BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Complaint of Thaah and Aaron Young,	)	
Complainants,	)	
v.	)	Case No. 18-1832-EL-CSS
Ohio Power Company,	)	
Respondent.	)	

MOTION IN LIMINE AND REQUEST FOR EXPEDITED RULING OF OHIO POWER COMPANY

Pursuant to Ohio Adm.Code 4901-1-12 and 4901-1-27(B)(7), Ohio Power Company ("AEP Ohio" or the "Company") respectfully moves the Public Utilities Commission of Ohio ("Commission") or its Attorney Examiner *in limine* to preclude at the hearing of this matter the presentation of irrelevant testimony, evidence, and documents that relate to advanced metering infrastructure ("AMI") technology generally, AEP Ohio's deployment of AMI meters, and the technical specifications of AEP Ohio's AMI meters, including, but not limited to, certain documents that Complainants have recently docketed and which are attached as Exhibit A. As set forth in the accompanying memorandum in support, such testimony and evidence is outside the scope of this proceeding, is barred by *res judicata*, and its admission would serve only to cause unnecessary delay and confusion of the issues before the Commission in this case. Accordingly, its presentation should be excluded at hearing.

Given that the hearing in this matter is scheduled September 11, 2019, AEP Ohio requests expedited ruling of this motion.

Respectfully submitted,

Tanner S. Wolffram

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Counsel for Respondent Ohio Power Company

MEMORANDUM IN SUPPORT

I. INTRODUCTION

On December 13, 2018, Complainants filed their Complaint in this proceeding, alleging that Ohio Power Company ("AEP Ohio" or the "Company") refused to allow them to opt out of the installation of an Advanced Metering Infrastructure ("AMI") meter at their residence. *See* Complaint (Dec. 13, 2018). The Complaint also alleges that the Company's AMI Opt Out Customer Acknowledgement ("Acknowledgment") form is inappropriate. *Id*. Since filing their Complaint, Complainants have filed multiple documents in this docket related to AMI technology and deployment and the technical specifications of the Company's AMI and opt-out digital non-emitting, non-communicating meters. *See* Exhibit AEP Opt-Out Meter (Aclara I-210+C) (July 2, 2019); Exhibit- AEP Opt-Out Meter (GE I-210+C) (July 2, 2019); Discovery Reponses from AEP Ohio (Aug. 21, 2019); Exhibit: Opt-Out Meter 2 Way Communication (Aug. 21, 2019); Exhibit: Opt-Out Meter Communication Protocol and AMI Infrastructure (Aug. 21, 2019).[1]

However, the scope of this complaint proceeding is limited to the Company's AMI opt-out tariff and the language in the Company's Acknowledgment. Testimony and evidence related to technical specification of the Company's meters and AMI deployment are not relevant and are well outside the scope of this proceeding, and they should be excluded on the basis of *res judicata*. Thus, to avoid the presentation of irrelevant evidence and assist the Public Utilities Commission of Ohio (the "Commission") by creating a manageable and relevant record, the Company requests the Commission grant this Motion in Limine to limit the scope of this proceeding to the provisions of the Company's AMI opt-out tariff and the Acknowledgement

[1] The documents that are the subject of this motion are collectively attached as Exhibit A.

and to exclude testimony and evidence regarding AMI technology generally, AEP Ohio's deployment of AMI meters, and the technical specifications of AEP Ohio's AMI meters, including the documents attached as Exhibit A. In the alternative, AEP Ohio moves to strike the documents attached as Exhibit A. Finally, because the hearing on this Complaint is scheduled for September 11, 2019, AEP Ohio requests an expedited ruling on this motion pursuant to Ohio Adm.Code 4901-1-12(C).

II. THE COMMISSION OR ATTORNEY EXAMINER SHOULD PRECLUDE THE TESTIMONY AND EVIDENCE AT ISSUE OR, ALTERNATIVELY, STRIKE THE DOCUMENTS AT ISSUE.

Ohio Adm.Code 4901-1-27(B)(7) authorizes an attorney examiner to take such actions necessary to avoid unnecessary delay and to prevent the presentation of irrelevant or cumulative evidence. Inherent in this grant is the authority to grant motions *in limine* and motions to strike. Ohio R. Evid. 401 defines "relevant evidence" as "evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable that it would be without the evidence."

Here, Complainants claim that the Company has refused to allow them to opt out of AMI installation and take issue with certain language in the Company's Acknowledgment. *See* Complaint. The technical specifications of the Company's digital non-emitting and AMI meters do not relate, in any way, to Complainants' request for opt-out service or the Acknowledgment language. The technical specifications of the Company's meters are not relevant to Complainants' claims that the Company refused to provide them with opt-out service, given the fact that the Company has agreed to allow Complainants to keep the analog meter currently serving their residence. Direct Testimony of Paula S. Igo at 5:5-10. Complainants' alleged concerns with the Acknowledgement relate to language they deem to be indemnity language

found in the second paragraph. *See* Complaint. The technical specifications of the Company's meters in no way support a finding that this Acknowledgment language is inappropriate, unjust or unreasonable. As such, information related to the technical specifications of the Company's meters do not make any fact of consequence more or less probable than it would be without the evidence and are, therefore, irrelevant to this proceeding. To prevent wasting time discussing irrelevant information, the Commission should grant the Company's Motion in Limine to limit the upcoming proceeding to issues related to the provisions of the Company's AMI opt-out tariff and the language in the Company's Acknowledgment or, alternatively, strike the five documents included in Exhibit A.

Further, any attempt by Complainants to challenge the Company's installation of digital non-emitting and/or AMI meters, generally, would be inappropriate, as the Commission has previously, repeatedly reviewed and approved the Company's AMI opt-out tariff, as well as the Company's AMI technology and deployment. *See In the Matter of the Application of Ohio Power Company for Approval of an Advanced Meter Opt-out Service Tariff*, Opinion and Order at 11-12 (April 27, 2016); P.U.C.O. No. 20 at 3rd Revised Sheet No. 103-12 (¶16); *In the Matter of the Application of Columbus Southern Power Company for approval or its Electric Security Plan*, Case No. 08-917-EL-SSO, Opinion and Order at 37-38 (Mar, 18, 2009); *In the Matter of the Application of Ohio Power Company to Initiate Phase 2 of its gridSMART Project and to Establish the gridSMART Phase 2 Rider*, Case No. 13-1939-EL-RDR, Opinion and Order at ¶70 (Feb. 1, 2017). As such, under the doctrine of *res judicata*, it would be inappropriate to re-litigate AEP Ohio's use of its approved metering equipment as part of this proceeding. This further supports the Commission granting Company's Motion in Limine to limit this proceeding and the Company's motion to strike the documents at issue. Finally, Complainants' filing of the

Company's discovery responses is contrary to Ohio Adm.Code 4901-1-18; thus, at a minimum, that document should be stricken from the Commission's docket.

Hearing on this Complaint is scheduled for September 11, 2019. Complainants filed three of the referenced documents on August 21, 2019, and these documents contain highly technical and complex information, which will impose a significant burden on the Company to review and prepare to address at hearing. Therefore, the Company requests an expedited ruling on this motion.

III. CONCLUSION

Complainants have docketed information that is not relevant to their claims in this case. Allowing this information to be presented at the hearing will only prolong the proceeding and complicate the record. Further, the issues Complainants seek to raise by presenting this irrelevant information have already been decided by the Commission and, therefore, should not be re-litigated as part of this proceeding. As such, the Commission should grant the Company's Motion in Limine to limit the scope of the proceeding to issues related to the Company's AMI opt-out tariff and the Acknowledgment or, in the alternative, strike the documents attached as Exhibit A.

Respectfully submitted,

/s/ Tanner S. Wolffram

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Counsel for Respondent Ohio Power Company

CERTIFICATE OF SERVICE

I hereby certify that the foregoing was served by regular mail upon the address listed below, on this 29th day of August, 2019.

/s/ Tanner S. Wolffram
Tanner S. Wolffram

Thaah and Aaron Young
9167 Taylor Rd. SW
Reynoldsburg, Ohio 43068

Complainant

Exhibit A

Document Record

Date Filed:	7/2/2019 5:23:26 PM	**View Document**
Document Type:	EX-Exhibit	
Link to Document:	**View Document**	
Number of pages:	9	
Case Numbers:	**18-1832-EL-CSS**	
Summary:	Exhibit AEP Opt-Out Meter (Aclara I-210+C) electronically filed by Mr. Aaron Young on behalf of Young, Thaah and Aaron.	
Source File(s):		

Aclara

Residential Electrical Metering

Advanced ANSI metering for the Smart Grid

Aclara's I-210 product line continues the tradition to bring innovative and flexible technology solutions that cover all your metering needs from basic electronic energy-only meters to highly-flexible smart metering solutions that provide advanced functionality to meet the evolving Smart Grid system needs.

Aclara's family of meters go beyond meeting your complex business challenges. The advanced, powerful and easy-to-use meters give you an extra edge in the energy business. You can look forward to realtime instrumentation, power quality monitoring and easy access to critical information. All these add up to give you higher productivity, improved efficiency and reduced energy costs.

KEY BENEFITS

- Reliable and accurate cash register for utilities
- AMR/AMI Plug-n-Play functionality
- Multiple communication technologies tied to AMI systems provide reliable data in a timely manner
- Smart metering functions such as Time of Use demand metering and service switch capabilities
- Demand side management through pre-payment and demand limiting features
- Advanced functions such as reactive measurement and, IEEE reliability indices measurement
- Robust meter security and standards compliance

COMMUNICATIONS

- Broad AMI/AMR Plug-n-Play options - RF Mesh, Power line carrier, Cellular, etc
- Allows interchangeability of AMR/AMI Plug-n-Play options
- Supports connectivity and integration with 3rd party communications solutions providers

Single Phase Meters

I-210+c

FULL FEATURED, SMART GRID ENABLED METERING

This is Aclara's flagship residential meter product, offering demand, load profile, TOU, service switch, and a full complement of communication options.

I-210+

VALUE PACKED SMART GRID FUNCTIONS

World class accuracy and reliability in a solid-state kWh meter platform package. Available with a service switch, as well as a wide array of communications options.

SMART CONFIGURATION

- Ability to customize advanced metering options to suit customer's needs
- Configure load profile, time of use and demand metering capabilities
- Versatile programming Softswitches allowing the selection of advanced functionality such as power quality measurement and reactive power measurement
- Service Switch option improves operational efficiency and addresses issues such as demand side management, remote repayment systems, and controlled outage restoration

RELIABILITY

- Robust revenue-grade watt-hour and demand meters
- Based on Aclara's cutting edge technology providing typical 0.2% accuracy, and reliability
- Enable utilities with tools to lower operational cost and provide accurate metering solutions

RELIABLE METERING

In this dynamic time of regulatory scrutiny and customer engagement, you can be assured of the product and the company behind the product. We have ANSI and ISO certified labs to ensure that our product design and manufacturing processes yield a robust product every time.

Our testing procedures go well beyond the ANSI and IEC requirements for which we design to, including some of the most aggressive internal standards in the market place today. We now have included world-class Radio Frequency (RF) communications expertise to ensure that our meter products are hardened to withstand even the harshest of RF environments without sacrificing the quality or integrity of the metrology or the communications technology.

ACCURATE & DEPENDABLE

Typically measured at +/- 0.2%, the Aclara I-210 family of meters provides best-inclass capabilities for accuracy. Combined with the low starting watts, the utility can have confidence in the metered value and measured electricity usage.

INTEGRITY OF SUPPLY

Having a partner that can provide assurance in supply is critical when a utility begins a mass deployment of meters. Aclara's process focus and rigor around supply chain excellence minimizes the risk to the utility, giving them confidence to manage installation crews and provide accurate scheduling to customers.

BROAD COMMUNICATIONS SUPPORT

The I-210 family has been designed to allow for the interchangeability of AMR/AMI modules and cover the broadest range of possible AMI communication technologies including RF Mesh, Cellular, Power Line and Ethernet. Modules can be added at the Aclara factory, after the fact, or replaced with another compatible module if the meter is redeployed.

ACLARA'S iiDEAS® OPERATIONAL DATA MANAGEMENT PLATFORM

iiDEAS integrates head-end and meter data management into one unified application. Iideas aggregates AMI meter data with existing utility applications and offers a single, customizable interface for personnel to access the critical data they need to better manage their distribution infrastructure, optimize operations and improve service reliability.

AMI meter data is significantly enhanced by the aggregation of data from such systems as GIS, OMS, CIS and SCADA. iiDEAS uses standard interfaces such as MultiSpeak and CIM to integrate with these systems. iiDEAS also provides a range of advanced analytics including loss analysis, transformer analysis, voltage analysis and fault detection and localization.

Full featured, Smart Grid Meter

I-210+c

SMART GRID ENABLED, CONSUMER FRIENDLY METERING

Aclara's most advanced residential electricity metering product line, the I-210+c, delivers Smart Grid capability for today and the future. Derived from our industry leading commercial and industrial product line, the kV2c, the I-210+c benefits from our advanced metrology capability and lessons learned from over 10 years of solid state metering design. All the way down to the advanced microprocessor, the I-210+c contains much of the advanced polyphase functionality that Aclara has been known for. We have also added capability that makes the I-210+c the referenced residential product line in the industry.

CAPABILITY

Designed for today's dynamic rate structures, the I-210+c provides capability for demand, load profile, and TOU recording, along with a number of other power quality and demand response related functions. Configurable to support various metering quantities, this meter supports delivered (+), received (-), and net metering for distributed generation.

ADVANCED FUNCTIONALITY

With the addition of the fully rated 200 amp service switch, the meter is capable of pre-payment metering without all the historical cost associated with card readers or other legacy pre-payment technology. Load limiting and emergency conservation modes set this meter apart when working in conjunction with a demand response program. Having the capability to be remotely configured, as well as being firmware upgradeable, this product serves today's needs, as well as tomorrow's evolving requirements.

COMMUNICATIONS

Designed to specifically accommodate the communications technology required to support a Smart Grid, the I-210+c has the same electrical and mechanical interface as our I-210+ platform, making communications interchangeable and interoperable between these two residential metering platforms.

FEATURES & BENEFITS

- Customize advanced metering options through SoftSwitches
- AMR/AMI Plug-n-Play designed to accommodate: - Radio Frequency Mesh (RF Mesh)
  - Radio Frequency Point-to-Multipoint
  - Cellular communications
  - Ethernet
- Advanced functionality such as: time-of-use, insensitive demand, load profile recording, event logging, voltage sag/swell recording
- Typical accuracy: within +/- 0.2%
- Service Switch to improve operational efficiency and address issues such as:
  - Demand side management
  - Remote prepayment systems
  - Controlled outage restoration
- Low starting watts; capture energy consumption at levels typically not registered by electromechanical meters
- Low burden, which minimizes utility system losses
- Patented tamper algorithm to detect tamper-by-meter inversion
- Meets or exceeds ANSI C12.1, C12.10, C12.20, C37.90.1 and and UL 2735

AMR/AMI PLUG AND PLAY COMMUNICATIONS

Multiple communication options on the I-210+c allows greater customer choice. Ideally optimized for RF Mesh, PLC, 3G/4G point-to-point communication technologies, the I-210+c can cover a wide variety of communication scenarios.

I-210+c

Utility Communication
- Radio Frequency Mesh (RF Mesh),
- Power Line Communications (PLC),
- Cellular Communications
- Ethernet

Utility Monitoring & Control Center

Value packed, Smart Grid Meter

I-210+

LOAD MANAGEMENT

The I-210+ is one of the most popular single phase meters among US utilities for residential metering installations. Equipped with a fully-rated 200A service switch, this meter platform is ideal to provide basic load management functionality.

RELIABILITY

The I-210+ has enjoyed tremendous success in the marketplace for smart meters, with over 10 million units shipped since 2009. This product is the industry benchmark for quality and reliability, having passed both internal and external validation tests for billing accuracy. At Aclara, we have an unprecedented testing and validation process to ensure that our products are robust and exceed the industry standard ANSI requirements.

We have substantial expertise in wireless communications and the testing that is required to ensure that our meters perform flawlessly, even in the harshest of radio frequency (RF) environments.

COMMUNICATIONS

The I-210+ has the same electrical and mechanical interface as our I-210+c platform, designed to specifically accommodate Smart Grid communications technology, making communications interchangeable and interoperable between these two residential metering platforms. Multiple RF Mesh and PLC communication technologies are supported with a newly updated power supply.

FEATURES & BENEFITS

- AMR/AMI Plug and Play designed to accommodate: RF Mesh, RF Point-to-Multipoint, PLC, Ethernet
- Typical accuracy: within +/-0.2%
- Service Switch to improve efficiency and address:
  - demand side management
  - remote prepayment systems
  - controlled outage restoration
- Low starting watts; capture energy consumption at levels
- typically not registered by electromechanical meters
- Low burden, which minimizes utility system losses
- Meet or exceeds ANSI C12.1, C12.10, C12.20, C37.90.1

Factory Integrated Communication Options for I-210+ and I-210+c Meters

AMI Technologies	Type	I210+	I210+c
Aclara TWACS	PLC	•	
Aclara Synergize® RF	RF P2MP	•	
Itron Single ERT HP (54-56ESS)	1-way RF AMR	•	
Itron Triple ERT HP (57ESS)	1-way RF AMR		•
Itron EVDO & HSPA	Cellular (3G)		•
Sensus Flexnet™	RF P2MP		•[1]
Silver Springs Networks© NIC 410	RF Mesh		•[1]
Silver Springs Networks© NIC 510	RF Mesh		•[1]
Silver Springs Networks© MicroAP	Cellular & RF Mesh		•[1]
Trilliant RPMA	RF P2MP	•	•[1]
Trilliant SecureMesh™	RF Mesh	•	•

Note 1 : Optional UL Certified Meter

Full featured, Secure Metering Software

MeterMate

SMART GRID ENABLED, CONSUMER FRIENDLY METERING

Aclara's innovative MeterMate™ software suite enables meter administrators to easily configure and manage Aclara meters. Each software component in the MeterMate suite is optimized to address the different aspects of a meter's lifecycle. MeterMate program creation software enables the user to effortlessly configure the meter's basic and advanced functionality, ranging from creating a simple demand program and setting up the meter display to configuring the meter's I/O and alerts. With MeterMate reading and programming software, a user can read, program and perform real-time instrumentation and power quality monitoring on a meter, via a variety of different communication methods such as local OPTOCOM, remote telephone, RS-232/485 and IP communications.

The MeterMate software also supports many functions such as:

- Analysis of load profile data
- Firmware upgrades
- Exporting of meter data to the MV-90 HHF format
- Configuration for automatic remote meter reading
- Direct table reads
- Conversion of meter configuration to an XML file format for AMI over-the-air configuration
- Comparison of a configuration from the database to a configured meter
- Opening and closing the meter service switch
- Importing and exporting of load profile data, event log data, configurations and security codes

FEATURES & BENEFITS

- One software suite to configure and read from the Aclara portfolio of meters: kV family, I-210 family and SGM3xxx family
- Supports the ANSI C12.19 communication protocol
- Multiple methods to communicate with meters: USB & RS232 OPTOCOM, RS485, Modem
- Modular configuration workflow that enable the reuse of frequently used configuration settings and measurements
- Various reports to display information for meter management, auditing, billing and monitoring power quality
- Command line interface and batch-control enabling automated and scheduled meter operations
- Configurable role-based access control security

Residential Meter Selector

<table>
<tr><th></th><th>Product Characteristics</th><th>I-210+ Basic Energy</th><th>I-120+c</th></tr>
<tr><td>1</td><td>Meter Functionality</td><td>• Real Energy Consumption Management</td><td>• Real Energy Consumption Management
• Reactive Energy Consumption Measurement
• Apparent Energy Consumption Measurement
• Voltage Measurement (Min, Avg, Max)
• Sag/Swell Measurement
• Outage Count and Duration</td></tr>
<tr><td>2</td><td>ANSI Models</td><td><table><tr><th>FORM</th><th>CLASS</th><th>VOLTS</th></tr><tr><td>1S</td><td>100</td><td>120 & 240</td></tr><tr><td>2S</td><td>200 & 320</td><td>240</td></tr><tr><td>3S & 3CS</td><td>20</td><td>120 & 240</td></tr><tr><td>4S</td><td>20</td><td>240</td></tr><tr><td>12S</td><td>200 & 320</td><td>120 & 240</td></tr><tr><td>25S</td><td>200 & 320</td><td>120 & 240</td></tr></table></td><td><table><tr><th>FORM</th><th>CLASS</th><th>VOLTS</th></tr><tr><td>1S</td><td>100</td><td>120 & 240</td></tr><tr><td>2S</td><td>200 & 320</td><td>240</td></tr><tr><td>3S & 3CS</td><td>20</td><td>120 & 240</td></tr><tr><td>4S</td><td>20</td><td>240</td></tr><tr><td>12S</td><td>200 & 320</td><td>120 & 240</td></tr><tr><td>25S</td><td>200 & 320</td><td>120 & 240</td></tr></table></td></tr>
<tr><td>3</td><td>Soft-Switches to upgrade meter function</td><td>• Optional Softswitches can be loaded in the factory or by the user to activate advanced functions
O — Activates communication capability with AMR/AMI modules
S2 — AMI/AMR calculated demand displayed on meter LCD
V2 — Simple Voltage Event monitor in addition to a display of RMS momentary voltage on the 3 lower LCD digits</td><td>• Optional Soft-switches can be loaded in the factory or by the user to activate advanced functions
A2 — Activates communication capability with AMR/AMI modules
E2 — Activates Event Log Recording (up to 200 Events)
K2 — Activates Reactive/Apparent Energy Consumption recording
N2 — Activates Demand
Q2 — Activates Instrument Recording
R2 — Activates LP recording (up to 4 channels)
T2 — Activates TOU recording
V2 — Activates Sag/Swell monitor and recording</td></tr>
<tr><td>4</td><td>AMR Interface

(Factory enabled or installed by customer)</td><td>• Quadrature Pulse
• SPI Format-1 data
• SPI Format-2 data
• PSEM Communications</td><td>• PSEM Communications</td></tr>
<tr><td>5</td><td>Energy Accumulation</td><td>• Must specify at time of order either:
- Delivered only
- Delivered + Received
- Delivered – Received
- Received only
• Customer can change selection later using MeterMate</td><td>• Specified at time of order for factory programmed meters or configured by the customer using MeterMate. Any two or four of the following energy measurements can be selected:
- Delivered only kWh
- Received only kWh
- Delivered + received kWh
- Delivered – received kWh
- Lagging only kvarh; requires K2 Soft-switch
- Leading only kvarh; requires K2 Soft-switch
- Lagging + Leading kvarh; requires K2 Soft-switch
- Lagging - Leading kvarh; requires K2 Soft-switch
- Phasor apparent VAh; requires K2 Soft-switch</td></tr>
<tr><td>6</td><td>Cycle Insensitive Demand</td><td>• Not available</td><td>Requires T2 & N2 Soft-switches to be enabled
• Provides an alternative method for calculating the maximum demand in meters equipped with one-way AMR system.
• The meter maintains the daily maximum demands and the two peaks for the period.
• Demand is calculated using the programmed method (Block, rolling or thermal).
• The daily maximum demands are stored in a circular queue.
• Each entry in the circular queue contains a date</td></tr>
<tr><td>7</td><td>Power Quality</td><td>• With V2 Softswitch enabled, provides a count of Sag/Swell Events. Value and duration thresholds are programmable</td><td>• With Q2 and R2 Softswitches enabled, Min, Max and Average Voltage recording is possible.
• With V2 Softswitch enabled, provides counts and magnitude recording of Sag/Swell Events with date and time stamped. Value and duration thresholds are programmable. This Sag/Swell Event Log is separate from the Event Log recording provided by the E2 Softswitch
• With E2, R2 and T2 Softswitches enabled, recording of sustained and total outage counts and duration is possible to permit calculation of IEEE Reliability indices.</td></tr>
<tr><td>8</td><td>Back-up power</td><td>• Not available</td><td>Back-up power is used to maintain the meter clock during outages. If the R2 or T2 softswitch is required, one of the following back-up power options must be selected.
• Battery
• Supercap
• Batteryless operation. For batteryless operation, the AMI system must be able to re- synchronize the meter clock after a power outage</td></tr>
<tr><td>9</td><td>Service Switch

(provide remote controllable disconnection and reconnection of electrical service for residential applications)</td><td>• A switching device intended to provide remote controllable disconnection and reconnection of electrical service for residential applications.
• Factory installed option, specify at time of order.
• Full functionality requires two-way AMI module
• Switch is installed under standard size cover
• Typical applications include:
- Remote disconnect and reconnect of service
- Energy conservation demand limiting
- Demand limiting as an alternative to service disconnection
- Prepayment metering
- Outage management/restoration
Note: Energy conservation demand limiting and prepayment metering functionalities are not available on forms 12S and 25S.</td><td>• A switching device intended to provide remote controllable disconnection and reconnection of electrical service for residential applications.
• Factory installed option, specify at time of order.
• Full functionality requires two-way AMI module
• Switch is installed under standard size cover
• Typical applications include:
- Remote disconnect and reconnect of service
- Energy conservation demand limiting
- Demand limiting as an alternative to service disconnection
- Prepayment metering
- Outage management/restoration</td></tr>
</table>

Technical Specifications

I-210+ c

Basic Functions

Single Phase Demand Meter
- Energy management, 4 quantities
- Demand, block or rolling demand
- Fundamental plus harmonic measurements
- Bi-directional energy measurements

Load Profile recording
Time of Use Billing Measures
Four Energy options (Delivered, Received, Delivered+Received, Delivered -Received)
Tamper detect capability
Broad communication module options
Network applications
Models available for 120 or 240 volt CL 20, CL 100, 200, CL 320 applications.
50 or 60 Hz operation

Optional Functions

Factory integrated Service Switch Capability

Soft-Switch Functions

- The Alternate Communication Soft-switch allows a communication option option board to communication with the meter

E_2 Soft-switch

- The Event Log Soft-switch allows the meter to track the most recent 200 events. Use MeterMate™ Program Manager, Diagnostics Editor, to select the event types to be logged and how many occurences should be tracked, up to a maximum of 200 events. Date and time stamps are included on logged events for Demand/LP or TOU meters

K_2 Soft-switch

The kVA and kvar Soft-switch adds kVA(h) and kva(h) measurement capability.

N_2 Soft-switch

- The Demand (N_2) Soft-switch adds billing demand calculations.

Q_2 Soft-switch

The Instrumentation Measurements Soft-switch enables
- Voltage (L-N): VA (max, min store) for summations, demand, and load profile recording
- RMS voltage measurement for reading and display
- Low potential caution
- Temperature (max, min,avg) load profile recording

T_2 Soft-switch

The time-of-use soft-switch enables TYOU operation
- Up to four TOU periods and four Seasons
- Up to three daily rate schedule types and one holiday schedule
- Up to 80 TOU schedule set points
- Up to 50 programmable dates
- Holidays, season changes, Daylight Savings Time (DST), self-read, and demand reset
- Perpetual calendar handles most dates
- Up to two billing and two demand measures per TOU period
- Self-read actions on specified dates, with o4r without a demand reset

V2 Soft-switch

- The voltage Soft-switch activates Sag/Swell monitor and recording

Accuracy

Typical Accuracy: Within +/- 0.2%
Starting Watts: 12W @ 240V, 6W @ 120V
Typical Watt Loss: 0.7 Watts

Rating

Voltage: 120V -240V
Current: Class 100, Class 200, Class 320, Class 20
Frequency: 50 or 60 Hz

Cover Options

Polycarbonate over with molded sunshield
- Plain cover without RESET or "D" ring
- With Optocom "D" ring
- With RESET latch and "D" ring

Operation Range

Voltage: +/- 20%
Operates over a broad temperaure range (-40C through +85C under the cover)

Available Models

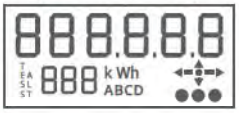
ANSI Form 1S, 2S, 3S, 4S, 12S, 25S
CL20, CL100, CL200, CL320

Applicable Standards

Performance meets or exceeds industry standards
ANSI C12.19
ANSI C12.1
ANSI C12.10
ANSI C12.20
ANSI C37.90.1
UL 2735

LCD Display

6 large charaters to display the main programmed metering quantities



Weights and Dimensions

Approximate Weight

Meters with service disconnect
- Individual meter 2.0 - 2.4 lbs
- 4 meter pack 9.0 - 10.6 lbs
- Pallet (120 meters) 285 - 340 lbs

Meters without service disconnect
- Individual meter 1.3 - 1.7 lbs
- 4 meter pack 6.2 - 7.8 lbs
- Pallet (120 meters) 200 - 255 lbs

I-210+

Basic Functions

Basic function as electronic single phase Revenue Meter
Four energy options (delivered, received, delivered+received, delivered -received)
Tamper detect capability
Broad communication module options
Network applications
Models available for 120 or 240 volt CL 20, CL 100, 200, CL 320 applications.
50 or 60 Hz operation

Optional Functions

Factory integrated Service Switch Capability

Soft-Switch Functions

AMR/AMI Communications (AMR/AMI Interface formats include quadrature pulse, PSEM, SPI Format-1 data, SPI Format-2 Data)
Display AMR calculated Demand value shown on the lower 3 LCD digits
Simple Voltage Event monitoring in addition to RMS momentary voltage display

Rating

Voltage: 120V - 240V
Current: Class 100, Class 200, Class 320, Class 20
Frequency: 50 or 60 Hz

Cover Options

Polycarbonate cover with molded sunshield
- Plain cover without RESET or "D" ring
- With Optocom "D" ring

Operating Range

Voltage +/- 20%
Operates over a broad temperature range (-40C through +85C under the cover)

Available Models

ANSI Form 1S, 2S, 3S, 4S, 12S, 25S
CL20, CL100, CL200, CL320

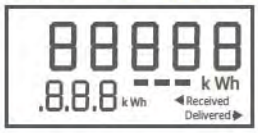
Applicable Standards

Performance meets or exceeds industry standards ANSI C12.1
ANSI C12.10
ANSI C12.20
ANSI C37.90.1

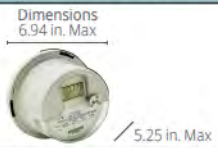
Technical Specifications

I-210+ (cont'd)

Soft-Switch Functions
5 large characters to display the billing quantities



Weights and Dimensions



Approximate Weight	
Meters with service disconnect	
– Individual meter	2.0 – 2.4 lbs
– 4 meter pack	9.0 – 10.6 lbs
– Pallet (120 meters)	285 –340 lbs
Meters without service disconnect	
– Individual meter	1.3 – 1.7 lbs
– 4 meter pack	6.2 – 7.8 lbs
– Pallet (120 meters)	200 –255 lbs

Aclara is a world-class supplier of smart infrastructure solutions (SIS) to more than 800 water, gas, and electric utilities globally. Aclara SIS offerings include smart meters and other field devices, advanced metering infrastructure and software and services that enable utilities to predict and respond to conditions, leverage their distribution networks effectively and engage with their customers. Aclara is owned by an affiliate of Sun Capital Partners.
Visit us at Aclara.com, phone 800 297 2728 or contact us at info@aclara.com and follow us on Twitter @AclaraSolutions.

This foregoing document was electronically filed with the Public Utilities

Commission of Ohio Docketing Information System on

7/2/2019 5:23:26 PM

in

Case No(s). 18-1832-EL-CSS

Summary: Exhibit AEP Opt-Out Meter (Aclara I-210+C) electronically filed by Mr. Aaron Young on behalf of YOUNG, THAAH AND AARON

Document Record

Date Filed:	7/2/2019 5:19:55 PM	**View Document**
Document Type:	EX-Exhibit	
Link to Document:	**View Document**	
Number of pages:	9	
Case Numbers:	**18-1832-EL-CSS**	
Summary:	Exhibit - AEP Opt-Out Meter (GE I-210+C) electronically filed by Mr. Aaron Young on behalf of YOUNG, THAAH AND AARON.	
Source File(s):		

GE
Digital Energy

Residential Electrical Metering

Advanced ANSI metering for the Smart Grid

For over 100 years, GE's metering solutions have provided utilities with a dependable partner known for our robust and quality metering platform. The I-210 product line brings innovative and flexible technology solutions that covers all your metering needs from basic electronic energy-only meters to highly-flexible smart metering solutions that provide advanced functionality to meet the evolving Smart Grid system needs.

GE's family of meters goes beyond meeting your complex business challenges. The advanced, powerful and easy-to-use meters give you an extra edge in the energy business. You can look forward to real-time instrumentation, power quality monitoring and easy access to critical information. All these add up to give you higher productivity, improved efficiency and reduced energy costs.

Key Benefits

- Reliable and accurate cash register for utilities
- AMR/AMI Plug-n-Play functionality
- Multiple communication technologies tied to AMI systems provide reliable data in a timely manner
- Smart metering functions such as Time of Use demand metering and service switch capabilities
- Demand side management through pre-payment and demand limiting features
- Advanced functions such as reactive measurement and, IEEE reliability indices measurement
- Robust meter security and standards compliance

ANSI Single Phase Meters

I-210+c Full featured, Smart Grid enabled metering
This is GE's flagship residential meter product, offering demand, load profile, TOU, service switch, and a full complement of communication options.

I-210+ Value packed Smart Grid functions
World class accuracy and reliability in a solid-state kWh meter platform package. Available with a service switch, as well as a wide array of communications options.

Communications

- Broad AMI/AMR Plug-n-Play options - RF Mesh, Power line carrier, Cellular, etc
- Allows interchangeability of AMR/AMI Plug-n-Play options
- Supports connectivity and integration with 3rd party communications solutions providers

Smart Configuration

- Ability to customize advanced metering options to suit customer's needs
- Configure load profile, time of use and demand metering capabilities
- Versatile programming Softswitches allowing the selection of advanced functionality such as power quality measurement and reactive power measurement
- Service Switch option improves operational efficiency and addresses issues such as demand side management, remote repayment systems, and controlled outage restoration

Reliability

- Robust revenue-grade watt-hour and demand meters
- Based on GE's cutting edge technology providing typical 0.2% accuracy, and reliability
- Enable utilities with tools to lower operational cost and provide accurate metering solutions

imagination at work

Reliable Metering

In this dynamic time of regulatory scrutiny and customer engagement, you can be assured of the product and the company behind the product. We have ANSI and ISO certified labs to ensure that our product design and manufacturing processes yield a robust product every time.

Our testing procedures go well beyond the ANSI and IEC requirements for which we design to, including some of the most aggressive internal standards in the market place today. We now have included world-class Radio Frequency (RF) communications expertise to ensure that our meter products are hardened to withstand even the harshest of RF environments without sacrificing the quality or integrity of the metrology or the communications technology.

Accurate & Dependable

Typically measured at +/- 0.2%, the GE I-210 family of meters provides best-in-class capabilities for accuracy. Combined with the low starting watts, the utility can have confidence in the metered value and measured electricity usage.

Integrity of Supply

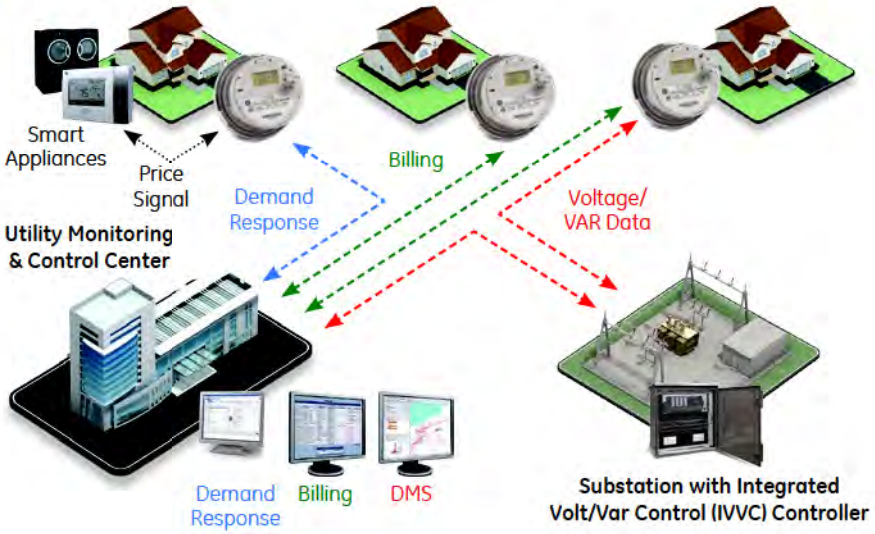
Having a partner that can provide assurance in supply is critical when a utility begins a mass deployment of meters. GE's process focus and rigor around supply chain excellence minimizes the risk to the utility, giving them confidence to manage installation crews and provide accurate scheduling to customers.

Broad Communications Support

The I-210 family has been designed to allow for the interchangeability of AMR/AMI modules and cover the broadest range of possible AMI communication technologies including RF Mesh, Cellular, Power Line and Ethernet. Modules can be added at the GE factory, after the fact, or replaced with another compatible module if the meter is redeployed.

Billing & Smart Applications

Traditional billing continues to be a vital component of today's solid state meters, but they are also now a vital part of your grid operation. We've leveraged the strength and knowledge of GE Digital Energy around distribution automation, volt-var control, demand optimization, and distributed generation to develop a line of metering products that are designed to integrate and provide the critical information needed to optimize all of these grid operation solutions. As GE continues to build on its Smart Grid solutions, you can count on GE Digital Energy and our new metering products to include innovative and unique capabilities you never thought possible.



Leading the way on integrated appliances for demand response

One of the most compelling benefits of the Smart Grid is the promise of delivering demand management or load control. Utilities will save energy, lower costs, and defer additional transmission and generation expenses with the ability to shave peak load, shape load and curtail load to mitigate grid events. Additionally, consumers will be able to conserve energy and shift energy use to benefit from time of use or time based rate structures. Various studies have shown that these actions can generate customer savings from 5% to 15% of their monthly electricity use.

GE, through our Digital Energy and Appliance businesses, is continuing to work on integrated solutions for electricity metering and smart appliances in the home. This is an exciting time for our business as we pioneer a new generation of electricity smart meters and smart appliances that work seamlessly together to deliver energy savings never thought possible.

Full featured, Smart Grid Meter

I-210+c

Smart Grid enabled, consumer friendly metering

GE's most advanced residential electricity metering product line, the I-210+c, delivers Smart Grid capability for today and the future. Derived from our industry leading commercial and industrial product line, the kV2c, the I-210+c benefits from our advanced metrology capability and lessons learned from over 10 years of solid state metering design. All the way down to the advanced microprocessor, the I-210+c contains much of the advanced polyphase functionality that GE has been known for. We have also added capability that makes the I-210+c the referenced residential product line in the industry.

Capability

Designed for today's dynamic rate structures, the I-210+c provides capability for demand, load profile, and TOU recording, along with a number of other power quality and demand response related functions. Configurable to support various metering quantities, this meter supports delivered (+), received (-), and net metering for distributed generation.

Advanced Functionality

With the addition of the fully rated 200 amp service switch, the meter is capable of pre-payment metering without all the historical cost associated with card readers or other legacy pre-payment technology. Load limiting and emergency conservation modes set this meter apart when working in conjunction with a demand response program. Having the capability to be remotely configured, as well as being firmware upgradeable, this product serves today's needs, as well as tomorrow's evolving requirements.

Communications

Designed to specifically accommodate the communications technology required to support a Smart Grid, the I-210+c has the same electrical and mechanical interface as our I-210+ platform, making communications interchangeable and interoperable between these two residential metering platforms. Designed with an enhanced power supply, the platform is ideally optimized for RF Mesh, PLC, and 3G/4G point-to-point communication technologies.

Features & Benefits

- Customize advanced metering options through SoftSwitches
- AMR/AMI Plug-n-Play designed to accommodate:
  - Radio Frequency Mesh (RF Mesh)
  - Power Line Communications (PLC)
  - Cellular (GPRS/CDMA) communications
  - Ethernet
- Advanced functionality such as: time-of-use, insensitive demand load profile recording, event logging.
- Typical accuracy: within +/- 0.2%
- Service Switch to improve operational efficiency and address issues such as:
  - Demand side management
  - Remote prepayment systems
  - Controlled outage restoration
- Low starting watts; capture energy consumption at levels typically not registered by electromechanical meters
- Low burden, which minimizes utility system losses
- Patented tamper algorithm to detect tamper-by-meter inversion
- Meets or exceeds ANSI C12.1, C12.10, C12.20, C37.90.1
- Communications Options:
  - Silver Springs Networks NIC
  - Trilliant SecureMesh
  - Itron Cellular
  - Itron 57ESS ERT

AMR/AMI Plug and Play Communications

Multiple communication options on the I-210+c allows greater customer choice. Ideally optimized for RF Mesh, PLC, 3G/4G point-to-point communication technologies, the I-210+c can cover a wide variety of communication scenarios.

Residential Communication
- ZigBee ESI 802.15.4 SEP 1.0

I-210+c

Utility Communication
- Radio Frequency Mesh (RF Mesh),
- Power Line Communications (PLC),
- Cellular (GPRS/CDMA) communications
- Ethernet

Utility Monitoring & Control Center

Value packed, Smart Grid Meter

I-210+

Load Management

The I-210+ is one of the most popular single phase meters among US utilities for residential metering installations. Equipped with a fully-rated 200A service switch, this meter platform is ideal to provide basic load management functionality.

Reliability

The I-210+ has enjoyed tremendous success in the marketplace for smart meters, with over 3.5 million units shipped since 2009. This product is the industry benchmark for quality and reliability, having passed both internal and external validation tests for billing accuracy. At GE, we have an unprecedented testing and validation process to ensure that our products are robust and exceed the industry standard ANSI requirements.

We have substantial expertise in wireless communications and the testing that is required to ensure that our meters perform flawlessly, even in the harshest of radio frequency (RF) environments.

Communications

The I-210+ has the same electrical and mechanical interface as our I-210+c platform, designed to specifically accommodate Smart Grid communications technology, making communications interchangeable and interoperable between these two residential metering platforms. Multiple RF Mesh and PLC communication technologies are supported with a newly updated power supply.

Features & Benefits

- AMR/AMI Plug and Play designed to accommodate: RF Mesh, PLC, Cellular (GPRS/CDMA), Ethernet
- Communications Options:
  - Grid IQ P2MP
  - SSN NIC
  - Trilliant SecureMesh
  - Aclara UMT-R
  - Itron 54ESS ERT, 55ESS ERT, 56ESS ERT
  - Tantalus TC-I210
- Advanced functionality such as; time-of-use, insensitive demand load profile recording, event logging.
- Customize advanced metering options through SoftSwitches
- Service Switch to improve efficiency and address:
  - demand side management
  - remote prepayment systems
  - controlled outage restoration

AMI Technology Selection for I-210+ and I-210+c Meters

AMI Technologies	Type	I-210+	I-120+c
Aclara UMT-R	PLC	X	
Grid IQ P2MP	RF P2MP	X	
Itron 54ESS ERT, 55ESS ERT, 56ESS ERT	1-way RF AMR	X	
Itron 57ESS ERT	1-way RF AMR		X
Itron Cellular	Cellular Network		X
Silver Springs Networks NIC	RF Mesh	X	X
Tantalus TC-I210	RF Mesh	X	
Trilliant SecureMesh	RF Mesh	X	X

Full featured, Secure Metering Software

MeterMate™

GE's innovative MeterMate software suite enables meter administrators to easily configure and manage GE meters. Each software component in the MeterMate suite is optimized to address the different aspects of a meter's lifecycle. MeterMate program creation software enables the user to effortlessly configure the meter's basic and advanced functionality, ranging from creating a simple demand program and setting up the meter display to configuring the meter's I/O and alerts. With MeterMate reading and programming software, a user can read, program and perform real-time instrumentation and power quality monitoring on a meter, via a variety of different communication methods such as local OPTOCOM, remote telephone, RS-232/485 and IP communications.

The suite also provides the MeterMate Batch Control, MeterMate Load Profile (MMLp) and MeterMate XTR utilities. MeterMate Batch Control enables the user to automate remote meter reading. MeterMate Load Profile (MMLp) provides analysis of load profile data and MeterMate XTR supports the export of meter data to the MV-90 HHF format.

Features & Benefits

- One software suite to configure and read from the GE portfolio of meters: kV family, I-210 family and SGM3xxx family
- Supports the ANSI C12.19 communication protocol
- Multiple methods to communicate with meters: USB & RS232 OPTOCOM, RS485, Modem
- Modular configuration workflow that enable the reuse of frequently used configuration settings and measurements
- Various reports to display information for meter management, auditing, billing and monitoring power quality
- Command line interface and batch-control enabling automated and scheduled meter operations
- Configurable role-based access control security

With GE meters, your business case just got a whole lot better

At GE, we've leveraged our expertise to ensure you get the most out of your investment in GE products and solutions. The capability available in the GE Smart Meter's provide for data that can be used to optimize a number of utility operational systems outside of traditional billing. These integrated solutions include:

- Outage events and alarms integrated into PowerOn™, GE's Outage Management Solution
- Voltage and Var data, provided in real-time, to enhance distribution automation solutions for Conservation Voltage or Integrated Volt/Var Coordination
- Integration with GE's GridIQ™ Demand Optimization Solution for coordinated load control and demand response for surgical implementation of load shedding and load deferral

The strength of metering products come from our broad knowledge of electrical utilities and their operational systems. We will continue to provide metering products that build on this knowledge and provide differentiated value for both the utilities and the consumer.

Residential Meter Selector

<table>
<tr><th></th><th>Product Characteristics</th><th>I-210+ Basic Energy</th><th>I-120+c</th></tr>
<tr><td>1</td><td>Meter Functionality</td><td>• Real Energy Consumption Management</td><td>• Real Energy Consumption Management
• Reactive Energy Consumption Measurement
• Apparent Energy Consumption Measurement
• Voltage Measurement (Min, Avg, Max)
• Sag/Swell Measurement
• Outage Count and Duration</td></tr>
<tr><td>2</td><td>ANSI Models</td><td><table><tr><th>Form</th><th>Class</th><th>Volts</th></tr><tr><td>1S</td><td>100</td><td>120 & 240</td></tr><tr><td>2S</td><td>200 & 320</td><td>240</td></tr><tr><td>3S & 3CS</td><td>20</td><td>120 & 240</td></tr><tr><td>4S</td><td>20</td><td>240</td></tr><tr><td>12S</td><td>200 & 320</td><td>120 & 240</td></tr><tr><td>25S</td><td>200 & 320</td><td>120 & 240</td></tr></table></td><td><table><tr><th>Form</th><th>Class</th><th>Volts</th></tr><tr><td>1S</td><td>100</td><td>120 & 240</td></tr><tr><td>2S</td><td>200 & 320</td><td>240</td></tr><tr><td>3S & 3CS</td><td>20</td><td>120 & 240</td></tr><tr><td>4S</td><td>20</td><td>240</td></tr><tr><td>12S</td><td>200 & 320</td><td>120 & 240</td></tr><tr><td>25S</td><td>200 & 320</td><td>120 & 240</td></tr></table></td></tr>
<tr><td>3</td><td>Soft-Switches to upgrade meter function</td><td>• Optional Softswitches can be loaded in the factory or by the user to activate advanced functions
O — Activates communication capability with AMR/AMI modules
S_2 — AMI/AMR calculated demand displayed on meter LCD
V_2 — Simple Voltage Event monitor in addition to a display of RMS momentary voltage on the 3 lower LCD digits</td><td>• Optional Soft-switches can be loaded in the factory or by the user to activate advanced functions
A_3 — Activates communication capability with AMR/AMI modules
E_2 — Activates Event Log Recording (up to 200 Events)
K_2 — Activates Reactive/Apparent Energy Consumption recording
N_2 — Activates Demand
Q_2 — Activates Power Quality (Min, Avg, Max Voltage) recording
R_2 — Activates LP recording (up to 4 channels)
T_2 — Activates TOU recording
V_2 — Activates Sag/Swell monitor and recording</td></tr>
<tr><td>4</td><td>AMR Interface

(Factory enabled or installed by customer)</td><td>• Quadrature Pulse
• SPI Format-1 data
• SPI Format-2 data
• PSEM Communications</td><td>• PSEM Communications</td></tr>
<tr><td>5</td><td>Energy Accumulation</td><td>• Must specify at time of order either:
- Delivered only
- Delivered + Received
- Delivered – Received
- Received only
• Customer can change selection later using MeterMate</td><td>• Specified at time of order for factory programmed meters or configured by the customer using MeterMate. Any two or four of the following energy measurements can be selected:
- Delivered only kWh
- Received only kWh
- Delivered + received kWh
- Delivered – received kWh
- Lagging only kvarh; requires K_2 Soft-switch
- Leading only kvarh; requires K_2 Soft-switch
- Lagging + Leading kvarh; requires K_2 Soft-switch
- Lagging - Leading kvarh; requires K_2 Soft-switch
- Phasor apparent VAh; requires K_2 Soft-switch</td></tr>
<tr><td>6</td><td>Cycle Insensitive Demand</td><td>• Not available</td><td>Requires T_2 & N_2 Soft-switches to be enabled
• Provides an alternative method for calculating the maximum demand in meters equipped with one-way AMR system.
• The meter maintains the daily maximum demands and the two peaks for the period.
• Demand is calculated using the programmed method (Block, rolling or thermal).
• The daily maximum demands are stored in a circular queue.
• Each entry in the circular queue contains a date.</td></tr>
<tr><td>7</td><td>Power Quality</td><td>• With V_2 Softswitch enabled, provides a count of Sag/Swell Events. Value and duration thresholds are programmable.</td><td>• With Q_2 and R_2 Softswitches enabled, Min, Max and Average Voltage recording is possible.
• With V_2 Softswitch enabled, provides counts and magnitude recording of Sag/Swell Events with date and time stamped. Value and duration thresholds are programmable. This Sag/Swell Event Log is separate from the Event Log recording provided by the E_2 Softswitch
• With E_2, R_2 and T_2 Softswitches enabled, recording of sustained and total outage counts and duration is possible to permit calculation of IEEE Reliability indices.</td></tr>
<tr><td>8</td><td>MeterMate Reading and Programming access</td><td>• Available</td><td>• Available</td></tr>
<tr><td>9</td><td>Service Switch

(provide remote controllable disconnection and reconnection of electrical service for residential applications)</td><td>• A switching device intended to provide remote controllable disconnection and reconnection of electrical service for residential applications.
• Factory installed option, specify at time of order.
• Full functionality requires two-way AMI module
• Switch is installed under standard size cover
• Typical applications include:
- Remote disconnect and reconnect of service
- Energy conservation demand limiting
- Demand limiting as an alternative to service disconnection
- Prepayment metering
- Outage management/restoration
Note: Energy conservation demand limiting and prepayment metering functionalities are not available on forms 12S and 25S.</td><td>• A switching device intended to provide remote controllable disconnection and reconnection of electrical service for residential applications.
• Factory installed option, specify at time of order.
• Full functionality requires two-way AMI module
• Switch is installed under standard size cover
• Typical applications include:
- Remote disconnect and reconnect of service
- Energy conservation demand limiting
- Demand limiting as an alternative to service disconnection
- Prepayment metering
- Outage management/restoration</td></tr>
</table>

Technical Specifications

I-210+c

Basic Functions
Single Phase Demand Meter
- Energy management, 4 quantities
- Demand, block, or rolling demand
- Fundamental plus harmonic measurements
- Bi-directional energy measurements
Load Profile recording
Time of Use Billing Measures
Four Energy options (Delivered, Received, Delivered+Received, Delivered-Received)
Tamper detect capability
Broad communication module options
Network applications
Models available for 120 or 240 volt CL 20, CL 100, CL 200, CL 320 applications.
50 or 60 Hz operation

Optional Functions
Factory integrated Service Switch Capability

Soft-Switch Functions
A_2 Soft-switch
- The Alternate Communication Soft-switch allows a communication option board to communicate with the meter
E_2 Soft-switch
- The Event Log Soft-switch allows the meter to track the most recent 200 events. Use MeterMate™ Program Manager, Diagnostics Editor, to select the event types to be logged and how many occurrences should be tracked, up to a maximum of 200 events. Date and time stamps are included on logged events for Demand/LP or TOU meters
K_2 Soft-switch
- The kVA and kvar Soft-switch adds kVA(h) and kvar(h) measurement capability.
N_2 Soft-switch
- The Demand (N_2) Soft-switch adds billing demand calculations.
Q_2 Soft-switch
The Power Quality Measurements Soft-switch enables
- Voltage (L-N): VA (max, min, store) for summations, demand, and load profile recording
- RMS voltage measurement for reading and display
- Low potential caution
R_2 Soft-switch
- The Load Profile Soft-switch activates up to 4 channels of LP recording
T_2 Soft-switch
The Time-of-use Soft-switch enables TOU operation
- Up to four TOU periods and four Seasons
- Up to three daily rate schedule types and one holiday schedule
- Up to 80 TOU schedule set points
- Up to 50 programmable dates:
- Holidays, season changes, Daylight Savings Time (DST), self-read, and demand reset
- Perpetual calendar handles most dates
- Up to two billing and two demand measures per TOU period
- Self-read actions on specified dates, with or without a demand reset
V_2 Soft-switch
- The voltage Soft-switch activates Sag/Swell monitor and recording

Accuracy
Typical Accuracy: Within +/- 0.2%
Starting Watts: 12W @ 240V, 6W @ 120V
Typical Watt Loss: 0.7 Watts

Rating
Voltage: 120 V –240 V
Current: Class 100, Class 200, Class 320, Class 20
Frequency: 50 or 60 Hz

Cover Options
Polycarbonate cover with molded sunshield
- Plain cover without RESET OR "D" ring
- With Optocom "D" ring
- With RESET latch and Optocom "D" ring

Operating Range
Voltage: +/- 20%
Operates over a broad temperature range (–40°C through +85°C)

Available Models
ANSI Form 1S, 2S, 3S, 4S, 12S, 25S
CL 20, CL100, CL200, CL320

Applicable Standards
Performance meets or exceeds industry standards
ANSI C12.19
ANSI C12.1
ANSI C12.10
ANSI C12.20
ANSI C37.90.1

I-210+

Basic Functions
Basic function as electronic single phase Revenue Meter
Four Energy options (Delivered, Received, Delivered+Received, Delivered-Received)
Tamper detect capability
Broad communication module options
Network applications
Models available for 120 or 240 volt CL 20, CL 100, CL 200, CL 320 applications.
50 or 60 Hz operation.

Optional Functions
Factory integrated Service Switch Capability
- Soft Switch Functions
- AMR/AMI Communications (AMR/AMI Interface formats include quadrature pulse, PSEM, SPI Format-1 data, SPI Format-2 Data)
- Display AMR calculated Demand value shown on the lower 3 LCD digits
- Simple Voltage Event monitoring in addition to RMS momentary voltage display

Accuracy
Typical Accuracy: Within +/- 0.2%
Starting Watts: 12W @ 240V, 6W @ 120V
Typical Watt Loss: 0.7 Watts

Rating
Voltage: 120 V –240 V
Current: Class 100, Class 200, Class 320, Class 20
Frequency: 50 or 60 Hz

Cover Options
Polycarbonate cover with molded sunshield
- Plain *cover* without RESET OR "D" ring
- *With Optocom "D" ring*

Operating Range
Voltage: +/- 20%
Operates over a broad temperature range (–40°C through +85°C)

Available Models
ANSI Form 1S, 2S, 3S, 4S, 12S, 25S
CL 20, CL100, CL200, CL320

Applicable Standards
Performance meets or exceeds industry standards ANSI C12.1
ANSI C12.10
ANSI C12.20
ANSI C37.90.1
ANSI C12.20
ANSI C37.90.1

Visit the Digital Energy Online Store: store.gedigitalenergy.com

A wide range of product solutions available for online ordering

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gedigitalenergy@ge.com

GEDigitalEnergy.com

imagination at work

GEA-12672B(E)
English
130716

Summary: Exhibit AEP Opt-Out Meter (GE I-210+C) electronically filed by Mr. Aaron Young on behalf of YOUNG, THAAH AND AARON

Document Record

Date Filed:	8/21/2019 1:00:37 PM	**View Document**
Document Type:	RES-Response	
Link to Document:	**View Document**	
Number of pages:	8	
Case Numbers:	**18-1832-EL-CSS**	
Summary:	Discovery Responses from AEP Ohio electronically filed by Mr. Aaron Young on behalf of Thaah & Aaron Young.	
Source File(s):		

BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

Thaah and Aaron Young,	)	
	)	
Complainants,	)	
	)	
v.	)	Case No. 18-1832-EL-CSS
	)	
Ohio Power Company,	)	
	)	
Respondent.	)	

OHIO POWER COMPANY'S RESPONSES TO COMPLAINANTS' FIRST REQUESTS FOR PRODUCTION OF DOCUMENTS AND INTERROGATORIES

Pursuant to Rules 4901-1-16, 4901-1-17, 4901-1-18, 4901-1-19, 4901-1-20, and 4901-1-22 of the Ohio Administrative Code, Ohio Power Company ("AEP Ohio" or the "Company") objects and responds to Thaah and Aaron Youngs' (collectively the "Youngs" or "Complainants") first set of Interrogatories and Requests for Production of Documents propounded June 20, 2018, June 21, 2018, June 26, 2018 (collectively, the "Youngs' Requests") as follows:

GENERAL OBJECTIONS

1. AEP Ohio objects to the Youngs' Requests to the extent that they seek information or documents that are neither relevant to the subject matter of this proceeding nor reasonably calculated to lead to the discovery of admissible evidence.

2. AEP Ohio objects to the Youngs' Requests to the extent that they purport to impose obligations beyond those that Ohio Adm. Code 4901-1-16, 4901-1-17, 4901-1-18, 4901-1-19, 4901-1-20, and 4901-1-22 impose.

3. AEP Ohio objects to the Youngs' Requests to the extent that they seek information or documents, or both, protected by the attorney-client privilege, the work product doctrine, or any other applicable privilege.

4. AEP Ohio objects to the Youngs' Requests to the extent that they are overly broad or unduly burdensome.

5. AEP Ohio objects to the Youngs' Requests to the extent that they seek information or documents, or both, that are within the Youngs' possession, custody, or control; in the custody, control, or possession of the Youngs' authorized agents or representatives; and/or which AEP Ohio has furnished to the Youngs in the last twelve months.

6. AEP Ohio objects to the Youngs' Requests to the extent that they are unreasonably cumulative or duplicative, or seek information or documents, or both, that may be obtained from another source that is more convenient, less burdensome or less expensive.

7. AEP Ohio objects to the Youngs' Requests to the extent that they seek answers that call for a legal conclusion.

8. AEP Ohio objects to the Youngs' Requests to the extent that they are vague, ambiguous, or otherwise employ undefined terms subject to more than one reasonable interpretation.

9. Each response below is subject to these general objections, and is made without waiver of any general or specific objection.

OBJECTIONS AND ANSWERS TO INTERROGATORIES

YOUNG-INT-01-001: When deployed, does the Company's Opt-Out meter have any one or more of these communication capabilities offered by GE/Aclara for the I-210+C including RF mesh communication, 1-way RF AMR, RF P2MP, Cellular communication, power line communication (PLC), Ethernet communication, USB, RS232 OPTOCOM, RS485, modem, or any soft-switches?

ANSWER:

AEP Ohio objects to this interrogatory as overly broad, vague, and ambiguous. Subject to and without waiving the foregoing objections and the general objections set forth above, AEP Ohio states that its normal "Opt-Out meter" is a digital non-emitting meter. The digital non-emitting meter does not have any remote communication capabilities. Specifically, the digital non-emitting meter has no RF Mesh communication, 1-way RF AMR, RF P2MP, Cellular communication, Power Line communication, Ethernet communication, USB, RS485, or modem.

The digital non-emitting meter allows for the use of soft-switches when there is a need to generate a customer bill for unique tariffs and/or billing parameters (*i.e.,* reactive capability, time of use tariffs, etc.). However, for normal residential service, the digital non-emitting meter does not have a soft-switch installed. Regardless, soft-switches do not add or remove any communication capability within the meter.

Finally, the digital non-emitting meter does have a RS232 OPTOCOM type port. The purpose of this port is to allow for on-site programming, maintenance, and data reading. In order to access this port, AEP Ohio personnel must travel to the customer's residence and manually connect to the meter.

YOUNG-INT-01-002: Where any one or more of the above communication technologies is not used in the Opt-Out meter when deployed, as a design feature of this meter, is it possible for AEP to add any of the above communication devices, modules or hardware to the meter by AEP after the meter is deployed?

ANSWER:

AEP Ohio objects to this interrogatory as overly broad, vague, and ambiguous. Subject to and without waiving the foregoing objections and the general objections set forth above, AEP Ohio states that it is not possible for AEP Ohio to retrofit any of the listed communication technologies into the digital non-emitting meter at any time. The various communication hardware referenced in YOUNG-INT-01-001 can only be factory installed by the Company's meter vendor.

OBJECTIONS AND RESPONSES TO REQUESTS FOR PRODUCTION OF DOCUMENTS

YOUNG-RPD-01-001: Provide any records of AEP's internal mechanism or policy in place specifically regarding voicemail from its customers when requesting a service.

ANSWER:

AEP Ohio objects to this request because it seeks information that is neither relevant to the subject matter of this proceeding nor reasonably calculated to lead to the discovery of admissible evidence. AEP Ohio also objects to this request as vague and ambiguous. Subject to and without waiving the foregoing objections and the general objections set forth above, AEP Ohio states that it has no records or documents responsive to this request. The AEP Ohio gridSMART team does not have a written internal mechanism or policy regarding voicemails left by customers. However, once the team receives or hears a voicemail from a customer requesting service, it follow ups with the customer, typically within two-business days. In this instance, Complainants allege they left a voicemail on August 20, 2018. That same day, Complainants sent an email to the Company related to opting out of AMI installation. The Company responded to Complainants via email on August 21, 2018.

YOUNG-RPD-01-002: If AEP is able to confirm this voicemail was left on AEP's voicemail system, please provide a record of this either in text or audible file format.

ANSWER:

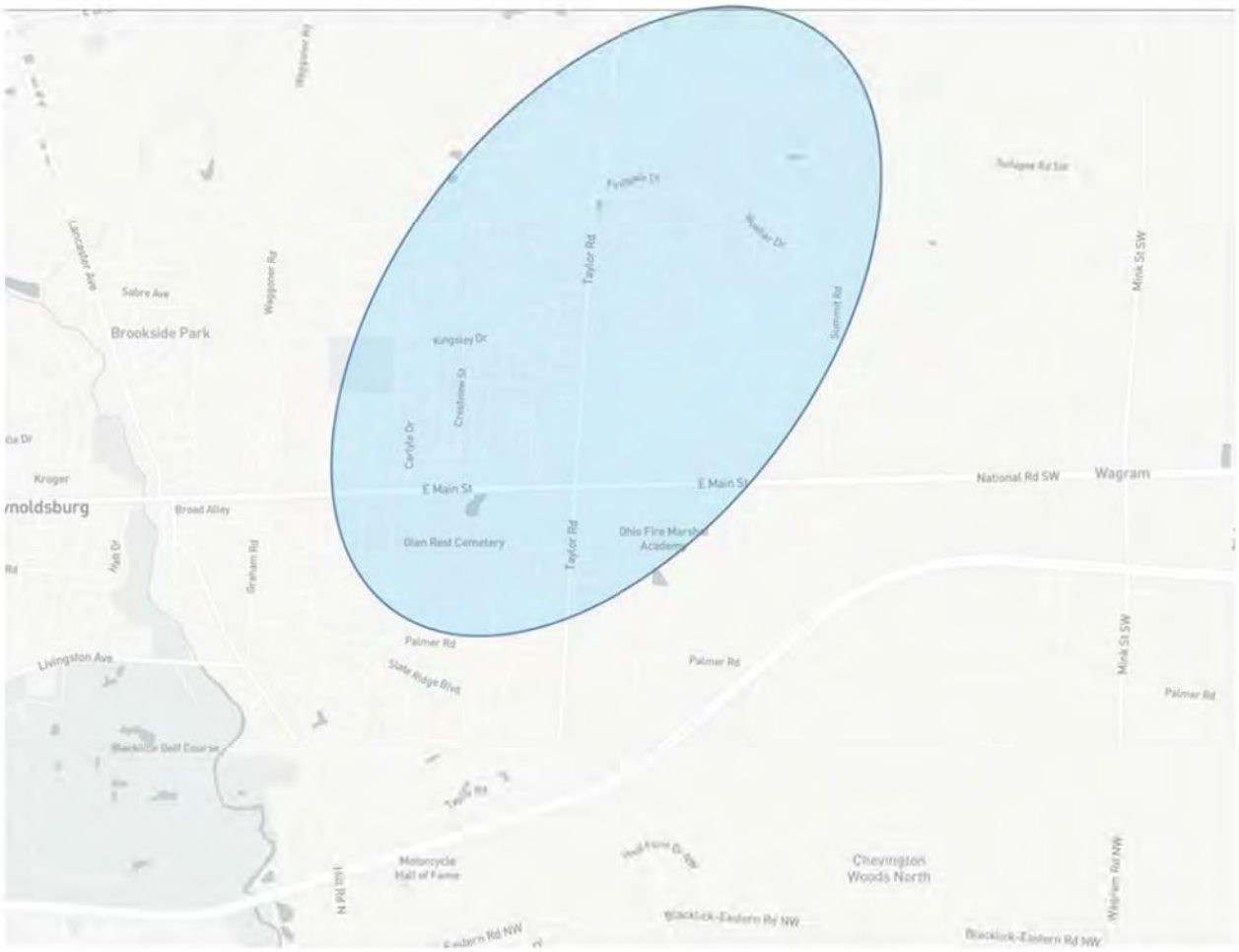
AEP Ohio objects to this request because it seeks information that is neither relevant to the subject matter of this proceeding nor reasonably calculated to lead to the discovery of admissible evidence. AEP Ohio also objects to this request as vague and ambiguous. Subject to and without waiving the foregoing objections and the general objections set forth above, AEP Ohio states that it has no documents or records responsive to this request and cannot confirm that Complainants left a voicemail on August 20, 2018

YOUNG-RPD-01-003: Provide a map or other geographical information in which AEP illustrates, defines or designates the particular meter-reading route associated with the Youngs' account.

ANSWER:

AEP Ohio objects to this request because it seeks information that is neither relevant to the subject matter of this proceeding nor reasonably calculated to lead to the discovery of admissible evidence. AEP Ohio also objects to this request as vague and ambiguous, and because it seeks to impose obligations beyond those that Ohio Adm. Code 4901-1-20 imposes inasmuch as it requests that AEP Ohio create a document. Subject to and without waiving the foregoing

objections and the general objections set forth above, the area within the blue oval on the map below reflects the area of the meter-reading route associated with the Youngs' service address.



YOUNG-RPD-01-004: Provide record(s) of evidence which show the percentage of AMI and/or AMR meters in which AEP had installed on this meter reading route on the day of August 21, 2018.

ANSWER:

AEP Ohio objects to this request because it seeks information that is neither relevant to the subject matter of this proceeding nor reasonably calculated to lead to the discovery of admissible evidence. AEP Ohio also objects to this request as vague and ambiguous, and because it seeks to impose obligations beyond those that Ohio Adm. Code 4901-1-20 imposes inasmuch as it requests that AEP Ohio create a document. Subject to and without waiving the foregoing objections and the general objections set forth above, AEP Ohio ran a data query by meter type using AEP Ohio's Marketing Accounting Customer Services System (MACSS). The query identified 299 meters within the meter-reading route that includes the Youngs' service address. On August 21, 2018,

five residences along the Youngs' meter-reading route had either an AMI or AMR meter installed at their premises.

YOUNG-RPD-01-005: Provide record(s) of evidence which show the actual day in which AEP had installed 85% percent of AMI and/or AMR meters on this meter reading route.

ANSWER:

AEP Ohio objects to this request because it seeks information that is neither relevant to the subject matter of this proceeding nor reasonably calculated to lead to the discovery of admissible evidence. AEP Ohio also objects to this request as vague and ambiguous, and because it seeks to impose obligations beyond those that Ohio Adm. Code 4901-1-20 imposes inasmuch as it requests that AEP Ohio create a document. Subject to and without waiving the foregoing objections and the general objections set forth above, AEP Ohio ran a data query by meter type using MACSS. According to the data query, as of October 25, 2018, the Company had installed 255 AMI and/or AMR meters along the Youngs' meter-reading route.

As to objections to interrogatories:

/s/ Tanner S. Wolffram
Tanner S. Wolffram (0097789)

Respectfully submitted,

/s/ Tanner S. Wolffram
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(willing to accept service by e-mail)

Counsel for Ohio Power Company

CERTIFICATE OF SERVICE

I hereby certify that a true and accurate copy of the foregoing was served upon the following parties via electronic mail on June 10, 2019.

Thaah Young
Aaron Young
9164 Taylor Rd. SW
Reynoldsburg, Ohio 43065
aaron2457@sbcglobal.net
th2457@sbcglobal.net

/s/ Tanner S. Wolffram
Tanner S. Wolffram

Summary: Exhibit Discovery Responses from AEP Ohio electronically filed by Mr. Aaron Young on behalf of YOUNG, THAAH AND AARON

Document Record

Date Filed:	8/21/2019 1:18:40 PM	**View Document**
Document Type:	EX-Exhibit	
Link to Document:	**View Document**	
Number of pages:	3	
Case Numbers:	**18-1832-EL-CSS**	
Summary:	Exhibit: Opt-Out Meter 2 Way Communication electronically filed by Mr. Aaron Young on behalf of Thaah & Aaron Young.	
Source File(s):		

iP500-302

Laptop **RS232** Universal Optical Probe

Features:

- Designed for Desktop and Laptop computers
- Compatible with virtually all utility meters, registers and recorders
- Supports **ANSI C12.18-1996, GE OPTOCOM**
- Serial RS232 & EIA232D communication
- Powered by computer's PS/2 mouse port, battery pack, AC adapter or optional USB port
- Designed with rugged Aluminum housing (head)
- Power switch in head to control power
- Rugged and long lasting Polyurethane coiled cord (64" long, Ext. to 25 feet)
- Lightweight for reduced fatigue, wear and tear
- Powerful magnets in probe head for attaching to meter's optical port

Overview

The iP**500-302** Laptop Optical Probes are designed for reading and programming electrical power meters employing the **ANSI Type 2** optical port. These probes are specifically configured for use with desktop and laptop computers employing the Serial Communication Ports with DB9 and DB25 connectors and derive power from their PS/2 mouse or keyboard ports. Its optical circuitry supports **ANSI C12.18-1996** and **General Electric OPTOCOM** communications protocols by switching automatically from one to the other depending on the meter type being read. The power to this probe is controlled by the **"power switch"** mounted in the probe head. When probe not in use, the switch turns off and power is conserved, extending the laptop's battery charge.

The iP**500-302** Optical Probes use advanced optical sensors to collect meter data and transmit it to the laptop computers. This allows metering data to be recorded more simply, accurately and efficiently. In addition, the iP**500-302** probes incorporate a universal compatibility design to read virtually all utility meters, registers and recorders.

The iP**500-302** Optical Probes solve problems relating to mechanical wear-out due to the demanding environment under which probes are constantly subjected to. We address this problem using the most rugged mechanical and electrical design in the industry. These probes are designed with an almost indestructible aluminum head that contains powerful magnets that ensure a good retention when attached to the meter's optical port. They are also designed with a high-endurance polyurethane molded cable 64" long that withstands the outside rugged environment. This claim is backed with an aggressive warranty and service policy.

WWW.INTELLIPROBE.NET
intelliprobe

2041 Industrial Drive | McAllen, Texas 78504 | Phone: 956-630-1833 | Fax: 956-630-2241

Technical Specifications

Mechanical Specifications

Physical size	Height 2.44"; Length 1.68"; Width 1.38"
Cable Type	Coiled, Polyurethane and Hytrel construction, Flexible and Rugged
Cable Length	18" Coiled, extends to 10 Feet
Connector	DB9 9-pin w/housing and DTR switch 6-pin mini-DIN (PS/2 mouse/keyboard)
Weight	Complete assembly weighs a maximum of 9 ounces
Finish	Probe head has either a Clear Anodized Outer Coating per MIL-A-68625, Type 2 or a Hard Black Anodized Outer Coating per MIL-A-8625, Type 3

Electrical Specifications

Signal Spec.	Serial RS232, EIA232D, V28, V32
Power Req.	Operating Supply Voltage: 4.5 to 6.0 VDC (from computer's PS/2 port)
Data Rate	Controlled by meter for OPTOCOM interface, 0 to 19,200 baud for Non-OPTOCOM meters
Optical	880 nm bi-directional IR interface, ANSI C12.18, GE OPTOCOM

Environmental Specifications

Temperature	Operating -30° to 60° C; Storage -40° to +85° C
Ruggedness	Meets the requirements of a numbers of tests including those for Thermal Shock, Humidity, Water Resistance, RF Susceptibility, ESD, Drop, Random Vibration, Solar Radiation, Salt, Fog and Low Pressure.

Handheld Interface

Serial RS232 (DB9)

Some Compatible Meters

ABB	2550, 2650, All Alpha, Alpha T, A3, Alt, Alr-al, 2430
Aptech/Robinton	LPR1, LPR2, LPR3, SR500, TR403, TR804
General Electric	DR87, KM901, M90-AE, Phase 3, T80, T91, TM80, TM81, TMR82, TM92, KC901, KTC-901, KV, KV2, KV2-C, others
Siemens (Landis&Gyr)	CTR101, CTR102, DC, DCR, DD, DG100, DT, DX, DXR, SD100, SM101, SM301, TMC101, LINC, DCRMA, DDMA, S4 family, AX series, RX series, MAXSYS 2410, MAXSYS 2510, Quad 4, others
Metricom	C
PSI	S100, S200, Quad 4
Pwr Measurement	ION 7000 series, 8000 series
Itron (Schlumbergér)	Datastar, Fulcrum, MT100, MT200, Quantum, Q1000, Sentinel, Centron, Vectron
Synergistics	B40
Transdata	EMA, Mark V

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Summary: Exhibit Exhibit: Opt-Out Meter 2 Way Communication electronically filed by Mr. Aaron Young on behalf of YOUNG, THAAH AND AARON

Document Record

Date Filed:	8/21/2019 1:29:59 PM	**View Document**
Document Type:	EX-Exhibit	
Link to Document:	**View Document**	
Number of pages:	86	
Case Numbers:	**18-1832-EL-CSS**	
Summary:	Exhibit: Opt-Out Meter Communication Protocol and AMI Infrastructure electronically filed by Mr. Aaron Young on behalf of Thaah & Aaron Young.	
Source File(s):		

SmartGrid/AEIC AMI Interoperability Standard Guidelines for ANSI C12.19 / IEEE 1377 / MC12.19 End Device Communications and Supporting Enterprise Devices, Networks and Related Accessories

Version 2.1
Approved May 02, 2012
Published July 26, 2012

Abstract

This SmartGrid/AEIC AMI Interoperability Standard identifies the components of Enterprise semantics and object models defined by IEEE Std 1377™-2012 / ANSI C12.19-2008 / MC12.19-201x and the required communication Application Services protocols provided by Standards such as IEEE Std 1703™-2012 / ANSI C12.22-2008 / MC12.22-201x, IEEE Std 1701™-2011 / ANSI C12.18-2006 / MC12.18-201x and IEEE Std 1702™-2011 / ANSI C12.21-2006 / MC12.21-201x. This document should be used by all compliant Utility enterprise head-end systems, billing systems, interfaces to the metering network, all the way down to the meters and End Devices. The Guidelines build on the original work from AEIC Guidelines v1.0-09-21-98, Proposed AEIC Guidelines for Implementation of ANSI C12.19-1997 "Utility Industry End Device Data Tables", to define minimum requirements for ANSI C12.19 AMI interoperable End Devices, software and firmware produced by AMI technology solutions providers that meet the needs of NIST, AEIC and the SmartGrid interoperability.

It is an objective of the Interoperability Standard Guidelines to recommend migration paths toward supporting enterprise infrastructure with consideration for existing deployments, capital investments and transition requirements from legacy technology. It is not an expectation that existing deployments, capital investments and legacy technology in place and/or production prior to the release of these guidelines comply with these guidelines.

It also is the objective of the Interoperability Standard Guidelines to require that the ANSI C12.19 interoperability mechanisms identified within become a recommended purchasing requirement for all systems that implement IEEE Std 1377™-2012 / ANSI C12.19-2008 / MC12.19-201x and their required communication Application Services protocols provided by IEEE Std 1703™-2012 / ANSI C12.22-2008 / MC12.22-201x, IEEE Std 1701™-2011 / ANSI C12.18-2006 / MC12.18-201x or IEEE Std 1702™-2011 / ANSI C12.21-2006 / MC12.21-201x) or other communication Application Service protocol Standard(s) compliant to ANSI C12.19-2008 requirements for the SmartGrid and recognized in the NIST Framework and Roadmap for Smart Grid Interoperability Standards.

It is an objective to contribute this document to NIST, IEEE, ANSI and Measurement Canada so that similar approaches may be taken throughout North America for increased interoperability of AMI on the SmartGrid.

It is an objective of these Interoperability Standard Guidelines to support the NIST Priority Action Plan (PAP05) Standard Meter Data Profiles (6.2.5), which is to utilize ANSI C12.19 / IEEE 1377 / MC12.19 data models to represent one or more meter profiles with distinct information locations and formats to simplify client access to commonly shared information.

Participants

Chair: Young Nguyen, Pacific Gas & Electric
Vice Chair: Anthony Hawkins, CPS Energy
Secretary: Shannon Spizzirri, Southern California Edison
Editors: Terry Penn, Georgia Power Company & Shannon Spizzirri, Southern California Edison

At the time this document was completed, the AEIC Working Team had the following membership:

Michael	Anderson	Landis+Gyr	Tim	Morgan	Duke Energy
Larry	Barto	Georgia Power Company	Young	Nguyen	Pacific Gas & Electric
Ed	Beroset	Elster Electricity, LLC	Dan	Nordell	Xcel Energy
Brent	Cain	Itron	Tony	Osmanski	PPL Electric Utilities Corp.
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Anthony	Hawkins	CPS Energy	Derl	Rhoades	Alabama Power Company
David	Jirikovic	Consumers Energy	Greg	Sheran	Southern California Edison
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Ed	May	Itron	Kostas	Tolios	DTE Energy
Bill	Mazza	Sensus	Richard	Tucker	Tucker Engineering
Mike	Miller	Itron	James	Tucker	SDG&E
Avygdor	Moise	Future DOS R&D, Inc.	Ginger	Zinkowski	GE

Table of Contents

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1.0 Introduction

IEEE, ANSI and Measurement Canada developed the "Utility Industry End Device Data Tables" and "Protocol Specification for Interfacing to Data Communication Networks" Standards for electronic metering products (water, gas, electric, generic appliances and related equipment) with the designations ANSI C12.19 / IEEE-1377 / MC12.19 and ANSI C12.22 / IEEE-1703 / MC12.22 respectively. These Standards are commonly referred to as ANSI C12.19 standard and ANSI C12.22 for short. This Standard's objective is to achieve interoperability among systems that implement hardware and software from multiple vendors. The Standard organizes metering device data and defines operating requirements for communications. ANSI C12.19 defines a semantic data model that is based on Tables, thus providing significant flexibility. Indirect addressing (TABLES) for AMI End Devices was chosen deliberately over object-oriented methodology to allow simple "One way" and "Two way" devices entry into the ANSI C12.19 suite of Standards venue for AMI compliance and interoperability.

This significant flexibility is expressed in many ways. A number of transmission and encoding formats are provided for time, values, data order and text formats. Communications methods, data access methods and procedures are prescribed for dealing with the multitude of choices and the functionality offered. ANSI C12.19 contains up to 2040 "Standard Tables" that are fully defined by the Standard. These are organized into functional groups known as decades (up to 10 Tables per decade). In addition, provision is made for an additional 2040 "Manufacturers' Tables" so that future innovations can be implemented utilizing the framework and mechanisms specified by the semantic model of the Standard. These mechanisms facilitate the possibility of future inclusion of Manufacturer-Defined Tables into future publications of the Standard. Another set of 2040 Extended User-Defined Tables is available for "One way" and "Two way" communicating devices and enterprise systems that have a demand for extremely low communications overhead. The (Extended) User-Defined Tables aggregate elements of information from other Tables (Standard or Manufacturer Table Elements) and bundles them into a single "virtual" Table for transmission. Finally, 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 roll-back capabilities. The Pending Tables also enable event driven and synchronized actionable communication.

The Standard's flexibility presents a challenge to system developers, to equipment Manufacturers, and to Utilities. System developers must continue to consider the real need to provide the capability of processing multiple data formats from the End Devices. The obvious advantage of ANSI C12.19 is that the rules and semantic model are published, the Tables provided are machine-readable (TDL XML Form and EDL XML Form), human readable (Standard Document Form) and will be accessible through certified registries through the Internet.

Implementing all the mechanisms identified in ANSI C12.19 represents a significant challenge. For that reason, it is expected that data acquisition products should be capable of processing data from any End Device that follows the access rules defined by ANSI C12.19 and required communication services. The End Device's table of contents is provisioned by ANSI C12.19 Table 00 – General Configuration Table. Access to Standard Table 00, function limiting Tables, and information found in device control Tables can be combined with ANSI C12.19 registrar-supplied Device Class information about "End Devices" for improved efficiency and interoperability.

Equipment Manufacturers will continue to be faced with the cost versus function questions in designing devices and will continue to look for innovations to increase their competitive position and efficiencies in their design options. ANSI C12.19 recognizes this need and has provided for both Standard and Manufacturer-Defined Tables to permit the introduction of new products. While ANSI C12.19 may appear to impose some overhead in the system design, ultimately, compliance to the Standard would seem to increase market exposure because the processing of the data is facilitated through the mechanisms within the Standard. Access to Table 00 provides the information that allows the data to be processed. Manufacturers shall provide this information with the syntax of ANSI C12.19 to facilitate data exchange. The Utility may require the Manufacturer(s) to register the metering product utilizing ANSI C12.19 to ensure compliance and interoperability with the Utility's meter population.

Utilities face the most interesting challenges of all the participants in this discussion. The industry is in a state of change with an unclear future. Future roles for metering in the energy marketplace may not yet

be defined. Despite this uncertainty, it would seem intuitive that metering will play an important part in future transactions with multiple parties desiring access to the meter or at least the metering data. The flexibility provided by ANSI C12.19 facilitates access to the necessary data and potentially reduces overall cost to the industry and ultimately the customers. It is up to the utility industry, now and in the future, to specify that systems and devices be in compliance with ANSI C12.19 and required companion communication protocols.

The Guidelines described within this document were created in order to assist utilities in specifying implementations of ANSI C12.19 typical metering devices and AMI devices. Utilities using these Guidelines will be able to purchase devices for AMI system interoperability and be able to enjoy an economy of scale with participating Utilities. Manufacturers will be able to reduce their extra product design work due to speciality requests from each Utility. Participating Utilities and Manufacturers will advance the Smart Grid another step towards interoperability of metering devices and enterprise metering systems.

These Guidelines are the result of the work of an ad hoc team from interested members of the utility industry to identify common data requirements (within the ANSI C12.19 Standard) and to develop a set of voluntary implementation Guidelines for Utilities' purchasing and operating requirements. The resultant Guidelines reflect the collective opinions of the members of the working group. Where recommendations for values are stated, these recommendations should not be misunderstood by system developers as reducing the need for flexibility in the host system.

These Guidelines have been made to facilitate the real challenges of operation and maintenance of End Devices. The recommendations reflect the existing needs for revenue data as perceived by the members of the working group. The working group has attempted to define these needs using the Standard Tables found within ANSI C12.19 exclusively. The user must compare his individual needs to the recommendations.

This version of the Guidelines has been created to clarify sections of the AEIC v1.0 Guidelines document and to further define the different classifications of metering that are expected in the near future. Data requirements may shift as newer rate schedules in the utility industry are developed, or as the application of new communication technologies evolve. In addition, revisions to ANSI C12.19 and introduction of new device data models may necessitate further revision to this document.

It is extremely important to note that this document is a voluntary guideline for use by any Utility or other interested party for purchase order specifications of electronic metering devices and associated enterprise apparatus. This document is not intended in any respect to preclude other designs, manufacture, purchase, or use of any products not conforming to this document.

Familiarity of the user with ANSI C12.19-2008 is assumed in this document. For definitions and for the range of values possible, please reference C12.19-2008, ANSI C12.22-2008, ANSI C12.21-2006 and ANSI C12.18-2006 as appropriate. Some of the required Standard Tables are scattered among all of the above Standards. The above Standards are co-published as IEEE Std 1377™-2012 [7], IEEE Std 1703™-2012 [10], IEEE Std 1701™-2011 [8] and IEEE Std 1702™-2011 [9] respectively and MC12.19, MC12.22, MC12.18, and MC12.21 respectively. The IEEE (and Measurement Canada) publications contain Errata to the ANSI Standards and provide additional elaborations; therefore they are required reading.

2.0 Overview

2.1 Purpose

This document is to be utilized when specifying an implementation of ANSI C12.19, "Utility Industry End Device Data Tables" and required associated control service elements that are provided by Standard communication protocols that implement (E)PSEM. Users of these Guidelines need to evaluate their individual needs against those stated herein and decide on their applicability.

The AEIC Guidelines document shall provide clear and unambiguous instructions for the Utility to purchase ANSI C12.19 end devices. The instructions shall be provided allowing Utilities without intimate knowledge of the ANSI suite of Standards to attain populations of interoperable end devices. These Guidelines apply to Smart Grid metering and all data being communicated whether the data comes from

the meter or communication module or data concentrator, etc. shall comply with the AEIC Guidelines for C12.19.

These Guidelines shall identify typical End Devices such as simple register, demand register, TOU registers, etc. and provide tabular or other organizational grouping to assist the Utility with quick and concise ordering information. Utilities will benefit with other participating Utilities in an economy of scale of the common and typical End Devices and the Manufacturers will benefit with less specialty design for each Utility.

These Guidelines shall indicate where possible suggestions or possible mechanisms to guide Utilities toward the goal of system device interoperability and interchangeability without the loss of existing legacy systems' and devices' remaining life value. All references to ANSI C12.19-2008 are assumed to include all of the corrections to errors and omissions published in IEEE Std 1377™-2012. Similarly all references to ANSI C12.22-2008 are assumed to include all of the corrections to errors and omissions published in IEEE Std 1703™-2012.

The AEIC Guidelines document shall provide clear and unambiguous instructions for the Utility to purchase ANSI C12.19 End Devices. The instructions shall be provided allowing Utilities without intimate knowledge of the ANSI suite of Standards to attain populations of interoperable End Devices. These Guidelines apply to Smart Grid metering and all data being communicated whether the data comes from the meter or communication module or data concentrator, etc. shall comply with the AEIC Guidelines for ANSI C12.19.

These Guidelines are designed to forward the following definitions of interoperability:

1. It shall be possible to determine the contents of ANSI C12.19 Meters and other End Devices through the analysis of only the ANSI C12.19 Standard and the Tables that are internal to the meter or externally provided by the Manufacturer via the North American Utility End Device Registry Authority which is overseen by the IEEE / ANSI / MC Object ID Oversight Committee. Additional features may be present as defined in Manufacturer-specific Tables and the Manufacturers are encouraged to create extended features. However, information modeled in Standard Tables must be completely represented through Standard Tables and this includes utilizing space in Standard Tables designated for Manufacturer-specific data, e.g., the display Tables, data source Tables, etc.
2. It shall be possible to obtain an unambiguous measurement of kWh, kVARh, accumulated values, and related demands from reading and analyzing the Tables. This includes the units of measure and the other attributes of information needed for billing.
3. Certain desirable capabilities shall be configurable within any instance of a meter claiming to be represented by this specification. These capabilities are those arising from modification via writing to Tables identified as writable. When these writable Tables are so modified, the resulting observable behaviour of the meter through communications shall be consistent with the ANSI C12.19 Standard.
4. All Standard, Manufacturer and Extended User-Defined Tables shall be written (expressed) utilizing the ANSI C12.19 Standard Syntax and communicated using the Standard's data transmission formats.
5. All Manufacturer Tables shall be written (expressed) to co-exist within Decade structure and Decade functionality of the ANSI C12.19 Standard as follows:
    a. Manufacturer Tables X0 / X1 shall be reserved for FLC Tables of Manufacturer-Defined Decades.
    b. Manufacturer-Defined Decades shall not utilize Decade numbers that are used by the ANSI C12.19 Standard that the End Device references semantically.
    c. Manufacturer Tables may be associated with a Standard Decade using the TDL Table's "associate" attribute.
    d. Manufacturer Tables that are associated with a Standard Decade may (it is recommended) assume Table Decade number of the Standard Decade, e.g., <Tables name="MFG_DISPLAY_CONTROL_TBL" number="33" associate="LOCAL_DISPLAY_DEC"> is a Manufacturer-Defined Table that exists in the context of Standard Decade 3.

e. Subject to the constraints (a) and (b) above, Manufacturer Tables do not need to be associated with any Decade.

6. Programming, reading and or writing data to ANSI C12.19 meters or other AMI End Devices shall utilize ANSI C12.19 Tables read / write operations on Tables structures via supported Standard communication protocols.

2.2 Objectives

This document is the framework and accreditation criteria to be used for ANSI C12.19 / IEEE 1377 / MC12.19 meters and other AMI devices by users and testers of this technology. It is noted here that these three Standards are identical because of mutual Memorandums Of Understanding (MOU) that exist among the three organizations, ANSI, IEEE and Measurement Canada (Legal Metrology Branch). The three Standards will be referenced throughout this document as ANSI C12.19. The ANSI C12.19 Standard relies on complementary ancillary suite of Standards to handle communication methodologies using interfaces such as optical port, telephone and any-area network.

The three Standards organizations have jointly produced the following communication and application protocol-services for ANSI C12.19:

- ANSI C12.18 / IEEE 1701 / MC12.18 – Protocol Specification for ANSI Type 2 Optical Port.
- ANSI C12.21 / IEEE 1702 / MC12.21 – Protocol Specification for Telephone Modem Communication.
- ANSI C12.22 / IEEE 1703 / MC12.22 – Protocol Specification for Interfacing to Data Communication Networks.

Similarly, ANSI C12.19 is referenced by class_id: 26 of ISO / IEC 62056-62, 2006 [19]. Therefore, any Data Model that is defined by this document will be applicable for any implementation that is based on ISO / IEC 62056-62.

This set of Guidelines aims to:

1. Reduce the complexity of meter reading through the reduction of variations in the implementation and interpretation of the ANSI C12.19 and its required communication suite of Standards.
2. Establish a user's expectation for "best practices" for implementers of ANSI C12.19 and its required suite of Standards.
3. Provide definite interpretation, from a Utility user's perspective, for terms and items that are vaguely defined, undefined or optionally supported by the C12 suite of Standards.
4. Provide implementation Guidelines for the uniform definition, display, transportation and interpretation of metering logical units of measures.
5. Provide performance Guidelines and metrics for the efficient definition, display, transportation and interpretation of metering legal units of measures.
6. Establish pass / fail acceptance criteria for ANSI C12.19 metering devices and required communication technologies.
7. Provide easy tabular reference to typical meters and other AMI devices for Utility purchase order description. This is for Utilities desiring system interoperability without intimate knowledge of these Standards.

It is expected that reduced variation, decreased complexity and uniform implementation of these Standards will help the users of these Standards to attain the objectives of reducing the overall complexity and cost of AMI for the SmartGrid. Specifically, the Utilities' economy of scale and Manufacturers' reduction of extra design work due to Utility specialty requirements are clear opportunities for the Utilities and Manufacturers while providing interoperability for Smart Grid.

2.3 Scope

This document provides implementation Guidelines in the following areas:

1. Usage requirements and rules for implementers of ANSI C12.19-2008 in regard to:
    a. The transmission of Table Data.
    b. The security of Table Data.

   c. The encoding of Table Data.
   d. The interpretation of Table Data.
   e. Enterprise use of the Table Structure and Table Data semantic model.
   f. Use of Event Loggers.
   g. Use of Manufacturer-Defined Tables.
   h. Use of Extended User-Defined Tables.
2. Communication Protocol Standards and Application services required to communicate ANSI C12.19 Elements.
   a. Use of local optical port communication protocols covering all 7-layers of the OSI stack [26].
   b. Use of telephone MODEM communication protocols covering top 6-layers of the OSI model down to the Datalink later only.
   c. Use of Network communication protocols covering top 3-layers of the OSI model (Application, Presentation and Session).
   d. Use of Network communication protocols covering the Transport layers of the OSI model for Internet Enterprise use (e.g., TCP/IP, UDP/IP and IGMP/IP).
   e. Use of other Network communication protocols covering the Network layers of the OSI model for Internet Enterprise use.
3. Define and develop a number of utility metering models using the semantic model of ANSI C12.19 including:
   a. Data models for residential single phase meters.
   b. Data models for commercial polyphase meters.
   c. Data models for industrial polyphase meters.
   d. Data models for AMI load control devices.
4. Provide guiding principles for achieving end-to-end and Enterprise AMI interoperability when communicating C12.19 and Standard protocols and services over any medium.

3.0 References

1. ANSI C12.18-2006: Protocol Specification for ANSI Type 2 Optical Port.
2. ANSI C12.19-2008: Utility Industry End Device Data Tables.
3. ANSI C12.21-2006: Protocol Specification For Telephone Modem Communication.
4. ANSI C12.22-2008: Protocol Specification for Interfacing to Data Communication Networks.
5. FIPS PUB 140-2: Security Requirements for Cryptographic Modules, National Institute of Standards and Technology, May 25, 2001.
6. Handbook for Electricity Metering, 10th Edition, Washington, District of Columbia, Edison Electric Institute, 2002, ISBN 0-931032-52-0.
7. IEEE Std 1377™-2012: IEEE Standard for Utility Industry Metering Communication Protocol Application Layer (End Device Data Tables). *Contains Errata for ANSI C12.19-2008.*
8. IEEE Std 1701™-2011: IEEE Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables. *Same as ANSI C12.18-2006.*
9. IEEE Std 1702™-2011: IEEE Standard for Telephone Modem Communication Protocol to Complement the Utility Industry End Device Data Tables, *Same as ANSI C12.21-2006.*
10. IEEE Std 1703™-2012: IEEE Standard for Local Area Network / Wide Area Network (LAN / WAN) Node Communication Protocol to Complement the Utility Industry End Device Data Tables. *Contains Errata for ANSI C12.22-2008.*
11. IETF RFC 768-1980: User Datagram Protocol, J. Postel.
12. IETF RFC 791-1981: Internet Protocol, Information Sciences Institute University of Southern California.

13. IETF RFC 793-1981: Transmission Control Protocol, J. Postel.
14. IETF RFC 3376-2002: Internet Group Management Protocol, Version 3, B. Cain et. al.
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16. ISO/IEC 7498-1, 1994: Information Technology - Open Systems Interconnection - Basic Reference Model: The Basic Model.
17. ISO/IEC 10035-1, 1995: Information Technology - Open Systems Interconnection - Connectionless Protocol for the Association Control Service Element - Protocol Specification.
18. 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).
19. ISO/IEC 62056-62, 2006: Electricity metering – Data exchange for meter reading, tariff and load control – Part 62: Interface classes.
20. LUM-0610-01-V17: Recommendations for Establishing Electricity LUM Outside an Approved Meter – Final Report, 2009.
21. NEMA SG-AMI 1-2009: Requirements for Smart Meter Upgradeability, 2009.
22. Principles for Sealing Meters and Trade Devices, Measurement Canada, 1999-07-26.
23. Specifications Relating to Event Loggers for Electricity Metering Devices and Systems (Measurement Canada, IS-E-01-E, 2003).
24. XHTML 1.0 The Extensible HyperText Markup Language (Second Edition). W3C Recommendation 26 January 2000, revised 1 August 2002.
25. XML Schema Part 1: Structures Second Edition, W3C Recommendation 28 October 2004.
26. ISO/IEC 7498-1:1994: Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model.

4.0 Definitions

For additional definitions, please reference the most current version of
ANSI C12.19 / IEEE 1377 / MC12.19, ANSI C12.22 / IEEE 1703 / MC12.22,
ANSI C12.21 / IEEE 1702 / MC12.21 and ANSI C12.18 / IEEE 1701 / MC12.22 as appropriate.

4.1 AEIC

The Association of Edison Illuminating Companies. Founded by Thomas Edison and his associates, AEIC is one of the oldest associations to be affiliated with the electric energy industry.

4.2 ANSI C12.19 Device

Any device that contains ANSI C12.19 data Tables and uses ANSI C12.18, ANSI C12.21 or ANSI C12.22 protocols for communication in any combination.

4.3 AMI (Advanced Metering Infrastructure)

AMI is defined as the communications hardware and software and associated system and data management software that creates a network between advanced meters and utility business systems and which allows collection and distribution of information to customers and other parties such as competitive retail providers, in addition to providing it to the Utility itself.

Also, according to FERC, advanced metering is a metering system that records customer consumption (and possibly other parameters) hourly or more frequently and that provides for daily or more frequent transmittal of measurements over a communication network to a central collection point.

4.4 AMI Communication Module

A physical hardware device that enables two-way and end-to-end communications capabilities between an End Device (such as a meter) and the Utility Enterprise. AMI Communication Modules service layers 4-1 of the OSI 7-layer protocol stack.

4.5 AMI Integrated Meter

A C12.19 Device that implements both the metrology registers (C12.19 Tables) and all 7-layers of the OSI communication protocol and hardware using an integrated solution. An Integrated AMI Meter does not have an Interchangeable AMI Communication Module.

4.6 AMI Modular Meter

A C12.19 Device that implements both the metrology registers (C12.19 Tables) and can be physically attached (internally or externally) to one or more Interchangeable AMI Communication Modules. As seen from the network, it is not possible to distinguish between an AMI Integrated Meter and an AMI Modular Meter.

4.7 AMI Interchangeable Communication Module

An AMI Communication Module that attaches to an End Device (e.g., a Modular AMI Meter) using the End Device's internal or an external physical interface. The Interchangeable AMI Communication Module enables communication to at least one LAN / WAN that can reach the Utility Enterprise.

4.8 ANSI C12.19 Meter (a.k.a. End Device)

An AMI Meter that contains ANSI C12.19 data Tables and uses ANSI C12.18, ANSI C12.21 or ANSI C12.22 protocols for communication in any combination. This device and its accessories are constituted by this set of Guidelines.

4.9 AMI Meter

An AMI Modular Meter or an AMI Integrated Meter.

4.10 End Device

The closest device to the sensor or control point within a metering application communication system which is compliant with the Utility Industry End Device Data Tables. [ANSI C12.19-2008 / Sec. 3.30]

4.11 AMR (Automated Meter Reading)

The automated meter reading application is software built which enables users to read and program ANSI C12.19 Standard-based meters. It communicates using any of the ANSI C12.18, ANSI C12.21 or ANSI C12.22 Standard communication protocols. It may also accept and use Table Definition Language (ANSI C12.19 XML/TDL Form) and Exchange Data Language (ANSI C12.19 XML/EDL Form) files. These are XML files which describe the meter's specific Tables architecture, default sets used and constant values associated with the ANSI C12.19 meter registered with a C12.19 Device Class. The C12.19 Device Class may be obtained from NAEDRA, the "North American End Device Registrar Authority" which is overseen by the IEEE / ANSI / MC Object ID Oversight Committee.

4.12 Catastrophic Failure a.k.a. Fatal Failure

A failure that results in temporary or permanent disruption of communication, corruption of protocol, corruption of data, unexpected manipulation of data, delivery of wrong data, unexpected data format or incorrect placement of data within transported record. The assessment shall be performed by a reference implementation (a test that is based upon the registered End Device Table data model).

4.13 Decade

A decade is a functional grouping of Tables into groups of ten (10). The Tables are numbered X0 through X9, with X representing the decade number.

4.14 Detent Metering

Detent metering, or a detent meter, will only record the power flow delivered from the electric service provider to the customer. This is also known as delivered power only.

4.15 EDL (Exchange Data Language)

The EDL file form is used to express C12.19 Device data values that make up the device Tables (this is in contrast to TDL which describe the device's Tables structures). The EDL file is associated with one specific C12.19 Device model, thus it is uniquely associated with a registered C12.19 Device Class.

This property implies that the EDL file content is derived from the data model of all the Tables used (Standard and Manufacturer) and all of the procedures used (Standard and Manufacturer) that are defined for the C12.19 Device Class referenced.

EDL files shall be used to express imported and exported values and parameters to (and from) the reference AMR application or reference Test Application and among utilities.

4.16 Enterprise Systems (ES)

Enterprise systems are large-scale, integrated application software packages that use the computational, data storage, and data transmission power of modern information technology (IT) to support processes, information flows, reporting, and data analytics within and between complex organizations.

4.17 EPSEM (Extended PSEM)

Extended PSEM defines the application layer services of ANSI C12.22 / IEEE 1703 / MC12.22. For a complete description of EPSEM see the referenced Standards ANSI C12.12 / IEEE 1703 / MC12.22. See also PSEM.

4.18 Event Logger Data

The entire content of all Tables designated as Program Tables (and secured read Tables), all associated pointers and all signatures that are expressed by or implied by Event Logger Record for a specific Event. The Event Logger Data originates initially inside the End Device, but it may extend into the End Device Agent record-keeping system. [ANSI C12.19-2008, Sec. 3.34]

4.19 FERC (U.S. Federal Energy Regulatory Commission)

The U.S. Federal Energy Regulatory Commission is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil.

4.20 Flagging

An action of the End Device whereby a status bit is set in a C12.19 Status Table, or an Event Logger Data is created or a History Logger Data is created as a result of a noteworthy event (e.g., Automatically flagging the fact that during the daily time validation the End Device time is greater than some configurable value or it is out of synchronization with the external time reference).

4.21 FLC (Function Limiting Control)

ANSI C12.19 Function Limiting Control Tables (X0/X1, where X is the decade number 0-204).

4.22 HAN (Home Area Network)

A HAN is a Communication Network within a customer's residence, which may be a capable of communicating with an AMI meter, Energy Management System, other Gateways or devices inside a home.

4.23 Head-end

Head-end: An application associated with both one way and two way metering and end point systems that provides some of the following features:

1. Manages the communication network for meters and end points.
2. Manages the collection of data.
3. Allows operators of the system to extract data and send commands to meters and end points.
4. Supplies metering and associated data to Enterprise systems, such as a MDM.

4.24 History Logger Data

The entire content of all ANSI C12.19 Tables that are designated as history logger that capture End Device events. History Logger provides for monitoring any End Device activity or events which may be of general interest to the operator, utility or technician (e.g., communication access logs, debugging information, clock drift data, demand reset tracking, etc.). Both History Logger and Event Logger (secured audit trail) coexist in an End Device.

4.25 Load Profile

A load profile is the recording, storage and analysis of consumption, demand and other sensory data over a period of time, using ANSI C12.19 Load Profile Tables from Decade 6 (Standard Tables 60-69).

4.26 Manufacturer (Supplied) Tables

Tables defined by the Manufacturer of the C12.19 Meter. Manufacturer Table descriptions shall use Table description syntax. These Tables shall be available and readable by the Enterprise and/or Head-end system and used for configuration, set-up and data storage of component-data and only for processes not already fully or partially covered by ANSI C12.19.

4.27 Meter

A meter is a device that measures the amount of electrical, gas or water utility commodities supplied, generated or consumed. Some or all values measured by these meters may be used for the purpose of billing.

4.28 MDMS (Meter Data Management System)

An MDM system performs long term data storage and management for the vast quantities of data that are now being delivered by advanced metering systems. This data consists primarily of usage data and events that are imported from the Head-end applications that manage the data collection in Advanced Metering Infrastructure (AMI) or Automated Meter Reading (AMR) systems. An MDM system will typically import the data, then validate, cleanse and process it before making it available for billing and analysis.

4.29 Metrological Element (parameter)

A metrological element is any constant, factor or algorithm that is used by a C12.19 Meter to produce results for the purpose of billing.

4.30 Net Metering

Electric energy generated by an electric consumer from an eligible on-site generating facility and delivered to the local distribution facilities may be used to offset electric energy provided by the electric utility to the electric consumer during the applicable billing period (ref: U.S.A. Energy Policy Act of 2005, Sec. 1251). Net metering allows a customer to net the energy produced by its generating facility against the energy received from its electric service provider. The power flow measurement performed by net metering is |delivered| - |received|.

4.31 Programming, Programmable

The term programming refers to the action of writing values to ANSI C12.19 Tables. Programming may be used to configure the End Device operating characteristics. Programming may also be used to upgrade the End Device firmware or the firmware of End Device's communication modules or its embedded electronic accessories. A device is considered programmable if it can be successfully programmed.

4.32 PSEM (Protocol Specifications for Electric Metering)

PSEM defines the application layer services of ANSI C12.18 / IEEE 1701 / MC12.18 or ANSI C12.21 / IEEE 1702 / MC12.21. In implementations that are not restricted just to electricity metering (e.g., gas and water), the acronym PSEM may also equivalently represent the Protocol Specifications for Electronic Metering. For a complete description of PSEM see the referenced Standards ANSI C12.18 / IEEE 1701 / MC12.18 and ANSI C12.21 / IEEE 1702 / MC12.21.

4.33 Read Meter (Meter Reading)

The transmission from the meter to the Enterprise and/or Head-end system of an entire or partial C12.19 Table is a meter reading operation. The act of data retrieval may require the invocation of some or all the following (E)PSEM services: Identification, Negotiate, Timing-setup, Logon, Wait, Security, Authenticate, Read, Write, Logoff, Terminate and Disconnect as per the relevant communication protocol implemented by the meter.

4.34 Reliable Transportation

In the context of billing and trade, this is a requirement that metered data shall be accurately and safely transported across any communication media. The method of transportation of the metered data shall ensure that the metered data remains intact on arrival at its destination (e.g., billing system) regardless of the medium the metered data are transported.

4.35 Secure Metering

Secure metering does not enable a customer to net the energy produced by its generating facility against the energy received from its electric service provider. The power flow measurement performed by secure metering is |delivered| + |received|.

4.36 TDL (Table Definition Language)

ANSI C12.19 defines the Tables' syntax using the Published Document Form (the printed Standard). The document form can be derived from a corresponding syntax using XML notation. Similarly, the XML notation may be derived from the document form. The XML annotated file is also an input to an AMR application that communicates with any C12.19 Device.

4.37 TOU Metering

TOU is an acronym for "Time of Use" metering. TOU metering equipment records metered or measured quantities according to a time schedule into separate registers (collection bins or tiers) using ANSI C12.19 Standard Decade 2 (Time and TOU, Standard Tables 20-29) and Standard Decade 5 (Clock Standard Tables 50-59).

4.38 UOM (Unit of Measure)

UOM is an acronym for "Unit of Measure". The unit of measure provides a method for describing a billing / trade quantity or selecting data source attributes. Some of the attributes include the physical quantity measured, the time base used for averaging, the scaling constants, direction of flow, method of measurement and harmonic component indication.

4.39 Upgrade / Upgrade Process

The series of communication steps required to replace or modify the existing operating firmware of a meter and/or its associated communication and metrology components. The upgrade process does not require the removal of the meter and/or its associated communication and metrology components from service.

4.40 Write / Program Meter

Writing and programming an ANSI C12.19 meter will affect the entire or partial ANSI C12.19 Table set. The act of data writing may, in addition to the aforementioned, require the invocation of some meter reading functions and any of the following (E)PSEM services: Identification, Negotiate, Timing-Setup, Logon, Wait, Security, Authenticate, Read, Write, Logoff, Terminate and Disconnect, as per the relevant communication protocol implemented by the meter. The C12.19 Meter may require the invocation of Standard Procedure 2, "Save Configuration", prior to Logoff to ensure retention of the changes. No other procedure shall be used for this purpose.

5.0 General Requirements

5.1 Interoperability

The AEIC Guidelines document strives to describe, illustrate and create the environment for interoperability of the ANSI C12.19 – 2008 Communications Standard End Devices, metering Head-end systems and MDM systems. One of the goals of this set of Guidelines is to provide a more efficient use of the C12.19 Standard and to provide interoperability for the "Smart Grid". Where the ANSI C12.19 – 2008 Standard is ambiguous or unclear or opaque, this set of Guidelines shall augment those areas to insure clear and unambiguous description for utilities' purchasing and vendors' manufacturing of interoperable End Devices.

5.1.1 Disclosure of Data Model

Full and timely disclosure shall be provided. This disclosure shall minimally include the configuration, state-management of the meter based on the Device Class, TDL, EDL and reference C12.19 Standard used, Manufacturer Tables and any Manufacturer-specific procedures. These shall be provided so any party may independently read, write, program, and interpret the metering data using the C12.19 Semantics and Syntax.

5.1.2 Access to Semantic Data Model

The registered ANSI Standard C12.19 Device Class, TDL and EDL shall be directly available from the registrar using the Internet as a delivery mechanism. The C12.19 Meter device class shall be registered with a certified North American End Device Registrar who is responsible to the IEEE / ANSI / MC Object ID Oversight Committee.

5.1.3 Valuation and Assessment

The relevant ANSI Standard normative text is used as a reference for making these Guidelines. However, when a Standard is clear about its intent, but does not provide implementation details, then these Guidelines shall be used as the definitive guide for the implementation of the Standards under these Guidelines. Formal interpretations requests of the Standards shall be submitted to the appropriate party as identified in the Standards. However, when these guidelines restrict available choices or mandate specific selections or specific protocol behaviours of the standards then these guidelines take precedence of the Standards with respect to compliance with these Guidelines.

5.1.4 Functions Considered and Ranking

It is the intention of these Guidelines to establish whether the meters and End Devices expose and provide the interface, state, timing, data values, data representation, data placement, protocol, implementation parameters or performance in accordance with these Guidelines. A “Conforming”, “Non-Conforming” and “Not-applicable” assignment shall be used for each identified component when ranking the meter or End Device for conformance.

5.1.5 Use of ANSI C12.19 Tables and Syntax

The primary objective of this document is to establish an interoperable data format for gas, water and electricity meters for the purpose of control and transport of data records between the Enterprise and/or Head-end system and End Device. This document aims to maximize the degree of interoperability, recognizing that it is not possible to define a universal data format that is suitable for all devices. It defines mechanisms for the promotion and establishment of interoperability with End Devices through the introduction of pre-defined data structures and syntax, also known as Tables.

5.1.5.1 *Type of Tables*

The Tables shall be transferred to and from the Head-end system and End Device. These shall be grouped according to content into three major types: “Standard Tables”, “Manufacturer Tables” and “Extended User-Defined Tables”. Each type is capable of having up to 2040 Tables. The “Standard Tables” and “Manufacturer Tables” shall be organized by function into groups of 10 Tables, known as Decades. [ANSI C12.19-2008 Sections 4.1.1 Standard Tables Grouping and 4.2.1 Manufacturer Tables Grouping]

The Standard Decades are:

0 General Configuration Tables.
1 Data Source Tables.
2 Register Tables.
3 Local Display Tables.
4 Security Tables.
5 Time-of-Use Tables.
6 Load Profile Tables.
7 History & Event Logs Tables.
8 User-Defined Tables.

9 Telephone Control Tables.
10 Unassigned.
11 Load Control and Pricing Tables.
12 Node Network Control Tables.
13 Network Relay Control Tables.
14 Extended User-Defined Tables.
15 Quality of Service Tables.
16 One-way Devices Tables.

In contrast, the Extended User-Defined Tables are not organized into decade structures. They are collections of contiguous data sub-elements related to the formal data elements of the ANSI C12.19 / IEEE 1377 / MC12.19 Standard. The Extended User-Defined Tables allow data streams of repetitive billing data for communication efficiency for "one-way" devices or "two-way" devices.

5.1.5.2 *Manufacturer Tables*

Manufacturer Tables shall not have a predefined or overlapping Standard function. These Tables shall only be provided by the Manufacturers in those instances where it is not possible to provide the desired functionality using Standard Tables or when the Manufacturer desires to introduce new innovation. Manufacturer Tables shall be defined using the Standard Table syntax.

5.1.5.3 *User-Defined Tables and Extended User-Defined Tables*

User-Defined Tables refer to the Tables defined by Decade 8, "User-Defined Tables", Extended User-Defined Tables represent Tables defined by Decade 14, "Extended User-Defined Tables" of ANSI C12.19 – 2008. The Extended User-Defined Tables may provide data collation from more than one End Device instance that is registered for a device class.

User-Defined Tables and Extended User-Defined Tables shall only make references to Standard or Manufacturer-Defined Table elements that are available physically (can be transported by a communication protocol) or logically in the C12.19 Device (a logically defined Table is also referred to as a "virtual Table"). Collectively these elements are referred to as "Formal Table Elements"

A User-Defined Table syntax or element shall not make a reference to another User-Defined Table Element. An Extended User-Defined Table syntax or Element shall not make a reference to another Extended User-Defined data Element (selected in Decade 14) or User-Defined data Element (defined in Decade 8).

When encoded as EDL elements for the purpose of enterprise data exchange; User-Defined Table Element data and Extended User-Defined Table Element data shall be encoded in the EDL as the ANSI C12.19 registered Formal Table Elements.

5.1.5.4 *Standard Table Syntax*

All Table structures shall be described in terms of ANSI C12.19 syntax. The Enterprise and/or head-end system recognize this syntax (XML/TDL Form) and use it to describe the Manufacturer, Standard and Extended User-Defined Tables' structure of the meter. When describing Tables and Procedures, the Manufacturer's End Device Manual shall also utilize the ANSI C.12.19 Standard Document Form syntax and annotations.

5.1.5.5 *Binary Formal Elements*

All Table structures may be encoded using binary representation, as described by the ANSI C12.19 syntax. The head-end system shall recognize this encoding and use it to encode and decode Table Elements when communicating with End Devices. Binary Formal Elements (Elements other than EUDTs) representation may also be exchanged in EDL XML Form files between Enterprise and head-end systems.

5.1.6 Tables Requirements

5.1.6.1 *Operations on Tables*

The Tables are structured such that only Table Read and Table Write services are required to perform AMI metering operations. These Guidelines require that the Enterprise and/or Head-end system utilize

exclusively the full or partial Table read / write services (following link, session and security establishment using the appropriate communication protocol) to setup, program, manage and read the meter.

5.1.6.2 *Table 00, General Configuration Table*

The Standard organizes the Tables by functional groups beginning with Table 00, General Configuration Table. These Guidelines require that the meter provides Tables 00 with valid contents, whereby the Enterprise and/or Head-end system may confirm the presence of all Tables and their write access modes. Only Standard and Manufacturer Devices shall be configured to allow read access to Table 00 for all roles.

5.1.6.3 *Function Limiting Control Tables*

In addition to Table 00, the Standard defines rules for the implementation of Function Limiting Tables. When Standard or Manufacturer Tables supported by the meter are numbered X0/X1 they shall be interpreted as FLC/FLC+1 Tables according to ANSI C12.19.

5.1.6.4 *Special Function, Placement and Management*

The Standard defines certain meter procedures for process management, interpretation mechanisms and placeholders for meter specific functions. These Guidelines require that:

1. Manufacturer functions and control parameters shall be placed in the Standard designated areas, if supported by the meter and if the Standard provides Standard Table Elements as a placeholder for those functions (e.g., Display Tables, Data Source Control Tables).
2. List management facilities shall be implemented using Standard Procedures for correct operation. This includes Self-read Tables, History Tables, Event-logger Tables, Load Profile Tables, Power-quality Tables and the like.
3. Calendar and clock programming shall be implemented using Standard Clock Tables and Standard Clock management Procedures.
4. Standard Security and Key Tables shall be used if a security policy is implemented (as per communication protocol implementation requirements). Also, access control is consistent with the ANSI C12.19 Standard security model.
5. Register Data Tables shall reflect correct and linear readings as described in Data Sources Table (Decade 1) multipliers, constants, timing and related UOMs.
6. Data types, source identification, scaling and application shall be readable and correctly implemented.
7. Control and presentation of Pending Tables shall be correctly implemented as per the ANSI C12.19 Standard.
8. Procedure invocation and Procedure status reporting shall work correctly in a manner that the last Procedure invoked via Standard Table 7 shall have its completion status available from Standard Table 8.

5.1.6.5 *UOM Usage*

UOM shall be available through Standard Decade 1's Standard Table 12. Billing and trade quantities shall be transmitted by the ANSI C12.19 Meter in the proper units of measure and scale (i.e., ask for kWh - get kWh). The order of placement of UOMs should be prioritized by the user of the ANSI C12.19 Meter, not the Manufacturer. For example, the Utility may group UOMs as follows:

1. UOMs are first prioritized by function as follows (from high priority to low priority):
    a. Energy.
    b. Demand.
    c. Instantaneous.
    d. Event.
    e. Time.
    f. Count.
2. Within each function above the UOMs could be prioritized as follows (from high to low priority):

a. Active (Real) Power.
b. Reactive (VAR) Power.
c. Apparent Power.
d. Quantity (Q) Power (e.g., 45 or 60 degrees Q-Power).
e. Voltage.
f. Current.
g. Power Quality.
h. Time, counters, sense input etc.
i. Gas measurements.
j. Water measurements.

3. All data shall be delivered with all calculations and enabled (by the user) multipliers applied within the metering device (again, i.e., ask for kWh - get kWh).

5.1.6.6 *Miscellaneous*

1. Reserved Table fields shall be set to zero or space values, in accord with their data type.
2. When FLC Tables are not present, default sets shall be assumed.
3. Limited Table Elements (FLC+1) shall operate within FLC limits stated, respectively.
4. Hidden Tables or Procedures shall only be accessible when the device is in Factory Mode.
5. All data type implementation in all Tables present in the meter including Manufacturer Tables shall be consistent and implemented with the types defined in Table 00.

5.1.7 Communication Services for ANSI C12.19 / IEEE 1377 / MC12.19 Data Structures

The data structures and functions of ANSI C12.19 require read, write and other services specified in the ANSI C12.19 Standard. The ANSI C12 body has produced the ANSI C12.18 (Optical Port) Standard, the ANSI C12.21 (Telephone modem) Standard and the ANSI C12.22 (LAN / WAN) Standard to accommodate the necessary services for the ANSI C12.19 data functions. If other Standards become known and certified to satisfy the ANSI C12.19 data structure services requirements, they will be included in these following sections. When using ANSI C12.19 in conjunction with ANSI C12.18, ANSI C12.21 or ANSI C12.22 then the following is applicable.

5.1.7.1 *(E)PSEM Services*

These Guidelines require the ANSI C12.18, ANSI C12.21 PSEM and ANSI C12.22 EPSEM services identified in this document to be implemented.

5.1.7.2 *State Machine*

These Guidelines require the ANSI C12.18, ANSI C12.21 and ANSI C12.22 state machine described in the Standards' informative annexes to be implemented.

5.1.7.3 *ANSI C12.21 Modem Tables*

ANSI C12.19 Meters implementing ANSI C12.21 protocol shall have Decade 9 Telephone Control Tables and default sets.

5.1.7.4 *ANSI C12.21 Inbound Base State Timeouts*

ANSI C12.21 Meters shall wait for an Identification Service request for a minimum of default channel-traffic-timeout (30 seconds) before telephone line hang-up.

5.1.7.5 *ANSI C12.21 Timing Setup Service*

ANSI C12.19 Meters implementing ANSI C12.21 protocol shall support the optional Timing Setup Service.

5.1.7.6 *ANSI C12.21 Outbound Base State Timeouts*

ANSI C12.19 Meters implementing ANSI C12.21 protocol shall wait for an Identification Service request for a minimum of default channel-traffic-timeout (30 seconds) before telephone line hang-up.

5.1.7.7 *ANSI C12.18 and ANSI C12.21 Data Link Identity Byte*

Value 0 shall always access the meter and not its modem or communication interface.

5.1.7.8 *ANSI C12.22 Network Tables*

ANSI C12.19 Meters and other End Devices implementing ANSI C12.22 protocol shall have Network Tables. C12.19 Devices implementing C12.22 Relay and C12.22 Master Relay protocol shall have Relay Tables.

5.1.7.9 *ANSI C12.22 Physical Layer Requirements*

ANSI C12.22 does not specify the Physical Layer for integrated devices. Any Physical Layer may be utilized as applicable.

5.1.7.10 *ANSI C12.22 Communication Module Requirements*

When implementing an external, or optionally an internal, communication module, the physical interface and Transport Layer interfaces of the C12.22 Communication Module shall be implemented as specified by ANSI C12.22 for a C12.22 Communication Module. Also, the physical interface and transport layer interfaces of the mating C12.22 Device (meter) shall be implemented as specified by ANSI C12.22 for a C12.22 Device.

5.1.7.11 *ANSI C12.22 Local Optical Port*

An ANSI C12.22 Optical Port shall be present on ANSI C12.19 metering devices and implemented as a minimum to be compliant with ANSI C12.18 Optical Port Communication.

5.1.8 Algorithms

These interoperability Guidelines expect the End Devices, meters, Head-end systems and meter reader to utilize the ANSI C12.19 / IEEE 1377 / MC12.19 and ANSI C12.22 / IEEE 1703 / MC12.22 and service communication protocol's Standard algorithms that are described in normative and informative sections as follows:

1. When performing local time to GMT (UTC) conversions, they shall be implemented as per: ANSI C12.19 / IEEE 1377 / MC12.19 Section 9.6 and H.
2. When performing GMT (UTC) to local time conversions, they shall be implemented as per: ANSI C12.19 / IEEE 1377 / MC12.19, Section 9.6 and H.
3. Setting the clock and time-zone management: ANSI C12.19 / IEEE 1377 / MC12.19 Sections Section 9.6, 9.1.8, 9.1.9, 9.1.10.11, 9.1.10.13 and H.
4. End Device operating mode management (Metering Mode: Test Mode, Meter Shop Mode, Factory Mode, as defined in Section 3 of ANSI C12.19.): ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.1.4, 9.1.5, 9.1.6, 9.1.7, 9.1.8, 9.1.9, 9.1.10.1, 9.1.10.2, 9.1.10.7.
5. When performing conversions of register (sensor) values to physical units (billing data retrieval), they shall be implemented as per: ANSI C12.19 / IEEE 1377 / MC12.19, Sections 9.1.1, 9.2, 9.3.3, 9.3.8, F and K.
6. Register (sensor) data management: ANSI C12.19 / IEEE 1377 / MC12.19, Sections 9.1.10.4, 9.1.10.5, 9.1.10.6, 9.1.10.10, 9.1.10.11, 9.1.10.31, 9.1.10.32, 9.1.10.33, 9.2, 9.3.1, 9.3.2, 9.3.3, 9.3.8.
7. When performing conversions of load profile readings to physical units (profile data retrieval), they shall be implemented as per: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.1.1, 9.7, F and K.
8. Load Profile management: ANSI C12.19 / IEEE 1377 / MC12.19, Sections 9.1.10.4, 9.1.10.5, 9.1.10.6, 9.1.10.17, 9.1.10.18, 9.7.1, 9.7.2, 9.7.3 and 9.7.4.
9. Synchronization of start of load profile interval on at the beginning of the hour, each hour: ANSI C12.19 / IEEE 1377 / MC12.19, Sections 9.1.1, 9.7, F and K, also see sections 9.7.5, 9.7.6, 9.7.7, 9.7.8 BLK_END_TIME.
10. Meter status flag operation: ANSI C12.19 / IEEE 1377 / MC12.19, Sections 9.1.4, 9.1.5, 9.1.8, 9.1.9, 9.1.10.1, 9.1.10.2, 9.1.10.3, 9.1.10.4, 9.1.10.5, 9.1.10.6, 9.1.10.7, 9.1.10.8, 9.1.10.9.

11. Meter security programming (Table roles and communication protocols): ANSI C12.19 / IEEE 1377 / MC12.19, Sections 4.1, 4.2, each Table's Global Default Table Property Overrides, 9.1.8, 9.1.9, 9.1.10.19 (shall be possible within an existing session), 9.1.10.20 (shall be possible within an existing session, returns the End Device to the default security mode and shall not terminate a session), and 9.5. Also ANSI C12.22 / IEEE 1703 / MC12.22 section C.5, C.6 and I.
12. Display configuration: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.4.
13. History log management and retrieval: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.8.1, 9.8.2, 9.8.3, 9.8.4, 9.8.5 and B.
14. Event logger / audit trail processing, including secure register activations including secure register activations, ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.8.1, 9.8.2, 9.8.3, 9.8.6, 9.8.7, 9.8.8, 9.8.9, and B.
15. Time of use and calendar scheduling: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.3.4, 9.3.5, 9.3.6, 9.3.7, 9.6 Decade 5 Data Description, 9.6.1, 9.6.2, 9.6.5, 9.6.6.
16. When performing power quality control monitoring and acquisition conversions, they shall be implemented as per: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.2, 9.1.10.4, 9.1.10.5, 9.1.10.6, 9.2, 9.29, 9.2, 9.30, 9.16 and K.
17. When performing Extended User-Defined Table setup, it shall be implemented as per: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.9 and 9.15.
18. Standard procedures operations: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.10 and ANSI C12.22 / IEEE 1703 / MC12.22 Section C.4.
19. Telephone Control Tables and Procedures operations: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.1.10.21 and 9.10.
20. When Node Network Tables and Procedures operations are needed, they shall be implemented as per: ANSI C12.22 / IEEE 1703 / MC12.22 Sections C.1, C.3, C.5, C.6 and C.4.
21. When Relay Tables and Procedures operations are needed, they shall be implemented as per: ANSI C12.22 / IEEE 1703 / MC12.22 Section C.
22. When Pending Tables operation and activations are needed, they shall be implemented as per: ANSI C12.19 / IEEE 1377 / MC12.19 Sections 9.1.5, 9.1.10.14 and 9.1.10.15.

6.0 Communications Requirements

Compliant communication protocols shall be implemented in accordance with ANSI C12.19-2008, Sections 3, 4, 7, 8, and 9.1. A compliant End Device's firmware shall not be changed by an End Device vendor, while retaining the existing device class designation, without ensuring that the change in the End Device registered Data Model will not create interoperability problems with existing implementations that use the existing Device Class. T*o ensure interoperability it is strongly recommended that users also require compliance with Annex L.* All references to ANSI C12.19-2008 are assumed to include all of the corrections to errors and omissions published in IEEE Std 1377™-2012.

6.1 General Principles for Interoperable Communications

All compliant protocol implementations shall be based on Standards.

The Application Layer of a compliant communication protocol shall be defined by a published Standard. When the lower layers (such as Transport, Network, Data-link and Physical) are not defined by a Standard protocol the protocol may be based on draft Standards or industry de-facto implementations as specified by these Guidelines.

In addition all compliant communication protocols shall meet the requirements listed in the following subsections.

6.1.1 Types of Tables Transported

In accordance with ANSI C12.19 / IEEE 1377 / MC12.19, the compliant communication protocol shall be able to transport Standard Tables and Manufacturer Tables. Any of the Standard Tables or Manufacturer Tables may be tagged as Pending Tables, or may be referenced by Extended User-Defined Tables. This is not meant to imply that all variations of Tables (Standard Tables, Manufacturer Tables, Standard

Pending Tables, Manufacturer Pending Tables, Extended User-Defined Tables and Pending Extended User-Defined Tables) must be present in any particular End Device.

6.1.2 Types of Procedures Transported

In accordance with ANSI C12.19 / IEEE 1377 / MC12.19, the compliant communication protocol shall be able to transport Standard Procedures, Manufacturer Procedures, Standard Pending Procedures and Manufacturer Pending Procedures. This is not meant to imply that all variations of procedures (Standard Procedures, Manufacturer Procedures, and Pending Standard Procedures and Pending Manufacturer Procedures) must be available in any particular End Device.

6.1.3 Extent of Tables Transported

1. The compliant communication protocol shall be able to transport full Tables and partial Tables, in accordance with ANSI C12.19-2008. For specific details on Table access methods see ANSI C12.19-2008, Sections 4, 7, 8 and 9.1.1.
2. The transport protocol shall also comply (when requesting Table elements and when transmitting Table elements) with the default accessibility properties defined in ANSI C12.19-2008, Section 4, as modified the data model of the registered Device Class of the End Device.
3. The compliant communication protocol shall be able to transmit the End Device Class in accordance with ANSI C12.19-2008, Section 9.1.1.
4. The compliant communication protocol shall be able to transmit the End Device IDENTIFICATION element in accordance with ANSI C12.19-2008, Section 9.1.6 / IDENTIFICATION at index 2 and Section 9.1.1 ID_FORM 0 and CHAR_FORMAT 1, 2 or 3.
5. The compliant communication protocol shall be able to transmit the entire Table 00, General Configuration Table, when requested to do so, as a result of a full Table read request.
6. The compliant communication protocol shall not transmit partial atomic Tables, unless it can guarantee that none of the elements of an atomic Table can change during the transmission of a subset of the atomic Table, as part of a single transaction.

   e.g., when a Table is atomic, and it contains 100 bytes, then it should be transmitted as a single 100 bytes element. It may also be transmitted as 40+40+20 bytes (assuming a maximum payload size of 40 bytes) only if none of the elements can change during the transmission of the three payloads that make up the atomic Table.
7. All compliant meters and sensors shall implement the full Table and partial Table read / write capabilities (read / write requests are initiated by the enterprise application).
8. All compliant meters and sensors shall implement the partial Table offset / octet-count Table read / write capability (read / write requests are initiated by the enterprise application).
9. Non-meters and non-sensors-based compliant communication protocols of End Devices shall implement the full Table and partial Table read and write capabilities.
10. All compliant communication protocols shall implement the partial Table index / element-count read and write capabilities.
11. The compliant Enterprise application shall implement the full Table read / write, partial Table read / write using offset / octet-count method and partial Table read / write using index / element-count methods.

6.1.4 Element format of Tables Transported

1. Transmission of active (non-pending Standard or Manufacturer) Tables shall not include a pending header. [ANSI C12.19-2008, Section 8.2]
2. Transmission of pending (Standard or Manufacturer) Tables shall include a pending header in addition to the read or written Table Elements. [ANSI C12.19-2008, Section 8.2]
3. Transmission of Table Element Data shall be ordered per Table Element definition order and per selections made. [ANSI C12.19-2008, Sections 8.1.3, 8.1.4 and 8.1.5]

6.1.5 Table Element Security and Reliability

1. Compliant communication protocols that connect, bridge or interface Enterprise systems to field Meters and End Devices shall not re-write transmitted encapsulated Table elements in a manner that results in the loss of data integrity and authentication of the source and destination and data. [ANSI C12.19-2008, Section 3.25-3.39, 9.1.8 procedures 30/31, 9.8, B]
2. Compliant communication protocols shall implement and not permit violation of Table-role based security per ANSI C12.19-2008, Sections 9.1.1 STD_TBLS_WRITE and MFG_TBLS_WRITE, 9.5.1, 9.5.2, 9.5.3, 9.5.4 and 9.5.5, whether Table element or Procedure were requested directly or indirectly through User-Defined Tables or Extended User-Defined Tables.
3. Compliant communication protocols shall use the security passwords and keys as defined in ANSI C12.19-2008, Sections, 9.5.3, 9.5.6, 9.5.7, 9.5.8 or 9.5.8 and ANSI C12.22, Sections C.1.4, C.5 and C.6 as appropriate for the type of communication protocol type, in order to maintain Enterprise to field End Device interoperability.
4. ANSI C12.22 provides native end-to-end security mechanisms within the APDU. ANSI C12.22 provides support for multiple standards-based security mechanisms. In order to ensure interoperability, all devices shall be able to support native ANSI C12.22 and ANSI C12.19 security mechanisms. While additional standards-based Transport or Network Layer security protocols are not required, they may be provided, or even necessary, in order to further improve security. Layered Transport or Network Layer standards-based security protocols shall be transparent to the ANSI C12.22 application protocol.

6.1.6 Meter and End Device Firmware Upgradability

1. The compliant communication protocol shall be capable of performing End Device firmware upgrade strictly through the communication of ANSI C12.19-2008 Tables and the execution of ANSI C12.19-2008 Procedures, in accordance with the registered device class.
2. Although it is possible to use any Manufacturer Tables to make any Manufacturer upgrade, it is strongly recommended that the following protocol be applied:

   The compliant communication protocol should use partial Pending Table writes or full Pending Table writes, Pending Table management procedures and state-storage management procedures to transmit the firmware upgrades. [ANSI C12.19-2008, Sections 6.3.1, 6.4, 7, 8.2, 9.1.1, 9.1.9 and 9.1.10 procedures 0, 1, 2, 11, 12, 13, 14 and 15]
3. Compliant implementations shall use the same pending Tables activation header for all Pending Table write requests of the same Pending Table that is associated with a single firmware image upgrade.
4. An End Device shall not fail as a result of Rule 3 above being violated and it shall reject (NOK response) to the infringing Pending Table or discard the previous contents of Pending Table, at the discretion of the vendor.

6.1.7 Directionality and Performance

1. All compliant communication protocols shall implement bi-directional (two-way) communication capability.
2. The compliant communication protocol shall be capable of encoding the entire ANSI C12.19 Table 00 in one contiguous Application data unit.

6.2 Point-to-point Optical Port Communication Standards

6.2.1 Optical Port Communication using ANSI C12.18 / IEEE 1701 / MC12.18

The ANSI C12.18 protocol defines the roles (a) C12.18 Device and (b) C12.18 Client. Unless stated otherwise, devices that are C12.18 Devices shall assume the role of an ANSI C12.18 PSEM service responder, and devices that are C12.18 Clients shall assume the role of an ANSI C12.18 PSEM service requester. Terms enclosed within '<' and '>', e.g., <full-read>, represent PSEM service descriptors that are defined in ANSI C12.18. The service states described in ANSI C12.18, Annex C - Service Sequence State Control, shall be implemented.

6.2.1.1 *Identification Service (required)*

The code identifying reference Standard <std> shall be set to 00_H for ANSI C12.18.

6.2.1.2 *Read Service (required)*

The device shall support a full Table read <full-read> and partial Table read with offset <pread-offset>.

6.2.1.3 *Write Service (required: ANSI C12.18 Device, optional: ANSI C12.18 Client)*

C12.18 Devices shall support a full Tables write <full-write> and partial Tables write with offset <pwrite-offset>. C12.18 Clients that implement procedures and writable Tables shall support a full Tables write <full-write> and partial Tables write with offset <pwrite-offset>.

6.2.1.4 *Logon Service (required)*

6.2.1.5 *Security Service (optional)*

The security service is optional in those instances where the End Device does not implement the PSEM write service and all Tables are readable by any C12.18 client. Otherwise, the Security Service is required. When the Security Service is implemented by a C12.18 Device, the <password> element shall be compared with the PASSWORD elements of SECURITY_TBL (Table 42) of ANSI C12.19. When the passwords are not unique in the passwords Tables the highest authority (most permissive access) password that is operational via optical port shall prevail for this interface.

Note: ANSI C12.18 as presently written allows sending passwords in clear text on the communication path. This is a serious security issue. Passwords that are operational via optical port access using this protocol should not be operational when accessing the End Device via a Telephone / MODEM (such as ANSI C12.21) or over a network (e.g., ANSI C12.22).

When the passwords are not unique in the password Tables then the highest authority password that is operational via the optical port shall prevail for this interface.

6.2.1.6 *Logoff Service (required)*

The <logoff> service shall be used to conclude a successful session, thus causing the orderly shutdown of the session established by the <logon> service.

6.2.1.7 *Negotiate Service (required)*

6.2.1.8 *Wait Service (required)*

C12.18 Devices shall support all <time> values whereby <time> = 0 shall not affect the channel settings; otherwise all the <time> idle values in the range of 1 to 255 seconds shall be supported.

6.2.1.9 *Terminate Service (required)*

The <terminate> service shall be used to abort any open session for reasons such as excessive errors, security issues and internal error conditions. It may also be used to establish a well known initial state of the C12.18 Device. Following terminate service any or all session-oriented transactions may be lost. Also utility Enterprise and/or Head-end system shall assume the role of a C12.21 Client. Meters shall assume the role of a C12.18 Device.

6.2.2 Optical Port Communication using ANSI C12.22 / IEEE 1703 / MC12.22

All C12.22 Nodes shall implement a local port (in accordance with Local Port of ANSI C12.22) using the physical form and type defined in ANSI C12.18. Two implementations are possible:

1. A local port that supports the ANSI C12.18 protocol. This mode is also referred to as ANSI C12.18 compatibility mode.
2. A local port that implements both the ANSI C12.22 protocol and the ANSI C12.18 protocol (optional).

C12.22 Meters and ANSI C12.22 embedded field devices shall comply with ANSI C12.22 Section 7.2, C12.22 Local Port Communication using a C12.18 Optical Port. This section describes the means to establish an ANSI C12.22 compatibility mode of the Local Port and an ANSI C12.18 compatibility mode of the Local Port.

When operating in ANSI C12.22 Local Port compatibility mode, the C12.22 Node shall implement the Application, Transport, Data link and Physical layers as specified in Section 7, Local Port Communication

Protocol Details, of ANSI C12.22. In addition the ANSI C12.22 Local Port shall provide access to the C12.22 Node's interfaces. The implementation of the ANSI C12.22 data link protocol is optional.

When operating in ANSI C12.18 compatibility mode, the C12.18 Device shall operate in accordance with Section 6.2.1, Optical Port Communication using ANSI C12.18-2006.

When operating in ANSI C12.22 compatibility mode, the ANSI C12.22 Node application layer shall operate in accordance with Section 5.3, Layer 7-Application Layer, of ANSI C12.22. The C12.22 Node's transport layer shall operate in accordance with Section 6, Protocol Details: C12.22 Device to C12.22 Communication Module Interface.

6.3 Point-to-point Telephone MODEM Communications Standards

6.3.1 Telephone MODEM Communications using ANSI C12.21 / IEEE 1702 / MC12.21

ANSI C12.21 is a protocol that supports legacy POT (plain old telephone) and point-to-point communication between Enterprise and/or Head-end systems and ANSI C12.19 meters. Looking forward, it is likely that ANSI C12.21 will be superseded by the ANSI C12.22 protocol. Users of ANSI C12.21 are cautioned that the ANSI C12.21 security service (provides password) may be communicated in clear text (not encrypted). For this reason, users of the ANSI C12.21 protocol are advised not to use ANSI C12.21 on unsecured networks (networks that may compromise the security of the meter, metering system or the Smart Grid, through the weakness in password delivery). When transmission of passwords in the clear is not acceptable, then it is strongly recommended that a secured ANSI C12.22 protocol be used instead, optionally acting as a gateway to ANSI C12.21 legacy technology.

The ANSI C12.21 protocol defines the roles (a) C12.21 Device and (b) C12.21 Client. Unless stated otherwise, devices that are C12.21 Devices shall assume the role of a C12.21 PSEM service responder, and devices that are C12.21 Clients shall assume the role of a C12.21 PSEM service requester. Terms enclosed within '<' and '>', e.g., <full-read>, represent PSEM service descriptors that are defined in ANSI C12.18. Also the utility AMR / AMI system shall assume the role of a C12.21 Client. Meters shall assume the role of a C12.21 Device. The service states described in ANSI C12.21, Annex C - Service Sequence State Control, shall be implemented.

6.3.1.1 *Identification Service (required)*

The code identifying reference Standard <std> shall be set to 02_H for ANSI C12.21.

The <feature> list of the identification response shall provide the <auth-ser> and <auth-ser-ticket> elements in support of the <authenticate> service. The authentication algorithm used, <auth-alg-id>, shall be set to 00_H thus selecting the ANSI INCITS 92-1981 (R2003), Data Encryption Algorithm.

6.3.1.2 *Read Service (required)*

The device shall support a full Tables read <full-read> and partial Tables read with offset <pread-offset>.

6.3.1.3 *Write Service (required)*

C12.21 Devices shall support a full Tables write <full-write> and partial Tables write with offset <pwrite-offset>. C12.21 Clients that implement procedures and writable Tables shall support a full Tables write <full-write> and partial Tables write with offset <pwrite-offset>.

6.3.1.4 *Logon Service (required)*

6.3.1.5 *Security Service (optional)*

The <security> service may serve the same roles as the <security> service of ANSI C12.18. It establishes the Tables and procedures access role of the C12.21 Client. The security service is optional in those instances where the End Device does not implement the PSEM write service and all Tables are readable by any C12.21 Client. Otherwise, the Security Service is required. When the Security Service is implemented by a C12.21 Device, the <password> element may be compared with the PASSWORD elements of SECURITY_TBL (Table 42) of ANSI C12.19.

Note: ANSI C12.21 as presently written allows sending passwords in clear text on the communication path. This is a serious security issue.

When the passwords are not unique in the password Tables then the highest authority password that is operational via the telephone modem interface shall prevail for this interface.

6.3.1.6 *Authenticate Service (required)*

The <auth-request> element shall be compared with the KEY elements of KEY_TBL (Table 45) of ANSI C12.19.

6.3.1.7 *Logoff Service (required)*

The <logoff> service shall be used to conclude a successful session, thus causing the orderly shutdown of the session established by the <logon> service.

6.3.1.8 *Negotiate Service (required)*

6.3.1.9 *Timing Setup Service (required)*

C12.21 Devices shall support all <traffic>, <inter-char>, <resp-to> and <nbr-retries> values in the range of 1 to 255. The value zero (00_H) should be avoided, however when supplied as a parameter, the corresponding state of the timing service shall not change (i.e., it shall remain in its present state).

6.3.1.10 *Wait Service (required)*

C12.21 Devices shall support all <time> values whereby <time> = 0 shall not affect the channel settings, otherwise the all <time> idle values in the range of 1 to 255 seconds shall be supported.

6.3.1.11 *Terminate Service (required)*

The <terminate> service shall be used to abort any open session for reasons such as excessive errors, security issues and internal error conditions. It may also be used to establish a well known initial state of the C12.18 Device. Following terminate service any or all session-oriented transactions may be lost.

6.4 Network Communications Standards

6.4.1 Networks Communication using ANSI C12.22 / IEEE 1703 / MC12.22

6.4.1.1 *Common Requirements*

The C12.22 Network shall support multicast and uni-cast messaging. It is recommended that C12.22 Network Segments support multicast natively.

6.4.1.2 *Minimum Requirements for all ANSI C12.22 Communication*

6.4.1.2.1 ANSI C12.22 Application Message Envelop Structure (required)

ANSI C12.22 Applications relies on the use of Connectionless-mode ACSE to convey association and security parameters. This includes the identification of the application context, application process titles (names) of called and calling processes, authentication information if an authentication or privacy of transaction is required.

6.4.1.2.2 ACSE Un-segmented APDU Processing (required)

6.4.1.2.3 Un-segmented ACSE Constituents

Although many of the elements may be optional in constructing the ACSE-PDU, their interpretation, processing and devices' ability to generate in compliance with the Standard is not optional. The following members shall be understood by all implementations:

<aSO-context-element>
<called-AP-title-element>
<called-AP-invocation-id-element>
<calling-AP-title-element>
<calling-AE-qualifier-element>
<calling-AP-invocation-id-element>
<mechanism-name-element>
<calling-authentication-value-element>
<user-information-element>

6.4.1.2.4 Segmented APDU Processing (required)

6.4.1.2.4.1 APDU Segmentation and Segment Creation (optional)

C12.22 Nodes with large Tables or C12.22 Relays that bridge across mixed message–size topologies should implement full segment assembly and disassembly. This is an interoperability requirement.

6.4.1.2.4.2 APDU Segments-assembly (required)

C12.22 Nodes that implement message processing need to be able to assemble incoming segments.

6.4.1.2.5 APDU C12.22 Security / Authentication / Privacy (required)

The following are Standard-registered authentication-mechanism names. Other mechanism names can be registered.

6.4.1.2.5.1 APDU C12.22 Security Mechanisms (RelOID=.2.1, required, MGMT)

Processing of ACSE-PDU (ANSI C12.22 application message) that is encoded with RELATIVE-OID ".2.1" shall be supported.

6.4.1.2.5.2 APDU C12.22 Security Mechanisms (RelOID=.2.0, optional, C12.21 Tunnels)

Processing of ACSE-PDU (ANSI C12.22 application message) that are encoded with RELATIVE-OID ".2.0" shall be supported in tunneling application to C12.21 Meters.

6.4.1.2.5.3 ANSI C12.19-Tables Role-based Security (required)

Processing of ACSE-PDU (ANSI C12.22 application message) that implement the ANSI C12.22 Security Service shall be supported.

6.4.1.2.6 Use of Sub-branches of a Registered ApTitle (required)

6.4.1.2.6.1 Use of assigned sub-branch spaces (required)

Any sub-branch of the registered root ApTitle can be used to communicate with the C12.22 Node that registered that root under controlled conditions. All sub-branches are assumed to be registered and managed by the root ApTitle holder as long as the root ApTitle is registered.

This requires recognition and proper use of:

1. Assigned sub-branch.
2. Reserved sub-branch.
3. Dynamic sub-branch.

6.4.1.2.6.2 Use of local-ports and Mailboxes (required)

Reserved sub-branches were assigned by the Standard to access the C12.22 Devices' Local Ports and C12.22 Communication Modules' interfaces. The assignments shall be respected and processed by C12.22 Nodes.

6.4.1.2.7 EPSEM Application Services (required)

6.4.1.2.7.1 EPSEM Envelope Structure (required)

All elements described are required.

6.4.1.2.7.2 Required EPSEM Services

C12.22 Master Stations (i.e., C12.22 Notification Hosts) must implement all of the following services as initiators of the service. They must implement the Write service as recipients of C12.22 Notification messages. They must also implement the registration / de-registration services as notification and authentication hosts. They must implement the resolve service as C12.22 Relays.

6.4.1.2.7.3 Identification Service (respondent all: required)

This service is used to obtain information about C12.19 / C12.22 Device functionality.

Note: Session-less mode or session-state mode.

6.4.1.2.7.4 Read Service (respondent meters+C12.22 Hosts: required)

6.4.1.2.7.4.1 Full Tables read (required)

If any Tables cannot be read using this mode then in addition the partial Tables read forms (byte offset / count and element index / count) is required.

6.4.1.2.7.4.2 Partial Tables read byte offset / count (conditionally optional)

If any Tables cannot be read using the full Tables read then this form is required.

6.4.1.2.7.4.3 Partial Tables read element (index) offset / count (conditionally optional)

If any Tables cannot be read using the full Tables read then this form is required.

6.4.1.2.7.4.4 Default Tables read (optional)

When implemented it reads the preset default Tables not defined by this specification.

6.4.1.2.7.5 Write Service (respondent meters+C12.22 Hosts all: optional)

Support for this service is required only when ANSI C12.19 End Devices are programmable or implement procedures.

6.4.1.2.7.5.1 Full Tables write (required if write service implemented)

This is a minimal requirement.

If any Tables cannot be written using this mode then in addition the partial Tables write forms (byte offset / count and element index / count) are required.

6.4.1.2.7.5.2 Partial Tables write byte offset / count (conditionally optional)

This service is required when any Tables cannot be written using the Full Table Write mode.

6.4.1.2.7.5.3 Partial Tables write element (index) offset / count (conditionally optional)

This service is required when any Tables cannot be written using the Full Table Write mode.

6.4.1.2.7.6 Logon Service (respondent meters+C12.22 Hosts all: optional)

Logon Service establishes a session without establishing access permissions.

This service is required if there is no way to establish C12.22 peer-to-peer Node association in support of complex and lengthy transactions with the possibility of transaction rollback (cancellation).

Also supports audit requirements of ANSI C12.19 and system recovery sessions of ANSI C12.22.

Note: This is really a required service for SmartGrid especially across wide-area heterogeneous network implementations.

6.4.1.2.7.7 Security Service (respondent meters+C12.22 Hosts all: optional)

The Security Service is provided for setting access permissions to Tables (not to be confused with APDU content security).

Note: The Security Service shall be implemented when read access restrictions apply or it is possible to modify any Tables.

Note: ANSI C12.22 as presently written allows sending passwords in clear text on the communication path. This is a serious security issue, and this practice should be avoided. Passwords that are operational via networks using this protocol should not be operational when accessing the End Device via a local port (such as ANSI C12.18 optical port, or ANSI C12.22 optical port) or via telephone / MODEM access (e.g., ANSI C12.21). When passwords are not unique within the password Tables then the highest authority shall prevail for the network interface.

6.4.1.2.7.8 Logoff Service (respondent meters+C12.22 Hosts all: optional, all: required if Logon implemented)

The Logoff Service provides for an orderly termination of the session that was established by the Logon Service and leads to the completion of the processing of all transactions that were carried during that session.

6.4.1.2.7.9 Terminate Service (all: optional, all: required if Logon implemented)

The Terminate Service provides for an orderly abortion of the Session that was established by the Logon Service.

6.4.1.2.7.10 Disconnect Service (respondent meters+C12.22 Hosts all: optional, all: required MGMT)

The Disconnect Service is used to remove a C12.22 Node from the C12.22 Network Segment. The service is required for interoperability if the nodes can be instructed to get off the network.

All peer-to-peer associations across the interface of the C12.22 Node on the C12.22 Network segment that processed this request shall terminate. The C12.22 Node's settings shall reset to their default off-line state values for that C12.22 Network Segment.
Note: If not implemented it impedes interoperability.

6.4.1.2.7.11 Wait Service (respondent meters+C12.22 Hosts all: optional, all: required if Logon supported)

The Wait Service is used to maintain an established Session during idle periods, thus preventing automatic termination.

6.4.1.2.7.12 Registration Service (all: required, MGMT)

To be part of a C12.22 Network, a C12.22 Node shall send a Registration Service request to one of the C12.22 Master Relays.

6.4.1.2.7.13 De-registration Service (all: required, MGMT)

This service provides ANSI C12.22 service discontinuation notification to all of the C12.22 Master Relay Authentication and Notification hosts.

6.4.1.2.7.14 Resolve Service (all: required, MGMT)

The Resolve Service is used to retrieve the native network address of a C12.22 Node. The native address is used to communicate directly with other C12.22 Nodes, such as C12.22 Relays, on the same native network (i.e., for network node discovery).

Note: On network segments capable of broadcast (or multicast), this service should also be used to retrieve native addresses of C12.22 Relays.

6.4.1.2.7.15 Trace Service (all: optional, MGMT)

The Trace Service is used to retrieve the list of C12.22 Relays that have forwarded this C12.22 Message to a target C12.22 Node across heterogeneous networks.

6.4.1.2.8 EPSEM Service Responses (required)

6.4.1.2.9 Response Codes (required)

EPSEM responses always include a one-byte response code

<nok> ::= <sns>|<isss>|<iar>|<sme>|<isc>|<onp>|<bsy>|<dlk>|
<dnr>|<rno>|<uat>|<netr>|<nett>|<rqtl>|<rstl>|<sgnp>|<sgerr>|<err>
or
<ok> ::=00

6.4.1.2.10 Application Timers

6.4.1.2.10.1 Application Session-mode Timeout (required)

Each session established with a C12.22 Server shall be monitored by the C12.22 Server and shut down when the session becomes inactive.

The Session Time-out value is set by the Logon Service request and can be temporarily modified for the next request through the use of the Wait Service.

Note: Interoperability requires support for Logon (for sessions) and Wait (for timeout).

6.4.1.2.10.2 Application Layer Response Time-out (required)

The Application Layer Response Timeout is used by a C12.22 Node that issues service requests to another C12.22 Node and needs to know how long to wait for responses.

A non-recoverable Application Layer Response Timeout shall terminate the associated session if one exists.

6.4.1.2.11 Compliance with Normative Sections of ANSI C12.22 (required)

All specifications cited in all normative sections that touch upon the required and optional services cited above shall be implemented for compliance and interoperability.

6.4.1.2.12 C12.22 Communication Module (optional)

The use or presence of a C12.22 Communication module is not pertinent for the SmartGrid operations. It is only pertinent for the interoperability and assets used to build C12.22 Nodes from the two parts a C12.22 Communication Module + a C12.22 Device.

6.4.1.2.13 C12.22 Local Optical Port (required)

The use or presence of a C12.22 Local (optical) port (that is compatible backward with ANSI C12.18) is pertinent for the SmartGrid operations and deployment. It is pertinent for the interoperability and provision of guaranteed and reliable access to the C12.22 Node under conditions where it may not be possible or desirable to access the C12.22 Node from the C12.22 Network Segment.

6.4.1.2.14 C12.22 / C12.19 Network Support Tables (required)

6.4.1.2.14.1 C12.22 / C12.19 Network Tables (all C12.22 Nodes: required)

The first release Tables of ANSI C12.19 / IEEE 1377 / MC12.19 Node Network Tables are published in the ANSI C12.22 / IEEE 1703 / MC12.22 Standard. These nodes are collectively referred to as C12.22 Nodes. All C12.22 Nodes that are attached to the C12.22 Network shall implement the network Tables and network procedures in accordance with Decade 12 requirements of Section 8.1.2, Standard Tables Needed and Procedures 23 (Register), 24 (Deregister), 25 (Network Interface Control) and 26 (Exception Report).

6.4.1.2.15 C12.22 / C12.19 Relay Tables (C12.22 Relays only: optional)

The first release of ANSI C12.19 / IEEE 1377 / MC12.19 Relay Network Tables are published in the ANSI C12.22 / IEEE 1703 / MC12.22 Standard. These nodes are collectively referred to as C12.22 Relays. C12.22 Relays include C12.22 Master Relays and C12.22 Gateways. All C12.22 Relays that are attached to the C12.22 Network shall implement the network Tables and network procedures in accordance with Decade 12 requirements of Section 8.1.2, Standard Tables Needed and Procedures 23 (Register), 24 (Deregister), 25 (Network Interface Control) and 26 (Exception Report). In addition they shall implement the Decade 13 Network Relay Control Tables in accordance with Section 8.1.2, Standard Tables Needed.

6.4.1.2.16 Security-key and Authentication Tables (all C12.22 Nodes: required)

All C12.22 Nodes that are attached to the C12.22 Network shall implement the security Tables in accordance with Decade 4 requirements of Section 8.1.2, Standard Tables Needed. The first release of ANSI C12.19 / IEEE 1377 / MC12.19 Extended Key and Host Access Tables are published in the ANSI C12.22 / IEEE 1703 / MC12.22 Standard.

All C12.22 Nodes shall support clear-text, plain-text and cipher-text messaging and message acceptance and rejection windows. The actual deployment requirements for AMI Meters shall be defined by the utility on a per network interface basis (e.g., HAN vs. WAN). All C12.22 Nodes shall minimally support the C12.22 Security Mechanism (2.16.124.113620.1.22.2.1).

Encryption and authentication of the above services may require public key sharing and/or public key exchange agreements to exist among all the C12.22 Relays of C12.22 Network service providers.

During both session-based and session less communication, it shall be possible to establish or modify the Tables' access privileges by providing a password using the EPSEM security service. It should be noted that sending passwords as clear-text or plain-text (unencrypted) over any network is a security concern, and it should be avoided.

6.4.1.3 *ANSI C12.22 Application Messaging using the Internet Protocol*

The interface transport protocol used by C12.22 IP Nodes shall be as defined by IETF RFC 6142 [15].

7.0 ANSI C12.19 Data Model General Requirements

The five meter types listed are near-future projections for revenue applications with requirements for reasonably high functionality. The single-phase meters might be applied at the service of a small

commercial or special residential customer. One of the polyphase meters (in either a self-contained or transformer-rated configuration) might be applied on a commercial or small industrial account requiring more data. The highest functionality types of meters are for industrial or other special accounts with high conventional data requirements.

These projections of functionality assume the quantities in general usage for most billing applications will not change dramatically in the near future. In addition, the remote retrieval of data will add functional requirements that increase customer service quality and provide the Utility with operating information. These selections and recommendations represent a compromise by the working group on practical requirements versus design capabilities found within ANSI C12.19 / IEEE 1377 / MC12.19 Standard.

Future developments in the utility industry may quickly change the functions required. Because the mechanisms exist in ANSI C12.19 / IEEE 1377 / MC12.19 Standard to accommodate innovation and change when implemented holistically as a system, the user is not confined or bound when following these Guidelines. The Guidelines are simply one expression of the capability of the Standard while using "Standard Tables" to universally reflect conventional functionality.

1. Residential single phase.
2. Commercial polyphase.
3. Industrial polyphase.

The following lists the various smart meter types recommended to be used for billing applications at most utilities. These meter types are currently represented in existing product lines from multiple sources and are expected to continue for the foreseeable future. Some variation in parameters from utility to utility may be expected according to individual requirements for billing rates and tariffs. For example, demand may be accumulated in either block or sliding mode. Demand interval lengths may vary from rates to rate, and there may be sub-intervals. Current production meter types have been designed to accommodate this variability. It is expected that meter types complying with the Guidelines would continue that flexibility. In addition, remote communications to the meter, network or dial-up, will facilitate the use of customer service information and will become an expectation rather than an exception.

7.1 Meter Types

The minimum functionality requirements for the meter types listed below are also delineated in Table 7.2.1 Revenue Billing Data Requirements and Table 7.2.2 Operational Requirement Data ("Metadata" Not Critical To Billing). It is understood that the utilities may use some or all of the defined functionality, as dictated by their business model and/or customer / regulatory requirements.

7.1.1 Residential Single Phase, Self-contained, Class 200 or 320 amps

7.1.1.1 *The minimum revenue billing data and functionality requirements are:*

1. Energy (Default) KWH delivered Register Only.
2. KWH received Register Only.
3. Energy Net Metering (|Delivered| - |Received|) Register Only.
4. Energy Detent Metering (Delivered, disable received) Register Only.
5. Energy Secure Metering (|Delivered| + |Received|) Register Only.
6. Demand (Block or Rolling Sub) kW Register Only.
7. Instantaneous KW Register Only.
8. TOU 4 + dynamic tier (e.g., Critical Peak Pricing, Real Time Pricing, etc.).
9. Up to 4 Daily Schedules (Weekdays, Sat, Sun, Holiday).
10. Up to 4 Seasons.
11. 2 sets of TOU seasons Registers (current and previous Season).
12. Real Time Pricing Tier.
13. Reactive Energy KVARh delivered (Q1+Q2).
14. Apparent Energy (KVAh).
15. Load Profile (4 Channels) 1st Channel Default kW.

7.1.1.2 *The minimum operational data and functionality requirements are:*

1. Outage / Restoration Reporting.
2. Tamper Detection Reporting.
3. Voltage Min / Max During Reporting Period.
4. Integrated Voltage for Period (average voltage).
5. Instantaneous Voltage.
6. Other Power Quality Reporting.
7. Event Log.
8. History Log.
9. Service Switch Disconnect Count.
10. Service Switch Connection Status.
11. Network Interfaces (Utility and HAN).
12. Network Interfaces Firmware.
13. Optical Port.
14. Voltage & Current Phase Angle Measurements (Phasor Analysis).

7.1.2 Residential Single Phase, Transformer Rated, Class 10 or 20 amps

7.1.2.1 *The minimum revenue billing data and functionality requirements are:*

1. Energy (Default) KWh delivered Register Only.
2. KWh received Register Only.
3. Energy Net Metering (|Delivered| - |Received|) Register Only.
4. Energy Detent Metering (Delivered, disable received) Register Only.
5. Demand (Block or Rolling Sub) kW Register Only.
6. Instantaneous KW Register Only.
7. TOU 4 + dynamic tier (e.g., Critical Peak Pricing, Real Time Pricing, etc.).
8. Up to 4 Daily Schedules (Weekdays, Sat, Sun, Holiday).
9. Up to 4 Seasons.
10. 2 sets TOU season Registers (current and previous Season).
11. Real Time Pricing Tier.
12. Reactive Energy KVARh delivered (Q1+Q2).
13. Apparent Energy (KVAh).
14. Load Profile (4 Channels), 1st Channel Default kW.

7.1.2.2 *The minimum operational data and functionality requirements are:*

1. Outage / Restoration Reporting.
2. Tamper Detection Reporting.
3. Voltage Min / Max During Reporting Period.
4. Integrated Voltage for Period (average voltage).
5. Instantaneous Voltage.
6. Other Power Quality Reporting.
7. Event Log.
8. History Log.
9. Service Switch Disconnect Count.
10. Service Switch Connection Status.
11. Network Interfaces (Utility and HAN).
12. Network Interfaces Firmware.

13. Optical Port.
14. Voltage & Current Phase Angle Measurements (Phasor Analysis).

7.1.3 Commerical Polyphase, Self-contained, Class 200 or 320 amps

7.1.3.1 *The minimum revenue billing data and functionality requirements are:*

1. Energy KWh delivered (Default Setup) Register Only.
2. KWh received Register Only.
3. Energy Net Metering (|Delivered| - |Received|) Register Only.
4. Energy Detent Metering (Delivered, disable received) Register Only.
5. Energy Secure Metering (|Delivered + Received|) Register Only.
6. Demand (Block or Rolling Sub) kW Register Only.
7. Instantaneous KW Register Only.
8. TOU 4 + dynamic tier (e.g., Critical Peak Pricing, Real Time Pricing, etc.).
9. Up to 4 Daily Schedules (Weekdays, Sat, Sun, Holiday).
10. Up to 4 Seasons.
11. 2 sets of TOU season Registers (current and previous Season).
12. Real Time Pricing Tier.
13. Reactive Energy KVARh delivered (Q1+Q2).
14. Apparent Energy (KVAh).
15. Load Profile (4 Channels), 1st Channel Default kW.

7.1.3.2 *The minimum operational data and functionality requirements are:*

1. Outage / Restoration Reporting.
2. Tamper Detection Reporting.
3. Voltage Min / Max During Reporting Period.
4. Integrated Voltage for Period (average voltage).
5. Instantaneous Voltage.
6. Harmonic Measurements.
7. Other Power Quality Reporting.
8. Event Log.
9. History Log.
10. Remote Switch Disconnect Count, when available.
11. Service Switch Connection Status, when available.
12. Network Interfaces (Utility and HAN).
13. Network Interfaces Firmware.
14. Optical Port.
15. Voltage & Current Phase Angle Measurements (Phasor Analysis).

7.1.4 Commercial Polyphase, Transformer Rated, Class 10 or 20 amps

7.1.4.1 *The minimum revenue billing data and functionality requirements are:*

1. Energy KWh delivered (Default Setup) Register Only.
2. KWh received Register Only.
3. Energy Net Metering (|Delivered| - |Received|) Register Only.
4. Energy Detent Metering (Delivered, disable received) Register Only.
5. Energy Secure Metering (|Delivered| + |Received}) Register Only.
6. Demand (Block or Rolling Sub) kW Register Only.

7. Instantaneous KW Register Only.
8. TOU 4 + dynamic tier (e.g., Critical Peak Pricing, Real Time Pricing, etc.).
9. Up to 4 Daily Schedules (Weekdays, Sat, Sun, Holiday).
10. Up to 4 Seasons.
11. 2 sets of TOU season Registers (current and previous Season).
12. Real Time Pricing Tier.
13. Reactive Energy KVARh delivered (Q1+Q2).
14. Reactive Energy KVARh received (Q3+Q4).
15. Four Quadrant Reactive Energy.
16. Apparent Energy (KVAh).
17. Load Profile (4 Channels), 1st Channel Default kW.
18. Load Profile (more than 4 channels), 1st Channel Default kW.
19. Transformer and Line Loss Compensation.

7.1.4.2 *The minimum operational data and functionality requirements are:*

1. Outage / Restoration Reporting.
2. Tamper Detection Reporting.
3. Voltage Min / Max During Reporting Period.
4. Integrated Voltage for Period (average voltage).
5. Instantaneous Voltage.
6. Harmonic Measurements.
7. Other Power Quality Reporting.
8. Event Log.
9. History Log.
10. Service Switch Disconnect Count, when available.
11. Service Switch Connection Status, when available.
12. Network Interfaces (Utility and HAN).
13. Network Interfaces Firmware.
14. Optical Port.
15. Voltage & Current Phase Angle Measurements (Phasor Analysis).

7.1.5 Industrial Polyphase, Transformer Rated, Class 10 or 20 amps.

7.1.5.1 *The minimum revenue billing data and functionality requirements are:*

1. Energy KWh delivered (Default Setup) Register Only.
2. KWh received Register Only.
3. Energy Net Metering (|Delivered| - |Received}) Register Only.
4. Energy Detent Metering (Delivered, Disable Received) Register Only.
5. Energy Secure Metering (|Delivered| + |Received|) Register Only.
6. Demand (Block or Rolling Sub) kW Register Only.
7. Instantaneous KW Register Only.
8. TOU 4 + dynamic tier (e.g., Critical Peak Pricing, Real Time Pricing, etc.).
9. Up to 4 Daily Schedules (Weekdays, Sat, Sun, Holiday).
10. Up to 4 Seasons.
11. 2 sets of TOU season Registers (current and previous Season).
12. Real Time Pricing Tier.
13. Reactive Energy KVARH delivered (Q1+Q2).

14. Reactive Energy KVARH received (Q3+Q4).
15. Four Quadrant Reactive Energy.
16. Apparent Energy (KVAh).
17. Load Profile (4 Channels), 1st Channel Default kW.
18. Load Profile (more than 4 channels), 1st Channel Default kW.
19. Transformer and Line Loss Compensation.

7.1.5.2 *The minimum operational data and functionality requirements are:*

1. Outage / Restoration Reporting.
2. Tamper Detection Reporting.
3. Voltage Min / Max During Reporting Period.
4. Integrated Voltage for Period (average voltage).
5. Instantaneous Voltage.
6. Harmonic Measurements.
7. Voltage SAG, Swell Values and/or Counts.
8. Event Log.
9. History Log.
10. Service Switch Disconnect Count, when available.
11. Service Switch Connection Status, when available.
12. Network Interfaces (Utility and HAN).
13. Network Interfaces Firmware.
14. Optical Port.
15. Voltage & Current Phase Angle Measurements (Phasor Analysis).

7.2 Data Model General Requirements

The following Tables define the minimum requirements and functionality supported by these Guidelines.

7.2.1 Revenue Billing Data Requirements

Revenue Billing Data Requirements	**Smart Grid Meter Category**				
	Residential Single Phase Self Contained (Class 200 & 320)	Residential Single Phase Transformer Rated (Class 10 & 20)	Commercial Polyphase Self Contained (Class 200 & 320)	Commercial Polyphase Transformer Rated (Class 10 & 20)	Industrial Polyphase Transformer Rated (Class 10 & 20)
Energy (Default) KWH delivered Register Only	X	X	X	X	X
KWH received Register Only	X	X	X	X	X
Energy Net Metering (Delivered - Received) Register Only	X	X	X	X	X
Energy Detent Metering (Delivered, disable received) Register Only	X	X	X	X	X

Revenue Billing Data Requirements	Smart Grid Meter Category				
	Residential Single Phase Self Contained (Class 200 & 320)	Residential Single Phase Transformer Rated (Class 10 & 20)	Commercial Polyphase Self Contained (Class 200 & 320)	Commercial Polyphase Transformer Rated (Class 10 & 20)	Industrial Polyphase Transformer Rated (Class 10 & 20)
Energy Secure (audited) Metering (Delivered + Received) Register Only	X	X	X	X	X
Demand (Block or Rolling Sub) kW Register Only	X	X	X	X	X
Instantaneous KW Register Only	X	X	X	X	X
TOU 4 Tiers	X	X	X	X	X
TOU 4 Tiers + CPP Tier	X	X	X	X	X
More Than 4 TOU Tiers	X	X	X	X	X
Up to 4 Daily Schedules (Weekdays, Sat, Sun, Holiday)	X	X	X	X	X
Up to 4 Seasons	X	X	X	X	X
2 TOU Registers (current and previous Season)	X	X	X	X	X
Real Time Pricing Tier	X	X	X	X	X
Reactive Energy KVARH delivered (Q1+Q2)	X	X	X	X	X
Reactive Energy KVARH received (Q3+Q4)				X	X
Four Quadrant Reactive Energy				X	X
Apparent Energy (KVAh)	X	X	X	X	X
Load Profile (4 Channels), 1st Channel Default kW			X	X	X
Load Profile (more than 4 channels), 1st Channel Default kW				X	X
Transformer and Line Loss Compensation				X	X

7.2.2 Operational Requirement Data ("Metadata" Not Critical To Billing)

Operational Requirement Data ("Metadata" Not Critical To Billing)	Smart Grid Meter Category				
	Residential Single Phase Self Contained (Class 200 & 320)	Residential Single Phase Transformer Rated (Class 10 & 20)	Commercial Polyphase Self Contained (Class 200 & 320)	Commercial Polyphase Transformer Rated (Class 10 & 20)	Industrial Polyphase Transformer Rated (Class 10 & 20)
Outage / Restoration Reporting	X	X	X	X	X
Tamper Detection Reporting	X	X	X	X	X
Voltage Min / Max During Reporting Period	X	X	X	X	X
Integrated Voltage for Period (average voltage)	X	X	X	X	X
Instantaneous Voltage	X	X	X	X	X
Harmonic Measurements			X	X	X
Other Power Quality Reporting	X	X	X	X	X
Event Log	X	X	X	X	X
History Log	X	X	X	X	X
Disconnect Count	X	X	X	X	X
Disconnect Status	X	X	X	X	X
Network Interfaces (Utility + HAN)	X	X	X	X	X
Network Interfaces Firmware	X	X	X	X	X
Optical Port	X	X	X	X	X
Voltage & Current Phase Angle Measurements (Phasor Analysis)	X	X	X	X	X

8.0 ANSI C12.19 / IEEE 1377 / MC12.19 Registered Semantic Models

8.1 Common Requirements

8.1.1 Classification of Features

The following subsections list the complete Tables and Procedures inventory of ANSI C12.19 and related communication protocols. The Tables and Procedures are each associated with communication properties and attributes. Of special significance is the accessibility attribute, which determines the user's ability to access or to modify the related elements values. The accessibility attribute **AM** tag is described below.

AM	Description
W	The End Device Table entity (or entries) are expected to be writable by the user (utility, programmer) in accordance with access security constraints. A writable shall also be readable by the user (utility, programmer) in accordance with access

security constraints. Some exception may apply to certain Table elements (e.g., Table 42 – PASSWORD, which may be read back as random text due to security considerations).

R The End Device Table entity (or entries) should not be writable by the user (utility, programmer).

All End Devices, regardless of type, being residential single phase meters, commercial polyphase meters, or Industrial polyphase meters, may support one or more of the features listed in the Tables below.

Feature ID	Feature Name	Feature Description
FA	All devices	An AMI End Device that records data with no special or extra capability
FD	Demand	An End Device that in addition to being a simple End Device (FA) also supports demand measurements.
FT	TOU	An End Device that in addition to being a simple End Device (FA) also supports Time-of-Use measurements.
FS	Self-read	An End Device that in addition to being a simple End Device (FA) also supports trigger-based or calendar-based capture of historical or metrological data or measurements.
FL	Load Profile	An End Device that in addition to being a simple End Device (FA) also supports load profile recorder measurements.
FQ	Quality-of-Service	An End Device that in addition to being a simple End Device (FA) also supports quality of service measurement (e.g., power quality measurement and waveform capture).
FH	History logs	An End Device that in addition to being a simple End Device (FA) also supports session and activity logging.
FE	Event logs	An End Device that in addition to being a simple End Device (FA) also supports secured audit logs that capture firmware upgrade / updates changes, secured register reading and tracking of End Device programming to metrological Tables.
FC	Load Control	An End Device that in addition to being a simple End Device (FA) also supports load control capability or remote switch (connect / disconnect) functions.
FR	Demand Response and Real-time Pricing	An End Device that in addition to being a simple End Device (FA) also supports load real-time-pricing and interactions with the customer in support of price signals and demand response requirements.
FP	Prepayment	An End Device that in addition to being a simple End Device (FA) also supports prepayment signals.

8.1.2 Standard Tables Needed

The following chart lists the standard Tables from ANSI C12.19 / IEEE 1377 / MC12.19 and ANSI C12.22 / IEEE 1703 / MC12.22 that are needed for interoperability for the feature described by these Guidelines in the previous section. A mandatory T is tagged with an “M” and an optional Table is tagged with an “O”. Tags, such as “M” and “O”, that are grayed out represent inherited features from the minimum subset represented by column “FA”. If such a feature is listed as mandatory in the “FA” column

then it shall be mandatory throughout. If such a feature is listed as optional in the "FA" column then it may be optional throughout, unless called for specifically by an End Device feature.

The charts shown below apply primarily to End Devices that are also meters. When the End Device acts strictly as a C12.22 Master Relay or a C12.22 Relay then it is exempt from implementing decades 1, 2, 3, and 14. For more details consult the charts below.

8.1.2.1 *Decade 0 – General Configuration Tables*

Decade 0 – General Configuration Tables			Features										
Table Number and Name		AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
0	General Configuration	R	M	M	M	M	M	M	M	M	M	M	
1	General Manufacturer Identification	R	M	M	M	M	M	M	M	M	M	M	
2	Device Nameplate	W	M	M	M	M	M	M	M	M	M	M	
3	End Device Mode Status	R	M	M	M	M	M	M	M	M	M	M	
4	Pending Status	R	M	M	M	M	M	M	M	M	M	M	
5	Device Identification	W	M	M	M	M	M	M	M	M	M	M	
6	Utility Information*	W	M	M	M	M	M	M	M	M	M	M	
7	Procedure Initiate	W	M	M	M	M	M	M	M	M	M	M	
8	Procedure Response	R	M	M	M	M	M	M	M	M	M	M	
9	Not Used												

* COORDINATE_1, COORDINATE_2 and COORDINATE_3 are redefined to contain the End Device location coordinates. Each coordinate encoded as STRING(10) that holds a floating point string number (see C12.19 / BNF. floatingPointCHAR for encoding details) as follows: LATITUDE_N (in decimal degrees and fraction of a degree, positive values are North of the equator), LONGITUDE_E (in decimal degrees and fraction of a degree, positive values are east of the Prime Meridian) and ALTITUDE_M (in meters and fraction of a meter, positive values are above sea level). For example the latitude 33° 45′ 18″ N, longitude 84° 23′ 24″ W and altitude 308m shall be encoded in LATITUDE_N = "33.755", LONGITUDE_E = "-84.39" and ALTITUDE = "308.0" (Atlanta WGS84). When not in use these elements should each be filled with ten (10) spaces (20_H).

8.1.2.2 *Decade 1 – Data Source Tables*

Decade 1 – Data Source Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
10 Data Source Dimension Limits	R	M	M	M	M	M	M	M	M	M	M	
11 Actual Data Sources Limiting	W	M	M	M	M	M	M	M	M	M	M	
12 Units of Measure Entry	W	M	M	M	M	M	M	M	M	M	M	
13 Demand Control	W	M	M	M	M	M	M	M	M	M	M	
14 Data Control	W	O	O	O	O	O	O	O	O	O	O	
15 Constants Table	W	M	M	M	M	M	M	M	M	M	M	
16 Source Definition	W	M	M	M	M	M	M	M	M	M	M	
17 Transformer Loss Compensation	W	O*	O	O	O	O	O	O	O	O	O	
18 Not Used												
19 Not Used												

* Transformer based End Devices only.

8.1.2.3 *Decade 2 – Register Tables*

Decade 2 – Register Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
20 Register Dimension Limits	R	M	M	M	M	M	M	M	M	M	M	M
21 Actual Register Limiting	W	M	M	M	M	M	M	M	M	M	M	M
22 Data Selection	W	O	M	M	M	O	O	O	O	O	O	M
23 Current Register Data	R	O*	M	M	M	O	O	O	O	O	O	M
24 Previous Season Data	R	O†	O	O	O	O	O	O	O	O	O	O
25 Previous Demand Reset Data	R	O†	M	M	M	O	O	O	O	O	O	O
26 Self-read Data	R	O†	O	O	M	O	O	O	O	O	O	O
27 Present Register Selection	W	M	M	M	M	M	M	M	M	M	M	M
28 Present Register Data	R	M	M	M	M	M	M	M	M	M	M	M
29 Not Used												

* When this Table is present in the End Device then Table 22 shall also be present.

† When this T is present in the End Device then Table 22 and 23 shall also be present.

8.1.2.4 *Decade 3 – Local Display Tables*

Decade 3 – Local Display Tables*		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
30 Display Dimension Limits	R	M	M	M	M	M	M	M	M	M	M	
31 Actual Display Limiting	W	M	M	M	M	M	M	M	M	M	M	
32 Display Source	W†	M	M	M	M	M	M	M	M	M	M	
33 Primary Display List	W	M	M	M	M	M	M	M	M	M	M	
34 Secondary Display List	W‡	O	O	O	O	O	O	O	O	O	O	
35 Not Used												
36 Not Used												
37 Not Used												
38 Not Used												
39 Not Used												

* Local display represents any display that is controlled by the End Device.

† When registering a device class, the End Device Manufacturer should register a device class that overrides the definition of DISP_SOURCE_DESC_RCD.DISPLAY_SOURCE to provide the missing display identifications and format characteristics.

‡ The secondary display list may be used to drive a remote in-home display.

8.1.2.5 *Decade 4 – Security Tables*

Decade 4 – Security Tables‡		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
40 Security Dimension Limits	R	M	M	M	M	M	M	M	M	M	M	
41 Actual Security Limiting	W	M	M	M	M	M	M	M	M	M	M	
42 Security*	W	M	M	M	M	M	M	M	M	M	M	
43 Default Access Control	W	M	M	M	M	M	M	M	M	M	M	
44 Access Control	W	M	M	M	M	M	M	M	M	M	M	
45 Key	W	O†	O	O	O	O	O	O	O	O	O	
46 Extended Key	W	M	M	M	M	M	M	M	M	M	M	
47 Host Access Security	W	M	M	M	M	M	M	M	M	M	M	
48 Not Used												
49 Not Used												

* Contains the Table access roles that are bound to passwords. Access roles are independent of the manner in which the Tables are transported. Implementers of the ANSI C12.21 protocol should ensure that passwords that used by ANSI C12.18 (Optical-Port access) or ANSI C12.22 (Network access), are disabled when the End Device is accessed by ANSI C12.21. Similarly the rule should apply to the access from ANSI C12.22 and ANSI C12.21 interfaces. This can be accomplished by assigning the first *n* of ACT_SECURITY_LIMITING_TBL.NBR_PASSWORDS passwords in the list to ANSI C12.18 protocol access and the next to ANSI C12.21 and the rest ANSI C12.21 protocol. When the passwords are not unique in the password Tables then the highest authority password that is operational on an interface should prevail.

† Mandatory when the End Device (or Comm. Module) implements the ANSI C12.21 protocol.

‡ Although some secured Elements within Tables may be read back, some of values reported back are not defined in order

Decade 4 – Security Tables‡		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
to avoid revealing secured information when read back.												

8.1.2.6 *Decade 5 – Time and Time-of-Use Tables*

Decade 5 – Time and Time-of-Use Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
50 Time and TOU Dimension Limits	R	M	M	M	M	M	M	M	M	M	M	M
51 Actual Time and TOU Limiting	W	M	M	M	M	M	M	M	M	M	M	M
52 Clock	R	M†	M	M	M	M	M	M	M	M	M	M
53 Time Offset	W	M	M	M	M	M	M	M	M	M	M	M
54 Calendar	W	O*	O	M	M	O	O	O	O	O	O	O
55 Clock State	R	O	O	M	O	O	O	O	O	O	O	O
56 Time Remaining	R	O	M	M	M	M	O	O	O	O	O	O
57 Precision Clock State	R	O†	O	O	O	O	M	O	O	O	O	O
58 Not Used												
59 Not Used												

* If the End Device internal clock requires a "calendar action" to switch daylight saving on / off then Table 54 is mandatory as an "FA" feature.

† The operator of the End Device should always set the clock.

8.1.2.7 *Decade 6 – Load Profile Tables*

Decade 6 – Load Profile Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
60 Load Profile Dimension Limits	R	O*	O	O	O	M	O	O	O	O	O	
61 Actual Load Profile Limiting	W	O*	O	O	O	M	O	O	O	O	O	
62 Load Profile Control	W	O	O	O	O	M	O	O	O	O	O	
63 Load Profile Status	R	O	O	O	O	M	O	O	O	O	O	
64 Load Profile Data Set One	R	O	O	O	O	M	O	O	O	O	O	
65 Load Profile Data Set Two	R	O	O	O	O	O	O	O	O	O	O	
66 Load Profile Data Set Three	R	O	O	O	O	O	O	O	O	O	O	
67 Load Profile Data Set Four	R	O	O	O	O	O	O	O	O	O	O	
68 Not Used												
69 Not Used												

* Mandatory (M) if any Tables in Decade 6 are implemented by the End Device.

8.1.2.8 *Decade 7 – History Log & Event Log Tables*

Decade 7 – History Log & Event Log Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
70 Log Dimension Limits	R	M*	M	M	M	M	M	M	M	M	M	
71 Actual Log Limiting	W	M*	M	M	M	M	M	M	M	M	M	
72 Events Identification	W	M*	M	M	M	M	M	M	M	M	M	
73 History Log Control	W	O	O	O	O	O	O	M	O	O	O	
74 History Log Data	R	O	O	O	O	O	O	M	O	O	O	
75 Event Log Control	W	M†	M	M	M	M	M	M	M	M	M	
76 Event Log Data	R	M†	M	M	M	M	M	M	M	M	M	
77 Event Log and Signatures Enable	W	M†	M	M	M	M	M	M	M	M	M	
78 End Device Program State	R	M†	M	M	M	M	M	M	M	M	M	
79 Event Counters	R	M†	M	M	M	M	M	M	M	M	M	

* Mandatory (M) if any Tables in Decade 7 are implemented by the End Device.
† Event log Tables are not mandatory (M) when the End Device does not support secured register reads, and its firmware is not upgradable / updatable and its metrological parameters cannot be re-programmed.

8.1.2.9 *Decade 8 – User-Defined Tables*

Decade 8 – User-Defined Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
80 User-Defined Tables Dimension Limits	R	O*	O	O	O	O	O	O	O	O	O	
81 Actual User-Defined Tables Limiting	W	O*	O	O	O	O	O	O	O	O	O	
82 User-Defined Tables List Table	W	O*	O	O	O	O	O	O	O	O	O	
83 User-Defined Tables Selections	W	O*	O	O	O	O	O	O	O	O	O	
84 User-Defined Table Zero	R	O*	O	O	O	O	O	O	O	O	O	
85 User-Defined Table One	R	O*	O	O	O	O	O	O	O	O	O	
86 User-Defined Table Two	R	O	O	O	O	O	O	O	O	O	O	
87 User-Defined Table Three	R	O	O	O	O	O	O	O	O	O	O	
88 User-Defined Table Four	R	O	O	O	O	O	O	O	O	O	O	
88 User-Defined Table Four	R											

* Mandatory (M) if any Tables in Decade 8 are implemented by the End Device. Use of Extended User-Defined Tables is mandatory by these Guidelines.

8.1.2.10 *Decade 9 – Telephone Control Tables*

Decade 9 – Telephone Control Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
90 Telephone Dimension Limits	R	O†	O	O	O	O	O	O	O	O	O	
91 Actual Telephone Limiting	W	O†	O	O	O	O	O	O	O	O	O	
92 Telephone Global Parameters	W	O*	O	O	O	O	O	O	O	O	O	
93 Telephone Call Originate Parameters	W	O*	O	O	O	O	O	O	O	O	O	
94 Telephone Call Originate Schedule	W	O†	O	O	O	O	O	O	O	O	O	
95 Telephone Call Answer Parameters	W	O*	O	O	O	O	O	O	O	O	O	
96 Originating Telephone Call Purpose	R	O*	O	O	O	O	O	O	O	O	O	
97 Last Telephone Call Status	R	O*	O	O	O	O	O	O	O	O	O	
98 Telephone Call Originate Status	R	O*	O	O	O	O	O	O	O	O	O	
99 Not Used												

* Mandatory (M) if ANSI C12.21 / IEEE 1702 / MC12.21 communication protocol is implemented by the End Device.

† Mandatory (M) if ANSI C12.21 / IEEE 1702 / MC12.21 communication protocol is implemented by the End Device. Also, ANSI C12.22 / IEEE 1703 / MC12.22 do not provide End Device call originating schedule Tables. Table 90, 91 and 94 could be used when the End Device implements a call originating capability using the network. When call scheduling is used from the network then the members CTRL_BFLD.PRIMARY_PHONE_NUMBER and CTRL_BFLD.SECONDARY_PHONE_NUMBER shall be ignored (redefined to be ignored); use Table 123, Exception Report Configuration Table's APTITLE_NOTIFY corresponding element instead. The APTITLE_NOTIFY element that is associated with scheduled calls shall be any End Device access for read event code 7.

8.1.2.11 *Decade 10 – Not Used*

Decade 10 – Not Used by ANSI C12.19		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
100 Not Used												
101 Not Used												
102 Not Used												
103 Not Used												
104 Not Used												
105 Not Used												
106 Not Used												
107 Not Used												
108 Not Used												
109 Not Used												

8.1.2.12 *Decade 11 – Load Control and Pricing Tables*

Decade 11 – Load Control and Pricing Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
110 Load Control Dimension Limits	R	O*	O	O	O	O	O	O	O	M	M	
111 Actual Load Control Limiting	W	O*	O	O	O	O	O	O	O	M	M	
112 Load Control Status	R	O	O	O	O	O	O	O	O	M	O	
113 Load Control Configuration	W	O	O	O	O	O	O	O	O	M	O	
114 Load Control Schedule	W	O	O	O	O	O	O	O	O	M	O	
115 Load Control Conditions	W	O	O	O	O	O	O	O	O	M	O	
116 Prepayment Status	R	O	O	O	O	O	O	O	O	O	M	
117 Prepayment Control	W	O	O	O	O	O	O	O	O	O	M	
118 Billing Control	W	O	O	O	O	O	O	O	O	O	M	
119 Not Used												

* Mandatory (M) if any Tables in Decade 11 are implemented by the End Device.

8.1.2.13 *Decade 12 – Node Network Control Tables*

Decade 12 – Node Network Control Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
120 Node Network Control Dimension Limits	R	M*	M	M	M	M	M	M	M	M	M	
121 Actual Node Network Control Limiting	W	M*	M	M	M	M	M	M	M	M	M	
122 Interface Control	W	M*	M	M	M	M	M	M	M	M	M	
123 Exception Report Configuration	W	O	O	O	O	O	O	O	M*	O	O	
124 Filtering Rules Table	W	O†	O	O	O	O	O	O	O	O	O	
125 Interface Status	R	M*	M	M	M	M	M	M	M	M	M	
126 Registration Status	R	M*	M	M	M	M	M	M	M	M	M	
127 Network Statistics Selections	W	O	O	O	O	O	O	O	O	O	O	
128 Network Statistics	R	O‡	O	O	O	O	O	O	O	O	O	
129 Not Used												

* Mandatory (M) when the End Device is deployed in any AMI / SmartGrid network.
† Provides interface "fire-wall" capability within the End Device that are interoperable across any-network.
‡ Mandatory (M) when Table 127, Network Statistics Selections, is implemented.

8.1.2.14 *Decade 13 – Network Relay Control Tables*

Decade 13 – Network Relay Control Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
130 Relay Network Control Dimension Limits	R	M*	M	M	M	M	M	M	M	M	M	
131 Actual Network Relay Limiting	W	M*	M	M	M	M	M	M	M	M	M	
132 Registration List	R	M*	M	M	M	M	M	M	M	M	M	
133 Static Routing	W	M*	M	M	M	M	M	M	M	M	M	
134 Host Notification Table	W	M†	M	M	M	M	M	M	M	M	M	
135 Master Relay Assignment	W	M*	M	M	M	M	M	M	M	M	M	
136 Dynamic Routing Report	R	M*	M	M	M	M	M	M	M	M	M	
138 Not Used												
139 Not Used												

* Mandatory (M) when the End Device is deployed in any AMI / SmartGrid network and it is a Relay or a Master Relay.
† Mandatory (M) when the End Device is deployed in any AMI / SmartGrid network and it is a Mater Relay.

8.1.2.15 *Decade 14 – Extended User-Defined Tables*

Decade 14 – Extended User-Defined Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
140 Extended User-Defined Tables Function Limiting	R	M	M	M	M	M	M	M	M	M	M	
141 Extended User-Defined Tables Actual Limits	W	M	M	M	M	M	M	M	M	M	M	
142 Extended User-Defined Selections	W	M	M	M	M	M	M	M	M	M	M	
143 Extended User-Defined Constants	W	M	M	M	M	M	M	M	M	M	M	
145 Not Used												
146 Not Used												
147 Not Used												
148 Not Used												
149 Not Used												

8.1.2.16 *Decade 15 – Quality-of-Service Tables*

Decade 15 – Quality-of-Service Tables		Features										
Table Number and Name	AM	FA	FR	FT	FS	FL	FQ	FH	FE	FC	FR	FP
150 Quality-of-Service Dimension Limits	R	O*	O	O	O	O	M	O	O	O	O	
151 Actual Quality-of-Service Limiting	W	O*	O	O	O	O	M	O	O	O	O	
152 Quality-of-Service Control	W	O	O	O	O	O	M	O	O	O	O	
153 Quality-of-Service Incidents	R	O	O	O	O	O	M	O	O	O	O	
154 Quality-of-Service Log	R	O	O	O	O	O	M	O	O	O	O	
155 Asynchronous Time-Domain Waveforms	R	O	O	O	O	O	O	O	O	O	O	
156 Asynchronous Frequency-Domain Spectrum	R	O	O	O	O	O	O	O	O	O	O	
157 Periodic Time Domain Waveforms	R	O	O	O	O	O	O	O	O	O	O	
158 Periodic Frequency-Domain Spectrum	R	O	O	O	O	O	O	O	O	O	O	
159 Not Used												

* Mandatory (M) if any Tables in Decade 15 are implemented by the End Device.

8.1.2.17 *Decade 16 – One-way Devices Tables*

Decade 16 – One-way Devices Tables		Features										
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
160 One-way Dimension Limits	R	O*	O	O	O	O	O	O	O	O	O	
161 Actual One-way	W	O*	O	O	O	O	O	O	O	O	O	
162 One-way Control	W	O	O	O	O	O	O	O	O	O	O	
163 One-way Data Table	R	O	O	O	O	O	O	O	O	O	O	
164 One-way Commands / Responses / Extended User-Defined Tables	R	O	O	O	O	O	O	O	O	O	O	
165 Not Used												
166 Not Used												
167 Not Used												
168 Not Used												
169 Not Used												
* Mandatory (M) if any Tables in Decade 16 are implemented by the End Device.												

8.1.3 Standard Procedures Needed

The following chart lists the standard procedures from ANSI C12.19 that are needed for interoperability for the feature described by these Guidelines in the previous section. A mandatory procedure is tagged with an "M" and an optional Table is tagged with an "O". "M" and "O" tags that are grayed out represent inherited features from the minimum subset represented by column "FA". If such a feature is listed as mandatory in the "FA" column then it shall be mandatory throughout. If such a feature is listed as optional in the "FA" column then it may be optional throughout, unless called for specifically by an End Device feature.

Procedure Number and Name		Features										
		FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	
0	Cold Start	M	M	M	M	M	M	M	M	M	M	
1	Warm Start	M	M	M	M	M	M	M	M	M	M	
2	Save Configuration	M*	M	M	M	M	M	M	M	M	M	
3	Clear Data	O	O	O	O	O	O	O	O	O	O	
4	Reset List Pointers	O	O	M	M	M	M	M	M	O	O	
5	Update Last Read Entry	O	O	M	M	M	M	M	M	O	O	
6	Change End Device Mode	M	M	M	M	M	M	M	M	M	M	
7	Clear Standard Status Flags	M	M	M	M	M	M	M	M	M	M	
8	Clear Manufacturer Status Flags	O	O	O	O	O	O	O	O	O	O	
9	Remote Reset	O	M	M	M	O	O	O	O	O	O	
10	Set Date and/or Time	M	M	M	M	M	M	M	M	M	M	
11	Execute Diagnostics Procedure	O	O	O	O	O	O	O	O	O	O	

Procedure Number and Name	Features										
	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	
12 Activate All Pending Tables	M	M	M	M	M	M	M	M	M	M	
13 Activate Specific Pending Tables	M	M	M	M	M	M	M	M	M	M	
14 Clear All Pending Tables	M	M	M	M	M	M	M	M	M	M	
15 Clear Specific Pending Tables	M	M	M	M	M	M	M	M	M	M	
16 Start Load Profile	O	O	O	O	M	O	O	O	O	O	
17 Stop Load Profile	O	O	O	O	M	O	O	O	O	O	
18 Log In	O†	O	O	O	O	O	O	O	O	O	
19 Log Out	O†	O	O	O	O	O	O	O	O	O	
20 Initiate an Immediate Call	O‡	O	O	O	O	O	O	O	O	O	
21 Direct Load Control	O	O	O	O	O	O	O	O	M	O	
22 Modify Credit	O	O	O	O	O	O	O	O	O	M	
23 Register	M¥	M	M	M	M	M	M	M	M	M	
24 Deregister	M¥	M	M	M	M	M	M	M	M	M	
25 Network Interface Control	M¥	M	M	M	M	M	M	M	M	M	
26 Exception Report	M¥	M	M	M	M	M	M	M	M	M	
27 Clear Pending Call Status	O‡	O	O	O	O	O	O	O	O	O	
28 Start Quality-of-Service Monitors	O	O	O	O	O	M	O	O	O	O	
29 Stop Quality-of-Service Monitors	O	O	O	O	O	M	O	O	O	O	
30 Start Secured Registers	O	O	O	O	O	O	O	M	O	O	
31 Stop Secured Registers	O	O	O	O	O	O	O	M	O	O	
32 Set Precision Date and/or Time	O	O	O	O	O	M	O	O	O	O	

* The End Device "program" may be "lost" after a "Warm Start" or power restoration if the Save Configuration procedure did not execute to a successful completion.

† The "Log in" / "Log out" Procedures are mandatory (M) in implementations that do not implement a login / logout services in support of role-based Tables security and audit trail / history log management.

‡ This procedure is mandatory when implementing ANSI C12.21. It is also recommended that implementations of ANSI C12.22 implement this procedure, in this case the PHONE_NUMBER_INDEX should be redefined to be an index into EXCEPTION_REPORT of Table 123 that supplies APTITLE_NOTIFY.

¥ This procedure is mandatory in support of network service establishment, diagnosis, management and End Device commissioning.

8.2 AMI Common Requirements

8.2.1 Default Read Schedule

AMI Meters shall be able to:

1. Provide all interval data upon request.
2. Recognize and log when it cannot send a scheduled read.

8.2.2 Demand Response

AMI Meters shall be able to:

1. Automatically launch and terminate demand response events, once it has received the event message from the Head-end.
2. Receive and process demand response event cancellations or reschedule messages.
3. Log demand response events and send acknowledgement of successful receipt of message by the load control device to the Head-end.

8.2.3 Distributed Generation Support

AMI Meters shall be able to:

1. Be re-programmed remotely to support bi-directional metering. This reprogramming event will be logged in the meter and sent back with the next regular meter read.
2. Respond to a request from an authorized source for present voltage (line-to-line voltage only).

8.2.4 Event / Message Management & History Logs

AMI Meter shall be able to:

1. Reject messages / requests that are received from unauthorized systems or devices.
2. Log and/or send an acknowledgement of receipt of event and informational messages to the Head-end within a configurable length of time (>= 60 seconds - this does not include on-demand read scenarios or other time critical response).
3. Log all messages sent to and received from the Head-end.
4. Include the following information at a minimum:
   a. Message type;
   b. System / device source;
   c. Event Date / time;
   d. Event schedule (start and end) date / time (if applicable);
   e. Hourly and/or Ttime-of-Use price information (if applicable for the event type).

8.2.5 Installation

Upon installation, AMI Meters shall be able to:

1. Perform a self diagnostic and detect and log all failures in the History Log Tables and End Device Status Tables. Utility identified critical failures shall be reported to Head-end immediately (at a minimum: checksum errors, End Device failure from firmware upgrade, metrology failure, program or memory failure, time synch failure). Fatal errors can send exception reports which are configurable.
2. Communicate to Installer:
   a. Meter health check / diagnostic results.
   b. Communications network check results on all installed interfaces (WAN & HAN).
   c. Communicate via local port (not using the network).

8.2.6 Internal Clock ("Time Keeping")

AMI Meter's clock / time keeper shall be capable of:

1. Being validated with an external time source at least once per day.
2. Automatically synchronizing during the daily time validation if meter time is greater than some configurable value out of synch with the external time source.
3. Automatically flagging during the daily time validation if meter time is greater than some configurable value out of synch with the external time source.
4. Being synchronized within a recording interval, but not at an interval boundary.
5. Logging all successful and failed internal clock time corrections or adjustments.
6. Keeping time even if there is no communication with the network and shall maintain holdover accuracy to ANSI C12.1 specifications.

7. The Head-end shall validate the internal clock time for AMI Meters and all other field communications components at least once per day and synchronize it with system time if the difference exceeds a Head-end configurable tolerance.

8.2.7 Service / Load Control

AMI Meter shall be able to:

1. Receive, log, and execute secure load control / curtailment requests, via AMI communications system.
2. Receive load control / curtailment event messages (to be sent to meter display or local display device) that differentiate between predicted (override available) and emergency (no override) energy shortage curtailment requests.
3. Enable a grace period allowing the customer to reduce load after receiving a curtailment event. Grace period shall be configurable based on event type (predicted or emergency).
4. Receive and simultaneously store at least two separate scheduled curtailment requests.
5. Receive, log, and process secure load control / curtailment END messages, so that the curtailment can be ended (with full restoration of service) earlier than specified in the original request.
6. Allow curtailment events to expire (with full restoration of service), if no load restoration message is received before the curtailment end time specified in the curtailment initiation message.
7. Support a curtailment override option at the customer site for non-emergency events. This override function could be implemented directly through the use of a button / data link to the meter or indirectly via communications equipment and back.
8. Monitor and log customer non-compliance with curtailment requests (load level above curtailment threshold). AMI Meters will support this requirement as defined at the remote communication network AMI profile level. Data is retrieved as regularly scheduled reads as meter log events.
9. If requested, the AMI Meter shall send log of curtailment requests (and corresponding compliance / non-compliance) to the Head-end within 24 hours for compliance evaluation, and at least once per week for system auditing.
10. Support on-demand request for log of curtailment requests / events (and corresponding compliance / non-compliance).
11. Measure power quality (sags and surges on a one (1) second or faster basis).
12. Harmonics Measure would be useful for a sample of meters, but not required for all meters.
13. Detect loss of voltage on a single leg and report it as an outage.

8.2.8 Local Connectivity

Upon completion of proper authorization by the AMI Meter of a field tool, AMI Meters shall be able to:

1. Identify itself to the field tool and provide access to its data and configuration settings at installation time, and later in support of ongoing operations & maintenance activities.
2. Communicate bi-directionally locally (e.g., C12.18 Optical Port or ANSI C12.22 Optical Port) to a field tool without use of the Network.
3. Support local data exchange to a field tool of all AMI Meter and communications data and logs stored in AMI Meter.
4. Provide security / authentication for local AMI Meter data exchange to ensure that data exchanges can only be executed by authorized utility or third party personnel.
5. Log all local data exchange attempts in History Log Tables (reference Section 9.8 of the ANSI C12.19 Standard).
6. Log all local Metrological Tables data exchange in Event Log Tables (reference Section 9.8 of the ANSI C12.19 Standard).

8.2.9 Memory / Storage

AMI Meters shall able to:

1. Store five (5) minute interval data for a minimum of 45 days for four channels.
2. Store at least the last 100 diagnostic events / errors in the History Log Tables with a timestamp indicating the occurrence of the event / error.
3. Store at least the last 100 informational messages in the History Log Tables with a timestamp indicating the occurrence of the message or event.
4. Store at least the last 420 communications events in a log with a timestamp indicating the occurrence of the event.

8.2.10 Meter Performance

AMI Meter shall be able to:

1. Start processing responses for On Demand meter data (up to seven days of data) within two (2) seconds of the meter receipt of the request.
2. During a current limiting mode, allow a service switch reconnect event to occur following a service switch disconnect event only after a configurable amount of time (e.g., at least 1 to 2 minutes) has elapsed since the service switch disconnect event.
3. Be remotely limited on demand and send acknowledgement to the requesting system.
4. Receive, log, and update tariff and rate information received from the Head-end, and send an acknowledgement to the Head-end within five (5) minutes of completed processing.
5. Be remotely configurable to record customer's instantaneous demand (e.g., W or kW) so that it can be displayed on a premise device and/or meter display (and updated as frequently as every three (3) seconds).
6. Start transmitting utility messages(e.g., pricing information, load control, etc.) to a display device within ten (10) seconds after receipt by the meter from the utility.
7. AMI Meter shall be capable of local and remote configuration.
8. Complete remotely initiated meter display configuration requests within 60 seconds of being received.
9. The AMI Meter shall at least daily perform self-tests and have pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter History Log Tables and Status Tables when configured and the Utility elects this configuration.
10. AMI Meter shall be capable of reporting a set of events.
11. The set of events to be reported shall be configurable.
12. An AMI Meter that contains an optical port shall support local download to a field tool of all AMI Meter and communications data and logs stored in AMI Meter memory at a minimum effective rate of 512 bytes per second.

8.2.11 Meter Communications

1. AMI Meters shall be enabled for two-way secure communications with authorized systems and devices. This applies to all communication interfaces including optical port, Home Area Network, and communication back to the Utility.
2. AMI Meter shall have a unique identity (stored in Device Identification Table and that can be associated with a Network Node Name, e.g., ApTitle) to enable targeted messaging and communications (i.e., individually addressable AMI Meters).
3. AMI Meters shall be capable of continuing to record data while communicating and during a communications failure.
4. AMI Meters shall be capable of keeping an on-board log of communications events:
   a. link fail.
   b. link switch.
   c. link up.

d. link quality.

5. AMI Meters shall be capable of separately identifying communications event data from metering data to prevent loss of meter data (e.g., interval usage data, demand response events, pricing event data, etc) to excessive communication event messages.

8.2.12 Meter Display - Configuration

1. AMI Meters shall be able to execute and log meter display provisioning and configuration requests.
2. AMI Meter display shall be capable of being configurable to customize individual information attributes as available or not available for display.

8.2.13 Meter Display - Energy

AMI Meters shall be able to:

1. Be remotely configurable to record the amount of gross and/or net energy consumed and generated (kWh) within the current bill cycle so that it can be displayed on a premise device and/or meter display.
2. Be remotely configurable to record the peak demand in kW (consumed and generated) recorded to date in the current bill cycle with the date / time it occurred so that it can be displayed on a premise device and/or meter display.
3. Be remotely configurable to record the energy consumed and generated in kWh, in Time-of-Use periods, for energy consumed and generated within the current bill cycle so that it can be displayed on a premise device and/or meter display.
4. Be remotely configurable to record the peak demand (consumed and generated) in kW, in Time-of-Use-periods, recorded to date in the current bill cycle with the date / time it occurred so that it can be displayed on a premise device and/or meter display.

8.2.14 Meter Display - Info

AMI Meter shall be able to:

1. Communicate information (e.g., price signal, etc.) to any compatible authenticated in-home device including in-home display, smart appliances, PCTs, etc.
2. Provide date and time in "local time", displaying the time in Local Daylight Time or Local Standard Time as appropriate.
3. Externally indicate electric service switch status so that it is visible to customer or Utility employee on site.
4. Be configurable to deliver the Meter Tables subject to Utility's permission so that it can be displayed on a premise device and/or meter display.

8.2.15 Metrology

AMI Meter shall be able to:

1. Record self reads at midnight (of the End Device location) for each register and channel every day.
2. Support interval data collection for energy usage.
3. Support a minimum of 4 channels of interval data.
4. Support measurement of current and voltage data (line-to-neutral or line-to-line, as applicable) through the load profile channel. This data shall be the average over a programmable interval of 5, 15, 30, or 60 minutes with timestamp.
5. Support measurement of peak demand.
6. Support measurement of Time-of-Use kWh and kW demand.
7. Support interval data of 5, 15, 30, or 60 minutes in length.
8. AMI Meter's recording interval length shall be capable of being remotely configurable.
9. When an AMI Meter gets a re-configuration request where the new configuration changes either the interval length or number of intervals, the meter will be capable of automatically

returning the interval data from the previous interval stop time of uploaded data through the end of the current interval. Additionally, the meter will preserve the current register read.

10. Support bi-directional commodity flow metering to support distributed generation measurement.
11. Distinguish between a missing interval and zero consumption.
12. Distinguish between a power outage and zero consumption.
13. The Head-end shall be able to remotely configure the AMI Meter's recording interval length (to all interval lengths supported by the AMI Meter).

8.2.16 Non-Default Read Schedule

1. AMI Meters shall be capable of sending all read data upon request at a frequency configurable down to the meter's interval data recording length.

8.2.17 On Demand Reads

AMI Meter shall be able to:

1. Respond to requests for on-demand access to meter and log data.
2. Log failed on demand reads (meter unable to respond to on demand request) in the History Log Tables along with all information available to define the cause of the failure. The Head-end logs failed requests.
3. The communication protocol shall be able to issue a remote AMI Meter test upon on-demand read request failure.
4. The AMI Meter shall be able to continuously perform self tests and has pre-defined fatal and non-fatal errors that can be generated. These shall be accessible in the meter history or event log and status Tables.

8.2.18 Outage Detection / Management

AMI Meters shall be able to:

1. Communicate its energized status (i.e., has voltage).
2. Detect and communicate a power outage at the premise prior to communications loss, where technically possible.
3. Report restoration information (voltage quality and quantity).

8.2.19 Prepayment Metering

1. AMI prepayment Meters shall use C12.19 Standard Tables and Procedures for this purpose.

8.2.20 Service Switch

AMI Meter shall be able to:

1. Be remotely disconnected / reconnected on demand.
2. Remain energized and continue to monitor and record consumption (i.e., zero consumption for each interval) when disconnect service switch is the open / disconnected position.
3. Detect duplicate service switch disconnect / reconnect events and ignore the duplicate events (e.g., Meter is already on -- reconnect event accepted with no action taken).
4. Cancel or update / reschedule scheduled disconnect / reconnect events prior to their completion.
5. Send a meter read and acknowledgement to the Head-end upon a successfully completed or failed electric service switch disconnect / reconnect event.
6. Support an external authorization / authentication routine (i.e., by remote systems or field tool) to enable only active and eligible Utility employees to operate its service disconnect / reconnect switch on-site at the customer premise.
7. Allow authorized Utility employee (while on-site at the customer premise) to operate the service disconnect / reconnect switch immediately (regardless of interval) or to schedule a service switch connect / disconnect for a future interval.

8. Log date / time and status of attempts to operate the service disconnect / reconnect switch remotely or on-site at the customer premise. Log entries will include requesting user or system identity and authorization status.
9. Send a command result back to the requesting system with the result of the service switch command including response codes of "Success" or "Failed" with reason codes in the event of a failure.
10. Should a disconnect event and reconnect event be scheduled to occur for the same AMI Meter on the same day, AMI Meter shall be able to log the events and automatically provide an on-demand read to the Head-end without operating the disconnect / reconnect switch.
11. If the AMI meter detects load side voltage during a connect, the meter shall not complete the connect and shall send a failure command result back to the requesting system.
12. Determine if there is load side voltage "before" and "after" processing a remote service switch command.
13. Receive and process remote service switch connect or disconnect command and provide command results to the requesting system by receiving one command from the requesting system (i.e., second command for command result not required).
14. Be configurable to not provide an IDR read (interval data) when completing a service switch connect or disconnect command.
15. Execute service switch connect / disconnect commands upon receipt.
16. The AMI meter shall have the ability to receive and process commands to "open or close" the service switch based on a command received locally through an optical port or remote communication network from the Utility employee.
17. Log, reject, and send an command result to the requesting system when remote service switch commands received either locally or remotely that cannot be authenticated.
18. The AMI meter shall be capable of providing the following information (command result) back to the requesting system after processing a service switch command:
    a. Date / time command processed.
    b. Meter ID.
    c. Event Number.
    d. Success = Disconnect success, or Reconnect success.
    e. Failure = Disconnect failed, or Reconnect failed.
    f. Load Side voltage present during reconnect.
19. Successfully process remote service switch commands as requested (i.e., open or close) and provide command results back to the requesting system (i.e., Head-end, field tool or HAN) 99% of the time.
20. Provide command results back to the requesting system (i.e., Head-end, field tool or HAN) when the service switch command cannot be completed successfully.

    It is understood that Standard Procedure 21 within the current version of C12.19 does not support this capability. This has been recorded as a gap in the Standard, to be addressed by the appropriate Standards body.
21. Provide command results back to the requesting system (i.e., Head-end, field tool or HAN) when the service switch command is completed.

    It is understood that Standard Procedure 21 within the current version of C12.19 does not support this capability. This has been recorded as a gap in the Standard, to be addressed by the appropriate Standards body.
22. Log the date and time each time a service switch connect / disconnect command is executed.
23. Remain energized and continue to monitor and record consumption (i.e., zero consumption for each interval) when service switch is in the open / disconnected position.
24. Allow authorized utility employees (while on-site at the customer premise) to operate the service disconnect / reconnect switch immediately (regardless of interval).

25. Receive and process requests from the Head-end to determine if load side voltage is present on the customer side of the meter and provide the result back to the requesting system (e.g., load side voltage present or no load side voltage present).

    It is understood that Standard Procedure 21 within the current version of ANSI C12.19 does not support this capability. This has been recorded as a gap in the Standard, to be addressed by the appropriate Standards body.
26. Receive and process requests to determine if load side voltage is present and provide the result back to the requesting system within one minute of the original command date and time.
27. Be configured to NOT retry processing a service switch command (within the same command). Only one attempt shall be made by the meter to process a service switch connect / disconnect command per request.
28. Allow a utility employee working on-site at the customer premises to physically operate its service disconnect / reconnect switch through the optical port or via remote communication network (using a field tool) at any time (including when the communication network is down).
29. Receive, log and process commands to "open or close" the service switch from an authenticated system (e.g., Head-end, field tool or HAN).
30. Log if a service switch command was received locally or via network, as well as, the user ID if received locally.

8.2.21 Secure Communications

The AMI Meter shall be able to:

1. Log the invalid login attempts.
2. Support a lockout for a configurable amount of time after a failed login / access attempt.

   It is understood that Standard Procedure 21 within the current version of ANSI C12.19 does not support this capability. This has been recorded as a gap in the Standard, to be addressed by the appropriate Standards body.
3. Each optical port password shall be capable of being individually changeable in the AMI Meter.
4. Comply with FIPS 140-2 (Level 1) Security Requirements for Cryptographic Modules (dated 5/25/2001).
5. Support AES-128 as defined by Advanced Encryption Standard, FIPS-197.
6. Create mechanisms that ensure device integrity from external tamper and compromise.
7. Create mechanisms that allow for additional security functionality to be remotely added during operation (i.e., after initial installation).
8. Support ANSI C12.19 / C12.18 / C12.22 cryptographic solutions including clear text, plain text and cipher text communication.
9. Supply mechanisms which allow for secure device authentication, registration, and revocation or registration.
10. Supply cryptographic mechanisms or materials which allow for unique device identification, authentication and communications for both unique device and device groups.
11. Shall supply mechanisms which audit and store all security related events including all access and modifications events within the system.
12. Supply a security audit store which includes the date and time of the event, type of event, subject identity, and the outcome (success or failure) of the event.
13. Supply access control mechanisms (i.e., Identification & Authentication mechanisms) which prevent unauthorized access of information and resource.
14. Provide mechanisms to ensure the integrity of logging and audit data.

8.2.22 Self-Monitoring & Alarms

AMI Meter shall be able to:

1. Initiate meter tests (Diagnostic) automatically based on a schedule stored within the meter, or based on a command from an external system / source, or based upon the detection of certain events by the meter. The AMI Meter shall continuously perform self tests and have pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured and the Utility elects this configuration.
2. Send non-usage messages and alarms to the Head-end that contain date / time from internal meter clock, message code / type, and meter identifier.
3. Diagnose a variety of self-test results and determine if failures are critical or non-critical to determine what kind of notification should be provided (e.g., immediate, nightly, only upon request, etc.).
4. Test / check that it is recording data correctly and consistently. Detected failures shall be logged and generate an event specific to that measurement to report to the Head-end.
5. Perform self check at least once per month and as often as once per day and results logged and sent in with next scheduled read.
6. Detect, log, and report program or memory failure.
7. Detect and log communications link failures upon failed communications initiated from the meter.
8. Send an alarm / event to the Head-end when a configurable number of consecutive communications link failures are detected (e.g., three consecutive link failures).
9. Periodically record the communication signal strength and report it back to the Head-end.
10. Prioritize failures by safety / service versus other failure types. Priorities will be provided by the utility. Fatal errors can send exception today which is configurable.
11. Make diagnostic log information available either on-demand or by regularly sending to the Head-end.

8.2.23 Service Limiting

AMI Meter shall have the ability to:

1. Limit service to customers upon a remote utility request (on-demand, scheduled, or via pre-configured rules).
2. Detect duplicate service limiting events and ensure the duplicate event is ignored (e.g., AMI Meter is already limited -- identical limit event accepted with no action taken).
3. Cancel or update / reschedule scheduled service limiting events prior to their completion.
4. Send a meter read and acknowledgement to the Head-end upon a successfully completed or failed electric service limiting event.
5. Have service limited at configurable set points.
6. Disconnect (i.e., open disconnect switch) if customer load is above agreed configured limiting level.
7. Reconnect automatically after a configurable amount of time (e.g., two (2) minutes) to its presently configured limiting level if meter disconnects because the configured limit is exceeded.
8. Attempt automatic reconnection a set number of times per 24 hour period if meter disconnects because configured limit is exceeded.
9. Attempt automatic reconnection a configurable number of times (e.g., only once) after a configurable duration (e.g., two (2) minutes) per 24 hour period if meter disconnects because configured limit is exceeded. Meter shall be able to generate an alarm after it exceeds the limit and fails to reclose. It is understood that the current version of C12.19 does not support this capability. This has been recorded as a gap in the Standard, to be addressed by the appropriate Standards body.

8.2.24 Software / Firmware Upgrades

AMI Meter shall be able to:

1. Accept and install software / firmware upgrades provided remotely via the AMI communications network.
2. Accept and install software / firmware upgrades provided locally on site either through both wireless and optical port communications.
3. Continue normal operation while downloading software / firmware upgrades until instructed to change to the new version.
4. Permit remotely or locally initiated reversion of software / firmware to a previous version.
5. AMI Meter full firmware upgrade logic shall be capable of containing mechanisms to protect against critical failures including but not limited to loading incomplete or corrupted firmware images, or loading invalid firmware images. It is checked for integrity prior to activation. Exception errors are sent to Head-end of the NMS. AMI firmware image will not activate a new version of firmware that does not pass the data integrity check at the time of the activation.
6. AMI Meter's current software / firmware version shall be capable of being remotely and locally readable in Standard Table 1.
7. Be configurable to retain stored register reads over a full software / firmware upgrade.
8. Be configurable to reset stored register reads over a full software / firmware upgrade.
9. Retain all AMI Meter configuration settings, statuses, customer information, and event logs over a full software / firmware upgrade.
10. AMI Meter shall be designed with failsafe logic to minimize mis-operation of the service switch and load control / distributed generation during full software / firmware upgrades.
11. To log firmware download and upgrade attempts, failures, successes, reversions, etc. with timestamp.
12. Report non-critical failures following a full software / firmware upgrade with the next regularly scheduled meter read.
13. When upgrading large number of AMI Meters, AMI Meter shall be able to report software / firmware upgrade failures (where reversion is required) at the next meter read.

8.2.25 Tamper Detection

AMI Meter shall be able to:

1. Detect insertion and / or removal from its socket and generate a tamper event before it loses ability to communicate with the communications network.
2. Detect voltage at the load side when the service switch in the AMI Meter is open (for the purpose of detecting AMI Meter bypass) and generate a tamper event.
3. Detect physical inversion and generate a tamper event.
4. For each tamper event, the AMI Meter shall be able to, at a minimum, transmit and log the following information:
   a. Event Timestamp.
   b. Tamper status (event type).
   c. AMI Meter ID.
5. Communicate tamper events to the Head-end as soon as they occur (when possible).
6. Tamper events shall be able to be sent with a higher priority than normal status messages.
7. If the AMI Meter is unable to communicate at the time the tamper event is detected, the AMI Meter shall be capable of storing tamper events and transmit them when meter communications are re-established.

8.2.26 Tariff / Rate Configuration

1. AMI Meter shall be able to receive, log, and update tariff and rate information received from the Head-end.

8.2.27 Testing & Diagnostics

AMI Meter shall be able to:

1. Support on-demand or scheduled meter tests issued remotely or locally on-site (e.g., via a field tool or optical port) through both wireless and optical port communications. The AMI Meter shall be able to continuously perform self tests and have pre-defined fatal and non-fatal errors that can be generated. The meter shall be configurable to log such events.
2. Support a remotely or locally initiated meter test for communications connection status. Local diagnostic will include the capability to perform meter "ping" and obtain network interface and link information, network association status, signal level status.
3. Support a remotely or locally initiated meter test for energized status.
4. Support a remotely or locally initiated meter test for load side voltage (line-to-line voltage only).
5. Support a remotely or locally initiated meter test for disconnect switch status.
6. Support a remotely or locally initiated meter test for internal metering timekeeping accuracy - to be checked against Network Clock as provided by the communication network.

8.3 Table 00 General Configuration Table

Requirements for configuration Table 00 are listed below. The column labeled "FIXED" indicates whether the value should be fixed by the registered vendor's EDL. A "YES" indicates that the registered End Device should also register an EDL that provides those "FIXED" constant element values; and those values shall be readable from Table 0. A "NO" indicates that the registered EDL may provide constant values, but it is not mandatory for the indicated element, however when more than one value is indicated then one of the indicated values shall be reported in Table 00 and optionally by the registered EDL.

For interpretation of the entries the following Tables shall be as follows:

1. "F" means that the Boolean Element value of zero (0) or "FALSE" is selected.
2. "T" means that the Boolean Element value of one (1) or "TRUE" is selected.
3. "X" means not specified. It should be a valid value per referenced standard and these Guidelines (e.g., if the Element is a Boolean then "X" may be replaced with a "TRUE" or a "FALSE").
4. "?" means that the choice depends on another selector or is left to the user / owner to set. An explanation is provided.
5. "≥n" means that the value must be greater than or equal to the quantity "n".
6. Unless otherwise stated the values are equally applicable to all meters classes.

ELEMENT	VALUE	DESCRIPTION	FIXED
FORMAT_CONTROL_1_BFLD			
DATA_ORDER	1	Multi-byte numeric data transfer order is most significant byte first	NO
CHAR_FORMAT	3	Character set selection is UTF-8**	YES
MODEL_SELECT	1	ANSI C12.19 / IEEE 1377 / MC12.19 standard compliant implementation that is also compliant with the AEIC Interoperability Standard Guidelines 2010. This is the same as MODEL_SELECT code 0, but in addition it also indicates that the End Device interoperability model is compliant the AEIC Guidelines Version 2. Legacy End Devices, pre 2010, may use MODEL_SELECT code = 0.	YES
FORMAT_CONTROL_2_BFLD			
TM_FORMAT	4	Representation format selector for use by HTIME_DATE, LTIME_DATE, STIME_DATE, TIME, STIME and HTIME Elements is UINT32 counters where HTIME_DATE, LTIME_DATE and STIME_DATE types are encoded relative to	YES

ELEMENT	VALUE	DESCRIPTION	FIXED
		01/01/1970 @ 00:00:00 UTC), with discrete fields for seconds and fraction of a second.	
DATA_ACCESS_METHOD	3	Designates the method of passing the Tables data after GEN_CONFIG_TBL (Table 00) has been interrogated. Full Tables access method and partial Tables access using offset-count method and index-count accesses are supported by the End Device. Note 1: All other communication protocols (e.g., HAN, SEP2.0, IEC 61850 implement dot-notation object selections. The other HAN protocols dot notation maps to the C12.19 Index method.). Note 2: For future proofing, the use of the index method is strongly recommended when dealing with application data elements.	NO
ID_FORM	0	String per CHAR_FORMAT encoded as UTF-8.	YES
INT_FORMAT	0	Signed integer types are represented in two's complement format.	YES
FORMAT_CONTROL_3_BFLD			
NI_FORMAT1	0	Binary FLOAT64 (IEEE 754) scaled to natural units (e.g., Watt-Hour, Volt-Hour etc.).	YES
NI_FORMAT2	1	Binary FLOAT32 (IEEE 754) scaled to natural units (e.g., Watts, Volts etc.).	YES
FORMAT_CONTROL_1	?	See **FORMAT_CONTROL_1_BFLD**.	
FORMAT_CONTROL_2	?	See **FORMAT_CONTROL_2_BFLD**.	
FORMAT_CONTROL_3	?	See **FORMAT_CONTROL_3_BFLD**.	
DEVICE_CLASS	?	Manufacturer End Device Classes OIDs need to be registered and referenced to relative Device Class ".0.2.0.?", where the referenced Device Class sub-fields are interpreted as follows: .0 = ANSI C12.19 / IEEE 1377 / MC12.19 Standard. .2 = ANSI C12.19 / IEEE 1377 / MC12.19 Standard Version 2 or higher. .0 = ANSI C12.19 / IEEE 1377 / MC12.19 Revision 0 or higher. .? = AEIC Guidelines compliance. This number shall be identical to **MODEL_SELECT**.	NO
NAMEPLATE_TYPE	0	A Gas device (e.g., Gas Meter, Gas Heater, Gas Dryer, Gas Furnace)	NO
	1	A Water device (e.g., Water Meter, Sprinkler, Dish Washer)	
	2	An electric device (e.g., Electricity Meter, Light Switch, Communication Device)	
DEFAULT_SET_USED	0	Default sets are not used.	YES
MAX_PROC_PARM_LENGTH	?	The minimum value used shall be large enough to accommodate all Standard procedure request parameters that are implemented by the End Device in accordance with these Guidelines and the feature-sets supported by the End Device.	NO
MAX_RESP_DATA_LEN	?	The minimum value used shall be large enough to accommodate all Standard procedure response elements that are implemented by the End Device	NO

ELEMENT	VALUE	DESCRIPTION	FIXED
		in accordance with these Guidelines and the feature-sets supported by the End Device.	
STD_VERSION_NO	2	The Tables' standard version number. It is the second release of the ANSI C12.19 / IEEE 1377 / MC12.19 standard as qualified by this document. If Decade 12 or Decade 13 Tables are implemented, this also implies the use of ANSI C12.22-2008 / IEEE Std 1703™-2012 / MC12.22-201x.	YES*
STD_REVISION_NO	0	The Tables' standard revision number. A number that designates a minor change to a version of the standard. Within a given version of the standard, all revisions with a lower revision number shall be backward compatible. If this is not true then a new version number shall be required.	NO*
DIM_STD_TBLS_USED	≥1	The minimum value used shall be large enough to accommodate all Standard Tables implemented by the End Device in accordance with these Guidelines and the feature-sets implemented by the End Device. **Note**: This transmitted Element represents the number of bytes not the number of Tables. 1 byte = 8 Tables.	NO
DIM_MFG_TBLS_USED	X	Manufacturer-Defined. This value should be minimized.	NO
DIM_STD_PROC_USED	≥1	The minimum value used shall be large enough to accommodate all Standard procedures implemented by the End Device in accordance with these Guidelines and the feature-sets implemented by the End Device. **Note**: This transmitted Element represents the number of bytes not the number of procedures, 1 byte = 8 Procedures.	NO
DIM_MFG_PROC_USED	X	Manufacturer-Defined.	NO
DIM_MFG_STATUS_USED	X	Manufacturer-Defined.	NO
NBR_PENDING	≥1	The minimum value used shall be large enough to accommodate the union of Standard and Manufacturer pending Tables operations implemented by the End Device in accordance with these Guidelines and the feature-sets implemented by the End Device.	NO
STD_TBLS_USED	?	Actual values based on features implemented and in accordance with these Guidelines. All bits identified with a "M" under the FA (Feature All) or for an available feature columns in Section 8.1.2 Standard Tables Needed, shall be set to TRUE. All other bits may be set to TRUE.	NO
MFG_TBLS_USED	X	Manufacturer-Defined.	NO
STD_PROC_USED	?	Actual value based on features implemented and in accordance with these Guidelines. All bits identified with a "M" under the FA (Feature All) or for an available feature columns in Section 8.1.3,	NO

ELEMENT	VALUE	DESCRIPTION	FIXED
		Standard Procedures Needed shall be set to TRUE. All other bits may be set to TRUE.	
MFG_PROC_USED	X	Manufacturer-Defined.	
STD_TBLS_WRITE	?	Actual value based on the C12.19 Standard and in accordance with these Guidelines and features. Table 00 and FLC+0 Tables bits may be set to false, "read-only"; Control Tables and FLC+1 Tables, shall be set to true, "writeable", unless indicated otherwise by the C12.19 Standard as qualified by these Guidelines. All bits identified with a "W" under the AM (Access Mode) column in 8.1.2,Standard Tables Needed shall be set to TRUE. All other bits may be set to TRUE.	NO
MFG_TBLS_WRITE	X	Manufacturer-Defined.	NO

* These Guidelines apply to ANSI C12.19 / IEEE 1377 / MC12.19 Standard version 2.x.

** Implementers and users should note that not all systems are capable of visually rendering the entire UTF-8 character set. These systems include meter and other device displays, head-end systems, meter data management systems, customer information systems, billing systems, printed customer bills, etc.

8.4 Actual Function Limiting Control (FLC+1) Tables

The following chart lists Guidelines for the residential meters parameters for the maximum and actual Function Limiting Control Tables (FLC+0 / FCL+1) of each Decade of ANSI C12.19 and ANSI C12.22 standards. It is expected that the minimum Dimension Function Limiting Control (FLC+0) Tables would indicate functionality equal to or greater than the corresponding FLC+1 Tables. The presence or absence of certain Tables and decades is governed by the features column implemented by the End Device (FD, FT, FS, FL, FQ, FH, FE, FC, FR and FP). The FA feature represents an "Energy Only" minimal meter requirements for its class (e.g., residential, commercial etc). Certain common FLC Tables (such as security and communication) are omitted in this section. These will be covered later on in this section.

It is believed that the implementation of these Guidelines in the Actual Function Limiting Control Tables will effectively define the implementation of most of the subsequent Tables in each decade. The user must be aware that different selections may be needed in subsequent Tables depending upon the features designed into the End Device.

For interpretation of the entries the following Tables shall be as follows:

1. "F" means that the Boolean Element value of zero (0) or "FALSE" is selected.
2. "T" means that the Boolean Element value of one (1) or "TRUE" is selected.
3. "X" means not specified. It should be a valid value per referenced standard and these Guidelines (e.g., if the Element is a Boolean then "X" may be replaced with a "TRUE" or a "FALSE").
4. "?" means that the choice depends on another selector. A comment at the end of the Tables will explain the selector and the permissible values.
5. A blank indicates that the selected feature does not affect this element.
6. The FLC+0 and FLC+1 Elements and the Tables that they control shall be user-programmable in accordance with Section 8.1.2, Standard Tables Needed columns "AM". This means that the AMI Application may change Element values of the End Device via communication means subject to attaining the correct Tables-role and access permissions in accordance with the ANSI C12.19 standard, the associated application communication services (e.g., ANSI C12.22) and in accordance with the underlying security requirement of the AMI network.
7. Each recommended value column contains the two values that are separated by a slash ('/'). These represent the expected value to be placed in an FLC+0 Tables (thus representing a

required minimum or fixed value) and the recommended default for the End Device in the FLC+1. FLC+1 values shall be programmable by the user.

8. Unless otherwise stated the values are equally applicable to Single Phase, Polyphase, Self Contained and Transformer Rated AMI meters.
9. When one or more features affect the same element then the value used shall be the largest necessary to accommodate the sum of all features selected with the "+" sign starting plus the largest of the values indicated by the "FA" feature or the desired features (not prefixed with a "+").

8.4.1 Actual Data Sources Limiting Table Element Sizing

For detailed measurement requirements see Section 7.1 Meter Types. A Low functionality Single AMI Meter shall minimally be capable of the "FA" features that include:

1. Watt-hour (delivered, received, delivered-received, | delivered |+| received |).
2. VAR-hour (delivered).
3. VA-hour.
4. Watts (delivered, received, delivered-received, | delivered |+| received |).
5. Line Voltage (phase-phase or phase-neutral).
6. Line current in Amperes.
7. Minimally the above quantities shall be readable from Standard Table 28, Present Register Data Table and from Standard Table 23, Current Register Data Table.
8. Support for 4 TOU tiers + 4 coincident peaks using at least 4 daily schedules and up to 4 seasons, current and previous season.
9. Real-time pricing.
10. Load profile, 4 channels (simple meter), or 8 channel (advanced meter).
11. If the Energy and average quantities are not refreshed in real-time (i.e., they are not instantaneous as prescribed in Table 12, Units of Measure Entry Table, then standard Table 13, Demand Control Table, shall be implemented to set (and document) the averaging and / or integration interval used to measure, calculate and update the quantities above.

8.4.2 Decade 1 – Data Source Tables 10/11

Decade 1 – Data Source Tables 10/11	Assumed Feature											
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**	**FR**
SOURCE_FLAGS_BFLD												
PF_EXCLUDE_FLAG	F/F	T/F										
RESET_EXCLUDE_FLAG	F/F	T/F										
BLOCK_DEMAND_FLAG	F/F	T/F										
SLIDING_DEMAND_FLAG	F/F	T/T										
THERMAL_DEMAND_FLAG	F/F											
SET1_PRESENT_FLAG*	F/F											
SET2_PRESENT_FLAG†	?/F											
CONVERSION_ALG_FLAG	T/T											
SOURCE_FLAGS‡												
NBR_UOM_ENTRIES	≥13/1											
NBR_DEMAND_CTRL_ENTRIES¥	?/0	?/+1										
DATA_CTRL_LENGTH	X/X											
NBR_DATA_CTRL_ENTRIES	X/X											
NBR_CONSTANTS_ENTRIES△	?/?											
CONSTANTS_SELECTOR	≥2/2											
NBR_SOURCES	≥13/1	+0/+1										

* **SET1_PRESENT_FLAG** represents the presence of End Device internal scalars. When these values are false then the SET1 multipliers are assumed to be 1.0 and the offsets 0.0. When the FLC+1 value is set to TRUE then the multipliers should to be set to 1.0 and the offsets should be set 0.0 so that the internal measurements do not require scaling to natural units.
Note: This does not preclude the scaling of load profile Elements defined by feature FL.

† **SET2_PRESENT_FLAG** represents the presence of End Device secondary transformer scalars. The FLC+0 Element shall be set to FALSE on self-contained meters. FLC+0 Element shall be set to TRUE on transformer-rated meters. When the FLC+1 value is FALSE then the corresponding multipliers in Standard Table 15, Constants Table, are assumes to be 1.0 and the offsets 0.0.

‡ See **SOURCE_FLAGS_BFLD** above.

¥ When any of the energy and average quantities are not refreshed in real-time then FLC+0 shall be 4 and the values of FLC+1 shall be set by default to the number of non-instantaneous measures.

△ When the constant multipliers are not 1.0 and the offsets are not 0.0 then FLC+0 shall match the values of FLC+0 Element **NBR_SOURCES**.

8.4.3 Decade 2 – Register Tables 20/21

Decade 2 – Register Tables 20/21	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
REG_FUNC1_BFLD											
SEASON_INFO_FIELD_FLAG	F/F		T/T								
DATE_TIME_FIELD_FLAG	F/F		T/T								
DEMAND_RESET_CTR_FLAG	F/F		T/T								
DEMAND_RESET_LOCK_FLAG	F/F		T/T								
CUM_DEMAND_FLAG	F/F		T/F								
CONT_CUM_DEMAND_FLAG	F/F		T/F								
TIME_REMAINING_FLAG	F/F		T/T								
REG_FUNC2_BFLD											
SELF_READ_INHIBIT_OVERFLOW_FLAG	F/F			T/F							
SELF_READ_SEQ_NBR_FLAG	F/F			T/T							
DAILY_SELF_READ_FLAG	F/F			T/T							
WEEKLY_SELF_READ_FLAG	F/F			T/F							
SELF_READ_DEMAND_RESET	0/0			3/3							
REGS_RCD											
REG_FUNC1_FLAGS*	?/?										
REG_FUNC2_FLAGS†	?/?										
NBR_SELF_READS	0/0			≥3/1							
NBR_SUMMATIONS	≥1/1		≥3/3								
NBR_DEMANDS	≥3/0		≥3/1								
NBR_COIN_VALUES	0/0		≥6/4								
NBR_OCCUR	0/0		≥1/1								
NBR_TIERS	0/0		≥4/4								
NBR_PRESENT_DEMANDS	≥3/0	≥3/1									
NBR_PRESENT_VALUES	≥1/1	≥3/3									

* See **REG_FUNC1_BFLD** above.
† See **REG_FUNC2_BFLD** above.

8.4.4 Decade 3 – Display Tables 30/31

Decade 3 – Display Tables 30/31	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
DISP_FLAG_BFLD											
ON_TIME_FLAG	T/T										
OFF_TIME_FLAG	T/F										
HOLD_TIME_FLAG	T/F										
DISP_RCD											
DISPLAY_CTRL*											
NBR_DISP_SOURCES**	≥32/4										
WIDTH_DISP_SOURCES	X/X										
NBR_PRI_DISP_LIST_ITEMS	≥64/4										
NBR_PRI_DISP_LISTS†	3/1										
NBR_SEC_DISP_LIST_ITEMS‡	≥64/4										
NBR_SEC_DISP_LISTS‡	4/1										

* See **DISP_FLAG_BFLD** above.

† Normal, alternate, test.

‡ Secondary display may be an in-home display.

** By default, a meter shall display energy usage, meter ID, time and segment check.

8.4.4.1 *Display List*

The following is a listing of common display values and display modes that might be used within the classifications defined above for the Guidelines. The individual requirements for utilities may increase, decrease or vary the number of quantities utilized. The display should be available from Standard Tables in normal, alternate and test mode display sequences. Additional values such as diagnostic counters that are not defined by the Standard may also be displayed.

Application	Item #	Display Name	C12.19 Section
All	1	Segment Check	N/A
Billing Data	2	Total KWH	ST28, ST23
	3	Max KW	ST23
	4	Rate A KWH	ST23
	5	Rate A Max KW	ST23
	6	Rate B KWH	ST23
	7	Rate B Max KW	ST23
	8	Rate C KWH	ST23
	9	Rate C Max KW	ST23
	10	Rate D KWH	ST23
	11	Rate D Max KW	ST23
	12	KVARH Delivered	ST28, ST23
	13	KVARH Received	ST28, ST23
	14	Present KW	ST28
	15	Total KWH Delivered	ST28, ST23
	16	Total KWH Received	ST28, ST23
	17	KVAR Q1	ST28, ST23
	18	KVAR Q2	ST28, ST23

Application	Item #	Display Name	C12.19 Section
	19	KVAR Q3	ST28, ST23
	20	KVAR Q4	ST28, ST23
Last Reset Billing Data	21	LR Rate A KWH	ST25
	22	LR Rate A Max KW	ST25
	23	LR Rate B KWH	ST25
	24	LR Rate B Max KW	ST25
	25	LR Rate C KWH	ST25
	26	LR Rate C Max KW	ST25
	27	LR Rate D KWH	ST25
	28	LR Rate D Max KW	ST25
	29	LR KVARH Delivered	ST25
	30	LR KVARH Received	ST25
Past Season Billing Data	31	PS Rate A KWH	ST24
	32	PS Rate A Max KW	ST24
	33	PS Rate B KWH	ST24
	34	PS Rate B Max KW	ST24
	35	PS Rate C KWH	ST24
	36	PS Rate C Max KW	ST24
	37	PS Rate D KWH	ST24
	38	PS Rate D Max KW	ST24
	39	PS KVARH Delivered	ST24
	40	PS KVARH Received	ST24
Instantaneous Data	41	Instantaneous KW	ST28
	42	Instantaneous VRMS Ph A	ST28
	43	Instantaneous VRMS Ph B	ST28
	44	Instantaneous VRMS Ph C	ST28
	45	Instantaneous I RMS Ph A	ST28
	46	Instantaneous I RMS Ph B	ST28
	47	Instantaneous I RMS Ph C	ST28
	48	V Angle Phase A	ST28
	49	V Angle Phase B	ST28
	50	V Angle Phase C	ST28
	51	I Angle Phase A	ST28
	52	I Angle Phase B	ST28
	53	I Angle Phase C	ST28
	54	Firmware Version	ST1
	55	Hardware Version	ST1
	56	Time on Battery (UOM 53)	ST28
	57	Time Remaining in Subinterval	ST23
	58	Demand Interval Length	ST13
	59	Demand Sub-Interval Length	ST13
	60	Number Power Fails (UOM 50)	ST28, ST3
	61	Number Demand Resets	ST23
	62	Current Date	ST52
	63	Current Time	ST52
	64	Cumulative KW	ST28, ST23
	65	Continuous Cumulative KW	ST28, ST23
	66	Program ID	ST6
	67	Programmer ID	ST6
	68	Days Since Reset	
	69	Kh	ST2
	70	Kt	ST2
	71	Device ID #1 [IDENTIFICATION]	ST5,ST6
	72	Device ID #2 [MISC_ID]	ST6
Other Values	73	Integrated average KW	ST28
	74	Integrated average KVAR Lag	ST28
	75	Integrated average KVAR Lead	ST28
	76	Integrated average VRMS Ph A	ST28

Application	Item #	Display Name	C12.19 Section
	77	Integrated average VRMS Ph B	ST28
	78	Integrated average VRMS Ph C	ST28
	79	Integrated average I RMS Ph A	ST28
	80	Integrated average I RMS Ph B	ST28
	81	Integrated average I RMS Ph C	ST28
	82	Maximum Integrated average VRMS Ph A	ST28
	83	Maximum Integrated average VRMS Ph B	ST28
	84	Maximum Integrated average VRMS Ph C	ST28
	85	Minimum Integrated average VRMS Ph A	ST28
	86	Minimum Integrated average VRMS Ph B	ST28
	87	Minimum Integrated average VRMS Ph C	ST28

8.4.5 Decade 4 – Security Tables 40/41

Decade 4 – Security Tables 40/41	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
SECURITY_RCD											
PASSWORD_LEN	20/20										
NBR_PASSWORDS* (per interface †)	≥4/4										
NBR_KEYS	≥4/4										
KEY_LEN‡	≥16/16										
NBR_PERM_USED	≥32/4										

* By default, master, programmer, billing read and demand reset, client read-only access.

† An interface type is local / optical port interface, telephone / MODEM interface, Utility Network Interface, Customer / HAN network interface. Secured implementations shall not permit passwords that facilitate access on one interface to operate on another, unless the password is transmitted in cipher text by the communication protocol.

‡ The key length must support at least 128 bits, since this value is shared by ANSI C12.21 and ANSI C12.22 application service communication protocols. Unused key-pad bits may be set to zero and shall be ignored by the cryptographic processor.

8.4.6 Decade 5 – Time and Time-of-Use Tables 50/51

Decade 5 – Time and TOU Tables 50/51	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
TIME_FUNC_FLAG1_BFLD											
TOU_SELF_READ_FLAG	F/F		T/F	T/F							
SEASON_SELF_READ_FLAG	F/F			T/F							
SEASON_DEMAND_RESET_FLAG	F/F			T/F							
SEASON_CHNG_ARMED_FLAG	F/F			T/F							
SORT_DATES_FLAG	F/F		T/T	T/T							
ANCHOR_DATE_FLAG	F/F		T/T	T/T							
TIME_FUNC_FLAG2_BFLD											
CAP_DST_AUTO_FLAG	T/F										
SEPARATE_WEEKDAYS_FLAG	F/F										
SEPARATE_SUM_DEMANDS_FLAG	F/F										
SORT_TIER_SWITCHES_FLAG	F/F		T/T	T/T							
CAP_TM_ZN_OFFSET_FLAG	T/T										
CALENDAR_BFLD											
NBR_SEASONS	0		4/4								
NBR_SPECIAL_SCHED	0		1/1								
TIME_TOU_RCD											
TIME_FUNC_FLAG1*											
TIME_FUNC_FLAG2†											
CALENDAR_FUNC‡											
NBR_NON_RECURR_DATES	0/0		32/0								
NBR_RECURR_DATES	0/0		16/0								
NBR_TIER_SWITCHES	0/0		32/0								
CALENDAR_TBL_SIZEΔ	X/?										

* See **TIME_FUNC_FLAG1_BFLD** above.

† See **TIME_FUNC_FLAG2_BFLD** above.

‡ See **CALENDAR_BFLD** above.

Δ Any value may be programmed into **ACT_TIME_TOU_TBL.CALENDAR_TBL_SIZE**, however the End Device shall automatically adjust the value (when read back) to the actual number octets of that may be transported by **CALENDAR_TBL** (Table 54) for the given program. The value presented in **DIM_TIME_TOU_TBL.CALENDAR_TBL_SIZE** shall be consistent with the maximum End Device capability.

8.4.7 Decade 6 – Load Profile Table 60/61

Decade 6 – Load Profile Table 60/61	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
LP_FLAGS_BFLD	X/X										
LP_SET1_INHIBIT_OVF_FLAG					T/F						
LP_SET2_INHIBIT_OVF_FLAG					F/F						
LP_SET3_INHIBIT_OVF_FLAG					F/F						
LP_SET4_INHIBIT_OVF_FLAG					F/F						
BLK_END_READ_FLAG*					T/T						
BLK_END_PULSE_FLAG					F/F						
SCALAR_DIVISOR_FLAG_SET1†					T/T						
SCALAR_DIVISOR_FLAG_SET2‡					X/F						
SCALAR_DIVISOR_FLAG_SET3‡					X/F						
SCALAR_DIVISOR_FLAG_SET4‡					X/F						
EXTENDED_INT_STATUS_FLAG					T/T						
SIMPLE_INT_STATUS_FLAG					F/F						
BLK_END_RD_INDICATOR_FLAGΔ					F/F						
LP_FMATS_BFLD	X/X										
INV_UINT8_FLAG					X/F						
INV_UINT16_FLAG					X/F						
INV_UINT32_FLAG					T/F						
INV_INT8_FLAG					X/F						
INV_INT16_FLAG					X/F						
INV_INT32_FLAG					T/F						
INV_NI_FMAT1_FLAG					T/F						
INV_NI_FMAT2_FLAG					T/T						
LP_FMATS_BFLD	X/X										
LP_MEMORY_LEN¥					X/?						
LP_FLAGS■					?/?						
LP_FMATS‼					?/?						
NBR_BLKS_SET1‼					≥45/7						
NBR_BLK_INTS_SET1					312/104						
NBR_CHNS_SET1					≥4/2 (base) ≥8/4 (adv)						
MAX_INT_TIME_SET1‼					60/15						
NBR_BLKS_SET2 (advanced)					≥45/7 (adv)						

Decade 6 – Load Profile Table 60/61	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
NBR_BLK_INTS_SET2 (advanced)					312/104 (adv)						
NBR_CHNS_SET2 (advanced)					8/0 (adv)						
MAX_INT_TIME_SET2 (advanced)					60/15 (adv)						
NBR_BLKS_SET3					X/X						
NBR_BLK_INTS_SET3					X/X						
NBR_CHNS_SET3					X/X						
MAX_INT_TIME_SET3					X/X						
NBR_BLKS_SET4					X/X						
NBR_BLK_INTS_SET4					X/X						
NBR_CHNS_SET4					X/X						
MAX_INT_TIME_SET4					X/X						

* This required flag is set by default to TRUE since it enables the independent reporting (thus verification) of interval energy usage and the block total energy usage.

† When the reported interval data is transmitted in physical units (i.e., using **INV_NI_FMAT1** or **INV_NI_FMAT2**) this value may be set to False.

‡ This specification assumes a single load profile recorder per End Device. Advanced End Devices may implement a second load profile recorder.

Δ May be programmable.

¥ Any value may be programmed into **ACT_LP_TBL.LP_MEMORY_LEN**, however the End Device shall automatically adjust the value (when read back) to the actual number octets of that may be transported shall reflects the combined sizes of **LP_DATA_SET1_TBL** (Table 64), **LP_DATA_SET2_TBL** (Table 65), **LP_DATA_SET3_TBL** (Table 66), and **LP_DATA_SET4_TBL** (Table 67).

■ See **LP_FLAGS_BFLD**.

╬ See **LP_FMATS_BFLD**.

╥ Store five (5) minute interval data for a minimum of 45 days for two channels and allow for time zone changes. Interval programmed shall be any of 1, 5, 10, 15, 30 or 60 minutes.

8.4.8 Decade 7 – History Log & Event Log Tables 70/71

Decade 7 – History Log & Event Log Tables 70/71	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
LOG_FLAGS_BFLD	X/X										
EVENT_NUMBER_FLAG								T/T			
HIST_DATE_TIME_FLAG							T/T				
HIST_SEQ_NBR_FLAG							T/T				
HIST_INHIBIT_OVF_FLAG							T/F				
EVENT_INHIBIT_OVF_FLAG								T/T			
EXT_LOG_FLAGS_BFLD	X/X										
METROLOGICAL_SIG_FLAG								T/T			
PROGRAM_SIG_FLAG								T/T			
ALTERNATE_SIG_FLAG								T/F			
SECURED_REGISTER_FLAG								T/T			
SIG_ALGORITHM								1/1			
LOG_RCD	X/X										
LOG_FLAGS*											
NBR_STD_EVENTS							≥77/?	≥77/?			
NBR_MFG_EVENTS							X/X	X/X			
HIST_DATA_LENGTH‡							X/X	X/X			
EVENT_DATA_LENGTHΔ							X/X	X/X			
NBR_HISTORY_ENTRIES							≥200/?				
NBR_EVENT_ENTRIES								≥420/?			
EXT_LOG_FLAGS†											
NBR_PROGRAM_TABLES¥								?/?			

* See **LOG_FLAGS_BFLD**.
† See **EXT_LOG_FLAGS_BFLD**.
‡ Shall be sufficiently large to accommodate history log data.
Δ Shall be sufficiently large to accommodate history log data.
¥ Must be large enough to account for each programmable Tables that is marked as role="CONTROL" or role="ACTUAL".

8.4.9 Decade 8 – User-Defined Tables 80/81

Decade 8 – User-Defined Tables 80/81	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
UDT_CTRL_BFLD											
NBR_UDTS	≥1/≥1										
INSTANCE_FLAG*	?/?										
DATA_ACCESS_METHOD	3/2										
UDT_FUNC_LIM_RCD											
NBR_XFR_LIST_ITEMS	≥16/?										
UDT_FUNC_CTRL†											
MAX_INSTANCE*	?/?										
UDT_0_SIZE	≥256/ ?										
UDT_1_SIZE	X/X										
UDT_2_SIZE	X/X										
UDT_3_SIZE	X/X										
UDT_4_SIZE	X/X										
UDT_5_SIZE	X/X										

* Must be if implemented in an End Device that is a data aggregator then **INSTANCE_FLAG** should be T/T and **MAX_INSTANCE** should match site requirements.

† See **UDT_CTRL_BFLD**.

‡ Shall be sufficiently large to accommodate history log data.

Δ Shall be sufficiently large to accommodate history log data.

¥ Must be large enough to account for each programmable Tables that is marked as role="CONTROL" or role="ACTUAL".

8.4.10 Decade 9 – Telephone Control Tables 90/91

Decade is implemented only when there is a telephone MODEM interfaces in the End Device.

Decade 9 – Telephone Control Tables 90/91	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
TELEPHONE_FLAGS_BFLD											
ANSWER_FLAG	T/F										
S_ANCHOR_DATE_FLAG*	T/T		T/F	T/F							
OFFHOOK_DETECT_FLAG	T/F										
BIT_RATE	T/F										
ID_IN_PURPOSE	T/F										
NO_LOCKOUT_PARM	F/F										
EXTENDED_STATUS	T/F										
TELEPHONE_RCD											
TELEPHONE_FLAGS	?/?										
NBR_ORIGINATE_WINDOWS	≥2/1										
NBR_SETUP_STRINGS	≥2/1										
SETUP_STRING_LENGTH	≥20/20										
PREFIX_LENGTH	≥10/10										
NBR_ORIGINATE_NUMBERS	≥2/1										
PHONE_NUMBER_LENGTH	≥10/10										
NBR_RECURRING_DATES	≥16/0										
NBR_NON_RECURRING_DATES	≥32/0										
NBR_EVENTS	≥32/0										
NBR_WEEKLY_SCHEDULES	≥7/7										
NBR_ANSWER_WINDOWS	≥2/1										
NBR_CALLER_IDS	≥1/1										
CALLER_ID_LENGTH	≥10/10										

* This implies that the End Device should use the global anchor date defined in **CALENDAR_TBL.ANCHOR_DATE**, unless FT and FS features are not available in the End Device.

† See **TELEPHONE_FLAGS_BFLD**.

8.4.11 Decade 10 – Unassigned

Decade 10 is not defined.

8.4.12 Decade 11 – Load Control and Pricing Tables 110/111

Decade 11 – Load Control and Pricing Tables 110/111	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
DIM_LOAD_CONTROL_BFLD											
DURATION_SUPPORTED_FLAG									T/T	X/X	X/X
RANDOMIZATION_SUPPORTED_FLAG									T/T	X/X	X/X
MANUAL_OVERRIDE_SUPPORTED_FLAG*									T/F	X/X	X/X
MANUAL_TURN_ON_SUPPORTED_FLAG*									T/F	X/X	X/X
STATE_VERIFICATION_SUPPORTED_FLAG									T/T	X/X	X/X
ANCHOR_DATE_SUPPORTED_FLAG†									T/F	X/X	X/X
SOURCE_CONDITION_SUPPORTED_FLAG									T/F	X/X	X/X
TIER_CONDITION_SUPPORTED_FLAG									T/F	X/X	X/X
TIME_CONDITION_SUPPORTED_FLAG									T/F	X/X	X/X
DIM_LOAD_CONTROL_RCD										X/X	X/X
DIM_LOAD_CONTROL‡									?/?	X/X	X/X
NBR_OF_CONTROL_POINTS									≥1/0	X/X	X/X
NBR_RECURRING_DATES									≥16/0	X/X	X/X
NBR_NON_RECURRING_DATES									≥32/0	X/X	X/X
NBR_EVENTS									≥32/0	X/X	X/X
NBR_OF_WEEKLY_SCHEDULES									≥7/0	X/X	X/X
NBR_OF_CONDITIONS									≥16/0	X/X	X/X
NBR_OF_CONSUMPTIONS◊									?/?	X/X	≥12/2
SLM_CONDITION_LEN									≥40/40	X/X	X/X
SLM_EQUATION_LEN									≥40/40	X/X	X/X

* Manual implies the used of Procedure 21, Direct Load Control.

† This implies that the End Device should use the global anchor date defined in **CALENDAR_TBL.ANCHOR_DATE**, unless FT and FS features are not available in the End Device.

‡ See **DIM_LOAD_CONTROL_BFLD**.

◊ Used only in Table 116, Prepayment Status.

8.4.13 Decade 12 – Node Network Control Tables 120/121

Decade 12 shall be implemented by any C12.22 Node.

Decade 12 – Node Network Control Tables 120/121	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
DIM_NETWORK_BFLD											
TIME_STAMP_ENABLE_FLAG	T/T										
PROG_NATIVE_ADDRESS	T/F										
PROG_BROADCAST_ADDRESS	T/F										
STATIC_RELAY	T/F										
STATIC_APTITLE	T/F										
STATIC_MASTER_RELAY	T/F										
CLIENT_RESPONSE_CTRL	T/F										
COMM_MODULE_SUPP_FLAG*	?/?										
DIM_MESSAGE_BFLD											
MESSAGE_ACCEPTANCE_WINDOW_FLAG	T/T										
ACCEPTANCE_RECOVERY_SESSION_FLAG	T/T										
DIM_NETWORK_RCD											
CONTROL†	?/?										
NBR_INTERFACES	≥2/1										
NBR_REGISTRATIONS	≥2/1										
NBR_FILTERING_RULES	X/X										
NBR_EXCEPTION_HOSTS	≥2/1										
NBR_EXCEPTION_EVENTS	≥16/0										
NBR_STATISTICS	≥22/8										
NBR_MULTICAST_ADDRESSES	≥0/0										
NATIVE_ADDRESS_LEN◊	?/?										
FILTERING_EXP_LEN	X/X										
MESSAGE_CONTROL‡	?/?										
NBR_PLAYBACK_REJECT_MSGS	≥1/1										

* Shall be set to T/? by the Manufacturer when a C12.22 Communication Module can be attached to this C12.22 Device. Shall be set to T/T when one or more C12.22 Communication Modules are attached to this C12.22 Device.

† See **DIM_NETWORK_BFLD**.

‡ See **DIM_MESSAGE_BFLD**.

◊ The length of a C12.22 Network Segment Native Address depends on the type of the LAN that the C12.22 Node is attached.

8.4.14 Decade 13 – Network Relay Control Tables 130/131

Decade 13 shall be implemented by any C12.22 Relay.

Decade 13 – Network Relay Control Tables 130/131	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
RELAY_CONFIGURATION_BFLD											
ASSIGN_APTITLE_LOCALLY	T/F										
PATTERN_LEN_MULT	1/1										
DIM_RELAY_RCD											
RELAY_CONFIGURATION*	?/?										
NBR_REGISTRATION_ENTRIES†	?/?										
NBR_STATIC_ROUTING_ENTRIES†	?/?										
NBR_DYNAMIC_ROUTING_ENTRIES†	?/?										
NBR_ASSIGNED_MASTER_RELAY	≥1/1										
NBR_HOSTS	≥1/0										

* See **RELAY_CONFIGURATION_BFLD**.

† The actual value depends on the type of C12.22 Relay and the size of the C12.22 Network Segments it serves.

8.4.15 Decade 14 – Extended User-Defined Tables 140/141

This decade may be used to map CIM objects and Energy Usage Objects to equivalent C12.19 Element data.

Decade 14 – Extended User-Defined Tables 140/141	Assumed Feature										
Table Element Name	**FA**	**FD**	**FT**	**FS**	**FL**	**FQ**	**FH**	**FE**	**FC**	**FR**	**FP**
EUDT_BFLD											
DATA_ACCESS_METHOD	3/2										
INDEX_DEPTH	≥3/3										
EUDT_LIMITS_RCD											
EUDT_CTRL*	?/?										
NBR_EUDT	≥16/0										
NBR_INSTANCES	≥1/1										
NBR_SELECTIONS	≥16/8										
NBR_CONSTANTS	≥16/8										
NBR_LABEL_CHARS	≥20/20										

* See **EUDT_BFLD**.

8.4.16 Decade 15 – Quality-of-Service (Power Quality) 150/151

The quality of service decade is very complex. The actual values may need to be fully defined subject to specific user's requirements. The dimensions defined in this Standard are not mandatory. The flags are mandatory.

Decade 15 – Quality-of-Service (Power Quality) 150/151	Assumed Feature										
Table Element Name	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
QS_FEATURES_BFLD											
INHIBIT_OVF_QS_LOG_FLAG						T/F					
NOTIFY_OVF_QS_LOG_FLAG						T/F					
INHIBIT_OVF_TD_ASYNC_FLAG						T/F					
NOTIFY_OVF_TD_ASYNC_FLAG						T/F					
TD_SCALAR_DIVISOR_FLAG						T/F					
INHIBIT_OVF_FD_ASYNC_FLAG						T/F					
NOTIFY_OVF_FD_ASYNC_FLAG						T/F					
SCALAR_DIVISOR_FD_ASYNC_FLAG						T/F					
INHIBIT_OVF_TD_PERIODIC_FLAG						T/F					
NOTIFY_OVF_TD_PERIODIC_FLAG						T/F					
SCALAR_DIVISOR_TD_PERIODIC_FLAG						T/F					
INHIBIT_OVF_FD_PERIODIC_FLAG						T/F					
NOTIFY_OVF_FD_PERIODIC_FLAG						T/F					
SCALAR_DIVISOR_FD_PERIODIC_FLAG						T/F					
REPEAT_TD_FLAG						T/F					
REPEAT_FD_FLAG						T/F					
FD_COMPLEX_FLAG						T/T					
FD_PHASOR_FLAG						T/F					
QUALITY_RESET_CTR_FLAG						T/F					
INCIDENT_SORTABLE_FLAG						T/F					
COMMON_SAMPLING_RATE_FLAG						T/F					
COMMON_NBR_OF_SAMPLES_FLAG						T/F					
INTERHARMONICS_FLAG						T/F					
WAVEFORM_FORMATS_BFLD[†]											
INV_UINT8_FLAG						X/F					
INV_UINT16_FLAG						X/F					
INV_UINT32_FLAG						T/F					
INV_INT8_FLAG						X/F					
INV_INT16_FLAG						X/F					
INV_INT32_FLAG						T/F					
INV_NI_FMAT1_FLAG						T/F					

Decade 15 – Quality-of-Service (Power Quality) 150/151	Assumed Feature										
Table Element Name	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
INV_NI_FMAT2_FLAG						T/T					
QS_LIMITS_RCD											
FEATURES*						?/?					
NBR_OF_EVENT_IDS						≥8/4					
NBR_OF_EVENTS						≥8/4					
NBR_OF_INCIDENTS						≥8/4					
NBR_OF_COINCIDENT_VALUES						≥8/4					
WAVEFORM_FORMATS‡						?/?					
TD_SAMPLING_RATE						X/X					
NBR_OF_TD_SAMPLES						X/X					
NBR_OF_TD_BLOCKS						X/X					
NBR_OF_TD_CHANNELS						≥4/2					
NBR_OF_TD_CHANNELS_PER_BLOCK						≥4/2					
NBR_OF_TD_SAMPLES_PER_BLOCK						X/X					
NBR_OF_TD_PREFETCH_SAMPLES						X/X					
FD_SAMPLING_RATE						X/X					
NBR_OF_SPECTRAL_COMPONENTS						X/X					
NBR_OF_FD_SAMPLES						X/X					
NBR_OF_FD_BLOCKS						X/X					
NBR_OF_FD_CHANNELS						≥4/2					
NBR_OF_FD_CHANNELS_PER_BLOCK						≥4/2					
NBR_OF_FD_SPECTRA_PER_BLOCK						X/X					
NBR_OF_FD_PREFETCH_SAMPLES						X/X					
LABEL_LENGTH						≥20/20					

* See **QS_FEATURES_BFLD**.
† These values match the settings used by **DIM_LP_TBL.LP_FMATS_BFLD**.
‡ See **WAVEFORM_FORMATS_BFLD**.

8.4.17 Decade 16 – One-way Devices 160/161

Decade 16 – One-way Devices 160/161	Assumed Feature										
Table Element Name	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
WAKE_UP_FUNC_FLAG_BFLD											
ALWAYS_AWAKE_FLAG	X/X										
PERIODIC_SELF_WAKE_FLAG	X/X										
EXTERNAL_WAKE_FLAG	X/X										
RF_TRANSM_WAKE_FLAG	X/X										
IR_TRANSM_WAKE_FLAG	X/X										
PL_TRANSM_WAKE_FLAG	X/X										
POT_WAKE_FLAG	X/X										
LAN_WAN_WAKE_FLAG	X/X										
REGISTER_READ_FUNC_FLAG_BFLD											
REG_READ_IMMEDIATE_WAKE_FLAG	X/X										
REG_READ_DELAY_TO_TIME_FLAG	X/X										
REG_READ_EXTERNAL_STIME_FLAG	X/X										
DATA_TRANSMIT_FUNC_BFLD											
DATA_XMIT_IMMEDIATE_READ	X/X										
DATA_XMIT_DELAY_TO_TIME_FLAG	X/X										
COMMODITY_OUTAGE_DUTY_RCD											
COMMODITY_OUTAGE_DUTY_NUM	X/X										
RESTORATION_CALL_ATTEMPTS	X/X										
RESTORATION_CALL_WAIT	X/X										
COMMODITY_ZERO_USAGE_RCD											
COMMODITY_ZERO_USAGE	X/X										
COMMODITY_ZERO_USAGE_TRIGGER	X/X										
COMMODITY_NON_RETURN_ZERO_TRIGGER	X/X										
ONE_WAY_RCD											
WAKE_UP_FUNC_FLAGS*	?/?										
REGISTER_READ_FUNC_FLAGS†	?/?										
DATA_TRANSMIT_FUNC_FLAGS‡	?/?										
WAKE_CODE_LEN											
COMMODITY_OUTAGE_DUTY◊	?/?										
COMMODITY_ZERO_USAGE¥	?/?										
NBR_COMMANDS	X/X										

* See **WAKE_UP_FUNC_FLAG_BFLD**.
† See **REGISTER_READ_FUNC_FLAG_BFLD**.
‡ See **DATA_TRANSMIT_FUNC_BFLD**.

Decade 16 – One-way Devices 160/161	Assumed Feature									
Table Element Name	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR	FP
◊ See **COMMODITY_OUTAGE_DUTY_RCD**. ¥ See **COMMODITY_ZERO_USAGE_RCD**.											

Summary: Exhibit Exhibit: Opt-Out Meter Communication Protocol and AMI Infrastructure electronically filed by Mr. Aaron Young on behalf of YOUNG, THAAH AND AARON

Summary: Motion - Motion in Limine and Request for Expedited Ruling of Ohio Power Company electronically filed by Tanner Wolffram on behalf of Ohio Power Company