MESA-DER Workshops: Deeper Dive into MESA-DER Functions

June 20, 2023

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Contents

Introduction to MESA Alliance and MESA-DER

The **Modular Energy System Architecture (MESA) Standards Alliance** is an industry association comprised of electric utilities and technology suppliers dedicated to providing interoperable communications for DER systems and DER devices.

MESA Membership

Salt River Project

MESA Members 2022-23
A full listed of members and partners is available at
www.mesastandards.org/members

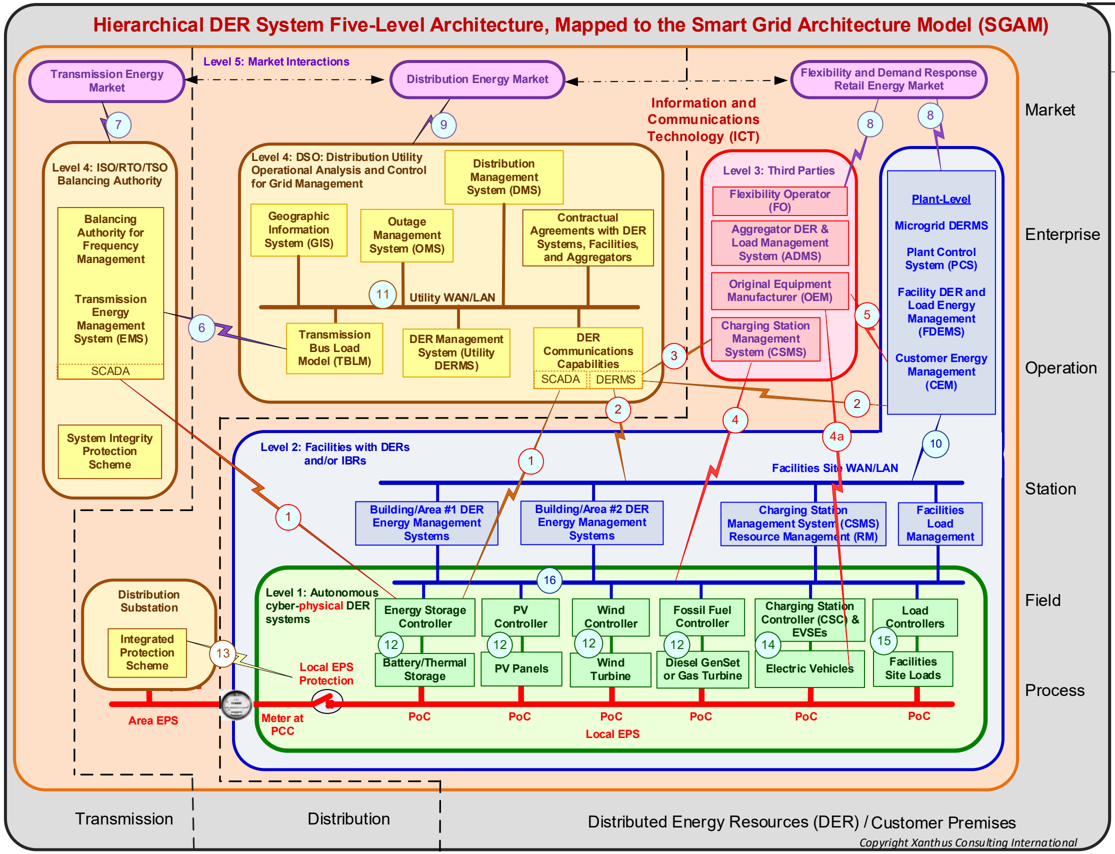
MESA's Mission

MESA's mission is to accelerate the interconnection of Distributed Energy Resources (DER) through the development of interoperable communication specifications, based on well-established standards that meet the specific needs of utilities and DER integrators.

MESA-DER's focus is on using DNP3 with IEC 61850-7-420 data models for interoperability to meet IEEE 1547, IEEE 2800, and energy storage requirements

	UTILITIES	DEVELOPERS	INDUSTRY
Meet all DER interoperability requirements for IEEE 1547 DER interconnection and interoperability standard	✓	✓	✓
Use international communication standards, including IEEE 1815 (DNP3), IEC 61850, and SunSpec Modbus	✓	✓	✓
Streamline deployments and meet customer timelines	✓	✓	✓
Focus resources on implementing market-based functions for improved efficiency and revenue streams	✓	✓	✓
Reduce costs of technology development and deployment	✓	✓	
Reduce risk by enabling supplier flexibility	✓	✓	
Simplify long-term maintenance and system upgrades	✓	✓	
Efficiently scale DER deployments	✓	✓	
Reduce training and compliance testing costs	✓	✓	✓
Provide products designed for integration with other MESA-compliant products		✓	✓
Increase the array of available partners for projects			✓

MESA-DER Focus on Interface #1, #2, #4, & #10 (DNP3 for SCADA) and **MESA-Device/SunSpec on Interface #12** (Modbus for Storage Devices)



MESA-DER Specification

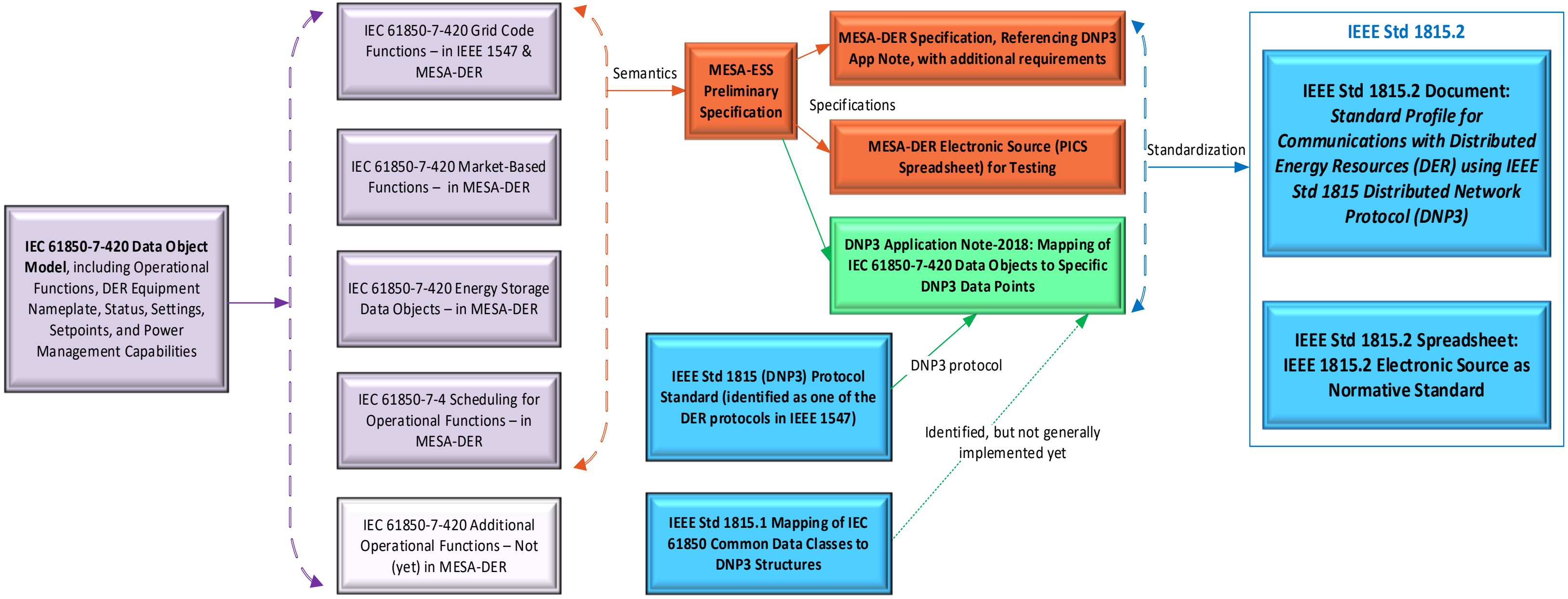
The MESA-DER Specification provides *standardized* and *interoperable* communications language using the IEC 61850 information Model mapped to specific DNP3 (IEEE 1815) data points, thus ensuring both utilities and DER vendors have precisely the same understanding of the meaning of these data points.

This MESA-DER Specification meets the IEEE 1547 functional and interoperability requirements and is specified in IEEE 1547.1 for the interoperability testing of DNP3. MESA-DER also supports many additional functions, such as AGC, Generation Following, Load Following, Set Active Power (base load), Peak Power Limiting, Operational Reserve, and Coordinated Charge/Discharge for storage.

MESA-DER can be used for interactions among the various "stakeholders", including the SCADA system (distribution and/or transmission) operator, the balancing authority, DER facility energy management systems, interactions between DERs within a facility, response to power market requirements, inter-DER markets (e.g., generation following of a PV plant by a storage plant), virtual DER plants, microgrids, etc.).

Status 2023: Integration into IEEE 1815.2

IEC 61850-7-420 Semantics, MESA-DER Specification, MESA-DER Spreadsheet, and DNP3 Application Note
Integration into IEEE 1815.2



- IEEE PSCC P15 WG, with major support by MESA and the DNP User Group is developing the draft IEEE 1815.2
- Draft is being reviewed by the P15 WG
- Next Step is Balloting – probably around September 2023

MESA-DER: 21 Functions

IEEE 1547.1 Functions (Via NRTL Test Tools)

- Low/High Voltage Ride-Through
- Low/High Frequency Ride-Through
- Dynamic Volt-Watt Function
- Frequency-Watt Function (Droop)
- Limit Active Power Function
- Volt-Watt Function
- Constant VArs Function
- Fixed Power Factor Function
- Volt-VAr Control Function
- Watt-VAr Function
- Dynamic Reactive Current Support

Additional MESA Functions

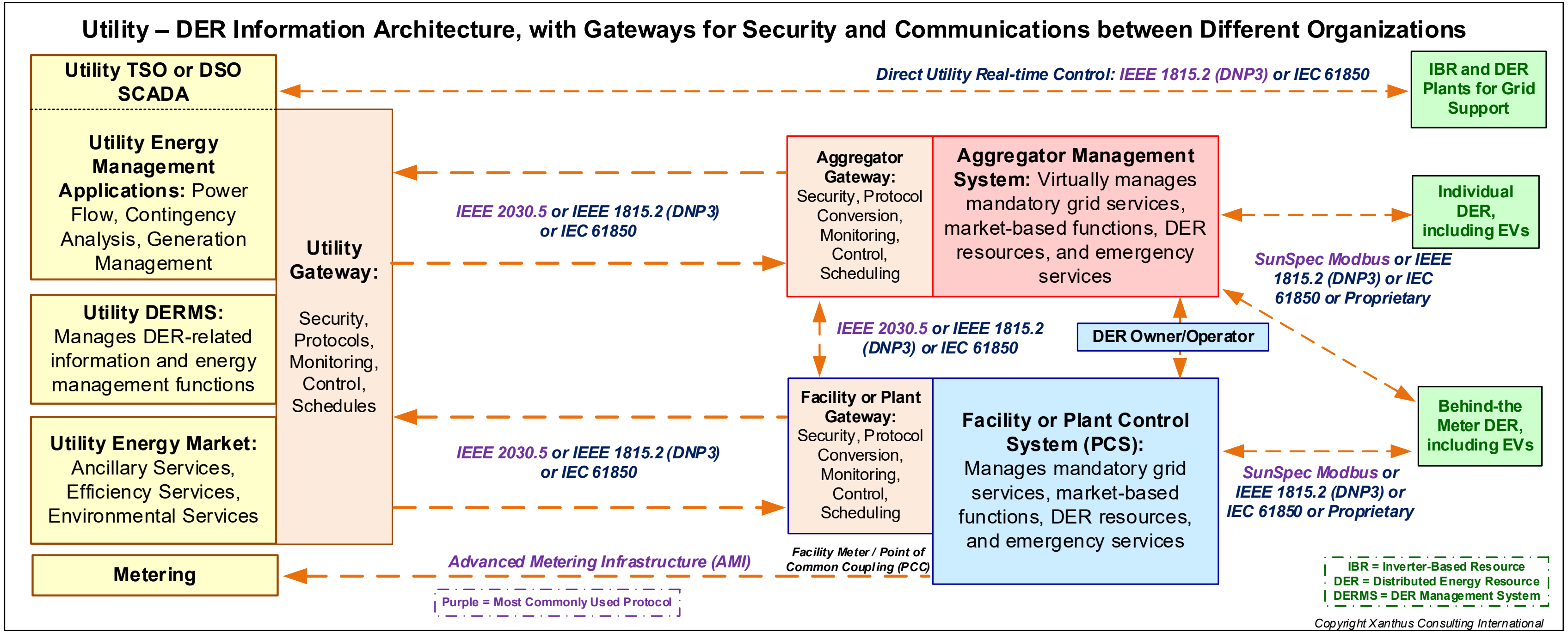
- Charge/Discharge Function (Set Active Power)
- Coordinated Charge/Discharge Function
- Active Power Response Function #1 (Peak Power Limiting)
- Active Power Response Function #2 (Generation Following)
- Active Power Response Function #3 (Load Following)
- Automatic Generation Control (AGC) Function
- Active Power Smoothing Function
- Frequency-Watt “Curve” Function (Artificial Inertia, Fast Frequency Response, etc.)
- Power Factor Correction Function
- Pricing Function
- Scheduling

Interoperability and Communication Concepts for DER

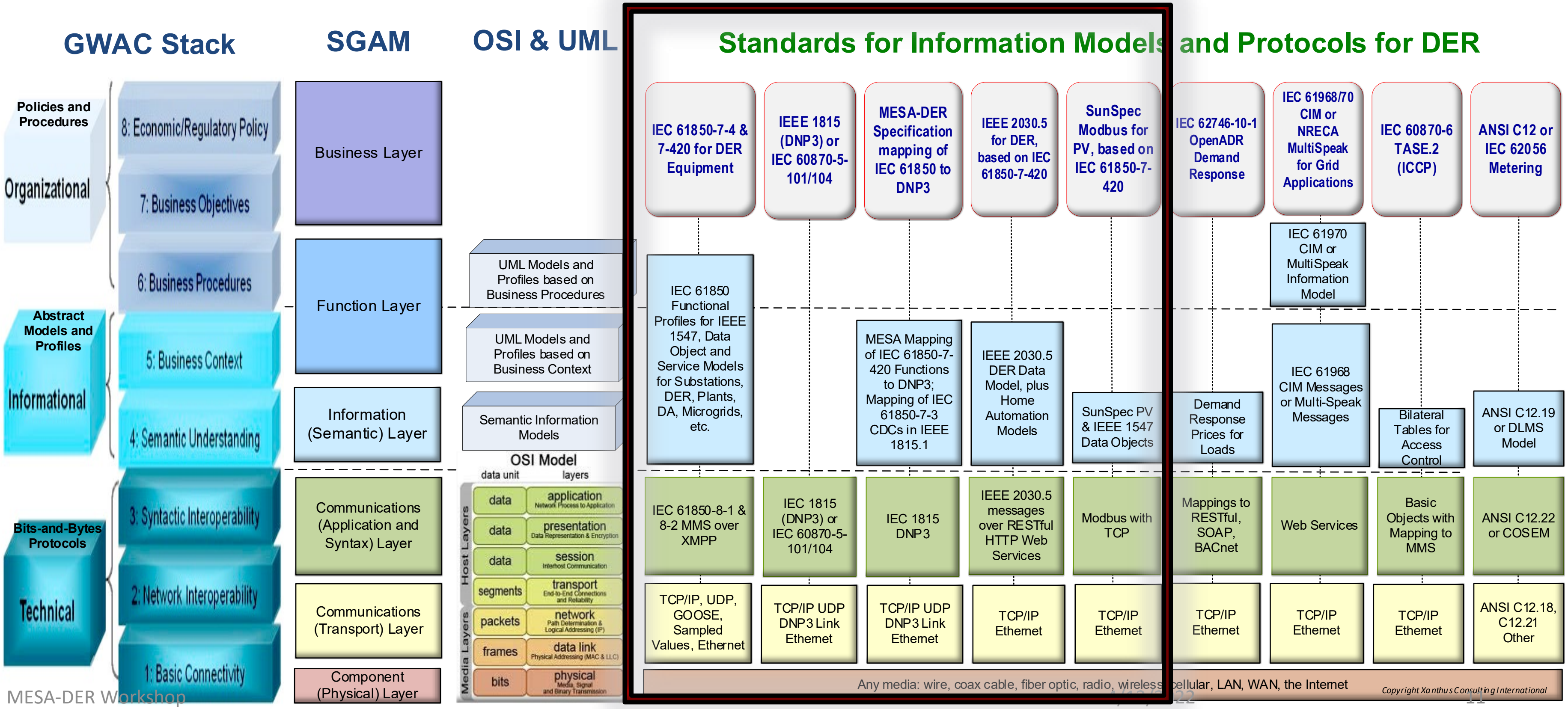
Communication concepts required for **Interoperability** (*the ability of computer systems or software to exchange and make use of information. "interoperability between devices made by different manufacturers“)*

Why more than one protocol? Strengths and Weaknesses

Communications Architecture: Utility, Aggregators, DER Facilities, DER, and Gateways



DER Communications: Comprised of Layers, Including Semantic, Syntax, Application, and Transport Layers

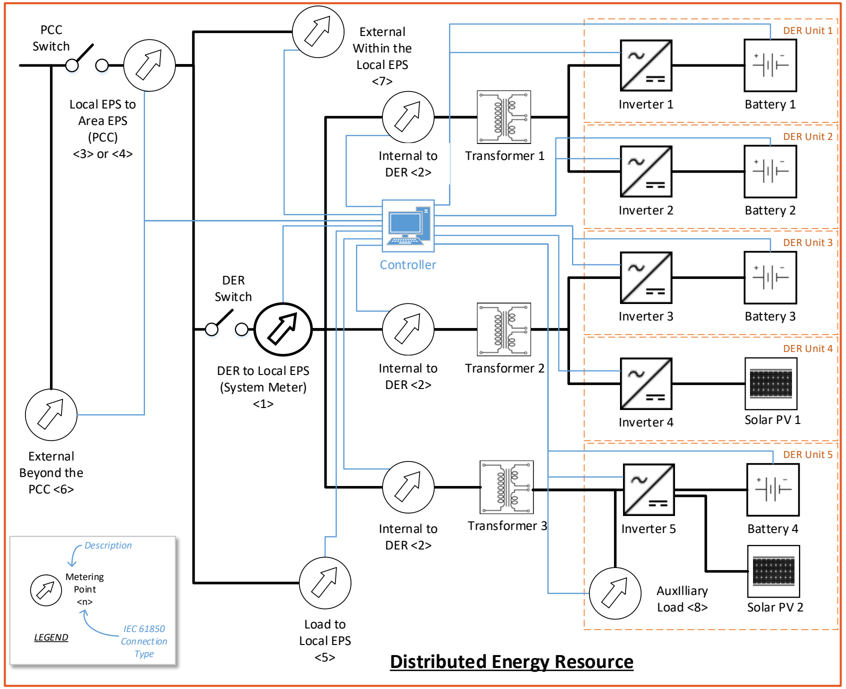


Section 3

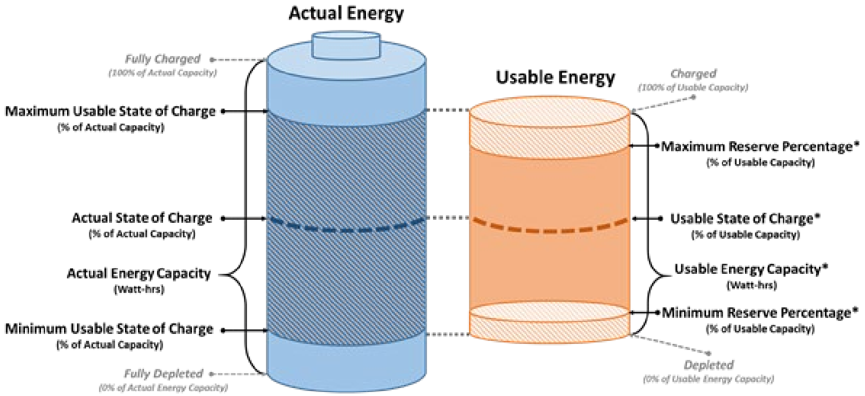
MESA-DER Spreadsheet Contents and Layout

DER can be simple or complex

DER configurations include prime movers, inverters, transformers, controllers, meters, switches, PoC, and PCC



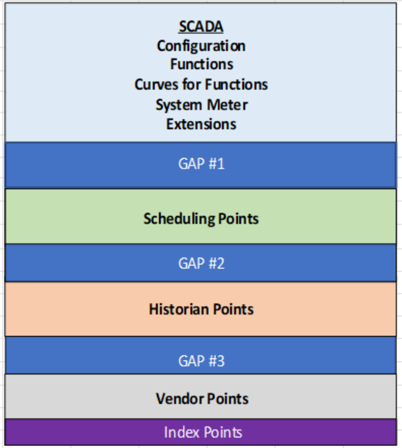
Storage includes state of charge, actual energy, and usable energy



Overview of MESA-DER Functions in IEEE 1815.2

Function	Brief Description	Document Section	DNP3 Points Range
Monitored Data			
Nameplate data	Factory-related DER data	See Table 2 for details	AI0-AI23;
Configuration data	Configuration of DER Which functions are supported	-	AI24-AI31; AO0-AO2 BI31-BI51;
Operational Settings	Installation-related DER data Which functions are enabled Enable functions commands	See Table 2 for details	AI32-AI49; AI62-AI68; AO3-AO6; AO18-AO19; BI64-BI85; BO12-BO33;
Counters	Counters for meters		AI69-AI70; AO20-AO21;
Alarms	Alarms from DER		BI0-BI9; BI94-BI106;
State	State of DER		BI10-BI30; BO0; BO3-BO11;
Protection			BI52-BI63;
Basic Functions		**Section 6.3**	
Connect/Disconnect	Cause the DER to electrically connect or disconnect at the DER's Point of Connection (PoC) or at the facility's Point of Common Coupling (PCC).	Section 6.3.1	AI60-AI61; AO16-AO17;
Cease to Energize/Return to Service	Cause the cessation of active power delivery, used primarily in voltage or frequency ride-through situations. Return to service allows the DER to start active power delivery, if permission is granted.	Section 6.3.2	AI50-AI59; AO6-AO15; BO1-BO2;
Voltage Ride-Through	Allows voltage excursions from the normal range to be tolerated for specific voltage excursion levels over specific lengths of time.	Section 6.3.3	AI71-AI76; AO22-AO26;
Frequency Ride-Through	Allows frequency excursions from the normal range to be tolerated for specific frequency excursion levels over specific lengths of time.	Section 6.3.4	AI77-AI82; AO27-AO31;
Active Power Functions		**Section 6.4**	
Charge/Discharge (Set Active Power)	Manages the charging and discharging DER, typically storage, by setting specific active power outputs or inputs for the DER.	Section 6.4.1	AI150-AI162; AO89-AO101; BI90; BO38;
Active Power Limit	Active power generation and/or consumption are limited. Usually, this limit is applied at the Point of Common Coupling (PCC) although it may be applied at any DER's Point of Connection (PoC).	Section 6.4.2	AI142-AI149; AO82-AO88;
Frequency-Watt	Active power is modified based on frequency. Usually used for imitating the "droop" of mechanical generators or motors, but can be used for other purposes, depending on the settings.	Section 6.4.3	AI115-AI141; AO57-AO81; BI86-BI87; BO34-BO35;

Structure of the MESA-DER Spreadsheet



IEEE 1815.2 Standard Profile Companion Data Point Tables: Version 1.1

DNP3 Points		Index	BO	BI	AO	AI
SCADA						
Configuration & Control Points		0	0	0	0	0
Functions		x	12	31	22	71
Curves	Max of 100 x,y pairs per Curve	x	-	107	244	328
System Meter		x	-	94	449	533
Extensions in IEEE 1815.2-2024		x	42	108	461	569
Gap #1	Reserved for future extensions	x	44	111	476	586
Schedules (SCH)	Max of 100 x,t pairs per Schedule	2000	2000	2000	2000	2000
Gap #2	Reserved for future extensions	3000				
Historical Points			BO	BI	AO	AI
HM	Start of historical meter points.	5000	5000	5000	5000	5000
HDU	Start of historical DER unit points.	x	5000	5026	5024	5074
HI	Start of historical inverter points.	x	5000	5038	5024	5116
HB	Start of historical battery points.	x	5000	5178	5072	5248
Gap #3	Reserved for future extensions	30000				
Vendor Points (VP)		50000	50000	50000	50000	50000
Index Points	Used for optional Auto Discovery	65000	65000	65000	65000	65000
Maximum Index Value		65535				

For each meter, DER unit, inverter, and battery, additional historical data rows need to be added in the spreadsheet to define the actual points

Number of Historian Points in Version 1.1, based on number of devices				Example: used to calculate the starting index for devices: HM, HDU, HI, and HB DNP3 points	
BO	BI	AO	AI		
0	13	12	37	2	No. of Meters (HM)
0	4	0	14	3	No. DER Units (HDU)
0	35	12	33	4	No. Inverters (HI)
0	54	4	27	6	No. Batteries (HB)

Grouping of points

- SCADA
  - Configuration
  - Functions
  - Curves for functions
  - System meter
- Scheduling points
- Historical points
- Vendor points

Indexing

- SCADA start at DNP3 point zero (BO0, BI0, AO0, AI0) (no gaps in DNP3 points)
- Gap #1 reserved for future SCADA extensions
- Schedules (SCH) start at DNP3 point 2000 (BO2000, BI2000, AO2000, AI2000)
- Gap #2 reserved for future scheduling extensions
- Historical Points start at DNP3 point 5000 (BO5000, BI5000, AO5000, AI5000)
- Gap #3 reserved for future historical point extensions
- Vendor points (VP) start at DNP3 point 50,000 (BO50000, BI50000, AO50000, AI50000)

Configuration Binary Outputs: DNP3 Point, Description, IEC 61850 Unique String, etc.

DNP3 Point Index	Name / Description	Name for State when value is 0	Name for State when value is 1	IEC 61850	Additional Information		
				IEC61850UniqueString	Assoc. BI	Purpose/Mode/Function	1547-2018
	Configuration and Control						
BO0	**System Set Lockout State**	Not Locked Out	Lock Out	DSTO.DEROpSt.disconnected and blocked	**BI11**	State	
BO1	**System Initiate Start-up Sequence (Return to Service).** Setting this to 1 does the following: - Sets BI "System Is Starting Up" to 1 indicating that the system is starting up. Additional start-up status can be found in AI "System Start-up Status". - Instructs all batteries to connect. - Once each battery has reported that it has connect successfully, instructs corresponding DER Unit to start. System can be shut down by executing B0 "Emergency Stop" command. This operation is the same as California Rule 21 "Soft Start".	No Change	Initiate Start-up	DCTE.CeaEgzReqCtl.2	**BI12**	Cease	
BO2	**System Execute Stop (Cease to Energize).** Setting this to 1 does the following: - Sets BI "System Is Emergency Stopping" to 1 indicating that an emergency stop is in progress. - Ensures that any executing operating modes are shut down (disabled). - Ensures that any executing schedules are shut down (disabled). - Instructs all inverters to shut down. - Instructs all batteries to disconnect. System can be started again by executing BO "Initiate Start-up Sequence" command.	No Change	Stop (Emergency)	DCTE.CeaEgzReqCtl.1	**BI15**	Cease	
BO3	**System Permission to Start**	Start Permission Not Granted	Start Permission Granted	DGEN.PrmConn	**BI16**	State	Yes
BO4	**System Permission to Stop**	Stop Permission Not Granted	Stop Permission Granted	DGEN.PrmDscon	**BI17**	State	
BO5	**DER Connect/Disconnect Switch**	Open Switch	Close Switch	CSWI. Pos	**BI23**	State	

Configuration Analog Inputs

DNP3 Point Index	Name / Description	Default Event Class	Transmitted Value		Scaling		Units	IEC 61850	Additional Information			
			Minimum	Maximum	Multiplier	Offset		IEC61850UniqueString	Value	Assoc. AO	Purpose/Mode/Function	1547-2018
	Configuration and Control											
AI0	**DER Profile Version Number.**	3	100	10000	0.01	0	n/a	MESA.VersNum	**1.1**		Nameplate	
AI1	**DER Profile Implementation Level.** 1, 2 or 3 to indicate support for Level 1, Level 2 or Level 3 respectively.	3	1	3	1	0	n/a	MESA.ImplLvl			Nameplate	
AI2	**Nameplate Minimum Voltage Rating**	3	0	2147483647	0.1	0	Volts	DGEN.VMinRtg			Nameplate	Yes
AI3	**Nameplate Maximum Voltage Rating**	3	0	2147483647	0.1	0	Volts	DGEN.VMaxRtg			Nameplate	Yes
AI4	**Nameplate Active Generation Power Rating at Unity Power Factor**	3	0	2147483647	1	0	Watts	DGEN.WMaxRtg			Nameplate	Yes
AI5	**Nameplate Active Charging Power Rating at Unity Power Factor**	3	-2147483648	0	1	0	Watts	DSTO.ChaWMaxRtg			Nameplate	
AI6	**Nameplate Active Generation Power Rating at Specified Over-Excited Power Factor**	3	0	2147483647	1	0	Watts	DGEN.WOvPFRtg			Nameplate	Yes
AI7	**Nameplate Active Charging Power Rating at Specified Over-Excited Power Factor**	3	-2147483648	0	1	0	Watts	DSTO.ChaWOvPFRtg			Nameplate	
AI8	**Specified Over-Excited Power Factor**	3	-100	100	0.01	0	None	DGEN.OvPFRtg			Nameplate	Yes
AI9	**Nameplate Active Generation Power Rating at Specified Under-Excited Power Factor**	3	0	2147483647	1	0	Watts	DGEN.WUnPFRtg			Nameplate	Yes
AI10	**Nameplate Active Charging Power Rating at Specified Under-Excited Power Factor**	3	-2147483648	0	1	0	Watts	DSTO.ChaWUnPFRtg			Nameplate	Yes
AI11	**Specified Under-Excited Power Factor**	3	-100	100	0.01	0	None	DGEN.UnPFRtg			Nameplate	Yes
AI12	**Nameplate Reactive Supply (Injection) Power Rating**	3	0	2147483647	1	0	VARs	DGEN.IvarMaxRtg			Nameplate	Yes
AI13	**Nameplate Reactive Absorption Power Rating**	3	-2147483648	0	1	0	VARs	DGEN.AvarMaxRtg			Nameplate	Yes
AI14	**Nameplate Apparent Generation Power Rating**	3	0	2147483647	1	0	VAs	DGEN.VAMaxRtg			Nameplate	
AI15	**Nameplate Apparent Charging Power Rating**	3	-2147483648	0	1	0	VAs	DSTO.ChaVAMaxRtg			Nameplate	Yes
AI16	**Nameplate Storage Actual Energy Capacity.** Nameplate (original) actual total energy capacity of the storage system expressed in Storage Capacity Units.	3	0	2147483647	1	0	Amp-hrs or Watt-hrs	DSTO.WhRtg			Nameplate	Yes
AI17	**Storage Effective Actual Energy Capacity.** Present actual total energy capacity of the storage system expressed in Storage Capacity Units.	3	0	2147483647	1	0	Amp-hrs or Watt-hrs	DSTO.EffWh			Nameplate	
AI18	**Storage Usable Energy Capacity.** Usable energy capacity of the storage system expressed in Storage Capacity Units.	3	0	2147483647	1	0	Amp-hrs or Watt-hrs	DSTO.UseWh			Nameplate	

Functions: Active Power Limit

DNP3 Point Index	Name / Description	Default Event Class	Transmitted Value		Scaling		Units	IEC 61850	Additional Information			
			Minimum	Maximum	Multiplier	Offset		IEC61850UniqueString	Value	Assoc. AO	Purpose/Mode/Function	1547-2018
AI142	**Active Power Limit Mode Priority**	2	0	100	1	0	n/a	DWMX.ModPrio		AO82	Act Power Limit	
AI143	**Active Power Limit Enabling Time Window.** Time window (in seconds) within which to randomly execute a command. If the time window is zero, the command will be executed immediately	2	0	2147483647	1	0	Seconds	DWMX.WinTms		AO83	Act Power Limit	
AI144	**Active Power Limit Enabling Ramp Time.** Ramp time, in seconds, for moving from current operational mode settings to new operational mode settings	2	0	2147483647	1	0	Seconds	DWMX.RmpTms		AO84	Act Power Limit	
AI145	**Active Power Limit Reversion Timeout Period.** Reversion Timeout Period (in seconds), after which the device will revert to its default status, such as closing the switch to reconnect to the grid or allowing maximum watts output, in case communications are lost or mitigating messages are not received	2	0	2147483647	1	0	Seconds	DWMX.RvrtTms		AO85	Act Power Limit	
AI146	**Active Power Limit Signal Meter ID**	2	0	2147483647	1	0	n/a	DWMX.EcpRef			Act Power Limit	
AI147	**Active Power Limit Reference Input.** Active Power measurement read from the meter and used as an input to the mode.	2	-2147483648	2147483647	1	0	Watts	MMXU4.TotW			Act Power Limit	
AI148	**Active Power Limit Charge Setpoint**	2	0	1000	0.1	0	Percent	DWMX.WLimPct		AO87	Act Power Limit	Yes
AI149	**Active Power Limit Generation Setpoint**	2	0	1000	0.1	0	Percent	DWMN.WLimPct		AO88	Act Power Limit	Yes

Spreadsheet of the DNP3 points, the full description, the min/max values, the IEC 61850 Unique String, purpose, inclusion in IEEE 1547

Step	Description	Optionality	Function Codes	Data Type	Point Number	Read-back Point
1.	Set priority of this mode	Optional	Direct Operate / Response	AO	AO82	AI142
2.	Set enabling time window	Optional	Direct Operate / Response	AO	AO83	AI143
3.	Set enabling ramp time	Optional	Direct Operate / Response	AO	AO84	AI144
4.	Set reversion timeout	Optional	Direct Operate / Response	AO	AO85	AI145
5.	Identify the meter used to measure the active power. By default this is the System Meter (ID = 0)	Optional	Direct Operate / Response	AO	AO86	AI146
6.	Retrieve Maximum Active Power Capability (Charging and Discharging)	Optional	Read / Response	AI	AI32 and AI33	n/a
7.	Set maximum output in percent of nominal Watts (Charging and Generating)	Required	Direct Operate / Response	AO	AO87 and AO88	AI148 and AI149
8.	Enable Active Power Limit mode and receive response	Required	Select / Response, Operate / Response	BO	BO17	BI69

Steps for initiating an Active Power Limit function are described in the DNP3 App Note (IEEE 1815.2)

Functions: Frequency-Watt (Droop)

DNP3 Point Index	Name / Description	Default Event Class	Transmitted Value		Scaling		Units	IEC 61850	Additional Information			
			Minimum	Maximum	Multiplier	Offset		IEC61850UniqueString	Value	Assoc. AO	Purpose/Mode/Function	1547-2018
AI115	**Frequency-Watt Mode Priority**		0	100	1	0	n/a	DHFW1.ModPrio		AO57	Freq-Watt	
AI116	**Frequency-Watt Enabling Time Window**	2	0	2147483647	1	0	Seconds	DHFW1.WinTms			Freq-Watt	
AI117	**Frequency-Watt Enabling Ramp Time**	2	0	2147483647	1	0	Seconds	DHFW1.RmpTms			Freq-Watt	
AI118	**Frequency-Watt Reversion Timeout Period**	2	0	2147483647	1	0	Seconds	DHFW1.RvrtTms			Freq-Watt	
AI119	**Frequency-Watt Signal Meter ID**	2	0	2147483647	1	0	n/a	DHFW1.EcpRef			Freq-Watt	
AI120	**Frequency-Watt Frequency Reference Input.** Frequency measurement read from the meter and used as an input to the mode.	2	0	70000	0.001	0	Hz	MMXU3.Hz			Freq-Watt	
AI121	**Frequency-Watt High Starting Frequency.** Delta frequency between start frequency and nominal grid frequency for high frequency events.	2	0	70000	0.001	0	Hz	DHFW1.HzStr			Freq-Watt	Yes
AI122	**Frequency-Watt High Stopping Frequency.** Delta frequency between stop frequency and nominal grid frequency for high frequency events.	2	0	70000	0.001	0	Hz	DHFW1.HzStop			Freq-Watt	Yes
AI123	**Frequency-Watt High Discharging / Generating Gradient**	2	-2147483648	2147483647	0.001	0	Percent watts per percent frequency difference	DHFW1.WGra		AO64	Freq-Watt	Yes
AI124	**Frequency-Watt High Charging Gradient**	2	-2147483648	2147483647	0.001	0	Percent watts per percent frequency difference	DHFW1.WChaGra		AO65	Freq-Watt	Yes
AI125	**Frequency-Watt Low Starting Frequency.** Delta frequency between start frequency and nominal grid frequency for low frequency events.	2	-70000	0	0.001	0	Hz	DLFW1.HzStr			Freq-Watt	Yes
AI126	**Frequency-Watt Low Stopping Frequency.** Delta frequency between stop frequency and nominal grid frequency for low frequency events.	2	-70000	0	0.001	0	Hz	DLFW1.HzStop			Freq-Watt	Yes
AI127	**Frequency-Watt Low Discharging / Generating Gradient**	2	-2147483648	2147483647	0.001	0	Percent watts per percent frequency difference	DLFW1.WGra		AO68	Freq-Watt	Yes
AI128	**Frequency-Watt Low Charging Gradient**	2	-2147483648	2147483647	0.001	0	Percent watts per percent frequency difference	DLFW1.WChaGra		AO69	Freq-Watt	Yes
AI129	**Frequency-Watt Start Delay**	2	0	2147483647	1	0	milliseconds	DHFW1.ActStrDlTmms		AO70	Freq-Watt	
AI130	**Frequency-Watt Stop Delay**	2	0	2147483647	1	0	milliseconds	DHFW1.ActStopDlTmms		AO71	Freq-Watt	
AI131	**Frequency-Watt Ramp Up Time Constant.** Time constant or open loop response time for moving from the current active power target to a higher active power target.	2	0	2147483647	1	0	Seconds	DLFW1.OplTmsMax[1]			Freq-Watt	Yes
AI132	**Frequency-Watt Ramp Down Time Constant.** Time constant or open loop response time for moving from the current active power target to a lower active power target.	2	0	2147483647	1	0	Seconds	DHFW1.OplTmsMax[2]			Freq-Watt	Yes
AI133	**Frequency-Watt Discharge Ramp Up Rate**	2	0	500000	0.1	0	Percent per Second	DHFW1.RpuRte			Freq-Watt	
AI134	**Frequency-Watt Discharge Ramp Down Rate**	2	0	500000	0.1	0	Percent per Second	DHFW1.RpdRteMax			Freq-Watt	
AI135	**Frequency-Watt Charge Ramp Up Rate**	2	0	500000	0.1	0	Percent per Second	DHFW1.RpuChaRte			Freq-Watt	
AI136	**Frequency-Watt Charge Ramp Down Rate**	2	0	500000	0.1	0	Percent per Second	DHFW1.RpdChaRteMax			Freq-Watt	
AI137	**Frequency-Watt High Return Gradient.**	2	0	1000	0.1	0	Percent watts per percent frequency difference	DHFW1.RtnRmpRte			Freq-Watt	
AI138	**Frequency-Watt Low Return Gradient**	2	0	1000	0.1	0	Percent watts per percent frequency difference	DLFW1.RtnRmpRte			Freq-Watt	
AI139	**Frequency-Watt Attempted Output.** Watt output that the mode is attempting to achieve based on the Frequency input and other parameters. If	2	-2147483648	2147483647	1	0	Watts	DHFW1.ReqWLim			Freq-Watt	
AI140	**Frequency-Watt Minimum Usable SOC**	2	0	1000	0.1	0	Percent	DHFW1.SocUseMinPct			Freq-Watt	
AI141	**Frequency-Watt Maximum Usable SOC**	2	0	1000	0.1	0	Percent	DHFW1.SocUseMaxPct			Freq-Watt	

Frequency-Watt

- Priority
- Enabling time window or ramp
- Meter Id used for measurements
- Frequency reference input
- High starting frequency
- High stopping frequency
- High generating (discharging) gradient
- High charging gradient
- {Low data points}
- {Etc.}

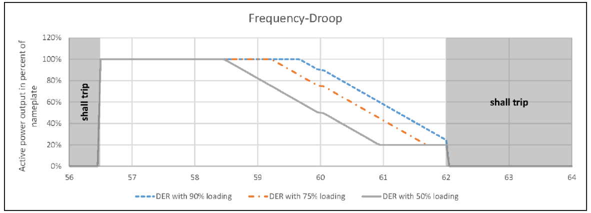
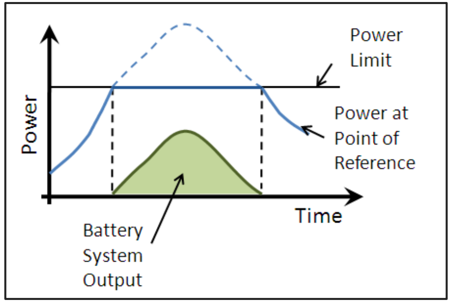
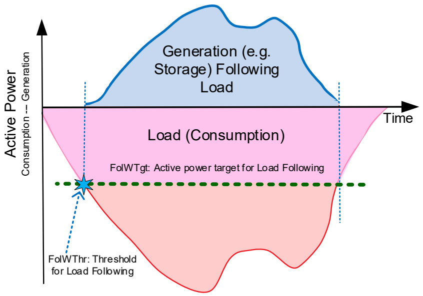


Figure H.11—Example of a three frequency-droop function curves with a 5% droop, 36 mHz deadband, and 20% minimum active power output for DER operating at different pre-disturbance levels of nameplate rating (50%, 75%, and 90%)

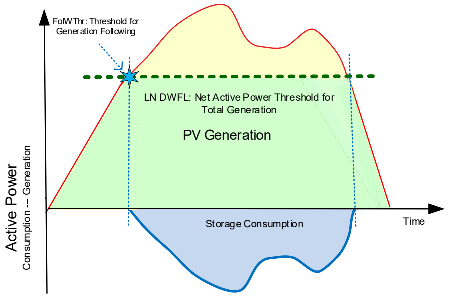
Functions: Peak Power Limiting, Load Following, Generation Following



Peak Power Limiting



Load Following by Generation



PV Generation Following by Storage

Step	Description	Optionality	Function Codes	Data Type	Point Numbers	Read-Back Points
1.	Identify the meter used to measure the Reference Power Input. By default this is the System Meter (ID = 0)	Optional	Direct Operate / Response	AO	AO119, AO128, AO137	AI180, AI191, AI202
2.	Set the power threshold for activating the mode	Required	Direct Operate / Response	AO	AO120, AO129, AO138	AI182, AI193, AI204
3.	Set the ratio used to calculate the output power from the measured power	Required	Direct Operate / Response	AO	AO121, AO130, AO139	AI183, AI194, AI205
4.	Set the maximum ramp up rate	Optional	Direct Operate / Response	AO	AO122, AO131, AO140	AI184, AI195, AI206
5.	Set the maximum ramp down rate	Optional	Direct Operate / Response	AO	AO123, AO132, AO141	AI185, AI196, AI207
6.	Set the Max SOC. The energy reserve level above which the storage system may only be charged in emergency situations, expressed as a percentage of the usable capacity, DSTO.UseWh, which is defined as "Operational setpoint for usable energy storage capacity in Wh".	Optional	Direct Operate / Response		AI584	AO474
7.	Set the Min SOC: In 61850, this is DSTO.UseWhMinPct	Optional	Direct Operate / Response		AI585	AO475
8.	Enable the active response mode	Required	Select / Response, Operate / Response	BO	BO20, BO21, BO22	BI72, BI73, BI74

Synthetic Inertia (new)

DNP3 Point Index	Name / Description	Default Event Class	Transmitted Value		Scaling		Units	IEC 61850	Additional Information			
			Minimum	Maximum	Multiplier	Offset		IEC61850UniqueString	Value	Assoc. AO	Purpose/Mode/Function	1547-2018
	Extensions in IEEE 1815.2-2024											
AI569	Synthetic Inertia Priority		0	100	1	0	n/a	DSYN.ModPrio		AO461	Synthetic Inertia	
AI570	Synthetic Inertia Time Window		0	2147483647	1	0	Seconds	DSYN.WinTms		AO462	Synthetic Inertia	
AI571	Synthetic Inertia Ramp Time		0	2147483647	1	0	Seconds	DSYN.RmpTms		AO463	Synthetic Inertia	
AI572	Synthetic Inertia Reversion Timeout		0	2147483647	1	0	Seconds	DSYN.RvrtTms		AO464	Synthetic Inertia	
AI573	Synthetic Inertia Signal Meter ID		0	2147483647	1	0	n/a	DSYN.EcpRef		AO465	Synthetic Inertia	
AI574	Set the Synthetic Inertia Discharge Ramp Up Rate		0	2147483647	1	0	Percent per Second	DSYN.DschRpuPct		AO466	Synthetic Inertia	
AI575	Set the Synthetic Inertia Discharge Ramp Down Rate		0	2147483647	1	0	Percent per Second	DSYN.DschRpdPct		AO467	Synthetic Inertia	
AI576	Set the Synthetic Inertia Charge Ramp Up Rate		0	2147483647	1	0	Percent per Second	DSYN.ChaRpuPct		AO468	Synthetic Inertia	
AI577	Set the Synthetic Inertia Charge Ramp Down Rate		0	2147483647	1	0	Percent per Second	DSYN.ChaRpdPct		AO469	Synthetic Inertia	
AI578	Set the Synthetic Inertia Derivative Factor		0	2147483647	1	0	Percent W per Hz per sec	DSYN.RcfWHzTmPct		AO470	Synthetic Inertia	
AI579	Set the Synthetic Inertia Lower Deadband		0	2147483647	1	0	Hz	DSYN.DbHzMin		AO471	Synthetic Inertia	
AI580	Set the Synthetic Inertia Upper Deadband		0	2147483647	1	0	Hz	DSYN.DbHzMax		AO472	Synthetic Inertia	

Step	Description	Type or Value	Point Number	Read-back Point
5.	Set enabling reversion timeout	Direct Operate / Response	AO464	AI572
6.	Identify the meter used to measure the frequency. By default this is the System Meter (ID = 0)	Direct Operate / Response	AO465	AI573
7.	Set the Synthetic Inertia Discharge Ramp Up Rate	3 (.3%/sec= 720kW/min)	AO466	AI574
8.	Set the Synthetic Inertia Discharge Ramp Down Rate	3 (.3%/sec= 720kW/min)	AO467	AI575
9.	Set the Synthetic Inertia Charge Ramp Up Rate	3 (.3%/sec= 720kW/min)	AO468	AI576
10.	Set the Synthetic Inertia Charge Ramp Down Rate	3 (.3%/sec= 720kW/min)	AO469	AI577
11.	Set the Synthetic Inertia Derivative Factor (ROCOF)	33 (33 = 3.3%MW/Hz/sec = 132kW/Hz/Sec)	AO470	AI578
12.	Set the Lower Deadband	59600 (frequency)	AO471	AI579
13.	Set the Upper Deadband	60400 (frequency)	AO472	AI580
14.	Enable the Synthetic inertia Mode	1	BO42	BI109

This Synthetic Inertia procedure uses a simplified df/dt approach by defining a Synthetic Inertia Derivative Factor in %W/Hz/s to describe the active power response to a change in the Rate of Change of Frequency (ROCOF).

DNP3 Structures for BI, BO, AI, and AO

DNP OBJECT GROUP & VARIATION			REQUEST Master may issue Outstation must parse		RESPONSE Master must parse Outstation may issue	
Group Num	Var Num	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
1	0	Binary Input – Any Variation	1 (read)	06 (no range, or all)		
1	1	Binary Input – Packed format			129 (response)	00, 01 (start-stop)
1	2	Binary Input – With flags			129 (response)	00, 01 (start-stop)
2	0	Binary Input Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
2	2	Binary Input Event – With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	3	Binary Input Event – With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
10	0	Binary Output – Any Variation	1 (read)	06 (no range, or all)		
10	2	Binary Output – Output status with flags			129 (response)	00, 01 (start-stop)
12	1	Binary Command – Control relay output block (CROB)	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	echo of request

DNP OBJECT GROUP & VARIATION			REQUEST Master may issue Outstation must parse		RESPONSE Master must parse Outstation may issue	
Group Num	Var Num	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
30	0	Analog Input – Any Variation	1 (read)	06 (no range, or all)		
30	1	Analog Input – 32-bit with flag			129 (response)	00, 01 (start-stop)
32	0	Analog Input Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
32	1	Analog Input Event – 32-bit without time			129 (response) 130 (unsol. resp)	17, 28 (index)
40	0	Analog Output Status – Any Variation	1 (read)	06 (no range, or all)		
40	2	Analog Output Status – 16-bit with flag			129 (response)	00, 01 (start-stop)
41	2	Analog Output – 16-bit	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	echo of request

Management of Curves and Schedules

Association between Curves and Functions

DNP3 Point Index	Name / Description	Default Event Class	Minim
	Curves		
AI328	Curve Edit Selector	2	1
AI329	Curve Mode Type. Enumeration: <0> Curve is not defined <1> None, dimensionless <2> Volt-Var modes VV11-VV12 <3> Frequency-Watt mode FW22 <4> Watt-VAr mode WP42 <5> Voltage-Watt modes VW51-VW52 <6> Remain Connected <7> Temperature mode <8> Pricing signal mode High Voltage ride-through curves <9> HVRT Must Trip <10> HVRT Momentary Cessation Low Voltage ride-through curves <12> LVRT Must Trip <13> LVRT Momentary Cessation High Frequency ride-through curves <15> HFRT Must Trip <16> HFRT Momentary Cessation Low Frequency ride-through curves <18> LFRT Must Trip <19> LFRT Momentary Cessation	2	0
AI330	Curve Number of Points	2	0

DNP3 Point Index	Name / Description	D
AI333	Curve Point 1 X-Value	
AI334	Curve Point 1 Y-Value	
AI335	Curve Point 2 X-Value	
AI336	Curve Point 2 Y-Value	
AI337	Curve Point 3 X-Value	
AI338	Curve Point 3 Y-Value	
AI339	Curve Point 4 X-Value	
AI340	Curve Point 4 Y-Value	
AI341	Curve Point 5 X-Value	
AI342	Curve Point 5 Y-Value	
AI343	Curve Point 6 X-Value	
AI344	Curve Point 6 Y-Value	
AI345	Curve Point 7 X-Value	
AI346	Curve Point 7 Y-Value	
AI347	Curve Point 8 X-Value	
AI348	Curve Point 8 Y-Value	
AI349	Curve Point 9 X-Value	
AI350	Curve Point 9 Y-Value	
AI351	Curve Point 10 X-Value	
AI352	Curve Point 10 Y-Value	

Schedule Structure

DNP3 Point Index	Name / Description	Default Event Class	Transmitted Value		Scaling		Units	IEC 61850	Additional Information			
			Minimum	Maximum	Multiplier	Offset		IEC61850UniqueString	Value	Assoc. AO	Purpose/Mode/Function	1547-2018
	Schedules											
SCH+0	**Running Schedule Index**	2	0	2147483647	1	0	n/a	FSCC.ActSchdRef			Scheduling	
SCH+1	**Schedule to Edit Selector (n)**	3	0	2147483647	1		n/a	FSCC.Schd		**SCH_AO+0**	Scheduling	
SCH+2	**Selected Schedule Identity**	3	0	2147483647	1		n/a	FSCCn.Schd		**SCH_AO+1**	Scheduling	
SCH+3	**Selected Schedule Priority**	3	1	2147483647	1		n/a	FSCHn.SchdPrio		**SCH_AO+2**	Scheduling	
SCH+4	**Selected Schedule Type.** Enumeration: <1> Low/High Voltage Ride-Through – Hi Must Trip <2> Low/High Voltage Ride-Through – Low Must Trip <3> Low/High Voltage Ride-Through – Hi Momentary <4> Low/High Voltage Ride-Through – Lo Momentary <5> Low/High Frequency Ride-Through – Hi Must Trip <6> Low/High Frequency Ride-Through – Lo Must Trip <7> Low/High Frequency Ride-Through – Hi Momentary <8> Low/High Frequency Ride-Through – Low Momentary <9> Dynamic Reactive Current Support - On/Off <10> Dynamic Volt-Watt - On/Off <11> Frequency-Watt - On/Off <12> Active Power Limit - Charging <13> Active Power Limit - Discharging <14> Charge/Discharge - Percent of Maximum <15> Coordinated Charge/Discharge - SOC Target <16> Active Power Response #1 - On/Off <17> Active Power Response #2 - On/Off <18> Active Power Response #3 - On/Off <19> AGC – Watts <20> Active Power Smoothing - On/Off <21> Volt-Watt – Curve Index <22> Frequency-Watt Curve – Curve Index <23> Frequency-Watt Curve – High Hysteresis <24> Frequency-Watt Curve – Low Hysteresis <25> Constant VArs - Percent of Maximum <26> Fixed Power Factor - Power Factor <27> Volt-VAr – Curve Index <28> Watt-VAr – Curve Index <29> Power Factor Correction - On/Off <30> Reserved - For pricing mode	3	0	50	1		List	MESAn.SchdTyp		**SCH_AO+3**	Scheduling	
SCH+5	**Selected Schedule Start Date**	3	0	2147483647	1		Days	FSCHn.StrTm[Date]		**SCH_AO+4**	Scheduling	
SCH+6	**Selected Schedule Start Time**	3	0	86400000	1		Seconds	FSCHn.StrTm[Time]		**SCH_AO+5**	Scheduling	
SCH+7	**Selected Schedule Repeat Interval**	3	0	2147483647	1		Varies	FSCHn.NxtStrTm		**SCH_AO+6**	Scheduling	
SCH+8	**Selected Schedule Repeat Interval Units**	3	0	8	1		n/a	FSCHn.SchdReuse		**SCH_AO+7**	Scheduling	
SCH+9	**Selected Schedule Validation Status**	3	0	4	1		n/a	FSCHn.SchdSt[1]			Scheduling	
SCH+10	**Selected Schedule Status**	2	0	4	1		List	FSCHn.SchdSt[2]			Scheduling	
SCH+11	**Selected Schedule Number of Points**	3	0	2147483647	1		Integer	FSCHn.NumEntr		**SCH_AO+8**	Scheduling	
SCH+12	**Selected Schedule Point [1] Time Offset**	2	0	2147483647	1		Seconds	FSCHn.SchdIntv[1]		**SCH_AO+9**	Scheduling	
SCH+13	**Selected Schedule Point [1] Value**	2	-2147483648	2147483647	1		Varies	FSCHn.SchdEntr[1]		**SCH_AO+10**	Scheduling	
SCH+14	**Selected Schedule Point [2] Time Offset**	2	0	2147483647	1		Seconds	FSCHn.SchdIntv[2]		**SCH_AO+11**	Scheduling	
SCH+15	**Selected Schedule Point [2] Value**	2	-2147483648	2147483647	1		Varies	FSCHn.SchdEntr[2]		**SCH_AO+12**	Scheduling	

DNP3 Point Index	Name / Description	Default Event Class	Name for State when value is 0	Name for State when value is 1	IEC 61850	Additional Information		
					IEC61850UniqueString	Assoc. BO	Purpose/Mode/Function	1547-2018
	Schedules							
SCH+0	**Selected Schedule Is Ready**	2	Not Ready	Ready	FSCHn.SchdSt.3	**SCH_BO+0**	Scheduling	
SCH+1	**Selected Schedule is Validated**	2	Not validated	Validated	FSCHn.SchdSt.2		Scheduling	
SCH+2	**Selected Schedule Repeat Weekly Sunday**	2	Do Not Repeat	Repeat	FSCHn.SchdReuse[1]	**SCH_BO+1**	Scheduling	
SCH+3	**Selected Schedule Repeat Weekly Monday**	2	Do Not Repeat	Repeat	FSCHn.SchdReuse[2]	**SCH_BO+2**	Scheduling	
SCH+4	**Selected Schedule Repeat Weekly Tuesday**	2	Do Not Repeat	Repeat	FSCHn.SchdReuse[3]	**SCH_BO+3**	Scheduling	
SCH+5	**Selected Schedule Repeat Weekly Wednesday**	2	Do Not Repeat	Repeat	FSCHn.SchdReuse[4]	**SCH_BO+4**	Scheduling	
SCH+6	**Selected Schedule Repeat Weekly Thursday**	2	Do Not Repeat	Repeat	FSCHn.SchdReuse[5]	**SCH_BO+5**	Scheduling	
SCH+7	**Selected Schedule Repeat Weekly Friday**	2	Do Not Repeat	Repeat	FSCHn.SchdReuse[6]	**SCH_BO+6**	Scheduling	
SCH+8	**Selected Schedule Repeat Weekly Saturday**	2	Do Not Repeat	Repeat	FSCHn.SchdReuse[7]	**SCH_BO+7**	Scheduling	

Scheduled Day of the Week

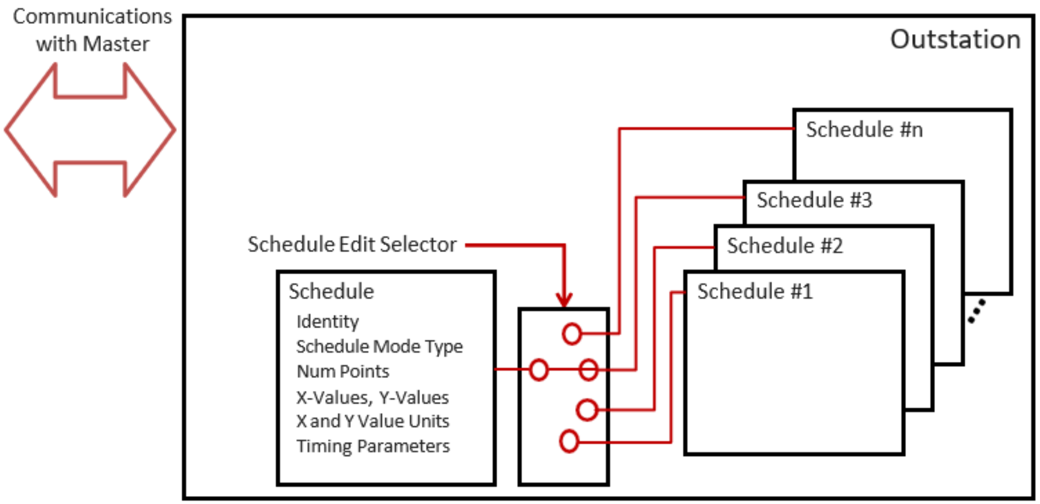
Schedule Description:

- Identity
- Priority
- **Function being scheduled**
- Start date & time of schedule
- Repeat interval
- Validation status
- Number of points in schedule (up to 100)
  - Sched Pt [1]Time offset
  - Sched Pt [1] Value
  - Sched Pt [2]Time offset
  - Sched Pt [2] Value
- Etc.

Mechanism for Updating Schedules (and Curves)

<u>**To enter or update a schedule:**</u>

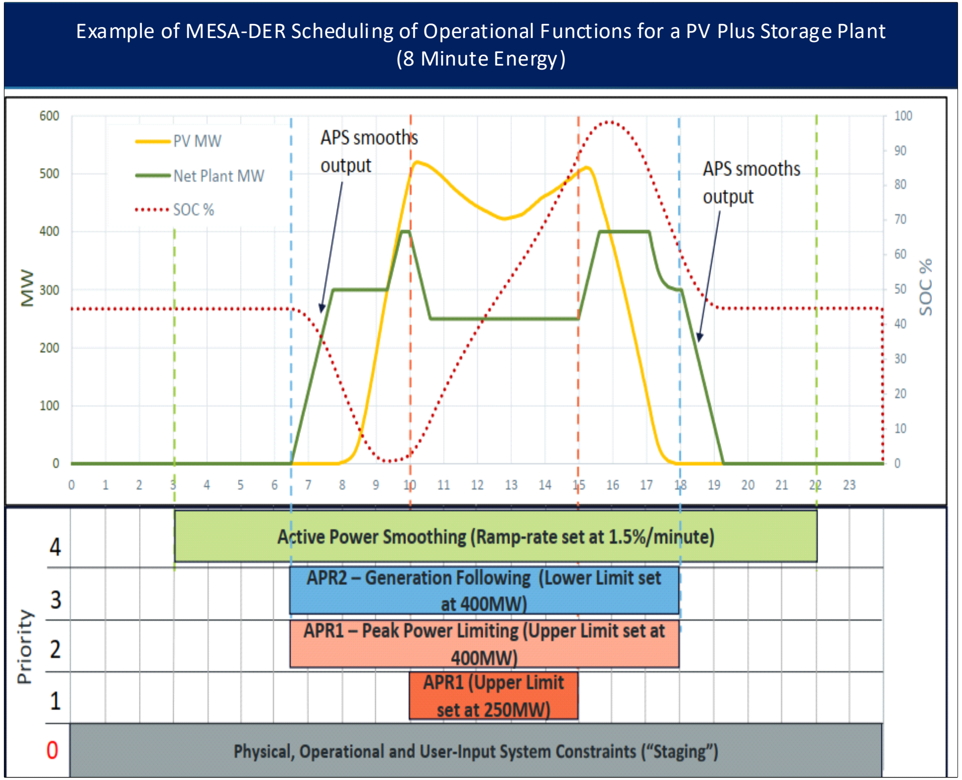
- Select the schedule to be modified
- Update the selected schedule
  - Identity
  - Priority
  - Function being scheduled
  - Start date & time of schedule
  - Repeat interval
  - Days of the week
  - Validation status
  - Number of points in schedule
  - Up to 100 pairs of time offsets and values



Example of Scheduling Active Power Limiting

Schedule Index (S+1)	Schedule ID (S+2)	Schedule Priority (S+3)	Schedule type (S+4)	Start Date (S+5) and Time (S+6)	Repetition interval (S+7)	Repetition units (S+8)	Number of schedule entries (S+11)	Day of the week for repetition (Binary S+2 thru S+8)	Paired entries: Time Offset (X-Value) in seconds for each schedule point (S+12), Schedule Value (Y-Value) for each schedule point (S+13) { TimeOffset : "X-Value", ScheduleValue : "Y-Value"}
3	1	Priority = 1 (Lowest possible)	Meaning = 13 (Active Power Limiting - Generation)	July 11, 2021 00:00 (Sunday midnight) (Start date and time updated every week)	Repeats every 7 days	Unit= Week=5	1	{Sun = "F", Mon = "T", Tue = "T", Wed = "T", Thu = "T", Fri = "T", Sat = "F" } Execute only on weekdays	[{{TimeOffset: 00:00 am, SchedValue: AI 149 = 100}, = Disable},] Default, Fallback schedule
4	29	Priority = 30 (Higher than Sched Id #68 to ensure function is enabled and disabled according to contractual agreements)	Meaning = 13 (Active Power Limiting - Generation)	July 11, 2021 00:00 (Sunday midnight) (Start date and time updated every week)	Repeats every 7 days	Unit= Week=5	2	{Sun = "F", Mon = "T", Tue = "T", Wed = "T", Thu = "T", Fri = "T", Sat = "F" } Execute only on weekdays	[{TimeOffset: 10:00 am, SchedValue: BI69 = Enable}, {TimeOffset: 5:30 pm, SchedValue: BI69 = Disable},] At 10:00 am, enable Active Power Limiting At 5:30, disable Active Power Limiting, due to contractual obligations
5	16	Priority = 20 (Medium)	Meaning = 13 (Active Power Limiting - Generation)	July 11, 2021 00:00 (Sunday midnight) (Start date and time updated every week)	Repeats every 7 days	Unit= Week=5	4	{Sun = "F", Mon = "T", Tue = "T", Wed = "T", Thu = "T", Fri = "T", Sat = "F" } Execute only on weekdays	[{TimeOffset: 09:30 am, SchedValue: AI 149 = 100}, { TimeOffset : 12:00 pm, SchedValue : AI 149 = 80 }, { TimeOffset : 4:00 pm, SchedValue : AI 149 = 70 }, {TimeOffset: 5:00 pm, SchedValue: AI 149 = 100}] At 09:30, set limit to 100% to ensure no limit when enabled. At 10:00 am, enable Active Power Limiting (See Sched ID=29) At noon, limit active power to 80% of WMax. At 4 pm, limit active power to 70% of WMax, At 5 pm, limit active power to 100%, effectively disabling active power limiting as default, but able to receive a command or higher priority schedule for a different limit At 5:30, disable Active Power Limiting, due to contractual obligations (See Sched ID=29)

Combining Schedules



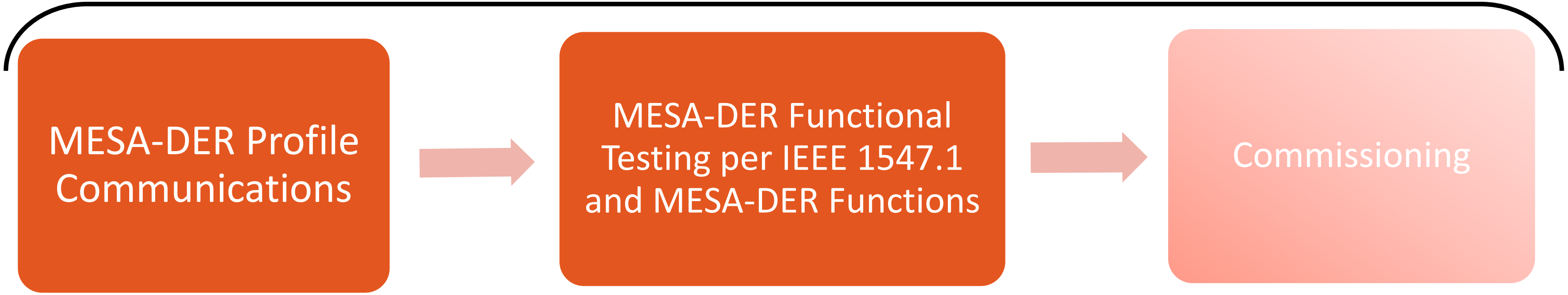
Combination of schedules can achieve the desired output while making optimal use of PV plus storage capabilities

- The **Peak Power Limiting** function can be used to with high priority to ensure P-Limit is maintained at the PCC
- **Active Power Smoothing** ensures smooth transitions

Testing: Profile Conformance and Functional Testing using DNP3

MESA-DER (IEEE P1815.2) Testing and Certification Process

A "one-stop-shopping" MESA-DER (IEEE P1815.2) **UL-managed** NRTL Testing and Certification Program for DER and/or Plant Control Systems



MESA-DER (IEEE P1815.2) Profile Communication Test: Verifies Communications Protocol Conformance:

- Requires: Passing the Triangle Microworks' MESA-DER test tool: Mandatory MESA points plus specific Modes and Functions called out in PICS
- Recommended: DNP3 protocol certification

MESA-DER (IEEE P1815.2) Functional Test of IEEE 1547 functions:

Verifies Functional Performance:

- Prerequisite: MESA-DER Profile Communications Certification
- Requires: MESA-DER Functional Testing per IEEE 1547.1/UL 1741 SB
  - Verifies: 1547.1 Functions using DNP3 with MESA-DER Profile:
  - Requires: Passing 1547.1/UL 1741 SB NRTL test using DNP3

MESA-DER Factory Acceptance Testing (FAT)/Commissioning Test:

These evaluations shall be performed on-site by qualified personnel as required by Designated Certification Body

- Prerequisite: MESA-DER Profile Communications Certification
- Requires: MESA-DER Functional Testing per IEEE 1547.1/UL 1741 SB
  - Verifies: 1547.1 Functions using DNP3 with MESA-DER Profile:
  - Requires: Passing 1547.1/UL 1741 SB NRTL test using DNP3
  - Recommended: Additional MESA-DER (IEEE P1815.2) functions beyond those in IEEE 1547-2018

MESA-DER Spreadsheet for Profile Conformance Testing

DNP3 Point Index	Name / Description	IEC 61850	For Phase 1 Conformance Testing					EUT Capabilities		
		UniqueString	Value	Assoc. AO	Mandatory: Yes or specific	Purpose/Mode/Function	1547-2018	Supported by EUT? (Mark "x")	EUT Minimum? (Only If Different)	EUT Maximum? (Only If Different)
AI154	**Charge/Discharge Active Power Target.** Percentage of maximum active power.	DWGC.GnWPctSpt		AO93	Yes	Set Act Power				
AI155	**Charge/Discharge Ramp Up Time Constant.** Ramp time, in seconds, for moving from the current active power target to a higher active power target.	DWGC.OplTmsMax[1]			Yes	Set Act Power				
AI156	**Charge/Discharge Ramp Down Time Constant.** Ramp time, in seconds, for moving from the current active power target to a lower active power target.	DWGC.OplTmsMax[2]			Yes	Set Act Power				
AI157	**Charge/Discharge Discharge Ramp Up Rate**	DWGC.RpuRte			Yes	Set Act Power				
AI158	**Charge/Discharge Discharge Ramp Down Rate**	DWGC.RpdRteMax			Yes	Set Act Power				
AI159	**Charge/Discharge Charge Ramp Up Rate**	DWGC.RpuChaRte			For Storage	Set Act Power				
AI160	**Charge/Discharge Charge Ramp Down Rate**	DWGC.RpdChaRteMax			For Storage	Set Act Power				
AI161	**Charge/Discharge Minimum Reserve for Storage.** The reserve level below which the storage system may be only be discharged in emergency situations, expressed as a percentage of the usable capacity.	DWGC.SocUseMinPct		AO100	For Storage	Set Act Power				
AI162	**Charge/Discharge Maximum Reserve for Storage.** The reserve level above which the storage system may be only be charged in emergency situations, expressed as a percentage of the usable capacity.	DWGC.SocUseMaxPct		AO101	For Storage	Set Act Power				

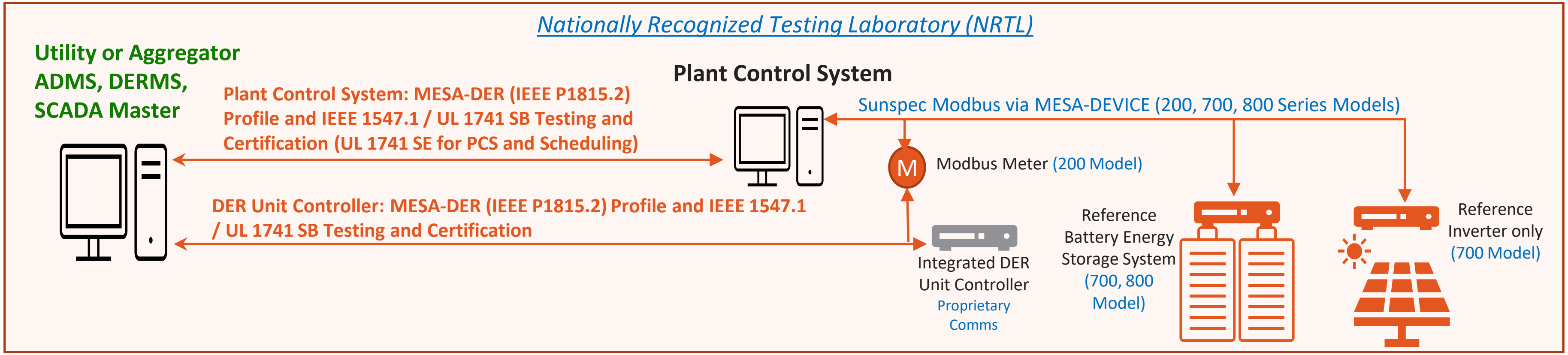
Columns added to spreadsheet for Equipment under Test (EUT) Capabilities, to be filled out by vendor

Triangle Microworks MESA-DER tool validates the EUT per this spreadsheet

MESA-DER (IEEE P1815.2): UL-Managed Testing of Communications plus Functions for Plant Control Systems & DER Unit Controllers

Plant Control Systems will use "Reference" Battery Energy Storage System, Inverter, and Meter which may be MESA-Device compliant

DER Unit Controller is tested at the NRTL or at the facility



- Triangle Microworks, Inc. (TMW)
- QualityLogic, Inc. (QL)
- Nationally Recognized Testing Laboratory (NRTL)
- Underwriters Laboratories (UL)

- *Note: Reference BESS, inverter, and meter will be MESA DEVICE Compliant. Translation may be used if SunSpec Modbus 200, 700 & 800 Models are not currently available for the device at the time of testing.*
- *Since Plant Control Systems may communicate with many inverter types with different protocols, we require they at minimum communicate via SunSpec Modbus/MESA-Device internal to the "plant".*

Functional Tests for MESA-DER Functions Not Covered in IEEE 1547.1

Table of Contents

Need support from MESA members and testing experts to complete this MESA-DER Testing document … ??

MESA Membership

MESA Membership

2022 Membership Options:

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

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

MESA/SunSpec Joint Modbus Membership: $8,000

Individual/Strategic Partner: $1,000

Student: $350

Read more about MESA's membership options at http://mesastandards.org/membership/

Membership Contact:

info@mesastandards.org

2022 Technical Allocation:

$5,000+ focused on MESA-DER testing and certification program development

Discretionary Allocation to Technical Priorities:

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

Membership Fee:

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

Questions?