SunSaver MPPT
MODBUS® Specification

v11
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www.morningstarcorp.com
info@morningstarcorp.com

Contents

General Information

The SunSaver MPPT supports the industry standard MODBUS® application protocol via its Meter RJ-11 interface. A *Meterbus to Serial Converter* (MSC) is required to adapt the Meter interface to an isolated RS-232 interface**. This document assumes the user is familiar with the MODBUS® protocol and its terminology. Please refer to the documents listed in the References section for more information.

** The MSC adapter is a Morningstar accessory. Contact your dealer for more information.

MODBUS® is a registered trademark of Modbus-IDA (www.modbus-ida.org)

Parameters

The SunSaver MPPT supports RTU mode only.
16bit MODBUS® addresses (per the modbus.org spec)
The serial communication parameters are

- BPS: 9600 baud
- Parity: None
- Data bits: 8
- Stop bits: 2
- Flow control: None

All addresses listed are for the request PDU.
The SunSaver MPPT default server address: 0x01.

Supported MODBUS® Functions

Read Holding Registers (0x03) and Read Input Registers (0x04)

RAM

PDU Addr	Logical Addr	Variable name	Variable description	Units	Scaling or Range
0x0008	9	Adc_vb_f	Battery voltage, filtered ($\tau \approx 1s$)	V	$n \cdot 100 \cdot 2^{-15}$
0x0009	10	Adc_va_f	Array voltage, filtered ($\tau \approx 1s$)	V	$n \cdot 100 \cdot 2^{-15}$
0x000A	11	Adc_vl_f	Load voltage, filtered ($\tau \approx 1s$)	V	$n \cdot 100 \cdot 2^{-15}$
0x000B	12	Adc_ic_f	Charging current, filtered ($\tau \approx 1s$)	A	$n \cdot 79.16 \cdot 2^{-15}$
0x000C	13	Adc_il_f	Load current, filtered ($\tau \approx 1s$)	A	$n \cdot 79.16 \cdot 2^{-15}$
0x000D	14	T_hs	Heatsink temperature	ºC	-128 to +127
0x000E	15	T_batt	Battery temperature (Either ambient or RTS if connected)	ºC	-127 to +127
0x000F	16	T_amb	Ambient temperature	ºC	-127 to +127
0x0010	17	T_rts	Remote battery temperature sensor (0x80 if not	ºC	-127 to

			connected)		+127
0x0011	18	charge_state	Charge state	-	
0x0012	19	array_fault	Array fault bitfield	-	
0x0013	20	Vb_f	Battery voltage, slow filter ($\tau \approx 25s$)	V	$n \cdot 100 \cdot 2^{-15}$
0x0014	21	Vb_ref	Battery regulator reference voltage	V	$n \cdot 96.667 \cdot 2^{-15}$
0x0015	22	Ahc_r_HI	Ah charge resetable, HI word	Ah	$n \cdot 0.1$
0x0016	23	Ahc_r_LO	Ah charge resetable, LO word	-	
0x0017	24	Ahc_t_HI	Ah charge total, HI word	Ah	$n \cdot 0.1$
0x0018	25	Ahc_t_LO	Ah charge total, LO word	-	
0x0019	26	kWhc	kWh charge (resetable?)	kWh	$n \cdot 0.1$
0x001A	27	load_state	Load state	-	
0x001B	28	load_fault	Load fault bitfield	-	
0x001C	29	V_lvd	load current compensated LVD voltage	V	$n \cdot 100 \cdot 2^{-15}$
0x001D	30	Ahl_r_HI	Ah load resetable, HI word	Ah	$n \cdot 0.1$
0x001E	31	Ahl_r_LO	Ah load resetable, LO word	-	
0x001F	32	Ahl_t_HI	Ah load total, HI word	Ah	$n \cdot 0.1$
0x0020	33	Ahl_t_LO	Ah load total, LO word	-	
0x0021	34	hourmeter_HI	hourmeter, HI word	h	0 to $(2^{24}-1)$
0x0022	35	hourmeter_LO	hourmeter, LO word	-	
0x0023	36	alarm_HI	alarm bitfield – HI word	-	
0x0024	37	alarm_LO	alarm bitfield – LO word	-	
0x0025	38	dip_switch	dip switch settings at power on switch[1..8] in bits[0..7]	-	
0x0026	39	led_state	SOC LED state	-	
0x0027	40	Power_out	Charge output power	W	$n \cdot 989.5 \cdot 2^{-16}$
0x0028	41	Sweep_Vmp	Array Vmp found during sweep	V	$n \cdot 100 \cdot 2^{-15}$
0x0029	42	Sweep_Pmax	Arrap Pmax(output) found during sweep	W	$n \cdot 989.5 \cdot 2^{-16}$
0x002A	43	Sweep_Voc	Array Voc found during sweep	V	$n \cdot 100 \cdot 2^{-15}$
0x002B	44	Vb_min_daily	Vb minimum voltage – daily	V	$n \cdot 100 \cdot 2^{-15}$
0x002C	45	Vb_max_daily	Vb maximum voltage – daily	V	$n \cdot 100 \cdot 2^{-15}$
0x002D	46	Ahc_daily	Ah charge - daily	Ah	$n \cdot 0.1$
0x002E	47	Ahl_daily	Ah load - daily	Ah	$n \cdot 0.1$
0x002F	48	array_fault_daily	Array fault bitfield - daily	-	
0x0030	49	load_fault_daily	Load fault bitfield - daily	-	
0x0031	50	alarm_HI_daily	alarm bitfield – daily, HI word	-	
0x0032	51	alarm_LO_daily	alarm bitfield – daily, LO word	-	
0x0033	52	vb_min	minimum battery voltage	V	$n \cdot 100 \cdot 2^{-15}$
0x0034	53	vb_max	maximum battery voltage	V	$n \cdot 100 \cdot 2^{-15}$
0x0038	57	lighting_should_be_on	In lighting mode, if non-zero, the light output should be on (independent of LVD, etc.). (v08 and later code)	-	
0x0039	58	va_ref_fixed	fixed Vmp if set (overrides % if both set)	V	$n \cdot 100 \cdot 2^{-15}$
0x003A	59	va_ref_fixed_pct	Vmp = % of Voc if set (0 or 0xff disables)	%	$n*100*2^{-8}$

Read Coils (0x01), Read Discrete Inputs (0x02), Write Single Coil (0x05)

PDU Addr	Logical Addr	Variable description
0x0000	1	Equalize triggered
0x0001	2	Load disconnect (1 will force load into a disconnect state)
0x0002	3	Charge disconnect (1 will force charger into a disconnect state)
...	4-16	reserved
0x0010	17	Clear Ah resetable (set only, will always read 0)
0x0011	18	Clear Ah total (set only, will always read 0)
0x0012	19	Clear kWh (set only, will always read 0)
0x0013	20	reserved
0x0014	21	reserved
0x0015	22	reserved
0x0016	23	Force EEPROM update (set only, will always read 0)
0x0018 - 0x0019	25 - 26	reserved
0x0020	27	When lighting mode is enabled, turns on lighting output for 10 minutes (set only, will always read 0).
...	27-254	reserved
0x00FF	256	Reset control (respond and then reset?)

EEPROM

PDU Addr	Logical Addr	Variable name	Variable description	Units	Scaling or Range
			Charge settings (bank 1)		
0xE000	57345	EV_reg	Regulation voltage @ 25ºC	V	$n \cdot 100 \cdot 2^{-15}$
0xE001	57346	EV_float	Float voltage @ 25ºC Set to zero to disable float	V	$n \cdot 100 \cdot 2^{-15}$
0xE002	57347	Et_float	time before entering float	s	$0-(2^{16}-1)$
0xE003	57348	Et_floatlb	time before entering float due to low battery	s	$0-(2^{16}-1)$
0xE004	57349	EV_floatlb_trip	Voltage that triggers low battery float time	V	$n \cdot 100 \cdot 2^{-15}$
0xE005	57350	EV_float_cancel	Voltage that cancels float	V	$n \cdot 100 \cdot 2^{-15}$
0xE006	57351	Et_float_exit_cum	time before exiting float	s	$0-(2^{16}-1)$
0xE007	57352	EV_eq	Equalize voltage @ 25ºC Set to zero to disable equalize	V	$n \cdot 100 \cdot 2^{-15}$
0xE008	57353	Et_eqcalendar	days between eq cycles	days	0-255
0xE009	57354	Et_eq_above	equalize time limit above Vreg	s	$0-(2^{16}-1)$
0xE00A	57355	Et_eq_reg	equalize time limit at Veq	s	$0-(2^{16}-1)$
0xE00B	57356		not used	-	
0xE00C	57357		not used	-	
			Charge settings (bank 2)		
0xE00D	57558	EV_reg2	Regulation voltage @ 25ºC	V	$n \cdot 100 \cdot 2^{-15}$
0xE00E	57359	EV_float2	Float voltage @ 25ºC Set to zero to disable float	V	$n \cdot 100 \cdot 2^{-15}$
0xE00F	57360	Et_float2	time before entering float	s	$0-(2^{16}-1)$
0xE010	57361	Et_floatlb2	time before entering float due to low battery	s	$0-(2^{16}-1)$
0xE011	57362	EV_floatlb_trip2	Voltage that triggers low battery float time	V	$n \cdot 100 \cdot 2^{-15}$
0xE012	57363	EV_float_cancel2	Voltage that cancels float	V	$n \cdot 100 \cdot 2^{-15}$
0xE013	57364	Et_float_exit_cum2		s	$0-(2^{16}-1)$
0xE014	57365	EV_eq2	Equalize voltage @ 25ºC Set to zero to disable equalize	V	$n \cdot 100 \cdot 2^{-15}$
0xE015	57366	Et_eqcalendar2	days between eq cycles	days	0-255
0xE016	57367	Et_eq_above2	equalize time limit above Vreg	s	$0-(2^{16}-1)$
0xE017	57368	Et_eq_reg2	equalize time limit at Veq	s	$0-(2^{16}-1)$
0xE018	57369		not used	-	
0xE019	57370		not used	-	
			Charge settings (shared)		
0xE01A	57371	EV_tempcomp	LSB only (note 2^{-16} scaling, negative sign is assumed)	V	$n \cdot 100 \cdot 2^{-16}$
0xE01B	57372	EV_hvd	High Voltage Disconnect @ 25ºC Set to zero to disable HVD	V	$n \cdot 100 \cdot 2^{-15}$
0xE01C	57373	EV_hvr	High Voltage Reconnect	V	$n \cdot 100 \cdot 2^{-15}$
0xE01D	57374	Evb_ref_lim	Maximum charge reference (0 disables)	V	$n \cdot 100 \cdot 2^{-15}$
0xE01E	57375	ETb_max	Max battery temp compensation limit	ºC	-128 to +127
0xE01F	57376	ETb_min	Min battery temp compensation limit	ºC	-128 to +127
0xE020	57377		not used	-	
0xE021	57378		not used	-	
			Load settings		
0xE022	57379	EV_lvd	Low Voltage Disconnect	V	$n \cdot 100 \cdot 2^{-15}$
0xE023	57380	EV_lvr	Low Voltage Reconnect	V	$n \cdot 100 \cdot 2^{-15}$
0xE024	57381	EV_lhvd	Load High Voltage Disconnect Set to zero to disable HVD	V	$n \cdot 100 \cdot 2^{-15}$
0xE025	57382	EV_lhvr	Load High Voltage Reconnect	V	$n \cdot 100 \cdot 2^{-15}$

0xE026	57383	ER_icomp	LVD Load current compensation	Ω	$n \cdot 1.263 \cdot 2^{-16}$
0xE027	57384	Et_lvd_warn	LVD warning timeout	s	n*0.1
			Misc settings		
0xE030	57393	EV_soc_y2g	LED yellow to green limit	V	$n \cdot 100 \cdot 2^{-15}$
0xE031	57394	EV_soc_g2y	LED green to yellow limit	V	$n \cdot 100 \cdot 2^{-15}$
0xE032	57395	EV_soc_y2r0	LED yellow to blinking red	V	$n \cdot 100 \cdot 2^{-15}$
0xE033	57396	EV_soc_r2y	LED red to yellow limit	V	$n \cdot 100 \cdot 2^{-15}$
0xE034	57397	Emodbus_id	Modbus ID	-	1-247
0xE035	57398	Emeter_id	meter bus ID	-	1-15
			MPPT Settings		
0xE036	57399	EVa_ref_fixed	fixed Vmp if set (overrides % if both set)	V	$n \cdot 100 \cdot 2^{-15}$
0xE037	57400	EVa_ref_fixed_pct	Vmp = % of Voc if set (0 or 0xff disables)	%	$n \cdot 100 \cdot 2^{-8}$
0xE038	57401	Eic_lim	Charge current limit (into battery)	A	$n \cdot 79.16 \cdot 2^{-15}$
0xE039	57402		not used		
0xE03A	57403		not used		
			Read only section		
0xE040	57409	Ehourmeter_LO	hourmeter	h	0 to $(2^{24}-1)$
0xE041	57410	Ehourmeter_HI			
0xE042	57411	EAhl_r_LO	Ah load resetable	Ah	n·0.1
0xE043	57412	EAhl_r_HI		-	
0xE044	57413	EAhl_t_LO	Ah load total	Ah	n·0.1
0xE045	57414	EAhl_t_HI		-	
0xE046	57415	EAhc_r_LO	Ah charge resetable	Ah	n·0.1
0xE047	57416	EAhc_r_HI		-	
0xE048	57417	EAhc_t_LO	Ah charge total	Ah	n·0.1
0xE049	57418	EAhc_t_HI		-	
0xE04A	57419	EkWhc	kWhc (resetable?)	kWh	n·0.1
0xE04B	57420	EVb_min	Vb minimum	V	$n \cdot 100 \cdot 2^{-15}$
0xE04C	57421	EVb_max	Vb maximum	V	$n \cdot 100 \cdot 2^{-15}$
0xE04D	57422	EVa_max	Va maximum	V	$n \cdot 100 \cdot 2^{-15}$
0xE04F	57424	Etmr_eqcalander	Equalize calendar timer	days	

Logged Data

The SS-MPPT stores approximately 32 days of data. This data is stored in a circular buffer where the oldest data is over-written by the newest data. The log data must be requested and sorted into correct order before the data will be useful.

- The logged data is mapped from 0x8000-0x81FF (1kB)
- The data consists of up to 32 blocks of data. (One block is generally one day w/ some exceptions)
- Each block is 32bytes (16 modbus variables)
- It is written in a circular buffer format. All blocks must be read and then put in linear order via the hourmeter field. Ignore blocks w/ hourmeters of 0x000000 or 0xFFFFFF. The largest hourmeter block is the most recent.

PDU Addr	Logical Addr	Variable name	Variable description
0x8000-800F	32769-32795	logger[0]	
…	…		
0x81F0-81FF	33249 - 33280	logger[31]	

Data is stored in big endian format.

```
struct {
        Uint24 hourmeter;
        Uint24 alarm_daily;
        Uint16 Vb_min_daily;
        Uint16 Vb_max_daily;
        Uint16 Ahc_daily;
        Uint16 Ahl_daily;
        Uint16 array_fault_daily;
        Uint16 load_fault_daily;
        Uint16 Va_max_daily;
        Uint16 time_ab_daily;       v0.7 code and later
        Uint16 time_eq_daily;       v0.7 code and later
        Uint16 time_fl_daily;       v0.7 code and later

        Uint16 reserved[6];
}
```

Byte Offset	Variable name	Bytes	Variable description	Units	Scaling or Range
0	hourmeter	3		h	0 to $(2^{24}-1)$
3	alarm_daily	3	Alarm bitfield – daily	-	
6	Vb_min_daily	2	Vb minimum voltage – daily	V	$n \cdot 100 \cdot 2^{-15}$
8	Vb_max_daily	2	Vb maximum voltage – daily	V	$n \cdot 100 \cdot 2^{-15}$
10	Ahc_daily	2	Ah charge – daily	Ah	$n \cdot 0.1$
12	Ahl_daily	2	Ah load – daily	Ah	$n \cdot 0.1$
14	array_fault_daily	2	Array fault bitfield – daily	-	

16	load_fault_daily	2	Load fault bitfield – daily	-	
18	Va_max_daily	2	Va maximum voltage – daily (v0.7 code and later)	V	$n \cdot 100 \cdot 2^{-15}$
19	time_ab_daily	2	Time in absorption – daily	min	-
20	time_eq_daily	2	Time in equalize – daily	min	-
21	time_fl_daily	2	Time in float - daily	min	-
22-31			reserved		

Write Single Register (0x06)

Any write to EEPROM will set an "EEPROM changed" fault. The control must be reset to clear this fault.
Note: No verify is performed on the write.

See EEPROM table in Read Input Registers(0x04).

Read Device Identification (0x2B, subcode 0x0E)

Only supports "basic device identification (stream access)" (ID code 0x01)

Object Id	Object Name/Description	Typical Value
0x00	VendorName	"Morningstar Corp."
0x01	Product Code	"SS-MPPT"
0x02	MajorMinorRevision (hardware major.minor. software revision)	"v01.01.01"

Variables and Definitions

Variable_name
[Logical Address][PDU Address] (Units). *Short description*.
Definition.

Read Holding and Read Input Registers
Located in processor RAM, updated continuously.

Adc_vb_f
[09][0x0008] (V). *battery voltage, filtered.*
Voltage measured directly at the battery connection on the SunSaver MPPT.

Adc_va_f
[10][0x0009] (V). *solar input voltage.*
Va is the terminal voltage of the solar input connection.

Adc_vl_f
[11][0x000A] (V). *load voltage.*
Vl is the terminal voltage of the load output connection.

Adc_ic_f
[12][0x000B] (A). *battery charge current, filtered.*
Charging current to the battery as measured by on-board shunt.

Adc_il_f
[13][0x000C] (A). *load current, filtered.*
Load current to the systems loads as measured by on-board shunt.

T_hs
[14][0x000D] (C). *Heatsink Temperature.*
Sunsaver MPPT Heatsink temperature. Reported in degrees C.

T_batt
[15][0x000E] (C). *Battery Temperature.*
Battery temperature as measured by the ambient temperature sensor or the optional RTS (if connected). Reported in degrees C.

T_amb
[16][0x000F] (C). *Ambient Temperature.*
Ambient temperature as measured by the ambient temperature sensor. Reported in degrees C.

T_rts

[17][0x0010] (C). *RTS Temperature.*
Temperature as measured by the optional Remote Temperature Sensor(RTS). Reported in degrees C.

Charge_state

[18][0x0011] ( ).
Reports the charge state.

Value	Charge State
0	START
1	NIGHT_CHECK
2	DISCONNECT
3	NIGHT
4	FAULT
5	BULK_CHARGE
6	ABSORPTION
7	FLOAT
8	EQUALIZE

Array_fault

[19][0x0012] (bit-field). *Solar input self-diagnostic faults.*
Reports faults identified by self diagnostics. Each bit corresponds to a specific fault.

Array Faults Table	
Bit	Fault
0	overcurrent
1	FETs shorted
2	software bug
3	battery HVD
4	array HVD
5	EEPROM setting edit (reset required)
6	RTS shorted
7	RTS was valid, now disconnected
8	local temp. sensor failed
9	Fault 10
10	Fault 11
11	Fault 12
12	Fault 13
13	Fault 14
14	Fault 15
15	Fault 16

Vb_f

[20][0x0013] (V). *battery voltage, slow filtered.*
Voltage measured directly at the battery connection on the SunSaver MPPT.

Vb_ref

[21][0x0014] (V). *Reference Voltage.*
Target voltage to which the battery will be charged. This value is temperature compensated.

Ahc_r_HI / Ahc_r_LO

[22, 23][0x0015, 0x0016] (ah).*Charge amp-hours (reset-able counter).*
Reports total solar amp-hours since last ah reset.

Ahc_t_HI / Ahc_t_LO

[24, 25][0x0017, 0x0018] (ah).*Charge amp-hours (Total cumulative counter).*
Reports total solar amp-hours since last ah reset.

kWhc

[26][0x0019] (kWh).*Charge kilowatt-hours (reset-able counter).*
Reports total solar kilowatt-hours since last ah/kWh reset.

Load_state

[27][0x001A] ( ).
Reports the charge state.

Value	Charge State
0	START
1	LOAD_ON
2	LVD_WARNING
3	LVD
4	FAULT
5	DISCONNECT

Load_fault

[28][0x001B] (bit-field). *Solar input self-diagnostic faults.*
Reports faults identified by self diagnostics. Each bit corresponds to a specific fault.

Load Faults Table	
Bit	Fault
0	external short circuit
1	overcurrent
2	FETs shorted
3	software bug
4	HVD
5	heatsink over-temperature
6	EEPROM setting edit (reset required)
7	Fault 8

V_lvd

[29][0x001C] (V). *LVD voltage.*
Low voltage disconnect setpoint, current compensated.

Ahl_r_HI / Ahl_r_LO

[30, 31][0x001D, 0x001E] (ah).*Load amp-hours (reset-able counter).*
Reports total load amp-hours since last ah reset.

Ahl_t_HI / Ahl_t_LO

[32, 33][0x001F, 0x0020] (ah).*Load amp-hours (Total cumulative counter).*
Reports total load amp-hours since last ah reset.

hourmeter_HI / hourmeter_LO

[34, 35][0x0021, 0x0022] (hrs).*hour meter counter.*
Reports total hours of operation since installed.

alarm_HI / alarm_LO

[36, 37][0x0023, 0x0024] (bitfield).*Controller self-diagnostics alarms.*
Reports alarms identified by self diagnostics. Each bit corresponds to a specific alarm.

BIT	ALARM
0	RTS open
1	RTS shorted
2	RTS disconnected
3	Ths open
4	Ths shorted
5	SSMPPT hot
6	Current limit
7	Current offset
8	Undefined
9	Undefined
10	Uncalibrated
11	RTS miswire
12	Undefined
13	Undefined
14	miswire
15	FET open
16	P12
17	high Va current limit
18	Alarm 19
19	Alarm 20
20	Alarm 21
21	Alarm 22
22	Alarm 23
23	Alarm 24

dip_switch

[38][0x0025] (bit-field). *dip switch positions.*
Each bit in the bit-field corresponds to an individual DIP switch setting. Useful for remote applications where access to SunSaver MPPT to verify DIP positions is not feasible.

Bit	**Function**	**“0” value**	**“1” value**
0	Battery Type	User Select jumper	custom battery settings
1	LVD / LVR	11.5 V / 12.6 V	custom load settings
2	Equalize	disabled	enabled (if battery type has EQ)
3	Comm. Select	Meterbus (MS remote meter)	MODBUS® protocol

LED_state

[39][0x0026] ( ).
Reports the LED state.

Value	**LED State**
0	LED_START
1	LED_START2
2	LED_BRANCH
3	EQUALIZE (FAST GREEN BLINK)
4	FLOAT (SLOW GREEN BLINK)
5	ABSORPTION (GREEN BLINK, 1HZ)
6	GREEN_LED
7	UNDEFINED
8	YELLOW_LED
9	UNDEFINED
10	BLINK_RED_LED
11	RED_LED
12	R-Y-G ERROR
13	R/Y-G ERROR
14	R/G-Y ERROR
15	R-Y ERROR (HTD)
16	R-G ERROR (HVD)
17	R/Y-G/Y ERROR
18	G/Y/R ERROR
19	G/Y/R x 2

Power_out

[40][0x0027] (W). *Charge output power.*
Output power to the battery.

Sweep_Vmp

[41][0x0028] (V). *Solar array Vmp.*
Maximum power voltage of the solar array found during last sweep.

Sweep_Pmax

[42][0x0029] (W). *Maximum array power.*
Maximum power output of the solar array found during last sweep.

Sweep_Voc

[43][0x002A] (V). *Solar array Voc.*
Open circuit voltage of the solar array found during last sweep.

Vb_min_daily

[44][0x002B] (V). *Today's minimum battery voltage.*
Minimum battery voltage measured today (value resets after dark).

Vb_max_daily

[45][0x002C] (V). *Today's maximum battery voltage.*
Maximum battery voltage measured today (value resets after dark).

Ahc _daily

[46][0x002D] (Ah). *Today's total charge amp-hours.*
Total charging amp-hours accumulated today (value resets after dark).

Ahl _daily

[47][0x002E] (Ah). *Today's total load amp-hours.*
Total load amp-hours accumulated today (value resets after dark).

Array_fault_daily

[48][0x002F] (bit-field). *Today's solar input self-diagnostic faults (sticky).*
Reports array faults identified by self diagnostics that occurred today. Each bit corresponds to a specific fault. If a bit is set, that fault occurred at least once today. Bit order is identical to the **Array_fault** bitfield.

Load_fault_daily

[49][0x0030] (bit-field). *Today's load output self-diagnostic faults (sticky).*
Reports load faults identified by self diagnostics that occurred today. Each bit corresponds to a specific fault. If a bit is set, that fault occurred at least once today. Bit order is identical to the **Load_fault** bitfield.

alarm_HI_Daily / alarm_LO_Daily

[50, 51][0x0031, 0x0032] (bitfield). *Today's controller self-diagnostics alarms (sticky).*

Reports alarms identified by self diagnostics that occurred today. Each bit corresponds to a specific alarm. If a bit is set, that alarm occurred at least once today. Bit order is identical to the **alarm_hi/alarm_lo** bitfield.

Vb_min

[52][0x0033] (V). *Minimum battery voltage*
Tracks the minimum battery voltage over time. This value is set equal to the present battery voltage when a Ah / kWh reset is requested through the meter or Modbus Coil.

Vb_max

[53][0x0034] (V). *Maximum battery voltage*
Tracks the maximum battery voltage over time. This value is set equal to the present battery voltage when a Ah / kWh resets is requested through the meter or Modbus Coil.

Va_ref_fixed

[58][0x0039] (V). *Array Voltage fixed target*
Write a voltage value to this register to fix the Array input voltage to a specific value. If this register is a non-zero value, the MPPT function of the controller will stop (sweeping and tracking are disabled) and the array input will be fixed to the specified voltage. This value can be written at anytime during operation to adjust the array voltage target value. On start-up, this value is initialized with the non-volatile EEPROM value in register 0xE036.
Supported in V08 firmware and later.

Va_ref_fixed_pct

[59][0x003A] (%). *Array Voltage percent of Voc voltage target*
Write a value to this register to fix the Array input voltage to a percent of the Array open circuit voltage. If this register is a non-zero value, the MPPT function of the controller will stop (sweeping and tracking are disabled) and the array target voltage will be fixed to the specified % of array Voc. The controller will perform periodic Voc checks and move the array voltage if needed to maintain the correct % target. If this register value is changed, the array voltage will not adjust until the next Voc check.
On start-up, this value is initialized with the non-volatile EEPROM value in register 0xE037.
Supported in V08 firmware and later.

Note: if the Va_ref_fixed (0x0039) register is non-zero, it will override this setting.

EEPROM Values

EEPROM values that require updating are done so once every 24 hours.

Charging Settings (bank 1 & bank 2)

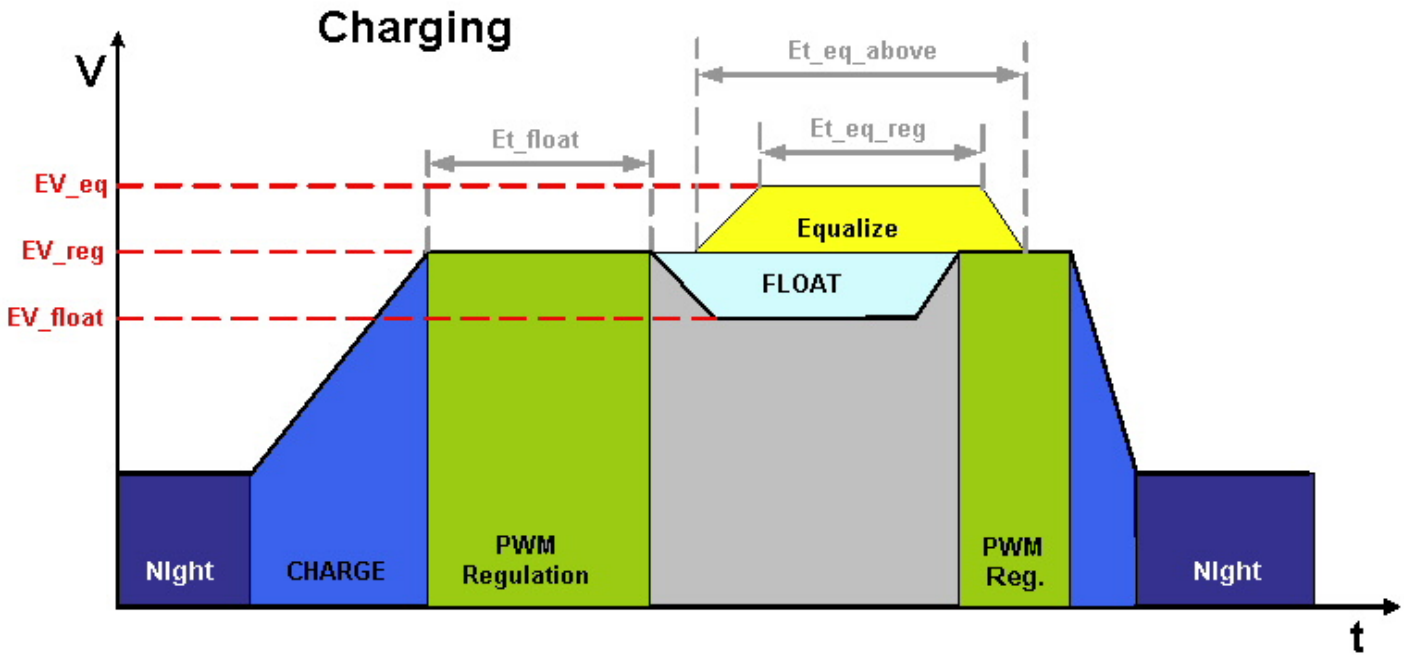

Diagram A Charging stages and defining variables.

EV_reg [57345][0xE000](V). Regulation voltage (absorption), bank 1 @ 25ºC.

EV_reg2 [57558][0xE00D](V). Regulation voltage (absorption), bank 2 @ 25ºC.

The battery will charge at 100% charge current until battery voltage reaches this setpoint. The controller will begin to taper input current so that this setpoint is maintained, but not exceeded. See diagram A.

EV_float [57346][0xE001](V). *Float voltage, bank 1 @ 25ºC*

EV_float2 [57359][0xE00E](V). *Float voltage, bank 2 @ 25ºC*

After Et_float seconds in absorption, when the battery is fully charged, the battery will transition to this lower voltage charge setting to reduce gassing. See diagram A.
Set to zero to disable float stage

Et_float [57347][0xE002](seconds) *time before entering float, bank 1*

Et_float2 [57360][0xE00F](seconds) *time before entering float, bank 2*

Defines the length of time in absorption before transitioning to the float stage. See diagram A.

Et_floatlb [57348][0xE003](seconds) time before entering float due to low battery, bank 1

Et_floatlb2 [57361][0xE010](seconds) time before entering float due to low battery, bank 2

If the battery voltage drops too low during the previous night, this value allows the user to specify a longer period of time before entering float stage.

EV_floatlb_trip [57349][0xE004](V). Voltage that triggers low battery float time, bank 1

EV_floatlb_trip2 [57362][0xE011](V). Voltage that triggers low battery float time, bank 2

Battery voltage that will trigger a longer period of time before entering float. - See Et_floatlb -

EV_float_cancel [57350][0xE005](V). *Voltage that cancels float, bank 1*

EV_float_cancel2 [57363][0xE012](V). *Voltage that cancels float, bank 2*

Specify the battery voltage that will cancel float for the next charge cycle. If the battery discharged too low the previous night, the user may want to cancel float for the next day.

Et_float_exit_cum [57351][0xE006](V). *Exit float timer, bank 1*

Et_float_exit_cum2 [57364][0xE013](V). *Exit float timer, bank 2*

Specify (cumulative) amount of time below float voltage before exiting the float stage. Battery voltage may drop below the target float voltage due to insufficient charge current or a system load draws more current from the battery than the array can provide.

EV_eq [57352][0xE007](V). *Equalize voltage @ 25ºC*, bank 1

EV_eq2 [57365][0xE014](V). *Equalize voltage @ 25ºC*, bank 2

Battery equalize voltage. Periodic equalization equalizes cell voltages, bubbles the electrolyte, and helps prevent sulfation of the battery. See diagram A.
Set to zero to disable equalization

Et_eqcalendar [57353][0xE008](days). *days between eq cycles, bank 1*

Et_eqcalendar2 [57366][0xE015](days). *days between eq cycles, bank 2*

Specify the number of days between equalizations. Equalizing on a calendar basis ensures proper maintenance of batteries.

Et_eq_above [57354][0xE009](seconds) *equalize time limit above Vreg, bank 1*

Et_eq_above2 [57367][0xE016](seconds) *equalize time limit above Vreg, bank 2*

Equalization will timeout after the specified number of seconds above PWM regulation voltage. If the battery is charged above absorption voltage but has not yet reached the equalization setting, this value serves as a safety timeout to prevent partial equalizations for extended periods of time. See diagram A.

Et_eq_reg [57355][0xE00A](seconds) *equalize time limit at Veq*

Et_eq_reg [57368][0xE017](seconds) *equalize time limit at Veq*

Equalization will stop after the specified number of seconds at the equalization setpoint voltage. See diagram A.

Charging Settings (shared)

EV_tempcomp

[57371][0xE01A](V/C). *temperature compensation.*
Battery chemistry changes with temperature. Temperature compensation coefficient specifies the amount that regulation voltage will be shifted with temperature. 25ºC reference, the negative is implied (write a positive value). 12V lead-acid battery temperature compensation is approximately 0.03 V/C

EV_hvd

[57372][0xE01B] *High Voltage Disconnect @ 25ºC*
Flag a fault/alarm if the battery voltage exceeds this setpoint. Also attempts to open the MOSFETs to stop charging. Set to zero to disable HVD

EV_hvr

[57373][0xE01C](V) *High Voltage Reconnect*
The HVD fault/alarm will be cleared once the battery voltage drops below this setpoint.

Evb_ref_lim

[57374][0xE01D](V) *Maximum regulation limit*
An absolute limit on the battery regulation voltage. This is not a temperature compensated value. Protects high voltage sensitive system loads. Set to zero to disable.

ETb_max

[57375][0xE01E](C) *Maximum temperature compensation limit*
Maximum temperature to clamp temperature compensation.

ETb_min

[57376][0xE01F](C) *Minimum temperature compensation limit*
Maximum temperature to clamp temperature compensation.

Load Mode

EV_lvd

[57379][0xE022](V). *Low Voltage Disconnect*
Setpoint to determine the load turn off voltage. When the battery has discharged too far, the load should be turned off to prevent over-discharge of the battery.

EV_lvr

[57380][0xE023](V). *Low Voltage Reconnect*
Battery setpoint that determines when the load will be reconnected. After the battery recharges to this setpoint, the load will be reconnected.

EV_lhvd

[57381][0xE024](V). *Load High Voltage Disconnect*
Disconnect the loads if the battery voltage rises too high. This function can protect DC loads that are sensitive to high input voltage.
Set to zero to disable HVD

EV_lhvr

[57382][0xE025](V). *Load High Voltage Reconnect*

Setpoint at which the loads will reconnect after a high voltage condition.

ER_icomp

[57383][0xE026](V/A). *LVD Load current compensation*
The LVD setpoint can be compensated in proportion to load current, lowering the disconnect value when the battery is under load. Note that the LED setpoints are also compensated accordingly.

Et_lvd_warn

[57384][0xE027](sec). *LVD warning timeout*
Defines the period of time to wait before disconnecting the loads, once battery voltage has dropped to the Low Voltage Disconnect setpoint.

Miscellaneous Settings

EV_soc_g_gy

[57372][0xE01B](V). *green to green/yellow limit*
LED transition setpoint. Specifies the battery voltage at which the LED state will change from Green to Green/Yellow.

EV_soc_y2g

[57393][0xE030](V). *LED Yellow to Green limit (rising voltage)*
LED transition setpoint. Specifies the battery threshold voltage at which the LEDs will change from yellow to Green indication.

EV_soc_g2y

[57394][0xE031](V). *LED Green to Yellow limit (falling voltage)*
LED transition setpoint. Specifies the battery threshold voltage at which the LEDs will change from Green to Yellow indication.

EV_soc_y2r0

[57395][0xE032](V). *LED Yellow to Blinking Red limit (falling voltage)*
LED transition setpoint. Specifies the battery threshold voltage at which the LEDs will change from Yellow to Blinking Red indication.

EV_soc_r2y

[57396][0xE033](V). *LED Red to Yellow limit (rising voltage)*

LED transition setpoint. Specifies the battery threshold voltage at which the LEDs will change from Red to Yellow indication.

Emodbus _id

[57397][0xE034](). *MODBUS ID*
MODBUS address which uniquely identifies the controller on the MODBUS network.

Emeter _id

[57398][0xE035](). *MeterBus ID*
Address which uniquely identifies the controller on the Morningstar proprietary Meter Bus network. Devices are daisy-chained on the Meter Bus network via the RJ-11 connections. Addresses are limited to the range of 1-15
Warning: do not change this value unless necessary.

MPPT Settings

EVa_ref_fixed_init

[57399][0xE036](V). *Array Voltage fixed target - initialize*
Write a voltage value to this register to fix the Array input voltage to a specific value. If this register is a non-zero value, the MPPT function of the controller will be disabled (sweeping and tracking are disabled) and the array input will be fixed to the specified voltage. On start-up, the value in this register is copied to the volatile RAM register 0x0039, which allows for real-time control of Va.
Supported in V08 firmware and later.

EVa_ref_fixed_pct_init

[57400][0xE037](%). *Array Voltage percent of Voc voltage target - initialize*
Write a value to this register to fix the Array input voltage to a percent of the Array open circuit voltage. If this register is a non-zero value, the MPPT function of the controller will be disabled (sweeping and tracking are disabled) and the array target voltage will be fixed to the specified % of array Voc. The controller will perform periodic Voc checks and move the array voltage if needed to maintain the correct % target. On start-up, the value in this register is copied to the volatile RAM register 0x003A, which allows for real-time control of Va.
Supported in V08 firmware and later.

Note: if the Va_ref_fixed_init (0xE036) register is non-zero, it will override this setting.

Eic _lim

[57401][0xE038](A). *Charge current limit.*
Specify a battery current limit (up to 15 Amps).

Read-Only Variables

Ehourmeter_LO / Ehourmeter_HI

[57409,57410][0xE040,0xE041](hours). *Hourmeter*
Cumulative hours the controller has been running. Non-volatile, written every 24hrs.

EAhl_r_LO / EAhl_r_HI

[57411,57412][0xE042,0xE043](amp-hours). Load *resetable Ah*
Cumulative amp-hours typically used for short-term logging. Resetable.

EAhl_t_LO / EAhl_t_HI

[57413,57414][0xE044,0xE045](amp-hours). Load *total Ah*
Cumulative amp-hours for long term logging. Can be reset if needed.

EAhc_r_LO / EAhc_r_HI

[57415,57416][0xE046,0xE047](amp-hours). Load *resetable Ah*
Cumulative amp-hours typically used for short-term logging. Resetable.

EAhc_t_LO / EAhc_t_HI

[57417,57418][0xE048,0xE049](amp-hours). Load *total Ah*
Cumulative amp-hours for long term logging. Can be reset if needed.

EkWhc

[57419][0xE04A](kWh). Charge *Kilowatt hours*
Cumulative charging kilowatt hours.

EVb_min

[57420][0xE04B](V). *Minimum battery voltage*
Minimum battery voltage over last 24 hours. Written once every 24hrs.

EVb_max

[57421][0xE04C](V). *Maximum battery voltage*
Maximum battery voltage over last 24 hours. Written once every 24hrs.

EVa_max

[57422][0xE04D](V). *Maximum array voltage*
Maximum array voltage over last 24 hours. Written once every 24hrs.

Etmr_eqcalendar

[57424][0xE04F](V). *Equalize calendar timer*
Number of days since last equalize.

Coils

Equalize Triggered

[01] [0x0000]
Trigger an equalize charge. Controller must be configured to a battery type that has equalization stage and the equalize DIP switch must not be set to “disabled”. After the equalize charge has been administered, the equalize calendar will be reset.

Load Disconnect

[02] [0x0001]
Forces load controller into disconnect state. Load will remain off until this coil is cleared.
Values:
0 = normal operation
1= load disconnect

Charge Disconnect

[03] [0x0002]
Forces charge controller into disconnect state. Charging will cease until this coil is cleared.
Values:
0 = normal charging
1= charging stopped

Clear resetable amp-hours

[17] [0x0010]
Resets solar and load Ah (resetable) counters back to 0.
(set only, will always read 0)

Clear total amp-hours

[18] [0x0011]
Resets solar and load Ah (total) counters back to 0.
(set only, will always read 0)

Clear kWh

[19] [0x0012]
Resets solar kilowatt-hour counter back to 0.
(set only, will always read 0)

Force EEPROM update

[23] [0x0016]
Force the controller to update EEPROM with RAM values.
(set only, will always read 0)

Reset control

[256] [0x00FF]
Reset control will force a reboot of the processor software.

Examples

Read Holding Register, Scaling

Variable (RAM): Battery Voltage
Register Address: 0x0008
Scaling for this variable: $n \cdot 100 \cdot 2^{-15}$

```
1. read Register value(hex):  0x0F96
2. Convert to decimal:        3990
3. Scale decimal value:       (3990 * 100) / 32768  = 12.18 Volts
```

Read Holding Register, 2 Word values

Variable (RAM): hours (hourmeter)
LO Register Address: 0x0025
HI Register Address: 0x0026
Scaling for this variable: none

```
1. read LO Register value(hex):    0x13D8
2. read HI Register value(hex):    0x0022
3. combine register values(hex):   0x002213D8
4. Convert to decimal:             2,233,304 hours
```

References

- MODBUS® Protocol Reference Guide, Modicon, June 1996, PI-MODBUS-300 Rev.J
- MODBUS® Application Protocol Specification, modbus.org, 8May02,
- Modbus_application_protocol_v1

Document Revision History

V05: Public Release
V06: MSC meterbus adapter available through your local dealer
V07: EEPROM register [0xE04A] kWhr scaling was incorrect. Correct scaling is n·0.1
V08: Added logged data information
V09: Updated logged data information with address changes [not released to public]
V10: Added lighting mode information (EEPROM variables, Modbus coil, Modbus holding register)
Added fixed Vmp control register info
V11: Removed footnote from p. 4