolute-uid-element>`
{The C12.19 Device Class encoded as an absolute or relative registered universal object identifier.}

`<absolute-uid-element> ::= 06H <uid-length><absolute-uid>`
{The absolute encoding of the C12.19 Device Class; e.g., 1.2.840.10066.0.<relative-uid>, encoded as described in ISO/IEC 8825-1, Basic Encoding Rules (BER). The last four (4) bytes of this identifier shall be identical to the values delivered in the C12.19 Table elements MANUFACTURER as defined in Table 00 of ANSI C12.19-1997 or the DEVICE_CLASS as defined by Version 2 of ANSI C12.19.}

`<relative-uid-element> ::= 0DH <uid-length><relative-uid>`
{The relative encoding of the C12.19 Device Class relative to the universal identifier 1.2.840.10066.0, encoded as described in ISO/IEC 8825-1, Basic Encoding Rules (BER). The <uid-length> shall range between to 00_H to 04_H resulting in up to four (4) bytes being transmitted. These four (4) bytes shall be identical

		to the C12.19 Table elements MANUFACTURER_ID as defined in Table 00 of ANSI C12.19-1997 or the DEVICE_CLASS as defined by Version 2 of ANSI C12.19, with assumed 00 _H trailing pad.}
<uid-length>	::= <byte>	{Length of number of bytes that follow. This value shall range between 00 _H to 7F _H }
<absolute-uid>	::= <byte> ⁺	{Absolute object identifier encoded as described in ISO/IEC 8825-1, Basic Encoding Rules (BER). The size of this field shall not exceed 127 bytes.}
<relative-uid>	::= <byte> ⁺	{Relative object identifier encoded as described in ISO/IEC 8825-1, Basic Encoding Rules (BER). The size of this field shall not exceed 4 bytes.}
<device-identity>	::= 07 _H <identity-length><identity>	{An Identifier that uniquely identifies a C12.19 Device in the application space of the C12.19 Device. This provides for early detection of the device identification element as per IDENTIFICATION of Table 05, DEVICE_IDENT_TBL, or DEVICE_ID found in Table 06 of ANSI C12.19. The C12.19 <device-identity> feature shall be supplied when the C12.19 Device Table 05 or Table 06 are readable immediately following the Logon Service. When C12.19 Device identification is provided it shall not preceded features with codes that are less than 07 _H .}
<identity-length>	::= <byte>	{Length of number of bytes that follow in <identity>. This value shall range between 00 _H to 7F _H }
<identity>	::= <char-format><identification>	{Provides for disclosure of the C12.19 Device identification.}
<char-format>	::= <byte>	{The character encoding format of the bytes which make up <identification>. Its interpretation shall be according to the relevant ANSI C12.19 data model referenced by the C12.19

registered Device Class feature <device-class>. When the <device-class> feature was not supplied in this <ident> response, the value of <char-format> shall be set to 01_H, and <identification> shall be encoded according to ISO 7-bit coded character set for information interchange, per ISO/IEC 646 (1991).}

<identification>::= <byte>*

{The C12.19 Device identification string encoded and transmitted according to <char-format>. If the C12.19 Device ID_FORM in Table 00, is set to BCD then the BCD digits shall be transmitted as their text equivalent also encoded as per <char-format>.

For example, assuming that the C12.19 Device GEN_CONFIG_TBL.ID_FORM is BCD and the Device GEN_CONFIG_TBL.CHAR_FORMAT is ISO 7 bit ASCII, as per ISO/IEC 646 (1991), then the BCD digits 00_H 01_H 02_H 03_H 0A_H 04_H 0D_H 05_H 06_H 07_H shall be transmitted as the character sequence "123-4.567". The C12.19 application shall logically pad this string with trailing spaces, as needed, to fill the identification field width of the C12.19 Device.}

4.2.2.4 Read Service

The Read Service is identical to that in ANSI C12.18.

At least one (1) form of the Read Service is required to be supported by a C12.21 Device.

4.2.2.5 Write Service

The Write Service is identical to that in ANSI C12.18.

The Write Service is an optional service.

4.2.2.6 Logon Service

The Logon Service is identical to that in ANSI C12.18.

The Logon Service is a required service.

The Logon Service shall be initiated only by a C12.21 Client.

4.2.2.7 Security Service

The Security Service is identical to that in ANSI C12.18.

The Security Service is an optional service.

The Security Service shall be initiated only by a C12.21 Client.

4.2.2.8 Logoff Service

The Logoff Service provides for an orderly shutdown of the session established by the Logon Service.

The Logoff Service is a required service.

Request:

Following a Logoff Service request, the communication channel will return to the ID State, retaining the parameters previously established.

$$\langle \log \text{off} \rangle \quad ::= \quad 52_{\text{H}}$$

Response:

The responses <iss>, <bsy>, and <err> indicate a problem with the received Logoff Service request.

The response <ok> indicates the acceptance of the Logoff Service and the cessation of the session established by the Logon Service. Prior to further data transfers with the C12.21 Device, the Logon Service must be reissued.

```
<logoff-r> ::= <isss> | <bsy> | <err> |
               <ok>
```

4.2.2.9 Authenticate Service

The Authenticate Service is used to provide a two-way authentication with playback rejection during a session. It is recommended that the Authentication Service be used to complement the Security Service, not be used exclusively. The contents of the <auth-request> and <auth-response> fields are a function of the authentication algorithm used. This algorithm is returned by the Identification Service response.

The Authenticate Service is an optional service.

Request:

<authenticate>	::= 53 _H <auth-req-length><auth-request>	
<auth-req-length>	::= <byte>	{<auth-req-length> number of bytes of the <auth-request> field.}
<auth-request>	::= <byte> ⁺	{Information used to authenticate the initiator of this service.}

Response:

The responses <sns>, <iss>, <bsy>, and <err> indicate a problem with the received Authenticate Service request.

The response <isc> indicates the authentication failure of the requester.

The response <ok> indicates the Authenticate Service was successfully completed and the access permission associated with the <auth-request> field was granted.

<authenticate-r>	::= <sns> <isss> <isc> <bsy> <err> <ok><auth-res-length><auth-response>	
<auth-res-length>	::= <byte>	{Number of bytes of the <auth-response> field.}
<auth-response>	::= <byte> ⁺	{Information used to authenticate the recipient of this service.}

4.2.2.10 Negotiate Service

The Negotiate Service is identical to that in ANSI C12.18. However, the <baud-rate> field of the request shall be ignored because in this standard the data rate is established by the modem.

The Negotiate Service is an optional service.

4.2.2.11 Wait Service

The Wait Service is identical to that in ANSI C12.18.

The Wait Service is an optional service.

4.2.2.12 Terminate Service

The Terminate Service provides for immediate transfer to the Base State. All parameters return to their default values.

The Terminate Service is an optional service.

Request:

<terminate> ::= 21_H

Response:

The responses <sns> and <err> indicate a problem with the received Terminate Service request and the channel retains its negotiated settings.

The response <ok> indicates the Terminate Service request was accepted and the channel will return to default settings as stated in 4.7.1.2 upon receipt of a positive acknowledgment.

<terminate-r> ::= <sns> | <err> |
<ok>

4.2.2.13 Timing Setup Service

The Timing Setup Service provides the mechanism for reconfiguring timeouts, delays, and retry attempts from the default values specified in this standard.

The Timing Setup Service is an optional service.

The Timing Setup Service is initiated by the C12.21 Client.