SUBARU

QUALITY DRIVEN® SERVICE

CERTIFIED SUBARU TECHNICIAN

Technicians Reference Booklet

Heating , Ventilation and Air Conditioning (HVAC)

Module 603

AUTOMOTIVE Youth Educational Systems

September 2005

MSA5P0137C

Technical Training

Subaru of America, Inc. reserves the right at any time to make changes or modifications to systems, procedures, descriptions, and illustrations contained in this book without necessarily updating this document. Information contained herein is considered current as of September 2005.

Table of Contents

Introduction

This Technician's Reference Booklet, reviews the Basic Theory and Operating Characteristics of Subaru Heating, Ventilation, and Air Conditioning Systems. The text and illustrations are derived from and follow the classroom lectures and PowerPoint presentations. They are intended to supplement and reinforce classroom instruction, and serve as a home-study reference source.

NOTE: ALWAYS REFER TO THE APPROPRIATE MODEL YEAR SUBARU SERVICE MANUAL AND THE APPLICABLE SERVICE BULLETINS FOR ALL SPECIFICATIONS AND DETAILED SERVICING PROCEDURES.

Pages for Diagnostic Tips and Notes are also provided. Technician worksheets are to be completed during the hands-on lab work segments of the HVAC Module.

General Overview

A/C Label

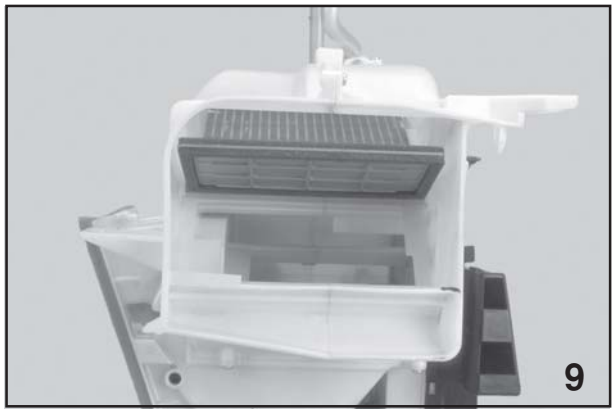
It is very important to first identify the refrigerant type and the manufacturer of the HVAC System. This information, along with refrigerant charge level, lubricating oil type and quantity, can be found on the A/C System Identification Label. The Label is located inside the engine compartment. The information can also be found within the Service Manual.

CAUTION: IT IS VITAL THAT ONLY THE CORRECT COMPONENT FOR THE SYSTEM TYPE BE USED OR SYSTEM PERFORMANCE COULD BE AFFECTED.

Heating

Heater Core

The heat source comes from the heated coolant that is routed through the Heat Exchanger or Heater Core. There is no coolant shut-off valve, so once the engine coolant has reached optimum operating temperature, there is a constant supply of heat available when needed. The air that is forced through the Heater Core by the Blower Motor absorbs the heat provided by the engine coolant.

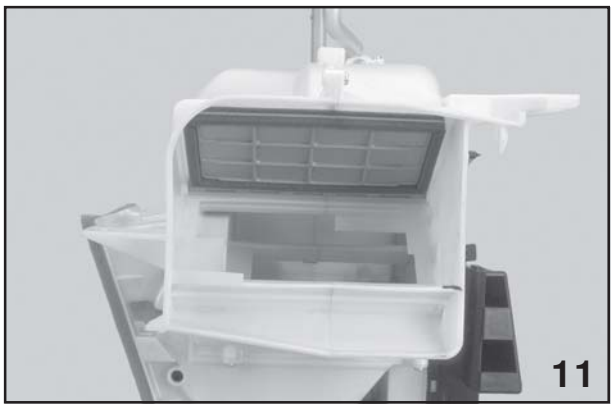


Heater Chamber

This heat is isolated within the Heater Chamber by a door or a series of doors.

Heater Door open

When the heat is not needed, it is very important that the heat source is completely isolated from the airflow, or a Poor A/C Performance complaint might occur.



Heater Door closed

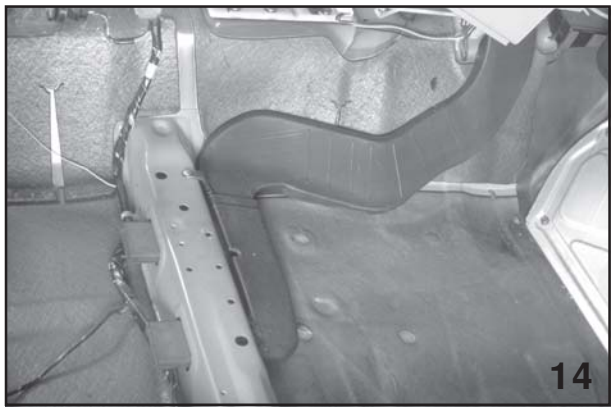
EXAMPLE: AIR-MIX DOORS ARE NOT CLOSING PROPERLY DUE TO INCORRECT ADJUSTMENT OR DAMAGED FOAM SURROUNDING THE DOOR.

NOTE: IF A/C SYSTEM OPERATING PRESSURES ARE WITHIN SPECIFICATIONS AND THE VENT TEMPERATURE IS TOO HIGH, MAKE SURE YOU CHECK TO SEE IF THE HEAT IS ISOLATED WITHIN THE HEATER CHAMBER AND NO HEATED AIR IS MIXING WITH THE AIR EXITING THE EVAPORATOR CORE.

Seat Heaters

Front Seat Heater

Some later model vehicles offer seat heaters for the driver and front passenger. The seat heaters have internal heating elements with thermostats to control heating.



Ducts under Front Seat

Certain model year vehicles have heater ducts routed below the front seats, to offer heating for the passengers seated in the rear seats.

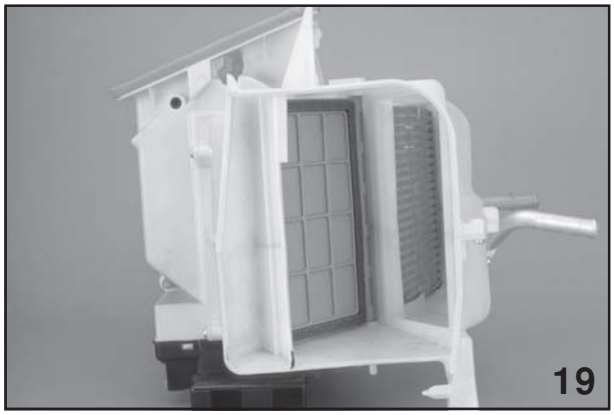
Ventilation

The ventilation system consists of modules that include the blower motor assembly, the evaporator assembly and the heater assembly

Blower Motor Assembly

Evaporator Assembly

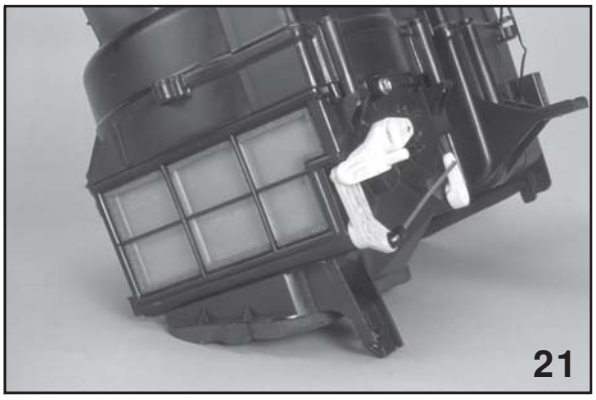
Heater Core



Heater Core installed

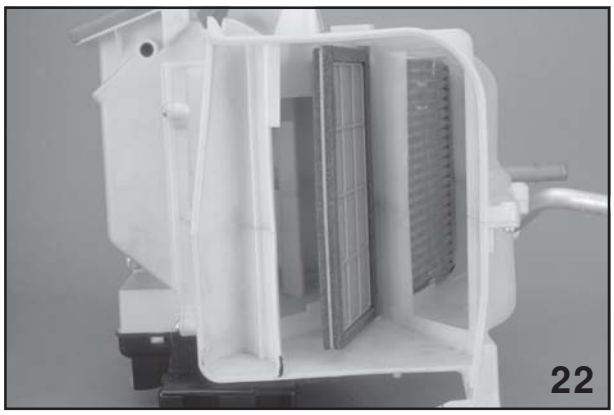
NOTE: IF THE VEHICLE IS NOT EQUIPPED WITH AIR CONDITIONING; A TRANSITION DUCT INCLUDING THE BLOWER RESISTOR IS USED TO CARRY THE AIR FROM THE BLOWER MODULE TO THE HEATER MODULE.

Air Source - Recirculate

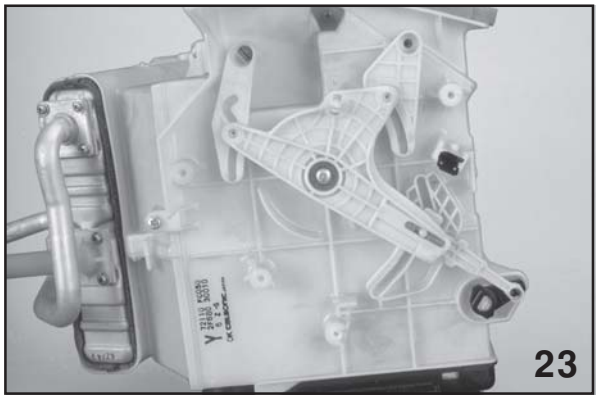


Air Source - Fresh

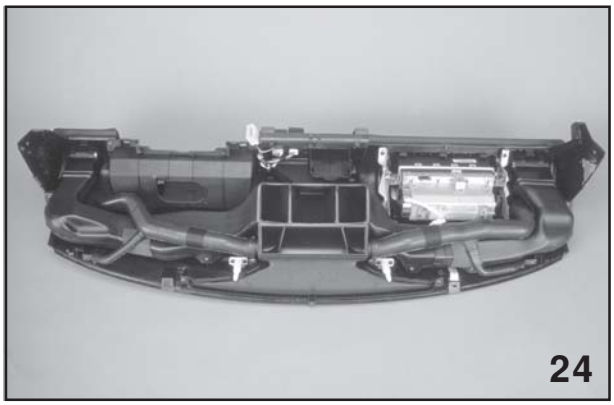
A door or a series of doors are moved by either a cable or an Actuator Motor to control the air source, the air blend or air-mix doors, and the air direction or mode doors.



Air Blend or Air - Mix doors



Mode doors



Air Ducts

Air ducts are utilized to direct the airflow from the modules to the outlet vents.

Air Vents

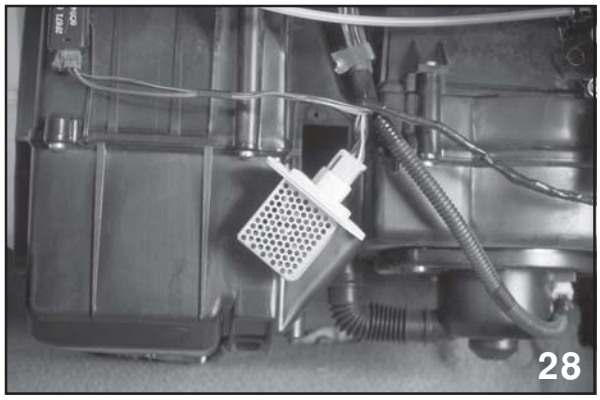
The outlet vents are louvered to direct the airflow as it exits the air ducts. Some model vehicles have outlet vents that can be shut off to stop airflow through the vent.

Blower Motor

The Blower Motor supplies the airflow.

Manual Controls

The Fan Control located on the dash, controls the blower motor speeds.



Resistor Block

A resistor block consisting of three internal resistors is used to control the blower circuit voltage on Manual Systems. For low speed, the negative signal from the control panel passes through three resistors within the resistor block, which lowers the circuit operating voltage. For fan speed number two, the signal is routed through two resistors, offering less resistance and more voltage. For number three-fan speed, the negative signal from the control panel is routed through only one resistor, the voltage supply to the blower circuit is increased, and the fan speed increases. For high fan speed there is no added restriction in the circuit. Due to the high heat that develops as the signal passes through the resistors, a fusible solder is used to protect against the heat. The solder will melt and open the circuit within the resistor block, if the heat is too high.

With Automatic and Semi-Automatic Climate Control Systems, the blower motor circuit signal is routed through a Power Transistor that restricts the circuit in all but high speed. The signal from the control panel is sent to the Automatic Climate Control Module. The signal is processed, and an output signal is sent to the Power Transistor. The base voltage of the Power Transistor changes due to the signal from the Control Module, thereby changing the blower speeds.

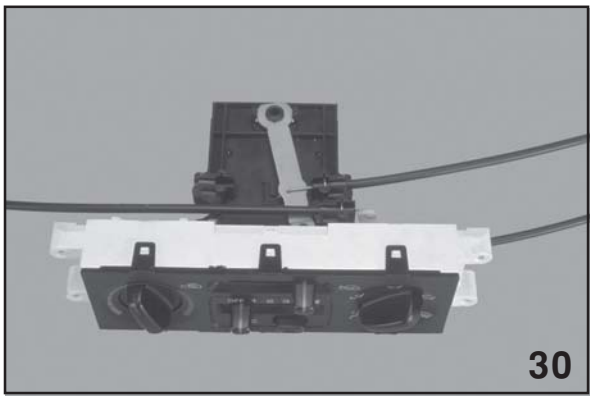
NOTE: BOTH THE RESISTOR BLOCK AND THE POWER TRANSISTOR, CREATE HIGH HEAT DURING OPERATION. A HEAT SINK IS BUILT INTO THE COMPONENT TO ABSORB AND HOLD THE HEAT. THE AIR- FLOW, CREATED BY THE BLOWER FAN, HELPS TO DISSIPATE THE HEAT AS IT PASSES ACROSS THE HEAT SINK. DO NOT OPERATE THE BLOWER MOTOR WITH EITHER COMPONENT REMOVED FROM THE AIR STREAM OR DAMAGE TO THE COMPONENT WILL OCCUR.

Air Conditioning

General Overview

All Subaru Air Conditioning systems are cycling systems. A cycling system prohibits an evaporator freeze condition by cycling the air compressor off when the air off evaporator temperature approaches 32° F. The advantage of a cycling system is a rapid cool down time.

Manual System



Manual Controls

The operator controls the air mode, air blend, air source, air speed, and compressor engagement, by manually setting the controls at the Control Panel. Later models will automatically engage the compressor when the Defrost and Defrost/Heat modes are selected, as well as directing the air source to fresh.

Automatic and Semi-Automatic Climate Control Systems

Auto Control Panel

The operator chooses the temperature setting on an Automatic and Semi Automatic Climate Control System, a series of sensors then send input signals to a Control Module. The Automatic Climate Control Module will then process the signals and send output signals to the Actuators, Blower Motor, and the Engine Control Module. This will control the air mode, air blend, air source, air speed, and compressor engagement. Automatic or Semi Automatic Climate Control Systems can also be operated in a manual mode if the operator so chooses.

Automatic and Semi-Automatic Climate Control Systems also have a self-diagnostic function or "D" Check Mode. This self-diagnostic function will check the sensor circuits, operate the compressor, operate the blower motor, and will also check Actuator operation.

Please consult the appropriate service manual for self-diagnostic mode application.

Control Panel

HVAC Display Panel

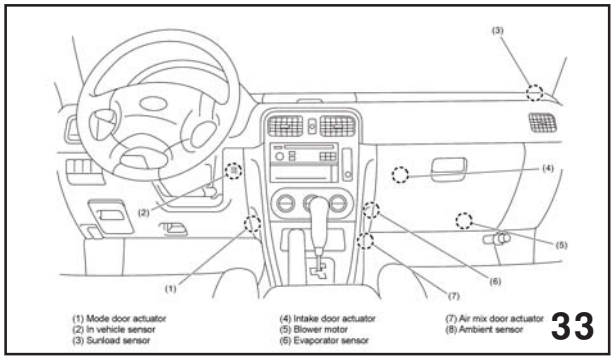
The HVAC Control panel gives the user the opportunity to select temperature output, compressor engagement, air direction and air source. In later model systems, the air compressor will become engaged and the air source moved to fresh, anytime the air direction is in the "Defrost or Defrost/Heat" mode. There is also a delay built into the controls for compressor engagement.

A Zoned Air Control Panel was introduced in limited 2005 Model Year vehicles. This gives the Passenger their own temperature control.

To avoid a "musty" type of smell upon start up, it is recommended to move the air source to Fresh before shutting down the system. This gives the Evaporator Assembly the opportunity to "breath".

Please consult the appropriate Service Manual and/or User's guide for detailed data regarding Control Panel operation.

Sensors



Sensor / Actuator Location

Sensors provide input to the Automatic and Semi Automatic Climate Control Module. The Control Module processes the signals and then sends output signals to the Actuators, Blower Motor, and Engine Control Module (ECM). The Climate Control's Self-Diagnostic Mode will check the Sensor Circuits for an "Open" or "Shorted" condition. The self-diagnostic function will not check for an incorrect sensor signal. If the Sensor is sending an incorrect signal to the Control Module, system performance problems could develop.

Example: If the Cabin Sensor sends a signal that the Control Module interprets as 68 degrees, but the actual cabin temperature is 98 degrees, a poor performance complaint might be reported. Since the sensor input signal to the Control Module directly affects the Control Module output signal. Please consult the appropriate service manual for diagnosing a sensor whose signal is suspect.

Cabin Sensor

Aspirator Intake

The Cabin, or In-Vehicle Sensor, uses an Aspirator Tube to draw cabin air to the sensor. The air stream from the blower motor exiting the center vent outlet acts as a vacuum to draw the air into the aspirator tube. The sensor detects the cabin air temperature as it passes and converts the temperature to a signal that is then input to the Control Module where it is processed. The higher the temperature, the lower the resistance value in the circuit, therefore the higher the voltage signal. Always make sure that the aspirator tube is correctly positioned when servicing the control unit or other dash components.

Ambient Sensor

The Ambient Sensor measures the temperature of the ambient, or outside air, which is input to the Control Module. Due to its construction, the ambient sensor can only measure an average outside temperature and does not respond to sharp temperature changes quickly.

NOTE:REVIEW SERVICE BULLETIN

Number 10-75-04 Date: 09/24/04
15-112-04

APPLICABILITY: 2005MY LEGACY & OUTBACK VEHICLES

SUBJECT: AUDIO AND AUDIO/HVAC DIAGNOSTIC FACEPLATE

Sun Load Sensor

A photosensitive diode is used in the construction of the Sun Load Sensor. The sensor detects changes in the sun's intensity and converts it into a small current, which is then input to the Control Module. This sensor will effect the target location of the air blend actuator.

NOTE: A HIGH INTENSITY INCANDESCENT SHOP LIGHT MUST BE USED WHEN TESTING THE SUN-LOAD SENSOR OR AN "OPEN" CIRCUIT COULD EXIST WHILE CHECKING THE SYSTEM IN THE SELF-DIAGNOSTIC MODE.

Evaporator Sensor

Evaporator Sensor

This sensor is located at the air outlet side of the Evaporator Core. It is positioned on the evaporator core at a location that develops the coldest air off evaporator temperatures. This sensor inputs a value to the ECM, which changes with temperature. If the temperature approaches the freezing level, the ECM will cut the output signal to the Compressor Clutch Circuit.

NOTE: CONSULT THE SERVICE MANUAL FOR THE "CYCLE OFF" TEMPERATURE SETTING OF THE SENSOR.

Refrigerant Temperature Sensor

This sensor is only found on the SVX Automatic Climate Control system. This sensor is installed on the inlet side of the evaporator piping. The refrigerant Temperature sensor inputs a value to the ECM, which changes with temperature.

Coolant Temperature Sensor

This sensor is only found on the SVX and early Legacy Automatic Climate Control systems. It detects the coolant temperature at the heater core then inputs it to the Control Module.

Control Module

Control Module

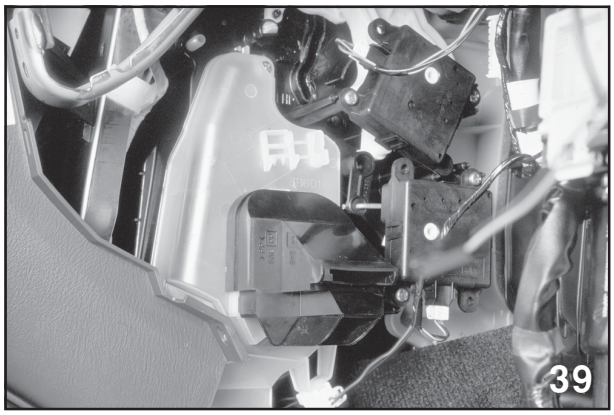
The Automatic and Semi-Automatic Climate Control Module is a microprocessor that receives input from the Controls, Sensors, and Actuators, processes the information and then delivers output signals to the Actuators, Blower Motor, and the ECM.

For 2005 vehicles with CAN Communications, the control module is part of the Low Speed CAN that communicates with the BIU.

NOTE: CONNECTING THE BATTERY IN REVERSE POLARITY COULD DAMAGE THE AUTOMATIC CLIMATE CONTROL UNIT.

WARNING: A SRS WIRING HARNESS IS ROUTED CLOSE TO THE CONTROL MODULE; TAKE CARE NOT TO DAMAGE THE HARNESS WHEN SERVICING THE MODULE.

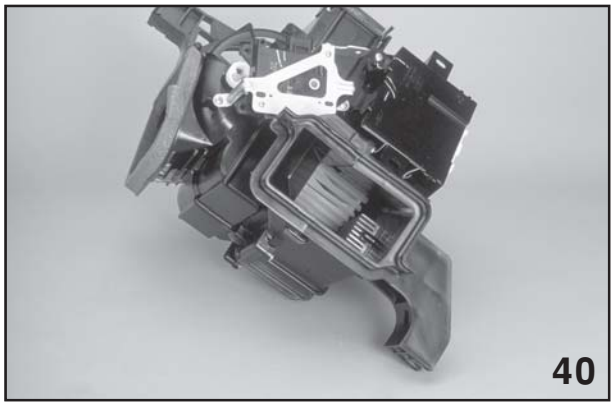
Actuators



Actuators

Actuators are used to position doors within the HVAC Modules, directing airflow by utilizing bidirectional motors. Actuators are used in Manual, Automatic, and Semi-Automatic Climate Control Systems. Mode and Air Blend Actuators have a signal wire to let the Control Module know the position of the doors.

Air Source Actuator

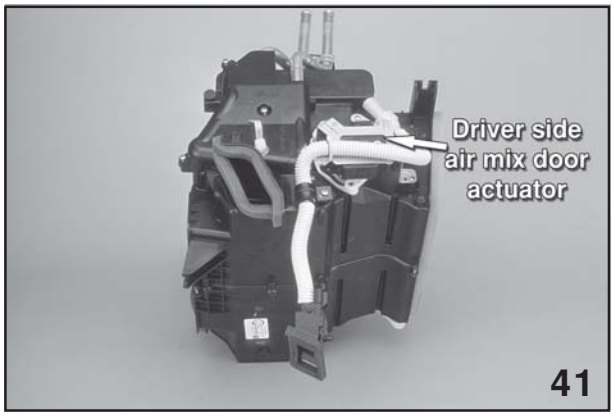


Air Source Actuator

The air source actuator positions a door to introduce either fresh or recirculated air to the HVAC system. The actuator receives its signal from the Control Module on an Automatic System, and from the Control Panel on a Manual and Semi-Automatic System.

On later model vehicles, the actuator will automatically move to the fresh air position when the Defrost and/or Defrost/Heat modes are selected. On early systems, the air source door would only stay in recirculate for a certain time period.

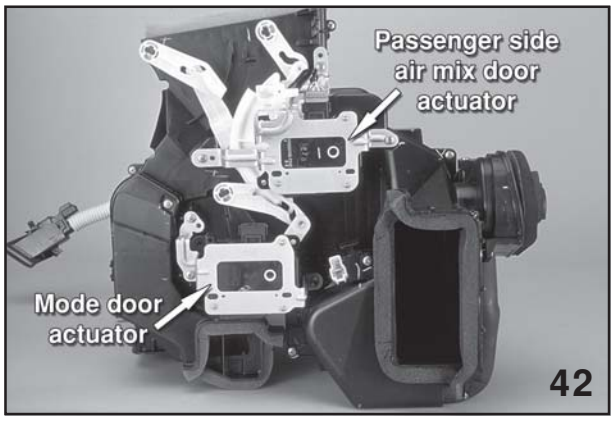
Air Mix Actuator



Air Mix Actuator

The air blend or air mix actuator controls the amount of heated air from the heat exchanger introduced to the airflow from the blower motor by moving one or more doors. This actuator is found only on Automatic and Semi-Automatic Climate Control Systems. This actuator provides a signal wire back to the HVAC Control Module indicating its position. For vehicles with Zoned Air, there are two air mix actuators.

Air Mode Actuator



Air Mode Actuator

The air mode actuator controls the direction of the airflow as it enters the cabin area. The actuator is driven to a fixed location by input signals from the Control Module on Automatic Systems and from the Control Panel on Semi-Automatic and Manual systems. The actuator drives a series of doors that are timed with rods and levers to a fixed location depending on the mode setting. This actuator provides a signal back to the HVAC Control Module indicating its position.

The number of modes available change with different model years, please consult the Service Manual or Owner's Operation Guide for mode selections.

System Protection

There have been three devices used for system protection.

A fusible plug:

Equipped on R-12 Systems to protect the system from high refrigerant discharge pressures. The plug was located at the top of the Receiver Drier. Once the pressure / temperature increased to potentially damaging levels, the high temperature would melt the plug and the system charge would then vent to the atmosphere. This is no longer acceptable and is prohibited by law. If this device is left on an R-12 system after retrofitting to R-134a, then problems could develop.

Receiver Drier

A Pressure Switch:

Is used to protect the system from an over or under charged system. If system-operating pressures become too high or too low, problems with lubricating the system as well as damage to components could develop. The system pressure switch can be found on the High or Discharge side of the system. If the pressures are not within specifications, the Compressor Clutch Circuit will be “opened” by the Pressure Switch and the compressor clutch will not engage. The operating parameters of the pressure switch changed considerably when the R-134a systems were introduced. The switches should not be interchanged. Please consult the appropriate service manual for pressure switch operating specifications.

Pressure Switch

Some systems use a pressure switch with a third or medium pressure control. This operates the engine cooling fans at a higher speed when the high side pressure reaches a certain level, and lowers the fan speed when the pressure drops back to a set level. The four-wire connector can identify the triple function pressure switch.

Electronic Thermostat

A Thermo-Amplifier or Electronic Thermostat:

Is used to protect the System from an Evaporator Freeze up condition. There is always moisture in the air. If the temperature is allowed to drop below freezing at the Evaporator, ice can develop restricting the airflow through the evaporator core.

Compressor

Compressor

There have been three types of compressors used since the 1990 model year. The Axial Piston Type, which has pistons located axially around a plate attached to the compressor drive shaft. A Rotary Vane Type, which has vanes located within a rotor assembly fixed to the drive shaft. And new for 2005, a Scroll Type, which has two scrolls, one fixed to the rear plate, and one that is fixed to the Compressor shaft.

Axial Piston Type

There are two types of Axial Piston Compressors found on Subaru vehicles. A Wobble Plate compressor, which is a variable displacement compressor and a Swash plate compressor, which is a fixed displacement compressor. Both Axial Piston Type Compressors will knock if the refrigerant charge is too high or an internal problem develops. The type and amount of lubricating oil is very important. Use the oil with the correct viscosity. Please consult the System Label located within the engine compartment and/or the Service Manual for Oil type and capacity.

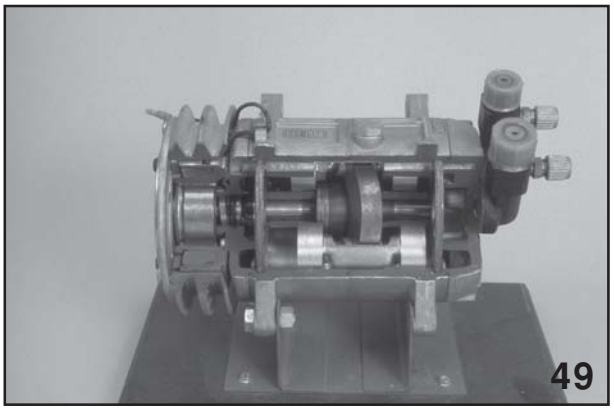
Wobble Plate

Wobble Plate

This compressor is a variable displacement compressor found on early Legacy and all SVX Vehicles. Five pistons are fixed to the front side of a wobble plate attached to the compressor shaft. For the Legacy, the Low Pressure Refrigerant from the Evaporator entering the compressor is monitored. The lower the pressure/temperature, the larger the amount of high-pressure refrigerant supplied to the backside of the wobble plate. The changing of the pressure to the backside of the wobble plate will change the length of the piston stroke, thereby changing the displacement.

The ECM controls the displacement on SVX Compressors, by providing a voltage signal to a valve on the rear of the compressor. The higher the signal, the larger the amount of high-pressure refrigerant supplied to the backside of the wobble plate, limiting its displacement by shortening the piston stroke. The ECM would also control compressor displacement due to engine coolant condition. As the coolant approaches an overheat condition the displacement of the compressor would change from full displacement to 75% displacement, to 50% displacement, to 25% displacement as the coolant continues to overheat. The compressor would then be turned off if the coolant reaches a fully overheated condition.

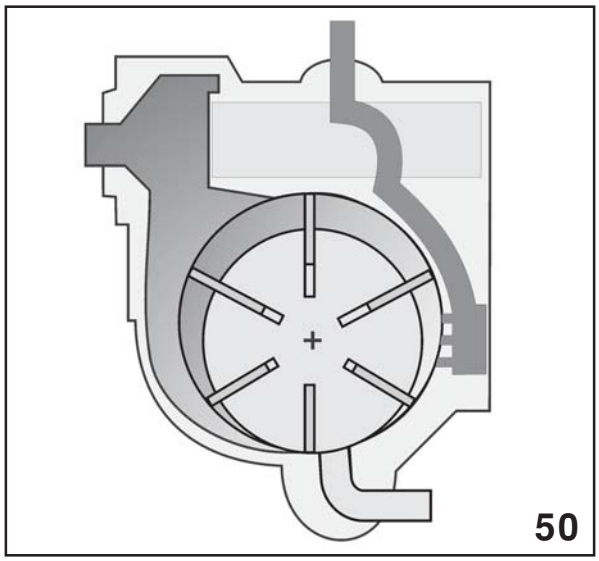
Swash Plate



Swash Plate

Three two sided pistons are arranged around an offset plate fixed to the compressor shaft. As the shaft rotates, each piston will be moved forward and back, drawing in low pressure refrigerant on its back stroke and forcing out high pressure refrigerant on its forward stroke. This compressor is a fixed displacement compressor. It was last used on 1993 Legacy's with a ZEXEL system.

Rotary Vane Type



Rotary Vane Compressor

The Rotary Vane Compressor has a rotor fixed to a shaft, which is fitted with six vanes. The rotor and vanes are rotated by the shaft within an elliptical cylinder. As the rotor rotates, the vanes are extended and compress the low-pressure refrigerant as it enters the compressor. A trigger valve is used to route high-pressure refrigerant to the shaft side of the vanes to help them extend during low engine speeds. Due to the trigger valve operation, an intermittent “Buzz” noise sometimes can be detected.

This type of compressor will not “Knock” but will experience a “Chatter” type noise if an internal problem develops. A “Moaning” noise can develop with this type of compressor at extreme operating pressures. The noise should diminish once the pressure drops back down within normal operating conditions.

Scroll Type

Scroll Compressor

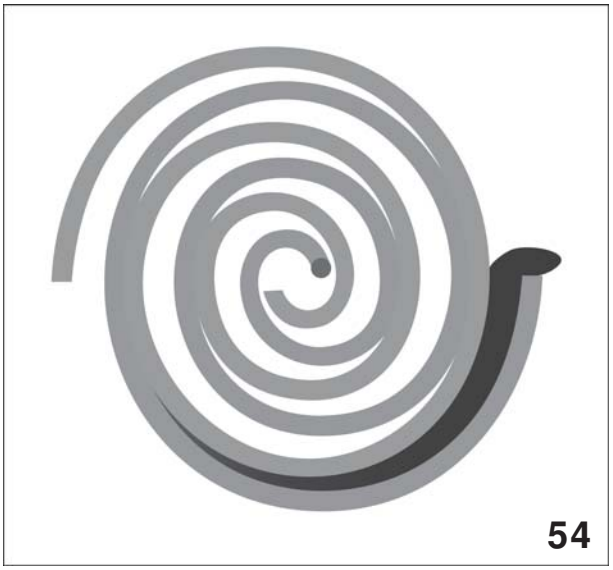
This type of compressor was introduced for the 2005 model year.

Compressor Halves

This compressor utilizes two scrolls to pressurize the refrigerant. One scroll is fixed to the shaft and rotates within another scroll fixed to the rear plate of the compressor.

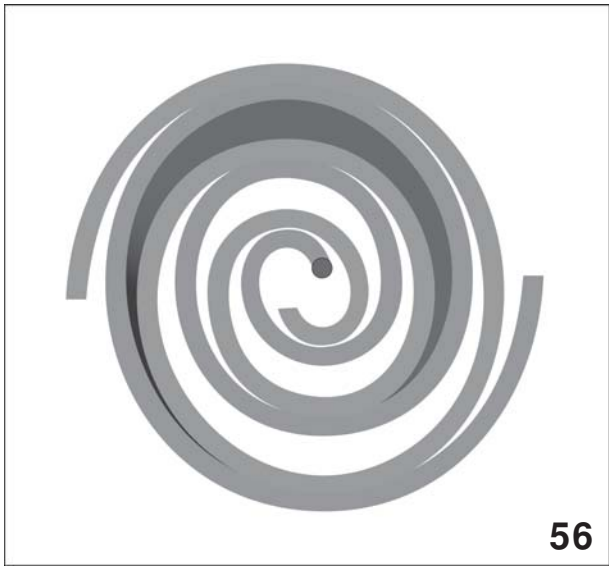
Reed Valves

The refrigerant enters into the compressor through two intake valves and exits the Compressor through one exhaust valve.

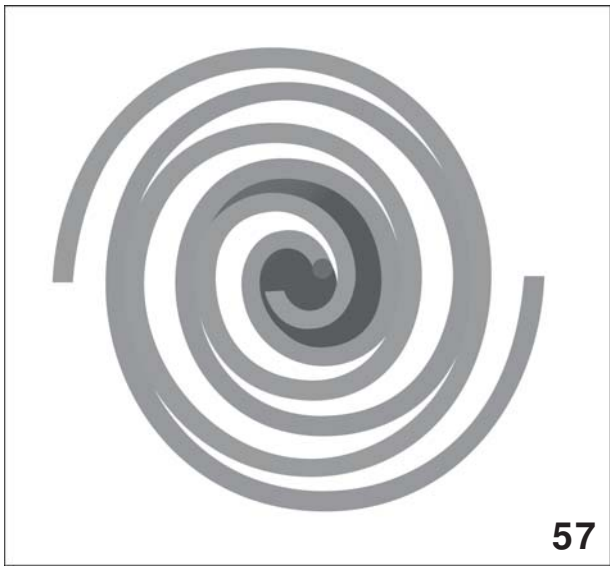


Operation Intake

Operation Compression



Operation Compression _2



Operation Discharge

As the refrigerant is drawn into the compressor, the area becomes smaller as the scrolls Rotate, thus boosting the pressure of the refrigerant as it is drawn to the center of the Scrolls.

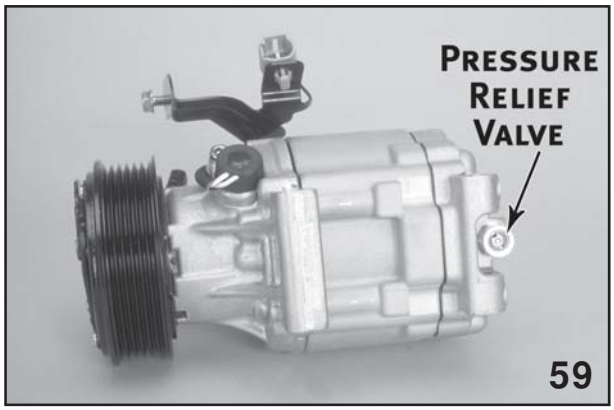
Compressor Protection

There are currently three different types of devices used to protect the compressor.

Check Valve

The check valve is designed to stop high pressure refrigerant flowing to the low-pressure side of the system through the compressor when the compressor has cycled off. It is located on the inlet side access port of the compressor.

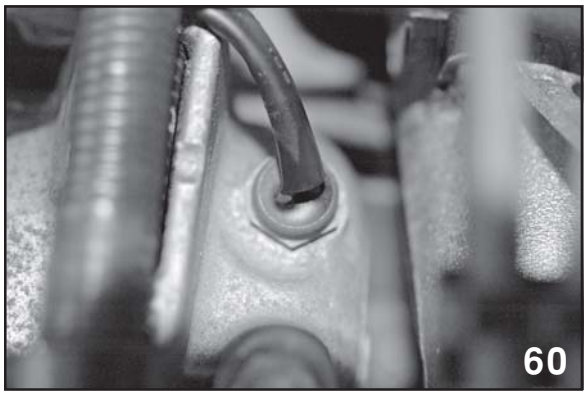
Pressure Relief Valve



Pressure Relief Valve

The PRV is located on the compressor case with access to the high pressure refrigerant within the compressor. It is designed to purge a limited amount of refrigerant when the refrigerant reaches a certain pressure within the compressor. Once the pressure drops to within a specified level the valve is designed to close.

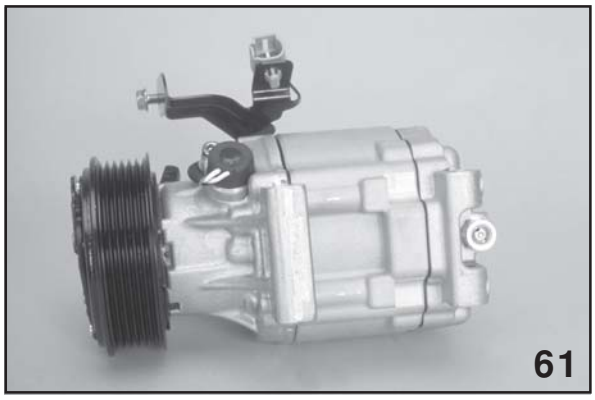
Thermo-Switch



Thermo-Switch

The thermo-switch is fixed to the case of the compressor and is designed to open the compressor clutch circuit when the surface of the compressor case reaches a specified temperature.

Compressor Replacement



Scroll Compressor

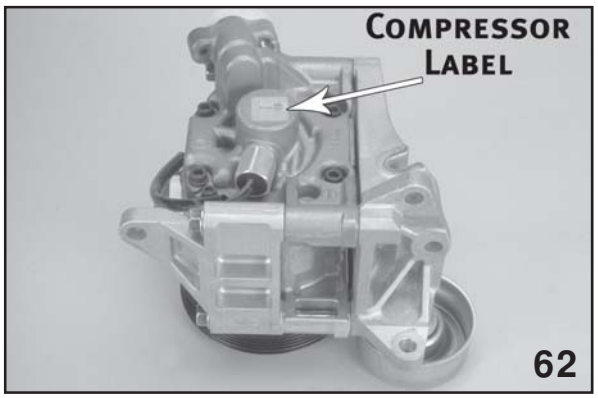
The amount and type of lubricating oil used is very important when servicing the Compressor. Remember that every service compressor comes with a full system charge of oil. If the system becomes saturated with compressor oil, poor cooling performance can develop. Only add the amount of oil that was drained from the compressor being replaced. This means that new oil from the replacement compressor might have to be drained.

Lubricating Oil

R-12 refrigerant systems utilize mineral oil to lubricate the system.

R-134a refrigerant systems utilize a poly alkaline glycol or PAG oil to lubricate the System. The relationship between the PAG oil and R-134a refrigerant is not as compatible as that of R-12 and mineral oil. The PAG oil does not completely immerse with R134a refrigerant, therefore a sight glass cannot be used to verify the system charge level.

PAG oils with different viscosities are used depending on what type of compressor is used. Do not mix PAG oils with different viscosities or the life of the compressor could be affected. PAG oil is highly hygroscopic, which means that it absorbs moisture at a very high rate. PAG oil will turn yellow in color when it becomes contaminated with moisture. Clean all spilled PAG oil immediately from all vehicle surfaces.

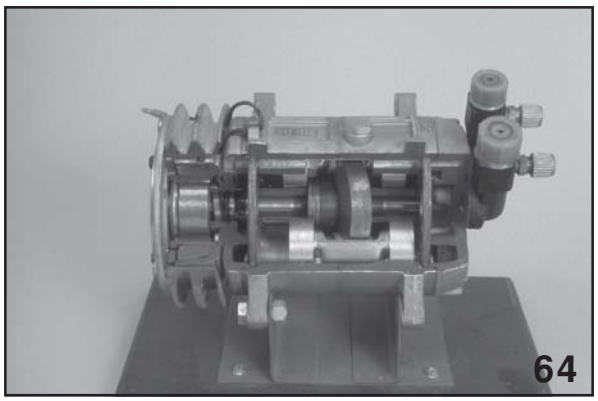


Compressor Label

A label on the back of the compressor, on the system-identifying label within the engine compartment, and the service manual all list the type and system capacity of oil that should be used when adding oil to the system.

Compressor Clutch Assembly

The compressor clutch assembly is made up of three components.



Compressor Clutch Assembly

Field Coil

A 12-volt signal from the compressor clutch relay energizes the field coil. When energized, it becomes a strong electromagnet that pulls in the armature plate against the compressor pulley. The signal must not drop below 10.5 volts for the coil to be effective.

Pulley

The pulley is mounted to the compressor case. A sealed bearing is positioned between the case and the pulley. The engine, through the use of a drive belt, rotates the pulley.

Armature Plate

The armature plate is splined to the compressor shaft. When the coil is energized, the armature pulls in against the pulley, letting the drive belt rotate the compressor. The distance, or air-gap, between the pulley and the armature is very important. If the distance is too large, then a noise can develop as the armature momentarily slips against the pulley when the coil pulls it in. If the distance or air-gap is too small, a noise can develop when the compressor is not engaged.

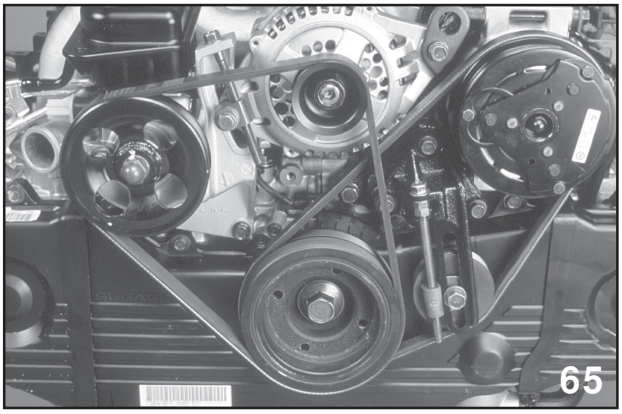
Clutch Engagement

The following conditions have to be met before the compressor clutch will engage and stay engaged:

1) A minimum of 10.5 volts to the clutch coil.
2) A minimum amount of refrigerant in the system to overcome the low system pressure cutout switch.
3) A ground signal from the ECM to the Compressor Clutch Relay, energizing the coil of the relay.
   a) If the engine coolant is in an overheated condition, the ECM will cease to provide the ground signal to the Clutch Relay, thereby disengaging the compressor clutch.
   b) If the throttle is at or over the 90% level, then the ECM will cease to provide the ground signal to the Clutch Relay.
   c) On the 3.0 liter Engine, a compressor speed sensor input must remain within specifications or the compressor clutch will be “Locked Out” and will not engage.
4) The A/C Switch circuit, which includes the Electronic Thermostat circuit, must provide a compressor “ON” request to the ECM.

NOTE: THE “ON” REQUEST FROM THE A/C SWITCH CIRCUIT, THE SIGNAL FROM THE ECM TO THE CLUTCH RELAY, AND THE SPEED SENSOR “LOCK OUT” SIGNAL, CAN ALL BE CHECKED WITH THE SELECT MONITOR.

Drive Belt

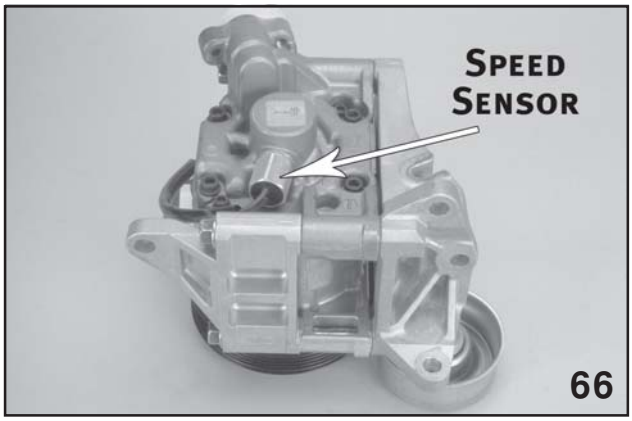


Compressor Drive Belt

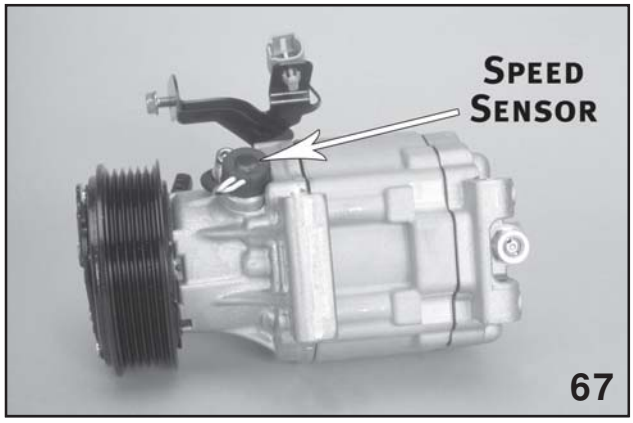
A drive belt, driven by the engine, is used to rotate the compressor pulley. The tension of the drive belt is very critical. If the tension is too loose slippage can occur creating noise and heat. If the tension is too tight, then damage could occur to the compressor pulley bearing. Proper alignment of the compressor pulley is also very critical. The drive belt tension is adjusted by the use of a manually adjustable idler pulley, or by an automatic tensioner. When inspecting for belt tension, also visually inspect the belt for improper wear patterns or frayed edges. Consult the Service Manual for the proper service procedure.

When replacing a new drive belt, remember that the belt might stretch a little after a short run-in time.

Belt Protection



Speed Sensor (newer)



Speed Sensor (older)

A device used to protect against the seizure of the compressor throwing the drive belt off of the pulley is currently being used on the vehicles with the 3.0 liter engine. The speed sensor, monitors the rotational speed of the compressor shaft and sends a sine-wave signal to the ECM. The ECM compares this signal against other engine speed input signals. If the speed signals differ by more than 20 percent, the ECM stops its ground signal to the compressor clutch relay, therefore disengaging the compressor clutch. This "locking out" of the compressor will remain until the ignition key is cycled "off and on". If there is an interruption in the speed sensor circuit, open or short, the compressor will be "locked out" as well.

Condensers

Condenser

There are four types of condensers that have been used on Subaru vehicles.

Serpentine

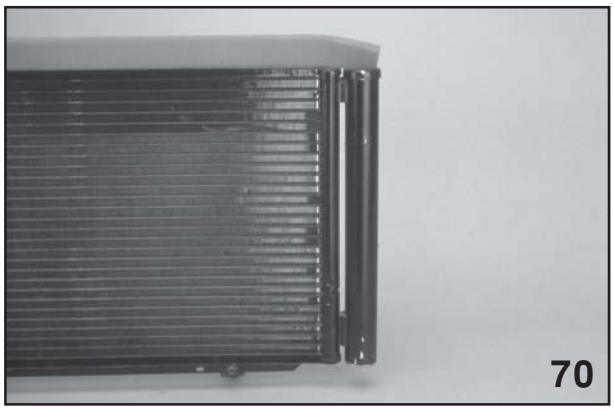
As the refrigerant enters the condenser at the top it flows from one side to the other, then down until it reaches the bottom of the condenser. This type of condenser is used primarily with R-12 refrigerant systems.

Parallel Flow

As the refrigerant enters the condenser on one side it drops down and flows through all tubes to the opposite side of the condenser. This type of condenser was used on early R-134a refrigerant systems.

Multi-flow

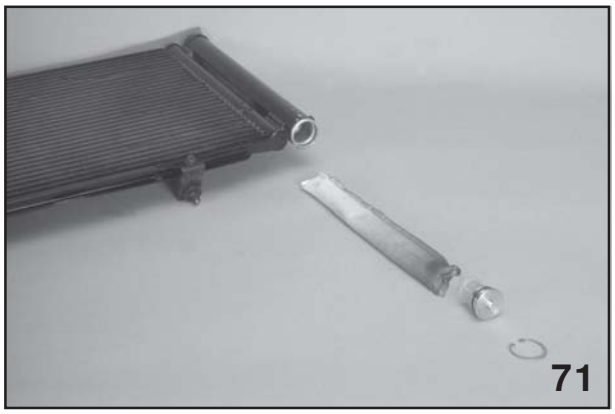
Multi-Flow Side View



Multi-Flow Front View

As refrigerant in a gas state enters the condenser, it partially drops down one side tank until it reaches a baffle plate. At this point it crosses the condenser, drops down until it reaches another baffle plate, then crosses back across the condenser. The refrigerant will flow through three passes until it reaches the bottom of the condenser where it is now in a liquid state.

Multi-flow with Receiver Drier (Sub-cooling)



Multi-Flow (Sub-cooling) Condenser

This condenser works the same as the multi-flow condenser, only this condenser has a Receiver Drier built into it at the outlet side of the condenser.

With all condensers it is very important that there is no restriction or partial restriction whether it is internal or external.

If a partial internal restriction develops, then a measurable difference of surface temperature will occur with the lower temperature being found downstream of the restriction. If the condenser has been opened to the atmosphere for a length of time the PAG oil at the bottom of the condenser, can absorb enough moisture from the atmosphere to partially restrict the flow of refrigerant through the condenser.

External restrictions such as bent fins or debris, can affect the heat transfer capabilities of the condenser. A slow increase in high side operating pressures will develop, leading to a poor cooling complaint. If the engine cooling fans are not operating correctly, then the same increase in high side operating pressures will develop. If the restriction to air flow is large enough then the high side operating pressure will increase until the Pressure Switch cycles the system off due to high operating pressures.

Receiver Drier

Receiver Drier

The receiver drier is designed to perform three functions.

Receiver

The R/D is used to receive the refrigerant and store it in a liquid state to pass on to the Expansion Valve. It is very important that the refrigerant reaches the expansion valve in a liquid state so it can readily change state back to a vapor within the evaporator.

Drier

The R/D has a drying agent within it. The drying agent, or desiccant, is used to absorb any moisture within the system. It only takes a small drop of moisture to freeze up and block the refrigerant from entering into the evaporator through the expansion valve. Moisture in the system will displace the refrigerant and can become acidic, affecting the integrity of the system.

Filter

A filter to trap particulates within the system is also found within the R/D. This is to trap any unwanted debris from circulating throughout the system.

If the system has been opened to the atmosphere for a considerable length of time and there is no residual pressure within the system, then the R/D needs to be replaced.

As with any component replacement, make sure that any opened system is isolated from the atmosphere when making repairs.

Thermal Expansion Valve

Evaporator

Three types of thermal expansion valves have been used on Subaru vehicles with A/C. An expansion valve located within the evaporator case with an equalizing tube, an expansion valve within the evaporator case without an equalizing tube, and a block type expansion valve.

Block Type TXV

All valves control the flow of refrigerant into the evaporator core, to deliver the refrigerant in a "misty" or primed state. The expansion valve controls the amount of refrigerant entering the evaporator by monitoring the temperature of the refrigerant as it exits the evaporator.

When the system cycles "off" the expansion valve will open due to the increase in the refrigerant outlet temperature. Due to the opening of the expansion valve when the compressor cycles "off", an intermittent gurgling noise might develop as refrigerant in a liquid state enters the evaporator.

If the expansion valve looses it's capability to sense the temperature of the refrigerant as it leaves the evaporator, such as sensing bulb or sensing element failure, then the expansion valve closes and the low side operating pressure drops into negative pressure.

NOTE: IF THERE IS A <u>COMPLETE</u> BLOCKAGE AT THE EXPANSION VALVE INLET, THEN THE LOW SIDE PRESSURE WILL DROP INTO A NEGATIVE PRESSURE, WHICH CAN DAMAGE THE COMPRESSOR DUE TO A LACK OF LUBRICATION. IF THERE IS ONLY A PARTIAL RESTRICTION AT THE EXPANSION VALVE INLET THEN LOWER THAN NORMAL LOW SIDE OPERATING PRESSURES WILL DEVELOP.

Evaporator Assembly

Evaporator Assembly

The evaporator assembly includes the following components:

- Evaporator Core
- Thermal Expansion Valve
- Blower Resistor Assembly
- Case
- Drain Tube
- Thermo-sensor
- Air Filter (If so equipped)

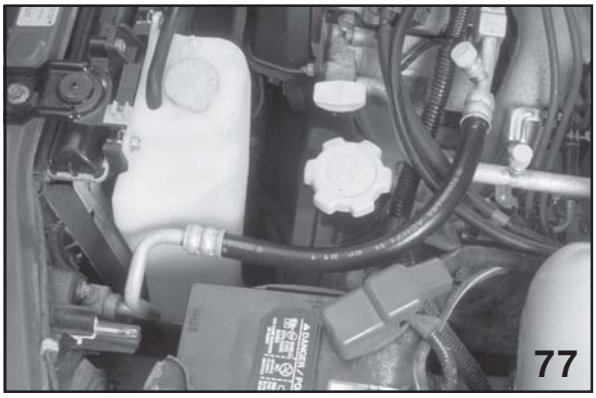
The evaporator core itself is made of aluminum, which provides excellent heat transfer. The refrigerant enters the core through the expansion valve in a misty condition and changes state to a vapor absorbing the heat from the air stream provided by the blower motor. There is always moisture in the air, so the casing is designed to collect the moisture from the core and drain it out of the evaporator assembly through the drain tube.

Air - Filter

Some evaporator assemblies have an air filter in line between the core and the blower motor to catch any organic debris before it collects on the inlet side of the core. The combination of moisture and organic debris at the bottom of the evaporator case can become acidic, causing premature failure of the core. If enough debris collects on the inlet side of the core, then airflow can become restricted. Due partially to the debris and moisture, a musty odor can develop within the evaporator assembly. This smell is common within the industry and there are many aftermarket aerosol and coatings available to temporarily get rid of the smell. Be aware that a musty odor can return. If any treatment is used for the musty smell, avoid coating the resistor attached to the case.

If the system has an Air Filter at the evaporator assembly, then it must be cleaned or replaced periodically or poor airflow from the vents could occur.

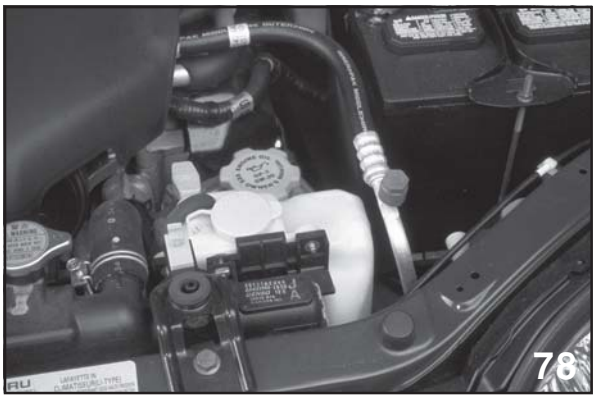
Pipes and Hoses



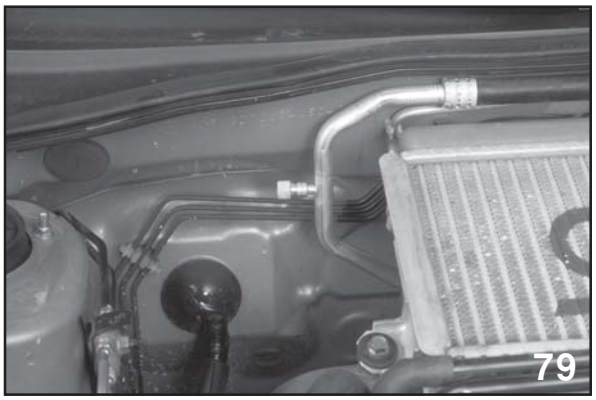
Hose

Throughout the years many different hose and pipe combinations have been used on Subaru A/C Systems. If a replacement hose or pipe is needed, always verify the system manufacturer and refrigerant type first. O-ring sizes have also changed throughout the years and replacing the O-rings with the correct size is vital in maintaining the system charge level. When replacing O-rings always lubricate the new O-ring upon installation and position them properly on the pipe. Take care to clean any residual lubricating oil from the component after completing the repair. If a component is to be replaced, seal off the opening at the hose or pipe from the atmosphere to prevent moisture from entering the system. Remember that both the desiccant within the R/D and the PAG oil (R-134a Systems) absorb moisture from the atmosphere at a very high rate.

Tighten O-ring connections at the proper torque specifications. If the connection is not torqued properly a refrigerant leak could develop.

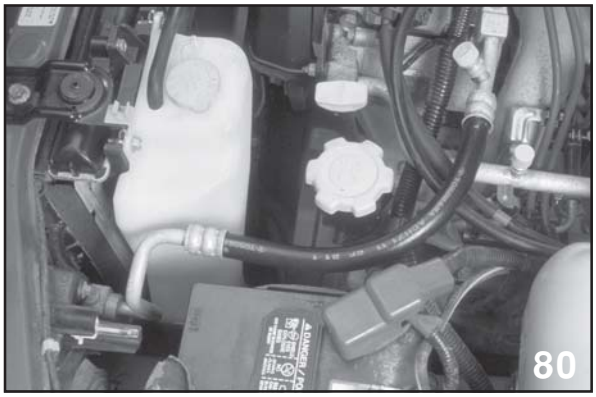


Service Cap, High Pressure



Service Cap, Low Pressure

The service access points of the system are currently located on the pipe/hose assemblies. It is very important that the service valve caps remain on the fittings for two reasons.



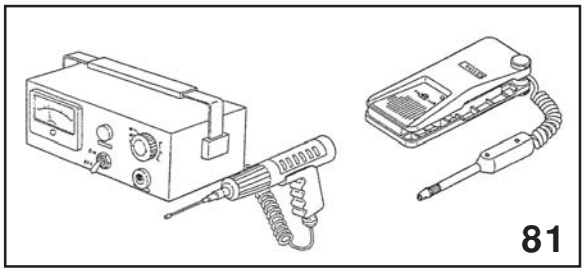
Service Cap

1) The cap keeps debris from entering the service valve opening. This debris can be introduced to the system or to the service equipment when servicing the system.
2) There is a seal positioned within the cap that helps seal the service valve from refrigerant.

If the service valve caps are missing from the system when servicing an A/C System, then new caps need to be installed. When inspecting the valves for damage or leakage concerns, always inspect the seal within the service valve cap. If the seal is damaged then a potential refrigerant leak could develop, and the cap must be replaced.

If an internal partial restriction develops within the hose or pipe, then system performance will be affected. If a partial restriction develops due to a crimped pipe or an internal breakdown of a hose, a temperature difference will occur where the partial restriction is located. This change in temperature can be large enough for frosting or icing to develop on the outlet side of the restriction.

Leak Detection



Leak Detectors

It is vital to conduct the A/C System leak check correctly. If the vehicle comes into the shop with Service Valve Caps on the vehicle, then the leak check procedure must be performed with the caps “ON”. First verify that the system performance is not within specifications and that a low refrigerant charge is the concern:

NOTE: OPERATE LEAK CHECK EQUIPMENT PER FEDERAL GUIDELINES. (J-1028)

1) Visually inspect for any leaks.
2) Isolate the vehicle from the wind or shop fan.
3) Operate the system until it has stabilized.
4) Shut the engine off.
5) Remove the gauges and install the service valve caps.
6) Start your leak detection on the high side of the system at the compressor and then work your way to the expansion valve. By the time you check the low side of the system, the pressures should have equalized.
7) Check the low side of the system starting at the compressor and then work back towards the expansion valve.
8) Remove the resistor block from the Evaporator Case and check for leaks within the case.

If there is no refrigerant within the system, the compressor should not engage. Add enough refrigerant for the system to overcome the low-pressure cutout, which enables compressor clutch engagement. Then perform your leak check procedure.

If a low refrigerant charge is verified, and the leak cannot be found by any other means, then introduce an approved refrigerant dye into the system to isolate the leak. When using dye:

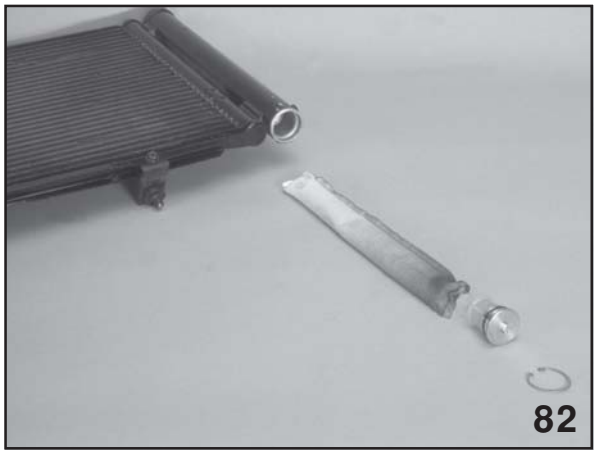
1) Follow the manufacturer's guidelines on how to introduce the dye into the system and for the amount of dye to be introduced.
2) Always clean any residual dye from the system after repairs are made.
3) An overcharge of dye can affect the integrity of the system.

NOTE: BE AWARE THAT THE DYE MUST IMMERSE WITH THE OIL TO WORK CORRECTLY. THE OIL IS MOVED THROUGH THE SYSTEM BY THE REFRIGERANT. SOME R-134A LEAKS DO NOT LEAK PAG OIL; THEREFORE THERE WILL BE NO DYE AT THE LEAK AREA. SOME SMALL HIGH SIDE LEAKS, LEAK PAG OIL IN AN ATOMIZED CONDITION THAT DISSIPATES BEFORE COLLECTING AT THE LEAK AREA.

After the leak has been repaired, another system leak check must be performed to verify that the leak has indeed been repaired, and that no other leaks exist.

When performing the leak check procedure:

1) Remember that there could be more than one leak.
2) Always operate leak detection devices per manufacturer's and federal guidelines.
3) A very small percentage of refrigerant leaks, leak at cold temperatures only. This is due to the contraction of components due to the cold weather, and as the operating pressures/ temperatures increase, expansion occurs and the leak seals off.



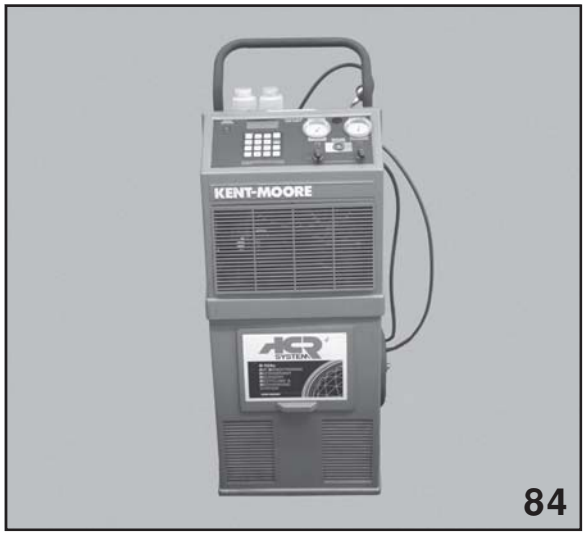
Receiver Drier O-ring

4) Be aware that some combination Condenser/Receiver Drier assemblies have an additional leak check point at the bottom of the condenser.

Retrofit

Please consult the Service Bulletin # 10-68-96R for the retrofit scenario for the vehicle being retrofitted. Remember that an R-12 system is most efficient when charged with R-12 refrigerant. Retrofit only if requested by the customer or if there is no R-12 refrigerant available.

Service Equipment



Service Equipment

It is very important that the Recovery/Recycle/ Leak Detection equipment be kept calibrated.

Controls

Gauges

Most Recovery and Recycle Machines have a Self-Calibration Mode. Check the Operation Manual. You want to be able to dial in a Refrigerant Charge and know that the equipment is indeed charging only the amount of refrigerant indicated.

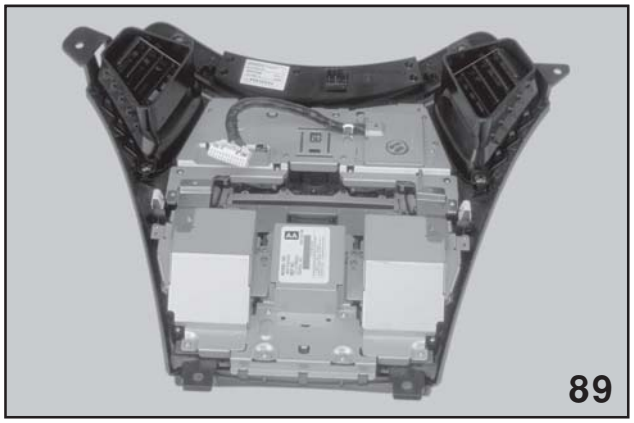
If the system has been opened to the atmosphere for a length of time then a complete vacuum must be performed on the system. The vacuum process, removes any moisture within the system. A two or three minute vacuum is not sufficient to remove all moisture in the system. Remember moisture will degrade system performance and can cause premature failure of components.

Operate all Service Equipment per manufacturer's specifications.

Subaru B9 Tribeca Audio System

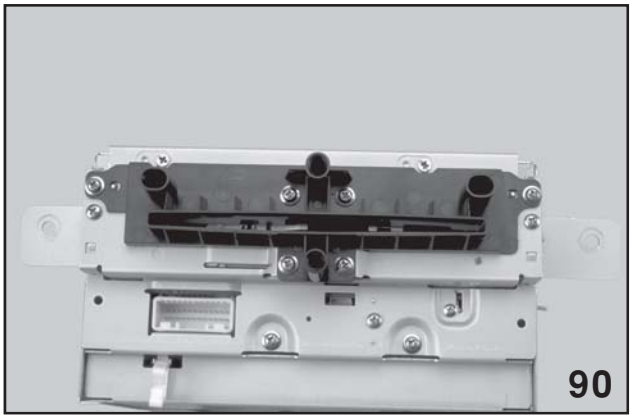
Face Plate Front View

The Audio Unit is controlled by a faceplate which is also used to control the Air Conditioning.



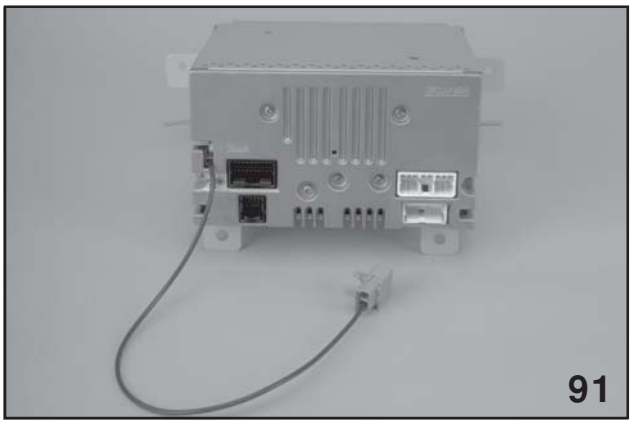
Face Plate Back View

The Audio Unit transfers the control signals from the faceplate through the Audio Unit circuitry to the harness connecting to the radio. This harness then connects to the HVAC wiring and to the HVAC Control Unit.



Audio Unit Front View

The faceplate connects to the audio unit with a single connector.



Audio Unit Rear View

Before diagnostics for the HVAC control system can be performed the faceplate operation must be checked.

NOTE: RADIO AND HVAC MUST BE OFF

- Turn the key to accessory on and wait 2 seconds
- Press and hold the Auto and Mode buttons on while the ignition is turned on.
- Check that all segments of the Vacuum Fluorescent Displays (VFD) are illuminating.
- If Seat Heater equipped, those switches can be checked at this time.
- Press all control buttons and observe if a corresponding indicator light is illuminated.

Audio control check

Multi-Function Display (MFD) or Navigation Display will display mechanical problems and compact disc problems when “MECHA ERROR” or “CHECK DISC” appears on the display.

The audio set can diagnose problems using its face panel buttons so that the face panel and the CD/radio unit can be separated depending on their problems.

By use of this diagnostic function, judgement to one of the following three conditions can be made:

(A) Face Panel failure

(B) CD/radio unit failure

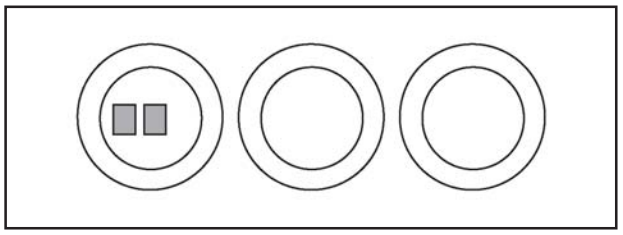
(C) Poor contact between the face panel and CD/radio unit (communication error)

1. To enter the diagnostic mode:
   1) Turn the ignition switch to ACC. (Turn off the audio.)
   2) Press buttons “TUNE ∆”, “SEEK ∇” and “RDM” together for at least **2 seconds.**
   3) You will hear a beep.
      (If beep does not sound, try again. If you cannot hear the beep, both face panel and CD/radio unit have a possibility of a problem and/or poor contact between the face panel and CD/radio unit should be considered.)
   4) **Within 15 seconds** after the beep sounds, press the preset button “1” to enter the diagnostic mode.

      In the diagnostic mode, VDF’S (Vacuum Fluorescent Displays) on the climate control dials illuminate.

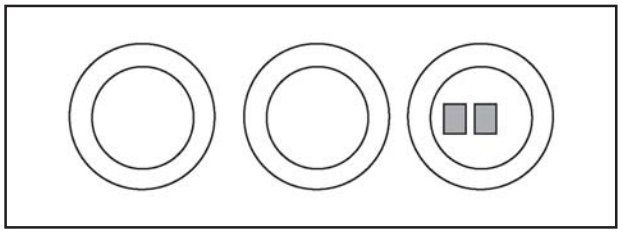
In Diagnostic Mode

If VFD on the Left side dial illuminates



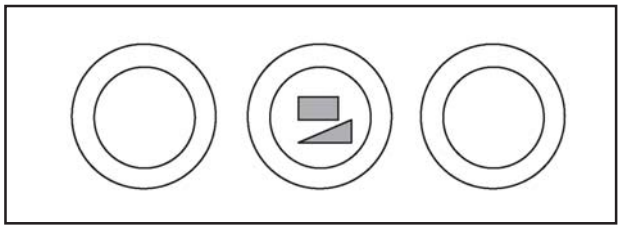
The face panel has NO problem. The CD/radio unit has a possibility of a problem and/or poor contact between the face panel and CD/radio unit is considered.

If VFD on the Right side dial illuminates



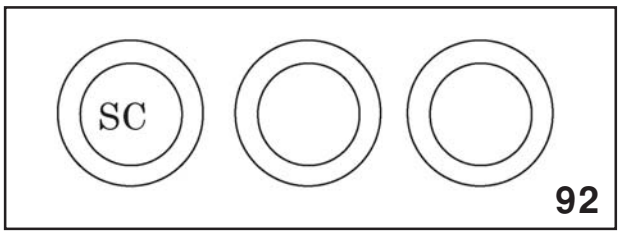
The CD/radio unit has NO problem. The face panel has a possibility of a problem and/or poor contact between the face panel and CD/radio unit should be considered.

If VDF on the Center dial illuminates



Confirm each audio control button’s function by pressing the button.

VFD’S will show specific letter symbol corresponding to each button’s function. For example, when “SCAN” button is pressed, letter symbol “SC” appears on the VFD.



VFD Chart

(However buttons of “POWER”, “FM”, “AM”, “CD” and “RES/AUX” have no this function.)

If each button is confirmed to be functioning
The CD/radio unit has a possibility of problem.

If any of buttons is confirmed to be malfunctioning
The face panel is faulty.

NOTES:

If VFD'S on the 3 dials do not illuminate

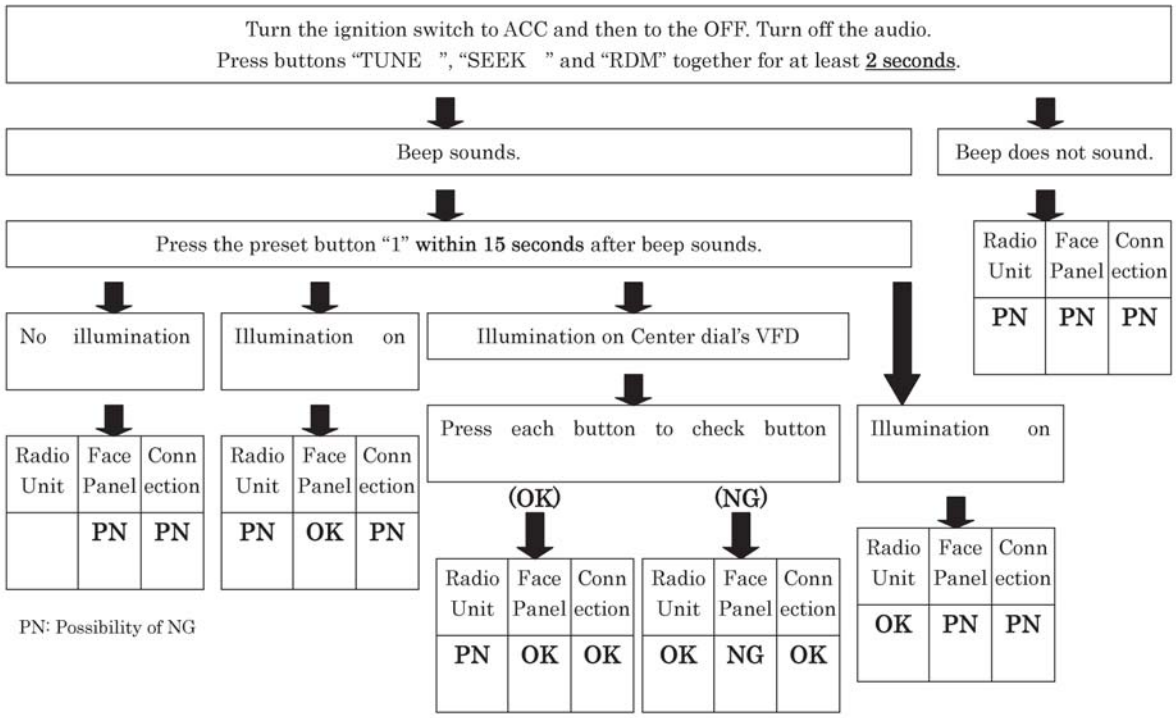
Audio set has not been switched to diagnostic mode. Try procedure 1 again.
If you cannot enter the diagnostic mode, both face panel and CD/radio unit have a possibility of a problem and/or poor contact between the face panel and CD/radio unit should be considered.

To return from diagnostic mode

Perform any of the following operations.

- Press "POWER" button
- Press "CD", "FM", "AM" or "AUX" button
- Turn ignition switch to OFF

PN: Possibility of NG



PN: Possibility of NG

Subaru B9 Tribeca HVAC (Automatic Air)

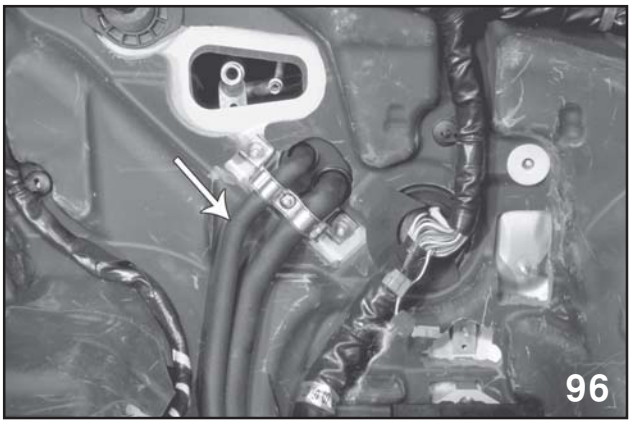
Compressor

Above Engine Compartment

NOTE: FIXED SWASH PLATE COMPRESSOR

The Subaru B9 Tribeca is equipped with Dual Zone climate control and rear air conditioning (7 passenger models). Diagnostics for climate control is provided using the A/C control unit to communicate trouble codes to the control displays. The control unit is located on the blower housing assembly.

The low pressure refrigerant hose is routed from the compressor to the front expansion valve and Ts to the grommet for the rear evaporator hose. The high pressure refrigerant hose is routed from the compressor to the condenser. Then along the frame rail to the trinary switch and above the engine compartment to the front expansion valve and T's to the grommet for the rear evaporator hose.



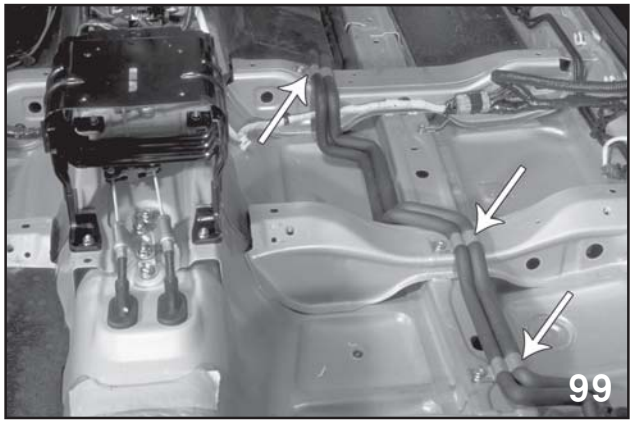
Entering Passenger Compartment

Both the high and low pressure hoses enter the passenger compartment and are clamped in place to the vehicle body behind the dash and above and to the left of the ECM.

Under Passenger Seat

There are three different sections of A/C hoses in the passenger compartment. The front section is routed from the bulkhead to just ahead of the second row seat bottom cushion. The connection between the front section and the rear section of A/C hoses are accessed by removing the lower door jam trim of the right rear passenger side door. Removal of the front section of hoses requires the removal of the dash, steering support beam, blower motor assembly and right front passenger seat.

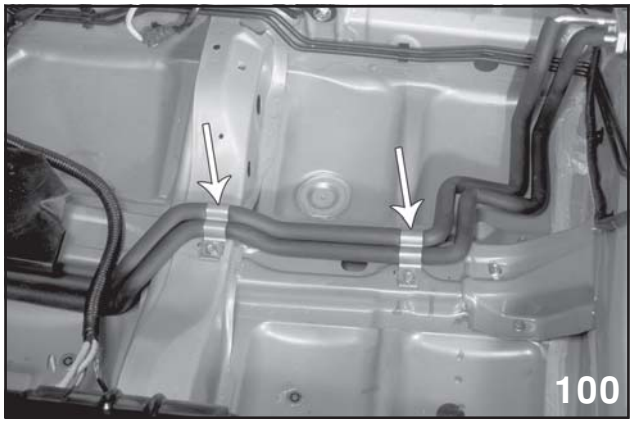
In Front of 2nd Row Seat



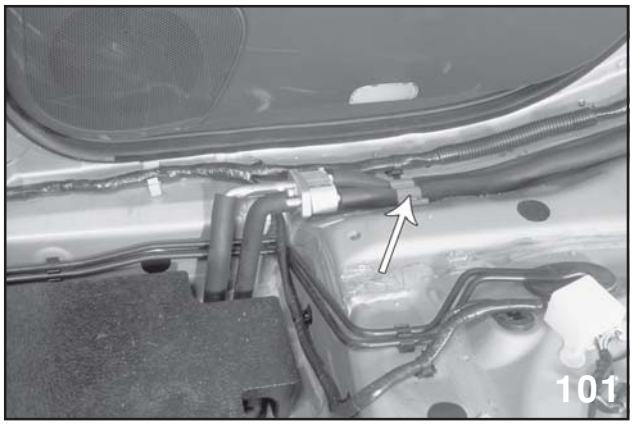
Clamps

From the bulk head the hoses are routed to the right side of the center console and cross over the frame channel that serves as a forward mount for the front seat. The hoses are protected by a shield and are clamped to the frame channel.

The hoses are then routed under the right front seat and cross over the frame channel that serves as the rear mount of the front seat. The shape of the channel and the location of the hoses crossing the frame channel, protect the hoses from damage.

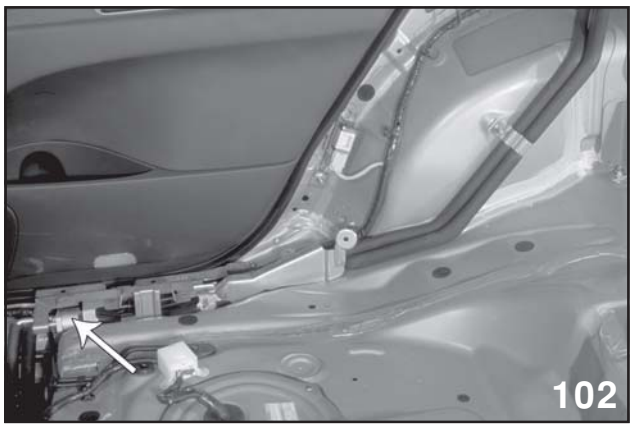


Hose Clamps



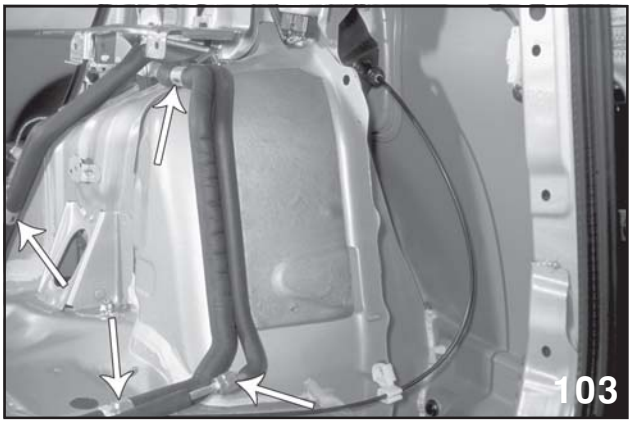
Connection

A polystyrene block protects the hoses as they are routed on to the right rear door jam area.



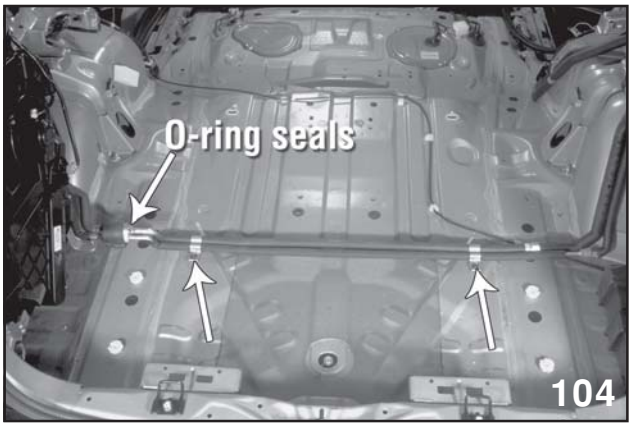
Wheel Well

A metal cover protects the hoses as the front and middle sections meet (O-ring seals). The metal cover provides protection until the hoses are routed to the wheel well area where the inner trim panels provide protection.



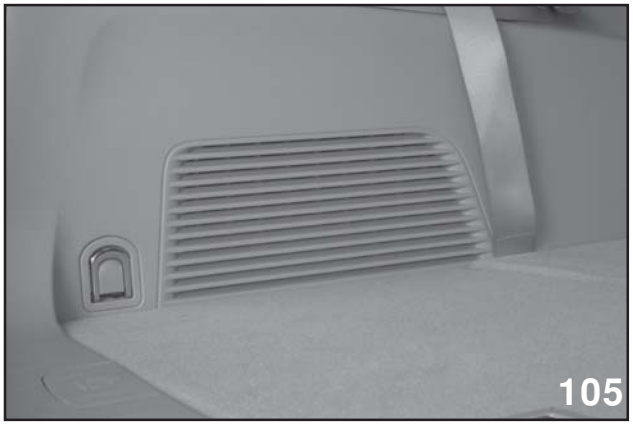
Connection

The hoses are routed over the wheel well and make a turn to the driver side of the vehicle. At this point the middle and the rear section of A/C hoses meet (compression sealed).



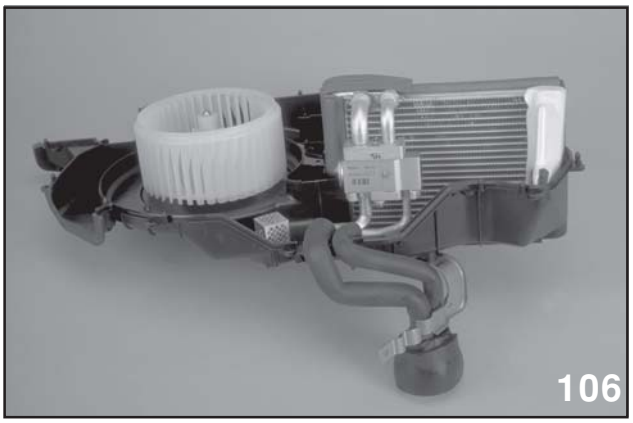
Connection At Rear Evaporator

The hoses are routed across the back of the vehicle just ahead of the tool storage tray, to the rear evaporator.



Air Inlet

Air cooled by the rear evaporator is drawn into rear blower motor through the rear vent in the cargo area.

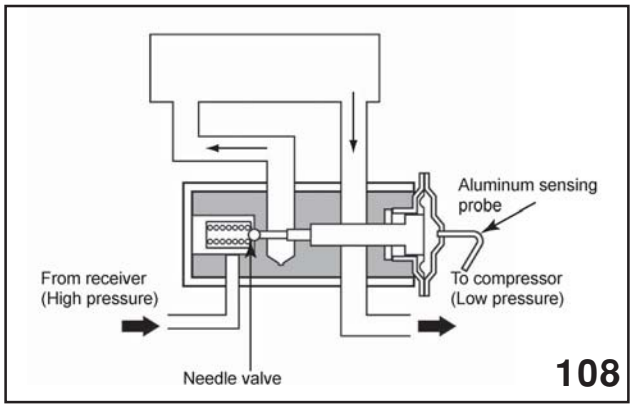


Rear Evaporator Split

The rear blower motor is equipped with a resistor style fan speed controller which is controlled by a single blower motor fan speed switch. In operation the refrigerant flowing through the rear evaporator will decrease as the rear expansion valve senses the decreasing evaporator outlet temperature.

Rear Blower Switch

As the amount of refrigerant flowing through rear evaporator decreases the efficiency of the front evaporator increases due to the reduce heat load placed on the low pressure side. Only one thermistor is used on the Subaru B9 Tribeca A/C system and it is located in the front evaporator.



Rear Expansion Valve

Low temperature at evaporator exit:

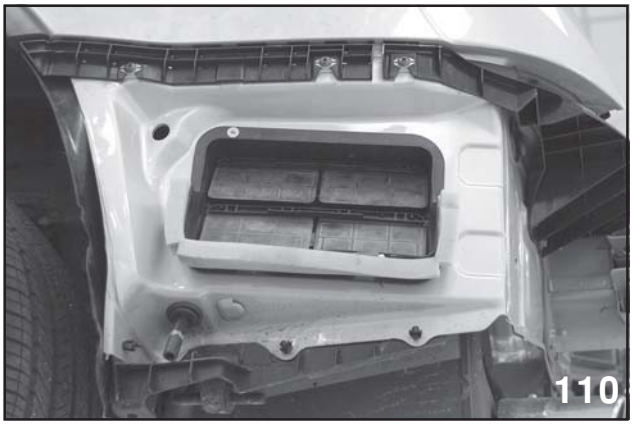
Gas pressure inside diaphragm decreases, reducing volume, pulling aluminum sensing probe right and throttling the needle valve.

High temperature at evaporator exit:

Gas pressure inside diaphragm increases, expanding volume, pushing aluminum sensing probe left, opening the needle valve to increase coolant flow.

Rear Evaporator Removed

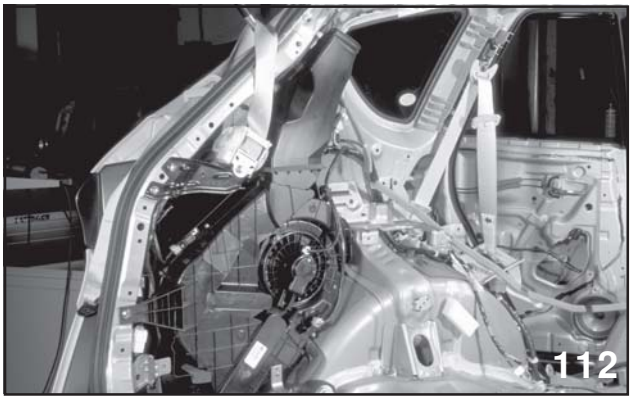
The rear evaporator drain hose is routed from the rear evaporator case to a grommet in the bottom of the left rear cargo area. The drain hose exits the vehicle behind the left rear inner fender and in front of the rear bumper cover. Installation of the hose to the vehicle body is accomplished by depressing the lock tabs of the forced ventilation assemble and pushing the forced ventilation assemble outward slightly. Place the hose into the grommet. Pull the forced ventilation assemble back into place, ensuring the lock tabs engage. Position the rear evaporator assemble in the vehicle, leaving enough room to reach behind the evaporator assemble install the drain hose onto the evaporator case.



Rear Evaporator Drain Hose

Verify the drain hose did not move out of the grommet. Secure the evaporator case to the vehicle.

Head Liner



Rear Blower Motor

Bottom Of Head Liner

The blown air from the rear evaporator case is routed up the D pillar post area through the vent tube made onto the head liner. The air distribution vent tubes are an incorporated portion of the headliner and cannot be serviced separately. Air blown into the passenger compartment can be closed off or redirected by operating the vent levers of the individual headliner vents.

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Slide Sequence

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Service Bulletins

No.	Date	Title	Subject
10-61-91	7/2/91	All vehicles equipped with Air Conditioning	Removal & recycling of Refrigerant R-12
10-63-93	4/12/93	All 93MY SVX	A/C systems using R134a Refrigerant handling procedures
10-64-93	11/8/93	93MY Impreza	Heater vent door binding or leaking air
10-65-94	3/8/94	All Subaru Models	Proper oils for Subaru A/C systems
10-66-94	6/17/94	Subaru Vehicle	R-12 & R 134a A/C system handling procedures
10-67-94	11/11/94	92-94 MY Legacy	Clicking noise from the heater mode door actuator
10-68-96	7/12/96	87-'92 Retrofit procedures	A/C Retrofit procedures R-12 to R-134a
10-68-96R	8/15/98	87-'92 Retroit procedures	Adjustable driver's side defroster grill
10-69-96	11/15/96	1995 and later MY Legacy	Adjustable driver's side defroster grill
10-70-00	7/11/00	2001MY Legacy and Outback	A/C Relay disconnection
10-71-00	12/15/00	Some 2000MY Legacy Vehicles	Recirculation door actuator noise
10-73-02	8/12/02	All 2003 Legacy and Baja Vehicles	A/C system relay storage and activation during PDI
10-74-02	9/1/02	2001~2002MY H-6 Legacy Vehicles	Legacy H-6 A/C Compressor revolution sensor
10-72-02R	7/15/03	All 2002~2003MY Impreza Vehicles up to VIN 3*801514	Countermeasure to prevent icing in the evaporator on air conditioned vehicles correction
10-75-04 15-112-04	09/24/04	2005MY Legacy & Outback Vehicles	Audio and Audio/HVAC Diagnostic Faceplate

TechTIPS

Date	Subject
05/00	2000MY Legacy heater control cables
07/00	2001MY A/C disconnect procedure
02/01	Mode control panel change
07/01	2001MY Legacy evaporator thermostat probe location
08/01	Legacy H-6 A/C compressor's cutting out
08/01	Valeo/Zexel A/C TXV fastener torque specification
09/01	H-6 climate control system information
09/01	Change to 2002MY Legacy/Outback A/C information
11/01	2001/2002MY Legacy blower motor noise
08/02	Blower motor noise
01-02/03	Blower motor noise
04/03	H-6 A/C compressors cutting out
07/03	Auto. A/C system aspirator tubes
10/03	Service bulletin 10-72-02R an update


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