ProStar MPPT
MODBUS® Specification

v06
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General Information

The ProStar 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

Parameters

The ProStar 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 ProStarMPPT default server address: 0x01.

Floating point values are represented in either half-precision (designated as f16 or Float16) or single-precision (designated as f32 or Float32)

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
0x0000	1	sw_ver	Software Version	-	
0x0001	2	n_sys_v	Battery Voltage Settings multiplier (1 for 12V nominal, 2 for 24V nominal)	-	
0x0002 - 0x0003	3 - 4	RESERVED			
RAW ADC					
0x0004	5	vdd_actual	3.3V Supply Voltage	V	Float16
0x0005	6	adc_p12	12V Supply Voltage	V	Float16
0x0006	7	adc_p5	5V Supply Voltage	V	Float16
0x0007	8	adc_fgdrive	Gate Drive Voltage	V	Float16
0x0008	9	adc_vmeter	MeterBus Supply Voltage	V	Float16
VOLTAGES FLOAT32					
0x0009	10	adc_vb_f_1m_f32_HI	Battery Voltage, slow filter (60s), HI word	V	Float32
0x000A	11	adc_vb_f_1m_f32_LO	Battery Voltage, slow filter (60s), LO word	-	
0x000B	12	adc_va_f_shadow_f32_HI	Array Voltage, HI word	V	Float32
0x000C	13	adc_va_f_shadow_f32_LO	Array Voltage, LO word	-	
0x000D	14	adc_vl_f32_HI	Load Voltage, HI word	V	Float32
0x000E	15	adc_vl_f32_LO	Load Voltage, LO word	-	
0x000F	16	RESERVED			
FILTERED ADC					
0x0010	17	adc_ic_f_shadow	Charge Current	A	Float16
0x0011	18	adc_ia_f_shadow	Array Current	A	Float16
0x0012	19	adc_vbterm	Battery Terminal Voltage	V	Float16
0x0013	20	adc_va_f_shadow	Array Voltage	V	Float16
0x0014	21	adc_vl	Load Voltage	V	Float16
0x0015	22	adc_ib_f_shadow	Battery Current (net)	A	Float16
0x0016	23	adc_il	Load Current	A	Float16
0x0017	24	adc_vbsense	Battery Sense Voltage	V	Float16
0x0018	25	adc_vb_f_1m	Battery Voltage, slow filter (60s)	V	Float16
0x0019	26	adc_ib_f_1m	Battery Current (net), slow filter (60s)	A	Float16
TEMPERATURES					
0x001A	27	T_hs	Heatsink Temperature	ºC	Float16
0x001B	28	T_batt	Battery Temperature (Either Ambient or RTS if connected)	ºC	Float16
0x001C	29	T_amb	Ambient (local) Temperature	ºC	Float16
0x001D	30	T_rts	Remote Temperature Sensor Temp.	ºC	Float16
0x001E	31	T_ind[U]	Phase U inductor temperature	ºC	Float16
0x001F	32	T_ind[V]	Phase V inductor temperature	ºC	Float16
0x0020	33	T_ind[W]	Phase W inductor temperature	ºC	Float16

CHARGER STATUS					
0x0021	34	charge_state	Charge State	-	
0x0022	35	array_fault	Array Fault Bitfield	-	
0x0023	36	vb_f	Battery Voltage, slow filter (25s)	V	Float16
0x0024	37	vb_ref	Battery Regulator Reference Voltage	V	Float16
0x0025	38	vb_ref_charge_slave	Battery Regulator Slave Voltage	V	Float16
0x0026	39	Ahc_r_HI	Ah Charge Resettable, HI word	Ah	n*0.1
0x0027	40	Ahc_r_LO	Ah Charge Resettable, LO word	-	
0x0028	41	Ahc_t_HI	Ah Charge Total, HI word	Ah	n*0.1
0x0029	42	Ahc_t_LO	Ah Charge Total, LO word	-	
0x002A	43	kWhc_r	kWh Charge Resettable	kWh	n*0.1
0x002B	44	kWhc_t	Kwh Charge Total	kWh	n*0.1
BATTERY REFERENCE FLOAT32					
0x002C	45	vb_ref_f32_HI	Battery Regulator Reference Voltage, HI Word	V	Float32
0x002D	46	vb_ref_f32_LO	Battery Regulator Reference Voltage, LO Word	-	
LOAD STATUS					
0x002E	47	load_state	Load State	-	
0x002F	48	load_fault	Load Fault Bitfield	-	
0x0030	49	V_lvd	Load Current Compensated LVD Voltage	V	Float16
0x0031	50	V_lhvd	Load HVD Voltage	V	Float16
0x0032	51	Ahl_r_HI	Ah Load Resettable, HI word	Ah	n*0.1
0x0033	52	Ahl_r_LO	Ah Load Resettable, LO word	-	
0x0034	53	Ahl_t_HI	Ah Load Total, HI word	Ah	n*0.1
0x0035	54	Ahl_t_LO	Ah Load Total, LO word	-	
MISC					
0x0036	55	hourmeter_HI	Hourmeter, HI word	hours	
0x0037	56	hourmeter_LO	Hourmeter, LO word	-	
0x0038	57	alarm_HI	Alarm Bitfield – HI word	-	
0x0039	58	alarm_LO	Alarm Bitfield – LO word	-	
0x003A	59	dip_switch	DIP Switch Settings at Power On (switch[1..8] in bits[0..7])	-	
0x003B	60	led_state	SOC LED State	-	
MPPT					
0x003C	61	Power_out	Charger Output Power	W	Float16
0x003D	62	Sweep_Vmp	Array Vmp (found during sweep)	V	Float16
0x003E	63	Sweep_Pmax	Array Max Output Power (found during sweep)	W	Float16
0x003F	64	Sweep_Voc	Array Voc (found during sweep)	V	Float16
0x0040	65	va_ref	Array Target Voltage	V	Float16
LOGGER					
0x0041	66	Vb_min_daily	Minimum Battery Voltage (daily)	V	Float16
0x0042	67	Vb_max_daily	Maximum Battery Voltage (daily)	V	Float16
0x0043	68	Ahc_daily	Ah Charge (daily)	Ah	Float16
0x0044	69	Ahl_daily	Ah Load (daily)	Ah	Float16
0x0045	70	array_fault_daily	Array Fault Bitfield (daily)	-	
0x0046	71	load_fault_daily	Load Fault Bitfield (daily)	-	
0x0047	72	alarm_daily_HI	Alarm Bitfield (daily), HI word	-	
0x0048	73	alarm_daily_LO	Alarm Bitfield (daily), LO word	-	
0x0049	74	time_ab_daily	Time in Absorption (daily)	sec	0 to (2^{16}-1)

0x004A	75	time_eq_daily	Time in Equalization (daily)	sec	0 to (2^{16}-1)
0x004B	76	time_fl_daily	Time in Float (daily)	sec	0 to (2^{16}-1)
0x004C	77	Va_max_daily	Maximum Array Voltage (daily)	V	Float16
MISC 2					
0x004D	78	charge_led_state	Charge Status LED State	-	
0x004E	79	lighting_should_be_on	In lighting mode, non-zero indicates load ON	-	
0x004F	80	va_ref_fixed	Fixed Vmp if set (overrides va_ref_fixed_pct below if both set)	V	Float16
0x0050	81	va_ref_fixed_pct	Vmp = this fraction of Voc if set (0.0 to 0.99; 0.0 disables)	-	Float16
0x0051	82	alarm_on_setting_ change	If set to 1, writing EEPROM settings will cause an alarm (0x1000 0000) instead of a fault. If set to 0, the default, the normal traditional behavior (fault on settings change) remains. See the variable of the same name in EEPROM for a persistent version of this. New in sw_ver=13		
CURRENTS AND TEMPS FLOAT32					
0x0052	83	adc_ic_f_shadow_f32_HI	Charge Current, HI Word	A	Float32
0x0053	84	adc_ic_f_shadow_f32_LO	Charge Current, LO Word	-	
0x0054	85	adc_ib_f_1m_f32_HI	Battery Current (net), slow filter (60s), HI Word	A	Float32
0x0055	86	adc_ib_f_1m_f32_LO	Battery Current (net), slow filter (60s), LO Word	-	
0x0056	87	adc_il_f32_HI	Load Current, HI Word	A	Float32
0x0057	88	adc_il_f32_LO	Load Current, LO Word	-	
0x0058	89	T_batt_f32_HI	Battery Temperature (Either Ambient or RTS if connected), HI Word	ºC	Float32
0x0059	90	T_batt_f32_LO	Battery Temperature (Either Ambient or RTS if connected), LO Word	-	

EEPROM

PDU Addr	Logical Addr	Variable name	Variable description	Units	Scaling or Range
CHARGE SETTINGS					
0xE000	57345	EV_reg	Regulation Voltage @ 25ºC	V	Float16
0xE001	57346	EV_float	Float Voltage @ 25ºC (Set to zero to disable float)	V	Float16
0xE002	57347	Et_float	Time Before Entering Float (Absorption Time)	sec	0 to (2^{16}-1)
0xE003	57348	Et_floatlb	Time Before Entering Float due to Low Battery (Absorption Extension Time)	sec	0 to (2^{16}-1)
0xE004	57349	EV_floatlb_trip	Voltage Trigger for Low Battery Float Time	V	Float16
0xE005	57350	EV_float_cancel	Voltage to Cancel Float	V	Float16
0xE006	57351	Et_float_exit_cum	Exit Float Time	sec	0 to (2^{16}-1)
0xE007	57352	EV_eq	Equalize Voltage @ 25ºC (Set to zero to disable equalize)	V	Float16
0xE008	57353	Et_eqcalendar	Days Between EQ Cycles	days	0 to 255
0xE009	57354	Et_eq_above	Equalize Time Limit above EV_reg	sec	0 to (2^{16}-1)
0xE00A	57355	Et_eq_reg	Equalize Time Limit at EV_eq	sec	0 to (2^{16}-1)
0xE00B - 0xE00C	57356 - 57357	RESERVED			
0xE00D	57358	alarm_on_setting_change	If set to 1, writing EEPROM settings will cause an alarm (0x1000 0000) instead of a fault. If set to 0 or 0xFFFF, the default, the normal traditional behavior (fault on settings change) remains. Note that writing this setting for the first time will fault the control, so see the equivalent temporary variable with the same name in RAM. New in sw_ver=13.		
0xE00E - 0xE00F	57359 - 57360	RESERVED			
0xE010	57361	Evb_ref_charge_lim	Reference Charge Voltage Limit	V	Float16
0xE011 - 0xE012	57362 - 57363	RESERVED			
0xE013	57364	Eib_lim	Battery Charge Current Limit	A	Float16
0xE014 - 0xE019	57365 - 57370	RESERVED			
0xE01A	57371	EV_tempcomp	Temperature Compensation Coefficient	V	Float16
0xE01B	57372	EV_hvd	High Voltage Disconnect @ 25ºC (Set to zero to disable HVD)	V	Float16
0xE01C	57373	EV_hvr	High Voltage Reconnect	V	Float16
0xE01D	57374	Evb_ref_lim	Maximum Charge Voltage Reference (0 disables)	V	Float16
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	ETb_lo_limit_100	Battery temperature limit for 100% current	ºC	Float16
0xE021	57378	ETb_lo_limit_0	Battery current limit for 0% current	ºC	Float16
LOAD SETTINGS					
0xE022	57379	EV_lvd	Low Voltage Disconnect	V	Float16
0xE023	57380	EV_lvr	Low Voltage Reconnect	V	Float16
0xE024	57381	EV_lhvd	Load High Voltage Disconnect (Set to zero to disable HVD)	V	Float16
0xE025	57382	EV_lhvr	Load High Voltage Reconnect	V	Float16
0xE026	57383	ER_icomp	LVD Load Current Compensation	Ω	Float16
0xE027	57384	Et_lvd_warn	LVD Warning Timeout	mins	0 to (2^{16}-1)

0xE028 - 0xE02F	57385 - 57392	RESERVED			
MISC SETTINGS					
0xE030	57393	EV_soc_g_gy	LED Green to Green&Yellow Limit	V	Float16
0xE031	57394	EV_soc_gy_y	LED Green&Yellow to Yellow Limit	V	Float16
0xE032	57395	EV_soc_y_yr	LED Yellow to Yellow&Red Limit	V	Float16
0xE033	57396	EV_soc_yr_r	LED Yellow&Red to Red Flashing Limit	V	Float16
0xE034	57397	Emodbus_id	Modbus ID	-	1 to 247
0xE035	57398	Emeter_id	Meterbus ID	-	1 to 15
MPPT SETTINGS					
0xE036	57399	EVa_ref_fixed	Fixed Vmp if set (overrides EVa_ref_fixed_pct below if both set)	V	Float16
0xE037	57400	EVa_ref_fixed_pct	Vmp = this fraction of Voc if set (0.0 to 0.99; 0.0 disables)	-	Float16
0xE038	57401	Eic_lim	Charge Current Limit	A	Float16
0xE039 - 0xE03F	57402 - 57408	RESERVED			
READ ONLY SECTION					
0xE040	57409	Ehourmeter_LO	Hourmeter, LO Word	hours	0 to (2^{32}-1)
0xE041	57410	Ehourmeter_HI	Hourmeter, HI Word		
0xE042	57411	EAhl_r_LO	Ah Load Resettable, LO Word	Ah	n*0.1
0xE043	57412	EAhl_r_HI	Ah Load Resettable, HI Word	-	
0xE044	57413	EAhl_t_LO	Ah Load Total, LO Word	Ah	n*0.1
0xE045	57414	EAhl_t_HI	Ah Load Total, HI Word	-	
0xE046	57415	EAhc_r_LO	Ah Charge Resettable, LO Word	Ah	n*0.1
0xE047	57416	EAhc_r_HI	Ah Charge Resettable, HI Word	-	
0xE048	57417	EAhc_t_LO	Ah Charge Total, LO Word	Ah	n*0.1
0xE049	57418	EAhc_t_HI	Ah Charge Total, HI Word	-	
0xE04A	57419	EkWhc_r	kWhc Resettable	kWh	n*0.1
0xE04B	57420	EkWhc_t	kWhc Total	kWh	n*0.1
0xE04C	57421	EVb_min	Battery Voltage Minimum	V	Float16
0xE04D	57422	EVb_max	Battery Voltage Maximum	V	Float16
0xE04E	57423	EVa_max	Array Voltage Maximum	V	Float16
0xE04F	57424	Etmr_eqcalander	Time Since Last Equalize	days	

Logged Data

The PS-MPPT stores up to 256 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 0x8000-0x8FFF
- The data consists of up to 256 blocks of data.
- 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]	
…	…		
0x8FF0-8FFF	36848- 36863	logger[255]	

Data is stored in big endian format.

```
struct {
        Uint32 hourmeter;
        Uint32 alarm_daily;
        Uint32 load_fault_daily;
        Uint32 array_fault_daily;
        Float16 Vb_min_daily;
        Float16 Vb_max_daily;
        Float16 Ahc_daily;
        Float16 Ahl_daily;
        Float16 Va_max_daily;
        Uint16 time_ab_daily;
        Uint16 time_eq_daily;
        Uint16 time_fl_daily;
}
```

Byte Offset	Variable name	Bytes	Variable description	Units	Scaling or Range
0	hourmeter	4		hours	0 to (2^{32}-1)
4	alarm_daily	4	Alarm Bitfield – daily	-	
8	load_fault_daily	4	Load Fault Bitfield – daily	-	
12	array_fault_daily	4	Array Fault Bitfield – daily	-	
16	Vb_min_daily	2	Battery Voltage Minimum – daily	V	Float16
18	Vb_max_daily	2	Battery Voltage Maximum – daily	V	Float16
20	Ahc_daily	2	Ah Charge – daily	Ah	Float16
22	Ahl_daily	2	Ah Load – daily	Ah	Float16
24	Va_max_daily	2	Maximum Array Voltage – daily	V	Float16
26	time_ab_daily	2	Time in Absorption – daily	min	
28	time_eq_daily	2	Time in Equalize – daily	min	
30	time_fl_daily	2	Time in Float – daily	min	

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)
0x0003 - 0x000F	4 - 16	RESERVED
0x0010	17	Clear Ah Resettable (set only, will always read 0)
0x0011	18	Clear Ah Total (set only, will always read 0)
0x0012	19	Clear kWh Resettable (set only, will always read 0)
0x0013	20	RESERVED
0x0014	21	Clear Faults
0x0015	22	Clear Alarms
0x0016	23	Force EEPROM Update (set only, will always read 0)
0x0017	24	RESERVED
0x0018	25	Clear kWh Total (set only, will always read 0)
0x0019	26	Clear Vb (Battery Voltage) Min/Max
0x0020	27	Lighting Mode Test - when lighting mode is enabled, turns on load output for 10 minutes (set only, will always read 0).
0x0021 - 0x00FD	28 - 254	RESERVED
0x00FE	255	Factory Reset - revert settings to factory defaults (display settings are not reset)
0x00FF	256	Reset Control

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	“PS-MPPT-25” “PS-MPPT-25M” “PS-MPPT-40” “PS-MPPT-40M”
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.

ver_sw
[1][0x0000] (-). *Software version.*
Firmware version for the controller. The value is stored in binary coded decimal (BCD) format. Decimal version 12 is thus stored as 0x0012 not as 0x000c.

n_sys_v
[2][0x0001] (-). *Battery Voltage Settings Multiplier.*
Multiplication factor for charging and load voltage settings. Voltage settings are stored as 12V nominal in the controller. A value of 1 indicates these settings are used unmodified. A value of 2 indicates these settings are multiplied by 2 for use in a 24V nominal battery system.

RAW ADC

vdd_actual
[05][0x0004] (V). *Internal 3.3V Supply Voltage.*
Voltage of the internal 3.3V power supply.

adc_P12
[06][0x0005] (V). *Internal 12V Supply Voltage.*
Voltage of the internal 12V power supply.

adc_P5
[07][0x0006] (V). *Internal 5V Supply Voltage.*
Voltage of the internal 5V power supply.

adc_fgdrive
[08][0x0007] (V). *Internal Gate Drive Voltage.*
Voltage of the internal MOSFET gate drive voltage.

adc_vmeter
[09][0x0008] (A). *Internal MeterBus Supply Voltage.*
Voltage of the MeterBus supply.

FILTERED ADC

adc_ic_f_shadow

[17][0x0010] (Float16 format) (A). *Charge Current.*
[83-84][0x0052-0x0053] (Float32 format) (A). *Charge Current, HI/LO Word.*
Current provided by the MPPT charger stage.

adc_ia_f_shadow

[18][0x0011] (A). *Array Current.*
Current into the array terminal connections of the ProStar MPPT.

adc_vbterm

[19][0x0012] (Float16 format) (V). *Battery Terminal Voltage.*
Voltage measured at the battery terminal connections of the ProStar MPPT.

adc_va_f_shadow

[20][0x0013] (Float16 format) (V). *Array Voltage.*
[12-13][0x000B-0x000C] (Float32 format) (V). *Array Voltage, HI/LO word.*
Input voltage measured at the array terminal connections of the ProStar MPPT.

adc_vl

[21][0x0014] (Float16 format) (V). *Load Voltage.*
[14-15][0x000D-0x000E] (Float32 format) (V). *Load Voltage, HI/LO word.*
Output voltage measured at the load terminal connections of the ProStar MPPT.

adc_ib_f_shadow

[22][0x0015] (Float16 format) (A). *Battery Current (net)*.
Net current into / out of the battery terminal connections of the ProStar MPPT.

adc_il

[23][0x0016] (Float16 format) (A). *Load Current.*
[87-88][0x0056-0x0057] (Float32 format) (A). *Load Current, HI/LO Word.*
Current out of the load terminal connections of the ProStar MPPT.

adc_vbsense

[24][0x0017] (V). *Battery Sense Voltage.*
Voltage measured at the battery sense connections of the ProStar MPPT.

adc_vb_f_1m

[25][0x0018] (Float16 format) (V). *Battery Voltage, slow filter.*
[10-11][0x0009-0x000A](Float32 format) (V). *Battery Voltage, slow filter, HI/LO Word.*
Slow filtered value of the battery voltage. 60 second filtering time.

adc_ib_f_1m

[26][0x0019](Float16 format) (A). *Battery Current (net), slow filter.*
[85-86][0x54-0x0055] (Float32 format) (A). *Battery Current (net), slow filter.*
Slow filtered value of the net battery current into / out of the battery terminal connections of the ProStar MPPT. 60 second filtering time.

TEMPERATURES

T_hs

[27][0x001A] (C). *Heatsink Temperature.*
ProsStar MPPT Heatsink temperature. Reported in degrees C.

T_batt

[28][0x001B] (Float16 format) (C). *Battery Temperature.*
[89-90][0x0058-0x0059] (Float32 format) (C°). *Battery Temperature, HI/LO Word.*
Battery temperature measured by the ambient temperature sensor or the optional RTS (if connected). Reported in degrees C.

T_amb

[29][0x001C] (C). *Ambient (local) Temperature.*
Ambient temperature measured by the local ambient temperature sensor. Reported in degrees C.

T_rts

[30][0x001D] (C). *RTS Temperature.*
Temperature measured by the optional Remote Temperature Sensor (RTS). Reported in degrees C.

T_ind[U]

[31][0x001E] (C). *Phase U Inductor Temperature.*
ProsStar MPPT Phase U inductor temperature. Reported in degrees C.

T_ind[V]

[32][0x001F] (C). *Phase V Inductor Temperature.*
ProsStar MPPT phase V inductor temperature. Reported in degrees C.

T_ind[W]

[33][0x0020] (C). *Phase W Inductor Temperature.*
ProsStar MPPT phase W inductor temperature. Reported in degrees C. Only present in 40A models.

CHARGER STATUS

charge_state

[34][0x0021] (-). *Charge State.*
Reports the present charge state.

Value	Charge State
0	START
1	NIGHT_CHECK
2	DISCONNECT
3	NIGHT
4	FAULT
5	MPPT
6	ABSORPTION
7	FLOAT
8	EQUALIZE
9	SLAVE
10	FIXED

array_fault

[35][0x0022] (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 Phase 1
1	FET(s) Shorted
2	Software Bug
3	Battery HVD (High Voltage Disconnect)
4	Array HVD (High Voltage Disconnect)
5	EEPROM Setting Edit (reset required)
6	RTS Shorted
7	RTS was valid, now disconnected
8	Local temp. sensor failed
9	Battery LVD (Low Voltage Disconnect)
10	Slave Control Timeout
11	DIP Switch Changed (excl. DIP 8)

vb_f

[36][0x0023] (V). *Battery Voltage, slow filter.*
Slow filtered value of the battery voltage. 25 second filtering time.

vb_ref

[37][0x0024] (Float16 format) (V). *Battery Regulator Reference Voltage.*
[45-46][0x002C-0x002D] (Float32 format) (V). *Battery Regulator Reference Voltage, HI/LO Word.*
Present target battery voltage. The controller is attempting to charge the batteries to this voltage.

Vb_ref_slave

[38][0x0025] (V). *Battery regulation override.*
Write a voltage value to this register to override the battery regulation. This allows for system control of 1 or more controllers via Modbus. Writing a non-zero value to this register forces the controller into "slave" state. The register value must be updated every 60 seconds or less, else the controller will fault. Writing to the register after a timeout will exit fault state and resume operation.

Ahc_r (HI / LO)

[39-40][0x0026-0x0027] (Ah). *Amp-Hours Charge Resettable.*
Resettable counter which reports charging amp-hours. Reset of this counter is achieved with a Coil Command (see Coil information section above).

Ahc_t (HI / LO)

[41-42][0x0028-0x0029] (Ah). *Amp-Hours Charge Total.*
Counter which reports charging amp-hours. This counter can also be reset using a Coil Command (see Coil information section above).

kWhc_r

[43][0x002A] (kWh). *kiloWatt-Hours Charge Resettable.*
Resettable counter which reports charging kilowatt-hours. Reset of this counter is achieved with a Coil Command (see Coil information section above).

kWhc_t

[44][0x002B] (kWh). *kiloWatt-Hours Charge Total.*
Counter which reports total charging kilowatt-hours. This counter can also be reset using a Coil Command (see Coil information section above).

LOAD STATUS

load_state

[47][0x002E] (-). *Load State.*
Reports the present load output state.

Value	Load State
0	START
1	LOAD_ON
2	LVD_WARNING
3	LVD
4	FAULT

5	DISCONNECT
6	LOAD_OFF
7	OVERRIDE

load_fault

[48][0x002F] (bit-field). *Load Output 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	FET(s) Shorted
3	Software Bug
4	High Voltage Disconnect
5	Heatsink Over-Temperature
6	DIP Switch Changed (excl. DIP 8)
7	EEPROM Setting Edit (reset required)

V_lvd

[49][0x0030] (V). *Load LVD Voltage.*
Low voltage disconnect setpoint, current compensated.

V_lvd

[50][0x0031] (V). *Load HVD Voltage.*
High voltage disconnect setpoint.

Ahl_r_HI / Ahl_r_LO

[51, 52][0x0032, 0x0033] (Ah). *Load Amp-Hours Resettable.*
Resettable counter which reports load amp-hours. Reset of this counter is achieved with a Coil Command (see Coil information section above).

Ahl_t_HI / Ahl_t_LO

[53, 54][0x0034, 0x0035] (Ah). *Load Amp-Hours Total.*
Counter which reports load amp-hours. This counter can also be reset using a Coil Command (see Coil information section above).

MISCELLANEOUS

hourmeter (HI / LO)

[55,56][0x0036, 0x0037] (hrs). *Hourmeter.*
Reports total hours of operation since installed.

Alarm (HI / LO)

[57, 58][0x0038, 0x0039] (bitfield). *Controller Self-Diagnostics Alarms.*
Reports alarms identified by self diagnostics. Each bit corresponds to a specific alarm.

Alarms Table	
BIT	**ALARM**
0	RTS Open
1	RTS Shorted
2	RTS Disconnected
3	Ths (heatsink temp sensor) Open
4	Ths (heatsink temp sensor) Shorted
5	Heatsink Hot (active temp limiting)
6	Tind (inductor temp sensor) Open
7	Tind (inductor temp sensor) Short
8	Tind Hot (active temp limiting)
9	Current Limit
10	I Offset
11	Battery Sense Out of Range
12	Battery Sense Disconnected
13	Uncalibrated
14	TB 5V
15	FP10 Supply Out of Range
16	[unused]
17	FET Open
18	IA Offset
19	IL Offset
20	3V Supply Out of Range
21	12V Supply Out of Range
22	VA High (current limit due to high Voc)
23	Reset
24	LVD
25	Log Timeout
26	EEPROM Access Failure
27	[unused]
28	EEPROM Settings edit

dip_switch

[59][0x003A] (bit-field). *DIP Switch Settings.*
Each bit in the bit-field corresponds to an individual DIP switch setting. Useful for remote applications where access to ProStar MPPT to verify DIP positions is not feasible. Bit 0 (LSB) corresponds to settings switch 1. (Only valid for DIP settings at controller power-up)

LED_state

[60][0x003B] ( ).
Reports the State-of-Charge 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	GREEN / YELLOW LED
8	YELLOW LED
9	YELLOW / RED LED
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
16	R-G ERROR
17	R/Y-G/Y ERROR
18	G/Y/R ERROR
19	G/Y/R x2
20	OFF
21	G/Y/R x2 – GREEN x2
22	G/Y/R x2 – RED x2

MPPT

Power_out

[61][0x003C] (W). *Charge Output Power.*
Charger output power to the battery/load combination.

Sweep_Vmp

[62][0x003D] (V). *Solar Array Vmp.*
Maximum power voltage of the solar array found during last sweep.

Sweep_Pmax

[63][0x003E] (W). *Maximum Array Power.*
Maximum power output of the solar array found during last sweep.

Sweep_Voc

[64][0x003F] (V). *Solar Array Voc.*
Open circuit voltage of the solar array found during last sweep.

va_ref

[65][0x0040] (V). *Array Target Voltage.*
Target Vmp voltage. The controller attempts to hold this array Vmp target.

LOGGER

Vb_min_daily

[66][0x0041] (V). *Today's minimum battery voltage.*
Minimum battery voltage measured today (value resets after dark).

Vb_max_daily

[67][0x0042] (V). *Today's maximum battery voltage.*
Maximum battery voltage measured today (value resets after dark).

Ahc _daily

[68][0x0043] (Ah). *Today's total charge amp-hours.*
Total charging amp-hours accumulated today (value resets after dark).

Ahl _daily

[69][0x0044] (Ah). *Today's total load amp-hours.*
Total load amp-hours accumulated today (value resets after dark).

Array_fault_daily

[70][0x0045] (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

[71][0x0046] (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_daily (HI / LO)

[72, 73][0x0047, 0x0048] (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.

time_ab_daily

[74][0x0049] (s). *Cumulative time in Absorption today.*

Reports the cumulative number of seconds the battery has been in the Absorption charge stage today. Counter resets at night.

time_eq_daily

[75][0x004A] (s). *Cumulative time in Equalization today.*
Reports the cumulative number of seconds the battery has been in the Equalization charge stage today. Counter resets at night.

time_fl_daily

[76][0x004B] (s). *Cumulative time in Float today.*
Reports the cumulative number of seconds the battery has been in the Float charge stage today. Counter resets at night.

Va_max_daily

[77][0x004C] (V). *Array Voltage max today.*
Reports the maximum array voltage seen today. Value resets after dark.

MISCELLANEOUS 2

LED_state

[78][0x004D] ( ).
Reports the Status 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	GREEN / YELLOW LED
8	YELLOW LED

lighting_should_be_on

[79][0x004E] ( ). *Lighting (load) on/off indication*
A non-zero value here indicates that the load output should be ON. A zero value indicates the load output should be OFF.

Va_ref_fixed

[80][0x004F] (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.

Va_ref_fixed_pct

[81][0x0050] ( ). *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 fraction 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.
Valid values are from 0.0 to 0.99.

Note: if the Va_ref_fixed (0x004F) register is non-zero, it will override this setting.

alarm_on_setting_change

[82][0x0051] ( ). *Alarm/fault indicator for EEPROM settings changes*
If set to 1, writing EEPROM settings will cause an alarm (0x1000 0000) instead of a fault. If set to 0, the default, the normal traditional behavior (fault on settings change) remains. See the variable of the same name in EEPROM for a persistent version of this. New in sw_ver=13

CHARGING SETTINGS

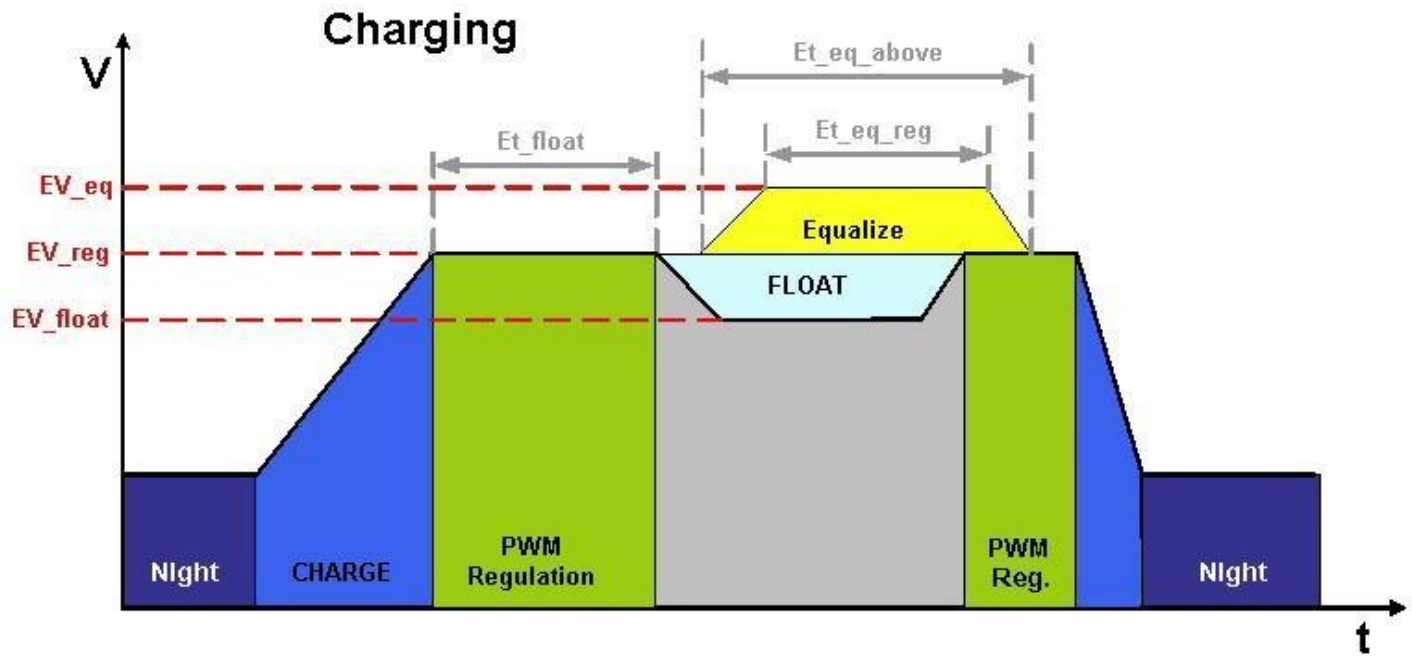

Diagram A Charging stages and defining variables.

EV_reg

[57345][0xE000] (V). *Regulation voltage (absorption), @ 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, @ 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] (s) *Time before entering float.*
Defines the length of time in absorption before transitioning to the float stage. See diagram A.

Et_floatlb

[57348][0xE003] (s) *Time before entering float due to low battery.*
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.*
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.*
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.*
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.*
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 equalize cycles.*
Specify the number of days between equalizations. Equalizing on a calendar basis ensures proper maintenance of batteries.

Et_eq_above

[57354][0xE009] (s) *Equalize time limit above Vreg.*
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] (s) *Equalize time limit at Veq.*
Equalization will stop after the specified number of seconds at the equalization setpoint voltage. See diagram A.

EVb_ref_charge_lim

[57361][0xE010] (V). *Reference charge limit.*
Battery charge voltage limit.

Eib_lim

[57364][0xE013] (V). *Battery current.*
Charger battery current limit

EV_tempcomp

[57371][0xE01A] (V/ºC). *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] (V). *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.

ETb_lo_limit_100

[57377][0xE020] (C). *Battery current limit upper temperature.*
Battery temperature limit for 100% charging output to batteries. Battery temperatures above this value will allow for up to 100% charging current. Linear charging current taper from ETb_lo_limit_100 to Etb_lo_limit_0. ETb_lo_limit_100 must be greater that ETb_lo_limit_0 to operate.

ETb_lo_limit_0

[57378][0xE021] (C). *Battery current limit low temperature.*
Battery temperature limit for 0% charging output to batteries. Battery temperatures below this value will provide 0% charging current. Linear charging current taper from ETb_lo_limit_100 to ETb_lo_limit_0. ETb_lo_limit_100 must be greater that ETb_lo_limit_0 to operate.

LOAD SETTINGS

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] (s). *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

[57393][0xE030] (V). *LED 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_gy_y

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

EV_soc_y_yr

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

EV_soc_y2r0

[57396][0xE033] (V). *LED yellow/red to blinking red limit.*
LED transition setpoint. Specifies the battery threshold voltage at which the LEDs will change from Yellow/Red to Blinking Red 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 0x003F, which allows for real-time control of Va.

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 fraction 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 0x003F, which allows for real-time control of Va. ***Valid values are from 0.0 to 0.99.***

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 charging current limit. 0-25A for 25A models, 0-40A for 40A models.

READ ONLY VARIABLES

Ehourmeter (LO / HI)

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

EAhl_r (LO / HI)

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

EAhl_t (LO / 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 / HI)

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

Eahc_t (LO / HI)

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

EkWhc_r

[57419][0xE04A] (kWh). *Charge Kilowatt hours resettable.*
Cumulative charging kilowatt hours typically used for short-term logging. Resettable.

EkWhc_t

[57420][0xE04B] (kWh). *Charge Kilowatt hours total.*
Cumulative charging kilowatt hours for long term logging. Can be reset if needed.

EVb_min

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

EVb_max

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

EVa_max

[57423][0xE04E] (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
0xFF00= 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 Ah Resettable

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

Clear Ah Total

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

Clear kWh Resettable

[19] [0x0012]
Resets kilowatt hours charge (resettable) counter back to 0.
(set only, will always read 0)

Clear Faults

[21] [0x0014]
Clears active faults

(set only, will always read 0)

Clear Alarms

[22] [0x0015]
Clears active alarms
(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)

Clear kWh Total

[25] [0x0018]
Resets total solar kilowatt-hour counter back to 0.
(set only, will always read 0)

Clear VB Min/Max

[26] [0x0019]
Resets battery voltage minimum and maximum.

Lighting Test

[27] [0x0020]
If lighting is enabled, turns on lighting output for 10 minutes.
(set only, will always read 0)

Factory Reset

[255][0x00FE]

Reverts controller back to Factory Default settings.

Reset control

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

Examples

Read Holding Register, 2 Word values

Variable (RAM): hours (hourmeter)
LO Register Address: 0x0037
HI Register Address: 0x0036
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
```

C Float32 Conversion to Float16 example

```
// Convert a float32 (IEEE754 Single precision binary32) to float16 (IEEE754 half precision binary16)
#include <stdint.h>
#include <math.h>

uint16_t F32ConvertToF16(float f32) {
        uint16_t f16 = 0;
        uint32_t f32_u = *(uint32_t*)&f32;
        unsigned sign           =       (f32_u & 0x80000000) >> 31;
        unsigned exponent       =       (f32_u & 0x7f800000) >> 23;
        unsigned fraction       =       (f32_u & 0x007fffff) >> 13;
        //check for inf and NaN
        if (exponent == 0xFF) {
                if (fraction == 0) { //inf detected
                        f16 = (sign == 1) ? 0xfc00 : 0x7c00;
                } else { // NaN detected
                        f16 = 0x7c01;// output a NaN
                }
        } else {
                //verify the number if within range
                if (((int)exponent - 127) >= 15) {
                        //overflow, if exponent values are too high, we should return an inf
                        f16 =  (sign == 1) ? 0xfc00 : 0x7c00; // negative and positive infinity, respectively
                } else if (((int)exponent - 127) <= -14) {
                        //underflow
                } else {
                        // normal numbers
                        f16 =  (sign << 15) + ((unsigned)((int)exponent - 127) << 10) + (fraction);
                }
        }
        return f16;
}
```

C Float16 Conversion to Float32 example

```
// Convert a float16 (IEEE754 half-precision binary16) to float32 (IEEE754 Single precision binary32)
#include <stdint.h>
#include <math.h>

float F16ConvertToF32(uint16_t f16) {
	float f32 = 0;

	unsigned sign = (f16 & 0x8000) >> 15;		//extract out the sign
	unsigned exponent = ((f16 & 0x7C00) >> 10);	//extract out the exponent
	float fraction = (f16 & 0x03ff) / 1024.0;	//extract out the fraction

	//check for inf & NaN, 0x7F800000 = +inf  0xFF800000 = -inf
	if (exponent == 0x1f) {
		if (fraction == 0) {
			int positveInf = 0x7f800000;
			int negativeInf = 0xff800000;
			return (sign == 0) ? *(float*)&positveInf : *(float*)&negativeInf;
		}
		else {
			return 0.0 / 0.0; //use 0.0 to generate NaN
		}
	}
	//check for 0 or subnormal
	if (exponent == 0 ) {
		if (fraction == 0 ) { // if it is 0
			if(sign == 1 )
				return -0.0;
			return 0.0; // use 0.0 to return a zero in float
		}
		else {
			f32 = fraction * pow(2.0, -14.0);
			if (sign == 1)
				f32 *= -1.0;
			return f32;
		}
	}
	//the number is not a NaN or 0 or subnormal
	f32 = (fraction + 1.0) * pow(2.0, ((int)exponent - 15));
	if (sign == 1)
		f32 *= -1.0;

	return f32;

}
```

JavaScript Float16 conversion example

```
/*
Converts an integer read by modbus to float16 (IEEE754 half-precision binary16)
Modbus result is likely sign extended but we will ignore that
*/
function ScaleF16(passedVal)
{
	var s = 0;		// sign
	var e = 0;		// exponent
	var currentVal = 0;	// mantissa/result

	currentVal = (passedVal & 0x03ff) / 1024.0;  // 10 bit mantissa (normalized)
	passedVal >>= 10;
	e = (passedVal & 0x001f);	// 5 bit exponent (stored w/ 15 offset)
	passedVal >>= 5;
	s = passedVal & 0x0001;			// 1 bit sign

	if (e == 0) {	// zero or subnormal
		if (currentVal == 0) return(0); // zero

		// else subnormal (no leading 1.xxx)
		currentVal *= Math.pow(2.0,-14);
		if (s != 0) currentVal *= -1.0;
		return (currentVal);
	}

	if (e == 0x1f) {		// infinity or NaN
		if (currentVal == 0) {
			if (s==0) return(Number.POSITIVE_INFINITY);	// +infinity
			else return (Number.NEGATIVE_INFINITY);			// -infinity
		} else return(Number.NaN);	// NaN
	}

	currentVal += 1.0;	// add in leading 1
	currentVal *= Math.pow(2.0,e-15);
	if (s != 0) currentVal *= -1.0;

	return (currentVal);
}
```

References

- Visit modbus.org for full protocol documentation, news, and technical resources
- 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

v01: First Release
v02: PDU address 0x0001 scaling changed to Float16
v03: PDU address 0x0043, 0x0044 scaling changed to Float16
v04: Added register descriptions (EEPROM settings for Faults and Alarms) for RAM 0x0051 and EEPROM 0xE00D. Version 13 firmware supported.
v05: PDU address 0xE027 units changed from secs to mins.
Modbus.org URL links removed
v06: Added Float32 versions of several Float16 variables, found at PDU addresses 0x0009-0x000E, 0x002C-0x002D, and 0x0052-0x0059