OPERATION MANUAL FOR PCS 125KW/100KW PROTOCOL

V1.2.4

DRAFT VERSION

Reversion	Date	Update by	Description	FW version
V1.0.0	2018/4/10	Longqing Xia	File created	
V1.1.0	2019/6/15	Zhiguang Gao	Initial Version	PCS100kW: v2.0.0.6 and above. PCS125kW: v.1.1.7.3 and above
V1.2.0	2020/08/24	Zhiguang Gao	1.Fixed some description error: 0: PCS Off ->2: PCS Off 2.Modify the "close or open" of PCS QS status to "ON or OFF" 3.Modify/fix some description to avoid to misunderstanding.	PCS100kW: v2.0.0.9 and above. PCS125kW: v.1.1.8.4 and above
V1.2.1	2020/10/12	Zhiguang Gao	1. Add chapter 5.3 and 5.7 for AFE mode setting 2. Add chapter5.4 SPF mode setting	PCS100kW: v2.0.1.4 and above. PCS125kW: v1.1.8.6 and above
V1.2.2	2020/12/6	Zhiguang Gao	1. Add chapter 6. Grid code	PCS100kW: v2.0.0.9 and above PCS125kW: v1.1.8.6 and

				above
			1. Add the register[0x1519] for PCS system operation state 2. Update the flowchart of state machine and related description.	PCS100kW: v2.0.1.4 and above. PCS125kW: v1.1.8.6 and above
V1.2.3	2021/06/18	Zhiguang Gao	1. Add configuration steps for LVRT function of VDE4110 grid code in chapter 6.5	PCS100kW: v2.0.1.6 and above. PCS125kW: v1.1.8.6 and above
V1.2.4	2021/09/26	Zhiguang Gao	1. Add some description and content for AU4777.2-2020 grid rule in chapter 6.1	PCS100kW: v2.0.1.7 and above. PCS125kW: v1.1.8.6 and above

Contents

OPERATION MANUAL FOR PCS 125KW/100KW PROTOCOL 1
DRAFT VERSION 1
1. Objectives 8
1.1. Application Notes 8
1.2. Abbreviations 8
2. System architecture 9
2.1. State of DC Disconnect and AC Disconnect [PERIODIC / WHEN NEED] 10
3. Sequence Diagram / Chart of State Machine 11
3.1. State Machine of PCS 11
3.2. Definitions of States 13
3.3. State transitions conditions 16
3.4. Get State Info [PERIODIC / WHEN NEED] 20
4. System Configurations 22
4.1. Installation Configuration 23
4.1.1. Communication Configuration [FIRST RUN / WHEN NEED] 24
4.1.2. Basic Infrastructure Configuration [FIRST RUN / WHEN NEED] 26
4.1.3. Run Mode / Operation Mode [FIRST RUN / WHEN NEED] 27
5. Normal Operation 31
5.1. Run under grid-tie mode 31
5.2. Run under standalone(SA) mode 34
5.3. Run under AFE mode 35
5.4. Transfer from grid-tie mode to SA mode 35
5.5. Transfer from SA to grid-tie mode 35
5.6. Transfer from AFE to grid-tie mode 36

6. Grid code 37
6.1. Set Grid Code 37
6.2. SPF mode setting 39
6.3. Volt-Var function Setting 40
6.4. Volt-Watt function setting 42
6.5. Freq-Watt function setting 43
6.6. Frequency/Voltage ride through function setting 44
7. Miscellaneous 46
7.1. Load Fault Logs [WHEN NEED] 46

Table List

Table 1 Table for State of DC/AC Disconnect 10
Table 2 System State Definitions (2-1) 13
Table 3 System State Definitions (2-2) 14
Table 4 Transition Table (3-1) 16
Table 5 Transition Table (3-2) 19
Table 6 Abbreviation Table 22
Table 7 Configuration Table for Communication with PCS. 24
Table 8 Configuration Table for Communication with BBMS (PCS using) 25
Table 9 Configuration Table for Filed Infrastructure 26
Table 10 Table of Run Mode & Operation Mode 28
Table 11 Configure Run Mode and Operation Mode for GT-A 29
Table 12 Configure Run Mode and Operation Mode for SA-A 30
Table 13 Operation sequence for Power ON in GRID TIE Mode (Standard mode) 32
Table 14 Run Steps for SA Mode 34
Table 15 Steps for AFE mode 35
Table 16 Steps from AFE Mode to GT normal mode 36
Table 17 Steps for setting SPF mode [FIRST RUN / WHEN NEED] 39
Table 18 Steps for disabling SPF mode 39
Table 19 Steps for setting Volt-Var function [FIRST RUN / WHEN NEED] 40
Table 20 Steps for disabling Volt-Var mode 41
Table 21 Steps for setting Volt-Watt function [FIRST RUN / WHEN NEED] 42
Table 22 Steps for disabling Volt-Watt mode 42
Table 23 Steps for setting Freq-Watt function [FIRST RUN / WHEN NEED] 43
Table 24 Steps for disabling Volt-Watt mode 43
Table 25 Steps for setting Freq-Watt function [FIRST RUN / WHEN NEED] 44

Table 26 Steps for disabling Volt-Watt mode.....44
Table 27 Steps for disabling Volt-Watt mode.....46

Figure List

Figure 2-1 System Architecture Diagram Sample A 9
Figure 3-1 State Machine 11

1. Objectives

This document is written for user to understand the system architecture of PCS 125kW/100kW and understand the normal operation on PCS 125kW/100kW. Most knowledge is based on operation via communication on Modbus RTU.

1.1. Application Notes

Before reading this documents, we suggest you read following notes for information inquiring first.

a) Inquiries are generally sorted as PERIODIC / WHEN NEED / FIRST RUN.
b) Recommended period for inquiring information is 100-200ms.
c) Recommended maximum length of inquiry data is 40 -50.
d) Recommended period for inquiring measurements data is 500ms+.
e) In first co-test, a READ is recommended when a WRITE is applied.

1.2. Abbreviations

ID: Address of register Map
RW: Readable / Writable
R: Read only
W: Write Only
OA: Online Access, which means items could be accessed in any STATE of PCS

2. System architecture

In order to describe PCS operation, we define a general system architecture as follows. And the system mentioned in this document would be same as follows. Notes would be added when different appears.

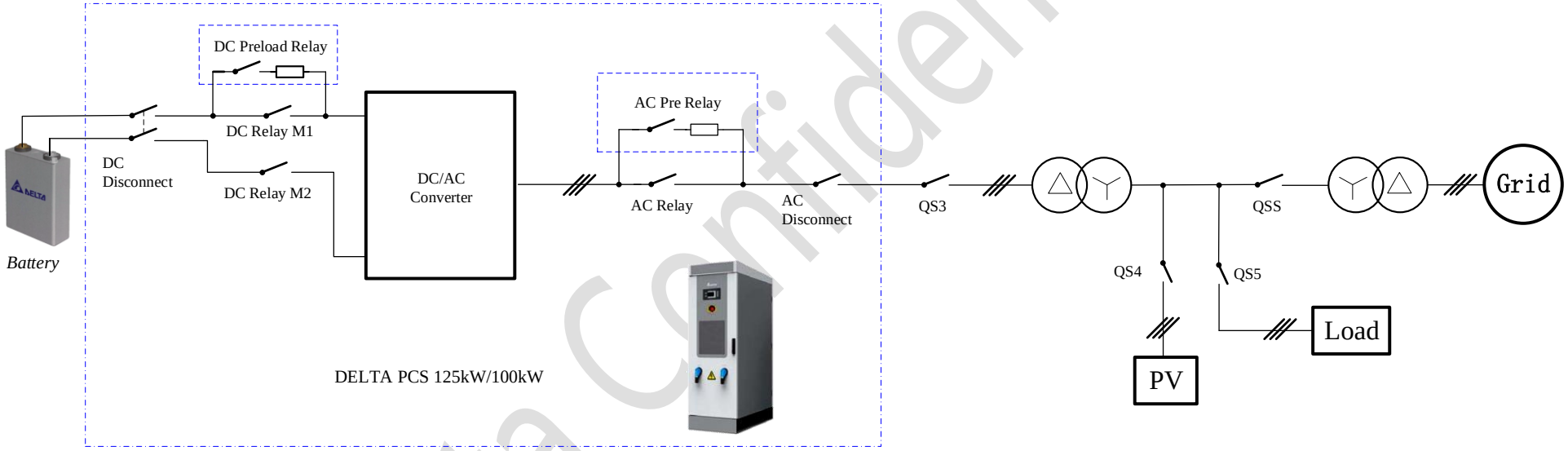

Figure 2-1 System Architecture Diagram Sample A

2.1. State of DC Disconnect and AC Disconnect [PERIODIC / WHEN NEED]

In Fig2-1 you may find 2 breakers, one is DC DISCONNECT and the other one is AC DISCONNECT. User could request PCS for the states of these 2 breakers via following register map, while communication is well connected.

Table 1 Table for State of DC/AC Disconnect

ID (HEX)	Data Group	Definition	Description	RW	OA	Scale	Unit	Min	Max	Default
1514	SYSTEM_STATE	STATE_QS	bit0 STATE_QS_01 "State of QS1. AC switch in PCS 125kW/100kW. 0: OFF; 1: ON. bit1 STATE_QS_02 "State of QS2. DC Switch in PCS 125kW/100kW. 0: OFF; 1: ON. bit2 STATE_QS_03 NA. bit3 STATE_QS_04 NA. bit4 STATE_QS_05 NA. bit5~bit15 NA	R	No	NA	NA	-32768	32767	0

Recommended CMD for inquiring STATE_QS is:

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	15	14	00	01	C0 02

3. Sequence Diagram / Chart of State Machine

3.1. State Machine of PCS

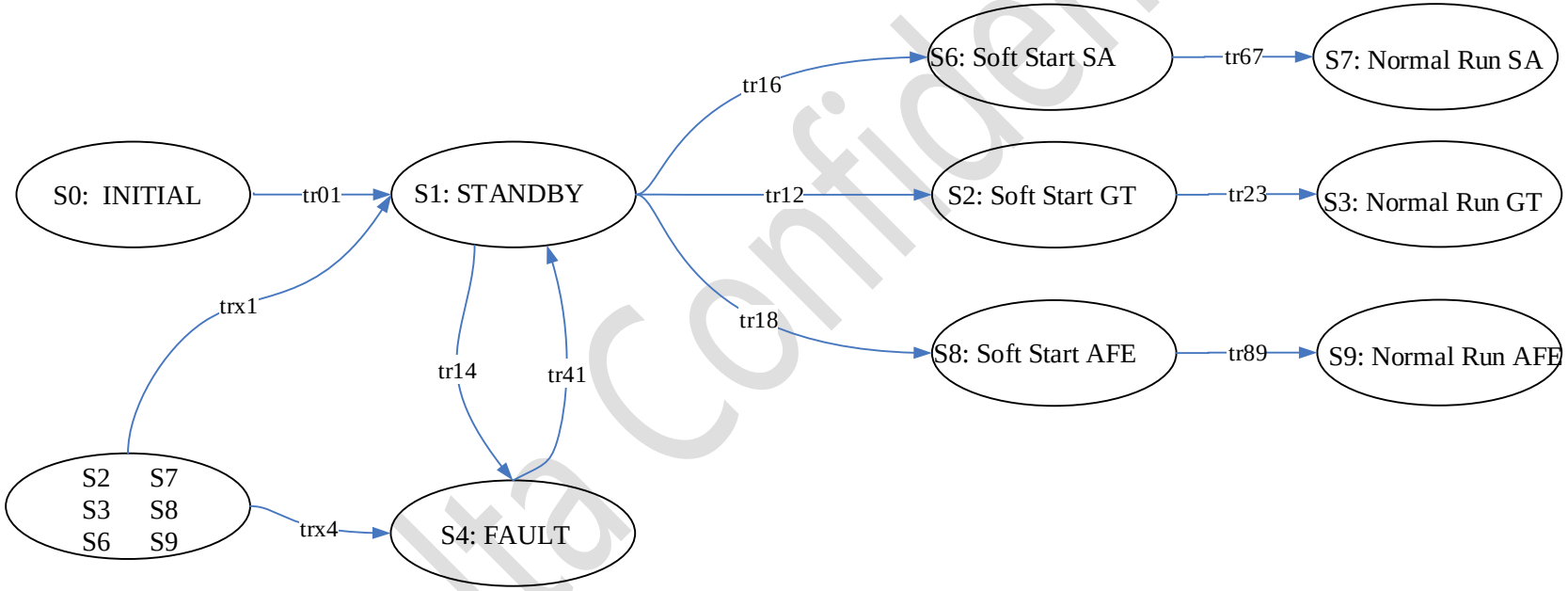

Figure 3-1 State Machine

Refer to section 3.2 for Definitions of States(Sx).

Refer to section 3.3 for State Transitions Condition(trxy).

Refer to section 3.4 for Get State Info of PCS(Method).

3.2. Definitions of States

Table 2 System State Definitions (2-1)

State ID	Name / Definition	DC Relay			AC Relay		PWM	Remark
		M2	Pre-Load	M1	Pre-Load	Main		
S0	Initial	Open	Open	Open	Open	Open	Off	PCS initialization stage. PCSs power on, it will initial hardware /software configuration. Delay 3s to standby.
S1	Standby	Open	Open	Open	Open	Open	Off	System finished initialization. And is waiting for system configuration or operation commands. It will check the system fault and warning condition in standby mode.
S2	Soft Start GT	Open	Open	Open	Open	Open	Off	System is configured as grid tie mode. The method of configuration refers to section 3.3-tr16/tr67.And got PCS on command. Relays operation follow: DC Relay M2 Closed -> DC Pre-Load relay Closed -> DC Relay M1 Closed -> DC Pre-Load relay Open -> AC Pre-Load relay Close -> AC Main Relay Close -> AC Pre-Load Relay Open. Then PCS PWM on. The relay states are showing at the last line.
		Close	Close					
				Close				
			Open					
					Close			
						Close		
					Open			
							On	
		Close	Open	Close	Open	Close	On	

S3	Normal Run GT	Close	Open	Close	Open	Close	On	System is running normally under Grid-Tie Mode.

Table 3 System State Definitions (2-2)

State ID	Name / Definition	DC Relay			AC Relay		PWM	Remark
		M2	Pre-Load	M1	Pre-Load	Main		
S4	Fault	Open	Open	Open	Open	Open	Off	System detected either AC fault, Converter Fault, Hardware fault or Other fault. Fault definition table refer to chapter 4.
S6	Soft Start SA	Open	Open	Open	Open	Open	Off	System is configured as standalone mode, or got command for transfer to standalone mode. PCS got power on command. DC Relay M2 Close -> DC Preload Relay Close -> DC Relay M1 Close -> DC Preload Relay Open -> AC Main Relay Close -> Then PCS PWM On. The relay states are showing at the last line.
		Close	Close					
				Close				
			Open					
						Close		
							On	
		Close	Open	Close	Open	Close	On	
S7	Normal Run SA	Close	Open	Close	Open	Close	On	System is running in normal operation state under standalone mode.
S8	Soft Start AFE	Open	Open	Open	Open	Open	Off	System is configured as grid tie mode. The method of configuration refers to section 3.3-tr18/tr89.And got PCS on command. Relays operation follow: DC Relay M2 Closed -> AC Pre-Load relay Closed ->
		Close						
					Close			
			Close					
				Close				
			Open			Close		

					Open			DC Relay M1 Closed -> DC Pre-Load relay Open -> AC Main relay Close -> AC Pre-Load Relay Open -> Then PCS PWM on. The relay states are showing at the last line.
							On	
		Close	Open	Close	Open	Close	On	
S9	Normal Run AFE	Close	Open	Close	Open	Close	On	System is running in normal operation state under standalone mode.

Note that: Refer to section 3.4 for the definition of system state

3.3. State transitions conditions

Table 4 Transition Table (3-1)

No.	Previous State(s)	Next State	Conditions	Register Operation					Remarks
				Step(s)	R/W	Register ID	Value	Must Option	
tr01	S0	S1	Delay about 1s. after initialization done.	1	R	0x1513	0x01	O	Read PCS system mode. Refers to Section 3.4 for detail method.
tr12	S1	S2	Run Mode: Grid Tie CMD_PCS_GT_OR_SA 0: Grid-tied mode 1: Stand-alone mode Command On. CMD_PCS_ON_OFF 1: PCS On 2: PCS Off Delay about 10s.	1	R	0x1005	0x00	M	Confirm those Settings are correct before operation. Or configure PCS before RUN. Check step1: 0x1005 equal to '0x00' - Pass, If step1 fail, execute step2 until step1 pass. Check step3: 0x1513 equal to '0x01' - Pass, If step3 fail, confirm what's PCS state it is, and fault state by corresponding methods. If step3 pass, process step4. Normally, step 1 and 2 could be ignored. Final PCS state is '0x02'-Soft start GT mode. Note: Every time the PCS is powered on again, the initial value of this register[0x1000] is "0".When this register is written "0", no action is performed.
				2	W	0x1005	0x00	O/M	
				3	R	0x1513	0x01	M	
				4	W	0x1000	0x01	M	
				5	R	0x1513	0x02	O	
tr23	S2	S3	Soft start stage is ongoing. Delay about 3s.	1	R	0x1513	0x02	O	This transition is being done automatically. Final PCS state is '0x03'-Normal Run GT
				2	R	0x1513	0x03	O	

									mode.
tr16	S1	S6	Run Mode: Grid Off (Stand Alone) Command On. Register map refer to tr12. Delay about 10s.	1	R	0x1005	0x01	M	Check step1: 0x1005 equal to '0x01'-Pass,
				2	W	0x1005	0x01	O/M	If step1 fail, execute step2 until step1 pass.
				3	R	0x1513	0x01	M	Check step3: 0x1513 equal to '0x01'-Pass,
				4	W	0x1000	0x01	M	If step3 pass, process step4.
				5	R	0x1513	0x06	O	Final PCS state is '0x06'-Soft start SA mode.
tr67	S6	S7	Soft start stage is done. Delay about 3s.	1	R	0x1513	0x06	O	This transition is being done automatically.
				2	R	0x1513	0x07	O	Final PCS state is '0x07'-Normal Run SA mode.
tr18	S1	S8	Run Mode: AFE CMD_PCS_GT_OR_SA 0: Grid-tied mode 1: Stand-alone mode PR_SYS_RM_FLAG 1: Standard 2: AFE PR_D2A_RM_FLAG 2: AFE 3: VSG Command On. CMD_PCS_ON_OFF 1: PCS On 2: PCS Off	1	R	0x1005	0x00	M	Confirm those Settings are correct before operation. Or configure PCS before RUN. Check step1: 0x1005 equal to '0x00' - Pass, If step1 fail, execute step2 until step1 pass. Check step3: 0x1513 equal to '0x01' - Pass, If step3 fail, confirm what's PCS state it is, and fault state by corresponding methods. If step3 pass, process step4-step5. Normally, step 1 and 2 could be ignored. Final PCS state is '0x08'- AFE Power On. Note: Every time the PCS is powered on again, the initial value of this register[0x1000] is "0".When this register is written "0", no action is performed.
				2	W	0x1005	0x00	O/M	
				3	R	0x1519	0x01	M	
				4	W	0x1081	0x02	M	
				5	W	0x1082	0x02	M	
				6	W	0x1000	0x01	M	
				7	R	0x1519	0x09	O	
tr89	S8	S9	Soft start stage is done. Delay about 3s.	1	R	0x1519	0x06	O	This transition is being done automatically. Final PCS state is '0x09'- AFE Normal.

Note: a time delay between command and next state request should be over 20ms.

Note2: PCS will respond the corresponding operation only after the system state enters normal operation. for example, the power demand commands only available under the normal run state of grid-tied mode(0x06), Voltage and Frequency regulation only available under the normal run state of stand-alone mode.

Note3: The time delay is an approximate time of execution of ONE PCS. It needs an additional about 3 seconds for each PCS for parallel system.

Table 5 Transition Table (3-2)

No.	Previous State(s)	Next State	Conditions	Register Operation					Remarks
				Step(s)	R/W	Register ID	Value	Must Option	
trx4, tr14	S1, S2, S3, S6, S7 S8 S9	S4	Any fault is detected. Delay time depends on the check time of fault.	1	R	0x1513	0x04	O	Get detail fault info from step2 to step 9. Detail description about fault definition please refer to protocol file. FAULT_SYS_GRID_AC(0x15B0) FAULT_SYS_BAT(0x15B1) FAULT_SYS_HARDWARE(0x15B2) FAULT_SYS_OTHER(0x15B3) FAULT_DAM01_GRID_AC(0x3120) FAULT_DAM01_CONVERTER(0x3121) FAULT_DAM01_HARDWARE(0x3122) FAULT_DAM01_OTHER(0x3123)
				2	R	0x15B0	X	O	
				3	R	0x15B1	X	O	
				4	R	0x15B2	X	O	
				5	R	0x15B3	X	O	
				6	R	0x3120	X	O	
				7	R	0x3121	X	O	
				8	R	0x3122	X	O	
				9	R	0x3123	X	O	
trx1	S2, S3, S6, S7 S8 S9	S1	Command Off. Delay about 1s.	1	W	0x1000	0x02	M	Note: Off command value is 0x02; If step2 return other value, process step1 first.
				2	R	0x1513	0x01	O	
tr41	S4	S1	Faults cleared. Delay about 1s.	1	R	0x1513	0x01	O	This transition would be processed automatically. Conditions: Read Register ID: 0x15B0~0x15B3, Read Register ID: 0x3120~0x3123,

									All fault bits return 0, except warning bits.

Note: a time delay between command and next state request should be over 20ms.

3.4. Get State Info [PERIODIC / WHEN NEED]

System state of PCS could be accessed via ID 1513(HEX).

ID (HEX)	Definition	Description	RW	OA	Scale	Unit	Min	Max	Default
1513	STATE_PCS_SYSTEM	0: Initial 1: Standby 2: Soft-start 3 Normal 4: Fault 6: SA Soft-Start 7: SA Normal	R	No	NA	NA	0	7	0
1519	STATE_PCS_GLOBLE	**State of PCS system statue machine** 0: Initial 1: Standby 2:GT Power On 3:GT Normal 4:SA Power On 5:SA Soft-start 6:SA Normal 7:Fault	R	No	NA	NA	0	9	0

		8:AFE Power On 9:AFE Normal							

Recommended CMD for inquiring STATE_PCS_SYSTEM is:

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	15	13	00	01	71 C3

4. System Configurations

PCS **SHOULD** be configured before any other operation. Here the configurations are divided to following groups, Installation configuration, Ratings & Run Mode, Grid Code & Protection, System Clock & Communication, and Battery Info. If no action is done, factory default settings would be applied. Abbreviations would be referred in following sections:

Table 6 Abbreviation Table

Abbr.	Definition
[M]	Must
[O]	Optional

4.1. Installation Configuration

In this part, we mainly pay attention to system configurations linked with installation. For example, how many PCSs are installed, how many BBMS are installed, Basic communication parameters like ID, baud rate and etc. Before configuration, please check the system configuration documents with AFE or contract.

For these items, a recommended process is as follows,

[M] Step1. Read value stored in PCS;
[O] Step2. Write new value to PCS, if change is necessary;
[O] Step3. Read new value to verify if new setting is applied.

Note:

1. If step2 is processed, step3 is a must operation. If step3 failed, try step2 and step3 again.
2. All these items only could be modified off line, which means they only could be modified in S1 (Standby) and S4 (Fault)

4.1.1. Communication Configuration [FIRST RUN / WHEN NEED]

Configurations about communication items **SHOULD** be set before others. Which means that, communication configurations should be done first.

Table 7 Configuration Table for Communication with PCS.

ID(HEX)	Default	Definition	Description	RW	OA	Scale	Unit	Min	Max
1200	1	PR_COM_RS485_ID_PCS	RS485 ID for PCS.	RW	No	NA	NA	1	247
1201	3	PR_COM_RS485_BAUDRATE_PCS	3: 38400 bits/s (Default, and Constant now)	RW	No	NA	NA	1	6
1202	0	PR_COM_RS485_PARITY_PCS	0: No Parity 1: Even Parity 2: Odd Parity	RW	No	NA	NA	0	2
1203	0	PR_COM_RS485_DATABITS_PCS	0: 8 bits 1: 9 bits	RW	No	NA	NA	0	1
1204	0	PR_COM_RS485_STOPBITS_PCS	0: 1 Stop bits 1: 2 Stop bits	RW	No	NA	NA	0	3
120F	1	PR_COM_CAN_ID_PCS	CAN ID for Parallel 1: Default value(Master); 2-8: Configurable(Slaver). If register 0x109f greater than 1, PCS system is configured as parallel state.	RW	No	NA	NA	1	8
1210	4	PR_COM_CAN_BAUDRATE_PCS	CAN BAUDRATE for Parallel 4: 500k(Default)	RW	No	NA	NA	0	5
10FE	0	PR_CONSOLIDATE_EMS_COM_FAULT	EMS Com Fault Check Enable: 0: Disable, 1: Enable.	RW	No	NA	NA	0	1

Table 8 Configuration Table for Communication with BBMS (PCS using)

ID(Hex)	Default	Definition	Description	RW	OA	Scale	Unit	Min	Max
1205	1	PR_COM_RS485_ID_BMS	ID for BMS (Unused in PCS-Constant).	RW	No	NA	NA	1	247
1206	1	PR_COM_RS485_BAUDRATE_BMS	1: 9600 bits/s (Default and Constant now)	RW	No	NA	NA	1	6
1207	0	PR_COM_RS485_PARITY_BMS	0: No Parity 1: Even Parity 2: Odd Parity	RW	No	NA	NA	0	2
1208	0	PR_COM_RS485_DATABITS_BMS	0: 8 Bits 1: 9 Bits	RW	No	NA	NA	0	1
1209	0	PR_COM_RS485_STOPBITS_BMS	0: 1 Stop bits 1: 2 Stop bits	RW	No	NA	NA	0	3

4.1.2. Basic Infrastructure Configuration [FIRST RUN / WHEN NEED]

Table 9 Configuration Table for Filed Infrastructure

ID(Hex)	Default	Definition	Description	RW	OA	Scale	Unit	Min	Max
109F	1	PR_RATING_NUM_OF_PCS_IN_PARA	Number indicate how many PCSs are installed. If PCS paralleled, recommend that all PCSs set this parameter to actual number value.	RW	No	NA	NA	1	8
10A1	1	PR_SET_BAT_SUPPLIER	0: DELTA-ESD - CAN 1: LGC - CAN 2: SAMSUNG-SDI - RS485 3: DELTA-ESD - RS485(Container) 4: DELTA-ESD - RS485(MBMS) 8: None Other: Reserved	RW	No	NA	NA	0	8
10A2	1	PR_SET_BAT_NUM_OF_BANKS	Number of how many banks of batteries are installed in system.	RW	No	NA	NA	1	8
10A3	1	PR_SET_NUM_OF_RACKS_PER_BANK	Number of how many racks in each bank.	RW	No	NA	NA	1	8
118B	0	PR_CHK_FAULT_SOC_EN	Battery Fault check enable/disable: 0: Disable (Default); 1: Enable..	RW	No	NA	NA	0	1

4.1.3. Run Mode / Operation Mode [FIRST RUN / WHEN NEED]

PCS run mode should be set before run. PCS may run in different run modes according to user's instant requirements.
For example,
at 8:00 PCS could run in grid-time mode under an operation mode as 'demand response'.
And at 9:00, maybe PCS would be changed to run in grid-off mode with constant voltage and constant frequency.
Anyway, one run mode should be set first.
The most important key items are listed in "Table 10 Table of Run Mode & Operation Mode".

For these items, a recommended process is as follows,

[M] Step1. Read value stored in PCS;
[O] Step2. Write new value to PCS, if change is necessary;
[O] Step3. Read new value to verify if new setting is applied.

Note:

1. If step2 is processed, step3 is a must operation. If step3 failed, try step2 and step3 again.
2. All these items only could be modified off line, which means they only could be modified in S1 and S4.

Table 10 Table of Run Mode & Operation Mode

ID(Hex)	Default	Definition	Description	RW	OA	Scale	Unit	Min	Max
1005	0	CMD_PCS_GT_OR_SA	0x00: PCS Run with Grid tie mode; 0x01: PCS Run with Grid off/Stand-alone mode; Other: NA;	RW	No	NA	NA	0	1
1081	1	PR_SYS_RM_FLAG	PCS system run mode setting; 1: Standard; 2: AFE;	RW	No	NA	NA	1	2
1082	3	PR_D2A_RM_FLAG	PCS module run mode setting; 1: Reserved; 2: AFE; 3: VSG;	RW	No	NA	NA	1	3
120F	1	PR_COM_CAN_ID_PCS	1: Master Other : Slaver.	RW	No	NA	NA	1	8
1200	1	PR_COM_RS485_ID_PCS	RS485 ID.	RW	No	NA	NA	1	247
109F	1	PR_RATING_NUM_OF_PCS_IN_PARA	Parallel number.	RW	No	NA	NA	1	8

Note: Register ID: 0x120F\0x1200\0x109F use for PCS system run mode & operation mode operation (Register 0x109F greater than 1). Refers to 4.1.1 for more details.

Two typical configurations for system application are listed as follows for reference. For example, there are four PCSs for installing and applying.

PCS System mode: Independent mode.

M/O	ID(Hex)	Definition	Default	PCS1	PCS2	PCS3	PCS4	Description
M	1200	PR_COM_RS485_ID_PCS	1	1	1	1	1	Modbus Command ID
M	120F	PR_COM_CAN_ID_PCS	1	1	1	1	1	Sys can id, PCS1/2/3/4 Master
M	109F	PR_RATING_NUM_OF_PCS_IN_PARA	1	1	1	1	1	Parallel number is 1

Note: All PCSs ID are the same, so they cannot use a common RS485 Bus and Can Bus to communicate with each other.

PCS System mode: Parallel mode.

M/O	ID(Hex)	Definition	Default	PCS1	PCS2	PCS3	PCS4	Description
M	1200	PR_COM_RS485_ID_PCS	1	1	2	3	4	Modbus Command ID
M	120F	PR_COM_CAN_ID_PCS	1	1	2	3	4	Sys can id, PCS1 Master
M	109F	PR_RATING_NUM_OF_PCS_IN_PARA	1	4	4	4	4	Parallel number is 4

Note: All PCSs ID are different, so they could use a common bus to communicate with each other.

Note: When user need to configure these parameters, it must be powered on only one PCS, the others needs powered off. After configured, Power off this PCS.

Two typical configurations for different operation are listed as follows for reference. For more details about normal operation please refer to chapter 6.

Demand Response under Grid-Tie Mode

Table 11 Configure Run Mode and Operation Mode for GT-A

M/O	ID(Hex)	Default	Definition	Description
M	1005	0	CMD_PCS_GT_OR_SA	Grid-tied mode. Command available only for Master PCS (System CAN ID = 1).
M	10FD	1	PR_FUNC_Q_MODE_SEL	01: Demand response;

Note: NA in “Description” means not available. The value in these registers are not applied.

Grid-Off / Standalone Mode

Table 12 Configure Run Mode and Operation Mode for SA-A

M/O	ID(Hex)	Default	Definition	Description
M	1005	1	CMD_PCS_GT_OR_SA	Stand-alone mode. Command available only for Master PCS(System CAN ID = 1).

Note: NA in "Description" means not available. The value in these registers are not applied.

5. Normal Operation

5.1. Run under grid-tie mode

PCS should be configured before run. Once PCS was configured, core settings are memorized. PCS would load default settings if customer do not want to change anything.
Core settings are only could be modified when PCS's state is 'STANDBY' or 'FAULT'. If you find that the changes could not be applied, please check the PCS's state first. And you can get PCS state via following register:

Note:

We recommend user check settings before run PCS each time, to make sure all the settings are the same as you planed.

Please confirm SS/Main breaker / Contactor for GRID TIE is close.

Table 13 Operation sequence for Power ON in GRID TIE Mode (Standard mode)

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	1005	0000	9D 0B	Set PCS run as GRID TIE mode	0: Grid Tie	[M]
II	01	06	1081	0001	1C E2	Set System run mode	1:Standard	[M]
III	01	06	1082	0003	6D 23	Set Module run mode	3:VSG	[M]
IV	01	06	1013	0000	7C CF	Reset active power command to 0.	Unit 0.1 kW, 10 means 1.0 kW	[M]
V	01	06	1014	0000	CD 0E	Reset Reactive Power command to 0.	Unit 0.1 kW, 10 means 1.0 kW	[M]
VI	01	06	1241	0000	DC A6	Enable Ramp Rate Function switch	Optional	[O]
VII	01	06	1242	00C8	2D 30	Set slope for ramp rate - power increase.	0xC8 for reference. Means 20%Prated/s	[O]
VIII	01	06	1243	00C8	7C F0	Set slope for ramp rate - power decrease	0xC8 for reference. Means 20%Prated/s	[O]
IX	01	06	1000	0001	4C CA	Command for PCS ON	Please Check if PCS State is in Standby first. After a few seconds (About 8-10s), PCS state would change to "RUN". Or check ID 0x1513.	[M]
X	01	06	1013	00C8	7D 59	Set Active Power Command.	Value in Hex, unit is 0.1kW. 0xC8 is 20kW for example.	[M]
XI	01	06	1014	00C8	CC 98	Set Reactive Power Command.	Value in Hex, unit is 0.1kVar	[M]
XII	01	06	1000	0002	0C CB	Command to Stop/Off PCS.	PCS would turn to Standby if there is no any fault.	[M]

NOTE:

1. When PCS is running, user could change commands for active and reactive power (step VIII and IX) when it is necessary.
2. Model PCS100: Prated is 100kW, Model PCS125: Prated is 125kW.

5.2. Run under standalone(SA) mode

NOTE:
Reference 4.1.4 for PCS configuration.
The SS/ Grid Tie Breaker (Contactor) SHOULD be OPEN.

Table 14 Run Steps for SA Mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	1005	0001	5C CB	Set PCS run in SA mode temporarily.	1: SA mode.	[M]
II	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]
III	01	06	1000	0002	0C CB	PCS Power OFF	Turn to STANDBY STATE	[M]

5.3. Run under AFE mode

Table 15 Steps for AFE mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	1005	0000	9D 0B	Set PCS run in GT mode.	0: Grid Tie mode.	[M]
II	01	06	1081	0002	5C E3	Turn on AFE mode flagA	System flag 2:AFE	[M]
III	01	06	1082	0002	AC E3	Turn on AFE mode flagB	Module flag 2:AFE	[M]
IV	01	06	124E	0384	EC 36	Set output voltage value	Set DC voltage to 900V	[M]
V	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]

5.4. Transfer from grid-tie mode to SA mode

If islanding detected or grid off detected, PCS would power off automatically. If user want to ask PCS run in SA mode, please OPEN SS first. Then Run commands listed in Table14.

5.5. Transfer from SA to grid-tie mode

If grid recovers when PCS is running in SA mode, and user would like to ask PCS run in Grid-Tie mode, user SHOULD power off PCS first. And then operate system as Table 13 described.

5.6. Transfer from AFE to grid-tie mode

Table 16 Steps from AFE Mode to GT normal mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	1005	0000	9D 0B	Set PCS run in GT mode.	0: Grid Tie mode.	[M]
II	01	06	1081	0001	1C E2	Turn off AFE mode flagA	System flag 1: Standard;	[M]
III	01	06	1082	0003	6D 23	Turn off AFE mode flagB	Module flag 3: VSG;	[M]
IV	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]

6. Grid code

PCS should be configured before run. Once PCS was configured, core settings are memorized. PCS would load default settings if customer do not want to change anything.
Core settings are only could be modified when PCS's state is 'STANDBY' or 'FAULT'. If you find that the changes could not be applied, please check the PCS's state first. And you can get PCS state via following register:

Note:
(a) We recommend user check settings before run PCS each time, to make sure all the settings are the same as you planed.
(b) Please confirm SS/Main breaker / Contactor for GRID TIE is close.
(c) This chapter applies to the parameter configuration of grid code for different area in grid-connected mode.
(d) To model PCS100kW, only need to select different grid code and enable one or more functions, while don't need to modify any detailed curve point or parameters

6.1. Set Grid Code

The register parameters of this chapter will vary depending on the register [0x10DE] (Grid code type). When PCS is applied to a certain area, you should first confirm the applicable grid regulations and set the following register. For Australian regulation AS4777.2-2A, the user need to write the value "7" to register [0x10DE], and 8-14 are used for AS4777.2-2020, G99, VDE4105 and VDE4110 certification, refer to the below table for detail.

Index	Grid Code Type	Description
0	No Set	No grid code application.
7	AS4777.2A	Applicable to Australia Region A grid-connected regulatory certification
8	NZS4777.2	Applicable to New Zealand grid-connected regulatory certification

9	VDE4105-2018	Applicable to German grid-connected regulatory certification
10	G99	Applicable to UK grid-connected regulatory certification
12	VDE4110	Applicable to German grid-connected regulatory certification
13	AS4777.2B	Applicable to Australia Region B grid-connected regulatory certification
14	AS4777.2C	Applicable to Australia Region C grid-connected regulatory certification
31	Delta Default	Default configuration, cannot be applied to specific regions, only for test use.

Grid code parameter setting (example)

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	10DE	0007	3D 19	Grid code.	Choose and confirm the appropriate code according to the application area. 7: AS4777.2A(Default) 8: NZS4777.2 9: VDE4105-2018 10: G99 12: VDE4110 13: AS4777.2B 14: AS4777.2C 31: Delta Others reserved	[M]

6.2. SPF mode setting

Table 17 Steps for setting SPF mode [FIRST RUN / WHEN NEED]

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10DC	0001	8D 30	Enable SPF mode.	1: Enable SPF.	[M]
II	01	06	10DD	0000	1D 30	Mode priority:	0: FPF(Fixed power factor)	[M]
III	01	06	10DF	03E8	BC 4E	Set target PF	PF = 1.000	[M]
IV	01	06	10E1	00BE	5D 4C	Exit level for active power in SPF	Setting value = 19%, means 19%*Prated	[M]
V	01	06	10E2	00C8	2C AA	Enter level for active power in SPF	Setting value = 20%, means 20%*Prated	[M]
VI	01	06	10FD	0000	1C FA	Select SPF mode	0: SPF mode	[M]
VII	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]

NOTE: Model PCS100: Prated is 100kW, Model PCS125: Prated is 125kW

Table 18 Steps for disabling SPF mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10DC	0000	4C F0	Disable SPF mode.	0: Disable SPF.	[M]
II	01	06	10FD	0001	DD 3A	Return to default value	1: Power set (Demand mode)	[M]

6.3. Volt-Var function Setting

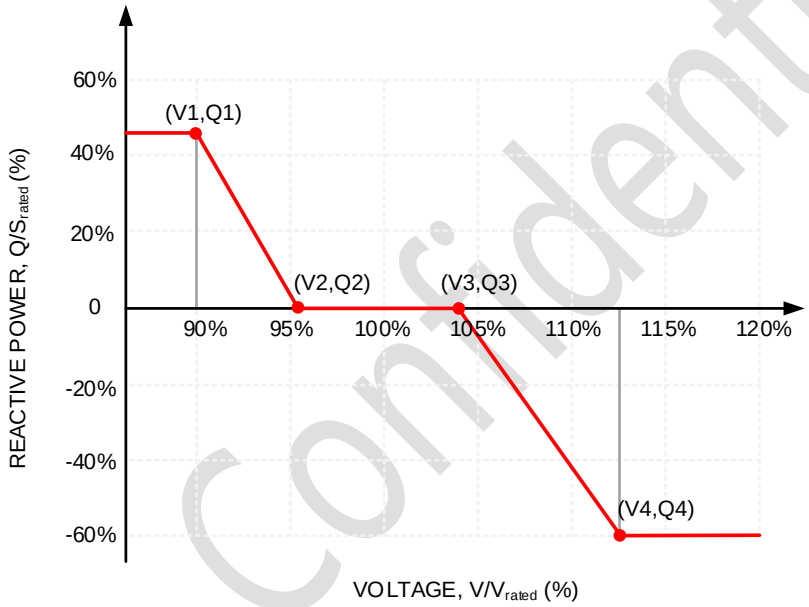

Table 19 Steps for setting Volt-Var function [FIRST RUN / WHEN NEED]

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10DE	0002	AC F2	Grid code.	Choose and confirm the appropriate code according to the application area. 1:default (for PCS125)	[M]

							7: default (for PCS100)	
II	01	06	10E0	0001	8D 30	Volt-Var function enable.	1: Enable.	[M]
III	01	06	10E3-10EA	/	/	Curve points configuration. Q1->[0x10E3], V1->[0x10E4] Q2->[0x10E5], V2->[0x10E6] Q3->[0x10E7], V3->[0x10E8] Q4->[0x10E9], V4->[0x10EA]	The value is different based on different grid code, please refer to PCS100/125kW_Protocol.	[O]
IV	01	06	10FD	0003	BC 4E	Reactive Power Mode Selection.	3 = Volt-Var	[M]
V	01	06	10E1	00BE	5D 4C	Exit level for active power in Volt-Var	Setting value = 19%, means 19%*Prated	[M]
VI	01	06	10E2	00C8	2C AA	Enter level for active power in Volt-Var	Setting value = 20%, means 20%*Prated	[M]
VII	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]

NOTE: Model PCS100: Prated is 100kW, Model PCS125: Prated is 125kW

Table 20 Steps for disabling Volt-Var mode

STEP	**CMD**					**DESCRIPTION**	**REMARK**	**Option**
	ID(PCS)	**Function**	**Register**	**Value**	**CRC REF**			
I	01	06	10E0	0000	8C FC	Disable Volt-Var function.	0: Disable .	[M]
II	01	06	10FD	0001	DD 3A	Return to default value	1: Power set (Demand mode)	[M]

6.4. Volt-Watt function setting

Table 21 Steps for setting Volt-Watt function [FIRST RUN / WHEN NEED]

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10DE	0001	2C F0	Grid code.	Choose and confirm the appropriate code according to the application area. 1: default.	[M]
II	01	06	10F1	0001	1D 39	Volt-Watt function enable.	1: Enable.	[M]
III	01	06	10F4, 10F6, 10F7	/	/	Curve points configuration. Vstart->[0x10F4] Kslope->[0x10F6] Pstop->[0x10F7]	The value is different based on different grid code, please refer to PCS100/125kW_Protocol.	[O]
IV	01	06	10FD	0001	DD 3A	Reactive Power Mode Selection.	1 = Power Set	[M]
V	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]

Table 22 Steps for disabling Volt-Watt mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10F1	0000	DC F9	Disable Volt-Watt function.	0: Disable.	[M]

6.5. Freq-Watt function setting

Table 23 Steps for setting Freq-Watt function [FIRST RUN / WHEN NEED]

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10DE	0001	2C F0	Grid code.	Choose and confirm the appropriate code according to the application area. 1: default.	[M]
II	01	06	10EB	0001	3C FE	Freq-Watt function enable.	1: Enable.	[M]
III	01	06	10EE, 10EF, 10F0	/	/	Curve points configuration. FHstart->[0x10EE] FHslop->[0x10EF] Pstop->[0x10F0]	The value is different based on different grid code, please refer to PCS100/125kW_Protocol.	[O]
IV	01	06	10FD	0001	DD 3A	Reactive Power Mode Selection.	1 = Power Set	[M]
V	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]

Table 24 Steps for disabling Volt-Watt mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10EB	0000	FD 3E	Disable Freq-Watt function.	0: Disable.	[M]

6.6. Frequency/Voltage ride through function setting

Table 25 Steps for setting Freq-Watt function [FIRST RUN / WHEN NEED]

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10DE	0001	2C F0	Grid code.	Choose and confirm the appropriate code according to the application area. 1: default.	[M]
II	01	06	10CB	0001	3D 34	Ride through function enable.	1: Enable.	[M]
III	01	06	1148-, 1151	/	/	Voltage trip points configuration.	The value is different based on different grid code, please refer to PCS100/125kW_Protocol.	[M]
IV	01	06	1140-1147	/	/	Frequency trip points configuration.		[M]
V	01	06	112A	0000	AD3E	High / Low voltage ride through mode selection for reactive power injection	Default:0, means no reactive power injection. Note: Only for grid code-VDE4110	[O]
VI	01	06	112B	0000	FCFE	High / Low voltage ride through feed in reactive current ratio	Range: 0~60, Scale: 0.1 Note: Only for grid-code VDE4110	[O]
VII	01	06	1000	0001	4C CA	PCS Power ON	Turn to RUN STATE	[M]

Table 26 Steps for disabling Volt-Watt mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
I	01	06	10CB	0000	FC F4	Disable ride through function.	0: Disable.	[M]

Note: when the function of ride through is disabled, the above threshold of voltage/frequency are still used for voltage and frequency abnormal protection.

7. Miscellaneous

7.1. Load Fault Logs [WHEN NEED]

Table 27 Steps for disabling Volt-Watt mode

ID	ID(DEC)	Definition	Description	Data Type	Scale	Unit	Min	Max	RW	OA
101A	4122	CMD_PRE_LOAD_FAULT_LOG	Command for user to preload system fault log. 0: No Action; 1: The first Pre-Load Fault Log; 2: The second Pre-Load Fault Log;3-200: The Other Pre-Load Fault Log; Other: NA. Total: 200	Uint16	NA	NA	0	200	RW	No
1600	5632	EVENT_LOG_0001	Fault Code Word. bit12~15: NA bit8~11: NA bit4~7: Fault Word Number bit1~4: Fault Bit Number	Uint16	NA	NA	0	0	R	Yes
1601	5633	EVENT_LOG_0002	Uint8(MSB): Year Uint8(LSB): Month	Uint16	NA	NA	0	0	R	Yes
1602	5634	EVENT_LOG_0003	Uint8(MSB): Day Uint8(LSB): Hour	Uint16	NA	NA	0	0	R	Yes

1603	5635	EVENT_LOG_0004	Uint8(MSB): Minute Uint8(LSB): Second	Uint16	NA	NA	0	0	R	Yes

Recommended CMD for preloading FAULT LOG is:

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	06	10	1A	00	01	6D 0D

Note: The value of LSB is an example for the index of Log, it can be set from 1 to 200, that's means to select one of fault log in EEPROM to read. The smaller the number, the closer the occurrence.

Recommended CMD for inquiring FAULT LOG has been preload is:

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	16	00	00	04	40 41

Note: The data returned contains historical fault information. Please refer to protocol file.