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Beijing IN-POWER Electric Co., Ltd.

Protocol for External ModBus Communication of PCS

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Document name	Protocol for External ModBus Communication of PCS					
Scope of application						
Creation	**Prepared by:**	Peng Yu	**Date:**	2021.11.20	**Version No.:**	V1.0
	Newly created.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2021.12.20	**Version No.:**	V1.1
	1. Revised to add split-phase active and reactive power settings.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2022.1.19	**Version No.:**	V1.2
	1. Revised the protocol of CMS to BMS communication data. 2. Modified the definition of fault word, and added PCS and DCDC communication fault, EMS communication fault and dry contact input fault. 3. Added the rules for offset address under multi-module parallel connection. 4. Added the description that DCDC system is not included.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2022.1.25	**Version No.:**	V1.3
	1. Added the upper computer to display the above fault code for query. 2. Added the EMS communication fault as well as DC fuse and emergency stop input fault.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2022.2.20	**Version No.:**	V1.4
	1. Deleted the description of the temporarily unsupported RS485 from the hardware part of the protocol.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2022.9.16	**Version No.:**	V1.6
	1. RS485 is supported.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2022.9.30	**Version No.:**	V1.7
	1. Modified the DCDC fault word parsing to fault code determination.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2022.12.18	**Version No.:**	V1.8
	1. Added one PCS fault word 5, address 256, and added phase N current display.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2022.12.21	**Version No.:**	V1.9
	1. Added BMS dry contact fault valid status to remote signaling address 94, corresponding to PCS version 641.0 or above.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2023.1.3	**Version No.:**	V2.0
	1. Added primary FM parameter address 319 frequency dead zone, address 320 active power FM coefficient K.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2023.6.13	**Version No.:**	V2.2
	1. Redefined the function of addresses 280-295. Supported read-only and read-write.					
Revision	**Prepared by:**	Peng Yu	**Date:**	2023.9.1	**Version No.:**	V2.3
	1. Modified the network port speed as 100M full duplex. 2. Added temperature display to addresses 257-261. 3. Added DC component overrun to fault word 3. 4. Modified communication use cases.					

I. Overview

This protocol is applicable to the communication between the energy storage system of PCS and the background monitoring system. It can read the running information and fault status of the inverter in real time, and control the running of the system.

II. Physical Interface

1. Ethernet

   Transmission mode: ModBus Tcp

   Network card type: 100M full duplex

   Maximum frame length: 263 bytes

   Maximum slave response time: 20ms

   Minimum master polling interval: 5ms

   IP address: 192.168.0.20

   Port No.: 502

   Check mode: Hardware check

   Modbus station address: 1 by default

2. RS485

   Transmission mode: ModBus RTU

   Baud rate: 4800, 9600, 19200, etc. may be set; 9600 by default

   Check bit: No check;

   Data bit: 8 bits;

   Stop bit: 1 bit;

   Frame interval: Not less than 3.5 bytes of time;

   Intra-frame character interval: Not more than 1.5 bytes of time;

   Maximum frame length: 100 bytes;

   Maximum slave response time: 150 bytes of time;

   Minimum master polling interval: 100 bytes of time;

   Check type: CRC16 check, generator polynomial, with the low byte before the high byte;

   Modbus station address: 1 by default.

III. Protocol Description

Based on the different medium imported on the DC side of PCS, the definition of the register address is different. When DCDC is connected on the DC side of PCS, the labelled address in *(1) is valid. When the energy storage device connected to the PCS system is a battery, *(2) is valid. When the connected energy storage device is a super capacitor or others, *(2) is invalid, and it needs to be communicated separately.

Based on the different mode of import on the DC side of PCS, the definition of the register address is different. When the number of PCS modules connected to the energy storage system is greater than or equal to 2, if the DC side of PCS is connected in parallel, the definition of the register address remains unchanged. If the DC side is a separate system, the access address of N#PCS (N>=2) is +1000 offset from the access address of 1#PCS.

3.1 Data type

Table 1: Data Type

Data type	Explanation
Signed integer_16	16-bit character, 2 complement
Signed integer_32	32-bit word, two consecutive Modbus addresses are used for transmission. The low word is located at the Modbus low address.
Unsigned integer_16	16-bit word
Unsigned integer_32	32-bit word, two consecutive Modbus addresses are used for transmission. The low word is located at the Modbus low address.
Single precision floating point	32-bit word, IEEE-754 floating point format

The data transmission sequence is in big-endian mode, with the high byte before the low byte.

For example: For U16 data 0x0102, the transmission sequence is 01, 02.

3.2 Function code

Table 2: Function Code

Function code	Function	Corresponding address type
0x01	Read slave coil register, bit operation	0x
0x02	Read discrete input register, bit operation	1x
0x03	Read multiple holding registers, byte operation	4x
0x04	Read multiple input registers, byte operation	3x
0x05	Write coil register, bit operation	0x
0x06	Write single holding register, byte operation	4x
0x10	Write multiple holding registers, byte operation	4x

IV. Address Information

4.1 Definition of remote control variable address (address type 0x)

(1) Write single coil: (take ModBus-Tcp format as an example)

0xFF00 request output is ON, and 0x000 request output is OFF

Request: MBAP function code Output address H Output address L Output value H Output value L (12 bytes in total)

Response: MBAP function code Output address H Output address L Output value H Output value L (12 bytes in total)

For example: Set the coil with the address as 0x0002 in the slave station to ON: 00 01 00 00 00 06 01 05 00 02 FF 00

Response: Write successfully-00 01 00 00 00 06 01 05 00 03 FF 00

No.	Modbus address	Name	Permission	Data type	Coefficient	Unit	Remarks
1	00001	Fault reset	Read-write	Bool	1	1	1-Reset
2	00002	Device startup	Read-write	Bool	1	1	1-Startup
3	00003	Device shutdown	Read-write	Bool	1	1	1-Shutdown
4	00004	Remote emergency stop	Read-write	Bool	1	1	1-Emergency stop
5	00005	Accumulated charging power reset to zero	Read-write	Bool	1	1	1-Reset to zero
6	00006	Accumulated discharging power reset to zero	Read-write	Bool	1	1	1-Reset to zero
7	00007	Remote/local settings	Read-write	Bool	1	1	1-Remote; 0-Local
8	00008	Reserve	Read-write	Bool	1	1	
9	00009	Reserve	Read-write	Bool	1	1	
10	00010	Reserve	Read-write	Bool	1	1	
11	00011	Reserve	Read-write	Bool	1	1	
12	00012	Reserve	Read-write	Bool	1	1	
13	00013	Reserve	Read-write	Bool	1	1	
14	00014	Reserve	Read-write	Bool	1	1	
15	00015	Reserve	Read-write	Bool	1	1	
16	00016	Reserve	Read-write	Bool	1	1	

4.2 Definition of remote signaling data address (address type 1x)

(1) Read the input status of continuous discrete quantities from the slave station (take ModBus-Tcp format as an example)

Request: MBAP function code Start address H Start address L Number H Number L (12 bytes in total)

Response: MBAP function code Data length Data (length: 9+ceil (number/8))

Read 16 inputs of discrete quantities starting from address 81 00 01 00 00 00 06 01 02 00 51 00 10

Response: 00 01 00 00 00 06 01 02 02 81 00

The data length is 0x02 bytes, and the data is 0x81 00, which means that the device address 81 and device address 88 are ON, the device is in the grid-connected shutdown status, and the rest are OFF.

It is recommended to read 16 consecutive statuses starting from address 81.

No.	Modbus address	Name	Permission	Data type	Coefficient	Unit	Remarks
1	00081	Shutdown status	Read-only	Bool	1	1	1-Shutdown
2	00082	Standby status	Read-only	Bool	1	1	1-Standby
3	00083	Running status	Read-only	Bool	1	1	1-Running
4	00084	Total fault status	Read-only	Bool	1	1	1-Fault
5	00085	Total alarm status	Read-only	Bool	1	1	1-Alarm
6	00086	Remote/local status	Read-only	Bool	1	1	1-Remote; 0-Local
7	00087	Emergency stop input status	Read-only	Bool	1	1	1-Emergency stop valid
8	00088	Grid-connected status	Read-only	Bool	1	1	1-Grid-connected
9	00089	VF grid-disconnected status	Read-only	Bool	1	1	1-VF grid-disconnected
10	00090	Overload derating	Read-only	Bool	1	1	1-Overload occurred
11	00091	Reserve	Read-only	Bool	1	1	
12	00092	Reserve	Read-only	Bool	1	1	
13	00093	Reserve	Read-only	Bool	1	1	
14	00094	BMS dry contact input	Read-only	Bool	1	1	1-Fault valid
15	00095	Reserve	Read-only	Bool	1	1	
16	00096	Reserve	Read-only	Bool	1	1	

4.3 Definition of remote metering data address (address type 3x)

(1) Read the analog quantity information and fault word of device running from the slave station. (take ModBus-Tcp format as an example)

Request: MBAP function code Start address H Start address L Number of registers H Number of registers L (12 bytes in total)

Response: MBAP function code Data length Register data (length: 9 + number of registers × 2)

For example: Read the data of the register of which the start address is 201 and the number is 0x0003:

00 01 00 00 00 06 01 04 00 C9 00 03

Response: The data length is 0x06, and the phase A voltage of port is 223.0V, phase B 223.0V, phase C 223.0V

00 01 00 00 00 0D 01 04 06 08 B6 08 B6 08 B6

No.	Modbus address	Name	Permission	Data type	Coefficient	Unit	Remarks
1	00201	Phase A voltage of PCS port	Read-only	U16	0.1	V	
2	00202	Phase B voltage of PCS port	Read-only	U16	0.1	V	

3	00203	Phase C voltage of PCS port	Read-only	U16	0.1	V	
4	00204	Phase A current of PCS output	Read-only	S16	0.1	A	
5	00205	Phase B current of PCS output	Read-only	S16	0.1	A	
6	00206	Phase C current of PCS output	Read-only	S16	0.1	A	
7	00207	Grid frequency	Read-only	U16	0.01	Hz	
8	00208	Active power of phase A output of PCS	Read-only	S16	0.1	kW	
9	00209	Active power of phase B output of PCS	Read-only	S16	0.1	kW	
10	00210	Active power of phase C output of PCS	Read-only	S16	0.1	kW	
11	00211	Active power of total output of PCS	Read-only	S16	0.1	kW	
12	00212	Reactive power of phase A output of PCS	Read-only	S16	0.1	kVar	
13	00213	Reactive power of phase B output of PCS	Read-only	S16	0.1	kVar	
14	00214	Reactive power of phase C output of PCS	Read-only	S16	0.1	kVar	
15	00215	Reactive power of total output of PCS	Read-only	S16	0.1	kVar	
16	00216	Apparent power of phase A output of PCS	Read-only	U16	0.1	kVA	
17	00217	Apparent power of phase B output of PCS	Read-only	U16	0.1	kVA	
18	00218	Apparent power of phase C output of PCS	Read-only	U16	0.1	kVA	
19	00219	Apparent power of total output of PCS	Read-only	U16	0.1	kVA	
20	00220	Phase A power factor of PCS output	Read-only	U16	0.001		
21	00221	Phase B power factor of PCS output	Read-only	U16	0.001		
22	00222	Phase C power factor of PCS output	Read-only	U16	0.001		
23	00223	Total power factor of PCS output	Read-only	U16	0.001		
24	00224	PCS input power	Read-only	S16	0.1	kW	PCS DC input power
25	00225	PCS input voltage	Read-only	S16	0.1	V	PCS DC input voltage
26	00226	PCS input current	Read-only	S16	0.1	A	PCS DC input current

27	00227	PCS radiator temperature	Read-only	S16	1	℃	IGBT maximum temperature
28	00228	Reserve	Read-only	S16	1		
29	00229	Reserve	Read-only	S16	1		
30	00230	PCS AC accumulated charging power low 16 bits	Read-only	U16	0.001	kWh	
31	00231	PCS AC accumulated charging power high 16 bits	Read-only	U16	0.001	kWh	
32	00232	PCS AC accumulated discharging power low 16 bits	Read-only	U16	0.001	kWh	
33	00233	PCS AC accumulated discharging power high 16 bits	Read-only	U16	0.001	kWh	
34	00234	PCS DC accumulated charging power low 16 bits	Read-only	U16	0.001	kWh	
35	00235	PCS DC accumulated charging power high 16 bits	Read-only	U16	0.001	kWh	
36	00236	PCS DC accumulated discharging power low 16 bits	Read-only	U16	0.001	kWh	
37	00237	PCS DC accumulated discharging power high 16 bits	Read-only	U16	0.001	kWh	
38	00238	PCS communication status word	Read-only	U16	1		Auto-increased by 1 every second
39	00239	System clock-Second	Read-only	U16	1		
40	00240	System clock-Minute	Read-only	U16	1		
41	00241	System clock-Hour	Read-only	U16	1		
42	00242	System clock-Day	Read-only	U16	1		
43	00243	System clock-Month	Read-only	U16	1		
44	00244	System clock-Year	Read-only	U16	1		
45	00245	PCS program version	Read-only	U16	0.1		
46	00246	FPGA program version	Read-only	U16	1		
47	00247	Phase N current effective value	Read-only	U16	0.1	A	
48	00248	PCS status query code 1	Read-only	U16	1		For running history queries
49	00249	PCS status query code 2	Read-only	U16	1		For running history queries
50	00250	PCS status query code 3	Read-only	U16	1		For running history queries
51	00251	PCS status query code 4	Read-only	U16	1		For running history

							queries
52	00252	PCS status query code 5	Read-only	U16	1		For running history queries
53	00253	PCS status query code 6	Read-only	U16	1		For running history queries
54	00254	PCS status query code 7	Read-only	U16	1		For running history queries
55	00255	PCS status query code 8	Read-only	U16	1		For running history queries
56	00256	PCS fault word 5	Read-only	U16	1		
57	00257	**SOC temperature**	Read-only	U16	1		Temperature difference from ambient temperature is roughly 40°C
58	00258	IGBT temperature 1	Read-only	U16	1		The 8 high bits and 8 low bits are a set of temperature values respectively
59	00259	IGBT temperature 2	Read-only	U16	1		As above
60	00260	IGBT temperature 3	Read-only	U16	1		As above
61	00261	IGBT temperature 4	Read-only	U16	1		As above
62	00262	Reserve	Read-only	U16	1		
63	00263	DCDC input voltage	Read-only	S16	0.1	V	*(1)
64	00264	DCDC output voltage	Read-only	S16	0.1	V	*(1)
65	00265	DCDC input current	Read-only	S16	0.1	A	*(1)
66	00266	DCDC output current	Read-only	S16	0.1	A	*(1)
67	00267	DCDC input power	Read-only	S16	0.1	kW	*(1)
68	00268	DCDC radiator temperature	Read-only	S16	1		*(1)
69	00269	Reserve	Read-only	S16	1		*(1)
70	00270	Reserve	Read-only	S16	1		*(1)
71	00271	DCDC program version	U16	0.1			*(1)
72	00272	PCS fault word 1	Read-only	U16	1		
73	00273	PCS fault word 2	Read-only	U16	1		
74	00274	PCS fault word 3	Read-only	U16	1		
75	00275	PCS fault word 4	Read-only	U16	1		
76	00276	DCDC fault word 1	Read-only	U16	1		*(1)
77	00277	DCDC fault word 2	Read-only	U16	1		*(1)
78	00278	DCDC fault word 3	Read-only	U16	1		*(1)
79	00279	DCDC fault word 4	Read-only	U16	1		*(1)
80	00280	BMS/CMS work instructions	**Read-write**	U16	1		0x1111 charging disabled 0x2222 discharging disabled 0x5555 standby 0xaaaa fault

							0xbbbb normal 0xcccc alarm
81	00281	BMS/CMS allowable charging current	**Read-write**	U16	0.1	A	*(2)
82	00282	BMS/CMS allowable discharging current	**Read-write**	U16	0.1	A	*(2)
83	00283	BMS/CMS SOC	**Read-write**	U16	0.1	%	*(2)
84	00284	BMS/CMS chargeable power	**Read-write**	U16	0.1	kWh	*(2)
85	00285	BMS/CMS dischargeable power	**Read-write**	U16	0.1	kWh	*(2)
86	00286	BMS/CMS total voltage	**Read-write**	U16	0.1	V	*(2)
87	00287	BMS/CMS total current	**Read-write**	S16	0.1	A	*(2)
88	00288	BMS/CMS single highest SOC	**Read-write**	U16	0.1	%	*(2)
89	00289	BMS/CMS single lowest SOC	**Read-write**	U16	0.1	%	*(2)
90	00290	BMS/CMS single highest voltage	**Read-write**	U16	0.1	V	*(2)
91	00291	BMS/CMS single lowest voltage	**Read-write**	U16	0.1	V	*(2)
92	00292	BMS/CMS single highest temperature	**Read-write**	U16	0.1	℃	*(2)
93	00293	BMS/CMS single lowest temperature	**Read-write**	S16	0.1	℃	*(2)
94	00294	BMS/CMS allowable charging power	**Read-write**	U16	0.1	kW	*(2)
95	00295	BMS/CMS allowable discharging power	**Read-write**	U16	0.1	kW	*(2)
96	00296	Reserve	Read-only	U16	1		*(2)
97	00297	Reserve	Read-only	U16	1		*(2)
98	00298	Reserve	Read-only	U16	1		*(2)
99	00299	Reserve	Read-only	U16	1		*(2)
100	00300	Reserve	Read-only	U16	1		*(2)

Note: Addresses 280-295 are used as read-only addresses when the PCS and BMS have an independent communication link, and function code 04 applies. They are used as read-write addresses when the PCS and BMS do not have an independent communication link and EMS and BMS integrated controllers are applied, and function codes 0x03, 0x06, and 0x10 apply.

4.4 Definition of remote regulating data address (address type 4x)

(1) Read the content of continuous blocks of holding registers from the remote device:

Request: MBAP function code Start address H Start address L Number of registers H Number of

registers L (12 bytes in total)

Response: MBAP function code Data length Register data (length: 9 + number of registers × 2)

For example: The start address is 301, and the number of registers is 0x0003:

00 01 00 00 00 06 01 03 01 2D 00 03

Response: The data length is 0x06, the running mode of address 301 is set to 3, constant power mode, and the rest are 0x00

00 01 00 00 00 09 01 03 06 00 03 00 00 00 00

(2) Write a holding register in a remote device:

Request: MBAP function code Register address H Register address L Register value H Register value L (12 bytes in total)

Response: MBAP function code Register address H Register address L Register value H Register value L (12 bytes in total)

For example: Write data 0x0003 to the register with the address as 301: 00 01 00 00 00 06 01 06 01 2D 00 03

Response: Write successfully: 00 01 00 00 00 06 01 06 01 2D 00 03

(3) Write continuous register blocks in a remote device:

Request: MBAP function code Start address H Start address L Number of registers H Number of registers L Byte length Register value (13 + number of registers × 2)

Response: MBAP function code Start address H Start address L Number of registers H Number of registers L (12 bytes in total)

For example: Write data to the register of which the start address is 301 and the number is 0x0003, the data length is 0x06, write constant power, constant voltage 750V, constant current -50A. The data is 0x0003, 0x02EE, 0xFFCE: 00 01 00 00 00 09 01 10 01 2D 00 03 06 00 03 02 EE FF CE

Response: Write successfully 00 01 00 00 00 06 01 10 01 2D 00 03

No.	Modbus address	Name	Permission	Data type	Coefficient	Unit	Remarks
1	00301	Selection of running mode	Read-write	U16	1	/	3 by default 0-None; 1- Constant current charging; 2- Constant voltage charging; 3- Constant power charging;
2	00302	Voltage setting value of constant voltage charging	Read-write	U16	1	V	Charge the battery when it is higher than the current battery voltage, and discharge

							the battery when it is lower than the current battery voltage
3	00303	Current setting value of constant current charging	Read-write	S16	1	A	Negative means discharging to the grid, and positive means charging from the grid. 0 by default
4	00304	Expectation of constant power active power (three-phase three-wire system)	Read-write	S16	0.1	kW	Negative means discharging to the grid, and positive means charging from the grid.
5	00305	Expectation of constant power reactive power (three-phase three-wire system)	Read-write	S16	0.1	kVar	Negative inductive reactive power and positive capacitive reactive power
6	00306	Grid-connected and grid-disconnected settings	Read-write	U16	1	/	Grid-connected by default Grid-connected mode; VF grid-disconnected mode;
7	00307	Grid-disconnected output voltage given (three-phase three-wire system)	Read-write	U16	1	V	230 by default
8	00308	Grid-disconnected output frequency given	Read-write	U16	0.01	Hz	5000 by default
9	00309	Phase A active power of split-phase control (three-phase four-wire system)	Read-write	S16	0.1	kW	Negative means discharging to the grid, and positive means charging from the grid.
10	00310	Phase B active power of split-phase control (three-phase four-wire system)	Read-write	S16	0.1	kW	Negative means discharging to the grid, and positive means charging from the grid.
11	00311	Phase C active power of split-phase control (three-phase four-wire system)	Read-write	S16	0.1	kW	Negative means discharging to the grid, and positive means charging from the grid.
12	00312	Phase A reactive power of split-phase control (three-phase four-wire system)	Read-write	S16	0.1	kVar	Negative inductive and positive capacitive reactive power
13	00313	Phase B reactive power of split-phase control (three-phase four-wire system)	Read-write	S16	0.1	kVar	Negative inductive and positive capacitive reactive power
14	00314	Phase C reactive power	Read-	S16	0.1	kVar	Negative inductive and

		of split-phase control (three-phase four-wire system)	write				positive capacitive reactive power
15	00315	Grid-disconnected output voltage split-phase given A (three-phase four-wire system)	Read-write	U16	1	V	
16	00316	Grid-disconnected output voltage split-phase given B (three-phase four-wire system)	Read-write	U16	1	V	
17	00317	Grid-disconnected output voltage split-phase given C (three-phase four-wire system)	Read-write	U16	1	V	
18	00318	Microgrid DC voltage droop coefficient	Read-write	U16	1	V	0-100V
19	00319	Primary FM frequency dead zone	Read-write	U16	0.01	Hz	Dead zone >=0.05Hz
20	00320	Primary FM K value	Read-write	U16	1	/	Range 0-120 $\Delta P_t = -K_f \frac{\Delta f}{f_N} P_t$
21	00321	Reserve	Read-write	U16	1	/	
22	00322	Reserve	Read-write	U16	1	/	
23	00323	Reserve	Read-write	U16	1	/	
24	00324	Grid-connected and grid-disconnected switch running mode	Read-write	U16	1	/	0- None 1- Manual 2- Automatic 3- Mix 4- Silence
25	00325	Reserve	Read-write	U16	1	/	
26	00326	Battery/super capacitor allowable charging voltage	Read-write	U16	1	V	
27	00327	Battery/super capacitor allowable discharging voltage	Read-write	U16	1	V	
28	00328	Battery/super capacitor allowable charging current	Read-write	U16	1	A	
29	00329	Battery/super capacitor	Read-	U16	1	A	

		allowable discharging current	write				
30	00330	Time synchronization-Second	Read-write	U16	1		
31	00331	Time synchronization-Minute	Read-write	U16	1		
32	00332	Time synchronization-Hour	Read-write	U16	1		
33	00333	Time synchronization-Day	Read-write	U16	1		
34	00334	Time synchronization-Month	Read-write	U16	1		
35	00335	Time synchronization-Year	Read-write	U16	1		
36	00336	Reserve	Read-write	U16	1	/	
37	00337	Reserve	Read-write	U16	1	/	
38	00338	Reserve	Read-write	U16	1	/	
39	00339	Reserve	Read-write	U16	1	/	
40	00340	Reserve	Read-write	U16	1	/	

V. Appendix

PCS fault word 1		
FPGA hardware fault-Phase A hardware overcurrent	1-Fault; 0-Normal	Bit0 setting
FPGA hardware fault-Phase B hardware overcurrent	1-Fault; 0-Normal	Bit1 setting
FPGA hardware fault-Phase C hardware overcurrent	1-Fault; 0-Normal	Bit2 setting
FPGA hardware fault-Phase N hardware overcurrent	1-Fault; 0-Normal	Bit3 setting
FPGA hardware fault-Reserve	1-Fault; 0-Normal	Bit4 setting
FPGA hardware fault-Reserve	1-Fault; 0-Normal	Bit5 setting
FPGA hardware fault-Unit DC voltage fault	1-Fault; 0-Normal	Bit6 setting
FPGA hardware fault-Reserve	1-Fault; 0-Normal	Bit7 setting
FPGA hardware fault-Reserve	1-Fault; 0-Normal	Bit8 setting
FPGA hardware fault-Switching power supply undervoltage	1-Fault; 0-Normal	Bit9 setting
FPGA software fault-Phase A IGBT fault	1-Fault; 0-Normal	Bit10 setting
FPGA hardware fault-Phase B IGBT fault	1-Fault; 0-Normal	Bit11 setting
FPGA hardware fault-Phase C IGBT fault	1-Fault; 0-Normal	Bit12 setting
FPGA hardware fault-Phase N IGBT fault	1-Fault; 0-Normal	Bit13 setting
FPGA hardware fault-Overtemperature fault	1-Fault; 0-Normal	Bit14 setting
FPGA hardware fault-Reserve	1-Fault; 0-Normal	Bit15 setting

PCS fault word 2		
ARM software fault-Phase A output overcurrent	1-Fault; 0-Normal	Bit0 setting
ARM software fault-Phase A output quick-break	1-Fault; 0-Normal	Bit1 setting
ARM software fault-Phase B output overcurrent	1-Fault; 0-Normal	Bit2 setting
ARM software fault-Phase B output quick-break	1-Fault; 0-Normal	Bit3 setting
ARM software fault-Phase C output overcurrent	1-Fault; 0-Normal	Bit4 setting
ARM software fault-Phase C output quick-break	1-Fault; 0-Normal	Bit5 setting
ARM software fault-Phase N output quick-break	1-Fault; 0-Normal	Bit6 setting
ARM software fault-Phase N output quick-break	1-Fault; 0-Normal	Bit7 setting
ARM software fault-AC overvoltage	1-Fault; 0-Normal	Bit8 setting
ARM software fault-AC undervoltage	1-Fault; 0-Normal	Bit9 setting
ARM software fault-AC overfrequency	1-Fault; 0-Normal	Bit10 setting
ARM software fault-AC underfrequency	1-Fault; 0-Normal	Bit11 setting
ARM software fault-Voltage THDU overrun	1-Fault; 0-Normal	Bit12 setting
ARM software fault-System phase loss	1-Fault; 0-Normal	Bit13 setting
ARM software fault-System phase sequence error	1-Fault; 0-Normal	Bit14 setting
ARM software fault-DC polarity reversed	1-Fault; 0-Normal	Bit15 setting

PCS fault word 3		
ARM software fault-DC busbar software overvoltage	1-Fault; 0-Normal	Bit0 setting
ARM software fault-DC busbar software undervoltage	1-Fault; 0-Normal	Bit1 setting
ARM software fault-System overfrequency	1-Fault; 0-Normal	Bit2 setting
ARM software fault-System underfrequency	1-Fault; 0-Normal	Bit3 setting
ARM software fault-DC charging overcurrent	1-Fault; 0-Normal	Bit4 setting
ARM software fault-DC discharging overcurrent	1-Fault; 0-Normal	Bit5 setting
ARM software fault-Islanding protection	1-Fault; 0-Normal	Bit6 setting
ARM software fault-DC component overrun	1-Fault; 0-Normal	Bit7 setting
ARM software fault-AC main contact closing fault	1-Fault; 0-Normal	Bit8 setting
ARM software fault-AC main contact opening fault	1-Fault; 0-Normal	Bit9 setting
ARM software fault-AC soft start closing fault	1-Fault; 0-Normal	Bit10 setting
ARM software fault-AC soft start opening fault	1-Fault; 0-Normal	Bit11 setting
ARM software fault-DC main contact closing fault	1-Fault; 0-Normal	Bit12 setting
ARM software fault-DC main contact opening fault	1-Fault; 0-Normal	Bit13 setting
ARM software fault-DC soft start closing fault	1-Fault; 0-Normal	Bit14 setting
ARM software fault-DC soft start closing fault	1-Fault; 0-Normal	Bit15 setting

PCS fault word 4		
ARM software fault-Ferroelectric parameter storage error	1-Fault; 0-Normal	Bit0 setting
ARM software fault-DC soft start failure	1-Fault; 0-Normal	Bit1 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit2 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit3 setting
ARM software fault-Starting conditions not met	1-Fault; 0-Normal	Bit4 setting
ARM software fault-Switch fault during running	1-Fault; 0-Normal	Bit5 setting

ARM software fault-Inverter startup timeout	1-Fault; 0-Normal	Bit6 setting
ARM software fault-Parameter issuance setting error	1-Fault; 0-Normal	Bit7 setting
ARM software fault-BMS communication fault	1-Fault; 0-Normal	Bit8 setting
ARM software fault-BMS temperature abnormality	1-Fault; 0-Normal	Bit9 setting
ARM software fault-BMS trip	1-Fault; 0-Normal	Bit10 setting
ARM software fault-BMS battery alarm	1-Fault; 0-Normal	Bit11 setting
ARM software fault-DCDC communication fault	1-Fault; 0-Normal	Bit12 setting
ARM software fault-EMS communication fault	1-Fault; 0-Normal	Bit13 setting
ARM software fault-Emergency stop or fuse fault	1-Fault; 0-Normal	Bit14 setting
ARM software fault-PCS fiber-optic communication fault	1-Fault; 0-Normal	Bit15 setting

PCS fault word 5		
ARM software fault-Reserve	1-Fault; 0-Normal	Bit0 setting
ARM software fault-Battery software overvoltage	1-Fault; 0-Normal	Bit1 setting
ARM software fault-Battery software undervoltage	1-Fault; 0-Normal	Bit2 setting
ARM software fault-Busbar unbalance abnormality	1-Fault; 0-Normal	Bit3 setting
ARM software fault-Busbar semi-DC overvoltage	1-Fault; 0-Normal	Bit4 setting
ARM software fault-DCDC startup timeout	1-Fault; 0-Normal	Bit5 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit6 setting
ARM software fault-AC leakage current protection	1-Fault; 0-Normal	Bit7 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit8 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit9 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit10 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit11 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit12 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit13 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit14 setting
ARM software fault-Reserve	1-Fault; 0-Normal	Bit15 setting

DCDC Fault Word Parsing:

0: No fault

1: Reserve

2: Output overcurrent protection (hardware)

3: Communication fault

4: Overcurrent protection (hardware)

5: Reserve

6: Battery side overvoltage

7: Output overvoltage fault (hardware)

8: Output overvoltage protection (software)

9: Output undervoltage fault (software)

10: Fan fault

11: Input overvoltage fault (software)

12: Input overcurrent (software)

13: Input overcurrent (software)

14: Radiator overheat

15: Unit 1 overcurrent fault (hardware)

16: Unit 2 overcurrent fault (hardware)

17: Unit 3 overcurrent fault (hardware)

18: Unit 4 overcurrent fault (hardware)

19: Unit 5 overcurrent fault (hardware)

20: Unit 6 overcurrent fault (hardware)

21: EEPORM read/write fault (ERR21)

22: Unit 1VCE protection (hardware)

23: Unit 2VCE protection (hardware)

24: Unit 3VCE protection (hardware)

25: Unit 4VCE protection (hardware)

26: Unit 5VCE protection (hardware)

27: Unit 6VCE protection (hardware)