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Specification of controller for variable speed refrigeration condensing unit

Specification		Remark
Standard model	Controller for variable speed refrigeration condensing unit	（Match SANHUA Driver)
Extended model		
Extended model		

Revision record			
Revision	Revised by	Description	Date
V1.0.0	Z J	First edit	2020.1.7
	M Y Q	Supplementary description of the logic inside the code	2021.8.13
	M Y Q	Added parameter setting instructions and alarm logic table	2021.8.20

Checked by _____ Date _____

Approved by _____ Date _____

Contents

1. Overview

Controller for variable speed refrigeration condensing unit (hereinafter referred to as CDU) is specially designed for refrigeration applications. It includes a special control board (hereinafter referred to as the control board), a driver, a human machine interface (hereinafter referred to as HMI), an input filter (optional), a reactor, two communication cables, a low-pressure sensor (optional), and four temperature sensors (optional).

2. Control board

2.1. Parameter

No.	Item	Specification
1	Model	YMC-M-15T8D2C3P12R
2	Operating voltage range	220VAC±20%, 50/60HZ
3	Operating temperature range	-25~70℃
4	Analog input	15 channels NTC temperature detection NTC：R25=10kΩ, B = 3470 This parameter can be set in HMI. 3 channels 4-20mA current input detection Pressure sensor: 4-20mA output, the range can be set in HMI.
5	Digital input	8 channels digital input
6	Relay output	12 channels relay output Load：7A 250VAC/30VDC
7	Communication	RS485, Modbus

2.2. Hardware features

2.2.1. Analog input

4 of the 15 temperature detection channels are used in this CDU design, including condenser coil temperature, ambient temperature, suction line temperature and discharge line temperature. The condenser coil temperature, ambient temperature and discharge line temperature are used to control the condenser fans' speed. The suction line temperature and discharge line temperature are used to assist in controlling the speed of compressor.

Each of three 4-20mA current inputs is used to connect a pressure sensor. In design of this CDU, only low-pressure sensor is used for collecting suction pressure. It is used to control the speed of compressor and ensure that the suction pressure is maintained near the target pressure value.

All these functions can be enabled or disabled in HMI.

2.2.2. Digital input

In design of this CDU, two of the eight digital inputs are used to connect a low-pressure switch and a high-pressure switch to protect compressor. This function can be enabled or disabled in HMI.

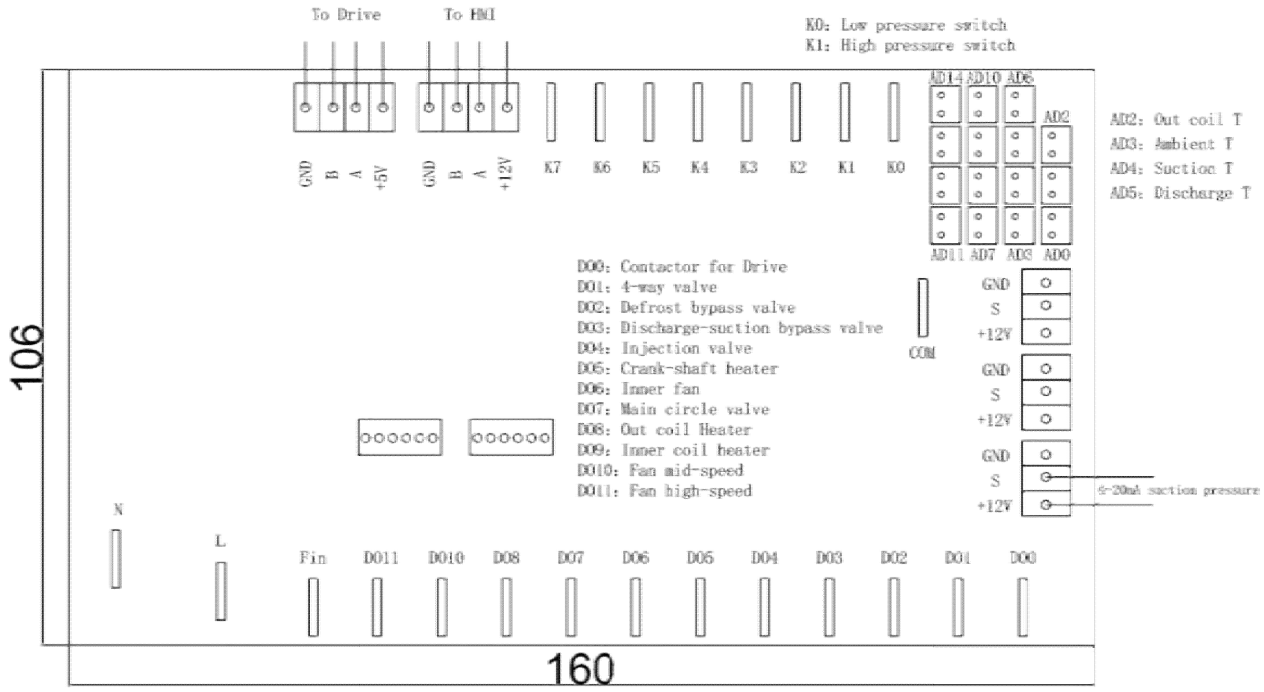
2.2.3. Relay output

In design of this CDU, 5 of the 12 relay outputs are used to control the contactor of driver, liquid line solenoid valve control, internal-coil defrost heating, running speed of the condenser fan (one for middle speed, one for high speed)

2.2.4. Communication

The controller has two RS485 communication ports, one communicates with the driver, and the other communicates with HMI.

2.2.5. Wiring diagram and size of controller



2.3. Software features

2.3.1. Working modes

There are three work modes: temperature-control refrigeration, pressure-control refrigeration and condensing unit;

Commonly used working modes are pressure-control refrigeration and temperature-control refrigeration; the condensing unit mode is suitable for situations where electronic expansion valves and four-way valves are not used;

If the temperature control mode is to be used, an analog input (the terminal temperature / cold storage temperature) needs to be added as the control target.

2.3.2. Start-up

When refrigeration system is shut down or standby and the following conditions are met at the same time, system will enter to running state:

1 / Received run command from HMI.

2 / System has no errors that caused the compressor to stop.

3 / Compressor has been stopped for more than 10 minutes since the last shutdown (the parameter is adjustable).

4 / Suction pressure is higher than the set value target pressure (Target pressure +differential).

2.3.3. Shutdown

Controller receives the stop command from HMI, then the system stops

2.3.4. Standby

When system is running, the system will enter the standby state when one of the following conditions is met:

1 / Suction pressure is below the set target pressure and the compressor speed is lower than or equal to the minimum speed.

2 / Suction pressure reaches protecting shutdown pressure (default setting 0.8bar).

3 / An error occurred that caused compressor to shut down.

2.3.5. System startup and shutdown process

After system satisfies the starting conditions from shutdown state, the bypass solenoid valve (if equipped) and liquid line solenoid valve are immediately turned on, after 5s for pressure balance, the condenser fan and evaporator fan are operated, and the bypass solenoid valve is turned off after energized for 50s, then compressor starts to run.

When system enters the shutdown mode, compressor will be stopped immediately, and the evaporator fan and condenser fan will be stopped after a delay of 30s, and all solenoid valves will be turned off.

When system enters the standby mode, compressor will be stopped immediately, and the condenser fan will be stopped after a delay of 30s, and the liquid line solenoid valve will be shut off after detecting the compressor has stopped running.

After system meets starting conditions from the standby state, the bypass solenoid valve and liquid line solenoid valve are immediately turned on, and the bypass solenoid valve is turned off after 50s, then compressor starts to run.

2.3.6. Compressor speed regulation

Compressor starts to adjust the speed after 1 minutes running; the adjustment period of the speed is 30s;

Under normal condition, controller calculates with PID algorithm according to the comparison between the actual suction pressure and the target pressure (pressure control mode), and adjusts between the highest and lowest speed.

When the discharge line temperature is higher than the set limit temperature (default setting 108°C), the controller will limit the compressor not to increase its speed; when it is lower than 98°C, it will resume the adjustment.

2.3.7. Electronic expansion valve adjustment

It is divided into main electronic expansion valve(for the liquid feed into evaporator)and branch electronic expansion valve (for the liquid feed into the enhanced vapor injection heat exchanger, if equipped), the control PID logic is basically the same; valve opening adjustment cycle is 30ms, according to the target opening +1 or -1;

Power-on initialization: the main and branch electronic expansion valve opens to the maximum opening of 500, and then drops to the initial opening of 20;

Running status failure detection: If suction temperature sensor failure is detected, the target opening of electronic expansion valve is set to a fixed opening of 250 (adjustable)

Start-up phase (3minutes before compressor starts to run): Delay 10s, and external ambit temperature is greater than -10°C, then the electronic expansion valve is set to the initial opening degree of 490;

Adjustment stage (3minutes after compressor running): At an interval of 30s, the target opening of electronic expansion valve is calculated according to the PID algorithm of the opening difference and superheat difference.

Compressor shutdown status: if compressor shutdown time is greater than 20s and less than 30s, the valve opening is opened to a minimum of 20; (reduce the starting load)

2.3.8. Speed of condenser fan

When system is in running mode, compressor starts to run, the bypass valve turns off, and suction valve turns on, then condenser fan starts to run;

Start-up phase of condenser fan: if the external coil temperature sensor failure is detected and the discharge pressure sensor is not enabled, the fan will be forced to run high-speed mode at 3 minutes before starting; if the discharge pressure sensor is enabled, adjust the speed of the external fan based on the saturation temperature of the discharge pressure conversion, otherwise adjust based on the temperature of the external coil;

External fan speed adjustment: If the temperature is greater than fan high-speed switching ambient temperature (default 15°C), the external fan will run at high speed mode; if the temperature is between the fan shutdown ambient temperature (10°C) and fan high-speed switching ambient temperature (15°C), the external fan will run at medium speed mode; if the temperature is lower than fan shutdown ambient temperature, the external fan will be stopped;

If compressor stops running, it will be delayed for 30s, the suction valve will be turned off, and the external fan will be stopped;

2.3.9. Evaporator fan or chiller water pump adjustment

In system running state, if the compressor is running, the internal fan (water pump) will be operated; if the compressor is stopped, the internal fan or water pump will be stopped after a delay of 30s.

2.3.10. Crankcase heater

When compressor is running or ambient temperature is higher than 30°C, the crankcase heater is turned off.

When compressor is shut down and ambient temperature is lower than 25°C, the crankcase heater is turned on.

2.3.11. Four-way valve adjustment (if equipped)

If unit stops running, 60s' delay after the compressor stops running, the four-way valve and bypass valve will be turned off;

If unit is in operation, the four-way valve and bypass valve will be enabled during 300s~400s after the compressor stops running; (code note: four-way valve reversal, air bypass valve balances system pressure)

After compressor stops running for more than 500s, thefour-way valve and bypass valve will be turned off;

2.3.12. Oil returns

When compressor runs continuously for 3 hours at a time and the compressor speed is lower than 3600rpm, the controller will increase the compressor speed to 3600rpm to take oil back, and continues to next speed adjustment cycle.

2.3.13. Defrost

Three defrosting modes: hot gas defrosting, natural defrosting and electric heating defrosting; the judgment conditions for entering each defrosting method are different;

Hot gas defrosting method is used by default, and the logic is as follows:

Conditions for entering defrosting: the outside ambient temperature is lower than 20°C, the inner coil temperature is lower than -3°C, and the heat exchange temperature difference between the inner coil and the outer ambient is lower than 10°C for more than 3 minutes;

Forced entry defrosting: forced defrosting in manual operation, ignoring the conditions for entering defrosting;

Conditions for exiting defrosting: reach the maximum defrostingtime-8min or inner coil temperature is above 12°C;

Forced exit defrosting: forced exit defrosting in manual operation, ignoring the conditions for exiting

defrosting;

When exiting defrosting: delay 3min for defrosting dripping;

2.3.14. System protection functions

There are temperature sensor fault, pressure sensor fault, communication fault, discharge temperature ultra high, condenser temperature ultra high, high pressure switch alarm, and low pressure switch alarm detection on controller.

Among them, the faults that will lead to the standby state of CDU include: the fault of the suction temperature sensor, the fault of the discharge temperature sensor, discharge temperature ultra high, condensing temperature ultra high, the high-pressure switch alarm, the low-pressure switch alarm, the communication fault with driver, and the fault of the suction pressure sensor.

The faults of suction temperature sensor, discharge temperature sensor, communication with driver and suction pressure sensor will automatically clear after troubleshooting.

The discharge line temperature ultra high, the condenser temperature ultra high, the high-pressure switch alarm and the low-pressure switch alarm have the limit for the number of automatic fault clearing. After the number of automatic fault recovery reaches the limit within half an hour, the fault state will not be automatically recovered. After manual troubleshooting, click “clear fault” on HMI. The automatic recovery time can be set on HMI.

2.3.15. Alarm logic table

Sensor fault can only be detected when it is enabled. The default enabled sensors are the outer coil temperature sensor, the outer ambient temperature sensor, the suction temperature sensor, and the discharge temperature sensor; the faults marked with a blue background are detected by default;

Alarm logic table			
Alarm name	**Description**	**Method**	**Recovery**
Storage temperature sensor fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the senor cable is connected, or check whether the interface is loose. Try to unplug and reconnect the senor.	Automatic recover after troubleshooting
Inner coil temperature sensor fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
External coil temperature sensor fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Outer ambient temperature sensor	Detected temperature value is	When the CDU is standby, check whether the sensor cable is connected,	Automatic recover after

fault	out of normal range	or check whether the interface is loose. Try to unplug and reconnect	troubleshooting
Suction temperature sensor fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Discharge temperature sensor fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Economizer inlet temperature sensor fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Economizer outlet temperature sensor fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Fault of temperature sensor before valve	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Spare sensor 1 fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Spare sensor 2fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Spare sensor 3fault	Detected temperature value is out of normal range	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Discharge temperature ultra high protection	Discharge temperature＞125°C	CDU standby. If there are 3 faults within half an hour, the system will be locked. After manual troubleshooting, click on HMI to clear the fault.	Locked state needs to be restored manually
Discharge temperature ultra high-speed limit	Discharge temperature＞108°C	Reduce compressor speed, automatic recover when the discharge temperature is lower than 98°C	Automatic recover
Condensing temperature ultra high protection	The saturation temperature of discharge pressure conversion or outer	CDU standby. If there are 3 faults within half an hour, system will be locked. After manual troubleshooting, click on HMI to clear the fault.	Locked state needs to be restored manually

	coil temperature exceeds 65°C (depending on whether the high pressure sensor is enabled)		
Condensing temperature ultra high-speed limit	The saturation temperature of discharge pressure conversion or outer coil temperature exceeds 60°C (depending on whether the high pressure sensor is enabled)	Warning only. Automatic recover when discharge temperature is lower than 60°C	Automatic recover
High pressure protection	Received high pressure signal or detected discharge pressure＞32bar	CDU standby. If there are 3 faults within half an hour, the system will be locked. After manual troubleshooting, click on HMI to clear the fault.	Locked state needs to be restored manually
Low pressure protection	Received low pressure signal or detected suction pressure＜0.2bar	CDU standby. If there are 3 faults within half an hour, the system will be locked. After manual troubleshooting, click on HMI to clear the fault.	Locked state needs to be restored manually
Inverter communication fault	Failed to communicate with the inverter for 10s consecutively (1 test in 0.5s)	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Suction pressure sensor fault	Detected the suction pressure is 0	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Discharge pressure sensor fault	Detected the discharge pressure is 0	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Backup pressure sensor fault	Detected the backup pressure is 0	When the CDU is standby, check whether the sensor cable is connected, or check whether the interface is loose. Try to unplug and reconnect	Automatic recover after troubleshooting
Humidity Sensor	N/A	N/A	N/A
High pressure protection 2	High pressure signal received	Reserved interface, consistent with high pressure protection function	Locked state needs to be restored

			manually
Low pressure protection 2	Low pressure signal received	Reserved interface, consistent with lowpressure protection function	Locked state needs to be restored manually

2.3.16. Parameter settings table

Parameter description: enable and disable;

Enable: turn on the corresponding peripheral and make it work
Disable: turn off the corresponding peripheral and make it stop working

The factory setups include a large number of temperature sensor enable, pressure sensor enable, switch input enable, and relay output enable, which are not described in the table.

Parameter settings table		
Category	**Name**	**Description**
User setup	Work mode	Three work modes: Temperature control mode: use the refrigeration temperature and the temperature control pressure hysteresis to control the unit; Pressure control mode: uses refrigeration pressure and pressure control hysteresis to control the unit; Condensing unit mode: same as the pressure control mode, which is suitable for the situation where the EXV and four-way valve are not used
	Refrigerant	It can be set to R134A, R404A, R22, R410A according to different system refrigerant
	Refrigeration pressure/ temperature	Set the refrigeration pressure in the pressure control and condensing unit mode, the unit is bar, and the initial default is 3.0 bar; Set the cooling temperature in temperature control mode, the unit is °C, and the initial default is 0°C
	Pressure control hysteresis/temperature control hysteresis	The compressor start condition of the pressure control refrigeration is that the suction pressure is greater than the target cooling pressure plus the pressure control hysteresis The compressor start condition of the temperature control refrigeration is that the storage temperature is greater than the target cooling temperature plus the temperature control hysteresis
	Pressure control stop pressure	Three working modes all adopt pressure-control shutdown; the unit is bar,default is 0.8bar. If the current suction pressure is lower than the pressure-control shutdown pressure, the compressor will stop;

3. Driver

For details, please refer to the specification of driver

4. HMI

4.1. HMI specification

HMI specification table		
Hardware performance	**Model**	**KNS035G2B**
	Display	3.5”TFT LCD
	Resolution	320×240 PX
	Color	260,000
	Luminance	400 cd/m^2
	Backlight	LED
	LED life	20000 Hours
	Screen	4-wire industrial resistance touch screen (surface hardness 4H)
	CPU	32-bit200MHz ARM9
	Memory	128M FLASH
	RTC	Built-in real-time clock
	Ethernet	N/A
	USB port	1* USB2.0 Device
	Download mode	USB download
	USB disk	N/A
	Serial port	2 channels, COM1/COM2 only support RS485
Electrical specifications	Rated power	<2W
	Rated voltage	DC12V-24V (±15%)
	Power protection	Surge protection
	Power loss	< 5 mS
	CE & RoHS	EN61000-6-2:2005，EN61000-6-4:2007,Surge±4KV, Group impulse±4KV；Electrostatic contact 4KV, Air discharge 8KV
Environmental specifications	Working temperature	0~50℃
	Storage temperature	-20~60℃
	Ambient humidity	10~90%RH（No condensing）
	Aseismic property	10～25 Hz (X,Y,Z direction 2G/30 minutes)
	Cooling mode	Natural air cooling

Others	Protection level	IP20
	Hole size	68mm×68mm
	Outline size	86mm×86mm×26mm

4.2. Instructions

4.2.1. Initial interface

Electrify the system, waiting for the initialization of main control board;

If it takes more than one minute for initialization, please troubleshoot the communication between wire controller and main control board

4.2.2. Home page

Main information:

Screen lock, On/off,State, Set, Alarm, Compressor status, Speed,Mode, Target value; Target hysteresis; Current value; Errors; Clear errors; Time.

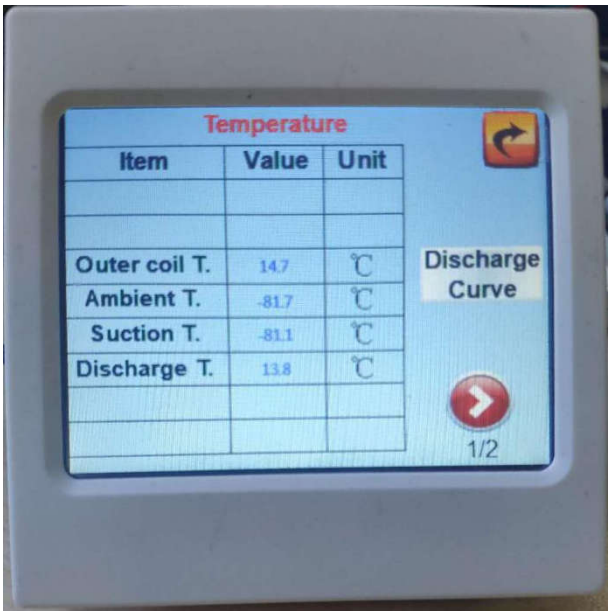
is a lock to prevent mistakenly touching, it appears after pressing ,then press to start up system with the icon turns to . To shut down the system, please press .

4.2.3. Status check

Press , to check the status

4. 2. 3. 1. **Temperature**

To check the temperature by press 



4. 2. 3. 2. **Pressure**

Press 

, to check the pressure.

4. 2. 3. 3. **Switches input**

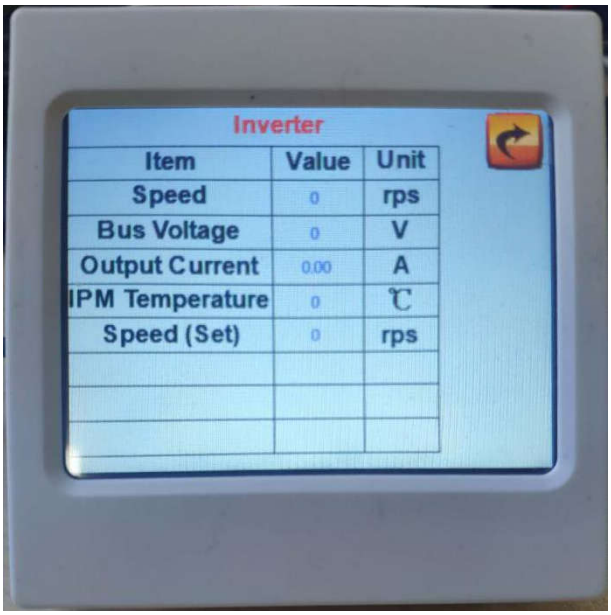
Press Digital Input, to check the switching input

4. 2. 3. 4. **Relay output**

Press Relay Output, to check the relay output.

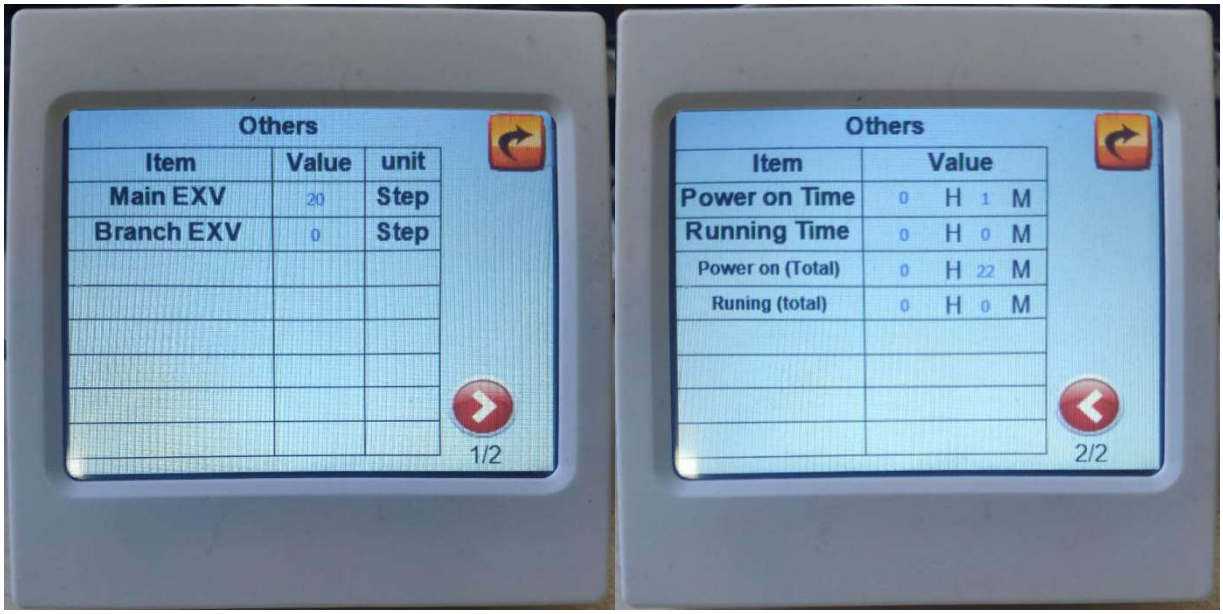
4. 2. 3. 5. **Inverter status**

Press Inverter, to check the status of inverter.



4. 2. 3. 6. **Other status**

Press Others, to check the other status.

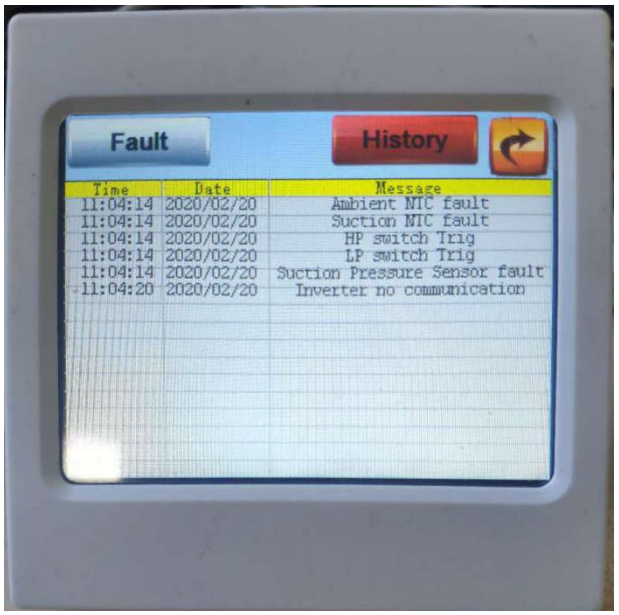


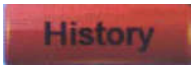
4.2.4. Alarm record

If an alarm situation occurs during operation, the homepage will show 

. Press 

for more details.



Press 

to check alarm records.

In most cases, system will automatically recover after troubleshooting. For some faults like low pressure protection, high pressure protection, discharge temperature protection, condensing temperature protection, press 

to clear the fault information.

4.2.5. Setting

Press 

, to access the setting.

Language selection, press 

for English and press 

for Chinese.

Switch 

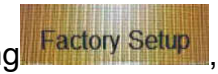
is for alarm ring.

Switch 

is for touching sound.

Press 

, to set the refrigerant, target pressure, hysteresis and minimal pressure to shutdown the compressor.

Default setting 

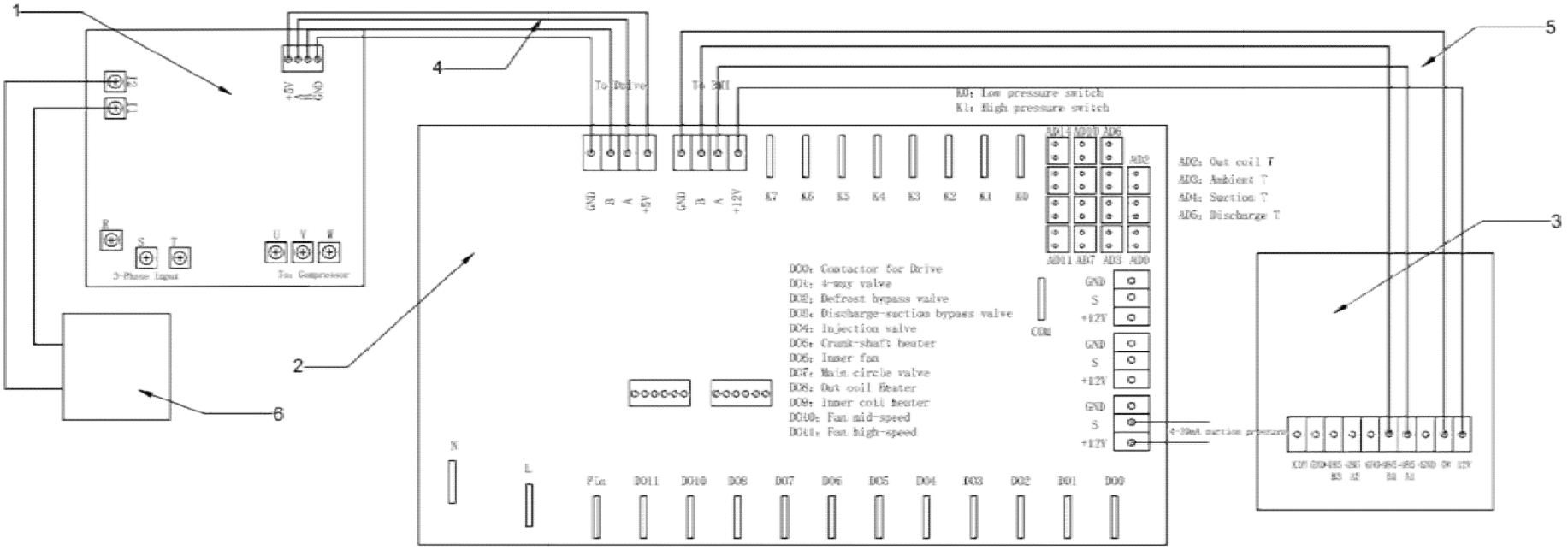
, it is not recommended to modify by customer. Password is required; please contact the manufacturer for more information

Press 

to restore factory settings, get the access by password “2222” and press 

again.

5. Wiring diagram



No.	Part No.	Name	Qt	Material	Each Weight	Total Weight	Note
6	100-2004-XX	Reactor	1				
5	100-2008-01	Communication cable	1				
4	100-2008-00	Communication cable	1				
3	100-2002-00	HMI	1				
2	100-2001-00	Controller	1				
1	100-2003-XX	Driver	1				