**38MHRB**
**Outdoor Unit Single Zone Ductless System**
**Sizes 09 to 24**

# 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 cleaning coils. 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 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 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

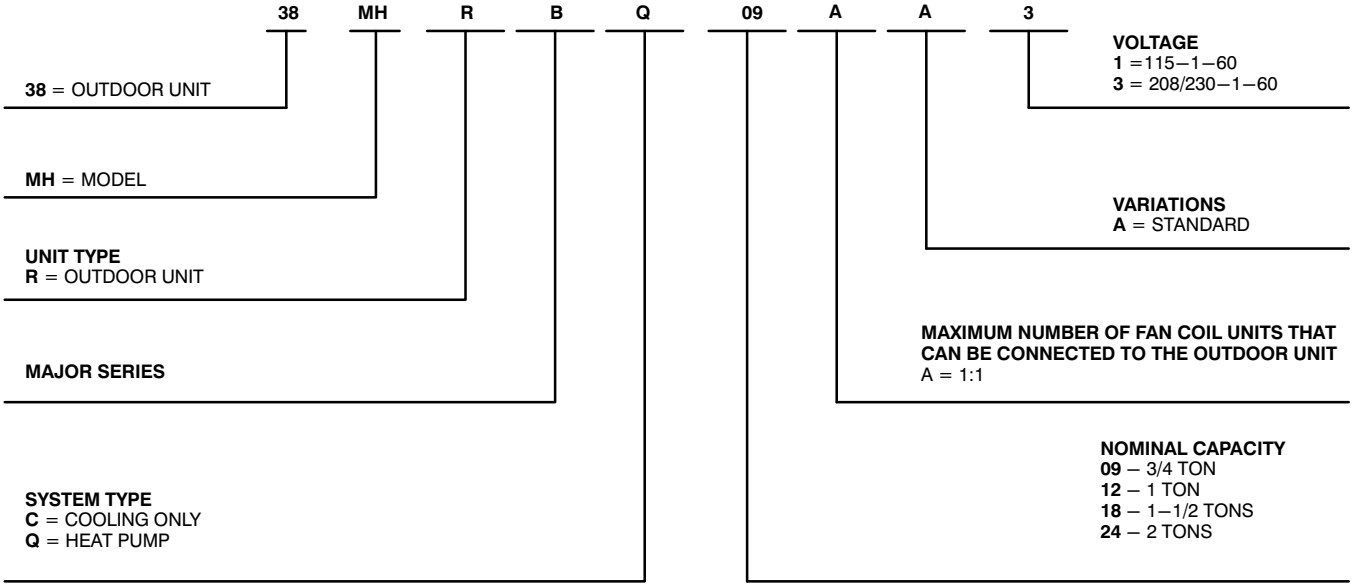
This Service Manual provides the necessary information to service, repair, and maintain the outdoor units. Section 2 of this manual has an appendix with data required to perform troubleshooting. Use the Table of Contents to locate a desired topic.

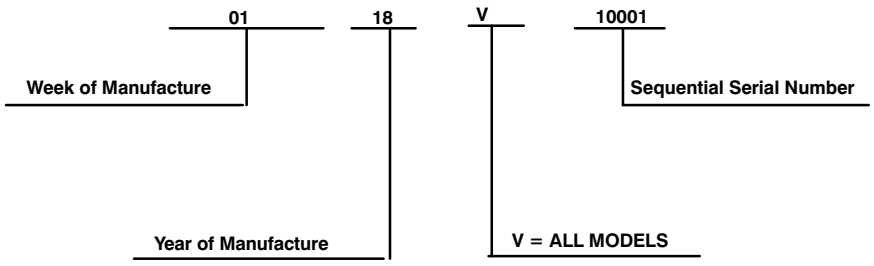
# MODEL/SERIAL NUMBER NOMENCLATURES

**Table 1—Unit Sizes**

| | SYSTEM TONS | BTUh | VOLTAGE – PHASE | OUTDOOR MODEL |
|---|---|---|---|---|
| **Cooling Only** | 1.00 | 12,000 | 115–1 | 38MHRBC12AA1 |
| | 1.00 | 12,000 | 208/230–1 | 38MHRBC12AA3 |
| | 1.50 | 18,000 | 208/230–1 | 38MHRBC18AA3 |
| | 2.00 | 24,000 | 208/230–1 | 38MHRBC24AA3 |
| **Heat Pump** | 1.00 | 12,000 | 115–1 | 38MHRBQ12AA1 |
| | 0.75 | 9,000 | 208/230–1 | 38MHRBQ09AA3 |
| | 1.00 | 12,000 | 208/230–1 | 38MHRBQ12AA3 |
| | 1.50 | 18,000 | 208/230–1 | 38MHRBQ18AA3 |
| | 2.00 | 24,000 | 208/230–1 | 38MHRBQ24AA3 |

## 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

**Table 2—Specifications (Cooling Only)**

| System | Size | | 12 | 12 | 18 | 24 |
|---|---|---|---|---|---|---|
| | Outdoor Model | | 38MHRBC12AA1 | 38MHRBC12AA3 | 38MHRBC18AA3 | 38MHRBC24AA3 |
| Electrical | Voltage, Phase, Cycle | V/Ph/Hz | 115−1−60 | 208/230−1−60 | 208/230−1−60 | 208/230−1−60 |
| | MCA | A. | 13 | 11 | 15 | 18 |
| | MOCP − Fuse Rating | A. | 20 | 15 | 20 | 25 |
| Operating Range | Cooling Outdoor DB Min − Max | °F (°C) | 0~122 (−17~50) | 0~122 (−17~50) | 0~122 (−17~50) | 0~122 (−17~50) |
| Piping | Total Piping Length | ft (m) | 82 (25) | 82 (25) | 98 (30) | 164 (50) |
| | Piping Lift* | ft (m) | 33 (10) | 33 (10) | 66 (20) | 66 (20) |
| | Pipe Connection Size − Liquid | in (mm) | 1/4 (6.35) | 1/4 (6.35) | 1/4 (6.35) | 3/8 (9.52) |
| | Pipe Connection Size − Suction | in (mm) | 1/2 (12.7) | 1/2 (12.7) | 1/2 (12.7) | 5/8 (16) |
| Refrigerant | Type | | R410A | R410A | R410A | R410A |
| | Charge | lbs (kg) | 1.30 (0.59) | 1.17 (0.53) | 1.98 (0.90) | 2.56 (1.16) |
| | Metering Device | | EEV | EEV | EEV | EEV |
| Outdoor Coil | Face Area | Sq. Ft. | 4.15 | 4.15 | 4.15 | 4.78 |
| | No. Rows | | 1 | 1 | 2 | 2 |
| | Fins per inch | | 22 | 22 | 22 | 22 |
| | Circuits | | 2 | 2 | 4 | 6 |
| Compressor | Type | | Rotary Inverter | Rotary Inverter | Rotary Inverter | Rotary Inverter |
| | Model | | ASN98D22UFZ | ASK89D29UEZD | ASN140D21UFZ | ATN150D30UFZA |
| | Oil Type | | VG74 | VG74 | VG74 | VG74 |
| | Oil Charge | Fl. Oz. | 13.0 | 13.0 | 15.5 | 23.6 |
| | Rated Current | RLA | 9.5 | 6.8 | 9.0 | 12.0 |
| Outdoor | Unit Width | in (mm) | 30.31 (770) | 30.31 (770) | 30.31 (770) | 33.27 (845) |
| | Unit Height | in (mm) | 21.85 (555) | 21.85 (555) | 21.85 (555) | 27.64 (702) |
| | Unit Depth | in (mm) | 11.81 (300) | 11.81 (300) | 11.81 (300) | 14.29 (363) |
| | Net Weight | lbs (kg) | 57.8 (26.2) | 53.8 (24.4) | 65.9 (29.9) | 88.6 (40.2) |
| | Airflow | CFM | 1,170 | 1,230 | 1,195 | 1,825 |
| | Sound Pressure | dB(A) | 52.0 | 53.6 | 55.3 | 58.0 |

## Compatibility

**Table 3—Compatibility**

| Indoor Unit | | 38MHRBC12AA1 | 38MHRBC12AA3 | 38MHRBC18AA3 | 38MHRBC24AA3 |
|---|---|---|---|---|---|
| High Wall | 40MHHC12−−−1 | ● | | | |
| | 40MHHC12−−−3 | | ● | | |
| | 40MHHC18−−−3 | | | ● | |
| | 40MHHC24−−−3 | | | | ● |

## Performance

**Table 4—Performance**

| | Indoor Model | | 40MHHC12−−−1 | 40MHHC12−−−3 | 40MHHC18−−−3 | 40MHHC24−−−3 |
|---|---|---|---|---|---|---|
| High Wall | Energy Star | | NO | NO | NO | NO |
| | Cooling System Tons | | 1.0 | 1.0 | 1.4 | 1.8 |
| | Cooling Rated Capacity | Btu/h | 12,000 | 11,500 | 17,000 | 22,000 |
| | Cooling Cap. Range Min − Max | Btu/h | 4,800~13,200 | 4,800~13,000 | 5,800~18,600 | 4,900~24,100 |
| | SEER | | 17.3 | 19.0 | 19.0 | 18.5 |
| | EER | | 10.7 | 11.2 | 10.3 | 11.1 |

# SPECIFICATIONS (CONT)

**Table 5—Specifications (Heat Pump)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **System** | Size | | **12** | **9** | **12** | **18** | **24** |
| | Outdoor Model | | 38MHRBQ12AA1 | 38MHRBQ09AA3 | 38MHRBQ12AA3 | 38MHRBQ18AA3 | 38MHRBQ24AA3 |
| **Electrical** | Voltage, Phase, Cycle | V/Ph/Hz | 115–1–60 | 208/230–1–60 | 208/230–1–60 | 208/230–1–60 | 208/230–1–60 |
| | MCA | A. | 13 | 8 | 10 | 15 | 18 |
| | MOCP – Fuse Rating | A. | 20 | 15 | 15 | 20 | 25 |
| **Operating Range** | Cooling Outdoor DB Min – Max | °F (°C) | 0~122 (–17~50) | 0~122 (–17~50) | 0~122 (–17~50) | 0~122 (–17~50) | 0~122 (–17~50) |
| | Heating Outdoor DB Min – Max | °F (°C) | 0~86 (–17~30) | 0~86 (–17~30) | 0~86 (–17~30) | 0~86 (–17~30) | 0~86 (–17~30) |
| **Piping** | Total Piping Length | ft (m) | 82 (25) | 82 (25) | 82 (25) | 98 (30) | 164 (50) |
| | Piping Lift* | ft (m) | 33 (10) | 33 (10) | 33 (10) | 66 (20) | 66 (20) |
| | Pipe Connection Size – Liquid | in (mm) | 1/4 (6.35) | 1/4 (6.35) | 1/4 (6.35) | 1/4 (6.35) | 3/8 (9.52) |
| | Pipe Connection Size – Suction | in (mm) | 1/2 (12.7) | 3/8 (9.52) | 1/2 (12.7) | 1/2 (12.7) | 5/8 (16) |
| **Refrigerant** | Type | | R410A | R410A | R410A | R410A | R410A |
| | Charge | lbs (kg) | 2.12 (0.96) | 1.76 (0.80) | 2.12 (0.96) | 2.82 (1.28) | 3.97 (1.80) |
| | Metering Device | | EEV | EEV | EEV | EEV | EEV |
| **Outdoor Coil** | Face Area | Sq. Ft. | 4.1 | 4.1 | 4.1 | 4.7 | 5.3 |
| | No. Rows | | 1.6 | 1 | 1.6 | 2 | 2 |
| | Fins per inch | | 18 | 18 | 18 | 21 | 18 |
| | Circuits | | 2 | 2 | 4 | 4 | 6 |
| **Compressor** | Type | | Rotary Inverter | Rotary Inverter | Rotary Inverter | Rotary Inverter | Rotary Inverter |
| | Model | | ASN98D22UFZ | ASN98D22UFZ | ASN98D22UFZ | ASN140D21UFZ | ATF235D22UMT |
| | Oil Type | | VG74 | VG74 | VG74 | VG74 | VG74 |
| | Oil Charge | Fl. Oz. | 13.0 | 13.0 | 13.0 | 15.5 | 23.6 |
| | Rated Current | RLA | 10.5 | 5.5 | 6.8 | 10.5 | 12.0 |
| **Outdoor** | Unit Width | in (mm) | 30.31 (770) | 30.31 (770) | 30.31 (770) | 31.50 (800) | 33.27 (845) |
| | Unit Height | in (mm) | 21.85 (555) | 21.85 (555) | 21.85 (555) | 21.81 (554) | 27.64 (702) |
| | Unit Depth | in (mm) | 11.81 (300) | 11.81 (300) | 11.81 (300) | 13.11 (333) | 14.29 (363) |
| | Net Weight | lbs (kg) | 69 (31.3) | 63 (28.6) | 65.5 (29.7) | 79.6 (36.1) | 114.2 (51.8) |
| | Airflow | CFM | 1,170 | 1,170 | 1,170 | 1,170 | 1,765 |
| | Sound Pressure | dB(A) | 54.5 | 57.2 | 57.4 | 57.0 | 60.2 |

## Compatibility

**Table 6—Compatibility**

| **Indoor Unit** | | **38MHRBQ12AA1** | **38MHRBQ09AA3** | **38MHRBQ12AA3** | **38MHRBQ18AA3** | **38MHRBQ24AA3** |
|---|---|---|---|---|---|---|
| **High Wall** | 40MHHQ12–––1 | • | | | | |
| | 40MHHQ09–––3 | | • | | | |
| | 40MHHQ12–––3 | | | • | | |
| | 40MHHQ18–––3 | | | | • | |
| | 40MHHQ24–––3 | | | | | • |

## Performance

**Table 7—Performance**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **High Wall** | Indoor Model | | **40MHHQ12–––1** | **40MHHQ09–––3** | **40MHHQ12–––3** | **40MHHQ18–––3** | **40MHHQ24–––3** |
| | Energy Star | | NO | NO | NO | NO | NO |
| | Cooling System Tons | | 1.0 | 0.8 | 1.0 | 1.5 | 2.0 |
| | Cooling Rated Capacity | Btu/h | 12,000 | 9,000 | 12,000 | 18,000 | 24,000 |
| | Cooling Cap. Range Min – Max | Btu/h | 3,700~13,000 | 3,400~10,500 | 3,700~13,000 | 5,500~19,000 | 8,987~26,585 |
| | SEER | | 19.8 | 18.5 | 19.8 | 19.0 | 17.3 |
| | EER | | 10 | 11.2 | 11.2 | 11.2 | 9.7 |
| | Heating Rated Capacity (47°F) | Btu/h | 12,000 | 9,800 | 12,000 | 18,000 | 24,800 |
| | Heating Rated Capacity (17°F) | Btu/h | 8,000 | 7,500 | 9,230 | 11,600 | 18,000 |
| | Heating Maximum Capacity (17°F) | Btu/h | 8,200 | 7,850 | 9,500 | 11,800 | 18,300 |
| | Heating Maximum Capacity (5°F) | Btu/h | 9,000 | 6,070 | 8,880 | 10,150 | 16,760 |
| | Heating Cap. Range Min – Max | Btu/h | 3,500~13,500 | 2,800~11,500 | 3,500~13,500 | 6,200~19,000 | 8,371~25,350 |
| | HSPF | | 10.6 | 10.0 | 9.6 | 10.6 | 9.6 |
| | COP (47°F) | W/W | 2.93 | 3.27 | 3.22 | 3.26 | 3.13 |
| | COP (17°F) | W/W | 2.58 | 2.58 | 2.64 | 2.64 | 2.49 |
| | COP (5°F) | W/W | 1.60 | 1.60 | 1.60 | 1.50 | 1.40 |

# DIMENSIONS

**Table 8—Dimensions**

| | System Size | | Height (H) in. (mm) | Width (W) in. (mm) | Depth (D) in. (mm) | Weight—Net lbs. (kg) |
|---|---|---|---|---|---|---|
| Cooling Only | 12K | (115V) | 21.85(555) | 30.31(770) | 11.81(300) | 57.8(26.2) |
| | 12K | (208/230V) | 21.85(555) | 30.31(770) | 11.81(300) | 53.8(24.4) |
| | 18K | (208/230V) | 21.85 (555) | 30.31 (770) | 11.81 (300) | 65.9 (29.9) |
| | 24K | (208/230V) | 27.64(702) | 33.27(845) | 14.29(363) | 88.6(40.2) |
| | System Size | | Height (H) in. (mm) | Width (W) in. (mm) | Depth (D) in. (mm) | Weight—Net lbs. (kg) |
| Heat Pump | 12K | (115V) | 21.85(555) | 30.31(770) | 11.81(300) | 69(31.3) |
| | 9K | (208/230V) | 21.85(555) | 30.31(770) | 11.81(300) | 63(28.6) |
| | 12K | (208/230V) | 21.85(555) | 30.31(770) | 11.81(300) | 65.5(29.7) |
| | 18K | (208/230V) | 21.81(554) | 31.50(800) | 13.11(333) | 79.6(36.1) |
| | 24K | (208/230V) | 27.64(702) | 33.27(845) | 14.29(363) | 114.2(51.8) |

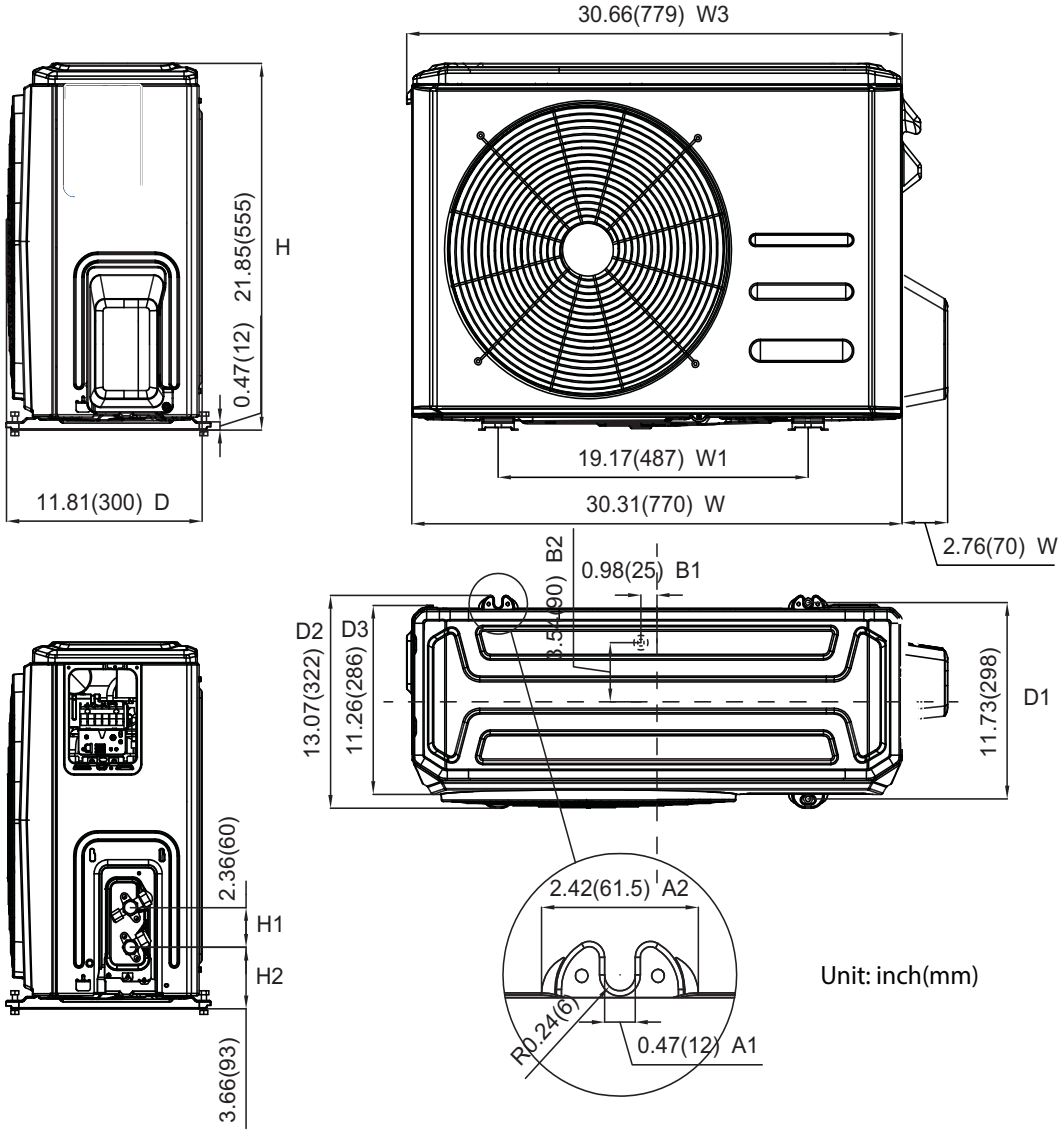



**Fig. 1 – Sizes 9K and 12K Heat Pump and Size 18K Cooling Only**

# DIMENSIONS − OUTDOOR (CONT)

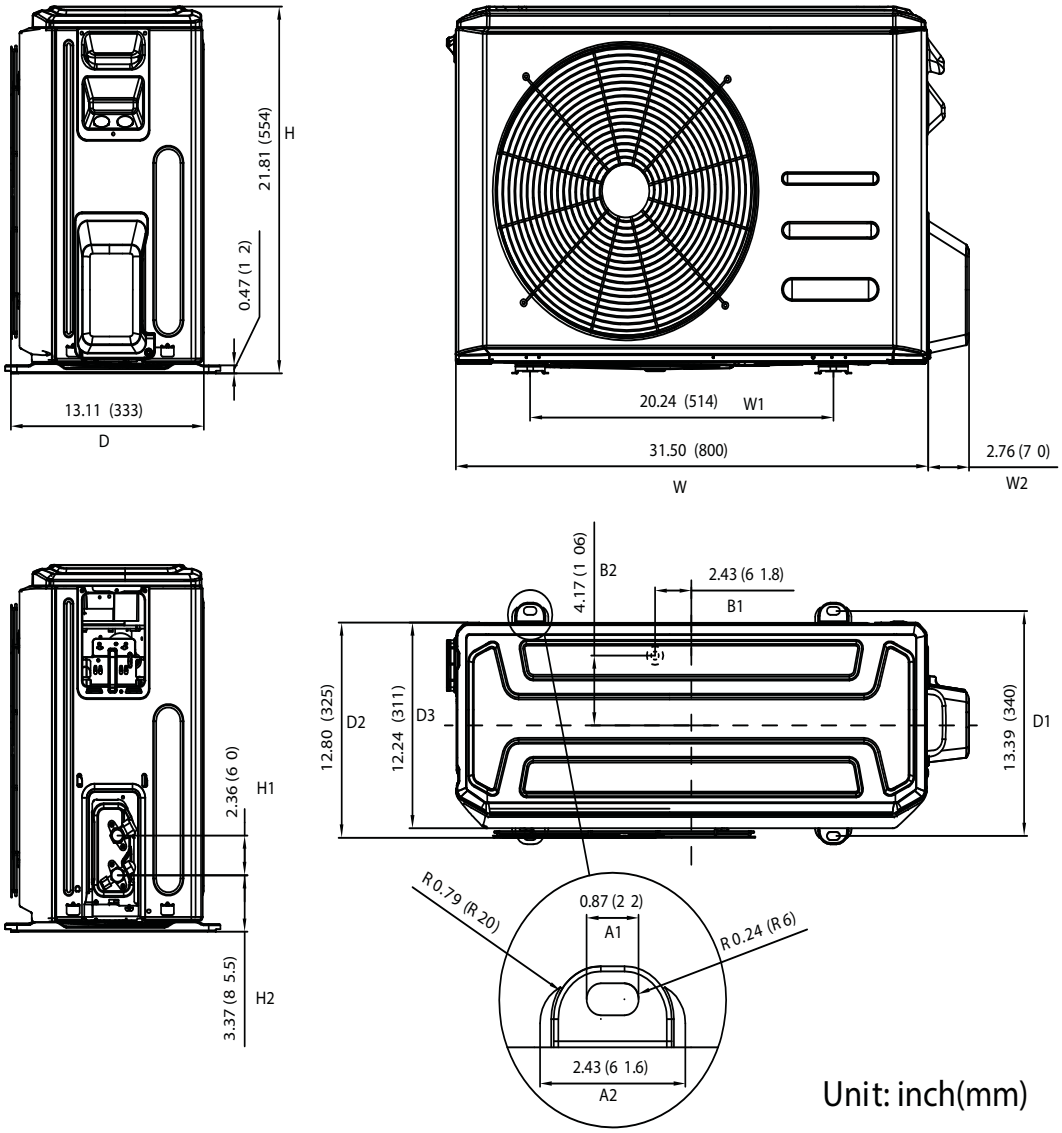
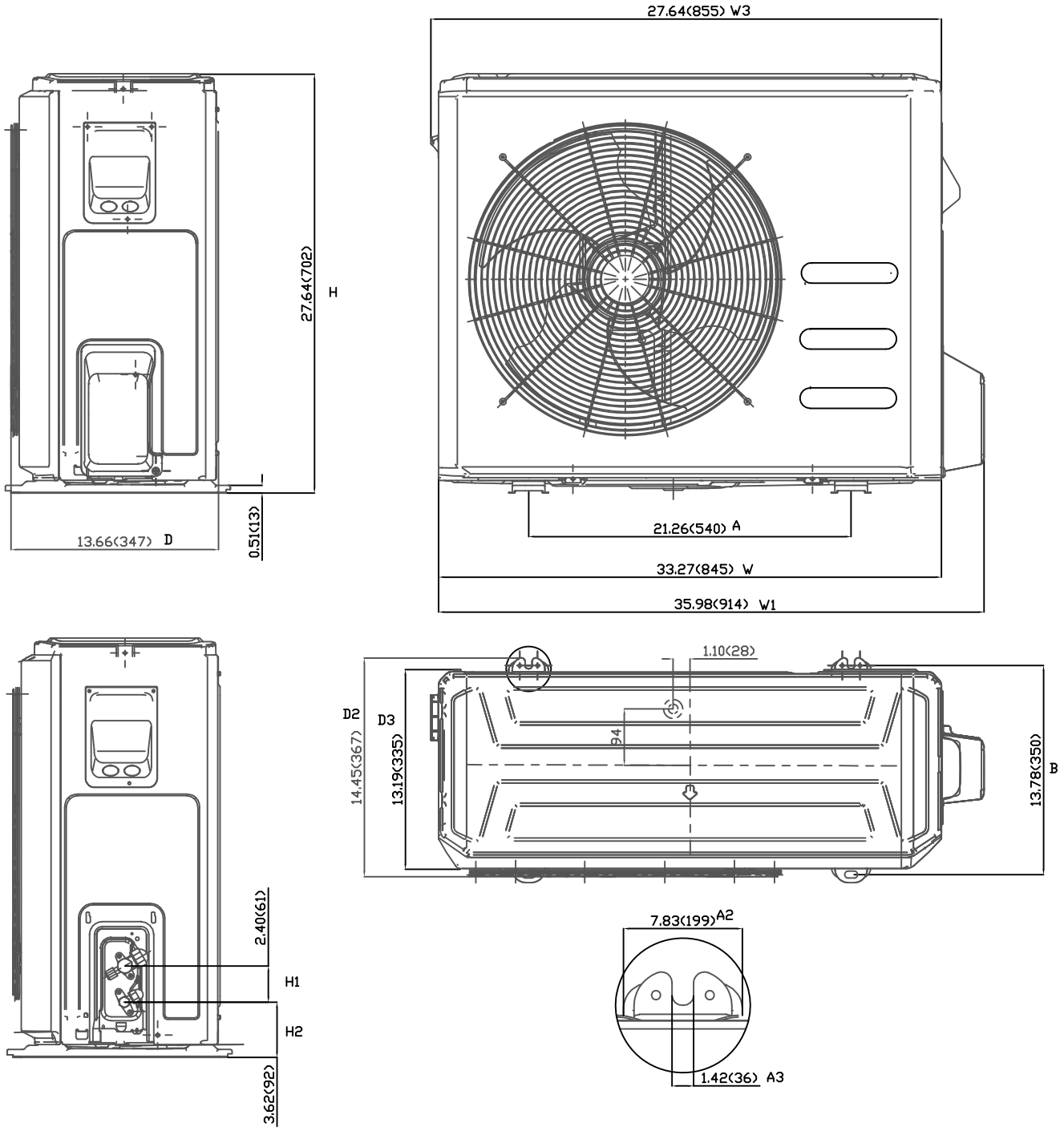



**Fig. 2 – Size 18K Heat Pump**

# DIMENSIONS − OUTDOOR (CONT)




Unit: inch (mm)

**Fig. 3 – Size 24K**

# CLEARANCES

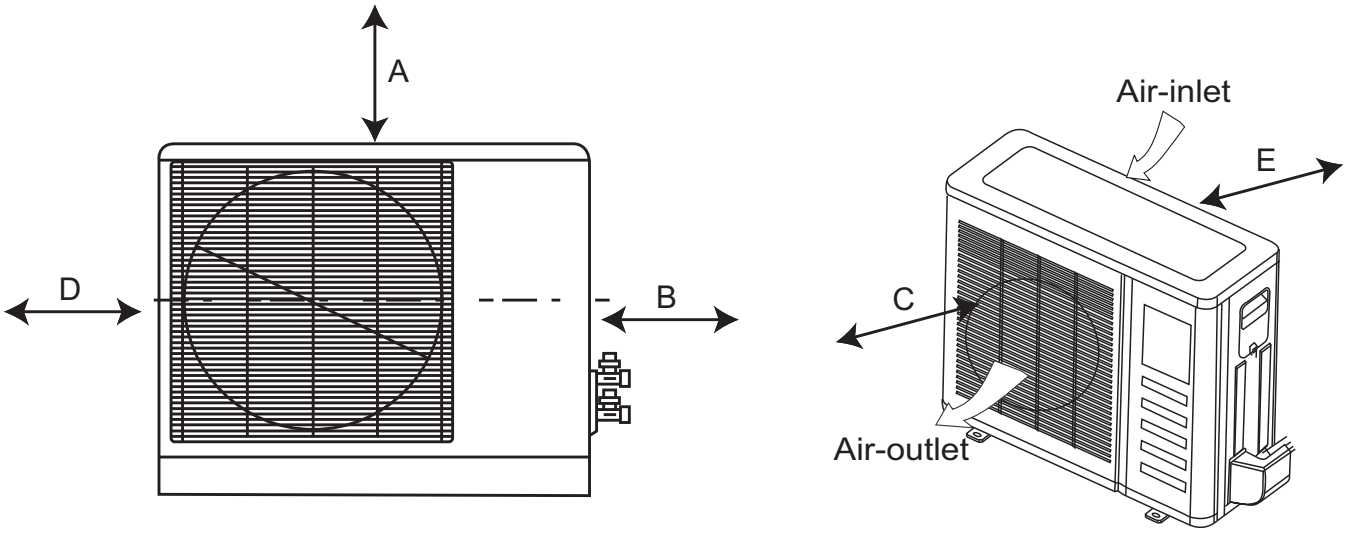



**Fig. 4 – Outdoor Unit Clearance**

**Table 9—Clearances**

| UNIT | MINIMUM VALUE in. (mm) |
|---|---|
| A | 24 (610) |
| B | 24 (610) |
| C | 24 (610) |
| D | 4 (101) |
| E | 4 (101) |

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

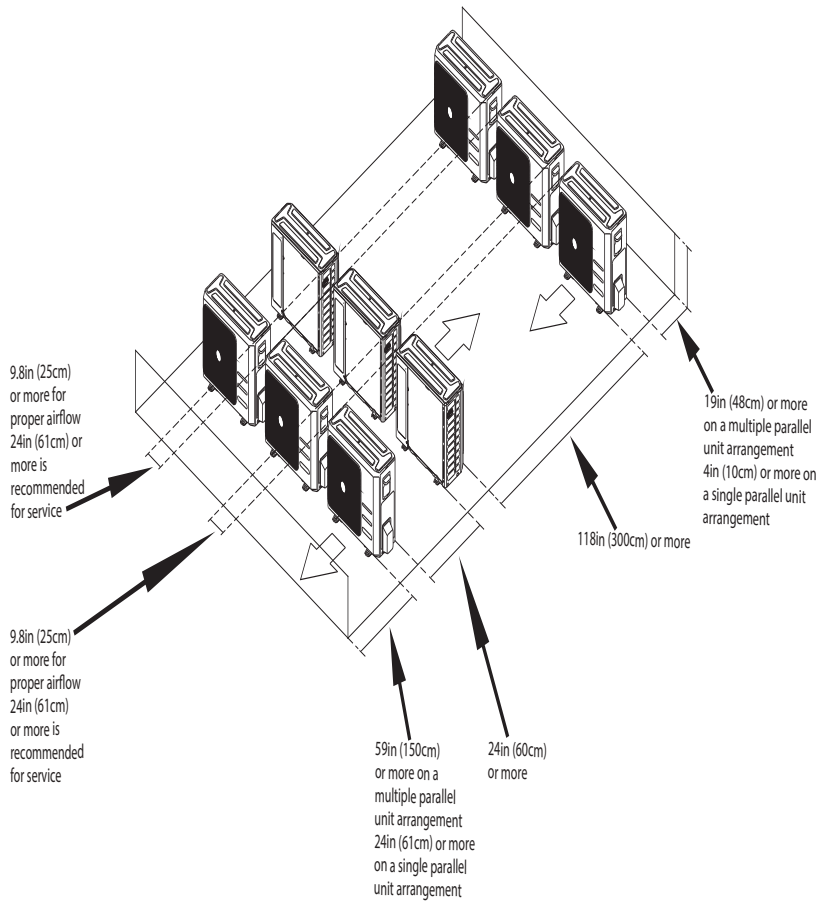



**Fig. 5 – Clearances for Multiple Units**

# ELECTRICAL DATA

**Table 10—Electrical Data (Cooling Only)**

| | | | | | |
|---|---|---|---|---|---|
| **Cooling Only** | **Outdoor Unit Size** | **12K** | **12K** | **18K** | **24K** |
| | **Volts—PH—Hz** | **(115V)** | **(208/230V)** | **(208/230V)** | **(208/230V)** |
| | **Max – Min* Oper. Voltage** | **127—104** | **253—187** | **253—187** | **253—187** |
| **Power Supply** | MCA | 13 | 11 | 15 | 18 |
| | MOCP | 20 | 15 | 20 | 25 |
| **Compressor** | RLA | 9.5 | 6.8 | 9 | 12 |
| **Outdoor Fan Motor** | FLA | 0.6 | 0.5 | 0.6 | 0.6 |
| | Rated HP | 0.054 | 0.054 | 0.054 | 0.068 |
| | Output | 40 | 40 | 40 | 50 |

**Table 11—Electrical Data (Heat Pump)**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Heat Pump** | **Outdoor Unit Size** | **12K** | **9K** | **12K** | **18K** | **24K** |
| | **Volts—PH—Hz** | **(115V)** | **(208/230V)** | **(208/230V)** | **(208/230V)** | **(208/230V)** |
| | **Max – Min* Oper. Voltage** | **127—104** | **253—187** | **253—187** | **253—187** | **253—187** |
| **Power Supply** | MCA | 13 | 8 | 10 | 15 | 18 |
| | MOCP | 20 | 15 | 15 | 20 | 25 |
| **Compressor** | RLA | 10.5 | 5.5 | 6.8 | 10.5 | 12 |
| **Outdoor Fan Motor** | FLA | 0.6 | 0.4 | 0.4 | 0.5 | 0.6 |
| | Rated HP | 0.054 | 0.054 | 0.054 | 0.054 | 0.068 |
| | Output | 40 | 40 | 40 | 40 | 50 |

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

**LEGEND**

FLA — Full Load Amps

MCA — Minimum Circuit Amps

MOCP — Maximum Over—Current Protection

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.

**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.

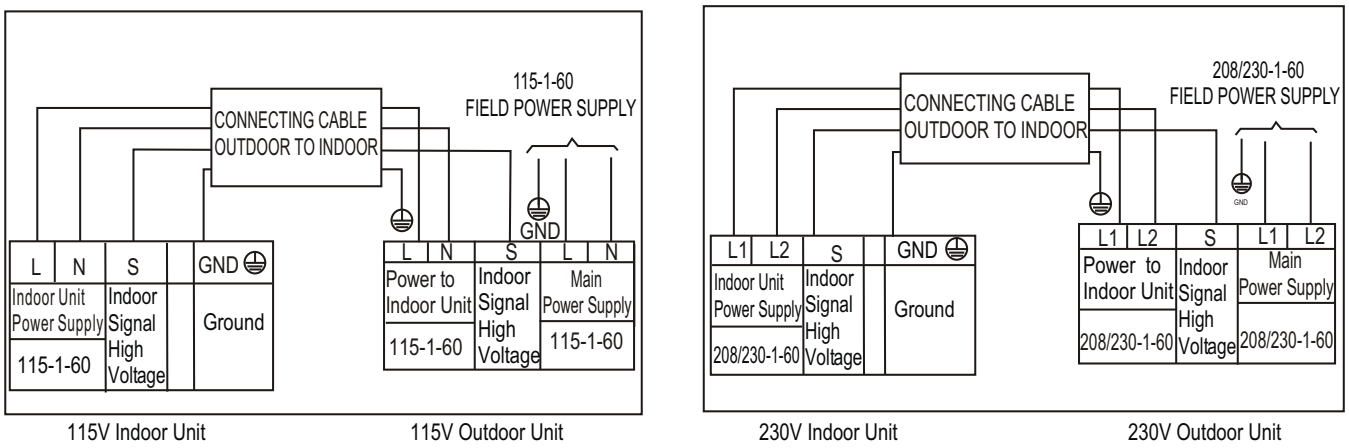
**⚠ CAUTION**

**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

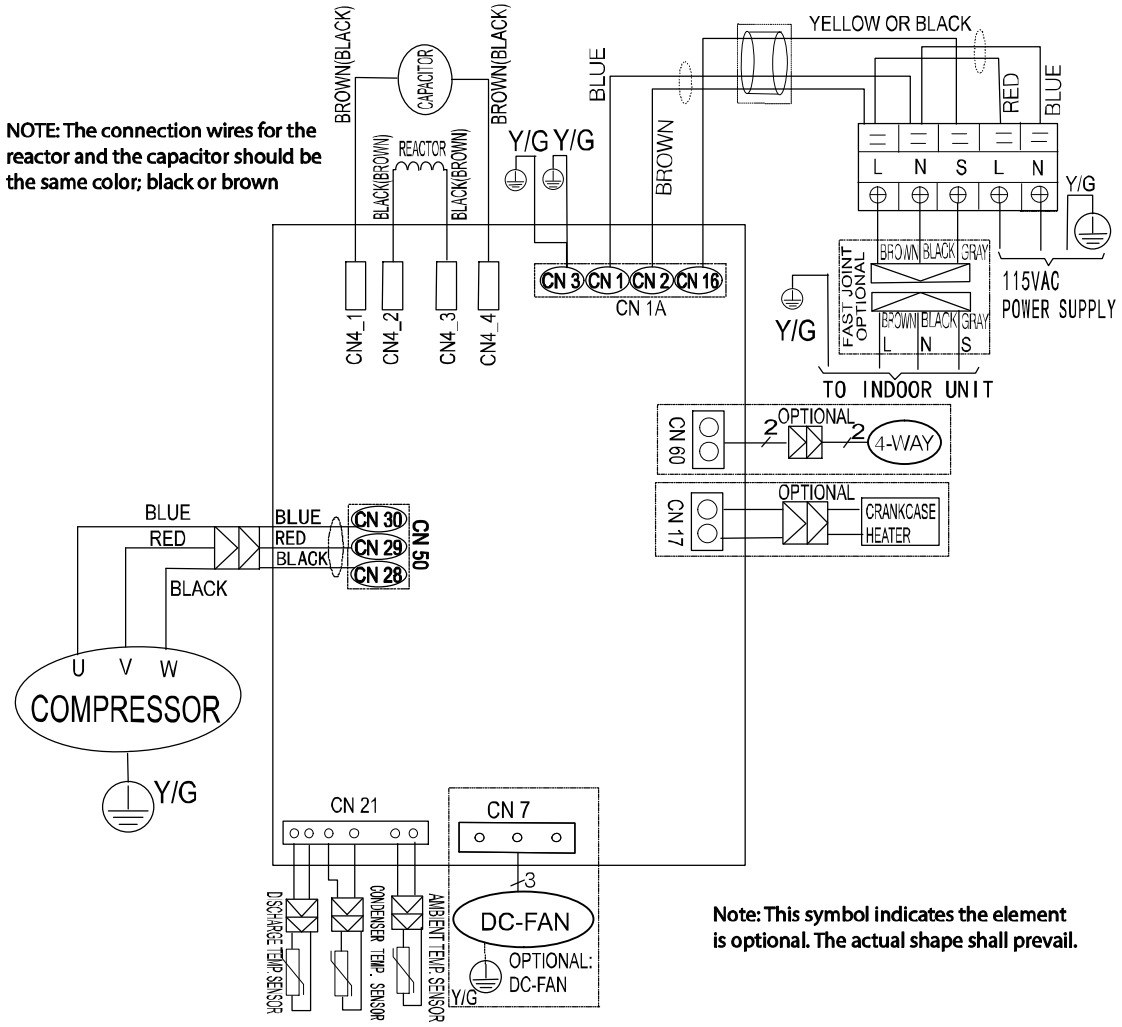



115V Indoor Unit 115V Outdoor Unit 230V Indoor Unit 230V Outdoor Unit

**Fig. 6 – 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.**

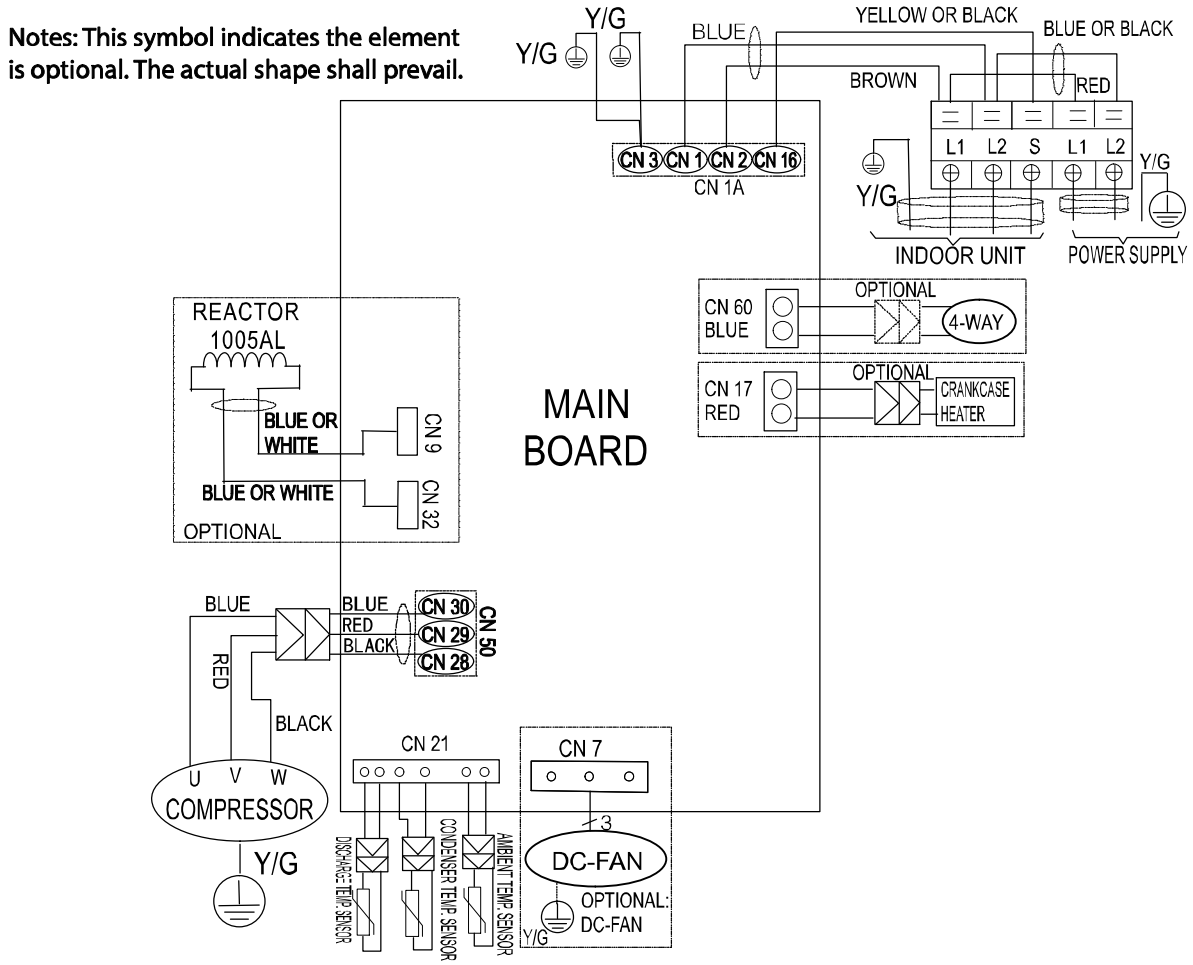
# WIRING DIAGRAMS (COOLING ONLY)




| CODE | PART NAME | CODE | PART NAME |
|---|---|---|---|
| CN1A | Input: 115V high voltage connector with L/N/signal/ground | CN21 | Input: temperature acquisition (0~5VDC) |
| CN7 | Output: 0~320VDC to control DC FAN | | |
| CN4_1 CN4_2 CN4_3 CN4_4 | Output:115VAC High voltage connector for power factor corrector(PFC) | | |
| CN17 | Output: 115VAC to control crankcase heater | CN60 | Output: 115 VAC to control 4-way valve |
| CN50 | Output: 0~320V DC to connect compressor | | |

**Fig. 7 – Wiring Diagram Size − Cooling Only Size 12K (115V)**

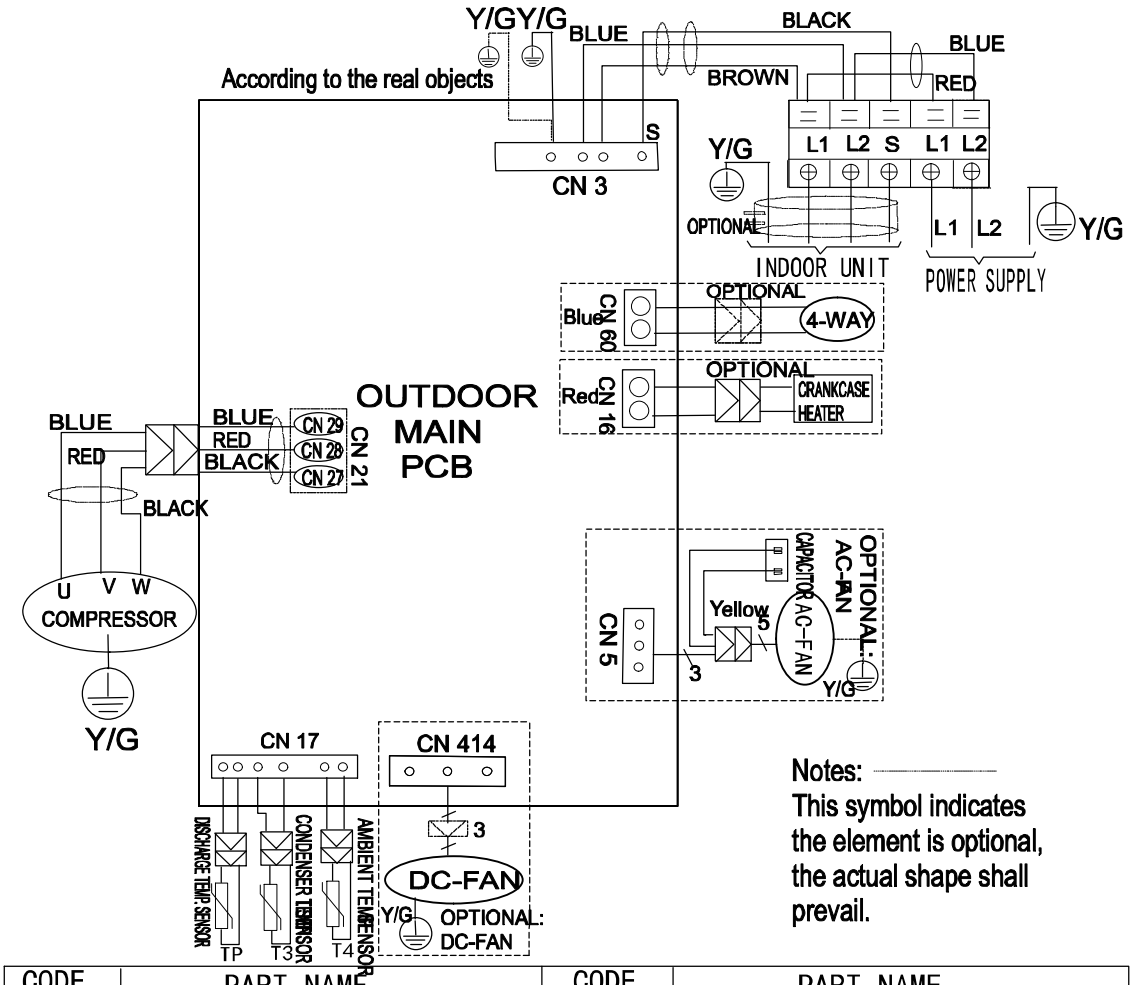
# WIRING DIAGRAMS (COOLING ONLY (CONTINUED))




| CODE | PART NAME | CODE | PART NAME |
|---|---|---|---|
| CN1A | Input: 220V high voltage connector with L1,L2/signal/ground | CN21 | Input: temperature sensor connector (0~5V DC) |
| CN7 | Output: 0~320V DC to connect DC FAN | | |
| CN9~CN32 | To connect PFC reactor | CN50 | Output: 0~320V DC to connect compressor |
| CN17 | Output: 220V AC to connect crankcase heater | CN60 | Output: 0~220V AC to connect 4-way valve |

**Fig. 8 – Wiring Diagram Cooling Only Size 12K (230V)**

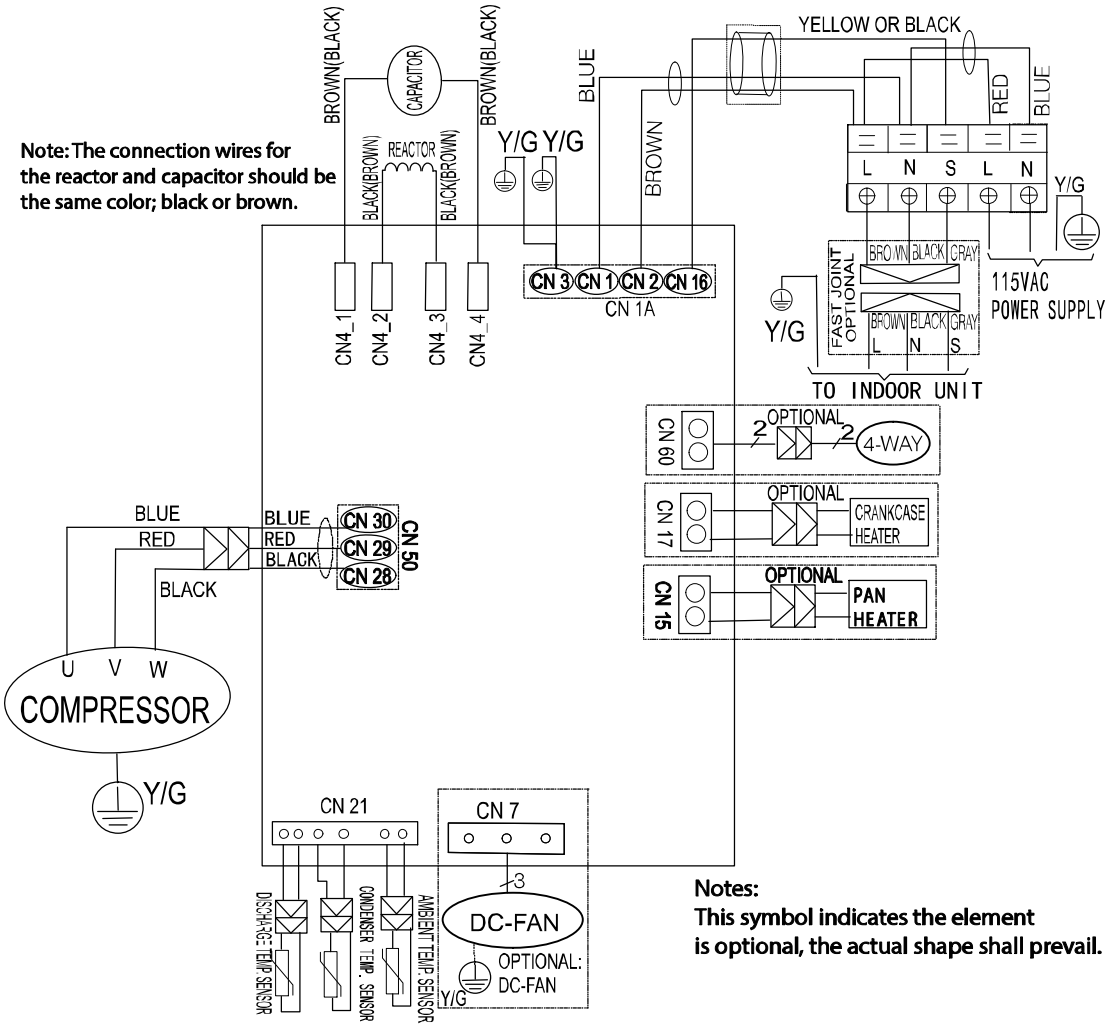
# WIRING DIAGRAMS (COOLING ONLY (CONTINUED))




| CODE | PART NAME | CODE | PART NAME |
|---|---|---|---|
| CN3 | Input: 220V high voltage connector with L1/L2/signal/ground | CN5 | Output: 0~220VAC to control AC FAN |
| CN21 | Output: PWM for UVW to control Compressor(0~320VDC) | CN16 | Output: 220V AC to control crankcase heater |
| CN17 | Input: Temperature acquisition(0-5VDC) | CN60 | Output: 0~220V AC to control 4-way valve |
| CN414 | Output: 0~320VDC to control DC FAN | | |

**Fig. 9 – Wiring Diagram Cooling Only Sizes 18−24K**

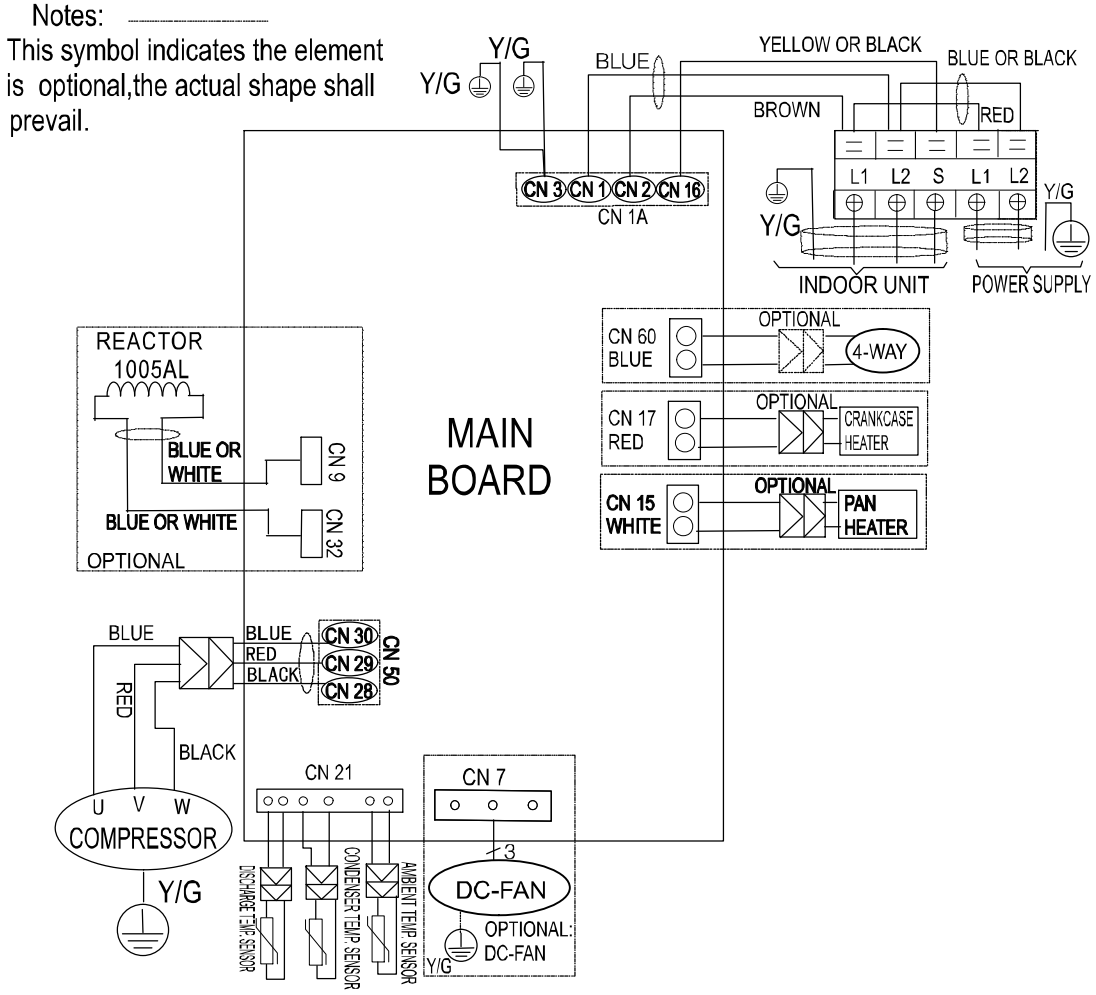
# WIRING DIAGRAMS (HEAT PUMP)




| CODE | PART NAME | CODE | PART NAME |
|---|---|---|---|
| CN 1A | Input: 115V high voltage connector with L/N/signal/ground | CN 15 | 100-130VAC Pan Heater |
| CN 50 | Output: PWM to control Compressor (0~320VDC) | CN 17 | Output: 115V AC to control crankcase heater |
| CN 21 | Input: Temperature acquisition(0-5VDC) | CN 60 | Output: 0-115V AC to control 4-way valve |
| CN 7 | Output: 0~320VDC to control DC FAN | CN4_1 CN4_ 2 CN4_3 CN4_4 | Output: Connection of the high voltage(REACTOR) |

**Fig. 10 – Wiring Diagram Heat Pump Size 12K (115V)**

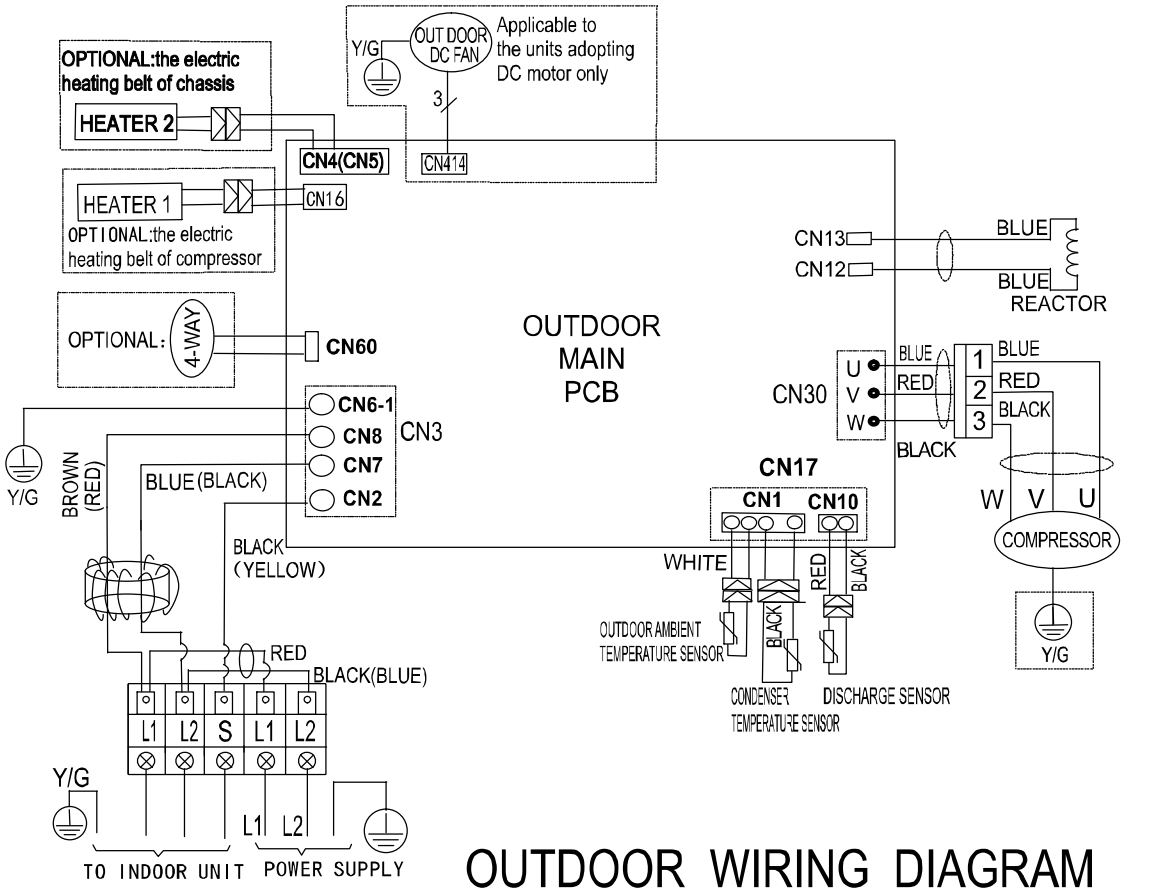
# WIRING DIAGRAMS (HEAT PUMP (CONTINUED))




| CODE | PART NAME | CODE | PART NAME |
|---|---|---|---|
| CN1A | Input: 220V high voltage connector with L1,L2/signal/ground | CN21 | Input: temperature sensor connector (0~5V DC) |
| CN7 | Output: 0~320V DC to connect DC FAN | CN15 | 220VAC Pan Heater |
| CN9~CN32 | To connect PFC reactor | CN50 | Output: 0~320V DC to connect compressor |
| CN17 | Output: 220V AC to connect crankcase heater | CN60 | Output: 0~220V AC to connect 4-way valve |

**Fig. 11 – Wiring Diagram Heat Pump Sizes 09, 12, 18 (230V)**

# WIRING DIAGRAMS (HEAT PUMP (CONTINUED))




OUTDOOR WIRING DIAGRAM

| CODE | PART NAME | CODE | PART NAME |
|---|---|---|---|
| CN414 | Output: 0~320VDC to control DC FAN | CN3 | Input: 230V high voltage connector with L1/L2/signal/ground |
| CN4 (CN5) | 208-230VAC Base Pan heater | CN17 | Input: Temperature acquisition(0-5VDC) |
| CN16 | Output: 220V AC to control crankcase heater | CN30 | Output: PWM for UVW to control Compressor(0~320VDC) |
| CN60 | Output: 0~220V AC to control 4-way valve | CN12~CN13 | Output: To connect PFC reactor |

**Fig. 12 – Wiring Diagram Heat Pump Size 24 (230V)**

# REFRIGERATION CYCLE DIAGRAMS

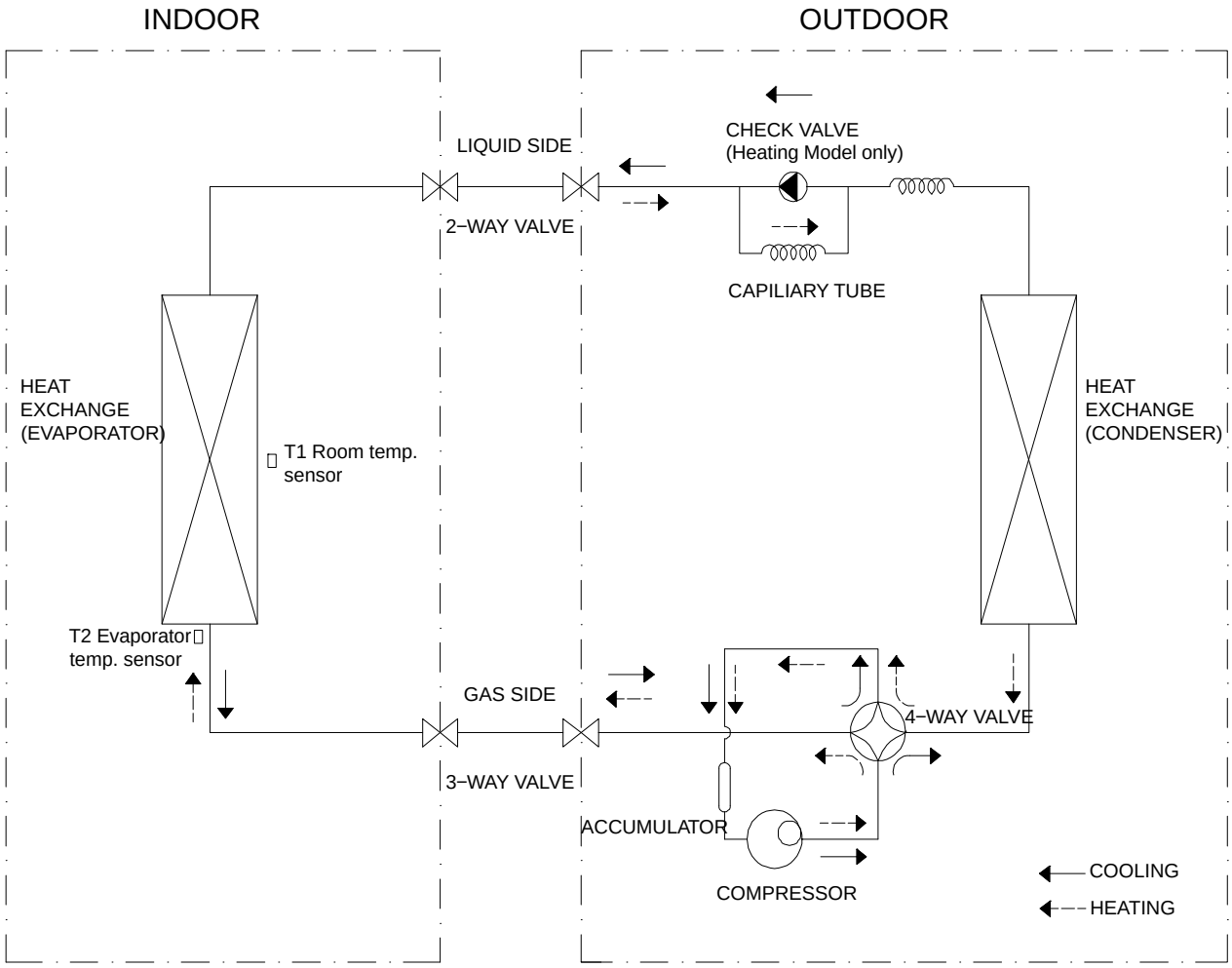



**Fig. 13 – Heat Pumps**

# 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.**

Table 12 lists the maximum lengths allowed.

**Table 12—Piping and Refrigerant Information**

| | System Size | | 12K (115V) | 9K (208−230V) | 12K (208−230V) | 18K (208−230V) | 24K (208−230V) |
|---|---|---|---|---|---|---|---|
| Piping | Min. Piping Length | ft. (m) | 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) |
| | Max. outdoor−indoor height difference (OU higher than IU) | ft. (m) | 33(10) | 33(10) | 33(10) | 66(20) | 66(20) |
| | Max. outdoor−indoor height difference (IU higher than OU) | ft. (m) | 33(10) | 33(10) | 33(10) | 66(20) | 66(20) |
| | Max. Piping Length with no additional refrigerant charge per System (Standard Piping length) | ft. (m) | 25(7.5) | 25(7.5) | 25(7.5) | 25(7.5) | 25(7.5) |
| | Total Max. Piping Length per system | ft. (m) | 82(25) | 82(25) | 82(25) | 98(30) | 164(50) |
| | Additional refrigerant charge (between Standard − Max piping length) | Oz/ft (g/m) | 0.161(15) | 0.161(15) | 0.161(15) | 0.161(15) | 0.322(30) |
| | Suction Pipe (size − connection type) | In (mm) | 1/2(12.7) | 3/8(9.52) | 1/2(12.7) | 1/2(12.7) | 5/8(15.9) |
| | Liquid Pipe (size − connection type) | In (mm) | 1/4(6.35) | 1/4(6.35) | 1/4(6.35) | 1/4(6.35) | 3/8(9.52) |
| | Refrigerant Type | Type | R410A | R410A | R410A | R410A | R410A |
| Refrigerant | Cooling Only Models Charge Amount | Lbs (kg) | 1.30(0.59) | N/A | 1.17 (0.53) | 1.98 (0.9) | 2.56 (1.16) |
| | Heat Pump Models Charge Amount | Lbs (kg) | 2.12(0.96) | 1.76(0.8) | 2.12(0.96) | 2.82 (1.28) | 3.97 (1.8) |

**Long Line Applications,:**

1 No change in line sizing is required.

2 Add refrigerant per Table 12.

# 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. 14).

2 Connect the charge hose to the vacuum pump.

3 Fully open the low side of manifold gage (see Fig. 15).

4 Start the vacuum pump

5 Evacuate using the triple evacuation method.

6 After evacuation is complete, fully close the low side of manifold gage and stop the vacuum pump operation.

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 *ADDITIONAL REFRIGERANT CHARGE* table in this document.

8 Disconnect the charge hose from the charge connection of the low side service valve.

9 Fully open service valves B and A.

10 Securely tighten the service valves caps.

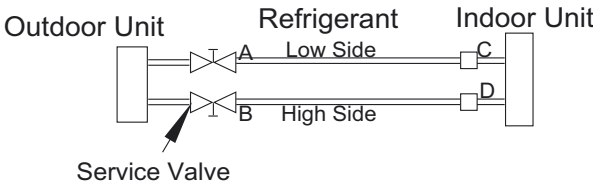



**Fig. 14 – Service Valve**

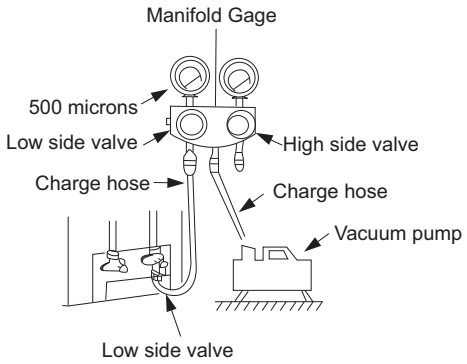



**Fig. 15 – Manifold**

**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. 16).

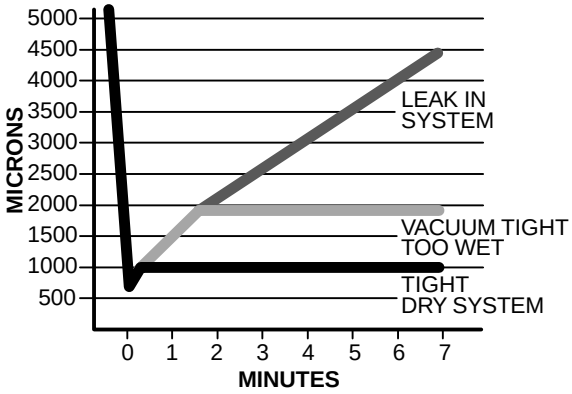



**Fig. 16 – Deep Vacuum Graph**

**Triple Evacuation Method**

The triple evacuation method should be used. Refer to Fig. 17 and proceed as follows:

1 Pump the system down to 1500 microns and allow the pump to continue operating for an additional 15 minutes.

2 Close the service valves and shut off the vacuum pump.

3 Connect a dry nitrogen cylinder and regulator to the system and break vacuum until the system reaches 2 psig.

4 Close the service valve and allow the system to stand for 1hr. During this time, the dry nitrogen can diffuse throughout the system absorbing moisture.

5 Pump the system down to 1000 microns.

6 Break the vacuum with dry nitrogen (2 psig).

7 Pump the system down to 500 microns.

8 Perform the hold test for 30 minutes.

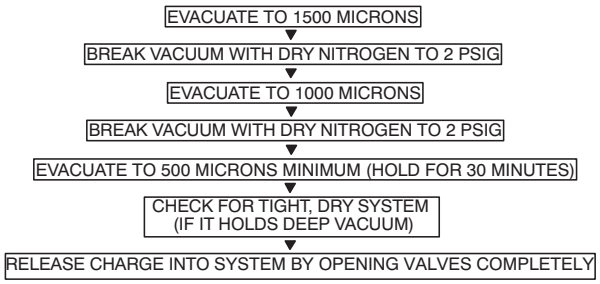



**Fig. 17 – Triple Evacuation Method**

**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.**

## Operation Modes and Functions

**FAN Mode**

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

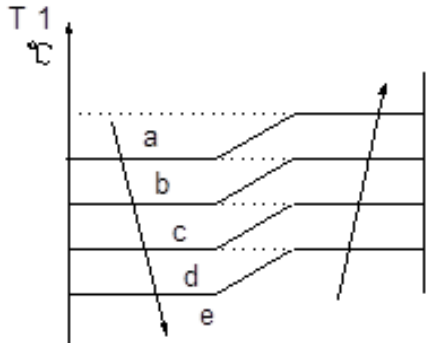



**Fig. 18 – Auto Fan**

**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.

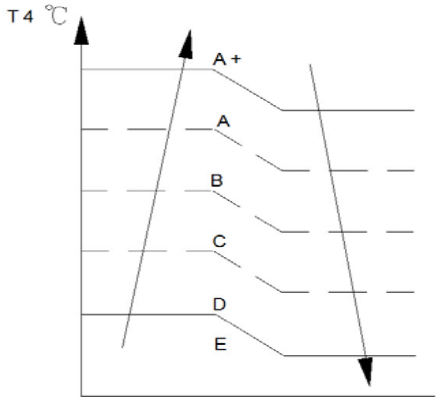



**Fig. 19 – Outdoor Fan Running Rules**

The auto fan adheres to the following rules.

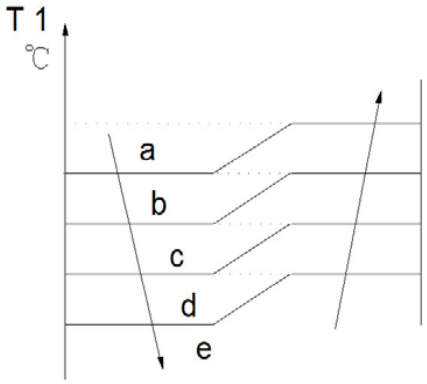



**Fig. 20 – Auto Fan**

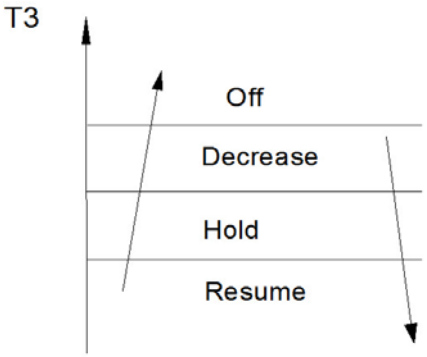



**Fig. 21 – Compressor Temperature Protection**

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

**Compressor Running Rules**

When T1−Ts>−ΔT, the compressor stops, when T1−Ts<ΔT−1.5， the compressor will be on. ΔT is the programmed parameter of temperature compensation. When the AC run in mute mode, the compressor runs with low frequency.

When the current is more than setting value, the current protection function is activated and the compressor stops.

**Outdoor Fan Running Rules**

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

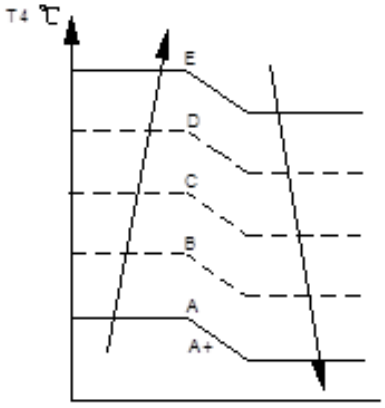



**Fig. 22 – Outdoor Fan Running Rules**

**Auto Fan Action in HEATING Mode**

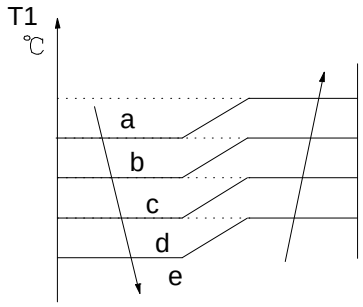



**Fig. 23 – Auto Fan Action in HEATING Mode**

**DEFROST Mode**

The air conditioner enters the **DEFROST** mode according to the T3 temperature value and the T3 temperature change value range plus the compressor running time.

During the **DEFROST** mode, the compressor continues to runs, the indoor and outdoor motors stop, and the indoor unit defrost lamp illuminates and dF appears.

If any one of the following items is satisfied, the defrosting finishes and the machine reverts to the normal heating mode.

−−−−T3 rises to be higher than TCDE1°C.

−−−−T3 keeps to be higher than TCDE2°C for 80 seconds.

−−−−The machine has run for 15 minutes in defrosting mode.

**Evaporator Coil Temperature Protection**

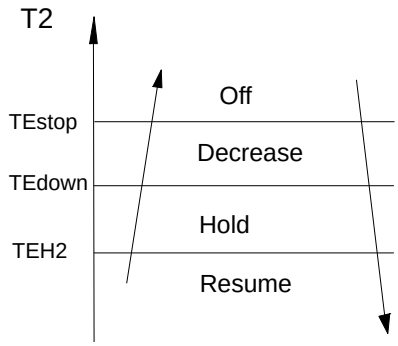



**Fig. 24 – Evaporator Coil Temperature Protection**

**NOTE**: The following applies to Fig. 24:

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

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

**Auto−Mode**

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

In the **AUTO** mode, the machine chooses the **COOLING**, **HEATING** or **FAN−ONLY** mode according to ΔT (ΔT =T1−Ts).

**Table 13—Auto Mode**

| ΔT=T1-Ts | Running mode |
|---|---|
| ΔT＞2°C | Cooling |
| -2≤ΔT≤2°C | Fan−only |
| ΔT<-2°C | Heating |

The indoor fan runs under auto fan in the relevant mode. The louver operates the same in the relevant mode. If the machine switches modes between **HEATING** and **COOLING**, the compressor stops for 15 minutes and then chooses the mode according to T1−Ts. If the setting temperature is modified, the machine chooses the running function again.

**DRY mode**

**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 the touch button to turn off the unit. In the forced operation mode, all general protections and remote control 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 as 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 the **AUTO−RESTART** function, which is carried out through an auto−restart module. In the event of a sudden power failure, the module memorizes the setting conditions prior to the power failure. The unit resumes the previous operation setting (not including the **SWING** function) automatically three (3) minutes after the power returns.

If the memorization condition is the **FORCED COOLING** mode, the unit will run in the **COOLING** mode for 30 minutes and turn to the **AUTO** mode at the 75.2°F(24°C) setting temperature.

If the air conditioner is off before the power turns off and the air conditioner is required to start up, the compressor delays start up for 1 minute before powering on. In other instances, the compressor waits three (3) minutes before restarts.

**Refrigerant Leak Detection**

With this new technology, the display area displays “EC” when the outdoor unit detects a refrigerant leak. This function is only active in cooling mode. It can better prevent the compressor being damaged by refrigerant leakage or compressor overload.

Open Condition: When the compressor is active, the value of the Coil temperature of evaporator T2 has no change or very little change.

**46°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's **LED DISPLAY** or **LED** or **MUTE** button three times, and then press the **AIR DIRECTION** or **SWING** button three times in ten seconds, the buzzer rings for two seconds. The air conditioner enters into the information enquiry status.

Press the **LED DISPLAY** or **AIR DIRECTION** button to check the next or front item's information.

When the air conditioner enters the information enquiry status, it displays the code name in 2 seconds (see Table 14).

**Table 14—Information Enquiry**

| 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 causes | ST | Compressor stop causes |
| Reserve | A0 | |
| Reserve | A1 | |
| Reserve | b0 | |
| Reserve | b1 | |
| Reserve | b2 | |
| Reserve | b3 | |
| Reserve | b4 | |
| Reserve | b5 | |
| Reserve | b6 | |
| Reserve | dL | |
| Reserve | Ac | |
| Reserve | Uo | |
| Reserve | Td | |

When the air conditioner enters the information enquiry status, it displays the code value for 25 seconds (see Table 15).

**Table 15—Information Enquiry**

| ENQUIRY INFORMATION | DISPLAY VALUE | MEANING | REMARK |
|---|---|---|---|
| T1,T2,T3,T4, T2B,TP,TH, Targeted Frequency, Actual Frequency | −1F,−1E,−1d,−1c, −1b,−1A | −25,−24,−23,−22,−21,−20 | 1. The displaying temperature is the actual value.<br>2. The temperature is °C no matter what kind of remote controller is used.<br>3. T1,T2,T3,T4,T2B display range:−25~70, TP display range:−20~130.<br>4. Frequency display range: 0~159HZ.<br>5. 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 the detailed meaning, please consult with 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.

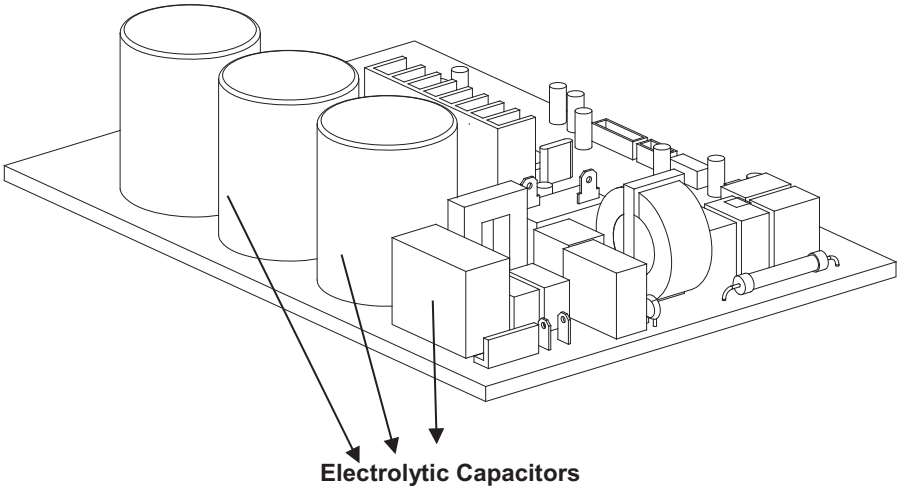



**Fig. 25 – Electrolytic Capacitors**

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.

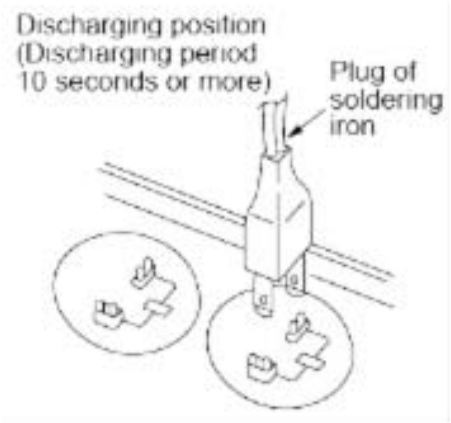



**Fig. 26 – Discharge Position**

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

# OUTDOOR UNIT DIAGNOSTIC GUIDES

**Table 16—Diagnostic Guides**

| 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 has been 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 T5 open circuit or short circuit |
| ☆ **5 times** | **O** | F4 | Outdoor unit EEPROM parameter error |
| ☆ **6 times** | **O** | F5 | Outdoor fan speed has been 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 or compressor top |
| ☆ **4 times** | ☆ | P3* | Outdoor ambient temperature too low. |
| ☆ **5 times** | ☆ | P4 | Inverter compressor drive error |
| ☆ **6 times** | ☆ | P5 | Indoor units mode conflict (multi−zone ONLY) |

O（light） X（off） ☆（flash）

# PCB DIAGRAMS

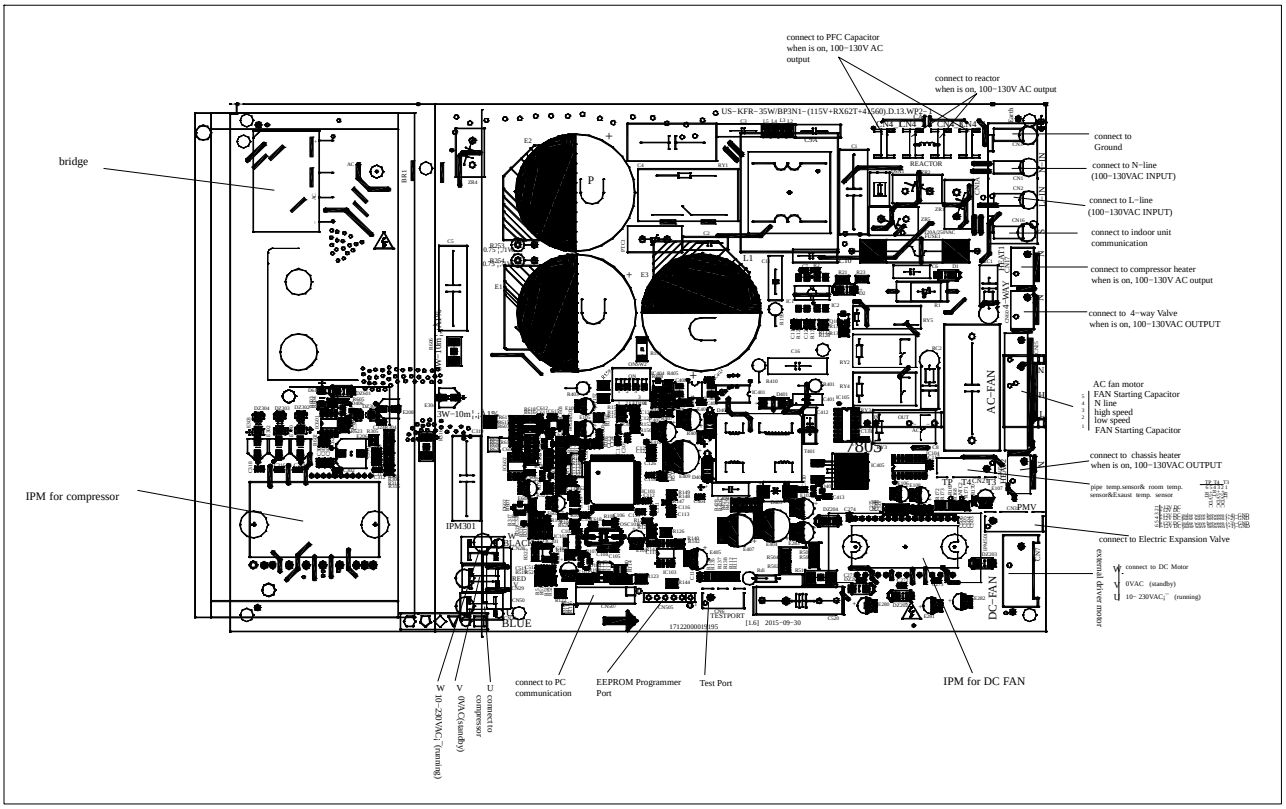



**Fig. 27 – Size 12 115V**

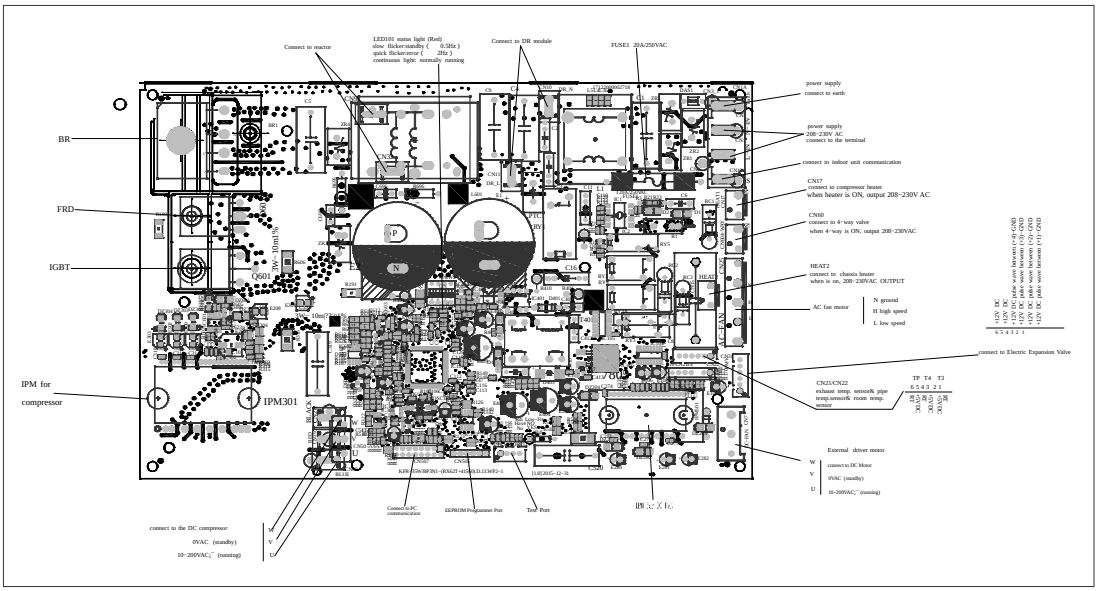



**Fig. 28 – Sizes 09~12 208~230V**

# PCB DIAGRAMS (CONT)

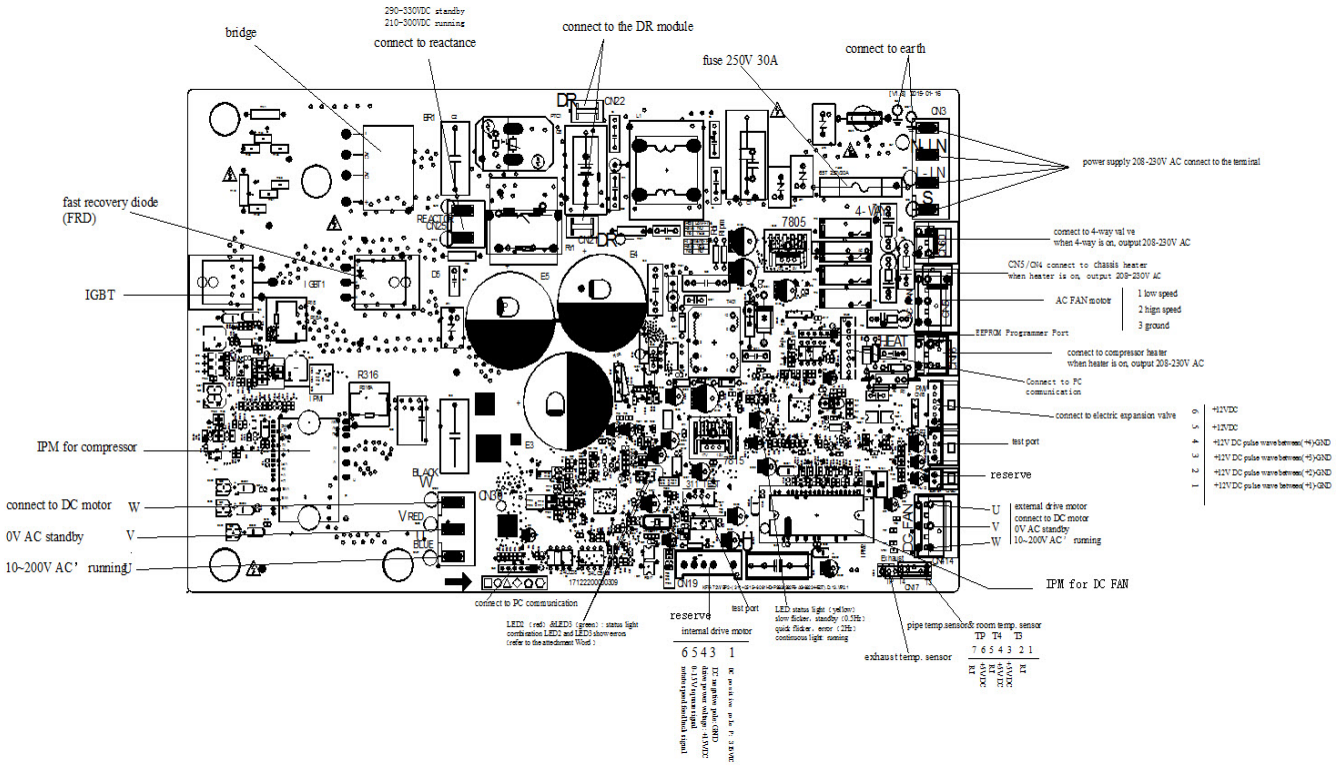



**Fig. 29 – Sizes 18−24 208−230V**

**NOTE**: After power on, LED3(Green color) and LED2(Red color) will flash if the unit has some problems.

**Table 17—LED Codes**

| No. | Problems | LED3 (Green) | LED2 (Red) | IU display |
|---|---|---|---|---|
| 1 | standby for normal | O | X | |
| 2 | Operation normally | 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 |

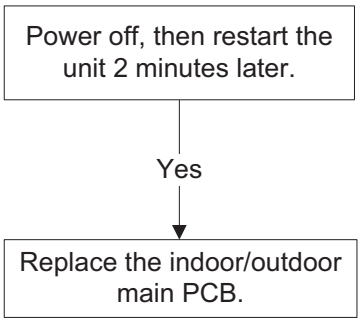
O(light) X(off) ☆(2.5Hz flash)

# DIAGNOSIS AND SOLUTION

## 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 the EEPROM chip. |
| Supposed causes | • Installation mistake<br>• PCB faulty |

**Troubleshooting**




**EEPROM:** A read−only memory whose contents can be erased and reprogrammed using a pulsed voltage. For the EEPROM chip location, please refer to Fig 30 and Fig. 31.

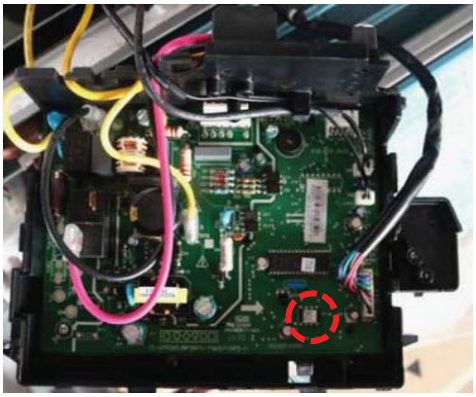


**Fig. 30 – Indoor PCB**

**Fig. 31 – Outdoor PCB**

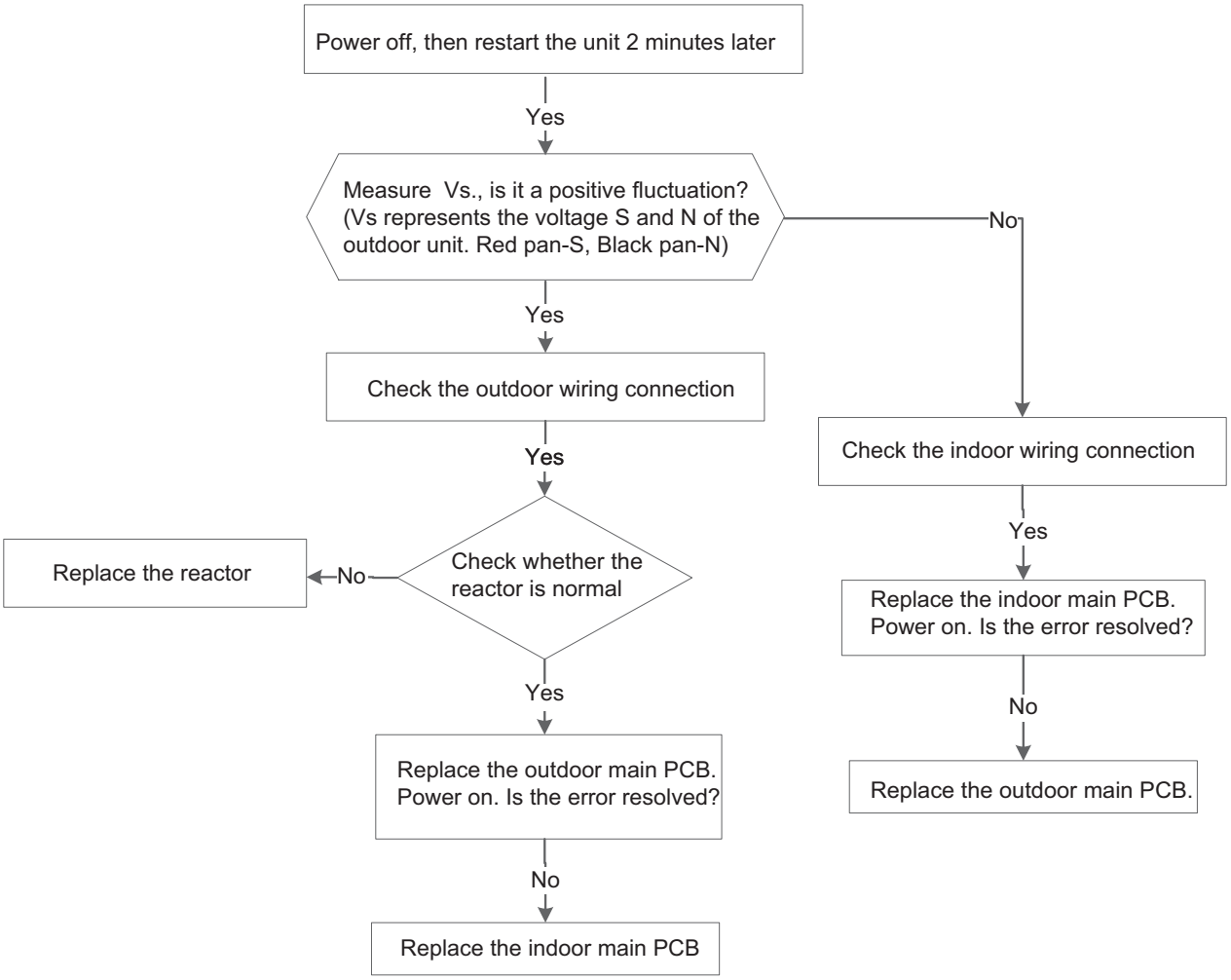
**NOTE**: The two pictures above are for reference only and they may differ from the actual unit.

# DIAGNOSIS AND SOLUTION (CONT)

## Indoor / outdoor unit's communication diagnosis and solution (E1)

| Error Code | E1 |
|---|---|
| Malfunction Decision Conditions | Indoor unit does not receive the feedback from outdoor unit during 110 seconds and this condition happens four times continuously. |
| Supposed Causes | • Wiring mistake<br>• Indoor or outdoor PCB faulty |

**Troubleshooting**



# DIAGNOSIS AND SOLUTION (CONT)

**Fig. 32 – Test the DC Voltage**

Use a multimeter to test the DC voltage between L2 port and S port of the outdoor unit. The red pin of the multimeter connects with the L2 port while the black pin is for the S port. When air conditioner is running normal, the voltage moves alternately between −50V to 50V. If the outdoor unit has a malfunction, the voltage will move alternately with positive value. If the indoor unit has malfunction, the voltage will have a certain value.


**Fig. 33 – Test the Reactor Resistance**

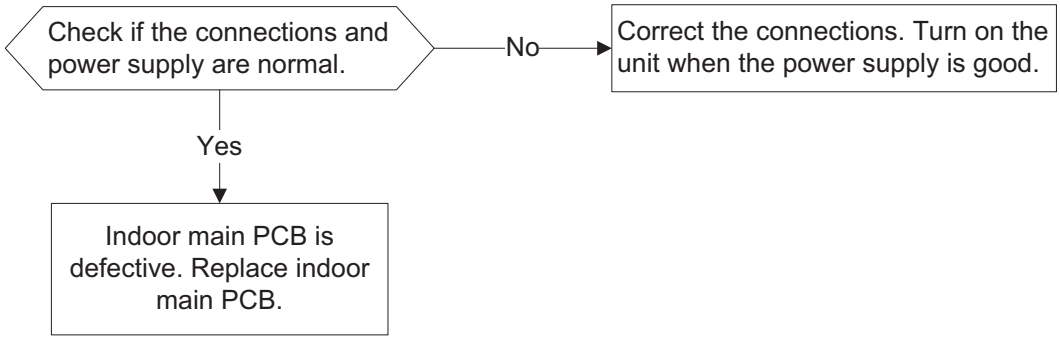
Use a multimeter to test the resistance of the reactor which does not connect with the capacitor. The normal value should be around zero (0) ohm. Otherwise, the reactor has a malfunction and needs to be replaced.

# DIAGNOSIS AND SOLUTION (CONT)

## Zero crossing detection error diagnosis and solution (E2)

| Error Code | E2 |
|---|---|
| Malfunction decision conditions | When the PCB does not receive a zero crossing signal feedback for 4 minutes or the zero crossing signal time interval is abnormal. |
| Supposed causes | • Connection mistake<br>• PCB faulty |

**Troubleshooting**

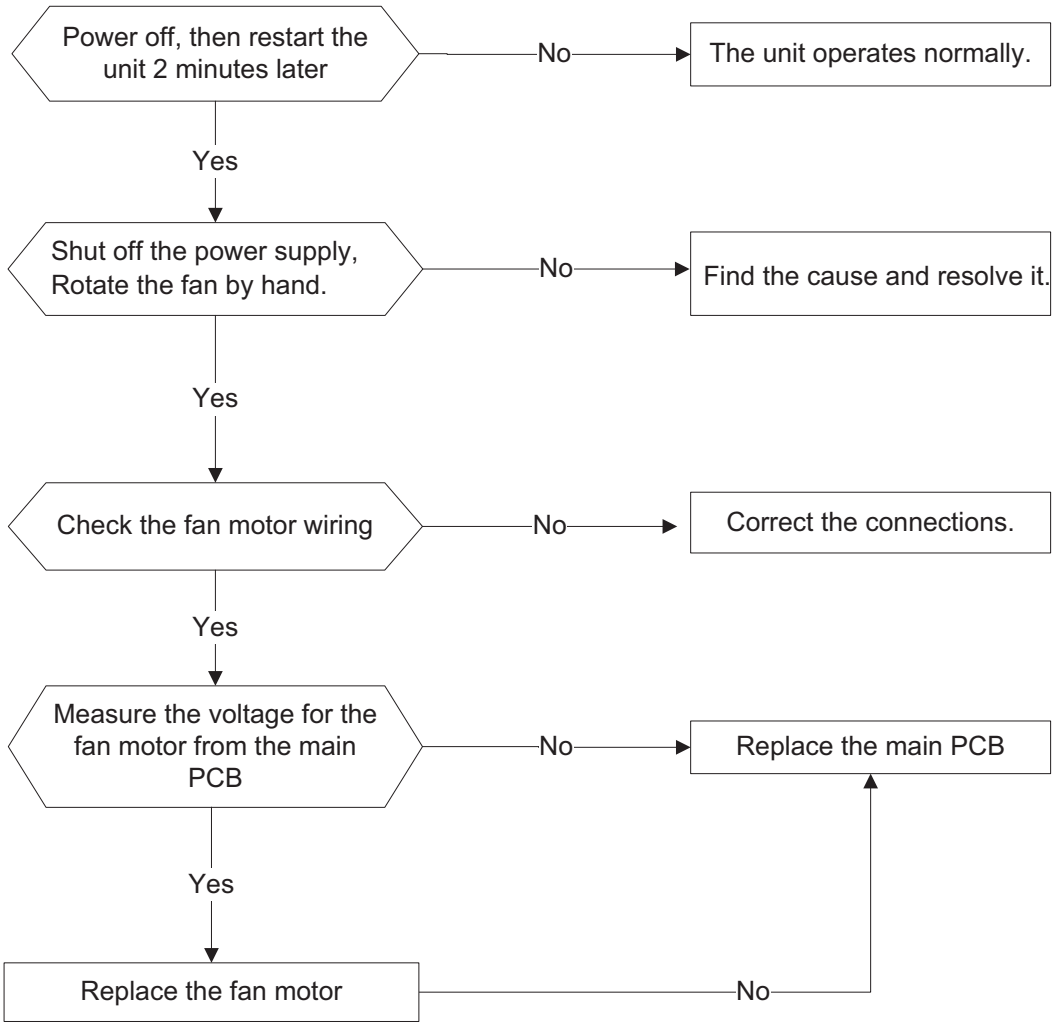


# DIAGNOSIS AND SOLUTION (CONT)

## Fan speed has been out of control diagnosis and solution (E3/F5)

| Error Code | E3/F5 |
|---|---|
| Malfunction decision conditions | When indoor fan speed remains too low (300RPM) for certain time, the unit stops and the LED displays the failure. |
| Supposed causes | • Wiring mistake<br>• Fan assembly faulty<br>• Fan motor faulty<br>• PCB faulty |

**Troubleshooting**



# DIAGNOSIS AND SOLUTION (CONT)

## Index 1

1 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 fan motor connector. If the voltage value is not in the range shown in Table 18 or Table 19, the PCB has an issue and needs to be replaced.

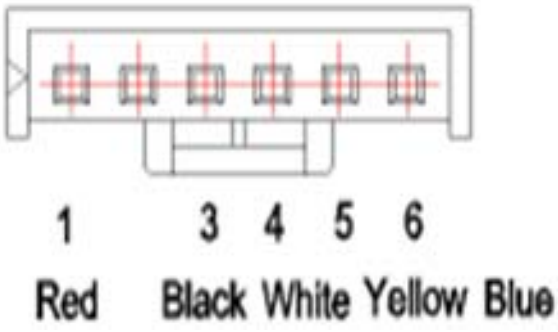



**Fig. 34 – Motor Connector**

**Table 18—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 19—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 the unit and check if the fan runs normally. If the fan runs normally, the PCB has an issue and needs to be replaced. If the fan does not run normally, measure the resistance of each two pins. If the resistance is not equal to each other, the fan motor has an issue and needs to be replaced, otherwise the PCB has an issue and needs to be replaced.

3 Indoor AC Fan Motor

- Power on the unit and set the unit in **FAN** mode at the high fan speed. Run for 15 seconds then measure the voltage of pin1 and pin2. If the voltage value is less than 100V(208~240V power supply) or 50V(115V power supply), the PCB has an issue and needs to be replaced.

# DIAGNOSIS AND SOLUTION (CONT)

## Open circuit or short circuit of temperature sensor diagnosis and solution (E4/E5/F1/F2/F3)

| Error Code | E4/E5/F1/F2/F3 |
|---|---|
| Malfunction decision conditions | If the sampling voltage is lower than 0.06V or higher than 4.94V, the LED displays the failure. |
| Supposed causes | • Wiring mistake<br>• Sensor faulty<br>• PCB faulty |

**Troubleshooting**

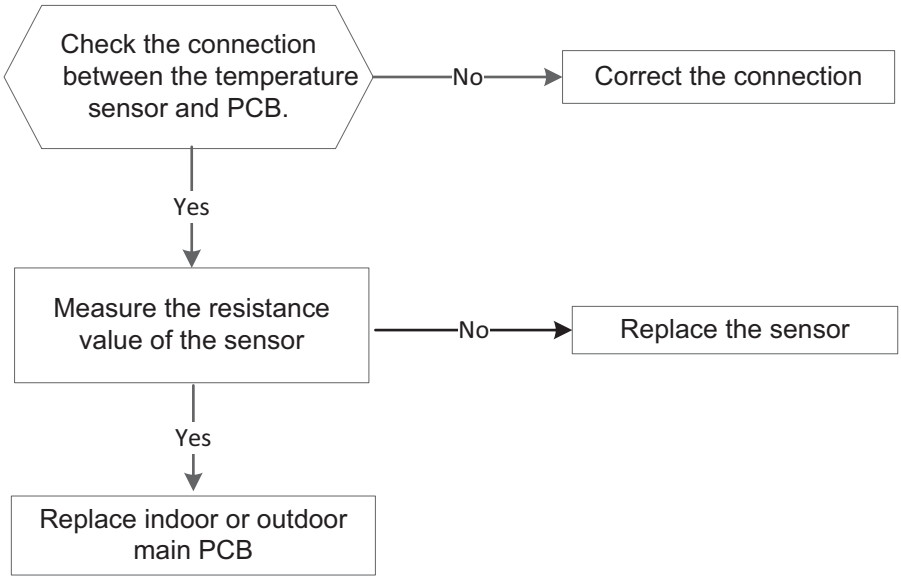




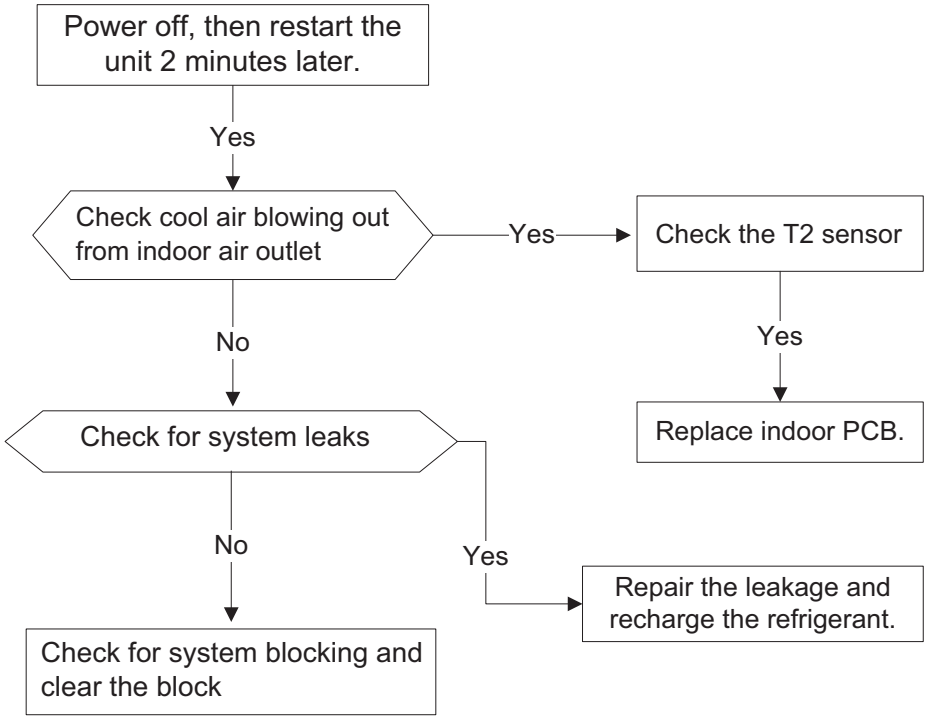
**Fig. 35 – Check the connection**

# DIAGNOSIS AND SOLUTION (CONT)

## Refrigerant Leakage Detection diagnosis and solution (EC)

| Error Code | EC |
|---|---|
| Malfunction decision conditions | Define the evaporator coil temp.T2 of the compressor. It starts running in Tcool.<br>At first, 5 minutes after the compressor starts up, if T2 ＜Tcool－35.6°F (Tcool－2 °C) does not run for 4 seconds and this situation occurs 3 times, the display area displays “EC” and the air conditioner will turn off. |
| Supposed causes | • T2 sensor faulty<br>• Indoor PCB faulty<br>• System problems, such as leakage or blocking. |

**Troubleshooting**

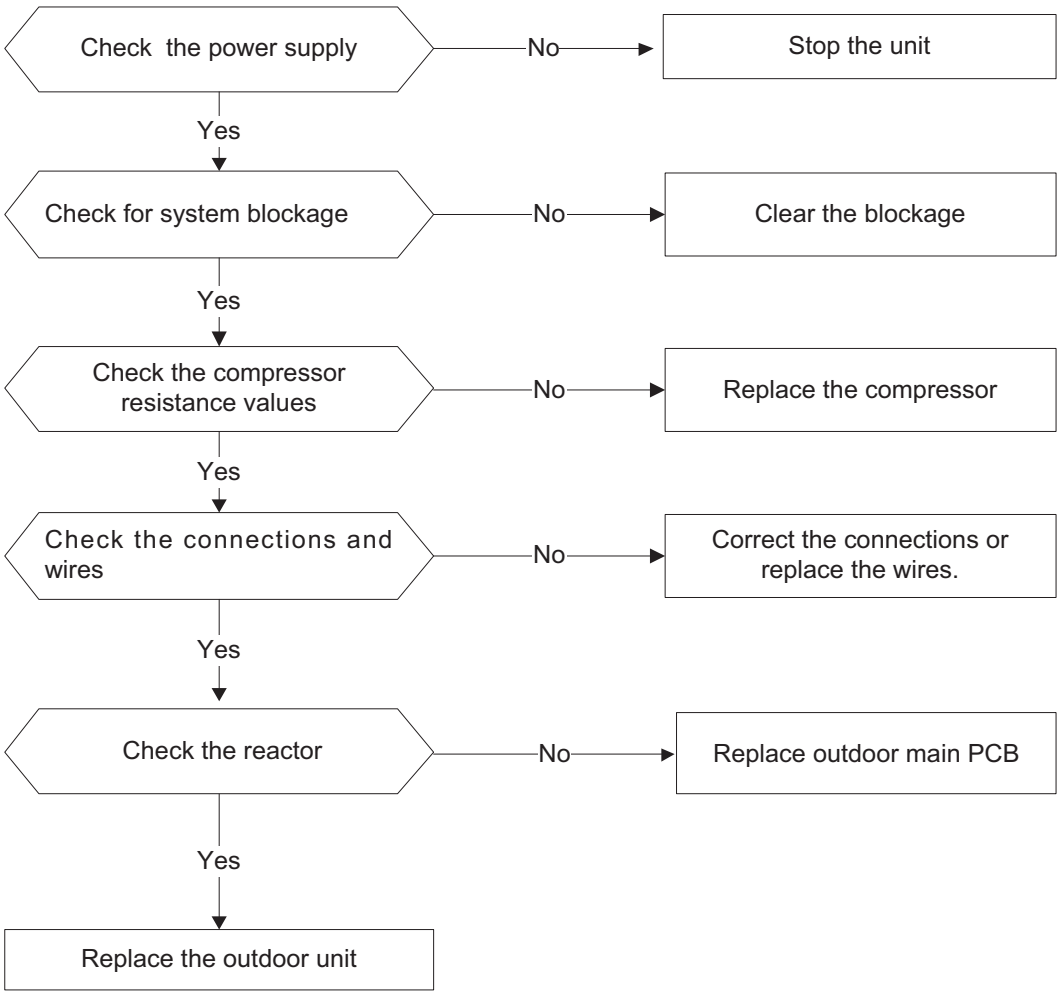


# DIAGNOSIS AND SOLUTION (CONT)

## 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<br>• System blockage<br>• PCB faulty<br>• Wiring mistake<br>• Compressor malfunction |

**Troubleshooting**

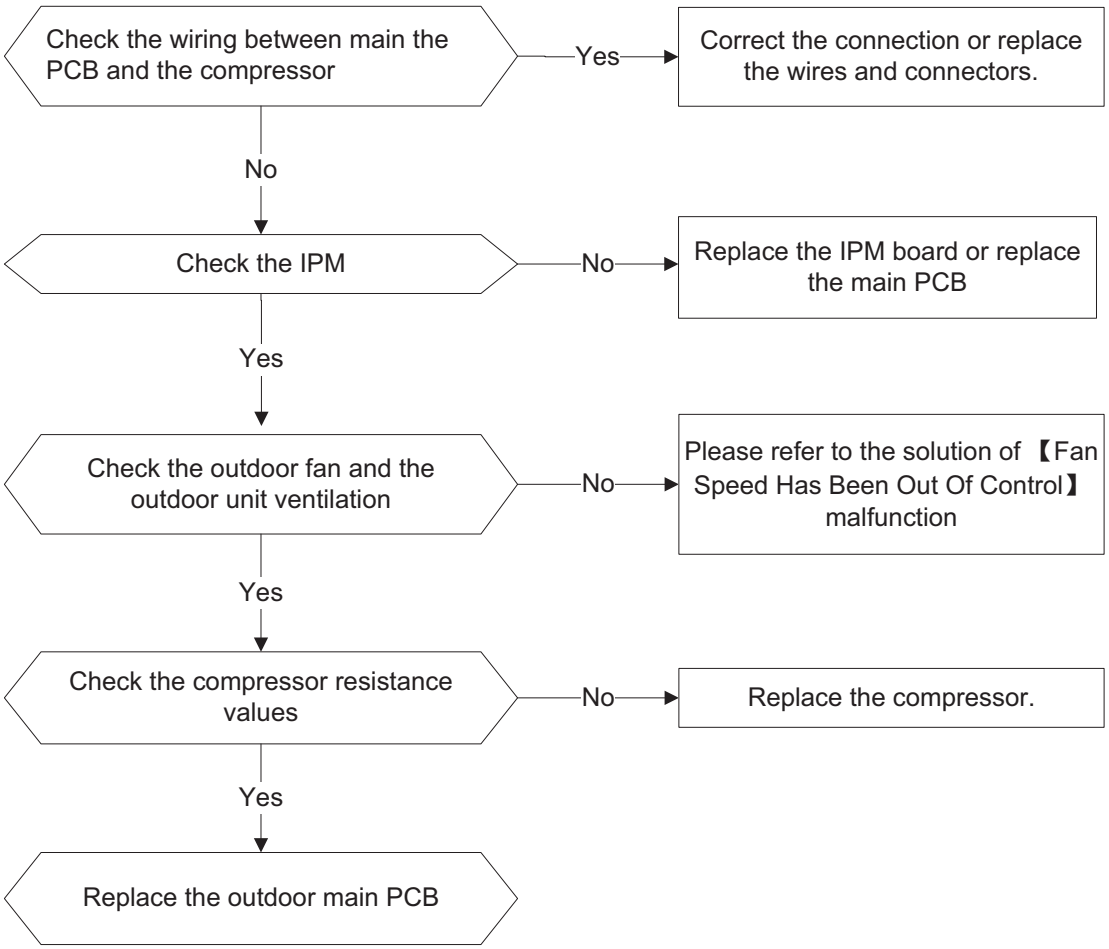


# DIAGNOSIS AND SOLUTION (CONT)

## IPM malfunction or IGBT over−strong current protection diagnosis and solution (P0)

| Error Code | P0 |
|---|---|
| Malfunction decision conditions | When the voltage signal, that the IPM sends to the compressor drive chip is abnormal, the display LED displays P0” and the air conditioner turns off. |
| Supposed causes | • Wiring mistake<br>• IPM malfunction<br>• Outdoor fan assembly faulty<br>• Compressor malfunction<br>• Outdoor PCB faulty |

**Troubleshooting**



# DIAGNOSIS AND SOLUTION (CONT)

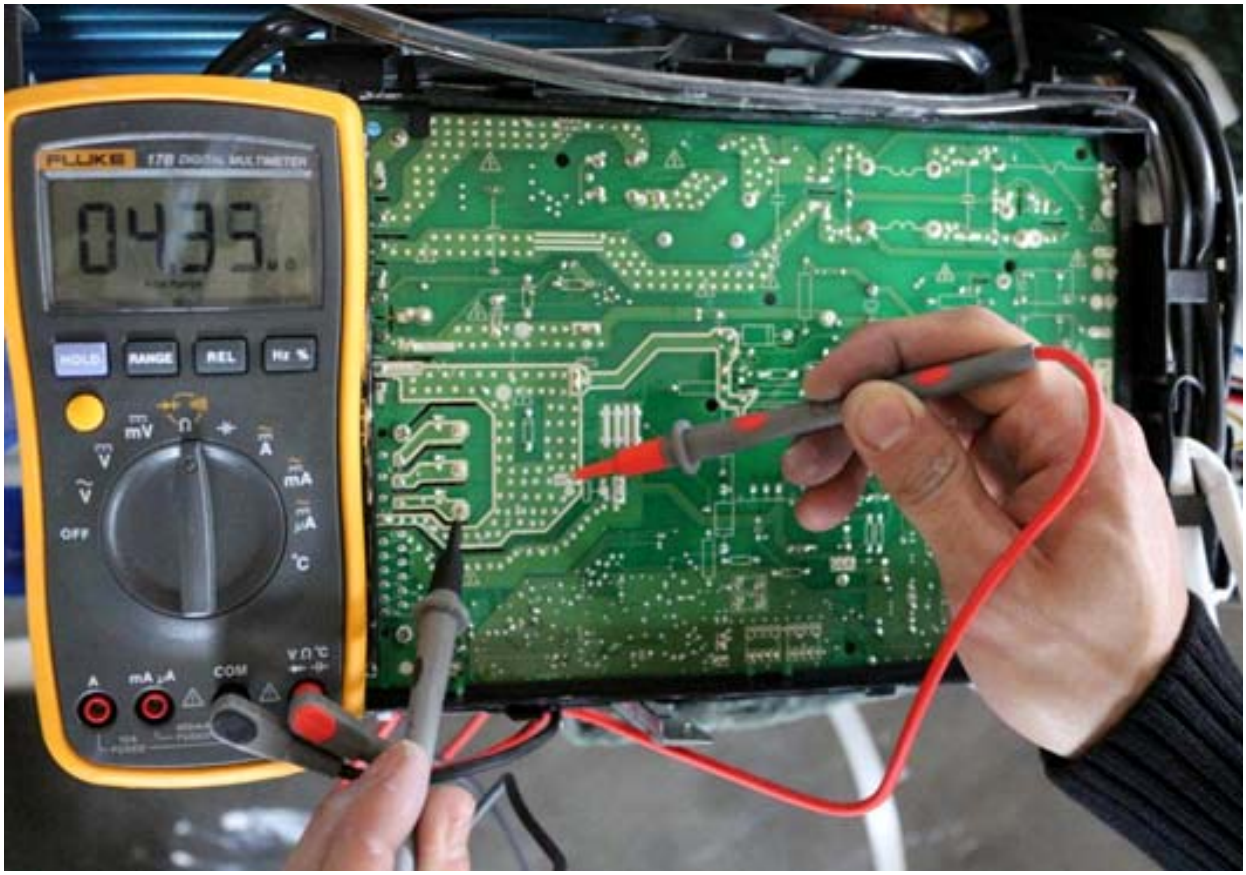



**Fig. 36 – P−U**

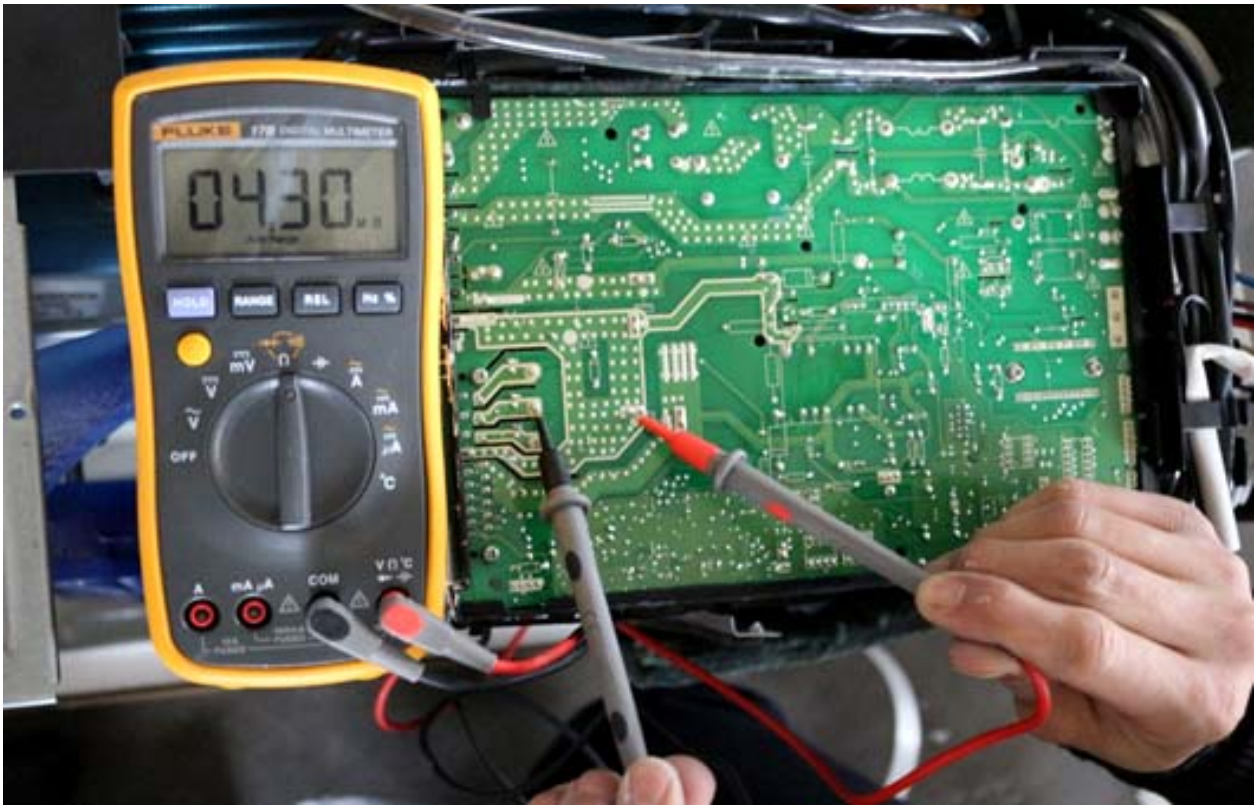



**Fig. 37 – P−V**

# DIAGNOSIS AND SOLUTION (CONT)

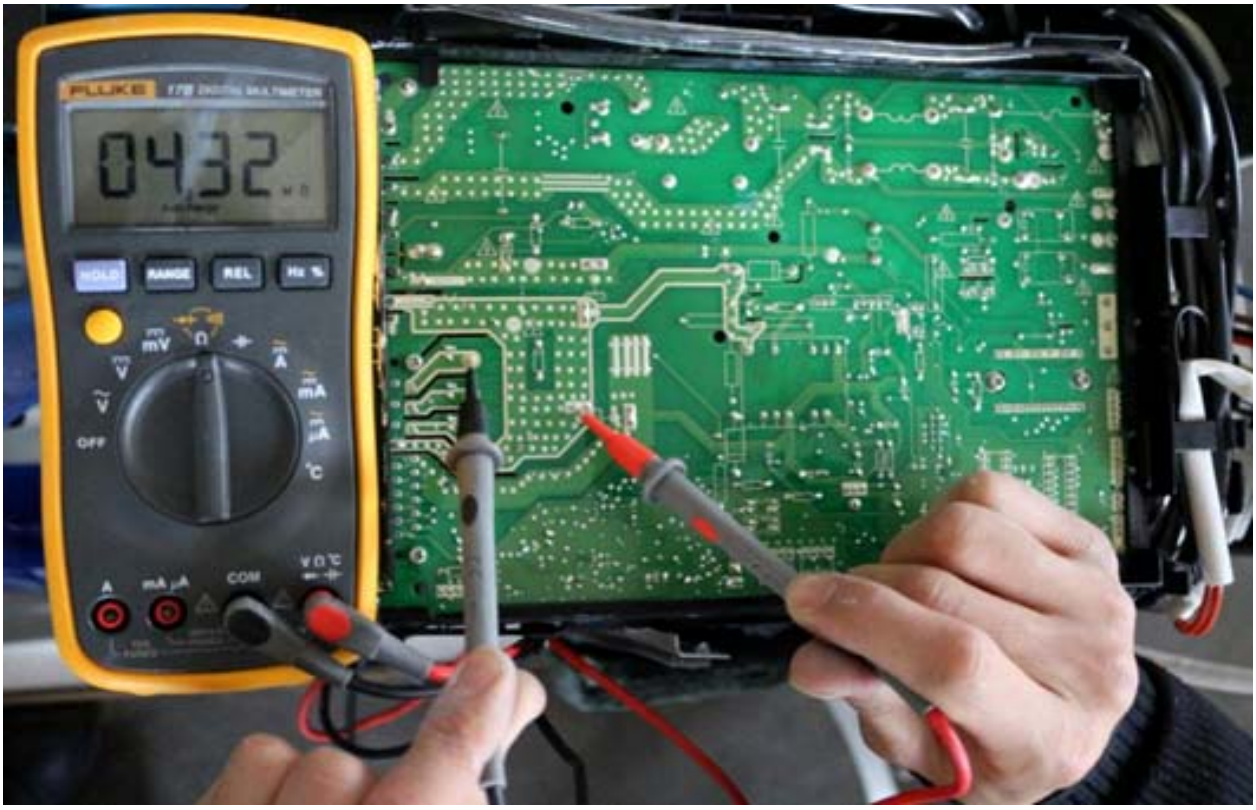



**Fig. 38 – P−W**

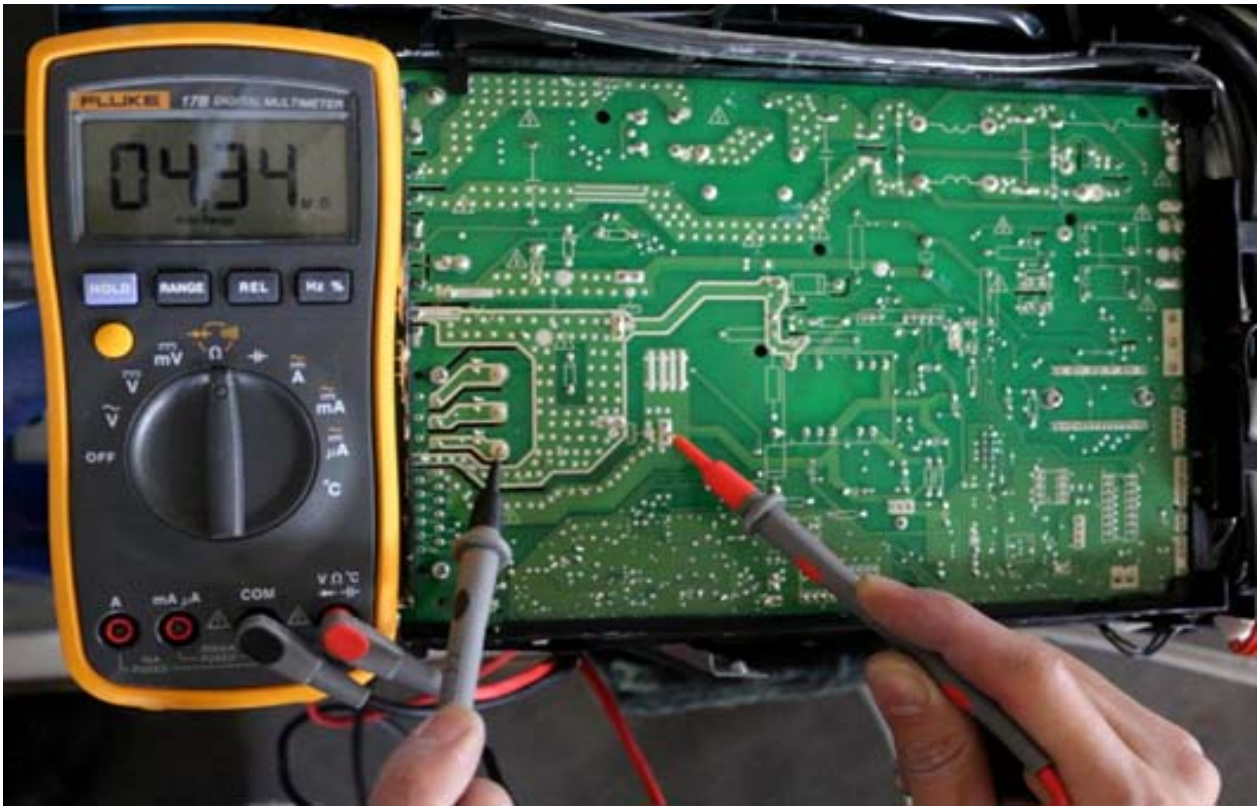



**Fig. 39 – N−U**

# DIAGNOSIS AND SOLUTION (CONT)

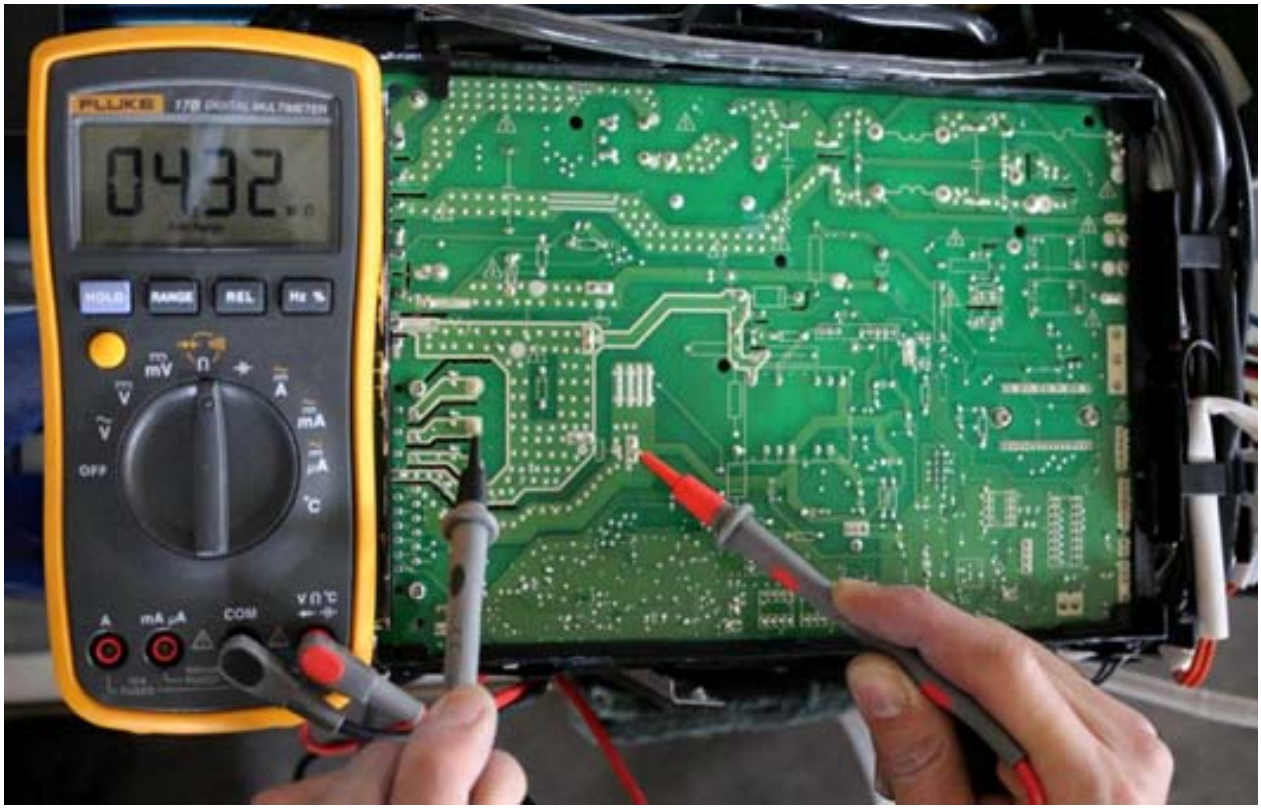



**Fig. 40 – N−V**

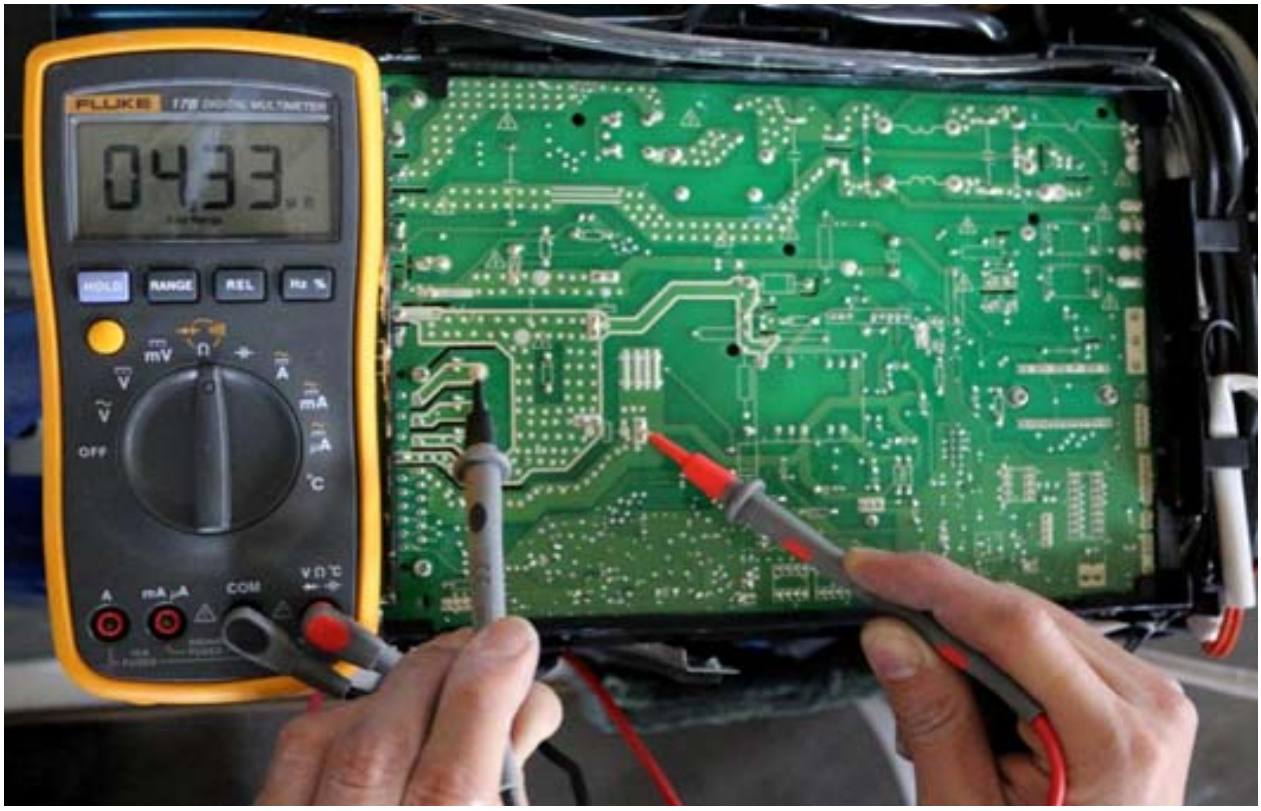


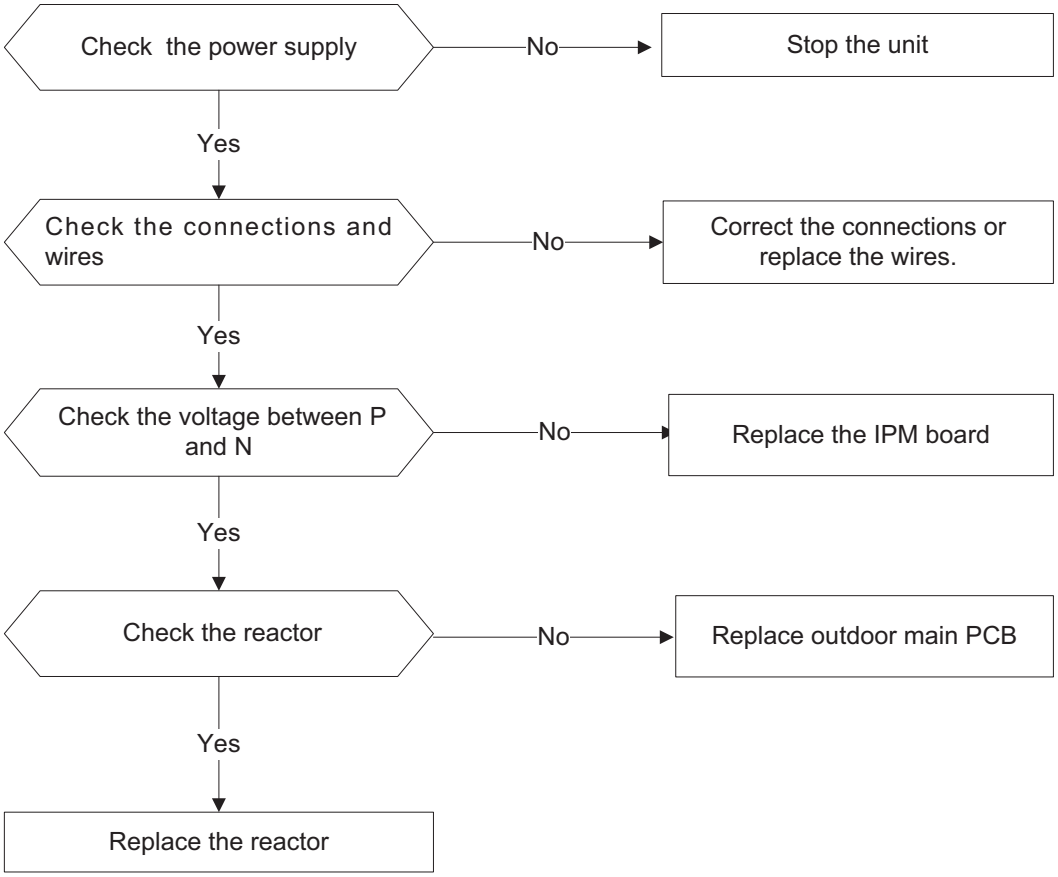

**Fig. 41 – N−W**

# DIAGNOSIS AND SOLUTION (CONT)

## 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<br>• System leakage or block<br>• PCB faulty |

**Troubleshooting**



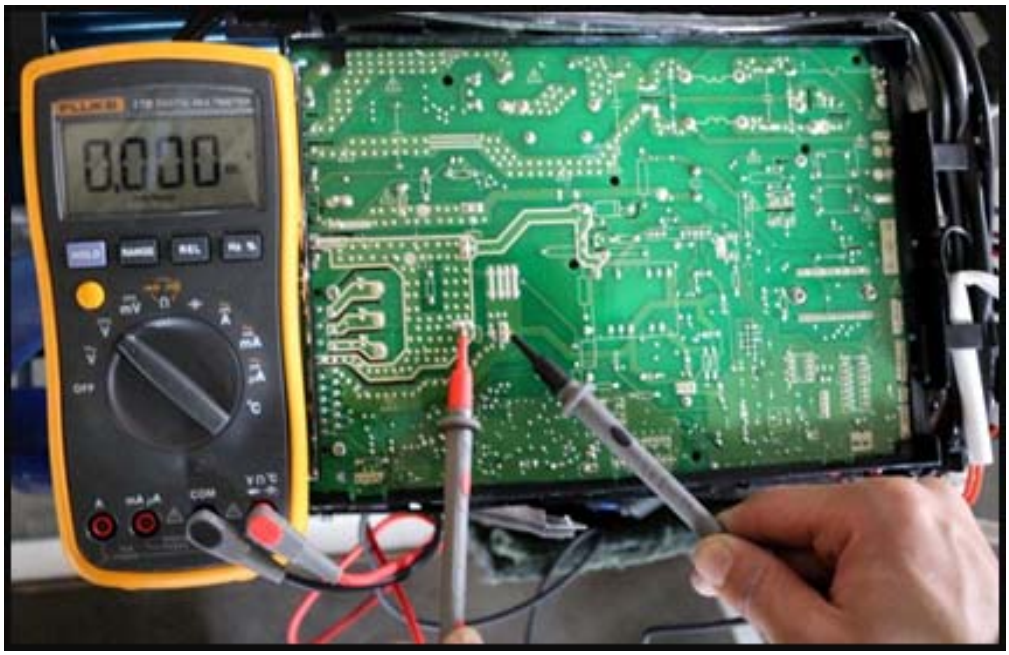



**Fig. 42 – Test**

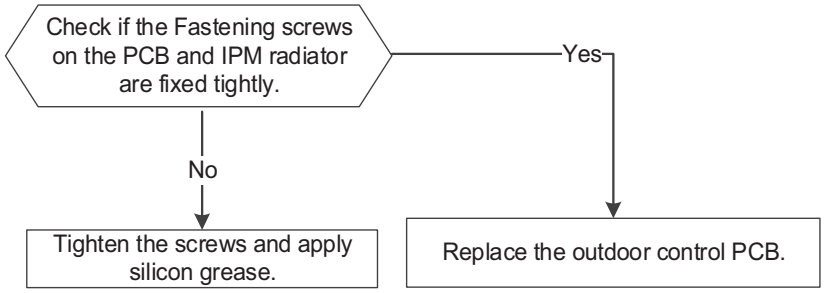
**NOTE**: Measure the DC voltage between the P and N port. The normal value should be around 310V.

# DIAGNOSIS AND SOLUTION (CONT)

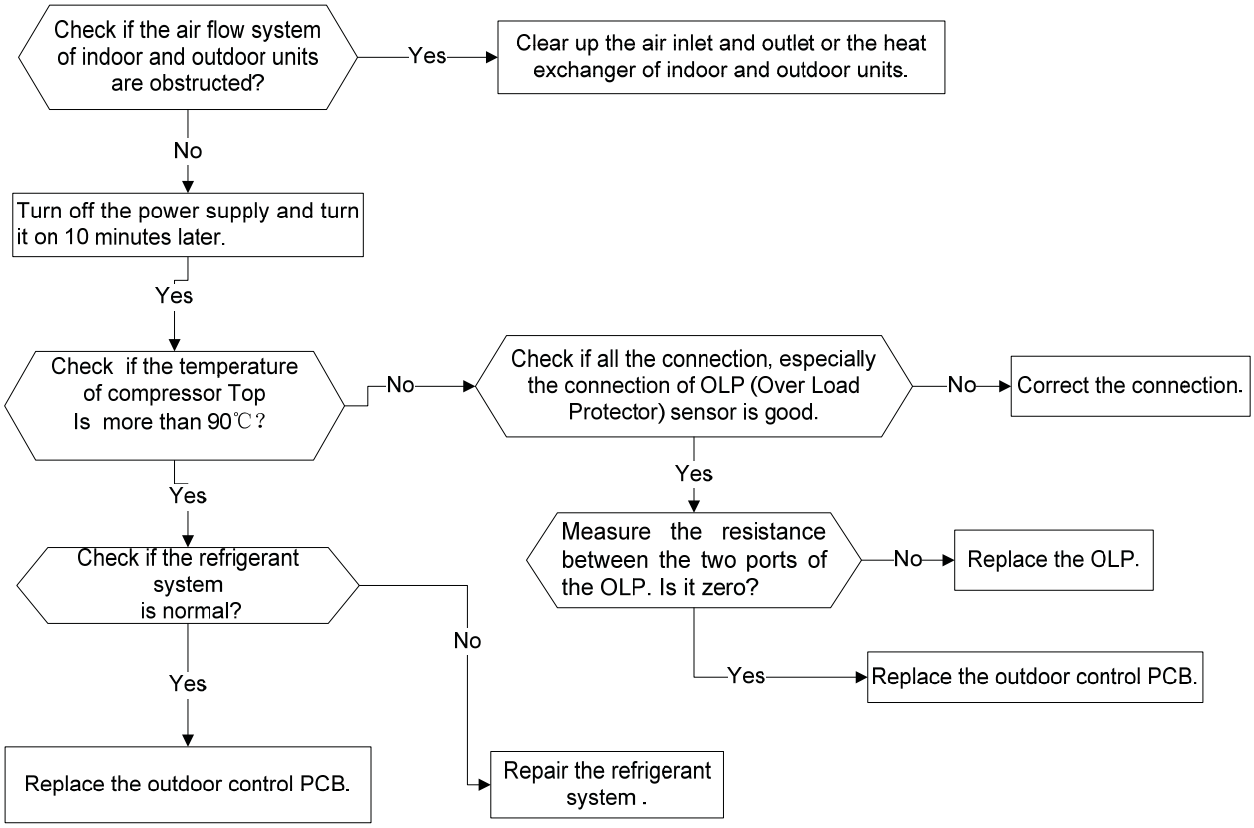
## High temperature protection of compressor top diagnosis and solution (P2)

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

**Troubleshooting**




**For other models,**

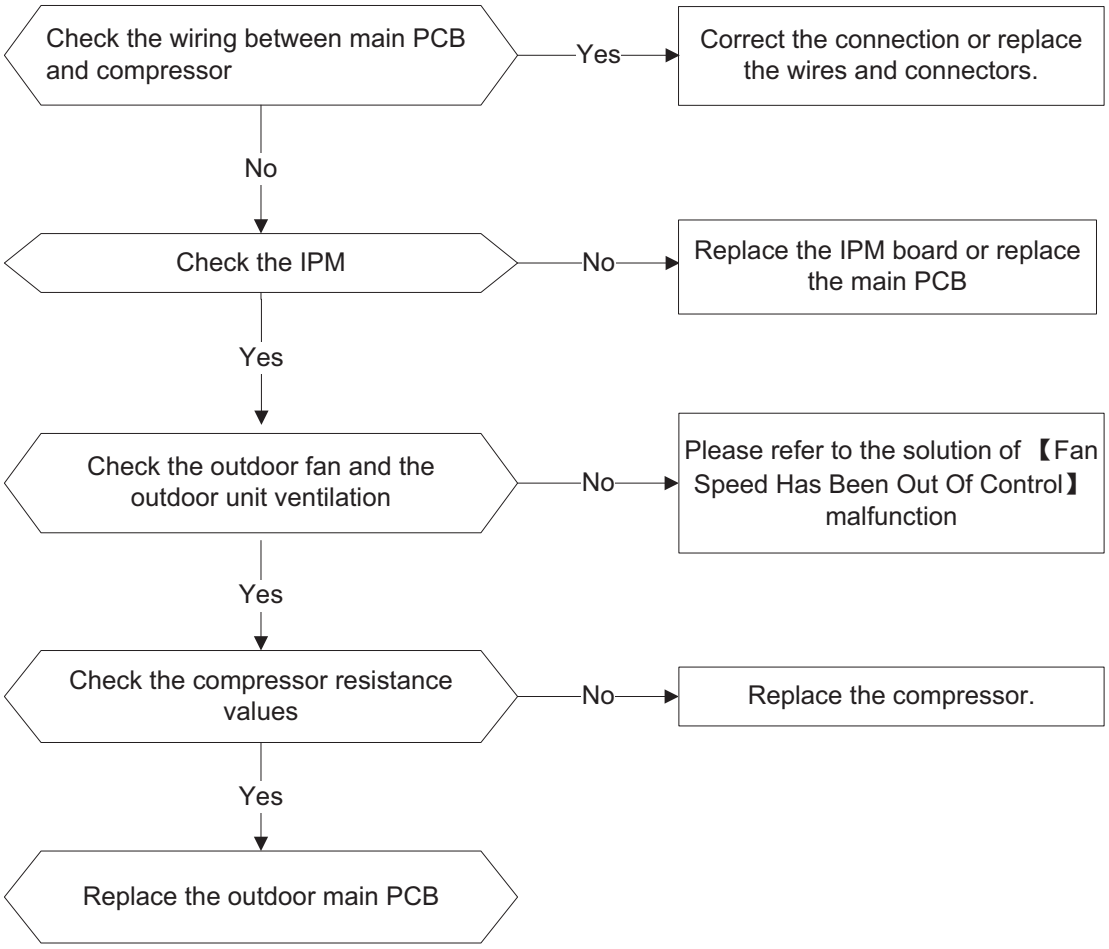


# DIAGNOSIS AND SOLUTION (CONT)

## 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, compressor rotation speed signal detection, etc. |
| Supposed causes | • Wiring mistake<br>• IPM malfunction<br>• Outdoor fan assembly faulty<br>• Compressor malfunction<br>• Outdoor PCB faulty |

**Troubleshooting**



# DIAGNOSIS AND SOLUTION (CONT)

## Main Parts Check

**Temperature Sensor Checking**

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

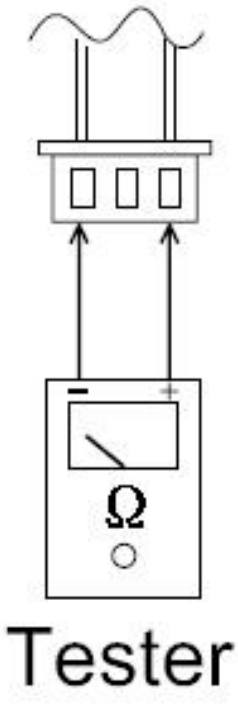



**Fig. 43 – Tester**

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.

# DIAGNOSIS AND SOLUTION (CONT)

## Compressor Checking

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

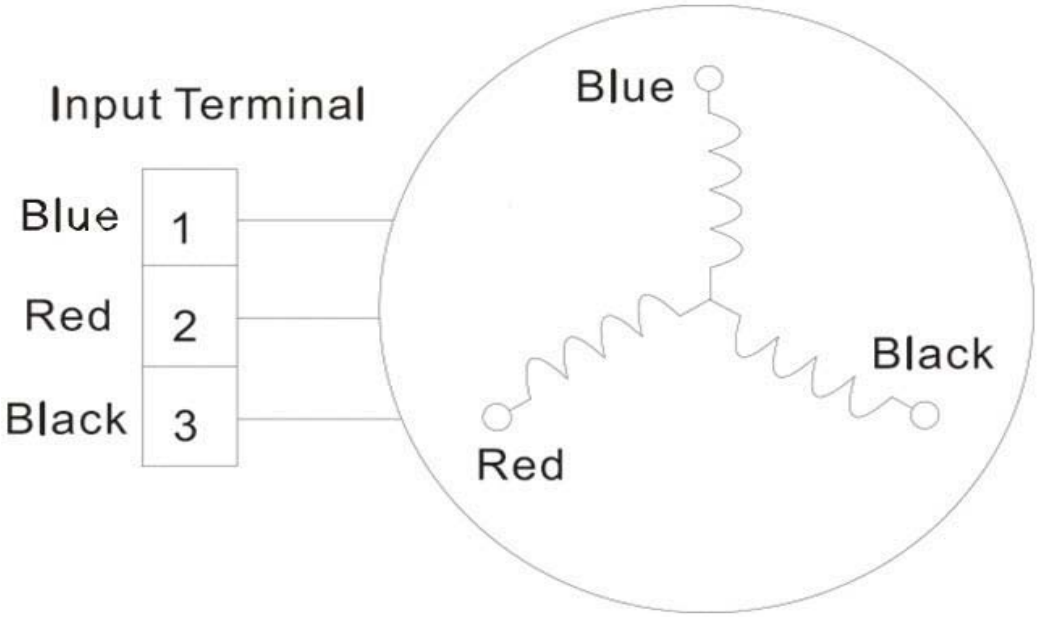



**Fig. 44 – Tester**

**Table 20—Compressor Checking**

| Position | Resistance Value | | | |
|---|---|---|---|---|
| | ASN98D22UFZ | ASM135D23UFZ | ATF235D22UMT | ATF250D22UMT |
| Blue – Red | 1.57Ω | 1.75 Ω | 0.75 Ω | 0.75 Ω |
| Blue – Black | | | | |
| Red – Blue | | | | |

**Fig. 45 – Compressor Checking**

# DIAGNOSIS AND SOLUTION (CONT)

## 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 21—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 | | |

## Fan Motor

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

**Table 22—Fan Motor**

| Model | | YKT−32−6−202L | YKT−32−6−3L | YKT−48−6−206 | YKT−63−6−200L |
|---|---|---|---|---|---|
| Brand | | Tongde | Welling | Welling | Welling |
| Black – Red (Main) | Ω | 86 | 213 | 152 | 88.5 |
| Blue –Black (AUX) | Ω | 64 | 156 | 142 | 138 |

## Pressure on Service Port

**Table 23—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 |
| | | | | | | |
| °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 | 132 | 155 |
| PSI | 80/67 | 135 | 129 | 132 | 140 | 162 |
| | | | | | | |
| °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 |

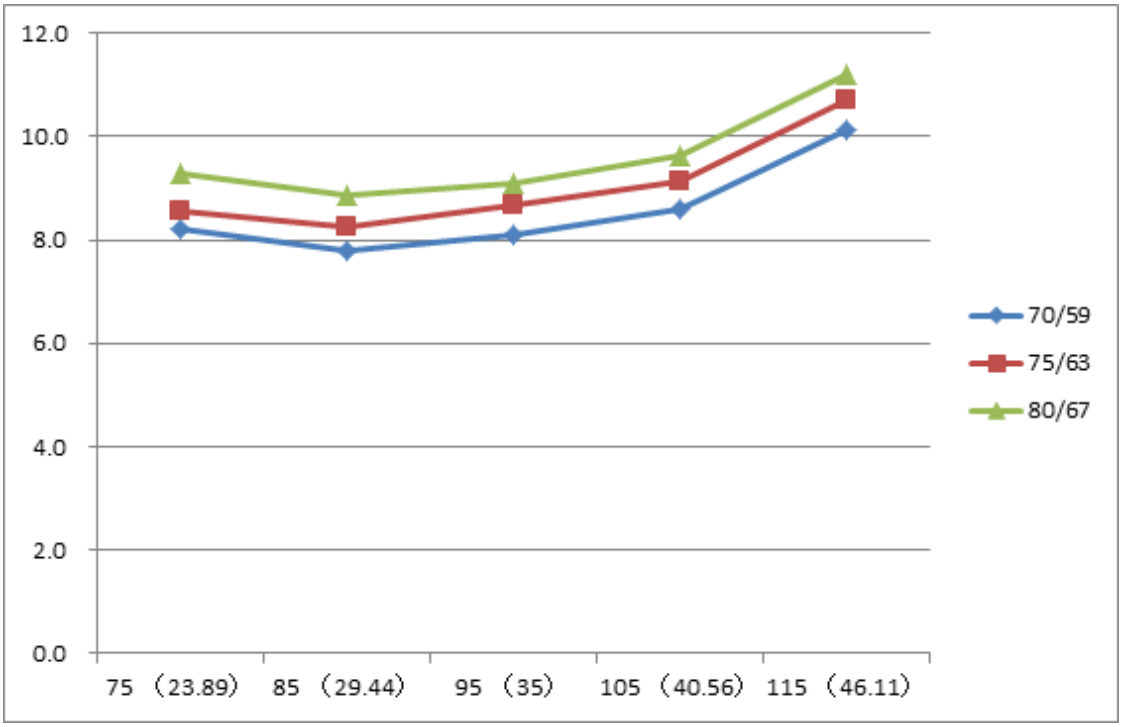



**Fig. 46 – Cooling Chart**

## Pressure on Service Port (Cont)

**Table 24—Heating Chart**

| °F (°C) | ODT<br>IDT | 57/53<br>(13.89/11.67) | 47/43<br>(8.33/6.11) | 37/33<br>(2.78/0.56) | 27/23<br>(−2.78/−5) | 17/13<br>(−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 |
| | | | | | | |
| °F (°C) | ODT<br>IDT | 57/53<br>(13.89/11.67) | 47/43<br>(8.33/6.11) | 37/33<br>(2.78/0.56) | 27/23<br>(−2.78/−5) | 17/13<br>(−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 |
| | | | | | | |
| °F (°C) | ODT<br>IDT | 57/53<br>(13.89/11.67) | 47/43<br>(8.33/6.11) | 37/33<br>(2.78/0.56) | 27/23<br>(−2.78/−5) | 17/13<br>(−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 |

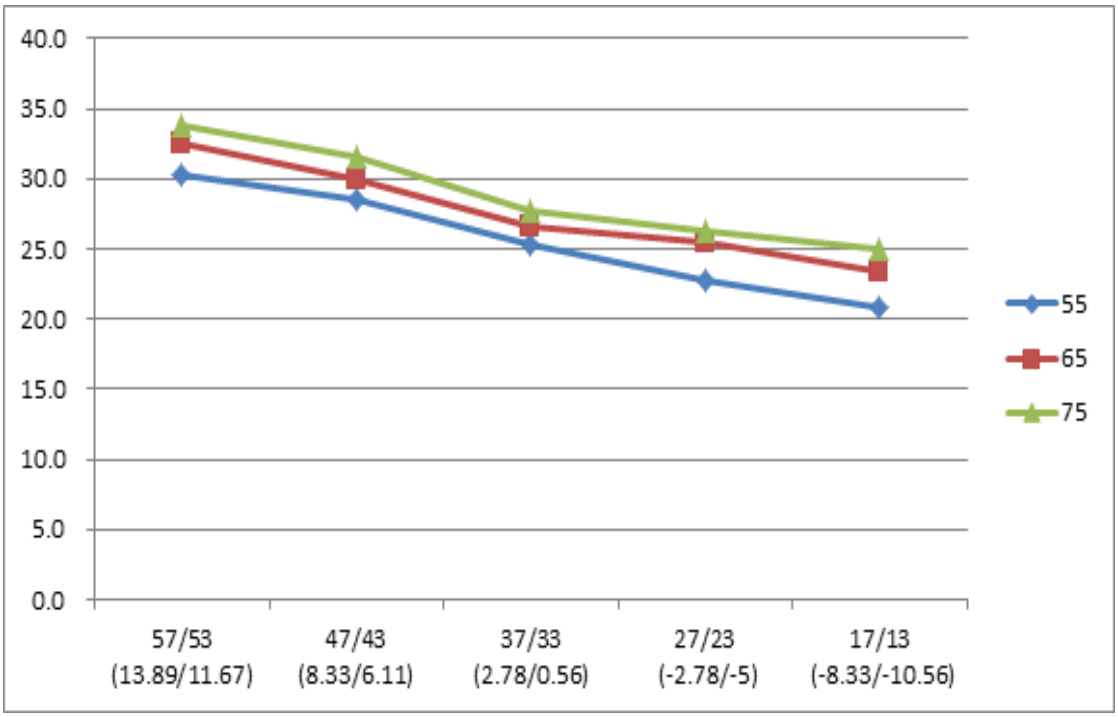
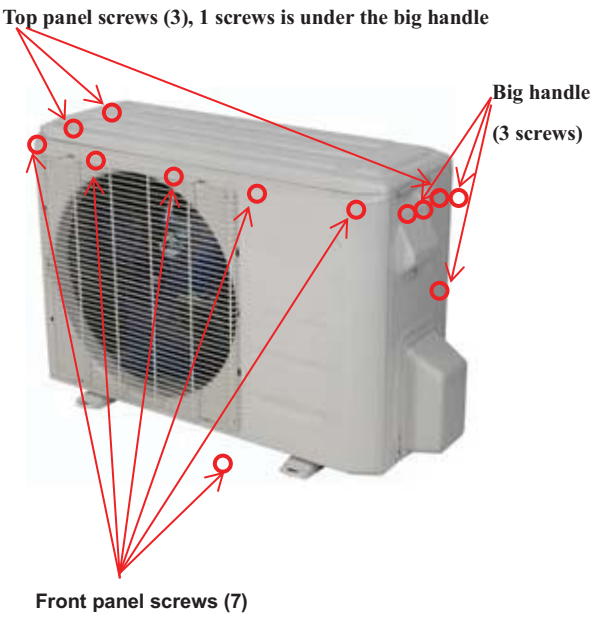
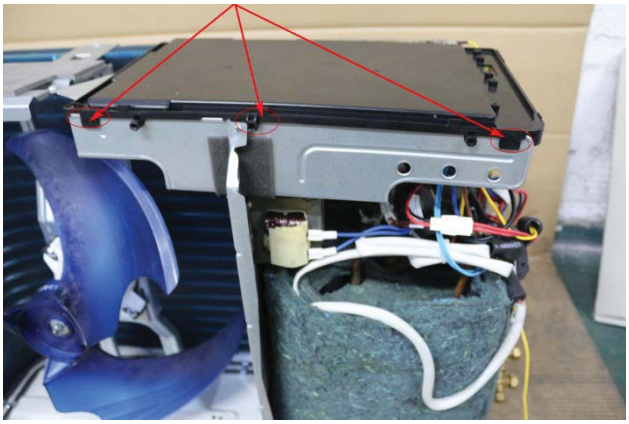
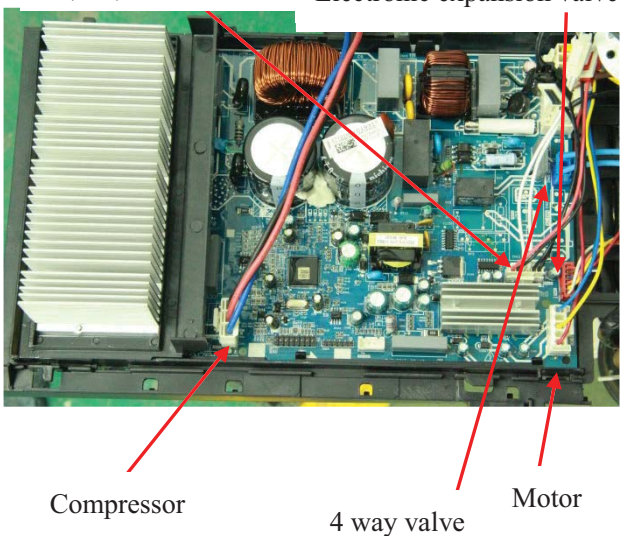



**Fig. 47 – Heating Chart**

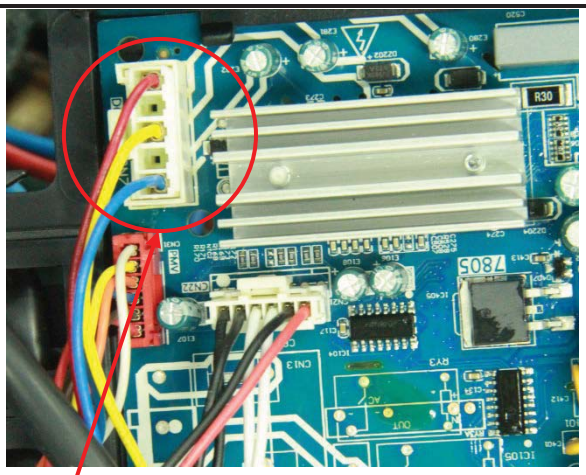
# DISASSEMBLY INSTRUCTIONS SIZES 12K (115V)

| | | | |
|---|---|---|---|
| 1 | Panel plate | How to remove the panel plate.<br>1. Stop the air conditioner and turn “OFF” the power breaker.<br>2. Remove the big handle first, and then remove the top cover (3 screws).<br>3. Remove the front panel screws (7).<br>4. Remove the right side panel screws (11). |  <br>  |

# DISASSEMBLY INSTRUCTIONS SIZES 12K (115V) (CONT)

| | | | |
|---|---|---|---|
| 2 | Fan assembly | How to remove the fan assembly.<br><br>1) Remove the nut securing the fan, and remove the fan.<br><br>2) After removing the top cover, release the hooks and open the electronic control box cover.<br><br>3) Disconnect the fan motor connector from the electronic control board. | ②<br>  <br>③<br>  <br>  |

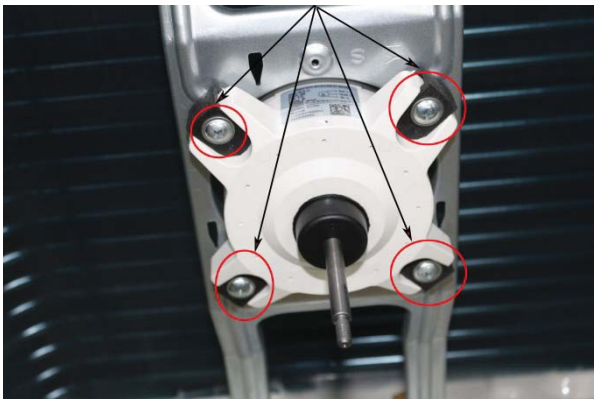
# DISASSEMBLY INSTRUCTIONS SIZES 12K (115V) (CONT)



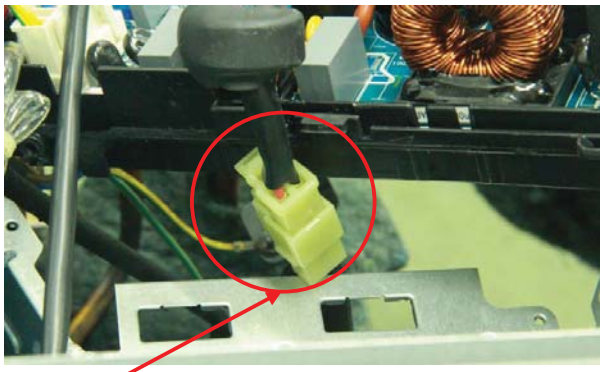
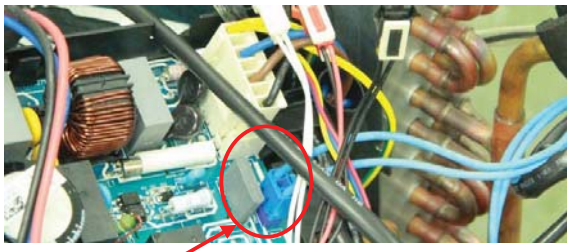
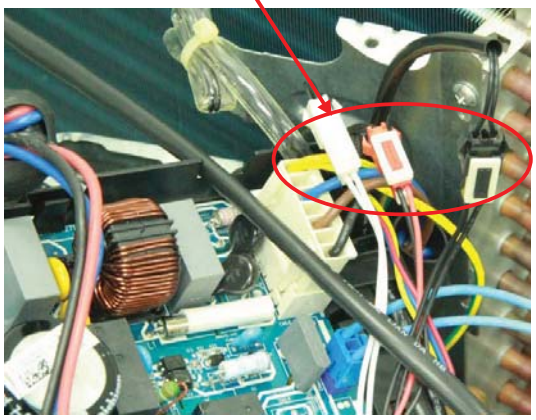

④

4) Remove the fan motor screws (4) then remove the motor.

⑤

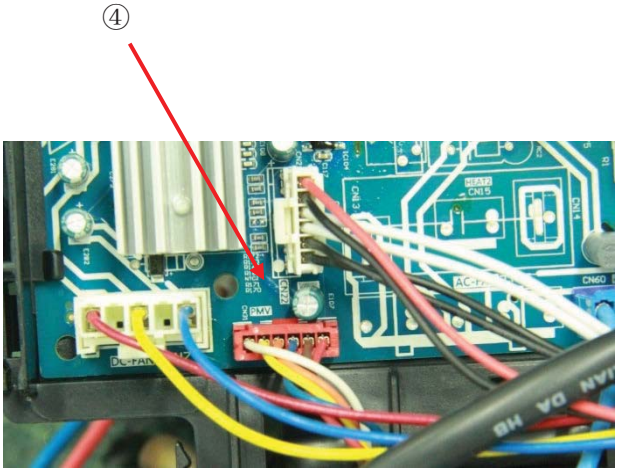


# DISASSEMBLY INSTRUCTIONS SIZES 12K (115V) (CONT)

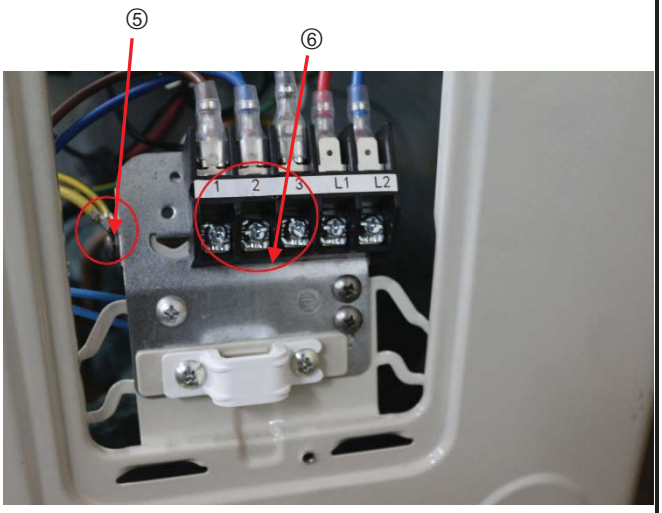
| | | | |
|---|---|---|---|
| 3 | Electrical parts | How to remove the electrical parts.<br>1) After you complete the steps in item 1 and 2, remove the compressor connector.<br>2) Pull out the two blue wires connected to the four way valve.<br>3) Pull out connectors of the condenser coil temp. sensor (T3), outdoor ambient temp. sensor (T4) and discharge temp. sensor (T5). |  <br>①<br>  <br>②<br>③<br>  |

# DISASSEMBLY INSTRUCTIONS SIZES 12K (115V) (CONT)

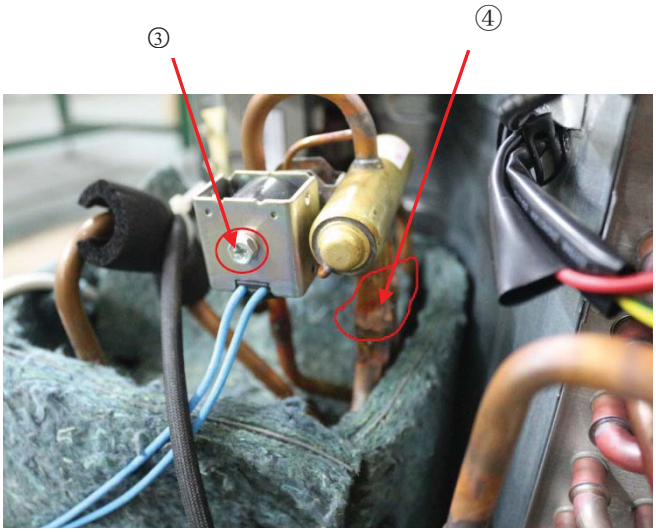
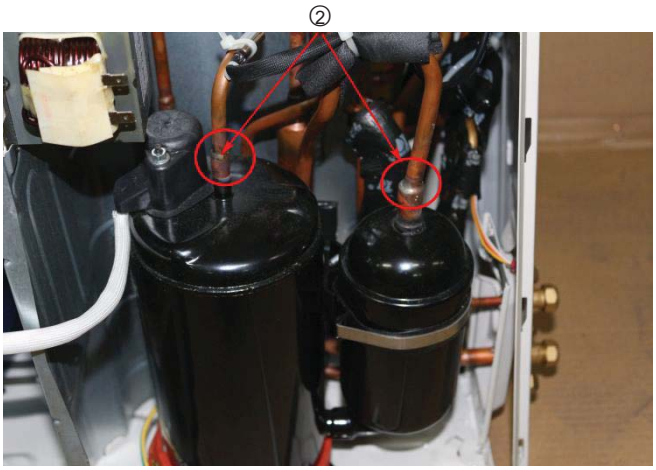
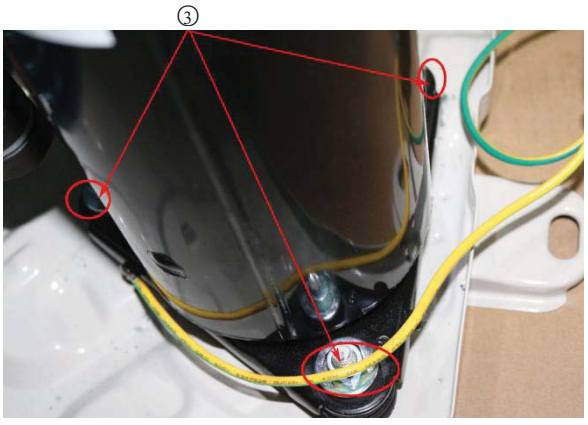
4) Disconnect the electronic expansion valve wire from the control board.



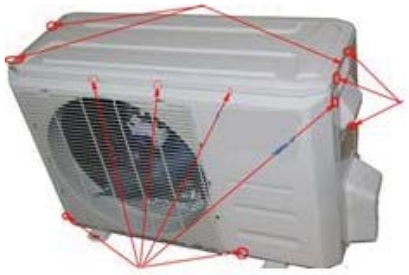

5) Remove the ground wires.
6) Remove the wires (1,2,3).
7) Remove the electronic control box.



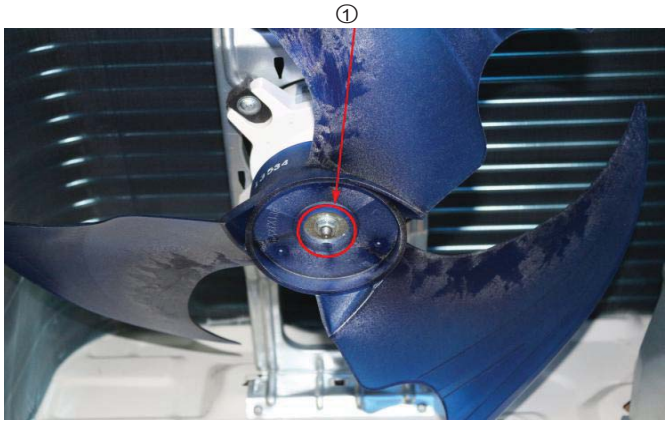
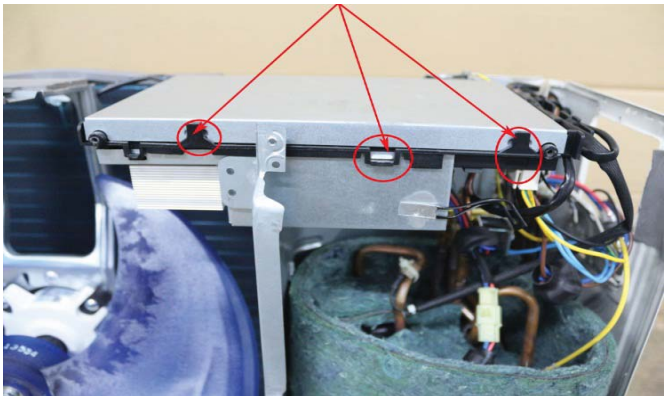
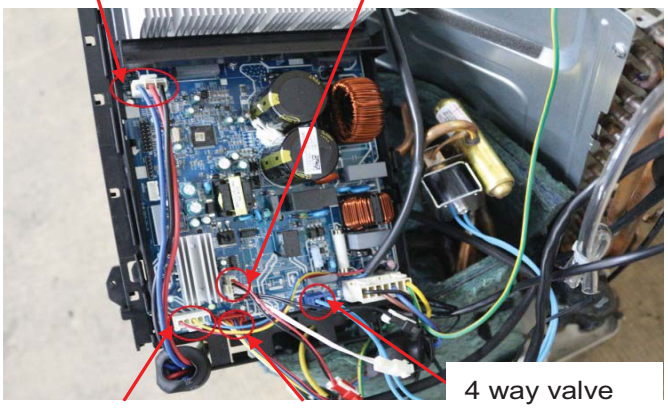
# DISASSEMBLY INSTRUCTIONS SIZES 12K (115V) (CONT)

| | | | |
|---|---|---|---|
| 4 | Four-way valve | How to remove the four-way valve.<br>1) Perform the work of sections 1 and 3.<br>2) Recover refrigerant from the refrigerant circuit.<br>3) Remove the coil screw then remove the coil.<br>4) Detach the welded parts of the four-way valve and pipe.<br>5) Remove the four-way valve assembly. | The picture of four-way valve may be different from your actual valve.<br>  |
| 5 | Compressor | How to remove the compressor.<br>1) Complete the work of sections1 and 3.<br>Recover the refrigerant from the refrigerant circuit.<br>2) Remove the discharge and suction pipes with a burner.<br>3) Remove the hex nuts and washers securing the compressor on the bottom plate.<br>4) Lift the compressor from the base pan assembly. |  <br>  |

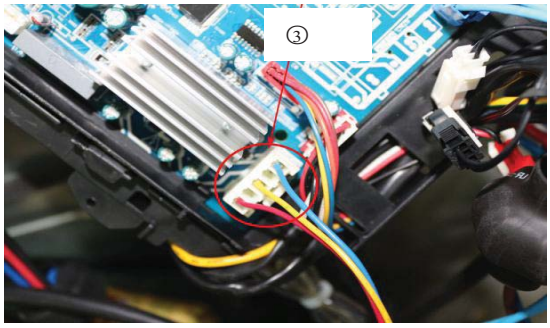
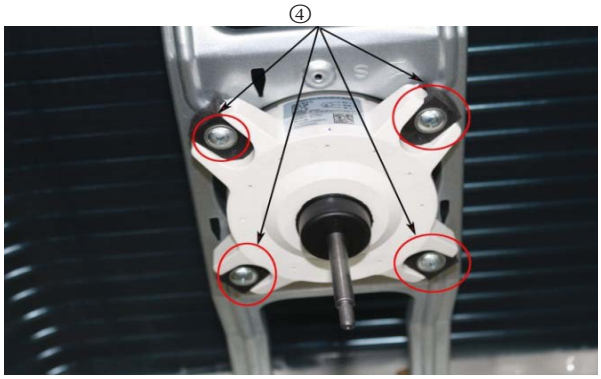
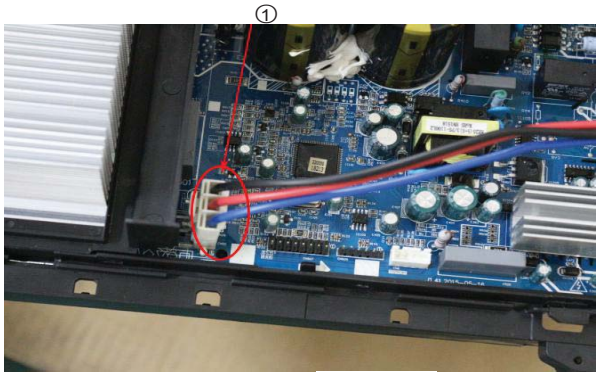
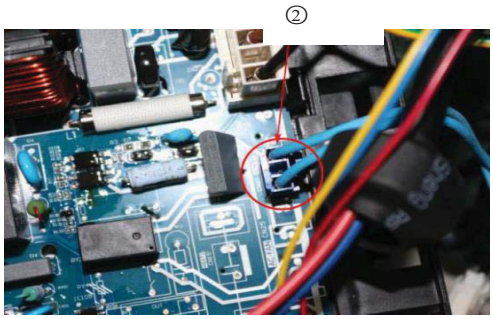
# DISASSEMBLY INSTRUCTIONS SIZES 12K (208−230V)

| No. | Part name | Procedures | Remarks |
|---|---|---|---|
| 1 | Panel plate | How to remove the panel plate.<br>1) Stop the air conditioner and turn “OFF” the power breaker.<br>2) Remove the big handle first, then remove the top panel (3 screws).<br>3) Remove the front panel screws (6).<br>4) Remove the right side panel screws (8). | **Top panel screws (3 screws, 1 screw is under the big handle)**<br>  <br>**Big Handler screws (3)**<br>**Front panel screws (6)**<br>  |

# DISASSEMBLY INSTRUCTIONS SIZES 12K (208−230V) (CONT)

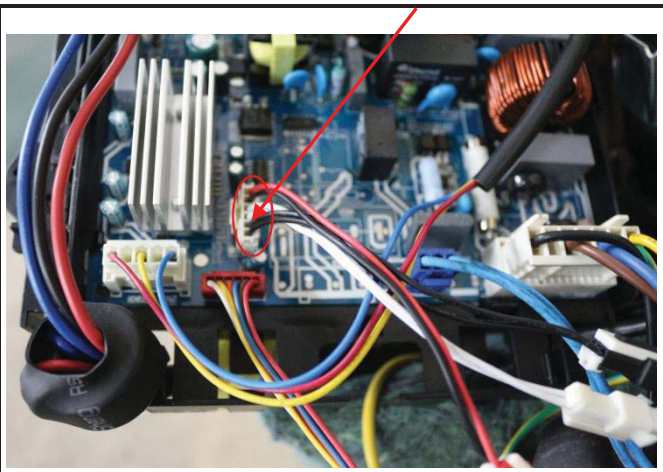
| | | | |
|---|---|---|---|
| 2 | Fan assembly | How to remove the fan assembly.<br><br>1) After removing the panel plate using section 1, remove the hex nut securing the fan then remove the fan.<br><br>2) Release the hooks and open the electronic control box cover. | ①<br>  <br>②<br>  <br>Compressor<br>T3, T4, T5 sensor<br>  <br>4 way valve<br>Motor<br>Electronic expansion valve |

# DISASSEMBLY INSTRUCTIONS SIZES 12K (208−230V) (CONT)

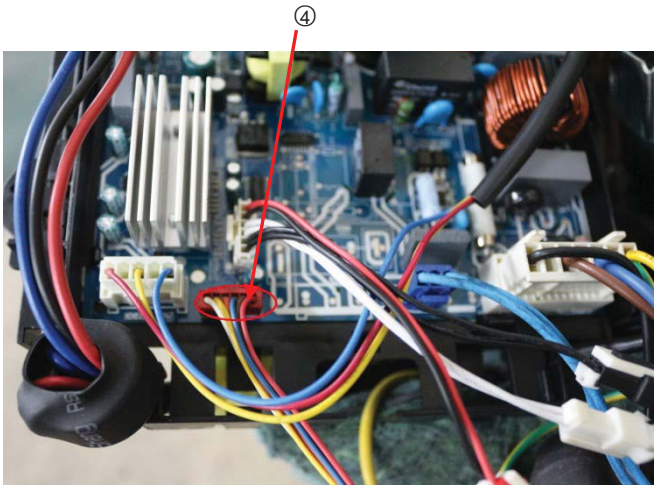
| | | | |
|---|---|---|---|
| | | 3) Disconnect the fan motor connector and from the electronic control board. |  |
| | | 4) Remove the fan motor screws (4). Then remove the fan motor. |  |
| 3 | Electrical parts | How to remove the electrical parts.<br>1) After completing the work in sections 1 and 2, remove the compressor connectors.<br>2) Pull out the two blue wires connected with the four way valve. |  <br>  <br>③ |

# DISASSEMBLY INSTRUCTIONS SIZES 12K (208−230V) (CONT)

3) Pull out connectors of the condenser coil temp. sensor (T3),outdoor ambient temp. sensor (T4) and discharge temp. sensor (T5).

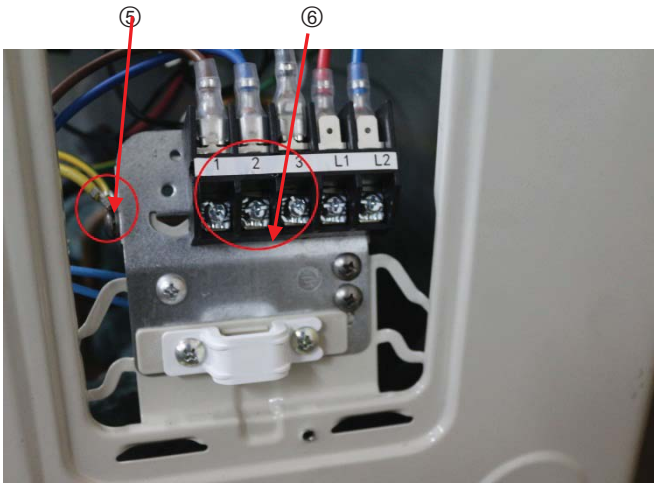


4) Disconnect the electronic expansion valve wire.

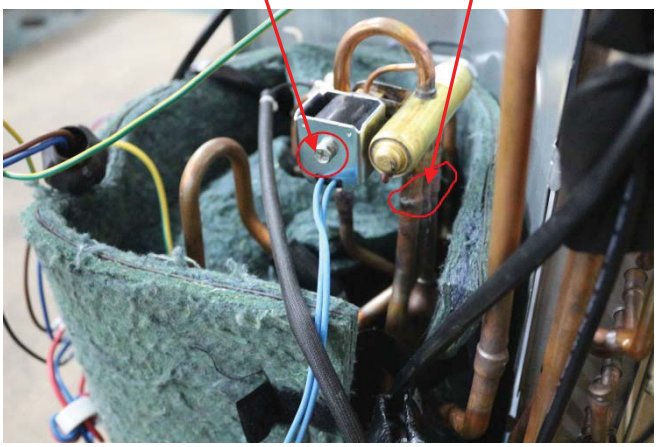
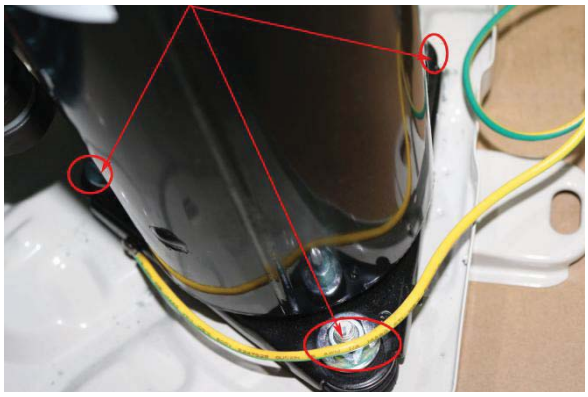



5) Remove the grounding screw.

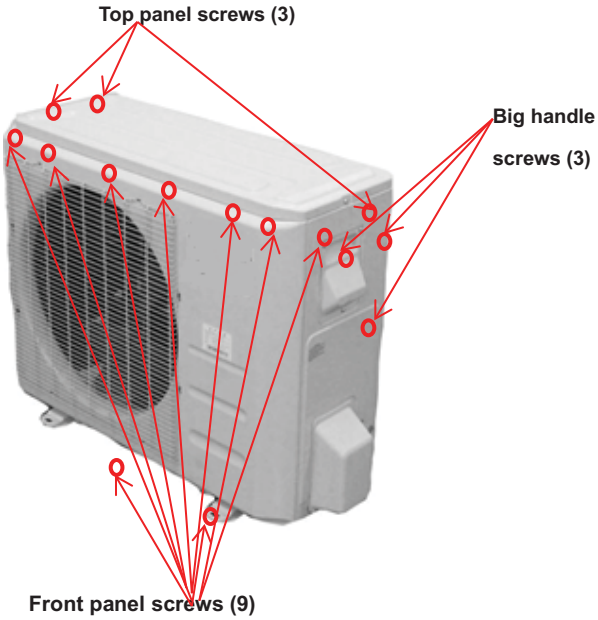
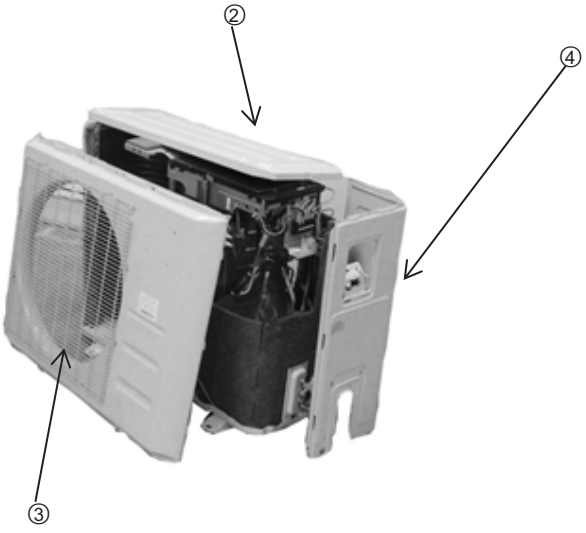
6) Remove the wires (1, 2, 3). Then remove the electronic control box.



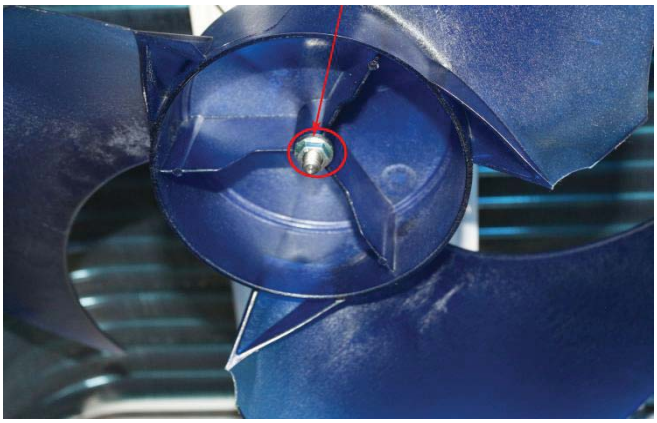
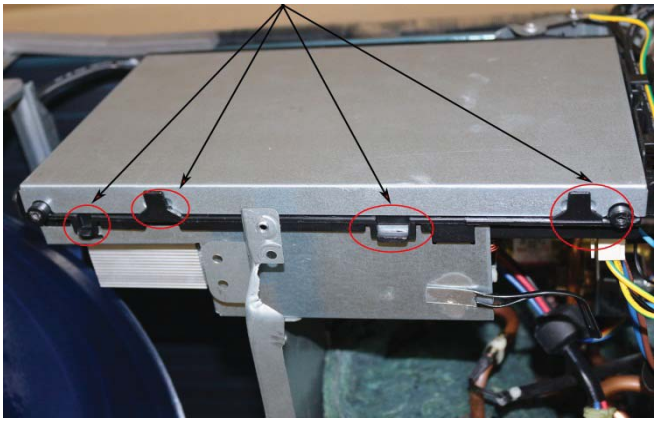
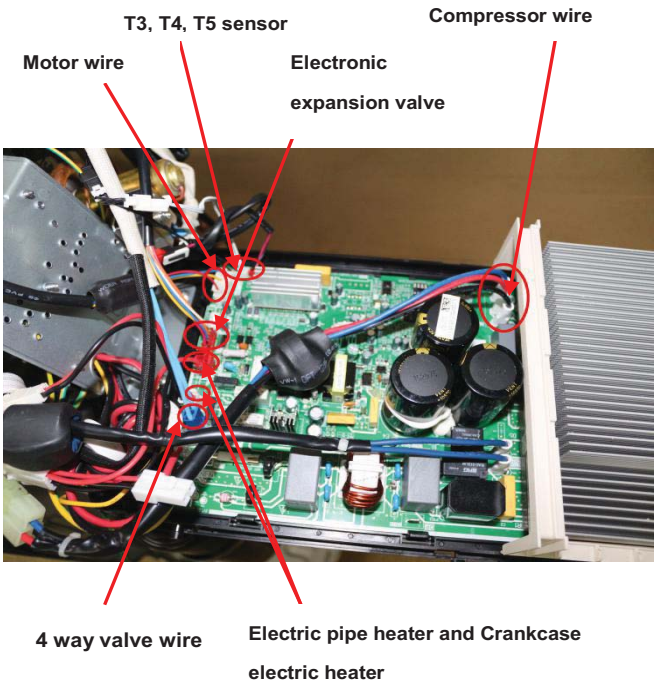
# DISASSEMBLY INSTRUCTIONS SIZES 12K (208−230V) (CONT)

| | | | |
|---|---|---|---|
| 4 | Four-way valve | How to remove the four-way valve.<br>1) Complete the steps in sections 1, 3.<br>2) Recover refrigerant from the refrigerant circuit.<br>3) Remove the coil screw then remove the coil.<br>4) Detach the welded parts of the four-way valve and pipe.<br>5) Remove the four-way valve assembly. | The picture of four-way valve may differ from your actual valve.<br>③ ④<br>  |
| 5 | Compressor | How to remove the compressor.<br>1) Complete steps in sections 1, 3.<br>2) Recover refrigerant from the refrigerant circuit.<br>3) Remove the<br>4) discharge and suction pipes with a burner.<br>5) Remove the hex nuts and washers securing the compressor on the bottom plate.<br>6) Lift the compressor from the base pan assembly. | ②<br>  <br>③<br>  |

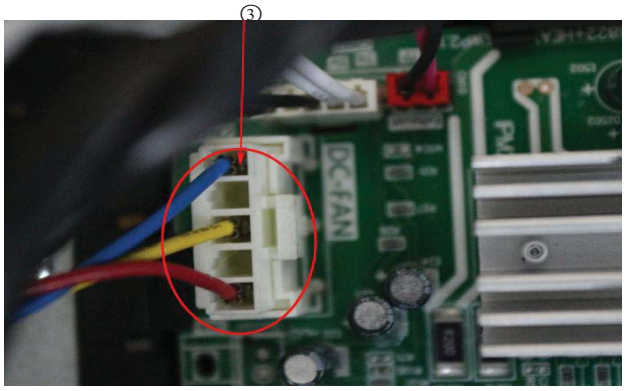
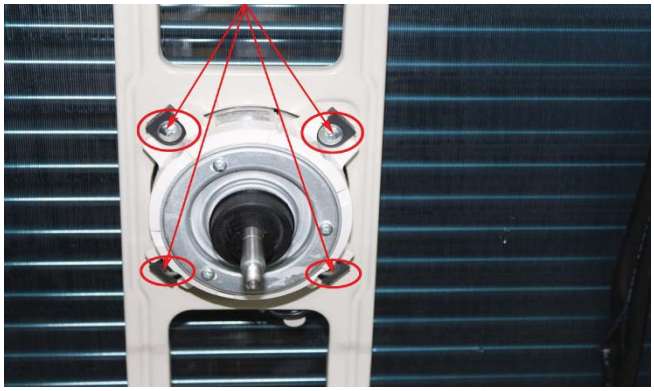
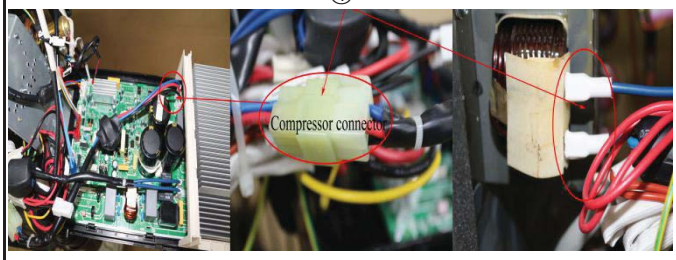
# DISASSEMBLY INSTRUCTIONS SIZES 18K (208−230V)

| No. | Part name | Procedures | Remarks |
|---|---|---|---|
| 1 | Panel plate | How to remove the panel plate.<br>1) Stop the air conditioner and turn “OFF” the power breaker.<br>2) Remove the top panel screws (3).<br>3) Remove the front panel screws (9).<br>4) Remove the right side panel screws (8). |  <br>  |

# DISASSEMBLY INSTRUCTIONS SIZES 18K (208−230V) (CONT)

| | | | |
|---|---|---|---|
| 2 | Fan assembly | How to remove the fan assembly.<br><br>1) After removing the panel plate using section 1, remove the hex nut securing the fan then remove the fan.<br><br>2) After removing the top cover, release the hooks then open the electronic control box cover. | ①<br>  <br>②<br>  <br>  |

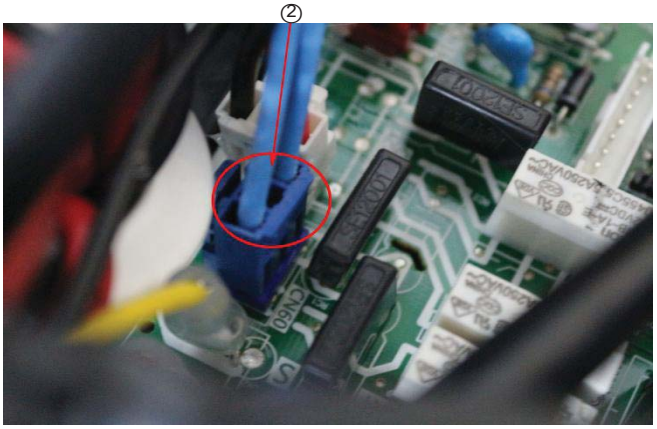
# DISASSEMBLY INSTRUCTIONS SIZES 18K (208−230V) (CONT)

| | | | |
|---|---|---|---|
| | | 3) Disconnect the connector for fan motor from the electronic control board.<br><br>4) Remove the fan motor screws. Then remove the fan motor. | ③<br>  <br><br>④<br>  |
| 3 | Electrical parts | How to remove the electrical parts.<br>1) Complete the work of items 1 and 2, then remove the compressor and reactor connectors. | ①<br>  <br> |

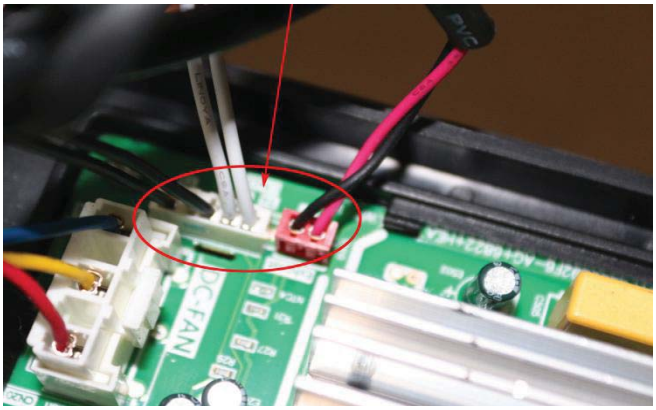
# DISASSEMBLY INSTRUCTIONS SIZES 18K (208−230V) (CONT)

2) Pull out the two blue wires connected to the four way valve.

②



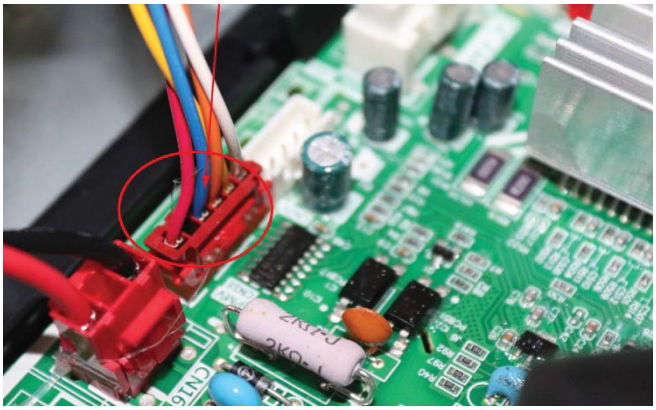
③



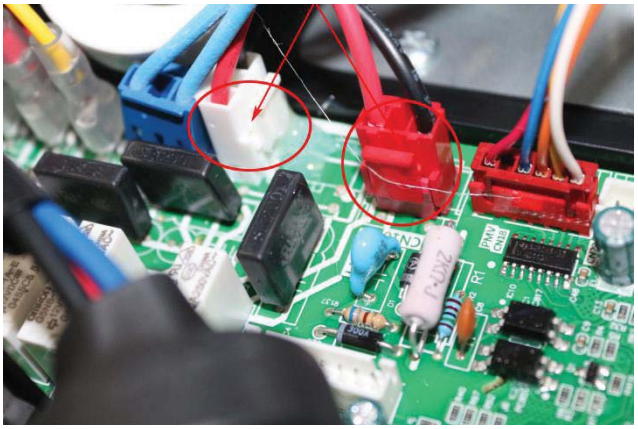
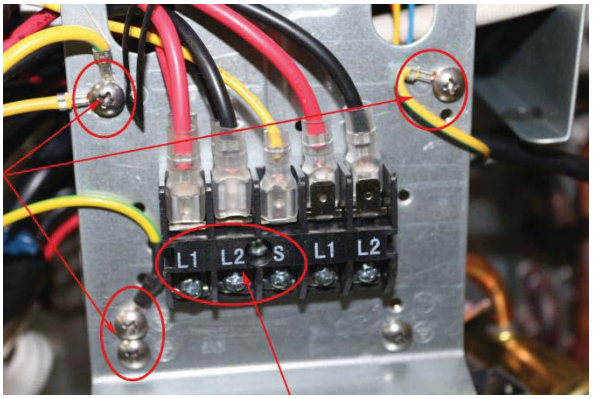
3) Remove the connectors of the condenser coil temp. sensor (T3),outdoor ambient temp. sensor (T4) and discharge temp. sensor (T5).

4) Disconnect the electronic expansion valve wire.

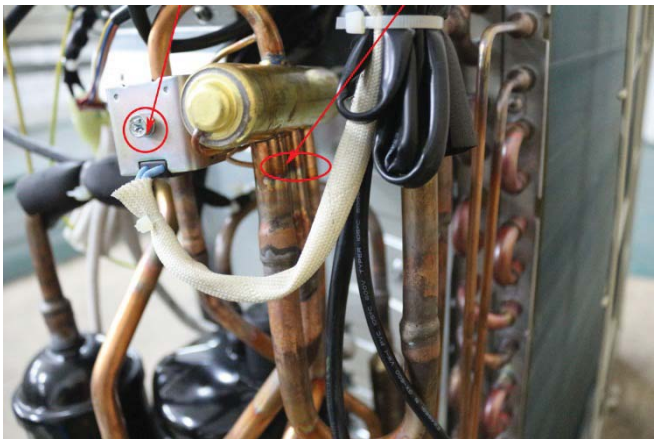
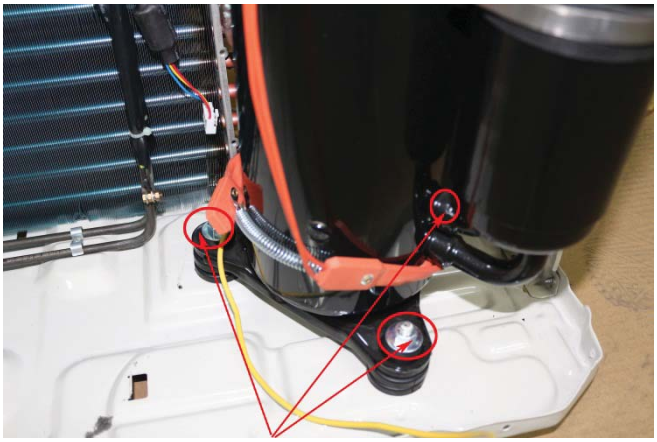
④



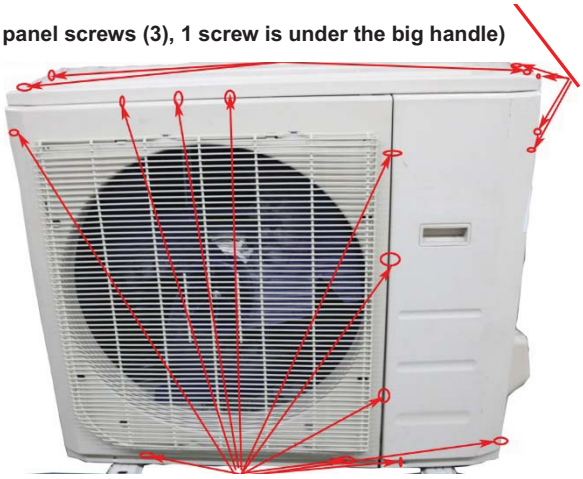
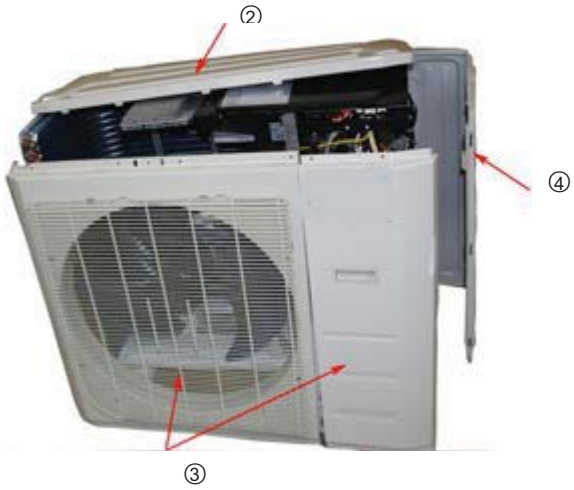
# DISASSEMBLY INSTRUCTIONS SIZES 18K (208−230V) (CONT)

| | | | |
|---|---|---|---|
| | | 5) Remove the electric heaters. | ⑤<br>  |
| | | 6) Remove the grounding screw.<br>7) Remove the wires (1, 2, 3 or L1, L2, S). Then remove the electronic control box. | ⑥<br>  <br><br>⑦ |

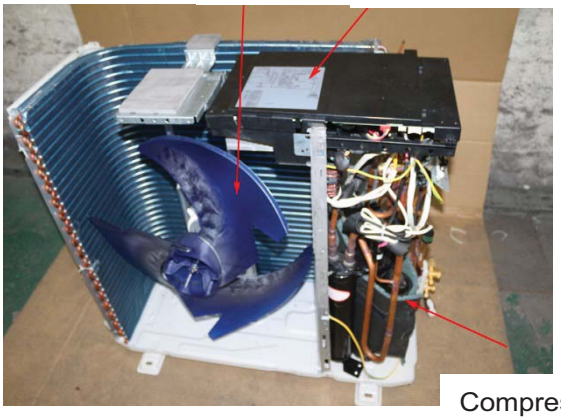
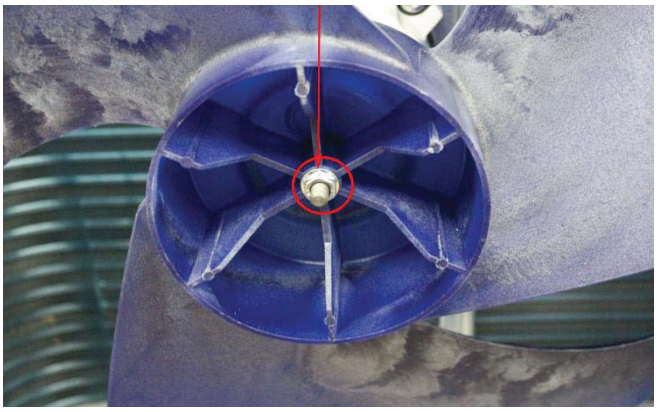
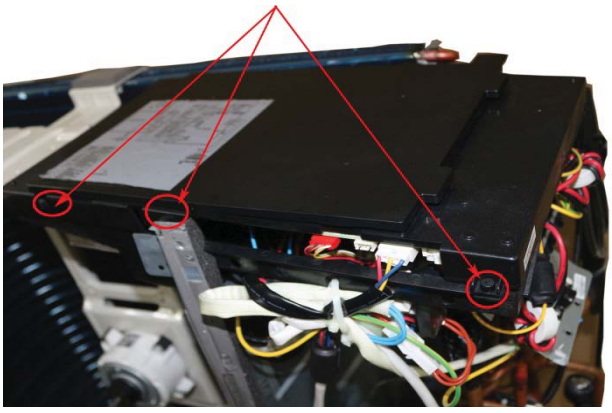
# DISASSEMBLY INSTRUCTIONS SIZES 18K (208−230V) (CONT)

| | | | |
|---|---|---|---|
| 4 | Four-way valve | How to remove the four-way valve.<br>1) Complete the steps in sections 1, 3.<br>2) Recover refrigerant from the refrigerant circuit.<br>3) Remove the coil screw then remove the coil.<br>4) Detach the welded parts of four-way valve and pipe.<br>5) Remove the four-way valve assembly. | The picture of four-way valve may differ from your actual valve.<br>④<br>③<br>  |
| 5 | Compressor | How to remove the compressor.<br>1) After completing steps in sections 1, 3, recover refrigerant from the refrigerant circuit.<br>2) Remove the discharge and suction pipes with a burner.<br>3) Remove the hex nuts and washers securing the compressor on the bottom plate.<br>5) Lift the compressor from the base pan assembly. | ②<br>  <br>  <br>③ |

# DISASSEMBLY INSTRUCTIONS SIZES 24K (208−230V)

| No. | Part name | Procedures | Remarks |
|---|---|---|---|
| 1 | Panel plate | How to remove the panel plate.<br>1) Stop the air conditioner and turn “OFF” the power breaker.<br>2) Remove the big handle first, then remove the top cover (7 screws).<br>3) Remove the front panel screws (11).<br>4) Remove the right side panel screws (13). | Big handle screws (4)<br>Top panel screws (3), 1 screw is under the big handle)<br>  <br>Front panel screws (11)<br>  |

# DISASSEMBLY INSTRUCTIONS SIZES 24K (208−230V) (CONT)

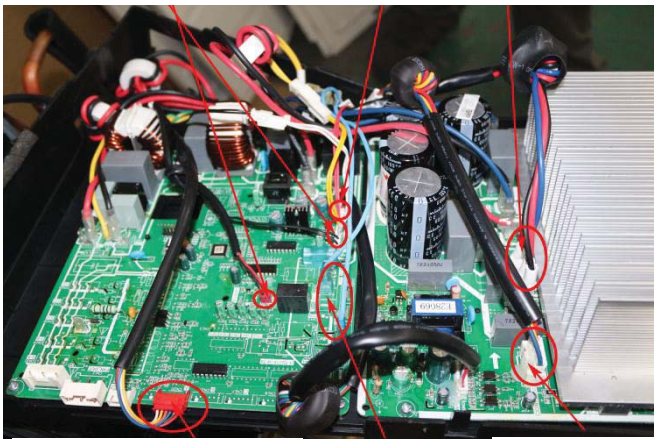
| | | | |
|---|---|---|---|
| 2 | Fan assembly | How to remove the fan assembly.<br><br>1) Remove the panel plate using the steps in section 1.<br><br>2) Remove the nut securing the fan, then remove the fan.<br><br>3) Release the hooks and remove the screws. Open the electronic control box cover. | Fan Electronic control box<br>  <br>Compressor<br>②<br>  <br>③<br>  |

# DISASSEMBLY INSTRUCTIONS SIZES 24K (208−230V) (CONT)

4) Disconnect the fan motor connector from the electronic control board.

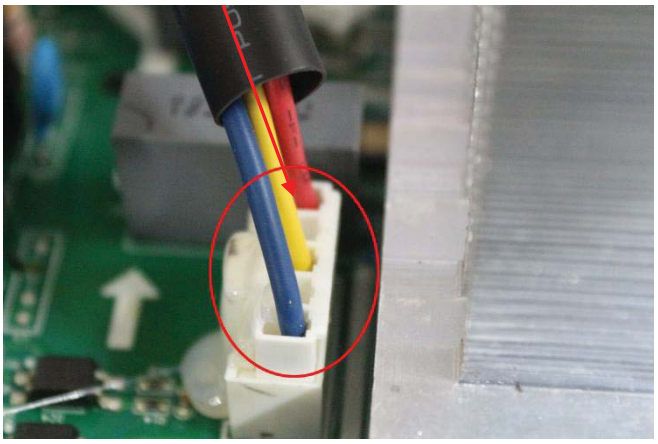
5) Remove the fan motor screws (4) of the fan motor, then remove the motor.

T3, T4, T5, sensor  Pressure switch  Compressor wire

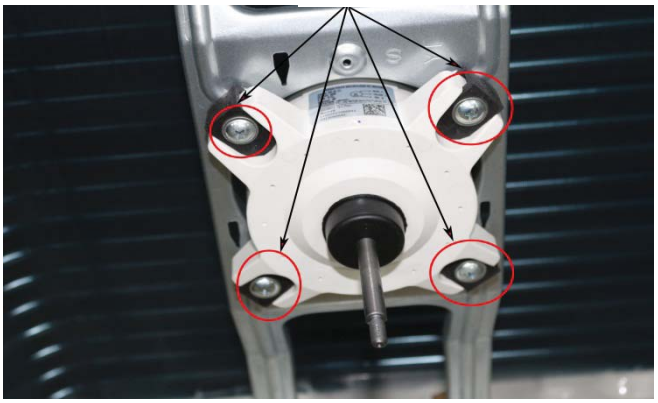


Electronic expansion  4 way valve  Motor wire

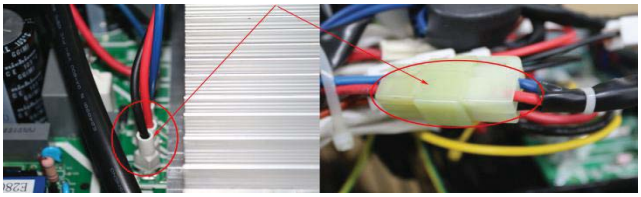
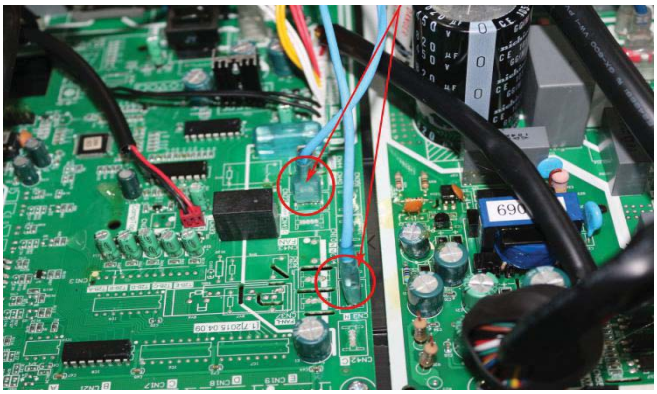
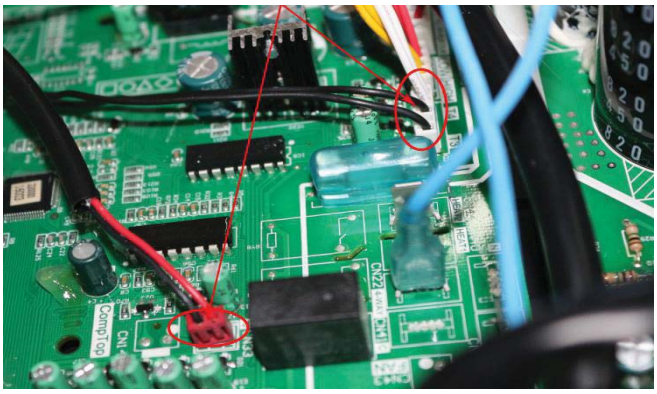
④



⑤

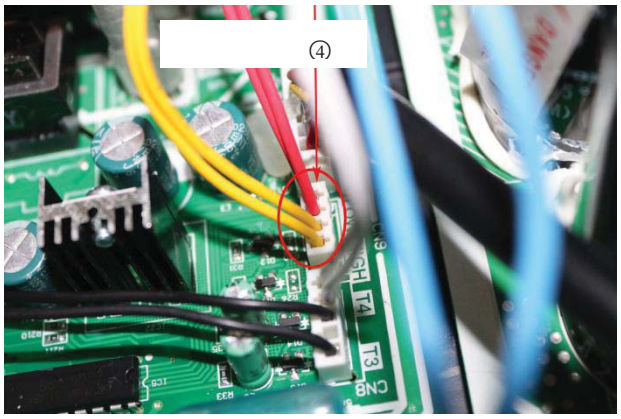


# DISASSEMBLY INSTRUCTIONS SIZES 24K (208−230V) (CONT)

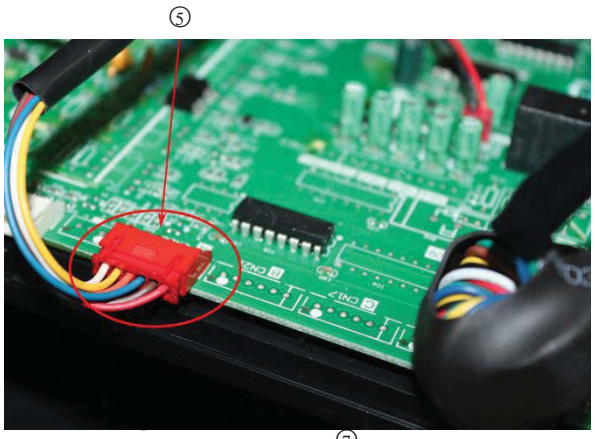
| | | | |
|---|---|---|---|
| 3 | Electrical parts | How to remove the electrical parts.<br>1) After completing the work in sections 1 and 2, remove the compressor connector.<br>2) Pull out the two blue<br>3) wires connected with the four way valve.<br>4) Pull out connectors of the condenser coil temp. sensor (T3), outdoor ambient temp. sensor (T4) and discharge temp. sensor (T5). | ①<br>  <br>②<br>  <br>③<br>  |

# DISASSEMBLY INSTRUCTIONS SIZES 24K (208−230V) (CONT)

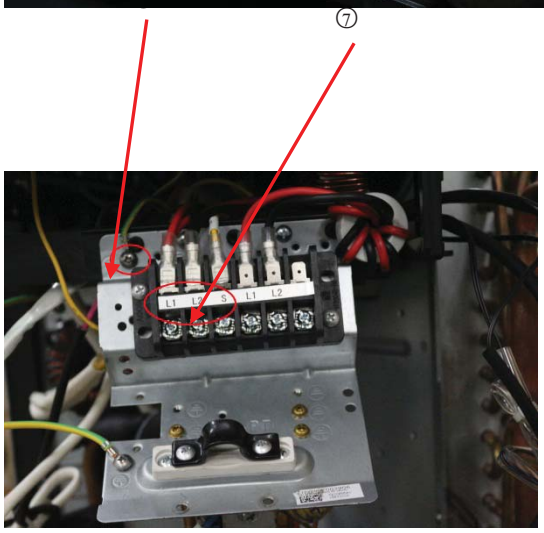
5) Disconnect the pressure switch connector.



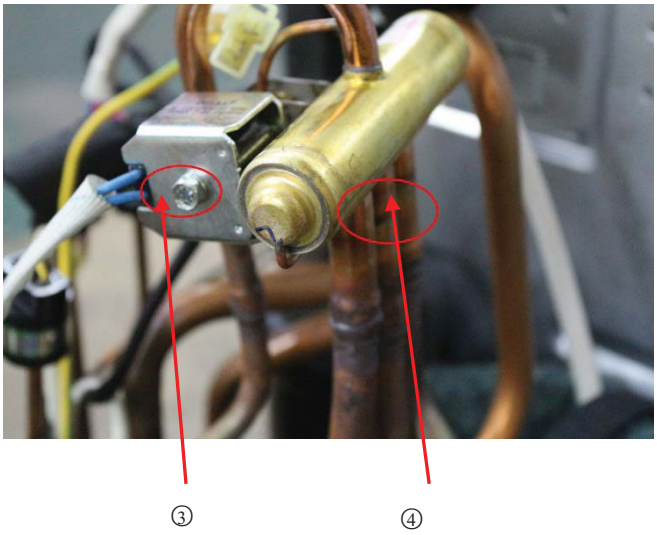
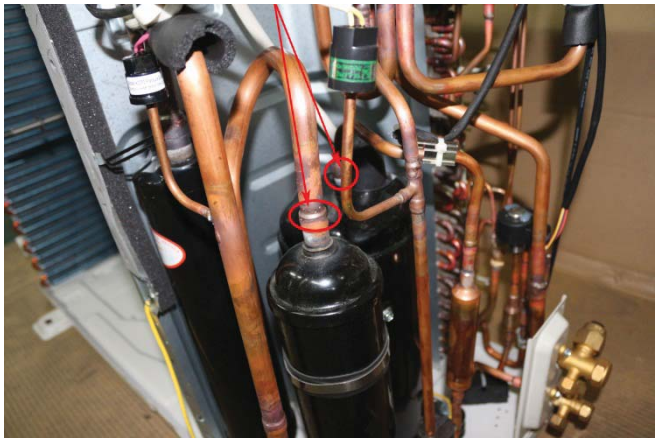
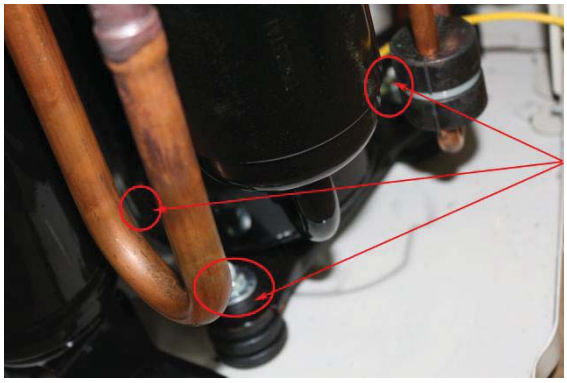

6) Disconnect the electronic expansion valve wire from the control board.




7) Remove the ground wires.
8) Remove the wires (1, 2, 3 or L1, L2, S). Then remove the electronic control box.



# DISASSEMBLY INSTRUCTIONS SIZES 24K (208−230V) (CONT)

| | | | |
|---|---|---|---|
| 4 | Four-way valve | How to remove the four-way valve.<br>1) Complete the steps in sections 1, 3.<br>2) Recover the refrigerant from the refrigerant circuit.<br>3) Remove the coil screw and then remove the coil.<br>4) Detach the welded parts of four-way valve and pipe.<br>5) Remove the four-way valve assembly. | The picture of four-way valve may differ from your actual valve.<br>  <br>③ ④ |
| 5 | Compressor | How to remove the compressor.<br>1) Complete steps in sections 1, 3. Recover refrigerant from the refrigerant circuit.<br>2) Remove the discharge and suction pipes with a burner.<br>3) Remove the hex nuts and washers securing the compressor to the bottom plate.<br>4) Lift the compressor from the base pan assembly. | ②<br>  <br>  <br>③ |

# APPENDIX

## Appendix 1

**Table 25—Temperature Sensor Resistance Value Table for T1, T2, T3, T4**

| °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 26—Temperature Sensor Resistance Value Table for T5**

| °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 27—Celsius to Fahrenheit**

| °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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