38MA*R
Outdoor Unit Single Zone Ductless System
Sizes 09 to 36

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

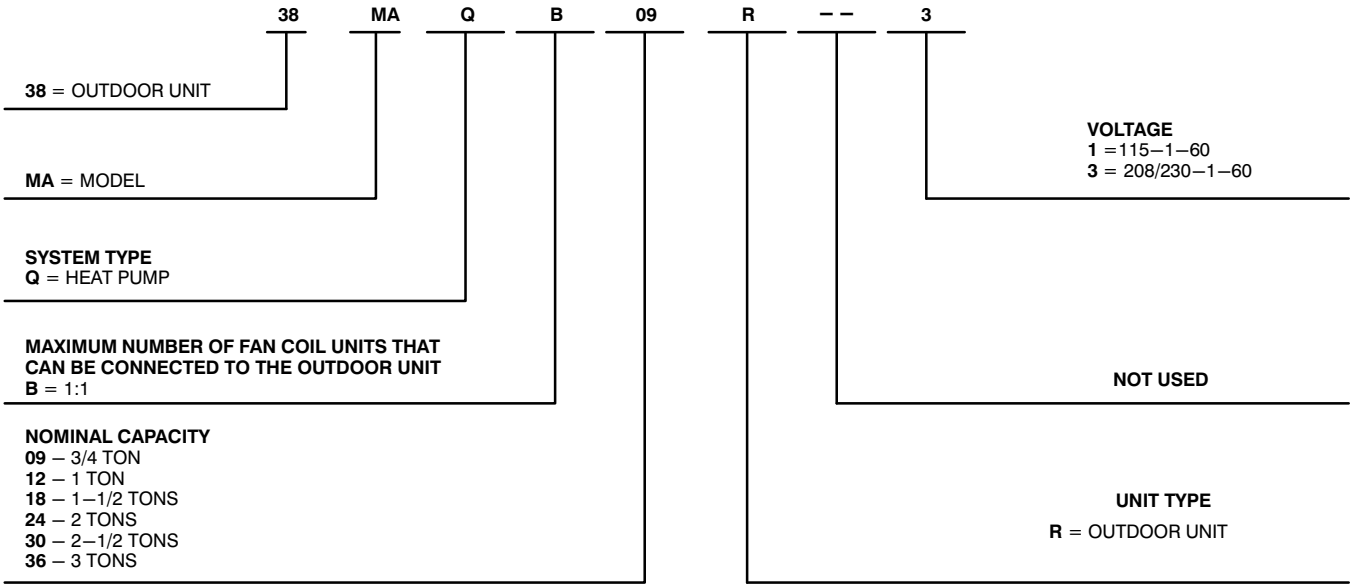
This Service Manual provides the necessary information to service, repair, and maintain the 38MA*R family of heat pumps. Section 2 of this manual has an appendix with data required to perform troubleshooting. Use the Table of Contents to locate a desired topic.

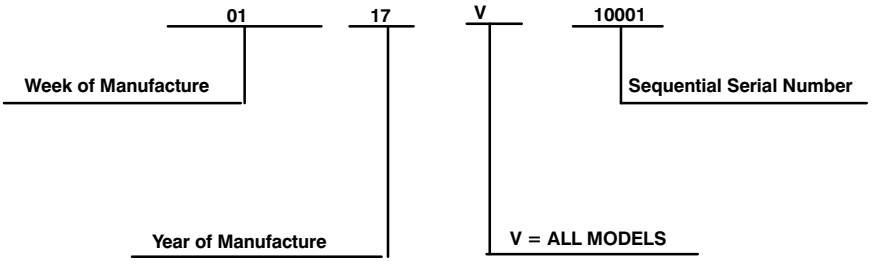
MODEL / SERIAL NUMBER NOMENCLATURES

Table 1—Unit Sizes

SYSTEM TONS	kBTUh	VOLTAGE	OUTDOOR MODEL
0.75	9,000	115/l/60	38MAQB09R−−1
1.00	12,000		38MAQB12R−−1
0.75	9,000	208/230−1	38MAQB09R−−3
1.00	12,000		38MAQB12R−−3
1.50	18,000		38MAQB18R−−3
2.00	24,000		38MAQB24R−−3
2.50	30,000		38MAQB30R−−3
3.00	36,000		38MAQB36R−−3

OUTDOOR UNIT





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.

SPECIFICATIONS − OUTDOOR HEAT PUMP

Table 2—Specifications

HEAT PUMP										
System	**SIZE**		**9**	**12**	**9**	**12**	**18**	**24**	**30**	**36**
	Outdoor Model		38MAQ B09R−−1	38MAQ B12R−−1	38MAQ B09R−−3	38MAQ B12R−−3	38MAQ B18R−−3	38MAQ B24R−−3	38MAQ B30R−−3	38MAQ B36R−−3
Electrical	Voltage, Phase, Cycle	V/Ph/ Hz	115−1− 60		208/230−1−60					
	MCA	A.	15	15	9	9	18	20	20	25
	MOCP − Fuse Rating	A.	20	20	15	15	25	30	30	35
Operating Range	Cooling Outdoor DB Min − Max	° F (° C)	−13~ 122 (−25~ 50)							
	Heating Outdoor DB Min − Max	° F (° C)	−13~ 86 (−25~ 30)	−13~ 86 (−25~ 30)	−22~ 86 (−30~ 30)	−22~ 86 (−30~ 30)	−22~ 86 (−30~ 30)	−22~ 86 (−30~ 30)	−13~ 86 (−25~ 30)	−13~ 86 (−25~ 30)
Piping	Total Piping Length	ft (m)	82 (25)	82 (25)	82 (25)	82 (25)	98 (30)	98 (30)	164 (50)	164 (50)
	Piping Lift*	ft (m)	32 (10)	32 (10)	32 (10)	32 (10)	65 (20)	65 (20)	82 (25)	82 (25)
	Pipe Connection Size − Liquid	in (mm)	1/4 (6.35)	1/4 (6.35)	1/4 (6.35)	1/4 (6.35)	1/4 (6.35)	3/8 (9.52)	3/8 (9.52)	3/8 (9.52)
	Pipe Connection Size − Suction	in (mm)	3/8 (9.52)	1/2 (12.7)	3/8 (9.52)	1/2 (12.7)	1/2 (12.7)	5/8 (16)	5/8 (16)	5/8 (16)
Refrigerant	Type		R410A							
	Charge	lbs (kg)	2.76 (1.25)	2.76 (1.25)	3.31 (1.5)	3.31 (1.5)	4.30 (1.95)	5.73 (2.60)	6.06 (2.75)	7.50 (3.40)
	Metering Device		EEV							
Outdoor Coil	Face Area	Sq. Ft.	4.5	4.5	4.5	4.5	5.2	8.0	8.0	8.0
	No. Rows		2	2	2	2	2	2	3	3
	Fins per inch		20	20	18	18	18	20	18	18
	Circuits		4	4	4	4	4	4	6	6
Compressor	Type		Rotary Inverter							
	Model		ASM98D32U FZ	ASM98D32U FZ	ATM115D43U FZ2	ATM115D43U FZ2	ATF235D22U MT	ATF235D22U MT	ATF250D22U MT	ATF250D22U MT
	Oil Type		VG74							
	Oil Charge	Fl. Oz.	13.0	13.0	17.6	17.6	23.6	23.6	23.6	23.6
	Rated Current	RLA	9.0	9.0	5.3	5.7	12.3	14.0	15.0	17.0
Outdoor	Unit Width	in (mm)	32.09 (815)	32.09 (815)	32.09 (815)	32.09 (815)	33.66 (855)	37.24 (946)	37.24 (946)	37.24 (946)
	Unit Height	in (mm)	21.81 (554)	21.81 (554)	21.81 (554)	21.81 (554)	27.63 (702)	31.89 (810)	31.89 (810)	31.89 (810)
	Unit Depth	in (mm)	13.11 (333)	13.11 (333)	13.11 (333)	13.11 (333)	14.17 (360)	16.14 (410)	16.14 (410)	16.14 (410)
	Net Weight	lbs (kg)	82.9 (37.6)	82.9 (37.6)	91.5 (41.5)	91.5 (41.5)	118.2 (53.6)	145.5 (66)	139.8 (63.4)	147.3 (66.8)
	Airflow	CFM	1,200	1,200	1,200	1,200	1,390	2,130	2,130	2,130
	Sound Pressure	dB(A)	52.5	52.5	55.5	56.0	57.5	60.5	60.5	60.5

* Condensing unit above or below the indoor unit

DIMENSIONS − OUTDOOR

Table 3—Unit Sizes

38MAR UNIT SIZE		9K	12K	9K	12K	18K	24K	30K	36K
Voltage		115V	115V	208/230V	208/230V	208/230V	208/230V	208/230V	208/230V
Height (H)	in (mm)	21.81(554)	21.81(554)	21.81(554)	21.81(554)	27.63(702)	31.89(810)	31.89(810)	31.89(810)
Width (W)	in (mm)	32.09(815)	32.09(815)	32.09(815)	32.09(815)	33.66 (855)	37.24(946)	37.24(946)	37.24(946)
Depth (D)	in (mm)	13.11(333)	13.11(333)	13.11(333)	13.11(333)	14.17(360)	16.14(410)	16.14(410)	16.14(410)
L1	in (mm)	20.24(514)	20.24(514)	20.24 (514)	20.24(514)	21.26(540)	26.50(673)	26.50(673)	26.50(673)
L2	in (mm)	13.39(340)	13.39(340)	13.39 (340)	13.39(340)	13.78(350)	15.87(403)	15.87(403)	15.87(403)
Operating Weight	Lbs (kg)	82.9(37.6)	82.9(37.6)	91.5(41.5)	91.5(41.5)	118.2(53.6)	145.5(66)	139.8(63.4)	147.3(66.8)

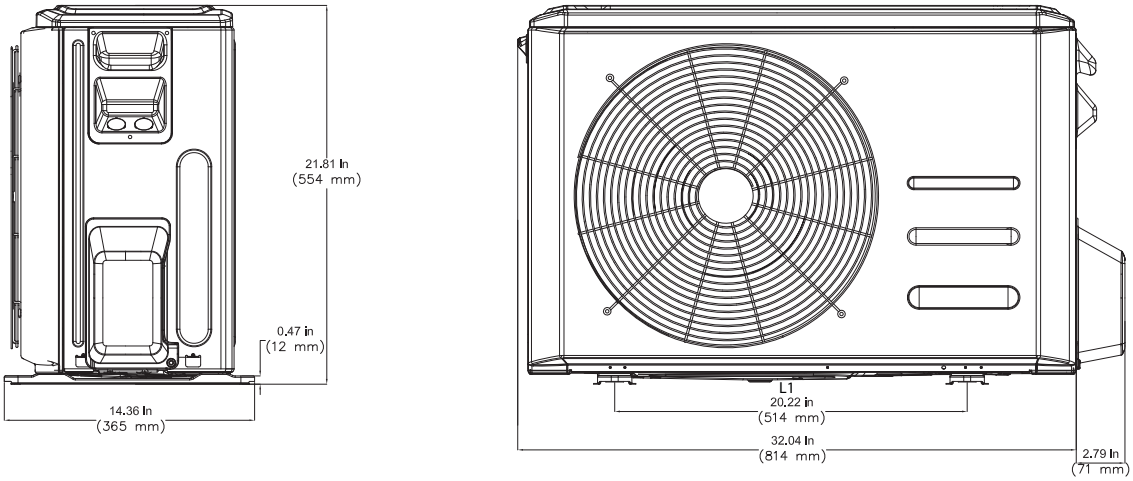


Fig. 1 – Sizes 09K−12K

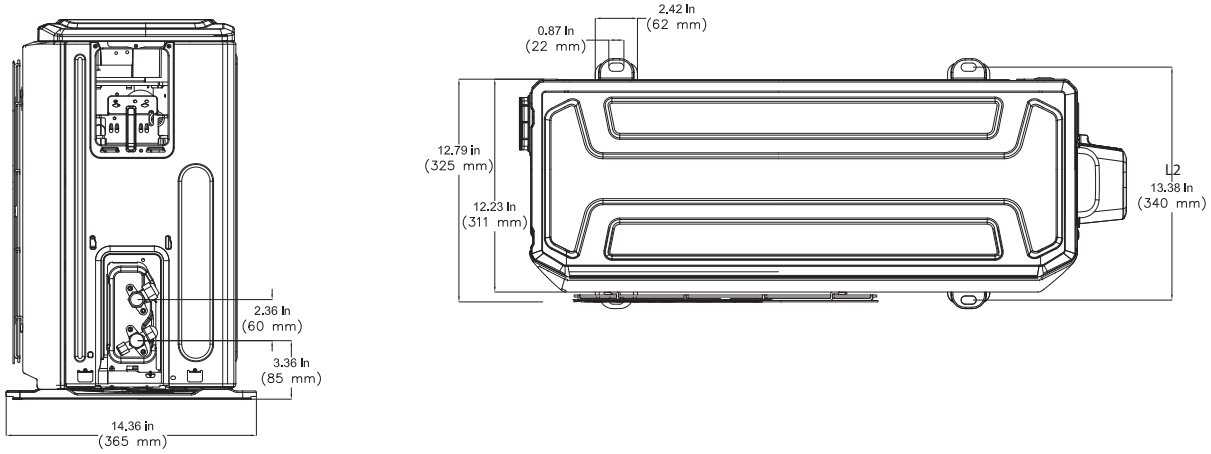


Fig. 2 – Sizes 09K−12K

DIMENSIONS − OUTDOOR (CONT)

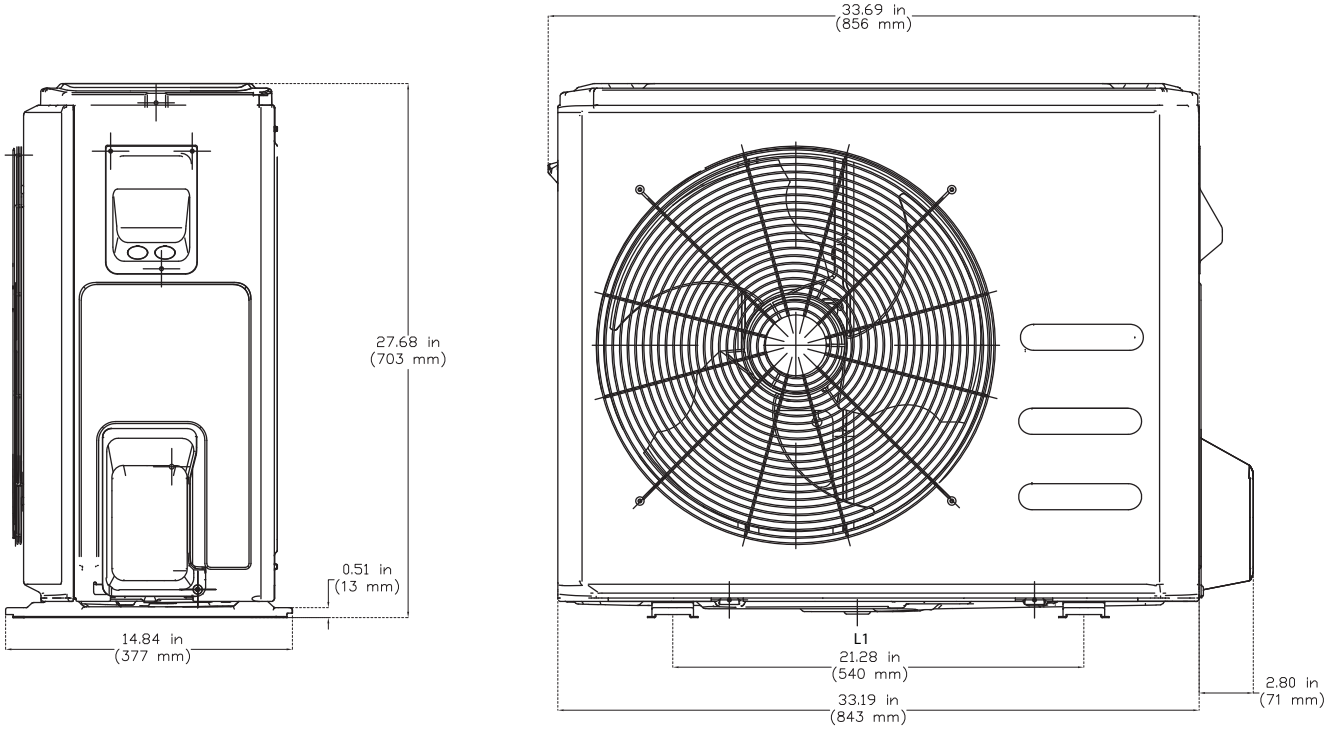


Fig. 3 – Sizes 18K

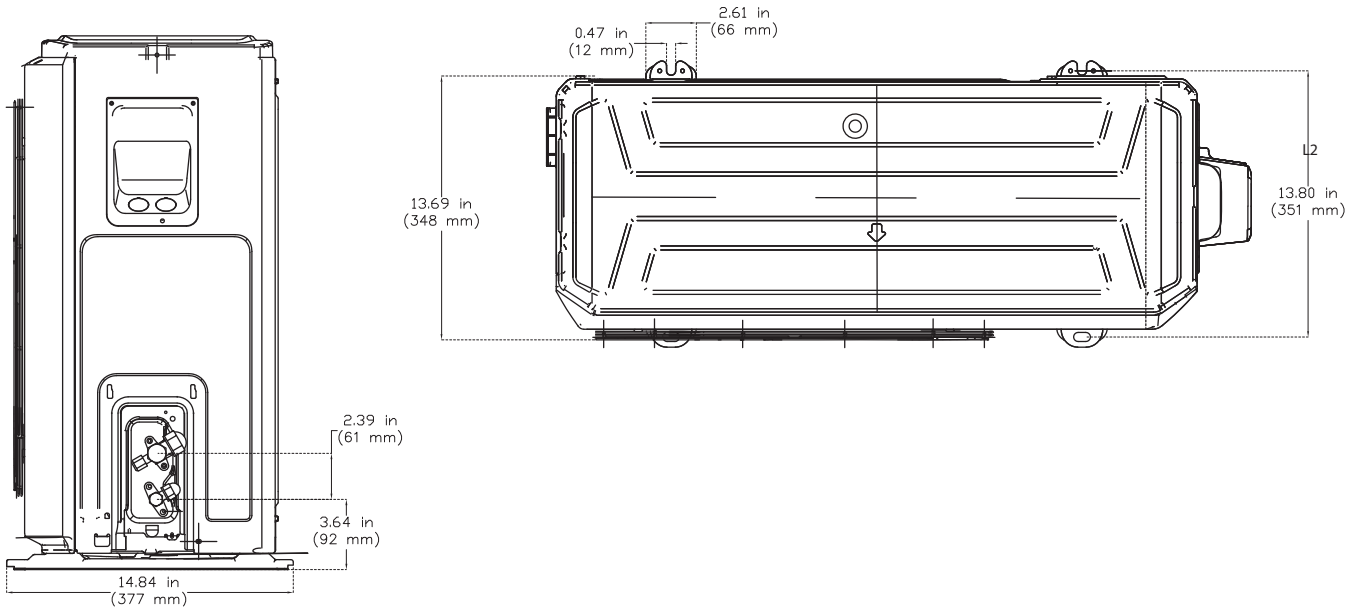


Fig. 4 – Sizes 18K

DIMENSIONS − OUTDOOR (CONT)

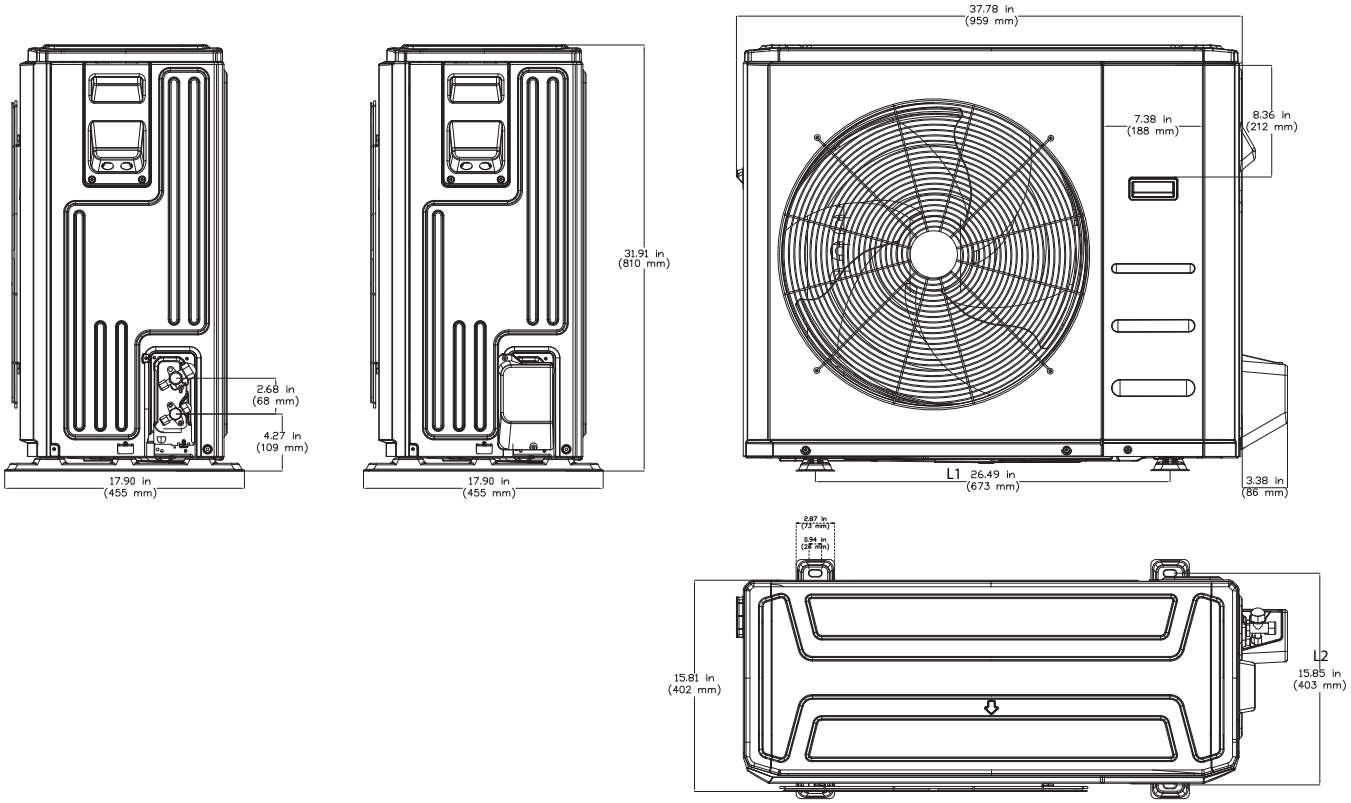


Fig. 5 – Sizes 24K, 30K, and 36K

CLEARANCES − OUTDOOR

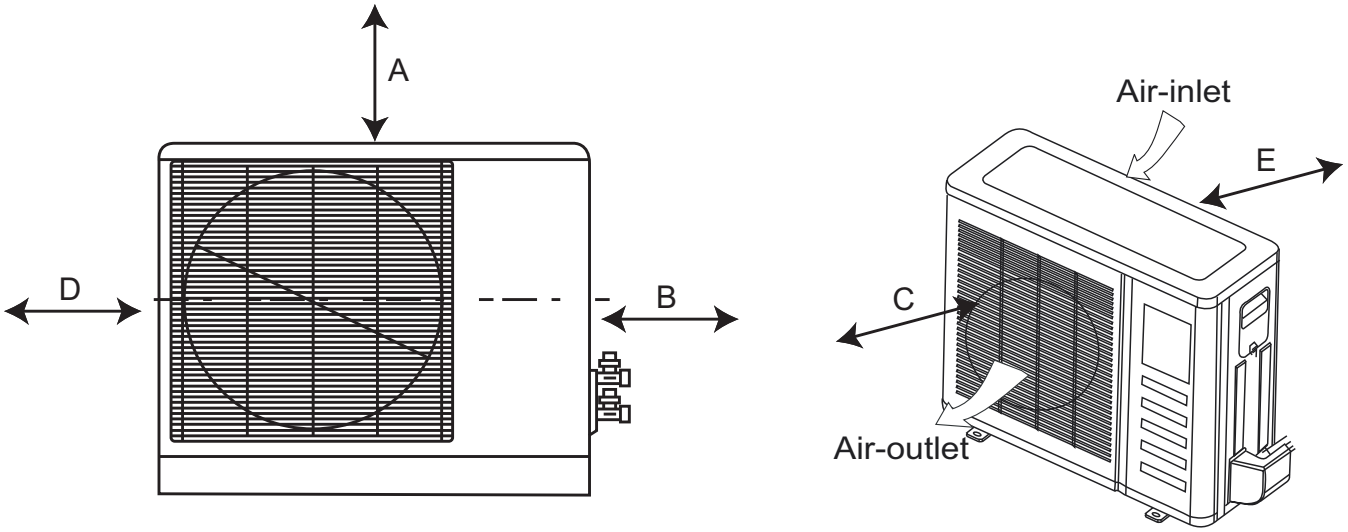


Fig. 6 – Clearances Outdoor

Table 4—Clearances

UNIT	MINIMUM VALUE in. (mm)
A	24 (609)
B	24 (609)
C	24 (609)
D	4 (101)
E	4 (101)

NOTE: **The outdoor unit must be mounted at least 2in (50mm) above the maximum anticipated snow depth.**

ELECTRICAL DATA

Table 5—Electrical Data

MAR OUTDOOR UNIT SIZE		9K	12K	9K	12K	18K	24K	30K	36K
Power Supply	Volts–PH–Hz	115–1–60	115–1–60	208/230–1–60	208/230–1–60	208/230–1–60	208/230–1–60	208/230–1–60	208/230–1–60
	Max – Min* Oper. Voltage	126–104	126–104	253–187	253–187	253–187	253–187	253–187	253–187
	MCA	15	15	9	9	18	20	20	25
	Max Fuse/ CB AMP	20	20	15	15	25	30	30	35
Compressor	Volts–PH–Hz	115–1–60	115–1–60	208/230–1–60	208/230–1–60	208/230–1–60	208/230–1–60	208/230–1–60	208/230–1–60
	RLA	9	9	5.25	5.65	12.3	14	15	17

*Permissible limits of the voltage range at which the unit will operate satisfactorily.

LEGEND

FLA – Full Load Amps

MCA – Minimum Circuit Amps

RLA – Rated Load Amps

WIRING

All wires must be sized per NEC (National Electrical Code) or CEC (Canadian Electrical Code) and local codes. Use Electrical Data table MCA (minimum circuit amps) and MOCP (maximum over current protection) to correctly size the wires and the disconnect fuse or breakers respectively.

Per the caution note, only stranded copper conductors with a 600 volt insulation rating wire must be used.

Recommended Connection Method for Power and Communication Wiring:

The main power is supplied to the outdoor unit. The field supplied 14/3 stranded wire with ground with a 600 volt insulation rating, power/communication wiring from the outdoor unit to indoor unit consists of four (4) wires and provides the power for the indoor unit. Two wires are line voltage AC power, one is communication wiring (S) and the other is a ground wire. Wiring between indoor and outdoor unit is polarity sensitive. The use of BX wire is NOT recommended.

If installed in a high Electromagnetic field (EMF) area and communication issues exists, a 14/2 stranded shielded wire can be used to replace L2/N and (S) between outdoor unit and indoor unit landing the shield onto ground in the outdoor unit only.

⚠ 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.

Use copper conductors only with a 600 volt insulation rating wire.

⚠ 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 DIAGRAMS

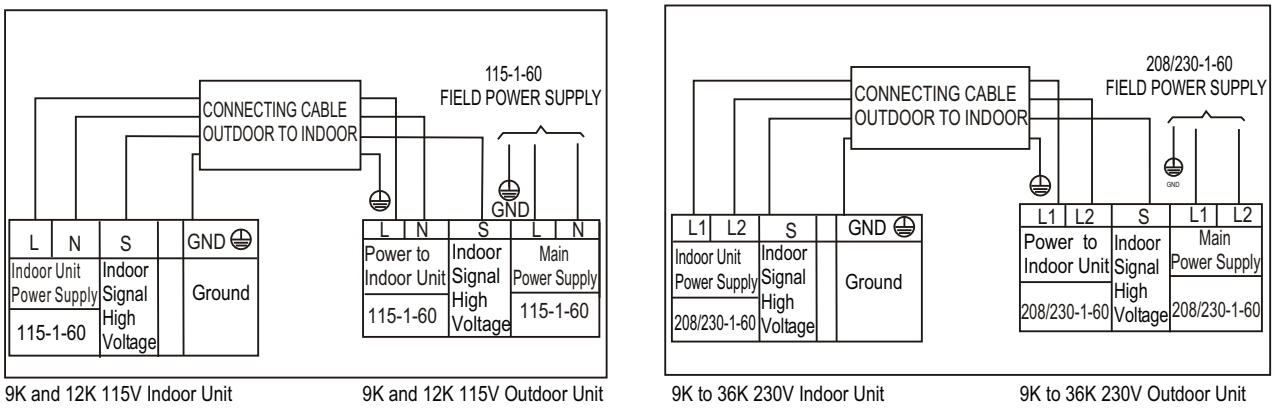


Fig. 7 – Connection Diagrams

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 result in a fault code.**

WIRING DIAGRAMS

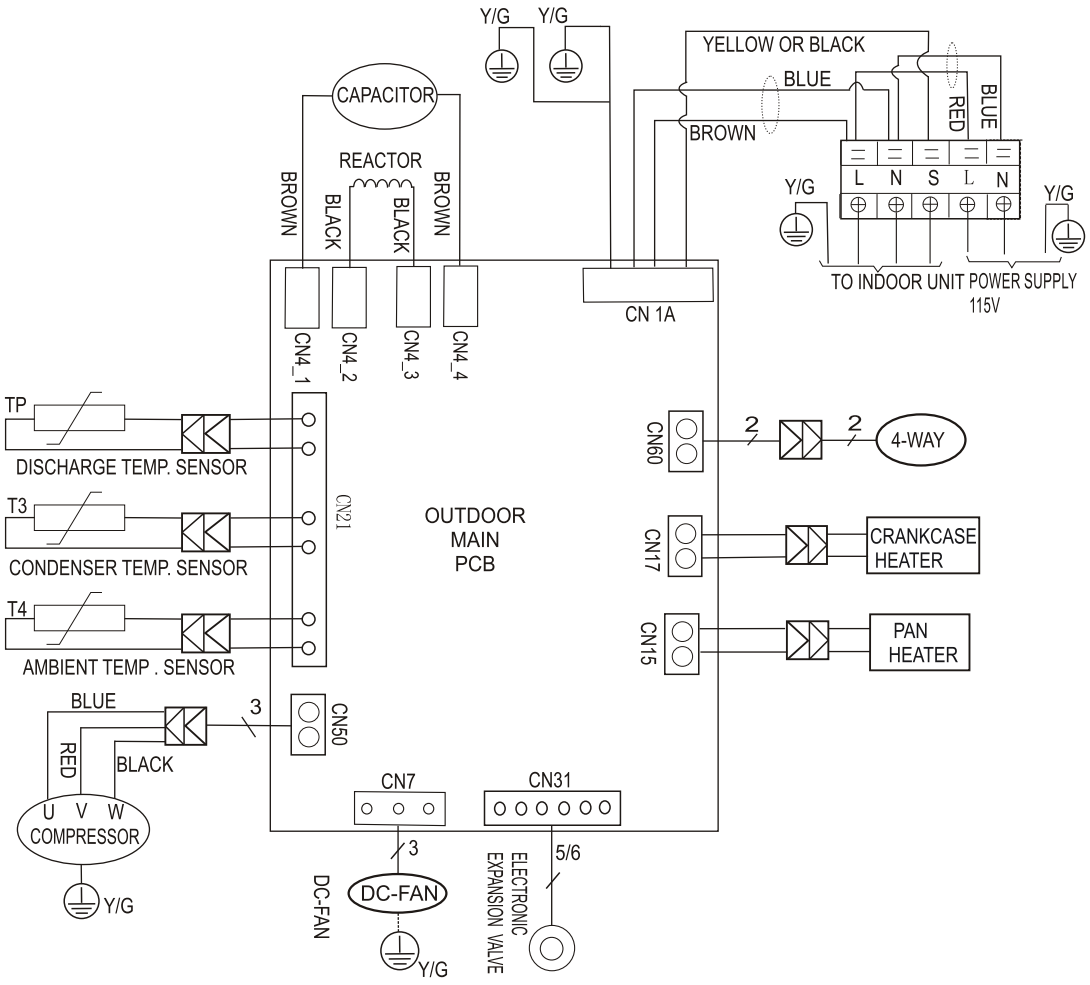


Fig. 8 – Wiring Diagram Sizes 09K−12K (115V)

Table 6—Diagram Sizes 09K−12K (115V)

CODE	PART NAME	CODE	PART NAME
CN1A	INPUT:115V High voltage connector with L/N/Ground/Signal	CN60	Output:115 VAC for 4−way valve control
CN4_1 CN4_2 CN4_3 CN4 4	Output: 115VAC High voltage connector for power factor corrector (PFC)	CN50	Output: PWM for UVW to control Compressor(0−320VAC)
CN7	Output: PWM for UVW to control the outdoor fan (0−320VAC)	CN21	Input: Temperature acquisition (0−5VDC)
CN15	Output:115VAC High voltage to control base pan heater	CN31	Connector for electronic expansion valve (0−12VDC)
CN17	Output:115VAC High voltage to control crankcase heater		

WIRING DIAGRAMS (CONTINUED)

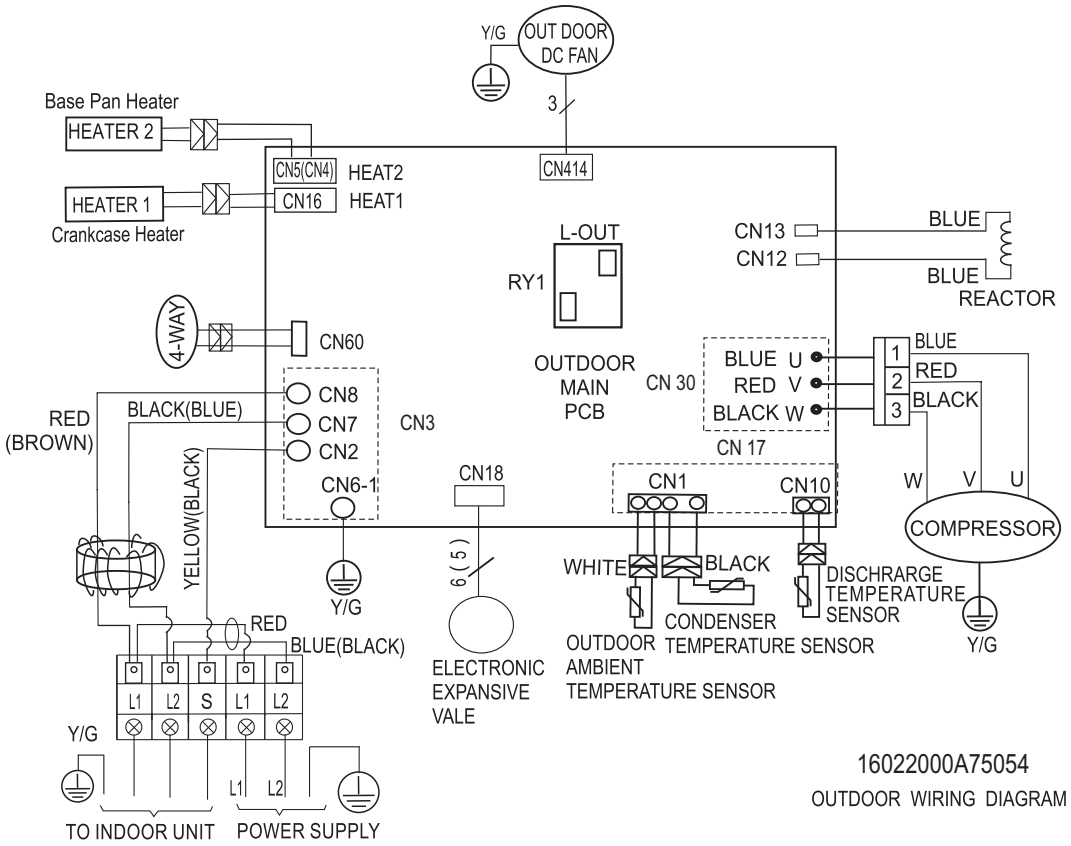


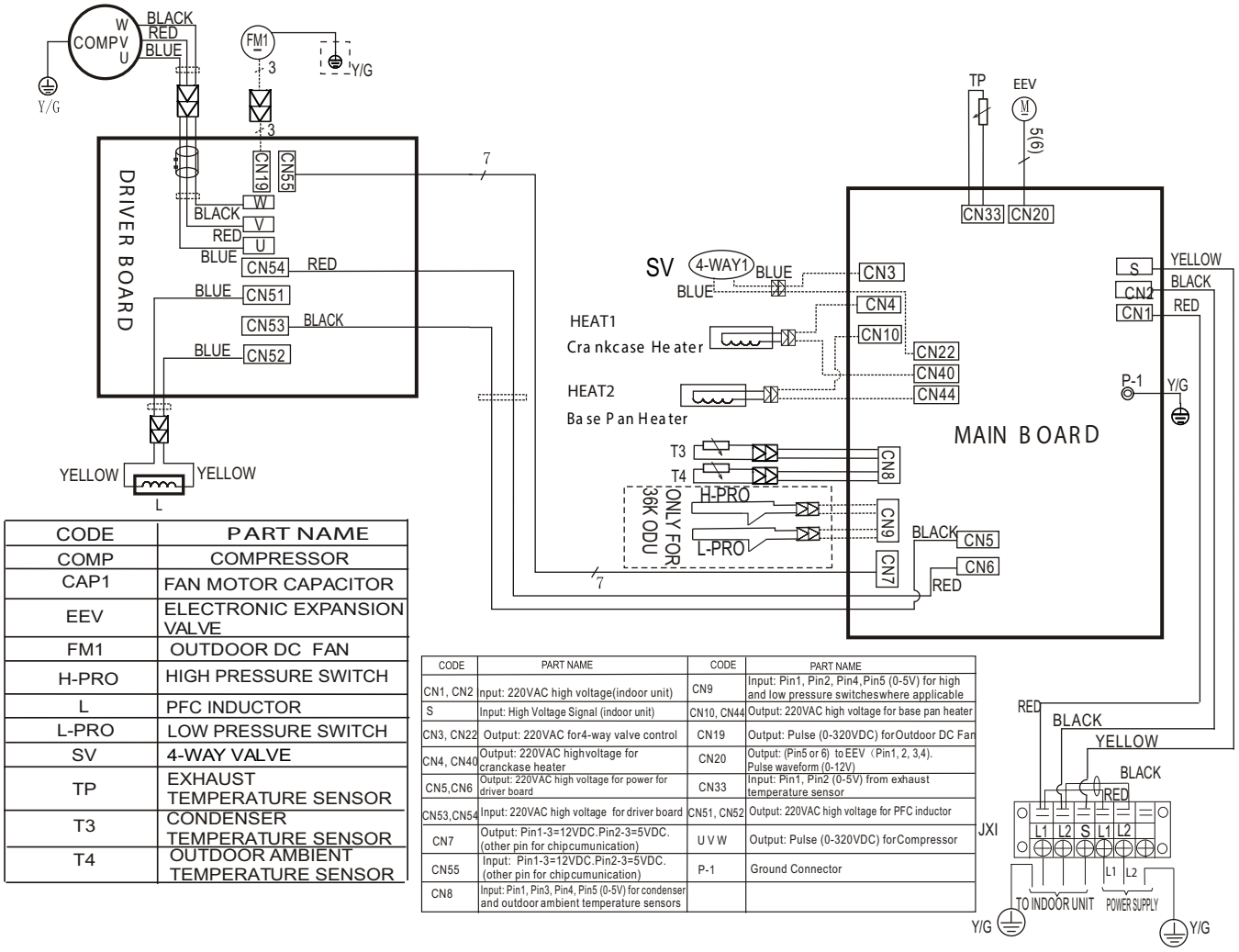
Fig. 9 – Wiring Diagram − Sizes 09K, 12K, 18K (208−230V)

Table 7—Diagram Sizes 09K, 12K, 18K (208−230V)

CODE	PART NAME	CODE	PART NAME
CN2	Output: high voltage signal (to indoor unit)	CN12,CN13	Output: High voltage to reactor
CN7, 8	Input: 220 VAC High voltage (from indoor unit)	U V W	Output: Pulse (0−320VDC) to compressor
CN60	Output: 220 VAC for 4−way valve control	CN10	Input: Pin1−Pin2 (0−5V) from discharge temperature sensor
CN16	Output: 220 VAC High voltage to control crankcase heater	CN1	Input: Pin1, Pin3, Pin4, Pin5 (0−5V) from condenser and outdoor ambient temperature sensors
CN414	Output: Pulse (0−320VDC) to outdoor fan motor	CN6−1	Ground Connector
CN5 (CN4)	Output: 220 VAC High voltage to control base pan heater	CN18	Output:Pin5&6 (12V) to electronic expansion valve

NOTE: The control board wiring diagram (see Fig. 9) for units starting with serial number 2616V10001 showing one harness CN17. Adapter harness for these units available through RCD, P/N 17401204002644. Prior units required 2 harnesses CN1 and CN10 on the control board.

WIRING DIAGRAMS (CONTINUED)



CODE	PART NAME
COMP	COMPRESSOR
CAP1	FAN MOTOR CAPACITOR
EEV	ELECTRONIC EXPANSION VALVE
FM1	OUTDOOR DC FAN
H-PRO	HIGH PRESSURE SWITCH
L	PFC INDUCTOR
L-PRO	LOW PRESSURE SWITCH
SV	4-WAY VALVE
TP	EXHAUST TEMPERATURE SENSOR
T3	CONDENSER TEMPERATURE SENSOR
T4	OUTDOOR AMBIENT TEMPERATURE SENSOR

CODE	PART NAME	CODE	PART NAME
CN1, CN2	nput: 220VAC high voltage(indoor unit)	CN9	Input: Pin1, Pin2, Pin4, Pin5 (0-5V) for high and low pressure switcheswhere applicable
S	Input: High Voltage Signal (indoor unit)	CN10, CN44	Output: 220VAC high voltage for base pan heater
CN3, CN22	Output: 220VAC for4-way valve control	CN19	Output: Pulse (0-320VDC) forOutdoor DC Fan
CN4, CN40	Output: 220VAC highvoltage for cranckase heater	CN20	Output: (Pin5 or 6) toEEV（Pin1, 2, 3,4). Pulse waveform (0-12V)
CN5,CN6	Output: 220VAC high voltage for power for driver board	CN33	Input: Pin1, Pin2 (0-5V) from exhaust temperature sensor
CN53,CN54	Input: 220VAC high voltage for driver board	CN51, CN52	Output: 220VAC high voltage for PFC inductor
CN7	Output: Pin1-3=12VDC.Pin2-3=5VDC. (other pin for chipcumunication)	U V W	Output: Pulse (0-320VDC) forCompressor
CN55	Input: Pin1-3=12VDC.Pin2-3=5VDC. (other pin for chipcumunication)	P-1	Ground Connector
CN8	Input: Pin1, Pin3, Pin4, Pin5 (0-5V) for condenser and outdoor ambient temperature sensors		

Fig. 10 – Wiring Diagram Sizes 24K−36K

FAN AND MOTOR SPECIFICATIONS

Table 8—Fan and Motor Specifications

	38MAR UNIT Size		9K (115V)	12K (115V)	9K (208/230V)	12K (208/230V)	18K (208/230V)	24K (208/230V)	30K (208/230V)	36K (208/230V)
Outdoor Fan	Material		AS							
	Type		ZL−429*119*8−3KN (ASG30)	ZL−429*119*8−3KN (ASG30)	ZL−427*139*8−3KN (ASG30)	ZL−427*139*8−3KN (ASG30)	ZL−490*151*12−3KN (ASG30)	ZL−560*139*12−3KN (ASG30)	ZL−560*139*12−3KN (ASG30)	ZL−560*139*12−3KN (ASG30)
	Diameter	inch	16.8	16.8	16.6	16.6	18.1	22.0	22.0	22.0
	Height	inch	4.7	4.7	5.5	5.5	6.0	5.5	5.5	5.5
Outdoor Fan Motor	Model		ZKFN−40−8−1L	ZKFN−40−8−1L	ZKFN−40−8−1L	ZKFN−40−8−1L	ZKFN−50−8−2	ZKFN−120−8−2	ZKFN−120−8−2	ZKFN−120−8−2
	Volts	V	115	115	208/230	208/230	208/230	208/230	208/230	208/230
	Phase		1							
	Hertz	Hz	60							
	FLA		0.6	0.6	0.38	0.38	0.42	0.5	0.6	0.6
	Rated HP	HP	0.053	0.053	0.053	0.053	0.067	0.16	0.16	0.16
	Output	W	40	40	40	40	50	120	120	120
	Type		DC							
	Insulation Class		A							
	Safe Class		IPX4							
	Input	W	54	54	54	54	115	87	87	87
	Range of Current	Amps	0.19±10%	0.19±10%	0.19±10%	0.19±10%	0.41±10%	0.31±10%	0.31±10%	0.31±10%
	Rated Current	Amps	0.19	0.19	0.19	0.19	0.41	0.31	0.31	0.31
	Capacitor	μF	No Capacitor							
	Speed	rev/ min	800/700/600	800/700/600	800/700/600	800/700/600	850/700/600	850/750/700	850/800/750	850/800/750
	Rated RPM	rev/ min	980	980	980	980	900	1150	1150	1150
	Max. Input	W	91	91	91	91	137	170	170	170

REFRIGERATION CYCLE DIAGRAMS

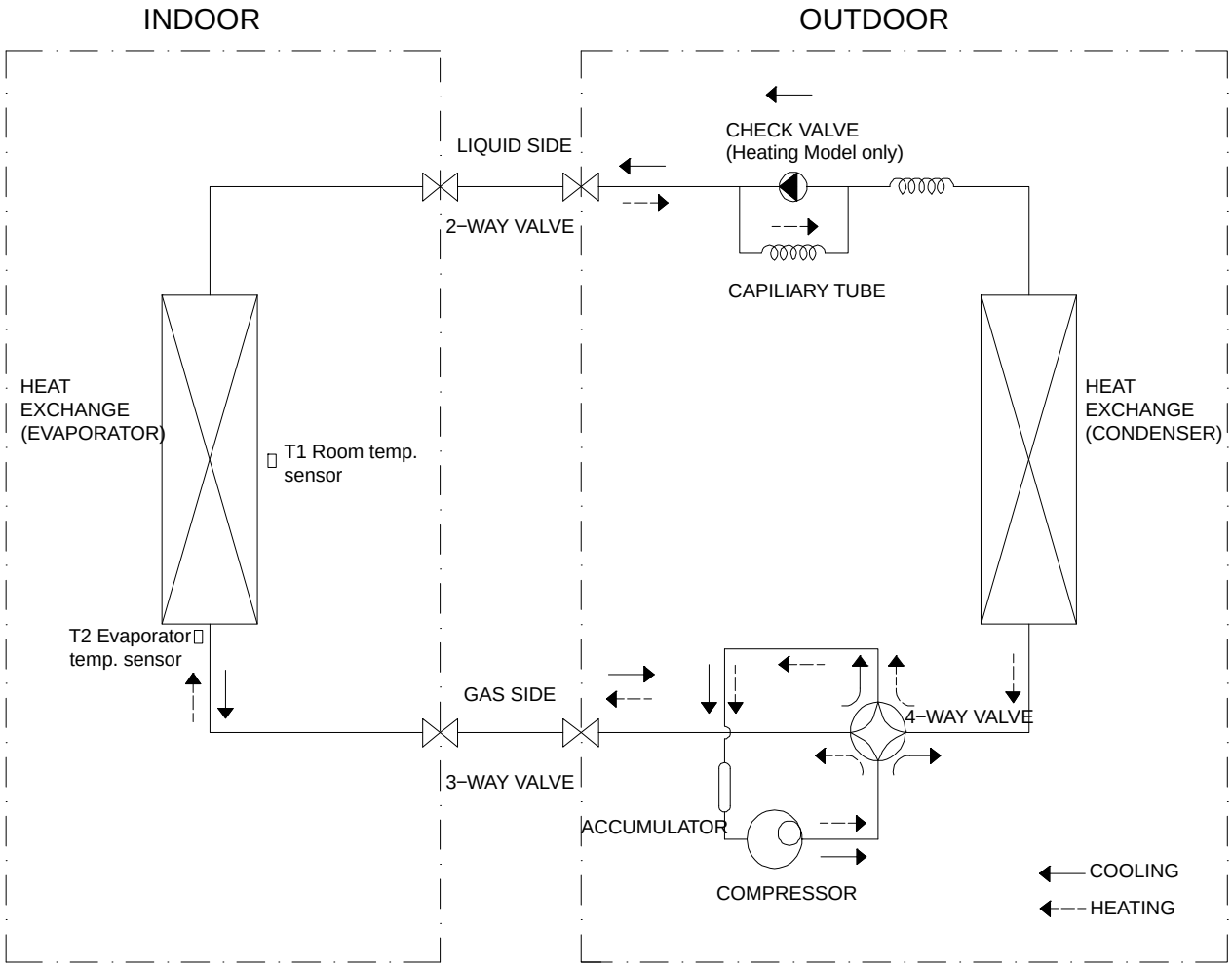


Fig. 11 – Heat Pumps

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 36 in (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 the tubing so vibration or noise is not transmitted into the structure.

IMPORTANT: Both refrigerant lines must be insulated separately.

- The following maximum lengths are allowed:

Table 9—Refrigerant Line Lengths ft. (m)

System Size			9K (115V)	12K (115V)	9K (208-230 V)	12K (208-230 V)	18K (208-230 V)	24K (208-230 V)	30K (208-230 V)
Piping	Min. Piping Length	ft (m)	10 (3)	10 (3)	10 (3)	10 (3)	10 (3)	10 (3)	10 (3)
	Standard Piping Length	ft (m)	25 (7.5)	25 (7.5)	25 (7.5)	25 (7.5)	25 (7.5)	25 (7.5)	25 (7.5)
	Max. outdoor-indoor height difference	ft (m)	32(10)	32(10)	32(10)	32(10)	65(20)	65(20)	82(25)
	Max. Piping Length with no additional refrigerant charge	ft (m)	26(8)	26 (8)	26(8)	26(8)	26(8)	26(8)	26(8)
	Max. Piping Length	ft (m)	82(25)	82 (25)	82(25)	82(25)	98(30)	98(30)	164(50)
	Additional refrigerant charge (between Standard – Max piping length)	Oz/ft (g/m)	0.16(15)	0.16 (15)	0.16(15)	0.16(15)	0.16(15)	0.32(30)	0.32(30)
	Gas Pipe (size - connection type)	in (mm)	3/8 (9.52)	1/2 (12.7)	3/8 (9.52)	1/2 (12.7)	1/2 (12.7)	5/8 (16)	5/8 (16)
	Liquid Pipe (size - connection type)	in	1/4 in	1/4 in	1/4 in	1/4 in	1/4 in	3/8 in	3/8 in
		(mm)	6.35	6.35	6.35	6.35	6.35	9.52	9.52
Refrigerant	Refrigerant Type		R410A	R410A	R410A	R410A	R410A	R410A	R410A
	Heat Pump Models Charge Amount	Lbs (kg)	2.76(1.25)	2.76 (1.25)	2.76(1.25)	2.76(1.25)	4.19(1.90)	5.18(2.35)	6.62(3.00)

- The charge amount listed in Table 9 is for piping runs up to 25 ft. (7.6 m).
- For piping runs greater than 25 ft. (7.6 m), add refrigerant up to the allowable length as specified in Table 10.

Long Line Applications,:

1. No change in line sizing is required.
2. Add refrigerant per Table 10.

Table 10—Additional Charge

UNIT SIZE	TOTAL LINE LENGHT ft (m)		ADDITIONAL CHARGE, oz/ft. ft (m)			
	Min	Max	10 – 25 (3 – 8)	>25 – 82 (8 – 25)	>82 – 98 (25 – 30)	>98 – 164 (30 – 50)
9	10(3)	82(25)	None	0.16		
12						
18		98(30)			0.16	
24				0.32	0.32	0.32
30		164(50)				
36						

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. Always break a vacuum with dry nitrogen.

System Vacuum and Charge

Using Vacuum Pump

1. Completely tighten all flare nuts and connect manifold gage charge hose to a charge port of the low side service valve. (See Fig. 12.)
2. Connect charge hose to vacuum pump.
3. Fully open the low side of manifold gage. (See Fig. 13)
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 25 ft. (8 m) of line length. For refrigerant lines longer than 25 ft (8 m), add refrigerant as specified in the Table 10.
8. Disconnect charge hose from charge connection of the low side service valve.
9. Fully open service valves B and A.
10. Securely tighten caps of service valves.

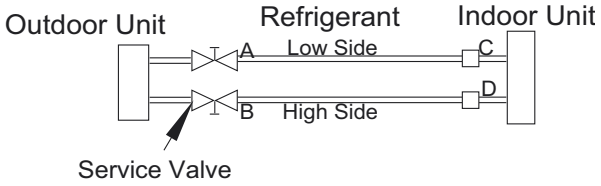


Fig. 12 – Service Valve

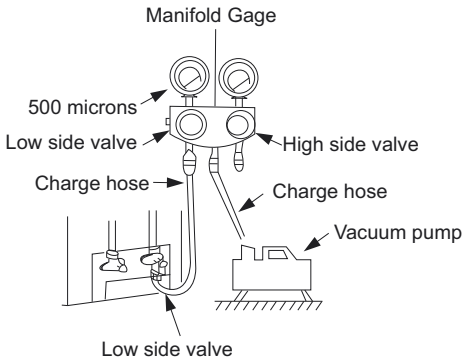


Fig. 13 – Manifold

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. 14)

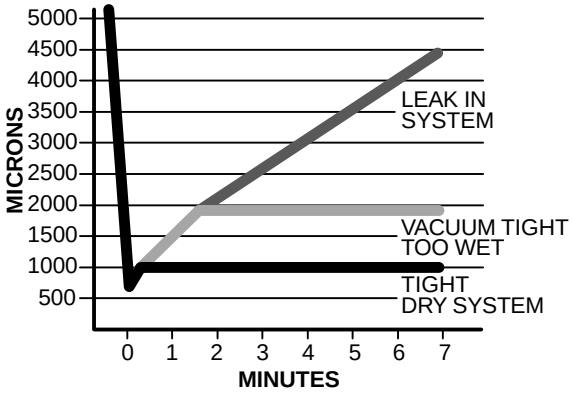


Fig. 14 – Deep Vacuum Graph

Triple Evacuation Method

The triple evacuation method should be used. Refer to Fig. 15 and proceed as follows:

1. Pump system down to 500 MICRONS of mercury and allow pump to continue operating for an additional 15 minutes.
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. 15. System will then be free of any contaminants and water vapor.

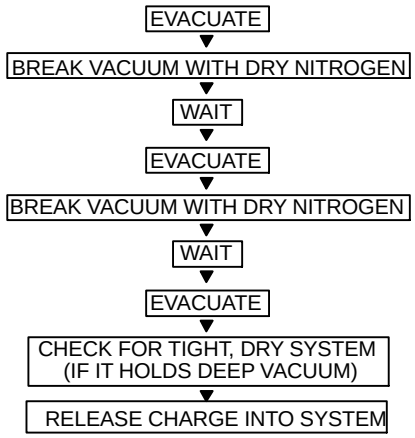


Fig. 15 – Triple Evacuation Method

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

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 high temperature cutout

The unit stops working when the compressor high temperature cutout opens, and restarts after the compressor high temperature cutout closes.

Compressor discharge temperature protection

Compressor discharge temp. T5>239°F(115°C) for 5s, compressor stops.

Fan speed is out of control

When the indoor fan speed is too low (300RPM) or too high (1500RPM) for a certain time, the unit stops and the LED displays the failure.

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 also controlled by the anti－cold wind function.

Compressor preheating functions

Preheat parameters: When the T4 (outdoor ambient temperature)<37.4°F (3°C), preheat function is activated.

Zero crossing detection error protection

If the AC detects the time interval is not correct for a continuous 240s, the unit stops and the LED displays the failure. The correct zero crossing signal time interval should be between 6－13ms.

Sensor protection at open circuit and breaking disconnection

If only one temperature sensor malfunctions, the air conditioner continues to work however the error code displays on the LED, in the event of any emergency use. If more than one temperature sensor malfunctions, the air conditioner stops working.

Refrigerant leakage detection

This function is only active in the **COOLING** mode. The function helps prevent the compressor from being damaged by a refrigerant leakage or a compressor overload.

Open condition:

When the compressor is active, the evaporator T2 coil temperature value has no or very little change.

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

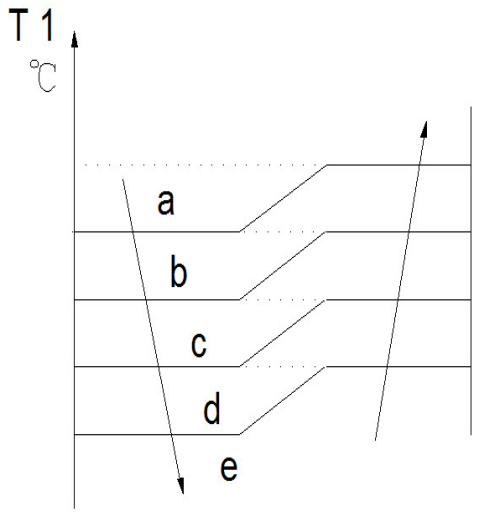


Fig. 16 – FAN Mode

COOLING Mode

Compressor Running Rules:

- When T1−Ts < 28.4°F(−2°C), the compressor stops.
- When T1−TS > 31.1°F(−0.5°C), the compressor activates.
- When the AC runs in the mute mode, the compressor runs with low frequency.
- When the current is more than setting value, the current protection function activates, and the compressor stops.

Outdoor Fan Running Rules:

The outdoor unit runs at a different fan speed according to T4. For different outdoor units, the fan speeds differ.

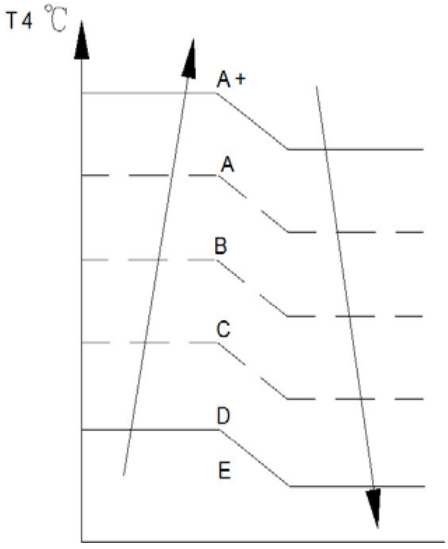


Fig. 17 – COOLING Mode

Indoor Fan Running Rules:

- In the **COOLING** mode, the indoor fan runs continuously and the user can select any of the following speeds: **HIGH**, **MEDIUM**, **LOW** and **AUTO**.
- When the setting temperature is reached, if the compressor stops running, the indoor fan motor runs in the minimum or setting speed (see Fig. 18).

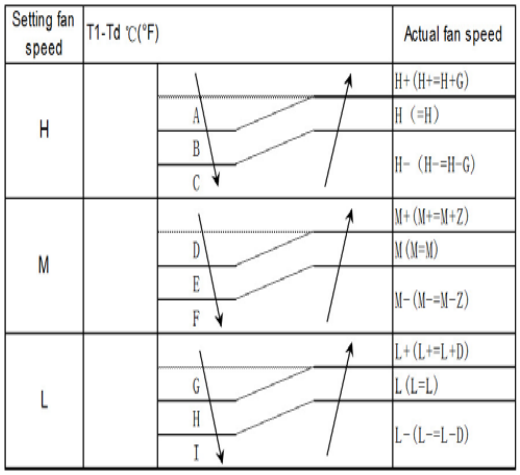


Fig. 18 – Indoor Fan Running Rules

The **AUTO** fan adheres to the following rules (see Fig. 19):

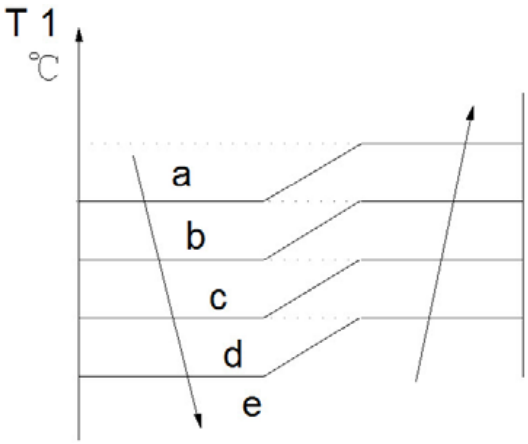


Fig. 19 – AUTO FAN Running Rules

Compressor Temperature Protection:

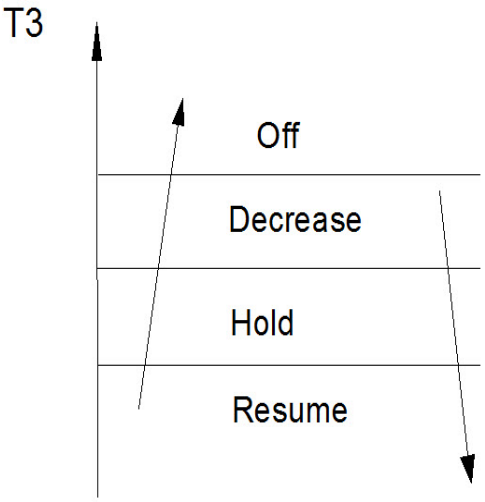


Fig. 20 – Compressor Temperature Protection

When the condenser temperature temperature is higher than the setting value, the compressor stops.

Evaporator Temperature Protection

When the evaporator temperature is lower than the setting value the compressor stops.

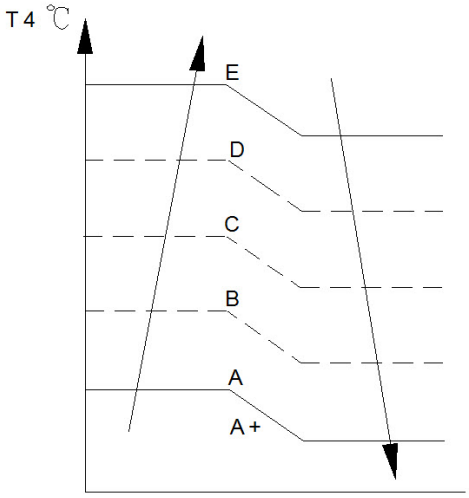
<u>Heating Mode</u>

Compressor Running Rules:

- When $T1 - Ts > -\Delta T$, the compressor stops
- When $T1 - TS < \Delta T - 1.5$, the compressor is on. ΔT is the programmed parameter for temperature compensation.
- When the AC runs in **MUTE** mode, the compressor runs with a low frequency.
- When the current is more than the setting value, the current protection function activates and the compressor stops.

Outdoor Fan Running Rules:

The outdoor unit runs at a different fan speed according to T4. For different outdoor units, the fan speeds differ.



Indoor Fan Running Rules:

When the compressor is on, the user can set the indoor fan to either **HIGH/MED/LOW/AUTO/MUTE**. When the indoor unit coil temperature is low, the anti−cold air function starts and the indoor fan motor runs at the low speed. The speed can not be changed.

When the temperature is lower than the setting value, the indoor fan motor stops. When the indoor temperature reaches the setting temperature, the compressor stops, the indoor fan motor runs at the minimum speed or setting speed. The anti−cold air function is valid. The indoor fan is controlled as shown in Fig. 21.

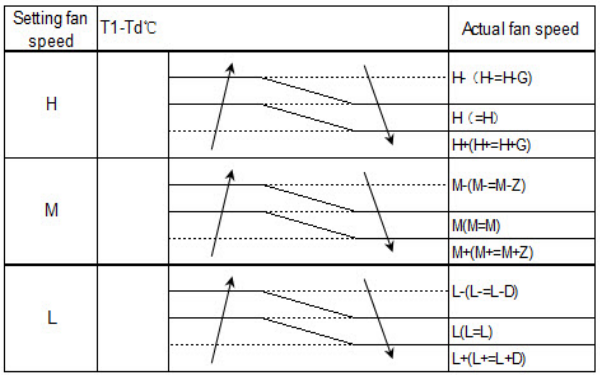


Fig. 21 – Indoor Fan Running Rules

Auto fan action in the **HEATING** mode.

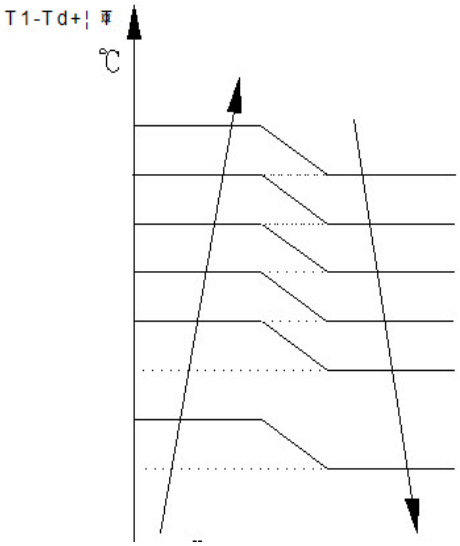


Fig. 22 – Auto Fan Action in HEATING Mode

DEFROST Mode

The air conditioning unit enters the **DEFROST** mode according to the value of temperature of T3 and the value range of temperature change of T3 plus the compressor running time. During the **DEFROST** mode, the compressor keeps running however the indoor and outdoor motors stop.

The indoor unit defrost lamp illuminates and the dF logo appears.

Evaporator Coil Temperature Protection

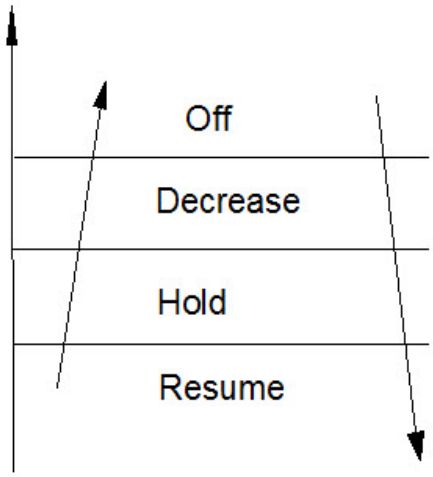


Fig. 23 – Evaporator Coil Temperature Protection

When the evaporator temperature is higher than the setting protection value, the compressor stops.

AUTO Mode

AUTO mode can be selected with the remote controller and the setting temperature can be changed between 62.6°F (17°C) ~86°F(30°C). In **AUTO** mode, the unit chooses either cooling, heating or fan−only mode according to ΔT (Example: (ΔT=T1−T2)).

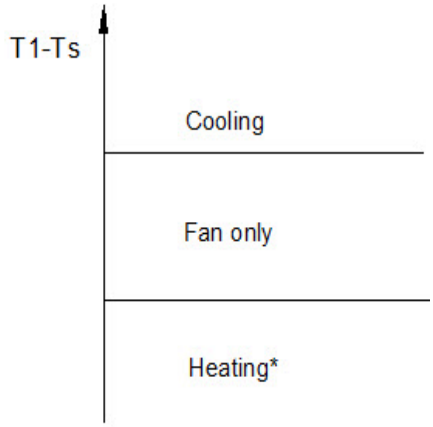


Fig. 24 – AUTO Mode

Heating*: For cooling only models, they will run at the fan speed. The indoor fan will run in the **AUTO** fan speed for the relevant mode. The louver operates the same as in the relevant mode.

If the unit switches mode between heating and cooling, the compressor keeps stopping for a certain time and then chooses the mode according to T1−Ts. If the setting temperature is modified, the unit selects a running function again.

DRYING mode

The indoor fan speed is fixed at breeze and can not be changed. The louver angle is the same as in the **COOLING** mode.

Low Indoor Room Temperature Protection

In the **DRYING** mode, if the room temperature is lower than 50°F (10°C), the compressor stops and does not resume until the room temperature exceeds 53.6°F (12°C).

Evaporator anti−freezing protection, condenser high temperature protection and outdoor unit frequency limit are active and are the same as that in the **COOLING** mode. The outdoor fan operates the same as in **COOLING** mode.

FORCED OPERATION Function

Enter FORCED OPERATION function:

When the machine is off, press **TOUCH** to engage the the **Forced Auto Mode**. Press **TOUCH** again, within 5 seconds, to engage the **FORCED COOLING** mode. In **FORCED AUTO**, **FORCED COOLING** or any other operation mode, press **TOUCH** to turn off the unit.

In the **FORCED OPERATION** mode, all general protections and the remote controller are available.

Operation Rules:

FORCED COOLING mode:

The compressor runs at the F2 frequency and the indoor fan runs as a breeze. After running for 30 minutes, the unit enters the **AUTO** mode at a 75.2°F (24°C) setting temperature.

FORCED AUTO mode:

The **FORCED AUTO** mode is the same as the normal **AUTO** mode with a 75.2°F (24°C) setting temperature.

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 the swing function) automatically 3 minutes after the power returns. If the memorization condition is the **FORCED COOLING** mode, the unit runs in the **COOLING** mode for 30 minutes and enters the **AUTO** mode as 75.2°F (24°C) setting temp.

If the air conditioner turns off before the unit powers off and the air conditioner is required to restart immediately, the compressor delays for 1 minute when the power is on. Under other conditions, the compressor has a 3 minute delay when it restarts.

Refrigerant Leakage Detection

With this new technology, the display area displays **EC** when the outdoor unit detects a refrigerant leak.

46.4°F (8°C) Heating

When the compressor is running, the indoor fan motor runs without the anti−cold air function. When the compressor is off, the indoor fan motor is off.

Point Check Function

Press the remote controller **LED DISPLAY** or **LED** or **MUTE** three times, and then press **AIR DIRECTION** or **SWING** three times within ten seconds (the buzzer rings for two seconds). The air conditioner enters the information enquiry status.

The user can press **LED DISPLAY** or **AIR DIRECTION** to check the next command. When the air conditioner enters the information enquiry status, it displays the code name in 2 seconds. When the air conditioner enters the information enquiry status, it displays the code value in the next 25 seconds.

Table 11—Enquiry Information

ENQUIRY INFORMATION	DISPLAYING CODE	MEANING
T1	T1	T1 temp.
T2	T2	T2 temp.
T3	T3	T3 temp.
T4	T4	T4 temp.
T2B	Tb	T2B temp.
TP	TP	TP temp.
TH	TH	TH temp.
Targeted Frequency	FT	Targeted Frequency
Actual Frequency	Fr	Actual Frequency
Indoor Fan Speed	IF	Indoor Fan Speed
Outdoor Fan Speed	OF	Outdoor Fan Speed
EXV Opening Angle	LA	EXV Opening Angle
Compressor Continuous Running Time	CT	Compressor Continuous Running Time
Compressor Stop Issues	ST	Compressor Stop Issues

When the air conditioner enters the information enquiry status, the LED displays the code value within 25 seconds (see Table 12).

Table 12—Enquiry Information

ENQUIRY INFORMATION	DISPLAY VALUE	MEANING	REMARK
T1,T2,T3,T4, T2B,TP,TH, Targeted Frequency, Actual Frequency	−1F,−1E,−1d,−1c,−1 b,−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 actual value exceeds 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 from 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, please consult with an engineer	Decimal display
Reserve	0−FF		

TROUBLESHOOTING

Safety

Electricity power is kept in capacitors even if the power supply is shut off.

NOTE: Remember to discharge the electricity power in capacitor.

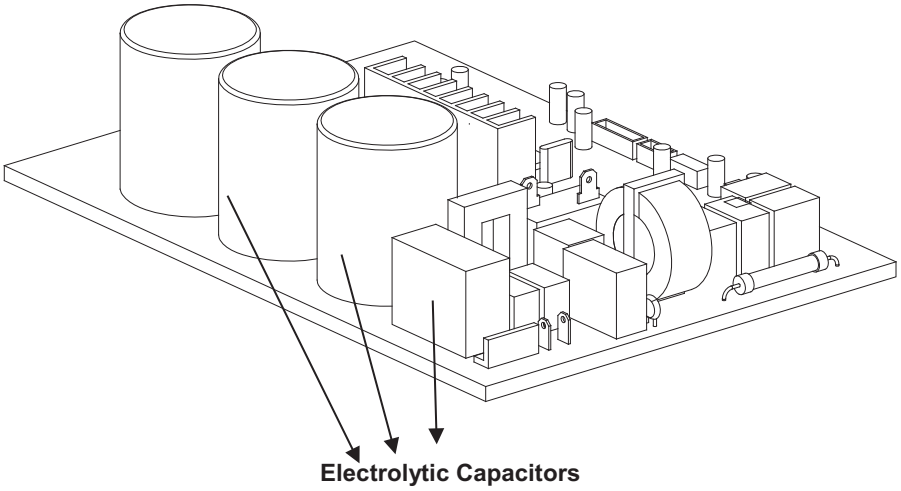


Fig. 25 – Electrolytic Capacitors

For other models, please connect discharge resistance (approximately 100Ω 40W) or a soldering iron (plug) between the +, − terminals of the electrolytic capacitor on the contrary side of the outdoor PCB.

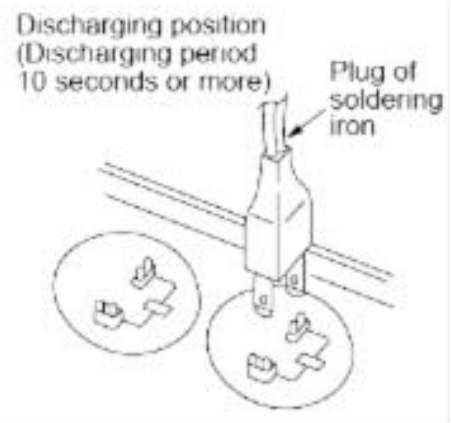


Fig. 26 – Discharge Position

NOTE: Fig. 26 is for reference only. The plug on your unit may differ.

INDOOR UNIT DIAGNOSTIC GUIDES

Table 13—Indoor Unit Diagnostic Guide

Operation lamp	Timer lamp	Display	LED STATUS
★ 1 time	X	E0	Indoor unit EEPROM parameter error
★ 2 times	X	E1	Indoor / outdoor units communication error
★ 3 times	X	E2	Zero-crossing signal detection error
★ 4 times	X	E3	Indoor fan speed is out of control
★ 5 times	X	E4	Indoor room temperature sensor T1 open circuit or short circuit
★ 6 times	X	E5	Evaporator coil temperature sensor T2 open circuit or short circuit
★ 7 times	X	EC	Refrigerant leakage detection
★ 1 time	O	F0	Overload current protection
★ 2 times	O	F1	Outdoor ambient temperature sensor T4 open circuit or short circuit
★ 3 times	O	F2	Condenser coil temperature sensor T3 open circuit or short circuit
★ 4 times	O	F3	Compressor discharge temperature sensor TP open circuit or short circuit
★ 5 times	O	F4	Outdoor unit EEPROM parameter error
★ 6 times	O	F5	Outdoor fan speed is out of control
★ 1 time	★	P0	IPM malfunction or IGBT over-strong current protection
★ 2 times	★	P1	Over voltage or over low voltage protection
★ 3 times	★	P2	High temperature protection of IPM module
★ 4 times	★	P3*	Outdoor ambient temperature is too low
★ 5 times	★	P4	Inverter compressor drive error
★ 7 times	★	P6	Low pressure protection (only for 36K)

O(light) X(off) ★(flash)

NOTES:

P3*

1. In the **HEATING** mode, when the outdoor temperature is lower than −25 °C for one hour, the indoor unit displays the error code **P3**.
2. If the outdoor temperature is higher than −22°C for 10 minutes and the compressor stops for 1 hour or the outdoor temperature is higher than −5°C for 10 minutes, the unit will start.

*** Fault Symptom:** The display board shows a garbled code or a code that is not an error code found in the service manual nor a temperature reading.

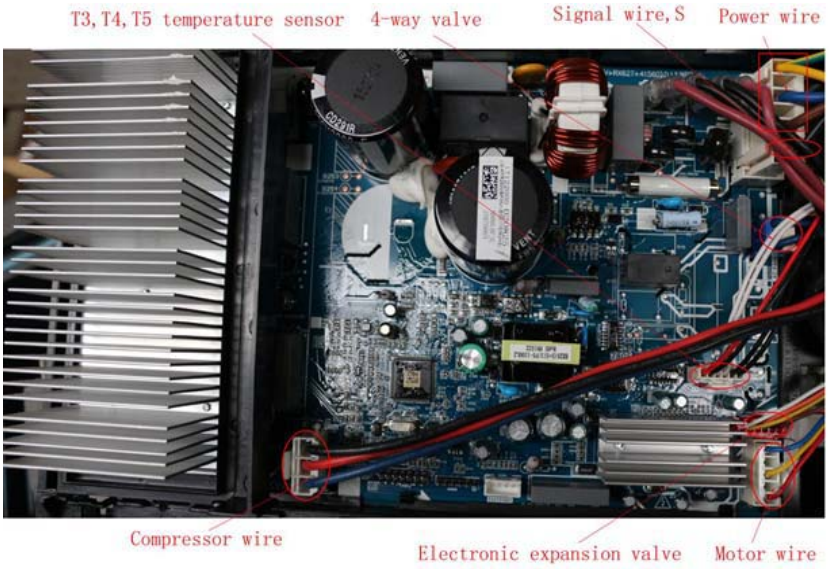
Troubleshooting

Use the remote controller. If the unit does not respond to the remote, the indoor PCB needs to be replaced; if the unit does respond, then the display board needs to be replaced.

DIAGNOSIS AND SOLUTION

Outdoor Unit Error Display

Sizes 9−12 (115V)



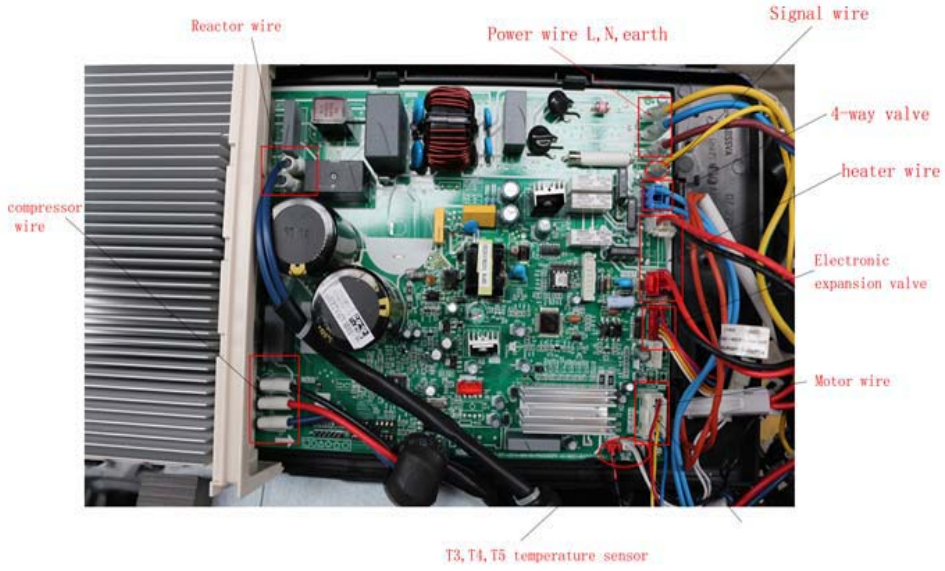
After the power is on, LED1 (blue color) flashes slowly (0.2Hz) when the unit is in standby. The LED flashes quickly (2.5Hz) if the unit has an issue.

Table 14—Diagnostic Table Sizes 9K−18K

No.	PROBLEMS	LED3 (Green)	LED2 (Red)	IU DISPLAY
1	Standby for normal	O	X	
2	Operation normal	X	O	
3	IPM malfunction or IGBT over−strong current protection	★	X	P0
4	Over voltage or too low voltage protection	O	O	P1
5	EEPROM parameter error	O	★	E5
6	Inverter compressor drive error	X	★	P4
7	Inverter compressor drive error	★	O	P4
8	Inverter compressor drive error	★	★	P4

O (light) X (off) ★ (2.5 Hz flash)

Sizes 9−18 (208−230V)



Sizes 24−36 (208−230V)

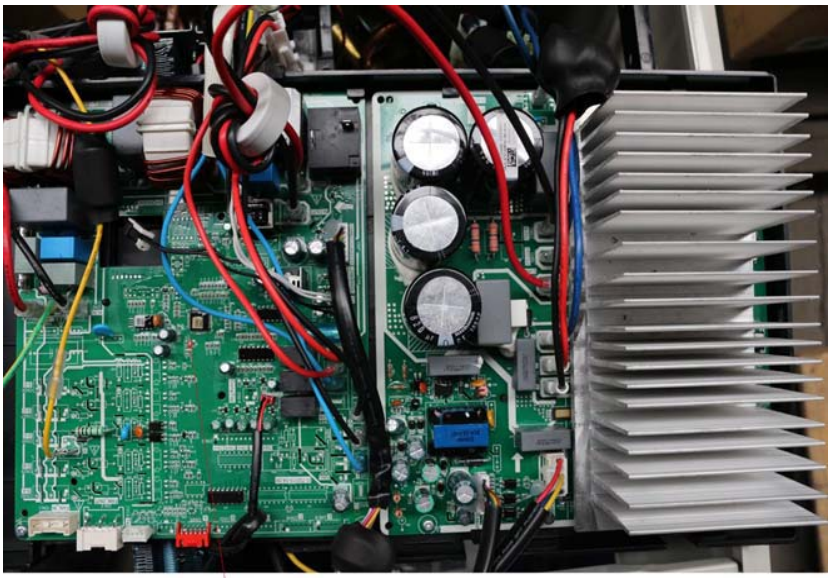
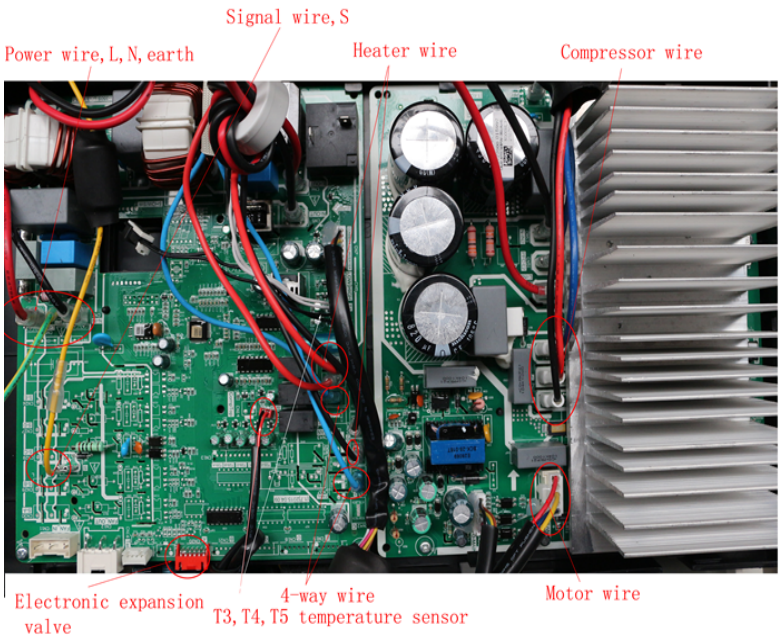


Table 15—Diagnostic Table Sizes 24K−36K

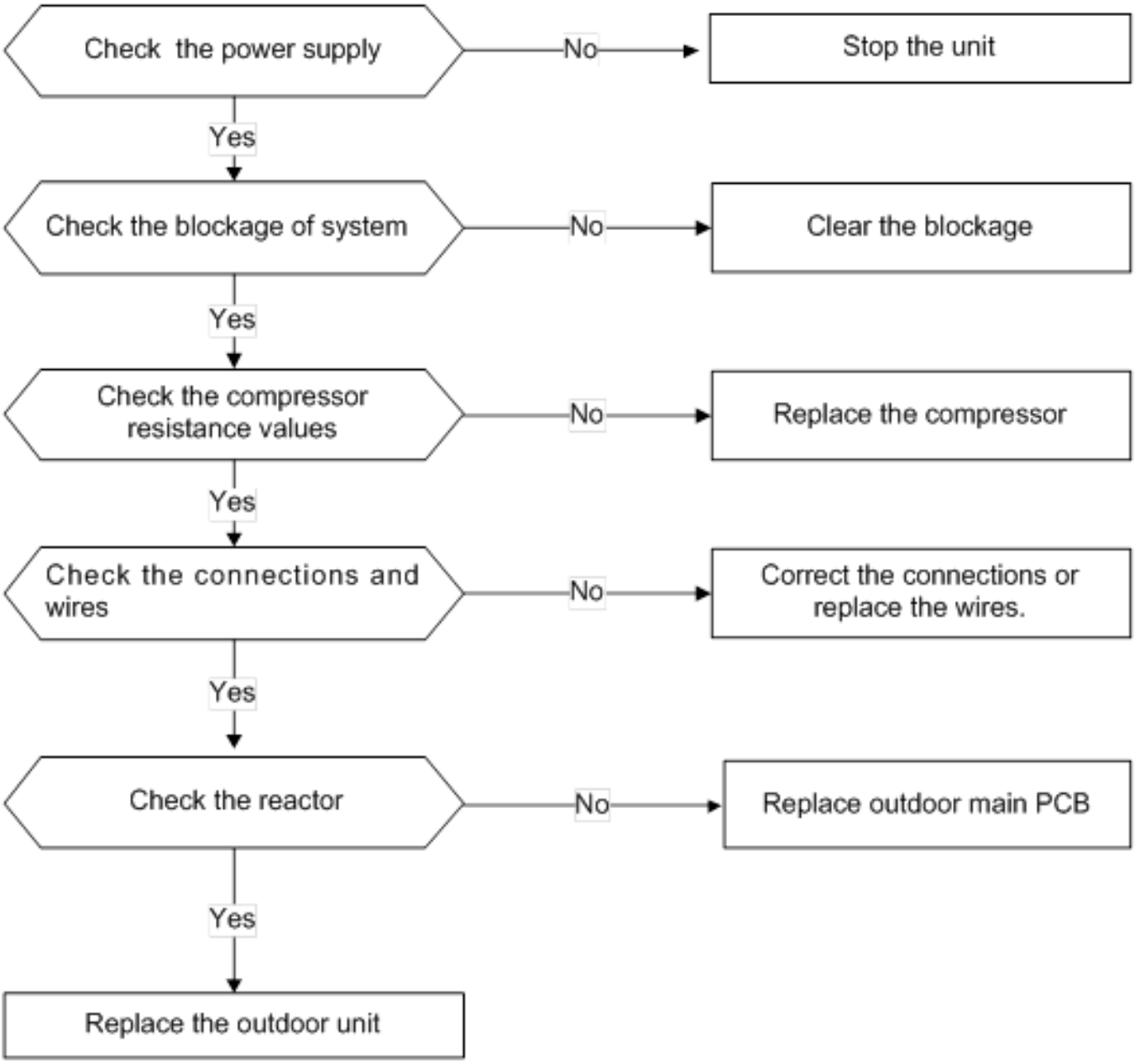
No.	PROBLEMS	LED2 (Green)	LED3 (Red)	IU DISPLAY
1	Standby for normal	O	X	
2	Operation normal	X	O	
3	IPM malfunction or IGBT over−strong current protection	★	X	P0
4	Over voltage or too low voltage protection	O	O	P1
5	EEPROM parameter error	O	★	E5
6	Inverter compressor drive error	X	★	P4
7	Inverter compressor drive error	★	O	P4
8	Inverter compressor drive error	★	★	P4



Overload Current Protection Diagnosis and Solution (F0)

Error Code	F0
Malfunction decision conditions	An abnormal current rise is detected by checking the specified current detection circuit.
Supposed Causes	• Power supply problems • System blockage • PCB faulty • Wiring mistake • Compressor malfunction

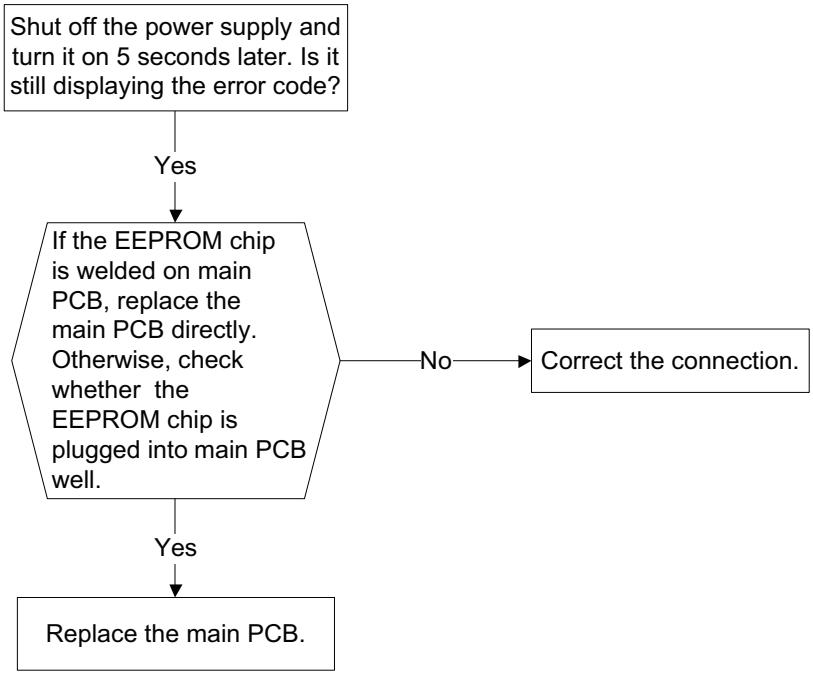
Troubleshooting:



EEPROM Parameter Error − Diagnosis and Solution (E0/F4)

Error Code	E0/F4
Malfunction decision conditions	Indoor or outdoor PCB main chip does not receive feedback from EEPROM chip.
Supposed Causes	• Installation mistake • PCB faulty

Troubleshooting:



EEPROM: A read−only memory whose contents can be erased and reprogrammed using a pulsed voltage. For the location of EEPROM chip, refer to the following images.

Fig. 27 – Indoor PCB

Fig. 28 – Outdoor (18K model) PCB

NOTE: Figures 27 and 28 are for illustration purposes only and may differ from your actual unit.

Index 1:

1. The indoor or outdoor DC Fan Motor control chip is in fan motor. Power on and when the unit is in standby, measure the voltage of pin1−pin3, pin4−pin3 in the fan motor connector. If the voltage value is out of range (see Tables 16 and 17) the PCB has an issue and must be replaced.

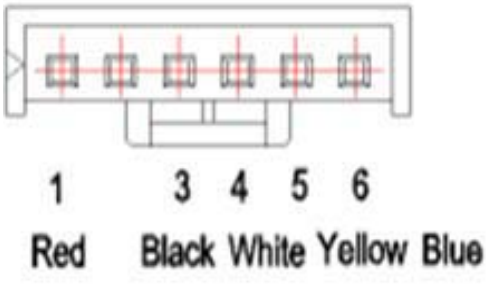


Table 16—DC Motor Voltage Input and Output (voltage: 220−240V~)

No.	COLOR	SIGNAL	VOLTAGE
1	Red	Vs/Vm	280V~380V
2	———	———	———
3	Black	GND	0V
4	White	Vcc	14—17.5V
5	Yellow	Vsp	0~5.6V
6	Blue	FG	14—17.5V

Table 17—DC Motor Voltage Input and Output (voltage:115V~)

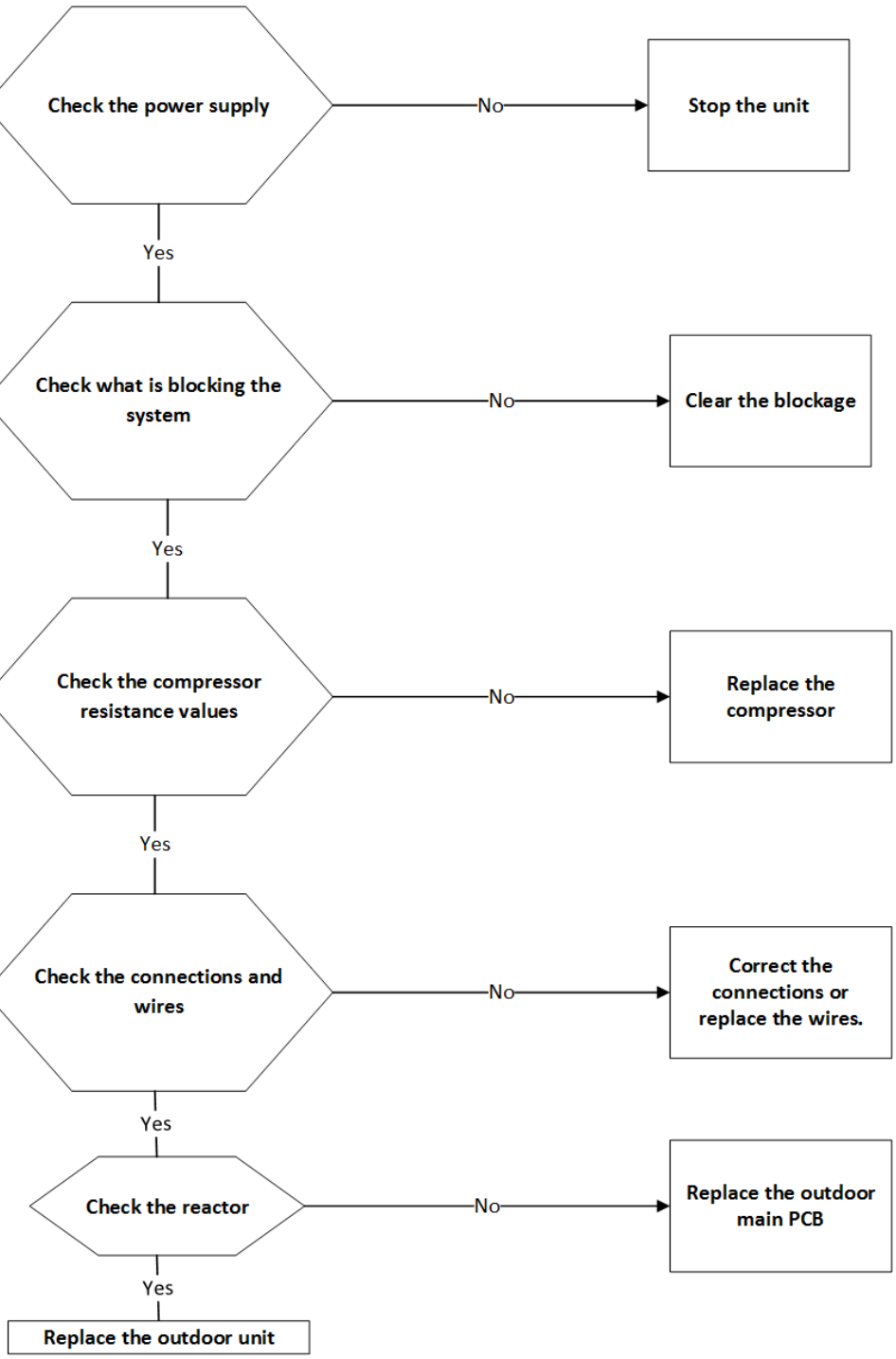
No.	COLOR	SIGNAL	VOLTAGE
1	Red	Vs/Vm	140V~190V
2	———	———	———
3	Black	GND	0V
4	White	Vcc	14—17.5V
5	Yellow	Vsp	0~5.6V
6	Blue	FG	14—17.5V

2. **Outdoor DC Fan Motor (control chip is in the outdoor PCB):** Power on and check if the fan will run normally. If the fan can run normally, the PCB has an issue and must be replaced. If the fan can not run normally, measure the resistance of each of the two pins. If the resistance is not equal to each other, the fan motor has an issue and must be replaced. Otherwise the PCB must have an issue and must be replaced.
3. **Indoor AC Fan Motor:** Power the unit on and engage the FAN mode at the high fan speed. After running for 15 seconds, measure the pin1 and pin2 voltage. If the voltage value is less than 100V(208~240V power supply) or 50V (115V power supply), the PCB has an issue and must be replaced.

Overload Current Protection Diagnosis and Solution (F0)

Error Code	F0
Malfunction decision conditions	An abnormal current rise is detected by checking the specified current detection circuit.
Supposed Causes	• Power supply problems • System blockage • PCB faulty • Wiring mistake • Compressor malfunction

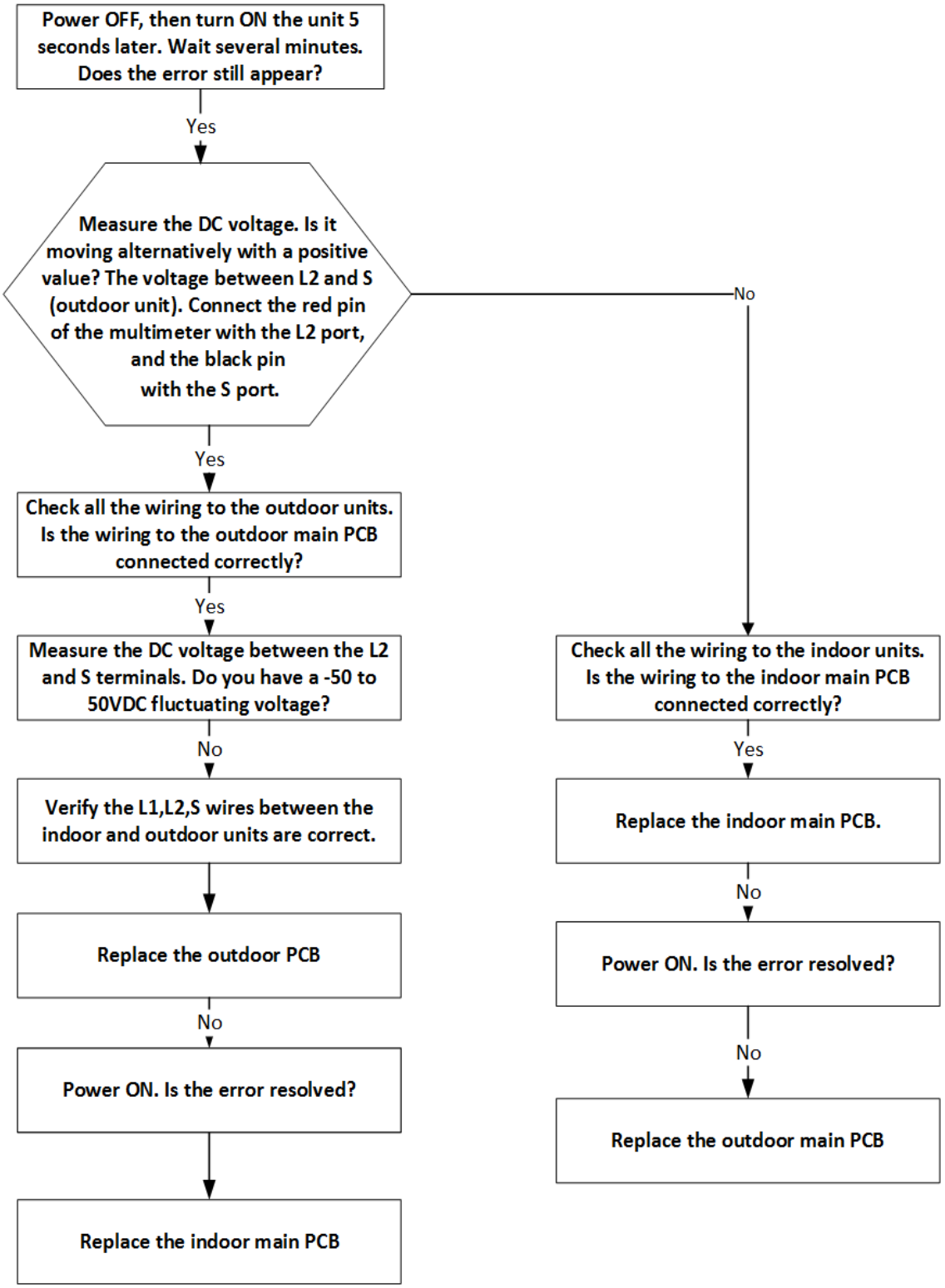
Troubleshooting:



Indoor / Outdoor Unit's Communication Error − Diagnosis and Solution (E1)

Error Code	E1
Malfunction decision conditions	Indoor unit does not receive feedback from outdoor unit in 110 seconds, and this condition occurs four times continuously.
Supposed Causes	Indoor and outdoor unit communications failure

Troubleshooting:



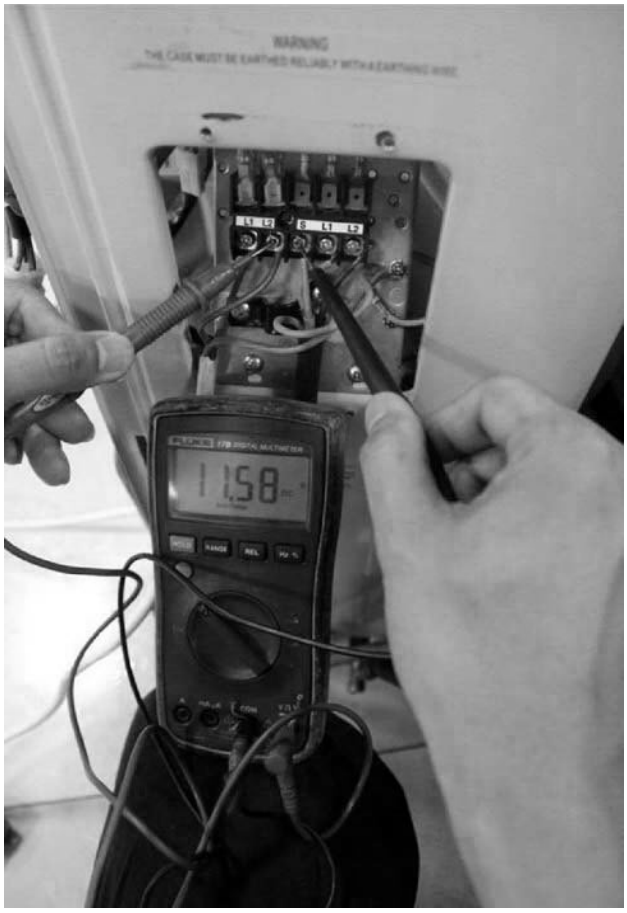


Fig. 29 – DC voltage test

Remark

Use a multimeter to test the DC voltage between the outdoor unit's L2 port and S ports (Fig. 29). The red pin of the multimeter connects with the L2 port while the black pin is for the S port.

When the AC is running normally, the voltage moves alternatively between −50V to 50V.

If the outdoor unit has a malfunction, the voltage moves alternatively with a positive value.

If the indoor unit has a malfunction, the voltage will have a fixed value. Example: 10−13VDC small fluctuating amount indicates an indoor unit malfunction.

Fig. 30 – Reactor resistance test

Remark

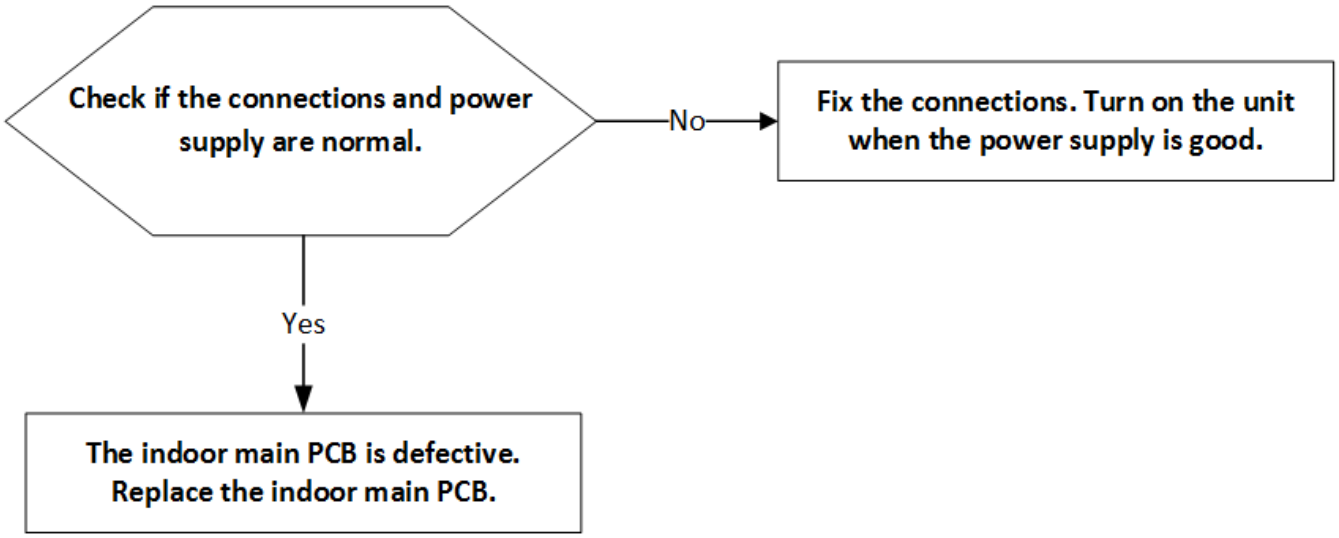
Use a multimeter to test the resistance of the reactor which does not connect with the capacitor (Fig. 30). The normal values should be around zero ohm.

Otherwise, the reactor has a malfunction and must be replaced.

Zero Crossing Detection Error Diagnosis and Solution (E2)

Error Code	E2
Malfunction decision conditions	When the PCB does not receive any zero crossing signal feedback for 4 minutes or the zero crossing signal interval is abnormal
Supposed Causes	• Connection mistake • PCB faulty

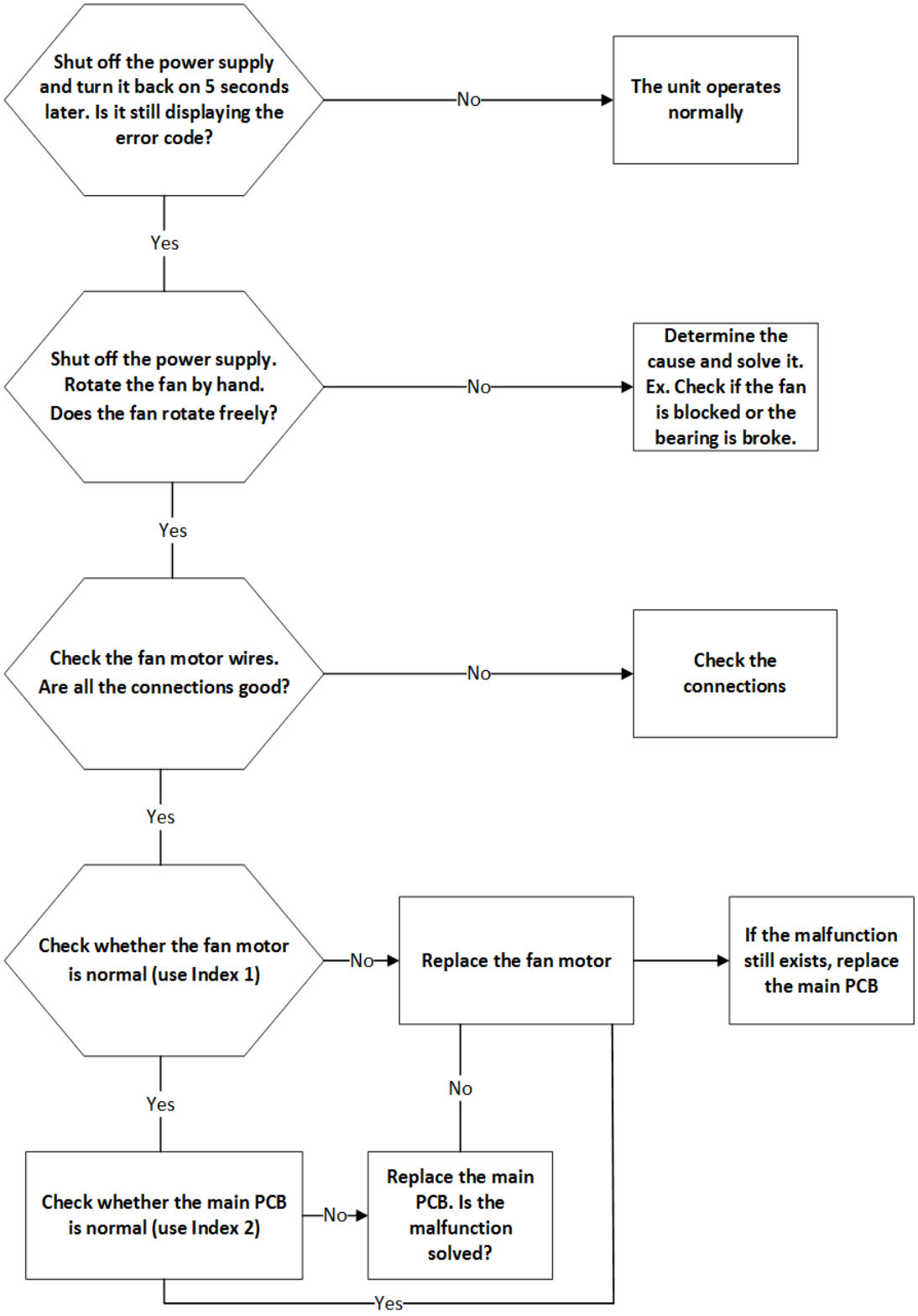
Troubleshooting:



Fan Speed has been out of Control Diagnosis and Solution (E3)

Error Code	E3
Malfunction decision conditions	When the indoor fan speed is too slow (300 RPM) for a certain time, the unit stops and the LED displays the failure.
Supposed Causes	• Wiring mistake • Fan assembly faulty • Fan motor faulty • PCB faulty

Troubleshooting:



Index 2:

Indoor or outdoor DC fan motor (control chip is in fan motor)

Measure the resistance value of each winding by using the tester. If any resistance value is zero, the fan motor must have problems and needs to be replaced.

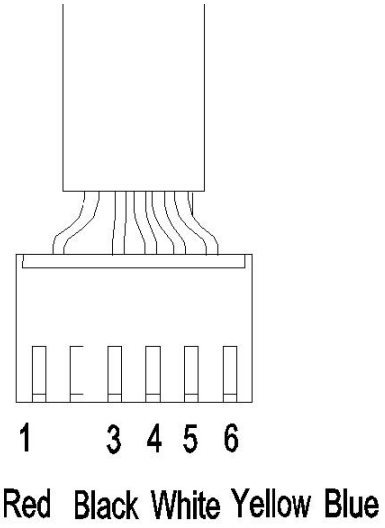


Fig. 31 – Fan motor

Index 3:

1. Indoor or Outdoor DC Fan Motor (control chip is in the fan motor). Power on and when the unit is in standby, measure the voltage of pin−1 − pin3, pin4−pin3 in the fan motor connector. If the value of the voltage is not in the range showing in the table below, the PCB has an issue and needs to be replaced.

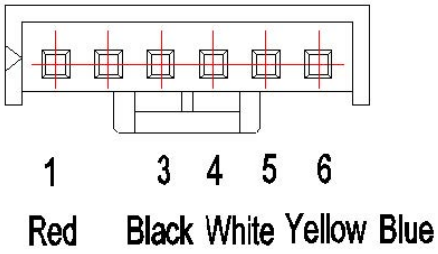


Fig. 32 – Control chip

Table 18—DC motor voltage input and output

No.	Color	Signal	Voltage
1	Red	Vs/Vm	280V−380V
2	−−−	−−−	−−−
3	Black	GND	OV
4	White	Vcc	14−14.5V
5	Yellow	Vsp	0~5.6V
6	Blue	FG	14−17.5V

2. Outdoor DC Fan Motor (control chip is in the outdoor PCB)

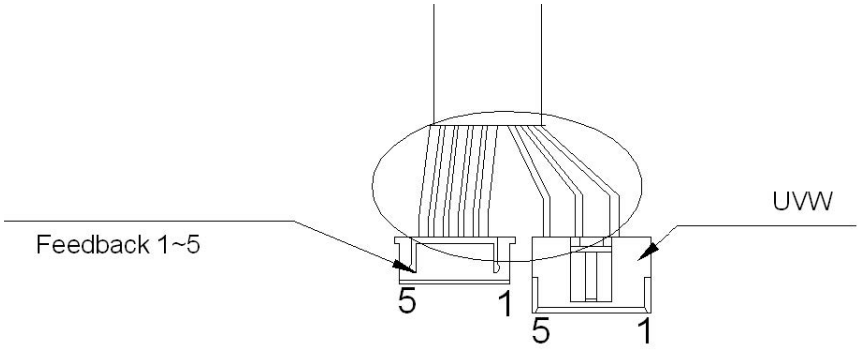


Fig. 33 – Outdoor DC Fan Motor

Table 19—Outdoor DC Fan Motor

No.	1	2	3	4	5
Color	Orange	Grey	White	Pink	Black
Signal	Hu	Hv	Hw	Vcc	GND

Table 20—Outdoor DC Fan Motor

Color	Red	Blue	Yellow
Signal	W	V	U

1. Release the UVW connector. Measure the resistance of U−V, U−W, V−W. If the resistance is not equal to each other, the fan motor has an issue and needs to be replaced. Otherwise, proceed to step 2.
2. Power on and when the unit is in standby, measure the voltage of pin 4−5 in the feedback signal connector. If the value is not 5V, change the PCB. Otherwise proceed to step 3.
3. Rotate the fan by hand, measure the voltage of pin 1−5, pin 2−5, and pin 3−5 in the feedback signal connector. If any voltage is not positive voltage fluctuation, the fan motor has an issue and must be replaced.

Open Circuit or Short Circuit of Temperature Sensor Diagnosis and Solution (E5)

Error Code	E5
Malfunction decision conditions	If the sampling voltage is lower than 0.06V or higher than 4.94V, the LED will display the failure.
Supposed Causes	• Wiring mistake • Sensor faulty

Troubleshooting:

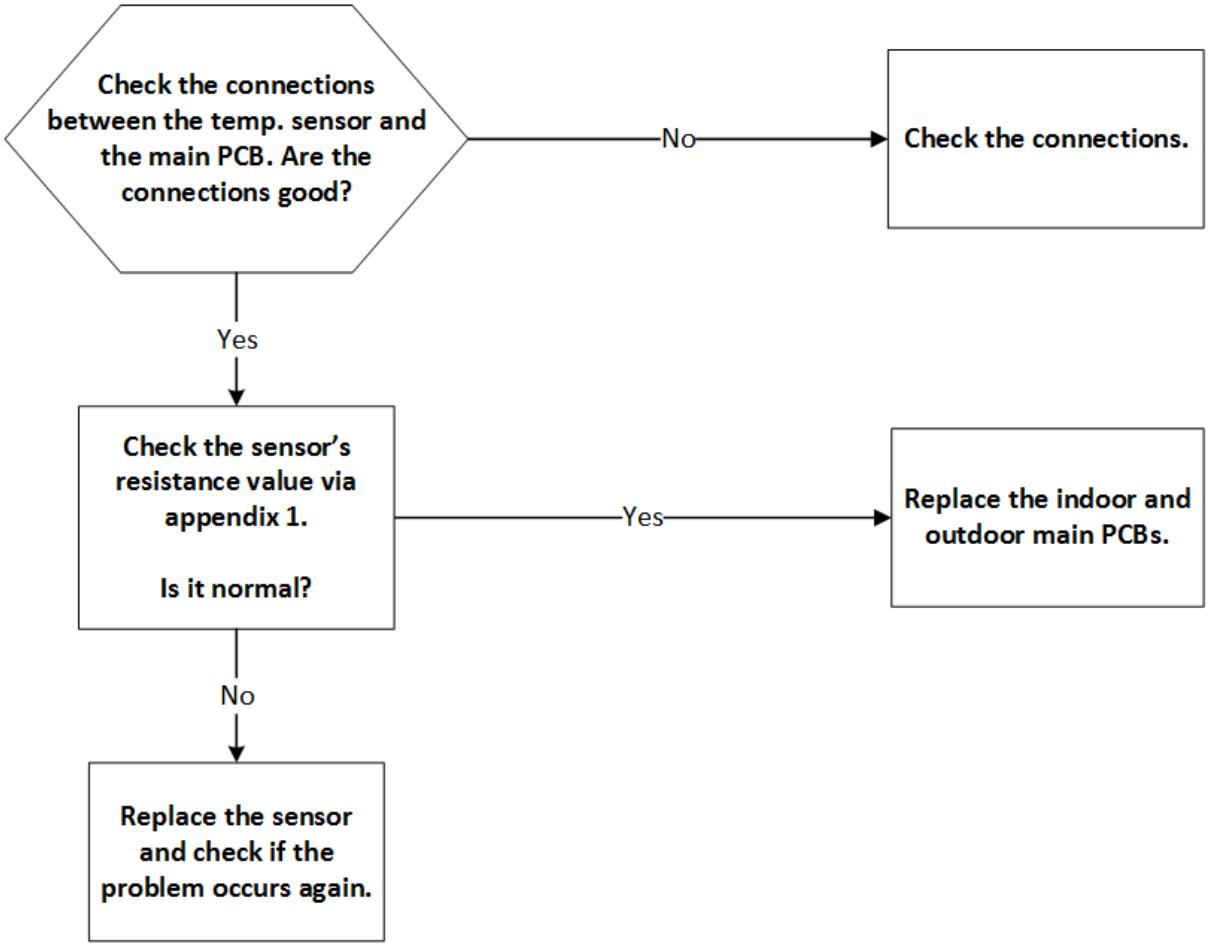
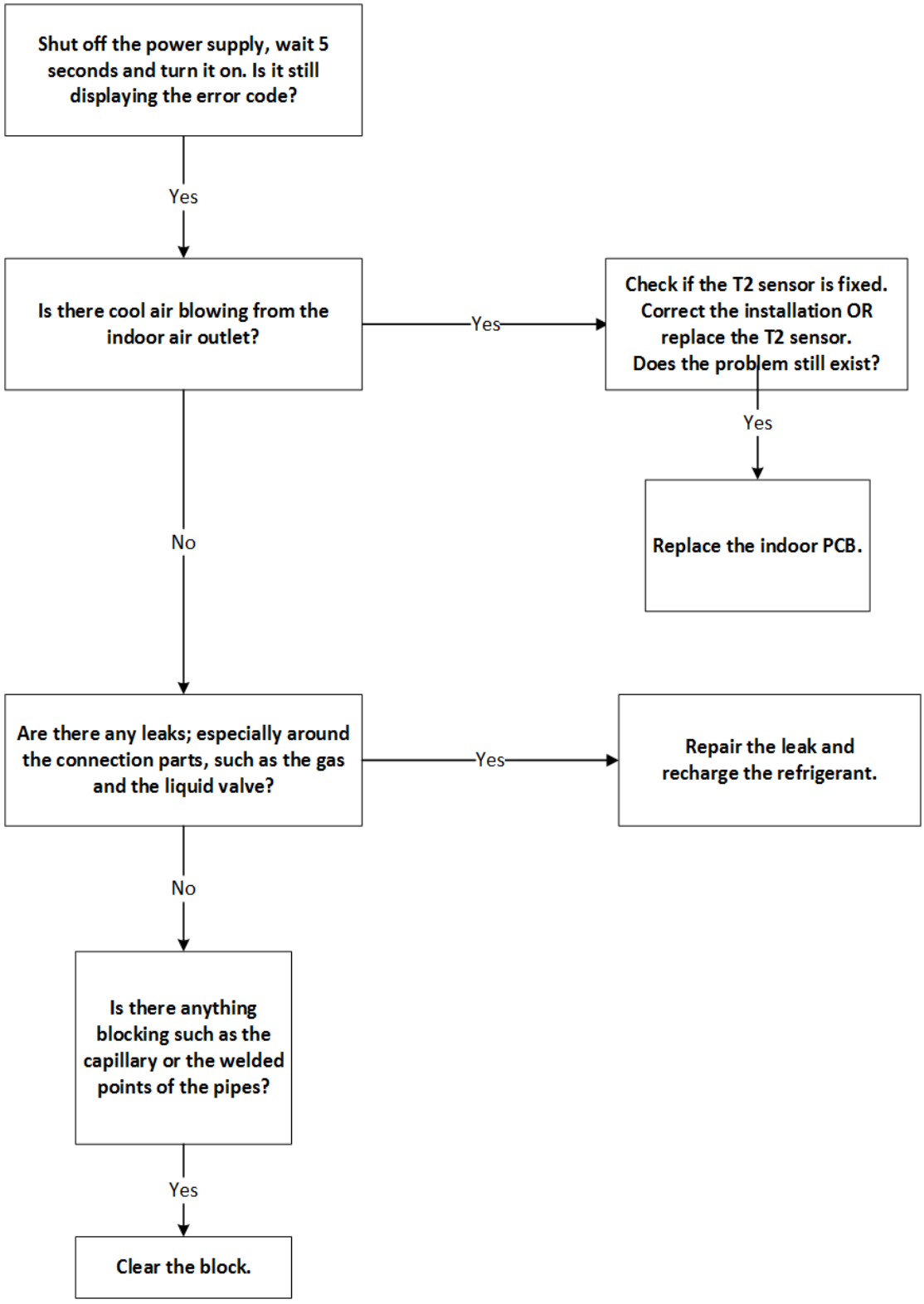


Fig. 34 – Test

Refrigerant Leakage Detection Diagnosis and Solution (EC)

Error Code	EC
Malfunction decision conditions	Define the evaporator coil temp.T2 of the compressor just starts running as Tcool. At the start, 5 minutes after the compressor starts up, if T2 <Tcool−35.6° F(Tcool−2° C) is not consistent for 4 seconds and this issue occurs 3 times, the display area will display "**EC**" and air conditioner will turn off.
Supposed causes	• T2 sensor faulty • Indoor PCB faulty • System problems, such as leakage or blocking

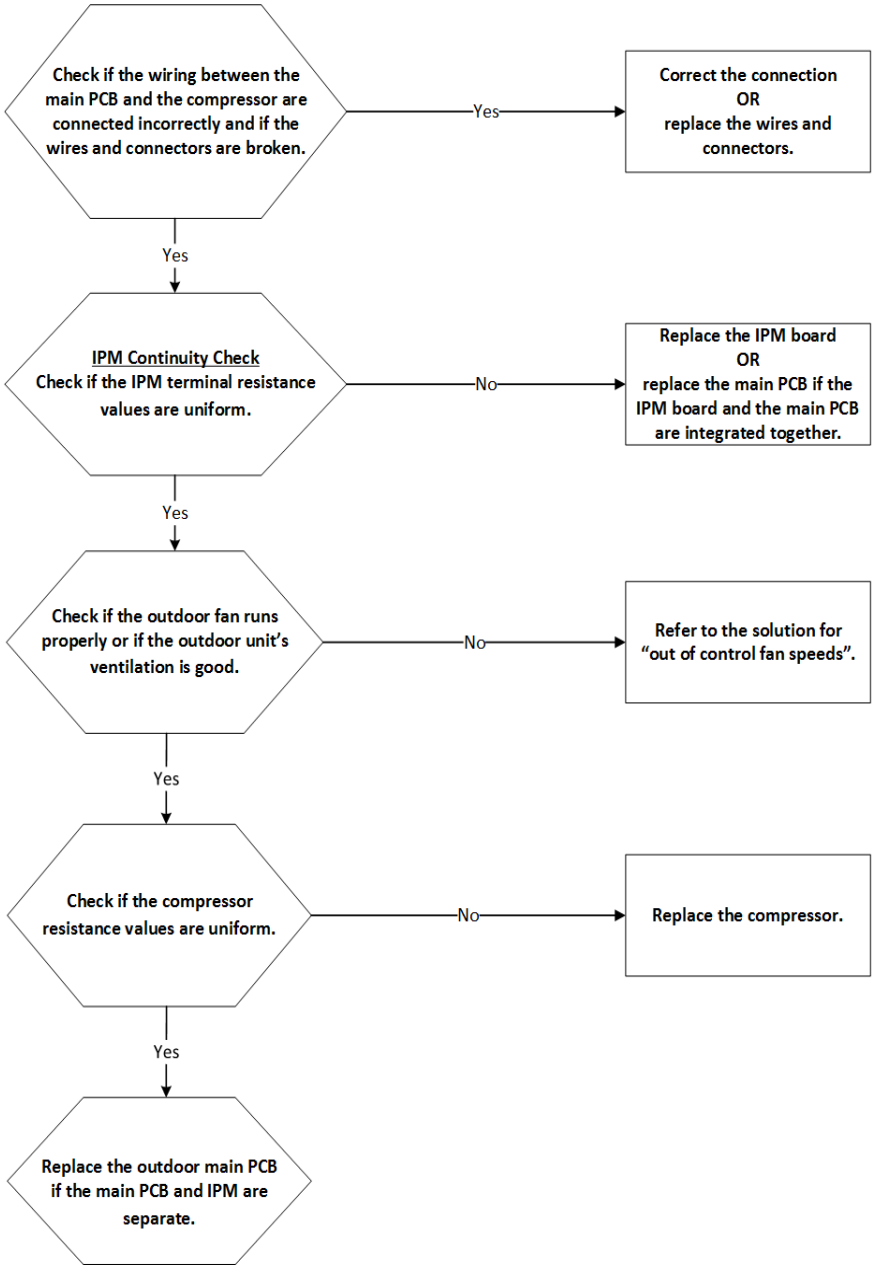
Troubleshooting



IPM Malfunction or IGBT Over−strong Current Protection Diagnosis and Solution (PO)

Error Code	PO
Malfunction decision conditions	When the voltage signal that IPM sends to the compressor drive chip is abnormal, the LED display displays "**PO**" and the air conditioner turns off.
Supposed causes	• Wiring mistake • IPM malfunction • Outdoor fan assembly faulty • Compressor malfunction • Outdoor PCB faulty

Troubleshooting



NOTE: In figures 35−40 the following is observed:

- U,V,W references compressor connection point
- P references input voltage
- N references output voltage

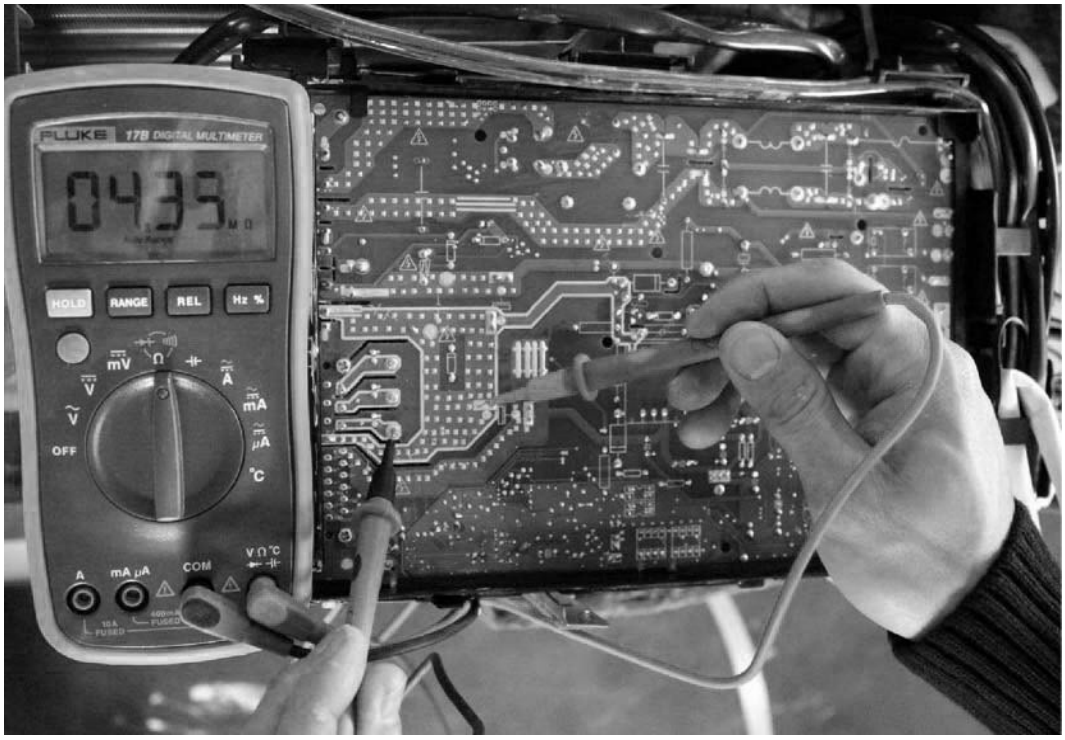


Fig. 35 – P−U

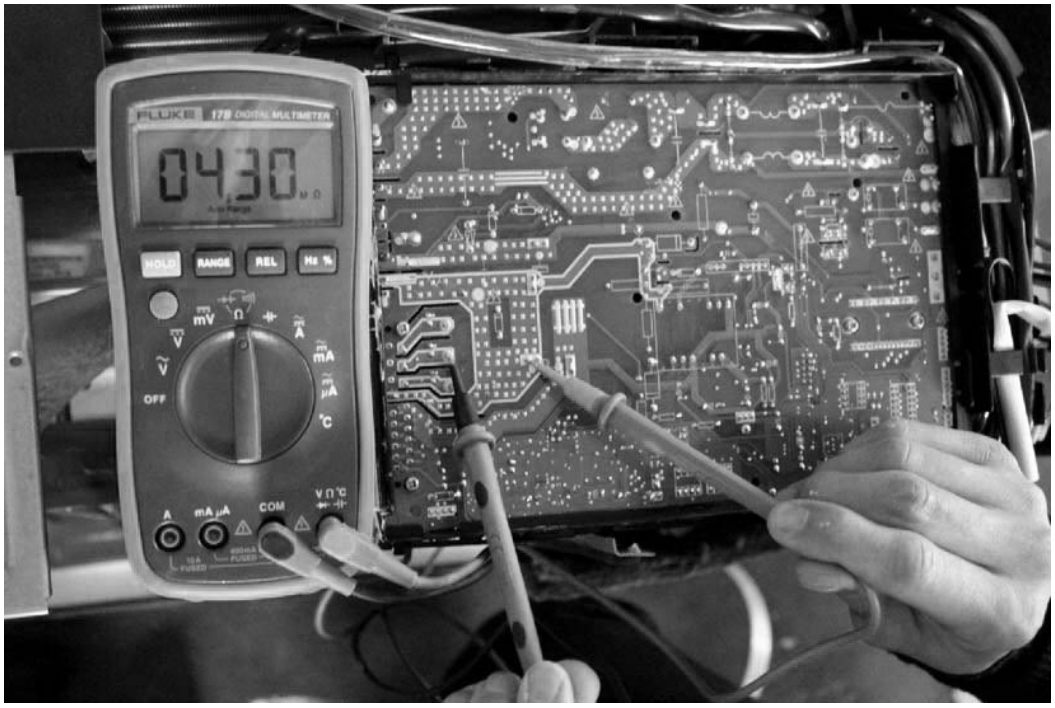


Fig. 36 – P−V

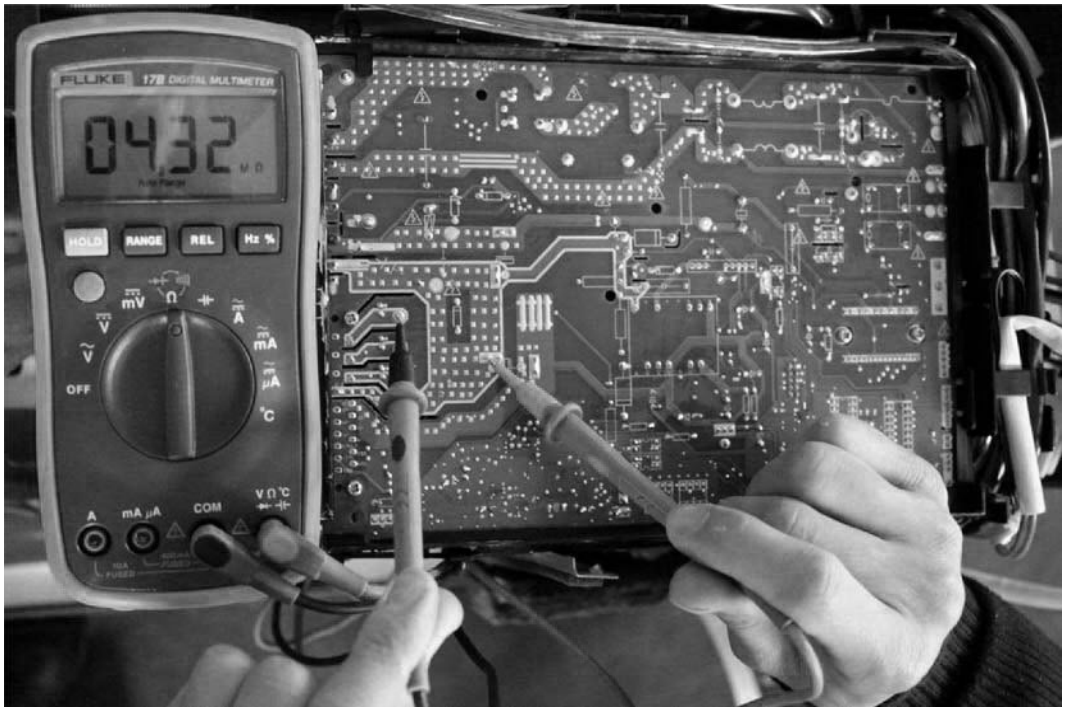


Fig. 37 – P−W

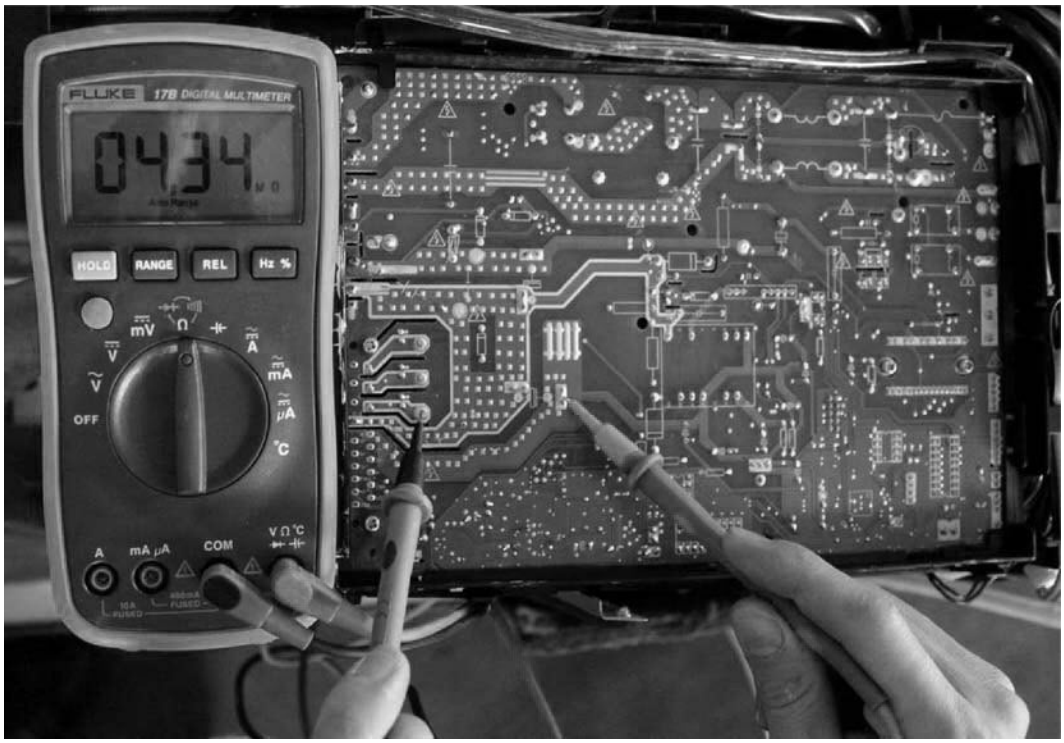


Fig. 38 – N−U

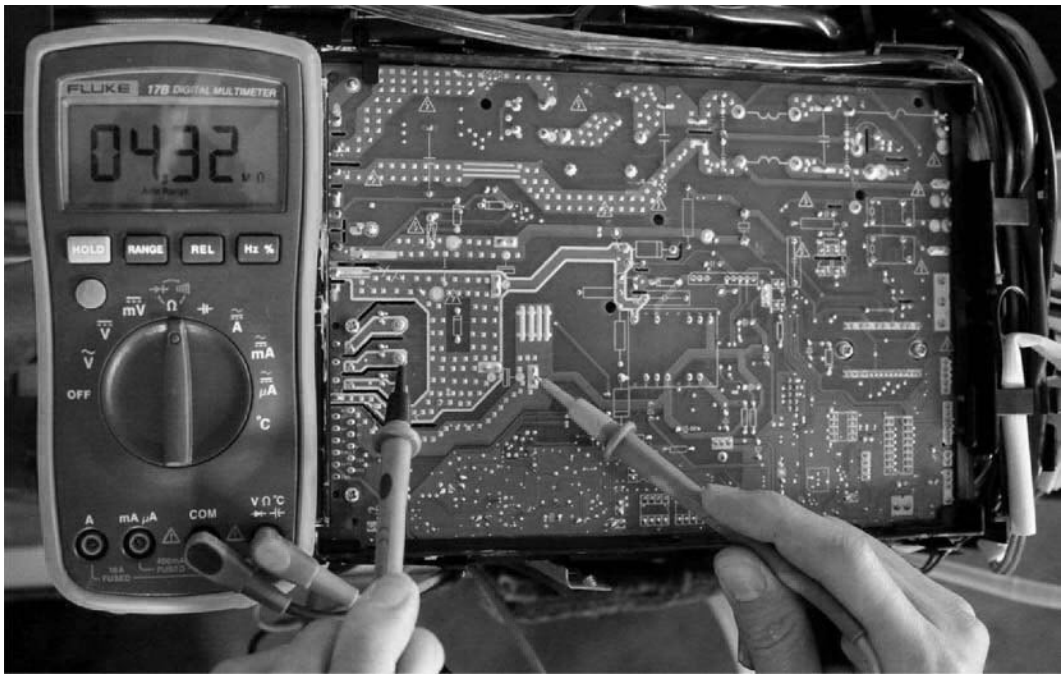


Fig. 39 – N−V

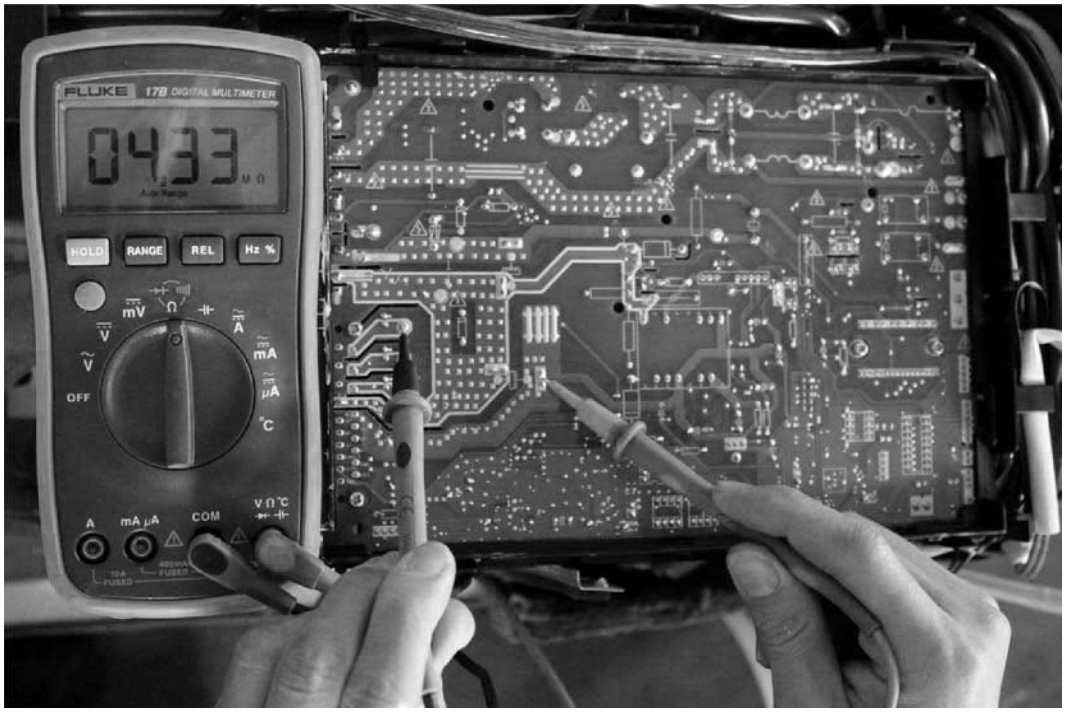
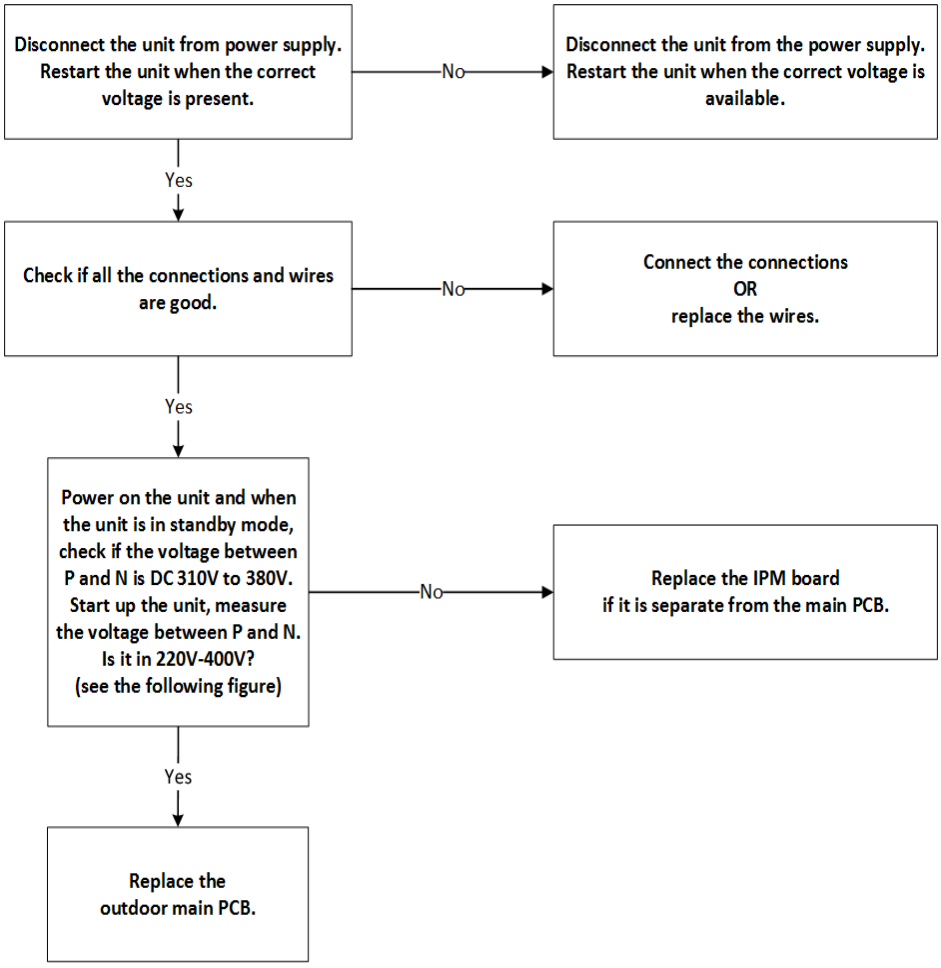


Fig. 40 – N−W

Over Voltage or Too Low Voltage Protection Diagnosis and Solution (P1)

Error Code	P1
Malfunction decision conditions	An abnormal voltage rise or drop is detected by checking the specified voltage detection circuit.
Supposed causes	• Power supply problems • System leakage or block • PCB faulty

Troubleshooting:



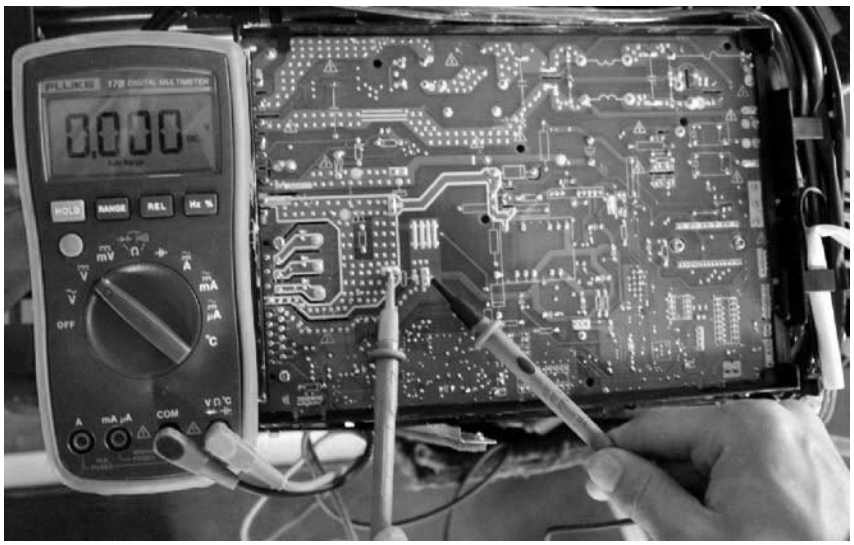


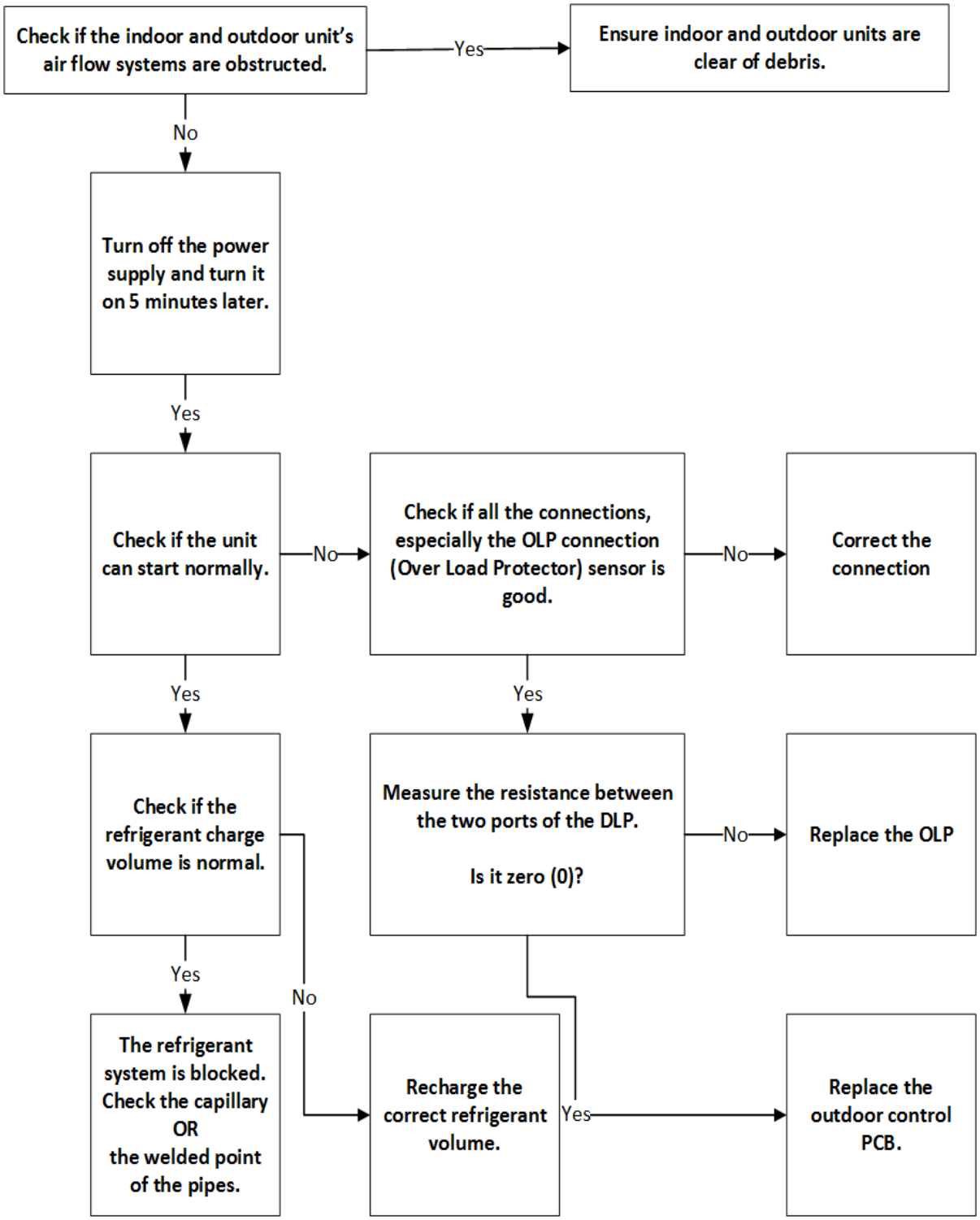
Fig. 41 – Test

NOTE: Measure the DC voltage between the P and N ports. The normal value should be around 310V.

High Temperature Protection of Compressor Top Diagnosis and Solution (P2)

Error Code	P2
Malfunction decision conditions	If the sampling voltage is not 5V, the LED displays the failure.
Supposed causes	• Power supply problems • System leakage or block • PCB faulty

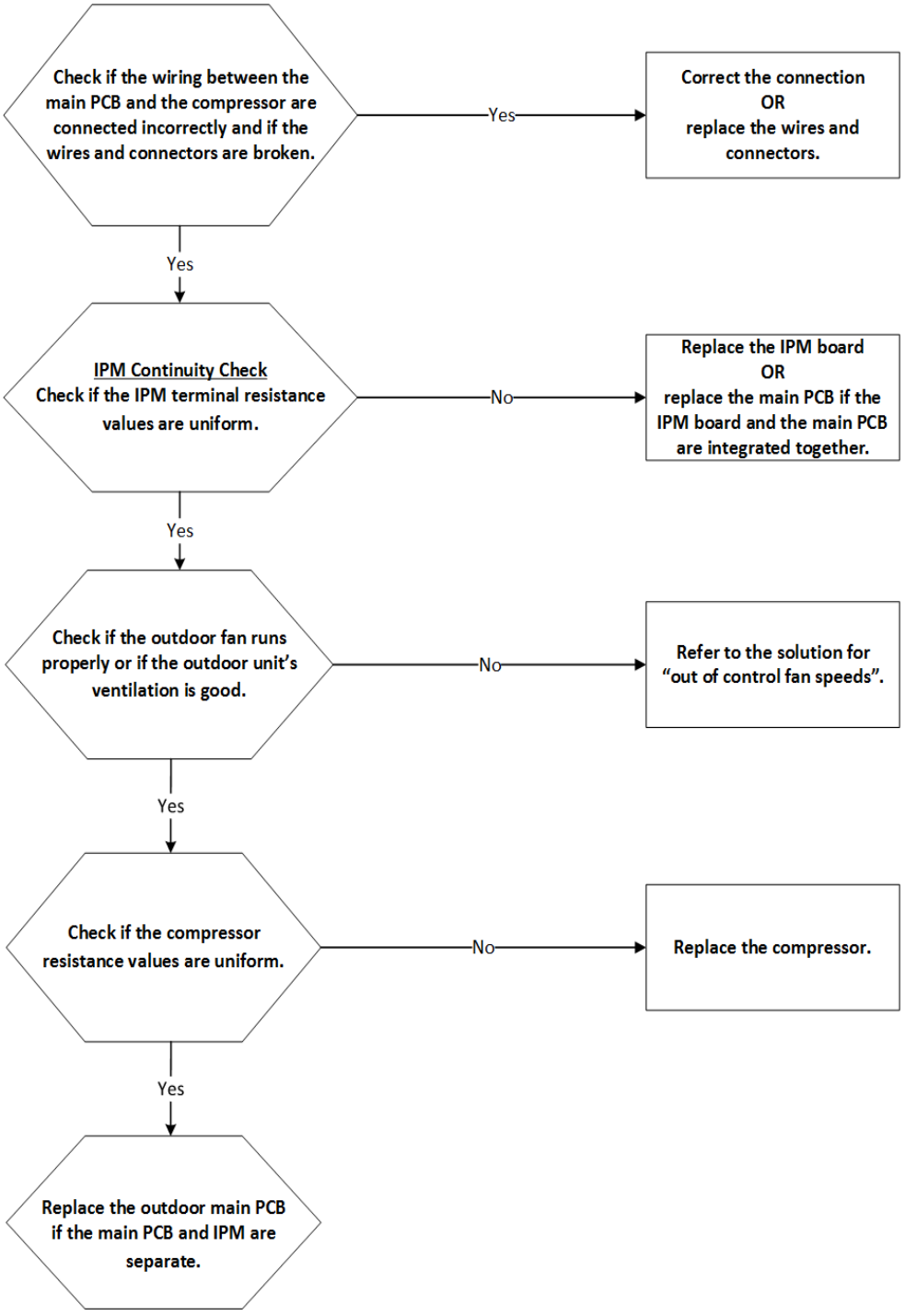
Troubleshooting



Inverter Compressor Drive Error Diagnosis and Solution (P4)

Error Code	P4
Malfunction decision conditions	An abnormal inverter compressor drive is detected by a special detection circuit, including communication signal detection, voltage detection and compressor rotation speed signal detection.
Supposed causes	• Wiring mistake • IPM malfunction • Outdoor fan assembly fault • Compressor malfunction • Outdoor PCB faulty

Troubleshooting



Main Parts Check

1. Temperature sensor checking

   Disconnect the temperature sensor from PCB, measure the resistance value with a tester.

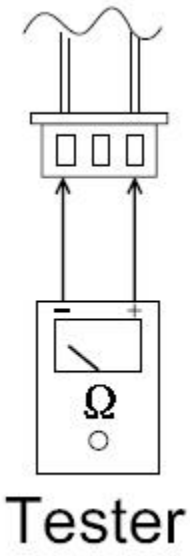


Fig. 42 – Tester

Temperature sensors.

- Room temp.
- (T1) sensor, Indoor coil temp.
- (T2) sensor, Outdoor coil temp.
- (T3) sensor, Outdoor ambient temp.
- (T4) sensor, Compressor discharge temp.
- (T5) sensor. Measure the resistance value of each winding by using the multi−meter.

Compressor Checking

Measure the resistance value of each winding by using the tester.

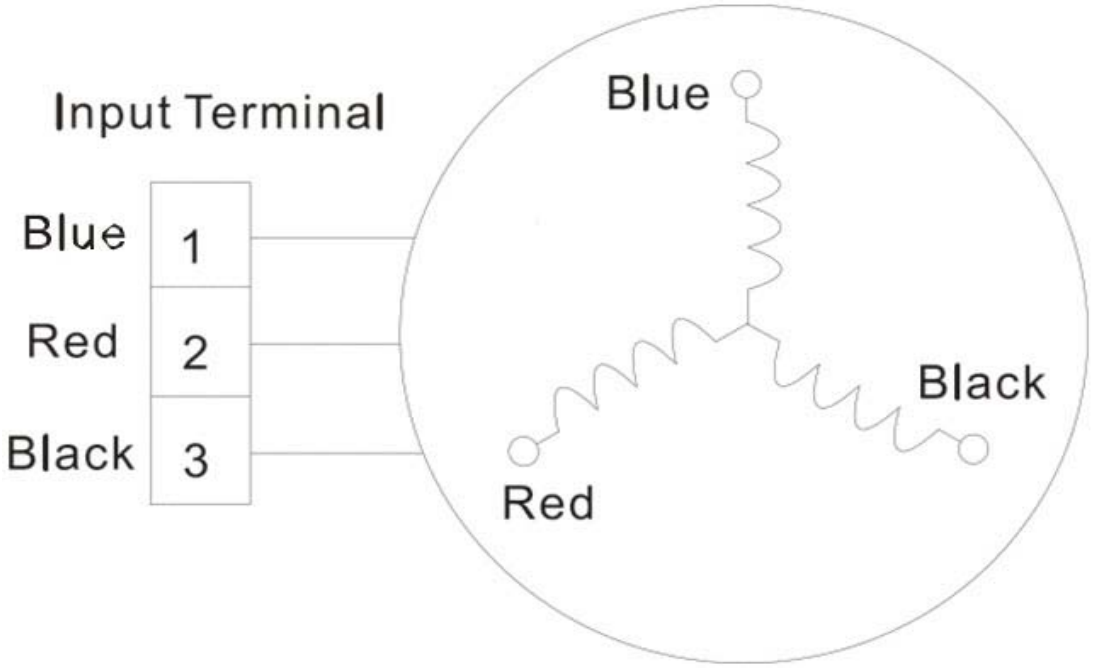


Fig. 43 – Tester

Table 21—Tester

Position	Resistance Value				
	ASM98D32UFZ	ATM115D43UFZ2	ATM150D23UFZ	ATF235D22UMT	ATF250D22UMT
Blue - Red Blue - Black Red - Blue	2.25Ω (68°F/20°C)	1.87Ω (68°F/20°C)	1.72Ω (68°F/20°C)	0.75Ω (68°F/20°C)	0.75Ω (68°F/20°C)

Fig. 44 – Compressor Checking

IPM Continuity Check

Turn off the power, let the large capacity electrolytic capacitors discharge completely, and dismount the IPM. Use a digital tester to measure the resistance between P and UVWN; UVW and N.

Table 22—IPM Continuity Check

Digital Tester		Normal Resistance Value	Digital Tester		Normal Resistance Value
(+)Red	(-)Black		(+)Red	(-)Black	
P	N	∞ (Several MΩ)	U	N	∞ (Several MΩ)
	U		V		
	V		W		
	W		(+)Red		

Indoor AC Fan Motor

Measure the resistance value of each winding by using the tester.

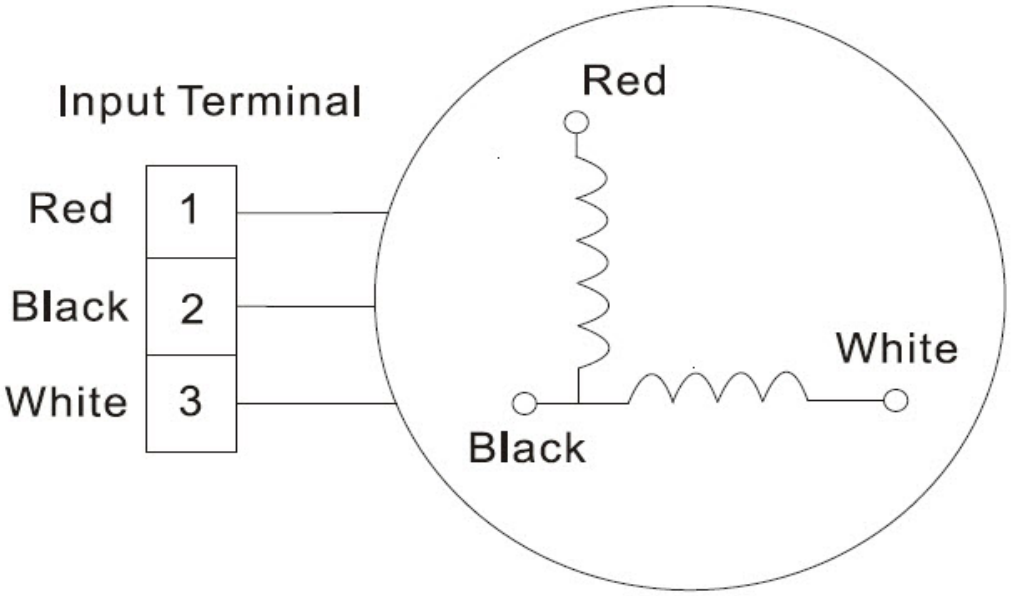


Fig. 45 – Indoor AC Fan Motor

Table 23—Resistance Value

Terminal	Resistance Value	
Black - Red	100.5Ω±8% (20°C /68°F) (Brand: Weiling)	100Ω±8% (20°C /68°F) (Brand: Dayang)
White - Black	64.5Ω±8% (20°C /68°F) (Brand: Weiling)	68.5Ω±8% (20°C /68°F) (Brand: Dayang)

Pressure on Service Port

Table 24—Cooling Chart

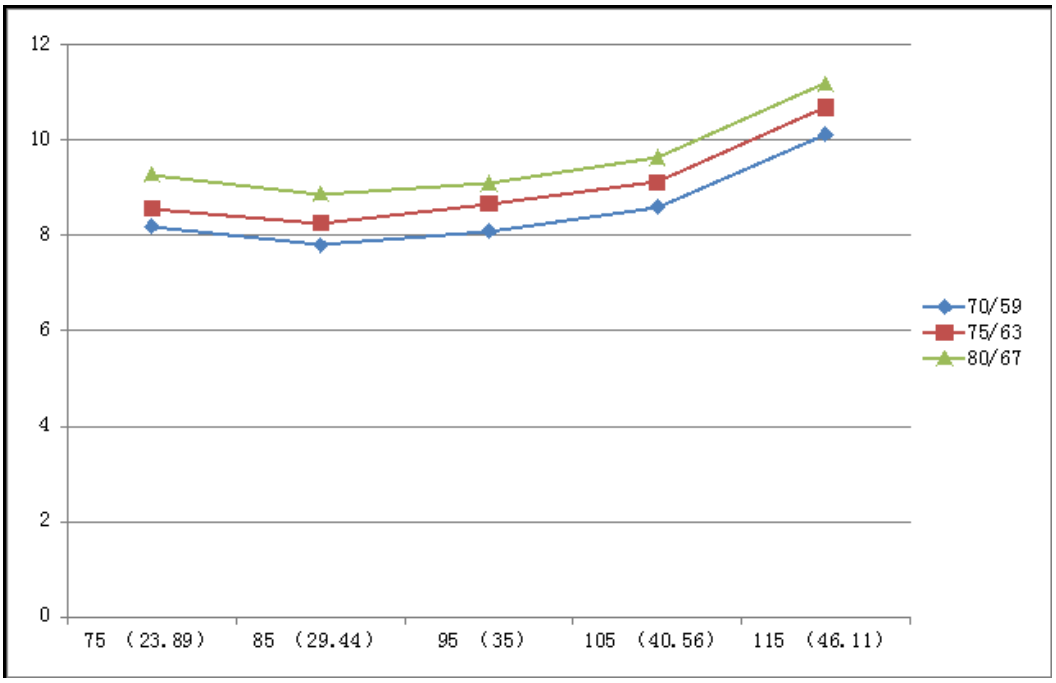
F° (C°)	IDT / ODT	75 (23.89)	85 (29.44)	95 (35)	105 (40.56)	115 (46.11)
BAR	70/59	8.2	7.8	8.1	8.6	10.1
BAR	75/63	8.6	8.3	8.7	9.1	10.7
BAR	80/67	9.3	8.9	9.1	9.6	11.2

Table 25—Cooling Chart

F° (C°)	IDT / ODT	75 (23.89)	85 (29.44)	95 (35)	105 (40.56)	115 (46.11)
PSI	70/59	119	113	117	125	147
PSI	75/63	124	120	126	135	155
PSI	80/67	135	129	132	140	162

Table 26—Cooling Chart

F° (C°)	IDT / ODT	75 (23.89)	85 (29.44)	95 (35)	105 (40.56)	115 (46.11)
MPA	70/59	0.82	0.78	0.81	0.86	1.01
MPA	75/63	0.86	0.83	0.87	0.91	1.07
MPA	80/67	0.93	0.89	0.91	0.96	1.12



Pressure on Service Port (Cont)

Table 27—Heating Chart

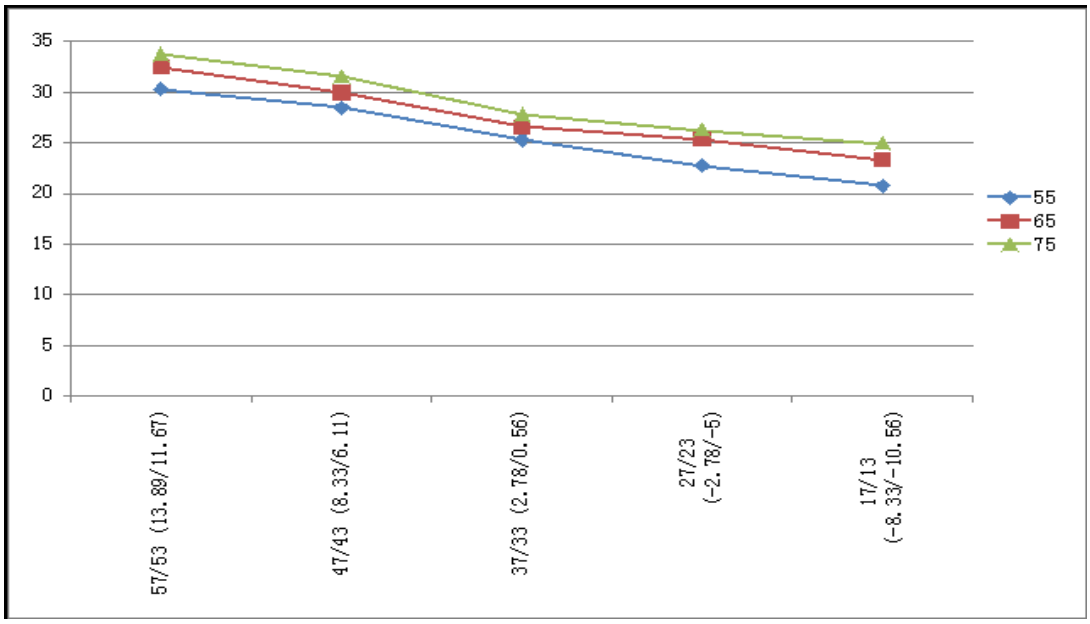
F° (C°)	IDT / ODT	57/53 (13.89/11.67)	47/43 (8.33/6.11)	37/33 (2.78/0.56)	27/23 (−2.78/−5)	17/13 (−8.33/−10.56)
BAR	55	30.3	28.5	25.3	22.8	20.8
BAR	65	32.5	30.0	26.6	25.4	23.3
BAR	75	33.8	31.5	27.8	26.3	24.9

Table 28—Heating Chart

F° (C°)	IDT / ODT	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)
PSI	55	439	413	367	330	302
PSI	65	471	435	386	368	339
PSI	75	489	457	403	381	362

Table 29—Heating Chart

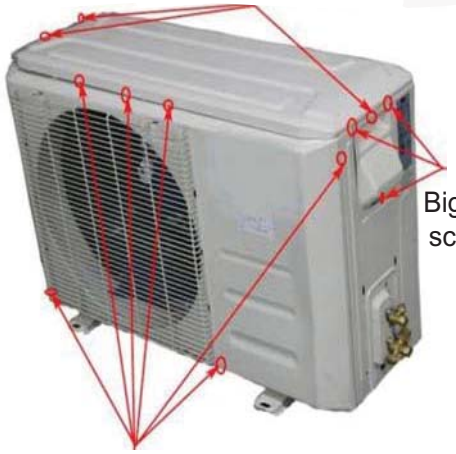
F° (C°)	IDT / ODT	57/53 (13.89/11.67)	47/43 (8.33/6.11)	37/33 (2.78/0.56)	27/23 (−2.78/−5)	17/13 (−8.33/−10.56)
MPA	55	3.03	2.85	2.53	2.28	2.08
MPA	65	3.25	3.00	2.66	2.54	2.33
MPA	75	3.38	3.15	2.78	2.63	2.49



DISASSEMBLY INSTRUCTIONS

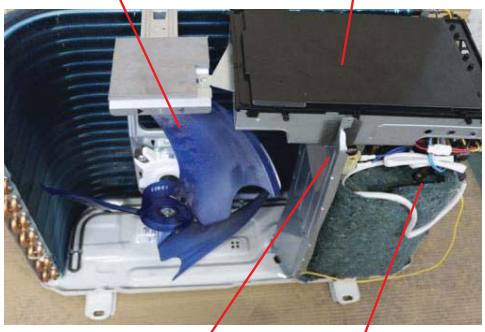
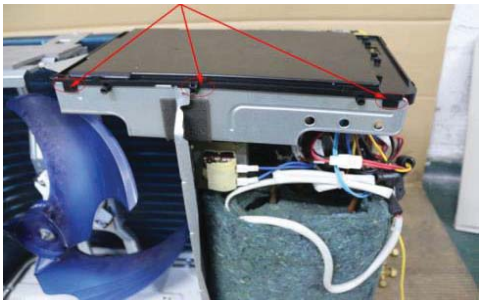
Outdoor Unit Sizes 9−12K (115V)

NOTE: This part is for reference only and the photos may differ from your actual unit.

No.	Part Name	Procedures	Remarks
1.	Panel Plate	Remove the Panel Plate 1. Stop the air conditioner operation and turn off the power breaker. 2. Remove the big handle. Next, remove the top cover screws (3). 3. Remove the front panel screws (6). 4. Remove the right side panel screws (6).	Top panel screws (3). 1 screw under the big handle  Big handle screws (3) Front panel screws (6) 

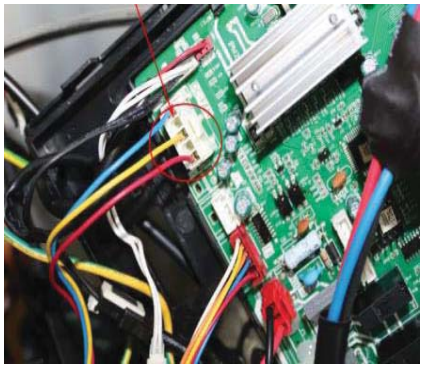
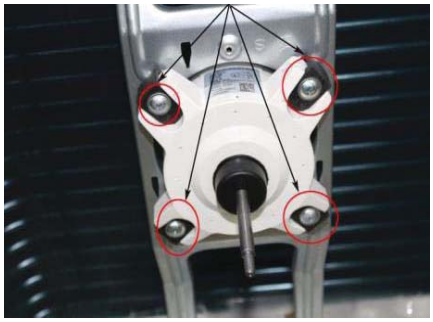
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (115V) (Cont)

No.	Part Name	Procedures	Remarks
2.	Fan Assembly	Remove the Fan Assembly 1. After removing the panel plate (see step 1) proceed to step 2. 2. Remove the nut securing the fan and remove the fan. 3. Disconnect the hooks. Open the electronic box cover.	Fan Assembly Electronic Control Box  Reactor Compressor and liquid gas separator  

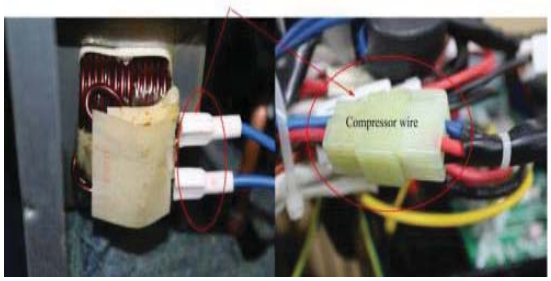
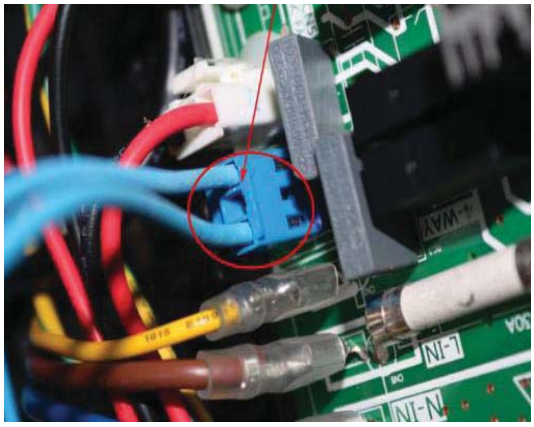
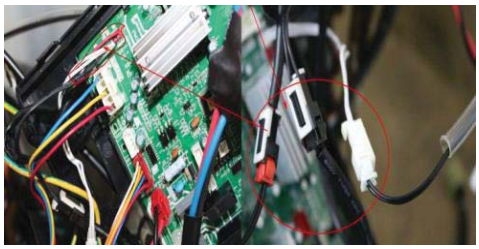
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (115V) (Cont)

No.	Part Name	Procedures	Remarks
	Fan Assembly	Remove the Fan Assembly 4. Disconnect the fan motor connector from the electronic control board.	 
		5. Remove the fan motor screws (4), then remove the motor.	

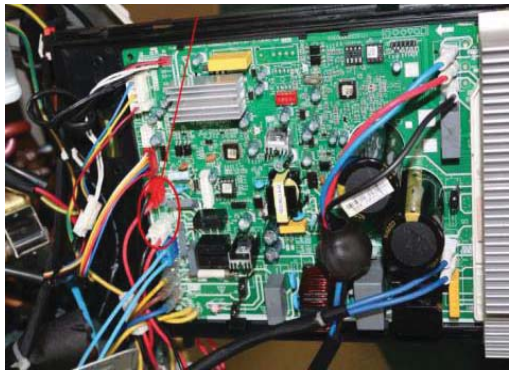
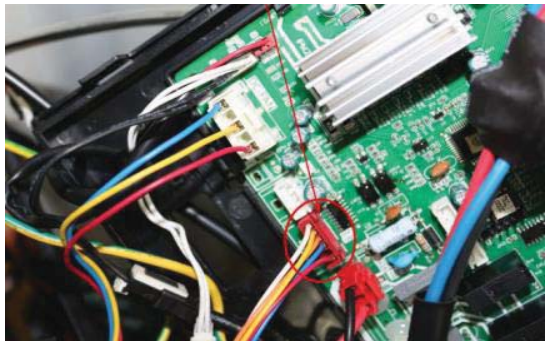
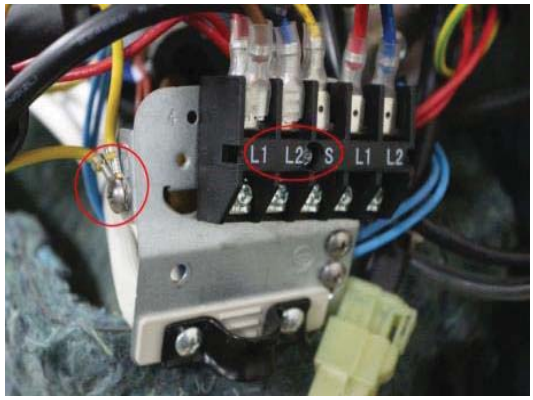
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (115V) (Cont)

No.	Part Name	Procedures	Remarks
3.	Electrical Parts	Remove the Electrical Parts 1. After steps 1 and 2 are complete, remove the two connectors for the compressor and the reactors.	
		2. Pull out the two blue wires connected with the 4-way valve.	
		3. Pull out the connectors: compressor top temp. sensor, condensor coil temp (T3), outdoor ambient temp. sensor (T4) and discharge temp. sensor (T5).	

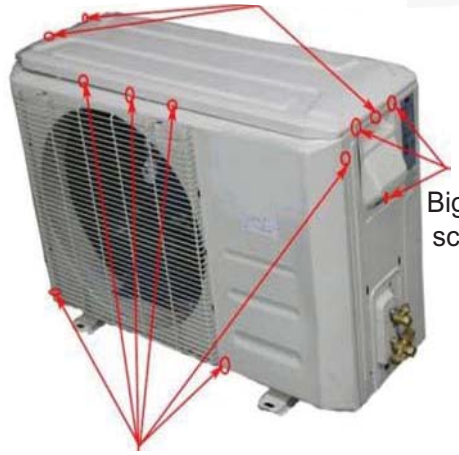
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (115V) (Cont)

No.	Part Name	Procedures	Remarks
	Electrical Parts	Remove the Electrical Parts 4. Disconnect the compressor crankcase heater connection.	
		5. Disconnect the electronic expansion valve wire from the control board.	
		6. Remove the ground wires. 7. Remove the power supply wires (L1,L2,S). 8. Remove the electronic control box.	

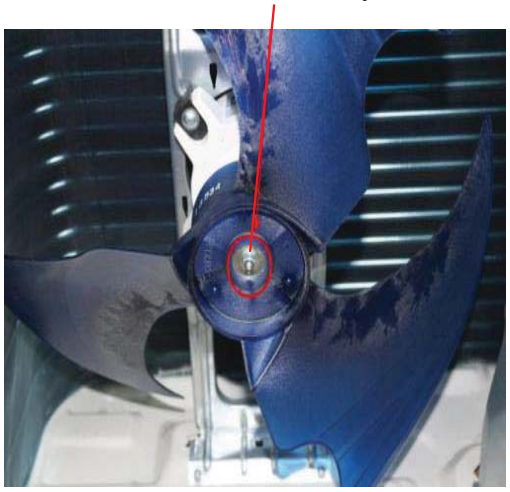
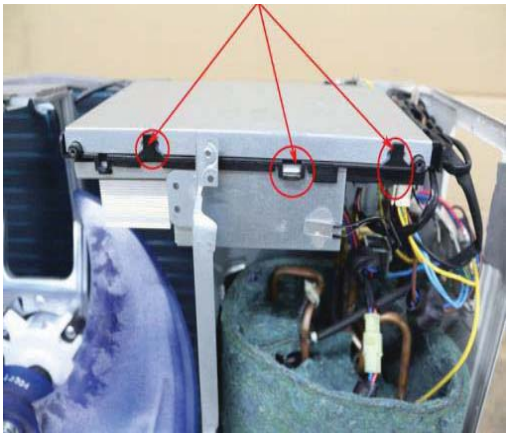
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (208−230V)

No.	Part Name	Procedures	Remarks
1.	Panel Plate	Remove the Panel Plate 1. Stop the air conditioner operation and turn off the power breaker. 2. Remove the big handle. Next, remove the top cover screws (3). 3. Remove the front panel screws (6). 4. Remove the right side panel screws (8).	Top panel screws (3). 1 screw under the big handle  Big handle screws (3) Front panel screws (6) 

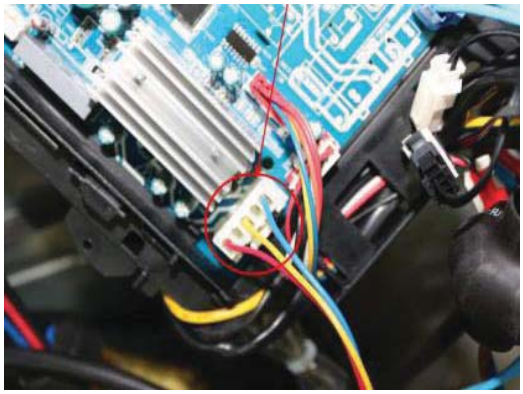
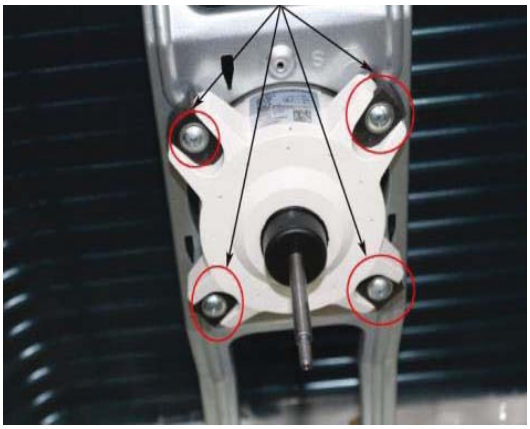
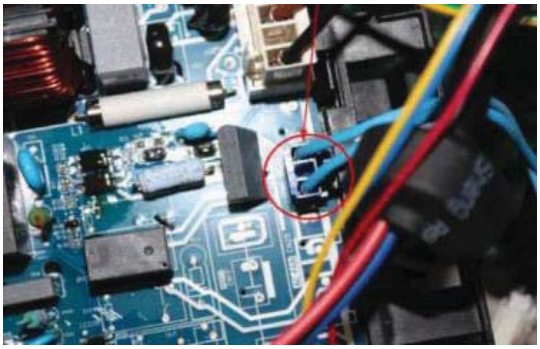
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
2.	Fan Assembly	Remove the Fan Assembly 1. After removing the panel plate remove the hex nut securing the fan. Next, remove the fan. 2. Remove the hooks and open the electronic control box cover.	Fan Assembly   

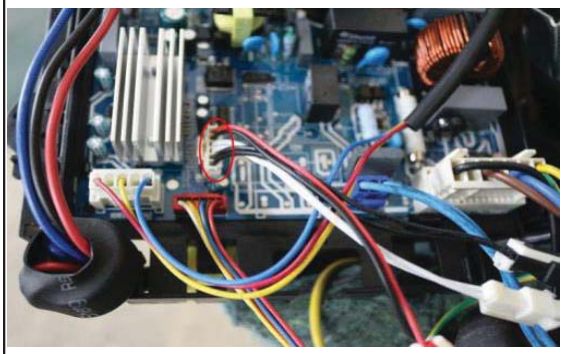
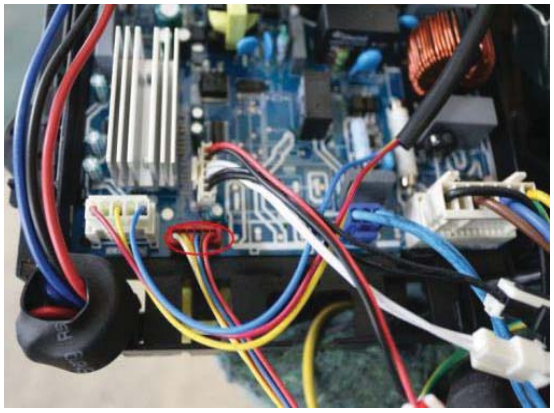
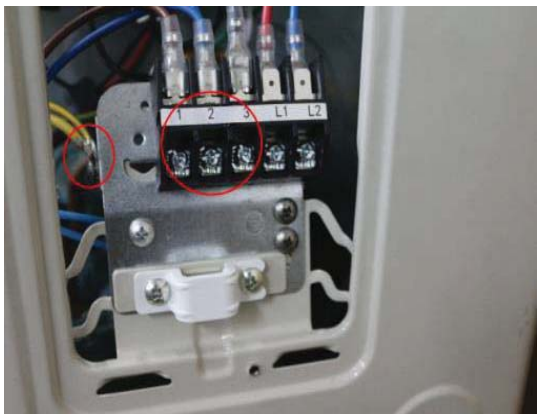
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Fan Assembly	Remove the Fan Assembly 3. Disconnect the fan motor from the electronic control board. 4. Remove the four fan motor screws. 5. Next, remove the fan motor.	 
3.	Electrical parts	Remove the electrical parts 1. After completing removal steps 1 and 2, remove the compressor connections. 2. Pull out the two blue wires connected to the 4-way valve.	 

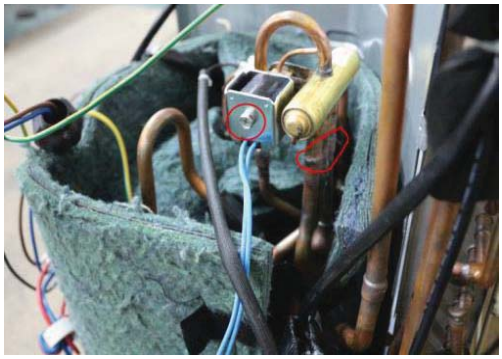
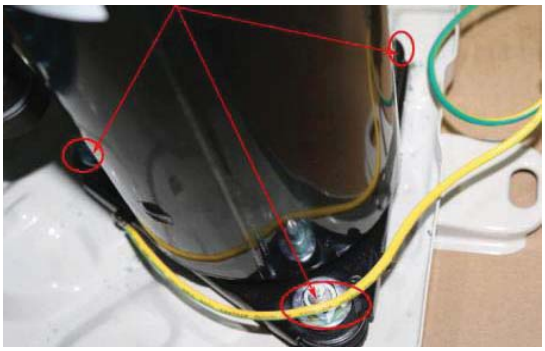
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Electrical parts	Remove the Fan Assembly 3. Remove the compressor connectors top temp. sensor, condenser coil temp. sensor (T3), outdoor ambient temp. sensor (T4) and discharge temp. sensor (T5). 4. Disconnect the electronic expansion valve wire. 5. Remove the grounding screw. 6. Remove the power supply wires (L1,L2,S). 7. Remove the electronic control box.	  

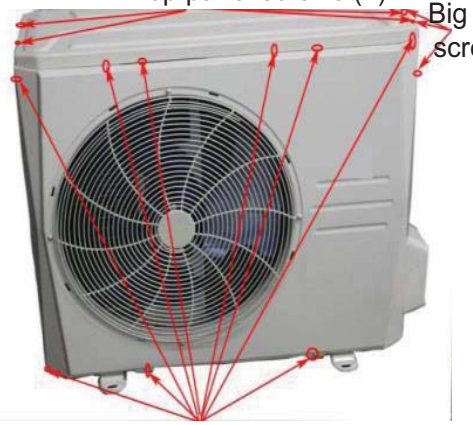
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 9−12K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
4.	4-way valve	Remove the 4-way valve 1. Complete removal steps 1-3. 2. Recover the refrigerant from the refrigerant circuit. 3. Remove the coil screw and remove the coil. 4. Detach the 4-way assembly and pipe's welded parts. 5. Remove the 4-way valve assembly.	This image of the 4-way valve may differ from your actual part. 
5.	Compressor	Remove the compressor 1. Complete removal steps 1- 4. 2. Remove the discharge and suction pipes with a burner. 3. Remove the hex nuts and washers that secure the compressor to the bottom plate. 4. Lift the compressor from the base pan assembly.	 

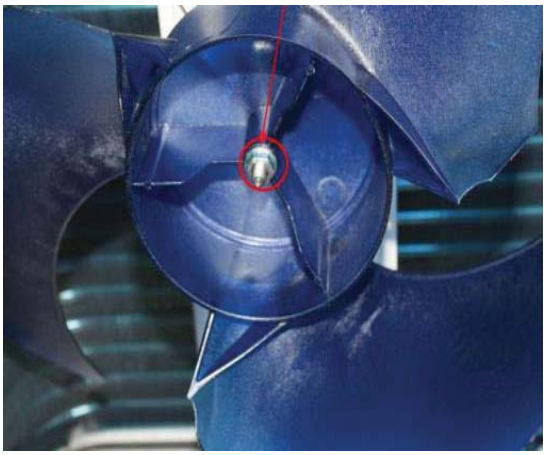
DISASSEMBLY INSTRUCTIONS

Outdoor Unit Sizes 18K (208−230V)

No.	Part Name	Procedures	Remarks
1.	Panel Plate	Remove the Panel Plate 1. Stop the air conditioner operation and turn off the power breaker. 2. Remove the top panel screws (7). 3. Remove the front panel screws (9). 4. Remove the right side panel screws (10).	Top panel screws (4). Big handle screws (3)  Front panel screws (9) 

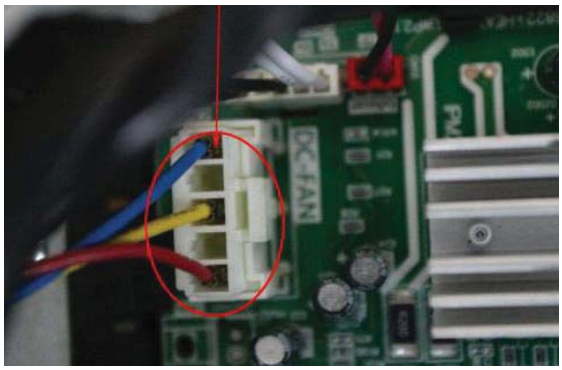
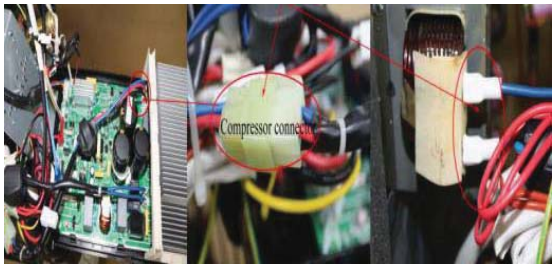
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 18K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
2.	Fan Assembly	Remove the Fan Assembly 1. After removing the panel plate remove the hex nut securing the fan. Next, remove the fan. 2. Release the hooks and open the electronic control box cover.	  

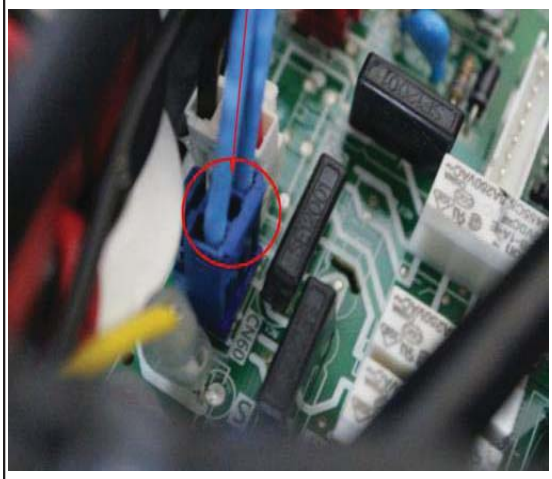
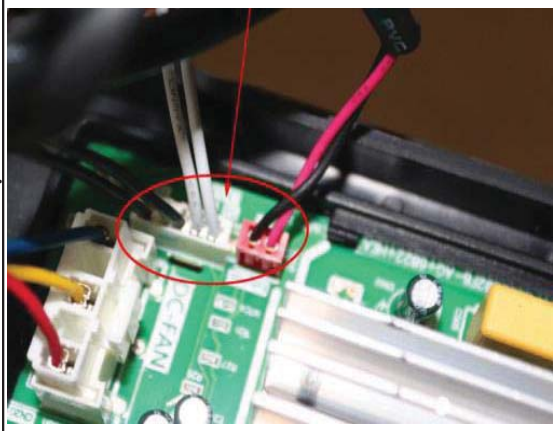
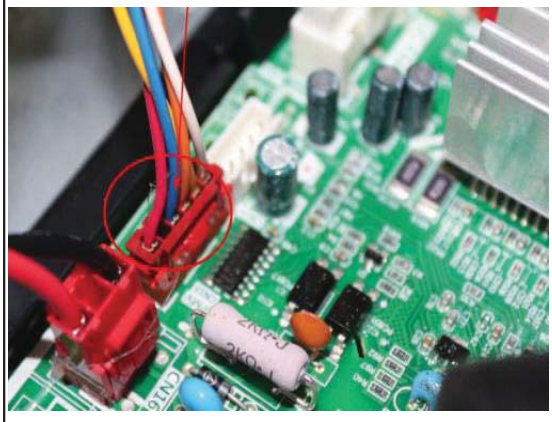
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 18K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Fan Assembly	Remove the Fan Assembly 3. Disconnect the fan motor connector from the electronic control board. 4. Remove the four fan motor screws. 5. Remove the fan motor.	 
2.	Electrical parts	Remove the electrical parts 1. After completing the prior steps, remove the compressor and reactor connectors.	

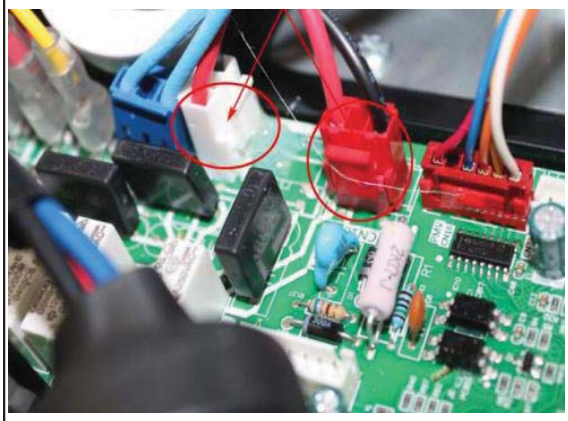
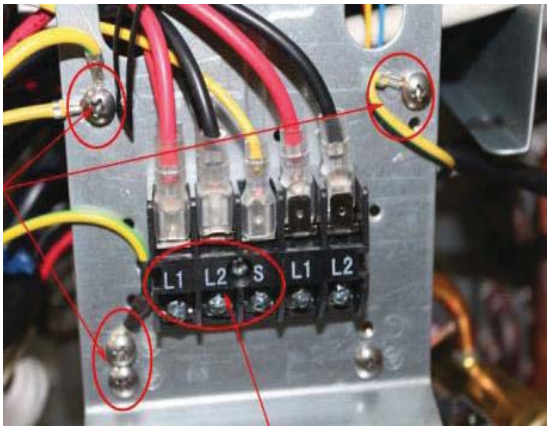
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 18K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Electrical parts	Remove the electrical parts 2. Remove the two blue wires connected with the 4 - way valve.	
		3. Remove the compressor top temp. sensor, condenser coil temp. sensor (T3), outdoor ambient temp. sensor (T4) and discharge temp. sensor (T5) connectors.	
		4. Disconnect the electronic expansion valve wire.	

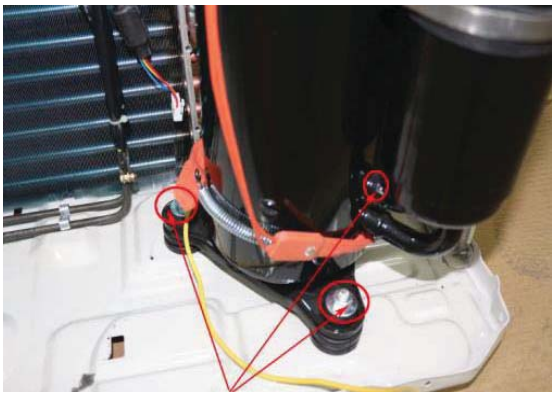
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 18K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Electrical parts	Remove the electrical parts 5. Remove the compressor crankcase electric heater.	
		6. Remove grounding screw. 7. Remove the power supply wires (L1,L2, S). 8. Remove the electronic control box.	

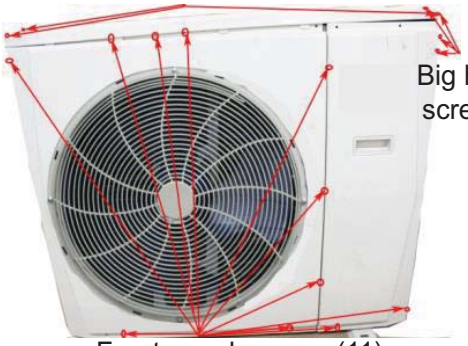
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 18K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
4.	4-way valve	Remove the 4-way valve 1. Complete the previous removal steps. 2. Recover the refrigerant from the refrigerant circuit. 3. Remove the coil screw and remove the coil. 4. Detach the welded parts of the 4-way valve and pipe. 5. Remove the 4-way valve assembly.	This 4-way valve picture may differ from the user's actual valve. 
5.	Compressor	Remove the compressor 1. Complete steps 1-3. 2. Remove the discharge and suction pipes with a burner. 3. Remove the hex nuts and washers securing the compressor to the bottom plate. 4. Lift the compressor from the base pan assembly.	 

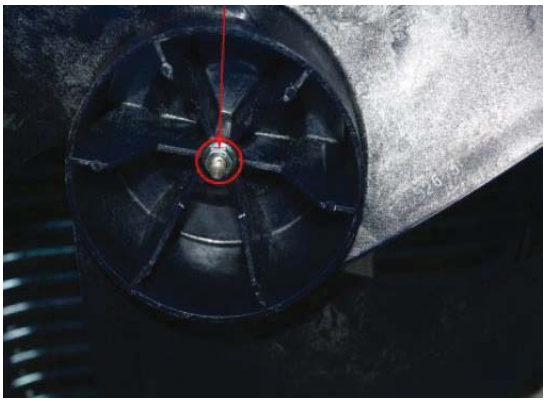
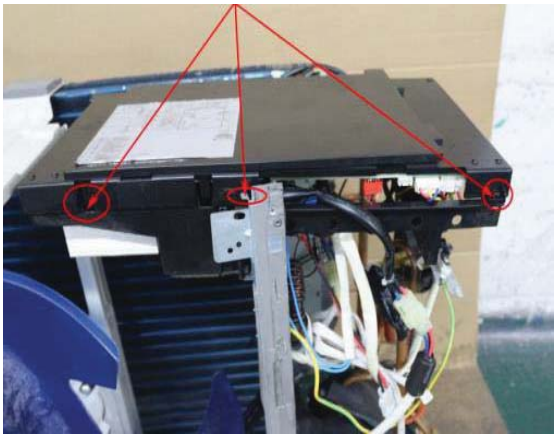
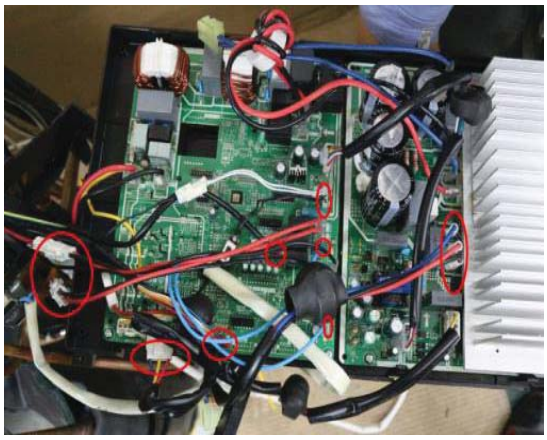
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 24K (208−230V)

No.	Part Name	Procedures	Remarks
1.	Panel Plate	Remove the Panel Plate 1. Stop the air conditioner operation and turn off the power breaker. 2. Remove the big handle. Next, remove the top panel screws (7). 3. Remove the front panel screws (11). 4. Remove the right side panel screws and remove the right side plate (12 screws).	Top panel screws (7).  Big handle screws (4) Front panel screws (11) 

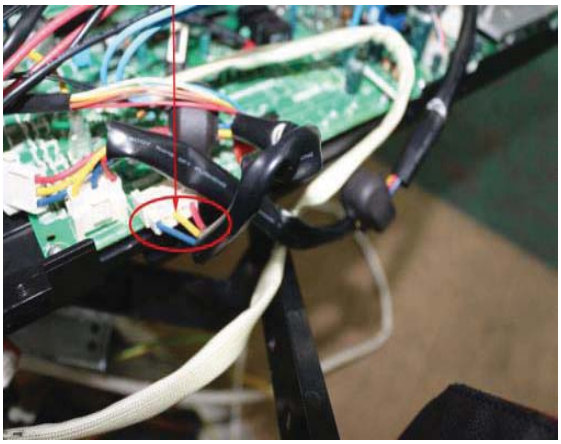
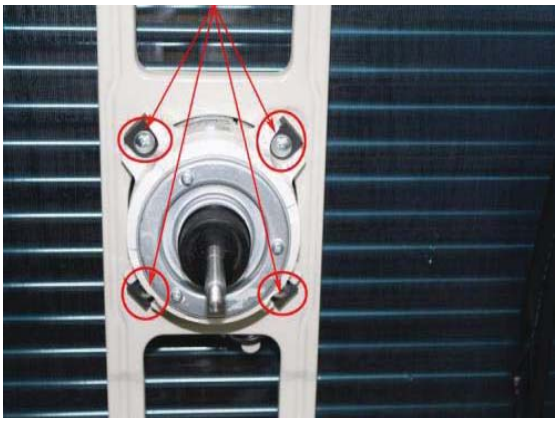
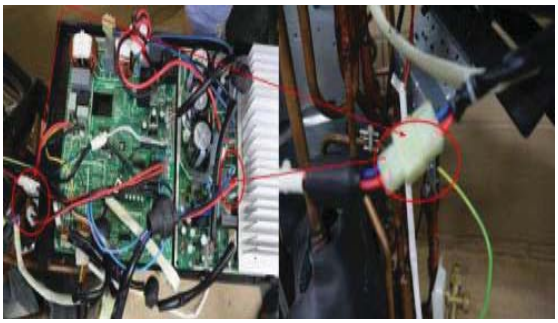
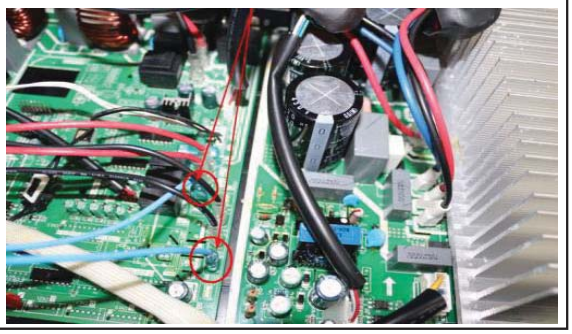
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 24K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
2.	Fan Assembly	Remove the Fan Assembly 1. After removing the panel plate remove the hex nut securing the fan and remove the fan. 2. Loosen the hooks and screws, then open the electronic control box cover.	  

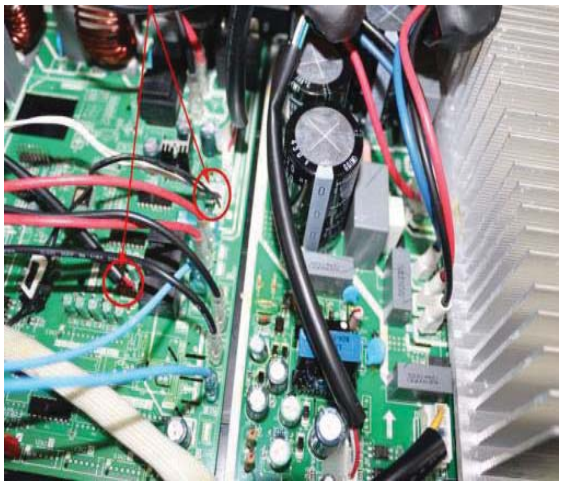
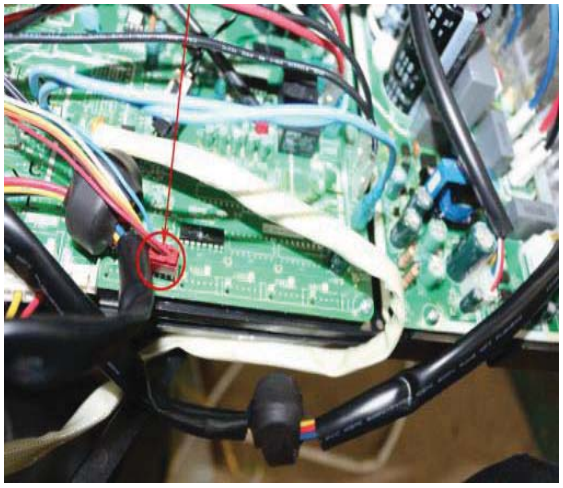
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 24K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Fan Assembly	Remove the Fan Assembly 3. Disconnect the fan motor connector from the electronic control board. 4. Remove the four fan motor screws. 5. Remove the fan motor.	 
3.	Electrical parts	Remove the electrical parts 1. After completing steps 1 and 2, remove the three connectors for the compressor, the compressor crankcase heater, and the electric heater. 2. Pull out the two blue wires connected with the 4-way valve.	 

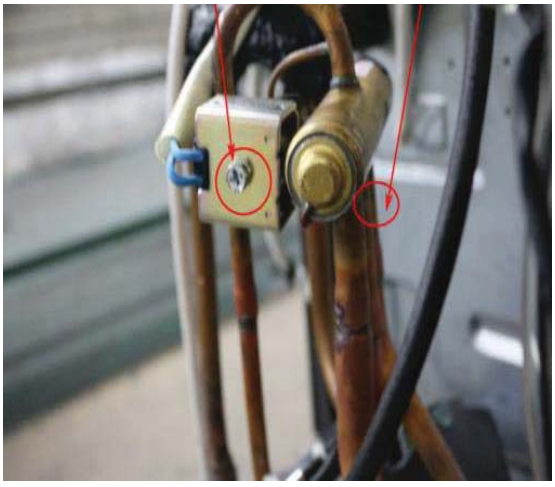
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 24K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Electrical parts	Remove the electrical parts	
		3. Remove the compressor top temp. sensor, condenser coil temp. sensor (T3), outdoor ambient temp. sensor (T4) and the discharge temp. sensor (T5) connectors.	
		4. Disconnect the electronic expansion valve wire from the control board.	
		5. Remove the grounding screw.	
		6. Remove the supply wires (L1, L2, S).	
		7. Remove the electronic control box.	

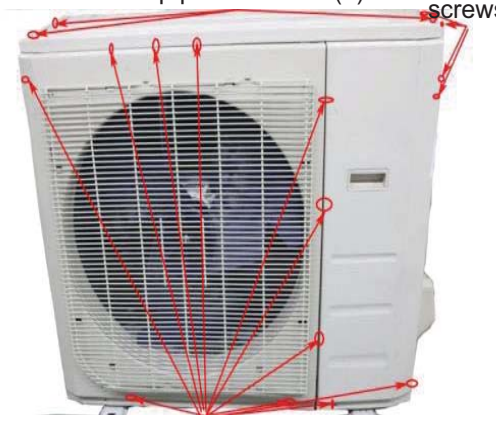
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 24K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
4.	4-way valve	Remove the 4-way valve 1. Complete the removal steps 1-3. 2. Recover the refrigerant from the refrigerant circuit. 3. Remove the coil screw and remove the coil. 4. Detach the welded parts of the 4-way valve and pipe. 5. Remove the 4-way valve assembly.	The picture of four-way valve may differ from your the valve. 
5.	Compressor	Remove the compressor 1. Complete the removal steps 1-3. 2. Remove the discharge and suction pipes with a burner. 3. Remove the hex nuts and washers securing the compressor on the bottom plate. 4. Lift the compressor from the base pan assembly.	 

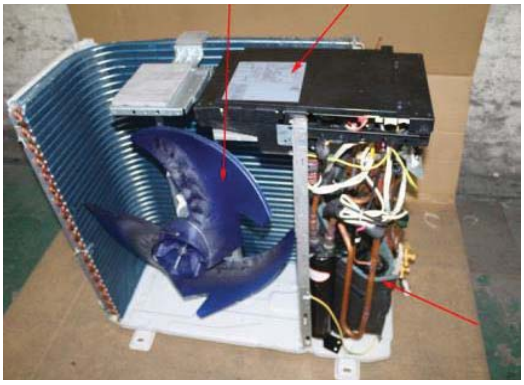
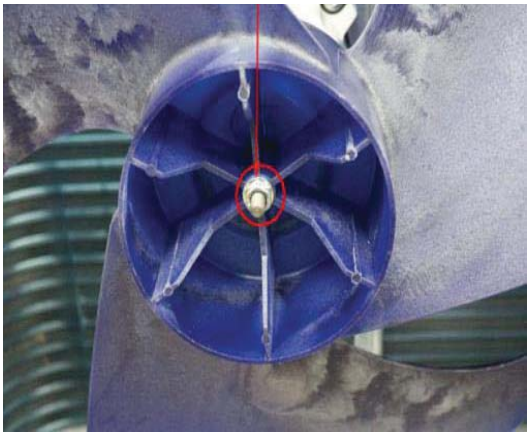
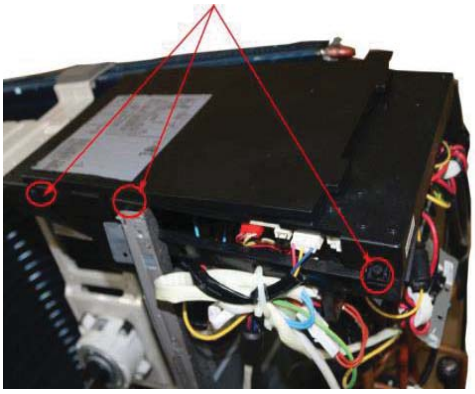
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 30−36K (208−230V)

No.	Part Name	Procedures	Remarks
1.	Panel Plate	Remove the Panel Plate 1. Stop the air conditioner operation and turn off the power breaker. 2. Remove the big handle. Next, remove the top panel screws (7). 3. Remove the front panel screws (11). 4. Remove the right side panel screws and remove the right side plate (13 screws).	Top panel screws (7). Big handle screws (4)  Front panel screws (11) 

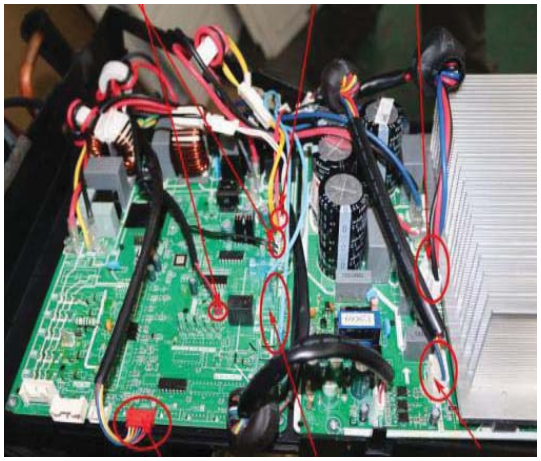
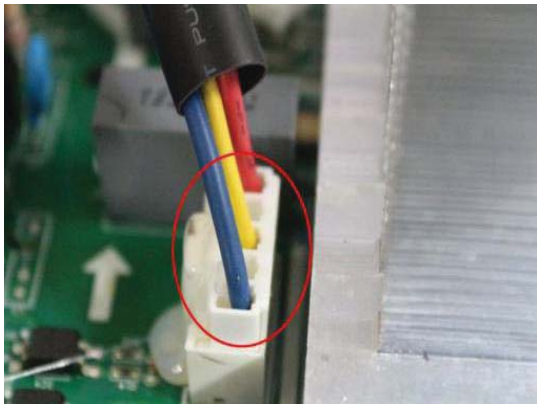
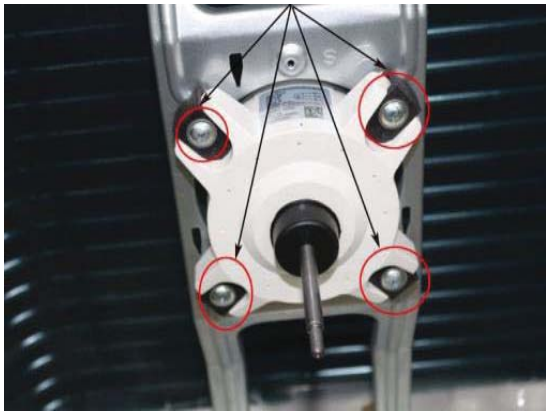
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 30−36K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
2.	Fan Assembly	Remove the Fan Assembly 1. After completing step 1, remove the nut securing the fan, and remove the fan.	
		2. Loosen the hooks and screws, then open the electronic control box cover.	 

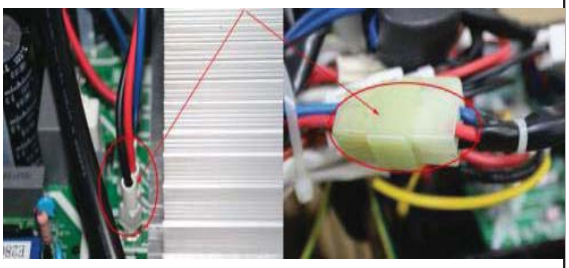
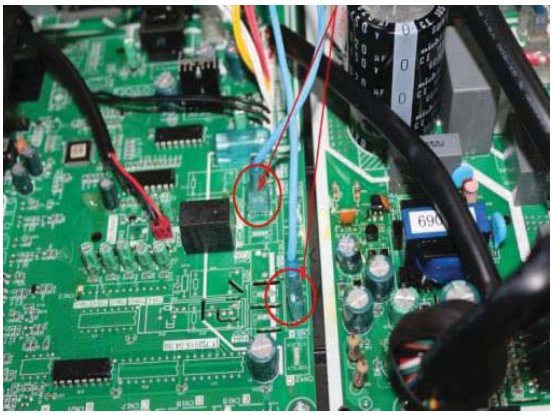
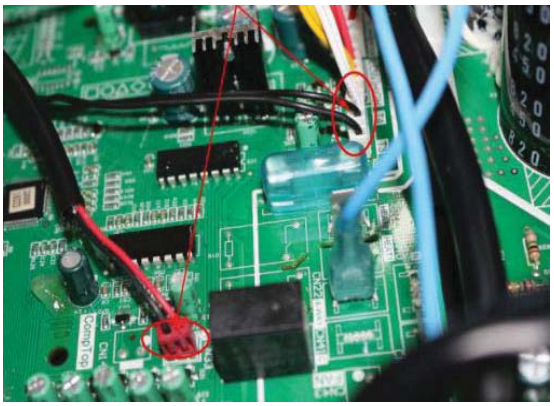
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 30−36K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Fan Assembly	Remove the Fan Assembly	
		3. Disconnect the fan motor connector from the electronic control board.	
		4. Remove the four fan motor screws. Next, remove the motor.	
			

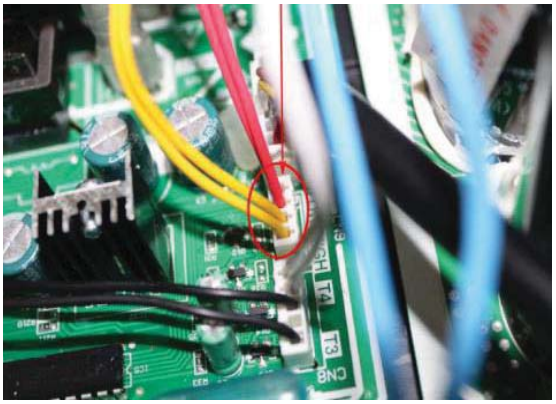
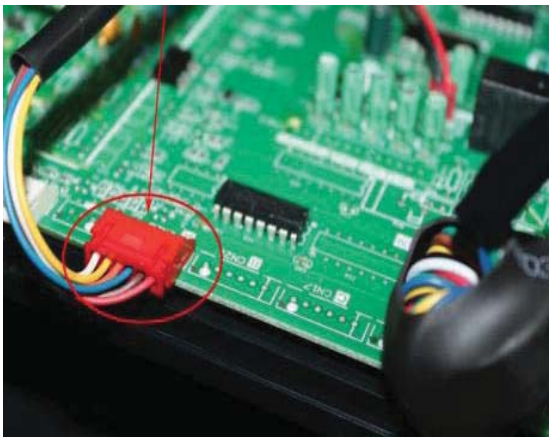
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 30−36K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
3.	Electrical Parts	Remove the electrical parts 1. After completing steps 1 and 2, remove the compressor connector. 2. Pull out the two blue wires connected with the 4-way valve. 3. Pull out the compressor connectors from the compressor top temp. sensor, condenser coil temp. sensor (T3) outdoor ambient temp. sensor (T4) and the discharge temp. sensor (T5).	  

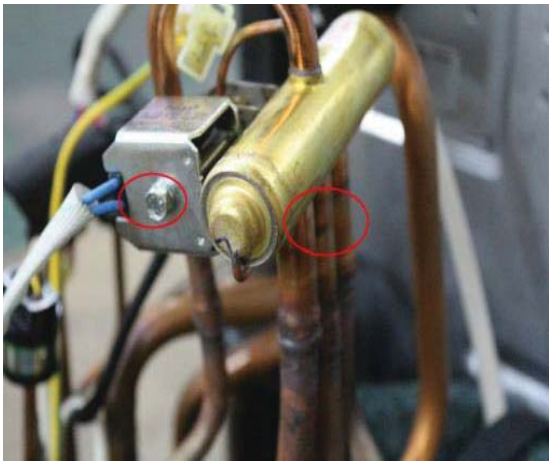
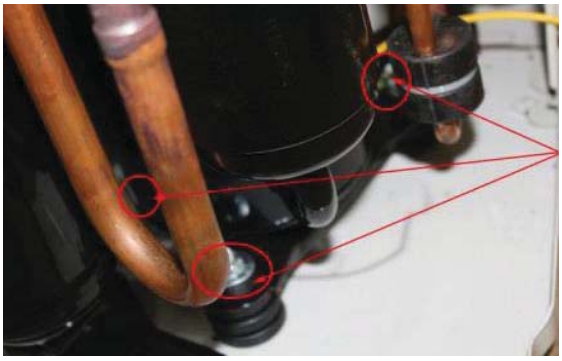
DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 30−36K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
	Electrical Parts	Remove the electrical parts 4. Disconnect the pressure switch connector. 5. Disconnect the electronic expansion valve wire from the control board. 6. Remove the ground wires. 7. Remove the power supply wires (L1,L2, S). 8. Remove the electronic control box.	  

DISASSEMBLY INSTRUCTIONS (CONT)

Outdoor Unit Sizes 30−36K (208−230V) (Cont)

No.	Part Name	Procedures	Remarks
4.	4-way valve	Remove the 4-way valve 1. After completing steps 1-3, recover the refrigerant from the refrigerant circuit. 2. Remove the coil screw and remove the coil. 3. Detach the welded parts of the 4-way valve and pipe. 4. Remove the 4-way valve assembly.	The picture of 4-way valve may differ from unit to unit. 
5.	Compressor	Remove the compressor 1. After completing steps 1-4, remove the discharge and suction pipes with a burner. 2. Remove the hex nuts and washers securing the compressor to the bottom plate. 3. Lift the compressor from the base pan assembly.	 

APPENDIX 1

Table 30—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 31—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 32—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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