38MBRC
Outdoor Unit Single Zone Ductless System
Sizes 36 to 58

Service Manual

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SAFETY CONSIDERATIONS

Installing, starting up, and servicing air-conditioning equipment can be hazardous due to system pressures, electrical components, and equipment location (roofs, elevated structures, etc.).

Only trained, qualified installers and service mechanics should install, start-up, and service this equipment.

Untrained personnel can perform basic maintenance functions such as coil cleaning. All other operations should be performed by trained service personnel.

When working on the equipment, observe precautions in the literature and on tags, stickers, and labels attached to the equipment.

Follow all safety codes. Wear safety glasses and work gloves. Keep a quenching cloth and fire extinguisher nearby when brazing. Use care in handling, rigging, and setting bulky equipment.

Read this manual thoroughly and follow all warnings or cautions included in the literature and attached to the unit. Consult local building codes and National Electrical Code (NEC) for special requirements. Recognize safety information. This is the safety-alert symbol ⚠. When you see this symbol on the unit and in instructions or manuals, be alert to the potential for personal injury. Understand these signal words: **DANGER**, **WARNING**, and **CAUTION**.

These words are used with the safety-alert symbol. **DANGER** identifies the most serious hazards which **will** result in severe personal injury or death. **WARNING** signifies hazards which **could** result in personal injury or death. **CAUTION** is used to identify unsafe practices which **may** result in minor personal injury or product and property damage. **NOTE** is used to highlight suggestions which **will** result in enhanced installation, reliability, or operation.

⚠ WARNING

ELECTRICAL SHOCK HAZARD

Failure to follow this warning could result in personal injury or death. Before installing, modifying, or servicing system, main electrical disconnect switch must be in the OFF position. There may be more than 1 disconnect switch.

Lock out and tag switch with a suitable warning label.

⚠ WARNING

EXPLOSION HAZARD

Failure to follow this warning could result in death, serious personal injury, and/or property damage. Never use air or gases containing oxygen for leak testing or operating refrigerant compressors. Pressurized mixtures of air or gases containing oxygen can lead to an explosion.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Failure to follow this caution may result in equipment damage or improper operation.

Do not bury more than 36 in. (914 mm) of refrigerant pipe in the ground. If any section of pipe is buried, there must be a 6 in. (152 mm) vertical rise to the valve connections on the outdoor units. If more than the recommended length is buried, refrigerant may migrate to the cooler buried section during extended periods of system shutdown. This causes refrigerant slugging and could possibly damage the compressor at start-up.

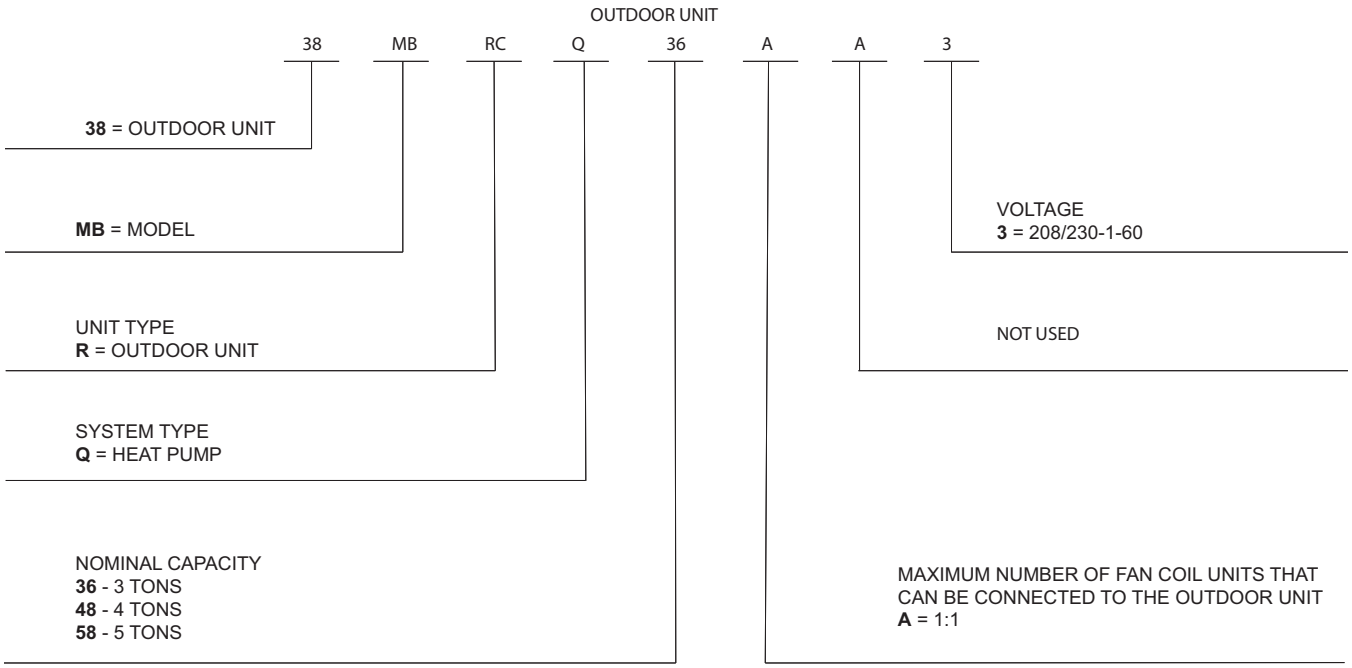
INTRODUCTION

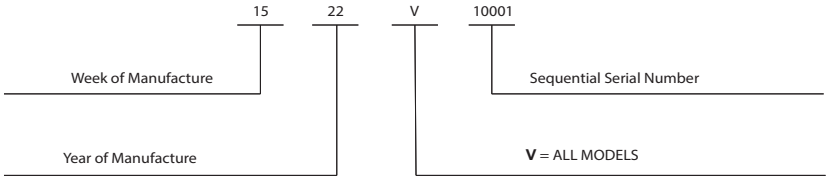
This service manual provides the necessary information to service, repair, and maintain the **38MBRC** family of heat pumps. Use the "TABLE of CONTENTS" on page 1 to locate a desired topic. For detailed information regarding product specifications refer to product data documentation.

MODEL / SERIAL NUMBER NOMENCLATURES

Table 1 —Unit Sizes

SYSTEM TONS	kBTUh	VOLTAGE-PHASE	OUTDOOR MODEL
3.00	36,000	208/230-1	38MBRCQ36AA3
4.00	48,000	208/230-1	38MBRCQ48AA3
5.00	58,000	208/230-1	38MBRCQ58AA3





Use of the AHRI Certified TM Mark indicates a manufacturer's participation in the program For verification of certification for individual products, go to www.ahridirectory.org.

WIRING

All wires must be sized per NEC (National Electrical Code) or CEC (Canadian Electrical Code) and local codes.

Sizes 36-58 Recommended Connection Method for Power and Communication Wiring

Power and Communication Wiring:

The main power is supplied to the outdoor unit. The field supplied power wiring from the outdoor unit to the indoor unit consists of three (3) wires and provides the power for the indoor unit. Two wires are high voltage AC power and one is a ground wire. To minimize voltage drop, the factory recommended wire size is 14/2 stranded with a ground.

Communication Wiring: A separate shielded stranded copper conductor only, with a 600 volt rating and double insulated copper wire, must be used as the communication wire from the outdoor unit to the indoor unit.

Please use a separate shielded 16GA stranded control wire.

Table 2 — Wiring Sizes 36K - 58K

CABLE	CABLE SIZE	REMARKS
Communication CABLE	16AWG	2 wire stranded shielded control wire

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Failure to follow this caution may result in equipment damage or improper operation.

Wires should be sized based on NEC and local codes.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Failure to follow this caution may result in equipment damage or improper operation.

Be sure to comply with local codes while running wire from the indoor unit to the outdoor unit.

Every wire must be connected firmly. Loose wiring may cause the terminal to overheat or result in unit malfunction. A fire hazard may also exist. Ensure all wiring is tightly connected.

No wire should touch the refrigerant tubing, compressor or any moving parts.

Disconnecting means must be provided and shall be located within sight and readily accessible from the air conditioner.

Connecting cable with conduit shall be routed through the hole in the conduit panel.

CONNECTION DIAGRAM

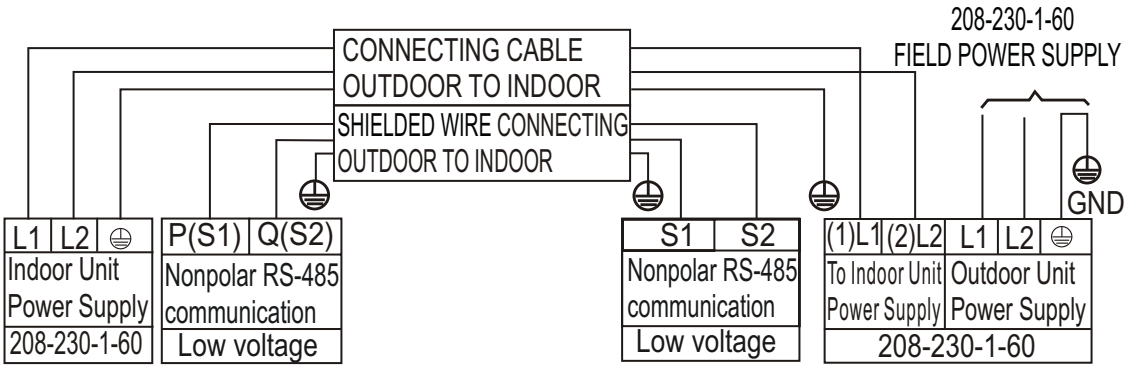


Fig. 1 — Connection Diagram Sizes 36K-58K

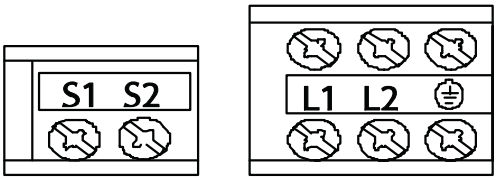


Fig. 2 — Control and Power Terminals Sizes 36K-58K

NOTES:

1. **Do not use thermostat wire for any connection between indoor and outdoor units.**
2. **All connections between indoor and outdoor units must be as shown. The connections are sensitive to polarity and will generate a fault code.**

WIRING DIAGRAMS

Size 36K

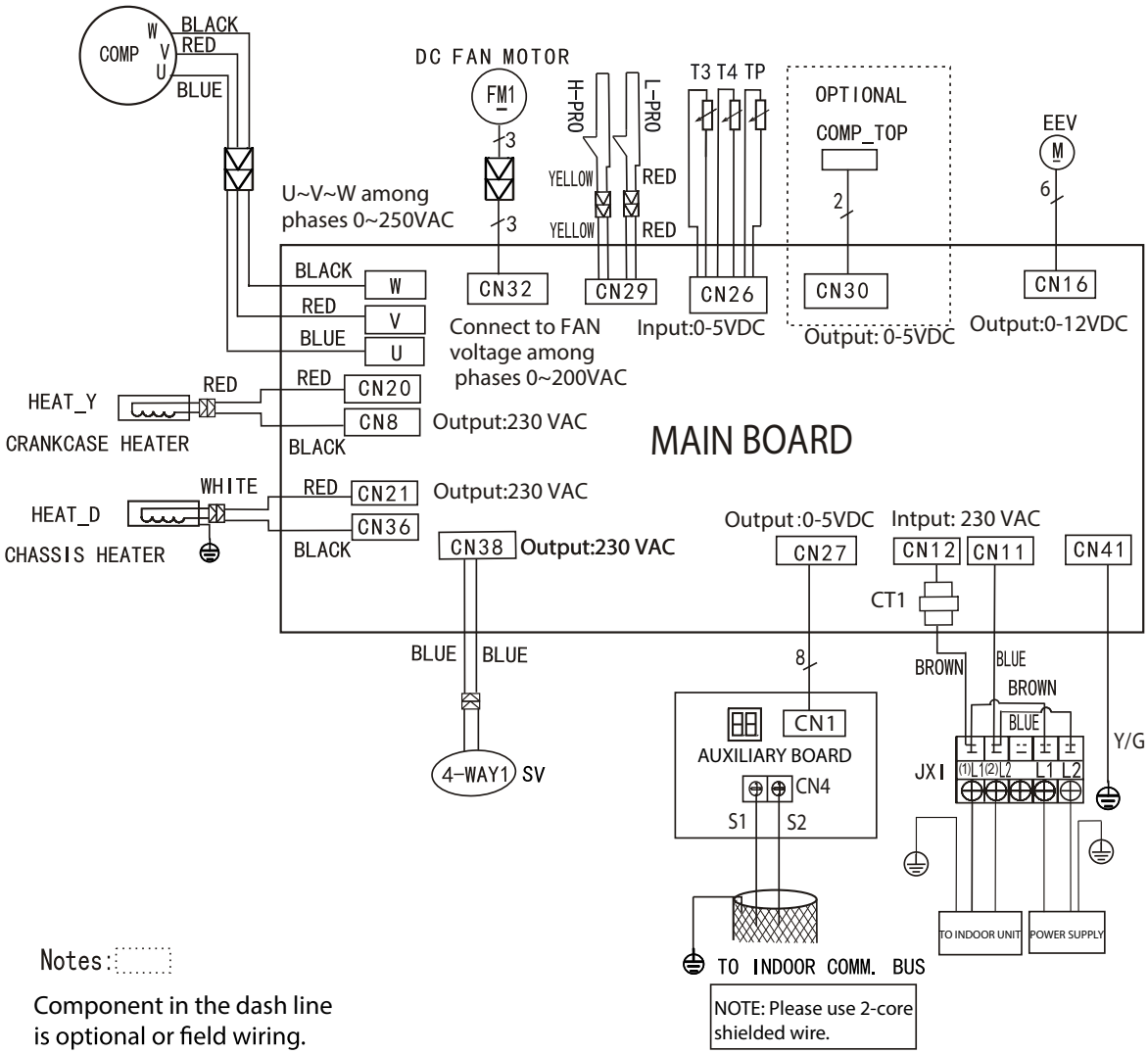


Fig. 3 — Wiring Diagram Size 36K

Table 3 — Wiring Diagram Size 36K Codes

CODE	PART NAME
JX1	Terminal Block
COMP_TOP	COMP. TOP OLP TEMP. Sensor
EEV	Electronic Expansion Valve
FM1	DC Fan Motor
COMP	Compressor
HEAT_Y	Crankcase Heater
CT1	AC Current Detector
H-PRO	High Pressure Switch
L-PRO	Low Pressure Switch
SV	Reversing Valve
TP	COMP. Discharge TEMP. Sensor
T3	COIL TEMP. Sensor
T4	Outdoor Ambient TEMP. Sensor
HEAT_D	Chassis Heater

WIRING DIAGRAMS (CONT)

Sizes 48K and 58K

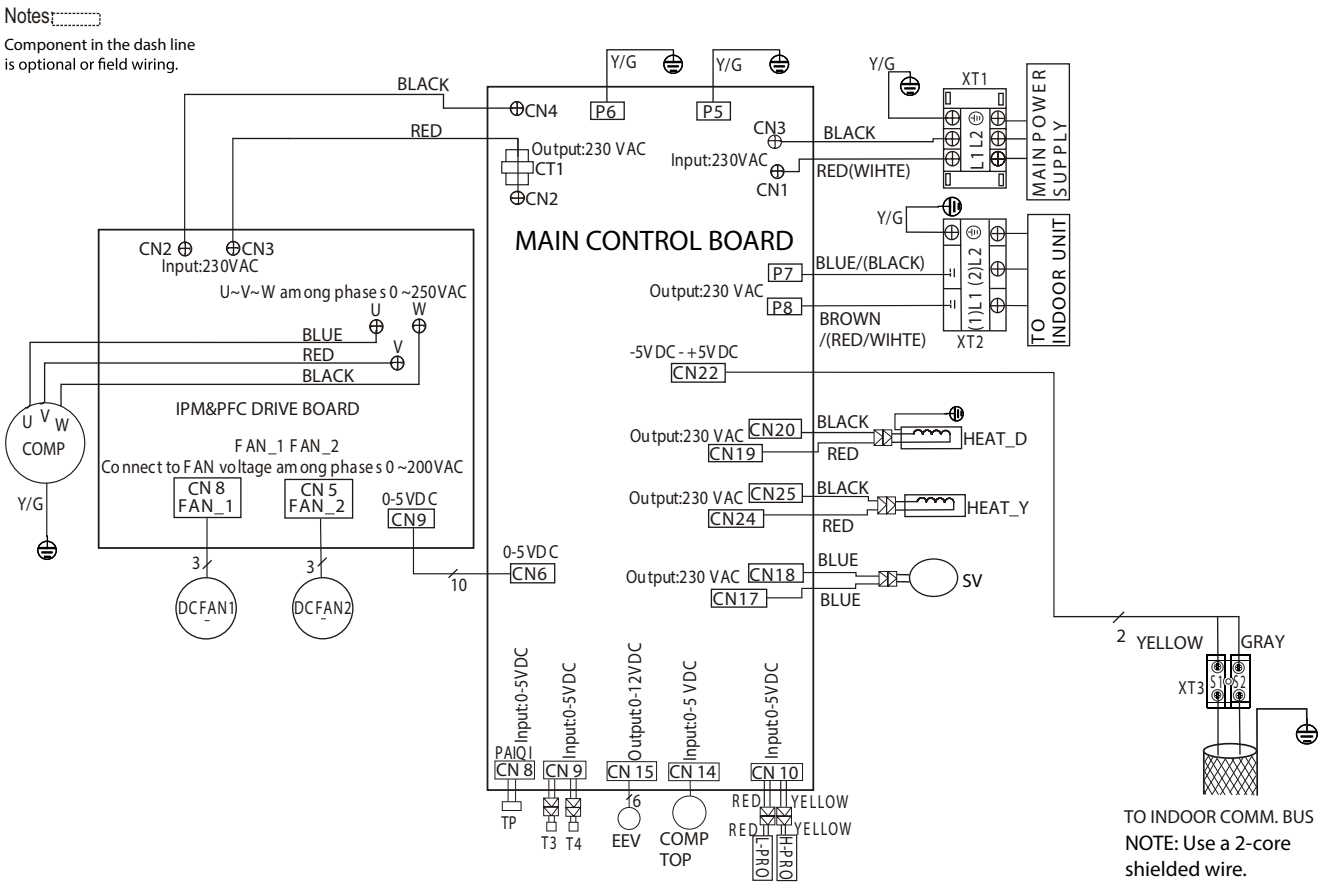


Fig. 4 — Wiring Diagram Sizes 48K and 58K

Table 4 — Wiring Diagram Sizes 48K and 58K Codes

CODE	PART NAME
COMP	Compressor
CTI	AC Current Detector
EEV	Electronic Expansion Valve
DCFAN1	Outdoor DC Fan Motor
DCFAN2	
HEAT_D	Chassis Heater
HEAT_Y	Crankcase Heater
H-PRO	High Pressure Switch
L-PRO	Low Pressure Switch
SV	Reversing Valve
TP	Comp. Discharge Temp Sensor
T3	Coil Temp. Sensor
T4	Outdoor Ambient Temp Sensor
COMP TOP	COMP. Top OLP Temp Sensor

REFRIGERATION CYCLE DIAGRAM

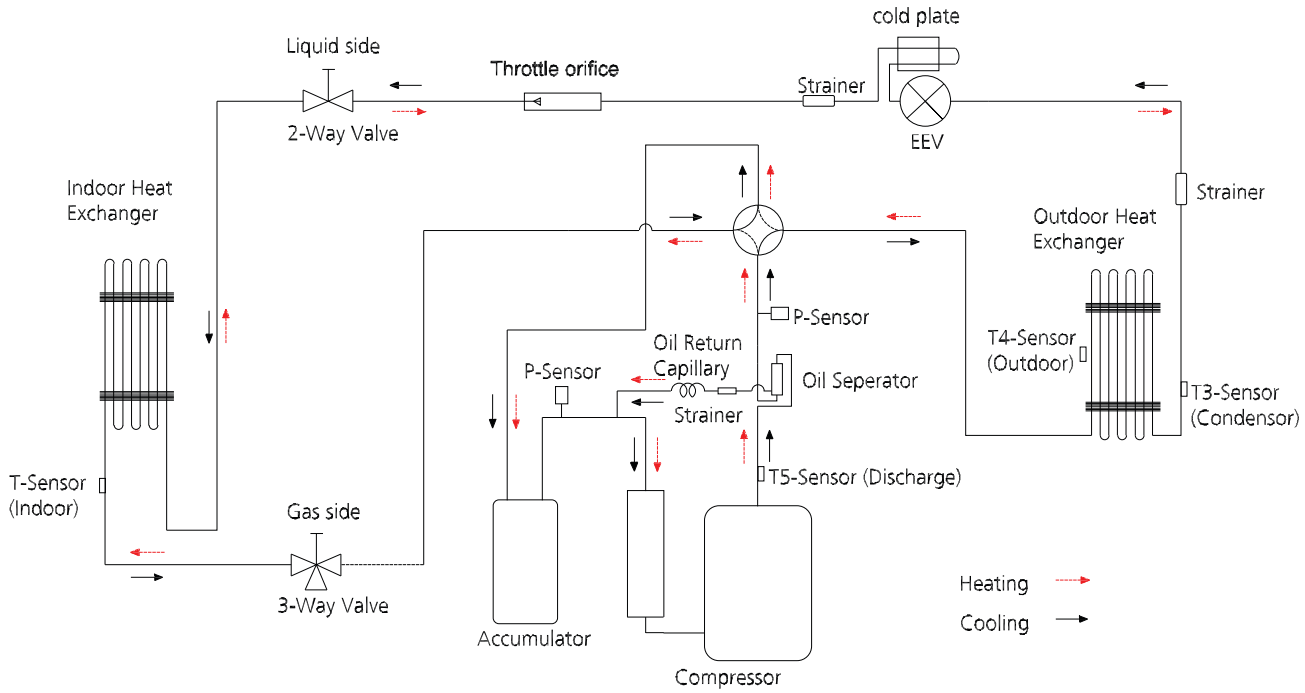


Fig. 5 — Refrigerant Cycle Diagram

REFRIGERANT LINES

General Refrigerant Line Sizing

1. The outdoor units are shipped with a full charge of R410A refrigerant. All charges, line sizing, and capacities are based on runs of 25ft. (7.6 m). For runs over 25 ft. (7.6 m), consult the long-line applications section for the proper charge adjustments.
2. The minimum refrigerant line length between the indoor and outdoor units is 10 ft. (3 m).
3. Refrigerant lines should not be buried in the ground. If it is necessary to bury the lines, not more than 36in (914 mm) should be buried. Provide a minimum 6in (152 mm) vertical rise to the service valves to prevent refrigerant migration.
4. Both lines must be insulated. Use a minimum of 1/2in. (12.7 mm) thick insulation. Closed-cell insulation is recommended in all long-line applications.
5. Special consideration should be given to isolating interconnecting tubing from the building structure. Isolate the tubing so vibration or noise is not transmitted into the structure.

IMPORTANT: Both refrigerant lines must be insulated separately.

Table 5 displays the following maximum lengths allowed.

Table 5 — Piping and Refrigerant

SYSTEM SIZE			36K	48K	58K
PIPING	Min. Piping Length	ft (m)	10(3)	10(3)	10 (3)
	Standard Piping Length	ft (m)	25(7.5)	25(7.5)	25(7.5)
	Max. outdoor-indoor height difference (OU higher than IU)	ft (m)	98(30)	98(30)	98(30)
	Max. outdoor-indoor height difference (IU higher than OU)	ft (m)	98(30)	98(30)	98(30)
	Max. Piping length with no additional refrigerant charge	ft (m)	26(8)	26(8)	26(8)
	Max. Piping Length	ft (m)	213(65)	213(65)	213 (65)
	Additional refrigerant charge	Oz/ft (g/m)	0.32(30)	0.32(30)	0.32(30)
	(between Standard - Max piping length)				
	Gas Pipe (size-connection type)	in (mm)	5/8(16)	5/8(16)	7/8(22)
	Liquid Pipe (size-connection type)	in (mm)	3/8(9.52)	3/8(9.52)	3/8(9.52)
REFRIGERANT	Refrigerant Type	--	R410A	R410A	R410A
	Charge Amount	Lbs (kg)	6.72(3.05)	9.26(4.2)	10.58 (4.8)

- The charge amount listed in Table 5 is for piping runs up to 26 ft. (8 m).
- For piping runs greater than 26 ft. (8 m), add refrigerant up to the allowable length as specified in Table 6.

Long Line Applications.:

1. No change in line sizing is required.
2. Add refrigerant per Table 6.

Table 6 — Additional Charge Table Per Zone

UNIT SIZE	TOTAL LINE LENGTH FT.		ADDITIONAL CHARGE OZ/FT. (M)	
	MIN.	MAX.	>10-26 (3-8)	>26-213 (8-65)
36-58	10	213	None	0.32

SYSTEM EVACUATION AND CHARGING

CAUTION

UNIT DAMAGE HAZARD

Failure to follow this caution may result in equipment damage or improper operation.

Never use the system compressor as a vacuum pump.

Refrigerant tubes and indoor coil should be evacuated using the recommended deep vacuum method of 500 microns. The alternate triple evacuation method may be used if the following procedure is followed. Always break a vacuum with dry nitrogen.

SYSTEM VACUUM AND CHARGE

Using Vacuum Pump

1. Completely tighten the flare nuts (A, B, C, D, E). Fully open all circuits service valves. Connect the manifold gage charge hose to the charge port of the low side Master service valve to evacuate all circuits at the same time (see Fig. 6).
2. Connect charge hose to vacuum pump.
3. Fully open the low side of manifold gage (see Fig. 7).
4. Start vacuum pump
5. Evacuate using the triple evacuation method.
6. After evacuation is complete, fully close the low side of manifold gage and stop operation of vacuum pump.
7. The factory charge contained in the outdoor unit is good for up to 25ft. (8 m) of line length. For refrigerant lines longer than 25ft. (8 m), add refrigerant as specified in "Additional Charge Table Per Zone" on page 8.
8. Disconnect charge hose from charge connection of the low side service valve.
9. Securely tighten caps of service valves.

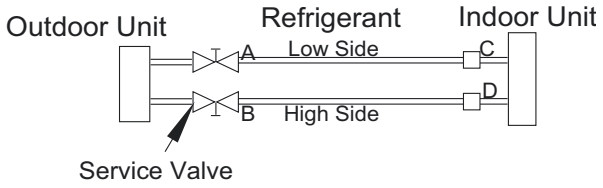


Fig. 6 — Service Valve

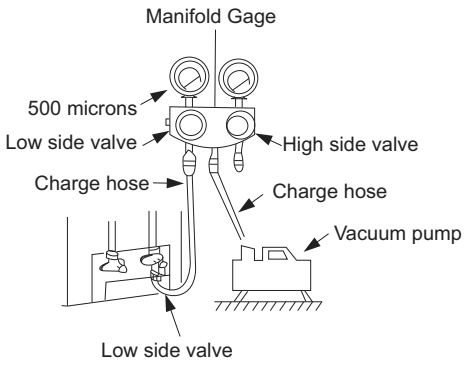


Fig. 7 — Manifold

Deep Vacuum Method

The deep vacuum method requires a vacuum pump capable of pulling a vacuum of 500 microns and a vacuum gage capable of accurately measuring this vacuum depth. The deep vacuum method is the most positive way of assuring a system is free of air and liquid water (see Fig. 8).

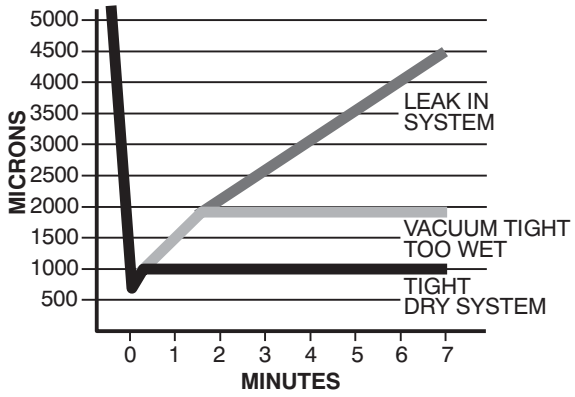


Fig. 8 — Deep Vacuum Graph

Triple Evacuation Method

The triple evacuation method should be used. Refer to Fig. 9 and proceed as follows:

1. Pump system down to 500 MICRONS of mercury and allow pump to continue operating for an additional 15 minutes. Unit must maintain 500 microns or less for 30 minutes or more to ensure a dry system.
2. Close service valves and shut off vacuum pump.
3. Connect a nitrogen cylinder and regulator to system and open until system pressure is 2 psig.
4. Close service valve and allow system to stand for 10 minutes. During this time, dry nitrogen will be able to diffuse throughout the system absorbing moisture.
5. Repeat this procedure as indicated in Fig. 9. System will then be free of any contaminants and water vapor.

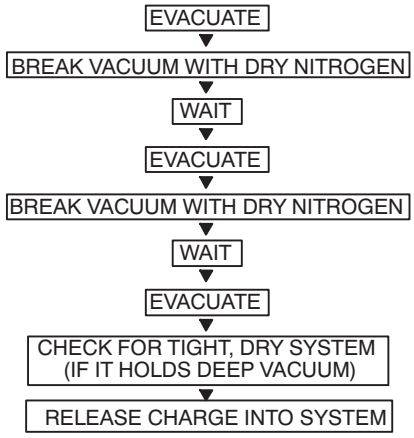


Fig. 9 — Triple Evacuation Method

Final Tubing Check

IMPORTANT: Check to be certain factory tubing on both indoor and outdoor unit has not shifted during shipment. Ensure tubes are not rubbing against each other or any sheet metal. Pay close attention to feeder tubes, making sure wire ties on feeder tubes are secure and tight.

ELECTRONIC FUNCTIONS

Abbreviation

- T1: Indoor room temperature
- T2: Coil temperature of indoor heat exchanger middle
- T2B: Coil temperature of indoor heat exchanger outlet
- T3: Coil temperature of condenser
- T4: Outdoor ambient temperature
- T5: Compressor discharge temperature (TP)
- Td: Target temperature

Main Protection

Three Minute Delay for Compressor Restart

Less than a 1 minute delay for the initial start-up and a 3 minute delay for subsequent starts.

Compressor Top Temperature Protection

The unit stops working when the compressor top temp. protector cuts off, and restarts after the compressor top temp. protector resets.

Compressor Discharge Temperature Protection

When the compressor discharge temp. increases, the running frequency is limited per the following rules:

- Compressor discharge temp. T5>239°F(115°C) for 5s, compressor stops and restarts up until T5<194°F (90°C)
- 110<T5<239°F(115°C), decrease the frequency to the lower level every 2 minutes.
- 221°F(105°C)<T5<230°F(110°C), keep running at the current frequency.
- T5<221°F(105°C), no limit for frequency.

Fan Speed is Out of Control

When the indoor fan speed remains low (lower than 300RPM) for 50s, the indoor fan shuts off and restarts 30s later. If the protection mode engages 3 times when the fan motor restarts continuously, the unit stops and the LED displays the failure.

When the outdoor fan speed remains low (lower than 100RPM) or too high (higher than 1500RPM) for 60s, the unit stops and the LED displays the failure. The malfunction clears 30s later.

Inverter Module Protection

The inverter module has a protection function for current, voltage and temperature. If any of these protections engage, the corresponding code displays on the indoor unit and the unit stops working.

Indoor Fan Delayed Open Function

When the unit starts up, the louver is active immediately and the indoor fan opens 10s later. If the unit is running in the **HEATING** mode, the indoor fan is controlled also by the anti-cold wind function.

Compressor Preheating Functions

Preheating Permitting Condition:

If T4<37.4°F(3°C) when the unit is first powered up within 5 seconds or if T4<37.4°F(3°C) and the compressor has stopped for over 3 hours, the compressor heating cable will work.

Preheating Mode:

A weak current flow through the compressor coil from the compressor wiring terminal, then the compressor is heated without operation.

Preheating Release Condition:

If T4=41°F(5°C) or the compressor starts running, the preheating function stops.

Condenser High Temperature T3 Protection:

- 131°F(55°C)<T3<140°F(60°C), the compressor frequency decreases to the lower level until to F1 and then runs at F1. If T3<129.2°F(54°C), the compressor keeps running at the current frequency.
- T3<125.6°F(52°C), the compressor does not limit the frequency and resumes the former frequency.
- T3>140°F(60°C) for 5 seconds, the compressor stops until T3<125.6°F(52°C).

Evaporator Low Temperature T2 Protection:

- T2<32°F(0°C), the compressor stops and restarts when T2=41°F(5°C).
- 32°F(0°C) ≦ T2<39.2°F(4°C), the compressor frequency is limited and decreases to the lower level
- 39.2°F(4°C)=T2<44.6°F(7°C), the compressor retains the current frequency
- T2>44.6°F(7°C), the compressor frequency is not limited.

Operation Modes and Functions

FAN Mode

1. Outdoor fan and compressor stop
2. Temperature setting function is disabled and no setting temperature appears.
3. Indoor fan can be set to high/med/low/auto
4. The louver operates same as in the **COOLING** mode.
5. Auto fan

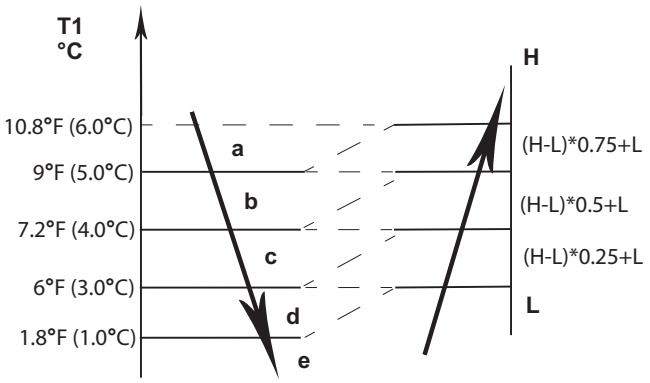


Fig. 10 — FAN Mode

COOLING Mode

Outdoor Fan Running Rules

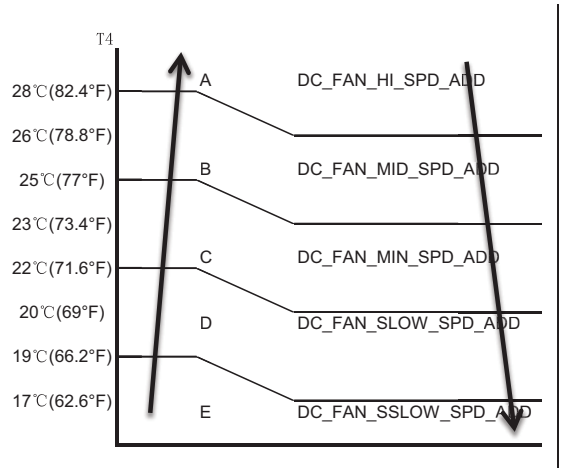


Fig. 11 — Outdoor Fan Running Rules

In the **COOLING** mode, the indoor fan runs all the time and the speed can be selected as high, medium, low and auto. The indoor fan is controlled as shown in Fig. 12.

Setting Fan Speed	T1-Td °F (°C)		Actual Fan Speed
H	4.5(40.1)		H+(H+=H+G)
	3.0(37.4)	A	H（=H）
	1.5(34.7)	B	H-（H-=H-G)
		C	
M	4.5(40.1)		M+(M+=M+Z)
	3.0(37.4)	D	M(M=M)
	1.5(34.7)	E	M-(M-=M-Z)
		F	
L	4.5(40.1)		L+(L+=L+D)
	3.0(37.4)	G	L(L=L)
	1.5(34.7)	H	L-(L-=L-D)
		I	

Fig. 12 — Indoor Fan Table

The **AUTO** Fan function under the **COOLING** mode acts (see Fig. 13).

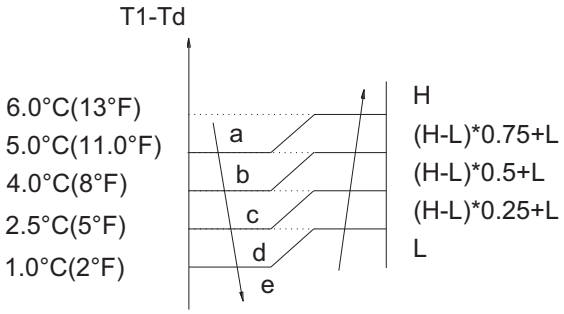


Fig. 13 —AUTO Fan function under the COOLING Mode

HEATING Mode

Outdoor Fan Running Rules

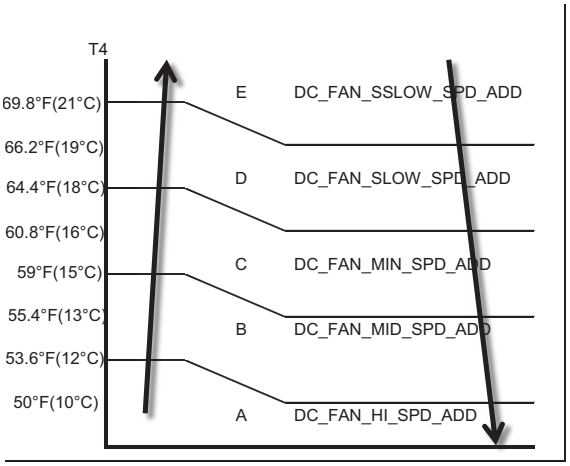


Fig. 14 — Outdoor Fan Running Rules

Indoor Fan Running Rules

When the compressor is on, the indoor fan can be set to high/med/low/ auto. And the anti-cold wind function has the priority. The indoor fan is controlled as shown in Fig. 15.

Setting Fan Speed	T1-Td+34.7°F(1.5°C)		Actual Fan Speed
H	-3°F(-1.5°C)		H-（H-=H-G)
	-6°F(-3.0°C)		H（=H）
	-10°F(-4.5°C)		H+(H+=H+G)
M	-3°F(-1.5°C)		M-(M-=M-Z)
	-6°F(-3.0°C)		M(M=M)
	-10°F(-4.5°C)		M+(M+=M+Z)
L	-3°F(-1.5°C)		L-(L-=L-D)
	-6°F(-3.0°C)		L(L=L)
	-10°F(-4.5°C)		L+(L+=L+D)

Fig. 15 — Indoor Fan Running Rules

AUTO Fan action in HEATING mode

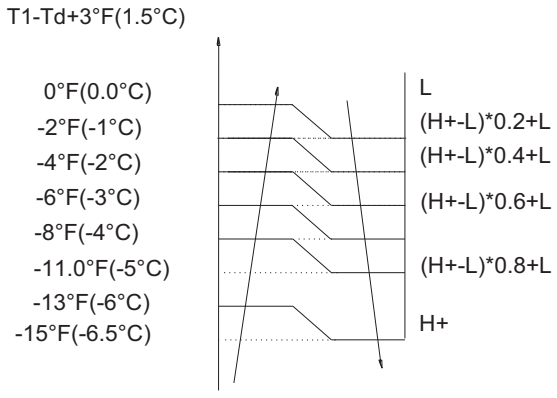
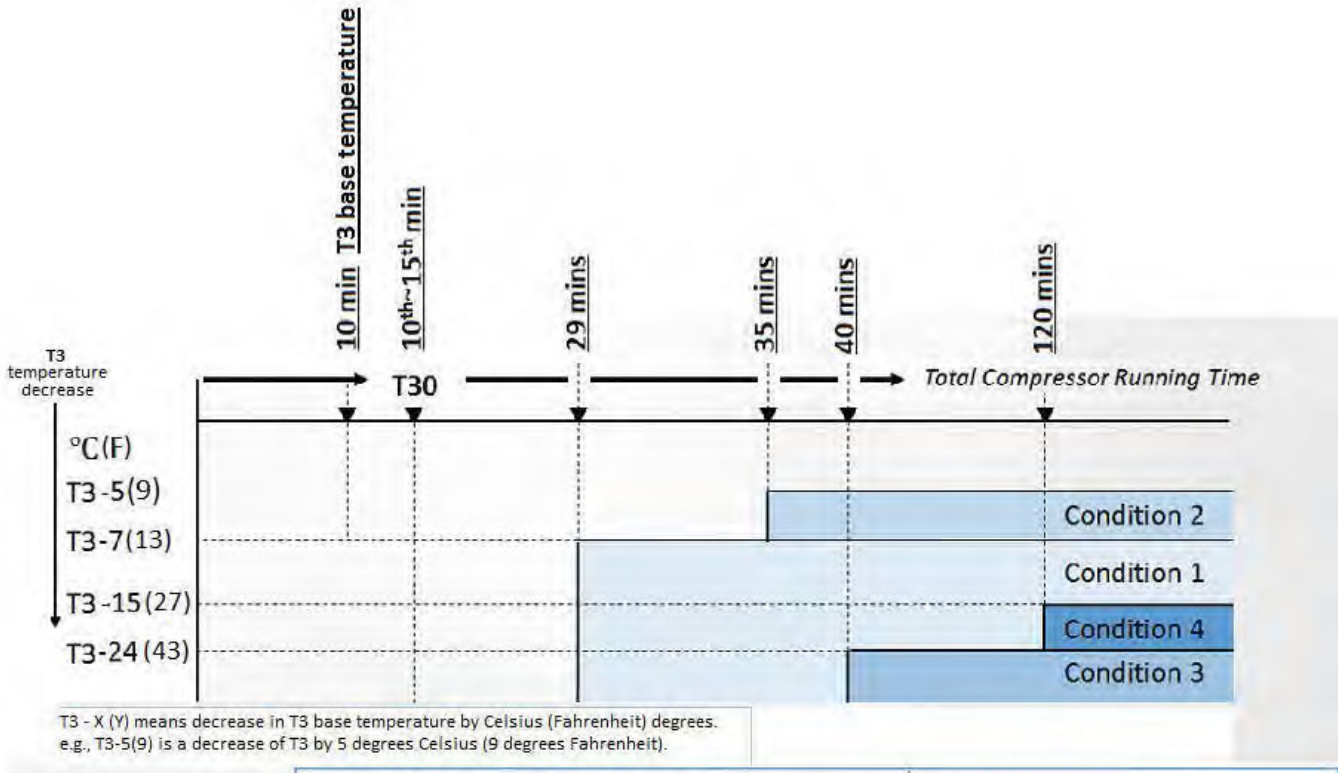


Fig. 16 — AUTO Fan action in HEATING mode

Defrosting Mode

If any one of the following conditions are met, AC enters the **DEFROSTING** mode. After the compressor starts and continues to run, mark the minimum value of T3 from the 10th minute to 15th minute as T30.



	Compressor run time	Temperature Change
Condition 1	Total compressor running time is 29 mins	T3-7°C & **T30**-2.5°C
Condition 2	Total compressor running time is 35 mins	T3-5 & **T30**-3°C
Condition 3	Total compressor running time is 40 mins	T3-24°C for 3 mins
Condition 4	Total compressor running time is 120 mins	T3-15°C

Defrost Exit Conditions: **Any of the following conditions will terminate Defrost and return the unit to normal heating mode.**

Note: T3 temperature refers to the sensor reading at the time when Defrost begins.

T3 temperature rises above 15°C (59°F).

T3 temperature remains above 8°C (46°F) for more than 80 seconds.

The unit has been in Defrost Mode for 10 minutes.

Fig. 17 — Defrosting Chart

Evaporator Coil Temperature Protection

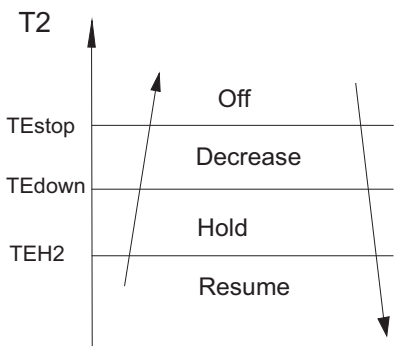


Fig. 18 — Evaporator Coil Temperature Protection

Off: Compressor stops
Decrease: Decrease the running frequency to the lower level
Hold: Keep the current frequency
Resume: No limitation for frequency

Auto Mode

This mode can be chosen with remote controller and the setting temperature can be changed between 62.6~86°F(17~30°C).

In **AUTO** mode, the machine either selects **COOLING**, **HEATING** or **FAN-Only** mode according to DT (DT=T1-Ts).

ΔT=T1-Ts	Running Mode
ΔT≥2F(1 ℃)	Cooling Mode
-2°F(-1 ℃)<ΔT<3(2°F1 ℃)	Fan-only Mode
ΔT≤-1 ℃ (-2°F)	Heating Mode

The indoor fan runs in the **AUTO** Fan mode of the relevant mode. The louver operates same as in relevant mode. If the machine switches mode between heating and cooling, the compressor will continue to stop for 15 minutes and then choose a mode according to T1-Ts. If the setting temperature is modified, the machine selects a running function once again.

DRYING Mode

DRYING mode works the same as **COOLING** mode in **BREEZE** speed. All protections are active and the same as that in the **COOLING** mode.

Auto-Restart Function

The indoor unit is equipped with an auto-restart function, which is carried out through an auto-restart module. In case of a sudden power failure, the module memorizes the setting conditions before the power failure. The unit resumes the previous operation setting (not including sleep function) automatically after 3 minutes when power returns.

Enquiry Information

Table 7 — Enquiry Information

ENQUIRY INFORMATION	DISPLAY VALUE	MEANING	REMARK
T1,T2,T3,T4, T2B,TP,TH, Targeted Frequency, Actual Frequency	- 1F,- 1E,- 1d,- 1c,- 1b,- 1A	- 25,- 24,- 23,- 22,- 21,- 20	1. All the displaying temperature is actual value. 2. Temperature is °C no matter the remote. 3. T1,T2,T3,T4,T2B display range:- 25 ~ 70, 4. TP display range:- 20 ~ 130. 5. Frequency display range: 0 ~ 159HZ. 6. If the range, it displays the maximum value or minimum value.
	- 19—99	- 19—99	
	A0,A1,●●●A9	100,101,●●●109	
	b0,b1,●●●b9	110,111,●●●119	
	c0,c1,●●●c9	120,121,●●●129	
	d0,d1,●●●d9	130,131,●●●139	
	E0,E1,●●●E9	140,141,●●●149	
	F0,F1,●●●F9	150,151,●●●159	
Indoor fan speed/ Outdoor fan speed	0	OFF	
	1,2,3,4	Low speed, Medium speed, High speed, Turbo	For some big capacity motors
	14- FF	Actual fan speed = Display value turns to decimal value and then multiply 10. The unit is RPM.	For some small capacity motors the display value is 14 - FF (hexadecimal), the corresponding fan speed range is from 200-2550 RPM.
EXV opening angle	0- FF	Actual EXV opening value = Display value turns to decimal value and then multiply 2.	
Compressor continuous running time	0- FF	0- 255 minutes	If the actual value exceeds the range, it displays the maximum value or minimum value.
Compressor stop causes	0- 99	For a detailed meaning, consult with an engineer	Decimal display
Reserve	0- FF		

TROUBLESHOOTING

This section provides the required flow charts to troubleshoot problems that may arise.

NOTE: Information required in the diagnoses can be found in the wiring diagrams.

Required Tools:

The following tools are needed when diagnosing the units:

- Digital multimeter
- Screw drivers (Phillips and straight head)
- Needle-nose pliers
- Refrigeration gauges

Recommended Steps

1. Refer to the diagnostic hierarchy charts below and determine the problem at hand.
2. Go to the chart listed in the diagnostic hierarchy and follow the steps in the chart for the selected problem.

For the ease of service, the systems are equipped with diagnostic code display LED's on both the indoor and outdoor units. The outdoor diagnostic display is on the outdoor unit board and is limited to very few errors. The indoor diagnostic display is a combination of flashing LED's on the display panel on the front of the unit. If possible always check the diagnostic codes displayed on the indoor unit first.

The diagnostic codes for the indoor and outdoor units are listed in the following pages.

Problems may occur that are not covered by a diagnostic code, but are covered by the diagnostic flow charts. These problems are typical air conditioning mechanical or electrical issues that can be corrected using standard air conditioning repair techniques.

For problems requiring measurements at the control boards, note the following:

1. Always disconnect the main power.
2. When possible check the outdoor board first.
3. Start by removing the outdoor unit top cover.
4. Reconnect the main power
5. Probe the outdoor board inputs and outputs with a digital multi-meter referring to the wiring diagrams.
6. Connect the red probe to hot signal and the black probe to the ground or negative.
7. Note that some of the DC voltage signals are pulsating voltages for signal. this pulse should be rapidly moving at all times when there is a signal present.
8. If it is necessary to check the indoor unit board you must start by disconnecting the main power.
9. Next remove the front cover of the unit and then control box cover.
10. Carefully remove the indoor board from the control box, place it face up on a plastic surface (not metal).
11. Reconnect the main power and repeat steps 5, 6, and 7.
12. Disconnect main power before reinstalling board to avoid shock hazard and board damage.

DIAGNOSIS AND SOLUTION

Outdoor Unit Error Display

Table 8 — Diagnostic Guide for Outdoor Units

DISPLAY	LED STATUS	PAGE
EL01	Communication malfunction between the indoor and outdoor units	Page 18
EC07	Outdoor DC fan motor malfunction/fan speed out of control	Page 21
EC50	Outdoor temperature sensor error	--
EC51	Outdoor EEPROM error	--
EC52	Condenser coil temperature sensor (T3) malfunction	Page 23
EC53	Outdoor ambient temperature sensor (T4) malfunction	Page 23
EC54	Compressor discharge temperature sensor TP is on open circuit or has short circuited	Page 23
EC55	Outdoor IPM module temperature sensor malfunction	--
EC71	Over current failure of the outdoor DC fan motor	Page 21
EC72	Lack phase failure of the outdoor DC fan motor	Page 23
PC00	Inverter module (IPM) protection	Page 25
PC02	Top temperature protection of compressor	Page 26
PC06	Discharge temperature protection of compressor	Page 27
PC08	Outdoor overcurrent protection	Page 28
PC0A	High temperature protection of condenser	Page 29
PC0F	PFC module protection	Page 30
PC0L	Low temperature protection of the outdoor unit	Page 35
PC10	Outdoor unit low AC voltage protection	Page 31
PC11	Outdoor unit main control board DC bus high voltage protection	Page 31
PC12	Outdoor unit main control board DC bus high voltage protection /341 MCE error	Page 31
PC30	System high pressure protection	Page 32
PC31	System low pressure protection	--
PC40	Communication error between the outdoor main chip and compressor driven chip	Page 33
PC42	Compressor start failure of the outdoor unit	--
PC43	Outdoor compressor lack phase protection	Page 34
PC44	Outdoor unit zero speed protection	Page 28
PC45	Outdoor unit IR chip drive failure	Page 35
PC46	Compressor speed has been out of control	Page 28
PC49	Compressor overcurrent failure	Page 28
PH90	High temperature protection of the evaporator	--
PH91	Low temperature protection of the evaporator	--
LC06	High temperature protection of the inverter module (IPM)	Page 26

Outdoor Unit Point Check Function

Table 9 — Outdoor Check Function

NUMBER OF PRESSES	DISPLAY	REMARK
00	Normal display	Displays the running frequency, running state, or malfunction code
01	Indoor unit capacity demand code	Actual data*HP*10 If the capacity demand code is higher than 99, the digital display tube displays a single digit and a tens digit. (For example, the digital display tube displays “5.0”, which means the capacity demand is 15. The digital display tube displays “60”, which means the capacity demand is 6.0) GA algorithm models display “--”
02	The frequency after the capacity requirement adapter	
03	Room temperature (T1)	If the temperature is lower than 0 degree, the digital display tube displays “0”. If the temperature is higher than 70 degrees, the digital display tube displays “70”.
04	Indoor unit evaporator temperature (T2)	If the temperature is lower than -9 degrees, the digital display tube displays “-9”. If the temperature is higher than 70 degrees, the digital display tube displays “70”. If the indoor unit is not connected, the digital display tube appears: “--”
05	Condenser pipe temp.(T3)	
06	Outdoor ambient temp.(T4)	
07	Compressor discharge temp. (TP)	The display value is between 0~199 degree. If the temp. is lower than 0 degree, the digital display tube displays “0”. If the temp. is higher than 99 degrees, the digital display tube displays a single digit and a tens digit. (For example, the digital display tube displays “0.5”, which means the compressor discharge temperature is 105 degrees. The digital display tube displays “1.6”, which means the compressor discharge temperature is 116 degrees.)
08	AD value of current	The display value is a hex number. For example, the digital display tube shows “Cd”, which means AD value is 205.
09	AD value of voltage	
10	Indoor unit running mode code	Standby:0,Cooling:1, Heating:2, Fan only 3, Drying:4, Forced cooling:6, Defrost:7
11	Outdoor unit running mode code	
12	EXV open angle	**Actual data/4.** If the value is higher than 99, the digital display tube displays a single digit and a tens digit. For example, the digital display tube displays “2.0”, which means the EXV open angle is 120×4=480p.
13	Frequency limit symbol	Bit7: Frequency limit caused by IGBT radiator Bit6: Reserved Bit5: Reserved Bit4: Frequency limit caused by low temperature of T2.(LH00) Bit3: Frequency limit caused by T3. (LC01) Bit2: Frequency limit caused by TP. (LC02) Bit1: Frequency limit caused by current (LC03) Bit0: Frequency limit caused by voltage (LC05) The display value is a hexadecimal number. For example, the digital display shows 2A, then **Bit5=1**, **Bit3=1**, and **Bit1=1**. This means that a frequency limit may be caused by T4, T3, or the current.
14	Outdoor unit fan speed	If it is higher than 99, the digital display tube displays a single digit and a tens digit. (For example, the digital display tube displays “2.0” which means the fan speed is 120.) This value is multiplied by 8, and it is the current fan speed: 120*8=960
15	The average value of the temperature values detected by the high and low pressure sensors in the last 10 seconds of the compressor frequency calculation period.	The displayed value is the actual value plus 60 (that is, when the displayed value is 10, the actual value is -50). When the displayed value is higher than 99, the digital display tube displays a single digit and a tens digit. (If it displays 2.0, it means 120). When there is no pressure sensor, it appears as --
16	The temperature value detected by the high and low pressure sensor	
17	AD value detected by the high and low pressure sensor	If it is higher than 199, the digital display tube displays a single digit and a tens digit. (For example, the digital display tube displays “2.0”, which means 220.) Otherwise, if the temperature is higher than 99 degrees, the digital display tube displays a tens digit. (For example, the digital display tube displays “2.0”, which means 120.) When there is no pressure sensor, it is displayed as --
18	The currently running communication protocol version	00-99

DIAGNOSIS AND SOLUTION

EL 01 (Indoor and Outdoor Unit Communication Error Diagnosis and Solution)

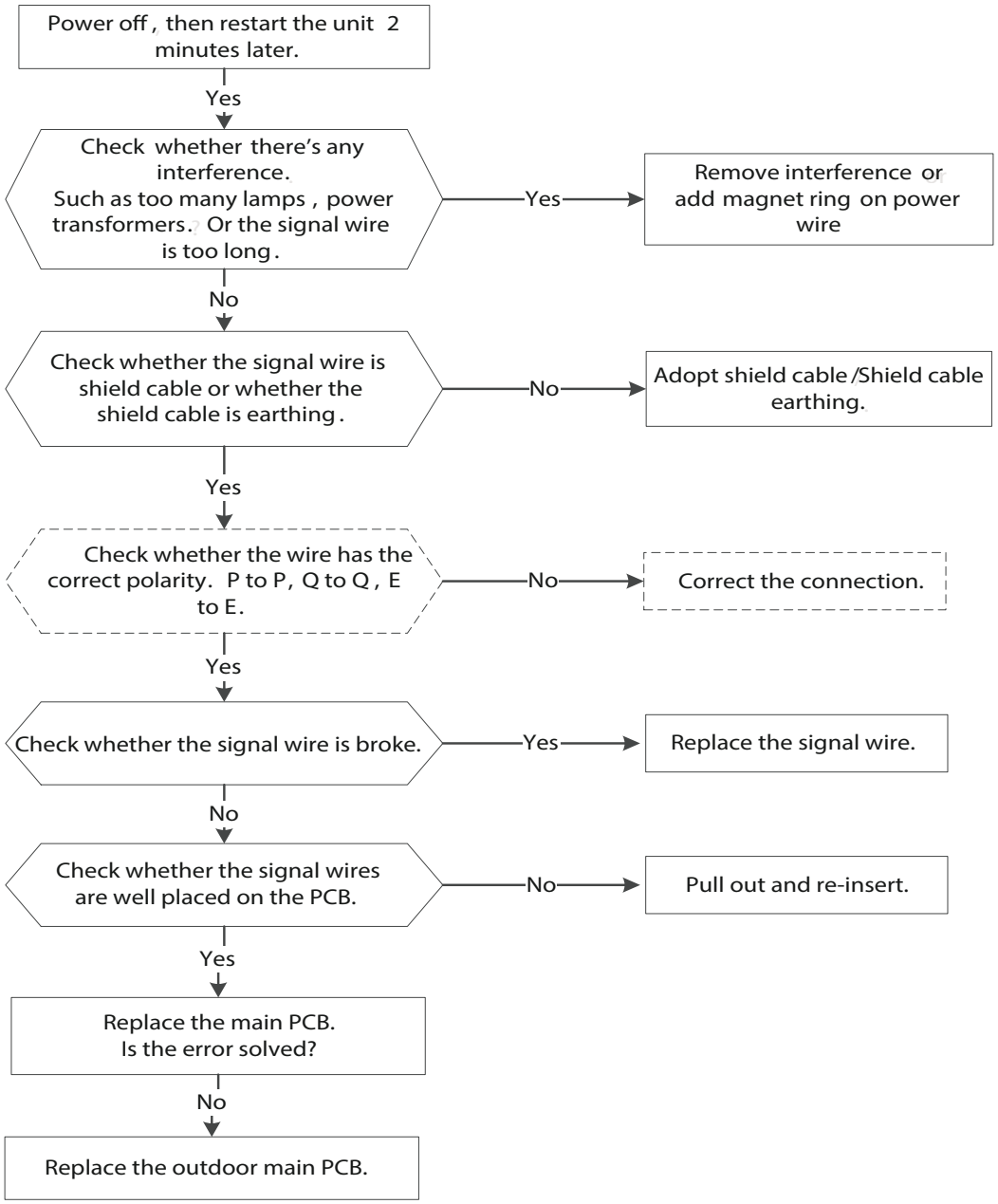
Description: Indoor unit can not communicate with outdoor unit

Recommended parts to prepare:

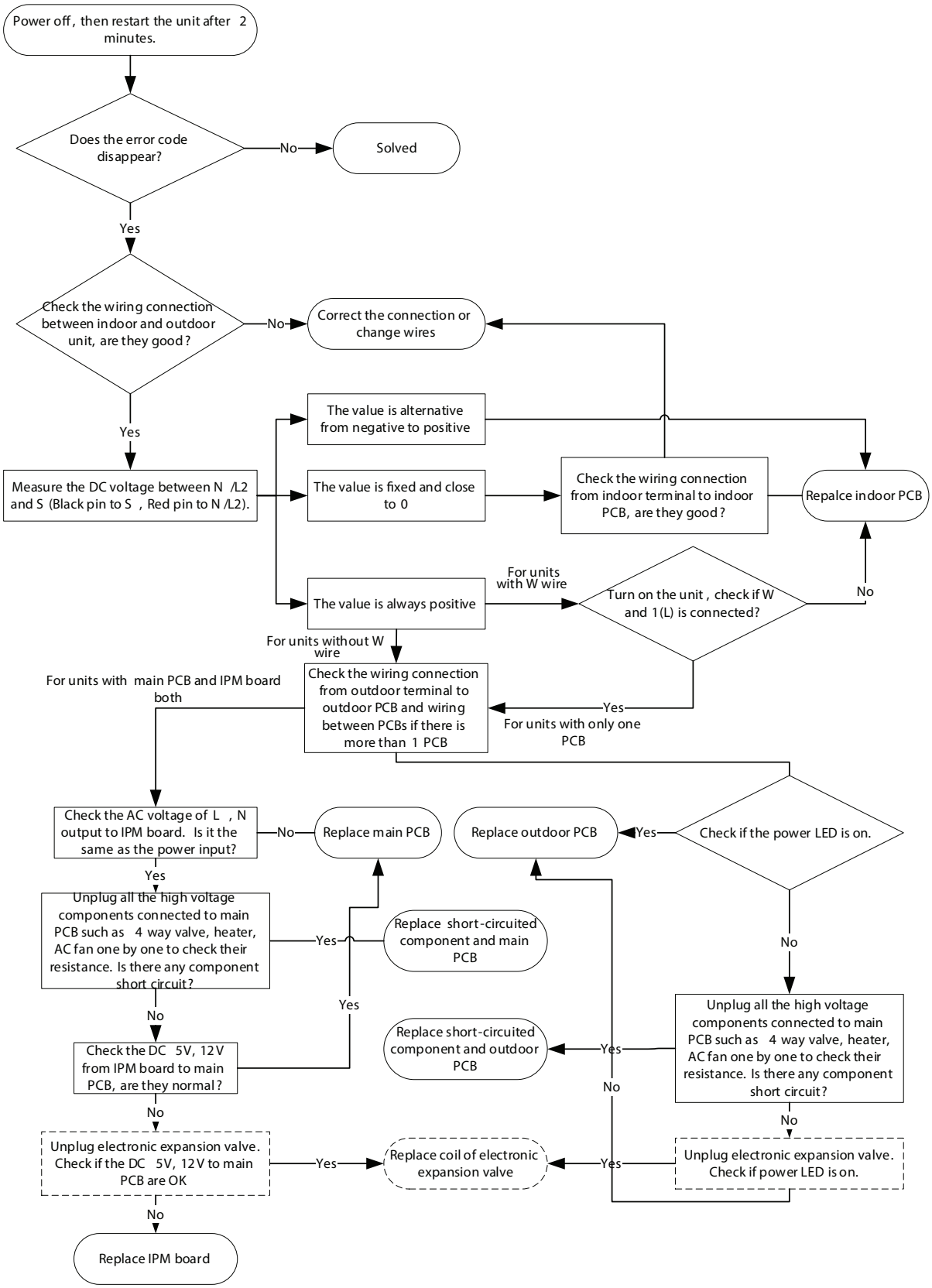
- Signal wires
- Magnet ring
- Indoor PCB
- Outdoor PCB

Troubleshooting and repair:

XYE Communication:



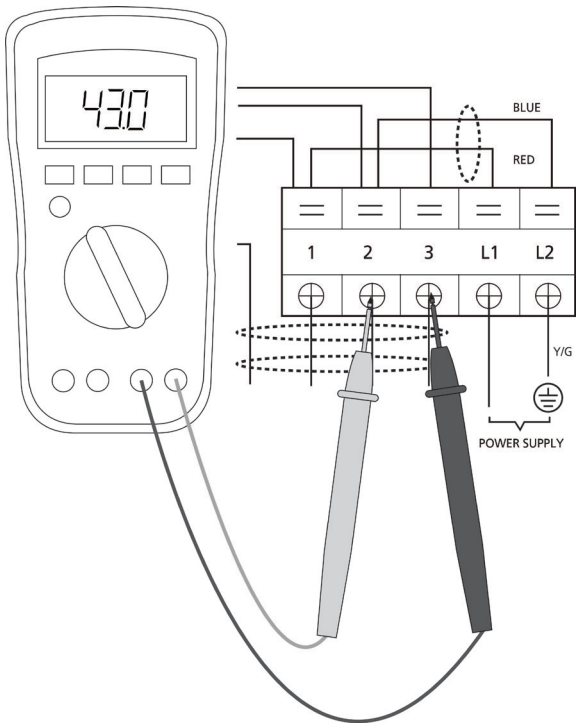
S Communication



NOTE: For certain models, outdoor PCB could not be removed separately. In this case, the outdoor electric control box should be replaced as a whole.

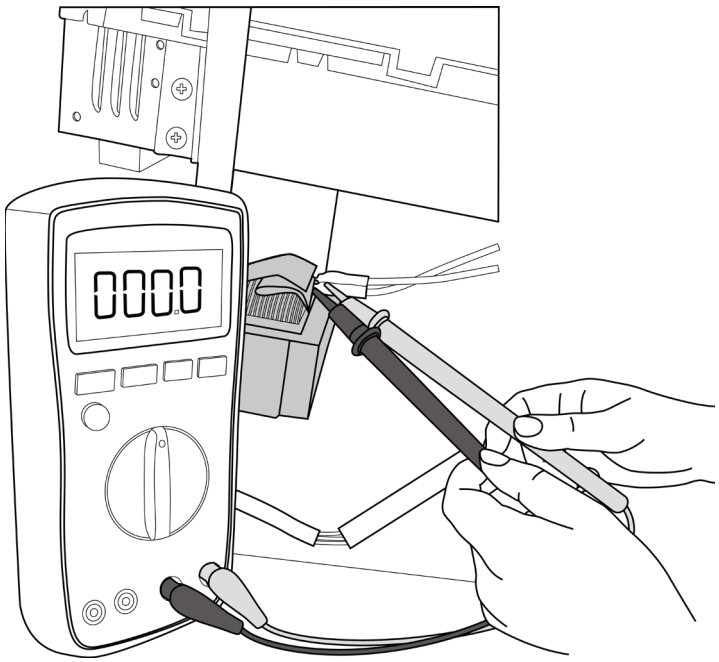
REMARKS:

- Use a multimeter to test the DC voltage between the 2 port (or S or L2 port) and the 3 port (or N or S port) of the outdoor unit.
- The red pin of the multimeter connects to the 2 port (or S or L2 port) while the black pin is for 3 port (or N or S port).
- When the air conditioner is running normally, the voltage is moving alternately as positive values and negative values.
- If the outdoor unit malfunctions, the voltage has always had a positive value.
- If the indoor unit malfunctions, the voltage has always had a certain value.



S and N
or
L2 and S
or
2 and 3

- Use a multimeter to test the reactor resistance which does not connect with a capacitor.
- The normal value should be around zero ohm. Otherwise, the reactor has malfunctioned.



NOTE: Images and the values inside are for reference only. Actual condition and specific value may vary.

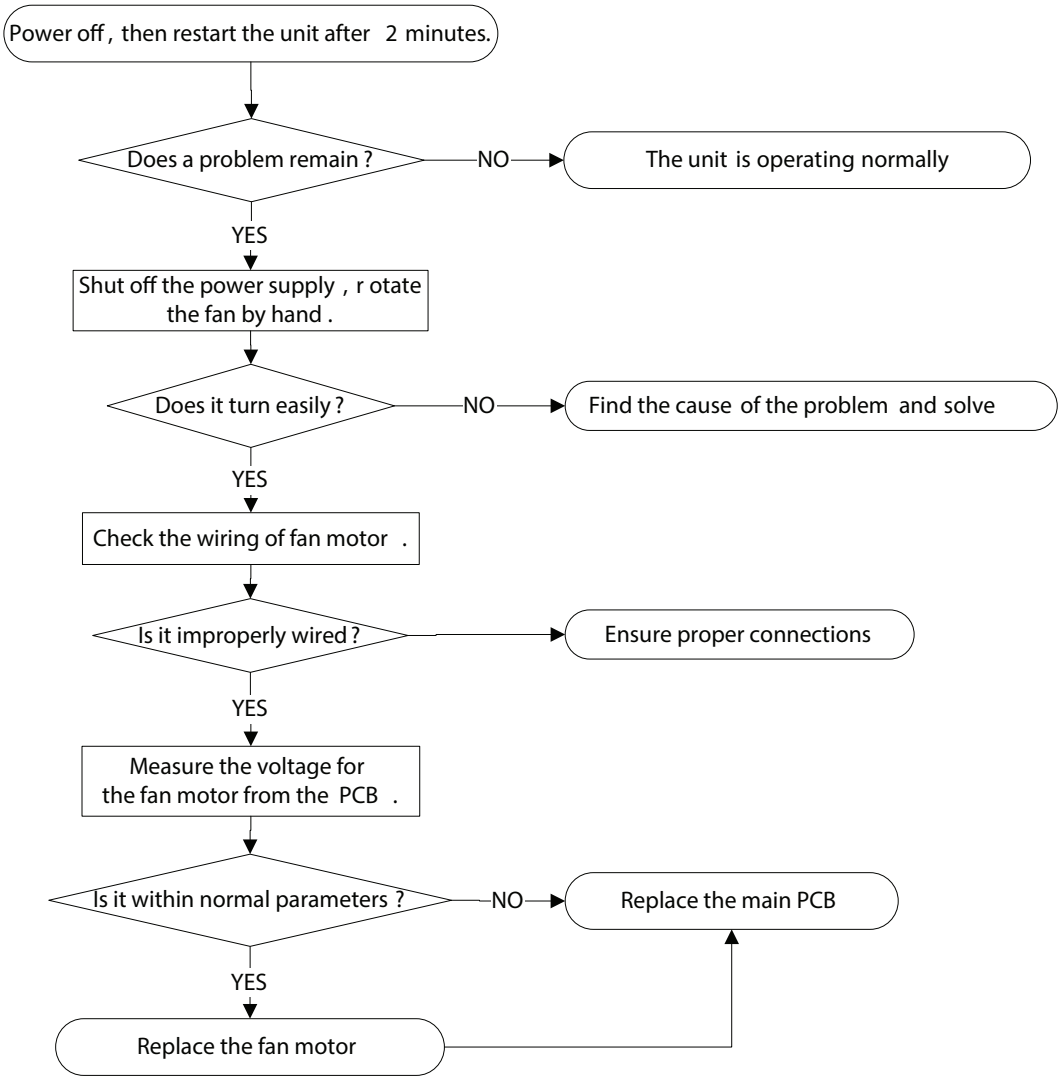
EC 07 (Fan Speed Is Operating Outside of Normal Range)/EC 71(Over Current Failure of Outdoor DC Fan Motor)/ EC73 (Zero-speed Failure of Outdoor DC Fan Motor) Diagnosis and Solution

Description: When indoor / outdoor fan speed keeps too low or too high for a certain time, the unit ceases operation and the LED displays the failure.

Recommended parts to prepare:

- Connection wires
- Fan assembly
- Fan motor
- PCB

Troubleshooting and repair:



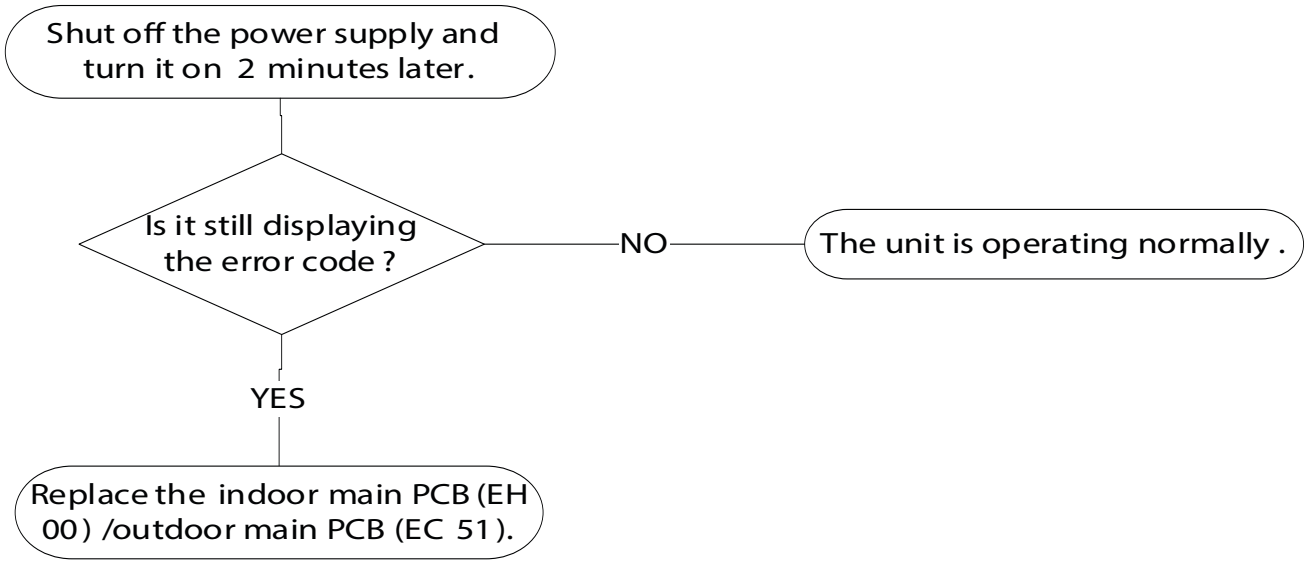
EC 51 (EEPROM Parameter Error Diagnosis and Solution)

Description: Indoor or outdoor PCB main chip does not receive feedback from EEPROM chip.

Recommended parts to prepare:

- Indoor PCB
- Outdoor PCB

Troubleshooting and repair:



REMARKS:

EEPROM: A read-only memory whose contents can be erased and reprogrammed using a pulsed voltage. The location of the EEPROM chip on the indoor and outdoor PCB is shown Figure 19 and Figure 20.

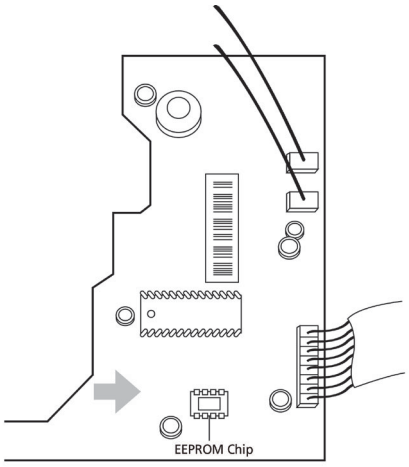


Fig. 19 — EEPROM

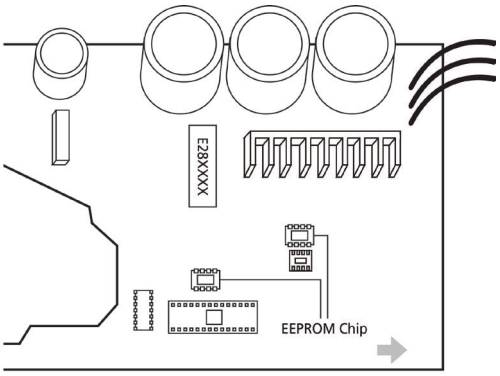


Fig. 20 — EEPROM

NOTE: For certain models, outdoor PCB could not be removed separately. In this case, the outdoor electric control box should be replaced as a whole. This pictures are only for reference, actual appearance may vary. Troubleshooting and repair of compressor driven chip EEPROM parameter error and communication error between outdoor main chip and compressor driven chip are same as EC 51.

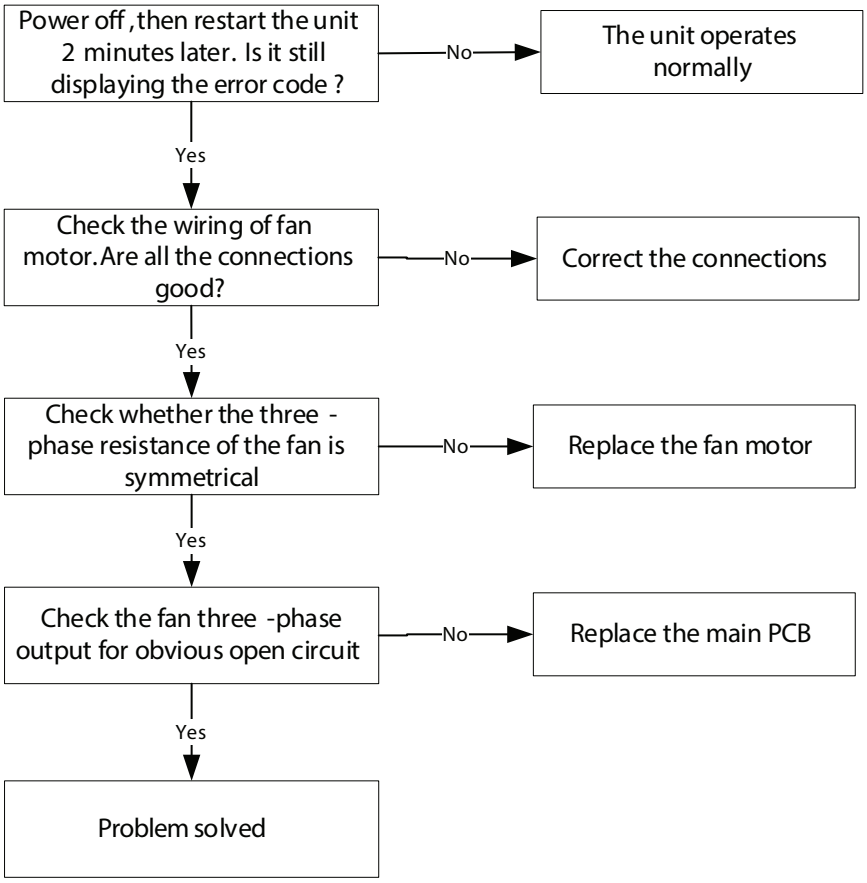
EC 72 (Lack Phase Failure of Outdoor DC Fan Motor Diagnosis and Solution)

Description: When the three-phase sampling current of the DC motor is abnormal, especially when the current of one or more phases is always small and almost 0, the LED displays the failure code.

Recommended parts to prepare:

- Connection wire
- Fan motor
- Outdoor PCB

Troubleshooting and repair:



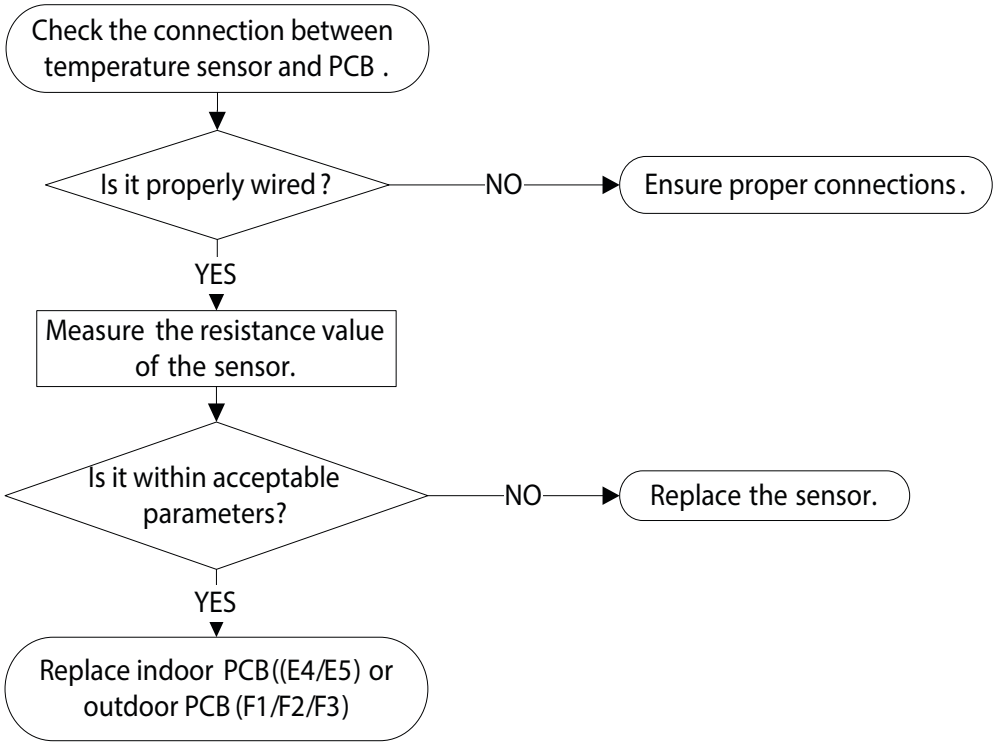
EH 60/EH 61/EH 62/ EH 65/ EC 53/EC 52/EC 54/ (Open Circuit or Short Circuit of Temperature Sensor Diagnosis and Solution)

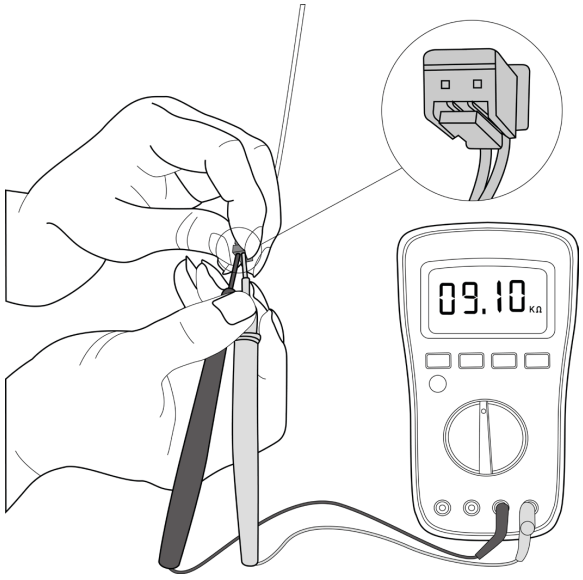
Description: If the sampling voltage is lower than 0.06V or higher than 4.94V, the LED displays the failure.

Recommended parts to prepare:

- Connection wires
- Sensors
- PCB

Troubleshooting and repair:





NOTE: For certain models, the outdoor PCB could not be removed separately. In this case, the outdoor electric control box should be replaced as a whole. The figure and the value above are for reference only. The actual appearance and value may vary.

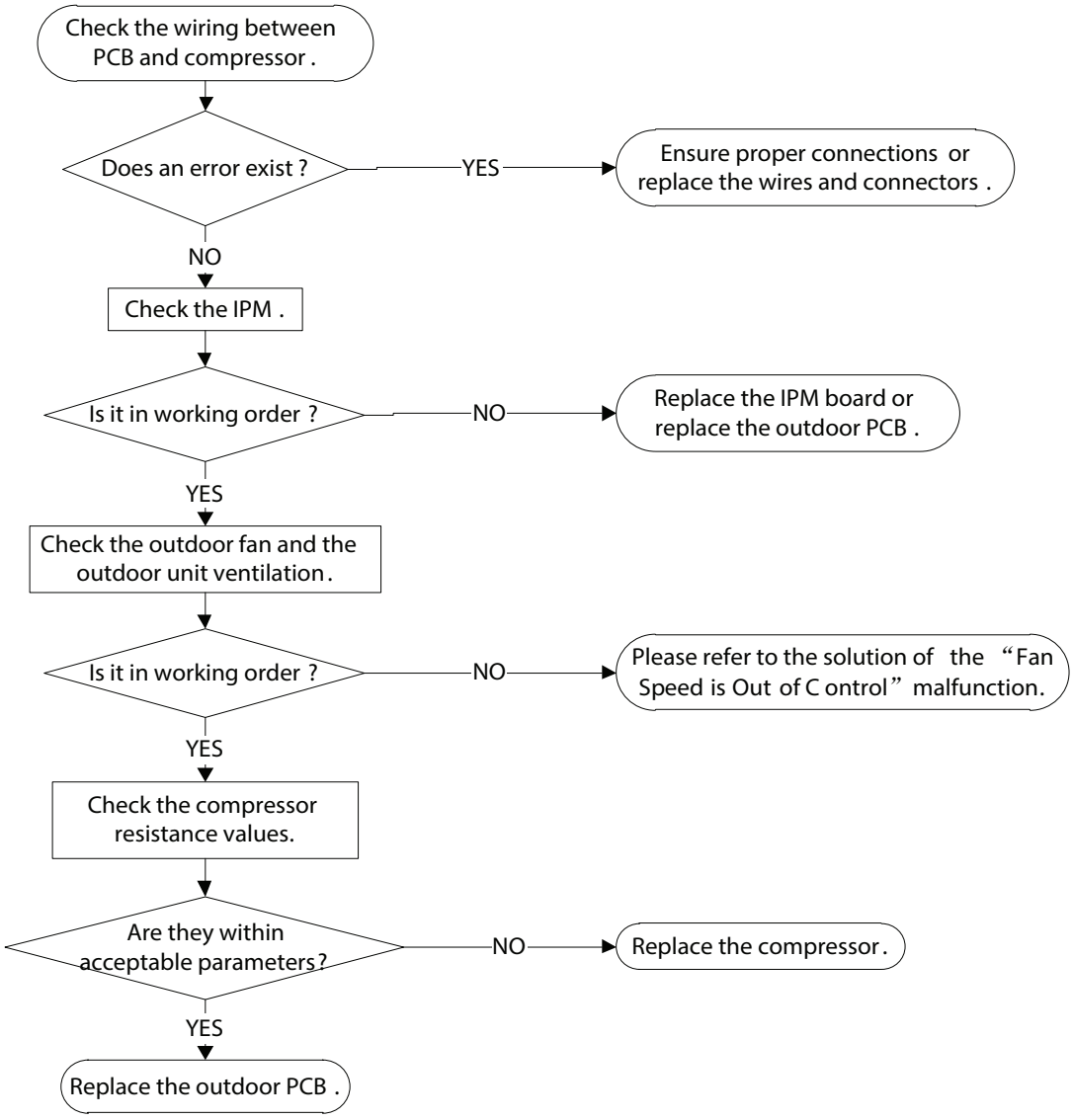
PC 00 (IPM Malfunction or IGBT Over-Strong Current Protection Diagnosis and Solution)

Description: When the voltage signal the IPM sends to the compressor drive chip is abnormal, the display LED displays “PC 00” and the air conditioner turn off.

Recommended parts to prepare:

- Connection wires
- IPM module board
- Outdoor fan assembly
- Compressor
- Outdoor PCB

Troubleshooting and repair:



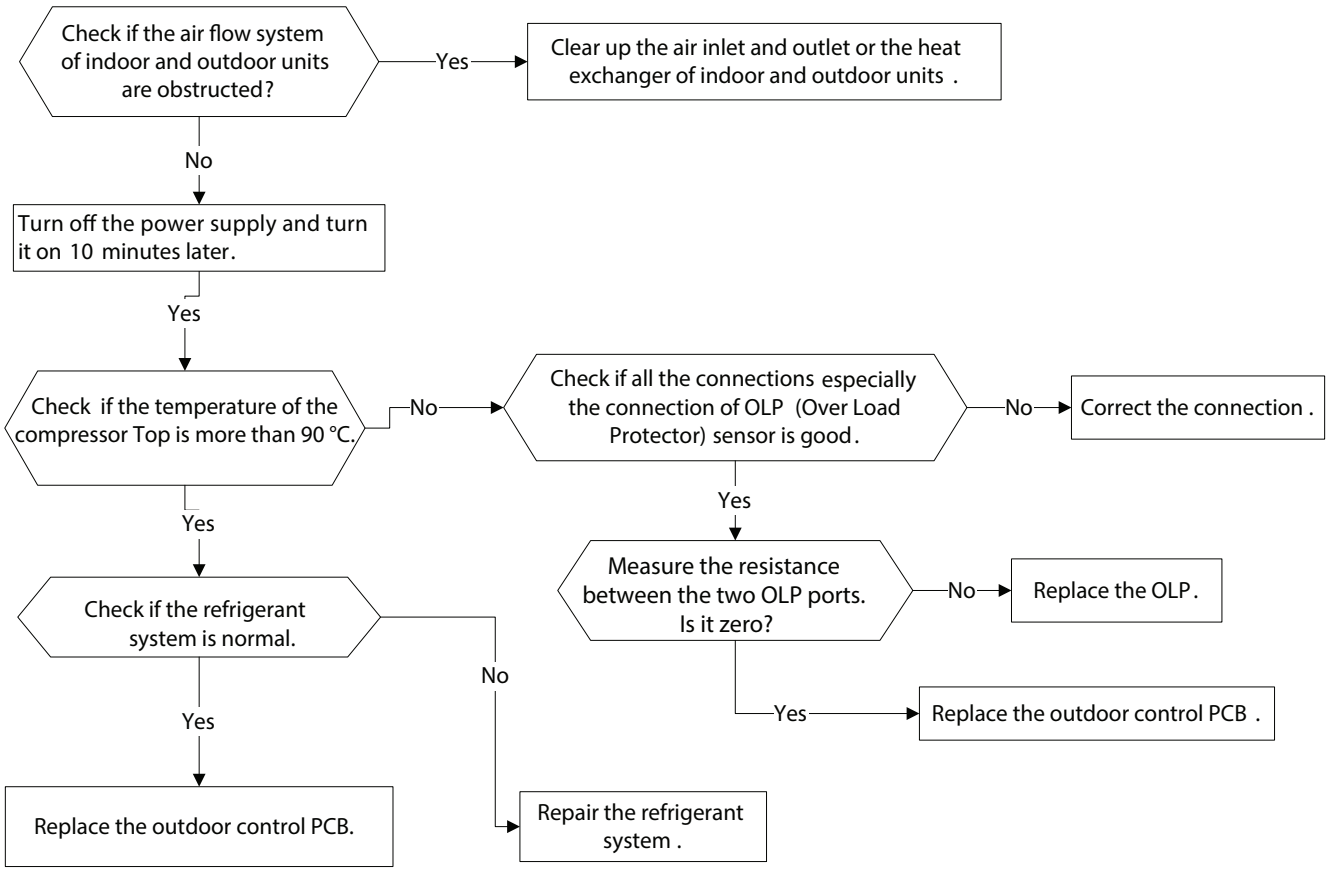
PC 02 (Top Temperature Compressor Protection or High Temperature IPM Module Protection of Diagnosis and Solution)

Description: For some models with overload protection, If the sampling voltage is not 5V, the LED displays the failure. If the IPM module temperature is higher than a certain value, the LED displays a failure code.

Recommended parts to prepare:

- Connection wires
- Outdoor PCB
- IPM module board
- High pressure protector
- System blockages

Troubleshooting and repair:



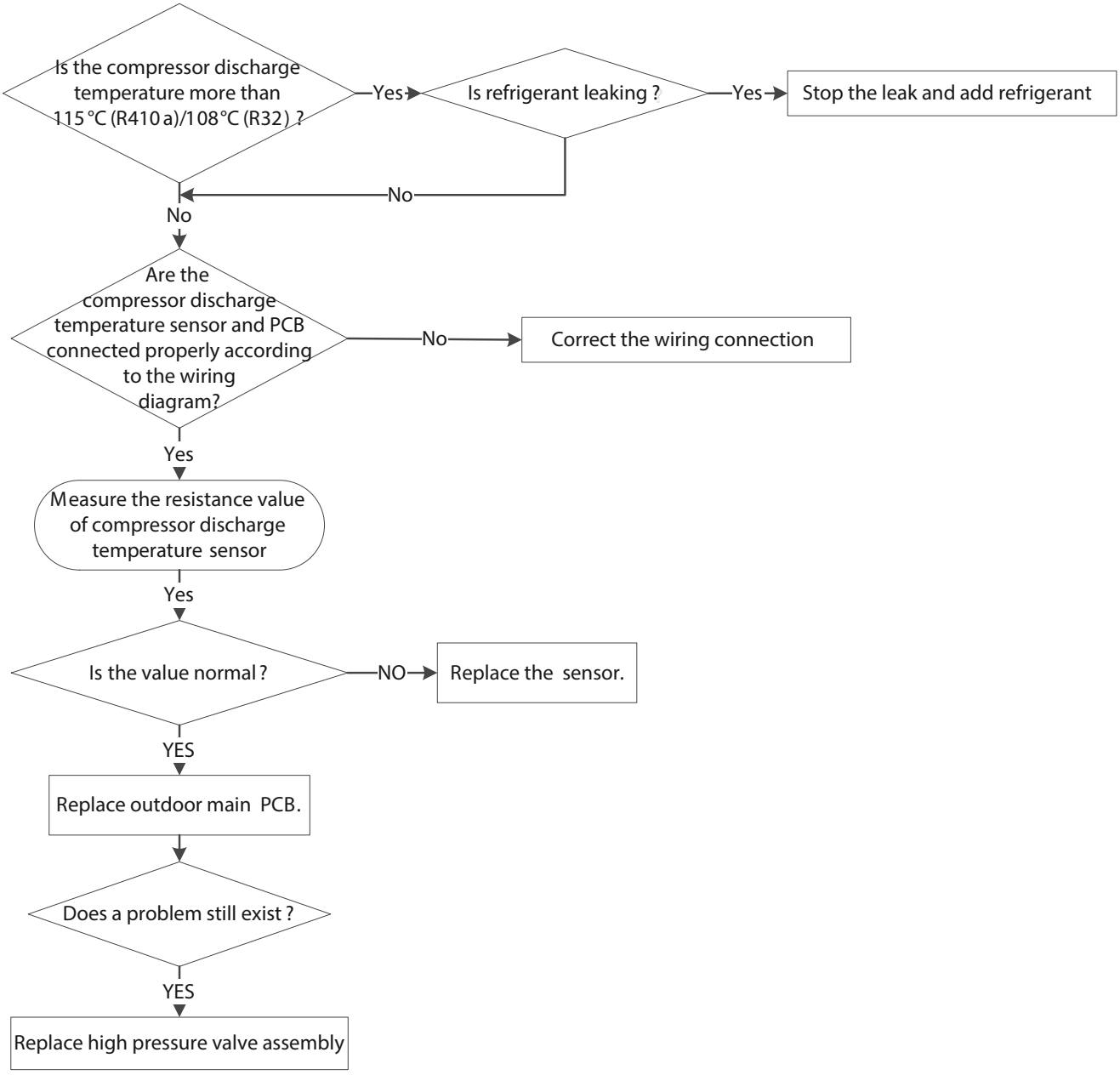
PC 06 (Discharge Temperature Protection of Compressor Diagnosis and Solution)

Description: If the compressor discharge temperature exceeds a certain level for nine seconds, the compressor ceases operation and the LED displays the failure code.

Recommended parts to prepare:

- Connection wires
- Discharge temperature sensor
- Additional refrigerant
- Outdoor main PCB

Troubleshooting and repair:



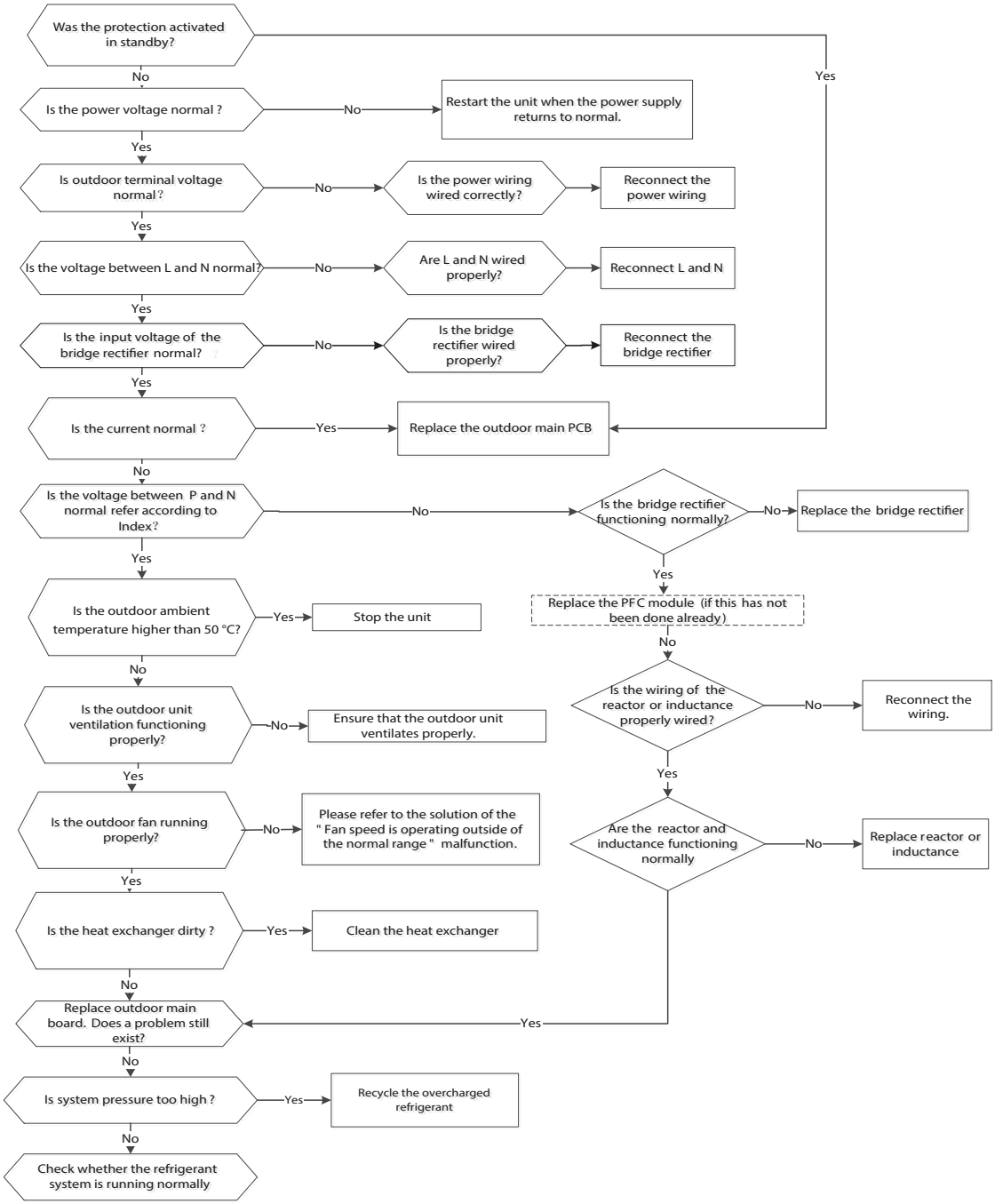
PC 08 (Current Overload Protection) / PC 44 (Outdoor Unit Zero Speed Protection) / PC 46 (Compressor Speed Has Been Out of Control) / PC 49 (Compressor Overcurrent Failure) Diagnosis and Solution

Description: An abnormal current rise is detected by checking the specified current detection circuit.

Recommended parts to prepare:

- Connection wires
- Rectifier
- PFC circuit or reactor
- Blocked refrigeration piping system
- Pressure switch
- Outdoor fan
- IPM module board
- Outdoor PCB

Troubleshooting and repair:



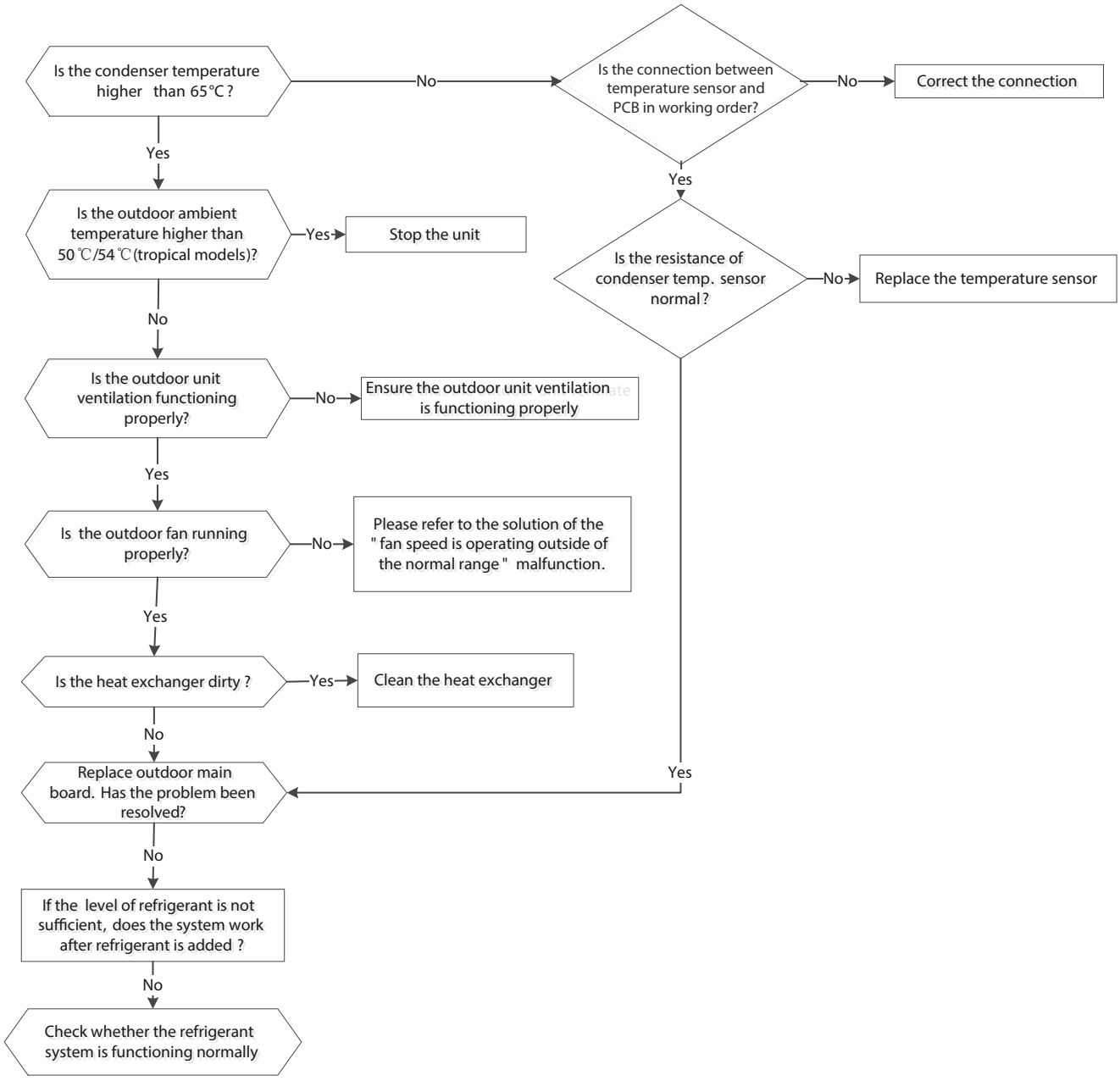
PC 0A (High Temperature Protection of Condenser Diagnosis and Solution)

Description: When the outdoor pipe temperature is more than 65°C, the unit stops. It starts again only when the outdoor pipe temperature is less than 52°C.

Recommended parts to prepare:

- Connection wires
- Condenser temperature sensor
- Outdoor fan
- Outdoor main PCB
- Refrigerant

Troubleshooting and repair:



PC 0F(PFC Module Protection Diagnosis and Solution)

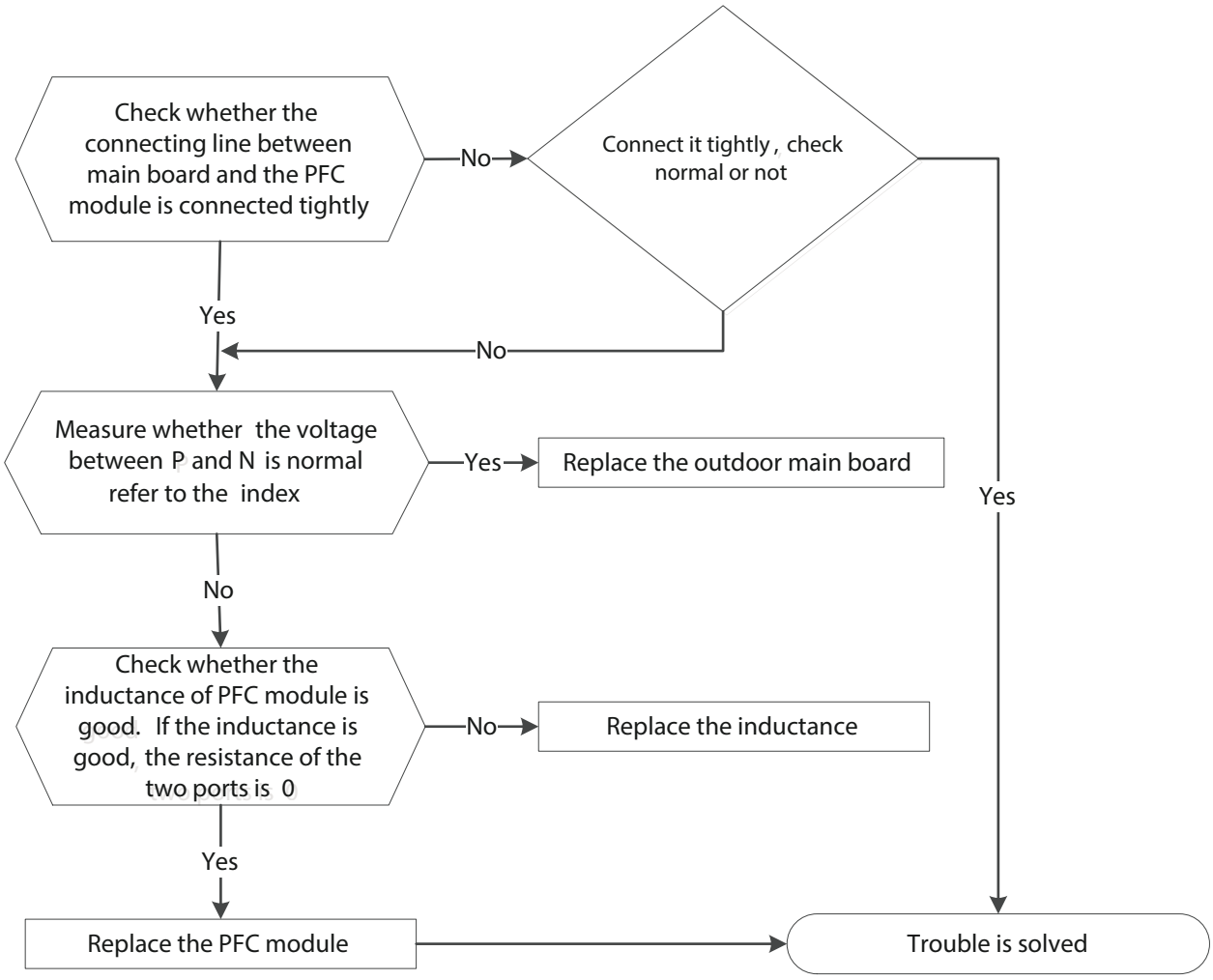
Description: When the voltage signal that the IPM sends to the compressor drive chip is abnormal, the LED displays the failure code and the air conditioner turns off.

Recommended parts to prepare:

- Connection wires
- Inductance
- Outdoor main PCB
- PFC module

Troubleshooting and repair:

Test the resistance between every two ports of U, V, W of IPM and P, N. If any of the ports result is 0 or close to 0, the IPM is defective. Otherwise, follow the procedure described on the following flowchart.



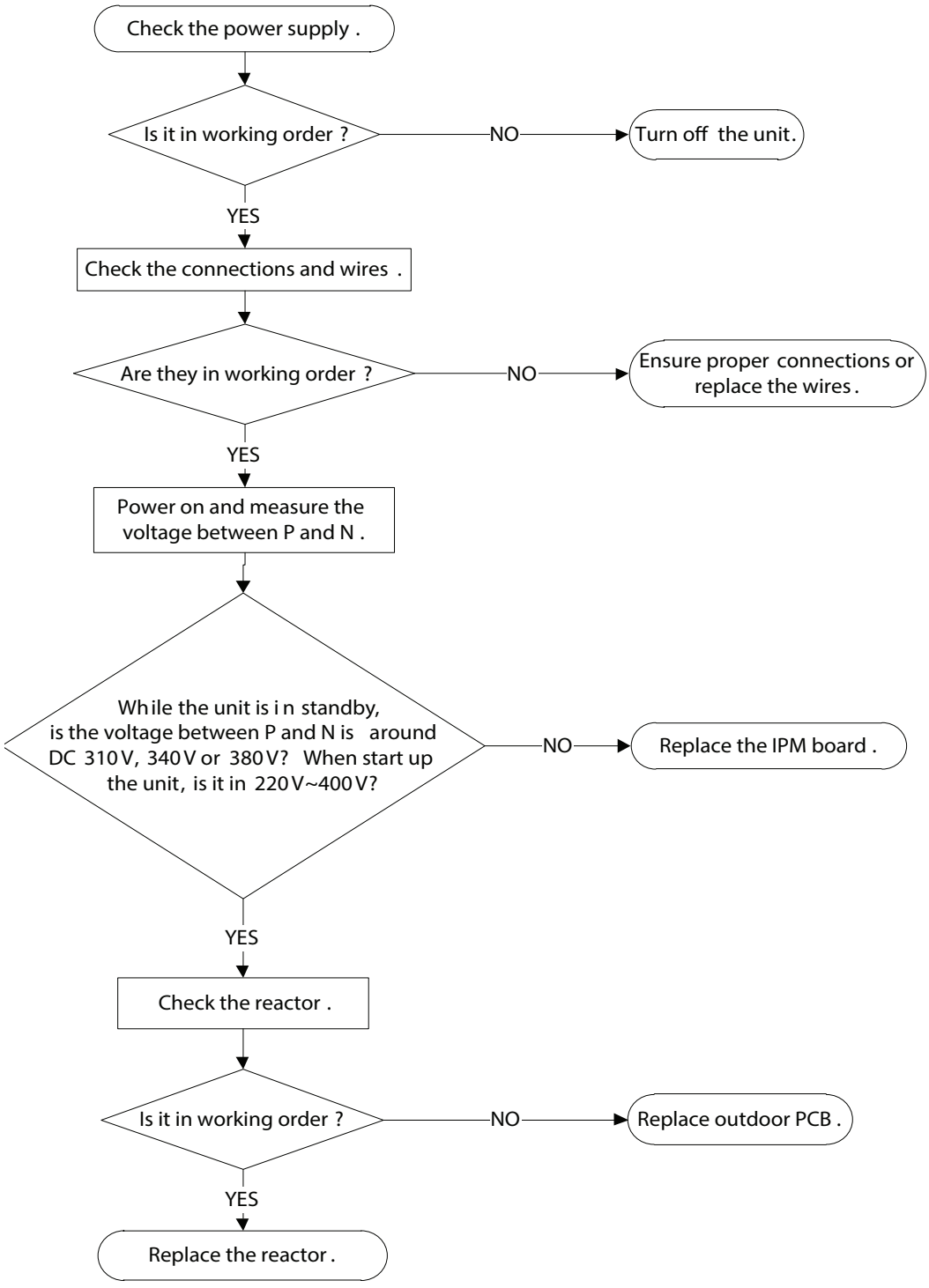
PC 01 (Over Voltage or Too Low Voltage Protection) / PC 10 (Outdoor Unit Low AC Voltage Protection) / PC 11 (Outdoor Unit Main Control Board DC Bus High Voltage Protection) / PC 12(Outdoor Unit Main Control Board DC Bus High Voltage Protection /341 MCE Error) Diagnosis and Solution

Description: Abnormal increases or decreases in voltage are detected by checking the specified voltage detection circuit.

Recommended parts to prepare:

- Power supply wires
- IPM module board
- PCB
- Reactor

Troubleshooting and repair:



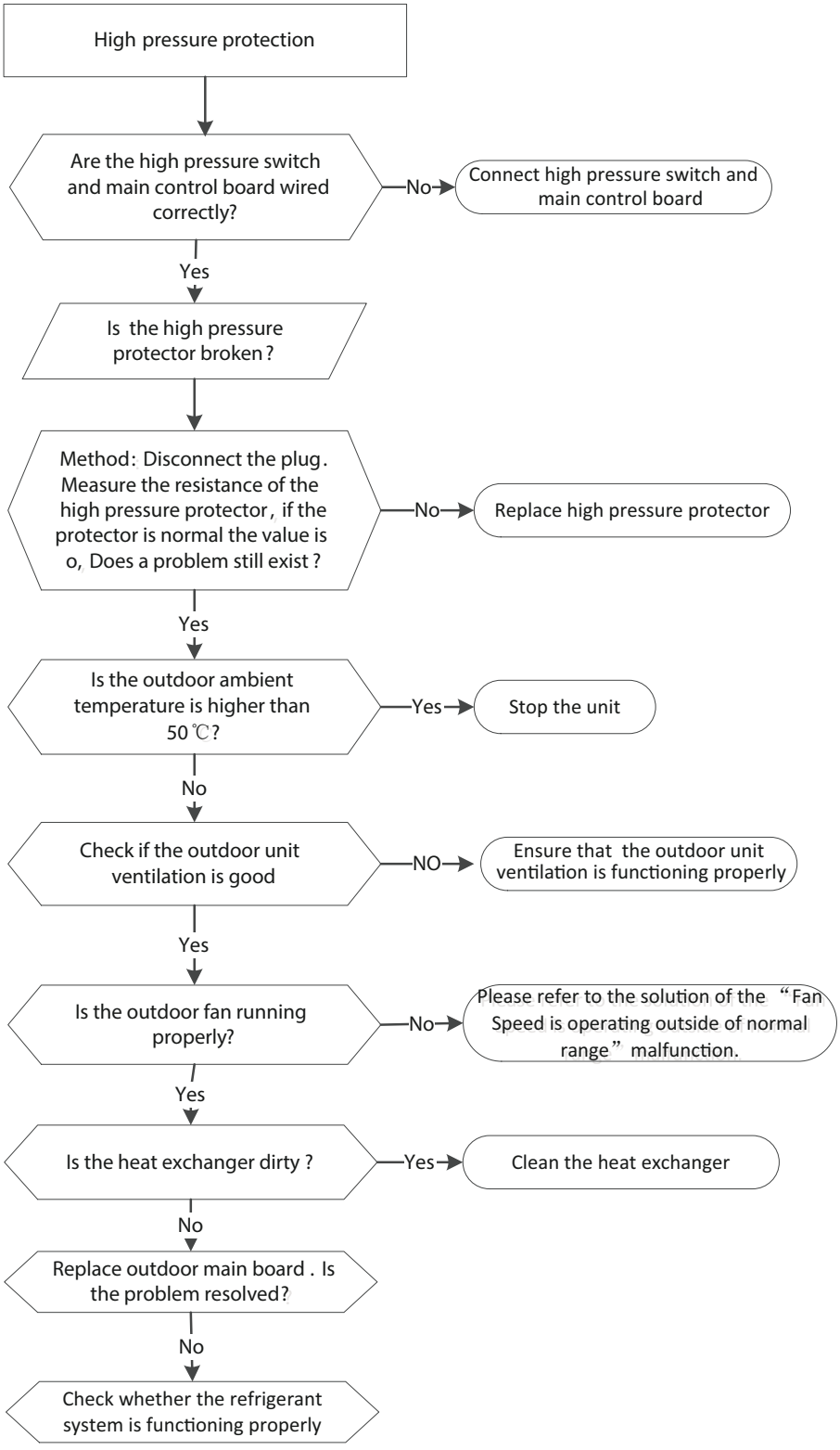
PC 30 (High Pressure Protection Diagnosis and Solution)

Description: Outdoor pressure switch cuts off the system when high pressure is higher than 4.4 MPa

Recommended parts to prepare:

- Connection wires
- Pressure switch
- Outdoor fan
- Outdoor main PCB

Troubleshooting and repair:



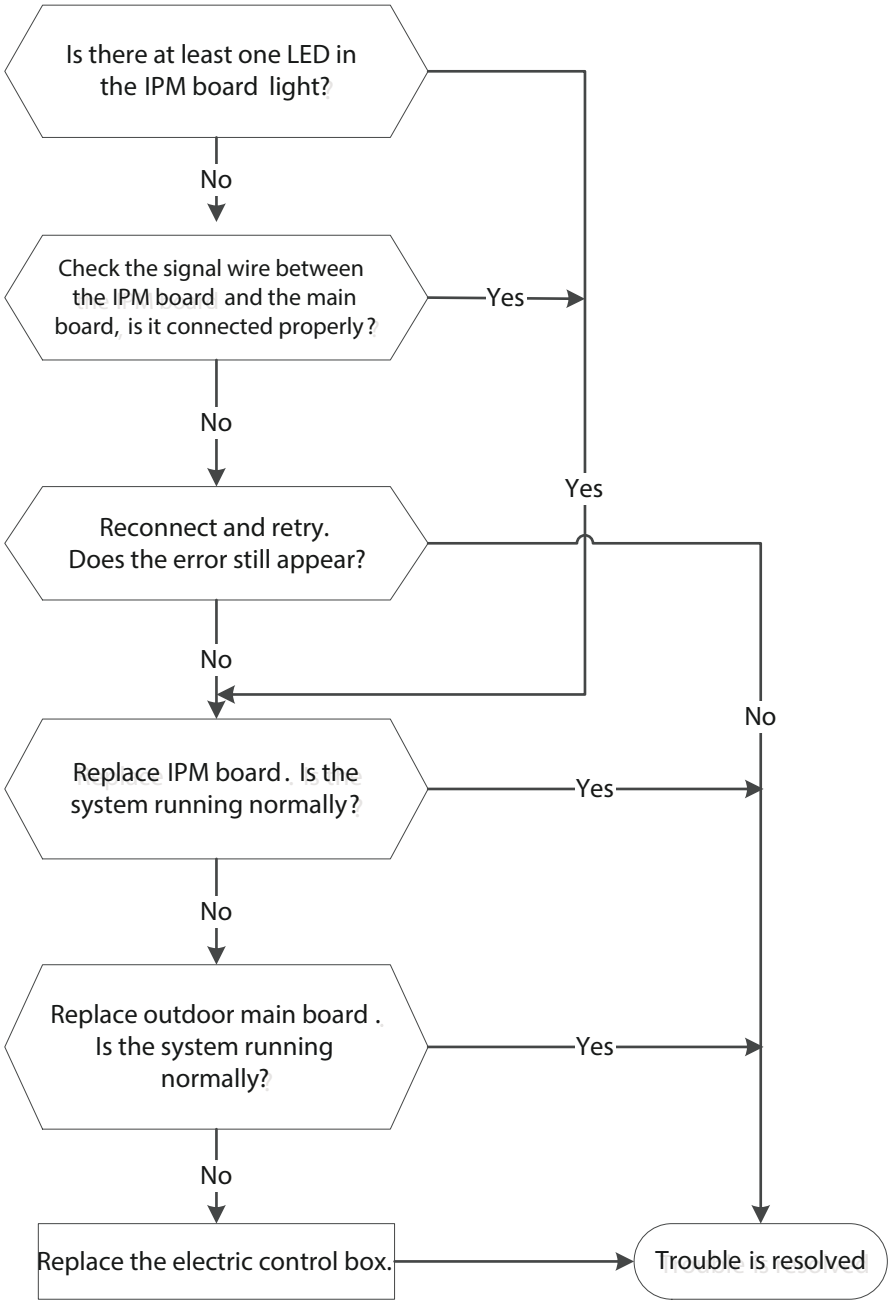
PC 40 (Communication Error Between Outdoor Main PCB and IPM Board Diagnosis and Solution)

Description: The main PCB cannot detect the IPM board.

Recommended parts to prepare:

- Connection wires
- IPM board
- Outdoor main PCB
- Electric control box

Troubleshooting and repair:



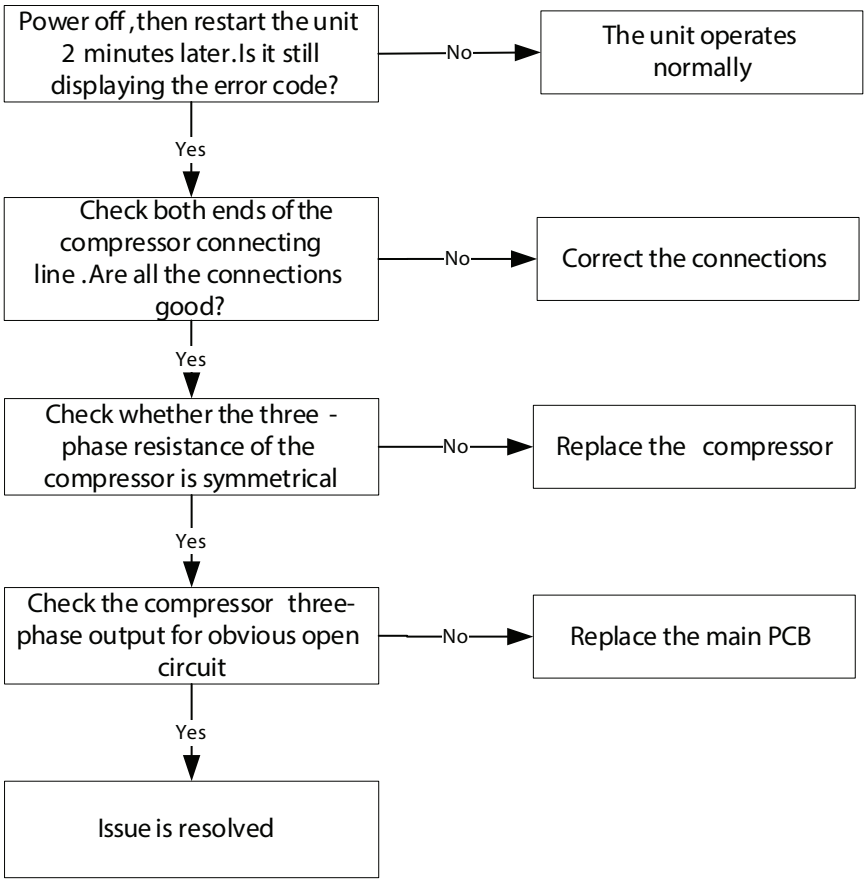
PC 43 (Outdoor Compressor Lack Phase Protection Diagnosis and Solution)

Description: When the three-phase sampling current of the compressor is abnormal, especially when the current of one or more phases is always small and almost 0, the LED displays the failure code

Recommended parts to prepare:

- Connection wire
- Compressor
- Outdoor PCB

Troubleshooting and repair:



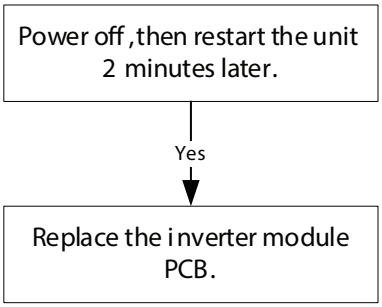
PC 45 (Outdoor Unit IR Chip Drive Failure Diagnosis and Solution)

Description: When the IR chip detects its own parameter error, the LED displays the failure code when powered on.

Recommended parts to prepare:

- Inverter module PCB

Troubleshooting and repair:



PC 0L (Low ambient temperature protection)

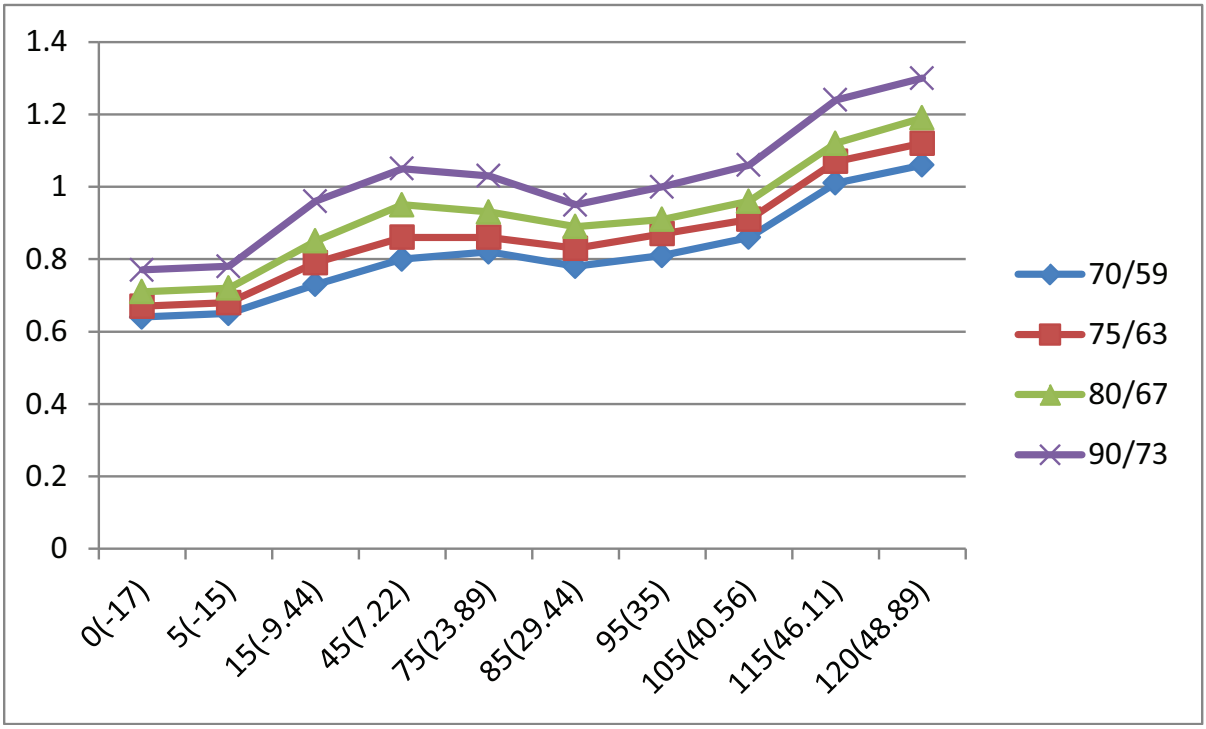
Description: It is a protection function. When compressor is off, outdoor ambient temperature(T4) is lower than -35ₒC. for 10s, the air conditioner stops and displays the failure code.

When compressor is on, the outdoor ambient temperature(T4) is lower than -40ₒC.for 10s, the air conditioner stops and displays the failure code. When outdoor ambient temperature(T4) is no lower than -32ₒC.for 10s, the unit exits protection.

Pressure on Service Port

Cooling Chart (R410A)

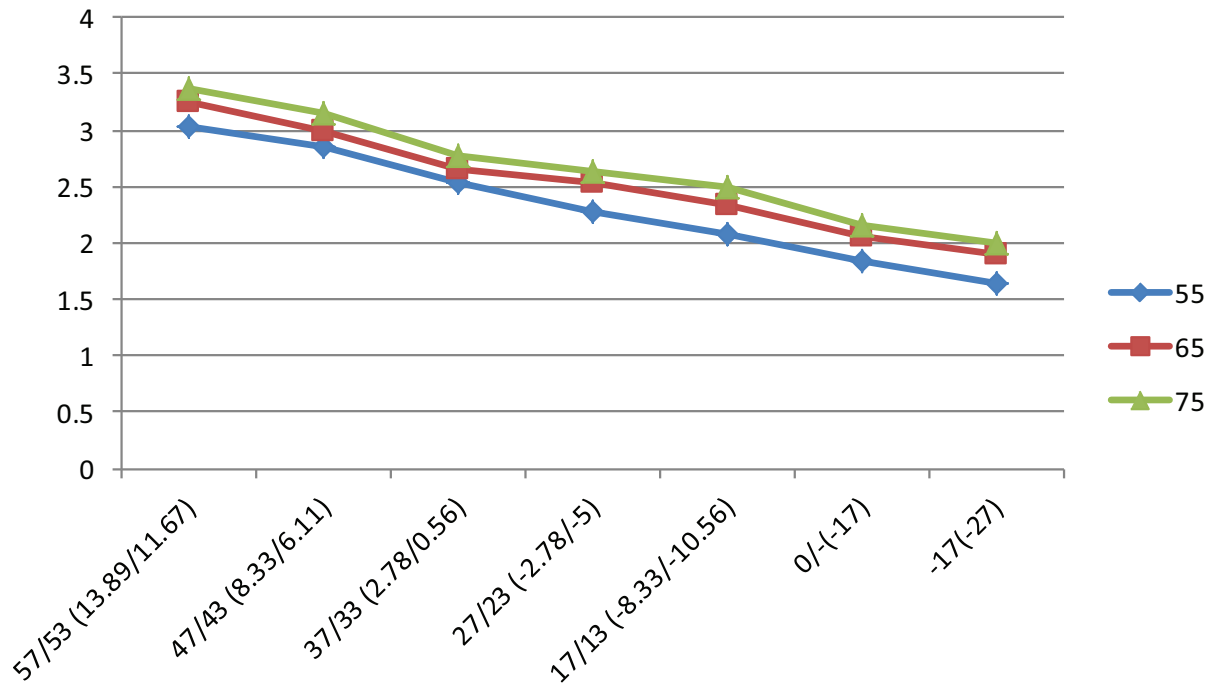
°F(°C)	ODU(DB) / IDU(DB/WB)	0 (-17)	5 (-15)	15 (-9.44)	45 (7.22)	75 (23.89)	85 (29.44)	95 (35)	105 (40.56)	115 (46.11)	120 (48.89)
BAR	70/59 (21.11/15)	6.4	6.5	7.3	8.0	8.2	7.8	8.1	8.6	10.1	10.6
	75/63 (23.89/17.22)	6.7	6.8	7.9	8.6	8.6	8.3	8.7	9.1	10.7	11.2
	80/67 (26.67/19.44)	7.1	7.2	8.5	9.5	9.3	8.9	9.1	9.6	11.2	11.9
	90/73 (32.22/22.78)	7.7	7.8	9.6	10.5	10.3	9.5	10.0	10.6	12.4	13.0
PSI	70/59 (21.11/15)	93	94	106	116	119	113	117	125	147	154
	75/63 (23.89/17.22)	97	99	115	125	124	120	126	132	155	162
	80/67 (26.67/19.44)	103	104	123	138	135	129	132	140	162	173
	90/73 (32.22/22.78)	112	113	139	152	149	138	145	154	180	189
MPA	70/59 (21.11/15)	0.64	0.65	0.73	0.8	0.82	0.78	0.81	0.86	1.01	1.06
	75/63 (23.89/17.22)	0.67	0.68	0.79	0.86	0.86	0.83	0.87	0.91	1.07	1.12
	80/67 (26.67/19.44)	0.71	0.72	0.85	0.95	0.93	0.89	0.91	0.96	1.12	1.19
	90/73 (32.22/22.78)	0.77	0.78	0.96	1.05	1.03	0.95	1	1.06	1.24	1.3



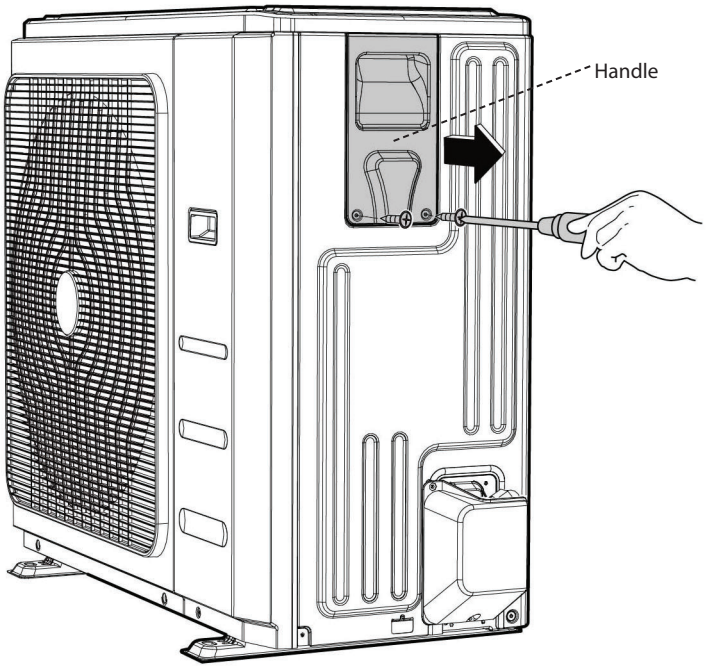
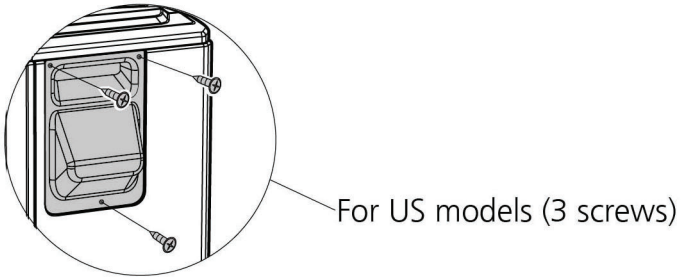
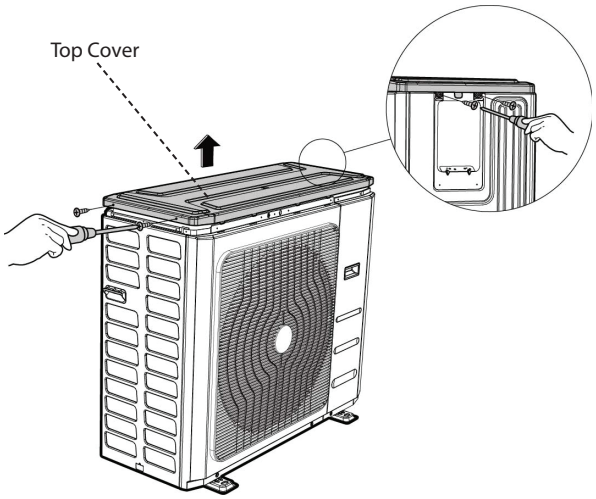
Pressure on Service Port (cont.)

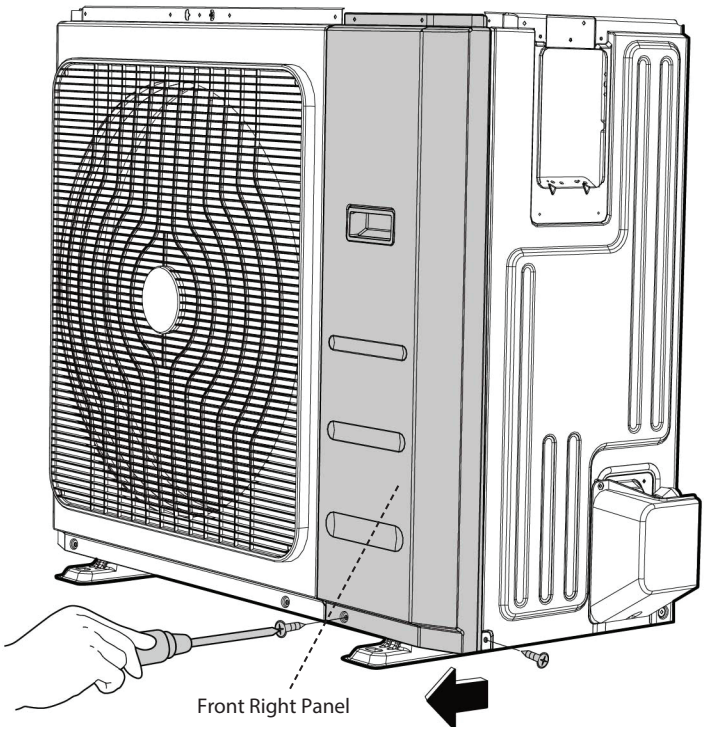
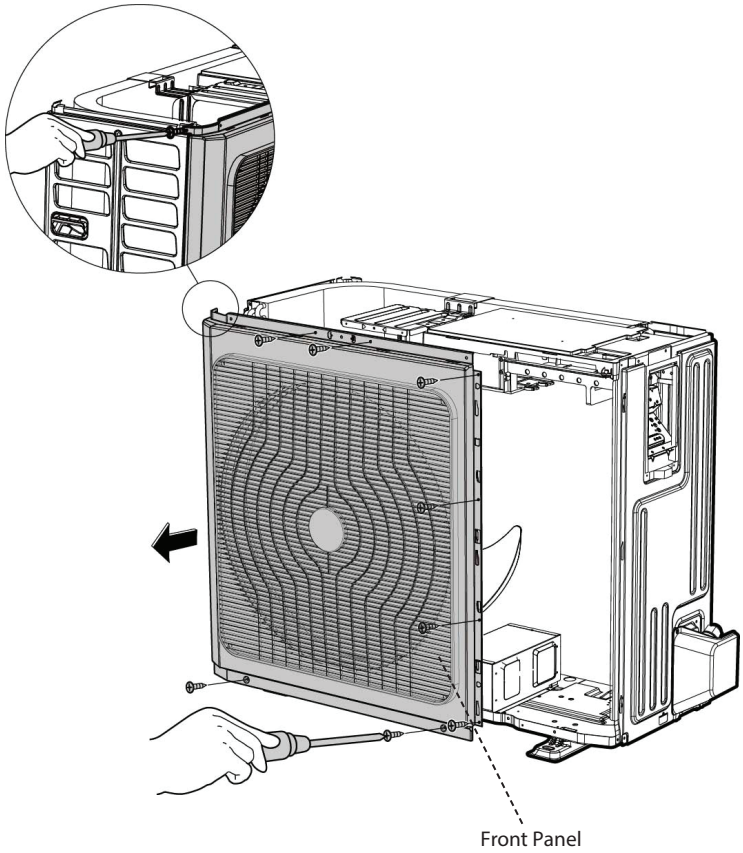
Heating Charts (Heating Mode)

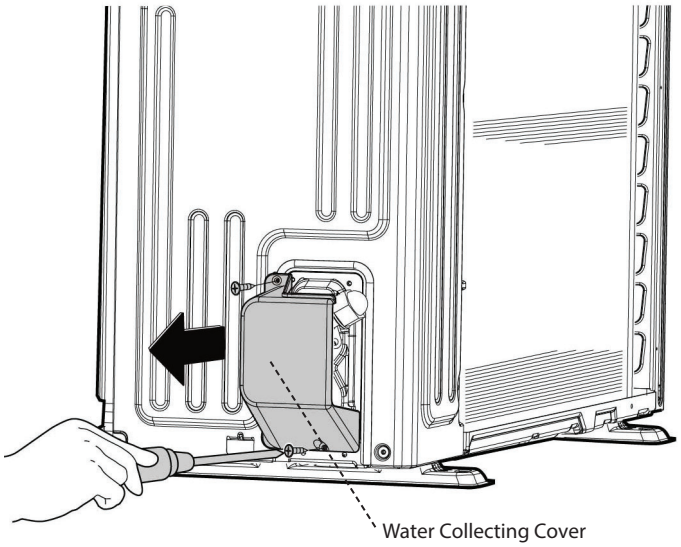
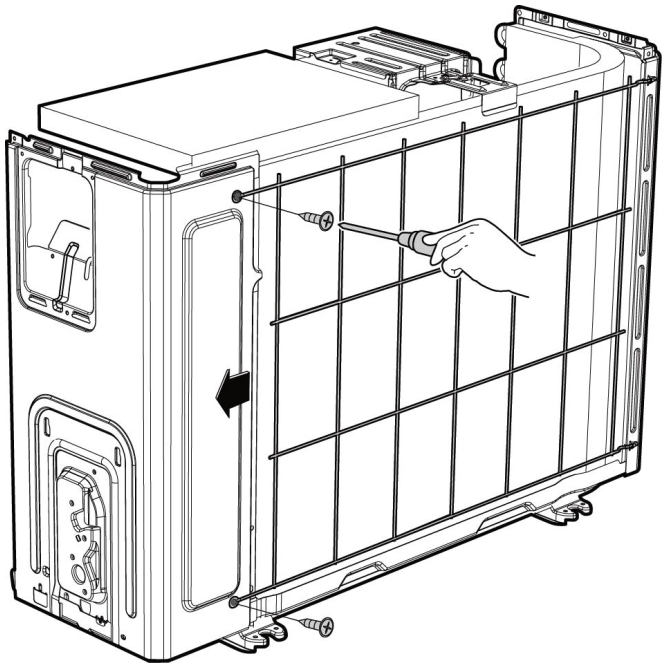
°F(°C)	ODU(DB/WB) / IDU(DB)	57/53 (13.89/11.67)	47/43 (8.33/6.11)	37/33 (2.78/0.56)	27/23 (-2.78/-5)	17/13 (-8.33/-10.56)	0/-2 (-17/-19)	-17/-18 (-27/-28)
BAR	55(12.78)	30.3	28.5	25.3	22.8	20.8	18.5	16.5
	65(18.33)	32.5	30.0	26.6	25.4	23.3	20.5	19.0
	75(23.89)	33.8	31.5	27.8	26.3	24.9	21.5	20.0
PSI	55(12.78)	439	413	367	330	302	268	239
	65(18.33)	471	435	386	368	339	297	276
	75(23.89)	489	457	403	381	362	312	290
MPA	55(12.78)	3.03	2.85	2.53	2.28	2.08	1.85	1.65
	65(18.33)	3.25	3.00	2.66	2.54	2.33	2.05	1.90
	75(23.89)	3.38	3.15	2.78	2.63	2.49	2.15	2.00

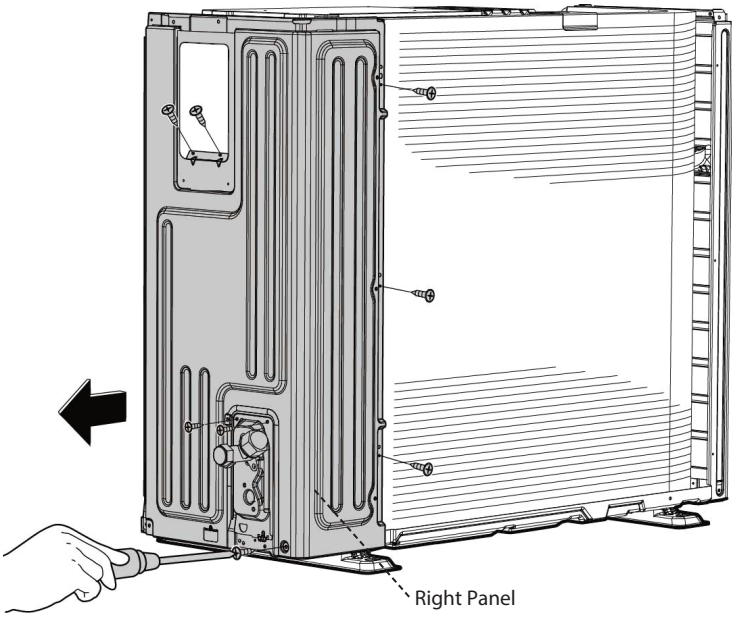


DISASSEMBLY INSTRUCTIONS
SIZE 36

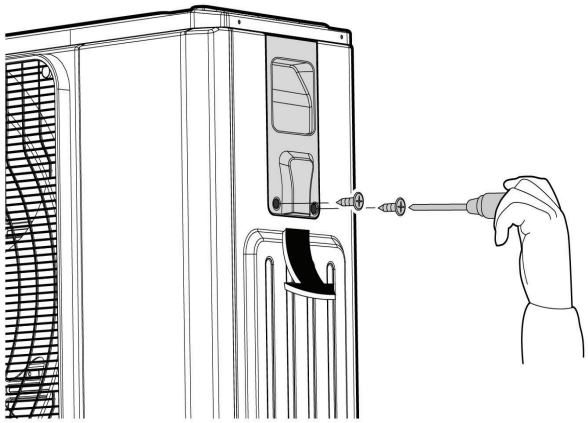
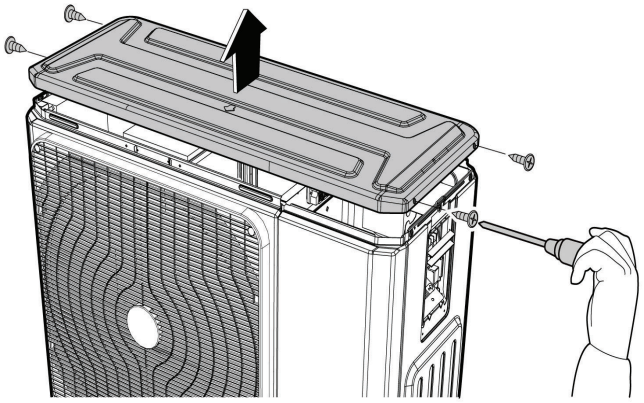
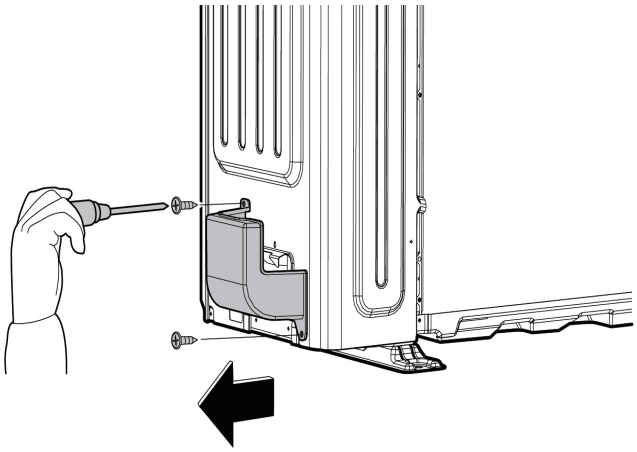
Procedure	Illustration
1) Turn off the air conditioner and the power breaker. 2) Remove the 2 handle screws then remove the handle.	
	
3) Remove the 4 top cover screws then remove the top cover. Two of the screws are located under the handle.	

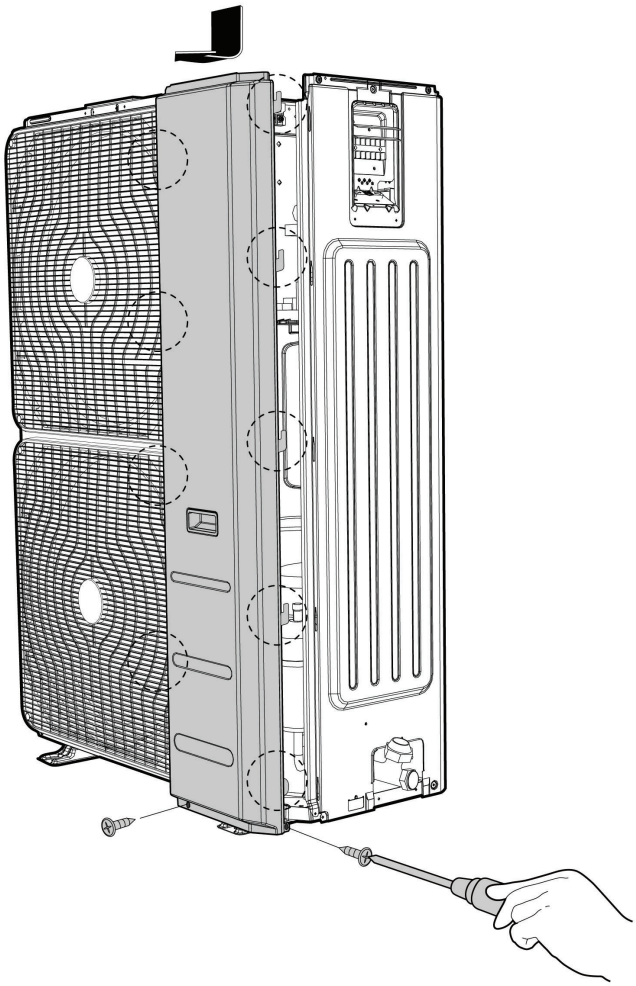
Procedure	Illustration
4) Remove the 2 screws of the front right panel then remove the front right panel.	
5) Remove the 9 screws from the front panel then remove the front panel.	

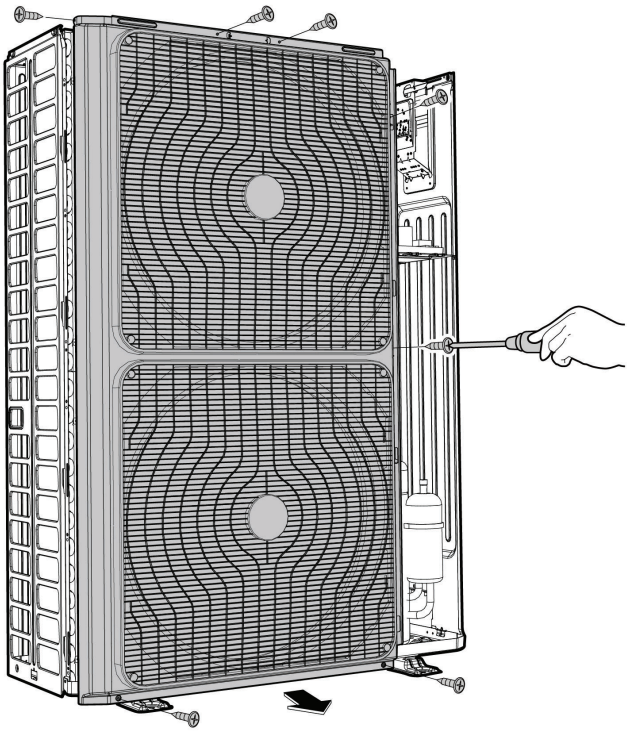
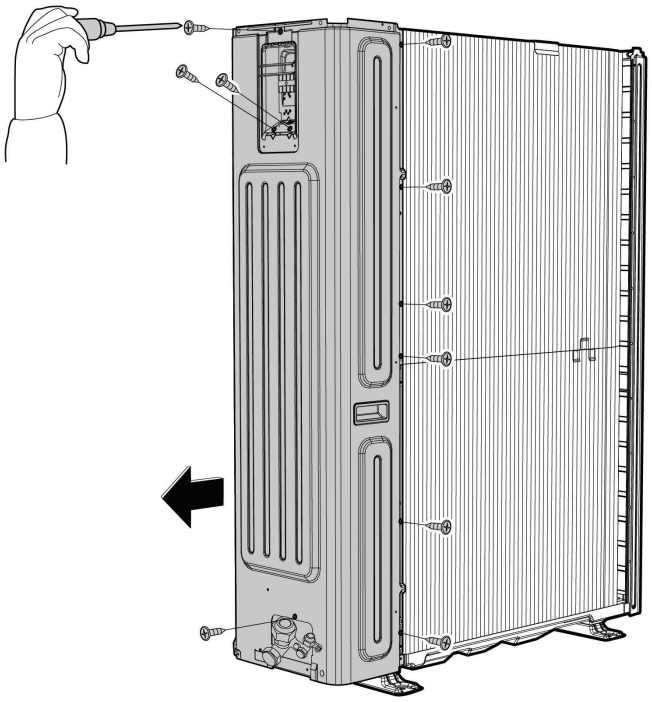
Procedure	Illustration
6) Remove the 2 screws from the water collecting cover then remove the water collecting cover.	
7) Remove the 2 screws of the rear net then remove the rear net.	

Procedure	Illustration
8) Remove the 8 right panel screws then remove the right panel.	

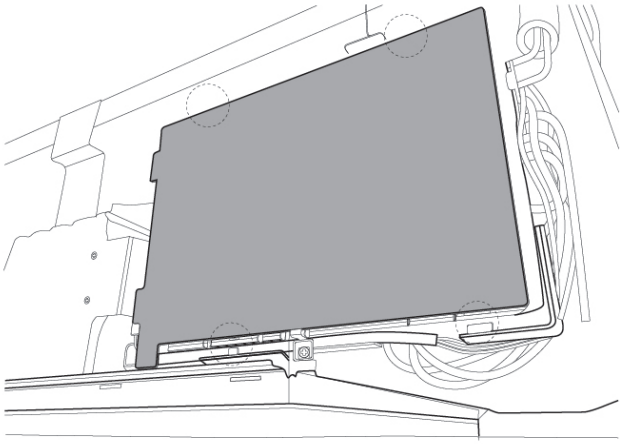
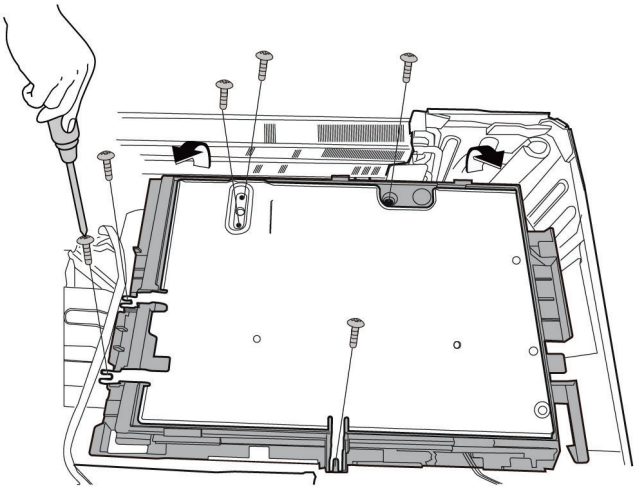
DISASSEMBLY INSTRUCTIONS
SIZES 48-58

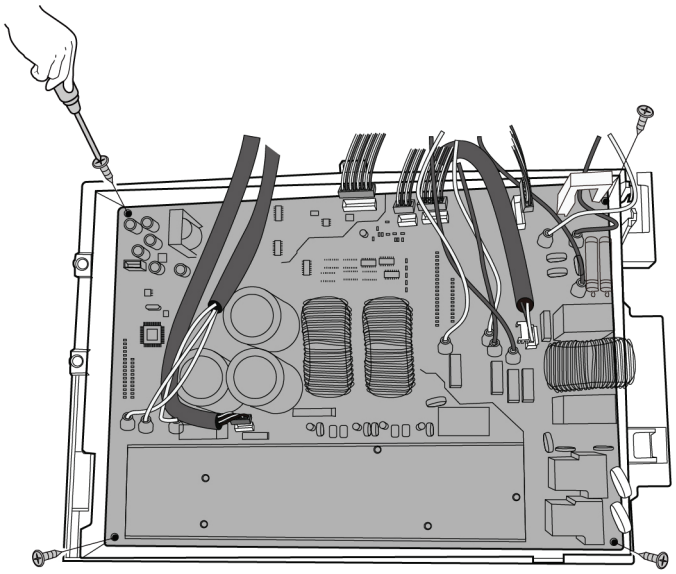
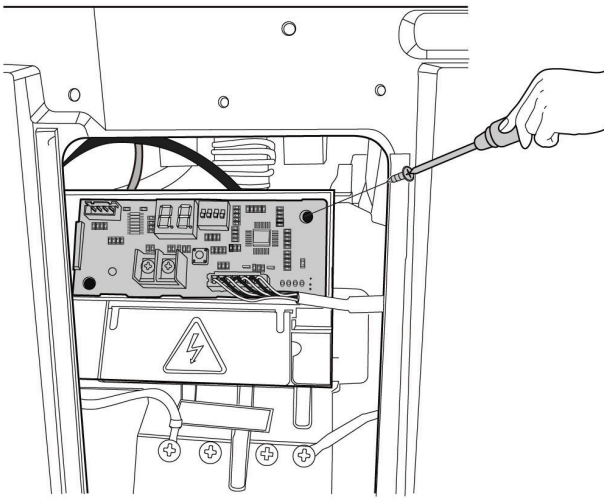
Procedure	Illustration
1) Turn off the air conditioner and the power breaker. 2) Remove the 2 screws of the handle then remove the handle.	
3) Remove the the 4 top cover screws then remove the top cover. Two of the screws are located under the handle.	
4) Remove the 2 water collecting cover screws then remove the water collecting cover.	

Procedure	Illustration
5) Remove the 2 screws of the front right panel then remove the front right panel.	

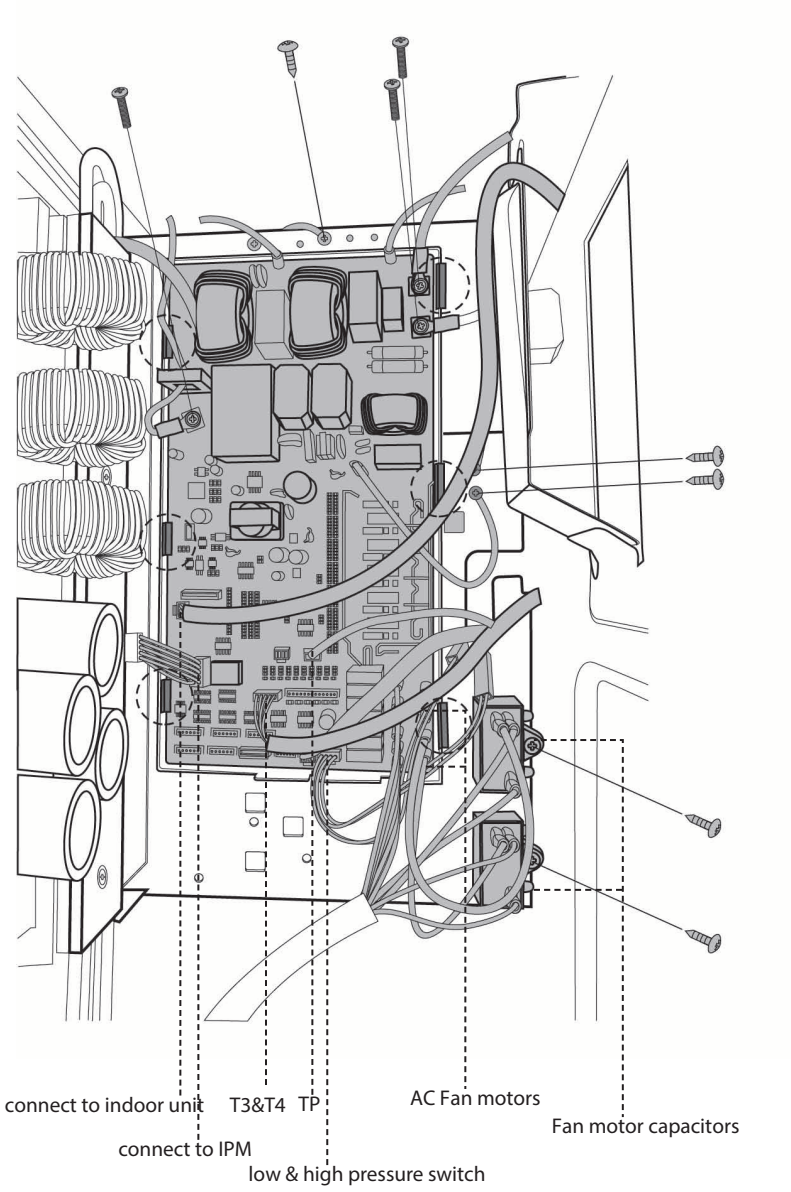
Procedure	Illustration
1) Remove the 7 front panel screws then remove the front panel.	
2) Remove the 10 right panel screws then remove the right panel.	

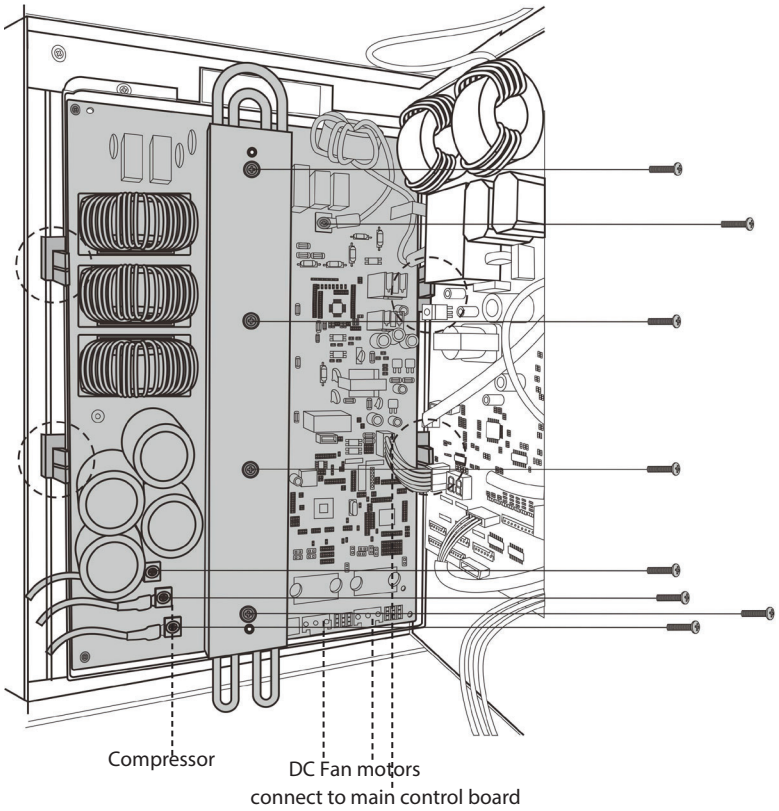
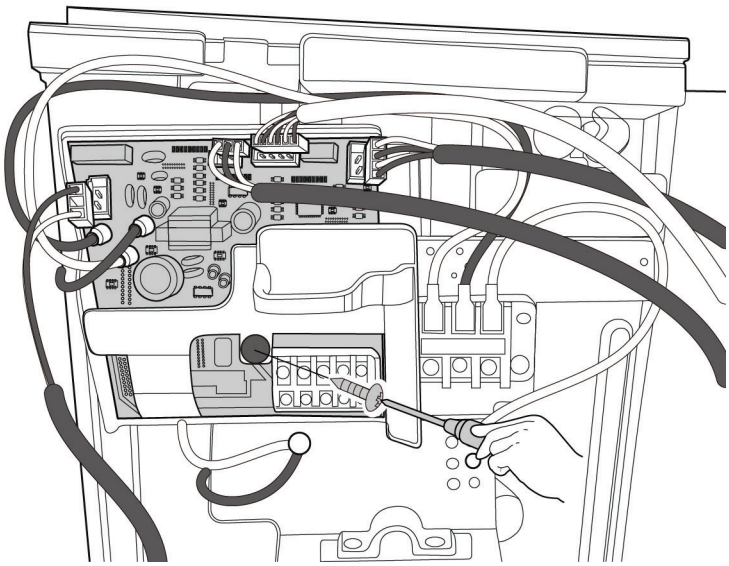
DISASSEMBLY INSTRUCTIONS (CONT)
ELECTRICAL PARTS SIZE 36K

Procedure	Illustration
1) Loosen the 4 hooks then open the electronic control box cover.	
2) Remove the 6 screws on the electronic control board then turn over the electronic control board.	

Procedure	Illustration
3) Pull out the connector. 4) Remove the 4 screws then remove the electronic control board.	
5) Pull out the connector, remove one screw then remove the key board subassembly on the terminal board.	

DISASSEMBLY INSTRUCTIONS (CONT)
ELECTRICAL PARTS SIZES 48K - 58K

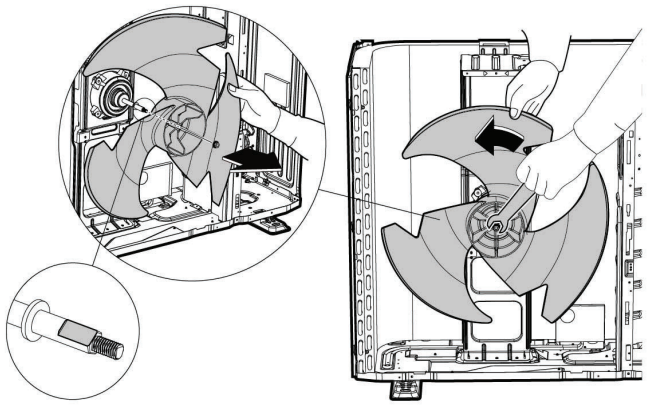
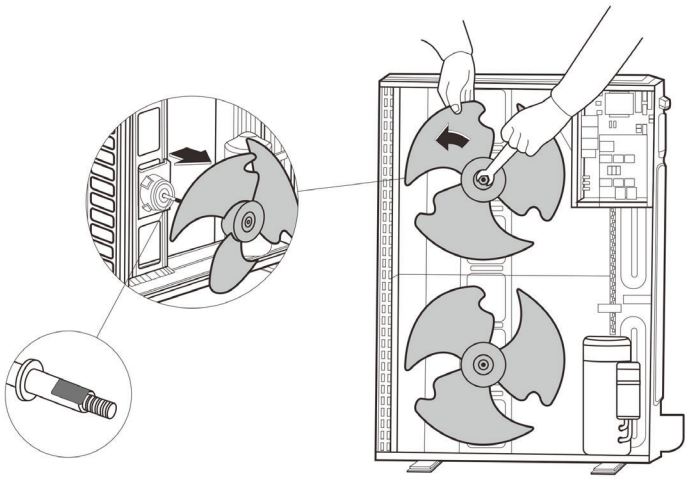
Procedure	Illustration
1) Remove the 2 screws to disconnect the power supply wires. 2) Remove 3 screws to disconnect the ground wires. 3) Disconnect the wires connected to main control board. (4) Disconnect the wires between the main control board and the IPM module board. 5) Remove the 4 screws and loosen the 6 hooks then remove the main control board. 6) Remove 1 screw to remove the fan motor capacitor (1 screw for each capacitor).	

Procedure	Illustration
1) Remove 2 screws to disconnect the power supply wires. 2) Remove 3 screws to disconnect the wires connected to the compressor. 3) Remove 3 screws to remove the radiator. 4) Disconnect the wires between the IPM module board and main control board. 5) Remove the 4 screws and loosen the 4 hooks then remove the IPM IPM module board.	
6) Remove the 1 screw and disconnect the wires then remove the 24V board.	

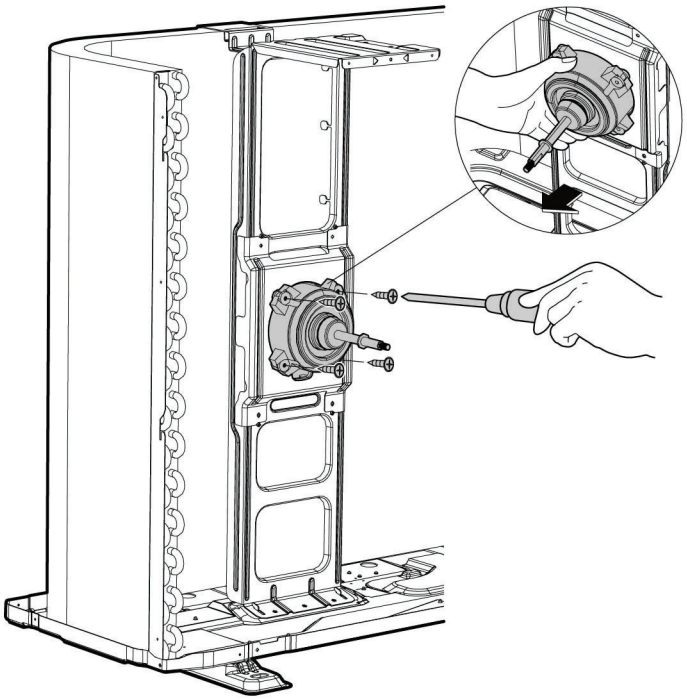
DISASSEMBLY INSTRUCTIONS SIZES 36K - 58K (CONT)

Fan Assembly

NOTE: Remove the panel plate before disassembling the fan.

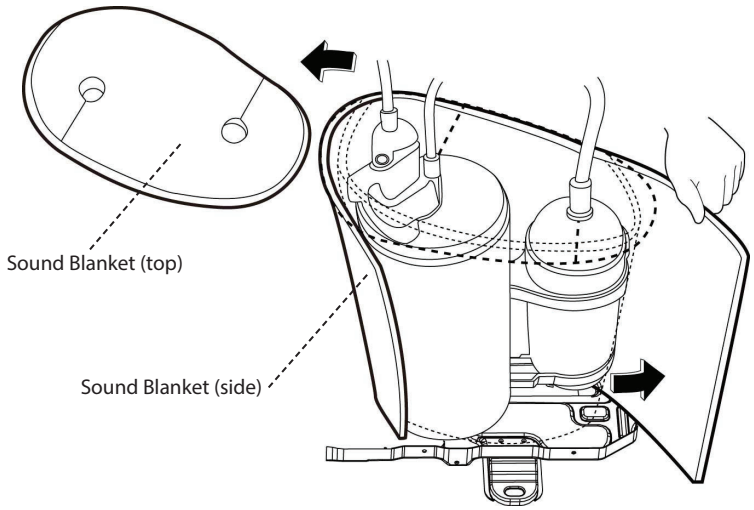
Procedure	Illustration
1) Remove the nut securing the fan with a spanner. 2) Remove the fan.	 

NOTE: Remove the panel plate and the fan motor connection on the PCB before dissembling the fan motor.

Procedure	Illustration
3) Remove the 4 fan motor screws. 4) Remove the fan motor.	

DISASSEMBLY INSTRUCTIONS SIZES 36K - 58K (CONT)

Sound Blanket

Procedure	Illustration
1) Remove the sound blanket (side and top).	

DISASSEMBLY INSTRUCTIONS SIZES 36K - 58K (CONT)

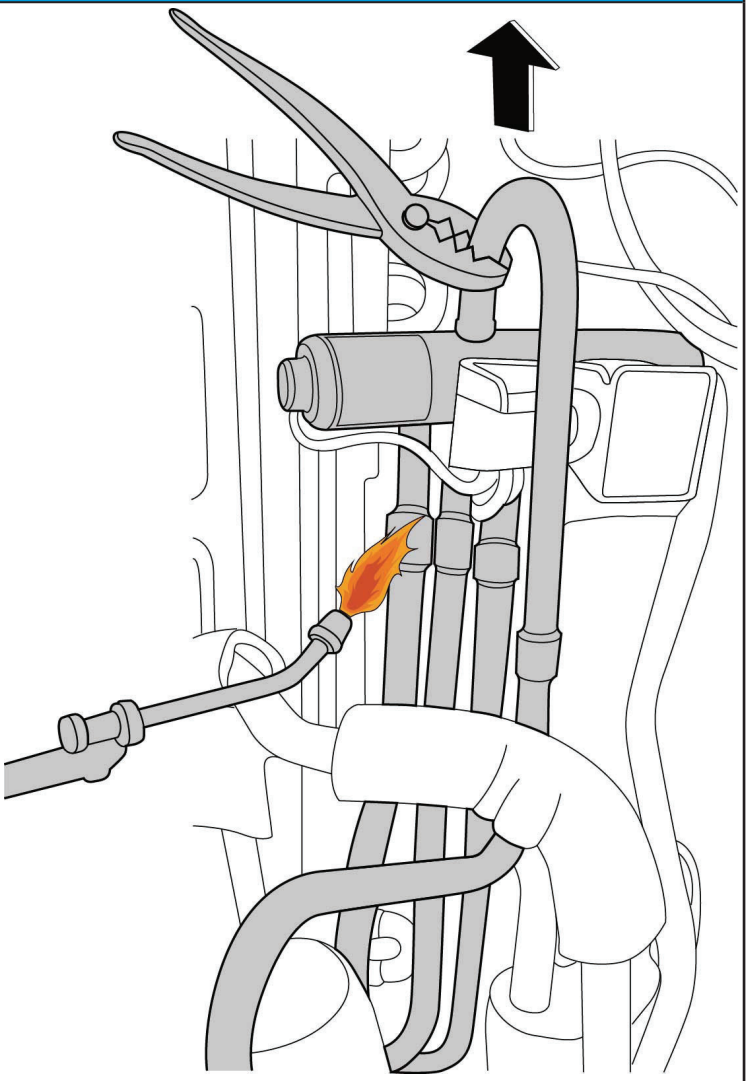
4-Way Valve

NOTE: Remove the panel plate, and the four-way valve connection on the PCB before disassembling the sound blanket.

WARNING

The following operations should be performed by an authorized technician,

Evacuate the system then confirm that there is no refrigerant left in the system before removing the four-way valve and the compressor. (For R32 & R290, evacuate the system with the vacuum pump; flush the system with nitrogen; then repeat the two steps before heating up the brazed parts.

Procedure	Illustration
1) Heat up the brazed parts then detach the four-way valve and the pipe. 2) Use pliers to remove the four-way valve assembly.	

DISASSEMBLY INSTRUCTIONS SIZES 36K - 58K (CONT)

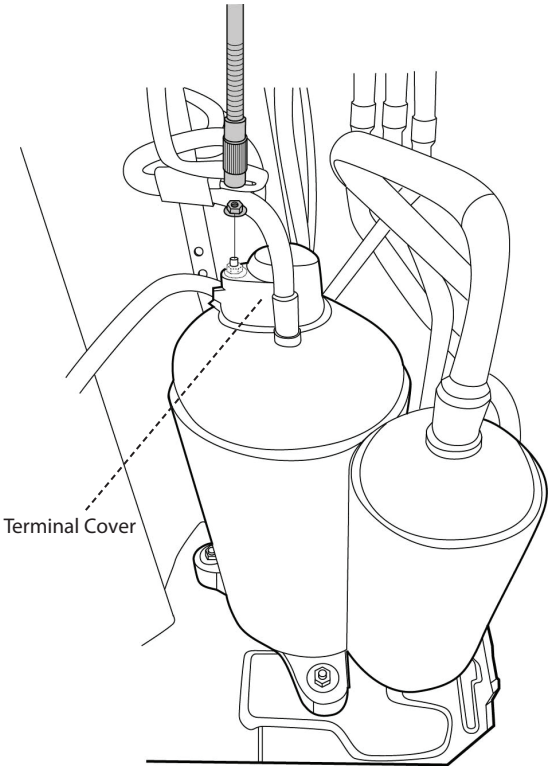
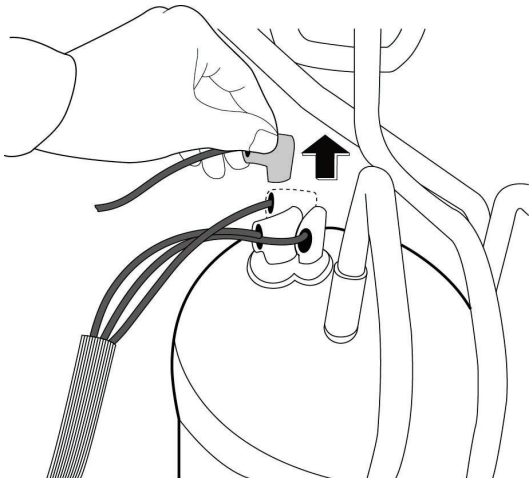
Compressor

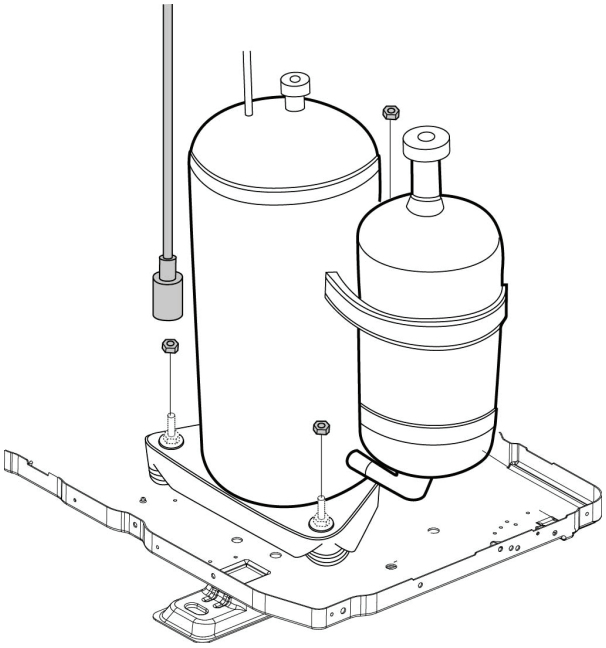
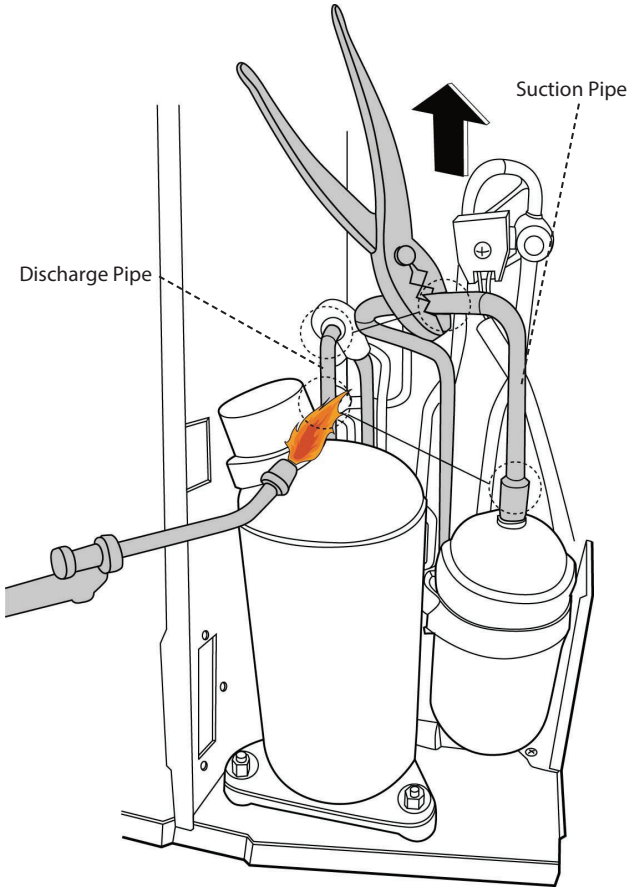
WARNING

The following operations should be performed by an authorized technician,

Evacuate the system and confirm that there is no refrigerant left in the system before removing the four-way valve and the compressor. (For R32 & R290, you should evacuate the system with the vacuum pump; flush the system with nitrogen; then repeat the two steps before heating up the brazed parts.

NOTE: Remove the panel plate and the compressor connection on the PCB before disassembling sound blanket.

Procedure	Illustration
1) Remove the terminal cover's flange nut then remove the terminal cover.	
2) Disconnect the connectors.	

Procedure	Illustration
3) Remove the hex nuts and washers securing the compressor, located on the bottom plate.	
4) Heat up the brazed parts then remove the discharge pipe and the suction pipe. 5) Use pliers to lift the compressor from the base pan assembly.	

APPENDICIES

Appendix 1

Table 10 — Temperature Sensor Resistance Value Table for T1, T2, T3, T4 (°C--K)

°C	°F	K OHM	°C	°F	K OHM	°C	°F	K OHM	°C	°F	K OHM
- 20	-4	115.266	20	68	12.6431	60	140	2.35774	100	212	0.62973
- 19	-2	108.146	21	70	12.0561	61	142	2.27249	101	214	0.61148
- 18	0	101.517	22	72	11.5	62	144	2.19073	102	216	0.59386
- 17	1	96.3423	23	73	10.9731	63	145	2.11241	103	217	0.57683
- 16	3	89.5865	24	75	10.4736	64	147	2.03732	104	219	0.56038
- 15	5	84.219	25	77	10	65	149	1.96532	105	221	0.54448
- 14	7	79.311	26	79	9.55074	66	151	1.89627	106	223	0.52912
- 13	9	74.536	27	81	9.12445	67	153	1.83003	107	225	0.51426
- 12	10	70.1698	28	82	8.71983	68	154	1.76647	108	226	0.49989
- 11	12	66.0898	29	84	8.33566	69	156	1.70547	109	228	0.486
- 10	14	62.2756	30	86	7.97078	70	158	1.64691	110	230	0.47256
-9	16	58.7079	31	88	7.62411	71	160	1.59068	111	232	0.45957
-8	18	56.3694	32	90	7.29464	72	162	1.53668	112	234	0.44699
-7	19	52.2438	33	91	6.98142	73	163	1.48481	113	235	0.43482
-6	21	49.3161	34	93	6.68355	74	165	1.43498	114	237	0.42304
-5	23	46.5725	35	95	6.40021	75	167	1.38703	115	239	0.41164
-4	25	44	36	97	6.13059	76	169	1.34105	116	241	0.4006
-3	27	41.5878	37	99	5.87359	77	171	1.29078	117	243	0.38991
-2	28	39.8239	38	100	5.62961	78	172	1.25423	118	244	0.37956
-1	30	37.1988	39	102	5.39689	79	174	1.2133	119	246	0.36954
0	32	35.2024	40	104	5.17519	80	176	1.17393	120	248	0.35982
1	34	33.3269	41	106	4.96392	81	178	1.13604	121	250	0.35042
2	36	31.5635	42	108	4.76253	82	180	1.09958	122	252	0.3413
3	37	29.9058	43	109	4.5705	83	181	1.06448	123	253	0.33246
4	39	28.3459	44	111	4.38736	84	183	1.03069	124	255	0.3239
5	41	26.8778	45	113	4.21263	85	185	0.99815	125	257	0.31559
6	43	25.4954	46	115	4.04589	86	187	0.96681	126	259	0.30754
7	45	24.1932	47	117	3.88673	87	189	0.93662	127	261	0.29974
8	46	22.5662	48	118	3.73476	88	190	0.90753	128	262	0.29216
9	48	21.8094	49	120	3.58962	89	192	0.8795	129	264	0.28482
10	50	20.7184	50	122	3.45097	90	194	0.85248	130	266	0.2777
11	52	19.6891	51	124	3.31847	91	196	0.82643	131	268	0.27078
12	54	18.7177	52	126	3.19183	92	198	0.80132	132	270	0.26408
13	55	17.8005	53	127	3.07075	93	199	0.77709	133	271	0.25757
14	57	16.9341	54	129	2.95896	94	201	0.75373	134	273	0.25125
15	59	16.1156	55	131	2.84421	95	203	0.73119	135	275	0.24512
16	61	15.3418	56	133	2.73823	96	205	0.70944	136	277	0.23916
17	63	14.6181	57	135	2.63682	97	207	0.68844	137	279	0.23338
18	64	13.918	58	136	2.53973	98	208	0.66818	138	280	0.22776
19	66	13.2631	59	138	2.44677	99	210	0.64862	139	282	0.22231

Appendix 2

Table 11 — Temperature Sensor Resistance Value Table for T5 (° C- -K)

°C	°F	K Ohm	°C	°F	K Ohm	°C	°F	K Ohm	°C	°F	K Ohm
-20	-4	542.7	20	68	68.66	60	140	13.59	100	212	3.702
-19	-2	511.9	21	70	65.62	61	142	13.11	101	214	3.595
-18	0	483	22	72	62.73	62	144	12.65	102	216	3.492
-17	1	455.9	23	73	59.98	63	145	12.21	103	217	3.392
-16	3	430.5	24	75	57.37	64	147	11.79	104	219	3.296
-15	5	406.7	25	77	54.89	65	149	11.38	105	221	3.203
-14	7	384.3	26	79	52.53	66	151	10.99	106	223	3.113
-13	9	363.3	27	81	50.28	67	153	10.61	107	225	3.025
-12	10	343.6	28	82	48.14	68	154	10.25	108	226	2.941
-11	12	325.1	29	84	46.11	69	156	9.902	109	228	2.86
-10	14	307.7	30	86	44.17	70	158	9.569	110	230	2.781
-9	16	291.3	31	88	42.33	71	160	9.248	111	232	2.704
-8	18	275.9	32	90	40.57	72	162	8.94	112	234	2.63
-7	19	261.4	33	91	38.89	73	163	8.643	113	235	2.559
-6	21	247.8	34	93	37.3	74	165	8.358	114	237	2.489
-5	23	234.9	35	95	35.78	75	167	8.084	115	239	2.422
-4	25	222.8	36	97	34.32	76	169	7.82	116	241	2.357
-3	27	211.4	37	99	32.94	77	171	7.566	117	243	2.294
-2	28	200.7	38	100	31.62	78	172	7.321	118	244	2.233
-1	30	190.5	39	102	30.36	79	174	7.086	119	246	2.174
0	32	180.9	40	104	29.15	80	176	6.859	120	248	2.117
1	34	171.9	41	106	28	81	178	6.641	121	250	2.061
2	36	163.3	42	108	26.9	82	180	6.43	122	252	2.007
3	37	155.2	43	109	25.86	83	181	6.228	123	253	1.955
4	39	147.6	44	111	24.85	84	183	6.033	124	255	1.905
5	41	140.4	45	113	23.89	85	185	5.844	125	257	1.856
6	43	133.5	46	115	22.89	86	187	5.663	126	259	1.808
7	45	127.1	47	117	22.1	87	189	5.488	127	261	1.762
8	46	121	48	118	21.26	88	190	5.32	128	262	1.717
9	48	115.2	49	120	20.46	89	192	5.157	129	264	1.674
10	50	109.8	50	122	19.69	90	194	5	130	266	1.632
11	52	104.6	51	124	18.96	91	196	4.849			
12	54	99.69	52	126	18.26	92	198	4.703			
13	55	95.05	53	127	17.58	93	199	4.562			
14	57	90.66	54	129	16.94	94	201	4.426			
15	59	86.49	55	131	16.32	95	203	4.294			
16	61	82.54	56	133	15.73	96	205	4.167			
17	63	78.79	57	135	15.16	97	207	4.045			
18	64	75.24	58	136	14.62	98	208	3.927			
19	66	71.86	59	138	14.09	99	210	3.812			

Appendix 3

Table 12 — Appendix 3

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
-5	23	21	69.8	51	123.8	82	179.6	113	235.4
-4	24.8	22	71.6	52	125.6	83	181.4	114	237.2
-3	26.6	23	73.4	53	127.4	84	183.2	115	239
-2	28.4	24	75.2	54	129.2	85	185	116	240.8
-1	30.2	25	77	55	131	86	186.8	117	242.6
0	32	25.5	77.9	56	132.8	87	188.6	118	244.4
0.5	32.9	26	78.8	57	134.6	88	190.4	119	246.2
1	33.8	27	80.6	58	136.4	89	192.2	120	248
1.5	34.7	28	82.4	59	138.2	90	194	121	249.8
2	35.6	29	84.2	60	140	91	195.8	122	251.6
2.5	36.5	30	86	61	141.8	92	197.6	123	253.4
3	37.4	31	87.8	62	143.6	93	199.4	124	255.2
3.5	38.3	32	89.6	63	145.4	94	201.2	125	257
4	39.2	33	91.4	64	147.2	95	203	126	258.8
4.5	40.1	34	93.2	65	149	96	204.8	127	260.6
5	41	35	95	66	150.8	97	206.6	128	262.4
6	42.8	36	96.8	67	152.6	98	208.4	129	264.2
7	44.6	37	98.6	68	154.4	99	210.2	130	266
8	46.4	38	100.4	69	156.2	100	212	131	267.8
9	48.2	39	102.2	70	158	101	213.8	132	269.6
10	50	40	104	71	159.8	102	215.6	133	271.4
11	51.8	41	105.8	72	161.6	103	217.4	134	273.2
12	53.6	42	107.6	73	163.4	104	219.2	135	275
13	55.4	43	109.4	74	165.2	105	221	136	276.8
14	57.2	44	111.2	75	167	106	222.8	137	278.6
15	59	45	113	76	168.8	107	224.6	138	280.4
16	60.8	46	114.8	77	170.6	108	226.4	139	282.2
17	62.6	47	116.6	78	172.4	109	228.2	140	284
18	64.4	48	118.4	79	174.2	110	230	141	285.8
19	66.2	49	120.2	80	176	111	231.8	142	287.6
20	68	50	122	81	177.8	112	233.6	143	289.4

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