SunSpec Alliance Interoperability Specification

Inverter Models

SunSpec Alliance Inverter Workgroup

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ABSTRACT

This document describes the inverter models of the SunSpec Alliance interoperability specification

Introduction

This SunSpec Alliance Interoperability Specification describes the data models and MODBUS register mappings for inverter devices used in Renewable Energy systems. This document defines a single combined model for single phase, split phase, and three phase inverters. Implementations should leave unused or unsuppored datapoints set to the "not implemented" value specified in the SunSpec Common Model. For example, the Not Implemented value for a 16 bit signed integer is 0x8000.

This revision of the Inverter Models specifically does not address Inverter Control Operations. It was felt by the group that this topic required additional study and the pressing need was to nail down the monitoring aspects of the inverter first.

Inverter Device Block

The following data elements are provided to describe inverters.

- **C_SunSpec_DID –** A well-known value that uniquely identifies this block as an inverter block. (2) for single phase inverters and (3) for three phase inverters, and (4) for split phase inverters.
- **C_SunSpec_Length** – The length of the inverter block in registers.
- **I_AC_xxxx**– Inverter AC values.
- **I_DC_xxxx** – Inverter DC values.
- **I_TEMP_xxxx** – Inverter Operating Temperature
- **I_STATUS_xxxx** – Inverter Operating Status
- **I_EVENT_xxxx** – Inverter Event Flags

Inverter Device Status Values

The SunSpec Common Elements defines a C_Status value. The inverter specific values are defined here.

- **I_Status_** – Status code associated with the operational state of the device. By definition the inverter may exist in only one operating state at any given time. Reflecting this property, the **I_Status** datapoint is implemented as an enumerated type. Inverter manufacturers should describe their inverters operational state using the closest applicable I_Status value at all times.

I_STATUS_OFF	1	Off
I_STATUS_SLEEPING	2	Sleeping (auto-shutdown)
I_STATUS_STARTING	3	Starting up

I_STATUS_MPPT	4	Tracking power point
I_STATUS_THROTTLED	5	Forced power reduction
I_STATUS_SHUTTING_DOWN	6	Shutting down
I_STATUS_FAULT	7	One or more faults exist
I_STATUS_STANDBY	8	Standby (service on unit)*might be in Events

Inverter Event Flag Values

The SunSpec Common Elements defines an I_Event value. The inverter specific flags are defined here. Any number of events may be active at the same time, and as a result the **I_Event** value is implemented as a bit-field.

I_EVENT_GROUND_FAULT	0x00000001	Ground fault
I_EVENT_DC_OVER_VOLT	0x00000002	DC over voltage
I_EVENT_AC_DISCONNECT	0x00000004	AC disconnect open
I_EVENT_DC_DISCONNECT	0x00000008	DC disconnect open
I_EVENT_GRID_DISCONNECT	0x00000010	Grid shutdown
I_EVENT_CABINET_OPEN	0x00000020	Cabinet open
I_EVENT_MANUAL_SHUTDOWN	0x00000040	Manual shutdown
I_EVENT_OVER_TEMP	0x00000080	Over temperature
I_EVENT_OVER_FREQUENCY	0x00000100	Frequency above limit
I_EVENT_UNDER_FREQUENCY	0x00000200	Frequency under limit
I_EVENT_AC_OVER_VOLT	0x00000400	AC Voltage above limit
I_EVENT_AC_UNDER_VOLT	0x00000800	AC Voltage under limit
I_EVENT_BLOWN_STRING_FUSE	0x00001000	Blown String fuse on input
I_EVENT_UNDER_TEMP	0x00002000	Under temperature
I_EVENT_MEMORY_LOSS	0x00004000	Generic Memory or Communication error (internal)
I_EVENT_HW_TEST_FAILURE	0x00008000	Hardware test failure

MODBUS Register Mappings

Combined Single Phase / Three Phase Inverter Model - MODBUS Mapping

Start	End	size	R/W	Name	Type	Units	Scale Factor	Contents	Description
1	1	1	R	C_SunSpec_DID	uint16	N/A	N/A	101, 102, or 103	Uniquely identifies this as a SunSpec Inverter Modbus Map; 101:

									single phase, 102: split phase 103: three phase
2	2	1	R	C_SunSpec_Length	uint16	Registers	N/A	50	Length of model block
3	3	1	R	I_AC_Current	uint16	Amps	_SF	Measured	AC Total Current value
4	4	1	R	I_AC_CurrentA	uint16	Amps	_SF	Measured	AC Phase-A Current value
5	5	1	R	I_AC_CurrentB	uint16	Amps	_SF	Measured	AC Phase-B Current value
6	6	1	R	I_AC_CurrentC	uint16	Amps	_SF	Measured	AC Phase-C Current value
7	7	1	R	I_AC_Current_SF	int16	SF	N/A		AC Current Scale factor
8	8	1	R	I_AC_VoltageAB	uint16	Volts	_SF	Measured	AC Voltage Phase-AB value
9	9	1	R	I_AC_VoltageBC	uint16	Volts	_SF	Measured	AC Voltage Phase BC value
10	10	1	R	I_AC_VoltageCA	uint16	Volts	_SF	Measured	AC Voltage Phase CA value
11	11	1	R	I_AC_VoltageAN	uint16	Volts	_SF	Measured	AC Voltage Phase-A-to-neutral value
12	12	1	R	I_AC_VoltageBN	uint16	Volts	_SF	Measured	AC Voltage Phase B-to-neutral value
13	13	1	R	I_AC_VoltageCN	uint16	Volts	_SF	Measured	AC Voltage Phase C-to-neutral value
14	14	1	R	I_AC_Voltage_SF	int16	SF	N/A		AC Voltage Scale factor
15	15	1	R	I_AC_Power	int16	Watts	_SF	Measured	AC Power value
16	16	1	R	I_AC_Power_SF	int16	SF	N/A		AC Power Scale factor
17	17	1	R	I_AC_Frequency	uint16	Hertz	_SF	Measured	AC Frequency value
18	18	1	R	I_AC_Frequency_SF	int16	SF	N/A		Scale factor
19	19	1	R	I_AC_VA	int16	VA	_SF	Measured	Apparent Power
20	20	1	R	I_AC_VA_SF	int16	SF	N/A		Scale factor

21	21	1	R	I_AC_VAR	int16	VAR	_SF	Measured	Reactive Power
22	22	1	R	I_AC_VAR_SF	int16	SF	N/A		Scale factor
23	23	1	R	I_AC_PF	int16	%	_SF	Measured	Power Factor
24	24	1	R	I_AC_PF_SF	int16	SF	N/A		Scale factor
25	26	2	R	I_AC_Energy_WH	acc32	WattHours	N/A	Measured	AC Lifetime Energy production
27	27	1	R	I_AC_Energy_WH_SF	uint16	SF	_SF	Measured	AC Lifetim Energy production scale factor
28	28	1	R	I_DC_Current	uint16	Amps	N/A	Measured	DC Current value
29	29	1	R	I_DC_Current_SF	int16	SF	_SF		Scale factor
30	30	1	R	I_DC_Voltage	uint16	Volts	N/A	Measured	DC Voltage value
31	31	1	R	I_DC_Voltage_SF	int16	SF	_SF		Scale factor
32	32	1	R	I_DC_Power	int16	Watts	N/A	Measured	DC Power value
33	33	1	R	I_DC_Power_SF	int16	SF	_SF		Scale factor
34	34	1	R	I_Temp_Cab	int16	Degrees C	N/A	Measured	Cabinet Temperature
35	35	1	R	I_Temp_Sink	int16	Degrees C	N/A	Measured	Coolant or Heat Sink Temperature
36	36	1	R	I_Temp_Trans	int16	Degrees C	N/A	Measured	Transformer Temperature
37	37	1	R	I_Temp_Other	int16	Degrees C	N/A	Measured	Other Temperature
38	38	1	R	I_Temp_SF	int16	SF	_SF		Scale factor
39	39	1	R	I_Status	uint16	Enumerated	N/A	Descriptive	Operating State
40	40	1	R	I_Status_Vendor	uint16	Enumerated	N/A	Descriptive	Vendor Defined Operating State
41	42	2	R	I_Event_1	uint32	Bitfield	N/A	Descriptive	Event Flags (bits 0-31)
43	44	2	R	I_Event_2	uint32	Bitfield	N/A	Descriptive	Event Flags (bits 32-63)
45	46	2	R	I_Event_1_Vendor	uint32	Bitfield	N/A	Descriptive	Vendor Defined Event Flags (bits 0-31)
47	48	2	R	I_Event_2_Vendor	uint32	Bitfield	N/A	Descriptive	Vendor Defined Event Flags (bits 32-63)
49	50	2	R	I_Event_3_Vendor	uint32	Bitfield	N/A	Descriptive	Vendor Defined Event Flags

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									(bits 64-95)
51	52	2	R	I_Event_4_Vendor	uint32	Bitfield	N/A	Descriptive	Vendor Defined Event Flags (bits 96-127)