

# OPERATION MANUAL FOR PCS100HV

## V1.0.2

| Reversion | Date      | Update by    | Description                                                                                                                                                                                                                              | FW version |
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| V1.0.0    | 2021/4/30 | Zhiguang Gao | File created                                                                                                                                                                                                                             |            |
| 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 chapter 8 "BMS" for battery system control and configuration<br>Add some chapters 6.6-6.13 related to grid code functions<br>Add some content in chapter 3.4 and 3.5.<br>Update chapter 5 about normal operation of power on and off |            |
|           |           |              |                                                                                                                                                                                                                                          |            |
|           |           |              |                                                                                                                                                                                                                                          |            |
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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) In first co-test, a READ is recommended when a WRITE is applied.
- f) 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

## 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.

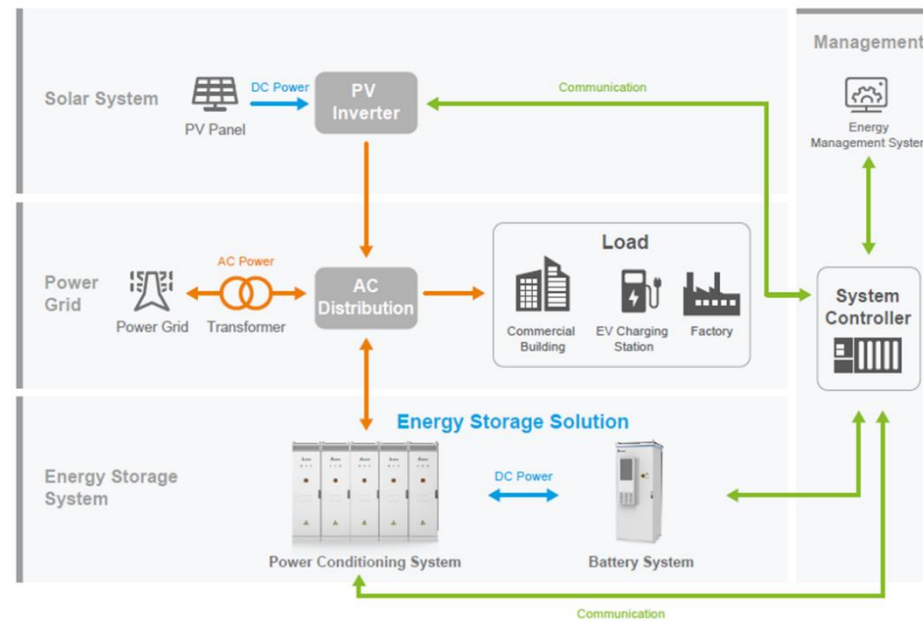


Figure 2-1 System Architecture Diagram.

## 3. Sequence Diagram / Chart of State Machine

### 3.1. State Machine of PCS

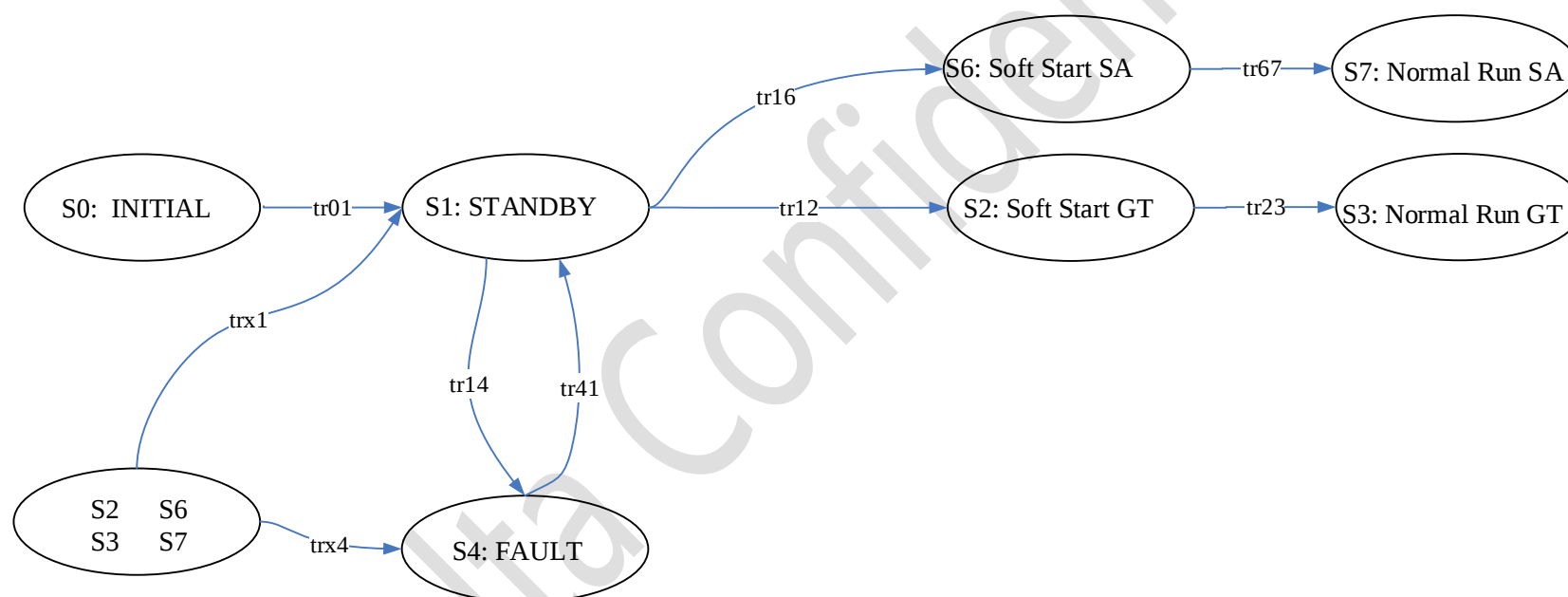


Figure 3-1 State Machine

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.<br>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.<br>Relays operation follow:<br>DC Relay M2 Closed -><br>DC Pre-Load relay Closed -><br>DC Relay M1 Closed -><br>DC Pre-Load relay Open -><br>AC Pre-Load relay Close -><br>AC Main Relay Close -><br>AC Pre-Load Relay Open.<br>Then PCS PWM on.<br>The relay states are showing at the last line. |
|          |                   | Close    | Close    |       |          |       |     |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                   |          |          | Close |          |       |     |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                   |          | Open     |       |          |       |     |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                   |          |          |       | Close    |       |     |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                   |          |          |       |          | Close |     |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                   |          |          |       | Open     |       |     |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                   |          |          |       |          |       | On  |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|          |                   | Close    | Open     | Close | Open     | Close | On  |                                                                                                                                                                                                                                                                                                                                                                                                                               |

|           |               |       |      |       |      |       |    |                                                 |
|-----------|---------------|-------|------|-------|------|-------|----|-------------------------------------------------|
| <b>S3</b> | Normal Run GT | Close | Open | Close | Open | Close | On | System is running normally under Grid-Tie Mode. |
|-----------|---------------|-------|------|-------|------|-------|----|-------------------------------------------------|

Table 2 System State Definitions (2-2)

| State ID  | Name / Definition | DC Relay |          |       | AC Relay |       | PWM | Remark                                                                                                                                                                                                                                                                                                                         |
|-----------|-------------------|----------|----------|-------|----------|-------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                   | M2       | Pre-Load | M1    | Pre-Load | Main  |     |                                                                                                                                                                                                                                                                                                                                |
| <b>S4</b> | Fault             | Open     | Open     | Open  | Open     | Open  | Off | System detected either AC fault, Converter Fault, Hardware fault or Other fault.<br>Fault definition table refer to chapter 4.                                                                                                                                                                                                 |
| <b>S6</b> | Soft Start SA     | Open     | Open     | Open  | Open     | Open  | Off | System is configured as standalone mode, or got command for transfer to standalone mode.<br>PCS got power on command.<br>DC Relay M2 Close -><br>DC Preload Relay Close -><br>DC Relay M1 Close -><br>DC Preload Relay Open -><br>AC Main Relay Close -><br>Then PCS PWM On.<br>The relay states are showing at the last line. |
|           |                   | Close    | Close    |       |          |       |     |                                                                                                                                                                                                                                                                                                                                |
|           |                   |          |          | Close |          |       |     |                                                                                                                                                                                                                                                                                                                                |
|           |                   |          | Open     |       |          |       |     |                                                                                                                                                                                                                                                                                                                                |
|           |                   |          |          |       |          | Close |     |                                                                                                                                                                                                                                                                                                                                |
|           |                   |          |          |       |          |       | On  |                                                                                                                                                                                                                                                                                                                                |
|           |                   | Close    | Open     | Close | Open     | Close | On  |                                                                                                                                                                                                                                                                                                                                |
| <b>S7</b> | 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.<br>after initialization done.                                                                                                                                           | 1                  | R   | 0x06F4        | 0x01  | O           | Read PCS system mode.<br>Refers to Section 3.4 for detail method.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| tr12 | S1                | S2         | Run Mode: Grid Tied<br><b>CMD_PCS_RUN_MODE</b><br>0: Grid-tied mode<br>1: Stand-alone mode<br>Command On/Off.<br><b>CMD_PCS_ON_OFF</b><br>1: PCS On<br>0/2: PCS Off<br>Delay about 10s. | 1                  | R   | 0x1000        | 0x00  | M           | Confirm those Settings are correct before operation. Or configure PCS before RUN.<br>Check step1: 0x1000 equal to '0x00' - Pass,<br>If step1 fail, execute step2 until step1 pass.<br>Check step3: 0x06F4 equal to '0x01' - Pass,<br>If step3 fail, confirm what's PCS state it is, and fault state by corresponding methods.<br>If step3 pass, process step4.<br>Normally, step 1 and 2 could be ignored.<br>Final PCS state is '0x02'-Soft start GT mode.<br>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.<br>Delay about 3s.                                                                                                                                         | 1                  | R   | 0x06F4        | 0x02  | O           | This transition is being done automatically.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|      |                   |            |                                                                                                                                                                                         | 2                  | R   | 0x06F4        | 0x03  | O           | Final PCS state is '0x03' - GT Normal mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

|      |    |    |                                                                                                           |   |   |        |      |     |                                                                                                                                                                                                                            |
|------|----|----|-----------------------------------------------------------------------------------------------------------|---|---|--------|------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| tr16 | S1 | S6 | Run Mode: Grid-forming<br>(Stand Alone)<br>Command On.<br>Register map refer to tr12.<br>Delay about 10s. | 1 | R | 0x1000 | 0x01 | M   | Check step1: 0x1000 equal to '0x01'-Pass,<br>If step1 fail, execute step2 until step1 pass.<br>Check step3: 0x06F4 equal to '0x01'-Pass,<br>If step3 pass, process step4.<br>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.<br>Delay about 3s.                                                              | 1 | R | 0x06F4 | 0x05 | O   | This transition is being done automatically.<br>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,<br>tr14 | S1,<br>S2,<br>S3,<br>S6,<br>S7 | S4         | Any fault is detected.<br>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-<br>0x06FE | X             | O           | Detail description about fault definition please refer to protocol file.                                                                                                                  |
|               |                                |            |                                                                          | 3                  | R   | 0x11E7-<br>0x11EE | X             | O           | System Alarm: 0x06F8-0x06FE<br>Module Alarm: 0x11E7-0x11EE                                                                                                                                |
| trx1          | S2,<br>S3,<br>S6,<br>S7        | S1         | Command Off.<br>Delay about 1s.                                          | 1                  | W   | 0x1001            | 0x02/<br>0x00 | M           | Note: Off command value is 0x02 or 0x00;<br>If step2 return other value, process step1 first.                                                                                             |
|               |                                |            |                                                                          | 2                  | R   | 0x06F4            | 0x01          | O           |                                                                                                                                                                                           |
| tr41          | S4                             | S1         | Faults cleared.<br>Delay about 1s.                                       | 1                  | R   | 0x06F4            | 0x01          | O           | This transition would be processed automatically.<br>Conditions:<br>Read Register ID: 0x06F8~0x06FE,<br>Read Register ID: 0x11E7~0x11EE,<br>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.<br>0: Initial<br>1: Standby<br>2: GT Power On<br>3: GT Normal<br>4: SA Power On<br>5: SA Soft-start<br>6: SA Normal<br>7: Fault<br>8: Test<br>9: Upgrade<br>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<br>0: Initial<br>1: Standby<br>2: DC Preload<br>3: Black Start<br>4: Self Start<br>5: AC Preload<br>6: SA Normal<br>7: GT Normal<br>8: Fault<br>9: Upgrade<br>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<br>(HEX) | Definition                   | Description                                                                                                                                                                                                                                                                     | RW | OA | Scale | Unit | Min | Max   | Default |
|---------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|-------|------|-----|-------|---------|
| 06F0          | EN_PR_SYS_MODEL_ID           | Master System Modbus RTU ID<br>Information:<br>b0~b7: System ID Number (1~8), Config by Hardware Switch.<br>b8~b15: Modules Online Flag. (Master Only, for Slave, b8~15 = 0)<br>b8: =1, Module 1 Online;<br>bx: =1, Module x Online;<br>bx: =0, Module x Offline.<br>(x = 8~15) | R  | No | NA    | NA   | 0   | 65535 | 0       |
| 06F6          | EN_PR_SYS_STATE_MASTER_SLAVE | PCS State of Master or Slave<br>0: Slave<br>1: Master                                                                                                                                                                                                                           | R  | No | NA    | NA   | 0   | 1     | 0       |
| 06F7          | EN_PR_SYS_STATE_SWITCH       | PCS Switch QS state<br>bit0: AC Switch State, = 1 Closed.<br>bit1: DC Switch State, =1 Closed                                                                                                                                                                                   | R  | No | NA    | NA   | 0   | 65535 | 0       |

## 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<br>(HEX) | ADDR<br>(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<br>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<br>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<br>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<br>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<br>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<br>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<br>(HEX) | ADDR<br>(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 |
|----|---------------|----------|----------|------------|------------|-----|
|----|---------------|----------|----------|------------|------------|-----|

|    |    |    |    |    |    |       |
|----|----|----|----|----|----|-------|
| 01 | 03 | 12 | 00 | 00 | 0D | 81 77 |
|----|----|----|----|----|----|-------|

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 |

## 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 | [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]    |

If PCS needs to communicate with BMS of Battery system through Ethernet, user must set the following IP registers. The configuration steps are same as the above.

Table 9 Configuration Table for Ethernet Communication with BMS.

| ADDR<br>(HEX) | ADDR<br>(DEC) | TYPE   | DEFINITION                   | DESCRIPTION          | Unit | RW | Min | Max   | Default | OA |
|---------------|---------------|--------|------------------------------|----------------------|------|----|-----|-------|---------|----|
| 15            | 21            | Uint16 | EN_PR_OS_BATTCONFIG_IP_ADDR1 | IP_ADDR1.XXX.XXX.XXX | NA   | RW | 0   | 255   | 0       | No |
| 16            | 22            | Uint16 | EN_PR_OS_BATTCONFIG_IP_ADDR2 | XXX.IP_ADDR2.XXX.XXX | NA   | RW | 0   | 255   | 0       | No |
| 17            | 23            | Uint16 | EN_PR_OS_BATTCONFIG_IP_ADDR3 | XXX.XXX.IP_ADDR3.XXX | NA   | RW | 0   | 255   | 0       | No |
| 18            | 24            | Uint16 | EN_PR_OS_BATTCONFIG_IP_ADDR4 | XXX.XXX.XXX.IP_ADDR4 | NA   | RW | 0   | 255   | 0       | No |
| 19            | 25            | Uint16 | EN_PR_OS_BATTCONFIG_IP_PORT  | IP_PORT              | NA   | RW | 0   | 32767 | 502     | No |

### 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 &amp; Operation Mode

| ADDR<br>(HEX) | ADDR<br>(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;<br>1: PCS Run with Grid-Forming/Off-grid mode;<br>Default: 0 - Grid-following mode<br><b>Note:</b> 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.<br>0: Master(Default).<br>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<br>0: SPF<br>1: Power Set (Demand response)<br>2: NA<br>3: Volt-Var<br>Other: NA                                                                                                                     | NA   | RW  | 0   | 3   | 1       | Yes |

|      |      |        |                      |                                                                                                |    |    |   |   |   |    |
|------|------|--------|----------------------|------------------------------------------------------------------------------------------------|----|----|---|---|---|----|
| 1073 | 4211 | Uint16 | EN_PR_GC_PQ_PRIORITY | Priority of active power / reactive power (GC mode)<br>0: Reactive first ;<br>1: Active first; | NA | RW | 0 | 1 | 0 | No |
|------|------|--------|----------------------|------------------------------------------------------------------------------------------------|----|----|---|---|---|----|

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<br>(ID=1) | PCS#2<br>(ID=2) | PCS#3<br>(ID=3) | PCS#4<br>(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<br>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. And you can get PCS state via following register:

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 do not support switch between grid-tied mode and standalone mode online.

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.*

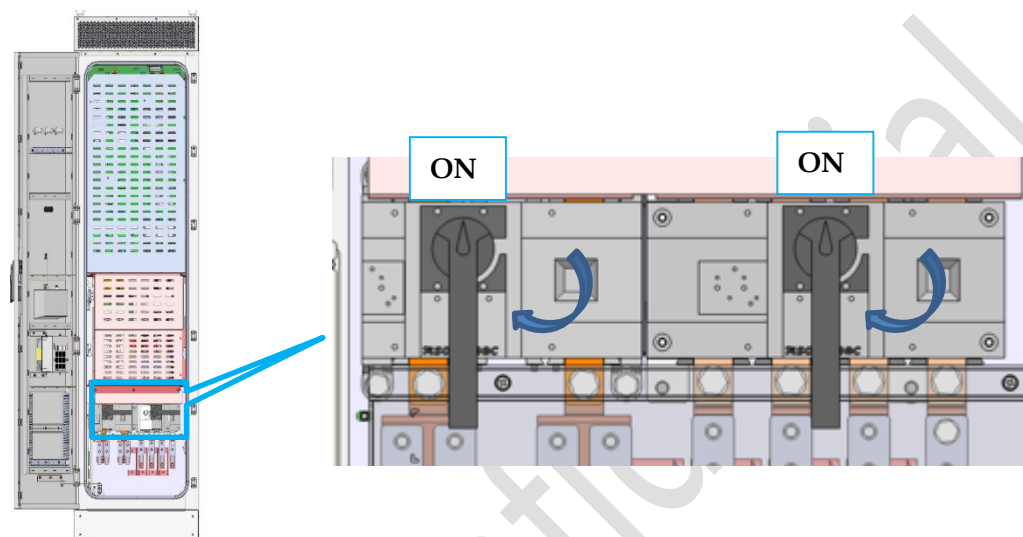


Figure 5-1 AC and DC disconnects ON location

**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.<br>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.<br>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.

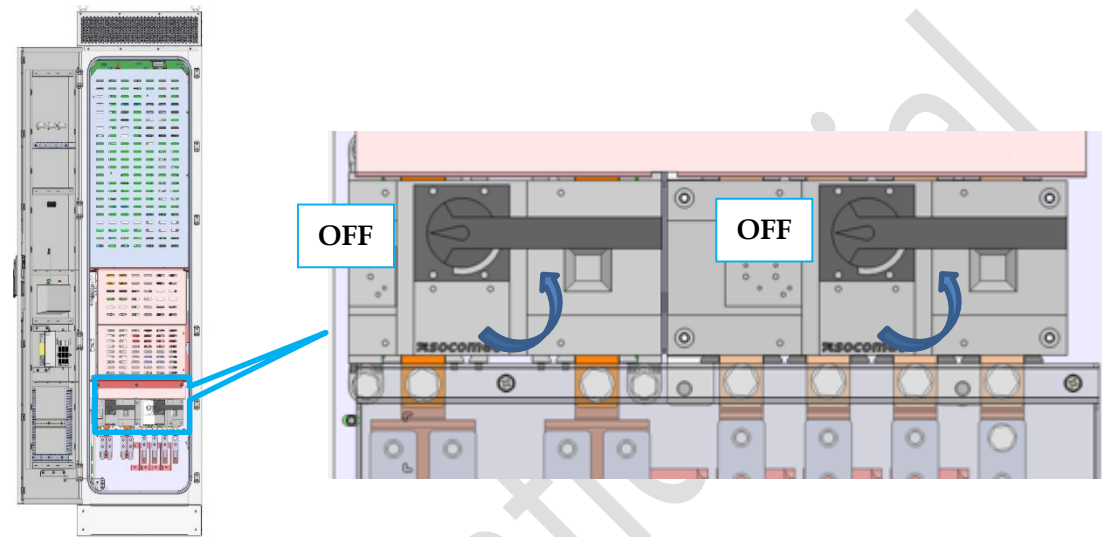


Figure 5-2 AC and DC disconnects OFF location

## 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 4187(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 reserved for AS4777.2-2020 and VDE4105 certification.

Table 17 grid code parameter

| STEP | CMD     |          | DESCRIPTION |       |         | REMARK                                                                                                                                                                                                                                                   | Option |
|------|---------|----------|-------------|-------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
|      | ID(PCS) | Function | Register    | Value | CRC REF |                                                                                                                                                                                                                                                          |        |
| 1    | 01      | 06       | 105B        | 0006  | 3D 19   | Grid code.<br><br>Choose and confirm the appropriate code according to the application area.<br>0: No Set<br>1: AS4777.2A<br>2: NZS4777.2<br>3: VDE4105-2018<br>4: AS4777.2B<br>5: AS4777.2C<br>6: AS4777.2-2015<br>31: Delta Default<br>Others reserved | [M]    |

## 6.2. Normal/Soft-Start ramp rates setting

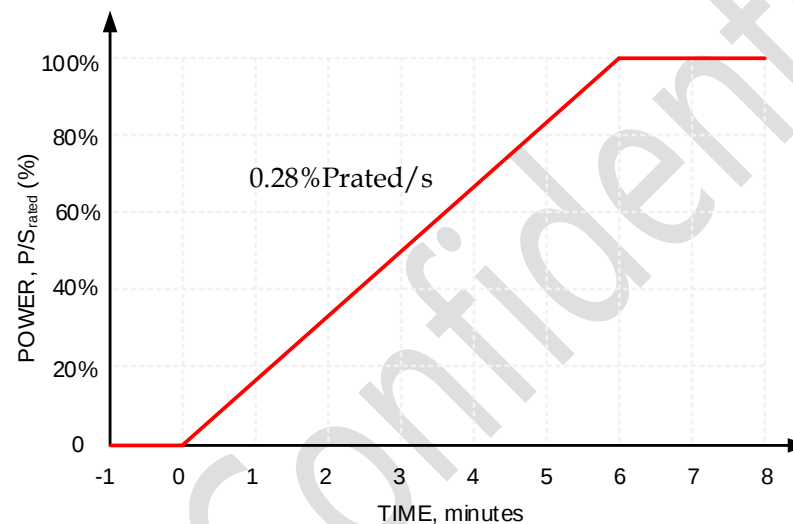


Table 18 Steps for setting Normal soft start ramp rates [FIRST RUN / WHEN NEED]

| 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<br>1: Active Enable<br>2: <b>Passive Enable</b><br>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<br>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<br>bit3 = 1: Over Level 1 enable<br>bit2 = 1: Under Level 1 enable<br>bit1 = 1: Under Level 2 enable<br>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<br>0.01s(10ms)<br>bit3 = 0: Over Level 1 scale<br>0.01s(10ms)<br>bit2 = 0: Under Level 1 scale<br>0.01s(10ms)<br>bit1 = 0: Under Level 2 scale | [O] |

|   |    |    |           |   |   |                                        |                                                                                                        |     |
|---|----|----|-----------|---|---|----------------------------------------|--------------------------------------------------------------------------------------------------------|-----|
| 3 | 01 | 06 | 107D-1086 | / | / | Threshold Value and time Configuration | 0.01s(10ms)                                                                                            | [O] |
|   |    |    |           |   |   |                                        | bit0 = 0: Under Level 3 scale                                                                          |     |
|   |    |    |           |   |   |                                        | 0.01s(10ms)<br>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<br>bit3 = 0: Over Level 1 disable<br>bit2 = 0: Under Level 1 disable<br>bit1 = 0: Under Level 2 disable<br>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<br>bit2 = 1: Over Level 1 enable<br>bit1 = 1: Under Level 1 enable<br>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)<br>bit3 = 0: Over Level 2 scale 0.01s(10ms)                                                                    | [O] |

|   |    |    |               |   |   |                                                                                                                                             |                                                                                                   |
|---|----|----|---------------|---|---|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
|   |    |    |               |   |   | bit2 = 0: Over Level 1 scale<br>0.01s(10ms)<br>bit1 = 0: Under Level 1 scale<br>0.01s(10ms)<br>bit0 = 0: Under Level 2 scale<br>0.01s(10ms) |                                                                                                   |
| 3 | 01 | 06 | 1089-<br>1090 | / | / | Protection Value and time<br>Configuration                                                                                                  | The value is different based on<br>different grid code, please refer to<br>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<br>bit3 = 0: Over Level 2 disable<br>bit2 = 0: Over Level 1 disable<br>bit1 = 0: Under Level 1 disable<br>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<br>[M]        |
| 2    | 01      | 06       | 1092        | 04EC  | 2F AA   | Auto reconnection voltage set high<br>Unit: 0.1%     | Setting value = 110%, means 110%*Vrated<br>[O]     |
| 3    | 01      | 06       | 1093        | 037B  | 3D F4   | Auto reconnection voltage set low<br>Unit: 0.1%      | Setting value = 89.1%, means 89.1%*Vrated<br>[O]   |
| 4    | 01      | 06       | 1094        | 1397  | 80 78   | Auto reconnection frequency set high<br>Unit: 0.01Hz | Setting value = 50.15%, means 50.15%*Frated<br>[O] |
| 5    | 01      | 06       | 1095        | 128E  | 11 E2   | Auto reconnection frequency set low<br>Unit: 0.01Hz  | Setting value = 47.50%, means 47.50%*Frated<br>[O] |
| 6    | 01      | 06       | 1096        | 003C  | 6D 37   | Auto reconnection time set delay<br>Unit: s          | Setting value = 60, means 60s<br>[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<br>[M] |

## 6.7. SPF mode setting

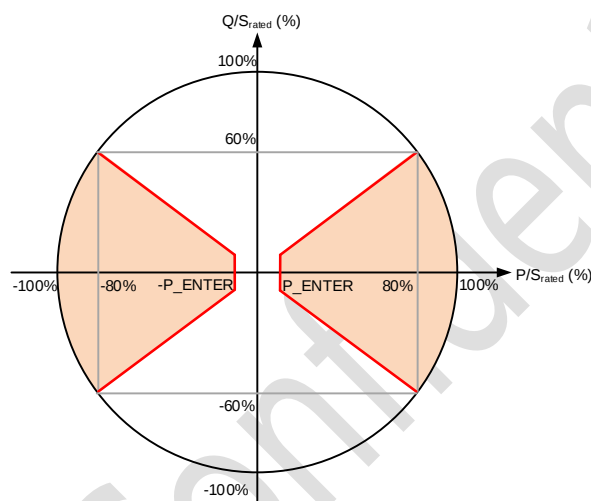


Figure 6-1 SPF control mode limit area

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<br>Set reactive power maximum<br>Default: 60% | [O] |
| 6 | 01 | 06 | 1098 | 0320 | 0D CD | Set PF minimum | Set PF minimum<br>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.<br>[M]            |
| 2    | 01      | 06       | 1072     | 0001        | EC D1   | Return to default value | 1: Power set (Demand mode)<br>[M] |

## 6.8. Volt-Var function setting

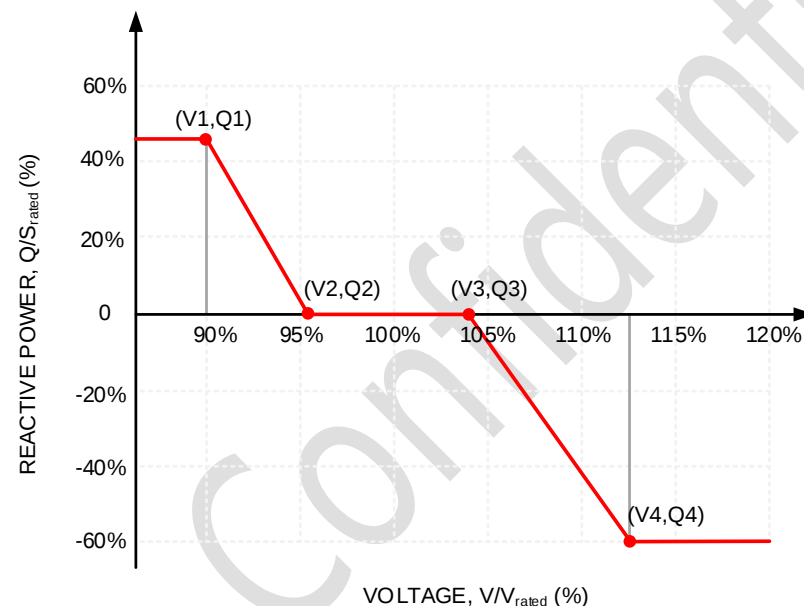


Figure 6-2 Volt-Var control mode curve

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]<br>Q2->[0x10AD], V2->[0x10AC]<br>Q3->[0x10AF], V3->[0x10AE]<br>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

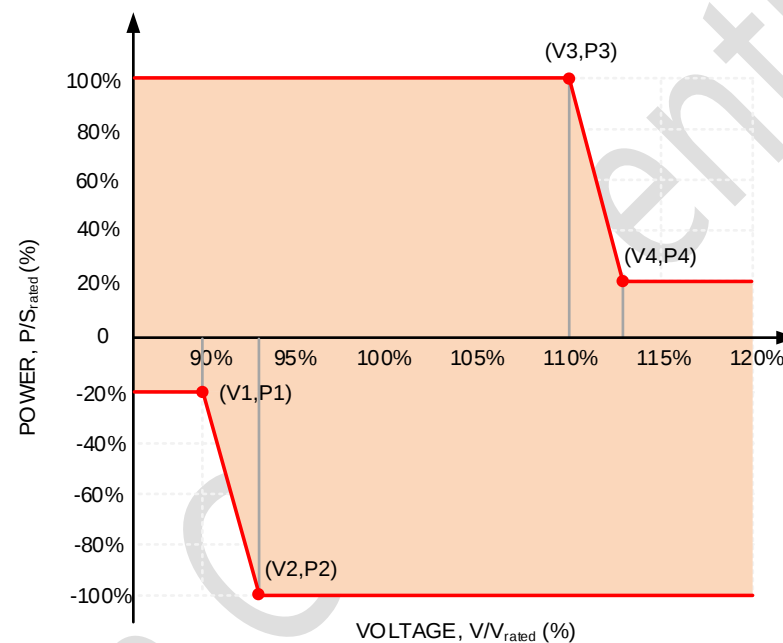


Figure 6-3 Volt-Watt control mode limit area

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]<br>P2->[0x10BB], V2->[0x10BA]<br>P3->[0x10BD], V3->[0x10BC]<br>P4->[0x10BF], V4->[0x10BE] | different grid code, please refer to<br>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.<br>[M] |

## 6.10. Freq-Watt function setting

### 6.10.1. 3-point mode

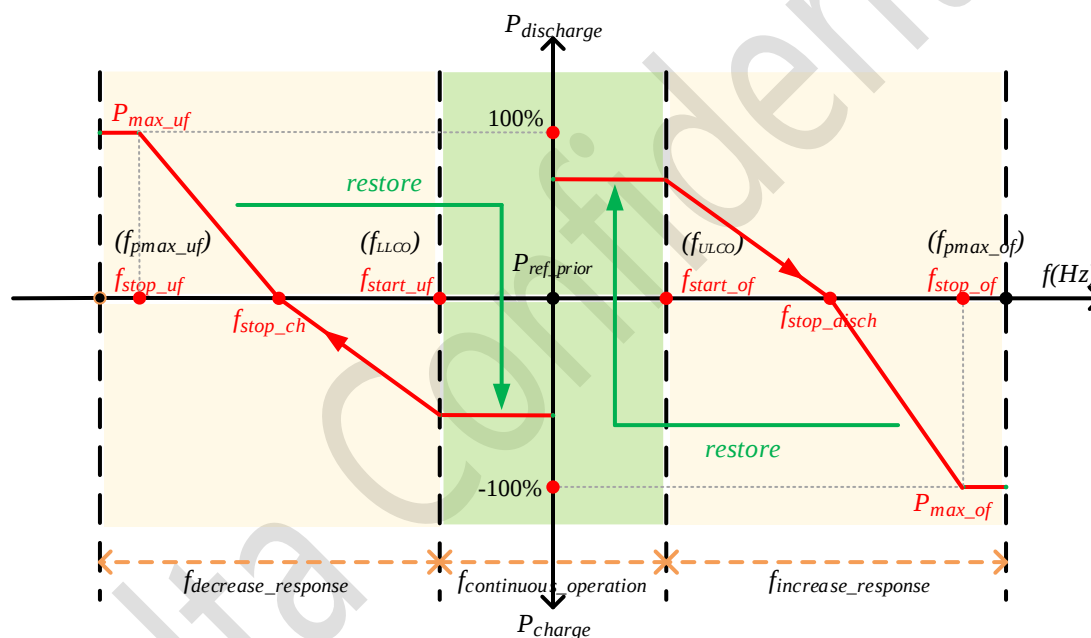


Figure 6-4 Freq-Watt control mode curve (3-point mode)

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-<br>10C4,<br>10C7-<br>10CA,<br>10CC,<br>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

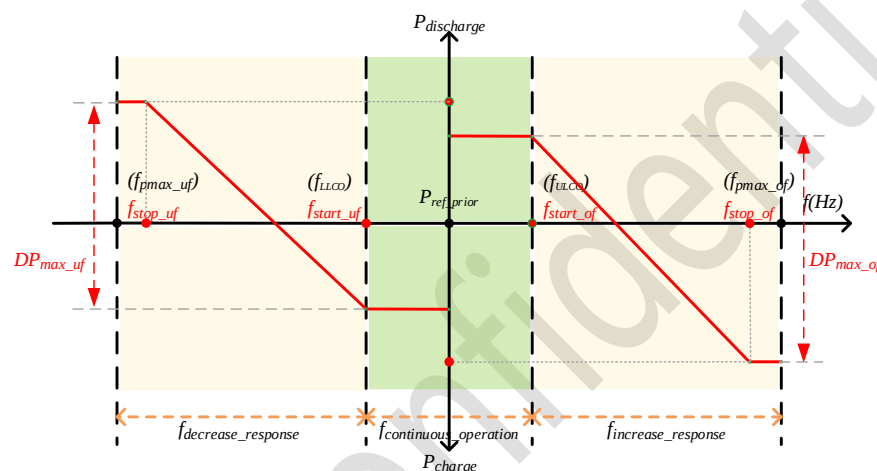


Figure 6-5 Freq-Watt control mode curve (2-point mode)

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.<br>0: No Set<br><b>1: AS4777.2A</b><br>2: NZS4777.2 |

|   |    |    |                      |      |       |                                             |                                                                                                             |     |
|---|----|----|----------------------|------|-------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----|
|   |    |    |                      |      |       |                                             | 3: VDE4105-2018<br>4: AS4777.2B<br>5: AS4777.2C<br>6: AS4777.2-2015<br>31: Delta Default<br>Others reserved |     |
| 2 | 01 | 06 | 10C0                 | 0004 | 8C F5 | Freq-Watt function enable(Over frequency).  | 4: 2-Point Mode (FCAS)                                                                                      | [M] |
| 3 | 01 | 06 | 10C6                 | 0004 | 6C F4 | Freq-Watt function enable(under frequency). | 4: 2-Point Mode (FCAS)                                                                                      | [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<br>bit 0 = 1: Average under voltage enable<br>bit 1 = 1: Average over voltage enable | [M]    |
| 2    | 01      | 06       | 10D0        | 0462  | 0F DA   | Average voltage OVP voltage value<br>Setting value = 112.2%, means 112.2%*Vrated                                       | [O]    |
| 3    | 01      | 06       | 10D2        | 012C  | 2D 7E   | Average voltage OVP time value<br>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<br>bit 0 = 0: Average under voltage disable<br>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.

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## 7. Miscellaneous

### 7.1. System Time Setting [WHEN NEED]

Table 47 system time configuration

| ADDR<br>(HEX) | ADDR<br>(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<br>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<br>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<br>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 <sup>st</sup> ,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<br>(HEX) | ADDR<br>(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<br>0: No action<br>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<br>(HEX) | ADDR<br>(DEC) | TYPE   | DEFINITION                     | DESCRIPTION                                                                    | Unit | RW | Min | Max | Default | OA  |
|---------------|---------------|--------|--------------------------------|--------------------------------------------------------------------------------|------|----|-----|-----|---------|-----|
| 0000          | 0000          | Uint16 | EN_PR_OS_CMD_EMS_PCS_HEARTBEAT | EMS HeartBeat.<br>EMS HeartBeat 0~255, Updated every 2s.<br>(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<br>(HEX) | ADDR<br>(DEC) | TYPE   | DEFINITION                   | DESCRIPTION                                                   | Unit | RW | Min | Max | Default | OA |
|---------------|---------------|--------|------------------------------|---------------------------------------------------------------|------|----|-----|-----|---------|----|
| 0001          | 0001          | Uint16 | EN_PR_OS_CMD_BMS_START       | BMS Stop/Start Command<br>0: NA<br>1: BMS ON<br>2: BMS OFF    | NA   | W  | 0   | 2   | 0       | No |
| 0002          | 0002          | Uint16 | EN_PR_OS_CMD_BMS_FAULT_CLEAR | BMS Fault Clear<br>0: NA/No Command<br>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<br>1: BMS ON  | [M]    |
| 2    | 01      | 06       | 0001        | 0002  | 59 CB   | BMS Stop/Start Command<br>2: BMS OFF | [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<br>1: Fault Clear Command | [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<br>bitx = 1: Check enable,<br>bitx = 0: Check disable; x=0-15<br><b>b0=1: BMS Communication Check Enable.</b><br><b>b1=1: BMS Fault Check Enable.</b><br><b>b2=1: BMS Warning Check Enable.</b><br><b>b3=1: Battery Voltage High Fault Check Enable.</b><br><b>b4=1: Battery Voltage Low Warning Check Enable.</b><br><b>b5=1: BMS SOC Fault Check Enable (high/low).</b><br><b>b6=1: BMS SOC Warning Check Enable (high/low).</b><br><b>b10=1: Battery Cell Volt High Warn Check Enable.</b><br><b>b11=1: Battery Cell Volt Low Warn Check Enable.</b> | Enable all related protection of Battery system<br><i>*Note: Auto recharging function isn't enabled.</i> | [M] |
| 2    | 01      | 06       | 0619-061E<br>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<br>bitx = 1: Check enable,<br>bitx = 0: Check disable; x=0-15<br><b>b8=1: Battery Auto Recharge by SOC Enable.</b><br><b>b9=1: Battery Auto Recharge Power by Set Enable.</b> | Enable auto-recharging function of Battery system<br><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<br>bitx = 1: Check enable,<br>bitx = 0: Check disable; x=0-15<br><b>b8=1: Battery Auto Recharge by SOC Enable.</b><br><b>b9=0: Battery Auto Recharge Power by Set Enable.</b> | Enable manual-recharging function of Battery system.<br><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<br>bitx = 1: Check enable,<br>bitx = 0: Check disable; x=0-15<br><b>b7=1: BMS Power Limitation Check Enable.</b> | Enable power limit function.<br><i>*Note: All protection functions<br/>and recharging function are<br/>disabled.</i> | [M]    |

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