Communication Protocol of Residential Hybrid Inverter

Version: V1.1.11

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Changes

Version	Date	Change Description
V1.1.6	2024-12-31	The following changes have been made based on V1.1.5: 1. Added the usage description of power regulation parameters. 2. Optimized adaptive model information.
V1.1.7	2025-05-09	The following changes have been made based on V1.1.6: 1. Added Firmware Version (13250~13369); 2. Added Active Power Limitation (13089) and Active Power Limit Ratio (13090); 3. Added Feed-in Limitation Ratio (13088); 4. Added Meter Active Power (5601); 5. Add remarks for read-only registers (5603、5605、5607、4954~4983); 6. Add Forced Startup Under Low SOC Standby (13017); 7. Modify the Protocol No (4950~4951) to reserved items; 8. Add Meter Channel 2 Data (13200-13207);
V1.1.8	2025-05-20	The following changes have been made based on V1.1.7: 1. Add new valid device types: MG5RL、MG6RL;
V1.1.9	2025-06-20	The following changes have been made based on V1.1.8: 1. Update the remark information for Firmware Information (13250~13369) and Meter Channel 2 Data (13200-13207);
V1.1.10	2025-07-25	The following changes have been made based on V1.1.9: 1、 Add a RW Register “PV power limitation” (13018); 2、 Update the note information of the register "PV power limitation" (13018);
V1.1.11	2025-11-17	The following changes have been made based on V1.1.10: 1、Add new valid device types: MG8RL、MG10RL; 2、Supplement the remark information for Firmware Information (13250~13369);

Contents

1 Introduction

The Modbus RTU protocol is a widely used communication protocol in the industrial field, through which the inverter can communicate with other devices via the communication link (such as RS485 bus). This protocol applies to the communication between Sungrow hybrid inverters (SH-inverter) and third-party upper computer monitoring software.

Note: The third-party upper computer monitoring software can read the real-time running data and fault data of the inverter through this protocol. The communication should be transmitted by the RS485 interface on the inverter or the Ethernet interface of WiNet-S/WiNet-S2/Logger1000, but not by iHomeManger or other communication modules.

1.1 Abbreviations

Table 1 Abbreviations

Name	Definition
Host station	In question-and-answer communication, the party that initiates the communication becomes the host station, such as a third-party upper computer monitoring system.
Slave station	In question-and-answer communication, the party that responds passively to the command becomes the slave station, such as an inverter.
Broadcast address	The value is fixed to 0. Through the broadcast address, you can set all slave stations on the communication link execute a command.
Register address	A register address corresponds to 2 bytes of data.
UTF8	String data，the high-byte data is in the front and the low-byte data is at back. Example: Transmission order of UTF-8 data ABCD is A, B, C, D.
U16	16-bit unsigned integer, big-endian. Example: Transmission order of U16 data 0x0102 is 01, 02.
S16	16-bit signed integer, big-endian.
U32	32-bit unsigned integer; little-endian for double-word data. Big-endian for byte data. Example: Transmission order of U32 data 0x01020304 is 03, 04, 01, 02
S32	32-bit signed integer; little-endian for double-word data. Big-endian for byte data.

1.2 System Requirements

1. **Communication Interface RS485**

Table 2 Communication Interface Definition

Parameter	Default setting
Slave station	Inverter: 1 - 247 settable, 1 by default
Baud rate	9600 bit/s
Check bit	Null or settable
Data bit	8
Stop bit	1
Mode	RTU
Appliance interface	RS485-2W cable connection

2. Ethernet (optional), Modbus TCP, Default DHCP Enable, Port: 502.

3. For adapted inverter models, See *Appendix 1 Adaptive Inverter Models*.

4. Data Requirements：

1) Visit all registers by subtracting 1 from the register address.

Example: if the register is 5000 –5001, visit it using address 4999 –5000.

Entering “01 04 1387 00 02 + CRC” to check the data of address 5000 –5001.

2) Verify type: CRC16 generates polynomial 0xA001, little-endian.

3) The decimal parameters are transmitted as integer after expansion.

Example: 10.333 kW is transmitted as 10333, 800.5 V is transmitted as 8005.

4) Negative numbers are transmitted as complement.

Example: 0xFFFF signifying -1.

5) Unavailable register cannot be viewed or set. The return of unsigned number is F,

Example: “0xFFFF” is the return for U16, “0xFFFFFFFF” is the return for U32;

The return of signed number is the max. positive number,

Example: “0x7FFF” for S16, “0x7FFFFFFF” for S32; 0x00 for UTF-8.

UTF-8 occupies 1 byte, the length of odd number is complemented by 0x00.

6) The RW (Read-Write) registers deacribed in section 2.2 Parameter Setting Definition do not support frequent periodic reading and setting when it is forwarded through communication modules such as WiNet-S/WiNet-S2/Logger1000.

7) Minimum Request period (RS485 Time out): 1000 ms

After sending an unicast request, before receiving a respond from the inverter, the host station should wait for up to 1000ms to send a new unicast request to inverter. If no respond is received from the inverter after waiting for 1000 ms, the host station should regard this request as a timeout.

2 Register Definition

2.1 Running Information Variable

Table 3 Running Information Variable（RO (read-only) register, Support Modbus Command 0x04）

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
1.	Reserved	4950~4951	U32			
2.	Protocol version	4952~4953	U32			For example, 0x01010700 represents the protocol version V1.1.7; Forwarding via Logger is not supported.
3.	Certification version of ARM Software	4954 - 4968	UTF-8			Certified version information after finalizing functions such as electrical, safety regulations, and standards for the whole machine.
4.	Certification version of DSP Software	4969 - 4983	UTF-8			
5.	Reserved	4984-4989				
6.	SN	4990~4999	UTF-8			
7.	Device type code	5000	U16			See *Appendix 1 Adaptive Inverter Models*
8.	Nominal output power	5001	U16		0.1kW	
9.	Output type	5002	U16	0—Single； 1—3P4L； 2—3P3L		
10.	Daily Output Energy	5003	U16		0.1kWh	Power generation of active output (including PV power generation and battery discharge)
11.	Total Output Energy	5004 ~ 5005	U32		0.1kWh	
12.	Reserved	5006 ~ 5007				
13.	Inside Temperature	5008	S16		0.1℃	
14.	Reserved	5009~5010				
15.	MPPT 1 Voltage	5011	U16		0.1V	See *Appendix 1 Adaptive Inverter Models*
16.	MPPT 1 Current	5012	U16		0.1A	
17.	MPPT 2 Voltage	5013	U16		0.1V	
18.	MPPT 2 Current	5014	U16		0.1A	
19.	MPPT 3 Voltage	5015	U16		0.1V	
20.	MPPT 3 Current	5016	U16		0.1A	
21.	Total DC power	5017 ~ 5018	U32		1W	Total PV power

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
22.	A-B line voltage/phase A voltage	5019	U16		0.1V	Refer to Output type (address: 5002) 0: phase voltage; 1: phase voltage; 2: line voltage
23.	B-C line voltage/phase B voltage	5020	U16		0.1V	
24.	C-A line voltage/phase voltage	5021	U16		0.1V	
25.	Reserved	5022~5030				
26.	Reactive power	5033~5034	S32		1Var	
27.	Power factor	5035	S16		0.001	> 0 means leading < 0 means lagging
28.	Grid frequency	5036	U16		0.1Hz	Compared with "Grid frequency" 5242, only the resolution is different.
29.	MPPT 4 Voltage	5115	U16		0.1V	See *Appendix 1 Adaptive Inverter Models*
30.	MPPT 4 Current	5116	U16		0.1A	
31.	Battery power	5214-5215	S32		1W	It is recommended to use this register instead of 13022.
32.	Grid Frequency	5242	U16		0.01Hz	It is recommended to use this register instead of 5036.
33.	Meter Active Power	5601	S32		1W	Only valid when the inverter is directly connected to the smart energy meter. (See note 1); ＞0 buy from grid; ＜0 sell to grid;
34.	Meter Phase A Active Power	5603	S32		1W	
35.	Meter Phase B Active Power	5605	S32		1W	
36.	Meter Phase C Active Power	5607	S32		1W	
37.	Min. Feed-in Power Limitation Value	5622	U16		0.01kW	
38.	Max. Feed-in Power Limitation Value	5623	U16		0.01kW	
39.	BDC rated power	5628	U16		0.1kW	
40.	Battery Current	5631	S16		0.1A	It is recommended to use this register instead of 13021.
41.	Max. Charging Current (BMS)	5635	U16		1A	
42.	Max. Discharging Current (BMS)	5636	U16		1A	
43.	Battery Capacity- High precision	5639	U16		0.01kWh	The precision is different from register 13039.
44.	Phase A Backup Current	5720	S16		0.1A	
45.	Phase B Backup Current	5721	S16		0.1A	
46.	Phase C Backup Current	5722	S16		0.1A	
47.	Phase A Backup Power	5723	S16		1W	
48.	Phase B Backup Power	5724	S16		1W	

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
49.	Phase C Backup Power	5725	S16		1W	
50.	Total Backup Power	5726-5727	S32		1W	
51.	Phase A Backup Voltage	5731	U16		0.1V	
52.	Phase B Backup Voltage	5732	U16		0.1V	
53.	Phase C Backup Voltage	5733	U16		0.1V	
54.	Backup Frequency	5734	U16		0.01Hz	
55.	PV Power of today	6100~6195	U16		1W	WiNet-S/S2 and Logger is not supported Applicable types: SH5.0-10.0RT
56.	Daily PV energy yields	6196~6226	U16		0.1kWh	
57.	Monthly PV energy yields	6227~6238	U16		0.1kWh	
58.	Reserved	6239~6243				
59.	Yearly PV energy yields	6250~6289	U32*20	Valid for 15 years	0.1kWh	
60.	Direct power consumption of today from PV	6290~6385	U16*96		1W	
61.	Daily direct energy consumption from PV	6386~6416	U16*31		0.1kWh	
62.	Monthly direct energy consumption from PV	6417~6428	U16*12		0.1kWh	
63.	Yearly direct energy consumption from PV	6429~6468	U32*20	Valid for 15 years	0.1kWh	
64.	Export power from PV of today	6469~6564	U16*96		1W	
65.	Daily export energy from PV	6565~6595	U16*31		0.1kWh	
66.	Monthly export energy from PV	6596~6607	U16*12		0.1kWh	
67.	Yearly export energy from PV	6608~6647	U32*20	Valid for 15 years	0.1kWh	
68.	Battery charge power of today	6648~6743	U16*96		1W	
69.	Daily battery charge energy from PV	6744~6774	U16*31		0.1kWh	
70.	Monthly battery charge energy from PV	6775~6786	U16*12		0.1kWh	
71.	Yearly battery charge energy from PV	6787~6826	U32*20	Valid for 15 years	0.1kWh	
72.	Reserved	6827-6849				
73.	Reserved	6862-12999				
74.	Running state	13000	U16			See ***Appendix 2 Running State***
75.	Power Flow Status	13001	U16			See ***Appendix 3 Power Flow State***

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
76.	Daily PV Generation	13002	U16		0.1kWh	Daily electricity generated by the inverter through the PV modules.
77.	Total PV Generation	13003~13004	U32		0.1kWh	Accumulated electricity generated by the inverter through the PV modules.
78.	Daily export power from PV	13005	U16		0.1kWh	Daily export electricity to the grid from PV generation (See note 1)
79.	Total export energy from PV	13006~13007	U32		0.1kWh	Accumulated export electricity to the grid from PV generation (See note 1)
80.	Load power	13008~13009	S32		1W	Power consumed by loads (See note 1)
81.	Export power	13010~13011	S32		1W	Power delivered by the inverter to the grid (See note 1)
82.	Daily battery charge energy from PV	13012	U16		0.1kWh	Daily electricity that the inverter charges the batteries through the PV modules.
83.	Total battery charge energy from PV	13013~13014	U32		0.1kWh	Accumulated electricity that the inverter charges the batteries through the PV modules.
84.	Daily direct energy consumption	13017	U16		0.1kWh	Daily electricity taken from PV modules by loads (See note 1)
85.	Total direct energy consumption	13018~13019	U32		0.1kWh	Accumulated electricity taken from PV modules by the inverter. (See note 1)
86.	Battery voltage	13020	U16		0.1V	
87.	Battery current	13021	U16		0.1A	The data type for SH3.0-6.0RS and SH8.0-10RS is S16. It is recommended to use registers 5631 and 5214-5215.
88.	Battery power	13022	U16		1W	
89.	Battery SOC	13023	U16		0.1%	
90.	Battery SOH	13024	U16		0.1%	
91.	Battery temperature	13025	S16		0.1℃	
92.	Daily battery discharge energy	13026	U16		0.1kWh	
93.	Total battery discharge energy	13027~13028	U32		0.1kWh	
94.	Self-consumption of today	13029	U16		0.1%	
95.	Reserved	13030	U16		-	
96.	Phase A current	13031	S16		0.1A	Output type (address 5002) is

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
97.	Phase B current	13032	S16		0.1A	0: only phase A current is uploaded; 1 or 2: current of corresponding phases is uploaded
98.	Phase C current	13033	S16		0.1A	
99.	Total active power	13034~13035	S32		1W	
100.	Daily Import Energy	13036	U16		0.1kWh	
101.	Total Import Energy	13037~13038	U32		0.1kWh	
102.	Battery Capacity	13039	U16		0.1kWh or 1Ah	Li-ion：0.1kWh； Lead-acid： 1Ah Applicable types： SH5.0-10RT SH3.0-6.0RS SH8.0-10RS
103.	Daily Charge Energy	13040	U16		0.1kWh	Total charge of batteries on the day
104.	Total Charge Energy	13041~13042	U32		0.1kWh	Accumulated charge of batteries
105.	DRM State	13043	U16	1~9: DRM0~DRM8 Other Value : Invalid		
106.	Reserved	13044				
107.	Daily export energy	13045	U16		0.1kWh	Daily electricity delivered by the inverter to the grid through PV modules or batteries. (See note 1)
108.	Total export energy	13046~13047	U32		0.1kWh	Accumulated electricity delivered by the inverter to the grid through PV modules or batteries. (See note 1)
109.	Reserved	13048~13049				
110.	Inverter alarm	13050~13051	U32			See ***Appendix 4 Fault Codes***
111.	Grid-side fault	13052~13053	U32			
112.	System fault 1	13054~13055	U32			
113.	System fault 2	13056~13057	U32			
114.	DC-side fault	13058~13059	U32			
115.	Permanent fault	13060~13061	U32			
116.	BDC-side fault	13062~13063	U32			
117.	BDC-side permanent fault	13064~13065	U32			

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
118.	Battery fault	13066~13067	U32			
119.	Battery alarm	13068~13069	U32			
120.	BMS alarm	13070~13071	U32			See ***Appendix 4 Fault Codes.*** See note 2 under the table.
121.	BMS protection	13072~13073	U32			
122.	BMS fault 1	13074~13075	U32			
123.	BMS fault 2	13076~13077	U32			
124.	BMS alarm 2	13078~13079	U32			
125.	Channel 2 Total Active Power	13200-13201	S32		1W	The data from Channel 2 is only valid when the inverter is connected to a dual-channel meter (e.g., DTSU666-20). SH3.0-10RS and MG5-10RL are not supported.
126.	Channel 2 Phase A Active Power	13202-13203	S32		1W	
127.	Channel 2 Phase B Active Power	13204-13205	S32		1W	
128.	Channel 2 Phase C Active Power	13206-13207	S32		1W	
129.	Inverter Firmware Information	13250-13264	UTF-8			SH3.0-10RS and MG5-10RL are not supported. See note 3 under the table.
130.	Communication Module Firmware Information	13265-13279	UTF-8			
131.	Battery Firmware Information	13280-13294	UTF-8			
132.	Reserved 1	13295-13309	UTF-8			
133.	Reserved 2	13310-13324	UTF-8			
134.	Reserved 3	13325-13339	UTF-8			
135.	Reserved 4	13340-13354	UTF-8			
136.	Reserved 5	13355-13369	UTF-8			

Note 1: Data related to the grid or load is only valid when the inverter is directly connected to a smart energy meter. Registers 5603-5607 are valid only when a three-phase meter is connected. These registers represent the power values of each phase (A, B, C). Data is invalid for single-phase meters.

Note 2: The data is the fault alarm information of the batteries connected to the inverter. If the data is obtained through the RS485 port of the inverter, the address is the battery communication address. For example, if 4 batteries in parallel are connected, the communication address of the batteries is 200-203. If the data is obtained through TCP/IP forwarding via the Ethernet port on WiNet, the battery communication address will be the WiNet internal forwarding address, which is displayed in the "Device List" on the embedded Web of WiNet. Logger is not supported.

Note 3: Only indicates sub-function optimization (such as adding communication points); data updates will not affect functions including electrical, safety regulations, and standards for the whole machine.

2.2 Parameter Setting Definition

Table 4 Parameter Setting Definition (RW (Read-Write) Register, Support Modbus Command 0x03/0x06/0x10)

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
1.	System clock: Year	5000	U16	2000~2099		Receive time synchronization setting of the monitoring system
2.	System clock: Month	5001	U16	1~12		
3.	System clock: Day	5002	U16	1~31		
4.	System clock: Hour	5003	U16	0~23		
5.	System clock: Minute	5004	U16	0~59		
6.	System clock: Second	5005	U16	0~59		
7.	Reserved	5006-12999				
8.	Start/Stop	13000	U16	0xCF: Boot 0xCE: Shutdown		
9.	DO Configuration	13001	U16	0: Off 1: Load Control Mode 2: Grounding Fault Indication 3: Micro Grid System Mode		SH3.0-10RS are not supported.
10.	Load Control Mode	13002	U16	0: Timing mode; 1: ON/OFF mode; 2: Power optimized mode 3: Disable		See ***Appendix 5 Load Control Mode***
11.	Load timing period 1: Start hour	13003	U16	0~23	1h	
12.	Load timing period 1: Start minute	13004	U16	0~59	1min	
13.	Load timing period 1: End hour	13005	U16	0~23	1h	
14.	Load timing period 1: End minute	13006	U16	0~59	1min	
15.	Load timing period 2: Start hour	13007	U16	0~23	1h	
16.	Load timing period 2: Start minute	13008	U16	0~59	1min	
17.	Load timing period 2: End hour	13009	U16	0~23	1h	
18.	Load timing period 2: End minute	13010	U16	0~59	1min	
19.	Load ON/OFF mode	13011	U16	0xAA (ON) 0x55 (OFF)		
20.	Load power optimized mode: Start hour	13012	U16	0~23	1h	
21.	Load power optimized mode: Start minute	13013	U16	0~59	1min	

22.	Load power optimized mode: End hour	13014	U16	0~23	1h	
23.	Load power optimized mode: End minute	13015	U16	0~59	1min	
24.	Optimized power of load	13016	U16	0~60000	1W	
25.	Forced Startup Under Low SOC Standby	13017	U16	0xAA：Forced Startup		See note 1 under the table
26.	PV power limitation	13018	U16	0xAA: Limit PV 0x55: Allow PV		Only SHT are supported
27.	Reserved	13019~13049				
28.	EMS mode selection	13050	U16	0: Self-consumption mode (by default) 2: Compulsory mode 3: External EMS mode 4: VPP		See ***Appendix 6 Energy Management Mode***
29.	Charge/discharge command	13051	U16	0xAA: Charge； 0xBB: Discharge 0xCC: Stop		
30.	Charge/discharge power	13052	U16		1W	0-100% of BDC rated power (RO register 5628)
31.	Reserved	13053~13054				
32.	Max. SOC	13058	U16	50.0~100.0	0.1%	
33.	Min. SOC	13059	U16	0.0~50.0	0.1%	
34.	Reserved	13064				
35.	Feed-in Limitation Value	13074	U16		1W	
36.	Off-grid option	13075	U16	0xAA: Enable 0x55: Disable		
37.	Reserved	13076~13079	-			
38.	External EMS heartbeat	13080	U16	0~1000	1s	Default: 20s
39.	Reserved	13081~13082				
40.	Meter Comm. Detection	13086	U16	0xAA: Enable 0x55: Disable		
41.	Feed-in Limitation	13087	U16	0xAA: Enable 0x55: Disable		
42.	Feed-in Limitation Ratio	13088	U16	0-1000	0.1%	See note 2 under the table MG5-10RL is not supported.
43.	Active Power Limitation	13089	U16	0xAA: Enable 0x55: Disable		MG5-10RL is not supported.
44.	Active Power Limit Ratio	13090	U16	0-1000	0.1%	
45.	Reserved	13085~13099				
46.	Reserved SOC for backup	13100	U16	0~100	%	

47.	Charge Cutoff Voltage – Wide range	33042	U16		0.1V	
48.	Max. Charging Power	33047	U16		0.01kW	
49.	Max. Discharging Power	33048	U16		0.01kW	
50.	Charging/Discharging Power –Wide range	33148	U16		0.01kW	
51.	Feed-in Limitation value– Wide range	31222	U16		0.01kW	
52.	Forced Charging	33208	U16	0xAA: Enable 0x55: Disable		MG5-10RL is not supported.
53.	Forced Charging Valid Time	33209	U16	0: Weekday 1: Every Day		
54.	Forced Charging Start Time 1(h)	33210	U16	0~23	h	
55.	Forced Charging Start Time 1(min)	33211	U16	0~59	min	
56.	Forced Charging End Time 1(h)	33212	U16	0~23	h	
57.	Forced Charging End Time 1(min)	33213	U16	0~59	min	
58.	Forced Charging Target SOC1	33214	U16	0~100	%	
59.	Forced Charging Start Time 2(h)	33215	U16	0~23	h	
60.	Forced Charging Start Time 2(min)	33216	U16	0~59	min	
61.	Forced Charging End Time 2(h)	33217	U16	0~23	h	
62.	Forced Charging End Time 2(min)	33218	U16	0~59	min	
63.	Forced Charging Target SOC 2	33219	U16	0~100	%	
64.	Load Rated Power	33274	U16	0~600.00	0.01kW	

Note 1： In scenarios without PV (photovoltaic) input, such as during nighttime, when the battery SOC falls below the lower SOC limit and the inverter is in standby mode, it will only automatically start up once sufficient PV energy becomes available. By setting the "Forced Startup Under Low SOC Standby" configuration point to "0xAA", the inverter can be manually initiated without waiting for adequate PV energy. This function is only active when the inverter is in grid-connected mode (i.e., connected to the grid) and does not work in off-grid scenarios.

Note 2： This tag is equivalent in meaning to tag 13074 (with the difference that tag 13074 uses W units while this tag uses percentage units). When both are configured, the value of this tag takes precedence.

3 Function Settings

3.1 Export Power Limitation

Table 5 Export Power Limitation Parameters

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
1.	Min. Feed-in Power Limitation Value	5622	U16		0.01kW	Read-only
2.	Max. Feed-in Power Limitation Value	5623	U16		0.01kW	Read-only
3.	Feed-in Limitation Value	13074	U16		1W	Read-Write
4.	Feed-in Limitation	13087	U16	0xAA: Enable 0x55: Disable		Read-Write
5.	Feed-in Limitation Ratio	13088	U16	0-1000	0.1%	Read-Write
6.	Feed-in Limitation value–Wide range	31222	U16		0.01kW	Read-Write
7.	Active Power Limitation	13089	U16	0xAA: Enable 0x55: Disable		Read-Write
8.	Active Power Limit Ratio	13090	U16	0-1000	0.1%	Read-Write

Note1： The Feed-in Limitation Function (related registers: Feed-in Limitation Ratio [13088], Feed-in Limitation Value [13074/31222]) differs from the Power Limiting Function (related register: Active Power Limit Ratio [13090]) in their control points for restricting inverter grid-connected power. As shown in Figure 1, Point A represents the control point of the Feed-in Limitation Function [grid connection point], while Point B represents the control point of the Power Limiting Function [inverter's AC output port]. Generally, the Feed-in Limitation Function requires the configuration of a grid gateway meter.

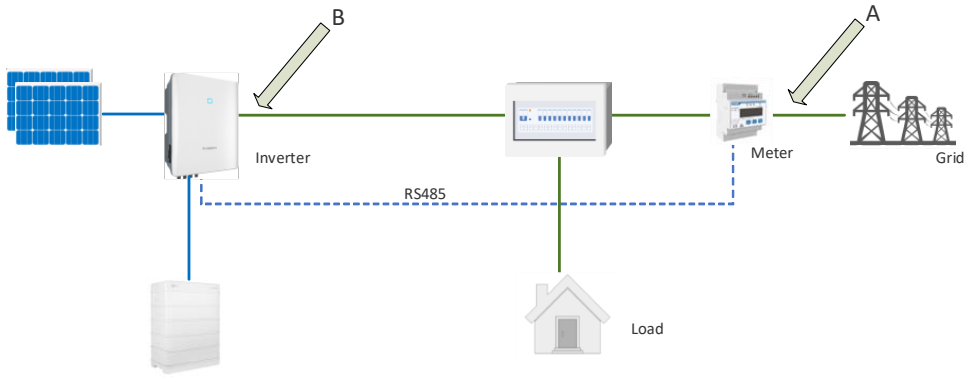

Figure 1 Schematic diagram of active power control points

3.1.1 Disabling Export Limitation

The inverter will not receive any derating command.

Method:

1. Set the **" Feed-in Limitation "** (register 13087) to 0x55 (disabled).

2. Set the " **Active Power Limitation** " (register 13089) to 0x55 (disabled).
3. If the value of the " **Active Power Limitation** " (Register 13089) is set to 0xAA, then the value of the " **Active Power Limit Ratio** " (Register 13090) needs to be set to 1000.

3.1.2 Setting Export Power Limitation

1. **The Feed-in Limitation Function:** The master inverter directly issues the target value of Feed-in limitation. The command is an absolute power value. The settable range is from " **Max. Feed-in Power Limitation Value** " (register 5623) to " **Max. Feed-in Power Limitation Value** " (register 5622) .

Method:

1. Set the **"Feed-in limitation"** (register 13087) to 0xAA.
2. If using absolute value control, set **"Feed-in limitation value"** (register 13074) to the target value. The unit is W and the adjustment accuracy is 1W. If you set **"Feed-in Limitation value–Wide range"** (register 31222), the unit is kW and the adjustment accuracy is 0.01kW.
3. If using percentage control, set **"Feed-in Limitation Ratio"** (register 13088) to the target value. The unit is % and the adjustment accuracy is 0.1.

Note2: If the inverter is connected to the smart energy meter, the power limitation control point is the power at the grid-connected point monitored by the smart energy meter. If the inverter is not connected to a smart energy meter, the power limitation control point is the inverter power of the inverter AC port.

Note3: If the "Export power limitation value" (register 13074) exceeds the maximum value in U16, i.e. 65.535kW, the " Feed-in Limitation value - Wide Range" (register 31222) can be used.

Note4: For multi-inverter (master/slave) systems, this parameter only needs to be issued to the master.

2. **The Power Limiting Function:** The master inverter directly issues the target value of Active Power Limitation. The command is in percentage form of rated power. The range is 0-100.0%.

Method:

1. Set the **"Active Power Limitation"** (register 13089) to 0xAA.
2. Set **"Active Power Limit Ratio"** (register 13090) to the target value. The unit is % and the adjustment accuracy is 0.1.

Note5: If both the "Feed-in Limitation Function" and "Power Limitation Function" have their set values activated simultaneously, the inverter will execute according to the most stringent output power requirement.

For example:
When the "Feed-in Limitation Ratio" is set to 0%,
"Active Power Limit Ratio" is set to 50%,
With a rated inverter power of 10 kW
Scenario: When the load is 8 kW.

1. To meet the 0% Feed-in Limitation requirement, the inverter's output power will be limited to 8 kW (matching the load power).
2. To meet the 50% Active Power Limit requirement, the inverter's output power will be limited to 5 kW (50% of 10 kW rated power).

Result: The inverter will ultimately implement the stricter 5 kW output power limitation.

3.2 Charging/Discharging Control

Table 6 Charging/Discharging Control Parameters

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
1.	BDC rated power	5628	U16		0.1kW	Read-only
2.	Charge/discharge command	13051	U16	0xAA: Charge； 0xBB: Discharge 0xCC: Stop；		Read-Write
3.	Charge/discharge power	13052	U16		1W	Read-Write
4.	Max. SOC	13058	U16	50.0-100.0	0.1%	Read-Write
5.	Min. SOC	13059	U16	0.0-50.0	0.1%	Read-Write
6.	Max. Charging Power	33047	U16		0.01kW	Read-Write
7.	Max. Discharging Power	33048	U16		0.01kW	Read-Write
8.	Charging/Discharging Power –Wide range	33148	U16		0.01kW	Read-Write

3.2.1 Stopping Charging/Discharging

The battery does not output power and is in the stopped state.

Method:

Set **"Charge/discharge command"** (register 13051) to 0xCC. It is the default setting.

3.2.2 Enabling Charging/Discharging

Set battery charging or discharging, where the charging and discharging power range is from 0 to **"BDC rated power"** (register 5628). Also, the charge and discharge power range can also be defined by **"Max. Charging Power"** (register 33047) and **"Max. Discharging Power"** (register 33048).

Method:

1. Set **"Charge/discharge command"** (register 13051) to 0xAA for charging or to 0xBB for discharging。
2. Set **"Charge/discharge power"** (register 13052) to a target value. The unit is W and the adjustment accuracy is 1W. If you set **"Charging/Discharging Power –Wide range"** (register 33148), the unit is kW and the adjustment accuracy is 0.01kW.

Note:

1. **Battery charging/discharging is limited by battery SOC. If battery SOC is higher than the "SOC upper limit" (register 13058), the battery will stop charging. If the battery SOC is lower than "SOC Lower Limit" (register 13059), the battery will stop discharging.**
2. **The battery charging/discharging power is limited by several parameters (including "BDC rated power, maximum charging power, maximum discharging power"), battery SOC, ambient temperature, etc. The battery discharge power is also affected by the "Export power Limitation value" (register 13074) or "Feed-in Limit value - wide range" (register 31222), and it cannot**

exceed this value.

3. **For multi-inverter (master/slave) systems, this parameter only needs to be issued to the master.**

3.3 Off-grid Control

Table 7 Off-grid Parameters

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
1.	Off-grid option	13075	U16	0xAA: Enable 0x55: Disable		Read-Write
2.	Reserved SOC for backup	13100	U16	0-100	%	Read-Write

3.3.1 Disabling Off-grid

The off-grid function is disabled and the BACKUP port has no power output.

Method:

Set **"Off-grid option"** (register 13075） to 0x55 (disabled). It is 0xAA (enabled) by default.

3.3.2 Enabling Off-grid

Set Reserved SOC for backup. When the SOC is lower than Reserved SOC for backup, the battery will enter emergency charging in grid-connected conditions until the SOC is not lower than Reserved SOC for backup. This parameter controls the minimum battery Reserved SOC for backup in grid-connected conditions.

Method:

1. Set **"Off-grid option"** (register 13075) to 0xAA (enabled).
2. Set **"Reserved SOC for backup"** (register 13100) to a target value. The unit is % and the adjustment accuracy is 1%.

Note: For multi-inverter (master/slave) systems, this parameter only needs to be issued to the master.

3.4 Load Control

Table 8 Load Control Parameters

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
1.	DO Configuration	13001	U16	0: Off 1: Load Control Mode 2: Grounding Fault Indication 3: Micro Grid System Mode		Read-Write
2.	Load Control Mode	13002	U16	0: Timing mode; 1: ON/OFF mode; 2: Power optimized mode 3: Disable		Read-Write

3.	Load timing period 1: Start hour	13003	U16	0-23	1h	Read-Write
4.	Load timing period 1: Start minute	13004	U16	0-59	1min	Read-Write
5.	Load timing period 1: End hour	13005	U16	0-23	1h	Read-Write
6.	Load timing period 1: End minute	13006	U16	0-59	1min	Read-Write
7.	Load timing period 2: Start hour	13007	U16	0-23	1h	Read-Write
8.	Load timing period 2: Start minute	13008	U16	0-59	1min	Read-Write
9.	Load timing period 2: End hour	13009	U16	0-23	1h	Read-Write
10.	Load timing period 2: End minute	13010	U16	0-59	1min	Read-Write
11.	Load ON/OFF mode	13011	U16	0xAA (On) 0x55 (Off)		Read-Write
12.	Load power optimized mode: Start hour	13012	U16	0-23	1h	Read-Write
13.	Load power optimized mode: Start minute	13013	U16	0-59	1min	Read-Write
14.	Load power optimized mode: End hour	13014	U16	0-23	1h	Read-Write
15.	Load power optimized mode: End minute	13015	U16	0-59	1min	Read-Write
16.	Optimized power of load	13016	U16	0-60000	1W	Read-Write
17.	Load Rated Power	33274	U16	0-600.00	0.01kW	Read-Write

3.4.1 DO Configuration

Configure the inverter DO port from "normally open" to "normally closed". There are three functions for "normally closed".

- **Load control mode:** the DO port is used to control load access.
- **Grounding fault indication:** the DO port is used to indicate the occurrence of a grounding fault.
- **Micro grid system mode:** the DO port is used to communicate with generator and the system is currently running in micro grid mode.

Method:

Set **"DO Configuration"** (register 13001) to 1, which stands for Load control.

3.4.2 Setting Timing Mode

Set the load timing mode to enable the load in the specified time period and disable the load in other time periods.

Method:

1. Set **"Load Control Mode"** (register 13002) to 0, which stands for timing mode.
2. Set **"Load timing period"** (register 13003-13010) to target time periods, two time periods are available.

3.4.3 Setting ON/OFF Mode

Set the load ON/OFF mode to turn on or turn off the load.

Method:

1. Set **"Load Control Mode"** (register13002) to 1, which stands for on/off mode。
2. Set **"Load ON/OFF mode"** (register13011) as required. 0xAA will turn on the load, while 0x55 will turn off the load.

3.4.4 Setting Power Optimized Mode

Set the power optimized mode to control the load starting condition: In self-consumption mode, when the export power is higher than load optimization power and the time is within the set time period, the DO relay will be automatically closed to power on the load. It will make full use of the remaining PV power and improve the self-consumption rate.

Method:

1. Set **"Load Control Mode"** (register 13002) to 2, which stands for power optimized mode。
2. The threshold to determine whether the load can be turned on can be set via **"Optimized power of load** (register 13016)" or **"Load rated Power"** (register 33274). The two parameters have different maximum limits. If the value is higher than 60 kW, **"Load rated Power"** (register 33274) is recommended ".
3. Set **"Load power optimized mode"** (register 13012-13015) to target time period.
4. when the export power is higher than load optimization power and the time is within the set time period, the DO relay will be automatically closed to power on the load for at least 20 minutes.

Note:

1. **For load control, the load power supply is actually controlled by the inverter DO port. So the "DO Configuration" (register 13001) should be set to 1.**
2. **For multi-inverter (master/slave) systems, this parameter only needs to be issued to the master.**

3.5 Setting Energy Management Mode

Table 9 Energy Management Parameters

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
1.	EMS mode selection	13050	U16	0: Self-consumption mode 2: Compulsory mode 3: External EMS mode 4: VPP		Read-Write
2.	External EMS heartbeat	13080	U16	0-1000	1s	Read-Write
3.	Charge/discharge command	13051	U16	0xAA: Charge; 0xBB: Discharge 0xCC: Stop		Read-Write
4.	Charge/discharge power	13052	U16			Read-Write

No.	Name	Register	Data type	Data range	Unit/Ratio	Remarks
5.	Forced Charging Valid Time	33208	U16	0xAA: Enable 0x55: Disable		Read-Write
6.	Forced Charging Start Time 1(h)	33209	U16	0: Weekday 1: Everyday		Read-Write
7.	Forced Charging Start Time 1(min)	33210	U16	0-23	h	Read-Write
8.	Forced Charging End Time 1(h)	33211	U16	0-59	min	Read-Write
9.	Forced Charging End Time 1(min)	33212	U16	0-23	h	Read-Write
10.	Forced Charging Target SOC1	33213	U16	0-59	min	Read-Write
11.	Forced Charging Start Time 2(h)	33214	U16	0-100	%	Read-Write
12.	Forced Charging Start Time 2(min)	33215	U16	0-23	h	Read-Write
13.	Forced Charging End Time 2(h)	33216	U16	0-59	min	Read-Write
14.	Forced Charging End Time 2(min)	33217	U16	0-23	h	Read-Write
15.	Forced Charging Target SOC 2	33218	U16	0-59	min	Read-Write
16.	Forced Charging Valid Time	33219	U16	0-100	%	Read-Write

Four Energy Management Modes are available.

- **Self-consumption mode:** the inverter dispatches itself, if the PV is sufficient, the load will take priority, if the PV is insufficient, the battery will discharge for supplement, to maximize the green electricity utilization rate.
- **Compulsory mode:** The inverter controls battery charge and discharge as much as possible based on the set mandatory charge and discharge power. This mode is used for general maintenance.
- **External EMS mode:** The external energy management system controls the inverter via Modbus RTU or TCP.
- **VPP:** The same as External EMS mode.

Method:

1. Set **"EMS mode selection"** (register 13050) as required, 0 for Self-consumption mode for example.
2. If the **"EMS mode selection"** (register 13050) is set to 2 (Forced mode), you can continue to set the battery **"Charging/discharging Command**" (register 13051) and the charging/discharging Power" (register 13052).
3. If the **"EMS mode selection"** (register 13050) is set to 3 (External EMS mode) or 4 (VPP), the inverter is fully scheduled by the external energy management system or VPP system. The scheduling command is delivered via Modbus protocol. Deliver the heartbeat value within the timeout period of **"External EMS Heartbeat"** (register 13080). If the heartbeat value is not delivered within the timeout period, the inverter returns to self-consumption mode. For example, if External EMS Heartbeat is set to 20s, you are advised to set the value to 20 every 10 seconds on average.
4. If you need to redefine the battery discharge and charge time period based on the electricity price difference or load usage period in self-consumption mode, you can set forced charging and its time period (register 33208-33219).

Note: For multi-inverter (master/slave) systems, this parameter only needs to be issued to the master.

4 Examples

4.1 Acquire One Piece of Running Information

Supposed that the inverter address is 1, it needs to acquire data from address 5000 of 3x address type.

The PC sends (HEX):

01 04 13 87 00 01 85 67

The inverter replies (HEX):

01 04 02 0E 28 BD 4E

Note: The type code of inverter is 0xE28

4.2 Acquire Multiple Running Information

Supposed that the inverter address is 1, it needs to acquire 10 data from address starting from 5000 of 3x address type

The PC sends (HEX):

01 04 13 87 00 0A C4 A0

The inverter replies (HEX):

01 04 14 0E 28 00 FA 00 01 03 5C 2B F6 00 0B 00 00 00 00 01A9 00 00 3F 05

Note: The type code of inverter is 0xE28. The nominal output power is 25.0 kW, three-phase four-wire. Daily power generation is 86.0kWh. The total power generation is 73215.0 kWh. The internal temperature is 42.5℃.

4.3 Read One Setting Datum

Supposed that the inverter address is 1, it needs to read data from address 5000 of 4x address type.

The PC sends (HEX):

01 03 13 87 00 01 30 A7

The inverter replies (HEX):

01 03 02 07 D8 BA 2E

Note: the data read out is year 2008.

4.4 Read Multiple Setting Data

Supposed that the inverter address is 1, it needs to read 10 data from address starting from 5000 of 4x address type.

The PC sends (HEX):

01 03 13 87 00 06 71 65

The inverter replies (HEX):

01 03 0C 07 DA 00 0A 00 1E 00 09 00 28 00 25 F2 D3

Note: The data are October 30th, 2010, 09:40:37.

4.5 Set One Datum

Supposed that the inverter address is 1, it needs to set data from address 5000 of 4x address type.

The PC sends (HEX):

01 10 13 87 00 01 02 07 DA 19 4D

The inverter replies (HEX):

01 10 13 87 00 01 B5 64

Or

The PC sends (HEX):

01 06 13 87 07 DA BE CC

The inverter replies (HEX):

01 06 13 87 07 DA BE CC

Note: The setting data is year 2010

4.6 Set Multiple Data

Supposed that the inverter address is 1, it needs to set 10 data to address starting from 5000 of 4x address type.

The PC sends (HEX):

01 10 13 87 00 06 0C 07 D9 00 0A 00 1E 00 09 00 10 00 00 FA 81

The inverter replies (HEX):

01 10 13 87 00 06 F4 A6

Note: The data are October 30th, 2009, 09:16:00.

4.7 Acquire SN

Supposed that the inverter address is 1, it needs to acquire 10 data from address starting from 4990 of 3x address type

The PC sends (HEX):

01 04 13 7D 00 0A E4 91

The inverter replies (HEX):

01 04 14 31 32 31 32 31 32 30 30 31 00 00 00 00 00 00 00 00 00 00 9B 56

Note:

1. SN data type is UTF-8;
2. Serial number is: 121212001

4.8 Read Device Running Information

Supposed that the inverter address is 1. It needs to acquire 2 data from address starting from 13000 of RO (Read-Only) type.

The PC sends (HEX):

01 04 32 C7 00 02 CE 8E

The inverter replies (HEX):

01 04 04 40 00 00 0D 2F 81

Note:

1. The running state of the inverter is external EMS mode (0x4000).
2. Power flow status: PV generation, battery discharging, load power (0x0D, corresponding to BIT0, BIT2, BIT3 is 1).

5 Appendix

Appendix 1 Adaptive Inverter Models

Note: **String/MPPT means the string number in a MPPT. For example, the string/MPPT of SH8.0RS is 1;1;1;1, which means that the inverter has a total of 4 strings, one string per MPPT.**

Table 10 Adaptive Inverter Models

Series	Specific model	Device type code	MPPT	String/MPPT
SH3.0-6.0RS	SH3.0RS	0xD17	2	1;1
	SH3.6RS	0xD0D	2	1;1
	SH4.0RS	0xD18	2	1;1
	SH5.0RS	0xD0F	2	1;1
	SH6.0RS	0xD10	2	1;1
SH8.0-10RS	SH8.0RS	0xD1A	4	1;1;1;1
	SH10RS	0xD1B	4	1;1;1;1
SH5.0-10RT	SH5.0RT	0xE00	2	1;1
	SH6.0RT	0xE01	2	1;1
	SH8.0RT	0xE02	2	1;1
	SH10RT	0xE03	2	1;1
	SH5.0RT-20	0xE10	2	1;1
	SH6.0RT-20	0xE11	2	1;1
	SH8.0RT-20	0xE12	2	1;1
	SH10RT-20	0xE13	2	1;1
	SH5.0RT-V112	0xE0C	2	1;1
	SH6.0RT-V112	0xE0D	2	1;1
	SH8.0RT-V112	0xE0E	2	1;1
	SH10RT-V112	0xE0F	2	1;1
	SH5.0RT-V122	0xE08	2	1;1
	SH6.0RT-V122	0xE09	2	1;1
	SH8.0RT-V122	0xE0A	2	1;1
	SH10RT-V122	0xE0B	2	1;1
SH5-25T	SH5T	0xE20	2	1;1
	SH6T	0xE21	2	1;1
	SH8T	0xE22	2	1;1
	SH10T	0xE23	2	2;1
	SH12T	0xE24	2	2;1
	SH15T	0xE25	3	2;2;1
	SH20T	0xE26	3	2;2;1
	SH25T	0xE28	3	2;2;1
MG5-10RL	MG5RL	0xD27	2	1;1
	MG6RL	0xD28	2	1;1
	MG8RL	0xD29	3	1;1;1
	MG10RL	0xD2A	3	1;1;1

Appendix 2 Running State

State	Register value	Explanation	Power generation
Running (On-**grid)**	0x0000/0x0040	After being energized, inverter tracks the PV arrays' maximum power point (MPP) and converts the DC power into AC power. This is the normal operation mode.	√
Microgrid Operation	0x0014	The inverter is running with the generator.	√
Running in maintain mode	0x0400	Battery needs maintenance and the inverter will discharge the battery to empty first and then fully charge the battery.	√
Running in compulsory mode	0x0800	The inverter is in the energy management state that charge or discharge the battery forcibly.	√
Running (off-grid)	0x1000	The inverter works in off-grid mode and supplies power to the load through the backup port.	√
Open loop	0x2000	The test mode for inverter interior and it is used to detect the inverter.	×
Running in External EMS mode	0x4000	The inverter is receiving external energy scheduling.	√
Emergency Charging Operation	0x4001	The inverter is performing emergency battery charging.	√
Uninitialized	0x1111	The inverter is not initialized. The grid-connected standard has not been set and the inverter cannot be connected to the grid yet.	×
Stop	0x8000/0x0001	The inverter is stopped.	×
Key stop	0x1300/0x0002	The inverter will stop operation by manually "stop" via app. In this way, inverter internal DSP stops. To restart the inverter, manually start via app.	×
Emergency Stop	0x1500/0x0004	When the dry contact signal of the inverter is triggered by external device, the inverter performs an emergency shutdown and the inverter is in stop state. This function is supported only when the inverter has dry contact terminal in hardware.	×
Standby	0x1400/0x0008	Inverter enters standby mode when DC side input is insufficient. In this mode inverter will wait.	×
Initial standby	0x1200/0x0010	The inverter is in the initial power-on standby state.	×
Starting	0x1600/0x0020	The inverter is initializing and synchronizing with the grid.	×
Intelligent Station Building Status	0x1800	The PV optimizer or PV rapid shutdown equipment configured with the inverter is during the process of creating a plant. This feature is only supported by inverters that support optimizers or PV rapid shutdown equipment.	×
Warn Running	0x9100	Warning information is detected.	√
Derating Running	0x8100/0x0080	The inverter derates actively due to environmental factors such as temperature or altitude.	√
Dispatch Running	0x8200	The inverter runs according to the scheduling instructions received from the monitoring background. The active power is set to less than 100%.	√
Fault	0x5500/0x0100	If a fault occurs, inverter will automatically stop operation, and disconnect the AC relay. The fault information will be displayed in the app. Once the fault is removed in recovery time, inverter will automatically resume running.	×
AFCI self-test shutdown	0x1700	AFCI self-test detects the arc and the inverter is shutdown.	×
Safe Mode	0x1900	The DC side voltage of the inverter is shut down within the safe voltage range	×
Off-grid Charge	0x0041	When off-grid operation, the battery SOC is low and the inverter directly charges the battery through PV.	×

State	Register value	Explanation	Power generation
Update Failed	0x0200	The inverter firmware fails to upgrade.	×
Communicate fault	0x2500	The internal communication between the ARM and DSP of the inverter fails, and the ARM cannot obtain the status of the DSP running information.	Unconfirmed
Restarting	0x2501	The inverter is restarting.	×

Appendix 3 Power Flow State

Power Flow State			
Bit0	PV power	Bit0 == 0	No power generated from PV
		Bit0 == 1	Power generated from PV
Bit1	Battery charging	Bit1 == 0	Not charging
		Bit1 == 1	Charging
Bit2	Battery discharging	Bit2 == 0	Not discharging
		Bit2 == 1	Discharging
Bit3	Positive load power	Bit3 == 0	No load power
		Bit3 == 1	With load power
Bit4	Feed-in power	Bit4 == 0	No power feed-in the grid
		Bit4 == 1	Power feed-in the grid
Bit5	Import power from grid	Bit5 == 0	No power imported from the grid
		Bit5 == 1	Importing power from grid
Bit6	Reserved	/	/
Bit7 (retrofitting system)	Negative load power	Bit7 == 0	No power generated from “Load”
		Bit7== 1	Power generated from “Load”

Appendix 4 Fault Codes

Bit-based fault analysis of inverter:

Inverter alarm	Bit0	Fan Alarm
	Bit1	Lightning Protection Alarm on AC Side
	Bit2	Lightning Protection Alarm on DC Side
	Bit3	Bypass Switch Abnormal
	Bit4	Communication Alarm
	Bit5	Parallel Communication Alarm
	Bit6	Device Abnormality
	Bit7	Junction Box leakage Protector Alarm
	Bit8	PV1 Abnormal Warn
	Bit9	PV2 Abnormal Warn
	Bit10	PV3 Abnormal Warn
	Bit11	PV4 Abnormal Warn
	Bit12	Fan 2 Rotate Low Speed Alarm
	Bit13	Fan 2 Stall Alarm
	Bit14	The energy meter input and output ports are reversed, or the meter is connected to other wrong terminals
	Bit15	Software Version Mismatch
	Bit16	SPD or Fuse Alarm
	Bit17	FRAM Read Alarm
	Bit18	SPI Com Alarm
	Bit19	Ambient Temperature Sensor Open Circuit Alarm
	Bit20	Ambient Temperature Sensor Short Circuit Alarm

	Bit21	Inversion T Sensor Open Circuit Alarm
	Bit22	Inversion T Sensor Short Circuit Alarm
	Bit23	Boost T Sensor Open Circuit Alarm
	Bit24	Boost T Sensor Short Circuit Alarm
	Bit25	Input Cfg Alarm In DC Source Mode Or Clock Reset Abnormal Alarm
	Bit26	PV HV Flt
	Bit27	Ambient Low Temperature Sensor Open Circuit Alarm
	Bit28	Fan 1 Low Rotation Speed Alarm
	Bit29	Fan 1 Stall Alarm
	Bit30	Meter Communication Alarm
	Bit31	BOOST Short Circuit Alarm
Grid-side fault	Bit0	Grid Overvoltage
	Bit1	Grid Transient V-over
	Bit2	Grid Under-voltage
	Bit3	Grid V-low
	Bit4	Reserved
	Bit5	AC C-over
	Bit6	Grid Over-frequency
	Bit7	Grid Under-frequency
	Bit8	Grid Power Outage
	Bit9	Device Abnormality
	Bit10	Excessive Leakage Current
	Bit11	Grid Abnormal
	Bit12	10 Minutes Grid Overvoltage
	Bit13	High Grid Voltage
	Bit14	Output Overload
	Bit15	Grid Voltage Imbalance
	Bit16	Inversion C-over Hardware Flt
	Bit17	High Grid Frequency
	Bit18	Grid F-low
	Bit19	V-Grid Uniform Fault
	Bit20	Grid Frequency Uniform Fault
	Bit21	Network Side Protection Self-test Failed
	Bit22	Grounding Cable Fault
	Bit23	Inversion V DC Ject V-over Flt
	Bit24	AC Side Under-voltage
	Bit25	AC Side Overvoltage
	Bit26	AC Side Under-frequency
	Bit27	AC Side Over-frequency
	Bit28	Vac Unbal
	Bit29	Bypass Instantaneous Overcurrent
	Bit30	Bypass Switch Over Current
	Bit31	Reserved
System fault 1	Bit0	Inversion Switch Tube Over-temperature
	Bit1	BOOST Switch Tube T-over

	Bit2	PV IR Flt
	Bit3	Bypass Switch Fault
	Bit4	EPS Relay Failure
	Bit5	Junction Box Relay Fault
	Bit6	Input and Output Mismatch Fault
	Bit7	PV HV P-over Alarm or Prot
	Bit8	Redundancy Fault
	Bit9	R-phase inverter voltage sampling channel abnormal
	Bit10	S-phase inverter voltage sampling channel abnormal
	Bit11	T-phase inverter voltage sampling channel abnormal
	Bit12	R-phase DC component sampling channel abnormal
	Bit13	S-phase DC component sampling channel abnormal
	Bit14	T-phase DC component sampling channel abnormal
	Bit15	PV 1 current sampling channel abnormal
	Bit16	PV 2 current sampling channel abnormal
	Bit17	PV 1 MPPT current sampling channel abnormal
	Bit18	PV 2 MPPT current sampling channel abnormal
	Bit19	Control Board Power Supply Under-voltage Fault
	Bit20	Leak Current CT Self-detection Fault
	Bit21	SPI Com Flt
	Bit22	LCD and Main DSP Communication Fault
	Bit23	Reserved
	Bit24	PV3 current sampling channel failure
	Bit25	N-wire current sampling channel abnormal
	Bit26	Balance bridge current sampling channel abnormal
	Bit27- Bit31	Reserved
System fault 2	Bit0	Module Over-temperature
	Bit1	Excessively High Ambient Temperature
	Bit2	Device Abnormality
	Bit3	Low System Insulation Resistance
	Bit4 - Bit6	Device Abnormality
	Bit7	Low Ambient Temperature
	Bit8 - Bit10	Device Abnormality
	Bit11	Input Configuration Abnormality
	Bit12 - Bit14	Device Abnormality
	Bit15	Backup Load Overpower Fault
	Bit16 - Bit31	Reserved
DC-side fault	Bit0 - Bit3	Device Abnormality
	Bit4	PV Access Failure
	Bit5 – Bit6	Device Abnormality
	Bit7 - Bit8	Reserved
	Bit9	PV1 Reverse Connection Fault
	Bit10	PV2 Reverse Connection Fault
	Bit11 – Bit15	Device Abnormality
	Bit16	Bus Overvoltage Hardware Fault

	Bit17	Busbar Average Under-voltage
	Bit18	PV Hardware Overcurrent Fault
	Bit19	PV Voltage Exceeds Bus Voltage
	Bit20	BOOST1 Short Circuit Fault
	Bit21	BOOST2 Short Circuit Fault
	Bit22	DC C-over
	Bit23	PV3 Overcurrent
	Bit24	PV3 Reverse Connection Fault
	Bit25	BOOST3 short circuit fault
	Bit26	Half-bus overvoltage hardware fault
	Bit27	Balance bridge overcurrent hardware fault
	Bit28	PV4 Reverse Connection Fault
	Bit29 - Bit31	Reserved
Permanent fault	Bit0	PV Overcurrent Permanent Fault
	Bit1	Inversion Overcurrent Permanent Fault
	Bit2	High DC Injection Permanent Fault
	Bit3	Bus V-over Perm. Flt
	Bit4	Relay Perm Fault
	Bit5	PV1 Self-check Permanent Fault
	Bit6	PV2 Self-check Permanent Fault
	Bit7	Inversion Open-loop Self-detection Perm. Flt
	Bit8	Entire Temperature Sensor Failure
	Bit9	BOOST3 open-loop self-check permanent fault
	Bit10	Balance bridge overcurrent permanent fault
	Bit11	Half-bus overvoltage permanent fault
	Bit12 - Bit31	Reserved
BDC-side fault	Bit0	BDC Charge Transient I-over
	Bit1	BDC Discharge Transient I-over
	Bit2	Clamping Capacitance V-low Fault
	Bit3	Clamping Capacitance Transient V-over
	Bit4	Reserved
	Bit5	Battery Pre-charge Relay Failure
	Bit6 - Bit7	Reserved
	Bit8	BDC Self-detect Flt
	Bit9 - Bit11	Reserved
	Bit12	BDC T-over Flt
	Bit13 - Bit15	Reserved
	Bit16	BDC Hardware I-over
	Bit17 - Bit19	Reserved
	Bit20	BDC Current Sampling Channel Abnormality
	Bit21	Reserved
	Bit22	Leakage Current Sampling Channel Abnormality
	Bit23	Secondary DSP Communication Fault
	Bit24	BDC Soft Start Flt
	Bit25 - Bit31	Reserved

BDC-side permanent fault	Bit0	BDC I-over Perm. Flt
	Bit1	Reserved
	Bit2	Battery Overvoltage Permanent Fault
	Bit3	Reserved
	Bit4	BDC Self-detect Permanent Flt
	Bit5 - Bit6	Reserved
	Bit7	BDC Soft Start Perm. Flt
	Bit8 - Bit31	Reserved
Battery fault	Bit0 - Bit2	Reserved
	Bit3	Battery Average Under-voltage Fault
	Bit4 - Bit6	Reserved
	Bit7	Battery Over-temperature Fault
	Bit8	Battery Low Temperature Fault
	Bit9 - Bit10	Reserved
	Bit11	Battery Transient Overvoltage
	Bit12	Battery Average Overvoltage Fault
	Bit13	Reserved
	Bit14	BMS Communication Fault
	Bit15	Battery Hardware Overvoltage
	Bit16	Abnormal Battery Connection(Reversed Polarity)
	Bit17	BMS and Battery Fault
	Bit18 - Bit31	Reserved
Battery alarm	Bit0	BDC T Sensor Open Circuit Alarm
	Bit1	BDC T Sensor Short Circuit Alarm
	Bit2 - Bit31	Reserved

Bit-based fault analysis of individual battery:

BMS alarm	Bit0	Overvoltage Alarm
	Bit1	Over-temperature Alarm
	Bit2	Low Temperature Alarm
	Bit3	Charge/Discharge Overcurrent Alarm
	Bit4	Reserved
	Bit5	Battery Voltage Unbalance
	Bit6	Reserved
	Bit7	Under-voltage Alarm
	Bit8	Abnormal SD Card
	Bit9	Cell Voltage Imbalance Alarm
	Bit10	Cell Temperature Difference Alarm
	Bit11	Battery Module Inconsistency Alarm
	Bit12	Mixed Cell Alarm
	Bit13 - Bit31	Reserved
BMS protection	Bit0	Overvoltage Protection
	Bit1	Over-temperature Protection
	Bit2	Low Temperature Protection
	Bit3	Charge/Discharge Overcurrent Protection

	Bit4	Over Charge Power Limit Fault
	Bit5	Over Discharge Power Limit Fault
	Bit6	Reserved
	Bit7	Low Voltage Protection
	Bit8	Slave Battery Fault
	Bit9	Pre-Charge Failed
	Bit10	Abnormal External Power Line Status
	Bit11	Current Sampling Fault
	Bit12	Temperature Sampling Fault
	Bit13	Voltage Sampling Fault
	Bit14	Battery Internal Communication Failure
	Bit15	DC Contactor Failure
	Bit16 - Bit31	Reserved
BMS fault 1	Bit0	FET Failure/Battery Switch Failure
	Bit1	Failure in Battery Internal Hardware
	Bit2	Overcurrent Fault
	Bit3	Battery Short Circuit Fault
	Bit4	Internal Communication Fault
	Bit5	Input Overvoltage
	Bit6	Reserved
	Bit7	Software Version Mismatch Fault
	Bit8	Heating Alarm
	Bit9	Heating Circuit Abnormal
	Bit10 - Bit11	Reserved
	Bit12	Battery Self-test Fault
	Bit13 - Bit31	Reserved
BMS fault 2	Bit0 – Bit31	Reserved
BMS alarm 2	Bit0	BMS Internal Alarm
	Bit1 - Bit31	Reserved

Appendix 5 Load Control Mode

Load Control Mode	Description
0: Timing mode	Turn no the load within the set time period.
1: ON/OFF mode	Control the load according to the set switch state.
2: Power optimized mode	In the self-consumption mode, the feed power is > the rated power of the load. The DO relay automatically pulls in within the set time frame, thus the surplus PV power can be fully utilized to increase the self-consumption rate; Tips: (1) It is forbidden to enable this function in off-grid mode or inverter fault state; (2) When the intelligent mode is enabled, the DO will run for at least 20 minutes after DO relay closed; (3) When the communication of the smart energy meter is abnormal, maintain the original DO state before the abnormality until the intelligent mode time is over, and then disconnect DO;

Appendix 6 Energy Management Mode

Energy Management Mode	Description
0: Self-Consumption (Default)	Inverter self-scheduling.
2: Compulsory Mode	The inverter is devised to charge or discharge the battery with the charging and discharging power as much as practicable.
3: External EMS Mode	The external energy management system controls the inverter via Modbus RTU or TCP.
4: VPP	The inverter receives charge and discharge commands from an external VPP system.