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Network Operations Subcommittee

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Requirements for Power Sensing in Cable and Utility Networks

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140 Philips Road
Exton, PA 19341

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☐ Procedure, Process or Method	☐ Cloud	☐ Customer Premises

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1. Introduction

1.1. Executive Summary

This specification provides precision, sampling rate, and configuration requirements if vendors choose to measure and report voltage and/or current in hardware and software to enable advanced power sensing in cable and utility networks. Included are requirements for sensing and communicating power quality observations from both the 60/75/90 VAC quasi-square wave HFC network and the 120/240 VAC supply from the electric power grid. For systems that require remote communication of measurements, requirements for the control plane and communications security are specified. This specification does not *require* any particular measurements, but if supply voltage and/or current is measured, it specifies *how* those measurements must be made to realize the benefits described in section 1.3.

More details about the specified measurements and their precision, sampling rate, and reporting requirements usefulness and application are further detailed in the published paper "High-Resolution, Time-Synchronized Grid Monitoring Devices" referenced in section 3.3.

1.2. Scope

The scope of the standard covers two distinct use cases.

1. Cable TV Hybrid Fiber-Coax (HFC) power quality needs to be monitored for anomaly 'glitches' known to have caused the reboot of some newer digital HFC actives which interrupted voice, video, and data services for up to 15 minutes.
2. Utility secondary distribution grid power quality needs to be monitored for anomaly 'glitches' known to cause wildfires and shorten the lifespan of cable TV infrastructure elements, customer premises equipment (CPE), and consumer appliances.

1.3. Benefits

Since 2002, Cable TV providers have relied on voltage and inverter status readings retrieved from DOCSIS® modems connected to neighborhood HFC power supplies to detect grid power outages. Since the release of the Simple Network Management Protocol (SNMP) transport protocol and circa 2000 sensing technology, new technologies have become available for improved voltage resolution, sampling rates, and secured information transport to enable detecting critical anomalies that may ultimately lead to loss of life/property and disrupt service. Detecting anomalies will aid in early detection of potentially customer-affecting issues.

The increasing complexity of the grid requires a concomitant growth in sensing technology. The resilience of the 5.5 million miles (over 8 million kilometers) of distribution lines (96.5% of the grid) can be greatly enhanced with additional monitoring. Supervisory control and data acquisition (SCADA) systems and other telemetry systems will benefit. Migration from 1-way delivery of central power to dynamic 2-way flows of distributed renewable power creates an unlimited number of changing 'normal' states that thwart detection of anomalous states created by cyberattacks and failing infrastructure. Cable providers need the grid to be reliable to power millions of nodes. These nodes and other network elements can provide useful power quality and status information to utility providers.

1.4. Intended Audience

The intended audience of this specification includes power providers and broadband telecommunications providers including operations centers, product managers, designers, engineers, plant and field service

technicians, and end users of equipment that is used to sense the quality of power delivered by the electric power secondary distribution network and broadband networks such as the HFC network.

1.5. Areas for Further Investigation or to be Added in Future Versions

Future versions of this specification may specify the measurement accuracy, sampling rate, communications, and security of non-customer premises devices on other networks including passive optical networks (xPON), switched Ethernet, powered Ethernet, Wi-Fi hotspots, small cells, etc.

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

- SCTE 216 2020, Adaptive Power System Interface Specification (APSIS™)

2.2. Standards from Other Organizations

- RFC 6101 The Secure Sockets Layer (SSL) Protocol Version 3.0
- RFC 8446 The Transport Layer Security (TLS) Protocol Version 1.3

2.3. Published Materials

- No normative references are applicable.

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

3.1. SCTE References

- No normative references are applicable.

3.2. Standards from Other Organizations

- IEEE P2888.1 - Specification of Sensor Interface for Cyber and Physical World
- IEEE P2888.2 - Standard for Actuator Interface for Cyber and Physical Worlds
- IEEE P2888.3 - Standard on Orchestration of Digital Synchronization between Cyber and Physical Worlds
- RFC 1157 Simple Network Management Protocol (SNMP)
- [YANG] – A description of the YANG modeling language is available at: http://www.yang-central.org/twiki/bin/view/Main/WebHome
- [YANGTOOLS] http://www.yang-central.org/twiki/bin/view/Main/YangTools

3.3. Published Materials

- North American Synchrophasor Initiative, Technical Report: High-Resolution, Time-Synchronized Grid Monitoring Devices, Alison Silverstein, Alison Silverstein Consulting, Dr. Jim Follum, PNNL, March 20, 2020.

4. Compliance Notation

Shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
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5. Abbreviations and Definitions

5.1. Abbreviations

APSIS	Adaptive Power Systems Interface Specification
CPE	customer premises equipment
CPOW	continuous point on wave
DOCSIS	Data-over-Cable Service Interface Specifications
EV	electric vehicle
GPS	global positioning system
gRPC	Remote Procedure Call developed at Google
HFC	hybrid fiber-coax
IETF	Internet Engineering Task Force
OSS	operational support system
SCADA	supervisory control and data acquisition
SCTE	Society of Cable Telecommunications Engineers
SNMP	Simple Network Management Protocol
UTC	universal time coordinated
VAC	volts alternating current
xPON	X version of passive optical network

5.2. Definitions

continuous point on wave	Means of tracking performance of a sinusoidal power wave traditionally found on grid power, taken over very short intervals of time for extremely high resolution of observation.
YANG	A data modeling language used to model configuration, state data, and administrative actions manipulated by the NETCONF protocol
cyber-physical security	The superset of cybersecurity used in protecting cyber-physical systems.

6. Requirements

6.1. Sensing Requirements

For network elements, if HFC voltage and/or current is sensed grid and HFC voltage ***shall*** be measured with a precision of 0.002 per-unit (0.2% of the nominal value), e.g., +/- 0.24 volts at 120 VAC and current, ***shall*** be measured with the same precision of 0.002 per-unit.

If a continuous point on wave (CPOW) capture (see the "North American Synchrophasor Initiative, Technical Report") capability is provided, the sampling rate ***shall*** be a minimum of 10k samples/sec. This enables the identification of loose seizure screws, life-threatening faults such as unbonded grounds and floating neutrals, high-impedance faults such as arcing grid conductors, and unintended behavior of distributed energy resources such as solar inverters and EV chargers feeding power into the grid when undesirable or unsafe to do so, e.g., during line maintenance.

Higher sensing rates could provide specific benefits. If the rate of change of frequency and sine-wave goodness-of-fit (See "North American Synchrophasor Initiative, Technical Report") is provided, they *may* be calculated remotely from the measuring network element.

6.2. Timing Requirements

If a measurement observation timestamp capability is provided in the sensing network element, the observation timestamp resolution ***shall*** be <= 10e-6 seconds (1 microsecond). Clock accuracy ***shall*** be <=500*10e-9 seconds (500 nanoseconds) relative to Coordinated Universal Time (UTC). Reporting of values ***shall*** use UTC timestamps.

To meet the clock accuracy requirement, the system timing signal *should* be driven by either an onboard GNSS (Global Navigation Satellite System)-based timing subsystem such as GPS, DOCSIS or xPON loop timing, or other timing system with comparable stability and accuracy.

6.3. Configuration Requirements

If a configurable remote reporting capability is provided in the sensing network element, the control plane ***shall*** enable configuration for a) a 1-time poll reply, b) continuous replies and/or c) fixed interval replies.

6.4. Communication Requirements

If a communication plane is provided, it ***shall*** use the IETF/APSIS YANG model as defined in SCTE 216 Adaptive Power System Interface Specification.

Streaming oriented communications protocols such as gRPC are preferred.

7. Security Requirements

If a communication plane is used, it ***shall*** use SSL as defined in RFC 6101 The Secure Sockets Layer (SSL) Protocol Version 3.0 or TLS as defined in RFC 8446 The Transport Layer Security (TLS) Protocol Version 1.3, for authentication and encryption.