MESA-PCS Specification

Standard communication interface for power conversion systems participating in the Modular Energy Storage Architecture

1 Introduction

The MESA Alliance develops and promotes standard interfaces for communicating with the components that are used in today's energy storage systems. The collection of component interfaces is referred to as MESA-Device. MESA-Device is composed of three different sub-components:

MESA-PCS: A standard interface for power conversion systems.

MESA-Storage: A standard interface for batteries and other storage technologies.

MESA-Meter: A standard interface for power meters.

Working closely with the SunSpec Alliance, the MESA Standards Alliance has developed these interfaces for use by component manufacturers. They have been designed to work together in the safe and efficient operation of a stand-alone energy storage systems.

This specification describes MESA-PCS: A standard communication interface for power conversion systems participating in the Modular Energy Storage Architecture. Information on the other MESA-Device interfaces can be found on the MESA web site: www.mesastandards.org.

1.1 References

The documents listed in Table 1 are either explicitly or implicitly referenced herein.

Table 1: References

Document	Purpose
SunSpec Common Models	Provides foundational information for all devices which implement one or more of the SunSpec models.
SunSpec Inverter Monitoring Models	Describes the inverter monitoring models and is an approved SunSpec Alliance interoperability specification.
SunSpec Inverter Controls Models	Describes the inverter control models and is an approved SunSpec Alliance interoperability specification.
SunSpec Meter Models	Describes the meter models and is an approved SunSpec Alliance interoperability specification.

1.2 Energy Storage System Diagram

While there are certainly different ways to assemble energy storage systems, all ESSs contain a few key components: a power conversion system, a storage device, one or more metering devices, and a control system of some kind. The diagram shows how the MESA interfaces are used in communicating between the various devices.

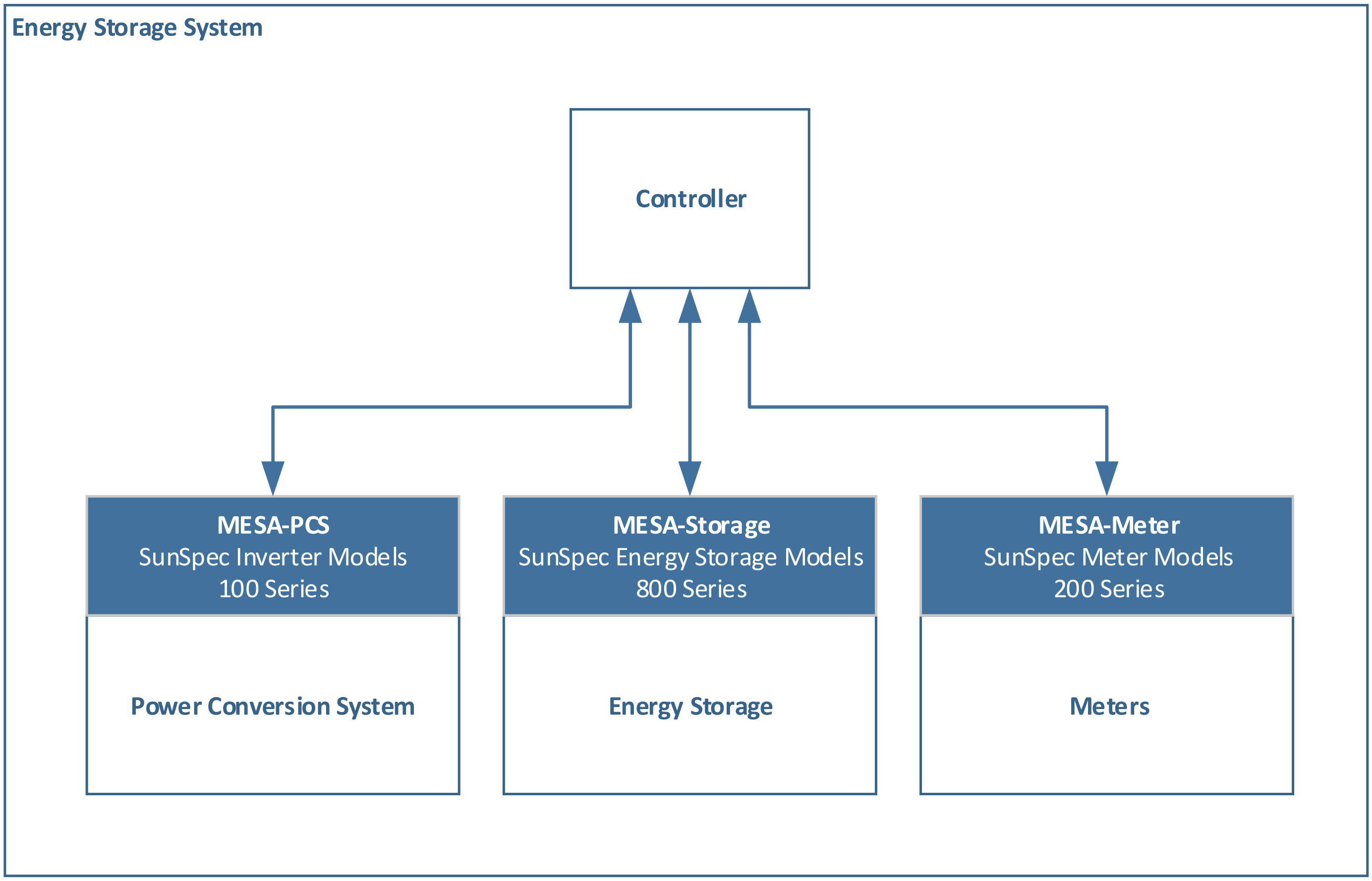

Diagram 1: Energy Storage Systems and MESA

2 MESA-PCS

A MESA-compliant power conversion system is a PCS which provides a Modbus/TCP communication interface and which implements a specific set of SunSpec models. Modbus has been selected as the base protocol given the large number of power conversion systems and inverters in the market today which already provide a Modbus interface. TCP has been selected as the transport given its ubiquity and flexibility.

2.1 SunSpec Inverter Models

All MESA-compliant power conversion systems are by definition SunSpec devices. This means that they must include the Common Model at the top of their Modbus register map, and they must include the End Model at the end of their register map. For more information on the Common Model and the End Model, please see the SunSpec Common Models document referenced in Section 1.1.

Additionally, all MESA-compliant power conversion systems must implement a small number of SunSpec inverter models. The SunSpec Alliance has published over 20 different inverter models, many of which apply directly to power conversion systems used in stand-alone energy storage systems. Other models which don't apply to energy storage systems may be implemented by the PCS vendor (e.g. for other applications) but are not required by MESA.

Table 2 lists all of the existing SunSpec inverter models and identifies those that must be implemented by a MESA-compliant power conversion system.

Table 2: SunSpec Inverter Models

Model ID	Description	Required by MESA-PCS
101	Single Phase Inverter Model (Integer Based)	No
102	Split Phase Inverter Model (Integer Based)	No
103	3 Phase Inverter Model (Integer Based)	**Yes**
111	Single Phase Inverter Model (Float Based)	No
112	Split Phase Inverter Model (Float Based)	No
113	3-Phase Inverter Model (Float Based)	**Yes**
120	Inverter Controls Nameplate Ratings	**Yes**
121	Inverter Controls Basic Settings	No
122	Inverter Controls Measurement and Status	No
123	Inverter Controls Immediate Controls	**Yes**
124	Inverter Controls Basic Storage Controls	No
125	Inverter Controls Pricing Signal	No
126	Inverter Controls Static Volt-VAR Arrays	No
127	Inverter Controls Frequency Watt Control	No
128	Inverter Controls Dynamic Reactive Current	No
129	Inverter Controls LVRT Arrays	No
130	Inverter Controls HVRT Arrays	No
131	Inverter Controls Watt-Power Factor Arrays	No
132	Inverter Controls Voltage-Watt Arrays	No
133	Inverter Controls Basic Scheduling	No
160	Inverter Multiple Power Point Tracker (MPPT)	No

Note that only one of Model 103 and Model 113 needs to be implemented. These are effectively the same SunSpec model, where 103 uses an integer-based representation, and 113 uses floats.

More information on the SunSpec inverter models can be found here:

http://www.sunspec.org/specifications

2.1.1 Inverter Model Enhancements

Because of the differences between the inverters used in PV installations and the power conversion systems typically used in energy storage systems, a few minor additions/changes are required in the implementation of the models shown in the table above. These enhancements are shown in Table 3.

Table 3: Inverter Model Enhancements

Model Number	Register	Additions/Changes
103	Amps (A)	This register should be treated as a signed value since current may move in both directions.
103	DC Amps (DCA)	This register should be treated as a signed value since current may move in both directions.
103/113	Operating State (St)	In addition to the eight operating states listed in the SunSpec Inverter (Three Phase) model, an additional ninth state shall be implemented: 9: Started This additional state indicates that the PCS has been properly initialized, that the AC breaker and DC contractors are connected, and that the PCS is ready to accept real and reactive power commands.
103/113	Event1 (Evt1)	In addition to the 16 bits identified in the SunSpec Inverter (Three Phase) model, two additional bits shall be implemented: 16: OTHER_ALARM 17: OTHER_WARNING When OTHER_ALARM is set, it indicates that some other alarm has occurred in the PCS (i.e. an alarm which does not map to one of the other alarm categories). When OTHER_WARNING is set, it indicates that some other warning has occurred in the PCS (i.e. a warning which does not map to one of the other warning categories).
123	WMaxLimPct	This register should be treated as a signed value since real power may be both exported and imported. This is also consistent with VArMaxPct which is treated as a signed value.

The MESA Standards Alliance has proposed the Inverter Model Enhancements listed in Table 3 to the SunSpec Alliance Inverter Control Workgroup for review and approval and expect the enhancements to be incorporated in the next revision of the SunSpec Inverter Control Models Specification.

2.2 MESA-PCS Extensions Model (V 64800)

In addition to the values and settings contained within the models listed in Section 2.1, testing with MESA partners has shown that a small number of additional Modbus registers are required for safe and effective operation of the PCS. These additional values and settings have been assembled into the MESA-PCS Extensions Model. The MESA-PCS Extensions Model is a SunSpec vendor model with an ID of 64800.

As with the inverter model enhancements listed in Section 2.1.1, the MESA Standards Alliance is actively working with SunSpec to push these additional registers into the official SunSpec models where possible.

The values and settings in the MESA-PCS Extensions Model are described in the subsections below.

2.2.1 Local vs. Remote Control

When maintenance is being performed on a PCS, remote control of the device should be prevented to ensure the safety of the personnel performing the maintenance.

The Control Mode value (LocRemCtl) in the MESA-PCS Extensions Model indicates whether or not remote control is allowed. Under normal conditions, this value is 0 which indicates that remote control is allowed. If local maintenance is required, on-site personnel will generally use a device-specific switch or HMI to put the PCS into local mode, at which point Control Mode will return 1 and all remote commands will be refused. Once the maintenance operation is complete, the same switch or HMI would be used to restore the ability to control the device remotely.

2.2.2 Heartbeats

When a PCS is asked to export or import power, it will generally continue doing so until a) it is asked to stop or b) the energy source is exhausted. Should a communication error occur between the PCS and an upstream controller during a charge or discharge operation, it is often not desirable to continue the export or import of power. It is important to be able to detect these cases and respond accordingly.

The PCS Heartbeat value (PCSHb) in Model 64800 is an unsigned numeric value which is incremented every second on the PCS. Periodically, this value resets to zero and the incrementing process continues (reset periodicity is up to the device manufacturer). A controller or other master can use this changing value to confirm that the PCS is healthy and able to provide updated values on demand. Should this heartbeat stop for any reason, a controller may assume that the PCS is no longer in a healthy state, and take appropriate action (e.g. disconnecting the battery bank attached to the PCS).

Similarly, the Controller Heartbeat value (ControllerHb) in Model 64800 can be used by the PCS to determine if it is properly communicating with the controller. If this value is not updated every second as expected, a PCS may choose to alter its state in some way, such as disabling the import or export of power.

It is worth noting that the use of these heartbeat values is optional.

2.2.3 Commands

The MESA-PCS Extensions Model provides two registers which may be used to control the PCS.

The Alarm Reset control setting (PCSAlarmReset) is used to request that the PCS attempt to reset any latched alarms. A controller or other master who wishes to reset alarms on the PCS should set this register to one, which triggers the action in the PCS. When the PCS is done resetting alarms (even if the resets were not successful), it should set the value back to zero.

The Set Operation control setting (PCSSetOperation) is used start and stop the PCS, and also to move the PCS into or out of standby mode. This setting is an enumerated value, and similar to Alarm Reset, once the operation is complete the PCS should set the value back to zero.

2.2.4 Charge and Discharge Currents

As the state of charge in a battery bank rises and falls, the current limits for charging and discharging that battery vary. A battery or other storage device may advertise these current limits using the SunSpec models described in the MESA-Storage interface standard.

To ensure the safe and effective operation of the battery bank, a PCS generally needs to be aware of the instantaneous current limits. The MESA-PCS Extensions Model exposes the Charge Current Limit (MaxBatACha) and Discharge Current

Limit (MaxBatADischa) settings for this reason. A controller or other master which reads current limits from the battery bank should update these two values in Model 64800 to ensure that the PCS is aware of any updated limits on current. The power conversion system, for its part, shall make every effort to honor the current limits provided to it.

2.2.5 AC Current Limits

Based on temperature and other operational factors, a PCS may not be able to perform at nameplate levels. When these situations occur, it is important that the PCS be able to convey derating information to the controller. The AC Maximum Current Limit (MaxA) and AC Maximum Current Limit Percentage (MaxACur) values in the MESA-PCS Extension Model may be used to specify this information.

AC Maximum Current Limit is a nameplate value which specifies the maximum current on the AC side in amperes. The AC Maximum Current Limit Percentage register is an instantaneous value which indicates the percentage of MaxA that the inverter is able to achieve at the current time.

If the PCS implements these registers, a master or other controller must monitor them and make sure that no power requests are made that would push the current above MaxA * MaxACur.