

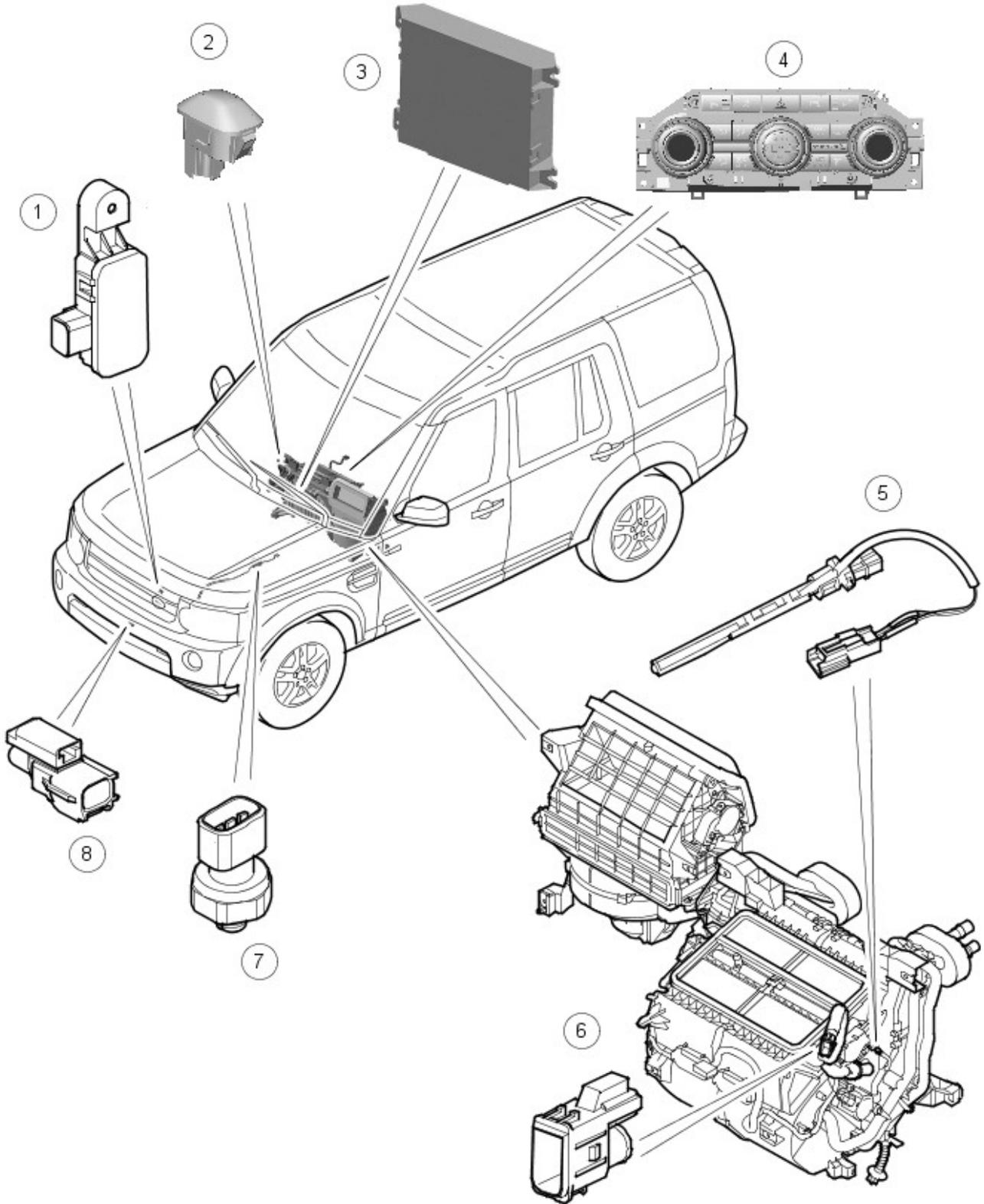
Control Components - Control Components

Description and Operation

COMPONENT LOCATIONS



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



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E 132921

Item	Part Number	Description
1	-	Pollution sensor (Japan only)

2	-	Sunlight sensor
3	-	automatic temperature control (ATC) module
4	-	Center instrument panel switch pack
5	-	Evaporator temperature sensor
6	-	In-vehicle temperature sensor (all except Japan), or in-vehicle temperature and humidity sensor (Japan only)
7	-	Refrigerant pressure sensor
8	-	Ambient air temperature sensor

GENERAL

The control system operates the air conditioning (A/C) system and the heating and ventilation system to control the temperature, volume and distribution of air from the heater.

The system is a dual zone system that 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 passenger compartment. The system also has manual overrides for the intake air source, blower speed and air distribution. The system includes:

- An ATC module.
- Center instrument panel switch pack
- An ambient temperature sensor.
- A refrigerant pressure sensor.
- An evaporator temperature sensor.
- An in-vehicle temperature sensor.
- A sunlight sensor.

Vehicles in the Japan market also incorporate:

- A pollution sensor.
- A humidity sensor.

ATC MODULE



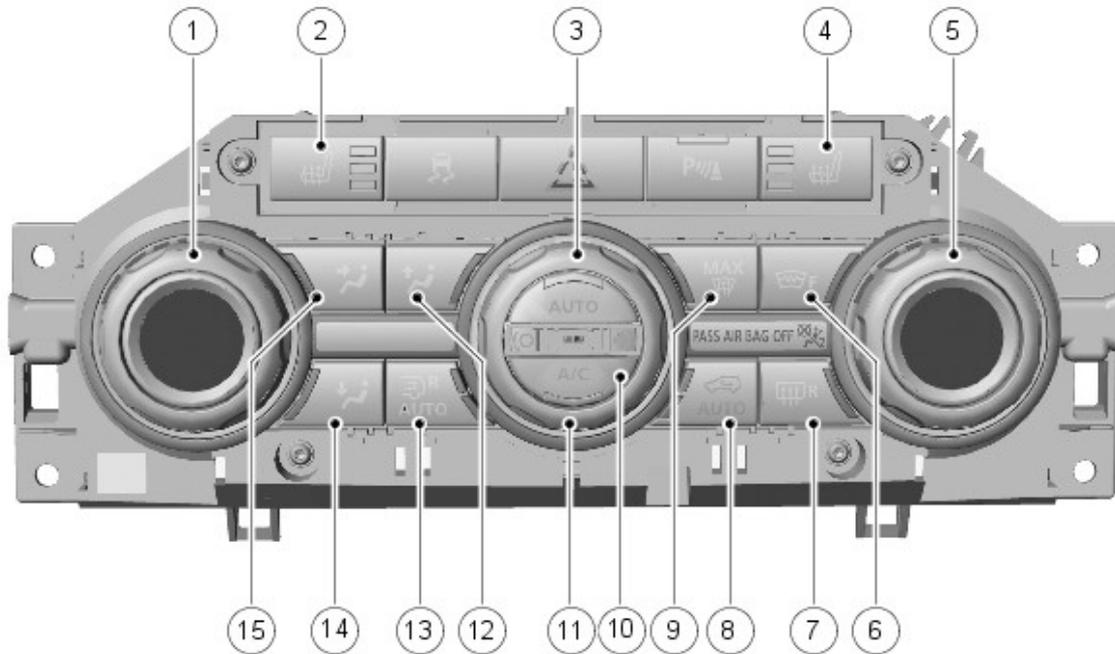
E128058

The [ATC \(automatic temperature control\)](#) 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 center instrument panel switch pack, system sensors and the medium speed controller area network (CAN) bus, then outputs the appropriate control signals to the A/C system and the heating and ventilation system. In addition to controlling the A/C system and the heating and ventilation system, the ATC module also controls the following:

- The front seat heaters.
For additional information, refer to: Seats (501-10, Description and Operation).
- The rear window heater.
For additional information, refer to: Glass, Frames and Mechanisms (501-11, Description and Operation).
- The windshield heater.
For additional information, refer to: Glass, Frames and Mechanisms (501-11, Description and Operation).
- The windshield washer jets and exterior mirror heaters.
For additional information, refer to: Rear View Mirrors (501-09, Description and Operation).

CENTER INSTRUMENT PANEL SWITCH PACK



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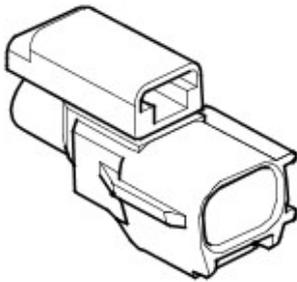
Item	Part Number	Description
1	-	LH temperature switch
2	-	LH front seat heater switch
3	-	Automatic mode switch
4	-	RH front seat heater switch
5	-	RH temperature switch
6	-	Heated windshield switch
7	-	Heated rear window switch
8	-	Defrost program switch
9	-	Air recirculation switch
10	-	A/C (air conditioning) control switch
11	-	Blower control switch
12	-	Windshield and side window distribution switch
13	-	Rear environment
14	-	Footwell distribution switch
15	-	Face distribution switch

The switches on the **Center instrument panel switch pack** have the following functions:

- **LH and RH Temperature Switches:** Adjusts the nominal temperature settings of the LH and RH sides of the passenger compartment. The switch can rotate through 270°, between full cold and full hot. The switch surrounds are graduated in 2° increments between 16 and 28 °C. Minor detents define 1 °C steps over the range of the switch. Amber light emitting diode (LED)s in the switch surround illuminate to indicate the temperature setting. When maximum cold is selected, the ATC module also automatically sets the air source to recirculated air, blower speed to maximum and distribution to face. When maximum hot is selected, the ATC module also automatically sets the air source to fresh air, blower speed to maximum and distribution to footwell.
- **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 engine is turned off.
- **Blower Switch:** For manual adjustment of blower speed. The switch can rotate through 240°, from off to maximum speed. Eight primary detents define the off position and seven blower speeds. Minor detents define small steps between the primary detents. When blower speed is manually adjusted, amber LEDs in the switch surround illuminate to indicate the selected blower speed. The LEDs remain off when blower speed is under automatic control.
- **Automatic Mode Switch:** Activates the automatic modes for the A/C system, blower speed and distribution. Separate amber LEDs in the automatic mode switch illuminate to show when the blower and the distribution are in automatic mode. Manually selecting the blower speed or a distribution switch extinguishes the related LED.
- **A/C control switch:** Controls activation of the A/C compressor. Allows the A/C compressor to be selected off for economy operation. A LED (light emitting diode) switch is illuminated when the A/C compressor is selected

- on.
- **Defrost program switch:** Activates a program that automatically selects: inlet air to fresh air; distribution to screen only; blower to speed 5; rear screen heater on; windshield heater on (where fitted), A/C system to automatic mode. An amber LED in the switch is illuminated while the defrost program is active.
 - **Heated windshield switch:** Energizes the windshield heater for a set time period, until the switch is pressed again or until the engine stops, whichever occurs first. An amber LED in the switch is illuminated while the heater is on.
 - **Heated rear window switch:** Enabled only with the engine running. Pressing the switch energizes the rear window heater for a set time period, until the switch is pressed again or until the engine stops, whichever occurs first. An amber LED in the switch is illuminated while the heater is on.
 - **Air recirculation switch:** For selection of fresh or recirculated air. On models without pollution sensing, an amber LED in the switch is illuminated when recirculated air is selected. On models with pollution sensing, the recirculation switch incorporates two amber LED. The first press of the switch sets the recirculation flaps to automatic mode and illuminates one LED. A second press of the switch manually selects recirculated air and illuminates the second LED. A further press of the switch manually selects fresh air and extinguishes the two LEDs.
 - **Distribution Switches (Windshield, Face and Footwell):** For manual selection of air distribution in any combination of windshield, face and footwell outlets. Each switch has a LED which illuminates when the related distribution mode is selected.

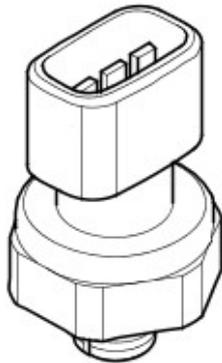
AMBIENT AIR TEMPERATURE SENSOR



E43580

The ambient air temperature sensor is a negative temperature coefficient (NTC) thermistor that provides the ATC module with an input of external air temperature. The sensor is attached to a bracket on the rear of the bumper beam, on the vehicle center-line.

REFRIGERANT PRESSURE SENSOR



E43581

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.

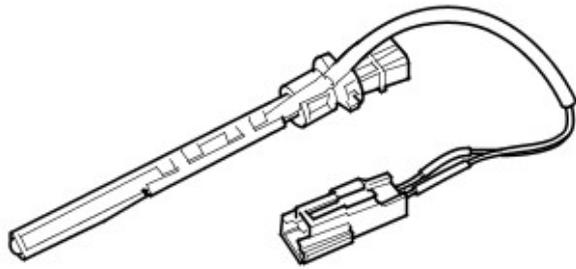
The ATC module supplies a 5 V reference voltage to the refrigerant pressure sensor and receives a return signal voltage, between 0 and 5 V, related to system pressure.

The ATC module uses the signal from the refrigerant pressure sensor to protect the refrigerant system from extremes of pressure and to calculate A/C compressor load on the engine. The ATC module also transmits the A/C compressor load value to the engine control module (ECM), via the medium speed CAN bus, instrument cluster and high speed CAN bus, for use in controlling the speed of the engine cooling fan.

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 1.9 ± 0.2 bar (27.5 ± 3 lbf/in²); the ATC module loads the A/C compressor again when the pressure increases to 2.8 ± 0.2 bar (40.5 ± 3 lbf/in²).
- Increases to 33 ± 1 bar (479 ± 14.5 lbf/in²); the ATC module loads the A/C compressor again when the pressure decreases to 23.5 ± 1 bar (341 ± 14.5 lbf/in²).

EVAPORATOR TEMPERATURE SENSOR

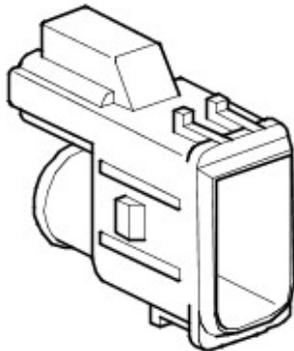


E43582

The evaporator temperature sensor is a NTC thermistor that provides the ATC module with a temperature signal from the downstream side of the evaporator. The evaporator temperature sensor is installed in the right side of the heater assembly casing.

The ATC module 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



E43583

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. The sensor is connected to a tube, the other end of which is connected to a venturi on the side casing of the heater. 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.

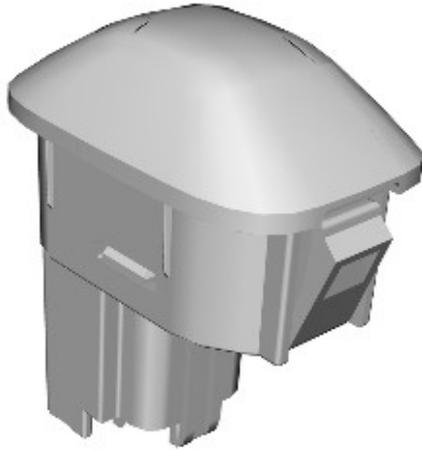
HUMIDITY SENSOR (WHERE FITTED)

The humidity sensor is a capacitive device integrated into the in-vehicle temperature sensor (see above).

The humidity sensor element is constructed from 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.

The humidity sensor and the in-vehicle temperature sensor are connected to a PCB (printed circuit board) inside the sensor housing. The PCB is powered by a 5V feed from the ATC module. Separate signals of temperature and relative humidity are transmitted from the PCB to the ATC module.

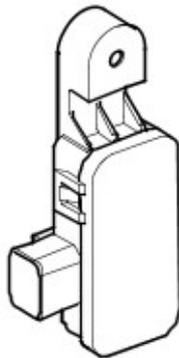
SUNLIGHT SENSOR



E132923

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 are used by the ATC module to adjust blower speed, temperature and distribution to improve comfort. The sensor is installed in the center of the instrument panel upper surface and is powered by a 5V feed from the ATC module.

POLLUTION SENSOR (WHERE FITTED)



E43588

The pollution sensor allows the ATC module to monitor the ambient air for the level of hydrocarbons and oxidized gases such as nitrous oxides, sulphur oxides and carbon monoxide. The sensor is attached to a bracket on the front-end carrier, at the top left corner of the condenser.

The pollution sensor is powered by a battery voltage feed from the ATC module, and returns separate signals of hydrocarbon and oxidized gases.

If there is a fault with the pollution sensor, the ATC module disables the automatic operation of the recirculation door.

SYSTEM OPERATION

A/C Compressor Control

The variable displacement A/C compressor is permanently driven by the engine. The flow of refrigerant through the A/C compressor, and the resultant system pressure and evaporator operating temperature, is regulated by the refrigerant solenoid valve. Operation of the refrigerant solenoid valve is controlled by the ATC module using a 400 Hz pulse width modulation (PWM) signal. The duty cycle of the PWM signal is calculated using the following parameters:

- A/C compressor torque.
- A/C compressor torque maximum.
- A/C cooling status.
- A/C demand.
- A/C refrigerant pressure.
- Ambient air temperature.
- Blower speed.
- Engine cranking status.
- Evaporator temperature.
- Transmission gear status.

When A/C is selected, the ATC module maintains the evaporator at an operating temperature that varies with the in-vehicle cooling requirement. The ATC module increases the evaporator operating temperature, by reducing the refrigerant flow, as the requirement for air cooling decreases, and vice versa. During an increase of evaporator operating temperature, to avoid compromising the dehumidification function, the ATC module controls the rate of temperature increase, which keeps the cabin humidity at a comfortable level.

When the economy mode is selected, the PWM signal holds the refrigerant 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 duty cycle of the PWM signal is progressively reduced until the system pressure decreases. When the system pressure falls below the low pressure limit, the duty cycle of the PWM signal is held at its lowest setting, so that the A/C compressor is maintained at the minimum stroke, to avoid depletion of lubricant from the A/C compressor. The protection algorithm is calculated at a high rate, to enable early detection of the rapid pressure changes possible if a system fault develops.

A/C Compressor Torque

The ATC module uses refrigerant pressure, evaporator temperature and engine speed to calculate the torque being used to drive the A/C compressor. The calculated value is broadcast on the medium speed CAN bus for the ECM, which uses the calculated value for idle speed control and fueling control. The ATC module also compares the calculated value with a maximum A/C compressor torque value received from the ECM over the medium speed CAN bus. If the calculated value exceeds the maximum value, the ATC module signals the refrigerant solenoid valve to reduce the refrigerant flow and so reduce the torque being used to drive the A/C compressor. By reducing the maximum A/C compressor cooling torque value, the ECM is able to reduce the load on the engine when it needs to maintain vehicle performance or cooling system integrity.

Idle Speed Control

In order to maintain A/C cooling performance, the ATC module requests an increase in engine idle speed if the evaporator temperature starts to rise while the refrigerant solenoid valve is already set to the maximum flow rate. The increase in engine idle speed is requested in three stages, using a medium speed CAN bus message to the ECM. For additional information, refer to:

- Electronic Engine Controls (303-14A, Description and Operation),
- Electronic Engine Controls (303-14B, Description and Operation),
- Electronic Engine Controls (303-14C, Description and Operation).

The need for a change in idle speed is determined as follows:

- If the evaporator temperature increases by 3 °C (5.4 °F), or to 6 °C (10.8 °F) above the target operating temperature, over a 10 seconds period, the first stage of idle speed increase is requested.
- When the first stage of idle speed increase is set, if the evaporator temperature increases by 3 °C (5.4 °F), or increases to 12 °C (21.6 °F) above the target operating temperature, over a 9 seconds period, the second stage of idle speed increase is requested.
- When the second stage of idle speed increase is set, if the evaporator temperature increases by 3 °C (5.4 °F), or increases to 15 °C (27 °F) above the target operating temperature, over a 10 seconds period, the third stage of idle speed increase is requested.
- When an idle speed increase is set, if the evaporator temperature decreases by 3 °C (5.4 °F) over a 10 seconds period, the next stage down of idle speed increase is requested.

Electrical Load Management

The ATC module manages the vehicle electrical loads to:

- Maintain the vehicle battery in a healthy state of charge.
- Ensure adequate power is available for defrost demisting during engine warm-up.
- Ensure adequate power is available for A/C during extended periods with the engine at idle speed.
- To maintain system voltage within acceptable limits.
- To provide adequate power to meet customer expectations.

Electrical load management is achieved by increasing the engine idle speed and controlling the electrical load of systems that do not affect the driveability or safety of the vehicle.

During the engine warm-up period, the ATC module manages the electrical load to make sure that the battery voltage is maintained above a pre-determined level. The battery voltage level that is maintained and the duration of the start period varies with ambient air temperature and engine coolant temperature (ECT). After the engine warm-up period, the ATC module manages the electrical load to make sure that the requested electrical load does not exceed the generator output.

The duration of the engine warm-up period depends on the ambient air temperature and the ECT, as detailed in the following table:

Engine Warm-up Times

Ambient Air Temperature, °C (°F)	ECT, °C (°F)			
	<10 (<50)	>10 to <30 (>50 to <86)	>30 to <60 (>86 to <140)	>60 (>140)
	Warm-up Period, Minutes			
>10 (>50)	15	15	15	15
>5 to <10 (>41 to <50)	15	15	15	15
>0 to <5 (>32 to <41)	10	15	15	15
>-10 to <0 (>14 to <32)	10	10	15	15
<-10 (<14)	5	5	10	15

The ATC module calculates the electrical load from the battery voltage and generator output voltage, and compares the result against the maximum load available from the generator. The calculation is averaged across the first 20 seconds after the engine starts, and subsequently averaged every 60 seconds. When the engine is turned off, the ATC module stores the status of the electrical load management for 20 seconds. If the engine is re-started within the 20 seconds, the ATC module resumes electrical load management using the stored status. If the engine is re-started after the 20 seconds, the timers are reset and the ATC module re-calculates the status.

If the electrical load is more than the maximum load available, the ATC module requests an increase of engine idle speed using the medium speed CAN bus message to the ECM. If an electrical load imbalance remains after an increase in engine idle speed, or if the electrical load is more than the capacity of the charging system, the ATC module reduces the electrical load by reducing the power of some vehicle systems or inhibiting their operation. The number of systems controlled depends on the electrical load reduction required. The systems controlled and the order in which their power is reduced or they are inhibited are contained in three priority tables. The table used depends on the ambient air temperature, battery temperature and ECT:

- The cold start table is used when the ambient air temperature is less than 5 °C (41 °F) and the ECT is less than 30 °C (86 °F).
- The hot start table is used when the ambient air temperature is 5 °C (41 °F) or more and the ECT is less than 30 °C (86 °F).
- The continuous table is used when battery temperature is more than 5 °C (41 °F) and the ECT is more than 50 °C (122 °F).
- If none of the above conditions are met, the ATC module adopts the last used table.

Cold Start Electrical Load Management

Priority		System
Power Reduction	Inhibited	
1	-	Air suspension
2	-	Front seat heaters
3	-	Entertainment system
-	4	Front seat heaters
5	-	Rear window heater
6	-	Windshield washer jet and exterior mirror heaters
-	7	Windshield washer jet and exterior mirror heaters
8	-	Windshield heater
9	-	Climate control blower
-	10	Rear window heater
-	11	Windshield heater

Hot Start Electrical Load Management

Priority		System
Power Reduction	Inhibited	
-	1	Front seat heaters; windshield washer jet and exterior mirror heaters
2	-	Windshield heater
3	-	Rear window heater
4	-	Air suspension
5	-	Entertainment system
-	6	Windshield heater
-	7	Rear window heater

Continuous Electrical Load Management

Priority		System
Power Reduction	Inhibited	
-	1	Front seat heaters
2	-	Windshield heater
3	-	Rear window heater
4	-	Air suspension
5	-	Entertainment system

Engine idle speed changes, and electrical load changes of systems not under direct control of the ATC module (air suspension and entertainment), are initiated using the appropriate medium speed CAN bus message. When partial operation is requested:

- The air suspension system still performs height changes but reduces air compressor operation by not replenishing the reservoir.
- The entertainment system restricts the maximum volume level and reduces the output frequency bandwidth.

Cooling Fan Control

The ATC module determines the amount of condenser cooling required from the refrigerant pressure, since there is a direct relationship between the temperature and pressure of the refrigerant. The cooling requirement is transmitted to the ECM in a medium speed CAN bus message. The ECM controls the condenser cooling using the cooling fan. For additional information, refer to:

- Electronic Engine Controls (303-14A, Description and Operation),
- Electronic Engine Controls (303-14B, Description and Operation),
- Electronic Engine Controls (303-14C, Description and Operation).

Air Temperature Control

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 discharge air temperature. The two temperature blend doors operate independently to enable independent temperature selection for the left and right sides of the vehicle interior. The temperature blend doors are operated by stepper motors. The stepper motors are controlled by the ATC module.

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

Air temperature is controlled automatically unless maximum heating or maximum cooling is selected. The required air temperature may be adjusted between 16 °C (61 °F) and 28 °C (82 °F) using the air temperature control switches. The control algorithms then attempt to maintain the desired set temperature.

Turning the temperature switches fully counterclockwise gives maximum available cooling. Turning the temperature switches fully clockwise gives maximum available heating. When maximum cooling or maximum heating is selected, the comfort algorithm adopts an appropriate strategy for the air distribution, blower speed,

A/C and air source functions, except where a function is under manual control.

The temperature control of one zone can be compromised by the other zone being set to maximum heating or maximum cooling. True maximum heating or maximum cooling can only be obtained with both controls set to the same maximum state.

When the economy mode is selected, the automatic temperature control function still operates, but with no cooling capability the minimum discharge temperature achievable will be ambient air temperature plus any heat pick up in the air intake path.

Air Distribution Control

When the A/C is in the automatic mode, the ATC module automatically controls air distribution according to a comfort strategy. Automatic control is overridden when one of the manual modes is selected. Air distribution remains manually controlled until the automatic mode is selected again. The distribution doors are operated by two stepper motors, which are controlled by the ATC module.

Blower Control

When A/C is selected or the blower speed is manually selected, the ATC module energizes the coil of the blower relay in the battery junction box (BJB). The energized blower relay supplies battery power to the blower motor, which is grounded through the blower control module. The speed of the blower is controlled by a PWM signal from the ATC module to the blower control module. The blower control module regulates the blower motor voltage in relation to the PWM signal.

When the blower is in the automatic mode the ATC module determines the blower speed required from the comfort algorithms. When the blower is in the manual mode, the ATC module operates the blower at one of seven fixed speeds as selected on the center instrument panel switch pack.

Maximum Defrost

The maximum defrost function automatically provides the maximum defrosting of the vehicle. When the maximum defrost function is selected, the ATC module configures the control system as follows:

- Automatic mode off.
- Air inlet to fresh air, manual control.
- Selected temperature unchanged, automatic control.
- Air distribution set to screen mode, manual control.
- Blower speed set to speed 5, manual control.
- Rear screen heater and windshield heater (if applicable) selected on.
- A/C mode in automatic.

The maximum defrost function is cancelled by one of the following:

- Selecting any distribution switch. The system response will be identical to the normal manual distribution control operation.
- Selecting the automatic switch. This will restore the system to fully automatic operation.
- Selecting the maximum defrost switch again. This returns the system to the state in use immediately before the maximum defrost function was first selected.
- Turning the engine off.

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

Intake Air Control

The source of intake air is automatically controlled unless overridden by manual selection of recirculation. Under automatic control the ATC module determines the required position of the recirculation door from the comfort strategy and the input from the pollution sensor (if fitted). The recirculation door is operated by an electric motor, which is controlled by hardwired analogue signals from the ATC module. A potentiometer in the motor supplies the ATC module with a position feedback signal for closed loop control.

Provided the intake air has not been manually selected to recirculation, the ATC module adjusts the recirculation door to reduce the ram effect produced by the forward motion of the vehicle.

When the ignition switch is turned off, the ATC module evaluates the ambient air temperature. If the ambient air temperature is less than a pre-determined value, the intake air source is set to recirculation, to prevent the ingress of damp air while the vehicle is parked.

When the vehicle is in the transportation mode, the ATC module sets the intake door to recirculation every time the engine is turned off, regardless of the ambient air temperature.

Pollution Sensing

With a pollution sensor fitted to the vehicle, the ATC module controls the intake air source to reduce contamination of the intake air by external pollutants. This function is fully automatic, but can be overridden by manual selection of the intake air source.

Humidity Sensing

With a humidity sensor fitted, the ATC module controls the moisture content of the air in the vehicle. This is achieved by raising the evaporator temperature to increase the humidity of the air entering the vehicle, and reducing the evaporator temperature to reduce the humidity of the air entering the vehicle.

Front Seat Heaters

The front seat heaters are enabled when Power mode 6 engaged, and operate at one of two temperature settings. With the first press of a front seat heater switch the ATC module adopts the higher temperature setting, supplies a power feed to the related front seat heater elements and illuminates two amber LEDs in the switch. At the second press of the switch the ATC module adopts the lower temperature setting and extinguishes one of the LEDs. At the third press of the switch the ATC module de-energizes the heater elements and extinguishes the second LED. The seat heaters remain on until selected off or the engine is turned off.

The ATC module receives an input from a temperature sensor in each front seat, and regulates the power feed of the heater elements to control the seat temperature at the appropriate temperature setting between 35 and 45 °C (95 and 113 °F). The actual temperature settings vary with the type of seat covering, to allow for the different heat conduction properties of the different materials.

When the front seat heaters are activated at the higher temperature setting, the ATC module automatically resets them to the lower temperature after a time delay. The length of the time delay depends on the in-vehicle temperature.

Temperature Reset Time Delay

In-vehicle Temperature, °C (°F)	< -15 (5)	-15 to -10 (5 to 14)	-10 to 0 (14 to 32)	0 to 15 (32 to 59)	15 to 25 (59 to 77)	>25 (77)
Time Delay, minutes	Remains at higher temperature until manually de-selected	20	15	10	5	3

To protect the heater elements, the ATC module disables front seat heating if battery voltage exceeds 16.5 ± 0.3 V for more than 5 seconds. Front seat heating is re-enabled when battery voltage decreases to 16.2 ± 0.3 V.

The ATC module monitors the power feeds to the heater elements and disables the applicable front seat heating if a short or open circuit is detected. The ATC module also disables seat heating if the seat temperature rises significantly above the target temperature setting.

The plausibility of the temperature sensor inputs is also monitored by the ATC module. When seat heating is selected, if one of the temperature sensor inputs is within 5 °C (9 °F) below the target temperature, the ATC module monitors the sensor input for a temperature increase and checks that it is between the minimum and maximum working temperatures. If a temperature sensor input is at the high end of the working range, while the ambient air temperature and the engine temperature are within 10 °C (18 °F) of each other, the ATC module disables front seat heating until the input decreases below the target temperature setting. The ATC module interprets a temperature sensor input value of -45 °C (-49 °F) or below as an open circuit, and temperature sensor input value of 100 °C (212 °F) or more as a short circuit.

Rear Window Heater

The ATC module controls operation of the rear window heater using medium speed CAN messages to operate the rear window heater relay in the central junction box (CJB). The control module in the CJB interprets the CAN messages and switches the ground connection of the relay coil to operate the rear window heater. While the rear window heater relay is energized, a battery power feed is connected to the rear window heater elements. Rear window heater operation is only enabled when the engine is running.

The ATC module operates the rear window heater in heating cycles of varying power and time. The heating cycle used depends on the ambient air temperature and whether it is the initial or subsequent operation during the current Power mode cycle.

When the rear window heater switch is pressed, the ATC module illuminates an LED in the switch and initiates the appropriate heating cycle. The LED remains illuminated until the rear window heater is selected off, the heating cycle is completed or the engine stops. If the engine stalls or turned off, rear window heating resumes if the engine is re-started within 20 seconds.

On the initial selection of rear window heating, the ATC module uses a short or long defrost phase at full power, followed by a low power phase. The defrost phase used depends on the ambient temperature. During the low power phase, the rear window heater relay is cycled off for 80 seconds and on for 40 seconds.

On subsequent operations, during the same Power mode cycle, the ATC module operates the rear window heater at full power for a fixed time period.

Rear Window Heating Phases

Phase	Time, minutes
Short defrost (-5°C (23°F) and above)	10
Long defrost (less than -5°C (23°F))	15
Low power	20
Subsequent operation	10

Windshield Heater

The ATC module controls operation of the windshield heater using the windshield heater relay in the BJB. The ATC module switches the ground connection of the relay coil to operate the windshield heater. While the windshield heater relay is energized, a battery power feed is connected to each of the two windshield heater elements. Windshield heater operation is only enabled when the engine is running.

The ATC module operates the windshield heater in heating cycles of varying power and time. The heating cycle used depends on the ambient air temperature and whether it is the initial or subsequent operation during the current

Power mode cycle.

When the windshield heater switch is pressed, the ATC module illuminates a LED in the switch and initiates the appropriate heating cycle. The LED remains illuminated until the windshield heater is selected off, the heating cycle is completed or the engine stops. If the engine stalls or turned off, windshield heating resumes if the engine is re-started within 20 seconds.

On the initial selection of the windshield heater, the ATC module uses a short or long defrost phase at full power, followed by a low power phase. The defrost phase used depends on the ambient temperature. During the low power phase, the windshield heater relay is cycled off for 80 seconds and on for 40 seconds.

On subsequent operations, during the same Power mode cycle, the ATC module operates the windshield heater at full power for a fixed time period.

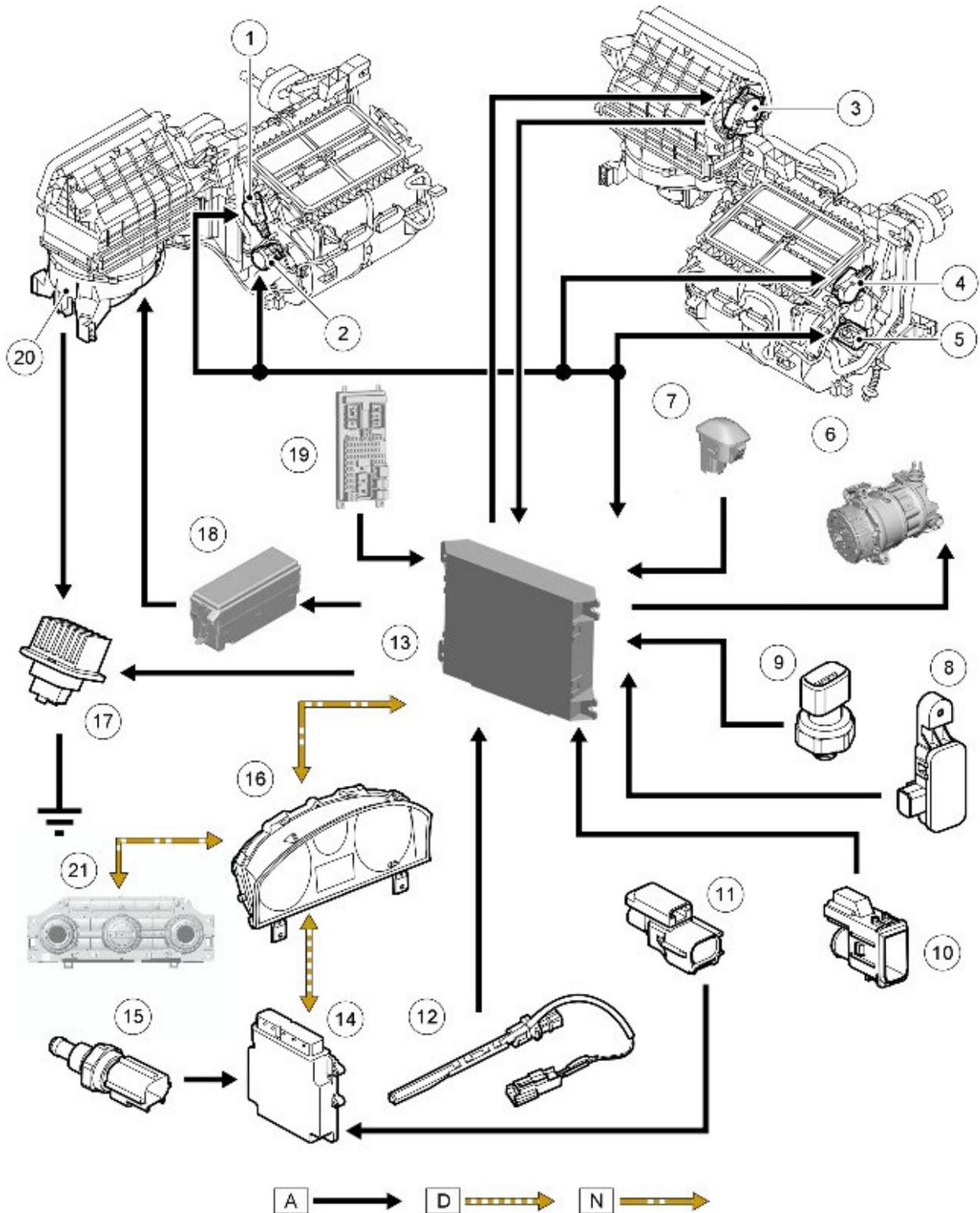
Windshield Heating Phases

Phase	Time, minutes
Short defrost (-5 °C (23 °F) and above)	3
Long defrost (less than -5 °C (23 °F))	5
Low power	10
Subsequent operation	3

CONTROL DIAGRAM



NOTE: **A** = Hardwired connections; **D** = High speed CAN bus; **N** = Medium speed CAN bus



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E132924

Item	Part Number	Description
1	-	Face and feet distribution motor
2	-	LH temperature blend motor
3	-	Recirculation motor
4	-	Windshield distribution motor
5	-	RH temperature blend motor
6	-	A/C compressor solenoid valve
7	-	Sunlight sensor
8	-	Pollution sensor
9	-	Refrigerant pressure sensor
10	-	In-vehicle temperature sensor (all except Japan) or in-vehicle temperature and humidity sensor (Japan only)

- 11 - Ambient air temperature sensor
- 12 - Evaporator temperature sensor
- 13 - ATC module
- 14 - ECM
- 15 - ECT sensor
- 16 - Instrument cluster
- 17 - Blower control module
- 18 - [BJB \(battery junction box\)](#)
- 19 - CJB
- 20 - Blower
- 21 - Center instrument panel switch pack

Control Components - Control Components

Diagnosis and Testing

Principle of Operation

For a detailed description of the climate control system and operation, refer to the relevant Description and Operation section of the workshop manual. REFER to: Control Components (412-04 Control Components, Description and Operation).

Inspection and Verification



CAUTION: Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a fault and may also cause additional faults in the vehicle being checked and/or the donor vehicle.



NOTE: Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection

Mechanical	Electrical
<ul style="list-style-type: none"> • Front End Accessory Drive (FEAD) belt • Refrigerant • Heater control flaps • Ducting • Cabin air filter • Coolant level • Compressor • Cooling fan 	<ul style="list-style-type: none"> • Fuses • Electrical harnesses • Harness connectors • Blower motor • Cooling fan • Actuators

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, check for Diagnostic Trouble Codes (DTCs) and refer to the DTC Index.

DTC Index

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to Section 100-00.

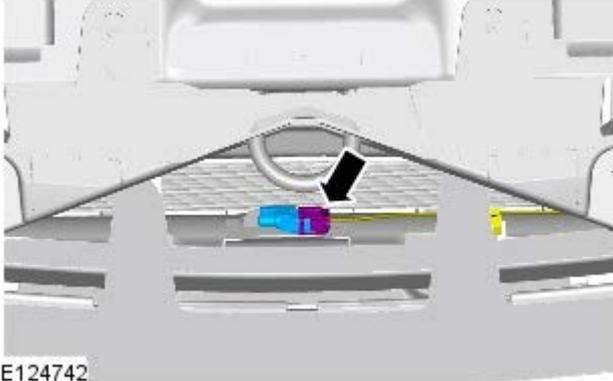
REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Climate Control Module (HVAC) (100-00, Description and Operation).

Control Components - Ambient Air Temperature Sensor

Removal and Installation

Removal

1. Remove the front spoiler.
For additional information, refer to: Front Bumper Lower Cover (501-19, Removal and Installation).
2. Remove the ambient air temperature sensor.
 - Disconnect the electrical connector.
 - Release the clip.



Installation

1. To install, reverse the removal procedure.

Control Components - Climate Control Assembly

Removal and Installation

Removal

NOTES:



Removal steps in this procedure may contain installation details.



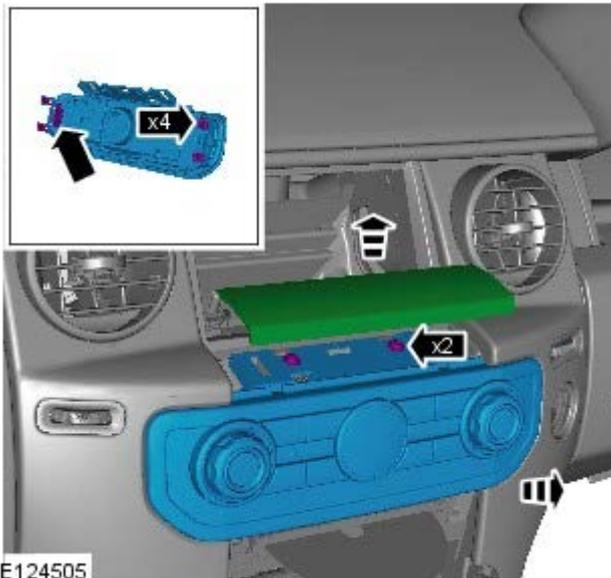
Some variation in the illustrations may occur, but the essential information is always correct.



Make sure that the gear selector lever is in position N before removing any components.

1. Refer to: Floor Console Upper Section (501-12, Removal and Installation).

2. Torque: 2.5 Nm



3.  CAUTION: When installing the lower locating tang of the trim panel, make sure the floor console is not damaged. If necessary protect the surrounding areas using masking tape.

NOTES:



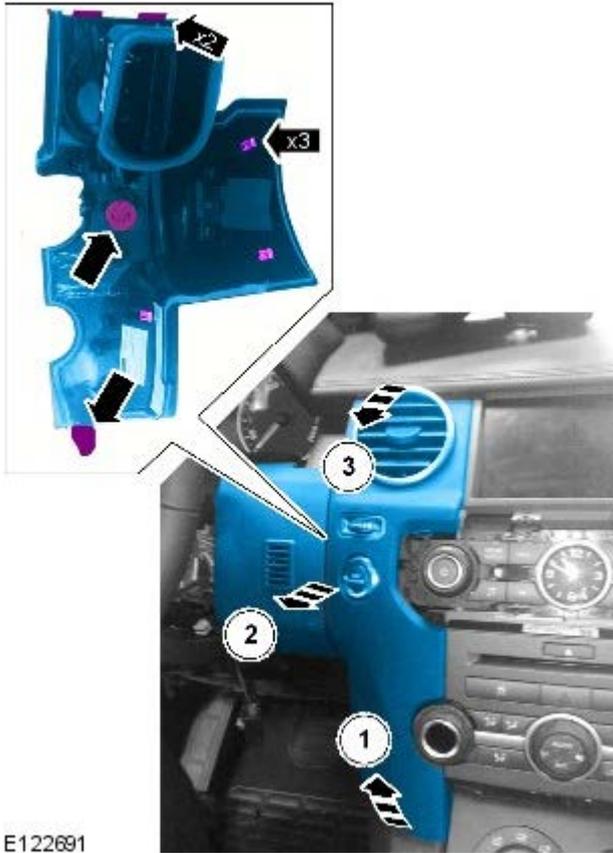
LHD illustration shown, RHD is similar.



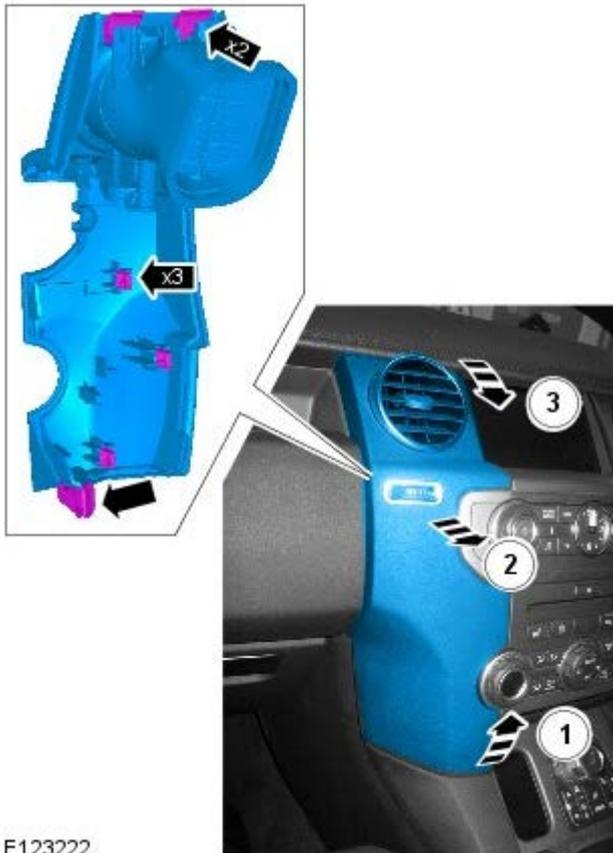
Remove in the sequence shown.



To install, reverse the removal sequence.



E122691



E123222

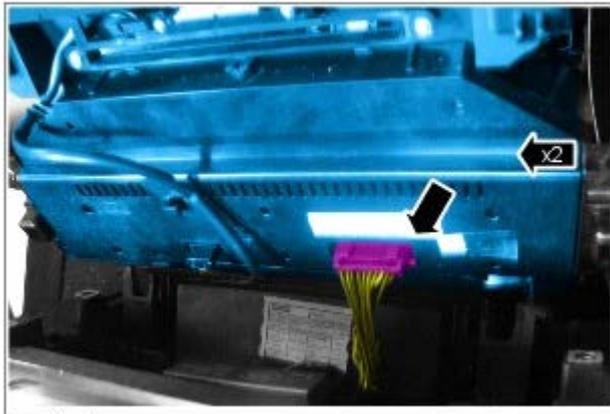
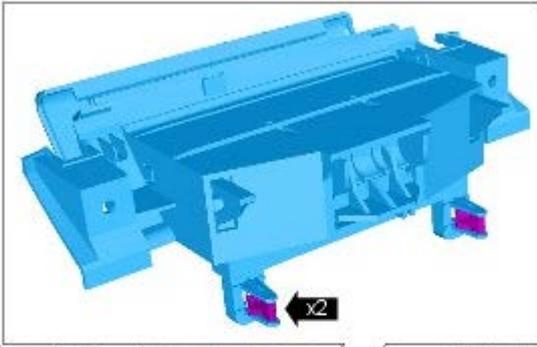
4.  CAUTION: When installing the lower locating tang of the trim panel, make sure the floor console is not damaged. If necessary protect the surrounding areas using masking tape.

NOTES:

 Remove in the sequence shown.

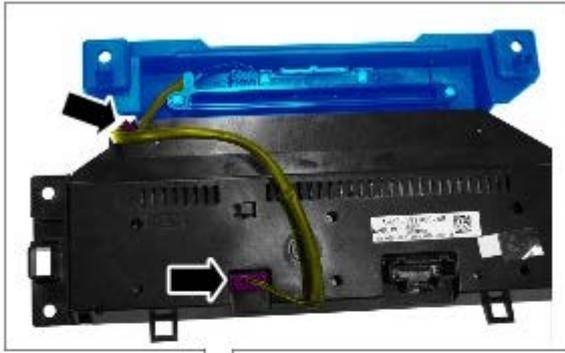
 To install, reverse the removal sequence.

5. Torque: 2.5 Nm



6. Torque: 2.5 Nm

7.



E125464

8.



E125465

Installation

1.  **NOTE:** Make sure that all the clips are correctly installed.
To install, reverse the removal procedure.

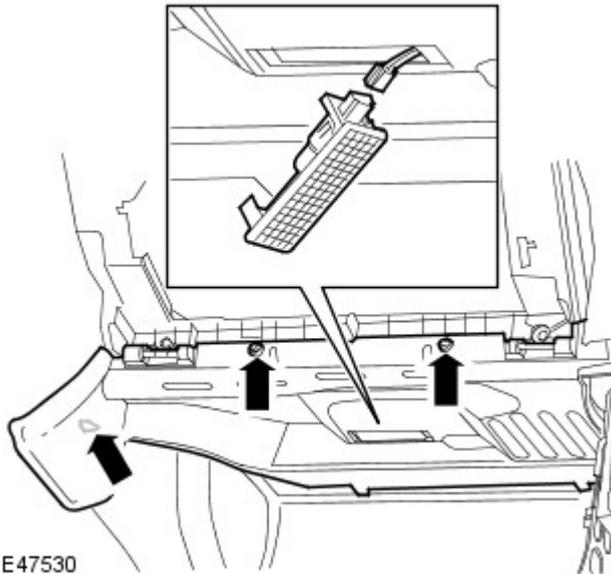
Control Components - Defrost Vent/Register Blend Door Actuator LHD AWD

Removal and Installation

Removal

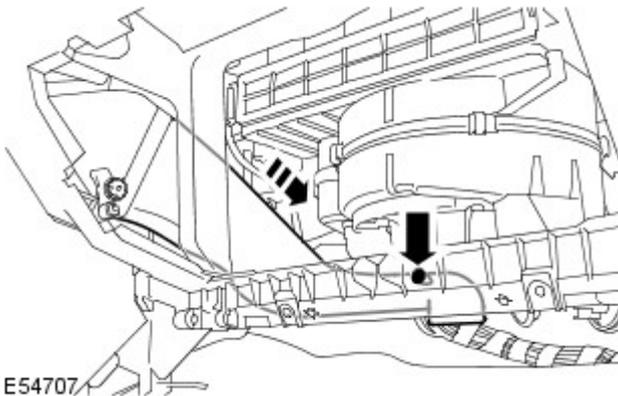
1. Remove the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

2. Remove the passenger side closing trim panel.
 - Release the clip.
 - Remove the 2 screws.
 - Disconnect the electrical connector.



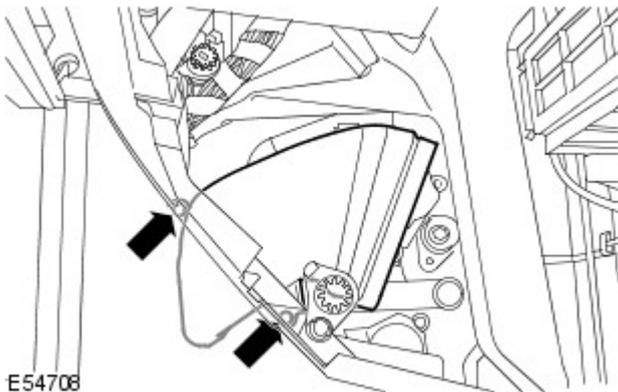
E47530

3. Remove the passenger side footwell duct.
 - Remove the clip.



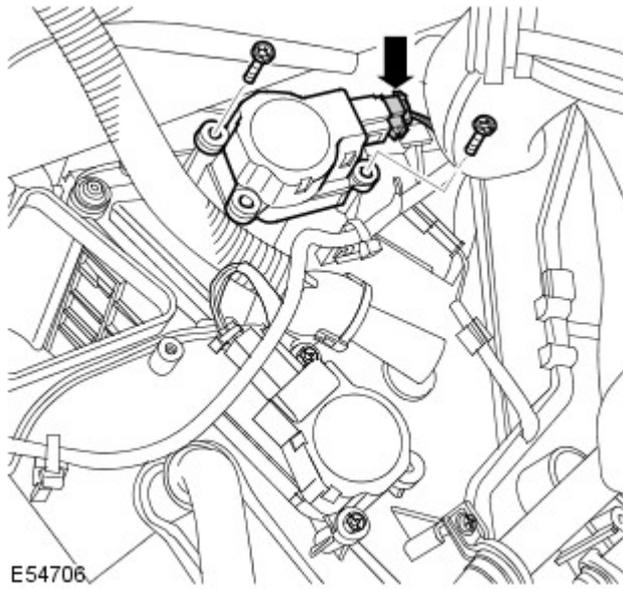
E54707

4. Remove the passenger side footwell duct elbow.
 - Remove the 2 Torx screws.



E54708

5. Remove the defrost vent/register blend door actuator.
 - Disconnect the electrical connector.
 - Remove the 2 screws.



Installation

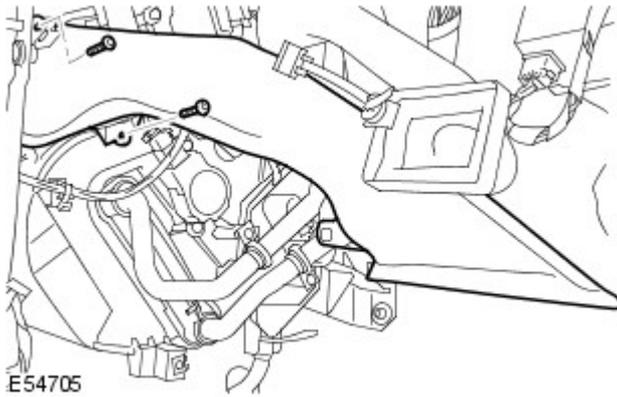
1. Install the defrost vent/register blend door actuator.
 - Tighten the screws to 1 Nm.
 - Connect the electrical connector.
2. Install the passenger side footwell duct elbow.
 - Tighten the screws.
3. Install the passenger side footwell duct.
 - Install the clip.
4. Install the passenger side closing trim panel.
 - Install the interior lamp.
 - Connect the electrical connector.
 - Secure the clip.
5. Install the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

Control Components - Defrost Vent/Register Blend Door Actuator RHD AWD

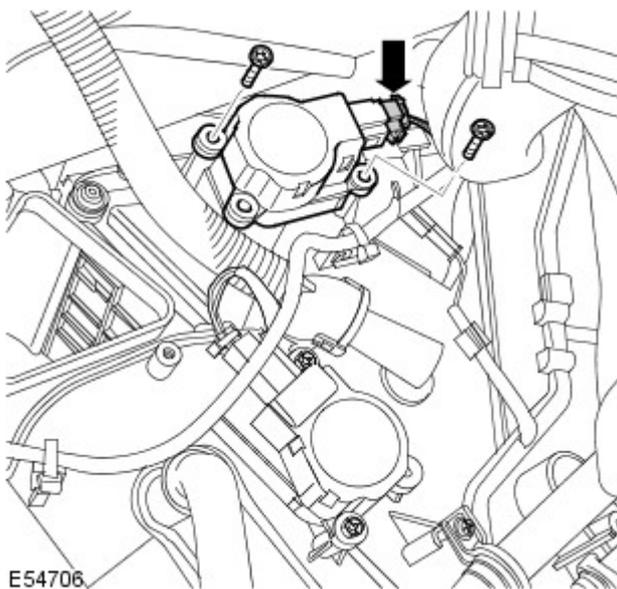
Removal and Installation

Removal

1. Remove the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).



2. Remove the driver side footwell duct.
 - Remove the 2 Torx screws.



3. Remove the defrost door actuator.
 - Disconnect the electrical connector.
 - Remove the 2 screws.

Installation

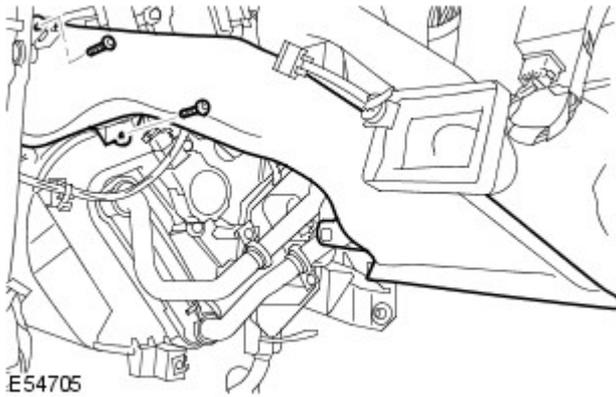
1. Install the defrost door actuator.
 - Tighten the screws.
 - Connect the electrical connector.
2. Install the driver side footwell duct.
 - Tighten the screws.
3. Install the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).

Control Components - Driver Side Temperature Blend Door Actuator LHD AWD

Removal and Installation

Removal

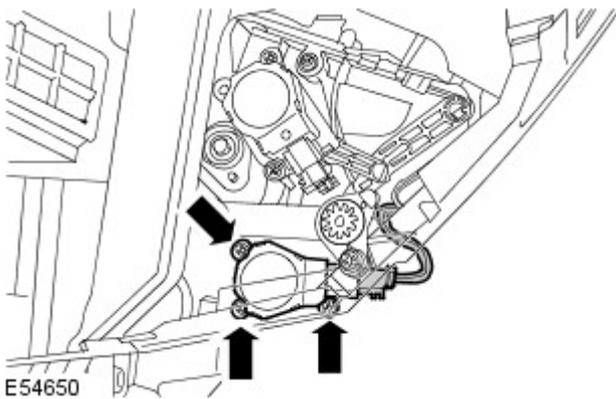
1. Remove the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).



2.  **NOTE:** RHD illustration shown, LHD is similar.

Remove the driver side footwell duct.

- Remove the 2 Torx screws.



3.  **NOTE:** Some variation in the illustrations may occur, but the essential information is always correct.

Remove the temperature blend door actuator.

- Disconnect the electrical connector.
- Remove the 3 screws.

Installation

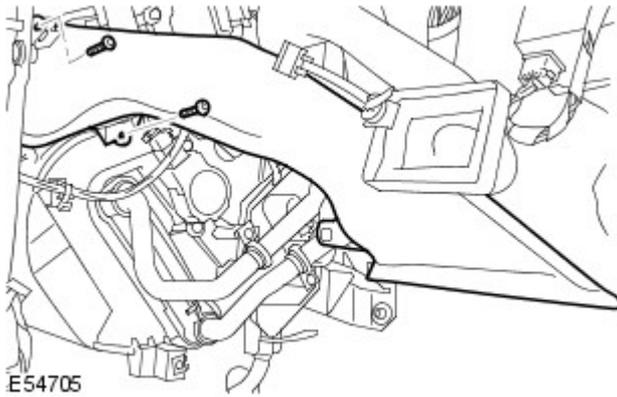
1. Install the temperature blend door actuator.
 - Tighten the screws to 1 Nm.
 - Connect the electrical connector.
2. Install the driver side footwell duct.
 - Tighten the screws.
3. Install the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).

Control Components - Driver Side Temperature Blend Door Actuator RHD AWD

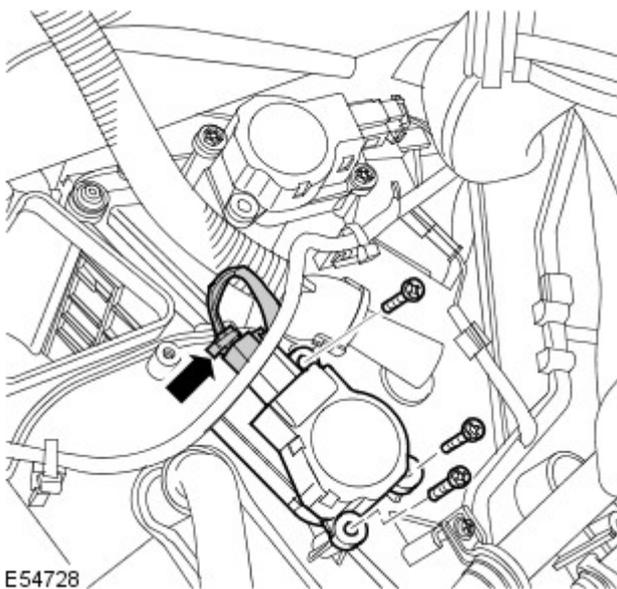
Removal and Installation

Removal

1. Remove the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).



2. Remove the driver side footwell duct.
 - Remove the 2 Torx screws.



3. Remove the temperature blend door actuator.
 - Disconnect the electrical connector.
 - Remove the 2 screws.

Installation

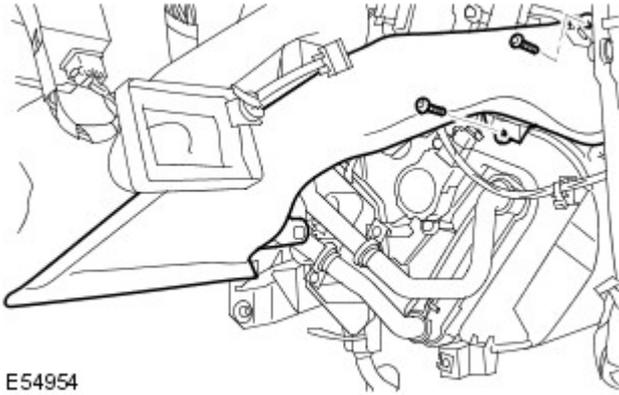
1. Install the temperature blend door actuator.
 - Tighten the screws.
 - Connect the electrical connector.
2. Install the driver side footwell duct.
 - Tighten the screws.
3. Install the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).

Control Components - Instrument Panel Blend Door Actuator LHD AWD

Removal and Installation

Removal

1. Remove the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).

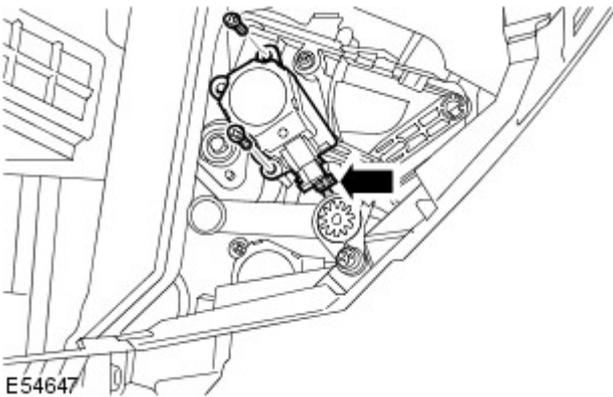


E54954

2.  **NOTE:** Some variation in the illustrations may occur, but the essential information is always correct.

Remove the driver side footwell duct.

- Remove the 2 Torx screws.



E54647

3.  **NOTE:** Some variation in the illustrations may occur, but the essential information is always correct.

Remove the instrument panel blend door actuator.

- Disconnect the electrical connector.
- Remove the 2 screws.

Installation

1. Install the instrument panel blend door actuator.
 - Tighten the screws to 1 Nm.
 - Connect the electrical connector.
2. Install the driver side footwell duct.
 - Tighten the screws.
3. Install the instrument panel driver side reinforcement.
For additional information, refer to: Instrument Panel Driver Side Reinforcement (501-12, Removal and Installation).

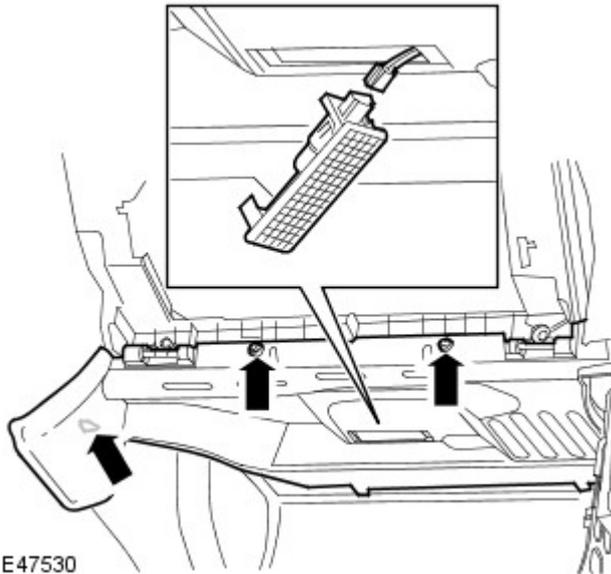
Control Components - Instrument Panel Blend Door Actuator RHD AWD

Removal and Installation

Removal

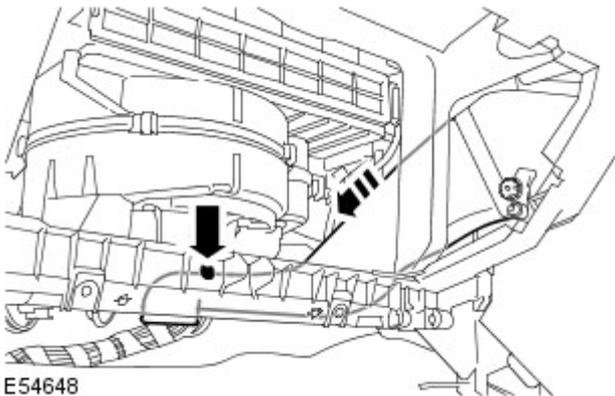
1. Remove the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

2. Remove the passenger side closing trim panel.
 - Release the clip.
 - Remove the 2 screws.
 - Disconnect the electrical connector.



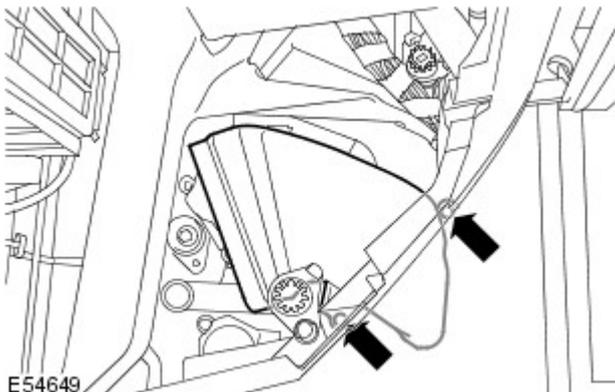
E47530

3. Remove the passenger side footwell duct.
 - Remove the clip.



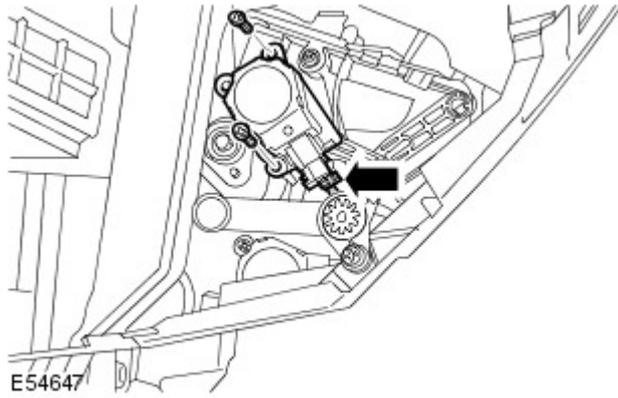
E54648

4. Remove the passenger side footwell duct elbow.
 - Remove the 2 Torx screws.



E54649

5. Remove the instrument panel blend door actuator.
 - Disconnect the electrical connector.
 - Remove the 2 screws.



Installation

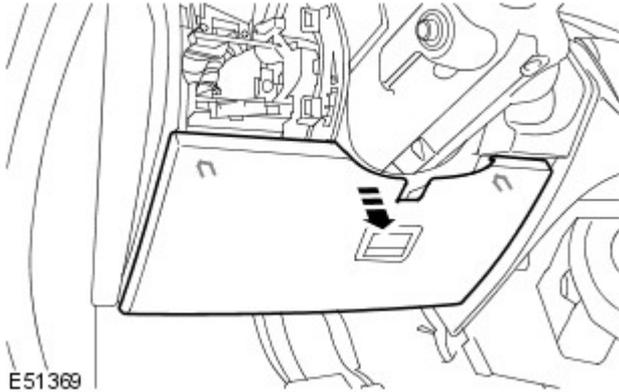
1. Install the instrument panel blend door actuator.
 - Tighten the screws.
 - Connect the electrical connector.
2. Install the passenger side footwell duct elbow.
 - Tighten the screws.
3. Install the passenger side footwell duct.
 - Install the clip.
4. Install the passenger side closing trim panel.
 - Install the interior lamp.
 - Connect the electrical connector.
 - Secure the clip.
5. Install the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

Control Components - In-Vehicle Temperature Sensor

Removal and Installation

Removal

1. Fully extend the steering column for access.

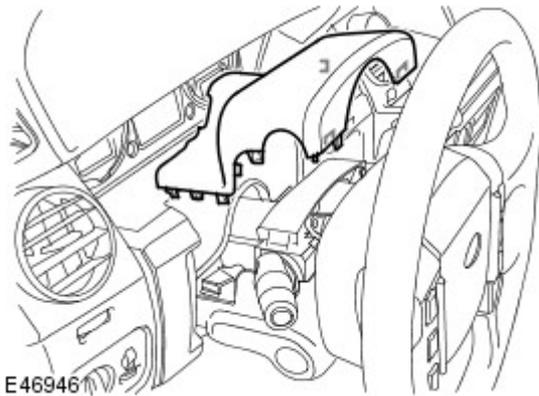


2. Remove the instrument panel access panel.

- Release the 2 clips.

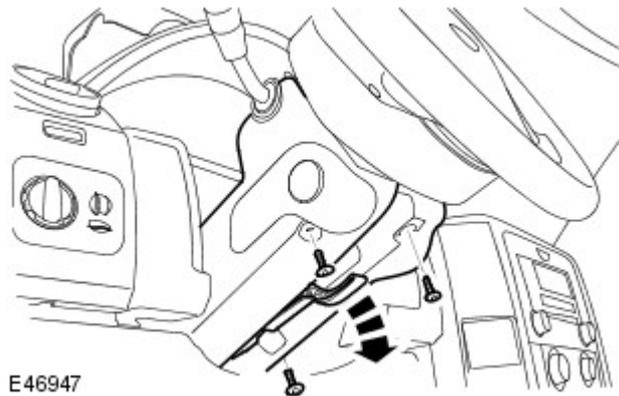
3. Remove the steering column upper shroud.

- Release the 6 clips.

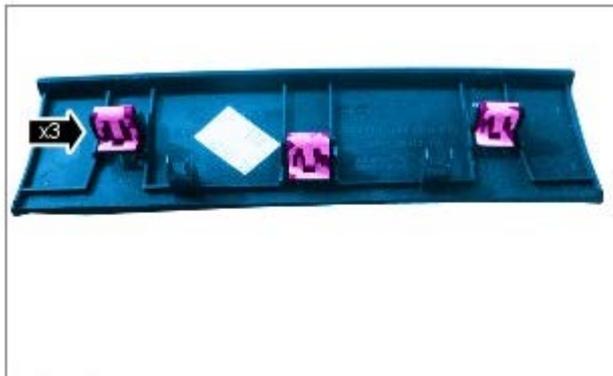


4. Remove the steering column lower shroud.

- Remove the 3 Torx screws.
- Release the steering column adjustment lever.



5. Remove the center console upper finisher trim.



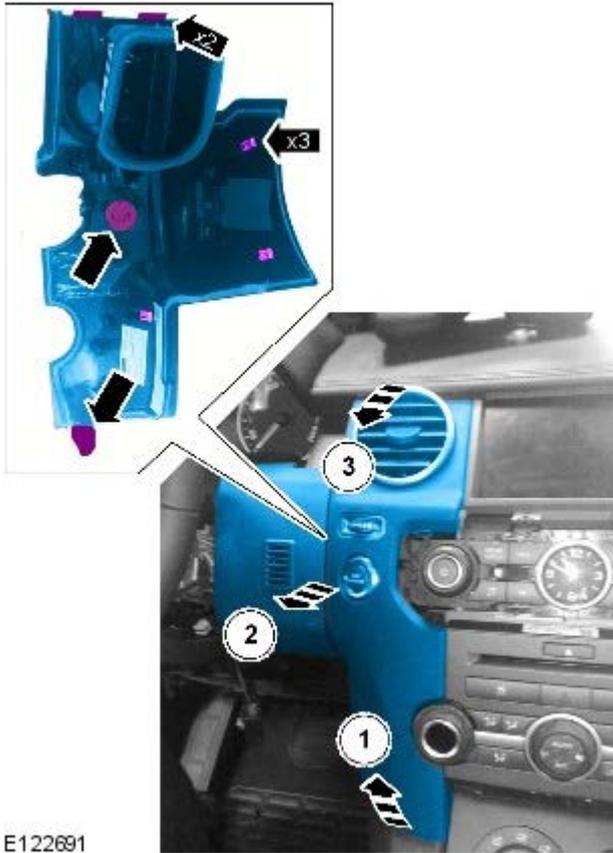
E123215

6. Remove the audio unit bezel.

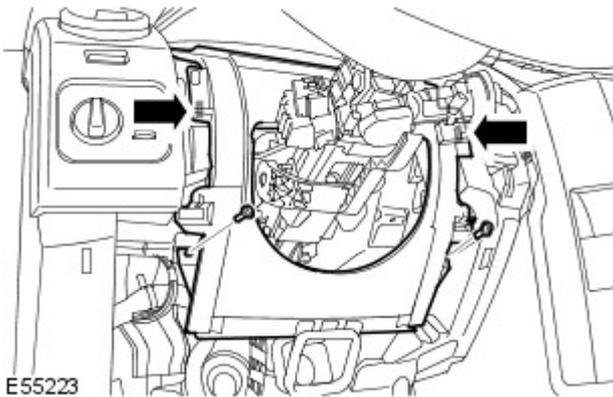


E123217

7. Remove the instrument panel centre finisher.



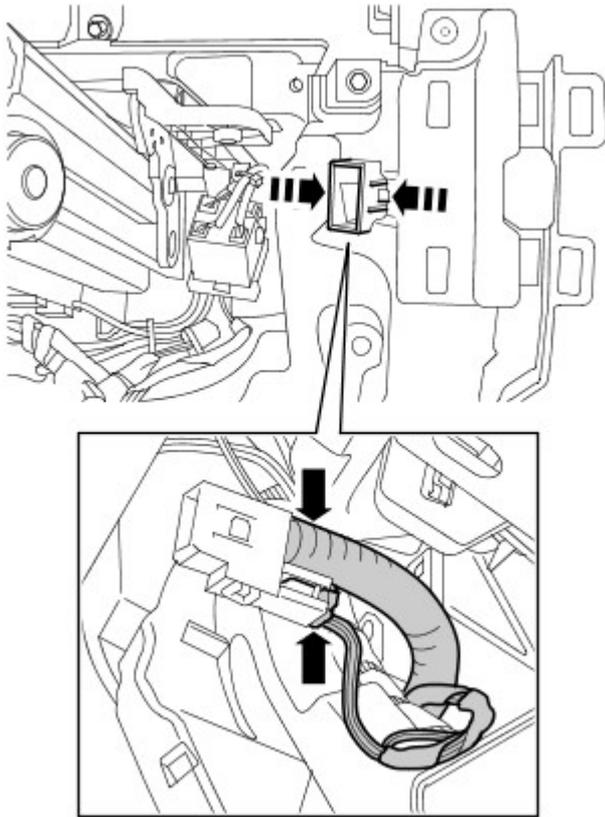
E122691



E55223

8. Release the steering column gaiter panel.
 - Remove the 2 Torx screws.
 - Release the 2 clips.

9. Remove the in-vehicle temperature sensor.
 - Release the 2 clips.
 - Disconnect the electrical connector.
 - Disconnect the hose.



E55224

Installation

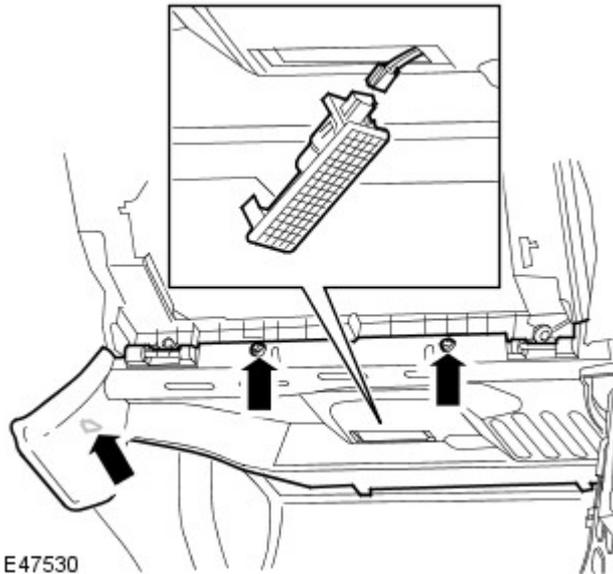
1. Install the in-vehicle temperature sensor.
 - Connect the hose.
 - Connect the electrical connector.
 - Secure the clips.
2. Install the steering column gaiter panel.
 - Secure with the clips.
 - Tighten the Torx screws.
3. Install the instrument panel centre finisher.
4. Install the audio unit bezel.
5. Install the center console upper finisher trim.
6. Install the steering column shrouds.
7. Install the instrument panel access panel.

Control Components - Passenger Side Temperature Blend Door Actuator LHD AWD

Removal and Installation

Removal

1. Remove the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

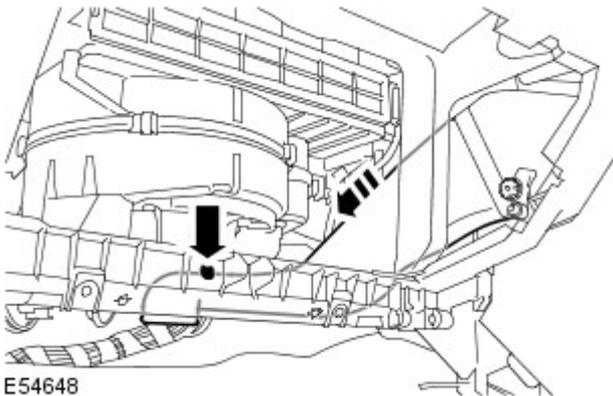


E47530

2.  **NOTE:** RHD illustration shown, LHD is similar.

Remove the passenger side closing trim panel.

- Release the clip.
- Remove the 2 screws.
- Disconnect the electrical connector.

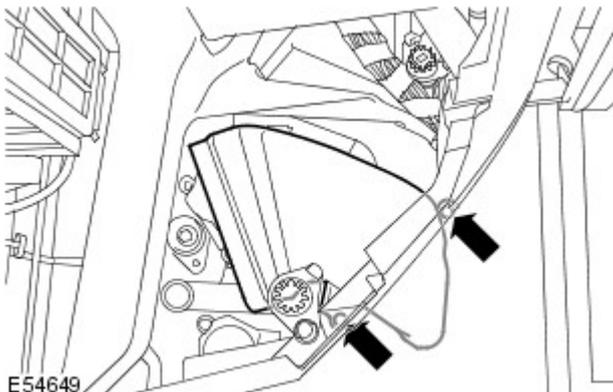


E54648

3.  **NOTE:** RHD illustration shown, LHD is similar.

Remove the passenger side footwell duct.

- Remove the clip.



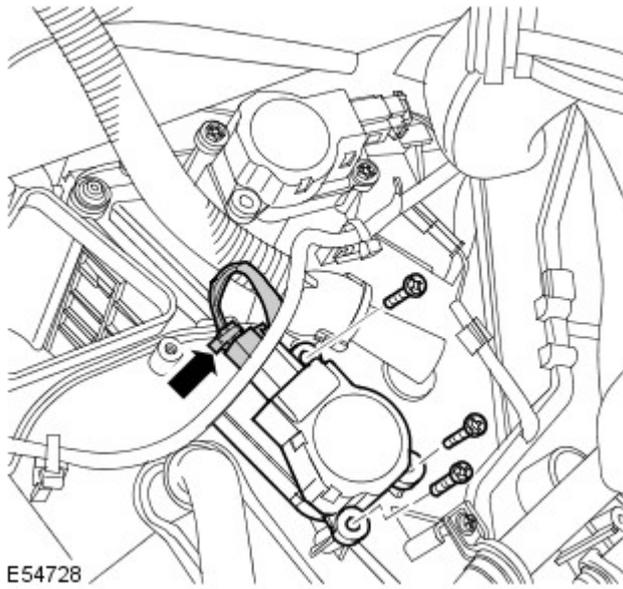
E54649

4.  **NOTE:** RHD illustration shown, LHD is similar.

Remove the passenger side footwell duct elbow.

- Remove the 2 Torx screws.

5. Remove the temperature blend door actuator.
 - Disconnect the electrical connector.
 - Remove the 3 screws.



E54728

Installation

1. Install the temperature blend door actuator.
 - Tighten the screws to 1 Nm.
 - Connect the electrical connector.
2. Install the passenger side footwell duct elbow.
 - Tighten the screws.
3. Install the passenger side footwell duct.
 - Install the clip.
4. Install the passenger side closing trim panel.
 - Connect the electrical connector.
 - Tighten the screws.
 - Secure the clip.
5. Install the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

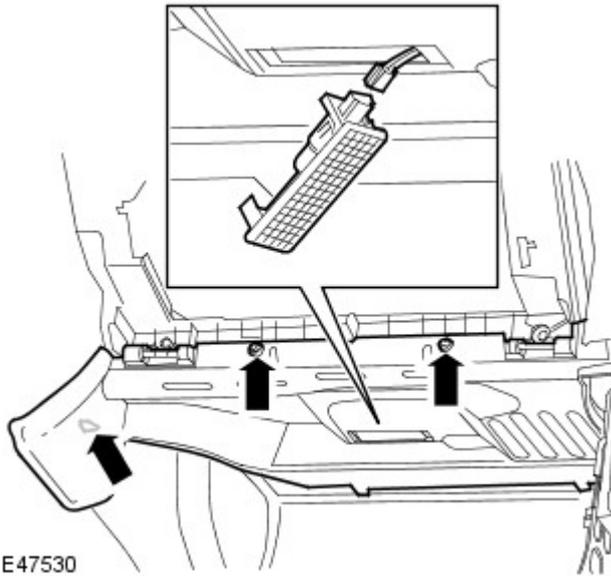
Control Components - Passenger Side Temperature Blend Door Actuator RHD AWD

Removal and Installation

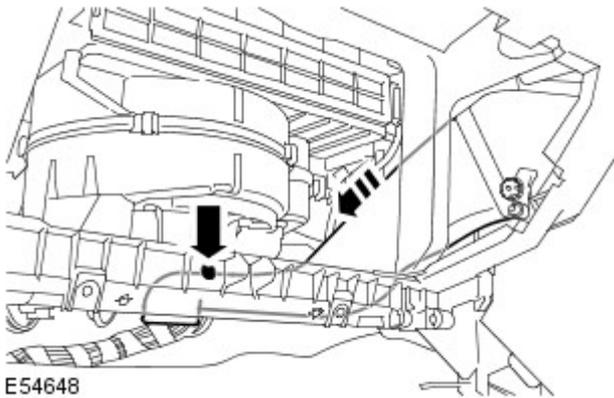
Removal

1. Remove the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

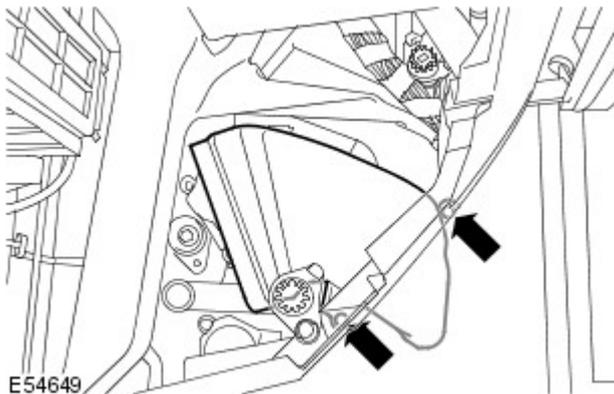
2. Remove the passenger side closing trim panel.
 - Release the clip.
 - Remove the 2 screws.
 - Disconnect the electrical connector.



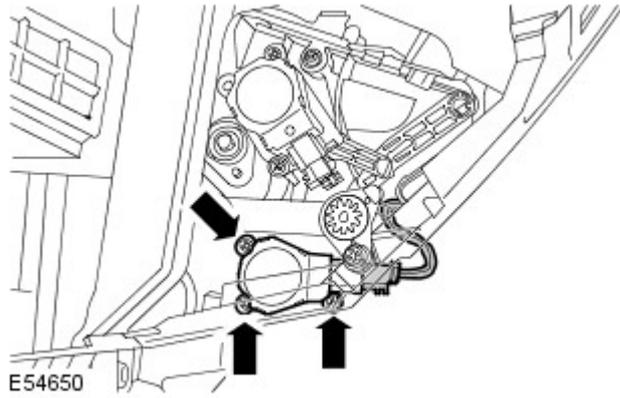
3. Remove the passenger side footwell duct.
 - Remove the clip.



4. Remove the passenger side footwell duct elbow.
 - Remove the 2 Torx screws.



5. Remove the temperature blend door actuator.
 - Disconnect the electrical connector.
 - Remove the 3 screws.



Installation

1. Install the temperature blend door actuator.
 - Tighten the screws.
 - Connect the electrical connector.
2. Install the passenger side footwell duct elbow.
 - Tighten the screws.
3. Install the passenger side footwell duct.
 - Install the clip.
4. Install the passenger side closing trim panel.
 - Install the interior lamp.
 - Connect the electrical connector.
 - Secure the clip.
5. Install the glove compartment.
For additional information, refer to: Glove Compartment (501-12, Removal and Installation).

Control Components - Recirculation Blend Door Actuator LHD AWD

Removal and Installation

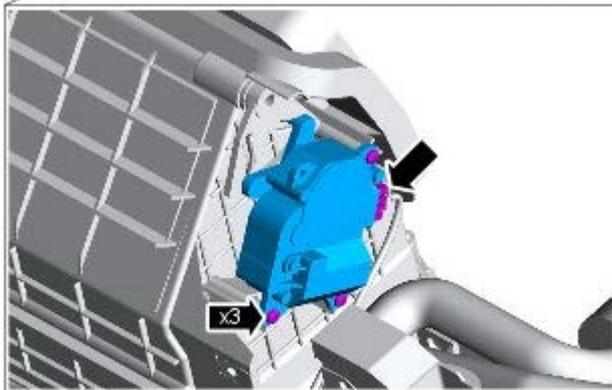
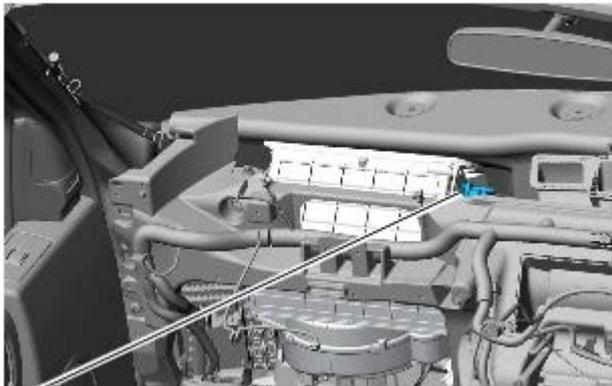
Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Specifications (414-00, Specifications).
2. Make the SRS system safe.
For additional information, refer to: Standard Workshop Practices (100-00, Description and Operation).
3. Remove the instrument panel upper section.
For additional information, refer to: Instrument Panel Upper Section (501-12, Removal and Installation).

4.  **NOTE:** RHD illustration shown, LHD is similar.

Remove the recirculation blend door actuator.

- Disconnect the electrical connector.
- Remove the 3 screws.



E91604

Installation

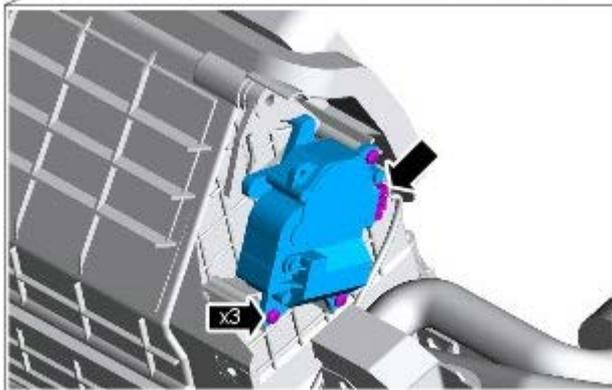
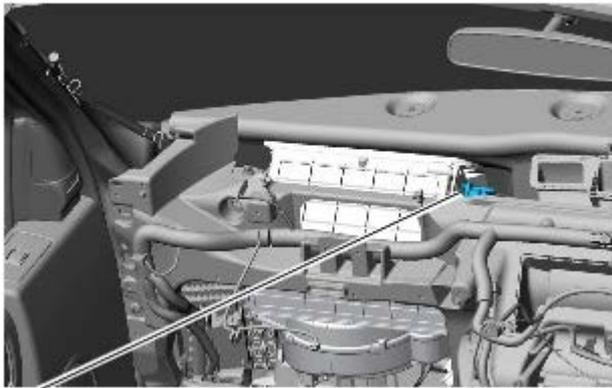
1. Install the recirculation blend door actuator.
 - Align the control arm to the recirculation blend door.
 - Install the 3 screws.
 - Connect the electrical connector.
2. Install the instrument panel upper section.
For additional information, refer to: Instrument Panel Upper Section (501-12, Removal and Installation).
3. Connect the battery ground cable.
For additional information, refer to: Specifications (414-00, Specifications).

Control Components - Recirculation Blend Door Actuator RHD AWD

Removal and Installation

Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Specifications (414-00, Specifications).
2. Make the SRS system safe.
For additional information, refer to: Standard Workshop Practices (100-00, Description and Operation).
3. Remove the instrument panel upper section.
For additional information, refer to: Instrument Panel Upper Section (501-12, Removal and Installation).
4. Remove the recirculation blend door actuator.
 - Disconnect the electrical connector.
 - Remove the 3 screws.



E91604

Installation

1. Install the recirculation blend door actuator.
 - Align the control arm to the recirculation blend door.
 - Install the 3 screws.
 - Connect the electrical connector.
2. Install the instrument panel upper section.
For additional information, refer to: Instrument Panel Upper Section (501-12, Removal and Installation).
3. Connect the battery ground cable.
For additional information, refer to: Specifications (414-00, Specifications).

Control Components - Sunload Sensor

Removal and Installation

Removal



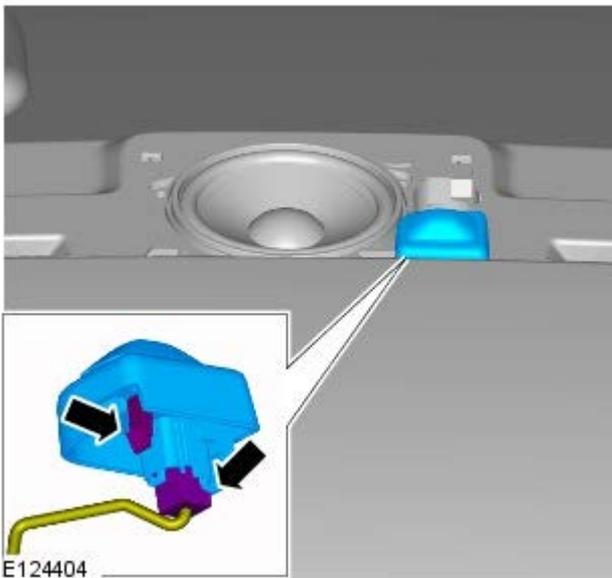
NOTE: Removal steps in this procedure may contain installation details.

1.



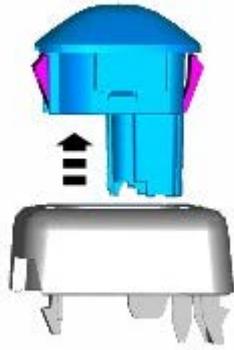
E124403

2.



E124404

3.



E124405

Installation

1. To install, reverse the removal procedure.