LEVEL 1

Air Conditioning

Operation & Diagnosis

TC070-15-01H

Student Guide

Mazda Motor Corporation
Technical Service Training

Masters

OUTLINE

Air conditioning operation & diagnosis course is 2-day training and centered on Manual air conditioning system. Through this course, you can learn most frequent services for air conditioning, such as Performance check, Refrigerant charge, and Symptom troubleshooting.

The course begins with reviewing A/C Fundamentals (Mazda Masters Level F); you are required to bring your textbook “A/C Fundamentals” to this training session.

Student guide and Student activity sheet are to be provided before the session starts. In the Student guide and the Student activity sheet, you will find some questions and tables that some information is intentionally removed. Try to answer to the question in reference to what you have learnt so far and get information from relevant service materials, such workshop manual and wiring diagram.

NOTE This course is developed based on the service materials of Mazda 3 included in the CD-ESI (Electronic Service Information) 2/2004 Ver. 3.0 CD08-XX-04BE.

OBJECTIVES

After completing this course, you will be able to:

- Describe a refrigeration cycle and what part the components play in the cooling process.
- Identify major components of a manual A/C system
- Identify the components of Manual Air Conditioner and distinguish the components from those of Full-auto Air Conditioner.
- Describe a control system and how the system controls the Manual Air Conditioner.
- Identify major components of a manual A/C system
- Locate A/C system protection devices
- Explain the function of protection devices
- Conduct A/C performance checks
- Perform A/C refrigerant charging
- Perform checks for A/C components
- Isolate trouble cause based on Symptom based approach

CONTENTS

TIMETABLE

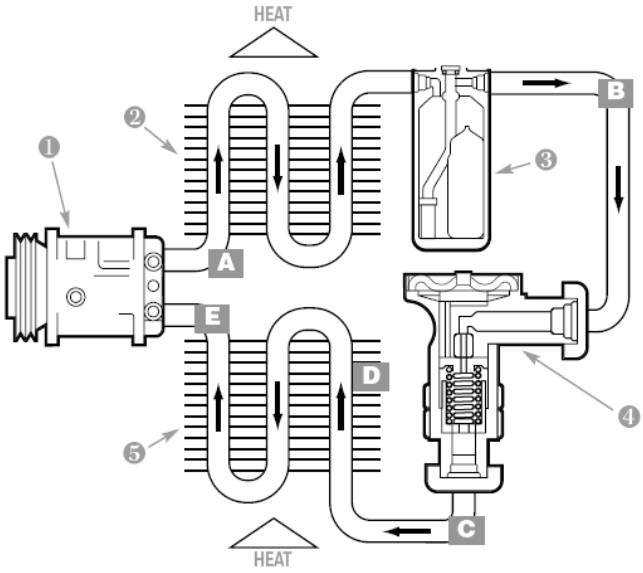
Day 1		
Time	Session	Remark
8:30 – 9:00	Introductions	
9:00 – 10:20	Review A/C Fundamentals	A/C Fundamentals textbook
10:20 – 10:30	Break	
10:30 – 11:50	Basic System	SG (Classroom)
12:00 – 13:00	Lunch	
13:00 – 14:50	Identifying AC Components Locating AC Protection Devices Refrigerant Pressure Check	SG Activity (Workshop)
14:50 – 15:00	Break	
15:00 – 17:00	Performance Check	SG Activity (Workshop)

Day 2		
Time	Session	Remark
8:30 – 9:50	Control System	SG (Classroom)
9:50 – 10:00	Break	
10:00 – 11:50	Units and parts checks	SG Activity (Workshop)
12:00 – 13:00	Lunch	
13:00 – 14:50	Symptom troubleshooting	SG Activity (Workshop)
14:50 – 15:00	Break	
15:00 – 16:40	Course completion test	
16:40 – 17:00	Session evaluation Conclusion	Attendees satisfaction survey

This schedule is subject to change when necessary.

1. Technician A says the refrigerant used in the A/C system absorbs and releases large amounts of heat as it changes from a liquid to a gas.
Technician B says as the refrigerant circulates through the tubes and hoses of an operating A/C system, it constantly changes from a liquid to a gas and back to a liquid again.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician



2. Technician A says that at point E in this illustration the refrigerant is high pressure vapor.
Technician B says at point E in this illustration the refrigerant is a low pressure vapor.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

3. One BTU is the amount of heat needed at sea level to raise the temperature of one pound of water;

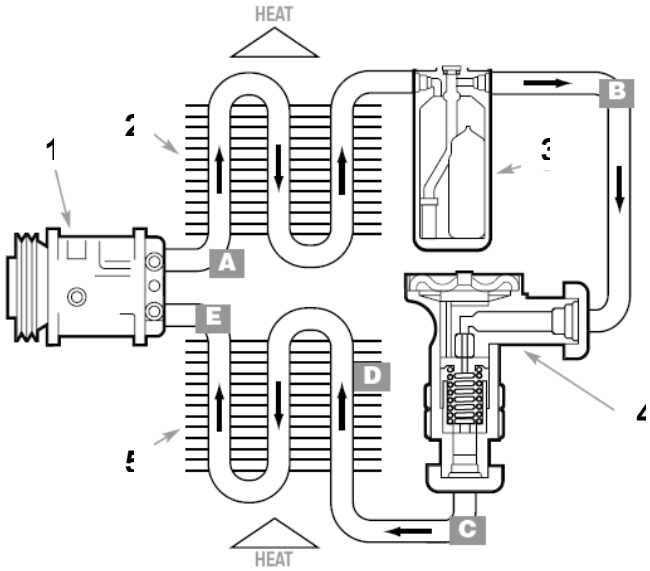
a. One degree Centigrade
b. Ten degrees Centigrade
c. Ten degrees Fahrenheit
d. One degree Fahrenheit

4. Technician A says the latent heat applied to change a substance from a liquid to a vapor is called the latent heat of vaporization.
Technician B says the latent heat applied to change a substance from a liquid to a vapor is called the latent heat of condensation.

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

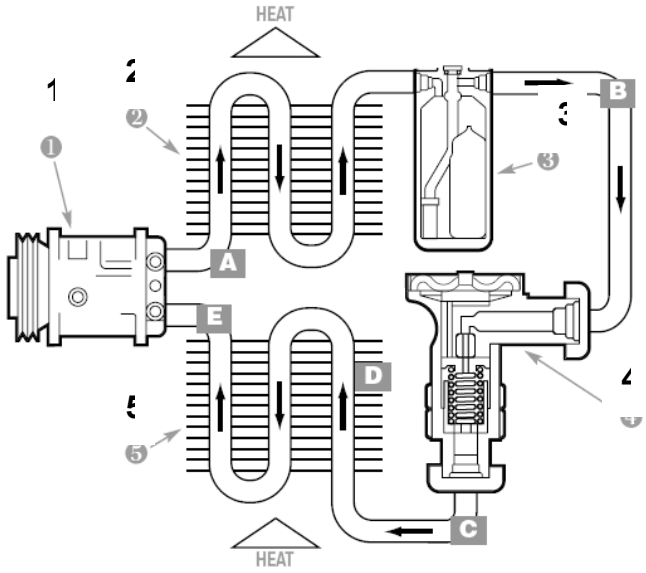
5. Technician A says in a Mazda A/C system the refrigerant changes state from a liquid to a vapor in the compressor while losing heat.
Technician B says the compressor acts as a pump for the refrigerant in an A/C system.
Who is correct?
a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

6. Technician A says the compressor increases the temperature of the vaporized refrigerant without adding heat.
Technician B says the compressor raises the pressure of the vaporized refrigerant and not the temperature.
Who is correct?
a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

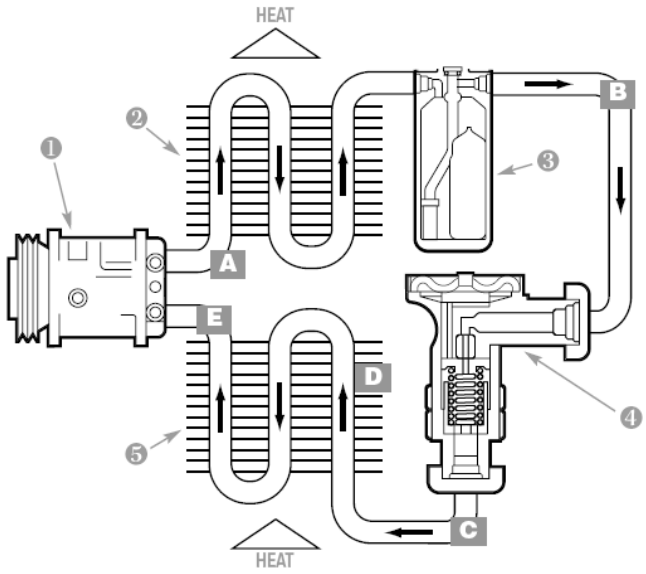


7. Which component in this illustration receives hot, high pressure refrigerant gas from the compressor and transfers the heat to the outside air.
a. 2
b. 3
c. 4
d. 5

8. Technician A says the expansion valve or orifice tube controls the amount of refrigerant entering the evaporator.
Technician B says the accumulator regulates the refrigerant flow to the evaporator.
Who is correct?
a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician



9. Which component in this illustration removes heat from the passenger compartment and transfers it to the refrigerant?
   a. 2
   b. 3
   c. 4
   d. 5



10. At point A the refrigerant is;
   a. High pressure liquid
   b. High pressure vapor
   c. Low pressure liquid
   d. Low pressure vapor

11. Technician A says R-12 and R-134a system have different-sized service valves, to prevent accidental mixing of refrigerants.
Technician B says R-134a systems use larger, metric-thread, quick connect service valves.
Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technicians
   d. Neither technician

12. Technician A says do not expose refrigerant to open flame. R-12 may produce poisonous phosgene gas, and R-134a may support combustion.
Technician B says a propane torch style leak detector is the best type of detector for R-12 and R134a systems.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

13. Technician A says if refrigeration oil is not sealed properly, it will absorb moisture from the air.
Technician B says you can reuse refrigeration oil removed from an operating A/C system.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
a. Neither technician

14. Technician A says after repairs have been performed, or if a system has been open for a long period of time, the system must be evacuated to remove moisture and ensure that it will hold a vacuum.
Technician B says the minimum time any system should be evacuated is 15 minutes. The longer the system has been open, the longer it should be evacuated.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

15. Technician A says all refrigerant should be recovered and recycled.
Technician B says only R-12 needs to be recovered and recycled.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

16. Technician A says the accumulator traps liquid refrigerant allowing it time to completely vaporize.
Technician B says if liquid refrigerant reaches the compressor it could be damaged.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

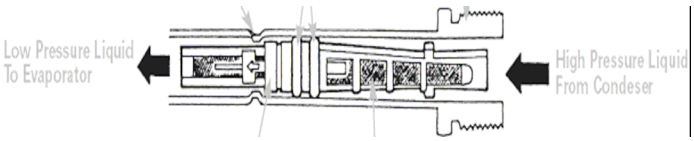
17. Technician A says small refrigerant leaks are normal and the refrigerant should be replaced once a year as a maintenance item.
Technician B says if the refrigerant has leaked out of an A/C system the technician should charge the system with a small amount of refrigerant for leak testing purposes.
Who is correct?

a. Technician A
b. Technician B
c. Both Technicians
d. Neither technician

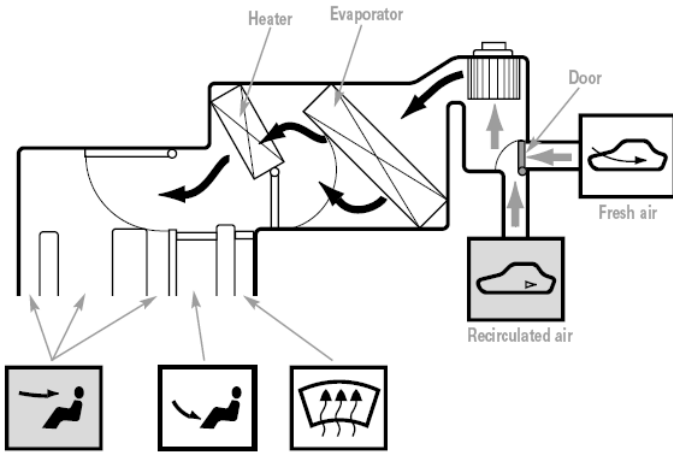
18. This method of charging an A/C system adds gaseous refrigerant through the low-side service valve while the compressor is running.

a. Liquid charging
b. Vapor charging
c. Both answers a and b
d. Neither answer a or b

19. The component in this illustration divides the A/C system into high and low pressure sides, what is it?



a. Fixed orifice tube
b. Expansion valve
c. Accumulator
d. Receiver dryer



20. Which statement is true about this climate control plenum assembly?
    a. All air passes through the evaporator
    b. The air is being re-circulated
    c. The temperature blend door is set for max heat
    d. All the above

OBJECTIVES

After completing this section, you will be able to:

- Describe a refrigeration cycle and what part the components play in the cooling process.
- Identify major components of a manual A/C system

Activities To complete this section, you will perform the following activities:

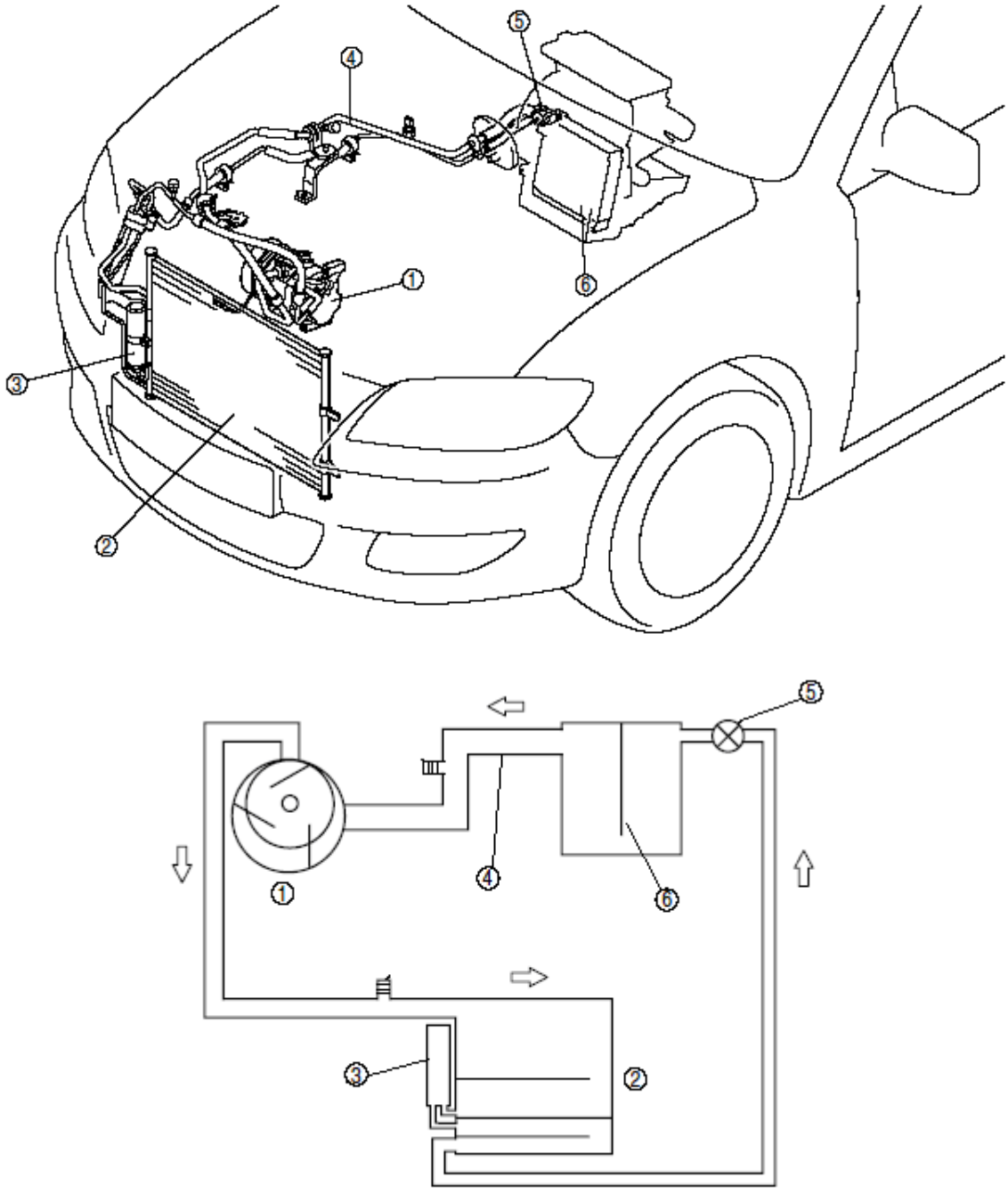
Activity	Title/Description	Location
AC01	Identifying A/C Components	Shop
AC02	Locating A/C Protection Devices	Shop
AC03	A/C performance Check	Shop
AC04	Refrigerant Charging	Shop

In this section:

Basic System

NOTE
This SG: Student Guide is developed based on Mazda 3.

A/C Components

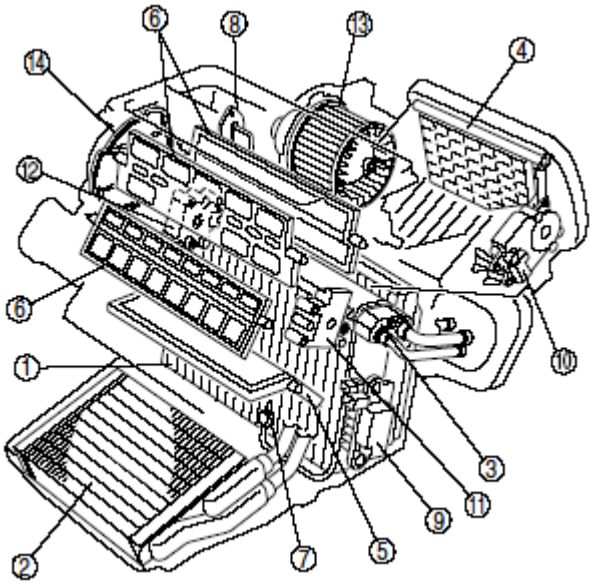


Name the components.

①		④	
②		⑤	
③		⑥	

A/C unit construction/operation

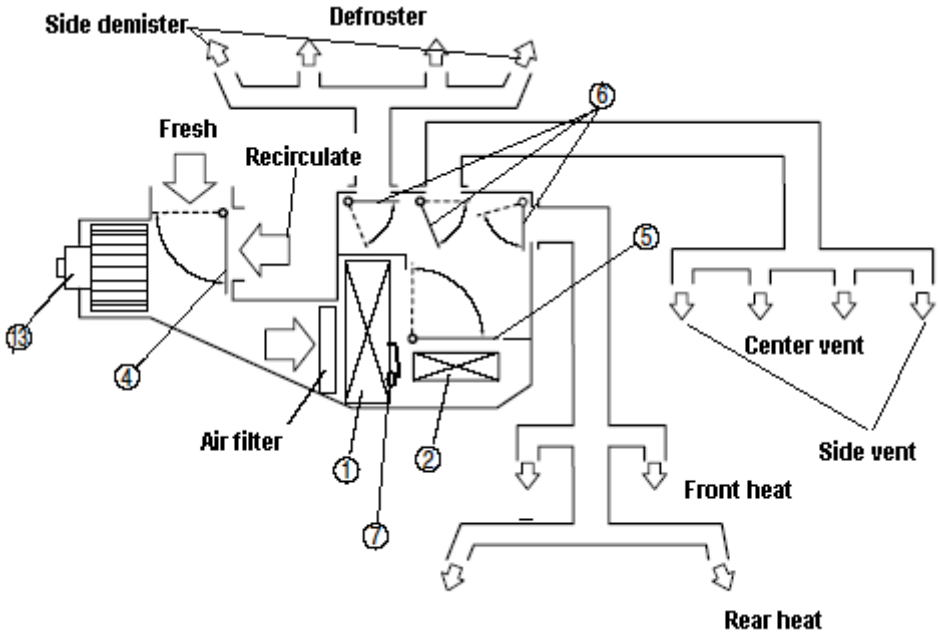
• The figure below shows A/C unit which integrates the blower, cooling and heater units.



1. Evaporator*
2. Heater core*
3. Expansion valve
4. Air intake door*
5. Air mix door*
6. Airflow mode door*
7. Evaporator temperature sensor*
8. Resistor (manual air conditioner)
9. Power MOS FET (full-auto air conditioner)
10. Air intake actuator
11. Air mix actuator (full-auto air conditioner)
12. Airflow mode actuator (full-auto air conditioner)
13. Blower motor*
14. Airflow mode main link

* Also refer to the figure below “Ventilation System”

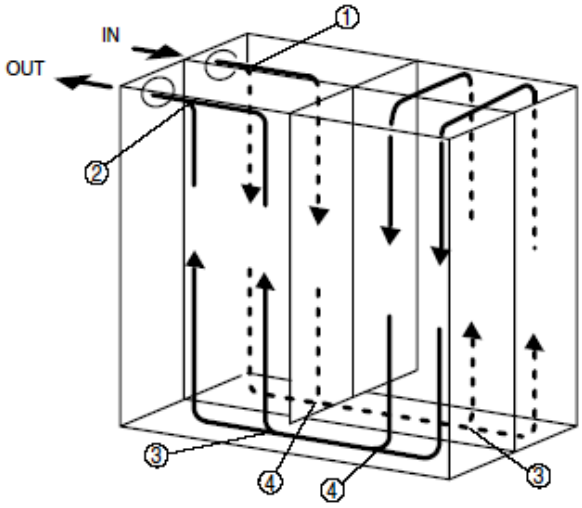
Ventilation System



Evaporator

• The figure below shows a double-tank drawn cup.

1. Separation part
2. Rejoining point
3. Separation part
4. Rejoining point

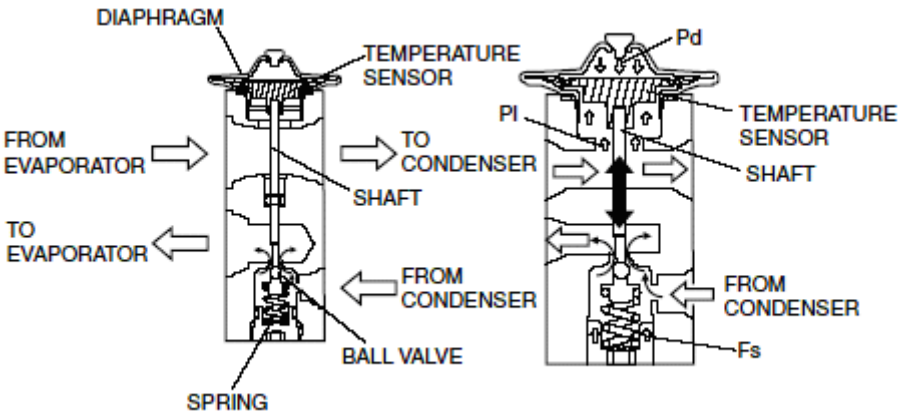


Expansion valve

• The liquid refrigerant of about 1.5 MPa is sprayed at the expansion valve. The splayed refrigerant is, then, expanded its volume that causes its pressure decreased to about 0.2 MPa. This makes the refrigerant to be vaporized causing reduction of temperature. The expansion valve regulates the flow volume of the refrigerant.

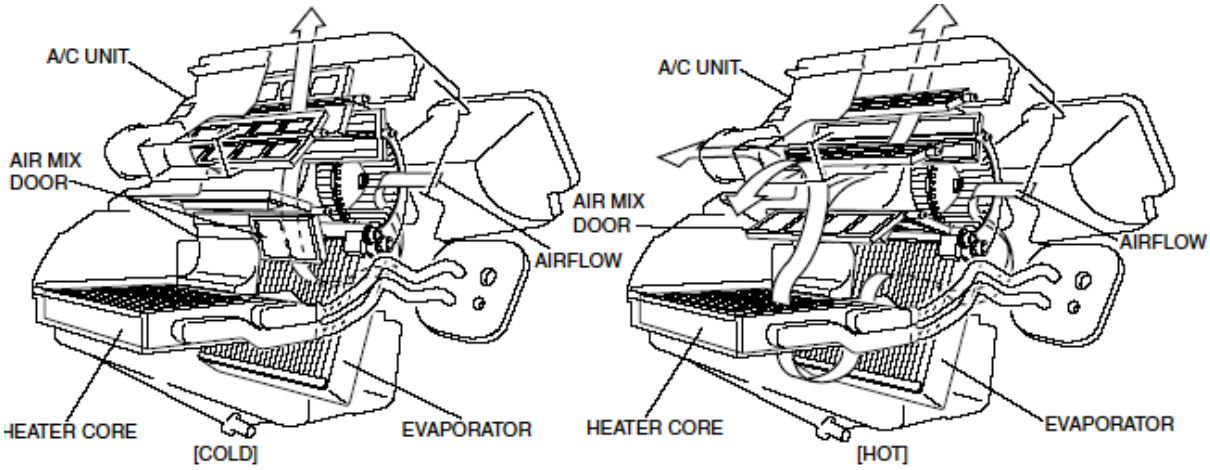
• The amount of refrigerant delivered to the evaporator is adjusted by the opening angle of the ball valve in the expansion valve.

• Opening angle is adjusted by a balance of the R-134a pressure (**Pd**) in the diaphragm, and a composite force of evaporator discharge pressure (**PI**) against the lower part of the diaphragm and spring force (**Fs**) pushing up the ball valve. When **PI** increases, the temperature of the temperature sensor near the diaphragm rises and the **Pd** heated by the R-134a in the diaphragm increases. When the **Pd** increases more than **PI + Fs**, the diaphragm is pushed down, and the shaft attached to end of the temperature sensor rod pushes down the ball valve, increasing the amount of liquid refrigerant flow. When the evaporator discharge refrigerant temperature decreases, **PI + Fs** increases more than **Pd**, the ball valve is pushed up, and the amount of liquid refrigerant flow decreases.



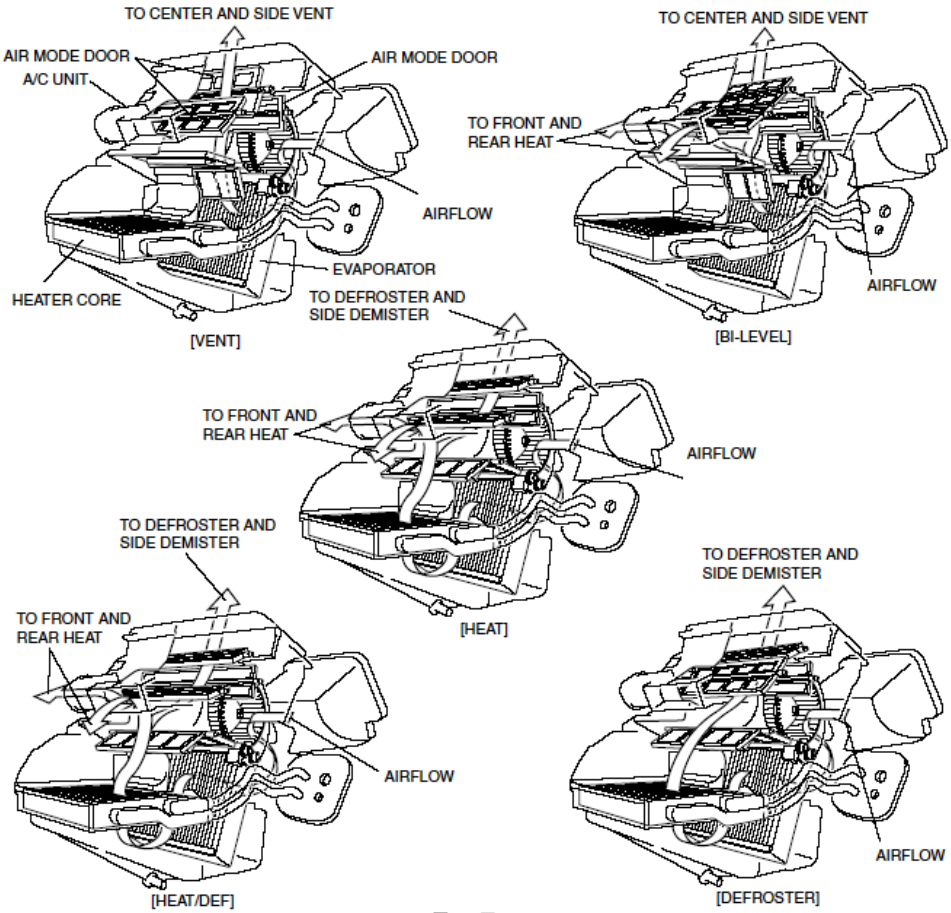
Air Mix Door Operation

• The air mix door, installed in the A/C unit, controls HOT or COLD position, depending on the position of the temperature control dial. As a result, airflow distribution changes, and the airflow temperature is controlled.



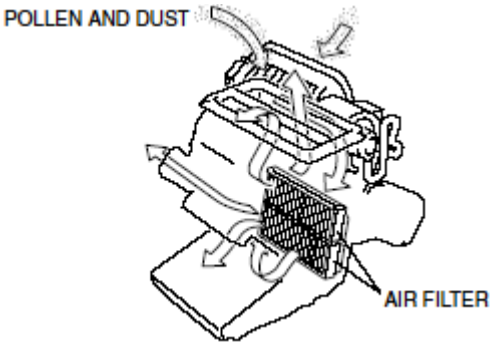
Airflow Mode Door Operation

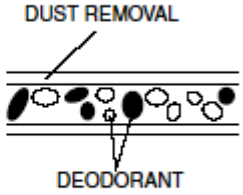
• The airflow mode doors move to VENT, BI-LEVEL, HEAT, HEAT/DEF, or DEFROSTER position, depending on the position of the airflow mode selector dial.



Air filter function

• The figure below shows air filter that can remove pollen and dust has been added.
• The air filter cannot be reused and must be replaced periodically.
NOTE Even new air filters are gray; be careful not to mistake the gray color as dirt.



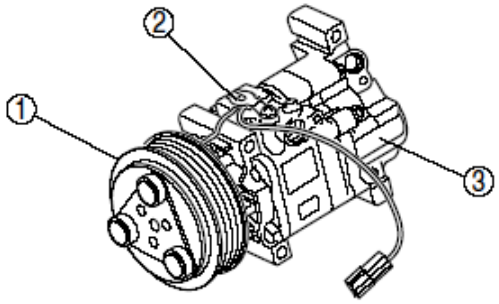


A/C compressor

• A rotary-vane type (H12A1) A/C compressor body has been adopted for size, weight, and operation vibration reduction.

1. Magnetic clutch
2. Thermal protector
3. A/C compressor

Z6



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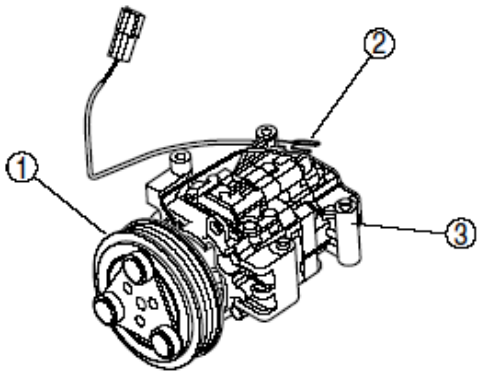
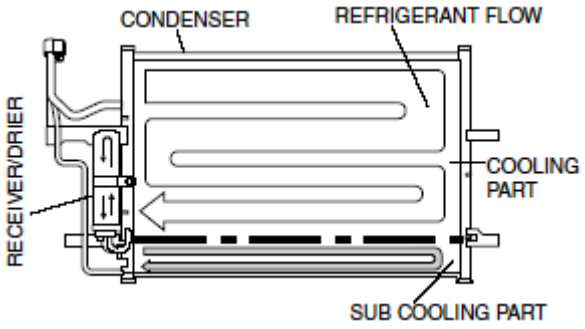


Condenser

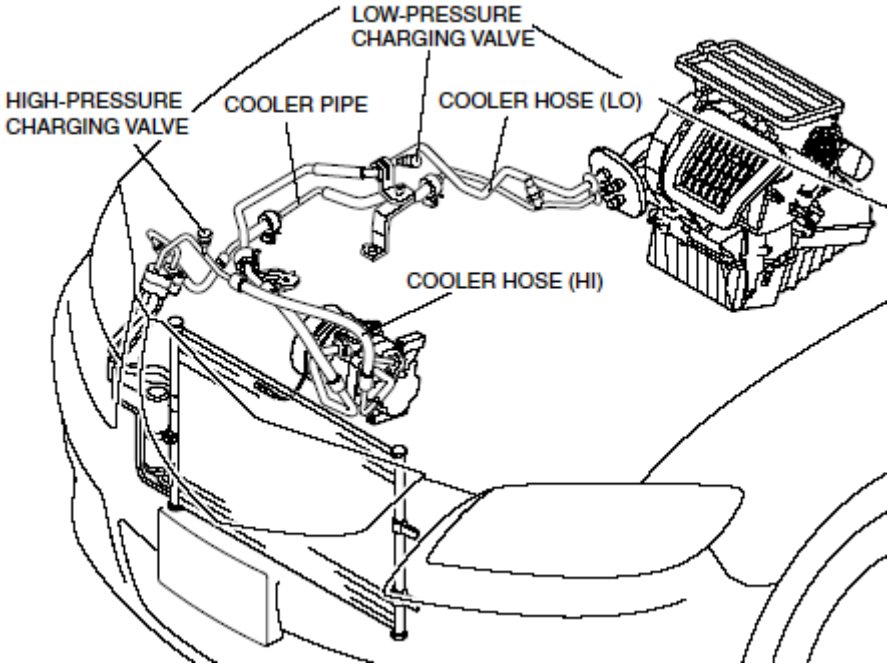
- The figure below shows a sub cool condenser. It is a multi-flow condenser which is equipped with a sub cooling part and integrated with a receiver/drier.
- The sub cool condenser separates liquid-gas refrigerant initially cooled at the condenser via the receiver/drier, where it returns again to the condenser sub cooling part and is cooled, accelerating liquefaction and improving cooling capacity.



Refrigerant life

- The pipes in the refrigerant lines are made of aluminum alloy and the hoses are made of rubber (flexible hose).
- A high-pressure charging valve is located on the cooler hose (HI) and a low-pressure charging valve is located on the cooler hose (LO).

Z6



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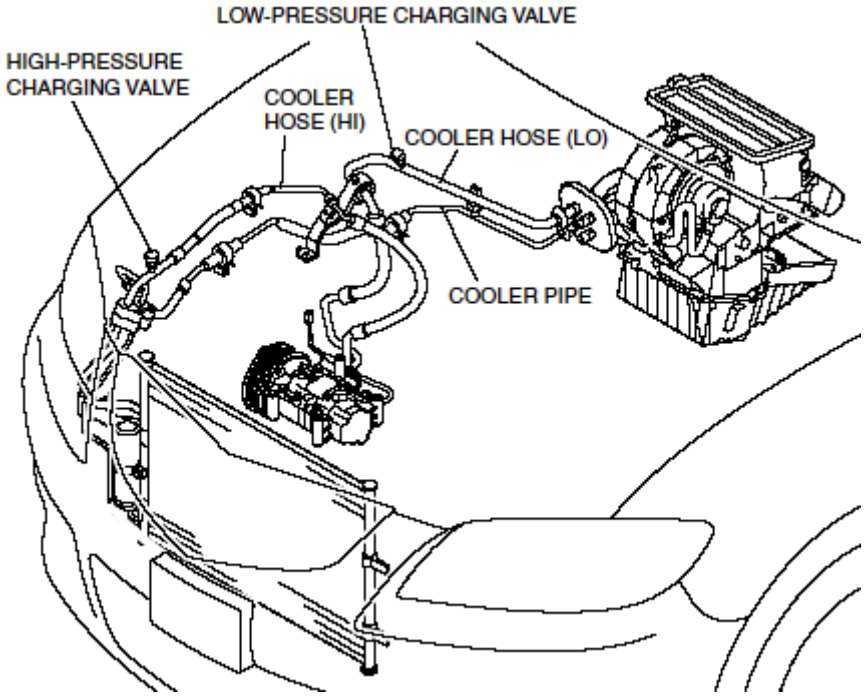
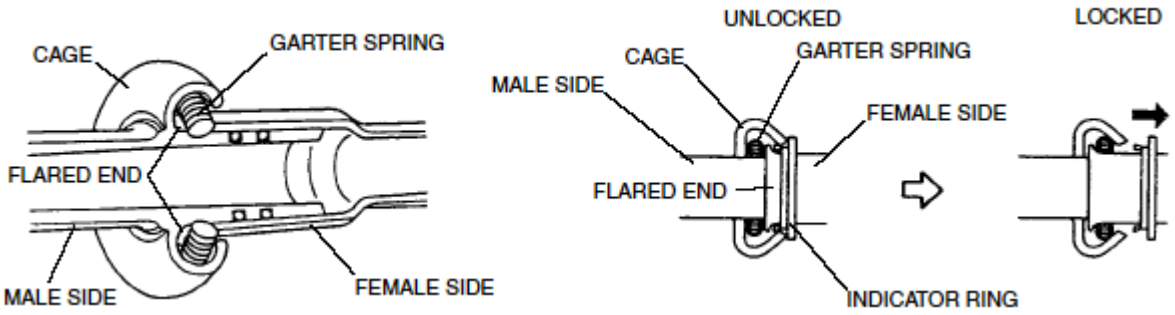


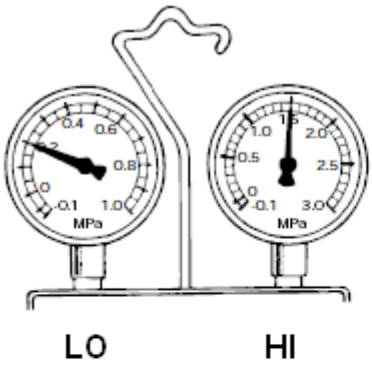
Spring-lock Coupling

- Spring-lock coupling is used for pipe-to-pipe connections. As a result, pipes can be connected easily, maintenance of torque is unnecessary, and serviceability is improved.
- There is a garter spring in the cage on the male side (cooler pipe or cooler hose (LO)) of spring-lock coupling type and the end of the pipe on the female side (A/C unit) is flared. When the pipes are being connected, the flared end of the female side forces the garter spring on the female side to expand, and by fully inserting the male side into the female side, the flared end is locked by the garter spring. When the cooler pipe or cooler hose (LO) is replaced, the additional indicator ring comes out after connecting; indicating that the flared end is locked.



Gauge manifold reading

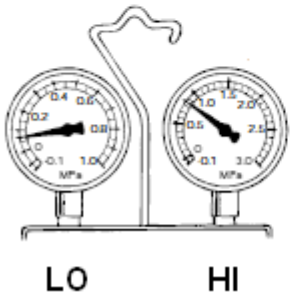
Normal



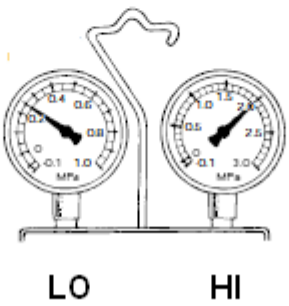
LO: 0.15 – 0.25 MPa
HI: 1.37 – 1.57 MPa

It may vary under the different condition.

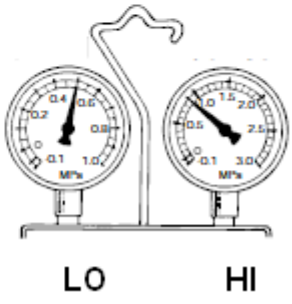
A



B



C



A: Insufficient refrigerant
B: Excessive refrigerant or insufficient cooling
C: Compressor failure

Refrigerant System Service Warnings (Reference)

Handling Refrigerant
• Avoid breathing air conditioning refrigerant or lubricant vapor. Exposure may irritate eyes, nose and throat. Also, due to environmental concerns, we urge use of recovery/recycling/recharging equipment when draining R-134a from the air conditioning system. If accidental system discharge occurs, ventilate work area before resuming service.

• Do not perform pressure test or leak test for R-134a service equipment and/or vehicle air conditioning system using compressed air. Some mixtures of air and R-134a have been shown to be combustible at elevated pressures. These mixtures, if ignited, may cause injury or property damage. Additional health and safety information may be obtained from refrigerant manufacturers.

• Do not allow the refrigerant to leak near fire or any kind of heat. A poisonous gas may be generated if the refrigerant gas contacts fire or heat such as from cigarettes and heaters. When carrying out any operation that can cause refrigerant leakage, extinguish or remove the above-mentioned heat sources and maintain adequate ventilation.

• Handling liquid refrigerant is dangerous. A drop of it on the skin can result in localized frostbite. When handling the refrigerant, wear gloves and safety goggles. If refrigerant splashes into the eyes, immediately wash them with clean water and consult a doctor.

Storing Refrigerant
• The refrigerant container is highly pressurized. If it is subjected to high heat, it could explode, scattering metal fragments and liquid refrigerant that can seriously injure you. Store the refrigerant at temperatures below 40 °C {104 °F}.

Refrigerant System Service Cautions

Handling Insufficient Refrigerant Level
• If an insufficient refrigerant level is detected at troubleshooting, do not charge (add) the refrigerant. Because an accurate amount of refrigerant cannot be determined from the pressure indicated on the manifold gauge, never charge the refrigerant. If there is too much or too little refrigerant from the refilling, there may be secondary problems such as damage to the refrigerant cycle parts, or a decrease of cooling performance. Therefore, if it is determined that the refrigerant level is insufficient, completely remove refrigerant from the refrigerant cycle and refill with refrigerant to the specified amount.

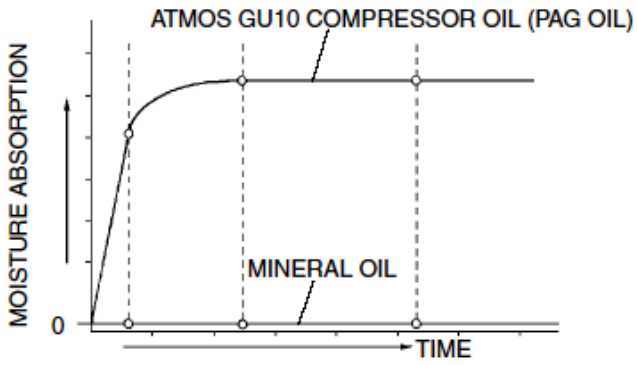
Handling Compressor Oil

- Use only ATMOS GU10 compressor oil for this vehicle. Using a PAG oil other than ATMOS GU10 compressor oil can damage the A/C compressor.

- Do not spill ATMOS GU10 compressor oil on the vehicle. A drop of compressor oil on the vehicle surface can eat away at the paint. If oil gets on the vehicle, wipe it off immediately.

- ATMOS GU10 compressor oil (PAG oil) has higher moisture absorption efficiency than the previously used mineral oil. If moisture mixes with the compressor oil, the refrigerant system could be damaged. Therefore, install caps immediately after using the compressor oil or removing refrigerant system parts to prevent moisture absorption.

Moisture Absorption



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- If the refrigerant gas is completely discharged from the system for reasons such as a malfunction during A/C operation, repair or replace the malfunctioning part, charge the refrigerant to the specified amount and always add 60 ml {60 cc, 2.03 fl oz} of compressor. If the compressor oil is not adequately replenished, the A/C compressor may quickly deteriorate, abnormal noise may develop, cooling performance may be affected or, in the worst case, the A/C compressor may seize.

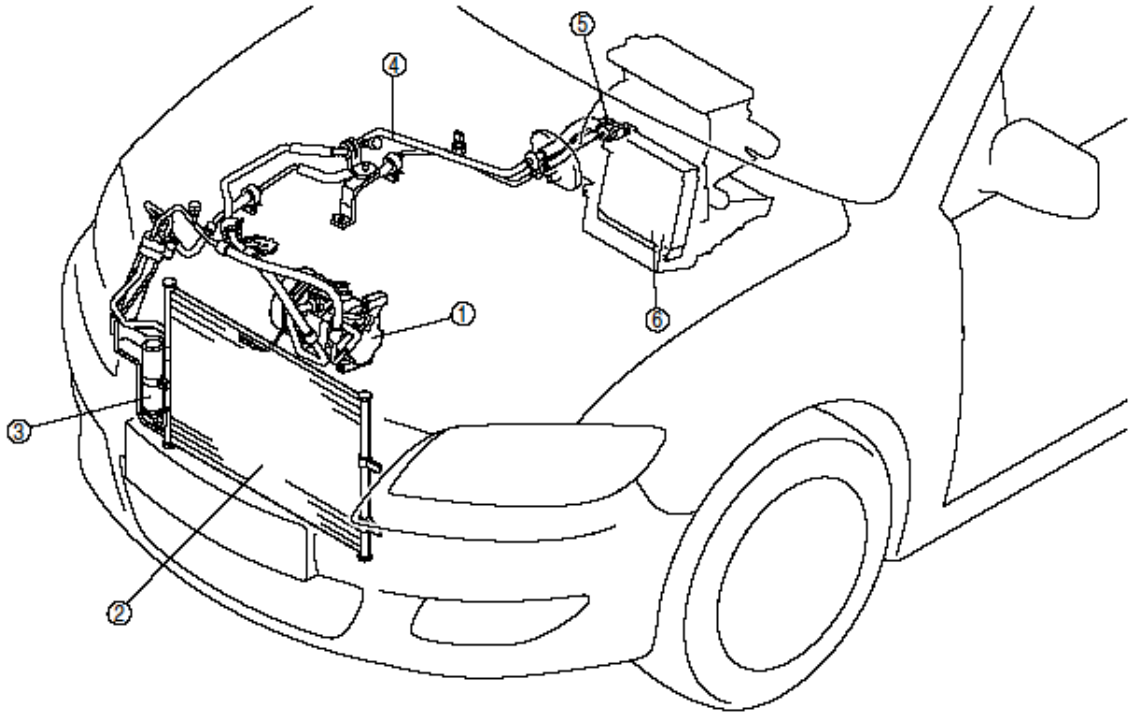
HVAC ABBREVIATION

A/C: Air Conditioning
B+: Battery Positive Voltage
CAN: Control Area Network
CPU: Central Processing Unit
HI: High
IG: Ignition
ISO: International Organization for Standardization
LO: Low
M: Motor
MAX: Maximum
OFF: Switch Off
ON: Switch On
PCM: Powertrain Control Module
REC: Recirculate
SW: Switch

Item Specification (Mazda 3)

Heating capacity (kW {kcal/h}): 4.550 {3,913}
Cooling capacity (kW {kcal/h}): 3.960 {3,406}
Refrigerant
Type: R-134a
Regular amount: (approx. quantity) (g {oz}) 525 {18.5}
A/C compressor
Type: Vane-rotary
Discharge capacity (ml {cc, fl oz}): 120 {120, 4.06}
Max. allowable speed (rpm): 6,400/Z6, 7,200/LF
Lube oil
Type: ATMOS GU10
Sealed volume (approx. quantity) (ml {cc, fl oz}): 120 {120, 4.06}/Z6, 150 {150, 5.07}: LF
Condenser
Type: Multi-flow (sub-cooling type)
Radiated heat (kW {kcal/h}): 6.600 {5,680}
Receiver/drier capacity (ml {cc, fl oz}): 180 {180, 6.08}
Desiccant: Synthetic zeolite
Expansion valve type: Block type
Evaporator type: Double-tank drawn cup
Temperature control: Reheat full air mix type

Review Exercise



1. Name the components.

①		④	
②		⑤	
③		⑥	

2. Explain the function of the “Airflow Mode Door”.

3. Explain the function of the “Air Mix Door”.

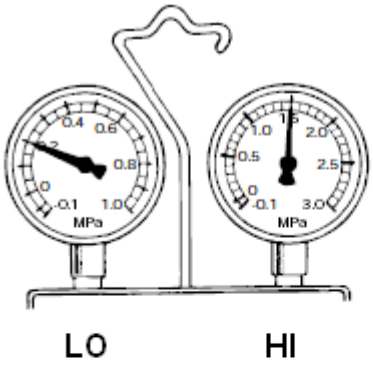
4. Explain the function of the “Air Filter”.

5. Explain the purpose of the “Thermal Protector” and where it is located.

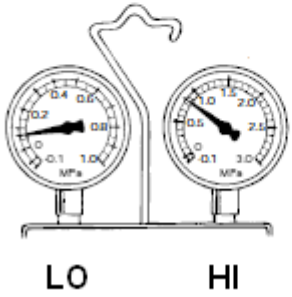
6. In this example match the gauge reading with the possible condition.

Compressor Failure _____
Insufficient refrigerant _____
Excessive refrigerant _____
Normal _____

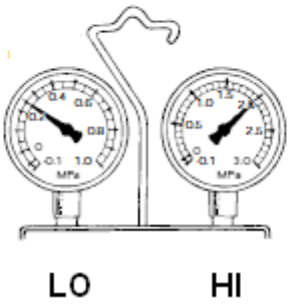
A



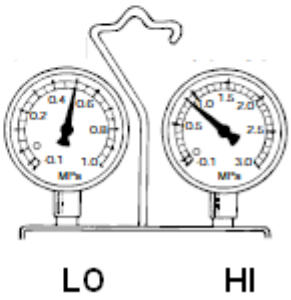
B



C



D



Technician Name _____

IDENTIFYTING A/C COMPONENTS

Purpose: In this activity, you will identify major A/C components.

What you will need to complete this activity:

- Current model vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual

Component Identification
Identify the numbered A/C components on the vehicle and record in the spaces below. If you need help, refer to the Workshop Manual.

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

Visual Inspection

1. Do the condenser and radiator have any obstructions to airflow? ☐ Yes ☐ No

NOTE
Perform the following checks with engine off and key out of ignition.

2. Do the electric cooling fans turn easily with engine and power off? ☐ Yes ☐ No
3. Does the coolant reservoir tank have proper fluid level? ☐ Yes ☐ No
4. What is the general appearance of the refrigeration system components?

_____

NOTE
A leak can look like an oily residue. The oily residue will often show up at hose connections and seal locations.

5. Is the compressor drive belt in good condition and adjusted to specification?

☐ Yes ☐ No

NOTE
If the answer of any of the questions was no, fix the problem before continuing the inspection. Visual and component inspection help isolate the concern to a specific system.

Instructor Sign-Off:
Now that you have completed this activity, you should be able to:

- Identify A/C components

This skill will help you service an A/C system.

Instructor's initials: _____

Technician Name _____

LOCATING A/C PROTECTION DEVICES

Purpose: In this activity, you will locate A/C protection devices and explain how they operate.

What you will need to complete this activity:

- Current model vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual

Protection Devices react to abnormally high or low pressure and excessively high temperature which would damage the system.

Refrigerant Pressure Switch

1. Where is the pressure switch located?

_____

2. How does it protect a system that has a leak in the condenser?

_____

3. How does it protect a system that has inoperative condenser fans?

_____

4. Is the refrigerant that contacts the switch a liquid or vapor?

_____

Thermal Protector (Thermal Switch)

1. Where is this device located?

_____

2. This component senses the temperature of liquid or vapor refrigerant?

_____

3. In what way does the thermal protector safeguard the system?

_____

4. If this component fails due to an open circuit, what will the customer notice?

_____

NOTE
In some models, the Thermal Protector is called “Thermal Protector “ and “Thermo-switch.” When ordering parts, use the term “Thermal Protector Kit.”

Pressure Relief Valve

1. Where is this device located?

_____

2. At what pressure will you expect the pressure relief valve to discharge refrigerant to the atmosphere?

_____

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- locate A/C system protection devices
- explain the function of protection devices

This skill will help you evaluate protection devices for correct operation.

Instructor's initials: [ ]

Technician Name _____

CONDUCTING A PERFORMANCE CHECK

Purpose: In this activity, you will diagnose a vehicle's air conditioning system.

A performance check is the basis of air conditioning diagnosis. All diagnostic routines should begin and end with this test to determine if the system is performing to specifications. It is thorough and easy to perform.

What you will need to complete this activity:

- Current model vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual
- Thermometer
- R-134a Refrigerant Pressure Gauge Set (49 C061 0A0B Gas Charge Set)
- Safety Glasses

NOTE
Humidity and temperature have an effect on the outcome of this test.

Function Check

NOTE
During the following tests, monitor instrument panel gauges and warning lights for out of specification readings.

1. Set hand brake and place gear selector in Park (ATX) or Neutral (MTX).

2. Keep hood open throughout the test to maximize airflow through the radiator and condenser.

3. With engine running, select all the blower fan speeds.
   Does the fan speed change? ☐ Yes ☐ No

   Are all speeds available? ☐ Yes ☐ No
   (If no, repair according to workshop manual directions.)

4. Operate mode control to all positions and confirm that sufficient airflow is at each position.
   Does the airflow change according to the position of the mode control indication on the dash? ☐ Yes ☐ No
   (If no, repair according to workshop manual directions.)

5. Operate temperature select control throughout its range and confirm that the airflow temperature matches the setting. Start with the control in the coolest setting and slowly increase temperature to highest setting, then back to original setting. Does the temperature match the control setting? ☐ Yes ☐ No
   (If no, repair according to workshop manual directions.)

6. Turn off engine.

INFORMATION POINT
A small temperature difference between the setting and the actual duct temperature is normal. The duct temperature will usually be cooler than the interior temperature. This is because the evaporator is concentrated in the small area of the duct very close to the evaporator.

Gauge Installation

Install R-134a Refrigerant Pressure Gauge Set according to the workshop manual.

a. Confirm that high and low valves are closed.
b. Remove caps from charging ports.
c. Connect the quick disconnect couples to vehicle charging ports and open line valves.

NOTE
Support A/C lines during coupling. Excessive pressure can cause damage to unsupported lines.

Refrigerant Pressure Check

2. Place a dry-bulb thermometer in the driver-side center ventilator outlet.

3. Close all doors and windows.

4. Set A/C controls for maximum cooling with:

   a. temperature to full cold
   b. airflow to face/vent to Vent
   c. fresh/recirculate control to Recirculate
   d. activate compressor with fan speed high

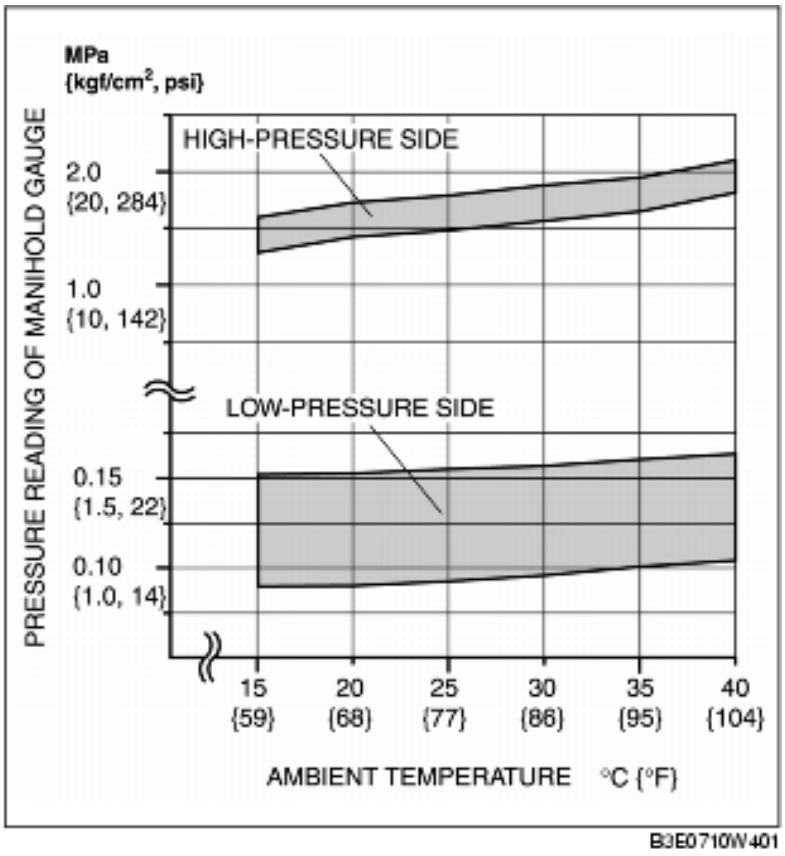
5. Start engine and hold at 1,500 rpm.

6. Measure the ambient temperature and high- and low- pressure side reading of the pressure gauge.

   Ambient temperature _____ °C

   High pressure _____ psi / Low pressure _____ psi
   Ambient temperature

7. Verify that the intersection of the pressure reading of the pressure gauge and ambient temperature is in the shaded zone.



Performance Check

1. Place a dry-bulb thermometer in the driver-side center ventilator outlet.

2. Close all doors and windows.

3. Set A/C controls for maximum cooling with:

   a. temperature to full cold
   b. airflow to face/vent to Vent
   c. fresh/recirculate control to Recirculate
   d. activate compressor with fan speed high

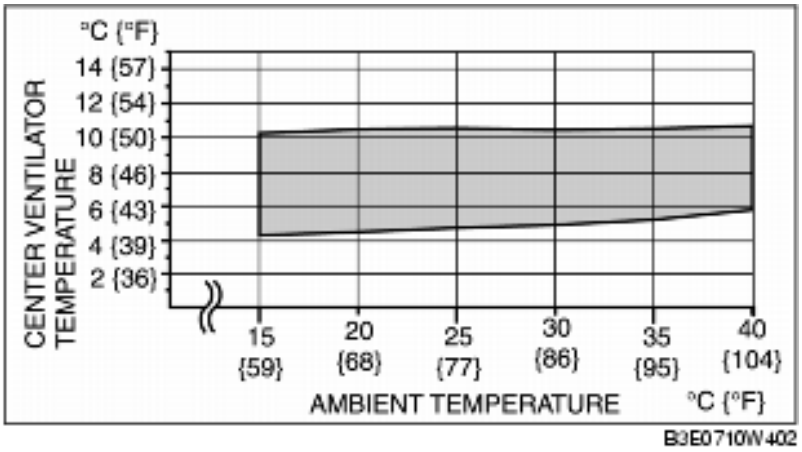
4. Start engine and hold at 1,500 rpm.
5. After the blower air is stabilized, read the dry-bulb thermometer.

   Dry-bulb temperature _____ °C

6. Verify that the temperature reading is in the shaded zone.

INFORMATION POINT

Stabilized refrigerant pressures occur when maximum high side pressure remains the same each time the compressor cycle off. This pressure should not vary with the cycles.



(If the pressure reading is out of the specification, inspect the refrigerant system according to the troubleshooting chart in the Workshop Manual.)

NOTE

It is acceptable for outlet temperatures to be cooler than the specification. If you perform the test in an air-conditioned shop, your reading will not match the temperature/humidity zone charts.

KEY POINT

Because of individual comfort zones, customer perception of air conditioning performance varies. The customer may not understand the effect of humidity, solar gain, vehicle color, and glass area on vehicle cooling.

Use this performance check to confirm that a customer's A/C system is operating to manufacturer's specifications. This check also helps guide you towards the problem during diagnosis.

Instructor Sign-Off:
Now that you have completed this activity, you should be able to:

- conduct A/C performance checks

This skill will help you accurately diagnose an A/C system.

Instructor's initials: _____

Technician Name _____

REFRIGERANT CHARGING

Purpose: After completing this activity, you will be able to recharge refrigerant to the A/C system and confirm proper cooling.

What you will need to complete this activity:

- Current model vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual
- R-134a Refrigerant Pressure Gauge Set (49 C061 0A0B Gas Charge Set)
- Vacuum Pump
- Electronic Leak Detector
- Safety Glasses

NOTE
Do not exceed the specification when charging the system with refrigerant. Doing so will decrease the efficiency of the air conditioner or damage the refrigeration cycle parts.

Recover/Recycle R-134a Refrigerant

NOTE
Follow the device manufacturer's instructions.

1. Connect an R-134a recovery/recycling/recharging device to the vehicle.

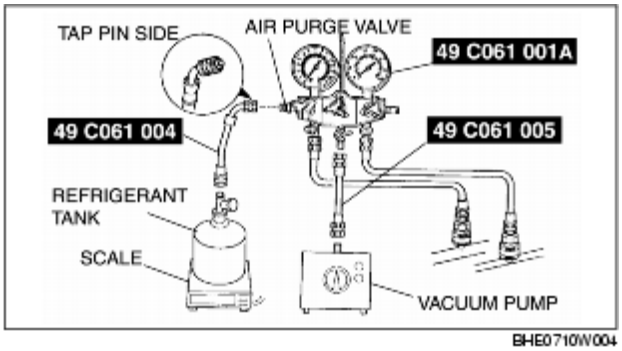
2. Recover and recycle the refrigerant

Charging Preparation

1. Install the R-134a Refrigerant Pressure Gauge Set.

2. Connect the vacuum pump.

3. Connect the **SST** (49 C061 004) to the refrigerant tank



BHE0710W004

4. Place the refrigerant tank on the scale.

Regular amount of refrigerant (approx. quantity)
500 g {17.65 oz}

Evacuation

1. Open all the valves of the pressure gauge.

NOTE
Close the SST (49 C061 001A) valve immediately after stopping the vacuum pump. If the valve is left open, the vacuum pump oil will flow back into the refrigeration cycle and cause a decrease in the efficiency of the air conditioner.

2. Start the vacuum pump and let it operate for **15 min**.

3. Verify that high- and low-pressure side readings are at **-101 kPa {-760 mmHg, -29.9 inHg}**. Close each valve.

Air-tightness Check

1. Stop the vacuum pump and wait for **5 min**.

2. Check the high- and low-pressure side readings of the gauge.
(If the reading has changed, inspect for leakage and go to Evacuation.)

Charging New R-134a Refrigerant

1. Open the valve of the refrigerant tank.

2. Weigh the refrigerant tank and record it.

Weight _____ g (oz)

NOTE
If the refrigerant system is charged with a large amount of refrigerant when inspecting for gas leakage, and if any leakage should occur, the refrigerant will be released into the atmosphere. In order to prevent the accidental release of refrigerant that can destroy the ozone layer in the stratosphere, follow the proper procedures and charge with only a small amount of refrigerant when inspecting for gas leakage.

NOTE

When using service can, do not open the high-pressure side valve while the engine is running. If you open, the compressed refrigerant will enter into the can causing a burst and it may damages surroundings and you may get injured.

3. Open the high-pressure side valve.

NOTE

Always begin charging with the high-pressure side valve open. If you begin with the low-pressure side valve, the vanes of the A/C compressor will not spread to work properly and abnormal noise may occur.

4. When the low-pressure side reading increases to **0.098 MPa {1.0 kgf/cm^2, 14 psi}**, close the high-pressure side valve.

5. Using an electronic leak detector, inspect the system for leakage from the cooler pipe/hose connections. (If leakage is found at a loose joint, tighten the joint, then inspect for leakage again.)

6. Open the high-pressure side valve and charge with refrigerant until the weight of refrigerant tank has decreased **250 g {8.83 oz}** from the recorded amount in Step 2.

7. Close the high-pressure side valve.

8. Start the engine and actuate the A/C compressor.

9. Open the low-pressure side valve and charge with refrigerant until the weight of the refrigerant tank has decreased regular amount from the recorded amount in Step 2.

10. Close the low-pressure side valve and the valve of the refrigerant tank.

11. Stop the engine and A/C compressor.

Leak Test

1. Using an electronic leak detector, inspect the system for leakage. (If leakage is detected at a loose joint, tighten the joint and/or repair the faulty place.)

2. Disconnect the pressure gauge from the charging valves.

4. Install the caps to the charging valves.

Instructor Sign-Off:
Now that you have completed this activity, you should be able to:

- perform A/C refrigerant charging

This skill will help you properly charge the refrigerant.

Instructor's initials: _____

OBJECTIVES

After completing this section, you will be able to:

- Identify the components of Manual Air Conditioner and distinguish the components from those of Full-auto Air Conditioner.
- Describe a control system and how the system controls the Manual Air Conditioner.
- Identify major components of a manual A/C system

Activities To complete this section, you will perform the following activities:

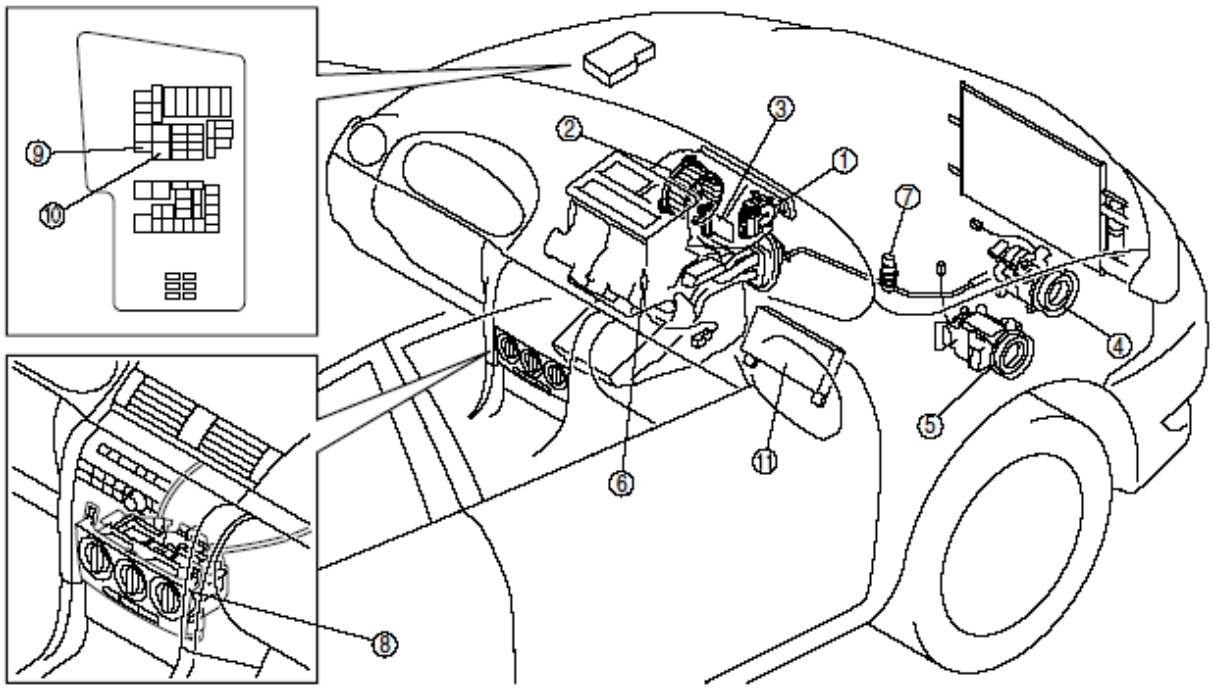
Activity	Title/Description	Location
AC – 05	Units and parts checks*	Shop
AC – 06	Symptom troubleshooting	Shop

What's in this section?

* Activity AC – 05 is an optional activity. If units and parts are not available, this activity is to be cancelled.

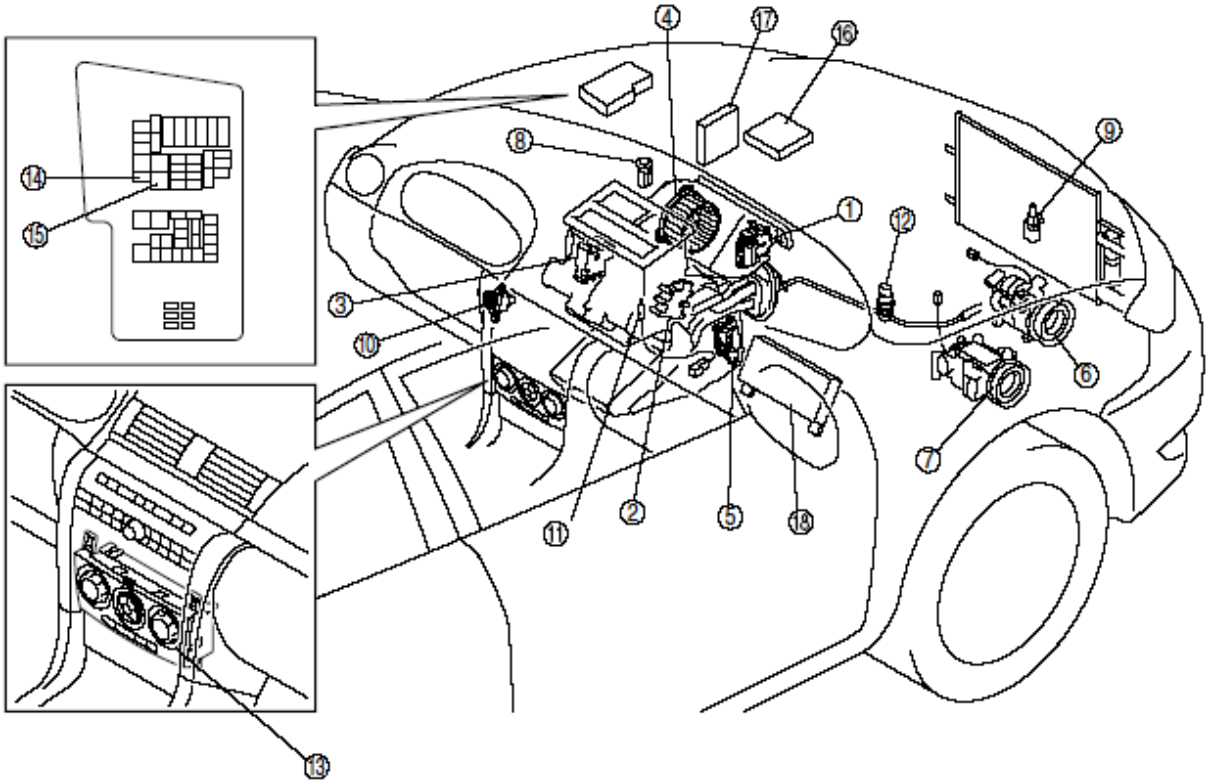
Control System [Manual Air Conditioner]

Structural View (Mazda 3)



1. Air intake actuator
2. Blower motor
3. Resistor
4. Magnetic clutch (Z6)
5. Magnetic clutch (LF)
6. Evaporator temperature sensor
7. Refrigerant pressure switch
8. Climate control unit
9. A/C relay
10. Blower relay
11. Main fuse block

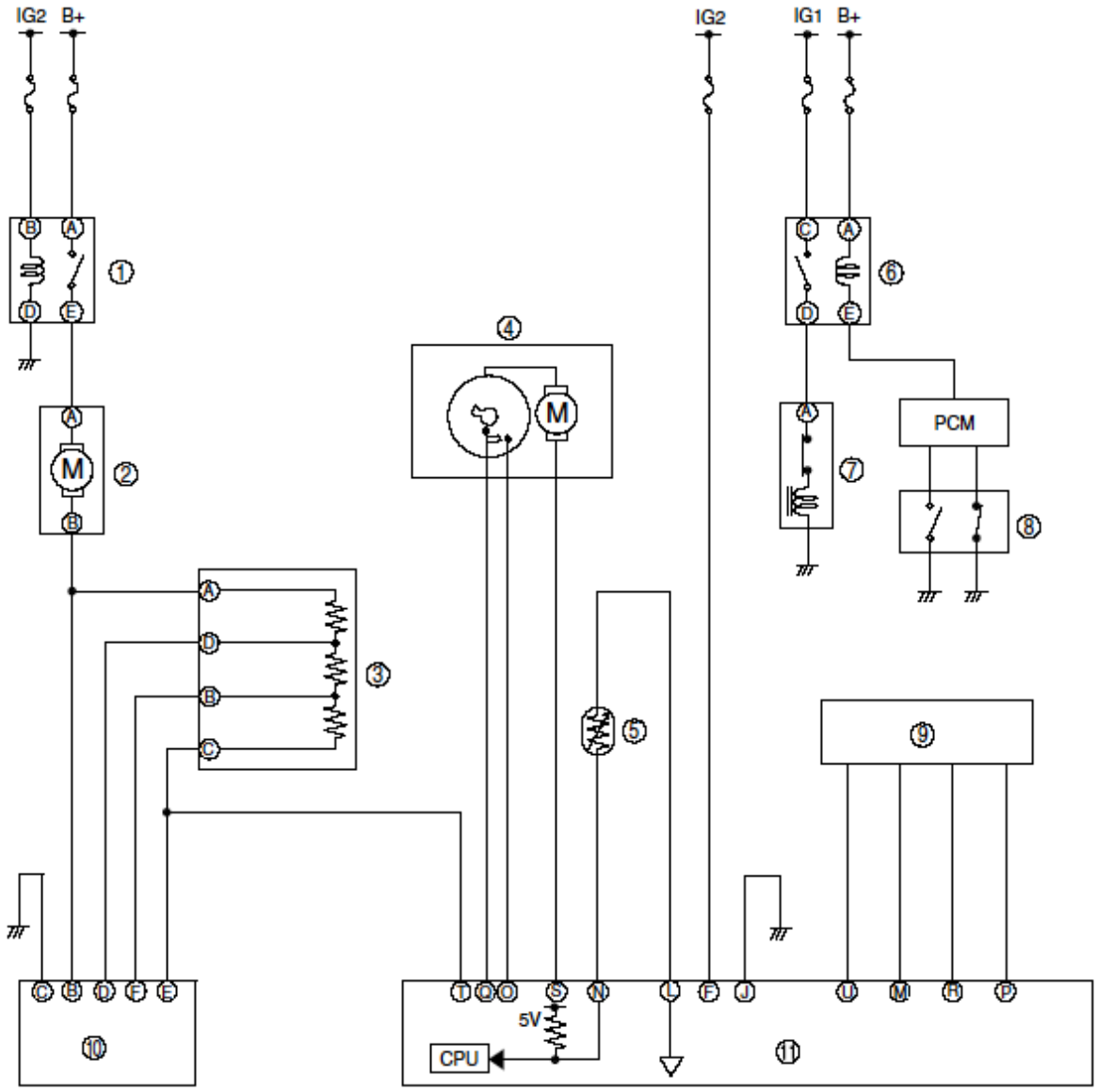
Control System [Full-auto Air Conditioner]



Tick the components that are equipped with only Full-auto Air Conditioner.

☐ 1. Air intake actuator
☐ 2. Air mix actuator
☐ 3. Airflow mode actuator
☐ 4. Blower motor
☐ 5. Power MOS FET
☐ 6. Magnetic clutch (Z6)
☐ 7. Magnetic clutch (LF)
☐ 8. Solar radiation sensor
☐ 9. Ambient temperature sensor
☐ 10. Cabin temperature sensor
☐ 11. Evaporator temperature sensor
☐ 12. Refrigerant pressure switch
☐ 13. Climate control unit
☐ 14. A/C relay
☐ 15. Blower relay
☐ 16. PCM (Z6)
☐ 17. PCM (LF)
☐ 18. Main fuse block

Control System Wiring Diagram [Manual Air Conditioner]



1. Blower relay
2. Blower motor
3. Resistor
4. Air intake actuator
5. Evaporator temperature sensor
6. A/C relay
7. Magnetic clutch
8. Refrigerant pressure switch
9. Main fuse block
10. Fan switch
11. Climate control unit

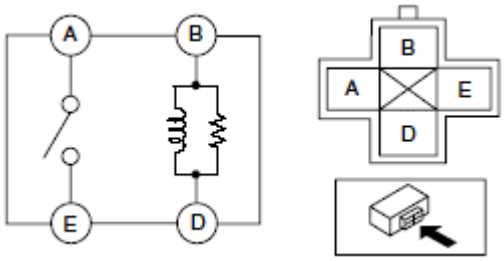
Blower relay

Blower relay is classified as Type B as shown in the table below. Its function is to be checked by measuring the continuities.

Relay type

Terminal type		Part name
4 terminals	Type A	• Front fog light relay • A/C relay • Rear window defroster relay • Fuel pump relay • Horn relay
	Type B	• Main relay • Starter relay • Blower relay

Type B relay



○—○ : Continuity

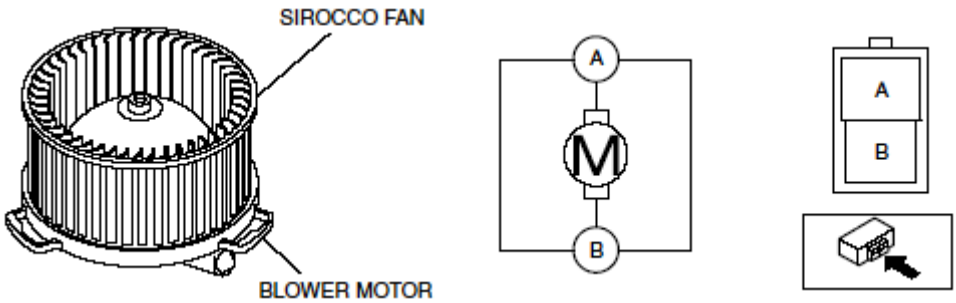
Step	Terminal			
	B	D	A	E
1	○	○		
2 *	B+	GND	○	○

* It requires supplying battery voltage.

Service Tip

Although your multi-meter might have a function to check continuity by giving beep sounds, use the range of your multi-meter to check resistance (ohm) when you check continuity between the terminals B and D. This is because your multi-meter may determine there is a malfunction due to the combined resistance of the resister and coil between the terminals B and D.

Blower motor

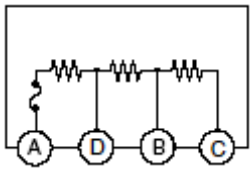


Service Tip

Blower motor can be inspected by directly supplying battery voltage. Connect battery positive voltage to blower motor terminal A, connect terminal B to ground, and then verify its operation. It should be operated the same as Fan switch is at its position 4.

Resistor

According to the fan switch position, the number of resister connected in series with the blower motor varies. The voltage applied to the blower motor changes due to the variation. Look at the table below. The more resistance connected in series with the blower motor, the less voltage applying to the blower motor, therefore the lower the revolution of the blower motor.



Terminal	Resistance (ohm)
A—D	0.27—0.30
A—B	0.77—0.87
A—C	3.05—3.49

Provided the measurements are as shown in the table “1”, what do you assume resistance of each register? (Complete the table “2”)

Table 1

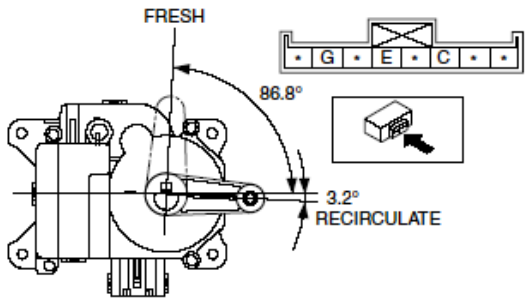
Terminal	Resistance (ohm)
A-D	0.30
A-B	0.80
A-C	3.10

Table 2

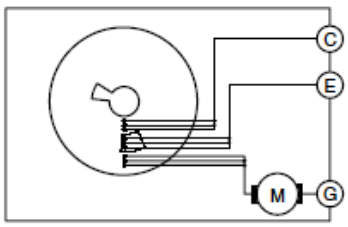
Resister	Resistance (ohm)
A-D	
D-B	
B-C	

Air intake actuator

Air intake actuator function can be checked by directly applying the battery voltage. Connect battery positive voltage to air intake actuator terminal C (or G), connect terminal G (or E) to ground, and verify that the air intake actuator operates as shown in the table.



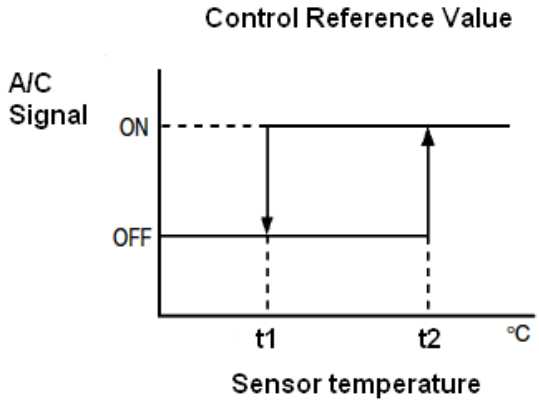
Terminal			Air intake actuator operation
C	E	G	
B+	–	Ground	FRESH→RECIRCULATE
–	Ground	B+	RECIRCULATE→FRESH

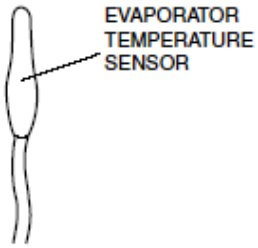


Evaporator temperature sensor

A/C signal on/off is controlled by the climate control unit turning the A/C signal (magnetic clutch) on and off based on the temperature of the air passed through the evaporator when both the A/C and fan switches are on. This keeps the evaporator surface temperature within the specified range to prevent the evaporator from being frosted.

Look at the chart below, Control Reference Value. The predetermined value “t1” must be above freezing point. The difference between “t1” and “t2” are usually 2 – 3 ºC.

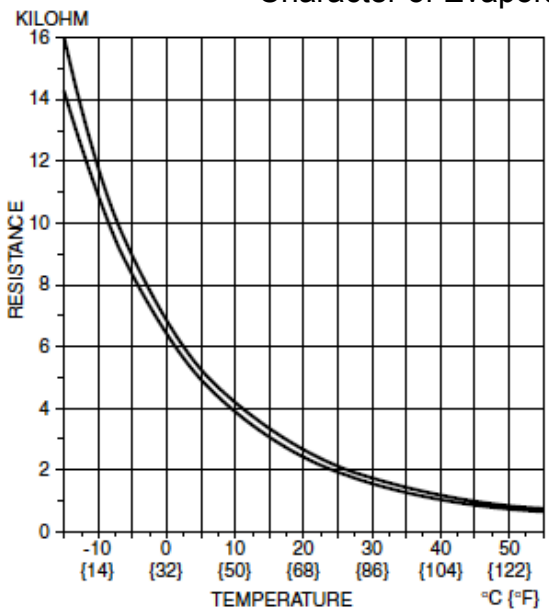




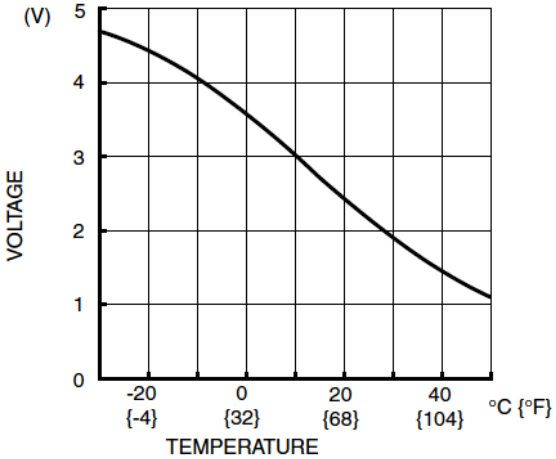
t1 =4.5, t2=5.5 (Mazda 3)

The difference value in temperature between “t1” and “t2” is referred as hysteresis that prevents continuing repetition of changes ON and OFF at a specified temperature.

Character of Evaporator Temperature Sensor



Temperature – Resistance



Temperature – Voltage (PCM input)

Look at both graphs, “Temperature – Resistance” and “Temperature – Voltage (PCM input)” and read the resistance and voltage at each given temperature as below.

Resistance _____ kilo-ohm, Voltage _____ V at -10 ºC

Resistance _____ kilo-ohm, Voltage _____ V at 0 ºC

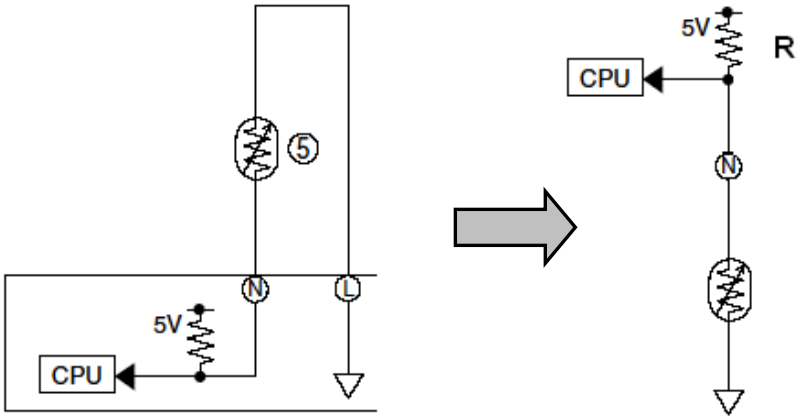
Resistance _____ kilo-ohm, Voltage _____ V at 10 ºC

Insert “higher” or “lower” in the blanks of the explanation below.

The higher temperature it senses, the [ ] resistance it creates, therefore the CPU detects [ ] voltage.

Look at the wiring diagram below. The left one shows the circuit of evaporator temperature sensor extracted from the control system wiring diagram. And the right one is a rearranged diagram of the circuit.

The evaporator temperature sensor is grounded through the climate control unit. The circuit operates with 5 V power supply. The voltage between the resister R and the evaporator temperature sensor varies according to the temperature that the sensor senses. The CPU detects this variation of the voltage (potential) which is equivalent at the terminal N of the climate control unit.



What do you think is the voltage at the terminal N if the resistance of the evaporator temperature sensor is 0 ohm?

_____ V

What do you think is the voltage at the terminal N if the resistance of the evaporator temperature sensor is infinity?

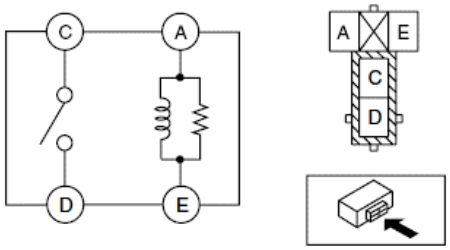
_____ V

Apply the ohm’s low and calculate the constant value of the resister R’s resistance.

_____ ohm

A/C relay

A/C relay is classified as Type A as shown in the table below. Its function is to be checked by measuring the continuities.



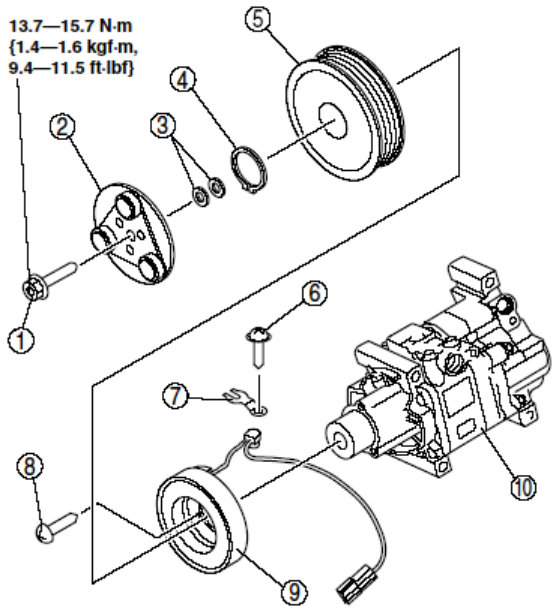
○—○ : Continuity

Step	Terminal			
	A	E	C	D
1	○	○		
2 *	B+	GND	○	○

* It requires supplying battery voltage.

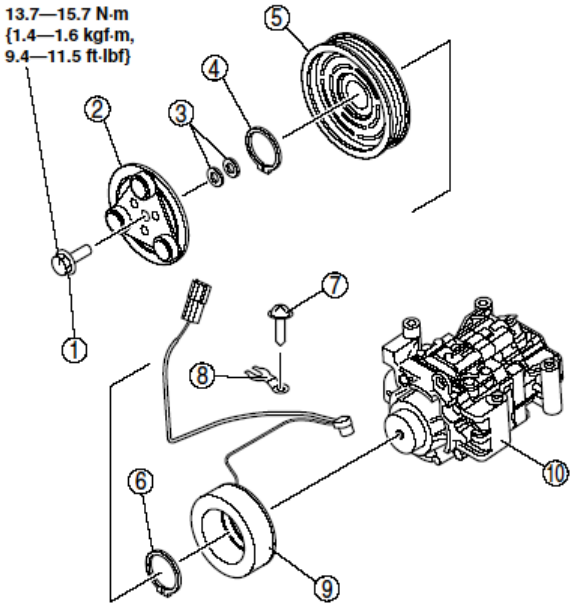
Magnetic clutch

Mazda 3 [Z6, ZY]



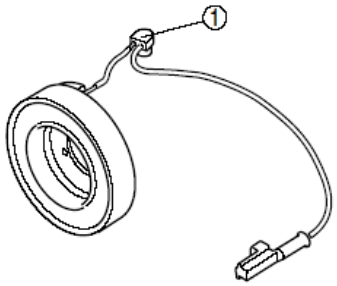
1. Bolt
2. Pressure plate
3. Shim
4. Snap ring
5. A/C compressor pulley
6. Screw
7. Clamp
8. Screw
9. Stator and thermal protector
10. A/C compressor body

Mazda 3 [LF, L3]

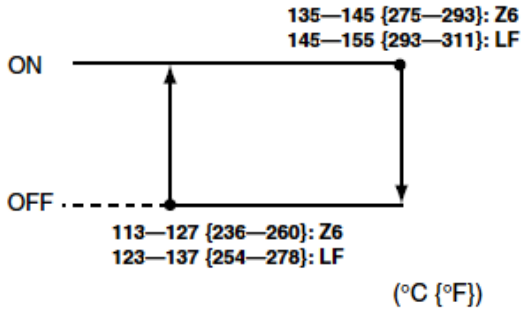


1. Bolt
2. Pressure plate
3. Shim
4. Snap ring
5. A/C compressor pulley
6. Snap ring
7. Screw
8. Clamp
9. Stator and thermal protector
10. A/C compressor body

A bimetallic (Indirect sensing type) type thermal protector is shown in the figure below.

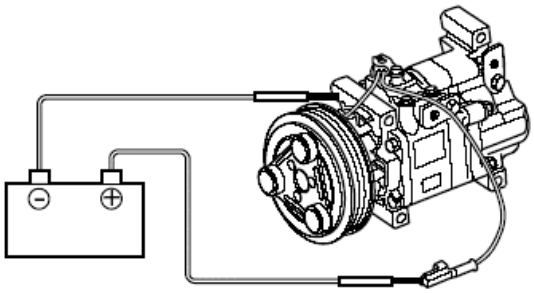


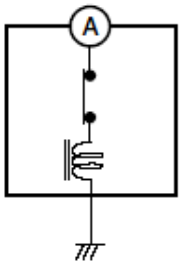
1. Thermal protector

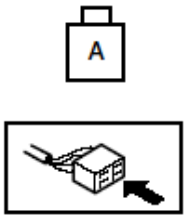


Mazda 3

Magnet clutch function can be checked by directly applying the battery voltage as shown in the figure below.

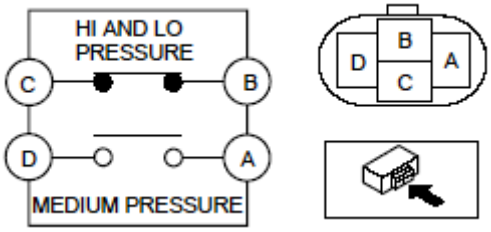


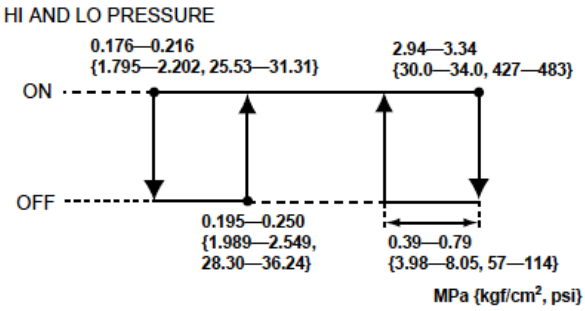




Refrigerant pressure switch

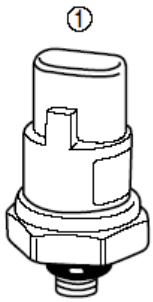
The figure below shows a triple pressure type refrigerant pressure switch that consists of the low/high-pressure switch and the medium-pressure switch. The low/high-pressure switch protects the refrigerant cycle by cutting the A/C signal when pressure in the refrigerant cycle is either abnormally high or low. The medium-pressure switch outputs an idling increase signal according to the A/C compressor operation load.

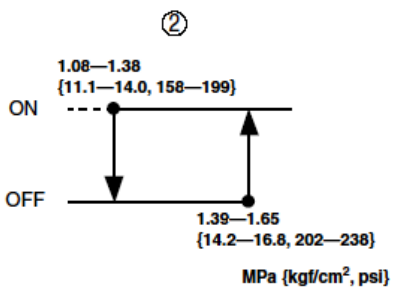


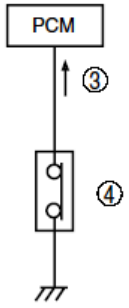


Why do you think the system needs to cut the A/C signal when pressure in the refrigerant cycle is abnormally low? How does it affect the system?

Medium-pressure switch operates when the refrigerant pressure is approx. 1.52 kPa {14.2 kgf·cm2, 202 psi} or more. When it operates, the contact is closed to send an “Idling increase signal” to the PCM. When the A/C is on and an Idling increase signal is input to the PCM, it sends an operation signal to the IAC solenoid valve.

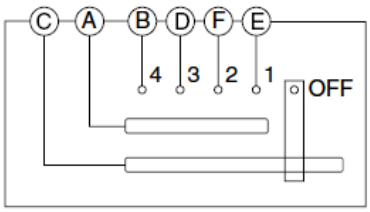


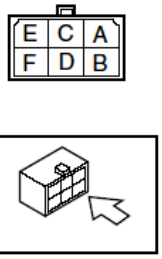




Fan switch

The diagram of fan switch is shown in the figure below. Its function can be verified by checking the continuity between the terminals at a given status of switch position as shown in the table below.



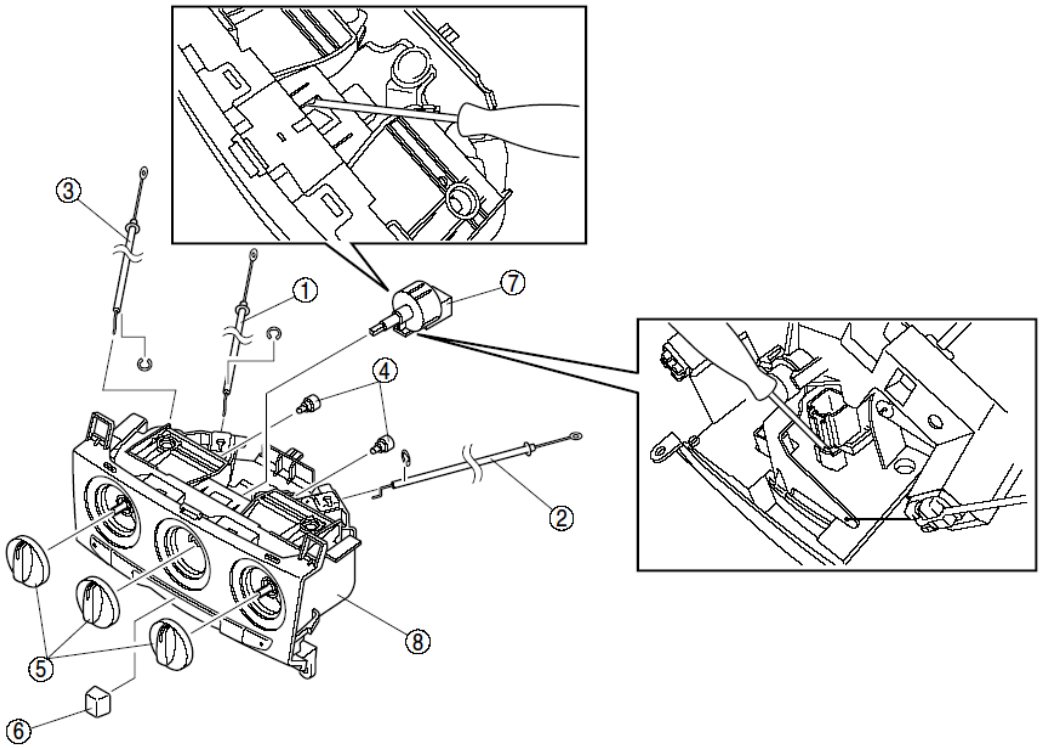


○—○ : Continuity

Switch position	Terminal					
	A	B	C	D	E	F
OFF						
1	○		○		○	
2	○		○			○
3	○		○	○		
4	○	○	○			

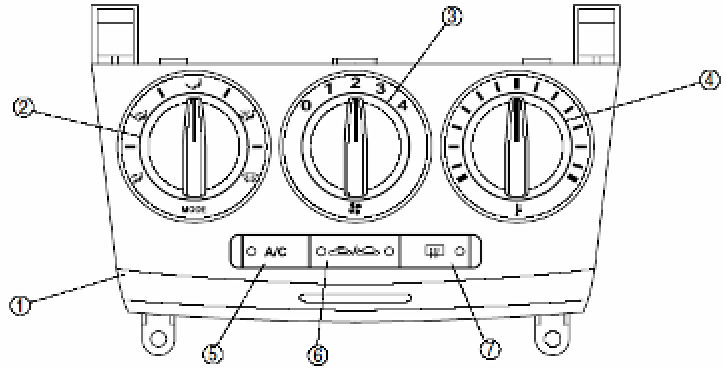
Climate control unit

A wire-type climate control unit is used with the manual air conditioner.



1. Airflow mode wire
2. Air mix wire
3. Air intake wire
4. Illumination bulb
5. Dial
6. Knob
7. Fan switch
8. Body

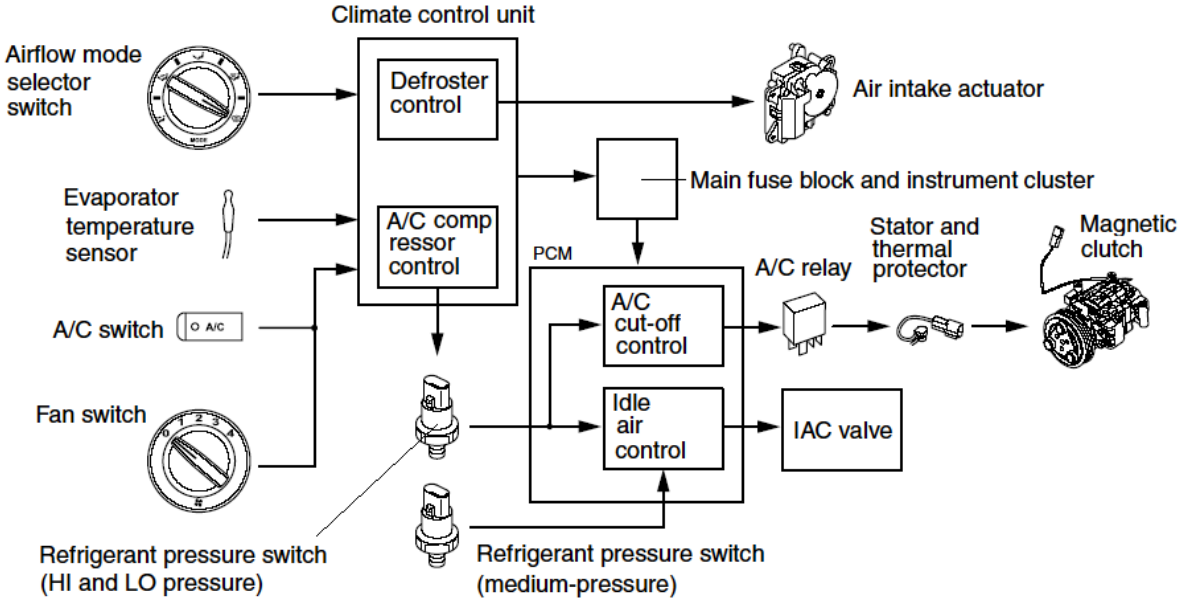
The airflow mode selector dial, temperature control dial, airflow volume control dial have been enlarged to improve ease of operation.



1. Climate control unit
2. Airflow mode selector dial
3. Airflow volume control dial
4. Temperature control dial
5. A/C switch
6. REC/FRESH switch
7. Rear window defroster switch

Block Diagram

The climate control unit sends an A/C signal to the PCM via the main fuse and instrument cluster (PJB and instrument cluster) based on signals sent from the A/C switch, fan switch and evaporator temperature sensor.
The PCM sends operating signals to the A/C relay and IAC valve based on A/C signal and vehicle signal.



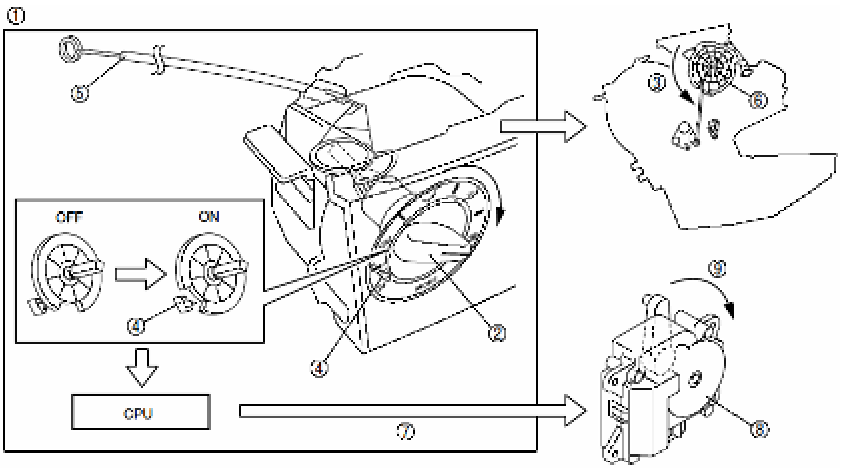
Outline of Control System

Manual air conditioner defroster control and A/C compressor control.

Control name	Control part
Defroster control	Climate control unit
A/C compressor control	Center panel

Defroster Control

1. When the airflow mode selector dial is turned to DEFROSTER position, a wire moves the airflow mode main link, turning the airflow mode to DEFROSTER.
2. The defroster switch turns on at the same time, and the CPU sends a signal to turn the air intake mode to FRESH.
3. The air intake actuator operates and turns the air intake mode to FRESH.



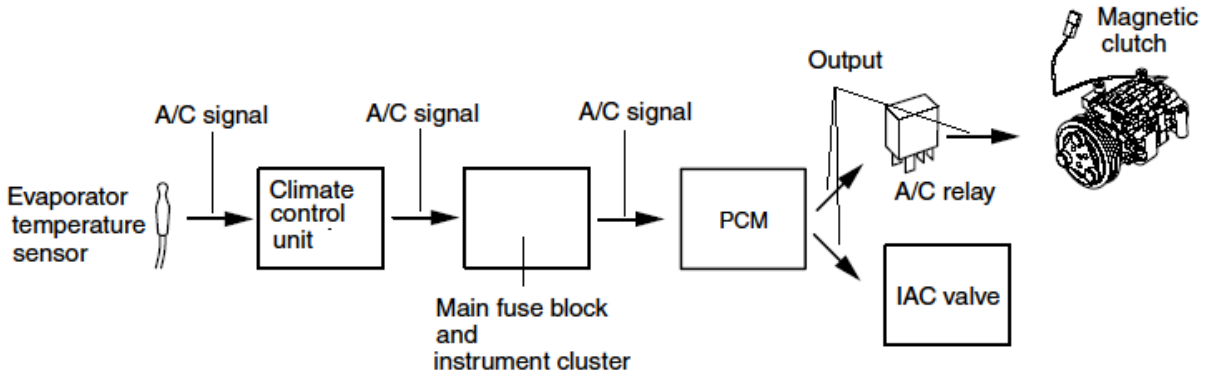
1. Climate control unit
2. Airflow mode selector dial
3. To DEFROSTER position
4. Defroster switch
5. Wire
6. Airflow mode main link
7. FRESH signal
8. Air intake actuator
9. To FRESH position

X: Operates
–: Does not operate

Airflow mode	Air intake mode (REC/FRESH switch pushed)	Defroster control
VENT	REC ⇔ FRESH	–
BI-LEVEL	REC ⇔ FRESH	–
HEAT	REC ⇔ FRESH	–
HEAT/DEF	REC ⇔ FRESH	–
Airflow mode	**Air intake mode (REC/FRESH switch pushed)**	**Defroster control**
DEFROSTER	FRESH	x

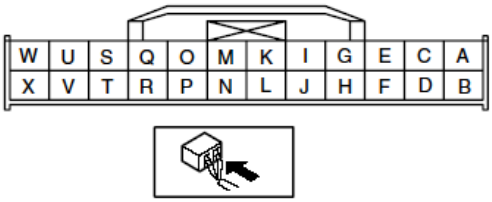
A/C Compressor Control

The climate control unit sends an A/C signal to the PCM via the main fuse block and instrument cluster (PJB and instrument cluster) based on signals sent from the A/C switch, fan switch and evaporator temperature sensor.
The PCM controls the A/C relay and IAC valve based on the input signal from the climate control unit and refrigerant pressure switch.



Climate control unit inspection (Reference)

1. Turn the ignition switch to the ON position.
2. Connect the negative (-) lead of the tester to body ground.
3. By inserting the positive (+) lead of the tester into each climate control unit terminal, measure the voltage according to the terminal voltage table.



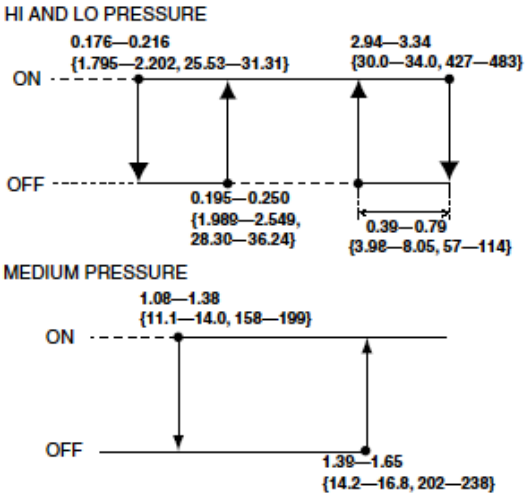
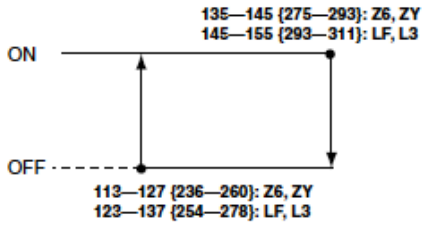
Terminal	Signal name	Connected to	Measurement condition	Voltage (V)	Inspection item (s)
A	—	—	—	—	—
B	—	—	—	—	—
C	—	—	—	—	—
D	B+	ROOM 15 A fuse	Under any condition	B+	• Wiring harness: continuity, short circuit (Climate control unit— fuse: D—ROOM 15 A) • ROOM 15 A fuse
E	—	—	—	—	—
F	IG2	A/C 10 A fuse	IG SW ON	B+	• Wiring harness: continuity, short circuit (Climate control unit— fuse: F—A/C 10 A) • A/C 10 A fuse
			IG SW LOCK	1.0 or less	• Wiring harness: continuity, short circuit (Climate control unit— fuse: F—A/C 10 A)
G	—	—	—	—	—
H	—	—	—	—	—
I	—	—	—	—	—
J	GND	Body ground	Under any condition	1.0 or less	• Wiring harness: continuity (Climate control unit—GND: J—GND)
K	—	—	—	—	—
L	Sensor GND	Evaporator temperature sensor	Under any condition	1.0 or less	• Climate control unit: terminal voltage (J)
M	A/C	PJB	A/C switch ON, fan switch at 1st	1.0 or less	• Wiring harness: continuity (Climate control unit—PJB: M—J-04 AF)
			A/C switch OFF	B+	• Wiring harness: continuity, short circuit (Climate control unit—PJB: M—J-04 AF) • PJB
N	Evaporator temperature sensor input	Evaporator temperature sensor	Compared with temperature detected by evaporator temperature sensor	Refer to graph 1	• Wiring harness: continuity (Climate control unit—evaporator temperature sensor: N—B, L—A) • Wiring harness: short circuit (Climate control unit—evaporator temperature sensor: N—B) • Evaporator temperature sensor • Climate control unit: terminal voltage (F, J)
O	—	—	—	—	—
P	Rear window defroster switch indicator light	PJB	Rear window defroster switch ON	1.0 or less	• Wiring harness: continuity (Climate control unit—PJB: P—J-04 I) • PJB
			Rear window defroster switch OFF	4.0	• Wiring harness: short circuit (Climate control unit—PJB: P—J-04 I) • PJB
Q	—	—	—	—	—

(Cont'd)

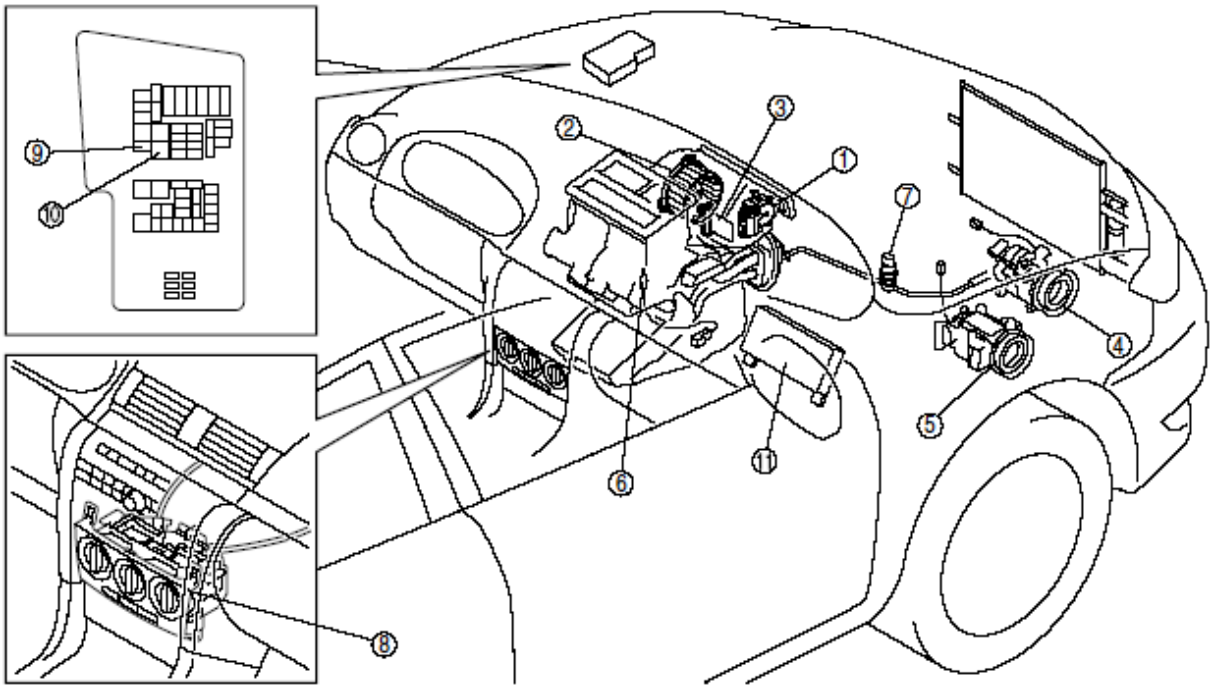
Terminal	Signal name	Connected to	Measurement condition	Voltage (V)	Inspection item (s)
R	Rear window defroster switch	PJB	Rear window defroster switch ON	10 or less	• Wiring harness: continuity, short circuit (Climate control unit—PJB: R—J-04 AD) • Climate control unit: terminal voltage (J) • PJB
			Rear window defroster switch OFF	10 or less	• Wiring harness: continuity, short circuit (Climate control unit—PJB: R—J-04 AD) • PJB
S	—	—	—	—	—
T	FAN signal	Fan switch	FAN switch ON	1.0 or less	• Wiring harness: continuity (Climate control unit—fan switch: T—A) • Fan switch
			FAN switch OFF	4.4	• Wiring harness: continuity (Climate control unit—fan switch: T—A) • Climate control unit: terminal voltage (F) • Fan switch
U	TNS signal	Panel light control switch	Headlight switch OFF	1.0 or less	• Wiring harness: continuity (Climate control unit—panel light control switch: U—F) • Panel light control switch • Climate control unit: terminal voltage (V)
			Headlight switch ON	12	• Wiring harness: short circuit (Climate control unit—panel light control switch: U—F)
V	TNS signal	PJB	Headlight switch OFF	1.0 or less	• Wiring harness: short circuit (Climate control unit—PJB: V—J-03 H) • PJB • Headlight switch
			Headlight switch ON	B+	• Wiring harness: continuity, short circuit (Climate control unit—PJB: V—J-03 H) • PJB • Headlight switch
W	—	—	—	—	—
X	—	—	—	—	—

Technical Data

Item			Specification
Airflow volume (during heater operation)	Blower motor	(m^3/h)	300
Electricity consumption (during heater operation)	Blower motor	(W)	256
Airflow volume (during air conditioner operation)	Blower motor	(m^3/h)	450
Electricity consumption (during air conditioner operation)	Blower motor	(W)	256
	Magnetic clutch	(W)	46.0: Z6, ZY 49.7: LF, L3
Magnetic clutch clearance		(mm {in})	0.3—0.5 {0.012—0.019}
Fan type	Blower motor		Sirocco fan

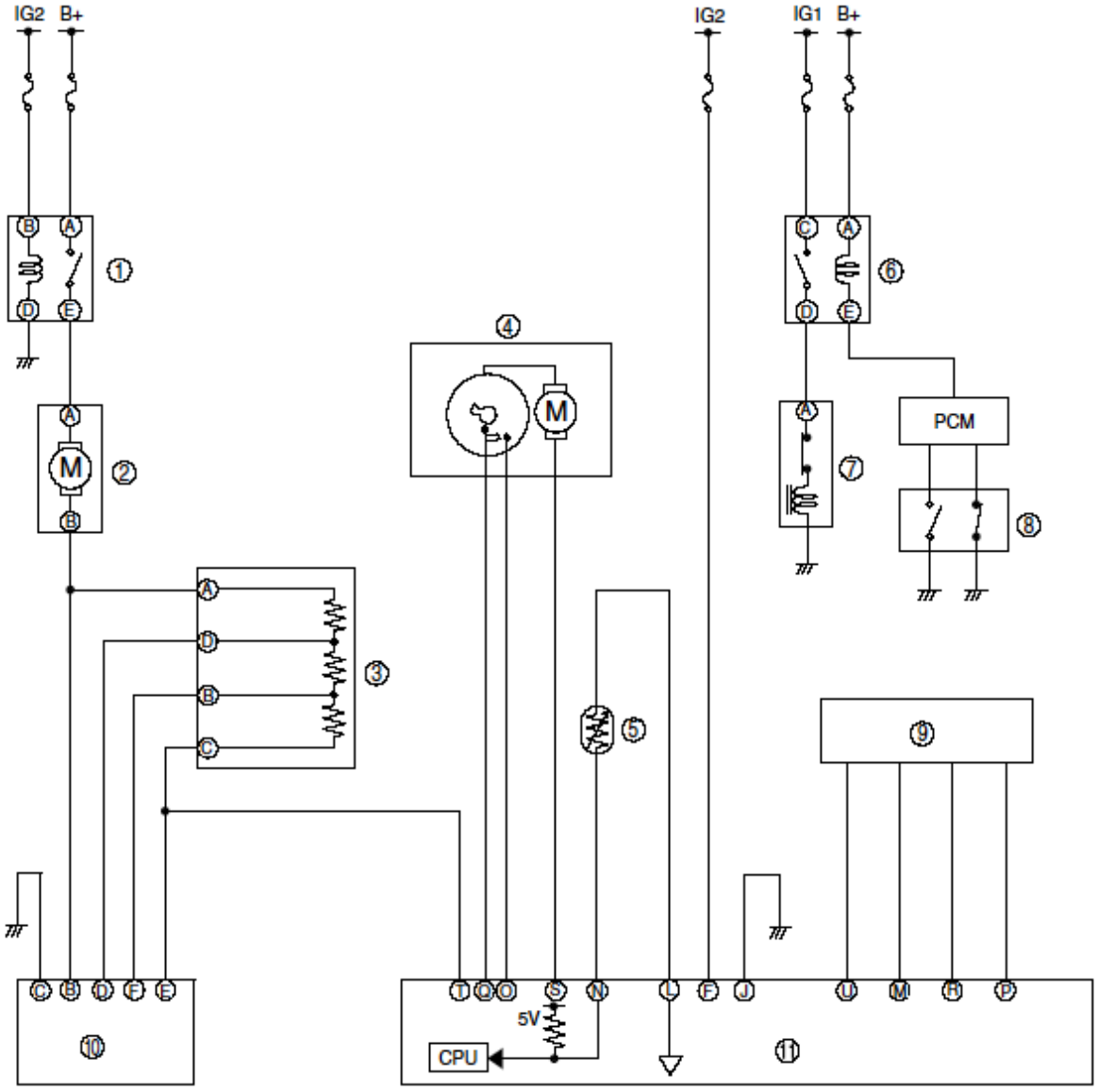
Item		Specification
Refrigerant pressure switch	Type	Triple-pressure
	Operating pressure (MPa {kgf/cm^2, psi})	
Thermal protector	Type	Bimetallic (Indirect sensing type)
	Operating temperature (°C {°F})	
Sensor	Evaporator temperature sensor	Thermistor

Review Exercises



1. Refer to the illustration and place the number of each component by the correct description.

Air Intake actuator	_____
Resistor	_____
Evaporator temperature sensor	_____
Main fuse block	_____
Blower relay	_____
Climate control unit	_____
Refrigerant pressure switch	_____
A/C Relay	_____
Blower Motor	_____
Magnetic clutch (Z6)	_____
Magnetic clutch (LF)	_____



2. In the above manual wiring diagram identify the components and place the number beside the correct description.

Blower Relay	_____	**Air Intake Actuator**	_____
Blower Motor	_____	**Magnetic Clutch**	_____
A/C Relay	_____	**Fan Switch**	_____

3. Describe the operation of the blower motor resistor.

4. Describe the function of the "Air Intake Actuator".

5. Describe the function of the "Evaporator Temperature Sensor".

6. Describe the function of the "Medium Pressure Switch".

Technician Name _____

Units and Parts Checks [Manual Air Conditioner]

Purpose: After completing this activity, you will be able to perform checks for Air Conditioner components.

What you will need to complete this activity:

- Current model vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual
- DVOM (Digital Volts/Ohm Meter)

NOTE:
Most of units and parts can be checked individually. To avoid any damage on vehicle, it is recommended to prepare units and parts.

NOTE:
This activity sheets are designed based on Mazda 3 technical information. It's recommended to provide Mazda 3 and/or units and parts for Mazda 3.

AC – 05 is an optional activity. If units and parts are not available, this activity is to be cancelled.

Blower relay

Check continuities Step 1 and 2.

Continuity Step 1: OK / NG

Continuity Step 2: OK / NG

Blower motor

Inspect by directly applying battery voltage.

Operation: OK / NG

Resistor

Measure the resistances.

A – D: _____ ohm, Condition OK / NG

A – B: _____ ohm, Condition OK / NG

A – C: _____ ohm, Condition OK / NG

Air intake actuator

Check the air intake actuator for its function by directly applying the battery voltage.

C (B+) – G (Ground): Operation OK / NG

G (B+) – E (Ground): Operation OK / NG

Evaporator temperature sensor

Measure the resistance between the evaporator temperature sensor terminals.

Resistance: _____ ohm at _____ ºC

Resistance: _____ ohm at _____ ºC

A/C relay

Check continuities Step 1 and 2.

Continuity Step 1: OK / NG, Continuity Step 2: OK / NG

Magnetic clutch

Connect battery positive voltage to magnetic clutch terminal A and the A/C compressor body to ground.

Operation: OK / NG

Refrigerant pressure switch

1. Install the manifold gauge.
2. Disconnect the refrigerant pressure switch connector.
3. Verify the high-pressure side reading of the manifold gauge and continuity between the refrigerant pressure switch terminals.

Continuity: OK / NG at _____ psi

Fan switch

Remove the climate control unit. Verify that the continuity between the fan switch terminals is as indicated in the table.

Continuity (switch position OFF): OK / NG

Continuity (switch position 1): OK / NG

Continuity (switch position 2): OK / NG

Continuity (switch position 3): OK / NG

Continuity (switch position 4): OK / NG

Note
Refer to the workshop manual to remove the fan switch.

Climate control unit inspection

Terminal	Signal name	Connected to	Measurement condition	Voltage (V)	Remark
D	B+	ROOM 15 A fuse	Under any condition		
F	IG2	A/C 10 A fuse	IG SW ON		
			IG SW LOCK		
J	GND	Body ground	Under any condition		
L	Sensor GND	Evaporator temperature sensor	Under any condition		
M	A/C	PJB	A/C switch ON, fan switch at 1st		
			A/C switch OFF		
N	Evaporator temperature sensor input	Evaporator temperature sensor	Compared with temperature detected by evaporator temperature sensor		
P	Rear window defroster switch indicator light	PJB	Rear window defroster switch ON		
			Rear window defroster switch OFF		
R	Rear window defroster switch	PJB	Rear window defroster switch ON		
			Rear window defroster switch OFF		
T	FAN signal	Fan switch	FAN switch ON		
			FAN switch OFF		
U	TNS signal	Panel light control switch	Headlight switch OFF		
			Headlight switch		
V	TNS signal	PJB	Headlight switch OFF		
			Headlight switch ON		

Instructor Sign-Off:
Now that you have completed this activity, you should be able to:

- Perform checks for A/C components

This skill will help you evaluate protection devices for correct operation.

Instructor's initials: _____

Technician Name _____

Symptom Troubleshooting [Manual Air Conditioner]

Purpose: After completing this activity, you will be able to diagnose trouble cause by using Symptom based approach.

What you will need to complete this activity:

- Current model vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual
- DVOM (Digital Volts/Ohm Meter)

NOTE
The purpose of this activity is to experience symptom troubleshooting to diagnose logically. Try not to find the defect setting by just guesswork.

NOTE
This activity sheets are designed based on Mazda 3 technical information. It's recommended to provide Mazda 3.

Troubleshooting Index

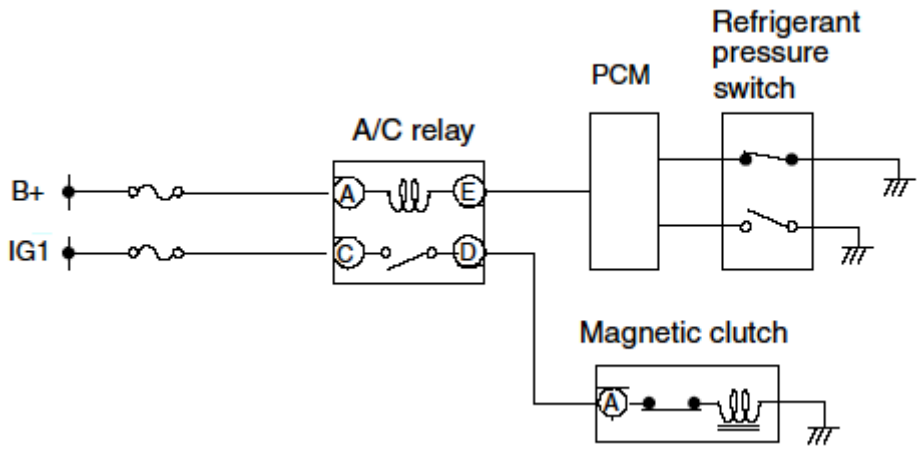
No.	TROUBLESHOOTING ITEM	TROUBLESHOOTING ITEM
1	Insufficient air (or no air) blown from vents	• Problem with each vent and/or duct
2	Amount of air blown from vents does not change. (Full-auto air conditioner)	• Malfunction in blower system
3	Amount of air blown from vents does not change. (Manual air conditioner)	• Malfunction in blower system
4	Air intake mode does not change.	• Air intake mode does not change when switching REC/FRESH mode.
5	No temperature control with climate control unit	• Malfunction in A/C unit and/or climate control unit air mix system
6	Windshield fogged.	• A/C compressor does not operate while airflow mode is in DEFROSTER or HEAT/DEF modes.
7	Air from vents not cold enough	• Magnetic clutch operates but A/C system malfunctions.
8	No cool air	• Magnetic clutch does not operate.
9	Noise while operating A/C system	• Noise from magnetic clutch, A/C compressor, hose or refrigerant line

8 No cool air (DESCRIPTION: Magnetic clutch does not operate.)

Among the nine troubleshooting items indicated on the previous page, we see the item No. 8 to learn how to diagnose Air Conditioner.

Preparatory study

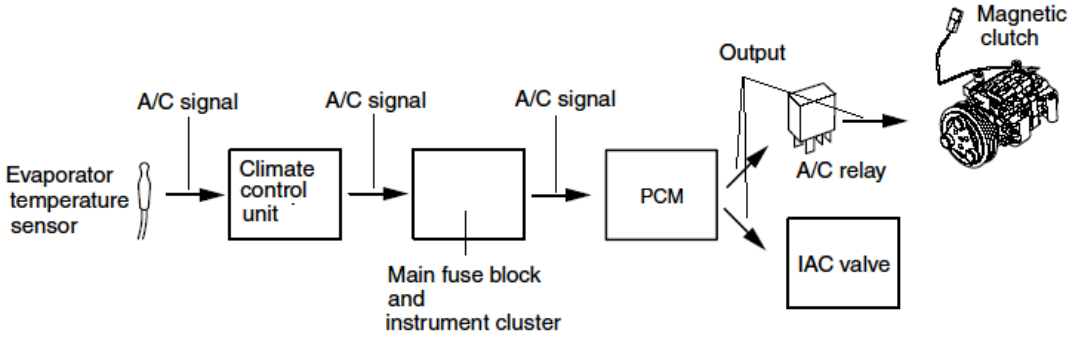
As it's given the description "Magnetic clutch does not operate", the trouble is with an electrical/electronic device. See the Magnetic clutch circuit below. The magnetic clutch is activated when the PCM ground the coil inside the A/C relay to close the contact of the relay. Magnetic clutch is grounded through its body; an open circuit between Magnetic clutch and ground is unlikely occurred. If the magnetic clutch doesn't operate with battery voltage applied through the A/C relay, the magnetic clutch may be faulty. Thermal protector inside the Magnetic clutch opens the circuit when its temperature is approximately 120 ºC or more.



Look at the diagram above; predict the voltage at each terminal given in the table below during each status.

Part name	Terminal	Status		
		IG switch OFF	IG switch ON	PCM ground the coil inside A/C relay
A/C relay	**A**	V	V	V
	E	V	V	V
	C	V	V	V
	D	V	V	V
Magnetic clutch	**A**	V	V	V

The figure below describes the A/C Compressor Control. The climate control unit sends an A/C signal to the PCM via the main fuse block and instrument cluster (PJB and instrument cluster) based on signals sent from the A/C switch, fan switch and evaporator temperature sensor.



Chose the correct status or insert an appropriate number to complete the conditions that the PCM will close the circuit of the A/C relay to supply power activating the magnetic clutch.

1. A/C switch: **ON / OFF**.

2. Fan switch: **OFF position / Other than OFF position (1, 2, 3, or 4)**.

3. Evaporator temperature sensor: _____ **V or more**
   (4.5 ºC or more)

4. Refrigerant pressure switch: **ON / OFF**.
   (Between 0.2 and 3.0 MPa)

Service Tip

1. The LED on the A/C switch goes on when the switch is on. This proves the switch operates properly. However, it doesn't exactly tell you the climate control unit receives the signal.
2. If the blower motor activated with the Fan switch turned on, it proves the Fan switch is working properly.
4. If there is no refrigerant, the Refrigerant pressure switch is off.

POSSIBLE CAUSE

• A/C relay malfunction (Step 2)
• A/C compressor malfunction (Step 3)
• Evaporator temperature sensor malfunction (Step 4)

STEP INSPECTION ACTION

1 INSPECT AIR BLOW OUT
• Does air blow out?
Yes Go to the next step.
No Go to Step 1 of troubleshooting indexes No.1 and 2.

2 INSPECT FUSE
• Are the A/C relay power supply fuses normal?
Yes Go to the next step.
No Replace the fuse, then go to Step 5. If fuse burns out immediately, go to the next step.

3 INSPECT A/C COMPRESSOR OPERATION
• Start the engine.
• Turn the A/C switch and fan switch on.
• Does the A/C compressor operate?
Yes Go to Step 1 of troubleshooting index No.7.
No Go to the next step.

4 INSPECT EVAPORATOR TEMPERATURE SENSOR
• Inspect the evaporator temperature sensor.
• Is it normal?
Yes Go to the next step.
No Replace the evaporator temperature sensor, then go to the next step.

5 CONFIRM THAT MALFUNCTION SYMPTOMS DO NOT RECUR AFTER REPAIR
• Does cool air blow out? (Are the results of refrigerant system performance test normal?)
Yes Troubleshooting completed. Explain repairs to customer.
No Recheck malfunction symptoms, then repeat from Step 1 if the malfunction recurs.

Repair Order

Name of student:	Total score:	

Description/Procedure/Remarks/Results	Score

Instructor Sign-Off:
Now that you have completed this activity, you should be able to:

- Isolate trouble cause based on Symptom based approach

This skill will help you evaluate protection devices for correct operation.

Instructor's initials: