

MODBUS Protocol

Application Note

Tx1 andTx3 Series

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1 Purpose and Scope

This Application Note describes MODBUS protocol of Tx1 and Tx3 Inverter Series.

- **Supported MOD types**
 - Modbus TCP/IP
 - SunSpec Specification - Common Block (Device ID 1)
 - SunSpec Specification - Inverter (Split Phase) Model (Device ID 102)
 - SunSpec Specification - Inverter (3 Phase) Model (Device ID 103)
- **Supported Inverter Model**
 - blueplanet TL3 series
 - Powador TL3 series
 - blueplanet TL1
- **Supported SW Version**
 - blueplanet TL3 series V2.02 or higher
 - Powador TL3 series V2.10 or higher
 - blueplanet TL1 series V3.00 or higher

2 Configurations

2.1 Physical Connection

Following user interface should be connected for MODBUS protocol of Tx1 and Tx3 Series.

- Ethernet

For more detailed information, please refer to the inverter's User Manual [2] Chapter 7.3.4.

2.2 HMI Setting

It is necessary to activate the MODBUS/SunSpec protocol by the menu. For US series inverters the MODBUS/SunSpec protocol is activated by default. The MODBUS/TCP Port is set to 502 by default.

For more detailed information, please refer to the inverter's User Manual [2] Chapter 8.3.2.

3 Modbus Register Reading & Writings

3.1 Function Code

You can use two following MODBUS function codes.

- 03 (0x03) Read Holding Registers

3.2 An Example of Request and Response

This is an example of request and response for Reading 8 registers from address 40001.

Request							
	MBAP				PDU		
Data (Hex)	00 00	00 00	00 06	01	03	9C 40	00 08
Field Name	Trans-action ID	Protocol ID	Length	Unit Identifier	Function Code	*Starting Address	# of Registers

* The address of response is always 1 less than the address of register map in accordance with the MODBUS specification.

Response							
	MBAP				PDU		
Data (Hex)	00 00	00 00	00 13	01	03	10	53 75 6e 53 00 01 00 42 4b 41 43 4f 20 4e 65 77
Field Name	Trans-action ID	Protocol ID	Length	Unit Identifier	Function Code	Byte Count	Register Values

The field "Unit Identifier (UID)" in the request is not supported will be ignored by the inverter. In the response the UID from request will returned.

3.3 Data Types

This MODBUS Protocol Data Type follows the one of SunSpec Specifications [8],[9].

- uint32, uint16, int16
- string, bitfield32, enum16

For more detailed information, please refer to SunSpec Specifications [8] in Chapter "Standard Data Formats".

4 Register Map

SF in below table is an abbreviation of “Scale Factor”. You can calculate a real value of specific address using SF value, received value via MODBUS and following equation.

$$\{\text{Real Value}\} = \{\text{Received value via MODBUS}\} * 10^{\{\text{SF}\}}$$

Example:

Address 40100 and 40101 mean DC voltage and the DCV-SF value is -1. If a received value via MODBUS is 5042, DC voltage is as follow.

$$\{\text{DC Voltage}\} = (5042) * 10^{(-1)} = 504.2 \text{ Volt}$$

The way to use Scale factor is the same of SunSpec specification. For more detailed information, please refer to SunSpec Specifications in Chap 5.

Registers for Common Block

Address Start / End		Size	R/W	Name	Type	Units	SF	Description	Value Range
40001	40002	2	R	SunSpec ID	uint32	-	-	Uniquely identifies this as a SunSpec Modbus Map	0x53756e53
40003	40003	1	R	SunSpec DID	uint16	-	-	Uniquely identifies this as a SunSpec Common Model	001 (dec)
40004	40004	1	R	SunSpec Length	uint16	-	-	Well-known # of 16 bit registers to follow : 64	64 (dec)
40005	40020	16	R	Manufacturer	string	-	-		„KACO new energy“
40021	40036	16	R	Model	string	-	-	KACO inverter name	e.g. “Powador 39.0 TL3”
40037	40044	8	R	Options	string	-	-	Data logger ID-String	e.g. “390TL”
40045	40052	8	R	Version	string	-	-	The packet version of the currently installed software	e.g. “V2.10”
40053	40068	16	R	Serial Number	string	-	-	Serial number set during production process	e.g. “39.0TL011 23456”
40069	40069	1	-	Device Address	uint16			Not available.	
40070	40070	1	R	-	pad			Force even alignment	0

Registers for 3 Phase Inverter Model used for Tx3 devices (Integer + SF)

Address Start / End		Size	R/W	Name	Type	Units	SF	Description	Value Range
40071	40071	1	R	SunSpec ID	uint16	-	-	Uniquely identifies this as a SunSpec Inverter (Three Phase) Model	103 (dec)
40072	40072	1	R	SunSpec Length	uint16	-	-	Well-known # of 16 bit registers to follow : 50	50 (dec)
40073	40073	1	R	Amps	uint16	A	A_SF	Sum of active phases	-
40074	40074	1	R	Amps PhaseA	uint16	A	A_SF	Phase A Current	-
40075	40075	1	R	Amps PhaseB	uint16	A	A_SF	Phase B Current	-
40076	40076	1	R	Amps PhaseC	uint16	A	A_SF	Phase C Current	-
40077	40077	1	R	A_SF	sunssf	-	-	Amps scale factor	-2
40078	40078	1	R	Phase Voltage AB	uint16	V	V_SF	Optional / not supported	
40079	40079	1	R	Phase Voltage BC	uint16	V	V_SF	Optional / not supported	
40080	40080	1	R	Phase Voltage CA	uint16	V	V_SF	Optional / not supported	
40081	40081	1	R	Phase Voltage AN	uint16	V	V_SF	Voltage phase A to N	-
40082	40082	1	R	Phase Voltage BN	uint16	V	V_SF	Voltage phase B to N	-
40083	40083	1	R	Phase Voltage CN	uint16	V	V_SF	Voltage phase C to N	-
40084	40084	1	R	V_SF	sunssf	-	-	Voltage scale factor	-1
40085	40085	1	R	Watts	int16	W	W_SF	Total AC Power	-
40086	40086	1	R	W_SF	sunssf	-	-	AC Power Scale Factor	1
40087	40087	1	R	Hz	uint16	Hz	Hz_SF	Line Frequency	-
40088	40088	1	R	Hz_SF	sunssf	-	-	Line Frequency Scale Factor	-1
40089	40089	1	R	VA	int16	VA	VA_SF	AC Apparent Power	-
40090	40090	1	R	VA_SF	sunssf	-	-	AC Apparent Power Scale Factor	1

Address Start / End		Size	R/W	Name	Type	Units	SF	Description	Value Range
40091	40091	1	R	VAr	int16	var	VAr_SF	AC Reactive Power	-
40092	40092	1	R	VAr_SF	sunssf	-	-	AC Reactive Power Scale Factor	1
40093	40093	1	R	PF	int16	Pct	PF_SF	AC Power Factor	-
40094	40094	1	R	PF_SF	sunssf	-	-	AC Power Factor Scale Factor	-1
40095	40096	2	R	WattHours	acc32	Wh	WH_SF	AC Energy	-
40097	40097	1	R	WH_SF	sunssf	-	-	AC Energy Scale Factor	0
40098	40098	1	R	DC Amps	uint16	A	DCA_SF	DC Current	-
40099	40099	1	R	DCA_SF	sunssf	-	-	DC Current Scale Factor	-2
40100	40100	1	R	DC Voltage	uint16	V	DCV_SF	DC Voltage	-
40101	40101	1	R	DCV_SF	sunssf	-	-	DC Voltage Scale Factor	-1
40102	40102	1	R	DC Watts	int16	W	DCW_SF	DC Power	-
40103	40103	1	R	DCW_SF	sunssf	-	-	DC Power Scale Factor	1
40104	40104	1	R	Cabinet Temperature	int16	C	Tmp_SF	Cabinet Temperature	-
40105	40105	1	R	Heat Sink Temperature	int16	C	Tmp_SF	Optional / not supported	-
40106	40106	1	R	Transformer Temperature	int16	C	Tmp_SF	Optional / not supported	-
40107	40107	1	R	Other Temperature	int16	C	Tmp_SF	Optional / not supported	-
40108	40108	1	R	Tmp_SF	sunssf	-	-	Temperature Scale Factor	-1
40109	40109	1	R	Operating State	enum16	-	-	Enumerated value. Operating state.	Additional Description .
40110	40110	1	R	Vendor Operating State	enum16	-	-	KACO Powador-proLOG Status Description in [3]	0 to 255
40111	40112	2	R	Event1	bitfield32	-	-	Bitmask value. Event fields	Additional Description .

Address Start / End		Size	R/W	Name	Type	Units	SF	Description	Value Range
40113	40114	2	R	Event Bitfield 2	bitfield32	-	-	Reserved for future use (Not used)	-
40115	40116	2	R	Vendor Event Bitfield 1	bitfield32	-	-	Optional / not supported	-
40117	40118	2	R	Vendor Event Bitfield 2	bitfield32	-	-	Optional / not supported	-
40119	40120	2	R	Vendor Event Bitfield 3	bitfield32	-	-	Optional / not supported	-
40121	40122	2	R	Vendor Event Bitfield 4	bitfield32	-	-	Optional / not supported	-

Registers for Split Phase Inverter Model used for Tx1 devices (Integer + SF)

Address Start / End		Size	R/W	Name	Type	Units	SF	Description	Value Range
40071	40071	1	R	SunSpec ID	uint16	-	-	Uniquely identifies this as a SunSpec Inverter (Three Phase) Model	102 (dec)
40072	40072	1	R	SunSpec Length	uint16	-	-	Well-known # of 16 bit registers to follow : 50	50 (dec)
40073	40073	1	R	Amps	uint16	A	A_SF	Sum of active phases	-
40074	40074	1	R	Amps PhaseA	uint16	A	A_SF	Phase A Current	-
40075	40075	1	R	Amps PhaseB	uint16	A	A_SF	Phase B Current (For INT devices and for US devices with neutral conductor)	-
40076	40076	1	R	Amps PhaseC	uint16	A	A_SF	Phase C Current (For INT devices)	-
40077	40077	1	R	A_SF	sunssf	-	-	Amps scale factor	-2
40078	40078	1	R	Phase Voltage AB	uint16	V	V_SF	Voltage phase A to B (For US devices)	
40079	40079	1	R	Phase Voltage BC	uint16	V	V_SF	Optional / not supported	
40080	40080	1	R	Phase Voltage CA	uint16	V	V_SF	Optional / not supported	
40081	40081	1	R	Phase Voltage AN	uint16	V	V_SF	Voltage phase A to N (For INT devices and for US devices with neutral conductor)	-
40082	40082	1	R	Phase Voltage BN	uint16	V	V_SF	Voltage phase B to N (For INT devices and for US	-

Address Start / End		Size	R/W	Name	Type	Units	SF	Description	Value Range
								devices with neutral conductor)	
40083	40083	1	R	Phase Voltage CN	uint16	V	V_SF	Voltage phase C to N (For INT devices)	-
40084	40084	1	R	V_SF	sunssf	-	-	Voltage scale factor	-1
40085	40085	1	R	Watts	int16	W	W_SF	Total AC Power	-
40086	40086	1	R	W_SF	sunssf	-	-	AC Power Scale Factor	1
40087	40087	1	R	Hz	uint16	Hz	Hz_SF	Line Frequency	-
40088	40088	1	R	Hz_SF	sunssf	-	-	Line Frequency Scale Factor	-1
40089	40089	1	R	VA	int16	VA	VA_SF	AC Apparent Power	-
40090	40090	1	R	VA_SF	sunssf	-	-	AC Apparent Power Scale Factor	1
40091	40091	1	R	VAr	int16	var	VAr_SF	AC Reactive Power	-
40092	40092	1	R	VAr_SF	sunssf	-	-	AC Reactive Power Scale Factor	1
40093	40093	1	R	PF	int16	Pct	PF_SF	AC Power Factor	-
40094	40094	1	R	PF_SF	sunssf	-	-	AC Power Factor Scale Factor	-1
40095	40096	2	R	WattHours	acc32	Wh	WH_SF	AC Energy	-
40097	40097	1	R	WH_SF	sunssf	-	-	AC Energy Scale Factor	0
40098	40098	1	R	DC Amps	uint16	A	DCA_SF	DC Current	-
40099	40099	1	R	DCA_SF	sunssf	-	-	DC Current Scale Factor	-2
40100	40100	1	R	DC Voltage	uint16	V	DCV_SF	DC Voltage	-
40101	40101	1	R	DCV_SF	sunssf	-	-	DC Voltage Scale Factor	-1
40102	40102	1	R	DC Watts	int16	W	DCW_S F	DC Power	-
40103	40103	1	R	DCW_SF	sunssf	-	-	DC Power Scale Factor	1
40104	40104	1	R	Cabinet Temperature	int16	C	Tmp_SF	Cabinet Temperature	-

Address Start / End		Size	R/W	Name	Type	Units	SF	Description	Value Range
40105	40105	1	R	Heat Sink Temperature	int16	C	Tmp_SF	Optional / not supported	-
40106	40106	1	R	Transformer Temperature	int16	C	Tmp_SF	Optional / not supported	-
40107	40107	1	R	Other Temperature	int16	C	Tmp_SF	Optional / not supported	-
40108	40108	1	R	Tmp_SF	sunssf	-	-	Temperature Scale Factor	-1
40109	40109	1	R	Operating State	enum16	-	-	Enumerated value. Operating state.	Additional Description .
40110	40110	1	R	Vendor Operating State	enum16	-	-	KACO Powador-proLOG Status Description in [3]	0 to 255
40111	40112	2	R	Event1	bitfield32	-	-	Bitmask value. Event fields	Additional Description .
40113	40114	2	R	Event Bitfield 2	bitfield32	-	-	Reserved for future use (Not used)	-
40115	40116	2	R	Vendor Event Bitfield 1	bitfield32	-	-	Optional / not supported	-
40117	40118	2	R	Vendor Event Bitfield 2	bitfield32	-	-	Optional / not supported	-
40119	40120	2	R	Vendor Event Bitfield 3	bitfield32	-	-	Optional / not supported	-
40121	40122	2	R	Vendor Event Bitfield 4	bitfield32	-	-	Optional / not supported	-

4.1 Additional Descriptions of SunSpec Register

Additional Descriptions for Operating State (Address: 40109)

ID	Value (1..8)	Label	Description
OFF	1	Off	Device is not operating
SLEEPING	2	Sleeping	Device is sleeping / auto-shutdown
STARTING	3	Starting	Device is starting up
MPPT	4	MPPT	Device is auto tracking maximum power point
THROTTLED	5	Throttled	Device is operating at reduced power output
SHUTTING_DOWN	6	Shutting down	Device is shutting down
FAULT	7	Fault	One or more faults exist
STANDBY	8	Standby	Device is in standby mode

Additional Descriptions for Event1 (Address: 40111)

ID	Bit (0..15)	Label
GROUND_FAULT	0	Ground fault
DC_OVER_VOLT	1	DC over voltage
AC_DISCONNECT	2	AC disconnect open (not used)
DC_DISCONNECT	3	DC disconnect open
GRID_DISCONNECT	4	Grid shutdown (not used)
CABINET_OPEN	5	Cabinet open
MANUAL_SHUTDOWN	6	Manual shutdown (not used)
OVER_TEMP	7	Over temperature
OVER_FREQUENCY	8	Frequency above limit
UNDER_FREQUENCY	9	Frequency under limit
AC_OVER_VOLT	10	AC Voltage above limit
AC_UNDER_VOLT	11	AC Voltage under limit
BLOWN_STRING_FUSE	12	Blown String fuse on input (not used)
UNDER_TEMP	13	Under temperature (not used)
MEMORY_LOSS	14	Generic Memory or Communication error (internal)
HW_TEST_FAILURE	15	Hardware test failure

Example:

If the value of “Event 1” is 0x0080 (address 40111), it means as follow.

0080(hex) = 0000 0000 1000 0000(binary)

Because the bit 7 is 1, it means “Over temperature”

5 References

User Manual

- [1] 3005151-01-130411_HB_BP_32.0-50.0_Installation_EN_Druck.pdf
- [2] 3005149-01-130108_HB_BP 32.0-50.0_TL3_Operator_EN.pdf

Specification

- [3] Status and Event Mapping on Tx3 for SunSpec Inverter Model.xlsx

Modbus Organization

- [4] <http://www.modbus.org>
- [5] Modbus_Application_Protocol_V1_1b3.pdf
- [6] Modbus_Messaging_Implementation_Guide_V1_0b.pdf

SunSpec Specification

- [7] <http://www.sunspec.org>
- [8] SunSpec-Alliance-Specification-Common-Models-v1.5.pdf
- [9] SunSpec Alliance Specification - Inverter Models v1.1.pdf



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