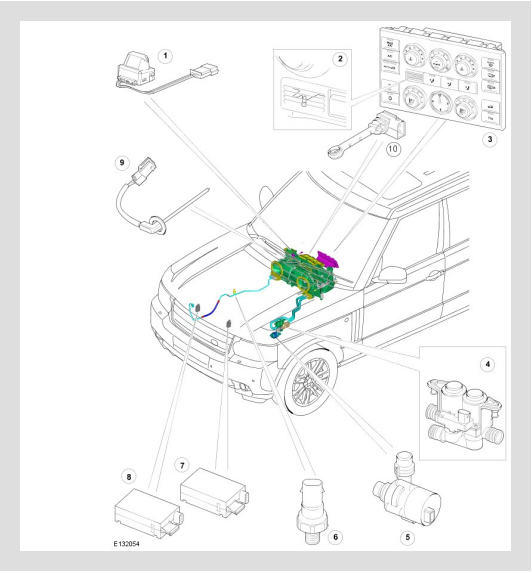
PUBLISHED: 26-MAR-2019
2011.0 RANGE ROVER (LM), 412-01B

CLIMATE CONTROL

CONTROL COMPONENTS (G1346510)

COMPONENT LOCATION



ITEM	DESCRIPTION
1	Sunlight sensor
2	In-vehicle temperature sensor
3	automatic temperature control (ATC) module
4	Coolant valve
5	Auxiliary coolant pump
6	Refrigerant pressure sensor
7	Pollution sensor - TdV8
8	Pollution sensor - 5.0L petrol
9	Evaporator temperature sensor
10	Heater temperature sensor

OVERVIEW

The air conditioning (A/C) control system automatically adjusts the temperature, volume and distribution of the air from the heater to maintain the individual temperature levels selected for the left-hand (LH) and right-hand (RH) sides of the cabin. The system also has manual overrides for the intake air source, blower speed and air distribution.

Some vehicles may be fitted with a 4 zone climate control system.

ATC MODULE

The ATC module is installed in the center of the instrument panel. An integral control panel contains push switches and rotary switches/knobs for system control inputs. Orange tell-tale light emitting diode (LED)s in the switches and switch surrounds illuminate to indicate the current settings of the system. The rotary temperature switch is graduated in degrees Celsius, except on USA vehicles, where it is graduated in degrees Fahrenheit.

An in-vehicle temperature sensor and associated electric fan are installed behind a grille in the control panel.

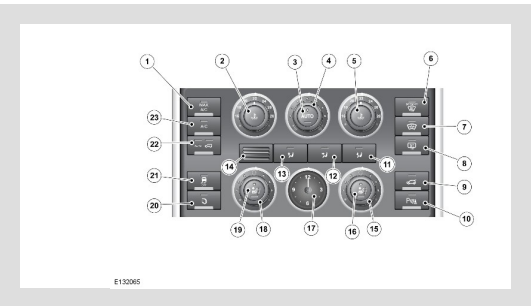
The ATC module processes inputs from the control panel switches and system sensors, then outputs the appropriate signals to control the A/C system. In addition to controlling the A/C system, the ATC module also controls the following:

NOTE:

Operation of the climatic seats is controlled by rotary knobs on the ATC module. For further information, refer to the 'Climatic Seats' information later in this section.

- The heated windshield and windshield wiper parking area heater (optional fit, not available on vehicles with infra red protection glass).
- The windshield washer jet heaters.
- The heated rear window.
- The front seat heaters.

CONTROL PANEL



ITEM	DESCRIPTION
1	Maximum A/C switch
2	LH temperature switch
3	Automatic mode switch
4	Blower switch
5	RH temperature switch

ITEM	DESCRIPTION
6	Defrost program switch
7	Heated front screen switch
8	Heated rear window switch
9	Tailgate release button
10	PDC (Park Distance Control) switch
11	Footwell distribution switch
12	Face distribution switch
13	Windshield distribution switch
14	In-vehicle temperature sensor
15	RH temperature switch
16	RH Climatic front seat switch
17	Clock
18	LH temperature switch
19	LH Climatic front seat switch
20	Rear system on/off switch
21	DSC (Dynamic Stability Control) switch
22	Air recirculation switch
23	A/C control switch

The switches on the control panel have the following functions:

Heated Windshield Switch

Energizes the heated windshield and the windshield wiper parking area heater for a set time period, until the switch is pressed again or until the engine stops, whichever occurs first. A LED above the switch is illuminated while the heaters are on.

LH and RH Seat Heater Switches

Activates the heater elements in the seat cushion and seat back at one of two heat levels. The first press of the switch energizes the heater elements at the higher heat setting and illuminates two LEDs in the switch. A second press of the switch sets the heater elements to the lower heat setting and extinguishes one of the LEDs. A further press of the switch de-energizes the heater elements and extinguishes the second LED. The seat heaters remain on until selected off or the ignition is switched off.

Enabled only with the engine running.

LH and RH Temperature Switches

Adjusts the nominal temperature settings of the LH and RH sides of the cabin between 16 and 28 °C (60 and 84 °F). The temperature range is engraved on the switch surrounds. A pointer on each switch indicates the selected temperature. In the minimum and maximum temperature positions, the system operates at maximum cooling or maximum heating respectively.

Automatic Mode Switch

Activates the automatic modes for air volume and distribution and also activates the A/C compressor. Separate LEDs in the automatic mode switch illuminate when the blower and the distribution control doors are in automatic mode. Manually selecting the blower speed or a distribution switch extinguishes the related LED.

Blower Switch

For manual adjustment of blower speed. Up to seven LEDs in the switch surround illuminate to indicate the selected blower speed.

In automatic mode the LED does not illuminate.

A/C Switch

Controls activation of the A/C compressor. Allows the A/C compressor to be selected off for economy operation. A LED above the switch is illuminated when the A/C compressor is selected on.

Recirculation Switch

For manual or automatic selection of fresh or recirculated air. Two LEDs above the switch illuminate to indicate the mode and position of the recirculation doors. The first press of the switch sets the recirculation doors to automatic mode and illuminates the LH LED. A second press of the switch manually sets the recirculation doors to the recirculation position, extinguishes the LH LED and illuminates the RH LED. A further press of the switch manually sets the recirculation doors to the fresh air position and extinguishes the RH LED.

Maximum A/C Switch

For selection of maximum A/C when the ignition is on or rest heating when the ignition is off. A LED above the switch is illuminated when maximum cooling or rest heating is selected.

Distribution Switches (Windshield, Face and Footwell)

For manual selection of air distribution in any combination of windshield, face and footwell outlets. A LED above each switch illuminates when a selection is made.

Defrost Program Switch

Activates a program that automatically selects the heated windshield on, activates the A/C compressor and changes the system settings to direct dry heat to the windshield. A LED above the switch is illuminated while the defrost program is active.

Heated Rear Window Switch and Heated Front Screen

Enabled only with the engine running. Pressing the switch energizes the heated rear window for a set time period based on ambient temperature (i.e. stays on longer in cold ambient temperature), until the switch is pressed again or until the engine stops, whichever occurs first. A LED above the switch is illuminated while the heater is on.

INPUTS AND OUTPUTS

Five electrical connectors provide the interface between the ATC module and the vehicle/heater assembly wiring.

The ATC receives all information from EMS via BCM. If the signal is controller area network (CAN) based and it has an associated QF (Quality Factor), then this is what will be stored in random access memory (RAM), so that it will be possible to log via CAN calibration protocol (CCP). If the signal is CAN based and lacking a QF, or if the signal is hardwired, then the HVAC s/w must determine the applicable QF value and report this via diagnostics or CCP when requested.

If a fault develops and QF = 0 at start up, then the evaporator sensor signal is used until QF >= 2.

If evaporator temperature sensor is faulty, then a default of 10 ^{o}C will be used until either sensor QF >= 2.

If ambient temperature sensor QF >= 2 at start up, then during session QF drops to < 2, then the last known "good" value will be used until QF >= 2 again.

IN-VEHICLE TEMPERATURE SENSOR

The in-vehicle temperature sensor is an encapsulated negative temperature coefficient (NTC) thermistor that provides the ATC module with an input of cabin air temperature. The in-vehicle temperature sensor is installed behind a grille in the ATC module control panel. An electric fan in the ATC module runs, to draw air through the grille and across the in-vehicle temperature sensor based on:

If MSCAN-Bus inactiv/active then

- Fan on for 300sec, then switch off.

If Power mode changes to 4, then

- Fan on for 300sec then fan off.

If Power mode changes to 6 and HVAC on, then

- Fan is on.

If Power mode changes to 6 and HVAC off, then

- Fan on for 15sec, then fan off.

If fan off, then fan requested to be on, then

- Wait x sec before fan on.

If Power mode 7, then:

- Fan on regardless of HVAC on/off status.

Fan is not disabled during crank (Power mode 9)

The ATC module uses the signal from the in-vehicle temperature sensor for control of the coolant temperature valve (s), blower speed and air distribution.

The signal voltage from the in-vehicle temperature sensor is between 0 and 5 V. The ATC module monitors the signal voltage and defaults to a temperature of 20 °C (68 °F) if it goes out of the range 0.4 - 4.8 V:

- If the signal voltage is less than 0.4 V, the ATC module assumes there is a short circuit to ground.
- If the signal voltage is more than 4.8 V, the ATC module assumes there is an open circuit or a short circuit to battery.

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.

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

The ATC module uses the signal from the refrigerant pressure sensor to protect the system from extremes of pressure and to calculate A/C compressor load on the engine for idle speed control.

For further information, refer to the 'Compressor Control' information later in this section.

EVAPORATOR TEMPERATURE SENSOR

The evaporator temperature sensor is a NTC thermistor that provides the ATC module with a temperature signal from the air outlet side of the evaporator. The evaporator temperature sensor is installed in the RH side of the heater assembly casing, and extends into the core of the evaporator.

The ATC module uses the input from the evaporator temperature sensor to control the engagement and disengagement of the A/C compressor clutch, to prevent the formation of ice on the evaporator.

The signal voltage from the evaporator temperature sensor is between 0 and 5 V. The ATC module monitors the signal voltage and defaults to a temperature of 0 °C (32 °F) if it goes out of the range 0.157 - 4.784 V:

- If the signal voltage is less than 0.157 V, the ATC module assumes there is a short circuit to ground.
- If the signal voltage is more than 4.784 V, the ATC module assumes there is an open circuit or a short circuit to battery.

HEATER TEMPERATURE SENSOR

The heater temperature sensor is a NTC thermistor that provides the ATC module with a temperature signal from the air outlet side of the heater core. Two sensors are installed, one each side of the vehicle center-line.

The ATC module uses the input from the heater temperature sensors to control the operation of the coolant valves.

The signal voltage from each heater temperature sensor is between 0 and 5 V. The ATC module monitors the signal voltage and defaults to a temperature of 55 °C (131 °F) if it goes out of the range 0.173 - 4.890 V:

- If the signal voltage is less than 0.173 V, the ATC module assumes there is a short circuit to ground
- If the signal voltage is more than 4.890 V, the ATC module assumes there is an open circuit or a short circuit to battery.

AUXILIARY COOLANT PUMP

The auxiliary coolant pump is an electric pump that ensures there is a satisfactory flow rate through the heater core at low engine speeds. The auxiliary coolant pump is installed in the engine compartment, in a rubber mounting attached to the side of the LH suspension turret. Operation of the auxiliary coolant pump is controlled by a power supply from the ATC module.

COOLANT VALVES

The coolant valves control the coolant flow to each side of the heater core. The coolant valves are installed in the engine compartment on a bracket attached to the side of the LH suspension turret.

Each coolant valve is a normally open solenoid valve controlled by a pulse width modulation (PWM) signal from the ATC module. The ATC module changes the length of time the coolant valve is open each duty cycle between 0 second (valve closed) and 3.6 seconds (valve held open). On the automatic system, the PWM signals to the two valves are phase offset by 1.8 seconds to reduce coolant flow fluctuations.

SUNLIGHT SENSOR

The sunlight sensor consists of two 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 used by the ATC module to adjust blower speed, temperature and distribution to improve comfort. The sensor is installed in the center of the fascia upper surface.

If one of the photoelectric cells is faulty, the output from the other photoelectric cell is used for both sides of the vehicle. If both photoelectric cells are faulty, the ATC module uses a default value of zero.

POLLUTION SENSOR

The pollution sensor allows the ATC module to monitor the ambient air for the level of carbon monoxide (CO) and oxides of nitrogen (NOx). The pollution sensor is installed at the rear of the radiator, on the upper left side of the fan cowl.

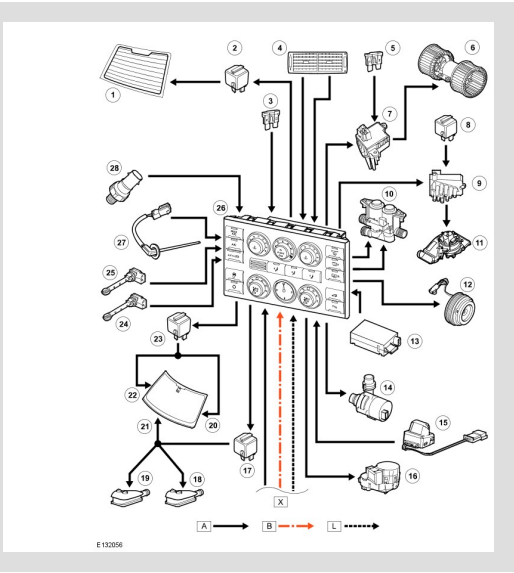
The ATC module outputs a battery power supply to heat the pollution sensor to operating temperature, and a 5 V reference voltage for the signal. The signal voltage from the pollution sensor is between 0 and 5 V.

If there is a fault with the pollution sensor, the ATC module disables automatic closing of the recirculation doors on detection of pollutants.

CONTROL DIAGRAM - SHEET 1 OF 2

NOTE:

A = Hardwired; **B** = MSCAN; **L** = LIN bus



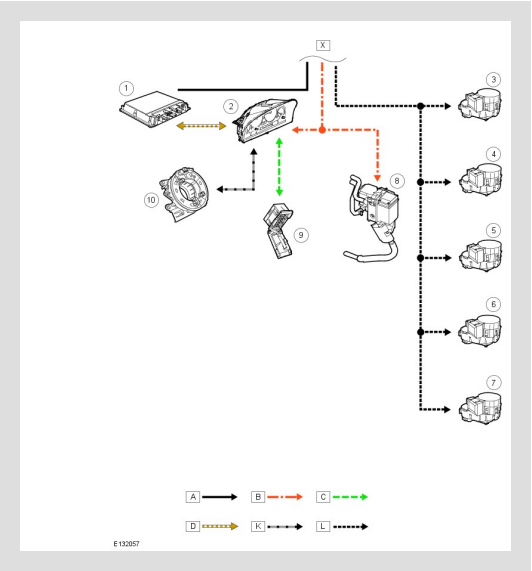
ITEM	DESCRIPTION
1	Heated rear window
2	Heated rear window relay
3	Fuse 12, central junction box (CJB)

ITEM	DESCRIPTION
4	Rear passenger face register
5	Fuse 64, CJB
6	Blower
7	Blower output stage
8	Rear blower relay
9	Rear blower output stage
10	Dual coolant valve
11	Rear blower
12	Compressor clutch only on 3.6L TDV8
13	Pollution sensor
14	Auxiliary coolant pump
15	Sunlight sensor
16	Fresh/Recirculated air doors motor
17	Washer jet heater relay
18	LH washer jet
19	RH washer jet
20	Heated windshield, LH heater element
21	Heated windshield, wiper park heater element
22	Heated windshield, RH heater element
23	Heated windshield relay
24	RH heater temperature sensor
25	LH heater temperature sensor
26	ATC module
27	Evaporator temperature sensor
28	Refrigerant pressure sensor

CONTROL DIAGRAM – SHEET 2 OF 2

NOTE:

A = Hardwired; **B** = K bus; **C** = Diagnostic DS2 bus; **D** = High speed CAN bus; **K** = I bus; **L** = M bus;



ITEM	DESCRIPTION
1	engine control module (ECM)
2	Instrument cluster
3	Windshield distribution motor
4	Face level distribution motor
5	Footwell distribution motor
6	Rear face level temperature blend motor
7	Ram air motor
8	Fuel fired booster heater
9	Diagnostic socket
10	Clockspring

PRINCIPLES OF OPERATION

The system operates on the reheat principle. Air entering the heater assembly is cooled to a constant value by the evaporator and then reheated as necessary by the heater core to produce the temperature(s) selected on the control panel.

To determine the various system settings, the ATC module derives a reference value (called the Y factor) from:

- The temperature setting on the control panel.
- The ambient temperature.
- The in-vehicle temperature.

The reference value is measured in %, where -27.5% means maximum cooling is required and 100% means maximum heating is required. Separate reference values are produced for the LH and RH sides of the heater assembly.

The reference value is used for temperature control. The driver's side reference value is also used for door positioning and blower speed calculations.

When the ignition is turned off the ATC module memorizes the system settings and resumes the same settings the next time the ignition is switched on.

A/C COMPRESSOR CONTROL

There are 2 types of compressor:

- Internally controlled, clutched compressor (3.6L TDV8)
- Externally controlled, clutchless compressor (5.0L AJ133 NA/SC)

The A/C compressor is engaged by pressing either;

- the automatic mode switch
- the defrost switch
- the A/C switch
- or the maximum A/C switch.

INTERNALLY CONTROLLED CLUTCHED COMPRESSOR

This type of compressor uses a variable swash plate to vary to the displacement of the A/C compressor which improves efficiency. This is achieved by reducing the displacement when the difference between the suction and discharge pressures in the A/C compressor is small.

The only external control of this device is a magnetic clutch which is controlled by the HVAC ECU. It is used to engage /disengage the compressor from the engine. The clutch is driven directly from the HVAC ECU via a high side power FET.

The software include an A/C off delay (10s) to prevent the rapid cycling of the clutch if a customer quickly presses the A/C button multiple time.

The following are the conditions will inhibit the A/C.

- Low ambient Temperature (Off at <-2DegC, On at > 2DegC)
- Low A/C Pressure (Off at <1.5Bar, On at > 2.5Bar)
- High A/C Pressure (Off at >20Bar, On at < 28Bar)
- Climate System Off/Blower zero
- Engine Off

- Engine Inhibit (due to high coolant, engine limp home, wide open throttle etc)
- Low evaporator temperature

The evaporator cut-off threshold is dependent on ambient, i.e. the lower the ambient, the higher the cut-off. The inhibit will be removed when the evaporator temp has recovered by 2º Celsius (ºC) over the cut-out temp threshold.

EXTERNALLY CONTROLLED CLUTCHLESS COMPRESSOR

This type of compressor uses a variable swash plate to vary the displacement but this time it is indirectly controlled by the HVAC ECU. A small solenoid inside the compressor moves a spring which controls the displacement. The HVAC ECU controls this solenoid via a high side drive FET. The valve is a current controlled device which means the HVAC ECU include a current shunt in the drive circuit to measure the current being drawn by the device. The current is reduced by reducing the duty of the 400Hz PWM control signal to the valve.

The HVAC ECU includes a complex algorithm to calculate the required duty by using a PID controller. It adjusts the PWM signal to try to get the measured evaporator sensor temperature to be the same as the target evaporator temperature.

The conditions for turning off the A/C are the same as the internally controlled except that the compressor duty is reduced rather than cut straight away which leads to a more refined control.

ENGINE IDLE SPEED CONTROL

There are 3 levels and the request from HVAC is set in both hot and cold ambients.

In hot ambients, the feature is to help with A/C performance by raising the A/C compressor speed and in cold ambients to help with cabin warm-up by increasing the engine speed.

The request is only sent when the climate system is on and engine is running. Otherwise the request is zero.

The 3 speeds are:

- Level 1 = 750rpm
- Level 2 = 900RPM
- Level 3 = 1200RPM

The speed thresholds are held in PCM and operate in both Neutral and Drive mode.

Also there is a piece of code to increase to level 2 if the A/C pressure jumps to more than 20Bar as this means the A/C is struggling and needs an increased engine idle to help by increasing the A/C compressor speed and the viscous cooling fan speed.

ENGINE COOLING FAN CONTROL

The HVAC ECU calculates the requested cooling fan speed to PCM. The request is sent to the HVAC, and calculated based on ambient temperature, A/C pressure and then is compensated for vehicle speed. The request is only sent if the HVAC is switched on, A/C is on and engine is running.

The cooling fan demand (0..100%) has a rate limiter and includes a delay if the A/C is switched off.

A/C TORQUE CALCULATION

The torque used by the A/C system is calculated in the PCM. The PCM uses ambient temp, A/C pressure and A/C compressor displacement control valve current as inputs to determine the torque on the engine.

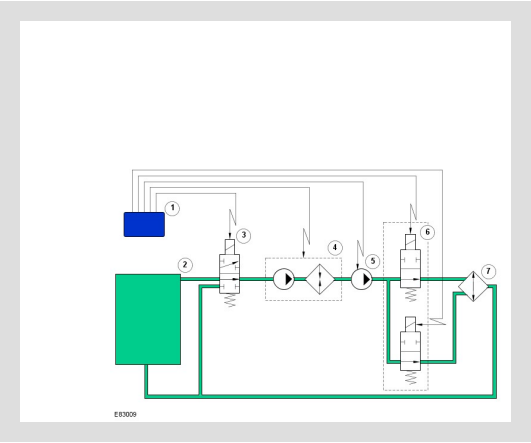
TEMPERATURE CONTROL

To determine the amount of heat required, in the form of coolant flow through the heater, the ATC module compares the reference value with the heater temperature and incorporates a correction factor to compensate for changes of coolant flow rate with engine speed. From the resultant value the ATC module determines the open duration of the coolant valve and outputs the appropriate control signal. On the automatic system, separate values and output signals are generated for each coolant valve to produce the individual temperature control for the LH and RH sides of the cabin.

When the temperature setting on the control panel is set to maximum, the ATC module signals the coolant valve to remain open. When the temperature setting on the control panel is set to minimum, the ATC module signals the coolant valve to remain closed.

On the automatic system, the minimum setting is over-ridden when the defrost program, maximum A/C, rest heating or fuel fired booster heater functions are selected.

Heater Coolant Circuit



ITEM	DESCRIPTION
1	ATC module
2	Engine cooling system
3	Changeover valve (where fitted)
4	Fuel fired booster heater unit (where fitted)
5	Auxiliary coolant pump
6	Coolant valves (automatic system)
7	Heater core

DOOR CONTROL

The position of the ram air doors is automatically controlled by the ATC module. The positions of the recirculation doors and the distribution doors are either automatically controlled by the ATC module or manually controlled by the related switches.

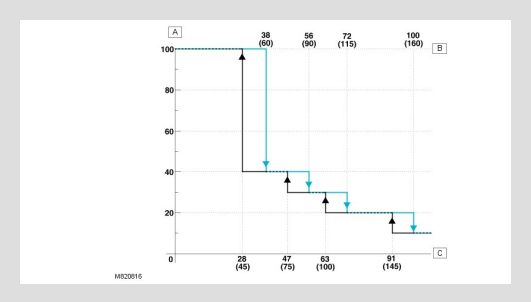
Ram Air Doors

The ATC module progressively closes the ram air doors, in four steps, as vehicle speed increases, and opens them again as vehicle speed decreases. At the maximum closed position, 90% of the fresh air inlet area is closed off. A hysteresis of 15 km/h (9 mph) prevents the ram air doors from hunting at a constant vehicle speed.

Ram Air Door Positions

NOTE:

A = Door position, % open; **B** = Opening speeds, mph (km/h); **C** = Closing speeds, mph (km/h)



Recirculation Doors

Unless the recirculation doors are manually selected closed, using the recirculation switch on the control panel or the steering wheel recirculation switch (where fitted), they are normally open, but automatically closed by the ATC module under certain conditions:

Rapid Cooling: For rapid cooling of the cabin, when the A/C system is selected on, if the driver's side reference value is less than -20% and the ambient temperature is more than 6 °C (43 °F), the ATC module closes the recirculation doors. The ATC module opens the recirculation doors after 12 minutes (temperate climates) or 20 minutes (hot climates), if the driver's side reference value increases to more than -5% or if the ambient temperature decreases to 6 ° C (43 °F).

Pollution: When the ATC module detects a high level of pollutants, it sets the recirculation doors to the recirculation position for:

- 3 minutes if the A/C system is in the heating mode.
- 10 minutes if the A/C system is in the cooling mode.

After the recirculation time period, the ATC module returns the recirculation doors to the fresh air position. After 1 minute, if the pollutants are still present, the ATC module repeats the recirculation cycle.

Ignition Off: If the recirculation doors are in the recirculation position when the ignition is switched off, the ATC module automatically sets them to the fresh air position, to ensure that fresh air is available if a fault occurs with the recirculation door drive circuit at the next ignition on. When the ignition is switched on, the ATC module sets the recirculation doors to the position they were in at ignition off.

Distribution Doors

When a manual distribution selection is made on the control panel, the ATC module moves the distribution doors to preset positions. When the system is in the automatic mode, the ATC module uses maps of the driver's side reference value to determine the position of the distribution doors. Each distribution door has a separate map, and there are separate maps for temperate, hot climates and Japan. The mapped positions of the face level distribution doors are given a correction factor from the sunlight sensor inputs.

BLOWER CONTROL

In the automatic mode, blower speed is determined from reference temperature maps. In general terms, the more heating or cooling required to achieve the temperature selected on the control panel with the driver's side temperature switch, the faster the blower speed.

When maximum cooling is first required in the automatic mode, the ATC module runs the blower at full speed for a fixed period regardless of any drop in cabin temperature. Different time periods are incorporated for the following markets:

- NAS and Gulf States
- Europe, ROW and Japan

NAS and Gulf States have the longest time period with the blower at full speed. The Land Rover approved diagnostic equipment can be used to change the market setting so, in some cases, if a customer complains of the duration the blower runs at full speed, changing the market setting could resolve the complaint.

When heating is required, blower speed is reduced if the engine is cold and then progressively increased to the nominal setting as the engine coolant temperature increases from 20 to 50 °C (68 to 122 °F).

Blower speed is also influenced by the sunlight sensor. At high light levels blower speed will increase to increase the cooling effect.

When the blower is selected off temperature regulation is no longer possible so the ATC module disengages the A/C compressor, de-energizes the auxiliary water pump and closes the coolant valves. Pressing any of the A/C system switches restores blower operation and activates the required function. If the blower is selected off when the ignition is switched off, the blower remains off if the ignition is switched on again within 15 minutes. If more than 15 minutes elapses between the ignition being switched off and back on again, the ATC module switches the blower on at speed 1.

If battery voltage is low the ATC module reduces blower speed to conserve power. If battery voltage decreases to less than 12 V, the ATC module decreases the blower signal voltage, and thus the voltage to the blower motor, in direct proportion to the reduction in battery voltage.

DEFROST PROGRAM

When the defrost program is selected the ATC module:

- Opens the windshield distribution doors and closes the face and footwell doors.
- Sets the recirculation doors to the fresh air position.
- Runs the blower at speed 7.
- Activates the A/C compressor.
- Activates the heated rear window.
- Activates the heated windshield (where fitted).

When the ambient temperature is 10 °C (50 °F) and below, the ATC module signals the coolant valves to remain open. When the ambient temperature is more than 10 °C (50 °F), the ATC module checks the existing heater core temperature and, if necessary, increases the open time of the coolant valves to produce a minimum heater core temperature of 30 °C (86 °F).

The defrost program is cancelled by pressing the defrost switch again, or pressing the automatic, A/C or maximum A/C switches

MAXIMUM A/C

Pressing the maximum A/C switch while the engine is running and the ambient temperature is more than 7 °C (45 °F) provides the maximum cooling possible from the system to cool the cabin down as rapidly as possible. When maximum A/C is selected the coolant valves are held closed, the A/C compressor is engaged, the blower speed is set to maximum and the recirculation doors are set to the recirculation position. After 12 minutes the recirculation doors will be set to fresh air for 1 minute then returned to the recirculation position.

The maximum A/C function is cancelled when any of the other A/C system switches are pressed.

REST HEATING

When the engine is not running, pressing the maximum A/C switch activates the rest heating function to heat the cabin with residual heat from the engine. The rest heating function activates provided the following conditions exist:

- It is less than 2 minutes since the ignition was selected off.
- Ambient temperature is less than 15 °C (59 °F).
- On the previous ignition cycle engine temperature exceeded 70 °C (158 °F).
- Battery voltage is 11.4 V minimum.

To provide the rest heating function, the ATC module activates the auxiliary coolant pump, coolant valves, control door and blower. The ATC module regulates the temperature (to the driver setting selected before the ignition was switched off), opens the face level distribution doors and runs the blower at speed 4.

The rest heating function is cancelled after 15 minutes or when:

- The maximum A/C switch is pressed again.
- The ignition is selected on.
- Battery voltage decreases to less than 11 V.

REAR PASSENGER FACE LEVEL AIR

The volume and temperature of the air from the rear passenger face register are adjusted with the rotary controls positioned at the rear of the floor console. Each rotary control operates a variable potentiometer connected to the ATC module. The rotary control initiates stepless changes of rear blower speed between off and full speed. The temperature rotary control controls the position of the rear passenger face level blend door in the heater assembly when the driver's side reference temperature is more than 0%.

Volume Control

The volume potentiometer outputs between 0 and 5 V to the ATC module. The ATC module translates the voltage from the potentiometer into a signal voltage for the output stage in the rear blower. Potentiometer voltages of less than 1.25 V are interpreted as a blower off selection and translate into a signal voltages less than 0.1 V. Potentiometer voltages between 1.25 and 5 V are translated into proportional signal voltages between 0.1 and 5 V.

The ATC module automatically switches off the rear blower when:

- The defrost program is active.
- The main blower is selected off.
- The engine cranks.
- The ignition is selected off (the rear blower remains off during rest heating, parked heating and parked ventilation).

Temperature Control

The temperature potentiometer outputs between 0 and 5 V to the ATC module. The ATC module translates the voltage from the potentiometer into a blend door position between 0% (cold) and 100% (hot) and outputs the appropriate control signal on the M bus to the blend door motor. Potentiometer voltages of less than 1.5 V translate to a blend door position of 0%. Potentiometer voltages of more than 3.4 V translate to a blend door position of 100%. Potentiometer voltages between 1.5 and 3.4 V translate linearly to blend door positions between 0 and 100%.

HEATED WINDSHIELD (WHERE FITTED)

When the engine is running and the heated windshield is selected on, the ATC module illuminates the LED above the switch and energizes the heated windshield relay attached to the passenger end of the fascia cross tube. If not already active, the ATC module also activates the A/C compressor and the blower, and sets air distribution to windscreen. After 10 minutes (when ambient temperature is -15 °C (5 °F) or above) or 17 minutes (when ambient temperature is less than -15 °C (5 °F)), the ATC module extinguishes the LED and de-energizes the heated windshield relay. After the heater times out or is switched off, the timer in the ATC module is reset to zero.

HEATED REAR WINDOW

When the engine is running and the heated rear window is selected on, the ATC module illuminates the LED above the switch and energizes the heated rear window relay in the AJB (auxiliary junction box). After 10 minutes (when

ambient temperature is -15 °C (5 °F) or above) or 17 minutes (when ambient temperature is less than -15 °C (5 °F)), the ATC module extinguishes the LED and operates the heated rear window at low power for 60 minutes. During the 60 minutes, the ATC module cycles the heated rear window relay off for 80 seconds and on for 40 seconds. If the heated rear window switch is pressed again during the low power phase, the ATC module illuminates the LED again and returns the heated rear window to full power by keeping the heated rear window relay energized for 5 minutes. At the end of the 5 minutes the LED is extinguished and the 60 minutes low power phase is repeated.

The ATC module outputs a K bus message when the heated rear window is active. The message allows the navigation computer to compensate for the effect of the magnetic field generated when the heated rear window is active. In addition, the generic electronic module (GEM) transfers the message onto the P bus for the door modules, which activate the door mirror heaters together with the heated rear window.

WASHER JET HEATERS

The ATC module automatically energizes the washer jets relay, on the CJB, when the ignition is on and the ambient temperature is less than 3 °C (37 °F). If the ambient temperature increases to more than 6 °C (43 °F), the ATC module de-energizes the washer jets relay.

PARKED VENTILATION

Parked ventilation allows the vehicle interior to be ventilated with ambient air while parked with the engine stopped. Vehicles without a fuel fired booster heater have parked ventilation only. On vehicles with a fuel fired booster heater, parked ventilation operates in conjunction with parked heating. For additional information, refer to: Auxiliary Heater (412-02B Auxiliary Heating, Description and Operation).

Parked ventilation is controlled by direct selection on the TSD (touch screen display), or by using the TSD to program one or two on/off cycle times in the following 24 hour period. Both the direct selection and programmed time modes of operation are selected when the engine is stopped and the ignition switch is in position I; if required, the key can then be removed from the ignition switch and the vehicle locked. Parked ventilation only operates if the ambient temperature is 16 °C (61 °F) or more, and is automatically de-activated after 30 minutes, regardless of any programmed 'off' time, to prevent excessive drain on the battery. Parked ventilation is automatically de-activated when the ignition is switched on.

When programmed times for parked ventilation are entered on the TSD, the times are stored in the memory of the instrument cluster and the climate set indicator in the top left corner of the TSD is permanently illuminated.

At a programmed parked ventilation start time, or when parked ventilation is selected on using the TSD, the instrument cluster outputs:

- A parked ventilation request to the TSD on a hardwired connection
- A parked ventilation request to the ATC module on the K bus
- The ambient temperature to the ATC module and GEM on the K bus.

On receipt of the messages:

- The climate set indicator flashes at 2 Hz, to indicate that parked ventilation is active.

- The ATC module operates the blower at speed 1, opens the face level distribution doors in the heater assembly and closes the windshield and footwell doors.

The ATC module disables parked ventilation if battery voltage is less than 11.4 V.

CLIMATIC SEATS

High specification vehicles are fitted with climatic seats, which are able to deliver heating and cooling to the front seat occupants. Vehicles fitted with climatic seats feature 2 additional rotary controllers mounted in the ATC module.

> **NOTE:**
>
> If climatic seats are fitted, heated seat rotary controllers are featured on the ATC module control panel.

The controlling software for the climatic seats is contained within a control module mounted below the drivers seat. When a temperature selection is made through either of the rotary controllers, the instrument panel switch pack provides a PWM signal to the control module. The control module interprets the PWM signal as a temperature value and attempts to heat or cool the seat accordingly.

Both climatic front seats contain two Peltier cells; one in the cushion, one in the backrest. The Peltier cells are able to deliver heating and cooling based on a voltage provided by the control module. Each seat also contains a fan, which blows air over the Peltier cells to distribute heating or cooling throughout the seat.

The climatic seat control module monitors seat heating through a NTC temperature sensor. The temperature sensor is only used to monitor seat heating. Seat cooling is open loop, with no temperature signal provided back to the control module.

Although the switch LED's will illuminate if a selection is made when the ignition is switched on, the Peltier cells will not operate until the engine is running. After the ignition has been switched off, the control module will remember 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.