

OPERATION MANUAL FOR PCS100HV

V1.0.8

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V1.0.1	2021/7/28	Wei Guan	Add description about close AC and DC switches in startup operation and open AC and DC switches in shut down operation.	
V1.0.2	2021/8/9	Zhiguang Gao	Add some chapters 6.6-6.13 related to grid code functions Add some content in chapter 3.4 and 3.5. Update chapter 5 about normal operation of power on and off	
V1.0.3	2021/9/6	Zhiguang Gao	Add some description about grid code type. Updated chapter 5 about mode transition	
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V1.0.6	2023/6/17	Shunxi.Huang	Modify PCS100 communication	
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1. Objectives

This document is written for user to understand the system architecture of PCS and understand the normal operation on PCS. Most knowledge is based on operation via Modbus TCP.

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 200ms.
- c) Recommended maximum length of inquiry data is less than 50.
- d) Recommended period for inquiring measurements data is 500ms+.
- e) The parameters of configurable parameters are Readable/Writable attribute, including registers related to grid code. After modifying parameters, users can read them again to confirm whether the modification is successful.
- f) In first co-test, a READ is recommended when a WRITE is applied.
- g) All the parameter configuration steps in this article are described with the register address of the PCS (ID=1) as an example. For the scenario of multiple PCS parallel applications, please refer to " Appendix B Status & Monitoring Variables Table" of PCS100HV Protocol.pdf for the more registers information.

1.2. Abbreviations

ADDR: 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

1.3. Scope

It is valid for following PCS.

EPCS-A100K400FSC1

EPCS-A100K400FSC2

EPCS-A100K400FSC4

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.

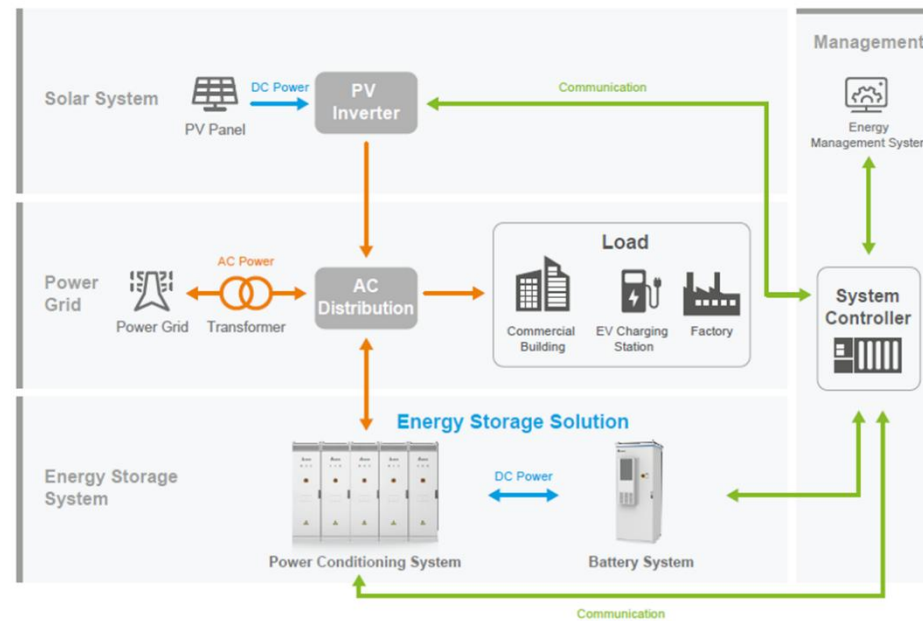


Figure 2-1 System Architecture Diagram.

3. Sequence Diagram / Chart of State Machine

3.1. State Machine of PCS

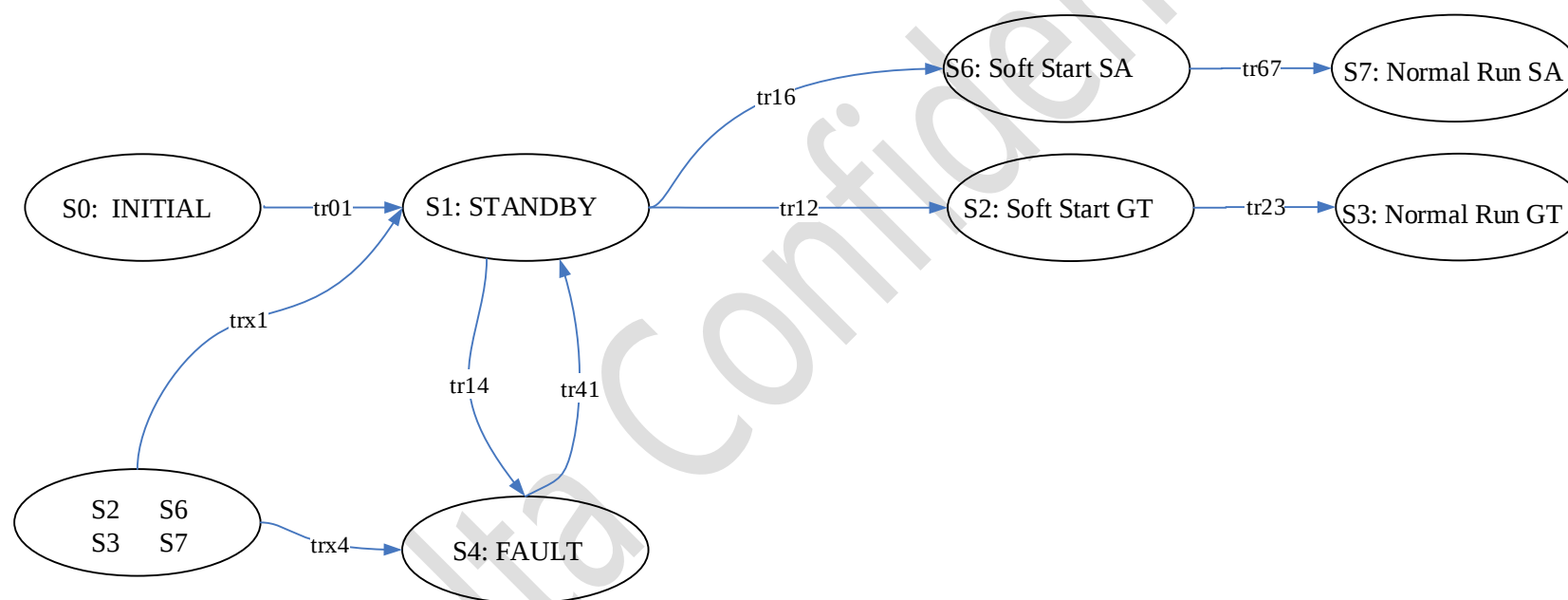


Figure 3-1 State Machine

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 1 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.
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Table 2 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.

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

3.3. State transitions conditions

Table 3 Transition Table (3-1)

No.	Previous State(s)	Next State	Conditions	Register Operation					Remarks
				Step(s)	R/W	Register ADDR	Value	Must Option	
tr01	S0	S1	Delay about 1s. after initialization done.	1	R	0x06F4	0x01	O	Read PCS system mode. Refers to Section 3.4 for detail method.
tr12	S1	S2	Run Mode: Grid Tied CMD_PCS_RUN_MODE 0: Grid-tied mode 1: Stand-alone mode Command On/Off. CMD_PCS_ON_OFF 1: PCS On 0/2: PCS Off Delay about 10s.	1	R	0x1000	0x00	M	Confirm those Settings are correct before operation. Or configure PCS before RUN. Check step1: 0x1000 equal to '0x00' - Pass, If step1 fail, execute step2 until step1 pass. Check step3: 0x06F4 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[0x1001] is "0".When this register is written "0", no action is performed.
				2	W	0x1000	0x00	O/M	
				3	R	0x06F4	0x01	M	
				4	W	0x1001	0x01	M	
				5	R	0x06F4	0x02	O	
tr23	S2	S3	Soft start stage is ongoing. Delay about 3s.	1	R	0x06F4	0x02	O	This transition is being done automatically. Final PCS state is '0x03' - GT Normal mode.
				2	R	0x06F4	0x03	O	

tr16	S1	S6	Run Mode: Grid-forming (Stand Alone) Command On. Register map refer to tr12. Delay about 10s.	1	R	0x1000	0x01	M	Check step1: 0x1000 equal to '0x01'-Pass, If step1 fail, execute step2 until step1 pass. Check step3: 0x06F4 equal to '0x01'-Pass, If step3 pass, process step4. Final PCS state is '0x05'-SA Soft start mode.
				2	W	0x1000	0x01	O/M	
				3	R	0x06F4	0x01	M	
				4	W	0x1001	0x01	M	
				5	R	0x06F4	0x05	O	
tr67	S6	S7	Soft start stage is done. Delay about 3s.	1	R	0x06F4	0x05	O	This transition is being done automatically. Final PCS state is '0x06'-SA Normal run mode.
				2	R	0x06F4	0x06	O	

Note: a time delay between command and next state request should be over 50ms.

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(0x03), 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 4 Transition Table (3-2)

No.	Previous State(s)	Next State	Conditions	Register Operation					Remarks
				Step(s)	R/W	Register ADDR	Value	Must Option	
trx4, tr14	S1, S2, S3, S6, S7	S4	Any fault is detected. Delay time depends on the check time of fault.	1	R	0x06F4	0x07	O	Get detail fault info from step2 to step 9.
				2	R	0x06F8-0x06FE	X	O	Detail description about fault definition please refer to protocol file.
				3	R	0x11E7-0x11EE	X	O	System Alarm: 0x06F8-0x06FE Module Alarm: 0x11E7-0x11EE
trx1	S2, S3, S6, S7	S1	Command Off. Delay about 1s.	1	W	0x1001	0x02/ 0x00	M	Note: Off command value is 0x02 or 0x00; If step2 return other value, process step1 first.
				2	R	0x06F4	0x01	O	
tr41	S4	S1	Faults cleared. Delay about 1s.	1	R	0x06F4	0x01	O	This transition would be processed automatically. Conditions: Read Register ID: 0x06F8~0x06FE, Read Register ID: 0x11E7~0x11EE, All fault bits return 0, except warning bits.

Note: a time delay between command and next state request should be over 50ms.

3.4. Get State Info [PERIODIC / WHEN NEED]

Delta do not provide a monitoring application. User can get the operation status and key monitoring information of PCS100HV through Modbus TCP.

3.4.1. System state

System state of PCS could be accessed via address 0x06F4(HEX) of PCS100HV Master for single or parallel system.

ADDR (HEX)	Definition	Description	RW	OA	Scale	Unit	Min	Max	Default
06F4	SYS_STATE_PCS_GLOBAL	Global State of PCS System. 0: Initial 1: Standby 2: GT Power On 3: GT Normal 4: SA Power On 5: SA Soft-start 6: SA Normal 7: Fault 8: Test 9: Upgrade Other: Reserved	R	No	NA	NA	0	16	0

Recommended CMD for inquiring STATE_PCS_SYSTEM is:

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	06	F4	00	01	C5 70

3.4.2. Module state

User can get the ID number, master/slave and PCS100HV Master/slave for single or parallel system.

ADDR (HEX)	Definition	Description	RW	OA	Scale	Unit	Min	Max	Default
11E4	EN_PR_STATE_DAM	Operations state of PCS Module 0: Initial 1: Standby 2: DC Preload 3: AC Preload 4: AFE Start 5: Black Start 6: Sync Start 7: SA Normal 8: GC Normal 9: SA2GC 10: GC2SA 11: Fault 12: Test Mode (only for internal testing purpose) 13: Upgrade Other: Reserved	R	No	NA	NA	0	16	0

Recommended CMD for inquiring STATE of PCS MODULE (PCS #1 master) is (example):

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	11	E4	00	01	C1 01

Recommended CMD for inquiring STATE of PCS MODULE (PCS #2 slave) is (example):

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	15	E4	00	01	C0 31

3.4.3. Other

User can get the ID number, master/slave role and AC/DC disconnect of PCS100HV through reading the below registers of Master/slave PCS.

ADDR (HEX)	Definition	Description	RW	OA	Scale	Unit	Min	Max	Default
06F0	EN_PR_SYS_MODEL_ID	Master System Modbus RTU ID Information: b0~b7: System ID Number (1~8), Config by Hardware Switch. b8~b15: Modules Online Flag. (Master Only, for Slave, b8~15 = 0) b8: =1, Module 1 Online; bx: =1, Module x Online; bx: =0, Module x Offline. (x = 8~15)	R	No	NA	NA	0	65535	0
06F6	EN_PR_SYS_STATE_MASTER_SLAVE	PCS State of Master or Slave 0: Slave 1: Master	R	No	NA	NA	0	1	0

06F7	EN_PR_SYS_STATE_SWITCH	PCS Switch QS state bit0: AC Switch State, = 1 Closed. bit1: DC Switch State, =1 Closed	R	No	NA	NA	0	65535	0
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3.5. Get Monitoring Info [PERIODIC / WHEN NEED]

Delta do not provide a monitoring application. User can get the operation status and key monitoring information of PCS100HV through Modbus TCP.

3.5.1. System Monitoring

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default
06FF	1791	Uint16	EN_MEAS_SYS_FREQ_GRID	Frequency of Grid	0.01Hz	R	2000	7000	0
0700	1792	Uint16	EN_MEAS_SYS_VOLT_GRID_RS	Vrms of Grid RS The variable is displayed If Remote Grid is connected to PCS.(bit1 of Reg 0x0611 set to "1").	0.1V	R	0	7000	0
0701	1793	Uint16	EN_MEAS_SYS_VOLT_GRID_ST	Vrms of Grid ST The variable is displayed If Remote Grid is connected to PCS.(bit1 of Reg 0x0611 set to "1").	0.1V	R	0	7000	0
0702	1794	Uint16	EN_MEAS_SYS_VOLT_GRID_TR	Vrms of Grid TR The variable is displayed If Remote Grid is connected to PCS.(bit1 of Reg 0x0611 set to "1").	0.1V	R	0	7000	0
0703	1795	Uint16	EN_MEAS_SYS_VOLT_PCS_RS	Vrms of PCS AC RS	0.1V	R	0	7000	0
0704	1796	Uint16	EN_MEAS_SYS_VOLT_PCS_ST	Vrms of PCS AC ST	0.1V	R	0	7000	0
0705	1797	Uint16	EN_MEAS_SYS_VOLT_PCS_TR	Vrms of PCS AC TR	0.1V	R	0	7000	0

0706	1798	Uint16	EN_MEAS_SYS_VOLT_GRID_R	Vrms of Grid R The variable is displayed if Remote Grid is connected to PCS.(bit1 of Reg 0x0611 set to "1").	0.1V	R	0	4000	0
0707	1799	Uint16	EN_MEAS_SYS_VOLT_GRID_S	Vrms of Grid S The variable is displayed if Remote Grid is connected to PCS.(bit1 of Reg 0x0611 set to "1").	0.1V	R	0	4000	0
0708	1800	Uint16	EN_MEAS_SYS_VOLT_GRID_T	Vrms of Grid T The variable is displayed if Remote Grid is connected to PCS.(bit1 of Reg 0x0611 set to "1").	0.1V	R	0	4000	0
0709	1801	Uint16	EN_MEAS_SYS_VOLT_PCS_R	Vrms of PCS AC R	0.1V	R	0	4000	0
070A	1802	Uint16	EN_MEAS_SYS_VOLT_PCS_S	Vrms of PCS AC S	0.1V	R	0	4000	0
070B	1803	Uint16	EN_MEAS_SYS_VOLT_PCS_T	Vrms of PCS AC T	0.1V	R	0	4000	0
070F	1807	Int16	EN_MEAS_SYS_POWER_ACTIVE_R	Active Power of Phase R	0.1KW	R	-15000	15000	0
0710	1808	Int16	EN_MEAS_SYS_POWER_ACTIVE_S	Active Power of Phase S	0.1KW	R	-15000	15000	0
0711	1809	Int16	EN_MEAS_SYS_POWER_ACTIVE_T	Active Power of Phase T	0.1KW	R	-15000	15000	0
0712	1810	Int16	EN_MEAS_SYS_POWER_REACTIVE_R	Reactive Power of Phase R	0.1KVAR	R	-15000	15000	0
0713	1811	Int16	EN_MEAS_SYS_POWER_REACTIVE_S	Reactive Power of Phase S	0.1KVAR	R	-15000	15000	0
0714	1812	Int16	EN_MEAS_SYS_POWER_REACTIVE_T	Reactive Power of Phase T	0.1KVAR	R	-15000	15000	0
0715	1813	Uint16	EN_MEAS_SYS_POWER_APPA_R	Apparent Power of Phase R	0.1KVA	R	0	15000	0
0716	1814	Uint16	EN_MEAS_SYS_POWER_APPA_S	Apparent Power of Phase S	0.1KVA	R	0	15000	0
0717	1815	Uint16	EN_MEAS_SYS_POWER_APPA_T	Apparent Power of Phase T	0.1KVA	R	0	15000	0

0718	1816	Int16	EN_MEAS_SYS_POWER_ACTIVE_ALL	Active Power Total	0.1KW	R	-15000	15000	0
0719	1817	Int16	EN_MEAS_SYS_POWER_REACTIVE_ALL	Reactive Power Total	0.1KVAR	R	-15000	15000	0
071A	1818	Uint16	EN_MEAS_SYS_POWER_APPA_ALL	Apparent Power Total	0.1KVA	R	0	15000	0
071B	1819	Uint16	EN_MEAS_SYS_VOLT_IN	DC Input Voltage	0.1V	R	0	15000	0
071E	1822	Int16	EN_MEAS_SYS_TEMP_AMBIENT	Ambient Temperature	0.1°C	R	-1000	2000	0
071F	1823	Int16	EN_MEAS_SYS_TEMP_INLET	Inlet Temperature	0.1°C	R	-1000	2000	0
0720	1824	Uint16	EN_MEAS_SYS_IMD_ISO	ISO Measurement	kΩ	R	0	30000	0

Recommended CMD for inquiring monitor information of PCS module is (example):

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	06	EF	00	22	F5 6B

3.5.2. Module Monitoring

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default
11EF	4591	Uint16	EN_MEAS_DAM_V_GRID_RS	Vrms of Grid RS	0.1V	R	0	7000	0
11F0	4592	Uint16	EN_MEAS_DAM_V_GRID_ST	Vrms of Grid ST	0.1V	R	0	7000	0
11F1	4593	Uint16	EN_MEAS_DAM_V_GRID_TR	Vrms of Grid TR	0.1V	R	0	7000	0
11F5	4597	Uint16	EN_MEAS_DAM_V_GRID_R	Vrms of Grid R	0.1V	R	0	7000	0
11F6	4598	Uint16	EN_MEAS_DAM_V_GRID_S	Vrms of Grid S	0.1V	R	0	7000	0
11F7	4599	Uint16	EN_MEAS_DAM_V_GRID_T	Vrms of Grid T	0.1V	R	0	7000	0
11F8	4600	Uint16	EN_MEAS_DAM_FREQ_GRID	Frequency of Grid	0.01Hz	R	0	7000	0
11FC	4604	Uint16	EN_MEAS_DAM_IO_R	Irms of Output Current R	0.1A	R	0	4000	0
11FD	4605	Uint16	EN_MEAS_DAM_IO_S	Irms of Output Current S	0.1A	R	0	4000	0
11FE	4606	Uint16	EN_MEAS_DAM_IO_T	Irms of Output Current T	0.1A	R	0	4000	0
11FF	4607	Uint16	EN_MEAS_DAM_POWER_APPA_R	Apparent Power of Phase R	0.1KVA	R	0	1500	0
1200	4608	Uint16	EN_MEAS_DAM_POWER_APPA_S	Apparent Power of Phase S	0.1KVA	R	0	1500	0
1201	4609	Uint16	EN_MEAS_DAM_POWER_APPA_T	Apparent Power of Phase T	0.1KVA	R	0	1500	0
1202	4610	Int16	EN_MEAS_DAM_POWER_ACTIVE_R	Active Power of Phase R	0.1KW	R	-1500	1500	0
1203	4611	Int16	EN_MEAS_DAM_POWER_ACTIVE_S	Active Power of Phase S	0.1KW	R	-1500	1500	0

1204	4612	Int16	EN_MEAS_DAM_POWER_ACTIVE_T	Active Power of Phase T	0.1KW	R	-1500	1500	0
1205	4613	Int16	EN_MEAS_DAM_POWER_REACTIVE_R	Reactive Power of Phase R	0.1KVAR	R	-1500	1500	0
1206	4614	Int16	EN_MEAS_DAM_POWER_REACTIVE_S	Reactive Power of Phase S	0.1KVAR	R	-1500	1500	0
1207	4615	Int16	EN_MEAS_DAM_POWER_REACTIVE_T	Reactive Power of Phase T	0.1KVAR	R	-1500	1500	0
1208	4616	Uint16	EN_MEAS_DAM_S	Apparent Power Total	0.1KVA	R	0	1500	0
1209	4617	Int16	EN_MEAS_DAM_P	Active Power Total	0.1KW	R	-1500	1500	0
120A	4618	Int16	EN_MEAS_DAM_Q	Reactive Power Total	0.1KVAR	R	-1500	1500	0
120B	4619	Uint16	EN_MEAS_DAM_DC_VIN	DC Input Voltage	0.1V	R	0	15000	0
120C	4620	Int16	EN_MEAS_DAM_DC_IIN	DC Input Current	0.1A	R	-4000	4000	0
120D	4621	Uint16	EN_MEAS_DAM_DC_BUS	DC BUS Voltage	0.1V	R	0	15000	0
1214	4628	Int16	EN_MEAS_DAM_TEMP_AMBIENT	Ambient Temperature	0.1°C	R	-1000	2000	0
1215	4629	Int16	EN_MEAS_DAM_TEMP_R	IGBT Temperature R	0.1°C	R	-1000	2000	0
1216	4630	Int16	EN_MEAS_DAM_TEMP_S	IGBT Temperature S	0.1°C	R	-1000	2000	0
1217	4631	Int16	EN_MEAS_DAM_TEMP_T	IGBT Temperature T	0.1°C	R	-1000	2000	0

Recommended CMD for inquiring monitor information of PCS#1 module[Master] is (example):

ID	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
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01	03	12	00	00	0D	81 77
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Recommended CMD for inquiring monitor information of PCS#2 module[Slave] is (example):

ID(PCS)	Function Code	ADDR MSB	ADDR LSB	Length MSB	Length LSB	CRC
01	03	16	00	00	0D	80 47

3.5.3. SN and Version

The user can read the below registers to get the serial number & firmware version of PCS100HV through EMS controller.

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default
06E0	1760	Uint16	EN_PR_SYS_VER_FW_APP_SEC_1	System Application Version 1	NA	R	0	99	0
06E1	1761	Uint16	EN_PR_SYS_VER_FW_APP_SEC_2	System Application Version 2	NA	R	0	99	0
06E2	1762	Uint16	EN_PR_SYS_VER_FW_APP_SEC_3	System Application Version 3	NA	R	0	99	0
06E3	1763	Uint16	EN_PR_SYS_VER_FW_APP_SEC_4	System Application Version 4	NA	R	0	99	0
06E4	1764	Uint16	EN_PR_SYS_VER_FW_APP_SEC_5	System Application Version 5	NA	R	0	99	0
06E8	1768	String	EN_PR_SYS_ONLINE_SN_SEC_1	System Serial Number 1 Example:0x'5741' = 'WA'	NA	R	0	65535	22337
06E9	1769	String	EN_PR_SYS_ONLINE_SN_SEC_2	System Serial Number 2 Example:0x'4D4A' = 'MJ'	NA	R	0	65535	19786
06EA	1770	String	EN_PR_SYS_ONLINE_SN_SEC_3	System Serial Number 3 Example:0x'3030' = '00'	NA	R	0	65535	12336
06EB	1771	String	EN_PR_SYS_ONLINE_SN_SEC_4	System Serial Number 4	NA	R	0	65535	12336

				Example:0x'3030' = '00'					
06EC	1772	String	EN_PR_SYS_ONLINE_SN_SEC_5	System Serial Number 5 Example:0x'3030' = '00'	NA	R	0	65535	12336
06ED	1773	String	EN_PR_SYS_ONLINE_SN_SEC_6	System Serial Number 6 Example:0x'3030' = '00'	NA	R	0	65535	12336
06EE	1774	String	EN_PR_SYS_ONLINE_SN_SEC_7	System Serial Number 7 Example:0x'2020' = ' ' '	NA	R	0	65535	8224
06EF	1775	String	EN_PR_SYS_ONLINE_SN_SEC_8	System Serial Number 8 Example:0x'2020' = ' ' '	NA	R	0	65535	8224
11C0	4544	Uint16	EN_PR_DAM_VER_FW_APP_SEC_1	DAM Application Version 1	NA	R	0	99	0
11C1	4545	Uint16	EN_PR_DAM_VER_FW_APP_SEC_2	DAM Application Version 2	NA	R	0	99	0
11C2	4546	Uint16	EN_PR_DAM_VER_FW_APP_SEC_3	DAM Application Version 3	NA	R	0	99	0
11C3	4547	Uint16	EN_PR_DAM_VER_FW_APP_SEC_4	DAM Application Version 4	NA	R	0	99	0
11C4	4548	Uint16	EN_PR_DAM_VER_FW_APP_SEC_5	DAM Application Version 5	NA	R	0	99	0
11CD	4557	String	EN_PR_DAM_ONLINE_SN_SEC_1	Module Serial Number 1 Example:0x'5741' = 'WA'	NA	R	0	65535	22337
11CE	4558	String	EN_PR_DAM_ONLINE_SN_SEC_2	Module Serial Number 2 Example:0x'4D4A' = 'MJ'	NA	R	0	65535	19786
11CF	4559	String	EN_PR_DAM_ONLINE_SN_SEC_3	Module Serial Number 3 Example:0x'3030' = '00'	NA	R	0	65535	12336

11D0	4560	String	EN_PR_DAM_ONLINE_SN_SEC_4	Module Serial Number 4 Example:0x'3030' = '00'	NA	R	0	65535	12336
11D1	4561	String	EN_PR_DAM_ONLINE_SN_SEC_5	Module Serial Number 5 Example:0x'3030' = '00'	NA	R	0	65535	12336
11D2	4562	String	EN_PR_DAM_ONLINE_SN_SEC_6	Module Serial Number 6 Example:0x'3030' = '00'	NA	R	0	65535	12336
11D3	4563	String	EN_PR_DAM_ONLINE_SN_SEC_7	Module Serial Number 7 Example:0x'2020' = ' '	NA	R	0	65535	8224
11D4	4564	String	EN_PR_DAM_ONLINE_SN_SEC_8	Module Serial Number 8 Example:0x'2020' = ' '	NA	R	0	65535	8224

4. System Configuration

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 5 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, , Basic communication parameters like IP address, baud rate and etc. Before configuration, please check the system configuration documents.

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 Ethernet Communication.

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default	OA
10	16	Uint16	EN_PR_OS_CONFIGURE_IP_ADDR1	IP_ADDR1.XXX.XXX.XXX	NA	RW	0	255	192	No
11	17	Uint16	EN_PR_OS_CONFIGURE_IP_ADDR2	XXX.IP_ADDR2.XXX.XXX	NA	RW	0	255	168	No
12	18	Uint16	EN_PR_OS_CONFIGURE_IP_ADDR3	XXX.XXX.IP_ADDR3.XXX	NA	RW	0	255	1	No
13	19	Uint16	EN_PR_OS_CONFIGURE_IP_ADDR4	XXX.XXX.XXX.IP_ADDR4	NA	RW	0	255	136	No
14	20	Uint16	EN_PR_OS_CONFIGURE_IP_PORT	IP_PORT	NA	RW	0	32767	502	No

The default IP address is 192.168.1.136 and port is 502, if need to set new IP address, please modify the above registers.

Table 8 Set new IP address, for example new IP address=10.7.21.40, port=502

STEP	CMD		DESCRIPTION				REMARK	Option	
	ID(PCS)	Function	Register	Value	CRC	REF			
1	01	06	10	000A	08	08	Set IP_ADDR1 =10	Set new IP address: 10.7.21.40	[M]
2	01	06	11	0007	98	0D	Set IP_ADDR2 =7		[M]
3	01	06	12	0015	E8	00	Set IP_ADDR3 =21		[M]
4	01	06	13	0028	78	11	Set IP_ADDR4 =40		[M]
5	01	06	13	01F6	48	18	Set IP_PORT =502		[M]

4.1.2. 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-tie/grid-following mode under an operation mode as '1. Power Set'.

And at 9:00, maybe PCS would be changed to run in Standalone/Grid-forming 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.

Table 10 Table of Run Mode & Operation Mode

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default	OA
1000	4096	Uint16	EN_CMD_PCS_RUN_MODE	0: PCS Run with Grid-Following /Grid-tie mode; 1: PCS Run with Grid-Forming/Off-grid mode; Default: 0 - Grid-following mode Note: The PCS will be restored to the default value every time it is powered on again.	NA	R/W	0	1	0	No
0610	1552	Uint16	EN_PR_SYS_MASTER_CONFIG	System Master configuration. 0: Master(Default). 1: Slave.	NA	RW	0	1	0	No
1052	4178	Uint16	EN_PR_NUM_OF_PCS_IN_PARA	How many PCS module are installed in system.	NA	RW	1	5	1	No
1072	4210	Uint16	EN_PR_GC_Q_MODE_SEL	Reactive Power Mode Selection 0: SPF 1: Power Set (Demand response) 2: NA 3: Volt-Var Other: NA	NA	RW	0	3	1	Yes

1073	4211	Uint16	EN_PR_GC_PQ_PRIORITY	Priority of active power / reactive power (GC mode) 0: Reactive first ; 1: Active first;	NA	RW	0	1	0	No
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Two typical configurations for system application are listed as follows for reference.

Table 11 PCS System mode: Independent mode (Factory default)

M/O	ADDR(Hex)	Definition	Default	PCS#1	Description
M	1000	CMD_PCS_RUN_MODE	0	0	Grid following
M	0610	PR_SYS_MASTER_CONFIG	0	0	Master
M	1052	PR_NUM_OF_PCS_IN_PARA	1	1	Single PCS application
M	1072	PR_GC_Q_MODE_SEL	1	1	Power demand mode
M/O	1073	PR_GC_PQ_PRIORITY	0	0	Reactive power priority

if four PCSs are installed in some storage system applications. Configuration parameters as the table shown below.

Table 12 PCS System mode: Parallel mode

M/O	ADDR(Hex)	Definition	Default	PCS#1 (ID=1)	PCS#2 (ID=2)	PCS#3 (ID=3)	PCS#4 (ID=4)	Description
M	1000	CMD_PCS_RUN_MODE	0	0	0	0	0	PCS run mode(0:Grid following,1:Grid-forming)
M	0610	PR_SYS_MASTER_CONFIG	0	0	1	1	1	PCS#1: master PCS#2,#3,#4: slave
M	1052	PR_NUM_OF_PCS_IN_PARA	1	4	4	4	4	Parallel number is 4
M	1072	PR_GC_Q_MODE_SEL	1	1	1	1	1	Power demand mode
M/O	1073	PR_GC_PQ_PRIORITY	0	0	0	0	0	Reactive power priority

Note:

1. All PCSs ID are set through hardware switch, refer to the chapter “ID setting switches” of PCS100HV-IM.pdf for how to set.
2. For parallel system mode, only the register [0610] need to be configured one by one. Except the configured PCS can be powered on, the other PCS need to be powered off. For the other registers, the upstream controller or EMS only needs to communicate with the Master for parameter configuration, and the Master will copy these parameters to each slave via broadcast mode.
3. After setting parameters, Power off PCSs and power on them again.

5. Normal Operation

PCS should be configured before run. Once PCS was configured, core settings are memorized.

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.

The AC output terminals of PCS100HV is 3 phase 4 wire, including a neutral line, and PCS100HV can connected to a TN system with neutral line grounded or to a IT system without neutral line. But the neutral line output of PCS100HV will not be grounded by PCS itself. In grid-tied mode, the neutral line should be grounded by utility grid. In standalone mode, the neutral line should be grounded by load side distribution cabinet.

The PCS100HV can support switch between grid-tied mode and standalone mode online. For the detail of how PCS100HV switch between grid-tied mode and standalone mode, one can refer to the document <PCS100HV GT_SA mode switching method V1.0>.

Note:

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

After PCS power on each time, the run mode is always "Grid-Tie", which isn't be memorized.

Only need to send the command to PCS Master.

5.1. Grid-tie mode operation

Power On PCS

To power on the PCS100HV in grid-tied mode, see the following requirements:

1. After the PCS installation is completed, check to ensure that the upstream breaker of AC side is in the closed state before powering on PCS.
2. And also check to make sure the battery system is powered on and battery system output switch is in closed state.
3. Ethernet communication port (CNS4) of PCS100HV shall be connected to EMS or upper level controller or site controller to establish the communication link.

Step 1: open the front door.

Step 2: turn the AC and DC switches/disconnects in the front of the cabinet to ON state as shown in Figure 5-1. The PCS powers on and enters standby mode.

NOTE:

ON: Vertical, turn counterclockwise to horizontal position to OFF state.

OFF: Horizontal, turn clockwise to vertical position to ON state.

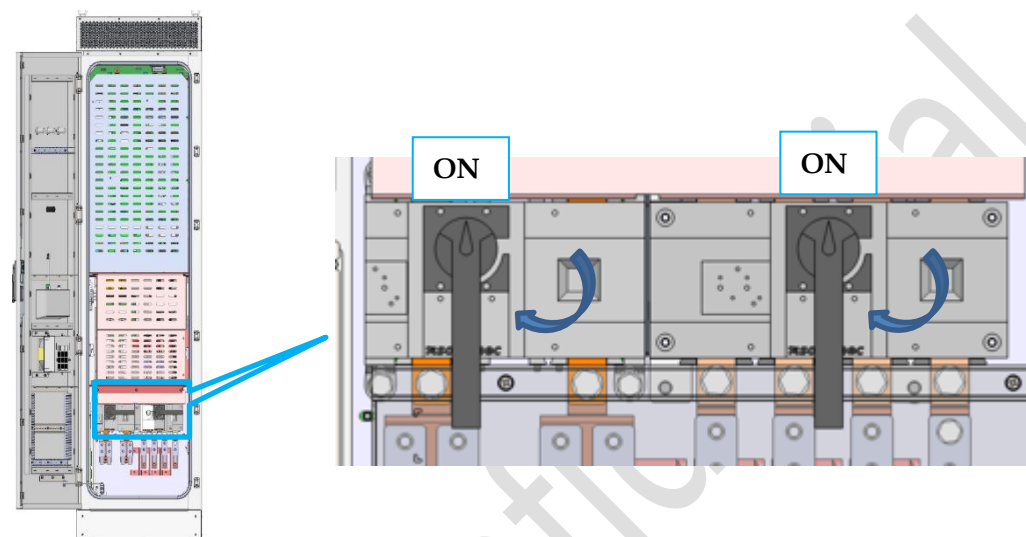


Figure 5-1 AC and DC disconnects ON location

Step 3: set the correct IP address (Default:192.168.1.136) and port number (502) and start communicating with PCS100HV.

Step 4: configure and confirm the right operation mode (Grid-tied mode) and parameters by following the below table via upper level controller.

Table 13 Parameters of GRID TIE Mode

CMD					DESCRIPTION	REMARK	Option
ID(PCS)	Function	Register	Value	CRC REF			
01	06	1000	0000	8D 0A	Set PCS run as GRID TIE mode	0: Grid Tie/Grid-following	[M]
01	06	1050	0000	8D 1B	Set wiring mode	0: 3P3L	[M]
01	06	0610	0000	88 87	Set Master	0: Master	[O]
01	06	1052	0001	ED 1B	Set parallel number	1: single PCS	[O]
01	06	1072	0001	EC D1	Set Power demand mode	1: Power demand mode	[O]
01	06	1073	0000	7CD1	Set Reactive power priority	0: Reactive power priority	[O]

Step 5: after completing the configuration, check whether PCS100HV is “Standby” status, if it is, the upper level controller sends “Power ON” command to PCS100HV. PCS will synchronize with grid.

Step 6: when PCS100HV enters the “Normal” status, the upper level controller sends “Reactive Power” or/and “Active Power” command to PCS100HV, it will output the corresponding power to the grid. See below table for parameters of power on and power command of PCS100HV.

Table 14 Parameters of power on and power command

CMD		DESCRIPTION				REMARK	Option
ID(PCS)	Function	Register	Value	CRC REF			
01	06	1001	0001	1D 0A	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 register 0x06F4.	[M]
01	06	1007	00C8	3D 5D	Set Active Power Command.	Value in Hex, unit is 0.1kW. 0xC8 is 20kW for example.	[M]
01	06	1008	00C8	0D 5E	Set Reactive Power Command.	Value in Hex, unit is 0.1kVar	[M]

NOTE:

1. When PCS is running, user could change commands for active and reactive power (step 6 and 7) when it is necessary.
2. Model PCS100HV: Prated is 100kW.

Power Off PCS

After PCS100HV is working in grid-tied mode, one can shut down and power off PCS by following steps.

Step 1: the upper level controller sets “Reactive Power” or/and “Active Power” command to 0, and PCS out power will become to 0.

Step 2: the upper level controller sends “Power OFF” command to PCS100HV, PCS100HV will stops running and enters the “Standby” status.

Table 15 Parameters of power off

CMD					DESCRIPTION	REMARK	Option
ID(PCS)	Function	Register	Value	CRC REF			
01	06	1001	0002	5D 0B	Command to Stop/Off PCS.	PCS would turn to Standby if there is no any fault.	[M]

NOTE: In emergency status, one can press the “EPO” button on the front door to shut down PCS.

Step 3: open the front door.

Step 4: turn the AC and DC switches/disconnects in the front of the cabinet to OFF state as shown in Figure 5-2. The PCS powers off and one can do maintenance to PCS.

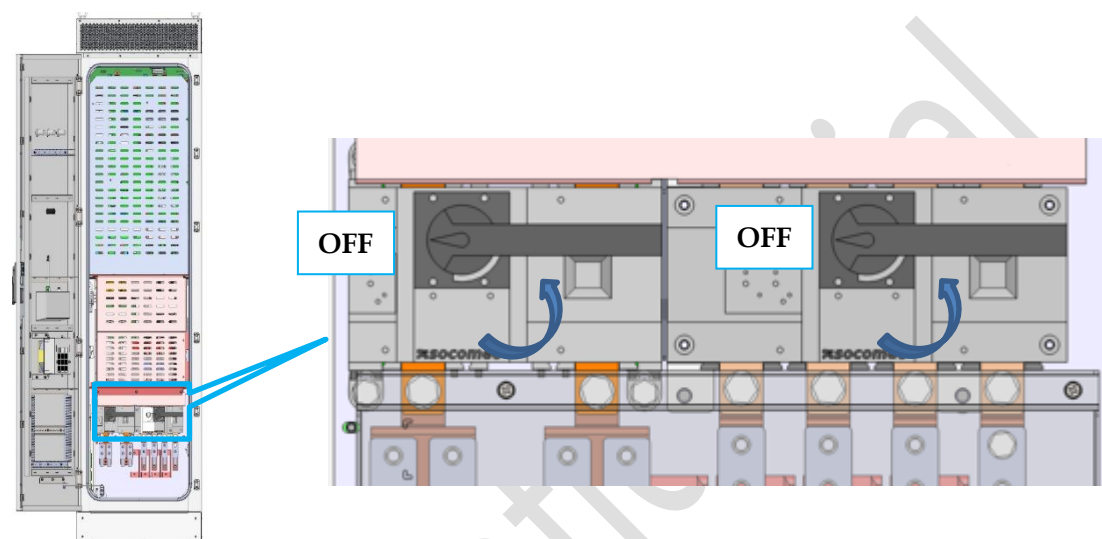


Figure 5-2 AC and DC disconnects OFF location

5.2. Standalone(SA) mode operation

Power On PCS

To power on the PCS100HV in standalone mode, see the following requirements:

1. After the PCS installation is completed, check to ensure that the upstream breaker to utility grid is in the open state, and the breaker to load is in the closed state before powering on PCS.
2. And also check to make sure the battery system is powered on and battery system output switch is in closed state.
3. Ethernet communication port (CNS4) of PCS100HV shall be connected to EMS or upper level controller or site controller to establish the communication link.

Step 1: open the front door.

Step 2: turn the AC and DC switches/disconnects in the front of the cabinet to ON state as shown in Figure 5-1. The PCS powers on and enters standby mode.

Step 3: set the correct IP address (Default:192.168.1.136) and port number (502) and start communicating with PCS100HV.

Step 4: configure and confirm the right operation mode (Standalone mode) and parameters by following the below table via upper level controller.

Table 16 Parameters in Standalone/Grid-forming Mode

CMD					DESCRIPTION	REMARK	Option
ID(PCS)	Function	Register	Value	c			
01	06	1000	0001	4C CA	Set PCS run in SA mode temporarily.	1: SA/Grid-forming mode.	[M]
01	06	1050	0001	4C DB	Set wiring mode	1: 3P4L	[M]
01	06	1001	0001	1D 0A	PCS ON	Turn to RUN STATE	[M]
01	06	1001	0002	5D 0B	PCS OFF	Turn to STANDBY STATE	[M]

NOTE: The value of register [0x1000] will be restored to the default value every time it is powered on again.

Step 5: after completing the configuration, check whether PCS100HV is “Standby” status, if it is, the upper level controller sends “Power ON” command to PCS100HV. PCS will output 3 phase sine wave voltage.

Step 6: when PCS100HV enters the “Normal” status, the local load connected to PCS output can be powered.

Power Off PCS

After PCS100HV is working in standalone mode, one can shut down and power off PCS by following steps.

Step 1: all the load is open, and PCS out power will become to 0.

Step 2: the upper level controller sends “Power OFF” command to PCS100HV, PCS100HV will stops running and enters the “Standby” status.

NOTE: In emergency status, one can press the “EPO” button on the front door to shut down PCS.

Step 3: open the front door.

Step 4: turn the AC and DC switches/disconnects in the front of the cabinet to OFF state as shown in Figure 5-2. The PCS powers off and one can do maintenance to PCS.

6. Grid code [FIRST RUN / WHEN NEED]

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.

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 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 PCS100HV, only need to select different grid code and enable one or more functions, generally 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 [0x105B] (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 AS4777.2-2015, the user need to write the value “6” to register [0x105B], and 1-5 are used for AS4777.2-2020 and VDE4105 certification, refer to the below table for detail.

Index	Grid Code Type	Description
0	No Set	No grid code application.
1	AS4777.2A	Applicable to Australia Region A grid-connected regulatory certification
2	NZS4777.2	Applicable to New Zealand grid-connected regulatory certification
3	VDE4105-2018	Applicable to German grid-connected regulatory certification
4	AS4777.2B	Applicable to Australia Region B grid-connected regulatory certification
5	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.

Table 17 grid code parameter setting (example)

STEP	CMD			DESCRIPTION		REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	105B	0006	3D 19	Grid code.	[M]
						Choose and confirm the appropriate code according to the application area.	
						0: No Set	
						1: AS4777.2A	
						2: NZS4777.2	
						3: VDE4105-2018	
						4: AS4777.2B	

5: AS4777.2C
6: AS4777.2-2015
31: Delta Default
Others reserved

6.2. Normal/Soft-Start ramp rates setting

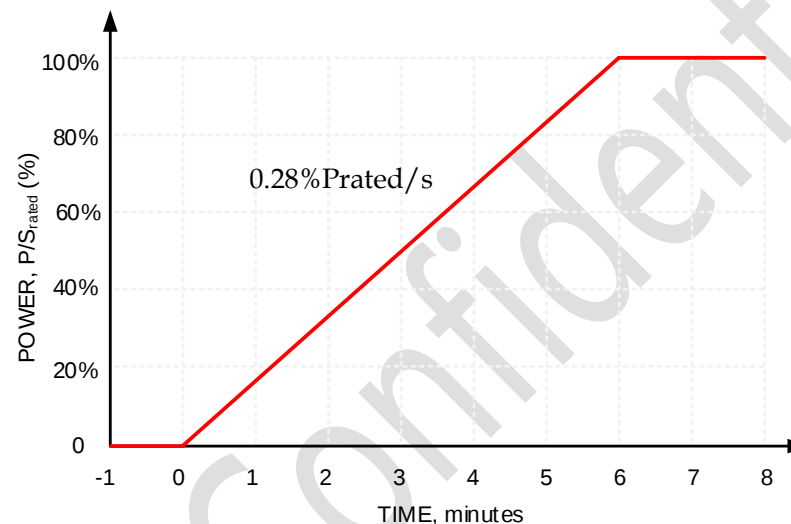


Table 18 Steps for setting Normal soft start ramp rates [FIRST RUN / WHEN NEED]

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	1076	0001	AD 10	Enable normal soft start ramp rate	1: Enable with 0.01% Scale [M]
2	01	06	1077	001C	3C D9	Set normal soft start ramp rate value	Setting normal soft start ramp rate value = 0.28% [O]

Table 19 Steps for disabling Normal soft start ramp rates

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	1076	0000	6C D0	Disable normal soft start ramp rate	0: Disable normal soft start ramp rate	[M]

Note: For Normal ramp rates function configuration, which is suitable for user-defined slope, the configuration steps are the same as above table.

6.3. Anti-Islanding protection function setting

Table 20 Steps for setting anti-islanding protection function [FIRST RUN / WHEN NEED]

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	107A	0002	2D 12	Enable anti-islanding passive check 1: Active Enable 2: Passive Enable 3: Active/Passive Enable	[M]

Table 21 Steps for disabling anti-islanding protection function

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	107A	0000	AC D3	Disable anti-islanding check 0: Disable	[M]

6.4. High/Low voltage protection function setting

Table 22 Passive anti-islanding voltage limit values

Protective function	Protective function limit	Trip delay time	Maximum disconnection time
Undervoltage 2 ($V < <$)	70 V	1 s	2 s
Undervoltage 1 ($V <$)	180 V	10 s	11 s
Overvoltage 1 ($V >$)	265 V	1 s	2 s
Overvoltage 2 ($V > >$)	275 V	—	0.2 s

Table 23 Steps for setting high/low voltage protection function [FIRST RUN / WHEN NEED]

STEP	CMD				DESCRIPTION	REMARK	Option	
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	107B	001E	7D 1B	Enable high/low voltage protection	bit4 = 1: Over Level 2 enable bit3 = 1: Over Level 1 enable bit2 = 1: Under Level 1 enable bit1 = 1: Under Level 2 enable bit0 = 0: Under Level 3 disable	[M]
2	01	06	107C	0000	4C D2	Set over/under voltage time scale	bit4 = 0: Over Level 2 scale 0.01s(10ms) bit3 = 0: Over Level 1 scale 0.01s(10ms) bit2 = 0: Under Level 1 scale 0.01s(10ms) bit1 = 0: Under Level 2 scale	[O]

3	01	06	107D-1086	/	/	Threshold Value and time Configuration	0.01s(10ms)	[O]
							0.01s(10ms) The value is different based on different grid code, please refer to PCS100HV Protocol.	

Table 24 Steps for disabling high/low voltage protection function

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	107B	0000	FD 13	Disable high/low voltage protection	bit4 = 0: Over Level 2 disable bit3 = 0: Over Level 1 disable bit2 = 0: Under Level 1 disable bit1 = 0: Under Level 2 disable bit0 = 0: Under Level 3 disable	[M]

6.5. High/Low frequency protection function setting

Table 25 Passive anti-islanding frequency limit values

	Region	Australia A	Australia B	Australia C	New Zealand
Under-frequency 1 ($F < $)	Protective function limit value	47 Hz	47 Hz	45 Hz	45 Hz
	Trip delay time	1 s	1 s	5 s	1 s
	Maximum disconnection time	2 s	2 s	6 s	2 s
Over-frequency 1 ($F > $)	Protective function limit value	52 Hz	52 Hz	55 Hz	55 Hz
	Trip delay time	—	—	—	—
	Maximum disconnection time	0.2 s	0.2 s	0.2 s	0.2 s

Table 26 Steps for setting high/low frequency protection function [FIRST RUN / WHEN NEED]

STEP	CMD				DESCRIPTION	REMARK	Option	
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	1087	0006	BD 21	Enable high/low frequency protection	bit3 = 0: Over Level 2 disable bit2 = 1: Over Level 1 enable bit1 = 1: Under Level 1 enable bit0 = 0: Under Level 2 disable	[M]
2	01	06	1088	0000	0D 20	Set over/under frequency time scale	bitx = 0: 0.01s(10ms) bit3 = 0: Over Level 2 scale 0.01s(10ms)	[O]

						bit2 = 0: Over Level 1 scale 0.01s(10ms) bit1 = 0: Under Level 1 scale 0.01s(10ms) bit0 = 0: Under Level 2 scale 0.01s(10ms)		
3	01	06	1089- 1090	/	/	Protection Value and time Configuration	The value is different based on different grid code, please refer to PCS100HV Protocol.	[O]

Table 27 Steps for disabling high/low frequency protection function

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	1087	0000	3D 23	Disable high/low voltage protection bit3 = 0: Over Level 2 disable bit2 = 0: Over Level 1 disable bit1 = 0: Under Level 1 disable bit0 = 0: Under Level 2 disable	[M]

6.6. Reconnection function setting

Table 28 Steps for setting Reconnection function [FIRST RUN / WHEN NEED]

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	1091	0001	1D 27	Auto reconnection function enable	1: Enable auto reconnection function [M]
2	01	06	1092	04EC	2F AA	Auto reconnection voltage set high Unit: 0.1%	Setting value = 110%, means 110%*Vrated [O]
3	01	06	1093	037B	3D F4	Auto reconnection voltage set low Unit: 0.1%	Setting value = 89.1%, means 89.1%*Vrated [O]
4	01	06	1094	1397	80 78	Auto reconnection frequency set high Unit: 0.01Hz	Setting value = 50.15%, means 50.15%*Frated [O]
5	01	06	1095	128E	11 E2	Auto reconnection frequency set low Unit: 0.01Hz	Setting value = 47.50%, means 47.50%*Frated [O]
6	01	06	1096	003C	6D 37	Auto reconnection time set delay Unit: s	Setting value = 60, means 60s [O]

NOTE: Model PCS100HV: Vrated is 230V, Frated=50Hz

Table 29 Steps for disabling Reconnection function

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	1091	0000	DC E7	Auto reconnection function disable	0: Disable auto reconnection [M]

6.7. SPF mode setting

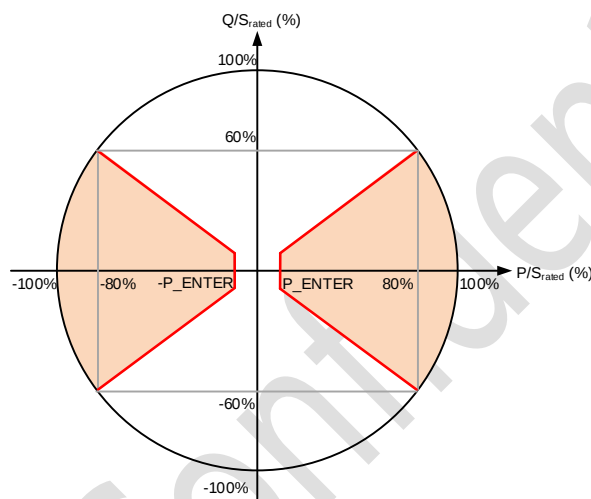


Figure 6-1 SPF control mode limit area

Table 30 Steps for setting SPF mode [FIRST RUN / WHEN NEED]

STEP	ID(PCS)		CMD		DESCRIPTION		REMARK	Option
		Function	Register	Value	CRC REF			
1	01	06	109C	0001	8C E4	Enable SPF mode.	1: Enable SPF.	[M]
2	01	06	109D	03E8	1C 5A	Set target PF	PF = 1.000	[M]
3	01	06	109A	005A	2D 1E	Exit level for active power in SPF	Setting value = 9%, means 9%*Prated	[O]
4	01	06	109B	0064	FD 0E	Enter level for active power in SPF	Setting value = 10%, means	[O]

5	01	06	1097	0258	3C 7C	Set Q maximum	10%*Prated Set reactive power maximum Default: 60%	[O]
6	01	06	1098	0320	0D CD	Set PF minimum	Set PF minimum Default: 60%	[O]
7	01	06	1072	0000	2D 11	Set Q mode	0: SPF	[M]

NOTE: Model PCS100HV: Prated is 100kW

Table 31 Steps for disabling SPF mode

STEP	CMD			DESCRIPTION		REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10DC	0000	4C F0	Disable SPF mode.	0: Disable SPF. [M]
2	01	06	1072	0001	EC D1	Return to default value	1: Power set (Demand mode) [M]

6.8. Volt-Var function setting

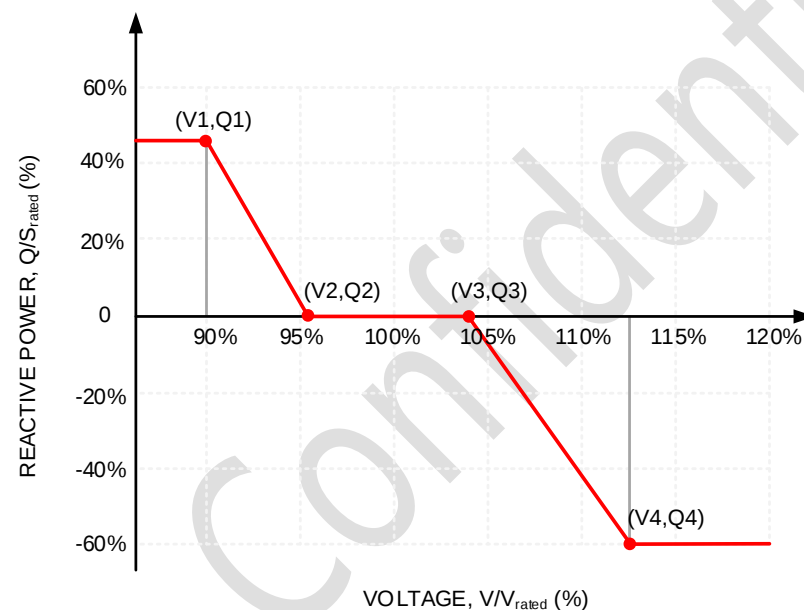


Figure 6-2 Volt-Var control mode curve

Table 32 Steps for setting Volt-Var function [FIRST RUN / WHEN NEED]

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10A9	0001	9C EA	Volt-Var function enable.	1: Enable. [M]
2	01	06	10AA-	/	/	Curve points configuration.	The value is different based on [O]

			10B1			Q1->[0x10AB], V1->[0x10AA] Q2->[0x10AD], V2->[0x10AC] Q3->[0x10AF], V3->[0x10AE] Q4->[0x10B1], V4->[0x10B0]	different grid code, please refer to PCS100HV Protocol.	
3	01	06	109A	005A	2D 1E	Exit level for active power in Volt-Var	Setting value = 9%, means 9%*Prated	[O]
4	01	06	109B	0064	FD 0E	Enter level for active power in Volt-Var	Setting value = 10%, means 10%*Prated	[O]
5	01	06	1072	0003	6D 10	Reactive Power Mode Selection.	3 = Volt-Var	[M]
6	01	06	1001	0001	1D 0A	PCS Power ON	Turn to RUN STATE	[M]

NOTE: Model PCS100HV; Prated is 100kW;

Table 33 Steps for disabling Volt-Var function

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10A9	0000	5D 2A	Disable Volt-Var function.	0: Disable . [M]
2	01	06	1072	0001	EC D1	Return to default value	1: Power set (Demand mode) [M]

6.9. Volt-Watt function setting

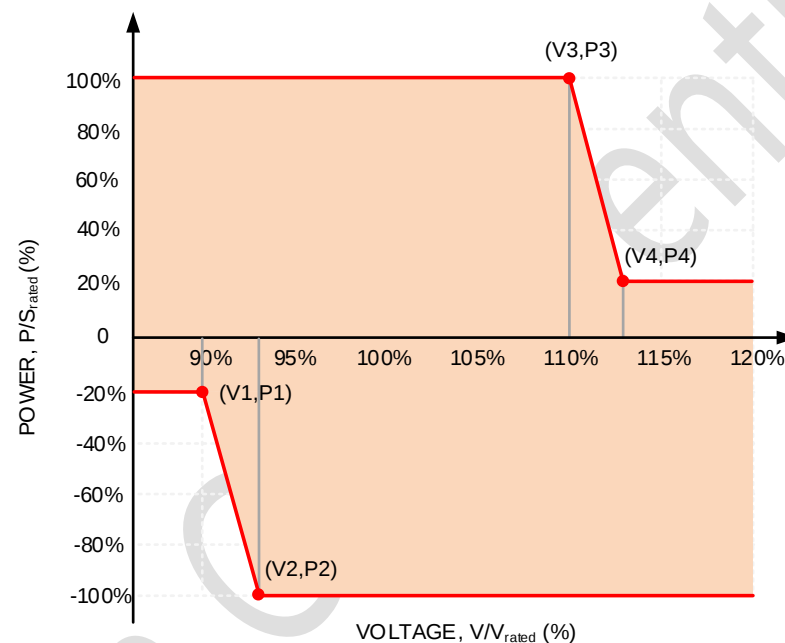


Figure 6-3 Volt-Watt control mode limit area

Table 34 Steps for setting Volt-Watt function [FIRST RUN / WHEN NEED]

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
2	01	06	10B7	0001	FC EC	Volt-Watt function enable.	1: Enable. [M]
3	01	06	10B8-	/	/	Curve points configuration.	The value is different based on [O]

			10BF			P1->[0x10B9], V1->[0x10B8] P2->[0x10BB], V2->[0x10BA] P3->[0x10BD], V3->[0x10BC] P4->[0x10BF], V4->[0x10BE]	different grid code, please refer to PCS100HV Protocol.	
4	01	06	1072	0001	EC D1	Reactive Power Mode Selection.	1 = Power Set	[M]

Table 35 Steps for disabling Volt-Watt function

STEP	CMD			DESCRIPTION		REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10B7	0000	3D 2C	Disable Volt-Watt function.	0: Disable. [M]

6.10. Freq-Watt function setting

6.10.1. 3-point mode

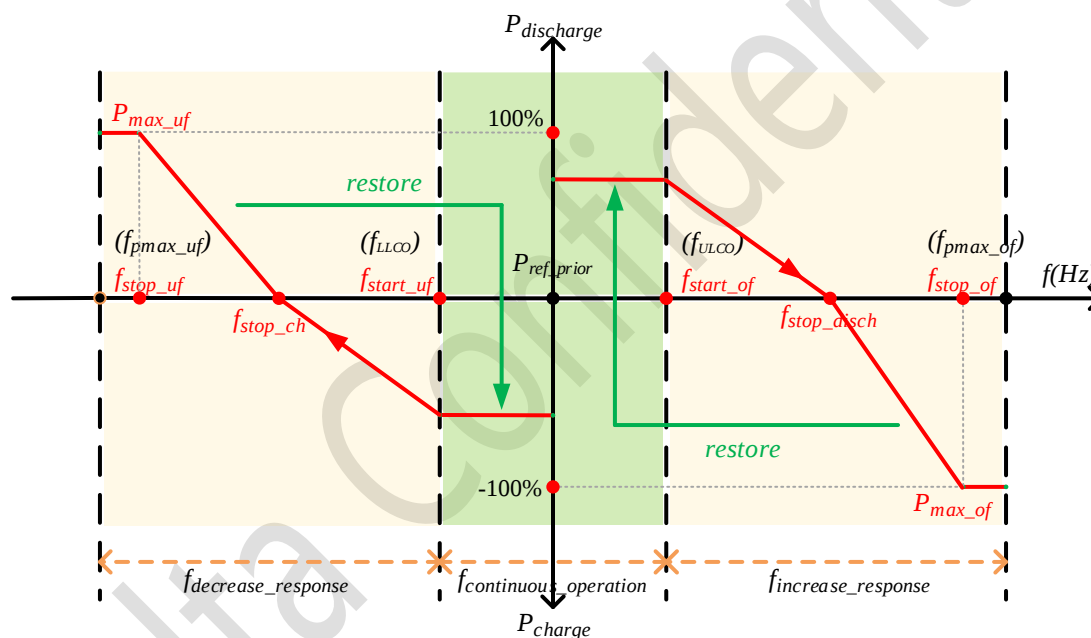


Figure 6-4 Freq-Watt control mode curve (3-point mode)

Table 36 Steps for setting Freq-Watt function [FIRST RUN / WHEN NEED]

STEP	CMD	DESCRIPTION	REMARK	Option
------	-----	-------------	--------	--------

	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	10C0	0003	CD 37	Freq-Watt function enable(Over frequency).	3: 3-Point Mode (w/ Register 4291.)	[M]
2	01	06	10C6	0003	2D 36	Freq-Watt function enable(under frequency).	3: 3-Point Mode (w/ Register 4297.)	[M]
3	01	06	10C1- 10C4, 10C7- 10CA, 10CC, 10CE	/	/	Curve points configuration.	The value is different based on different grid code, please refer to PCS100HV Protocol.	[O]

Table 37 Steps for disabling Freq-Watt function

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	10C0	0000	8D 36	Disable Freq-Watt function(Over frequency).	0: Disable.	[M]
2	01	06	10C6	0000	6D 37	Disable Freq-Watt function(Under frequency).	0: Disable.	[M]

6.10.2. 2-point mode

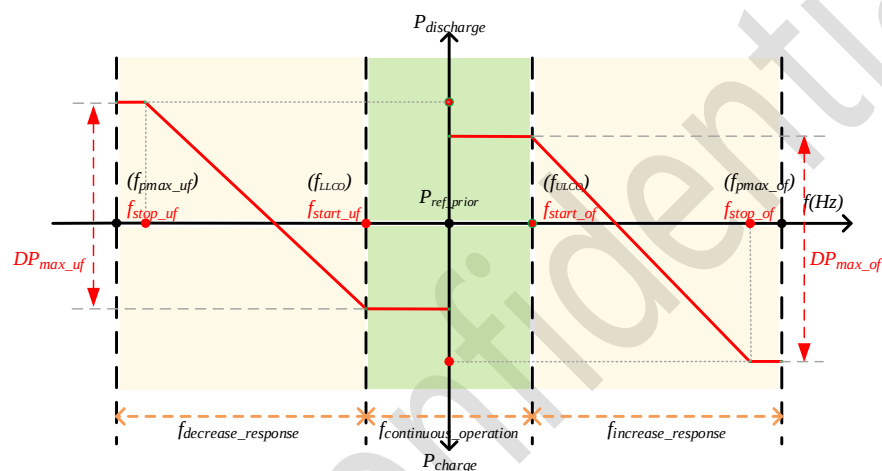


Figure 6-5 Freq-Watt control mode curve (2-point mode)

Table 38 Steps for setting Freq-Watt function [FIRST RUN / WHEN NEED]

STEP	CMD			DESCRIPTION		REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	105B	0001	3D 19	Grid code.	Choose and confirm the appropriate code according to the application area. 0: No Set 1: AS4777.2A 2: NZS4777.2

							3: VDE4105-2018 4: AS4777.2B 5: AS4777.2C 6: AS4777.2-2015 31: Delta Default Others reserved	
2	01	06	10C0	0004	8C F5	Freq-Watt function enable(Over frequency).	4: 2-Point Mode	[M]
3	01	06	10C6	0004	6C F4	Freq-Watt function enable(under frequency).	4: 2-Point Mode	[M]
4	01	06	10C1-10C2, 10C7-10C8	/	/	Curve points configuration.	The value is different based on different grid code, please refer to PCS100HV Protocol.	[O]
5	01	06	0624	03E8	C9 F7			[M]
6	01	06	0625	03E8	98 37			[M]

Note: the 2-point mode is only available in grid code AS4777.2A for EVO project.

Table 39 Steps for disabling Freq-Watt function

STEP	ID(PCS)	Function	CMD Register	Value	CRC REF	DESCRIPTION	REMARK	Option
1	01	06	10C0	0000	8D 36	Disable Freq-Watt function(Over frequency).	0: Disable.	[M]
2	01	06	10C6	0000	6D 37	Disable Freq-Watt function(Under frequency).	0: Disable.	[M]

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6.11. Voltage average protection function setting

Table 40 Steps for setting voltage average protection function [FIRST RUN / WHEN NEED]

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10CF	0003	FD 34	Average voltage protection enable bit 0 = 1: Average under voltage enable bit 1 = 1: Average over voltage enable	[M]
2	01	06	10D0	0462	0F DA	Average voltage OVP voltage value Setting value = 112.2%, means 112.2%*Vrated	[O]
3	01	06	10D2	012C	2D 7E	Average voltage OVP time value Setting value = 3, means 3s	[O]

NOTE: Model PCS100HV: Vrated is 230V

Table 41 Steps for disabling voltage average protection function

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10CF	0000	BD 35	Average voltage protection disable bit 0 = 0: Average under voltage disable bit 1 = 0: Average over voltage disable	[M]

6.12. Demand response mode setting

Table 42 Steps for setting demand response mode [FIRST RUN / WHEN NEED]

STEP	CMD			DESCRIPTION		REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10D4	0001	0C F2	Demand response mode enable	1: Enable demand response mode [M]
2	01	06	10D5	0000	9C F2	Reactive power demand of DRM3 and DRM7.(AS/NZS4777.2 only)	Setting value = 0, means reactive power is 0 [O]

NOTE: Model PCS100HV: Vrated is 230V

Table 43 Steps for disabling demand response mode

STEP	CMD			DESCRIPTION		REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10D4	0000	CD 32	Demand response mode disable	1: disable demand response mode [M]

6.13. Voltage ride through function setting

Table 44 Voltage ride through response

Voltage limits	Inverter response
> 260 V	Cease power generation
180 V to 260 V	Continuous operation
< 180 V	Cease power generation

Table 45 Steps for setting Voltage ride through function [FIRST RUN / WHEN NEED]

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10D6	0001	AD 32	High Ride through function enable.	1: Enable. [M]
2	01	06	10D7	0001	FC F2	Low Ride through function enable.	1: Enable. [M]
3	01	06	10D9	046A	DE 1E	Over voltage trip point	Over voltage : 113% [O]
4	01	06	10DA	030E	2D C5	Under voltage trip point configuration.	[O]

Table 46 Steps for disabling Voltage ride through function

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	10D6	0000	6C F2	Disable high ride through function.	0: Disable. [M]
2	01	06	10D7	0000	3D 32	Disable low 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.

6.14. Soft or Hard Gen/Exp Power limitation

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default	OA
0x611	1553	Uint16	PR_GC_GEN_EXP_LIMIT_EN	Generation/export power limit mode enable. b0: Generation soft limit enabled b1: Generation hard limit enabled b2: Export soft limit enabled b3: Export hard limit enabled b4-b15: reserved Only for AS4777.2:2020	NA	RW	0	15	0	No
0x614	1556	Uint16	PR_GC_GEN_SOFT_LIMIT	Generation power soft limit. Only for AS4777.2:2020	0.1%	RW	0	1000	1000	No
0x615	1557	Uint16	PR_GC_GEN_HARD_LIMIT	Generation power hard limit. Only for AS4777.2:2020	0.1%	RW	0	1000	1000	No
0x616	1558	Uint16	PR_GC_EXP_SOFT_LIMIT	Export power soft limit. Only for AS4777.2:2020	0.1%	RW	0	1000	1000	No
0x617	1559	Uint16	PR_GC_EXP_HARD_LIMIT	Export power hard limit. Only for AS4777.2:2020	0.1%	RW	0	1000	1000	No

Table 42 Steps for setting generation soft limit mode [FIRST RUN / WHEN NEED]

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	0x614	03E8	0B FC	Generation power soft limit to 100%Pn	Limit to 100% rated active power	[M]
2	01	06	0x611	0001	0B C2	Enable generation soft power limit	Setting value = 1	[M]

NOTE: Model PCS100HV: Vrated is 230V

Table 43 Steps for disabling demand response mode

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	0x611	0000	0B 32	Generation power soft limit disable	0: disable Generation power soft limit	[M]

7. Miscellaneous

7.1. System Time Setting [WHEN NEED]

Table 47 system time configuration

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default	OA
100D	4109	Uint16	EN_CMD_TIME_YEAR_MONTH_SET	Uint8(MSB): Local Time: Year to be set. Range: 0-99, for example 2021Y→21 Uint8(LSB): Local Time: Month to be set	NA	RW	0	23502	1	No
100E	4110	Uint16	EN_CMD_TIME_DAY_HOUR_SET	Uint8(MSB) Local Time: Day to be set Uint8(LSB) Local Time: Hour to be set	NA	RW	0	7960	256	No
100F	4111	Uint16	EN_CMD_TIME_MIN_SEC_SET	Uint8(MSB) Local Time: Minute to be set Uint8(LSB) Local Time: Second to be set	NA	RW	0	15420	0	No

For example: 01:09:30 01/12/2018

Table 48 Set system time.

STEP	CMD	DESCRIPTION	REMARK	Option
------	-----	-------------	--------	--------

	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	100E	091E	6A 91	1: Set Minute and Second.	9:30 as example	[M]
2	01	06	100F	0101	7D 59	2: Set Day and Hour	1 st ,1 am, as example	[M]
3	01	06	100D	120C	10 6C	3:Set Year, Month	12/2018 as example	[M]

NOTE: Only need to set the system time of the master, the PCS master will synchronize to the slave for parallel system.

7.2. Clear Faults Command [WHEN NEED]

EMS need to send “Clear faults” command to reset the all fault words to “0” in order to clear the unrecoverable faults.

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default	OA
1004	4100	Uint16	EN_CMD_CLEAR_ALL_FAULT	Clear all faults of system and module 0: No action 1: Clear command	NA	R/W	0	1	0	No

Table 49 Clear system fault.

STEP		CMD				DESCRIPTION	REMARK	Option
		ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	1004	0001	0D 0B	1: clear faults command.	Clear all faults of system and module	[M]

NOTE:

1. Only need to set the command to the PCS master, the PCS master will synchronize to the slaves for parallel system.
2. After the fault clearing operation is completed, the value of register will be automatically return to 0.

7.3. Heartbeat Signal[PERIODIC]

The EMS needs to send a heartbeat signal to the PCS every 2s. The PCS will continue to detect whether the heartbeat signal has changed within 10s. If the heartbeat signal remains unchanged, a communication exception fault will be triggered and the PCS will stop running.

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default	OA
0000	0000	Uint16	EN_PR_OS_CMD_EMS_PCS_HEARTBEAT	EMS HeartBeat. EMS HeartBeat 0~255, Updated every 2s. (Check with Users)	NA	RW	0	255	0	Yes

8. BMS

8.1. Communication Configuration [FIRST RUN / WHEN NEED]

Please refer to the chapter 4.1.1

8.2. BMS Control, Protection and Recharging

8.2.1. Turn on/off BMS

ADDR (HEX)	ADDR (DEC)	TYPE	DEFINITION	DESCRIPTION	Unit	RW	Min	Max	Default	OA
0001	0001	Uint16	EN_PR_OS_CMD_BMS_START	BMS Stop/Start Command 0: NA 1: BMS ON 2: BMS OFF	NA	W	0	2	0	No
0002	0002	Uint16	EN_PR_OS_CMD_BMS_FAULT_CLEAR	BMS Fault Clear 0: NA/No Command 1: Fault Clear Command	NA	W	0	1	0	No

EMS need to write "1" to the register[0x0001] of PCS100HV local controller, then PCS100HV will send BMS ON command to the BMS to TURN ON the battery system. And write "2" to TURN OFF the battery system.

Table 50 Clear system fault.

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	0001	0001	19 CA	BMS Stop/Start Command 1: BMS ON	Turn on BMS [M]
2	01	06	0001	0002	59 CB	BMS Stop/Start Command 2: BMS OFF	Turn off BMS [M]

NOTE:

1. Only need to set the command to the PCS100HV master.
2. The "BMS OFF" command is only available when PCS100HV is "Standby" status.

8.2.2. Clear BMS Fault

EMS need to write "1" to the register[0x0002] of PCS100HV local controller when BMS is failure, then PCS100HV will send reset fault command to the BMS to clear fault through Modbus TCP.

Table 51 Clear system fault.

STEP	CMD		DESCRIPTION			REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF		
1	01	06	0002	0001	E9 CA	BMS Fault Clear 1: Fault Clear Command	Clear all faults of BMS [M]

NOTE: Only need to set the command to the PCS100HV master.

8.2.3. Protection Parameters Configuration

If the battery system is included in the system, some protection parameters need to be set before using it. The following table shows the setting steps.

Table 52 Steps for setting demand response mode [FIRST RUN / WHEN NEED]

STEP	CMD			DESCRIPTION		REMARK	Option	
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	0618	0C7F	4D A5	BMS Auxiliary Configuration Enable Registers bitx = 1: Check enable, bitx = 0: Check disable; x=0-15 b0=1: BMS Communication Check Enable. b1=1: BMS Fault Check Enable. b2=1: BMS Warning Check Enable. b3=1: Battery Voltage High Fault Check Enable. b4=1: Battery Voltage Low Warning Check Enable. b5=1: BMS SOC Fault Check Enable (high/low). b6=1: BMS SOC Warning Check Enable (high/low). b10=1: Battery Cell Volt High Warn Check Enable. b11=1: Battery Cell Volt Low Warn Check Enable.	Enable all related protection of Battery system <i>*Note: Auto recharging function isn't enabled.</i>	[M]
2	01	06	0619-061E 0622-0623	/	/	Protection threshold setting of SOC, battery DC voltage, cell voltage.	Refer to the chapter “4.3 Battery Parameter” of PCS100HV Prototocol.pdf for more information.	[O]

Note: The user can enable or disable one or more protection items by setting bitx of register[0x0618] to "1" or "0".

8.2.4. Auto Recharging Control mode

When the SOC is lower than the set lower limit [0x061F], if the auto-recharging function is enabled through setting the register [0x0618] (**bit8=1, bit9=1**), the PCS100HV will automatically start recharging according to the power command set by the register [0x0621].

STEP	CMD			DESCRIPTION		REMARK	Option	
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	0618	0FFF	4C F5	BMS Auxiliary Configuration Enable Registers bitx = 1: Check enable, bitx = 0: Check disable; x=0-15 b8=1: Battery Auto Recharge by SOC Enable. b9=1: Battery Auto Recharge Power by Set Enable.	Enable auto-recharging function of Battery system <i>*Note: All protection functions and power limit function are enabled.</i>	[M]
2	01	06	061F	0019	79 4E	Start charging when SOC is less than 2.5%.	SOC low limit= 2.5%	[O]
3	01	06	0620	0064	89 63	Stop charging when SOC is greater than 10%.	SOC high limit= 10%	[O]
4	01	06	0621	00C8	D8 DE	Power command for auto-charging	Power Command = 20kW	[M]

8.2.5. Manual Recharging Control mode

When the SOC is lower than the set lower limit [0x061F], if the manual-recharging function is enabled through setting the register [0x0618] (**bit8=1**,

bit9=0), the PCS100HV will start recharging according to the power command set by the register [0x1007].

STEP	CMD			DESCRIPTION		REMARK	Option	
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	0618	0DFF	4D 95	BMS Auxiliary Configuration Enable Registers bitx = 1: Check enable, bitx = 0: Check disable; x=0-15 b8=1: Battery Auto Recharge by SOC Enable. b9=0: Battery Auto Recharge Power by Set Enable.	Enable manual-recharging function of Battery system. <i>*Note: All protection functions are enabled.</i>	[M]
2	01	06	061F	0019	79 4E	Start charging when SOC is less than 2.5%.	SOC low limit= 2.5%	[O]
3	01	06	0620	0064	89 63	Stop charging when SOC is greater than 10%.	SOC high limit= 10%	[O]
4	01	06	1007	01F4	3C DC	Power command for manual-recharging	Power Command = 50kW	[M]

8.2.6. Power Limit Control function

If the “BMS Power Limitation” function is enabled (bit7=1), then the maximum output power of PCS100HV will be limited by the available charge and discharge power curve from BMS.

STEP	CMD					DESCRIPTION	REMARK	Option
	ID(PCS)	Function	Register	Value	CRC REF			
1	01	06	0618	0080	08 E5	BMS Auxiliary Configuration Enable Registers bitx = 1: Check enable, bitx = 0: Check disable; x=0-15 b7=1: BMS Power Limitation Check Enable.	Enable power limit function. <i>*Note: All protection functions and recharging function are disabled.</i>	[M]

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