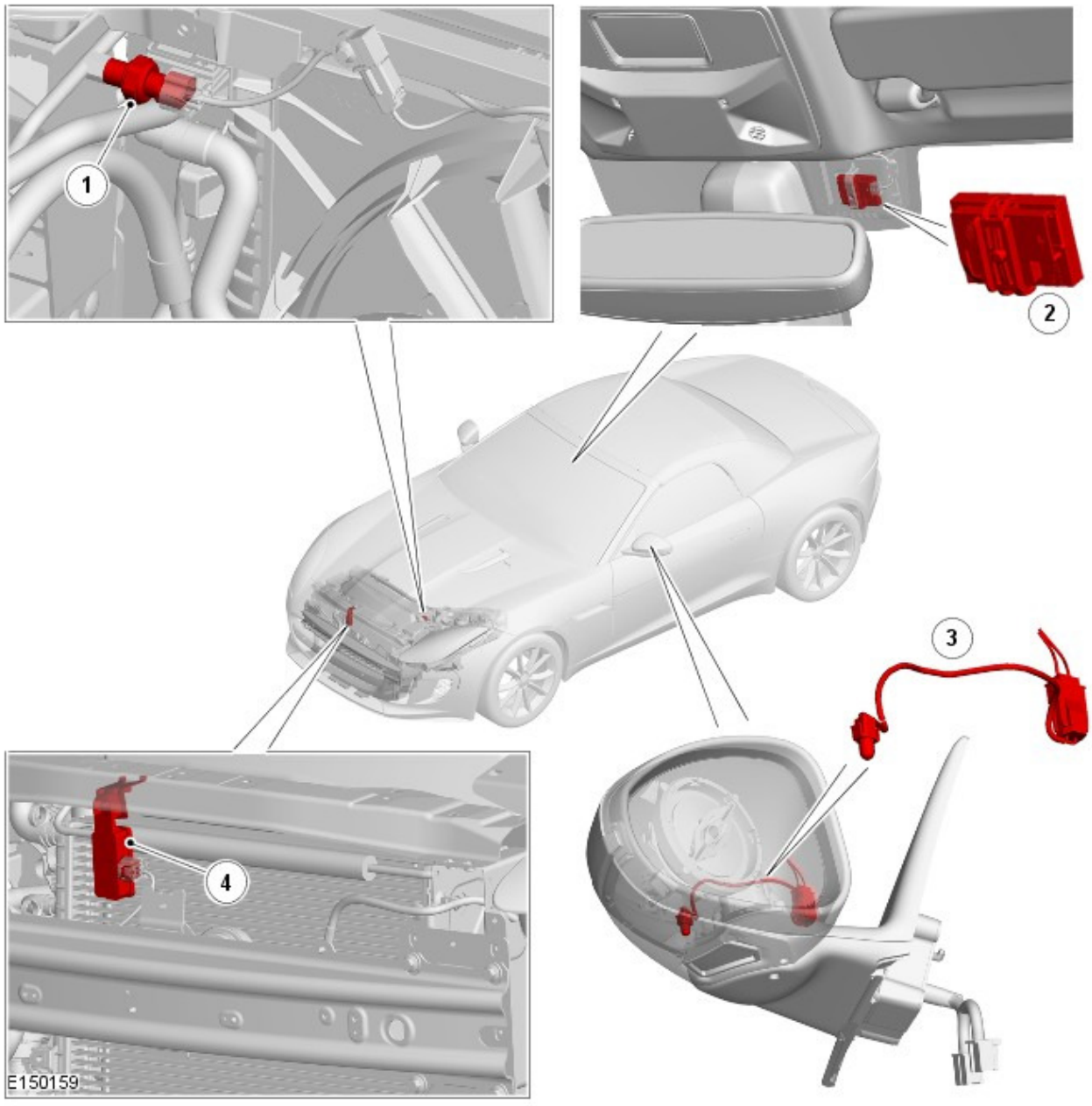
Published: 28-Feb-2013

Climate Control - Control Components

Description and Operation

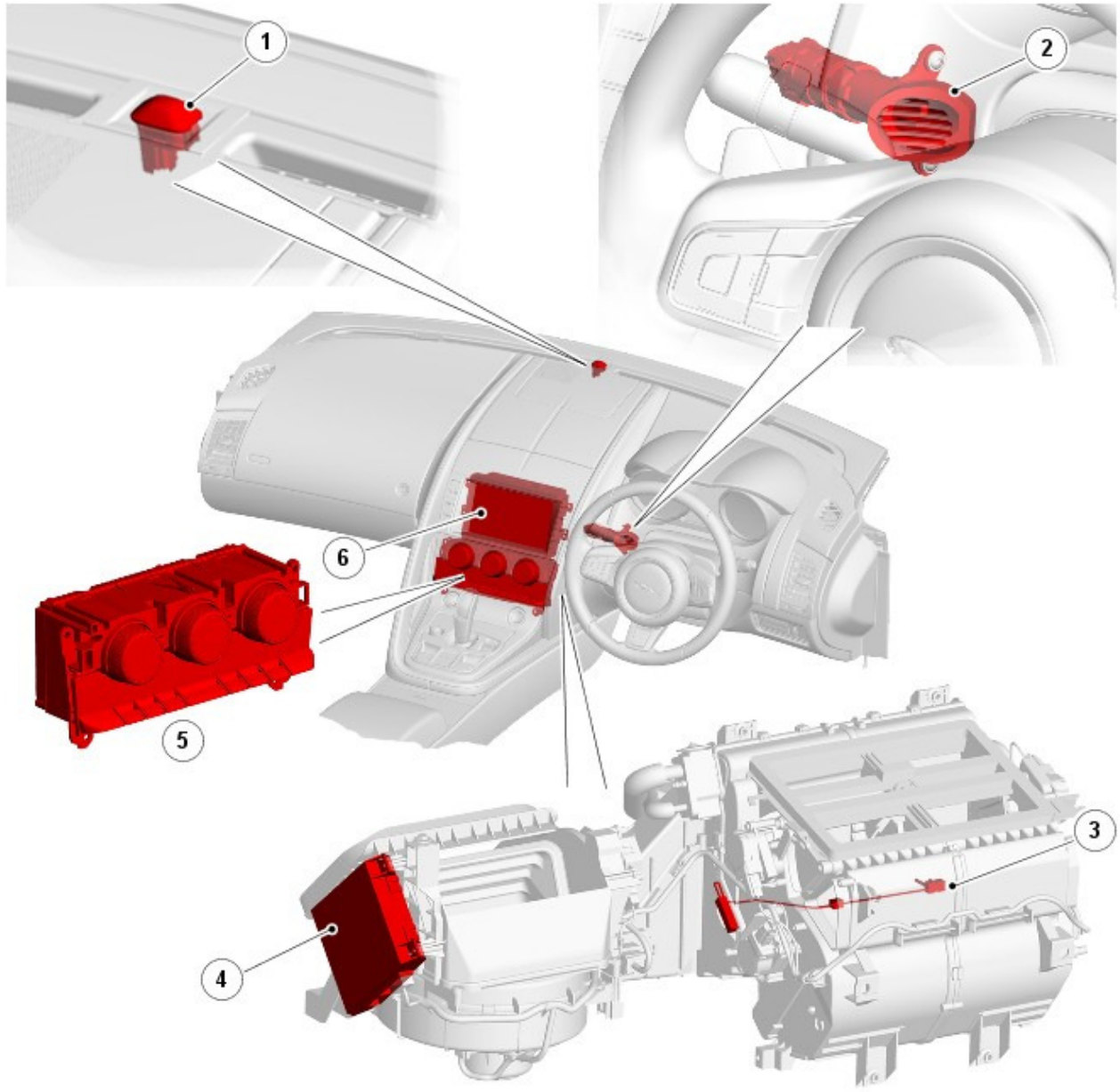
COMPONENT LOCATION - SHEET 1 OF 2



Item	Description
1	Refrigerant pressure sensor
2	Humidity sensor
3	Ambient air temperature sensor
4	Pollution sensor (where fitted)

COMPONENT LOCATION - SHEET 2 OF 2

NOTE: RHD (right-hand drive) installation shown, LHD (left-hand drive) installation similar.



E150160

Item	Description
1	Sunload sensor
2	In-vehicle temperature sensor
3	Evaporator temperature sensor
4	Automatic temperature control module
5	Integrated control panel
6	Touch screen

OVERVIEW

The control components operate the heating and ventilation system and the A/C (air conditioning) system to regulate the temperature, volume and distribution of air into the passenger compartment. The climate control system is configured as either a single or dual zone system, depending on vehicle specification. The dual zone system supplies individual temperature levels, to the driver and passenger zones, up to a maximum differential of approximately 3 ºC (5.4 ºF). The single and dual zone systems contain the same hardware, but with different software to produce the functionality required by each system.

The climate control system is controlled by the ATCM (automatic temperature control module) in response to inputs from the ICP (integrated control panel), the touch screen and the following sensors:

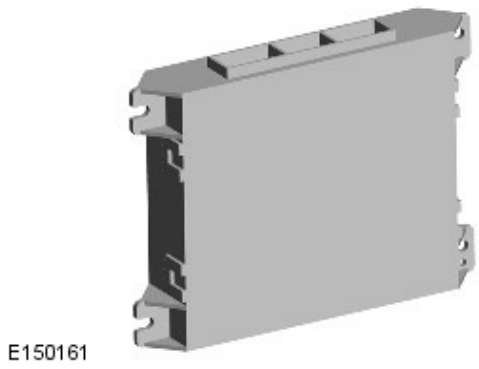
- Ambient air temperature sensor
- Evaporator temperature sensor
- Humidity sensor

- In-vehicle temperature sensor
- Pollution sensor (where fitted)
- Refrigerant pressure sensor
- Sunload sensor.

Operation can be fully automatic, or manual selections can be made for the intake air source, blower speed and air distribution. These selections can be made on the touch screen and the ICP (integrated control panel).

DESCRIPTION

Automatic Temperature Control Module

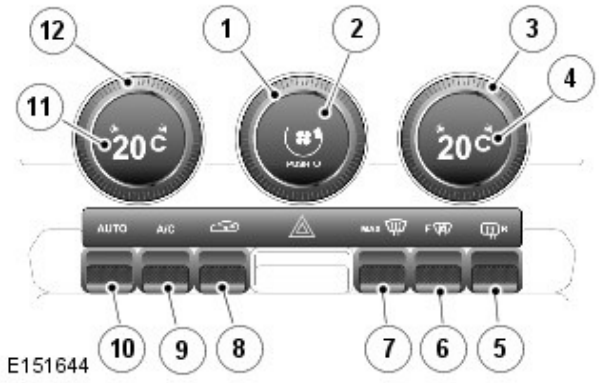

E150161

The ATCM is mounted on the end of the air intake duct, behind the instrument panel. The ATCM processes inputs from the touch screen, the ICP and the system sensors. In response to these inputs, the ATCM outputs control signals to the A/C system and the heating and ventilation system.

Three electrical connectors provide the interface between the ATCM and the vehicle wiring. The ATCM uses hardwired inputs from the system sensors, the LIN (local interconnect network) bus to communicate with the recirculation, temperature blend, distribution and center face vent motors, and the medium speed CAN (controller area network) bus to communicate with other control modules on the vehicle.

In addition to controlling the A/C system and the heating and ventilation system, the ATCM also controls the seat heaters (where fitted).
For additional information, refer to: Seats (501-10 Seating, Description and Operation).

Integrated Control Panel

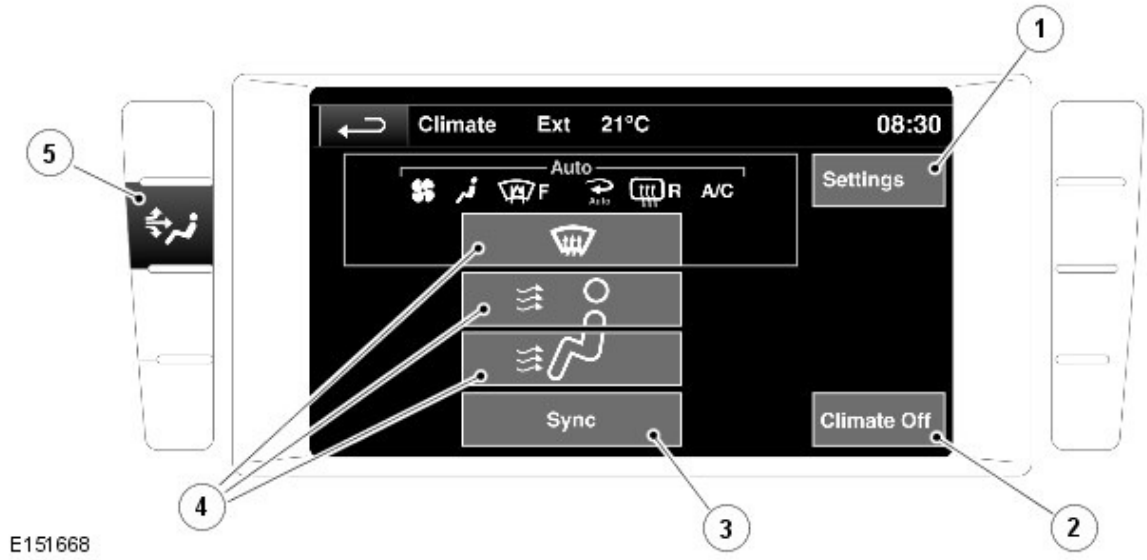


E151644

Item	Description
1	Blower speed control switch
2	Blower speed display and climate control on/off switch
3	Right temperature control switch
4	Right temperature display and seat heater switch
5	Heated rear window switch
6	Heated windshield switch
7	Maximum demist switch
8	Recirculation switch
9	Air conditioning on/off switch
10	Automatic mode switch
11	Left temperature display and seat heater switch

12	Left temperature control switch

Touch Screen



E151668

Item	Description
1	Climate control settings menu soft key
2	Climate control on/off soft key
3	Synchronize soft key (dual zone systems only)
4	Distribution soft keys
5	Climate menu shortcut switch

Refrigerant Pressure Sensor

E128364

The refrigerant pressure sensor provides the ATCM 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.

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

The ATCM uses the signal from the pressure sensor to protect the refrigerant system from extremes of pressure. The ATCM transmits the A/C pressure, along with the compressor drive current value, to the instrument cluster on the medium speed CAN bus. These signals are broadcast to the ECM (engine control module) on the high speed CAN bus to allow it to calculate the torque being applied to the engine by the compressor.

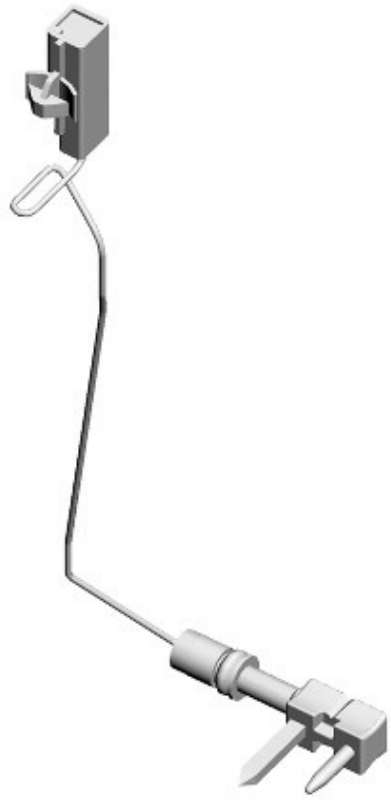
To protect the system from extremes of pressure, the ATCM sets the A/C compressor to the minimum flow position if the pressure:

- Decreases to 2.1 ± 0.2 bar (31.5 ± 3 lbf/in²); the ATC (automatic temperature control) module loads the A/C compressor again when the pressure increases to 2.3 ± 0.2 bar (33.4 ± 3 lbf/in²)
- Increases to 31 ± 1 bar (450 ± 14.5 lbf/in²); the ATCM loads the A/C compressor again when the pressure decreases to 26 ± 1 bar (377 ± 14.5 lbf/in²).

The ATCM also uses the signal from the pressure sensor to request engine cooling fan duty from the ECM, using the medium speed CAN bus to the instrument cluster, then on to the ECM on the high speed CAN bus.

In addition, the ATCM calculates the amount of torque used to drive the A/C compressor using inputs from the pressure sensor and the ambient air temperature sensor. This information is also transmitted to the ECM via the CAN networks.

Evaporator Temperature Sensor

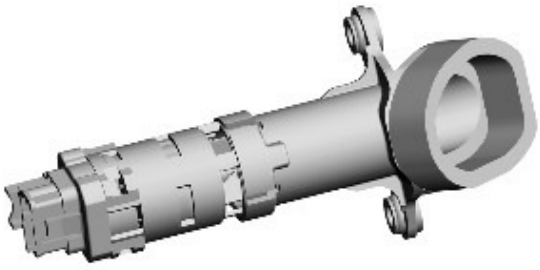


E97626

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

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

In-vehicle Temperature Sensor



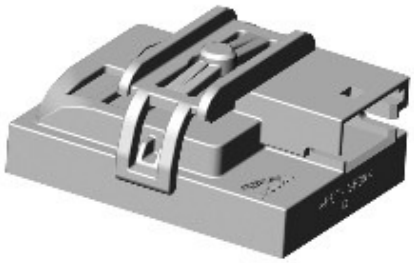
E150162

The in-vehicle temperature sensor is a NTC thermistor installed behind a grill in the instrument panel, on the inboard side of the steering column. A motor within the sensor draws air in through the grill and over the thermistor. The motor is powered by an ignition feed from the CJB (central junction box).

The ATCM uses the signal from the in-vehicle temperature sensor for control of the climate control assembly output temperatures, blower speed and air distribution.

The ATCM supplies the in-vehicle temperature sensor with a 5 V reference voltage and translates the return signal voltage into a temperature. If the in-vehicle temperature sensor develops a fault, the ATCM adopts a default temperature of 25 °C (77 °F).

Humidity Sensor



E141130

The humidity sensor is installed in a bracket attached to the inside of the windshield, to the right of the interior mirror. The sensor is concealed under a cover, which clips onto the bracket. The sensor comprises three individual elements:

- A capacitive humidity sensor
- A NTC thermistor air temperature sensor
- An infrared windshield glass temperature sensor.

The humidity sensor is powered by a feed from the ignition relay in the CJB. The data from the three individual elements of the humidity sensor are transmitted in LIN bus messages to the ATCM. From the data, the ATC module:

- Adjusts the humidity of the air in the vehicle as necessary, to provide the optimum comfort level for occupants
- Calculates the dew point temperature of the air at the inside of the windshield.

Humidity within the vehicle is controlled by raising or lowering the temperature of the evaporator. An increase in evaporator temperature increases the moisture content of the air at the windshield. Lowering the evaporator temperature reduces the moisture content of the air in the interior.

If the dew point of the air within the passenger compartment rises to be close to that of the windshield, temperature misting is likely to occur. To prevent this, the ATCM will:

- Increase the blower speed
- Reduce the evaporator operating temperature to its lowest safe running temperature
- Increase the temperature of the air leaving the climate control assembly
- Adjust the position of the demist distribution motor to direct more air to the windshield
- Adjust the position of the recirculation motor to admit more fresh air
- Signal the CJB to energize the windshield heater (where fitted).

Ambient Air Temperature Sensor

E116093

The ambient air temperature sensor is a NTC thermistor that provides the ATCM with an input of external air temperature. The sensor is installed in the left door mirror and hard wired to the ECM, which transmits the temperature on the high speed CAN bus. The ATCM receives the temperature via the gateway module and medium speed CAN bus.

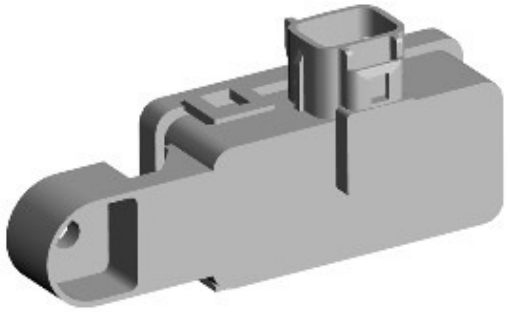
Sunload Sensor

E128016

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

The sunload sensor consists of 2 photoelectric cells that provide the ATCM 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 ATCM to adjust blower speed, temperature and distribution to improve comfort.

Pollution Sensor (Where Fitted)



E150163

The pollution sensor is attached to a bracket on the underside of the bumper support assembly, immediately in front of the cooling pack. The sensor allows the ATCM to monitor the air being drawn into the passenger compartment for contaminants commonly found in traffic pollution, such as hydrocarbons, carbon monoxide and oxides of nitrogen.

The pollution sensor is powered by an ignition controlled voltage feed from the CJB and provides the ATCM with separate signals of hydrocarbon and oxidized gases. With a pollution sensor fitted, the ATCM can control the air intake source to reduce the amount of contaminants entering the passenger compartment.

OPERATION

Air Intake Control

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

The source of intake air is automatically controlled unless overridden by pressing the recirculation switch on the ICP. Under automatic control, the ATCM determines the required position of the recirculation door from its comfort algorithm and, if fitted, the pollution sensor.

A brief press of the recirculation 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 ATCM 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, if the ATCM detects pollution it sets the air source to recirculation for 10 minutes, then to fresh air for 20 seconds to renew the air in the vehicle. The ATCM repeats this cycle until the pollution is no longer present.

The sensitivity of the pollution sensor can be adjusted, or pollution sensing can be selected off, on the **Front climate, Settings** screen of the touch screen. If there is a fault with the pollution sensor, the ATC module disables automatic operation of the recirculation door.

Air Temperature Control

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

On vehicles with dual zone climate control, the 2 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 electric motors, which are controlled by the ATCM using LIN bus messages.

The ATCM calculates the temperature blend motor positions required to achieve the selected temperature and compares it against the current position. If there is any difference, the ATCM signals the 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 ATCM adopts an appropriate strategy for air distribution, blower speed, and air source.

On vehicles with dual zone climate control, temperature control of 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 can only be selected from the driver side temperature control switch. If HI or LO is selected from the driver side, the passenger side temperature will be automatically set to match the driver side. If the **Sync** soft key on the touch screen is selected, the ATCM synchronizes the passenger side settings with those of the driver side.

When air conditioning is selected off, no cooling of the intake 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 intake path.

Blower Motor Control

The ATCM monitors a feedback voltage from the blower control module. In response to the feedback voltage, the ATCM provides a drive signal back to the blower control module which is used to regulate the voltage flow across the blower motor and hence regulate blower speed. The blower is provided with a battery voltage feed from the blower relay in the CJB.

When the blower is in automatic mode, the ATCM determines the blower speed required from comfort algorithms. When the blower is in the manual mode, the ATCM operates the blower at the speed selected on the ICP.

The ATCM also controls blower 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 speed is reduced.

Air Distribution Control

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

When the climate control system is in automatic mode, the ATCM automatically controls air distribution into the passenger compartment in line with its comfort algorithm. Automatic control is overridden if any of the touch screen air distribution soft keys are selected. Air distribution in the passenger compartment will remain as selected until the **AUTO** switch on the ICP is pressed or a different distribution selection is made on the touch screen.

Programmed Demist

When the maximum demist switch on the ICP is pressed, the ATCM instigates the programmed demist function. When selected, the ATCM configures the system as follows:

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

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

- Selecting any air distribution soft key on the touch screen
- Pressing the **AUTO** switch on the ICP
- A second press of the maximum demist switch
- Switching the ignition OFF.

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

Air Conditioning Compressor Control

The A/C compressor incorporates both a conventional A/C clutch and an integral internal solenoid. The clutch is switched on and off by means of a relay in the left EJB (engine junction box). The solenoid is supplied with a current from the ATCM by a direct hardwired connection. By increasing the supply current the internal stroke of the compressor is increased, which results in more refrigerant being pumped around the A/C system, which in turn lowers the evaporator temperature. Reducing the solenoid supply current results in the evaporator temperature rising.

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

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

When A/C is selected off by pressing the **A/C** switch on the ICP, the compressor current signal supplied by the ATCM reduces the A/C compressor solenoid valve to the minimum flow position. The compressor clutch is then released and the compressor stops.

The ATCM 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. However, if the operating pressure continues to rise the compressor clutch is released and not allowed to re-engage until the pressure has dropped below a safe limit.

Air Conditioning Compressor Torque

The ATCM calculates A/C compressor torque using refrigerant pressure, ambient air temperature and compressor solenoid current. The calculated torque is transmitted via the medium speed CAN bus to the ECM. Under extreme conditions the ECM sends a CAN message requesting the ATCM to limit A/C compressor torque. This causes the ATCM to reduce the solenoid current. If the ECM transmits the 'ACClutchInhibit' CAN message, the ATCM reduces the A/C solenoid current to zero and then disengages the A/C compressor clutch.

Cooling Fan Control

The ATCM determines the amount of cooling fan duty required using the refrigerant pressure combined with the ambient air temperature. The cooling fan duty request is broadcast to the ECM on the medium speed CAN bus. For additional information, refer to:

Engine Cooling (303-03A Engine Cooling - V6 S/C 3.0L Petrol, Description and Operation),
Engine Cooling (303-03C Engine Cooling - V8 S/C 5.0L Petrol, Description and Operation).

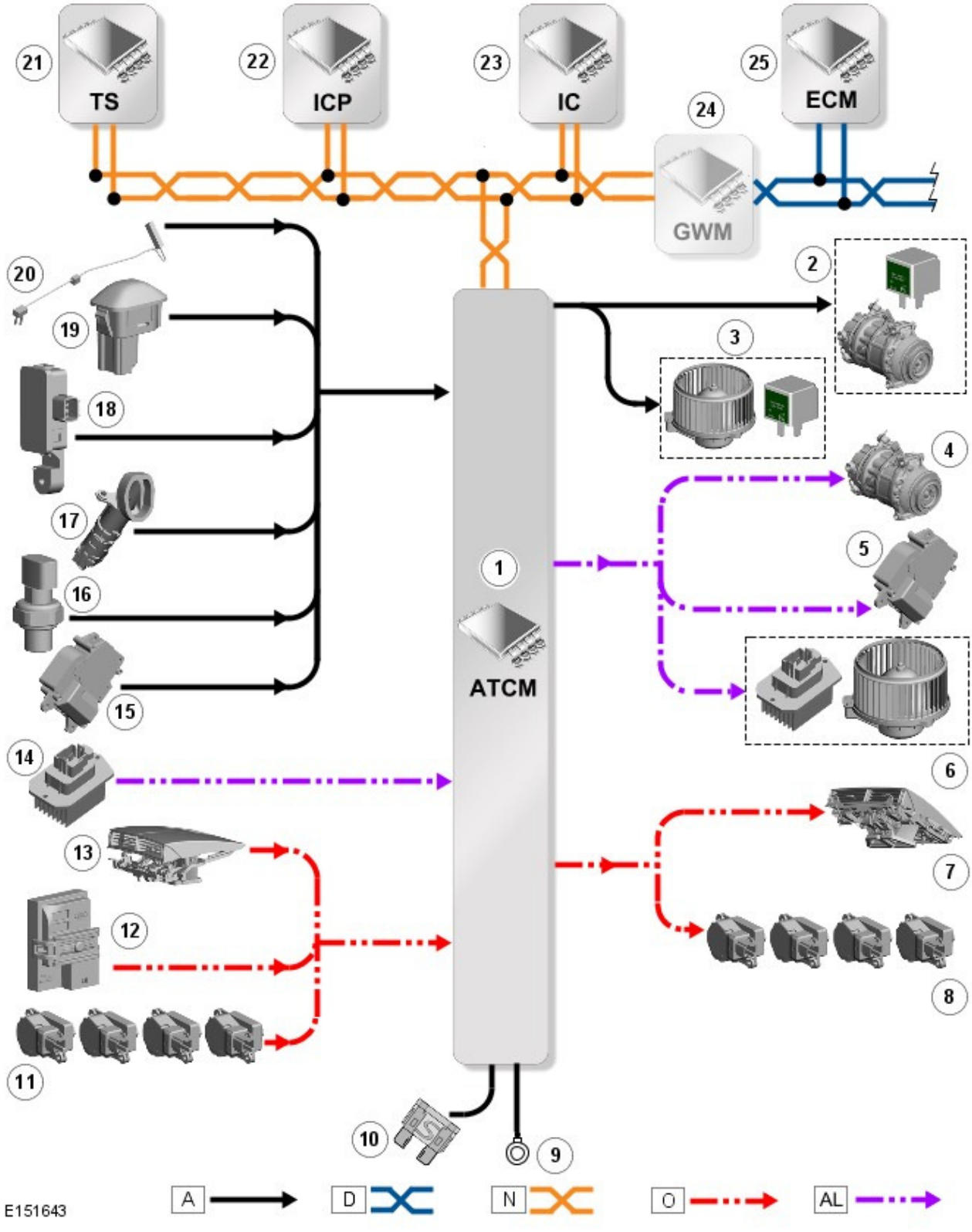
Heated Rear Window

The ATCM controls operation of an electrical heater element to rapidly defrost/demist the rear window.
For additional information, refer to: Glass, Frames and Mechanisms (501-11 Glass, Frames and Mechanisms, Description and Operation).

Heated Windshield (Where Fitted)

The ATCM controls operation of two electrical heater elements to rapidly defrost/demist the windshield.
For additional information, refer to: Glass, Frames and Mechanisms (501-11 Glass, Frames and Mechanisms, Description and Operation).

Input/Output Diagram



A = Hardwired connection; D = High speed CAN bus; N = Medium speed CAN bus; O = LIN bus; AL = PWM (pulse width modulation) connection.

Item	Description
1	Automatic temperature control module
2	Air conditioning compressor relay
3	Blower relay
4	Air conditioning compressor
5	Recirculation motor

6	Blower control module
7	Center face vents motor
8	Distribution and temperature blend motors
9	Ground
10	Power feed from quiescent current control module
11	Distribution and temperature blend motors
12	Humidity sensor
13	Center face vents motor
14	Blower control module
15	Recirculation motor
16	Refrigerant pressure sensor
17	In-vehicle temperature sensor
18	Pollution sensor (where fitted)
19	Sunload sensor
20	Evaporator temperature sensor
21	Touch screen
22	Integrated control panel
23	Instrument cluster
24	Gateway module
25	Engine control module