

TriStar MPPT MODBUS® Specification

v04
16 July 2009

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General Information

The TriStar MPPT supports the industry standard MODBUS® application protocol via its serial RS-232 and EIA-485 interfaces and MODBUS TCP via the Ethernet port (TS-MPPT-60-150V models only). This document assumes the user is familiar with both MODBUS® protocols. Please refer to the documents listed in the [References](#) section for more information.

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

Parameters

The TriStar MPPT supports RTU mode only.
16bit MODBUS addresses (per the modbus.org spec)

The serial communication parameters:

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

The default TCP communication parameters:

- DHCP enabled
- Port 502
- MODBUS ID 1
- NETBIOS address tsmpt + serial number (no spaces)
- LiveView Web address <http://tsmpptXXXXXXXX> (where X is the serial number)

If DHCP fails, the following default parameters will be assigned:

- IP 192.168.1.237
- Gateway 192.168.1.1
- Primary DNS 192.168.1.1
- Secondary DNS 192.168.1.1
- Subnet Mask 255.255.255.0

Note: the TCP socket is closed by the TS-MPPT after each MODBUS response (change pending)

All addresses listed are for the request PDU.

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
Scaling Values					
0x0000	1	V_PU_hi	Voltage scaling, whole term	V	-
0x0001	2	V_PU_lo	Voltage scaling, fractional term	-	-
0x0002	3	I_PU_hi	Current scaling, whole term	A	-
0x0003	4	I_PU_lo	Voltage scaling, fractional term	-	-
0x0004	5	ver_sw	Software Version	-	-
0x0005 – 0x0017	6-9	RESERVED			
Filtered ADC					
0x0018	25	adc_vb_f_med	Battery voltage, filtered ($\tau \approx ?s$)	V	$n \cdot V_{PU} \cdot 2^{-15}$
0x0019	26	adc_vbterm_f	Batt. Terminal voltage, filtered ($\tau \approx ?s$)	V	$n \cdot V_{PU} \cdot 2^{-15}$
0x001A	27	adc_vbs_f	Battery Sense voltage, filtered ($\tau \approx ?s$)	V	$n \cdot V_{PU} \cdot 2^{-15}$
0x001B	28	adc_va_f	Array voltage, filtered ($\tau \approx ?s$)	A	$n \cdot I_{PU} \cdot 2^{-15}$
0x001C	29	adc_ib_f_shadow	Battery current, filtered ($\tau \approx ?s$)	A	$n \cdot I_{PU} \cdot 2^{-15}$
0x001D	30	adc_ia_f_shadow	Array current, filtered ($\tau \approx ?s$)	A	$n \cdot I_{PU} \cdot 2^{-15}$
0x001E	31	adc_p12_f	12 volt supply, filtered ($\tau \approx ?s$)	V	$n \cdot 18.612 \cdot 2^{-15}$
0x001F	32	adc_p3_f	3 volt supply, filtered ($\tau \approx ?s$)	V	$6.6 \cdot 2^{-15}$
0x0020	33	adc_pmeter_f	MeterBus voltage, filtered ($\tau \approx ?s$)	V	$n \cdot 18.612 \cdot 2^{-15}$
0x0021	34	adc_p18_f	1.8 volt supply, filtered ($\tau \approx ?s$)	V	$n \cdot 3 \cdot 2^{-15}$
0x0022	35	adc_v_ref	reference voltage	V	$n \cdot V_{PU} \cdot 2^{-15}$
Temperatures					
0x0023	36	T_hs	Heatsink temperature	C	-127 to +127
0x0024	37	T_rts	RTS temperature (0x80 = disconnect)	C	-127 to +127
0x0025	38	T_batt	Battery regulation temperature	C	-127 to +127
Status					
0x0026	39	adc_vb_f_1m	Battery voltage, filtered ($\tau \approx 1min$)	V	$n \cdot V_{PU} \cdot 2^{-15}$
0x0027	40	adc_ib_f_1m	Charging current, filtered ($\tau \approx 1min$)	A	$n \cdot I_{PU} \cdot 2^{-15}$
0x0028	41	vb_min	Minimum battery voltage	V	$n \cdot V_{PU} \cdot 2^{-15}$
0x0029	42	vb_max	Maximum battery voltage	V	$n \cdot V_{PU} \cdot 2^{-15}$
0x002A	43	hourmeter_HI	hourmeter, HI word	h	-
0x002B	44	hourmeter_LO	hourmeter, LO word	h	-
0x002C	45	fault.all	Controller faults bitfield	-	-
0x002D	46	reserved			
0x002E	47	alarm_HI	alarm bitfield – HI word	-	-
0x002F	48	alarm_LO	alarm bitfield – LO word	-	-
0x0030	49	dip.all	DIP switch positions bitfield	-	-
0x0031	50	led.state	State of LED indications	-	-
Charger					
0x0032	51	charge_state	Charging stage	-	-
0x0033	52	vb_ref	Target regulation voltage	V	$n \cdot V_{PU} \cdot 2^{-15}$
0x0034	53	Ahc_r_HI	Ah charge – resetable	Ah	n·0.1

0x0035	54	Ahc r LO		-	
0x0036	55	Ahc t HI	Ah charge – total	Ah	n·0.1
0x0037	56	Ahc t LO		-	
0x0038	57	kwhc r	kWhr charge resetable	-	
0x0039	58	kwhc t	kWhr charge total	-	
MPPT					
0x003A	59	power_out_shadow	Output Power	W	$n \cdot V_{PU-I} \cdot PU \cdot 2^{-17}$
0x003B	60	power_in_shadow	Input Power	W	$n \cdot V_{PU-I} \cdot PU \cdot 2^{-17}$
0x003C	61	sweep_Pin_max	Max. Power of last sweep	W	$n \cdot V_{PU-I} \cdot PU \cdot 2^{-17}$
0x003D	62	sweep_vmp	Vmp of last sweep	V	$n \cdot V_{PU \cdot 2^{-15}}$
0x003E	63	sweep_voc	Voc of last sweep	V	$n \cdot V_{PU \cdot 2^{-15}}$
0x003F	64	RESERVED			
Logger – Today's values					
0x0040	65	vb_min_daily	Min. daily battery voltage	V	$n \cdot V_{PU \cdot 2^{-15}}$
0x0041	66	vb_max_daily	Max. daily battery voltage	V	$n \cdot V_{PU \cdot 2^{-15}}$
0x0042	67	va_max_daily	Max. daily input voltage	V	$n \cdot V_{PU \cdot 2^{-15}}$
0x0043	68	Ahc_daily	Total Ah charge daily	Ah	n·0.1
0x0044	69	whc_daily	Total Wh charge daily	Wh	
0x0045	70	flags_daily	Daily flags bitfield	-	
0x0046	71	Pout_max_daily	Max. Power Out, daily	W	$n \cdot V_{PU-I} \cdot PU \cdot 2^{-17}$
0x0047	72	Tb_min_daily	Min. battery temp. daily	C	
0x0048	73	Tb_max_daily	Max. battery temp. daily	C	
0x0049	74	fault_daily	Faults, daily	-	
0x004A	75	RESERVED			
0x004B	76	alarm_daily_HI	Daily alarms bitfield	-	
0x004C	77	alarm_daily_LO		-	
0x004D	78	time_ab_daily	cumulative time in absorption, daily	s	
0x004E	79	time_eq_daily	cumulative time in equalize, daily	s	
0x004F	80	time_fl_daily	cumulative time in float, daily	s	
0x0050 – 0x0058	81 - 89	RESERVED			
0x0059	90	vb_ref_slave	battery voltage regulation override	V	$n \cdot V_{PU \cdot 2^{-15}}$
Sweep data					
0x0200 – 0x0263	513 - 612	sweep_x	sweep data (Va)	V	$n \cdot V_{PU \cdot 2^{-15}}$
0x0280 – 0x02E3	641 - 740	sweep_y	sweep data (Ia)	A	$n \cdot I_{PU \cdot 2^{-15}}$

EEPROM

PDU Addr	Logical Addr	Variable name	Variable description	Units	Scaling or Range
TCP Network Settings					
0x1501	5378	IPAddrByte [2][3]	IP Address Bytes	-	
0x1502	5379	IPAddrByte [0][1]	IP Address Bytes	-	
0x1503	5340	SubNetMask [2][3]	Subnet Mask Bytes	-	
0x1504	5341	SubNetMask [0][1]	Subnet Mask Bytes	-	
0x1505	5342	Gateway [2][3]	Gateway Bytes	-	
0x1506	5343	Gateway [0][1]	Gateway Bytes	-	
0x1507	5344	PrimaryDNS [2][3]	PrimaryDNS Bytes	-	
0x1508	5345	PrimaryDNS [0][1]	PrimaryDNS Bytes	-	
0x1509	5346	SecondaryDNS [2][3]	SecondaryDNS Bytes	-	

0x150A	5347	SecondaryDNS [0][1]	SecondaryDNS Bytes	-	
0x150B	5348	DefaultIP [2][3]	DefaultIP Bytes???	-	
0x150C	5349	DefaultIP [0][1]	DefaultIP Bytes???	-	
0x150D	5350	DefaultMask [2][3]	DefaultMask Bytes???	-	
0x150E	5351	DefaultMask [0][1]	DefaultMask Bytes???	-	
0x150F – 0x1516	5352 – 5399	ControllerID	String of 16 bytes, 00 terminates string	-	ASCII
0x1517	5400	NetFlags	0x4000=DHCP Enabled, 0x0=DHCP disabled	-	
0x1518	5401	MACAddress[4],[5]	MAC Address Bytes	-	
0x1519	5402	MACAddress[2],[3]	MAC Address Bytes	-	
0x151A	5403	MACAddress[0],[1]	MAC Address Bytes	-	
0x151B	5404	HTTTPort	HTTP Port Number	-	1 to 65535
0x151C	5405	MBIPPort	MODBUS IP Port Number	-	1 to 65535
0x151D	5406	NetRules	BIT0: IP Bridging Enabled	-	0 or 1
0x151E	5407	SNMPTrapRecPort	SNMP Trap Destination NMS Port	-	1 to 65535
0x151F – 0x1528	...	RESERVED			
0x1529	5418	SNMPTrapIPAddr[2],[3]	SNMP Trap Receiver IP Address Bytes	-	
0x152A	5419	SNMPTrapIPAddr[0],[1]	SNMP Trap Receiver IP Address Bytes	-	
0x152B – 0x1534	...	RESERVED			
Notification 0 Settings					
0x1535	5430	NotifyEnabled	BIT0: Enable Notification	-	0 or 1
0x1536	5431	CompareServerID	MB ServerID to compare, 0 = local	-	0 to 255
0x1537	5432	Compare Address	MB address to compare	-	0 to 65535
0x1538	5433	Compare Value	Value to compare	-	0 to 65535
0x1539	5434	CompareType	BIT0:==, BIT1:<, BIT2:>, BIT3:!= BIT0 BIT1: =<, BIT0 BIT2: =>	-	
0x153A	5435	OverThreshSeconds	Seconds over threshold before Notify Sent	-	
0x153B	5436	ResetThreshSeconds	Seconds below threshold before notify is reenabled.	-	
0x153C – 0x1543	5437	NotifyID	Notify ID String	-	ASCII
Notification 1 Settings					
0x1544	5445	NotifyEnabled	BIT0: Enabled, BIT1:SMTP,BIT2:SNMP, ??BIT3:SMS	-	
0x1545	5446	CompareServerID	MB ServerID to compare, 0 = local	-	0 to 255
0x1546	5447	Compare Address	MB address to compare	-	0 to 65535
0x1547	5448	Compare Value	Value to compare	-	0 to 65535
0x1548	5449	CompareType	BIT0:==, BIT1:<, BIT2:>, BIT3:!= BIT0 BIT1: =<, BIT0 BIT2: =>	-	
0x1549	5450	OverThreshSeconds	Seconds over threshold before Notify Sent	-	
0x154A	5451	ResetThreshSeconds	Seconds below threshold before notify is reenabled.	-	
0x154B – 0x1552	5452	NotifyID	Notify ID String	-	ASCII
Notification 2 Settings					

0x1553	5460	NotifyEnabled	BIT0: Enabled, BIT1:SMTP,BIT2:SNMP, ??BIT3:SMS	-	
0x1554	5461	CompareServerID	MB ServerID to compare, 0 = local	-	0 to 255
0x1555	5462	Compare Address	MB address to compare	-	0 to 65535
0x1556	5463	Compare Value	Value to compare	-	0 to 65535
0x1557	5464	CompareType	BIT0:==, BIT1:<, BIT2:>, BIT3:!= BIT0 BIT1: =<, BIT0 BIT2: =>	-	
0x1558	5465	OverThreshSeconds	Seconds over threshold before Notify Sent	-	
0x1559	5466	ResetThreshSeconds	Seconds below threshold before notify is reenabled.	-	
0x155A– 0x1561	5467	NotifyID	Notify ID String	-	ASCII
Notification 3 Settings					
0x1562	5475	NotifyEnabled	BIT0: Enabled, BIT1:SMTP,BIT2:SNMP, ??BIT3:SMS	-	
0x1563	5476	CompareServerID	MB ServerID to compare, 0 = local	-	0 to 255
0x1564	5477	Compare Address	MB address to compare	-	0 to 65535
0x1565	5478	Compare Value	Value to compare	-	0 to 65535
0x1566	5479	CompareType	BIT0:==, BIT1:<, BIT2:>, BIT3:!= BIT0 BIT1: =<, BIT0 BIT2: =>	-	
0x1567	5480	OverThreshSeconds	Seconds over threshold before Notify Sent	-	
0x1568	5481	ResetThreshSeconds	Seconds below threshold before notify is reenabled.	-	
0x1569 – 0x1570	5482	NotifyID	Notify ID String	-	ASCII
0x1571 – 0x16AF	...	RESERVED			
SMTP Notification Settings					
0x16B0 – 0x16BF	5809 – 5824	SMTPServerName	SMTP Server Name, 16 Bytes	-	ASCII
0x16C0 – 0x16CF	5825 – 5840	SMTPUserName	SMTP Server Username, 16 bytes	-	ASCII
0x16D0– 0x16EF	5841 – 5872	SMTPEmailAddress	Email Address for SMTP alerts 64 bytes	-	ASCII
0x16F0 – 0x16FF	5873 – 5889	SMTPPassword	Email account password, 32 bytes (WRITE-ONLY)	-	ASCII
Charge settings					
0xE000	57345	EV_absorp	Absorption voltage @ 25°C	V	$n \cdot V_{PU} \cdot 2^{-15}$
0xE001	57346	EV_float	Float voltage @ 25°C Set to zero to disable float	V	$n \cdot V_{PU} \cdot 2^{-15}$
0xE002	57347	Et_absorp	absorption time	s	$0 - (2^{16} - 1)$
0xE003	57348	Et_absorp_ext	absorption extension time	s	$0 - (2^{16} - 1)$
0xE004	57349	EV_absorp_ext	absorp. Extension threshold voltage	V	$n \cdot V_{PU} \cdot 2^{-15}$
0xE005	57350	EV_float_cancel	Voltage that cancels float	V	$n \cdot V_{PU} \cdot 2^{-15}$
0xE006	57351	Et_float_exit_cum	Exit float timer	s	$0 - (2^{16} - 1)$
0xE007	57352	EV_eq	Equalize V @ 25°C Set 0 to disable	V	$n \cdot V_{PU} \cdot 2^{-15}$
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	Et_batt_service	battery service timer	days	
0xE00C	57357		not used	-	
0xE00D	57558	EV_tempcomp	temp. compensation coefficient Note:2 ⁻¹⁶ scaling, negative assumed	V	n·V_PU·2 ⁻¹⁶
0xE00E	57359	EV_hvd	Battery High Voltage Disconnect	V	n·V_PU·2 ⁻¹⁵
0xE00F	57360	EV_hvr	Battery High Voltage Reconnect	V	n·V_PU·2 ⁻¹⁵
0xE010	57361	Evb_ref_lim	battery charge reference limit	V	n·V_PU·2 ⁻¹⁵
0xE011	57362	ETb_max	max. temp comp limit	C	
0xE012	57363	ETb_min	min. temp comp limit	C	
0xE013	57364		not used		
0xE014	57365		not used		
0xE015	57366	EV_soc_g_gy	LED threshold: green to green/yellow	V	n·V_PU·2 ⁻¹⁵
0xE016	57367	EV_soc_gy_y	LED threshold: green/yellow to yellow	V	n·V_PU·2 ⁻¹⁵
0xE017	57368	EV_soc_y_yr	LED threshold: yel to yel/red	V	n·V_PU·2 ⁻¹⁵
0xE018	57369	EV_soc_yr_r	LED threshold: yellow/red to red	V	n·V_PU·2 ⁻¹⁵
0xE019	57370	Emodbus_id	MODBUS slave address	-	1-247
0xE01A	57371	Emeterbus_id	MeterBus address	-	1-15
Read only section					
0xE080	57473	Ehourmeter_LO	hourmeter	h	0 to (2 ²⁴ -1)
0xE081	57474	Ehourmeter_HI			
0xE082	57475	EAhc_r_LO	Ah charge resetable	Ah	n·0.1
0xE083	57476	EAhc_r_HI		-	
0xE084	57477	EAhc_t_LO	Ah charge total	Ah	n·0.1
0xE085	57478	EAhc_t_HI		-	
0xE086	57479	EkWhc_r	kWh charge resetable	kWh	
0xE087	57480	EkWhc_t	kWh charge total	kWh	
0xE088	57481	EVb_min	Vb minimum	V	n·V_PU·2 ⁻¹⁵
0xE089	57482	EVb_max	Vb maximum	V	n·V_PU·2 ⁻¹⁵
0xE08A	57483	EVa_max	Va maximum	V	n·V_PU·2 ⁻¹⁵
0xE08B	57484	Etmr_eqcalendar	days since last equalize	days	
0xE08C	57485	Etmr_batt_service	battery service timer	days	
0xE08D	57486	Elog_ptr	EE address of end of last log record	-	
0xE08E	57487	Elog_opt_var_list	bitfield of optional variables to log	-	
RESERVED					
0xE0C0-0xE0C3	57537 – 57540	Eserial	Serial Number	-	
0xE0CC	57548	Emodel	Model: 0 = 45A, 1=60A version	-	0 or 1
0xE0CD	57549	Ehw_version	Hardware version	-	none
0xE0CE	57550	Eva_max_lifetime	Max. array voltage over product life	V	n·V_PU·2 ⁻¹⁵
0xE0CF	57551	Evb_term_max_lifetime	Max. batt voltage over product life	V	n·V_PU·2 ⁻¹⁵
0xE0D0	57552	Eths_max_lifetime	Max. heatsink temp over product life	C	-127 to +127
0xE0D1	57553	Eths_min_lifetime	Min. heatsink temp. over product life	C	-127 to +127

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

PDU Addr	Logical Addr	Variable description
0x0000	1	Equalize triggered
0x0001	2	reserved
0x0002	3	Charge disconnect (1 will force charger into a disconnect state)
...	4-16	reserved
0x0010	17	Clear Ah <input type="checkbox"/> esettable (set only, will always read 0)
0x0011	18	Clear Ah total (set only, will always read 0)
0x0012	19	Clear kWh <input type="checkbox"/> esettable (set only, will always read 0)
0x0013	20	Reset battery service calendar
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)
...	26-240	reserved
0x00F0	241	test a single phase (test mode only)
...	242-255	reserved
0x00FF	256	Reset control (respond and then reset?)

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	“TS-MPPT-45” or “TS-MPPT-60”
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.

V_PU hi, V_PU lo

[1,2][0x0000, 0x0001] (V). *voltage scaling.*

The scaling value for all voltages. The scaling value is defined as:

$$V_{\text{scaling}} = \text{whole.fraction} = [V_PU \text{ hi}].[V_PU \text{ lo}]$$

Example:

$$V_PU \text{ hi} = 0x004E = 78$$

$$V_PU \text{ lo} = 0x03A6 = 934$$

V_PU lo must be shifted by 16 (divided by 2¹⁶) and then added to V_PU hi

$$V_{\text{scaling}} = 78 + 934/(2^{16}) = 78.0285$$

I_PU hi, I_PU lo

[3,4][0x0002, 0x0003] (V). *current scaling.*

The scaling value for all currents. The scaling value is defined as:

$$I_{\text{scaling}} = \text{whole.fraction} = [I_PU \text{ hi}].[I_PU \text{ lo}]$$

See the V_PU scaling example above

ver_sw

[5][0x0004] (). *Software version.*

Firmware version for the controller. This is not the version number for the network software, which can be found in the web page views.

Filtered ADC

Vb

[25][0x0018] (V). *battery voltage, filtered.*

Battery voltage used for regulation by the TS-MPPT. This voltage will be the same as the Battery Sense voltage if the sense connections are connected and valid. Otherwise, this value is the same as Vb_term voltage.

Vb_term

[26][0x0019] (V). *battery terminal voltage, filtered.*

Voltage measured directly at the battery power connections on the TriStar MPPT.

Vb_sense

[27][0x001A] (V). *battery sense voltage, filtered.*

Voltage measured by the Battery Sense connections on the TriStar MPPT.

Va

[28][0x001B] (V). *solar input voltage, filtered.*

Va is the terminal voltage of the solar input connection.

Ib

[29][0x001C] (A). *battery charge current, filtered.*

Charging current to the battery as measured by on-board shunts.

Ia

[30][0x001D] (A). *solar input current, filtered.*

Input current from the solar array.

NOTE: Input current is not measured by precision shunts and may differ from the actual input current by +/- 20%.

Vp12

[31][0x001E] (V). *12 volt supply.*

12 Volt power supply voltage.

Vp3

[32][0x001F] (V). *3 volt supply.*

3 Volt power supply voltage.

Vmeter

[33][0x0020] (V). *MeterBus supply voltage.*

MeterBus power supply voltage.

Vp1.8

[34][0x0021] (V). *1.8 volt supply.*
1.8 Volt power supply voltage.

V_ref

[35][0x0022] (V). *reference voltage.*
External voltage reference

Temperatures

T_hs

[36][0x0023] (C). *Heatsink Temperature.*
Sunsaver MPPT Heatsink temperature. Reported in degrees C.

T_rts

[37][0x0024] (C). *RTS Temperature.*
Temperature as measured by the optional Remote Temperature Sensor(RTS). Reported in degrees C.

T_batt

[38][0x0025] (C). *Battery Temperature.*
Battery temperature as measured by the ambient temperature sensor or the optional RTS (if connected).
Reported in degrees C.

Status

Vb_slow

[39][0x0026] (V). *battery voltage, slow filtered ($\tau \approx 1\text{min}$).*
Heavily filtered battery voltage reading. Ideal for use in threshold alarms.

Ib_slow

[40][0x0027] (A). *battery charge current, slow filtered ($\tau \approx 1\text{min}$).*
Heavily filtered charging current value.

Vb_min

[41][0x0028] (V). *minimum battery voltage.*
Long term minimum battery voltage. Resets when Ah(resettable) is reset.

Vb_max

[42][0x0029] (V). *maximum battery voltage*.

Long term maximum battery voltage. Resets when Ah(resettable) is reset.

hourmeter_HI / hourmeter_LO

[43, 44][0x002A, 0x002B] (hrs).*hour meter counter*.

Reports total hours of operation.

Faults

[45][0x002C] (bit-field). *TS-MPPT self-diagnostic faults*.

Reports faults identified by self diagnostics. Each bit corresponds to a specific fault.

Faults Table	
Bit	Fault
0	overcurrent
1	FETs shorted
2	software bug
3	battery HVD
4	array HVD
5	settings switch changed
6	custom settings edit
7	RTS shorted
8	RTS disconnected
9	EEPROM retry limit
10	Fault 11
11	Fault 12
12	Fault 13
13	Fault 14
14	Fault 15
15	Fault 16

Example:

Bit 0 is the LSB

Faults = 0x0013 indicates the following faults have been detected:

[bit 0] overcurrent

[bit 1] MOSFETs shorted

[bit 4] array HVD

alarm_HI / alarm_LO

[47, 48][0x002E, 0x002F] (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	Heatsink temp sensor open
4	Heatsink temp sensor shorted
5	High temperature current limit
6	Current limit
7	Current offset
8	Battery sense out of range
9	Battery sense disconnected
10	Uncalibrated
11	RTS miswire
12	High voltage disconnect
13	Undefined
14	system miswire
15	MOSFET open
16	P12 voltage off
17	High input voltage current limit
18	ADC input max
19	Controller was reset
20	Alarm 21
21	Alarm 22
22	Alarm 23
23	Alarm 24

dip_switch

[49][0x0030] (bit-field). *settings switch positions.*

Each bit in the bit-field corresponds to an individual DIP switch setting. Useful for remote applications where access to the TriStar MPPT to verify DIP positions is not feasible. Bit 0 (LSB) corresponds to settings switch 1.

LED_state

[50][0x0031] ().

Reports the LED state.

Value	LED State
0	LED_START
1	LED_START2
2	LED_BRANCH
3	FAST GREEN BLINK
4	SLOW GREEN BLINK
5	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

Charger

Charge_state

[51][0x0032] ().

Reports the charge state.

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

V_target

[52][0x0033] (V). *Target Voltage.*

Voltage to which the battery will be charged at any given time. This value changes with each charge stage and is temperature compensated.

Ahc_r_HI / Ahc_r_LO

[53,54][0x0034, 0x0035] (ah). *Charge amp-hours (reset-able counter).*

Reports total solar amp-hours since last ah reset.

Ahc_t_HI / Ahc_t_LO

[55,56][0x0036, 0x0037] (ah). *Charge amp-hours (Total cumulative counter).*
Reports total solar amp-hours since last ah reset.

kWhc_r HI / kWhc_r LO

[57,58][0x0038, 0x0039] (kWh). *Charge kilowatt-hours (reset-able counter).*
Reports total solar kilowatt-hours since last ah/kWh reset.

MPPT

Power_out

[59][0x003A] (W). *Charge output power.*
Output power to the battery.

Power_in

[60][0x003B] (W). *Array input power.*
Input power from the solar array. Input current is not measured by precision shunts, therefore the reported input power may have significant error.

Sweep_Pmax

[61][0x003C] (W). *Maximum array power.*
Maximum power output of the solar array found during last sweep.

Sweep_Vmp

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

Sweep_Voc

[63][0x003E] (V). *Solar array Voc.*
Open circuit voltage of the solar array found during last sweep.

Logger

Vb_min_daily

[65][0x0040] (V). *Today's minimum battery voltage.*
Minimum battery voltage measured today. This value is stored in the daily record at the end of each charging day. A new daily record is created X hours after NIGHT state.

Vb_max_daily

[66][0x0041] (V). *Today's maximum battery voltage.*

Maximum battery voltage measured today. This value is stored in the daily record at the end of each charging day. A new daily record is created X hours after NIGHT state.

Va_max_daily

[67][0x0042] (V). *Today's maximum array voltage.*

Maximum battery voltage measured today. This value is stored in the daily record at the end of each charging day. A new daily record is created X hours after NIGHT state.

Ahc_daily

[68][0x0043] (Ah). *Today's total charge amp-hours.*

Total charging amp-hours accumulated today. This value is stored in the daily record at the end of each charging day. A new daily record is created X hours after NIGHT state.

whc_daily

[69][0x0044] (wh). *Today's total charge watt--hours.*

Total watt-hours accumulated today. This value is stored in the daily record at the end of each charging day. A new daily record is created X hours after NIGHT state. Reports increments of 10 Whrs.

flags_daily

[70][0x0045] (bit-field). *Today's event flags (sticky).*

Reports daily flags, as defined below, that occurred today.

Bit	Flag
0 (LSB)	Reset detected
1	Equalize triggered
2	Entered float
3	an alarm occurred
4	a fault occurred

Pout_max_daily

[71][0x0046] (bit-field). *Maximum power out today.*

Reports maximum power delivered to the battery today.

Tb_min_daily

[72][0x0047] (bit-field). *Today's minimum battery temperature.*

Reports the lowest battery temperature that occurred today.

Tb_max_daily

[73][0x0048] (bit-field). *Today's maximum battery temperature.*
Reports the highest battery temperature that occurred today.

fault_daily

[74][0x0049] (bit-field). *Today's self-diagnostic faults (sticky).*
Reports 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 **fault** bitfield.

alarm_HI_Daily / alarm_LO_Daily

[76,77][0x004B, 0x004C] (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

[78][0x004D] (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

[79][0x004E] (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

[80][0x004F] (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.

Vb_ref_slave

[90][0x0059] (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 10 seconds or less, else the controller will fault. Writing to the register after a timeout will exit fault state and resume operation.

EEPROM not yet documented

Examples

Read Holding Register, Scaling a voltage value

Read and scale the following value:

Variable (RAM): Battery Voltage
 Register Address: 0x0018

The voltage scaling term is stored in variable V_PU at addresses 0x0000 and 0x0001.

Suppose the following values are read from RAM:

Address	Value(hex)	Variable Name
0x0000	0x007B	V_PU HI byte
0x0001	0xE041	V_PU LO byte
0x0018	0x0DB0	Battery Voltage value

1. Compute voltage scaler

Whole term = 0x007B → 123

Fractional term = 0xE041 / 2¹⁶ → 0.876

Voltage scaler = 123 + 0.876 = 123.876

Scaling for this variable is: $n * V_PU * 2^{-16}$ (as listed in the table of RAM variables)

2. Convert hexadecimal Vbattery register value to decimal

0x0DB0 → 3504

3. Scale Vbattery value

Vbattery = (3504 * 123.876) / 32768 = 13.25 Volts

Read Holding Register, 2 Word values

Variable (RAM): hours (hourmeter)

LO Register Address: 0x002A

HI Register Address: 0x002B

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

- Visit <http://www.modbus-ida.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: added EEPROM variable EV_soc_y_yr (0xE017) to variable list, shifted remaining variables

Added EEPROM variable serial number (0xE0C0)

Added EEPROM variable Ehdw_version (0xE0CD)

Specified some missing scaling values

V03: Reordered address space for RAM

Added RAM variable sw_ver (0x0005)

Added flags, PoutMax, TbMin, TbMax to daily logged values list

V04: Changed scaling values for RAM power supply voltages

Added Vb_ref_slave variable for modbus control of regulation

Changed scaling of daily Whr charge from 0.1 to 1 (no scaling)

Change to NetFlags (0x1517), 0x4000 turns on DHCP.

Modified the default network settings on front page. DHCP enabled by default.