Test Project

Part B – Specifications, drawings and information

Refrigeration and Air Conditioning

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WSC2026_TP38_en

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Introduction

This Test Project was developed by Independent Test Project Designer.

Part A Module descriptions and Competitor instructions will be released by WorldSkills International to the Experts, Interpreters, and Competitors one (1) month prior to the Competition to enable it to be translated into the Competitor's preferred language.

Part B Specifications and drawings will be released by the Skill Competition Manager to the:

- Experts at the Competition (C-4)
- Competitors at the Competition (C-2)

This Test Project reflects the best international practice as described by the Technical Description and the WorldSkills Occupational Standards. The Test Project's Marking Scheme will for the most part assess and allocate marks to those skills that are set out in the WorldSkills Occupational Standards.

Description of project and tasks

The Test Project is a series of standalone modules.

There are four (4) modules to complete in the 15 hours of Competition over four (4) days.

- Module A – System installation and commissioning — Time allowed 3.5 hours
- Module B – Refrigeration systems electrical fault-finding — Time allowed 2.25 hours
- Module C – Component fabrication and brazing — Time allowed 2.25 hours
- Module D – Refrigeration system fault finding and repair — Time allowed 7.0 hours

Test Project documentation

The Test Project documentation is a series of standalone modules and consists of the following two (2) parts:

Part A – Module descriptions and Competitor instructions

This contains all the Competition details for each module, including the task description, time limits, and instructions to the Competitor.

Part B – Module specifications drawings and information

This document Test Project Part B contains the Test Project drawings, information, and specifications including the following:

- Refrigeration system piping diagram
- Electrical circuit diagram
- Refrigeration system components layout
- Refrigeration system installation specifications
- Fault finding system's specification and drawings
- Component fabrication drawing

This will be provided to all Experts at the Competition at C-4 to enable it to be translated into the

Competitor's language and presented with translations to the Competitor at C-2.

Equipment manufacturers' drawings and instructions

The details for most of the equipment were possible will be released on the WorldSkills Infrastructure List to the participating Members in June 2026 in preparation for WS2026 Shanghai to enable relevant manufacturers' instructions to be sourced by the Experts and translated into the Competitor's language if needed and provided to Competitors prior to the Competition for use in this Competition.

Additional Information

The installation instructions supplied with the equipment and accessories on site will be used for installation and commissioning.

Any additional information will be provided to all Competitors at the familiarization prior to start of the Competition.

Call light (colour cards) and corresponding K-number buttons on the XKRAAC training unit:

- K1 – Light blue: Unit operational and commissioning in progress
- K2 – Purple: Ready for welding/brazing
- K3 – Dark blue: Ready to commence the evacuation process
- K4 – Red: Ready to apply power supply to the unit
- K5 – Yellow: Ready to add nitrogen to the system for pressure testing
- K6 – Lime green: Call Experts for technical support



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Module A – System installation and commissioning

System design specifications

Below are system design specifications and drawings for the Heat Pump unit that will be used for the installation and commissioning.

Split Heat Pump Water Heater:

- Make: Midea
- Rated Capacity 200lt Heating 2.60 kW
- Indoor unit: Model No: MT-200R26E20-
- Outdoor unit: Model No: MHW-F26WN3-
- Electrical Rating: 1 phase, 220~240-volt AC, 50 Hertz, 10 amp

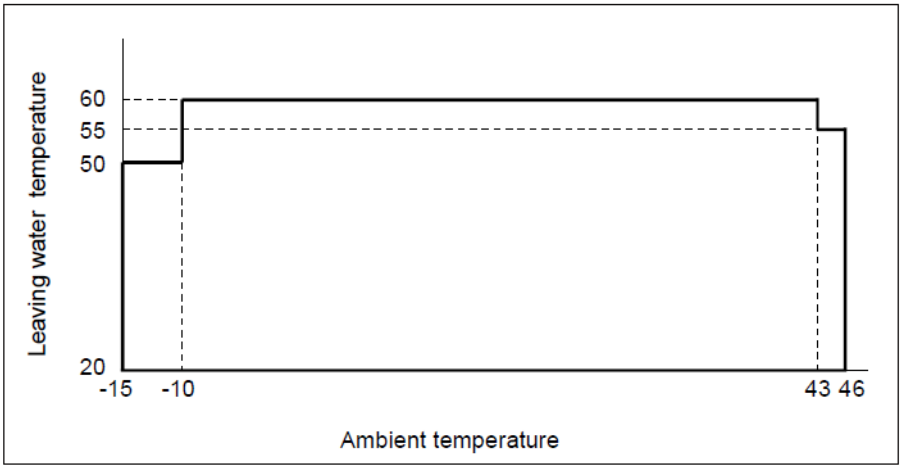
Design Conditions

- Refrigerant = R32
- Refrigerant Charge = 600 grams (21.2 ounces) TBC
- Unit charge for pipe runs between 2 meters to 10 meters. (6.6 feet – 32.9 feet)
- Operating ambient temperature = -15°C - 46°C (5°F - 115°F)
- Leaving water temperature = 20°C – 60 °C (68°F - 140°F)
- Tank Set Point = 55°C (131°F)
- Set "Dial code" (Dip Switch) with no auxiliary heater
- Design saturated suction temperature = 5°C (41°F)
- Difference between the air-entering and the evaporation temperature = 20 Kelvin (35°F)
- Suction line pressure drop = 1 Kelvin (2°F)
- Condensing temperature = 45°C (113°F) (Approx)
- Maximum current = 8.7A

Unit: ℃ *Table 2-4*

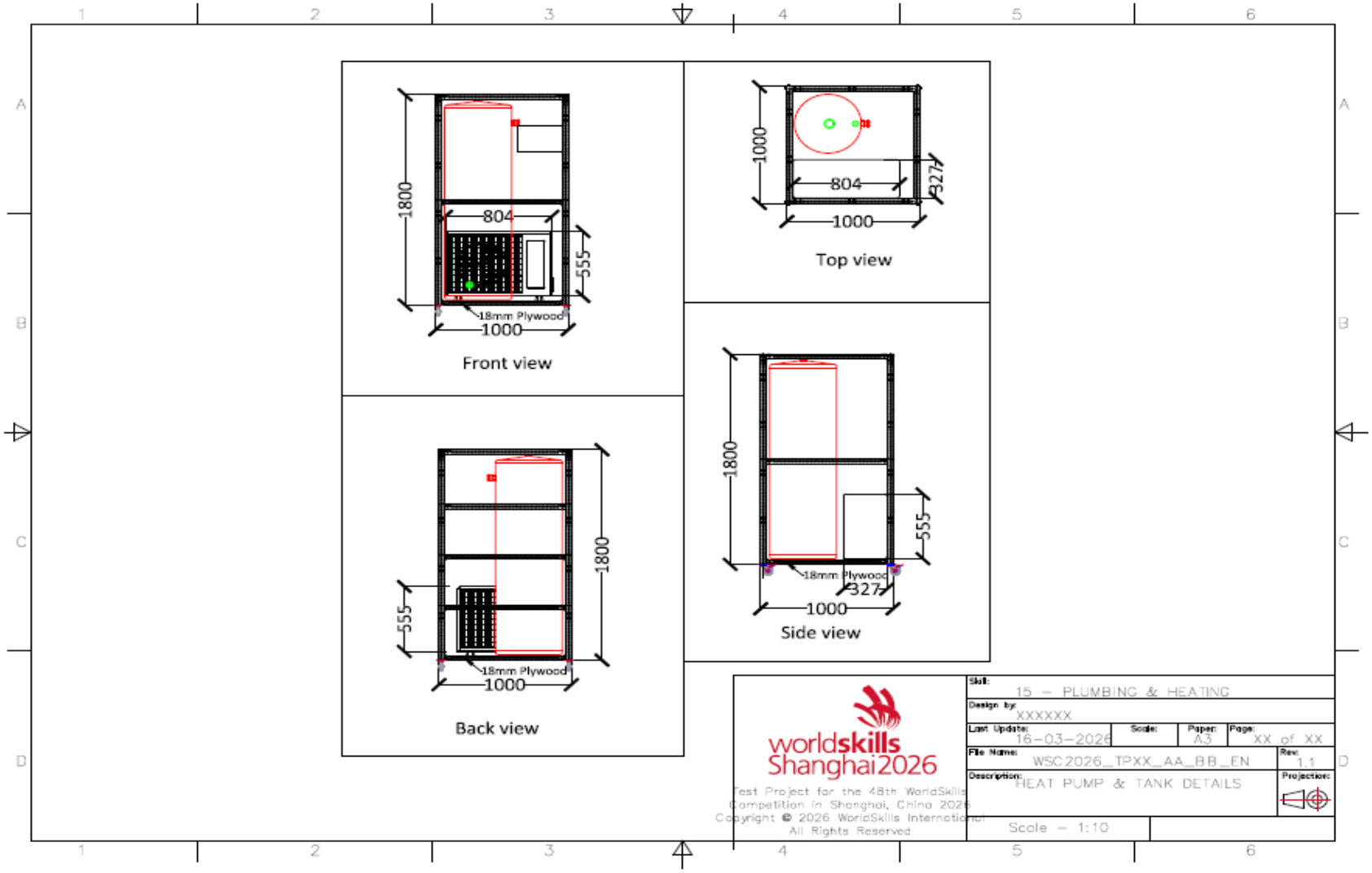
Ambient temperature	Leaving water temperature
-15~-10	50
-10~43	60
43~46	55

Fig. 2-3

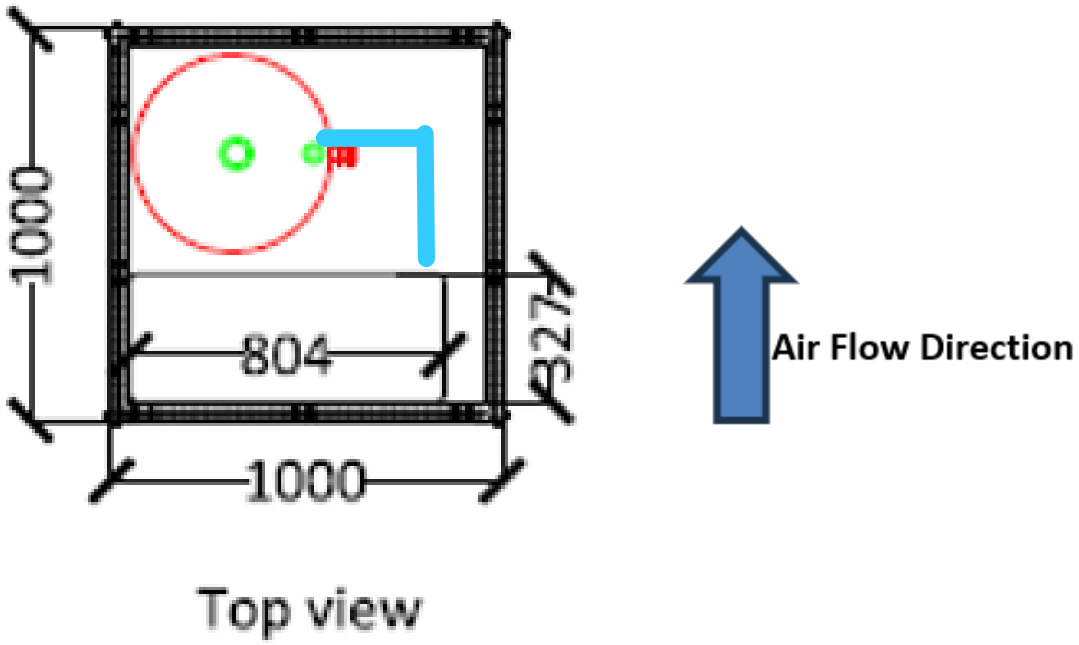


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Units position on frame



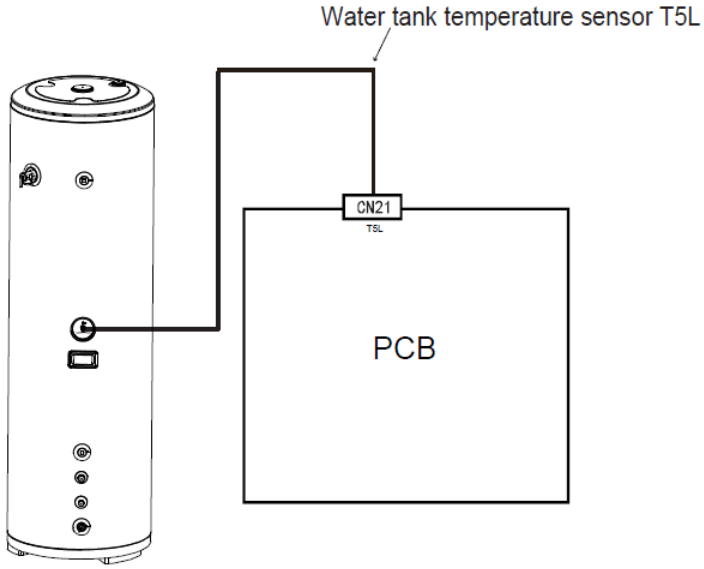
Heater cylinder and outdoor unit refrigeration pipe pathway



Refrigerant pipe pathway connecting outdoor unit and water tank shown above.

Water tank temperature sensor installation

Connect the water tank temperature sensor wire connector to the outdoor unit T5L connector. PCB/Controller is to be mounted to wall board centrally.



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Possible work practices and/or check point values, Competitor could confirm with Experts in this Module A.

WORK/CHECK POINT	COMPETITOR TICK AND SIGN	EXPERTS SIGN	DATE AND TIME
To start brazing			
Finished commissioning			
Electrical safety			
Charging refrigerant			
Evacuation			
Lock out tag out			
Pressure test			
Refrigerant components			
System pipe work installs			
Break vacuum			
Low pressure control set			
High pressure control set			
Fan cycling control set			
Temperature control set			
Overload set			
Energize Unit			

Notes/workings:_____

_____

_____

_____

_____

_____

_____

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Possible electrical tests to ensure the installed system is safe to energize and record the results below.

1. Earth continuity from supply plug top to:

POSSIBLE TEST LOCATION	RECORDED VALUE
Condenser unit frame	
Condenser unit electrical terminations mount	
Condenser unit pipe work	
Evaporator electrical box	
Evaporator pipes support	
Main earth of unit	

2. Continuity of supply:

POSSIBLE TEST LOCATION	RECORDED VALUE
Supply plug top to main Active link	
Supply plug top to main Neutral link	
Supply plug top Active to Neutral	

3. Insulation resistance:

POSSIBLE TEST LOCATION	RECORDED VALUE
Supply plug top Active and Earth	
Supply plug top Neutral and Earth	

4. Electrical Supply Voltage

POSSIBLE TEST LOCATION	RECORDED VALUE
Active and Neutral	
Active and Earth	
Neutral and Earth	

5. Based on your above tests, is the unit safe to connect to the electrical supply?

□ **Yes, or** □ **No, because: (Tick your answers below).**

TEST	□ **YES**	□ **NO**
It is electrically safe		
The earth is not connected		
The polarity is not correct		
There is a short between Active and Earth		
There is a short between Neutral and Earth		

EXPERTS COMMENTS:	
Refrigeration system electrical testing – Assessed **All wiring inspected and installation electrically safe to connect to supply** Day No._____Time: _____	Expert 1 Initials and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:

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System commissioning report – Module A (C1)

RECORDED CONDITIONS BELOW IN HEATING	HEATING VALUES	UNITS
Refrigerant type and Amount		R grams
Ambient temperature		□ Celsius □ Fahrenheit
Air on Outdoor Unit Dry Bulb temperature		□ Celsius □ Fahrenheit
Air off Outdoor Unit Dry Bulb temperature		□ Celsius □ Fahrenheit
Suction pressure (Gauge) TBC		□ kPa □ psi □ bar □ kg/cm^2
Evaporation temperature		□ Celsius □ Fahrenheit
Discharge pressure: (Gauge) TBC		□ kPa □ psi □ bar □ kg/cm^2
Condensing temperature		□ Celsius □ Fahrenheit
Liquid line temperature at Outdoor Unit		□ Celsius □ Fahrenheit
Unit's operating current		Amps
Controller set point		□ Celsius □ Fahrenheit
Full Tank of Water Temperature at power on		□ Celsius □ Fahrenheit
Full Tank of Temperature @ 5 Minutes of operation		□ Celsius □ Fahrenheit
Full Tank Temperature @ 15 Minutes of operation		□ Celsius □ Fahrenheit
Full Tank Temperature @ 30 Minutes of operation		□ Celsius □ Fahrenheit

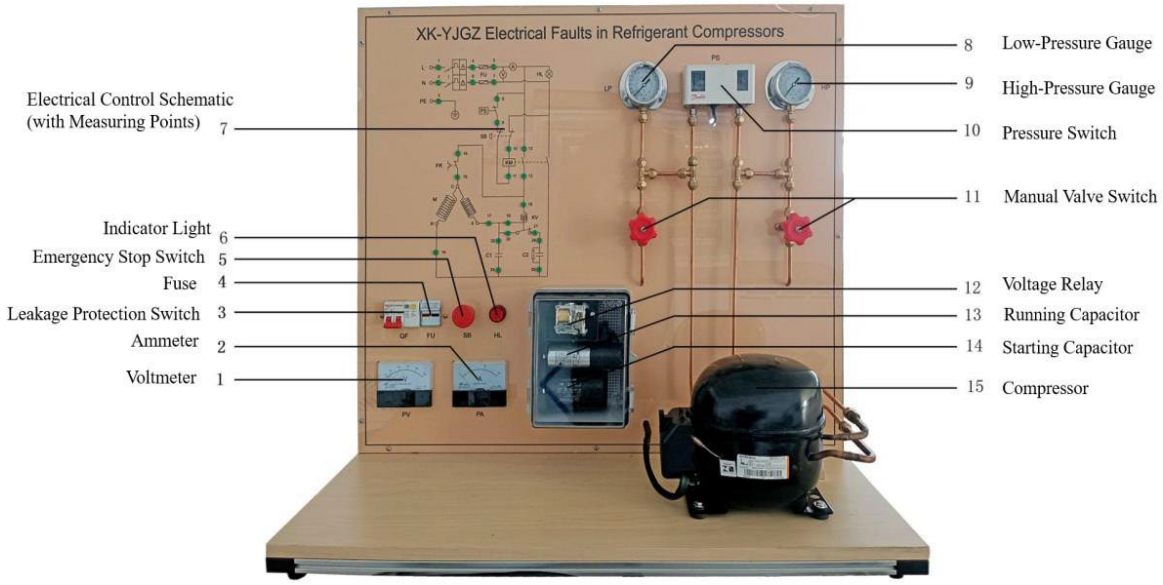
RECORDED CONDITIONS BELOW IN HEATING	HEATING VALUES	UNITS
Full Tank Water Temperature @ cut out		□ Celsius □ Fahrenheit
Control Display Reading	Normal display =	
	Running mode =	
	Outdoor fan speed =	

EXPERTS SIGN OFF	
Refrigeration system commissioning – Completed Day No._____Time: _____	Expert 1 Initials and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:

Module B – Refrigeration system electrical fault finding

Refer to relevant Electrical Diagrams provided in this Test Project Part B.

XK-YJGZ Electrical faults in refrigerant compressors information



Unit description and operation

Display Devices

1. V (Voltmeter) Measures voltage across the circuit
2. A (Ammeter) Measures current drawn by the system
3. HL (Indicator Light) Shows system ON/OFF status.

Power Supply Section

1. L (Live), N (Neutral), PE (Protective Earth) Main incoming AC supply
2. QF (Leakage Protection Switch) Main isolator for the system, provides earth leakage protection.
3. FU (Fuses) Protects against short circuit and overcurrent.

Protection and Control

1. PS (Pressure Switch) Opens control circuit if pressure is too high/low, protects compressor from abnormal pressure.
2. ES (Start/Stop / Emergency Switch) Manual control of compressor, starts or stops the system.
3. FR (Overload Protector) Thermal protection device uses bimetallic strip.

Main Circuit and Contactors

1. KM (Contactor) Main switching device, coil controlled in control circuit, contacts switch compressor power.
2. M (Compressor Motor) Terminals:

   (a) C (Common)
   (b) R (Run winding)
   (c) S (Start winding)

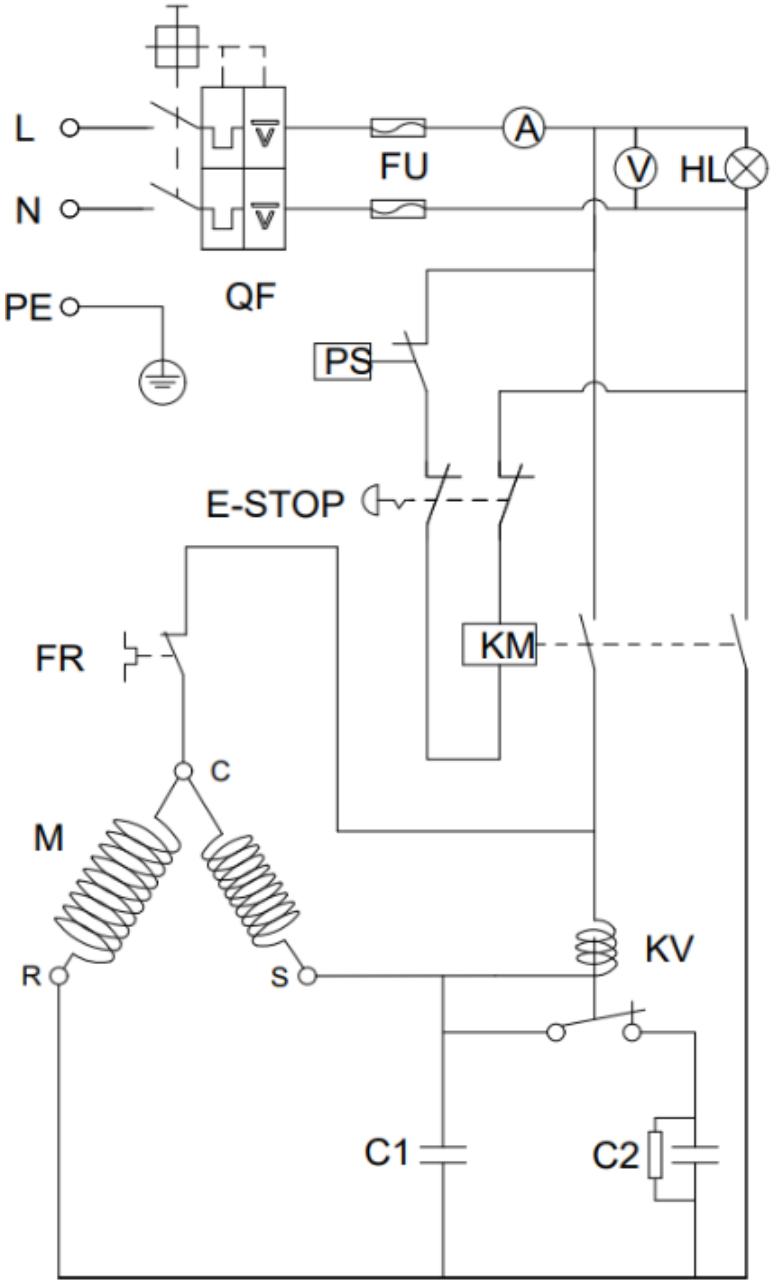
Starting and Running Components

1. KV (Voltage-Type Starting Relay) Aids in compressor startup:

   (a) C1 (Run Capacitor)
   (b) C2 (Start Capacitor)

Summary

This circuit is a typical, complete single-phase compressor, Capacitor Start - Capacitor Run (CSR) control circuit. It integrates components such as manual control (SB), automatic pressure protection (PS), overcurrent/short circuit protection (FU), overload/overheat protection (FR), and automatic start control (KV, C1, C2).



XKYJGZ Electrical Schematic Electrical Drawing

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Module B – Refrigeration system electrical fault readings

Starting with the overall unit electrical safety tests, record results here:

_____

There are 16 (sixteen) electrical faults on the Unit to test and record your test values, point location for fault found, and the description of the fault. Record in table below.

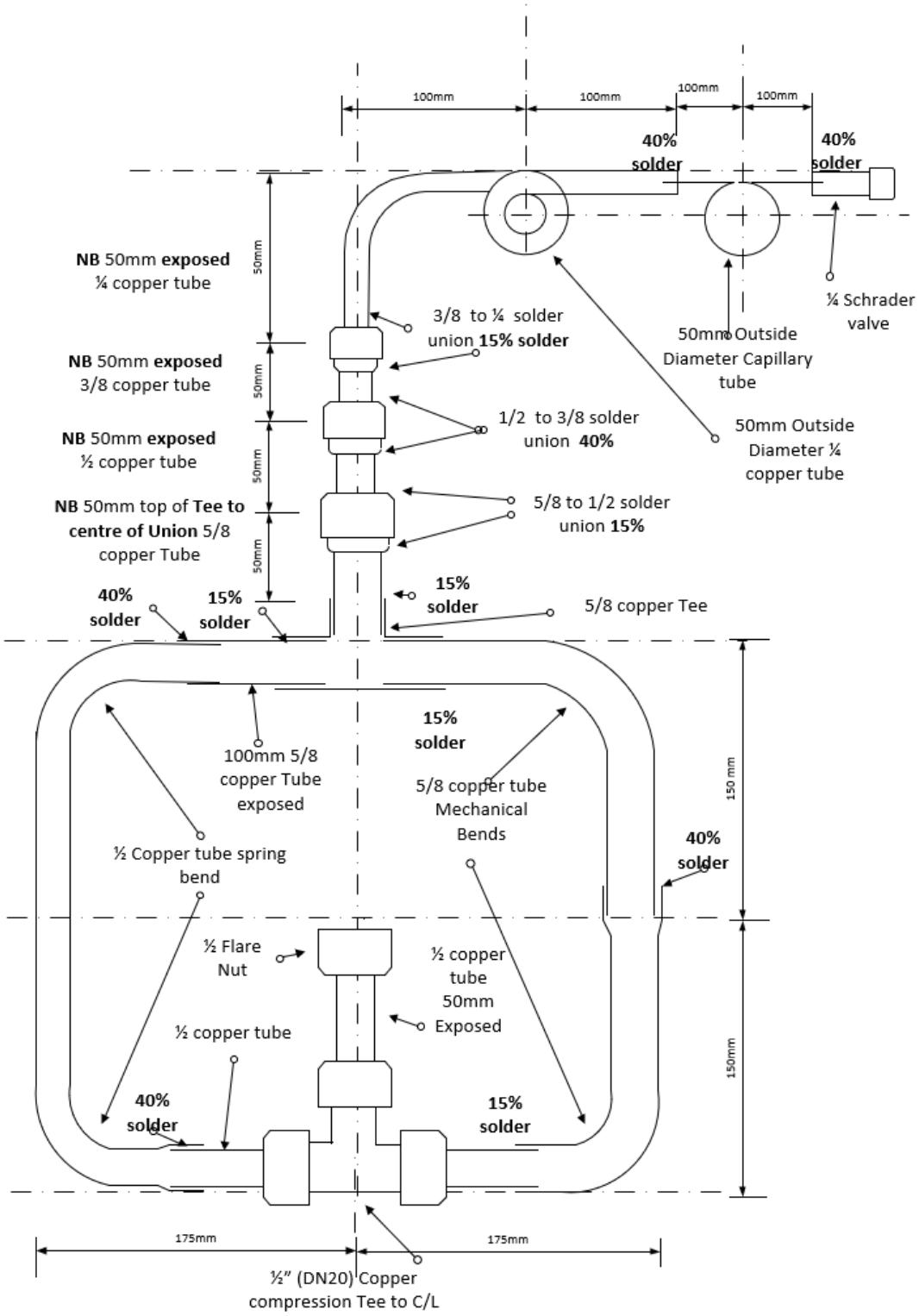
FAULT NUMBER	TEST POINT FAULT LOCATIONS #	READINGS	ANSWER	RESULT
1				□ Yes or □ No
2				□ Yes or □ No
3				□ Yes or □ No
4				□ Yes or □ No
5				□ Yes or □ No
6				□ Yes or □ No
7				□ Yes or □ No
8				□ Yes or □ No
9				□ Yes or □ No
10				□ Yes or □ No
11				□ Yes or □ No
12				□ Yes or □ No
13				□ Yes or □ No
14				□ Yes or □ No
15				□ Yes or □ No
16				□ Yes or □ No

This task is to be carried out, and the report filled in by Competitors under supervision by Experts.

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Module C – Component fabrication

Component fabrication drawing



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Module D – Refrigeration system fault finding and repair

System design specifications

Below are system design specifications and drawings for the XK-RAAC-WS Comprehensive Training Unit of Refrigeration and Air Conditioning unit that will be used for the installation and commissioning.

- Manufacture: Shandong Xingke Digital Technology
- Model: RAAC-XK Training Unit
- Electrical Rating: 3 phase, 400~415-volt AC, 50 Hertz, 10 amp

System Design Specification

The following system design specifications for the installation should be used for commissioning and control setting and are as follows:

- System Type: Refrigerated Trainer Unit
- Refrigerant = R513A
- Design space/air off temperature = 10°C +/- 1K (50°F +/-2°F)
- Maximum ambient temperature = 35°C Db, 28°C Wb (95°F Db, 82°F)
- Cabinet temperature controller is to cut out at 10°C (50°F) and cut in at 12°C (72°F)
- Design saturated suction temperature (SST) = -4°C (25°F)
- Suction line pressure drop = 1 K (2°F)

Control and safety settings

- Temperature Controller
  - The Controller is set to operate the evaporator fan/s.
  - S1 probe (TCP1) is to be installed to sense the temperature of the air off the evaporator coil.
  - S2 probe (TCP2) is to be installed to sense the temperature of the pipe.
- Dual pressure Controller
  - Low Pressure cut off 20K (35°F) lower than design saturated suction temperature (SST) and cut in at 2°C (35°F) saturated suction temperature
  - High Pressure cut out when the condensing temperature reaches 55°C (130°F). The differential is factory set.

Possible work practices and/or check point values, Competitor could confirm with Experts in this module D.

WORK/CHECK POINT	COMPETITOR TICK AND SIGN	EXPERTS SIGN	DATE AND TIME
Start brazing			
Finished commissioning			
Electrical safety			
Charging refrigerant			
Evacuation			
Lock out tag out			
Pressure test			
Refrigerant components			
System pipe work installs			
Break vacuum			
Low pressure control set			
High pressure control set			
Fan cycling control set			
Temperature control set			
Overload set			
Leak testing			

Notes/workings:_____

_____

_____

_____

_____

_____

_____

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Possible electrical tests to ensure the installed system is safe to energize and record the results below.

1. Earth continuity from supply plug top to:

POSSIBLE TEST LOCATION	RECORDED VALUE
Condenser unit frame	
Condenser unit electrical terminations mount	
Condenser unit pipe work	
Evaporator electrical box	
Evaporator pipes support	
Main earth of unit	

2. Continuity of supply:

POSSIBLE TEST LOCATION	RECORDED VALUE
Supply plug top to main Active link	
Supply plug top to main Neutral link	
Supply plug top Active to Neutral	

3. Insulation resistance:

POSSIBLE TEST LOCATION	RECORDED VALUE
Supply plug top Active and Earth	
Supply plug top Neutral and Earth	

4. Electrical Supply Voltage

POSSIBLE TEST LOCATION	RECORDED VALUE
Active and Neutral	
Active and Earth	
Neutral and Earth	

5. Based on your above tests, is the unit safe to connect to the electrical supply?

□ **Yes, or** □ **No, because: (Tick your answers below).**

TEST	**□ YES**	**□ NO**
It is electrically safe		
The earth is not connected		
The polarity is not correct		
There is a short between Active and Earth		
There is a short between Neutral and Earth		

EXPERTS COMMENTS:	
Refrigeration system electrical testing – Assessed **All wiring inspected and installation electrically safe to connect to supply** Day No._____Time: _____	Expert 1 Initials and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:

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Module D – Task 1 and 2 [C2/C3] – Commissioning report

Fill out the following commissioning report when the system is fully operational and operating close to the design saturated suction temperature. Please indicate units by checking appropriate boxes.

The report filled in by Competitor; Readings #1 for day C2 and Readings #2 on day C3

CONDITION	READINGS #1 COMMISSIONING (C2)	READINGS #2 AFTER REPAIR (C3)	UNIT
Refrigerant Type			
Mass of Refrigerant Charge			□ grams □ ounces
Ambient Temperature			□ Celsius □ Fahrenheit
Air-Off Evaporator Temperature			□ Celsius □ Fahrenheit
Suction Pressure (Gauge)			□ kPa □ psi □ bar
Evaporation Temperature			□ Celsius □ Fahrenheit
TX bulb Temperature			□ Celsius □ Fahrenheit
Compressor Suction Pipe Temperature			□ Celsius □ Fahrenheit
Discharge Pressure: (Gauge)			□ kPa □ psi □ bar
Condensing Temperature			□ Celsius □ Fahrenheit
Liquid Line Temperature			□ Celsius □ Fahrenheit
CONDITION		**QUANTITY**	**UNIT**
TX Valve Superheat	Show workings	Show workings	□ Kelvin □ Fahrenheit
Total Suction Superheat	Show workings	Show workings	□ Kelvin □ Fahrenheit
Total Liquid Line Subcooling	Show workings	Show workings	□ Kelvin □ Fahrenheit
Temperature controller's Set Point			□ Celsius □ Fahrenheit
Temperature controller's Differential			□ Kelvin □ Fahrenheit
Unit Operating Current			Amps

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Based on the readings above, is the refrigeration system operating safely and efficiently per the design specifications?

C2 □ Yes, or □ N **C3 □ Yes, or □ N**

Refrigeration Fault C3:

Identify the symptom/s on the list below with a tick √: that helps you identify the fault.

□ Compressor operation noisy	□ Compressor discharge line very hot
□ System current draw much lower that rated	□ System current draw higher that rated
□ Low operating suction pressure	□ High operating suction pressure
□ Suction pipe return temperature high	□ Signs of flood back to compressor
□ Low operating head pressure	□ High operating head pressure
□ Evaporator coil fin partially iced up	□ System short of gas – bubbles in sight glass
□ Evaporator coil fins fully iced up	□ TX valve operation ericaite (hunting)
□ Low oil levels in compressor	□ Longer Compressor run times
□ Compressor short cycling	□ System is over charge with refrigerant
□ TX valve flooding system	□ Suction pressure rising and falling quickly
□ Other:	Other:

On C3, write your answer here and on the wire diagram on page 19 draw in changes to diagram for the repair carried out.

The refrigeration fault is:

Answer:_____
_____
_____
_____
_____
_____
_____

Module D – Indicator lights and switch instructions



- **TC:** Temperature Controller
- **SA1:** Controls compressor operating status (Shown in the "ON" position)
- **SA2:** Powers the temperature controller. Based on the set temperature, the temperature controller controls the operating status of the evaporator fan/s. (Shown in the "ON" position)
- **HR1:** Power supply indicator
- **HR2:** AC contactor power supply indicator for compressor
- **HR3:** Pressure protection indicator
- **HG1:** Evaporator fan/s operation indicator
- **HG2:** Condenser fan operation indicator
- **HG3:** Temperature controller power supply indicator

To power up: Close (rotate) switch SA2. Indicator HG3 turns on, power is supplied to the temperature controller, and the screen displays parameters.

TCP1 sensor detects the air outlet temperature of the evaporator, and its temperature signal controls intermediate relay KA1.

TCP2 sensor detects the outlet temperature of the condenser pipeline, and its temperature signal controls intermediate relay KA2.

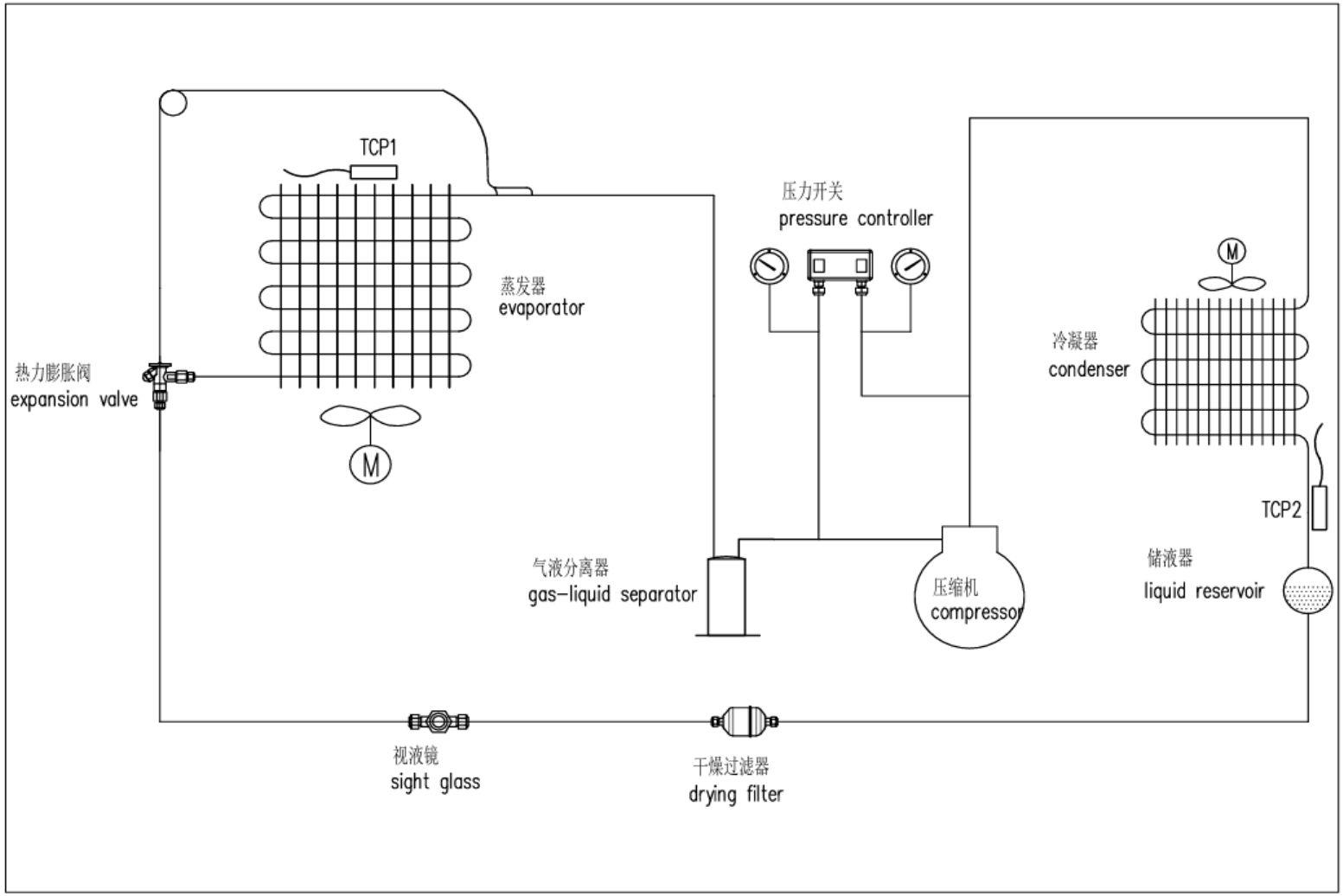
TCP3 sensor displays ambient temperature data.

At initial startup, the contacts of the compressor protection module remain closed.

At this point, close (rotate) switch SA1. AC contactor KM is energized with closed contacts, indicator HR2 illuminates simultaneously. AC 380V power is supplied to the compressor via overload protector FR, and the compressor starts operating.

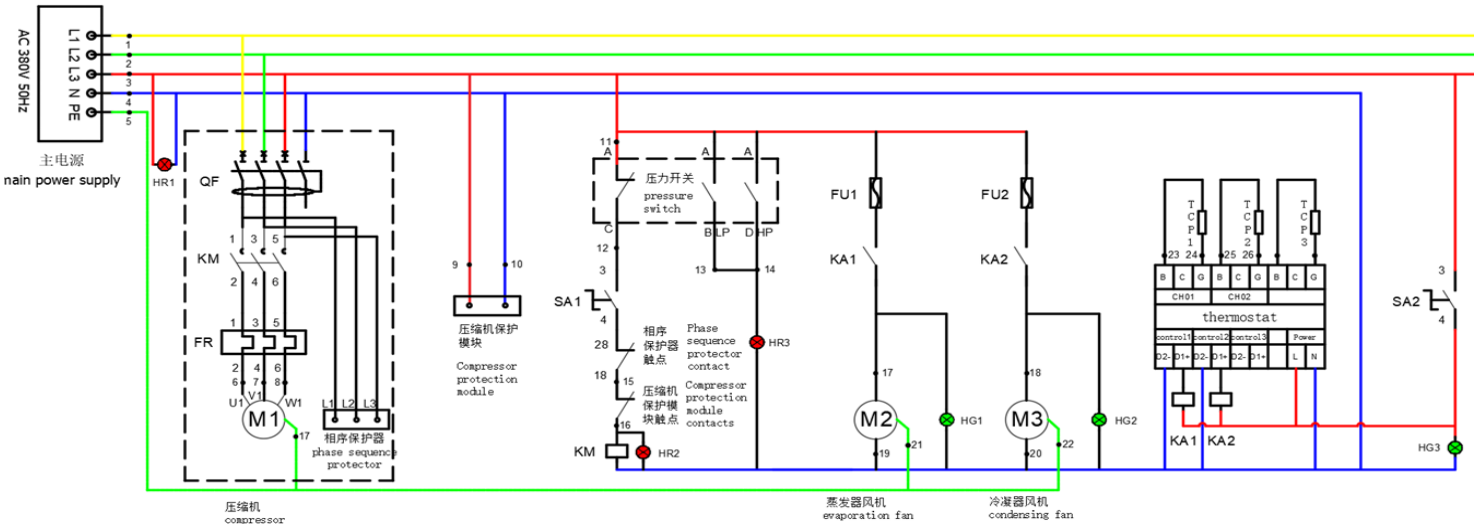
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Module D – Refrigeration system piping diagram



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Module D – Electrical circuit diagram



Operation: Close (rotate) switch SA2. Indicator HG3 turns on, power is supplied to the temperature controller, and the screen displays parameters.
TCP1 sensor detects the air outlet temperature of the evaporator, and its temperature signal controls intermediate relay KA1.
TCP2 sensor detects the outlet temperature of the condenser pipeline, and its temperature signal controls intermediate relay KA2.
TCP3 sensor displays ambient temperature data.
At initial startup, the contacts of the compressor protection module remain closed.
At this point, close (rotate) switch SA1. AC contactor KM is energized with closed contacts, indicator HR2 illuminates simultaneously. AC 380V power is supplied to the compressor via overload protector FR, and the compressor starts operating.
FOR C3 ONLY On the **Module D - Electrical circuit diagram, draw in your electrical changes to match your repairs (as installed by the Competitor).**

EXPERTS SIGN OFF	
Electrical circuit diagram – Changes drawn in. Day No._____Time: _____	Expert 1 Initials and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:

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Module D – Refrigeration system specifications

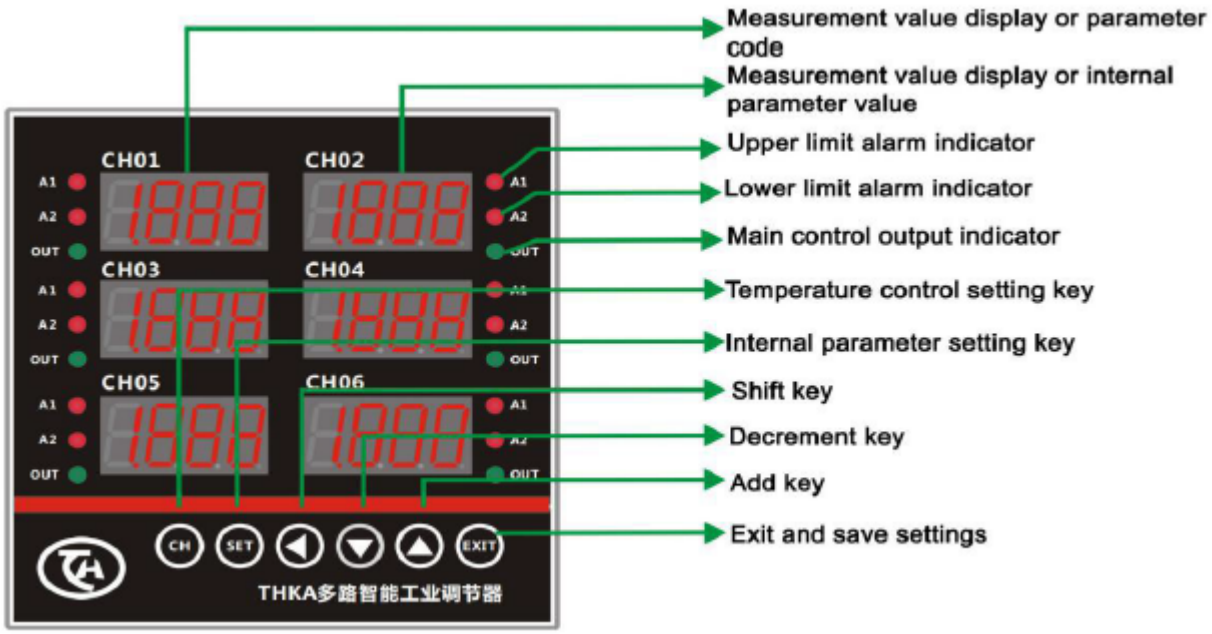
System Design Specification

The following system design specifications for the installation should be used for commissioning and control setting and are as follows:

- System Type: Refrigerated cabinet
- Refrigerant = R513A
- Design cabinet space temperature = 10°C +/- 1K (50°F +/-2°F)
- Maximum ambient temperature = 35°C Db, 28°C Wb (95°F Db, 82°F)
- Cabinet temperature controller is to cut out at 10°C (50°F) and cut in at 12°C (72°F)
- Design saturated suction temperature (SST) = -4°C (25°F)
- Suction line pressure drop = 1 K (2°F)

Control and safety settings

- Temperature Controller
  - The Controller is set to operate the evaporator fan/s.
  - S1 probe (TCP1) is to be installed to sense the temperature of the air off the evaporator coil.
  - S2 probe (TCP2) is to be installed to sense the temperature of the pipe



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Controller THKA031

	SYMBOL	MEANING	FACTORY DEFAULT PARAMETER	ACTUAL SET PARAMETER OF CURRENT EQUIPMENT (CH1)	ACTUAL SET PARAMETER OF CURRENT EQUIPMENT (CH2)
General parameter setting	LoCY	Press SET to enter menu	88	88	88
	Addr	Communication address	0	0	0
	bAUd	Baud rate	9600	9600	9600
	Stb	Stop bit	1	1	1
	AL-P	Alarm definition	0	0	0
Channel input setting/control setting	LoCY	Press SET to enter menu	66	66	66
	CH	Channel selection menu	1	1	2
	CoPy	Copy operation	0	0	0
	HY 1	dead band value	0.5	1	5
	AH 1	A1 Alarm	200	200	200
	AL 1	A2 Alarm	0	0	0
	P 1	proportional coefficient	0	0	0
	I 1	Integral coefficient	100 sec	100	100 sec
	d 1	differential coefficient	25 sec	25	25 sec
	At 1	auto-tuning	0	0	0
	t 1	control period cycle	10	10	10

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	SYMBOL	MEANING	FACTORY DEFAULT PARAMETER	ACTUAL SET PARAMETER OF CURRENT EQUIPMENT (CH1)	ACTUAL SET PARAMETER OF CURRENT EQUIPMENT (CH2)
	SC 1	deviation amendment	0.0	0.0	0.0
	Sn 1	input type	21	21	21 (PT100)
	dP 1	decimal point	1	1	1
	PSL 1	Lower limit of range	0	0	0
	PSH 1	Upper limit range	2000	2000	2000
	oPA 1	Output mode	1	1	1
	OL 1	Output lower limit value	0	0	0
	OH 1	Output upper limit value	100	100	100
	CoL 1	output mode	0	1	1
	Cn 1	Backup parameters	0	0	0

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Pressure/Temperature chart

SATURATION TEMPERATURE		R513A		R32	
TEMP (°C)	TEMP (°F)	PRESSURE (KPAG)	PRESSURE (PSIG)	PRESSURE (KPAG)	PRESSURE (PSIG)
-20	-4,0	52	7.5	304	44.1
-18	-0.4	65	9.4	336	48.7
-16	3.2	78	11.4	369	53.5
-14	6.8	93	13.5	405	58.7
-12	10.4	109	15.8	442	64.1
-10	14,0	125	18.2	481	69.7
-8	17.6	143	20.7	523	75.8
-6	21.2	161	23.4	567	82.2
-4	24.8	181	26.3	613	88.9
-2	28.4	202	29.2	661	95.9
0	32.0	224	32.4	712	103.2
2	35.6	247	35.8	765	110.9
4	39.2	271	39.3	821	119.1
6	42.8	297	43.0	880	127.6
8	46.4	324	46.9	941	136.5
10	50.0	352	51.0	1006	145.9
12	53.6	382	55.4	1073	155.6
14	57.2	413	59.9	1143	165.8
16	60.8	446	64.6	1217	176.5
18	64.4	480	69.6	1293	187.5
20	68.0	516	74.7	1373	199.1
22	71.6	553	80.2	1457	211.3
24	75.2	592	85.8	1544	223.9
26	78.8	633	91.8	1634	237.0
28	82.4	675	97.9	1728	250.6
30	86.0	720	104.4	1826	264.8
32	89.6	768	111.1	1928	279.6
34	93.2	814	118.1	2034	295.0
36	96.8	865	125.4	2144	311.0
38	100.4	917	132.9	2258	327.5

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SATURATION TEMPERATURE		R513A		R32	
TEMP (°C)	TEMP (°F)	PRESSURE (KPAG)	PRESSURE (PSIG)	PRESSURE (KPAG)	PRESSURE (PSIG)
40	104.0	971	140.8	2377	344.8
42	107.6	1028	149.0	2500	362.6
44	111.2	1086	157.5	2628	381.2
46	114.8	1147	166.4	2760	400.3
48	118.4	1828	175.5	2898	420.3
50	122.0	1276	185.0	3040	440.9
52	125.6	1344	194.9	3187	462.2
54	129.2	1415	205.2	3340	484.4
56	132.8	1488	215.7	3498	507.4
58	136.4	1564	226.7	3662	531.1
60	140.0	1642	238.1	3833	555.9

1 bar – 100 kPa

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