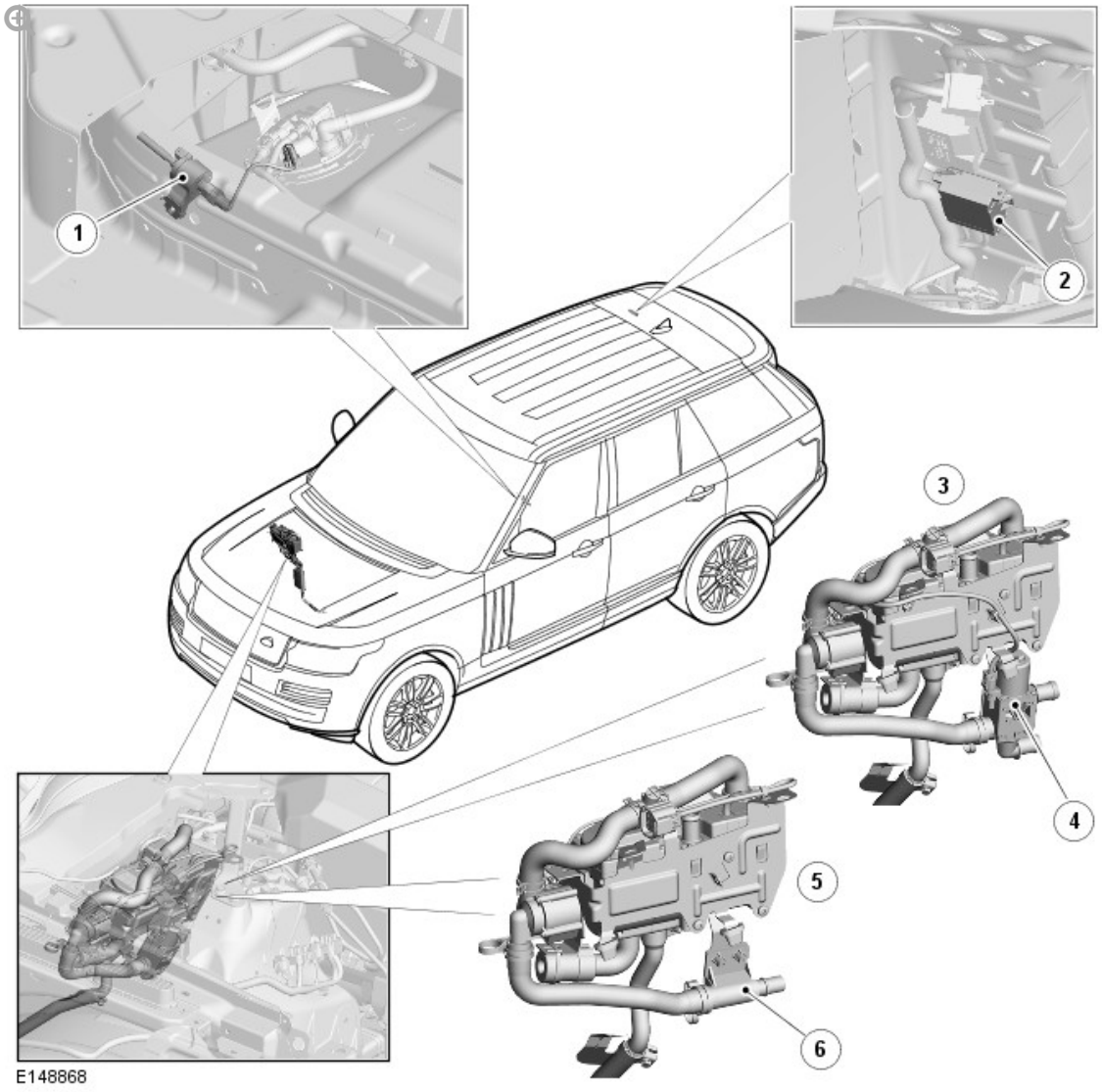
2016.0 RANGE ROVER (LG), 412-02

AUXILIARY CLIMATE CONTROL

DESCRIPTION AND OPERATION

COMPONENT LOCATION



ITEM	DESCRIPTION
1	Fuel Fired Booster Heater (FFBH) fuel pump (diesel installation shown, petrol installations similar)
2	Fuel Fired Booster Heater (FFBH) receiver (vehicles with timed climate control only)
3	Fuel Fired Booster Heater (FFBH) (vehicles with timed climate control)
4	Changeover valve (vehicles with timed climate control)
5	Fuel Fired Booster Heater (FFBH) (vehicles without timed climate control)
6	Coolant tube connector (vehicles without timed climate control)

OVERVIEW

Depending on model specification and market, the vehicle may incorporate auxiliary heating in the form of a FFBH (Fuel Fired Booster Heater). The FFBH boosts the temperature of the engine coolant supplied to the climate control assembly and, where fitted, the auxiliary climate control assembly.

Fuel for the FFBH is taken from the vehicle fuel tank, through a fuel line attached to the fuel pump module. A FFBH fuel pump supplies the fuel at low pressure to the FFBH. In the FFBH, the fuel is burned and the resultant heat output is used to heat the engine coolant, which is circulated through the climate control assembly and, where fitted, the auxiliary climate control assembly, by a FFBH coolant pump.

FFBH operation is automatic while the engine is running. Where timed climate control is incorporated, the FFBH can be selected to operate (depending on the ambient air temperature) while the vehicle is parked using the touch screen or a remote control.

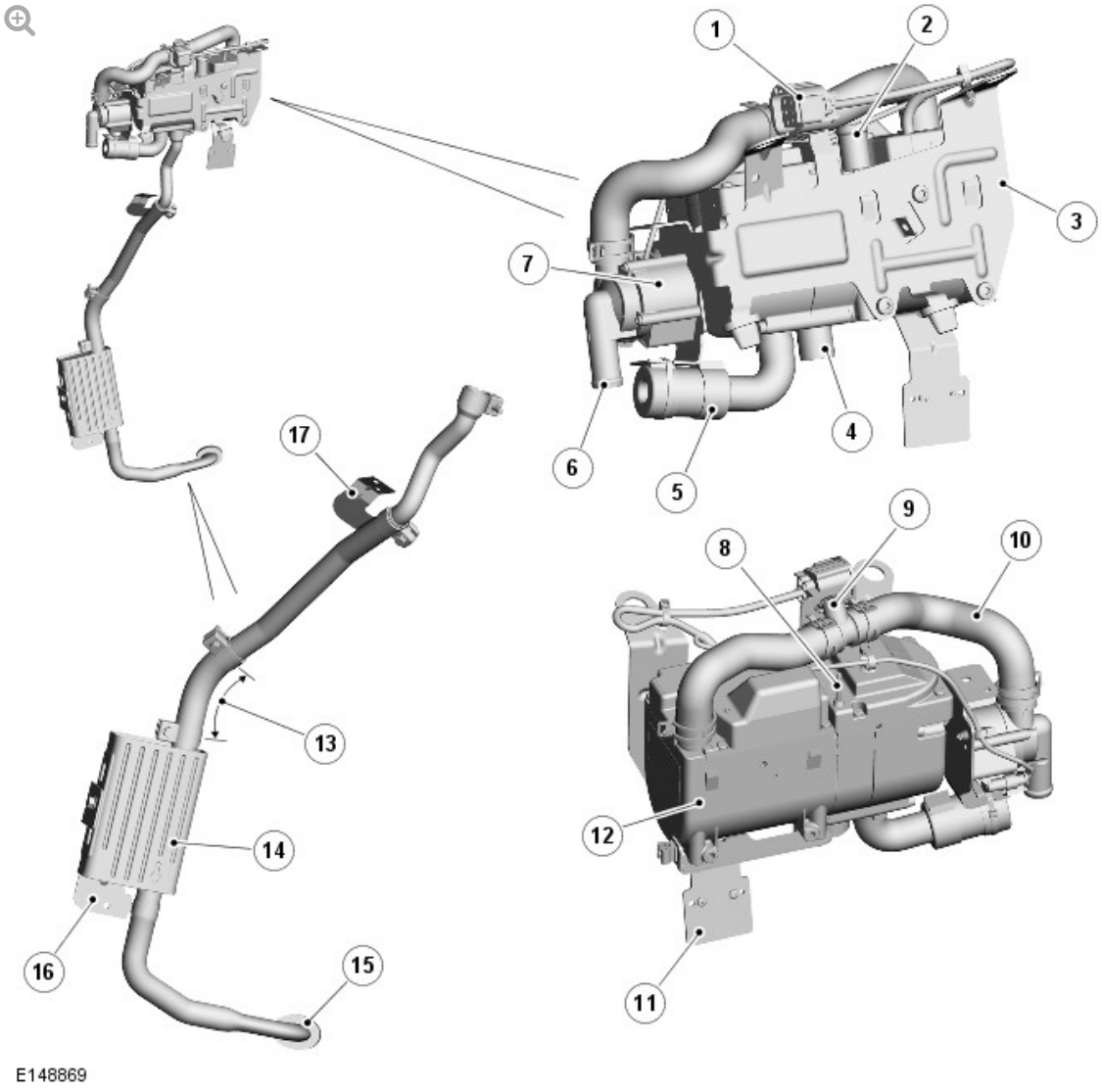
Vehicles with timed climate control also incorporate:

- A FFBH receiver for communication with the remote control
- A changeover valve that allows the climate control coolant circuit to be isolated from the engine coolant circuit to reduce the warmup time of the

passenger compartment.

DESCRIPTION

FUEL FIRED BOOSTER HEATER



ITEM	DESCRIPTION
1	Electrical connector
2	Coolant outlet
3	Support bracket
4	Exhaust outlet
5	Air intake hose

6	Coolant pump inlet
7	Coolant pump
8	Fuel inlet
9	Bleed screw
10	Coolant inlet hose
11	Coolant tube connector / changeover valve bracket
12	Fuel fired booster heater base unit
13	Exhaust flexible section
14	Muffler
15	Exhaust tailpipe bush
16	Muffler bracket
17	Exhaust bracket

The FFBH is installed in the engine compartment, on a support bracket attached to the rear of the right suspension housing. It is connected in series with the coolant supply to the climate control assembly. A flying lead on the FFBH connects it to the vehicle wiring. The FFBH consists of the following:

- A control module
- A combustion air fan
- A combustion chamber
- A heat exchanger
- A coolant pump
- An air intake hose and muffler
- An exhaust pipe and muffler.

CONTROL MODULE

The control module controls and monitors operation of the FFBH system.

Power for the control module is provided by a permanent feed from the QCCM (quiescent current control module). A LIN (local interconnect network) bus connection provides the communication link between the control module and the ATCM (automatic temperature control module). The control module also has:

- A ground connection
- Power feed and ground connections with the FFBH coolant pump
- A power feed connection with the FFBH fuel pump
- A signal line connection with the FFBH receiver (vehicles with timed climate control only).

COMBUSTION AIR FAN

The combustion air fan regulates the flow of air to the heater so as to ensure correct combustion. If the heater is operational while the engine is stopped or the heater enters the control idle phase, the air fan will continue to run in order to cool the combustion chamber in readiness for the next required start. The operation of the fan may be noticed during this process. This is perfectly normal.

COMBUSTION CHAMBER

The combustion chamber is located in the heat exchanger casing and the combustion air fan casing. The fuel feed pipe of the combustion chamber extends up through the cover of the combustion air fan. A glow plug is installed in the combustion chamber to provide the ignition source for the fuel and air mixture.

HEAT EXCHANGER

The heat exchanger transfers heat generated by the combustion chamber to the engine coolant. An overheating temperature sensor and a surface temperature sensor are installed in the heat exchanger and connected to the control module. The control module uses the temperature inputs to

control system operation.

FFBH COOLANT PUMP

The FFBH coolant pump is an electric pump attached to outboard end of the FFBH support bracket. The pump intake is connected to either the heater coolant feed from the engine (vehicles without timed climate control) or to the changeover valve (vehicles with timed climate control). A hose, which incorporates a bleed screw, connects the outlet of the coolant pump to the coolant inlet of the FFBH.

The coolant pump runs continuously while the FFBH is in control idle or active operating modes. While the FFBH is inactive, coolant flow is reliant on the engine coolant pump.

AIR INTAKE HOSE AND MUFFLER

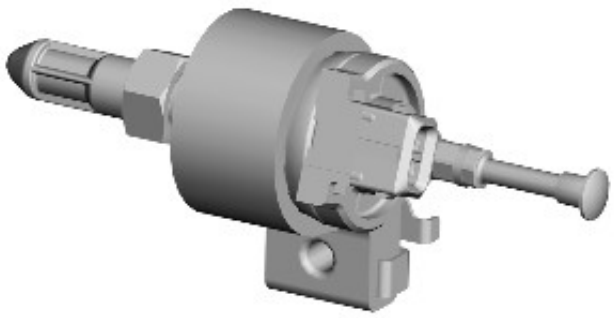
A canister type muffler and filter is incorporated into the air intake hose.

EXHAUST PIPE AND MUFFLER

The exhaust pipe and muffler directs exhaust combustion gases to atmosphere below the vehicle, to the rear of the right front wheel arch and towards the center of the vehicle. Exhaust vapor may be visible when the FFBH is running, depending on atmospheric conditions. Under normal operating conditions, the exhaust vapor will subside once the FFBH has achieved “Power status” and the exhaust pipe has reached normal operating temperature.

Under certain circumstances, for example after heater replacement or the disconnection of the fuel or coolant circuits, smoke may be visible from the general vicinity of the heater rather than the outlet of the exhaust. This may be as a result of residual fuel or coolant on the exhaust or heater body as a result of the service procedure. Under these circumstances, the heater must be run continually for 15-20 minutes until there are no signs of excessive smoke.

FFBH FUEL PUMP



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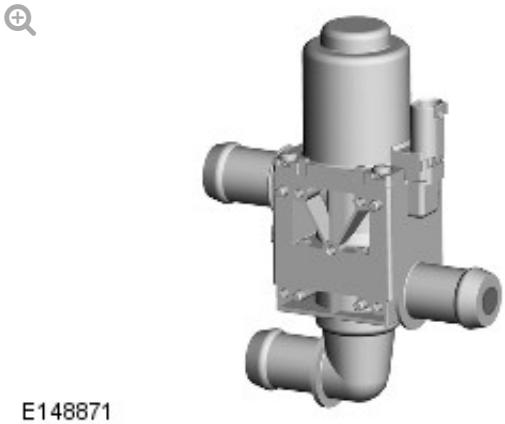
The FFBH fuel pump is installed in a rubber mounting attached to a crossmember under the rear floor, above the fuel tank. The pump is a self priming, solenoid operated plunger pump. The control module in the FFBH outputs a PWM (pulse width modulation) signal to control the operation of the pump. When the pump is de-energized, it provides a positive shut-off of the fuel supply to the FFBH.

CHANGEOVER VALVE (VEHICLES WITH TIMED CLIMATE CONTROL ONLY)



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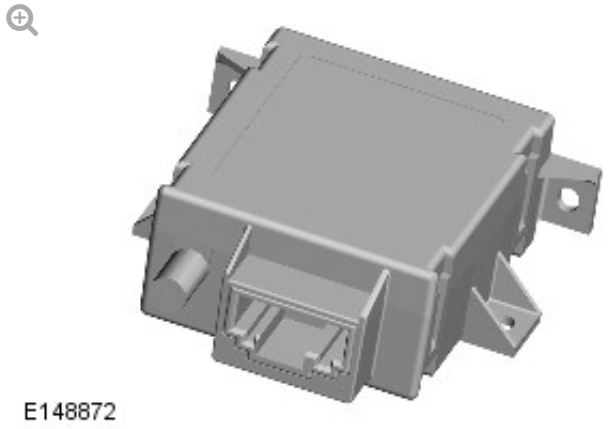
Where fitted, the changeover valve is attached to a bracket on the underside of the FFBH. The changeover valve is a normally open solenoid valve installed between the supply and return sides of the heater coolant circuit. When de-energized, the changeover valve connects the heater coolant circuit to the engine coolant circuit. When energized, the changeover valve isolates the heater coolant circuit from the engine coolant circuit.

Operation of the changeover valve is controlled by a power feed from the ATCM.

FFBH RECEIVER (VEHICLES WITH TIMED CLIMATE CONTROL ONLY)



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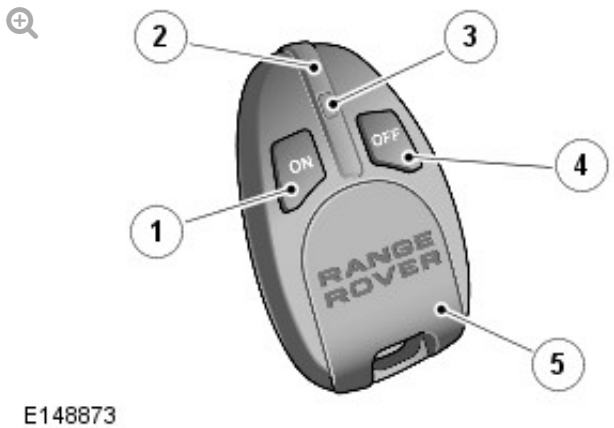
The FFBH receiver translates the FFBH remote control radio signals, relayed from the TV antenna amplifier, into a voltage output to the FFBH. When a request for timed climate control is received, the FFBH receiver outputs a battery power feed to the FFBH unit. When a request to switch off timed climate control is received, the FFBH receiver disconnects the power feed.

The FFBH receiver has a permanent power feed from the CJB (Central Junction Box) and is connected to the television antenna amplifier by a coaxial cable.
For additional information, refer to: Antenna (415-01 Information and Entertainment System, Description and Operation).

FFBH REMOTE CONTROL (VEHICLES WITH TIMED CLIMATE CONTROL ONLY)



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ITEM	DESCRIPTION
1	ON switch
2	Antenna
3	Light Emitting Diode (LED) operating indicator
4	OFF switch
5	Battery cover

NOTE:

Avoid touching the antenna when operating the ON or OFF switch. Covering the antenna will have an adverse affect on the transmitting range.

The FFBH remote control enables the timed climate control program to be activated and deactivated from outside the vehicle. The remote control has an approximate range of 100 m (328 ft). There is no need to point the remote control at the vehicle. Press and hold the ON button for approximately 2 seconds. The LED illuminates green to confirm that a timed climate program has been initiated. The LED continues to flash for a few seconds to indicate that the timed climate is active.

The timed climate program continues for 20-30 minutes, after which it switches off automatically to prevent the vehicle's battery from discharging. It also turns off automatically if the engine is started.

The LED indicator signals various states and conditions for the timed climate as follows:

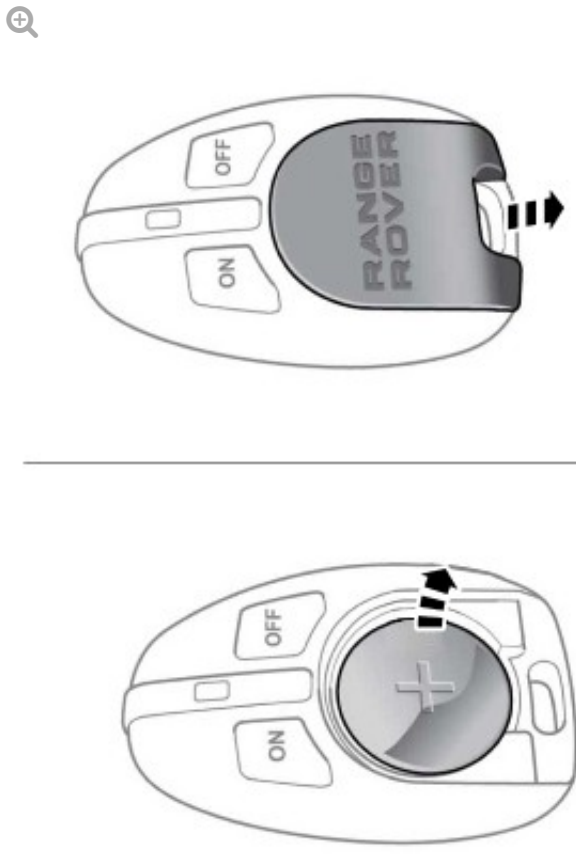
- Illuminates green when the ON button is pressed and then quickly flashes green, to indicate that heater operation has been requested.
- Illuminates green followed by red when the OFF button is pressed, to indicate that the heater has been requested to shut down.

- Illuminates green and then quickly flashes red when either the ON or OFF button is pressed, to indicate that there is no communication with the receiver. This normally occurs if the vehicle is too far away.
- Illuminates green and then slowly flashes red when either the ON or OFF button is pressed, to indicate that there is an error.
- Flashes red when either the ON or OFF button is pressed, to indicate that the Timed climate remote battery needs replacing.

NOTE:

The timed climate control program will only operate once per engine start to maintain battery condition.

REPLACING THE FFBH REMOTE CONTROL BATTERIES



With the front of the remote control facing upwards, press down on the rear

of the battery cover and push completely off to reveal the battery compartment. Note that the battery should be inserted with the positive side facing upwards. Remove the old battery and ensuring that the correct polarity is maintained, insert a new, unused 3 volt CR2032 battery. Align and push the cover back to the original position.

FFBH REMOTE CONTROL PAIRING

Each FFBH remote control must be 'paired' to the FFBH receiver to enable communications. Each remote control has a unique identification number which is stored by the receiver. The receiver can store up 4 remote control identification numbers. If a fifth remote control is paired to the receiver, the receiver will overwrite the first paired remote control number.

Pair a remote control to the vehicle, as follows:

1. Remove fuse F1 (5A) from the CJB (Central Junction Box).
2. Wait for a minimum of 5 seconds.
3. Replace fuse F1 (5A) in the CJB then, within 5 seconds, press and hold the remote control OFF switch.
4. A successful pairing is indicated by the remote control LED illuminating red for 2 seconds.

NOTE:

The pairing process relies on the FFBH receiver having the power supply removed and then the power supply re-instated. The fuse method is the easiest method but it can also be achieved by battery disconnection or removal of the harness connector from the FFBH receiver.

OPERATION

FUEL FIRED BOOSTER HEATER

Operation of the FFBH is controlled by a status message from the ATCM (automatic temperature control module) to the control module. A similar status message, from the control module to the ATCM, advises the ATCM of the current operating status of the FFBH.

While the engine is running, if the ambient air temperature is less than 12°C (54°F) (Diesel) or 1°C (34°F) (Petrol) and the engine coolant temperature is less than 75°C (167°F) the ATCM changes the status message from 'heater off' to 'supplemental heat'. The control module then changes the status message it sends the ATCM to 'supplemental heat' and starts the FFBH.

If the engine is started and the FFBH is requested, the ATCM closes the recirculation door for the first 4 minutes or until the vehicle road speed exceeds 16 km/h (10 mph), after which time the ATCM opens the door to enable the ingress of fresh air. This feature is over ridden if the MAX demist switch on the ICP (integrated control panel) is selected or if the ATCM detects a risk of misting of the windshield.

The FFBH will not start, or will discontinue operation, if any of the following occur:

- The control module is in the error lockout mode (see DIAGNOSTICS below).
- The engine stops running for approximately 4 seconds. The time delay is included for stall detection.
- The ATCM receives a 'fuel cut-off' message from the CJB (central junction box) on the medium speed CAN (controller area network) comfort bus, via the medium speed CAN body bus and the GWM (gateway module). The CJB sends the message if it receives a crash signal from the RCM (restraints control module).
  For additional information, refer to: Airbag and Safety Belt Pretensioner Supplemental Restraint System (501-20B Supplemental Restraint System, Description and Operation).

- The ATCM receives a low fuel level message from the CJB on the medium speed CAN comfort bus, via the medium speed CAN body systems and the GWM (gateway module).
- The QCCM (Quiescent Current Control Module) disconnects the power supply to the FFBH.
  For additional information, refer to: Battery and Cables (414-01 Battery, Mounting and Cables, Description and Operation).

If the control module does not start the FFBH, or discontinues operation, the status message to the ATCM remains at, or changes to, 'heater off'.

If the ambient air temperature increases to 15°C (59°F) (Diesel) or 4°C (40°F) (Petrol) or the engine coolant temperature increases to 85°C (185°F), the ATCM cancels supplemental heating, by changing the status message to the control module back to 'heater off'. The control module then cancels FFBH operation and changes the status message to the ATCM to 'heater off'.

START SEQUENCE

At the beginning of a start sequence, the control module energizes the FFBH coolant pump then operates the following in a preset sequence to start the FFBH:

- The combustion air fan
- The glow plug
- The FFBH fuel pump.

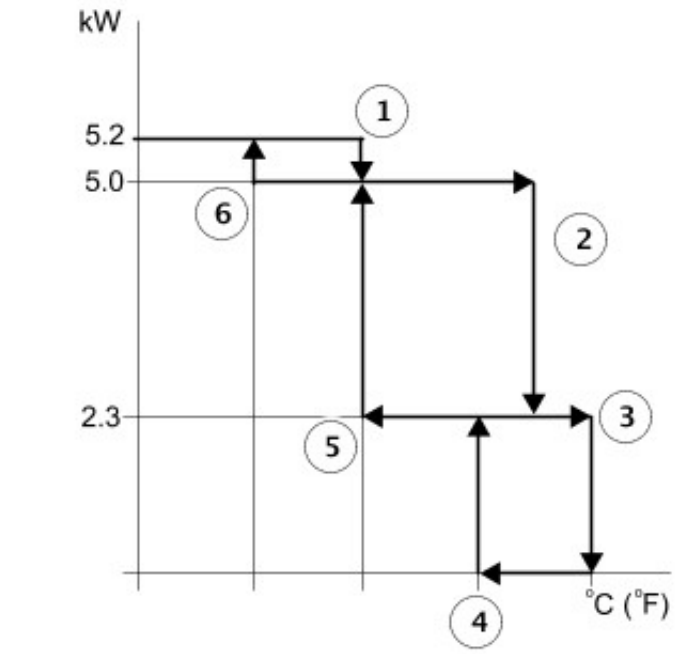
Once combustion has stabilized, the control module switches off the glow plug. If the FFBH fails to ignite the control module repeats the start sequence.

COMBUSTION LOADS

While the FFBH is running, the control module cycles between power, high or low load combustion and a control idle phase of operation, depending on the temperature of the coolant in the heat exchanger. The heat output

level at low load combustion is 2.3 kW. This rises to 5 kW at high load combustion and 5.2 kW at power load combustion. The control module transmits the amount of fuel used by the FFBH to the CJB, and the FFBH coolant temperature to the ATCM.

Switching Point Temperatures



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SWITCHING POINT		TEMPERATURE, °C (°F)
ITEM NUMBER	DESCRIPTION	
1	Power load to high load	65 °C (149°F)
2	High load to low load	80 °C (176°F)
3	Low load to control idle	85 °C (185°F)
4	Control idle to low load	75 °C (167°F)
5	Low load to high load	65 °C (149°F)
6	High load to power load	55 °C (131°F)

The switching point temperatures are for reference only and may vary depending on the fuel type and engine size.

After the start sequence, the control module maintains power load combustion until the coolant temperature reaches switching point temperature 1. At this temperature, the control module decreases the speed of the FFBH fuel pump and the combustion air fan to enable high load combustion. The control module maintains high load combustion while the coolant temperature remains between switching point temperatures 2 and 6. At high load combustion the temperature of the coolant will increase or decrease depending on the amount of heat required to heat the vehicle interior. If the coolant temperature decreases to switching point temperature 6, the control module increases the speed of the FFBH fuel pump and the combustion air fan to full speed, to return to power load combustion. If the coolant temperature increases to switching point temperature 2, the control module decreases the speed of the FFBH fuel pump and the combustion air fan to enable low load combustion. At low load combustion the temperature of the coolant will again increase or decrease depending on the amount of heat required to heat the vehicle interior. If the coolant temperature decreases to switching point temperature 5 the control module increases the speed of the FFBH fuel pump and the combustion air fan to enable high load combustion. If the coolant temperature increases to switching point temperature 3, the control module enters a control idle phase of operation.

On entering the control idle phase, the control module immediately switches the FFBH fuel pump off, to stop combustion, and starts a timer for the combustion air fan. After a 90 seconds (diesel vehicles) or 120 seconds (petrol vehicles) cool down period, the control module switches the combustion air fan off and then remains in the control idle phase while the coolant temperature remains above switching point temperature 4. If the coolant temperature decreases to switching point temperature 4, the control module initiates a start to low load combustion.

SHUTDOWN

To stop the FFBH, the control module de-energizes the FFBH fuel pump to stop combustion, but continues operation of the combustion air fan and the coolant pump for a time, to cool down the FFBH. The cool down time is approximately 90 (diesel vehicles) or 120 (petrol vehicles) seconds.

DIAGNOSTICS

The control module monitors the FFBH system for faults. Any faults detected are stored in a volatile memory in the control module, which can be interrogated by Land Rover approved diagnostic equipment via the medium speed CAN comfort bus. A maximum of three faults and associated freeze frame data can be stored at any one time. If a further fault is detected, the oldest fault is overwritten by the new fault.

The control module also incorporates an error lockout mode of operation that inhibits operation to prevent serious faults from causing further damage to the system. In the error lockout mode, the control module immediately stops the FFBH fuel pump, and stops the combustion air fan and coolant pump after the cool down time. Error lockout occurs for start sequence failures, combustion flameouts, heat exchanger casing overheat and if battery voltage is out of limits.

- Start failure and flameout: If a start sequence fails to establish combustion, or a flameout occurs after combustion is established, the control module immediately initiates another start sequence. The start failure or flameout is also recorded by an event timer in the control module. The event timer is increased by one after each start failure or flameout, and decreased by one if a subsequent start is successful. If the event timer increases to three (over any number of drive cycles), the control module enters the error lockout mode.
- Heat exchanger casing overheat: To protect the system from excessive temperatures, the control module enters the error lockout mode if the heat exchanger coolant temperature exceeds 125°C (257°F).
- Battery voltage out of limits: Error lockout will occur if battery voltage is outside the limits of 10.5 to 16.0 volts.

The error lockout mode can be cleared using Land Rover approved diagnostic equipment, or by disconnecting the battery power supply to the FFBH for a minimum of 10 seconds.

TIMED CLIMATE CONTROL

Where fitted, timed climate control provides a comfortable temperature in the passenger compartment of a vehicle parked with the engine off. When timed climate control operates, the passenger compartment is either heated by the FFBH and climate control blower (parked heating) or cooled by the climate control blower (parked ventilation), depending on the ambient air temperature. Parked heating occurs if the ambient air temperature is less than 16°C (61°F); parked ventilation occurs if the ambient air temperature is 16°C (61°F) or more. To prevent excessive drain on the battery, both parked heating and parked ventilation are automatically de-activated after 30 minutes.

In very cold conditions timed climate control also warms the engine to aid starting. Engine warming occurs if the ambient air temperature is -20 °C (-4 °F) or below.

When timed climate control is operating, the LED in the AUTO or A/C switch on the ICP will flash. If the AUTO switch LED flashes the engine or passenger compartment are being heated. If the A/C switch LED (light emitting diode) flashes the passenger compartment is being ventilated.

Timed climate control is controlled using either the touch screen or the FFBH remote control.

In order to minimize the potential for odor ingress from the FFBH, the ATCM will automatically close the recirculation door in the climate control assembly for the first 7 minutes of FFBH operation when activated by the timed climate control feature.

TOUCH SCREEN

The touch screen is used for direct selection of timed climate control or to

program one or two 'on/off' cycle start-times per day, and one 'on/off' cycle start-time further in the future. The programmed start times are stored in the CJB. The direct selection and programmed time modes of operation are selected when the engine is stopped and the smart key is in the vehicle. The key can then be removed and the vehicle locked. Any timed event will automatically run without the key inside the vehicle.

At a programmed start time or a direct selection on the touch screen, the CJB sends a start signal to the ATCM via the medium speed CAN body systems, GWM and medium speed CAN comfort bus. The ATCM module then initiates the appropriate mode of timed climate control operation.

To set a timed climate program:

- 1. Press the HOME MENU switch.
- 2. Touch the **Timed climate** soft key. This soft key may be set on a personal shortcut or accessed via the **Extra Features** soft key. Select 7 day timer, or single event, then select the timer soft key. If 7 day timer selected, then select the day for which you want to set a program. Alternatively, select **All week** to select the same start time for every day.
- 3. Touch the Timer 1 or Timer 2 soft key. The timers can be toggled between on and off using the power soft key.
- 4. Touch the up or down arrows to set the start time. Hours and minutes are adjusted separately.
- 5. Touch **OK**. The screen will display the activation time. If required, set the time for the other timer using the same process.
- 6. Once set, the timer events can be turned on or off as required in the Timed climate screen by selecting the 7 day timer or the single event soft key.

NOTES:

- Set times should to be programmed to start 30 minutes before the planned journey.
- Timed climate control will only operate once between engine starts. For example, a timed climate control request from the FFBH remote control will not be performed if a programmed timed climate control event has already occurred.

Any programmed timed climate control cycle may be cancelled by touching the relevant power soft key on the timer set up menu or the **Power** soft key on the **Timed climate** information home menu.

REMOTE CONTROL

When timed climate control is selected on or off with the FFBH remote control, the request is received by the FFBH receiver via the right TV antenna and the TV antenna amplifier. The FFBH receiver relays the request as a hardwired signal to the FFBH control module. On receipt of the request, the FFBH control module sends the request to the ATCM on the LIN bus. The ATCM then initiates the appropriate mode of timed climate control operation.

A 'handshake' signal is sent back from the FFBH receiver to the remote control to confirm a valid on or off request and activate the remote control LED accordingly.

NOTE:

The ‘handshake’ signal only confirms remote control-FFBH receiver communications were successful, and not that the request has been performed.

TIMED CLIMATE CONTROL OPERATION

When the ATCM receives a timed climate control start request, its response depends on the ambient air temperature:

- If the ambient temperature is 16 °C (61 °F) or more, the ATCM initiates parked ventilation and:
  - Operates the blower at 47% of maximum speed.
  - Operates the distribution doors in the heater assembly to direct the air to the face level outlets.
- If the ambient temperature is less than 16 °C (61 °F) and more than -20 °C (-4 °F), the ATCM initiates parked heating and:
  - Energizes the changeover valve.
  - Sends a LIN bus message to activate the FFBH.
  - Operates the blower at 47% of the maximum speed.
  - Operates the distribution doors in the heater assembly to direct the air to the footwells for approximately 30 seconds, then to either only the windscreen, or to both the footwells and the windscreen, depending on the ambient air temperature.
- If the ambient temperature is -20 °C (-4 °F) or below, the ATCM sends a LIN bus message to activate the FFBH, but leaves the changeover valve de-energized and does not operate the blower or distribution doors. Heated coolant is circulated around the engine and heater core(s) to heat the engine and improve engine starting. Once the FFBH coolant temperature is above a suitable threshold the blower is switched on and passenger compartment heating commenced.

The FFBH will only activate in timed climate control if the following threshold conditions are met:

- Pre-burn battery voltage check: ≥11.5V (voltage at FFBH terminals).
- Pre-burn coolant temperature check: ≤15°C (internal FFBH measurement).
- Pre-burn fuel level check: ≥7.5 liters (value stored in FFBH at ignition off).

The fuel level value stored within the FFBH is only updated when the engine is running. When starting the FFBH in timed climate control with the engine off, the fuel level value used in the FFBH calculations will be that stored at the ignition off event. It is therefore possible for the FFBH to fail to operate in timed climate control if the engine was stopped with a low fuel level; if the fuel tank is subsequently refueled, the FFBH stored fuel level will still read low if the engine has not been started since refueling.

After 30 minutes, or if timed climate control is selected off with the touch screen or remote control, the ATCM discontinues timed climate control operation:

- If parked ventilation is active, the ATCM:
  - Switches off the blower.
  - Returns the distribution doors to the previous settings.
- If parked heating is active, the ATCM:
  - Sends a LIN bus message to de-activate the FFBH.
  - Switches off the blower.
  - Returns the distribution doors to the previous settings.
  - After 3 minutes, de-energizes the changeover valve.

TRANSITION FROM TIMED CLIMATE CONTROL TO ENGINE RUNNING

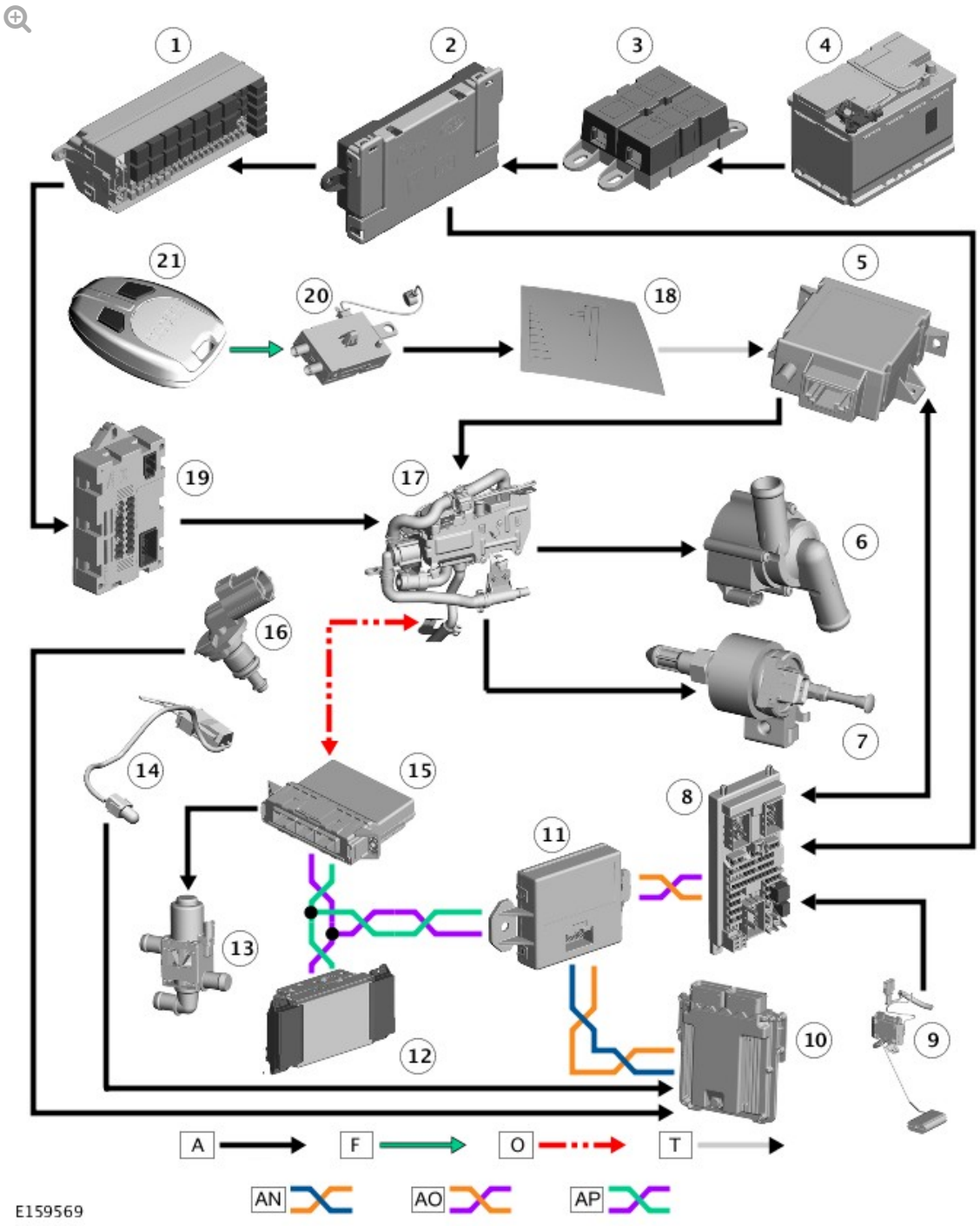
Parked ventilation is automatically de-activated when the ignition is switched on.

Parked heating:

- Is de-activated when the engine starts if the engine coolant temperature is equal to or more than the heater coolant temperature.
- If the engine coolant temperature is less than the heater coolant temperature, parked heating remains active until the engine coolant temperature reaches the heater coolant temperature. The changeover valve also remains closed until the engine coolant temperature reaches

the heater coolant temperature.

CONTROL DIAGRAM



A = HARDWIRED; F = RF TRANSMISSION; O = LIN BUS; T = CO-AXIAL CABLE; AN = HS (HIGH SPEED) CAN POWERTRAIN BUS; AO = MS (MEDIUM SPEED) CAN BODY BUS; AP = MS CAN COMFORT BUS.

ITEM	DESCRIPTION
1	Rear Junction Box (RJB)

2	Battery Junction Box (BJB)
3	BJB 2
4	Battery
5	Fuel Fired Booster Heater (FFBH) receiver (vehicles with timed climate control only)
6	FFBH coolant pump
7	FFBH fuel pump
8	Central Junction Box (CJB)
9	Fuel level sensor
10	Engine Control Module (ECM)
11	Gateway Module (GWM)
12	Touch Screen (TS)
13	Changeover valve (vehicles with timed climate control only)
14	Ambient Air Temperature (AAT) sensor
15	Automatic Temperature Control Module (ATCM)
16	Engine Coolant Temperature (ECT) sensor
17	FFBH
18	Television antenna amplifier
19	Quiescent Current Control Module (QCCM)
20	Right television antenna
21	FFBH remote control (vehicles with timed climate control only)