Service Manual

EU R32 Aqua Falcon

Air Cooled Modular Chiller

V1.0

CONTENT

Part 1 GENERAL INFORMATION

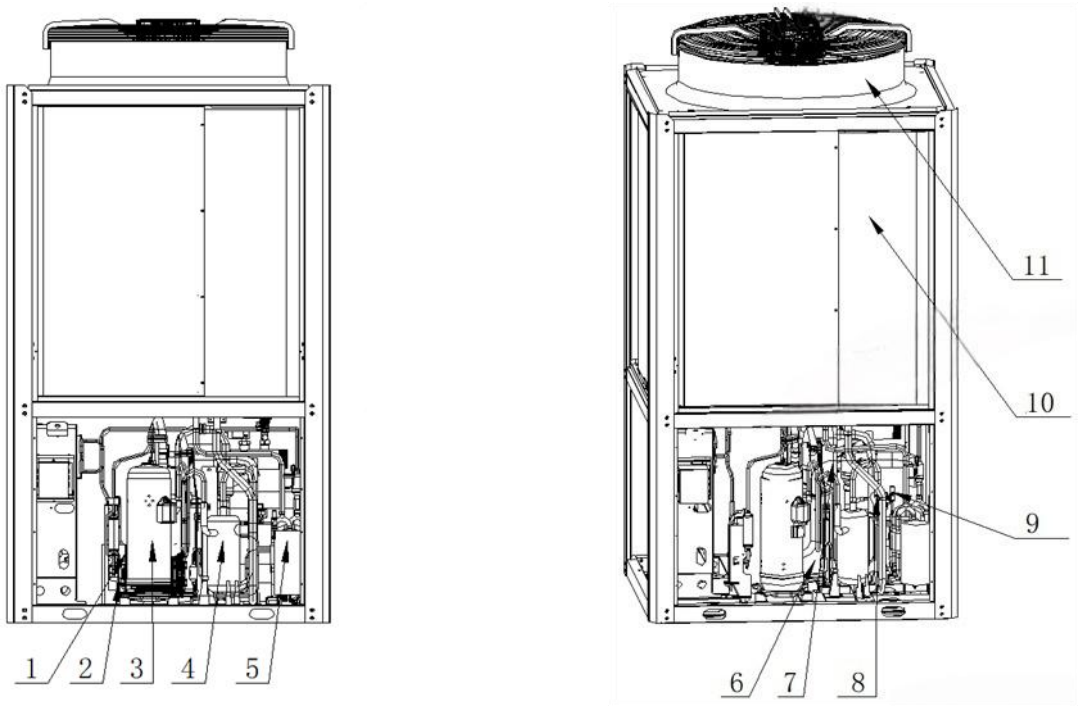
1 Unit Capacity and Appearance

Model	70 kW 70 kW (With hydro kit)	140kW 140 kW (With hydro kit)
Power supply	380V/3Ph/50Hz	380V/3Ph/50Hz
Appearance		

Part 2 COMPONENT LAYOUT AND REFRIGERANT CIRCUIT

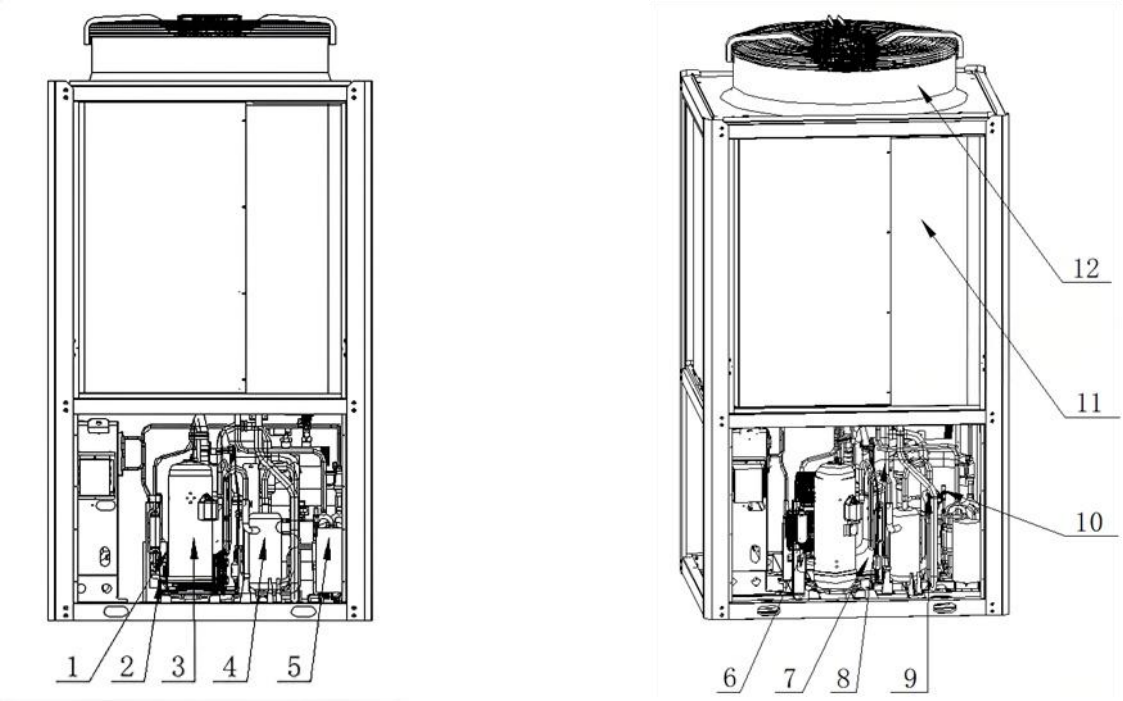
1 Component Layout

70 kW



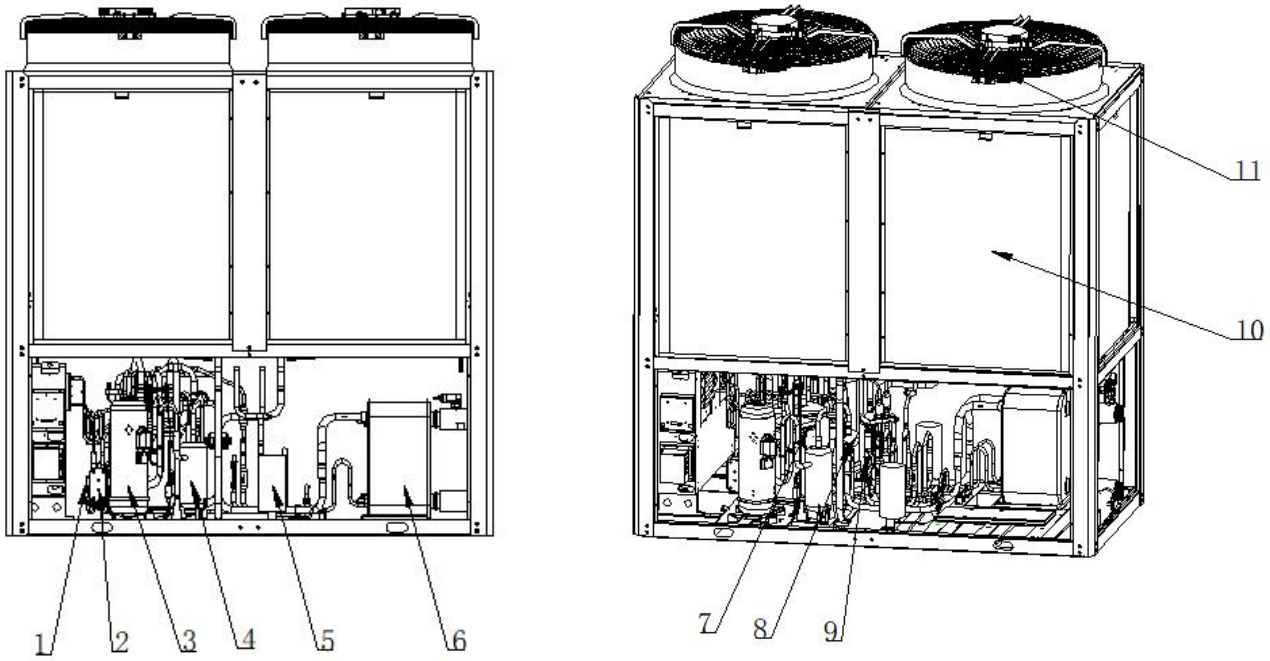
SN	Component	SN	Component	SN	Component
1	Auxiliary Electronic Expansion Valve	5	Liquid Receiver	9	Main Electronic Expansion Valve
2	Economizer	6	Gas-liquid Separator	10	Condenser Assembly
3	Compressor	7	Plate Heat Exchanger	11	Fan Motor Component
4	Oil Separator	8	Four-way Valve Assembly		

70kW (With hydro kit)



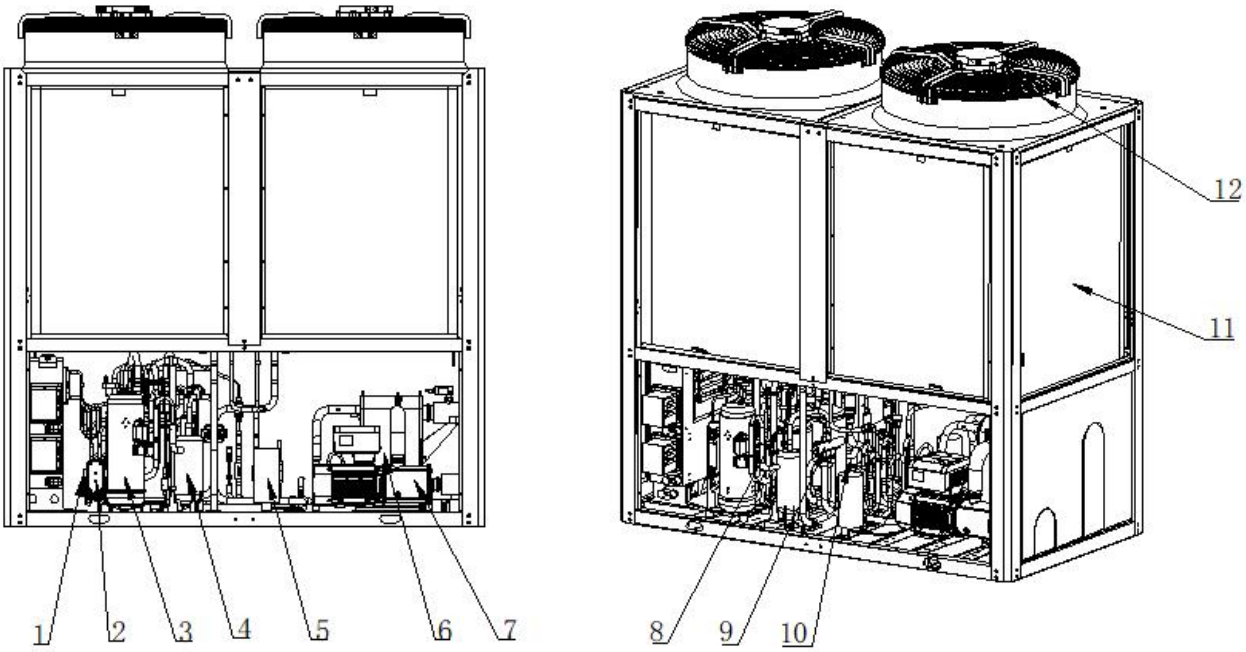
SN	Component	SN	Component	SN	Component
1	Auxiliary Electronic Expansion Valve	5	Liquid Receiver	9	Four-way Valve Assembly
2	Economizer	6	Water Pump	10	Main Electronic Expansion Valve
3	Compressor	7	Gas-liquid Separator	11	Condenser Assembly
4	Oil Separator	8	Plate Heat Exchanger	12	Fan Motor Component

140kW



SN	Component	SN	Component	SN	Component
1	Auxiliary Electronic Expansion Valve	5	Liquid Receiver	9	Main Electronic Expansion Valve
2	Economizer	6	Plate Heat Exchanger	10	Condenser Assembly
3	Compressor	7	Gas-liquid Separator	11	Fan Motor Component
4	Oil Separator	8	Four-way Valve Assembly		

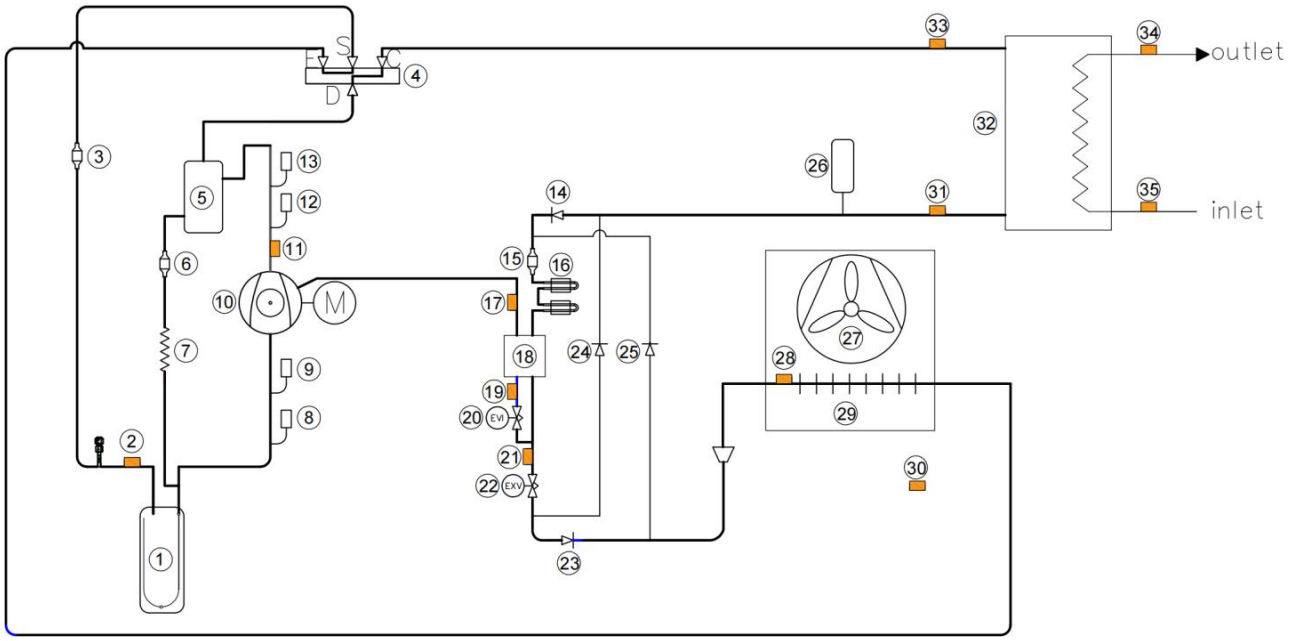
140kW (With hydro kit)



SN	Component	SN	Component	SN	Component
1	Auxiliary Electronic Expansion Valve	5	Liquid Receiver	9	Four-way Valve Assembly
2	Economizer	6	Plate Heat Exchanger	10	Main Electronic Expansion Valve
3	Compressor	7	Water Pump	11	Condenser Assembly
4	Oil Separator	8	Gas-liquid Separator	12	Fan Motor Component

2 Pipeline Diagram

70kW, 70kW (With hydro kit)



SN	Component	SN	Component
1	1# Gas-liquid separator	19	1# Enhanced enthalpy inlet temperature sensor
2	1# Suction temperature sensor	20	1# Auxiliary electronic expansion valve
3	1# Filter	21	1# Supercooled outlet temperature sensor
4	1# Four-way valve	22	1# Main electronic expansion valve
5	1# Oil separator	23	1# Check valve
6	1# Filter	24	1# Check valve
7	1# Oil return capillary	25	1# Check valve
8	1# Low pressure switch	26	1# Liquid receiver
9	1#Low pressure sensor	27	1# Fan
10	1# Compressor	28	1# Fin temperature sensor
11	1# Discharge temperature sensor	29	1# Finned tube heat exchanger
12	1# High pressure switch	30	1# Ambient temperature sensor
13	1# High pressure sensor	31	1# Liquid pipe temperature sensor
14	1# Check valve	32	Plate heat exchanger
15	1# Filter	33	1# Gas pipe temperature sensor
16	1# Refrigerant cooled plate	34	Water-outlet temperature sensor
17	1# Enhanced enthalpy outlet temperature sensor	35	Water-inlet temperature sensor
18	1# Economizer		

Key components:

1. Compressor:

Maintains the pressure difference between the high-pressure and low-pressure sides of the refrigerant system.

2. Fan motor:

Forced air flow accelerates heat exchange between outdoor air and the heat exchanger.

3. Finned tube heat exchanger:

During cooling, the refrigerant heat from the water-side heat exchanger can be released into the air.
During heating, the refrigerant can absorb heat from the air and provide it to the water-side heat exchanger.

4. Plate heat exchanger:

The plate heat exchanger of the air - source heat pump uses the partition - wall structure of the plates to enable heat exchange between the refrigerant and water in adjacent flow channels. It efficiently transfers heat, providing hot water for the user side or meeting the heating and cooling requirements of the air - conditioning water system.

5. Four-way valve:

Controls the direction of refrigerant flow. Closed in cooling mode and open in heating mode. When the four-way valve is closed, the air-side heat exchanger acts as a condenser and the water-side heat exchanger acts as an evaporator; when the four-way valve is open, the air-side heat exchanger acts as an evaporator and the water-side heat exchanger acts as a condenser.

6. Gas - liquid separator:

Separate the liquid refrigerant that has not been completely evaporated in the refrigerant circuit and allow only gaseous refrigerant to enter the compressor to prevent liquid hammer damage to the compressor

7. High & low pressure switches:

When the refrigerant pressure in the system is too high (exceeding the safety value) or too low (fluorine deficiency/abnormal), the circuit will be automatically cut off to protect the compressor and other components and avoid system damage.

8. Electronic expansion valve:

The flow rate and pressure reduction of the liquid refrigerant are dynamically adjusted according to the system load so that the refrigerant enters the evaporator in a suitable state for heat exchange.

9. Liquid receiver:

Balance refrigerant flow and adapt to operating condition fluctuations.

10. Discharge temperature sensor:

Monitor the temperature of high-temperature and high-pressure gaseous refrigerant discharged from the compressor, provide data for system control (such as adjusting the opening of the electronic expansion valve and the fan speed), and trigger the protection mechanism when the temperature is too high to prevent the compressor from being damaged by overheating.

11. Oil separator:

It separates the refrigerant gas from the compressor from the oil and quickly returns the oil to the compressor. The separation efficiency is as high as 99%.

12. Economizer:

In the cooling mode, it can increase the degree of sub - cooling. The sub - cooled refrigerant will achieve a better heat - transfer effect on the inner side (water side). In the heating mode, the refrigerant flows from the plate heat exchanger to the compressor. This component can increase the enthalpy value of the refrigerant, thus enhancing the heating capacity when the ambient temperature is low. The refrigerant capacity in the plate heat exchanger depends on the temperature difference between its inlet and outlet.

13. Oil return capillary tube:

It is usually used to guide the oil back to the compressor.

14. High and low pressure sensors:

They measure the refrigerant pressure on the discharge side/suction side of the compressor.

15. Automatic air vent valve:

Automatically discharges air from the water circuit.

16. Safety valve:

Prevents excessive water pressure. It opens when the pressure reaches 6 bar to discharge water from the water circuit.

17. Wire controller:

Controls and queries the operating status of the unit.

18. Water flow switch:

Detects the water flow rate and protects the compressor and water pump when the water flow is insufficient.

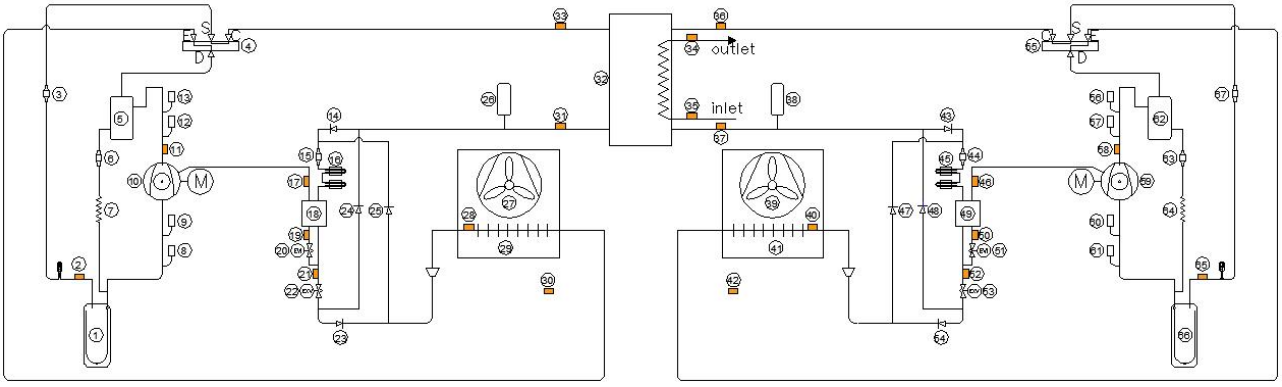
19. Electric heater for water flow switch:

Protects the water flow switch from internal icing.

20. Electric heater for plate heat exchanger

Protects the plate heat exchanger from icing.

140kW, 140kW (With hydro kit)



SN	Component	SN	Component
1	1# Gas-liquid separator	35	Water-inlet temperature sensor
2	1# Suction temperature sensor	36	2# Gas pipe temperature sensor
3	1# Filter	37	2# Liquid pipe temperature sensor
4	1# Four-way valve	38	2# Liquid receiver
5	1# Oil separator	39	2# Fan
6	1# Filter	40	2# Fin temperature sensor
7	1# Oil return capillary	41	2# Finned heat exchanger
8	1# Low pressure switch	42	2# Ambient temperature sensor
9	1# Low pressure sensor	43	2# Check valve
10	1# Compressor	44	2# Filter
11	1# Discharge temperature sensor	45	2# Refrigerant cooled plate
12	1# High pressure switch	46	2# Enhanced enthalpy outlet temperature sensor
13	1# High pressure sensor	47	2# Check valve
14	1# Check valve	48	2# Check valve
15	1# Filter	49	2# Economizer
16	1# Refrigerant cooled plate	50	2# Enhanced enthalpy inlet temperature sensor
17	1# Enhanced enthalpy outlet temperature sensor	51	2# Auxiliary electronic expansion valve
18	1# Economizer	52	2# Supercooled outlet temperature sensor
19	1# Enhanced enthalpy inlet temperature sensor	53	2# Main electronic expansion valve
20	1# Auxiliary electronic expansion valve	54	2# Check valve
21	1# Supercooled outlet temperature sensor	55	2# Four-way valve
22	1# Main electronic expansion valve	56	2# High pressure sensor
23	1# Check valve	57	2# High pressure switch

SN	Component	SN	Component
24	1# Check valve	58	2# Discharge temperature sensor
25	1# Check valve	59	2# Compressor
26	1# Liquid receiver	60	2# Low pressure sensor
27	1# Fan	61	2# High pressure switch
28	1# Fin temperature sensor	62	2# Oil separator
29	1# Finned tube heat exchanger	63	2# Filter
30	1# Ambient temperature sensor	64	2# Oil return capillary
31	1# Liquid pipe temperature sensor	65	2# Suction temperature sensor
32	Plate heat exchanger	66	2# Gas-liquid separator
33	1# Gas pipe temperature sensor	67	2# Filter
34	Water-outlet temperature sensor		

Key components:

1. Compressor:

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2. Fan motor:

Forced air flow accelerates heat exchange between outdoor air and the heat exchanger.

3. Finned tube heat exchanger:

During cooling, the refrigerant heat from the water-side heat exchanger can be released into the air.
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The plate heat exchanger of the air - source heat pump uses the partition - wall structure of the plates to enable heat exchange between the refrigerant and water in adjacent flow channels. It efficiently transfers heat, providing hot water for the user side or meeting the heating and cooling requirements of the air - conditioning water system.

5. Four-way valve:

Controls the direction of refrigerant flow. Closed in cooling mode and open in heating mode. When the four-way valve is closed, the air-side heat exchanger acts as a condenser and the water-side heat exchanger acts as an evaporator; when the four-way valve is open, the air-side heat exchanger acts as an evaporator and the water-side heat exchanger acts as a condenser.

6. Gas - liquid separator:

Separate the liquid refrigerant that has not been completely evaporated in the refrigerant circuit and allow only gaseous refrigerant to enter the compressor to prevent liquid hammer damage to the compressor

7. High & low pressure switches:

When the refrigerant pressure in the system is too high (exceeding the safety value) or too low (fluorine deficiency/abnormal), the circuit will be automatically cut off to protect the compressor and other components and avoid system damage.

8. Electronic expansion valve:

The flow rate and pressure reduction of the liquid refrigerant are dynamically adjusted according to the system load so that the refrigerant enters the evaporator in a suitable state for heat exchange.

9. Liquid receiver:

Balance refrigerant flow and adapt to operating condition fluctuations.

10. Discharge temperature sensor:

Monitor the temperature of high-temperature and high-pressure gaseous refrigerant discharged from the compressor, provide data for system control (such as adjusting the opening of the electronic expansion valve and

the fan speed), and trigger the protection mechanism when the temperature is too high to prevent the compressor from being damaged by overheating.

11. Oil separator:

It separates the refrigerant gas from the compressor from the oil and quickly returns the oil to the compressor. The separation efficiency is as high as 99%.

12. Economizer:

In the cooling mode, it can increase the degree of sub - cooling. The sub - cooled refrigerant will achieve a better heat - transfer effect on the inner side (water side). In the heating mode, the refrigerant flows from the plate heat exchanger to the compressor. This component can increase the enthalpy value of the refrigerant, thus enhancing the heating capacity when the ambient temperature is low. The refrigerant capacity in the plate heat exchanger depends on the temperature difference between its inlet and outlet.

13. Oil return capillary tube:

It is usually used to guide the oil back to the compressor.

14. High and low pressure sensors:

They measure the refrigerant pressure on the discharge side/suction side of the compressor.

15. Automatic air vent valve:

Automatically discharges air from the water circuit.

16. Safety valve:

Prevents excessive water pressure. It opens when the pressure reaches 6 bar to discharge water from the water circuit.

17. Wire controller:

Controls and queries the operating status of the unit.

18. Water flow switch:

Detects the water flow rate and protects the compressor and water pump when the water flow is insufficient.

19. Electric heater for water flow switch:

Protects the water flow switch from internal icing.

20. Electric heater for plate heat exchanger:

Protects the plate heat exchanger from icing.

3 Refrigerant Diagram

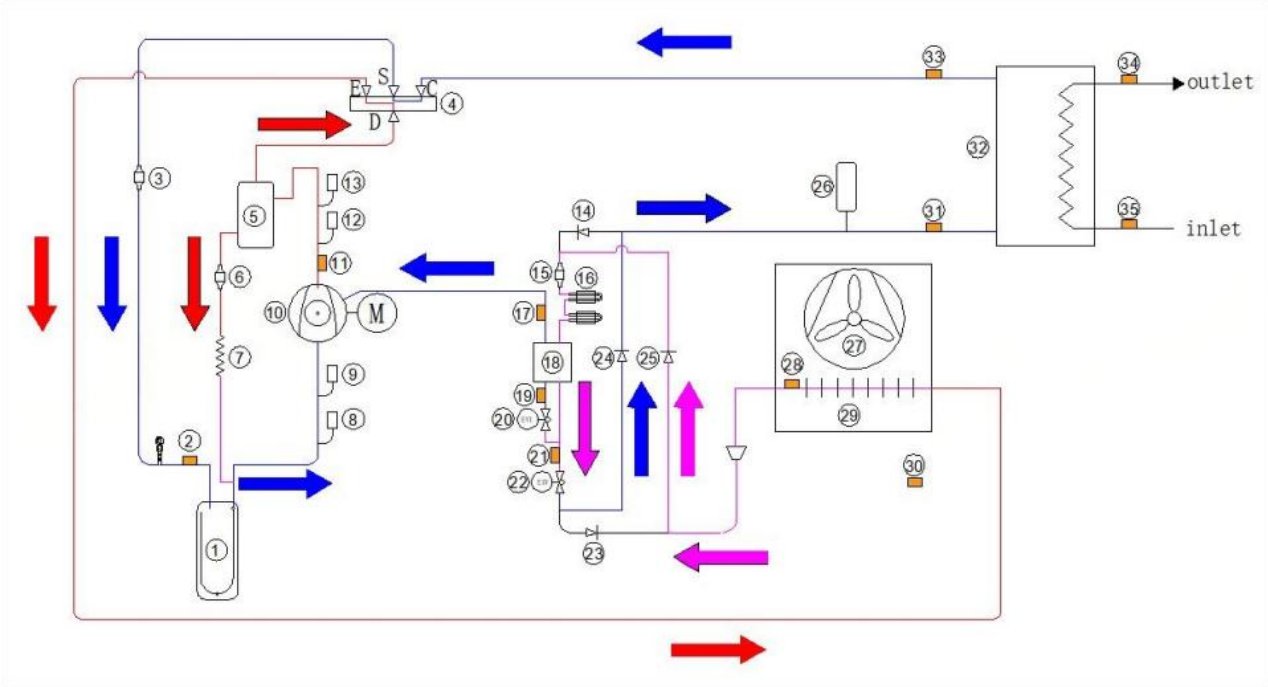
3.1 70kW, 70kW (With hydro kit)

3.1.1 Cooling Mode

—High-Temperature and High-Pressure Gas

—High-Temperature and High-Pressure Liquid

—Low-Temperature and Low-Pressure Gas

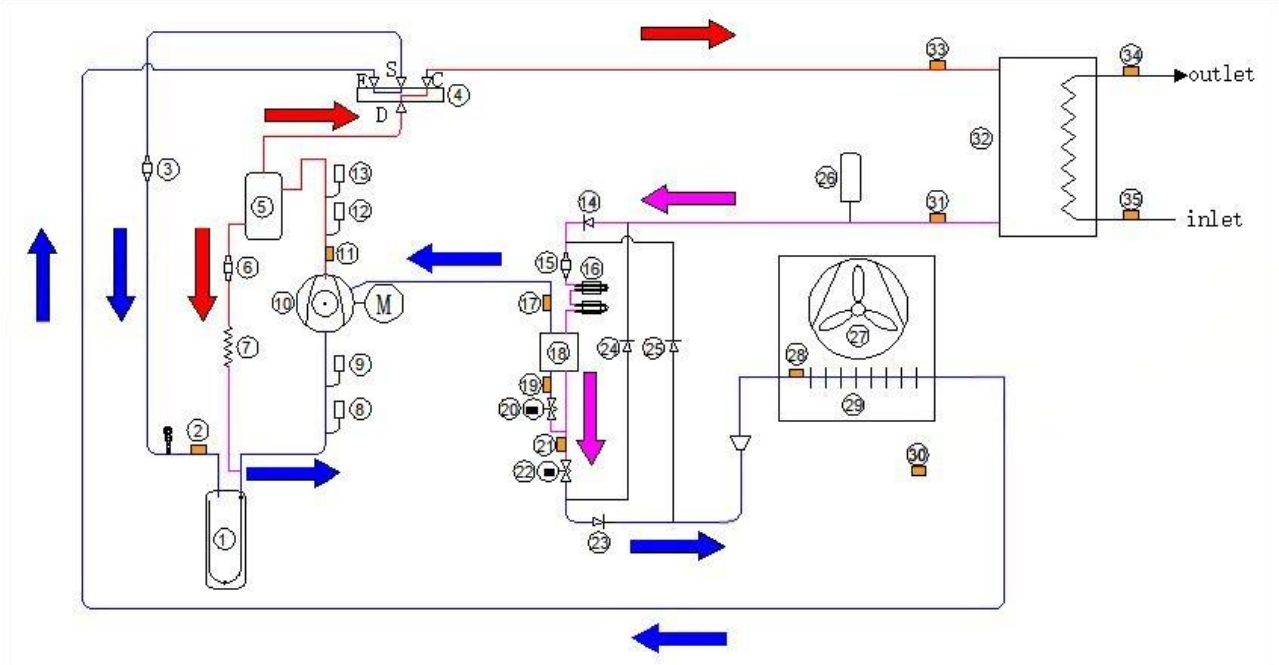


3.1.2 Heating Mode

—High-Temperature and High-Pressure Gas

—High-Temperature and High-Pressure Liquid

—Low-Temperature and Low-Pressure Gas



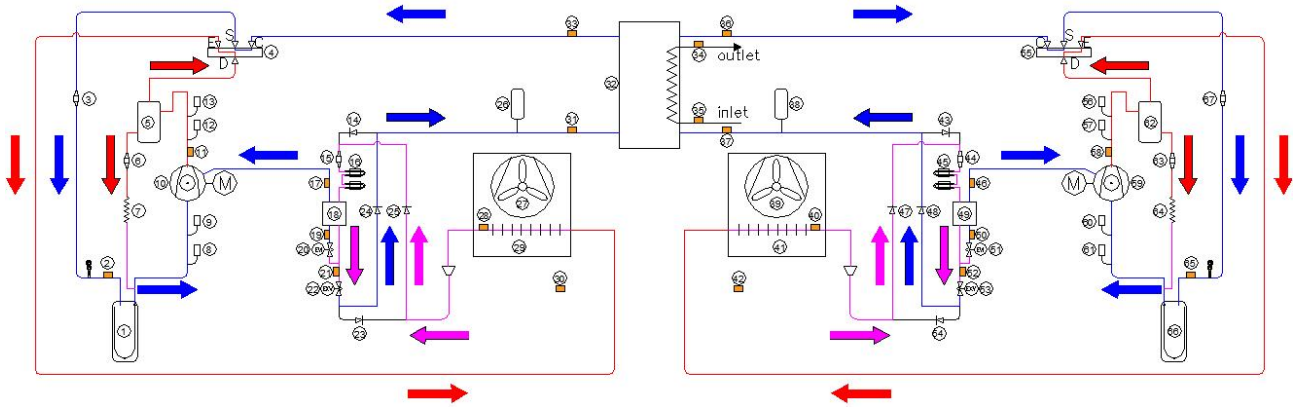
3.2 140kW, 140kW (With hydro kit)

3.2.1 Cooling Mode

—High-Temperature and High-Pressure Gas

—High-Temperature and High-Pressure Liquid

—Low-Temperature and Low-Pressure Gas

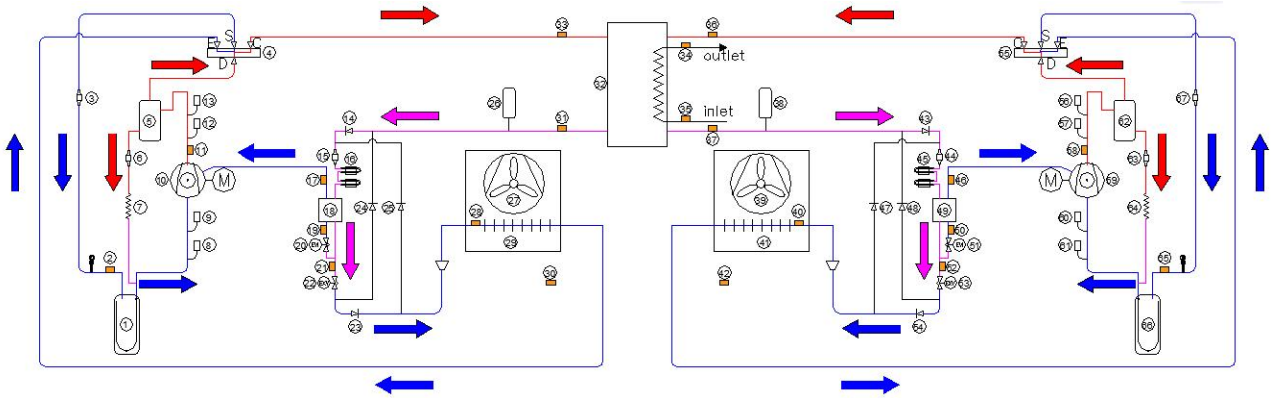


3.2.2 Heating Mode

—High-Temperature and High-Pressure Gas

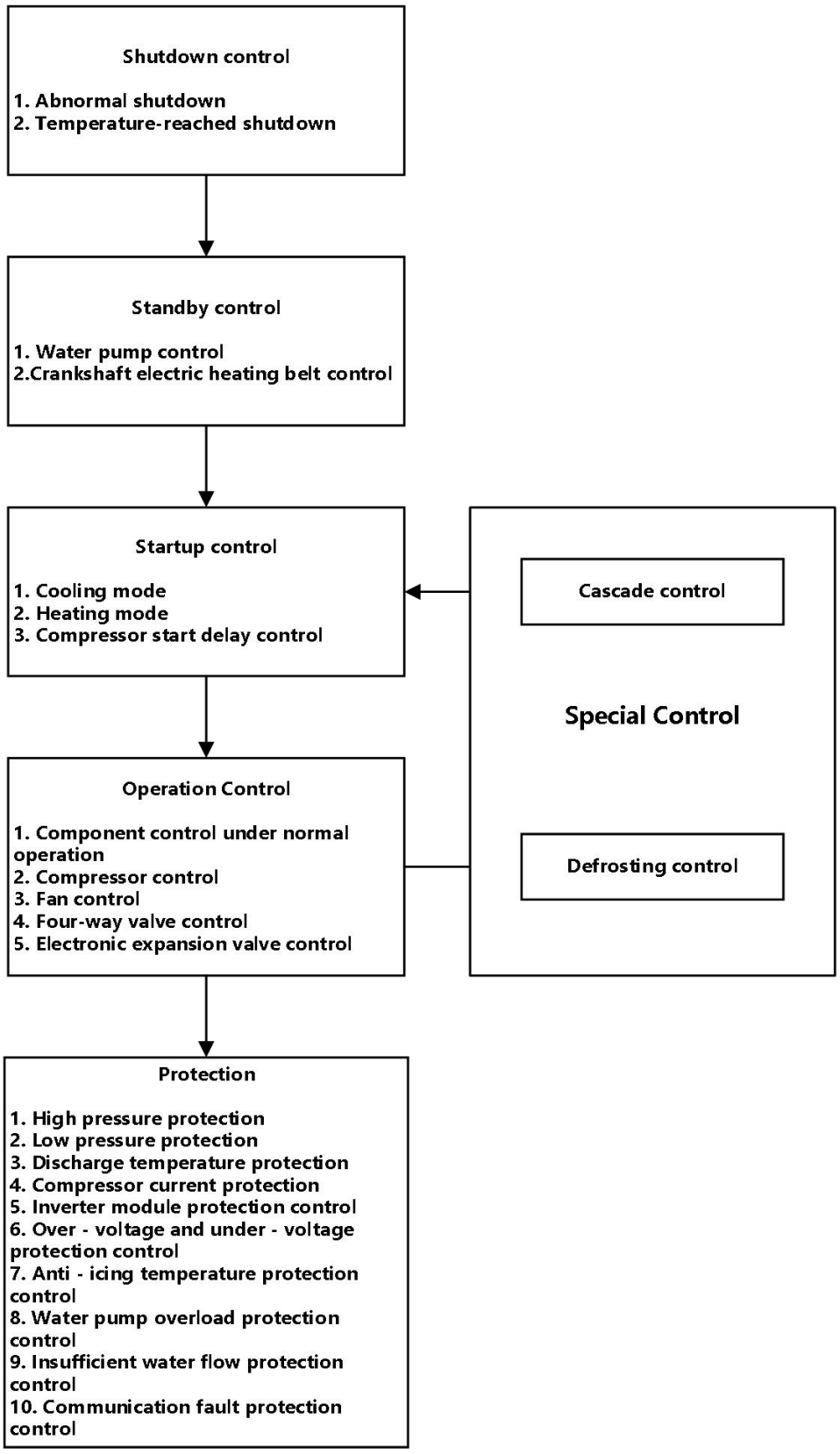
—High-Temperature and High-Pressure Liquid

—Low-Temperature and Low-Pressure Gas



Part 3 SYSTEM CONTROL

1 Flowchart Of Control Scheme



2 Shutdown Control

2.1 Abnormal

When an abnormal situation occurs in the system, the system will shut down directly to protect the compressor, and the abnormal status code will be displayed on the wired controller interface.

2.2 Temperature-Reached

When the detected water temperature reaches the temperature set by the wired controller, the system will execute the shutdown action.

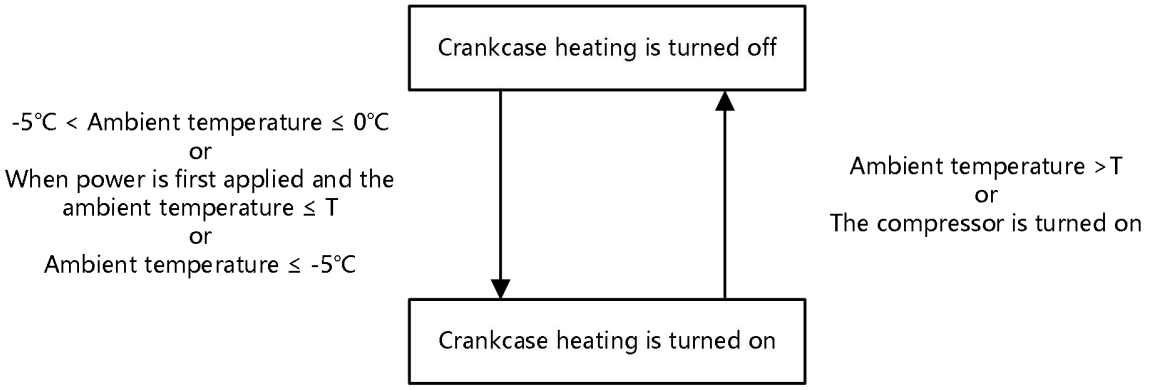
3 Standby Control

3.1 Water Pump

When the unit is in the temperature-reached state, the water pump will continue to run.

3.2 Crankcase Electric Heating

The crankcase heater is used to prevent the refrigerant from mixing with the compressor oil when the compressor stops. The crankcase heater is controlled based on the outdoor ambient temperature and the downtime of the compressor.



The T parameter is adjustable, with a default value of 10℃.

4 Startup Control

4.1 Compressor Start-up Delay Control

In initial startup control and restart control (excluding defrosting operations), the startup of the compressor is delayed such that compressor start delay ≥3 minutes after shutdown. This is to prevent the compressor from being frequently switched on and off and to balance the pressure within the refrigerant system.

4.2 Cooling Mode

70kW, 70kW (With hydro kit), 140kW, 140kW (With hydro kit)

Components	70kW 140kW	Control functions and status
Water Pump	•	One minutes after the water pump is turned on, continuously monitor the water flow switch. The compressor can only start after the water flow is normal.
Inverter Compressor 1	•	Control the outlet water temperature. The operating frequency rises and falls at a rate of 1 hz/s, and is executed according to the startup platform.
Inverter Compressor 2	•	Control the outlet water temperature. The operating frequency rises and falls at

Components	70kW 140kW	Control functions and status
		a rate of 1 hz/s, and is executed according to the startup platform.
Fan 1	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Fan 2	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Electronic Expansion Valve Ev1	●	From 0p to 480p, controlled according to ambient temperature and discharge temperature.
Electronic Expansion Valve Eev2	●	From 0p to 480p, controlled according to ambient temperature and discharge temperature.
Electronic Expansion Valve Evi1	●	From 0p to 480p, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Electronic Expansion Valve Evi2	●	From 0p to 480p, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Four-way Valve 1	●	On status
Four-way Valve 2	●	On status
Flow Switch	●	If the water flow switch is open and the remote controller displays a error code indicating insufficient water flow, the water flow switch should be closed only after the water flow returns to normal before the compressor can start.

4.3 Heating Mode

70kW, 70kW (With hydro kit), 140kW, 140kW (With hydro kit)

Components	70kW 140kW	Control functions and status
Water Pump	●	Two minutes after the water pump is turned on, continuously monitor the water flow switch. The compressor can only start after the water flow is normal.
Inverter Compressor 1	●	Control the outlet water temperature. The operating frequency rises and falls at a rate of 1 Hz/s, and is executed according to the startup platform.
Inverter Compressor 2	●	Control the outlet water temperature. The operating frequency rises and falls at a rate of 1 Hz/s, and is executed according to the startup platform.
Fan 1	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Fan 2	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Electronic Expansion Valve Eev1	●	From 0P to 480P, controlled according to ambient temperature and discharge temperature.
Electronic Expansion Valve Eev2	●	From 0P to 480P, controlled according to ambient temperature and discharge temperature.
Electronic Expansion Valve Evi1	●	From 0P to 480P, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Electronic Expansion Valve Evi2	●	From 0P to 480P, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Four-way Valve 1	●	Closed
Four-way Valve 2	●	Closed
Flow Switch	●	If the water flow switch is open and the remote controller displays a error code indicating insufficient water flow, the water flow switch should be closed only after the water flow returns to normal before the compressor can start.

5 Operation Control

5.1 Normal Operation

5.1.1 Cooling Mode

70kW, 70kW (With hydro kit), 140kW, 140kW (With hydro kit)

Components	70kW 140kW	Control functions and status
Water Pump	●	Open
Inverter Compressor 1	●	Control based on load requirements
Inverter Compressor 2	●	Control according to load requirements
Fan 1	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Fan 2	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Electronic Expansion Valve Eev1	●	From 0P to 480P, controlled according to subcooling and discharge temperature.
Electronic Expansion Valve Eev2	●	From 0P to 480P, controlled according to subcooling and discharge temperature.
Electronic Expansion Valve Evi1	●	From 0P to 480P, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Electronic Expansion Valve Evi2	●	From 0P to 480P, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Four-way Valve 1	●	On status
Four-way Valve 2	●	On status
Flow Switch	●	If the water flow switch is open and the remote controller displays a error code indicating insufficient water flow, the water flow switch should be closed only after the water flow returns to normal before the compressor can start.

5.1.2 Heating Mode

70kW, 70kW (With hydro kit), 140kW, 140kW (With hydro kit)

Components	70kW 140kW	Control functions and status
Water Pump	●	Open
Inverter Compressor 1	●	Control according to load requirements
Inverter Compressor 2	●	Control according to load requirements
Fan 1	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Fan 2	●	Control is based on ambient temperature, discharge pressure, and compressor frequency.
Electronic Expansion Valve Eev1	●	From 0P to 480P, controlled according to subcooling and discharge temperature.
Electronic Expansion Valve Eev2	●	From 0P to 480P, controlled according to subcooling and discharge temperature.
Electronic Expansion Valve Evi1	●	From 0P to 480P, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Electronic Expansion Valve Evi2	●	From 0P to 480P, controlled according to the inlet and outlet temperature difference of the plate heat exchanger (economizer).
Four-way Valve 1	●	Closed
Four-way Valve 2	●	Closed
Flow Switch	●	If the water flow switch is open and the remote controller displays a error code

	indicating insufficient water flow, the water flow switch should be closed only after the water flow returns to normal before the compressor can start.

5.2 Compressor

- The compressor starts when there's a load demand. Before starting, the water pump must run for a certain period of time to detect the water flow in the system. In a single-unit system, the compressors run the corresponding startup sequence upon startup.
- In a cascade system with multiple units, the number of compressors required to be loaded is calculated based on the temperature difference during startup to match the load demand. Once the number of compressors activated reaches the required number, normal compressor control begins, and further load determination is made based on the load demand.

5.3 Fan

The fan motor operates in conjunction with the compressor: when the compressor starts, the fan turns on in advance; when the compressor shuts down, the fan turns off with a delay. Similar to the compressor's start-up control, before the fan starts, the water pump must run for a certain period of time to detect the water flow in the system.

5.4 Four-way Valve

The four-way valve is used to change the direction of refrigerant flow through the shell and tube heat exchanger to switch between cooling and heating operations. During the heating mode, the four-way valve is in the opened state; during the cooling and defrost modes, the four-way valve is in the closed state.

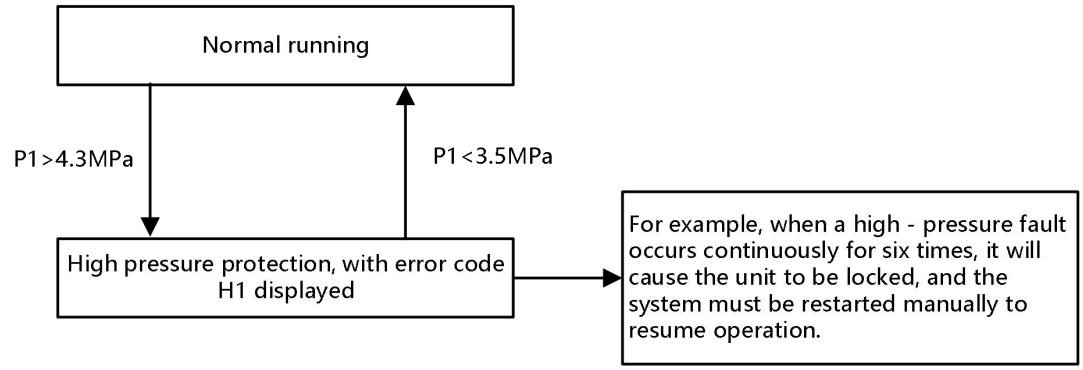
5.5 Electronic Expansion Valve

Power-on action:
When powered on for the first time or when powered on again, the electronic expansion valve performs the valve closing action to 0 P and then enters the standby action control.
Action during normal operation:
When the compressor is running, the opening of the electronic expansion valve is adjusted from the standby opening to the initial opening. The initial opening is determined by the ambient temperature. After running for a specified time, the electronic expansion valve is controlled according to the discharge temperature.
Standby action:
When the compressor is not running, the electronic expansion valve opens to the standby opening.
Shutdown reset action:
When the compressor stops running for more than a period of time, the electronic expansion valve first performs the valve closing action and then enters the standby action control.

6 Protection

6.1 High Pressure Protection

This control prevents the refrigerant system from experiencing abnormally high pressures and protects the compressor from transient high pressures.



Note:

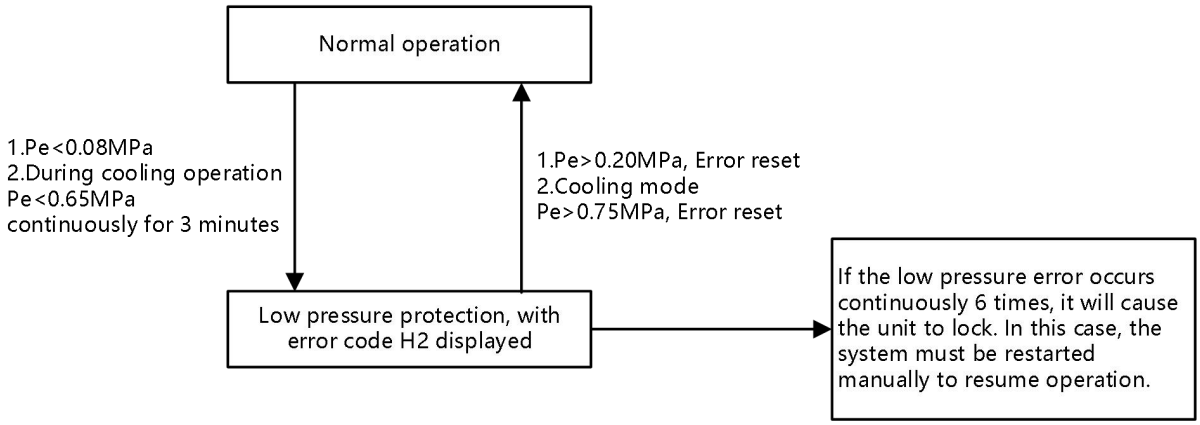
P1 represents high pressure

When the high pressure rises above 4.3 MPa, the user interface displays H1 protection and the error unit stops operating.

When the high pressure drops below 3.5 MPa, H1 protection is released and normal operation resumes.

6.2 Low Pressure Protection

This control prevents abnormal pressure drops in the refrigerant system and protects the compressor from damage due to sudden pressure drops.

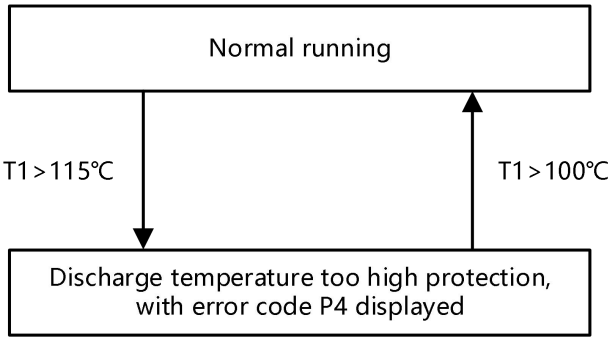


Note:

Pe represents low pressure

6.3 Discharge Temperature Protection

This control can prevent the compressor from being damaged due to abnormal high temperature.



Note:

T1 represents the discharge temperature

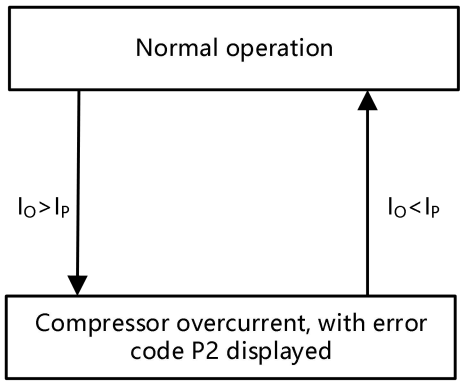
When the discharge temperature rises above 115°C, an "discharge temperature too high" fault is reported, the user interface displays P4 protection, and the faulty unit stops operating. When the discharge temperature drops below 100°C, the compressor enters restart control, and the unit continues to operate.

6.4 Compressor Overcurrent Protection

Over-Current Protection.

This control monitors the compressor's operating current in real time.

When the current exceeds the safety threshold, the power supply of the compressor is cut off rapidly to prevent damage to the unit. When the actual current of the compressor is greater than the rated current, a "compressor over current" error is reported. The user interface displays P2 and the compressor enters the frequency reduction control. When the compressor current drops below the required value and the compressor has been shut down for 3 minutes, the whole unit is allowed to resume operation.



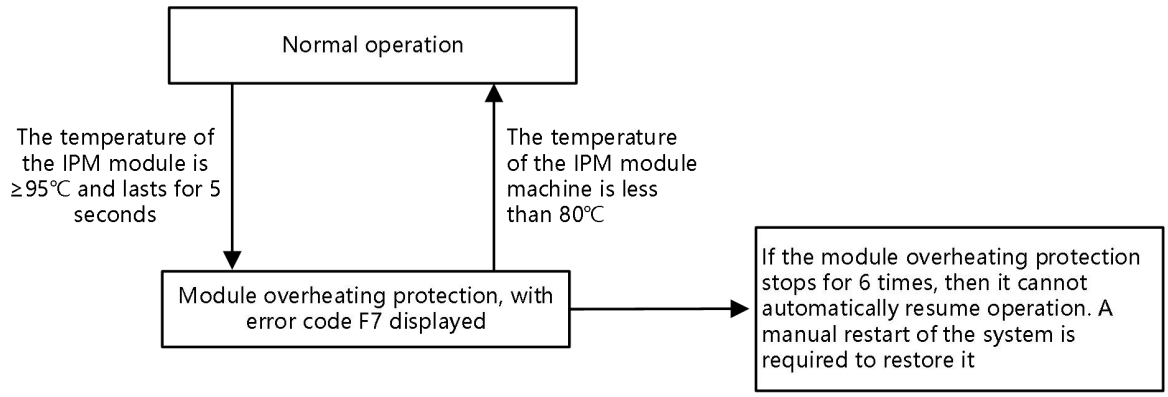
Note:

I_O represents compressor operating current; I_p represents compressor protection current; I_R represents compressor recover current

Model	I_p (A)	I_R (A)
70kW	52	48
70kW (With hydro kit)	52	48
140kW	52	48
140kW (With hydro kit)	52	48

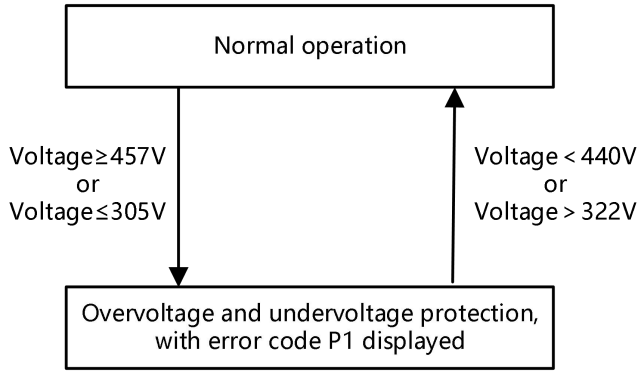
6.5 Inverter Module Protection

This control device protects the compressor and blower module from abnormally high temperatures.



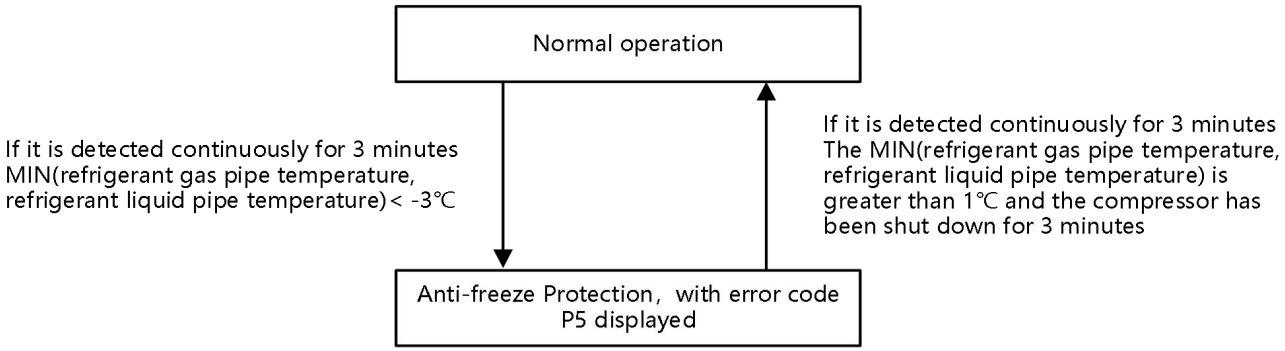
6.6 Over/Undervoltage Protection

This control device can protect the equipment from abnormally high or low voltage.



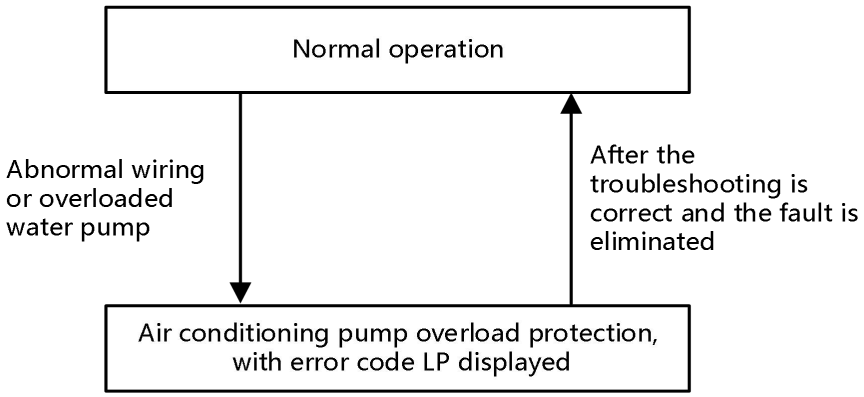
6.7 Cooling Anti-icing Protection

In cooling mode, this control monitors the temperature of the heat exchanger or pipeline medium. When the temperature approaches the freezing threshold, the unit stops operating to prevent the medium from freezing and damaging the equipment, avoid system failure, and ensure the safe operation of the unit at low temperatures.



6.8 Water Pump Overload Protection

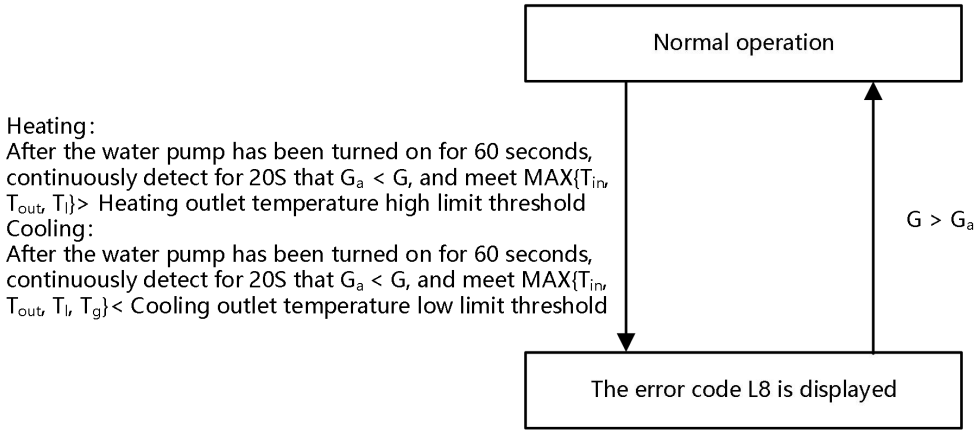
This control can promptly shut down the water pump and the unit when the load exceeds the rated value due to motor failure, pipeline blockage, abnormal voltage, etc. in the water pump, preventing damage to components.



When the water pump is overloaded, an "AC Pump Overload Protection" fault is reported, the user interface displays LP protection, and the unit stops operating. Once the "AC Pump Overload Protection Troubleshooting" steps are followed and the fault is resolved, the unit can operate normally.

6.9 Insufficient Water Flow Protection

This control system can promptly shut down the unit when the water circulation flow rate in the system drops below the safety threshold due to pump failure, pipeline blockage, or valve not being opened, thus preventing the heat exchanger from being damaged by dry burning due to lack of water and ensuring the safe and stable operation of the unit.



Model	G (m³/h)
70kW	6
70kW (With hydro kit)	6
140kW	14
140kW (With hydro kit)	14

Note:

G_a represents the unit actual water flow rate, G represents the protection value of the unit's water flow rate; T_{in} represents water inlet temperature; T_{out} represents water outlet temperature; T_l represents refrigerant liquid pipe temperature; T_g represents refrigerant gas pipe temperature.

6.10 Communication Fault Protection

This control system ensures normal communication between the master and slave units, thereby guaranteeing proper loading and unloading between them. If communication between the master and slave units is abnormal, a "communication fault" protection message is displayed, the user interface shows "E0," and the faulty unit stops operating. Once the communication cable connections between the units are confirmed to be correct and the fault is cleared, the units can resume operation.

If no correct signal is received from the indoor unit for 2 consecutive minutes, the communication fault protection will shut down the unit; if the communication fault is resolved, the unit will resume operation.

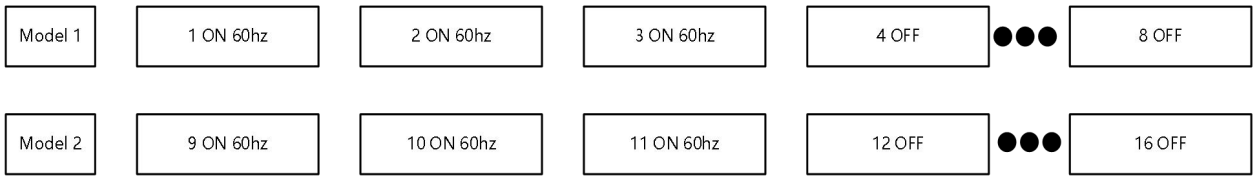
7 Special Controls

7.1 Cascade Loading and Unloading

In a system where multiple units are cascaded and connected for use, the running time of compressors can be balanced through cascade loading and unloading. When all units stop operating (stop due to reaching the set temperature or due to a fault), the following cyclic actions will be executed when starting again: Take 16 units in parallel as an example:

First cycle:

When the unit is powered on and starts for the first time, calculate the total system load, allocate the load of each module according to the capacity ratio, and calculate the initial frequency and the number of starting units for the modular units. The loading starts from the module with the lowest address bit to the highest one. After starting up to the specified number of units, enter the loading and unloading control and execute the final commands (start/shutdown/frequency increase/frequency decrease).



Second cycle:

Enter the loading and unloading control. When the water temperature has not reached the set temperature value, increase the frequency; conversely, when the water temperature exceeds the set temperature value, decrease the frequency.

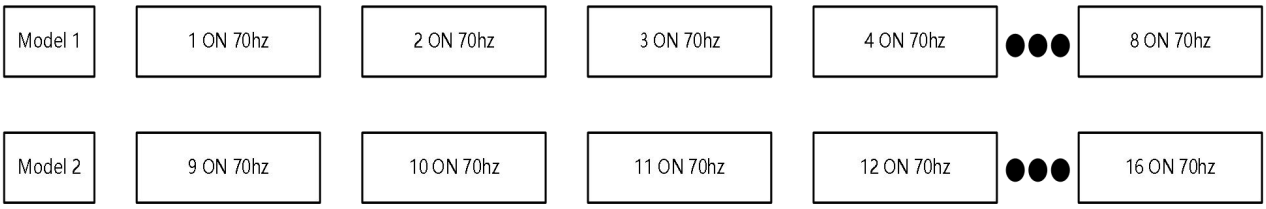
After the units that have been started have been operating stably for a period of time, if the water temperature requirement is not met, the operating frequency of the started units will be gradually increased, and units with a shorter operating time will be preferentially loaded; when the water temperature requirement is met, the operating frequency of all units will be gradually decreased, and units with a longer cumulative operating time will be preferentially unloaded.

Loading 1 is as follows:

Loading 2 is as follows:

Unloading 1 is as follows:

Unloading 2 is as follows:



7.2 Defrosting

To restore heating capacity, defrosting is required when the outdoor unit's air-side heat exchanger is operating as an evaporator. The defrosting process is controlled based on the outdoor ambient temperature, the refrigerant temperature of the air-side heat exchanger, the inlet water temperature, the compressor's operating time, and the defrosting time.

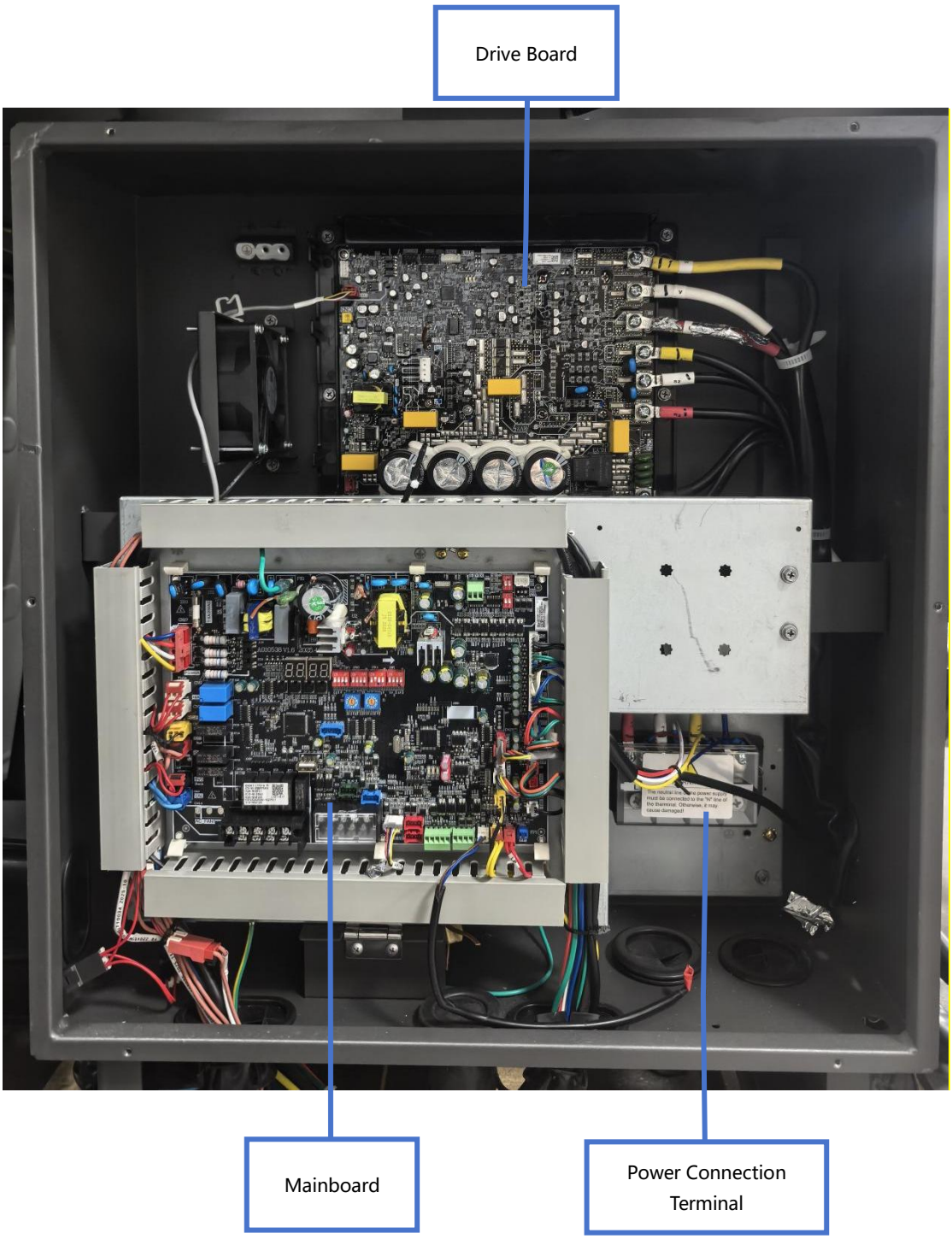
Components	70kW 140kW	Control functions and status
Inverter compressor	●	Running in defrost mode
Fan	●	Close
Electronic expansion valve (EEV)	●	Open to 480 degrees
Electronic expansion valve EVI	●	Close
Four-way valve	●	Open

Part 4 TROUBLESHOOTING

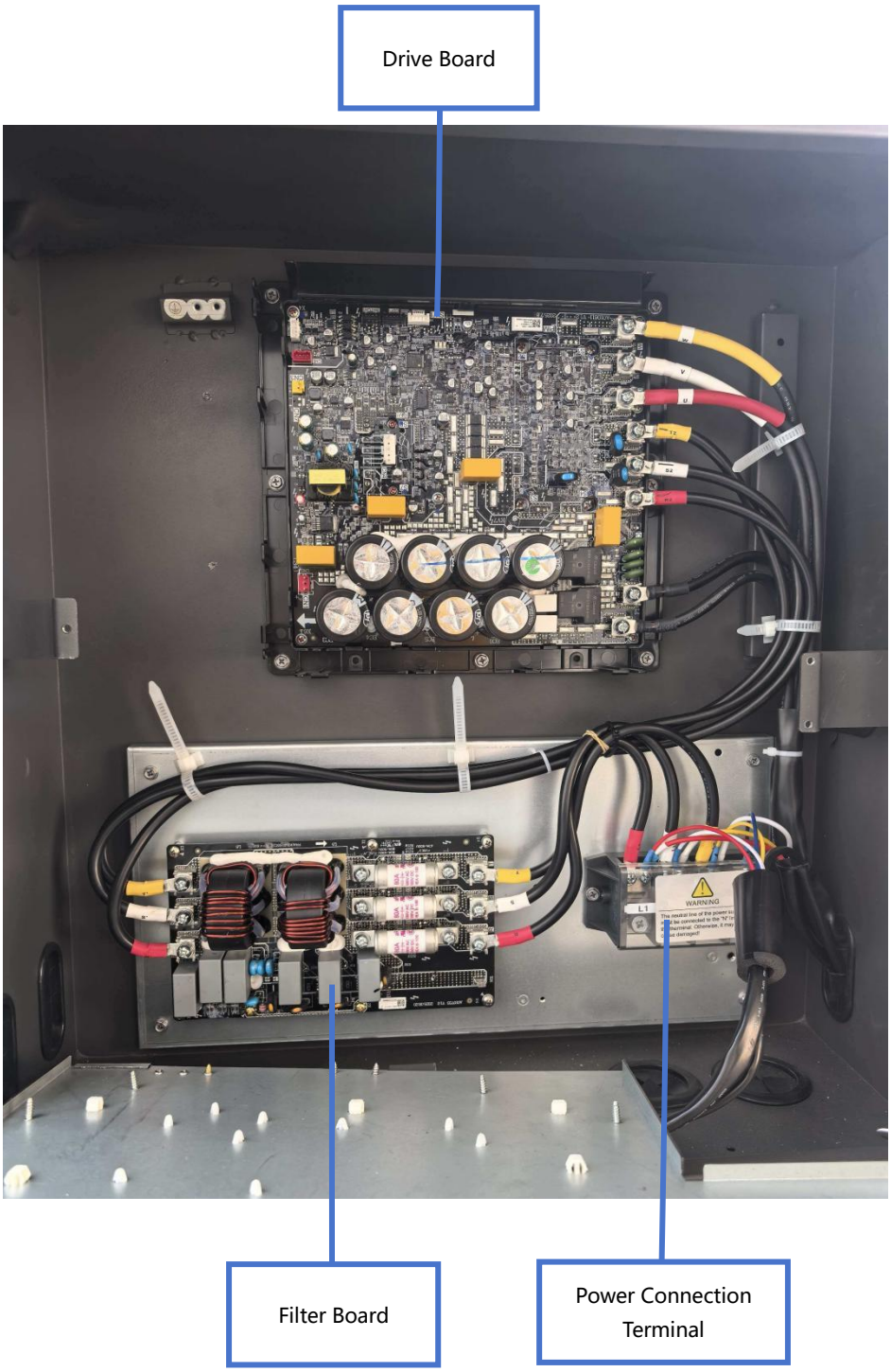
1 Electric Control Box Layout

70kW, 70kW (With hydro kit)

Layer 1

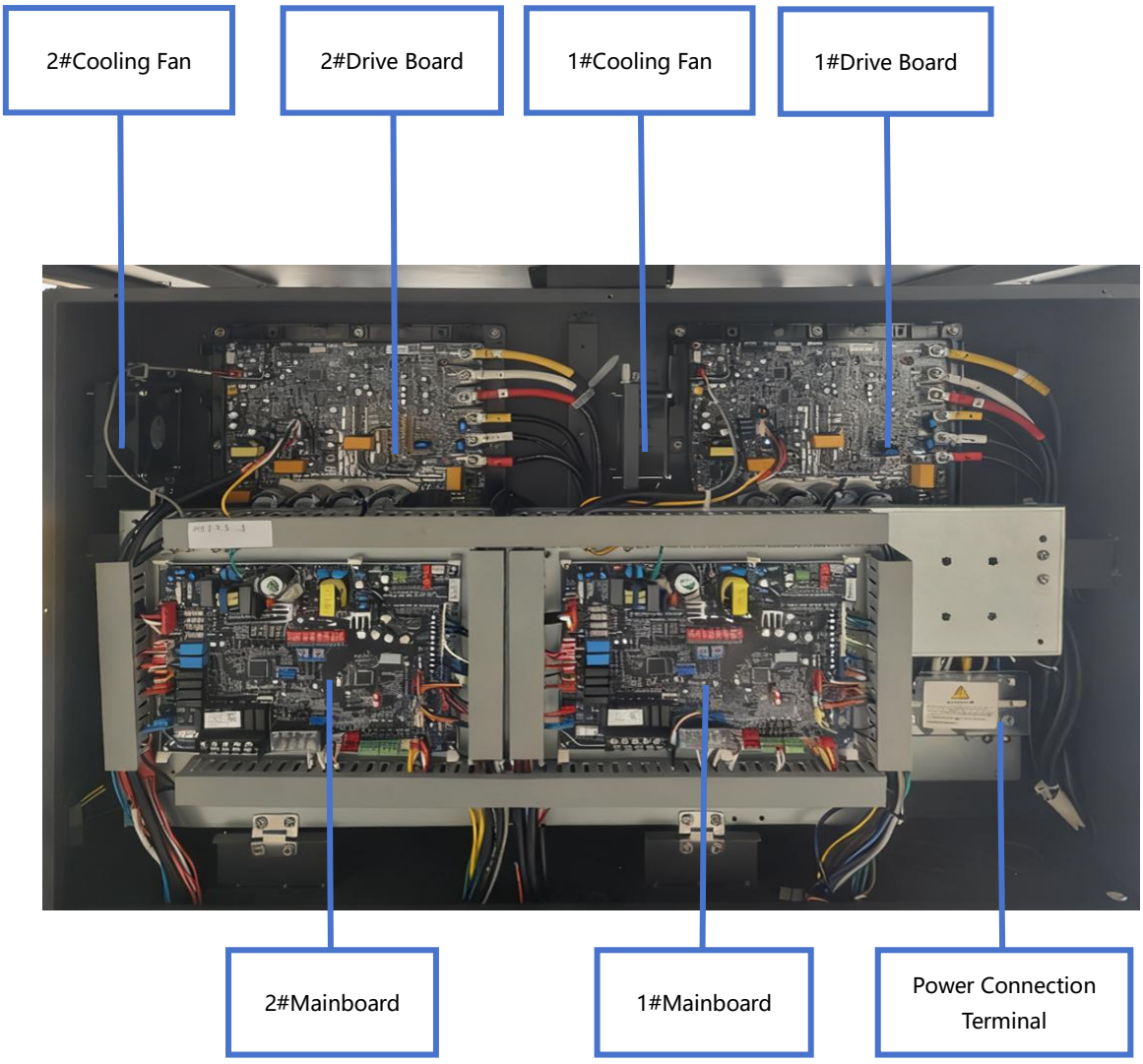


Layer2

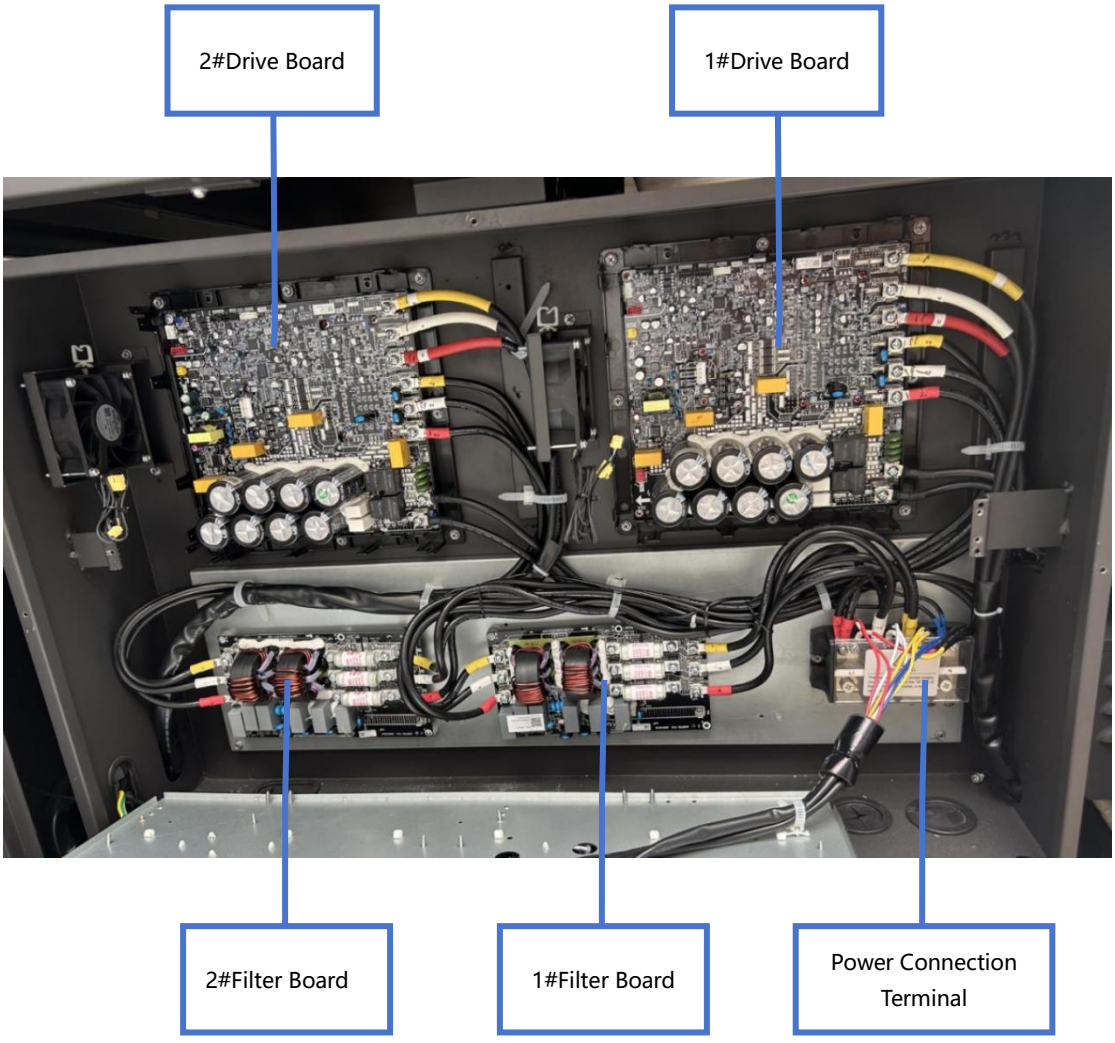


140kW, 140kW (With hydro kit)

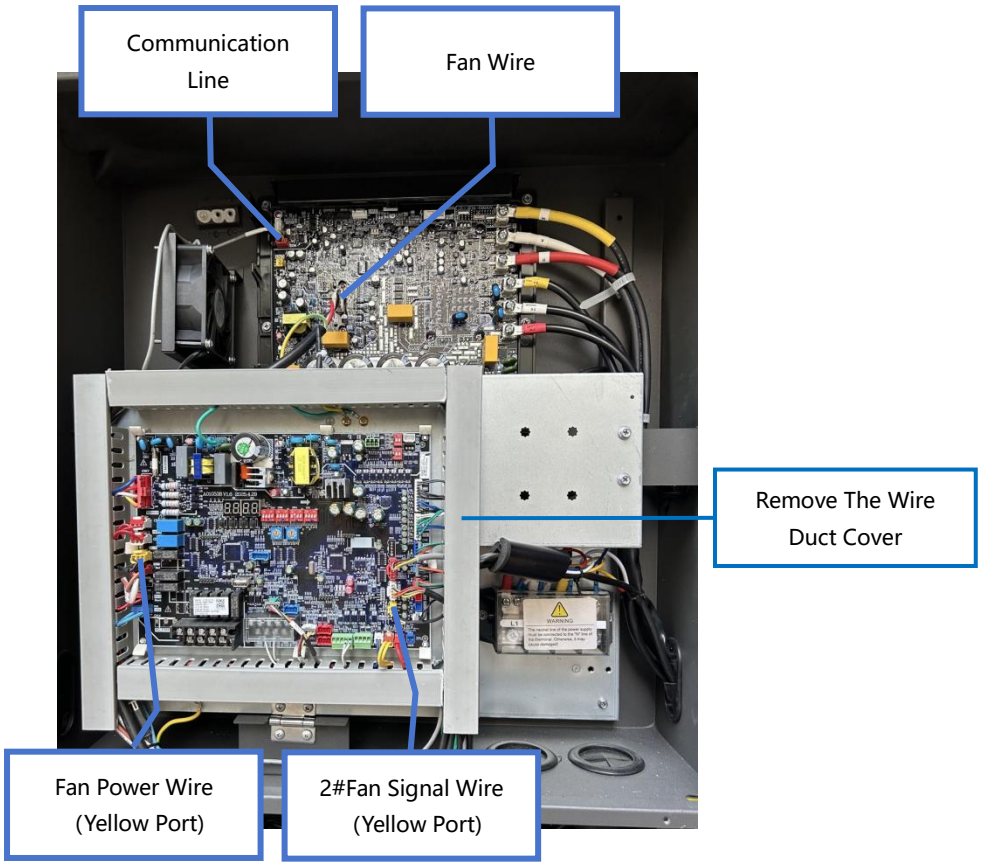
Layer 1



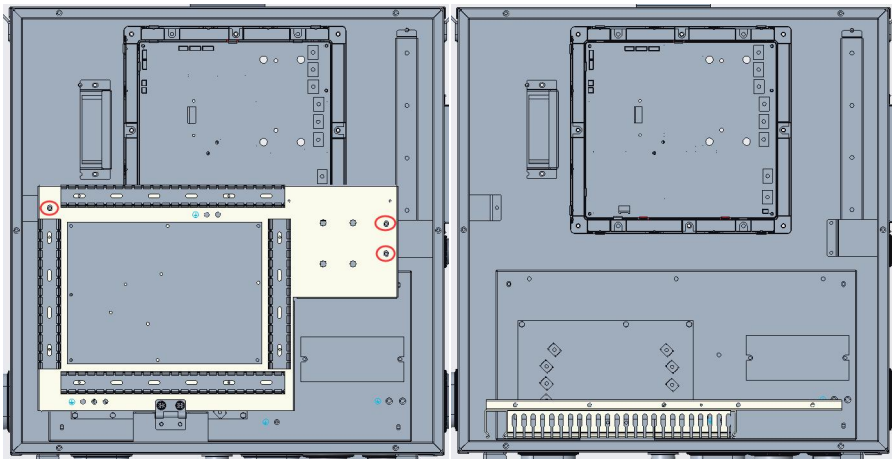
Layer 2


2#Drive Board
1#Drive Board
2#Filter Board
1#Filter Board
Power Connection Terminal

70kW, 70kW (With hydro kit)

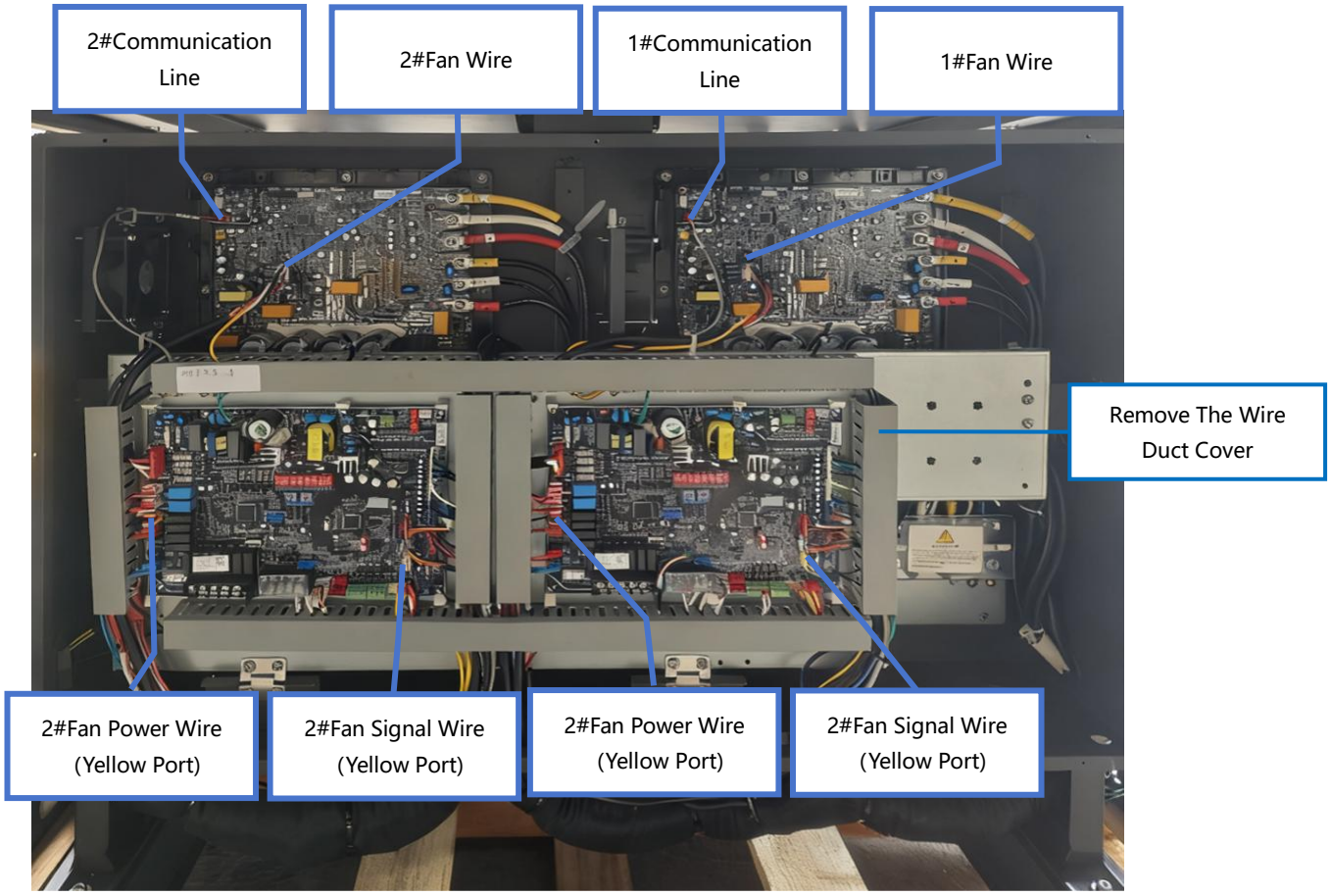


Remove the three screws of the upper installation board, flip it forward and lay it flat, as shown in the figure below.

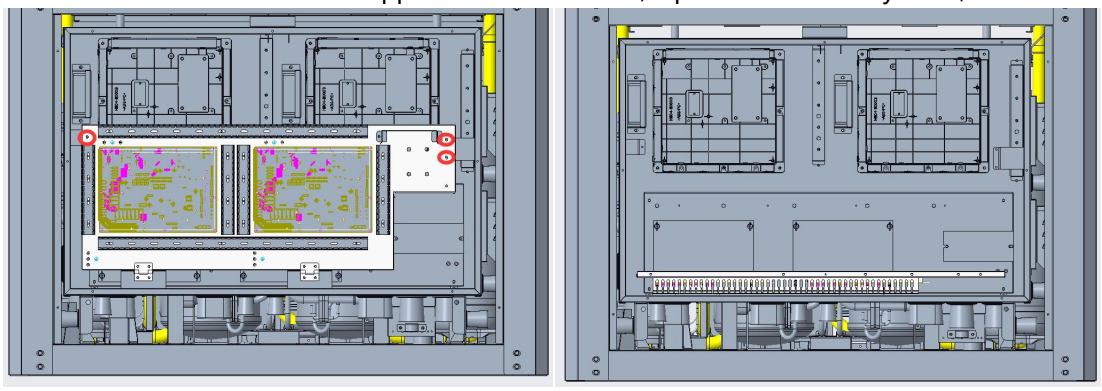


After the maintenance is completed, reinstall in the reverse order.

140kW, 140kW (With hydro kit)



Remove the three screws of the upper installation board, flip it forward and lay it flat, as shown in the figure below.



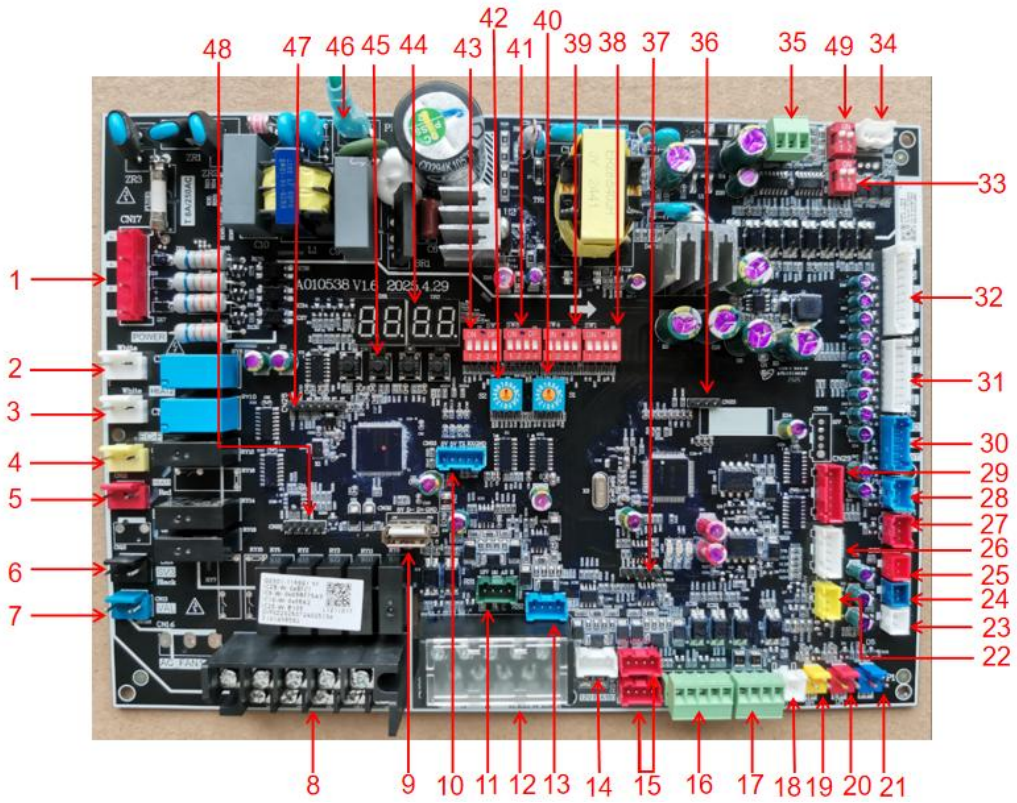
After the maintenance is completed, reinstall in the reverse order.

2 PCB Introduction

2.1 Mainboard

70kW, 70kW (With hydro kit), 140kW, 140kW (With hydro kit)

Mainboard



SN	Code	Function Description	Voltage
1	CN17	Power input terminal, three-phase sequence detection	220VAC
2	CN9	Chassis electric heating	220VAC
3	CN7	Chassis electric heating	220VAC
4	CN10	Cooling fan	220VAC
5	CN12	Compressor electric heating	220VAC
6	CN14	Electric heating belt for water flow switch, electric heating belt for water pipe, electric heating for plate heat exchanger	220VAC
7	CN13	Four-way valve	220VAC
8	CN31	Electric heating main switch	220VAC
		Electric heating for water tank	220VAC
		Electric water pipe heating	220VAC
		Water pump power output	220VAC
		Running status	220VAC
9	CN32	USB programming port	DC5V
10	CN53	Indoor MCU programming port	DC5V
11	RS1	Wire controller 485 communication interface	DC12V
12	CN30	485 communication interface	DC12V
		Water circuit electric heating feedback	DC12V
		Air conditioning pump overload switch	DC12V
		Unit cascade communication	DC5V

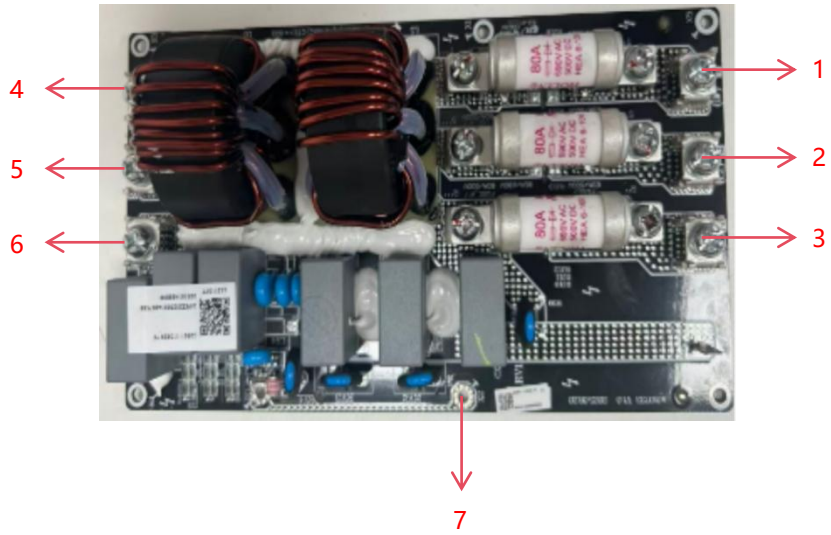
SN	Code	Function Description	Voltage
13	RS2	Reserved 485 communication interface	DC12V
14	RS3	Driver board 485 communication interface	DC12V
15	RS4/RS7	Monitor 485 communication interface	DC12V
16	CN28	0-10V water pump control	0-10V
		Mode switch 1	DC12V
		Mode switch 1	DC12V
17	CN51	Reserved 0-10V water pump control	0-10V
		Remote switch	DC12V
18	CN3	Flow switch	DC12V
19	HP1	High pressure protection switch	DC5V
20	LP1	Low pressure protection switch	DC5V
21	FP1	AC fan overload switch	DC5V
22	CN1	Cooling fan PWM speed control and feedback control	DC12V
23	CN6	Temperature sensor inside the electrical control box	DC5V
24	CN5	Water tank temperature sensor	DC5V
25	CN55	Total outlet water temperature sensor	DC5V
26	CN26	Main electronic expansion valve	DC12V
27	SHP1	High pressure sensor	DC5V
28	SLP1	Low pressure sensor	DC5V
29	CN29	Auxiliary electronic expansion valve	DC12V
30	CN2	Inlet water temperature sensor	DC5V
		Water outlet temperature sensor	DC5V
31	CN18	Enhanced enthalpy temperature sensor	DC5V
		Enhanced enthalpy temperature sensor	DC5V
		Refrigerant gas pipe temperature sensor	DC5V
		Refrigerant liquid pipe temperature sensor	DC5V
32	CN4	Discharge temperature sensor	DC5V
		Suction temperature sensor	DC5V
		Subcooled outlet temperature sensor	DC5V
		Outdoor condenser coil temperature sensor	DC5V
		Outdoor ambient temperature sensor	DC5V
33	SW10	Unit cascade matching resistor DIP switch	DC5V
34	CN56	Unit Cascade Communication Interface	DC5V
35	CN19	Modbus communication interface	DC5V
36	CN23	Outdoor MCU programming interface	DC5V
37	CN24	Outdoor EEPROM programming interface	DC5V
38	SW1	SW1-1: OFF - Low temperature model, ON - Normal temperature model SW1-4: OFF-1# system, ON-2# system	DC5V
39	SW4	Model selection DIP switch	DC5V
40	S1	Address selection DIP switch	DC5V
41	SW8	Reserved	DC5V
42	S2	Reserved	DC5V
43	SW7	Reserved	DC5V
44	DS1/DS2	Digital tube	DC5V
45	SW2/3/5/6	Tactile switch	DC5V
46	PE1	Earth	/
47	CN25	Indoor MCU debug port	DC5V
48	CN22	Indoor EEPROM programming interface	DC5V

SN	Code	Function Description	Voltage
49	SW9	Modbus communication matching resistor DIP switch	DC5V

2.2 Drive Board

SN	Port	Function Description	Detailed description
1	W	Compressor W phase	Output
2	V	Compressor V phase	Output
3	U	Compressor U phase	Output
4	T2	Three-phase power input - T	Input: AC, 380V
5	S2	Three-phase power input - S	Input: AC, 380V
6	R2	Three-phase power input - R	Input: AC, 380V
7	P1	Reactor	enter
8	P2	Reactor	enter
9	CN4	External fan	Output
10	CN5	Communication with the main control unit	Enter PIN1 12V DC PIN2 GND_12V
1 1	CN 6	Communication with the main control unit	Enter PIN2 12V DC, PIN1 GND

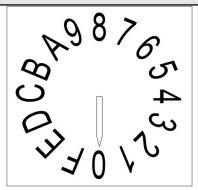
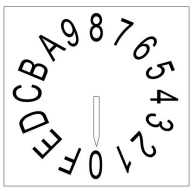
2.3 Filter Board



SN	Port	Function Description	Detailed description
1	R	Three-phase power input R line	AC, 380V
2	S	Three-phase power input S line	AC, 380V
3	T	Three-phase power input T line	AC, 380V
4	R '	Filter board R -line output	Output
5	S '	Filter board S -line output	Output
6	T'	Filter board T-line output	Output
7	PE	Filter board grounding	

2.4 DIP Switch Instruction

DIP switch		ON=1	OFF=0	Default
SW7	1	Reserve	Reserve	OFF
	2	Reserve	Reserve	OFF
	3	Reserve	Reserve	OFF
	4	With Hydro Kit	Without Hydro Kit	OFF
SW8	1	Reserve	Reserve	OFF
	2	Reserve	Reserve	OFF
	3	Reserve	Reserve	OFF
	4	Reserve	Reserve	OFF
SW4	1	Refer to "Model Selection DIP Switch Table"		
	2			
	3			
	4			
SW1	1	Normal Temperature Model	Low Temperature Model	Low Temperature Model
	2	Reserve	Reserve	OFF
	3	Reserve	Reserve	OFF
	4	System 2#	System 1#	/
S2		Reserve		Reserve

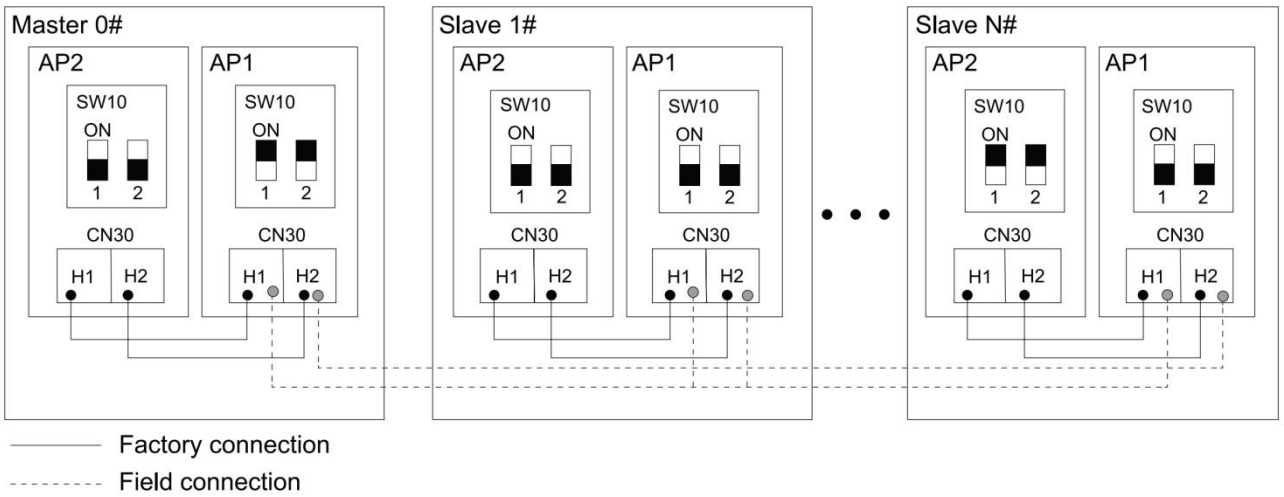
DIP switch	ON=1	OFF=0	Default
			
S2 	Cascade address code: 0 ~ F Remarks: Address code 0 corresponds to unit 0#. System 1# is the master system in 0# Unit;		0

Model Selection DIP Switch Table					
SN	SW4-1	SW4-2	SW4-3	SW4-4	Model
1	OFF	OFF	OFF	OFF	Report a model error
2	ON	OFF	ON	OFF	70kW
3	ON	ON	ON	OFF	140kW
4	OFF	ON	OFF	ON	70P (180)

2.5 Cascade Connection Diagram of Multiple Modular Units

1. Wiring guide diagram:

As shown in the diagram below, the green wires represent the cascading between units. The connection must be strictly made according to the diagram. H1 and H2 must not be connected together. Shielded twisted pair (STP) or unshielded twisted pair (UTP) is preferred for cascade communication cables.



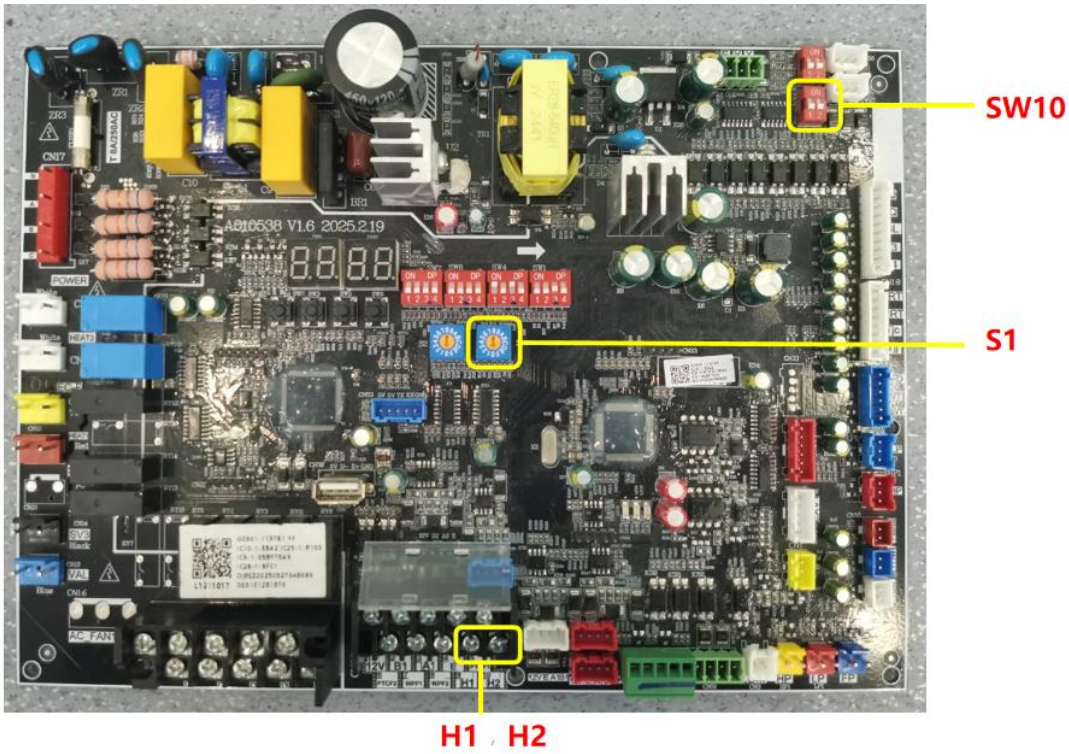
2. DIP switch guide diagram explanation

(1) S1 is the address turntable. The units are dialed sequentially from 0. Unit 0 is the master of the entire cascade, and the others are slaves. The two boards in each module need to dial the S1 address turntable.

(2) SW10 is the matching resistor for cascaded communication to prevent signal reflection; the first and last SW10 resistors need to be switched to ON as shown in Figure 1.

(3) Do not dial any other switches; the default factory settings are fine.

(4) After the address dial and DIP switch settings are completed, the unit needs to be powered off, and then powered on again after 5 minutes.

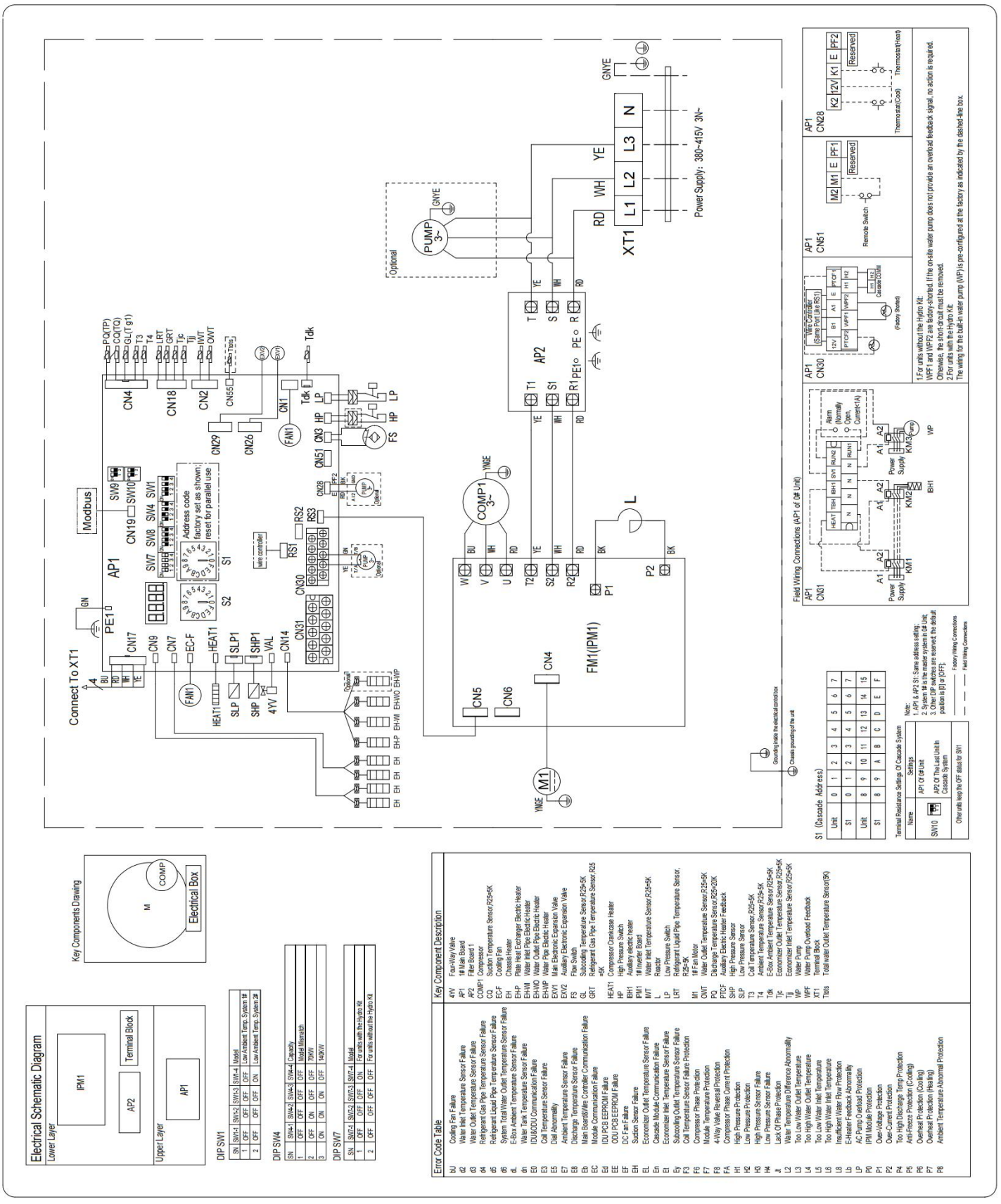


Note:

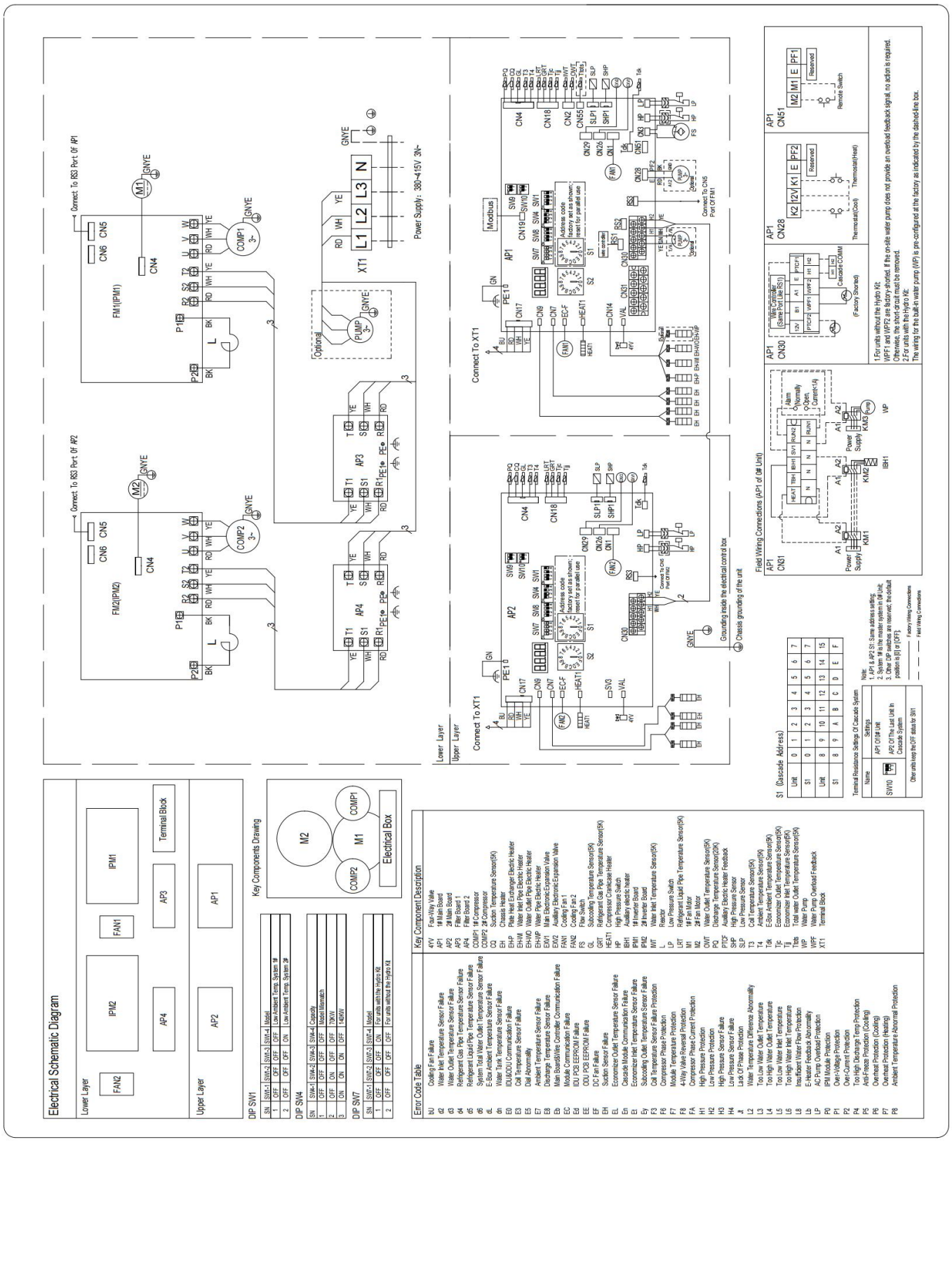
The appearance of the mainboard of the 70/140 and 160 module is different, but the cascading wiring is the same. Therefore, the cascading wiring and DIP switch operation are the same.

3 Electrical Wiring Diagram

70kW, 70kW (With hydro kit)



140kW, 140kW (With hydro kit)



4 Error Code

Code	Content	Code	Content
bU	Cooling Fan Failure	F7	Module Temperature Protection
d2	Water Inlet Temperature Failure	F8	Four-way Valve Reversal Protection
d3	Water Outlet Temperature Sensor Failure	FA	Compressor Phase Current Protection
d4	Refrigerant Gas Pipe Temperature Sensor Failure	Jt	Lack Of Phase Protection
d5	Refrigerant Liquid Pipe Temperature Sensor Failure	L2	Water Temperature Difference Abnormality
d6	System Total Water Outlet Temperature Sensor Failure	L3	Too Low Water Outlet Temperature
dL	E-Box Ambient Temperature Sensor Failure	L4	Too High Water Outlet Temperature
dn	Water Tank Temperature Sensor Failure	L5	Too Low Water Inlet Temperature
E0	**IDU&ODU Communication Failure**	L6	Too High Water Inlet Temperature
E3	Coil Temperature Sensor Failure	L8	Insufficient Water Flow Protection
E5	Dial Abnormality	Lb	E-Heater Feedback Abnormality
E7	Ambient Temperature Sensor Failure	LP	AC Pump Overload Protection
E8	Discharge Temperature Sensor Failure	P0	IPM Module Protection
Eb	Main Board&Wire Controller Communication Failure	P1	Over-Voltage Protection
EC	Module Communication Failure	P2	Over-Current Protection
Ed	IDU PCB EEPROM Failure	P4	Too High Discharge Temp Protection
EE	ODU PCB EEPROM Failure	P5	Anti-Freeze Protection (Cooling)
EF	DC Fan Failure	P6	Overheat Protection (Cooling)
EH	Suction Sensor Failure	P7	Overheat Protection (Heating)
EL	Economizer Outlet Temperature Sensor Failure	P8	Ambient Temperature Abnormal Protection
En	**Cascade Module Communication Failure**	H1	High Pressure Protection
Et	Economizer Inlet Temperature Sensor Failure	H2	Low Pressure Protection
Ey	Subcooling Outlet Temperature Sensor Failure	H3	High Pressure Sensor Failure
F3	Coil Temperature Sensor Failure Protection	H4	Low Pressure Sensor Failure
F6	Compressor Phase Protection		

5 Troubleshooting

5.1 En Troubleshooting

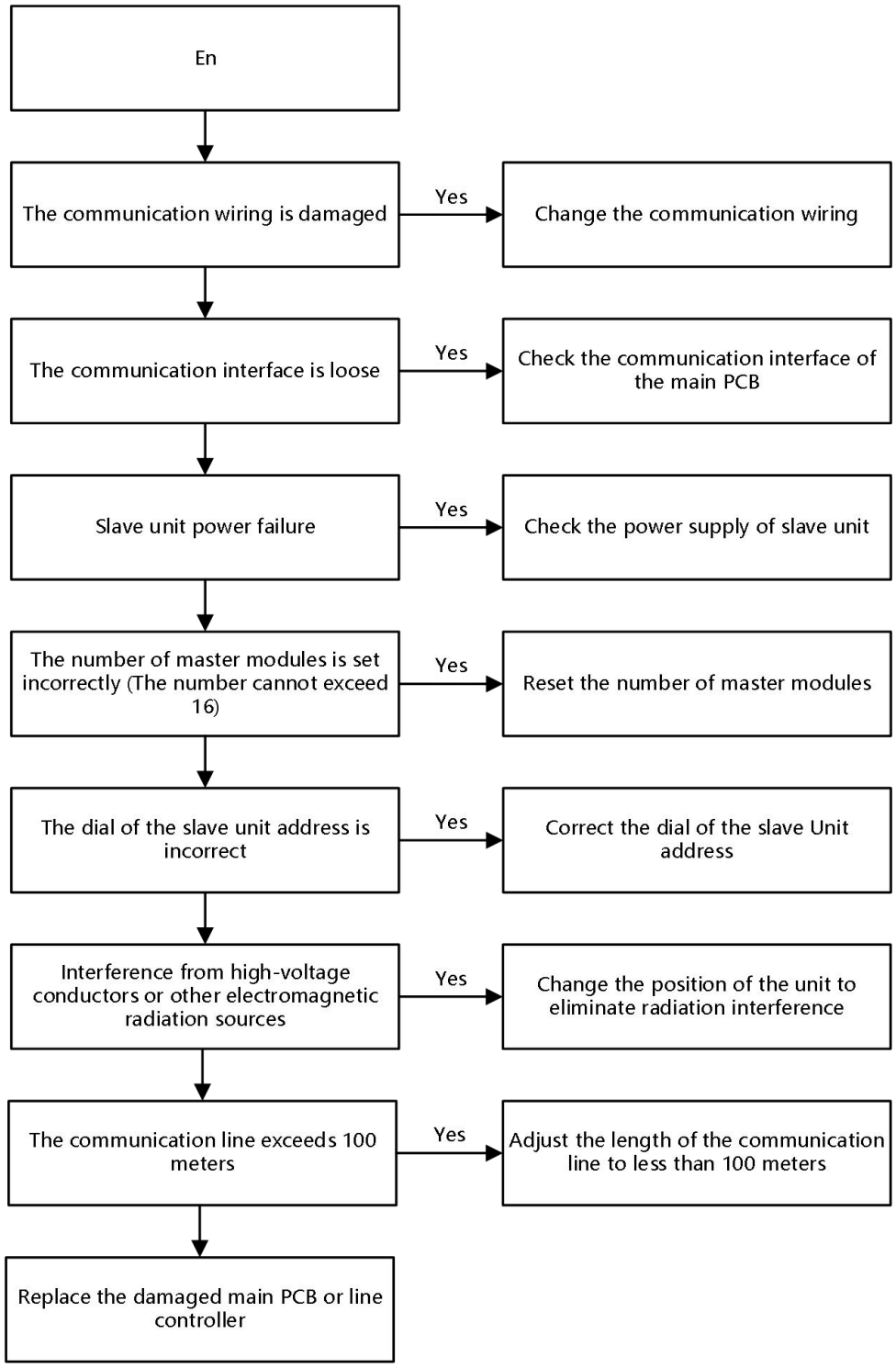
5.1.1 Description

- En indicates a cascade module communication failure.
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.1.2 Possible Causes

- Damaged communication cable.
- Communication interface is loose.
- Mainboard damage.
- Slave unit power failure.
- The number of master modules is set incorrectly (the number cannot exceed 16).
- Slave address dialing error.
- Interference from high-voltage wire or other electromagnetic radiation sources.
- The communication wire is too long (over 100 meters).

5.1.3 Troubleshooting Process



5.2 P1 Troubleshooting

5.2.1 Description

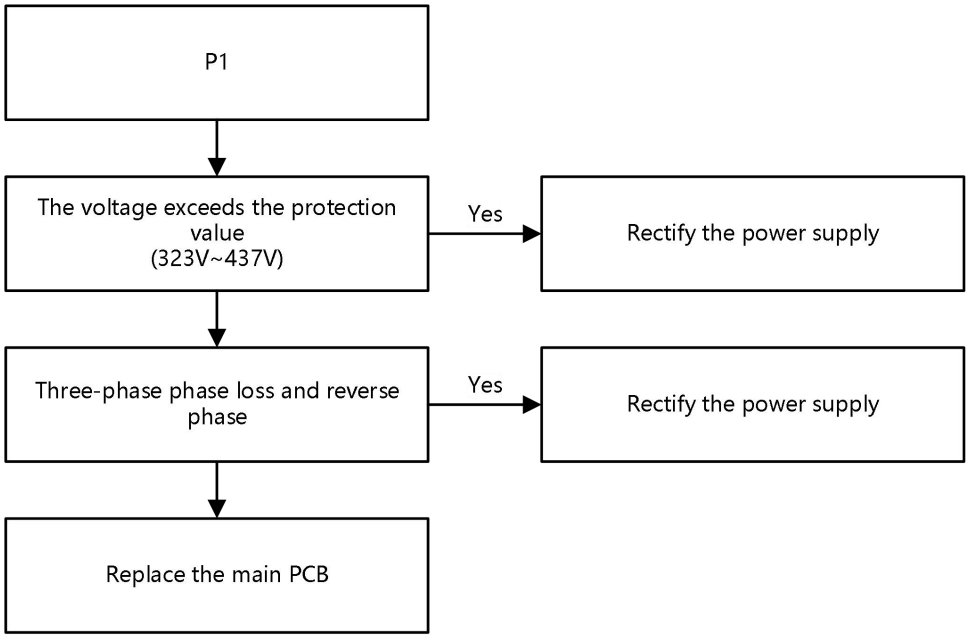
- P1 indicates Over-voltage protection.
- The faulty unit stops operating.

- Error code is displayed in the user interface.

5.2.2 Possible Causes

- Voltage exceeds protection limit (Normal range 323V ~ 437V).
- Three-phase missing / reverse phase.
- Mainboard damage.

5.2.3 Troubleshooting Process



Remark:

1. The A, B, and C terminals of the three-phase power supply must match the compressor's phase sequence. Reversing the phase sequence will cause the compressor to operate in reverse. When multiple outdoor units are connected in the A, B, and C phase sequence, since all loads are connected to phase C , the current difference between phase C and phases A and B will increase significantly, easily causing circuit tripping and terminal burnout. Therefore, when using multiple units in parallel, staggered phase connection is required to ensure even distribution of the three-phase current.
2. Loose power terminals will cause the compressor to operate abnormally and the compressor current to be too large.

5.3 E5 Troubleshooting

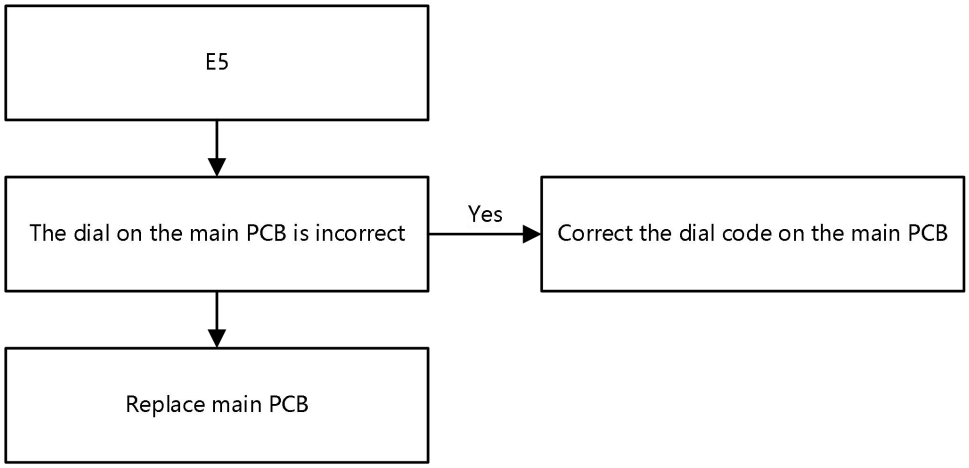
5.3.1 Description

- E5 indicates a Dial abnormality.
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.3.2 Possible Causes

- Mainboard DIP switch error.
- Mainboard damage.

5.3.3 Troubleshooting Process



5.4 LP Troubleshooting

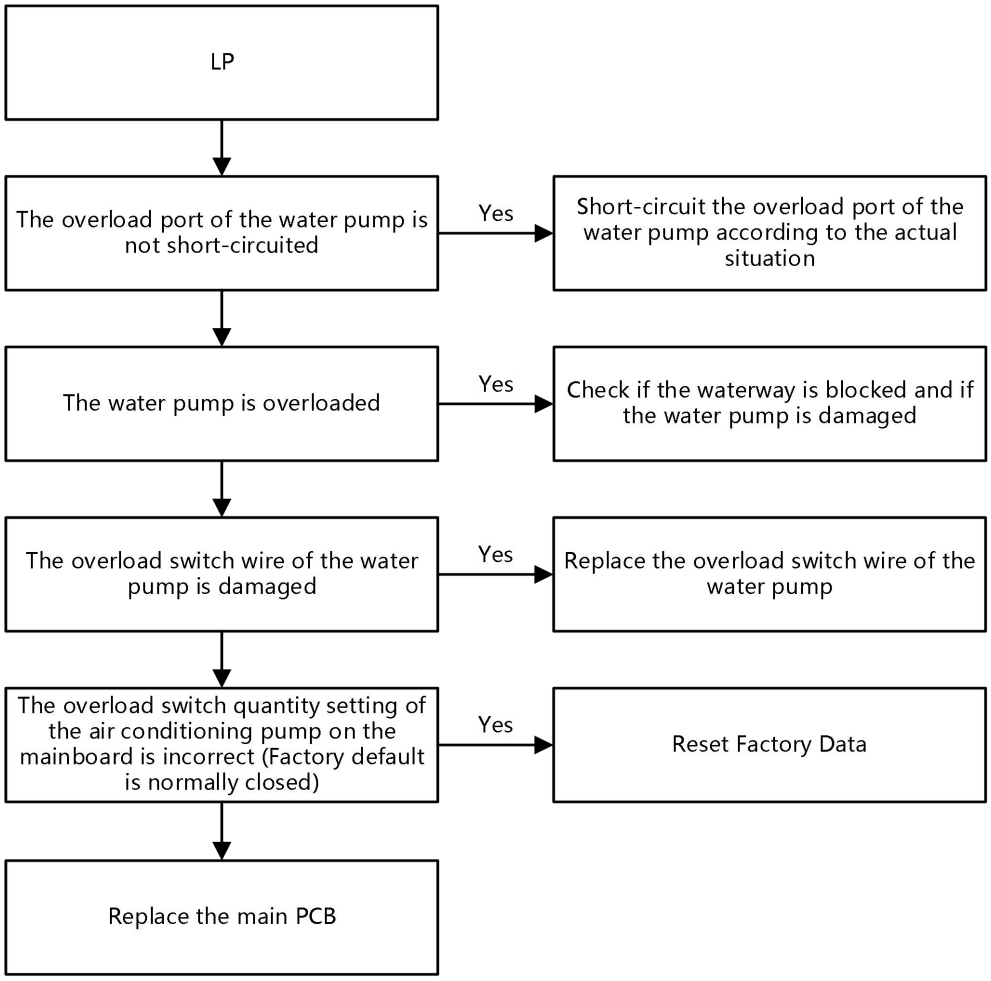
5.4.1 Description

- LP indicates an overload fault in the air conditioning pump.
- The faulty unit stops operating.
- Error code is displayed in the user interface.
- For units with hydro kit, if a fault occurs in the water pump, the corresponding fault code will be directly displayed on the operation interface of the dedicated water pump frequency converter.

5.4.2 Possible Causes

- The water pump overload port is not short-circuited.
- Pump overload.
- Water pump overload switch wire damaged.
- Mainboard water pump overload switch value setting error.
- Mainboard damage.

5.4.3 Troubleshooting Process



5.4.4 Troubleshooting of built - in water pumps

Error code	Type	Possible causes	Troubleshooting
E009	BUS Undervoltage	Low grid voltage	Check the grid input power supply
E010	Inverter Overload	Restart the rotating motor. 2. Low grid voltage. 3. Excessive load	1. Avoid restarting after shutdown. 2. Check the grid voltage. 3. Reduce the operating gear
E011	Motor Overload	Low grid voltage. 2. Motor blockage or excessive sudden load change	1. Check the grid voltage. 2. Inspect the water pump
E012	Input - side Phase Loss	Phase loss in input R, S, T	Check the input power supply. 2. Check the installation wiring
E013	Output - side Phase Loss	Phase - loss output of U, V, W	Check the output wiring. 2. Check the motor and cables
E014	Module Overheating	Phase - to - phase or ground short - circuit in the three - phase output. Blocked air duct or damaged fan. High ambient temperature. Loose connection wires or plugs of the control board. 5. Abnormal power supply circuit	1. Re - wire. 2. Clear the air duct or replace the fan. 3. Reduce the ambient temperature. 4. Check and reconnect. 5. Seek service
E023	Ground Short - circuit	Check if the motor is short - circuited to	Replace the motor.

Error code	Type	Possible causes	Troubleshooting
	Fault	the ground	2. Seek service
E098/E099	Keypad Communication Fault	1.Check if the keypad communication wiring is normal. 2.Check if the control board is normal. 3. Check if the keypad is normal	1. Replace the keypad connection wire. 2. Replace the control board or keyboard. 3. Seek service

5.5 L8 Troubleshooting

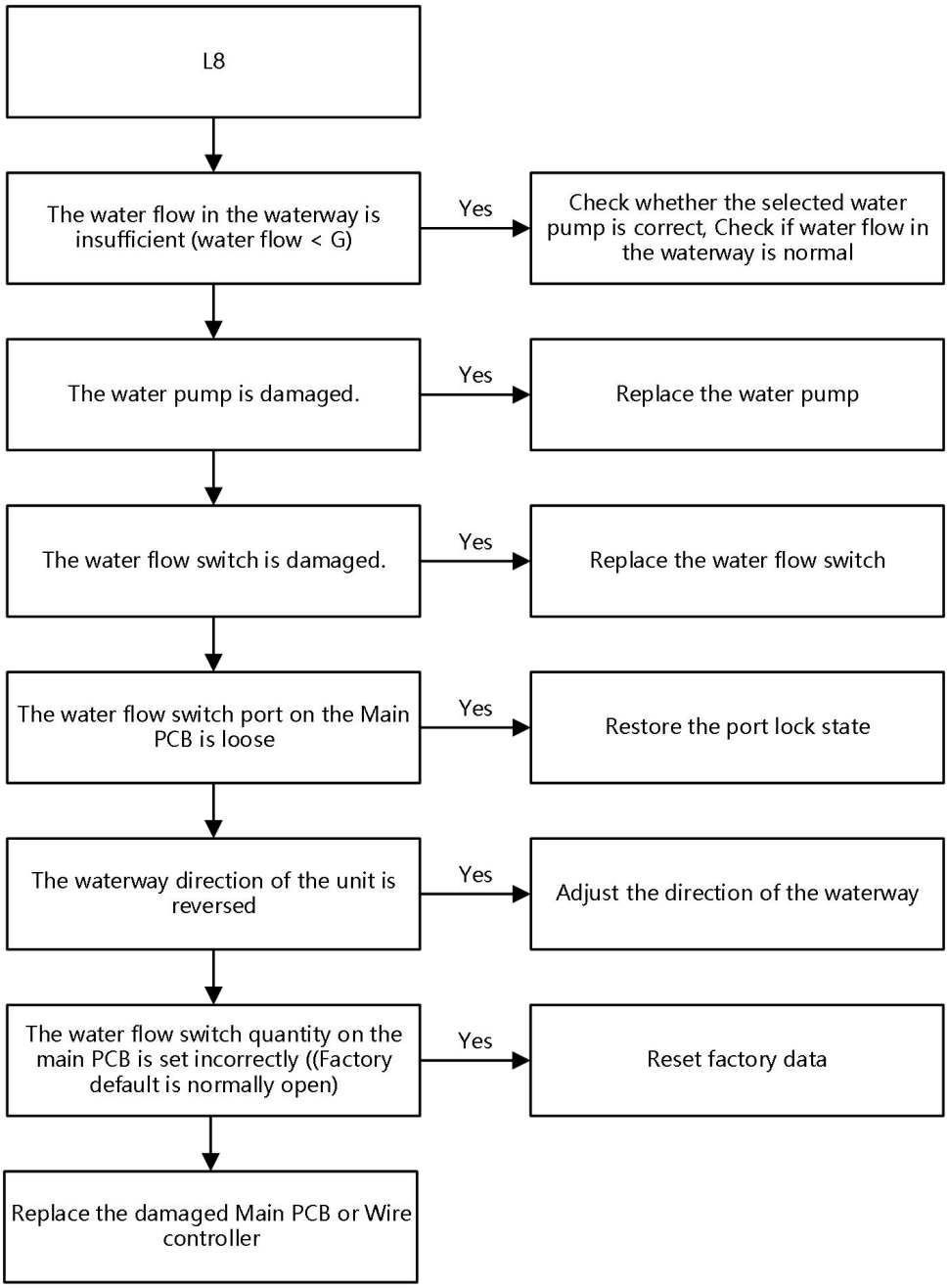
5.5.1 Description

- L8 indicates Insufficient water flow protection.
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.5.2 Possible Causes

- Insufficient water flow in the water system (the unit's detected water flow is less than 14 m^3/h).
- Water pump damaged.
- Damaged flow switch.
- The Mainboard's water flow switch port is loose.
- The water circuit direction of the unit is reversed.
- The Mainboard's water flow switch setting is incorrect (factory default is normally open).
- Mainboard damage.

5.5.3 Troubleshooting Process



Model	G (m³/h)
70kW	6
70kW (With hydro kit)	6
140kW	14
140kW (With hydro kit)	14

Note: G represents the unit water flow rate

5.6 d2, d3, d4, d5, d6, dL, dn, E3, E7, E8, EH, EL, Et, and Ey Troubleshooting

5.6.1 Description

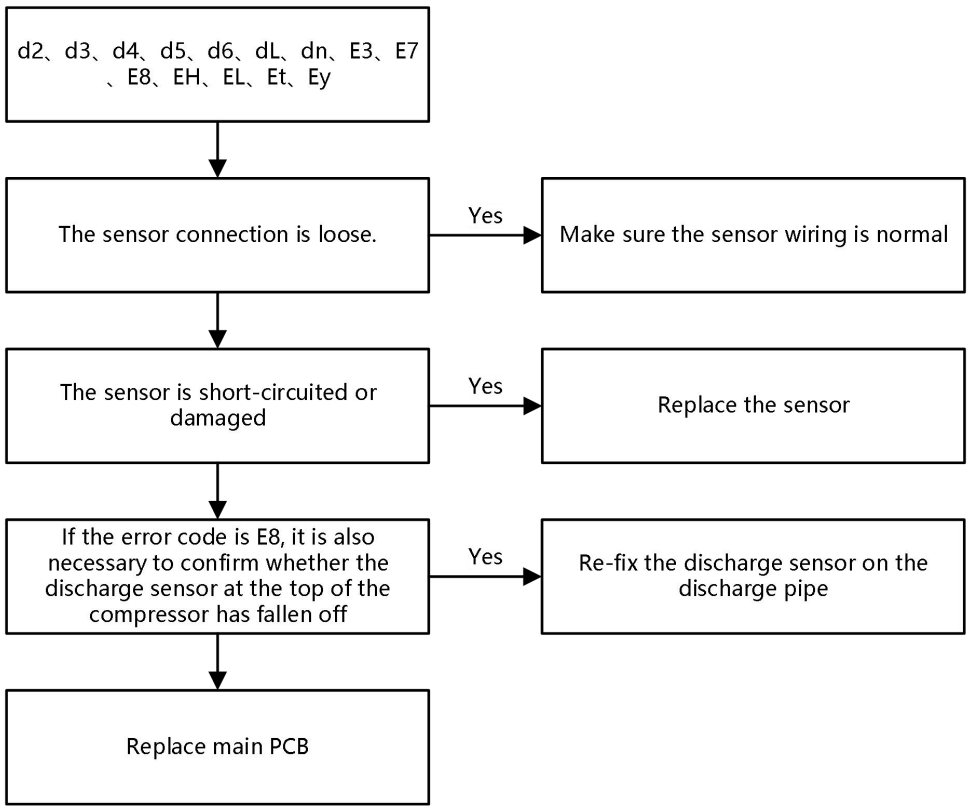
- d2 indicates Water inlet temperature failure.

- d3 indicates Water outlet temperature sensor failure.
- d4 indicates Gas pipe temperature sensor failure.
- d5 indicates Liquid pipe temperature sensor failure.
- d6 indicates System total water outlet temperature sensor failure.
- dL indicates Electric control box temperature sensor failure.
- dn indicates Water tank temperature sensor failure.
- E3 indicates Coil temperature sensor failure.
- E7 indicates Ambient temperature sensor failure.
- E8 indicates Discharge temperature sensor failure.
- EH indicates Suction sensor failure.
- EL indicates Economizer outlet temperature sensor failure.
- Et indicates Economizer inlet temperature sensor failure.
- Ey indicates Subcooling outlet temperature sensor failure.
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.6.2 Possible Causes

- The sensor is not connected correctly or is malfunctioning.
- Mainboard damage.

5.6.3 Troubleshooting Process



5.7 H2 Troubleshooting

5.7.1 Description

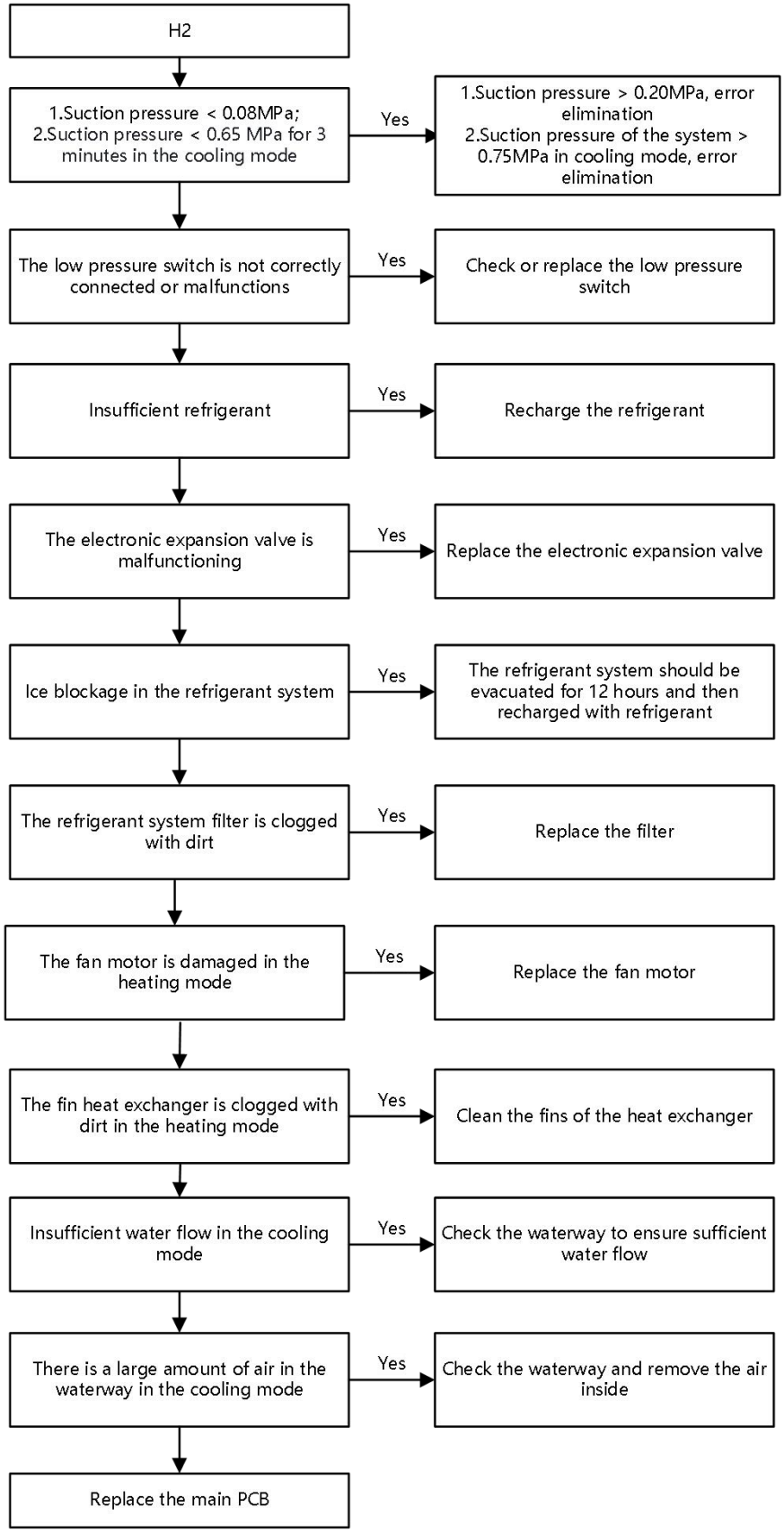
In Heating mode

- H2 indicates a low pressure protection in the compressor. When the suction pressure is lower than 0.08MPa or the suction pressure in the cooling mode remains lower than 0.65 MPa for 3 minutes, the system will display a low-pressure protection. The system in question will stop running. When the pressure rises above 0.2 MPa or the pressure in the cooling mode rises above 0.75 MPa, the low pressure protection will be lifted and normal operation will resume. If the low pressure fault occurs twice within 120 minutes, the system must be manually restarted to resume operation.
- Error code is displayed in the user interface.

5.7.2 Possible Causes

- System suction pressure < 0.08MPa.
- Suction pressure < 0.65 MPa for 3 minutes in the cooling mode
- The low pressure switch is not connected correctly or is faulty.
- Insufficient refrigerant.
- The electronic expansion valve is malfunctioning.
- Ice blockage in the refrigerant system.
- The refrigerant system filter is dirty and clogged.
- The fan is damaged in heating mode.
- The four-way valve is damaged in heating mode, preventing defrosting.
- The finned heat exchanger becomes dirty and clogged in heating mode.
- Insufficient water flow in cooling mode.
- In cooling mode, there is a large amount of air in the water circuit.
- Mainboard damage

5.7.3 Troubleshooting Process



5.8 H1 Troubleshooting

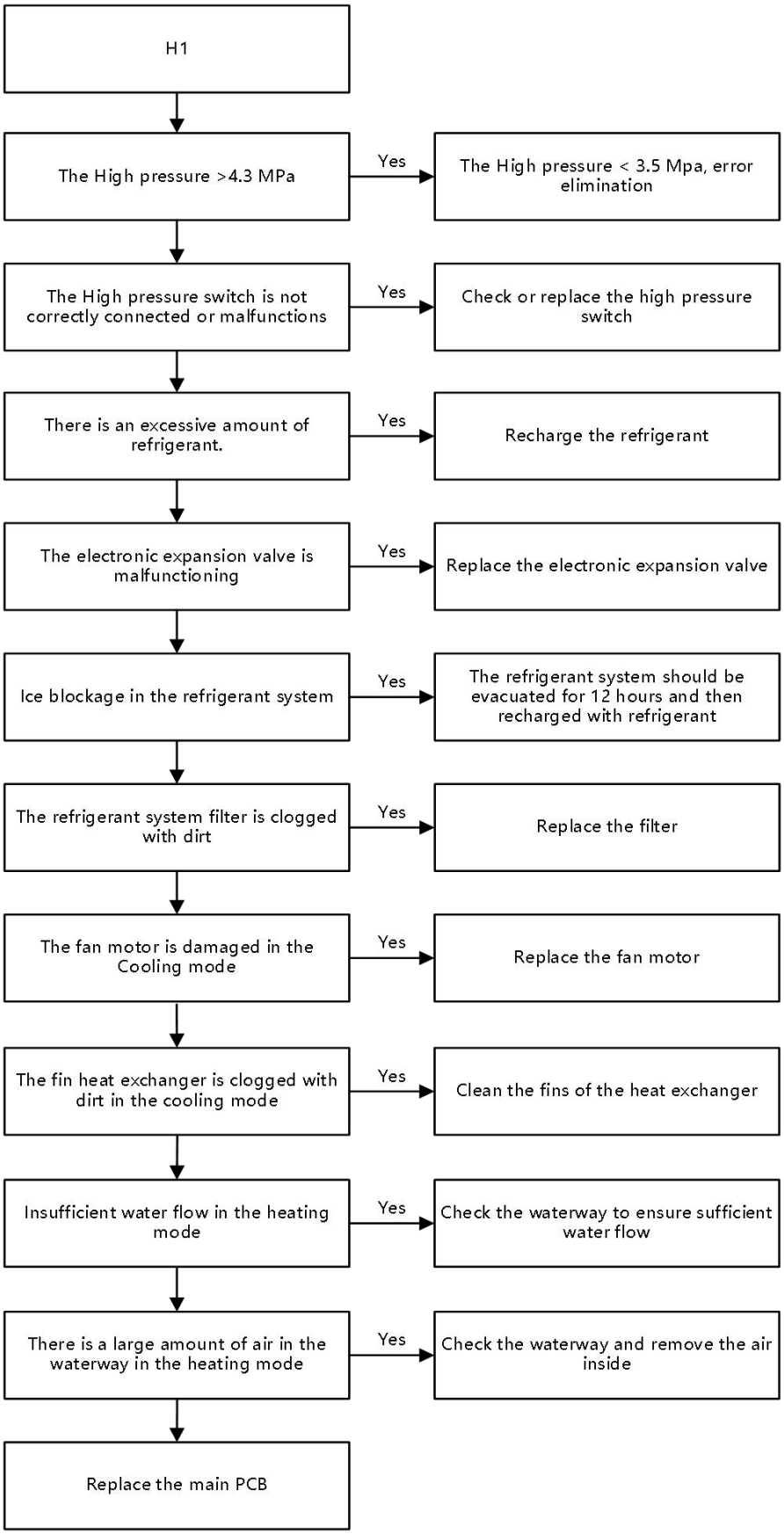
5.8.1 Description

• H1 indicates a High pressure protection in the compressor. When the high pressure rises above 4.3 MPa, the system displays H1 protection and shuts down all units. When the high pressure drops below 3.5 MPa, H1 protection is released and normal operation resumes. If a H1 occurs twice within 120 minutes, the system must be manually restarted to restore operation .
• Error code is displayed in the user interface.

5.8.2 Possible Causes

• System high pressure > 4.3 MPa.
• The High pressure switch is not connected correctly or is malfunctioning.
• Too much refrigerant.
• The electronic expansion valve is malfunctioning.
• Ice blockage in the refrigerant system.
• The refrigerant system filter is dirty and clogged.
• The system contains air or nitrogen.
• The fan malfunctions during cooling mode.
• The finned heat exchanger becomes dirty and clogged in cooling mode.
• Insufficient water flow in heating mode.
• A large amount of air exists in the water circuit during heating mode.
• Mainboard damage.

5.8.3 Troubleshooting Process



5.9 P4 Troubleshooting

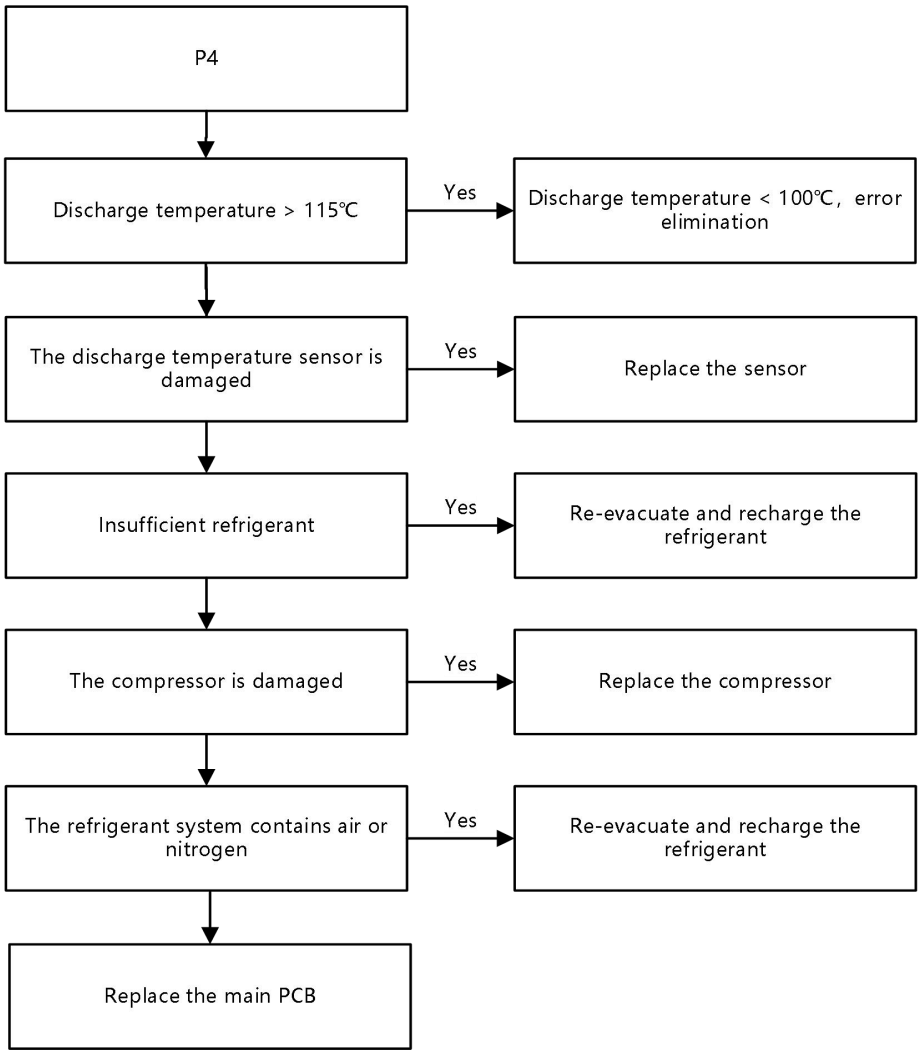
5.9.1 Description

- P4 indicates Too high discharge temp protection.
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.9.2 Possible Causes

- Exhaust temperature > 115℃.
- The discharge temperature sensor is damaged.
- Insufficient refrigerant.
- The compressor is damaged.
- The system contains air or nitrogen.
- Mainboard damaged.

5.9.3 Troubleshooting Process



5.10 P2 Troubleshooting

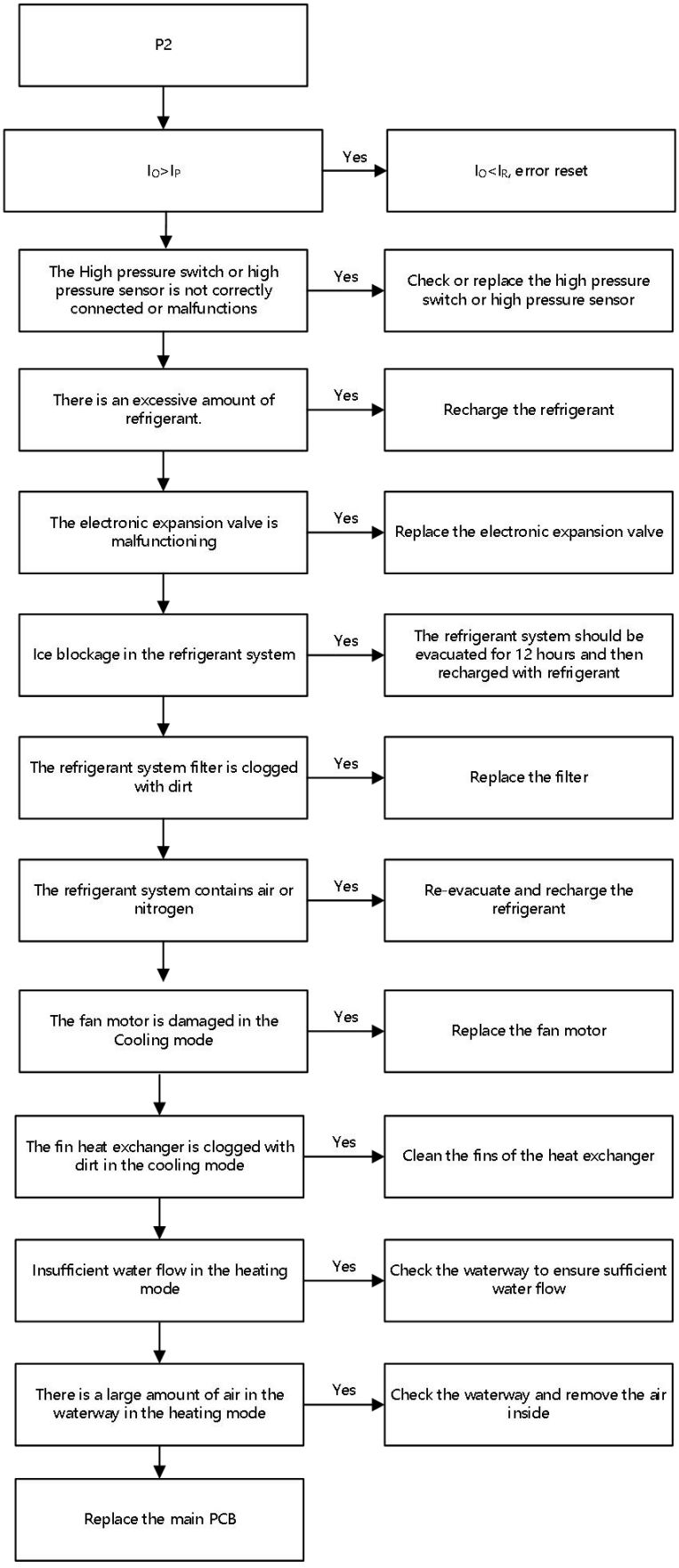
5.10.1 Description

- P2 indicates a compressor current overload fault.
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.10.2 Possible Causes

- The compressor operating current is more than the protection value .
- A large amount of air exists in the water circuit during heating mode.
- The electronic expansion valve is malfunctioning.
- Ice blockage in the refrigerant system.
- The refrigerant system filter is dirty and clogged.
- The system contains air or nitrogen.
- The fan malfunctions during cooling mode.
- The finned heat exchanger becomes dirty and clogged in cooling mode.
- Insufficient water flow in heating mode.
- Voltage too low or too high.
- The system contains air or nitrogen.
- Mainboard damaged.

5.10.3 Troubleshooting Process



Model	I_p (A)	I_R (A)
70kW	52	48
70kW (With hydro kit)	52	48
140kW	52	48
140kW (With hydro kit)	52	48

Note: I_O represents compressor operating current; I_p represents compressor protection current; I_R represents compressor recover current

5.11 L6 Troubleshooting

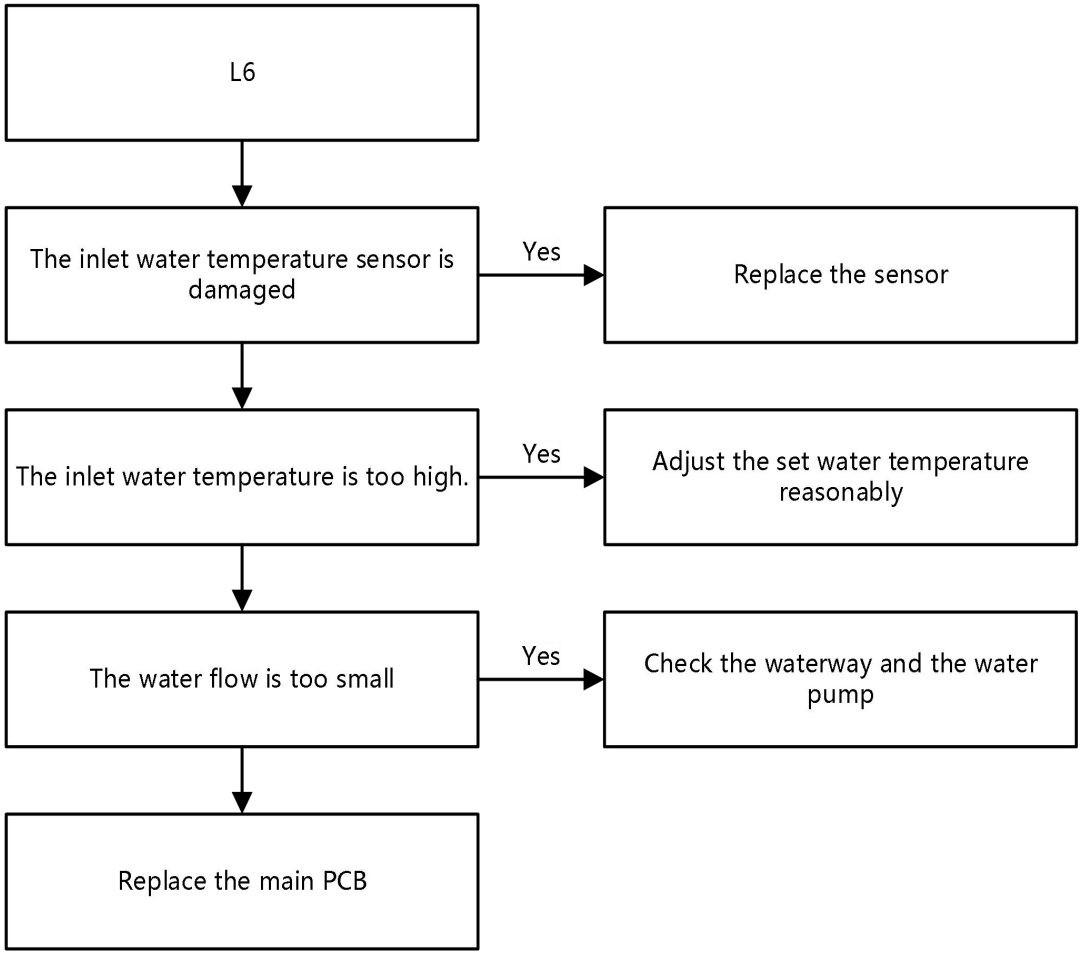
5.11.1 Description

- L6 indicates too high water inlet temperature.
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.11.2 Possible Causes

- The inlet water temperature is too high (inlet water temperature > 60℃).
- The water flow rate is too low.
- Mainboard damaged.

5.11.3 Troubleshooting Process



5.12 P5 Troubleshooting

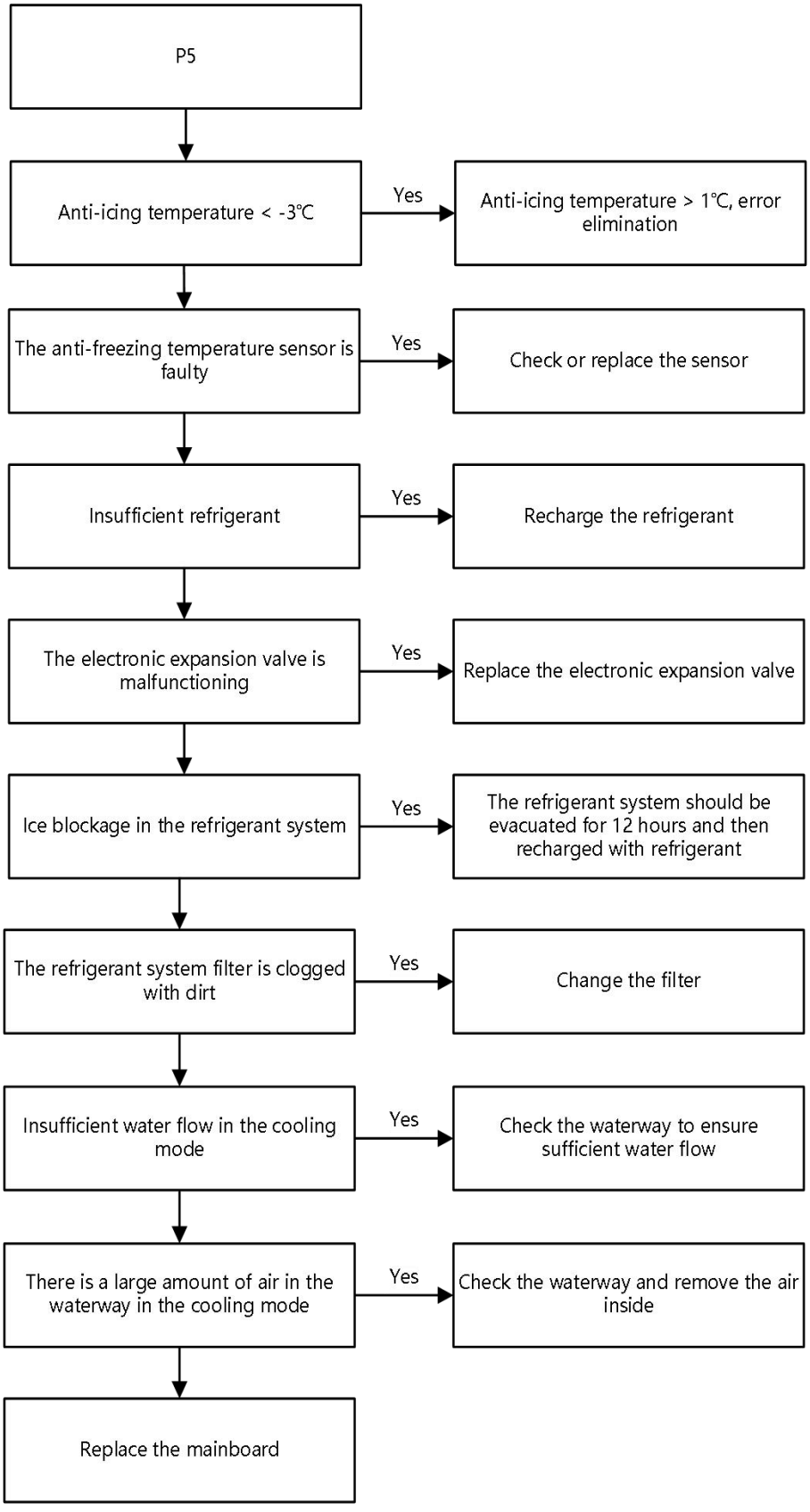
5.12.1 Description

- P5 indicates a anti-freeze protection (Cooling).
- The faulty unit stops operating.
- Error code is displayed in the user interface.

5.12.2 Possible Causes

- MIN (Refrigerant gas pipe temperature, refrigerant liquid pipe temperature) < -3℃.
- Insufficient refrigerant.
- The electronic expansion valve is malfunctioning.
- Ice blockage in the refrigerant system.
- The refrigerant system filter is dirty and clogged.
- Insufficient water flow in cooling mode.
- In cooling mode, there is a large amount of air in the water circuit.
- Mainboard damaged.

5.12.3 Troubleshooting Process



5.13 F7 Troubleshooting

5.13.1 Description

• IPM module temperature exceeds 95 °C.

• After a malfunction occurs, the compressor stops running. If the malfunction disappears after one minute, the compressor will restart.

5.13.2 Possible Causes

• The IPM mounting screws were not tightened, resulting in poor heat dissipation.

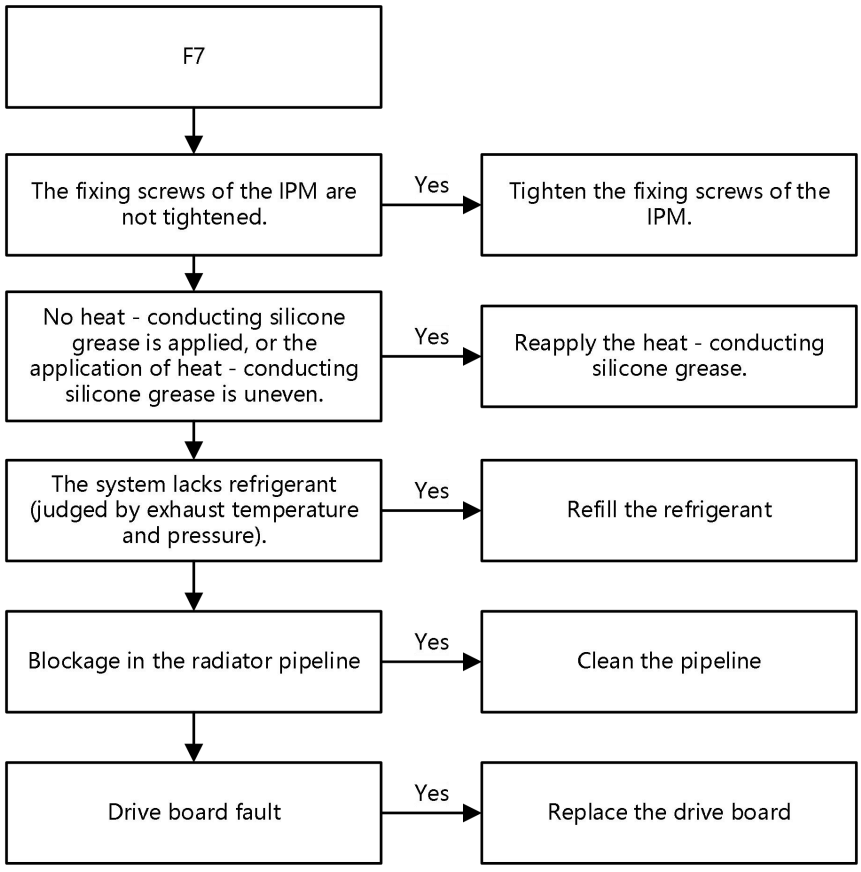
• Uneven distribution of thermal silicone on the IPM module results in poor heat dissipation.

• The system lacks refrigerant or the refrigerant radiator pipes are blocked, resulting in poor heat dissipation from the refrigerant radiator.

• Abnormal welding of the system refrigerant radiator resulted in excessive thermal resistance and poor heat dissipation.

• The IPM temperature detection circuit on the module board is malfunctioning.

5.13.3 Troubleshooting Process



5.14 P0 Troubleshooting

5.14.1 Description

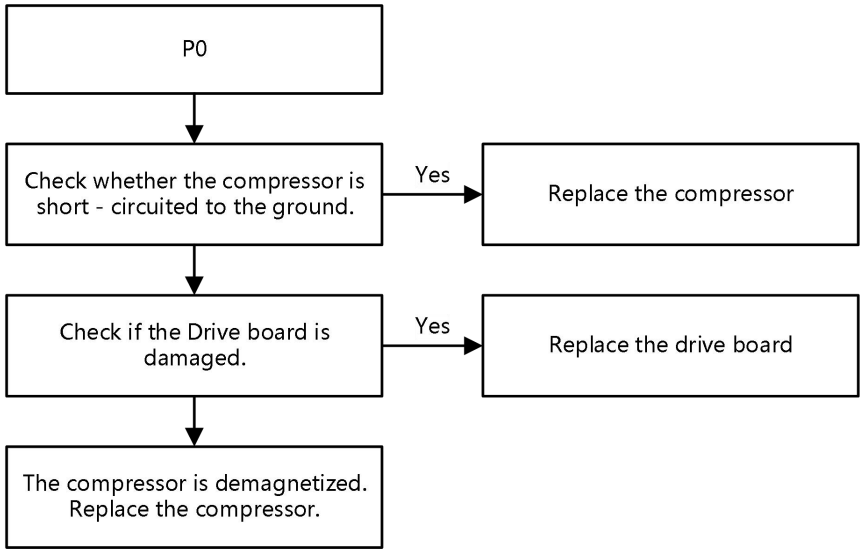
• P0 indicates IPM module protection.

• The faulty unit stops operating.

5.14.2 Possible Causes

• Compressor overcurrent.
• Compressor demagnetization (detect by coil resistance and insulation)
• Mainboard damage

5.14.3 Troubleshooting Process



5.14.4 Compressor Replacement Guidelines

• **Step 1 :**

Open the compressor junction box and measure the coil resistance and insulation to ground.

When the ambient temperature is 20℃, the normal resistance between UVW of the compressor（see attached table) and the resistance between UVW and ground is infinite. If the deviation is large, it can be determined that the compressor is damaged and needs to be replaced.

Model	Resistance/Ω
70kW	0.137
70kW (With hydro kit)	0.137
140kW	0.137
140kW (With hydro kit)	0.137

• **Step 2:**

Remove the faulty compressor and drain the compressor lubricating oil.

Remove the faulty compressor from the unit.

Before draining the oil, shake the compressor to prevent impurities from settling at the bottom.

Drain the oil from the compressor and retain it for inspection. Typically, the oil can be poured out from the compressor's discharge pipe.

• **Step 3:**

Check the lubricating oil of the faulty compressor.

The lubricating oil should be clear and transparent. A slightly yellowish tint is normal. However, if the oil darkens, turns black, or becomes contaminated with impurities, it indicates that the oil in the refrigerant system has deteriorated and needs to be replaced immediately. (If the lubricating oil deteriorates, the compressor will not be able to lubricate effectively, and the scroll plate, crankcase, and bearings will wear more quickly. This wear will lead to increased load, increased current, and more electrical energy loss as heat, causing the motor temperature to rise

continuously, which may eventually damage or burn out the compressor.)

- **Step 4:**

Replace the oil separator and gas-liquid separator.

If the compressor oil is deteriorated (slightly or severely), the oil separator and gas-liquid separator should be replaced.

- **Step 5:**

Check the filter.

If there are impurities in the compressor oil, the filter in the refrigerant system needs to be checked. If the filter is clogged, clean it with nitrogen or replace it.

- **Step 6:**

Replace the faulty compressor and reinstall a new compressor.

After completing steps 3 and 4, re-weld the new compressor to the refrigerant system.

- **Step 7:**

Add compressor lubricating oil.

Different compressors require different types of oil（see attached table）. Using the wrong oil can cause various problems. It is important to note that the lubricating oil level in the system after maintenance must be consistent with the factory settings.

Model	Types of oiL
70kW	FW68HT
70kW (With hydro kit)	FW68HT
140kW	FW68HT
140kW (With hydro kit)	FW68HT

- **Step 8:**

Vacuum drying and refrigerant charging.

After all compressors and other components are fully connected, the system is vacuum dried and recharged with refrigerant.

5.15 EF Troubleshooting

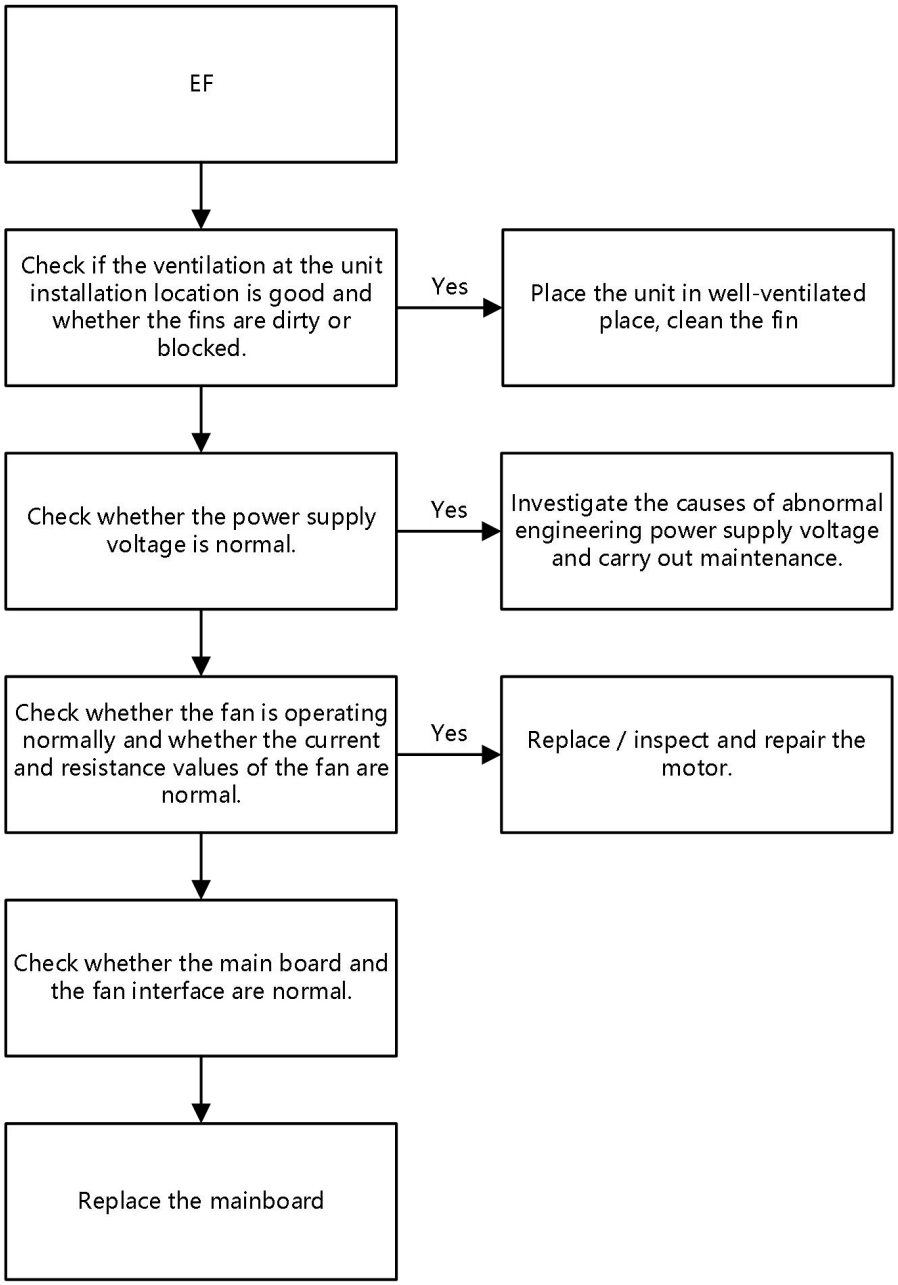
5.15.1 Description

- EF indicates DC fan failure.
- The faulty unit stops operating.

5.15.2 Possible Causes

- The fan temperature is too high.
- The fan current is excessive.
- The mainboard is damaged.

5.15.3 Troubleshooting Process



5.16 L2 Troubleshooting

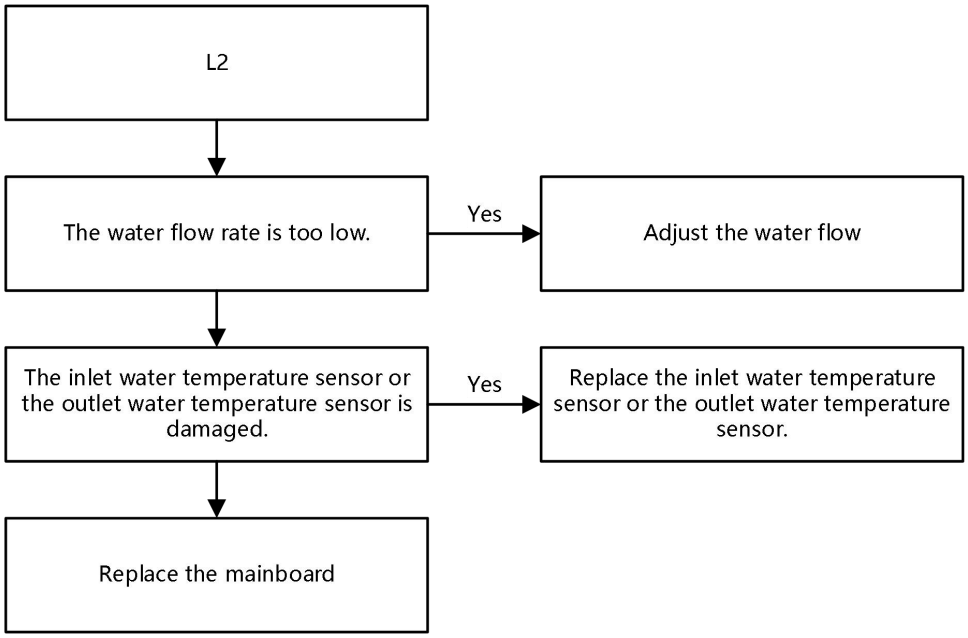
5.16.1 Description

- L2 indicates the water temperature difference abnormality.
- Error display: The wired controller displays "L2".
- The faulty unit stops operating.

5.16.2 Possible Causes

- The water flow rate is too low.
- The inlet water temperature sensor or the outlet water temperature sensor is damaged.
- The mainboard is damaged.

5.16.3 Troubleshooting Process



5.17 L3 Troubleshooting

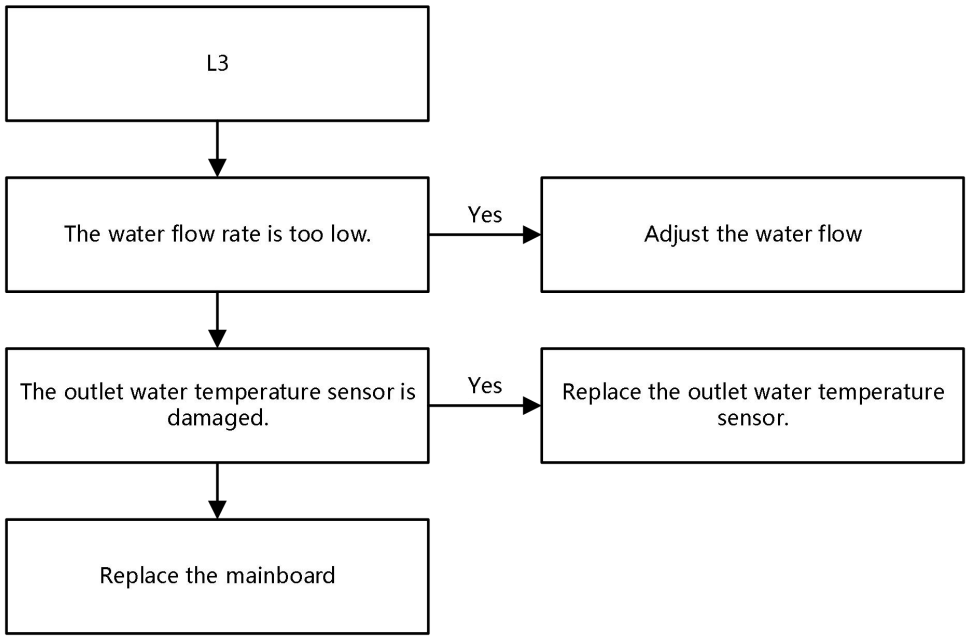
5.17.1 Description

- L3 indicates too low water outlet temperature.
- Error display: The wired controller displays "L3".
- The faulty unit stops operating.

5.17.2 Possible Causes

- The water flow rate is too low.
- The outlet water temperature sensor is damaged.
- The mainboard is damaged.

5.17.3 Troubleshooting Process



5.18 L4 Troubleshooting

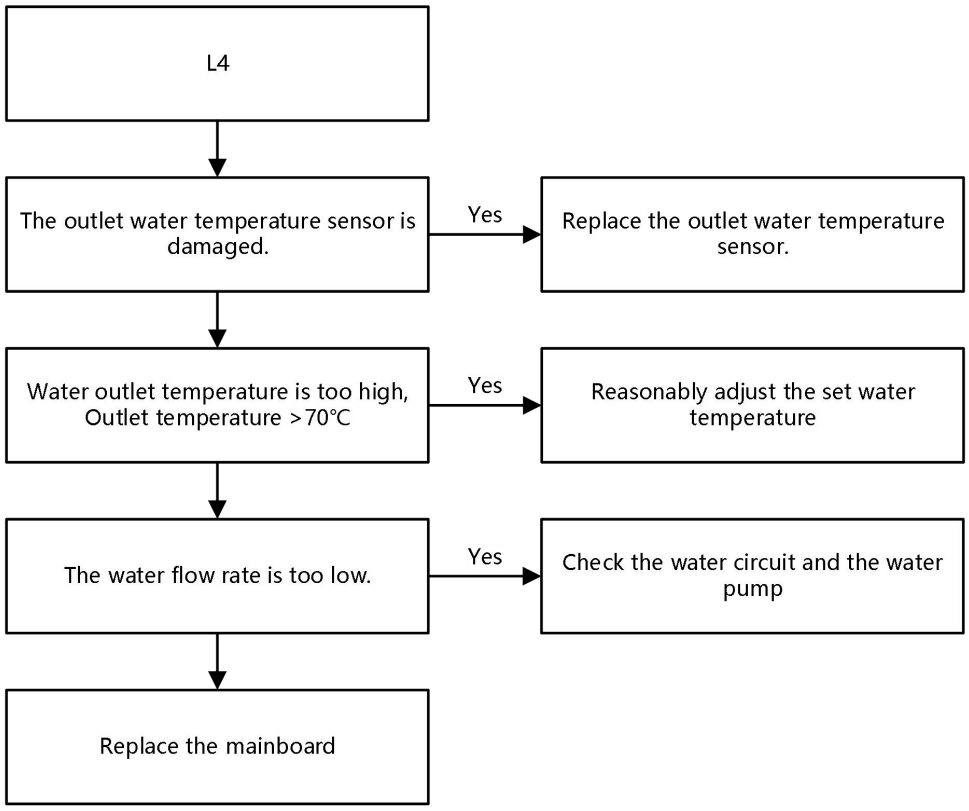
5.18.1 Description

- L4 indicates too high water outlet temperature.
- Error display: The wired controller displays "L4".
- The faulty unit stops operating.

5.18.2 Possible Causes

- The water flow rate is too low.
- The outlet water temperature is too high（Outlet temperature >70℃）.
- The mainboard is damaged.

5.18.3 Troubleshooting Process



5.19 L5 Troubleshooting

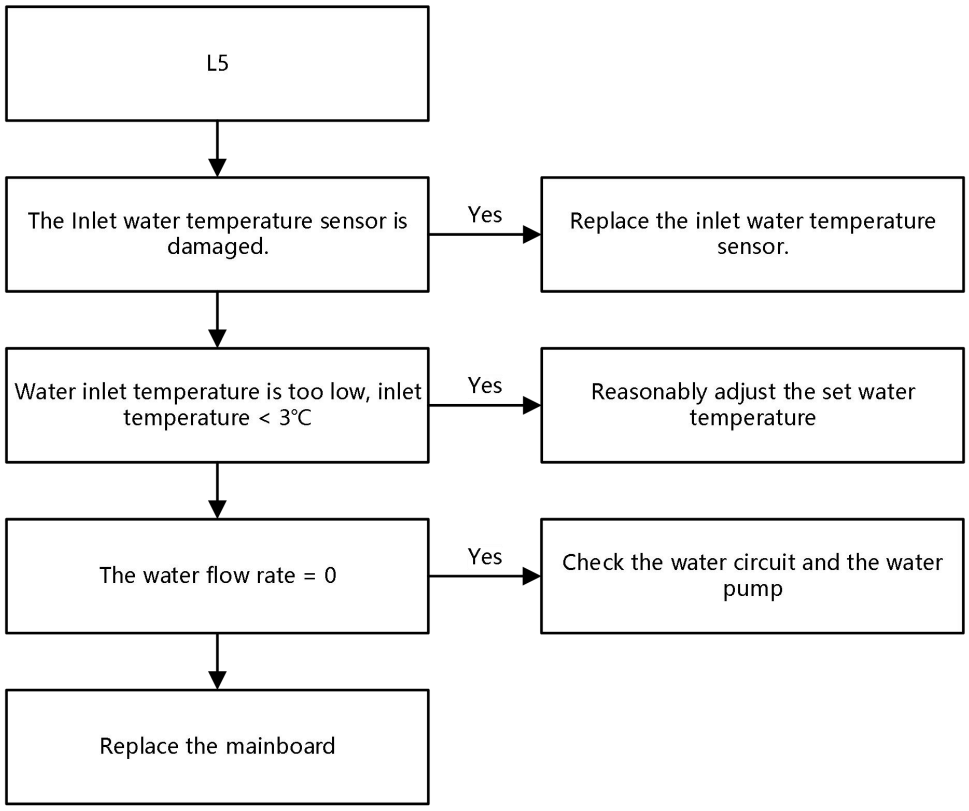
5.19.1 Description

- L5 indicates too low water inlet temperature.
- Error display: The wired controller displays "L5".
- The faulty unit stops operating.

5.19.2 Possible Causes

- The water flow rate = 0.
- The inlet water temperature is too low (inlet water temperature < 3℃).
- The mainboard is damaged.

5.19.3 Troubleshooting Process



5.20 Lb Troubleshooting

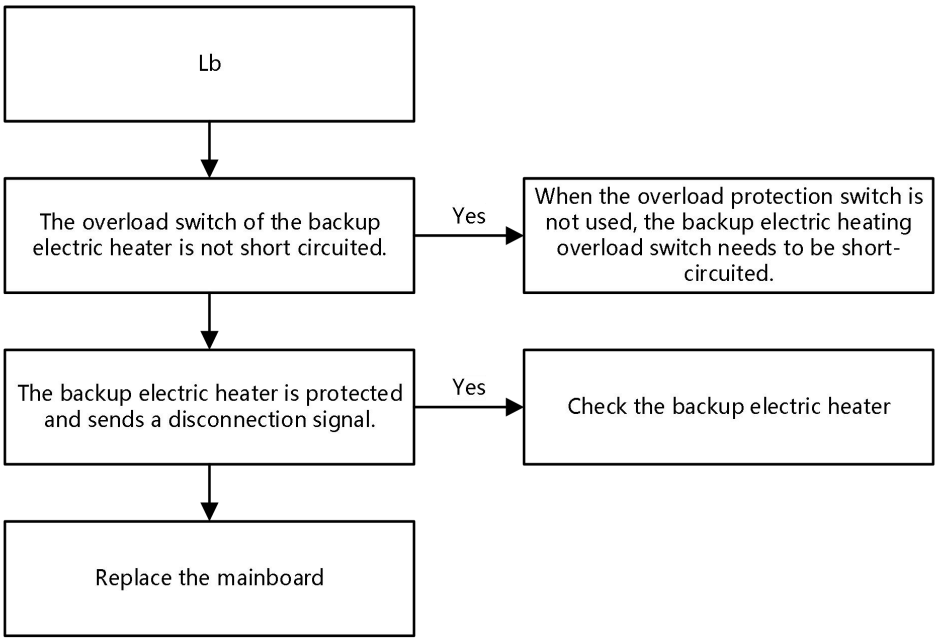
5.20.1 Description

- Lb indicates E-Heater feedback abnormality.
- Error display: The wired controller displays "Lb".
- The faulty unit stops operating.

5.20.2 Possible Causes

- The overload switch of the backup electric heater is not short circuited.
- The backup electric heater is protected and sends a disconnection signal.
- The mainboard is damaged.

5.20.3 Troubleshooting Process



5.21 Eb Troubleshooting

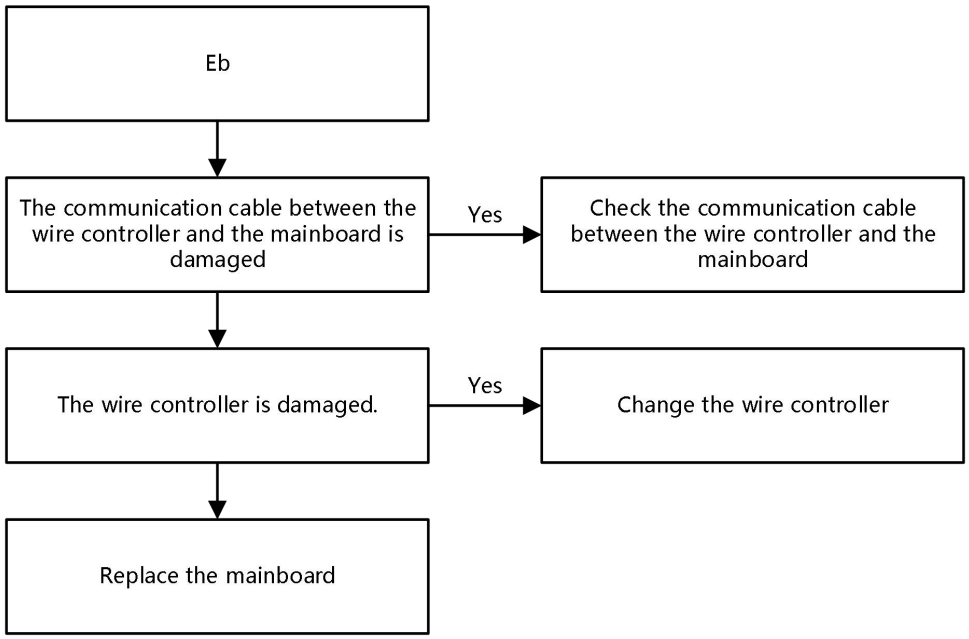
5.21.1 Description

- Eb indicates mainboard&wire controller communication failure.
- Error display: The wired controller displays "Eb".
- The faulty unit stops operating.

5.21.2 Possible Causes

- The communication cable between the wire controller and the mainboard is damaged.
- The wire controller is damaged.
- The mainboard is damaged.

5.21.3 Troubleshooting Process



5.22 EC Troubleshooting

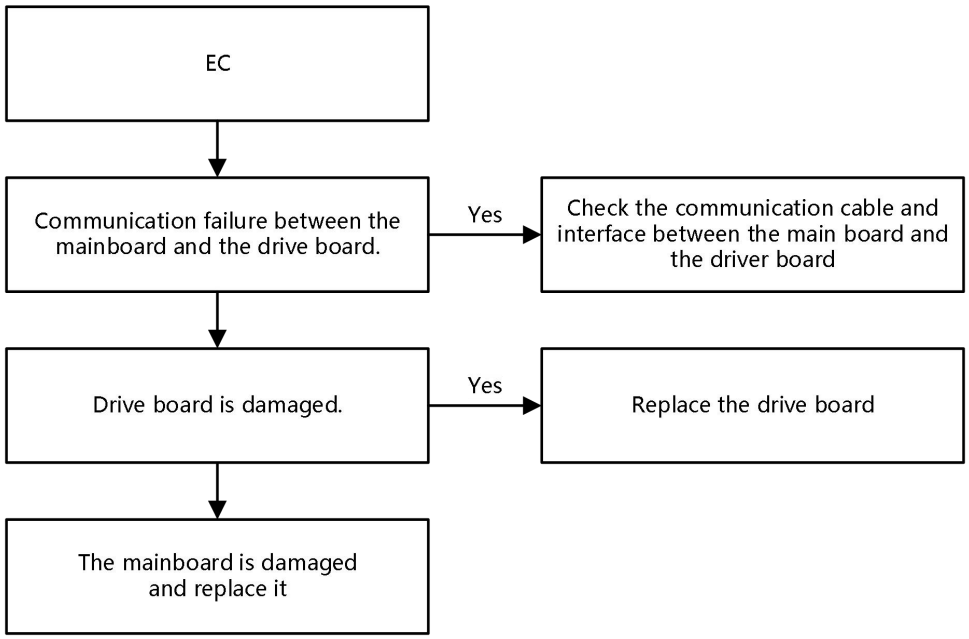
5.22.1 Description

- EC indicates module communication failure.
- Error display: The wired controller displays "EC".
- The faulty unit stops operating.

5.22.2 Possible Causes

- Communication failure between the mainboard and the drive board.
- Drive board is damaged.
- The mainboard is damaged.

5.22.3 Troubleshooting Process



5.23 Ed, EE, E0 Troubleshooting

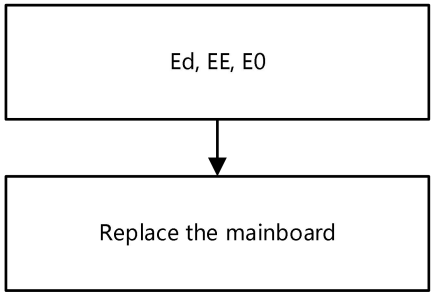
5.23.1 Description

- Ed indicates IDU PCB EEPROM Failure.
- EE indicates ODU PCB EEPROM Failure.
- E0 indicates IDU&ODU Communication Failure
- Error display: The wired controller displays "Ed, EE, E0"
- The faulty unit stops operating.

5.23.2 Possible Causes

- The mainboard is damaged.

5.23.3 Troubleshooting Process



5.24 P6 Troubleshooting

5.24.1 Description

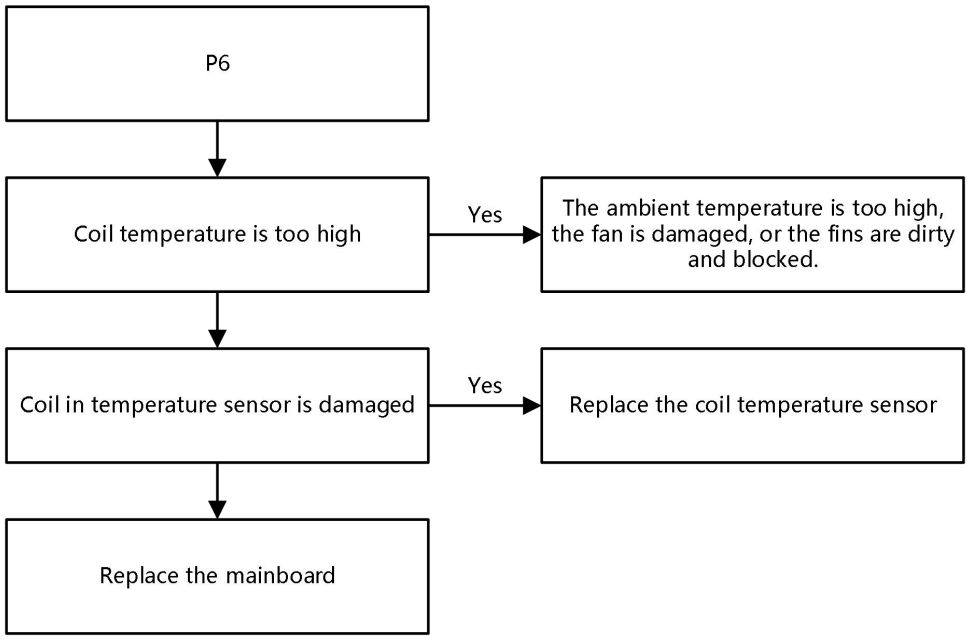
- P6 indicates overheat protection (Cooling).
- Error display: The wired controller displays "P6".

• The faulty unit stops operating.

5.24.2 Possible Causes

- Coil temperature is too high (coil Temperature > 63℃).
- Coil temperature sensor is damaged.
- The mainboard is damaged.

5.24.3 Troubleshooting Process



5.25 P7 Troubleshooting

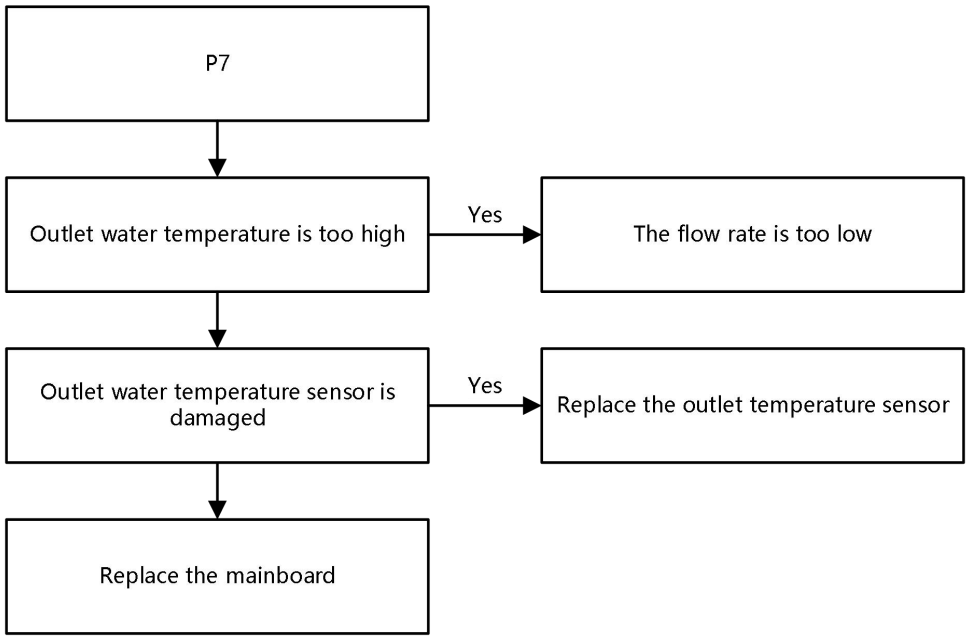
5.25.1 Description

• P7 indicates overheat protection (Heating).
• Error display: The wired controller displays "P7".
• The faulty unit stops operating.

5.25.2 Possible Causes

- The outlet water temperature is too high (Outlet water Temperature > 62℃).
- The outlet water temperature sensor is damaged.
- The mainboard is damaged.

5.25.3 Troubleshooting Process



5.26 P8 Troubleshooting

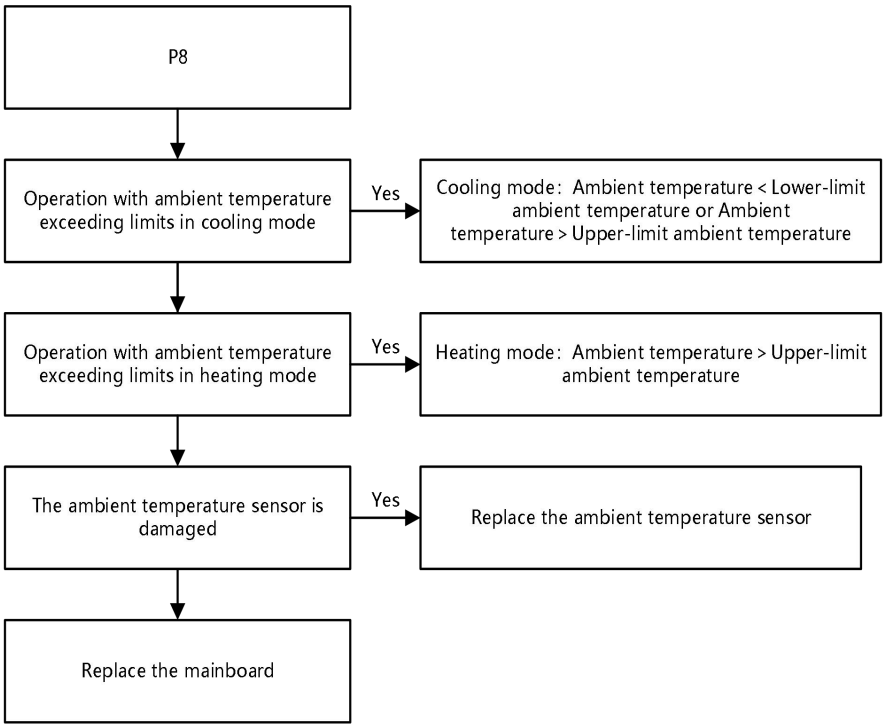
5.26.1 Description

- P8 indicates ambient temperature abnormal protection.
- Error display: The wired controller displays "P8".
- The faulty unit stops operating.

5.26.2 Possible Causes

- Operation with ambient temperature exceeding limits in cooling or heating mode
- The ambient temperature sensor is damaged.
- The mainboard is damaged.

5.26.3 Troubleshooting Process



Model	Lower-limit ambient temperature for cooling	Upper-limit ambient temperature for cooling	Upper-limit ambient temperature for Heating
70kW	-20℃	53℃	50℃
70kW (With hydro kit)	-20℃	53℃	50℃
140kW	-20℃	53℃	50℃
140kW (With hydro kit)	-20℃	53℃	50℃

5.27 H3 Troubleshooting

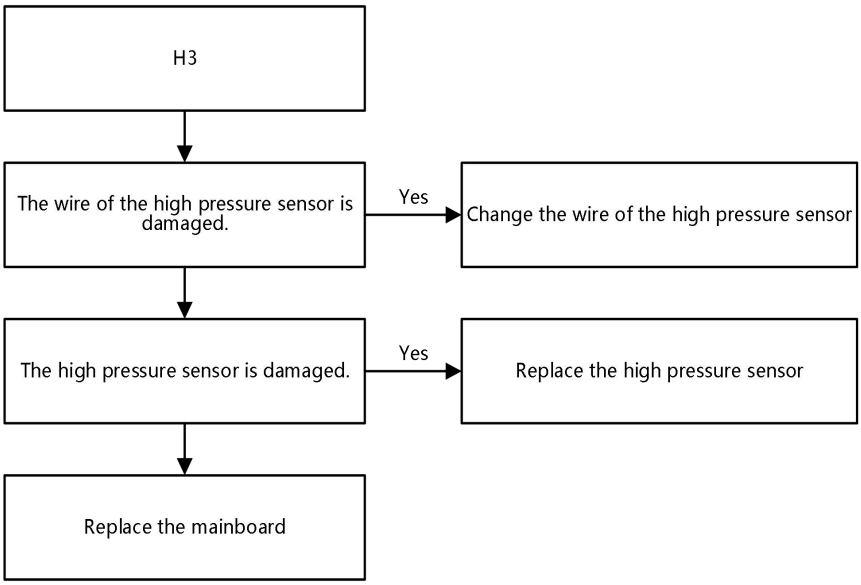
5.27.1 Description

- H3 indicates high pressure sensor failure.
- Error display: The wired controller displays "H3"
- The faulty unit stops operating.

5.27.2 Possible Causes

- The wire of the high pressure sensor is damaged.
- The high pressure sensor is damaged.
- The mainboard is damaged.

5.27.3 Troubleshooting Process



5.28 H4 Troubleshooting

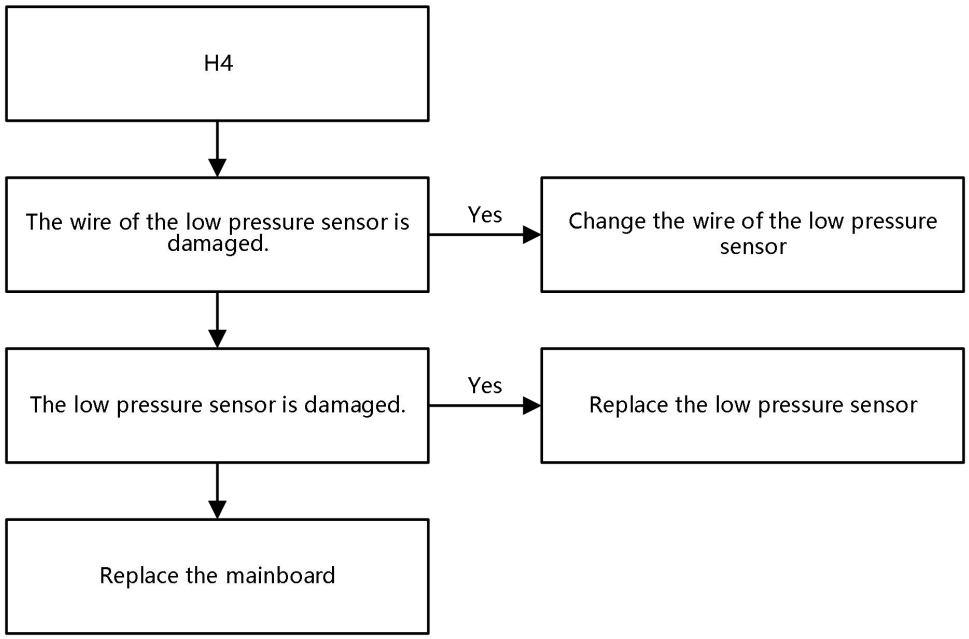
5.28.1 Description

- H4 indicates low pressure sensor failure.
- Error display: The wired controller displays "H4".
- The faulty unit stops operating.

5.28.2 Possible Causes

- The wire of the low pressure sensor is damaged.
- The low pressure sensor is damaged.
- The mainboard is damaged.

5.28.3 Troubleshooting Process



5.29 F3 Troubleshooting

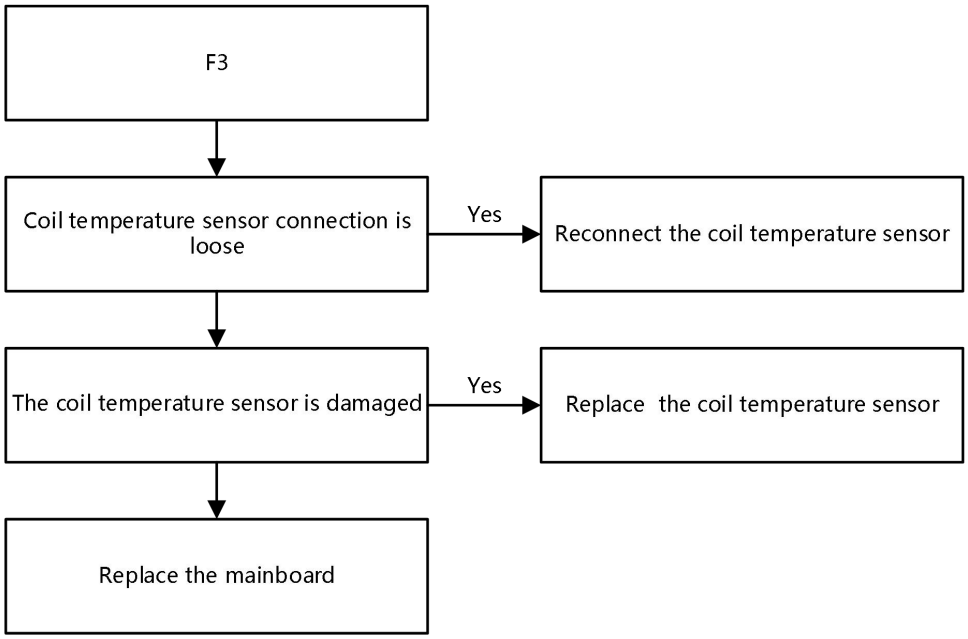
5.29.1 Description

- F3 indicates coil temperature sensor failure protection.
- Error display: The wired controller displays "F3".
- The faulty unit stops operating.

5.29.2 Possible Causes

- Coil temperature sensor connection is loose.
- The coil temperature sensor is damaged.
- The mainboard is damaged.

5.29.3 Troubleshooting Process



5.30 F6 Troubleshooting

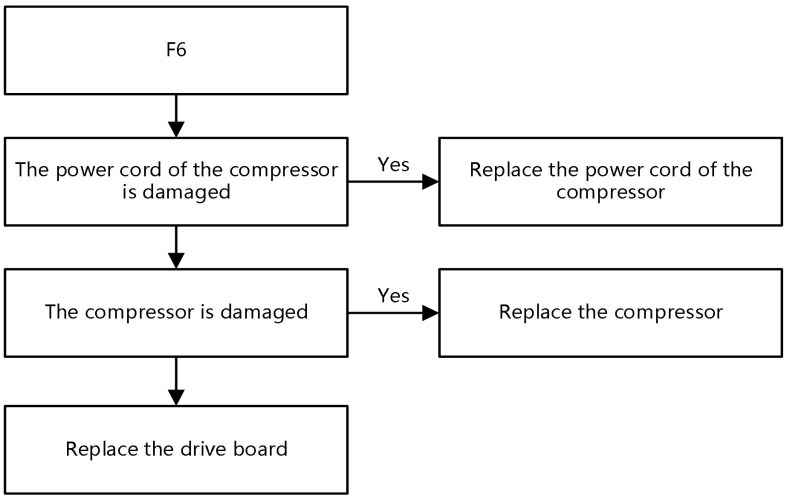
5.30.1 Troubleshooting

- F6 indicates compressor phase protection.
- Error display: The wired controller displays "F6".
- The faulty unit stops operating.

5.30.2 Possible Causes

- The power cord of the compressor is damaged.
- The compressor is damaged.
- The driver board is damaged.

5.30.3 Troubleshooting Process



5.31 F8 Troubleshooting

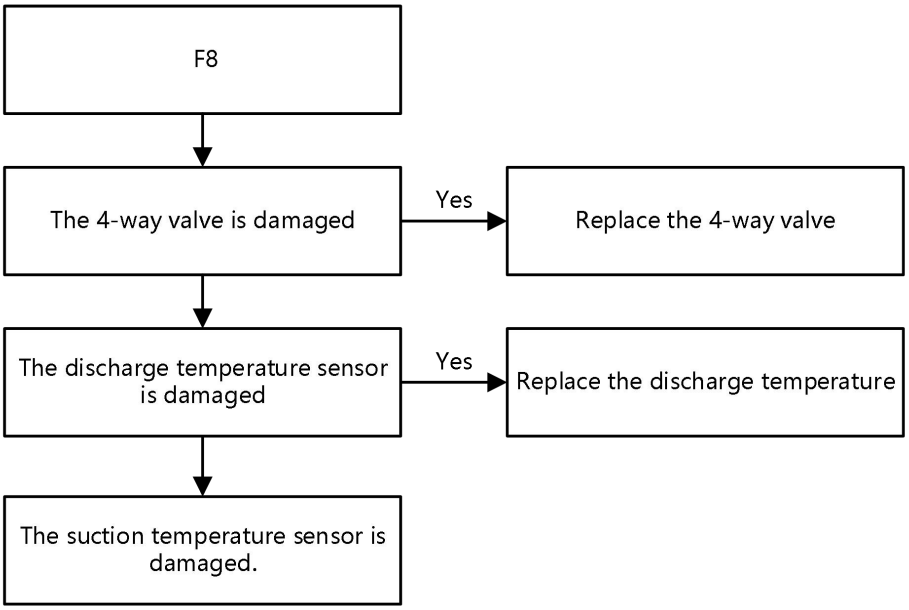
5.31.1 Description

- F8 indicates four-way valve reversal protection.
- Error display: The wired controller displays "F8".
- The faulty unit stops operating.

5.31.2 Possible Causes

- The four-way valve is damaged.
- The discharge temperature sensor is damaged.
- The suction temperature sensor is damaged.

5.31.3 Troubleshooting Process



5.32 Jt Troubleshooting

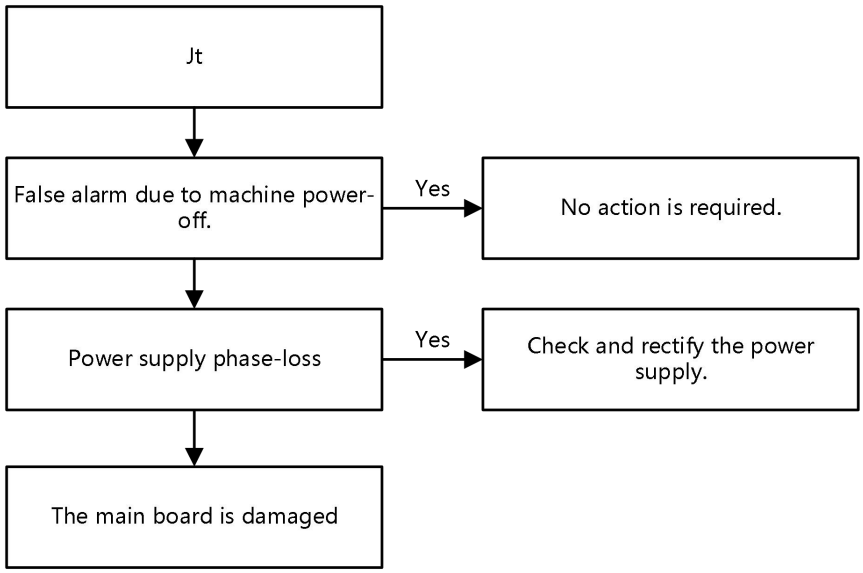
5.32.1 Description

- Jt indicates lack of phase protection.
- Error display: The wired controller displays "Jt".
- The faulty unit stops operating.

5.32.2 Possible Causes

- False alarm due to machine power-off.
- Power supply phase-loss.
- The mainboard is damaged.

5.32.3 Troubleshooting Process



5.33 FA Troubleshooting

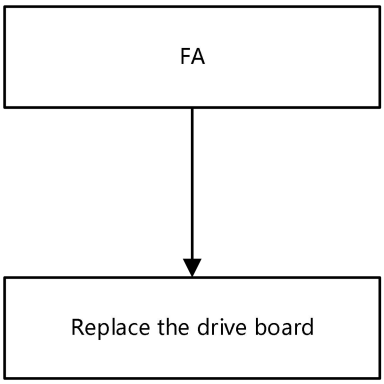
5.33.1 Description

- FA indicates Compressor phase current protection.
- Error display: The wired controller displays "FA".
- The faulty unit stops operating.

5.33.2 Possible Causes

- The drive board is damaged.

5.33.3 Troubleshooting Process



5.34 bU Troubleshooting

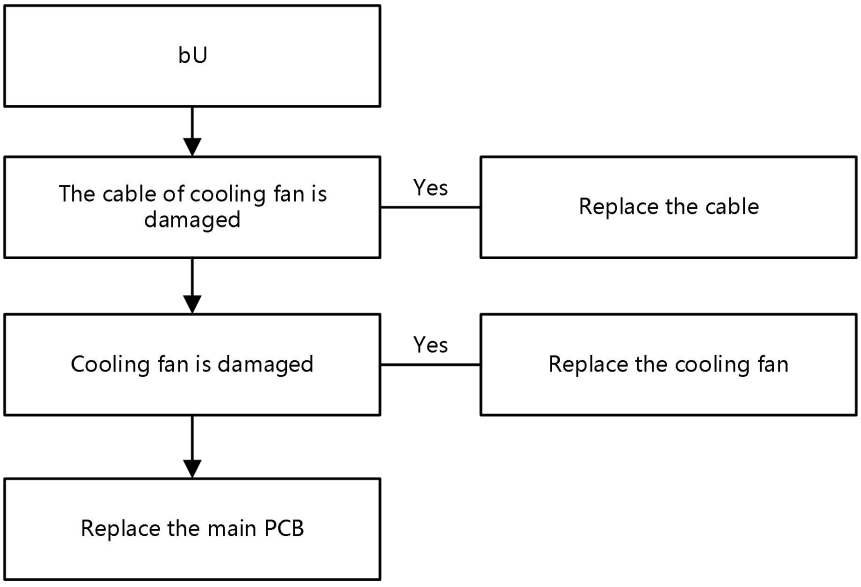
5.34.1 Description

• bU indicates Cooling fan failure.
• Error display: The wired controller displays "bU".
• The faulty unit stops operating.

5.34.2 Possible Causes

• The cable of cooling fan is damaged.
• The cooling fan is damaged.
• The main control board is damaged.

5.34.3 Troubleshooting Process



APPENDIX

1. Outdoor unit operating parameters under normal cooling mode

Outdoor ambient temperature	℃	16-25	25 - 35	35 - 48	
Average discharge temperature	℃	55-105	55-105	65-107	
Discharge superheat	℃	25-60	25-65	30-60	
Discharge pressure	MPa	2.1-3.0	2.3-3.8	2.6-4.1	
Suction superheat	℃	2-25	2-25	3-25	
Suction pressure	MPa	0.7-1.0	0.7-1.3	0.7-1.4	
Average suction temperature	℃	3-30	3-35	5-40	
Coil temperature	℃	15-45	30-50	35-57	
Inlet water temperature	℃	8-30	8-30	8-20	
Unit outlet water temperature	℃	5-25	5-25	5-15	
Anti-icing temperature	℃	5-25	5-25	5-15	
Compressor current	A	20-40	20-45	20-50	

2. Outdoor unit operating parameters under normal heating mode

Outdoor ambient temperature	℃	-15-0	0-7	7-10	>10
Average discharge temperature	℃	60-105	60-105	65-105	65-105
Discharge superheat	℃	20-60	20-60	20-55	20-55
Discharge pressure	MPa	1.8-3.7	2.0-3.9	2.0-4.0	2.5-4.0
Suction superheat	℃	-2-10	-2-10	0-8	0-10
Suction pressure	MPa	0.15-0.8	0.2-0.9	0.4-1.2	0.6-1.4
Average suction temperature	℃	-22-2	-12-7	0 -15	5-25
Coil temperature	℃	-25-0	-12-6	-5-9	0-40
Inlet water temperature	℃	20-30	20-35	20-40	20-55
Unit outlet water temperature	℃	25-35	25-40	25-45	25-50
Anti-icing temperature	℃	25-35	25-40	25-45	25-50
Compressor current	A	20-50	20-50	20-50	20-50

3. Resistance characteristics of temperature sensor

Temperature-Resistance characteristic sheet for the suction temperature sensor, subcooling temperature sensor, coil temperature sensor, ambient temperature sensor, refrigerant liquid/gas pipe temperature sensor, economizer outlet/inlet temperature sensor, water inlet/outlet temperature sensor, e-box ambient temperature sensor.

B25/50=3470K±2%, R25=5 KΩ±2%

Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)		Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)	
(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)	(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)
-40	122.059	113.858	106.153	7.20	6.77	-14	28.931	27.609	26.347	4.79	4.57
-39	114.913	107.292	100.128	7.10	6.68	-13	27.508	26.273	25.092	4.70	4.49
-38	108.234	101.150	94.488	7.00	6.59	-12	26.165	25.010	23.905	4.62	4.42
-37	101.988	95.402	89.204	6.90	6.50	-11	24.896	23.816	22.782	4.53	4.34
-36	96.145	90.020	84.253	6.80	6.41	-10	23.697	22.687	21.720	4.45	4.26

B25/50=3470K±2%, R25=5 KΩ±2%											
Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)		Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)	
(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)	(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)
-35	90.675	84.979	79.611	6.70	6.32	-9	22.562	21.618	20.713	4.37	4.19
-34	85.553	80.254	75.256	6.60	6.23	-8	21.490	20.607	19.759	4.29	4.11
-33	80.754	75.823	71.170	6.50	6.14	-7	20.475	19.649	18.855	4.21	4.04
-32	76.256	71.667	67.333	6.40	6.05	-6	19.515	18.742	17.999	4.13	3.97
-31	72.038	67.766	63.729	6.30	5.96	-5	18.606	17.883	17.187	4.05	3.89
-30	68.080	64.104	60.343	6.20	5.87	-4	17.745	17.068	16.416	3.97	3.82
-29	64.375	60.666	57.157	6.11	5.78	-3	16.930	16.296	15.685	3.89	3.75
-28	60.870	57.413	54.139	6.02	5.70	-2	16.156	15.563	14.991	3.81	3.68
-27	57.579	54.355	51.301	5.93	5.62	-1	15.423	14.868	14.332	3.73	3.61
-26	54.487	51.480	48.630	5.84	5.54	0	14.792	14.270	13.766	3.66	3.54
-25	51.582	48.776	46.115	5.75	5.46	1	14.069	13.582	13.111	3.58	3.47
-24	48.850	46.232	43.748	5.66	5.37	2	13.443	12.987	12.546	3.51	3.40
-23	46.279	43.836	41.517	5.57	5.29	3	12.849	12.422	12.008	3.43	3.33
-22	43.861	41.581	39.415	5.48	5.21	4	12.284	11.885	11.497	3.36	3.26
-21	41.585	39.456	37.432	5.40	5.13	5	11.749	11.375	11.012	3.29	3.19
-20	39.462	37.473	35.581	5.31	5.05	6	11.239	10.889	10.548	3.22	3.13
-19	37.421	35.565	33.798	5.22	4.97	7	10.756	10.428	10.109	3.15	3.06
-18	35.519	33.785	32.134	5.13	4.89	8	10.295	9.988	9.689	3.08	3.00
-17	33.725	32.105	30.561	5.05	4.81	9	9.858	9.570	9.289	3.01	2.93
-16	32.033	30.520	29.077	4.96	4.73	10	9.441	9.172	8.909	2.94	2.87
-15	30.437	29.023	27.673	4.87	4.65	11	9.044	8.792	8.545	2.87	2.81
12	8.667	8.431	8.199	2.80	2.75	53	1.896	1.839	1.783	3.11	3.04
13	8.308	8.087	7.870	2.74	2.69	54	1.835	1.779	1.724	3.14	3.07
14	7.965	7.758	7.554	2.67	2.62	55	1.776	1.721	1.668	3.18	3.11
15	7.639	7.445	7.254	2.61	2.56	56	1.719	1.666	1.614	3.21	3.14
16	7.329	7.147	6.968	2.54	2.51	57	1.665	1.613	1.562	3.24	3.17
17	7.032	6.862	6.694	2.48	2.45	58	1.613	1.562	1.512	3.27	3.20
18	6.749	6.590	6.433	2.42	2.39	59	1.562	1.512	1.463	3.31	3.23
19	6.480	6.331	6.183	2.36	2.33	60	1.514	1.465	1.417	3.34	3.26
20	6.223	6.083	5.945	2.30	2.27	61	1.467	1.419	1.372	3.37	3.29
21	5.977	5.846	5.716	2.23	2.22	62	1.421	1.374	1.328	3.40	3.32
22	5.742	5.620	5.498	2.18	2.16	63	1.378	1.332	1.287	3.43	3.35
23	5.518	5.404	5.290	2.12	2.11	64	1.336	1.291	1.247	3.46	3.38
24	5.305	5.198	5.091	2.06	2.05	65	1.295	1.251	1.208	3.49	3.41
25	5.100	5.000	4.900	2.00	2.00	66	1.256	1.213	1.171	3.52	3.43
26	4.909	4.811	4.713	2.05	2.04	67	1.218	1.176	1.135	3.55	3.46
27	4.727	4.630	4.533	2.09	2.09	68	1.181	1.140	1.100	3.58	3.49
28	4.552	4.457	4.362	2.14	2.13	69	1.146	1.106	1.067	3.61	3.52
29	4.386	4.292	4.199	2.18	2.17	70	1.112	1.073	1.035	3.64	3.55
30	4.225	4.133	4.042	2.23	2.21	71	1.079	1.041	1.004	3.67	3.57
31	4.072	3.982	3.892	2.27	2.25	72	1.047	1.010	0.974	3.70	3.60
32	3.925	3.836	3.748	2.31	2.29	73	1.016	0.980	0.944	3.72	3.63
33	3.784	3.697	3.611	2.36	2.33	74	0.988	0.952	0.917	3.75	3.65
34	3.649	3.564	3.479	2.40	2.37	75	0.959	0.924	0.890	3.78	3.68

B25/50=3470K±2%, R25=5 KΩ±2%											
Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)		Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)	
(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)	(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)
35	3.520	3.436	3.353	2.44	2.41	76	0.931	0.897	0.864	3.80	3.71
36	3.395	3.313	3.232	2.48	2.45	77	0.904	0.871	0.839	3.83	3.73
37	3.275	3.195	3.116	2.52	2.49	78	0.879	0.846	0.814	3.86	3.76
38	3.161	3.082	3.004	2.56	2.52	79	0.854	0.822	0.791	3.88	3.78
39	3.051	2.974	2.898	2.60	2.56	80	0.830	0.799	0.769	3.91	3.81
40	2.946	2.870	2.795	2.64	2.60	81	0.807	0.776	0.746	3.94	3.83
41	2.844	2.770	2.697	2.68	2.63	82	0.784	0.754	0.725	3.96	3.85
42	2.748	2.675	2.604	2.71	2.67	83	0.762	0.733	0.705	3.99	3.88
43	2.654	2.583	2.513	2.75	2.71	84	0.742	0.713	0.685	4.01	3.90
44	2.564	2.494	2.426	2.79	2.74	85	0.721	0.693	0.666	4.03	3.92
45	2.478	2.410	2.343	2.83	2.78	86	0.701	0.674	0.647	4.06	3.95
46	2.395	2.328	2.263	2.86	2.81	87	0.682	0.655	0.629	4.08	3.97
47	2.315	2.250	2.186	2.90	2.84	88	0.664	0.638	0.613	4.10	3.99
48	2.238	2.174	2.111	2.93	2.88	89	0.646	0.620	0.595	4.13	4.01
49	2.164	2.102	2.041	2.97	2.91	90	0.629	0.604	0.580	4.15	4.03
50	2.093	2.032	1.972	3.01	2.95	91	0.611	0.587	0.563	4.17	4.05
51	2.025	1.965	1.906	3.04	2.98	92	0.596	0.572	0.549	4.19	4.07
52	1.959	1.901	1.844	3.07	3.01	93	0.580	0.557	0.534	4.21	4.09
94	0.565	0.542	0.520	4.23	4.11	108	0.395	0.379	0.362	4.47	4.34
95	0.550	0.528	0.506	4.25	4.13	109	0.386	0.369	0.353	4.48	4.36
96	0.536	0.514	0.493	4.27	4.15	110	0.376	0.360	0.344	4.50	4.37
97	0.522	0.501	0.480	4.29	4.17	111	0.367	0.351	0.335	4.52	4.39
98	0.509	0.488	0.468	4.31	4.18	112	0.357	0.342	0.327	4.53	4.41
99	0.497	0.476	0.456	4.33	4.20	113	0.349	0.333	0.319	4.55	4.42
100	0.484	0.464	0.444	4.34	4.22	114	0.340	0.325	0.311	4.56	4.44
101	0.472	0.452	0.433	4.36	4.23	115	0.332	0.317	0.303	4.58	4.46
102	0.460	0.441	0.422	4.38	4.25	116	0.324	0.309	0.296	4.60	4.48
103	0.449	0.430	0.412	4.39	4.26	117	0.316	0.302	0.288	4.61	4.49
104	0.437	0.419	0.401	4.41	4.28	118	0.308	0.294	0.281	4.63	4.51
105	0.427	0.409	0.391	4.42	4.29	119	0.301	0.287	0.274	4.64	4.53
106	0.416	0.399	0.381	4.44	4.31	120	0.293	0.280	0.268	4.66	4.54
107	0.406	0.388	0.372	4.45	4.32						

Temperature-Resistance characteristic sheet for the discharge temperature sensor.

R25/85=4000K±2%, R85=2.113 KΩ±3%											
Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)		Temp	Resistance (KΩ)			Resistance deviation % (resist.tol)	
(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)	(°C)	Rmax	R(t) Normal	Rmin	MAX(+)	MIN(-)
-40	726.657	625.868	525.078	16.10	16.10	-6	98.209	88.362	78.516	11.14	11.14
-39	681.023	587.424	493.824	15.93	15.93	-5	93.126	83.883	74.640	11.02	11.02
-38	638.514	551.558	464.602	15.77	15.77	-4	88.332	79.653	70.974	10.90	10.90
-37	598.900	518.084	437.269	15.60	15.60	-3	83.810	75.659	67.507	10.77	10.77
-36	561.966	486.829	411.692	15.43	15.43	-2	79.543	71.885	64.227	10.65	10.65

-35	527.516	457.633	387.750	15.27	15.27	-1	75.515	68.319	61.123	10.53	10.53
-34	495.370	430.350	365.330	15.11	15.11	0	71.712	64.948	58.184	10.41	10.41
-33	465.362	404.844	344.326	14.95	14.95	1	68.120	61.761	55.402	10.30	10.30
-32	437.336	380.989	324.641	14.79	14.79	2	64.726	58.746	52.766	10.18	10.18
-31	411.152	358.670	306.187	14.63	14.63	3	61.519	55.894	50.269	10.06	10.06
-30	386.680	337.780	288.879	14.48	14.48	4	58.488	53.195	47.903	9.95	9.95
-29	363.797	318.219	272.641	14.32	14.32	5	55.621	50.641	45.661	9.83	9.83
-28	342.392	299.897	257.401	14.17	14.17	6	52.910	48.222	43.534	9.72	9.72
-27	322.363	282.727	243.092	14.02	14.02	7	50.345	45.931	41.517	9.61	9.61
-26	303.613	266.633	229.654	13.87	13.87	8	47.917	43.761	39.604	9.50	9.50
-25	286.054	251.541	217.028	13.72	13.72	9	45.619	41.704	37.789	9.39	9.39
-24	269.604	237.383	205.162	13.57	13.57	10	43.443	39.755	36.066	9.28	9.28
-23	254.188	224.097	194.005	13.43	13.43	11	41.383	37.907	34.431	9.17	9.17
-22	239.736	211.625	183.513	13.28	13.28	12	39.430	36.154	32.878	9.06	9.06
-21	226.181	199.912	173.642	13.14	13.14	13	37.580	34.491	31.403	8.95	8.95
-20	213.465	188.909	164.353	13.00	13.00	14	35.826	32.914	30.001	8.85	8.85
-19	201.530	178.569	155.608	12.86	12.86	15	34.163	31.417	28.670	8.74	8.74
-18	190.326	168.850	147.373	12.72	12.72	16	32.586	29.995	27.404	8.64	8.64
-17	179.803	159.710	139.616	12.58	12.58	17	31.090	28.645	26.200	8.54	8.54
-16	169.917	151.112	132.307	12.44	12.44	18	29.671	27.363	25.056	8.43	8.43
-15	160.627	143.022	125.417	12.31	12.31	19	28.324	26.145	23.967	8.33	8.33
-14	151.893	135.407	118.921	12.18	12.18	20	27.044	24.988	22.931	8.23	8.23
-13	143.679	128.236	112.794	12.04	12.04	21	25.830	23.888	21.946	8.13	8.13
-12	135.952	121.483	107.014	11.91	11.91	22	24.676	22.842	21.007	8.03	8.03
-11	128.680	115.120	101.559	11.78	11.78	23	23.579	21.847	20.114	7.93	7.93
-10	121.836	109.123	96.410	11.65	11.65	24	22.538	20.900	19.263	7.83	7.83
-9	115.391	103.469	91.548	11.52	11.52	25	21.547	20,000	18.453	7.74	7.74
-8	109.320	98.138	86.956	11.39	11.39	26	20.605	19.143	17.681	7.64	7.64
-7	103.600	93.108	82.617	11.27	11.27	27	19.710	18.327	16.945	7.54	7.54
28	18.858	17.551	16.243	7.45	7.45	69	3.743	3.596	3.450	4.08	4.08
29	18.047	16.811	15.575	7.35	7.35	70	3.614	3.475	3.335	4.01	4.01
30	17.275	16.106	14.937	7.26	7.26	71	3.490	3.357	3.225	3.94	3.94
31	16.541	15.434	14.328	7.17	7.17	72	3.370	3.245	3.119	3.87	3.87
32	15.841	14.794	13.748	7.07	7.07	73	3.255	3.136	3.017	3.80	3.80
33	15.175	14.184	13.194	6.98	6.98	74	3.145	3.032	2.919	3.73	3.73
34	14.540	13.602	12.665	6.89	6.89	75	3.039	2.932	2.824	3.66	3.66
35	13.935	13.048	12.160	6.80	6.80	76	2.937	2.835	2.733	3.59	3.59
36	13.358	12.518	11.678	6.71	6.71	77	2.839	2.742	2.646	3.53	3.53
37	12.809	12.013	11.217	6.62	6.62	78	2.745	2.653	2.561	3.46	3.46
38	12.284	11.531	10.777	6.53	6.53	79	2.654	2.567	2.480	3.39	3.39
39	11.784	11.071	10.357	6.45	6.45	80	2.567	2.484	2.401	3.33	3.33
40	11.307	10.631	9.955	6.36	6.36	81	2.483	2.404	2.326	3.26	3.26
41	10.852	10.211	9.571	6.27	6.27	82	2.402	2.327	2.253	3.19	3.19
42	10.417	9.810	9.203	6.19	6.19	83	2.324	2.253	2.183	3.13	3.13
43	10.002	9.427	8.852	6.10	6.10	84	2.249	2.182	2.115	3.06	3.06
44	9.606	9.061	8.516	6.02	6.02	85	2.176	2.113	2.050	3.00	3.00
45	9.228	8.711	8.194	5.93	5.93	86	2.109	2.047	1.984	3.06	3.06
46	8.866	8.376	7.886	5.85	5.85	87	2.045	1.983	1.921	3.13	3.13
47	8.520	8.056	7.591	5.77	5.77	88	1.982	1.921	1.860	3.19	3.19
48	8.190	7.750	7.309	5.69	5.69	89	1.922	1.862	1.801	3.25	3.25

49	7.874	7.456	7.039	5.60	5.60	90	1.864	1.804	1.744	3.32	3.32
50	7.572	7.176	6.780	5.52	5.52	91	1.808	1.749	1.690	3.38	3.38
51	7.283	6.908	6.532	5.44	5.44	92	1.754	1.695	1.637	3.44	3.44
52	7.007	6.650	6.294	5.36	5.36	93	1.701	1.644	1.586	3.50	3.50
53	6.743	6.404	6.066	5.28	5.28	94	1.651	1.594	1.537	3.57	3.57
54	6.489	6.168	5.847	5.20	5.20	95	1.602	1.546	1.490	3.63	3.63
55	6.247	5.942	5.638	5.12	5.12	96	1.555	1.500	1.444	3.69	3.69
56	6.015	5.726	5.437	5.05	5.05	97	1.509	1.455	1.400	3.75	3.75
57	5.793	5.518	5.244	4.97	4.97	98	1.465	1.412	1.358	3.81	3.81
58	5.580	5.319	5.059	4.89	4.89	99	1.423	1.370	1.317	3.87	3.87
59	5.376	5.129	4.882	4.82	4.82	100	1.382	1.329	1.277	3.93	3.93
60	5.180	4.946	4.711	4.74	4.74	101	1.342	1.290	1.239	3.99	3.99
61	4.993	4.770	4.548	4.67	4.67	102	1.303	1.253	1.202	4.05	4.05
62	4.813	4.602	4.390	4.59	4.59	103	1.266	1.216	1.166	4.11	4.11
63	4.641	4.440	4.240	4.52	4.52	104	1.230	1.181	1.132	4.17	4.17
64	4.475	4.285	4.094	4.44	4.44	105	1.195	1.147	1.099	4.22	4.22
65	4.317	4.136	3.955	4.37	4.37	106	1.162	1.114	1.066	4.28	4.28
66	4.164	3.993	3.821	4.30	4.30	107	1.129	1.082	1.035	4.34	4.34
67	4.018	3.855	3.693	4.22	4.22	108	1.098	1.051	1.005	4.40	4.40
68	3.878	3.723	3.569	4.15	4.15	109	1.067	1.022	0.976	4.46	4.46
110	1.038	0.993	0.948	4.51	4.51	123	0.729	0.693	0.657	5.23	5.23
111	1.009	0.965	0.921	4.57	4.57	124	0.710	0.675	0.639	5.28	5.28
112	0.981	0.938	0.895	4.63	4.63	125	0.692	0.657	0.622	5.34	5.34
113	0.955	0.912	0.869	4.68	4.68	126	0.674	0.640	0.605	5.39	5.39
114	0.929	0.887	0.845	4.74	4.74	127	0.657	0.623	0.589	5.44	5.44
115	0.904	0.862	0.821	4.79	4.79	128	0.641	0.607	0.574	5.50	5.50
116	0.879	0.839	0.798	4.85	4.85	129	0.624	0.592	0.559	5.55	5.55
117	0.856	0.816	0.776	4.90	4.90	130	0.609	0.577	0.544	5.60	5.60
118	0.833	0.794	0.754	4.96	4.96	131	0.594	0.562	0.530	5.65	5.65
119	0.811	0.772	0.733	5.01	5.01	132	0.579	0.548	0.517	5.70	5.70
120	0.789	0.751	0.713	5.07	5.07	133	0.565	0.534	0.503	5.76	5.76
121	0.769	0.731	0.694	5.12	5.12	134	0.551	0.521	0.491	5.81	5.81
122	0.749	0.712	0.675	5.18	5.18	135	0.538	0.508	0.478	5.86	5.86