# Operating Instructions for Variable Frequency Controller

## Temperature controller operating instructions

### 1. Temperature controller function

The temperature controller can remotely monitor and change some settings of the variable frequency controller, and can remotely control the operation of the variable frequency controller through 485 communications; The temperature controller is equipped with temperature and defrosting (evaporator) sensor probes, which can view real-time cabinet temperature and frequency; The temperature controller is equipped with fault display and buzzer alarm functions;

### 2. Operating conditions of temperature controller

Working voltage:220VAC±10%,50HZ
Working condition: -5°C~60°C,
Working relative humidity:10%~90% (No condensation allowed); Storage temperature: -25$^0$C~75$^0$C;

### 3. Specifications and Dimensions

Dimensions: 85 * 35 * 63.8(mm), Installation Dimensions:71* 29,
The sensor length: 2 (m)
Sensor length of 5m optional

### 4. Technical Parameter

Temperature control range: -40ºC~85ºC;
Measuring range: -40°C~99°C
Sensor type: NTC (10KQ /25C,B 3435K)

### 5. Operation and display panel


The display board can display three numbers
Two status indicators (key lock, Fan),
Four parameter description words (ON temperature, OFF temperature, Def cycle, Def time).

### 5.1. Key Description

There are six buttons on the Temperature controller:
unlock/ok; Forced defrosting key; ON Temp; OFF Temp; up key; down key.

### 5.2. Work instructions

| code | status | Description(EN) |
|---|---|---|
| 🔒 | light | lock |
| | Extinguish | unlock |
| **ON** | Extinguish | Compressor shutdown |
| | flicker | Delayed startup |
| | flight | Compressor startup |
| **Def** | flicker (slow) | Drip water |
| | Extinguish | Fan stop |
| | flicker | Fan delay |
| | light | Fan run |

### 5.3. Temperature controller unlocking, locking, user menu settings

1) The Temperature controller will automatically lock the buttons after 30 seconds without any button action to prevent accidental touch; When the Temperature controller is in a locked state, press and hold the "unlock button/OK" for 1 second to unlock the locked Temperature controller;
2) Temperature Quick Settings:

In normal operation, press the "ON Temp" key (or "OFF Temp" key), the corresponding parameter description word will light up, and the display window will display the "ON Temp" (or "OFF Temp") value, indicating that the "Start Temperature" (or "OFF Temperature") menu has been entered. You can use the "T" or "I" keys to adjust parameters, and hold down the "T" or "I" keys to quickly adjust parameters. In the setting state, exit the setting state and save the parameters by pressing and releasing the "unlock key/OK" or no button action within 30 seconds

### 5.4. Quick Actions

The temperature controller defaults to displaying the current library temperature.
When the temperature controller is not locked:
Click on the "unlock button/OK" to turn on or off the light; (The lamp needs to be connected to the temperature controller relay)
Press and hold "t" to view the current operating frequency.
Press and hold "I" to view the temperature of the defrosting probe.

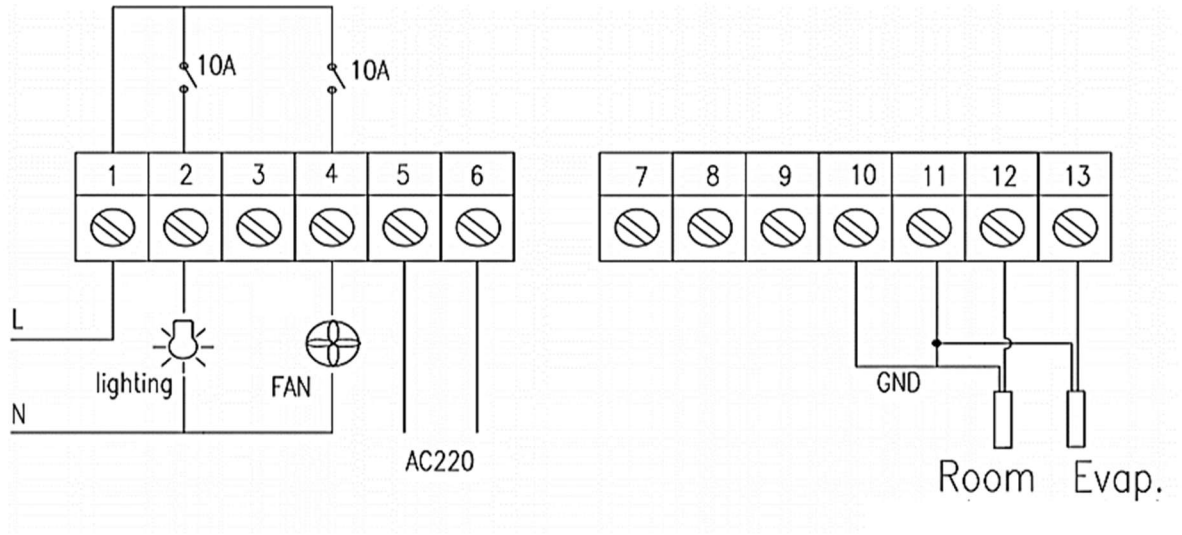
### 5.5. System settings

When the temperature controller is in a non-locked state, press and hold the "unlock button/OK" for more than 5 seconds until "F1" appears to enter the temperature controller parameter setting interface
Press the "↑" or "↓" keys to convert parameter code items; Press the "Unlock key/OK" to display the corresponding parameter values, press the "↑" or "↓" keys to adjust the parameters, and hold down the button to quickly adjust the parameters; Press the 'unlock key/OK' to temporarily store the modified parameter values and return to the displayed parameter code.
In the system menu setting state, if there is no button action within 3 seconds or 30 seconds of holding down the "Unlock Key/OK" button, the modified parameter values will be saved and the system menu setting state will be exited.

| Parameters | Default Value | Numeric Range | Meaning | Description |
|---|---|---|---|---|
| F1 | 10 | -40~85C | ON Temp | |
| F2 | -10 | -40~85C | OFF Temp | |
| F3 | 30 | 0~120min | Defrosting time | Defrosting Duration |
| F4 | 6 | 0~120h | Defrosting cycle | |
| F5 | 3 | 0~120min | Defrosting and dripping time | |
| F6 | 10 | -40~50C | Defrosting stop Temp | The defrost will automatically stop |
| F7 | 2 | 0~24h | STARTUP OVER-TEMPERATURE ALARM DELAY | No over-temperature |
| No over temperature alarm when the startup time is less than F7 | | | | |
| F8 | 5 | 0~50C | Overtemperature alarm value | Start-up temperature |
| F9 | 10 | 0~120min | Overtemperature alarm delay | + F8, over- |
| Startup temperature+F8, over temperature alarm after lasting for more than F9 time | | | | |
| F10 | 0 | -10~10C | Cabinet temperature sensor calibration | |
| F11 | 0 | -10~10C | Evaporator sensor calibration | |
| F12 | 0 | 0/1/2 | Defrost display mode \| 0/1/2 | |
| 0:Cabinet Temp; 1 : Display DEF ; 2: cabinet Temp at the beginning of defrosting | | | | |
| F13 | 0 | 0/1/2 | Fan working mode | 0/1/2 |
| 0: Continuous operation; 1: Follow the compressor; 2: Stop during defrosting | | | | |
| F14 \| 0 \| 0/1/2 \| Defrosting mode \| 0/1/2 | | | | |
| 0: Electrochemical frost; 1: Thermal fluorination cream; 2: Wind defrosting | | | | |
| ①F13 fan setting is only valid for the built-in fan of the temperature controller | | | | |

**6. Temperature controller connection**

The temperature controller can be connected to the evaporation fan and lighting. When the evaporation fan is connected to the temperature controller, the logic of the controller to the evaporation fan will become invalid, and the evaporation fan will be controlled according to the F13 setting of the temperature controller It is usually recommended to connect the evaporation fan to the control panel, and the control mode of the evaporation fan can be automatically adjusted according to the defrosting mode; If it is necessary to connect to the temperature controller and manually control the evaporation fan, it must be confirmed that there is no conflict between the current defrosting mode and the working mode of the fan; Refer to **5.6** Temperature Controller Parameter Table for details.



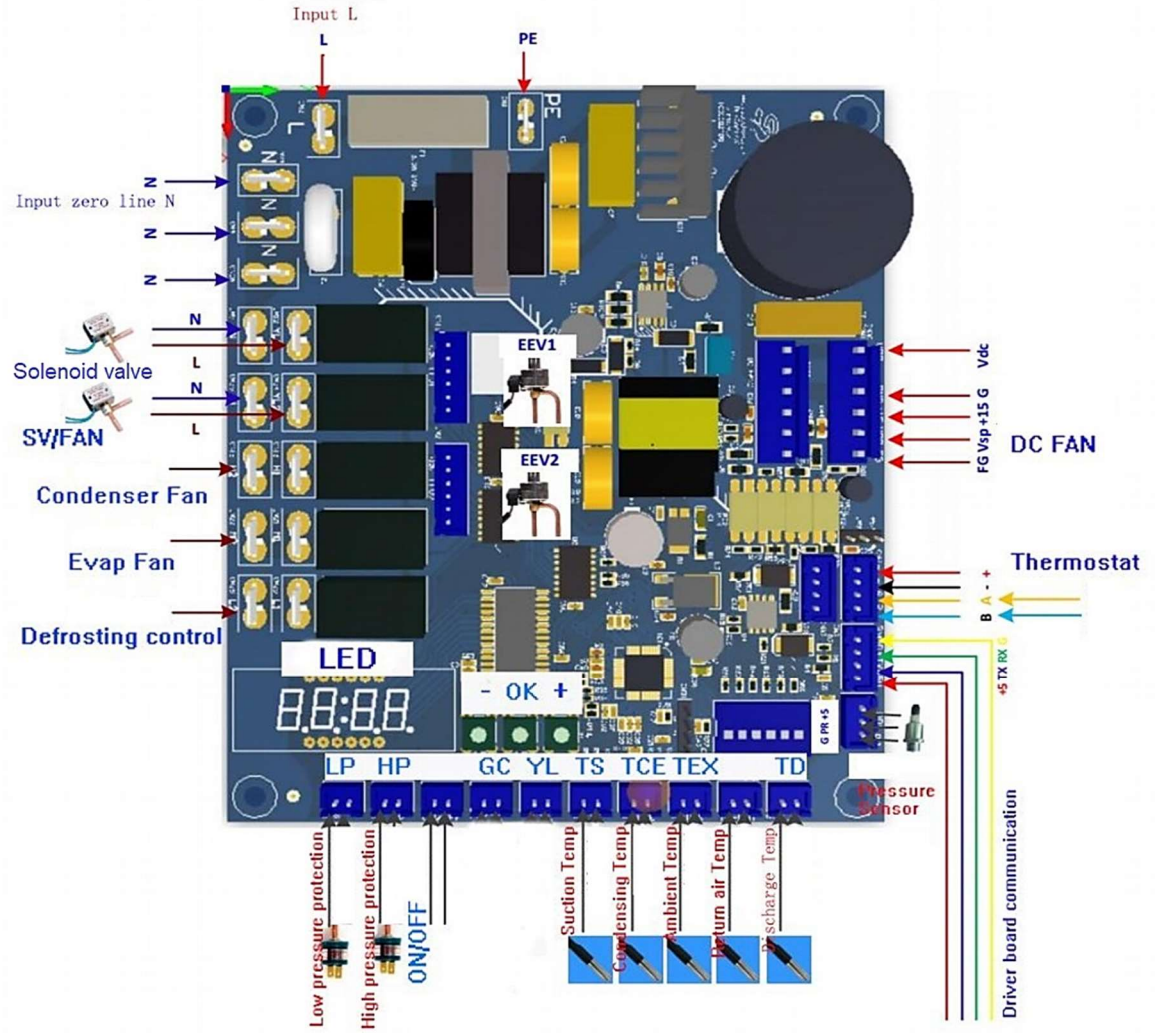

**Wiring diagram of temperature controller**

## 7. Temperature controller malfunction alarm reference

When certain faults occur in the unit, the temperature controller will prompt corresponding codes and sound an alarm. The code table can be used as a reference for troubleshooting

| Code | Description | Reason/Solution |
|---|---|---|
| E01 | Ambient temperature sensor fault | Check if the corresponding sensor on the main control board has poor contact or is damaged |
| E02 | Condensate temperature sensor fault | |
| E03 | Discharge temperature sensor short circuit fault | |
| E11 | Overtemperature alarm | The temperature of the cold storage cannot reach the target temperature for a long time, please check whether the system cooling is normal or whether the relevant parameters F7/8/9 are set reasonably |
| EC | Communication failure | Check the connection between the Thermostat and the motherboard |
| Er1 | storage temperature sensor fault | Check if the corresponding sensor has poor contact or damage |
| Er2 | Evaporator temperature sensor fault | |

**Main control board Function Description**
**Schematic Diagram of the functional connection of the main control board**




1) The unit can use a passive start signal to control the start and stop of the entire machine. If ON/OFF is short circuited, it will start and operate normally, and if disconnected, it will be in overall standby mode; Short circuit this port by default at the factory.
2) When connecting the defrosting equipment to the main control board, a relay relay should be used, and high-power equipment should not be directly connected to avoid damage to the main control board.The evaporation fan is allowed to directly connect to small power loads, and the port load of the evaporation fan shall not exceed 1.3A; The overall load of the main control board shall not exceed 3.5A

## 1. On/Off Control

**Temperature controller switch temperature control:**
The temperature controller detects the temperature inside the cabinet, and when there is no abnormal alarm from the controller, it starts and stops the control according to the set start/stop temperature;
Startup: cabinet temperature>startup temperature
Shutdown: cabinet temperature<shutdown temperature - shutdown temperature difference
The controller adjusts the compressor operating frequency based on the current cabinet temperature and the set shutdown temperature, with a default compressor startup delay of 180 seconds;

## 2. Fan control

### 2.1. Condenser Fan

After the compressor is started, the condensing fan controls the working mode of the condensing fan based on the outdoor ambient temperature and outdoor coil temperature: AC/DC fans can be selected according to demand; The AC fan is controlled on/off, while the DC fan has a speed regulation function;

**AC Fan**

1) When the ambient temperature probe detects a high temperature, the condensing fan is forced to open;
2) Determine the condensation temperature. When the condensation temperature is > 35℃, the condensation fan starts. When the outdoor coil is below 30℃, the fan stops (can be set)

**DC Fan**

After the DC fan is set, the wind speed can be automatically adjusted based on the current condensation temperature; When using DC fans, the number of fans must match the current setting. By dialing the code to select whether to enable or not to enable the DC fan (Factory preset), the starting temperature of the fan can be set;

### 2.2. Evaporation Fan

There are two wiring options for the evaporation fan:

1) Connect to the Main control board: The evaporation fan will be controlled according to the defrosting settings of (the fan working mode will be automatically adjusted according to the defrosting type);

2) Connect to the temperature controller: The evaporation fan will be independently controlled according to the parameters set by the temperature controller F13 (manual confirmation of the fan operating mode is required to avoid conflicts with the defrosting mode);

**Evaporation Fan default working mode**

1) The evaporation fan automatically starts after the temperature controller and variable frequency controller are powered on.
2) The evaporation fan does not operate in the defrosting and defrosting drip state. After the defrosting drip time is over, the evaporation fan starts (depending on the current defrosting mode operation mode)

## 3. Defrosting control

### 3.1. Defrosting type

1) The defrosting type can be changed by modifying the F14 parameters of the temperature controller. The operation mode of evaporation fans and defrosting relays varies for different defrosting types
2) Electric defrosting: The compressor stops, the evaporation fan stops running, the electric heating (connected to the relay on the variable frequency control board) starts running, and the condensing fan (connected to the relay on the variable frequency control board) stops running. (Default Mode)
3) Hot fluorination frost: Before using hot gas defrosting, the compressor should be stopped first, and then the defrosting relay should be turned on to start and run the compressor for defrosting. To ensure the stability of the system, the compressor should run for no less than 2 minutes. After defrosting with hot air, the compressor can only be started after a delay of 2 minutes when the conditions are met; During defrosting, the main refrigeration solenoid valve is activated, the evaporation fan is stopped, the electric heating relay is activated, and the condensation fan is activated
4) Wind defrosting: The compressor stops and the evaporation fan remains operational
5) Dripping time: After the defrosting is completed, in order to eliminate the accumulated water generated during defrosting and prevent icing again, the defrosting dripping time is set. During the defrosting and dripping time, the compressor, evaporator fan, and condenser fan all stop running. It can be set through the temperature controller (F5).

### 3.2. Defrosting mode

1) Forced defrosting: Press and hold the "Forced defrosting" button on the temperature controller, and if the defrosting conditions are met, the refrigerator will be forced to enter the defrosting state
2) Timing defrosting: When the temperature of the refrigeration cabinet pipeline is lower than the defrosting stop temperature, and the compressor is turned on and running for the set time (set by the temperature controller), it automatically enters defrosting mode.
3) Defrosting stop conditions
4) Defrosting stop conditions:
5) Active stop: After the refrigerator enters defrosting mode, if the temperature of the pipeline inside the refrigerator is detected to be higher than the defrosting stop temperature(F6), the refrigerator actively exits defrosting mode.

① Active stop: After the refrigerator enters defrosting mode, if the temperature of the pipeline inside the refrigerator is detected to be higher than the defrosting stop temperature(F6), the refrigerator actively exits defrosting mode.
②Automatic stop: After the refrigerator enters defrosting mode, if the temperature of the refrigerator pipeline is lower than the defrosting stop temperature(F6), it will automatically exit defrosting mode after defrosting time (F3).
③Forced exit from defrosting: You can forcibly exit the current defrosting by long pressing the forced defrosting button on the temperature controller; No dripping time during forced exit;

## 4. Overtemperature alarm function

After detecting that the compressor has been running for 2 hours with electric refrigeration, the buzzer will output if the temperature inside the cabinet is greater than the starting temperature+5 or the temperature inside the cabinet is less than the stopping temperature -5 for more than 10 minutes. (The relevant control parameters can be adjusted through temperature controllers F7, F8, and F9, and the actual settings of the current unit shall prevail when leaving the factory)

## 5. Electromagnetic valve control

1) Opening conditions of spray solenoid valve/electronic spray expansion valve:

During the operation of the compressor, when the exhaust temperature is detected to be ≥ 90 (parameter P16 60-120 can be set), the solenoid valve is powered on/the electronic spray expansion valve opens. When the exhaust temperature is ≤ 75 (parameter P17 50-110 can be set), the solenoid valve is powered off/the electronic spray expansion valve closes.

2) Main refrigeration solenoid valve: the compressor is opened in advance, and when the compression is closed, the solenoid valve is closed;

## 6. Controller protection function

1) ON/OFF Control

f this port on the main control board is closed, the entire machine will operate normally according to the target temperature; If this port is disconnected, the entire machine will stop standby and the digital tube will display OFF

2) High and low pressure protection.

If the pressure protection port is disconnected, the controller displays the corresponding high and low voltage protection fault code, and the unit shuts down.
The low-pressure port is not detected within 1 minute of starting the compressor.

## 7. Main control board debugging/operation

### 7.1. Key operation

The controller status can be queried and set through the main control
Key definition: **Down key (-)**; **Confirm key (OK)**; **Up key (+)** (from left to right); Refer to the 'Schematic Diagram of the functional connection of the main control board'for detailed information.
The main control board defaults to displaying the operating frequency;
Flashes to display the type of fault and displays Exx when there is a fault;
By pressing the up and down keys, you can enter the status query information and display C00;
By long pressing the confirm button (3s), you can exit the parameter query interface;
Under the default interface, long press the confirm button (3s) to enter the parameter setting interface, displaying P00; Select the parameters that need to be changed or queried through+-, and then click OK to change and set the current parameters;
Under the parameter setting interface, parameters can be set by pressing the+- keys; By pressing the confirm button, you can save the set parameters and return to the query status;

### 7.2. Status Query Table

| Code | Meaning | Description |
|---|---|---|
| C00 | operating frequency | |
| C01 | AC current (effective value) | |
| C02 | Operating phase current (peak) | |
| C03 | AC voltage | |
| C04 | Bus voltage | |
| C05 | Driver board fault codes | EXX corresponds to the drive board FXX and E00, indicating no faults |
| EXX corresponds to the drive board FXX and E00, indicating no faults | | |
| C06 | Frequency limiting code | |
| C07 | Radiator temperature | |
| C08 | Main control fault code | |
| C09 | Condensing temperature | |
| C10 | Return air temperature | |
| C11 | Ambient temperature | |
| C12 | Discharge temperature | |
| C13 | Cabinet temperature | |
| C14 | Evaporator temperature | |
| C15 | Low pressure sensor value | 100=1Mpa=10bar |
| C16 | 0/1/2 Defrosting type | Thermostat F14 |
| C17 | ^^EEV1^S Current EEV1 opening | |
| C18 | Current EEV2 opening | |
| C19 | Current fan 1 speed | Only use DC FAN |
| C20 | Current fan 1 speed | Only use DC FAN |
| C21 | Current overheating | Cyclic Refresh |
| C23 | Recent fault records | |

### 7.3. Controller setting parameters

**1) Electronic expansion valve related settings**

| Code | Meaning | min | Max | Default | Unit |
|---|---|---|---|---|---|
| P00 | EEV1 Minimum opening | 50 | 100 | 50 | Step |
| P01 | EEV1 Maximum opening | 450 | 500 | 500 | Step |
| P02 | EEV1 Default initial opening | 100 | 450 | 180 | Step |
| P03 | Initial opening duration | 50 | 500 | 150 | second |
| P04 | EEV1 adjusts Kp value | 1 | 200 | 18 | |
| P05 | EEV1 regulates Ki value | 1 | 200 | 4 | |
| P06 | EEV1 regulates Kd value | 1 | 200 | 8 | |
| P07 | EEV1 adjustment cycle | 20 | 1000 | 60 | second |
| P08 | EEV2 Minimum opening | 50 | 100 | 50 | Step |
| P09 | EEV2 Maximum opening | 450 | 500 | 500 | Step |
| P10 | EEV2 Default initial opening | 100 | 450 | 200 | Step |
| P11 | EEV2 Initial opening duration | 30 | 500 | 30 | second |
| P12 | EEV2 adjusts Kp value | 1 | 200 | 18 | |
| P13 | EEV2 regulates Ki value | 1 | 200 | 4 | |
| P14 | EEV2 regulates Kd value | 1 | 200 | 8 | |
| P15 | EEV2 adjustment period | 50 | 500 | 60 | second |
| P32 | The EEV1 opening does not decrease when the exhaust temperature is high | 60 | 120 | 70 | °C |
| **EEV1 opening does not decrease when discharge temperature is high** | | | | | |
| P33 | The EEV1 opening does not decrease when the exhaust temperature is high | 10 | 80 | 30 | °C |
| **EEV1 opening does not increase when discharge temperature is low** | | | | | |
| P34 | Type of refrigerant | 0 | 2 | 0 | |
| 0: R404 1:R448 2:R290 | | | | | |
| P35 | Overheating degree | 0 | 50 | 4 | |
| P36 | opening during defrosting | 50 | 500 | 100 | Step |

**Note: EEV1 slot defaults to controlling the main electronic expansion valve, and EEV2 defaults to controlling the spray cooling electronic expansion valve**

**2) Compression related parameter settings**

| Code | Meaning | min | Max | Default | Unit |
|---|---|---|---|---|---|
| P16 | Minimum frequency | 10 | 50 | 30 | Hz |
| P17 | Maximum frequency | 30 | 120 | 70 | Hz |
| **The P17 value cannot be set to be less than P16 setting value (Compressor operating frequency)** | | | | | |
| P18 | Compressor PID cycle | 5 | 500 | 60 | second |
| P19 | Compressor Kp value | 1 | 200 | 35 | |
| P20 | Compressor Ki value | 1 | 200 | 10 | |
| P21 | Oil return frequency | 10 | 70 | 35 | Hz |
| Entering return oil logic during continuous low-frequency operation | | | | | |
| P22 | | 10 | 80 | 50 | Hz |
| **P22 Operating frequency during oil return** | | | | | |
| P23 | Oil return interval time | 5 | 600 | 225 | min |
| P24 | Return oil running time | 5 | 1000 | 300 | second |
| P40 | Minimum press downtime | 60 | 1000 | 180 | second |
| **P40 Minimum downtime of the compressor** | | | | | |
| P31 | Target temperature compensation | 0 | 5 | 1 | °C |
| **P31 Target temperature compensation** | | | | | |

**3) Fan and spray control**

| Code | Meaning | min | Max | Default | Unit |
|---|---|---|---|---|---|
| P26 | Spray cooling opening Temp | 60 | 120 | 90 | °C |
| P27 | Spray cooling off Temp | 50 | 120 | 75 | °C |
| P41 | AC Fan on Temp | 15 | 105 | 35 | °C |
| P42 | AC Fan off Temp | 10 | 100 | 30 | °C |
| P51 | AC fan ambient start and stop temperature | 10 | 100 | 32 | °C |
| **P51 The temperature at which the AC fan is forced to start when the ambient temperature is high** | | | | | |
| P43 | Low wind speed of DC fan | 50 | 500 | 100 | RPM |
| P44 | High wind speed of DC fan | 500 | 1200 | 900 | RPM |
| P45 | DC fan control Temp | 10 | 20 | 10 | °C |
| P46 | Fan delay shutdown time | 0 | 240 | 10 | second |
| **P46 Delayed shutdown time of fan** | | | | | |
| P47 | Low voltage switch delay judgment time | 0 | 240 | 0 | second |
| **P47 Low pressure switch delay judgment time** | | | | | |

**4) Operation protection related settings**

| Code | Meaning | min | Max | Default | Unit |
|---|---|---|---|---|---|
| P28 | Low voltage switch delay judgment time | 50 | 50 | 35 | 0.5A |
| **P28 Compressor phase current too high shutdown point** | | | | | |
| P29 | Exhaust temperature is too high shutdown temperature | 120 | 120 | 110 | °C |
| **P29 High discharge temperature shutdown temperature** | | | | | |
| P30 | Condenser high temperature overload shutdown | 80 | 80 | 55 | °C |
| **P30 High condensation temperature shutdown temperature** | | | | | |

**5) Defrost settings**

| Code | Meaning | min | Max | Default | Unit |
|---|---|---|---|---|---|
| P37 | Compressor defrosting timing method | 0: Control board power-on timing | | 0 | |
| | | 1: Compressor start timing | | | |
| 0:Start timing when the control board is powered on ;1 Start timing when the compressor is turned on | | | | | |

## 8. Fault Code Table

### 1) Main control board fault code

| Code | Fault Type | Cause/Solution |
|---|---|---|
| E00 | Communication Failure | Check the communication line connection of the temperature controller |
| E01 | Return air Temp sensor malfunction | Check if the corresponding sensor on the main control board has poor contact or is damaged |
| E02 | Environmental Temp sensor failure | |
| E03 | Condensation Temp sensor malfunction | |
| E04 | Discharge Temp sensor malfunction | |
| E05 | Cabinet Temp sensor failure | Check if the corresponding sensor of the Temp controller |
| E06 | Evaporator Temp sensor malfunction | |
| E07 | Low pressure protection | Low pressur protection/sensor damage |
| E08 | High pressure protection | High pressure protection |
| E09 | Drive communication failure | Check the connection between the driver board and the motherboard |
| E10 | DC fan failure | Check the connection of the DC fan |
| E11 | Drive failure | Current driver board faults can be viewed through C05 |
| E13 | Condensation overload fault | Excessive condensation Temp |
| E14 | discharge Temp protection fault | discharge Temp too high |
| E15 | AC current overcurrent fault | Controller current too high |

### 2) Driver board fault codes

**Note: When the main control board generates an E11 drive fault, the current drive fault code can be queried through the main control board C05;**
**Used for C05 query comparison**

| Code | Fault Type | Reason/Solution |
|---|---|---|
| F01 | DC input overvoltage | Check input power |
| F02 | DC input low voltage | Check input power |
| F03 | Phase current output overcurrent | Abnormal motor |
| F04 | Out of step fault | Abnormal drive board or motor |
| F05 | Missing phase error O (speed judgment) | |
| F06 | Phase loss errori (current judgment) | |
| F07 | Inverter IPM fault (edge) | The driver board is abnormal and needs to be updated or replaced |
| F08 | Inverter IPM fault (level) | |
| F09 | PFC_ IPM fault (edge) | |
| F10 | PFC_ IPM fault (level) | |
| F11 | AC power supply phase loss | Check input power |
| F12 | AC overcurrent fault | |
| F13 | Total power overload fault | Check compressor operation |
| F14 | Abnormal AC voltage detection | Check input power |
| F15 | Abnormal bias voltage detection | Check input power |
| F22 | Communication failure | Check the communication line |
| F23 | Motor parameter setting fault | The driver board is abnormal and needs to be updated or replaced |
| F24 | DC motor fault | Check compressor operation |
| F28 | Control board temperature abnormality | Drive board Temp too high |
| F29 | Thermal protection fault | Drive board thermal protection |

## 9. Annex

1. Controller reference circuit Diagram

The actual controller used may use different drive boards due to the current power of the unit, so the wiring method may vary. Please refer to the configuration of the actual unit.