# PERATION MANUAL FOR PCS125HV

# V1.1.0

| Reversion | Date | Update by | Description | FW version |
|---|---|---|---|---|
| V1.0.0 | 2021/12/30 | Zhiguang Gao | File created | |
| V1.1.0 | 2022/7/4 | Zhiguang Gao | Updated some content about IEEE1547/UL1741SB grid code | |
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Contents

# 1. Objectives

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

## 1.1. Application Notes

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

a) Inquiries are generally sorted as PERIODIC / WHEN NEED / FIRST RUN.
b) Recommended period for inquiring information is 200ms.
c) Recommended maximum length of inquiry data is less than 50.
d) Recommended period for inquiring measurements data is 500ms+.
e) The parameters of configurable parameters are Readable/Writable attribute, including registers related to grid code. After modifying parameters, users can read them again to confirm whether the modification is successful.
f) In first co-test, a READ is recommended when a WRITE is applied.
g) All the parameter configuration steps in this article are described with the register address of the PCS (ID=1) as an example. For the scenario of multiple PCS parallel applications, please refer to " Appendix B Status & Monitoring Variables Table" of PCS125HV 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.

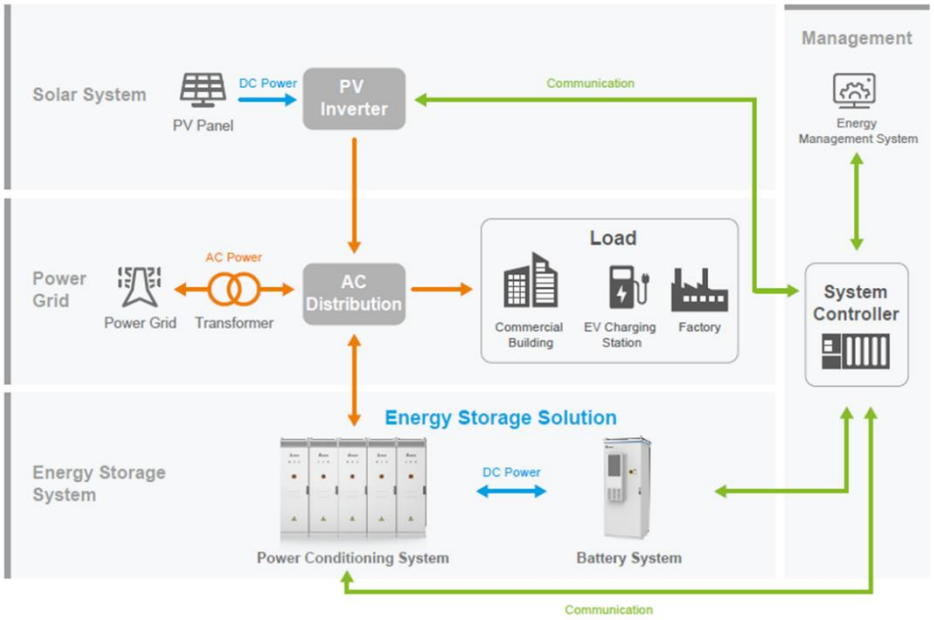


Figure 2-1 System Architecture Diagram.

# 3. Sequence Diagram / Chart of State Machine

## 3.1. State Machine of PCS

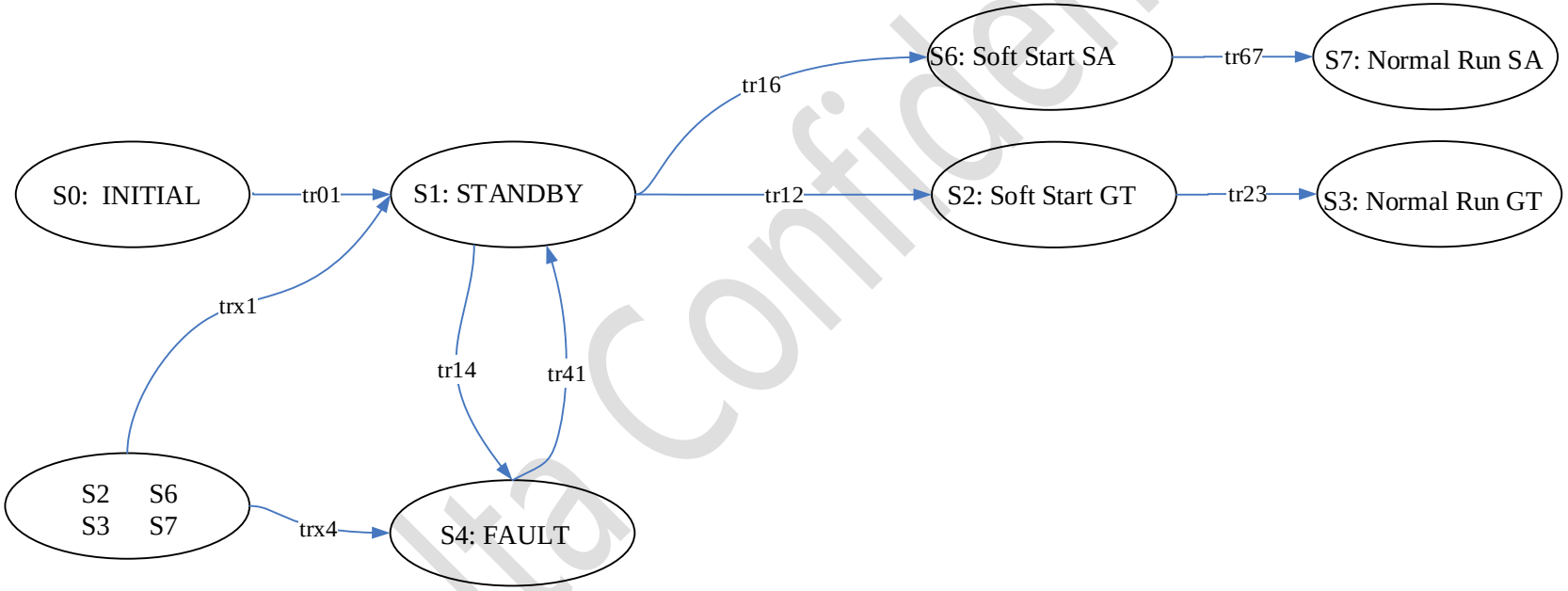


Figure 3-1 State Machine

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 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **S3** | 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 | | |
| **S4** | 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. |
| **S6** | 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 | |
| **S7** | Normal Run SA | Close | Open | Close | Open | Close | On | System is running in normal operation state under standalone mode. |

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

## 3.3. State transitions conditions

Table 3 Transition Table (3-1)

| No. | Previous State(s) | Next State | Conditions | Register Operation | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Step(s) | R/W | Register ADDR | Value | Must Option | |
| tr01 | S0 | S1 | Delay about 1s.<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>**CMD_PCS_RUN_MODE**<br>0: Grid-tied mode<br>1: Stand-alone mode<br>Command On/Off.<br>**CMD_PCS_ON_OFF**<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.<br>Final PCS state is '0x03'- GT Normal mode. |
| | | | | 2 | R | 0x06F4 | 0x03 | O | |

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

Note1: a time delay between command and next state request should be over 50ms.

Note2: PCS will respond the corresponding operation only after the system state enters normal operation. for example, the power demand commands only available under the normal run state of grid-tied mode(0x03), Voltage and Frequency regulation only available under the normal run state of stand-alone mode.

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

Table 4 Transition Table (3-2)

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

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

# 3.4. Get State Info [PERIODIC / WHEN NEED]

Delta do not provide a monitoring application. User can get the operation status and key monitoring information of PCS125HV through Modbus TCP.

## 3.4.1. System state

System state of PCS could be accessed via address 0x06F4(HEX) of PCS125HV 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 PCS125HV 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: AC Preload<br>4: AFE Start<br>5: Black Start<br>6: Sync Start<br>7: SA Normal<br>8: GC Normal<br>9: SA2GC<br>10: GC2SA<br>11: Fault<br>12: Test Mode (only for internal testing purpose)<br>13: 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 PCS125HV through reading the below registers of Master/slave PCS.

| ADDR (HEX) | Definition | Description | RW | OA | Scale | Unit | Min | Max | Default |
|---|---|---|---|---|---|---|---|---|---|
| 06F0 | EN_PR_SYS_MODEL_ID | Master System Modbus RTU ID<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 PCS125HV through Modbus TCP.

### 3.5.1. System Monitoring

| ADDR (HEX) | ADDR (DEC) | TYPE | DEFINITION | DESCRIPTION | Unit | RW | Min | Max | Default |
|---|---|---|---|---|---|---|---|---|---|
| 06FF | 1791 | Uint16 | EN_MEAS_SYS_FREQ_GRID | Frequency of Grid | 0.01Hz | R | 2000 | 7000 | 0 |
| 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 |
| 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℃ | R | -1000 | 2000 | 0 |
| 071F | 1823 | Int16 | EN_MEAS_SYS_TEMP_INLET | Inlet Temperature | 0.1℃ | R | -1000 | 2000 | 0 |
| 0720 | 1824 | Uint16 | EN_MEAS_SYS_IMD_ISO | ISO Measurement | kΩ | R | 0 | 30000 | 0 |

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

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

## 3.5.2. Module Monitoring

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

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

### 3.5.3. SN and Version

The user can read the below registers to get the serial number & firmware version of PCS125HV through EMS controller.

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

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

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

# 4. System Configuration

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

Table 5 Abbreviation Table

| Abbr. | Definition |
|---|---|
| **[M]** | Must |
| **[O]** | Optional |

## 4.1. Parameter Configuration

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

For these items, a recommended process is as follows,

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

Note:

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

## 4.1.1. Communication Configuration [FIRST RUN / WHEN NEED]

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

Table 7 Configuration Table for Ethernet Communication.

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

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

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

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 10 | 000A | 08 08 | Set IP_ADDR1 =10 | Set new IP address：10.7.21.40<br>Port:502 | [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 (Only support for CATL Battery & BMS).

| ADDR (HEX) | ADDR (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 & Operation Mode

| ADDR (HEX) | ADDR (DEC) | TYPE | DEFINITION | DESCRIPTION | Unit | RW | Min | Max | Default | OA |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | 4096 | Uint16 | EN_CMD_PCS_RUN_MODE | 0: PCS Run with Grid-Following /Grid-tie mode;<br>1: PCS Run with Grid-Forming/Off-grid mode;<br>Default: 0 - Grid-following mode<br>***Note**: The PCS will be restored to the default value every time it is powered on again.* | NA | R/W | 0 | 1 | 0 | No |
| 0610 | 1552 | Uint16 | EN_PR_SYS_MASTER_CONFIG | System Master configuration.<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 (ID=1) | PCS#2 (ID=2) | PCS#3 (ID=3) | PCS#4 (ID=4) | Description |
|---|---|---|---|---|---|---|---|---|
| **M** | 1000 | CMD_PCS_RUN_MODE | 0 | 0 | 0 | 0 | 0 | PCS run mode(0:Grid following,1:Grid-forming) |
| **M** | 0610 | PR_SYS_MASTER_CONFIG | 0 | 0 | 1 | 1 | 1 | PCS#1: master<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 PCS125HV-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.

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 PCS125HV 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 PCS125HV 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.*

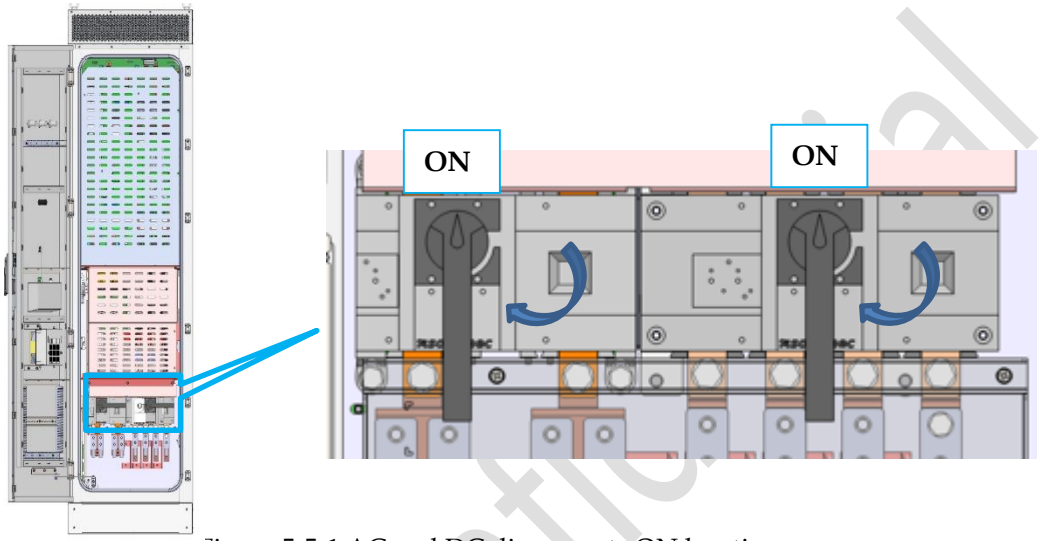


Figure 5-5-1 AC and DC disconnects ON location

**Step 3:** set the correct IP address (Default:192.168.1.136) and port number (502) and start communicating with PCS125HV.

**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 | 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 PCS125HV is "Standby" status, if it is, the upper level controller sends "Power ON" command

to PCS125HV. PCS will synchronize with grid.

**Step 6:** when PCS125HV enters the "Normal" status, the upper level controller sends "Reactive Power" or/and "Active Power" command to PCS125HV, it will output the corresponding power to the grid. See below table for parameters of power on and power command of PCS125HV.

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 PCS125HV: Prated is 125kW.*

**Power Off PCS**

After PCS125HV 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 PCS125HV, PCS125HV 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.

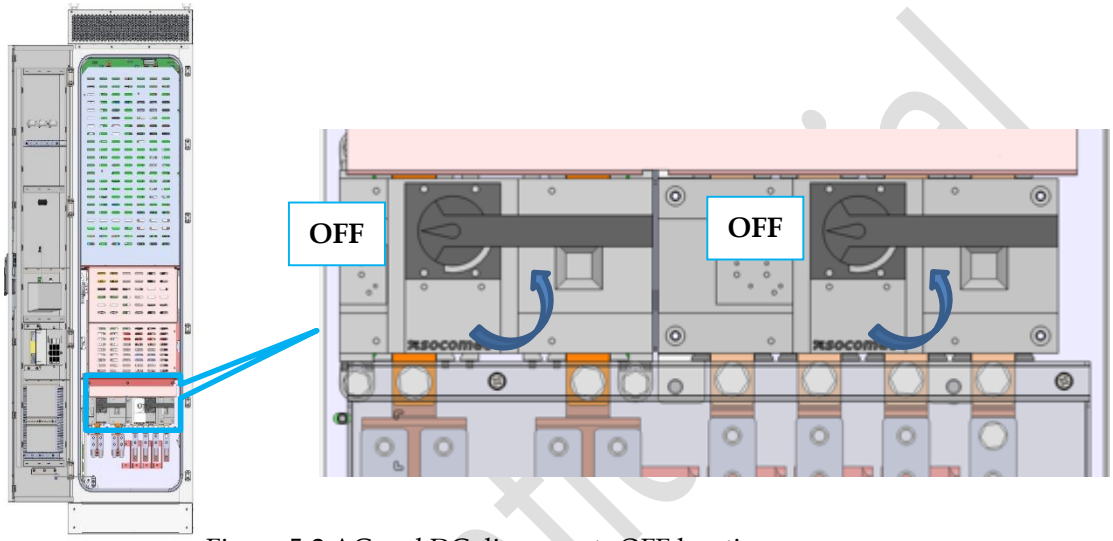


Figure 5-2 AC and DC disconnects OFF location

## 5.2. Standalone(SA) mode operation

**Power On PCS**

To power on the PCS125HV in standalone mode, see the following requirements:

1. After the PCS installation is completed, check to ensure that the upstream breaker to utility gird 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 PCS125HV 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 PCS125HV.

**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** | **CRC REF** | | | |
| **01** | 06 | 1000 | 0001 | 4C CA | Set PCS run in SA mode temporarily. | 1: SA/Grid-forming mode. | [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 PCS125HV is "Standby" status, if it is, the upper level controller sends "Power ON" command

to PCS125HV. PCS will output 3 phase sine wave voltage.
**Step 6:** when PCS125HV enters the "Normal" status, the local load connected to PCS output can be powered.

**Power Off PCS**

After PCS125HV 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 PCS125HV, PCS125HV 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.

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:
(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 PCS125HV, only need to select correct grid code and enable one or more functions, generally don't need to modify any detailed curve point or parameters.

# 6.1. Set Grid Code

The register parameters of this chapter will vary depending on the register [0x105B] (Grid code type). When PCS is applied to a certain area, you should first confirm the applicable grid regulations and set the following register. For IEEE1547, the user need to write the value "1" to register [0x105B].

| Index | Grid Code Type | Description |
|---|---|---|
| 0 | No Set | No grid code application. |
| 1 | IEEE1547-2018 | Grid-connected regulatory certification, meet IEEE-1547 and UL1741SB |
| 31 | Delta Default | Default configuration, cannot be applied to specific regions, only for test use. |

Table 17 grid code parameter setting (example)

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 105B | 0001 | 3D 19 | Grid code. | Choose and confirm the appropriate code according to the application area.<br>0: No Set<br>1: IEEE1547-2018(Default)<br>31: Delta Default<br>Others reserved | [M] |

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

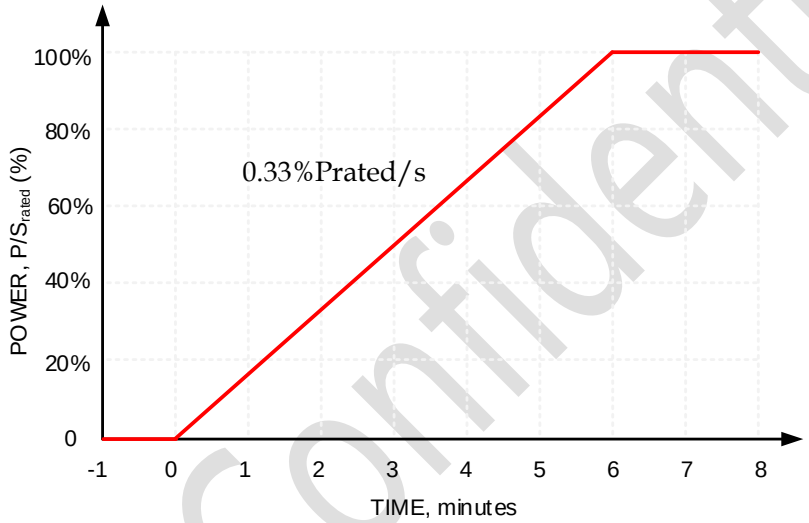


Table 18 Steps for setting Normal soft start ramp rates [FIRST RUN / WHEN NEED]

| 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 | 0021 | FD 08 | Set normal soft start ramp rate value | Setting normal soft start ramp rate value = 0.33% | [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 | 0003 | EC D2 | Enable anti-islanding passive check | 1: Active Enable<br>2: Passive Enable<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 | 0: Disable | [M] |

# 6.4. High/Low voltage protection function setting

Table 22 Abnormal voltages trip setting

**Table 13—DER response (shall trip) to abnormal voltages for DER of abnormal operating performance Category III (see Figure H.9)**

| Shall trip—Category III | | | | |
|---|---|---|---|---|
| Shall trip function | Default settings[a] | | Ranges of allowable settings[b] | |
| | Voltage (p.u. of nominal voltage) | Clearing time (s) | Voltage (p.u. of nominal voltage) | Clearing time (s) |
| OV2 | 1.20 | 0.16 | fixed at 1.20 | fixed at 0.16 |
| OV1 | 1.10 | 13.0 | 1.10 – 1.20 | 1.0 – 13.0 |
| UV1 | 0.88 | 21.0 | 0.0 – 0.88 | ~~21.0~~ 2.0 – 50.0 |
| UV2 | 0.50 | 2.0 | 0.0 – 0.50 | ~~2.0~~ 0.16 – 21.0 |

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 0.01s(10ms)<br>bit3 = 0: Over Level 1 scale 0.01s(10ms) | [O] |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | bit2 = 0: Under Level 1 scale 0.01s(10ms)<br>bit1 = 0: Under Level 2 scale 0.01s(10ms)<br>bit0 = 0: Under Level 3 scale 0.01s(10ms) | |
| **3** | 01 | 06 | 107D-1086 | / | / | Threshold Value and time Configuration | The value is different based on grid code, please refer to PCS125HV Protocol. | [O] |

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 Abnormal frequency trip setting

**Table 18—DER response (shall trip) to abnormal frequencies for DER of abnormal operating performance Category I, Category II, and Category III (see Figure H.10)**

| Shall trip function | Default settings[a] | | Ranges of allowable settings[b] | |
|---|---|---|---|---|
| | Frequency[c] (Hz) | Clearing time (s) | Frequency (Hz) | Clearing time (s) |
| OF2 | 62.0 | 0.16 | 61.8–66.0 | 0.16–1 000.0 |
| OF1 | 61.2 | 300.0 | 61.0–66.0 | 180.0–1 000.0 |
| UF1 | 58.5 | 300.0[c] | 50.0–59.0 | 180.0–1 000 |
| UF2 | 56.5 | 0.16 | 50.0–57.0 | 0.16–1 000 |

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)<br>bit2 = 0: Over Level 1 scale | [O] |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0.01s(10ms)<br>bit1 = 0: Under Level 1 scale 0.01s(10ms)<br>bit0 = 0: Under Level 2 scale 0.01s(10ms) | |
| **3** | 01 | 06 | 1089-1090 | / | / | Protection Value and time Configuration | The value is different based on grid code, please refer to PCS125HV Protocol. | [O] |

Table 27 Steps for disabling high/low frequency protection function

| **STEP** | **CMD** | | | | | **DESCRIPTION** | **REMARK** | **Option** |
|---|---|---|---|---|---|---|---|---|
| | **ID(PCS)** | **Function** | **Register** | **Value** | **CRC REF** | | | |
| **1** | 01 | 06 | 1087 | 0000 | 3D 23 | Disable high/low voltage protection | bit3 = 0: Over Level 2 disable<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 | [M] |
| **2** | 01 | 06 | 1092 | 041A | AF EC | Auto reconnection voltage set high<br>Unit: 0.1% | Setting value = 105%, means 105%*Vrated | [O] |
| **3** | 01 | 06 | 1093 | 0395 | BD B8 | Auto reconnection voltage set low<br>Unit: 0.1% | Setting value = 91.7%, means 91.7%*Vrated | [O] |
| **4** | 01 | 06 | 1094 | 177A | 42 F5 | Auto reconnection frequency set high<br>Unit: 0.01Hz | Setting value = 60.1%, means 60.1%*Frated | [O] |
| **5** | 01 | 06 | 1095 | 173E | 13 06 | Auto reconnection frequency set low<br>Unit: 0.01Hz | Setting value = 59.5%, means 59.5%*Frated | [O] |
| **6** | 01 | 06 | 1096 | 003C | 6D 37 | Auto reconnection time set delay<br>Unit: s | Setting value = 300, means 300s | [O] |

NOTE: Model PCS125HV: Vrated is 277.2V, Frated=60Hz

Table 29 Steps for disabling Reconnection function

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

# 6.7. SPF mode setting

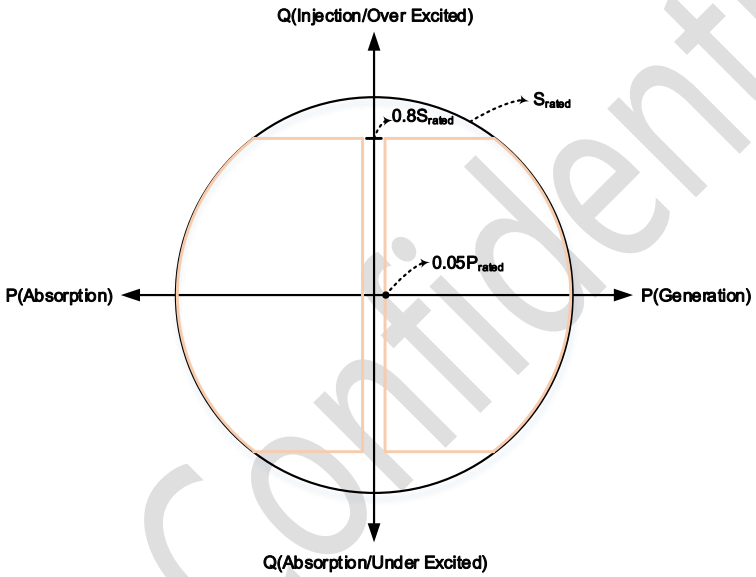


Figure 6-6-1 SPF control mode limit area

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

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | 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 | 0028 | AD 38 | Exit level for active power in SPF | Setting value = 4%, means | [O] |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4** | 01 | 06 | 109B | 0032 | 2C F0 | Enter level for active power in SPF | 4%*Prated<br>Setting value = 5%, means 5%*Prated | [O] |
| **5** | 01 | 06 | 1097 | 0320 | 3D CE | Set Q maximum | Set reactive power maximum<br>Default: 80% | [O] |
| **6** | 01 | 06 | 1098 | 0000 | 0C E5 | Set PF minimum | Set PF minimum<br>Default: 0% | [O] |
| **7** | 01 | 06 | 1072 | 0000 | 2D 11 | Set Q mode | 0: SPF | [M] |

NOTE: Model PCS125HV: Prated is 125kW

Table 31 Steps for disabling SPF mode

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

# 6.8. Volt-Var function setting

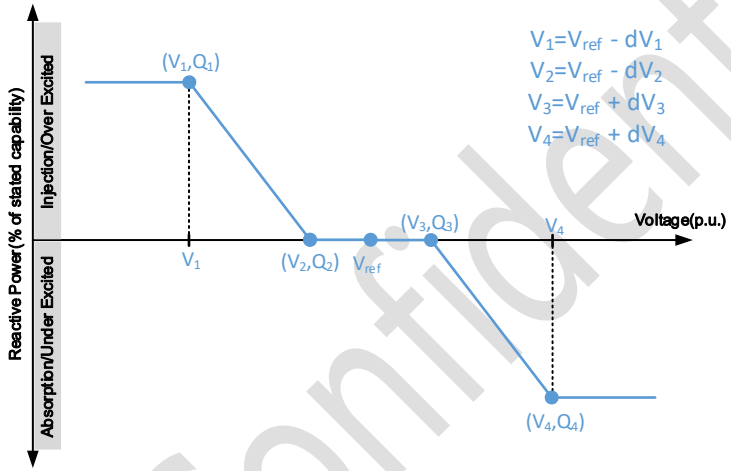


Figure 6-2 Volt-Var control mode curve

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

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 10A9 | 0001 | 9C EA | Volt-Var function enable. | 1: Enable. | [M] |
| **2** | 01 | 06 | 10AA-10B1 | / | / | Curve points configuration.<br>Q1->[0x10AB], V1->[0x10AA]<br>Q2->[0x10AD], V2->[0x10AC]<br>Q3->[0x10AF], V3->[0x10AE] | The value is different based on different grid code, please refer to PCS125HV Protocol. | [O] |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Q4->[0x10B1], V4->[0x10B0] | | |
| **3** | 01 | 06 | 109A | 0028 | AD 38 | Exit level for active power in Volt-Var | Setting value = 4%, means 4%*Prated | [O] |
| **4** | 01 | 06 | 109B | 0032 | 2C F0 | Enter level for active power in Volt-Var | Setting value = 5%, means 5%*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 PCS125HV: Prated is 125kW;

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

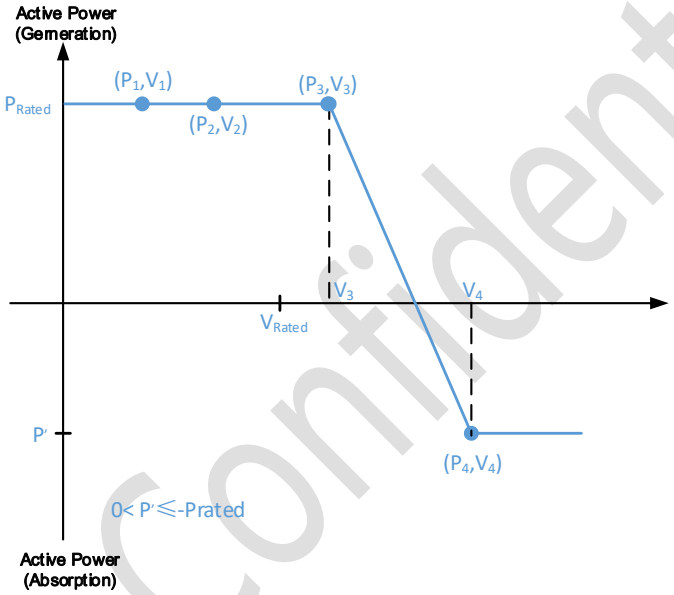


Figure 6-4 Volt-Watt control mode limit area

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 | 10C0 | 0001 | FC EC | Volt-Watt function enable. | 1: Enable. | [M] |
| **3** | 01 | 06 | 10C1-10C8 | / | / | Curve points configuration. P1->[0x10C2], V1->[0x10C1] | The value is different based on different grid code, please refer to | [O] |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | P2->[0x10C4], V2->[0x10C3]<br>P3->[0x10C6], V3->[0x10C5]<br>P4->[0x10C8], V4->[0x10C7] | PCS125HV Protocol. | |
| **4** | 01 | 06 | 1072 | 0001 | EC D1 | Reactive Power Mode Selection. | 1 = Power Set | [M] |

Table 35 Steps for disabling Volt-Watt function

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

## 6.10. Freq-Watt function setting

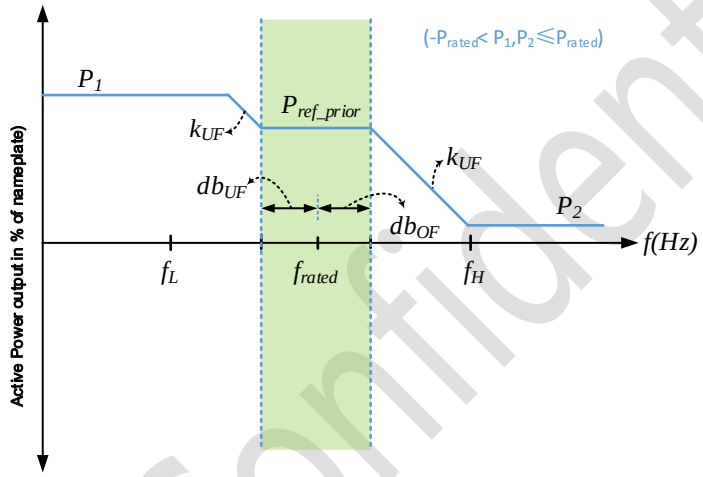


Figure 6-5 Freq-Watt control mode curve

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 | 10D0 | 0005 | 4C F0 | Freq-Watt function enable(Over frequency). | 5: F-W for IEEE1547 | [M] |
| **2** | 01 | 06 | 10DB | 0005 | CD 32 | Freq-Watt function enable(under frequency). | 5: F-W for IEEE1547 | [M] |
| **3** | 01 | 06 | 10D1- | / | / | Curve points configuration. | The value is different based on | [O] |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 10D5 | | | | different grid code, please refer to PCS125HV Protocol. | |

Table 37 Steps for disabling Freq-Watt function

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 10D0 | 0000 | 8C F3 | Disable Freq-Watt function(Over frequency). | 0: Disable. | [M] |
| **2** | 01 | 06 | 10D8 | 0000 | 0D 31 | Disable Freq-Watt function(Under frequency). | 0: Disable. | [M] |

## 6.11. Permit Service

Table 38 Enable Permit Service Function [FIRST RUN / WHEN NEED]

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 1116 | 0001 | AC F2 | Allow/Enable Permit Service | 1: Enable | [M] |
| **2** | 01 | 06 | 1115 | 0001 | 5C F2 | Enter Permit Service. | 1: Enable | [M] |

Table 39 Steps for disabling Permit Service

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 1116 | 0000 | 6D 32 | Exit Permit Service. | 0: Disable. | [M] |
| **2** | 01 | 06 | 1115 | 0000 | 9D 32 | Disable Permit Service.. | 0: Disable. | [M] |

## 6.12. Limit Active Power Setting

Table 40 Steps for limiting Active Power [FIRST RUN / WHEN NEED]

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 0628 | 600 | 0C F2 | Setting | Limit active power to 60% Prated | [M] |

NOTE: Model PCS125HV: Prated is 125kW

## 6.13. High/Low Frequency Ride Through

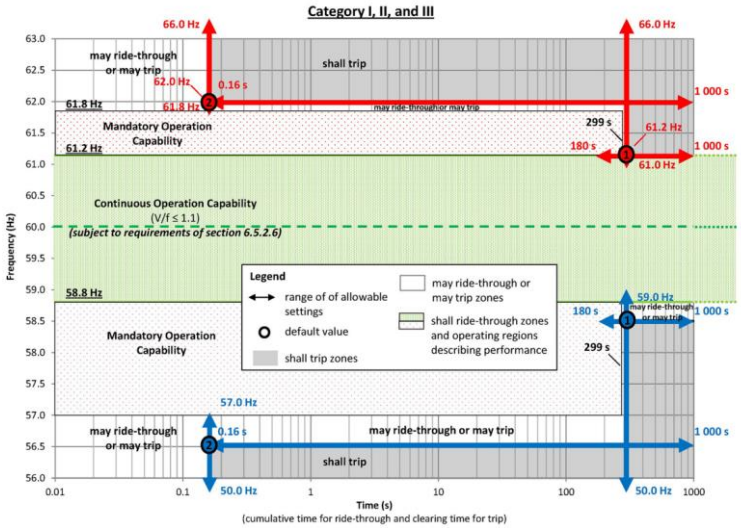


Figure 6-6 Frequency ride-through operating performance

Table 41 Steps for setting Frequency Ride Through [FIRST RUN / WHEN NEED]

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 10FE | 0001 | 2D 3A | Enable Freq Ride Through | 1: Enable | [M] |
| **2** | 01 | 06 | 10FF-1102 | / | / | Trip point setting | The value is different based on different grid code, please refer to PCS125HV Protocol. | [M] |

Table 42 Steps for disabling Frequency Ride Through [FIRST RUN / WHEN NEED]

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 10FE | 0000 | EC FA | Disable FRT | 0: Disable | [M] |

# 6.14. High/Low Voltage Ride Through

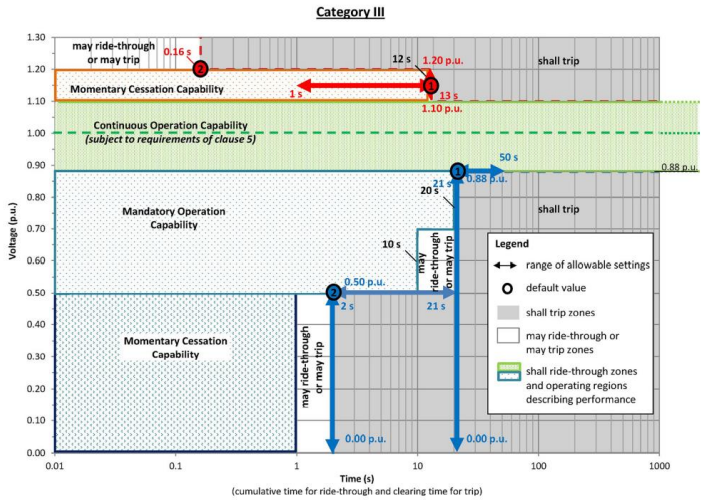


Figure 6-7 Voltage Ride-through operating performance(Category III)

Table 43 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 | 10F1 | 0001 | 1D 39 | High Ride through function enable. | 1: Enable. | [M] |
| **2** | 01 | 06 | 10F2 | 0001 | ED 39 | Low Ride through function enable. | 1: Enable. | [M] |
| **3** | 01 | 06 | 10F3-10F4 | / | / | Over voltage trip point | The value is different based on different grid code, please refer to PCS125HV Protocol. | [O] |
| **4** | 01 | 06 | 10F5- | / | / | Under voltage trip point | | [O] |

| | | |
|---|---|---|
| | 10F7 | configuration. |

Table 44 Steps for disabling Voltage ride through function

| STEP | CMD | | | | | DESCRIPTION | REMARK | Option |
|---|---|---|---|---|---|---|---|---|
| | ID(PCS) | Function | Register | Value | CRC REF | | | |
| **1** | 01 | 06 | 10F1 | 0000 | DC F9 | Disable high ride through function. | 0: Disable. | [M] |
| **2** | 01 | 06 | 10F2 | 0000 | 2C F9 | 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.

# 7. Miscellaneous

## 7.1. System Time Setting [WHEN NEED]

Table 45 system time configuration

| ADDR (HEX) | ADDR (DEC) | TYPE | DEFINITION | DESCRIPTION | Unit | RW | Min | Max | Default | OA |
|---|---|---|---|---|---|---|---|---|---|---|
| 100D | 4109 | Uint16 | EN_CMD_TIME_YEAR_MONTH_SET | Uint8(MSB): Local Time: Year to be set. Range: 0-99, for example 2021Y→21<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 46 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 | 1st ,1 am, as example | [M] |
| **3** | 01 | 06 | 100D | 120C | 10 6C | 3:Set Year, Month | 12/2018 as example | [M] |

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

## 7.2. Clear Faults Command [WHEN NEED]

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

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

Table 47 Clear system fault.

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

NOTE:

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

## 7.3. Heartbeat Signal[PERIODIC]

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

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