

The power behind competitiveness

Delta PQC Series Active Power Filter

User Manual

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DELTA
Smarter. Greener. Together.

Save This Manual

This manual contains important instructions and warnings that you should follow during the installation, operation, storage and maintenance of this product. Failure to heed these instructions and warnings will void the warranty.

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Chapter 1 : Important Safety Instructions

1.1. Safety Precautions

- The active power filter ('APF') is designed for industrial, IT and data centre applications to control harmonics, reactive power and imbalance correction. The APF shall be connected with a grid system and in parallel with harmonic sources (i.e. nonlinear loads).
- The APF shall not be exposed to rain or wet conditions, and shall be away from any flammable fluid, gas or explosives.
- Adequate space shall be left in both front and rear of the APF for well ventilation and convenient maintenance.
- To minimize fire and electric shock hazards, installation must be conducted by the qualified personnel in a controllable working environment.
- To minimize electric shock hazards, all maintenance work must be carried out by the qualified technician, and be sure to cut off all power supply before maintenance.
- High voltage hazards! It takes over 15 minutes for the DC capacitor to discharge. Please make sure the device has discharged completely before carrying out any operation.
- To minimize electric shock hazards, please read this Manual carefully before switching the power on, and keep this Manual properly for permanent reference.
- When the APF is used in IT applications, please install an insulation resistance detection device so that the alarm will go off when protection earth fault is detected.

1.2. Wiring Warnings

- To prevent a possible risk of current leakage, the APF shall be earthed properly. Please use the suggested diameter of PE wire mentioned in **Table 3-1** or use equivalent cross-section area of cooper bar to perform earthing.
- With regard to wiring, the compensation capacity and the current-carrying capacities of cables shall be taken into account.
- The incoming lines of the APF shall be connected with appropriate protective devices. It is recommended to provide every module with an over-current protective device with a third-party certification: rated voltage 400V and rated current 125A. Besides, take the installation positions of auxiliary equipment into consideration and choose the protective device with adequate breaking capacity.
- The capacity of the protective device shall fit that of the APF.

- To prevent scaling caused by high temperature, after the power is cut off, the operating switch shall be allowed to cool down before being operated again.
- The three-phase, four-wire APF is applicable to the power grid system with neutral grounding.

1.3. Usage Warnings

- Since the APF is used for harmonic compensation of the power grid, the capacity selection of the APF shall be subject to the harmonic content to avoid poor compensation due to insufficient capacity.
- Since the APF is used for harmonic control, it shall be connected to harmonic current from an external source for CT testing (CT: Current transformer).
- To guarantee sound reliability and avoid overheating, do not block or cover the air inlet and outlet.
- The working temperature range of the APF is -10°C - 50°C , beyond which the APF will not work.

1.4. Storage Precautions

- Please use the original packing material to protect the APF in order to avoid damage by rats.
- If the customer will not install the APF immediately after receiving the equipment, please be sure to store the APF in a dry and ventilated indoor place, which shall be maintained between -40°C and 70°C with relative humidity no higher than 95%.

1.5. Symbols

Item	Symbol	Meaning
1	R	Phase R of three-phase power supply
2	S	Phase S of three-phase power supply
3	T	Phase T of three-phase power supply
4	N	Neutral line
5		Main grounding terminal
6		EPO key
7	XT	Terminal board
8	QF	Circuit breaker
9	XK	Auxiliary switch

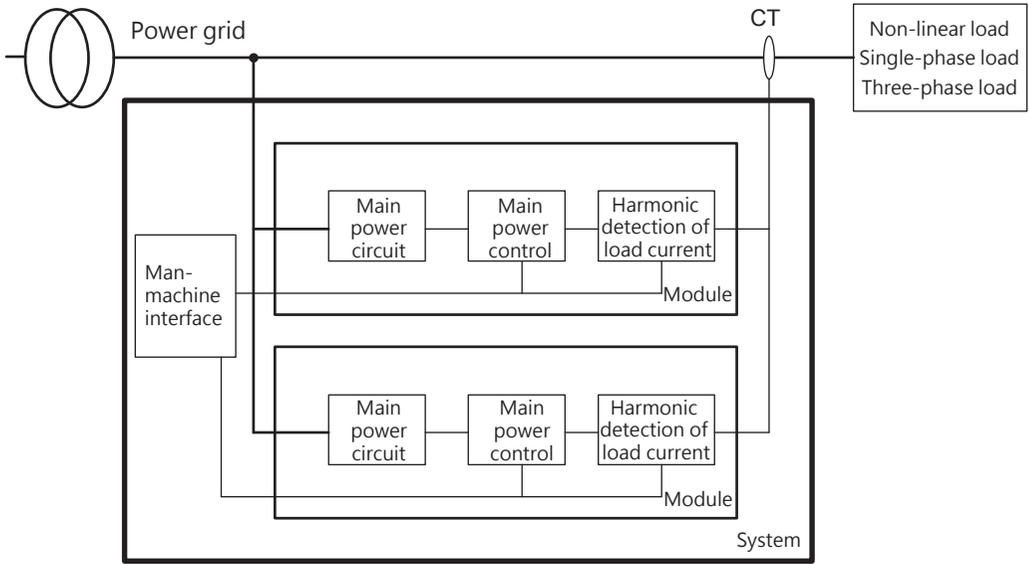
Chapter 2 : Introduction

2.1 Product Introduction

The Delta active power filter series ('APF'), a harmonic compensator for the three-phase power grid, is applied to the harmonic control of the power grid. Features of the device are shown as below:

- Compensates a wide range of harmonic frequency and any randomly specified harmonic.
- Rapid dynamic responses, stable parameters and good harmonic compensation results.
- High efficiency and low loss.
- Modular design offers a variety of coordination with various compensation capacities.
- The module is hot-swappable, which is convenient for replacement and installation.
- The system adopts an advanced 3-level structure and consists of digital signal processors (DSP), large programmable controllers and high power electronic devices, which has excellent performance and superior reliability.
- Provides perfect system protection functions.
- Supports remote power on/ off functions via computer monitoring.

Please see the system block diagram in **Fig. 2-1**. The system is composed of modules and a Cabinet System. The external CT is used for the detection of load current in the modules and extraction of harmonic components, based on which, the main power controller controls the main power circuit to generate reverse harmonic current; in this way, the load-carrying harmonic components are counteracted. Each Cabinet System can be connected to up to 7 modules in parallel. The Cabinet System is equipped with a man-machine interface to display the message of every module and manage the operation of every module.



(Fig. 2-1: System Block Diagram)

2.2 APF Series Product Category

The Delta APF series products can be classified as cabinet systems, embedded systems (containing embedded frames and power modules) and power modules. Optional accessories include embedded frames and LCD modules. **Table 2-1** lists the detailed products' series, models, capacities and wiring modes.

Table 2-1 APF Product Series Specifications

Series	Model	Capacity	System
Cabinet system	PQCA-400-50-50DC3 (4)	50A	Three-phase three-wire / four-wire
	PQCA-400-75-75DC3 (4)	75A	Three-phase three-wire / four-wire
	PQCA-400-75-150DC3 (4)	150A	Three-phase three-wire / four-wire
	PQCA-400-75-225DC3 (4)	225A	Three-phase three-wire / four-wire
	PQCA-400-75-300DC3 (4)	300A	Three-phase three-wire / four-wire
	PQCA-400-75-375DC3 (4)	375A	Three-phase three-wire / four-wire
	PQCA-400-75-450DC3 (4)	450A	Three-phase three-wire / four-wire

Series	Model	Capacity	System
Cabinet system	PQCA-400-75-525DC3 (4)	525A	Three-phase three-wire / four-wire
Embedded frame	PQC-Frame	N/A	N/A
Power module	PQCA-400-50-50DM3(4)	50A	Three-phase three-wire / four-wire
	PQCA-400-75-75DM3(4)	75A	Three-phase three-wire / four-wire
LCD module	PQC-LCM-D	N/A	N/A

- **Delta APF power module**

The Delta APF power module is provided with plug-in design and can be simply plugged into the standard cabinet system, embedded system and customized cabinet to form a front-operated, pluggable module system. Subject to the customer's requirement of equipment capacity, the APF power modules can be easily connected in parallel for capacity expansion.

The Delta APF power module is available in two wiring modes, i.e. 3P3W and 3P4W, and is available in two specifications in terms of the output current, i.e. 50A and 75A. The 3P4W module shall be connected to the neutral line, and it is able to compensate the current of neutral line, including zero sequence fundamental current and tertiary current; however, for the 3P3W module, it is unnecessary to connect the neutral line, and the module is unable to compensate the current of neutral line, such as zero sequence fundamental current and tertiary current. **Fig. 2-2** shows the Delta APF power module.



(Fig. 2-2: External View of 75A APF Power Module)

- **Delta APF Cabinet System**

The APF Cabinet Systems 3P4W and 3P3W power modules are sharing the same cabinet. In the applications of 3P4W, the cabinet must be connected to the neutral line and equipped with 3P4W power modules; in the applications of 3P3W, the cabinet is unnecessary to be connected to the neutral line and must be equipped with 3P3W power modules. **Fig. 2-3** shows the APF cabinet system.

The system capacity depends on the specifications & quantity of the power modules in the system. The customers can determine the required quantities of the power modules and the required cabinet system based on their capacity requirements, or consult the local distributors about the required capacity.



(Fig. 2-3: External View of the APF Cabinet System)

- **Delta APF embedded system**

The APF embedded system, dedicated for the customized embedded cabinets, can be mounted in a PDU cabinet to form a slideway for the APF module and provide a socket for plug-in connectors, of which, the APF module can be plugged in and out on the socket, to compose a fully front-operated, pluggable module system. The embedded system can be used individually to build a stand-alone APF system by connecting the power cable as well as secondary cable of CT. Moreover, the embedded system can be easily connected in parallel to extend capacity, to be exact, the embedded systems can be directly stacked

and the modules are connected to each other via communication lines so as to build an APF system with higher capacity. The embedded systems can be connected in parallel in uncapped mode, thus, the quantity of embedded systems installed in a single cabinet can be determined according to the installation height and heat dissipation conditions inside the PDU cabinet.

The APF embedded system can be equipped with an optional LCD module and installed in the customized cabinet, so that the parameter settings, alarms, running status enquiry and other functions of the whole system can be achieved.

The 3P4W and 3P3W power modules are sharing the same socket of embedded system. In the applications of 3P4W, the embedded system must be connected to the neutral line and equipped with the 3P4W power modules; in the applications of 3P3W, the system is unnecessary to be connected to the neutral line and must be equipped with the 3P3W power modules. **Fig. 2-4** shows the APF embedded system.

The system capacity depends on the specifications of the power modules in the system. The customers can determine the required specifications of the power modules based on their capacity requirements, or consult the local distributors about the required capacity.



(Fig. 2-4: External View of the APF Embedded System)

2.3 Functions & Features

- Multifunction: a single filter can simultaneously realize the purposes of harmonic, reactive and three-phase unbalance control.
- Superior harmonic control effects: up to 97% harmonics of the system can be effectively filtered.
- Excellent compensation of reactive power: the device can realize rapid (ms-grade response), precise ($-0.99 < PF < 0.99$) and bidirectional (both capacitive and inductive compensations) reactive power control.
- Outstanding compensation of unbalanced three-phase: the device can realize correction for either active or reactive unbalance, and can eliminate the neutral current (for the three-phase four-wire series only).

- Wide input voltage and frequency ranges, suitable for the applications with diesel generators and harsh power supply conditions, line voltage: 308V ~ 456V.
- Low power loss (lower than 3% of rated device power) and actual efficiency >97%.
- Sound stability: the device acts as an infinite impedance to the power grid system and has no effect on the impedance of the power grid system; it is able to produce accurate and flawless output waveform, which has no effect on other equipment.
- Simple and flexible applications: thanks to the modular design, it can be easily embedded into other cabinets to work with PDU.
- Easy maintenance and capacity expansion: the modular structure supports simple plug-in replacement and capacity expansion, and the Poka-Yoke design requires no on-site maintenance.
- Wide capacity coverage: 50A ~ 525A of a single cabinet, unlimited connection in parallel of Cabinet Systems.
- Applicable to all work conditions: the device is able to operate under high temperature up to 50°C and salt spray corrosive conditions, can withstand grade-9 seismic intensity and is compatible with the diesel engine generating system.
- User-friendly interface (in both Chinese and English): event log, automatic fault alarm, alarm history and other parameter setting functions.
- Complete functions: automatic self-checking start, settable soft start time, emergency stop (EPO), etc.

2.4 Mechanism & Appearance

2.4.1 Appearance & Dimensions of the Cabinet System



(Fig. 2-5: Cabinet System Diagram - door open & door closed)

Item	Name	Description
1	Control panel	Displays and manages the APF parameters and status.
2	EPO	Emergency stop button.
3	Breaker	Controls the power-on and power-off of various modules respectively.
4	Module	Refers to the power module of the plug-in system.
5	Breaker 2	Switches on or off the SPD
6	SPD	Surge protection device.

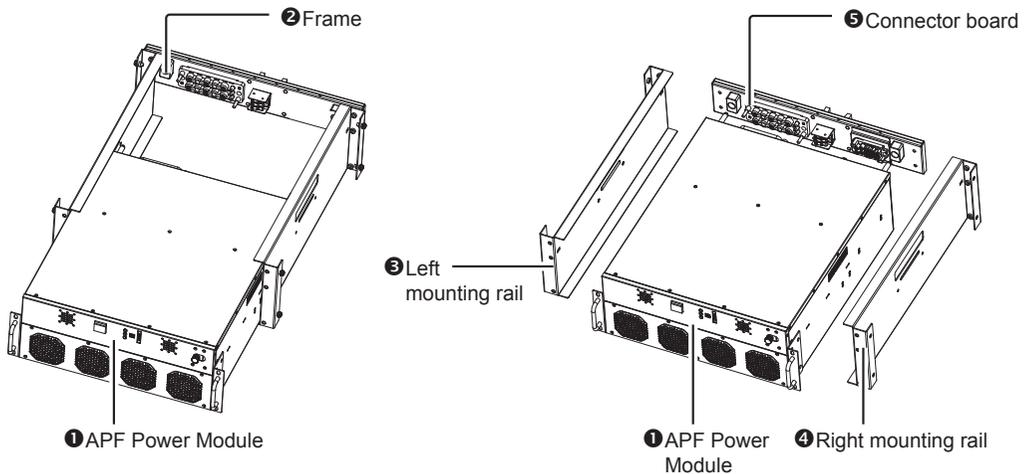
Table 2-2 System Dimensions & Weight

Model	Dimensions (W×D×H)	Weight (Kg)
PQCA-400-50-50DC3 (4)	608 × 800 × 2028 mm	246Kg
PQCA-400-75-75DC3 (4)	608 × 800 × 2028 mm	246Kg
PQCA-400-75-150DC3 (4)	608 × 800 × 2028 mm	287Kg
PQCA-400-75-225DC3 (4)	608 × 800 × 2028 mm	328Kg
PQCA-400-75-300DC3 (4)	608 × 800 × 2028 mm	369Kg
PQCA-400-75-375DC3 (4)	608 × 800 × 2028 mm	410Kg
PQCA-400-75-450DC3 (4)	608 × 800 × 2028 mm	451Kg
PQCA-400-75-525DC3 (4)	608 × 800 × 2028 mm	492Kg



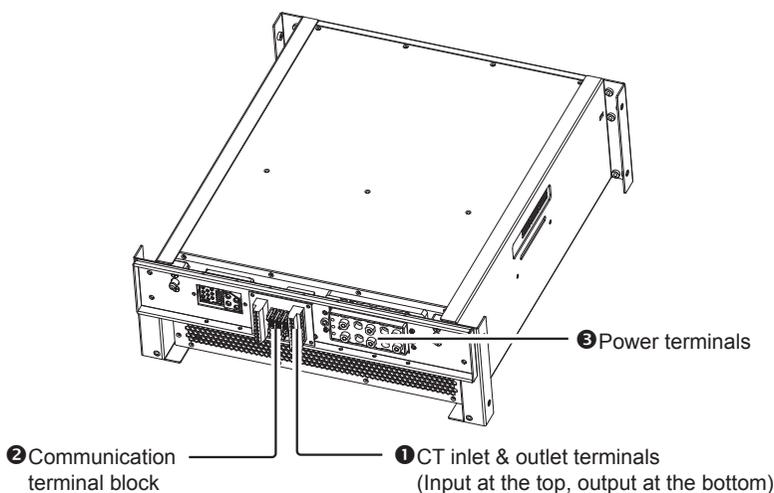
NOTE: The depth is 825mm when the upper handle is provided on the cabinet door; the height is 2065mm when the hoisting ring is provided.

2.4.2 Appearance & Dimensions of the Embedded System



(Fig. 2-6: Embedded System Diagram - Overall View & Exploded View)

Item	Name	Description
①	APF power module	APF 75A or 50A power module.
②	Frame	Accommodates the APF power module.
③	Left mounting rail	Refers to the left mounting rail of the embedded system.
④	Right mounting rail	Refers to the right mounting rail of the embedded system.
⑤	Connector board	Connects the APF power module and the embedded system.



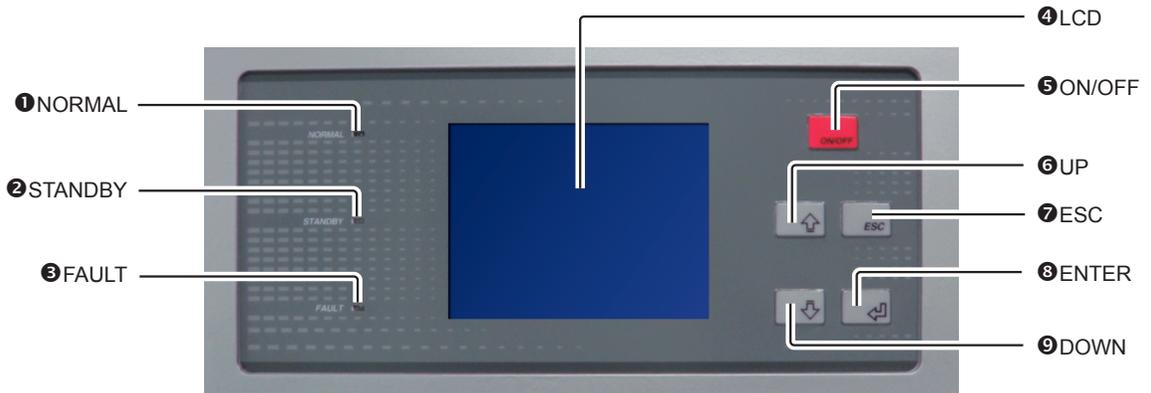
(Fig. 2-7: Back View of the Embedded System)

Item	Name	Description
①	CT inlet & outlet terminals	Connect the external CT's inlet and outlet.
②	Communication terminal block	Refers to the Communication terminal block for connection between modules and between modules and LCD.
③	Power terminals	Refer to the terminals connecting to the R/S/T/N/PE lines of the main power.

Table 2-3 Embedded System Dimensions & Weight

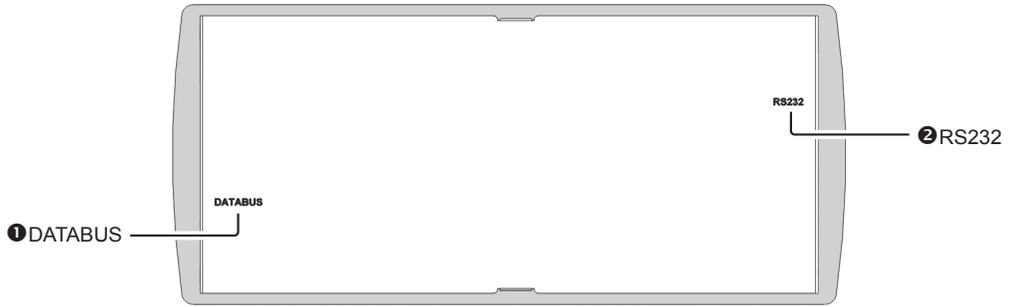
Model	Dimensions (W×D×H)	Weight (Kg)
PQCA-400-50-50DM3	440 × 522 × 174 mm	40Kg
PQCA-400-50-50DM4	440 × 522 × 174 mm	40Kg
PQCA-400-75-75DM3	440 × 522 × 174 mm	41Kg
PQCA-400-75-75DM4	440 × 522 × 174 mm	41Kg
PQC-Frame	512 × 602.5 × 180.5 mm	7Kg

2.4.3 Control Panel



(Fig. 2-8: Front View of the Control Panel)

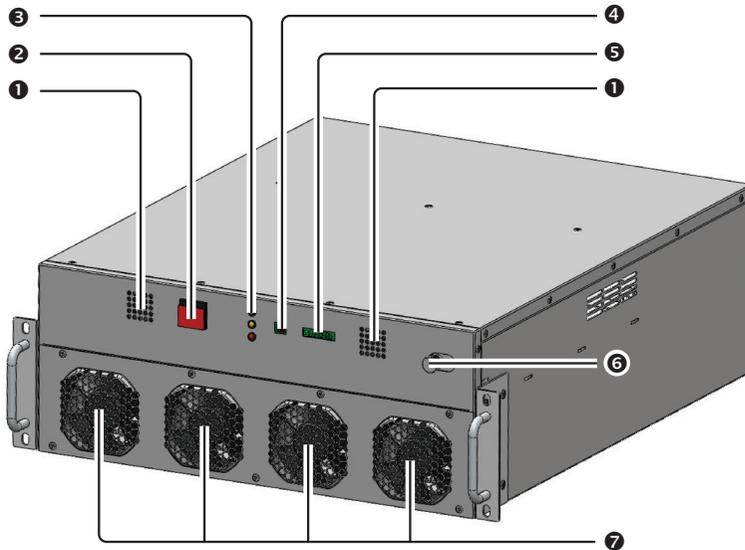
Item	Name	Description
①	NORMAL (green)	When the lamp is lit, it indicates the APF system is functioning properly.
②	STANDBY (yellow)	When the lamp is lit, it indicates the APF system is on standby.
③	FAULT (red)	When the lamp is lit, it indicates there is a fault in the APF system.
④	LCD display	The LCD can display both Chinese and English fonts.
⑤	ON / OFF key	Press and hold the key for 3 sec to switch on / off the APF system.
⑥	UP key	Press the key to move the menu items upward or to increase the parameter setting value.
⑦	ESC key	Press the key to return to the previous menu or to save the parameter setting when exit.
⑧	ENTER key	Press the key to go to the next page or to confirm the parameter setting.
⑨	DOWN key	Press the key to move the menu items downward or to reduce the parameter setting value.



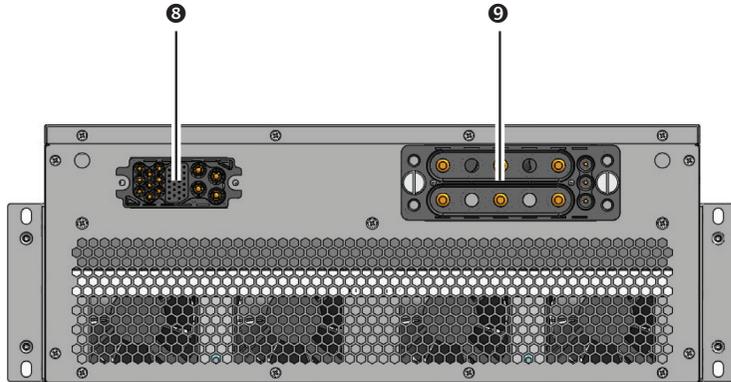
(Fig. 2-9: Back View of the Control Panel)

Item	Name	Description
①	DATABUS	Refers to the communication interface between the control panel and modules.
②	RS232	Refers to the standard 232 interface.

2.4.4 Appearance & Dimensions of the Power Module



(Fig. 2-10: External View of the Power Module)



(Fig. 2-11: Back View of the Power Module)

Item	Name	Description
①	DC fan	Refers to the DC cooling fan.
②	E.P.O button	Refers to the Emergency stop button, which is pressed down to shut down the device and is released to switch it on.
③	LED indicators	Refer to the LED indicators of the module. <ul style="list-style-type: none"> • Green (Normal): indicates that the module is functioning properly. • Yellow (Standby): indicates that the module is on standby. • Red (Fault): indicates that there is a fault on the module.
④	DIP switches	Set the module ID and terminal resistance.
⑤	Databus communication ports	Refer to the ports reserved for module settings, program update, etc.
⑥	Mechanical lock	The module shall be plugged into the cabinet system accurately and then pushed rightward to lock, otherwise, the fault alarm will not work properly.
⑦	DC fans	Refers to the DC cooling fans.
⑧	Signal transfer terminals	Refer to the connecting terminals for communication signals and CT signals.
⑨	Inlet terminals of the main power	Refer to the connecting terminals of R/S/T/N/PE lines of the main power.



NOTE: Since the Datasheet communication port is provided with insulation isolation, it is safe to touch it.

Table 2-4 APF Power Module Dimensions & Weight

Model	Dimensions (W×D×H)	Weight (Kg)
PQCA-400-50-50DM3	440 x 522 x 174mm	40Kg
PQCA-400-50-50DM4	440 x 522 x 174mm	40Kg
PQCA-400-75-75DM3	440 x 522 x 174mm	41Kg
PQCA-400-75-75DM4	440 x 522 x 174mm	41Kg

2.5 Package Inspection

- **Exterior**

1. It is recommended to check for any damage of the outer packaging after receiving the APF device since it may encounter some unpredictable conditions during transportation. If any, please contact your supplier.
2. The APF cabinet and power modules are packed separately.

- **Interior**

1. Please check the rating label of the APF to see if the product conforms to your order.
2. Please check if any parts are damaged or loose.
3. Please check if the accessories are complete.
4. Please see the table below for the standard accessories of the APF on delivery.

Table 2-5 Standard Accessories of the APF Cabinet System

Name	Quantity
Lintel	Upon customer request
Baffle of module	Upon customer request
User Manual	1

Table 2-6 Standard Accessories of the APF Embedded System

Name	Quantity
User Manual	1
LCD module	Upon customer request
CT interconnects	3
Communication interconnects	1
M6*16L bolt	8
M6*12L NYLOK	6

5. If any damage is found, please contact your supplier.
6. To return goods, please use the original packing material to pack the APF and all accessories.

Chapter 3 : Installation and Wiring

The PQC series active power filter is applicable to many applications and can meet the particular installation requirements of industrial sites, power distribution rooms and computerroom. According to different work conditions and environment requirements, either embedded installation of customized cabinet or standard cabinet installation can be made, and flexible configuration and on-site capacity expansion can be realized based on the current and subsequent capacity requirements.

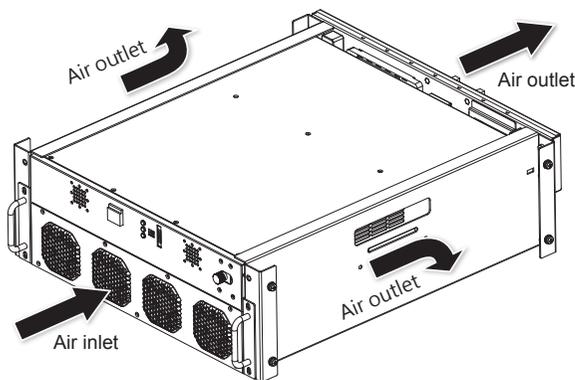
3.1 Pre-installation Confirmation

Since the installation environment varies for different users, please be sure to read this Manual carefully before installation. All installation, assembly and start-up work must be carried out by the qualified professional personnel. If the work is to be carried out by the customer, it shall be under the supervision of the qualified professional personnel. When a forklift or similar lifting equipment is used to handle the device, make sure the lifting capacity is sufficient. Please refer to **Table 2-2** for the APF weight.

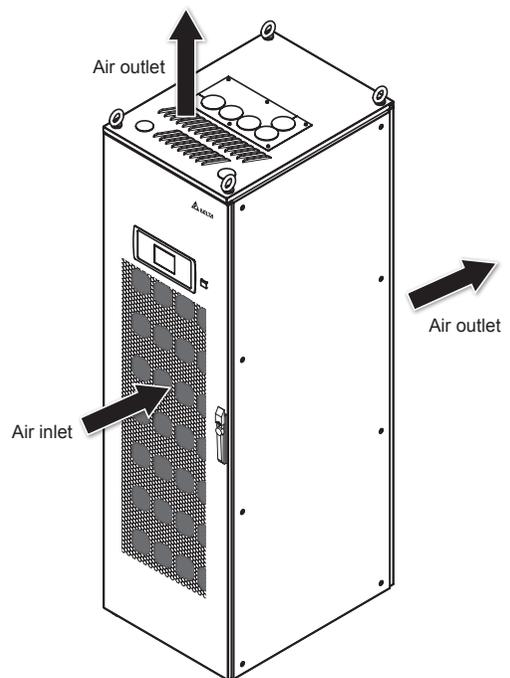
3.2 Installation Environment

1. The APF device can only be installed indoors. Do not install the device for outdoor use. Be sure to consider the IP21 protection degree of the device while installing. For a higher protection degree requirement, please contact the distributor.
2. The APF device shall not be installed in a place close to dust sources or subject to heavy environmental pollution. Because the conductive dust will damage the device, make sure the installation place is free of conductive dust.
3. Make sure the transport route and placement location are firm and big enough to accommodate the APF cabinet system and forklift.
4. Since some noise can be generated during the operation of the APF, please take the noise effects into account when choosing the installation position.
5. When installing the APF, please install the cabinet system first, and then plug in the power modules.
6. The installation place must be kept clean and dry. Pay attention to the sealing of cable inlet to avoid any possible damage caused by rats.
7. Make sure enough space is left in the installation place for future maintenance. For the purpose of ventilation, avoid installing the APF against the wall. A space of 1500mm shall be left in front of the device for front operation, maintenance and wiring.
8. Since some heat can be generated during the operation of the APF, please make sure the cooling system of the installation environment is sufficient for heat dissipation, so that the ambient temperature will not exceed the normal working temperature of the device.

9. The device is equipped with cooling fans, and is designed with air inlet at the front and air outlet at the back and on the top; thus, it is recommended to leave at least a 500mm space both on the top and at the back of the cabinet for ventilation purpose. The air outlet is also required on the sides of the embedded system, thus, please leave the ventilation space on the sides. **Fig. 3-1** and **Fig. 3-2** illustrate the air inlet & outlet schematic diagrams of the embedded system and the cabinet system.
10. Every module and system have their minimum vent flow requirements, which shall be met to guarantee the normal cooling of the device. The air must be properly cooled and treated to be free of conductive particles, heavy dust or hazardous gas before being fed into the device through the air inlet.
11. The working temperature range of the APF is $-10^{\circ}\text{C} \sim 50^{\circ}\text{C}$, beyond which the APF will not work.
12. Do not use the device in a place above an altitude of 1000m. If such a installation place can not be avoided, please consider derating, or contact the distributor.
13. The embedded system is recommended to be used in a customized cabinet with at least IP20 protection degree, in which, a distance of at least 10mm shall be kept between the conductive metal cabinet parts and the live terminals of the system.
14. When the embedded system is used separately, the live terminals at the back of the system must be provided with insulation caps. Please ask your supplier for insulation caps.



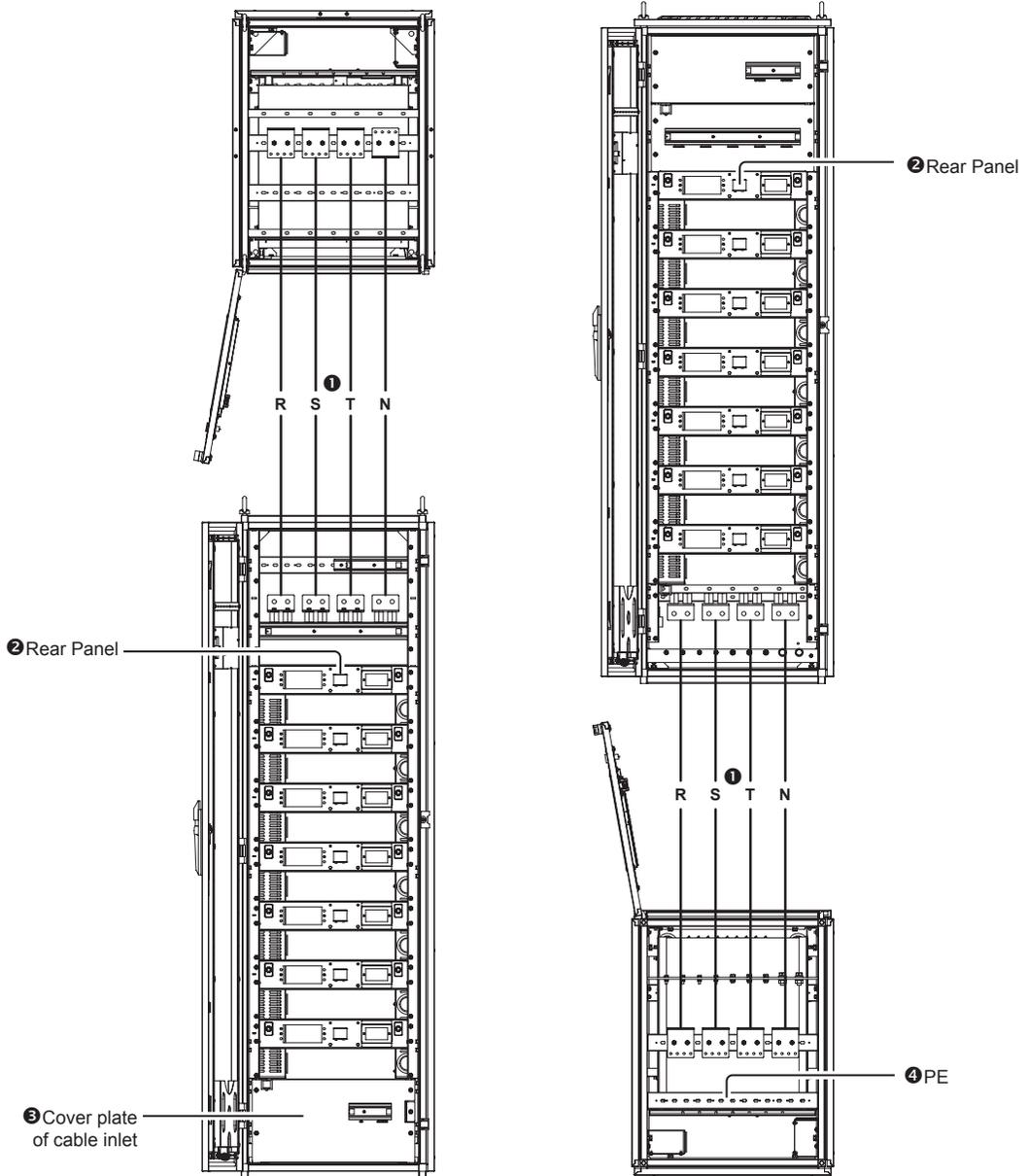
(Fig. 3-1: Air Inlet & Outlet Schematic Diagram of the Embedded System)



(Fig. 3-2: Air Inlet & Outlet Schematic Diagram of the Cabinet System)

3.3 Cabinet System Structure & Wiring

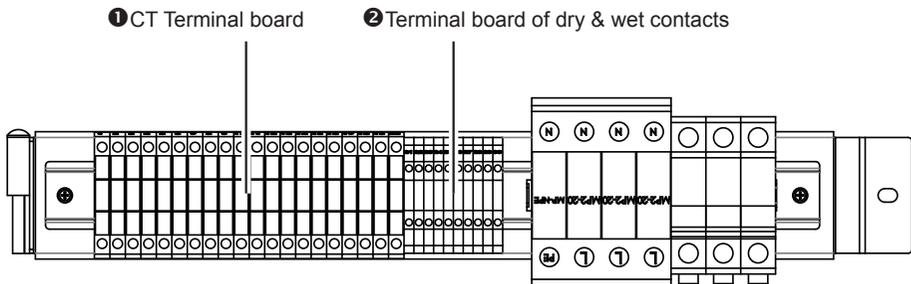
3.3.1 Cabinet System Structure



(Fig. 3-3: Front View and Top View of the Cabinet System w/ Top Inlet)

(Fig. 3-4: Front View and Bottom View of the Cabinet System w/ Bottom Inlet)

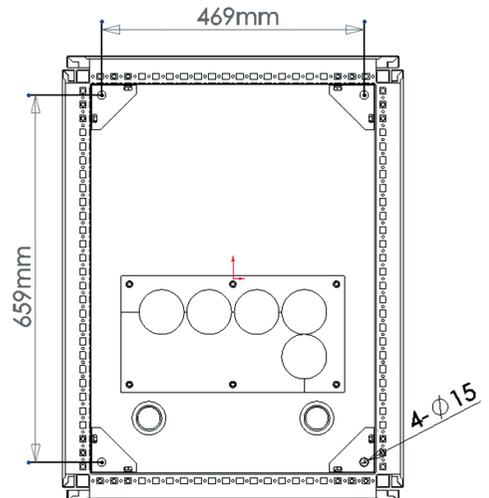
Item	Name	Description
①	R, S, T, N	Refer to the copper bars of the system.
②	Rear panel	Used for connection to rear connectors of the module.
③	Cover plate of cable inlet	Inside the cover plate, there are a CT terminal board & a terminal board of dry & wet contacts. Please refer to Fig. 3-5 .
④	PE	Refers to the copper earthing bar of the system.



(Fig. 3-5: CT Terminal Board and Terminal Board of Dry & Wet Contacts)

3.3.2 Cabinet System Wiring

1. Before connecting the cables or electronics, please be sure to cut off the input power of the APF device to avoid accidents.
2. The APF device must be grounded properly to avoid any possible damage caused by current leakage.
3. Use four M12x60L screws (the four screws securing the cabinet on the pallet) to fasten the base of the APF cabinet system. Refer to **Fig. 3-6** for the positions of fixing holes on the base.
4. Check the diameter marking of the APF's input wires, and make sure the wire diameter and phase sequence are correct. Please refer to **Table 3-1** for the specifications of power lines; the specifications of the cabinet system's copper bars and screws securing incoming lines shall meet the requirements listed in **Table 3-2** and the tightening torque shall meet the requirements listed in **Table 3-3**.



(Fig. 3-6: Fixing Holes on the Base of the Cabinet System)

Table 3-1 Cabinet System Wiring Table

Power Module Type	Power Module No.	Rating current	Wire diameter of R-, S-, T, N-phase	PE Wire diameter
75A Power Module	1	75A	1×50mm ²	1×35mm ²
	2	150A	1×120mm ²	1×70mm ²
	3	225A	1×185mm ²	1×95mm ²
	4	300A	2×120mm ²	1×120mm ²
	5	375A	2×150mm ²	1×150mm ²
	6	450A	2×185mm ²	1×185mm ²
	7	525A	2×240mm ²	1×240mm ²
50A Power Module	1	50A	1×35mm ²	1×25mm ²
	2	100A	1×70mm ²	1×35mm ²
	3	150A	1×95mm ²	1×50mm ²
	4	200A	1×150mm ²	1×70mm ²
	5	250A	2×95mm ²	1×95mm ²
	6	300A	2×120mm ²	1×120mm ²
	7	350A	2×150mm ²	1×150mm ²



NOTE: The above mentioned cables shall be selected according to the temperature-resistant requirement of 70°C.

Table 3-2 Specifications of the Cabinet System's Copper Bars and Required Screws

	7 power modules	4 power modules
Copper bar of R-phase	525A (80×4) incoming line 2-M12 screw	300A (60×4) incoming line 1-M12 screw
Copper bar of S-phase	525A (80×4) incoming line 2-M12 screw	300A (60×4) incoming line 1-M12 screw
Copper bar of T-phase	525A (80×4) incoming line 2-M12 screw	300A (60×4) incoming line 1-M12 screw
Copper bar of N-phase	525A (80×4) incoming line 2-M12 screw	300A (60×4) incoming line 1-M12 screw
Copper bar of PE-phase	(40×6) incoming line 1-M12 screw	(30×4) incoming line 1-M12 screw

Table 3-3 Steel Bolt Tightening Torque

Bolt size (mm)	Torque value (N.m)
M8	18
M12	61

5. Check the marking of wires connecting the APF cabinet system and the CT, and make sure the wire diameter and phase sequence are correct. **Table 3-4** lists the functions of the CT terminal board.

Table 3-4 PIN assignment of CT Terminal Board

CT secondary side	Position of terminal board	Function	Electrical specification
R-phase CT S1	XT_PIN1	R-phase positive output	5A
R-phase CT S1	XT_PIN2		
R-phase CT S1	XT_PIN3		
R-phase CT S2	XT_PIN4	R-phase negative output	5A
R-phase CT S2	XT_PIN5		
R-phase CT S2	XT_PIN6		
S-phase CT S1	XT_PIN7	S-phase positive output	5A
S-phase CT S1	XT_PIN8		
S-phase CT S1	XT_PIN9		
S-phase CT S2	XT_PIN10	S-phase negative output	5A
S-phase CT S2	XT_PIN11		
S-phase CT S2	XT_PIN12		
T-phase CT S1	XT_PIN13	T-phase positive output	5A
T-phase CT S1	XT_PIN14		
T-phase CT S1	XT_PIN15		
T-phase CT S2	XT_PIN16	T-phase negative output	5A
T-phase CT S2	XT_PIN17		
T-phase CT S2	XT_PIN18		

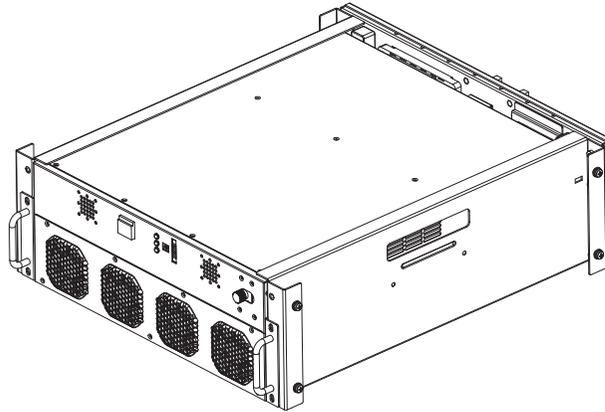
6. Dry & wet contacts: the system is provided with 2 dry contacts (output) and 1 wet contact (input), of which, the functions of the dry & wet contacts are as follows:

Table 3-5 Dry & Wet Contacts

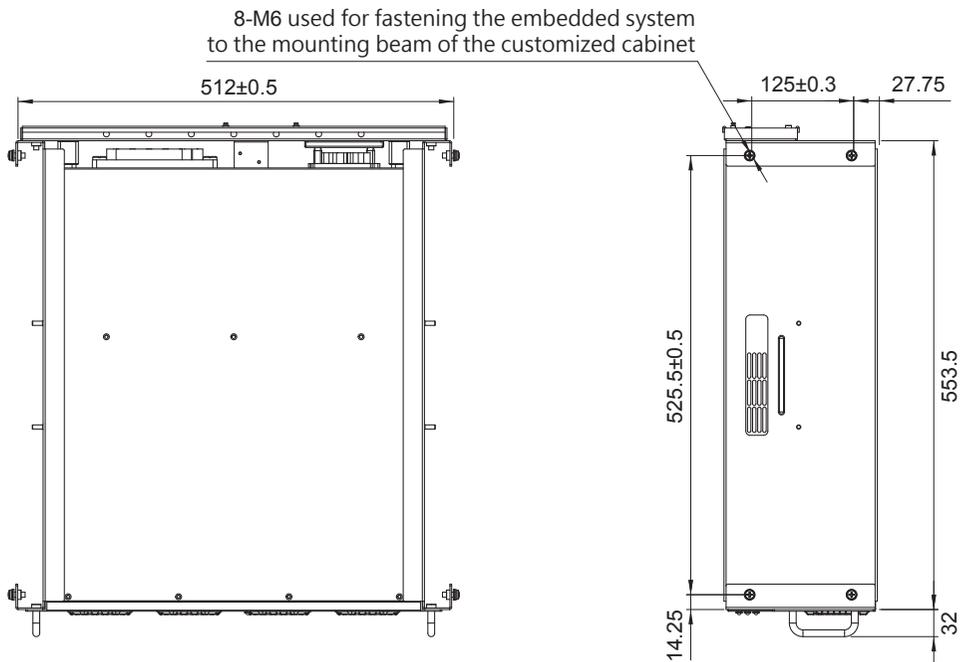
Contact	PIN assignment of terminal board	Electrical specification	Function
Dry contact 1	XT_PIN21	48V/24mA	ON/OFF status
	XT_PIN22		
Dry contact 2	XT_PIN23	48V/24mA	Fault status
	XT_PIN24		
Wet contact	XT_PIN27	24v/24mA	Remote control ON/OFF
	XT_PIN28		

3.4 Embedded System Structure & Wiring

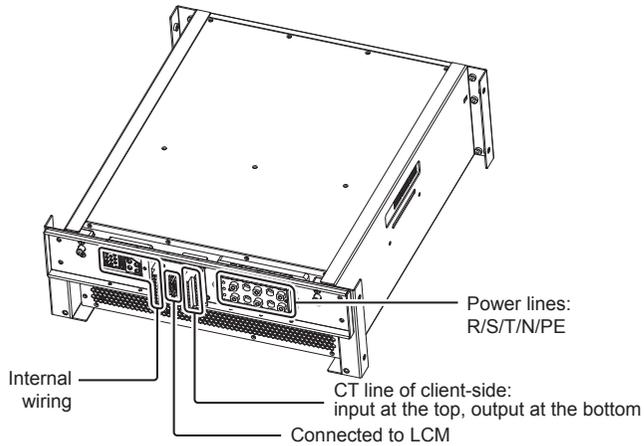
3.4.1 Embedded System Structure



(Fig. 3-7: Side View of the Embedded System)



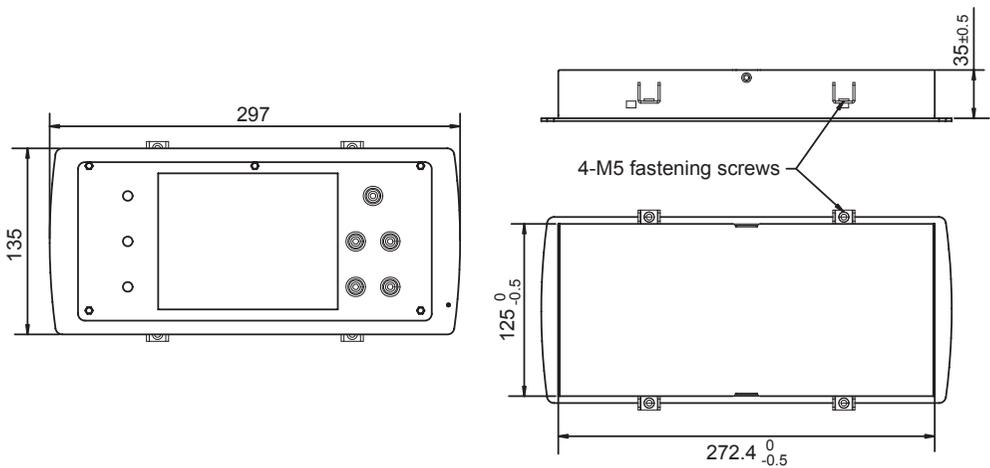
(Fig. 3-8: Top View and Side View of the Embedded System)



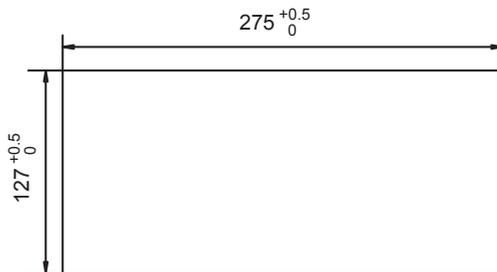
(Fig. 3-9: Connection Diagram of Rear Panel of the Embedded System)

3.4.2 LCM Module Structure

To install the LCM module, insert the LCM module into the mounting holes and secure it with 4 fastening screws.



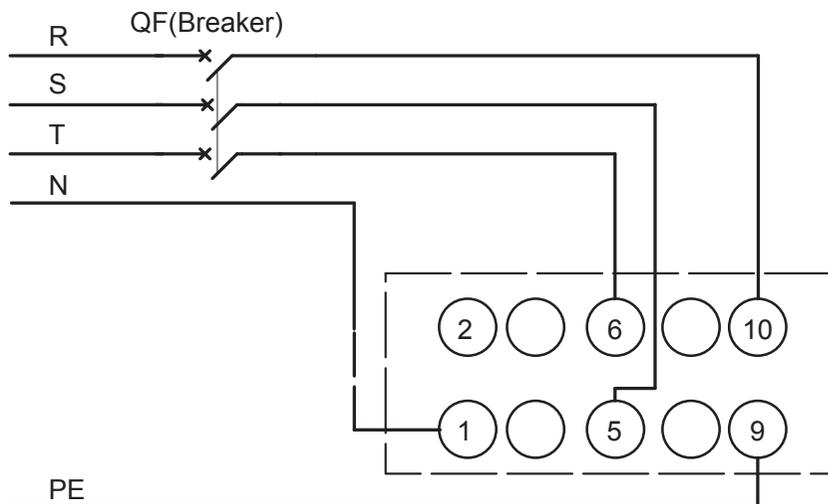
(Fig. 3-10: LCM Module Structure and Dimensions)



(Fig. 3-11: Mounting Hole Size of the LCM Module)

3.4.3 Embedded System Wiring

1. Before connecting the cables or electronics, please be sure to cut off the input power of the APF device to avoid accidents.
2. The APF device must be grounded properly to avoid any possible damage caused by current leakage.
3. To install the embedded system, use eight M6 screws to attach the left and right mounting rails of the embedded system respectively onto the mounting beam of the customized cabinet.
4. Check the diameter marking of the APF's input wires, and make sure the wire diameter and phase sequence are correct. Connect the incoming lines of the main power to the embedded system according to **Fig. 3-12**. Please refer to **Table 3-6** for the specifications of the power lines and **Table 3-7** for the tightening torque.



(Fig. 3-12: Connection Diagram of Main Power Lines on Rear Panel of the Embedded System)

Table 3-6 Embedded System Wiring Table

Category		50A embedded system	75A embedded system
Current and wire diameter of R-, S-, T-, N-phase	Current	50A	75A
	Wire diameter	25mm ²	35mm ²
Wire diameter of PE (protective earthing)	Wire diameter	16mm ²	25mm ²

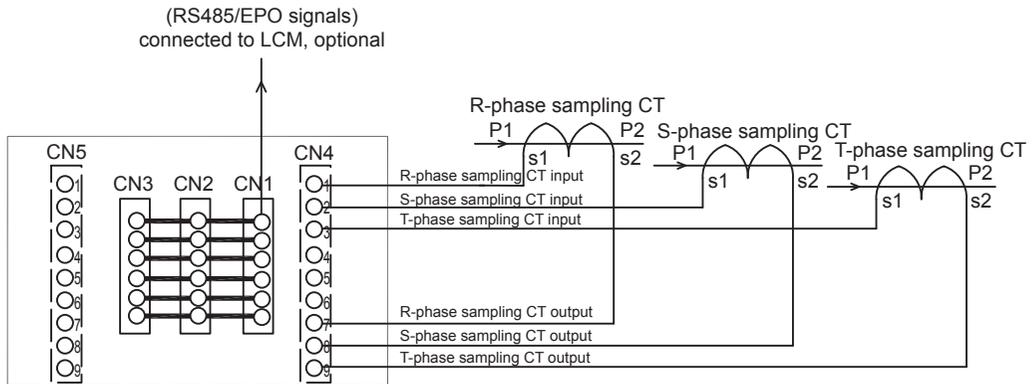
**NOTE:**

1. The above mentioned cables shall be selected according to the temperature-resistant requirement of 105°C.
2. The selection of wire diameter shall be verified in this manner: under the highest ambient temperature, when the highest harmonic compensation current and the maximum content of high-order harmonic exist, and several modules are synchronously running with full load, after long-time operation, the insulation layer temperature of the cable with the most severe heating conditions (the innermost cable in case of several cables) shall not exceed the permissible long-time working temperature. Connect the power lines to the switchgear of the PDU cabinet, and finally to the electrical access point of equipment on the bus-tie.

Table 3-7 Embedded System Power Line Tightening Torque

Bolt size (mm)	Torque value (N.m)
M6*12L NL	3.3 ~ 7

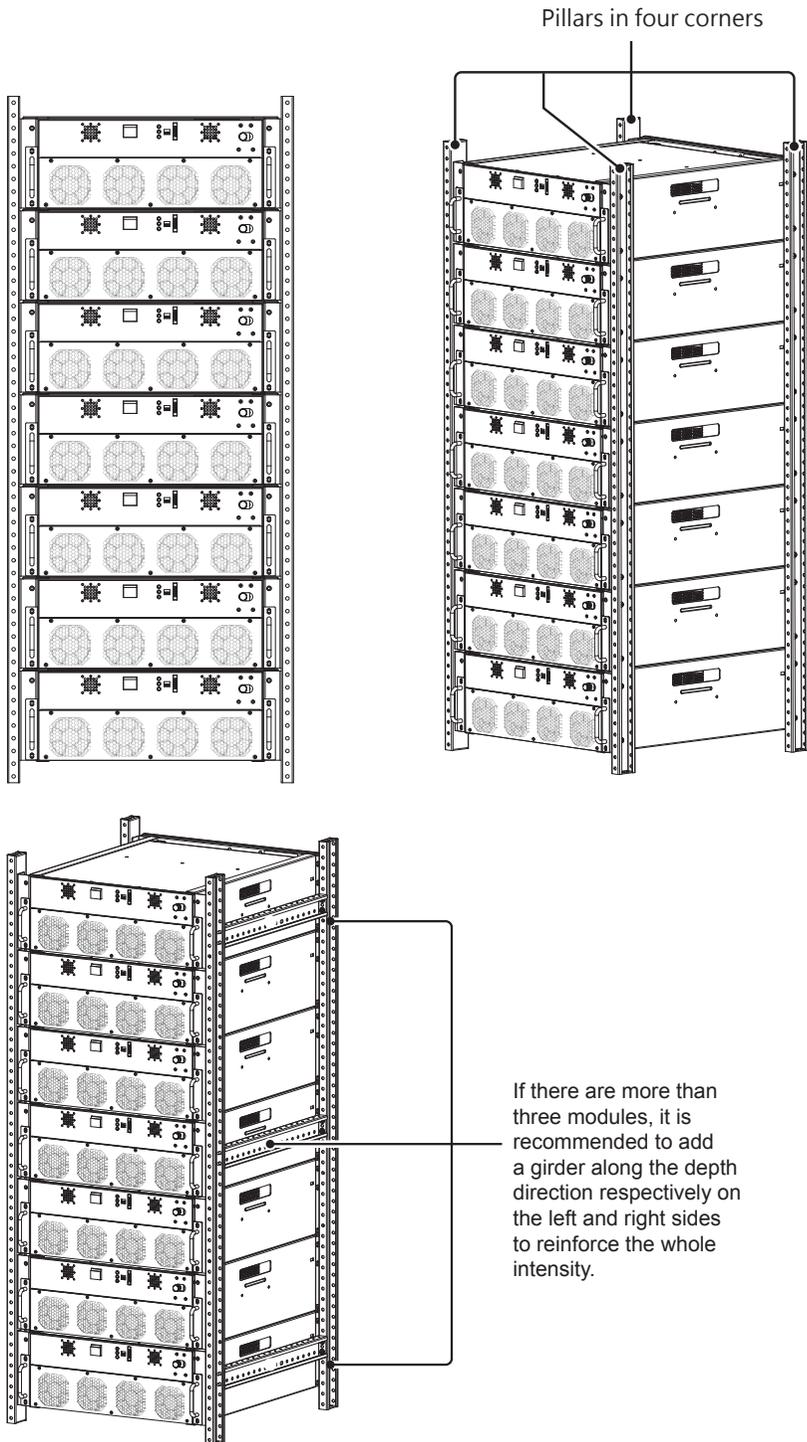
5. Check the marking of wires connecting the embedded system and the CT, and make sure the wire diameter and phase sequence are correct. Connect the input and output wires of the CT according to **Fig. 3-13**.

**(Fig. 3-13: Connection Diagram of CT Input/ Output Wires on Rear Panel of the Embedded System)**

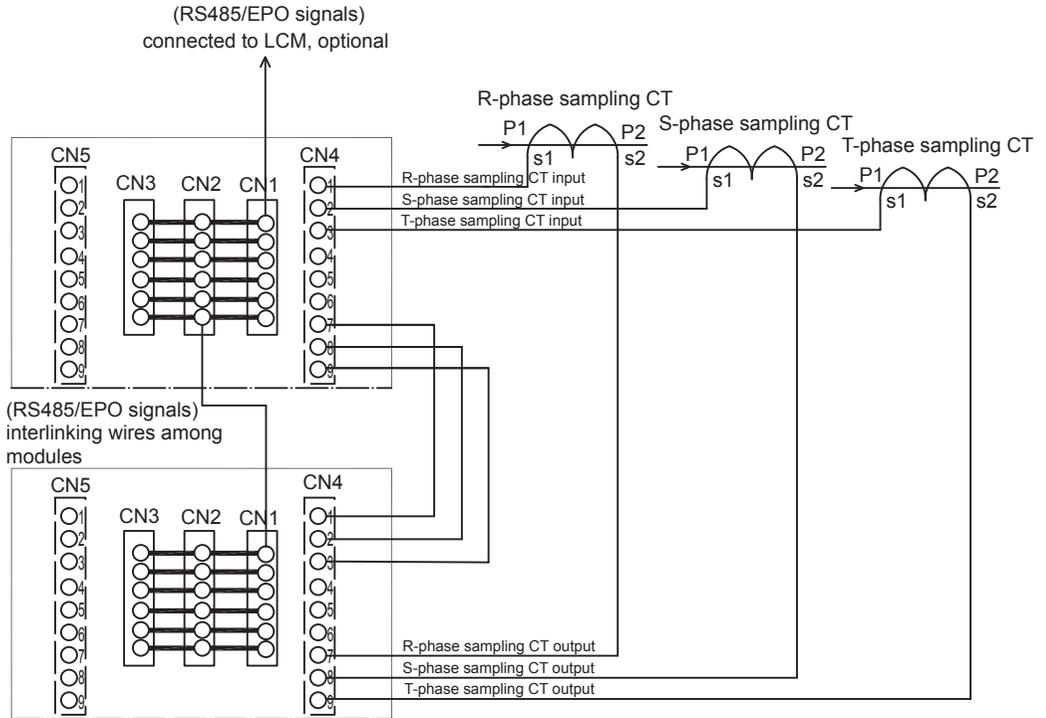
6. The embedded system can be directly stacked while installing with no upper limit of modules connected in parallel. Please define the upper limit of the APF power modules installed in a single cabinet based on the installing height in the PDU cabinet. **Fig. 3-14** is the installation diagram of multi-embedded system. Please refer to **Fig. 3-15** for the connection of the CT and communication lines. Use the communication lines to connect the data communication port on the LCM panel to the data communication port on the adapter plate of any of the embedded systems. When several embedded systems are connected in parallel, it is unnecessary to connect other modules to the LCM line, instead, the communication can be realized via the connection between the internal wires of the system.



NOTE: The LCM communication line is part of the secondary circuit, and shall be kept an insulation distance no less than 5.5mm from the primary circuit of the main power.



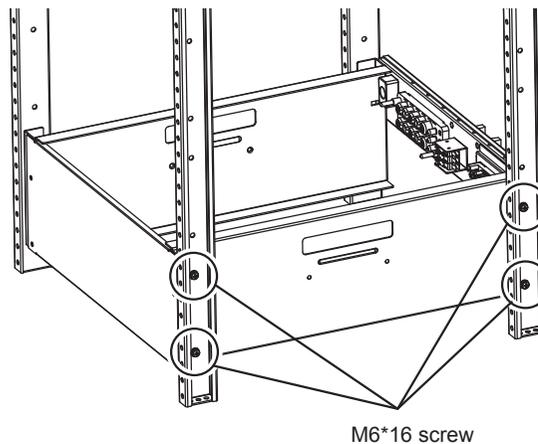
(Fig. 3-14: Installation Diagram of the Multi-embedded System)



(Fig. 3-15: Connection Diagram of the LCM and the CT on Rear Panel of the Multi-embedded System)

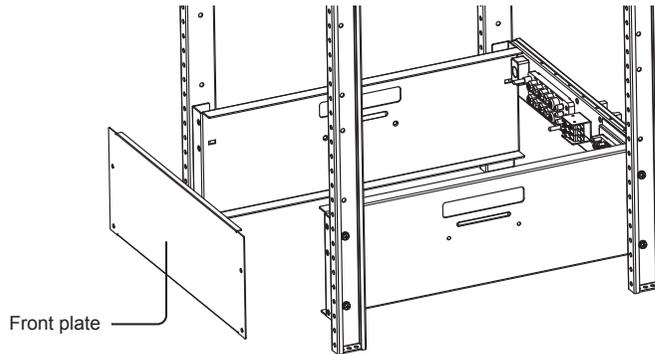
7. The recommended installation procedures of the embedded system are as follows.

- 1) Respectively use four M6*16 screws to secure the left and right sides of the embedded system components onto the four columns of the cabinet (please refer to Fig. 3-16).



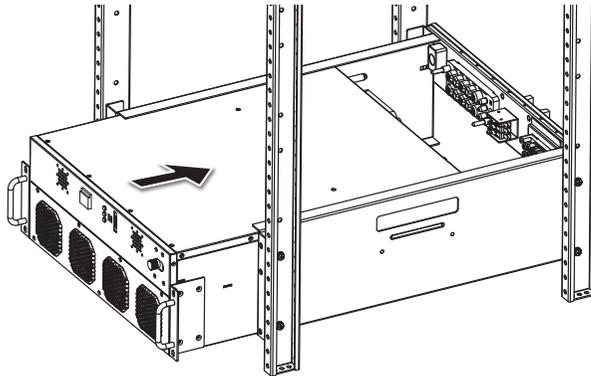
(Fig. 3-16: Schematic Diagram of Embedded system Installation Step 1)

- 2) Remove the front plate from the embedded system components (please refer to **Fig. 3-17**).



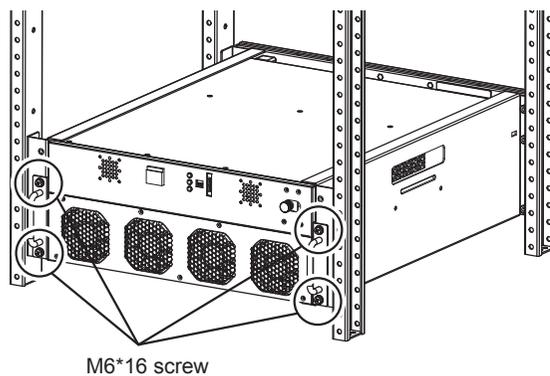
(Fig. 3-17: Schematic Diagram of Embedded System Installation Step 2)

- 3) Insert the APF power module (please refer to **Fig. 3-18**).



(Fig. 3-18: Schematic Diagram of Embedded System Installation Step 3)

- 4) Use four M6*16 screws to secure the left and right sides of the APF power module respectively onto the left and right mounting rails (please refer to **Fig. 3-19**).



(Fig. 3-19: Schematic Diagram of Embedded System Installation Step 4)

3.5 CT Installation & Wiring for Current Detection of Harmonic Source

3.5.1 CT Selection Precautions

1. The appropriate rated ratio of primary to secondary current shall be determined. The primary current is recommended to be $1.2 \cdot I_n$ (the actual rated current of the testing point).
2. The rated voltage is 0.5KV or 0.66KV, higher than or equal to the rated voltage of the testing point.
3. The secondary current is 5A.
4. The CT accuracy class shall be higher than or equal to 0.5.
5. To facilitate installation on site, according to the installation methods, select the split-core current transformer (CT, be further divided into two types, i.e. cable type and busbar type). Select the appropriate model based on the busbar size, distribution mode of busbar, phase-to-phase distance of busbar, and installation and wiring of the CT.
6. The nominal secondary capacity (rated load) of the CT shall meet the requirement of secondary impedance ($\geq 5VA$ when the secondary current is 5A). The capacity and the maximum one-way wiring length from the CT to the active power filter shall be calculated according to the following formula:

$$L_{\max} = \frac{(P_{ct} - P_1)}{I^2} \cdot \frac{S}{\rho} \cdot \frac{1}{2} \cdot 10^{-6}$$

Wherein:

L_{\max} : the maximum one-way wiring length from the CT to the cabinet system (m);

P_{ct} : the nominal secondary capacity of the CT (VA);

P : the capacity loss caused by the internal impedance of the cabinet system and the contact resistance (about 0.18Ω , when the secondary current is 5A, the loss is about 4.5VA in total);

I : the secondary current of the CT (A);

S : the cross-section area of the copper conductor (mm^2);

ρ : the resistivity of the copper conductor {at 20°C , calculate according to $1.72 \times 10^{-8} \Omega \cdot \text{m}$; at $t^\circ\text{C}$, calculate according to $1.72 \times 10^{-8} * [1 + 0.0041 * (t - 20)] \Omega \cdot \text{m}$ };

Take $I=5A$ as an example, at 20°C , refer to the following table for the secondary capacity requirement of the CT and the maximum one-way wiring length of the copper conductor:

Table 3-8 Secondary Capacity Requirements of the CT and Maximum One-way Wiring Length

Nominal secondary capacity of the CT (VA)	Cross-section area of the copper conductor (mm ²)	Maximum One-way Wiring Length (m)
5	4	About 2m
5	6	About 3m
10	2.5	About 16m
10	4	About 25m
15	2.5	About 30m
15	4	About 49m
20	2.5	About 45m
20	4	About 72m
30	2.5	About 74m
30	4	About 118m
40	2.5	About 103m
40	4	About 165m

**NOTE:**

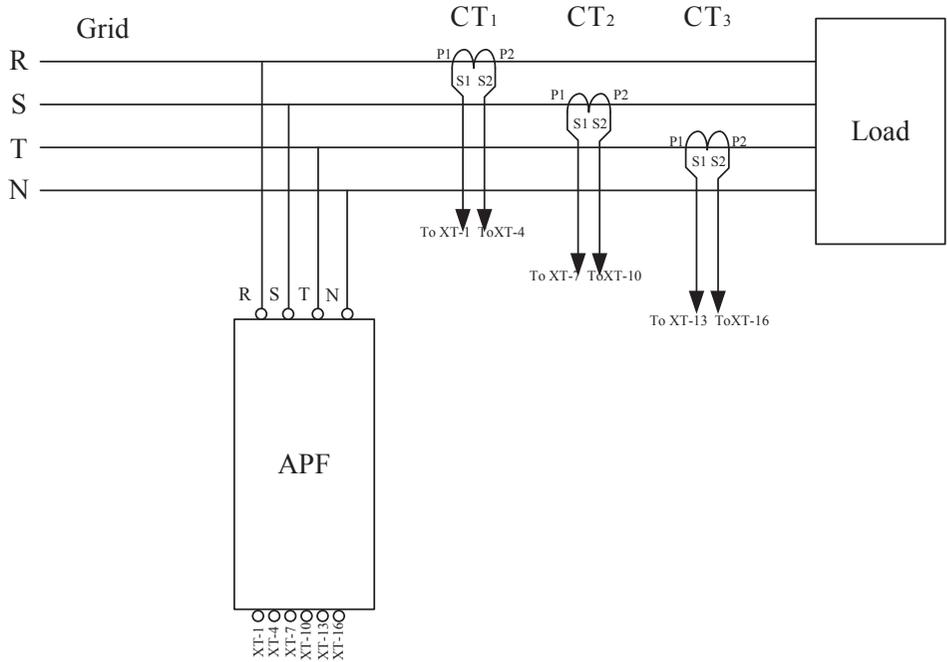
If the required conduct is longer than 165m, the CT capacity and conductor cross-section area shall be calculated according to the formula.

3.5.2 Basic CT Installation & Wiring

The CT for current detection shall be located on the side of the harmonic source to feed the detection signal to the APF, as shown in *Fig. 3-20*.

- A set of three CTs must be provided for current detection of the harmonic source.
- The CTs must be oriented accurately.
- The phase sequences of the detection signal of the CTs must not be exchanged.
 1. The secondary output S1 of CT₁ for R-phase detection must be connected to the terminal board XT-1, and the S2 outgoing line must be connected to the terminal board XT-4.
 2. The secondary output S1 of CT₂ for S-phase detection must be connected to the terminal board XT-7, and the S2 outgoing line must be connected to the terminal board XT-10.

- The secondary output S1 of CT₃ for T-phase detection must be connected to the terminal board XT-13, and the S2 outgoing line must be connected to the terminal board XT-16.



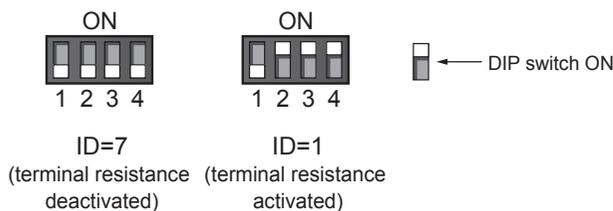
(Fig. 3-20: Basic CT Installation and Wiring Diagram)

Chapter 4 : APF Operation Procedure

4.1 Checks Before Start-up

- Make sure each EPO button is released.
- Make sure each module is plugged in place and each mechanical lock is turned to the LOCK position and fastened.
- Make sure each module's ID and terminal resistance are set properly.

The DIP switches used to set the ID and terminal resistance are as shown in **Fig. 4-1**. **Table 4-1** lists the positions of DIP switches 1~4.



(Fig. 4-1: Schematic Diagram of DIP Switches)

Table 4-1 Positions of DIP Switches

Position	Description
DIP Switch 1	Setting of the first digit of ID, which is valid when it is slid to the lower position
DIP Switch 2	Setting of the second digit of ID, which is valid when it is slid to the lower position
DIP Switch 3	Setting of the third digit of ID, which is valid when it is slid to the lower position
DIP Switch 4	Setting of the terminal resistance

The module ID setting of the cabinet system shall be made in the sequence of the module No. marked on the side of the cabinet system where the module locates, that is, PM1 ~ PM7 from top to bottom of the cabinet system, and the ID shall be set accordingly. The terminal resistance DIP switches of all modules shall be set to the lower position, except that of the module PM7 which shall be set to the upper position, i.e., the terminal resistance DIP switch of the power module which locates the furthest from the LCD module shall be set to the upper position.

If several embedded systems are connected in parallel and the communication lines are interlinked, make sure the ID of all modules are not repeated, and the terminal resistance DIP switch of the power module which locates the furthest from the LCD module is set to the upper position.

- The ID of all modules are not repeated.
- The module quantity and compensation capacity are confirmed.
- The connections on the rear panel are made properly.
- The connections of the LCM communication ports are made properly.
- Close the front door.

4.2 Start-up Procedures

1. Switch the main breaker of the system to the ON position.
2. Switch the breakers corresponding to all the modules of the system to the ON position; here, the internal auxiliary power supply of the modules will be started, the fans will rotate, check if the yellow LED indicators in front of the modules are lit. The LCM will go into the Start screen, communicate with the modules, read the system messages and check there is no fault.
3. Close the front door.
4. Set the system into the operating mode. Please refer to **Chapter 5: LCM Display and Settings** for the detailed LCM settings.
5. Press and hold the ON/OFF button on the LCM panel for 3 sec, and release it after the buzzer rings, now, the system starts.
6. When the system starts and works properly, the green LED indicator on the LCM will be lit.

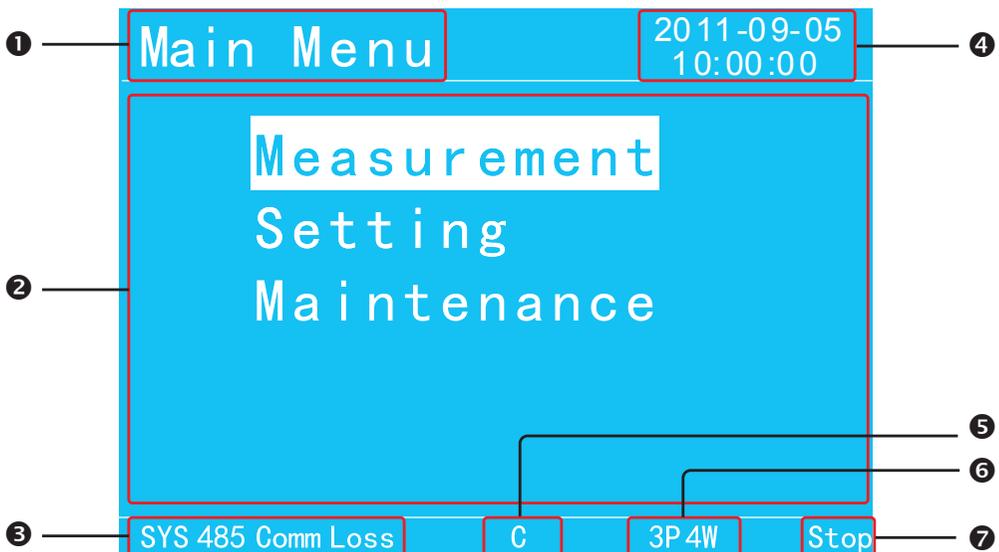
Chapter 5 : LCM Display and Settings

The control panel is mainly used to monitor the APF system parameters and display the status and settings of the system. It is available for two levels of user: User and Administrator.

The User is able to directly view the detailed displayed parameters in the measurement page and the user settings.

The Administrator is protected by password. The APF settings and maintenance page can only be set and viewed after entering the Administrator password.

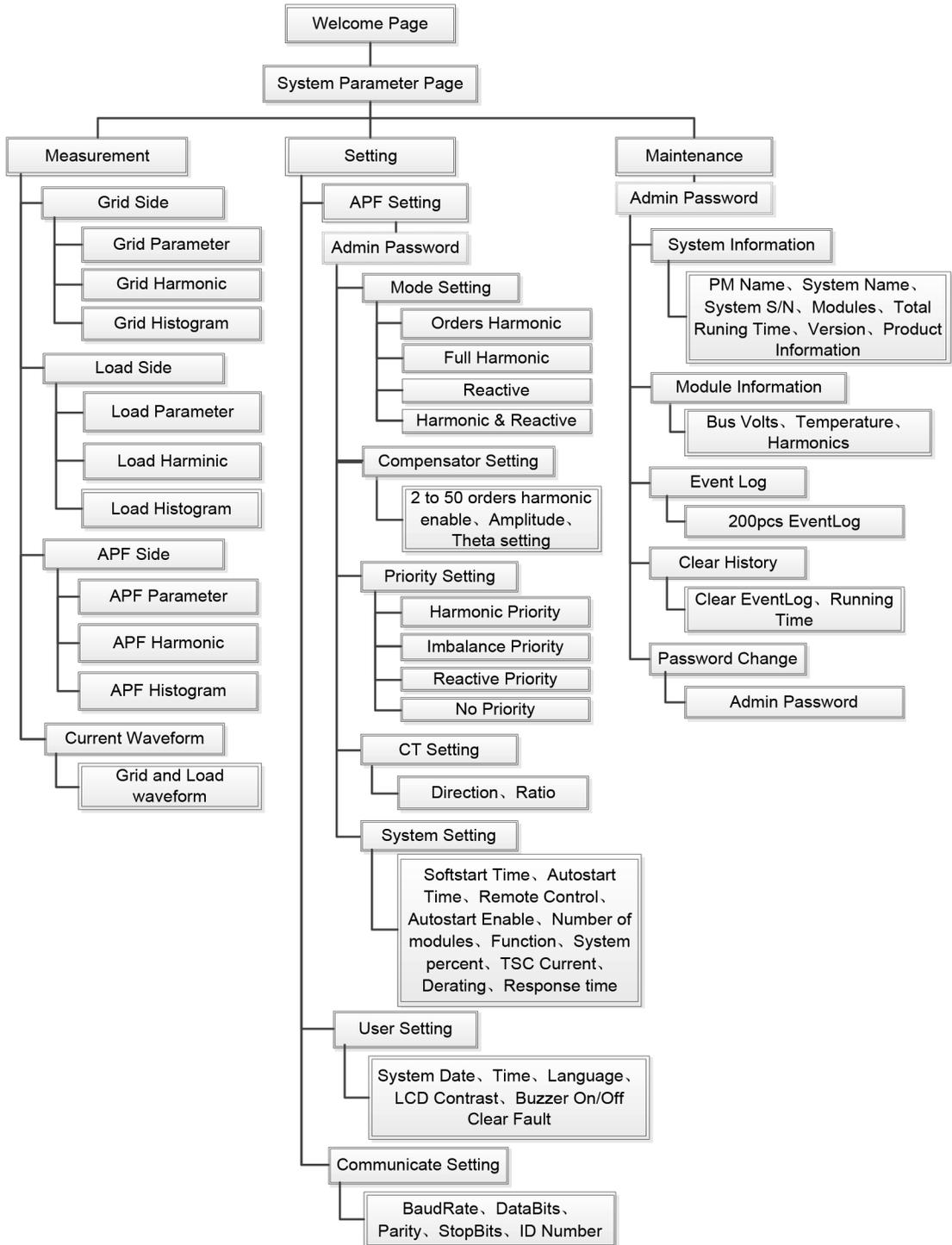
5.1 Description of LCD Display



(Fig. 5-1: LCD Display)

Item	Description
①	Displays the title.
②	Displays the contents relevant to the title.
③	Displays the real-time fault message of the system.
④	Displays the real time of the system.
⑤	Displays the system functions (C: Compensator/ S: Harmonic Source).
⑥	Displays the system wiring mode (three-phase three-wire/ three-phase four-wire)
⑦	Displays the system operating status (running/ stop).

5.2 LCD Display Hierarchy



(Fig. 5-2: LCD Display Hierarchy)

Chapter 6 : Maintenance

- **Cleaning of the APF:** please contact your supplier for regular cleaning of the APF (every 6 months; however, it is recommended that the customer clean up the dust on the baffles of air inlet and outlet every 3 months).
- **Regular inspection of the APF:** please contact your supplier for maintenance of the APF (every 6 months).

Chapter 7 : Troubleshooting

If any fault message is found, please refer to the table below for the corresponding solution.

Item	Fault message	Possible cause	Solution
1	SYS 485 Comm Loss	1. The communication lines are not connected properly. 2. There are repeated module IDs.	1. Check the communication lines for reliable connection. 2. Check the DIP switch of every module.
2	Grid Phase Seqen	Wrong wiring.	Please check the wiring and phase sequence, if anything wrong is found, please contact the distributor.
3	EPO Fault	The EPO button on the module or on the cabinet system is pressed.	Check all EPO buttons and make sure they are all released.
4	PM Numbers Error	1. Incorrect configuration of system module quantity in the LCM. 2. There are repeated module IDs.	1. Compare the module quantity with the configuration of module quantity in the LCM. 2. Check the DIP switches of every module.
5	Fuse Blowout	The input fuse is broken.	Please contact the distributor.
6	Ambient OTP	1. The air vents are blocked. 2. The fans do not work. 3. The IGBT is damaged.	Please contact your supplier.
7	BUS OVP/UVP	Failure of bus capacitor.	Please contact your supplier.
8	Fan Fail	Failure of fans.	Please contact your supplier.
9	Curr Detect Fail	The CT is not connected properly.	Check the CT wiring according to the CT wiring diagram.
10	Mechanic Unlock	The mechanical lock is not in place.	Check the mechanical lock.

Chapter 8 : Warranty

Seller warrants this product, if used in accordance with all applicable instructions, to be free from original defects in material and workmanship within the warranty period. If the product has any failure problem within the warranty period, Seller will repair or replace the product at its sole discretion according to the failure situation.

This warranty does not apply to normal wear or to damage resulting from improper installation, operation, usage, maintenance or irresistible force (i.e. war, fire, natural disaster, etc.), and this warranty also expressly excludes all incidental and consequential damages.

Maintenance service for a fee is provided for any damage out of the warranty period. If any maintenance is required, please directly contact the supplier or Seller.

**WARNING!**

The individual user should take care to determine prior to use whether the environment and the load characteristic are suitable, adequate or safe for the installation and the usage of this product. The User Manual must be carefully followed. Seller makes no representation or warranty as to the suitability or fitness of this product for any specific application.



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