# MESA Guidelines for IEEE Std 1815.2-2025

## *Overview*

***IEEE Standard Profile for Communications with Distributed Energy Resources (DERs) Using IEEE Std 1815™ [Distributed Network Protocol (DNP3)]***

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# 1 Introduction to IEEE 1815.2 Guidelines

## 1.1 Purpose of IEEE Std 1815.2-2025

IEEE Std 1815.2 establishes a semantic Standard Profile for Communications with Distributed Energy Resources (DER) using IEEE Std 1815, IEEE Standard for Electric Power Systems Communications - Distributed Network Protocol (DNP3). The DER systems may be distribution-connected, transmission-connected, or stand-alone. As stated in its abstract, the IEEE 1815.2 Profile is "a high-level data model for DER communications, based on selected data objects from International Electrotechnical Commission (IEC) 61850-7-420:2021 mapped to a fixed list of DNP3 data points. The data objects needed for many DER and inverter-base resources (IBRs) functions, including those in IEEE Std 1547™-2018, IEEE Std 2800™-2022, and IEEE Std 1547.9™-2022, as well as additional functions needed for storage systems, are also specified. In addition, a mapping to detailed equipment-related data objects, including meters, DER units, inverters, and batteries, is provided. The profile is presented in both a written and an electronic format (IEEE 1815.2 Profile Companion Data Point Tables) for ease of implementation."

IEEE 1815.2 is the "Bluetooth" for utility scale distributed energy resources (DER) communications. Broad adoption of IEEE 1815.2 will allow utilities to more seamlessly "talk" to a variety of DERs, microgrids, and aggregators – ensuring the smart grid can function and expand efficiently. The scope of IEEE 1815.2 is illustrated in Figure 1.

***Or more succinctly, IEEE 1815.2 establishes standardized data objects to be used with the DNP3 protocol for real-time communications with DER systems, IBR systems, microgrids, and energy storage systems.***

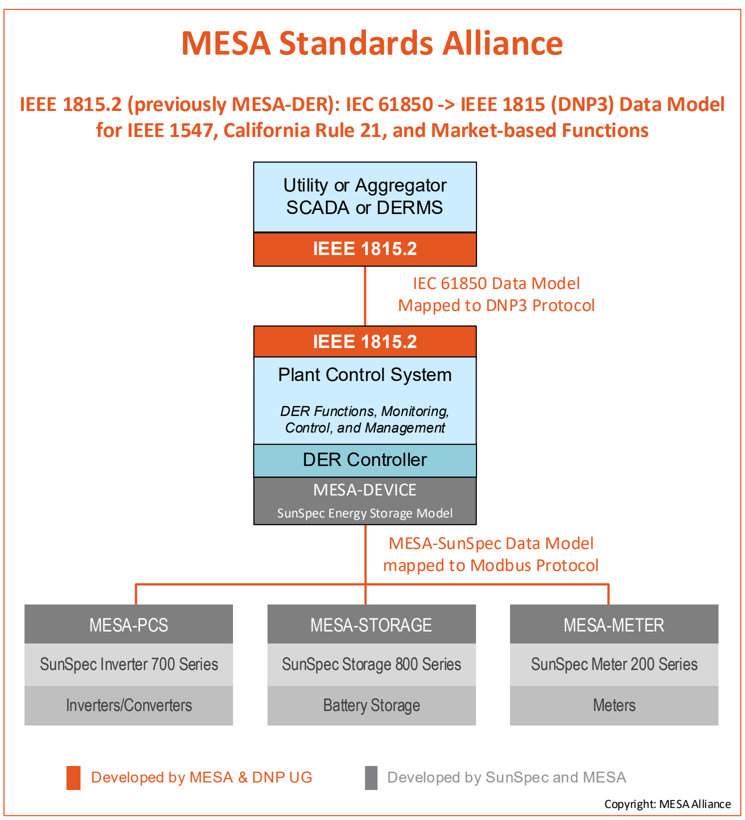


Figure 1: Scope of IEEE 1815.2

## 1.2 Fundamental Questions on IEEE 1815.2

IEEE 1815.2, as is typical of all standards, is both very flexible but therefore somewhat complex. It can be challenging to understand the nuances of this standard for achieving not only compliance, but efficiency, effectiveness, and reliability in communications with DER systems. In particular, it is not always clear what aspects of the standard are relevant to a particular implementation, what requirements are “mandatory” and which are “optional” for different scenarios, and how all the different parts of the standard are expected to work together. These IEEE 1815.2 Guidelines are attempting to provide this guidance as well as some examples to make implementations easier to undertake.

Some fundamental questions that are often asked include:

- **What does IEEE 1815.2 address?** IEEE 1815.2 is a communications standard (not an electric power standard) that defines a profile of uniquely named and standardized DNP3 data points to be used to communicate between a Controlling Station (a utility, aggregator, plant, or microgrid) and an Outstation in the DER domain which is distribution-connected, transmission-connected, or stand-alone.
- **What can an Outstation be in IEEE 1815.2?** The Outstation can be a DER unit (e.g., a single utility-scale battery system), a DER system (e.g., multiple PV plus storage systems), a customer site with the ability to manage its generation and load (e.g., a plant connected to the distribution or transmission system), a microgrid that can be grid-connected or isolated, or even a customer site that manages only load (e.g., an electric vehicle charging station).
- **Does IEEE 1815.2 require compliance with IEEE 1815 (DNP3)?** Yes, in part. It requires compliance with at least DNP3 Level 2, although there are some IEEE 1815.2 capabilities that require some additional DNP3 capabilities. It also strongly recommends implementation of the DNP3 cybersecurity requirements (either SAv5 or SAv6) but does not mandate them.
- **What does this IEEE 1815.2 profile consist of?** This profile includes the data which would need to be exchanged between the Controlling Station and the Outstation for basic operations, for some advanced capabilities, and for many types of functions defined in IEEE 1547 and in other standards.
- **Why is there a spreadsheet as well as a document?** IEEE 1815.2 consists of a text document that specifies the requirements for all aspects of the standard. The spreadsheet contains the actual mapping of unique names (derived from IEC 61850-7-420 data names) and associated parameters with the DNP3 point numbers and is the normative electronic source of the data objects. PNNL has developed a JSON version of the spreadsheet to be used for Phase 1 testing (see Section 3).
- **Which functions are mandatory?** Actually, no functions are mandatory from an IEEE 1815.2 perspective. It is entirely up to the implementors to determine which functions to implement. The spreadsheet does indicate which functions and data objects are required for IEEE 1547:2018, but again it is up to implementors whether or not they are actually implemented. However, for functions that are selected for implementation, some data objects are mandatory to ensure the functions operate correctly. It is presumed, but not mandatory, that some monitoring and control is included.
- **Does everything for a Controlling Station or Outstation need to be implemented immediately?** No. Functions can be implemented in stages or for different Outstations by identifying which functions are “enabled” and which are “disabled” via IEEE 1815.2 data objects. When (or if) the functions are eventually implemented, those settings can be updated to show that the functions are now “enabled”.
- **Can some of the settings, like ramp rates, priorities, or meter assignments to functions, be established at implementation time and not permitted to be changed?** Yes, the ability to update

these settings is optional. However, the ability to read the settings remains mandatory if the related function is enabled.

- **Do some of the more complex capabilities like scheduling have to be implemented?** No. Only capabilities that are needed should be implemented. The more complex capabilities can be added later if desired.
- **Are there some examples of what steps are required?** Most functions contain step-by-step instructions in the IEEE 1815.2 standard. Some examples are also in these Guidelines, including scheduling, which may be complex to implement initially, but is expected to be very powerful for managing the more complex DER systems.
- **Is the IEEE 1815.2 standard fixed in concrete?** Yes and no. Yes, in the sense that it remains backward compatible with the DNP3 Application Note and most existing implementations and expects to remain backward compatible in the future. No, in the sense that future revisions of IEEE 1815.2 will continue to add new functions and improve capabilities as these are functionally defined by other groups (e.g. fast frequency response, artificial inertia, etc.).

## 1.3 Background of IEEE 1815.2

### 1.3.1 Sources for IEEE 1815.2

As shown in Figure 2, IEEE 1815.2 is based on the following documents in rough chronological order although there were significant overlaps in time and cross-pollination of ideas and requirements:

- IEEE Std 1815-2012: IEEE Standard for Electric Power Systems Communications—Distributed Network Protocol (DNP3)
- MESA-DER Specification from the MESA Standards Alliance (2016-2018). This specification defines the communication requirements for utility-scale energy storage systems (ESS) and generation DER and controllable load. It was developed initially for ESS and then updated to support all DER in parallel with the development of the DNP3 Application Note and is incorporated as appropriate in this updated document.
- EPRI Common Functions for Smart Inverters, Versions 1-4 (EPRI reference 3002008217). This document was produced as a result of the work of the Photovoltaic Inverter Data Identification Focus Group (DIFG), organized by the Electric Power Research Institute (EPRI). The members of this group include photovoltaic inverter and storage manufacturers, utilities, research institutions and integrators. The document specifies a common set of application functions required for communicating with a DER system controlled by a “smart” inverter.
- IEEE 1547-2018, Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces. However, since the MESA effort started from the need for communications with storage systems, including while charging, the IEEE 1547 functions are not the only functions covered by the profile, and the communication profile for the many additional storage functions support more of the power plant management requirements.
- DNP3 Application Note-2018. This document was developed by MESA members, DNP User Group members, with funding from MESA and EPRI.
- MESA-DER Electronic Source (PICS) Spreadsheet for Testing. This spreadsheet was developed at the same time as the DNP3 Application Note since spreadsheet tables for this purpose was easier to manipulate than Word tables, but it was never included in DNP3 Application Note.

- IEC 61850-7-420 Ed. 2.0 2021 ( Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes. This document is the IEC specification for standard data models to be used for DERs. It incorporates all of the functions defined in IEEE 1547:2018 and includes many additional functions, in particular those required or useful for Energy Storage Systems (ESS).
- IEEE Std. 1815.1-2015: Standard for exchanging information between networks implementing IEC 61850 and IEEE 1815 (DNP3). This is a specification for mapping data between IEC 61850 and DNP3 networks and for configuring a gateway between such networks. This standard was developed through the assistance of the National Institute of Standards and Technology (NIST) and the Smart Grid Interoperability Panel (SGIP) under the label Priority Action Plan Twelve (PAP12).
- IEEE 1815.2-202X: Standard Profile for Communications with Distributed Energy Resources (DERs) using IEEE Std 1815™ Distributed Network Protocol (DNP3)

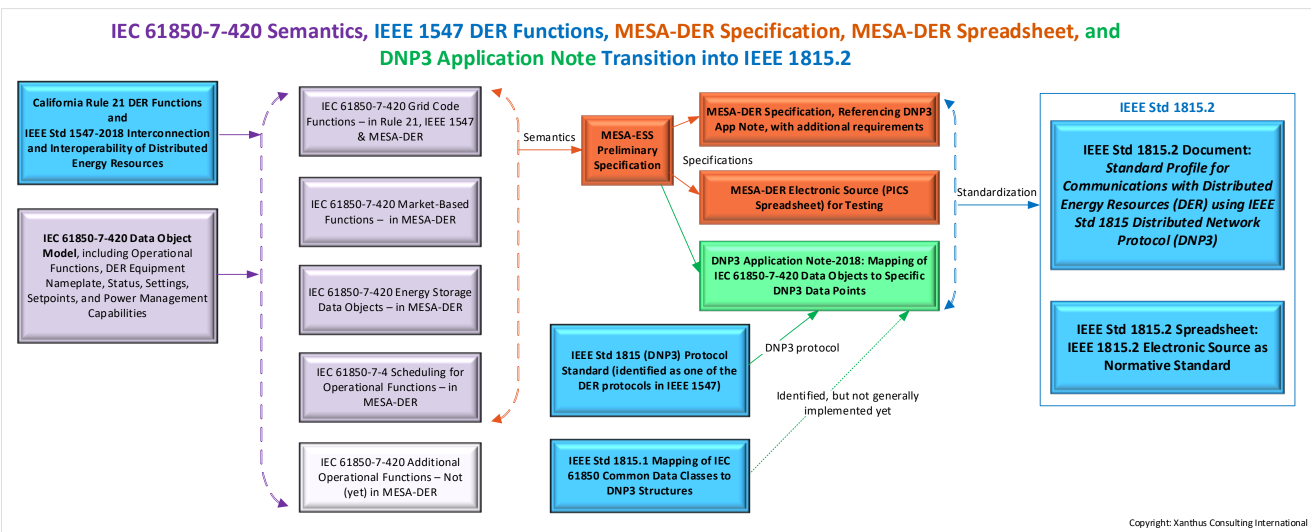


Figure 2: Sources and Development Process of IEEE 1815.2

### 1.3.2 Differences between the DNP3 Application Note and IEEE 1815.2

IEEE 1815.2 supersedes the DNP3 application note *AN2018-001: DNP3 Profile for Communications with Distributed Energy Resources (DERs)*, while remaining backward compatible as much as possible. The purpose of this revision is to make some corrections, to include additional clarifications, and to add some additional functionality. Over the time between the 2018 DNP3 Application Note and the development of IEEE 1815.2, a number editorial and technical changes have been made.

Technical changes include:

- The DNP3 data points are now in a spreadsheet rather than in tables in the Word document, so that a digital version is available to simplify implementations.
- The data points are now separated into blocks based on subject area. The gaps between the blocks can be used for future extensions.
- Scheduling now uses a backward compatible block of data points and a separate block for the new scheduling method.

- Historical data points are now called Engineering data points, and are organized into blocks using indexes as the starting DNP3 point numbers, rather than being consecutively numbered. The data points between the blocks could be used for extensions
- The scheduling capability was significantly enhanced since new requirements for scheduling have evolved. The existing scheduling data points were retained for backward compatibility, while the new scheduling has been assigned different data points.
- New data points were added in Gap #1 for some functions where the previous definitions or units needed to be updated, including for Active Power Following, Frequency-Watt Droop and Active Power Limiting.
- A few new functions were added in Gap #1, including alternative parameters for existing functions and renewable energy source.
- Two functions, Artificial Inertia and Advanced Volt-Watt, were added as Experimental functions since their use and their parameters have not become fully mature.
- Readable "index points" are now included at the end of the DNP3 addressing range (starting at AI 65000). These can be used to permit the starting index of each block to be modified, if so desired and with agreement between parties. They can also be used to support "automatic discovery" of the block starting indexes.

# 2 Overview of IEEE 1815.2

## 2.1 Overview of the IEEE 1815.2 Document Structure

The DNP3 points in IEEE 1815.2 consist of numbered binary output points, numbered binary input points, numbered analog output points, and numbered analog input points. In the base IEEE 1815 standard, these DNP3 points do not have any specific meanings: thus, DNP3 itself does not include a semantic model. IEEE 1815.2 adds a semantic model to DNP3 by applying a profile of specific data meanings to each of the DNP3 points.  This semantic model consists of IEC 61850-7-420 names, with additional profile attributes such as maximum and minimum values, scaling factors, and units.

IEEE 1815.2 specifies the basic communication data objects for photovoltaic systems, battery storage systems, and plant/microgrid controllers used to manage different types of DER. It also specifies the data objects needed for many DER functions and Inverter-Base Resources (IBR) functions, including those in IEEE 1547-2018, IEEE 2800, and IEEE 1547.9, as well as additional functions needed for storage systems. In addition, it specifies detailed equipment data objects for DER meters, DER units, inverters, and battery devices, primarily for alarms, logs, and historical records. Vendor-specific data objects can be added in a fixed area of DNP3 data points.

The DNP3 requirements, the curve and scheduling concepts, and the functions are described in a Word (pdf) document and while the actual data points are defined in an electronic format, currently a spreadsheet (Profile Companion Data Point Tables) for ease of implementation.

This standardized data model provides the interoperability identified by IEEE 1547-2018: a utility can communicate with many different DNP3 outstations supplied by many different DER manufacturers, while those DER manufacturers can also communicate with many different utilities.

Readers of these guidelines are assumed to have access to the IEEE 1815.2 document and Profile Companion Data Point Tables spreadsheet, so that material in those two documents is not copied here, although extracts and figures may sometimes be included for clarity.

## 2.2 IEEE 1815.2 Functions

IEEE 1815.2 contains many functions, not all of which are relevant to all implementations. From the perspective of this standard, no function is mandatory, although it is expected that the basic monitoring and control capabilities will be implemented.

To assist in determining which functions might be applicable for a particular implementation, the IEEE 1815.2 document in Section 1.5, Table 1, includes the full list of functions, where they are defined, and which DNP3 data points are used. Section 1.6, Table 2, lists the capabilities and functions that are mandated by IEEE 1547-2018.

The functions are shown in Figure 3.

**IEEE 1547 and Rule 21 Functions**

- Monitor Key DER Data (Currently one-way telemetry only)
- DER Disconnect/ Reconnect (Trip or Cease to Energize/Enter service)
- Limit Maximum Active Power (Export Limiting)
- Set Active Power
- Low/High Voltage Ride-Through
- Low/High Frequency Ride-Through
- Dynamic Volt-Watt Function
- Frequency-Watt
- Volt-Watt
- Constant VArs Function
- Fixed Power Factor Function
- Volt-VAr Control Function
- Watt-VAr Function
- Dynamic Reactive Current Support
- Scheduling (simple)

**Additional IEEE 1815.2 (MESA-DER) Functions**

- Charge/Discharge Function
- Coordinated Charge/Discharge Function
- Peak Power Limiting Function
- Generation Following Function
- Load Following Function
- Automatic Generation Control (AGC) Function
- Active Power Smoothing Function
- Frequency-Watt "Curve" Function, used for:
  - Advanced Frequency-Watt Function with Snapshot and Hysteresis
  - Fast Frequency Response (FFR)
  - Artificial Inertia (experimental)
  - Frequency smoothing
- Advanced Volt-Watt Function (experimental)
- Power Factor Correction Function
- Scheduling (more capable)

Figure 3: IEEE 1815.2 Functions

## 2.3 IEEE 1815.2 Interactions

The DNP3 profile permits a utility to communicate with Aggregators and/or DER facilities supplied by different DER manufacturers, while those DER manufacturers can communicate with different utilities using this standardized profile. These DER sites can be comprised of either a Power Control System which can manage multiple DER units or DER Controllers which each manage a single DER unit. In all cases, some form of "gateway" is expected for security reasons as well as for managing the data exchanges and, if necessary, translating protocols. See Figure 4.

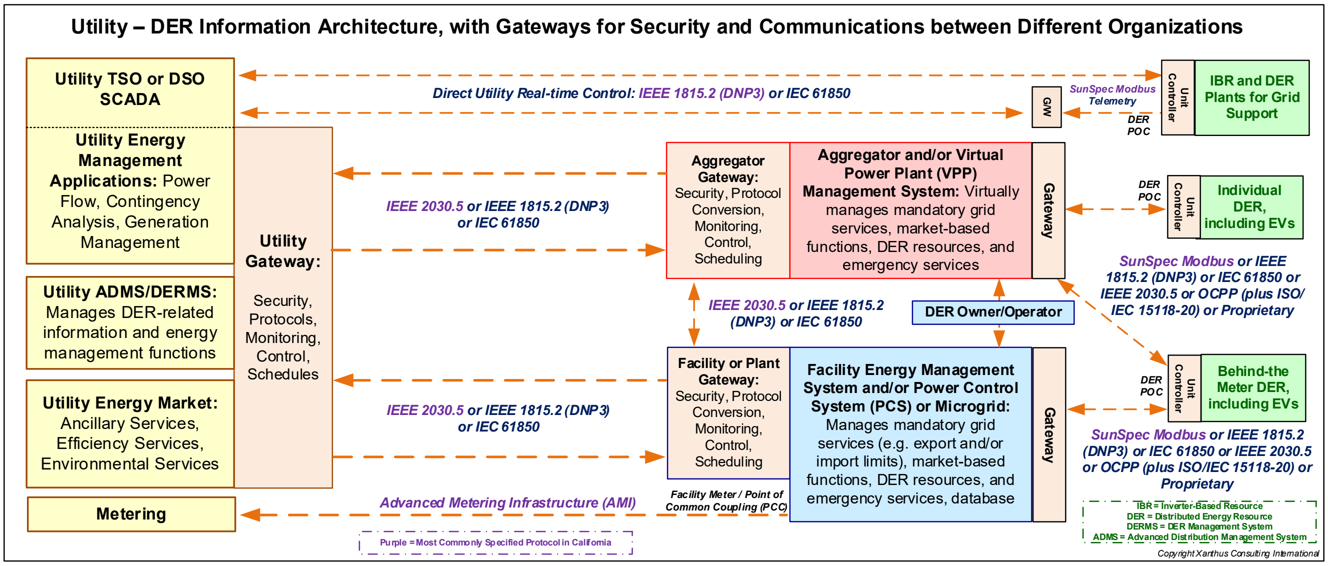


Figure 4: Utility interactions with DER systems, aggregators, and/or DER facilities

# 3 IEEE 1815.2 Testing and Certification

## 3.1 Overview of IEEE 1815.2 Testing and Certification Process

The IEEE 1815.2 testing and certification process is illustrated in Figure 2Figure 5 and consists of 4 basic steps:

- IEEE 1815.2 Profile Semantic Test
- IEEE 1815.2 Functional Testing per IEEE 1547.1
- IEEE 1815.2 Additional Functions Testing
- IEEE 1815.2 Commissioning on Site

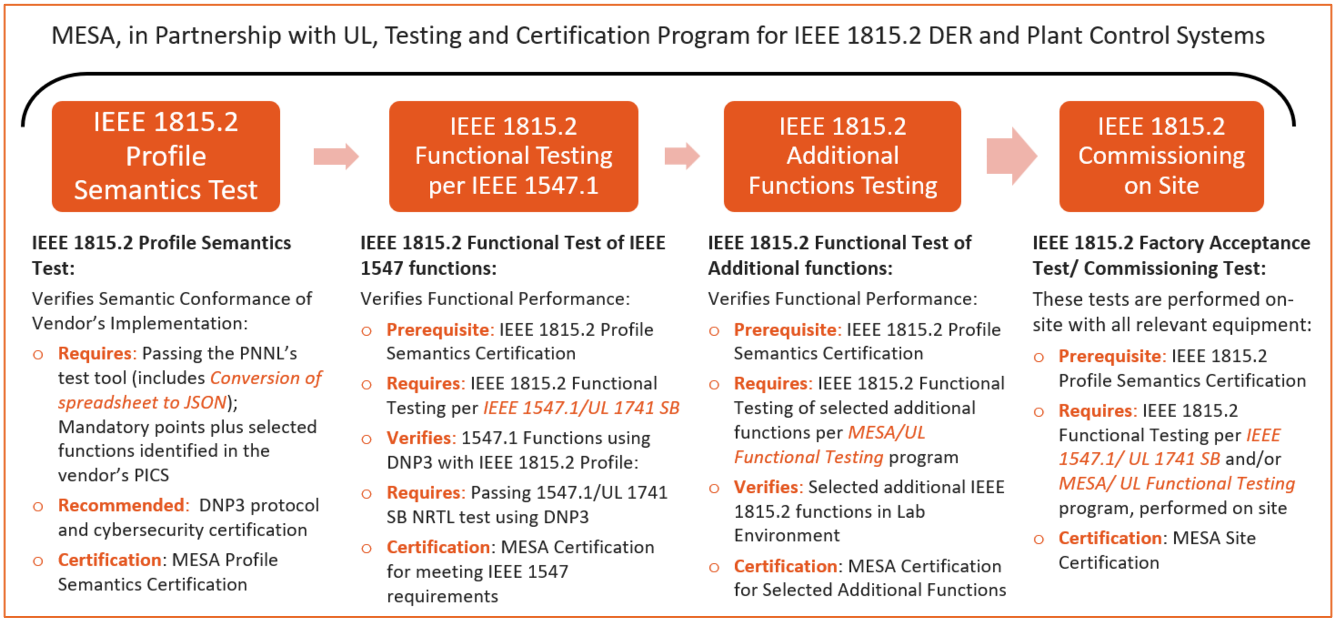


Figure 5: IEEE 1815.2 Testing and Certification Process

Table 1 lists the different types of certifications that MESA provides, the responsible organizations, and their tasks for achieving the different MESA-DER Certifications.

Table 1: IEEE 1815.2 Testing & Responsible Organizations Utilized for MESA Certifications

| MESA CERTIFIED | Test Description | Vendor Self Attestation | DNP User Group Review | UL-managed NRTL Testing | UL & Utility Factory Acceptance/ Site Testing |
|---|---|---|---|---|---|
| **IEEE 1815 DNP3<br>DNP User Group*** | Basic DNP3 protocol and security certification or self-attestation | ✓ | ✓ | | |
| **IEEE 1815.2 Semantic Profile Certification** | IEEE 1815.2 semantic profile conformance testing using PNNL tool with JSON conversion of Profile Spreadsheet | | | ✓ | |
| **IEEE 1815.2 Certification for IEEE 1547.1 Conformance**<br>**UL 1741-SB or later versions*** | IEEE 1547-2018 functional and interoperability lab testing using QualityLogic's or other test tool to meet IEEE 1547.1 testing requirements | | | ✓ | ✓ |
| **IEEE 1815.2 Additional Functional Testing and Certification**<br>*(Under Development)* | Lab testing of additional IEEE 1815.2 functions beyond IEEE 1547:<br>❖ Plant with Energy Storage<br>❖ Plant with IBR<br>❖ Microgrid | | | ✓ | |
| **IEEE 1815.2 FAT and Site Commissioning** | IEEE 1815.2 Functional Test of Plant Control System and all DER units on site (Factory Acceptance/ Commissioning) | | | | ✓ |
| Orange: MESA T&C programs | *Recommended T&C programs managed by others | | | | |

## 3.2 MESA IEEE 1815.2 Profile Semantic Certification Testing (PNNL Tool)

MESA, supported by PNNL, has developed the open-source IEEE 1815.2 Profile Semantic Certification Testing tool, based on conversion of the IEEE 1815.2 Profile Spreadsheet into JSON. The test tool and its documentation is available through GitHub (link available on the MESA website) and can be built from source. This test tool provides the following capabilities:

- Create and/or edit your Protocol Implementation Conformance Statement (PICS)
  - Select supported modes
  - Define upper/lower boundaries
  - Define Curves
  - Define Schedules
- Convert existing spreadsheets into JSON
  - Spreadsheet does not support multiple curve/schedules being defined nor specifying value to set.
  - JSON conversions can support the definition of multiple curve/schedules and the setting of values.
- Run a reference control station against your test outstation
- Run a reference outstation against your test control station

- Provide test reports for individual scenario results.

### 3.3 IEEE 1815.2 Testing and Certification for IEEE 1547.1 Conformance

MESA has partnered with UL to support the testing of IEEE 1815.2 for DER Systems and Plant Management Systems. UL will work with clients who want to test their equipment for conformance with IEEE 1815.2 to meet the IEEE 1547.1 and UL 1741 SB functional requirements using DNP3.

**IEEE 1815.2 certification** will be provided by MESA after the "Equipment Under Test" (EUT) successfully passes the IEEE 1547.1 / UL 1741 SB testing using DNP3 and the IEEE 1815.2 profile semantics.

### 3.4 IEEE 1815.2 Additional Functional Testing and Certification

IEEE 1815.2 includes many functions and capabilities that exceed the IEEE 1547 requirements. MESA has developed Test Procedures for these functions which will be used by UL for developing specific tests.

**IEEE 1815.2 certification** will be provided by MESA after the "Equipment Under Test" (EUT) successfully passes these additional tests.

### 3.5 IEEE 1815.2 Site Commissioning and Certification

IEEE 1815.2 site commissioning will be part of a much larger effort to implement and testing DER systems and Plant Control systems. Neither MESA nor UL will be directly involved in these site commissioning efforts.

However **IEEE 1815.2 certification** will be provided by MESA after the systems successfully passes these site tests.

### 3.6 MESA Certification

MESA is currently offering four types of certifications:

- **MESA IEEE 1815.2 Profile Semantics Certification.** This certification verifies semantics conformance to the IEEE 1815.2 Profile Spreadsheet using the PNNL test tool. The PICS, detailed in the MESA Certification Testing Documents provides the key DNP3 standardized Digital and Analog points required for Profile Semantics Certifications. MESA's profile test tool described in Testing Documents assists detailed testing of the DER device/system
- **MESA IEEE 1815.2 Certification for compliance with IEEE 1547.1 testing.** MESA Certification for IEEE 1547.1 compliance can be included as part of UL 1741-SB Laboratory Testing of the IEEE 1547-2018 functions, using DNP3 as the communication protocol. This testing verifies that MESA-DER signals are properly sent to an energy producing device, such as a solar inverter or energy storage inverter/charger and that these devices respond correctly as required by the IEEE 1547.1 Type Tests in the IEEE 1547.1-2020 Standard.
- **MESA IEEE 1815.2 Additional Functions Certification.** MESA is developing complete testing procedures for DER functions beyond those required for IEEE 1547 and IEEE 1547.1. These new testing procedures also include tests for the new scheduling capability.
- **MESA-DER Site Certification requirements {*Case by case basis*}**. Site testing of MESA-DER systems to validate the laboratory tests in the field.

## Annex A Table of Contents of Complete Guidelines

# Contents

## Annex B How To Join the MESA Alliance

### MESA Membership

**Membership Fee:**

- ✓ Offers entry into working groups and committees
- ✓ Members can be elected to the Board of Directors

**2024 Membership Options:**

**Standard** (Companies with revenue > $1M): $5,000

**Small Business** (Companies with revenue ≤ $1M): $3,000

**MESA/SunSpec Joint Modbus Membership:** $9,000

**Individual/Strategic Partner:** $1,000

**Student:** $350

**Discretionary Allocation to Technical Priorities:**

- ✓ Variable depending on organizational technical priorities
- ✓ Fees can be directed toward a specific project

**2023 Technical Allocation:**

A min $5,000 per company (depends on available funds) focused on MESA-DER certification program development