DENSO

Service Manual

MOVINCOOL®

THE PORTABLE SPOT COOLING SOLUTION

CM12 (Ceiling-Mounted Spot Cooling Solution)

DENSO SALES CALIFORNIA

00G00004EA

FOREWORD

This manual has been published to service the MovinCool CM12. Please use this service manual only when servicing the CM12.

DEFINITION OF TERMS

! WARNING: Describes precautions that should be observed in order to prevent injury to the user during installation or unit operation.

! CAUTION: Describes precautions that should be observed in order to prevent damage to the unit or its components, which may occur during installation or unit operation if sufficient care is not taken.

NOTE: Provides additional information that facilitates installation or unit operation.

GENERAL PRECAUTIONS

! WARNING:

- **All electrical work if necessary, should only be performed by qualified electrical personnel. Repair to electrical components by non-certified technicians may result in personal injury and / or damage to the unit. All electrical components replaced must be genuine MovinCool, purchased from an authorized dealer.**
- **When handling refrigerant, always wear proper eye protection and do not allow the refrigerant to come in contact with skin.**
- **Do not expose refrigerant to an open flame.**
- **The proper electrical outlet for MovinCool units must be equipped with a "UL" approved ground-fault breaker to prevent electrical shock from the unit.**
- **When brazing any tubing, always wear eye protection and work only in a well ventilated area.**

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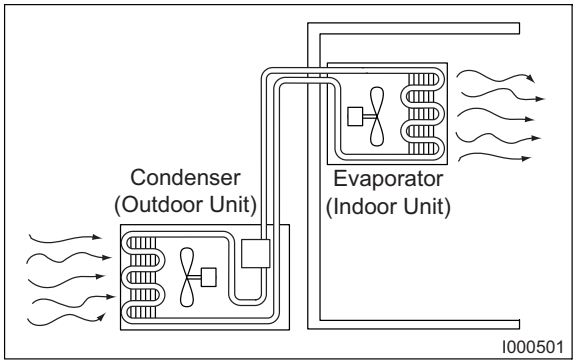
1. GENERAL DESCRIPTION

Generally speaking conventional air conditioners cool the entire enclosed environment. They act as “heat exchangers”, requiring an interior unit (evaporator) to blow cool air into the interior and an exterior unit (condenser) to exhaust exchanged heat to the outdoors. Unlike conventional air conditioners, the MovinCool Spot Cooling System is a spot cooler which directs cool air to particular areas or objects. MovinCool Spot Cooling Systems have the following features:



1-1. Lightweight, Compact, Ceiling Mounted

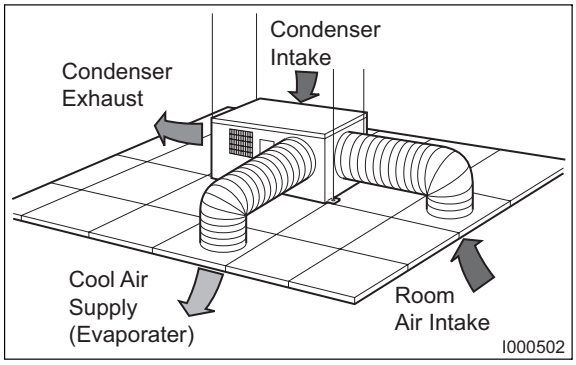
Since the compact, lightweight, CM12 can be easily installed in the ceiling, it allows for effective use of floor space without interfering with room design. In addition, effective cooling is achieved through the use of separate intake and discharge ducts within the room.

1-2. Commercial Controller Usage

The CM12 can use (Millivolt compatible thermostat) commercially available controllers, allowing the user to select the controller best suited to the room design.

1-3. Energy Conservation

MovinCool is economical because it cools only the area or objects which need to be cooled.

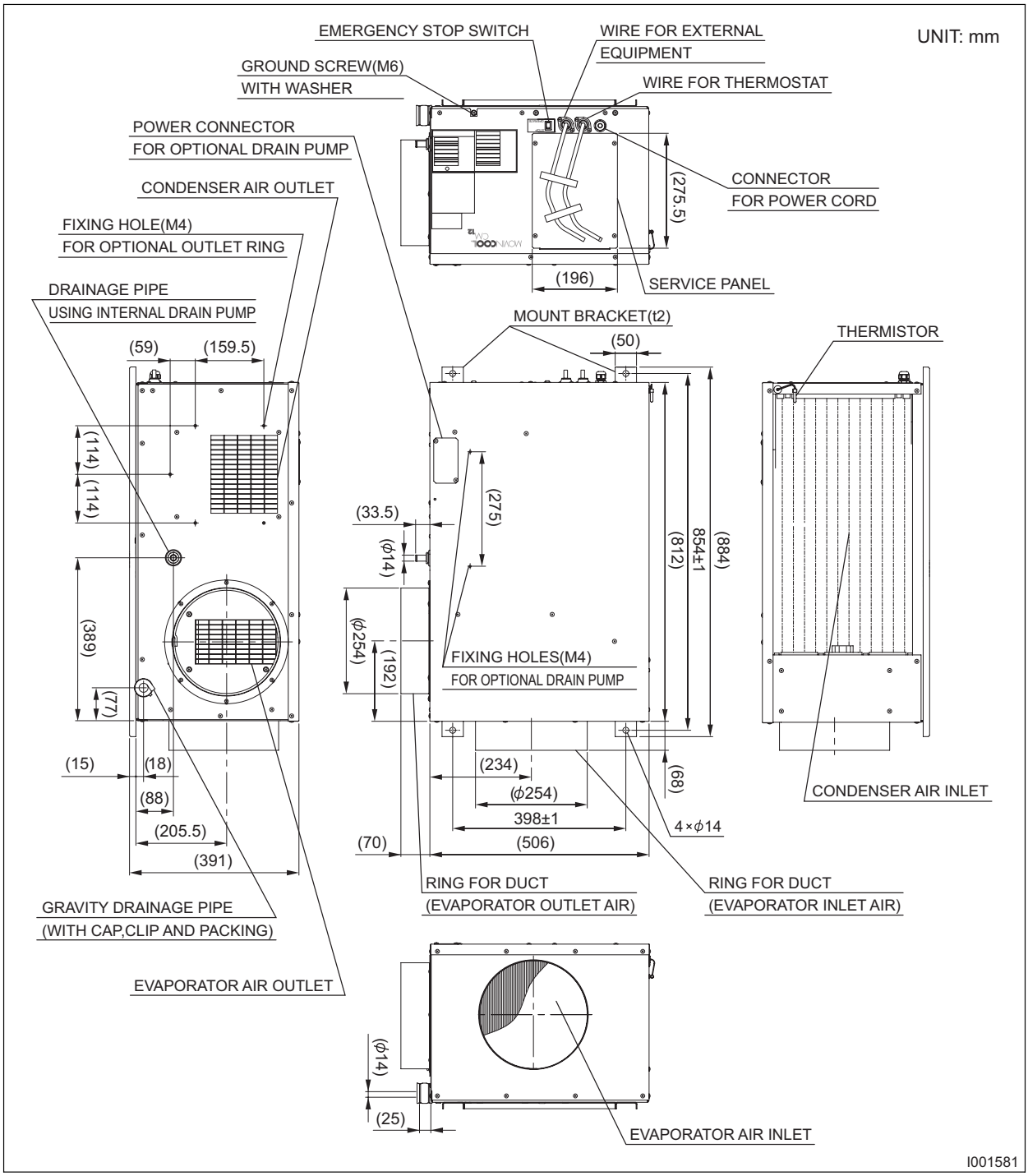


1-4. Added Safety through the Use of a Fire Alarm

The CM12 can be automatically shutdown via signals from a general fire alarm control panel and can also send out signal to monitoring devices such as environmental monitoring systems or announciator systems.

2. SPECIFICATIONS

2-1. Exterior Dimensions

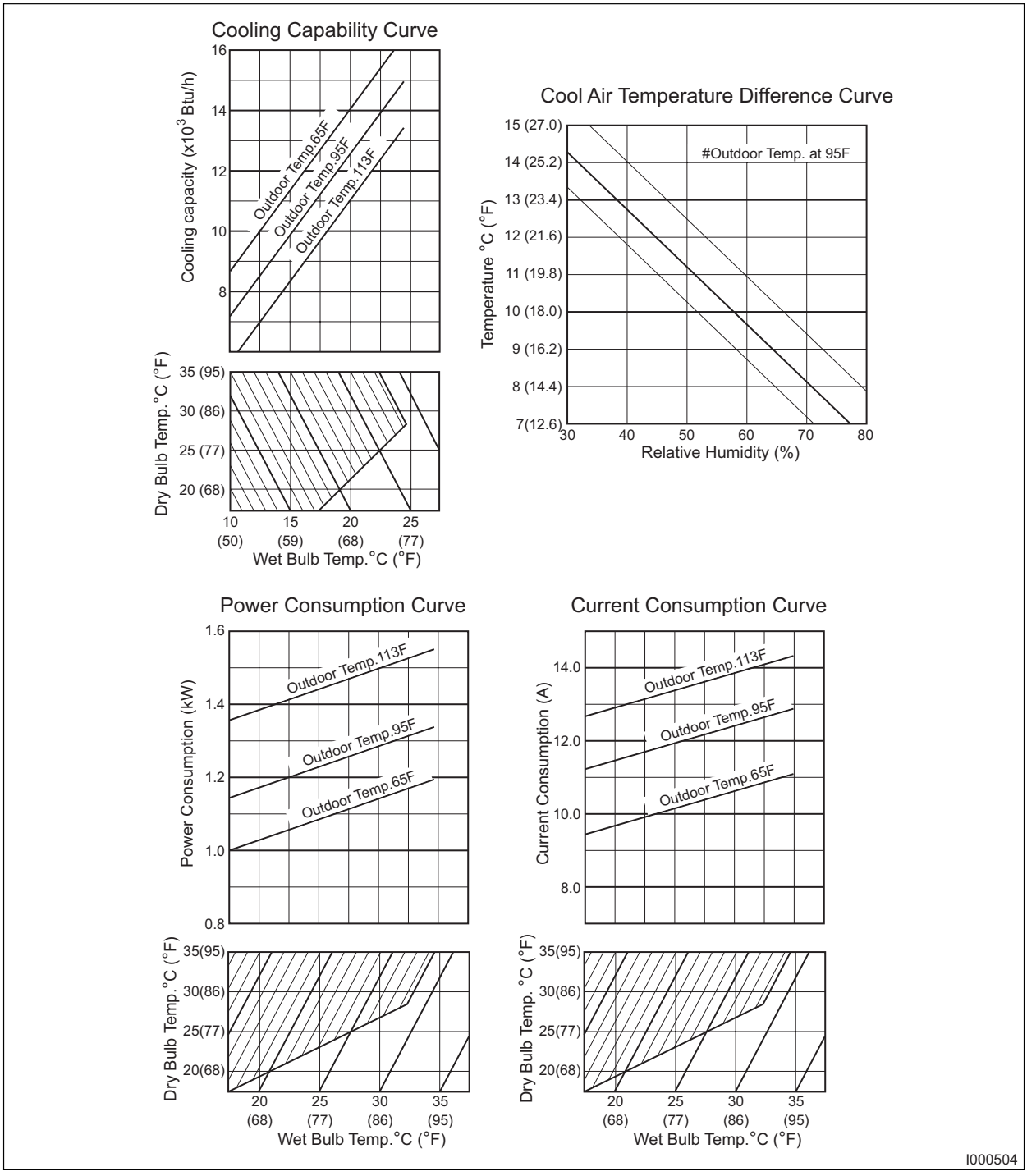


2-2. Technical Specifications

Electronic Features	Control Panel	Wall Thermostat	
	Thermostat Control	Electronic	
Cooling Capacity	80°F 50%RH (Evaporator) 95°F 40%RH (Condenser)	10,500 BTU / h	#1
Electrical Characteristics	Voltage Requirement	1 Phase, 115 V, 60 Hz	
	Total Power Consumption	1.23 kW	#1, #2
	Current Consumption	11.9 Amps	#1, #2
	Recommended Fuse Size	15 Amps	
	Min. - Max. Voltage	105 - 125	
Fans	Motor Output (Evaporator) - High / Low	0.04 / 0.013 kW	
	Motor Output (Condenser) - High / Low	0.1 / 0.025 kW	
Evaporator	Fan Type	Centrifugal	
	Max. Air Flow - High / Low	324 CFM / 228 CFM	#1
	Max. External Static Pressure	0.16 IWG	
Condenser	Fan Type	Centrifugal	
	Max. Air Flow - High / Low	700 CFM / 370 CFM	
	Max. External Static Pressure	0.12 IWG	
Compressor	Type	Hermetic Rotary	
	Output	0.89 kW	
Charging Refrigerant	R-22	1.14 lbs	
Dimensions	W × D × H (without Flange and Mounting Bracket)	32 × 20 × 15 inches	
	W × D × H (without Flange and Mounting Bracket)	35 × 23 × 15.5 inches	
Net Weight / Shipping	Weight	121 / 140 lbs	
Condensate Pump Capacity	Pump Rate	5 gal / hr	
	Head	4 ft.	
Operation Conditions	Min. - Max. (@50% RH)	65 - 95°F (Evaporator) 65 - 113°F (Condenser)	#1, #3
Max. Duct Length	Cold Duct Hose (Evaporator)	20 ft.	#4
	Hot Duct Hose (Condenser)	10 ft.	#4
Max. Sound Level	Under Ceiling Tile with Evaporator Duct	52 dB (A)	

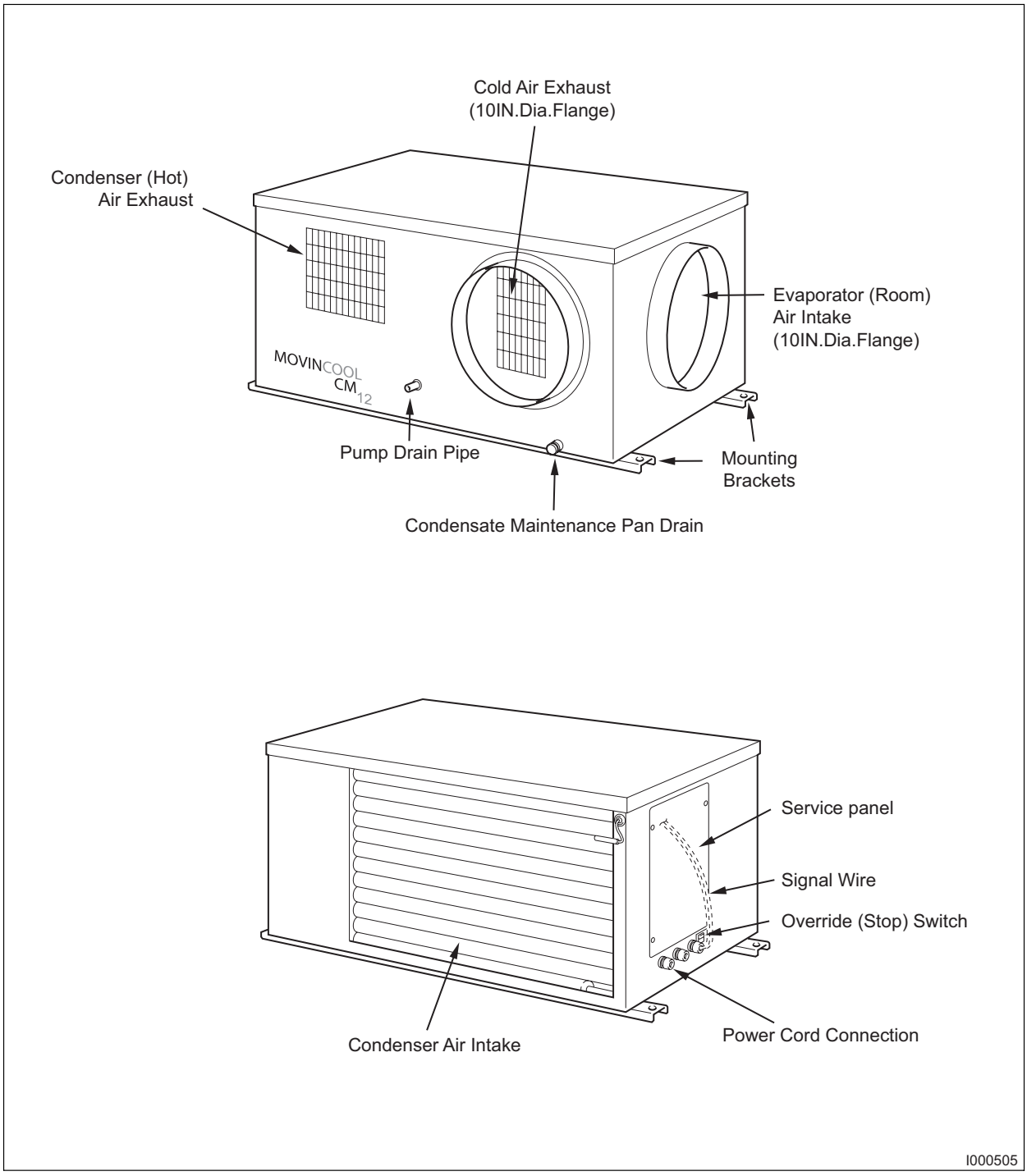
#1 With two 6 ft. ducts with one 90° bend each, supply grill and return grill with filter (0.16 IWG external static pressure).
#2 Ambient condition for rating: Evaporator: 80°F 50% RH / Condenser: 95°F 40% RH
#3 When ambient temperature is lower than 65°F, operation may interrupt due to anti-freeze protection activation.
#4 Confirm pressure drop of duct, grills and filter with manufacturer specifications.

2-3. Performance Curves

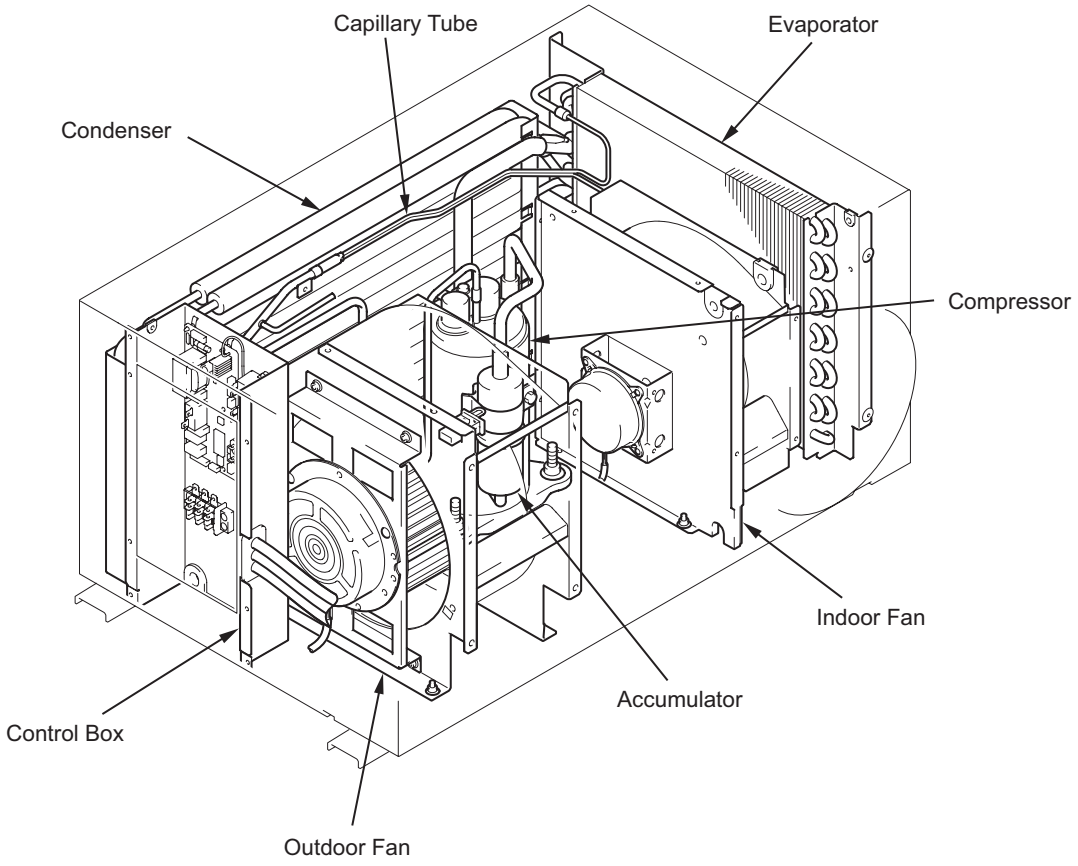


3. CONSTRUCTION

3-1. Unit Overview



3-2. Component Layout



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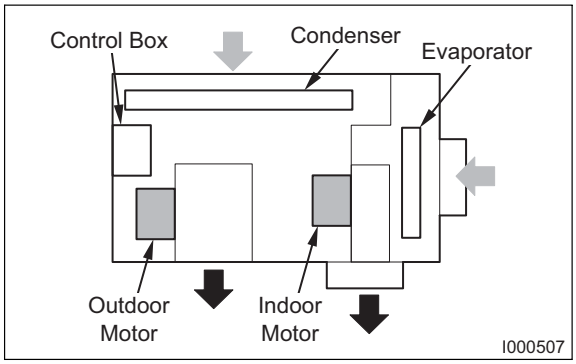
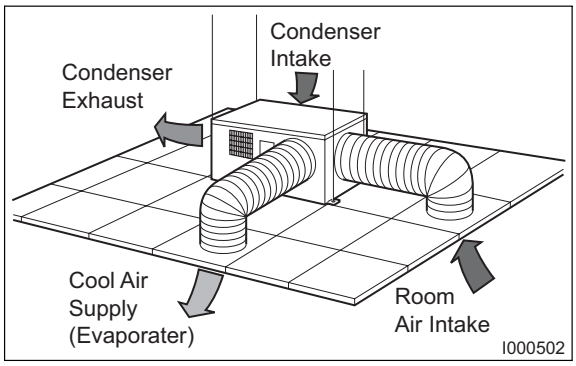
3-3. Basic Construction

The MovinCool Cooling System is compact in construction due to the condenser and evaporator being enclosed in one unit.
The interior of the unit is divided into two sections. One section contains the evaporator which cools room interior air. The other section is comprised of the condenser, compressor and control box.



3-4. Air Flow

Air drawn from the rear face passes over the condenser which extracts heat from the refrigerant. The hot air is blown out through the front exhaust air vent. Air taken in from the right side face is cooled by the evaporator and then blown through the front cool air duct.

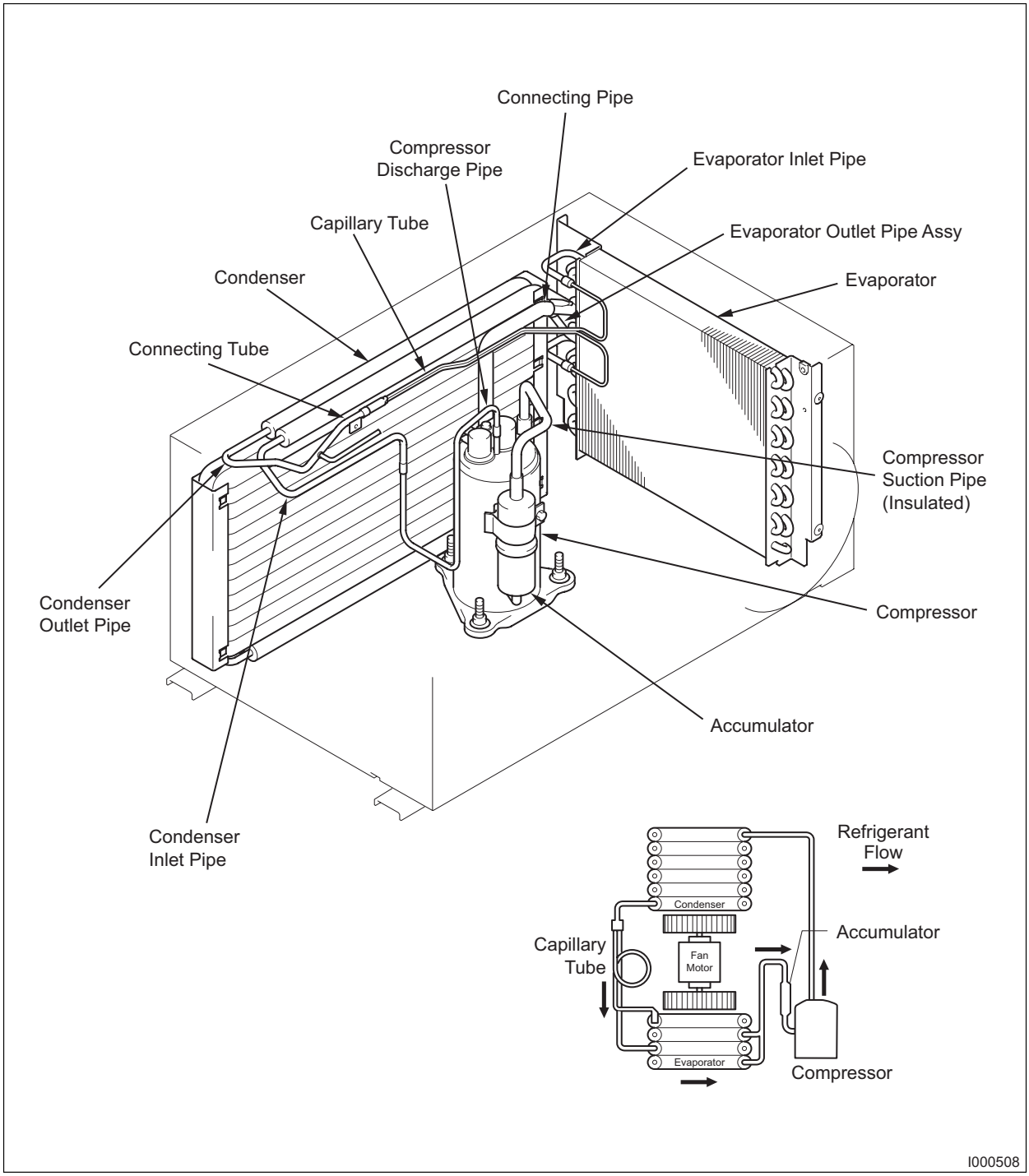


4. REFRIGERANT SYSTEM

4-1. The component parts of the refrigerant system include the following:

- Compressor
- Evaporator
- Condenser
- Accumulator
- Capillary tube

These parts are all connected by copper piping. All the connections have been brazed.

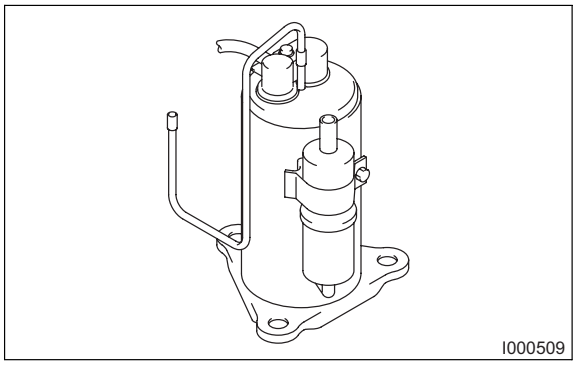


4-2. Compressor

The compressor used for the unit is hermetically sealed. The compressor and the compressor motor are in one casing.

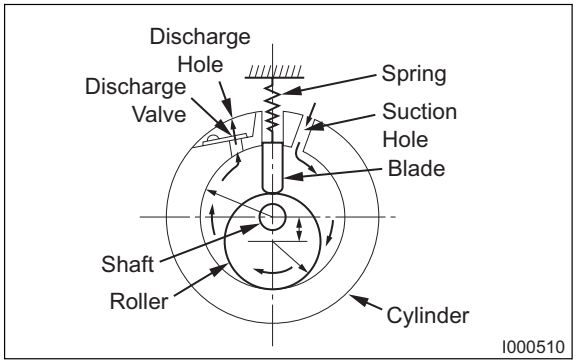
(1) Compressor construction

The construction of a rotary type compressor is divided into two mechanisms. The drive mechanism (compressor motor) and the compression mechanism (compressor). When the rotor shaft of the motor (drive mechanism) turns, the compressor roller (compression mechanism) rotates to compress the refrigerant.



(2) Basic compressor operation

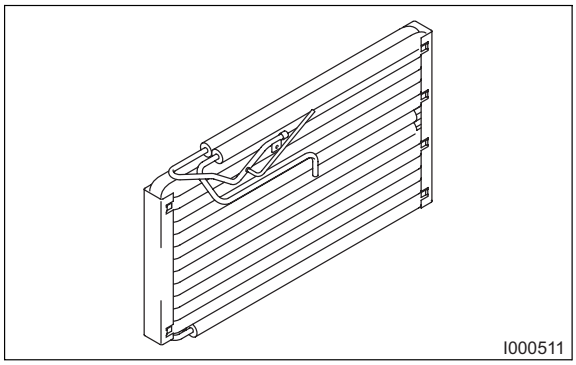
The roller (compression mechanism) is set eccentrically with a certain distance given from the axis of the center of the cylinder. A spring loaded blade is mounted on the cylinder. The roller turns to compress the refrigerant in the space between the cylinder and eccentrically mounted roller. The blade is in contact with the roller by means of spring force. It partitions the space between the suction side and the discharge side to keep compressed refrigerant from returning to the suction side. There is no suction valve. The discharge valve is designed not to open until the pressure of the refrigerant within the cylinder reaches or exceeds that of the refrigerant on the discharge side. It thus prevents the backward flow of discharge gas.



4-3. Condenser

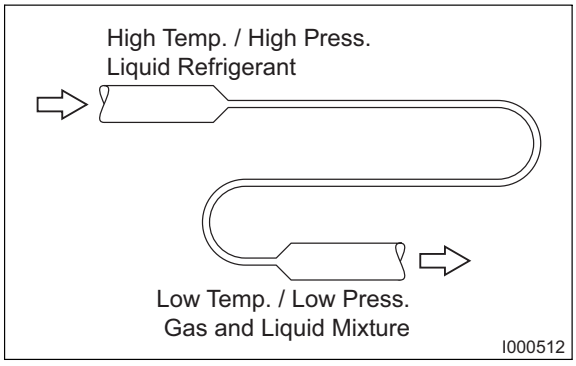
The condenser is a spine-fin type heat exchange device consisting of copper tubes passing through an aluminum fin.

Heat is given off and absorbed by air being pulled across the condenser fins by the centrifugal fan. The hot air is then expelled through the exhaust air duct.



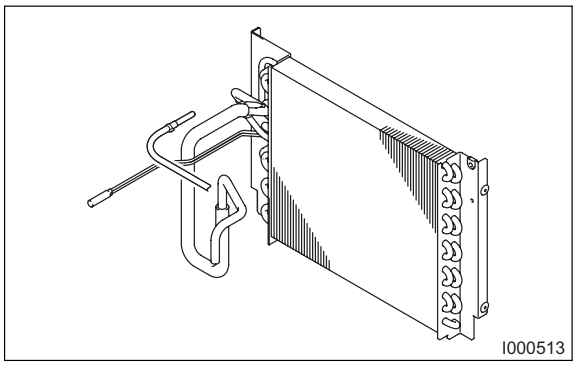
4-4. Capillary Tube

The capillary tube is a long thin tube that uses line flow resistance as an expansion valve. The length and the inner diameter of the capillary tube are determined according to the capacity of the refrigeration system, operating conditions and the amount of refrigerant. The capillary tube causes the high-pressure, high-temperature liquid refrigerant sent from the condenser to expand rapidly as the refrigerant is sprayed out through the fixed orifice in the capillary tube. As a result, the temperature and state of the refrigerant becomes low and mist-like. The refrigerant therefore evaporates easily.



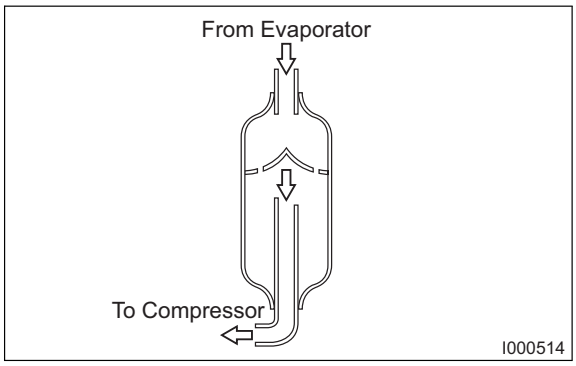
4-5. Evaporator

The evaporator, unlike the condenser, is a plate-fin type heat exchanger. Heat is removed from the air being pulled across the evaporator by the centrifugal fan and the resulting cool air is expelled through the cooling air ducts.



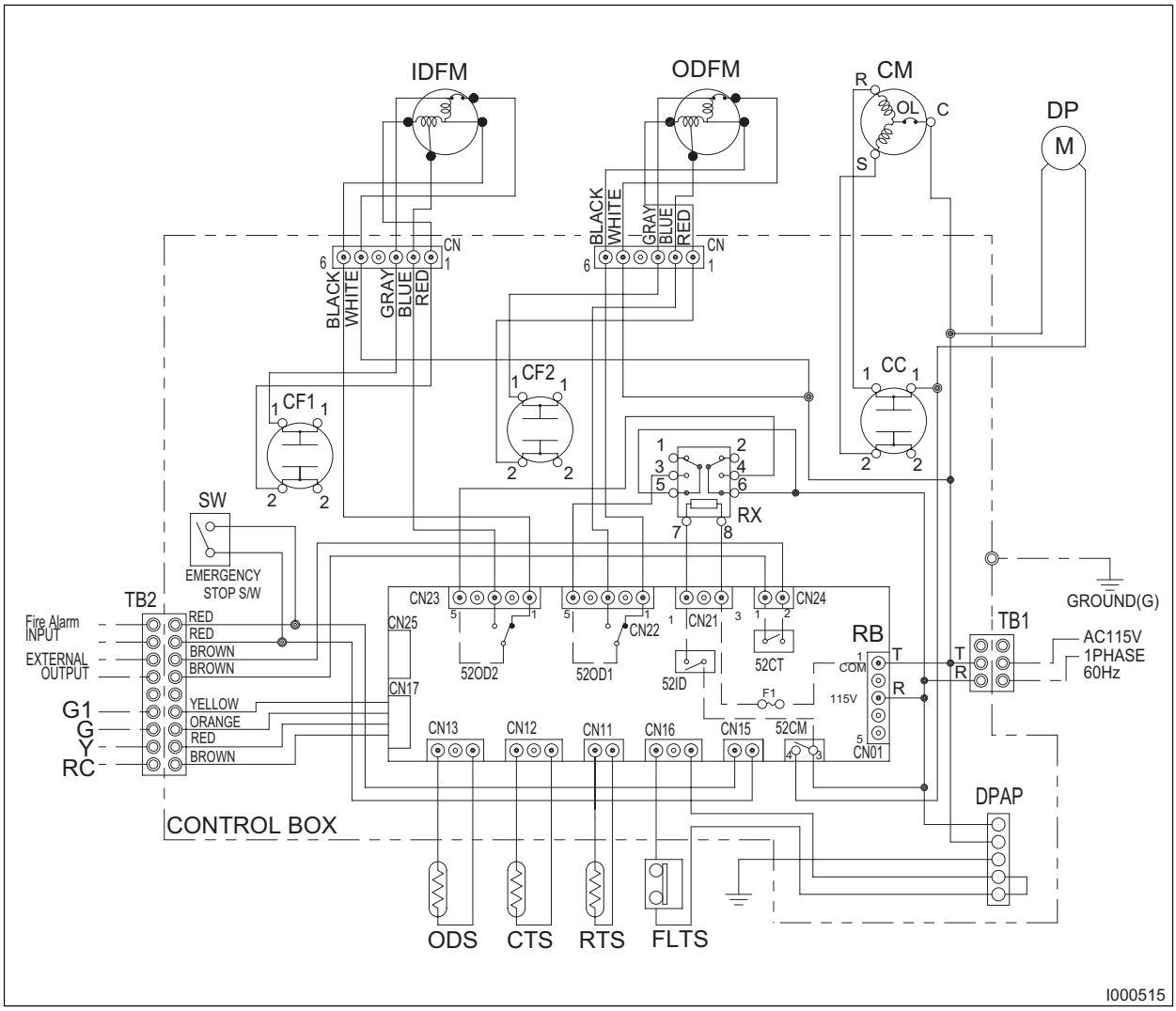
4-6. Accumulator

The accumulator is mounted on the suction gas piping between the evaporator and the compressor. The accumulator separates the liquid refrigerant from the gas refrigerant letting only the gas enter the compressor. In the accumulator, suction gas is led into a cylindrical vessel, decreasing the gas speed. The refrigerant contained in the gas is separated out by the force of gravity, causing it to accumulate at the bottom of the vessel. This protects the compressor from possible damage caused by the intake of liquid refrigerant.



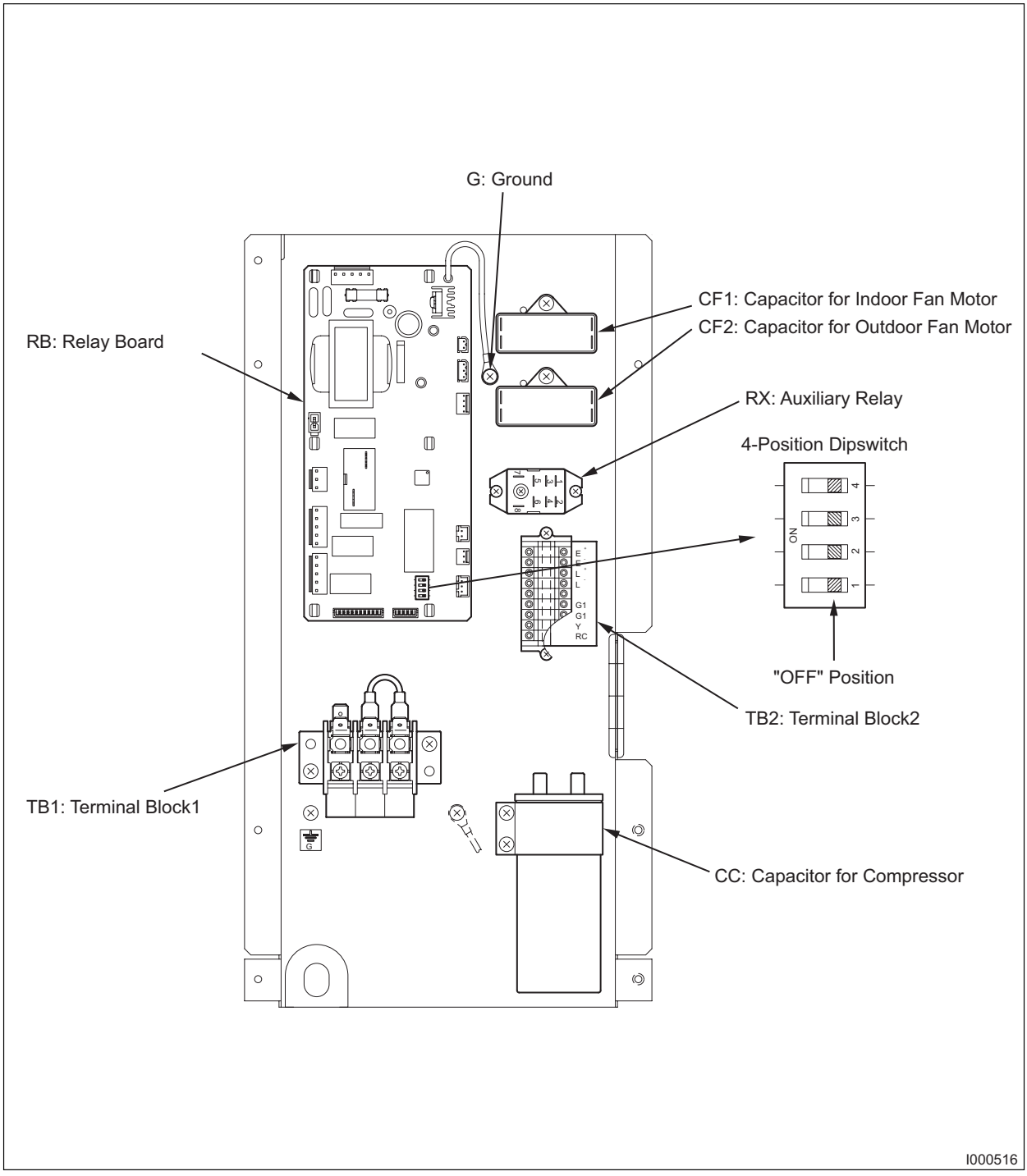
5. ELECTRICAL SYSTEM

5-1. Circuit Diagram



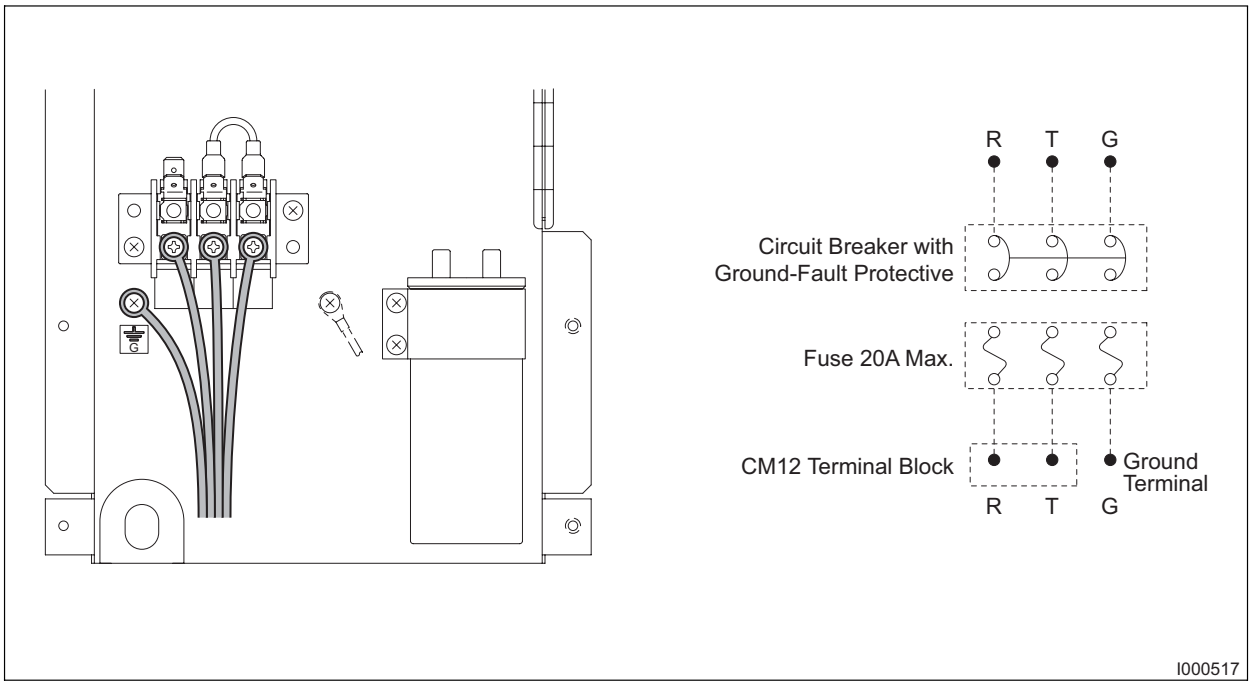
TB1	Terminal Block 1	CF1	IDFM Capacitor
TB2	Terminal Block 2	CF2	ODFM Capacitor
RB	Relay Board	CC	Compressor Capacitor
IDFM	Indoor Fan Motor	OL	Overload Protector
ODFM	Outdoor Fan Motor	DP	Drain Pump
MC	Compressor Motor	SW	Emergency Stop Switch (Override Stop Switch)
RX	Auxiliary Relay	FLTS	Float Switch (Normally Open)
ODS	Outdoor Thermistor	G	Ground
CTS	Freeze Protection Thermistor	DPAP	Drain Pump Attachment Plug
RTS	Room Thermistor		

5-2. Control Box



5-3. Power Supply Requirements

- The CM12 requires a single-phase 115 V, 60 Hz power supply to operate.
- The power supply should be a dedicated single outlet circuit with a UL approved short-circuit and ground fault protective breaker, and a maximum recommended fuse size of 20 A.



5-4. Input Signal

- Install the wall thermostat in a location inside the room where it can be conveniently accessed.
- Most thermostats provide these basic functions:

Fan Mode: On / Auto (Selects the desired fan mode.)

System: Cool / Heater (Selects Cool only.)

- The CM12 receives signals from the wall thermostat to perform the following operations.

Connector	Signal Name	Function
Y	Compressor ON / OFF Signal	When both Y and G signals are ON, the compressor comes ON.
G	Indoor Fan ON / OFF Signal	When the G signal is ON, the indoor fan comes ON. (When the signal is OFF, the indoor fan goes OFF.)
G1	Indoor Fan Hi / Lo Signal	When the G1 signal is ON, the indoor fan speed switches to Lo. (When the signal is OFF, the indoor fan speed switches to Hi.)

5-5. Operation

(1) Basic operation

- When a Y signal is input, the 52CM relay located on the relay board comes ON, and the compressor operates.
- When a G signal is input, both the 52ID relay and the RX (auxiliary relay) come ON, and the indoor and outdoor fans operate. However, when the G signal is OFF, both the 52CM and 52ID relays go OFF, stopping the compressor as well as the fans.

(2) Indoor fan speed control

With a G signal on, the fan will start at high speed. When a G1 signal is input, relay 52ID will become active and fan speed changes from high to low.

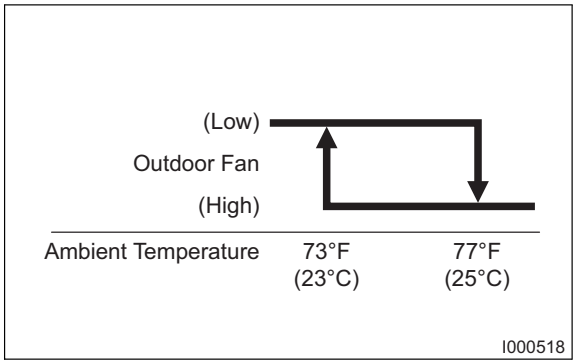
(3) Outdoor fan speed control Air Volume Control

Outdoor fan (condenser fan) air volume is controlled by the ODS (Outdoor Thermistor: ambient temperature).

When room temperature is approx. 77°F (25°C) or greater... Outdoor Fan Speed switches to high

When room temperature is approx. 73°F (23°C) or less... Outdoor Fan Speed switches to low

NOTE: However, when the 52ID relay is ON and the ODS temperature is 73°F (23°C) or less, the outdoor fan will switch to low speed after running in high speed for five seconds.



(4) Anti-frost control

Anti-frost controls turns the 52CM relay ON in accordance with the Freeze Protection Thermistor (CTS) temperature in order to turn the compressor ON and OFF to prevent a decrease in cooling performance resulting from a buildup of frost on the evaporator.

Compressor OFF conditions: Freeze Protection Thermistor (CTS) temperature ≤ 30°F (-1°C)

Compressor ON (recovery) conditions: CTS temperature ≥ 50°F (10°C) and continuous anti-frost control for 15 minutes.

(5) Compressor protection (Compressor time delay control)

Compressor protection consists of a time delay program within the microprocessor which prevents a heavy load from being applied to the compressor motor when restarting the unit (Cool Mode) after a very short period of time. This “delay” is in effect any time when the compressor is turned on by either the “Cool On / Off” button (after the Y signal goes OFF once and then comes back ON), or power interruption restart (automatic recovery.)

Time Delay Program Specifications: 120 sec.

(6) Automatic restart after power interruption (Automatic Recovery Function)

The program within the CM12 microprocessor contains a feature that will automatically restart the unit after power is lost and then regained. The unit also has memory in order to return itself back to the operating mode (either manual or preset program) it was in prior to the loss of power. Any “preset” program will also be retained in the memory in the event power loss occurs.

5-6. Relay Board

The relay board receives signals and outputs from a control board that contains a microprocessor.
The relay board contains the compressor, fan ON and fan mode (speed) relays. It also contains a step-down transformer that converts the line voltage (115 VAC) to 12 volts. This is then converted from AC to DC and used for relay coil activation. The 12 V (DC) power is sent to the control panel assembly where it is further reduced to 5 volts for the system logic. The relay board also contains the dipswitch.

(1) Relay board fuse

The relay board fuse is the only serviceable component on the relay board assembly. This fuse provides protection against damage to the step-down transformer. It must be replaced with the exact type of fuse or its equivalent.

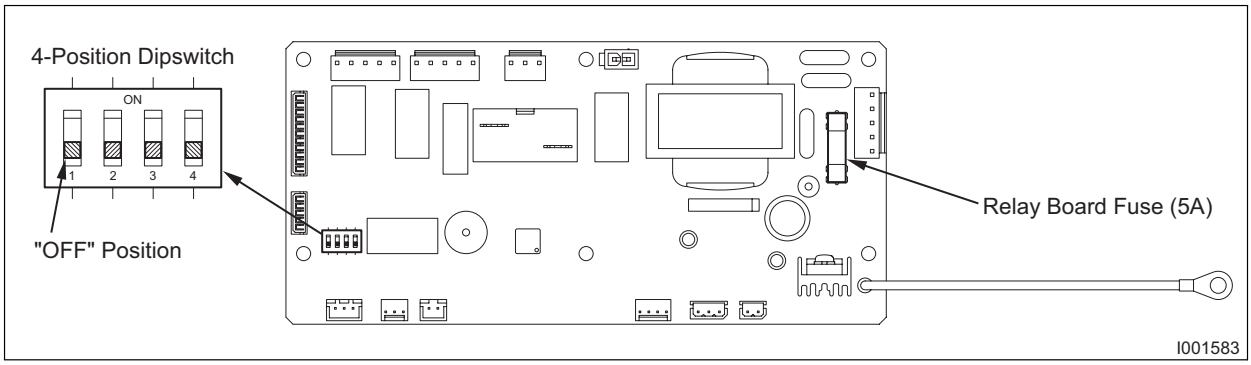
Fuse Specifications: 5 A, 250 VAC

! CAUTION: Failure to use the exact type of fuse could result in damage to the unit and / or its components. It will also void the unit warranty.

(2) Dipswitch

The CM12 controller is equipped with a four position dipswitch, which defaults in the OFF position. The dipswitch can be set to configure the following functions:

Switch	Setting Name	Function
DSW4	Alarm Setting	When DSW 4 is ON, the buzzer sound function is disabled.
DSW3	Compressor Time Delay Cut	When DSW 3 is ON, the compressor delay timer function is disabled.
DSW2	Cooling Test Operation	When DSW 2 is ON, the compressor, evaporator and condenser fan motor will turn ON. This function is used for test purposes and verification.
DSW1	Discharge Air Test Operation	When DSW 1 is ON, the evaporator and condenser fan motor will turn ON. This function is used for test purposes and verification.

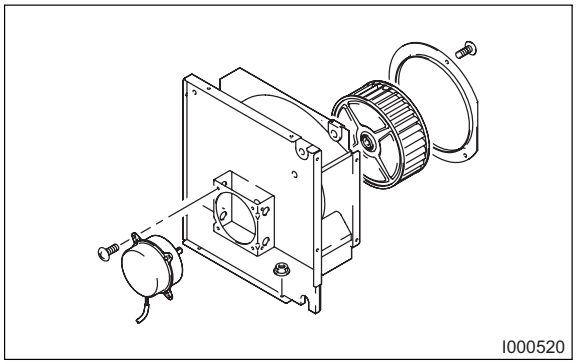


5-7. Evaporator Fan Motor

The evaporator fan motor is a single phase, two-speed induction motor.

Specifications:
Rated Voltage: 115 volts 60 Hz
Rated Output: High - 41.28 watts, Low - 12.08 watts
Rotational Speed: High - 1018 rpm, Low - 671 rpm

NOTE: An internal overload relay is used to protect the fan motor. This relay is built into the fan motor and will interrupt the flow of current when there is an overcurrent situation or if abnormally high temperature builds up in the fan motor.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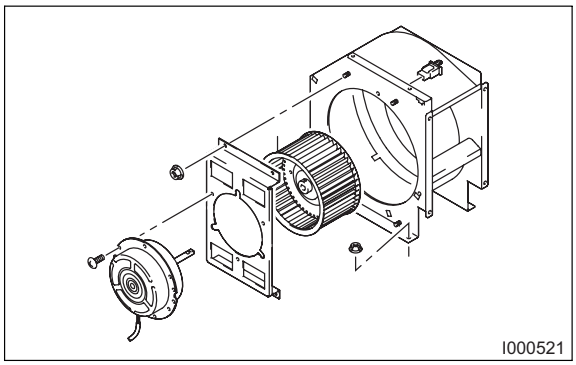
5-8. Condenser Fan Motor

The condenser fan motor is a single phase, two-speed induction motor.

Specifications:
Rated Voltage: 115 volts 60 Hz
Rated Output: High - 99.6 watts, Low - 27.3 watts
Rotational Speed: High - 1100 rpm, Low - 697 rpm

NOTE: An internal overload relay is used to protect the fan motor. This relay is built into the fan motor and will interrupt the flow of current when there is an overcurrent situation or if abnormally high temperature builds up in the fan motor.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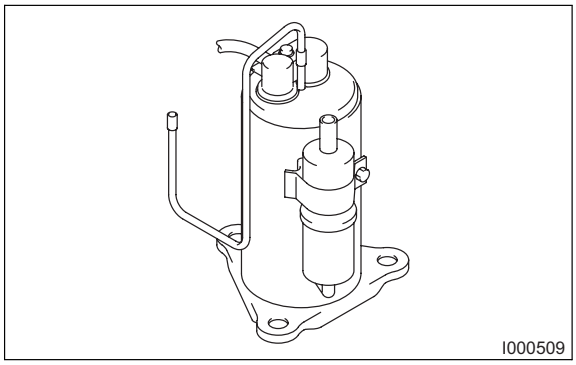
5-9. Compressor

(1) Compressor motor

The compressor motor is a single-phase motor and is contained within the same housing as the compressor.

Specifications:
Rated Voltage: 115 volts
Rated Output: 890 watts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(2) Compressor overload relay

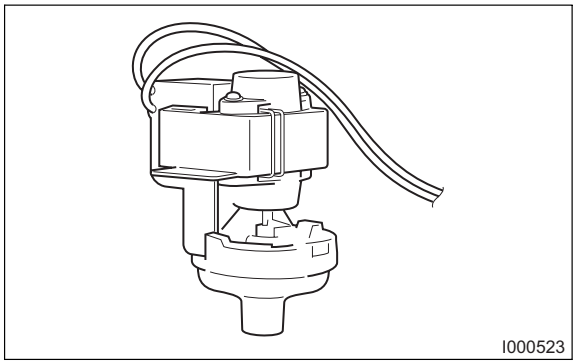
An external compressor overload relay is used to protect the compressor motor. This relay is mounted within the connector housing that attaches to the top of the compressor. The relay interrupts the flow of current when there is an overload condition and high temperature builds up in the compressor.

Specifications:

	Temperature	Overcurrent
Contact Open	302°F / 150°C	17 A 30min (at 212°F / 100°C)
Contact Close	142°F / 61°C	

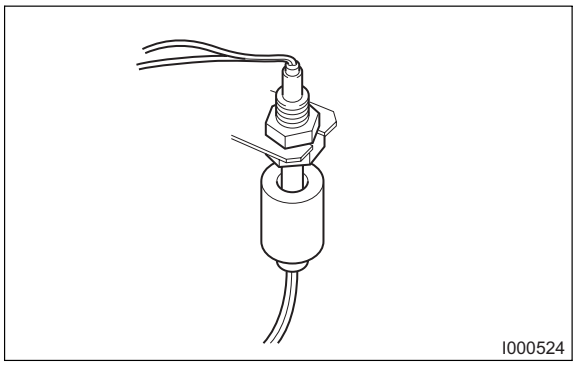
5-10. Drain Pump

The drain pump evacuates evaporator condensation accumulated in the drain pan. Drain pump operation is coupled with compressor operation.



5-11. Over-Flow Switch

An over-flow switch is installed in the drain pan, and it is a normally closed type switch. If evaporator condensation cannot be evacuated and the drain pan becomes full, the float rises, turning the switch OFF, which then halts relay CM12 operation. This prevents the drain pan from overflowing and alerts the user of an abnormality.



6. TROUBLESHOOTING

6-1. Troubleshooting Chart

Symptom	Possible Cause	Remedy
Unit Does not Operate	Power supply is off	Check circuit breaker.
	Power interruption	Unit will turn on automatically when power returns (some thermostats require resetting.)
	Air duct blockage	Check duct for any blockage or excessive kinks.
	OFF signal input	Check for OFF signal input (fire alarm control panel.)
	Override (Stop) switch is active	Ensure the switch is in the “OPERATE” position.
	Battery depleted by the thermostat	Change battery.
Insufficient Cooling / Unit Operation Interrupted Frequently.	Condenser air intake or outlet blockage in the ceiling	Check for any blockages in the ceiling.
	Dirty condenser surface	Clean condenser surface.
	Dirty / blocked filters	Clean / replace air filter.
	Excessive evaporator air ducting	Evaporator ducting should not exceed 30’ and bend radius should be larger than twice the duct diameter.
	Condenser air intake or outlet blockage in the ceiling	Remove the blockage.
	Outside operating range	Use within operating temperature range.
Unit does not operate / Buzzer sound turn on (Observe buzzer sound based on Pattern Indicated on Page 19)	Internal thermistor failure (Sound pattern 1)	Replace internal thermistor.
	Pump or drain problem (sound pattern 2)	Check drain connection. Check for blockage, kink or bend in drain hose.
	Refrigeration system problem (sound pattern 3)	Check for leakage. Check compressor relay. Check for refrigerant blockage.

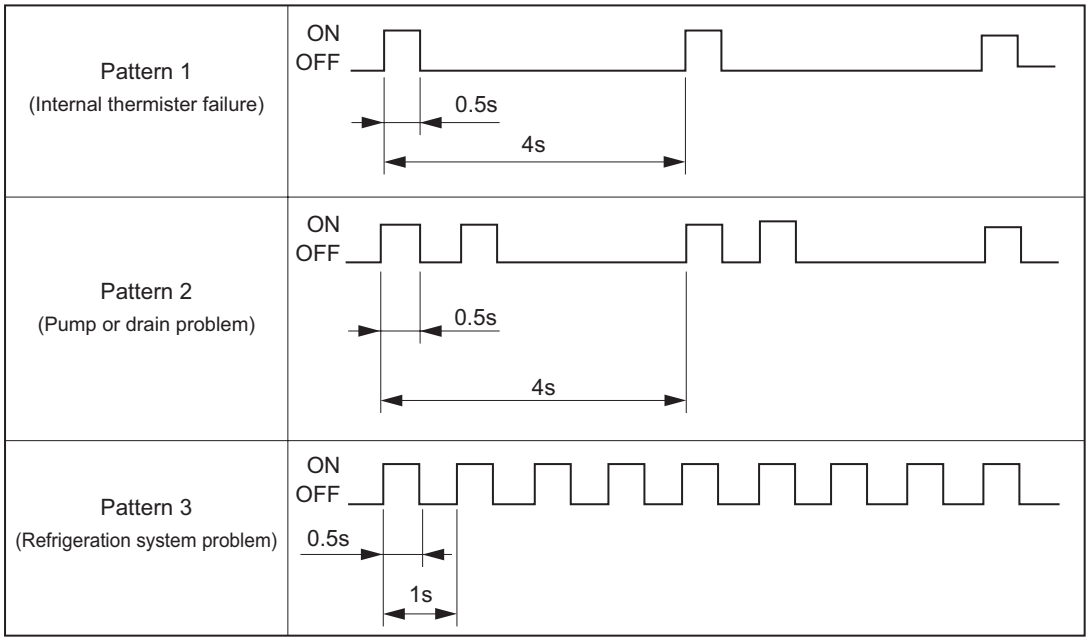
6-2. Alarm

An alarm is emitted when a system abnormality is detected, stopping the system. The type of abnormality can be recognized by the alarm pattern.
The CM12 controller is equipped with a warning signal output-type relay (Form-C, normally open dry contact), which can be used for monitoring the CM12 abnormality conditions. The relay contactor is closed when the following conditions have occurred:

1. Temperature sensor failure
2. Condensation overflow
3. Cooling function failure

The relay output is rated for 5 A at 30 VDC or 5 A at 250 VAC (resistive load). The relay can be used to connect to warning devices with compatible outputs such as alarm speakers, light indicators, etc.

NOTE: However,when dipswitch no. 4 on the relay board is OFF, an alarm will not sound.



Alarm Pattern	Cause	Detection Details	Alarm Clear Method
1	Temperature Sensor Failure (Thermistor Short / Failure)	When an abnormality is detected in either RTS, CTS, or ODS. Detection value: Below 136.5 kΩ (-34°C, 93.2°F) or above 566 kΩ (83°C, 181.4°F).	Unplug the unit and plug it back in. OR Reset the power from the breaker.
2	Condensation Overflow (Water Leak Detection)	When the float switch is OFF continuously for 60 seconds.	Unplug the unit and plug it back in. OR Reset the power from the breaker.
3	Cooling Function Failure (Refrigeration Cycle Abnormality)	When the following occurs 3 times. When 20 minutes from the start of operation has elapsed, RTS - CTS < 5°C continuously for one minute.	Unplug the unit and plug it back in. OR Reset the power from the breaker.

6-3. Inspection

Perform the following inspections before disassembly.

(1) Power supply voltage inspection

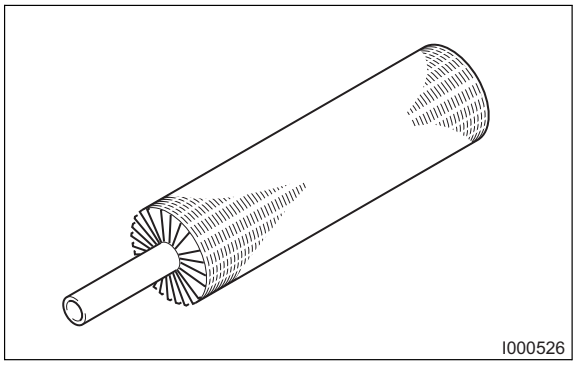
Check the power supply voltage.
Single phase 115 volts (60Hz)
Check the operation and condition of the fuse or circuit breaker for the power supply.

(2) Inspection of air filters

Remove the air filters and check the element. If it is dirty, clean or replace filters .

(3) Inspection of fins

To inspect spine or plate fins of either the evaporator or condenser, inspect the fins for any dirt, dust, lint, or debris that may have caused poor cooling performance. If spine fin cleaning is necessary, it is recommended that this service be performed by a qualified service technician.

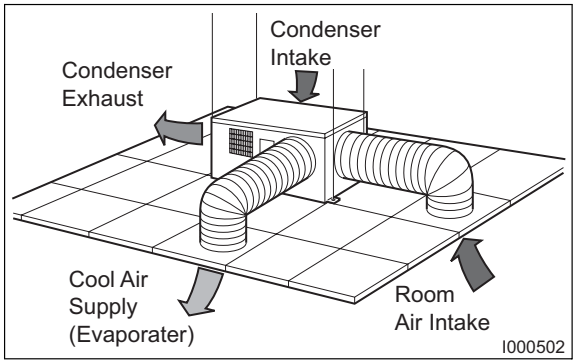


(4) Operating environment examination

Operating environments will vary depending on location, climate and surrounding conditions. Installation location also can cause operational problems. Refer to unit operation range in technical specifications (See section 2-2)

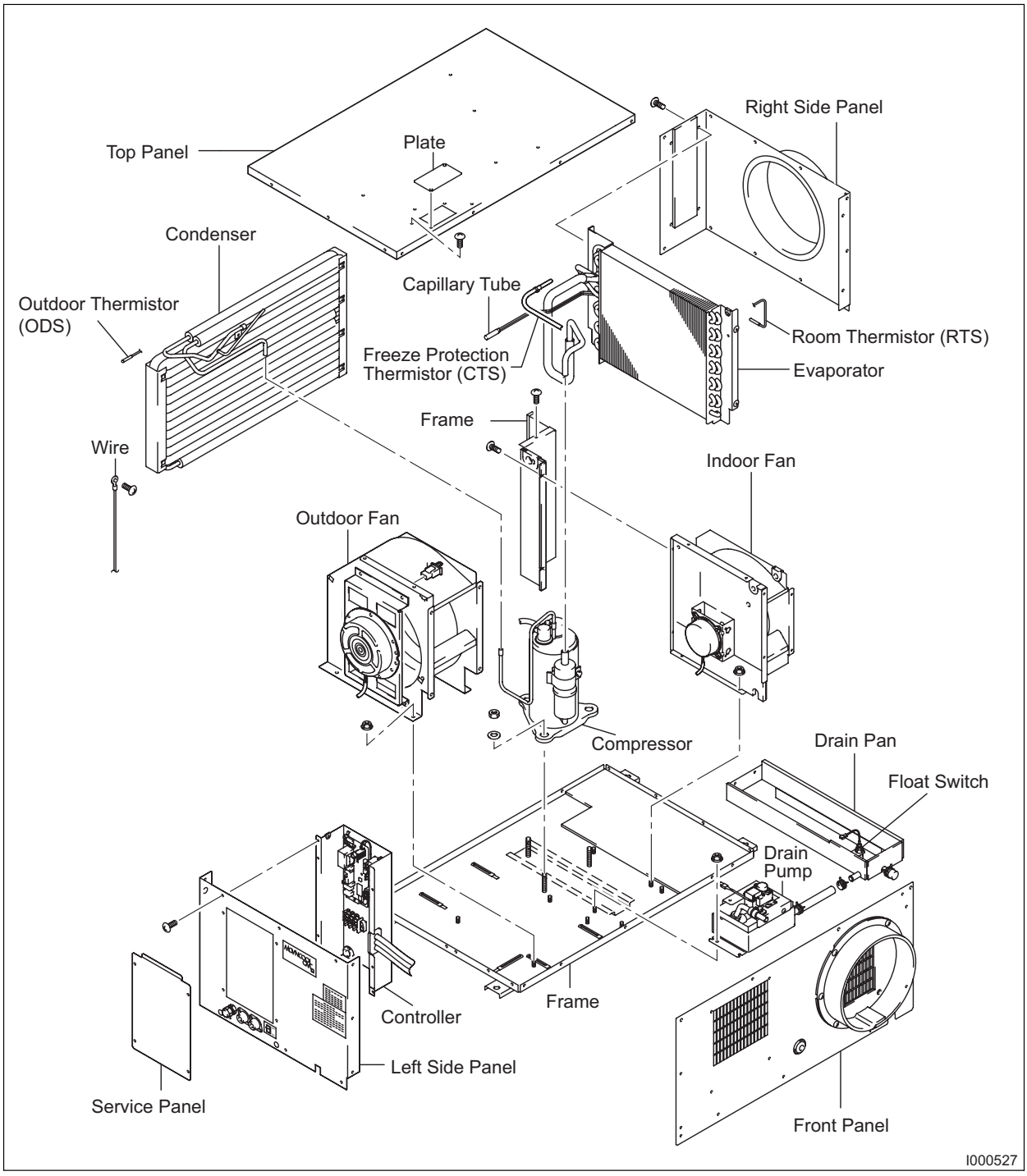
(5) Cooling Capacity Inspection

Measure the difference in temperature between the inlet of the evaporator and the cool air vent. If the difference is out of the range given in the graphs on page 4, proceed with the remedy suggested in the troubleshooting chart on page 18.



7. REPAIR

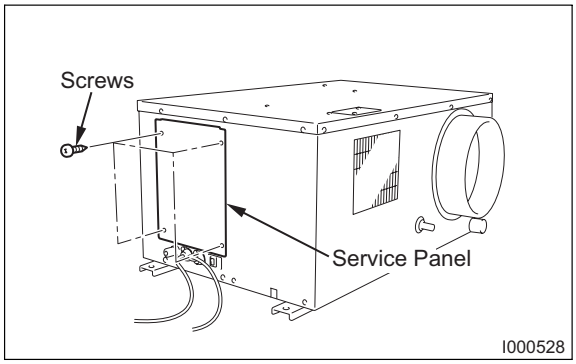
7-1. Unit Construction



7-2. Disassembly of Unit

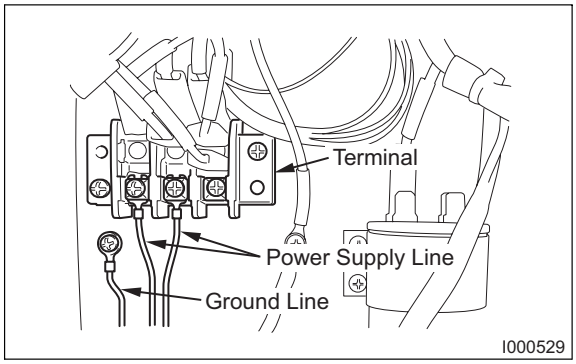
! CAUTION : Make sure to disconnect power at the source prior to disassemble the unit.

1) Remove the four screws, and the service panel.

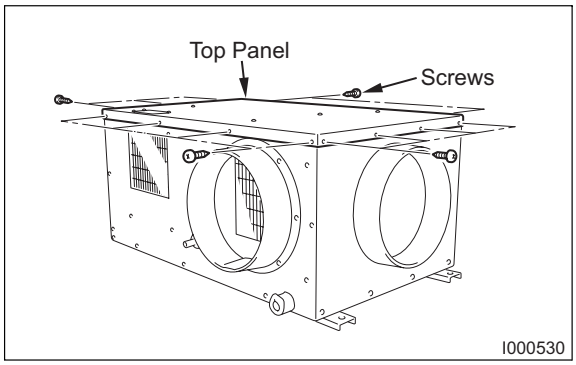


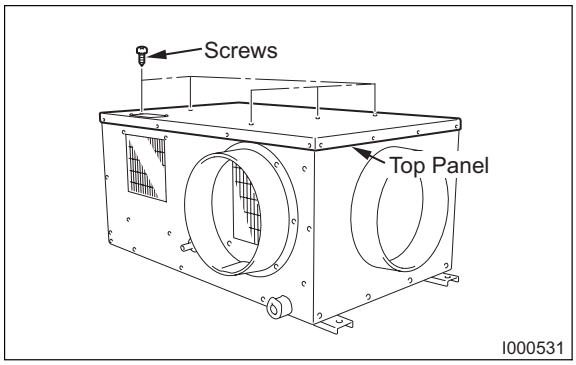
2) Remove the two power supply lines from the terminals, and then disconnect the ground line.

Ground tightening torque:
1.0 N•m (0.8 N•m ~ 1.2 N•m)
0.74 lb•ft (0.6 lb•ft ~ 0.89 lb•ft)

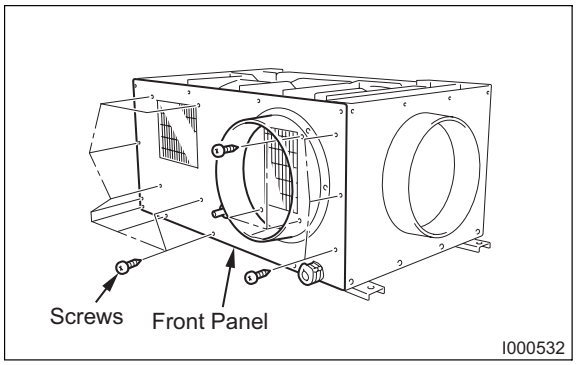


3) Remove the 18 screws, and the top panel.

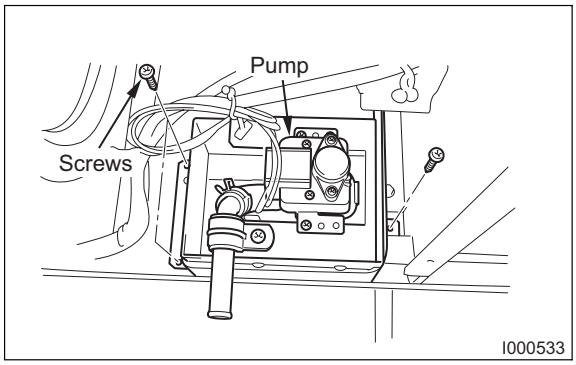


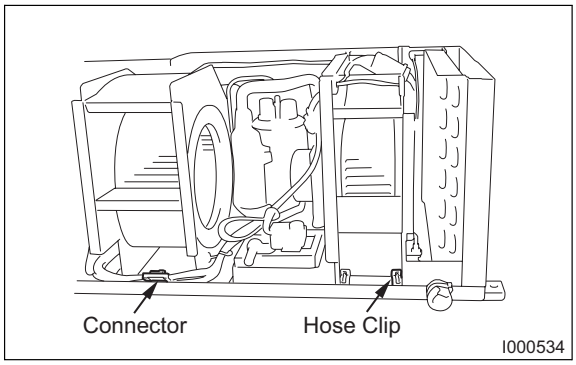


4) Remove the 16 screws, and the front panel.

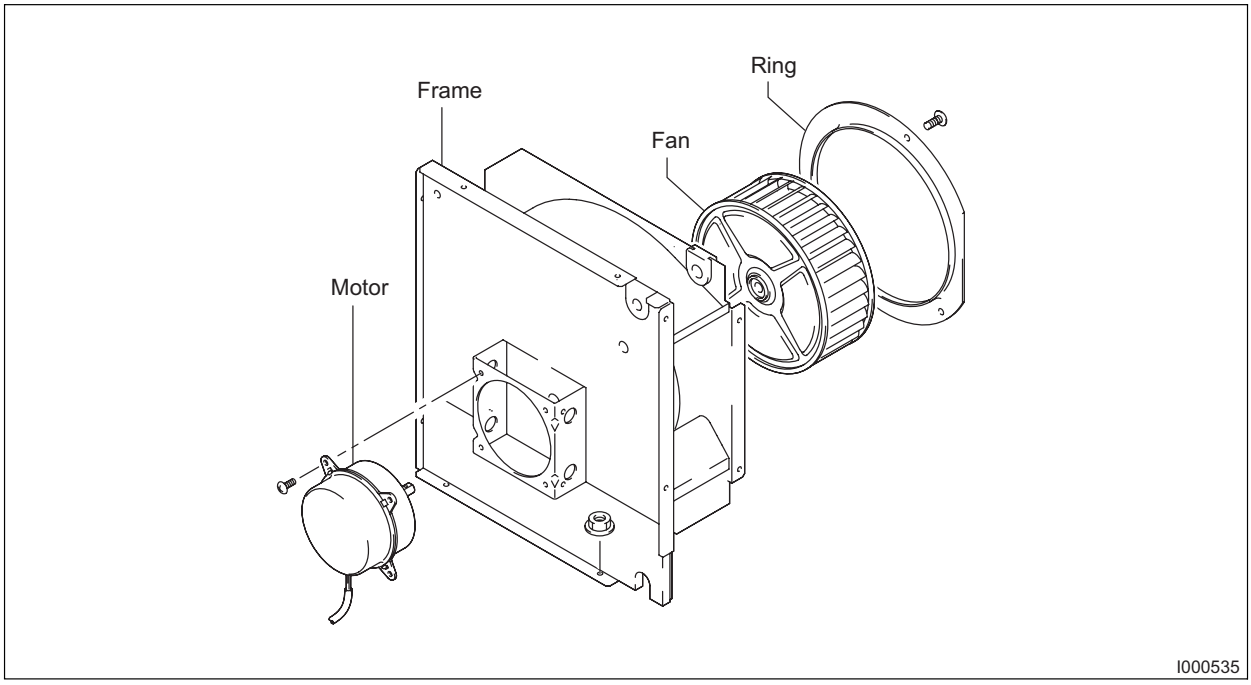


5) After disconnecting the relay connector (white, two-pin), removing the three screws and the hose clip, remove the drain pump.

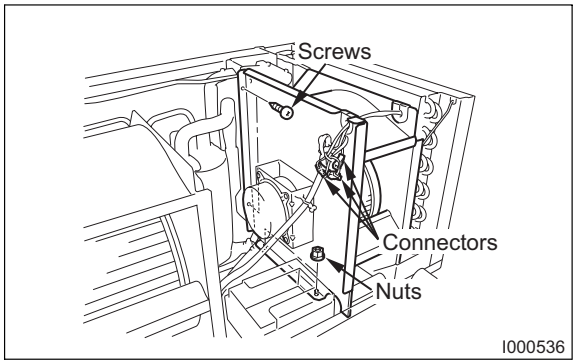




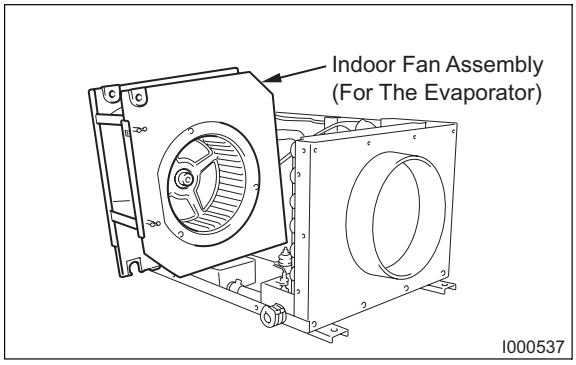
7-3. Removal of Indoor Fan Assembly (for Evaporator)



1) Disconnect the three connectors (two white, two-pin connectors; one white, three-pin connector), and then remove the two screws and the two nuts.

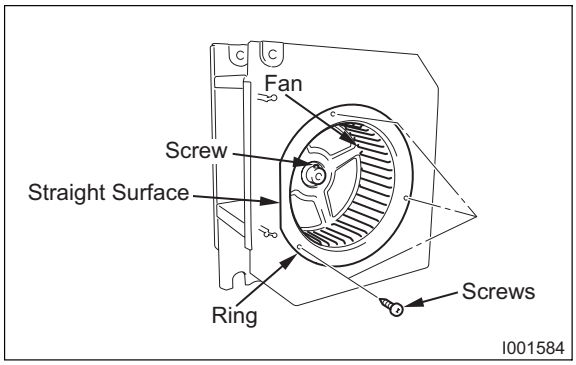


2) Disconnect the motor connector (white, six-pin) from circuit board CN23, and remove the indoor fan assembly (for the evaporator).



3) Remove the three screws and the ring. Loosen the screws with an Allen wrench and remove the fan.

! CAUTION: When assembling the ring, ensure that the straight surface of the ring is facing forward.

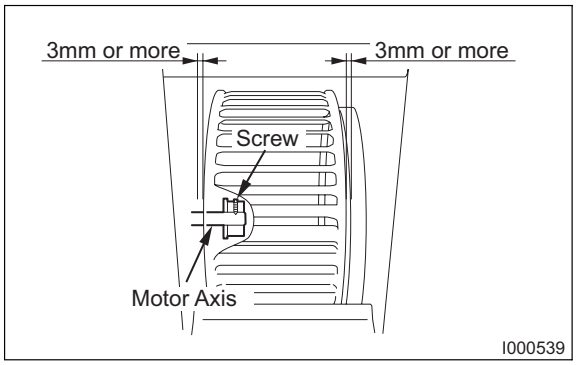


! CAUTION: When assembling the fan, ensure that the screws align with the motor axis positioning holes.

Tightening torque:
5 N•m (3.5 N•m ~ 6.5 N•m)
3.7 lb•ft (2.6 lb•ft ~ 4.8 lb•ft)

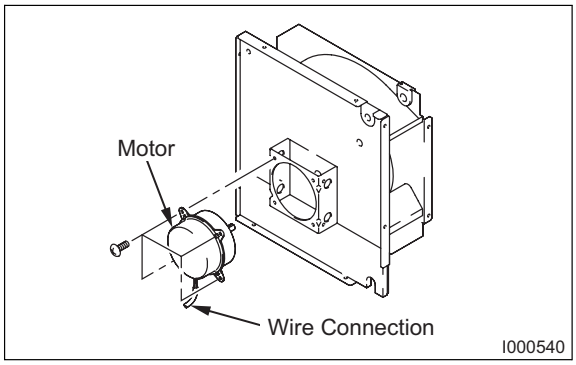
Maintain the clearance between the case ring and fans.

Clearance:
3 mm or more
0.12 inch or more



4) Remove the four screws, and then take away the motor.

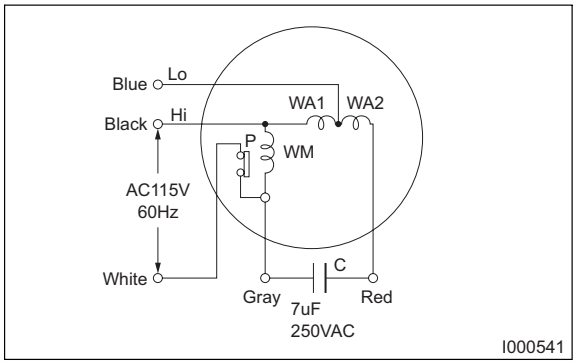
! CAUTION: When assembling the motor, ensure that the wire connection ends are facing down.



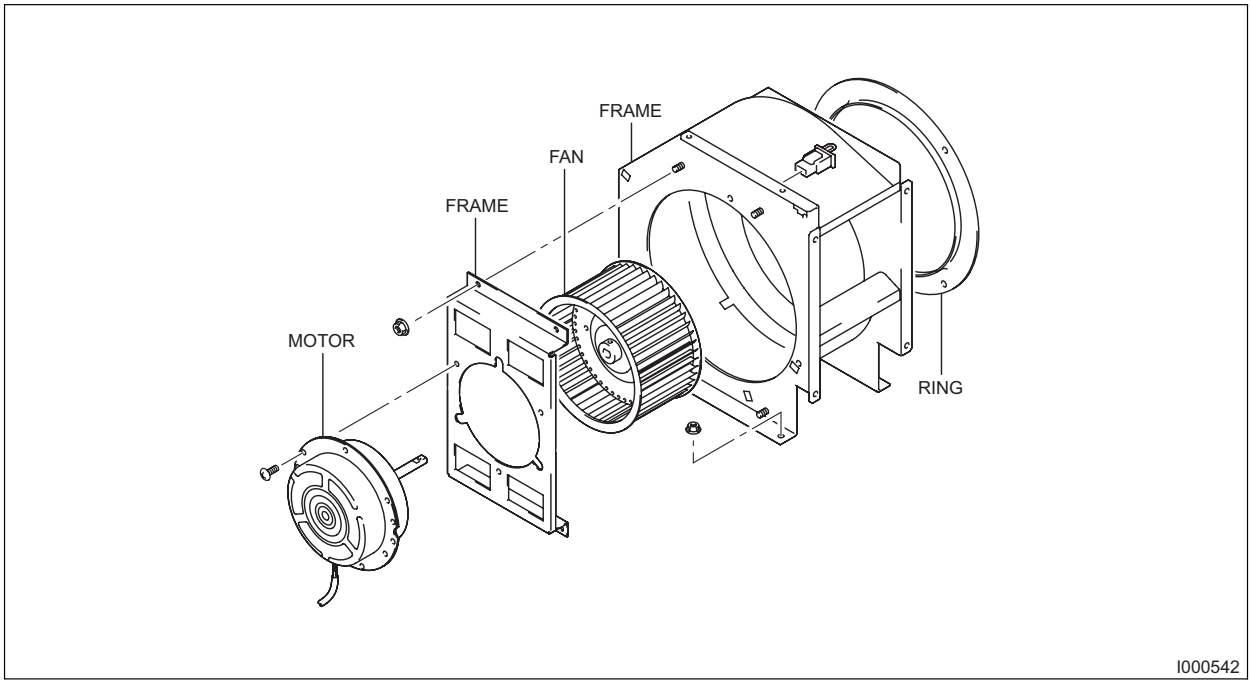
5) Indoor fan motor inspection
Measure the resistance across the terminals of the fan motor.

Terminals (at 68°F (20°C))
Black-White Approx. 35.5 Ω
Black-Blue Approx. 23.35 Ω
Blue-Red Approx. 28.23 Ω

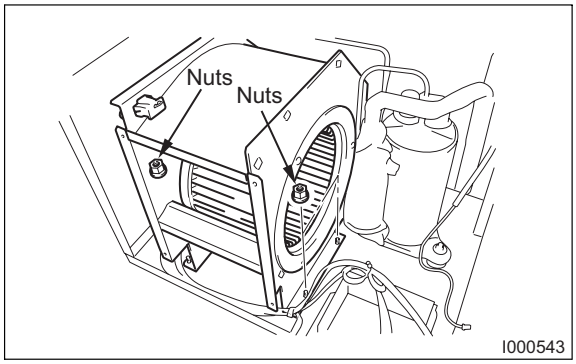
If the measured resistance is not equal to the standard values above, replace the fan motor.



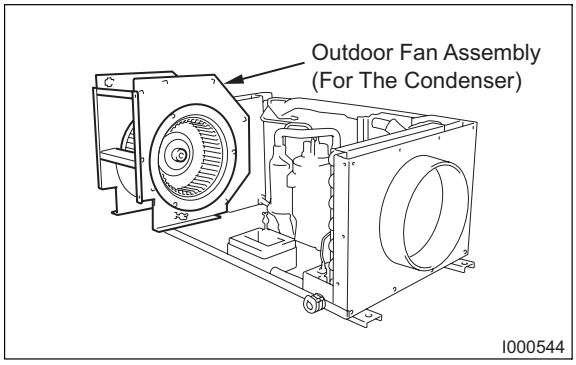
7-4. Removal of Outdoor Fan Assembly (for Condenser)



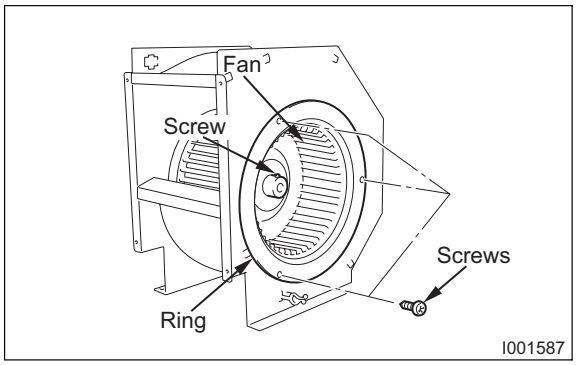
1) Remove the four nuts.



2) Disconnect the motor connector (white, six-pin) from circuit board CN22, and remove the outdoor fan assembly (for the condenser.)



3) Remove the three screws, and the ring. Loosen the screws with an Allen wrench and remove the fan.

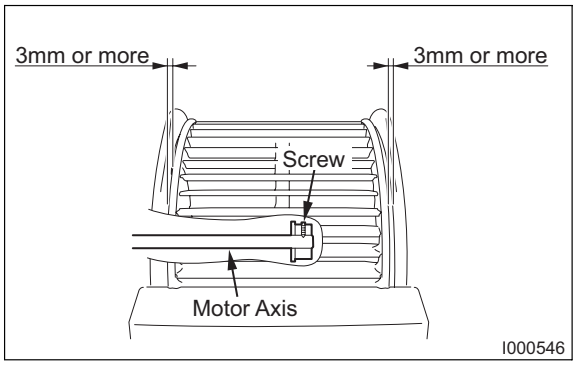


! CAUTION: When assembling the fan, ensure that the screws align with the motor axis positioning holes.

Tightening torque:
14.7 N•m (11.8 N•m ~ 17.7 N•m)
10.8 lb•ft (8.7 lb•ft ~ 13.1 lb•ft)

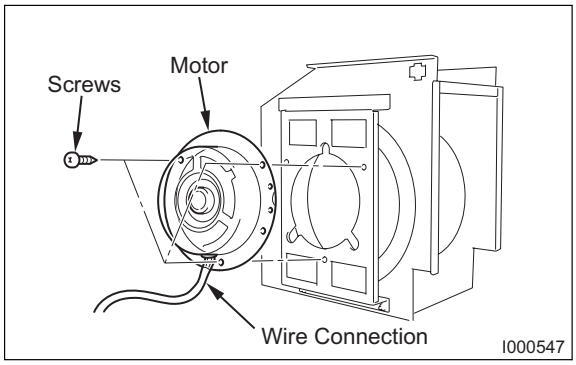
Maintain the clearance between the case ring and fans.

Clearance:
3mm or more
0.12 inch or more



4) Remove the three screws, and the motor.

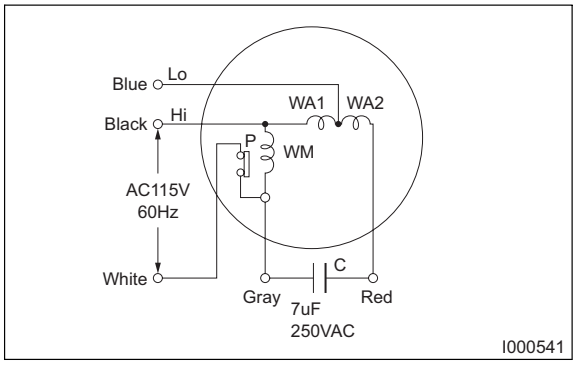
! CAUTION: When assembling the motor, ensure that the wire connection ends are facing down.



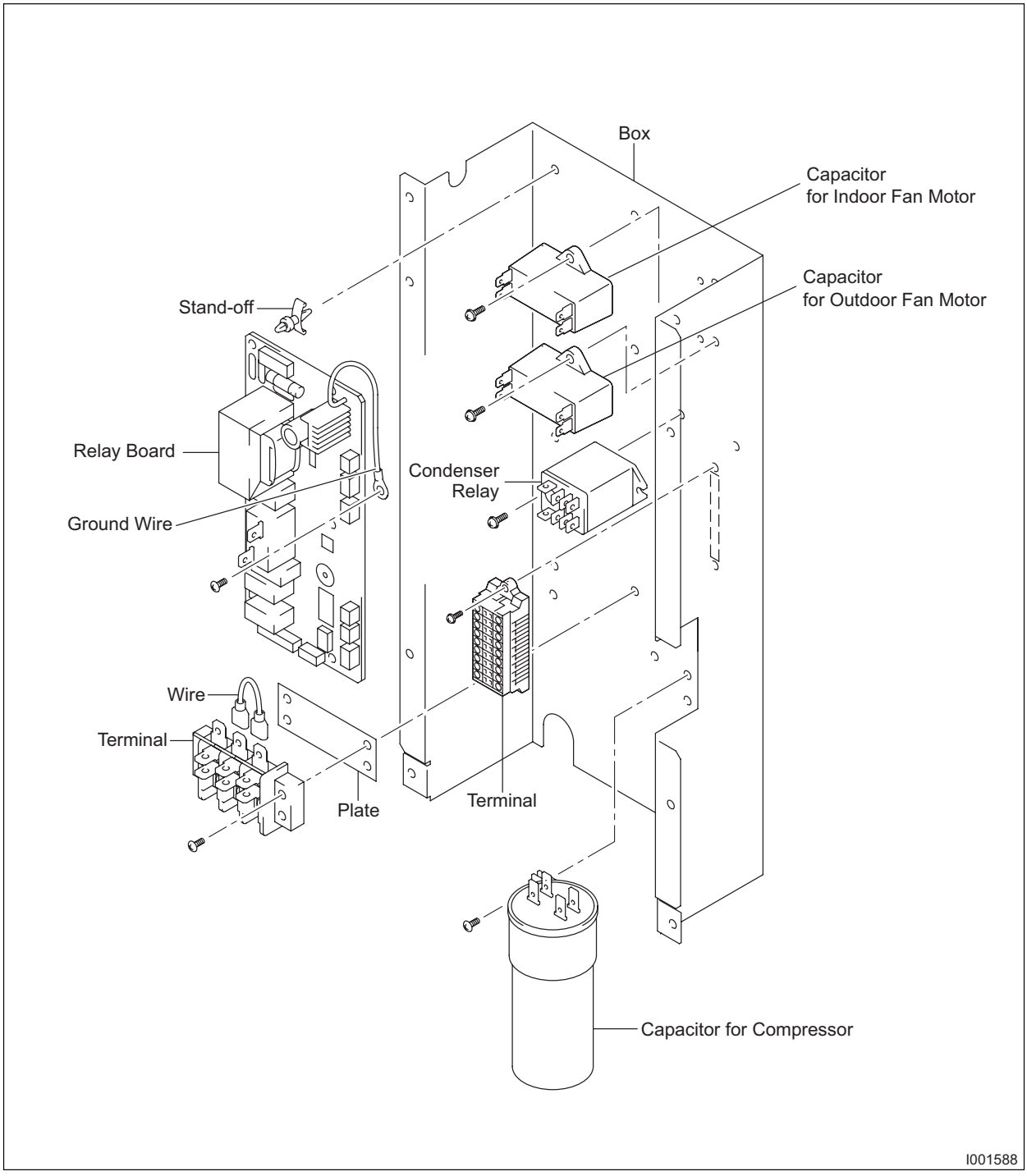
5) Outdoor fan motor inspection
Measure the resistance across the terminals of the fan motor.

Terminals (at 68°F (20°C))
Black-White Approx. 15.38 Ω
Black-Blue Approx. 12.59 Ω
Blue-Red Approx. 13.09 Ω

If the measured resistance is not equal to the standard values above, replace the fan motor.

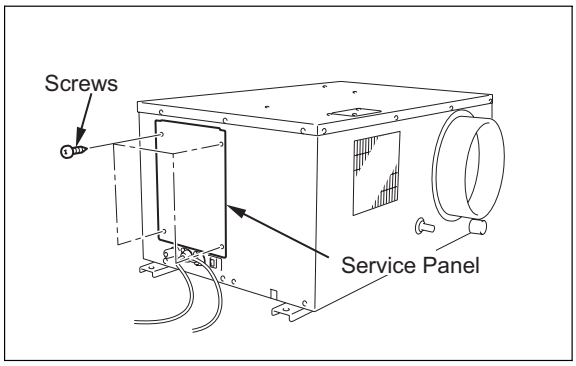


7-5. Electrical Parts and Relay Board Removal

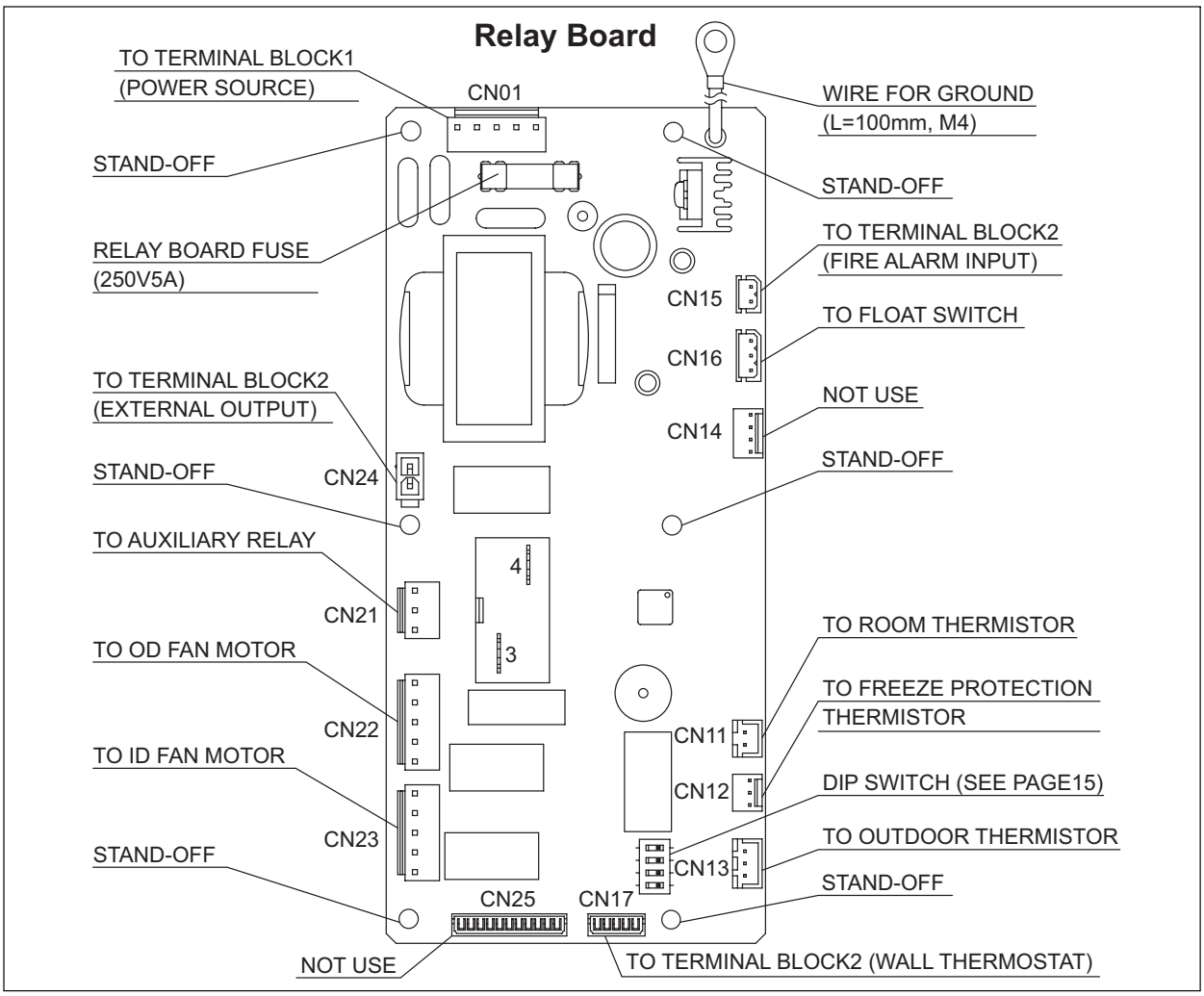


Relay Board Removal

1) Disconnect the power at the source.
2) Remove 4 screws from service panel of CM12 unit.
3) Remove the service panel and locate the relay board.
4) Disconnect all connector from relay board (11 connectors two connections on the relay board and ground wire). Refer to the figure “Relay Baord” to identify the relay connections and the connectors marked as CN##. (To ensure easy reinstallation, be sure to label each connector wire as you remove them)



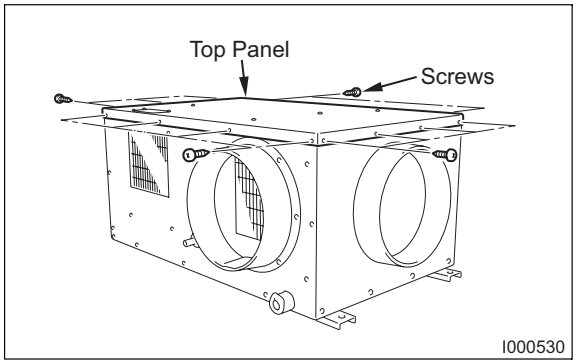
5) Remove relay board from plastic stand-off (6 locations). Use needle nose pliers to squeeze all the stand-offs before removing the relay board.(Note: If stand-off located upper corner can not be removed due to limited space, see page 30 for alternative method to remove relay board from upper corner stand-off)
6) Replace the new relay on existing stand-off (Make sure all stand-offs are aligned horizontally). Change the stand-off if damaged during removal process. Make sure that the dip switches on the new relay board are all set to off positions.
7) Reconnect all 11 connectors to the new relay board and make sure connector label 52CM3 is connected to terminal #3 and connector label 52CM4 is connected to terminal #4 of the relay. Also, connect the ground wire and make sure they are all properly connected. Refer to the figure “ Relay Board ” to identify the connectors that need to be connected.

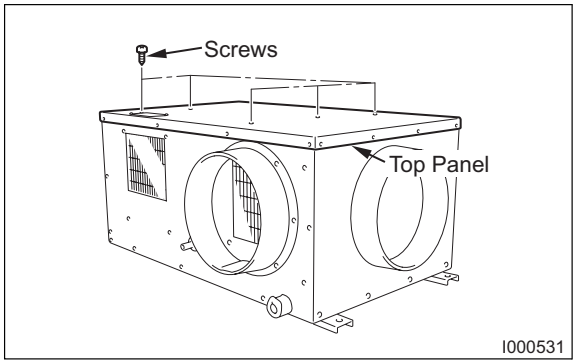


8) Reconnect the power at the source and turn on the unit to verify the function and operation of the unit. Turn off the unit.
9) Close the service panel and secure with 4 screws.

NOTE:
ALTERNATIVE METHOD TO REMOVE RELAY BOARD FROM UPPER CORNER STAND-OFF

1) Remove 18 screws from top cover panel.
2) Use needle nose pliers to squeeze stand-off.
3) Remove relay board from stand-off.
4) Continue to step # 6 of Relay Board Removal.





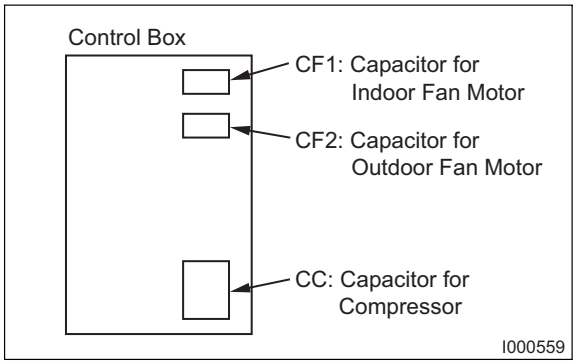
7-6. Capacitor Inspection (for Fan Motor and Compressor)

Ohmmeter Method - Set the ohmmeter to the 100 kilo ohm range. Place the two probes against the two terminals of the capacitor. At first, the ohmmeter should indicate 0 ohms, then the reading should gradually increase towards infinity (∞). This indicates that the capacitor is charging. If the reading indicates infinity right away (open circuit) or the the ohmmeter fails to move from 0 ohms (short circuit), replace the capacitor.

Capacitance Tester Method

Using a capacitance tester, test the capacitor for the value indicated. If the value tested is not within 10% of indicated capacitance, replace the capacitor.

Capacitor	Capacitance	Voltage Rating
CF1	7 μF	250 V
CF2	9 μF	220 V
CC	50 μF	250 V



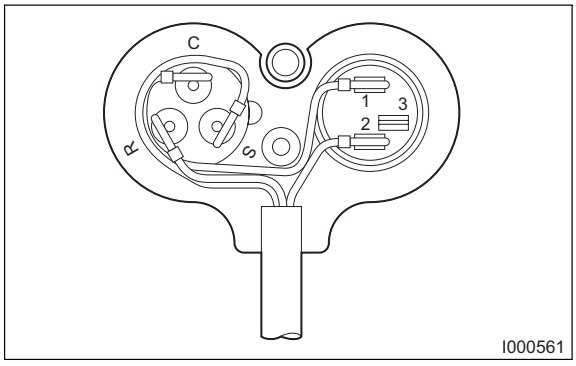
! WARNING: Properly discharge the capacitor(s) before testing, and after testing has been completed. Failure to do so could cause damage to test equipment or the unit and / or result in personal injury (electrical shock) or death.

7-7. Compressor Motor Inspection

Measure the resistance across the terminals of the compressor motor.

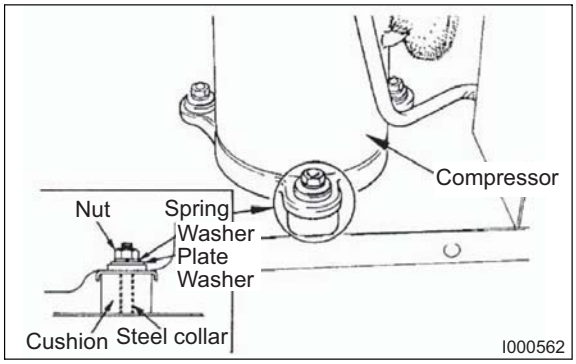
Terminals (at 77°F (25°C))
R-C Approx. 0.49 ~ 0.8 Ω
C-S Approx. 1.9 ~ 3.3 Ω

If the measured resistance is not equal to the standard values above, replace the compressor. The compressor has an external overload relay. The overload relay should be operational if the above resistance is obtained under normal temperature. For overload relay specifications, see chart on page 16



Compressor Mounting
Reassemble the unit in the reverse order of removal. Described below are parts that require special care when reassembling the unit. Perform all wiring or rewiring as referenced in the wiring diagram.

Mount the compressor on the frame using cushions, steel collars, spring washers, plate washers and nuts.



7-8. Inspection of Wiring Connections

Refer to the wiring diagrams on page 11 and check the connection of each wire.

! CAUTION: Secure the wires using clamps so that they do not come into contact with the edges of the structure, etc. Secure the wires using clamps in the same position they were before removal.

7-9. Thermistor Inspection

Using an Ohmmeter, check the resistance value across the two-pin connector. At normal temperature (77°F (25°C) all thermistors (room, freeze, or outdoor) should measure approximately 5 k ohms

7-10. Inspection

In most cases, the probable cause for insufficient cooling is a clogged system, leakage or an incorrect amount of refrigerant. In such cases, inspect the system according to the following procedure.

(1) Clogged system inspection

Check the component parts of the refrigerant system, including piping that could be clogged. If clogged due to refrigerant, only the clogged part is partially frosted. In such cases, change the part in question.

(2) Refrigerant leak inspection

Carefully check all connections, and each component for leaks whenever the refrigerant system is installed or repaired. Use an electronic gas leak tester to inspect the system.

(3) Insufficient refrigerant

In case the unit is judged to be deficient in cooling capacity, be sure to perform the inspections in 7-10. (1) and 7-10. (2) to confirm the cause of trouble. Following this, charge the system with refrigerant.

7-11. Refrigerant System Repair

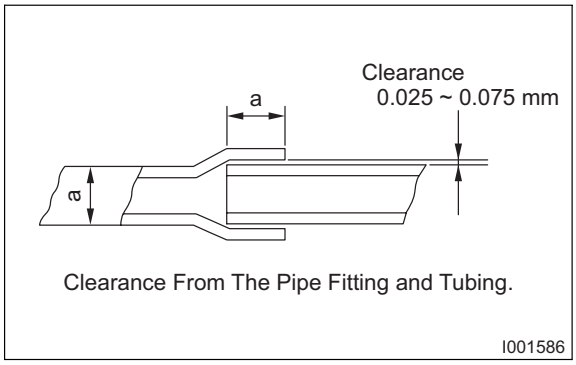
In the event of a leak, obstruction, or trouble in the refrigerant system of the cooling system, replace or repair the part in question. After replacing any component all connections must be brazed.

(1) Proper brazing techniques

It is desirable to use a slightly reduced flame. Oxyacetylene is commonly used since it is easy to judge and adjust the condition of the flame. Unlike gas welding, a secondary flame is used for brazing. It is necessary to preheat the base metal properly according to the shape, size or thermal conductivity of the brazed fitting.
The most important point in flame brazing is to bring the whole brazed fitting to a proper brazing temperature. Care should be taken to not cause overflow of brazing filler metal, oxidization of brazing filler metal, or deterioration due to overheating the flux.

(2) Brazed fittings and fitting clearance

In general, the strength of brazing filler metal is lower than that of the base metal. So, the shape and clearance of brazed fittings are quite important. Concerning the shape of brazed fittings, it is necessary to maximize the adhesive area. The clearance of the brazed fitting must be minimized to facilitate brazing filler metal to flow into it by capillary action.

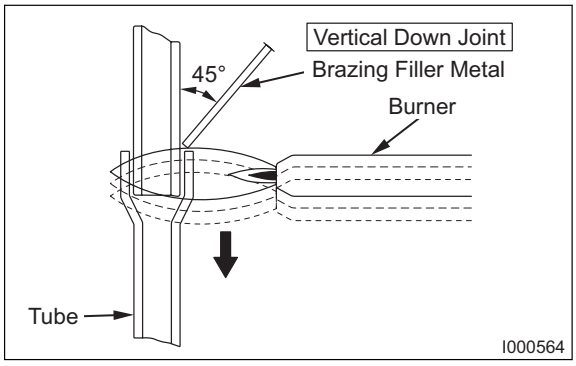


Clearance From The Pipe Fitting and Tubing.

I001586

(3) Cleaning brazing filler metal and pipe

When the refrigerant system has been opened, exposure to heat may cause brazing filler metal to stick to the inside and outside of the pipe. Brazing filler metal may also be combined with oxygen in the air to form an oxide film. Fats and oils may stick to the pipe from handling. All these factors will reduce the effectiveness of brazing. It is necessary to eliminate excess brazing filler metal using sand paper and by cleaning thoroughly with a solvent such as Trichlene.



I000564

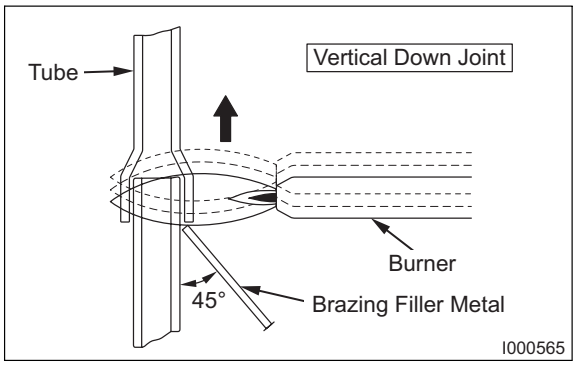
(4) Use of dry nitrogen gas

During brazing, the inside of the pipe undergoes an oxidative reaction due to the brazing flame. Introduce dry nitrogen gas (1 l/min.; adjust with the flow regulator) through the pinch-off tube of the refrigerant cycle to prevent oxidation.

NOTE: Take care not to allow dirt, water, oil, etc. to enter into the pipe

(5) Vertical joint

Heat the whole brazed fitting to the proper brazing temperature. Bring the brazing filler metal into contact with the fitting so that the brazing filler metal starts flowing by itself. Stop heating the fitting as soon as the brazing filler metal has flown into the clearance. Since the brazing filler metal flows easily into heated portions, it is essential to keep the whole fitting at the proper brazing temperature.



I000565

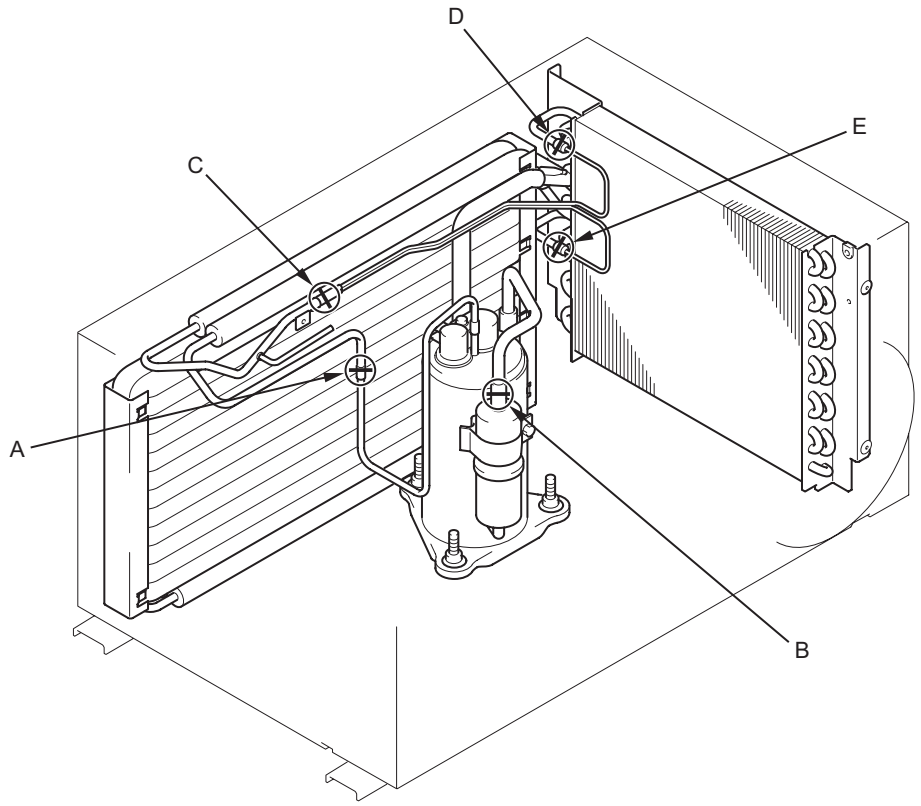
7-12. Removal of Refrigerant Cycle Components

! CAUTION:

- **Before any refrigerant cycle component can be replaced, it is necessary to recover the refrigerant using standard recovery procedures and equipment.**
- **To prevent oxidation, dry nitrogen should be conducted (flow rate 1 l/min) through the pinch-off tube during any brazing operation.**
- **During any component replacement involving brazing, shield nearby parts with a steel plate, asbestos, etc., to protect them from the flame.**

1. Evaporator
2. Capillary tube
3. Condenser
4. Compressor

NOTE: Hold the compressor body, not the tube, when carrying the compressor.



Part to Replace	Disconnect at
Compressor	A&B
Condenser	A&C
Capillary Tube	C&D&E
Evaporator	B&C

I000566

7-13. Charging the System with R-22 Refrigerant

Always ensure that the refrigerant system has been properly evacuated before charging with the specified amount of R-22.

! WARNING: When handling refrigerant (R-22), the following precautions should always be observed:

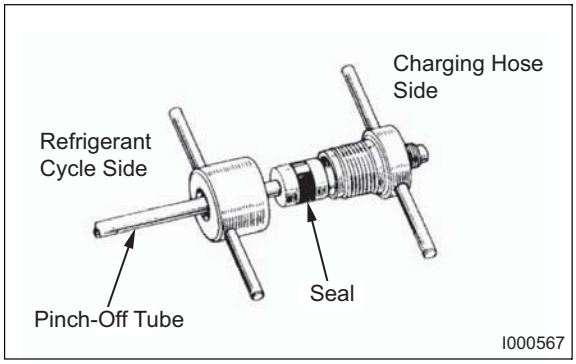
- **Always wear proper eye protection while handling refrigerant.**
- **Maintain the temperature of the refrigerant container below 40°C (104°F).**
- **Perform repairs in a properly ventilated area. (Never in an enclosed environment.)**
- **Do not expose refrigerant to an open flame.**
- **Never smoke while performing repairs, especially when handling refrigerant.**
- **Be careful the liquid refrigerant does not come in contact with skin.**

! WARNING: If liquid refrigerant contacts eye or skin:

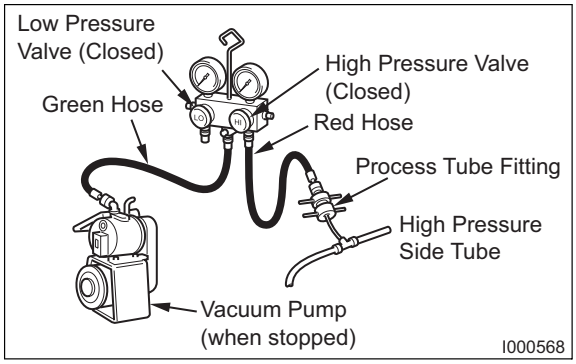
- **Do not rub eyes or skin.**
- **Splash large quantities of cool water on the affected areas.**
- **Apply clean petroleum jelly to skin.**
- **Seek a physician or go to a hospital for professional treatment.**

(1) Gauge manifold connection

1) Properly remove the crushed end of the pinch-off tube at the high-pressure side of the refrigerant cycle with a pipe cutter.
2) Fit the process tube fitting to the pinch-off tube.

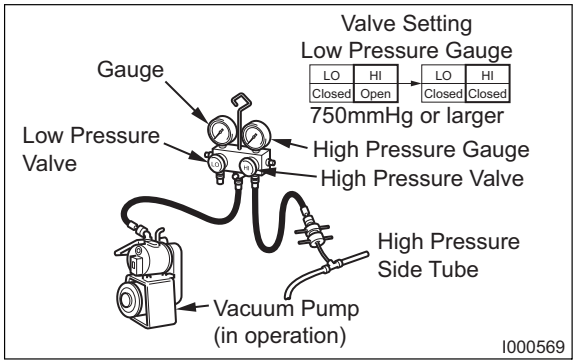


3) Connect the charging hoses (red = high-pressure side) of the gauge manifold to the process tube fitting.
4) Connect the charging hose (green) at the center of the gauge manifold to the vacuum pump.



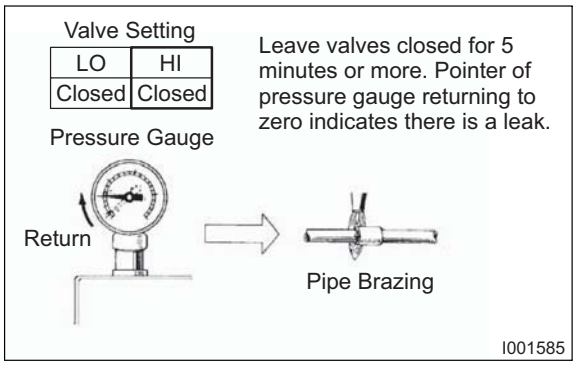
(2) Evacuation

1) Open the high-pressure valve (HI) of the gauge manifold.
2) Turn on the vacuum pump to start evacuation. (Evacuate the system for approximately 15 minutes.)
3) When the high-pressure gauge indicates 750 mmHg (30 in.Hg) or higher, turn the vacuum pump off and close the the gauge manifold high-pressure valve.



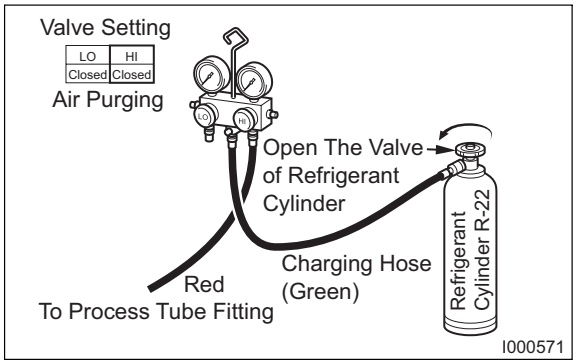
(3) Checking vacuum

1) Leave the gauge manifold high-pressure valve and the low-pressure valve closed for five minutes or more, and confirm that the gauge pointer does not return to zero.
2) If the gauge pointer returns gradually to zero there is a leak somewhere in the system (this could also include the gauge manifold). Perform a leak check according to the procedure indicated in step (4). Once the leak has been found and repaired, evacuate the system again, and confirm that the system holds vacuum.

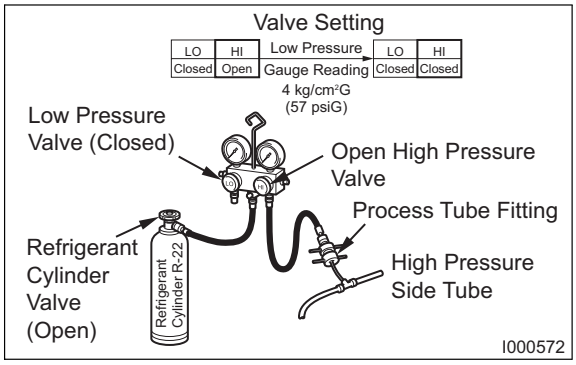


(4) Checking for gas leaks

1) Remove the charging hose (green) from the vacuum pump, and connect the hose to the refrigerant cylinder (R22).
2) Loosen the nut on the gauge manifold side of the charging hose (green).



3) Open the gauge manifold high-pressure valve. Charge the system with refrigerant until the high-pressure gauge indicates 57 psig (4 kg / cm^2G.) After charging is complete, close the high-pressure valve.
(Occasionally verify the high-pressure gauge pressure reading after closing the high-pressure valve.)
4) Check carefully for gas leaks inside the refrigerant system using the gas leak tester.
5) Repair any leaks.



! WARNING: Do not attempt any repairs on a charged system.

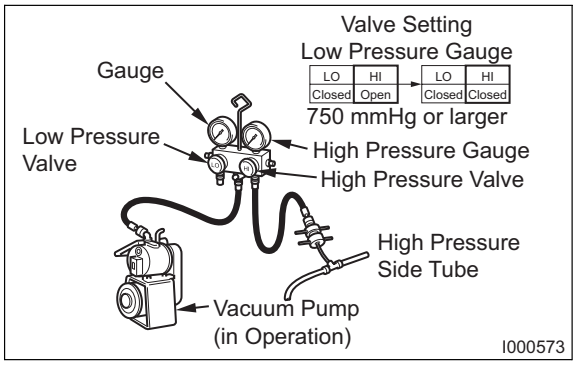
! WARNING: Before checking for gas leaks, fully confirm that there is nothing flammable in the area to cause an explosion or fire. Contacting refrigerant with an open flame generates toxic gas.

7-14. Evacuation (Repeat)

1) Close the refrigerant cylinder valve. Then remove the charging hose (green) from the refrigerant cylinder, and connect it to the refrigerant recovery machine.

NOTE: Keep the gauge manifold high-pressure valve and the low-pressure valve closed.

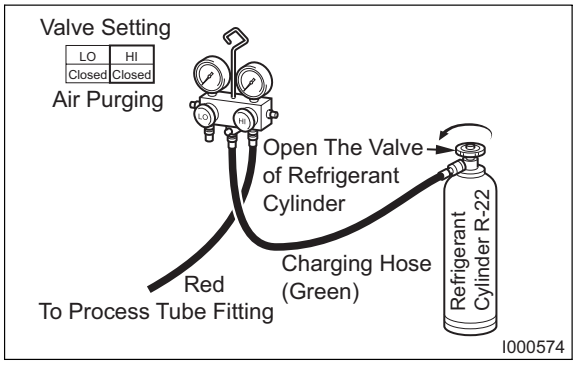
2) Using procedure step 7-13(2), evacuate the system until the high-pressure gauge indicates 750 mmHg (30 in.HG) or greater (for 15 minutes or more.)
3) After evacuation is complete, close the gauge manifold high-pressure valve.



! CAUTION: Be sure to evacuate the system twice or more using the repetitive vacuum method. Evacuate the system an additional time on rainy or humid days.

7-15. Refrigerant Charging Work

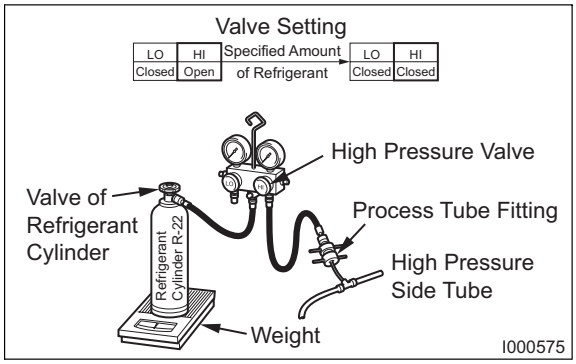
1) Remove the charging hose (green) from the vacuum pump, and connect it to the refrigerant cylinder (R-22).
2) Loosen the nut on the gauge manifold side of the charging hose (green). Open the refrigerant cylinder valve.



3) Securely place the refrigerant cylinder on a scale with a weighing capacity of 70 lbs (30 kg) that is graduated to 0.2 oz (5 g).
4) Open the gauge manifold high-pressure valve and the refrigerant cylinder valve. Charge the system with refrigerant to the specified amount.

Standard Refrigerant Amount: 18.2 oz / 1.14 lbs (517 g)

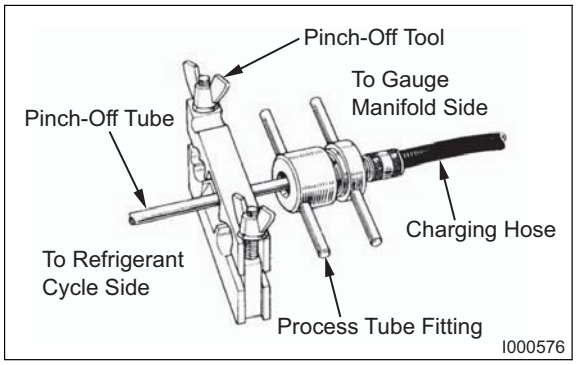
! CAUTION: The amount of refrigerant charged has a great influence on the cooling capacity of the unit. Charge to the specified amount, always observing the scale graduations while charging.



5) Close the manifold high-pressure valve and the refrigerant cylinder valve.

7-16. Gauge Manifold Removal

1) Crimp the pinch-off tube with a pinch-off tool.
2) Remove the gauge manifold and the process tube fitting. Crush the end of the pinch-off tube.
3) Braze the end of the pinch-off tube.
4) Ensure that a gas leak is not present at the pinched-off portion and the brazed end.



8. Repair Inspection

Perform a cooling operation inspection and check for abnormal noise or abnormal vibration.

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