Modbus-RTU protocol of

Solax Power three phase inverter

X3-MEGA G2/X3-FORTH

Version 1.1
2023.5.16

History list:

Data	Name	Protocol Version	Description
2022-01-21	Zhangqifan	V1.0	First version
2023-05-16	Yangye	V1.1	Add fault mapping

List

1 Introduction of Modbus

1.1 Scope of this document

The MODBUS Serial Line protocol is a Master-Slaves protocol. Only one master (at the same time) is connected to the bus, and one or several slaves nodes (247 maximum number) are also connected to the same serial bus. A MODBUS communication is always initiated by the master. The slave nodes will never transmit data without receiving a request from the master node. The slave nodes will never communicate with each other.
The master node initiates only one MODBUS transaction at the same time. The master node issues a MODBUS request to the slave nodes in two modes:
In unicast mode, the master addresses an individual slave. After receiving and processing the request, the slave returns a message (a 'reply') to the master. In that mode, a MODBUS transaction consists of 2 messages: a request from the master, and a reply from the slave. Each slave must have an unique address (from 1 to 247) so that it can be addressed independently from other nodes.
In broadcast mode, the master can send a request to all slaves. No response is returned to broadcast requests sent by the master. The broadcast requests are necessarily writing commands. **All devices must accept the broadcast for writing function.** The address 0 is reserved to identify a broadcast exchange.

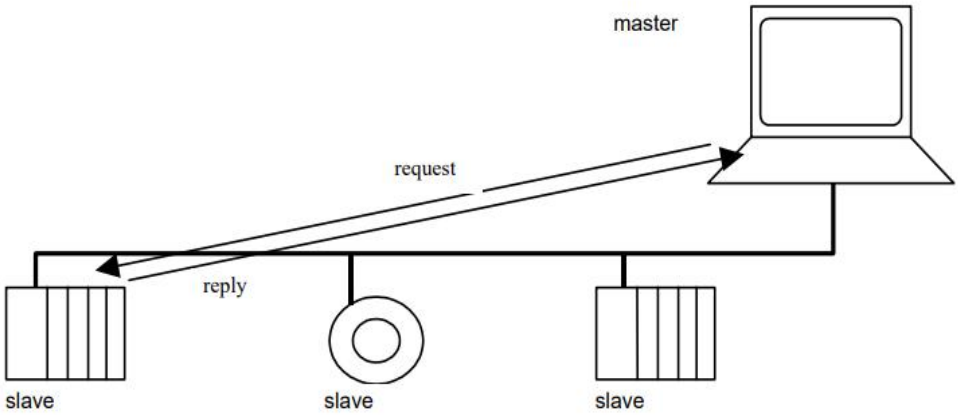


Figure 1 Unicast mode

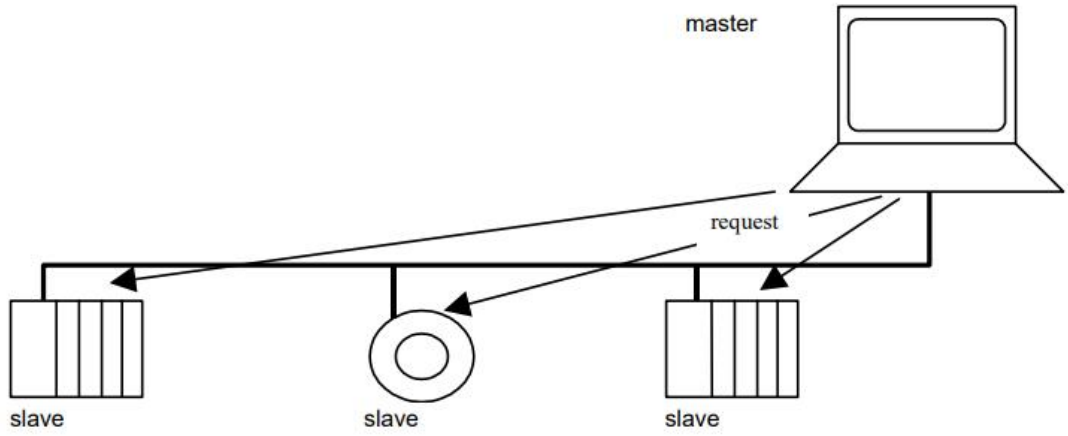


Figure 2 Broadcast mode

1.2 General description

1.2.1 Abbreviation description

ADU	Application Data Unit
HDLC	High level Data Link Control
HMI	Human Machine Interface
IETF	Internet Engineering Task Force
I/O	Input/Output
IP	Internet Protocol
MAC	Media Access Control
MB	MODBUS Protocol
MBAP	MODBUS Application Protocol
PDU	Protocol Data Unit
PLC	Programmable Logic Controller
TCP	Transmission Control Protocol

1.2.2 MODBUS Addressing rules

The MODBUS addressing space comprises 256 different addresses.

Broadcast address	Slave individual addresses	Reserved
0	From 1 to 247	From 248 to 255

The Address 0 is reserved as the broadcast address. All slave nodes must recognize the broadcast address. The MODBUS Master node has no specific address, only the slave nodes must have an address. This address must be unique on a MODBUS serial bus.

1.2.3 MODBUS frame description

The MODBUS application protocol [1] defines a simple Protocol Data Unit (PDU) independent of the underlying communication layers:

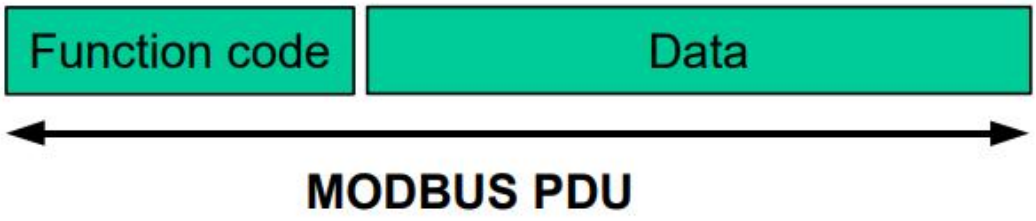


Figure 3 MODBUS Protocol Data Unit

The mapping of MODBUS protocol on a specific bus or network introduces some additional fields on the Protocol Data Unit. The client that initiates a MODBUS transaction builds the MODBUS PDU, and then adds fields in order to build the appropriate communication PDU.

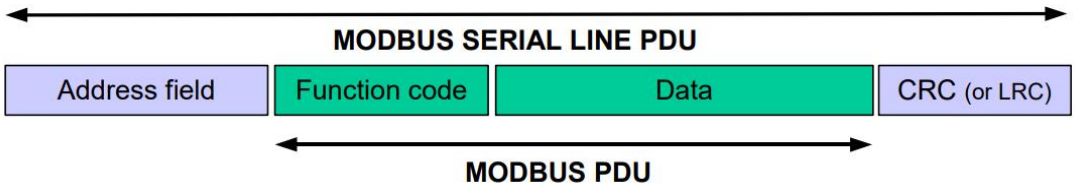


Figure 4 MODBUS frame over Serial Line

- On MODBUS Serial Line, the Address field only contains the slave address.

As described in the previous section the valid slave nodes addresses are in the decimal range from 0 to 247.The individual slave devices are assigned addresses in the range of 1 – 247. A master addresses a slave by placing the slave address in the address field of the message. When the slave returns its response, it places its own address in the response address field to let the master know which slave is responding.

- The function code indicates to the server what kind of action to perform.

The function code can be followed by a data field that contains request and response parameters.

- Error checking field is the result of a "Redundancy Checking" calculation that is performed on the message contents. Two kinds of calculation methods are used depending on the transmission mode that is being used (RTU or ASCII).

1.3 The two serial Transmission Modes

Two different serial transmission modes are defined: The RTU mode and the ASCII mode.

We choose the RTU mode as our communication mode.

It defines the bit contents of message fields transmitted serially on the line. It determines how information is packed into the message fields and decoded.

The transmission mode (and serial port parameters) must be the same for all devices on a MODBUS Serial Line.

Although the ASCII mode is required in some specific applications, interoperability between MODBUS devices can be reached only if each device has the same transmission mode: **All devices must implement the RTU Mode.** The ASCII transmission mode is an option.

Devices should be set up by the users to the desired transmission mode, RTU or ASCII. Default setup must be the RTU mode.

1.4 RTU Transmission Mode

When devices communicate on a MODBUS serial line using the RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII mode for the same baud rate. Each message must be transmitted in a continuous stream of characters.

The format (11 bits) for each byte in RTU mode is:

Coding System: 8–bit binary

Bits per Byte: 1 start bit
8 data bits, least significant bit sent first
1 bit for parity completion
1 stop bit

Even parity is required, other modes (odd parity, no parity) may also be used. In order to ensure a maximum compatibility with other products, it is recommended to support also No parity mode. The default parity mode must be even parity.

Remark: the use of no parity requires 2 stop bits.

How Characters are Transmitted Serially:

Each character or byte is sent in this order (left to right):

Least Significant Bit (LSB) . . . Most Significant Bit (MSB)

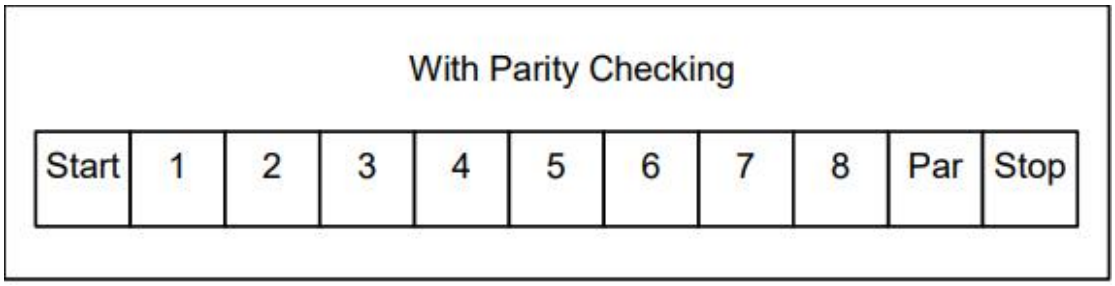


Figure 5 Bit Sequence in RTU mode

Devices may accept by configuration either Even, Odd, or No Parity checking. If No Parity is implemented, an additional stop bit is transmitted to fill out the character frame to a full 11-bit asynchronous character:

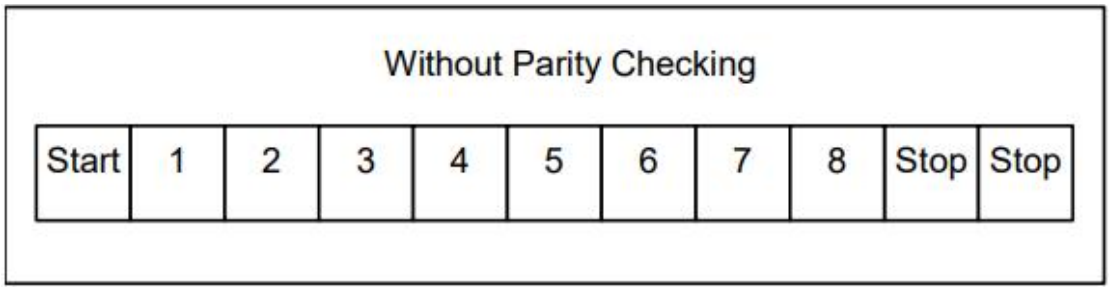


Figure 6 Bit Sequence in RTU mode (specific case of No Parity)

Frame Checking Field: Cyclical Redundancy Checking (CRC)

Frame description:

Slave Address	Function Code	Data	CRC
1 byte	1 byte	0 up to 252 byte(s)	2 bytes CRC Low, CRC Hi

Figure 7 RTU Message Frame

The maximum size of a MODBUS RTU frame is 256 bytes.

1.5 MODBUS Message RTU Framing

A MODBUS message is placed by the transmitting device into a frame that has a known beginning and ending point. This allows devices that receive a new frame to begin at the start of the message, and to know when the message is completed. Partial messages must be detected and errors must be set as a result.

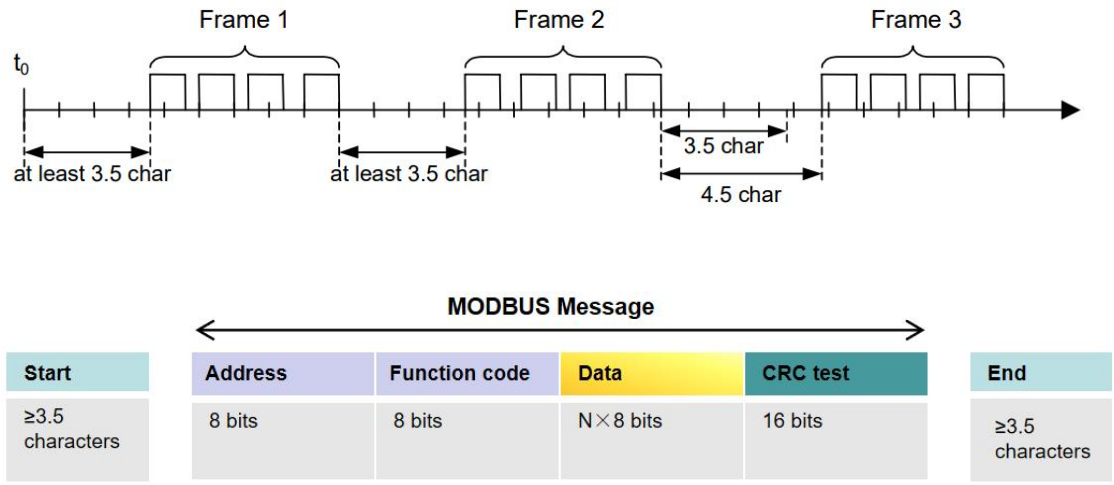


Figure 8 RTU Message Frame

The entire message frame must be transmitted as a continuous stream of characters.

If a silent interval of more than 1.5-character times occurs between two characters, the message frame is declared incomplete and should be discarded by the receiver.

1.5 Function codes descriptions

1.5.1 03 (0x03) Read Holding Registers

This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request PDU specifies the starting register address and the number of registers. In the PDU Registers are addressed starting at zero. Therefore, registers numbered 1-16 are addressed as 0-15.
The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.
The contents of register 108 are shown as the two-byte values of 02 2B hex, or decimal 555. The contents of registers 109–110 are 00 00 and 00 64 hex, or decimal 0 and 100, respectively

Request

Function code	1 Byte	**0x03**
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 125 (0x7D)

Response

Function code	1 Byte	**0x03**
Byte count	1 Byte	2 x **N***
Register value	**N*** x 2 Bytes	

***N** = Quantity of Registers

Error

Error code	1 Byte	**0x83**
Exception code	1 Byte	01 or 02 or 03 or 04

Here is an example of a request to read registers 108 – 110:

Request		**Response**	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	**03**	Function	**03**
Starting Address Hi	**00**	Byte Count	**06**
Starting Address Lo	**6B**	Register value Hi (108)	**02**
No. of Registers Hi	**00**	Register value Lo (108)	**2B**
No. of Registers Lo	**03**	Register value Hi (109)	**00**
		Register value Lo (109)	**00**
		Register value Hi (110)	**00**
		Register value Lo (110)	**64**

You can use 0x01 as Field Name to send an intact frame.

1.5.2 04 (0x04) Read Input Registers

This function code is used to read from 1 to 125 contiguous input registers in a remote device. The Request PDU specifies the starting register address and

the number of registers. In the PDU Registers are addressed starting at zero. Therefore, input registers numbered 1-16 are addressed as 0-15.
The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order
bits.

Request

Function code	1 Byte	**0x04**
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Input Registers	2 Bytes	0x0001 to 0x007D

Response

Function code	1 Byte	**0x04**
Byte count	1 Byte	2 x **N***
Input Registers	**N*** x 2 Bytes	

***N** = Quantity of Input Registers

Error

Error code	1 Byte	**0x84**
Exception code	1 Byte	01 or 02 or 03 or 04

Here is an example of a request to read input register 9:

Request		**Response**	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	**04**	Function	**04**
Starting Address Hi	**00**	Byte Count	**02**
Starting Address Lo	**08**	Input Reg. 9 Hi	**00**
Quantity of Input Reg. Hi	**00**	Input Reg. 9 Lo	**0A**
Quantity of Input Reg. Lo	**01**		

You can use 0x01 as Field Name to send an intact frame.

1.5.3 06 (0x06) Write Single Register

This function code is used to write a single holding register in a remote device. The Request PDU specifies the address of the register to be written. Registers are addressed starting at zero. Therefore, register numbered 1 is addressed as 0. The normal response is an echo of the request, returned after the register contents have been written.

Request

Function code	1 Byte	**0x06**
Register Address	2 Bytes	0x0000 to 0xFFFF
Register Value	2 Bytes	0x0000 to 0xFFFF

Response

Function code	1 Byte	**0x06**
Register Address	2 Bytes	0x0000 to 0xFFFF
Register Value	2 Bytes	0x0000 to 0xFFFF

Error

Error code	1 Byte	**0x86**
Exception code	1 Byte	01 or 02 or 03 or 04

Here is an example of a request to write register 2 to 00 03 hex:

Request		**Response**	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	**06**	Function	**06**
Register Address Hi	**00**	Register Address Hi	**00**
Register Address Lo	**01**	Register Address Lo	**01**
Register Value Hi	**00**	Register Value Hi	**00**
Register Value Lo	**03**	Register Value Lo	**03**

You can use 0x01 as Field Name to send an intact frame.

1.5.4 16 (0x10) Write Multiple registers

This function code is used to write a block of contiguous registers (1 to 123 registers) in a remote device. The requested written values are specified in the request data field. Data is packed as two bytes per register. The normal response returns the function code, starting address, and quantity of registers written.

Request

Function code	1 Byte	**0x10**
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	0x0001 to 0x007B
Byte Count	1 Byte	2 x **N***
Registers Value	**N*** x 2 Bytes	value

***N** = Quantity of Registers

Response

Function code	1 Byte	**0x10**
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 123 (0x7B)

Error

Error code	1 Byte	**0x90**
Exception code	1 Byte	01 or 02 or 03 or 04

Here is an example of a request to write two registers starting at 2 to 00 0A and 01 02 hex:

Request		**Response**	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	**10**	Function	**10**
Starting Address Hi	**00**	Starting Address Hi	**00**
Starting Address Lo	**01**	Starting Address Lo	**01**
Quantity of Registers Hi	**00**	Quantity of Registers Hi	**00**
Quantity of Registers Lo	**02**	Quantity of Registers Lo	**02**
Byte Count	**04**		
Registers Value Hi	**00**		
Registers Value Lo	**0A**		
Registers Value Hi	**01**		
Registers Value Lo	**02**		

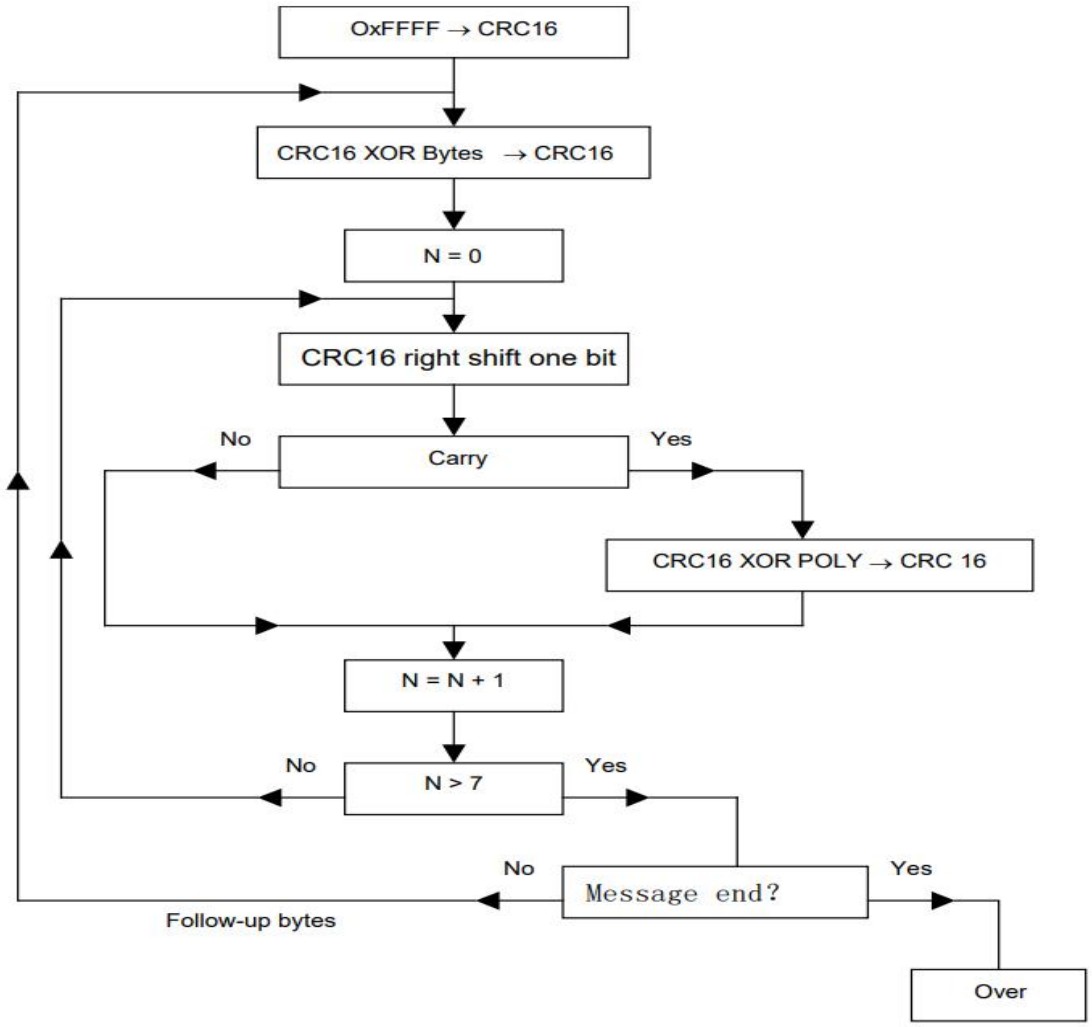
You can use 0x01 as Field Name to send an intact frame.

2 The specific agreement

2.1 Serial port Settings:

Parameters	Settings
Baud rate	9600bps
Data bits	8
Stop bits	1
Parity	None
Flow control	None

2.2 Cyclic Redundancy Check of Modbus



1. Preset a 16-bit register to hexadecimal 0xFFFF, Call this register a CRC register;

2. Combine the first 8-bit binary data (the first byte of the communication frame) xor with the lower of the 16-bit CRC register 8 bits, put the result in the CRC register;
3. Move the contents of the CRC register right one bit (towards the low place) and fill the highest bit with 0, and check the left bit after the right move;
4. If the position is 0, repeat step 3 (move right one more time).
If the shift-out bit is 1: the CRC register performs xor with polynomial 0xA001;
5. Repeat steps 3 and 4 until you move to the right eight times to process the entire 8-bit data.
6. Repeat Step 2 to Step 5 to process the next byte of the communication frame.
7. After all bytes of the communication information frame are calculated according to the above steps, the height and low of the 16-bit CRC register are obtained, Bytes are exchanged;
8. The final CRC register content is CRC code.

2.3 Input Register

2.3.1 Register Table

Start Hex	Size Dec	Register Meaning	Data Type	Units	Description
device description					
0	2	Protocol Identifier	string	NULL	
2	16	Reserved	string	NULL	Reserved
12	16	Model Type	string	NULL	
22	16	Software Version	string	NULL	
32	16	Serial Number	string	NULL	
42	10	Reserved	string	NULL	
4C	10	Reserved	string	NULL	
56	10	Protocol Version	string	NULL	Vx. x. x
Grid information					
100	1	line-voltage AB	uint16	0.1V	
101	1	line-voltage BC	uint16	0.1V	
102	1	line-voltage AC	uint16	0.1V	
103	1	Phase-A Voltage	uint16	0.1V	
104	1	Phase-B Voltage	uint16	0.1V	
105	1	Phase-C Voltage	uint16	0.1V	
106	1	Grid Frequency	uint16	0.01Hz	
Power generation information					
180	1	Phase-A Current	uint16	0.1A	
181	1	Phase-B Current	uint16	0.1A	
182	1	Phase-C Current	uint16	0.1A	

183	2	Active Power	int32	W	
185	2	Reactive Power	int32	Var	Reserved
187	2	Apparent Power	uint32	VA	Reserved
189	1	Today Energy	uint16	0.1kWh	
18A	2	Total Energy	uint32	0.1kWh	
18C	1	Today Reactive-energy	int16	0.1kVar Ah	Reserved
18D	2	Total Reactive-energy	int32	0.1kVar Ah	Reserved
18F	1	Power Factor	int16	0.001	
Inverter information					
200	1	Major Operation-mode	uint16		
201	1	Minor Operation-mode	uint16		Reserved
202	1	Internal Temperature	int16	0.1C	
203	1	Boost-module Temperature 1	int16	0.1C	
204	1	Boost-module Temperature 2	int16	0.1C	
205	1	Boost-module Temperature 3	int16	0.1C	
206	1	Boost-module Temperature 4	int16	0.1C	
207	1	Inverter-module Temperature 1	int16	0.1C	
208	1	Inverter-module Temperature 2	int16	0.1C	Reserved
209	1	Inverter-module Temperature 3	int16	0.1C	
20A	1	AC-connector Temperature 1	int16	0.1C	
20B	1	AC-connector Temperature 2	int16	0.1C	Reserved
20C	1	AC-connector Temperature 3	int16	0.1C	
20D	1	Reserved	int16		
20E	1	Reserved	int16		
20F	1	Reserved	int16		
210	1	Insulation Resistance	int16	0.1kOhm	
211	1	Reserved	uint16		Reserved
212	1	Reserved	uint16		Reserved
213	3	Fault Time	uint16		YY/MM/DD/HH/MM/SS
216	1	Fault Type	uint16		Reserved for warning

217	1	Fault Code	uint16		Details in the Section 2.5 Fault mappings
218	2	Warning Code	uint32		Details in the Section 2.5 Fault mappings
Module information					
280	1	MPPT Number	uint16		
281	1	Reserved	uint16		Reserved
282	1	Reserved	uint16		Reserved
283	1	Reserved	uint16	0.1V	Reserved
284	1	Reserved	uint16	0.1V	Reserved
285	1	Reserved	uint16		Reserved
286	3	Reserved	uint16		Reserved
289	1	Reserved	uint16		Reserved
28A	1	Reserved	uint16		Reserved
28B	1	MPPT Voltage 1	int16	0.1V	
28C	1	MPPT Current 1	int16	0.1A	
28D	2	Reserved	int32	1W	Reserved
28F	1	Reserved	int16	0.1C	Reserved
290	1	Reserved	uint16		Reserved
291	1	Reserved	uint16		Reserved
292	1	MPPT Voltage 2	int16	0.1V	
293	1	MPPT Current 2	int16	0.1A	
294	2	Reserved	int32	1W	Reserved
296	1	Reserved	int16	0.1C	Reserved
297	1	Reserved	uint16		Reserved
298	1	Reserved	uint16		Reserved
299	1	MPPT Voltage 3	int16	0.1V	
29A	1	MPPT Current 3	int16	0.1A	
29B	2	Reserved	int32	1W	Reserved
29D	1	Reserved	int16	0.1C	Reserved
29E	1	Reserved	uint16		Reserved
29F	1	Reserved	uint16		Reserved
2A0	1	MPPT Voltage 4	int16	0.1V	
2A1	1	MPPT Current 4	int16	0.1A	
2A2	2	Reserved	int32	1W	Reserved
2A4	1	Reserved	int16	0.1C	Reserved
2A5	1	Reserved	uint16		Reserved
2A6	1	Reserved	uint16		Reserved
2A7	1	MPPT Voltage 5	int16	0.1V	
2A8	1	MPPT Current 5	int16	0.1A	
2A9	2	Reserved	int32	1W	Reserved
2AB	1	Reserved	int16	0.1C	Reserved

2AC	1	Reserved	uint16		Reserved
2AD	1	Reserved	uint16		Reserved
2AE	1	MPPT Voltage 6	int16	0.1V	
2AF	1	MPPT Current 6	int16	0.1A	
2B0	2	Reserved	int32	1W	Reserved
2B2	1	Reserved	int16	0.1C	Reserved
2B3	1	Reserved	uint16		Reserved
2B4	1	Reserved	uint16		Reserved
2B5	1	MPPT Voltage 7	int16	0.1V	
2B6	1	MPPT Current 7	int16	0.1A	
2B7	2	Reserved	int32	1W	Reserved
2B9	1	Reserved	int16	0.1C	Reserved
2BA	1	Reserved	uint16		Reserved
2BB	1	Reserved	uint16		Reserved
2BC	1	MPPT Voltage 8	int16	0.1V	
2BD	1	MPPT Current 8	int16	0.1A	
2BE	2	Reserved	int32	1W	Reserved
2C0	1	Reserved	int16	0.1C	Reserved
2C1	1	Reserved	uint16		Reserved
2C2	1	Reserved	uint16		Reserved
2C3	1	MPPT Voltage 9	int16	0.1V	
2C4	1	MPPT Current 9	int16	0.1A	
2C5	2	Reserved	int32	1W	Reserved
2C7	1	Reserved	int16	0.1C	Reserved
2C8	1	Reserved	uint16		Reserved
2C9	1	Reserved	uint16		Reserved
2CA	1	MPPT Voltage 10	int16	0.1V	
2CB	1	MPPT Current 10	int16	0.1A	
2CC	2	Reserved	int32	1W	Reserved
2CE	1	Reserved	int16	0.1C	Reserved
2CF	1	Reserved	uint16		Reserved
2D0	1	Reserved	uint16		Reserved
2D1	1	MPPT Voltage 11	int16	0.1V	
2D2	1	MPPT Current 11	int16	0.1A	
2D3	2	Reserved	int32	1W	Reserved
2D5	1	Reserved	int16	0.1C	Reserved
2D6	1	Reserved	uint16		Reserved
2D7	1	Reserved	uint16		Reserved
2D8	1	MPPT Voltage 12	int16	0.1V	
2D9	1	MPPT Current 12	int16	0.1A	
2DA	2	Reserved	int32	1W	Reserved
2DC	1	Reserved	int16	0.1C	Reserved

2DD	1	Reserved	uint16		Reserved
2DE	1	PV Branch-current 1	uint16	0.1A	
2DF	1	PV Branch-current 2	uint16	0.1A	
2E0	1	PV Branch-current 3	uint16	0.1A	
2E1	1	PV Branch-current 4	uint16	0.1A	
2E2	1	PV Branch-current 5	uint16	0.1A	
2E3	1	PV Branch-current 6	uint16	0.1A	
2E4	1	PV Branch-current 7	uint16	0.1A	
2E5	1	PV Branch-current 8	uint16	0.1A	
2E6	1	PV Branch-current 9	uint16	0.1A	
2E7	1	PV Branch-current 10	uint16	0.1A	
2E8	1	PV Branch-current 11	uint16	0.1A	
2E9	1	PV Branch-current 12	uint16	0.1A	
2EA	1	PV Branch-current 13	uint16	0.1A	
2EB	1	PV Branch-current 14	uint16	0.1A	
2EC	1	PV Branch-current 15	uint16	0.1A	
2ED	1	PV Branch-current 16	uint16	0.1A	
2EE	1	PV Branch-current 17	uint16	0.1A	
2EF	1	PV Branch-current 18	uint16	0.1A	
2F0	1	PV Branch-current 19	uint16	0.1A	
2F1	1	PV Branch-current 20	uint16	0.1A	
2F2	1	PV Branch-current 21	uint16	0.1A	
2F3	1	PV Branch-current 22	uint16	0.1A	
2F4	1	PV Branch-current 23	uint16	0.1A	
2F5	1	PV Branch-current 24	uint16	0.1A	
Fault information					
300	3	Fault Time 1	string		Format: Year. Month. Day. Hour. Minute. Second
303	1	Fault Type 1	uint16		
304	1	Fault Code 1	uint16		
305	3	Fault Time 2	string		
308	1	Fault Type 2	uint16		
309	1	Fault Code 2	uint16		
30A	3	Fault Time 3	string		
30D	1	Fault Type 3	uint16		
30E	1	Fault Code 3	uint16		
30F	3	Fault Time 4	string		
312	1	Fault Type 4	uint16		
313	1	Fault Code 4	uint16		
314	3	Fault Time 5	string		
317	1	Fault Type 5	uint16		
318	1	Fault Code 5	uint16		

319	3	Fault Time 6	string		
31C	1	Fault Type 6	uint16		
31D	1	Fault Code 6	uint16		
31E	3	Fault Time 7	string		
321	1	Fault Type 7	uint16		
322	1	Fault Code 7	uint16		
323	3	Fault Time 8	string		
326	1	Fault Type 8	uint16		
327	1	Fault Code 8	uint16		
328	3	Fault Time 9	string		
32B	1	Fault Type 9	uint16		
32C	1	Fault Code 9	uint16		
32D	3	Fault Time 10	string		
330	1	Fault Type 10	uint16		
331	1	Fault Code 10	uint16		
332	3	Fault Time 11	string		
335	1	Fault Type 11	uint16		
336	1	Fault Code 11	uint16		
337	3	Fault Time 12	string		
33A	1	Fault Type 12	uint16		
33B	1	Fault Code 12	uint16		
33C	3	Fault Time 13	string		
33F	1	Fault Type 13	uint16		
340	1	Fault Code 13	uint16		
341	3	Fault Time 14	string		
344	1	Fault Type 14	uint16		
345	1	Fault Code 14	uint16		
346	3	Fault Time 15	string		
349	1	Fault Type 15	uint16		
34A	1	Fault Code 15	uint16		
34B	3	Fault Time 16	string		
34E	1	Fault Type 16	uint16		
34F	1	Fault Code 16	uint16		
350	3	Fault Time 17	string		
353	1	Fault Type 17	uint16		
354	1	Fault Code 17	uint16		
355	3	Fault Time 18	string		
358	1	Fault Type 18	uint16		
359	1	Fault Code 18	uint16		
35A	3	Fault Time 19	string		
35D	1	Fault Type 19	uint16		
35E	1	Fault Code 19	uint16		

35F	3	Fault Time 20	string		
362	1	Fault Type 20	uint16		
363	1	Fault Code 20	uint16		
Energy yield Log information					
380	1	Day Product 1	uint16		Format: Month. Day
381	1	Day Product 2	uint16	0.1kWh	
382	1	Day Product 3	uint16		
383	1	Day Product 4	uint16	0.1kWh	
384	1	Day Product 5	uint16		
385	1	Day Product 6	uint16	0.1kWh	
386	1	Day Product 7	uint16		
387	1	Day Product 8	uint16	0.1kWh	
388	1	Day Product 9	uint16		
389	1	Day Product 10	uint16	0.1kWh	
38A	1	Day Product 11	uint16		
38B	1	Day Product 12	uint16	0.1kWh	
38C	1	Day Product 13	uint16		
38D	1	Day Product 14	uint16	0.1kWh	
38E	1	Day Product 15	uint16		
38F	1	Day Product 16	uint16	0.1kWh	
390	1	Day Product 17	uint16		
391	1	Day Product 18	uint16	0.1kWh	
392	1	Day Product 19	uint16		
393	1	Day Product 20	uint16	0.1kWh	
394	1	Day Product 21	uint16		
395	1	Day Product 22	uint16	0.1kWh	
396	1	Day Product 23	uint16		
397	1	Day Product 24	uint16	0.1kWh	
398	1	Day Product 25	uint16		
399	1	Day Product 26	uint16	0.1kWh	
39A	1	Day Product 27	uint16		
39B	1	Day Product 28	uint16	0.1kWh	
39C	1	Day Product 29	uint16		
39D	1	Day Product 30	uint16	0.1kWh	
39E	1	Day Product 31	uint16		
39F	2	Month Product 1	uint16	0.1kWh	
3A1	2	Month Product 2	uint16		
3A3	2	Month Product 3	uint16	0.1kWh	
3A5	2	Month Product 4	uint16		
3A7	2	Month Product 5	uint16	0.1kWh	
3A9	2	Month Product 6	uint16		
3AB	2	Month Product 7	uint16	0.1kWh	

3AD	2	Month Product 8	uint16		
3AF	2	Month Product 9	uint16	0.1kWh	
3B1	2	Month Product 10	uint16		
3B3	2	Month Product 11	uint16	0.1kWh	
3B5	2	Month Product 12	uint16		
3B7	2	Year Product 1	uint16	0.1kWh	
3B9	2	Year Product 2	uint16		
3BB	2	Year Product 3	uint16	0.1kWh	
3BD	2	Year Product 4	uint16		
3BF	2	Year Product 5	uint16	0.1kWh	

2.3.2 Register Read

To read the values of these registers in the above table, the message example is as the following format. And all data are in hex format.

Read input register(function code:04 only read) request:

Read three consecutive registers starting at address 0x0000.

RTU address	Function code	Register address	Register Number	CRC
01	04	00 00	00 03	B0 0B

Read input register(function code:04 only read) response:

Six bytes of data are returned, from 0x0000 to 0x0003.

RTU address	Function code	Bytes	register values	CRC
01	04	06	58 33 46 48 20 20	E4 C9

2.4 Holding Register

2.4.1 Register Table

Start	Size	Register Meaning	Data Type	Units	Description
Hex	Dec				
Reserved					
2000	2	Reserved	String	NULL	Reserved
Communication parameters					
2080	1	Reserved	uint16		Enable: 0xAA Others are Disable
2081	1	Modbus Address	uint16	1	
2082	1	Modbus Baud Rate	uint16	0.01	Set baud rate, such as 9600 set 96
2083	6	Reserved	uint16		Reserved
Countries set					
2100	2	Reserved	string		Reserved
2102	1	Grid Code	uint16	1	
2103	1	Language	uint16	1	
2104	1	Voltage protection upper limit 1	uint16	0.1V	
2105	1	Voltage protection upper limit 2	uint16	0.1V	
2106	1	Voltage protection upper limit 3	uint16	0.1V	
2107	1	Voltage protection	uint16	0.1V	

		lower limit 1			
2108	1	Voltage protection lower limit 2	uint16	0.1V	
2109	1	Voltage protection lower limit 3	uint16	0.1V	
210A	1	Voltage Reconnect upper limit	uint16	0.1V	
210B	1	Voltage Reconnect lower limit	uint16	0.1V	
210C	1	Voltage Protect time upper limit 1	uint16	0.01s	
210D	1	Voltage Protect time upper limit 2	uint16	0.01s	
210E	1	Voltage Protect time upper limit 3	uint16	0.01s	
210F	1	Voltage Protect time lower limit 1	uint16	0.01s	
2110	1	Voltage Protect time lower limit 2	uint16	0.01s	
2111	1	Voltage Protect time lower limit 3	uint16	0.01s	
2112	1	Voltage-protect Recover-time	uint16	10s	
2113	1	Frequency Protect time upper limit 1	uint16	0.01Hz	
2114	1	Frequency Protect time upper limit 2	uint16	0.01Hz	
2115	1	Frequency Protect time upper limit 3	uint16	0.01Hz	
2116	1	Frequency Protect time lower limit 1	uint16	0.01Hz	
2117	1	Frequency Protect time lower limit 2	uint16	0.01Hz	
2118	1	Frequency Protect time lower limit 3	uint16	0.01Hz	
2119	1	Frequency-reconnect upper-limit time	uint16	0.01Hz	
211A	1	Frequency-reconnect lower-limit time	uint16	0.01Hz	
211B	1	Frequency Protect upper-limit time 1	uint16	0.01s	
211C	1	Frequency Protect upper-limit time 2	uint16	0.01s	

211D	1	Frequency Protect upper-limit time 3	uint16	0.01s	
211E	1	Frequency Protect lower-limit time 1	uint16	0.01s	
211F	1	Frequency Protect lower-limit time 2	uint16	0.01s	
2120	1	Frequency Protect lower-limit time 3	uint16	0.01s	
2121	1	Frequency Protect Recover Time	uint16	10s	
2122	1	Dc component limit 1	uint16	mA	
2123	1	Dc component limit 2	uint16	mA	
2124	1	Dc component check Time1	uint16	0.01s	
2125	1	Dc component check Time 2	uint16	0.01s	
2126	1	Grid protect level/ Grid type	uint16	NULL	Such as 1,2,3
2127	1	Fault Recover Time	uint16	Secs	Reserved
2128	1	Grid 10Min Over Voltage Value	uint16	0.1V	
Key Data Settings					
2200	2	Reserved	string		Reserved
2202	1	Restore factory	uint16		RESET: 0xAA
2203	1	Clear History Log	uint16		Clear: 0xAA
2204	1	Reserved	uint16		Reserved
2205	1	Energy Compensation	int16	0.1kWh	Max is 10000 default is 0
2206	1	Grid-connected contro l Set	uint16		
General Settings					
2280	3	System Time	uint16		
2283	2	Reserved	uint16		Reserved
2285	1	Scheduled boot time	uint16	Secs	default-0
2286	1	Scheduled shutdown time	uint16	Secs	default-0
2287	1	Command ON/OFF	uint16		Start up : 0xAF Shut down: 0xAE
Power control/Grid support setup					
2300	2	Reserved	string		Reserved
2302	1	Backflow prevention Percent	uint16	0.1%Wmax	
2303	1	Maximum power output Percent	uint16	0.1%Wmax	Max is 1100 Default is 1000

2304	1	Real-time active power percent	uint16		reserved
2305	1	Real-time reactive power percent	uint16		reserved
2306	1	active power rising slope	uint16	0.1%	No limit is 0xFFFF
2307	1	reactive power rising slope	uint16		
2308	1	Power factor Setting	int16	0.001	Directed number Absolute value 1-1000
2309	1	reactive power percent	int16	0.1%	Directed number Absolute value 1-1000
230A	1	reactive power regulations speed	uint16	0.1%	
230B	6	Reserved	int16		
2311	1	Watt-Freq Enable	uint16	1	
2312	20	Reserved	uint16		
2326	1	Watt-Volt Enable	uint16	1	
2327	20	Reserved	uint16		
233B	1	PF-Watt Enable	uint16	1	
233C	20	Reserved	uint16		
2350	1	Var-Volt Enable	uint16	1	
2351	1	Var-volt-set value 1	uint16		
2352	1	Var-volt-set value 2			
2353	1	Var-volt-set value 3			
2354	1	Var-volt-set value 4			
2355	1	Var-volt-set value 5			
2356	1	Var-volt-set value 6			
2365	1	Var-Watt Enable	uint16	1	
2366	20	Reserved	uint16		
237A	1	Reserved	uint16	1	
237B	20	Reserved	uint16		
238F	1	LVRT Enable	uint16	1	
2390	20	Reserved	uint16		
23A4	1	HVRT Enable	uint16	1	
23A5	20	Reserved	uint16		
23B9	1	LFRT Enable	uint16	1	
23BA	20	Reserved	uint16		
23CE	1	HFRT Enable	uint16	1	
23CF	20	Reserved	uint16		
Protect/Detection Enable/disable					
2480	2	Reserved	string		

2482	1	Reserved	uint16	1	Reserved
2483	1	Reserved	uint16	1	Reserved
2484	1	Reserved	uint16	1	Reserved
2485	1	Reserved	uint16	1	Reserved
2486	1	Auto Adjust voltage protection Enable/disable	uint16	1	
2487	1	High voltage derating Enable/disable	uint16	1	
2488	1	Global MPPT SCAN Enable/disable	uint16	1	
2489	1	Curve PVVI Enable/disable	uint16	1	
248A	1	Italy Self-Test Enable/disable	uint16	1	0x00: disable 0X01: 27.S1 0X02: 27.S2 0X03: 59.S1 0X04: 59.S2 0X05: 81<S1 0X06: 81<S2 0X07: 81>S1 0X08: 81>S2
248B	1	PID Enable/disable	uint16	1	
248C	1	DRM Enable/disable	uint16	1	
248D	1	ARC Detection Enable/disable	uint16	1	
248E	1	ARC Reset Enable/disable	uint16	1	
248F	1	Reconnect Power Limit Enable	uint16	1	
2490	1	Ground Line Check Enable/disable	uint16	1	
2491	1	Delta Grid Enable/disable	uint16	1	
2492	1	Fan Error Check Enable/disable	uint16	1	

2.4.2 Register Read

To read the values of these registers in the above table, the message example is as the following format. And all data are in hex format.

Read hod register(function code:03) request:

Read two consecutive registers starting at address 0x2081.

Slave address	Function code	Register address	Register number	CRC
01	03	20 81	00 02	9F E3

Read hod register(function code:03) response:

Four bytes of data are returned, the first two bytes corresponding to address 0x2081 and the last two bytes to address 0x2082

Slave address	Function code	bytes	register values	CRC
01	03	04	00 01 00 01	6A 33

2.4.3 Register Write

To write the single hold register, the function code 0x06 will be adopted. The message format is as the following tables. And all data are in hex format.

Request:

RTU address	Function code	Register address	Register Value	CRC
01	06	20 81	00 01	13 E2

Response:

RTU address	Function code	Register address	Register Value	CRC
01	06	20 81	00 01	13 E2

To write multiple hold registers, the function code 0x10 will be adopted. The message format is as the following tables. And all data are in hex format.

Request:

RTU address	Function code	Register address	Register number
01	10	20 81	00 02
Register bytes	Register 0x2081 value	Register 0x2082 value	CRC
04	00 01	00 01	33 C2

Response:

RTU address	Function code	Register address	Register number	CRC
01	10	20 81	00 02	1A 20

2.5 Fault Mappings

Fault code	Fault name	Fault description	Fault type
1	METER_OPPSITE	meter is backconnected	Grid Fault
2	REMOTE_TURN_OFF	remote shutdown	Grid Fault
3	FREQ_CFG_UNMATCH	The rated network frequency is incorrectly set	Grid Fault
4	GND_CONN_FAIL	inverter ground fault	Grid Fault
5	ISO_FAIL	PV insulation impedance is lower than the safe value	Grid Fault
10	INPUT_ABNORMAL	PV input is abnormal	PV Fault
11	PV01_REVERSE	PV No.1 polarity is reverse	PV Fault
12	PV02_REVERSE	PV No.2 polarity is reverse	PV Fault
13	PV03_REVERSE	PV No.3 polarity is reverse	PV Fault
14	PV04_REVERSE	PV No.4 polarity is reverse	PV Fault
15	PV05_REVERSE	PV No.5 polarity is reverse	PV Fault
16	PV06_REVERSE	PV No.6 polarity is reverse	PV Fault
17	PV07_REVERSE	PV No.7 polarity is reverse	PV Fault
18	PV08_REVERSE	PV No.8 polarity is reverse	PV Fault
19	PV09_REVERSE	PV No.9 polarity is reverse	PV Fault
20	PV10_REVERSE	PV No.10 polarity is reverse	PV Fault
21	PV11_REVERSE	PV No.11 polarity is reverse	PV Fault
22	PV12_REVERSE	PV No.12 polarity is reverse	PV Fault
30	VOLT_HIGH	PV voltage is high	PV Fault
31	PV01_VOLT_HIGH	PV No.1 voltage is high	PV Fault
32	PV02_VOLT_HIGH	PV No.2 voltage is high	PV Fault
33	PV03_VOLT_HIGH	PV No.3 voltage is high	PV Fault
34	PV04_VOLT_HIGH	PV No.4 voltage is high	PV Fault
35	PV05_VOLT_HIGH	PV No.5 voltage is high	PV Fault
36	PV06_VOLT_HIGH	PV No.6 voltage is high	PV Fault
37	PV07_VOLT_HIGH	PV No.7 voltage is high	PV Fault
38	PV08_VOLT_HIGH	PV No.8 voltage is high	PV Fault
39	PV09_VOLT_HIGH	PV No.9 voltage is high	PV Fault
40	PV10_VOLT_HIGH	PV No.10 voltage is high	PV Fault
41	PV11_VOLT_HIGH	PV No.11 voltage is high	PV Fault

42	PV12_VOLT_HIGH	PV No.12 voltage is high	PV Fault
50	BST_SW_OCP	Boost is over current protected	PV Fault
51	BST01_SW_OCP	Boost No.1 is software over current protected	PV Fault
52	BST02_SW_OCP	Boost No.2 is software over current protected	PV Fault
53	BST03_SW_OCP	Boost No.3 is software over current protected	PV Fault
54	BST04_SW_OCP	Boost No.4 is software over current protected	PV Fault
55	BST05_SW_OCP	Boost No.5 is software over current protected	PV Fault
56	BST06_SW_OCP	Boost No.6 is software over current protected	PV Fault
57	BST07_SW_OCP	Boost No.7 is software over current protected	PV Fault
58	BST08_SW_OCP	Boost No.8 is software over current protected	PV Fault
59	BST09_SW_OCP	Boost No.9 is software over current protected	PV Fault
60	BST10_SW_OCP	Boost No.10 is software over current protected	PV Fault
61	BST11_SW_OCP	Boost No.11 is software over current protected	PV Fault
62	BST12_SW_OCP	Boost No.12 is software over current protected	PV Fault
70	BST_HW_OCP	Boost is hardware over current protected	PV Fault
71	BST01_HW_OCP	Boost No.1 is hardware over current protected	PV Fault
72	BST02_HW_OCP	Boost No.2 is hardware over current protected	PV Fault
73	BST03_HW_OCP	Boost No.3 is hardware over current protected	PV Fault
74	BST04_HW_OCP	Boost No.4 is hardware over current protected	PV Fault
75	BST05_HW_OCP	Boost No.5 is hardware over current protected	PV Fault
76	BST06_HW_OCP	Boost No.6 is hardware over current protected	PV Fault
77	BST07_HW_OCP	Boost No.7 is hardware over current	PV Fault

		protected	
78	BST08_HW_OCP	Boost No.8 is hardware over current protected	PV Fault
79	BST09_HW_OCP	Boost No.9 is hardware over current protected	PV Fault
80	BST10_HW_OCP	Boost No.10 is hardware over current protected	PV Fault
81	BST11_HW_OCP	Boost No.11 is hardware over current protected	PV Fault
82	BST12_HW_OCP	Boost No.12 is hardware over current protected	PV Fault
90	GRID_LOSS	1. Power grid outage 2. The AC line or AC switch is disconnected	Grid Fault
91	GRID_OVP1	The power grid voltage exceeds the allowable value 1	Grid Fault
92	GRID_OVP2	The power grid voltage exceeds the allowable value 2	Grid Fault
93	GRID_UVP1	The grid voltage is lower than the allowable value 1	Grid Fault
94	GRID_UVP2	The grid voltage is lower than the allowable value 2	Grid Fault
95	GRID_10MIN_OVP	The grid voltage exceeds the allowable value in 10 minutes	Grid Fault
96	GRID_INST_OVP	Instantaneous high voltage of power network	Grid Fault
97	GRID_OFP1	The network frequency exceeds the allowable value 1	Grid Fault
98	GRID_OFP2	The network frequency exceeds the allowable value 2	Grid Fault
99	GRID_UFP1	The network frequency is below the allowable value 1	Grid Fault
100	GRID_UFP2	The network frequency is below the allowable value 2	Grid Fault
101	GRID_PHS_LOSS	Grid phase voltage loss	Grid Fault
102	GRID_UNBLC	The power grid voltage is unbalanced	Grid Fault
103	GRID_FRT	Grid crossing anomaly	Grid Fault
104	GRID_SMCU_VOLT	The voltage of the SMCU chip is abnormal	Grid Fault
105	GRID_SMCU_FREQ	The SMCU chip frequency is	Grid Fault

		abnormal. Procedure	
110	DCBUS_HW_OVP	The DC BUS hardware overvoltages	Inverter Fault
111	PBUS_FSW_OVP	Positive BUS software overvoltage	Inverter Fault
112	NBUS_FSW_OVP	Negative BUS software overvoltage	Inverter Fault
113	DCBUS_SW_OVP	The DC BUS software overvoltage	Inverter Fault
114	DCBUS_SW_UVP	The DC BUS software is underpowered	Inverter Fault
115	DCBUS_UNBLC	BUS unbalance	Inverter Fault
116	PV_ABOVE_BUS	The PV voltage is higher than the BUS voltage	Inverter Fault
117	DCBUS_SS_FAIL	The BUS is soft faulty	Inverter Fault
118	SUNPWR_WEAK	Low PV power	Inverter Fault
125	INV_RLY_FLT	Inverter relay fault	Inverter Fault
126	RLY_ON_FAIL	Relay suction failure	Inverter Fault
127	INV_SW_OCP	The inverter software overflows	Inverter Fault
128	INV_PEAKCURR_LMT	Inverter current peak protection	Inverter Fault
129	INV_HW_OCP	Inverter hardware overcurrent	Inverter Fault
130	INV_DCI_PROT	DCI fault	Inverter Fault
131	INV_SC	Inverter short circuit	Inverter Fault
132	GFCI_CT_FAIL	The GFCI sensor is faulty	Inverter Fault
133	GFCI_PROT	GFCI fault	Inverter Fault
136	INV_HW_OCP_A	The A-phase hardware overcurrent is faulty. Procedure	Inverter Fault
137	INV_HW_OCP_B	The B-phase hardware overcurrent is faulty. Procedure	Inverter Fault
138	INV_HW_OCP_C	The C-phase hardware overcurrent is faulty. Procedure	Inverter Fault
140	SCI_FAIL	The internal SCI communication is faulty	Inverter Fault
141	SPI_FAIL	The internal SPI communication is faulty	Inverter Fault
142	CAN_FAIL	The internal CAN communication is faulty	Inverter Fault
143	EPRM_RW_FAIL	Eeprom fault	Inverter Fault
144	MOV_AC_FAIL	The AC surge protection module is faulty	Inverter Fault
145	MOV_DC_FAIL	The DC surge protection module is faulty	Inverter Fault

146	FAN1_FAIL	External fan 1 is faulty	Inverter Fault
147	FAN2_FAIL	External fan 2 is faulty	Inverter Fault
148	FAN3_FAIL	External fan 3 is faulty	Inverter Fault
149	FAN4_FAIL	Internal fan 4 is faulty	Inverter Fault
150	BST_IGBT_NTC_OTP	The BOOST module is overheated	System Fault
151	INV_IGBT_NTC_OTP	The inverter IGBT module is overheated. Procedure	System Fault
152	AC_TB_NTC_OTP	The AC terminal is overheated	System Fault
154	ENVIR_TMP_LOW	The internal temperature is too low	System Fault
155	ENVIR_TMP_HIGH	Excessive internal temperature	System Fault
156	TMP_SENS_LOSS	The temperature sensor connection is faulty. Procedure	System Fault
157	ARC_TEST_FAIL	Arc pull test failed	System Fault
158	ARC_FAULT	Arc drawing fault	System Fault
198	TYPE_MODEL_ERR	Model setting error	Inverter Fault
199	SW_VER_UNMATCH	Software version error	Inverter Fault