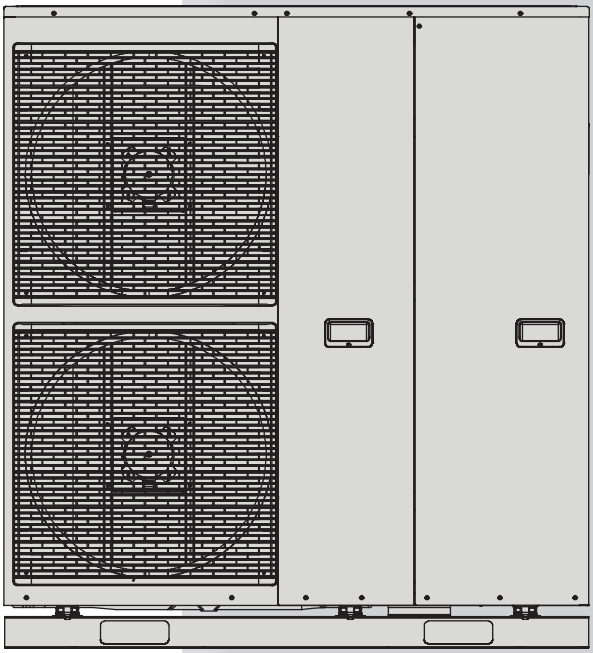
CENTRUS
Lochinvar

Residential Air-to-Water Heat Pump

Service Manual Part 2
Mono Bloc Unit
RAH040



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⚠ WARNING This service manual is intended for experienced repair technicians only and is not intended for use by the general public. It does not contain warnings or cautions to advise non-technical individuals of potential dangers in attempting to service a product. Products powered by electricity should be serviced or repaired only by experienced professional technicians. Any attempt to service or repair the products dealt with in this service manual by anyone else could result in serious injury or death.

Save this manual for future reference.

Contents

*Part 2 of the service manual begins here. For information in sections 1-10 refer to Centrus Service Manual Part 1.

11 Operation and Control

Basic function

The inverter control, which is equipped with a microcomputer for determining the most suitable operating mode at any time, automatically continuously adjusts output power for maximum comfort. In order to select the appropriate operating mode, the microcomputer maintains the set temperature by measuring the temperature of the environment and performing temperature shifting. The compressor in the outdoor unit operates following the frequency determined by the microcomputer in the indoor unit, and determines the condition according to internal water set temperature and water outlet temperature.

Internal water setting temperature

Once operation starts, the control panel temperature setting will be used as the base value for temperature-shifting processes. These shifting processes are dependent on the air-to-water heat pump settings and the operating environment. The final shifted value will be used as the internal water temperature setting and is updated continuously whenever electrical power is supplied to the unit.

Heating operation

Thermostat control

The compressor is OFF when water outlet temperature – internal water set temperature > 3°F for 3 minutes continuously. The compressor is ON after waiting for 3 minutes, if the water outlet temperature – water inlet temperature (temperature at thermostat OFF is triggered) < -5°F.

Thermostat control (outdoor ambient temperature)

Stops providing heating to room side when outdoor ambient temperature is high.

Control content:

Heating operation and water pump will turn OFF when outdoor ambient temperature > outdoor thermo OFF temperature + 5°F. (Outdoor thermo OFF temperature is set at the control panel. Thermo OFF set temperature is between 41°F ~ 95°F). Heating operation will resume when outdoor ambient temperature < outdoor thermo OFF set temperature + 1°F.

Heating Mode operation

Operating the heat pump provides heating to the room side by running hot water through the heating panel, floor heating, or fan coil unit.

1. Three-way valve will switch and fix to room side.
2. Heat pump operation follows normal heating operation.
3. Back-up heater operation follows normal operation.
4. Two-way valve will open.

Cooling operation

Thermostat control

The compressor is OFF when water outlet temperature – internal water setting temperature > -2°F for 3 continuous minutes. The compressor is ON after waiting for 3 minutes, if the water outlet temperature – water inlet temperature (temperature at thermostat OFF is triggered) > 5°F.

Cooling Mode operation

1. Three-way valve will switch and fix to room side.
2. Heat pump operates as normal for cooling operation.
3. Room heater DOES NOT operate in Cooling Mode.
4. Two-way valve is closed.

Target water temperature setting

Target water temperature control of standard system

There are two types of temperature control selections: compensation and direct.

- Temperature control type selection by installer:
  1. Compensation: WLo, WHi, ODLo, ODHi can be set in the installer menu.
  2. Direct: Direct water temperature setting
- Setting on the control pad by user:
  1. Compensation: Shift value ±9°F from the compensation curve.
  2. Direct: Direct water temperature setting change

*This setting can only be adjusted when the room sensor is selected as Water Temperature.

*Instead of water temperature, user will set target room temperature when room sensor is selected as Room Thermistor OR Internal Room Thermostat.

Target water temperature is calculated as follows:

- Target water temperature = A (base temperature) + B (shift temperature)
- B (shift temperature) value depends on the room sensor selection on the control pad as in Table 11-14.

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Table 11-1 *Regulation of maximum/minimum target water temperature.*

A (Base temperature)	Compensation	Direct
	Value from the curve + user shift value set	Direct value from user setting

B (Shift temp.)	B shift value depends on the room sensor selection on the control pad as shown in the table below
Sensor selection	
Water temperature	B = 0
External room thermostat	B = 0
Internal room thermostat & room thermistor	Cooling Mode: B = 0; when Zone OFF or Zone room thermo OFF B = 1* (room set temp (R/C) - actual room temp) Max/min regulation of B: (max = 9 ; min = -9)
	Heating Mode: B = 0; when Zone OFF or Zone room thermo OFF B = follow heating PI control contents

Table 11-2 *Operating conditions*

	Heating	Cooling
Max	131°F (below ambient -4°F) *2 140°F (ambient 41°F ~ 89.6°F or above ambient 77°F) *3 149°F (ambient 41°F ~ 68°F) *3*4	68°F
Min	68°F	41°F

*2 Between outdoor ambient 5°F and -4°F, the water outlet temperature gradually decreases from 140°F to 131°F.
*3 Between outdoor ambient 41°F and 32°F, the water outlet temperature gradually decreases from 149°F to 140°F.
*3 Between outdoor ambient 68°F and 77°F, the water outlet temperature gradually decreases from 149°F to 140°F.
*4 Only when ΔT is set to 27°F will the set temperature above 140°F take effect.

Compensation type: Operation in Heating Mode and Cooling Mode

The set temperature defines the parameters for the ambient-dependent (outdoor temperature) operation of the unit. The water temperature is determined automatically depending on the outdoor temperature. If the default setting is for a colder outdoor temperature, the result will be warmer water and vice versa. The user can shift the target water temperature using the control pad.

Outdoor ambient temperature is updated every 30 minutes when operation is ON. When setting the water outlet temperature, always follow W(LO) or W(HI) whenever it is higher if an outdoor ambient sensor error or indoor communication error occurs.

However, when Power Mode is engaged at the control pad during Heating Mode, the higher value of WLo or WHi will be used for a calculation.

There are 2 compensation curves (for heating and cooling). In Heating Mode, the heating curve is used; in Cooling Mode, the cooling curve is used.

Figure 11-1 *Heating and cooling operation*

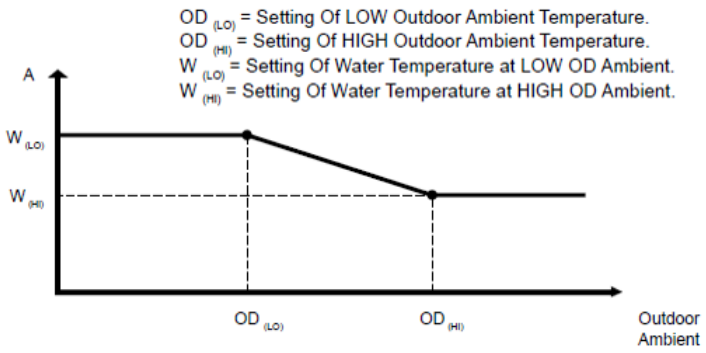

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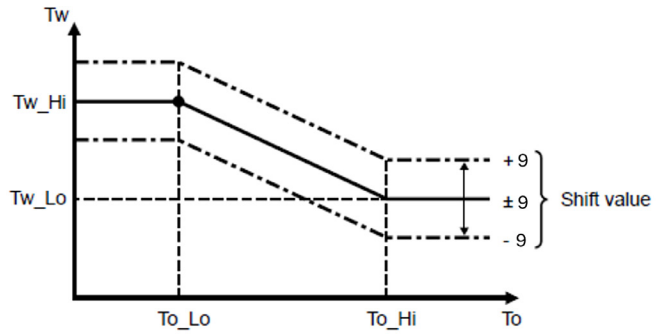
Figure 11-2 Compensation curve



Auto Mode operation

Control details:

To enable the unit to operate automatically either in Heating or Cooling Mode, heat-to-cool set temperature and cool-to-heat set temperature can be set at the control panel. Automatic operation is determined based on the control panel temperature setting and outdoor ambient temperature. Minimum temperature for the heat-to-cool set temperature setting is 2°F higher than the cool-to-heat set temperature setting.

Judgment control:

If the outdoor ambient temperature < heat-to-cool set temperature, unit will operate in Heating Mode or else the unit will operate in Cooling Mode. If current operation is Cooling Mode, outdoor ambient temperature > the cool-to-heat temperature, the unit will remain in Cooling Mode, or the unit will operate in Heating Mode.

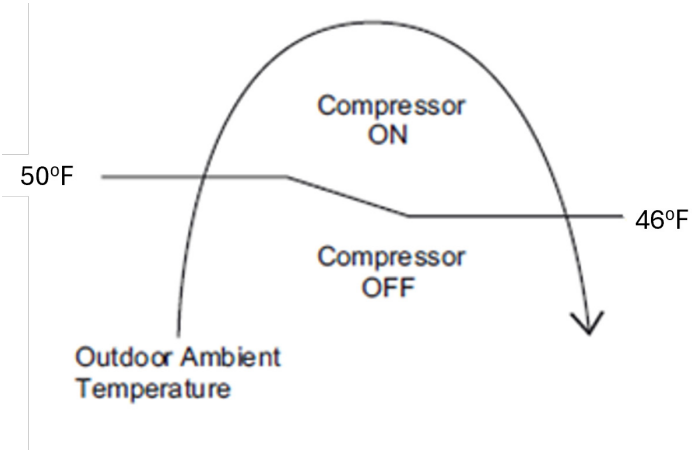
If the unit is currently operating in Heating Mode and the outdoor ambient temperature > the heat-to-cool temperature, the unit will remain in Heating Mode, or the unit will operate Cooling Mode. Every 60 minutes the outdoor ambient temperature is read. When Auto + Tank Mode is selected, operating mode switching is determined by both outdoor ambient temperature and indoor air temperature.

Auto-Cooling Mode operating limit

Auto-Cooling Only Mode will start once the outdoor ambient temperature reaches 50°F, and the compressor will continue to run until the outdoor ambient temperature drops to 46°F.

Because of this limit, if the heat-to-cool temperature is set lower than 50°F, the compressor will not operate until the outdoor ambient temperature reaches 50°F or higher.

Figure 11-3 Auto-Cooling Mode



Tank Mode operation

The three-way valve will switch to tank side when the tank thermo is ON. Switch the three-way valve to room side when the tank reaches tank thermo OFF temperature.

Tank thermo ON/OFF characteristics: Tank thermo OFF

Case 1: Internal tank heater is selected and tank heater is ON

- Tank temperature > tank set temperature for 15 continuous seconds.
- Water outlet > 167°F

Case 2: Tank heater OFF OR external heater is selected

- When the heat pump is OFF when water thermos & tank temperature > tank water set temperature for 20 continuous seconds. OR
- Tank temperature > tank set temperature + 1°F for 20 continuous seconds.

Tank thermo ON/OFF characteristics: Tank thermo ON

Case 1: Internal tank heater is selected and tank heater is ON

- Tank temperature < tank set temperature + R/C (tank reheat temperature)

Case 2: Tank heater is OFF OR external heater is selected

- Tank temperature < tank water set temperature + R/C (tank reheat temperature)

  *When tank thermo is ON, the water pump will be ON for 3 minutes, after which only the heat pump will turn ON.

  *Tank water set temperature = tank set temperature or tank limit temperature (whichever is lower).

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Outdoor ambient temperature	Tank limit temperature
OD < 1°F	118°F
1°F <= OD < 96°F	125°F
96°F <= OD	122°F

Heat pump water outlet set temperature setting is set to the table below:

Outdoor ambient temperature	Tank limit temperature
OD < 1°F	129°F
1°F <= OD < 26°F	132°F
26°F <= OD	138°F

Characteristics of heat pump thermos ON/OFF in Tank Mode:

1. Heat pump thermo OFF temperature = Target water outlet temperature + 3°F.
2. If water outlet temperature > heat pump thermostat OFF temperature for 90 continuous seconds, the heat pump turns OFF but the water pump remains ON.
3. Heat pump thermostat ON temperature = water inlet while thermostat OFF time + [-5°F].
4. When water outlet temperature < heat pump thermostat ON temperature, heat pump turns ON.
5. If the water inlet temperature > [140°F] for 30 continuous seconds, heat pump turns OFF but water pump remains ON.
6. Heat pump thermos ON temp = water inlet temperature < [140°F].

Thermo ON/OFF for heat pump in tank operation:

When tank temperature reaches heat pump OFF condition, refer to the below condition:

Condition 1: When internal tank heater is selected and tank heater is ON

- Heat pump will turn OFF, water pump will continue ON and room heater will continue ON, if tank temperature is below tank heater thermo ON setting. The three-way valve will only switch to room side after tank temperature reaches tank heater thermo OFF setting.

Condition 2: When the tank heater is set to OFF OR when the external tank heater is selected and the tank heater is ON

- If the tank temperature reaches the tank thermo OFF temperature, the heat pump will turn OFF, the water pump will turn OFF, the room heater will turn OFF, and the three-way valve switches to room side.

When the tank temperature reaches the heat pump ON temperature, the water pump will turn ON, the heat pump will turn ON, and room heater turns OFF.

Heat pump OFF in Tank Mode

- Tank temperature > tank water temperature setting continuously for 20 seconds after heat pump thermostat switches to OFF in response to the water thermostat. (Heat pump turns OFF but water pump continues ON and room heater turns ON to achieve tank set temperature)

OR

- Tank temperature > tank set temperature setting + [1°F] continuously for 20 seconds. (Heat pump OFF, water pump OFF, room heater OFF and three-way valve switches to room side)

Heat pump ON in Tank Mode

- Tank temperature < tank water set temperature setting + R/C setting (tank reheat temp)

(Water pump turns ON OR continues ON, heat pump ON and three-way valve switches to tank side or remains at tank side)

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Internal heater control

The internal heater only operates on the tank side if the internal tank heater is selected, the tank heater is ON, and the backup heater is enabled.

Internal heater turn ON trigger:

- Tank temperature < tank set temperature, AND
- Heat pump thermos are OFF, AND
- 20 minutes have elapsed from the previous heater shut off, AND
- Internal tank heater selects USE from control panel.

Internal heater turn OFF trigger:

- Tank temperature > tank set temperature for 15 continuous seconds, OR
- Heat pump thermo is ON, OR
- Mode change or operation is off at the control panel.

External heater control

- External heater only operates on the tank side if tank heater is ON and external heater is selected.

Heat + Tank Mode operation

1. Three-way valve control:
   - Three-way valve switches to room side during room heat-up interval and switches to tank side during tank heat-up interval. Both modes will switch alternately. Tank Mode is the initial running mode of Heat + Tank Mode.
2. Heat pump operation control:
   - During room heat-up interval, follow normal heating operation. Switching to tank side occurs in the following cases:

     Case 1: Previous switch from tank interval to room interval due to thermostat switching OFF
     - Switch to tank heat-up interval when tank temp < tank thermos ON temp (Room heat-up interval ends)

     Case 2: If heating operation at room side runs less than 30 minutes and switches to tank side 3 times consecutively
     - Maintain at room heat-up interval regardless of the tank temperature. Switch to tank heat-up interval only when (room interval timer is complete OR room heat pump thermo OFF) AND tank temperature < tank thermo ON temperature.

     Case 3: The previous switch from tank interval to room interval triggered by the tank interval timer having expired
     - Maintain room heat-up intervals regardless of the tank temperature. Switch to tank heat-up intervals only when (room interval timer has expired OR room heat pump thermo switches OFF), AND tank temperature < tank thermo ON temperature.
     - Tank interval is the first mode running when Heat + Tank Mode is selected.
     - Switch to room interval only when tank reaches tank thermo OFF, OR tank heat-up interval timer has expired.
     - Heat pump operates according to normal Tank Mode operation.
3. Room heater control:
   - During the heating warm-up interval, follow the normal room heater control operation.
4. Tank heater control:
   - During the heating warm-up interval, if the external tank heater is selected, the external heater is ON/OFF depending on the position of the external tank heater operation control.
   - If the internal tank heater is selected, the internal tank heater will not function during the heating warm-up interval.
   - During the tank heat-up interval, if the external tank heater is selected, once the heating heat-up interval is switched to tank heat-up interval and the tank heater is turned OFF, the tank heater delay timer will start counting.
   - The tank heater will turn ON after the tank heater delay timer has expired and the tank temperature is lower than the tank set temperature.
   - The tank heater delay timer is cleared when switching to the heating heat-up interval.
   - If the internal tank heater is selected, it will turn ON once the heat pump is off and will continue to heat the tank up to the tank set temperature.
   - Two-way valve control is open
   - The indoor water pump will always turn ON if the room heat pump thermostat is ON OR the tank thermostat is ON.

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Cool + Tank Mode operation

The three-way valve switches to room side during the room cooling interval and switches to tank side during the tank heat-up interval. Both modes will switch alternately. Tank Mode is the initial mode of Cool + Tank Mode.

During room heat-up intervals, follow normal cooling operation.

Switching to tank side occurs in the following cases:

Case 1: Previous switch from tank interval to room interval because thermo is OFF.

- Switch to tank heat-up interval when tank temperature < tank thermo ON temperature (room interval will end).

Case 2: If cooling operation on the room side is on for less than 30 minutes and switches to tank side 3 times consecutively.

- Remain at room-cooling interval regardless of the tank temperature. Switch to tank heat-up interval only when (room interval timer is complete OR room heat pump thermo OFF) AND tank temperature < tank thermo ON temperature.

Case 3: Previous switch from tank interval to room interval resulted because tank interval timer has expired.

- Remain at room-cooling interval regardless of the tank temperature. Switch to tank heat-up interval only when (room interval timer has expired OR room heat pump thermo is OFF), AND tank temperature < tank thermo ON temperature.

Table 11-3 *Cool and Tank Mode operation*

Internal tank heater select USE	<Tank set temperature + R/C setting (Tank reheat temperature)
Others	< Tank water set temperature + R/C setting (tank reheat temperature)

During tank heat-up interval, tank interval is the first mode running when the Cool + Tank Mode is selected. Switch to room interval only when tank reaches tank thermo OFF OR the tank heat-up interval timer has expired. Heat pump operates according to normal Tank Mode operation.

Room heater control

During room-cooling interval, room heater is OFF and does not operate.

Tank heater control

During room-cooling interval, if external tank heater is selected, the external heater will be ON/OFF according to external tank heater operation control.

If internal tank heater is selected and tank heater is ON, the internal tank heater will not function during the room-cooling interval.

During the tank heat-up interval, if the external tank heater is selected, once the room-cooling interval switches to tank heat-up interval, the tank heater will turn OFF and the tank heater delay timer will start its countdown.

The tank heater turns ON after the tank heater delay timer has expired, and the tank temperature is lower than the tank set temperature. Tank heater delay timer is clear when switching to room-cooling interval.

If the internal tank heater is selected and the tank heater is ON, the internal tank heater will turn ON after the heat pump thermostat is off and will continue to heat until the boiler tank temperature has been reached.

The two-way valve is closed.

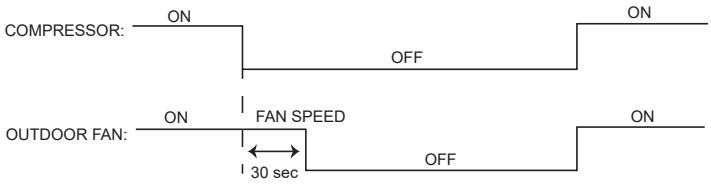
Indoor water pump control:

The indoor water pump always turns ON if the room heat pump thermostat is ON, OR if the tank thermostat is ON.

Outdoor fan motor operation

The outdoor fan motor is adjusted according to operating conditions. It starts when the compressor starts operation and it stops 30 seconds after the compressor stops operation.

Figure 11-4 *Outdoor fan operation*



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Water Pump

Water pump control

Once the indoor unit is ON, the water pump will switch ON immediately for 70 seconds with no error notification. However, during this 70-second period of operation, if there is any abnormality caused outdoors or malfunction, the compressor should immediately turn OFF and restart the delay after 3 minutes.

The system will start checking on the water flow level after operating for 70 seconds. If water flow level is determined to be low for 60 continuous seconds, the water pump and the compressor will switch OFF permanently and the OFF/ON control panel LED will blink (H62 error).

When the H62 error occurs, the power must be reset to clear the error. If there is no error indication, the water pump will run continuously.

The water pump will remain ON when the compressor is OFF until the thermostat OFF setting is reached. The water pump will be OFF when the room thermo, tank thermo, OR buffer tank thermo is OFF.

The water pump will delay for 15 seconds and turn OFF when requested to turn OFF except when anti-freeze de-icing is activated or during Air Purge Mode.

Water pump control

Once the indoor unit is ON, the water pump will switch ON immediately for 70 seconds with no error notification. However, during this 70 seconds of operation, if there is any abnormality caused outdoors or malfunction, the compressor should turn OFF immediately and delay restart for 3 minutes.

The system will start checking on the water flow level after operating for 70 seconds. If water flow level is determined to be low for 60 continuous seconds, the water pump and the compressor will turn OFF permanently, and the OFF/ON control panel LED will blink (H62 error occurs).

When error H62 occurs, the power must be reset to clear the error. If there is no error indication, the water pump will run continuously.

The water pump will remain ON when the compressor is OFF if the thermostat OFF setting has been reached.

The water pump will be OFF when the room thermo, tank thermo, OR buffer tank thermo is OFF.

The water pump will delay for 15 seconds and turn OFF when requested to be OFF, except during anti-freeze de-icing activation or Air Purge Mode.

Maximum pump speed setting on control pad

When Pump flowrate setting is ΔT, the standard pump speed is automatically controlled to reach the designated water temperature difference between the water inlet and outlet (ΔT). The maximum pump speed setting limitation can be adjusted by the installer according to the water circuit pressure drop.

When the pump flowrate setting is max duty, the indoor water pump will operate at the maximum pump speed setting during room side operation. The maximum pump speed setting can be adjusted by the installer according to water circuit pressure drop. The following sequences, however, do not respond to the maximum pump duty setting on the control pad:

- Pump-Down mode
- Air Purge Mode
- Normal de-icing

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Figure 11-5 *Water pump controls*

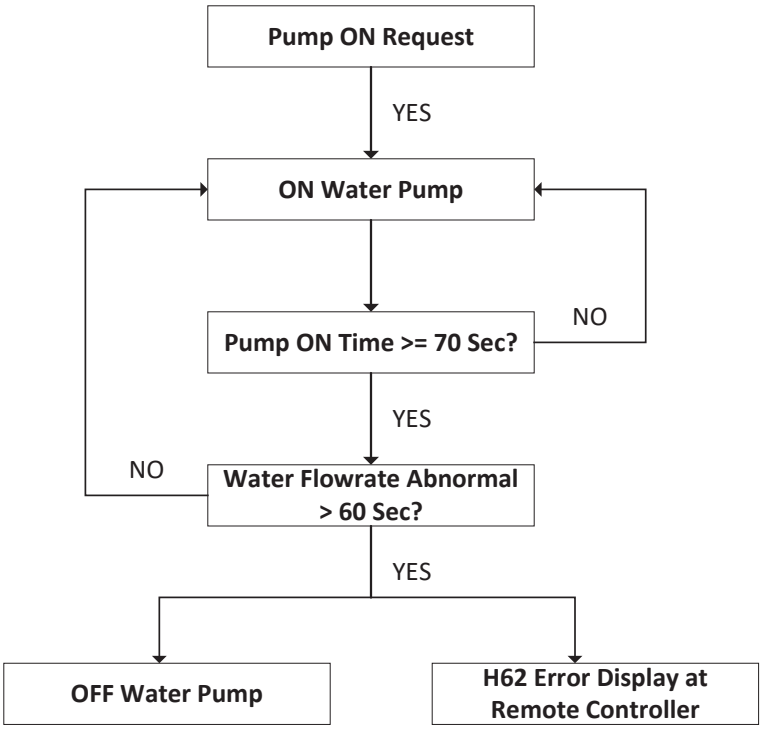
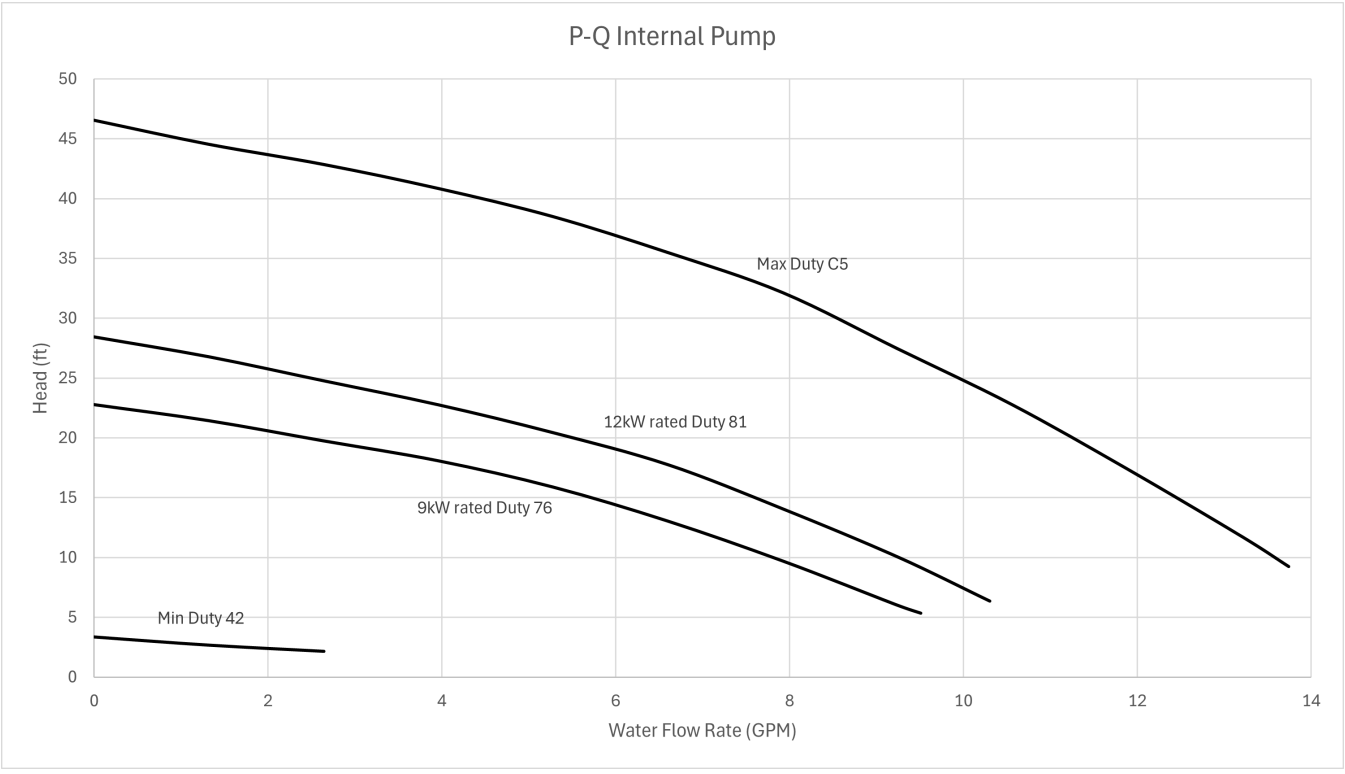


Figure 11-6 *Integral Pump Curve*



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Water pump speed feedback error

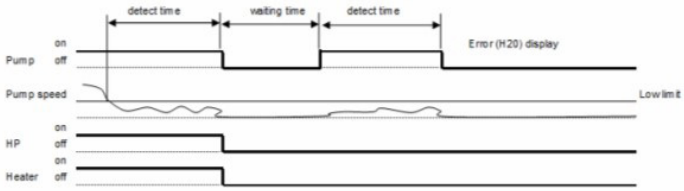
Pump speed feedback is monitored by micon. When the pump speed is below low limit or over high limit for a few seconds, micon detects a pump error and the system is stopped.

Error detection triggers are listed below:

- Detection of abnormal water pump speed for 10 continuous secs.
- Current pump speed < 700 rpm or
- Current pump speed > 6000 rpm for 10 seconds.

When an error occurs, the water pump, heating, and heater are stopped for 30 seconds. Then restart (Retry control). When micon detects an error again, the system is stopped and error code "H20" is displayed on the control panel.

Figure 11-7 *Pump speed feedback*



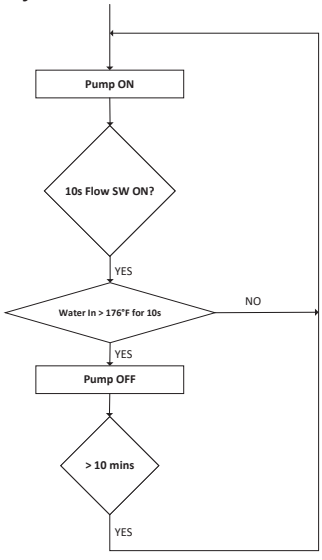
Indoor Unit Safety

Indoor unit safety control

When the water pump is ON, the system will start checking the flow switch status (ON/OFF). If the flow switch is ON for 10 seconds, the system will check the water inlet temperature for 10 seconds. If the water inlet temperature does not exceed 176°F, the water pump will run continuously in Normal Mode. If the water inlet temperature exceeds 176°F for 10 continuous seconds, the water pump will turn OFF immediately.

After the water pump is OFF for more than 10 minutes, it will turn ON, and the indoor unit safety control check is restarted.

Figure 11-8 *Safety control*



Auto Restart Control

When the power supply is cut off during the operation of the air-to-water heat pump, the compressor will restart after the power supply is restored.

Indication Panel

Table 11-4 *Indicator panel*

LED	Operation
Color	Green
Light ON	Operation ON
Light OFF	Operation OFF

NOTICE If the operation LED is blinking, there is an abnormality in operation.

Internal back-up heater control

Internal electric heater control

Normal Heating Mode

- Heater on:
  a. Heater switch is ON.
  b. After the heatpump thermo ON for [control pad set delay time] mins
  c. After water pump operates for [1] min
  d. Outdoor air temperature < Outdoor set temperature for heater
  e. When water outlet temperature < Water set temperature + [control pad heater ON setting]
  f. [20] minutes since previous backup heater off

  *When the heat pump cannot operate due to an error occurring during normal operation, the heater will go into Forced Heating Mode automatically.

  *Heater needs to operate during de-icing operation.
- Heater stop:
  a. When outdoor set temperature > outdoor set temperature +3°F for continuous 15 sec OR
  b. When the water out temp > water set temperature + [control pad heater OFF setting] for 15 continuous secs, OR
  c. Heater switch is off, OR
  d. Heatpump thermo-off is OFF

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Forced Heating Mode

- Heater on:
  a. After water pump operates for [2] mins
  b. When water outlet temperature < water set temperature + [control pad heater ON setting]
  c. [20] minutes since previous backup heater off
- Heater stop
  a. Force Mode off, OR
  b. When water outlet temperature > water set temperature + [control pad heater OFF setting] for 15 continuous secs

Do not operate heater if:

- The water outlet temperature sensor and water inlet sensor are abnormal
- The flow switch is abnormal
- The circulation pump stops

Room heater operation during de-icing

The purpose of this function is to protect the indoor heat exchanger from ice forming and preventing heat exchanger plate breakage.

This heater protection control will activate only if the backup heater is enabled during custom setup on the control pad. Once the start condition is fulfilled, the room heater will turn ON together (based on max heater capacity selection) and stop together if stop condition is fulfilled.

If the heater is requested to turn ON, OLP feedback will be detected.

Starting conditions:

1. During normal de-icing operation 4~9
2. Water outlet temperature < 44°F
3. Water flow rate < 5.28 gal/min
4. Water outlet temperature < 50°F, or
5. Outdoor air temperature < -22°F, or
6. Water inlet temperature < 50°F

The heater operates when 1 ~ 2 are fulfilled OR when 1 and 3 ~ 4 are fulfilled.

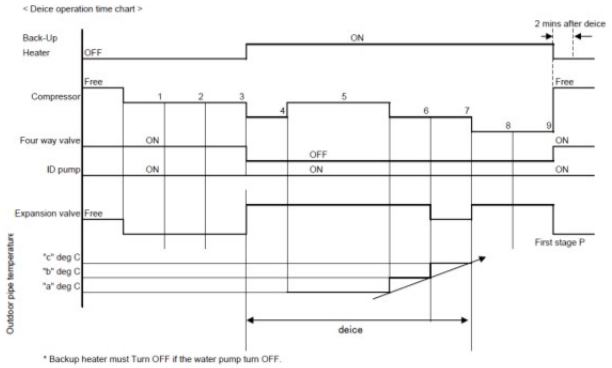
However, this control does not relate to the heater ON/OFF button on the control pad.

Stop condition:

1. When normal de-icing ends, or
2. Water outlet temperature > 113°F

The room heater stays ON, however, if the indoor electric heater control activates.

Figure 11-9 *Heating operating condition*



Tank Heater Control

Tank heater setting on the control pad

Tank heater selection:

- External: Booster heater used to heat up the tank when external is selected
- Internal: Backup heater used to heat up the tank when internal is selected

* When external tank heater is selected, heater delay is ON and the timer needs to be set (range: 20 min ~ 3 hrs).

Tank Heater ON/OFF selection by user.

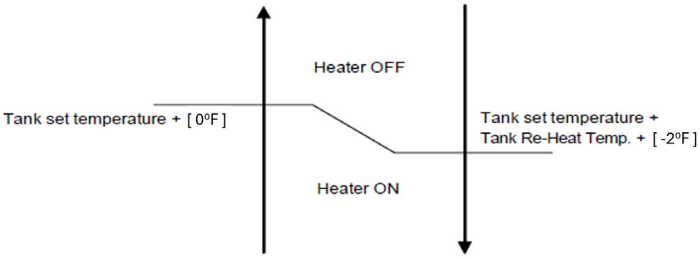
The tank set temperature range on the control pad will change according to external and internal tank heater use.

Table 11-5 *Tank heater selection*

Tank heater selection	Range
External	104 ~ 167°F
Internal	104 ~ 149°F

External heater control at tank side

Figure 11-10 *Heating control at tank side*



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Tank heater Turn On condition:

1. External heater selected for tank heater on control pad.
2. Tank heater selected ON by user.
3. Tank Mode operation ON (Tank Mode, Heat + Tank Mode, or Cool + Tank Mode).
4. After TANK HEATER DELAY TIMER has expired during heat-pump startup time in Tank Mode, or while switching from heating heat-up interval to tank heat-up interval in Heat + Tank Mode.
5. Tank temperature < tank set temperature +[control pad set tank re-heat temp] + [-1°F].
6. 20 minutes since the heater previously switched off.

* TANK HEATER DELAY TIMER is cleared when tank heat-up interval ends.

Tank heater turn off condition:

1. Tank temperature > tank set temperature + [0°F] for a continuous 15 seconds.
2. When BOOSTER HEATER DELAY TIMER starts counting after switching from heating heat-up interval to tank heat-up interval.
3. User selects tank heater OFF.
4. Tank Mode operation OFF.

Internal heater control in Tank Mode

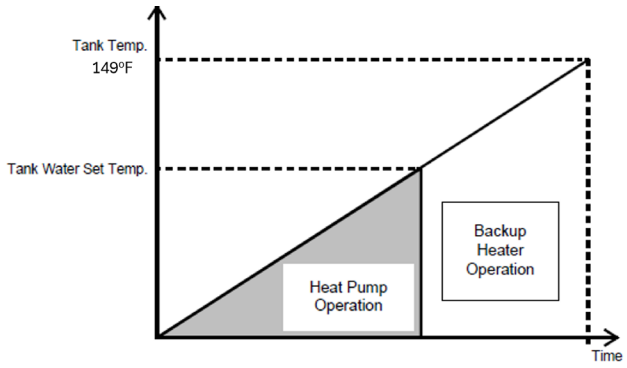
Internal heater turn ON condition:

1. Internal heater selected for tank heater by control pad
2. Tank heater ON selected by user
3. The backup heater is enabled
4. Tank Temperature < Tank Set Temperature
5. Heat pump thermo OFF
6. 20 minutes since the heater last switched off

Internal heater turn OFF trigger:

1. Tank Temperature > Tank Set Temperature + [0°F] for a continuous 15 seconds OR
2. Heat pump thermo ON, OR
3. Mode change or operation OFF at control pad, OR
4. Water outlet temperature >167°F.

Figure 11-11 *Internal heater control*



Base pan heater control

There are 2 start conditions that can be selected: Type A or Type B.

Type A is the default mode. It will start when outdoor air temperature is ≤ 37°F during heating and the de-icing operation is switched ON. Base pan heater is ON during de-icing operation and remains ON for 10 minutes after de-icing operation ends.

Type A will turn off when outdoor temperature > 42°F after de-icing ends, when operation is not in Heating Mode, or when the base pan heater ON timer count has expired.

Type B is the ON Mode. It will start when the outdoor air temperature is ≤ 41°F and the unit is operating in Heating Mode, and base pan heater is ON.

Type B will turn off when the outdoor air temperature is > 44°F or when the unit is not operating in Heating Mode.

Heater turn ON/OFF priority control

This control allows only one heater (room heater or tank heater) to turn ON at a time because both heater power supplies share the same GFCI. It prohibits two heater sources from turning ON at the same time to avoid overcurrent.

Heater turn ON/OFF priority control will turn on when the tank heater function is set to YES at the control pad.

When there is only one heater source (room heater or tank heater) request to turn ON, it will operate the same as in normal room heater and tank heater operation.

When both the backup heater and the booster heater are requested to turn ON at the same time, it will turn ON only ONE heater source. Under normal conditions, the tank heater has priority to turn ON with the exception of the conditions listed below:

- 1 Backup heater priority to turn ON when
  - ◊ Request for backup heater to turn ON at hex protection control during de-icing
  - ◊ Request for backup heater to turn ON at hex protection control if water temperature is low
  - ◊ Request for backup heater to turn ON at anti-frost control
  - ◊ Heat pump error during Forced Heating Mode operation.

11 Operation and Control

When switching from booster heater to backup heater OR backup heater to booster heater, delay 5 seconds between turning OFF one heater source and turning ON another heater source.

Forced Heating Mode

The purpose of Forced Heating Mode is to have a backup heat source when there is a heat pump error. Forced Heating Mode controls backup heaters to heat up the room circuit, and turn ON backup heater or booster heater to heat up tank water based on the tank heater selection (internal or external).

To start forced heating control, forced heating request must be turned ON by user OR by auto turn ON at the control pad during error. Forced Heating Mode can be operated regardless of mode selection. The control pad will be sent the latest mode selection and force bit to indoor. Indoor Mode will determine whether to turn ON heater to room side if Heating Mode is selected, and turn ON heater to heat-up tank water based on tank heater selection.

If an error occurs, exclude the error list below.

Table 11-6 *Forced heating errors to exclude*

H12	Capacity mismatch
H20	Abnormal water pump
H62	Abnormal water flow
H70	Abnormal backup heater OLP
H74	PCB communication error
H76	Indoor control pad communication error
H95	Abnormal voltage connection
F37	Abnormal water inlet sensor
F45	Abnormal water outlet sensor
H91	Abnormal tank heater OLP
[When tank mode operates with external heater selected & tank heater select ON]	
H72	Abnormal tank sensor

Forced heating control stop conditions:

- Forced heating request OFF, OR
- Operation OFF request, OR
- Mode change request, OR
- Power reset, OR
- Error from the above list occurs during forced heating operation.

After fulfilling start conditions, the indoor unit will operate forced heating according to the mode conditions below:

- Heat Mode only: Turn backup heater ON to reach room heat pump target water temperature.
- Heat + Tank Mode: Turn backup heater ON to heat up room OR turn Heater ON to heat up tank water.
- Cool Mode only: Water pump and backup heater will be OFF in Forced Heating Mode
- Cool + Tank Mode: Operate pump and internal heater OR external heater to heat up tank water.
- Tank Mode only: Operate pump and internal heater OR external heater to heat up tank water.

*For Heating Mode conditions, backup heater will only turn ON if the backup heater is enabled, regardless of room.

Heater selection

For Tank Mode conditions, if internal heater is selected, the backup heater will turn ON to heat up tank water. If external heater is selected, booster heater will turn ON to heat up tank water regardless of tank heater selection.

Room side: (Heat Mode)

1. When Forced Heating Mode start conditions are met, turn water pump ON and turn backup heater ON following procedure below.
2. Operate the three-way valve at room side only and turn ON two-way valve while Heat Mode is operating.
3. If buffer tank connection is YES, check according to normal zone pump and mixing valve control.
4. When Forced Heating Mode stop conditions are met, turn heater OFF in accordance with the status below and turn water pump OFF after pump delay time has expired.

Backup heater on conditions:

1. When Forced Heating control start conditions are met, AND
2. After the water pump has operated for 2 minutes, AND
3. When water outlet temperature < water set temperature + [control pad heater ON setting], AND
4. 20 minutes have elapsed since the backup heater switched OFF, AND
5. The backup heater is enabled

Tank side (Tank Mode)

1) When Tank Mode is selected and forced heating bit has been received, turn ON backup heater (INTERNAL) or booster heater (EXTERNAL) depending on the tank heater selection. If tank heater selection is INTERNAL, follow normal thermo determination to switch the three-way valve to tank side and room side. If tank heater selection is EXTERNAL, only turn ON booster heater according to tank thermostat reading.

11 Operation and Control

Tank heater selection is INTERNAL

Backup heater ON condition:

1. After water pump operates for 2 mins, AND
2. When tank temperature < Tank set temperature - [control pad set tank reheat temp] AND
3. 20 minutes since previous backup heater OFF, AND
4. Backup heater enable

Backup heater OFF condition:

1. Forced Heating Mode OFF, OR
2. When tank temperature > Tank set temperature for continuous 15 secs OR
3. Tank operation OFF

Tank heater selection is EXTERNAL

Backup heater ON condition:

1. After water pump operates for 2 mins, AND
2. When tank temperature < Tank set temperature + [control pad set tank re-heat temp] -1°F, AND
3. 20 minutes since previous backup heater OFF, AND
4. Backup heater enabled

Backup heater OFF condition:

1. Forced Heating Mode OFF, OR
2. When tank temperature > Tank set temperature for a continuous 15 secs OR
3. Tank operation OFF

Power Mode

Power Mode is used to increase the capacity of the heat pump to achieve higher target temperature. Power Mode is applicable when Heating Mode is operating.

Control pad setting

In the quick menu on the control pad, there are 4 options for Power Mode that can be selected:

- OFF: Cancel Power Mode
- 30 minutes: Set powerful for 30 minutes
- 60 minutes: Set powerful for 60 minutes
- 90 minutes: Set powerful for 90 minutes

During the time set by the control pad, Power Mode will activate according to 2 shift up controls. However, this function is applicable only for heating. The control pad will transmit the signal to indoor unit once this function is selected, then transmit OFF signal to indoor when the timer is complete. The indoor unit will transmit the signal to the outdoor unit for frequency control.

Indoor setting temperature shift targets water temperature, and will shift up to Wlo or Whi, whichever is higher. If "Direct Type" temperature control is selected, this powerful shift-up setting is not effective.

Power Mode is selected on the control pad. It can be turned off if the OFF/ON button is pressed or Power Mode is turned OFF on the control pad.

Quiet operation

Quiet Mode is used to reduce the noise of the outdoor unit by reducing the frequency or fan speed.

Quiet level

There are 3 levels (Level 1, Level 2, Level 3) to set menu function on control pad. Once the quiet function is selected, the control pad will transmit the signal to the indoor and outdoor units.

Quiet Mode is set on the control pad, or can be set by a weekly timer.

To turn off Quiet Mode, press the OFF/ON button, turn it off using the control pad, or it can be turned off with a weekly timer.

Sterilization Mode

The purpose of the Sterilization Mode is to sterilize the water tank by setting the required boiling temperature.

Day and time for Sterilization Mode to start can be selected on the control panel. The boiling temperature of the external heater is 131°F ~ 167°F. For the internal heater it is 131°F ~ 149°F. Maximum operation time is 5 minutes to 1 hour.

To turn on Sterilization Mode:

- Tank connection set to "YES" by control panel
- Sterilization function is set to "YES"
- Sterilization signal received from control panel by timer.
- Tank Mode request ON.

To stop Sterilization Mode:

- When boiling timer has expired. Boiling timer (use control pad to set maximum operation time) starts counting once tank reaches boiling set temperature OR
- After 8 hours of operation since sterilization started
- Tank Mode request OFF

During Sterilization mode activation time, the target tank set temperature will internally change to boiling set temperature.

When Sterilization mode activates, the heat pump and heater (external or internal) will operate as normal tank mode to achieve the boiling set temperature. Sterilization Mode will end when the stop condition is met. After sterilization is complete, the tank set temperature will return to normal operation.

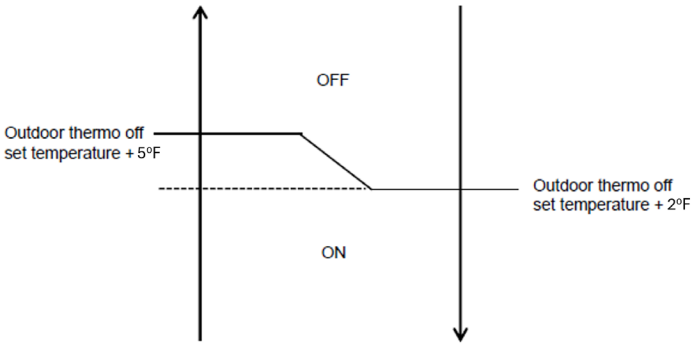
* Tank temperature may not reach boiling set temperature if tank heater is selected OFF OR external compressor switch.

11 Operation and Control

Outdoor ambient thermo OFF control

The purpose of the outdoor Ambient thermo OFF control is to stop providing heat to room side when outdoor ambient temperatures are high.

Figure 11-12 Outdoor ambient control



Heating outdoor ambient thermos OFF control is only applicable when heat pump is operating in heat mode. This control will not activate when running in tank side. The Heat pump and water pump will turn OFF when outdoor ambient is higher than the outdoor thermo OFF set temperature.

Heat pump thermostat ON when outdoor ambient < outdoor thermostat OFF set temperature + 1°F.

Alternative outdoor ambient sensor control

There is some possibility that the air-to-water heat pump unit will be installed at a location where the original ambient sensor is exposed to direct sunlight. Another optional ambient sensor can be connected to the indoor PCB and located at a new and better reading location to improve the heat pump's performance.

The control pad can be used to select whether the extra outdoor ambient sensor is connected or not. (YES/NO)

The alternative outdoor ambient sensor will connect to an indoor unit main PCB terminal when the alternative sensor is set to NO.

The original outdoor temperature sensor will be used as the indoor and outdoor heat pump operation reference sensor.

The OUTDOOR unit will send outdoor temperature readings to the INDOOR unit. The OUTDOOR will determine the original outdoor sensor error (F36 displays if error detected). There is no determination error on alternative outdoor sensors when alternative sensor is selected YES.

An alternative outdoor temperature sensor will be used as the indoor and outdoor heat pump operation reference sensor.

The INDOOR unit will send outdoor temperature readings to the OUTDOOR unit. INDOOR will judge the Extra outdoor sensor error only after operation ON request is received from the control pad (F36 displays if error detected). There is a no determination error on the original outdoor sensor.

Forced DHW Mode

When the user wants to use hot water immediately, the user can press the Forced DWH Mode in the quick menu to operate Tank Only Mode to heat up the tank temperature.

Forced DHW mode can be activated in the quick menu.
When the user presses the Forced DHW function when operation is OFF, the indoor unit will run Tank Only Mode regardless of the mode selection. After the tank temperature reaches the tank thermo off temperature, turn OFF Forced DHW Mode and return the mode setting to the previous mode selection.

When the user presses the Forced DHW function during operation, the indoor unit will memorize the running mode and run Tank Only Mode regardless of the mode selection. After the tank temperature reaches the tank thermo off temperature, turn OFF Forced DHW bit and return to the previously memorized running mode.

*When operation is OFF or mode change is requested from control pad during Forced DHW Mode, end Forced DHW Mode and follow the new request operation.

*Once Forced DHW Mode is received from the control pad, indoor direct will start tank mode and consider tank thermo ON.

Thermo is OFF only when reaching tank thermo OFF, depending on the tank system setting.

SMART DHW Mode

Lochinvar All In One model provides the option to choose STANDARD DHW Mode or SMART DHW Mode for tank meat-up according to requirements. SMART DHW mode comparatively consumes less power to heat up tank, but a longer reheat time than STANDARD DHW Mode.

During SMART DHW start time 20:00 (default setting) to SMART DHW stop time 05:00 (default setting), the heat pump reheats the tank water only when tank temperature drops below 68°F. This is the default setting.

In the time from 05:00 to 20:00 the heat pump will reheat the tank water when the tank temperature meets the following conditions:

- Condition 1: Tank heater ON

  Reheat when tank temperature is below tank set temperature + R/C (Tank reheat Temperature) -5°F

- Condition 2: Tank heater OFF

  Reheat when tank temperature is below tank set temperature or tank limit temperature (whichever is lower) + R/C (tank reheat temperature) -5°F

11 Operation and Control

*SMART DHW start time, stop time and SMART ON temperature can be changed in the CUSTOM Menu.

In STANDARD DHW Mode, the heat pump always reheats the tank water when tank temperature meets the following conditions:

- Condition 1: Tank heater ON

  Reheats when tank temperature is below tank set temperature + R/C (Tank reheat temperature)

- Condition 2: Tank heater OFF

  Reheats when tank temperature is below Tank set temperature or tank limit temperature (whichever is lower) + R/C (Tank reheat temperature)

Table 11-7 *Smart DHW conditions*

Outdoor ambient temperature	Tank limit temperature
OD < -1°F	118°F
1°F <= OD < 96°F	125°F
96°F <= OD	122°F

DHW Capacity Setting

DHW capacity is the heat pump heating capacity output control during tank heating operation. There are two DHW capacity settings (VARIABLE & STANDARD) which can be set on the control panel.

For the VARIABLE DHW capacity, the heat pump operates with efficient (low) capacity to heat tank temperature during the reheating process. And heat pump regulated to operate with high capacity to heat tank temperature when tank temperature drops below 77°F.

For the STANDARD DHW capacity, the heat pump operates according to outdoor rated heating capacity during the tank heating process.

Antifreeze Control

The anti-freeze protection control menu can be set to YES or NO from the control panel. In the heat pump system, there are 3 types of antifreeze control:

1. Expansion tank antifreeze control
   - Expansion tank anti-freeze heater ON condition: Outdoor ambient temp. < 37°F
   - Expansion tank anti-freeze heater OFF condition: Outdoor ambient temp. > 40°F
2. Water pump circulation antifreeze control
   - Water pump turns ON when ALL the conditions below are met:
     - ◊ Heat pump OFF (standby) OR error occurs.
     - ◊ Water flowing flag is ON.
     - ◊ Water flow switch is not abnormal.
     - ◊ Outdoor ambient temp. < 37°F OR outdoor ambient temp. sensor is abnormal.
     - ◊ Water inlet/outlet temp. < 42°F.
     - ◊ After 5 minutes from previous water pump OFF.
   - Water pump turns OFF when ANY of the conditions below is fulfilled:
     - ◊ Outdoor ambient temperature ≥ 40°F.
     - ◊ When 23°F < outdoor ambient temp. <40°F
   - After water pump ON for 4 minutes, and water inlet temp. ≥ 47°F.
   - Otherwise, shift to backup heater antifreeze control.
   - When outdoor ambient temp. < 23°F
   - After water pump ON for 4 minutes, and water inlet/outlet temp. ≥ 68°F.
   - Otherwise, shift to backup heater antifreeze control.
   - However, if the flow switch is abnormal (H62), then water pump circulation antifreeze control will not activate.
3. Backup heater anti-freeze control:
   - Backup heater turns ON when ALL the conditions below are met:
     - ◊ Water inlet/outlet temp. < 42°F.
     - ◊ Water pump circulation anti-freeze control activated and water pump ON for 4 minutes.
   - Backup heater turns OFF when ANY of the conditions below is fulfilled:
     - ◊ Water inlet/outlet temp. > 83°F.
     - ◊ Water pump circulation anti-freeze control deactivated/water pump OFF.
   - However, if backup heater is abnormal (H70) then back up heater anti-freeze control will not activate.

11 Operation and Control

Boiler prohibit flag control

The boiler prohibits flag control is for product safety. The boiler signal is OFF when the water temperature is too high.

When the water outlet temperature is ≥ 185°F for 5 minutes or the water inlet temperature is ≥ 185°F for 5 minutes, it will trigger the control.

After the control is triggered, set boiler prohibit flag = 1
The control can be canceled 30 minutes after the control is triggered.

External room thermostat control (optional)

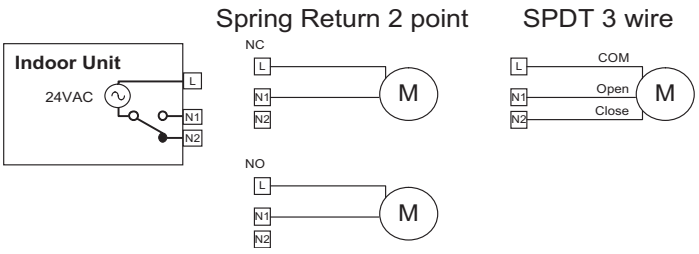
External room thermostat control is used for better room temperature control to fulfill different temperature requested by the external room thermostat.

External room thermostat control activates only when the thermostat connection is selected (YES on the indoor control panel). When the indoor unit is running in Heating Mode, refer to thermo On/Off from heating line feedback. And when indoor unit is running in Cooling Mode, refer to thermo On/Off from cooling line feedback. Turn the heat pump off immediately when thermo off feedback is received.

Three-way Valve Control

The three-way valve is used to change flow direction of hot water from the heat pump between heating side and tank side.
During the three-way valve switch off time, the hot water will provide heating capacity to the heating side.
During the three-way valve switch on time, the hot water will provide heating capacity to the tank side.
During Stop Mode, the three-way valve switch will be in the OFF position.

Figure 11-13 *Three-way valve*



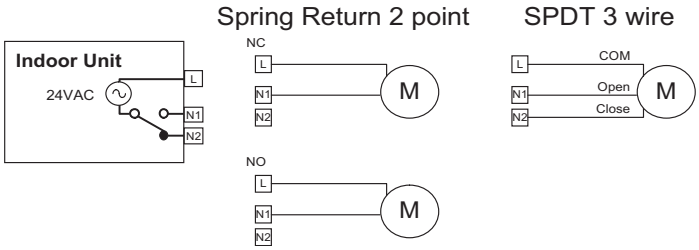
* During Pump-Down and Forced Mode, fix three-way valve in closed position.

Two-way Valve Control

The two-way valve is used to allow hot water to the floor heating panel or block cold water to the floor heating panel.

1. When the indoor unit is running in Heating Mode, OPEN the two-way valve.
2. When the indoor unit is running in Cooling Mode, CLOSE the two-way valve.
3. When in Stop Mode, fix the two-way valve in the closed condition.

Figure 11-14 *Two-way valve*



* During Pump-Down Mode, fix two-way valve in closed position.
* During Forced Mode, open two-way valve.

Heat/Cool Switch

The user can switch the operating mode from heat to cool or cool to heat through the externally installed Heat/Cool switch. This kind of heat / cool switch can be built inside the field supply room control pad as well.

This heat/cool switch control will activate only when the installer sets the heat/cool switch to "USE" on the control pad. Once the heat/cool switch is set to "USE", the control pad will check the indoor send signal to determine the options of the mode selected.

When the heat/cool switch contact is open, the control pad can only select Heat Mode, or Heat + Tank Mode, or Tank

Mode. When the heat/cool switch contact is closed, the control pad can only select Cool Mode, or Cool + Tank Mode, or Tank.

The heat/cool switch operation ON/OFF will depend on the control pad request. When Heating Mode is running with contact open, the user can change this setting to contact closed. The indoor unit will use this signal from the control pad to determine and change the mode to cool and send back to indoor. And it is same as changing from Cooling Mode to Heating Mode. This switch has higher priority, and the control panel will follow indoor send signal when control is activated.

There is no effect to the operation when the only mode running is Tank Mode. Weekly timer is ignored and cannot be set when Heat/Cool Switch is enabled.

11 Operation and Control

Backup Boiler Control

The boiler is an additional or alternative heat source to heat up the room when necessary. The purpose of this control is to turn the boiler output signal ON or OFF when boiler heating capacity is needed in the system. The boiler can connect to the DHW tank and buffer tank, depending on the installation. The boiler operation parameter must be set on the boiler itself, the indoor unit does not control the boiler operation direction and operation. There are alternative modes, Parallel Mode and Advanced Parallel Mode, which are available to be selected by the installer to fit the total system.

AUTO Control Mode

The installer can select Alternative Mode, Parallel Mode, and Advanced Parallel Mode to fit to the total system.

Backup control selection by control pad

Control pad setting value:

Outdoor ambient set = (range: 5°F ~ 59°F) Make heating similar to Parallel Mode:

- Only one heat source operates at a time, either the heat pump or boiler, depending on condition.
- The external pump will turn ON when the external pump selection is ON and the boiler is ON, even if the heat pump is OFF.

Heat Mode or Tank Mode or Heat + Tank Mode is operating, the boiler signal will turn ON, while the heat pump and water pump turn OFF when:

- Outdoor ambient < Outdoor ambient set, AND
- Boiler prohibit flag = 0

However, the indoor water pump can operate when the anti-freeze control conditions are met.

The boiler signal will turn OFF, and the heat pump and water pump turn ON when:

- Outdoor ambient > Outdoor ambient set + [3°F], OR
- Boiler prohibit flag = 1

Parallel Mode

Parallel Mode allows the heat pump and boiler to be ON at the same time. The boiler operates as an additional heating unit when the heat pump capacity is insufficient at low ambient temperatures.

When the unit is ON in Heating Mode or Tank Mode or Heating + Tank Mode, the boiler signal turns ON when:

- Outdoor ambient < Outdoor ambient set, AND
- Boiler prohibit flag = 0

The boiler signal turns OFF when:

- Outdoor ambient > Outdoor ambient set + [3°F], OR
- Boiler prohibit flag = 1

Advanced Parallel Mode

Advanced Parallel Mode will allow the heat pump to operate and turn the boiler ON only when the ambient and temperature conditions are met.

Control pad setting value:

1. Outdoor ambient set = (range: 5°F ~ 59°F)
2. Selection of boiler connection direction. (Heat only, DHW only, Heat & DHW)
3. Setting data under Heat direction
   Start temperature | START_TEMP |
   Start Delay Timer | START_TIMER |
   Stop Temperature | STOP_TEMP |
   Stop Delay Timer | STOP_TIMER |
4. Setting data under DHW Direction
   Delay Timer | DELAY_TIMER |

During operation, Advanced Parallel Mode is ON in Heating Mode. The boiler signal turns ON when:

- Outdoor ambient < Outdoor ambient set, AND
- Buffer tank temperature < Target buffer tank temperature + [START_TEMP] for [START_TIMER], AND
- Heat pump is operating at room side, AND
- Connection of boiler to heating selection is "YES" in installer menu, AND
- The buffer tank connection selection is "YES," AND
- Boiler prohibit flag = 0

The boiler signal turns OFF when:

- Outdoor ambient > Outdoor ambient set + [3°F], OR
- Buffer tank temperature > target buffer tank temperature + [STOP_TEMP] for [STOP_TIMER], OR
- Heat pump is not at room side. OR]
- Boiler prohibit flag = 1

When Tank Mode is operating, the boiler signal turns ON when:

- Outdoor ambient < Outdoor ambient set, AND
- Heat pump operates at tank side for | DELAY_TIMER |, AND
- Connection from boiler to DHW tank selection is "YES" in the installer menu, AND
- Boiler prohibit flag = 0

The boiler signal turns OFF when

- Outdoor ambient > Outdoor ambient set + [3°F], OR
- Heat pump is not operating at tank side, OR
- Boiler prohibit flag = 1

11 Operation and Control

Vacation Mode

Vacation Mode promotes energy saving by allowing the user to shutt the system off during vacation and enables the system to resume at the preset temperature after vacation.

Indoor operate the unit according to the operating mode request. Target temperatures will follow vacation setting temperature. If a Heating Mode request is received, the target water out temperature will change according to the vacation shift temperature setting. If a tank mode request is received, Target Tank Set Temperature will change according to the vacation tank shift temperature set. If the tank is set to OFF on vacation, the heat pump and tank heater will be OFF.

After days of holiday have been set, the heat pump will stop and only resume operation at the end of the vacation countdown. The day Vacation Mode is set is counted as Day 1.

Vacation Mode will stop when the OFF/ON button is pressed or when the vacation timer has expired.

Dry Concrete

Provide a heat-to-floor heating panel and dry the wet concrete during installation.

The dry concrete parameter can be set on the control pad under system setup. Parameters can be set for up to 99 days with different target set temperatures.
Dry Concrete Mode will be activated when ON is selected from service setup. Once the dry concrete function is started, the control pad will send step 1 "setting temperature" to the indoor unit. The heat pump will start Heating Mode operation to room side at tje received target water outlet temperature.

* Heat pump will operate to reach the heat pump target water temperature.

After completing Day 1 setup operation, Day 2 data will be sent to the indoor unit at 12:00 a.m. on the second day. Preset data will be sent each day until Dry Concrete Mode is complete. The unit will turn OFF and exit the dry concrete function. The three-way valve and booster heater will turn OFF, and the two-way valve will turn ON.
To cancel:
Dry Concrete Mode is complete and OFF signal is received. The OFF signal is received by pressing the OFF/ON button.

Flow sensor

The water flow sensor serves as an overload protector that shuts down the unit when the water level is detected at the values.

Table 11-8 *Abnormal flow detection*

Condition	Abnormal flow	Normal flow
Normal case	Flow rate < 1.3 gal/min or >= 18.2 gal/min	>= 1.3 gal/min
During de-icing operation, OR COOL Mode	Flow rate < 2.9 gal/min or >= 18.2 gal/min	>= 2.9 gal/min
During status 2~6 on znti-freeze de-icing	Flow rate >= 1.3 gal/min	< 1.3 gal/min

12 Protection control

Protection control for all operations

Time delay safety control

The compressor will not start until three minutes have passed after shutting down operation.

30 seconds forced operation

Once the compressor starts operation, it will not stop its operation for 30 seconds. However, it can be stopped using the control panel at the indoor unit.

Total running current control

When the outdoor running current exceeds X value, the compressor frequency will decrease. If the outdoor running current does not exceed X value, the compressor frequency will return to the normal operating frequency. If the outdoor running current continues to increase until it exceeds Y value, the compressor will stop. If this occurs 3 times within 20 minutes, system will stop operation and the OFF/ON LED on the control panel will blink (F16 error occurs).

Table 12-1 Current control

	RAH040	
Operation Mode	X (A)	Y (A)
Heating	28.0	30.0
Cooling	20.0	30.0

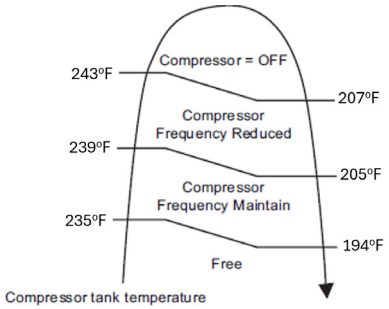
DC peak current control

When the current to IPM exceeds the set value, the compressor will stop. The compressor will restart after three minutes. If the IPM exceeds the set value for more than 30 seconds after the compressor restarts, operation will restart after two minutes. If the set value again exceeds within 30 seconds after the compressor restarts, operation will restart after one minute. If this condition repeats continuously seven times, the system will stop operation and the OFF/ON LED on the control panel will blink (F23 error occurs).

Compressor overheating prevention control

The compressor operating frequency is regulated in accordance with compressor tank temperature as shown in Figure 12-1. When the compressor tank temperature exceeds 224.6°F, the compressor will stop. If this occurs 4 times within 30 minutes, the system will stop operation and the OFF/ON LED on the control panel will blink (F20 error occurs).

Figure 12-1 Compressor overheating control

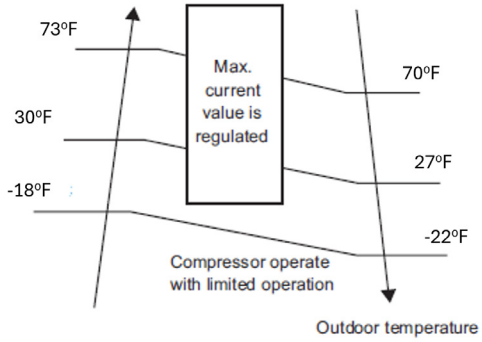


High pressure sensor control

The purpose of the high pressure sensor control is to protect system operation. The detection period begins after the compressor is on for 1 minute. The detection conditions are when there is an abnormally high voltage detection, 5 V, or when an open circuit detects 0V for 5 continuous seconds. After an abnormality is detected, or 5 continuous seconds, the unit will stop operation, and the OFF/ON LED on the control panel will blink (H64 error occurs).

Outside temperature current control

Figure 12-2 Pump speed feedback



Crankcase heater control

For compressor protection when operating during low outdoor ambient temperature (during heating low temperature operation):

a. Trigger heater START condition

1. When the outdoor air temperature is lower than 39°F, and discharge temperature is 48°F or lower.

b. Resetting heater STOP condition:

2. When the outdoor air temperature exceeds entry condition (43°F)
3. When the discharge temperature exceeds entry condition (56°F)

12 Protection control

Protection Control for Heating Operation

Outdoor air temperature control

The maximum current value is regulated when the outdoor air temperature rises above 57.2°F in order to avoid compressor overloading.

De-icing operation

When the outdoor pipe temperature and outdoor air temperature are low, de-icing starts when the outdoor fan motors stop. Normally, de-icing starts if the pipe sensor temperature fulfills de-icing conditions. If the control pad is set to AUTO forced defrost setting, the unit will start forced de-icing after the heat pump operates for 3 hours without de-icing at an outdoor temperature of below 41°F.

There are 2 de-icing modes. Which De-icing Mode is selected is decided based on water inlet temperature and outdoor ambient temperature.

When the water inlet temperature is higher than 140°F, the unit will operate De-icing Mode 1. When the water inlet temperature is less than 80.6°F, the unit will operate De-icing Mode 2. When the water inlet temperature is less than 140°F and outdoor ambient temperature is less than 14°F, the unit will operate De-icing Mode 2. When the water outlet temperature sensor 2 detects temperatures less than 71°F, the unit will operate De-icing Mode 2.

Figure 12-3 De-icing operation time diagram - Control 1

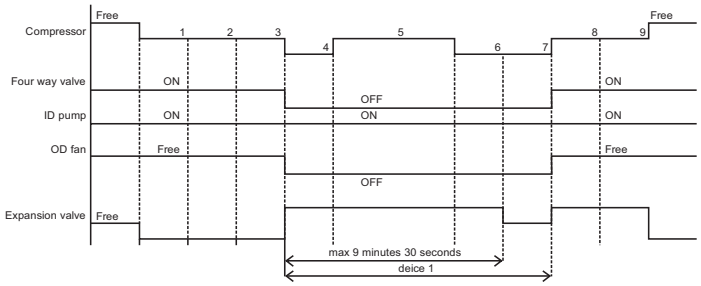
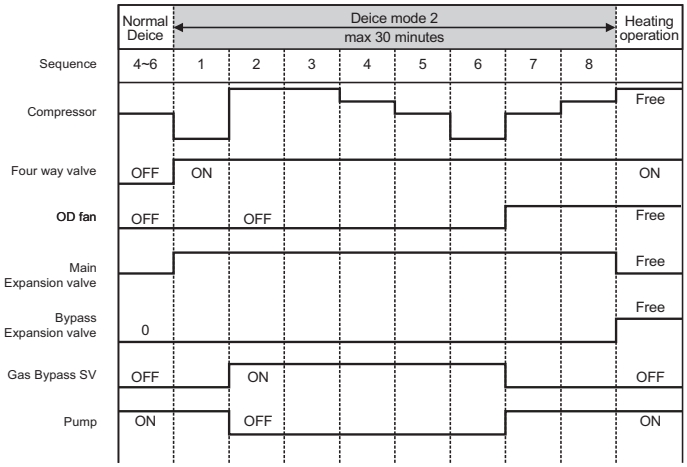


Figure 12-4 De-icing operation time diagram - control 2



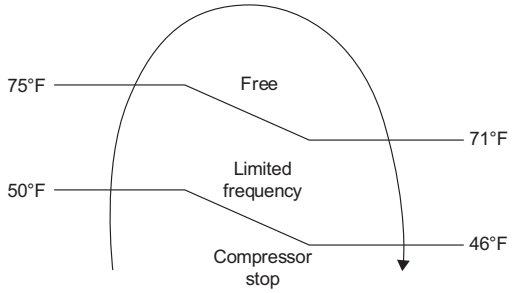
Forced defrost operation

Forced defrost can be set on the control pad with one of two settings (Manual OR Auto). If manual defrost is set, the heat pump will only run forced defrost in Heating Mode when forced defrost is requested from the quick menu on the control pad. If auto-defrost is selected, the heat pump automatically runs the forced defrost operation after 3 hours of cumulative heating time without defrost when the ambient temperature is below 41°F.

Outdoor air temperature control

The compressor operating frequency is regulated in accordance with the outdoor air temperature as shown in the diagram below. This control will begin 1 minute after the compressor starts. Compressor frequency will adjust based on outdoor air temperature.

Figure 12-5 Outdoor air compressor control



Freeze prevention control 1

When the indoor heat exchanger temperature is lower than 32°F for 10 continuousl seconds, the compressor will stop operating. The compressor will resume its operation three minutes after the indoor heat exchanger temperature exceeds 34°F. Indoor heat exchanger freeze prevention (H99) will be stored in the error history.

13 Service Mode

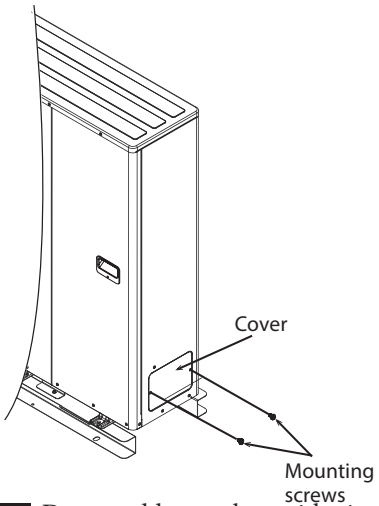
Maintenance

In order to ensure optimal performance of the unit, seasonal inspections of the unit, functional checks of the RCCB, field wiring, and piping must be carried out at regular intervals. This maintenance should be carried out by a qualified installer or technician.

Maintenance for water filter set

1. Remove the Cover by loosening the mounting screws to access the magnetic water filter set.
2. Turn power supply OFF.
3. Set the two valves for the magnetic water filter set to "CLOSE."
4. Remove the clip, then gently pull the mesh out. Be aware that a small amount of water will drain from the the mesh.
5. Clean the mesh with warm water to remove any residue. Use a soft brush if necessary.
6. Reinstall the mesh in the magnetic water filter set and replace the clip.
7. Set the two valves for the magnetic water filter set to "OPEN."
8. Turn power supply ON.
9. After cleaning, reinstall the Cover by tightening the mounting screws securely.

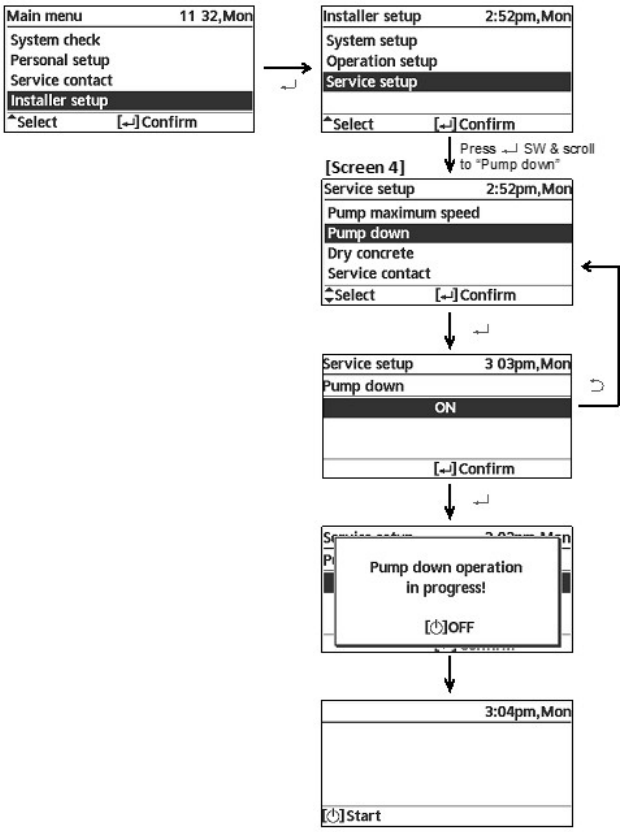
Figure 13-1 *Water filter maintenance port*



⚠WARNING Do not add or replace with piece other than R32 type. It may cause product damage, explosion, or injury. Use compatible R32 tools for refrigerant piping work and refrigerant charging during installation or servicing.

Pump-down Procedures

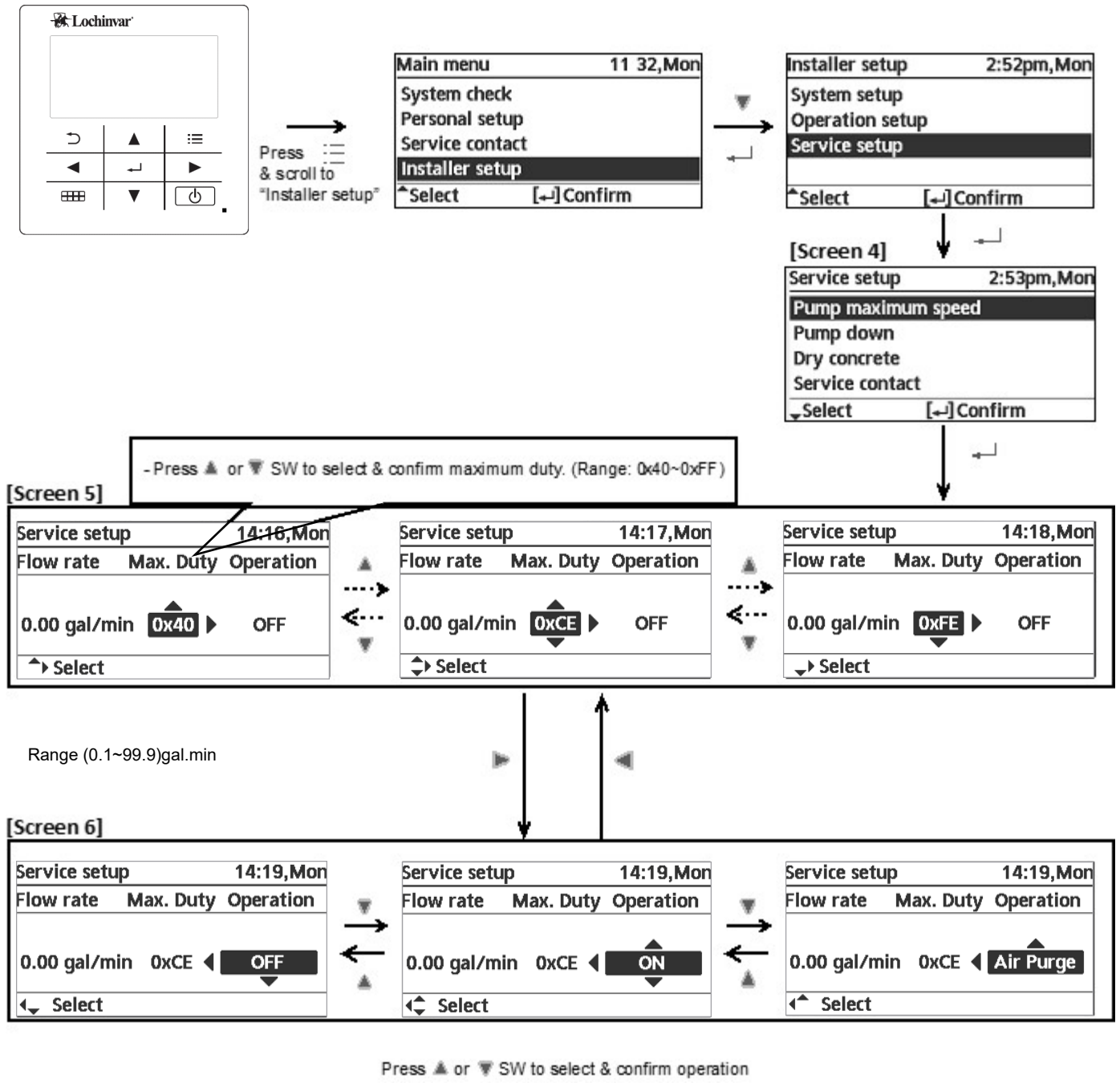
Refer to the steps below for the proper pump-down procedure.



13 Service Mode

How To Adjust Pump Speed

Refer to the steps below for the proper pump-down procedure.

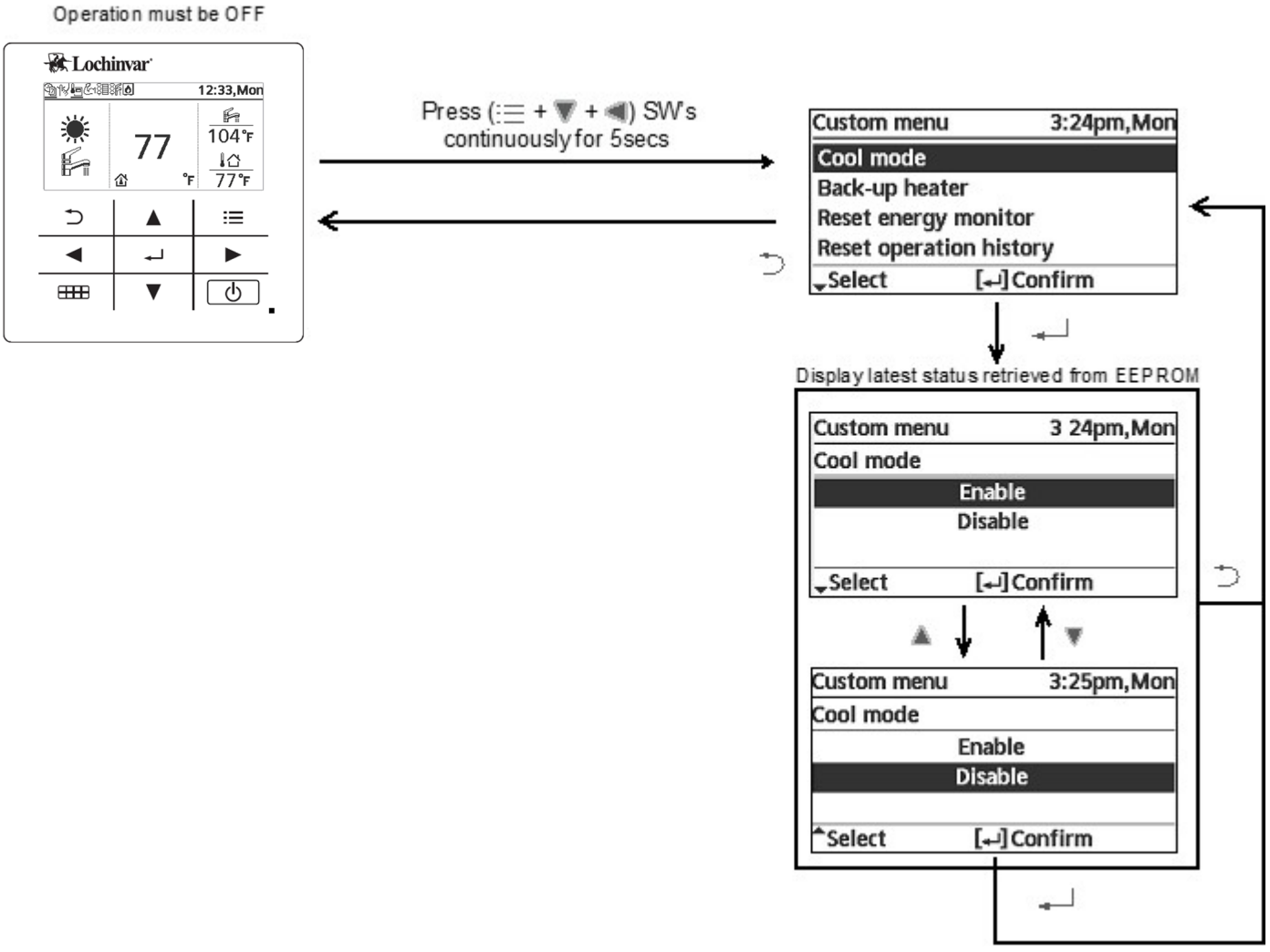


NOTICE When you are in [Screen 5], if press SW is set to OFF, pump operation should be turned OFF.

NOTICE Whe you are in [Screen 6], if press SW is set to OFF, pump operation should be turned OFF.

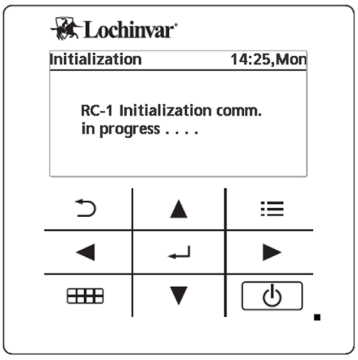
13 Service Mode

How to Unlock Cooling Mode



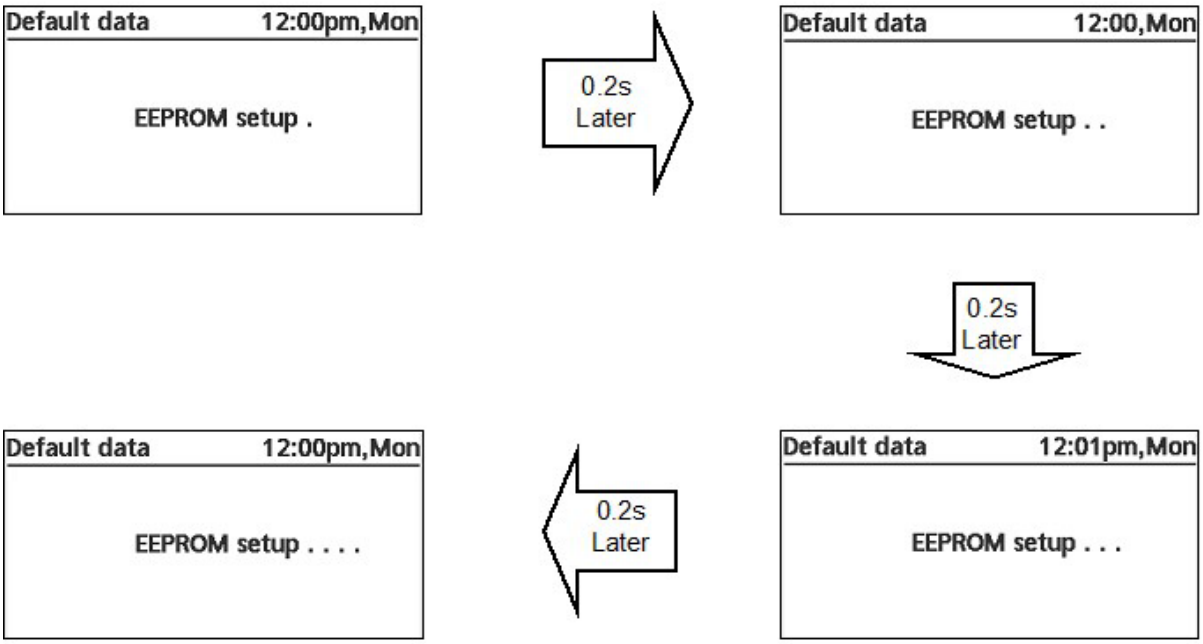
13 Service Mode

EEPROM Factory Default Data Setup Procedure

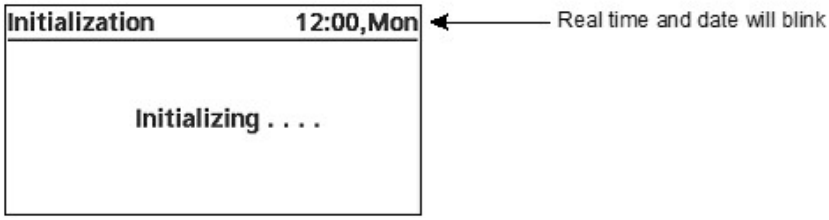


- EEPROM default data setup is only possible during initialization process.
- Press (▲, ▼, ◀, ▶)simultaneously for 5secs continuously, initialization process will stop & EEPROM default data setup process will start.

During EEPROM default data setup process, display should be as shown below.

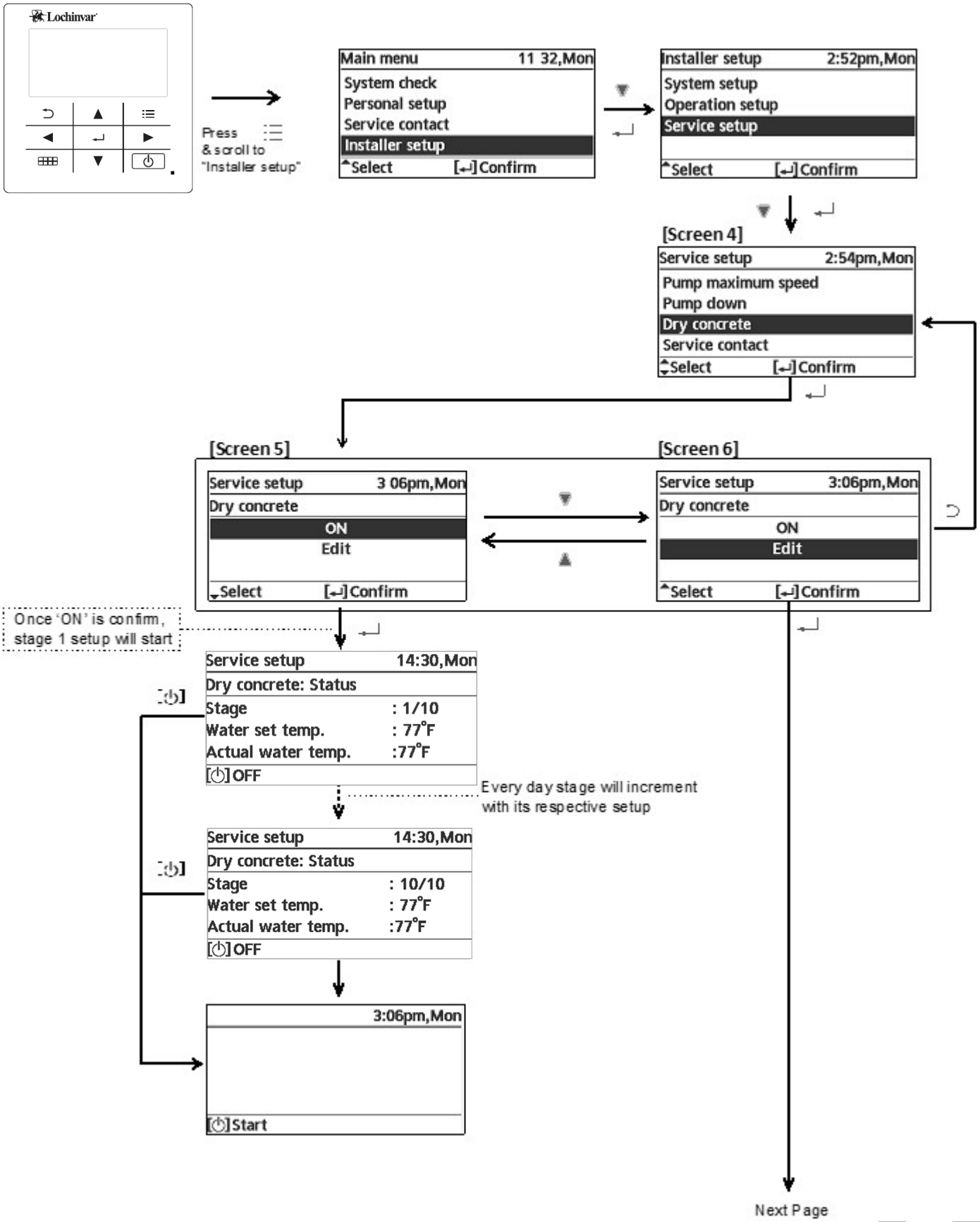


- Once EEPROM default data setup process is complete, initialization process will re-start from beginning.



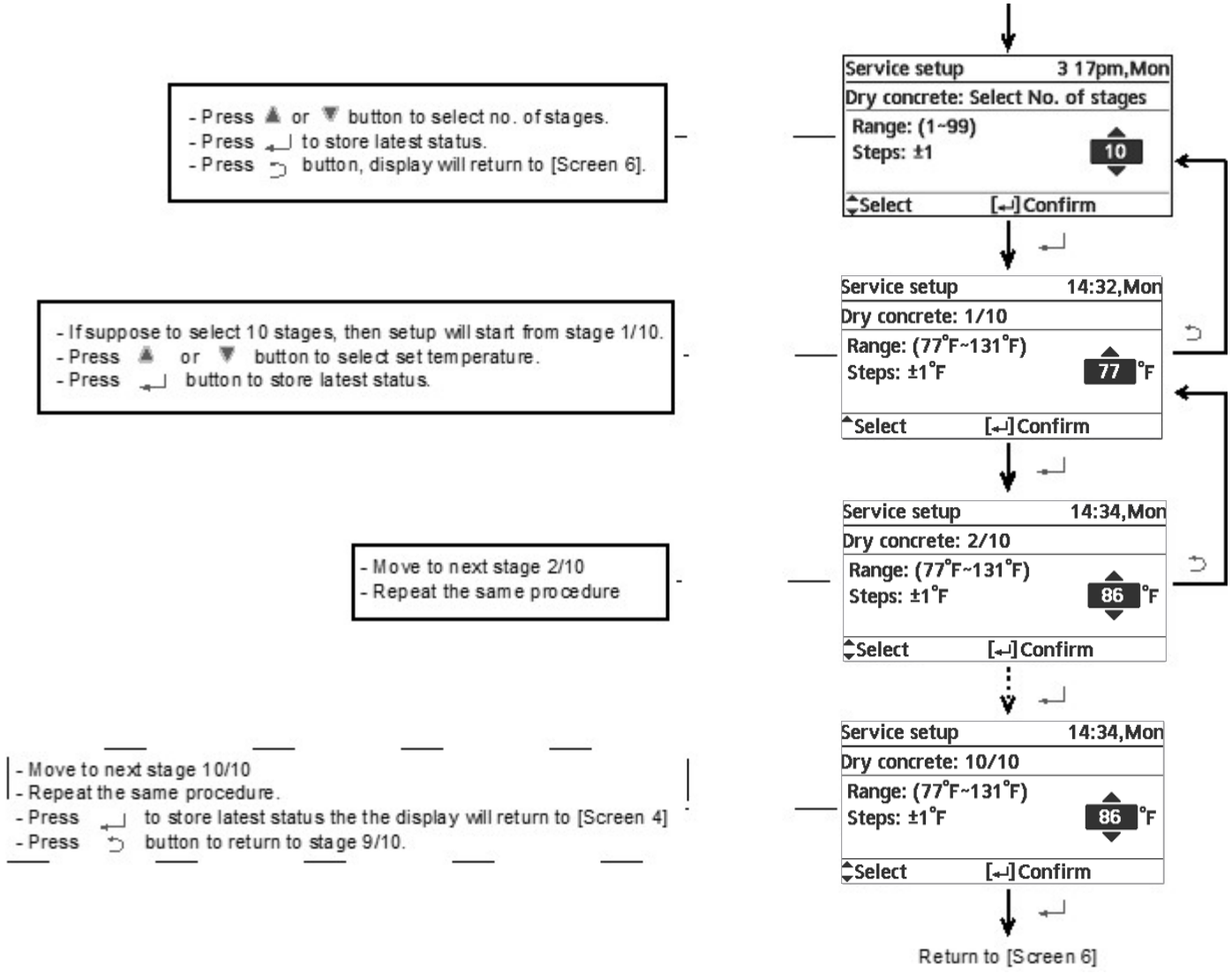
13 Service Mode

Dry Concrete Setup



13 Service Mode

Dry Concrete Setup



14 Maintenance Guide

In order to ensure safety and optimal performance of the unit, seasonal inspections on the unit, and functional checks of the RCCB/ELCB, field wiring, and piping must be carried out at regular intervals. This maintenance should be carried out by a qualified installer or technician. Contact the manufacturer for scheduled inspections.

Air purge valve

Make sure all the piping installations are properly completed before carrying out the steps below:

1. Open the cabinet front panel to access the pressure relief valve and air purge valve.
2. Turn the plug on the air purge valve outlet counterclockwise one complete turn from the fully closed position.
3. Set the pressure relief valve level to "DOWN."
4. Begin adding water (with pressure more than 14.5 PSI) to the Mono bloc unit via water inlet. Stop adding water if the free water flows into the pressure relief valve drain hose.
5. Turn the power supply ON and make sure the water pump is running.
6. Check to make sure no water is leaking at the tube connection points.
7. Reinstall the cabinet front panel by tightening the two mounting screws.

Water pressure *(14.5 PSI)

Water pressure should not be lower than 7.3 PSI (as reported by the water pressure gauge). If necessary, add tap water to the water circuit.

Pressure relief valve

1. Check that the pressure relief valve is operating correctly by turning the lever to the horizontal position.
2. If you do not hear a clacking sound (due to water drainage), contact your local a qualified installer or technician.
3. Push the lever to the down position after completing the check.
4. If the water keeps draining from the unit, switch off the system, and then contact your local qualified installer or technician.

Expansion tank

The Mono bloc unit has a built-in Expansion Vessel with 2.64-gal air capacity and initial pressure of 14.5 PSI.

Without antifreeze in the system, the total amount of water in the system should be below 52.8 gal. If the total amount of water is more than 52.8 gal, please add an expansion tank (field supply).

With antifreeze in the system, the expansion rate is different depending on its manufacturer. Please refer to the antifreeze manufacturer for the expansion rate before calculating the maximum water volume of the system.

RCCB

Ensure the RCCB is set to "ON" before checking the RCCB. Turn the power supply to the Mono bloc unit on. This test can only be performed when power is supplied to the Mono bloc unit.

1. Push the "TEST" button on the RCCB. The lever should be turned down and indicate "0" if it is functioning normally.
2. Contact a qualified installer or technician if the RCCB malfunctions.
3. Turn off the power supply to the Mono bloc unit.
4. If the RCCB is functioning normally, reset the lever to "ON" after testing is completed.

This product contains fluorinated greenhouse gases.
Refrigerant type: R32 (GWP=675)
For RAH040
Amount: 3.53 lbs (1.080 ton CO2 equivalent)

Test run

Before doing a test run, make sure the items below have been checked:

- Pipework is properly completed.
- Electric cable connections are properly made.
- Mono bloc unit has been filled with water and trapped air has been released. Antifreeze agent must be added to the water circuit to prevent freezing of water when outdoor ambient temperatures are low.

  Recommended antifreeze: Propylene glycol: 40% (equivalent to -4°F)

Turn ON to the Mono bloc unit and RCCB 2. Then, for control pad operation, please refer to the (Mono bloc) air-to-water heat pump operating instructions. For normal operation, the water pressure gauge reading should be between 7.3 PSI and 43.5 PSI. After a test run, please clean the magnetic water filter set. Reinstall it after cleaning.

Water flow in water circuit

Confirm that the maximum water flow during main pump operation is not less than 3.96 gal/min.

*Water flow can be checked via the service setup (pump max speed) [heating operation at low water temperature with lower water flow may trigger Error H75 during the defrost process.]

14 Maintenance Guide

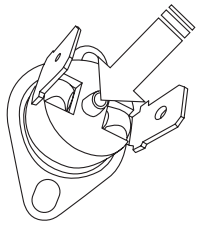
Reset the overload protector

The overload protector serves the safety purpose of preventing the water from overheating. When the overload protector trips at high water temperatures, take the steps below to reset it.

a. Remove the cover.

b. Use a test pen to push the center button gently in order to reset the overload protector.

c. Secure the cover in its original position.



Use test pen to push this button for reset Overload protector

Maintenance Menu

Service and maintenance

If forget Password and cannot operate remote controller

Press ⮌ + ↵ + ▶ for 5 sec.
Password unlock screen appears, press Confirm and it shall reset.
Password will become 0000. Please reset it again.
(NOTE) Only display when it is locked by password.

Maintenance Menu

Setting method of Maintenance menu

Maintenance menu	12:00am,Mon
Actuator check	
Test mode	
Sensor setup	
Reset password	
▼ Select	[↵] Confirm

Press ⮌ + ↵ + ▶ for 5 sec.

Items that can be set

1 Actuator check (Manual ON/OFF all functional parts)
(NOTE) As there is no protection action, please be careful not to cause any error when operating each part (do not turn on pump when there is no water etc.)

2 Test mode (Test run)
Normally it is not used.

3 Sensor setup (offset gap of detected temp of each sensor within 28.4~35.6°F range)
(NOTE) Please use only when sensor is deviated.
It affects temperature control.

4 Reset password (Reset password)

Custom Menu

Setting method of Custom menu

Custom menu	12:00am,Mon
Cool mode	
Back-up heater	
Reset energy monitor	
Reset operation history	
▼ Select	[↵] Confirm

Please press ☰ + ▼ + ◀ for 10 sec.

Items that can be set
① Cool mode (Set With/Without Cooling function) Default is without
(NOTE) As with/without Cool mode may affect electricity application, please be careful and do not simply change it.
In Cool mode, please be careful if piping is not insulated properly, dew may form on pipe and water may drip on the floor and damage the floor.

② Backup heater (Use/Do not use Backup heater)
(NOTE) It is different from to use/not to use backup heater set by client. When this setting is used, heater power on due to protection against frost will be disabled. (Please use this setting when it is required by utility company.)
By using this setting, it cannot defrost due to low Heating's setting temp and operation may stop (H75)
Please set under the responsibility of installer.
When it stops frequently, it may be due to insufficient circulation flow rate, setting temp of heating is too low etc.

③ Reset energy monitor (delete memory of Energy monitor)
Please use when moving house and handover the unit.
④ Reset operation history (delete memory of operation history).
Please use when moving house and handover the unit.

Specifications

Table 14-1 Specifications of fresh water with heat transfer medium in brazed heat exchanger

Parameter	Quality limits for tap water on the secondary side
Temperature	Below 140°F
pH	7 to 9
Alkalinity	0.0005 lbs/gal < HCO3 < 0.0025 lbs/gal
Conductivity	< 1.26 mS/in
Hardness	[Ca+, Mg+] / [HCO3 -] > 5
Chloride	< 0.0017 lbs/gal at 140°F
Sulfate	[SO4 2-] > 0.0008 lbs/gal and [HCO3 -] / [SO4 2-] > 1
Nitrate	NO3 < 0.0008 lbs/gal
Chlorine	< 0.000004 lbs/gal

External filter

Solids in the water must be filtered. Minimum filter mesh size required for the field supply external filter in the water inlet is 20 mesh.

15 Troubleshooting Guide

Refrigeration circuit system

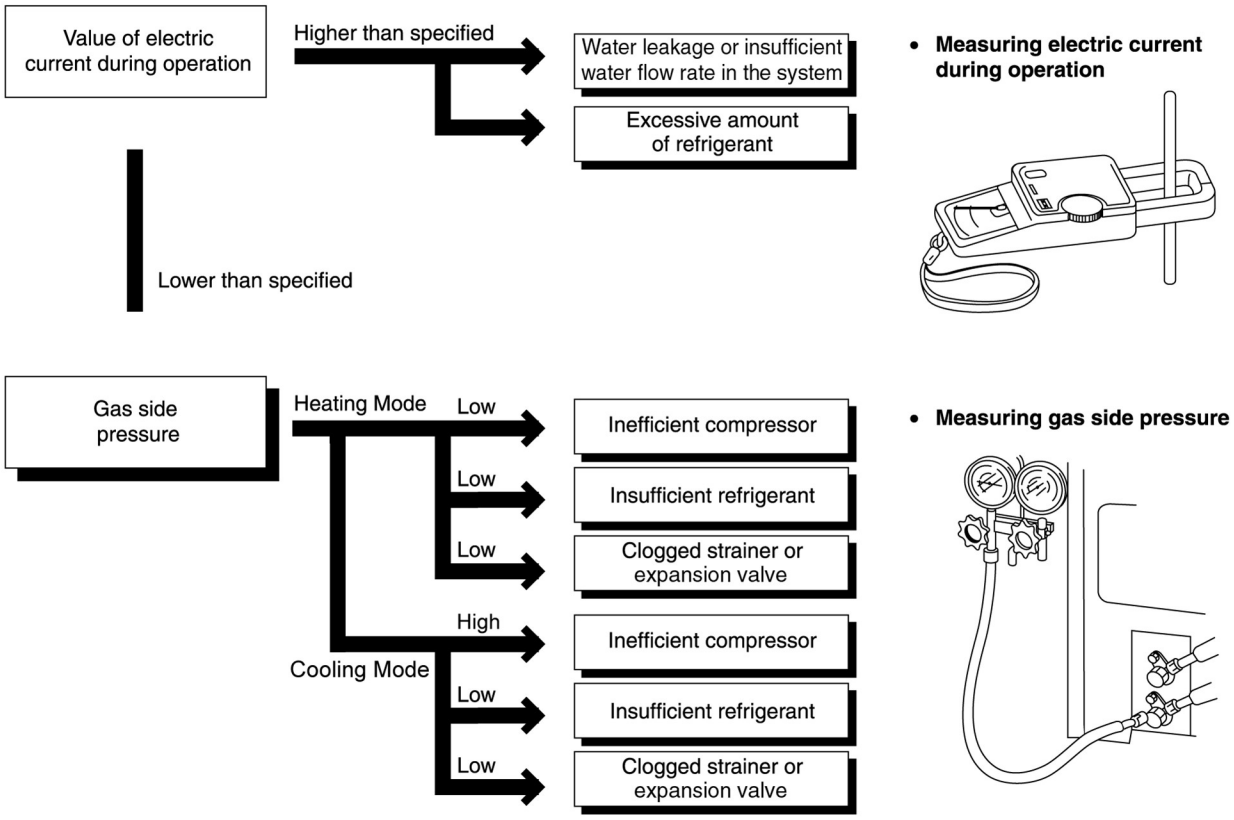
In order to diagnose malfunctions, make sure that there are no electrical problems before inspecting the refrigeration circuit. Such problems include insufficient insulation, problems with the power source, or malfunction of a compressor or fan. The normal pressure of the refrigeration circuit depends on various conditions; the standard pressure values are shown in Table 15-1.

Table 15-1 *Standard pressure*

	Gas pressure PSI
Heating Mode	333.6 ~ 420.6
Cooling Mode	130.5 ~ 174

*Conditions: Outdoor temperature 44.6°F in Heating Mode and 95°F in Cooling Mode. Compressor operates at rated frequency.

Figure 15-1 *Electric current during operation*



15 Troubleshooting Guide

Table 15-2 *Relationship between the status of the air-to-water heat pump indoor and outdoor units, pressure, and electric current*

Status of the air-to-water heat pump indoor and outdoor units	Heating Mode			Cooling Mode		
	Low pressure	High pressure	Electric current during operation	Low pressure	High pressure	Electric current during operation
Water leakage or insufficient water flow rate in the system	↗	↗	↗	↘	↘	↘
Excessive amount of refrigerant	↗	↗	↗	↘	↘	↘
Inefficient compression	↗	↘	↘	↗	↘	↘
Insufficient refrigerant (gas leakage)	↘	↘	↘	↘	↘	↘
Outdoor heat exchanger deficiency	↘	↘	↘	↗	↗	↗
Clogged expansion valve or strainer	↘	↗	↗	↗	↘	↘

*Carry out the measurements of pressure, electric current, and temperature fifteen minutes after an operation is started.

Breakdown Self-Diagnosis Function

Self-diagnosis function (three-digit alphanumeric code)

When an abnormality occurs during operation, the system will stop operation, the OFF/ON LED on the control panel will blink, and an error code will be displayed on the control panel. The error code can be canceled by turning the power supply OFF or by selecting ERROR RESET. If the system abnormality is still showing, the system will again stop operation, and the OFF/ON LED on the control panel will blink again, and an error code will be displayed. The error code will be stored in the IC memory.

To check the error code

When an abnormality occurs, system will stop operation and the OFF/ON LED on the control panel will blink. The error code for the abnormality will be displayed on the control panel. To determine which abnormality has occurred, refer to the error code table.

To display past/last error code

Turn power supply ON. Refer to the following procedures to retrieve the error code history.

To permanently delete error code from IC memory

Turn power supply ON. Refer to the following procedures to clear error history.

15 Troubleshooting Guide

Figure 15-2 *Locate error code*

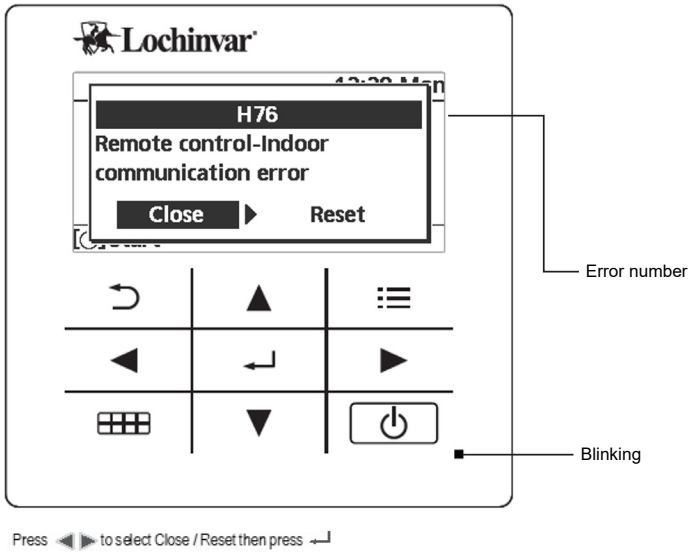
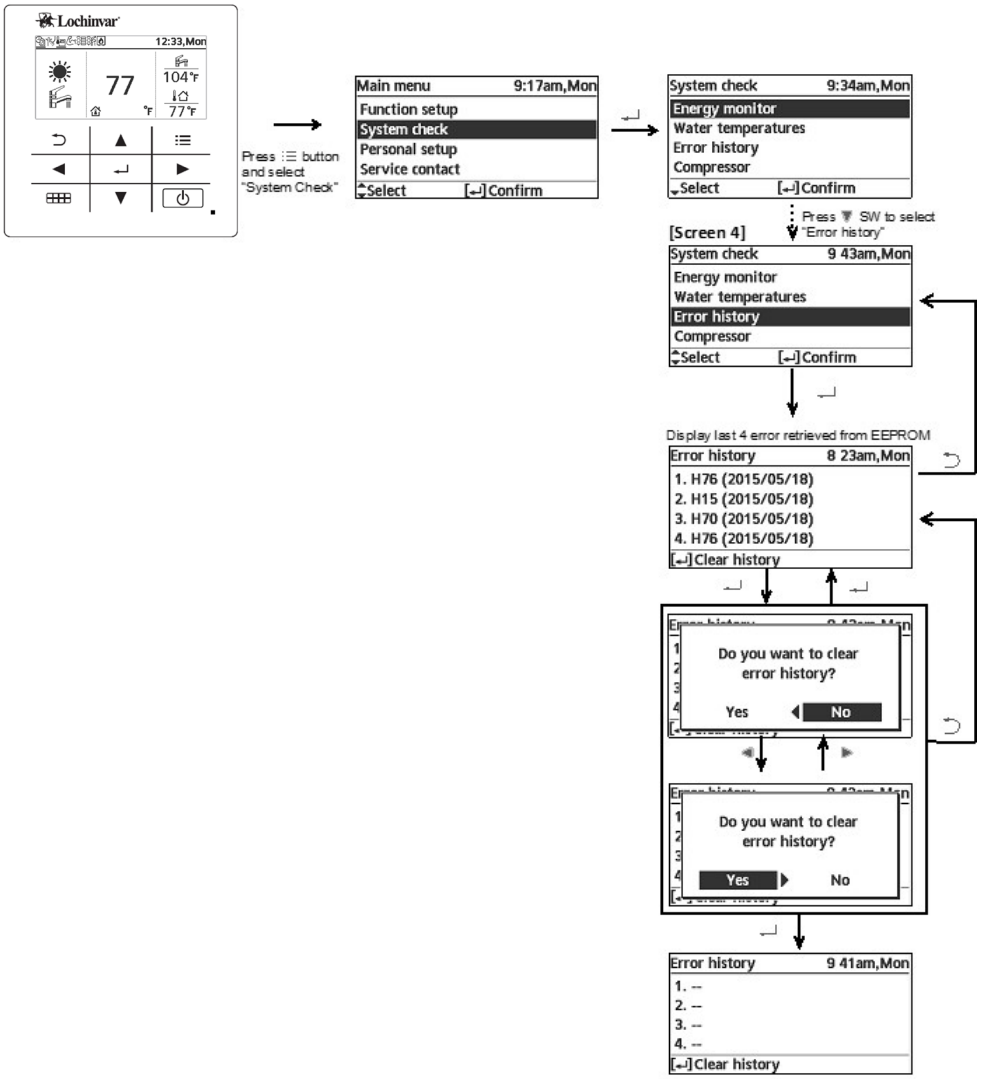


Figure 15-3 *Display past/last error code*



15 Troubleshooting Guide

Table 15-3 *Error chart*

Diagnosis display	Abnormality/protection control	Abnormality determination	Primary location to verify
H00	No abnormality detected	-	-
H12	Indoor/outdoor capacity mismatched	90 sec after power supply	• Indoor/outdoor connection wire • Indoor/outdoor PCB • Specification and combination table in catalog
H15	Outdoor compressor temperature sensor abnormality	Continue for 5 sec.	• Compressor temperature sensor (defective or disconnected)
H20	Water pump abnormality	Continue for 10 sec.	• Indoor PCB • Water pump (malfunction)
H23	Indoor refrigerant liquid temperature sensor abnormality	Continue for 5 sec.	• Refrigerant liquid temperature sensor (defective or disconnected)
H27	Service valve error	Continue for 5 minutes	• High pressure sensor (defective or disconnected)
H36	Abnormal buffer tank sensor	Continue for 5 sec.	• Buffer tank sensor (defective or disconnected)
H42	Compressor low pressure abnormality	-	• Outdoor pipe temperature sensor • Clogged expansion valve or strainer • Insufficient refrigerant • Outdoor PCB • Compressor
H62	Water flow switch abnormality	Continue for 1 min.	• Water flow switch
H64	Refrigerant high pressure abnormality	Continue for 5 sec.	• Outdoor high pressure sensor (defective or disconnected)
H65	Abnormal de-icing water circulation	Water flow > 1.8 gal/min continuously for 20 seconds during anti freeze de-icing	• Water pump

15 Troubleshooting Guide

Table 15-3 *Error chart continued*

Diagnosis display	Abnormality/protection control	Abnormality determination	Primary location to verify
H70	Back-up heater OLP abnormality	Continue for 60 sec.	• Back-up heater OLP (disconnected or activated)
H72	Tank sensor abnormal	Continue for 5 sec.	• Tank sensor
H74	PCB communication error	Communication or transfer error	• Indoor main PCB and sub PCB
H75	Low water temperature control	Room heater disable and de-icing request to operate under low water temperature	• Heater operation must enable to increase water temperature
H76	Indoor - control panel communication abnormality	-	• Indoor - control panel (defective or disconnected)
H90	Indoor/outdoor abnormal communication	> 1 min after starting operation	• Internal/external cable connections • Indoor/outdoor PCB
H91	Tank heater OLP abnormality	Continue for 60 sec.	• Tank heater OLP (disconnected or activated)
H95	Indoor/outdoor wrong connection	-	• Indoor/outdoor supply voltage
H98 / F95	Outdoor high pressure overload protection Cooling high pressure overload protection	-	• Outdoor high pressure sensor • Water pump or water leakage • Clogged expansion valve or strainer • Excess refrigerant • Outdoor PCB
H99	Indoor heat exchanger freeze prevention	-	• Indoor heat exchanger • Insufficient refrigerant
F12	Pressure switch activated	4 occurrences within 30 minutes	• Pressure switch
F14	Outdoor compressor abnormal revolution	4 occurrences within 20 minutes	• Outdoor compressor
F15	Outdoor fan motor lock abnormality	2 occurrences within 30 minutes	• Outdoor PCB • Outdoor fan motor
F16	Total running current protection	3 occurrences within 20 minutes	• Excess refrigerant • Outdoor PCB
F20	Outdoor compressor overheating protection	4 occurrences within 30 minutes	• Compressor tank temperature sensor • Clogged expansion valve or strainer • Insufficient refrigerant • Outdoor PCB • Compressor

15 Troubleshooting Guide

Table 15-3 *Error chart continued*

Diagnosis display	Abnormality/protection control	Abnormality determination	Primary location to verify
F22	IPM (power transistor) overheating protection	3 occurrences within 30 minutes	• Improper heat exchange • IPM (Power transistor)
F23	Outdoor direct current (DC) peak detection	7 occurrences continuously	• Outdoor PCB • Compressor
F24	Refrigeration cycle abnormality	2 occurrences within 30 minutes	• Insufficient refrigerant • Outdoor PCB • Compressor low compression
F25	Cooling/heating cycle changeover abnormality	4 occurrences within 30 minutes	• 4-way valve • V-coil
F27	Pressure switch abnormality	Continue for 1 min.	• Pressure switch
F30	Water outlet sensor 2 abnormality	Continue for 5 sec.	• Water outlet sensor 2 (defective or disconnected)
F32	Abnormal internal thermostat	Continue for 5 sec.	• Control panel PCB thermostat
F36	Outdoor air temperature sensor abnormality	Continue for 5 sec.	• Outdoor air temperature sensor (defective or disconnected)
F37	Indoor water inlet temperature sensor abnormality	Continue for 5 sec.	• Water inlet temperature sensor (defective or disconnected)
F40	Outdoor discharge pipe temperature sensor abnormality	Continue for 5 sec.	• Outdoor discharge pipe temperature sensor (defective or disconnected)
F41	PFC control	4 occurrences within 10 minutes	• Voltage at PFC
F42	Outdoor heat exchanger temperature sensor abnormality	Continue for 5 sec.	• Outdoor heat exchanger temperature sensor (defective or disconnected)
F43	Outdoor defrost sensor abnormality	Continue for 5 sec.	• Outdoor defrost sensor (defective or disconnected)
F45	Indoor water outlet temperature sensor abnormality	Continue for 5 sec.	• Water outlet temperature sensor (defective or disconnected)
F46	Outdoor current transformer open circuit	-	• Insufficient refrigerant • Outdoor PCB • Compressor low
F48	Outdoor EVA outlet temperature sensor abnormality	Continue for 5 sec.	• Outdoor EVA outlet temperature sensor (defective or disconnected)
F49	Outdoor bypass outlet temperature sensor abnormality	Continue for 5 sec.	• Outdoor bypass outlet temperature sensor (defective or disconnected)

15 Troubleshooting Guide

Self-diagnosis Method

Connection capability rank abnormality (H12).

Malfunction decision conditions

During startup and cooling and heating operation, the capability rank of indoor checked by the outdoor is used to determine connection capability rank abnormalities.

Malfunction causes

1 Wrong model interconnected.

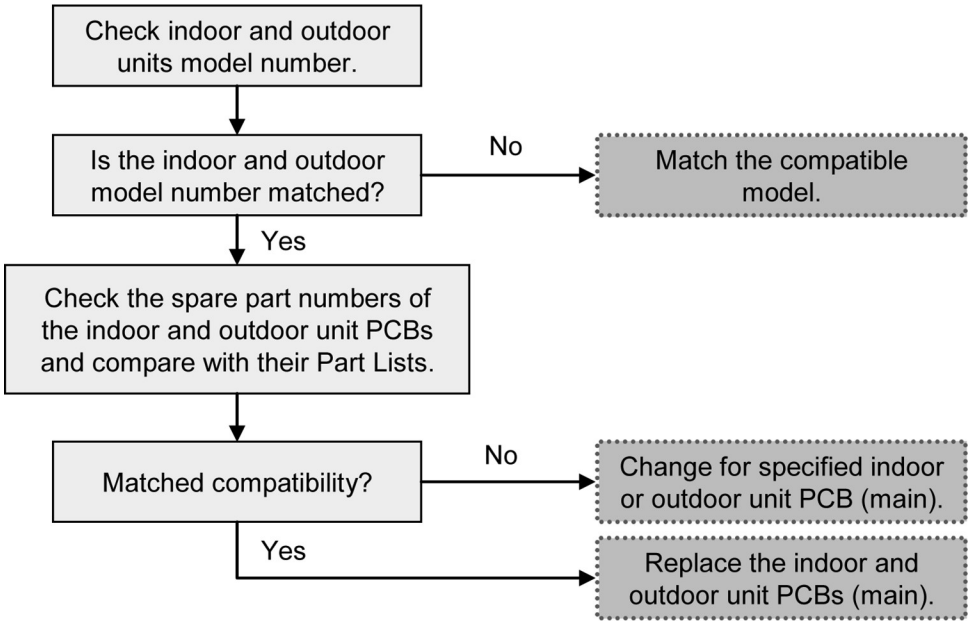
2 Wrong indoor unit or outdoor unit PCB (main) used.

3 Faulty indoor or outdoor unit PCB (main).

Abnormality determination

Continue for 90 seconds.

Figure 15-4 *Troubleshooting H12*



15 Troubleshooting Guide

Compressor tank temperature sensor abnormality (H15)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the compressor tank temperature sensor are used to determine sensor errors.

Malfunction causes

1 Faulty connector connection.

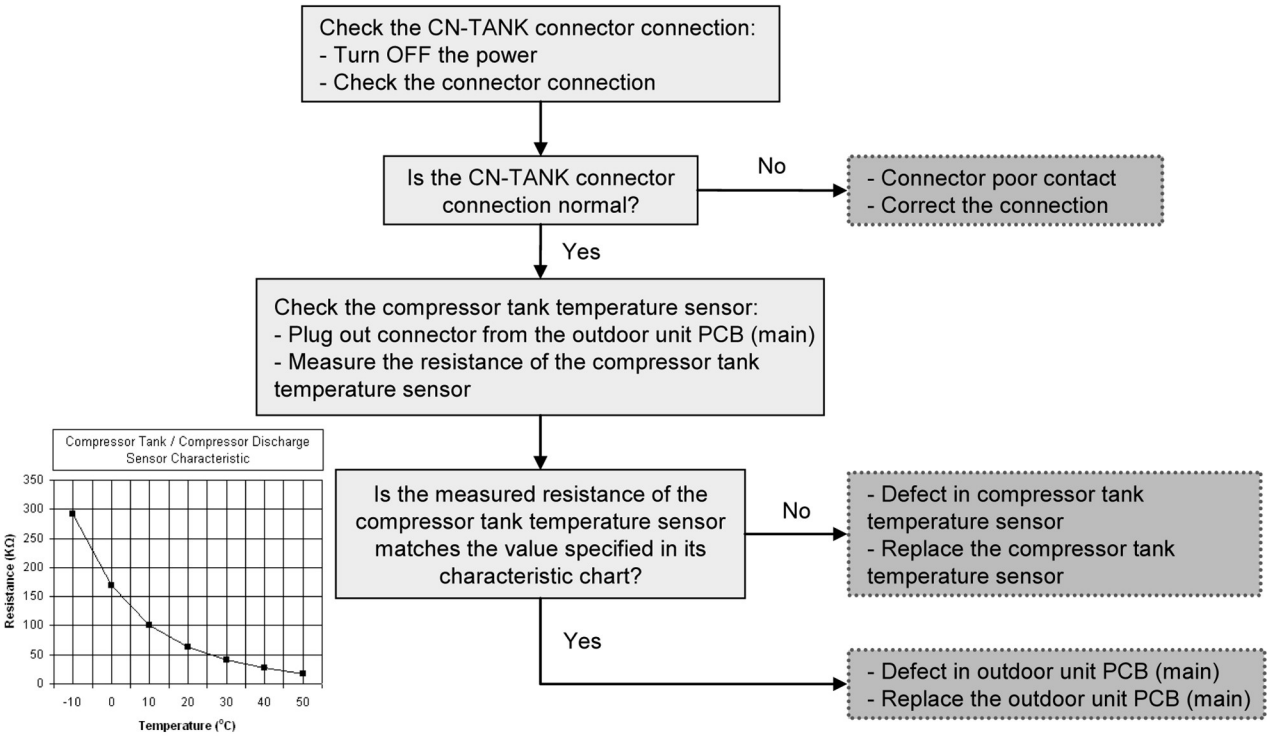
2 Faulty sensor.

3 Faulty outdoor unit PCB (main).

Abnormality determination

Continue for 5 seconds.

Figure 15-5 Troubleshooting H15



15 Troubleshooting Guide

Water pump abnormality (H20)

Malfunction decision conditions

During startup and cooling and heating operation, the rotation speed detected by the IPM of the water pump motor while the water pump is operating is used to determine abnormal water pump (feedback of rotation > 6,000 rpm or < 700 rpm).

Malfunction causes

1 Operation stop due to short circuit in the water pump motor winding.

2 Operation stop due to broken wire in the water pump motor.

3 Operation stop due to broken water pump lead wires.

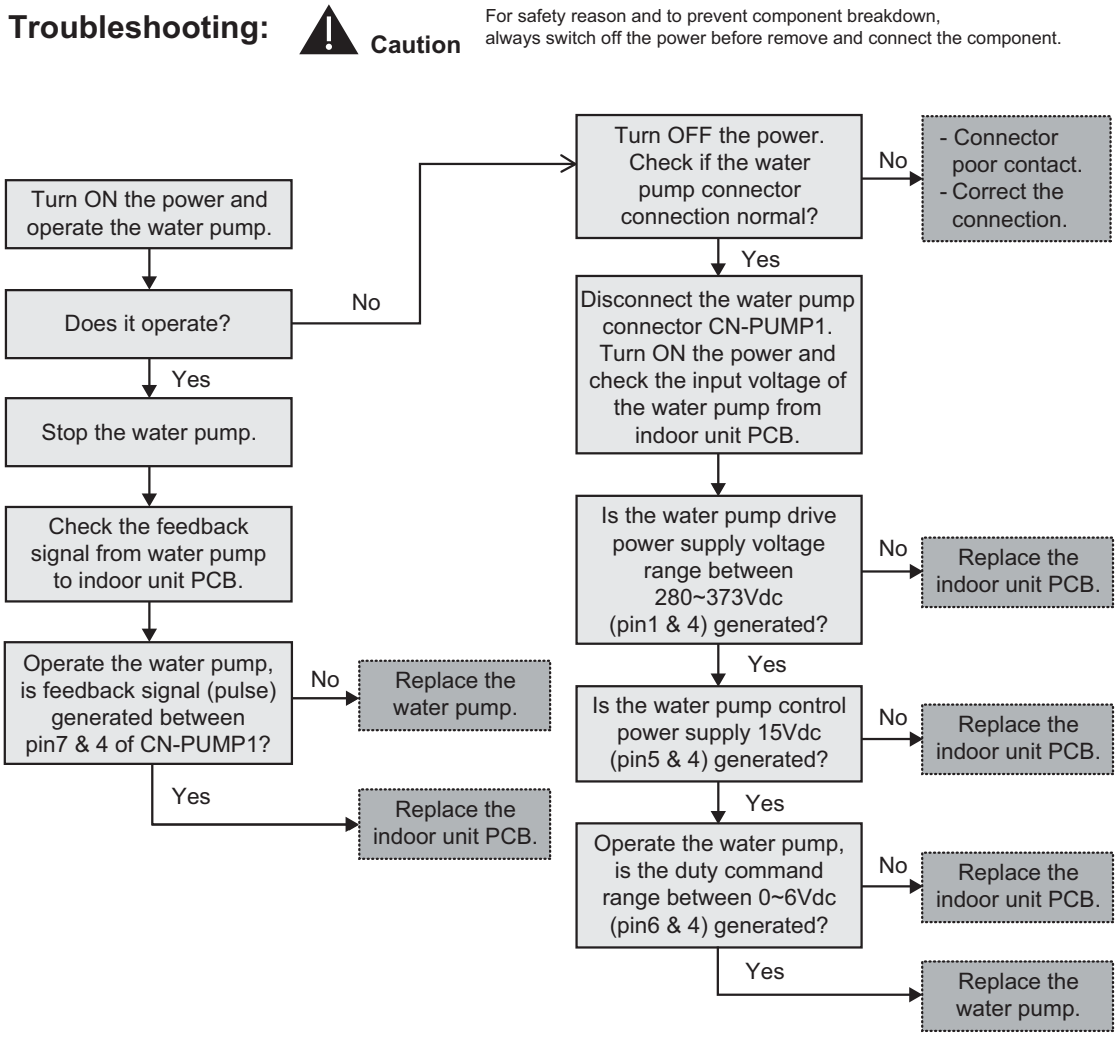
4 Operation stop due to water pump motor IPM malfunction.

5 Operation error due to faulty indoor unit PCB.

Abnormality determination

Continue for 5 seconds.

Figure 15-6 Troubleshooting H20



15 Troubleshooting Guide

Indoor refrigerant temperature sensor abnormality (H23)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the indoor refrigerant temperature sensor are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

2 Faulty sensor.

3 Faulty indoor unit PCB (main).

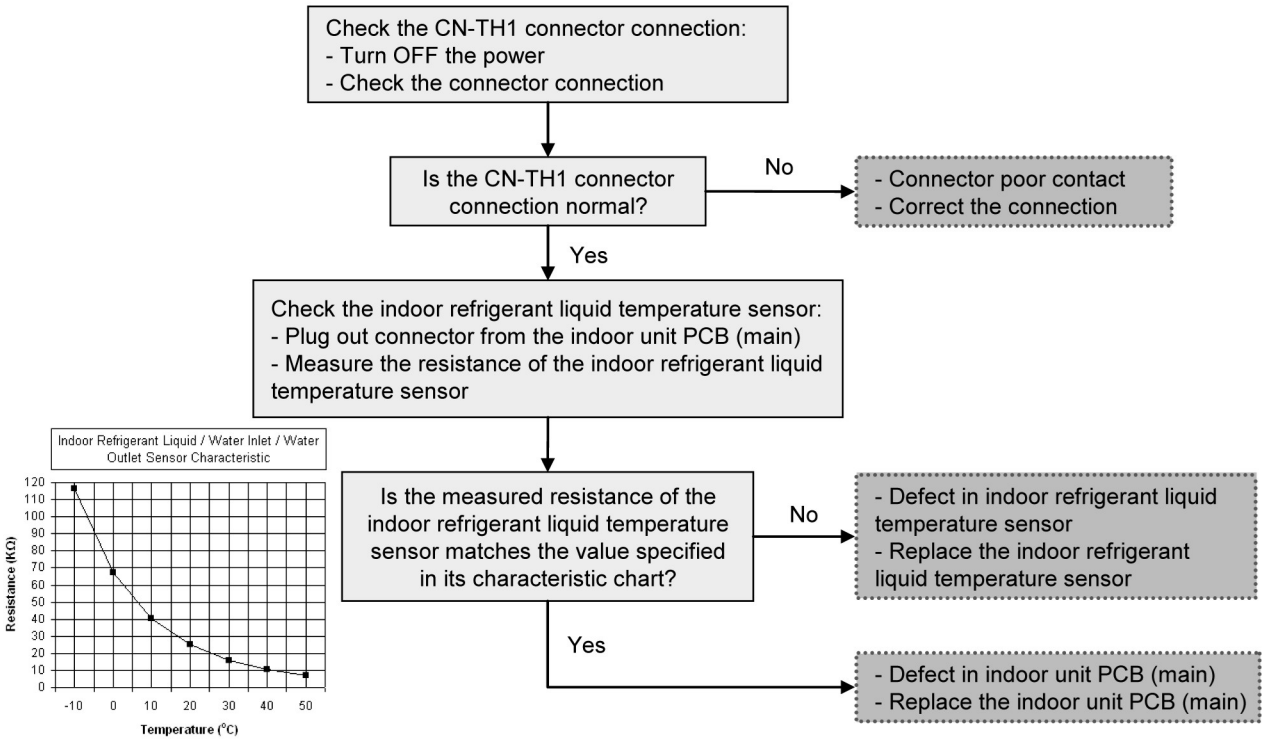
Abnormality determination

Continue for 5 seconds.

Figure 15-7 Troubleshooting H23

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Service valve error (H27)

Malfunction decision conditions

During cooling operation, when:

1. Indoor refrigerant pipe temperature at compressor startup - present indoor refrigerant pipe temperature < 5.4°F
2. Present high pressure - high pressure at compressor startup < 14.2 PSI

**Determination only for first time cooling operation and not during pump-down operation.

Malfunction causes

1 Three-way valves closed.

2 Faulty high-pressure sensor.

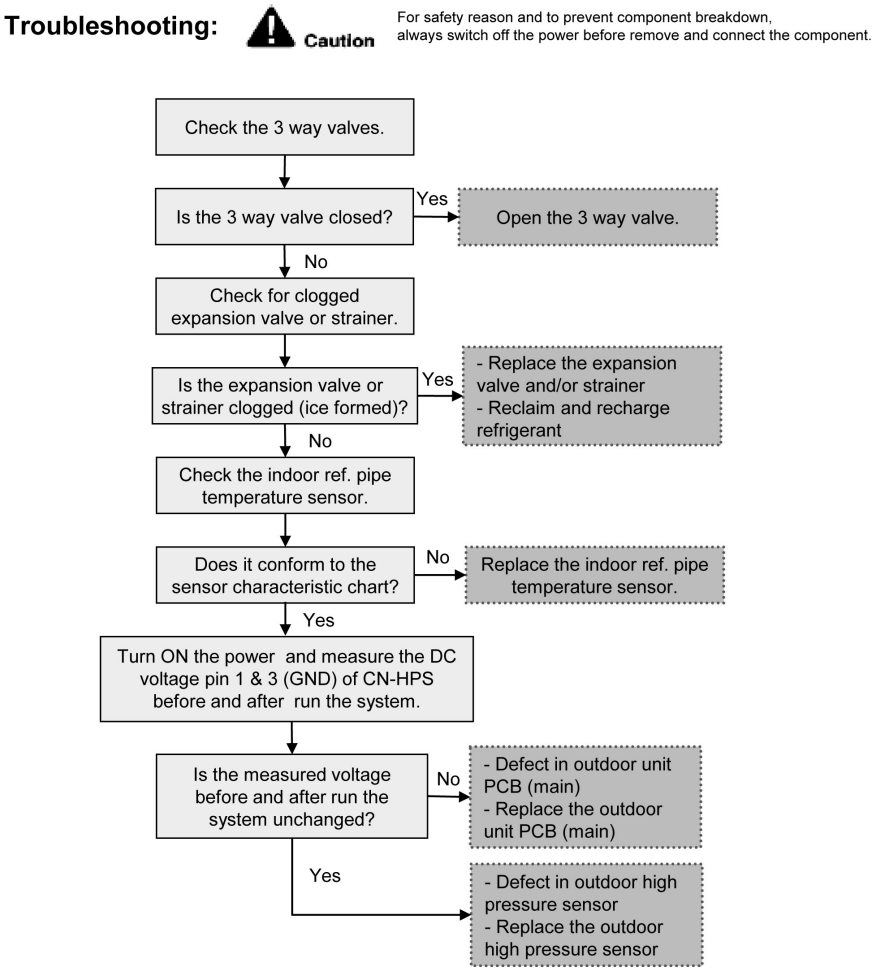
3 Faulty indoor refrigerant pipe temperature sensor

4 Faulty outdoor unit PCB (main).

Abnormality determination

Continue for 5 minutes.

Figure 15-8 Troubleshooting H27



15 Troubleshooting Guide

Abnormal buffer tank sensor (H36)

Malfunction causes

1 Faulty connector connection.

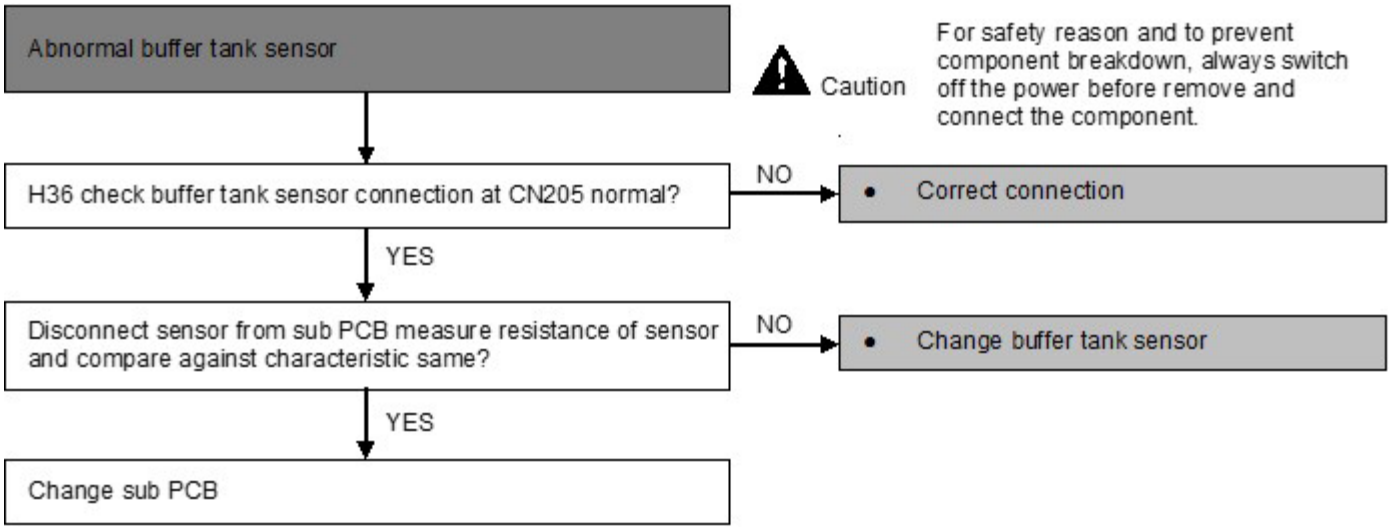
2 Faulty buffer tank sensor.

3 Faulty indoor sub PCB.

Abnormality determination

Continue for 5 seconds.

Figure 15-9 *Troubleshooting H36*



15 Troubleshooting Guide

Compressor low pressure protection (H42)

Malfunction decision conditions

During heating operation and after 5 minutes with compressor ON, when outdoor pipe temperatures below 34.6°F or above 78.8°F are detected by the outdoor pipe temperature sensor.

Malfunction causes

1 Dust accumulation on the outdoor unit heat exchanger.

2 Air short circuit at outdoor unit.

3 2-way valve partially closed.

4 Faulty outdoor unit fan motor.

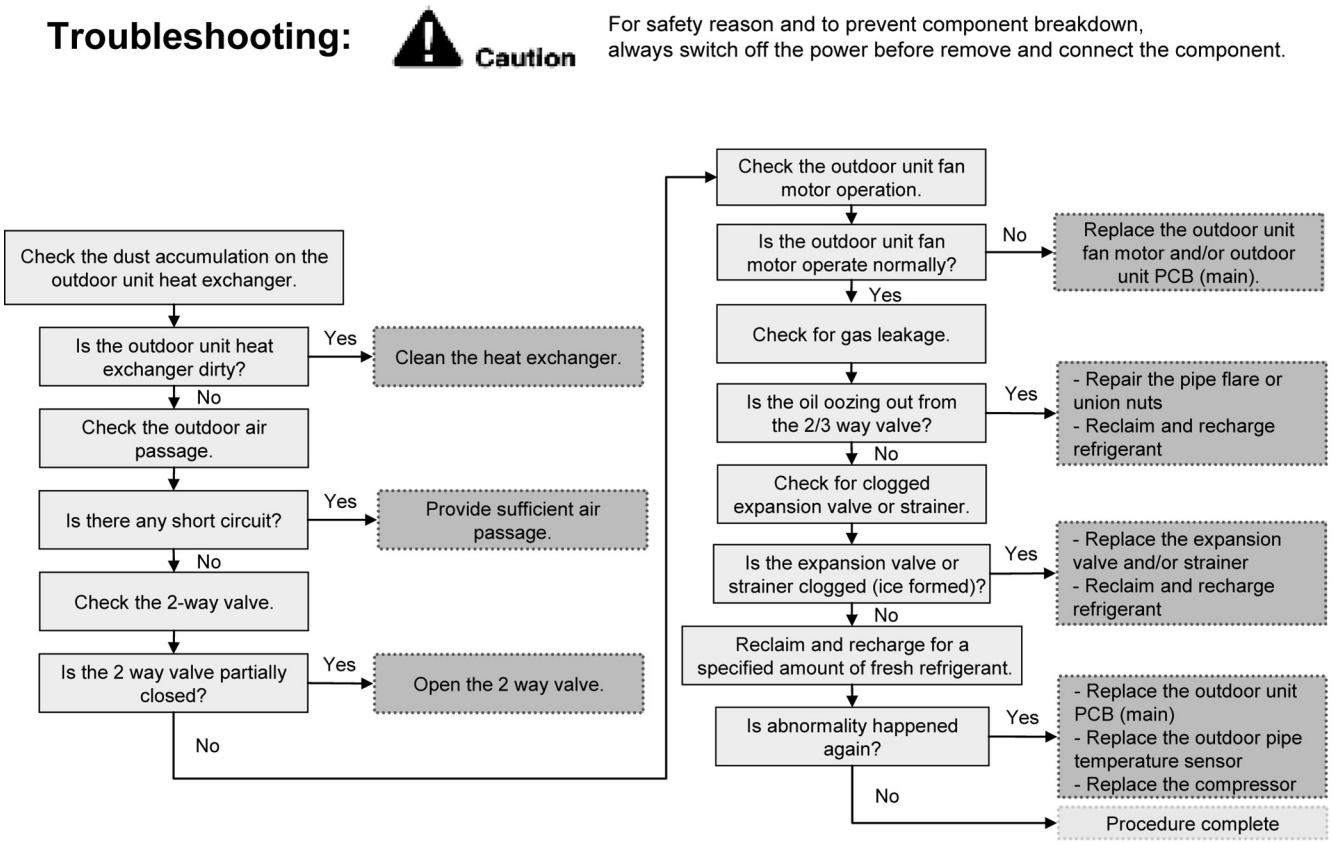
5 Insufficient refrigerant (refrigerant leakage).

6 Clogged expansion valve or strainer.

7 Faulty outdoor pipe temperature sensor.

8 Faulty outdoor unit main PCB (main).

Figure 15-10 *Troubleshooting H42*



15 Troubleshooting Guide

Water flow switch abnormality (H62)

Malfunction decision conditions

During cooling and heating operation, the water flow detected by the indoor water flow switch is used to determine water flow error.

Malfunction causes

1 Faulty water pump.

2 Water leak in system.

3 Faulty connector connection.

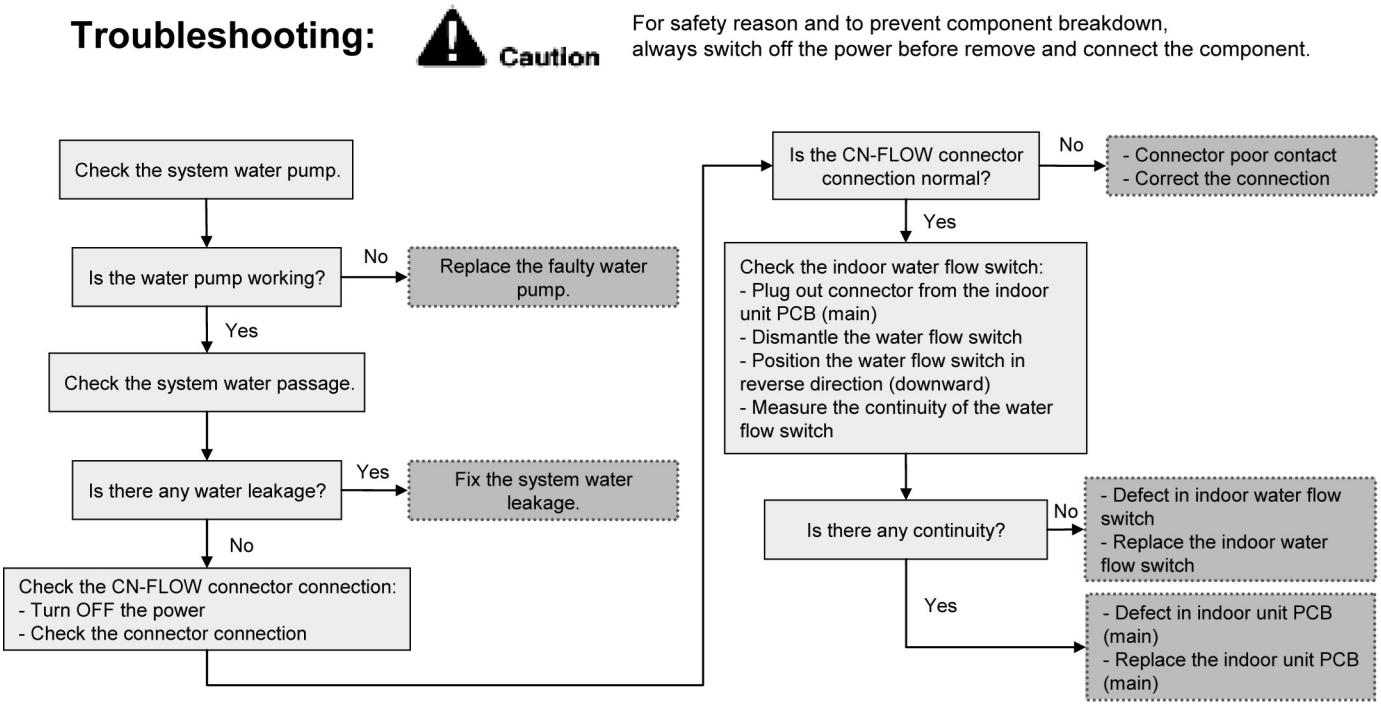
4 Faulty water flow switch.

5 Faulty indoor unit PCB (main).

Abnormality determination

Continue for 10 seconds (but no determination for 9 minutes following compressor startup/restart).

Figure 15-11 Troubleshooting H62



15 Troubleshooting Guide

Outdoor high-pressure abnormality (H64)

Malfunction decision conditions

During cooling and heating operation, when the outdoor high-pressure sensor output signal is 0 VDC or 5 VDC.

Malfunction causes

1 Faulty connector connection.

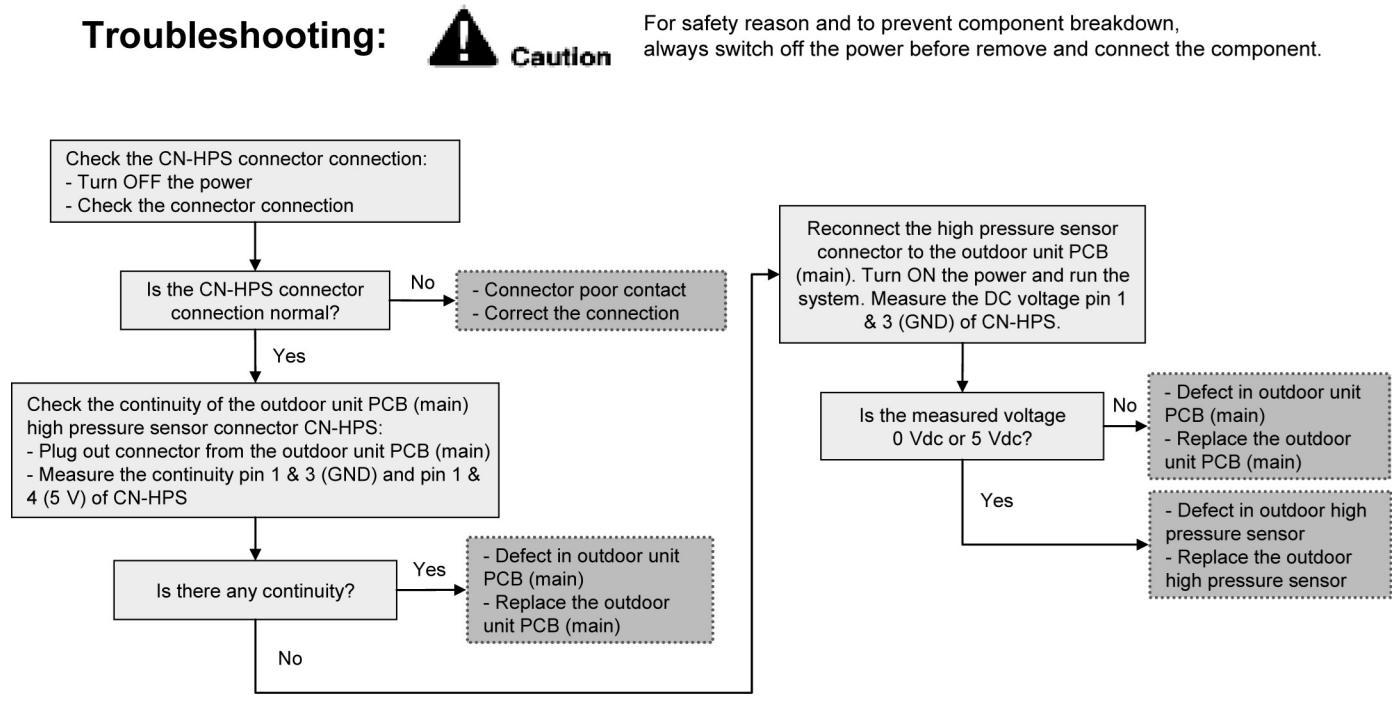
2 Faulty sensor.

3 Faulty outdoor unit PCB (main).

Abnormality determination

Continue 4 times in 20 minutes.

Figure 15-12 Troubleshooting H64



15 Troubleshooting Guide

De-icing circulation error (H65)

Malfunction decision conditions

During startup and operation of de-icing (Mode 2), the water flow (> 1.3 gal/min) detected by the water flow switch is used to determine de-icing circulation errors.

Malfunction causes

1 Water flow in air-to-water heat pump indoor unit circuit.

2 Faulty indoor unit water flow switch.

3 Faulty indoor unit water pump.

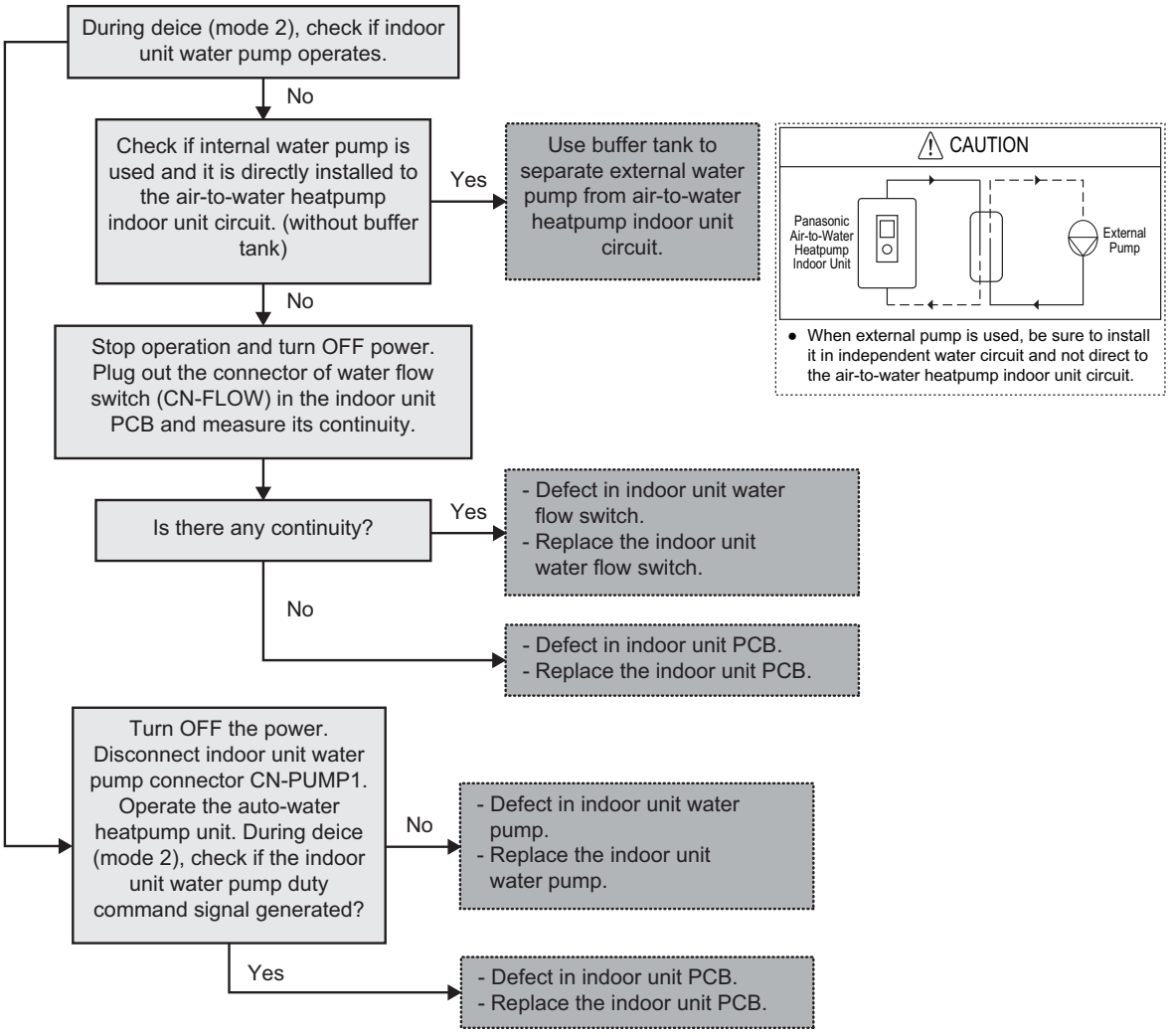
4 Faulty indoor unit PCB.

Abnormality determination

Continue for 10 seconds.

Figure 15-13 Troubleshooting H65

Troubleshooting: **Caution** For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Indoor backup heater OLP abnormality (H70)

Malfunction decision conditions

During indoor backup heater operation, when no power is supplied to the indoor backup heater or OLP open circuit.

Malfunction causes

1 Faulty power supply connection.

2 Faulty connector connection.

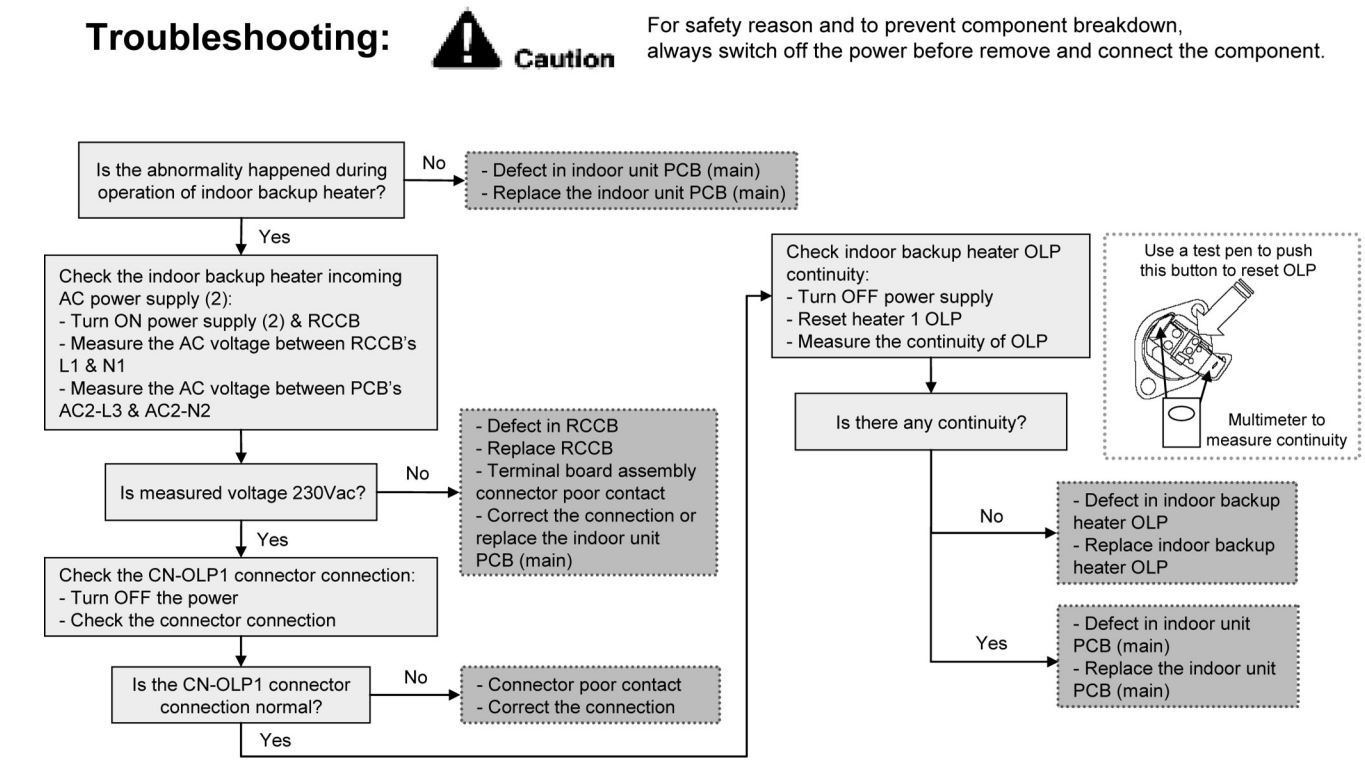
3 Faulty indoor backup heater overload protector (OLP).

4 Faulty indoor unit PCB (main).

Abnormality determination

Continue for 60 seconds.

Figure 15-14 Troubleshooting H70



15 Troubleshooting Guide

Tank temperature sensor abnormality (H72)

Malfunction decision conditions

When tank connection is set to ON, the temperatures detected by the tank temperature sensor are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

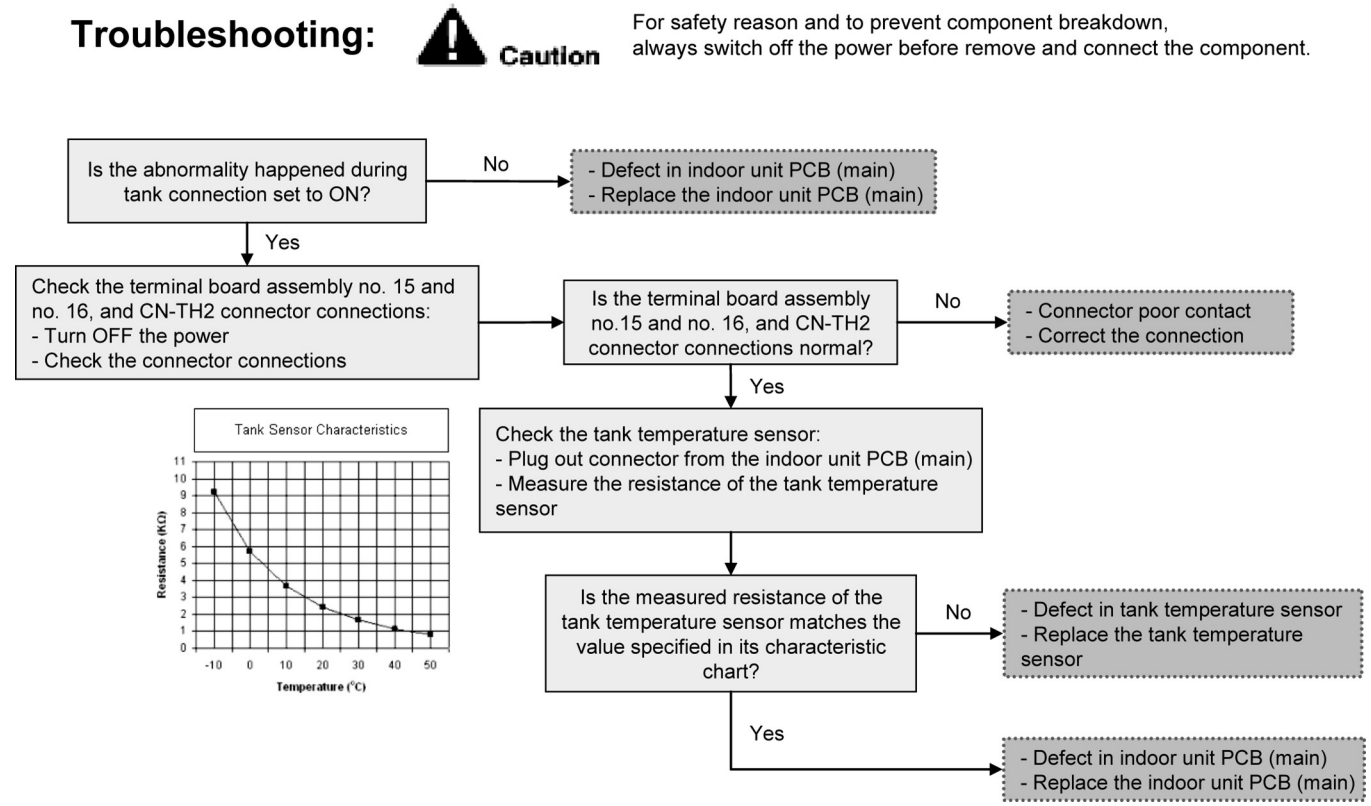
2 Faulty sensor.

3 Faulty indoor unit PCB (main).

Abnormality determination

Continue for 5 seconds.

Figure 15-15 Troubleshooting H72



15 Troubleshooting Guide

PCB communication error (H74)

Malfunction decision conditions

When external PCB connection is set to “YES” and there is no communication with the external PCB micon for 10 seconds or more.

Malfunction causes

1 Faulty connector connection.

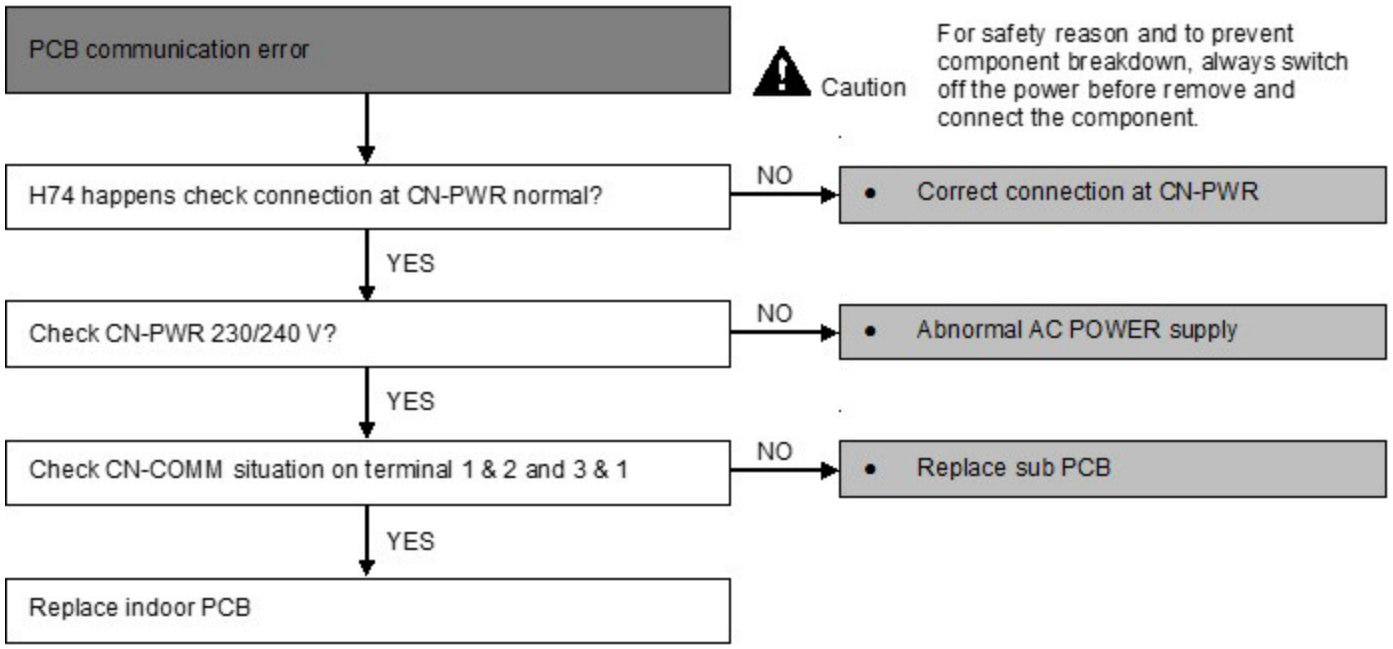
2 Faulty indoor PCB.

3 Faulty indoor sub PCB.

Abnormality determination

After 1 minute operation started.

Figure 15-16 *Troubleshooting H74*



15 Troubleshooting Guide

Indoor control panel communication abnormality (H76)

Malfunction decision conditions

Indoor control panel error occurs during standby and cooling and heating operation.

Malfunction causes

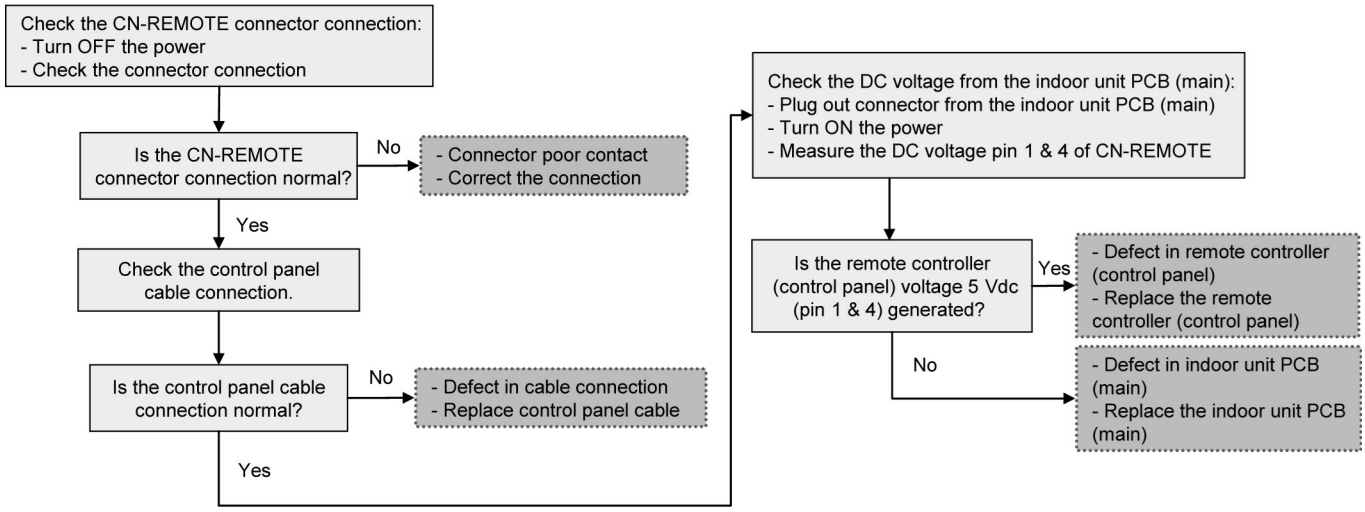
1 Faulty connector connection.

2 Faulty control panel.

3 Faulty indoor unit PCB (main).

Figure 15-17 Troubleshooting H76

Troubleshooting: **Caution** For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Indoor/outdoor abnormal communication (H90)

Malfunction decision conditions

During cooling and heating operation, the data received from the outdoor unit in indoor unit signal transmission is checked whether it is normal.

Malfunction causes

1 Faulty outdoor unit PCB (main).

2 Faulty indoor unit PCB (main).

3 Indoor-outdoor signal transmission error due to incorrect wiring.

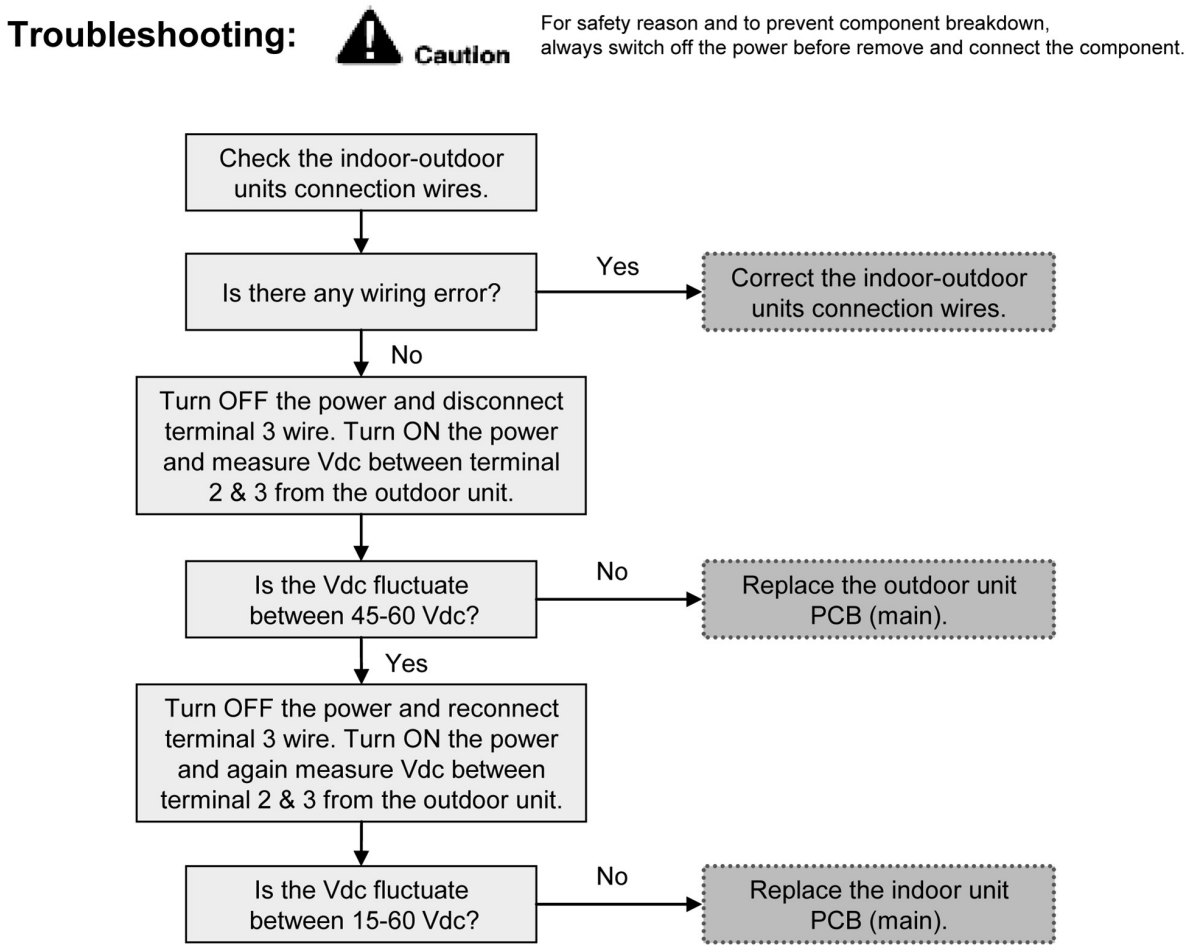
4 Indoor-outdoor signal transmission error due to broken wire in the connection between the indoor and outdoor units.

5 Indoor-outdoor signal transmission error due to disrupted power supply waveform.

Abnormality determination

Continue for 1 minute after operation.

Figure 15-18 *Troubleshooting H90*



15 Troubleshooting Guide

Tank booster heater OLP abnormality (H91)

Malfunction decision conditions

During operation of tank booster heater, and tank booster heater OLP open circuit.

Malfunction causes

1 Faulty connector connection.

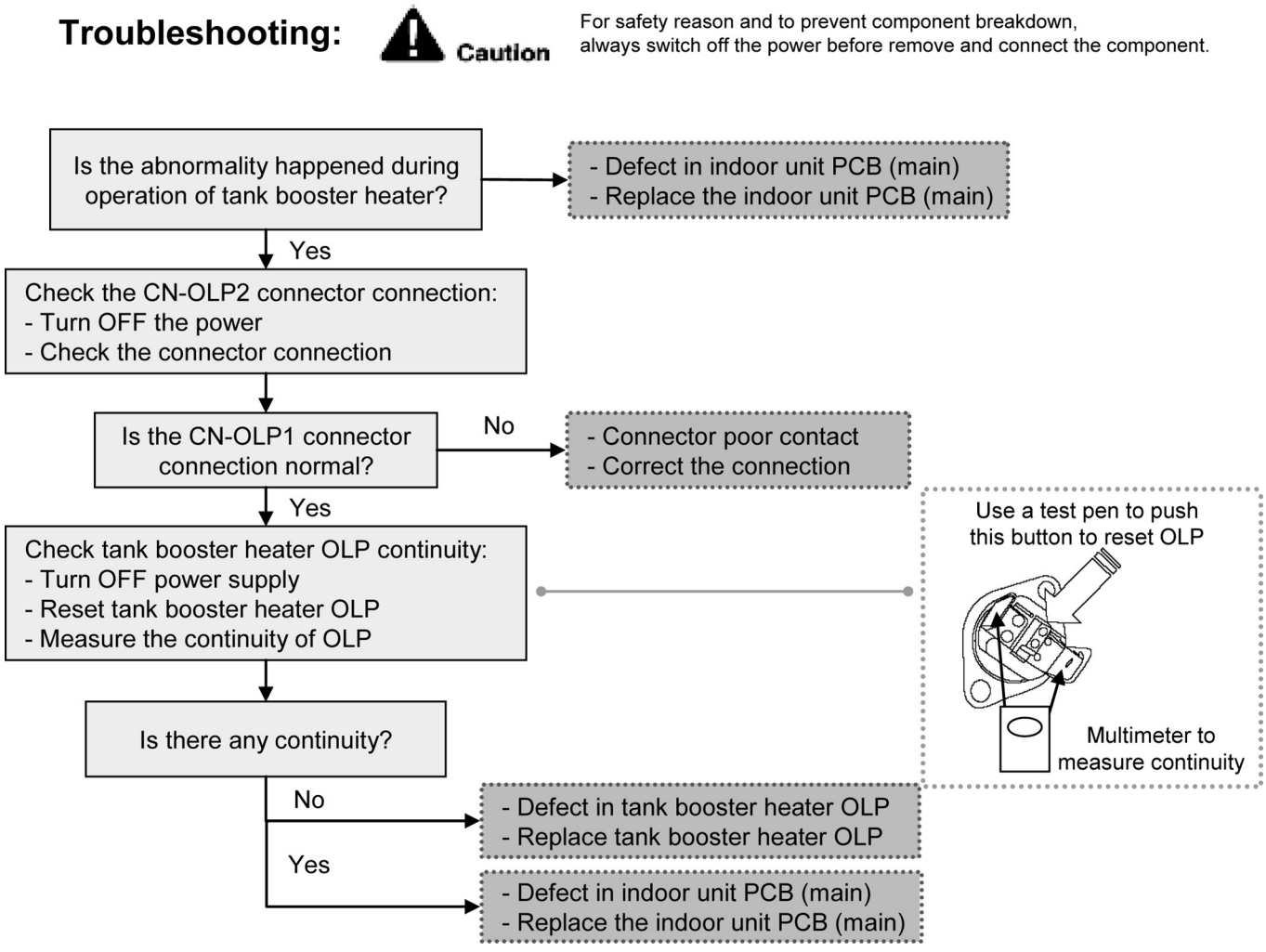
2 Faulty tank booster heater overload protector (OLP).

3 Faulty indoor unit PCB (main).

Abnormality determination

Continue for 60 seconds.

Figure 15-19 Troubleshooting H91



15 Troubleshooting Guide

Unspecified voltage between indoor and outdoor (H95)

Malfunction decision conditions

The supply power is detected for its requirement by the indoor/ outdoor transmission.

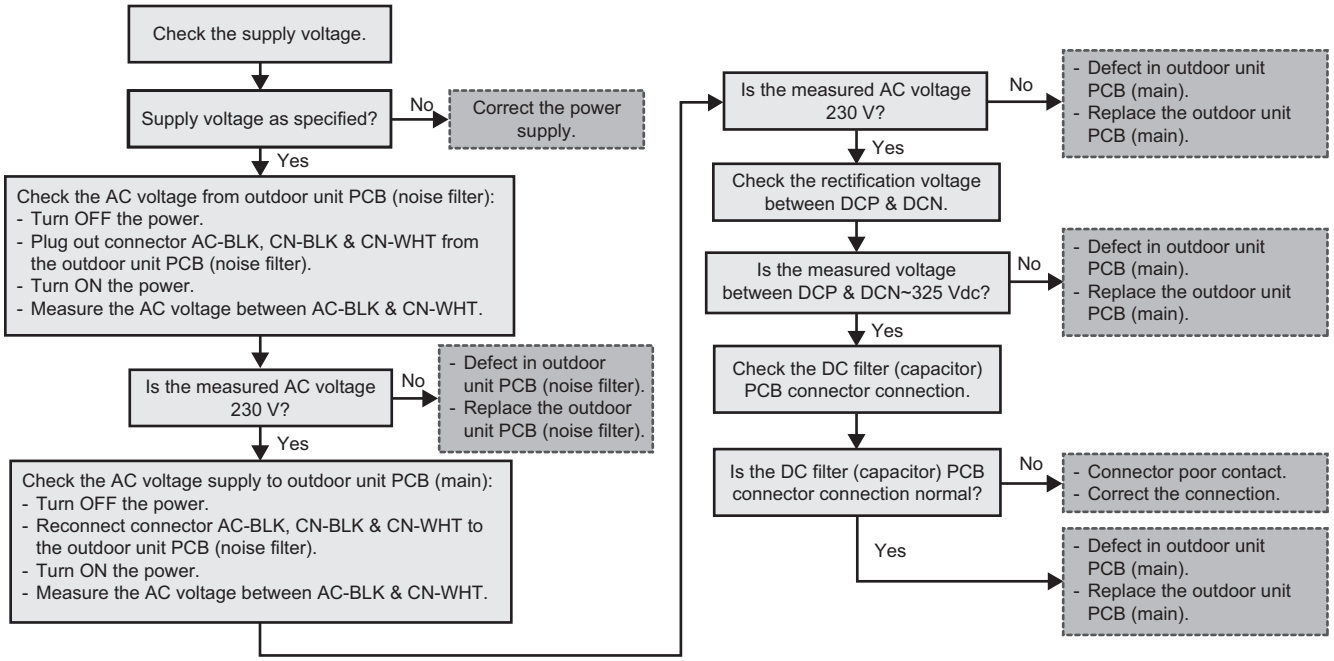
Malfunction causes

1 Insufficient power supply.

2 Faulty outdoor unit PCB (noise filter/main).

Figure 15-20 Troubleshooting H95

Troubleshooting: **Caution** For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Outdoor high pressure protection (H98 / F95)

Malfunction decision conditions

During cooling and heating operation, when a pressure 609.2 PSI or higher is detected by outdoor high pressure sensor.

Malfunction causes

1 Faulty water pump.

2 Insufficient water flow rate in system.

3 Water leak in system.

4 Dust accumulation in the outdoor unit heat exchanger.

5 Air short circuit outdoors.

6 Faulty outdoor unit fan motor.

7 2/three-way closed.

8 Clogged expansion valve or strainer.

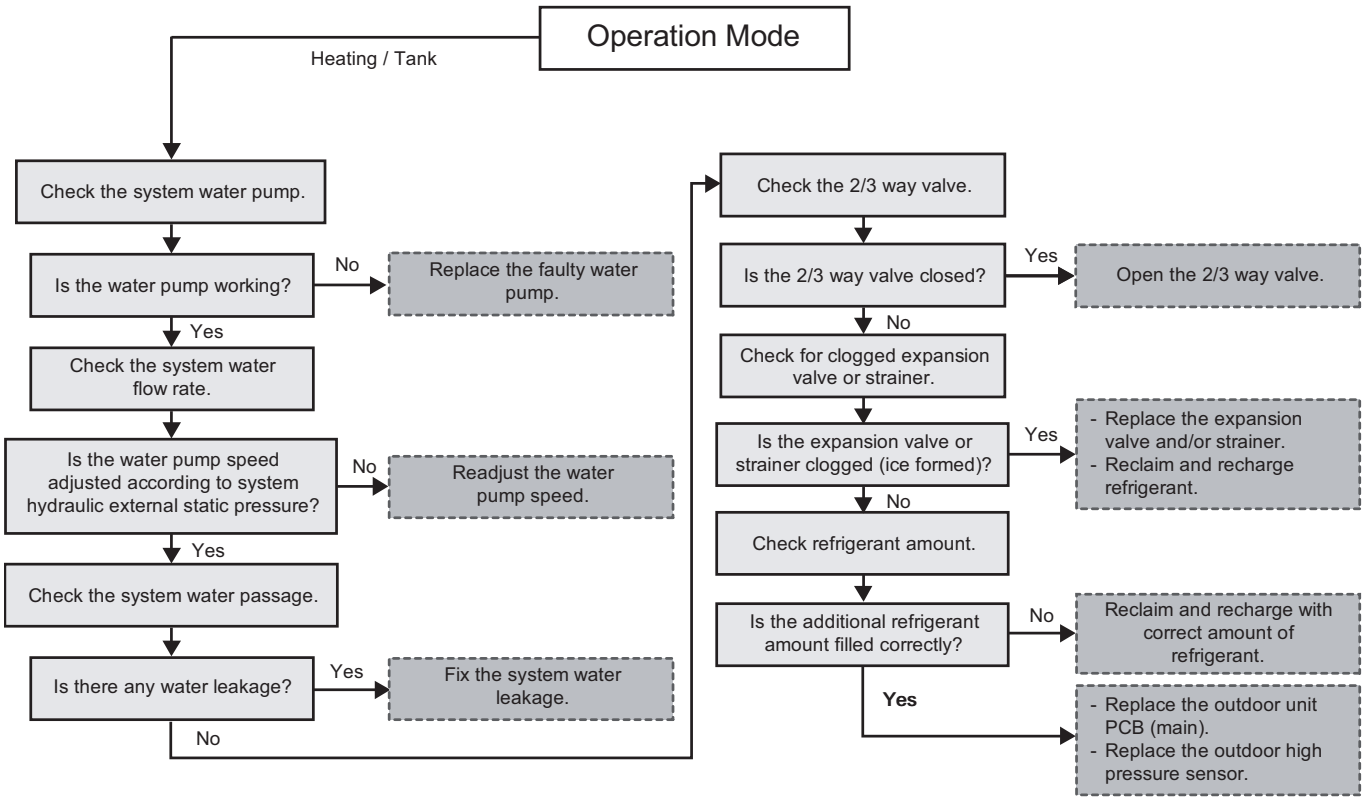
9 Excessive refrigerant.

10 Faulty outdoor high pressure sensor.

11 Faulty outdoor unit PCB (main).

Figure 15-21 Troubleshooting H98

Troubleshooting: **Caution** For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.

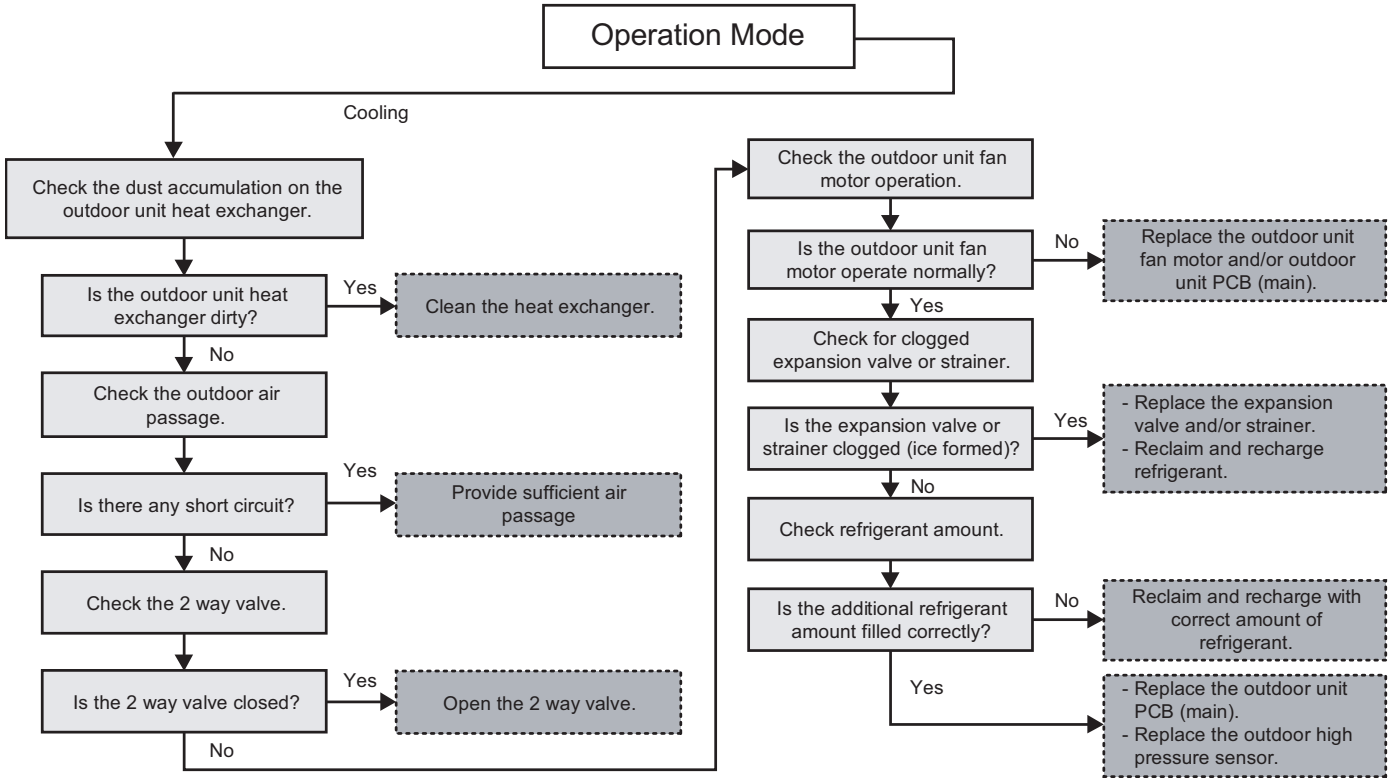


15 Troubleshooting Guide

Figure 15-22 Troubleshooting F95

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Indoor freeze-up protection (H99)

Malfunction decision conditions

During anti-freezing control in cooling operation, when the indoor refrigerant temperature < 32°F.

Malfunction causes

1 Faulty water pump.

2 Insufficient water flow rate in system.

3 Water leak in system.

4 2-way valve partially closed.

5 Clogged expansion valve or strainer.

6 Refrigerant shortage (refrigerant leak).

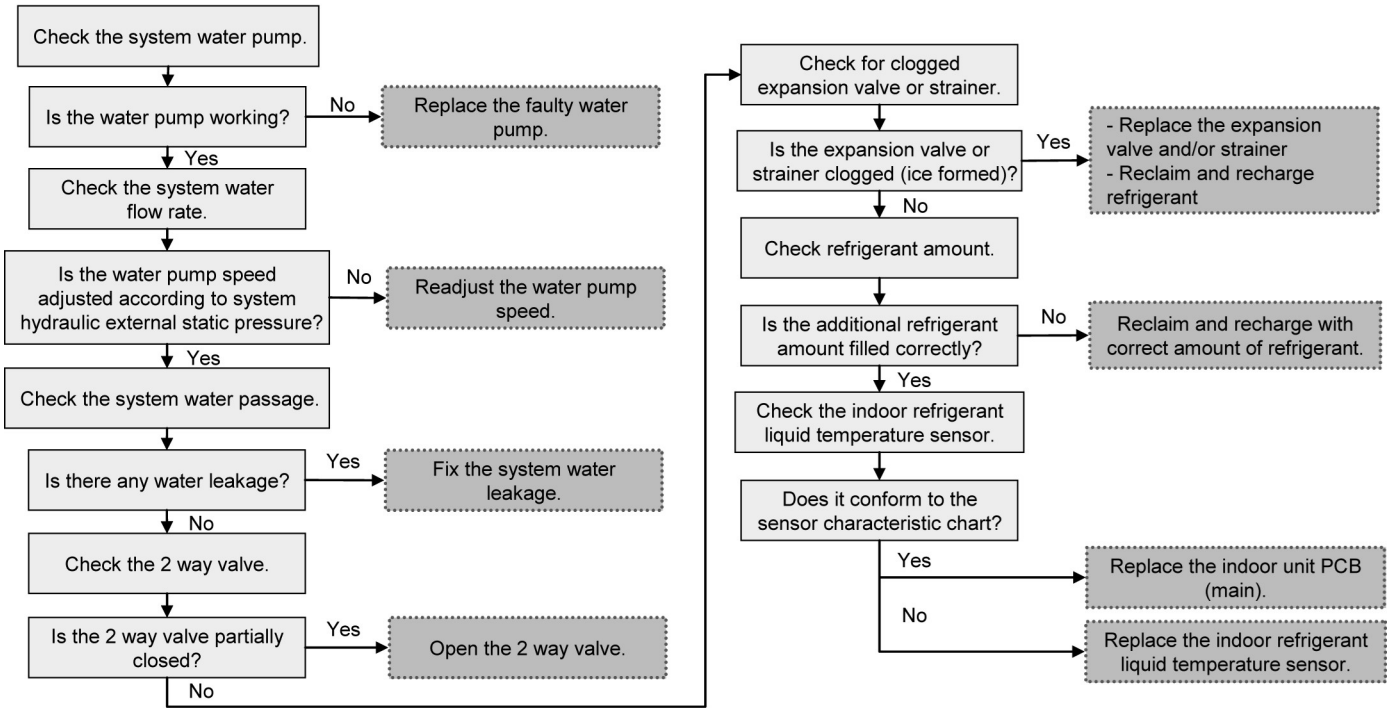
7 Faulty indoor refrigerant temperature sensor.

8 Faulty indoor unit PCB (main).

Figure 15-23 Troubleshooting H99

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Outdoor high pressure switch activate (F12)

Malfunction decision conditions

During cooling and heating operation, when pressures of 623.7 PSI and above are detected by outdoor high pressure switch.

Malfunction causes

1 Dust accumulation on the outdoor unit heat exchanger.

2 Air short circuit at outdoor unit.

3 Faulty water pump.

4 Insufficient water flow rate in system.

5 Water leak in system.

6 2/three-way valve closed.

7 Clogged expansion valve or strainer.

8 Excessive refrigerant.

9 Faulty outdoor high pressure sensor and switch.

10 Faulty outdoor unit PCB.

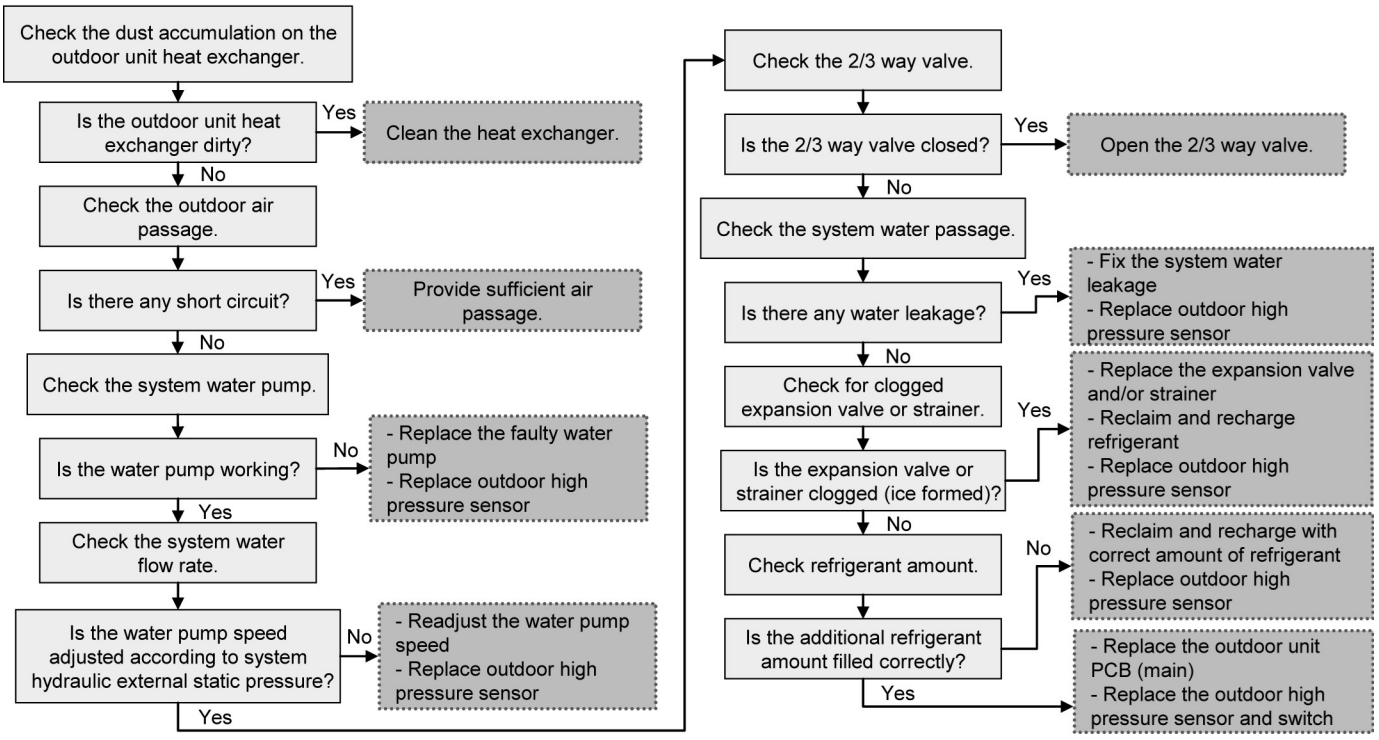
Abnormality determination

After 1 minute operation started.

Figure 15-24 *Troubleshooting F12*

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Compressor rotation failure (F14)

Malfunction decision conditions

A compressor rotation failure is detected by checking the compressor operating condition via the position detection circuit.

Malfunction causes

1 Compressor terminal disconnected.

2 Faulty outdoor unit PCB (main).

3 Faulty compressor.

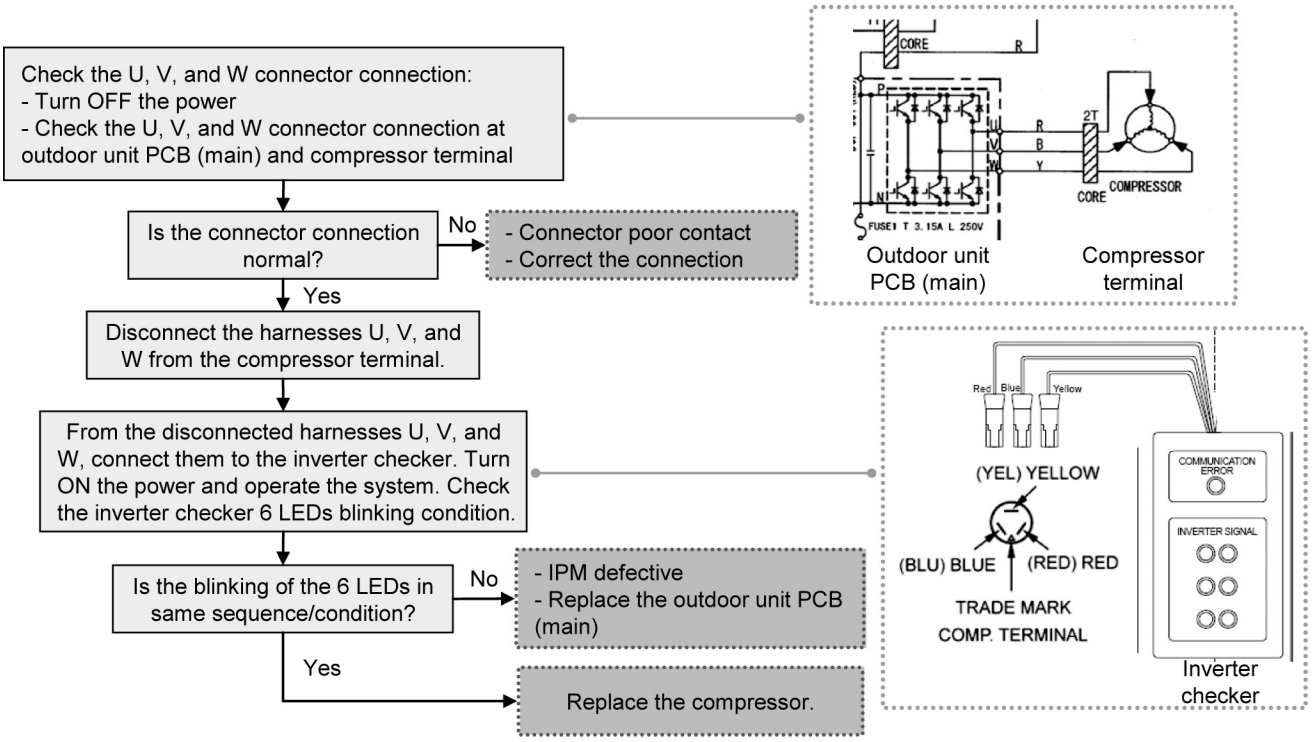
Abnormality determination

Continue 4 times in 20 minutes.

Figure 15-25 Troubleshooting F14

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Outdoor fan motor (DC motor) mechanism locked (F15)

Malfunction decision conditions

The rotation speed detected by the Hall IC of the fan motor during fan motor operation is used to determine abnormal fan motor speed (feedback of rotation > 2550 rpm or < 20 rpm).

Malfunction causes

1 Operation stop due to short circuit inside the fan motor winding.

2 Operation stop due to broken wire inside the fan motor.

3 Operation stop due to broken lead wires to fan motor.

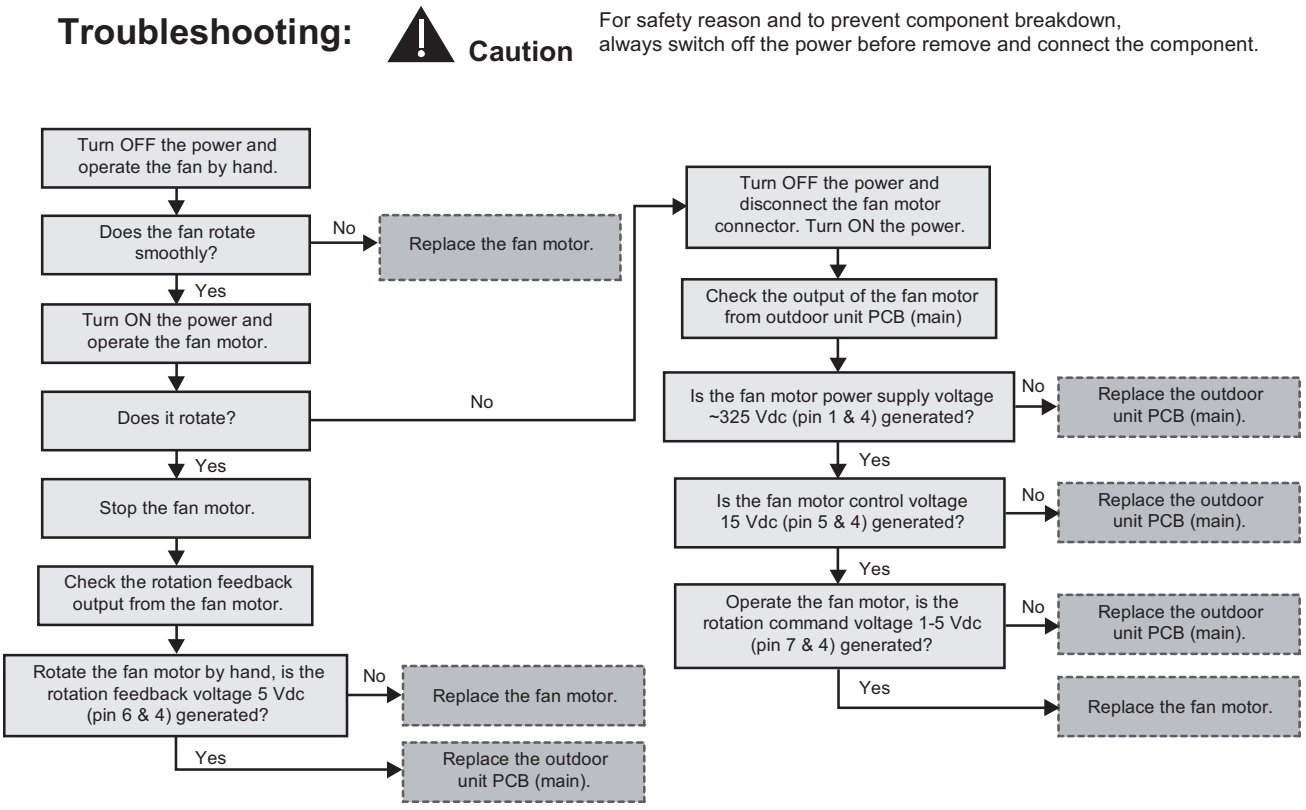
4 Operation stop due to fan motor Hall IC malfunction.

5 Operation error due to faulty outdoor unit PCB.

Abnormality determination

Continue 2 times in 30 minutes.

Figure 15-26 *Troubleshooting F15*



15 Troubleshooting Guide

Input overcurrent detection (F16)

Malfunction decision conditions

During cooling and heating operation, when outdoor currents of above 28.0A (heating) and 20.0A (cooling) are detected by the current transformer (CT) in the outdoor unit PCB.

Malfunction causes

1 Excessive refrigerant.

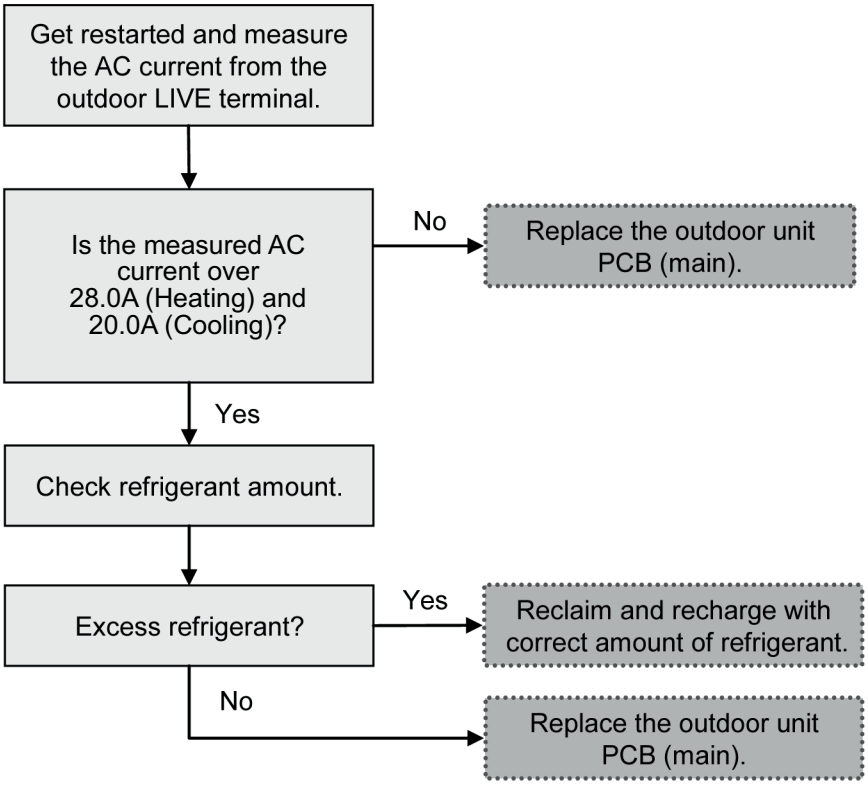
2 Faulty outdoor unit PCB (main).

Abnormality determination

Continue 3 times in 20 minutes.

Figure 15-27 Troubleshooting F16

Troubleshooting: Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Compressor overheating (F20)

Malfunction decision conditions

During cooling and heating operation, when temperatures above 242.6°F are detected by the outdoor discharge pipe temperature sensor.

Malfunction causes

1 Faulty outdoor discharge pipe temperature sensor.

2 2/three-way valve closed.

3 Refrigerant shortage (refrigerant leak).

4 Clogged expansion valve or strainer.

5 Faulty outdoor unit PCB (main).

6 Faulty compressor.

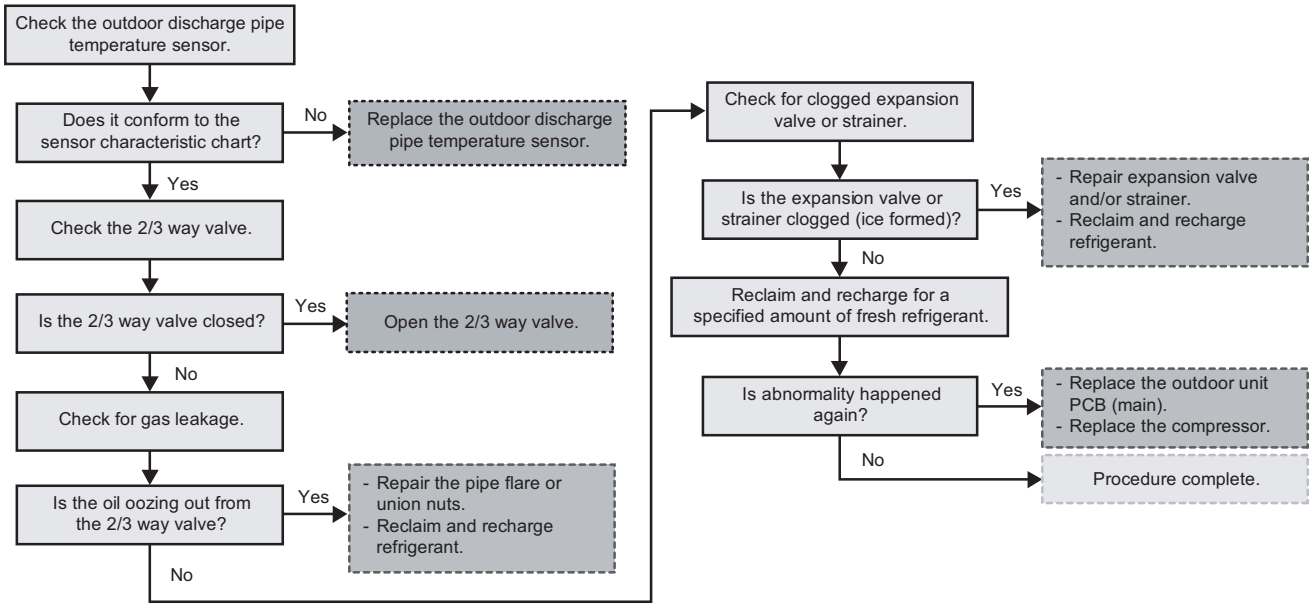
Abnormality determination

Continue 4 times in 30 minutes.

Figure 15-28 Troubleshooting F20

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

IPM overheating (F22)

Malfunction decision conditions

During cooling and heating operation, when temperature of 203°F is detected by the outdoor IPM temperature sensor.

Malfunction causes

1 Faulty outdoor unit fan motor.

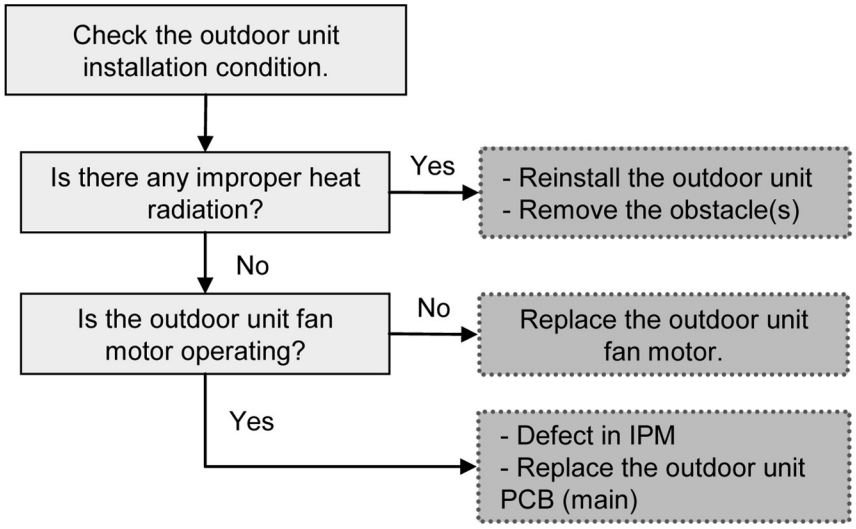
2 Faulty outdoor unit PCB (main).

Abnormality determination

Continue 3 times in 30 minutes.

Figure 15-29 Troubleshooting F22

Troubleshooting: Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Output overcurrent detection (F23)

Malfunction decision conditions

During cooling and heating operation, when outdoor DC current of above 53 A is detected by the IPM DC peak sensing circuitry in the outdoor unit PCB (main).

Malfunction causes

1 Faulty outdoor unit PCB (main).

2 Faulty compressor.

Abnormality determination

Continue for 7 times.

Figure 15-30 Troubleshooting F23

Troubleshooting: **Caution** For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.

Check the compressor winding resistance:
- Turn OFF the power and disconnect the harnesses U, V, and W
- Measure the winding resistance between U-V, V-W, and W-U

→ Are the compressor's winding resistance (U-V, V-W, or U-W) shorted?

Yes → - Compressor defective due to winding shorted
- Replace the compressor

No → - Outdoor electronic circuit defect due to power transistor shorted
- Replace the outdoor unit PCB (main)

- Checking the power transistor
- Never touch any live parts for at least 10 minutes after turning off the circuit breaker.
- If unavoidably necessary to touch a live part, make sure the power transistor's supply voltage is below 50 V using the tester.
- For the UVW, make measurements at the Faston terminal on the board or the relay connector.

Tester's negative terminal	Power transistor (+)	UVW	Power transistor (−)	UVW
Tester's positive terminal	UVW	Power transistor (+)	UVW	Power transistor (−)
Normal resistance	Several kohms to several Mohms			
Abnormal resistance	0 or ∞			

15 Troubleshooting Guide

Refrigeration circuit abnormality (F24)

Malfunction decision conditions

1 During heating and cooling operation for more than 5 minutes expect de-iceing, pump-down and test mode.

2 During heating / cooling, the temperature difference between the water outlet and water inlets is less than 1.8°F.

3 During heating / cooling, high pressure < 275 PSI is detected for more than 10 minutes or < 232 PSI for more than 4 minutes.

4 During heating / cooling, discharge temperature - saturation temperature of high pressure ≥ 140°F.

Malfunction causes

1 Refrigerant shortage (refrigerant leakage).

2 Faulty indoor water inlet, indoor water outlet, compressor discharge temp sensor or high pressure sensor.

3 2/three-way valve closed.

4 Clogged expansion valve or strainer.

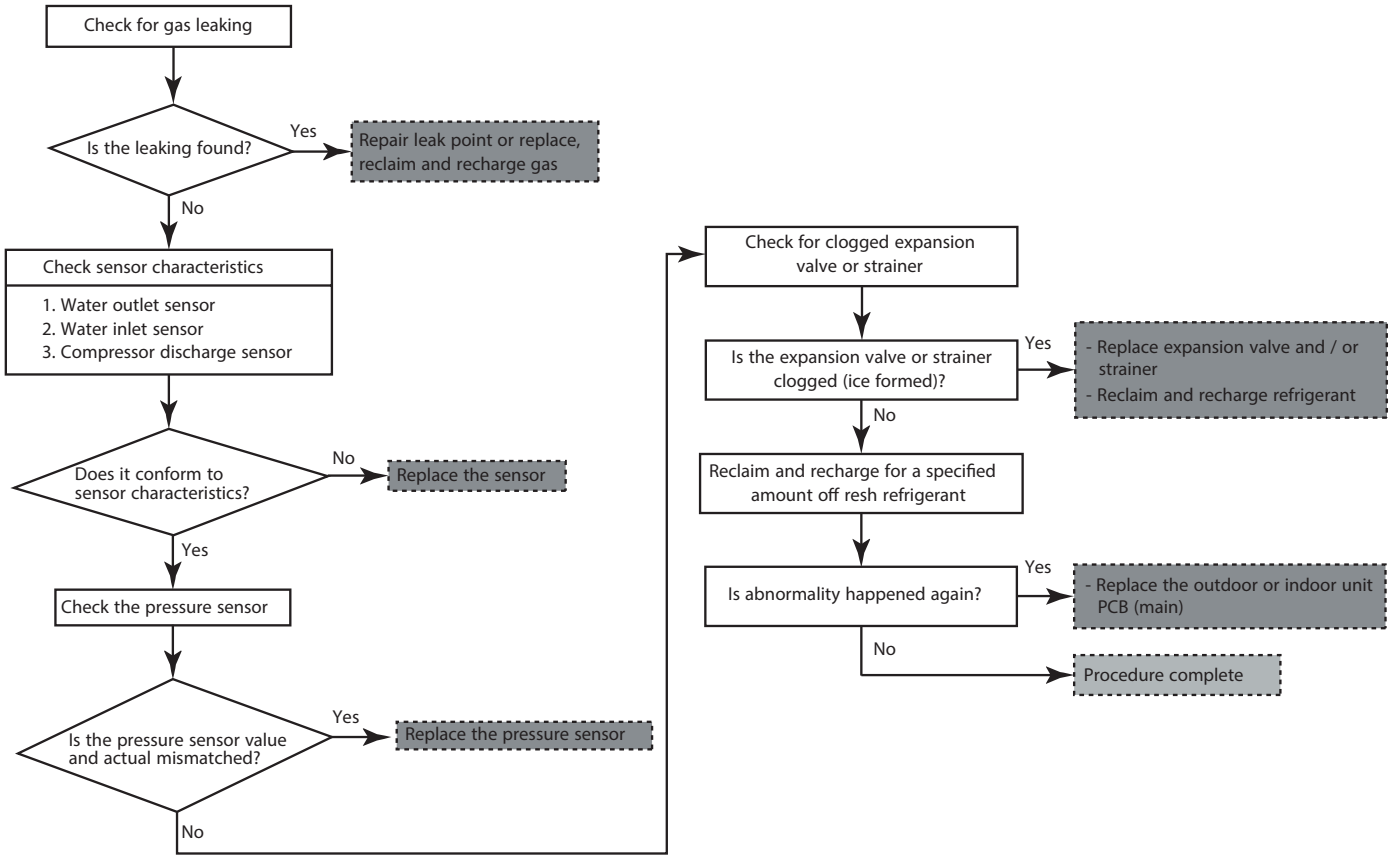
5 Faulty outdoor unit PCB (main).

6 Poor compressor function.

Abnormality determination

Continue 2 times in 30 minutes.

Figure 15-31 Troubleshooting F24



15 Troubleshooting Guide

Four-way valve abnormality (F25)

Malfunction decision conditions

1 During heating operation, when the indoor pipe temperature of thermostat ON for indoor unit < 32°F.

2 During cooling operation, when the indoor pipe temperature of thermostat ON for indoor unit > 113°F.

Malfunction causes

1 Faulty sensor.

2 Faulty connector connection.

3 Faulty outdoor unit PCB (noise filter/main).

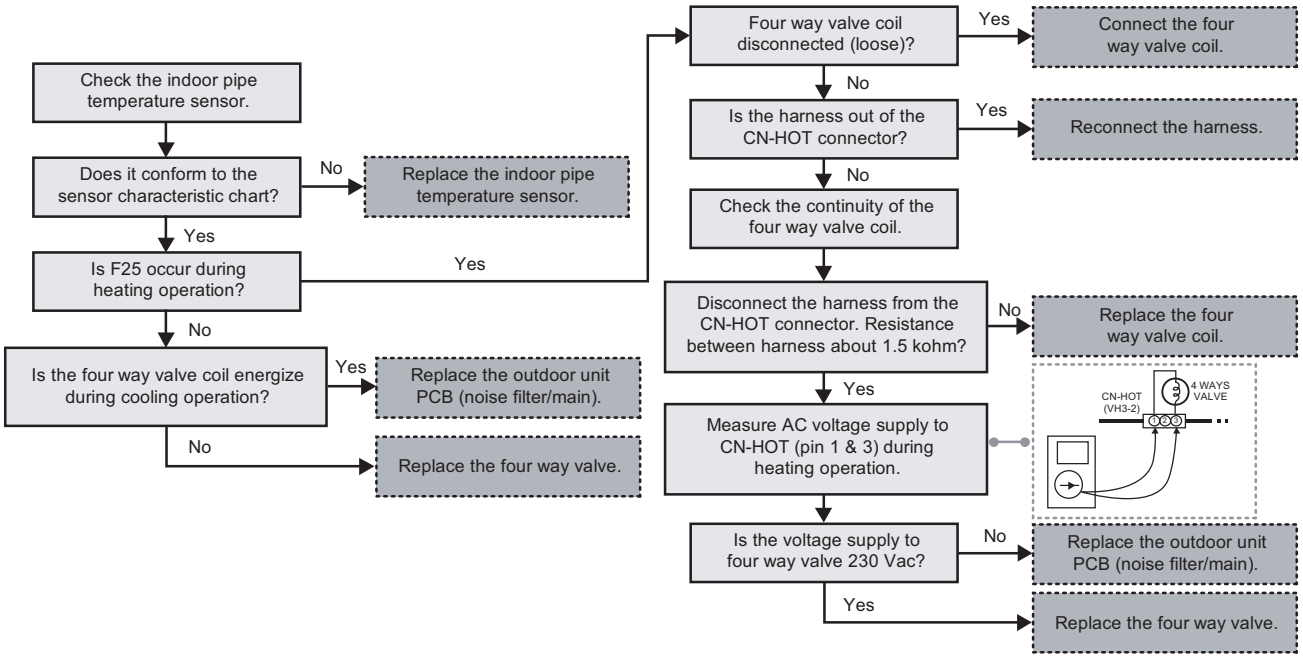
4 Faulty four-way valve.

Abnormality determination

Continue 4 times in 30 minutes.

Figure 15-32 *Troubleshooting F25*

Troubleshooting: **Caution** For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Outdoor high pressure switch abnormal (F27)

Malfunction decision conditions

With compressor stopped, the outdoor high pressure switch remains open.

Malfunction causes

1 Faulty connector connection.

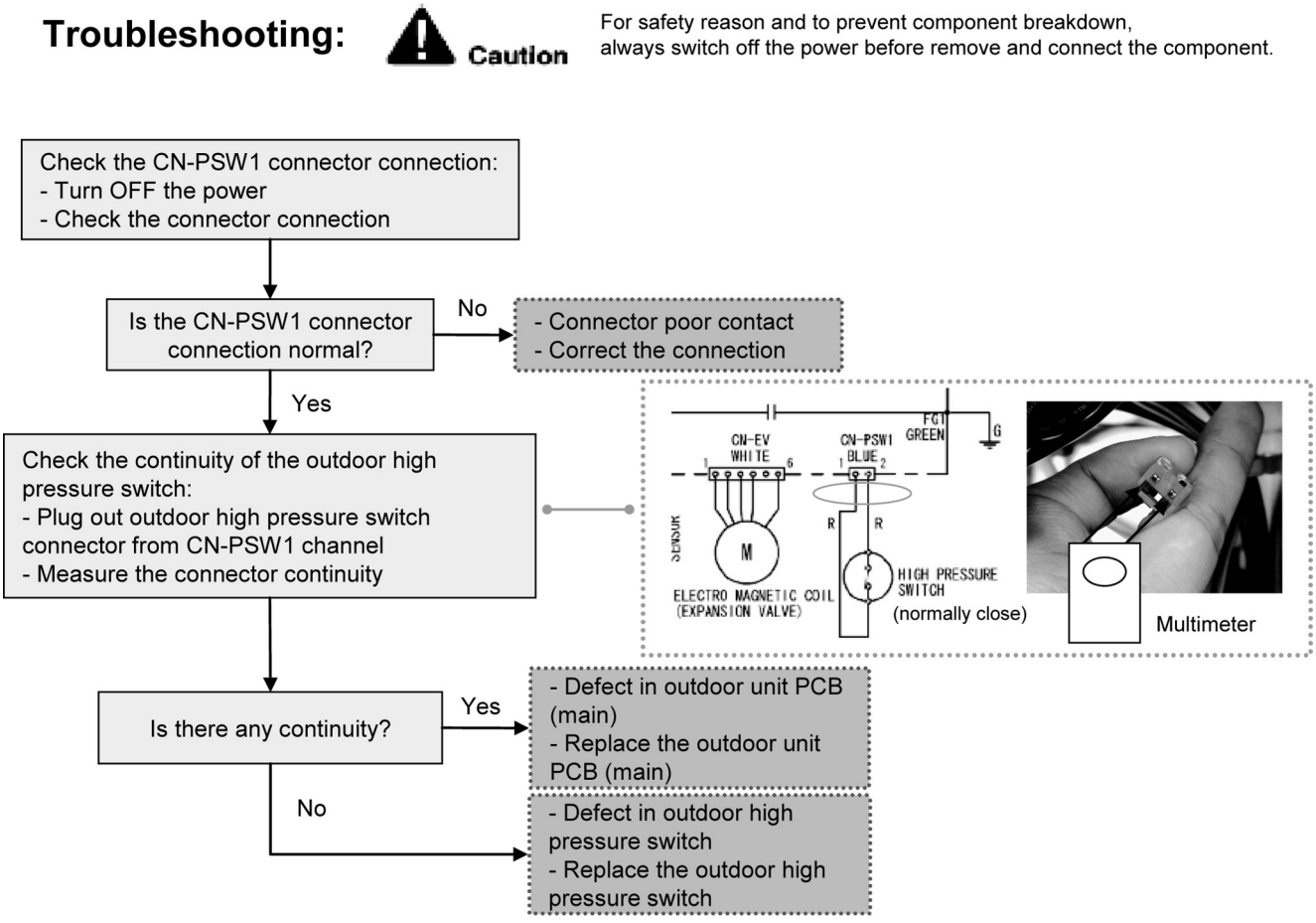
2 Faulty switch.

3 Faulty outdoor unit PCB (main).

Abnormality determination

Continue for 1 minute.

Figure 15-33 Troubleshooting F27



15 Troubleshooting Guide

Indoor water outlet temperature sensor 2 abnormality (F30)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the indoor water outlet temperature sensor 2 are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

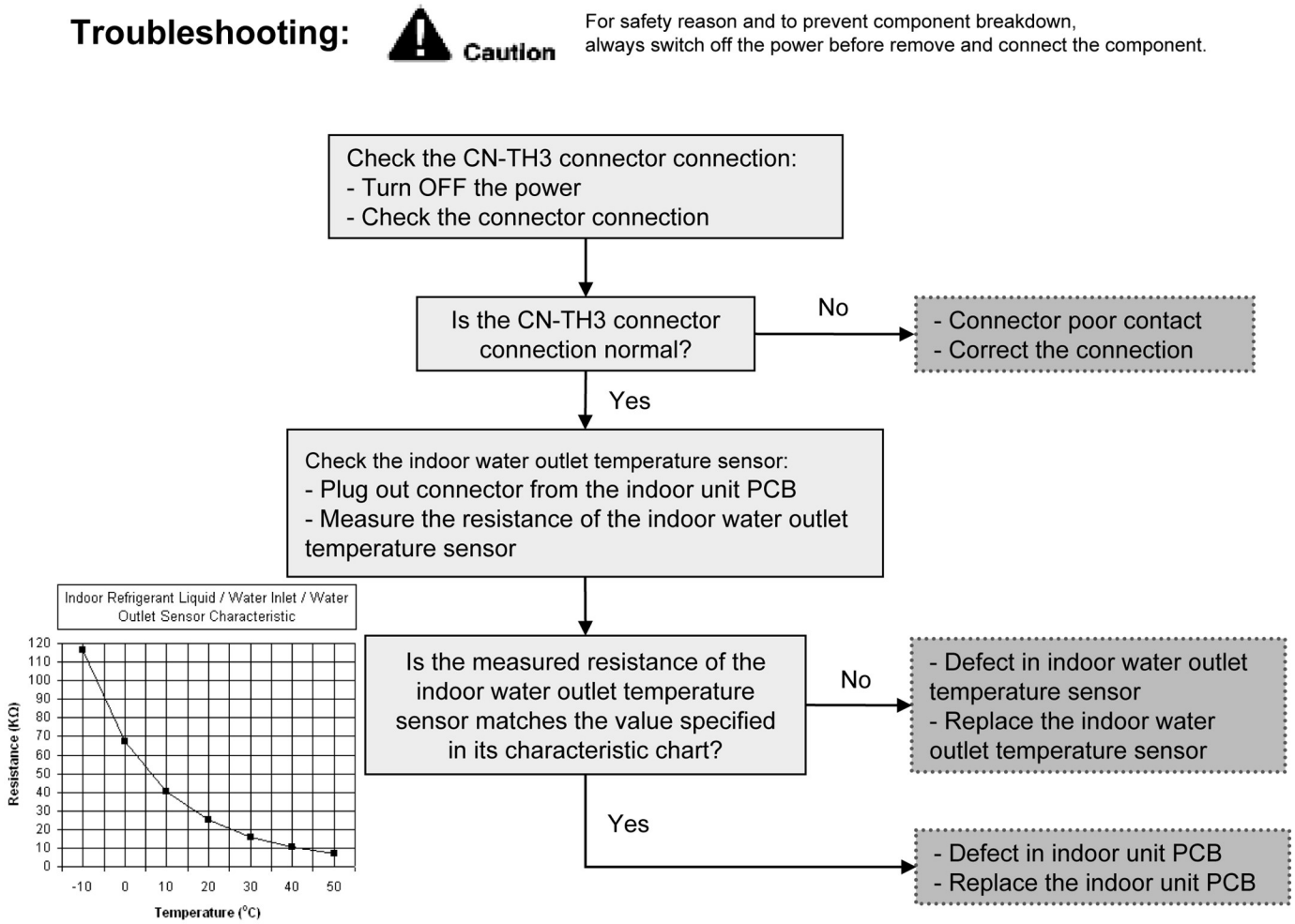
2 Faulty sensor.

3 Faulty indoor unit PCB.

Abnormality determination

Continue for 5 seconds.

Figure 15-34 *Troubleshooting F30*



15 Troubleshooting Guide

Outdoor air temperature sensor abnormality (F36)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the outdoor air temperature sensor are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

2 Faulty sensor.

3 Faulty outdoor unit PCB (main).

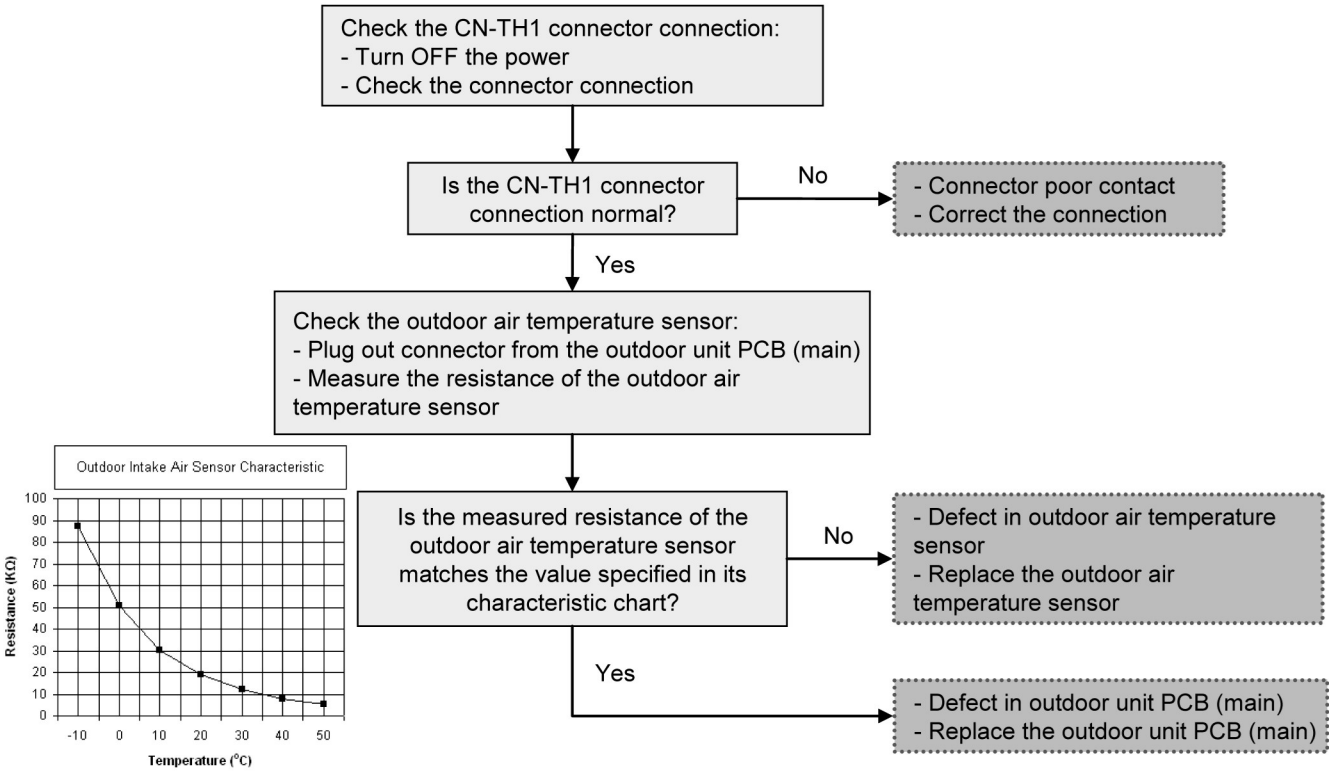
Abnormality determination

Continue for 5 seconds.

Figure 15-35 Troubleshooting F36

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Indoor water inlet temperature sensor abnormality (F37)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the indoor water inlet temperature sensor are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

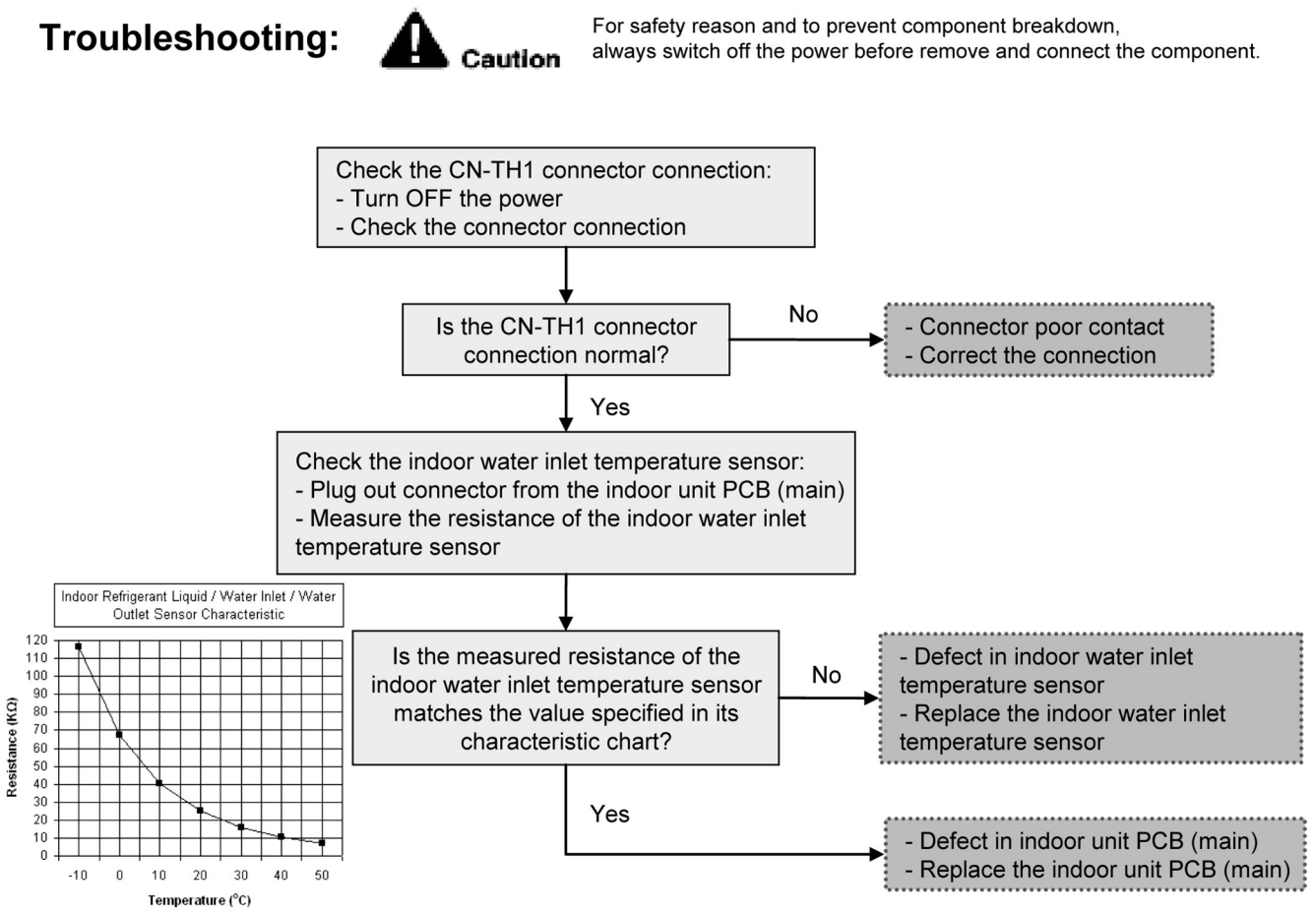
2 Faulty sensor.

3 Faulty indoor unit PCB (main).

Abnormality determination

Continue for 5 seconds.

Figure 15-36 *Troubleshooting F37*



15 Troubleshooting Guide

Outdoor discharge pipe temperature sensor abnormality (F40)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the outdoor discharge pipe temperature sensor are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

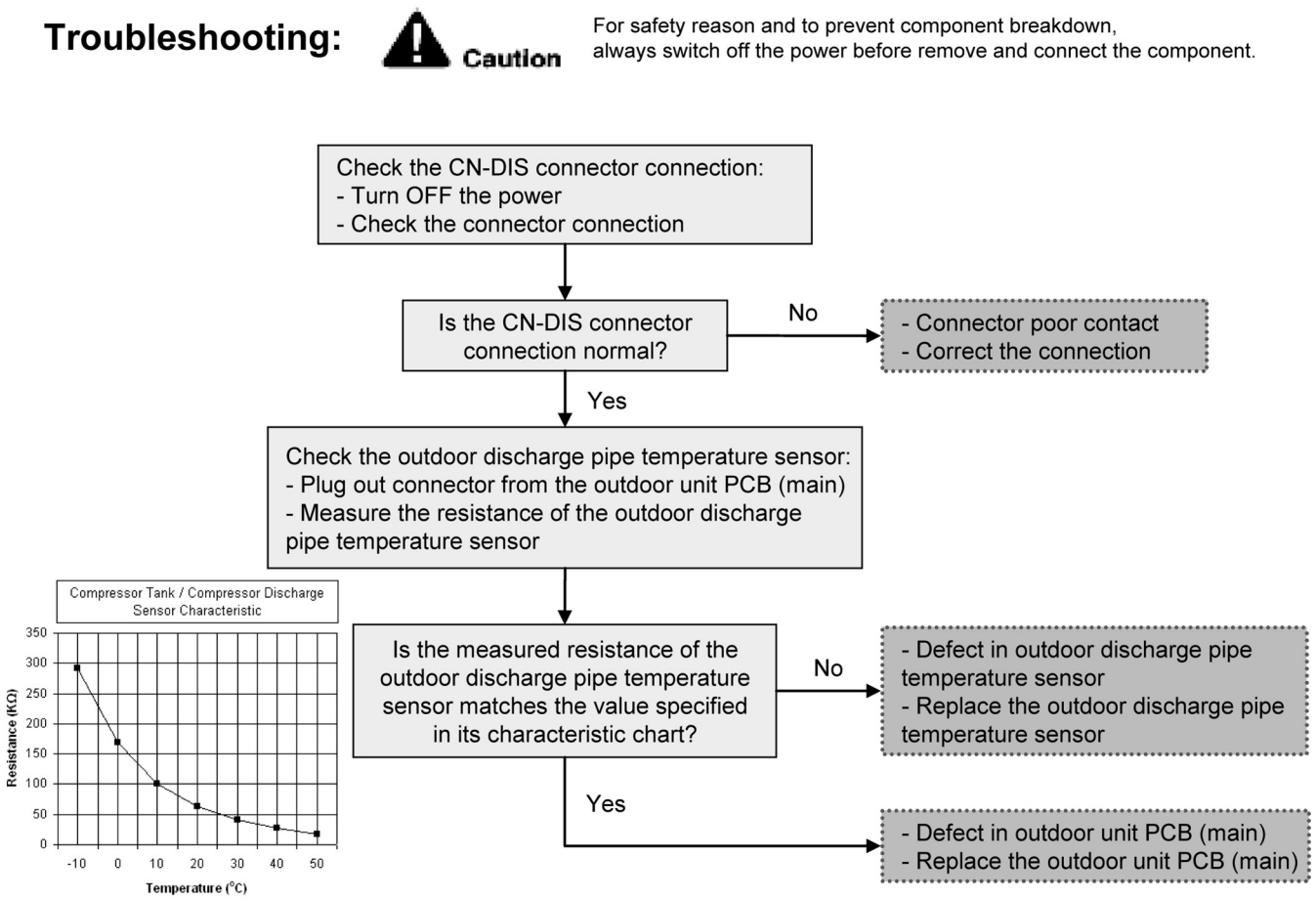
2 Faulty sensor.

3 Faulty outdoor unit PCB (main).

Abnormality determination

Continue for 5 seconds.

Figure 15-37 Troubleshooting F40



15 Troubleshooting Guide

Power factor correction (PFC) abnormality (F41)

Malfunction decision conditions

During cooling and heating operation, when the PFC protection circuitry in the outdoor unit PCB (main) senses abnormal high DC voltage level.

Malfunction causes

1 Power supply surge.

2 Compressor windings not uniform.

3 Faulty outdoor unit PCB (main).

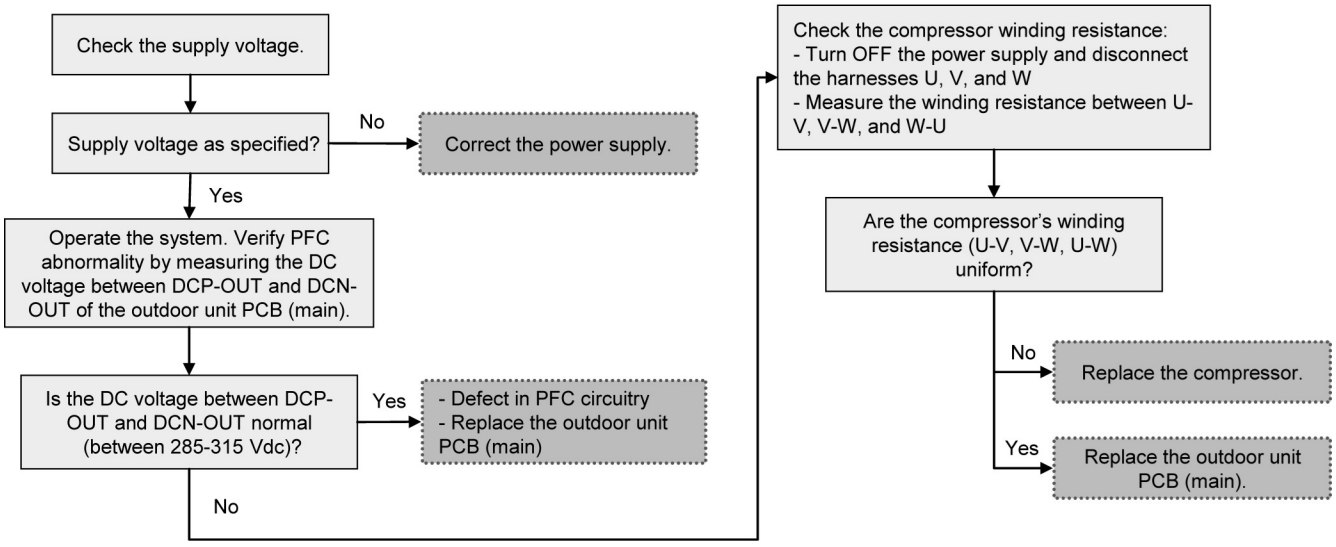
Abnormality determination

Continue 4 times in 10 minutes.

Figure 15-38 Troubleshooting F41

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Outdoor pipe temperature sensor abnormality (F42)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the outdoor pipe temperature sensor are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

2 Faulty sensor.

3 Faulty outdoor unit PCB (main).

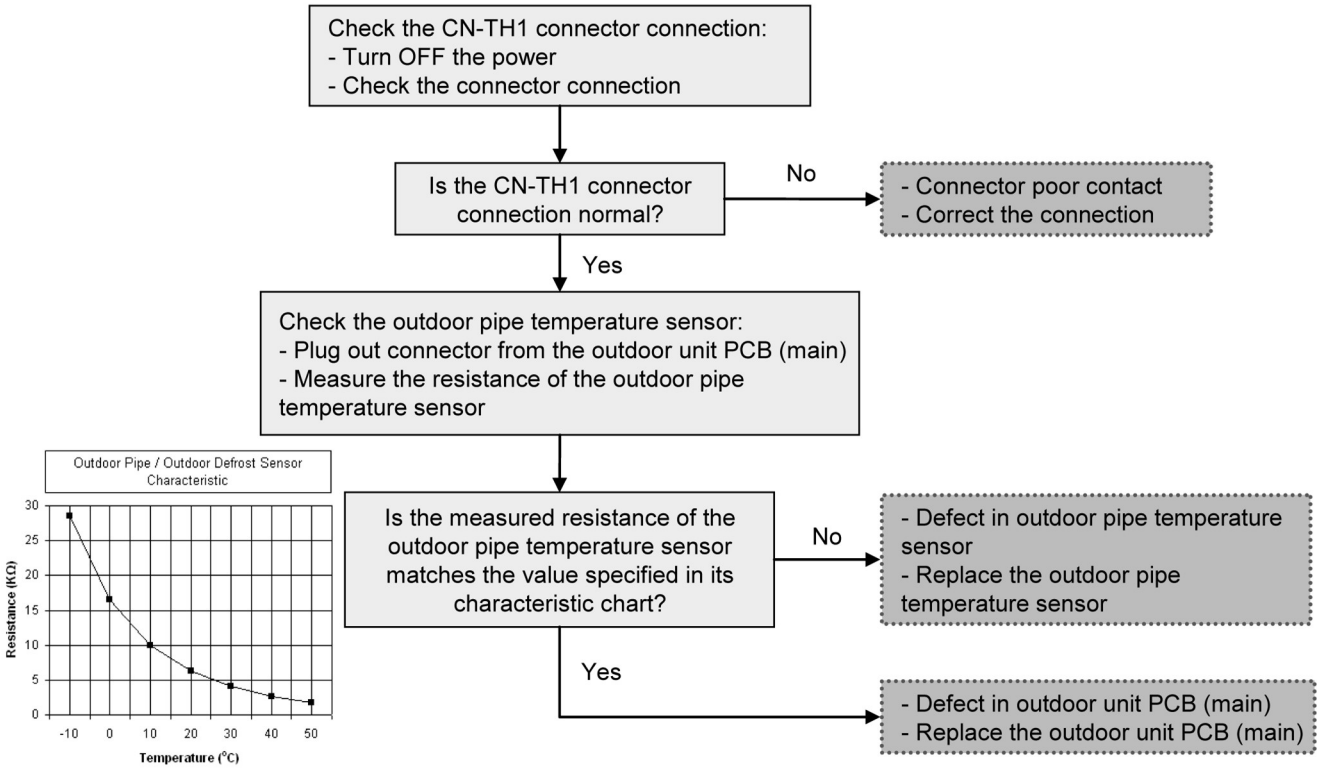
Abnormality determination

Continue for 5 seconds.

Figure 15-39 Troubleshooting F42

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Outdoor defrost temperature sensor abnormality (F43)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the outdoor defrost temperature sensor are used to determine sensor error.

Malfunction causes

1 Faulty connector connection.

2 Faulty sensor.

3 Faulty outdoor unit PCB (main).

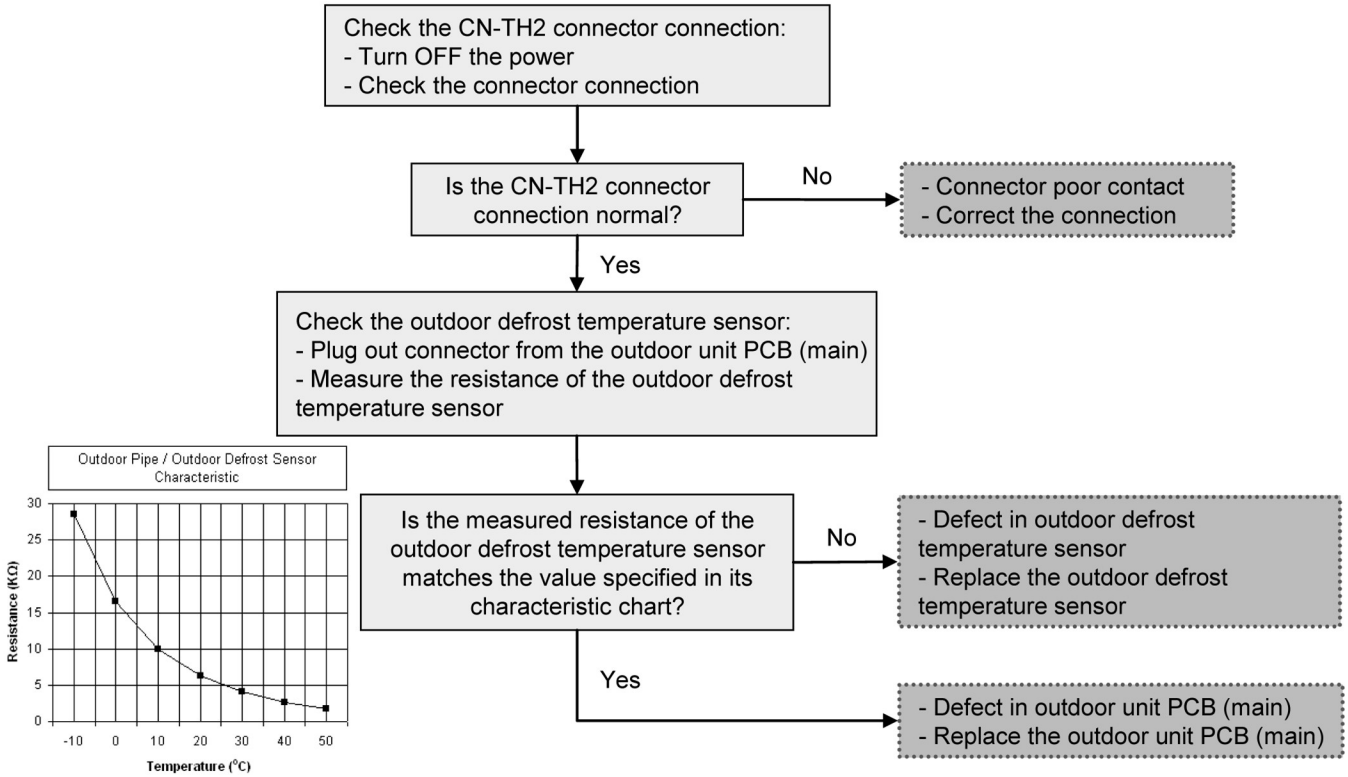
Abnormality determination

Continue for 5 seconds.

Figure 15-40 Troubleshooting F43

Troubleshooting:

Caution For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



15 Troubleshooting Guide

Indoor water outlet temperature sensor abnormality (F45)

Malfunction decision conditions

During startup and cooling and heating operation, the temperatures detected by the indoor water outlet temperature sensor are used to determine sensor errors.

Malfunction causes

1 Faulty connector connection.

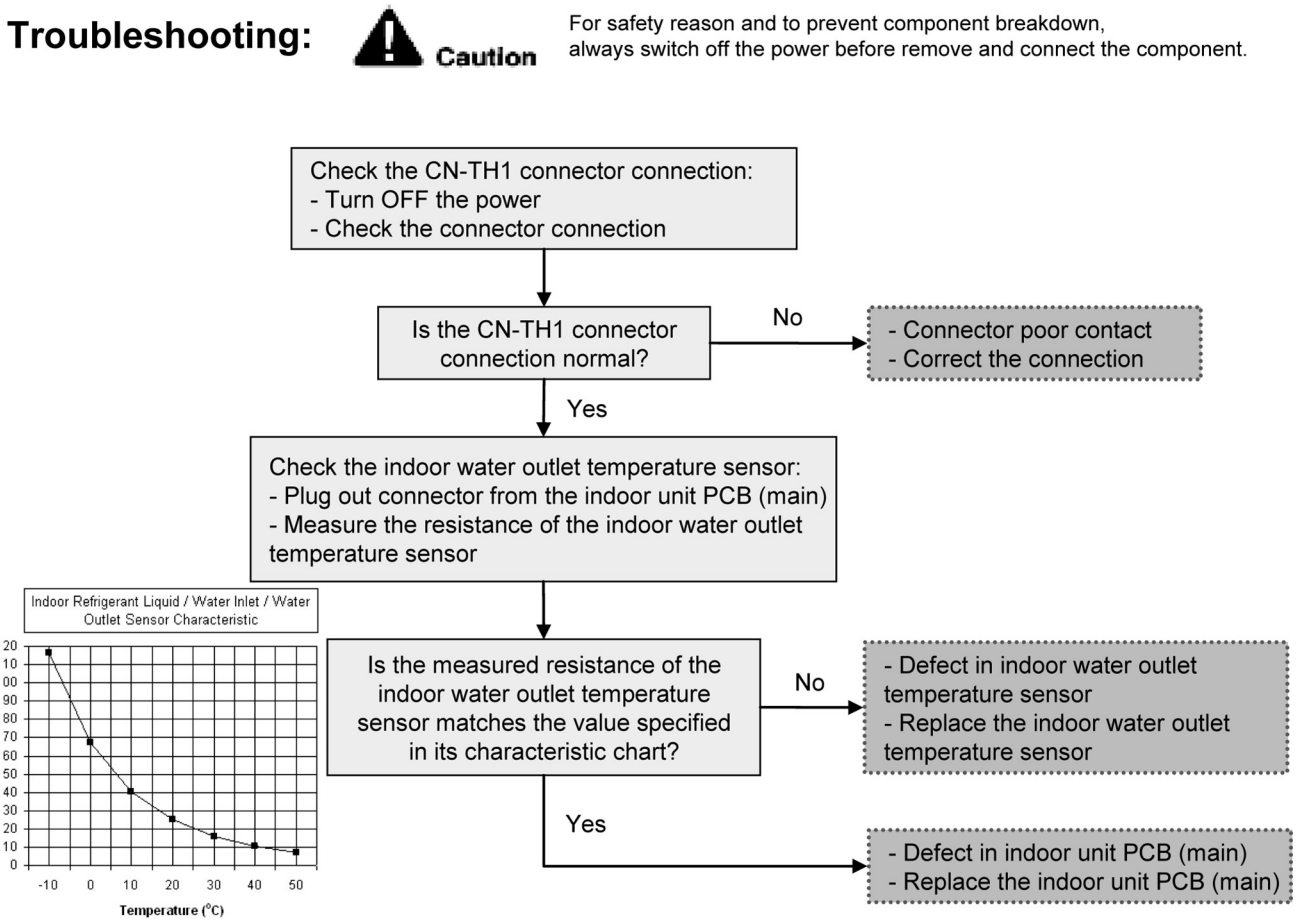
2 Faulty sensor.

3 Faulty indoor unit PCB (main).

Abnormality determination

Continue for 5 seconds.

Figure 15-41 Troubleshooting F45



15 Troubleshooting Guide

Outdoor current transformer open circuit (F46)

Malfunction decision conditions

A current transformer (CT) open circuit is detected by checking the compressor running frequency (rated frequency) and CT detected input current (< 1.6 A) for 20 continuous seconds.

Malfunction causes

1 CT defective.

2 Faulty outdoor unit PCB (main).

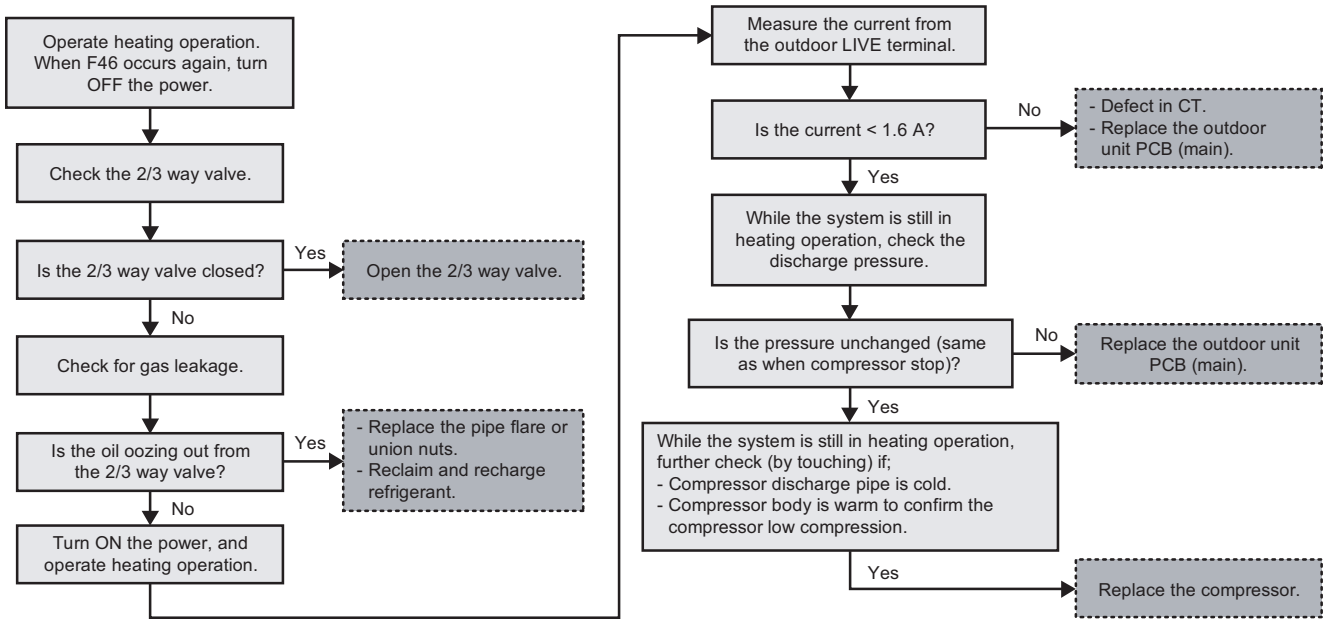
3 Compressor defective (low compression).

Abnormality determination

Continue 3 times in 20 minutes.

Figure 15-42 *Troubleshooting F46*

Troubleshooting: **Caution** For safety reason and to prevent component breakdown, always switch off the power before remove and connect the component.



16 Disassembly and Assembly Instructions

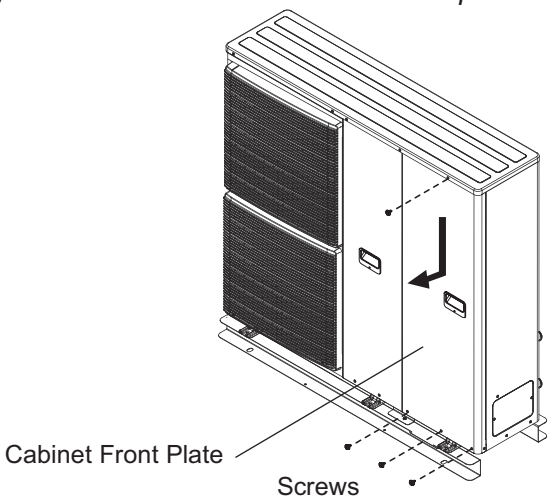
⚠WARNING This section is for authorized and licensed electricians only. Work behind the cabinet front panel secured by screws must only be carried out under supervision of a qualified installer or service technician.

⚠WARNING This section is for authorized and licensed electricians only. Work behind the cabinet front panel secured by screws must only be carried out under supervision of a qualified installer or service technician.

To remove the cabinet front panel

1. Remove 4 mounting screws.
2. Slide the cabinet front panel downward to release the pawls. Then, pull it toward the front to remove it.

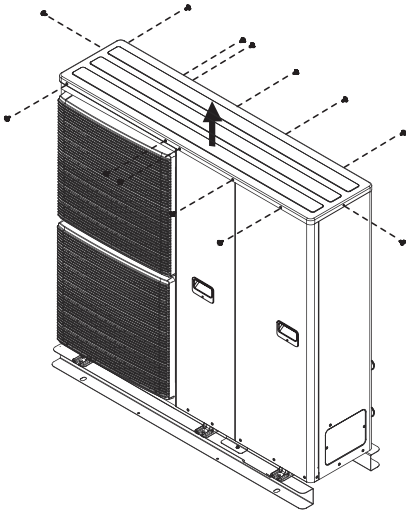
Figure 16-1 *Remove screws and front plate*



To remove the cabinet top panel

1. Remove the thirteen mounting screws.
2. Lift the cabinet top plate upward to remove it.

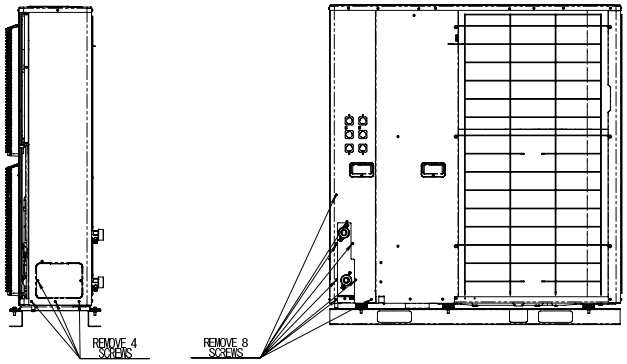
Figure 16-2 *Remove screws and top plate*



To remove the cabinet back panel

1. Remove the four mounting screws from the side of the unit.
2. Remove the eight mounting screws from the back of the unit.

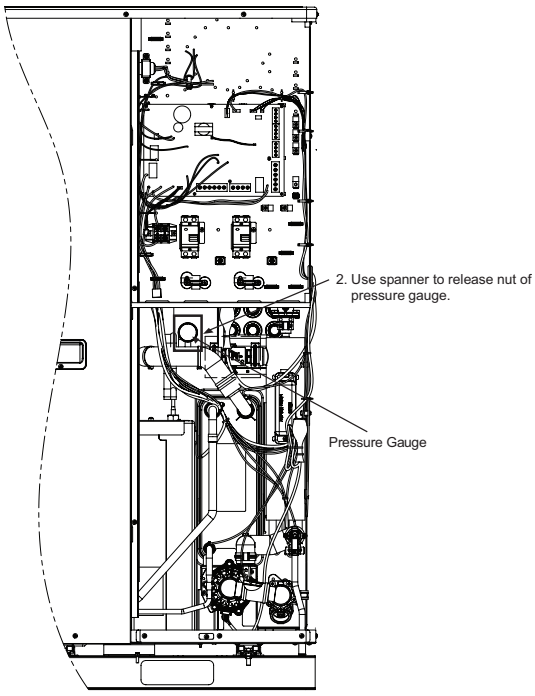
Figure 16-3 *Remove screws and service plate*



To remove the pressure gauge

1. Remove the four mounting screws.
2. Use a wrench to loosen the nut on the pressure gauge.

Figure 16-4 *Remove pressure gauge*



16 Disassembly and Assembly Instructions

To remove the water system electronic control board

1. Remove all the connectors from the electronic controller.
2. Disconnect all lead wires: G01 (green), G02 (green), G03 (green), AC2-N2 (white), AC2-L2 (yellow), Data (red), AC1-N (white), AC1-L3 (black), and ACL3 (black).

Figure 16-5 *Main PCB*

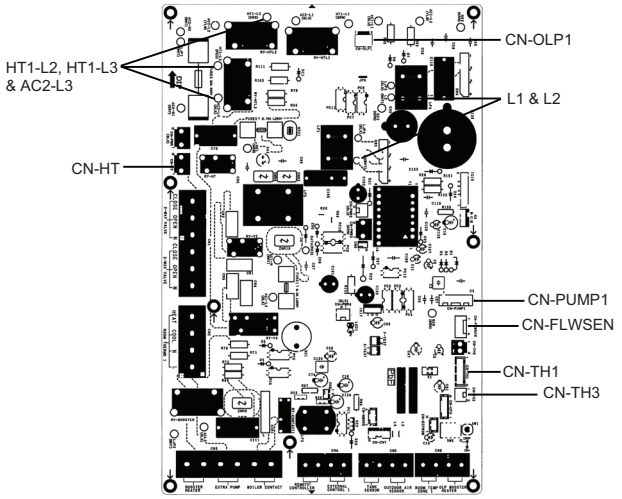
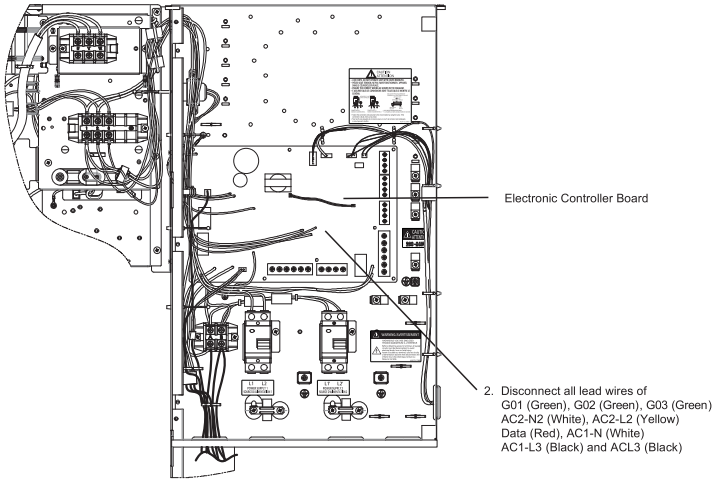


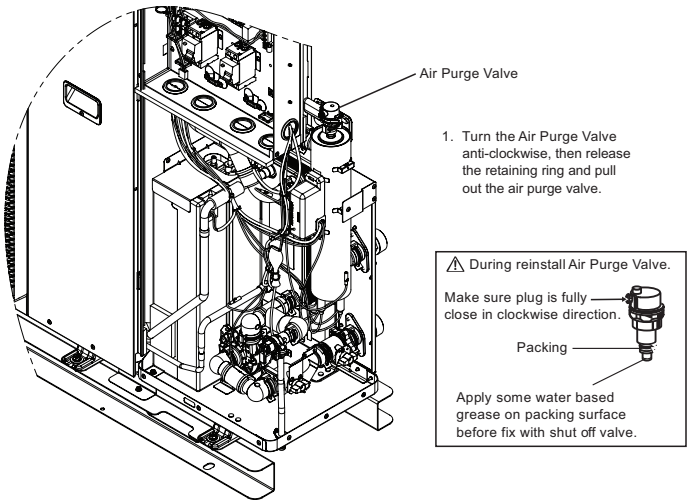
Figure 16-6 *Main PCB connections*



To remove air purge valve

1. Turn the air purge valve counterclockwise, then release the retaining ring and pull out the air purge valve.

Figure 16-7 *Remove air purge valve*

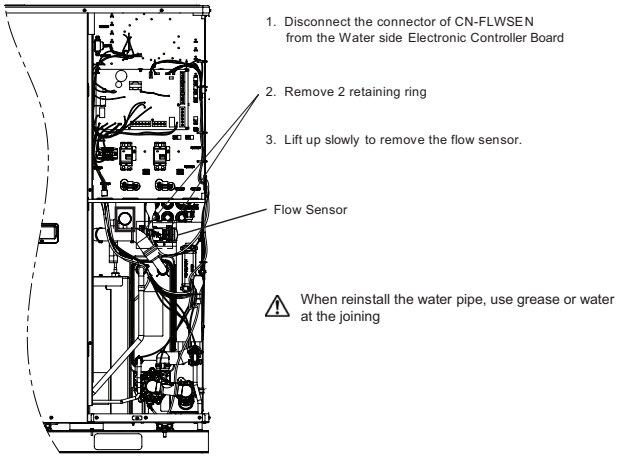


To remove flow sensor

1. Disconnect the connector on the CN-FLWSEN from the water-side electronic controller board.
2. Remove the two retaining rings.
3. Lift up slowly to remove the flow sensor.

⚠WARNING When reinstalling the water pipe, use grease or water at the joint.

Figure 16-8 *Remove flow sensor*



16 Disassembly and Assembly Instructions

To remove water pump

1. Disconnect the CN-PUMP1 connector from the electronic controller board.
2. Remove the two screws from the pump bracket.
3. Remove the two retaining rings, then slowly pull out the water pump.

Figure 16-9 *Remove connector*

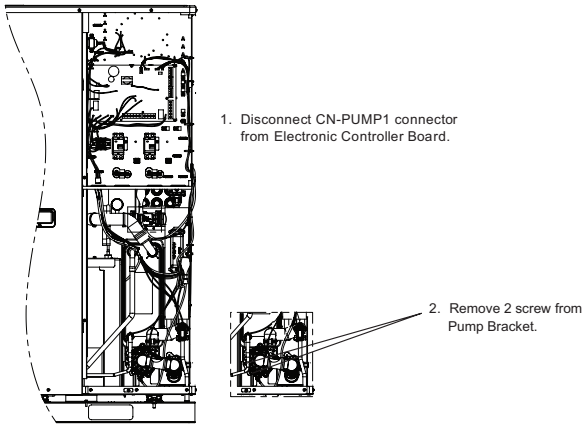
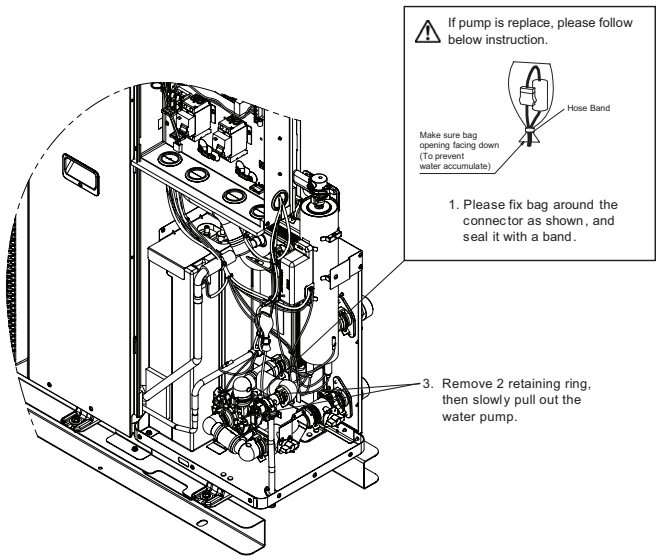


Figure 16-10 *Remove water pump*



To remove heater

1. Remove the four lead wires: HT1-L2 (orange), HT-L3 (red), AC2-N2 (white), and N1 (white) from below the heater.
2. Remove the terminal cover by releasing the one screw, then remove the overload protector (OLP) lead wires: (blue), (black), and (orange).
3. Remove the screw from the heater bracket.
4. Release the two retaining rings, and slowly remove the heater.

Figure 16-11 *Remove wires*

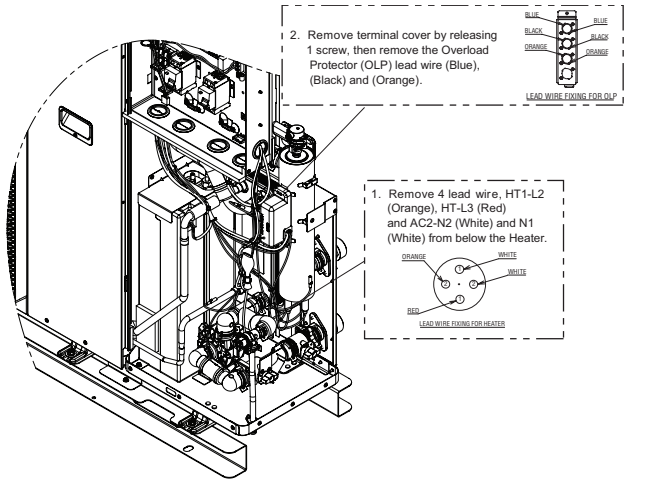
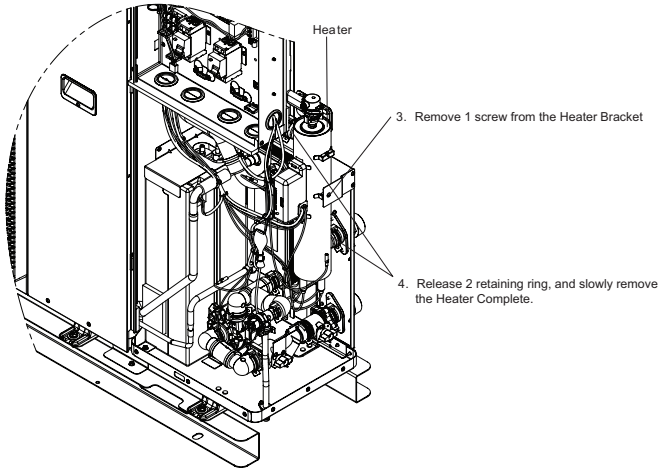


Figure 16-12 *Remove heater*



16 Disassembly and Assembly Instructions

To remove filter

1. Remove the access cover by removing the two screws.
2. Set the two valves for the water filter set to “CLOSE.”
3. Pull up the water filter set.
4. Remove the retaining ring, then remove the water filter.

Figure 16-13 *Remove service plate*

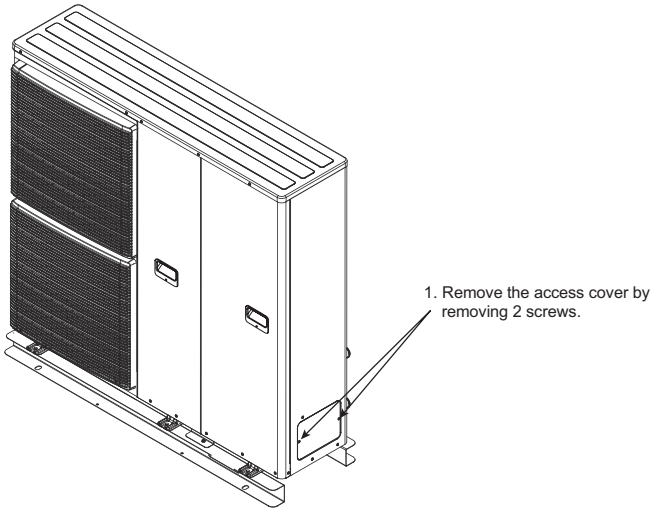
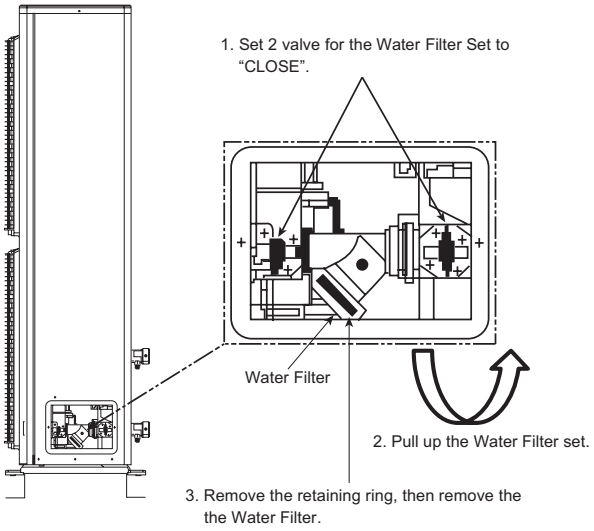


Figure 16-14 *Remove filter*



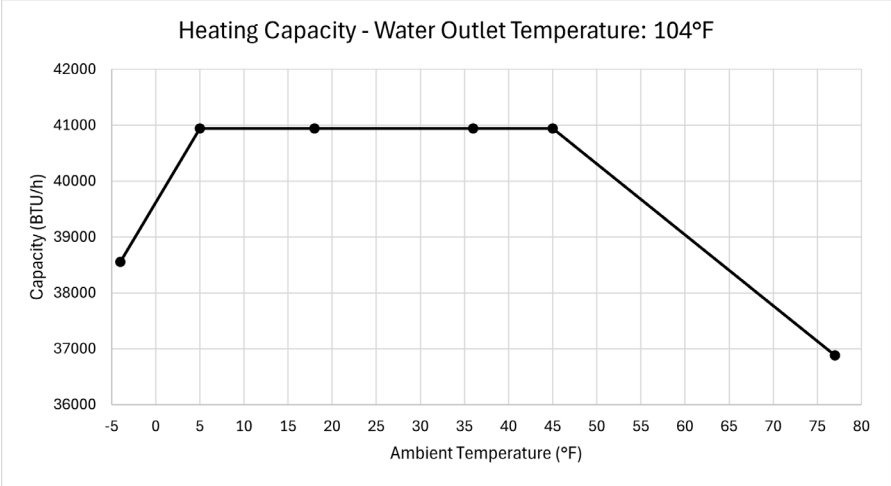
17 Technical Data

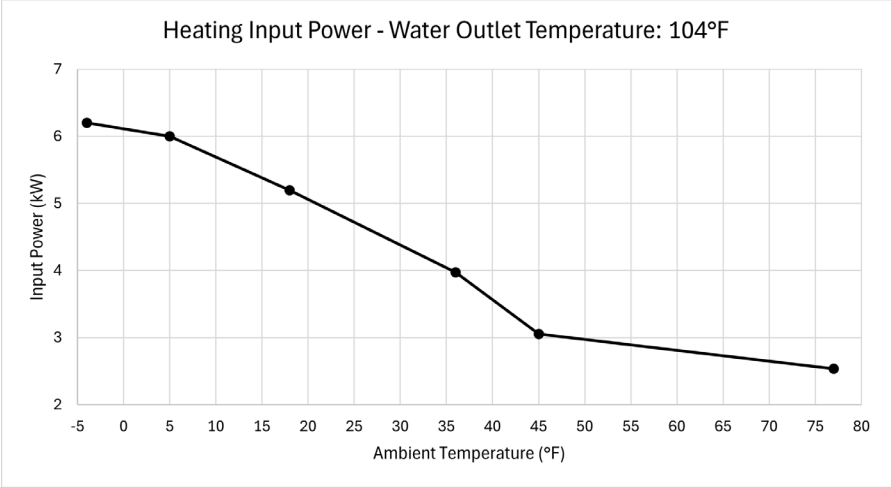
Operation characteristics

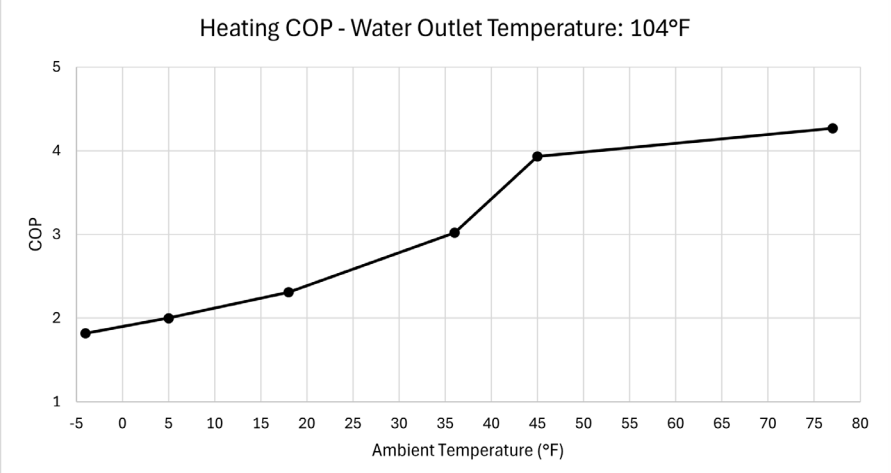
Heating characteristics at different outdoor air temperatures

Water outlet temperature: 104°F

Figure 17-1 Heating vapacity - water outlet temperature: 104°F





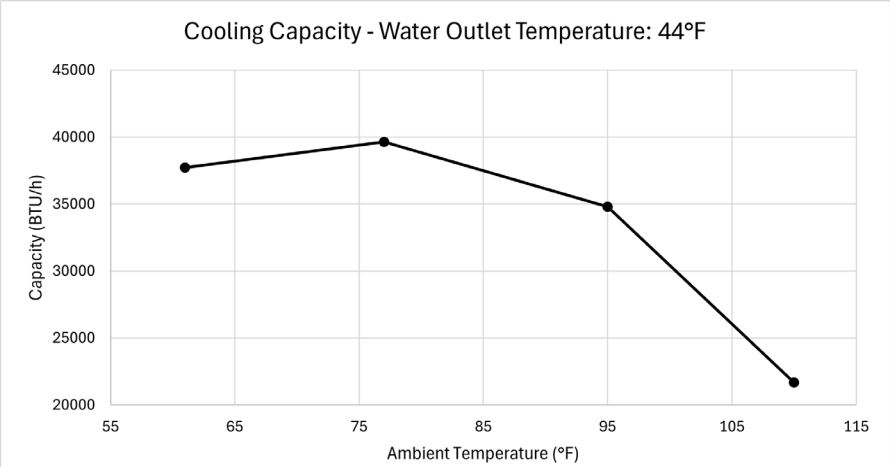


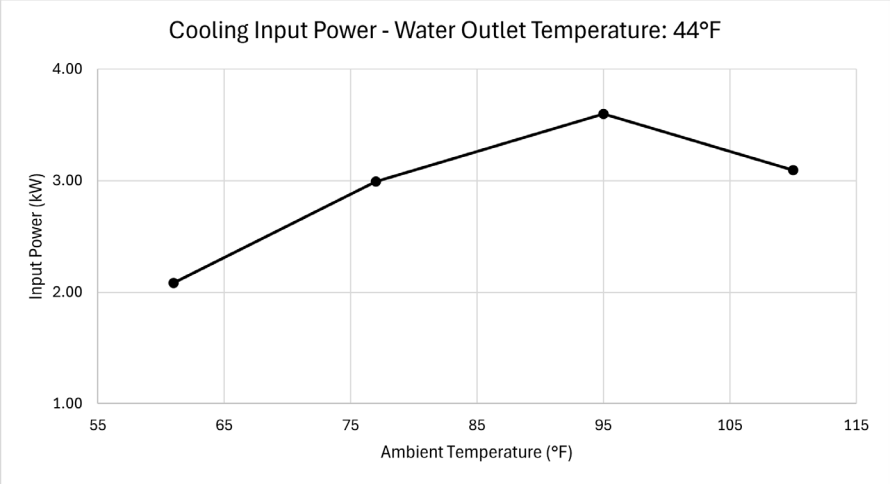
17 Technical Data

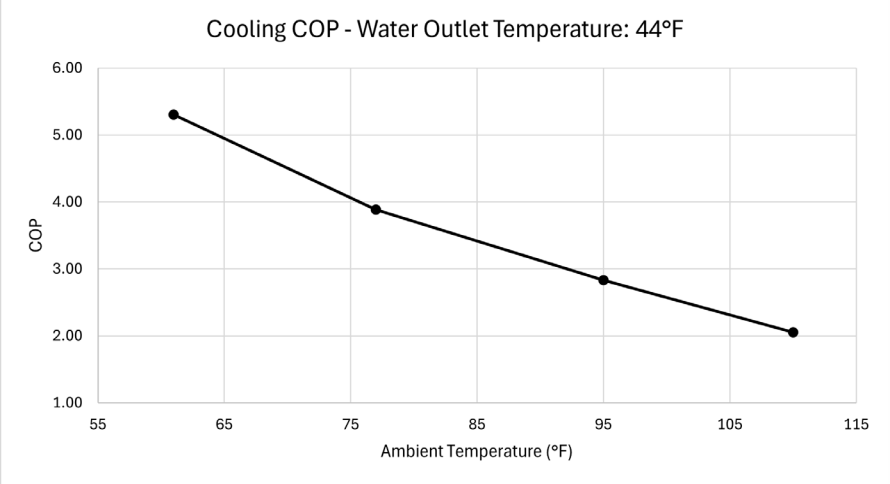
Cooling characteristics at different outdoor air temperatures

Water outlet temperature: 44°F

Figure 17-2 Cooling capacity - water outlet temperature: 44°F





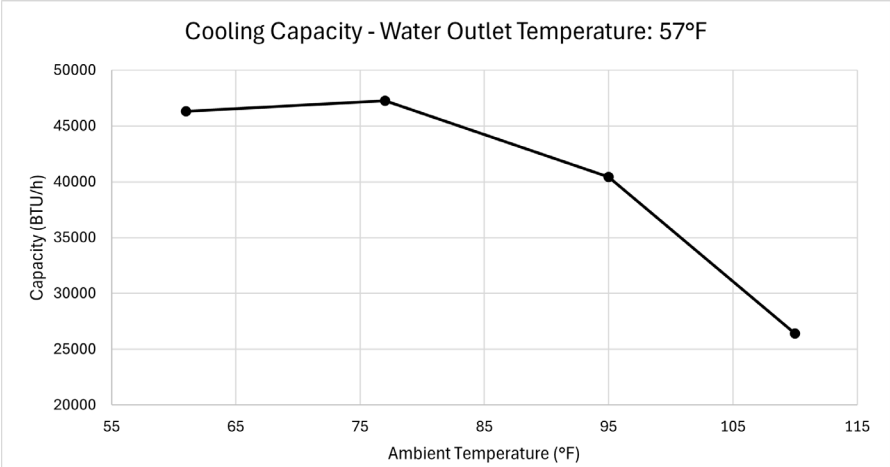


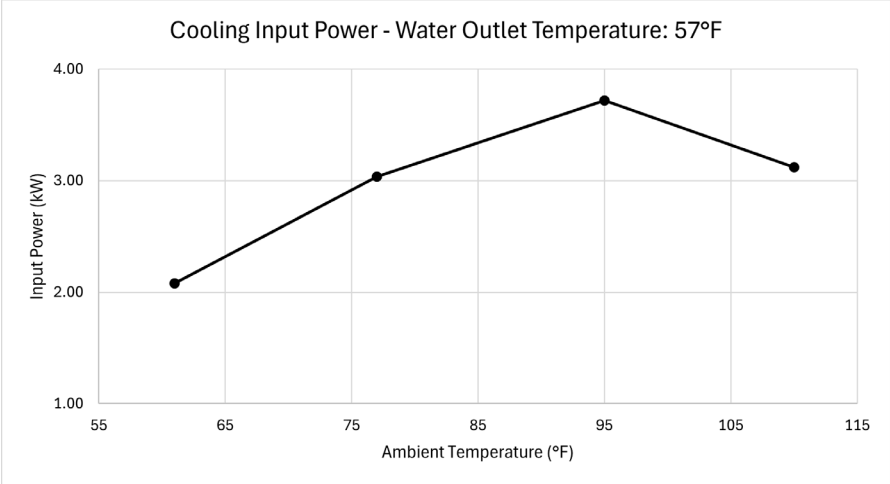
17 Technical Data

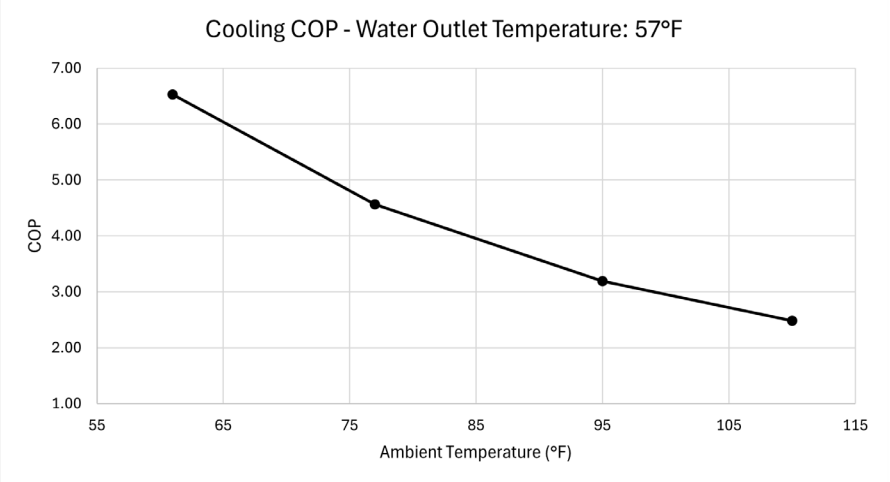
Cooling characteristics at different outdoor air temperatures

Water outlet temperature: 57°F

Figure 17-3 Cooling capacity - water outlet temperature: 57°F





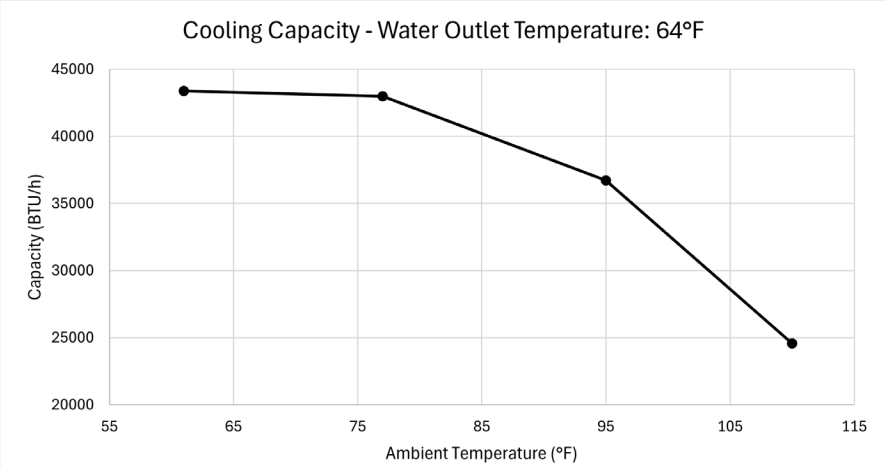


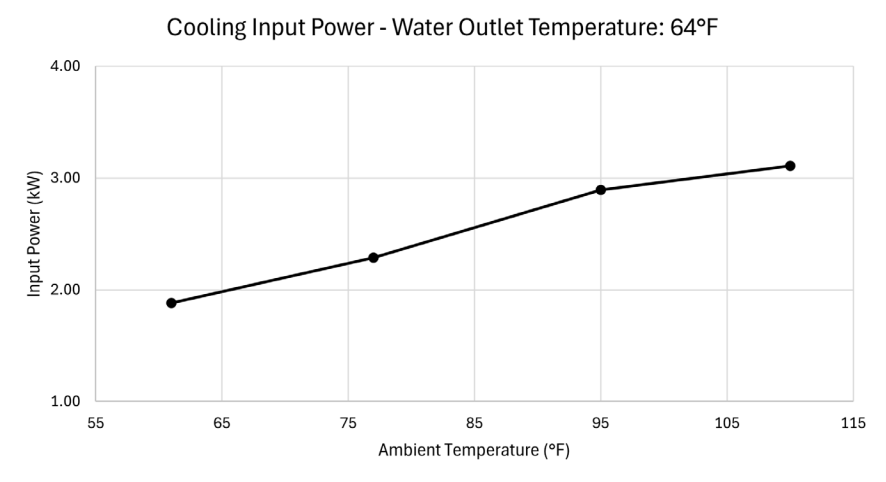
17 Technical Data

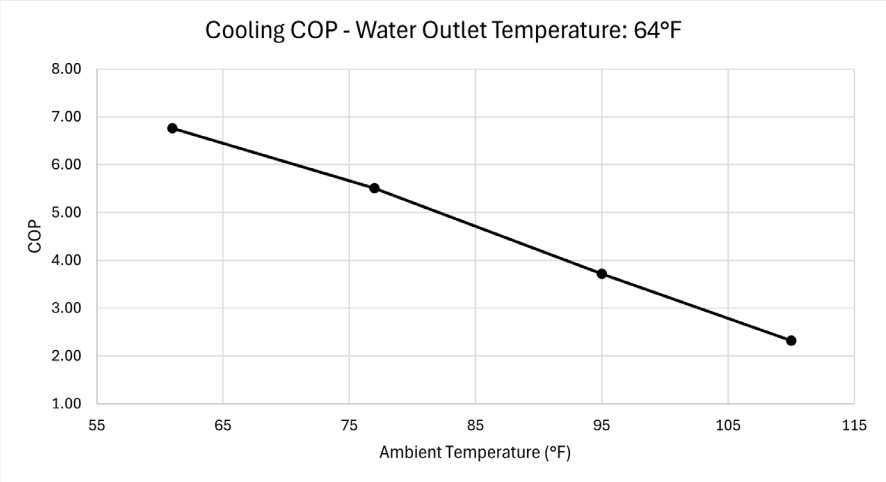
Cooling characteristics at different outdoor air temperatures

Water outlet temperature: 64°F

Figure 17-4 *Cooling capacity - water outlet temperature: 64°F*







17 Technical Data

Table 17-1 *Heating capacity*

Water out	86°F			104°F			122°F		
Outdoor Air	Capacity (BTU/hr)	Input power (W)	COP	Capacity (BTU/hr)	Input power (W)	COP	Capacity (BTU/hr)	Input power (W)	COP
-4	39240	5.5	2.09	38557	6.2	1.82	34804	6.5	1.57
5	40946	5.20	2.30	40946	6.00	2.00	35486	6.30	1.65
18	40754	4.32	2.76	40946	5.19	2.31	36169	5.49	1.93
36	38017	3.11	3.58	40946	3.97	3.02	39194	4.70	2.45
45	42299	2.42	5.13	40946	3.05	3.93	40946	3.93	3.05
77	40733	1.16	10.30	36879	2.53	4.27	36060	3.30	3.20
Water Out	140°F								
Outdoor Air	Capacity (BTU/hr)	Input power (W)	COP						
-4	N/A	N/A	N/A						
5	26922	6.43	1.23						
18	29003	5.80	1.47						
36	38325	5.44	2.06						
45	40946	5.20	2.31						
77	35357	3.66	2.83						

Note:

* Between outdoor ambient 5°F and -4°F, the water outlet temperature gradually decreases from 140°F to 131°F.

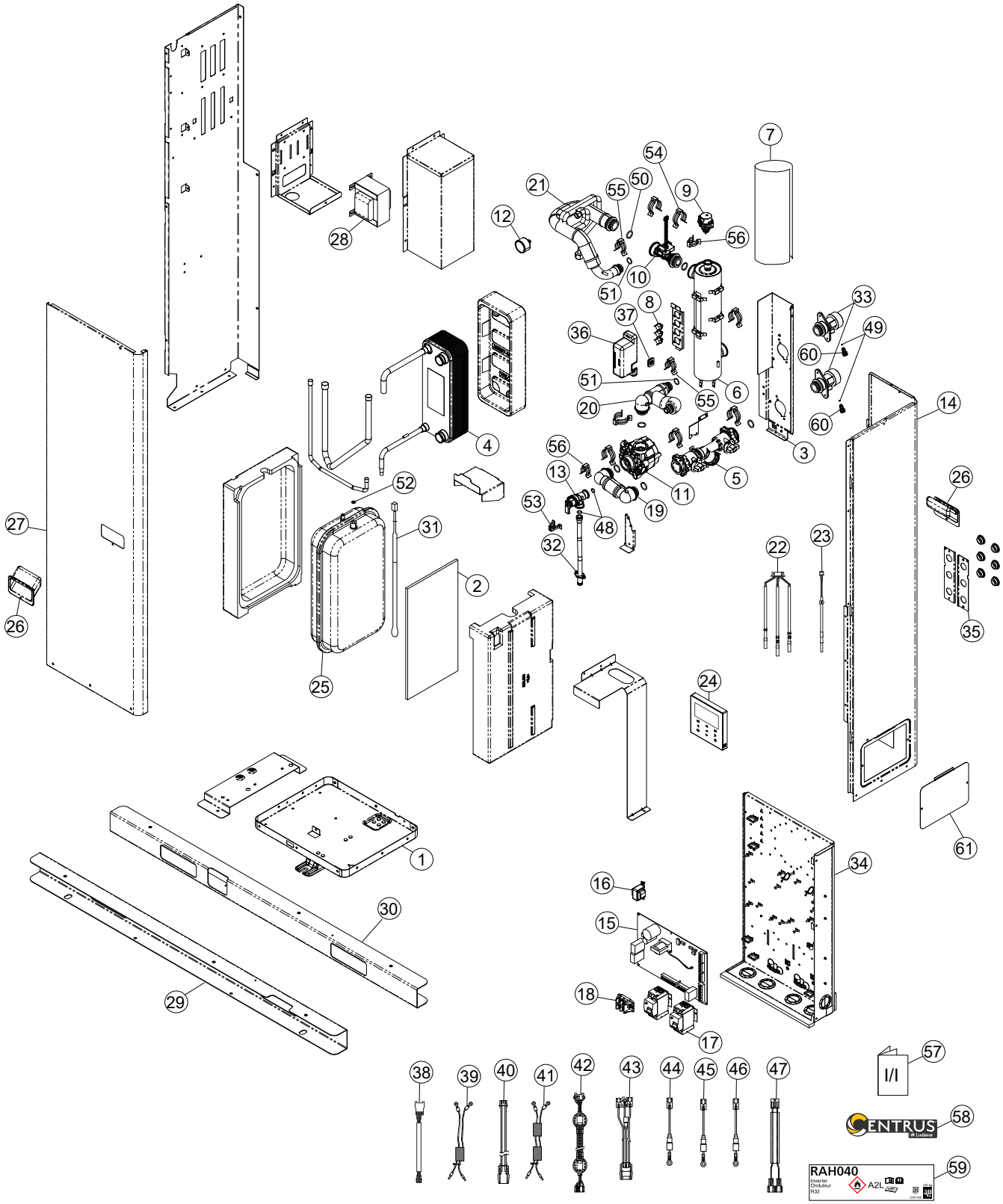
* Only when ΔT is set to 27°F will the set temperature above 140°F take effect.

Table 17-2 *Cooling capacity*

OD	Water Out 44°F			Water Out 57°F			Water Out 64°F		
	Capacity (BTU/hr)	Input power (W)	COP	Capacity (BTU/hr)	Input power (W)	COP	Capacity (BTU/hr)	Input power (W)	COP
61	37713	2.08	5.31	46324	2.08	6.53	43396	1.88	6.76
77	39628	2.99	3.88	47252	3.04	4.56	42994	2.29	5.51
95	34804	3.60	2.83	40435	3.72	3.19	36707	2.89	3.72
110	21670	3.09	2.05	26416	3.12	2.48	24581	3.11	2.32

18 Exploded View and Replacement Parts

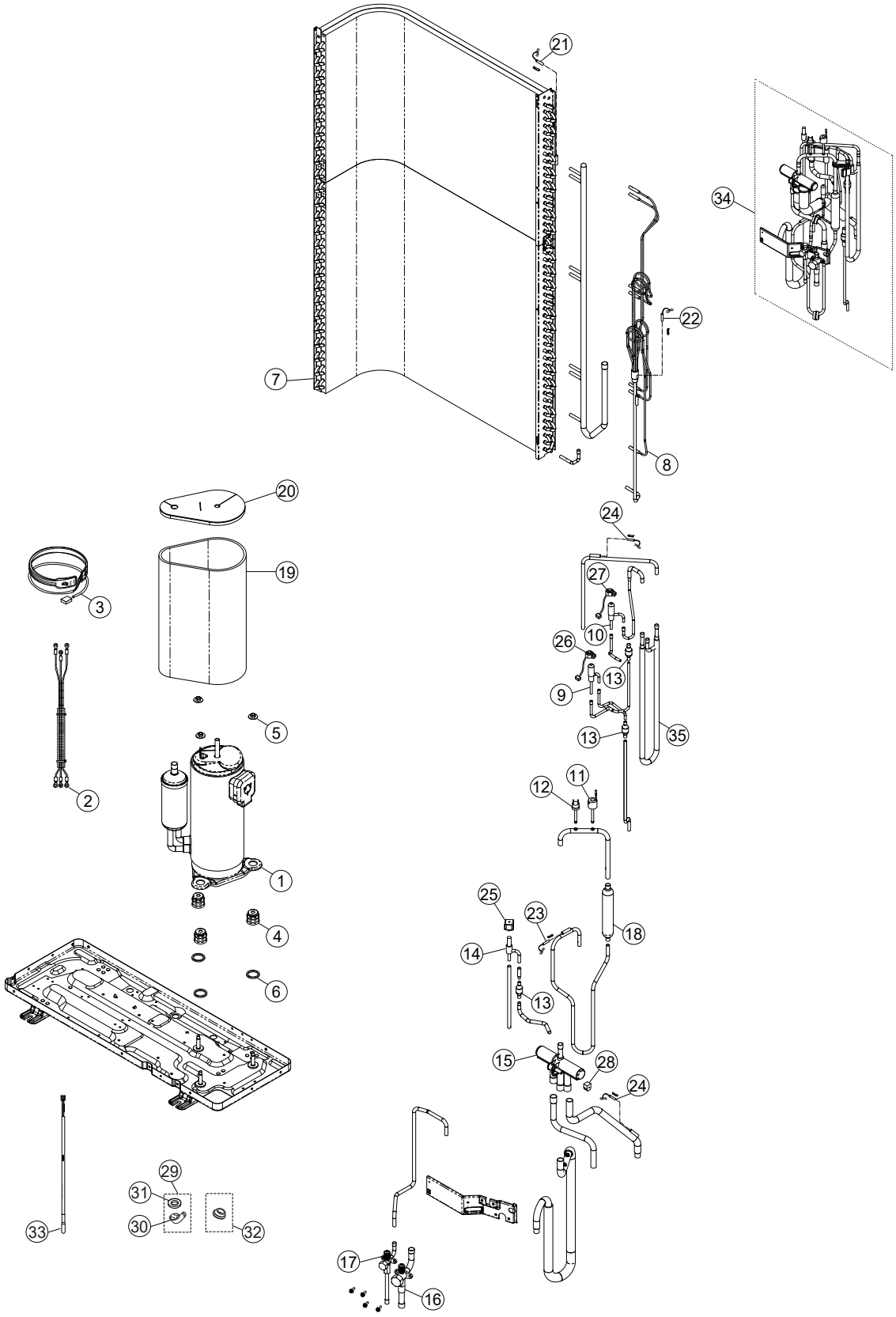
Water system



NOTICE The above exploded view is for the purposes of parts disassembly and replacement. The non-numbered parts are not kept as standard service parts.

18 Exploded View and Replacement Parts

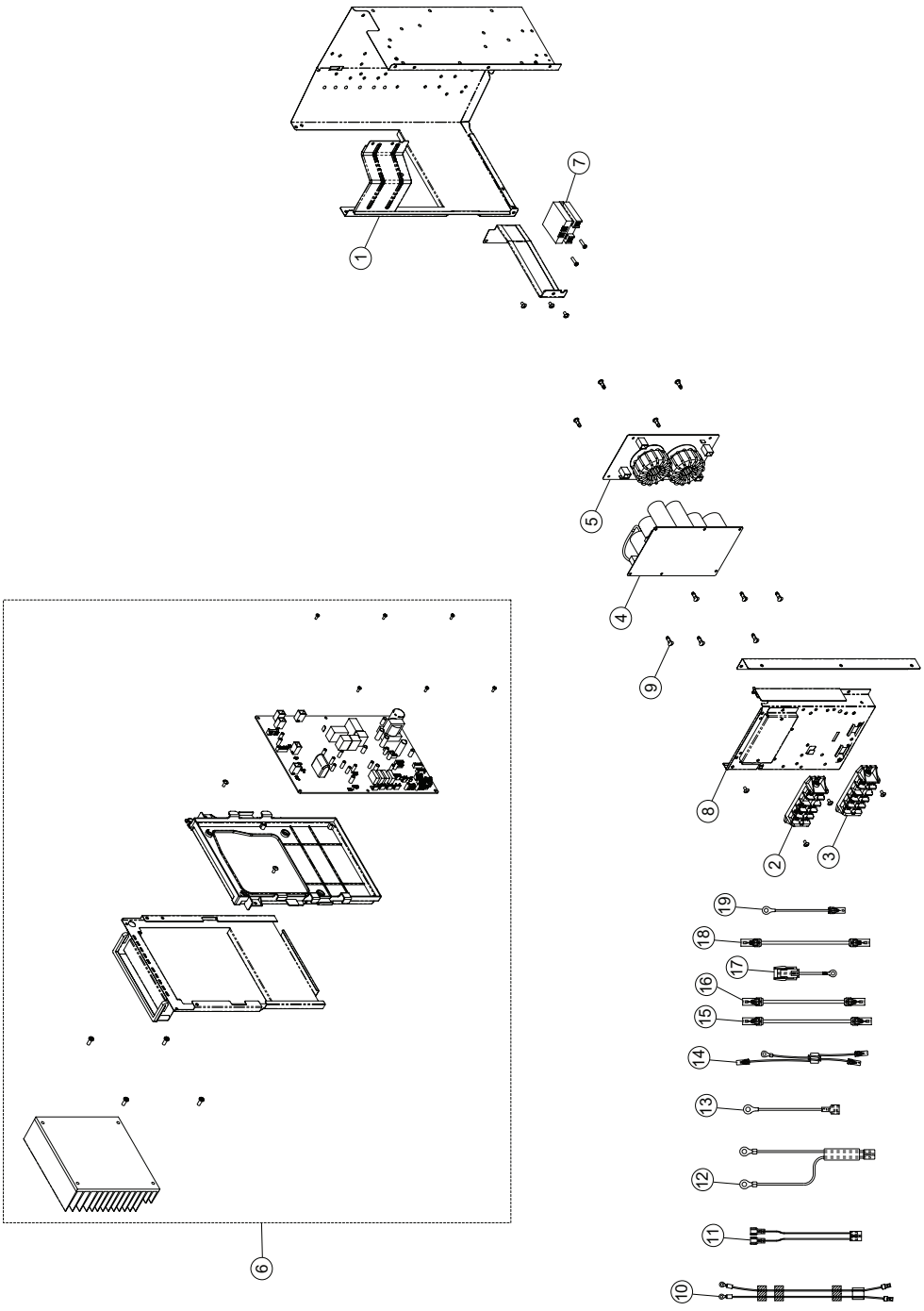
Refrigeration system



NOTICE The above exploded view is for the purposes of parts disassembly and replacement. The non-numbered parts are not kept as standard service parts.

18 Exploded View and Replacement Parts

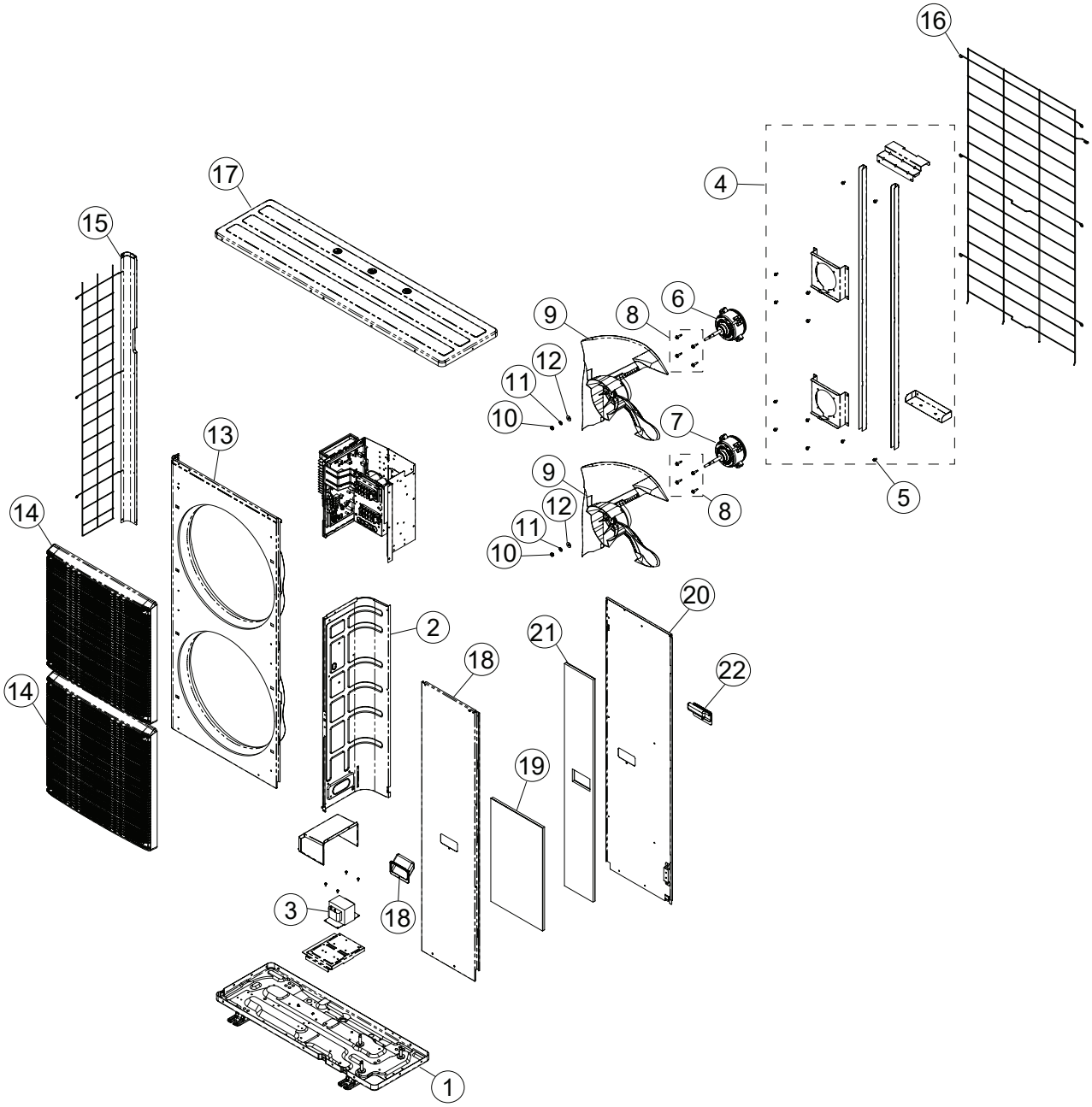
Outdoor control board



NOTICE The above exploded view is for the purposes of parts disassembly and replacement. The non-numbered parts are not kept as standard service parts.

18 Exploded View and Replacement Parts

Air Flow



NOTICE The above exploded view is for the purposes of parts disassembly and replacement. The non-numbered parts are not kept as standard service parts.

18 Exploded View and Replacement Parts

SAFETY	ITEM NO.	DESCRIPTION	QTY.	PART NO.
		WATER SYSTEM		
	1	BASE PAN,WTR,ASSY,RAH040	1	100390420
	2	INSUL,SOUND,ETNK,RAH040	1	100390421
	3	PANEL,CPLG,SUPT,RAH040	1	100390422
	4	HEX,WATER,RAH040	1	100390423
	5	FILTER,ASSY,RAH040	1	100383552
⚠	6	HEATER,ELEM,ASSY,RAH040	1	100390425
	7	INSUL,SOUND,HTR,RAH040	1	100390426
⚠	8	THERMOSTAT,HTR,RAH040	3	100390427
	9	VALVE,PURGE,AIR,RAH040	1	100390428
	10	SENSOR,FLOW,RAH040	1	100383553
⚠	11	PUMP,WATER,RAH040	1	100383554
	12	GAUGE,PRESSURE,RAH040	1	100383555
	13	VALVE,RELIEF,T&P,RAH040	1	100383556
	14	PANEL,SIDE,RAH040	1	100390433
⚠	15	PCB,MAIN,RAH040	1	100383557
⚠	16	REACTOR,MAIN,PCB,RAH040	1	100390471
⚠	17	BREAKER,CIRCUIT,RCCB,RAH040	2	100383559
⚠	18	BOARD,TERMINAL,AB,ASSY,RAH040	1	100390473
⚠	19	PIPE,FLTR,PMP,WTR,ASSY,RAH040	1	100390474
⚠	20	PIPE,PMP,HEX,WTR,ASSY,RAH040	1	100390475
⚠	21	PIPE,HEX,HTR,WTR,ASSY,RAH040	1	100390476
⚠	22	SENSOR,HRNS,WTR,OUT,IN,RAH040	1	100390477
⚠	23	SENSOR,HEX,WTR,OUT,RAH040	1	100390478
⚠	24	CONTROLPAD,RAH040	1	100390479
⚠	25	TANK,EXPANSION,RAH040	1	100390480
	26	HANDLE,PANEL,RAH040	2	100390567
	27	PANEL,FRONT,WTR,RAH040	1	100390482
⚠	28	XFRMR,RAH040	1	100390483
	29	BASE,LEG,FRONT,RAH040	1	100390484
	30	BASE,LEG,REAR,RAH040	1	100390485
⚠	31	TRACE,HEAT,ETNK,RAH040	1	100390486
	32	TUBE,VALVE,RELIEF,ASSY,RAH040	1	100390487
	33	COUPLING,BRASS,RAH040	2	100390488
	34	PANEL,PCB,MAIN,RAH040	1	100390489
	35	PANEL,EXTERNAL,WIRE,RAH040	2	100390490
	36	COVER,HEATER,TSTAT,RAH040	1	100390491
	37	O-RING,COVER,HTR,TSTAT,RAH040	1	100390492
	38	HRNS,SENSOR,FLOW,RAH040	1	100390493
⚠	39	HRNS,RCCB,TERM,12,RAH040	1	100390494
⚠	40	HRNS,TRACE,HEAT,ETNK,RAH040	1	100390495
⚠	41	HRNS,RCCB,TERM,AB,RAH040	1	100390496
⚠	42	HRNS,PUMP,RAH040	1	100390497
⚠	43	HRNS,TSTAT,HTR,RAH040	1	100390498
⚠	44	HRNS,TERM,B,HTR,ELEM,RAH040	1	100390499
⚠	45	HRNS,TERM,A,TSTAT,HTR,RAH040	1	100390502
⚠	46	HRNS,HTR,ELEM,TSTAT,RAH040	1	100390503
⚠	47	HRNS,OLP,RAH040	1	100390504
	48	O-RING,VALVE,RELIEF,RAH040	2	100390505

PLEASE HAVE PART NUMBER AVAILABLE WHEN ORDERING PARTS

18 Exploded View and Replacement Parts

SAFETY	ITEM NO.	DESCRIPTION	QTY.	PART NO.
		WATER SYSTEM CONTINUED		
	49	O-RING,CPLG,PLUG,RAH040	2	100390507
	50	O-RING,SENSOR,FLOW,RAH040	7	100390508
	51	O-RING,HEX,WTR,RAH040	2	100390509
	52	O-RING,ETNK,RAH040	1	100390510
	53	CLAMP,RETN,RLV,TUBE,RAH040	1	100390511
	54	CLAMP,RETN,SENSOR,FLOW,RAH040	7	100390513
	55	CLAMP,RETN,HEX,WTR,RAH040	2	100390514
	56	CLAMP,RETN,RLV,PIPE,RAH040	2	100390515
	57	INSTR,INSTALL,OPERATION,RAH040	1	100390516
	58	LABEL,CENTRUS,RAH040	1	100390517
	59	LABEL,MODEL,RAH040	2	100390518
	60	PLUG,CPLG,WTR,RAH040	2	100390520
	61	PANEL,SVC,FILTER,RAH040	1	100390521
		PLEASE HAVE PART NUMBER AVAILABLE WHEN ORDERING PARTS		

18 Exploded View and Replacement Parts

SAFETY	ITEM NO.	DESCRIPTION	QTY.	PART NO.
		REFRIGERANT SYSTEM		
⚠	1	COMPRESSOR,RAH040	1	100390353
⚠	2	HRNS,COMPRESSOR,RAH040	1	100390354
⚠	3	TRACE,HEAT,CRANKCASE,RAH040	1	100390355
	4	ABSORBER,VIBRATION,COMP,RAH040	3	100390356
	5	NUT,MOUNT,COMP,RAH040	3	100390357
	6	GASKET,MOUNT,COMP,RAH040	3	100390359
	7	HEX,AIR,RAH040	1	100390360
	8	PIPE,CAPILLARY,RAH040	1	100390362
	9	VLV,EXPANSION,BYPASS,RAH040	1	100390363
	10	VLV,EXPANSION,MAIN,RAH040	1	100390364
⚠	11	SENSOR,PRESSURE,HIGH,RAH040	1	100390366
⚠	12	SWITCH,PRESSURE,RAH040	1	100390368
	13	STRAINER,RAH040	3	100390369
	14	VALVE,2-WAY,RAH040	1	100390370
	15	VALVE,4-WAY,RAH040	1	100390392
	16	VALVE,KING,LOW,RAH040	1	100390393
	17	VALVE,KING,HIGH,RAH040	1	100390394
	18	MUFFLER,DISCHARGE,RAH040	1	100390395
	19	INSUL,SOUND,SIDE,COMP,RAH040	1	100390396
	20	INSUL,SOUND,TOP,COMP,RAH040	1	100390397
⚠	21	SENSOR,AMBIENT,RAH040	1	100390399
⚠	22	SENSOR,DEFROST,RAH040	1	100390400
⚠	23	SENSOR,DISCHARGE,RAH040	1	100390401
⚠	24	SENSOR,EEV,BYPASS,RAH040	1	100390403
⚠	25	COIL,VLV,2-WAY,RAH040	1	100390404
⚠	26	COIL,EEV,BYPASS,RAH040	1	100390405
⚠	27	COIL,EEV,MAIN,RAH040	1	100390406
⚠	28	COIL,VLV,4-WAY,RAH040	1	100390407
	29	ELBOW,O-RING,DRAIN,ASSY,RAH040	1	100390408
	30	ELBOW,DRAIN,RAH040	1	100390409
	31	O-RING,ELBOW,DRAIN,RAH040	1	100390410
	32	PLUG,BASE,RAH040	1	100390412
⚠	33	TRACE,HEAT,BASE PAN,RAH040	1	100390413
	34	PIPE,REFRIGERANT,ASSY,RAH040	1	100390415
	35	HEX,PIPE,RAH040	1	100390416
		PLEASE HAVE PART NUMBER AVAILABLE WHEN ORDERING PARTS		

18 Exploded View and Replacement Parts

SAFETY	ITEM NO.	DESCRIPTION	QTY.	PART NO.
		OUTDOOR CONTROL BOARD		
	1	HOUSING,PCB,OUTDOOR,RAH040	1	100390321
⚠	2	BOARD,TERM,UVWA,ASSY,RAH040	1	100390323
⚠	3	BOARD,TERM,123,ASSY,RAH040	1	100390324
⚠	4	BOARD,CAPICITOR,RAH040	1	100390325
⚠	5	BOARD,FILTER,NOISE,RAH040	1	100390326
⚠	6	PCB,OUTDOOR,RAH040	1	100390328
⚠	7	SWITCH,ELECTRO-MAGNETIC,RAH040	1	100390330
	8	PANEL,PCB,OUTDOOR,RAH040	1	100390331
	9	SPACER,RAH040	10	100390333
⚠	10	HRNS,TERM,12,NOISE,FILTER,RAH040	1	100390334
⚠	11	HRNS,SWITCH,PRESS,HIGH,RAH040	1	100390335
⚠	12	HRNS,RELAY,RAH040	1	100390336
⚠	13	HRNS,GROUND,RAH040	1	100390337
⚠	14	HRNS,NOISE,FILTER,RELAY,RAH040	1	100390338
⚠	15	HRNS,CAPACITOR,MOTOR,RAH040	1	100390339
⚠	16	HRNS,CAPACITOR,NOISE,RAH040	1	100390340
⚠	17	HRNS,TERM,3,COMMUNICATION,RAH040	1	100390341
⚠	18	HRNS,CAPACITOR,FUSE,RAH040	1	100390342
⚠	19	HRNS,TERM,A,RECTIFICATION,RAH040	1	100390343
		PLEASE HAVE PART NUMBER AVAILABLE WHEN ORDERING PARTS		

18 Exploded View and Replacement Parts

SAFETY	ITEM NO.	DESCRIPTION	QTY.	PART NO.
		AIR FLOW		
	1	BASE PAN,MAIN,ASSY,RAH040	1	100390523
	2	INSUL,SOUND,COMP,PNL,RAH040	1	100390524
⚠	3	REACTOR,OUTDOOR,PCB,RAH040	1	100390525
	4	BRACKET,MOTOR,FAN,RAH040	1	100390527
	5	SCREW,BRKT,MOTOR,FAN,RAH040	14	100390528
⚠	6	MOTOR,FAN,UPPER,RAH040	1	100390529
⚠	7	MOTOR,FAN,LOWER,RAH040	1	100390530
	8	SCREW,MOTOR,MOUNT,RAH040	8	100390551
	9	PROPELLER,FAN,ASSY,RAH040	2	100390552
	10	NUT,PROPELLER,FAN,RAH040	2	100390553
	11	WASHER,PROPELLER,FAN,RAH040	1	100390554
	12	BUSHING,PROPELLER,FAN,RAH040	1	100390555
	13	PANEL,FAN,RAH040	1	100390556
	14	GRILLE,FAN,DISCHARGE,RAH040	2	100390557
	15	NET,WIRE,SIDE,RAH040	1	100390558
	16	NET,WIRE,REAR,RAH040	1	100390559
	17	PANEL,TOP,RAH040	1	100390560
	18	PANEL,FRONT,AIR,RAH040	1	100390561
	19	INSUL,SOUND,PNL,FRONT,AIR,RAH040	1	100390562
	20	PANEL,REAR,RAH040	1	100390563
	21	INSUL,SOUND,PNL,REAR,RAH040	1	100390564
	22	HANDLE,PANEL,RAH040	2	100390567
		PLEASE HAVE PART NUMBER AVAILABLE WHEN ORDERING PARTS		

NOTES

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Lochinvar®
HIGH EFFICIENCY BOILERS & WATER HEATERS

Revision Notes: *(PCP #3000070431 / CN #500055911) initial release.*

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