Document #: X99999

Status: Draft

Version: 1.0

SunSpec DER Information Model Specification

SunSpec Specification

Abstract

This document describes the SunSpec Distributed Energy Resource (DER) information models that provide support for the Institute of Electrical and Electronics Engineers (IEEE) 1547-2018 functionality using SunSpec information modeling.

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Revision History

Version	Date	Comments
1.0	7-15-2019	Initial draft release

About the SunSpec Alliance

The SunSpec Alliance is a trade alliance of developers, manufacturers, operators, and service providers together pursuing open information standards for the distributed energy industry. SunSpec standards address most operational aspects of PV, storage, and other distributed energy power plants on the smart grid, including residential, commercial, and utility-scale systems, thus reducing cost, promoting innovation, and accelerating industry growth.

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SunSpec Alliance specifications are initiated by SunSpec members to establish an industry standard for mutual benefit. Any SunSpec member can propose a technical work item. Given sufficient interest and time to participate, and barring significant objections, a workgroup is formed and its charter is approved by the board of directors. The workgroup meets regularly to advance the agenda of the team.

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SunSpec Interoperability Specifications follow a lifecycle pattern of: DRAFT, TEST, APPROVED, and SUPERSEDED.

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1 Introduction

The SunSpec DER Information Model Specification defines SunSpec Device Information Models for DERs. A primary goal of this specification is to define a standard way for DERs and interfacing systems to exchange information. DERs and controlling entities that implement the models described in this specification can reliably perform DER management by implementing one or more of the following models, which comprise the complete set of DER related functions:

- DER AC Measurement
- DER Capacity
- DER Enter Service
- DER AC Controls
- DER Volt-Var
- DER Volt-Watt
- DER Trip LV
- DER Trip HV
- DER Trip LF
- DER Trip HF
- DER Frequency Droop
- DER Watt-Var
- DER DC Measurement

This specification is intended to be used in conjunction with the SunSpec Device Information Model Specification and is compliant with the information modeling requirements specified in that standard.

This specification supports reading and writing Information Model points implemented in a DER. This document describes the full SunSpec DER Information Model Specification. Developers can choose how much or how little to implement.

DER information models aim to achieve the following:

- Adhere to the SunSpec Device Information Model specification.
- Support all DER interoperability functionality specified in IEEE 1547-2018
- Define consistent implementation guidelines for all DERs that make it easy for developers to implement interoperable DER solutions.

1.1 Document Organization

Chapter 2 lists the standards documents that are normative references for this document.

Chapter 3 provides an introduction to DER management functions and the application of the DER Information Model.

125 Chapter 4 provides a detailed specification for each of the standardized SunSpec DER
126 Information Models, specifying points, point groups, and their valid attributes and values.

127 1.2 Terminology

Definition element	Definition elements are associated with a Device Information Model and describe the model data structure and usage. A definition element can have a value or provide a container for other elements. The Device Information Model defines the following elements: • model • point • point group • symbol • comment Definition elements have attributes that qualify or describe the element.
Device	A device is an entity that exchanges data across communications interfaces. A device has a data set, modeled by Device Information Models, that describes physical and state information about the device. The device data set is the set of logically-related data points specific to the device type. The collections of Device Information Models that describe the data set correspond to the full set of device data points supported by the device.
Device Information Model	The Device Information Model is used to structure device data for exchange across communications interfaces. The model provides a mechanism for specifying the data set supported by a device, which consists of a set of standardized definition elements.
Device Information Model definition	A Device Information Model definition specifies the data points that make up the particular Device Information Model and the usage information associated with each data point. There is one definition for each Device Information Model. Device Information Model definitions represent collections of device data points. The canonical form of Device Information Model definitions are specified using JSON encoding.
Device Information Model instance	A Device Information Model instance is created from a Device Information Model definition. The instance includes data point values specified for each of the defined data points. There can be any number of instances of a Device Information Model.
May trip	A set of conditions where a DER is allowed to trip but is not required to trip.

Model	A Device Information Model *model* element defines a logical grouping of *points*. Each *model* has a unique model ID.
Momentary cessation	Suspension of injection of active power based on current conditions. It implies the ability to resume injection immediately on a change of conditions.
MUST, MUST NOT, REQUIRED, SHALL, SHALL NOT, SHOULD, SHOULD NOT, RECOMMENDED, MAY, and OPTIONAL	The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this specification, are to be interpreted as described in IETF RFC 2119.
Must trip	A set of conditions where a DER must trip.
Point	A Device Information Model *point* element defines a device data point and has a value.
Point group	A Device Information Model *group* element contains a group of *points* and/or other *point groups*.
Point group, top-level	The top-level point group is the first element of a Device Information Model and contains all other elements.
Reversion timer	A timer that limits the duration of a control, which implies a behavior to revert to on the termination of the control based on timer expiration.
Symbol	A Device Information Model *symbol* element defines a name-value pair. It is used to represent a constant value associated with the enumerated value or bit position of a *point*.
Trip	Cessation of injection of power by the DER. Implies a set of conditions must be met to resume injection of power.

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2 Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

IEEE 1547-2018, Standard for Interconnection and Interoperability of Distributed Energy Resources With Associated Electric Power Systems Interfaces, Apr. 2018, <https://ieeexplore.ieee.org/document/8332112>.

SunSpec X99999; SunSpec Device Information Model Specification, version 0.1, May 2019.

3 Overview

This section presents the following general DER topics that apply to multiple information models:

- Curve management as applied to control functions that use linear curves to indicate the behavior associated with the function. Some information models have curve instances as data points.
- Reversion timers, which are used to limit the time a function operates with a specific set of settings.
- A trip/momentary cessation curve encoding for representing behavior during frequency and voltage disturbances.

3.1 Curve Management

Some control functions use piece-wise linear curves to indicate the behavior associated with the function. All functions that utilize curves have a set of curve management points, which can be updated to modify basic curve management functionality:

Symbol	Description	Access
Ena	Determines if the function is enabled or disabled.	read/write
CrvSt	Indicates the current state of the curve setting.	read-only
AdptCrvReq	Select a new curve setting.	read/write
AdptCrvRslt	Result of the AdptCrvReq operation.	read-only
NPt	Number of possible curve points in each curve instance.	read-only
NCrv	Number of curve instances.	read-only
ActPt	Number of active points in the curve	read/write

Table 1: Curve Management Points

3.1.1 Curve Layout

A control function information model that uses a curve contains a configurable number of curves that have a configurable number of points:

- number of curves (NCrv)
- number of points in each curve (NPt)

Device Information Model curve instances occupy sequential locations in the information model. Each curve instance is represented by a sequential set of points that together define the behavior associated with the curve function. Each point is represented by one or more values, and the NPt point specifies the number of possible points in each curve instance. The ActPt point specifies the number of points that currently active in the curve.

A Device Information Model that uses curves MUST contain at least two curve instances. The first curve instance is a read-only curve instance that contains the current curve settings. Subsequent curve instances hold curve settings that can be used to update the current curve settings.

3.1.2 Curve States

The function associated with a curve can be in one of the following states:

- disabled
- inactive
- active

The following figure shows the curve states and state transition events:

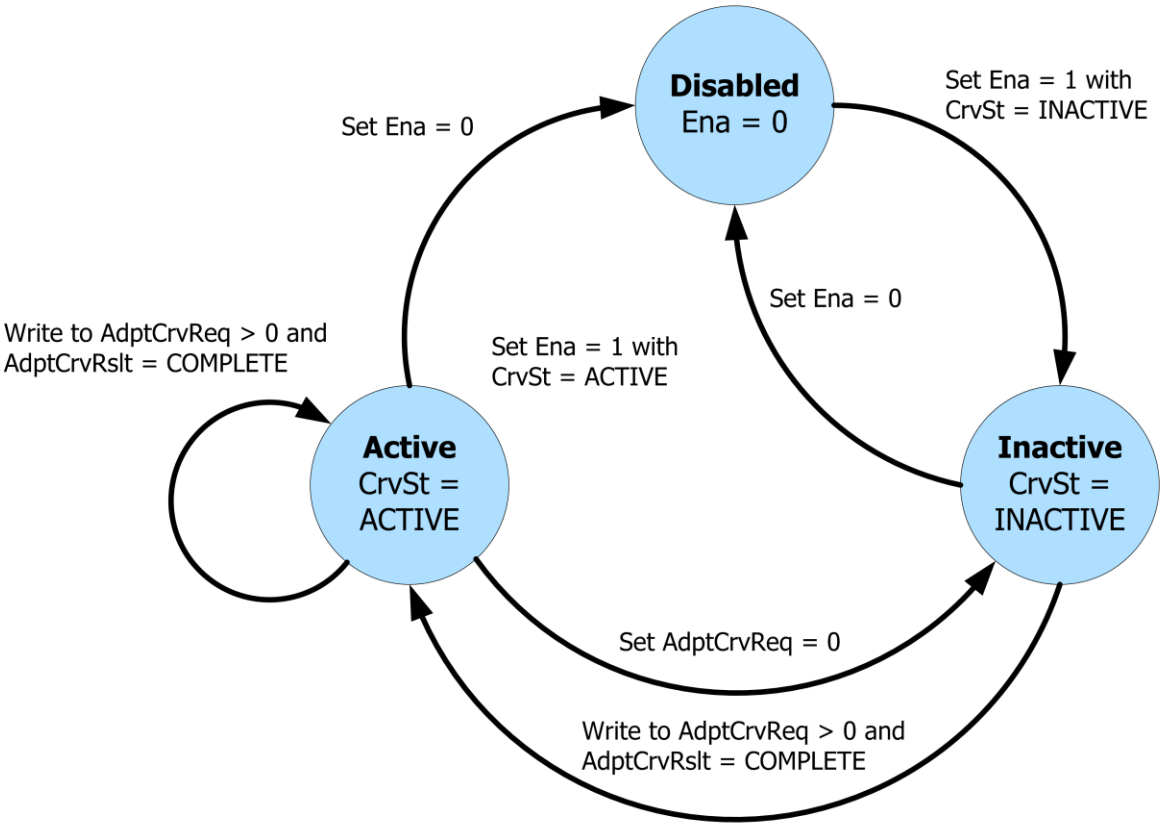

Figure 1: Curve Function States

Two points in the information model represent the three curve state:

- enable (`Ena`)
- curve state (`CrvSt`).

The enable point (`Ena`) determines if the function is enabled or disabled. If the enable point is set to zero (`0`) the function is disabled, and the setting associated with the function SHALL NOT be effective. If the enable point is set to one (`1`), the function SHALL be enabled, and the settings are active based on other points in the information model.

The read-only curve state point (CrvSt) indicates the current state of the curve settings, and its value SHALL be determined by interaction with other information model points. If the value of the curve state is INACTIVE, the curve setting values SHALL be inactive, and the function has no operational effect. If the value of the curve state is ACTIVE and the function is enabled, the current curve setting values SHALL be valid and the curve settings SHALL be operational. The curve settings can be active when the function is disabled.

New curve settings MUST be selected by writing one of the curve indexes to the adopt curve request point (AdptCrvReq). The index value MUST be greater than one (1), which is the index of the active curve. This operation SHALL cause the settings located at the specified curve index to be copied to the active curve settings. The result of the operation SHALL update the adopt curve response point (AdptCrvRslt) with is one of the following values:

- IN_PROGRESS
- COMPLETED
- FAILED

If the result is COMPLETED, the curve state SHALL be ACTIVE and reading the curve settings at curve index one (1) MUST reflect the updated settings.

If a set of active curve settings update is in progress, the current curve settings MUST remain active until the updated curve settings are accepted and made operational. If the update fails, the current settings MUST remain effective without interruption.

3.2 Reversion Timers

A reversion timer SHALL be used to limit the time a function operates with a specific set of settings. If a reversion timer is enabled for a function and the timer expires without an update, the function MUST revert to an alternate set of settings. If a setting is updated while the reversion timer is active or the function is re-enabled, the reversion timer MUST be reinitialized with the reversion timeout value, and the timer is restarted.

The following data points SHALL manage reversion timer functionality:

- reversion timeout value (RvrtTms)
- reversion time remaining (RvrtRem)
- alternate, function-dependent revision settings

The following figure shows reversion timer states and state transition events:

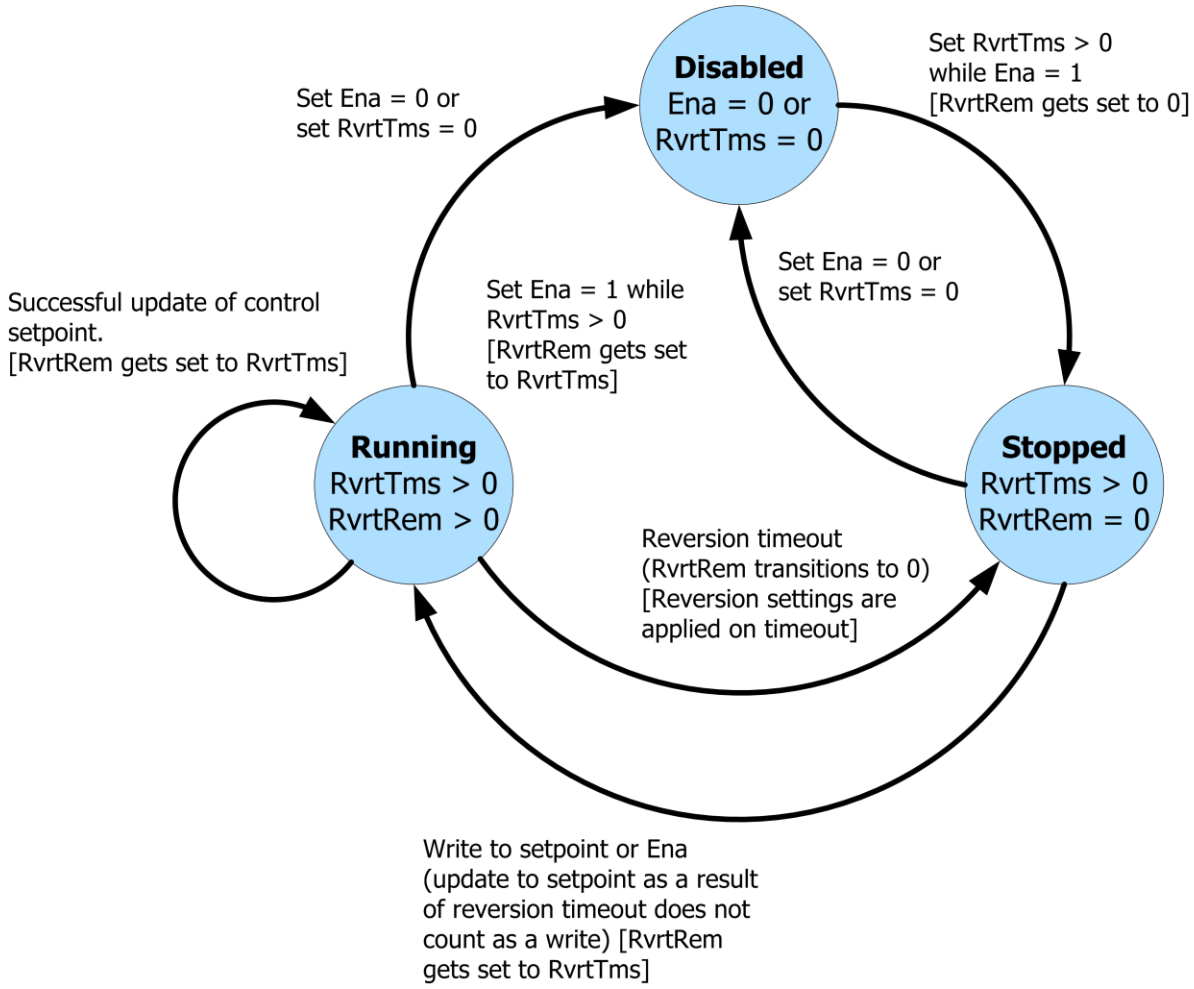

Figure 2: Reversion Timer States

A reversion timer MUST be in one of the following states:

- Disabled
- Stopped
- Running

If a reversion timer is in the Disabled state, the reversion timer SHALL not affect the current function settings. In this state, the function MUST be either not enabled or the reversion timeout value MUST be set to zero (0).

If a reversion timer is in the Stopped state, the reversion timer SHALL not affect the current function settings. If a function setting is changed or the function re-enabled, the reversion timer MUST be reinitialized with the reversion timeout value, and the timer MUST be restarted.

If the reversion timer is in the Running state, the reversion time remaining SHALL indicate the time interval remaining until the reversion timer expires. When the revision timer expires, the specified alternate set of function settings MUST be applied to the function and the reversion timer transitions to the Stopped state.

3.3 Trip/Momentary Cessation Settings

This section presents general information about the trip and momentary cessation settings for frequency and voltage disturbances.

3.3.1 Terminology Clarification

Historically, in communications information models, the term “ride-through” has been used as the general term referring to settings associated with voltage and frequency disturbance. However, IEEE 1547-2018 indicates that “ride-through” is a capability and that the term “ride-through” should not be used for settings. The preferred term that has been proposed generally is “disturbance response settings”. It is recommended that the term “ride-through” SHOULD NOT be used to describe the settings.

3.3.2 Trip/Momentary Cessation Region Representation

It is desirable to use a flexible mechanism to represent voltage and frequency trip regions and to handle as many use cases as possible. For example, the curves in some standards[1] require diagonal segments that cannot be represented using rectangular regions.

The trip and momentary cessation curves can be represented as piece-wise linear curves that define the regions associated with voltage and frequency trip, and momentary cessation behavior.

Most threshold requirements can be represented by providing a method that defines the following three regions.

Region	DER Behavior	Precedence Hierarchy
trip	When the trip region is entered, the DER SHALL trip.	1 (highest)
may trip	When the may trip region is entered, the DER may either continue in its current operational mode or trip.	3
momentary cessation	When the momentary cessation region is entered, the DER SHALL cease to energize but SHALL NOT trip.	2

Table 2: Voltage and Frequency Trip Regions

Each region boundary is defined by a piece-wise linear curve such that when crossing the *may trip* curve, the DER is in the *may trip* region.

When crossing a curve of higher precedence, the DER MUST assume the behavior of the higher precedence.

[1] European Network Code Requirements for Generators (RfG), “ENTSO-E Network Code for Requirements for Grid Connection Applicable to all Generators,” 2016.

The difference between the *trip* and *momentary cessation* is the process of resuming operation after that region has been entered. The general distinction is that resumption from *momentary cessation* may be done fully and immediately on leaving the region, while resumption from *trip* may require additional considerations such as a delay and ramping operation. The exact resumption process may vary based on grid code and additional parameters. Because of the limits of some DERs, galvanic isolation may or may not be provided on a *trip*.

The following figure shows an example of the CA Rule 21 trip/momentary cessation curves for voltage, and Table 3 shows curve points for the voltage example reference.

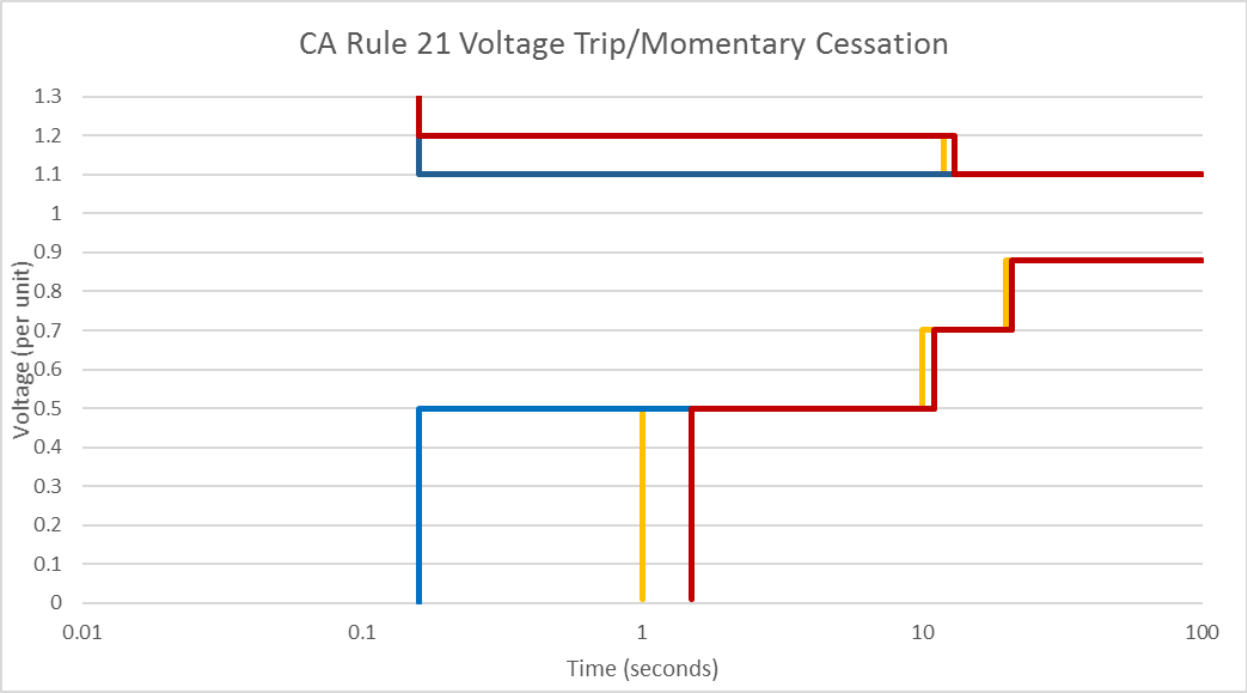

Figure 3: Voltage Trip Momentary Cessation

Curve	Points
LV Trip	(1.5, 0), (1.5, .5), (11, .5), (11, .7), (21, .7), (21, .88), (22, .88)
LV Momentary Cessation	(.16, 0), (.16, .5), (1.5, .5)
LM May Trip	(1,0), (1, .5), (10, .5), (10, .7), (20, .7), (20, .88), (22, .88)
HV Trip	(.16, 1.3), (.16, 1.2), (13, 1.2), (13, 1.1), (14, 1.1)
HV Momentary Cessation	(.16, 1.3), (.16, 1,1), (14, 1.1)
HV May Trip	(.16, 1.3), (.16, 1.2), (12, 1.2), (12, 1.1), (14, 1.1)

Table 3: Voltage Trip Momentary Cessation Points

3.3.3 Configuration

A DER is typically configured with only the trip and momentary cessation curves, provided the behavior complies with the interconnection certification standard. The *may trip* curve can be useful if the DER makes use of the optional regions. The *may trip* curve represents the minimum ride-through requirements.

Currently, frequency disturbance response standards do not include momentary cessation regions so only the *trip* curve SHALL be required. An optional *may trip* curve MAY be configured.

Curves are assumed to extend infinitely vertically from the first point on the curve (positive voltage direction for HV and negative voltage direction for LV), and horizontally (positive time) from the last point on the curve.

It is recognized that DERs might have significant limitations on the shape of the curves it can support. Many DERs might only be able to support curves with vertical and horizontal curve segments within very specific ranges.

3.4 Mandatory/Optional Points

The designation of points in a model as mandatory is based on the core functionality of the model. If a model would be become non-functional without the point being implemented, it is defined as mandatory. This designation is not meant to represent requirements for any other standard or juristic ion. Refer to the specific standards or jurisdictional guides for implementation requirements.

4 DER Information Models

This section describes each of the SunSpec DER Information Models:

- DER AC Measurement
- DER Capacity
- DER Enter Service
- DER AC Controls
- DER Volt-Var
- DER Volt-Watt
- DER Trip LV
- DER Trip HV
- DER Trip LF
- DER Trip HF
- DER Frequency Droop
- DER Watt-Var
- DER DC Measurement

These models provide a standardized way to implement communication protocols of DERs for common DER management functions. Each model specification includes a point summary for the model followed by a detailed description of each point. Points that are part of a point group are indicated in the descriptions.

The summary tables list the following attributes for each point of the model:

Point or Point Group name	The Point or Point Group name field is the acronym associated with the point. A Point Group has a name and a type and includes the points below it, as indicated by indentation.
Point label	The Point label field
Point data type	The point data type field specifies the data type of the point.
Point access capability	The point access capability field specifies whether the point read-only (`R`) or read-write (`RW`).
Point implementation requirement	The Point implementation requirement field specifies whether the point is mandatory (`M`), or optional (`O`).

The detailed point description of each point in a model includes:

- point or point group name, which is the same as the name in the point summary table.
- detailed description of the point or point group, including enumerated values for the point.

4.1 DER AC Measurement

The DER AC Measurement information model contains the measurement data associated with the DER along with current status and alarm information. Neither the status nor the alarm information points are latched. They both reflect the current state of the DER and change when that status or alarm state changes.

Group/Point Name	Label	Data Type	R/RW	M/O
DERMeasureAC	DER AC Measurement	group		
ID	DER AC Measure Model ID	uint16	R	M
L	DER AC Measure Model Length	uint16	R	M
ACType	AC Wiring Type	enum16	R	O
St	Operating State	enum16	R	M
Alrm	Alarm Bitfield	bitfield32	R	M
W	Active Power	int16	R	O
VA	Apparent Power	int16	R	O
VAR	Reactive Power	int16	R	O
PF	Power Factor	int16	R	O
A	Total AC Current	int16	R	O
PhPhV	Voltage LL	int16	R	O
PhV	Voltage LN	int16	R	O
Hz	Frequency	int16	R	O
TotWhInj	Total Energy Injected	acc64	R	O
TotWhAbs	Total Energy Absorbed	acc64	R	O
TotVarhInj	Total Reactive Energy Inj	acc64	R	O
TotVarhAbs	Total Reactive Energy Abs	acc64	R	O
TmpAmb	Ambient Temperature	int16	R	O
TmpCab	Cabinet Temperature	int16	R	O
TmpSnk	Heat Sink Temperature	uint16	R	O
TmpTrns	Transformer Temperature	int16	R	O
TmpSw	IGBT/MOSFET Temperature	int16	R	O
TmpOt	Other Temperature	int16	R	O
WPhA	Watts Ph A	int16	R	O
VAPhA	VA Ph A	int16	R	O
VARPhA	VAR Ph A	int16	R	O
PFPhA	PF Ph A	int16	R	O
APhA	Amps Ph A	int16	R	O
VPhAB	Phase Voltage AB	int16	R	O
VPhA	Phase Voltage AN	int16	R	O
TotWhInjPhA	Total Watt-hours Inj Ph A	acc64	R	O
TotWhAbsPhA	Total Watt-hours Abs Ph A	acc64	R	O
TotVarhInjPhA	Total Var-hours Inj Ph A	acc64	R	O

Group/Point Name	Label	Data Type	R/RW	M/O
TotVarhAbsPh	Total Var-hours Abs Ph A	acc64	R	O
WPhB	Watts Ph B	int16	R	O
VAphB	VA Ph B	int16	R	O
VARPhB	VA Ph B	int16	R	O
PFPhB	PF Ph B	int16	R	O
APhB	Amps Ph B	int16	R	O
VPhBC	Phase Voltage BC	int16	R	O
VPhB	Phase Voltage BN	int16	R	O
TotWhInjPhB	Total Watt-hours Inj Ph B	acc64	R	O
TotWhAbsPhB	Total Watt-hours Abs Ph B	acc64	R	O
TotVarhInjPhB	Total Var-hours Inj Ph B	acc64	R	O
TotVarhAbsPhB	Total Var-hours Abs Ph B	acc64	R	O
WPhC	Watts Ph C	int16	R	O
VAPhC	VA Ph C	int16	R	O
VARPhC	VAR Ph C	int16	R	O
PFPhC	PF Ph C	int16	R	O
APhC	Amps Ph C	int16	R	O
VPhCA	Phase Voltage CA	int16	R	O
VPhCN	Phase Voltage CN	int16	R	O
TotWhInjPhC	Total Watt-hours Inj Ph C	acc64	R	O
TotWhAbsPhC	Total Watt-hours Abs Ph C	acc64	R	O
TotVarhInjPhC	Total Var-hours Inj Ph C	acc64	R	O
TotVarhAbsPh	Total Var-hours Abs Ph C	acc64	R	O
A_SF	Current Scale Factor	sunssf	R	O
V_SF	Voltage Scale Factor	sunssf	R	O
Hz_SF	Frequency Scale Factor	sunssf	R	O
W_SF	Real Power Scale Factor	sunssf	R	O
PF_SF	Power Factor Scale Factor	sunssf	R	O
VA_SF	Apparent Power Scale Factor	sunssf	R	O
VAR_SF	Reactive Power Scale Factor	sunssf	R	O
TotWh_SF	Real Energy Scale Factor	sunssf	R	O
TotVarh_SF	Reactive Energy Scale Factor	sunssf	R	O
Tmp_SF	Temperature Scale Factor	sunssf	R	O

Table 4: DER AC Measurement Points

316 # *DERMeasureAC Points*

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DERMeasureAC	DER AC measurement model.
ID	The model ID of the DER AC Measurement model. The value MUST be a constant value of 701.
L	This point is only valid for model instances that have a length associated with a model instance. For Modbus implementations.
ACType	AC wiring type: SINGLE_PHASE (1) = Single phase SPLIT_PHASE (2) = Split phase THREE_PHASE_DELTA (3) = Three phase delta THREE_PHASE_WYE (4) = Three phase wye
St	Operating state of the DER: OFF (1) = Off ON (2) = On FAULT (3) = Fault ERROR (4) = Error
Alrm	Active alarms for the DER: GROUND_FAULT (0) = Ground fault DC_OVER_VOLT (1) = DC over voltage AC_DISCONNECT (2) = AC disconnect open DC_DISCONNECT (3) = DC disconnect open GRID_DISCONNECT (4) = Grid disconnect CABINET_OPEN (5) = Cabinet open MANUAL_SHUTDOWN (6) = Manual shutdown OVER_TEMP (7) = Over temperature OVER_FREQUENCY (8) = Frequency above limit UNDER_FREQUENCY (9) = Frequency under limit AC_OVER_VOLT (10) = AC Voltage above limit AC_UNDER_VOLT (11) = AC Voltage under limit BLOWN_STRING_FUSE (12) = Blown String fuse on input UNDER_TEMP (13) = Under temperature MEMORY_LOSS (14) = Generic Memory or Communication error (internal) HW_TEST_FAILURE (15) = Hardware test failure
W	Scale Factor: W_SF The active power being injected or absorbed in watts. The value is positive if power is being injected and negative if power is being absorbed.

VA	Scale Factor: VA_SF Units: VA The apparent power being injected or absorbed in volt-amps. The value is positive if power is being injected and negative if power is being absorbed.
VAR	Scale Factor: Var_SF Units: Var The reactive power being injected or absorbed in volt-amps. The value is positive if power is being injected and negative if power is being absorbed.
PF	Scale Factor: PF_SF The power factor as the ratio of active power to apparent power.
A	Scale Factor: A_SF The total AC current being injected or absorbed in amps. The value is positive if power is being injected and negative if power is being absorbed.
PhPhV	Scale Factor: V_SF Line to line AC voltage as an average of active phases.
PhV	Scale Factor: V_SF Line to neutral AC voltage as an average of active phases.
Hz	Scale Factor: Hz_SF Units: Hz AC frequency.
TotWhInj	Scale Factor: TotWh_SF Units: Wh Total active energy injected (Quadrants 1 & 4).
TotWhAbs	Scale Factor: TotWh_SF Units: Wh Total active energy absorbed (Quadrants 2 & 3).

TotVarhInj	Scale Factor: TotVar_SF Units: Varh Total reactive energy injected (Quadrants 1 & 2).
TotVarhAbs	Scale Factor: TotVar_SF Units:Varh Total reactive energy absorbed (Quadrants 3 & 4).
TmpAmb	Scale Factor: Tmp_SF Ambient temperature.
TmpCab	Scale Factor: Tmp_SF Cabinet temperature.
TmpSnk	Scale Factor: Tmp_SF Heat sink temperature.
TmpTrns	Scale Factor: Tmp_SF Transformer temperature.
TmpSw	Scale Factor: Tmp_SF IGBT/MOSFET temperature.
TmpOt	Scale Factor: Tmp_SF Units: Other temperature.
WPhA	Scale Factor: W_SF Active power phase A.

VAPhA	Scale Factor: VA_SF Units: VA Apparent power phase A.
VarPhA	Scale Factor: Var_SF Units: Var Reactive power phase A.
PFPhA	Scale Factor: PF_SF Power factor phase A.
APhA	Scale Factor: A_SF Current phase A.
VPhAB	Scale Factor: V_SF Phase voltage AB.
VPhA	Scale Factor: V_SF Phase voltage AN.
TotWhInjPhA	Scale Factor: TotWh_SF Units: Wh Total active energy injected phase A.
TotWhAbsPhA	Scale Factor: TotWh_SF Units: Wh Total active energy absorbed phase A.
TotVarhInjPhA	Scale Factor: TotVarh_SF Units: Varh Total reactive energy injected phase A.
TotVarhAbsPh	Scale Factor: TotVarh_SF Units: Varh Total reactive energy absorbed phase A.

WPhB	Scale Factor: W_SF Active power phase B.
VAPhB	Scale Factor: VA_SF Units: VA Apparent power phase B.
VarPhB	Scale Factor: Var_SF Units: Var Reactive power phase B.
PFPhB	Scale Factor: PF_SF Power factor phase B.
APhB	Scale Factor: A_SF Current phase B.
VPhBC	Scale Factor: V_SF Phase voltage BC.
VPhB	Scale Factor: V_SF Phase voltage BN.
TotWhInjPhB	Scale Factor: TotWh_SF Units: Wh Total active energy injected phase B.
TotWhAbsPhB	Scale Factor: TotWh_SF Units: Wh Total active energy absorbed phase B.
TotVarhInjPhB	Scale Factor: TotVarh_SF Units: Varh Total reactive energy injected phase B.

TotVarhAbsPhB	Scale Factor: TotVarh_SF Units: Varh Total reactive energy absorbed phase B.
WPhC	Scale Factor: W_SF Active power phase C.
VAPhC	Scale Factor: VA_SF Units: VA Apparent power phase C.
VarPhC	Scale Factor: Var_SF Units: Var Reactive power phase C.
PFPhC	Scale Factor: PF_SF Power factor phase C.
APhC	Scale Factor: A_SF Current phase C.
VPhCA	Scale Factor: V_SF Phase voltage CA
VPhC	Scale Factor: V_SF Phase voltage CN.
TotWhInjPhC	Scale Factor: TotWh_SF Units: Wh Total active energy injected phase C.
TotWhAbsPhC	Scale Factor: TotWh_SF Units: Wh Total active energy absorbed phase C.

TotVarhInjPhC	Scale Factor: TotVarh_SF Units: Varh Total reactive energy injected phase C.
TotVarhAbsPhC	Scale Factor: TotVarh_SF Units: Varh Total reactive energy absorbed phase C.
A_SF	Current scale factor.
V_SF	Voltage scale factor.
Hz_SF	Frequency scale factor.
W_SF	Active power scale factor.
PF_SF	Power factor scale factor.
VA_SF	Apparent power scale factor.
VAR_SF	Reactive power scale factor.
TotWh_SF	Active energy scale factor.
TotVarh_SF	Reactive energy scale factor.
Tmp_SF	Temperature scale factor.

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4.2 DER Capacity

The DER Capacity information model contains ratings for the DER that are read-only and settings for the DER that can be used to override some ratings.

The settings that are made available in an installation SHOULD default to the rating value. If a setting is adjusted from the default value, the setting value SHALL be used in place of the associated rating for any functions that use that rating to determine functional behavior.

Group/Point Name	Label	Data Type	R/RW	M/O
DERCapacity	DER Capacity	group		
ID	DER Capacity Model ID	uint16	R	M
L	DER Capacity Model Length	uint16	R	M
WMaxRtg	Active Power Max Rating	uint16	R	O
WOvrExtRtg	Active Power (Over-Excited) Rating	uint16	R	O
WOvrExtRtgPF	Specified Over-Excited PF	uint16	R	O
WUndExtRtg	Active Power (Under-Excited) Rating	uint16	R	O
WUndExtRtgPF	Specified Under-Excited PF	uint16	R	O
VAMaxRtg	Apparent Power Max Rating	uint16	R	O
VarMaxInjRtg	Reactive Power Injected Rating	uint16	R	O
VarMaxAbsRtg	Reactive Power Absorbed Rating	uint16	R	O
WChaRteMaxRtg	Charge Rate Max Rating	uint16	R	O
WDisChaRteMaxRtg	Discharge Rate Max Rating	uint16	R	O
VAChaRteMaxRtg	Charge Rate Max VA Rating	uint16	R	O
VADisChaRteMaxRtg	Discharge Rate Max VA Rating	uint16	R	O
VNomRtg	AC Voltage Nominal Rating	uint16	R	O
VMaxRtg	AC Voltage Max Rating	uint16	R	O
VMinRtg	AC Voltage Min Rating	uint16	R	O
AMaxRtg	AC Current Max Rating	uint16	R	O
PFOvrExtRtg	PF Over-Excited Rating	uint16	R	O
PFUndExtRtg	PF Under-Excited Rating	uint16	R	O
NorOpCatRtg	Normal Operating Category	enum16	R	O
AbnOpCatRtg	Abnormal Operating Category	enum16	R	O
WMax	Active Power Max Setting	uint16	RW	O
VAMax	Apparent Power Max Setting	uint16	RW	O
Amax	AC Current Max Setting	uint16	RW	O
Vref	Nominal AC Voltage Setting	uint16	RW	O
VRefOfs	Nominal AC Voltage Offset Setting	uint16	RW	O
Vmax	AC Voltage Max Setting	uint16	RW	O
Vmin	AC Voltage Min Setting	uint16	RW	O
VarMaxInj	Reactive Power Injected Setting	uint16	RW	O
VarMaxAbs	Reactive Power Absorbed Setting	uint16	RW	O
WChaRteMax	Charge Rate Max Setting	uint16	RW	O

Group/Point Name	Label	Data Type	R/RW	M/O
WDisChaRteMax	Discharge Rate Max Setting	uint16	RW	O
VAChaRteMax	Charge Rate Max VA Setting	uint16	RW	O
VADisChaRteMax	Discharge Rate Max VA Setting	uint16	RW	O
W_SF	Active Power Scale Factor	sunssf	R	O
PF_SF	Power Factor Scale Factor	sunssf	R	O
VA_SF	Apparent Power Scale Factor	sunssf	R	O
Var_SF	Reactive Power Scale Factor	sunssf	R	O
V_SF	Voltage Scale Factor	sunssf	R	O
A_SF	Current Scale Factor	sunssf	R	O

Table 5: DER Capacity Points

DERCapacity Points

DERCapacity — DER capacity model.

ID — DER capacity model ID. The value MUST be a constant value of 702.

L — DER capacity model length.

WMaxRtg — Scale Factor: W_SF

Maximum active power rating at unity power factor in watts.

WOvrExtRtg — Scale Factor: W_SF

Active power rating at specified over-excited power factor in watts.

WOvrExtRtgPF — Scale Factor: PF_SF

Active power rating at specified over-excited power factor in watts.

WUndExtRtg — Scale Factor: W_SF

Active power rating at specified under-excited power factor in watts.

WUndExtRtgPF — Scale Factor: PF_SF

Specified under-excited power factor.

VAMaxRtg	Scale Factor: VA_SF Units: VA Maximum apparent power rating in volt-amperes.
VarMaxInjRtg	Scale Factor: Var_SF Units: Var Maximum injected reactive power rating in vars.
VarMaxAbsRtg	Scale Factor: Var_SF Units: Var Maximum absorbed reactive power rating in vars.
WChaRteMaxRtg	Scale Factor: W_SF Maximum active power charge rate in watts.
WDisChaRteMaxRtg	Scale Factor: W_SF Maximum active power discharge rate in watts.
VAChaRteMaxRtg	Scale Factor: VA_SF Units: VA Maximum apparent power charge rate in volt-amperes.
VADisChaRteMaxRtg	Scale Factor: VA_SF Units: VA Maximum apparent power discharge rate in volt-amperes.
VNomRtg	Scale Factor: V_SF AC voltage nominal rating.
VMaxRtg	Scale Factor: V_SF AC voltage maximum rating.
VMinRtg	Scale Factor: V_SF AC voltage minimum rating.

AMaxRtg	Scale Factor: A_SF AC current maximum rating in amps.
PFOvrExtRtg	Scale Factor: PF_SF Power factor over-excited rating.
PFUndExtRtg	Scale Factor: PF_SF Power factor under-excited rating.
NorOpCatRtg	Normal operating performance category as specified in IEEE 1547-2018: CAT_A (1) = CAT_B (2) =
AbnOpCatRtg	Abnormal operating performance category as specified in IEEE 1547-2018: CAT_1 (1) = CAT_2 (2) = CAT_3 (3) =
WMax	Maximum active power setting used to adjust maximum active power rating.
VAMax	Maximum apparent power setting used to adjust maximum apparent power rating.
Amax	Maximum AC current setting used to adjust maximum AC current rating.
Vref	Nominal AC voltage setting.
VRefOfs	Nominal AC voltage offset setting.
Vmax	AC voltage maximum setting used to adjust AC voltage maximum rating.
Vmin	AC voltage minimum setting used to adjust AC voltage maximum rating.
VarMaxInj	Maximum injected reactive power setting used to adjust maximum injected reactive power rating.

VarMaxAbs	Maximum absorbed reactive power setting used to adjust maximum absorbed reactive power rating.
WChaRteMax	Maximum active power charge rate setting used to adjust maximum active power charge rate rating.
WDisChaRteMax	Maximum active power discharge rate setting used to adjust maximum active power discharge rate rating.
VAChaRteMax	Maximum apparent power charge rate setting used to adjust maximum apparent power charge rate rating.
VADisChaRteMax	Maximum apparent power discharge rate setting used to adjust maximum apparent power discharge rate rating.
W_SF	Active power scale factor.
PF_SF	Power factor scale factor.
VA_SF	Apparent power scale factor.
Var_SF	Reactive power scale factor.
V_SF	Voltage scale factor.
A_SF	Current scale factor.

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4.3 DER Enter Service

The DER Enter Service information model contains the Permit Enter Service point which determines if a DER is permitted to energize on the grid as well as points that contain the conditions that must be present to allow the DER to reenergize after tripping. If the Permit Enter Service is set to disabled while energized, the DER MUST cease to energize and trip.

Group/Point Name	Label	Data Type	R/RW	M/O
DEREnterService	Enter Service	group		
L	Enter Service Length	uint16	R	M
ES	Permit Enter Service	enum16	RW	M
ESVHi	Enter Service Voltage High	uint16	RW	O
ESVLo	Enter Service Voltage Low	uint16	RW	O
ESHzHi	Enter Service Frequency High	uint16	RW	O
ESHzLo	Enter Service Frequency Low	uint16	RW	O
ESDlyTms	Enter Service Delay Time	uint16	RW	O
ESRndTms	Enter Service Random Delay	uint16	RW	O
ESRmpTms	Enter Service Ramp Time	uint16	RW	O
V_SF	Voltage Scale Factor	sunssf	R	O
Hz_SF	Frequency Scale Factor	sunssf	R	O

Table 6: DER Enter Service Points

DEREnterService Points

DEREnterService — Enter service.

ID — Enter service model ID. The value MUST be a constant value of 703.

L — Enter service model length.

ES — Permit enter service:
DISABLED (0) = Cease to energize and trip, remain de-energized
ENABLED (1) = Permitted to energize

ESVHi — Scale Factor: V_SF
Units: Pct

Enter service voltage high threshold as a percent of normal voltage.

ESVLo	Scale Factor: V_SF Units: Pct Enter service voltage low threshold as a percent of normal voltage.
ESHzHi	Scale Factor: Hz_SF Units: Hz Enter service frequency high threshold
ESHzLo	Scale Factor: Hz_SF Units: Hz Enter service frequency low threshold.
ESDlyTms	Units: Secs Enter service delay time in seconds.
ESRndTms	Units: Secs Enter service random delay in seconds.
ESRmpTms	Units: Secs Enter service ramp time in seconds.
V_SF	Voltage scale factor.
Hz_SF	Frequency scale factor.

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4.4 DER AC Controls

The DER AC Controls information model provides a group of immediate controls that include power factor when injecting power, power factor when absorbing power, limit active power, set active power, and set reactive power. Each control also provides reversion timer functionality that, if implemented, MUST conform to the reversion timer behavior specified in 3.2 Reversion Timers

Synchronization groups are used for all power factor value pairs as they consist of a power factor and excitation value. The power factor and excitation values MUST be processed atomically when read and written.

Group/Point Name	Label	Data Type	R/RW	M/O
DERCtlAC	DER AC Controls	group		
ID	Model ID	uint16	R	M
L	Model Length	uint16	R	M
PFWInjEna	Power Factor Enable (W Inj) Enable	enum16	RW	O
DERCtlAC.PFWInj		sync		
PF	Power Factor (W Inj)	uint16	RW	O
Ext	Power Factor Excitation (W Inj)	enum32	RW	O
DERCtlAC.PFWInjRvrt		sync		
PF	Reversion Power Factor (W Inj)	uint16	RW	O
Ext	Reversion PF Excitation (W Inj)	enum32	RW	O
PFWInjEnaRvrt	Power Factor (W Inj) Reversion Enable Setting	enum16	R	O
PFWInjRvrtTms	PF Reversion Time (W Inj)	uint32	RW	O
PFWInjRvrtRem	PF Reversion Time Rem (W Inj)	uint32	R	O
PFWAbsEna	Power Factor Enable (W Abs) Enable	enum16	RW	O
DERCtlAC.PFWAbs		sync		
PF	Power Factor (W Abs)	uint16	RW	O
Ext	Power Factor Excitation (W Abs)	enum32	RW	O
DERCtlAC.PFWAbsRvrt		sync		
PF	Reversion Power Factor (W Abs)	uint16	RW	O
Ext	Reversion PF Excitation (W Abs)	enum32	RW	O
PFWAbsEnaRvrt	Power Factor (W Abs) Reversion Enable Setting	enum16	R	O
PFWAbsRvrtTms	PF Reversion Time (W Abs)	uint32	RW	O
PFWAbsRvrtRem	PF Reversion Time Rem (W Abs)	uint32	R	O
WMaxLimEna	Limit Max Active Power Enable	enum16	RW	O
WMaxLim	Limit Max Power Setpoint	uint16	RW	O
WMaxLimRvrt	Limit Max Power Reversion Setting	uint16	RW	O
WMaxLimEnaRvrt	Limit Max Power Reversion Enable Setting	enum16	R	O
WMaxLimRvrtTms	Limit Max Power Reversion Time	uint32	RW	O
WMaxLimRvrtRem	Limit Max Power Rev Time Rem	uint32	R	O
WSetEna	Set Active Power Enable	uint16	RW	O

Group/Point Name	Label	Data Type	R/RW	M/O
WSetMod	Set Active Power Mode	enum16	RW	O
WSet	Set Active Power Setpoint (W)	int32	RW	O
WSetRvrt	Set Active Power Reversion Setpoint (W)	int32	RW	O
WSetPct	Set Active Power Setpoint (Pct)	int32	RW	O
WSetPctRvrt	Set Active Power Reversion Setpoint (Pct)	int32	RW	O
WSetEnaRvrt	Set Active Power Reversion Enable Setting	enum16	R	O
WSetRvrtTms	Set Active Power Reversion Time	uint32	RW	O
WSetRvrtRem	Set Active Power Rev Time Rem	uint32	R	O
VarSetEna	Set Reactive Power Enable	enum16	RW	O
VarSetMod	Set Reactive Power Mode	enum16	RW	O
VarSetPri	Set Reactive Power Priority	enum16	R	O
VarSet	Reactive Power Setpoint (Vars)	int32	RW	O
VarSetRvrt	Reversion Reactive Power (Vars)	int32	RW	O
VarSetPct	Reactive Power Setpoint (Pct)	int32	RW	O
VarSetPctRvrt	Reversion Reactive Power (Pct)	int32	RW	O
VarSetRvrtTms	Reactive Power Reversion Time	uint32	RW	O
VarSetRvrtRem	Reactive Power Rev Time Rem	uint32	R	O
PF_SF	Power Factor Scale Factor	sunssf	R	O
WMaxLim_SF	Limit Max Power Scale Factor	sunssf	R	O
WSet_SF	Active Power Scale Factor	sunssf	R	O
WSetPct_SF	Active Power Pct Scale Factor	sunssf	R	O
VarSet_SF	Reactive Power Scale Factor	sunssf	R	O
VarSetPct_SF	Reactive Power Pct Scale Factor	sunssf	R	O

Table 7: DER AC Controls Points

DERCtlAC Points

DERCtlAC — DER AC controls model.

ID — DER AC controls model ID. The value MUST be a constant value of 704.

L — DER AC controls model length.

PFWInjEna — Power factor enable when injecting active power.
DISABLED (0) = Disabled
ENABLED (1) = Enabled

DERCtlAC.PFWInj

PF	Scale Factor: PF_SF Power factor setpoint when injecting active power.
Ext	Power factor excitation setpoint when injecting active power: OVER_EXCITED (0) = Over-excited UNDER_EXCITED (1) = Under-excited

DERCtlAC.PFWInjRvrt

PF	Scale Factor: PF_SF Reversion power factor setpoint when injecting active power.
Ext	Reversion power factor excitation setpoint when injecting active power: OVER_EXCITED (0) = Over-excited UNDER_EXCITED (1) = Under-excited
PFWInjEnaRvrt	Power factor when injecting active power enable setting after reversion timeout: DISABLED (0) = Disabled ENABLED (1) = Enabled
PFWInjRvrtTms	Units: Secs Power factor reversion timer when injecting active power.
PFWInjRvrtRem	Units: Secs Power factor reversion time remaining when injecting active power.
PFWAbsEna	Power factor enable when absorbing active power: DISABLED (0) = Disabled ENABLED (1) = Enabled

DERCtlAC.PFWAbs

PF	Scale Factor: PF_SF Power factor setpoint when absorbing active power.

Ext	Power factor excitation setpoint when absorbing active power: OVER_EXCITED (0) = Over-excited UNDER_EXCITED (1) = Under-excited
DERCtlAC.PFWAbsRvrt	
PF	Scale Factor: PF_SF Reversion power factor setpoint when absorbing active power.
Ext	Reversion power factor excitation setpoint when absorbing active power: OVER_EXCITED (0) = Over-excited UNDER_EXCITED (1) = Under-excited
PFWAbsEnaRvrt	Power factor when absorbing active power enable setting after reversion timeout: DISABLED (0) = Disabled ENABLED (1) = Enabled
PFWAbsRvrtTms	Units: Secs Power factor reversion timer when absorbing active power.
PFWAbsRvrtRem	Units: Secs Power factor reversion time remaining when absorbing active power.
WMaxLimEna	Limit maximum active power enable: DISABLED (0) = Disabled ENABLED (1) = Enabled
WMaxLim	Scale Factor: WMaxLim_SF Units: Pct Limit maximum active power value.
WMaxLimRvrt	Scale Factor: WMaxLim_SF Units: Pct Reversion limit maximum active power value.
WMaxLimEnaRvrt	Limit maximum active power enable setting after reversion timeout: DISABLED (0) = Disabled ENABLED (1) = Enabled

WMaxLimRvrtTms	Units: Secs Limit maximum active power reversion time.
WMaxLimRvrtRem	Units: Secs Limit maximum active power reversion time remaining.
WSetEna	Set active power enable: DISABLED (0) = Disabled ENABLED (1) = Enabled
WSetMod	Set active power mode: W_MAX_PCT (1) = Active Power As Max Percent WATTS (2) = Active Power As Watts
WSet	Scale Factor: WSet_SF Active power setting value in watts.
WSetRvrt	Scale Factor: WSet_SF Reversion active power setting value in watts.
WSetPct	Scale Factor: WSetPct_SF Units: Pct Active power setting value as a percent.
WSetPctRvrt	Scale Factor: WSetPct_SF Units: Pct Reversion active power setting value as a percent.
WSetEnaRvrt	Set active power enable setting after reversion timeout: DISABLED (0) = Disabled ENABLED (1) = Enabled
WSetRvrtTms	Units: Secs Set active power reversion time.
WSetRvrtRem	Units: Secs Set active power reversion time remaining.

VarSetEna	Set reactive power enable: DISABLED (0) = Disabled ENABLED (1) = Enabled
VarSetMod	Set reactive power mode: W_MAX_PCT (1) = Reactive Power as Watt Max Pct VAR_MAX_PCT (2) = Reactive Power as Var Max Pct VAR_AVAIL_PCT (3) = Reactive Power as Var Avail Pct VARS (4) = Reactive Power as Vars
VarSetPri	Power priority set reactive power: ACTIVE (1) = Active power priority REACTIVE (2) = Reactive power priority
VarSet	Scale Factor: VarSet_SF Units: Var Reactive power setting value in vars.
VarSetRvrt	Scale Factor: VarSet_SF Units: Var Reversion reactive power setting value in vars.
VarSetPct	Scale Factor: VarSetPct_SF Units: Pct Reactive power setting value as a percent.
VarSetPctRvrt	Scale Factor: VarSetPct_SF Units: Pct Reversion reactive power setting value as a percent: DISABLED (0) = Disabled ENABLED (1) = Enabled
VarSetRvrtTms	Units: Secs Set reactive power reversion time.
VarSetRvrtRem	Units: Secs Set reactive power reversion time remaining.
PF_SF	Power factor scale factor.

WMaxLim_SF	Limit maximum power scale factor.
WSet_SF	Active power scale factor.
WSetPct_SF	Active power pct scale factor.
VarSet_SF	Reactive power scale factor.
VarSetPct_SF	Reactive power pct scale factor.

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4.5 DER Volt-Var

The DER Volt-Var information model supports the setting of volt-var controls as piece-wise linear curves. The model allows multiple curves to be supported. The implementation MUST provide the curve support behavior specified in 3.1 Curve Management.

Group/Point Name	Label	Data Type	R/RW	M/O
DERVoltVar	DER Volt-Var	group		
ID	Model ID	uint16	R	M
L	Model Length	uint16	R	M
Ena	Module Enable	enum16	RW	M
CrvSt	Active Curve State	enum16	R	M
AdptCrvReq	Set active curve request	uint16	RW	M
AdptCrvRslt	Set active curve result	enum16	R	M
NPt	Number of Points	uint16	R	M
NCrv	Stored Curve Count	uint16	R	M
RvrtTms	Reversion timeout	uint32	RW	O
RvrtRem	Reversion time left	uint32	R	O
RvrtCrv	Reversion curve	uint16	RW	O
V_SF	Voltage Scale Factor	sunssf	R	M
DeptRef_SF	Var Scale Factor	sunssf	R	M
DERVoltVar.Crv	Stored Curves	group		
ActPt	Active Points	uint16	RW	M
DeptRef	Dependent Reference	enum16	RW	M
Pri	Power Priority	enum16	R	O
VRef	Vref adjustment	uint16	RW	O
VRefAuto	Autonomous Vref Enable	bitfield16	RW	O
VRefTms	Auto Vref Time Constant	uint16	RW	O
RspTms	Open Loop Response Time	uint16	RW	O
ReadOnly	Curve Access	enum16	RW	O
DERVoltVar.Crv.Pt	Stored Curve Points	group		
V	Voltage Point	uint16	RW	M
Var	Reactive Power Point	int16	RW	M

Table 8: DER Volt-Var Points

362 *DERVoltVar Points*

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DERVoltVar	DER Volt-Var model.
ID	DER Volt-Var model ID. The value MUST be a constant value of 705.
L	DER Volt-Var model length.
Ena	Is Volt-Var control active: DISABLED (0) = Disabled ENABLED (1) = Enabled
CrvSt	Current active curve state: INACTIVE (0) = No active curve ACTIVE (1) = Active curve enabled
AdptCrvReq	Set active curve. No active curve = 0.
AdptCrvRslt	Result of last set active curve operation: IN_PROGRESS (0) = Update In Progress COMPLETED (1) = Update Complete FAILED (2) = Update Failed
NPt	Number of curve points supported.
NCrv	Number of stored curves supported.
RvrtTms	Reversion time in seconds. No reversion time = 0.
RvrtRem	Reversion time remaining in seconds
RvrtCrv	Default curve after reversion timeout.
V_SF	Scale factor for curve voltage points.
DeptRef_SF	Scale factor for curve var points.
DERVoltVar.Crv	Stored Curves
ActPt	Number of active points.

DeptRef	Curve dependent reference: W_MAX_PCT (1) = Percent Max Watts VAR_MAX_PCT (2) = Percent Max Vars VAR_AVAL_PCT (3) = Percent Available Vars
Pri	Power priority: ACTIVE (1) = Active power priority REACTIVE (2) = Reactive power
VRef	Vref adjustment as a percentage.
VRefAuto	Enable autonomous Vref ENABLED (0) = Enabled Flag
VRefTms	Autonomous Vref time constant.
RspTms	Open loop response time.
ReadOnly	Curve read-write access: RW (0) = Read-Write Access R (1) = Read-Only Access
DERVoltVar.Crv.Pt	Stored Curve Points
V	Units: VRefPct Curve voltage point as a percentage.
Var	Scale Factor: DeptRef_SF Units: VarPct Curve reactive power point as set in DeptRef point.

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4.6 DER Volt-Watt

The DER Volt-Watt information model supports the setting of volt-watt controls as piece-wise linear curves. The model allows multiple curves to be supported. The implementation MUST provide the curve support behavior specified in 3.1, Curve Management.

Group/Point Name	Label	Data Type	R/W	M/O
DERVoltWatt	DER Volt-Watt	group		
ID	Model ID	uint16	R	M
L	Model Length	uint16	R	M
Ena	Module Enable	bitfield16	RW	M
AdoptCrv	Adopt Curve	uint16	RW	M
AdoptCrvRslt	Adopt Curve Result	enum16	R	M
NPt	Number of Points	uint16	R	M
NCrv	Stored Curve Count	uint16	R	M
Pad	Alignment Pad	pad	R	O
V_SF	Voltage Scale Factor	sunssf	R	M
DeptRef_SF	Watt Scale Factor	sunssf	R	M
DERVoltWatt.Crv	Stored Curves	group		
ActPt	Active Points	uint16	RW	M
DeptRef	Dependent Reference	enum16	RW	M
RspTms	Open Loop Response Time	uint16	RW	O
ReadOnly	Curve Access	enum16	RW	O
DERVoltWatt.Crv.Pt	Stored Curve Points	group		
V	Voltage Point	uint16	RW	M
W	Dependent Reference	int16	RW	M

Table 9: DER Volt-Watt Points

DERVoltWatt Points

DERVoltWatt — DER Volt-Watt model.

ID — DER Volt-Watt model ID. The value MUST be a constant value of 706.

L — DER Volt-Watt model length.

Ena — Is Volt-Watt control active:
ENABLED (0) = Enabled Flag

AdoptCrv — Index of curve points to adopt. The first curve index is 1.

AdoptCrvRslt	Result of last adopt curve operation: IN_PROGRESS (0) = Update In Progress COMPLETED (1) = Update Complete FAILED (2) = Update Failed
NPt	Number of curve points supported.
NCrv	Number of stored curves supported.
Pad	Pad field for alignment.
V_SF	Scale factor for curve voltage points.
DeptRef_SF	Scale factor for curve watt points.
DERVoltWatt.Crv	Stored Curves
ActPt	Number of active points.
DeptRef	Curve dependent reference: W_MAX_PCT (1) = W_AVAL_PCT (2) =
RspTms	Open loop response time.
ReadOnly	Curve read-write access: RW (0) = Read-Write Access R (1) = Read-Only Access
DERVoltWatt.Crv.Pt	Stored Curve Points
V	Units: VRefPct Curve voltage point as a percentage.
W	Scale Factor: DeptRef_SF Units: DeptRef Curve time point in seconds.

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4.7 DER Trip Low Voltage

The DER Trip Low Voltage information model provides the trip and momentary cessation settings for low voltage conditions. The implementation MUST provide the trip/momentary cessation support behavior specified in 3.1, Curve Management.

The information model organizes the curves as sets of three curves with each set containing a curve for must trip, may trip, and momentary cessation. Multiple curve sets can be supported in the model.

Group/Point Name	Label	Data Type	R/RW	M/O
DERTripLV	DER Trip LV	group		
ID	DER Trip LV Model ID	uint16	R	M
L	DER Trip LV Model Length	uint16	R	M
ModEna	DER Trip LV Module Enable	bitfield16	RW	M
AdoptCrv	Adopt Curve	uint16	RW	M
AdoptCrvRslt	Adopt Curve Result	enum16	R	M
NPt	Number of Points	uint16	R	M
NCrv	Stored Curve Count	uint16	R	M
V_SF	Voltage Scale Factor	sunssf	R	M
Tms_SF	Time Point Scale Factor	sunssf	R	M
DERTripLV.Crv	Stored Curves	group		
DERTripLV.Crv.MustTrip	Must Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripLV.Crv.MustTrip.Pt	Must Trip Curve Points	group		
V	Voltage Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripLV.Crv.MayTrip	May Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripLV.Crv.MayTrip.Pt	May Trip Curve Points	group		
V	Voltage Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripLV.Crv.MomCess	Momentary Cessation Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripLV.Crv.MomCess	Momentary Cessation Curve Points	group		
V	Voltage Point	uint16	R	O
Tms	Time Point	uint16	R	O

Table 10: DER Trip LV Points

DERTripLV Points

DERTripLV	DER low voltage trip model.
ID	DER low voltage trip model ID. The value MUST be a constant value of 707.
L	DER low voltage trip model length.
ModEna	Is DER low voltage trip control active: ENABLED (0) = Enabled Flag
AdoptCrv	Index of curve points to adopt. The first curve index is 1.
AdoptCrvRslt	Result of last adopt curve operation: IN_PROGRESS (0) = Update In Progress COMPLETED (1) = Update Complete FAILED (2) = Update Failed
NPt	Number of curve points supported.
NCrv	Number of stored curves supported.
V_SF	Scale factor for curve voltage points.
Tms_SF	Scale factor for curve time points.
DERTripLV.Crv.MustTrip	Must Trip Curve
ActPt	Number of active points in must trip curve.
DERTripLV.Crv.MustTrip.Pt	Must Trip Curve Points
V	Scale Factor: V_SF Units: VRefPct Curve voltage point as a percentage.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

DERTripLV.Crv.MayTrip	May Trip Curve
ActPt	Number of active points in the may trip curve.
DERTripLV.Crv.MayTrip.Pt	May Trip Curve Points
V	Scale Factor: V_SF Units: VRefPct Curve voltage point as a percentage.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.
DERTripLV.Crv.MomCess	Momentary Cessation Curve
ActPt	Number of active points in the momentary cessation curve.
DERTripLV.Crv.MomCess.Pt	Momentary Cessation Curve Points
V	Scale Factor: V_SF Units: VRefPct Curve voltage point as a percentage.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

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4.8 DER Trip High Voltage

The DER Trip High Voltage information model provides the trip and momentary cessation settings for low voltage conditions. The implementation MUST provide the trip/momentary cessation support behavior specified in 3.3, Trip/Momentary Cessation Settings.

The information model organizes the curves as sets of three curves with each set containing a curve for must trip, may trip, and momentary cessation. Multiple curve sets can be supported in the model.

Group/Point Name	Label	Data Type	R/W	M/O
DERTripHV	DER Trip HV	group		
ID	DER Trip HV Model ID	uint16	R	M
L	DER Trip HV Model Length	uint16	R	M
ModEna	DER Trip HV Module Enable	bitfield16	RW	M
AdoptCrv	Adopt Curve	uint16	RW	M
AdoptCrvRslt	Adopt Curve Result	enum16	R	M
NPt	Number of Points	uint16	R	M
NCrv	Stored Curve Count	uint16	R	M
V_SF	Voltage Scale Factor	sunssf	R	M
Tms_SF	Time Point Scale Factor	sunssf	R	M
DERTripHV.Crv	Stored Curves	group		
DERTripHV.Crv.MustTrip	Must Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripHV.Crv.MustTrip.Pt	Must Trip Curve Points	group		
V	Voltage Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripHV.Crv.MayTrip	May Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripHV.Crv.MayTrip.Pt	May Trip Curve Points	group		
V	Voltage Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripHV.Crv.MomCess	Momentary Cessation Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripHV.Crv.MomCess.Pt	Momentary Cessation Curve Points	group		
V	Voltage Point	uint16	R	O
Tms	Time Point	uint16	R	O

Table 11: DER Trip HV Points

DERTripHV Points

DERTripHV	DER high voltage trip model.
ID	DER high voltage trip model ID. The value MUST be a constant value of 708.
L	DER high voltage trip model length.
ModEna	Is DER high voltage trip control active: ENABLED (0) = Enabled Flag
AdoptCrv	Index of curve points to adopt. The first curve index is 1.
AdoptCrvRslt	Result of last adopt curve operation: IN_PROGRESS (0) = Update In Progress COMPLETED (1) = Update Complete FAILED (2) = Update Failed
NPt	Number of curve points supported.
NCrv	Number of stored curves supported.
V_SF	Scale factor for curve voltage points.
Tms_SF	Scale factor for curve time points.
DERTripHV.Crv.MustTrip	Must Trip Curve
ActPt	Number of active points in must trip curve.
DERTripHV.Crv.MustTrip.Pt	Must Trip Curve Points
V	Scale Factor: V_SF Units: VRefPct Curve voltage point as a percentage.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

DERTripHV.Crv.MayTrip	May Trip Curve
ActPt	Number of active points in the may trip curve.
DERTripHV.Crv.MayTrip.Pt	May Trip Curve Points
V	Scale Factor: V_SF Units: VRefPct Curve voltage point as a percentage.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.
DERTripHV.Crv.MomCess	Momentary Cessation Curve
ActPt	Number of active points in the momentary cessation curve.
DERTripHV.Crv.MomCess.Pt	Momentary Cessation Curve Points
V	Scale Factor: V_SF Units: VRefPct Curve voltage point as a percentage.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

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4.9 DER Trip Low Frequency

The DER Trip Low Frequency information model provides the trip and momentary cessation settings for low voltage conditions. The implementation MUST provide the trip/momentary cessation support behavior specified in 3.3, Trip/Momentary Cessation Settings.

The information model organizes the curves as sets of three curves with each set containing a curve for must trip, may trip, and momentary cessation. Multiple curve sets can be supported in the model.

Group/Point Name	Label	Data Type	R/RW	M/O
DERTripLF	DER Trip LF	group		
ID	DER Trip LF Model ID	uint16	R	M
L	DER Trip LF Model Length	uint16	R	M
ModEna	DER Trip LF Module Enable	bitfield16	RW	M
Time PointAdoptCrv	Adopt Curve	uint16	RW	M
AdoptCrvRslt	Adopt Curve Result	enum16	R	M
NPt	Number of Points	uint16	R	M
NCrv	Stored Curve Count	uint16	R	M
Freq_SF	Frequency Scale Factor	sunssf	R	M
Tms_SF	Time Point Scale Factor	sunssf	R	M
DERTripLF.Crv	Stored Curves	group		
DERTripLF.Crv.MustTrip	Must Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripLF.Crv.MustTrip.Pt	Must Trip Curve Points	group		
Freq	Frequency Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripLF.Crv.MayTrip	May Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripLF.Crv.MayTrip.Pt	May Trip Curve Points	group		
Freq	Frequency Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripLF.Crv.MomCess	Momentary Cessation Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripLF.Crv.MomCess.Pt	Momentary Cessation Curve Points	group		
Freq	Frequency Point	uint16	R	O
Tms	Time Point	uint16	R	O

Table 12: DER Trip LF Points

DERTripLF Points

DERTripLF	DER low frequency trip model.
ID	DER low frequency trip model ID. The value MUST be a constant value of 709.
L	DER low frequency trip model length.
ModEna	Is DER low frequency trip control active: ENABLED (0) = Enabled Flag
AdoptCrv	Index of curve points to adopt. The first curve index is 1.
AdoptCrvRslt	Result of last adopt curve operation: IN_PROGRESS (0) = Update In Progress COMPLETED (1) = Update Complete FAILED (2) = Update Failed
NPt	Number of curve points supported.
NCrv	Number of stored curves supported.
Freq_SF	Scale factor for curve frequency points.
Tms_SF	Scale factor for curve time points.
DERTripLF.Crv.MustTrip	Must Trip Curve
ActPt	Number of active points in must trip curve.
DERTripLF.Crv.MustTrip.Pt	Must Trip Curve Points
Freq	Scale Factor: Freq_SF Units: Hz Curve frequency point.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

DERTripLF.Crv.MayTrip	May Trip Curve
ActPt	Number of active points in the may trip curve.
DERTripLF.Crv.MayTrip.Pt	May Trip Curve Points
Freq	Scale Factor: Freq_SF Units: Hz Curve frequency point.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.
DERTripLF.Crv.MomCess	Momentary Cessation Curve
ActPt	Number of active points in the momentary cessation curve.
DERTripLF.Crv.MomCess.Pt	Momentary Cessation Curve Points
Freq	Scale Factor: Freq_SF Units: Hz Curve frequency point.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

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4.10 DER Trip High Frequency

The DER Trip High Frequency information model provides the trip and momentary cessation settings for low voltage conditions. The implementation MUST provide the trip/momentary cessation support behavior specified in 3.3, Trip/Momentary Cessation Settings.

The information model organizes the curves as sets of three curves with each set containing a curve for must trip, may trip, and momentary cessation. Multiple curve sets can be supported in the model.

Group/Point Name	Label	Data Type	R/W	M/O
DERTripHF	DER Trip HF	group		
ID	DER Trip HFModel ID	uint16	R	M
L	DER Trip HFModel Length	uint16	R	M
ModEna	DER Trip HFModule Enable	bitfield16	RW	M
AdoptCrv	Adopt Curve	uint16	RW	M
AdoptCrvRslt	Adopt Curve Result	enum16	R	M
NPt	Number of Points	uint16	R	M
NCrv	Stored Curve Count	uint16	R	M
Freq_SF	Frequency Scale Factor	sunssf	R	M
Tms_SF	Time Point Scale Factor	sunssf	R	M
DERTripHF.Crv	Stored Curves	group		
DERTripHF.Crv.MustTrip	Must Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripHF.Crv.MustTrip.Pt	Must Trip Curve Points	group		
Freq	Frequency Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripHF.Crv.MayTrip	May Trip Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripHF.Crv.MayTrip.Pt	May Trip Curve Points	group		
Freq	Frequency Point	uint16	R	O
Tms	Time Point	uint16	R	O
DERTripHF.Crv.MomCess	Momentary Cessation Curve	group		
ActPt	Number of Active Points	uint16	R	O
DERTripHF.Crv.MomCess.Pt	Momentary Cessation Curve Points	group		
Freq	Frequency Point	uint16	R	O
Tms	Time Point	uint16	R	O

Table 13: DER Trip HF Points

DERTripHF Points

DERTripHF	DER high frequency trip model.
ID	DER high frequency trip model ID. The value MUST be a constant value of 710.
L	DER high frequency trip model length.
ModEna	Is DER high frequency trip control active: ENABLED (0) = Enabled Flag
AdoptCrv	Index of curve points to adopt. The first curve index is 1.
AdoptCrvRslt	Result of last adopt curve operation: IN_PROGRESS (0) = Update In Progress COMPLETED (1) = Update Complete FAILED (2) = Update Failed
NPt	Number of curve points supported.
NCrv	Number of stored curves supported.
Freq_SF	Scale factor for curve frequency points.
Tms_SF	Scale factor for curve time points.
DERTripHF.Crv.MustTrip	Must Trip Curve
ActPt	Number of active points in must trip curve.
DERTripHF.Crv.MustTrip.Pt	Must Trip Curve Points
Freq	Scale Factor: Freq_SF Units: Hz Curve frequency point.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

DERTripHF.Crv.MayTrip	May Trip Curve
ActPt	Number of active points in the may trip curve.
DERTripHF.Crv.MayTrip.Pt	May Trip Curve Points
Freq	Scale Factor: Freq_SF Units: Hz Curve frequency point.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.
DERTripHF.Crv.MomCess	Momentary Cessation Curve
ActPt	Number of active points in the momentary cessation curve.
DERTripHF.Crv.MomCess.Pt	Momentary Cessation Curve Points
Freq	Scale Factor: Freq_SF Units: Hz Curve frequency point.
Tms	Scale Factor: Tms_SF Units: Secs Curve time point in seconds.

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4.11 DER Frequency Droop

The DER Frequency Droop information model supports frequency-watt settings as specified in IEEE 1547-2018. The terminology used in this information model corresponds directly to the IEEE 1547-2018 standard.

Group/Point Name	Label	Data Type	R/W	M/O
DERFreqDroop	DER Frequency Droop	group		
ID	DER Frequency Droop ID	uint16	R	M
L	DER Frequency Droop Length	uint16	R	M
ModEna		enum16	RW	M
DbOf	Over-frequency Deadband	uint16	RW	M
DbUf	Under-frequency Deadband	uint16	RW	M
KOf	Over-frequency Change Ratio	uint16	RW	M
KUf	Under-frequency Change Ratio	uint16	RW	M
RspTms	Open-Loop Response Time	uint16	RW	M
Db_SF	Deadband Scale Factor	sunssf	R	M
K_SF	Frequency Change Scale Factor	sunssf	R	M
RspTms_SF	Open-Loop Scale Factor	sunssf	R	M
Pad1		pad	R	M
Pad2		pad	R	M
Pad3		pad	R	M

Table 14: DER Frequency Droop Points

DERFreqDroop Points

DERFreqDroop — DER frequency droop model.

ID — DER Frequency Droop model ID. The value MUST be a constant value of 711.

L — DER Frequency Droop model length.

ModEna — Is DER Frequency-Watt (Frequency-Droop) control active:
DISABLED (0) =
ENABLED (1) =

DbOf — Scale Factor: Db_SF
Units: Hz

The deadband value for over-frequency conditions in Hz.

DbUf	Scale Factor: Db_SF Units: Hz The deadband value for under-frequency conditions in Hz.
KOf	Scale Factor: K_SF Frequency droop per-unit frequency change for over-frequency conditions corresponding to 1 per-unit power output change.
KUf	Scale Factor: K_SF Frequency droop per-unit frequency change for under-frequency conditions corresponding to 1 per-unit power output change.
RspTms	Scale Factor: TResp_SF Units: Secs "The duration from a step change in control signal input until the output changes by 90% of its final change
Db_SF	Deadband scale factor.
K_SF	Frequency change scale factor.
RspTms_SF	Open loop response time scale factor.
Pad1	Pad
Pad2	Pad
Pad3	Pad

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4.12 DER Watt-Var

The DER Watt-Var information model supports the setting of watt-var controls as piece-wise linear curves. The model allows multiple curves to be supported. The implementation MUST provide the curve support behavior specified in 3.1, Curve Management.

Group/Point Name	Label	Data Type	R/W	M/O
DERWattVar	DER Watt-Var	group		
ID	Model ID	uint16	R	M
L	Model Length	uint16	R	M
Ena	Module Enable	enum16	RW	MM
CrvSt	Active Curve State	enum16	R	
AdptCrvReq	Set active curve request	uint16	RW	M
AdptCrvRslt	Set active curve result	enum16	R	M
NPt	Number of Points	uint16	R	M
NCrv	Stored Curve Count	uint16	R	M
RvrtTms	Reversion timeout	uint32	RW	O
RvrtRem	Reversion time left	uint32	R	O
RvrtCrv	Reversion curve	uint16	RW	O
V_SF	Voltage Scale Factor	sunssf	R	M
DeptRef_SF	Var Scale Factor	sunssf	R	M
DERWattVar.Crv	Stored Curves	group		
ActPt	Active Points	uint16	RW	M
DeptRef	Dependent Reference	enum16	RW	M
Pri	Power Priority	enum16	R	O
ReadOnly	Curve Access	enum16	RW	O
DERWattVar.Crv.Pt	Stored Curve Points	group		
W	Active Power Point	uint16	RW	M
Var	Reactive Power Point	int16	RW	M

Table 15: DER Watt-Var Points

DERWattVar Points

DERWattVar — DER watt-var model.

ID — DER Watt-Var model ID. The value MUST be a constant value of 712.

L — DER Watt-Var model length.

Ena	Is Watt-Var control active: DISABLED (0) = Disabled ENABLED (1) = Enabled
CrvSt	Current active curve state: INACTIVE (0) = No active curve ACTIVE (1) = Active curve enabled
AdptCrvReq	Set active curve. No active curve = 0.
AdptCrvRslt	Result of last set active curve operation: IN_PROGRESS (0) = Update In Progress COMPLETED (1) = Update Complete FAILED (2) = Update Failed
NPt	Number of curve points supported.
NCrv	Number of stored curves supported.
RvrtTms	Reversion time in seconds. No reversion time = 0.
RvrtRem	Reversion time remaining in seconds
RvrtCrv	Default curve after reversion timeout.
V_SF	Scale factor for curve voltage points.
DeptRef_SF	Scale factor for curve var points.
DERWattVar.Crv	Stored Curves
ActPt	Number of active points.
DeptRef	Curve dependent reference: W_MAX_PCT (1) = Percent Max Watts VAR_MAX_PCT (2) = Percent Max Vars VAR_AVAL_PCT (3) = Percent Available Vars
Pri	Power priority: ACTIVE (1) = Active power priority REACTIVE (2) = Reactive power priority

ReadOnly	Curve read-write access: RW (0) = Read-Write Access R (1) = Read-Only Access
DERWattVar.Crv.Pt	Stored Curve Points
W	Units: VRefPct Curve active power point as a percentage.
Var	Scale Factor: DeptRef_SF Units: VarPct Curve reactive power point as set in DeptRef point.

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4.13 DER DC Measurement

The DER DC Measurement information model contains the measurement data associated with the DER along with current status and alarm information. Neither the status nor the alarm information points are latched. They both reflect the current state of the DER and change when that status or alarm state changes.

The information model supports multiple DC ports.

Group/Point Name	Label	Data Type	R/W	M/O
DERMeasureDC	DER DC Measurement	group		
ID	DER DC Measure Model ID	uint16	R	M
L	DER DC Measure Model Length	uint16	R	M
Alrm	Port Alarms	bitfield32	R	O
NPrt	Number of Ports	uint16	R	O
DCA	DC Current	int16	R	O
DCW	DC Power	int16	R	O
DCWhInj	DC Energy Injected	acc64	R	O
DCWhAbs	DC Energy Absorbed	acc64	R	O
DCA_SF	DC Current Scale Factor	sunssf	R	O
DCV_SF	DC Voltage Scale Factor	sunssf	R	O
DCW_SF	DC Power Scale Factor	sunssf	R	O
DCWH_SF	DC Energy Scale Factor	sunssf	R	O
DCMeasure.Prt		group		
PrtTyp	Port Type	enum16	R	O
ID	Port ID	uint16	R	O
IDStr	Port ID String	string	R	O
DCA	DC Current	int16	R	O
DCV	DC Voltage	uint16	R	O
DCW	DC Power	int16	R	O
DCWhInj	DC Energy Injected	acc64	R	O
DCWhAbs	DC Energy Absorbed	acc64	R	O
Tms	DC Port Timer	uint32	R	O
Tmp	DC Port Temperature	int16	R	O
DCSt	DC Port Status	enum16	R	O
DCAlrm	DC Port Alarm	bitfield32	R	O

Table 16: DER AC Measurement Points

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DERMeasureDC	DER DC measurement model.
ID	DER DC measurement model ID. The value MUST be a constant value of 713.
L	DER DC measurement model length.
Alrm	Bitfield of ports with active alarms: Active alarm bit value = 1. No alarm bit value = 0. Bit 0 is the first port.
NPrt	Number of DC ports.
DCA	Total DC current for all ports.
DCW	Total DC power for all ports.
DCWhInj	Total cumulative DC energy injected for all ports.
DCWhAbs	Total cumulative DC energy absorbed for all ports.
DCA_SF	DC current scale factor.
DCV_SF	DC voltage scale factor.
DCW_SF	DC power scale factor.
DCWH_SF	DC energy scale factor.
DCMeasure.Prt	Port group.
PrtTyp	Port type: PV (1) = Photovoltaic ESS (2) = Energy Storage System EV (3) = Electric Vehicle INJ (4) = Generic Injecting ABS (5) = Generic Absorbing BIDIR (6) = Generic Bidirectional

ID	Port ID.
IDStr	Port ID string.
DCA	DC current for the port.
DCV	DC voltage for the port.
DCW	DC power for the port.
DCWhInj	Total cumulative DC energy injected for the port.
DCWhAbs	Total cumulative DC energy absorbed for the port.
Tms	DC port timer.
Tmp	DC port temperature.
DCSt	DC port status.
DCAlrm	DC port alarm: GROUND_FAULT (0) = Ground Fault INPUT_OVER_VOLTAGE (1) = Input Over Voltage RESERVED (19) = Reserved DC_DISCONNECT (3) = DC Disconnect CABINET_OPEN (5) = Cabinet Open MANUAL_SHUTDOWN (6) = Manual Shutdown OVER_TEMP (7) = Over Temperature BLOWN_FUSE (12) = Blown Fuse UNDER_TEMP (13) = Under Temperature MEMORY_LOSS (14) = Memory Loss ARC_DETECTION (15) = Arc Detection TEST_FAILED (20) = Test Failed INPUT_UNDER_VOLTAGE (21) = Under Voltage INPUT_OVER_CURRENT (22) = Over Current

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