Version: 1.0

SunSpec Modbus IEEE 1547-2018 Profile Specification and Implementation Guide

SunSpec Profile Specification

Abstract

This document describes considerations for SunSpec Modbus IEEE 1547-2018 Profile implementations.

License Agreement and Copyright Notice

Prepared by the SunSpec Alliance

4040 Moorpark Avenue, Suite 110

San Jose, CA 95117

Website: sunspec.org

Email: info@sunspec.org

Revision History

Version	Date	Comments
1.0	09-30-2021	Initial 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.

Over 100 organizations are members of the SunSpec Alliance, including global leaders from Asia, Europe, and North America. Membership is open to corporations, non-profits, and individuals. For more information about the SunSpec Alliance, or to download SunSpec specifications at no charge, visit sunspec.org.

About the SunSpec Specification Process

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.

The output of the workgroup is generally in the form of a SunSpec Interoperability Specification. These documents are considered to be normative, meaning that there is a matter of conformance required to support interoperability. The revision and associated process of managing these documents is tightly controlled. Other documents are informative, or make some recommendation with regard to best practices, but are not a matter of conformance. Informative documents can be revised more freely and more frequently to improve the quality and quantity of information provided.

SunSpec Interoperability Specifications follow a lifecycle pattern of: DRAFT, TEST, APPROVED, and SUPERSEDED.

For more information or to download a SunSpec Alliance specification, go to https://sunspec.org/about-sunspec-specifications/.

Table of Contents

1 Overview 8

2 SunSpec Modbus IEEE 1547-2018 Profile 9

2.1 SunSpec Modbus Information Models 9

2.2 Nameplate Information 9

2.3 Configuration Information 11

2.4 Monitoring Information 12

2.5 Constant Power Factor 12

2.6 Voltage-Reactive Power 13

2.7 Active Power-Reactive Power 13

2.8 Constant Reactive Power 15

2.9 Voltage-Active Power 15

2.10 Voltage Trip 15

2.11 Momentary Cessation 19

2.12 Frequency Trip 19

2.13 Frequency Droop 23

2.14 Enter Service 23

2.15 Cease to Energize and Trip 24

2.16 Limit Maximum Active Power 24

3 SunSpec Modbus IEEE 1547-2018 Profile Requirements 25

3.1 General Requirements 25

3.2 Common Model (1) 25

3.3 DERMeasureAC Model (701) 25

3.4 DERCapacity Model (702) 26

3.5 DEREnterService Model (703) 27

3.6 DERCtlAC Model (704) 28

3.7 DERVoltVar Model (705) 29

3.8 DERVoltWatt Model (706) 30

3.9 DERTripLV/ DERTripHV Models (707/708) 30

3.10 DERTripLF/ DERTripHF Models (709/710) 31

3.11 DERFreqDroop (711) 32

3.12 DERWattVar (712) 33

3.13 DERStorageCapacity (713) 33

Index of Tables

Table 1 - IEEE 1547-2018 SunSpec Modbus Models 9
Table 2 - Nameplate Information to SunSpec Modbus Mapping 11
Table 3 - Configuration Information to SunSpec Modbus Mapping 12
Table 4 - Monitoring Information to SunSpec Modbus Mapping 12
Table 5 - Constant Power Factor to SunSpec Modbus Mapping 13
Table 6 - Voltage Reactive Power to SunSpec Modbus Mapping 13
Table 7 - Active Power-Reactive Power to SunSpec Modbus Mapping 14
Table 8 - Constant Reactive Power to SunSpec Modbus Mapping 15
Table 9 - Voltage-Active Power to SunSpec Modbus Mapping 15
Table 10 - Voltage Trip to SunSpec Modbus Mapping 19
Table 11 - Momentary Cessation to SunSpec Modbus Mapping 19
Table 12 - Frequency Trip to SunSpec Modbus Mapping 23
Table 13 - Frequency Droop to SunSpec Modbus Mapping 23
Table 14 - Enter Service to SunSpec Modbus Mapping 23
Table 15 - Limit Maximum Active Power to SunSpec Modbus Mapping 24
Table 16 - Common Model (1) Required Points 25
Table 17 - DERMeasureAC Model (701) Required Points 26
Table 18 - DERCapacity Model (702) Required Points 27
Table 19 - DERCapacity Model (702) Optional Points 27
Table 20 - DEREnterService Model (703) Required Points 28
Table 21 - DEREnterService Model (703) Optional Points 28
Table 22 - DERCtlAC Model (704) Required Points 29
Table 23 - DERVoltVar Model (705) Required Points 29
Table 24 - DERVoltWatt Model (706) Required Points 30
Table 25 - DERTripLV/DERTripHV Models (707/708) Required Points 31
Table 26 - DERTripLV/DERTripHV Models (707/708) Optional Points 31
Table 27 - DERTripLF/DERTripHF Models (709/710) Required Points 32
Table 28 - DERFreqDroop Model (711) Required Points 32
Table 29 - DERWattVar Model (712) Required Points 33
Table 30 - DERStorageCapacity Model (713) Required Points 34

Table of Figures

Figure 1 - IEEE Std 1547-2018 Active Power-Reactive Power Curve 14

1 Overview

This document specifies the requirements for implementing the SunSpec Modbus IEEE 1547-2018 Profile along with additional information and guidance.

The information is organized in two main sections.

The SunSpec Modbus IEEE 1547-2018 Profile section describes the 1547-2018 to SunSpec Modbus mapping along with addition context and usage information. This section is informative and is intended to expand as additional explanation is needed on areas that require clarification.

The SunSpec Modbus IEEE 1547-2018 Profile Requirements section specifies the SunSpec Modbus points that are required for a fully conformant implementation. This section is normative and is only changed to correct errors or omissions.

The requirements specified in the *SunSpec Device Information Model Reference* and the *SunSpec DER Information Model Reference* are also requirements in this profile. This document may restate some of the requirements specified in those documents for convenience, but all requirements specified in those documents are still in effect for this profile unless explicitly stated otherwise. This document is intended to augment those specifications and should not be considered a replacement.

2 SunSpec Modbus IEEE 1547-2018 Profile

This section describes the SunSpec Modbus information model content that is used to support the SunSpec Modbus IEEE 1547-2018 Profile. Additional implementation and usage information is also provided for clarification.

2.1 SunSpec Modbus Information Models

The SunSpec Modbus IEEE 1547-2018 Profile is implemented using SunSpec Information Models 701-713. The following table provides a high-level mapping of IEEE 1547-2018 functionality to the relevant SunSpec Modbus Information Model.

IEEE Std 1547-2018 Interoperability Functionality	SunSpec Modbus Information Model
Nameplate Information	DERCapacity (702), DERStorageCapacity (713)
Configuration Information	DERCapacity (702)
Monitoring Information	DERMeasurementAC (701)
Constant Power Factor	DERCtlAC (704)
Voltage-Reactive Power	DERVoltVar (705)
Active Power-Reactive Power	DERWattVar (712)
Constant Reactive Power	DERCtlAC (704)
Voltage-Active Power	DERVoltWatt (706)
Voltage Trip	DERTripLV (707), DERTripHV (708)
Momentary Cessation (optional)	DERTripLV (707), DERTripHV (708)
Frequency Trip	DERTripLF (709), DERTripHF (710)
Frequency Droop	DERFreqDroop (711)
Enter Service	DEREnterService (703)
Cease to Energize and Trip	DEREnterService (703)
Limit Maximum Active Power	DERCtlAC (704)

Table 1 - IEEE 1547-2018 SunSpec Modbus Models

2.2 Nameplate Information

This section describes the nameplate information content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required nameplate information, the associated IEEE 1547.1-2020 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Active power rating at specified over-excited power factor	NP_P_MAX	702.WMaxRtg
Specified over-excited power factor	NP_P_MAX_OVER_PF	702.WOvrExtRtg
Specified over-excited power factor	NP_OVER_PF	702.WOvrExtRtgPF
Active power rating at specified under-excited power factor	NP_P_MAX_UNDER_PF	702.WUndExtRtg
Specified under-excited power factor	NP_UNDER_PF	702.WUndExtRtgPF
Apparent power maximum rating	NP_VA_MAX	702.VAMaxRtg
Normal operating performance category	NP_NORMAL_OP_CAT	702.NorOpCatRtg
Abnormal operating performance category	NP_ABNORMAL_OP_CAT	702.AbnOpCatRtg
Reactive power injected maximum rating	NP_Q_MAX_INJ	702.VarMaxInjRtg
Reactive power absorbed maximum rating	NP_Q_MAX_ABS	702.VarMaxAbsRtg
Active power charge maximum rating	NP_P_MAX_CHARGE	702.WChaRteMaxRtg
Apparent power charge maximum rating	NP_APPARENT_POWER_CHARGE_MAX	702.VAChaRteMaxRtg
AC voltage nominal rating	NP_AC_V_NOM	702.VNomRtg
AC voltage maximum rating	NP_AC_V_MAX	702.VMaxRtg
AC voltage minimum rating	NP_AC_V_MIN	702.VMinRtg
Supported control mode functions	NP_SUPPORTED_MODES	702.CtrlModes
Reactive susceptance that remains connected to the area EPS in the cease-to-energize and trip state	NP_REACTIVE_SUSCEPTANCE	702.ReactSusceptRtg
Manufacturer	NP_MANUFACTURER	1.Mn

Model	NP_MODEL	1.Md
Serial number	NP_SERIAL_NUM	1.SN
Version	NP_FW_VER	1.Vr

Table 2 - Nameplate Information to SunSpec Modbus Mapping

The table below contains the IEEE 1547-2018 optional nameplate information, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Intentional Island Category	NP_INTENTIONAL_ISLAND_CAT	702.IntIslandCatRtg

2.3 Configuration Information

This section describes the configuration information content as specified in IEEE 1547-2018. Configuration Information is optional in the IEEE 1547-2018.

The table below contains the IEEE 1547-2018 optional configuration information, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Active power rating at specified over-excited power factor	NP_P_MAX-AS	702.WMax
Specified over-excited power factor	NP_P_MAX_OVER_PF-AS	702.WMaxOvrExt
Specified over-excited power factor	NP_OVER_PF-AS	702.WOvrExtPF
Active power rating at specified under-excited power factor	NP_P_MAX_UNDER_PF-AS	702.WMaxUndExt
Specified under-excited power factor	NP_UNDER_PF-AS	702.WUndExtPF
Apparent power maximum rating	NP_VA_MAX-AS	702.VAMax
Intentional Island Category	NP_INTENTIONAL_ISLAND_CAT-AS	702.IntIslandCat
Reactive power injected maximum rating	NP_Q_MAX_INJ-AS	702.VarMaxInjRtg
Reactive power absorbed maximum rating	NP_Q_MAX_ABS-AS	702.VarMaxAbsRtg

Active power charge maximum rating	NP_P_MAX_CHARGE-AS	702.WChaRteMax
Apparent power charge maximum rating	NP_APPARENT_POWER_CHARGE_MAX-AS	702.VAChaRteMax
AC voltage nominal rating	NP_AC_V_NOM-AS	702.VNom

Table 3 - Configuration Information to SunSpec Modbus Mapping

2.4 Monitoring Information

This section describes the monitoring information content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required monitoring information, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

The voltage points that are applicable must be implemented.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Active Power	N/A	701.W
Reactive Power	N/A	701.Var
Voltage	N/A	701.LLV, 701.LNV, 701.VL1L2, 701.VL1, 701.VL2L3, 701.VL2, 701.VL3L1, 701.VL3
Frequency	N/A	701.Hz
Operational State	N/A	701.St
Connection Status	N/A	701.ConnSt
Alarm Status	N/A	701.Alrm
Operational State of Charge	N/A	713.SoC

Table 4 - Monitoring Information to SunSpec Modbus Mapping

2.5 Constant Power Factor

This section describes the constant power factor content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required constant power factor adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Constant Power Factor Mode Enable	CONST_PF_MODE_ENABLE-AS	704. PFWInjEna
Constant Power Factor	CONST_PF-AS	704.PFWInj.PF

Constant Power Factor Excitation	CONST_PF_EXCITATION-AS	704.PFWInj.Ext

Table 5 - Constant Power Factor to SunSpec Modbus Mapping

The CONST_PF-AS label is a proposed extension for the constant power factor applied setting as the current applied settings names do not support a single power factor setting without specifying the direction of reactive power flow.

2.6 Voltage-Reactive Power

This section describes the voltage-reactive power content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required voltage-reactive power adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Voltage-Reactive Power Mode Enable	QV_MODE_ENABLE-AS	705.Ena
VRef	QV_VREF-AS	705.VRef
Autonomous VRef Adjustment Enable	QV_VREF_AUTO_MODE-AS	705.VRefAutoEna
VRef Adjustment Time Constant	QV_VREF_OLRT-AS	705.VRefAutoTms
Open Loop Response Time	QV_OLRT-AS	705.RspTms
Curve Point V1	QV_CURVE_V1-AS	705.Crv.Pt[1].V
Curve Point Q1	QV_CURVE_Q1-AS	705.Crv.Pt[1].Var
Curve Point V2	QV_CURVE_V2-AS	705.Crv.Pt[2].V
Curve Point Q2	QV_CURVE_Q2-AS	705.Crv.Pt[2].Var
Curve Point V3	QV_CURVE_V3-AS	705.Crv.Pt[3].V
Curve Point Q3	QV_CURVE_Q3-AS	705.Crv.Pt[3].Var
Curve Point V4	QV_CURVE_V4-AS	705.Crv.Pt[4].V
Curve Point Q4	QV_CURVE_Q4-AS	705.Crv.Pt[4].Var

Table 6 - Voltage Reactive Power to SunSpec Modbus Mapping

2.7 Active Power-Reactive Power

This section describes the active power-reactive power content as specified in IEEE 1547-2018.

The active power-reactive power curve in IEEE 1547-2018 has six possible points as shown in the figure below.

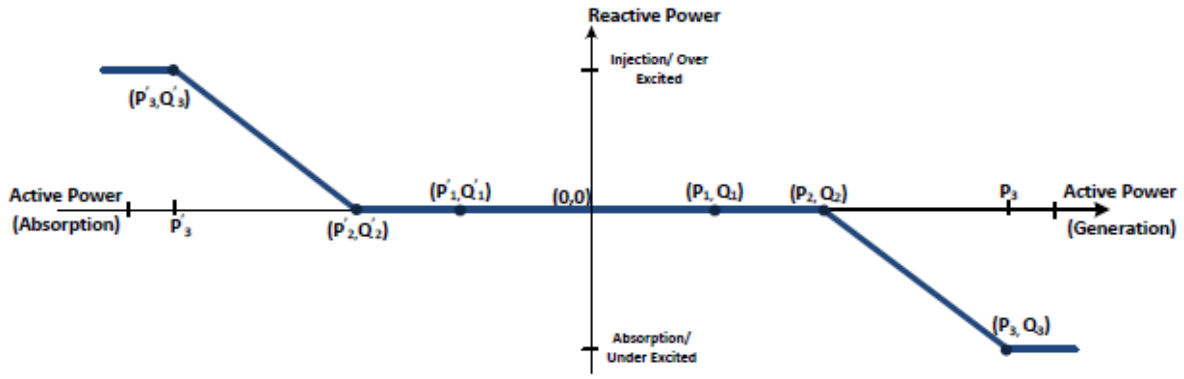

Figure 1 - IEEE Std 1547-2018 Active Power-Reactive Power Curve

The active power-reactive power function in IEEE 1547-2018 is implemented in SunSpec Modbus using the DERWattVar information model (712).

The IEEE 1547-2018 to SunSpec Modbus point mapping is specified in the table below. The SunSpec Modbus curve point indexes are 1-based in this table where index 1 is the first point in the curve.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Active Power-Reactive Power Mode Enable	QP_MODE_ENABLE-AS	712.Ena
P3	QP_CURVE_P3_GEN-AS	712.Crv.Pt[6].W
P2	QP_CURVE_P2_GEN-AS	712.Crv.Pt[5].W
P1	QP_CURVE_P1_GEN-AS	712.Crv.Pt[4].W
P'1	QP_CURVE_P1_LOAD-AS	712.Crv.Pt[3].W
P'2	QP_CURVE_P2_LOAD-AS	712.Crv.Pt[2].W
P'3	QP_CURVE_P3_LOAD-AS	712.Crv.Pt[1].W
Q3	QP_CURVE_Q3_GEN-AS	712.Crv.Pt[6].Var
Q2	QP_CURVE_Q2_GEN-AS	712.Crv.Pt[5].Var
Q1	QP_CURVE_Q1_GEN-AS	712.Crv.Pt[4].Var
Q'1	QP_CURVE_Q1_LOAD-AS	712.Crv.Pt[3].Var
Q'2	QP_CURVE_Q2_LOAD-AS	712.Crv.Pt[2].Var
Q'3	QP_CURVE_Q3_LOAD-AS	712.Crv.Pt[1].Var

Table 7 - Active Power-Reactive Power to SunSpec Modbus Mapping

Many systems may not support the first three points that are applicable when absorbing active power.

SunSpec Modbus IEEE 1547-2018 Profile implementations must support a curve containing six points. If the first three points of the curve are not used in the implementation, they should be ignored. If it is desired to set a curve that does not utilize the first three points, the curve point values can be set to 0.

2.8 Constant Reactive Power

This section describes the constant reactive power content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required constant power factor adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Constant Reactive Mode Enable	CONST_Q_MODE_ENABLE-AS	704.VarSetEna
Constant Reactive Power	CONST_Q-AS	704.VarSetPct

Table 8 - Constant Reactive Power to SunSpec Modbus Mapping

2.9 Voltage-Active Power

This section describes the voltage-active power content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required voltage-active power adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Voltage-Active Power Mode Enable	PV_MODE_ENABLE-AS	706.Ena
Open Loop Response Time	PV_OLRT-AS	706.RspTms
Curve Point V1	QV_CURVE_V1-AS	706.Crv.Pt[1].V
Curve Point P1	QV_CURVE_P1-AS	705.Crv.Pt[1].W
Curve Point V2	QV_CURVE_V2-AS	705.Crv.Pt[2].V
Curve Point P2 (gen)	QV_CURVE_P2_GEN-AS	705.Crv.Pt[2].W
Curve Point P2 (load)	QV_CURVE_P2_LOAD-AS	705.Crv.Pt[2].W

Table 9 - Voltage-Active Power to SunSpec Modbus Mapping

2.10 Voltage Trip

This section describes the voltage trip content as specified in IEEE 1547-2018 and how to map from 1547-2018 voltage trip settings to SunSpec information models.

The SunSpec information in this section is based on the content in the *SunSpec DER Information Model Specification* section 3.3 Trip/Momentary Cessation Settings.

SunSpec uses curves to specify the voltage trip settings. The ranges in 1547-2018 are specified for categories I, II, and III. Category III is referenced in the examples, but the concepts are the same for each.

Table 13 in IEEE 1547-2018 specifies ranges and default for high and low voltage trip.

Table 13—DER response (shall trip) to abnormal voltages for DER of abnormal operating performance Category III (see Figure H.9)

Shall trip—Category III				
Shall trip function	Default settings[a]		Ranges of allowable settings[b]	
	Voltage (p.u. of nominal voltage)	Clearing time (s)	Voltage (p.u. of nominal voltage)	Clearing time (s)
OV2	1.20	0.16	fixed at 1.20	fixed at 0.16
OV1	1.10	13.0	1.10–1.20	1.0–13.0
UV1	0.88	21.0	0.0–0.88	21.0–50.0
UV2	0.50	2.0	0.0–0.50	2.0–21.0

The following diagram maps the curve points used in the SunSpec information model to the adjustable settings in 1547-2018. Both high and low voltage trip settings map to five points in the respective SunSpec voltage trip curves in SunSpec models 707 and 708.

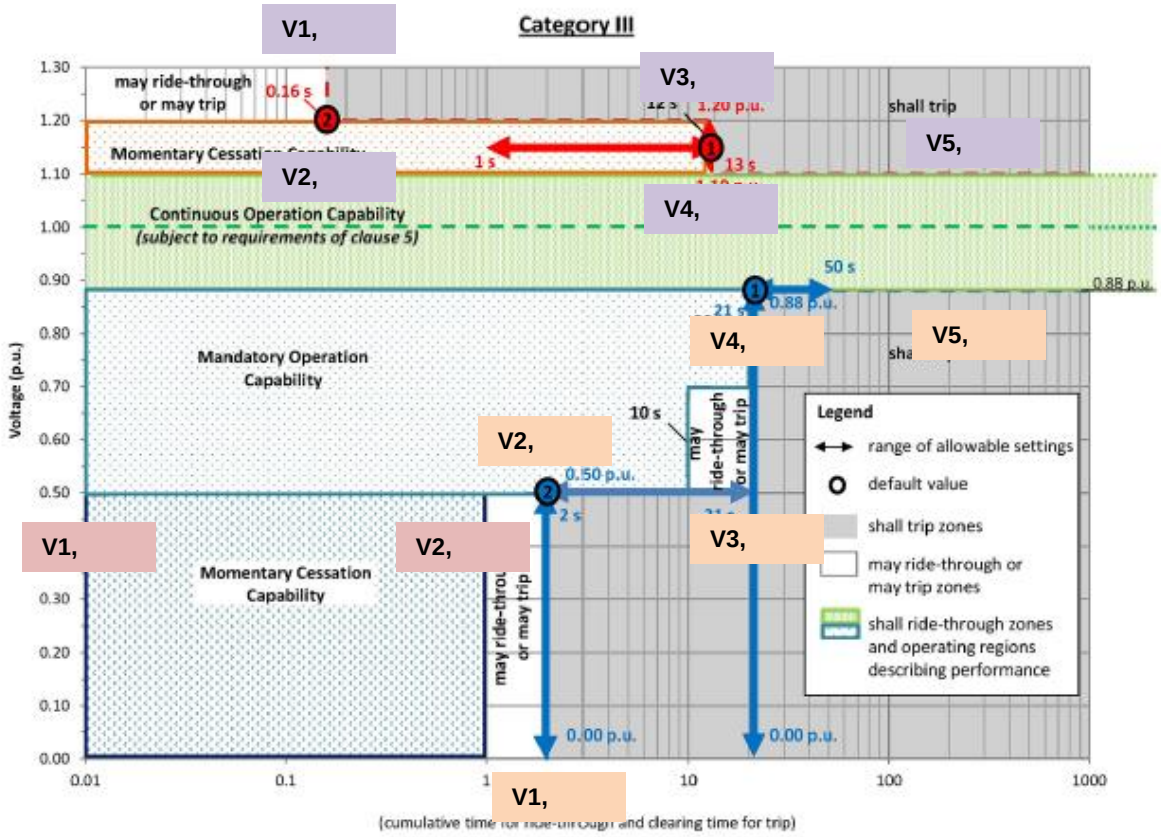

Figure H.9—DER response to abnormal voltages and voltage ride-through requirements for DER of abnormal operating performance Category III

Each segment in a curve is represented by two points. Even though the information in the curve may be able to be represented with less points in some circumstances, all the points are specified to provide a uniform method of representing all curves.

In the case of 1547-2018 trip curves, five points are used. The second and fourth points contain the voltage and time information needed. The other three points complete the uniform curve representation.

To create the over-voltage SunSpec curve form from the 1547-2018 trip settings the following steps can be performed:

V2 = OV2 voltage

Tms2 = OV2 clearing time

V4 = OV1 voltage

Tms4 = OV1 clearing time

V1 = any voltage > V2 to establish the segment slope

Tms1 = Tms2

V3 = V2

Tms3 = Tms4

V5 = V4

Tms5 = any time > Tms4 to establish the segment slope

To create the under-voltage SunSpec curve form from the 1547-2018 trip settings the following steps can be performed:

V2 = UV2 voltage

Tms2 = UV2 clearing time

V4 = UV1 voltage

Tms4 = UV1 clearing time

V1 = any voltage < V2 to establish the segment slope

Tms1 = Tms2

V3 = V2

Tms3 = Tms4

V5 = V4

Tms5 = any time > Tms4 to establish the segment slope

Based on the trip ranges in Table 13 the following V and Tms ranges are possible for low voltage:

	V	Tms

1	< V2	2 - 21
2	0 - 50	2 - 21
3	0 -50	21 - 50
4	0 - 88	21 - 50
5	0 - 88	> Tms4

The default low voltage trip curve would be:

	V	Tms
1	0	2
2	50	2
3	50	21
4	88	21
5	88	22

Based on the trip ranges in Table 13 the following V and Tms ranges are possible for high voltage:

	V	Tms
1	> V2	.16
2	120	.16
3	120	1 - 13
4	110 - 120	1 - 13
5	110 - 120	> Tms4

The default high voltage trip curve would be:

	V	Tms
1	121	.16
2	120	.16
3	120	13
4	110	13
5	110	> 13

Momentary cessation is represented by a horizontal two-point curve that specifies the voltage threshold for the momentary cessation. The default curve points for low voltage are (V1=50, Tms1=0), (V2=50, Tms2=2). The default curve points for high voltage are (V1=110, Tms1=0), (V2=110, Tms2=13).

The table below contains the IEEE 1547-2018 required voltage trip adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
OV2 Voltage	OV2_TRIP_V-AS	707.MustTrip.Crv.Pt[2].V
OV2 Clearing Time	OV2_TRIP_T-AS	707.MustTrip.Crv.Pt[2].Tms
OV1 Voltage	OV1_TRIP_V-AS	707.MustTrip.Crv.Pt[4].V
OV1 Clearing Time	OV1_TRIP_T-AS	707.MustTrip.Crv.Pt[4].Tms
UV1 Voltage	UV1_TRIP_V-AS	708.MustTrip.Crv.Pt[2].V
UV1 Clearing Time	UV1_TRIP_T-AS	708.MustTrip.Crv.Pt[2].Tms
UV2 Voltage	UV2_TRIP_V-AS	708.MustTrip.Crv.Pt[4].V
UV2 Clearing Time	UV2_TRIP_T-AS	708.MustTrip.Crv.Pt[4].Tms

Table 10 - Voltage Trip to SunSpec Modbus Mapping

2.11 Momentary Cessation

This section describes the momentary cessation content as specified in IEEE 1547-2018. Support for the adjustment of momentary cessation is optional in 1547-2018.

The table below contains the IEEE 1547-2018 optional voltage momentary cessation adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
OV Momentary Cessation Voltage	Not specified	707.MomCess.Crv.Pt[1].V
OV Momentary Cessation Clearing Time	Not specified	707.MomCess.Crv.Pt[1].Tms
UV Momentary Cessation Voltage	Not specified	708.MomCess.Crv.Pt[1].V
UV Momentary Cessation Time	Not specified	708.MomCess.Crv.Pt[1].Tms

Table 11 - Momentary Cessation to SunSpec Modbus Mapping

2.12 Frequency Trip

This section describes the frequency trip content as specified in IEEE 1547-2018.

SunSpec uses curves to specify the frequency trip settings. This information outlines how to map from 1547-2018 to the SunSpec information models (709, 710).

The SunSpec information in this section is based on the content in the *SunSpec DER Information Model Specification* section 3.3 Trip/Momentary Cessation Settings.

SunSpec uses curves to specify the voltage trip settings. The ranges in 1547-2018 are specified for categories I, II, and III. Category III is referenced in the examples, but the concepts are the same for each.

Table 18 in IEEE 1547-2018 specifies ranges and default for high and low frequency trip.

Table 18—DER response (shall trip) to abnormal frequencies for DER of abnormal operating performance Category I, Category II, and Category III (see Figure H.10)

Shall trip function	Default settings[a]		Ranges of allowable settings[b]	
	Frequency[c] (Hz)	Clearing time (s)	Frequency (Hz)	Clearing time (s)
OF2	62.0	0.16	61.8–66.0	0.16–1 000.0
OF1	61.2	300.0	61.0–66.0	180.0–1 000.0
UF1	58.5	300.0[c]	50.0–59.0	180.0–1 000
UF2	56.5	0.16	50.0–57.0	0.16–1 000

The following diagram maps the curve point used in the SunSpec information model to the adjustable settings in 1547-2018. Both high and low frequency trip settings map to five points in the respective SunSpec frequency trip curves in SunSpec models 709 and 710.

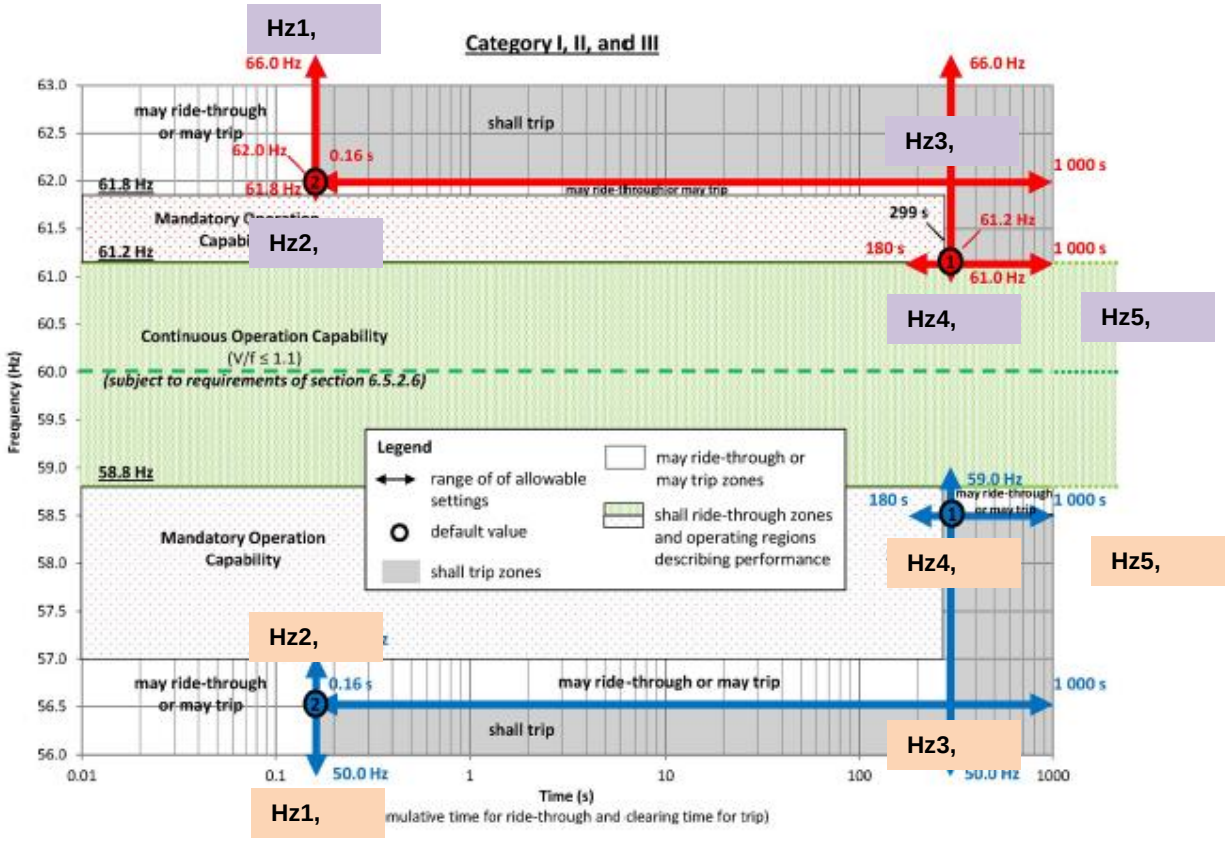

Figure H.10—DER default response to abnormal frequencies and frequency ride-through requirements for DER of abnormal operating performance Category I, Category II, and Category III

The same curve construction process is applied to the frequency curves as the voltage curves. See the Voltage Trip section above to get more details on 1547-2018 settings to SunSpec Modbus curve mapping.

Based on the trip ranges in Table 18 the following Hz and Tms ranges are possible for low frequency:

	Hz	Tms
1	< Hz2	.16 - 1000
2	50 - 57	.16 - 1000
3	50- 57	180 - 1000
4	50 - 59	180 - 1000
5	50 – 59	> Tms4

The default low frequency trip curve would be:

	Hz	Tms

1	50	.16
2	56.5	.16
3	56.5	300
4	58.5	300
5	58.5	> 300

Based on the trip ranges in Table 18 the following Hz and Tms ranges are possible for high frequency:

	Hz	Tms
1	> Hz2	.16 - 1000
2	61.8 - 66	.16 - 1000
3	61.8 - 66	180 - 1000
4	61 - 66	180 - 1000
5	61 – 66	> Tms4

The default high frequency trip curve would be:

	Hz	Tms
1	63	.16
2	62	.16
3	62	300
4	61.2	300
5	61.2	> 300

The table below contains the IEEE 1547-2018 required frequency trip adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
OV2 Frequency	OV2_TRIP_F-AS	709.MustTrip.Crv.Pt[2].Hz
OV2 Clearing Time	OV2_TRIP_T-AS	709.MustTrip.Crv.Pt[2].Tms
OV1 Frequency	OV1_TRIP_F-AS	709.MustTrip.Crv.Pt[4].Hz
OV1 Clearing Time	OV1_TRIP_T-AS	709.MustTrip.Crv.Pt[4].Tms

UV1 Frequency	UV1_TRIP_F-AS	710.MustTrip.Crv.Pt[2].Hz
UV1 Clearing Time	UV1_TRIP_T-AS	710.MustTrip.Crv.Pt[2].Tms
UV2 Frequency	UV2_TRIP_F-AS	710.MustTrip.Crv.Pt[4].Hz
UV2 Clearing Time	UV2_TRIP_T-AS	710.MustTrip.Crv.Pt[4].Tms

Table 12 - Frequency Trip to SunSpec Modbus Mapping

2.13 Frequency Droop

This section describes the frequency droop content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required frequency droop adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Over-frequency Droop dbOF	PF_DBOF-AS	711.Ctl.DbOf
Under-frequency Droop dbUF	PF_DBUF-AS	711.Ctl.DbUf
Over-frequency Droop kOF	PF_KOF-AS	711.Ctl.KOf
Under-frequency Droop kUF	PF_KUF-AS	711.Ctl.KUf
Open Loop Response Time	PF_OLRT-AS	711.Ctl.RspTms

Table 13 - Frequency Droop to SunSpec Modbus Mapping

2.14 Enter Service

This section describes the enter service content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required frequency trip adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Permit Service	ES_PERMIT_SERVICE-AS	703.ES
ES Voltage High	ES_V_HIGH-AS	703.ESVHi
ES Voltage Low	ES_V_LOW-AS	703.ESVLo
ES Frequency High	ES_F_HIGH-AS	703.ESHzHi
ES Frequency Low	ES_F_LOW-AS	703.ESHzLo
ES Delay	ES_DELAY-AS	703.ESDlyTms
ES Randomized Delay	ES_RANDOMIZED_DELAY-AS	703.ESRndTms
ES Ramp Rate	ES_RAMP_RATE-AS	703.ESRmpTms

Table 14 - Enter Service to SunSpec Modbus Mapping

2.15 Cease to Energize and Trip

The cease to energize and trip function is performed by disabling the permit service setting in the enter service function. Once the permit service setting is set to enabled, the DER returns to service based on the enter service settings.

2.16 Limit Maximum Active Power

This section describes the limit maximum active power content as specified in IEEE 1547-2018.

The table below contains the IEEE 1547-2018 required limit maximum active power adjustable settings, the associated IEEE 1547.1 results reporting label, and the SunSpec Modbus point mapping.

IEEE Std 1547-2018	IEEE Std 1547.1-2020 RR	SunSpec Modbus
Limit Maximum Active Power Mode Enable	Not specified	704.WMaxLimPctEna
Maximum Active Power	Not specified	704.WMaxLimPct

Table 15 - Limit Maximum Active Power to SunSpec Modbus Mapping

3 SunSpec Modbus IEEE 1547-2018 Profile Requirements

This section specifies the required SunSpec information model requirements for the IEEE 1547-2018 SunSpec Modbus profile

3.1 General Requirements

This section specifies general requirements that apply across all information models.

If a point that is specified in the information model as writable only supports a single value, the MUST support the writing of that value to the point.

Models with curves and curve sets MUST implement the first curve as read-only which contains the current settings.

Models with curves MUST implement the second curve as writable that can be used for settings updates.

Models with curves MAY implement addition curves. Additional curves MAY be writeable or read-only. Additional read-only curves SHOULD be placed at the end of the curve collection.

All the enumerated values specified in the following model specific sections MUST be supported.

3.2 Common Model (1)

The table below specifies the required points and associated enumerated point values in the common (1) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

ID
L
Mn
Md
SN
Vr

Table 16 - Common Model (1) Required Points

3.3 DERMeasureAC Model (701)

The table below specifies the required points and associated enumerated point values in the DERMeasureAC (701) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

The voltage points that are applicable must be implemented.

ID

L
W
Var
LLV
LNV
VL1L2
VL1
VL2L3
VL2
VL3L1
VL3
Hz
St
ConnSt
Alrm
SoC

Table 17 - DERMeasureAC Model (701) Required Points

3.4 DERCapacity Model (702)

The table below specifies the required points and associated enumerated point values in the DERCapacity (702) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

ID
L
WMaxRtg
WOvrExtRtg
WOvrExtRtgPF
WUndExtRtg
WUndExtRtgPF
VAMaxRtg
NorOpCatRtg
AbnOpCatRtg

VarMaxInjRtg
VarMaxAbsRtg
WChaRteMaxRtg
VAChaRteMaxRtg
VNomRtg
VMaxRtg
VMinRtg
CtrlModes
ReactSusceptRtg

Table 18 - DERCapacity Model (702) Required Points

The table below specifies the optional points and associated enumerated point values in the DERCapacity (702) information model that correspond to the configuration information specified as optional in IEEE 1547-2018.

IntIslandCatRtg [UNCATEGORIZED, INT_ISL_CAPABLE, BLACK_START_CAPABLE, ISOCH_CAPABLE]
WMax
WMaxOvrExt
WOvrExtPF
WMaxUndExt
WUndExtPF
VAMax
IntIslandCat
VarMaxInj
VarMaxAbs
WChaRteMax
VAChaRteMax
VNom

Table 19 - DERCapacity Model (702) Optional Points

3.5 DEREnterService Model (703)

The table below specifies the required points and associated enumerated point values in the DEREnterService (703) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

ID
L
ES [DISABLED, ENABLED]
ESVHi
ESVLo
ESHzHi
ESHzLo
ESDlyTms
ESRmpTms
V_SF
Hz_SF

Table 20 - DEREnterService Model (703) Required Points

The table below specifies the optional points and associated enumerated point values in the DEREnterService (703) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

ESRndTms

Table 21 - DEREnterService Model (703) Optional Points

3.6 DERCtlAC Model (704)

The tables below specify the required points and associated enumerated point values in the DERCtlAC (704) information model for constant power factor for the SunSpec Modbus IEEE 1547-2018 Profile.

ID
L
PFWInjEna [DISABLED, ENABLED]
PF_SF
PFWInj.PF
PFWInj.Ext
VarSetEna [DISABLED, ENABLED]
VarSetMod [W_MAX_PCT, VAR_MAX_PCT, VA_MAX_PCT]
VarSetPri [REACTIVE]
VarSetPct

VarSetPct _SF
WMaxLimPctEna [DISABLED, ENABLED]
WMaxLimPct
WMaxLimPct _SF

Table 22 - DERCtlAC Model (704) Required Points

3.7 DERVoltVar Model (705)

The table below specifies the required points and associated enumerated point values in the DERVoltVar (705) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

ID
L
Ena [DISABLED, ENABLED]
AdptCrvReq
AdptCrvRslt [IN_PROGRESS, COMPLETED, FAILED]
NPt
NCrv
V_SF
DeptRef_SF
RspTms_SF
Crv.ActPt
Crv.DeptRef [W_MAX_PCT, VAR_MAX_PCT, VA_MAX_PCT]
Crv.Pri [REACTIVE]
Crv.VRef
Crv.VRefAutoEna [DISABLED, ENABLED]
Crv.VRefAutoTms
Crv.RspTms
Crv.ReadOnly [RW, R]
Crv.Pt[1-4].V
Crv.Pt[1-4].Var

Table 23 - DERVoltVar Model (705) Required Points

3.8 DERVoltWatt Model (706)

The table below specifies the required points and associated enumerated point values in the DERVoltWatt (706) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

ID
L
Ena [DISABLED, ENABLED]
AdptCrvReq
AdptCrvRslt [IN_PROGRESS, COMPLETED, FAILED]
NPt
NCrv
V_SF
DeptRef_SF
RspTms_SF
Crv.ActPt
Crv.DeptRef [W_MAX_PCT]
Crv.RspTms
Crv.ReadOnly [RW, R]
Crv.Pt[1-2].V
Crv.Pt[1-2].W

Table 24 - DERVoltWatt Model (706) Required Points

3.9 DERTripLV/ DERTripHV Models (707/708)

The table below specifies the required points and associated enumerated point values in the DERTripLV (707) and DERTripHV (708) information models for the SunSpec Modbus IEEE 1547-2018 Profile.

The 1547-2018 standard does not require the ability to disable the voltage trip function. Under normal operation the function should be enabled. An implementation may support the DISABLED value for the Ena point. If the DISABLED value is not supported, the Ena point must still be writable and accept writing of the ENABLED value.

ID
L
Ena [ENABLED]

AdptCrvReq
AdptCrvRslt [IN_PROGRESS, COMPLETED, FAILED]
NPt
NCrvSet
V_SF
Tms_SF
Crv.ReadOnly [RW, R]
Crv.MustTrip.ActPt
Crv.MustTrip.Pt[1-5].V
Crv.MustTrip.Pt[1-5].Tms

Table 25 - DERTripLV/DERTripHV Models (707/708) Required Points

The table below specifies the optional points and associated enumerated point values in the DERTripLV (707) and DERTripHV (708) information models for momentary cessation for the SunSpec Modbus IEEE 1547-2018 Profile.

Crv.MomCess.ActPt
Crv.MomCess.Pt.V
Crv.MomCess.Pt.Tms

Table 26 - DERTripLV/DERTripHV Models (707/708) Optional Points

3.10 DERTripLF/ DERTripHF Models (709/710)

The table below specifies the required points and associated enumerated point values in the DERTripLF (709) and DERTripHF(710) information models for the SunSpec Modbus IEEE 1547-2018 Profile.

The 1547-2018 standard does not require the ability to disable the frequency trip function. Under normal operation the function should be enabled. An implementation may support the DISABLED value for the Ena point. If the DISABLED value is not supported, the Ena point must still be writable and accept writing of the ENABLED value.

ID
L
Ena [ENABLED]
AdptCrvReq
AdptCrvRslt [IN_PROGRESS, COMPLETED, FAILED]

NPt
NCrvSet
V_SF
Tms_SF
Crv.ReadOnly [RW, R]
Crv.MustTrip.ActPt
Crv.MustTrip.Pt[1-5].Hz
Crv.MustTrip.Pt[1-5].Tms

Table 27 - DERTripLF/DERTripHF Models (709/710) Required Points

3.11 DERFreqDroop (711)

The table below specifies the required points and associated enumerated point values in the DERFreqDroop (711) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

The 1547-2018 standard does not require the ability to disable the frequency droop function. Under normal operation the function should be enabled. An implementation may support the DISABLED value for the Ena point. If the DISABLED value is not supported, the Ena point must still be writable and accept writing of the ENABLED value.

ID
L
Ena [ENABLED]
AdptCtlReq
AdptCtlRslt [IN_PROGRESS, COMPLETED, FAILED]
NCtl
Db_SF
K_SF
RspTms_SF
Ctl.DbOf
Ctl.DbUf
Ctl.KOf
Ctl.KUf
Ctl.RspTms
Ctl.ReadOnly [RW, R]

Table 28 - DERFreqDroop Model (711) Required Points

3.12 DERWattVar (712)

The table below specifies the required points and associated enumerated point values in the DERWattVar (712) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

The Crv.Pri point must support writing of the REACTIVE (1) value even if it is the only value supported.

The implementation MUST support a curve containing six points. If the first three points of the curve are not used in the implementation, they MUST be ignored. If it is desired to set a curve that does not utilize the first three points, the curve point values MUST be set to 0.

ID
L
Ena [DISABLED. ENABLED]
AdptCrvReq
AdptCrvRslt [IN_PROGRESS, COMPLETED, FAILED]
NPt
NCrv
W_SF
DeptRef_SF
Crv.ActPt
Crv.DeptRef [W_MAX_PCT, VAR_MAX_PCT, VA_MAX_PCT]
Crv.Pri [REACTIVE]
Crv.ReadOnly [RW, R]
Crv.Pt[1-6].W
Crv.Pt[1-6].Var

Table 29 - DERWattVar Model (712) Required Points

3.13 DERStorageCapacity (713)

The table below specifies the required points and associated enumerated point values in the DERStorageCapacity (713) information model for the SunSpec Modbus IEEE 1547-2018 Profile.

If the implementation does not support storage, the DERStorageCapacity model and the SoC point are optional. If the model and SoC point is implemented in a system without storage, the value of SoC MUST be set to 0.

ID

L
SoC

Table 30 - DERStorageCapacity Model (713) Required Points