Technical Training
Climate Control Systems

711-JAG: Jaguar Climate Control Systems

JAGUAR

711-JAG 03/2011
Printed in USA

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General Information

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ONLINE COURSE EVALUATION

Class participants are encouraged to fill out an online evaluation for this course.

The Jaguar evaluation is available at:

- **http://www.hostedsurvey.com/takesurvey.asp?c=JLRUSJAG1**

The information provided in the evaluations is kept confidential and will only be used to improve training activities. Your prompt response will be appreciated.

Your feedback is extremely important to us!

COURSE OBJECTIVES AND CONTENT

This course addresses Jaguar Climate Control Systems theory, operation, and diagnostics.

Course Objectives

At the conclusion of this course technicians will:

- Understand refrigeration fundamentals
- Be able to identify and understand operation of Heating, Ventilation, and Air Conditioning (HVAC) components and subsystems
- Be able to diagnose HVAC system malfunctions
- Understand the operation of Climate Controlled Seats

Course Content

1. General Information
2. System Fundamentals
3. X350 Climate Control Systems
4. X150 Climate Control Systems
5. X250 Climate Control Systems
6. X351 Climate Control Systems
7. Climate Controlled Seats
8. System Diagnostics

Model Designations

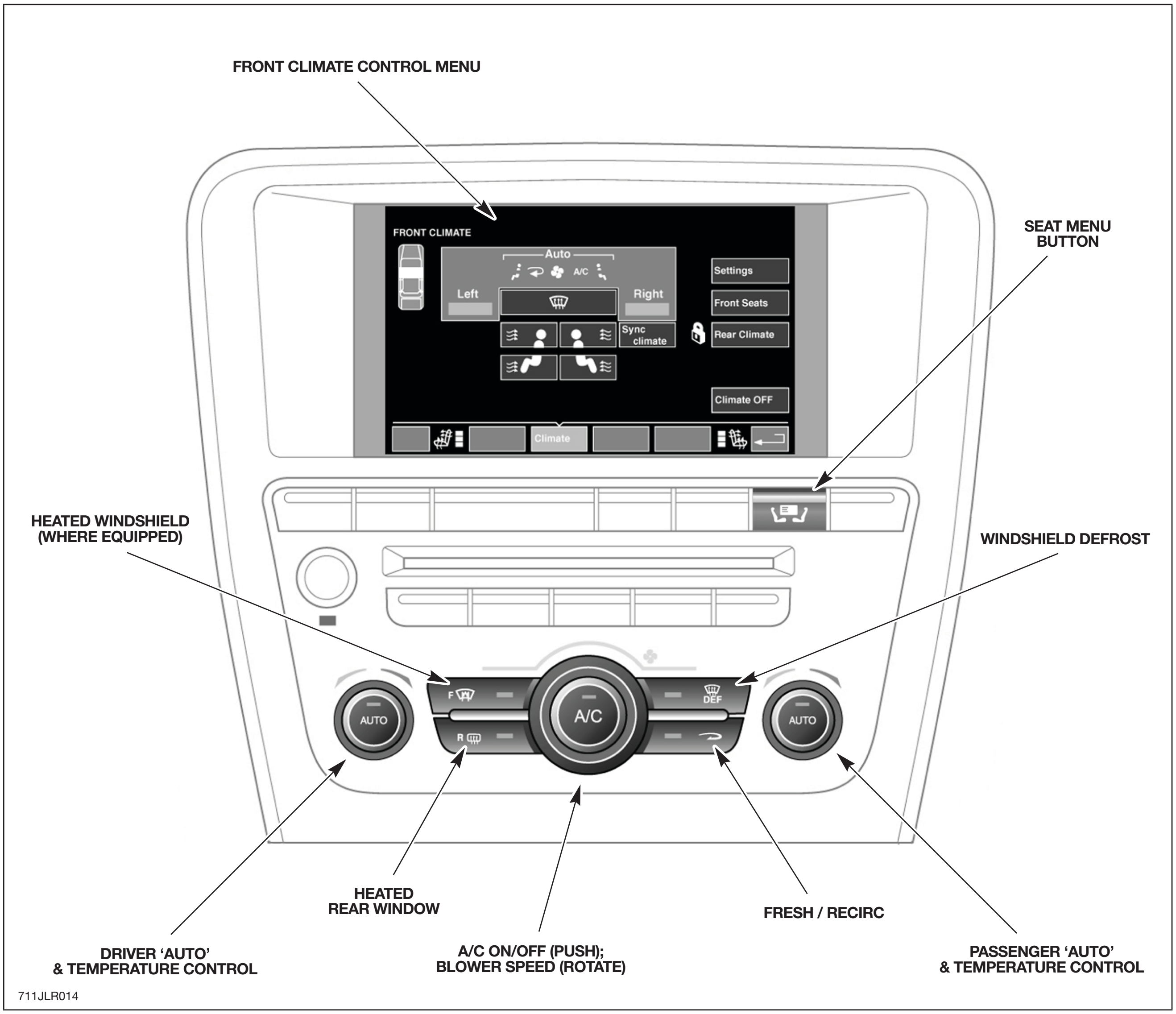
This publication uses Jaguar internal model designations to refer to specific model ranges and years.

Internal Designation	Model	Model Years
X150	XK	2007 MY Onward
X250	XF	2009 MY Onward
X350	XJ	2006 – 2009 MY
X351	XJ	2011 MY Onward

CLIMATE CONTROL OVERVIEW

Jaguar Climate Control Systems provide vehicle occupants with year-round automatic temperature and humidity control as selected on the control panel. The vehicle heating and air-conditioning systems are the foundation for providing the warm, cool, or combined warm/cool filtered air necessary to meet the desired conditions. Using advanced electronic components and a microprocessor-based control module, the Climate Control System produces a continuously comfortable environment over a wide range of ambient conditions. A clear windshield and comfortable cabin temperature help keep the driver alert and attentive.

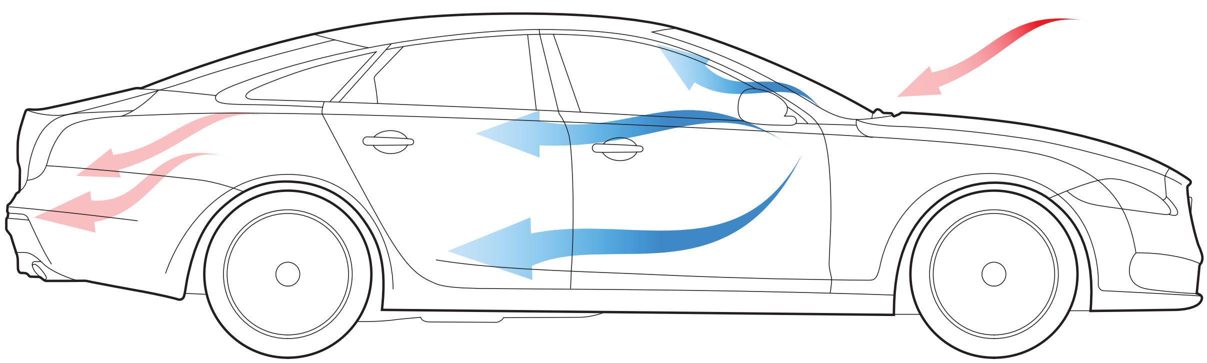
2011 XJ Front Climate Touch Screen Menu and Integrated Control Panel



The Climate Control System provides automatic regulation of:

- Outlet vent air temperature
- Air flow volume and distribution
- Air filtration
- Dehumidification
- Fresh / recirculated air
- Windshield demisting
- Heated / cooled seating (where equipped)

By controlling these parameters, the Climate Control System is capable of maintaining the vehicle's cabin at comfortable levels for the driver and passengers.



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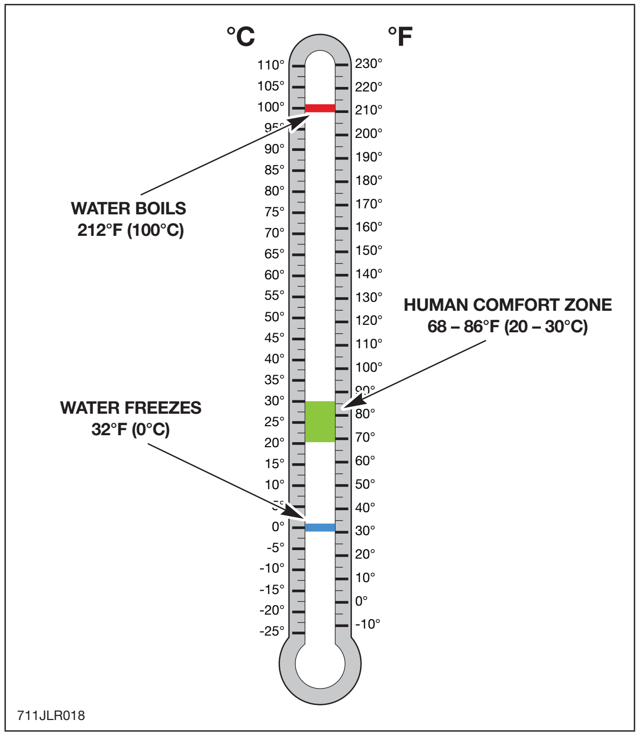
Human Comfort Zone

Temperature comfort levels are personal and will differ from person to person, however, they generally fall into a range between 68 – 86 °F (20 – 30 °C), which has become the accepted norm for the human ‘Comfort Zone’. Hotter or colder temperatures tend to cause discomfort, as will high levels of humidity.

A vehicle’s climate control system is designed to condition the cabin air by controlling the temperature and humidity to within a comfortable range. Further comfort levels can be achieved by filtering pollen and other impurities from the air.

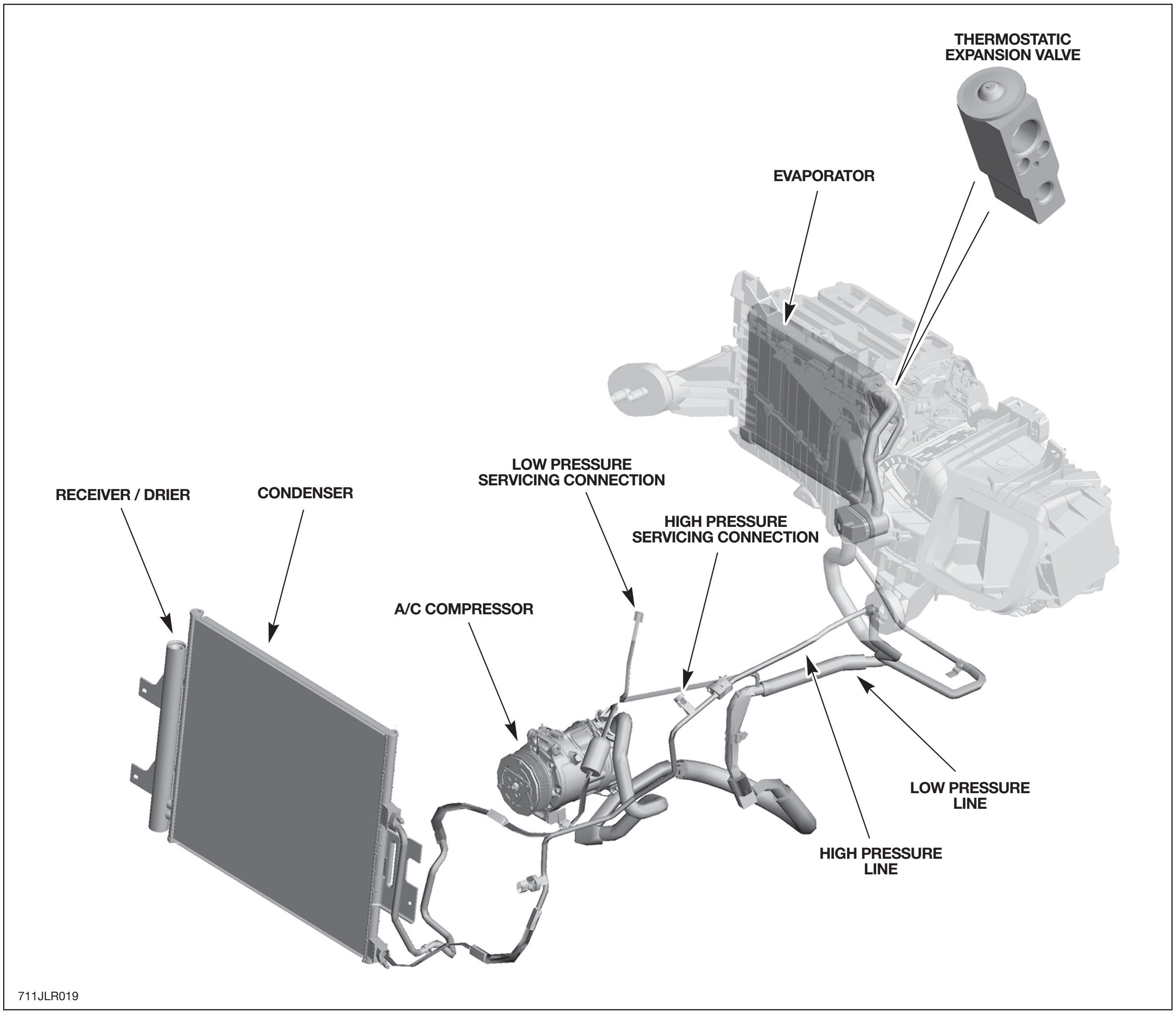


Climate Control Subsystems

The climate control system in a vehicle is divided into five closely related subsystems:

- Air conditioning / refrigeration system
- Heating system
- Air distribution and ventilation system
- Electrical system
- Climate Controlled Seats (where equipped)

2011 XJ Components Shown; Others Similar



ACRONYMS AND ABBREVIATIONS

The following acronyms, abbreviations and symbols are used in this training manual. The majority of them conform to J1930 standards.

Abbreviation	Definition or Description
A/C	Air Conditioning
AJB	Auxiliary Junction Box
ATC	Automatic Temperature Control
ATCM	Automatic Temperature Control Module
BJB	Battery Junction Box
BTU	British Thermal Units
C	Celsius / Centigrade
CAN	Controller Area Network
CCS	Climate-Controlled Seats™
CCSM	Climate-Controlled Seat Module
CFC	Chlorofluorocarbon
CJB	Central Junction Box
DTC	Diagnostic Trouble Code
ECM	Engine Control Module
EJB	Engine Junction Box
F	Fahrenheit
HVAC	Heating, Ventilation, and Air Conditioning
ICP	Integrated Control Panel
IDS	Integrated Diagnostic System
LED	Light-Emitting Diode
LH	Left Hand

Abbreviation	Definition or Description
LHD	Left-Hand Drive
LIN	Local Interconnect Network
MS CAN	Medium Speed CAN Bus
MY	Model Year
NA	Normally Aspirated
NAV	Navigation System
NTC	Negative Temperature Coefficient
NVH	Noise, Vibration, and Harshness
PAG	Polyalkylene Glycol
PID	Parameter Identification Data
PWM	Pulse Width Modulated (Signal)
RCCM	Remote Climate Control Module
RCCP	Rear Climate Control Panel
RH	Right-Hand
RHD	Right-Hand Drive
RJB	Rear Junction Box
SC	Supercharged
TED	Thermoelectric Device
TSD	Touch-Screen Display
UV	Ultraviolet

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System Fundamentals

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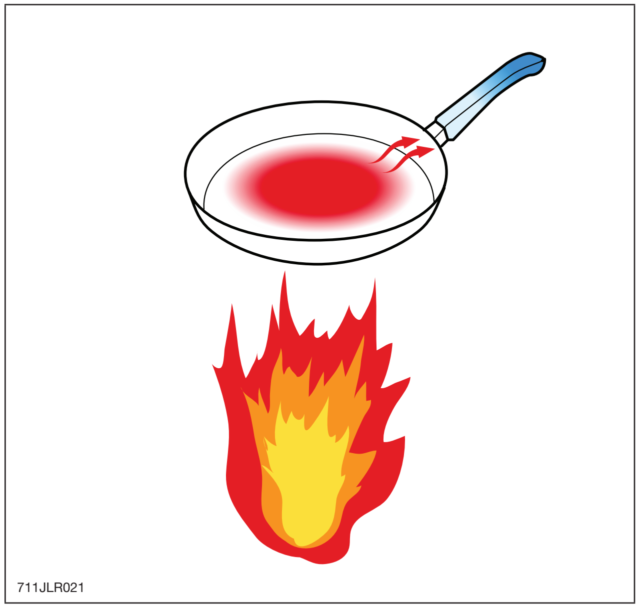
PRINCIPLES OF HEAT

Air conditioning systems use heat and energy from the vehicle's engine to move heat to and from the interior of the vehicle. System designers must take into account the size of the vehicle, number of passengers, and possible sources of heat when designing a system.



Air conditioning is the control of heat, which is a form of energy. Energy cannot be destroyed, only converted into another form of energy. An example of energy conversion is a flame under a container of water. The heat from the flame raises the temperature of the water, causing it to boil. The steam from the boiling water can be used to create mechanical motion, another form of energy.

Air conditioning systems 'create' cold, which is merely the lack of heat. Heat energy will always travel from an area or object with more heat to an area or object with less heat. See the example below of a cooking pan on a hot stove. Over time, heat on the bottom of the pan will travel toward the cold handle.

Vehicle air conditioning systems create a cold spot in the interior of the vehicle, giving the heat a cold area to transfer to.

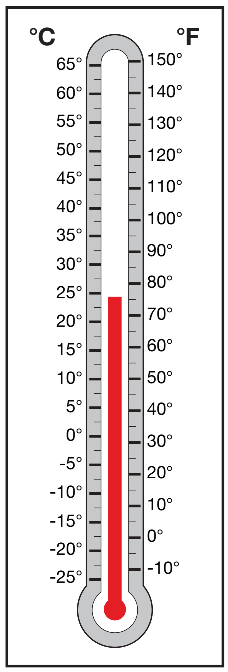
Heat Measurement

Heat is measured using two metrics:

- Intensity
- Quantity

Heat Intensity

Heat intensity is more commonly referred to as temperature, and is measured using a thermometer.



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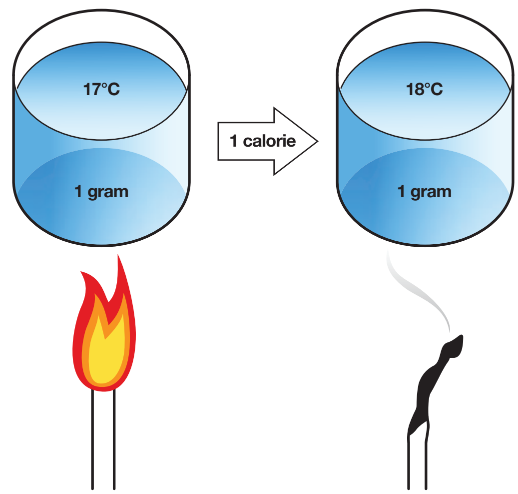
Heat Quantity

Heat quantity is measured in British Thermal Units (BTU) or calories. One calorie (1 cal) is the amount of energy required to increase the temperature of one gram (1g) of water by one degree Celsius (1 °C). A typical wooden match produces 251 calories. A liter of gasoline has approximately 2.3 million calories of heat energy.



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Metric	English
1 gram	0.035 ounce
252 cal	1 BTU
17 °C	62.6 °F
18 °C	64.4 °F

Humidity

Humidity is the amount of water or water vapor in the air. The humidity of the air may vary from dry (0%) to very damp (100%). Relative humidity is measured by comparing the moisture in a given sample of air with the maximum amount of moisture that the same sample of air can hold at the same temperature.

Humid cold air feels much colder than dry cold air at the same temperature; hot humid air is much more oppressive than hot dry air. As with temperature, excessive humidity makes humans uncomfortable. Humid hot air slows down the human body's ability to cool itself through perspiration and evaporation. Excessive humidity also puts added strain on the air conditioning system.

In addition to cooling the interior, a vehicle's air conditioner removes the moisture from the air, and purifies it as a by-product of the humidity reduction process. Air pollutants become attached to the film of water that forms on the evaporator; these pollutants then drain away with the condensate water. Air particulates are also reduced by the climate control intake filter.

Heat Transfer

Heat is in constant motion. It flows from warmer areas to colder areas until an overall equal temperature is established. The rate of heat movement is influenced by two factors: the difference in the temperature between the hot and cold areas, and the medium (material) that the heat moves through. A wide temperature differential moves heat much faster than if two areas are almost the same temperature.

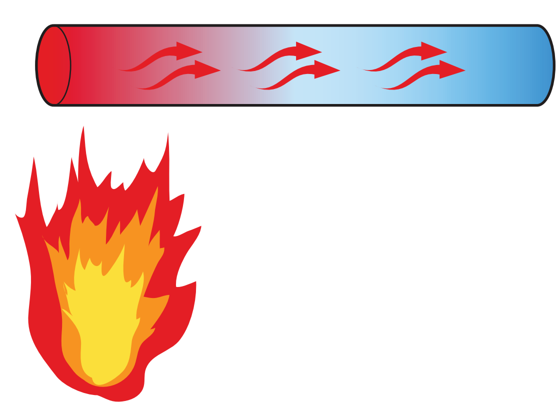
To cool a hot vehicle, the A/C system creates a cold place (the evaporator) for the unwanted heat to transfer to. Once the heat moves to this cold area, the heat is then removed and transferred to the air outside of the vehicle.

The movement of heat from a warmer object to a cooler one is called 'heat transfer'. There are three methods of heat transfer: conduction, convection, and radiation.

Conduction

Conduction is the movement of heat energy through a substance or from one substance to another by direct contact of atoms and molecules. Heat moves directly from one molecule to another. The heat energy speeds up the movement of the atoms and they collide with other molecules setting them into faster motion. This goes on until all the molecules are moving around faster and the entire object becomes hot.

For example, heat applied to one end of a cold metal bar will travel through the rod toward the cold end, until the entire bar is hot.



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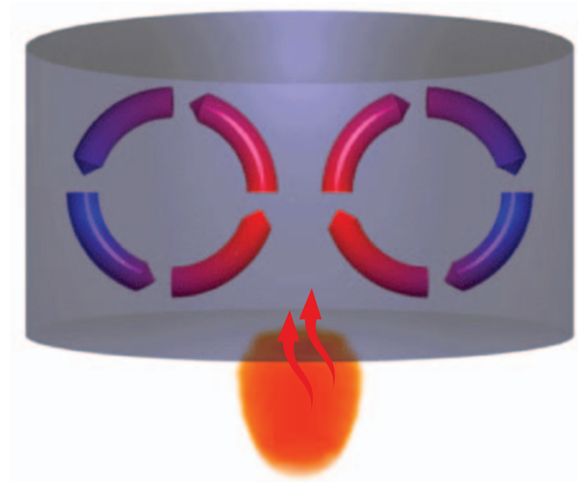
Convection

Convection is the transfer of heat in a liquid or gas as groups of molecules move in currents from one region to another. Warm air is less dense (lighter) than cooler air. The lighter air rises while the colder, denser (heavier) air sinks, pushing the lighter, warmer air up. This circular movement is called a convection current.

Water is also heated by convection. When water is heated in a pan, the water near the burner is heated first. The heat causes the water to expand, it becomes lighter, and it rises to the top of the pan. The heavier, colder water near the top sinks down, pushing up the hot water. This continues until all the water is evenly heated.



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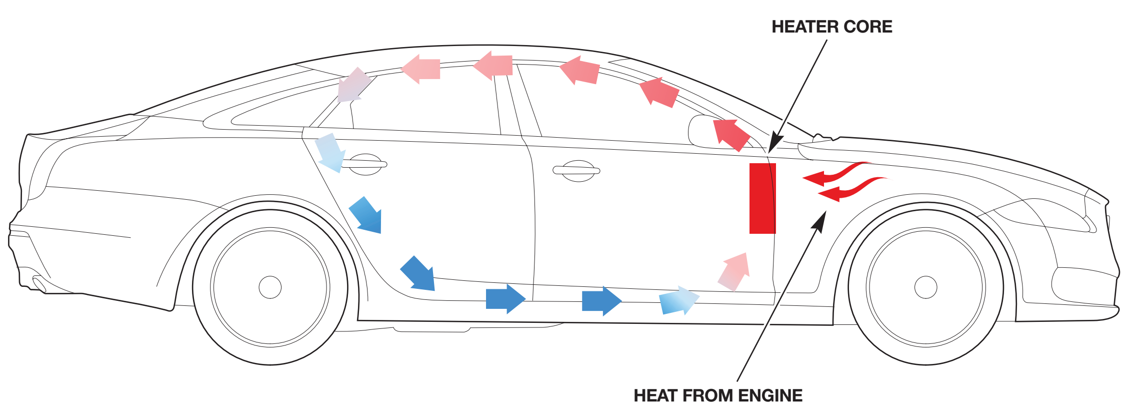
A vehicle's engine cooling system is a good example of both convection and conduction. Heat energy created by the combustion process must be removed from the engine to prevent overheating. The coolant in the engine absorbs engine heat (conduction). The heated coolant moves to the radiator (convection). The metal radiator absorbs heat from the liquid coolant (conduction). Finally, airflow through the radiator fins absorbs heat from the radiator (conduction and convection).



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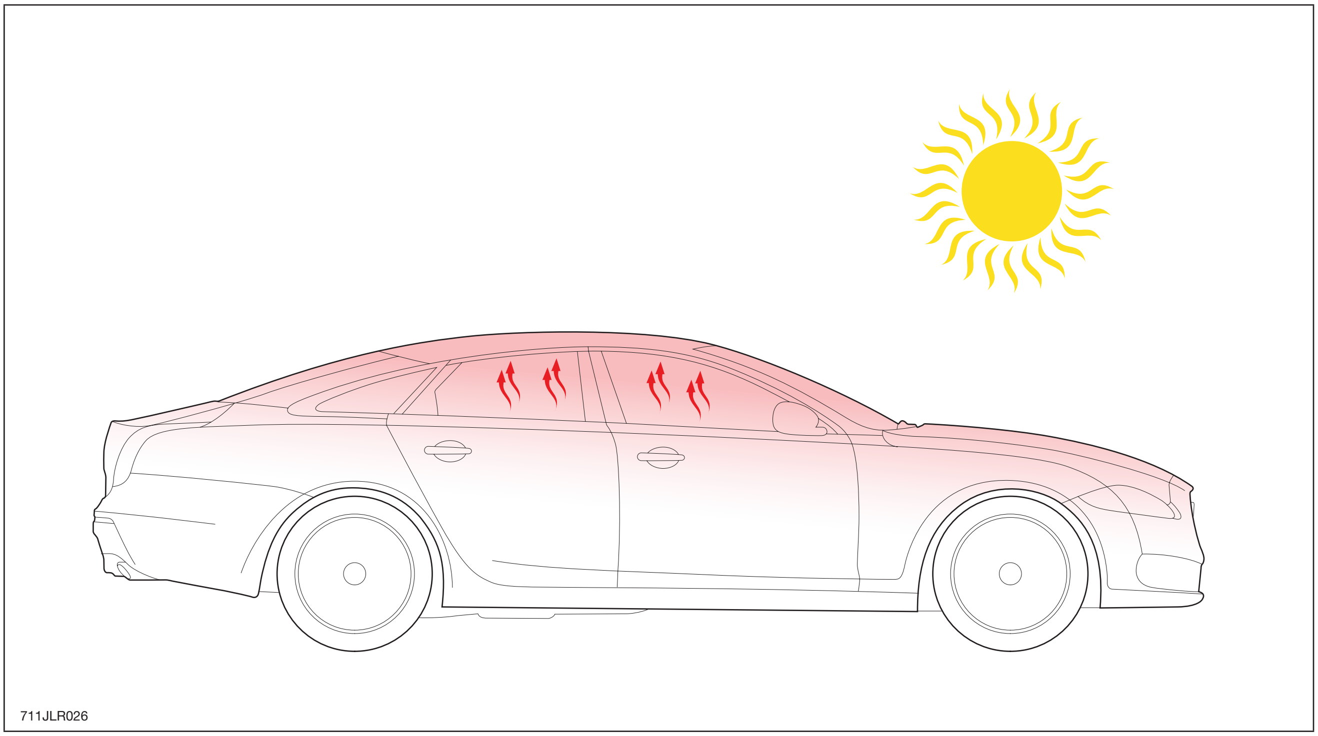
Radiation

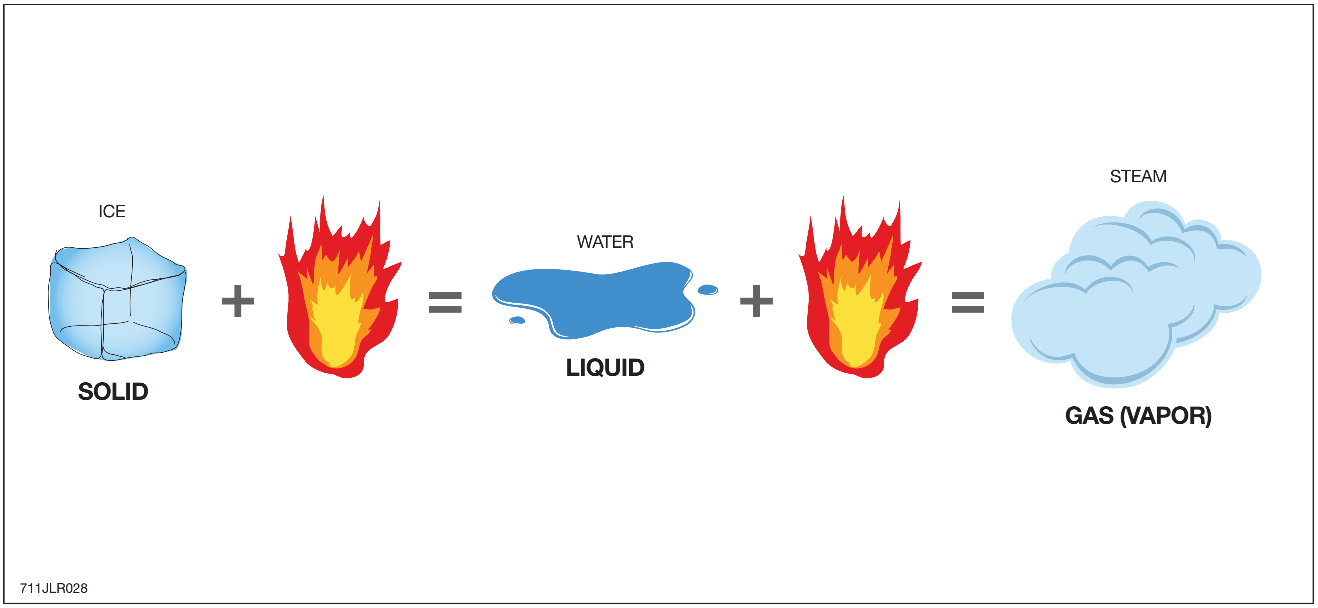
Radiation is heat energy transmitted through empty space by electromagnetic waves or infrared rays. This process involves only the molecules of the substance radiating the heat. Heat energy from the sun is transmitted to Earth as waves that travel through space and the Earth's atmosphere. When the heat waves hit an object on Earth, the energy passes into the object, and it becomes heated.

For example, on a cold sunny day, the sun's heat energy will be transferred through the cold air and absorbed by a vehicle sitting in the sun. The vehicle's exterior and interior will warmed, while the air around the vehicle remains cold.



States of Matter

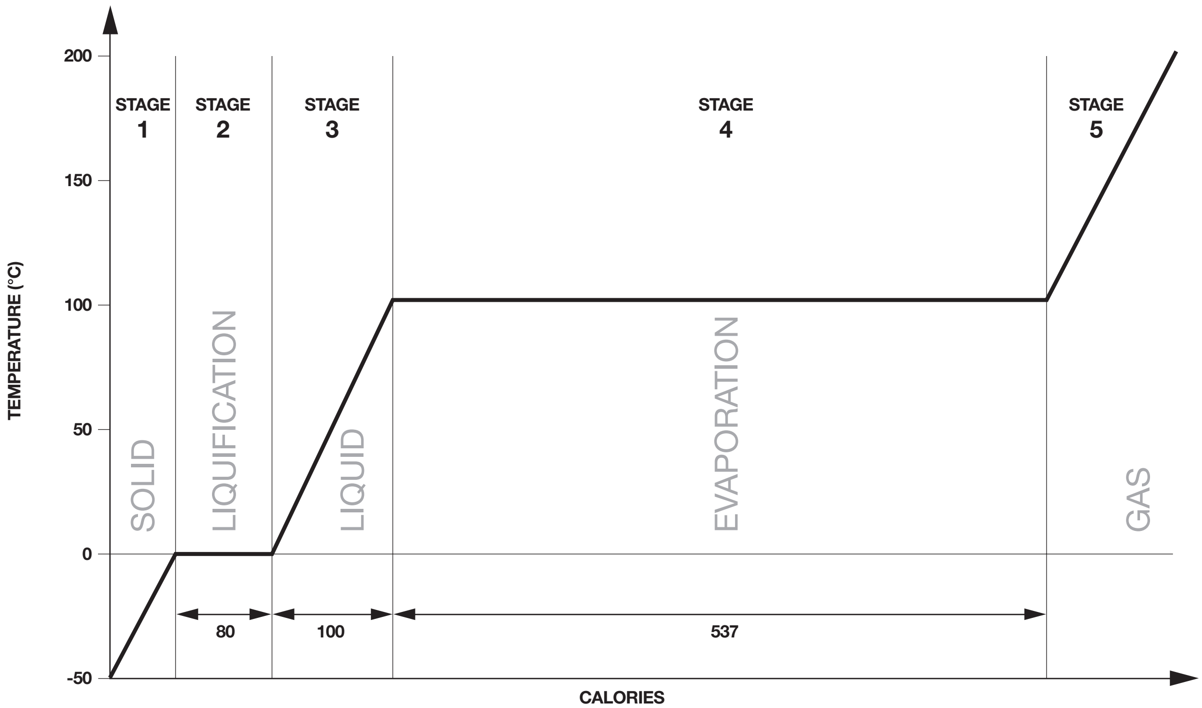
The three states of matter are solid, liquid, and gas. Changes in temperature can cause matter to change state. Water, for example, is a solid when it is frozen. A solid cube of ice will change state into a liquid if enough heat is added: the ice will melt into a puddle of water. If enough additional heat is added to boil the water (to 212 °F [100 °C]), the water will change state into a gas (steam). If heat is removed (that is, if cold is applied), the process is reversed: steam (gas) condenses into water (liquid), water freezes into ice (solid).



An air conditioning system works using a fluid called a ‘refrigerant’. The refrigerant in a functioning A/C system is always changing state from a liquid to a gas and back to a liquid.

Latent Heat

Latent heat is the amount of heat that must be added or removed from a liquid/gas/solid to make it change state. This form of heat is considered 'latent' because it cannot be measured with a thermometer. In the following illustration, a gram of water is used to illustrate the energy required to change state.



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Stage 1 (Solid):
As long as the ice is below 0°C, the ice increases in temperature by 1°C for each calorie added.

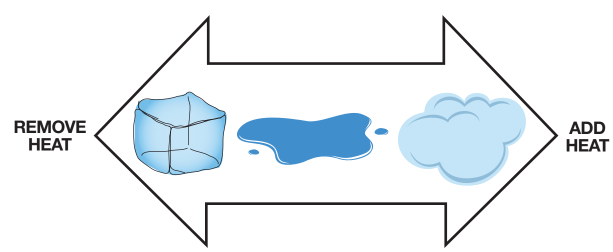
Stage 2 (Liquification):
An additional 80 calories must be added to the ice at 0°C to change the state from a solid to liquid at 0°C. Note that there is no change in temperature. This is the Latent Heat of Liquification.

Stage 3 (Liquid):
As long as the water is below 100°C, the water increases in temperature by 1°C for each calorie added.

Stage 4 (Evaporation):
An additional 537 calories must be added to the water at 100°C to change the state from a liquid to a gas (steam) at 100°C. Note that there is no change in temperature. This is the Latent Heat of Evaporation.

Stage 5 (Gas):
For each calorie added, the gas (steam) increases in temperature by 1°C.

The amount of energy need to reverse the process is the same, but heat is removed instead of added. The heat required to change a gas to a liquid is known as the Latent Heat of Condensation. The heat required to change a liquid to a solid is known as the Latent Heat of Solidification.



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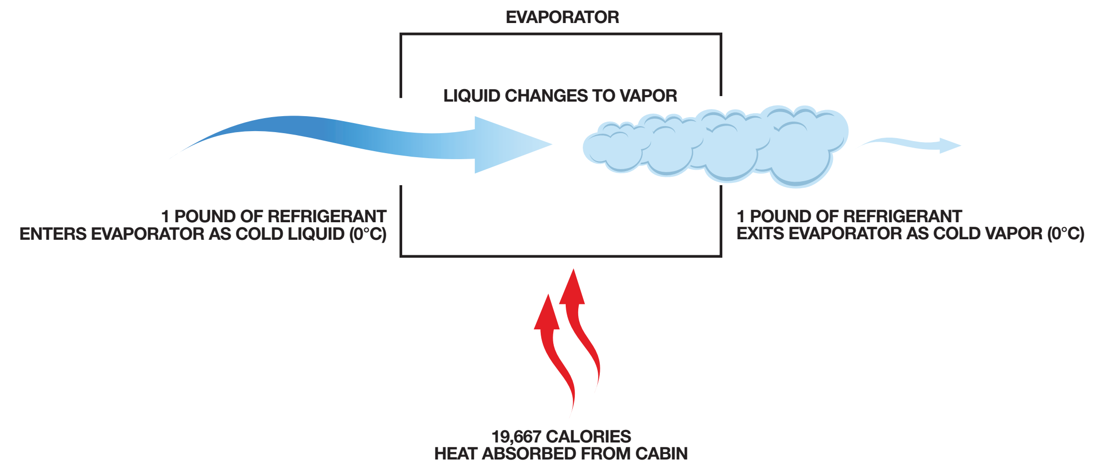
Evaporation

In an A/C system, vaporization occurs within the evaporator. When the refrigerant passes through the evaporator, it absorbs heat from inside the vehicle and begins to boil. As heat continues to be absorbed, the refrigerant changes from a low-pressure liquid into a low-pressure vapor.



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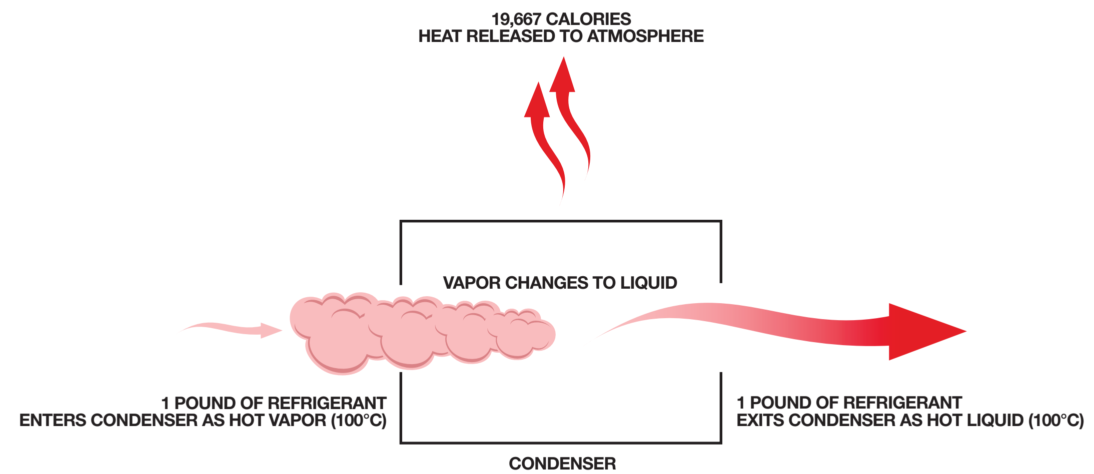
Condensation

In an A/C system, condensation occurs within the condenser. The condenser removes heat from the refrigerant and discharges it into the outside air. As the refrigerant cools, it condenses from a vapor to a liquid.



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Pressure, Temperature, and Boiling Point

Refrigeration systems work using basic principles that govern pressure, temperature, and boiling point. Within a confined space:

- For a given temperature, there is always a corresponding pressure
- If the pressure changes, the temperature will also change
- If the pressure changes, the boiling point of a liquid will also change

The engine cooling system provides a good example of how pressure can change the boiling point of a liquid.

As an engine warms up, thermal expansion of the water will result in the pressurization of a closed (capped) cooling system. A cooling system with 100% water and a pressure of 15 psi (103 kPa) would equate to a boiling point of approximately 121 °C (250 °F). For every pound per square inch (psi) increase in pressure, the boiling point of water will increase by 1.7 °C (3 °F). With a 50/50 coolant mixture, the boiling point increases to 130 °C (265 °F).

Conversely, if you lower a pressure, the boiling point will also decrease. The boiling point of water at sea level is 100 °C (212 °F). As elevation increases, atmospheric pressure decreases. For every 1000 feet of elevation increase, the boiling point of water decreases 1.1 °C (2 °F). The boiling point of water at the top of Pikes Peak (14,000 ft.) is only 86° C (187 °F).

The previous example used water, but the same principles apply to refrigerant. For example, at atmospheric pressure R134a refrigerant will boil at -26.5 °C (-15.7 °F).
If the pressure is increased by 14.5 psi (1.0 bar), the boiling point will be around -10.6 °C (12.9 °F). Lowering the pressure will decrease the refrigerant's boiling point.

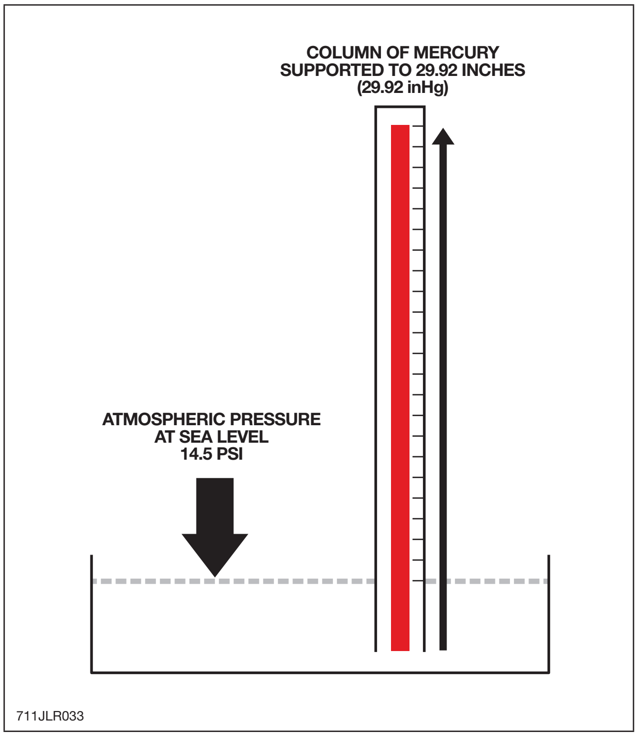
This explains why we 'evacuate' an air conditioning system: creating a vacuum in the system significantly lowers the system pressure and therefore lowers the boiling point. When the system pressure is lowered sufficiently the surrounding ambient air temperature will boil away any moisture located inside the air conditioning system.

Atmospheric and Vacuum Pressure

Pressure readings are achieved with gauges that can either measure above atmospheric pressure – in pounds per square inch (psi) or bar – or below atmospheric pressure (vacuum) in inches of mercury (inHg) or millibar (mbar).

The vacuum reading is based on a device that used liquid mercury to measure changes in the pressure of the surrounding air. Although mercury-based devices are no longer commonly used, the principle for measuring vacuum is still relevant.

At sea level, the atmospheric air pressure (14.5 psi) can support a column of mercury in an evacuated tube to a height of 29.92 inches.



If the atmospheric pressure falls, the column of mercury also falls. If all the surrounding air pressure is removed, the column of mercury would drop all the way down to the bottom of the tube. In this scenario we would say we have 'pulled' a vacuum of 29.92 inHg – from the top of the tube at 29.92 inHg to the bottom at 0 inHg.

REFRIGERANT

Safety

The following warnings and cautions should be reviewed and adhered to prior to working with refrigerant and refrigerant systems.

When handling refrigerant:

- Wear appropriate personal protection (gloves and goggles)
- Use chemical goggles or shield
- Keep away from open flame; NO SMOKING
- Work in a well-ventilated area
- Do not work over a ramp or pit
- Avoid using air pressure above 100 psi (6.9 bar)
- Observe local disposal regulations

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WARNINGS:

- **Do not allow liquid refrigerant to come into contact with your skin.**
- **The refrigerant takes the heat required for evaporation from its surroundings, even if this is the skin. Very low temperatures can be reached, which will cause serious frostbite.**
- **Always wear protective goggles, and gloves made of a fluoroelastomer/nitrile when handling refrigerant.**
- **If liquid refrigerant comes into contact with your skin or your eyes, immediately rinse the affected areas with plenty of water. Seek immediate medical assistance.**
- **If refrigerant comes into contact with hot surfaces or open flames, poisonous vapors will be produced (fluorine gas, phosgene gas). For this reason, you must NEVER SMOKE when working on air conditioning systems. The poisonous gases can be detected in even low concentrations due to their unpleasant smell.**
- **Refrigerant must not be released uncontrolled into the atmosphere.**
- **If refrigerant is accidentally released into the room, ensure that the room is adequately ventilated before continuing work, as gaseous refrigerant is heavier than air. This means that there is a risk of asphyxiation at ground level or in workshop pits.**
- **Refrigerants must not be mixed; R12 and R134a are NOT interchangeable and should NEVER be combined.**

⚠ **CAUTIONS:**

- **Do not expose the pressure vessels to direct sunlight or heat.**
- **Do not overfill the pressure vessels; leave room for expansion!**
- **Protect the pressure vessels from frost.**
- **Transport the pressure vessels in upright position and do not allow to fall.**
- **Always close the pressure vessels carefully.**

First Aid

Inhalation: Immediately remove exposed individual to fresh air, keep person calm; if not breathing, give artificial respiration. If breathing is difficult, call paramedics and give oxygen.

Skin: Immediately flush the skin with plenty of water for at least 15 minutes, while removing contaminated clothing and shoes; call paramedics; wash contaminated clothing before reuse; treat for frostbite if necessary by gently warming the affected area.

Eyes: Immediately flush the eyes with plenty of water for 15 minutes; call paramedics.

Ingestion: Ingestion is not considered a potential exposure hazard.

What is a Refrigerant?

A refrigerant is a compound used in a heat cycle that undergoes a phase change from a gas to a liquid and back. The ideal refrigerant has good thermodynamic properties, is non-corrosive, and safe.

The desired thermodynamic properties are a boiling point somewhat below the target temperature and also:

- A high heat of vaporization
- A moderate density in liquid form
- A high critical temperature

Since boiling point and gas density are affected by pressure, refrigerants may be made more suitable for a particular application by choice of operating pressure.

The two main uses of refrigerants are refrigerators/freezers and air conditioners.

Refrigerant R134a

Jaguar vehicles use Tetrafluoroethane, also called simply R134a, as an A/C refrigerant. R134a is a haloalkane refrigerant without ozone depletion potential. Previously used refrigerant know as R12 (dichlorodifluoromethane) has been banned from use and manufacturing because it contains chlorofluorocarbons (CFCs) which have been identified as a primary contributor to ozone depletion.

R134a has chemical properties that make it ideal for use as a refrigerant:

- Low boiling point of -26 °C (15 °F) at sea level
- Ability to change temperature readily in response to changes in pressure

R134a provides most of the benefits of R12 without the harmful atmospheric effects. The absence of chlorine in R134a makes it environmentally ‘friendly’, but R134a can be flammable at certain pressures and concentrations.

Cross-Contamination

A/C systems that use one type of refrigerant cannot use the other type. For example, you cannot use R134a to charge an older A/C system designed to use R12.

Under no circumstances should R12 and R134a be mixed in the same system. Mixing refrigerants is called cross-contamination, and it can seriously damage the A/C system. In addition, identifying contaminated refrigerant during normal diagnosis is difficult.

Handling Refrigerant

Technicians often remove or discharge refrigerants from an A/C system during service. Depending on how these refrigerants are processed after removal, they can be classified as extracted, recycled, or reclaimed.

Extracted Refrigerant
Extracted refrigerant is simply removed and stored in an approved container. This process is used when servicing the refrigeration system and the refrigerant must be removed and stored from the A/C system.

Recycled Refrigerant
Recycled refrigerant is cleaned to remove contaminants produced during normal operation of the A/C system. Mixing recycled refrigerant from a non-vehicle mobile system or a building type A/C system, for example, contaminates recycled mobile vehicle refrigerant.

Reclaimed Refrigerant
Reclaimed refrigerant is processed to the same standards and purity as new refrigerant. This process requires expensive equipment not ordinarily found in dealership service departments. Reclaimed and recycled refrigerant will perform equally well in all mobile A/C systems.

Typical R134a Charging Station

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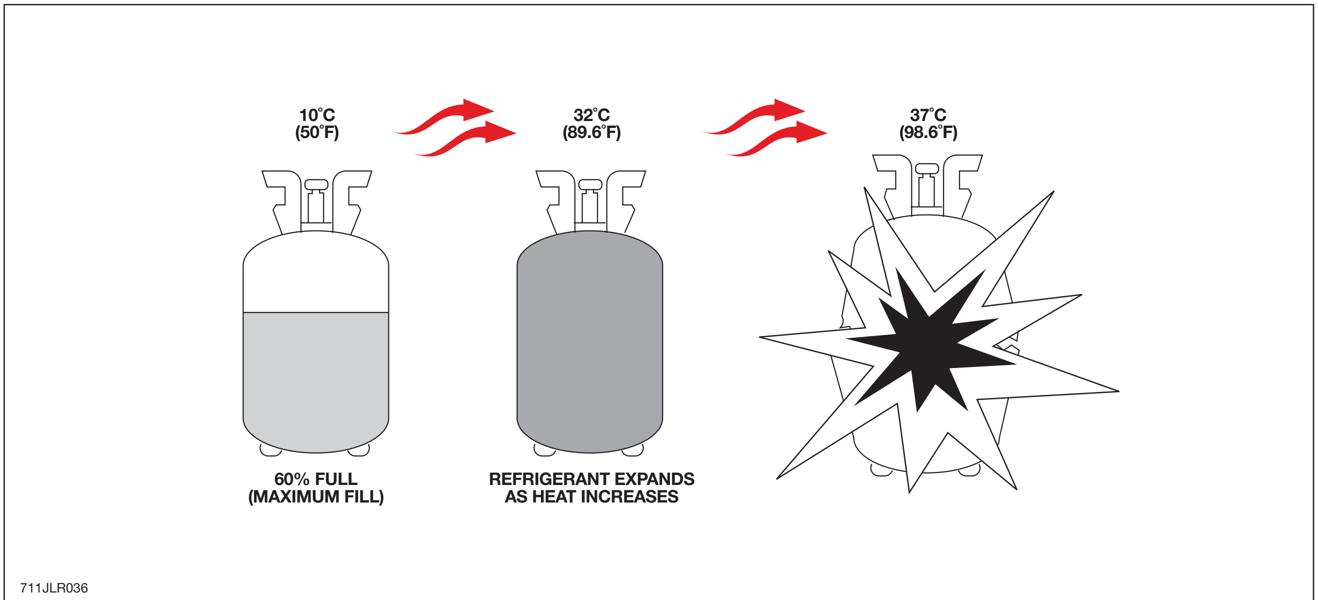
Storing Refrigerant

Both R12 and R134a are gases at normal room temperature, and they can be hazardous if stored improperly. New refrigerant stored in its original properly-filled container usually poses no safety hazard. However, recycled refrigerant can be dangerous if stored in the wrong type of container or in an overfilled container.



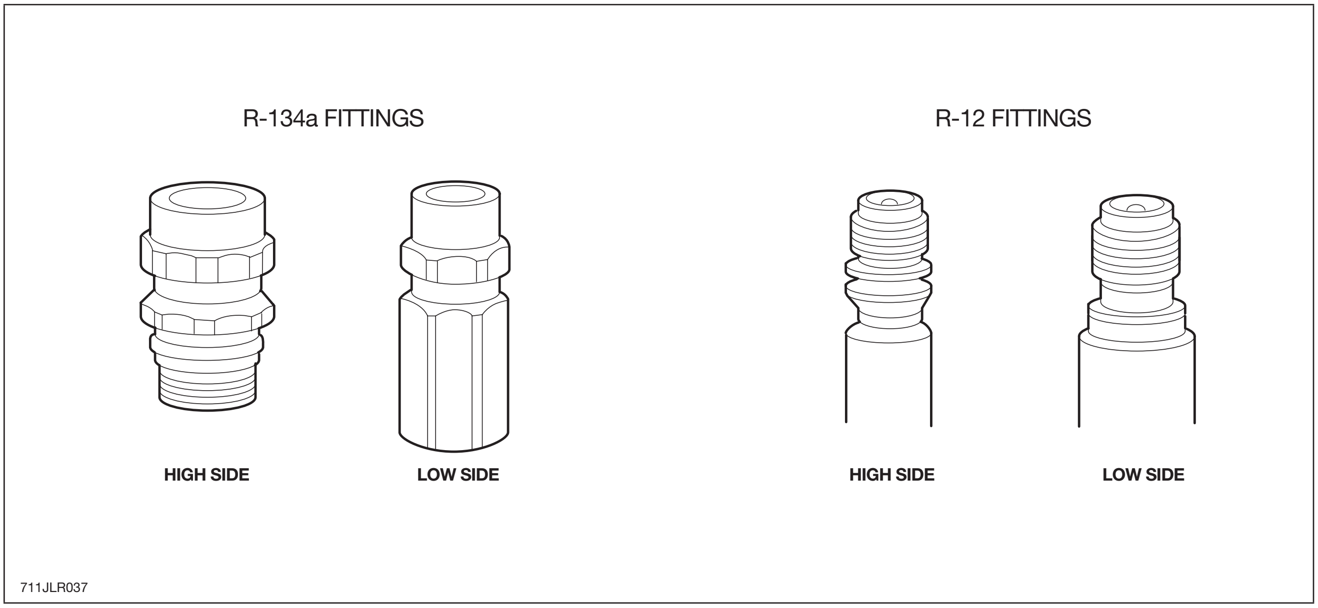
To prevent accidents when handling recycled refrigerant, always observe the following rules:

- Never save disposable refrigerant containers for reuse
- Remove all refrigerant and dispose of the containers properly
- Use only containers approved for refrigerant
- Never fill a container to more than 60% of container capacity
- Never store refrigerant containers in direct sun or heat. High temperature causes the gas to expand, which increases the pressure in the container and may cause the container to burst.

Refrigerant Fittings

Refrigeration ports allow the system to be checked for proper operating pressures, and allow for emptying or filling the system as needed. To prevent cross-contamination of different types of refrigerants – such as R134a vs. R12 – refrigeration systems use different styles of fittings.

There are several differences between R134a and R12 refrigeration fittings, the most significant being that R134a uses a special coupler that cannot be used on R12 systems. The new fittings on the R134a prevent excessive loss of refrigerant to the atmosphere.



Refrigeration Oil

Refrigeration oil lubricates the moving parts and seals of an A/C system. The oil flows along with the refrigerant throughout the system.

⚠ **CAUTION: Refrigeration oil and motor oil are different. Never use motor oil in an A/C system.**

Mineral Oil and PAG Oil

The type of refrigeration oil used in an A/C system depends on the type of refrigerant: when engineers develop a refrigerant, they simultaneously develop the lubrication oil used with it.

R12 A/C systems used mineral oil as a lubricant. R134a systems use oil made of polyalkylene glycols, commonly called PAG oil. PAG oil and mineral oil are completely incompatible and should never be mixed.

Characteristics of Refrigeration Oil

Refrigeration oil, either mineral or PAG oil, is highly refined and free of the additives and detergents found in conventional motor oil. Refrigeration oil flows freely at temperatures well below freezing, and it includes an additive to prevent foaming in the A/C system. Refrigeration oil readily absorbs moisture. If stored improperly, the oil becomes unusable. For example, an unsealed container of PAG oil becomes saturated with two percent water if left in a humid climate for five days. If you use saturated oil in an A/C system, acids form, damaging seals and other components.

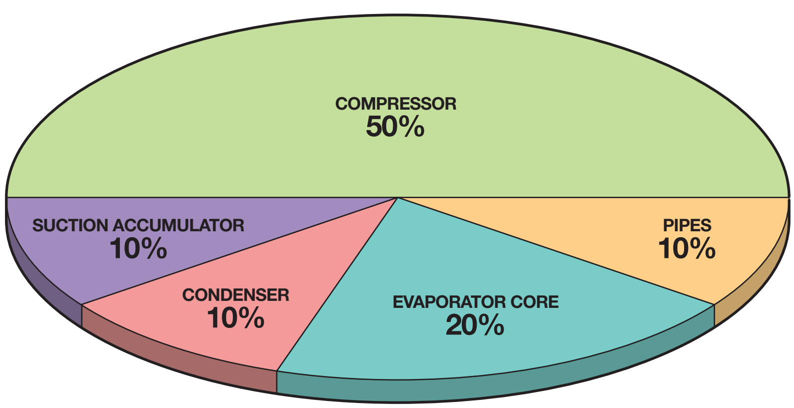
Always seal refrigerant oil properly after use, and never reuse oil removed from an operating A/C system.

In an A/C system, the components hold the refrigerant oil. The compressor helps to mix the oil with the refrigerant and circulates it throughout the system. When replacing an A/C component, the oil that is trapped in the component that is being replaced must also be replaced. Service manuals contain charts describing how much oil to add for various component replacements.

If an A/C system develops a leak, refrigeration oil will appear at the site of the leak. Any leaking refrigerant evaporates immediately. The amount of oil lost depends on the size of the leak and the length of time it was leaking. After you repair a leak, replace the amount of lost oil. Carefully measure the amount of oil removed during the evacuation process and replace it with a slightly greater amount. If lost oil is not replenished, severe damage may occur.

Oil Capacity

The following chart illustrates the distribution of refrigeration oil between the system components.



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REFRIGERATION SYSTEM COMPONENTS

Similar to the liquid in the engine cooling system, the refrigerant in an air conditioning system absorbs, carries, and releases heat. To do this, the A/C system utilizes several components to move refrigerant.

Compressor

The compressor is the refrigerant pump for the A/C system. The compressor is generally driven by the crankshaft via a multigrooved belt, which provides the power to operate the compressor. The compressor draws cool gas in through the suction port from the evaporator. The compressor then compresses the gas, which dramatically increases the pressure and temperature of the gas, then pumps the hot gas out the discharge port through the refrigeration lines and on into the condenser.

For practical purposes, liquids cannot be compressed; the A/C compressor operates only with refrigerant in its gaseous state. Liquid refrigerant in the compressor will damage the compressor.

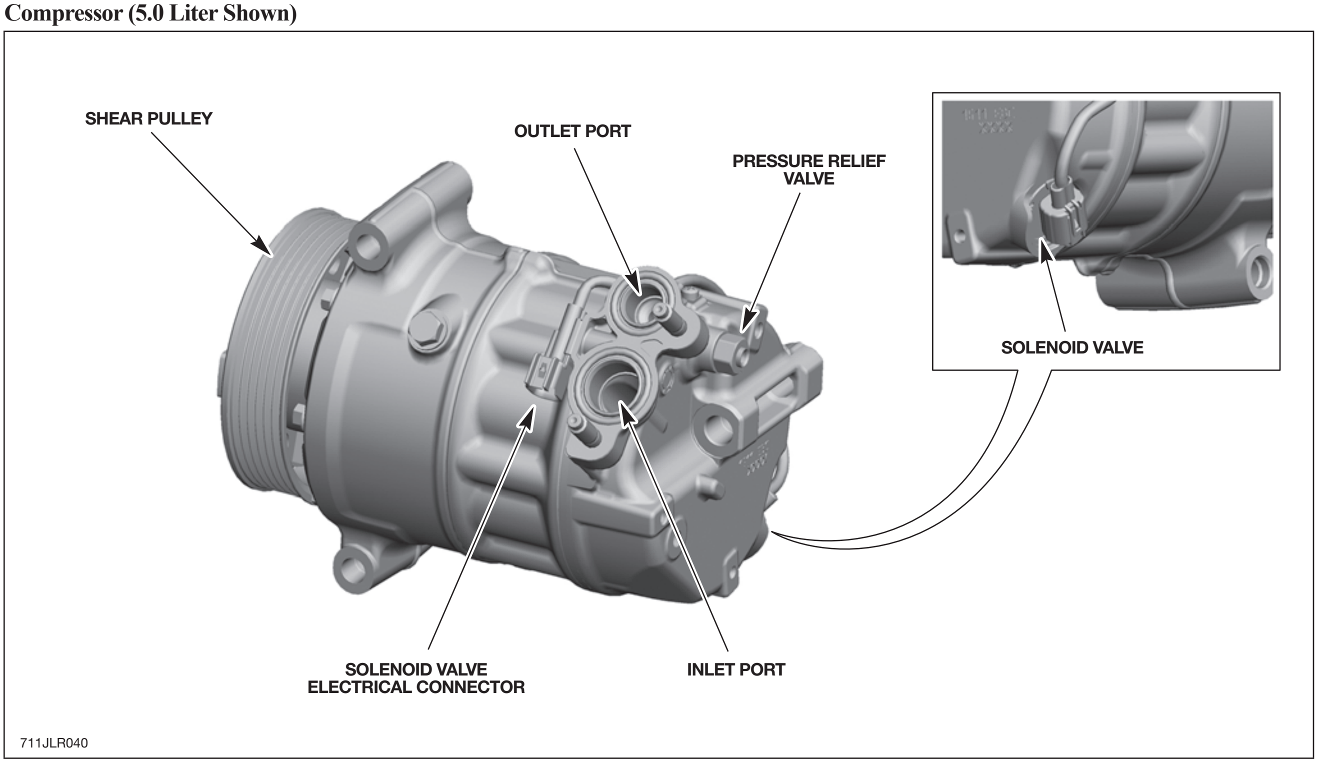
Compressors typically create suction and pressure through the use of pistons or scrolls. A pressure relief valve is incorporated into the compressor to protect the system from excessive refrigerant pressures; if system pressure becomes too high, the valve opens and refrigerant is vented to atmosphere.

A/C compressors for the different engine types differ due to their individual installation and system requirements, but otherwise are the same. The following are some compressor designs that have been previously fitted on Jaguar vehicles:

- Fixed swash plate piston compressor
- Scroll compressor

The most commonly used compressor is the clutchless compressor with variable swashplate/ variable displacement.

Compressor (5.0 Liter Shown)



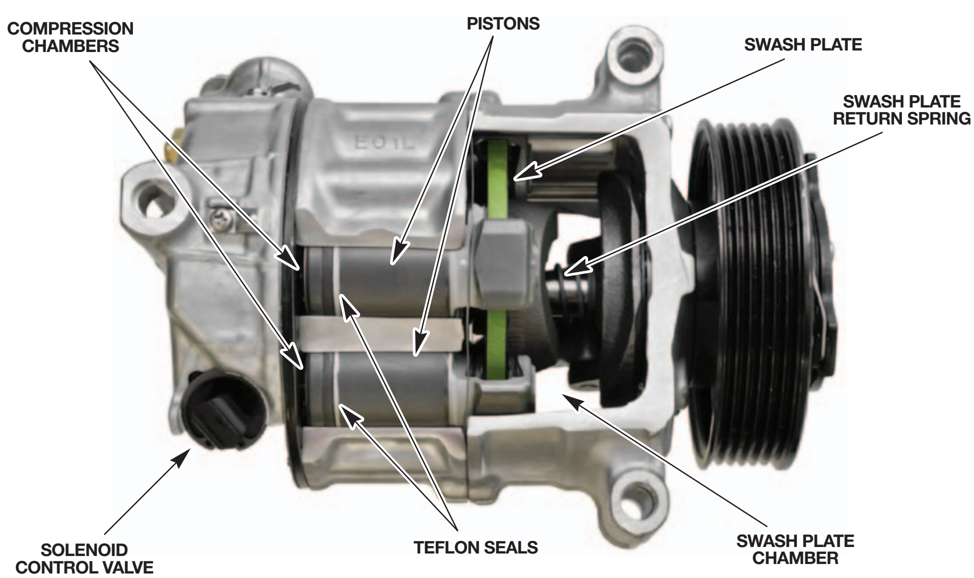
Clutchless Compressor with Variable Swash Plate

The shaft of a clutchless compressor rotates whenever the engine is running. Rather than engaging and disengaging a magnetic clutch to control compressor operation, a variable displacement design allows the flow rate to be electronically controlled. The benefits of using this type of compressor fall under the following areas:

- Improved noise, vibration, and harshness (NVH) characteristics (no clutch cycling)
- Improved efficiency/load (due to no clutch coil current and no cycling)
- Extended belt life
- Fuel economy benefits by de-stroking the compressor at the appropriate time (when maximum capacity not required)

The special feature of this type of compressor lies in the variable piston stroke created by the unique adjustable swash plate. The piston stroke, and thus the delivery rate, are determined by means of the variable angle of the swash plate.

The angle of the swash plate is dependent upon the swash plate chamber pressure, and thus on the pressure conditions at the top and bottom of the piston. This is supported by a spring in front of the swash plate. The swash plate and compression chamber pressures are determined by the compressor solenoid control valve, which is pulse width modulated (PWM) for precise refrigerant control.



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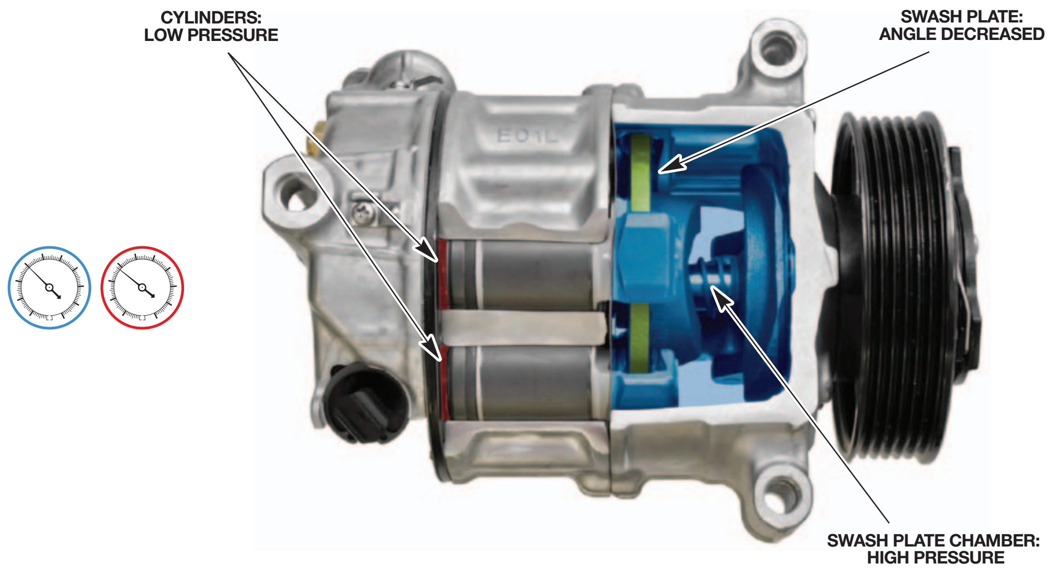
Reduced Stroke

To reduce the stroke of the compressor, the Automatic Temperature Control Module (ATCM) reduces the PWM signal to the normally-open solenoid control valve. As the valve opens, refrigerant pressure is allowed to flow into the swash plate chamber. The increased pressure acting on the bottom of the compressor pistons reduces the pressure differential between the top and bottom of each piston. As a result, piston travel is reduced, thereby reducing displacement.



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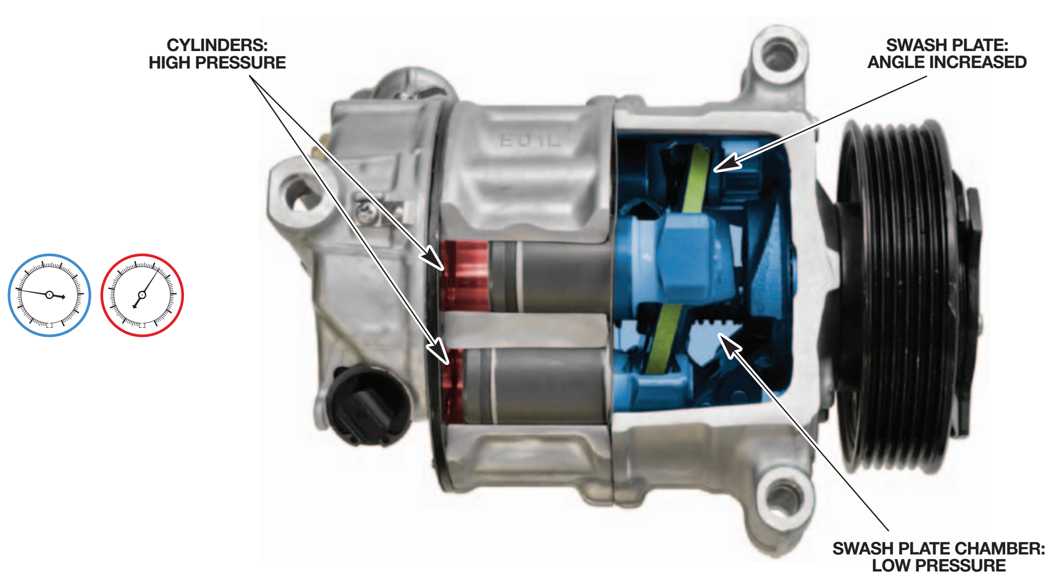
Increased Stroke

To increase the stroke of the compressor, the ATCM increases the PWM signal to the normally-open solenoid control valve. As the valve closes, refrigerant pressure flow into the swash plate chamber is reduced. The decreased pressure acting on the bottom of the compressor pistons increases the pressure differential between the top and bottom of each piston. As a result, piston travel is increased, thereby increasing displacement.



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A/C Compressor Solenoid Control Valve

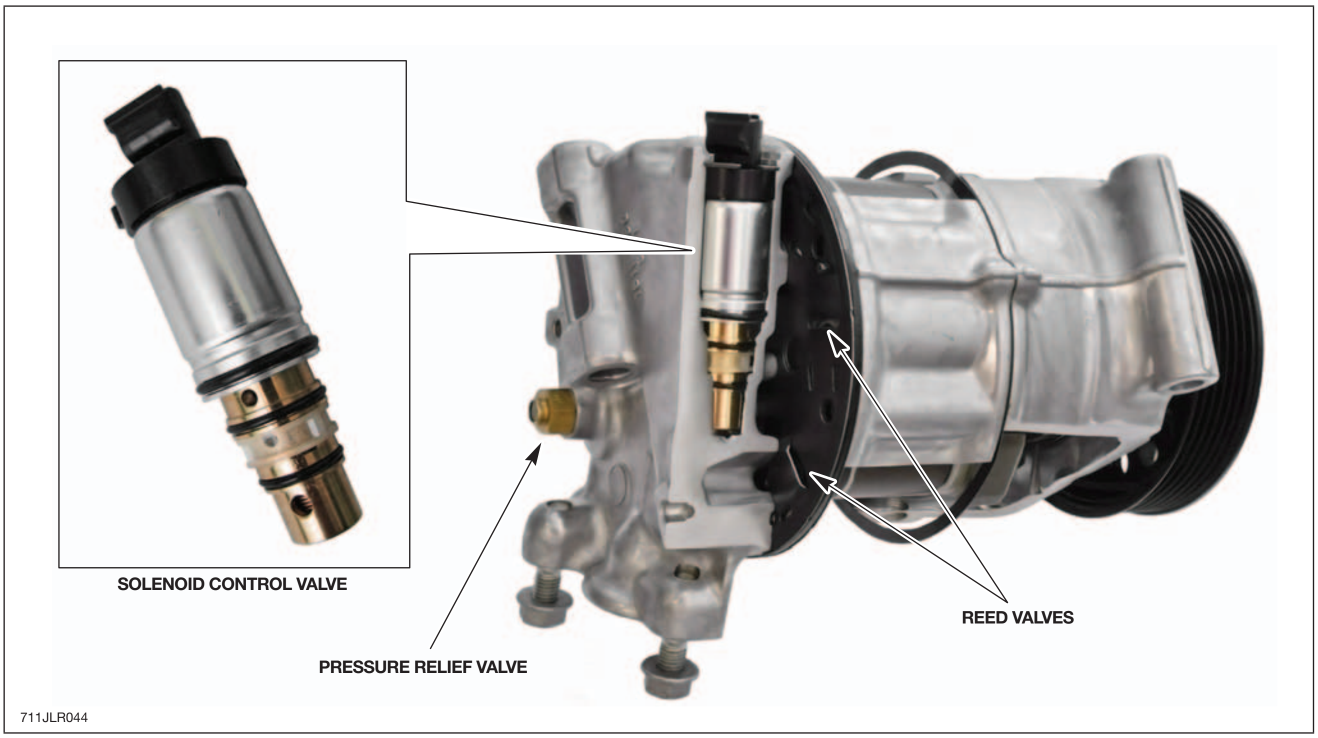
The A/C compressor solenoid valve is integral with the A/C compressor. Operation of the solenoid valve is controlled by the ATC module using a hardwired drive current of differing values. By controlling the flow of refrigerant through the compressor, the solenoid valve can control the A/C system pressure and the evaporator operating temperature.

Refrigerant flow is controlled by the control valve varying the pressure within the compressor suction chamber, which in turn adjusts the swash plate to suit demand. The valve is normally open and controlled by a PWM signal; the higher the current, the greater the displacement.

Control of the valve is between 2% and 100%, where the 2% effectively means the compressor is cycling within itself and the output flow is nonexistent. The solenoid controls the angle of the compressor swash plate, resulting in maximum refrigerant delivery.

To protect the system from excessive pressure, a pressure relief valve is installed in the outlet side of the A/C compressor. The pressure relief valve vents excess pressure into the engine compartment.

The variable displacement provides the ability to maintain a constant flow of refrigerant regardless of engine speed.



Reed Valves

Reed valves mechanically restrict the flow of refrigerant to a single direction. They are made of spring steel and open & close at a predetermined flow rate to create compression.

The intake reed valve allows refrigerant into the compression chamber, then closes upon compression stroke while the exhaust reed valve opens.

The control solenoid controls the volume of refrigerant entering and exiting the compression chamber.

Compressor 'Shear' Pulley

The compressor pulley includes a shear coupling, designed to break free of compressor drive in the event of a catastrophic compressor failure. The pulley will continue to function as an idler, preventing damage to the drive belt to preserve the integrity of the remaining accessory drive.

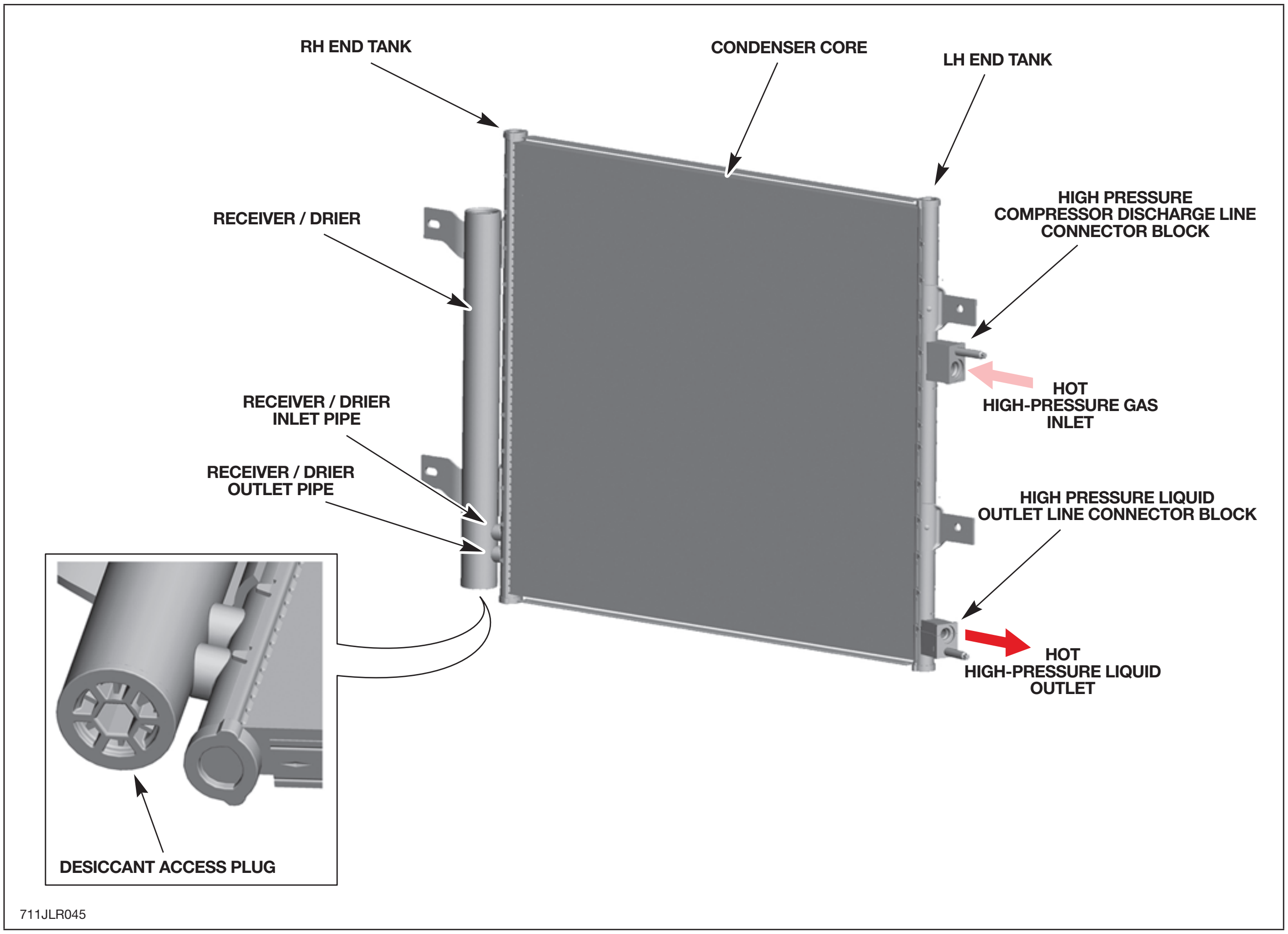
NOTE: Pulley shear is a one-time event, after which the pulley must be replaced along with the compressor.

Condenser

The condenser, located in front of the radiator, receives hot, high-pressure refrigerant gas from the compressor and transfers the heat to the outside air. The condenser circulates refrigerant through a series of tubes and fins. A fan draws outside air over the condenser's surface area, allowing the hot refrigerant to release its heat to the air. As the refrigerant cools, it changes from a high-pressure gas to a high-pressure liquid. The efficiency of the condenser is critical to A/C operation. The outside air must absorb the stored heat from the vehicle interior plus the additional heat that results from compressing the gas.

The more heat transferred by the condenser, the more cooling the evaporator can provide. A larger capacity condenser and a more efficient fan will reduce the interior temperature significantly.

Condenser (5.0 Liter Shown)



Receiver/Drier

After the refrigerant leaves the condenser, it enters the receiver/drier, which performs three functions:

- Filters particulate
- Removes moisture through the use of desiccant (typically silica gel)
- Acts as a refrigerant reservoir and separates refrigerant gas from refrigerant liquid.

The receiver/drier only allows liquid to pass on to the expansion valve. This maximizes the evaporator's performance by insuring all refrigerant entering the evaporator is in liquid form.

In some applications, the receiver/drier is integrated into the condenser. The receiver/drier may also have electrical controls and service ports for system operation and servicing.

Thermostatic Expansion Valve

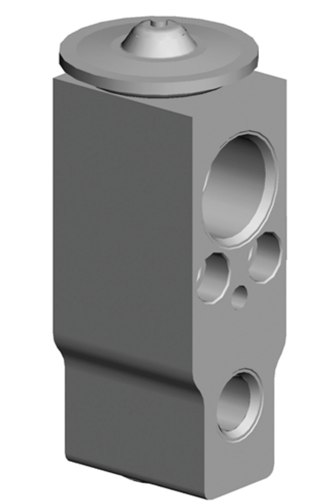
The expansion valve regulates the flow of refrigerant to the evaporator. To get maximum cooling potential, the pressure of the liquid refrigerant must be lowered before it enters the evaporator. At lower pressure, the refrigerant's temperature and boiling point drop, allowing it to absorb more heat as it passes through the evaporator.

The thermostatic expansion valve is a block type valve attached to the inlet and outlet ports of the evaporator. The valve consists of an aluminum housing containing inlet and outlet passages. A ball and spring metering valve is installed in the inlet passage and a temperature sensor is installed in the outlet passage.

The temperature sensor consists of a temperature-sensitive tube connected to a diaphragm. The bottom end of the tube acts on the ball of the metering valve. Pressure on top of the diaphragm is controlled by the evaporator outlet temperature conducted through the temperature-sensitive tube. The bottom of the diaphragm senses evaporator outlet pressure.

Liquid refrigerant flows through the metering valve into the evaporator. The restriction across the metering valve reduces the pressure and temperature of the refrigerant. The restriction also changes the liquid stream of refrigerant into a fine spray, to improve the evaporation process. As the refrigerant passes through the evaporator, it absorbs heat from the air flowing through the evaporator. The increase in temperature causes the refrigerant to vaporize.

The temperature and pressure of the refrigerant leaving the evaporator acts on the diaphragm and temperature sensitive tube, which regulate the metering valve opening and so control the volume of refrigerant flowing through the evaporator. The warmer the air flowing through the evaporator, the more heat available to evaporate refrigerant and thus the greater volume of refrigerant allowed through the metering valve.



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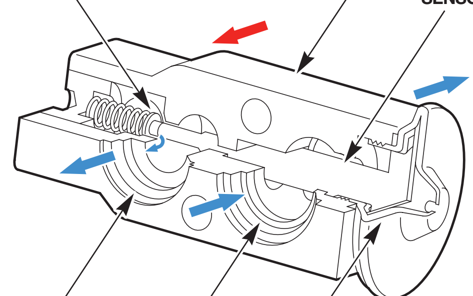

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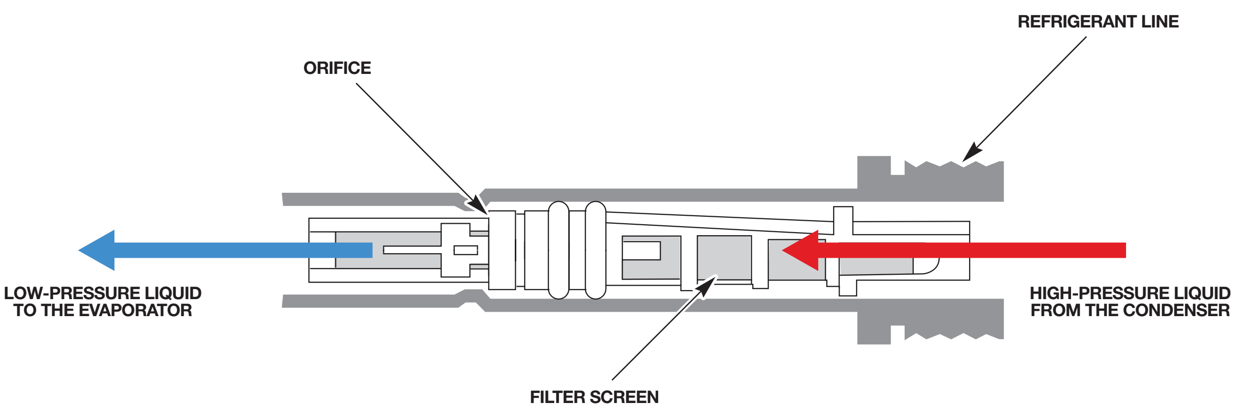
Orifice Tube

Like an expansion valve, an orifice tube divides the high- and low-pressure parts of the A/C system. The orifice tube has a fixed opening. The flow rate of the refrigerant through the opening is determined by the cycling of the compressor clutch.



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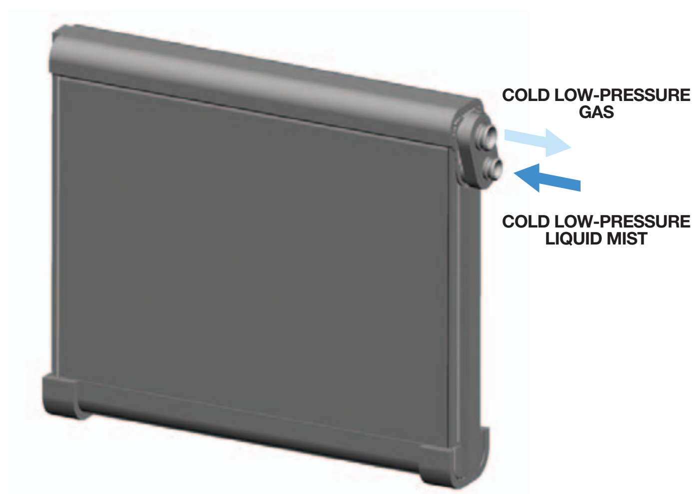
Evaporator

The evaporator is located within the cabin of the vehicle. The evaporator absorbs heat from the passenger compartment and transfers the heat to the refrigerant.



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Refrigerant enters the evaporator as a cold, low-pressure liquid mist, which circulates through the evaporator's tubes and fins much like coolant circulates through an engine's radiator. An electric blower fan forces warm air from the vehicle's interior over the surface of the evaporator. The refrigerant absorbs heat as it changes from a liquid to a gas. The refrigerant then exits the evaporator, carrying the heat with the refrigerant as a cool, low-pressure gas.

Accumulator/Drier

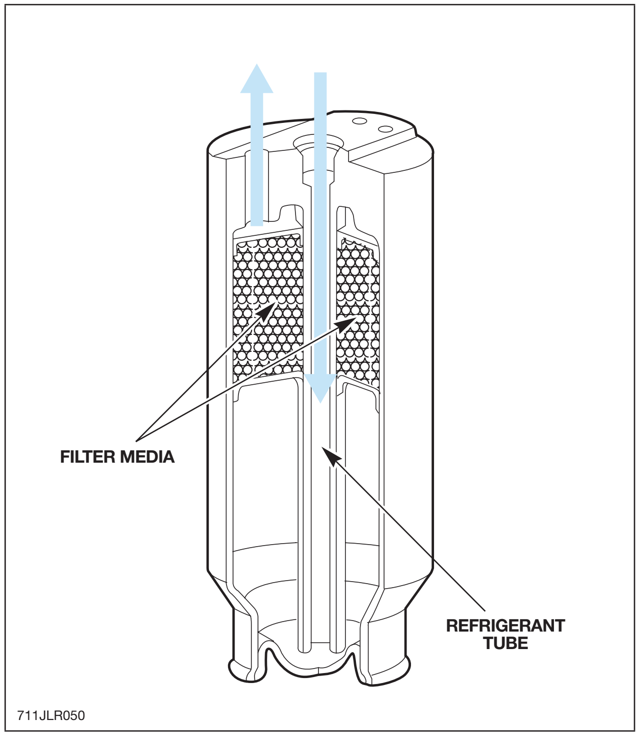
The accumulator is used in A/C systems with an orifice tube. The accumulator is located after the evaporator and before the compressor, on the low-pressure side of the system.

The accumulator performs three functions:

- Filters particulate
- Removes moisture through the use of desiccant (typically silica gel)
- Acts as a refrigerant reservoir and separates refrigerant gas from refrigerant liquid.

The accumulator only allows gas to pass on to the compressor. This prevents liquid from entering the compressor, which would likely damage the compressor.

NOTE: Receiver/driers and accumulators contain a dye that will fluoresce under a black light to aid in detecting refrigerant system leaks.

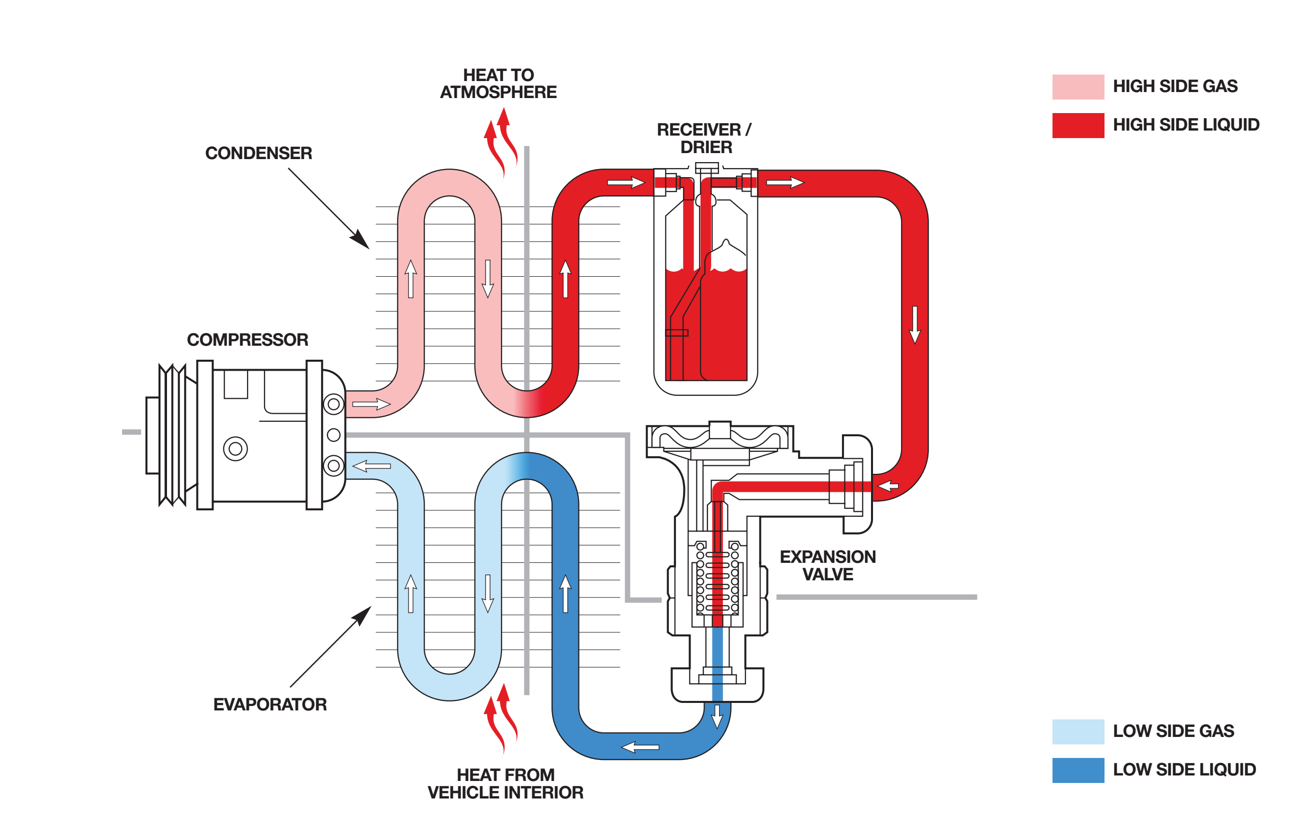


REFRIGERATION CYCLES

Vehicle A/C systems use the principles of pressure/temperature relationship and heat movement. These systems are typically expansion valve or orifice tube type systems. The A/C system is divided into two parts: a low-pressure side and a high pressure side. Refrigerant evaporates in the low side and condenses in the high side.

Expansion Valve System

As the refrigerant flows through a complete cycle, the refrigerant undergoes two changes in pressure and state. The A/C system can be divided into four sections. The horizontal line in the graphic divides the cycle into a ‘high-pressure side’ on top and a ‘low-pressure side’ on the bottom. The high-pressure side starts at the compressor outlet, extends through the condenser and receiver/drier, and ends at the expansion valve.



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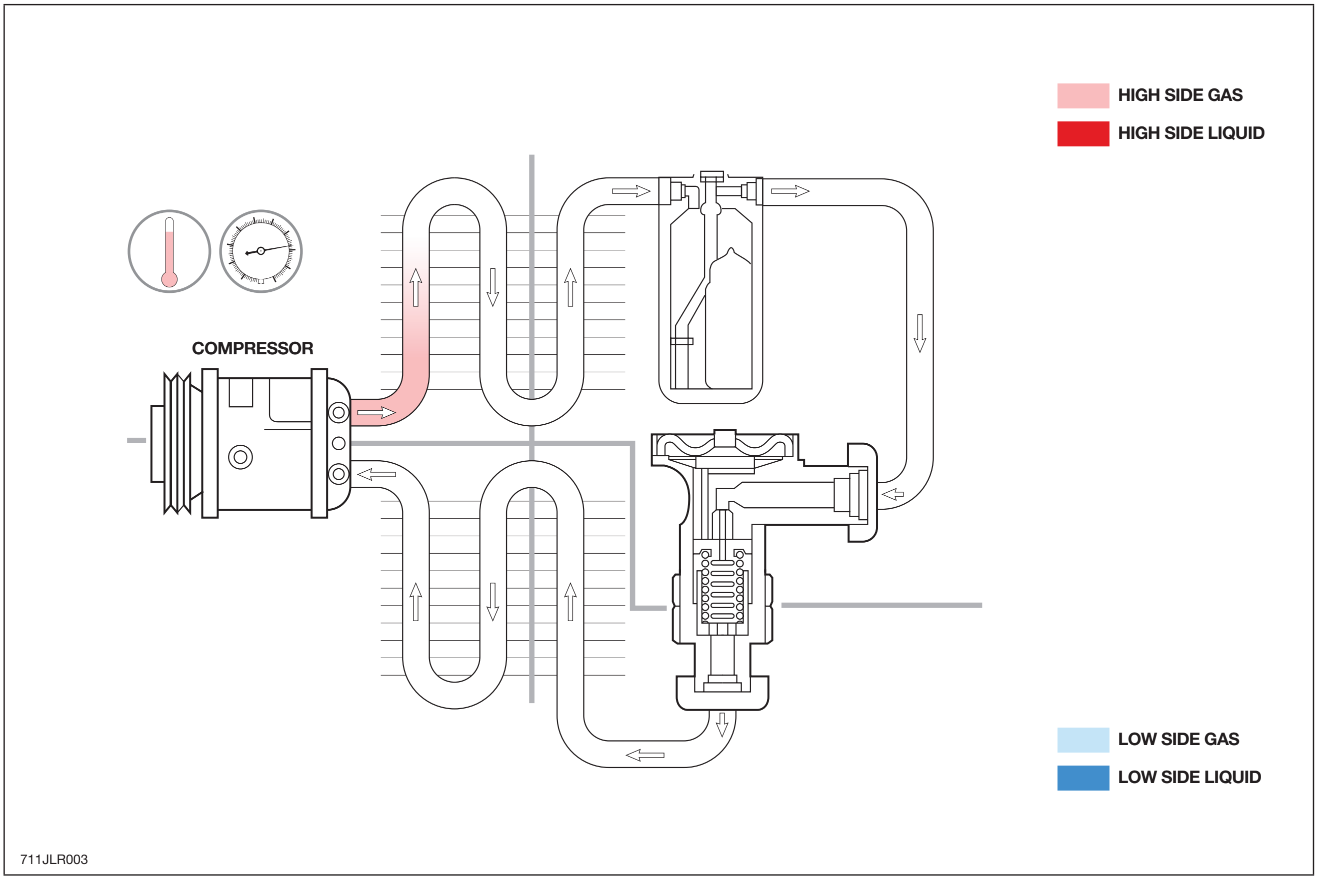
When refrigerant leaves the expansion valve, its pressure drops and it enters the low-pressure side. The low-pressure side extends through the evaporator and into the compressor’s inlet.

The vertical line in the illustration marks the points where the refrigerant changes state. On the left side of the circuit the refrigerant is a vapor; on the right side it is a liquid.

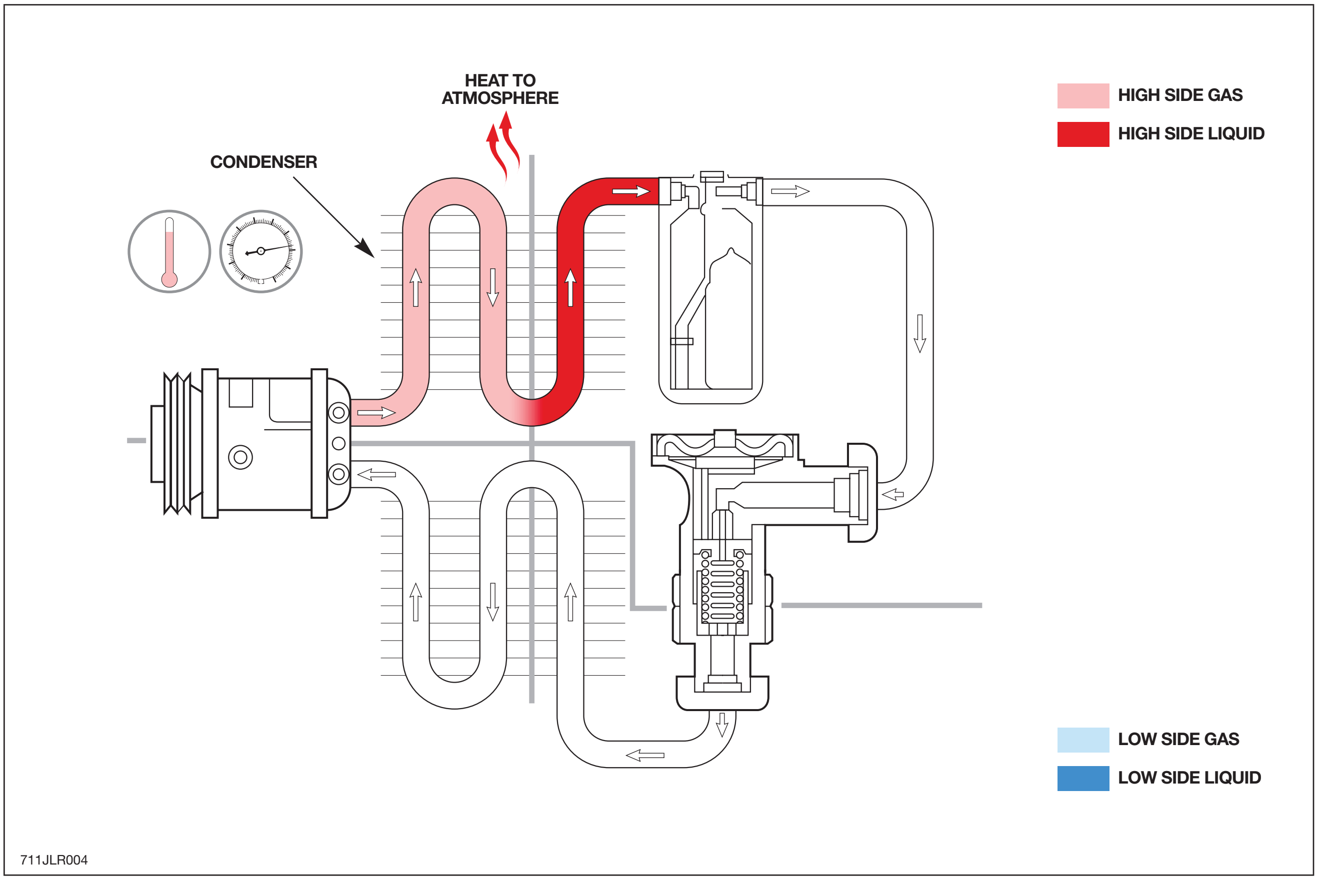
Refrigeration Cycle: Compressor

The refrigeration cycle begins at the compressor. The compressor pumps high pressure vapor to the condenser at about 175 psi (1,207 kPa). A drive belt on the engine rotates the compressor pulley, which drives the compressor. The system monitors refrigerant pressure and activates the compressor control valve to increase or decrease refrigerant flow as needed in order to maintain the desired pressure.



Refrigeration Cycle: Condenser

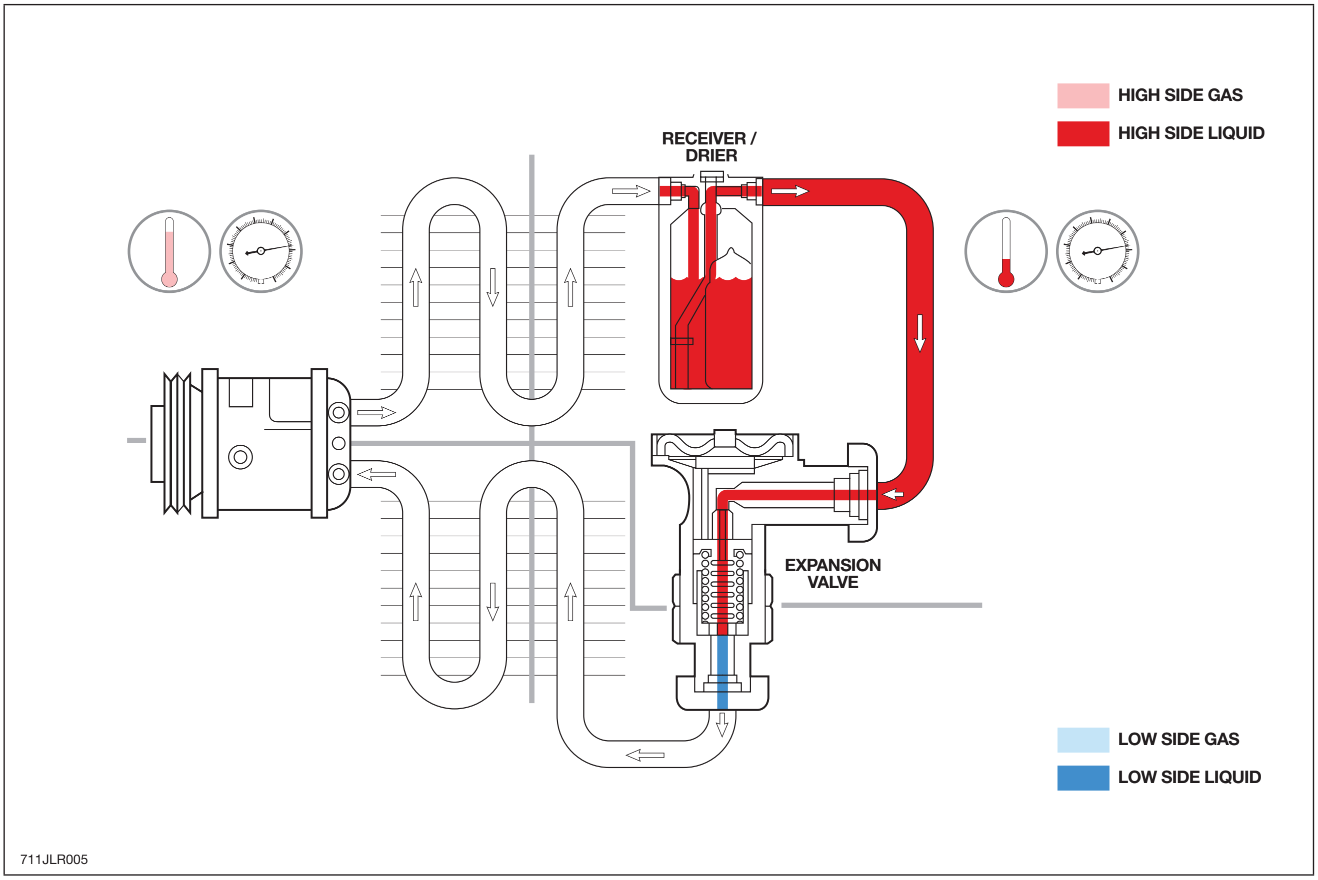
Hot refrigerant gas or vapor from the compressor enters the condenser under high pressure of about 175 psi (1,206 kPa). Due to the difference between the temperature of the outside air and the refrigerant, the refrigerant will quickly release heat to the air flowing over the surface of the condenser.



The hot gas at approximately 54 °C (130 °F) cools below its boiling point. As the vapor condenses to a liquid, it releases large amounts of heat or latent heat of condensation. Air flow across the condenser decreases when the vehicle is not moving or in stop-and-go traffic; to compensate, most A/C systems include an electric or belt-driven fan to supply additional air flow when needed.

Refrigerant Cycle: Expansion Valve

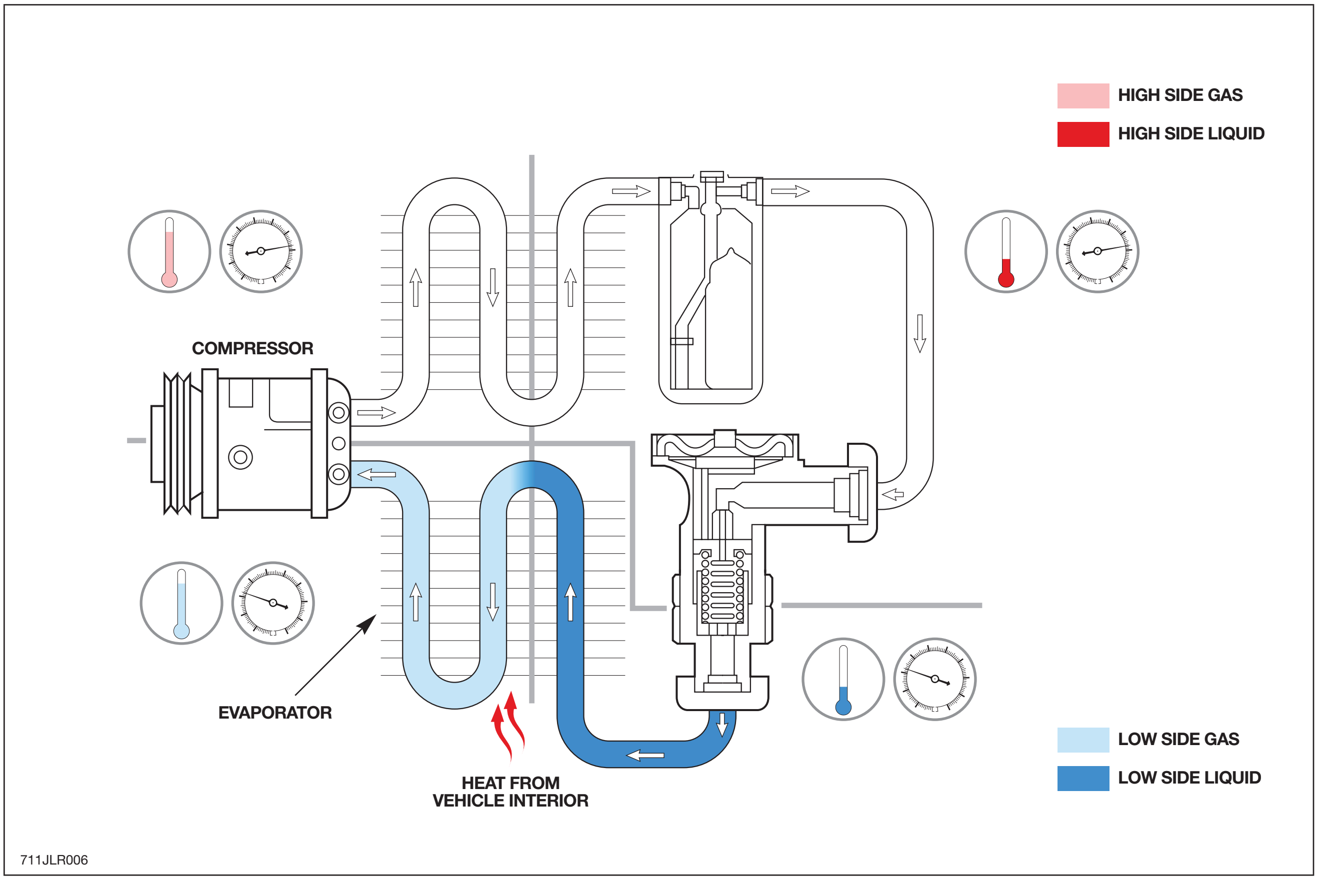
After flowing through the receiver/drier, which removes moisture and contaminants, the refrigerant enters the expansion valve. The expansion valve regulates the flow of refrigerant, allowing only a controlled amount to pass through on its way to the evaporator. The expansion valve monitors the temperature of the refrigerant exiting the evaporator and adjusts its orifice size accordingly.



Refrigerant pressure on the high side of the expansion valve can be as high as 250 psi (1,723 kPa) or more. The expansion valve reduces that pressure to about 30 psi (206 kPa) on the low side. At this low pressure, the temperature of the liquid refrigerant drops from about 54 °C (130 °F) to about -1 °C (30 °F) and its boiling point decreases. As the refrigerant passes through the expansion valve, it is atomized into a fine, liquid mist. This process increases the surface area of the refrigerant so it more rapidly absorbs heat when it passes through the evaporator.

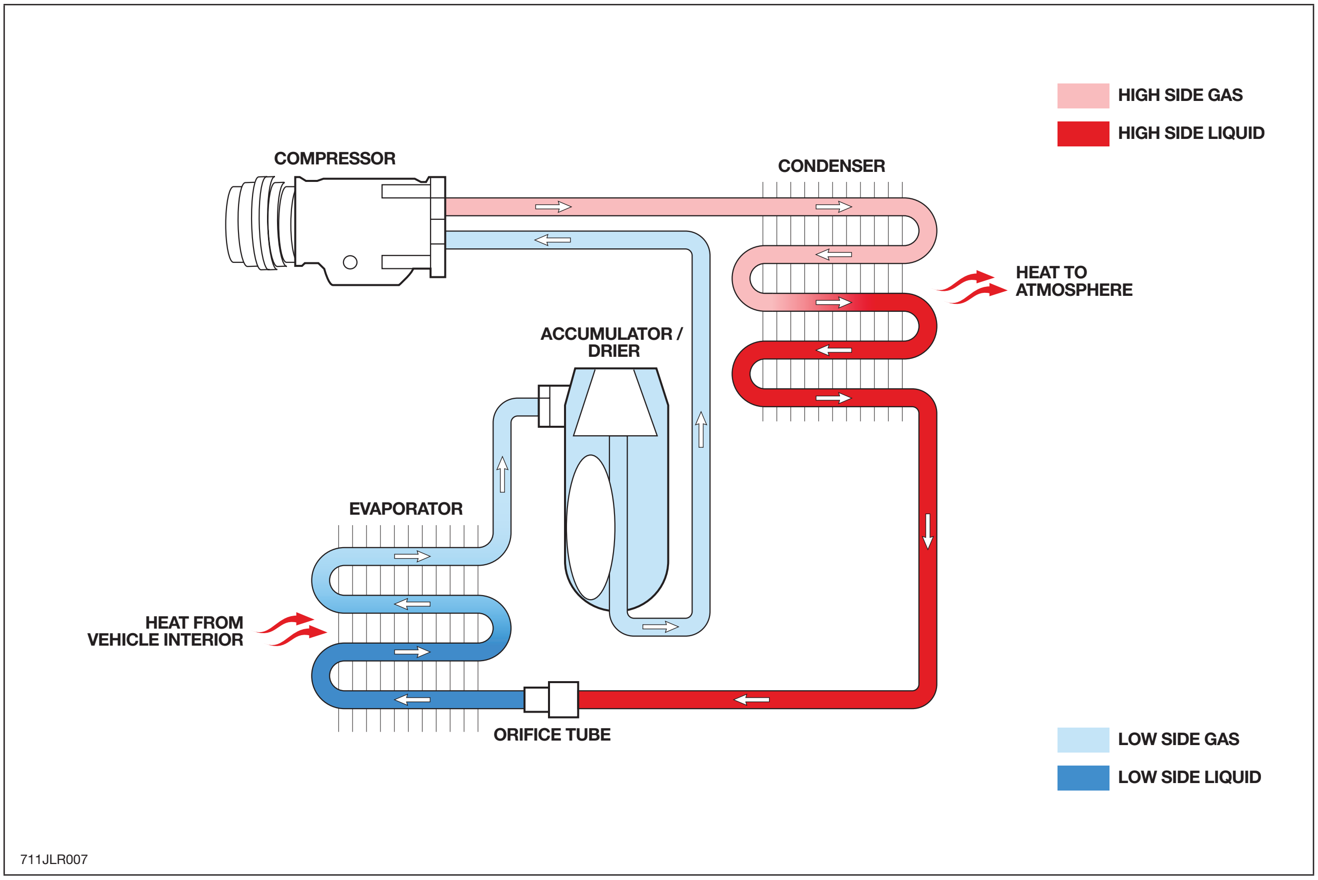
Refrigerant Cycle: Evaporator

As the refrigerant flows into the evaporator, the refrigerant is a cold, low-pressure liquid mist. At this low temperature, about -1 °C (30 °F), the refrigerant readily picks heat from the passenger compartment. An electric blower fan pushes warm interior air over the evaporator, where it releases its heat and returns to the passenger compartment as cool air. Since the refrigerant's boiling point is lower, it quickly changes into a gas, allowing it to absorb large amounts of heat as latent heat of evaporation. After absorbing heat in the evaporator, the refrigerant gas is drawn into the inlet side of the compressor, where it begins another refrigeration cycle.



Orifice Tube System

An orifice tube system is similar to an expansion valve system. However, since the orifice tube is a fixed size, the tube must flood the evaporator to work properly under all conditions. As the refrigerant passes through the evaporator, most of it changes into gas and then travels to the accumulator.

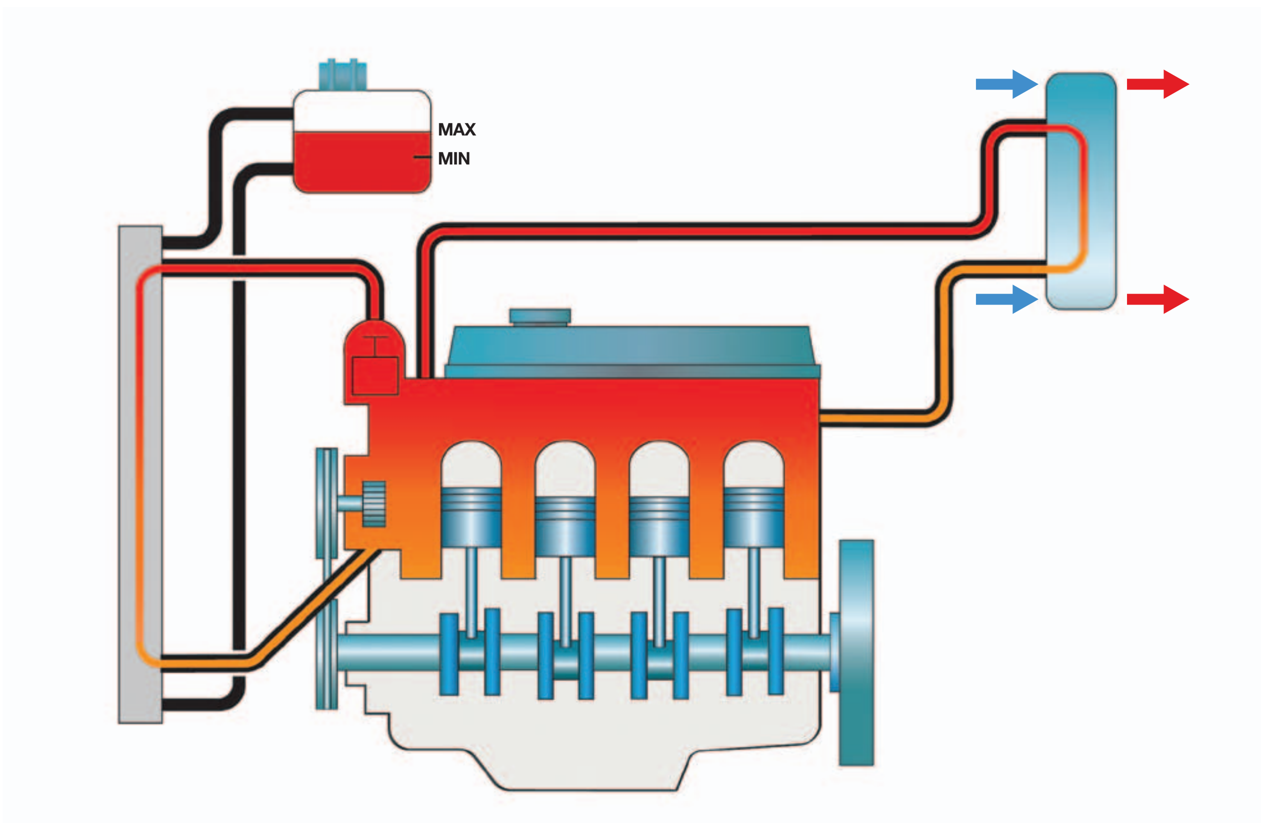


An accumulator replaces the receiver/drier and is located in the low-pressure side of the system. In addition to removing moisture and contaminants, the accumulator separates the liquid refrigerant from the refrigerant gas. This prevents liquid refrigerant from being drawn into the compressor.

HEATING CYCLES

Heating System

The heating system works in conjunction with the engine cooling system to transfer engine heat to the vehicle interior. The main components of the heating system are the engine, heater hoses, heater core, and electric blower motor fan. Hot engine coolant is moved by the coolant pump through the heater hoses to the heater core.



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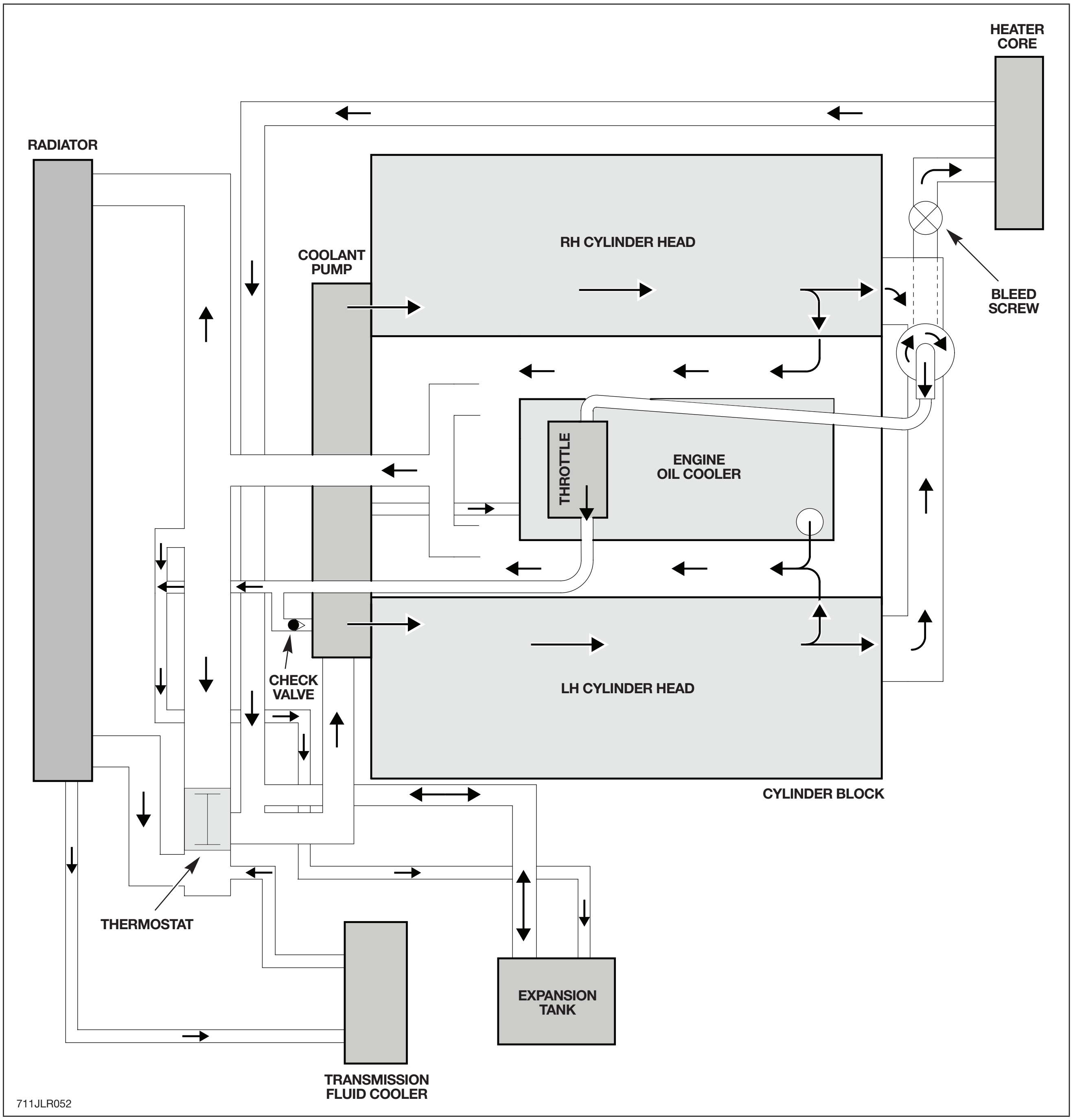
The heater core is like the radiator of the engine, with tubes and fins – also like the A/C evaporator. Heater cores are normally mounted in tandem next to A/C evaporators and use the same blower motor and air distribution system. The heat from the coolant is transferred to the air passing through it by the blower motor. The heated air is then moved through the vehicle by the air distribution system.

Engine Cooling System Flow (5.0 Liter NA Shown)



711-JAG: Jaguar Climate Control Systems

X350 Climate Control Systems

JAGUAR

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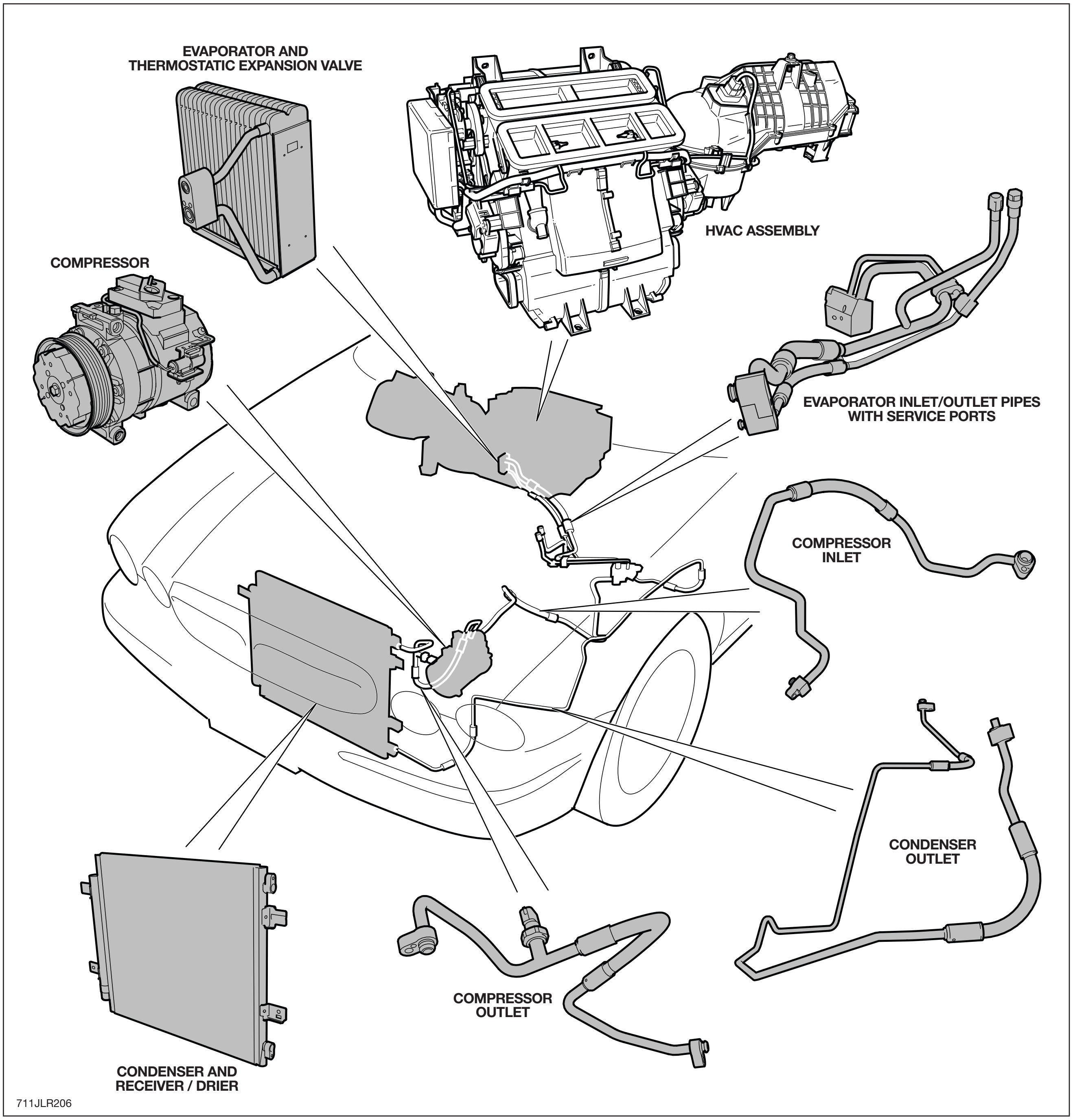
Printed in USA

REFRIGERATION SYSTEM

Overview

The A/C system transfers heat from the vehicle interior to the outside atmosphere to provide the cabin with dehumidified cool air. The system is a sealed, closed loop, filled with a charge weight of R134a refrigerant as the heat transfer medium. Oil is added to the refrigerant to lubricate the internal components of the A/C compressor.

Component Location

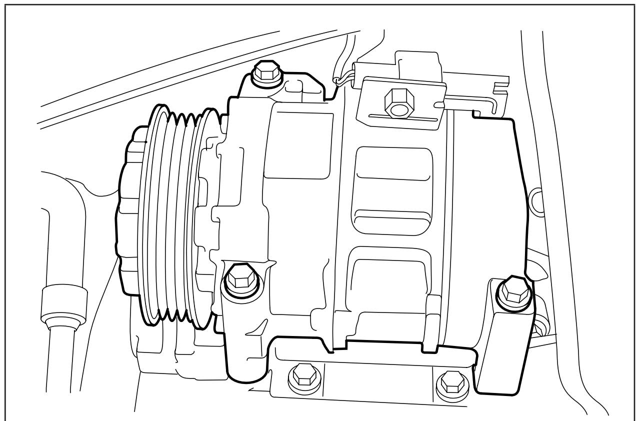


Component Description

Compressor

The refrigerant system incorporates a clutchless variable displacement A/C compressor. Due to oil quantities and system requirements, there are different compressors for the 2- and 4-zone systems.

Refrigerant flow is controlled by the compressor control valve via Pulse Width Modulated (PWM) signal from the Remote Climate Control Module (RCCM). The control valve varies the pressure within the suction chamber, which in turn adjusts the swash plate angle to suit demand. The compressor operates full time, between 2% and 100%, while the engine is running.



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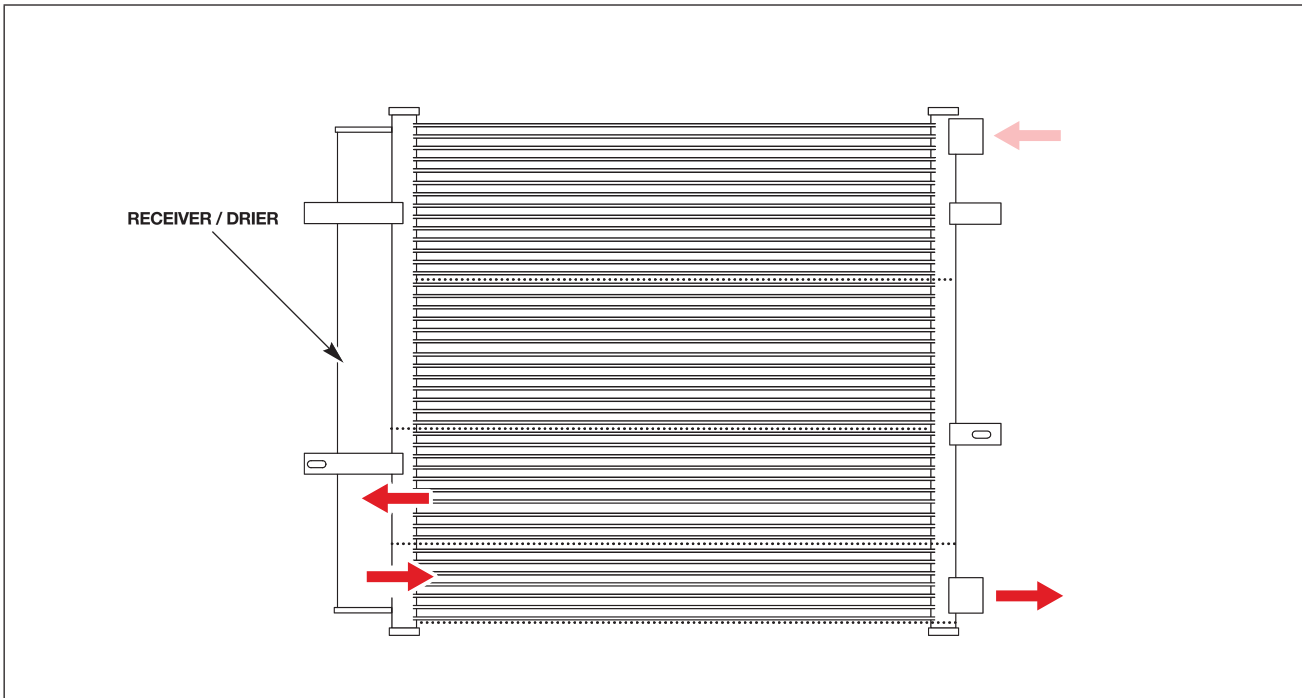
Condenser

The A/C condenser core is an aluminum fin and tube design heat exchanger located in front of the vehicle radiator. It cools compressed refrigerant gas by allowing air to pass over fins and tubes to extract heat and condenses gas to liquid refrigerant as it is cooled.



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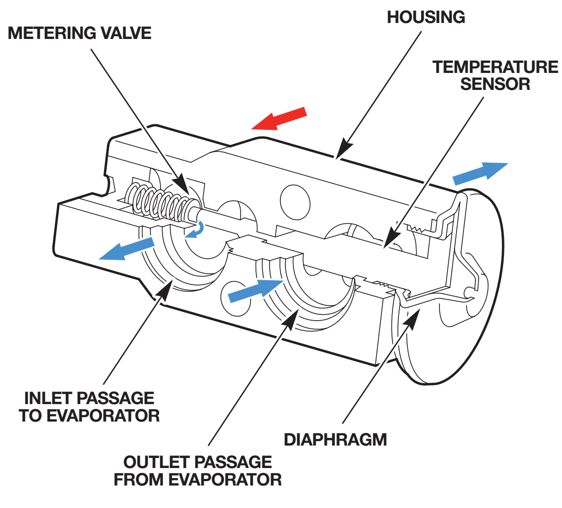
The receiver/drier mounted on the side of the condenser core contains a serviceable desiccant pack. Desiccant packs contain an ultraviolet (UV) dye pellet to assist in leak detection.

Thermostatic Expansion Valve

The thermostatic expansion valve meters the flow of refrigerant into the evaporator, to match the refrigerant flow with the heat load of the air passing through the evaporator matrix.



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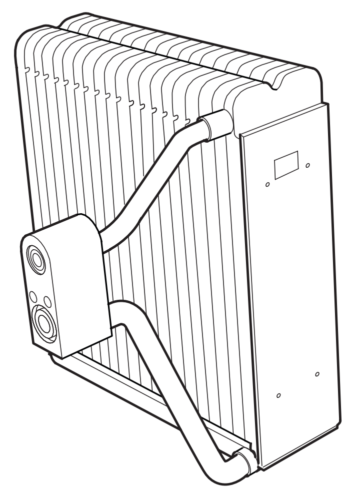
The temperature and pressure of the refrigerant leaving the evaporator act on the thermostatic expansion valve to control the volume of refrigerant flowing through the evaporator. The warmer the air flowing through the evaporator matrix, the more heat available to evaporate refrigerant and thus the greater the volume of refrigerant allowed through the metering valve.

Evaporator

The evaporator is installed in the HVAC assembly between the blower and the heater matrix to absorb heat from the exterior or recirculated air. Low pressure, low temperature refrigerant changes from liquid to vapor in the evaporator, absorbing large quantities of heat as it changes state.



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Most of the moisture in the air passing through the evaporator condenses into water, which drains out of the HVAC assembly through a drain tube, through the floor pan to the underside of the vehicle.

HEATING AND VENTILATION SYSTEM

Overview

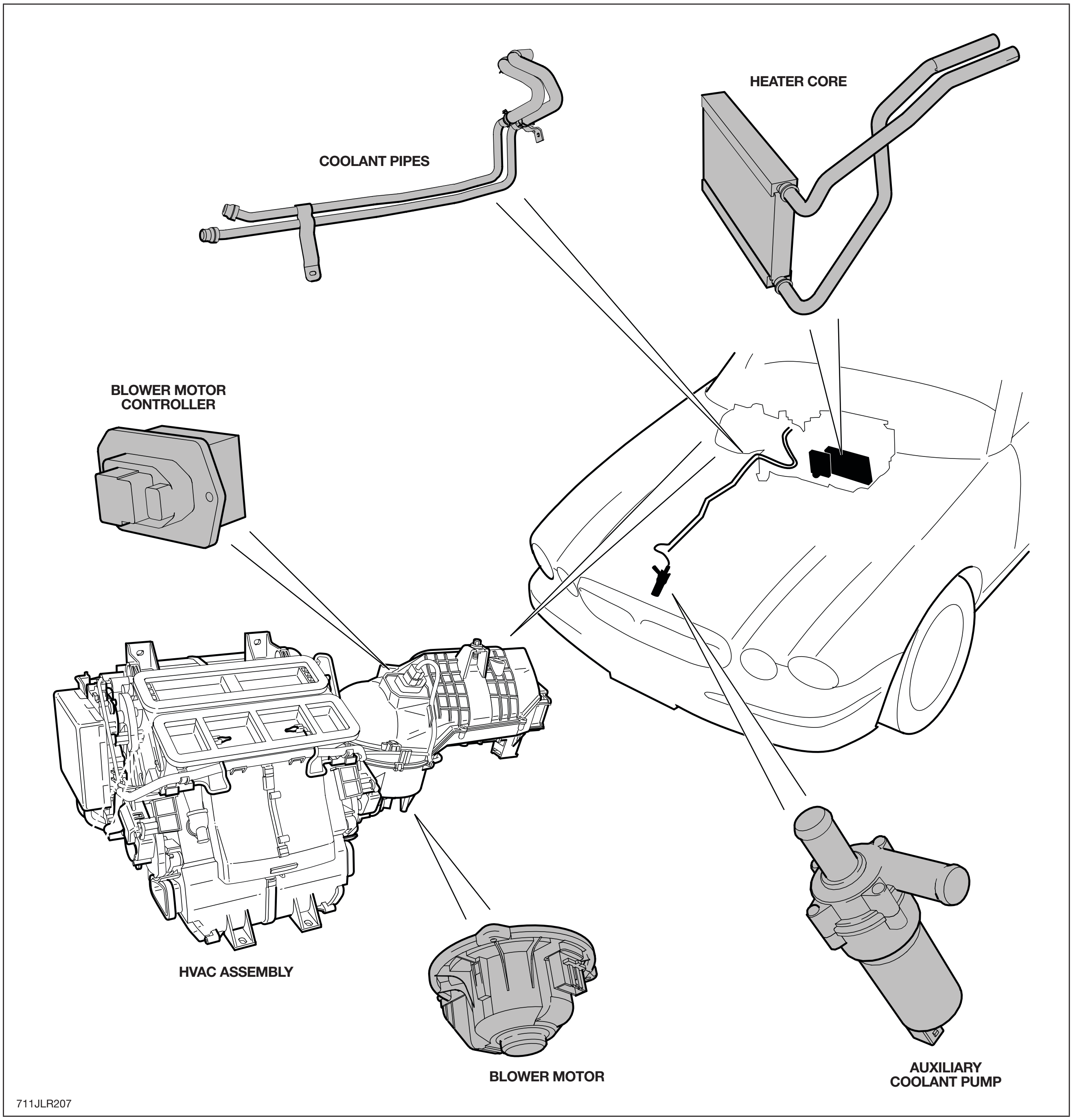
The heating and ventilation system controls the temperature and flow of air supplied to the vehicle interior. The system is dual zone, and can provide different temperature settings for the LH and RH side of the cabin. The system can be operated in 'Automatic' or 'Manual' mode, with temperature settings being selected using the control switches located below the TSD.

The system comprises:

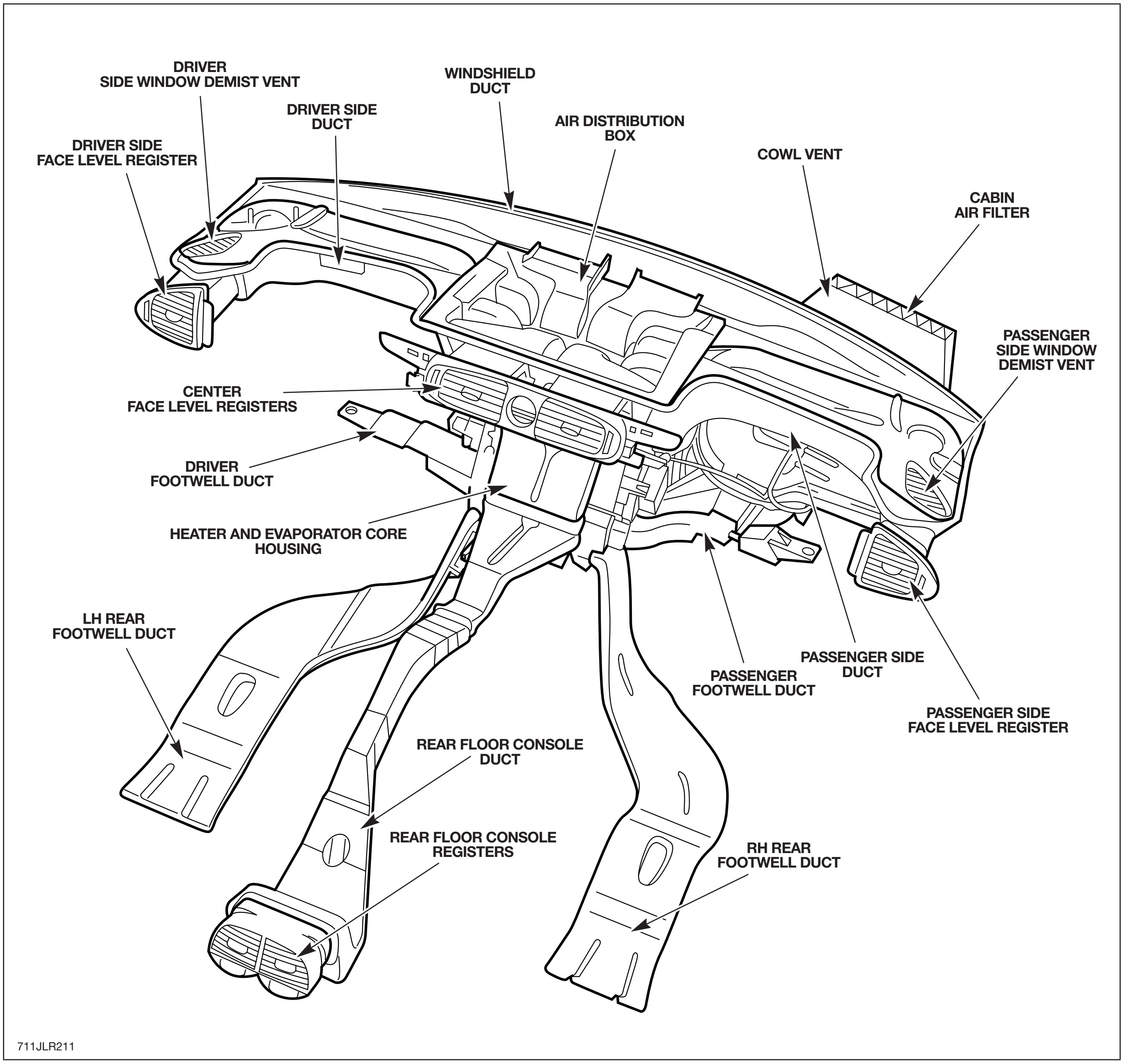
- An air inlet duct
- A blower motor
- A blower motor controller
- A blower relay
- An HVAC assembly
- Air ducts and vents
- Two ventilation outlets

Fresh or recirculated air flows into the HVAC assembly from the inlet duct. The blower, and 'ram' effect when the vehicle is moving, forces the air through the HVAC assembly. Air from the cabin exhausts through the ventilation outlets located in the rear of the vehicle.

Component Location



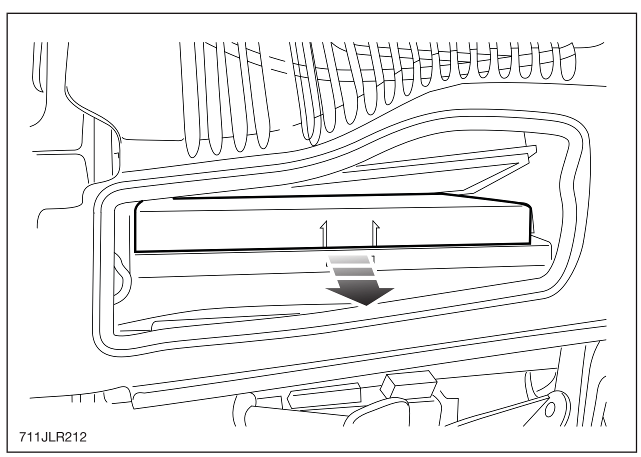
Air Ducts and Vents



Cabin Air Filter

Air enters into the cabin through the air inlet and passes through a combination filter located in the plenum chamber below the leaf screen. The filter helps reduce the pollen and exhaust odors entering the vehicle interior.

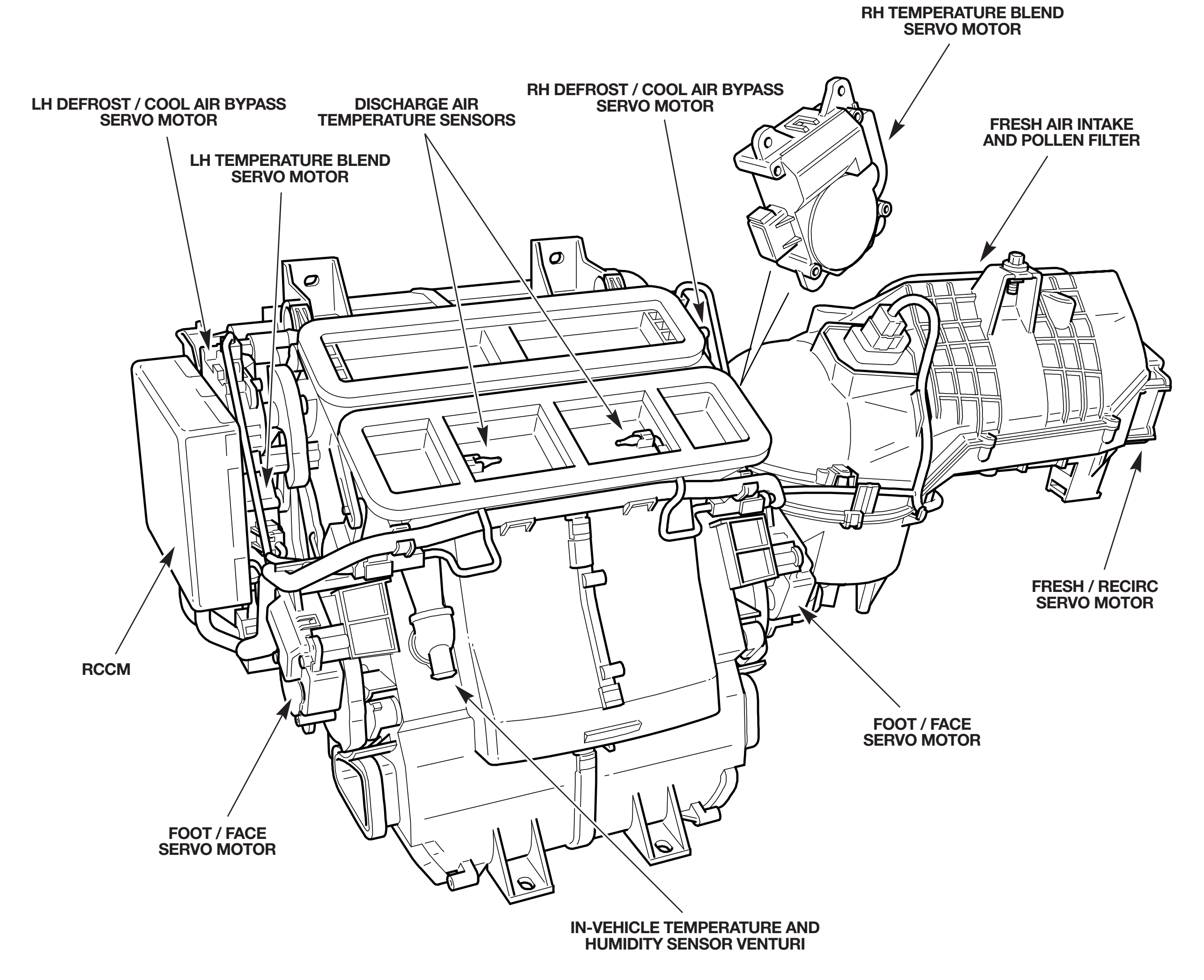
An access panel allows the filter to be changed without removing the leaf screen assembly.



Component Description

HVAC Assembly

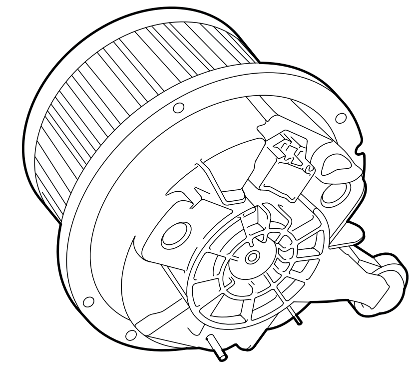
Inlet air is separated into two separate sides of the HVAC assembly. Air passing through one section is directed to the driver side of the vehicle, while air passing through the other section is directed to the passenger side of the vehicle.



Blower Motor

The blower motor is actuated by a power transistor, which permits infinitely variable adjustment of the blower speed. The blower motor receives power from the blower motor relay, which is controlled by the RCCM.

The blower switch provides an input signal to the RCCM, which outputs a variable drive signal to the blower motor controller. The blower motor controller outputs a variable ground path to the blower motor to control the blower speed.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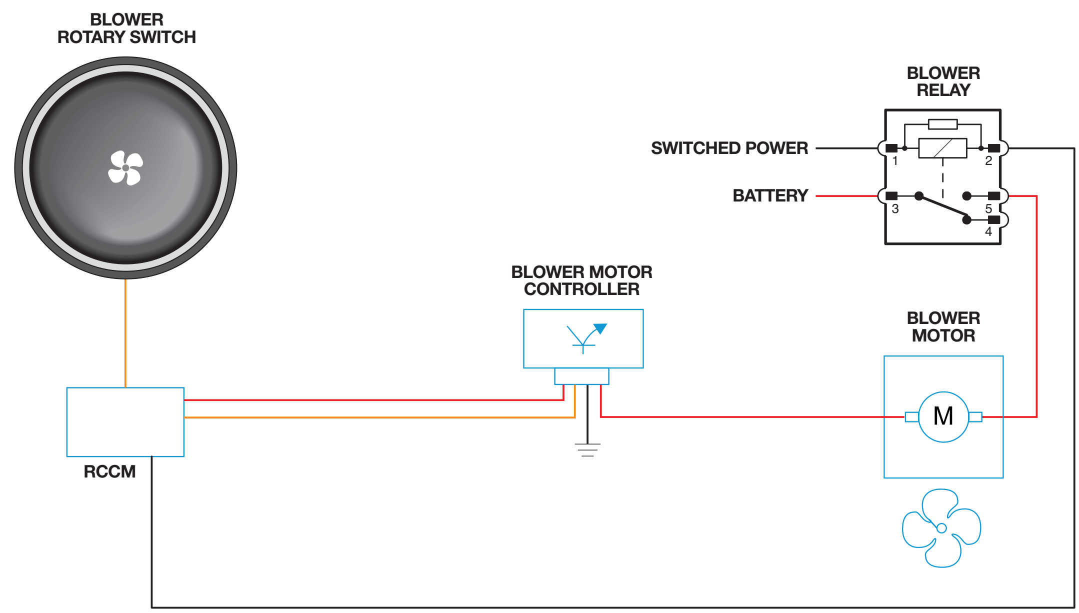
Blower Control



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Servo Motors

The RCCM positions the seven servo motors using various input commands and internal algorithms. This information is based against the actual position of the doors as indicated by the servo potentiometer.

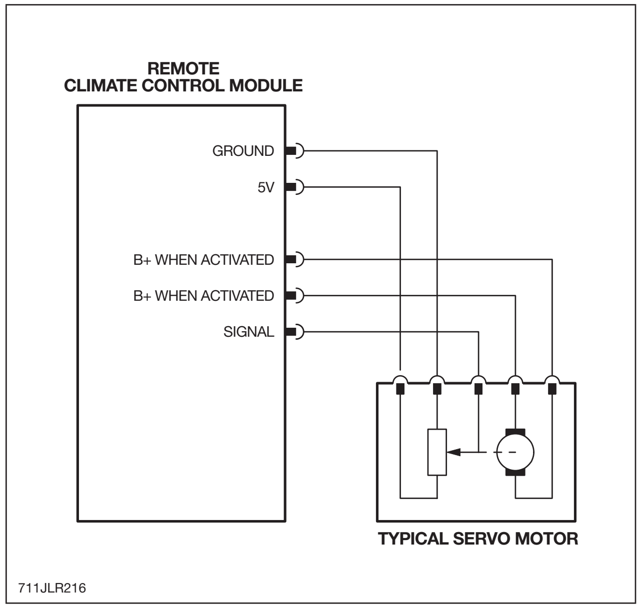
The RCCM drives the servo motor by applying power to one line while grounding the other, then reversing polarity to select another position. To stop the motor, both lines are grounded.

Each servo motor is a 5-wire unit containing a potentiometer for position feedback and a 2-pole drive motor. All servo motors are hardwired directly to the RCCM.

The RCCM drives the bidirectional servo motor to the desired position while monitoring its position. The position feedback voltage is Nominal 0 – 5V:

- Closed direction = lower voltage
- Open direction = higher voltage

Servo motor potentiometer feedback (door position) is in the form of voltage and can be between 0% (1V) and 100% (4V). Voltages at the extreme (0V and 5V) indicate that a fault has occurred.



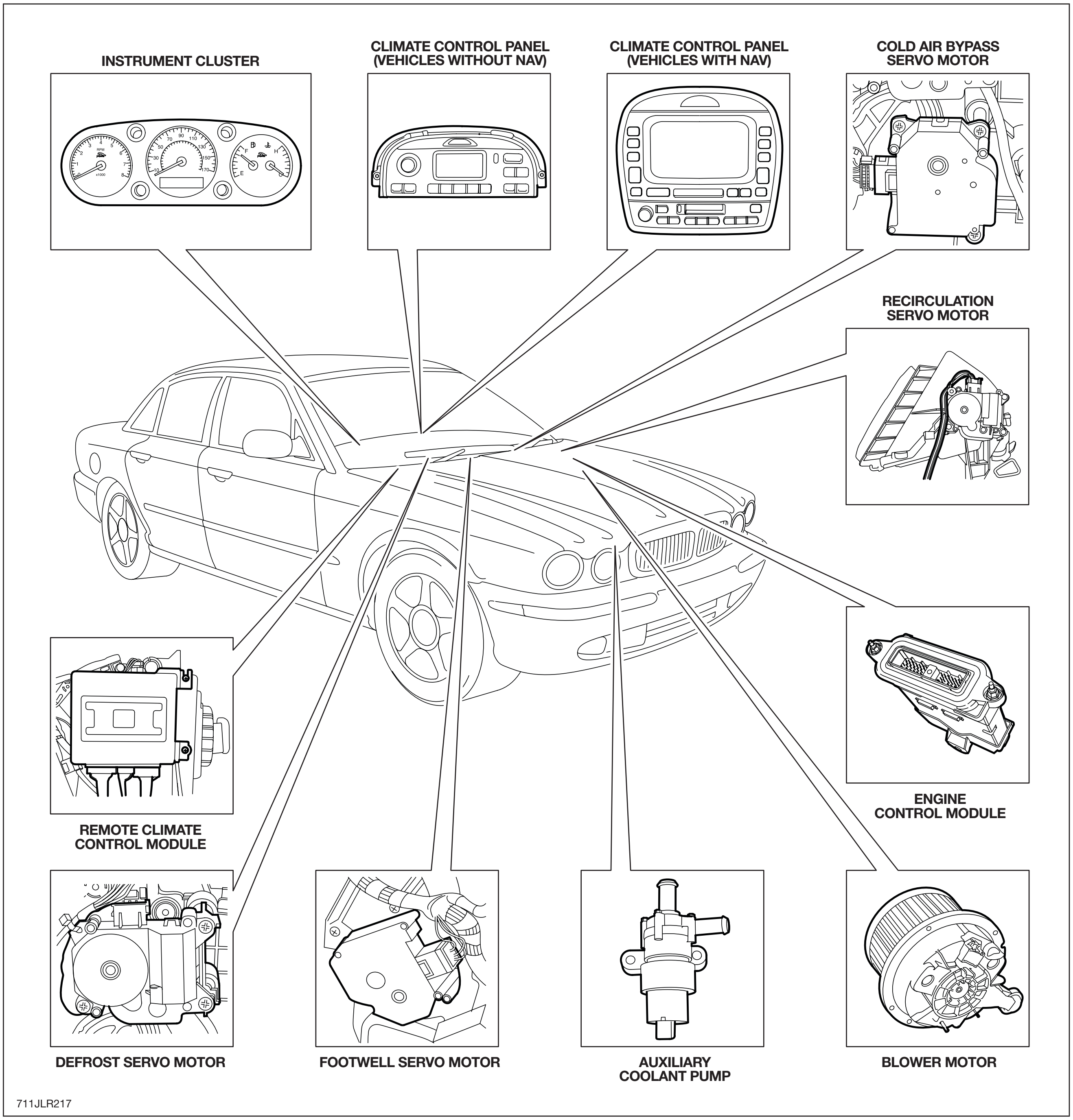
CONTROL SYSTEM

Overview

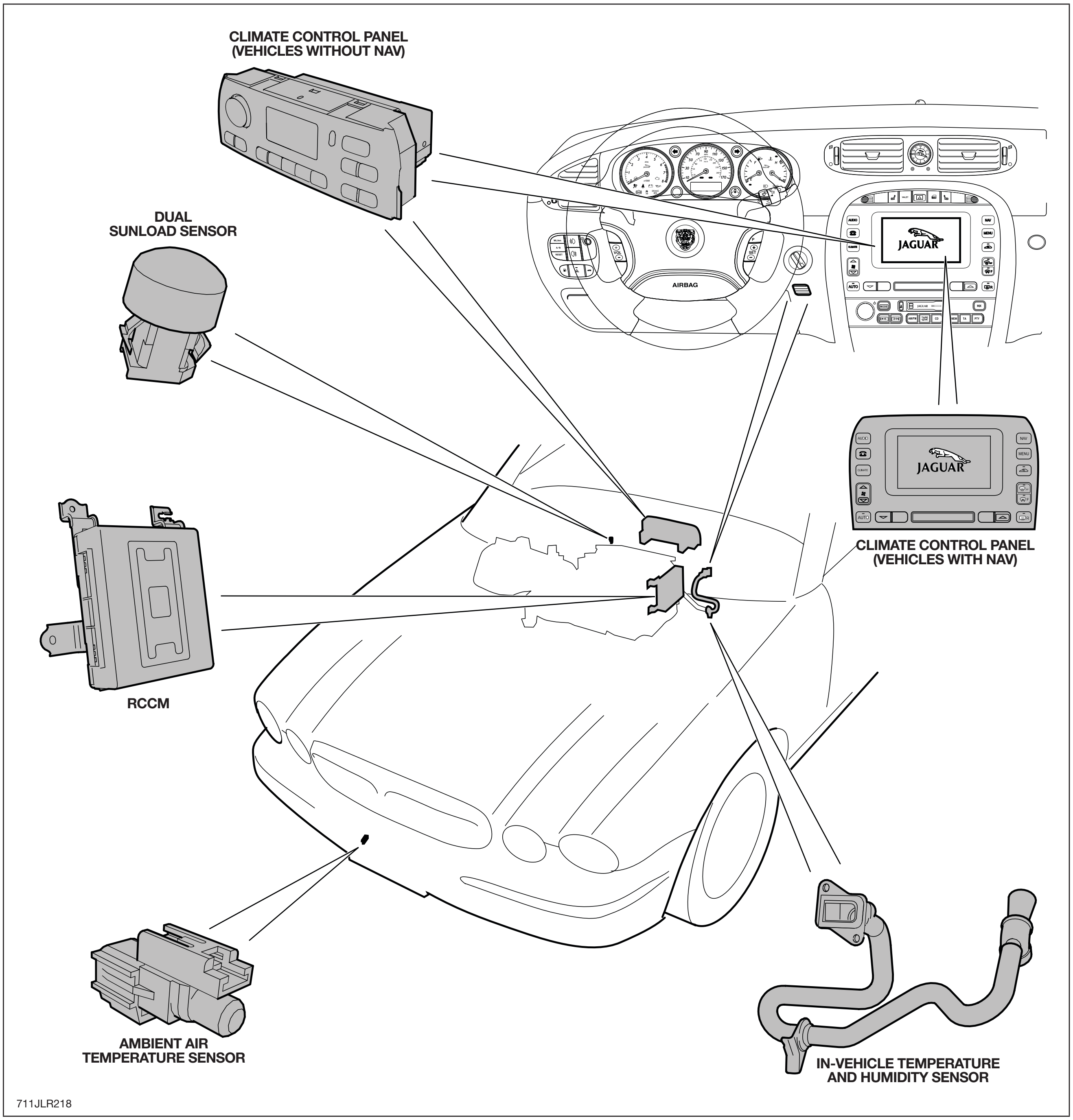
The Remote Climate Control Module (RCCM) controls the A/C system and the heating and ventilation system to regulate the temperature, volume, and distribution of air into the cabin. The fully automatic 2-zone system is capable of maintaining individual temperature levels selected for the LH and RH sides of the cabin.

When the 2-zone system is combined with the Auxiliary Climate Control System, there is a sharing of information to achieve a fully integrated 4-zone system.

Control Components: Part 1



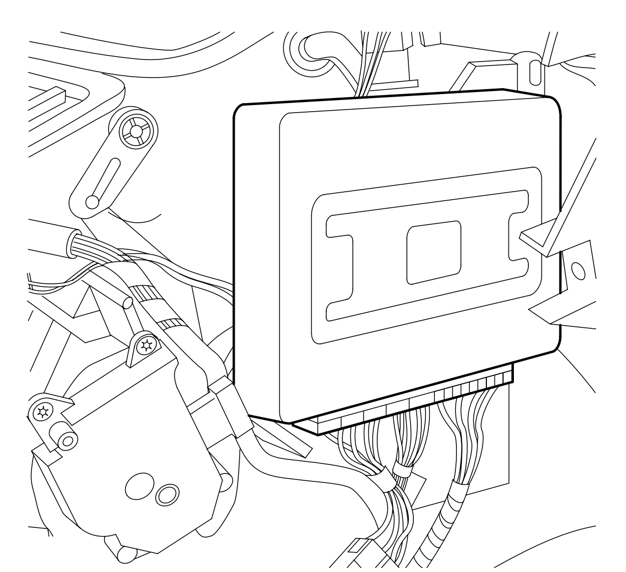
Control Components: Part 2



Component Description

Remote Climate Control Module

The 2-zone Remote Climate Control Module (RCCM) is located on the LH side of the climate control housing. The RCCM is the same part for both NAV and non-NAV control panels, with a different configuration for each.

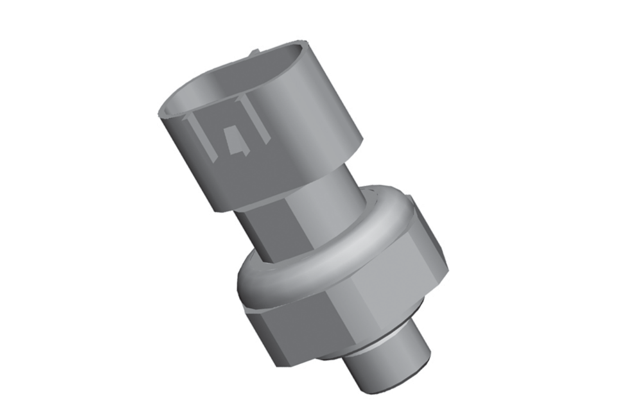


711JLR219

The RCCM monitors the evaporator discharge temperature sensor and communicates with the ECM to control A/C compressor operation. The RCCM also monitors the ambient air temperature and disables A/C operation when the ambient air temperature is below 30 °F (0 °C).

A pressure relief valve is installed in the A/C compressor to protect the system from excessively high refrigerant pressure.

Refrigerant Pressure Sensor



711JLR182

A pressure sensor is located in the A/C compressor discharge line and is hardwired to the ECM. Pressure information is communicated via CAN to the RCCM, which drives the compressor solenoid accordingly.

The pressure sensor is mounted on a Schrader valve fitting on the compressor-to-condenser discharge line. A valve depressor located inside the threaded end of the pressure sensor presses on the Schrader valve stem and allows the sensor to monitor the compressor discharge pressure.

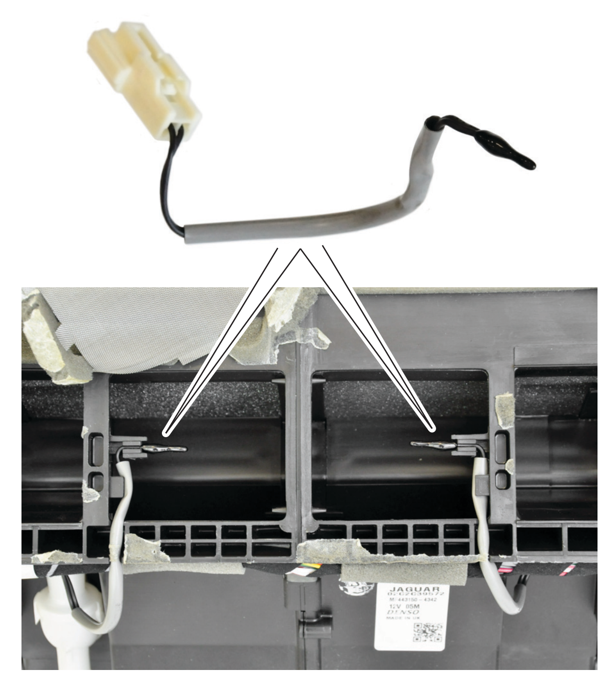
When compressor discharge pressure rises to approximately 420 psi (2,896 kPa), the compressor will be driven to minimum output.

When pressure drops to approximately 250 psi (1,724 kPa), compressor operation will resume.

Refrigerant Pressure Sensor:
Operates on 5V reference, signal varies
with pressure from 0-5V.
High Pressure = 5V
Low Pressure = 0V

Discharge Air Temperature Sensors

The discharge air temperature sensors are located in the LH and RH air discharge ducts in the HVAC assembly. The sensors are Negative Temperature Coefficient (NTC) thermistors.



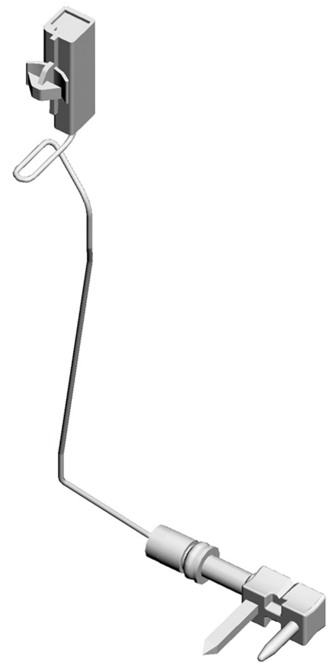
711JLR238

Discharge air temperature is determined by the RCCM from the change in sensor resistance. The RCCM applies a fixed voltage (5V) to the sensor and monitors the voltage across the pins to detect the varying resistance.

The RCCM uses the LH and RH discharge air temperature calculations to provide individual discharge air temperatures for the driver and front passenger. If the RCCM loses a discharge air temperature signal, a default value of 75 °F (24 °C) is substituted.

Evaporator Temperature Sensor

The evaporator temperature sensor is an NTC thermistor that provides the RCCM with a temperature signal from the downstream side of the evaporator. The evaporator temperature sensor is mounted directly onto the evaporator matrix fins.



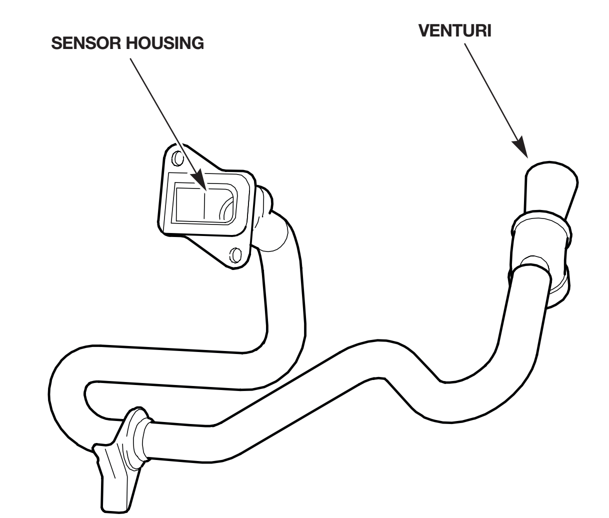
711JLR183

The RCCM uses the input from the evaporator temperature sensor to control the output of the A/C compressor and thus the operating temperature of the evaporator.

In-Vehicle Temperature and Humidity Sensor

The in-vehicle temperature and humidity sensor is installed behind a grill on the driver side of the center console finisher. The sensor comprises two components: a thermistor-type device for measuring in-vehicle temperature, and a capacitive device for measuring humidity.

The sensor is connected to a tube, the other end of which is connected to a venturi on the side casing of the HVAC assembly. An air bleed from the heater through the venturi induces a flow of air down the tube, which draws cabin air through the grill and over the sensor.



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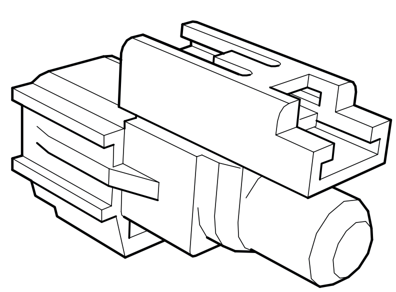
Ambient Air Temperature Sensor

The ambient air temperature sensor is an NTC thermistor that provides the RCCM with an input of external air temperature. The sensor is mounted on the lower front grille and is hardwired directly to the RCCM.



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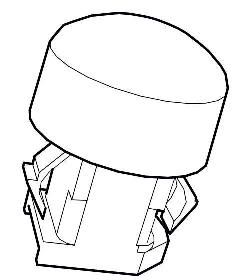
Dual Sunload Sensor



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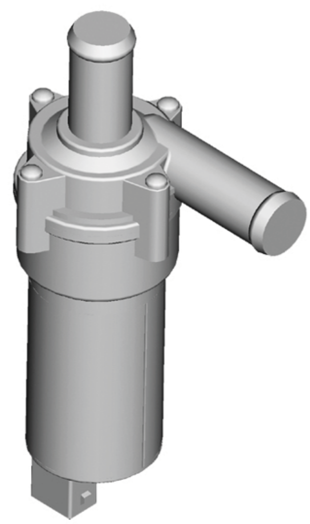
The dual sunload sensor is located in the center of the defrost grille. The sensor provides a feedback voltage, dependent on light levels, to the RCCM. The input is a measure of the solar heating effect on vehicle occupants, and is used by the RCCM to adjust blower speed, temperature, and distribution to improve comfort.

- Low light = low voltage
- Bright light = high voltage

A signal of 0V indicates either total darkness or an open circuit.

Auxiliary Heater Coolant Pump

The auxiliary coolant pump is electrically driven and provides positive coolant flow through the heater matrix.



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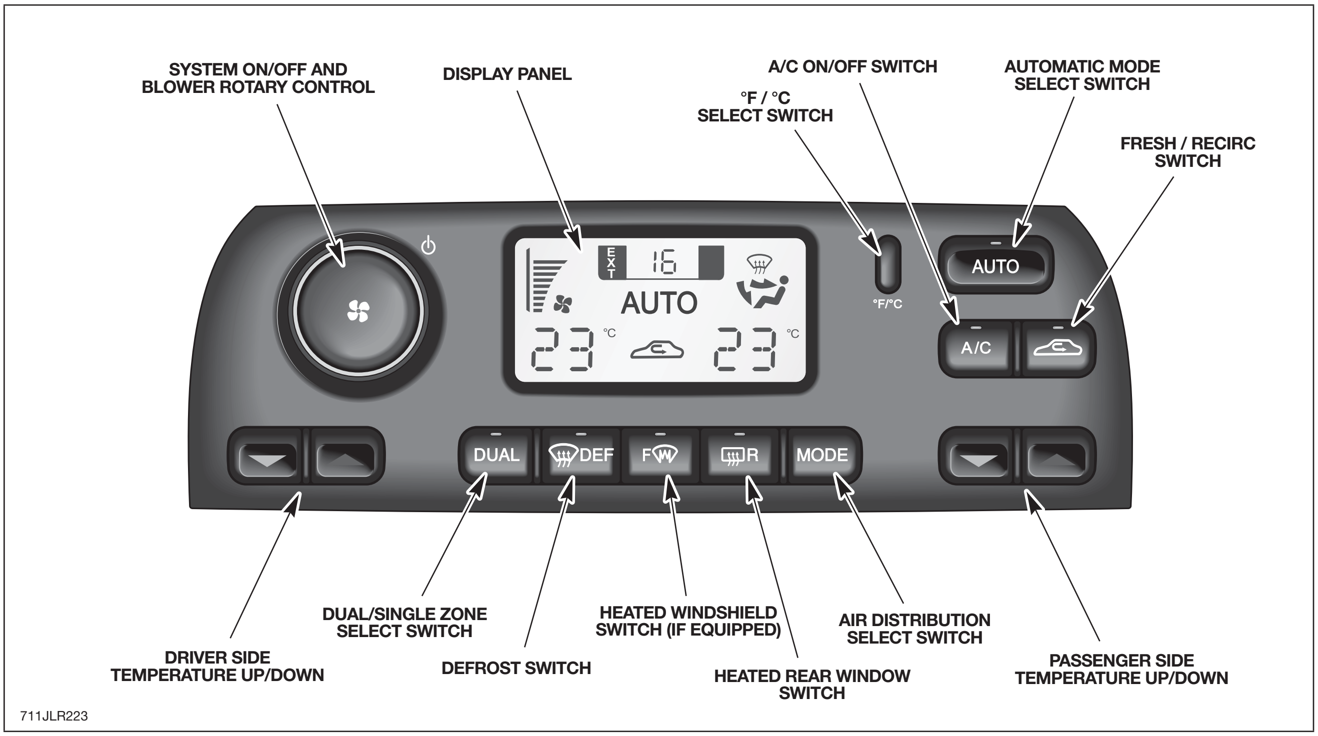
Climate Control Panels

The climate control panels provide the following driver interface controls:

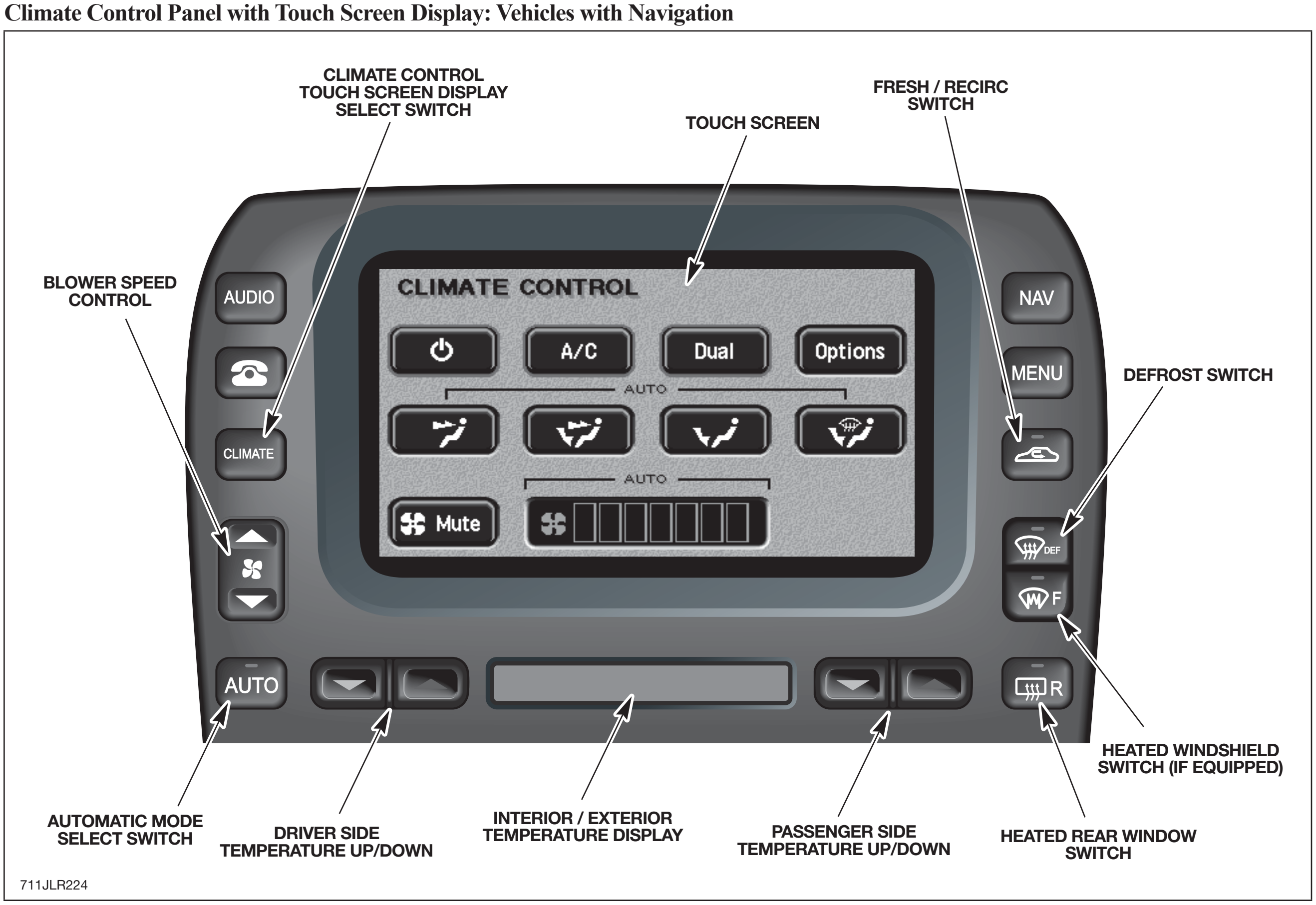
- A/C system ON/OFF switch / blower speed switch
- Manual temperature adjustment switches (driver/passenger)
- DUAL temperature selection switch
- DEFROST switch
- Heated windshield ON/OFF switch
- Heated rear window ON/OFF switch
- Manual air distribution MODE switch
- Fahrenheit/Celsius option switch
- AUTO mode switch
- A/C selection switch
- Fresh / recirc switch

There are 2 versions of climate control panel: the panel fitted to vehicles equipped with navigation includes a Touch-Screen Display.

Climate Control Panel: Vehicles without Navigation



Climate Control Panel with Touch Screen Display: Vehicles with Navigation



Principles of Operation

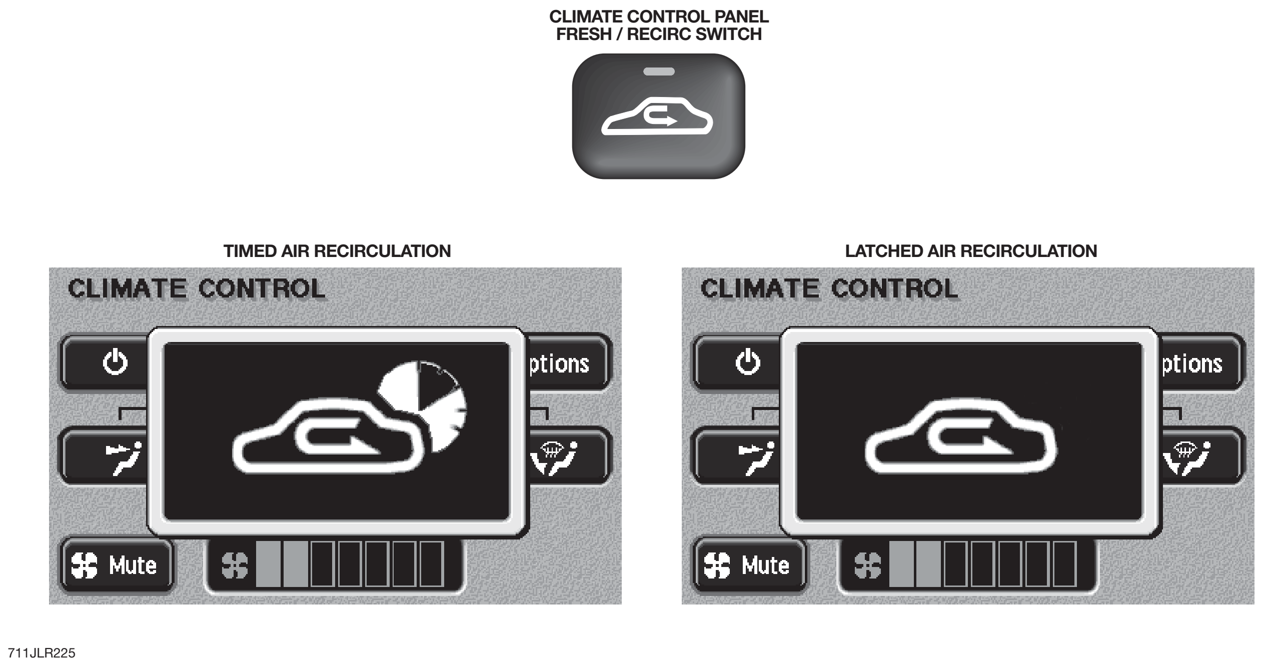
The climate control system automatically maintains the selected temperature for the interior of the vehicle. The system regulates the volume of airflow between the instrument panel registers, floor console registers, front and rear floor ducts, windshield defroster and side window registers. The system can automatically select between fresh and recirculated air, with an optional manual override. The climate control system endeavors to provide both driver and passenger with their selected temperature for comfort.

Air Distribution Control

The system has variable position control provided by the electrical servos. The system gives the option of manually selecting one of five preset air distribution modes or operating the climate control in automatic mode.

Air Recirculation

NOTE: Touch-Screen Display shown; Control Panel operation is similar.



Timed Air Recirculation

Press the air recirculation button briefly to select air recirculation for a timed period only; the pop-up shown above will appear for a few seconds on top of the currently selected touch-screen. At the end of the timed period, the fresh air intake opens and the button LED is extinguished.

Pressing the air recirculation button when the button LED is illuminated will cancel recirculation and allow fresh air into the vehicle.

Latched Air Recirculation

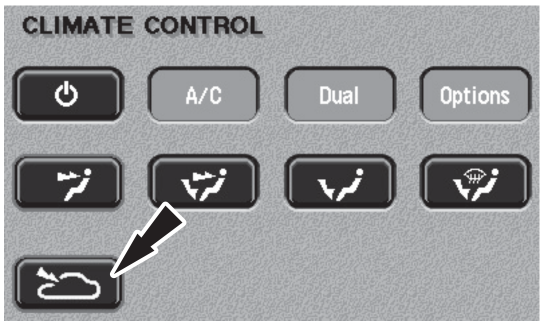
To 'latch' air recirculation (so that it remains selected), press and hold the air recirculation button until the pop-up changes from the timed to the latched recirculation symbol shown above.

Selection is also indicated by two beeps and the button LED flashing four times, then remaining illuminated.

NOTE: Prolonged operation with recirculation selected in cold, damp conditions may result in interior condensation.

Ram Air

Touch Screen Display



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With the climate control system switched off, air recirculation is automatically selected (intake flap closed). To select fresh air with the system off, touch the ram air button. The intake flap will open with air distribution to face level automatically selected. Any of the other air distribution modes may be selected manually using the touch-screen.

With the blower switched off, the fresh airflow results from the forward motion of the vehicle (ram air mode).

Climate Control Panel

711JLR228

With the climate control system switched off, air recirculation is automatically selected (intake flap closed). To select fresh air with the system off, press the 'MODE' button to select one of the air distribution modes. With the blower switched off, the fresh airflow results from the forward motion of the vehicle (ram air effect).

Blower Motor Control

The climate control system has a variable blower speed control. The operator has the option of manually selecting one of 11 preset blower speeds from the control panel (7 preset blower speeds with the touch screen) or selecting to operate the climate control system in automatic mode.

In automatic mode, blower speed is determined as a function of many input variables. Based on the desired in-vehicle temperature, the system constantly monitors the ambient temperature, discharge air temperatures, in-vehicle temperature and sunload levels, then calculates the desired blower setting.

There are special conditions that affect the blower speed while the system is operating in automatic mode:

- In cold ambient temperatures, the climate control assembly implements a Cold Engine Lock Out feature with the blower motor. For a cold vehicle interior, the climate control assembly will operate in low blower/defrost mode until the engine coolant temperature reaches a required value. Once the engine coolant has warmed up, the blower motor will continue in the automatic mode.
- At increasing vehicle speeds, monitored via the CAN vehicle speed status message, the system may adjust the blower motor speed to maintain constant air flow. This may be necessary in situations where the ram air effect at high speed alters the air flow into the vehicle interior.
- For vehicles fitted with a cellular phone, the climate control system may lower the blower motor speed to reduce the level of ambient noise in the vehicle interior when the phone is in use.

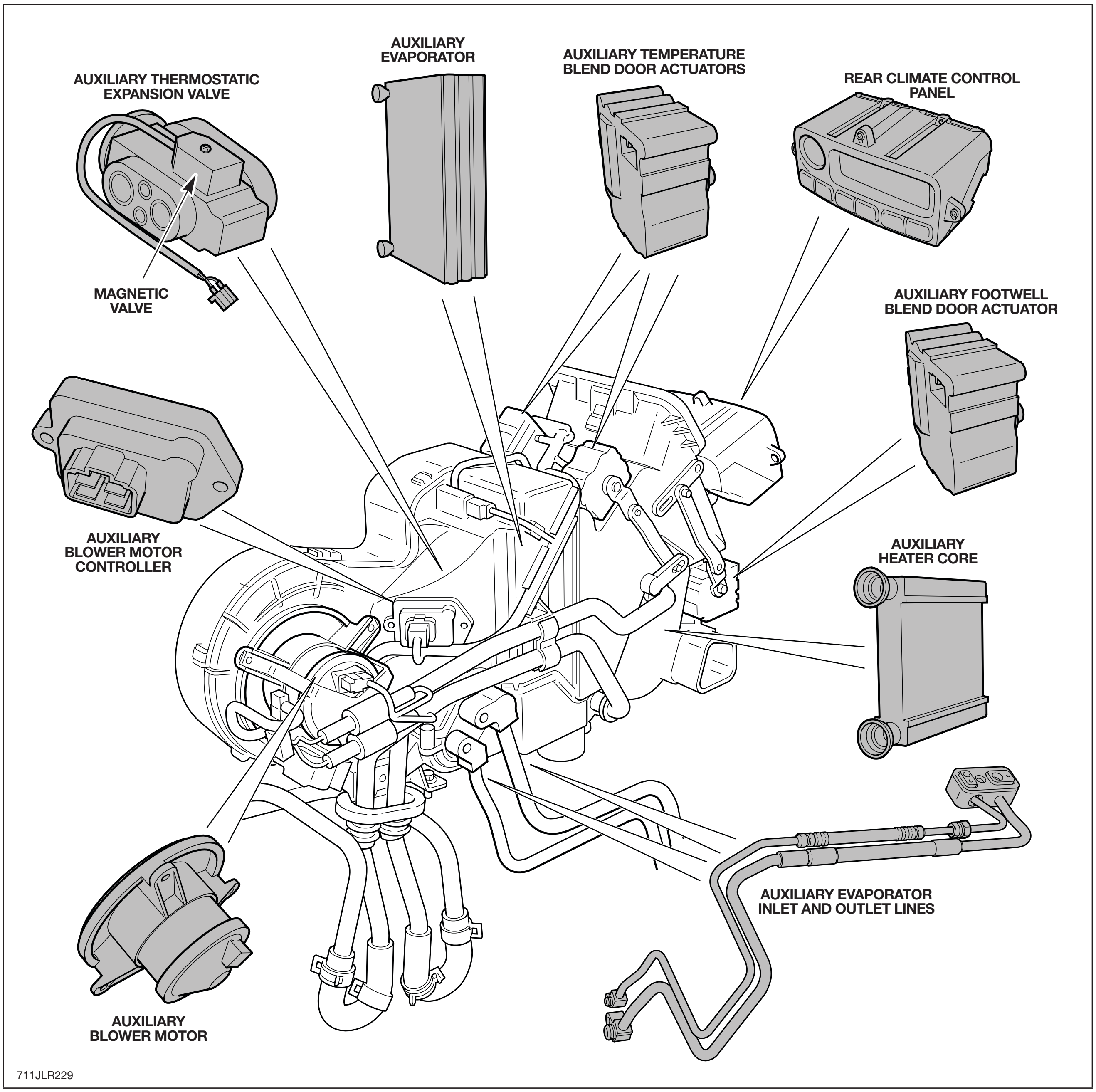
AUXILIARY CLIMATE CONTROL SYSTEM

Overview

The auxiliary climate control system provides additional heating, cooling, and air distribution for the rear seat occupants when the front control system is operating, with independent temperature control of the rear left and right passenger zones. The auxiliary climate control system consists of:

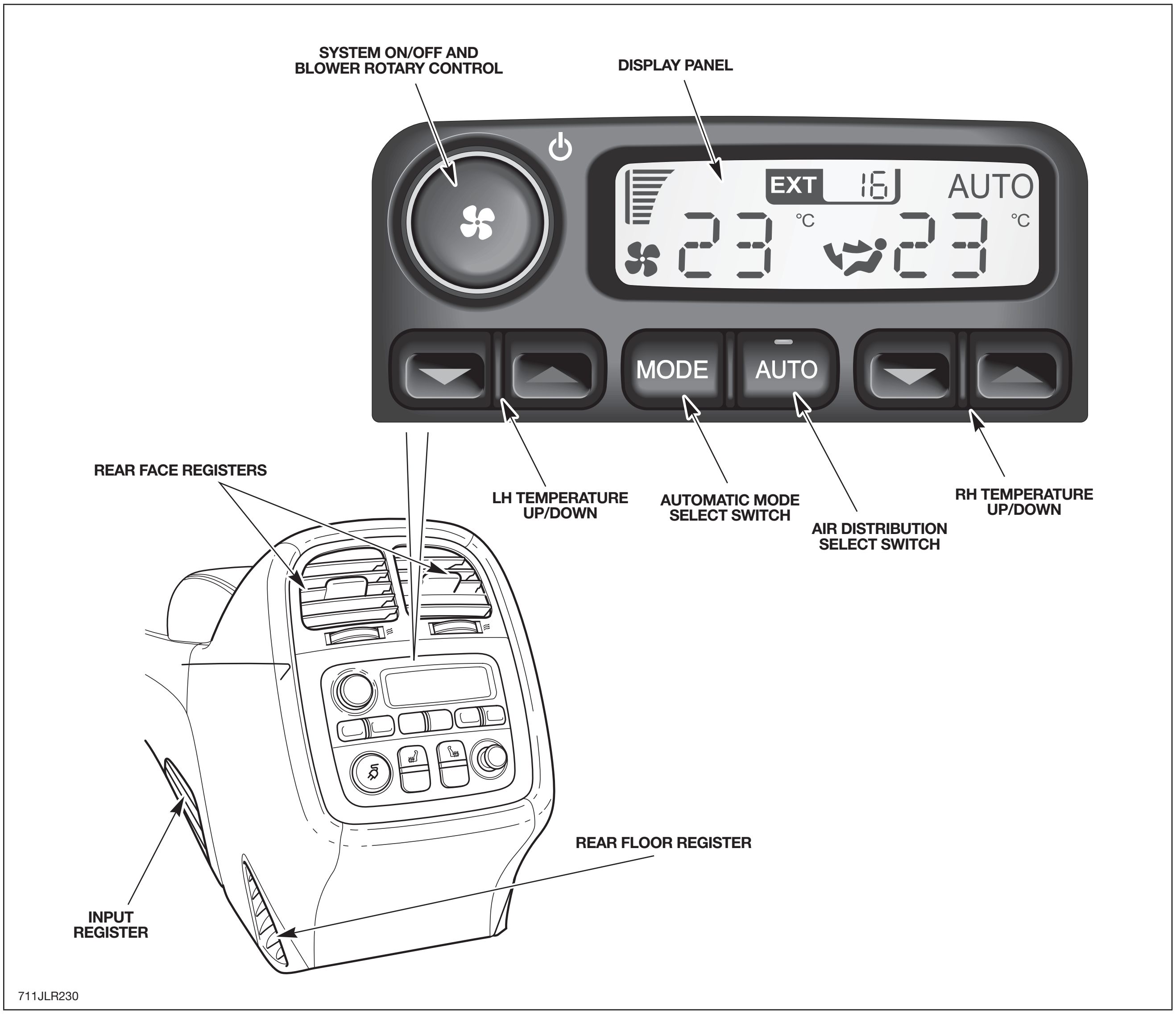
- An auxiliary climate control assembly
- A refrigerant circuit
- A heating circuit
- A distribution system
- Remote Climate Control Module (RCCM)
- Rear Climate Control Panel (RCCP)

Auxiliary Climate Control Assembly



Rear Climate Control Panel

To switch on the rear climate control system, press AUTO, or press the blower control knob on/off switch.



The auxiliary climate control system can only be switched on if the front system is already switched on. However, switching on the front system does not switch on the rear system.

The auxiliary climate control system can be controlled from the front touch screen display; the rear climate control panel can be locked out from the touch screen.

Principles of Operation

The RCCM module of the main system is also used in the control of the auxiliary climate control system. The volume, temperature and distribution of the air from the auxiliary climate control assembly can be controlled by both the RCCM and RCCP.

The auxiliary climate control assembly is a reheat unit, which cools the air to a constant value then reheats it as necessary to produce the required temperature.

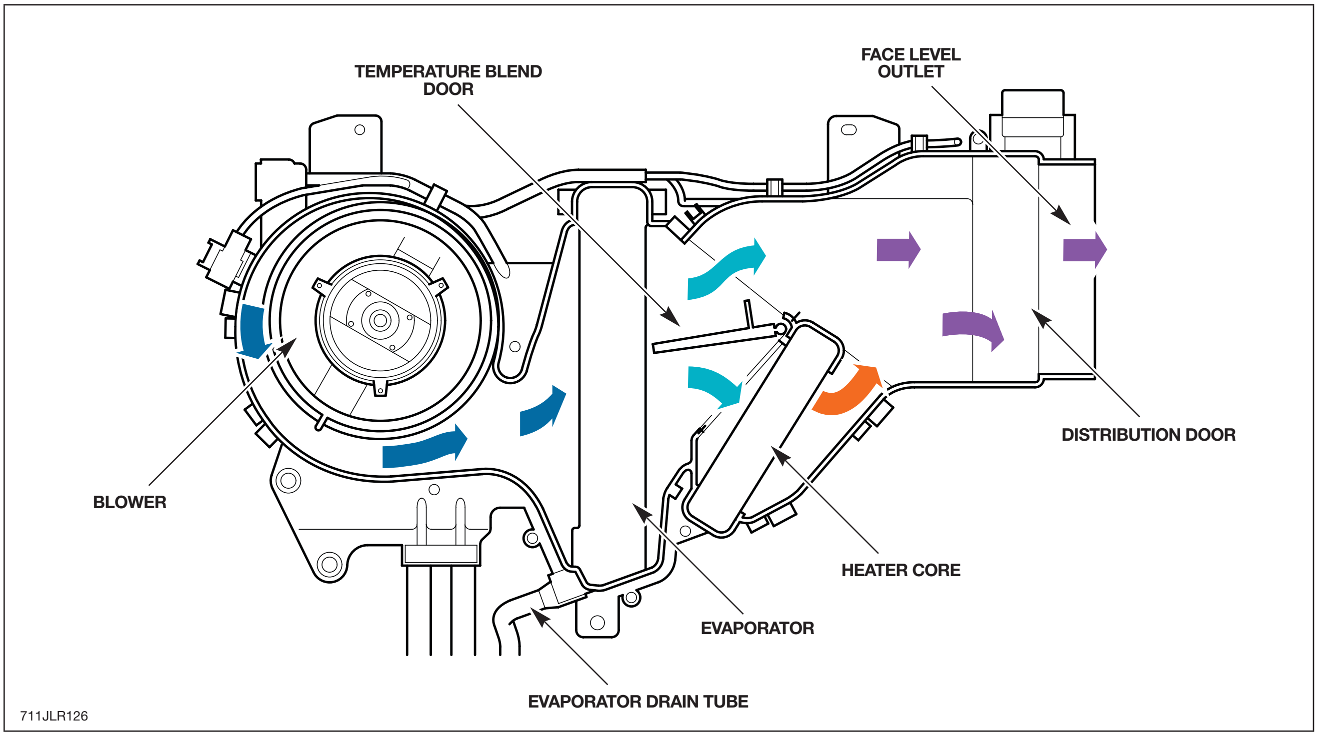
A servo motor installed on the rear of the casing operates the temperature blend door. Each servo motor incorporates a feedback potentiometer. The servo motors are powered by a feed from the RCCM. The RCCM/RCCP determines the positions of the distribution and temperature blend doors by monitoring the feedback signal from the individual servo motors.

The blower is in the air inlet of the auxiliary climate control assembly, and consists of an open-hub centrifugal fan powered by an electric motor. Battery power is provided to the blower motor via the rear ignition relay. When blower operation is required, the RCCP provides a varying voltage signal to the blower motor controller, which provides the blower motor with a variable ground path.

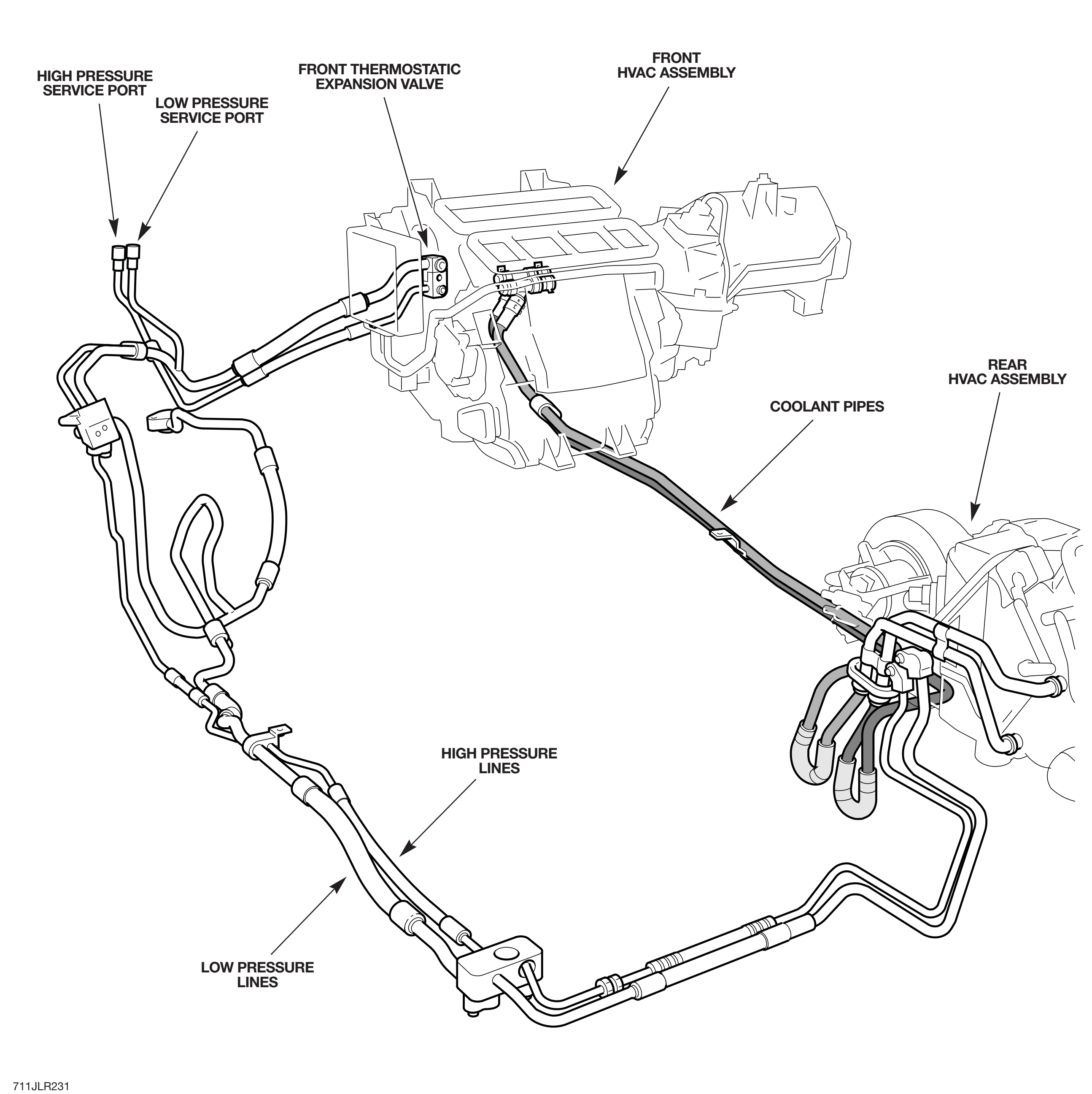
The rear blower motor controller is installed in the auxiliary climate control assembly downstream of the blower, where any heat generated during operation is dissipated by the air flow.

The auxiliary climate control system incorporates a magnetic valve that allows the auxiliary climate control assembly to be isolated from the front A/C refrigerant system by closing off refrigerant flow to the rear thermal expansion valve. The flow of refrigerant is isolated when the request for cold, dehumidified air to the rear of the vehicle is removed. The RCCP controls the magnetic valve by applying ground.

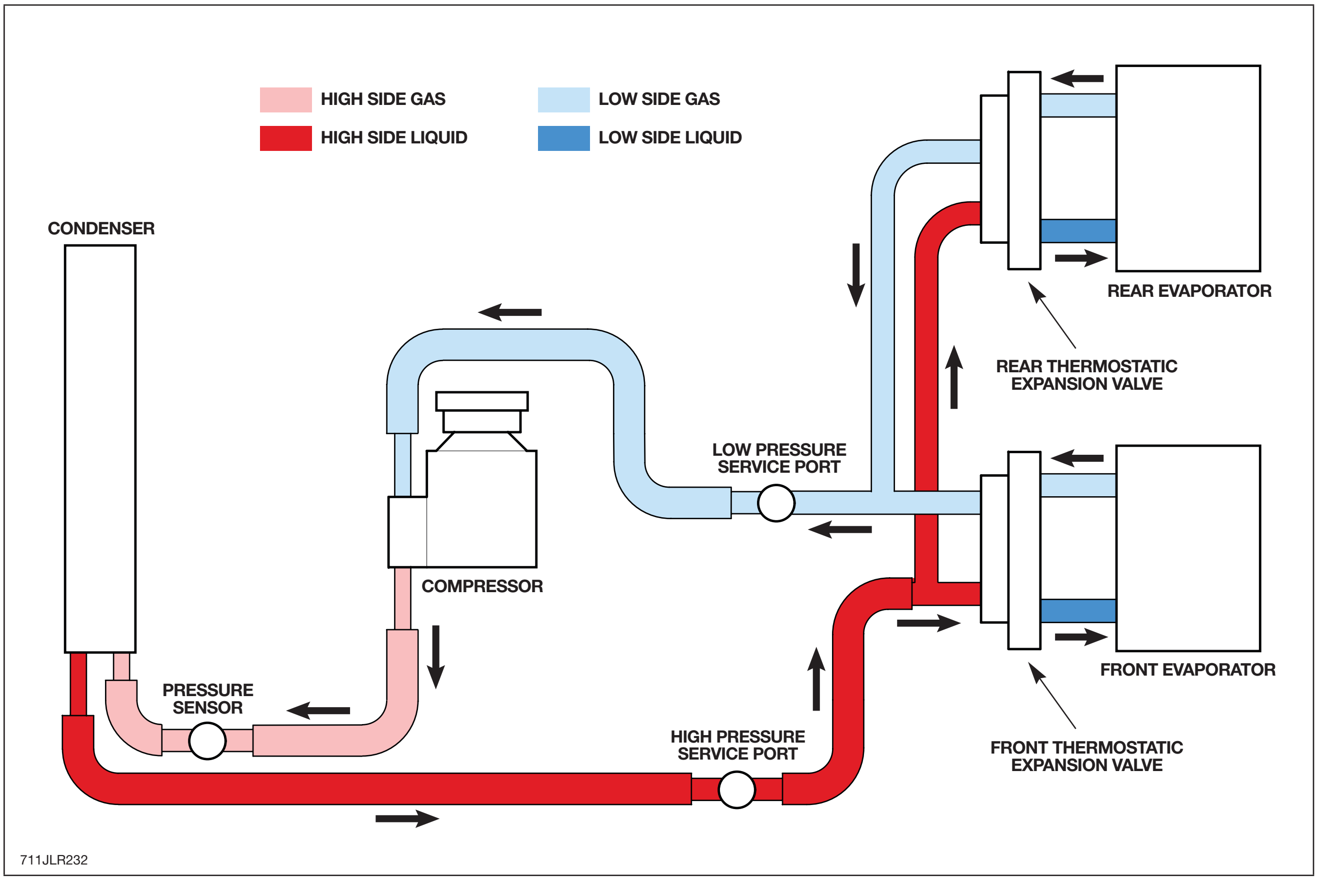
Auxiliary Air Flow



Auxiliary System Refrigerant and Heater Pipes



Schematic of Refrigeration System with Auxiliary Climate Control



711-JAG: Jaguar Climate Control Systems

X150 Climate Control Systems

JAGUAR

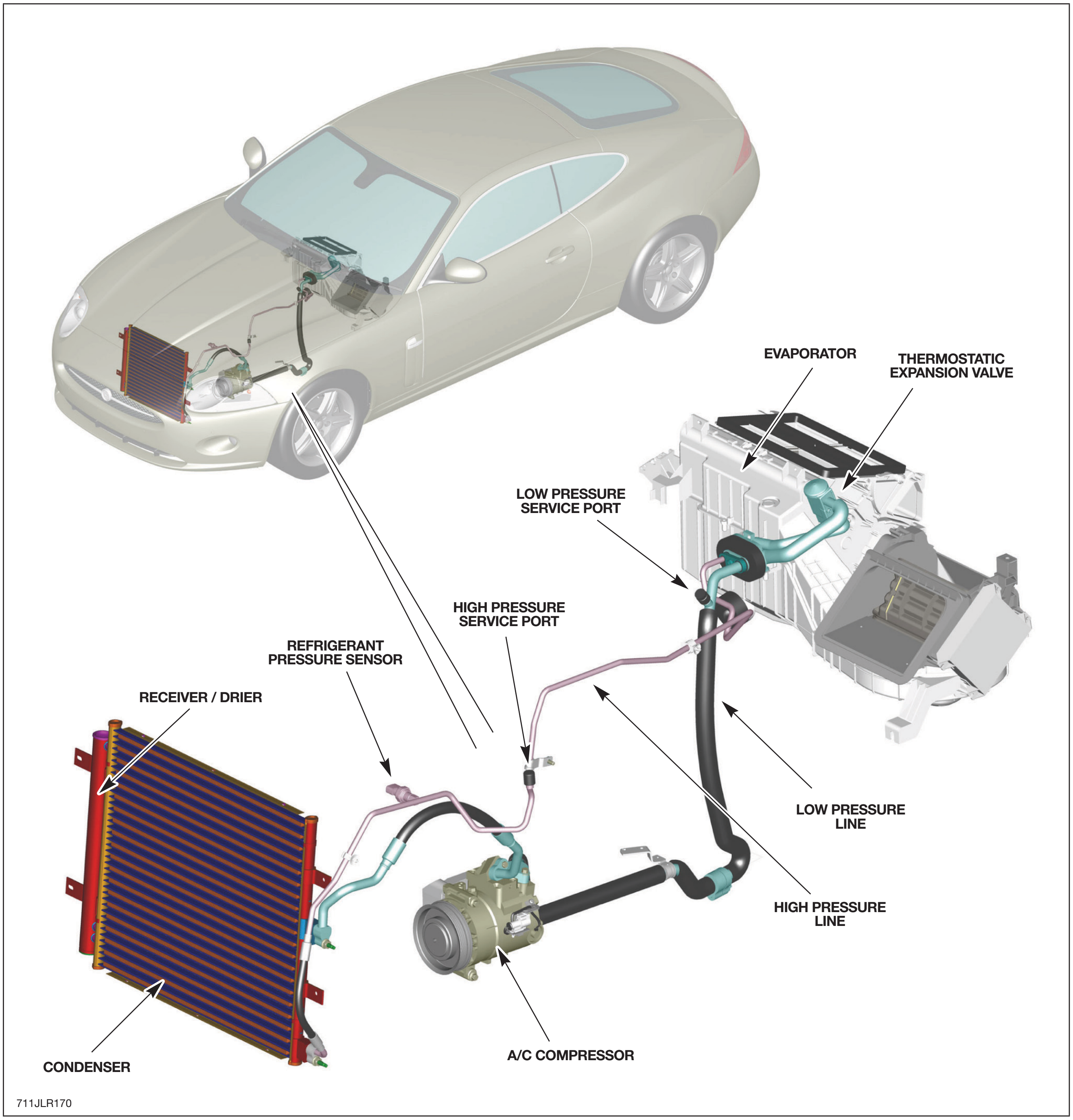
711-JAG 03/2011
Printed in USA

REFRIGERATION SYSTEM

Overview

The A/C system transfers heat from the vehicle interior to the outside atmosphere to provide the cabin with dehumidified cool air. The A/C system is a sealed, closed loop system, filled with a charge weight of R134a refrigerant as the heat transfer medium. Oil is added to the refrigerant to lubricate the internal components of the A/C compressor.

Component Location



Component Description

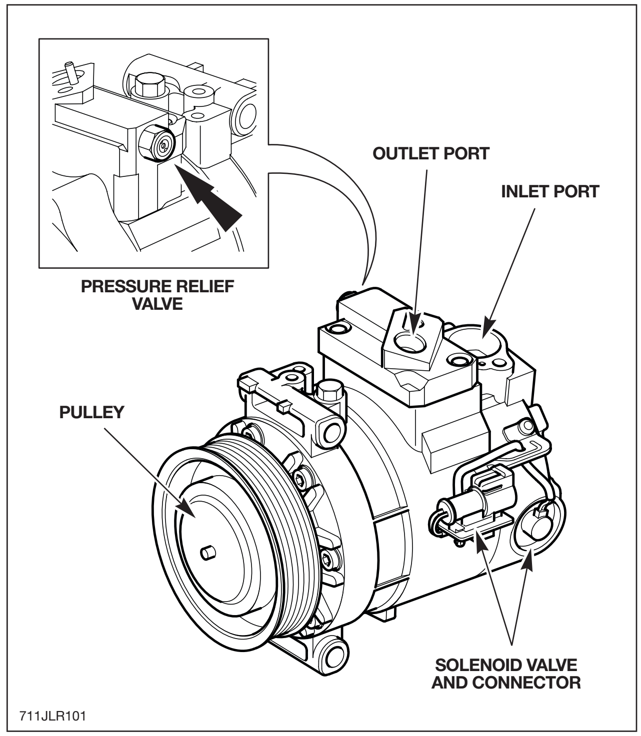
Compressor

The A/C compressor circulates refrigerant around the system by compressing low pressure, low temperature vapor from the evaporator and discharging the resultant high pressure, high temperature vapor to the condenser.

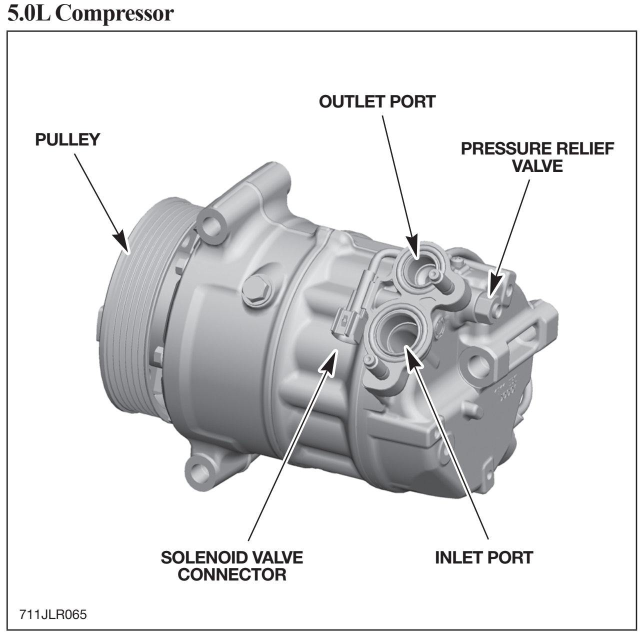
Both A/C compressors are clutchless variable displacement units with a swash plate design. The A/C compressor is permanently engaged, driven by the engine accessory drive belt. To protect the system from excessive pressure, a pressure relief valve is installed in the outlet side of the compressor. The pressure relief valve vents excess pressure into the engine compartment.

NOTE: For detailed compressor control operation refer to ATC module principles of operation in the Control System section.

4.2L Compressor

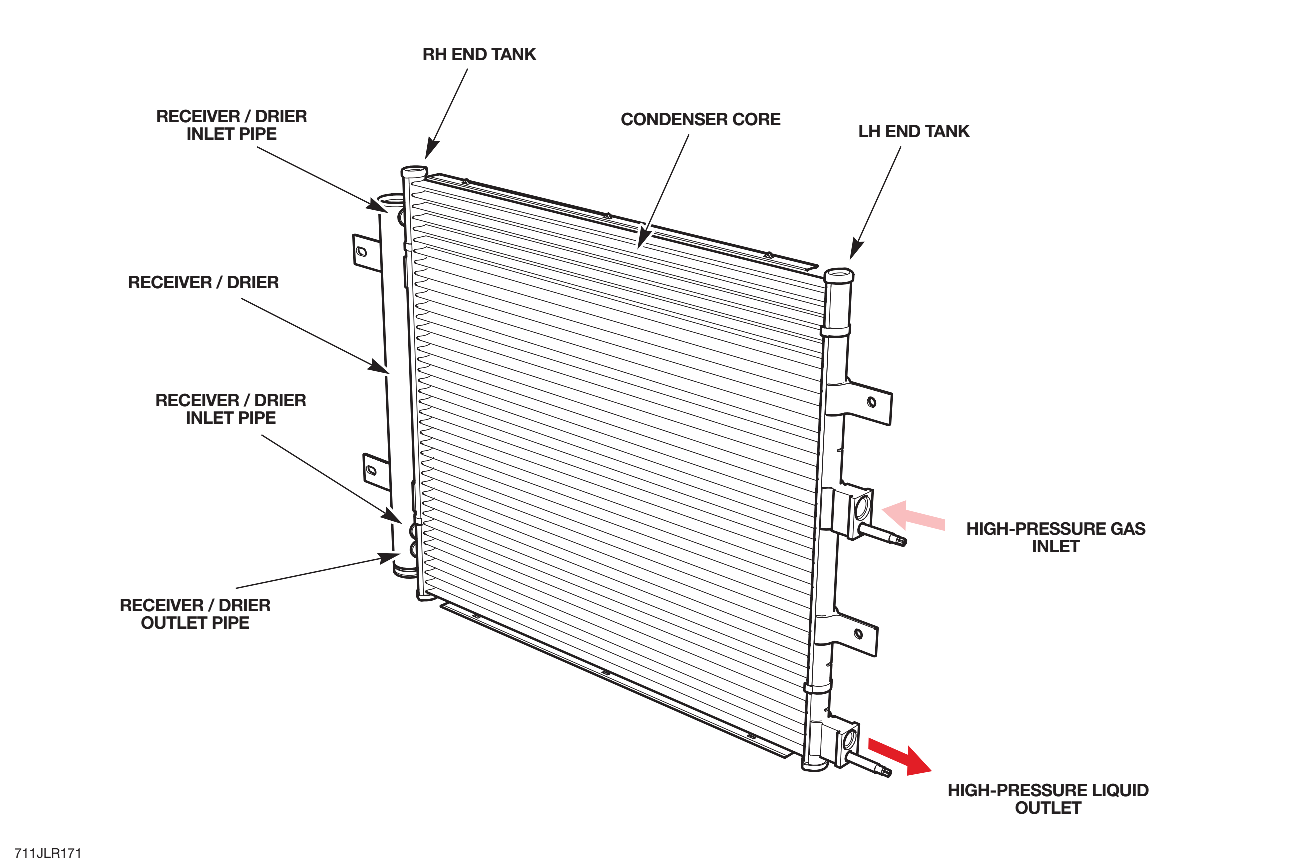


5.0L Compressor



Condenser

The condenser transfers heat from the refrigerant to the surrounding air to convert the high pressure vapor from the compressor into a liquid. The condenser is installed immediately in front of the radiator.



The condenser is classified as a sub-cooling condenser and consists of a fin and tube heat exchanger core installed between 2 end tanks. Divisions in the end tanks separate the heat exchanger into a 4-pass upper (condenser) section and a 2-pass lower (sub-cooler) section.

The LH end tank provides the connections to the high pressure line from the A/C compressor and the low pressure line to the evaporator. The RH end tank provides the connections to the receiver/drier.

Receiver/Drier

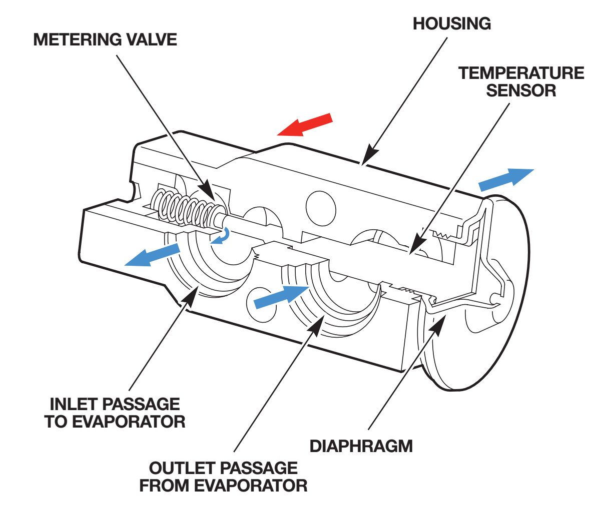
The receiver/drier is mounted on the condenser RH end tank and removes solid impurities and moisture from the refrigerant. It also provides a reservoir for liquid refrigerant to accommodate changes of heat load at the evaporator.

Refrigerant entering the receiver/drier passes through a filter and a desiccant pack, then collects in the base of the unit before flowing through the outlet pipe back to the condenser. The desiccant pack is serviceable separately from the condenser. Desiccant packs contain an ultraviolet (UV) dye pellet to assist in leak detection.

Thermostatic Expansion Valve

The thermostatic expansion valve meters the flow of refrigerant into the evaporator, to match the refrigerant flow with the heat load of the air passing through the evaporator.

The thermostatic expansion valve is a block type valve located behind the HVAC assembly, and attached to the inlet and outlet ports of the evaporator. The valve consists of an aluminum housing containing inlet and outlet passages.



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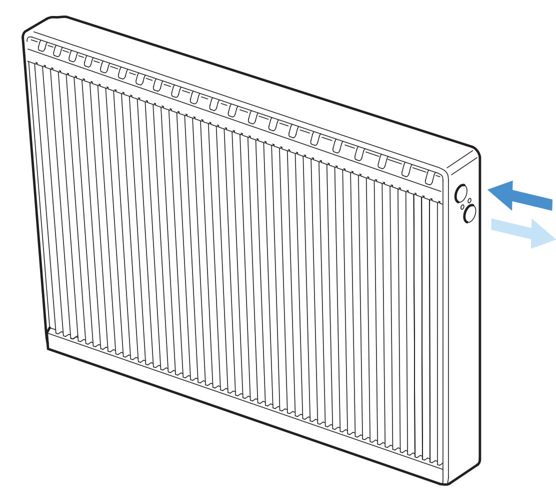
Evaporator

The evaporator is installed in the HVAC assembly, between the blower and the heater matrix, to absorb heat from the exterior or recirculated air. Low pressure, low temperature refrigerant changes from liquid to vapor in the evaporator, absorbing large quantities of heat as it changes state.



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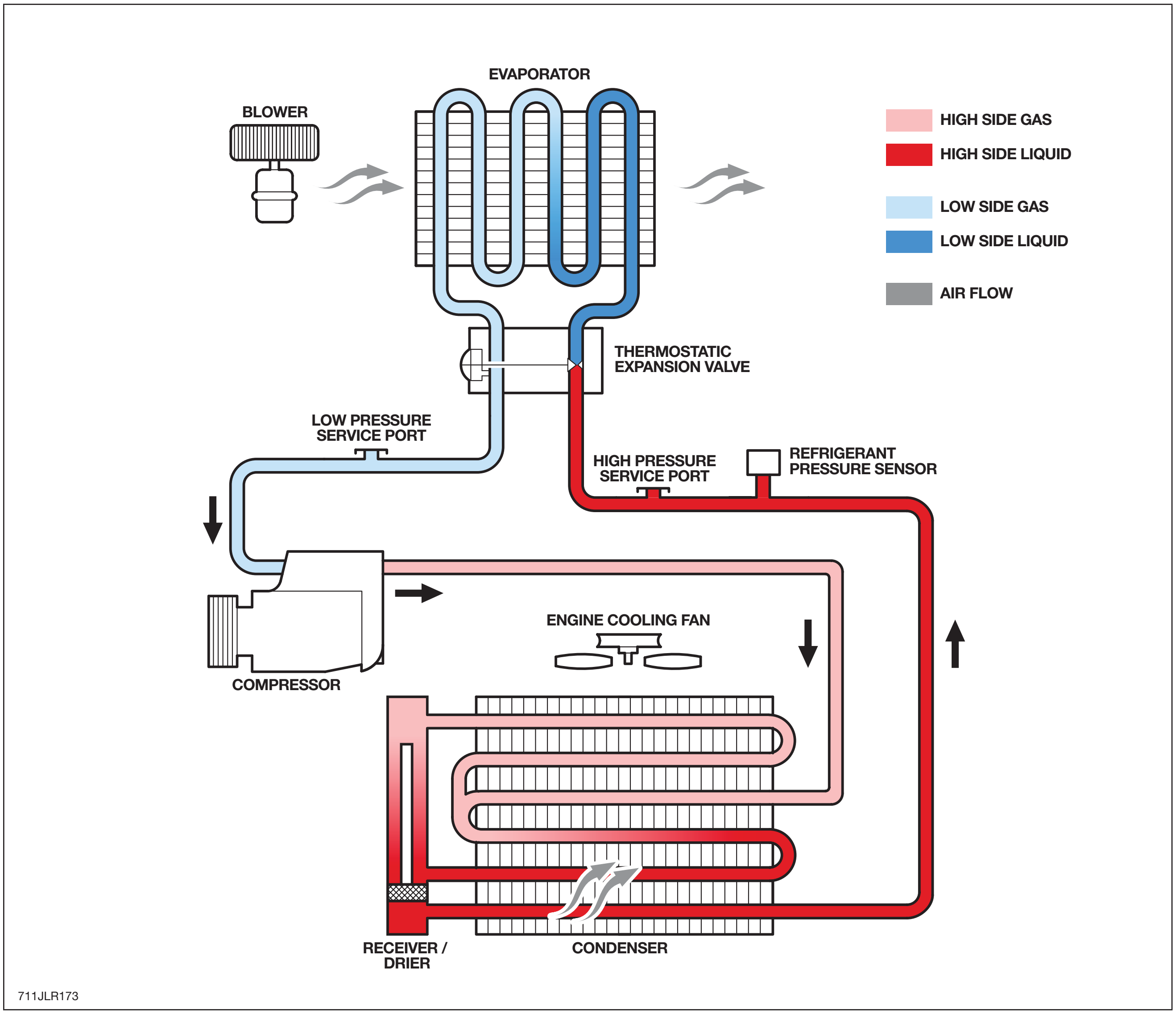
Most of the moisture in the air passing through the evaporator condenses into water, which drains out of the vehicle by passing through a drain tube to the underside of the vehicle.

Refrigerant Lines

To maintain similar flow velocities around the A/C system, the diameter of the refrigerant lines varies to suit the 2 pressure/temperature zones. Larger diameter pipes are installed in the low pressure/temperature zone; smaller diameter pipes are installed in the high pressure/temperature zone.

Low and high pressure charging connections are incorporated into the refrigerant lines for system servicing.

Refrigeration System Schematic



HEATING AND VENTILATION SYSTEM

Overview

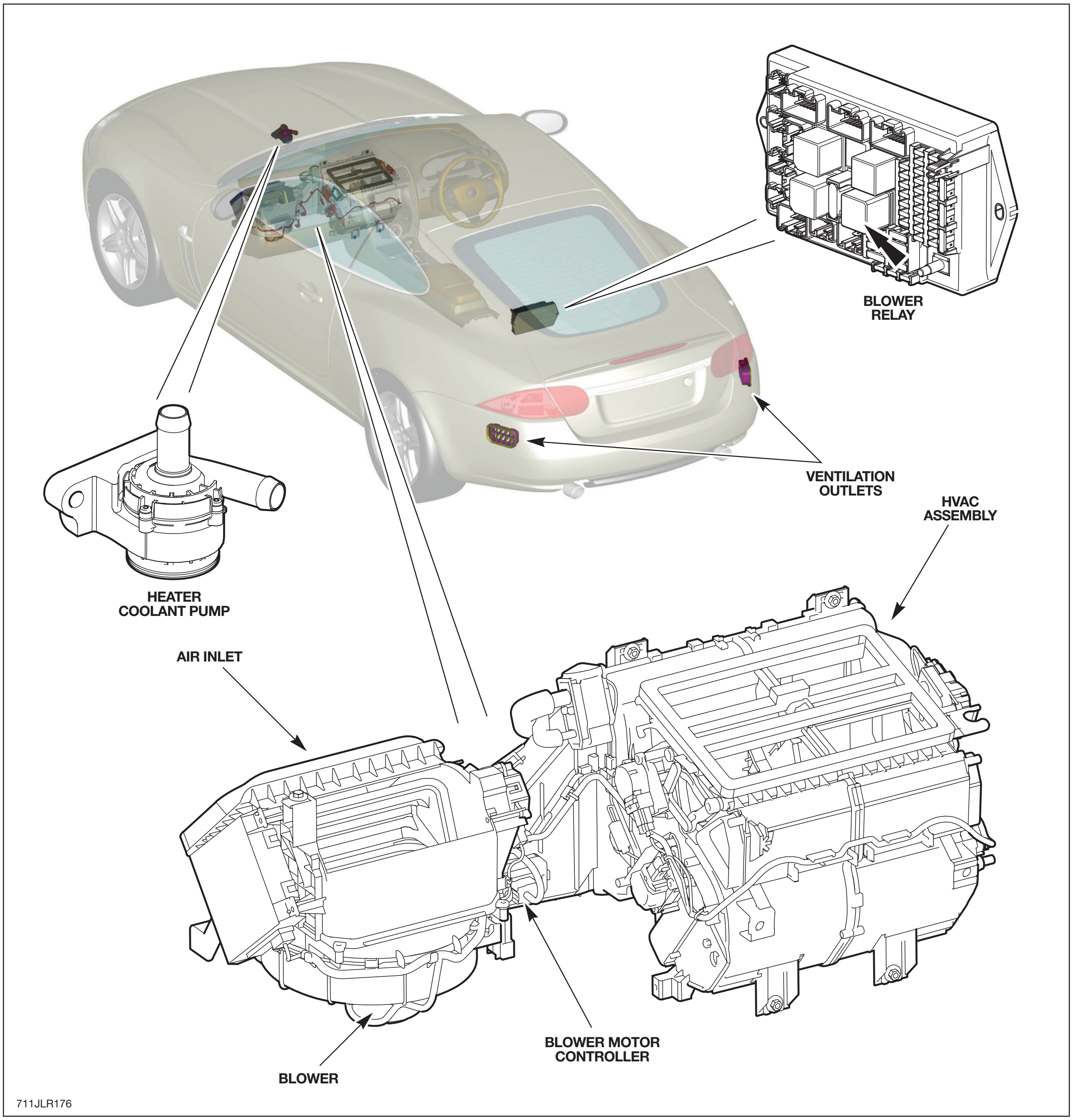
The heating and ventilation system controls the temperature and flow of air supplied to the vehicle interior. The system is dual zone, and can provide different temperature settings for the LH and RH side of the cabin. The system can be operated in 'Automatic' or 'Manual' mode, with temperature settings being selected using the control switches located below the TSD.

The system comprises:

- An air inlet duct
- A blower motor
- A blower motor controller
- A blower relay
- A HVAC assembly
- Air ducts and vents
- Two ventilation outlets

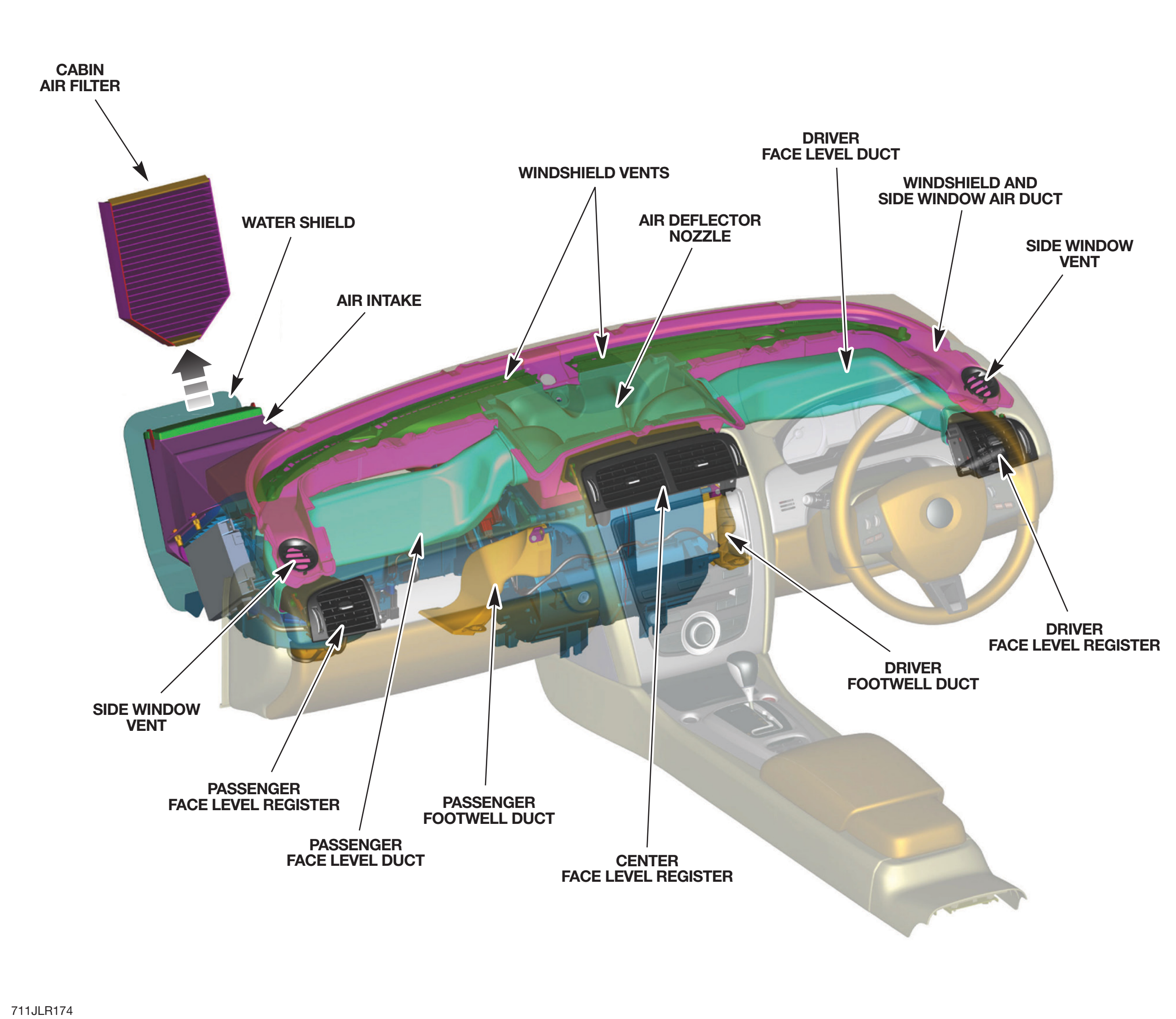
Fresh or recirculated air flows into the HVAC assembly from the inlet duct. The blower, and 'ram' effect when the vehicle is moving, forces the air through the HVAC assembly. Air from the cabin exhausts through the ventilation outlets located in the rear of the vehicle.

Components (RHD Shown; LHD Similar)



Air Ducts

The air ducts distribute air from the HVAC assembly to the various registers and vents in the instrument panel. The windshield and side window air duct, the driver instrument panel air duct, and the passenger instrument panel air duct all form part of the structure of the instrument panel.

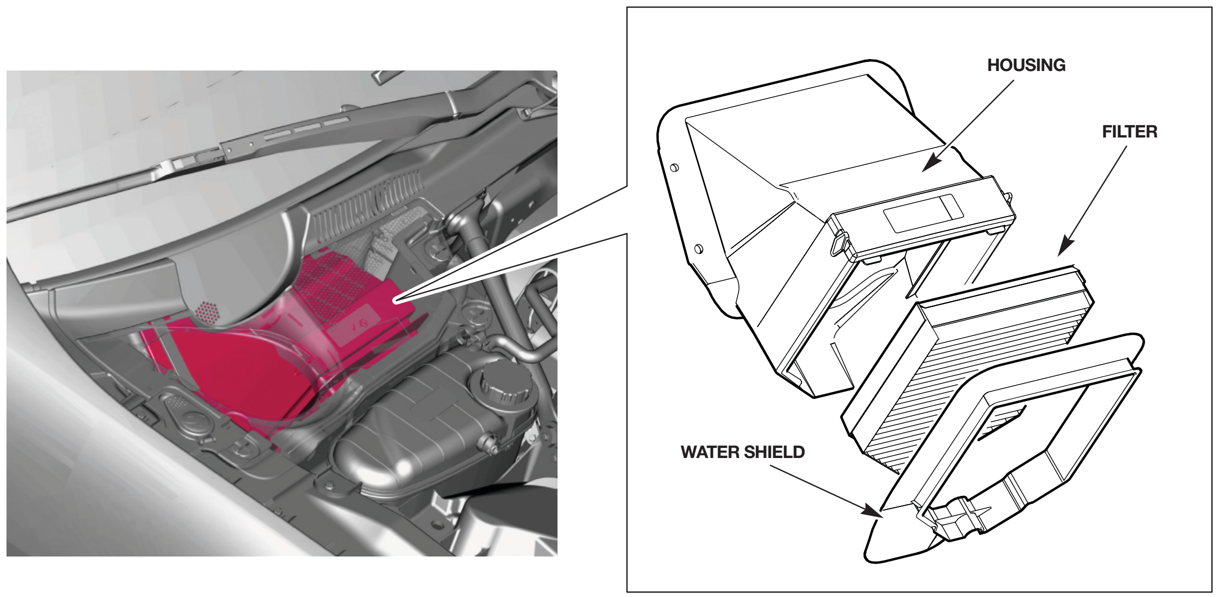


Air Registers and Vents

The air registers allow occupants to control the flow and direction of air from the air ducts. The instrument panel contains 4 air registers: 1 mounted at each end of the panel and 2 mounted centrally above the Touch Screen Display.

Cabin Filter

The cabin air filter is located in a plastic housing on the passenger side of the engine compartment. The filter removes odors and fine particles, including pollen, from air entering the blower assembly.



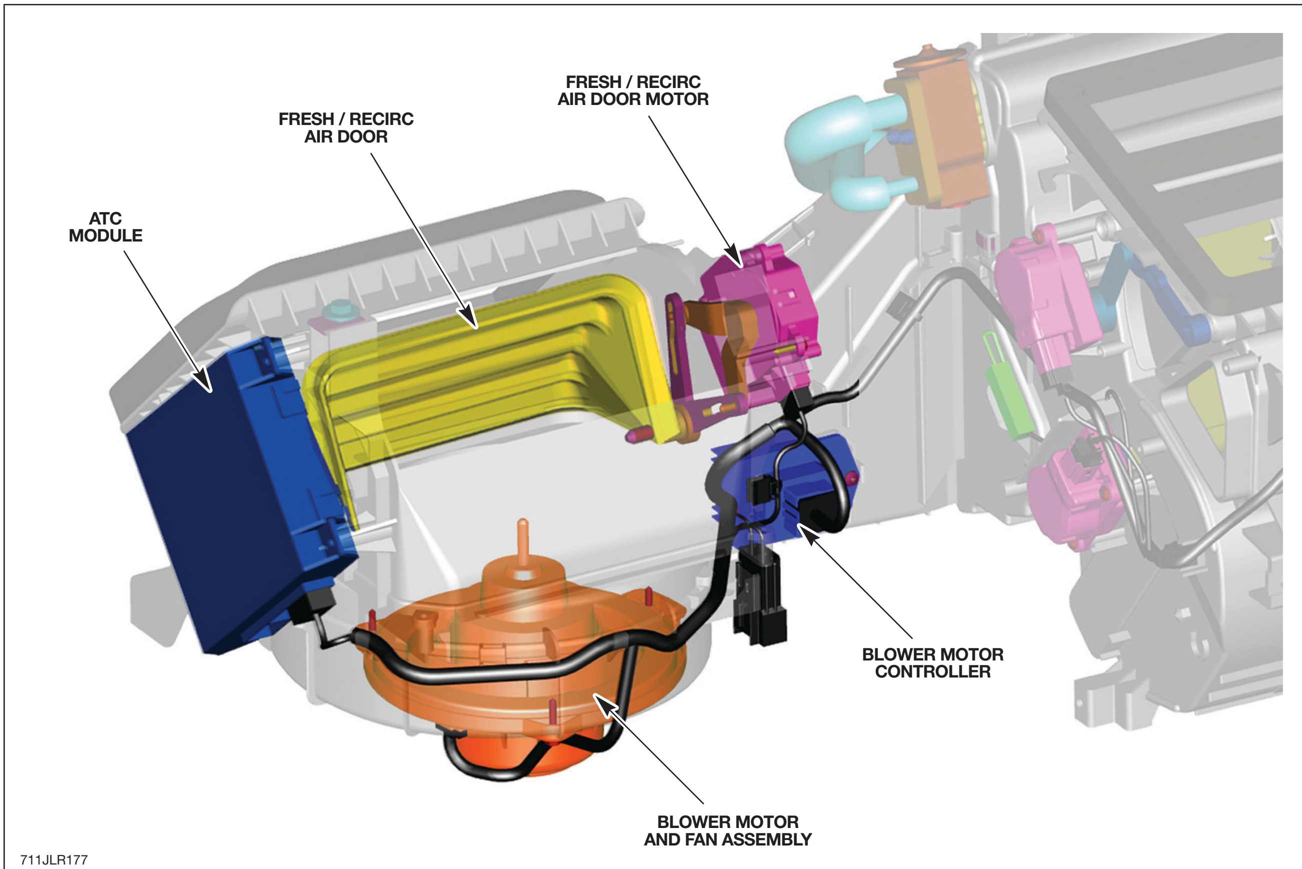
711JLR175

The filter housing also contains a shield to prevent water from contaminating the filter element and entering the heating and ventilation system.

Component Description

Air Inlet Duct

The air inlet duct is installed behind the instrument panel on the passenger side. Inlet air passes through the cabin filter and into the air inlet duct where it enters the blower. A servo motor mounted on the air inlet duct allows fresh or recirculated air to be selected. Operation of the fresh/recirculated door is controlled by the ATC module.



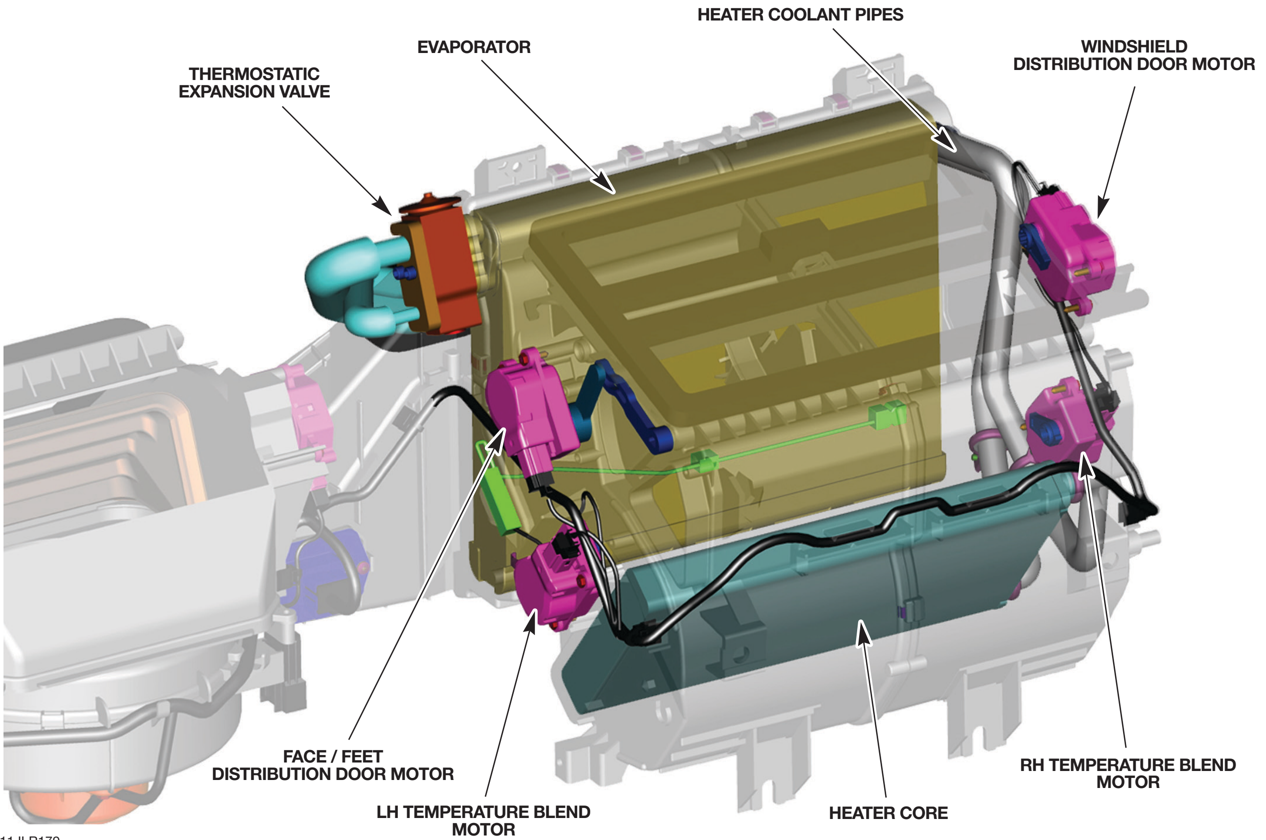
Blower

Operation of the blower is controlled by the ATC module using a relay located in the auxiliary junction box and the blower motor controller. The blower motor controller is installed in the air inlet duct downstream of the blower, where any heat generated during operation is dissipated by the air flow.

HVAC Assembly

The HVAC assembly controls the temperature of the air supplied to the air distribution ducts, as directed by the ATC module. The assembly is installed on the vehicle centerline, between the instrument panel and the engine bulkhead. The HVAC assembly consists of a casing which contains the evaporator, the heater core, 2 air distribution control doors, and 2 temperature blend control doors.

The heater core provides the heat source to warm the air being supplied to the cabin. The heater core is an aluminum 2-pass fin and tube heat exchanger, and is installed across the width of the heater housing.



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Ventilation Outlets

The ventilation outlets allow the free flow of air through the passenger compartment. The outlets are installed in the LH and RH rear quarter panels, below the tail lights.

Each ventilation outlet consists of a grille covered by a soft rubber flap, and is effectively a non-return valve. The flaps open and close automatically depending on the differential between cabin and outside air pressures.

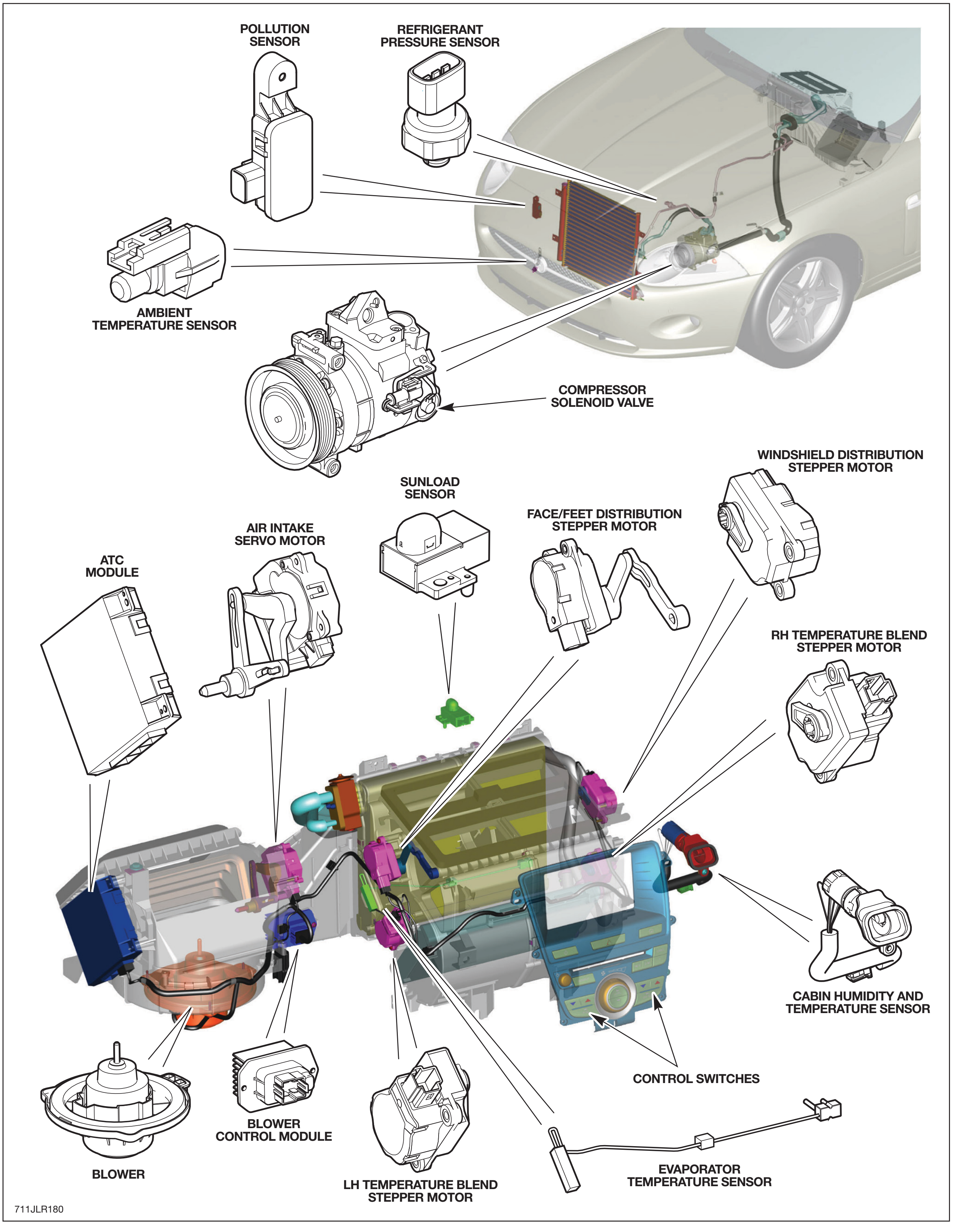
711JLR178

CONTROL SYSTEM

Overview

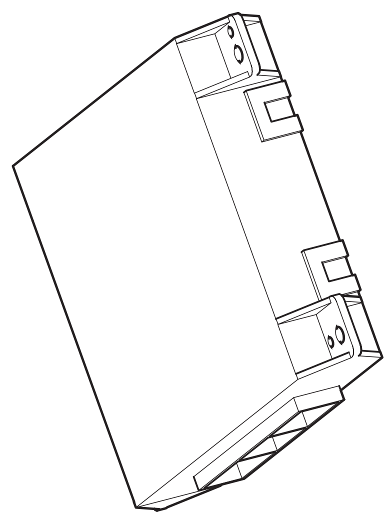
The Automatic Temperature Control (ATC) module controls the A/C system and the heating and ventilation system to regulate the temperature, volume, and distribution of air into the cabin. The fully automatic dual-zone system is capable of maintaining individual temperature levels selected for the LH and RH sides of the cabin.

Component Location



Component Description

Automatic Temperature Control Module



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The Automatic Temperature Control (ATC) module is mounted on the end of the blower motor casing, behind the instrument panel. The ATC module processes inputs from the TSD, the control switches located below the TSD, and the system sensors. In response to these inputs, the ATC module outputs the appropriate signals to control the following:

- A/C system
- Heating and ventilation
- Seat heaters
- Rear window heater
- Windshield heater (when equipped)
- Exterior mirror heaters
- Steering wheel heater

The ATC module uses hardwired inputs from the system sensors, LIN bus communication with the stepper motors, and the medium speed CAN bus to communicate with other control modules on the vehicle.

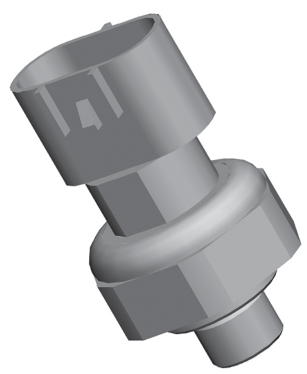
Air Conditioning Compressor Solenoid Valve

The A/C compressor solenoid valve is integral with the A/C compressor. Operation of the solenoid valve is controlled by the ATC module via PWM signal. By controlling the flow of refrigerant through the compressor, the solenoid valve can control the A/C system pressure and the evaporator operating temperature.

The ATC module broadcasts a CAN compressor drive current message to the ECM, which uses the signal to calculate compressor torque load.

Refrigerant Pressure Sensor

The refrigerant pressure sensor provides the ATC module with a pressure input from the high pressure side of the refrigerant system. The sensor is located in the refrigerant line between the condenser and the thermostatic expansion valve.



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The ATC module supplies a 5V reference voltage to the refrigerant pressure sensor and receives a return signal voltage, between 0V and 5V, related to system pressure.

The ATC module uses the signal from the pressure sensor to protect the refrigerant system from extremes of pressure. The ATC module also transmits an A/C pressure CAN signal to the ECM, which uses the signal to determine cooling fan operation.

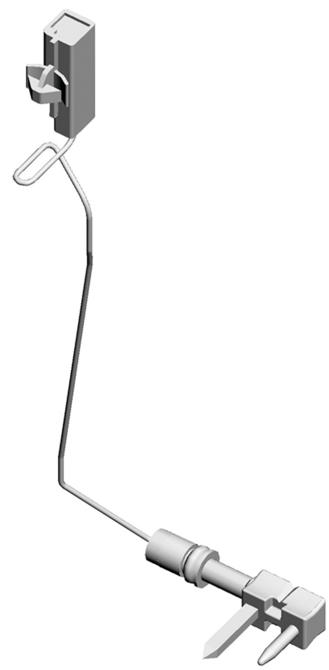
To protect the system from extremes of pressure, the ATC module sets the A/C compressor to the minimum flow position if the pressure:

- Decreases to 2.1 ± 0.2 bar (31.5 ± 3 psi); the ATC module loads the A/C compressor again when the pressure increases to 2.3 ± 0.2 bar (33.4 ± 3 psi)
- Increases to 31 ± 1 bar (450 ± 14.5 psi); the ATC module loads the A/C compressor again when the pressure decreases to 26 ± 1 bar (377 ± 14.5 psi)

Refrigerant Pressure Sensor Signal:
High Pressure = High Voltage [5V]
Low Pressure = Low Voltage [0V]

Evaporator Temperature Sensor

The evaporator temperature sensor is a negative temperature coefficient (NTC) thermistor that provides the ATC module with a temperature signal from the downstream side of the evaporator. The evaporator temperature sensor is mounted directly onto the evaporator matrix fins.



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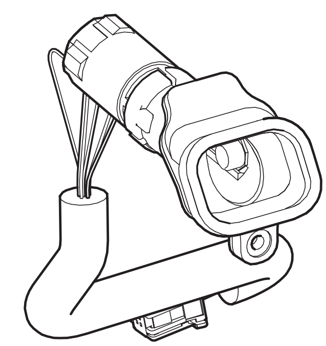
The ATC module uses the input from the evaporator temperature sensor to regulate compressor solenoid drive and thus the operating temperature of the evaporator.

Cabin Temperature and Humidity Sensor

The cabin humidity and temperature sensor is installed behind a grill on the driver's side of the instrument panel. The temperature inside the cabin is measured by an NTC thermistor. A motor within the sensor assembly draws cabin air in through the grill and over the thermistor. The motor is provided a battery voltage feed by a relay located within the Central Junction Box (CJB).



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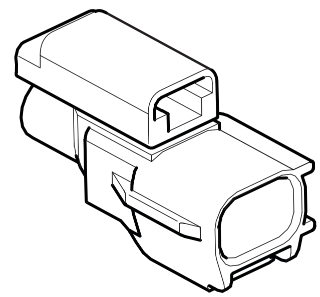
Humidity inside the cabin is measured by a sensor element made up of film capacitors on different substrates. The dielectric is a polymer which absorbs or releases water proportional to the relative humidity of the air being drawn through the sensor and thus changes the capacitance of the capacitor. For protection, the sensor element is contained in a nylon mesh cover.

Humidity within the cabin is controlled by raising and lowering the evaporator temperature. An increase in evaporator temperature increases the moisture content in the air entering the cabin. Lowering the evaporator temperature reduces the moisture content in the air entering the cabin.

Ambient Air Temperature Sensor

The ambient air temperature sensor is an NTC thermistor that provides the ATC module with an input of external air temperature. The sensor is hardwired to the ECM and its signal is transmitted to the instrument cluster on the high speed CAN bus. The instrument cluster acts as a gateway and transmits the ambient air temperature signal to the ATC module on the medium speed CAN bus.

2007 – 2009 MY



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2010 MY Onward

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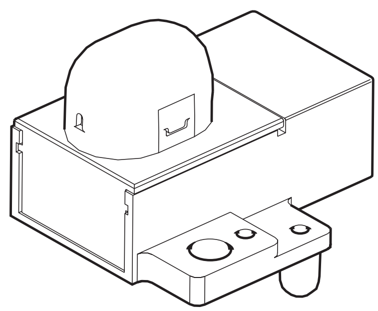
NOTE: The sensor is mounted on the vehicle centerline behind the lower front grill from 2007 through 2009 MY, and can be accessed from underneath the vehicle. At 2010 MY, the sensor was moved to the driver side door mirror.

Sunload Sensor

The sunload sensor consists of 2 photoelectric cells that provide the ATC module with inputs of light intensity, one as sensed coming from the left of the vehicle and one as sensed coming from the right. The inputs are a measure of the solar heating effect on vehicle occupants, and are used by the ATC module to adjust blower speed, temperature, and distribution to improve comfort.



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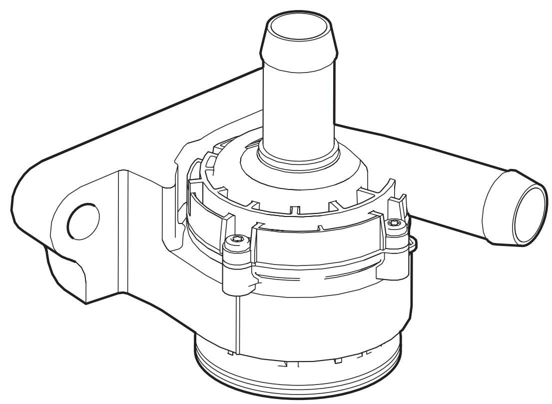
The sensor is installed in the center of the instrument panel upper surface and is powered by a 5V feed from the instrument cluster.

NOTE: The solar sensor is also used as part of the Autolamp feature, and contains the active anti-theft alarm indicator LED.

Heater Coolant Pump (4.2L Variants)

A heater coolant pump is mounted on the RH rear face of the radiator housing. The pump is electrically driven and provides the necessary flow rate of engine coolant to the heater core. Operation of the pump is controlled by the CJB on receipt of medium speed CAN bus signals from the ATC module.



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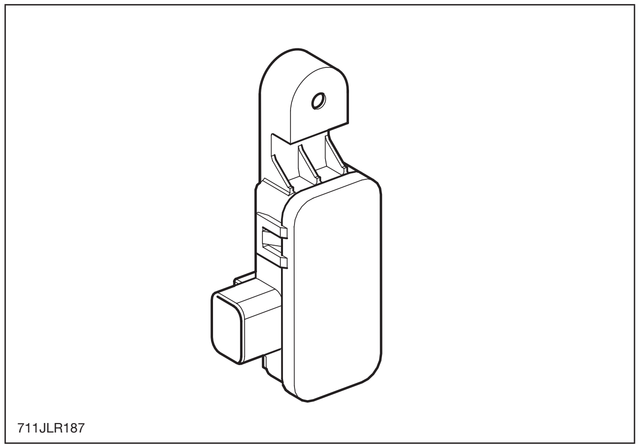
The pump will run when the engine is running and operates at a single speed. The CJB broadcasts pump status over the medium speed CAN bus for use by other vehicle systems.

NOTE: The heater coolant pump is not used on 5.0L variants.

Pollution Sensor

The pollution sensor was installed on the 2009 MY XK, but was then discontinued in 2010 MY.

The pollution sensor (mounted RH front of the A/C condenser) monitors levels of smog-producing contaminants – which include hydrocarbons and oxidized gases such as nitrous oxides, sulfur oxides, and carbon monoxide – from the ambient air in front of the vehicle. The ATC module uses pollution sensor input signals to control the air intake source. The recirculation (fresh/recirc) door is opened or closed in direct response to changes in pollution levels in order to reduce pollution contaminants entering the cabin.



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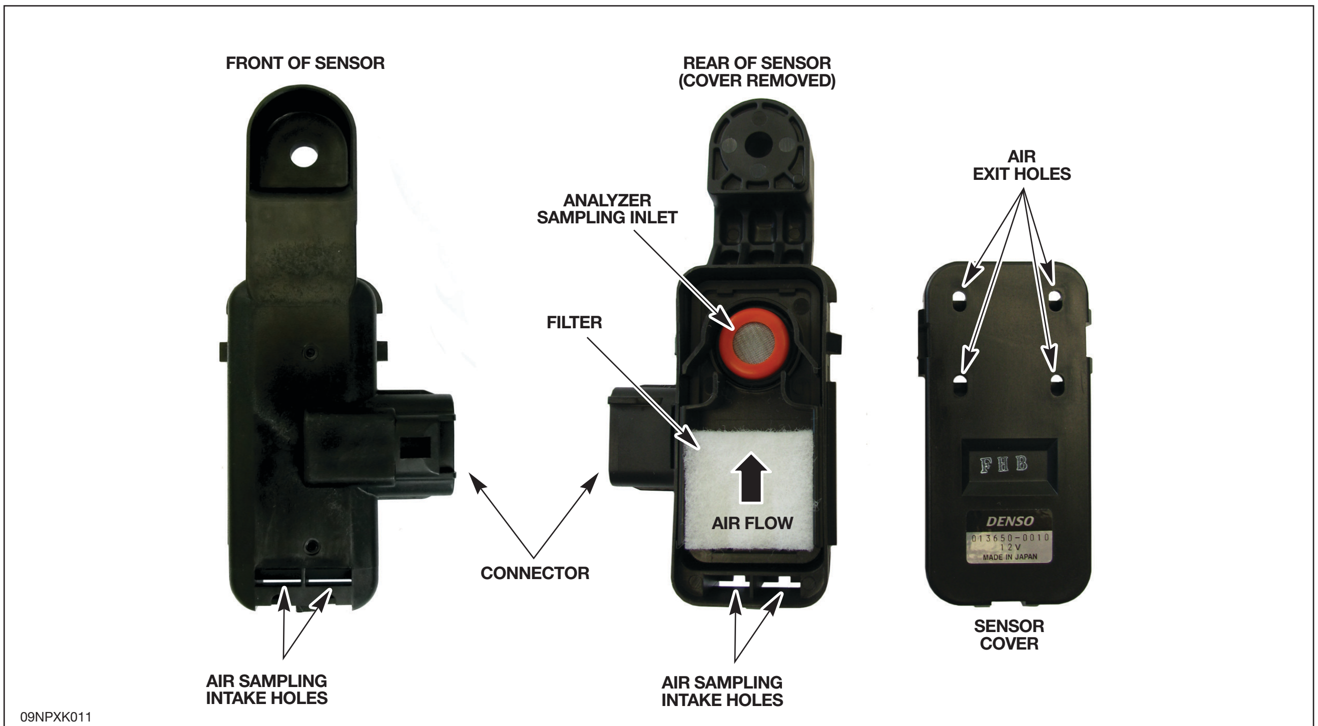
Pollution Sensor Strategy

- Only active while in ATC AUTO mode, and is fully automatic
- Can be overridden by manual selection of the air source using the recirculation control switch below the Touch Screen Display (TSD)
- Sensor sensitivity response levels can be adjusted from the TSD

The pollution sensor relies on the continuous airflow over the condenser to draw ambient air to sample for contaminant levels. Air is drawn through sampling holes on the bottom front of the sensor.

NOTE: The sensor is directional and must be oriented with the front facing forward for proper operation.



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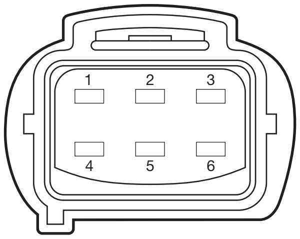
The pollution sensor is powered by an ignition-controlled voltage feed from the CJB and provides separate input signals for hydrocarbon and oxidized gas levels to the ATC module.



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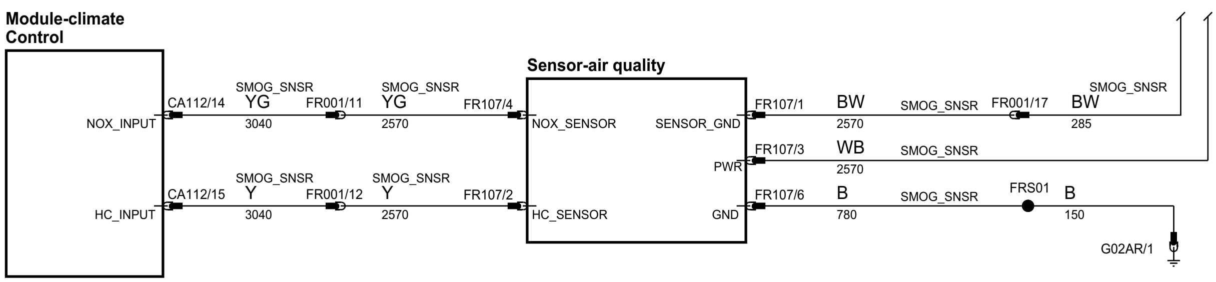
PIN	FUNCTION
1	SENSOR GROUND
2	INACTIVE: 5V FROM ATCM ACTIVE: PULLS VOLTAGE DOWN TO 0V
3	CJB IGNITION SWITCHED POWER
4	INACTIVE: 5V FROM ATCM ACTIVE: PULLS VOLTAGE DOWN TO APPROX. 2.8V
5	NOT USED
6	GROUND



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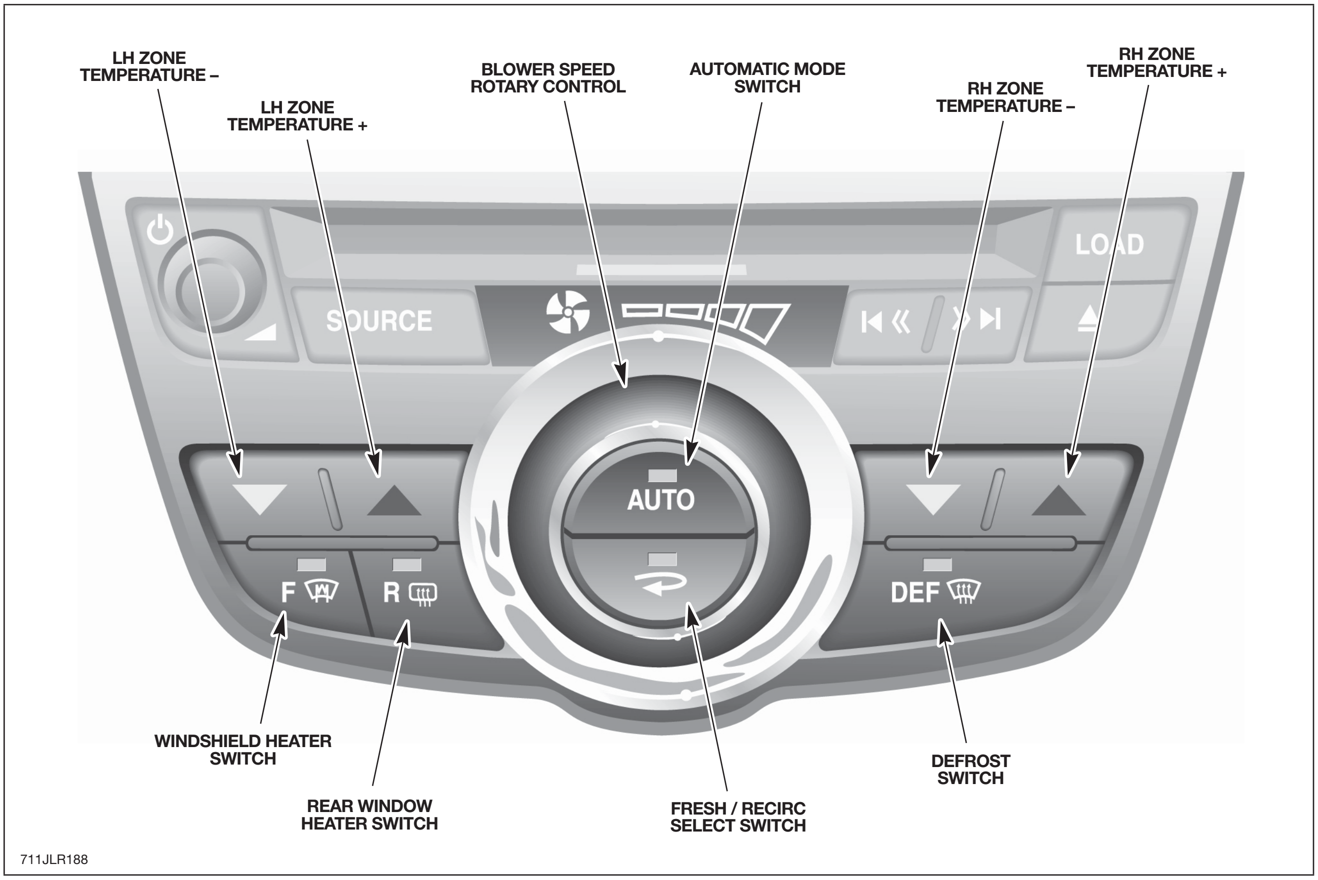
Diagnostics

- Sensor fault codes are stored in the ATC module and can be accessed using SDD
- If there is a fault with the sensor, the ATC module disables automatic operation of the recirculation door based on air quality
- Pollution sensor Parameter Identification Data (PIDs) can be monitored using SDD

Climate Control Panel

The climate control functions are selected using the push buttons and the rotary control knob in the centrally-mounted climate control panel. Most buttons have an illuminated LED; the illumination level is adjusted using the dimmer control switch. System status, including interior and exterior temperatures, is displayed in the TSD.



AUTO mode is the default operating mode, but may be overridden at any time. Manual selections can be made for:

- Defrost/demist
- Blower speed
- Air recirculation
- Air conditioning
- Windshield and rear window heating

System ON/OFF

With the ignition system ON, press the AUTO select switch in the center of the rotary control knob. The system will switch on in AUTO mode. The system can only be switched off using the OFF soft key in the TSD 'Climate' Menu. Pressing the soft key again will turn the system back on.

NOTE: Before making adjustments after system ON, it is advisable to allow the system to acclimate, particularly at the start of a drive cycle.

AUTO Mode

AUTO operation provides a controlled climate over a temperature range of 59 – 83 °F (16 – 28 °C), and should be regarded as the normal operating mode.

The system is in AUTO mode when the system is switched on. The temperature settings, windshield/rear window heating and timed air recirculation can be selected within the parameters of 'AUTO mode'. Any other control selections will cancel AUTO mode. AUTO mode can be reselected at any time by pressing the AUTO switch.

NOTE: When heating is required in AUTO mode, the blower will operate only in low speed when the engine is cold; faster speeds are achieved once the engine warms up.

Temperature Selection

Separate controls allow the driver and passenger zone temperatures to be adjusted independently. Press the red buttons to increase temperature; press the blue buttons to decrease temperature. Both driver and passenger temperatures are displayed in the TSD.

Pressing the driver's select buttons to the minimum or maximum temperature settings causes the display to change to HI or LO and cancels AUTO mode. To return quickly to a mid-range temperature (72 °F/ 22 °C), press and hold the AUTO switch for a few seconds.

Air Recirculation

To select timed air recirculation, press and release the recirculation switch in the center of the rotary control knob. The LED will illuminate and remain lit until recirculation times out. Vehicles from 2009 MY onward also offer 'latched' (continuous) air recirculation: press and hold the recirculation switch; the LED will flash 3 times then remain illuminated. Air recirculation will remain active until deselected. Deselect air recirculation by pressing the switch again.

NOTE: Prolonged operation of air recirculation in cold, damp conditions may result in interior fogging of the windows.

Windshield Defrost/Demist

To remove frost or heavy misting from the windshield, press the DEF button. The defrost-level blower will switch on at high speed and AUTO mode will be cancelled. The blower speed can be adjusted manually.

When defrost is selected:

- Air recirculation is canceled and cannot be selected
- Air conditioning is switched on automatically (to dehumidify the air) and cannot be deselected
- The windshield mirror and rear window heaters are switched on automatically

Deselect defrost by pressing the DEF button again, or press the AUTO switch.

Windshield and Rear Window Heaters

The windshield and rear window heaters can be switched on in any mode, but will only operate when the engine is running.

To select the windshield heater, press the F button. The windshield heater will switch off automatically after 6 minutes. To select the rear window heater, press the R button. The rear window heater will switch off automatically after 21 minutes.

The heater(s) can be deselected manually at any time by pressing the button(s) again. In cold ambient conditions, when temperatures are below 41 °F (5 °C), the windshield and rear window heaters will switch on automatically at the start of the drive cycle, and will remain on for the timed period.

Air Conditioning

Air conditioning operates automatically in AUTO mode when cooling is required to achieve the target temperature(s). A/C may also operate when warmer temperatures are selected but dehumidifying is required. A/C is also switched on automatically in defrost mode in order to dehumidify the air.

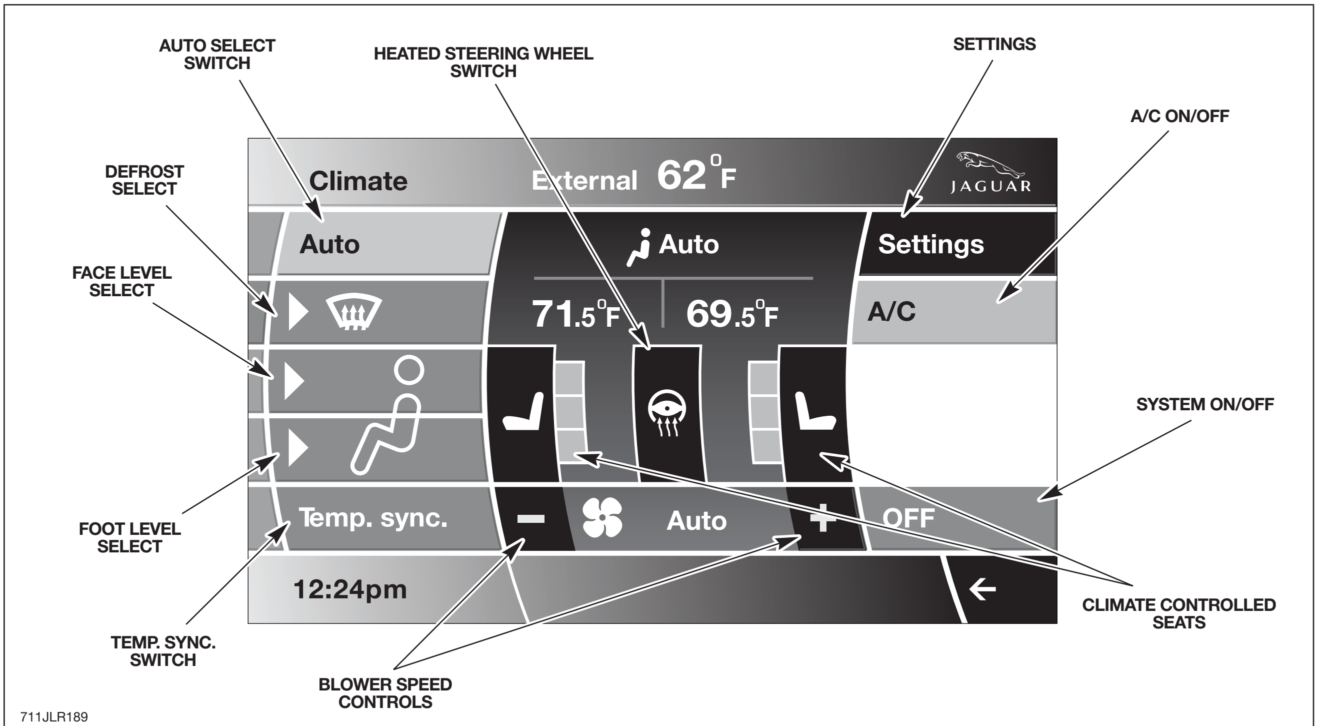
Blower Speed

Blower speed is controlled automatically in AUTO mode, but can be adjusted using the rotary control knob (this will cancel AUTO mode). Reselect AUTO mode by pressing the AUTO switch.

NOTE: When heating is required in AUTO mode, the blower will operate only in low speed when the engine is cold; faster speeds are achieved once the engine warms up.

Climate Control Touch Screen

Additional controls are accessed from the Touch Screen Display (TSD) ‘Climate’ menu, which is accessed from the touch-screen main ‘Home’ menu by selecting ‘Climate’.



The ‘Climate’ menu offers the following selections:

- **Auto** – press this button to switch AUTO climate control ON.
- **Distribution to windshield** (windshield icon) – press this button to direct air flow to the windshield-level vents
- **Distribution to face** (upper body icon) – press this button to direct air flow to the fascia face-level vents
- **Distribution to feet** (lower body icon) – press this button to direct air flow to the floor-level vents
- **Temp. Sync.** – matches the passenger’s zone temperature to the driver’s selected temperature
- **Blower speed control** – press the ‘ – ’ icon to decrease blower speed; press the ‘ + ’ icon to increase
- **Heated seats and steering wheel** (seat/steering wheel icons) – press buttons to toggle heated seats and steering wheel ON/OFF individually
- **A/C** – press this button to toggle air conditioning ON/OFF
- **OFF** – press this button to toggle the climate control system ON/OFF
- **Settings** – press this button to access further settings where equipped:
  - Pollution sensitivity
  - Climate controlled seat zone selection

Principles of Operation

Air Inlet Control

The source of inlet air is automatically controlled unless overridden by pressing the recirculation switch in the center of the rotary control knob. Under automatic control, the ATC module determines the required position of the recirculation door from its 'comfort' algorithm and, if fitted, the pollution sensor.

The recirculation door is operated by an electric motor. The ATC module provides analog signals to the motor along a hardwired connection. A potentiometer in the motor supplies the ATC module with a position feedback signal for closed loop control.

Air Temperature Control

Cooled air from the evaporator enters the HVAC assembly, where temperature blend doors direct a proportion of the air through the heater core to produce the required output air temperature.

The 2 temperature blend doors operate independently to enable individual temperature settings for the left and right sides of the cabin. The temperature blend doors are operated by stepper motors, which are controlled by the ATC module using LIN bus messages.

The ATC module calculates the temperature blend stepper motor positions required to achieve the selected temperature and compares it against the current position. If there is any difference, the ATC module signals the stepper motors to adopt the new position.

Air temperature is controlled automatically unless maximum heating (HI) or maximum cooling (LO) is selected. When maximum heating or cooling is selected, a 'comfort' algorithm in the ATC module adopts an appropriate strategy for air distribution, blower speed, and air source.

Temperature control of one side of the cabin can be compromised by the other side of the cabin being set to a high level of heating or cooling. True maximum heating or cooling (displayed as 'HI' or 'LO' on the TSD) can only be selected from the driver's side temperature control button. If 'HI' or 'LO' is selected from the driver's side, the passenger side temperature will be automatically set to match the driver's side.

When economy mode is selected, no cooling will occur. The minimum output air temperature will be ambient air temperature plus any heat picked up in the air intake path.

To select economy mode:

- On 2007 – 2008 MY vehicles, press the 'ECON' soft key on the TSD
- On vehicles from 2009 MY onward, press the 'A/C' soft key on the TSD to toggle the A/C system off

Blower Motor Control

Operation of the blower motor is controlled by the ATC module. The ATC module monitors a feedback voltage from the blower motor controller. In response to the feedback voltage, the ATC module provides a drive signal back to the blower motor controller to regulate the voltage flow across the blower motor and hence regulate blower speed. The blower motor is provided with a battery voltage feed from the blower motor relay, which is located within the auxiliary junction box.

When the A/C system is in Automatic mode, the ATC module determines the blower speed required from its 'comfort' algorithm. When the A/C system is in Manual mode, the ATC module operates the blower at the speed selected using either the rotary control switch or the '+/-' soft keys on the TSD.

The ATC module also controls blower motor speed to compensate for the ram effect on intake air produced by forward movement of the vehicle. As vehicle speed, and consequently the ram effect increases, blower motor speed is reduced.

Note:
Loss of blower motor feedback signal results in blower operation only if high speed is selected or requested by ATC.

Air Distribution Control

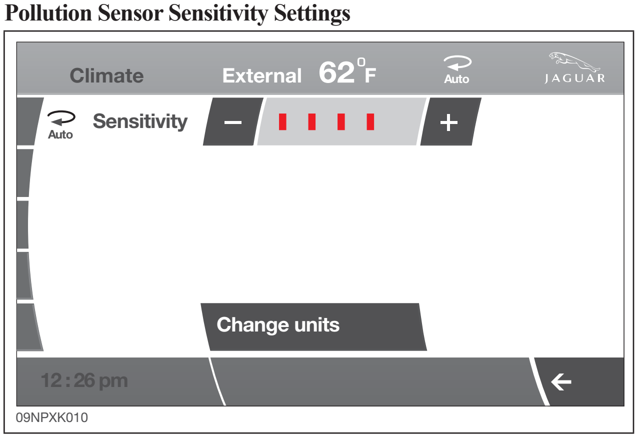
Two air distribution doors are used to direct air into the cabin. The doors are operated by stepper motors, which are controlled by the ATC module using LIN bus messages.

When the A/C system is in automatic mode, the ATC module automatically controls air distribution into the cabin in line with its 'comfort' algorithm. Automatic control is overridden if any of the TSD air distribution soft keys are selected. Air distribution in the cabin will remain as selected until the 'Auto' switch is pressed or a different manual selection is made.

Pollution Sensor

The sensor's sensitivity is adjustable. The sensitivity setting changes the threshold for pollution level increase over a base pollution level. When the threshold is exceeded, air recirculation is switched on (the recirc door closes). The recirc door remains closed either for a timed period or until the pollution levels decrease (whichever is sooner). Once the level of pollutants decreases below the threshold, air recirculation will switch off.

Pollution Sensor Sensitivity Settings



Sensor sensitivity can be adjusted using the TSD. From the TSD Climate menu, select 'Settings' to access the 'Auto' Sensitivity adjustment screen. Increase or decrease the sensitivity by pressing the ' + ' or ' – ' buttons.

Programmed Defrost

When the 'DEF' button is pressed, the ATC module instigates the programmed defrost function. When selected, the ATC module configures the system as follows:

- Automatic mode off
- Selected temperature unchanged
- Air inlet set to fresh air
- Air distribution set to windshield
- Blower speed set to level 6
- Windshield and rear window heaters on

The programmed defrost function can be cancelled by one of the following:

- Selecting any air distribution switch on the TSD
- Pressing the 'AUTO' switch below the TSD
- A second press of the 'DEF' button

NOTE: The blower speed can be adjusted without terminating the programmed defrost function.

A/C Compressor Control

When A/C is selected the ATC module maintains the evaporator at an operating temperature that varies with the cabin cooling requirements. If the requirement for cooled air decreases, the ATC module raises the evaporator operating temperature by reducing the flow of refrigerant provided by the A/C compressor.

NOTE: The ATC module closely controls the rate of temperature increase to avoid introducing moisture into the cabin.

If the requirement for cooled air increases, the ATC module lowers the evaporator operating temperature by increasing the flow of refrigerant provided by the A/C compressor.

When economy mode is selected, the compressor current signal supplied by the ATC module holds the A/C compressor solenoid valve in the minimum flow position, effectively switching off the A/C function.

The ATC module incorporates limits for the operating pressure of the refrigerant system. When the system approaches the high pressure limit the compressor current signal is progressively reduced until the system pressure decreases. When the system pressure falls below the low pressure limit the compressor current signal is held at its lowest setting so that the A/C compressor is maintained at its minimum stroke. This avoids depletion of the lubricant from the A/C compressor.

A/C Compressor Torque

The ATC module transmits refrigerant pressure and A/C compressor current values to the ECM over the medium speed then high speed CAN bus, using the instrument cluster as a gateway. The ECM uses these values to calculate the torque being used to drive the A/C compressor. The ECM compares the calculated value with its allowable value and if necessary forces the ATC module to inhibit the A/C compressor by transmitting the ‘AC Clutch Inhibit’ CAN message. This forces the ATC module to reduce the drive current to the A/C compressor solenoid valve, which reduces refrigerant flow. This in turn reduces the torque required to drive the A/C compressor.

By reducing the maximum A/C compressor torque, the ECM is able to reduce the load on the engine when it needs to maintain vehicle performance or cooling system integrity.

Cooling Fan Control

The ATC module determines the amount of condenser cooling required from the refrigerant pressure sensor, since there is a direct relationship between the temperature and pressure of the refrigerant. The cooling requirement is broadcast to the ECM on the medium speed CAN bus. The ECM then controls the temperature of the condenser using the cooling fan.

Windshield Heater

The ATC module controls operation of the windshield heater using 2 relays in the power distribution box. When a request is made for windshield heater operation, the ATC module broadcasts a message to the CJB on the medium speed CAN bus. On receipt of this message, the CJB energizes the relays by providing a ground path for both relay coils. This allows a battery feed to flow across the relays to power the left and right heater elements.

NOTE: Windshield heater operation is only enabled when the engine is running.

There are 2 modes of windshield heater operation: manual and automatic.

Manual
Manual operation is activated by pressing the windshield heater control switch. When the switch is pressed, the ATC module illuminates a LED in the switch and powers the heater elements for 6.5 minutes.

The switch LED remains illuminated until the windshield heater switch is pressed a second time (to switch the system off), the heating phase is completed, or the engine stops. If the engine is restarted within 30 seconds the windshield heater resumes the previous heating phase.

Automatic
There are 2 variants of automatic operation: automatic operation at the start of a journey and automatic operation during a journey.

Automatic operation at the start of a journey is initiated if the ambient air temperature is below 41 °F (5 °C) at the start of a journey. In this instance, the ATC module will automatically power the windshield heater elements and illuminate the switch LED for 6.5 minutes. The windshield heater can be switched off during this period by pressing the control switch or stopping the engine.

Automatic operation during a journey is initiated when low ambient air temperatures are experienced and the vehicle has been traveling for a set period of time above a threshold speed. In this instance, no feedback is given to the driver to inform him the windshield heater is operational (the switch LED is not illuminated) and the duration of operation is variable depending upon the ambient air temperature, vehicle speed and the amount of time the vehicle has been traveling.

Rear Window Heater

The ATC module controls operation of the rear window heater using a relay in the auxiliary junction box. When a request is made for rear window heater operation, the ATC module broadcasts a message to the auxiliary junction box on the medium speed CAN bus. On receipt of this message, the auxiliary junction box energizes the relay by providing a ground path for the relay coil. This allows a battery feed to flow across the relay to power the rear window heater element.

NOTE: Rear window heater operation is only enabled when the engine is running.

There are 2 modes of rear window heater operation: manual and automatic.

Manual
Manual operation is activated by pressing the rear window heater control switch. When the switch is pressed, the ATC module illuminates a LED in the switch and powers the heater element for 21 minutes.

The switch LED remains illuminated until the rear window heater switch is pressed a second time (to switch the system off), the heating phase is completed, or the engine stops. If the engine is restarted within 30 seconds the rear window heater resumes the previous heating phase.

Automatic
There are 2 variants of automatic operation: automatic operation at the start of a journey and automatic operation during a journey.

Automatic operation at the start of a journey is initiated if the ambient air temperature is below 41 °F (5 °C) at the start of a journey. In this instance, the ATC module will automatically power the rear window heater element and illuminate the switch LED for 21 minutes. The rear window heater can be switched off during this period by pressing the control switch or stopping the engine.

Automatic operation during a journey is initiated when low ambient air temperatures are experienced and the vehicle has been traveling for a set period of time above a threshold speed. In this instance, no feedback is given to the driver to inform him the rear window heater is operational (the switch LED is not illuminated) and the duration of operation is variable depending upon the ambient air temperature, vehicle speed and the amount of time the vehicle has been traveling.

Exterior Mirror Heaters

Exterior mirror heater operation is determined by ambient air temperature and windshield wiper status. When ambient air temperature reaches a predetermined level, the ATC module broadcasts an exterior mirror heating request to the door modules over the medium speed CAN bus. On receipt of this message, the door modules provide feed and ground connections to both exterior mirror heater elements.

NOTE: Operation of the exterior mirror heaters is fully automatic and not controllable by the driver.

The amount of time the exterior mirror heaters are operational increases if the windshield wipers are switched on. This ensures the mirrors remain mist free in damp and wet conditions, where there is an increased risk of misting.

Seat Heaters

There are 4 seat heater settings available: Off, 1, 2, or 3, which can be set through the TSD. The heat setting is relayed to the vehicle occupants through a graduated display on the TSD.

Operation of the heated seats is controlled by the ATC module. When the ATC module receives a heating request from the TSD, it broadcasts a message to the CJB over the medium speed CAN bus. The CJB then provides a hardwired 12V supply to the 3 heater elements contained within each seat. The 3 heater elements, 2 in the seat cushion and 1 in the seat squab, are wired in series.

The ATC module monitors seat temperature using a temperature sensor located in each seat cushion. The CJB provides the temperature sensors with a 5V supply. The level of the returned voltage back to the CJB is proportional to the seat temperature. The value of the return signal is broadcast to the ATC module over the medium speed CAN bus which it then converts into a temperature value to allow it to control seat temperature to the required level.

The ATC module will suspend or disable operation of the seat heaters if any of the following occur:

- Battery voltage exceeds 16.5 ± 0.3V for more than 5 seconds; Seat heating is re-enabled when battery voltage decreases to 16.2 ± 0.3V
- If a short or open circuit is detected
- If the seat heat temperature rises significantly above the target temperature setting.

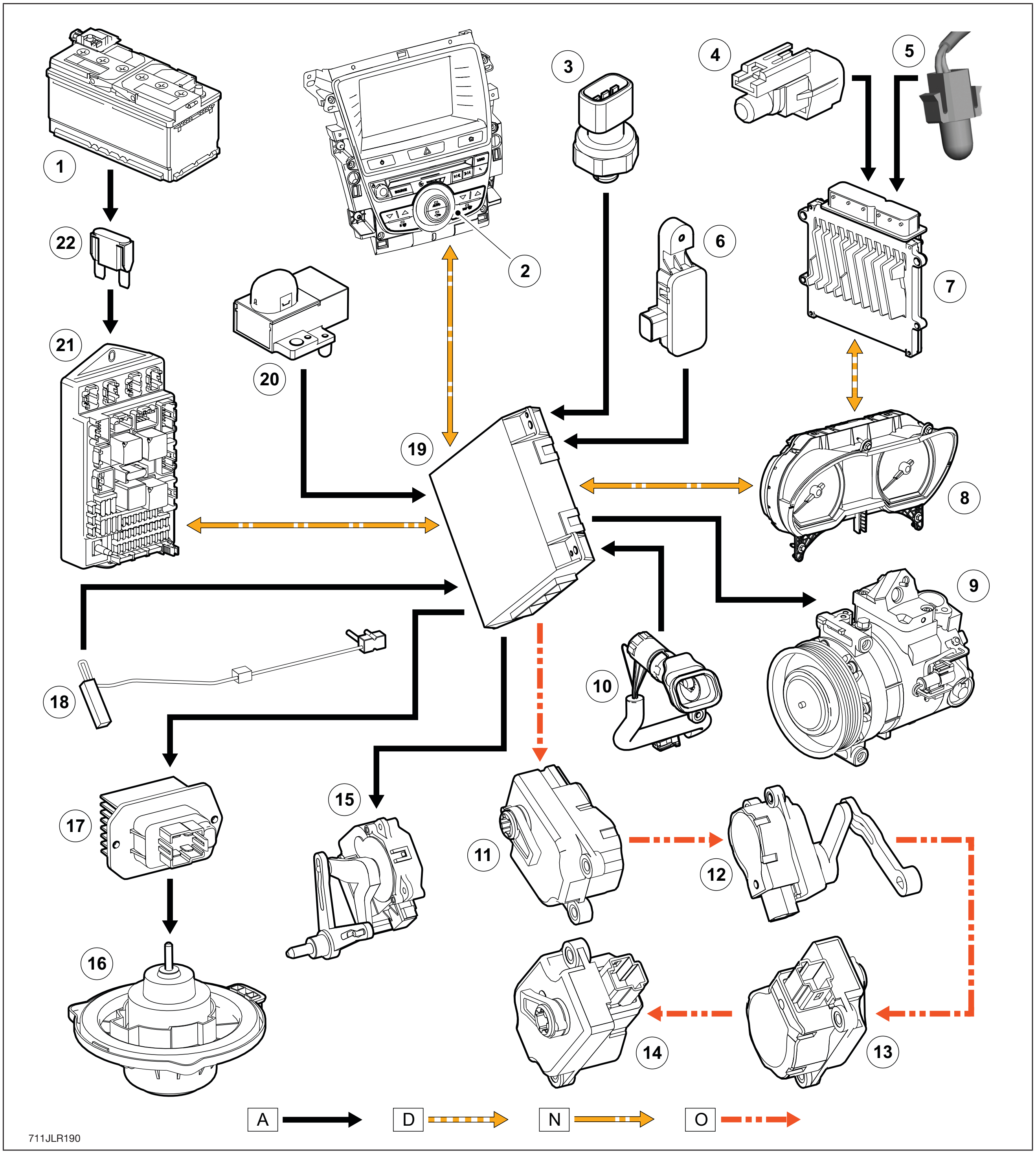
The graduated display on the TSD remains illuminated until the seat heaters are turned off or the engine stops. If the engine is restarted within 30 seconds the seat heater resumes the previous heating level.

Steering Wheel Heater

The steering wheel heater has 1 heat setting and can be turned on and off by pressing the soft key located on the seat heater TSD screen. The on/off status of the steering wheel heater is relayed to the vehicle occupants through the TSD. When the ignition is switched off, the heater will reset to off.

Power for the heater element is supplied by the CJB on receipt of a request from the ATC module over the medium speed CAN bus. Temperature control for the heater element is provided by the steering wheel heater control module which receives a temperature feedback signal from a NTC thermistor located within the steering wheel.

Control Diagram



A Hardwired
D HS CAN bus
N MS CAN bus
O LIN bus
1 Battery
2 Control switches
3 Refrigerant pressure sensor
4 Ambient temp. sensor – through 2009 MY
5 Ambient temp. sensor – 2010 MY Onward
6 Pollution sensor
7 ECM
8 Instrument cluster
9 A/C compressor solenoid
10 Cabin humidity and temperature sensor
11 Windshield distribution stepper motor
12 RH temperature blend stepper motor
13 LH temperature blend stepper motor
14 Face/feet distribution stepper motor
15 Air intake servo motor
16 Blower motor
17 Blower motor controller
18 Evaporator temperature sensor
19 ATC module
20 Sunload/Light sensor
21 CJB
22 Megafuse (175A)

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Technical Training
Climate Control Systems

711-JAG: Jaguar Climate Control Systems

X250 Climate Control Systems

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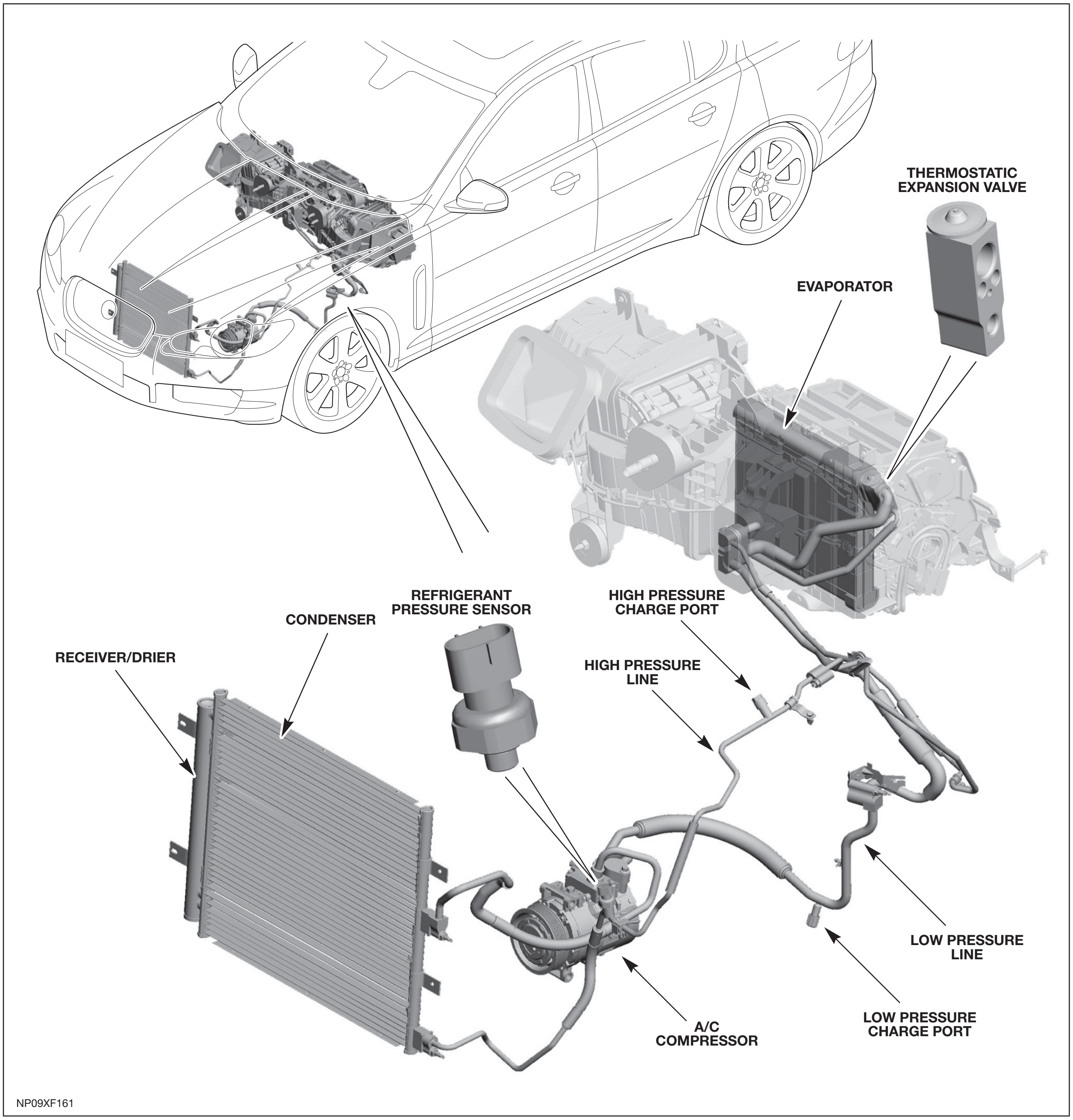
REFRIGERATION SYSTEM

Overview

The A/C system transfers heat from the vehicle interior to the outside atmosphere to provide the cabin with dehumidified cool air. The A/C system is a sealed, closed loop system, filled with a charge weight of R134a refrigerant as the heat transfer medium. Oil is added to the refrigerant to lubricate the internal components of the A/C compressor.

Component Location (RHD Shown; LHD Similar)



Component Description

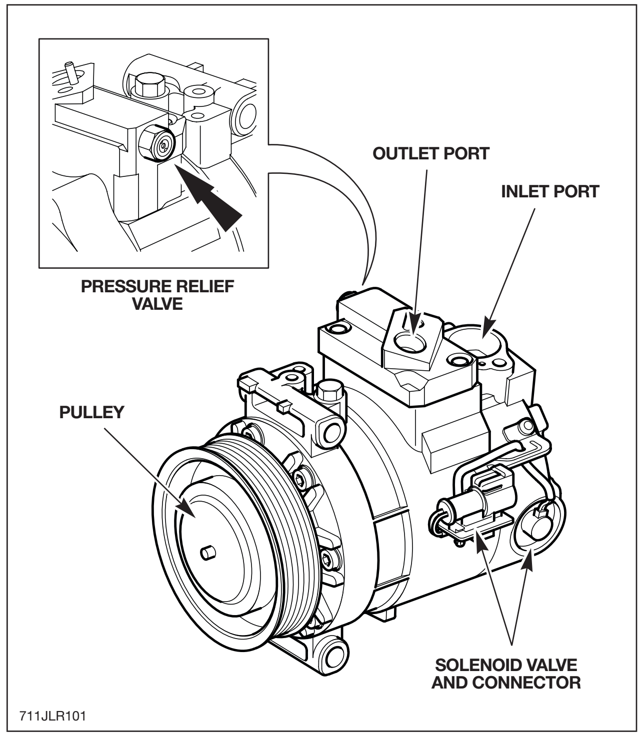
Compressor

The A/C compressor circulates refrigerant around the system by compressing low pressure, low temperature vapor from the evaporator and discharging the resultant high pressure, high temperature vapor to the condenser.

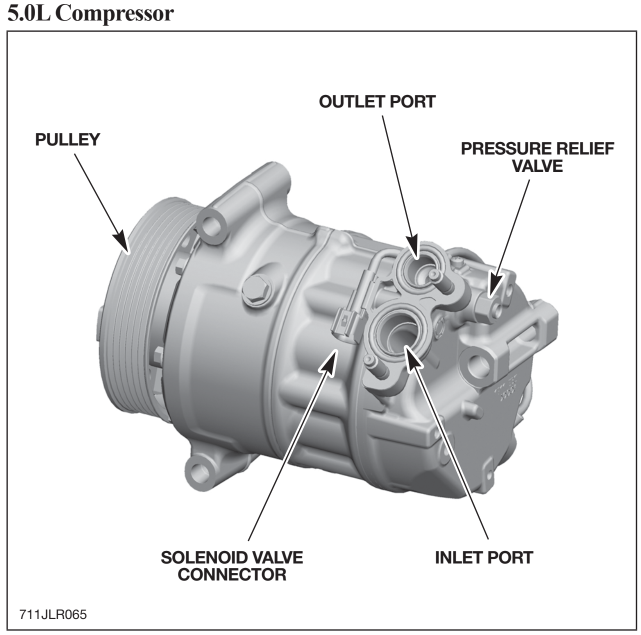
Both A/C compressors are clutchless variable displacement units with a swash plate design. The A/C compressor is permanently engaged, driven by the engine accessory drive belt. To protect the system from excessive pressure, a pressure relief valve is installed in the outlet side of the compressor. The pressure relief valve vents excess pressure into the engine compartment.

NOTE: For detailed compressor control operation refer to ATC module principles of operation in the Control System section.

4.2L Compressor

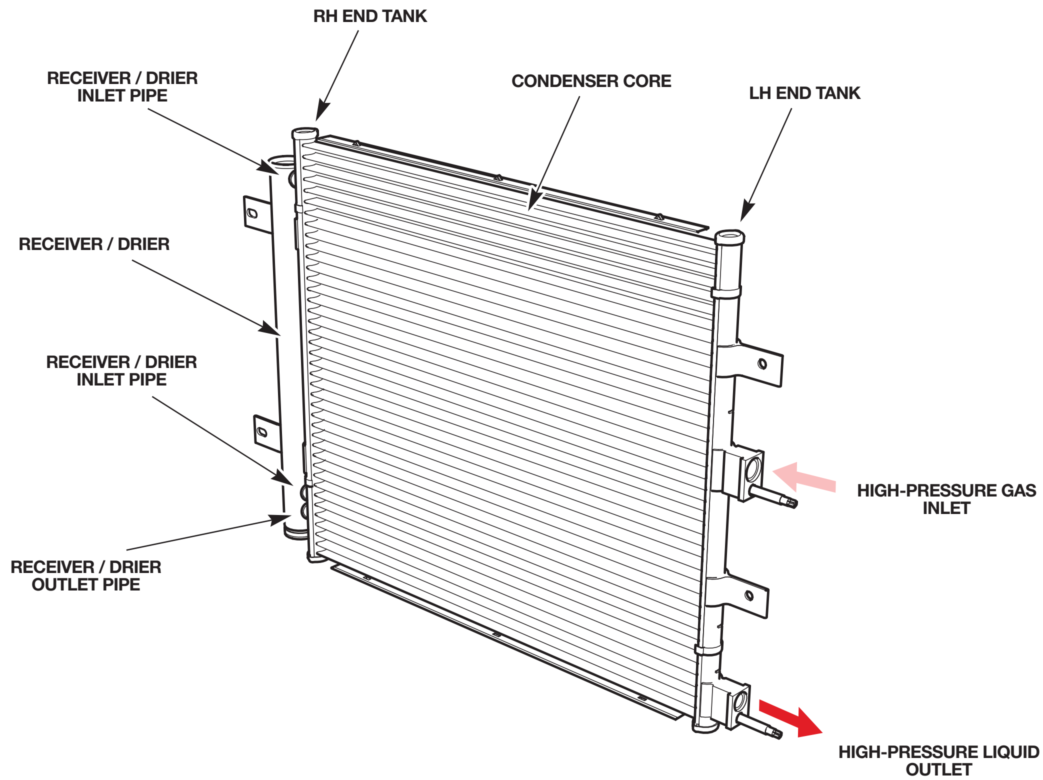


5.0L Compressor



Condenser

The condenser transfers heat from the refrigerant to the surrounding air to convert the high pressure vapor from the compressor into a liquid. The condenser is installed immediately in front of the radiator.



The condenser is classified as a sub-cooling condenser and consists of a fin and tube heat exchanger core installed between 2 end tanks. Divisions in the end tanks separate the heat exchanger into a 4-pass upper (condenser) section and a 2-pass lower (sub-cooler) section.

The LH end tank provides the connections to the high pressure line from the A/C compressor and the low pressure line to the evaporator. The RH end tank provides the connections to the receiver/drier.

Receiver/Drier

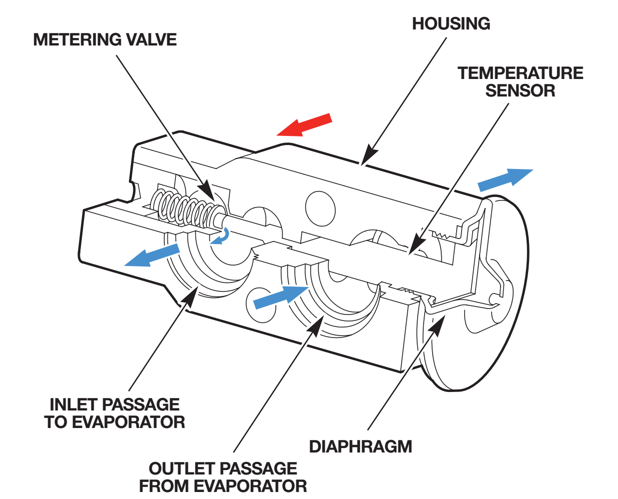
The receiver/drier is mounted on the condenser RH end tank and removes solid impurities and moisture from the refrigerant. It also provides a reservoir for liquid refrigerant to accommodate changes of heat load at the evaporator.

Refrigerant entering the receiver/drier passes through a filter and a desiccant pack, then collects in the base of the unit before flowing through the outlet pipe back to the condenser. The desiccant pack is serviceable separately from the condenser. Desiccant packs contain an ultraviolet (UV) dye pellet to assist in leak detection.

Thermostatic Expansion Valve

The thermostatic expansion valve meters the flow of refrigerant into the evaporator, to match the refrigerant flow with the heat load of the air passing through the evaporator.

The thermostatic expansion valve is a block type valve located behind the HVAC assembly, and attached to the inlet and outlet ports of the evaporator. The valve consists of an aluminum housing containing inlet and outlet passages.



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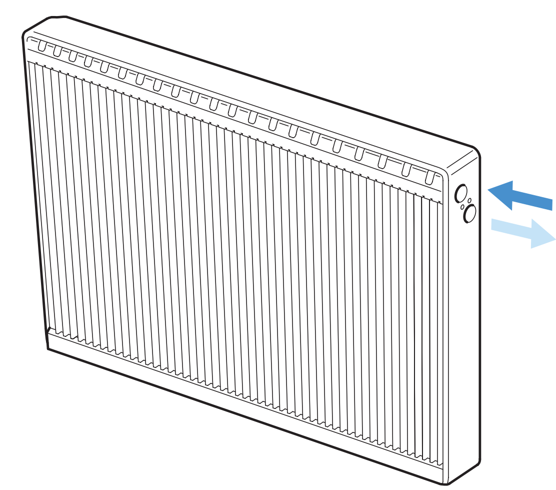
Evaporator

The evaporator is installed in the HVAC assembly, between the blower and the heater matrix, to absorb heat from the exterior or recirculated air. Low pressure, low temperature refrigerant changes from liquid to vapor in the evaporator, absorbing large quantities of heat as it changes state.



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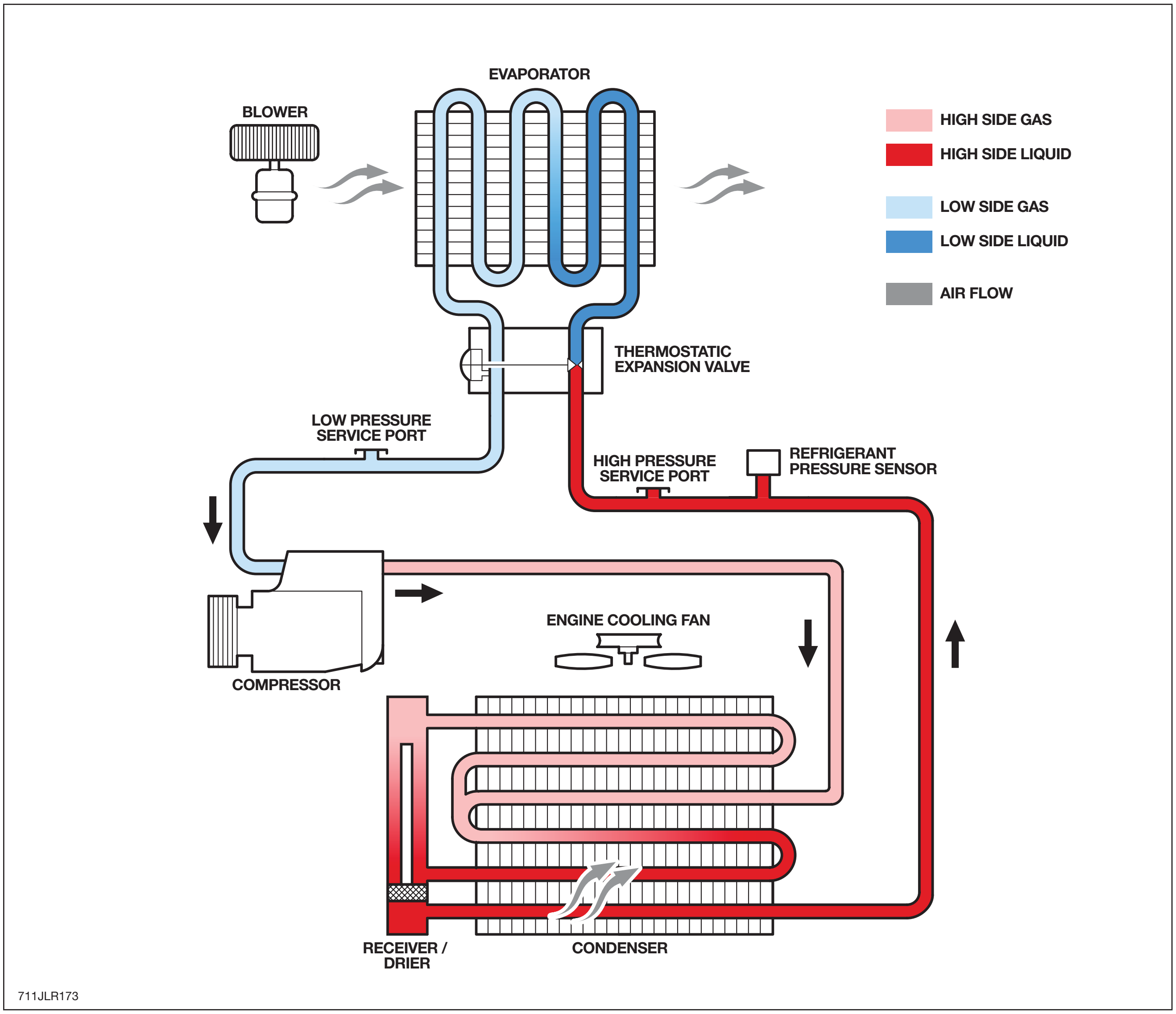
Most of the moisture in the air passing through the evaporator condenses into water, which drains out of the vehicle by passing through a drain tube to the underside of the vehicle.

Refrigerant Lines

To maintain similar flow velocities around the A/C system, the diameter of the refrigerant lines varies to suit the 2 pressure/temperature zones. Larger diameter pipes are installed in the low pressure/temperature zone; smaller diameter pipes are installed in the high pressure/temperature zone .

Low and high pressure charging connections are incorporated into the refrigerant lines for system servicing.

Refrigeration System Schematic



HEATING AND VENTILATION SYSTEM

Overview

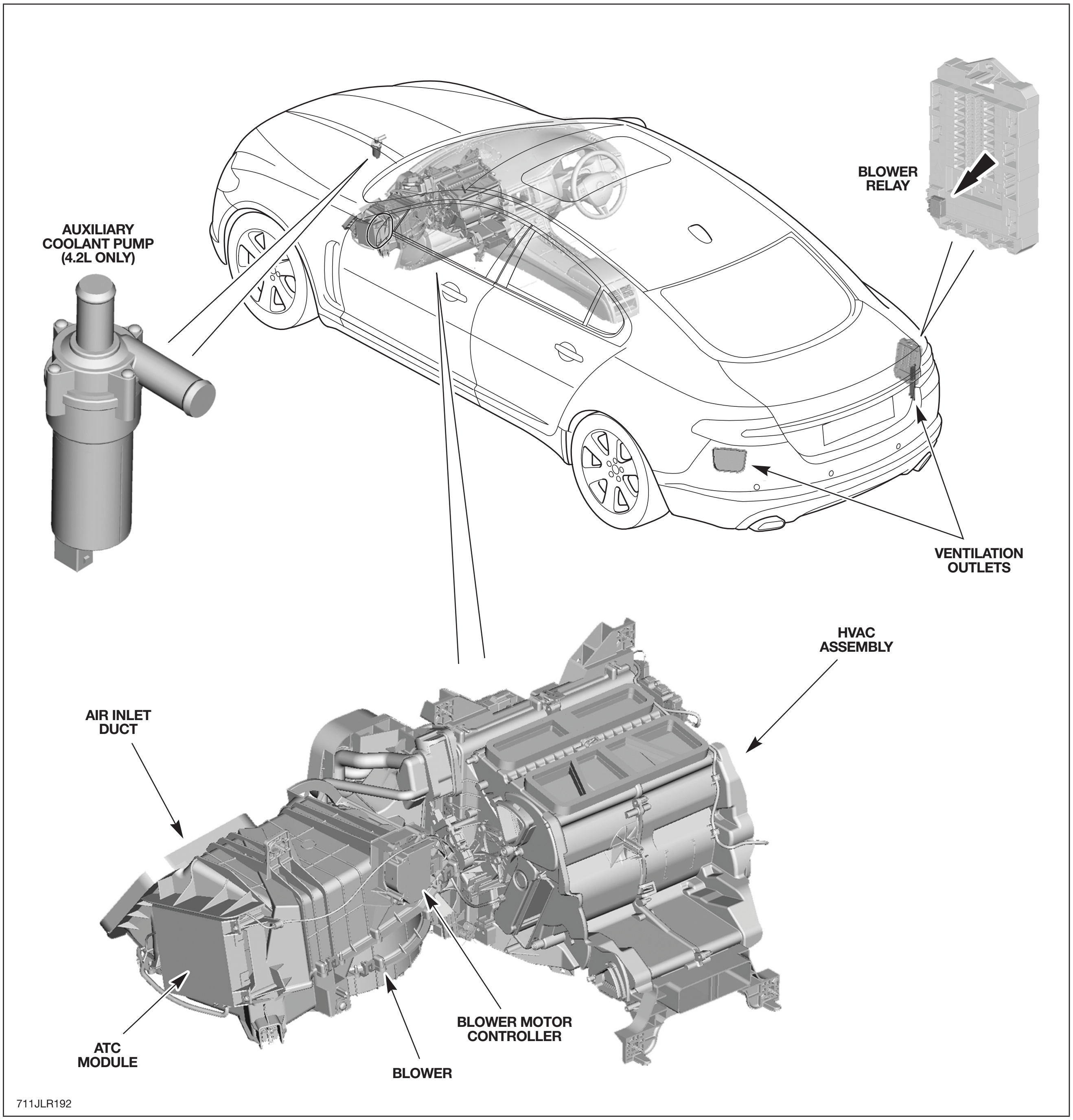
The heating and ventilation system controls the temperature and flow of air supplied to the vehicle interior. The system is dual zone, and can provide different temperature settings for the LH and RH side of the cabin. The system can be operated in 'Automatic' or 'Manual' mode, with temperature settings being selected using the control switches located below the TSD.

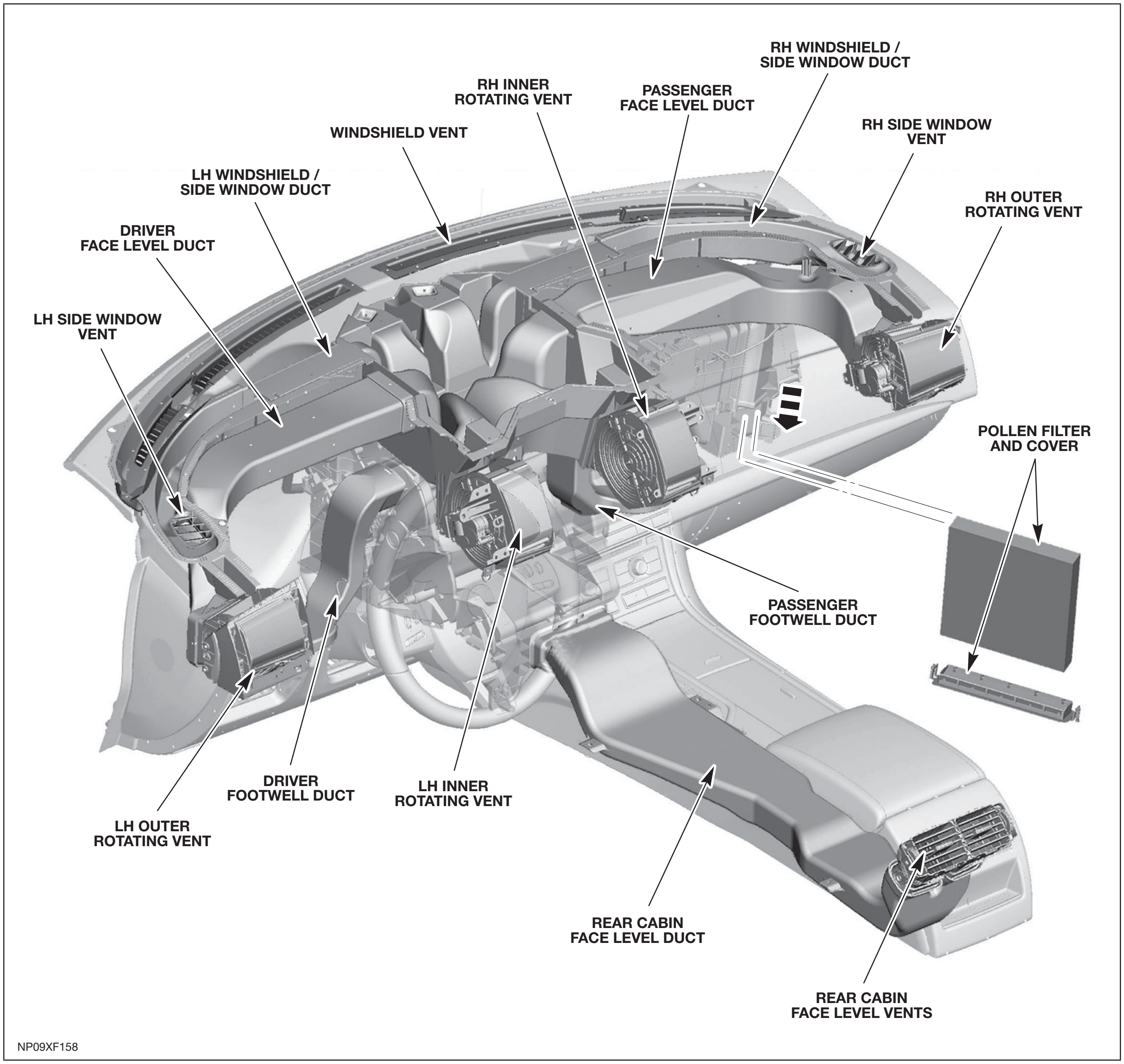
The system comprises:

- An air inlet duct
- A blower motor
- A blower motor controller
- A blower relay
- An HVAC assembly
- Air ducts and vents
- Two ventilation outlets

Fresh or recirculated air flows into the HVAC assembly from the inlet duct. The blower, and 'ram' effect when the vehicle is moving, forces the air through the HVAC assembly. Air from the cabin exhausts through the ventilation outlets located in the rear of the vehicle.

Components (RHD Shown; LHD Similar)





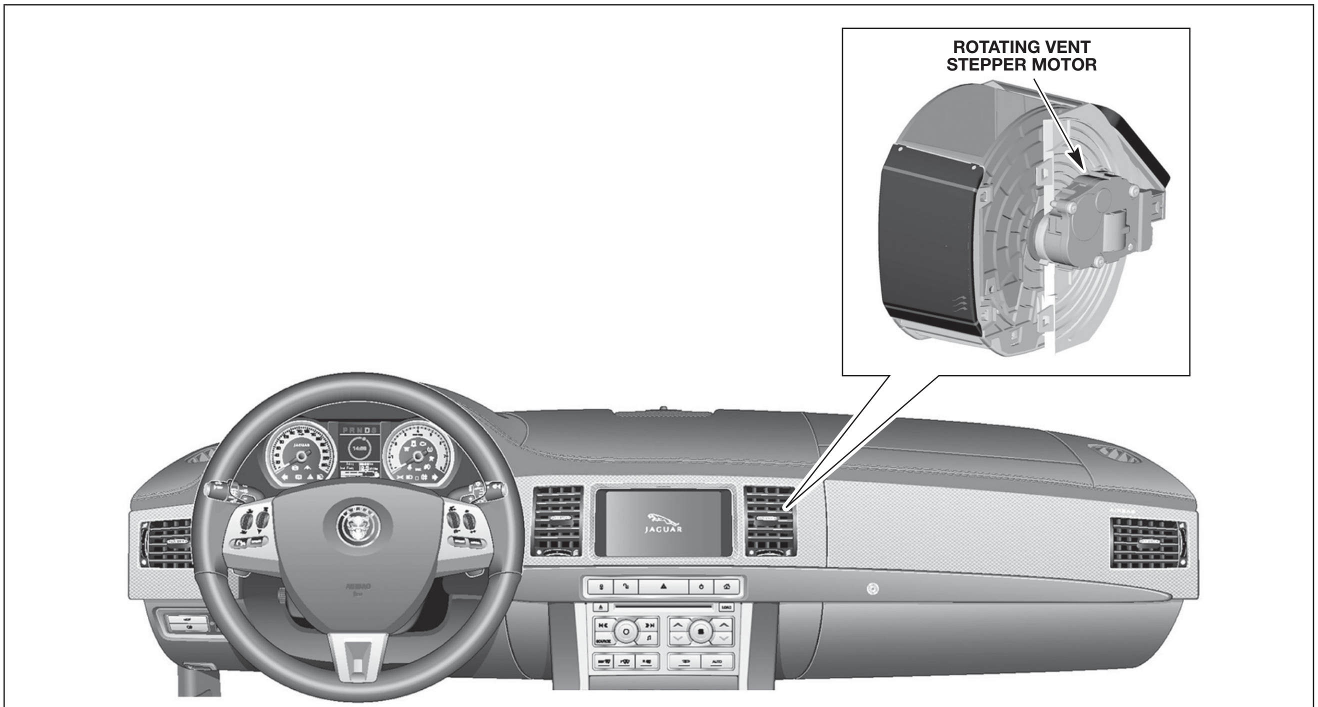
The XF has 4 instrument-panel mounted rotating vents: 2 in the center of the instrument panel, one on either side of the touch screen, and one rotating vent at each outboard end of the instrument panel. Each of the four rotating vents is a unique component, handed, and differing slightly in shape between center and outboard. The rear passenger area retains two conventional vents, in the center console.

A pollen charcoal filter removes odors and fine particles from the air entering the HVAC assembly. The filter is located in the air intake duct, in the inlet to the blower. A door on the underside of the air intake duct provides access to the filter for servicing.

NOTE: For clarity, rear floor vents and ductwork are not shown.

Rotating Vents

Each rotating vent is controlled by its own integral stepper motor linked through the Local Interconnect Network (LIN) Bus to the ATC module via the main heating and ventilation air distribution stepper motor controls. The 4 rotating vent stepper motors are synchronized to open and close together.



The rotating vents can be set to run in one of 2 modes: 'automatic' or 'always open'. This feature can be set using the climate control settings menu in the touchscreen display.

When the system is in automatic mode and the vehicle ignition is on, the ATC module opens the rotating vents. It does this by transmitting a LIN bus signal to each rotating vent stepper motor. If the ignition is in Convenience mode or the ignition is off the ATC module transmits a LIN bus signal to the stepper motors to close the rotating vents.

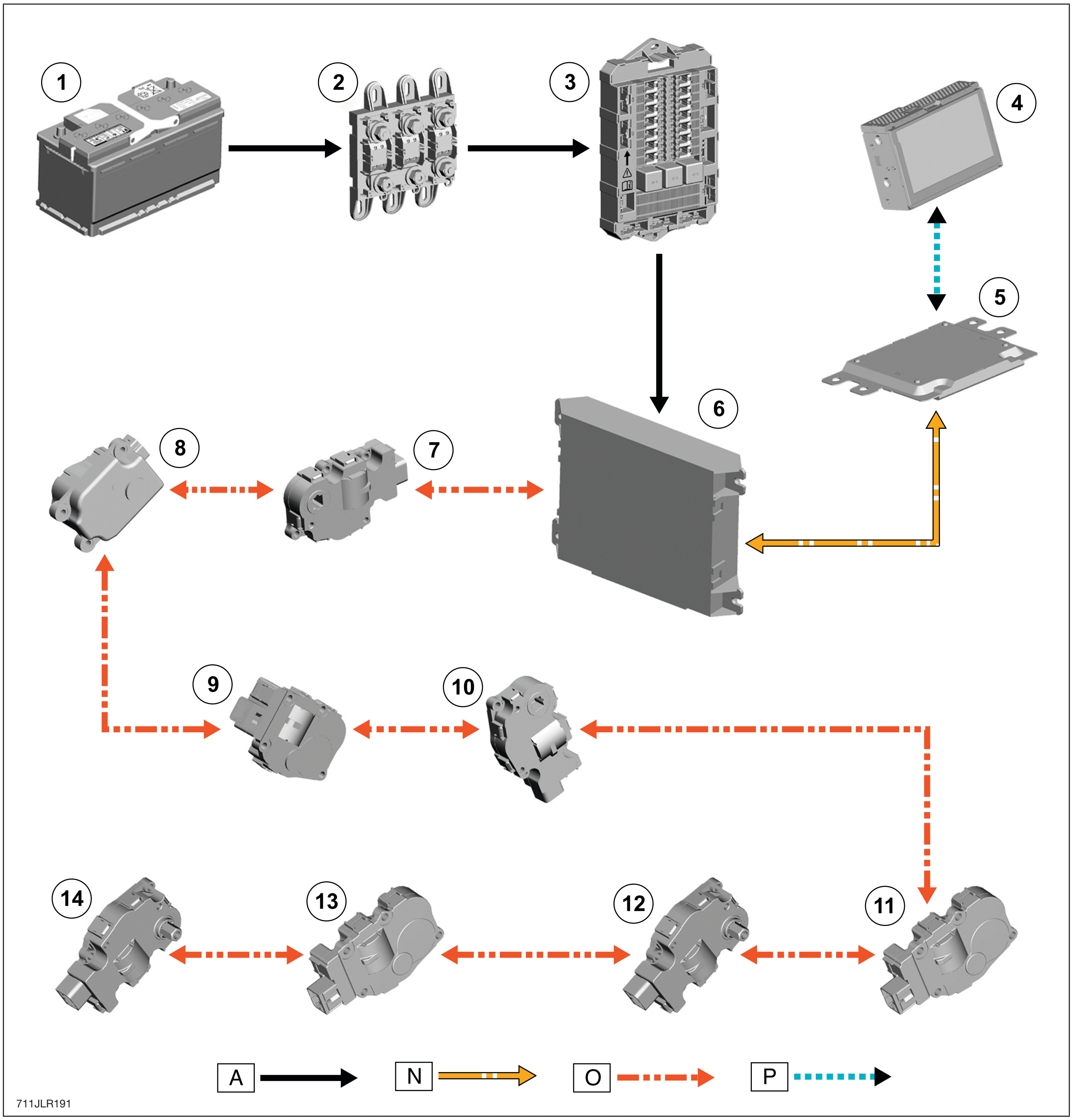
If at any point the climate control system is turned off when the system is in automatic mode, the ATC module will close the rotating vents. If a face level register is fouled, when it receives an open or close request, the register concerned makes a number of attempts to reach the requested position. If the register still does not move, it is left in the fouled position and a DTC will be set. The remaining registers will continue to open and close as normal.

Diagnostics

If a fault occurs with the rotating vents a DTC will be stored in the ATC module. These can be read using the Jaguar approved diagnostic system. On-demand self-test routines can be initiated to check operation of the rotating vents.

If a rotating vent assembly is replaced, the new unit is supplied preprogrammed. The setup procedure will require the clearing of any previously stored DTCs and initiating a vent self-test routine to check the new vent functions correctly.

Vent Control Diagram



A	Hardwired	3	CJB	9	LH temperature blend stepper motor
D	HS CAN bus	4	Touch-screen display	10	RH temperature blend stepper motor
N	MS CAN bus	5	Information control module	11	RH outer face level register
O	LIN bus	6	ATC module	12	RH inner face level register
1	Battery	7	Windshield distribution stepper motor	13	LH inner face level register
2	BJB	8	Face/feet distribution stepper motor	14	LH outer face level register

Component Description

Air Inlet Duct

The air inlet duct connects the fresh air inlet in the engine bulkhead to the HVAC assembly. The air inlet duct is installed behind the instrument panel on the passenger side.

The air inlet duct consists of a casing that contains a pollen filter, an air inlet door, a blower and a blower motor controller. A recirculation air inlet is incorporated into the casing. A servo motor is mounted on the casing and connected to the air inlet door, to allow selection between fresh and recirculated air.

Blower

The blower regulates the volume of air flowing through the air inlet duct to the HVAC assembly. The blower consists of an open hub, centrifugal fan and an electric motor.

The blower motor controller regulates the power supply to the blower motor. The blower motor controller is installed in the air inlet duct downstream of the blower, where any heat generated during operation is dissipated by the air flow.

HVAC Assembly

The HVAC assembly controls the temperature and flow of air supplied to the air distribution ducts. The HVAC assembly is mounted on the vehicle centerline, between the instrument panel and the engine bulkhead.

Four stepper motors are mounted on the heater casing. Each of the stepper motors is connected to either an air distribution control door or a temperature blend control door.

The heater core provides the heat source to warm the air supplied to the passenger compartment. The heater core is an aluminum two pass, fin and tube heat exchanger, and is installed across the width of the heater housing. Two aluminum tubes attached to the heater core extend through the engine bulkhead and connect to the engine cooling system.

Ventilation Outlets

The ventilation outlets allow the free flow of air through the passenger compartment. The outlets are installed in the LH and RH rear quarter panels, below the tail lights.

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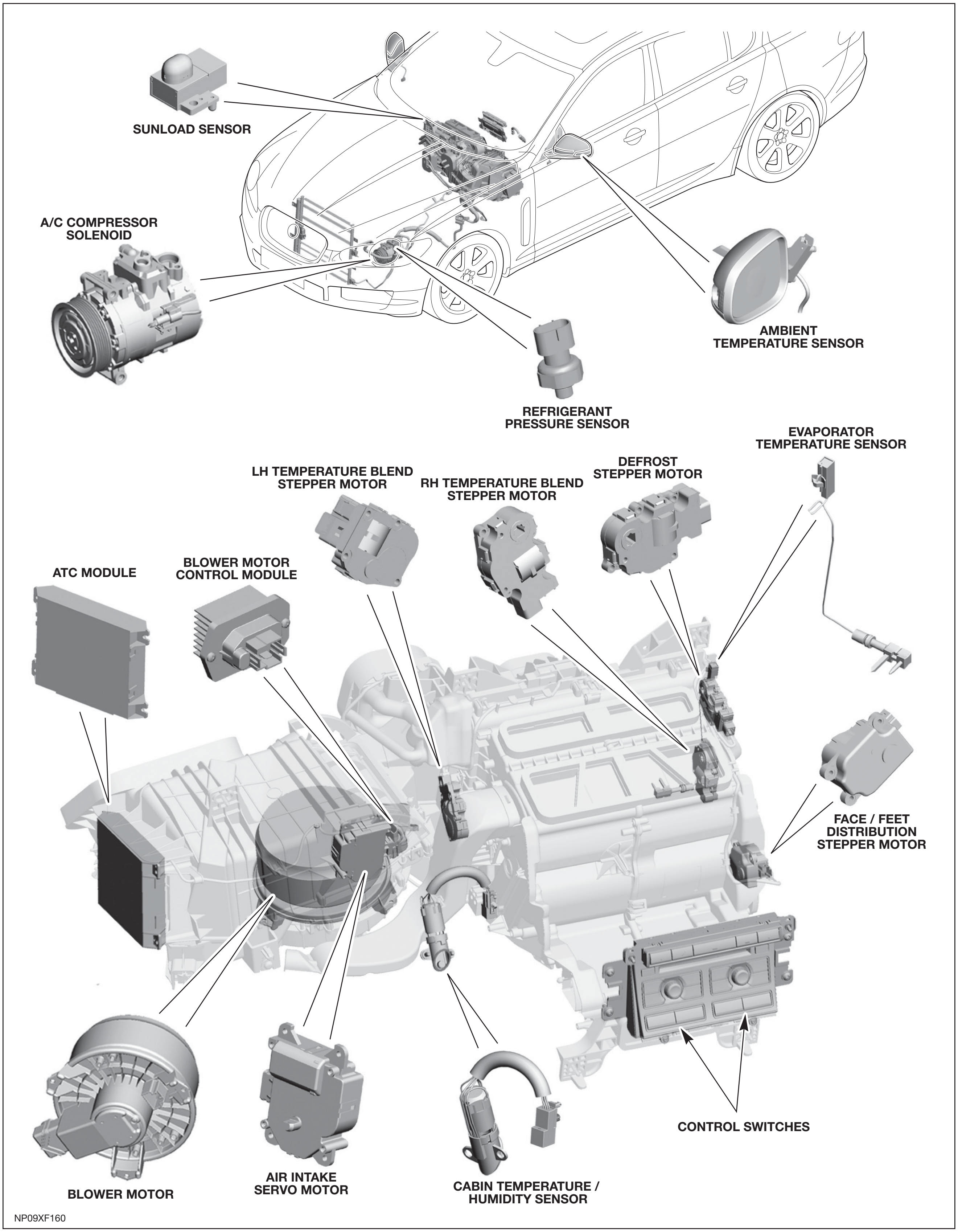
Each ventilation outlet consists of a grille covered by a soft rubber flap, and is effectively a non-return valve. The flaps open and close automatically depending on the pressure differential between the air inside and outside the vehicle.

CONTROL SYSTEM

Overview

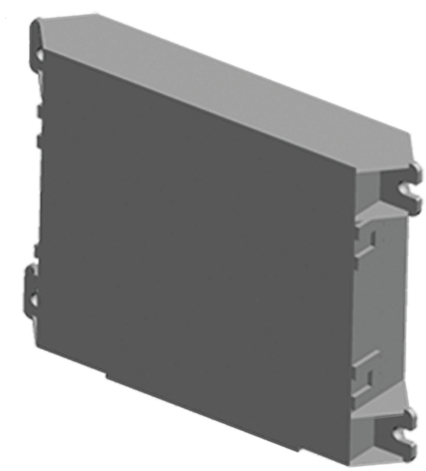
The Automatic Temperature Control (ATC) module controls the A/C system and the heating and ventilation system to regulate the temperature, volume, and distribution of air into the cabin. The fully automatic dual-zone system is capable of maintaining individual temperature levels selected for the LH and RH sides of the cabin.

Components (RHD Shown; LHD Similar)



Component Description

Automatic Temperature Control Module



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The Automatic Temperature Control (ATC) module is mounted on the end of the blower motor casing, behind the instrument panel. The ATC module processes inputs from the TSD, the control switches located below the TSD, and the system sensors. In response to these inputs, the ATC module outputs the appropriate signals to control the following:

- A/C system
- Heating and ventilation
- Seat heaters
- Rear window heater
- Windshield heater (when equipped)
- Exterior mirror heaters
- Steering wheel heater

The ATC module uses hardwired inputs from the system sensors, LIN bus communication with the stepper motors, and the medium speed CAN bus to communicate with other control modules on the vehicle.

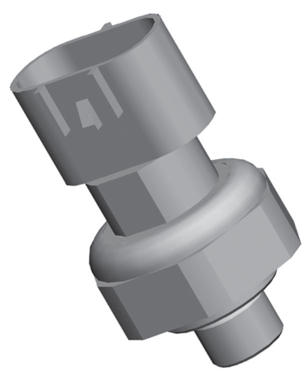
Air Conditioning Compressor Solenoid Valve

The A/C compressor solenoid valve is integral with the A/C compressor. Operation of the solenoid valve is controlled by the ATC module via PWM signal. By controlling the flow of refrigerant through the compressor, the solenoid valve can control the A/C system pressure and the evaporator operating temperature.

The ATC module broadcasts a CAN compressor drive current message to the ECM, which uses the signal to calculate compressor torque load.

Refrigerant Pressure Sensor

The refrigerant pressure sensor provides the ATC module with a pressure input from the high pressure side of the refrigerant system. The sensor is located in the refrigerant line between the condenser and the thermostatic expansion valve.



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The ATC module supplies a 5V reference voltage to the refrigerant pressure sensor and receives a return signal voltage, between 0V and 5V, related to system pressure.

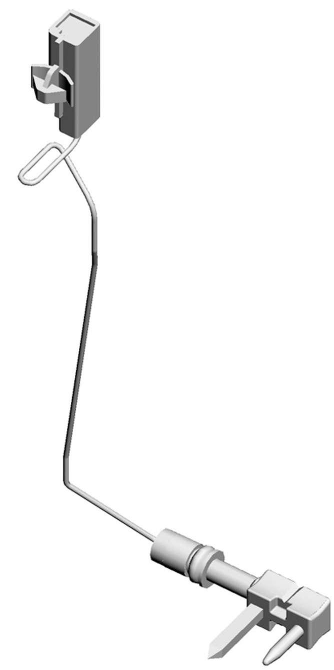
The ATC module uses the signal from the pressure sensor to protect the refrigerant system from extremes of pressure. The ATC module also transmits an A/C pressure CAN signal to the ECM. The ECM uses the signal to determine cooling fan operation.

To protect the system from extremes of pressure, the ATC module sets the A/C compressor to the minimum flow position if the pressure:

- Decreases to 2.1 ± 0.2 bar (31.5 ± 3 psi); the ATC module loads the A/C compressor again when the pressure increases to 2.3 ± 0.2 bar (33.4 ± 3 psi)
- Increases to 31 ± 1 bar (450 ± 14.5 psi); the ATC module loads the A/C compressor again when the pressure decreases to 26 ± 1 bar (377 ± 14.5 psi)

Evaporator Temperature Sensor

The evaporator temperature sensor is a negative temperature coefficient (NTC) thermistor that provides the ATC module with a temperature signal from the downstream side of the evaporator. The evaporator temperature sensor is mounted directly onto the evaporator matrix fins.



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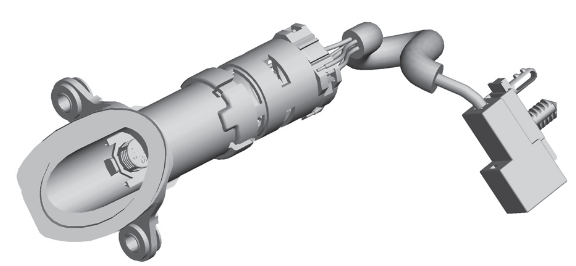
The ATC module uses the input from the evaporator temperature sensor to regulate compressor solenoid drive and thus the operating temperature of the evaporator.

Cabin Temperature and Humidity Sensor

The cabin humidity and temperature sensor is installed behind a grill on the driver's side of the instrument panel. The temperature inside the cabin is measured by an NTC thermistor. A motor within the sensor assembly draws cabin air in through the grill and over the thermistor. The motor is provided a battery voltage feed by a relay located within the Central Junction Box (CJB).



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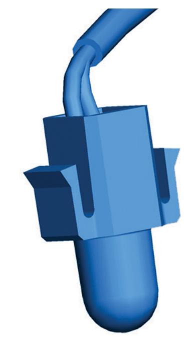
Humidity inside the cabin is measured by a sensor element made up of film capacitors on different substrates. The dielectric is a polymer which absorbs or releases water proportional to the relative humidity of the air being drawn through the sensor and thus changes the capacitance of the capacitor. For protection, the sensor element is contained in a nylon mesh cover.

Humidity within the cabin is controlled by raising and lowering the evaporator temperature. An increase in evaporator temperature increases the moisture content in the air entering the cabin. Lowering the evaporator temperature reduces the moisture content in the air entering the cabin.

Ambient Air Temperature Sensor

The ambient air temperature sensor is a NTC thermistor that provides the ATC module with an input of external air temperature. The sensor is hardwired to the ECM and its signal is transmitted to the instrument cluster on the high speed CAN bus. The instrument cluster acts as a gateway and transmits the ambient air temperature signal to the ATC module on the medium speed CAN bus.



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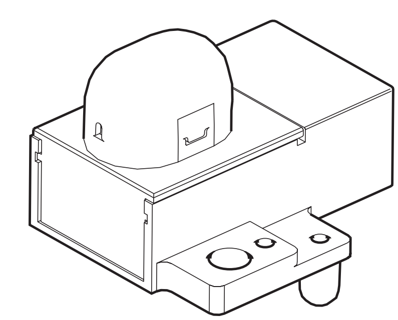
The sensor is mounted in the driver side mirror.

Sunload Sensor

The sunload/light sensor consists of 2 photoelectric cells that provide the ATC module with inputs of light intensity; one as sensed coming from the left of the vehicle and one as sensed coming from the right. The inputs are a measure of the solar heating effect on vehicle occupants, and are used by the ATC module to adjust blower speed, temperature and distribution to improve comfort.



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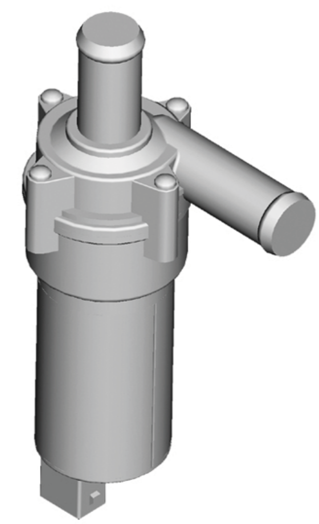
The solar sensor is also used as part of the Autolamp feature and also contains the active anti-theft alarm indicator LED.

The sensor is installed in the center of the instrument panel upper surface and is powered by a 5V feed from the instrument cluster.

Heater Coolant Pump

A heater coolant pump is mounted on the RH rear face of the radiator housing. The pump is electrically driven and provides the necessary flow rate of engine coolant to the heater core. Operation of the pump is controlled by the CJB on receipt of medium speed CAN bus signals from the ATC module.



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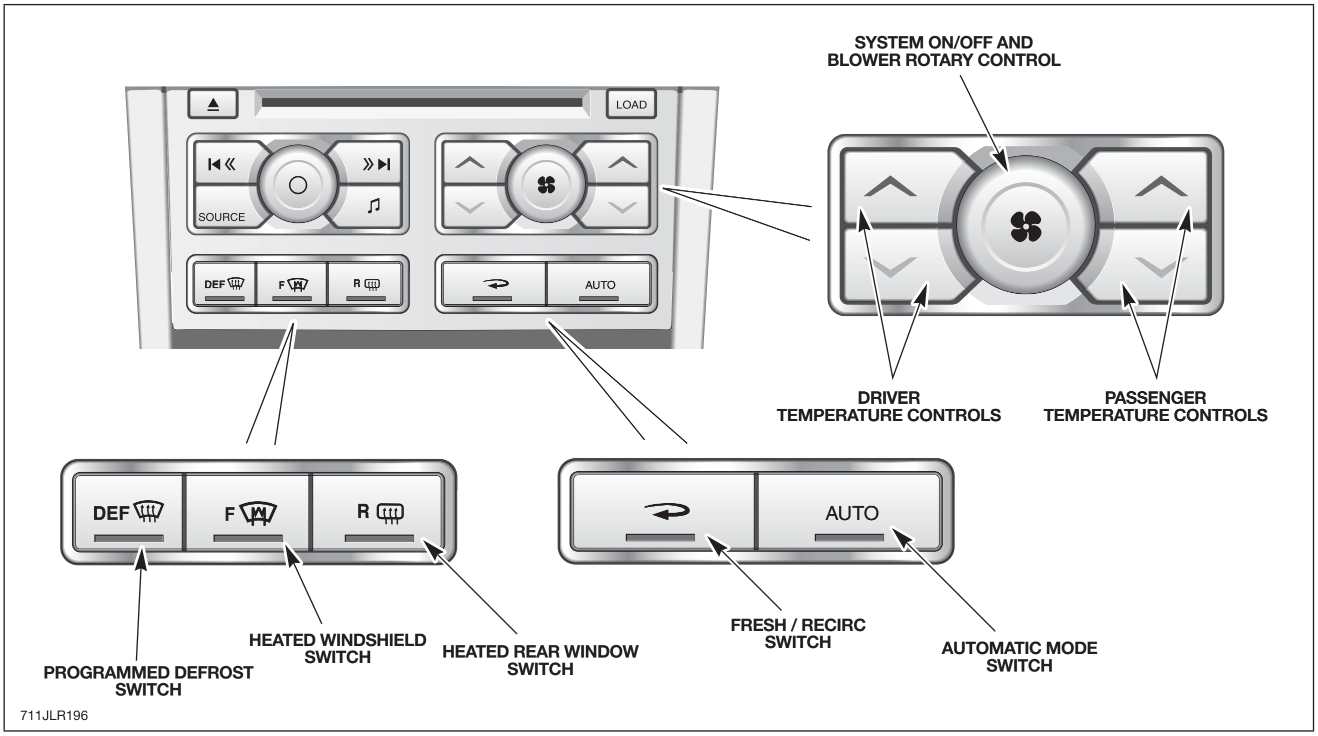
The pump will run when the engine is running and operates at a single speed. The CJB broadcasts pump status over the medium speed CAN bus for use by other vehicle systems.

NOTE: The heater coolant pump is not used on 5.0L variants.

Climate Control Panel

The climate control functions are selected using the push buttons and the rotary control knob in the centrally-mounted climate control panel. Most buttons have an illuminated LED; the illumination level is adjusted using the dimmer control switch. System status, including interior and exterior temperatures, is displayed in the TSD.



AUTO mode is the default operating mode, but may be overridden at any time. Manual selections can be made for:

- Defrost/demist
- Blower speed
- Air recirculation
- Air conditioning
- Windshield and rear window heating

System ON/OFF

With the ignition system ON, press the AUTO select switch on the switch panel. The system will switch on in AUTO mode. The system can be toggled ON/OFF using the 'OFF' soft key in the TSD 'Climate' menu. The system can also be toggled ON/OFF by pressing the blower rotary control switch.

NOTE: Before making adjustments after system ON, it is advisable to allow the system to acclimate, particularly at the start of a drive cycle.

AUTO Mode

AUTO operation provides a controlled climate over a temperature range of 59 – 83 °F (16 – 28 °C), and should be regarded as the normal operating mode.

The system is in AUTO mode when the system is switched on. The temperature settings, windshield/rear window heating and timed air recirculation can be selected within the parameters of 'AUTO mode'. Any other control selections will cancel AUTO mode. AUTO mode can be reselected at any time by pressing the AUTO switch.

NOTE: When heating is required in AUTO mode, the blower will operate only in low speed when the engine is cold; faster speeds are achieved once the engine warms up.

Temperature Selection

Separate controls allow the driver and passenger zone temperatures to be adjusted independently. Press the red buttons to increase temperature; press the blue buttons to decrease temperature. Both driver and passenger temperatures are displayed in the touch-screen.

Pressing the driver's select buttons to the minimum or maximum temperature settings causes the display to change to HI or LO and cancels AUTO mode. To return quickly to a mid-range temperature (72 °F/ 22 °C), press and hold the AUTO switch for a few seconds.

Air Recirculation

To select timed air recirculation, press and release the recirculation switch in the center of the rotary control knob. The LED will illuminate and remain lit until recirculation times out. For 'latched' (continuous) air recirculation: press and hold the recirculation switch; the LED will flash 3 times then remain illuminated. Air recirculation will remain active until deselected. Deselect air recirculation by pressing the switch again.

NOTE: Prolonged operation of air recirculation in cold, damp conditions may result in interior fogging of the windows.

Windshield Defrost/Demist

To remove frost or heavy misting from the windshield, press the DEF button. The defrost-level blower will switch on at high speed and AUTO mode will be cancelled. The blower speed can be adjusted manually.

When defrost is selected:

- Air recirculation is canceled and cannot be selected
- Air conditioning is switched on automatically (to dehumidify the air) and cannot be deselected
- The windshield mirror and rear window heaters are switched on automatically

Deselect defrost by pressing the DEF button again, or press the AUTO switch.

Windshield and Rear Window Heaters

The windshield and rear window heaters can be switched on in any mode, but will only operate when the engine is running.

To select the windshield heater, press the F button. The windshield heater will switch off automatically after 6 minutes. To select the rear window heater, press the R button. The rear window heater will switch off automatically after 21 minutes.

The heater(s) can be deselected manually at any time by pressing the button(s) again. In cold ambient conditions, when temperatures are below 41 °F (5 °C), the windshield and rear window heaters will switch on automatically at the start of the drive cycle, and will remain on for the timed period.

Air Conditioning

Air conditioning operates automatically in AUTO mode when cooling is required to achieve the target temperature(s). A/C may also operate when warmer temperatures are selected but dehumidifying is required. A/C is also switched on automatically in defrost mode in order to dehumidify the air.

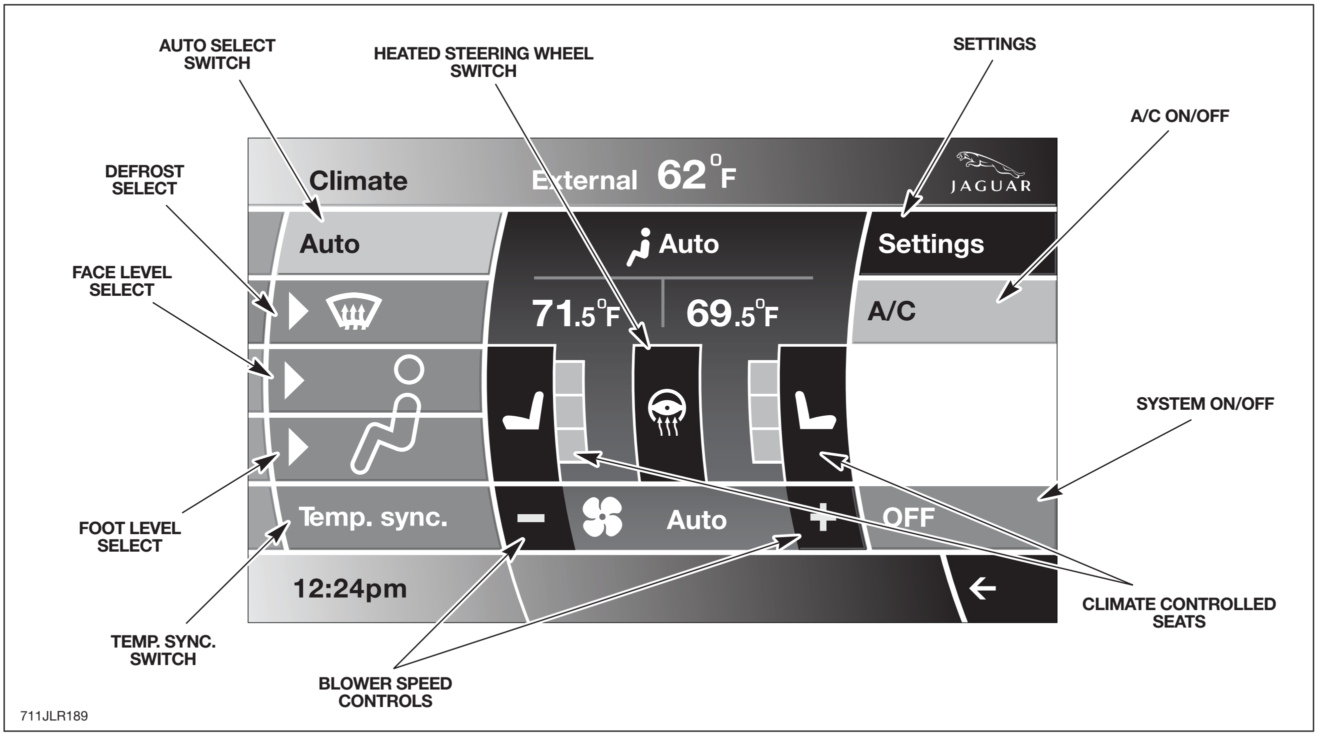
Blower Speed

Blower speed is controlled automatically in AUTO mode, but can be adjusted using the rotary control knob (this will cancel AUTO mode). Reselect AUTO mode by pressing the AUTO switch.

NOTE: When heating is required in AUTO mode, the blower will operate only in low speed when the engine is cold; faster speeds are achieved once the engine warms up.

Climate Control Touch Screen

Additional controls are accessed from the Touch Screen Display (TSD) 'Climate' menu, which is accessed from the touch-screen main 'Home' menu by selecting 'Climate'.



The 'Climate' menu offers the following selections:

- **Auto** – press this button to switch AUTO climate control ON.
- **Distribution to windshield** (windshield icon) – press this button to direct air flow to the windshield-level vents
- **Distribution to face** (upper body icon) – press this button to direct air flow to the fascia face-level vents
- **Distribution to feet** (lower body icon) – press this button to direct air flow to the floor-level vents
- **Temp. Sync.** – matches the passenger's zone temperature to the driver's selected temperature
- **Blower speed control** – press the ' – ' icon to decrease blower speed; press the ' + ' icon to increase
- **Heated seats and steering wheel** (seat/steering wheel icons) – press buttons to toggle heated seats and steering wheel ON/OFF individually
- **A/C** – press this button to toggle air conditioning ON/OFF
- **OFF** – press this button to toggle the climate control system ON/OFF
- **Settings** – press this button to access further settings
  - Climate seat zone
  - Rotary vent control (always open; auto)

Principles of Operation

Air Inlet Control

The source of inlet air is automatically controlled unless overridden by pressing the air recirculation switch on the integrated control panel. During automatic control, the ATC module determines the required position of the recirculation door from its ‘comfort’ algorithm.

The ATC module provides analog signals to the air inlet servo motor along a hardwired connection. A potentiometer in the motor supplies the ATC module with a position feedback signal for closed loop control.

Air Temperature Control

Cooled air from the evaporator enters the HVAC assembly, where temperature blend doors direct a proportion of the air through the heater core to produce the required output air temperature.

The two temperature blend doors operate independently to enable individual temperature settings for the left and right sides of the passenger compartment. The temperature blend doors are operated by stepper motors, which are controlled by the ATC module using LIN bus messages.

The ATC module calculates the temperature blend stepper motor positions required to achieve the selected temperature and compares it against the current position. If there is any difference, the ATC module signals the stepper motors to adopt the new position.

Air temperature is controlled automatically unless maximum heating (HI) or maximum cooling (LO) is selected. When maximum heating or cooling is selected, a ‘comfort’ algorithm in the ATC module adopts an appropriate strategy for air distribution, blower speed, and air source.

Temperature control in one side of the passenger compartment can be compromised by the other side of the passenger compartment being set to a high level of heating or cooling. True maximum heating or cooling (displayed as ‘HI’ or ‘LO’ on the TSD) can only be selected for the driver’s side of the passenger compartment. If ‘HI’ or ‘LO’ is selected for the driver’s side, the temperature for the front passenger’s side is automatically set to match the driver’s side.

If A/C is selected off in the automatic mode, no cooling of the inlet air will take place. The minimum output air temperature from the system will be ambient air temperature plus any heat pick up in the air inlet path.

If the Temp. sync. soft key on the TSD is pressed, the ATC module matches the passenger’s zone temperature to the driver’s selected temperature.

Blower Control

When the system is in the automatic mode, the ATC module determines the blower speed required from a comfort algorithm. When the system is in the manual mode, the ATC module operates the blower at the speed selected using either the rotary control switch on the integrated control panel or the ‘+’ and ‘–’ soft buttons on the touch screen display (TSD). The ATC module also adjusts blower speed to compensate for the ram effect on inlet air produced by forward movement of the vehicle. As vehicle speed and ram effect increases, blower motor speed is reduced, and vice versa.

Air Distribution Control

Two air distribution doors are used to direct air into the passenger compartment. The doors are operated by stepper motors, which are controlled by the ATC module using LIN bus messages.

When the A/C system is in automatic mode, the ATC module automatically controls air distribution into the passenger compartment in line with its 'comfort' algorithm. Automatic control is overridden if any of the TSD air distribution soft buttons are selected. Air distribution in the passenger compartment will remain as selected until the 'Auto' switch is pressed or a different manual selection is made.

A/C Compressor Control

When A/C is selected the ATC module maintains the evaporator at an operating temperature that varies with the passenger compartment cooling requirements. If the requirement for cooled air decreases, the ATC module raises the evaporator operating temperature by reducing the flow of refrigerant provided by the A/C compressor. The ATC module closely controls the rate of temperature increase to avoid introducing moisture into the passenger compartment.

If the requirement for cooled air increases, the ATC module lowers the evaporator operating temperature by increasing the flow of refrigerant provided by the A/C compressor.

When A/C is off, the compressor current signal supplied by the ATC module holds the A/C compressor solenoid valve in the minimum flow position, effectively switching off the A/C function.

The ATC module incorporates limits for the operating pressure of the refrigerant system. If the system approaches the high pressure limit, the compressor current signal is progressively reduced until the system pressure decreases. If the system falls below the low pressure limit, the compressor current signal is held at its lowest setting so that the A/C compressor is maintained at its minimum stroke. This avoids depletion of the lubricant from the A/C compressor.

A/C Compressor Torque

The ATC module transmits refrigerant pressure and A/C compressor current values to the ECM over the medium speed then high speed CAN bus, using the CJB as a gateway. The ECM uses these values to calculate the torque being used to drive the A/C compressor. The ECM compares the calculated value with its allowable value and if necessary forces the ATC module to inhibit the A/C compressor by transmitting the 'AC Clutch Inhibit' CAN message. This forces the ATC module to reduce the drive current to the A/C compressor solenoid valve, which reduces refrigerant flow. This in turn reduces the torque required to drive the A/C compressor.

By reducing the maximum A/C compressor torque, the ECM is able to reduce the load on the engine when it needs to maintain vehicle performance or cooling system integrity.

Cooling Fan Control

The ATC module determines the amount of condenser cooling required from the refrigerant pressure sensor, since there is a direct relationship between the temperature and pressure of the refrigerant. The cooling requirement is broadcast to the ECM on the medium speed CAN bus. The ECM then controls the temperature of the condenser using the cooling fan.

Programmed Defrost

The programmed defrost DEF switch is located on the integrated control panel. When the switch is pressed, the ATC module instigates the programmed defrost function. When selected, the ATC module configures the system as follows:

- Automatic mode off
- A/C on
- Selected temperature unchanged
- Air inlet set to fresh air
- Air distribution set to windshield
- Blower speed set to level 5
- Windshield heater (where fitted) and rear window heater on

The programmed defrost function can be cancelled by one of the following:

- Selecting any air distribution switch on the TSD
- Pressing the AUTO switch on the integrated control panel
- A second press of the DEF button

The blower speed can be adjusted without terminating the programmed defrost function.

Windshield Heater (When Equipped)

Windshield heater operation is only enabled when the engine is running. The ATC module controls operation of the windshield heater using two relays in the engine junction box (EJB). When windshield heater operation is required, the ATC module broadcasts a message to the CJB on the medium speed CAN bus. On receipt of the message, the CJB energizes the relays by providing a ground path for both relay coils. This allows a battery feed to flow across the relays to power the windshield left and right heater elements.

There are two modes of windshield heater operation: manual and automatic.

Manual
Manual operation is activated by pressing the windshield heater switch on the integrated control panel. When the switch is pressed, the status LED in the switch illuminates and the windshield heater elements are energized. Manual operation is discontinued when the windshield heater switch is pressed a second time, 5 minutes have elapsed (the heating phase), or the engine stops. If manual operation is discontinued by the engine stopping, the previous heating phase is resumed if the engine is re-started within 30 seconds.

Automatic
There are two variants of automatic operation: automatic operation at the start of a journey and automatic operation during a journey.

Automatic operation at the start of a journey is initiated if the ambient air temperature is below 5 °C (41 °F). In this instance, the switch LED is illuminated and the heater elements are energized for 5 minutes. Automatic operation is discontinued if the windshield heater switch is pressed or the engine stops.

Automatic operation during a journey is initiated when low ambient air temperatures are experienced and the vehicle has been traveling for a set period of time above a threshold speed. In this instance, no feedback is given to the driver to inform him the windshield heater is operational (the switch LED is not illuminated) and the duration of operation is variable depending upon the ambient air temperature, vehicle speed and the amount of time the vehicle has been traveling.

Rear Window Heater

Rear window heater operation is only enabled when the engine is running. The ATC module controls operation of the rear window heater using a relay in the RJB. When rear window heater operation is required, the ATC module broadcasts a message to the RJB on the medium speed CAN bus. On receipt of the message, the RJB energizes the relay by providing a ground path for the relay coil. This allows a battery feed to flow across the relay to power the rear window heater element.

There are two modes of rear window heater operation: manual and automatic.

Manual
Manual operation is activated by pressing the rear window heater switch on the integrated control panel. When the switch is pressed, the status LED (light emitting diode) in the switch illuminates and the rear window heater element is energized. Manual operation is discontinued when the rear window heater switch is pressed a second time, 21 minutes have elapsed (the heating phase), or the engine stops. If manual operation is discontinued by the engine stopping, the previous heating phase is resumed if the engine is re-started within 30 seconds.

Automatic
There are two variants of automatic operation: automatic operation at the start of a journey and automatic operation during a journey.

Automatic operation at the start of a journey is initiated if the ambient air temperature is below 5 °C (41 °F). In this instance, the switch LED is illuminated and the heater element is energized for 21 minutes. Automatic operation is discontinued if the rear window heater switch is pressed or the engine stops.

Automatic operation during a journey is initiated when low ambient air temperatures are experienced and the vehicle has been traveling for a set period of time above a threshold speed. In this instance, no feedback is given to the driver to inform him the rear window heater is operational (the switch LED is not illuminated). The duration of heater operation is variable depending on the ambient air temperature, vehicle speed and the amount of time the vehicle has been traveling.

Exterior Mirror Heaters

Operation of the exterior mirror heaters is fully automatic and not controllable by the driver. Exterior mirror heater operation is determined by ambient air temperature and windshield wiper status. When ambient air temperature reaches a predetermined level, the ATC module broadcasts an exterior mirror heating request to the door modules over the medium speed CAN bus. On receipt of this message, the door modules provide feed and ground connections to both exterior mirror heater elements.

The amount of time the exterior mirror heaters are operational increases if the windshield wipers are switched on. This ensures the mirrors remain mist free in damp and wet conditions, where there is an increased risk of misting.

Seat Heaters (When Equipped)

There are four seat heater settings available: Off, 1, 2, and 3, which can be selected on the home and climate control screens of the TSD. The heat setting is relayed to the vehicle occupants through a graduated display on the TSD.

Operation of the heated seats is controlled by the ATC module. When the ATC module receives a heating request from the TSD, it broadcasts a message to the CJB over the medium speed CAN bus. The CJB then provides a hardwired 12V supply to the three heater elements in the related front seat. The heater elements, two in the seat cushion and one in the seat squab, are wired in series. The ATC module monitors seat temperature using a temperature sensor located in each seat cushion. The CJB provides the temperature sensors with a 5V supply. The level of the returned voltage back to the CJB is proportional to the seat temperature. The value of the return signal is broadcast to the ATC module, over the medium speed CAN bus, which allows it to control the seat temperature to the required level.

The ATC module will suspend or disable operation of the seat heaters if any of the following occur:

- Battery voltage exceeds 16.5 ± 0.3V for more than 5 seconds; seat heating is re-enabled when battery voltage decreases to 16.2 ± 0.3V
- If a short or open circuit is detected
- If the seat heat temperature rises significantly above the target temperature setting

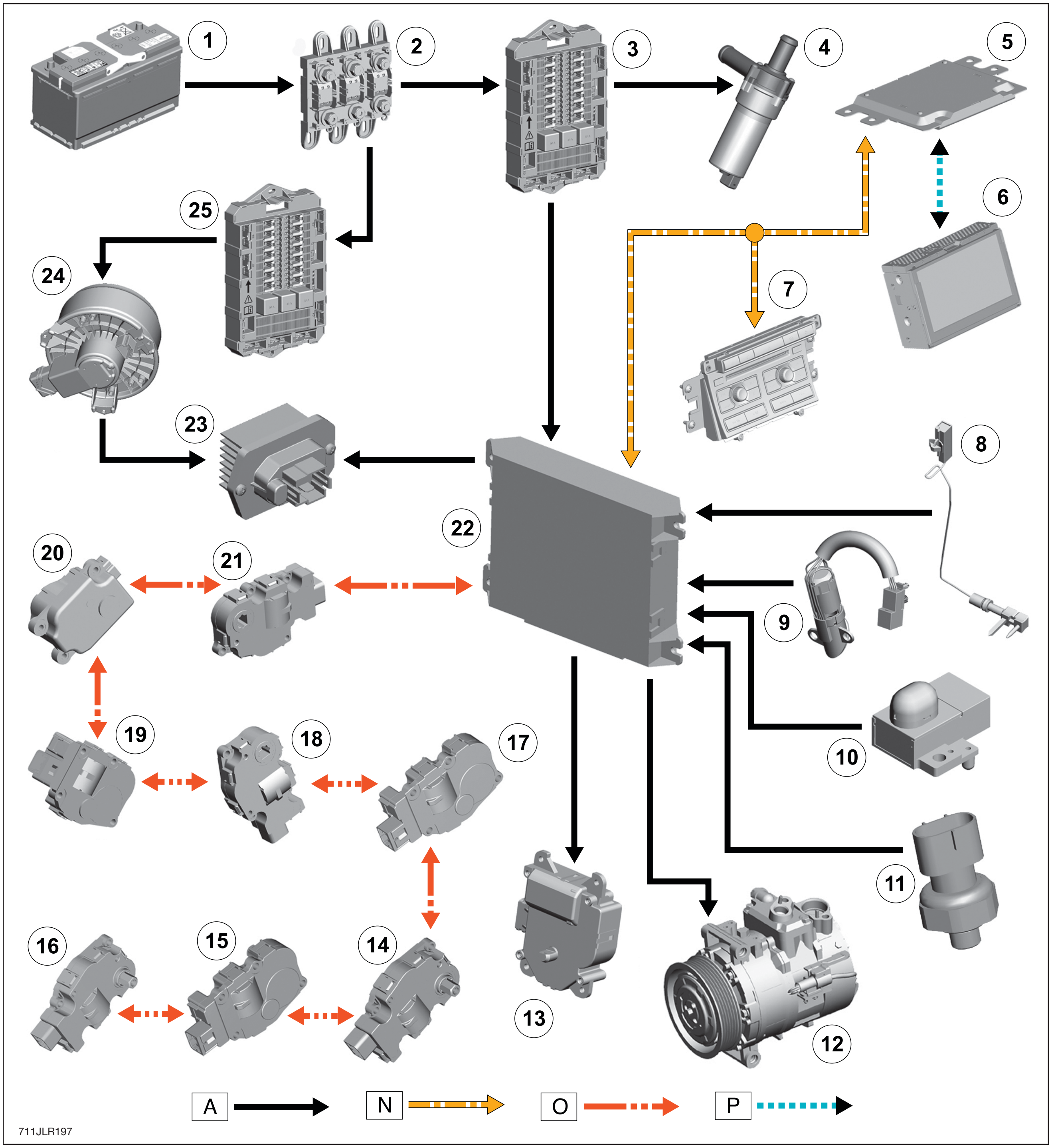
The graduated display on the TSD remains illuminated until the seat heaters are turned off or the engine stops. If the engine is restarted within 30 seconds the seat heater resumes the previous heating level.

Steering Wheel Heater

The steering wheel heater has a single heat setting and is turned on/off on the home and climate control screens of the TSD. The on/off status of the steering wheel heater is relayed to the vehicle occupants through the TSD. When the ignition is switched off, the steering wheel heater will reset to off.

Power for the heater element is supplied by the CJB on receipt of a request from the ATC module over the medium speed CAN bus. Temperature control for the heater element is provided by the steering wheel heater control module which receives a temperature feedback signal from a negative temperature coefficient (NTC) thermistor located within the steering wheel.

Control Diagram



A Hardwired
N MS CAN
O LIN Bus
P MOST
1 Battery
2 BJB
3 CJB
4 Auxiliary coolant pump (4.2L only)
5 Information control module
6 TSD
7 Integrated control panel
8 Evaporator temperature sensor
9 Cabin humidity and temperature sensor
10 Sunload sensor
11 Refrigerant pressure sensor
12 A/C compressor solenoid valve
13 Air inlet servo motor
14 RH inner face level register
15 LH inner face level register
16 LH outer face level register
17 RH outer face level register
18 RH temperature blend stepper motor
19 LH temperature blend stepper motor
20 Face/feet distribution stepper motor
21 Windshield stepper motor
22 ATC module
23 Blower motor controller
24 Blower
25 RJB

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Technical Training
Climate Control Systems

711-JAG: Jaguar Climate Control Systems

X351 Climate Control Systems

JAGUAR

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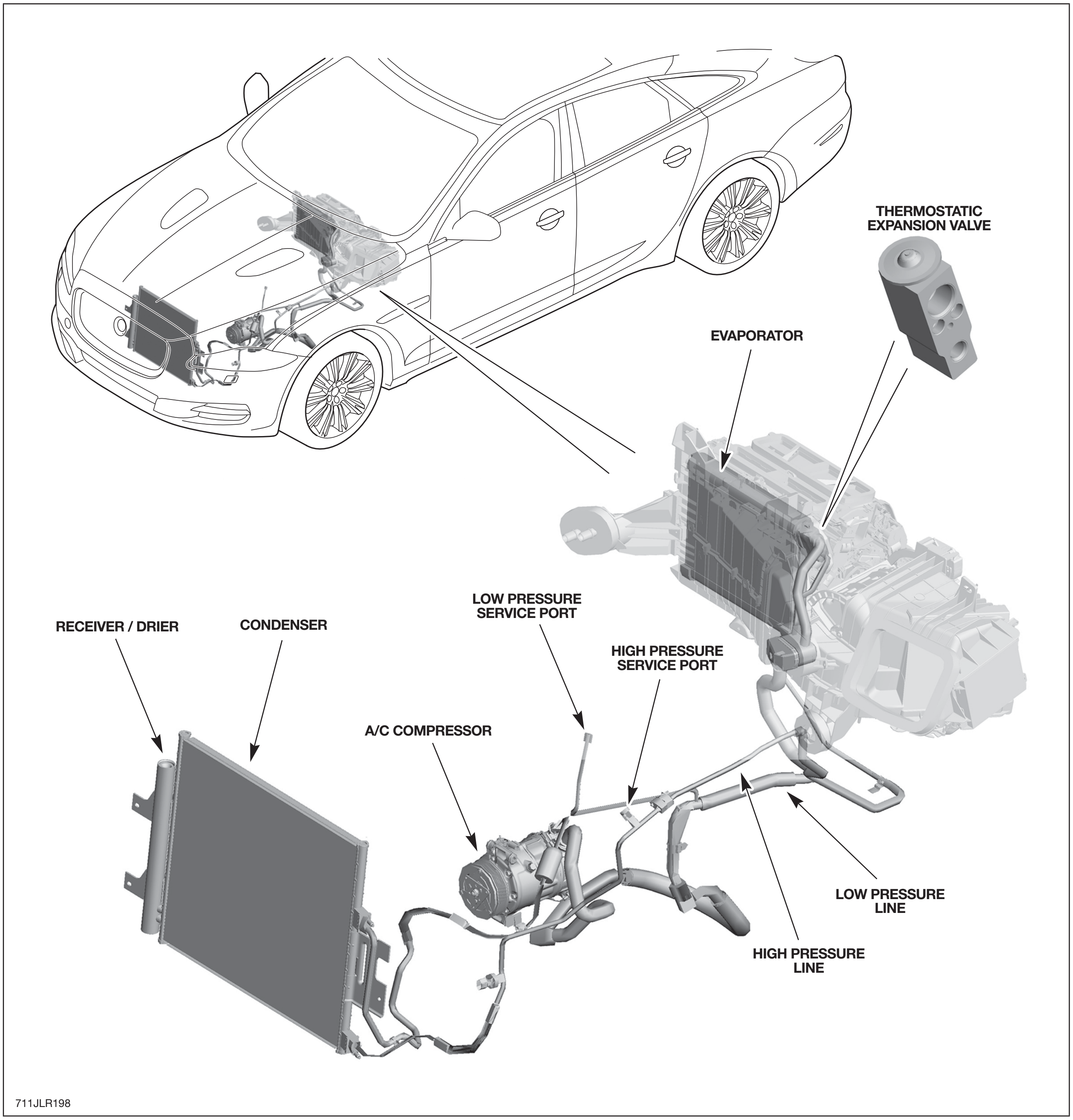
REFRIGERATION SYSTEM

Overview

The A/C system transfers heat from the passenger compartment to the outside atmosphere to provide the cabin with dehumidified cold air. It is a sealed, closed loop system filled with a charge weight of R134a refrigerant as the heat transfer medium. Oil is added to the refrigerant to lubricate the internal components of the A/C compressor.

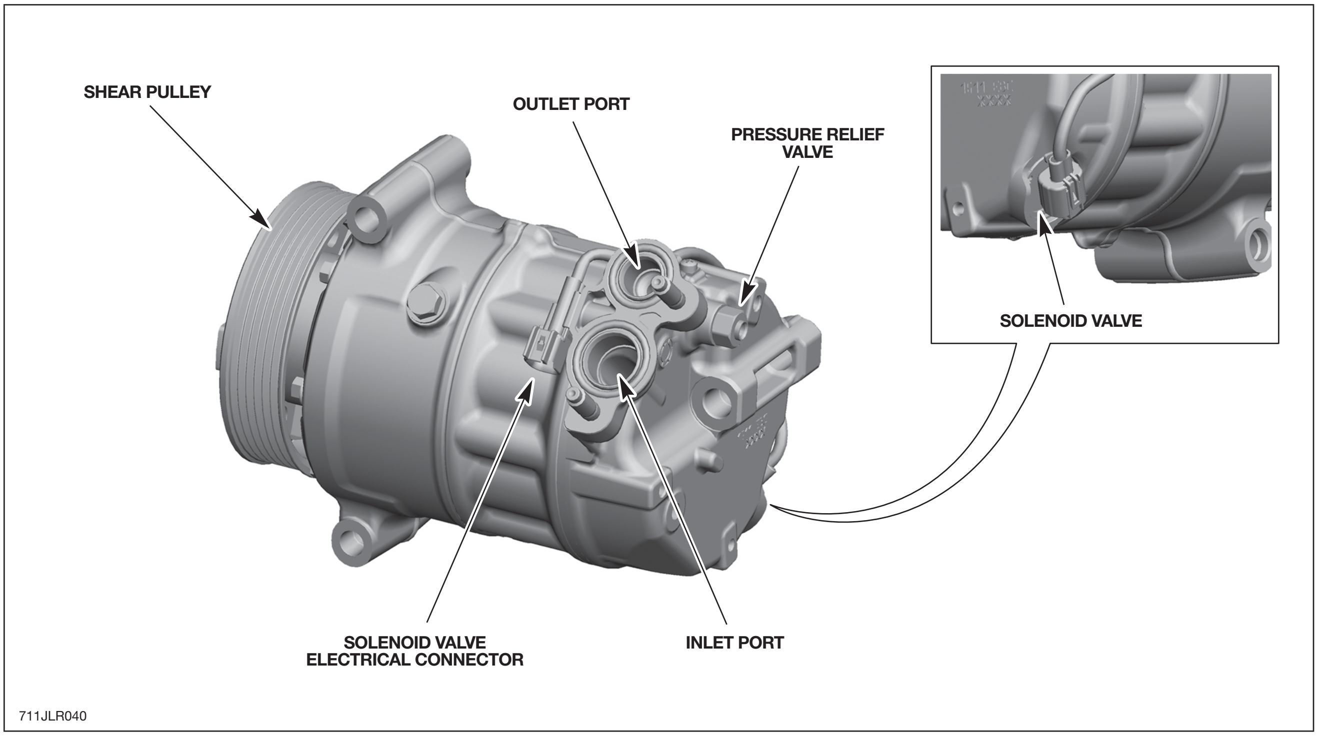
Component Location



Component Description

Compressor

The A/C compressor circulates refrigerant around the system by compressing low pressure, low temperature vapor from the evaporator and discharging the resultant high pressure, high temperature vapor to the condenser.

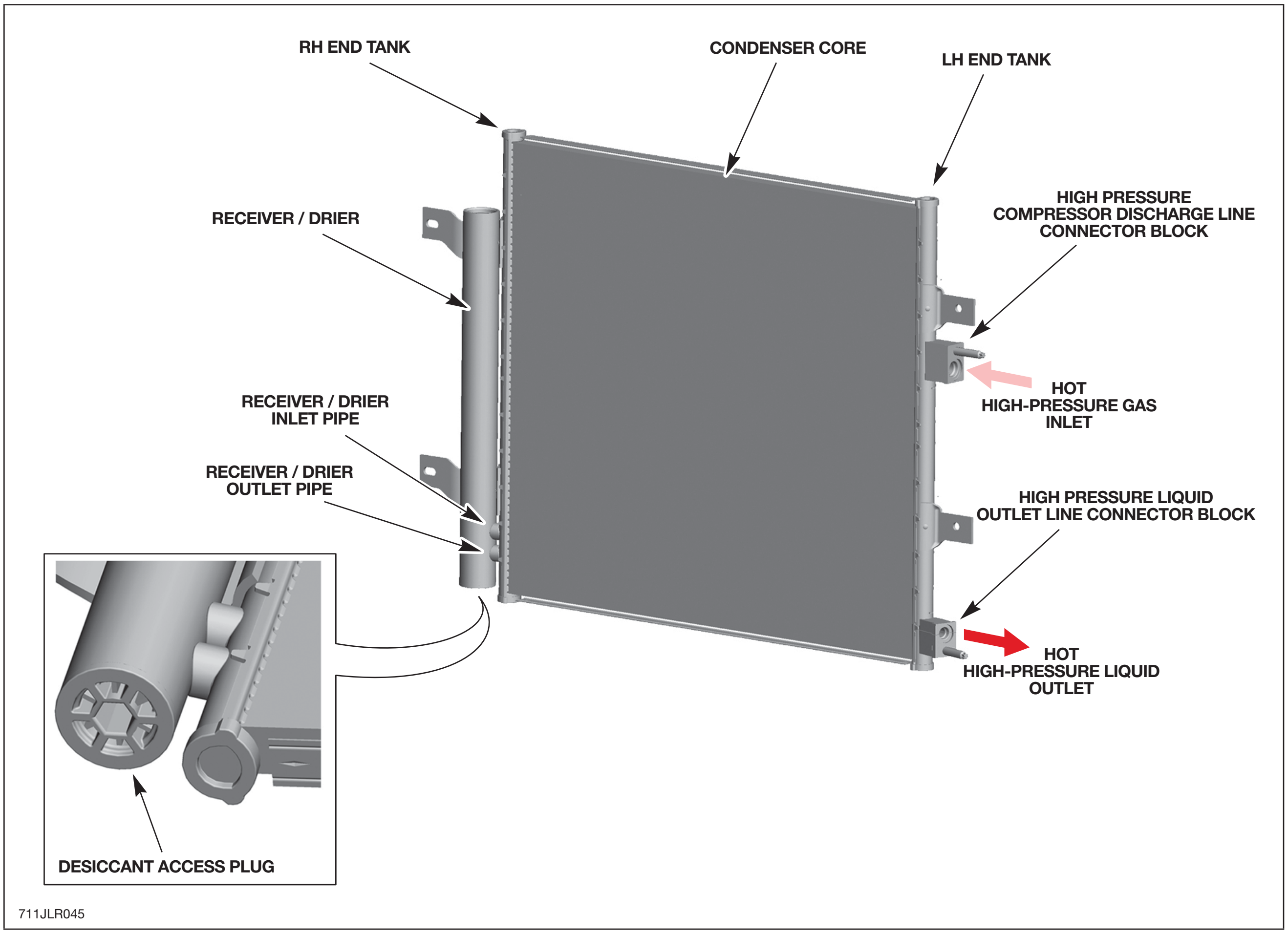


The A/C compressor is a variable displacement unit driven by the engine accessory drive belt. The A/C compressor is driven directly from the pulley. To protect the system from excessive pressure, a pressure relief valve is installed in the outlet side of the A/C compressor. The pressure relief valve vents excess pressure into the engine compartment.

The compressor solenoid control valve allows the flow of refrigerant through the A/C compressor to be adjusted to match the cooling load. Operation of the solenoid valve is controlled by the ATC module via PWM signal. By controlling the flow of refrigerant through the compressor, the solenoid valve controls the A/C system pressure and the evaporator operating temperature.

Condenser

The condenser transfers heat from the refrigerant to the surrounding air to convert the high pressure vapor from the compressor into a liquid. The condenser is installed immediately in front of the radiator. Two brackets on each end tank attach the condenser to the end tanks of the radiator.



The condenser is classified as a sub-cooling condenser and consists of a fin and tube heat exchanger core installed between two end tanks. Divisions in the end tanks separate the heat exchanger into a four pass upper (condenser) section and a two pass lower (sub-cooler) section.

Receiver/Drier

The receiver/drier is connected to the RH end tank of the condenser. It removes solid impurities and moisture from the refrigerant, and provides a reservoir for liquid refrigerant to accommodate changes of heat load at the evaporator. The receiver/drier is part of the condenser assembly.

The receiver/drier contains a serviceable desiccant bag. Desiccant packs contain an ultraviolet (UV) dye pellet to assist in leak detection.

Thermostatic Expansion Valve

The thermostatic expansion valve meters the flow of refrigerant into the evaporator, to match the refrigerant flow with the heat load of the air passing through the evaporator. The valve is a block type valve attached to the inlet and outlet ports of the evaporator. The thermostatic expansion valve consists of an aluminum housing containing inlet and outlet passages.

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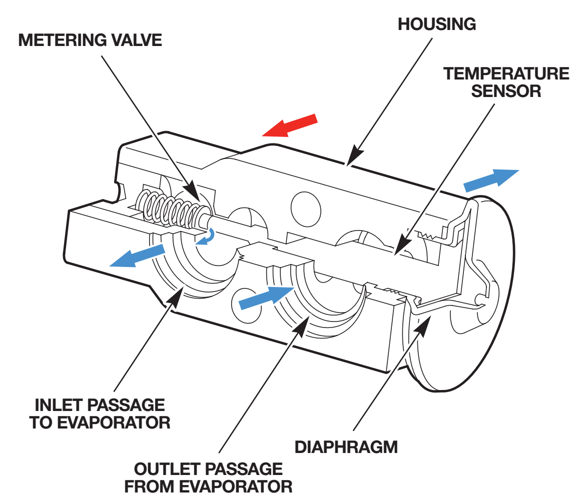

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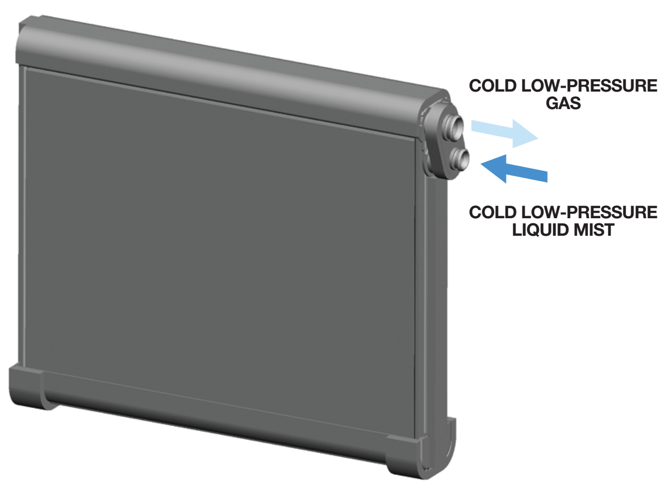
Evaporator

The evaporator is installed in the HVAC assembly, between the blower and the heater matrix, to absorb heat from the exterior or recirculated air. Low pressure, low temperature refrigerant changes from liquid to vapor in the evaporator, absorbing large quantities of heat as it changes state.



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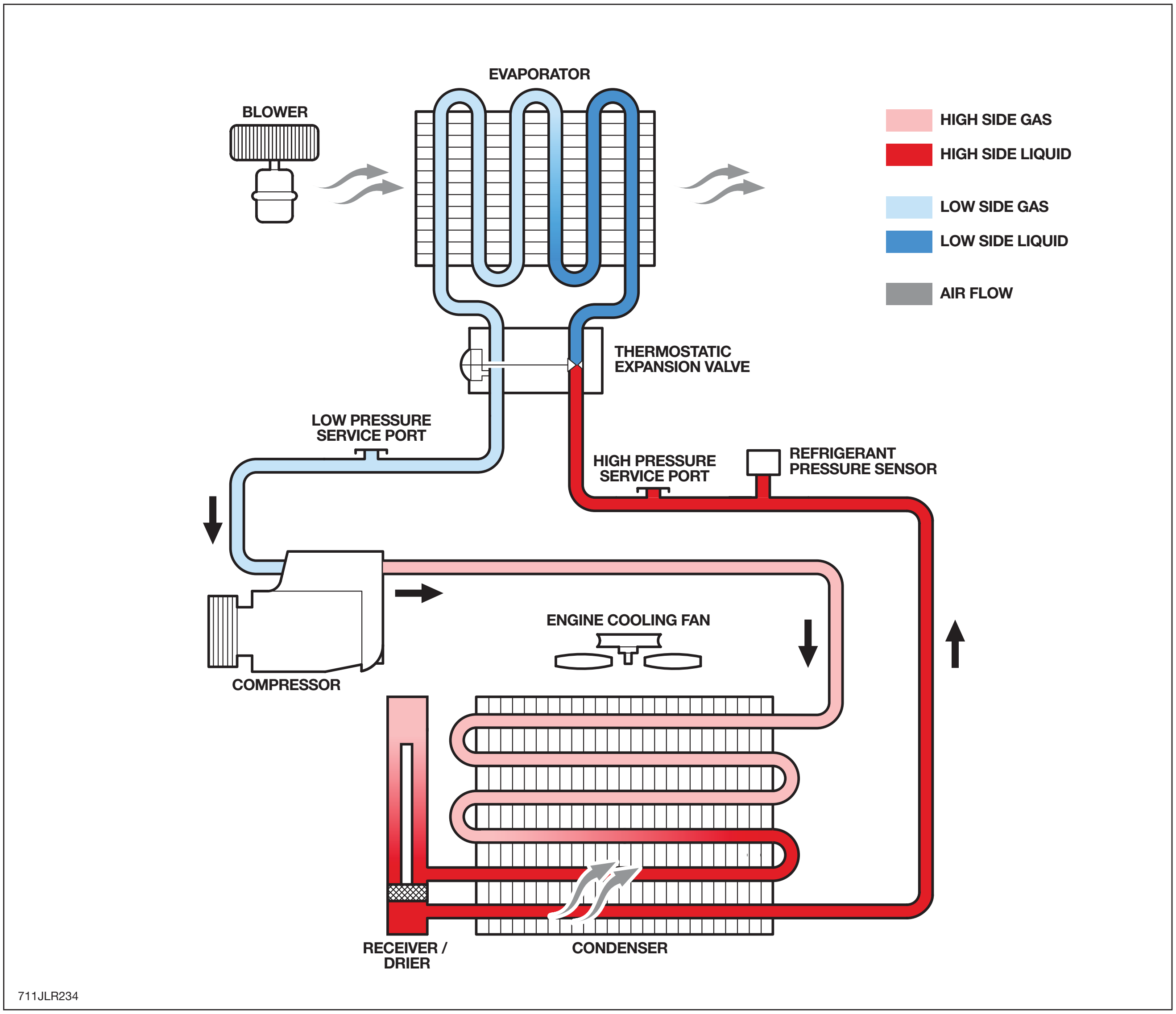
Most of the moisture in the air passing through the evaporator condenses into water, which drains out of the vehicle by passing through a drain tube to the underside of the vehicle.

Refrigerant Lines

To maintain similar flow velocities around the A/C system, the diameter of the refrigerant lines varies to suit the 2 pressure/temperature zones. Larger diameter pipes are installed in the low pressure/temperature zone; smaller diameter pipes are installed in the high pressure/temperature zone.

Low and high pressure charging connections are incorporated into the refrigerant lines for system servicing.

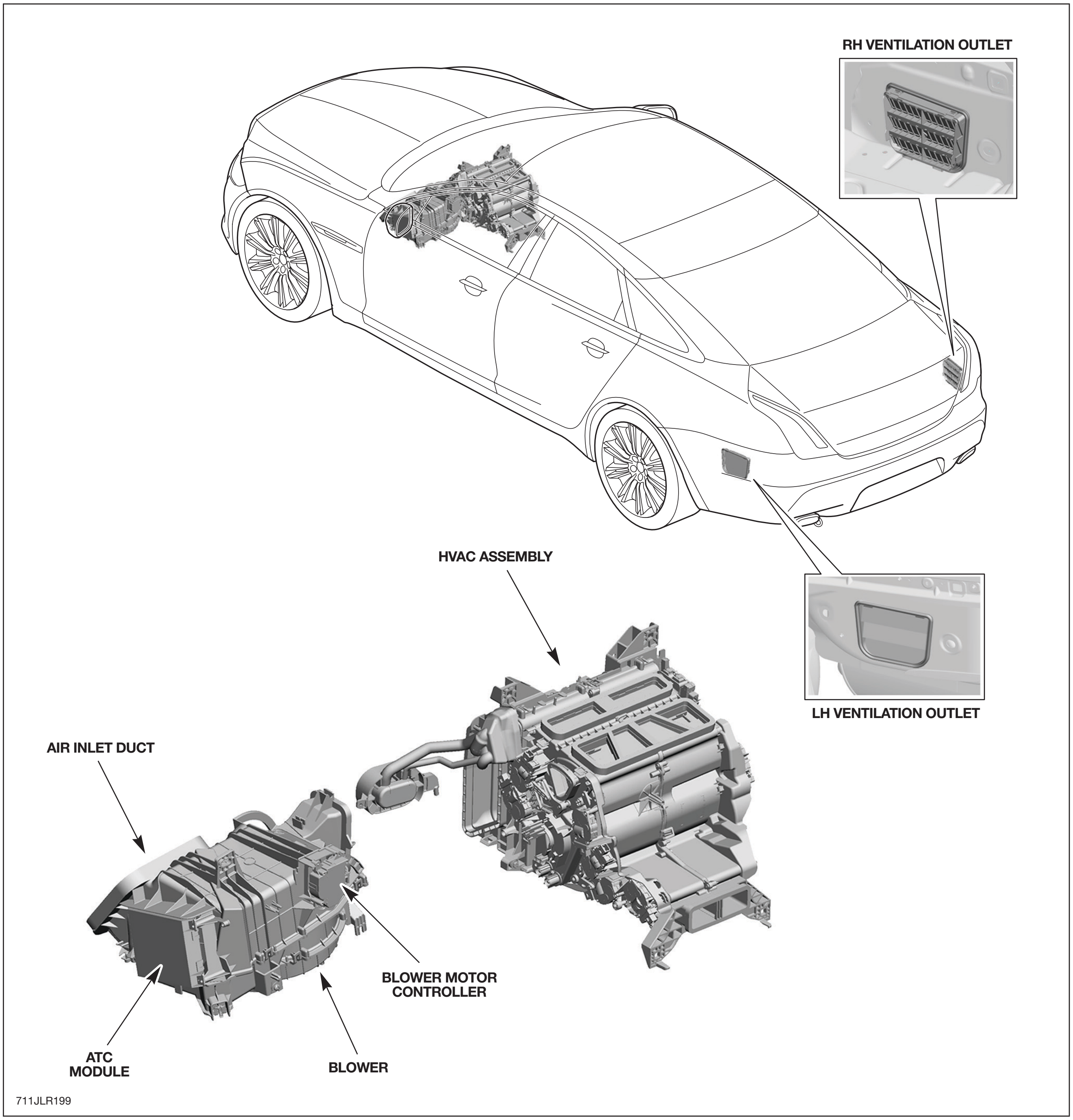
Refrigeration System Schematic



HEATING AND VENTILATION SYSTEM

Overview

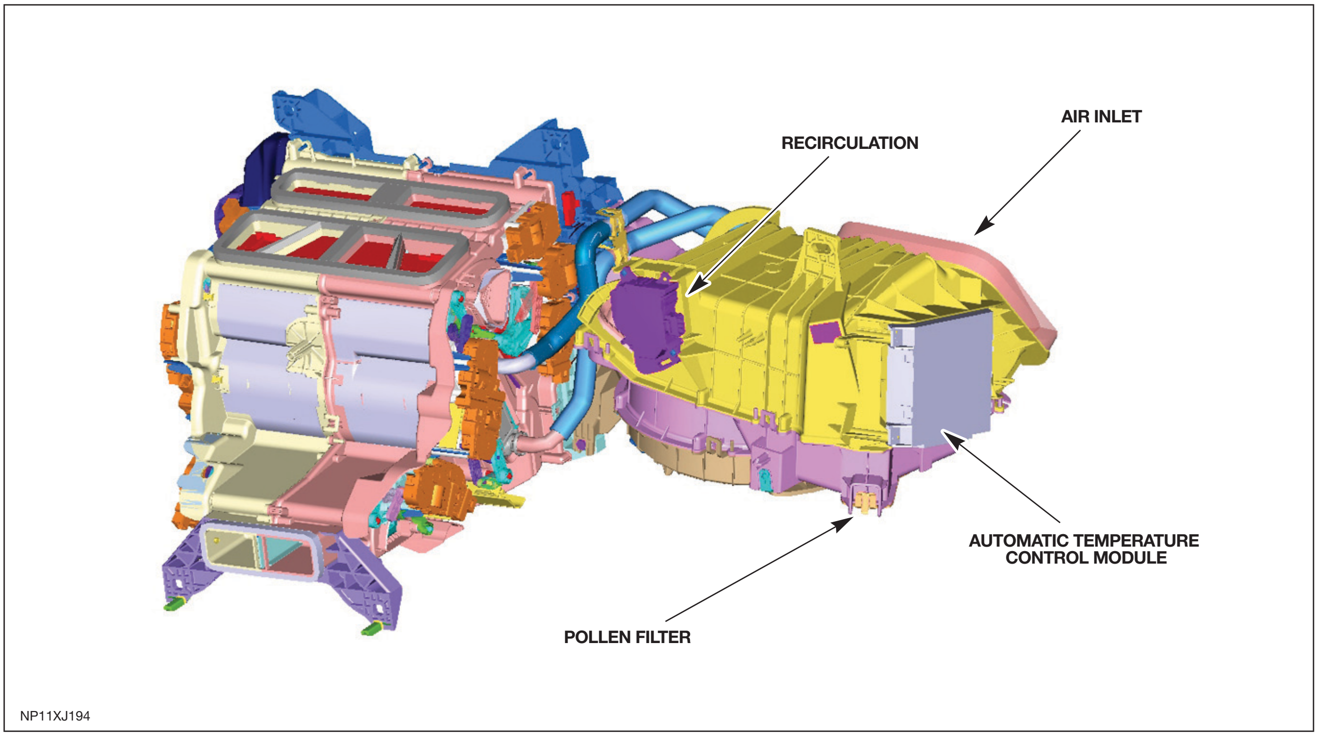
Component Location (RHD Shown; LHD Similar)



Heater/Cooler Unit

The 2011 MY XJ heater/cooler unit is available in 2- or 4-zone configurations. The 4-zone unit is virtually identical to the 2-zone, with the exception of additional stepper control motors. This 4-zone unit has no need for an auxiliary evaporator or HVAC assembly within the center console as with previous 4-zone climate control systems.

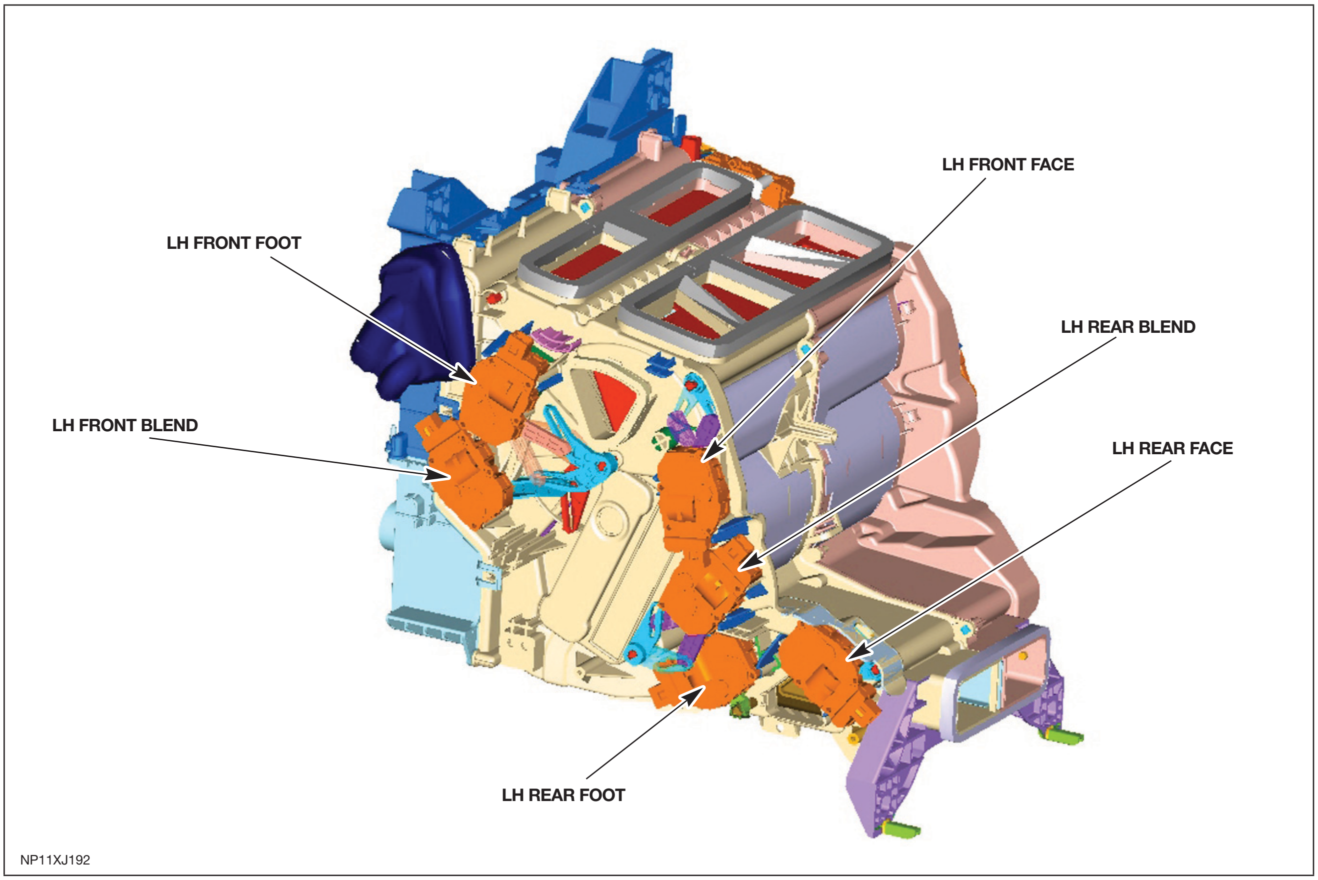
Component Location (4-Zone HVAC Assembly shown)



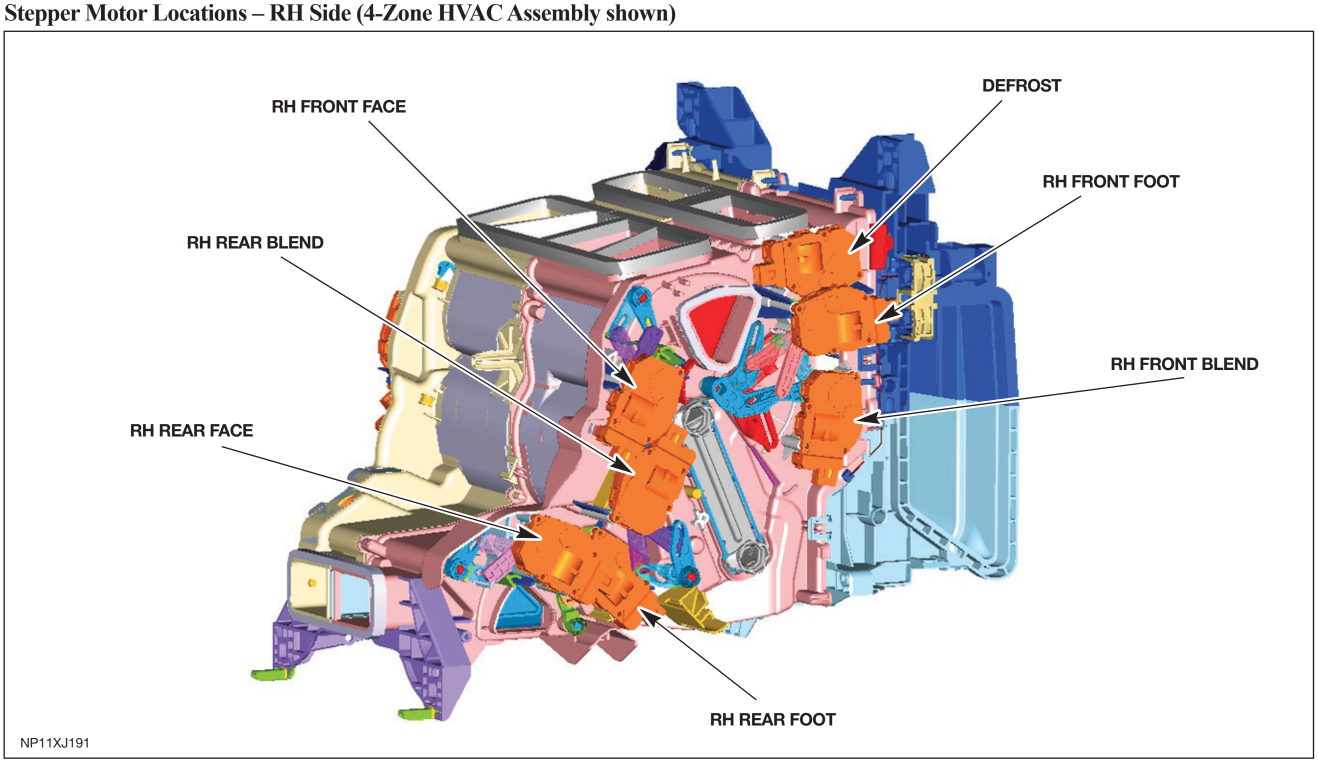
The heater core provides the heat source to warm the air supplied to the passenger compartment. The heater core is an aluminum two pass, fin and tube heat exchanger, and is installed across the width of the heater housing. Two aluminum tubes attached to the heater core extend through the engine bulkhead and connect to the engine cooling system.

The HVAC assembly consists of a casing that contains an A/C evaporator, a heater core, distribution control doors and temperature control doors. There are 13 stepper motors mounted on the heater casing. Each of the stepper motors is connected to either a distribution control door or a temperature control door.

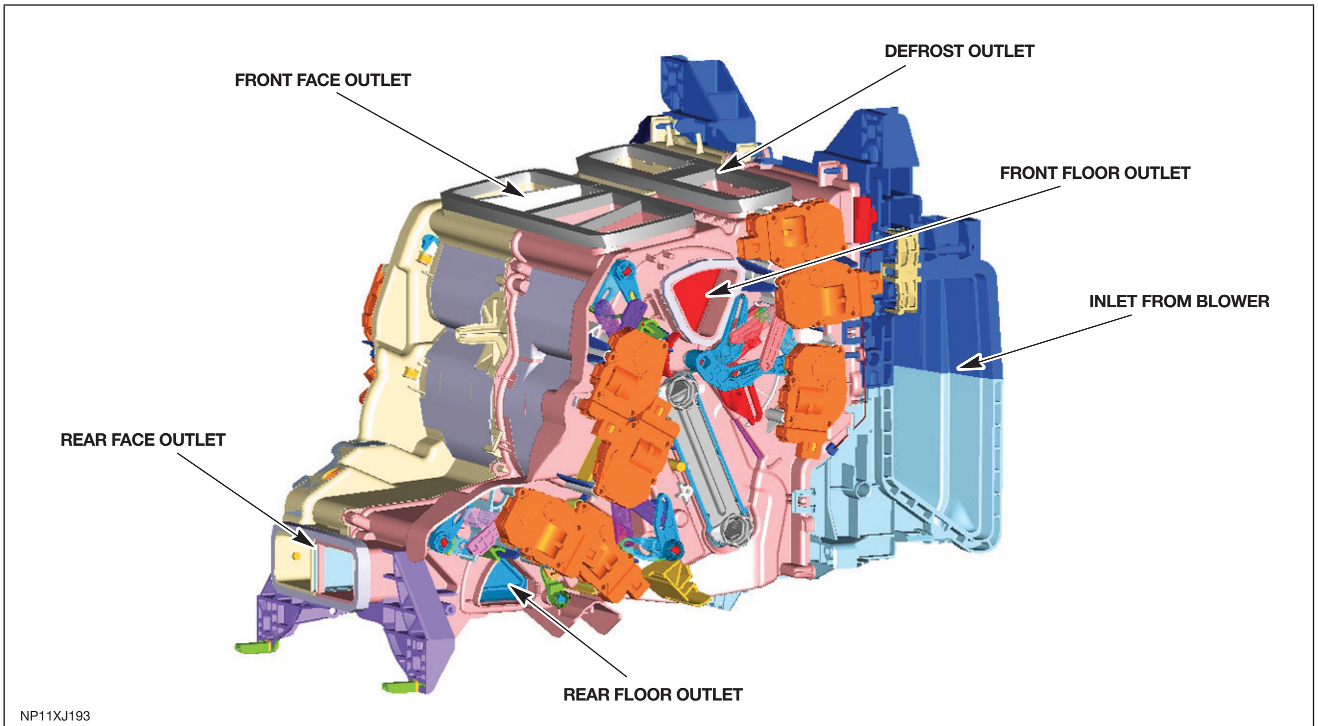
Stepper Motor Locations – LH Side (4-Zone HVAC Assembly shown)



Stepper Motor Locations – RH Side (4-Zone HVAC Assembly shown)



Air Distribution (4-Zone HVAC Assembly shown)



Air Inlet Duct

The air inlet duct connects the fresh air inlet in the engine bulkhead to the HVAC assembly. The air inlet duct is installed behind the instrument panel on the passenger side.

The air inlet duct consists of a casing that contains a pollen filter, an air inlet door, a blower and a blower motor controller. A recirculation air inlet is incorporated into the casing. A servo motor mounted on the casing is connected to the air inlet door, to allow selection between fresh and recirculated air.

The pollen filter is installed in the fresh air inlet of the air inlet duct. A cover on the underside of the air inlet duct allows access for replacement of the pollen filter.

The blower regulates the volume of air flowing through the air inlet duct to the HVAC assembly. The blower consists of an open hub, centrifugal fan and an electric motor.

The blower motor controller regulates the electrical current through the blower motor using a variable ground path. The blower motor controller is installed in the air inlet duct downstream of the blower, where any heat generated during operation is dissipated by the air flow.

Ventilation Outlets

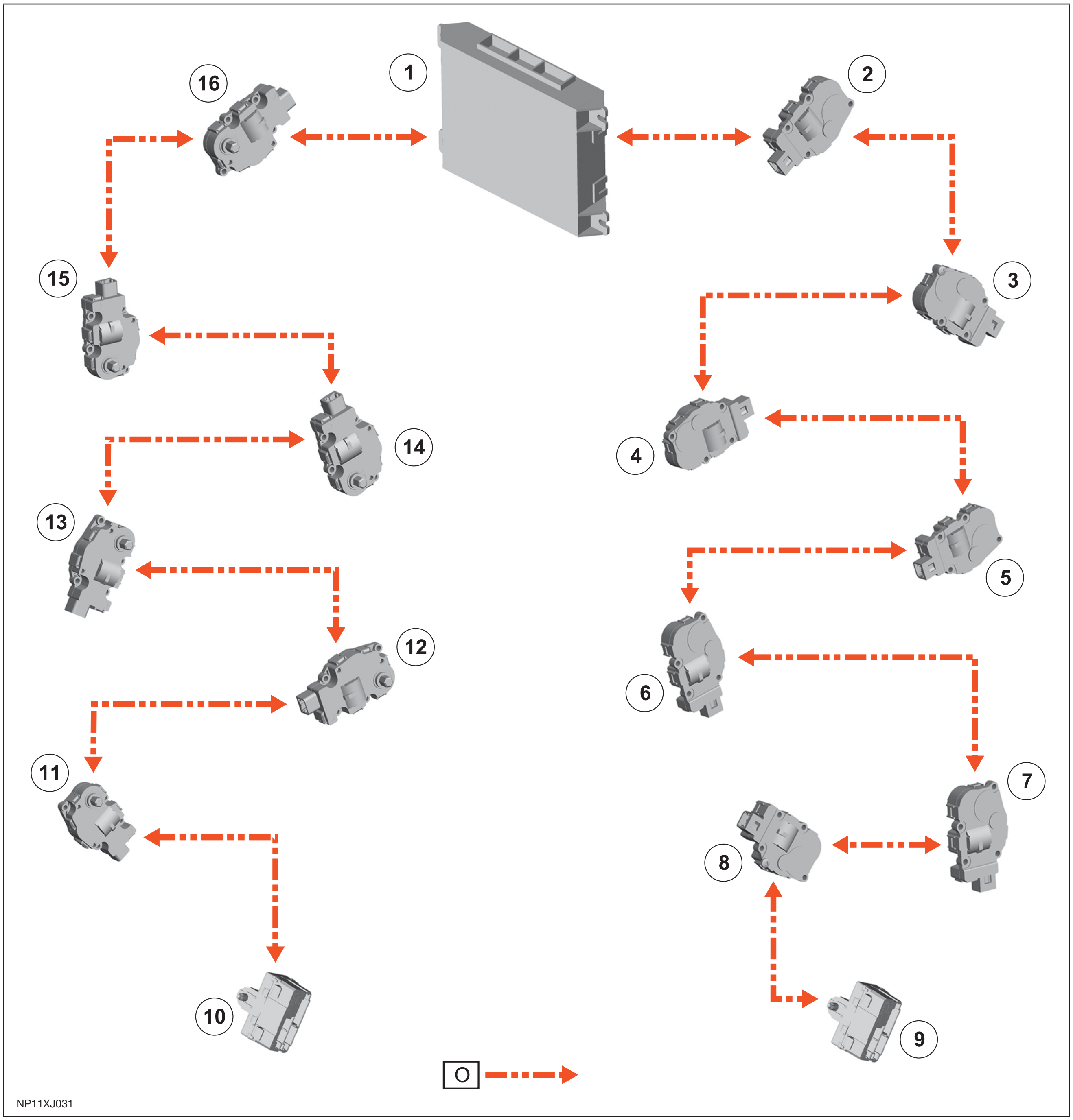
The ventilation outlets allow the free flow of air through the passenger compartment. The outlets are installed in the LH and RH rear quarter panels, behind the rear bumper.

Each ventilation outlet consists of a grille covered by a soft rubber flaps, and is effectively a non-return valve. The flaps open and close automatically depending on the pressure differential between the air inside and outside the vehicle.

Control Diagram

NOTE: Rear heated seat assemblies are controlled by the Automatic Temperature Control Module (ATCM). All heated/cooled active ventilated seats are controlled by separate climate-controlled seat modules, one front and one rear.

Stepper Motors / Rear Heated Seats



O LIN bus
1 Automatic Temperature Control Module
2 RH Front Temperature Blend Stepper Motor
3 RH Front Foot Distribution Stepper Motor
4 Windshield Defrost Stepper Motor
5 RH Rear Temperature Blend Stepper Motor
6 RH Front Face Distribution Stepper Motor
7 RH Rear Face Distribution Stepper Motor
8 RH Rear Foot Distribution Stepper Motor
9 RH Rear Seat Heater Module
10 LH Rear Seat Heater Module
11 LH Rear Foot Distribution Stepper Motor
12 LH Rear Face Distribution Stepper Motor
13 LH Front Face Distribution Stepper Motor
14 LH Rear Temperature Blend Stepper Motor
15 LH Front Foot Distribution Stepper Motor
16 LH Front Temperature Blend Stepper Motor

CONTROL SYSTEM

Overview

The climate control system features automatic climate control with air filtration, auto air recirculation, and humidity sensing. Depending on the variant, the vehicle may be equipped with a dual-zone system or four-zone system.

Dual-zone control only allows front driver and passenger separate temperature controls. Four-zone temperature control allows the driver, front seat passenger, and left and right rear seat passengers individual choice over temperature and air distribution, with independent controls in the front and rear of the vehicle.

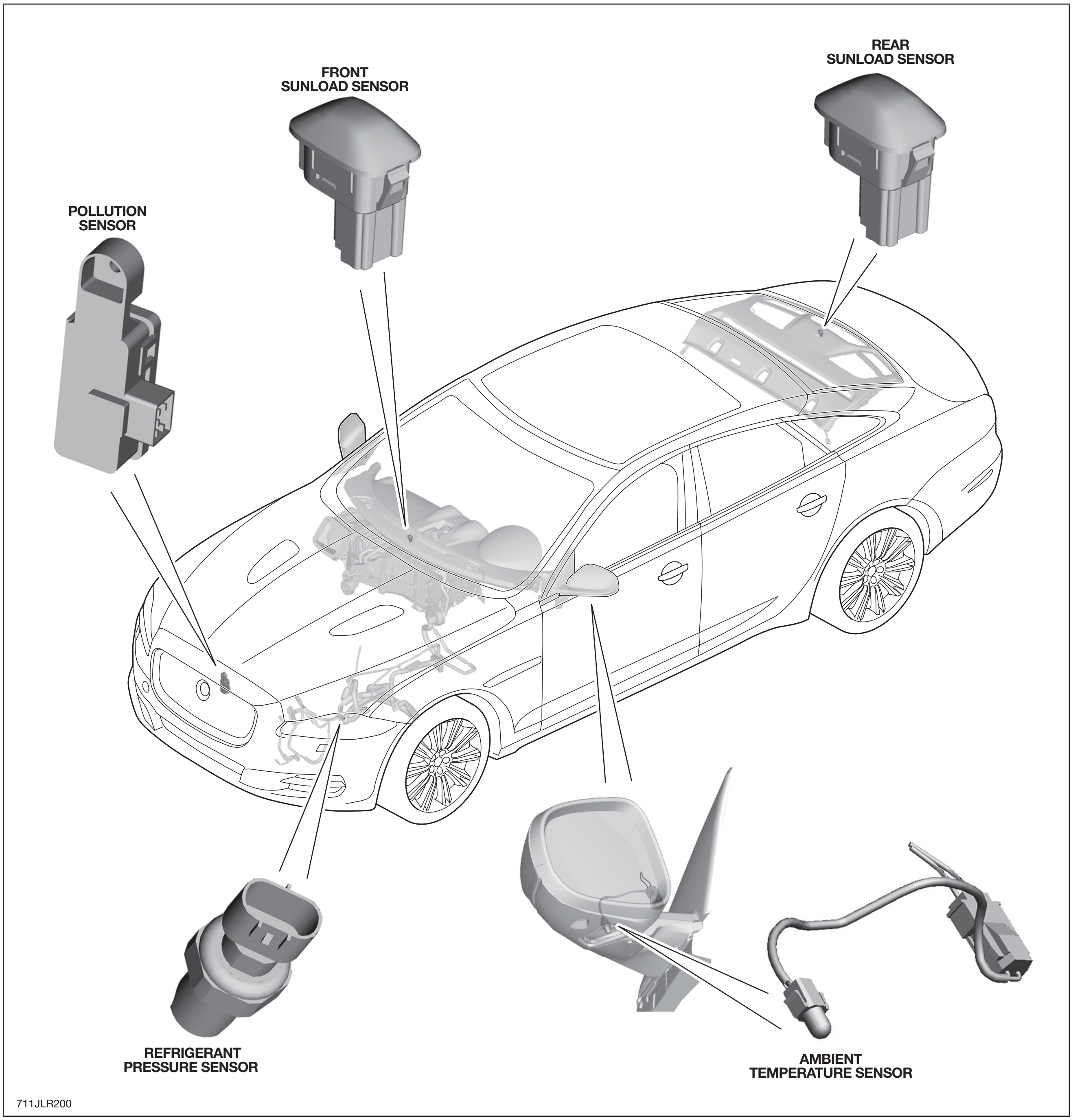
NOTE: The maximum achievable zone temperature differential is approximately 5.4 ºF (3 ºC).

The table below displays the different available climate control system configurations:

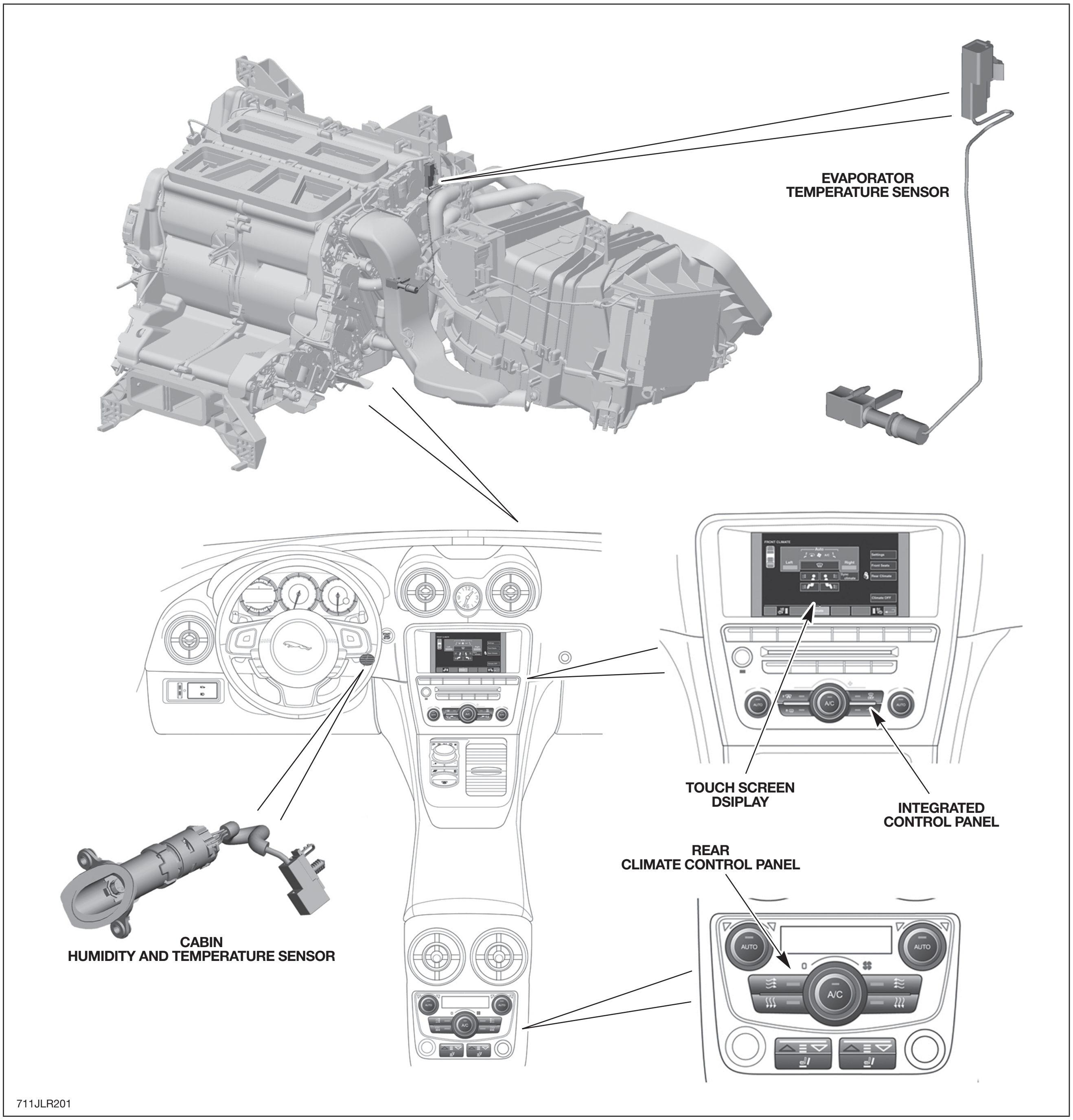
Climate System Features	XJ Non Luxury	XJL	XJ/XJL Supercharged	XJ/XJL Supersport
Dual Zone	X			
Four Zone		X	X	X
Air Quality Sensor	X	X	X	X
Illuminated Air Vents				X
Heated rear seats	X			
Heated front windshield *	X	X	X	X

* Heated Front Windshield is a standalone option.

Component Locations: Part 1



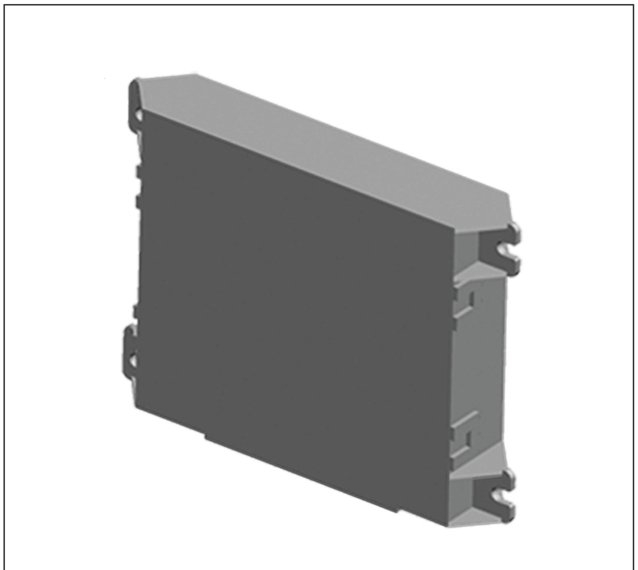
Component Locations: Part 2



Component Descriptions

Automatic Temperature Control Module

The Automatic Temperature Control (ATC) module is mounted on the outboard end of the air inlet duct, behind the front passenger side of the instrument panel. The ATC module processes inputs from the system sensors, the TSD, the Integrated Control Panel (ICP) and, on four zone systems, the rear climate control panel. In response to these inputs, the ATC module outputs control signals to the A/C system and the heating and ventilation system.



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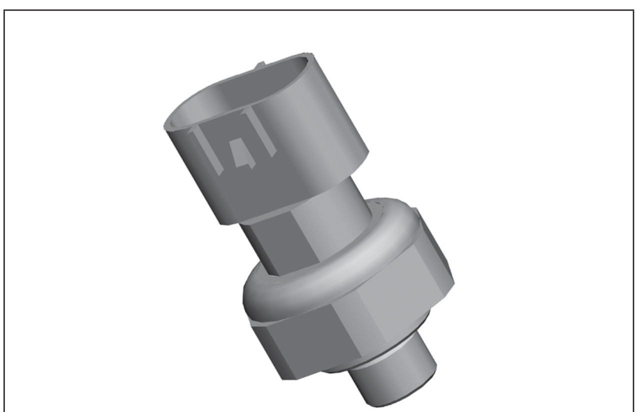
Refrigerant Pressure Sensor

The refrigerant pressure sensor provides the ATC module with a pressure input from the high pressure side of the refrigerant system. The refrigerant pressure sensor is located in the refrigerant line between the condenser and the thermostatic expansion valve.



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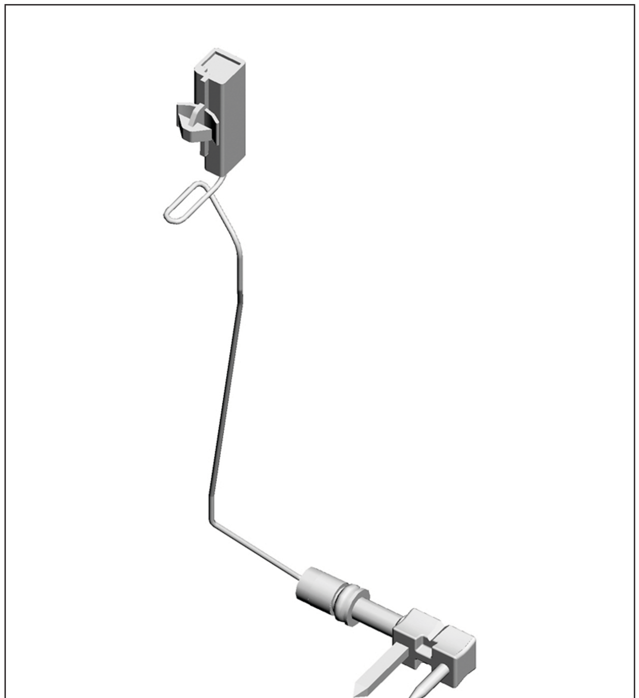
Evaporator Temperature Sensor

The evaporator temperature sensor is a negative temperature coefficient (NTC) thermistor that provides the ATC module with a temperature signal from the downstream side of the evaporator. The evaporator temperature sensor is mounted directly onto the evaporator matrix fins.



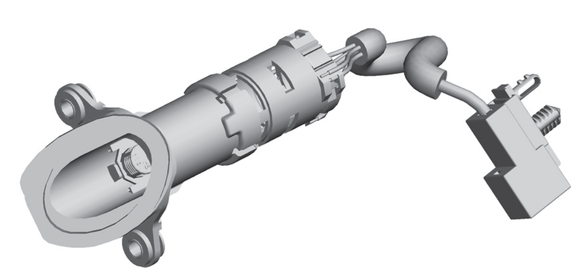
711JLR183

The ATC module uses the input from the evaporator temperature sensor to regulate compressor solenoid drive and thus the operating temperature of the evaporator.

Humidity Temperature Sensor

The humidity and temperature sensor is behind a grill in the instrument panel, on the inboard side of the steering column. The sensor incorporates:

- A NTC thermistor to measure temperature
- A capacitive sensor element to measure humidity
- A motor driven fan to draw air through the sensor and over the sensing elements

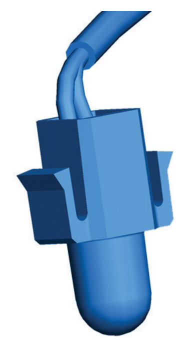


711JLR194

Humidity within the passenger compartment is controlled by raising and lowering the evaporator temperature. An increase in evaporator temperature increases the moisture content of the air entering the passenger compartment. Lowering the evaporator temperature reduces the moisture content of the air entering the passenger compartment.

Ambient Air Temperature Sensor

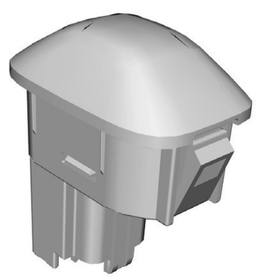
The ambient air temperature sensor is a NTC thermistor that provides the ATC module with an input of external air temperature. The sensor is hardwired to the ECM, which transmits the temperature to the CJB on the high speed CAN bus. The CJB acts as a gateway and transmits the ambient air temperature on the medium speed CAN bus for use by other systems. The sensor is installed in the LH door mirror and is accessed by removing the mirror glass, cap, and actuator.



810JLR100

Sunload Sensor

The dual-zone climate control system is equipped with a front sunload sensor; the four-zone system is equipped with a front and rear sunload sensor. The front sensor is located in the center of the instrument panel just below the windshield, and is hardwired to the ATC module. The rear sensor is located in the center of the rear parcel shelf below the rear screen, and is hardwired to the RCCP.



711JLR205

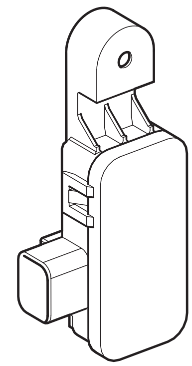
The sunload/autolamp sensor consists of two photoelectric cells that provide the Automatic Temperature Control (ATC) module with inputs for light intensity. Each photoelectric cell is positioned to sense solar load only from one side of the vehicle (LH or RH). The solar load is calculated by the change in sensor circuit voltage.

The separate LH and RH solar load signals allow the ATC module to independently trim driver and passenger discharge air temperature, compensating for LH and RH solar load.

The sensor enables the ATC module to react to sunlight by trimming the settings of the temperature blend flaps and blower speed in order to increase the cooling effect as necessary.

Pollution Sensor

The pollution sensor (mounted in front of the A/C condenser) monitors levels of smog-producing contaminants – which include hydrocarbons and oxidized gases such as nitrous oxides, sulfur oxides, and carbon monoxide – from the ambient air in front of the vehicle. The ATC module uses pollution sensor input signals to control the air intake source. The recirculation (fresh/recirc) door is opened or closed in direct response to changes in pollution levels in order to reduce pollution contaminants entering the cabin.



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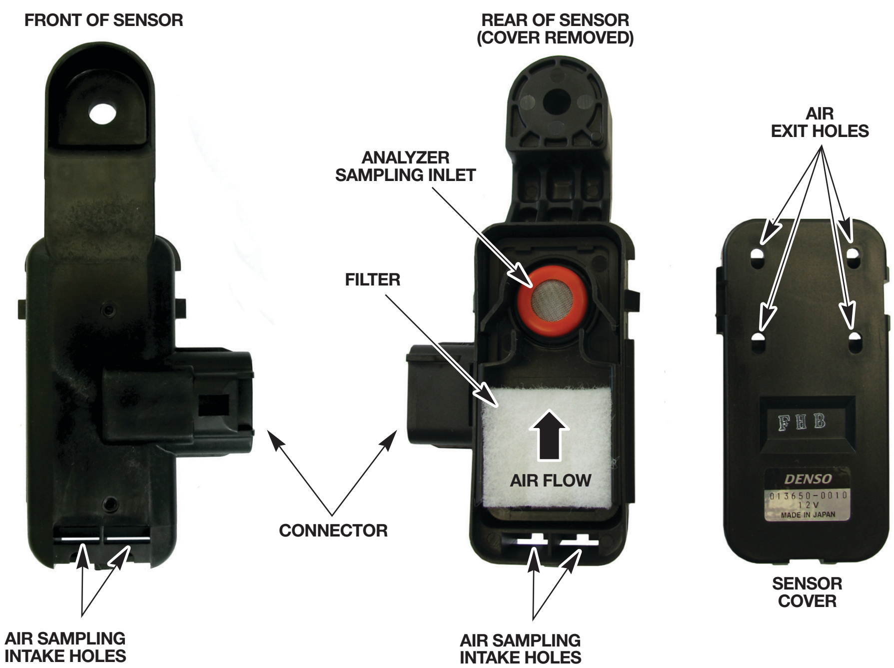
Pollution Sensor Strategy

- Only active while in ATC AUTO mode, and is fully automatic
- Can be overridden by manual selection of the air source using the recirculation control switch below the Touch Screen Display (TSD)
- Sensor sensitivity response levels can be adjusted from the TSD

The pollution sensor relies on the continuous airflow over the condenser to draw ambient air to sample for contaminant levels. Air is drawn through sampling holes on the bottom front of the sensor.

NOTE: The sensor is directional and must be oriented with the front facing forward for proper operation.



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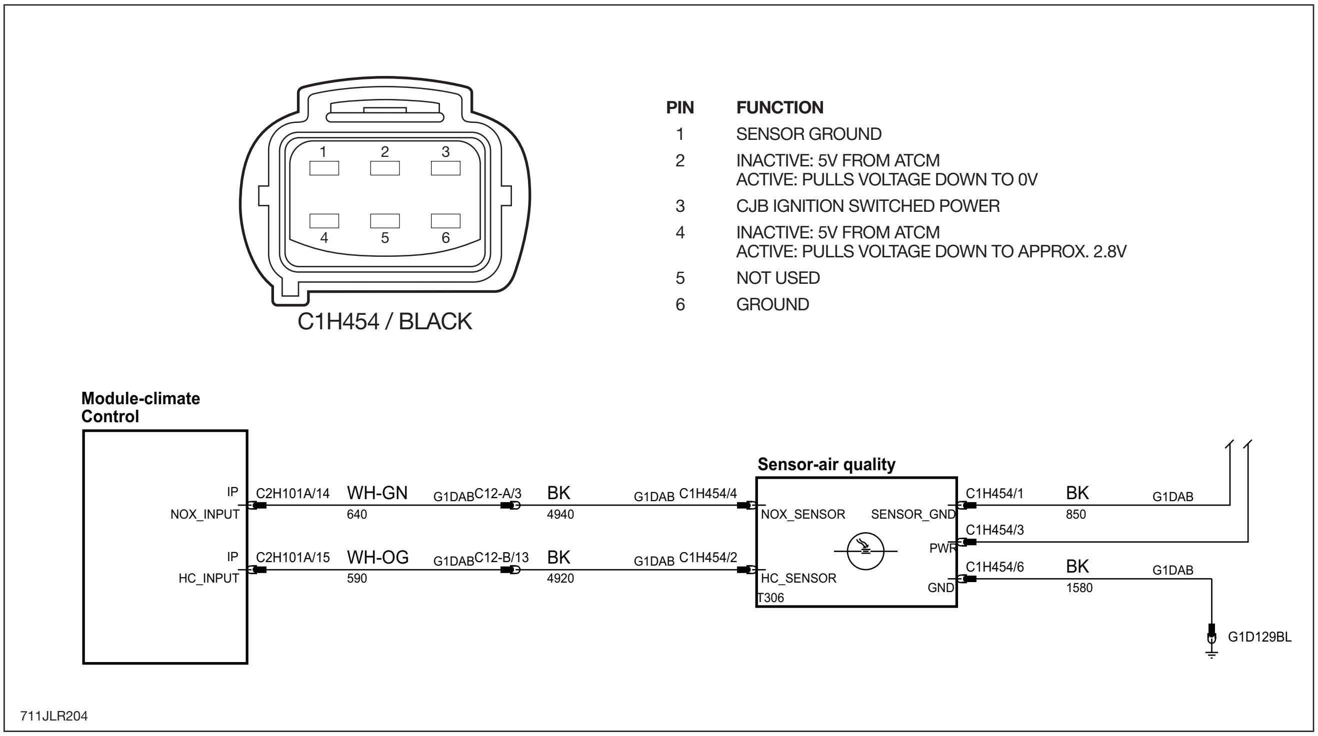
The pollution sensor is powered by an ignition-controlled voltage feed from the CJB and provides separate input signals for hydrocarbon and oxidized gas levels to the ATC module.

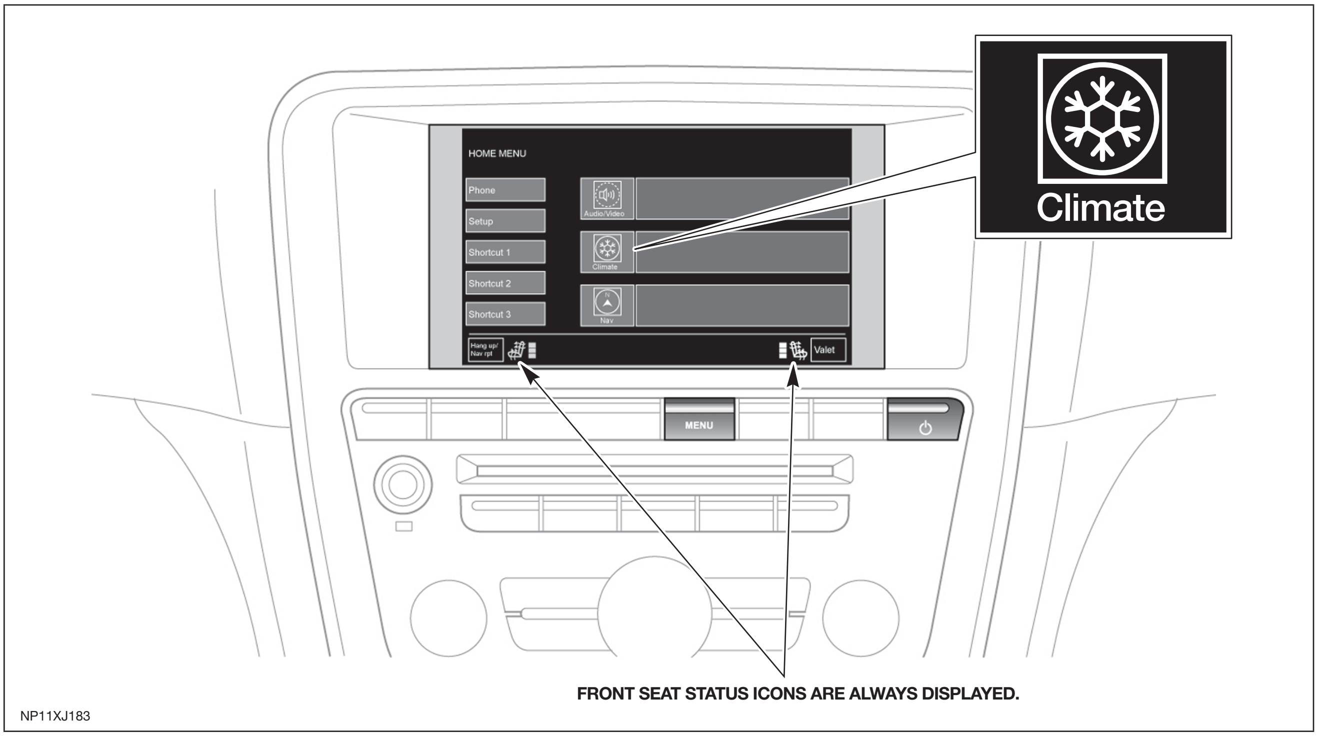


Diagnostics

- Sensor fault codes are stored in the ATC module and can be accessed using SDD
- If there is a fault with the sensor, the ATC module disables automatic operation of the recirculation door based on air quality
- Pollution sensor Parameter Identification Data (PIDs) can be monitored using SDD

Climate Control Touch-Screen and ICP Controls

Pressing the Climate Control icon on the Touch-Screen Home Menu activates the Front Climate menu.

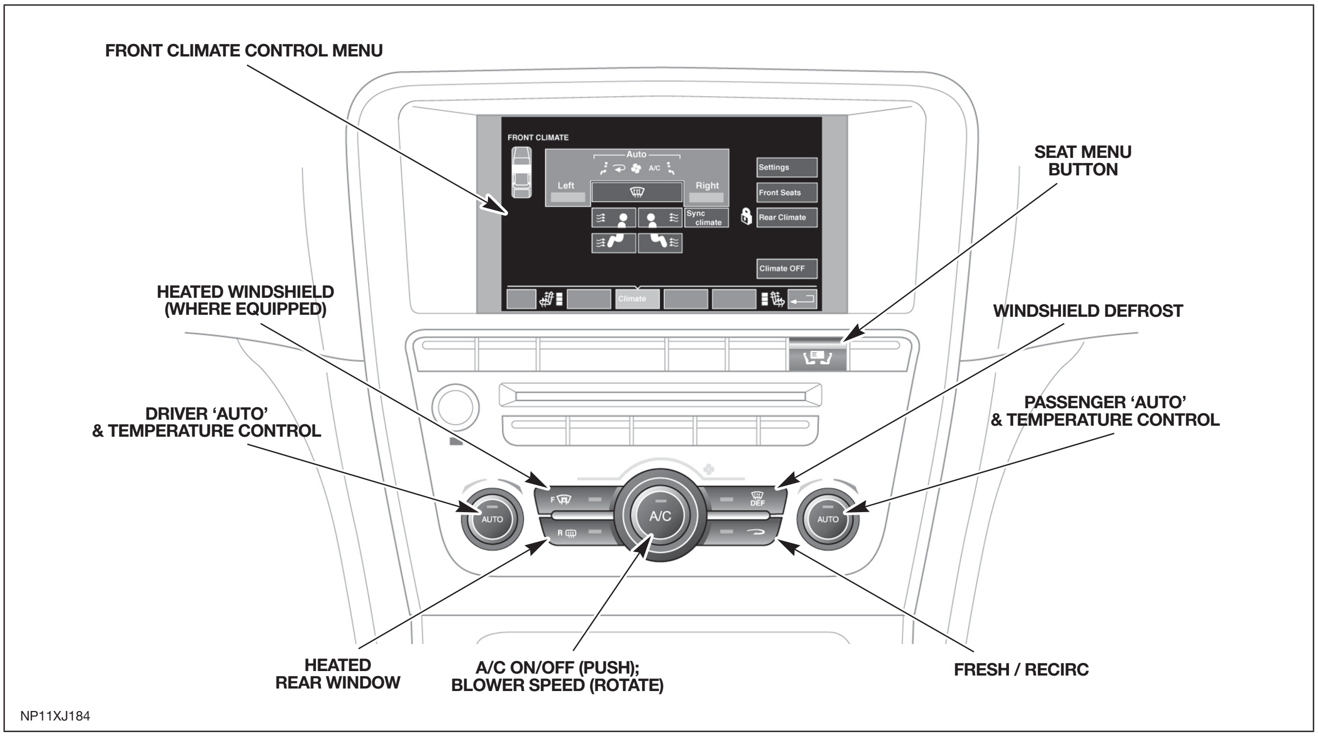


From the Front Climate menu, the user can access/control the following options:

- Air distribution to:
  - Defrost
  - Front LH or RH Face
  - Front LH or RH Feet
- Sync
  - Match driver/passenger(s) temperature
- Air Quality sensor sensitivity (via ‘Settings’)
- Front Seats adjust:
  - Temperature/Zone
  - Massage
- Rear settings (via ‘Rear Climate’)
  - Air temperature and distribution
  - Heated rear seat control (where equipped)
  - Heated/cooled rear seats & zone control (where equipped)
  - Panel lock

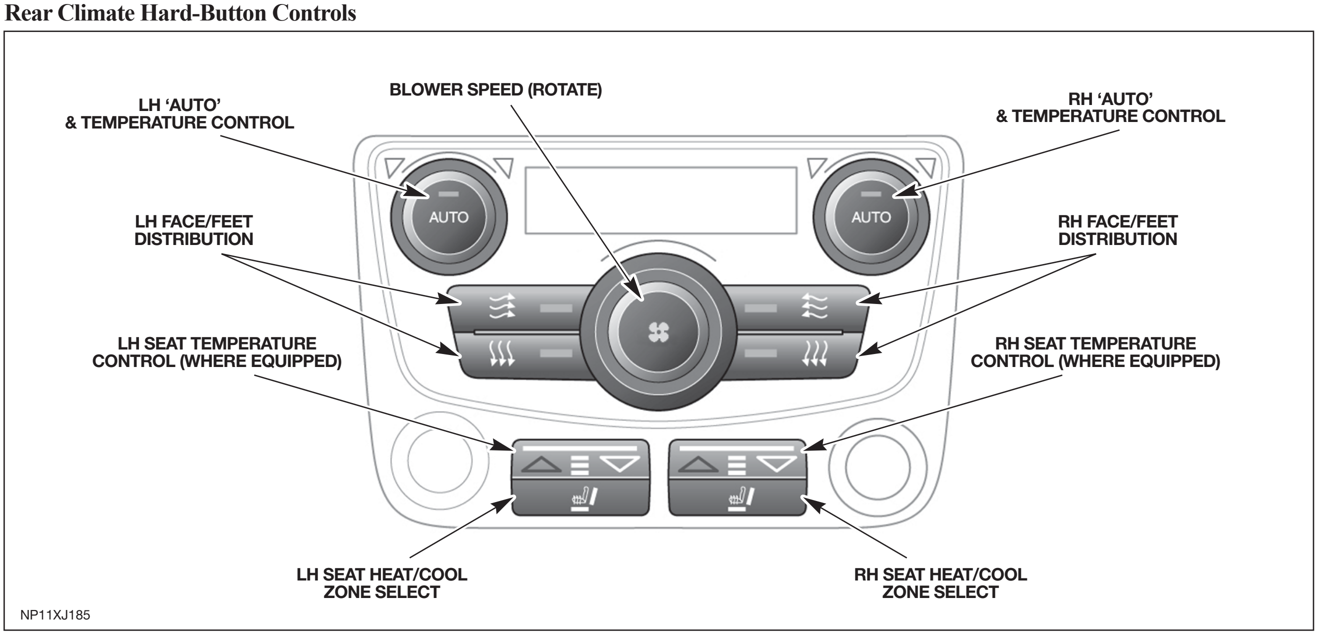
The hard buttons and rotary switches on the Integrated Control Panel (ICP) provide control for driver and passenger temperature, blower speed, A/C on/off, heated windshield (where equipped) and rear window, and recirculation. There is also a Seat Menu hard button to access the Touch-Screen front seat controls (heating, ventilation, and massage).

Front Climate Touch-Screen Menu and ICP Controls



The rear control panel provides controls for the rear occupants.

Rear Climate Hard-Button Controls



Principles of Operation

Air Inlet Control

The source of inlet air is automatically controlled by the ATC module, unless overridden by pressing the air recirculation switch on the ICP to give timed or latched recirculation. A brief press of the switch illuminates the switch indicator and activates timed recirculation. Pressing and holding the switch causes the switch indicator to flash and then illuminate constantly, indicating that the air inlet is in latched recirculation and the switch can be released. A second press of the switch cancels recirculation and the ATC module returns the recirculation door to the fresh air position. Timed recirculation is automatically cancelled after a set time, which varies with ambient air temperature.

During automatic control, the ATC module determines the required position of the recirculation door from its 'comfort' algorithm and the pollution sensor. If the sensor detects pollution, the ATC module sets the air source to recirculation for 10 minutes, then to fresh air for 20 seconds to renew the air in the vehicle. The ATC module repeats this cycle until the pollution is no longer detected.

The sensitivity of the pollution sensor can be adjusted on the TSD using the 'Settings' button on the 'FRONT CLIMATE' menu. The pollution sensing function can also be switched off by adjusting sensitivity to the minimum setting. If there is a fault with the pollution sensor, the ATC module disables automatic operation of the recirculation door based on air quality.

Air Temperature Control

The temperature blend doors adjust the proportion of cool air from the evaporator that passes through the heater core to produce the required output air temperature.

The temperature blend doors for each zone are operated independently to enable individual temperature settings for the different zones. The temperature blend doors are operated by stepper motors, which are controlled by the ATC module using Local Interconnect Network (LIN) bus messages.

The ATC module calculates the temperature blend stepper motor positions required to achieve the selected temperature and compares it against the current position. If there is any difference, the ATC module signals the stepper motors to adopt the new position.

Air temperature is controlled automatically unless maximum heating (HI) or maximum cooling (LO) is selected. When maximum heating or cooling is selected, a 'comfort' algorithm in the ATC module adopts an appropriate strategy for air distribution, blower speed, and air source.

Temperature control in one zone can be compromised by another zone being set to a high level of heating or cooling. True maximum heating or cooling (displayed as HI or LO on the TSD) can only be selected for the driver's zone. If HI or LO is selected for the driver's zone, the temperature for the other zone(s) is automatically set to match the driver's zone.

If A/C (air conditioning) is selected off in the automatic mode, no cooling of the inlet air will take place. The minimum output air temperature from the system will be ambient air temperature plus any heat pick up in the air inlet path.

If the SYNC button on the TSD is pressed, the ATC module synchronizes the temperature of the other zone(s) with the driver's zone. Sync is cancelled when another temperature zone is adjusted other that the driver' zone.

Blower Control

When the system is in the automatic mode, the ATC module determines the blower speed required from a comfort algorithm. When the system is in the manual mode, the ATC module operates the blower at the speed selected using the rotary control blower switch on the ICP. The ATC module also adjusts blower speed to compensate for the ram effect on inlet air produced by forward movement of the vehicle. As vehicle speed and ram effect increases, blower motor speed is reduced, and vice versa.

On vehicles fitted with the four zone system, the system cannot be turned on using the rotary blower control on the rear climate control panel. This is to encourage the use of the AUTO mode. Provided the rear climate control panel is unlocked, pressing a rear AUTO button on the rear climate control panel will reactivate the system if previously off.

Air Distribution Control

Air distribution doors direct the air to the individual vents and registers in the passenger compartment. The doors are operated by stepper motors, which are controlled by the ATC module using LIN bus messages.

When the A/C system is in automatic mode, the ATC module automatically controls air distribution into the passenger compartment in line with its 'comfort' algorithm. Automatic control is overridden if any of the buttons on the TSD, or switches on the ICP or rear climate control panel, are selected. Air distribution remains as selected until one of the AUTO switches is pressed or a different manual selection is made.

A/C Compressor Control

When A/C is selected the ATC module maintains the evaporator at an operating temperature that varies with the passenger compartment cooling requirements. If the requirement for cooled air decreases, the ATC module raises the evaporator operating temperature by reducing the flow of refrigerant provided by the A/C compressor. The ATC module closely controls the rate of temperature increase to avoid introducing moisture into the passenger compartment.

If the requirement for cooled air increases, the ATC module lowers the evaporator operating temperature by increasing the flow of refrigerant provided by the A/C compressor.

When A/C is off, the compressor current signal supplied by the ATC module holds the A/C compressor solenoid valve in the minimum flow position, effectively switching off the A/C function.

The ATC module incorporates limits for the operating pressure of the refrigerant system. If the system approaches the high pressure limit, the compressor current signal is progressively reduced until the system pressure decreases. If the system falls below the low pressure limit, the compressor current signal is held at its lowest setting so that the A/C compressor is maintained at its minimum stroke. This avoids depletion of the lubricant from the A/C compressor.

A/C Compressor Torque

The ATC module transmits refrigerant pressure and A/C compressor current values to the ECM over the medium speed then high speed CAN bus, using the CJB as a gateway. The ECM uses these values to calculate the torque being used to drive the A/C compressor. The ECM compares the calculated value with its allowable value and, if necessary, forces the ATC module to inhibit the A/C compressor by transmitting the 'AC Clutch Inhibit' CAN message. This forces the ATC module to reduce the drive current to the A/C compressor solenoid valve, which reduces refrigerant flow. This in turn reduces the torque required to drive the A/C compressor.

By reducing the maximum A/C compressor torque, the ECM is able to reduce the load on the engine when it needs to maintain vehicle performance or cooling system integrity.

Cooling Fan Control

The ATC module determines the amount of condenser cooling required from the refrigerant pressure sensor, since there is a direct relationship between the temperature and pressure of the refrigerant. The cooling requirement is broadcast to the CJB on the medium speed CAN bus. CJB converts the message to high speed CAN to the ECM. The ECM then controls the temperature of the condenser using the cooling fan.

Programmed Defrost

The programmed defrost DEF switch is located on the ICP. When the switch is pressed, the ATC module instigates the programmed defrost function. When selected, the ATC module configures the system as follows:

- Automatic mode off
- A/C on
- Selected temperature unchanged
- Air inlet set to fresh air
- Air distribution set to windshield
- Blower speed set to level 6

The ATC module also sends a medium speed CAN message to the CJB to activate the windshield heater (where fitted) and rear window heater

On vehicles fitted with the four zone system, the rear climate control panel shows a defrost symbol to indicate that the system is in defrost and no air flow will be available to the rear vents.

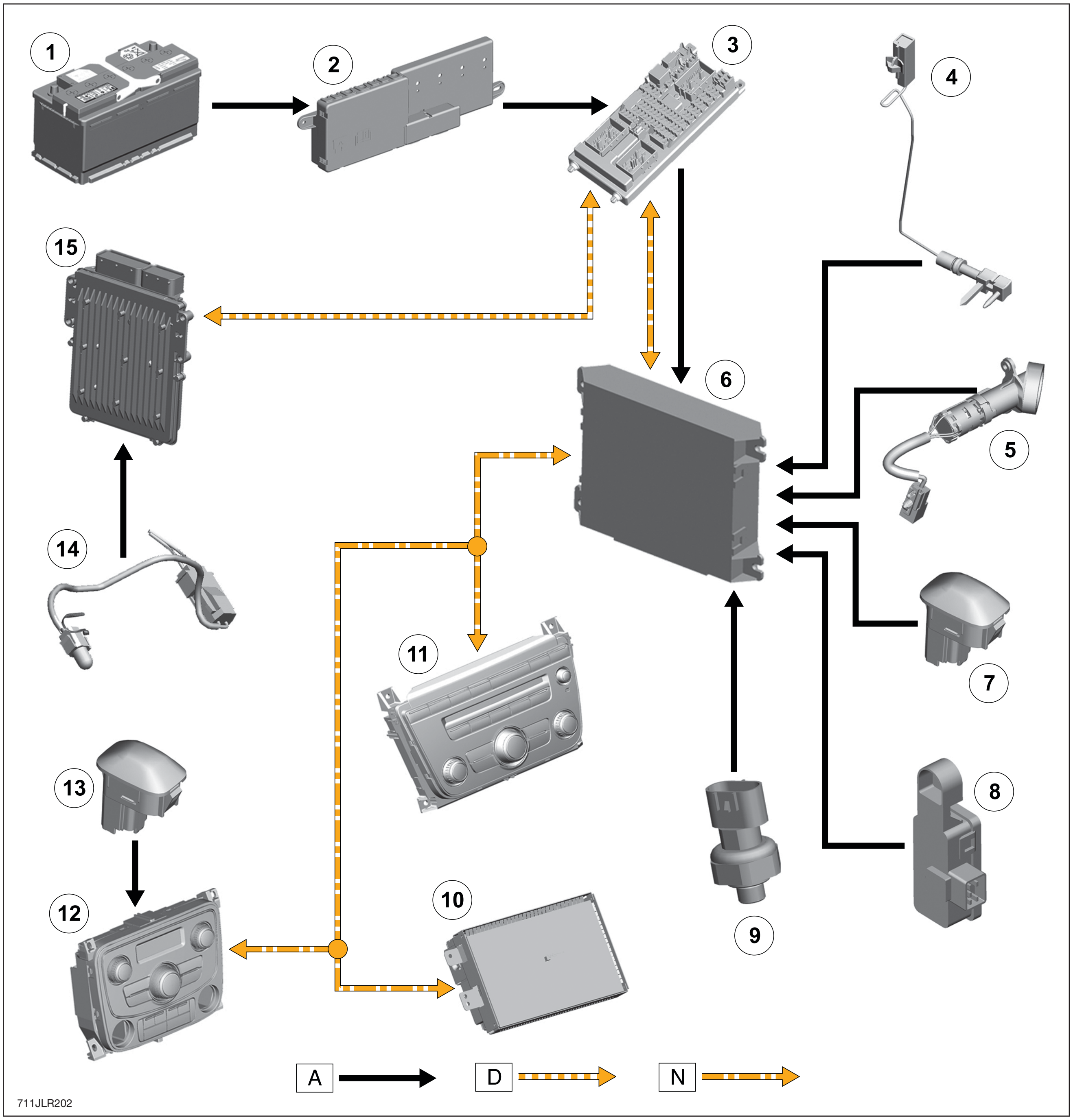
The programmed defrost function can be cancelled by one of the following:

- A second press of the DEF switch
- Selecting any air driver side distribution button on the TSD
- Pressing the driver side AUTO switch on the ICP

The blower speed can be adjusted without terminating the programmed defrost function. If the blower speed has been adjusted and then the DEF switch is pressed again, the system will go back to the DEFROST default settings. Another press of the DEF switch, or pressing the driver AUTO switch, will exit the DEFROST mode but leave the heated screen(s) on.

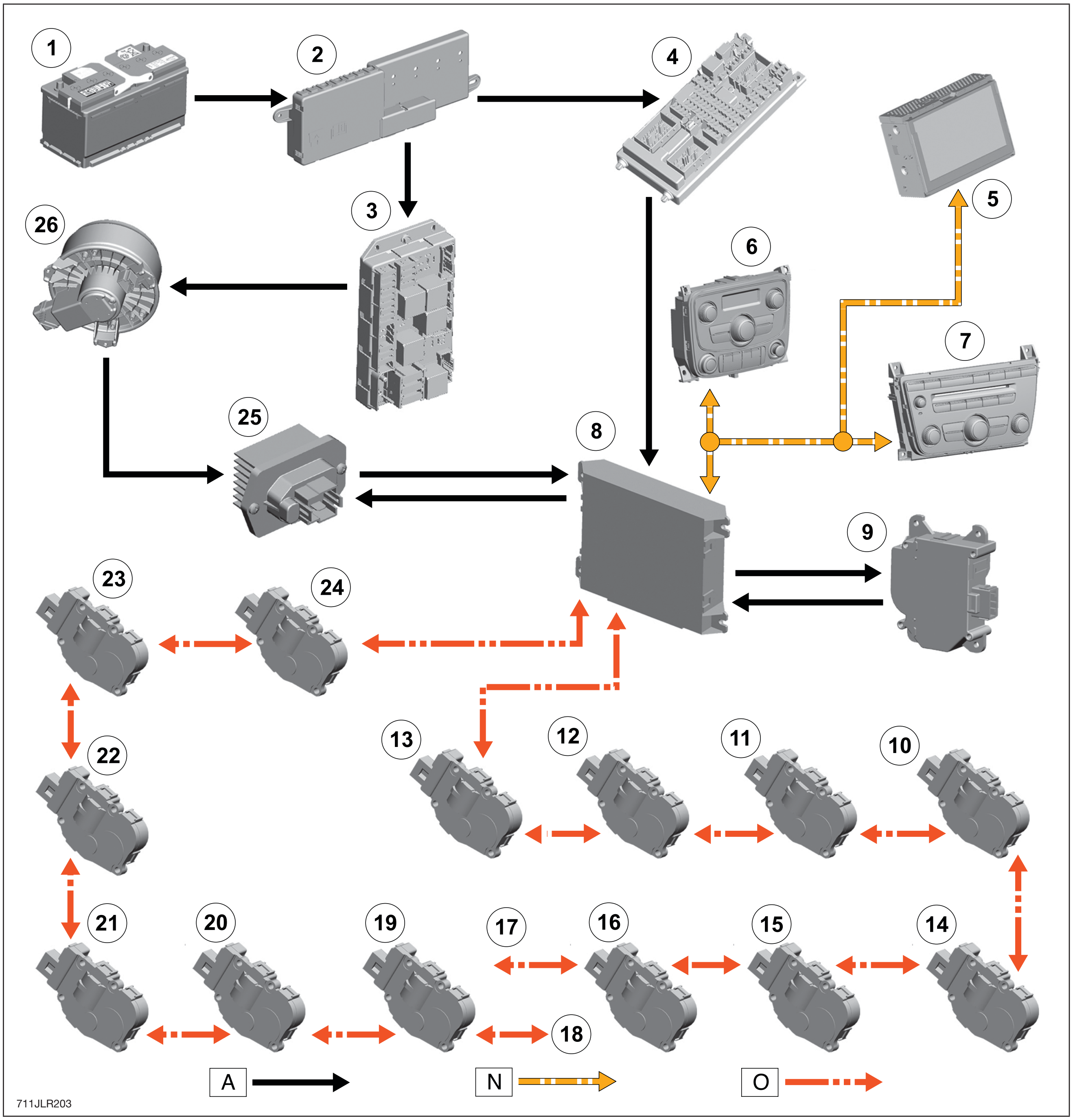
Control Diagrams

Control System: Part 1



A	Hardwired	4	Evaporator temperature sensor	10	TSD
D	HS CAN bus	5	Cabin humidity and temperature sensor	11	ICP
N	MS CAN bus	6	ATC module	12	Rear climate control panel (where equipped)
1	Battery	7	Front sunload sensor	13	Rear sunload sensor (where equipped)
2	BJB (50 A midi fuse)	8	Pollution sensor	14	Ambient air temperature sensor
3	CJB	9	Refrigerant pressure sensor	15	ECM

Control System: Part 2



A Hardwired
N MS CAN bus
O LIN bus
1 Battery
2 BJB
3 RJB
4 CJB
5 TSD
6 Rear climate control panel
7 Integrated control panel
8 ATC module
9 Fresh air / recirculation servo
10 RH rear temperature blend stepper motor
11 Defrost stepper motor
12 RH front foot stepper motor
13 RH front temperature blend stepper motor
14 RH front face stepper motor
15 RH rear face stepper motor
16 RH rear foot stepper motor
17 To RH rear mat type seat heating if equipped
18 To LH rear mat type seat heating if equipped
19 LH rear foot stepper motor
20 LH rear face stepper motor
21 LH front face stepper motor
22 LH rear temperature blend stepper motor
23 LH front foot stepper motor
24 LH front temperature blend stepper motor
25 Blower motor controller
26 Blower

711-JAG: Jaguar Climate Control Systems

Climate Controlled Seats

JAGUAR

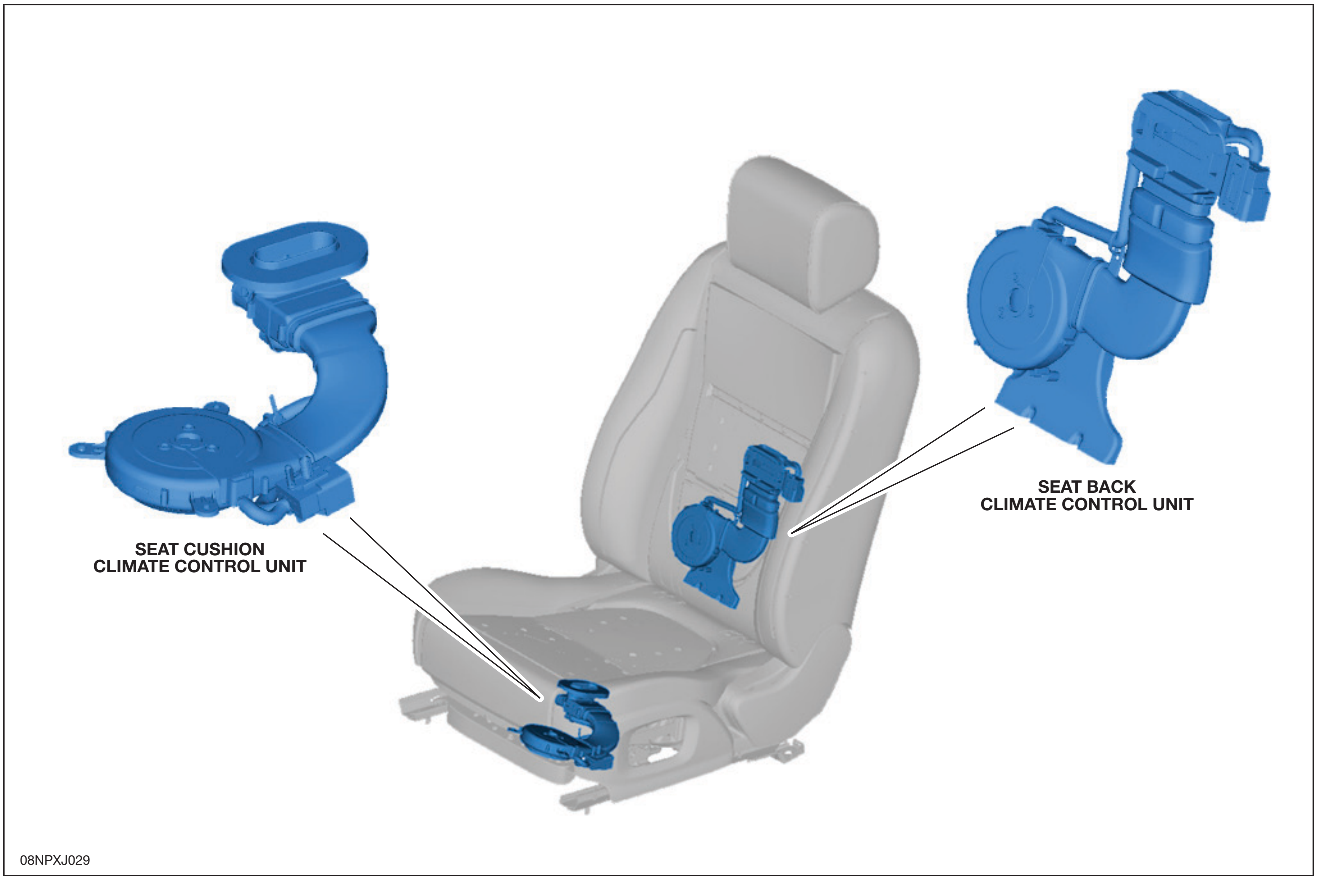
711-JAG 03/2011
Printed in USA

OVERVIEW

Vehicles fitted with the Climate Controlled Seat™ system (CCS) significantly improve the comfort level of the occupants by focusing heating and cooling directly on the passenger through the seat. The CCS system uses a Peltier cell to provide individual heating and cooling to the front and, if equipped, rear seat assemblies.

Each climate-controlled seat contains two climate units, one located in the seat back and the other in the seat cushion. Each contains a filter, blower fan, Peltier cell, and air duct. Ported channels in the foam cushions evenly direct the flow of conditioned air through breathable perforated leather seat covers to the occupant.

Typical Climate Controlled Seat



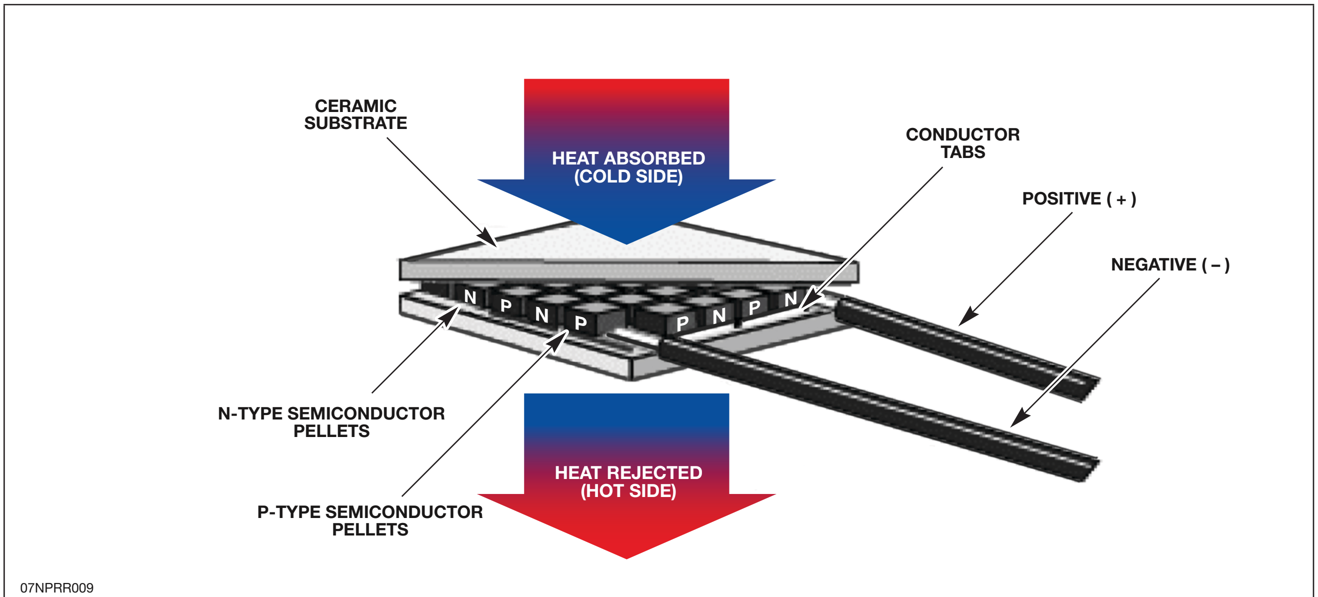
NOTE: Climate controlled seats operate independently of the Automatic Temperature Control System, using a separate Climate Controlled Seat Module.

Peltier Cells

The Climate Control Seat (CCS) system uses a Peltier cell, also known as a proprietary Thermoelectric Device (TED). Named for Jean Peltier, who discovered the thermoelectric cooling effect in 1834, the Peltier effect occurs when an electrical current is passed through a junction formed by two dissimilar conductors, creating a heat pump. A heat pump absorbs heat from one side of the system, causing it to cool, and then transfers the heat to the other side, causing it to warm. Jaguar vehicles use solid-state Peltier cells that consist of a number of semiconductor elements, sandwiched between two substrates and connected in series and parallel.

When current is applied in one direction, one side absorbs heat (creating a cooling effect) while the other the cell rejects heat. Switching polarity between the circuits creates the same effect but in the opposite direction.

The operation is similar to a conventional air conditioning system; one cell acts as the evaporator and absorbs heat while the other cell is the condenser which expels the heat. The pump is replaced by an electrical charge and the heat energy is transported by the cell's metal construction rather than by a refrigerant.



It is important to understand the operation and limitations of the Peltier cell. A Peltier cell has an efficiency of only 5-10%, compared to a conventional air conditioning system with an efficiency of 40%. The cell is capable of cooling the incoming air by approximately 8°C (12.4°F), which means that temperature output will depend on the ambient temperature inside the vehicle.

Example: If the temperature in the vehicle is the same as or exceeds the heat rejection side of the cell, poor cooling will be the result. If the temperature is colder than the heat absorption rate, the cell may start to ice up.

Benefits of using TEDs:

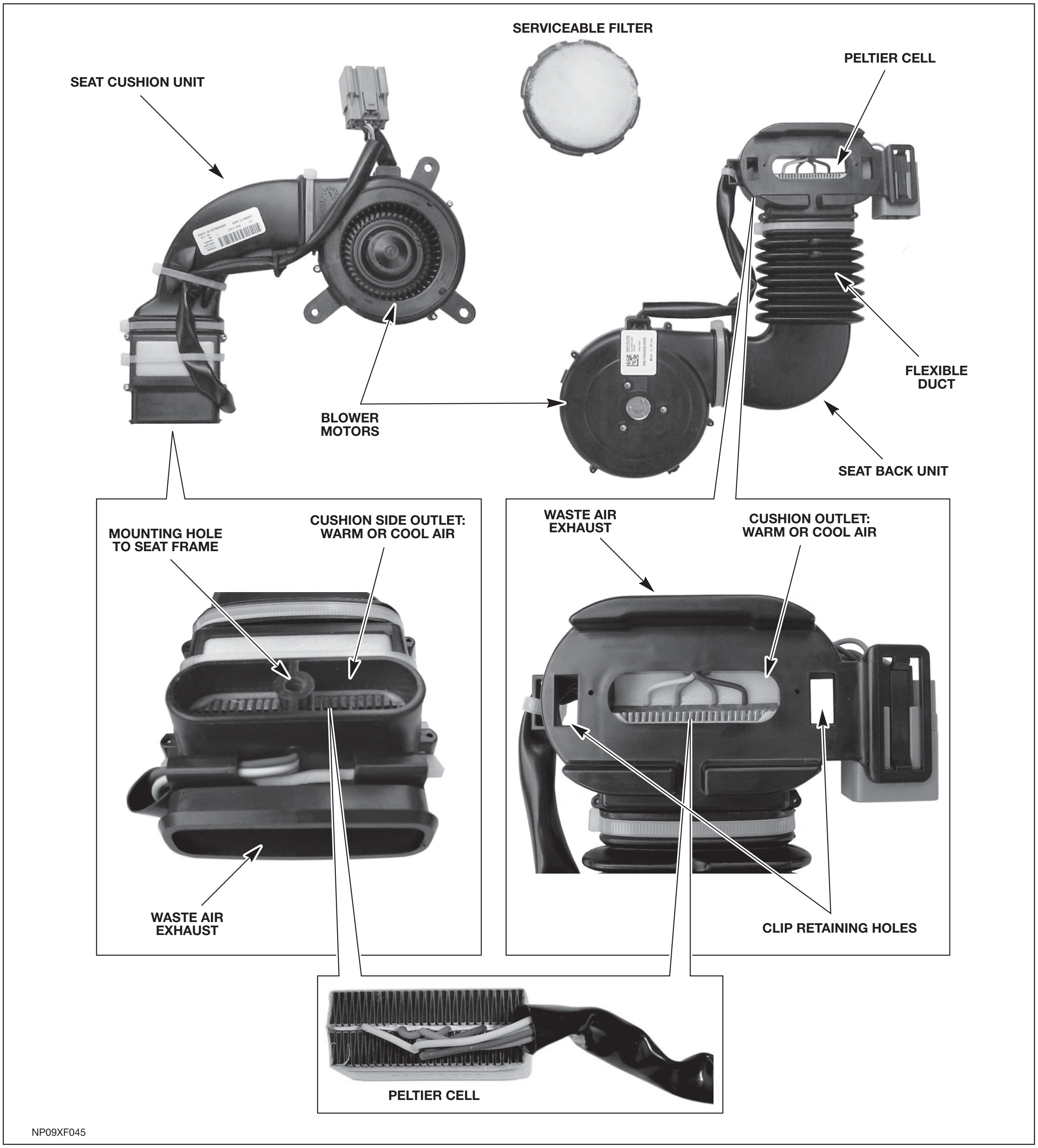
- Ability to cool or heat by simply reversing current flow
- Solid-state device, no moving parts
- Rugged, highly reliable
- Quiet, small & lightweight
- Pulse width modulated with feedback for accuracy

PRINCIPLES OF OPERATION

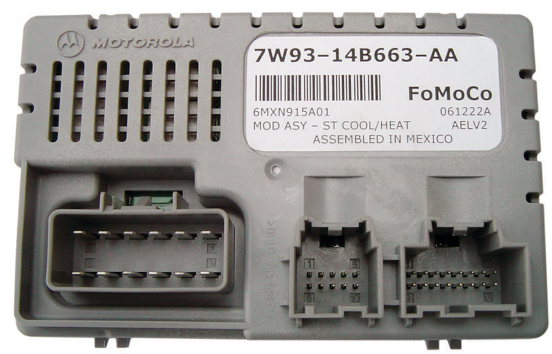
The controlling software for the climate controlled seats is contained within a designated Climate Controlled Seat Module (CCSM). One CCSM is designated for each pair of seats, one for front seats and the other for rear seats when equipped. The CCSM communicates across the CAN network.

All climate controlled seats contain two Peltier cells: one in the cushion, one in the backrest. The Peltier cells deliver heating and cooling based on a current provided by the control module. Each seat also contains two fans, which blow air over the Peltier cells to distribute heating or cooling throughout the seat.

Climate Units (front shown)



Climate Controlled Seat Module



08NPXJ033

The Climate Controlled Seat Module (CCSM) communicates on the CAN Bus, as it requires information from other modules for operation (such as engine speed). The CCSM has an internal electrical load management strategy which will enable or disable operation of the Peltier cells based on electrical loads in the vehicle. The CCSM achieves this by monitoring its own terminal voltage. If the CCSM voltage drops, it will initially change to a reduced power mode (system still operates but at a reduced power). When the voltage increases, the CCSM will return to normal power mode; if the voltage does not return quickly, the system will shut off. To prevent the system from cycling on and off during changes in electrical loads, the voltage threshold for return to normal power mode is set high. For example, if the system voltage drops below 12.5 volts, the CCSM strategy will apply reduced power mode; in order for the CCSM to return to normal power mode the voltage must be above 13.5 volts. This prevents the system from quickly reverting to reduced power mode and thus ensures smooth operation.

The CCSM uses a PWM signal to regulate the temperature of the Peltier cells and a variable-voltage for the speed of the blower fans in order to maintain the selected temperature. Fan speed may increase or decrease slightly while on a specific setting as the controller regulates system output temperature.

The CCSM logic goes through a series of steps when the system receives a command, depending on the mode selected and whether the cells are hot or cold. The CCSM powers up the cells with minimum air flow to set the cell temperature, then steps up the blower speed to ensure the correct temperature is achieved quickly.

Heat Mode Operation

The CCSM operates in a closed-loop control mode using the feedback from the system thermistor. The Peltier cells are wired in parallel in heat mode with nearly full battery voltage across each cell when first turned on. The CCSM monitors the NTC fin temperature sensors and adjusts the PWM duty cycle to the Peltier cells and blower speed to achieve and maintain the temperature set point. The airflow from the blower is split is over both sides of the cell, half going into the seat cushions and the other half released as waste. If either blower fails or the cells start to overheat, the CCSM will shut down both the assemblies in the individual seat for protection.

Cool Mode Operation

The CCSM operates in an open-loop mode. In cool mode the Peltier cells are wired in series, sharing the supply voltage across both of the cells. If the seat is switched from cushion and seat back to just seat back, the seat back now receives full voltage.

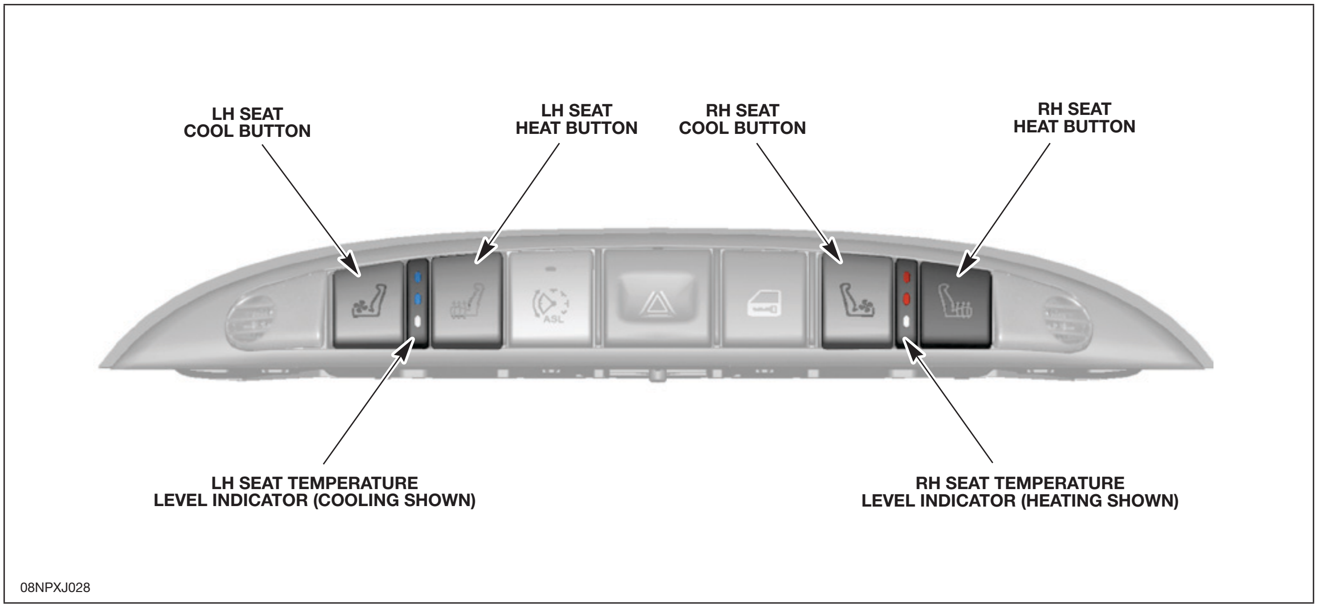
The difference between heat and cool modes is in the way the system is controlled. The CCSM monitors the fin temperature to ensure that the system is working properly with no PWM adjustments to the Peltier cells. For example, if the CCSM sees the fin temperature on the cells getting very cold to a potential ice up condition, it will turn off the cells for approximately 4 seconds, until the temperature stabilizes, then restart. During this process the blower speed will cycle from low to high, which may be noticeable to the user. This is considered normal operation if there are no codes stored in the CCSM.

The Peltier cells will not operate unless the engine is running, although the switch LEDs will illuminate if a selection is made when the ignition is switched on. After the ignition is switched off, the CCSM will retain the current temperature settings for approximately 15 minutes. After this period, the seats will be set to ‘off’ when the ignition is switched back on.

2008 – 2009 MY XJ

Temperature Control Switches

Temperature control switches are located in the instrument panel switch pack above the touch screen display (TSD). There are separate switches for heating or cooling. The switches are momentary contact non-latching.

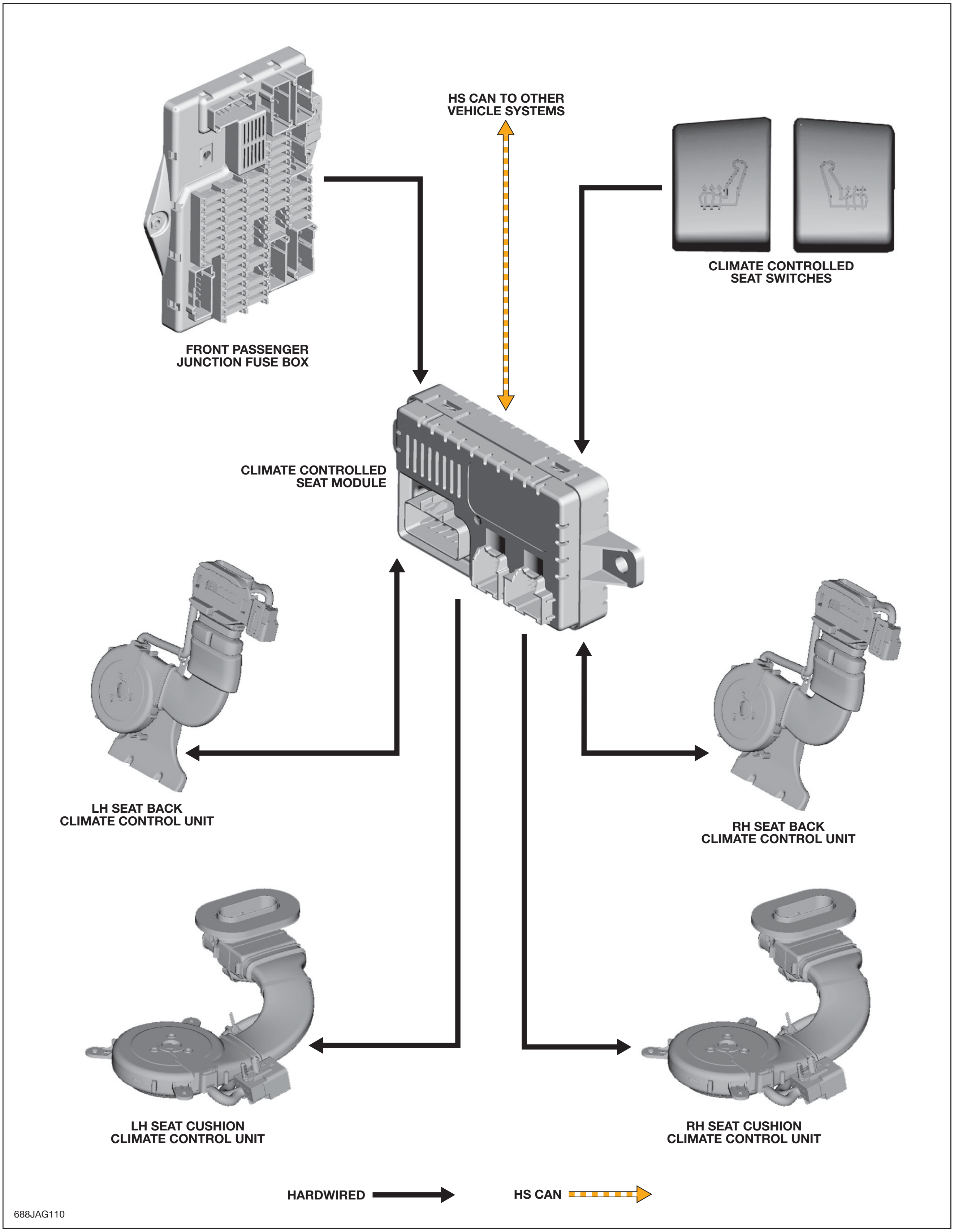


The electronics in the switch pack capture switch presses and step through the three levels of heating or cooling. The temperature level indicators light up either red or blue to show the selected level of heating or cooling. The internal electronics in the switch pack then output a steady PWM signal representing the selected heating or cooling level to the Climate Control Seat Module (CCSM).

When one of the heating or cooling settings is selected, filtered ambient air is circulated by a fan, forcing the air through a Peltier cell, where it is thermally conditioned.

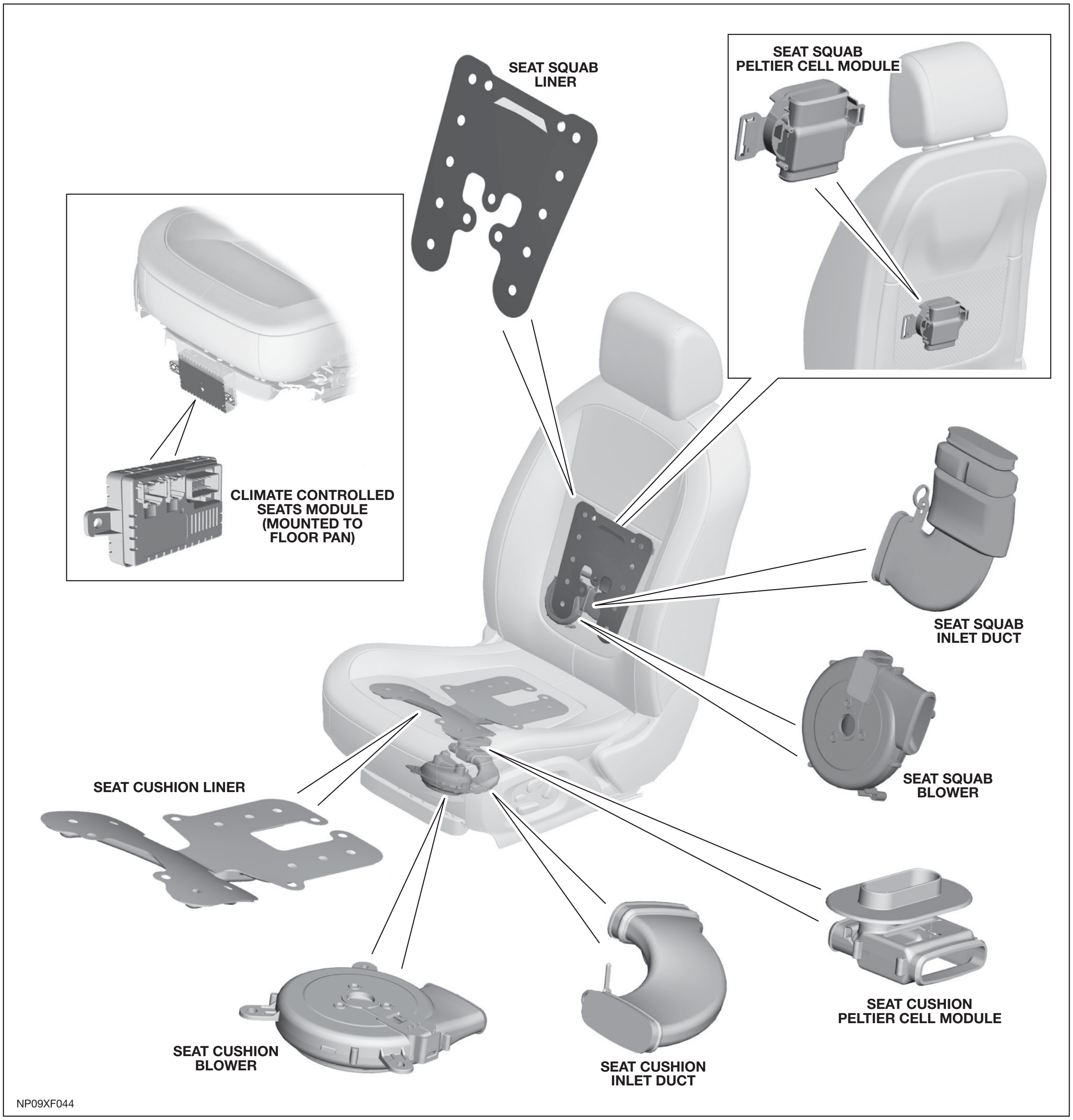
Due to electrical loads, if the CCS system is activated with the key on / engine off, the lights will illuminate on the dash, but the system will not operate.

Control Diagram: 2008 – 2009 XJ



2009 MY ONWARD XF

NOTE: CCS is not standard equipment on all XF vehicles.

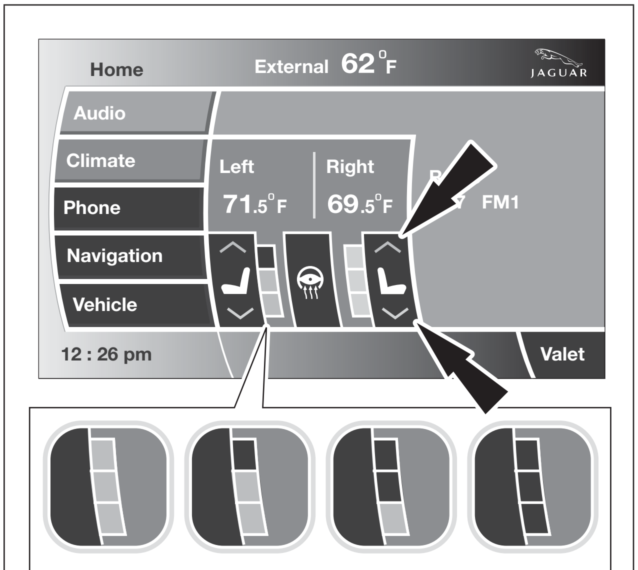


NOTE: Due to electrical loads, if the CCS system is activated with the key on / engine off, the system will not operate.

Touch Screen Display

Temperature control selections are made using the TSD from either the Climate menu or Home menu.

Heating and cooling requests are generated using the soft buttons on the TSD. The TSD captures switch presses and steps through the three levels of heating or cooling. The temperature level indicators light up either red or blue to show the selected level of heating or cooling.

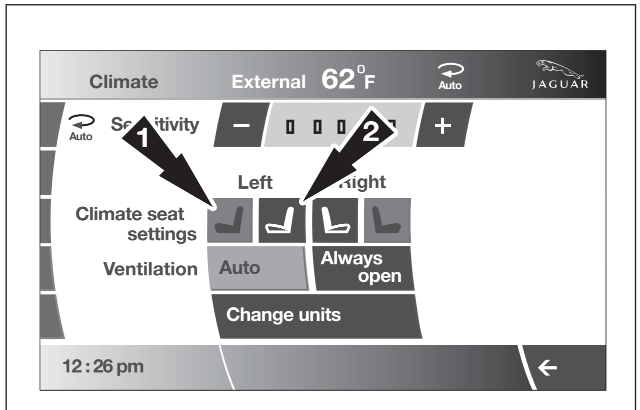


NP09XF042

Backrest Only Ventilation

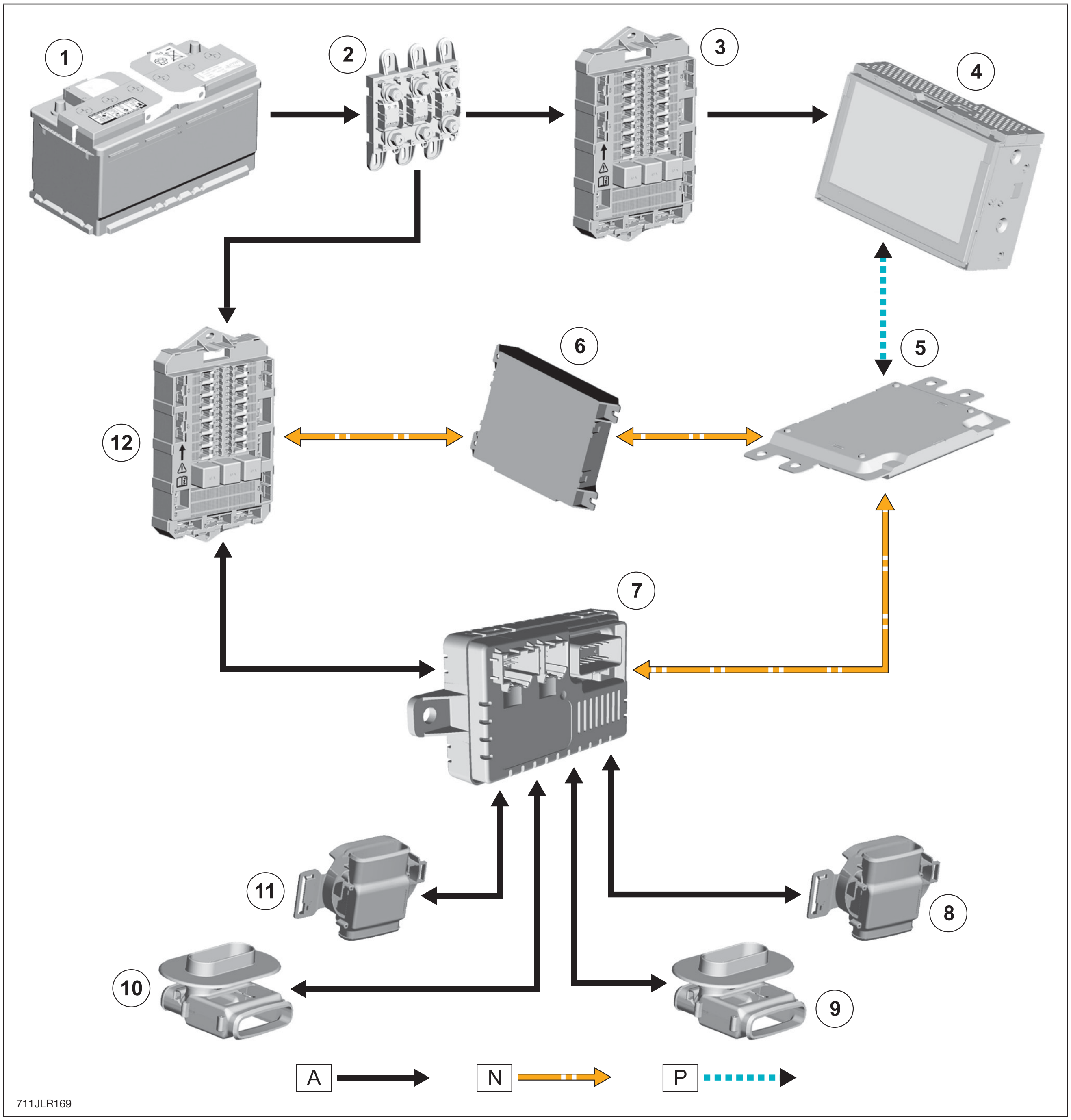
'Backrest only ventilation' allows the user to set the seat ventilation so that only the seat backrest is ventilated. Backrest only ventilation is selected using the TSD from the Climate menu.

For the left or right front seat select the appropriate icon:



NP09XF043

Control Diagram: 2009 MY Onward XF



A	Hardwired	3	RJB	8	Passenger seat squab climate module
N	Medium speed CAN bus	4	TSD	9	Driver seat cushion climate module
P	MOST ring	5	Information control module	10	Passenger seat cushion climate module
1	Battery	6	ATC module	11	Driver seat squab climate module
2	BJB	7	Climate controlled seat module	12	CJB

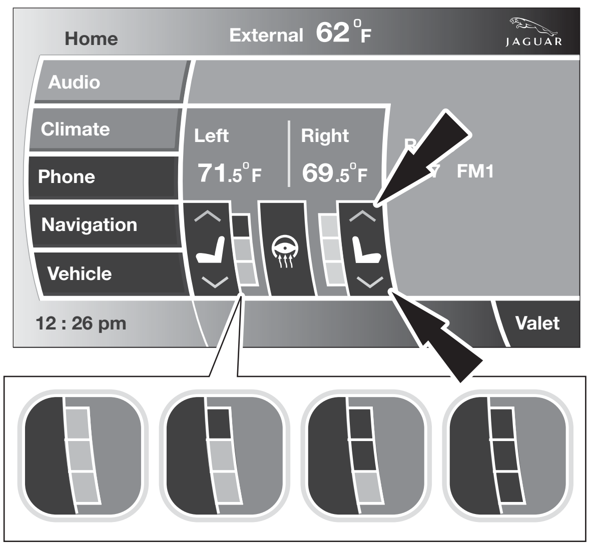
2010 MY ONWARD XK

The system consists of three-stage climate controlled (heated/cooled) seats with ‘full’ or ‘backrest only’ ventilation. The Climate Controlled Seat Module communicates on MS CAN and is mounted behind the LH side of the instrument panel.

Touch Screen Display

Temperature control selections are made using the TSD from either the Climate menu or Home menu.

Heating and cooling requests are generated using the soft buttons on the TSD. The TSD captures switch presses and steps through the three levels of heating or cooling. The temperature level indicators light up either red or blue to show the selected level of heating or cooling.

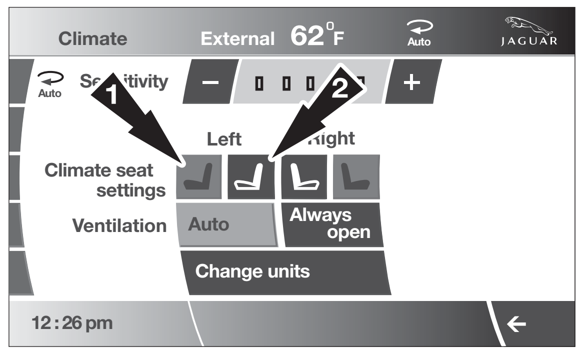


NP09XF042

Backrest Only Ventilation

‘Backrest only ventilation’ allows the user to set the seat ventilation so that only the seat backrest is ventilated. Backrest only ventilation is selected using the TSD from the Climate menu.

For the left or right front seat select the appropriate icon:



NP09XF043

Seat Back Assembly

Slight modifications have been made to the cooling units in the upper seat back assembly for improved ventilation, performance and access to the replaceable intake filter.

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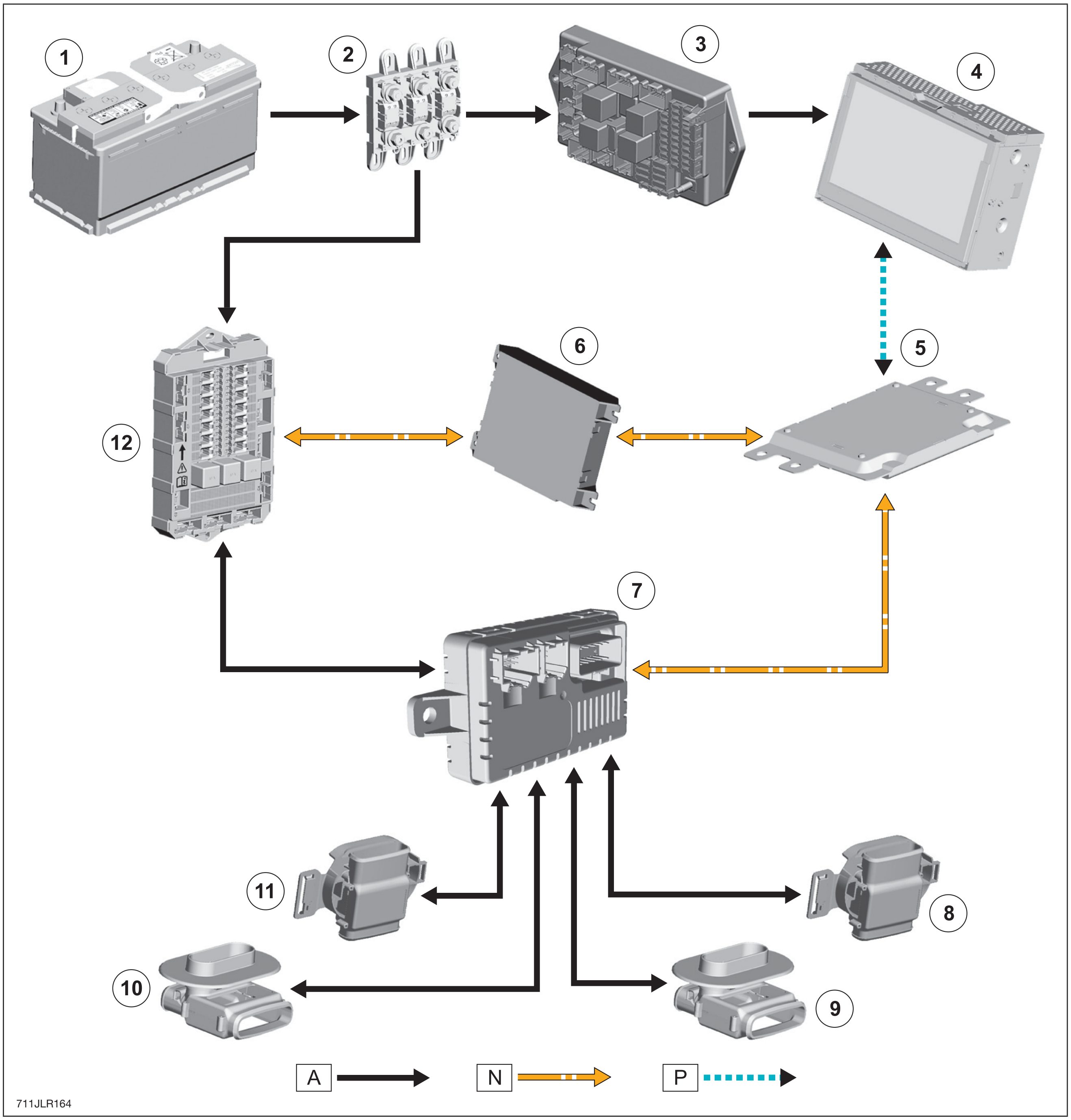
Control Diagram: 2010 MY Onward XK

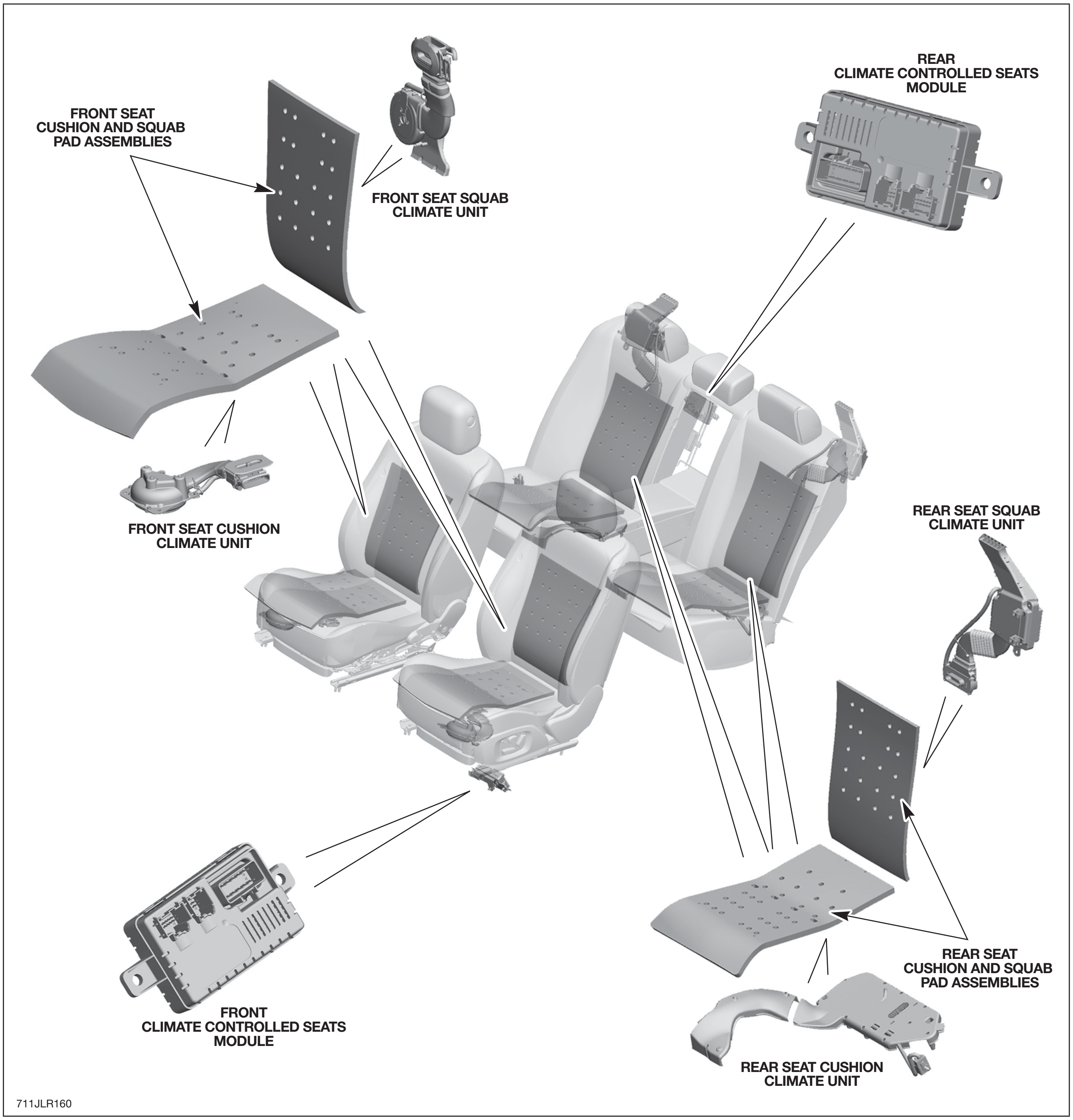


A	Hardwired	3	AJB	8	Passenger seat squab climate module
N	Medium speed CAN bus	4	TSD	9	Driver seat cushion climate module
P	MOST ring	5	Information control module	10	Passenger seat cushion climate module
1	Battery	6	ATC module	11	Driver seat squab climate module
2	BJB	7	Climate controlled seat module	12	CJB

2011 MY ONWARD XJ

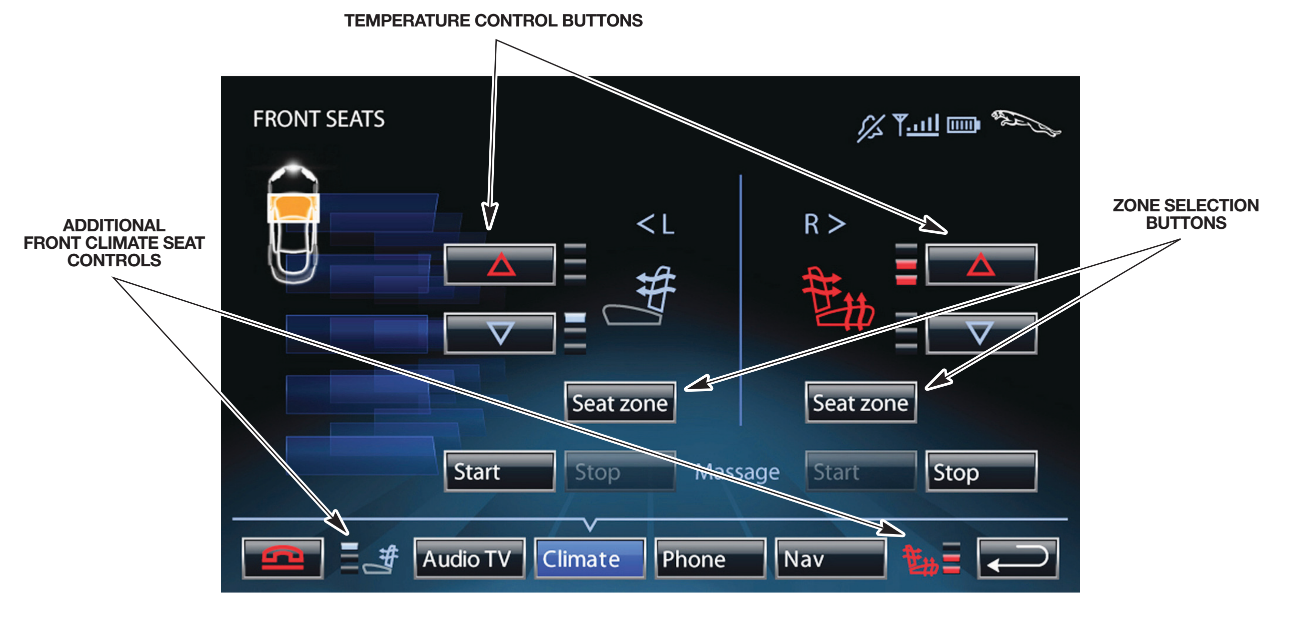
Operation of the front CCS is controlled by the climate controlled seat module attached to a bracket on the cabin floor, under the carpet at the front left corner of the LH front seat. Operation of the rear two outside climate seats is controlled by a separate climate seat control module attached to the body, behind the of the rear seat squab. Three levels of heating and three levels of cooling are available. Heating and cooling can also be selected for either the cushion and the squab, or just the squab.

All variants of the X351 are equipped with climate-controlled front seats. With the exception of the XJ Non-Luxury variant, all are equipped with climate-controlled rear seats.



Touch Screen Display

Seat heating and cooling for the front and rear seats can be selected on the climate menu of the TSD. Front seats can also be controlled from the individual seat icons on the bottom of the TSD.



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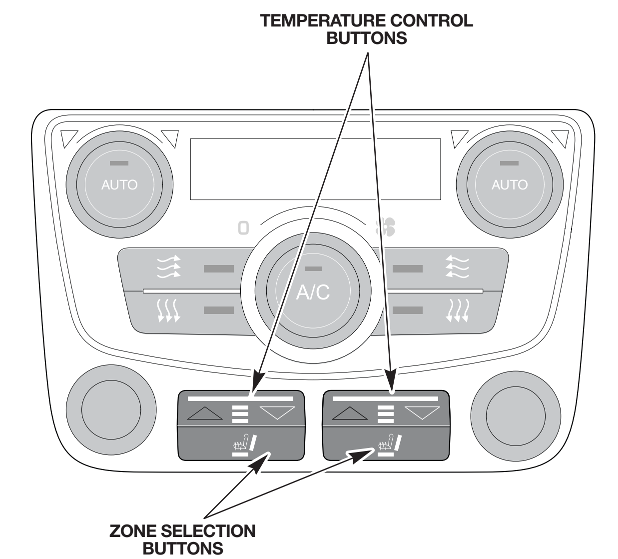
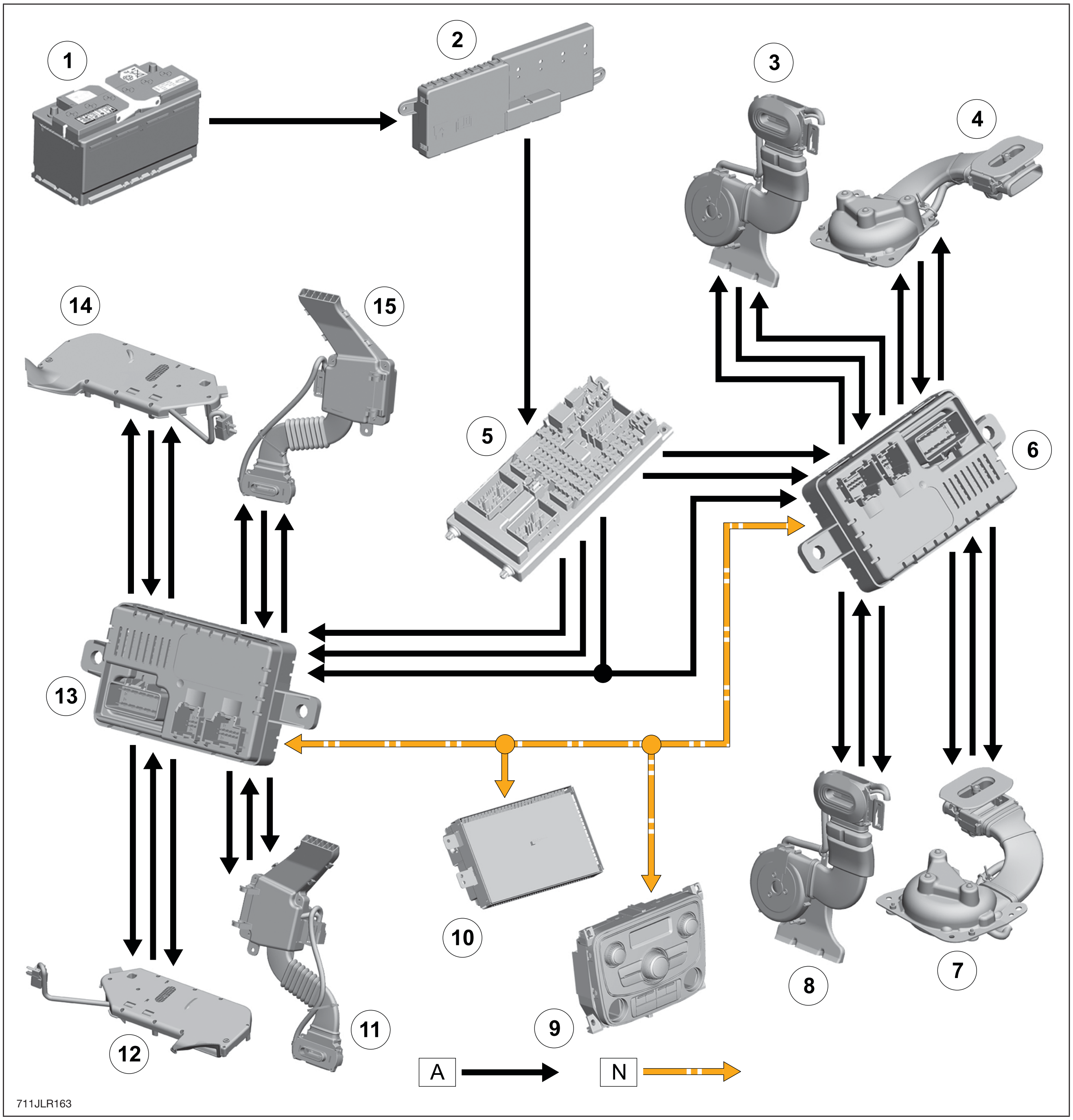
Rear Climate Control Panel

Seat heating and cooling for the rear seats can also be selected on the rear climate control panel.



711JLR162

Control Diagram: 2011 MY Onward XJ



A	Hardwired	5	CJB	11	Rear RH seat squab climate unit
N	MS CAN	6	Front climate controlled seats module	12	Rear RH seat cushion climate unit
1	Battery	7	Front LH seat cushion climate unit	13	Rear climate controlled seats module
2	BJB	8	Front LH seat squab climate unit	14	Rear LH seat cushion climate unit
3	Front RH seat squab climate unit	9	Rear climate control panel	15	Rear LH seat squab climate unit
4	Front RH seat cushion climate unit	10	TSD		

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Technical Training
Climate Control Systems

711-JAG: Jaguar Climate Control Systems

System Diagnostics

711-JAG 03/2011
Printed in USA

OVERVIEW

This section concentrates on the diagnostics available, assuming that the system is operating electrically and the compressor shaft is turning.

It is important to validate any repair with a thorough check of the operation of the air conditioning system, as well as a leak test if the system was found to be under-charged.

Diagnosis requires a complete knowledge of the system operation. As with all diagnosis, a technician must use symptoms and clues to determine the cause of a vehicle concern. To aid the technician when diagnosing vehicles, the strategies of many successful technicians have been analyzed and incorporated into a diagnostic strategy and into many service publications.

Electrical Inspection

The electrical components of the air conditioning system can be tested with the aid of the workshop literature. The tests offered depend on the system. They are divided into visual inspection, fault memory interrogation, check for fault codes, and symptom charts. The procedure for the electrical tests is not described in detail here.

Symptom-to-System-to-Component-to-Cause Diagnostic Process

Using the 'Symptom-to-System-to-Component-to-Cause' diagnostic process provides you with a logical method for correcting customer concerns:

- First, confirm the **Symptom** of the customer's concern.
- Next, determine which **System** on the vehicle could be causing the symptom.
- Once you identify the particular system, determine which **Component(s)** within that system could be the cause for the customer concern.
- After determining the faulty component(s) you should always try to identify the **Cause** of the failure.

In some cases parts just wear out. However, in other instances something other than the failed component is responsible for the problem. For example, if the A/C system is low on refrigerant, adding refrigerant may correct the problem for a short time, but finding and repairing the leak that is causing the low refrigerant corrects the problem and repairs the vehicle correctly the first time.

Workshop Literature

The vehicle workshop literature contains information about climate control diagnostic steps and checks, such as preliminary checks, verification of customer concern or special driving conditions, road test, and diagnostic pinpoint tests.

Manual Inspection

A preliminary test of the refrigerant lines while the air conditioning system is running offers a simple way of determining whether the system is fulfilling its basic cooling function.

WARNING: Extreme caution is required when performing this type of test. Depending on the conditions, lines may be extremely hot or extremely cold. Protect your hands using gloves. Avoid hot and/or moving engine components. Cooling fans may operate during testing.

The conversion process from gas to liquid and vice versa can be determined using the temperature of the various lines:

- The high-pressure line from the compressor to the condenser should be hot (approx. 80 °C or 175 °F).
- The line coming from the condenser is warm (approx. 50 °C or 122 °F) up to the evaporator core orifice or up to the thermostatic expansion valve, including the receiver/drier.
- The line from the thermostatic expansion orifice or thermostatic expansion valve must feel cold to the touch.
- The line from the evaporator core to the compressor must be cold/cool.

PRESSURE GAUGE DIAGNOSTICS

NOTE: The Diagnostics in this section are for A/C systems that use R134a refrigerant.

Low and high pressure gauges can be used to assess the system's health. Before the system can be assessed, it is important to know how a healthy system should behave so as to be able to make the comparison. It is also important that both gauges are operational at the same time, because diagnostics on the system can only be assessed correctly when both gauges are studied at the same time.

The low pressure gauge requires a scale of approximately 30 inHg to 145 psi (-1 to +10 bar). The high pressure gauge requires a scale of 0 to 500 psi (0 to 35 bar). By having a minus scale, the gauge can also be used to read partial vacuums.

If you are testing from cold, the system pressures will be lower at the start than at the finish.

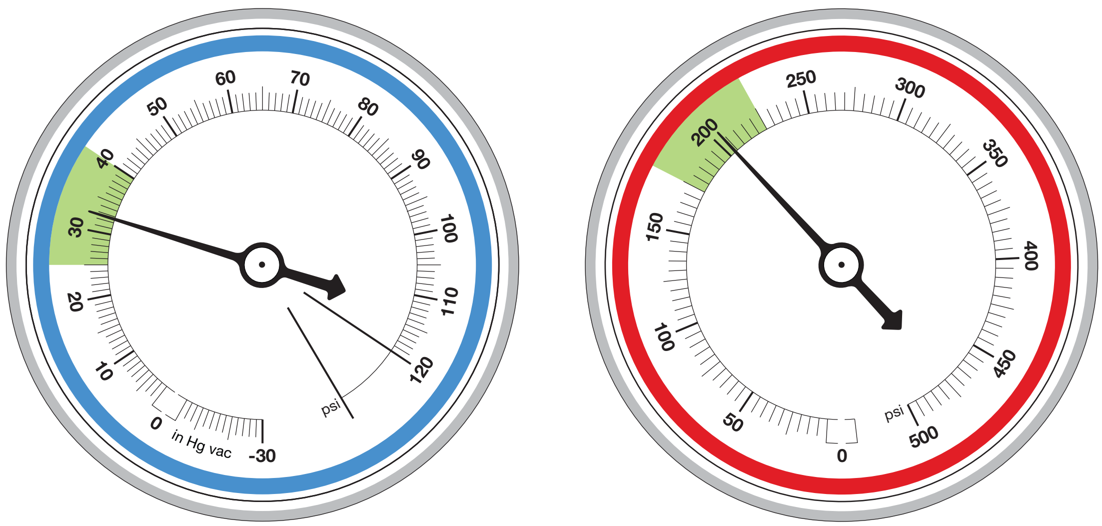
All tests should be completed with the vehicle set to the following conditions:

- The engine speed at approximately 1500 rpm
- The heater unit set to maximum cooling and maximum blower speed
- Normal pressure gauge readings for a good system:
  - Low pressure side 25 – 40 psi (1.7 – 2.8 bar)
  - High pressure side 175 – 225 psi (12 – 15.5 bar)

Pressure Gauges

Pressure gauge readings will vary within a given range. For clarity, the 'Normal' tolerance range is marked in green on the pressure gauge scale; readings within this range can be regarded as satisfactory.

Normal R134a Gauge Readings



LOW SIDE:
25 – 40 psi (1.7 – 2.8 bar)

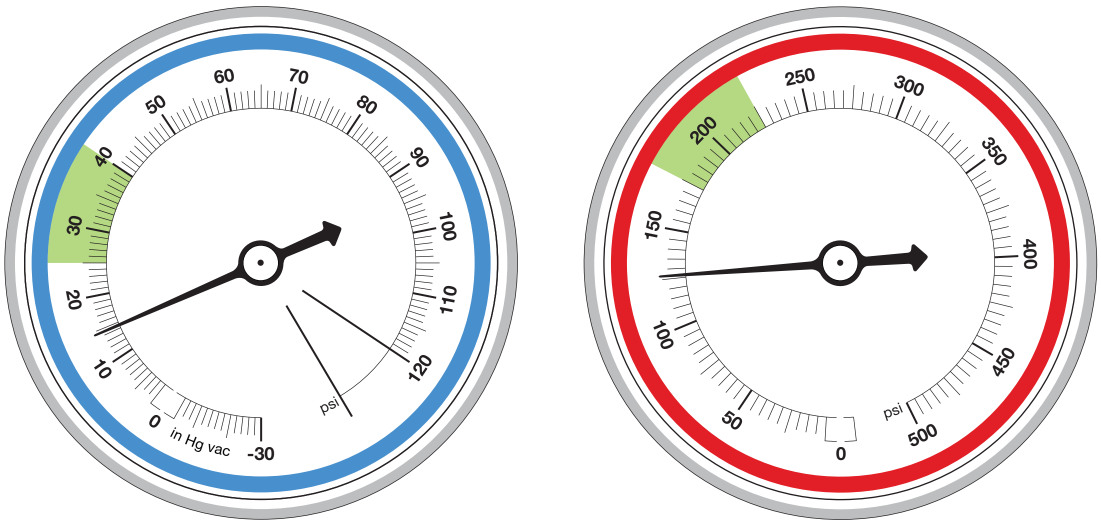
HIGH SIDE:
175 – 225 psi (12 – 15.5 bar)

711JLR054

In all the following gauge illustrations, the ambient temperature is assumed to be 25 – 28 °C (77 – 82 °F). If testing is carried out at a different ambient temperature, the reference values must be taken from the following table:

Ambient Temperature	High-Side Pressure	Low-Side Pressure
6 °C (60 °F)	140 – 170 psi (9.7 – 11.7 bar)	20 – 35 psi (1.4 – 2.4 bar)
21 °C (70 °F)	165 – 195 psi (11.4 – 13.4 bar)	25 – 35 psi (1.7 – 2.4 bar)
27 °C (80 °F)	175 – 225 psi (12 – 15.5 bar)	25 – 40 psi (1.7 – 2.8 bar)
32 °C (90 °F)	195 – 240 psi (13.4 – 16.5 bar)	30 – 40 psi (2.0 – 2.8 bar)
38 °C (100 °F)	210 – 270 psi (15.2 – 18.6 bar)	30 – 45 psi (2.0 – 3.1 bar)

System Undercharged



LOW SIDE:
7 – 22 psi (0.5 – 1.5 bar)

HIGH SIDE:
85 – 150 psi (6 – 10.3 bar)

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Possible Fault Symptoms

- Little or no cooling and the low-side pipes are not particularly cold

Fault Diagnosis

- The system is undercharged

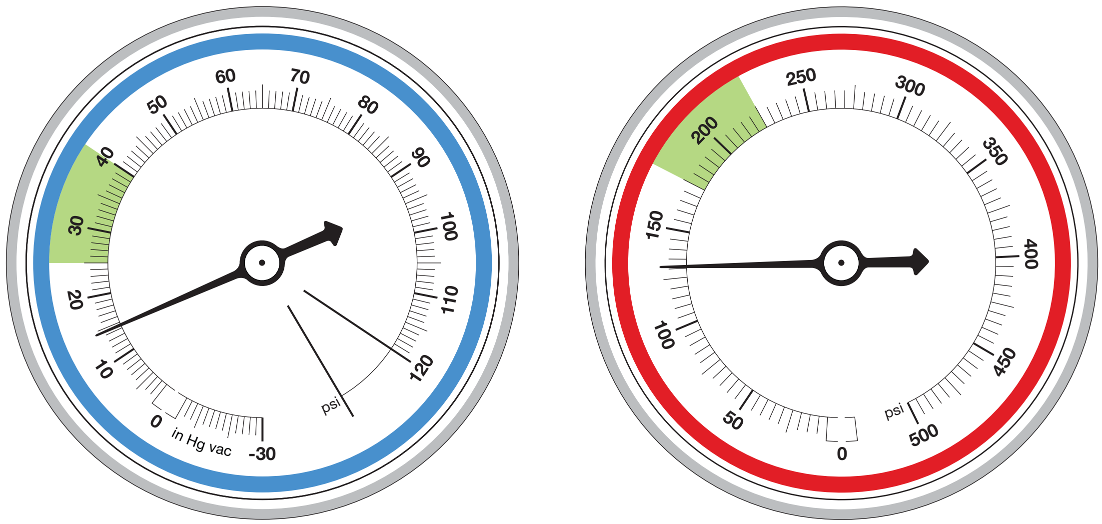
Why does this fault result in these pressure readings?

- A reduction in the volume of refrigerant within a confined space results in reduced pressure.

Action

- Test for possible leaks (may have to add 4-5 ounces of refrigerant for test purposes)
- Reclaim refrigerant
- Repair leaks
- Evacuate and recharge system
- Recheck pressures and system performance

System Restriction – Receiver/Drier



LOW SIDE:
7 – 22 psi (0.5 – 1.5 bar)

HIGH SIDE:
105 – 150 psi (7.2 – 10.3 bar)

711JLR056

Possible Fault Symptoms

- No cooling or insufficient cooling
- The pipe from the receiver/drier to the expansion valve is cooler than normal and may shows signs of frosting
- Receiver/drier may have cold spots

Fault Diagnosis

- Receiver/drier is blocked or clogged

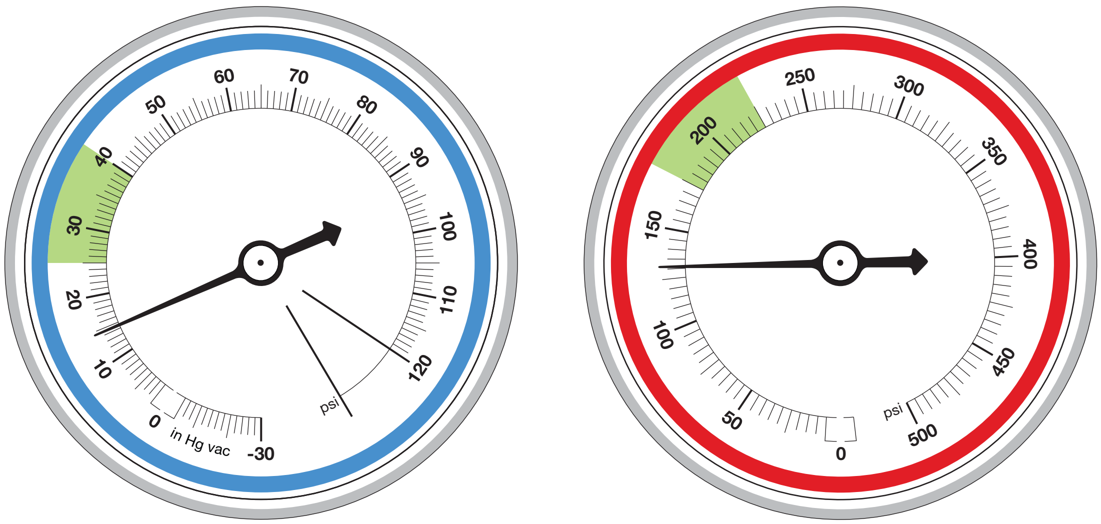
Why does this fault result in these pressure readings?

- Reduced flow through the system allows more time for the refrigerant in the condenser to cool (lower temperature = lower pressure) and reduced flow through the evaporator results in less heat being absorbed by the refrigerant (less heat = less pressure)

Action

- Reclaim refrigerant
- Remove and replace receiver/drier
- Evacuate the system and recharge with the correct amount of refrigerant and oil.
- Recheck pressures and system performance

System Restriction – Expansion Valve Blocked



LOW SIDE:
7 – 22 psi (0.5 – 1.5 bar)

HIGH SIDE:
105 – 150 psi (7.2 – 10.3 bar)

711JLR056

Possible Fault Symptoms

- No cooling or insufficient cooling
- Receiver drier is warm or hot

Fault Diagnosis

- Expansion valve is blocked or clogged

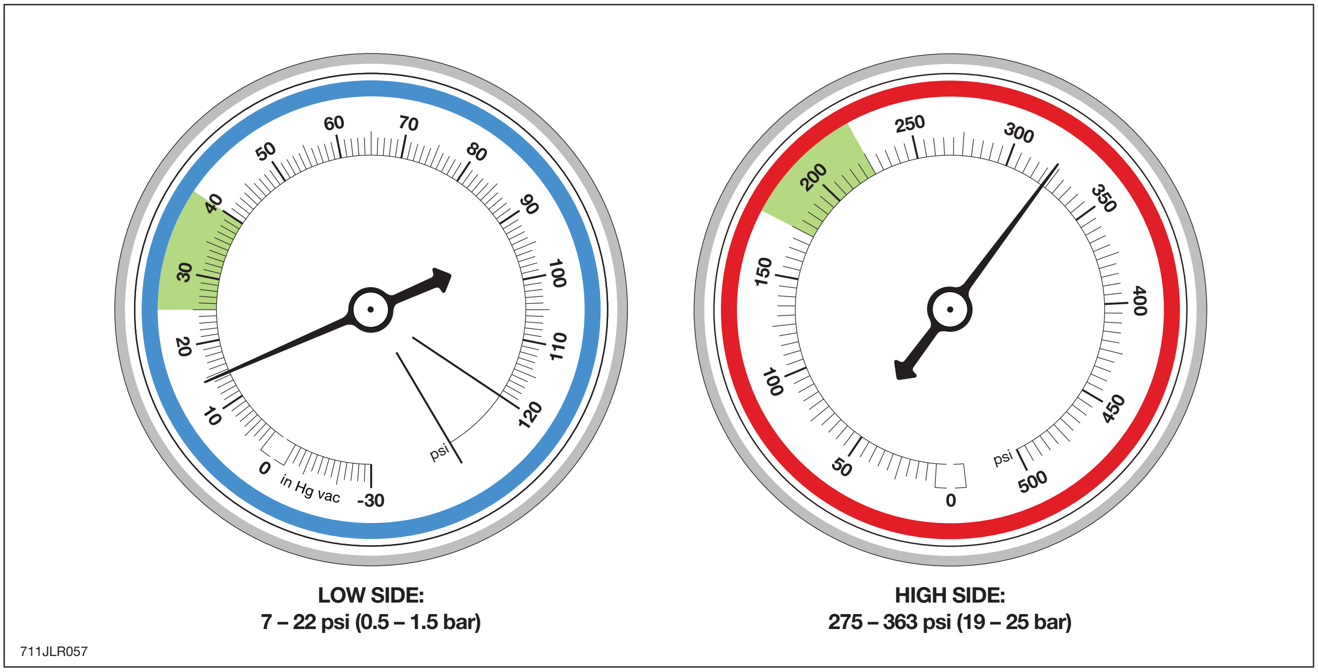
Why does this fault result in these pressure readings?

- Reduced flow through the system allows more time for the refrigerant in the condenser to cool (lower temperature = lower pressure) and reduced flow through the evaporator results in less heat being absorbed by the refrigerant (less heat = less pressure)

Action

- Reclaim refrigerant
- Remove and replace expansion valve
- Evacuate the system and recharge with the correct amount of refrigerant and oil.
- Recheck pressures and system performance

System Restriction – Condenser



Possible Fault Symptoms

- No cooling or insufficient cooling
- Frosting on compressor-to-condenser line or on the condenser
- Very fast rise in high-side pressure

Fault Diagnosis

- Restriction in compressor-to-condenser line
- Restriction in condenser

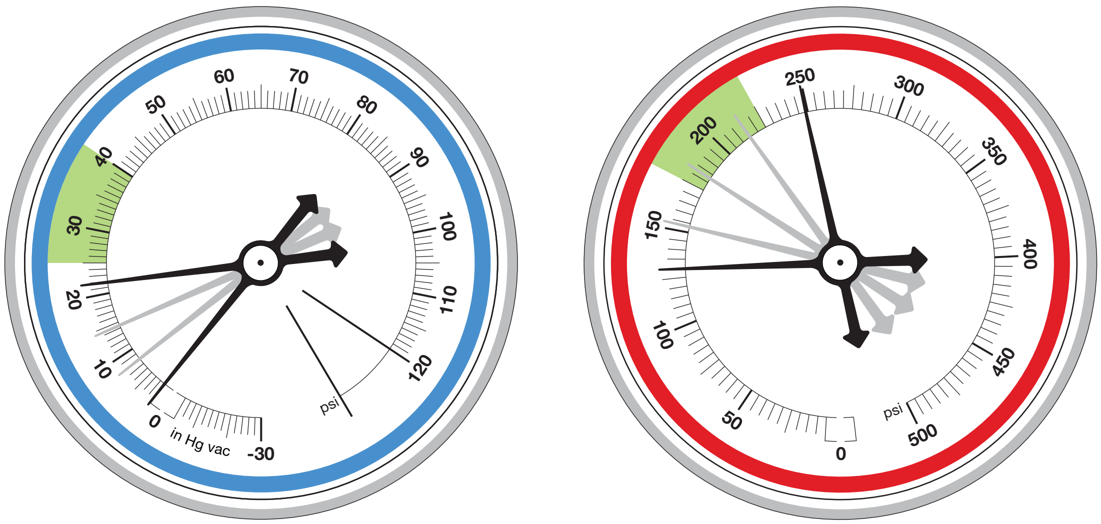
Why does this fault result in these pressure readings?

- The capacity of the high-side system has been effectively reduced by a restriction in the compressor-to-condenser hose or in the condenser. As the compressor pumps refrigerant, high side pressures will be high to extremely high as the same volume of refrigerant will now be pumped into a reduce area.
- Reduced flow through the evaporator results in lower than normal low side pressures

Action

- Reclaim refrigerant
- Remove and replace restricted component
- Evacuate the system and recharge with the correct amount of refrigerant and oil.
- Recheck pressures and system performance

Moisture in System



LOW SIDE:
FLUCTUATING 2 – 22 psi (0.1 – 1.5 bar)

HIGH SIDE:
FLUCTUATING 130 – 250 psi (9 – 17 bar)

711JLR058

Possible Fault Symptoms

- Erratic cooling
- Gauges are fluctuating between two sets of readings; normal as refrigerant flows through the system, the other showing 7 psi (0.5 bar) on the low pressure side and 101 psi (7 bar) on the high pressure side as the flow through the expansion valve is stopped or reduced by freezing moisture.

Fault Diagnosis

- Moisture in system

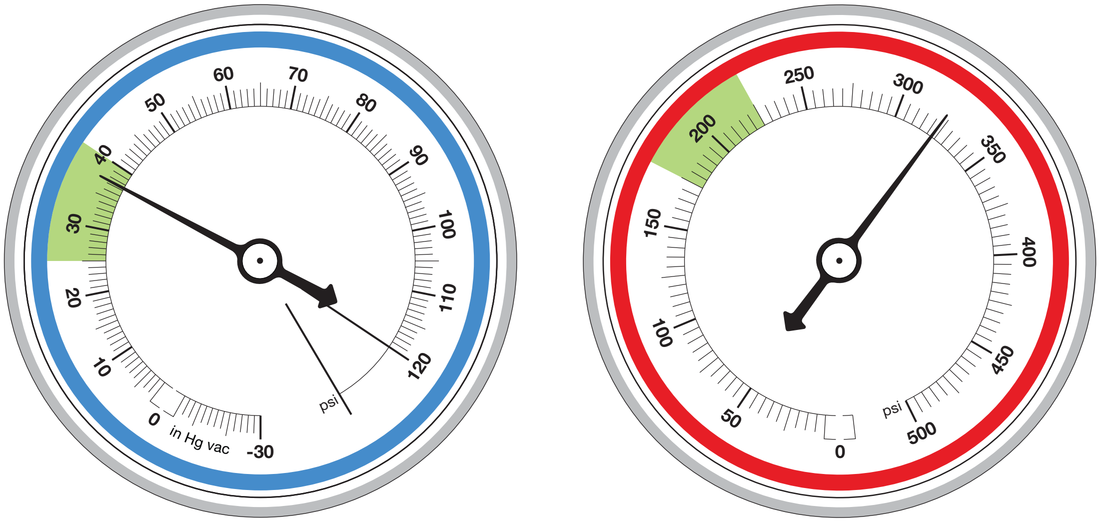
Why does this fault result in these pressure readings?

- As moisture freezes and blocks the expansion valve, reduced flow through the system allows more time for the refrigerant in the condenser to cool (lower temperature = lower pressure) and reduced flow through the evaporator results in less heat being absorbed by the refrigerant (less heat = less pressure)
- As moisture thaws and refrigerant begins to flow, pressure will return close to normal (the cycle of freezing/thawing can continuously repeat resulting in pressure fluctuations)

Action

- Test system for leaks
- Reclaim refrigerant
- Replace receiver/drier because of desiccant contamination
- Evacuate the system for a minimum of 30 minutes
- Recharge with the correct amount of refrigerant
- Recheck pressures and system performance

System Overcharged / Air in System / Inefficient Condenser



LOW SIDE:
29 – 44 psi (2 – 3 bar)

HIGH SIDE:
275 – 363 psi (19 – 25 bar)

711JLR059

Possible Fault Symptoms

- Insufficient cooling

Fault Diagnosis

- Too much refrigerant in the circuit
- Air in system
- Insufficient airflow across condenser

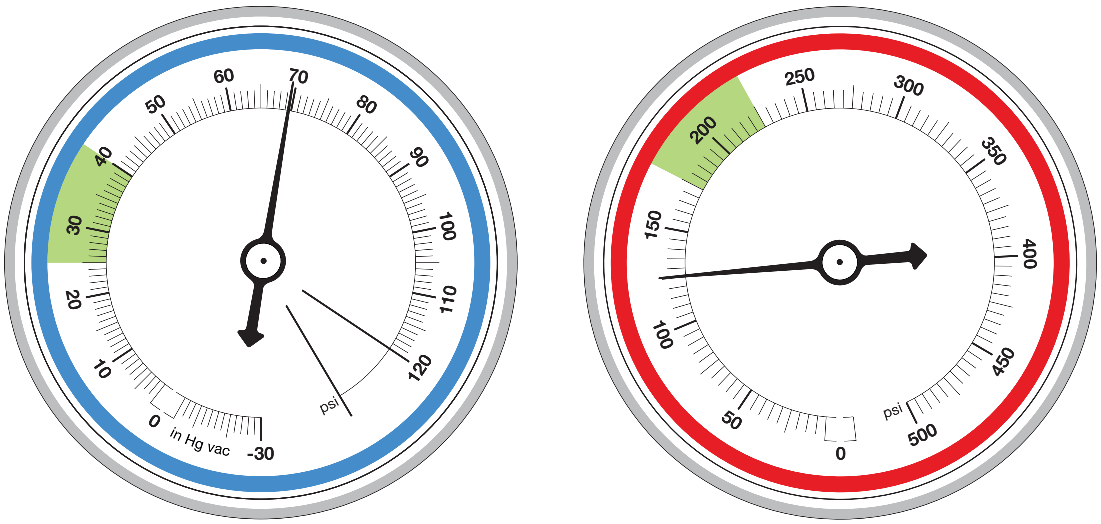
Why does this fault result in these pressure readings?

- Reduced airflow through the condenser results in less heat extraction from the refrigerant (high temperature = high pressure).
- Increased amounts of refrigerant or additional air in a confined space results in increased pressure (high side pressures will be higher than normal).

Action

- Check operation of condenser cooling fan(s) and insure fins of condenser are clean and clear of debris/blockage. If no fault found, continue with action list.
- Reclaim refrigerant
- Recharge with the correct amount of refrigerant
- Recheck pressures and system performance

Faulty Compressor



LOW SIDE:
55 – 87 psi (4 – 6 bar)

HIGH SIDE:
116 – 148 psi (8 – 10 bar)

711JLR060

Possible Fault Symptoms

- Little or no cooling
- Compressor may be noisy
- Little or no pressure change with change in engine speed
- Pressures may equalize quickly after compressor is stopped (due to faulty reed valves within the compressor)

Fault Diagnosis

- Faulty compressor

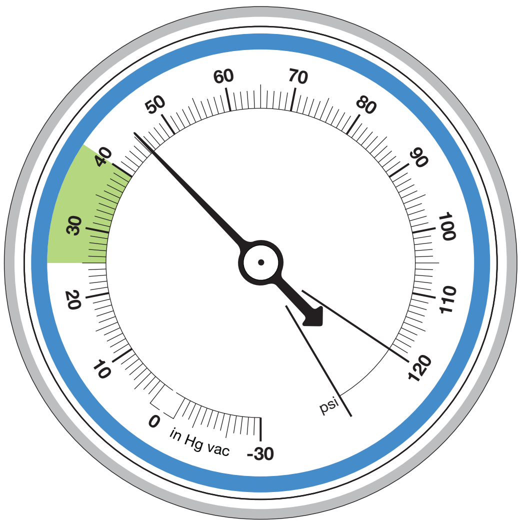
Why does this fault result in these pressure readings?

- Reduced flow from the compressor results in less refrigerant being pumped into the high side (lower than normal high side pressures) and less refrigerant being drawn from the low side (higher than normal low side pressures)

Action

- Reclaim refrigerant
- Flush system to remove possible contamination
- Remove and replace compressor and receiver/drier
- Evacuate the system and recharge with the correct amount of refrigerant and oil
- Recheck pressures and system performance

Expansion Valve Stuck Open



LOW SIDE:
35 – 55 psi (2.4 – 3.8 bar)

HIGH SIDE:
150 – 200 psi (10.3 – 13.7 bar)

711JLR061

Possible Fault Symptoms

- Reduced cooling with frosting on the low pressure pipes between the evaporator and compressor
- Compressor may be noisy or damaged as liquid refrigerant enters the suction port

Fault Diagnosis

- Expansion valve stuck open

Why does this fault result in these pressure readings?

- Increased flow through the expansion valve will results in less of a pressure drop (low side pressure will be higher that normal).
- Increased flow through the expansion valve does not allow the evaporator to work at peak efficiency and all the refrigerant will not be vaporized before exiting the evaporator. Less heat will be absorbed by the system (high side pressure will be slightly lower than normal).

Action

- Reclaim refrigerant
- Remove and replace expansion valve
- Evacuate the system and recharge with the correct amount of refrigerant
- Recheck pressures and system performance

LEAK DETECTION

If a low refrigerant charge is believed to be the cause of a poor cooling concern, then a thorough check for leaks must be conducted. Leak detection is available in many different forms. Many leak detection devices have both visual and audible level indicators.

The use of leak tracer dyes greatly improves refrigerant leak visibility and will assist with the smaller troublesome refrigerant leaks. Leak tracer dyes can be in pellet form – to be added when a system is opened – or in a liquid form, for injecting into a closed system. In either form, the use of an ultraviolet (UV) light is required. Visual detection can be further enhanced with the use of yellow colored glasses or goggles.

Leak Detectors

A leak detector specifically designed for this purpose is utilized. The leak detector can be used not only to identify a leak, but also to home in on the leak's source. Depending on whether the machine has an automatic or manual setting, the leak can be pinpointed by adjusting the sensitivity setting.

When the leak detector is progressively set to a lower sensitivity, it will only identify progressively stronger leaks (each leak detected will be stronger than the one previously detected). This process of decreasing sensitivity allows the operator to gain the direction of the leak.

Some testers feature automatic leak detection, which sets the detector to respond to increasing refrigerant densities in the air. By only picking up stronger leaks than before, the tester allows the operator to pinpoint the source of the leak.

The following guidelines should be observed when using the leak detector:

- The tester tip is a delicate piece of equipment. If it gets wet or contaminated by oil, it will need careful cleaning with the recommended cleaner.
- False readings may be obtained if there is excessive oil contamination, or other hydrocarbon leakage around the area being checked.
- Refrigerant in gas form is considerably heavier than air and tends to fall from the source of any leak towards the ground. Any leak testing should be done on the underside of the component
- False leak indications can be caused by air flow from the cooling fans causing the maximum movement rate of the tester to be exceeded.
- Evaporator leaks can be detected from either the water drain tubes or the distribution vents. For best results, test from the drains, as the refrigerant is heavier than air and will naturally go to the low point in the evaporator case.
- Leak detectors are very sensitive and can detect leaks as small as 15 grams/year. If there has been refrigerant leakage during recovery or charging, allow time for the cooling fans to exchange the air around the area being tested before checking for leaks.

SERVICE

System Flushing

Where a compressor has failed or a receiver/drier desiccant has disintegrated, system flushing is required to remove the debris and contamination from inside the air conditioning system.

The use of a flushing kit involves breaking into the refrigerant lines and connecting adaptors to the system lines. A fluid-based flushing agent or nitrogen is commonly used for system flushing. A combination of the two provides the best results. Reference TOPIx literature and for detailed flushing procedures. Always follow the manufacturer's guidelines for the proper use of flushing equipment.

Typical R134a Charging Station

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Air Conditioning Equipment

WARNING: All personnel must be trained in the operation of any air conditioning equipment, and know the health and safety implications connected with safe working practice on any air conditioning systems.

Portable charging station use color-coding for identification of the high- and low-pressure systems. The valves, gauges, and pipes are color coded RED for high pressure and BLUE for low pressure, with other colors for refrigerant input and evacuation.

When storing the charging station, ensure that all pipes are sealed from the atmosphere. When the pipe ends are not connected they should be screwed onto a dummy mounting.

All valves should be turned off during storage. Periodic checks should be made to monitor any pressure build-up within the charging station and to guard against possible leakage/seepage from the refrigerant bottle mounted on the charging station.

Recovery

With the system checks completed, recovery of the refrigerant in the system can commence.

Study the particular charging station that you are using to see which valves and switches need to be operated to recover the refrigerant.

Most charging stations have the ability to clean the refrigerant so that it can be reused.

It is important that any recovered oil is replaced.

Evacuation

Evacuation is important: it is this process that removes any air and moisture in the system.

By introducing a vacuum to the system, the boiling point of any water in the system is lowered and the water will become steam by way of evaporation. It is important that the system is subjected to a vacuum for a period long enough to ensure all moisture has been extracted. The minimum recommended time is 30 minutes.

Once evacuation has been completed, it is important to check for a sustained vacuum. No loss of vacuum should be detected within the first 5 minutes of completing evacuation. An increase in system pressure indicates that the system is not tight.

Charging

⚠ **CAUTION: The importance of using the correct amount of refrigerant cannot be overemphasized.**

Not Enough Refrigerant

- The system will not be able to supply sufficient liquid refrigerant to the evaporator.
- This will have the effect of reducing the cooling capability of the evaporator, as there is not enough refrigerant to absorb the heat energy surrounding the evaporator core.

Too Much Refrigerant

- If the system is overfilled, the pressure in the system will rise.
- If the system temperature is higher than the conversion temperature, then successful conversion will not take place.
- If liquid refrigerant enters the compressor, because it can't take on enough heat to convert to gas, it will cause a hydraulic lock or overload the internal workings, causing permanent damage.

Procedure

- After evacuation is completed and a sustainable vacuum has been achieved, add the correct amount of refrigerant into the system.
- The amount of refrigerant needed to charge the system is specified by its weight and will depend on the particular vehicle model.
- Most modern charging stations are automatic. They carry out much of the reclaiming, evacuating, and recharging automatically.
- At the end of the charging procedure, it is important to test the system for leaks and correct operation.

Air Conditioning Servicing

The following is a guideline to a complete service; |there may be other actions that can be carried out. This is dependent on the type of Service station that is being used.

- Reclaim refrigerant, following equipment manufacturer's instructions
- Prior to charging:
  - Drain and measure the amount of oil removed from the system; note the quantity for replacement
  - Where possible, particularly when refrigerant loss has occurred, it is more accurate to measure the amount of oil in the compressor
  - Renew the Drier filter, if required (normally after 2 years from last replacement)
  - Vacuum system for 30 minutes; check that system maintains vacuum for 5 – 10 minutes after vacuum pump is switched off
  - Replace the pollen (interior) filter (carried out during vacuum operation)
  - Add oil to system, if required
- Set the appropriate refrigerant charge amount on service equipment
- Recharge system
- Carry out performance and leak test
- Fill out service sticker and place on vehicle (usually on front panel)

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