Technical Note – SunSpec Logging in SolarEdge Inverters

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Overview

SolarEdge inverters support reading inverter-level monitoring data directly from the inverter to a local non-SolarEdge device, by implementing the SunSpec open protocol for interoperability between devices in renewable energy systems. This option can be used alongside the connection to the SolarEdge monitoring server. This document describes the connection method and the protocol and configurations needed to implement this feature.

Direct connection to a monitoring device is useful when a network connection is unavailable, when extensive custom data processing is required, or when authorities require direct access to monitoring data.

In many cases, it is possible – and recommended – to employ the direct connection **alongside** a SolarEdge monitoring portal connection. Connection to the SolarEdge monitoring portal enables all the monitoring benefits, primarily:

- Proactive installer maintenance and real time troubleshooting by SolarEdge support, using with the physical mapping available only in the SolarEdge monitoring portal
- Module-level monitoring

SunSpec Supported Inverters

All inverters with CPU version 3.xxxx and above are SunSpec-supported.

Please upgrade to the latest available firmware.

To check the inverter firmware versions, short press the LCD light button until reaching the following screen:

```
ID:  ########  ##
DSP1/2:x.xxxx/x.xxxx
CPU  :0002.0496
Country:XXXXX
```

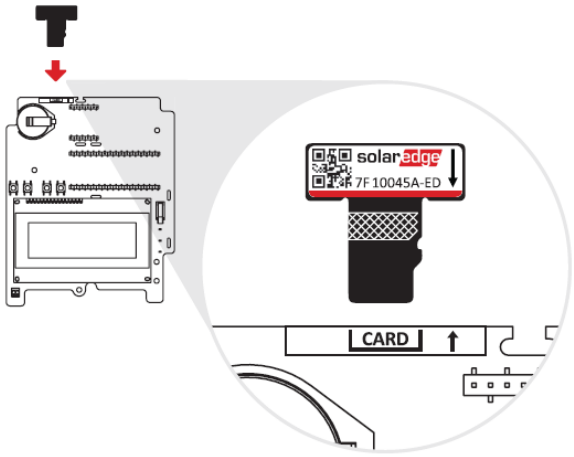
If needed, contact SolarEdge support to upgrade inverters with earlier versions.

► To upgrade the inverter firmware version:

1 Ensure that the inverter has been activated using the card supplied with the inverter.

2 Ensure that the ON/OFF switch of the inverter is OFF.

3 Insert the card into the communication board slot marked “CARD”.



4 Switch on the AC to the inverter.

5 Enter the inverter Setup mode: Press the internal Enter button for 5-10 seconds and release. Enter the password 12312312.

6 Select Maintenance ➔ SW Upgrade – SD Card.

7 The LCD shows: Running Script... ➔ Done!
If the LCD shows: Script error:

- Switch the AC OFF and ON (reset), and repeat the upgrade process.
- If the problem persists, contact Support.

Physical Connection

The connection is performed using an RS485 connector with a twisted pair cable. The transmission mode in SolarEdge inverters is set to RTU (binary).

The COM port default properties are: 115200 bps, 8 data bits, no parity, 1 stop bit, no flow control. Baud rate can be changed between 9600bps to 115200bps (supported from CPU version 2.0549).

The RS485 bus can be configured to support connection either to a non-SolarEdge monitoring device or Master-Slave connection between SolarEdge inverters. Therefore, a slave inverter cannot communicate simultaneously with a master inverter and with a non-SolarEdge monitoring device on the same RS485 port.

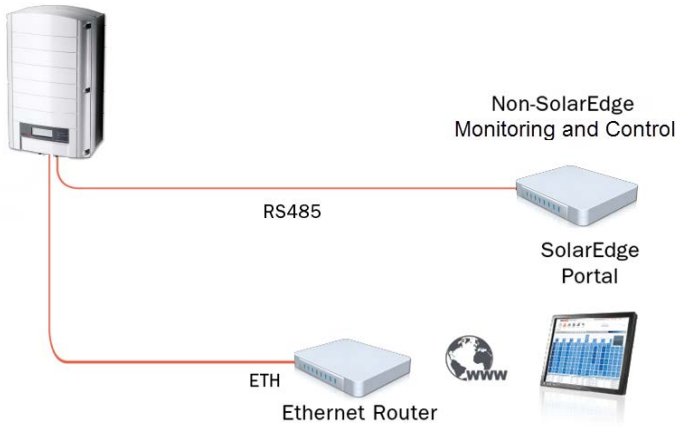
Use Cases for MODBUS over RS485

This section describes RS485 options to connect the inverter to a non-SolarEdge monitoring device and to a SolarEdge monitoring portal.

Single Inverter Connection

1 Use the RS485 bus for connecting to a non-SolarEdge monitoring device.

2 Use the Ethernet connection or any of the optional wireless connection options to connect to the SolarEdge monitoring portal.



Multiple Inverter Connection

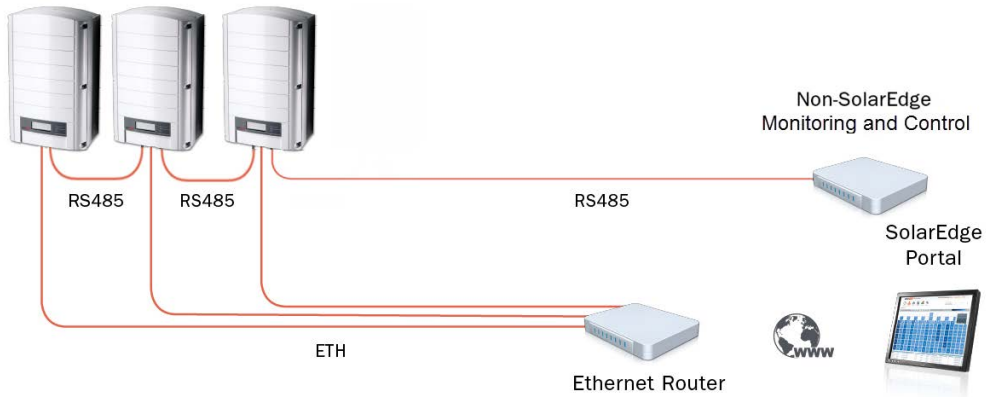
Connection to a non-SolarEdge monitoring device only (without connection to the SolarEdge monitoring portal)

Use the RS485 bus for connection to a non-SolarEdge monitoring device. Every inverter in the RS485 bus should be configured to a different device ID (MODBUS ID).

Connection to the SolarEdge monitoring portal and to a non-SolarEdge monitoring device

1 Use the RS485 bus for connection to a non-SolarEdge monitoring device. Every inverter in the RS485 bus should be configured to a different device ID (MODBUS ID).

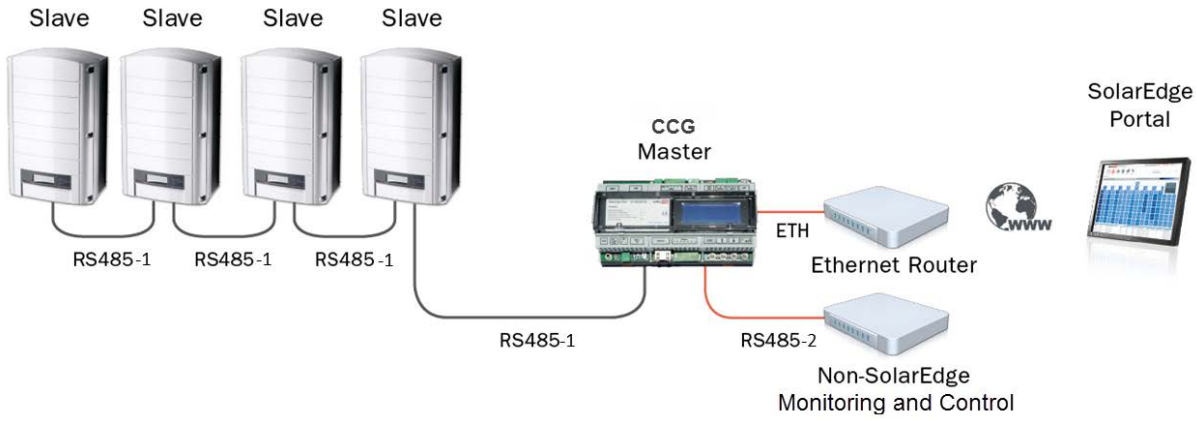
2 Connect each inverter to the SolarEdge monitoring portal via Ethernet cables.



Connection to SolarEdge monitoring portal and to a non-SolarEdge monitoring device using SolarEdge Control and Communication Gateway

1 Use the RS485-2 bus for connection to a non-SolarEdge monitoring device. Every inverter connected to the RS485 bus should be configured to a different device ID (MODBUS ID).

2 Use Ethernet cables to connect each inverter to the SolarEdge monitoring portal.



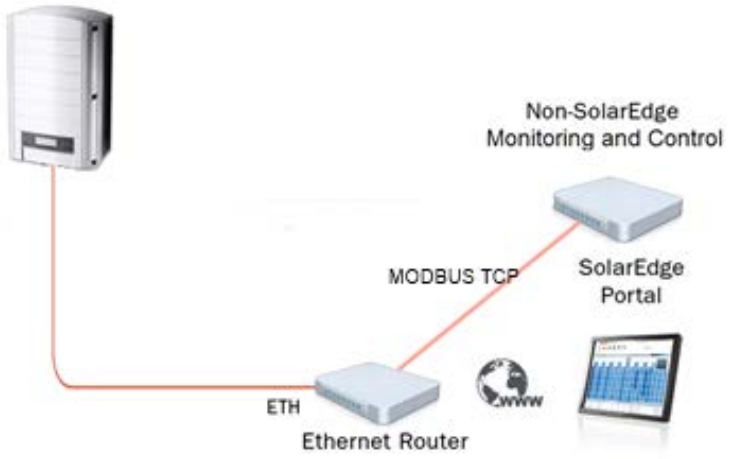
Use Cases for MODBUS over TCP

This section describes MODBUS options to connect the inverter to a non-SolarEdge monitoring device and to a SolarEdge monitoring portal.

Single Inverter Connection

1 Use the MODBUS for connecting to a non-SolarEdge monitoring device.

2 Use an Ethernet cable or any of the optional wireless connection options for connecting to the SolarEdge monitoring portal.



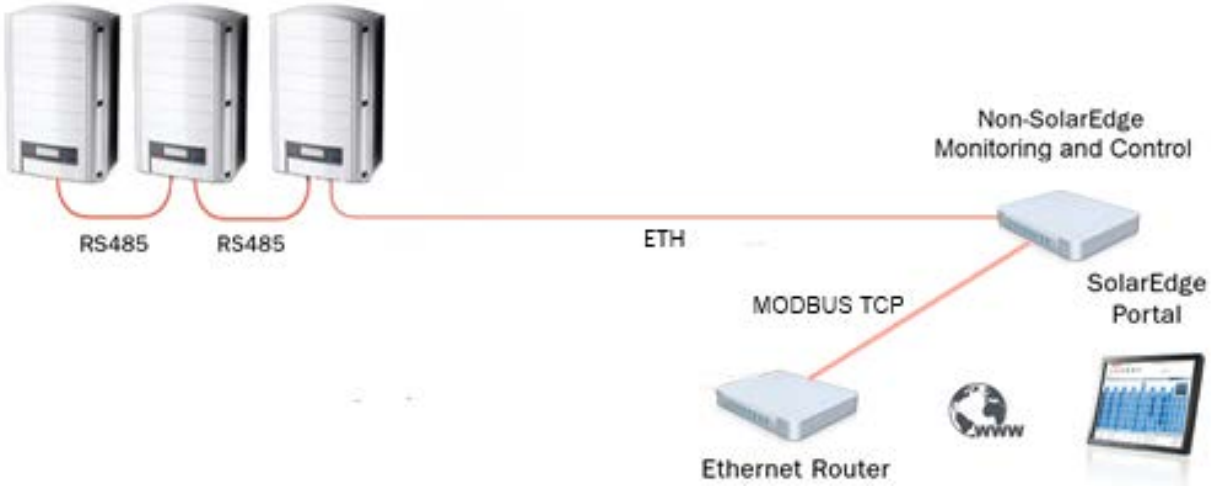
Multiple Inverter Connection

Connection to a non-SolarEdge monitoring device only (without connection to the SolarEdge monitoring portal)

Use the MODBUS for connection to a non-SolarEdge monitoring device. Every inverter in the RS485 should be configured to a different device ID (MODBUS ID).

Connection to the SolarEdge monitoring portal and to a non-SolarEdge monitoring device

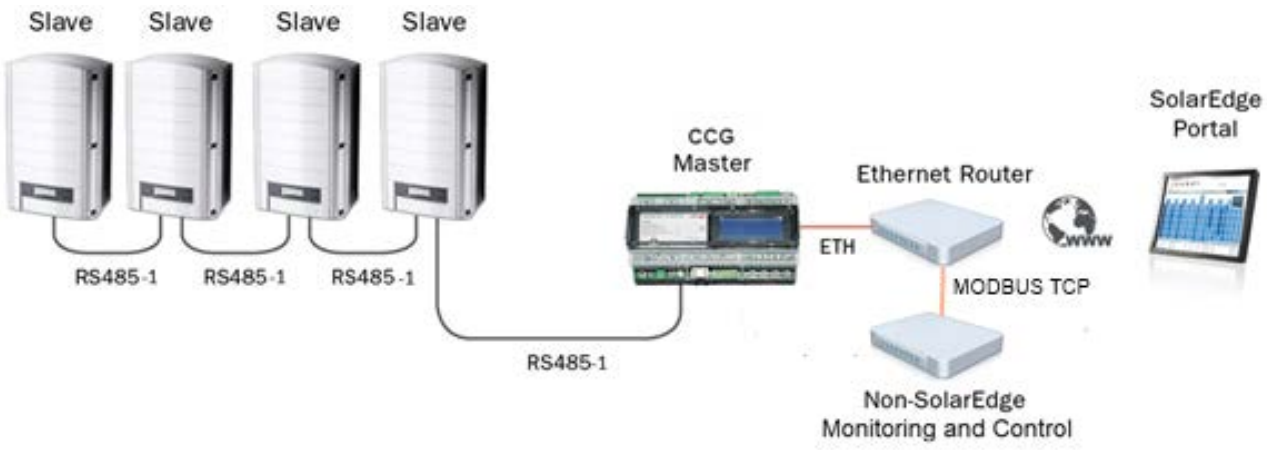
1. Use the MODBUS for connection to a non-SolarEdge monitoring device. Every inverter in the RS485 bus should be configured to a different device ID (MODBUS ID).
2. Connect each inverter to the SolarEdge monitoring portal via Ethernet cables.



Connection to SolarEdge monitoring portal and to a non-SolarEdge monitoring device using SolarEdge Control and Communication Gateway

1 Use the RS485-2 bus for connection to a non-SolarEdge monitoring device. Every inverter connected to the RS485 bus should be configured to a different device ID (MODBUS ID).

2 Use Ethernet cables to connect each inverter to the SolarEdge monitoring portal.



SolarEdge Device Configuration

This section describes how to configure the SolarEdge device (inverter or Control & Communication Gateway) as a non-SolarEdge monitoring device. To reach the main setup menu, follow the instructions in the *Installation Guide* of the specific SolarEdge device.

Modbus over RS485 Configuration

► To configure the inverters (when used without the Control and Communication Gateway):

1 Under the Communication menu, set the following:
- Communication ➔ Server ➔ Select any server connection, except for RS485 (if the inverter is *not* connected to the SolarEdge monitoring portal, select **None**.
- Communication ➔ RS485-1 Conf
- RS485-1 Conf ➔ Device Type ➔ Non-SE Logger
- RS485-1 Conf ➔ Protocol ➔ SunSpec
- RS485-1 Conf ➔ Device ID and enter the MODBUS address (a unique value 1…247). This will set the register C_DeviceAddress.

2 If needed, set the baud rate to a preferred value: RS485-1 Conf ➔ Baud rate and enter the rate.

► To configure the inverter (when used with the Control and Communication Gateway):

1 Inverters configuration: For all inverters, set the following RS485 bus settings:
   - Communication ➔ RS485-1 Conf ➔ Device Type ➔SolarEdge
   - Communication ➔ RS485-1 Conf ➔ Protocol ➔Slave
   - Communication ➔ RS485-1 Conf ➔ Device ID ➔ [a unique value 1…247]

2 Gateway configuration: Use RS485-1 to connect to the inverters. RS485-1 bus configuration is as follows:
   - Communication ➔RS485-1 Conf ➔Device Type ➔ SolarEdge
   - Communication ➔ RS485-1 Conf ➔ Protocol ➔Master
   - Communication ➔ RS485-1 Conf ➔ Slave Detect

   The Gateway should report the correct number of slaves. If it does not, verify the connections and terminations.

3 Use RS485-2 to connect to the non-SolarEdge monitoring device. RS485-2 bus configuration is as follows:
   - Communication ➔ RS485-2 Conf ➔ Device Type ➔Non-SE Logger
   - Communication ➔ RS485-2 Conf ➔ Protocol ➔SunSpec

   The Control and Communication Gateway device ID is irrelevant for the communication but needs to be set to one other than the that set for the inverters.

   - Communication ➔ RS485-2 Conf ➔ Device ID ➔ [use one of the higher ID's (e.g. 247) to make sure it is out of scope]
   - The default baud rate is 115200bps. If a different baud rate is required, select: Communication ➔ RS485-2 Conf ➔ Baud Rate

4 Make sure the device ID of the non-SolarEdge monitoring device is different from all other device IDs configured in the inverters and gateways.

5 Connect the gateway to the Ethernet and configure:
   - Communication ➔ Server ➔ LAN
   - Communication ➔ LAN Conf ➔ Set DHCP ➔ [Select Enable for DHCP or Disable for static IP configuration]
   - For Static DHCP setting, configure as follows:
   - Communication ➔ LAN Conf ➔ Set IP ➔ [Set inverters' IP]
   - Communication ➔ LAN Conf ➔ Set Mask ➔ [Set inverters' subnet mask]
   - Communication ➔ LAN Conf ➔ Set Gateway ➔ [Set inverters' gateway]
   - Communication ➔ LAN Conf ➔ Set DNS ➔ [Set inverters' DNS]

6 If Ethernet is connected to the server, verify that the LCD panel displays <S_OK>.

7 Verify that the LCD panel of all inverters is <S_OK>.

MODBUS over TCP Support

MODBUS/TCP uses the standard 100 Mbps Ethernet media in physical layers to carry the MODBUS message handling structure and can support a large number of devices in one network; it is easier to integrate into the Local Area Network (LAN) of a company, so it is the choice of more and more customers.

Here, it is used for remote 3rd party monitoring and control. MODBUS TCP is agnostic of the server connection. It works only over LAN. When configured, MODBUS TCP does not initiate a connection. The server waits for a client to connect. Only one connection is supported.

NOTE

MODBUS TCP function– is disabled by default. When enabled, it supports TCP port 502 by default. The port number can be reconfigured.

MODBUS over TCP Configuration

▶ To setup MODBUS TCP:

1 Select Communication ➔LAN Conf ➔ Modbus TCP (the default port is 502).

2 To modify the TCP port, select Modbus TCP ➔ TCP Port, set the port number and long-press <Enter>.

NOTE

The default device ID of the inverter connected to the Ethernet is 1.

When the MODBUS TCP feature is enabled, the following status screen is shown:

```
Modbus TCP: <status>
IP:192.168.1.210
Port:502
<error message>
```

- Status:
  - **Init** – Initializing server – This state only occurs after the first configuration until it reaches the ready status. This activity lasts about 10 seconds.
  - **Ready** – The server is up and waiting for a client to connect.
  - **Connected** – The client is connected.
  - **Failed** – The server is unable to accept clients (see error message).
- Error messages:
  - **Disconnected** – The Ethernet cable is not connected
  - **Gateway Ping Failed.** – A ping to the 1st router failed
  - **No IP** - Either no DHCP configuration or static IP config (no DHCP server that assigned an IP address) or need to define a static IP.

NOTE

The TCP server idle time is 2 minutes. In order to leave the connection open, the request should be made within 2 minutes. The connection can remain open without any MODBUS requests.

Register Mapping – Monitoring Data

This section describes the registers mapping for the inverter monitoring data (read-only MODBUS protocol data). The SolarEdge inverter mapping for monitoring data is based on the open protocol managed by SunSpec: SunSpec Alliance Interoperability Specification – Inverter Models v1.0. Refer to the *SunSpec Alliance Interoperability Specification – Common Models (Elements)* document for a detailed description of the protocol.

The register mapping can be downloaded from the SunSpec Alliance web page: http://www.sunspec.org/.

SolarEdge inverters support device ID (DID) 101, 102[1] and 103 register mappings.

SolarEdge SunSpec implementation supports three function codes for read and write operations: - 03 (0x03) read holding registers; 06 (0x06) write single register and 16 (0x10) write multiple registers.

[1] Supported only in split-phase configurations (Japanese grid and 240V grid in North America)

Common Model MODBUS Register Mappings

The base Register Common Block is set to 40001 (MODBUS PLC address [base 1]), or 40000 (MODBUS Protocol Address [base 0]).

All parameters are defined as in the SunSpec Common block definition, except for the **C_Options** register, which is set to NOT_IMPLEMENTED.

C_Manufacturer is set to SolarEdge.

C_Model is set to the appropriate inverter model, e.g. SE5000.

C_Version contains the CPU software version with leading zeroes, e.g. 0002.0611.

C_SerialNumber contains the inverter serial number.

C_DeviceAddress is the device MODBUS ID (default: 1), and may be changed using the inverter menu (refer to Meter Models on page 11).

Address	Size	Name	Type	Description
40001	2	C_SunSpec_ID	uint32	Value = "SunS" (0x53756e53). Uniquely identifies this as a SunSpec MODBUS Map
40003	1	C_SunSpec_DID	uint16	Value = 0x0001. Uniquely identifies this as a SunSpec Common Model Block
40004	1	C_SunSpec_Length	uint16	65 = Length of block in 16-bit registers
40005	16	C_Manufacturer	String(32)	Value Registered with SunSpec = "SolarEdge "
40021	16	C_Model	String(32)	SolarEdge Specific Value
40045	8	C_Version	String(16)	SolarEdge Specific Value
40053	16	C_SerialNumber	String(32)	SolarEdge Unique Value
40069	1	C_DeviceAddress	uint16	MODBUS Unit ID

Inverter Device Status Values

The following **I_Status_ xxxx** values are supported:

Parameter	Value	Description
I_STATUS_OFF	1	Off
I_STATUS_SLEEPING	2	Sleeping (auto-shutdown) – Night mode
I_STATUS_MPPT	4	Inverter is ON and producing power

Inverter Model MODBUS Register Mappings

The following table lists the supported MODBUS register values.

Unsupported values are indicated by the NOT_IMPLEMENTED value.

The base register of the Device Specific block is set to 40070 (MODBUS PLC address [base 1]), or 40069 (MODBUS Protocol Address [base 0]).

Address	Size	Name	Type	Units	Description
40070	1	C_SunSpec_DID	uint16		101 = single phase 102 = split phase[1] 103 = three phase
40071	1	C_SunSpec_Length	uint16	Registers	50 = Length of model block
40072	1	I_AC_Current	uint16	Amps	AC Total Current value
40073	1	I_AC_CurrentA	uint16	Amps	AC Phase A Current value
40074	1	I_AC_CurrentB	uint16	Amps	AC Phase B Current value
40075	1	I_AC_CurrentC	uint16	Amps	AC Phase C Current value
40076	1	I_AC_Current_SF	int16		AC Current scale factor
40077	1	I_AC_VoltageAB	uint16	Volts	AC Voltage Phase AB value
40078	1	I_AC_VoltageBC	uint16	Volts	AC Voltage Phase BC value
40079	1	I_AC_VoltageCA	uint16	Volts	AC Voltage Phase CA value
40080	1	I_AC_VoltageAN [2,3,4]	uint16	Volts	AC Voltage Phase A to N value
40081	1	I_AC_VoltageBN [3,4]	uint16	Volts	AC Voltage Phase B to N value
40082	1	I_AC_VoltageCN [4]	uint16	Volts	AC Voltage Phase C to N value
40083	1	I_AC_Voltage_SF	int16		AC Voltage scale factor
40084	1	I_AC_Power	int16	Watts	AC Power value
40085	1	I_AC_Power_SF	int16		AC Power scale factor
40086	1	I_AC_Frequency	uint16	Hertz	AC Frequency value
40087	1	I_AC_Frequency_SF	int16		Scale factor
40088	1	I_AC_VA	int16	VA	Apparent Power
40089	1	I_AC_VA_SF	int16		Scale factor
40090	1	I_AC_VAR	int16	VAR	Reactive Power
40091	1	I_AC_VAR_SF	int16		Scale factor
40092	1	I_AC_PF	int16	%	Power Factor[4]
40093	1	I_AC_PF_SF	int16		Scale factor
40094	2	I_AC_Energy_WH	acc32	WattHours	AC Lifetime Energy production
40096	1	I_AC_Energy_WH_SF	uint16		Scale factor
40097	1	I_DC_Current	uint16	Amps	DC Current value
40098	1	I_DC_Current_SF	int16		Scale factor
40099	1	I_DC_Voltage	uint16	Volts	DC Voltage value
40100	1	I_DC_Voltage_SF	int16		Scale factor
40101	1	I_DC_Power	int16	Watts	DC Power value
40102	1	I_DC_Power_SF	int16		Scale factor
40104	1	I_Temp_Sink	int16	Degrees C	Heat Sink Temperature

[2] Supported for single phase inverters
[3] Supported for split-phase configurations (Japanese grid and 240V grid in North America)
[4] Supported for three phase inverters

Address	Size	Name	Type	Units	Description
40107	1	I_Temp_SF	int16		Scale factor
40108	1	I_Status	uint16		Operating State
40109	1	I_Status_Vendor	uint16		Vendor-defined operating state and error codes. The errors displayed here are similar to the ones displayed on the inverter LCD screen. For error description, meaning and troubleshooting, refer to the *SolarEdge Installation Guide*. [5]*
40110	2	I_Event_1	uint32		Not implemented
40112	2	I_Event_2	uint32		Not implemented
40114	2	I_Event_1_Vendor	uint32 (bit-mask)		Vendor defined events: 0x1 – Off-grid (Available from inverter CPU firmware version 3.19xx and above) [4]*
40116	2	I_Event_2_Vendor	uint32		Not implemented
40118	2	I_Event_3_Vendor	uint32		Not implemented
40120	2	I_Event_4_Vendor	uint32		3x2 in the inverter manual (LCD display) is translated to 0x03000002 in the I_Event_4_Vendor register (Available from inverter CPU firmware version 3.19xx and above) [4]*

Meter Models

The SunSpec Alliance Interoperability Specification describes the data models and MODBUS register mappings for meter devices used in Renewable Energy systems. This section defines the models for:

- Single Phase Meter
- Split Phase Meter
- Wye Connect Meter
- Delta Connect Meter

Meter Device Block

The following data elements are provided to describe meters.

- **C_SunSpec_DID –** A well-known value that uniquely identifies this block as a meter
- block. (4) for single phase meters and (5) for three phase meter types.
- **C_SunSpec_Length** – The length of the meter block in registers.
- **M_AC_xxxx**– Meter AC values.
- **M_Exported_xxxx**– Meter Exported Energy values
- **M_Imported_xxxx**– Meter Imported Energy values

Energy value

The energy value is represented by a 32-bit unsigned integer accumulator with a scale factor. Values for import and export are provided. Unsupported or invalid accumulators may return 0x00000000. Power signs and Energy quadrants are per IEEE 1459-2000.

[5] The error codes on the inverter LCD were changed in inverter CPU firmware version 3.19xx and above to the hex decimal display

Meter Event Flag Values

The SunSpec Common Elements defines a C_Event value. The meter specific flags are defined here.

C_Event Value	Flag	Description
M_EVENT_Power_Failure	0x00000004	Loss of power or phase
M_EVENT_Under_Voltage	0x00000008	Voltage below threshold (Phase Loss)
M_EVENT_Low_PF	0x00000010	Power Factor below threshold (can indicate miss-associated voltage and current inputs in three phase systems)
M_EVENT_Over_Current	0x00000020	Current Input over threshold (out of measurement range)
M_EVENT_Over_Voltage	0x00000040	Voltage Input over threshold (out of measurement range)
M_EVENT_Missing_Sensor	0x00000080	Sensor not connected
M_EVENT_Reserved1	0x00000100	Reserved for future
M_EVENT_Reserved2	0x00000200	Reserved for future
M_EVENT_Reserved3	0x00000400	Reserved for future
M_EVENT_Reserved4	0x00000800	Reserved for future
M_EVENT_Reserved5	0x00001000	Reserved for future
M_EVENT_Reserved6	0x00002000	Reserved for future
M_EVENT_Reserved7	0x00004000	Reserved for future
M_EVENT_Reserved8	0x00008000	Reserved for future
M_EVENT_OEM1-15	0x7FFF000	Reserved for OEMs

MODBUS Register Mappings

Meter Model – MODBUS Mapping

This map supports single, split, wye, and delta meter connections in a single map as proper subsets. The connection type is distinguished by the C_SunSpec_DID. Registers that are not applicable to a meter class return the unsupported value. (e.g. Single Phase meters will support only summary and phase A values).

Meters base address:

- 1st meter – 40000 + 121
- 2nd meter – 40000 + 295
- 3rd meter – 40000 + 469

NOTE

Only enabled meters are readable, i.e. if meter 1 and 3 are enabled, they are readable as 1st meter and 2nd meter (and the 3rd meter isn't readable). The meter type can be read from the Common block Options field (the same strings that we use in the menus).

Meter 1

Address	Size	Name	Type	Units	Description
Common Block					
40121	1	C_SunSpec_DID	uint16	N/A	Value = 0x0001. Uniquely identifies this as a SunSpec Common Model Block
40122	1	C_SunSpec_Length	uint16	N/A	65 = Length of block in 16-bit registers
40123	16	C_Manufacturer	String(32)	N/A	Meter manufacturer
40139	16	C_Model	String(32)	N/A	Meter model

Address	Size	Name	Type	Units	Description
40155	8	C_Option	String(16)	N/A	Export + Import, Production, consumption,
40163	8	C_Version	String(16)	N/A	Meter version
40171	16	C_SerialNumber	String(32)	N/A	Meter SN
40187	1	C_DeviceAddress	uint16	N/A	Inverter Modbus ID
Identification					
40188	1	C_SunSpec_DID	uint16	N/A	Well-known value. Uniquely identifies this as a SunSpecMODBUS Map: Single Phase (AN or AB) Meter (201) Split Single Phase (ABN) Meter (202) Wye-Connect Three Phase (ABCN) Meter (203) Delta-Connect Three Phase (ABC) Meter(204)
40189	1	C_SunSpec_Length	uint16	Registers	Length of meter model block
Current					
40190	1	M_AC_Current	int16	Amps	**AC Current** (sum of active phases)
40191	1	M_AC_Current_A	int16	Amps	Phase A AC Current
40192	1	M_AC_Current_B	int16	Amps	Phase B AC Current
40193	1	M_AC_Current_C	int16	Amps	Phase C AC Current
40194	1	M_AC_Current_S F	int16	SF	AC Current Scale Factor
Voltage					
Line to Neutral Voltage					
40195	1	M_AC_Voltage_L N	int16	Volts	Line to Neutral AC Voltage (average of active phases)
40196	1	M_AC_Voltage_A N	int16	Volts	Phase A to Neutral AC Voltage
40197	1	M_AC_Voltage_B N	int16	Volts	Phase B to Neutral AC Voltage
40198	1	M_AC_Voltage_C N	int16	Volts	Phase C to Neutral AC Voltage
Line to Line Voltage					
40199	1	M_AC_Voltage_L L	int16	Volts	Line to Line AC Voltage (average of active phases)
40200	1	M_AC_Voltage_A B	int16	Volts	Phase A to Phase B AC Voltage
40201	1	M_AC_Voltage_B C	int16	Volts	Phase B to Phase C AC Voltage
40202	1	M_AC_Voltage_C A	int16	Volts	Phase C to Phase A AC Voltage
40203	1	M_AC_Voltage_S F	int16	SF	AC Voltage Scale Factor
Frequency					
40204	1	M_AC_Freq	int16	Herts	AC Frequency
40205	1	M_AC_Freq_SF	int16	SF	AC Frequency Scale Factor
Power					
Real Power					
40206	1	M_AC_Power	int16	Watts	**Total Real Power** (sum of active phases)
40207	1	M_AC_Power_A	int16	Watts	Phase A AC Real Power
40208	1	M_AC_Power_B	int16	Watts	Phase B AC Real Power
40209	1	M_AC_Power_C	int16	Watts	Phase C AC Real Power
40210	1	M_AC_Power_SF	int16	SF	AC Real Power Scale Factor
Apparent Power					
40211	1	M_AC_VA	int16	Volt- Amps	Total AC Apparent Power (sum of active phases)
40212	1	M_AC_VA_A	int16	Volt- Amps	Phase A AC Apparent Power
40213	1	M_AC_VA_B	int16	Volt- Amps	Phase B AC Apparent Power
40214	1	M_AC_VA_C	int16	Volt- Amps	Phase C AC Apparent Power

Address	Size	Name	Type	Units	Description
40215	1	M_AC_VA_SF	int16	SF	AC Apparent Power Scale Factor
Reactive Power					
40216	1	M_AC_VAR	int16	VAR	Total AC Reactive Power (sum of active phases)
40217	1	M_AC_VAR_A	int16	VAR	Phase A AC Reactive Power
40218	1	M_AC_VAR_B	int16	VAR	Phase B AC Reactive Power
40219	1	M_AC_VAR_C	int16	VAR	Phase C AC Reactive Power
40220	1	M_AC_VAR_SF	int16	SF	AC Reactive Power Scale Factor
Power Factor					
40221	1	M_AC_PF	int16	%	**Average Power Factor** (average of active phases)
40222	1	M_AC_PF_A	int16	%	Phase A Power Factor
40223	1	M_AC_PF_B	int16	%	Phase B Power Factor
40224	1	M_AC_PF_C	int16	%	Phase C Power Factor
40225	1	M_AC_PF_SF	int16	SF	AC Power Factor Scale Factor
Accumulated Energy					
Real Energy					
40226	2	M_Exported	uint32	Watt- hours	Total Exported Real Energy
40228	2	M_Exported_A	uint32	Watt- hours	Phase A Exported Real Energy
40230	2	M_Exported_B	uint32	Watt- hours	Phase B Exported Real Energy
40232	2	M_Exported_C	uint32	Watt- hours	Phase C Exported Real Energy
40234	2	M_Imported	uint32	Watt- hours	Total Imported Real Energy
40236	2	M_Imported_A	uint32	Watt- hours	Phase A Imported Real Energy
40238	2	M_Imported_B	uint32	Watt- hours	Phase B Imported Real Energy
40240	2	M_Imported_C	uint32	Watt- hours	Phase C Imported Real Energy
40242	1	M_Energy_W_SF	int16	SF	Real Energy Scale Factor
Apparent Energy					
40243	2	M_Exported_VA	uint32	VA-hours	Total Exported Apparent Energy
40245	2	M_Exported_VA_ A	uint32	VA-hours	Phase A Exported Apparent Energy
40247	2	M_Exported_VA_ B	uint32	VA-hours	Phase B Exported Apparent Energy
40249	2	M_Exported_VA_ C	uint32	VA-hours	Phase C Exported Apparent Energy
40251	2	M_Imported_VA	uint32	VA-hours	Total Imported Apparent Energy
40253	2	M_Imported_VA_ A	uint32	VA-hours	Phase A Imported Apparent Energy
40255	2	M_Imported_VA_ B	uint32	VA-hours	Phase B Imported Apparent Energy
40257	2	M_Imported_VA_ C	uint32	VA-hours	Phase C Imported Apparent Energy
40259	1	M_Energy_VA_S F	int16	SF	Apparent Energy Scale Factor
Reactive Energy					
40260	2	M_Import_VARh_ Q1	uint32	VAR-hours	Quadrant 1: Total Imported Reactive Energy
40262	2	M_Import_VARh_ Q1A	uint32	VAR-hours	Phase A - Quadrant 1: Imported Reactive Energy
40264	2	M_Import_VARh_ Q1B	uint32	VAR-hours	Phase B- Quadrant 1: Imported Reactive Energy
40266	2	M_Import_VARh_ Q1C	uint32	VAR-hours	Phase C- Quadrant 1: Imported Reactive Energy
40268	2	M_Import_VARh_ Q2	uint32	VAR-hours	Quadrant 2: Total Imported Reactive Energy
40270	2	M_Import_VARh_ Q2A	uint32	VAR-hours	Phase A - Quadrant 2: Imported Reactive Energy
40272	2	M_Import_VARh_ Q2B	uint32	VAR-hours	Phase B- Quadrant 2: Imported Reactive Energy
40274	2	M_Import_VARh_ Q2C	uint32	VAR-hours	Phase C- Quadrant 2: Imported Reactive Energy

Address	Size	Name	Type	Units	Description
40276	2	M_Export_VARh_ Q3	uint32	VAR-hours	Quadrant 3: Total Exported Reactive Energy
40278	2	M_Export_VARh_ Q3A	uint32	VAR-hours	Phase A - Quadrant 3: Exported Reactive Energy
40280	2	M_Export_VARh_ Q3B	uint32	VAR-hours	Phase B- Quadrant 3: Exported Reactive Energy
40282	2	M_Export_VARh_ Q3C	uint32	VAR-hours	Phase C- Quadrant 3: Exported Reactive Energy
40284	2	M_Export_VARh_ Q4	uint32	VAR-hours	Quadrant 4: Total Exported Reactive Energy
40286	2	M_Export_VARh_ Q4A	uint32	VAR-hours	Phase A - Quadrant 4: Exported Reactive Energy
40288	2	M_Export_VARh_ Q4B	uint32	VAR-hours	Phase B- Quadrant 4: Exported Reactive Energy
40290	2	M_Export_VARh_ Q4C	uint32	VAR-hours	Phase C- Quadrant 4: Exported Reactive Energy
40292	1	M_Energy_VAR_ SF	int16	SF	Reactive Energy Scale Factor
Events					
40293	2	M_Events	uint32	Flags	See M_EVENT_ flags. 0 = nts.

Meter 2

Address	Size	Name	Type	Units	Description
Common Block					
40295	1	C_SunSpec_DID	uint16	N/A	Value = 0x0001. Uniquely identifies this as a SunSpec Common Model Block
40296	1	C_SunSpec_Length	uint16	N/A	65 = Length of block in 16-bit registers
40297	16	C_Manufacturer	String(32)	N/A	Meter manufacturer
40313	16	C_Model	String(32)	N/A	Meter model
40329	8	C_Option	String(16)	N/A	Export+Import, Production,consumption,
40337	8	C_Version	String(16)	N/A	Meter version
40345	16	C_SerialNumber	String(32)	N/A	Meter SN
40361	1	C_DeviceAddress	uint16	N/A	Inverter Modbus ID
Identification					
40362	1	C_SunSpec_DID	uint16	N/A	Well-known value. Uniquely identifies this as a SunSpecMODBUS Map: Single Phase (AN or AB) Meter (201) Split Single Phase (ABN) Meter (202) Wye-Connect Three Phase (ABCN) Meter (203) Delta-Connect Three Phase (ABC) Meter(204)
40363	1	C_SunSpec_Length	uint16	Registers	Length of meter model block
Current					
40364	1	M_AC_Current	int16	Amps	**AC Current** (sum of active phases)
40365	1	M_AC_Current_A	int16	Amps	Phase A AC Current
40366	1	M_AC_Current_B	int16	Amps	Phase B AC Current
40367	1	M_AC_Current_C	int16	Amps	Phase C AC Current
40368	1	M_AC_Current_S F	int16	SF	AC Current Scale Factor
Voltage					
Line to Neutral Voltage					
40369	1	M_AC_Voltage_L N	int16	Volts	Line to Neutral AC Voltage (average of active phases)
40370	1	M_AC_Voltage_A N	int16	Volts	Phase A to Neutral AC Voltage
40371	1	M_AC_Voltage_B N	int16	Volts	Phase B to Neutral AC Voltage

Address	Size	Name	Type	Units	Description
40372	1	M_AC_Voltage_C N	int16	Volts	Phase C to Neutral AC Voltage
Line to Line Voltage					
40373	1	M_AC_Voltage_L L	int16	Volts	Line to Line AC Voltage (average of active phases)
40374	1	M_AC_Voltage_A B	int16	Volts	Phase A to Phase B AC Voltage
40375	1	M_AC_Voltage_B C	int16	Volts	Phase B to Phase C AC Voltage
40376	1	M_AC_Voltage_C A	int16	Volts	Phase C to Phase A AC Voltage
40377	1	M_AC_Voltage_S F	int16	SF	AC Voltage Scale Factor
Frequency					
40378	1	M_AC_Freq	int16	Herts	AC Frequency
40379	1	M_AC_Freq_SF	int16	SF	AC Frequency Scale Factor
Power					
Real Power					
40380	1	M_AC_Power	int16	Watts	**Total Real Power** (sum of active phases)
40381	1	M_AC_Power_A	int16	Watts	Phase A AC Real Power
40382	1	M_AC_Power_B	int16	Watts	Phase B AC Real Power
40383	1	M_AC_Power_C	int16	Watts	Phase C AC Real Power
40384	1	M_AC_Power_SF	int16	SF	AC Real Power Scale Factor
Apparent Power					
40385	1	M_AC_VA	int16	Volt- Amps	Total AC Apparent Power (sum of active phases)
40386	1	M_AC_VA_A	int16	Volt- Amps	Phase A AC Apparent Power
40387	1	M_AC_VA_B	int16	Volt- Amps	Phase B AC Apparent Power
40388	1	M_AC_VA_C	int16	Volt- Amps	Phase C AC Apparent Power
40389	1	M_AC_VA_SF	int16	SF	AC Apparent Power Scale Factor
Reactive Power					
40390	1	M_AC_VAR	int16	VAR	Total AC Reactive Power(sum of active phases)
40391	1	M_AC_VAR_A	int16	VAR	Phase A AC Reactive Power
40392	1	M_AC_VAR_B	int16	VAR	Phase B AC Reactive Power
40393	1	M_AC_VAR_C	int16	VAR	Phase C AC Reactive Power
40394	1	M_AC_VAR_SF	int16	SF	AC Reactive Power Scale Factor
Power Factor					
40395	1	M_AC_PF	int16	%	**Average Power Factor** (average of active phases)
40396	1	M_AC_PF_A	int16	%	Phase A Power Factor
40397	1	M_AC_PF_B	int16	%	Phase B Power Factor
40398	1	M_AC_PF_C	int16	%	Phase C Power Factor
40399	1	M_AC_PF_SF	int16	SF	AC Power Factor Scale Factor
Accumulated Energy					
Real Energy					
40400	2	M_Exported	uint32	Watt- hours	Total Exported Real Energy
40402	2	M_Exported_A	uint32	Watt- hours	Phase A Exported Real Energy
40404	2	M_Exported_B	uint32	Watt- hours	Phase B Exported Real Energy
40406	2	M_Exported_C	uint32	Watt- hours	Phase C Exported Real Energy
40408	2	M_Imported	uint32	Watt- hours	Total Imported Real Energy

Address	Size	Name	Type	Units	Description
40410	2	M_Imported_A	uint32	Watt- hours	Phase A Imported Real Energy
40412	2	M_Imported_B	uint32	Watt- hours	Phase B Imported Real Energy
40414	2	M_Imported_C	uint32	Watt- hours	Phase C Imported Real Energy
40416	1	M_Energy_W_SF	int16	SF	Real Energy Scale Factor
Apparent Energy					
40417	2	M_Exported_VA	uint32	VA-hours	Total Exported Apparent Energy
40419	2	M_Exported_VA_ A	uint32	VA-hours	Phase A Exported Apparent Energy
40421	2	M_Exported_VA_ B	uint32	VA-hours	Phase B Exported Apparent Energy
40423	2	M_Exported_VA_ C	uint32	VA-hours	Phase C Exported Apparent Energy
40425	2	M_Imported_VA	uint32	VA-hours	Total Imported Apparent Energy
40427	2	M_Imported_VA_ A	uint32	VA-hours	Phase A Imported Apparent Energy
40429	2	M_Imported_VA_ B	uint32	VA-hours	Phase B Imported Apparent Energy
40431	2	M_Imported_VA_ C	uint32	VA-hours	Phase C Imported Apparent Energy
40433	1	M_Energy_VA_S F	int16	SF	Apparent Energy Scale Factor
Reactive Energy					
40434	2	M_Import_VARh_ Q1	uint32	VAR-hours	Quadrant 1: Total Imported Reactive Energy
40436	2	M_Import_VARh_ Q1A	uint32	VAR-hours	Phase A - Quadrant 1: Imported Reactive Energy
40438	2	M_Import_VARh_ Q1B	uint32	VAR-hours	Phase B- Quadrant 1: Imported Reactive Energy
40440	2	M_Import_VARh_ Q1C	uint32	VAR-hours	Phase C- Quadrant 1: Imported Reactive Energy
40442	2	M_Import_VARh_ Q2	uint32	VAR-hours	Quadrant 2: Total Imported Reactive Energy
40444	2	M_Import_VARh_ Q2A	uint32	VAR-hours	Phase A - Quadrant 2: Imported Reactive Energy
40446	2	M_Import_VARh_ Q2B	uint32	VAR-hours	Phase B- Quadrant 2: Imported Reactive Energy
40448	2	M_Import_VARh_ Q2C	uint32	VAR-hours	Phase C- Quadrant 2: Imported Reactive Energy
40450	2	M_Export_VARh_ Q3	uint32	VAR-hours	Quadrant 3: Total Exported Reactive Energy
40452	2	M_Export_VARh_ Q3A	uint32	VAR-hours	Phase A - Quadrant 3: Exported Reactive Energy
40454	2	M_Export_VARh_ Q3B	uint32	VAR-hours	Phase B- Quadrant 3: Exported Reactive Energy
40456	2	M_Export_VARh_ Q3C	uint32	VAR-hours	Phase C- Quadrant 3: Exported Reactive Energy
40458	2	M_Export_VARh_ Q4	uint32	VAR-hours	Quadrant 4: Total Exported Reactive Energy
40460	2	M_Export_VARh_ Q4A	uint32	VAR-hours	Phase A - Quadrant 4: Exported Reactive Energy
40462	2	M_Export_VARh_ Q4B	uint32	VAR-hours	Phase B- Quadrant 4: Exported Reactive Energy
40464	2	M_Export_VARh_ Q4C	uint32	VAR-hours	Phase C- Quadrant 4: Exported Reactive Energy
40466	1	M_Energy_VAR_ SF	int16	SF	Reactive Energy Scale Factor
Events					
40467	2	M_Events	uint32	Flags	See M_EVENT_ flags. 0 = nts.

Meter 3

Address	Size	Name	Type	Units	Description
Common Block					
40469	1	C_SunSpec_DID	uint16	N/A	Value = 0x0001. Uniquely identifies this as a SunSpec Common Model Block
40470	1	C_SunSpec_Length	uint16	N/A	65 = Length of block in 16-bit registers

Address	Size	Name	Type	Units	Description
40472	16	C_Manufacturer	String(32)	N/A	Meter manufacturer
40488	16	C_Model	String(32)	N/A	Meter model
40504	8	C_Option	String(16)	N/A	Export+Import, Production,consumption,
40512	8	C_Version	String(16)	N/A	Meter version
40520	16	C_SerialNumber	String(32)	N/A	Meter SN
40536	1	C_DeviceAddress	uint16	N/A	Inverter Modbus ID
Identification					
40537	1	C_SunSpec_DID	uint16	N/A	Well-known value. Uniquely identifies this as a SunSpecMODBUS Map: Single Phase (AN or AB) Meter (201) Split Single Phase (ABN) Meter (202) Wye-Connect Three Phase (ABCN) Meter (203) Delta-Connect Three Phase (ABC) Meter(204)
40538	1	C_SunSpec_Length	uint16	Registers	Length of meter model block
Current					
40539	1	M_AC_Current	int16	Amps	**AC Current** (sum of active phases)
40540	1	M_AC_Current_A	int16	Amps	Phase A AC Current
40541	1	M_AC_Current_B	int16	Amps	Phase B AC Current
40542	1	M_AC_Current_C	int16	Amps	Phase C AC Current
40543	1	M_AC_Current_S F	int16	SF	AC Current Scale Factor
Voltage					
Line to Neutral Voltage					
40544	1	M_AC_Voltage_L N	int16	Volts	Line to Neutral AC Voltage (average of active phases)
40545	1	M_AC_Voltage_A N	int16	Volts	Phase A to Neutral AC Voltage
40546	1	M_AC_Voltage_B N	int16	Volts	Phase B to Neutral AC Voltage
40547	1	M_AC_Voltage_C N	int16	Volts	Phase C to Neutral AC Voltage
Line to Line Voltage					
40548	1	M_AC_Voltage_L L	int16	Volts	Line to Line AC Voltage (average of active phases)
40549	1	M_AC_Voltage_A B	int16	Volts	Phase A to Phase B AC Voltage
40550	1	M_AC_Voltage_B C	int16	Volts	Phase B to Phase C AC Voltage
40551	1	M_AC_Voltage_C A	int16	Volts	Phase C to Phase A AC Voltage
40552	1	M_AC_Voltage_S F	int16	SF	AC Voltage Scale Factor
Frequency					
40553	1	M_AC_Freq	int16	Herts	AC Frequency
40554	1	M_AC_Freq_SF	int16	SF	AC Frequency Scale Factor
Power					
Real Power					
40555	1	M_AC_Power	int16	Watts	**Total Real Power** (sum of active phases)
40556	1	M_AC_Power_A	int16	Watts	Phase A AC Real Power
40557	1	M_AC_Power_B	int16	Watts	Phase B AC Real Power
40558	1	M_AC_Power_C	int16	Watts	Phase C AC Real Power
40559	1	M_AC_Power_SF	int16	SF	AC Real Power Scale Factor
Apparent Power					
40560	1	M_AC_VA	int16	Volt- Amps	Total AC Apparent Power (sum of active phases)
40561	1	M_AC_VA_A	int16	Volt- Amps	Phase A AC Apparent Power

Address	Size	Name	Type	Units	Description
40562	1	M_AC_VA_B	int16	Volt- Amps	Phase B AC Apparent Power
40563	1	M_AC_VA_C	int16	Volt- Amps	Phase C AC Apparent Power
40564	1	M_AC_VA_SF	int16	SF	AC Apparent Power Scale Factor
Reactive Power					
40565	1	M_AC_VAR	int16	VAR	Total AC Reactive Power (sum of active phases)
40566	1	M_AC_VAR_A	int16	VAR	Phase A AC Reactive Power
40567	1	M_AC_VAR_B	int16	VAR	Phase B AC Reactive Power
40568	1	M_AC_VAR_C	int16	VAR	Phase C AC Reactive Power
40569	1	M_AC_VAR_SF	int16	SF	AC Reactive Power Scale Factor
Power Factor					
40570	1	M_AC_PF	int16	%	**Average Power Factor** (average of active phases)
40571	1	M_AC_PF_A	int16	%	Phase A Power Factor
40572	1	M_AC_PF_B	int16	%	Phase B Power Factor
40573	1	M_AC_PF_C	int16	%	Phase C Power Factor
40574	1	M_AC_PF_SF	int16	SF	AC Power Factor Scale Factor
Accumulated Energy					
Real Energy					
40575	2	M_Exported	uint32	Watt- hours	Total Exported Real Energy
40577	2	M_Exported_A	uint32	Watt- hours	Phase A Exported Real Energy
40579	2	M_Exported_B	uint32	Watt- hours	Phase B Exported Real Energy
40581	2	M_Exported_C	uint32	Watt- hours	Phase C Exported Real Energy
40583	2	M_Imported	uint32	Watt- hours	Total Imported Real Energy
40585	2	M_Imported_A	uint32	Watt- hours	Phase A Imported Real Energy
40587	2	M_Imported_B	uint32	Watt- hours	Phase B Imported Real Energy
40589	2	M_Imported_C	uint32	Watt- hours	Phase C Imported Real Energy
40591	1	M_Energy_W_SF	int16	SF	Real Energy Scale Factor
Apparent Energy					
40592	2	M_Exported_VA	uint32	VA-hours	Total Exported Apparent Energy
40594	2	M_Exported_VA_ A	uint32	VA-hours	Phase A Exported Apparent Energy
40596	2	M_Exported_VA_ B	uint32	VA-hours	Phase B Exported Apparent Energy
40598	2	M_Exported_VA_ C	uint32	VA-hours	Phase C Exported Apparent Energy
40600	2	M_Imported_VA	uint32	VA-hours	Total Imported Apparent Energy
40602	2	M_Imported_VA_ A	uint32	VA-hours	Phase A Imported Apparent Energy
40604	2	M_Imported_VA_ B	uint32	VA-hours	Phase B Imported Apparent Energy
40606	2	M_Imported_VA_ C	uint32	VA-hours	Phase C Imported Apparent Energy
40608	1	M_Energy_VA_S F	int16	SF	Apparent Energy Scale Factor
Reactive Energy					
40610	2	M_Import_VARh_ Q1	uint32	VAR-hours	Quadrant 1: Total Imported Reactive Energy
40612	2	M_Import_VARh_ Q1A	uint32	VAR-hours	Phase A - Quadrant 1: Imported Reactive Energy
40614	2	M_Import_VARh_ Q1B	uint32	VAR-hours	Phase B- Quadrant 1: Imported Reactive Energy
40616	2	M_Import_VARh_ Q1C	uint32	VAR-hours	Phase C- Quadrant 1: Imported Reactive Energy
40618	2	M_Import_VARh_ Q2	uint32	VAR-hours	Quadrant 2: Total Imported Reactive Energy
40620	2	M_Import_VARh_ Q2A	uint32	VAR-hours	Phase A - Quadrant 2: Imported Reactive Energy

Address	Size	Name	Type	Units	Description
40622	2	M_Import_VARh_ Q2B	uint32	VAR-hours	Phase B- Quadrant 2: Imported Reactive Energy
40624	2	M_Import_VARh_ Q2C	uint32	VAR-hours	Phase C- Quadrant 2: Imported Reactive Energy
40626	2	M_Export_VARh_ Q3	uint32	VAR-hours	Quadrant 3: Total Exported Reactive Energy
40628	2	M_Export_VARh_ Q3A	uint32	VAR-hours	Phase A - Quadrant 3: Exported Reactive Energy
40630	2	M_Export_VARh_ Q3B	uint32	VAR-hours	Phase B- Quadrant 3: Exported Reactive Energy
40632	2	M_Export_VARh_ Q3C	uint32	VAR-hours	Phase C- Quadrant 3: Exported Reactive Energy
40634	2	M_Export_VARh_ Q4	uint32	VAR-hours	Quadrant 4: Total Exported Reactive Energy
40636	2	M_Export_VARh_ Q4A	uint32	VAR-hours	Phase A - Quadrant 4: Exported Reactive Energy
40638	2	M_Export_VARh_ Q4B	uint32	VAR-hours	Phase B- Quadrant 4: Exported Reactive Energy
40640	2	M_Export_VARh_ Q4C	uint32	VAR-hours	Phase C- Quadrant 4: Exported Reactive Energy
40642	1	M_Energy_VAR_ SF	int16	SF	Reactive Energy Scale Factor
Events					
40643	2	M_Events	uint32	Flags	See M_EVENT_ flags. 0 = nts.

Appendix A – Examples of a Supported MODBUS Request

SolarEdge has implemented two methods of the MODBUS request procedure:

- MODBUS request with explicit register addressing - supported by all communication board CPU versions. For example:
  - Tx: 01 03 9C 40 00 7A EB AD –
    - Read 122 registers starting at protocol address 40000 (PLC address 40001).
    - 01 – Slave ID
    - 03 – Read Holding Register
    - 9C40 – Register address; notice that for both protocol addressing (40000) and PLC addressing (40001), the transmitted address is 0x9C40
    - 007A – Requested register number (122)
    - EBAD - Checksum
  - Rx: 01 03 F4 53 75 … [Registers data] … FF FF 12 1B –
    - 01 – Slave ID
    - 03 – Read Holding Registers
    - F4 – Byte size or response (244 bytes)
    - Response payload
    - 121B – Checksum

Appendix B – Response Time Information

When not connected through a Control and Communication Gateway (CCG), the response time of an inverter is *<100ms per inverter @115200bps*.

When connected through a CCG, the response delay through the CCG can be as much as *N*100[ms]+60[ms]*, where:

- *N* is the number of slave inverters on the bus
- *100ms* is max slot time per slave in the SolarEdge bus
- *60ms* is a constant delay for MODBUS packet assuming 115200bps.

The timeout delay per slave is the sum of:

- *N*100 [ms]* - SolarEdge bus delay of N slaves, assuming each inverter transmits one SolarEdge telemetry and one full MODBUS response per grant slot.
- *256 * 10000/Baud rate [ms]* - at least one full MODBUS packet over the MODBUS link, and limited to a minimum of 60ms (hardcoded).

For example, the timeout delay of a bus of 10 slaves and 115200 bps MODBUS link is: 1000 [ms] + 60 [ms].

Part of the slot is also consumed by the slave inverters transmitting SolarEdge telemetries at the same time.

Consider the following if trying to reduce delays when a CCG is installed:

- Waiting for a response is part of the MODBUS definition, and this is limiting the bandwidth.
- Multiple retries may result in multiple replies, as the inverters receive all the MODBUS commands, but the SolarEdge bus topology delays the response. In this case, implementing a no-response-expected MODBUS command may balance between performance and reliability, as:
  - Inverters can be controlled with no delay except for the fixed 60ms per inverter (since a response is not expected).
  - An ACK from the inverter is not expected and the measured power from the meter is used as the feedback loop.
  - The responses from all the inverters are received in an *Nx100ms* timeframe, which can be used for a sanity check.
  - If you try 0 [ms] timeout, expect the timeout to occur intentionally and disregard it.
- If you use MODBUS-over-SolarEdge with MODBUS replies, consider lower rates.

For identifying the CCG detection, check the **C_Model** field of the MODBUS map; the CCG should reply with "SE1000-CCG".

A query on the inverter model MODBUS registers (addresses 40070 to 40109) will receive the response: "NOT_IMPLEMENTED“ for the CCG.