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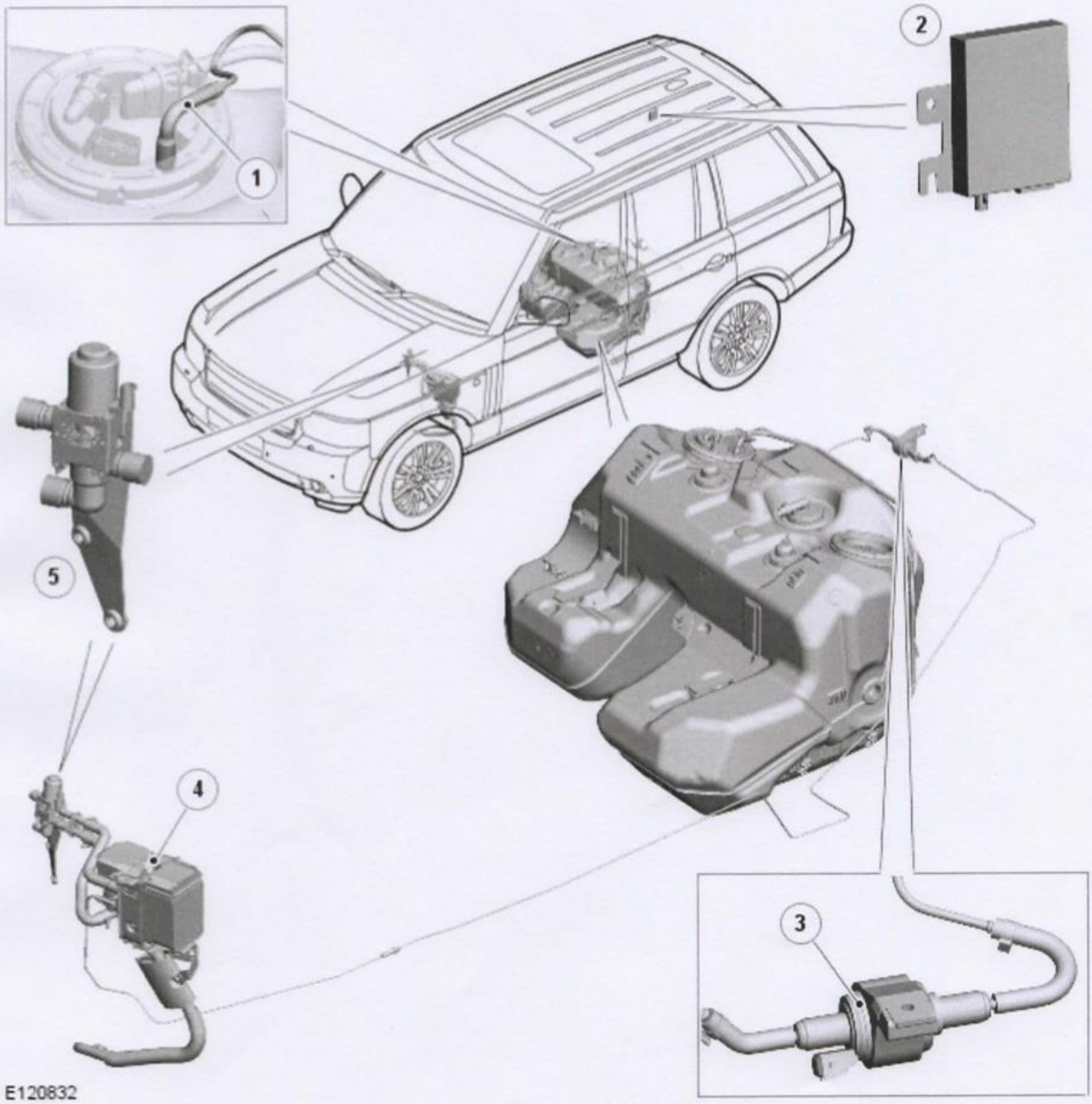
Auxiliary Heating - Auxiliary Heater

Description and Operation

COMPONENT LOCATION

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



E120832

Item	Description
1	Fuel Fired Booster Heater (FFBH) fuel pipe tank connection
2	FFBH receiver
3	FFBH fuel pump
4	FFBH unit
5	Changeover valve

INTRODUCTION

Where fitted, auxiliary heating is provided by a FFBH, which boosts the temperature of the engine coolant. Fuel for the FFBH is taken from the vehicle fuel tank, through a fuel line attached to the fuel pump module. An auxiliary 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.

For remote operation, the system includes a FFBH receiver and a remote handset.

A changeover valve allows the heater coolant circuit to be isolated from the engine coolant circuit during parked heating, to reduce the warmup time of the passenger compartment.

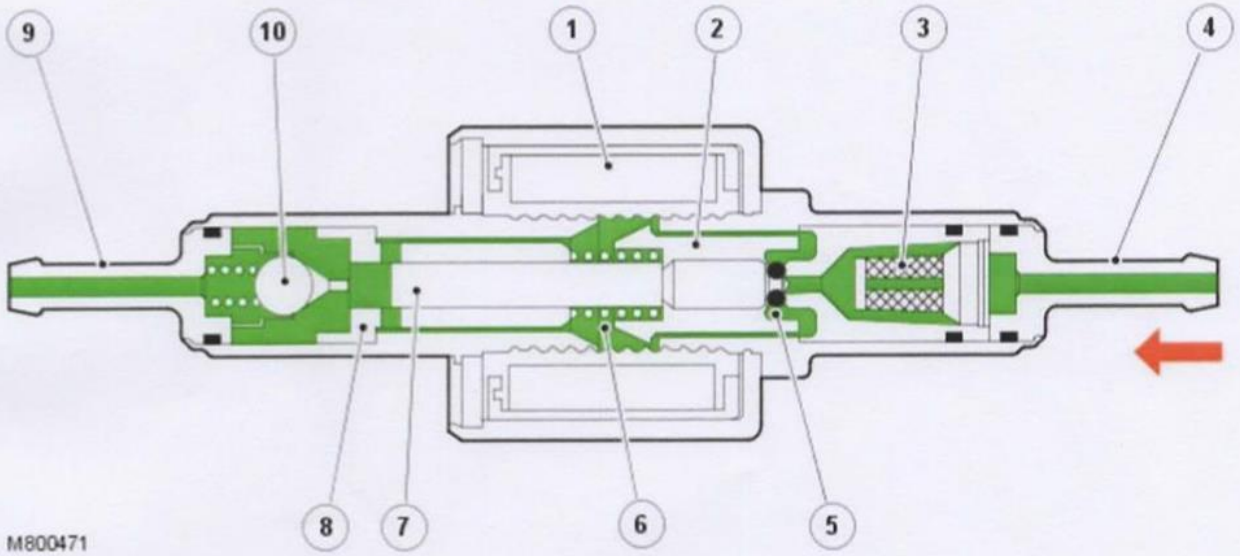
A control module integrated into the FFBH unit controls the operation of the FFBH unit and the FFBH fuel pump. The ATC (automatic temperature control) module controls the changeover valve. System operation is initiated by:

- The CJB (central junction box) , via the ATC module, for parked heating selections made on the TSD (touch screen display).
  For additional information, refer to: Audio System (415-01A Audio Unit, Description and Operation).
- The remote handset, via the TV (television)) system antenna and antenna amplifier, and the FFBH receiver, for remote activation of parked heating.
- The ATC module, for additional heating while the engine is running.

FFBH FUEL PUMP

The FFBH fuel pump regulates the fuel supply to the FFBH unit. The FFBH fuel pump is installed in a rubber mounting attached to a bracket on the underside of the rear floor, immediately in front of the spare wheel well. The pump is a self priming, solenoid operated plunger pump. The control module in the FFBH unit 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 unit.

Sectioned View of FFBH Fuel Pump



Item	Description
1	Solenoid coil
2	Plunger
3	Filter insert
4	Fuel line connector
5	O-ring seal
6	Spring
7	Piston
8	Bush
9	Fuel line connector
10	Non return valve

The solenoid coil of the FFBH fuel pump is installed around a housing, which contains a plunger and piston. The piston locates in a bush, and a spring is installed on the piston between the bush and the plunger. A filter insert and a fuel line connector are installed in the inlet end of the housing. A non return valve and a fuel line connector are installed in the fuel outlet end of the housing.

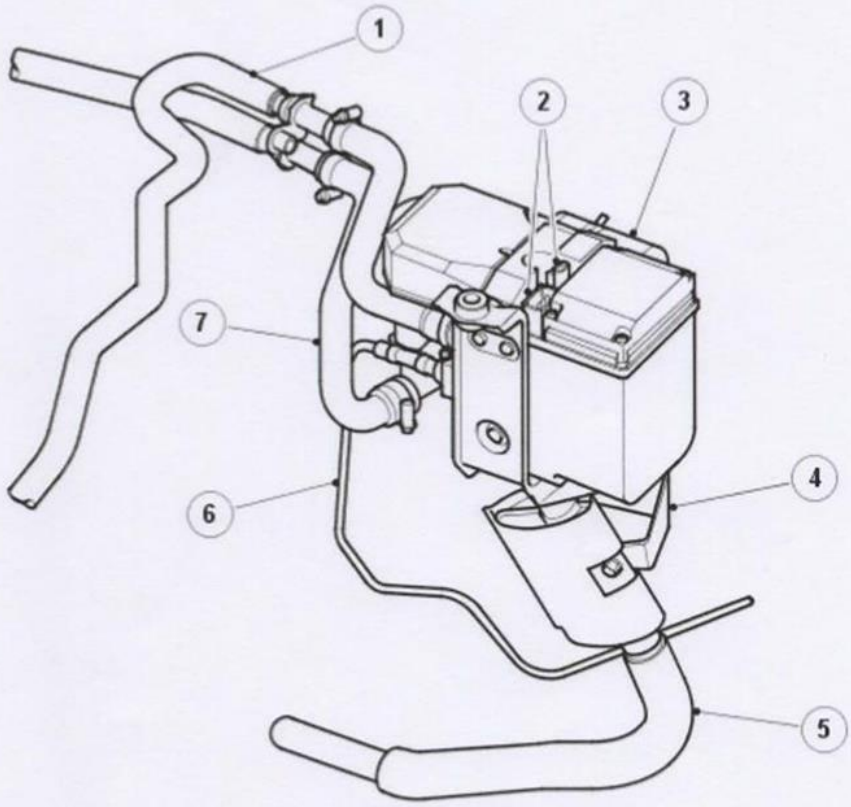
While the solenoid coil is de-energized, the spring holds the piston and plunger in the closed position at the inlet end of the housing. An O-ring seal on the plunger provides a fuel tight seal between the plunger and the filter insert, preventing any flow through the pump. When the solenoid coil is energized, the piston and plunger move towards the outlet end of the housing, until the plunger contacts the bush; fuel is then drawn in through the inlet connection and filter. The initial movement of the

piston also closes transverse drillings in the bush and isolates the pumping chamber at the outlet end of the housing. Subsequent movement of the piston then forces fuel from the pumping chamber through the non return valve and into the line to the FFBH unit. When the solenoid de-energizes, the spring moves the piston and plunger back towards the closed position. As the piston and plunger move towards the closed position, fuel flows past the plunger and through the annular gaps and transverse holes in the bush to replenish the pumping chamber.

FFBH UNIT

The FFBH unit is installed in the passenger side rear of the engine compartment, below the battery. It is connected in series with the coolant supply to the heater assembly. Two electrical connectors on the FFBH unit connect it to the vehicle wiring.

FFBH Unit Components



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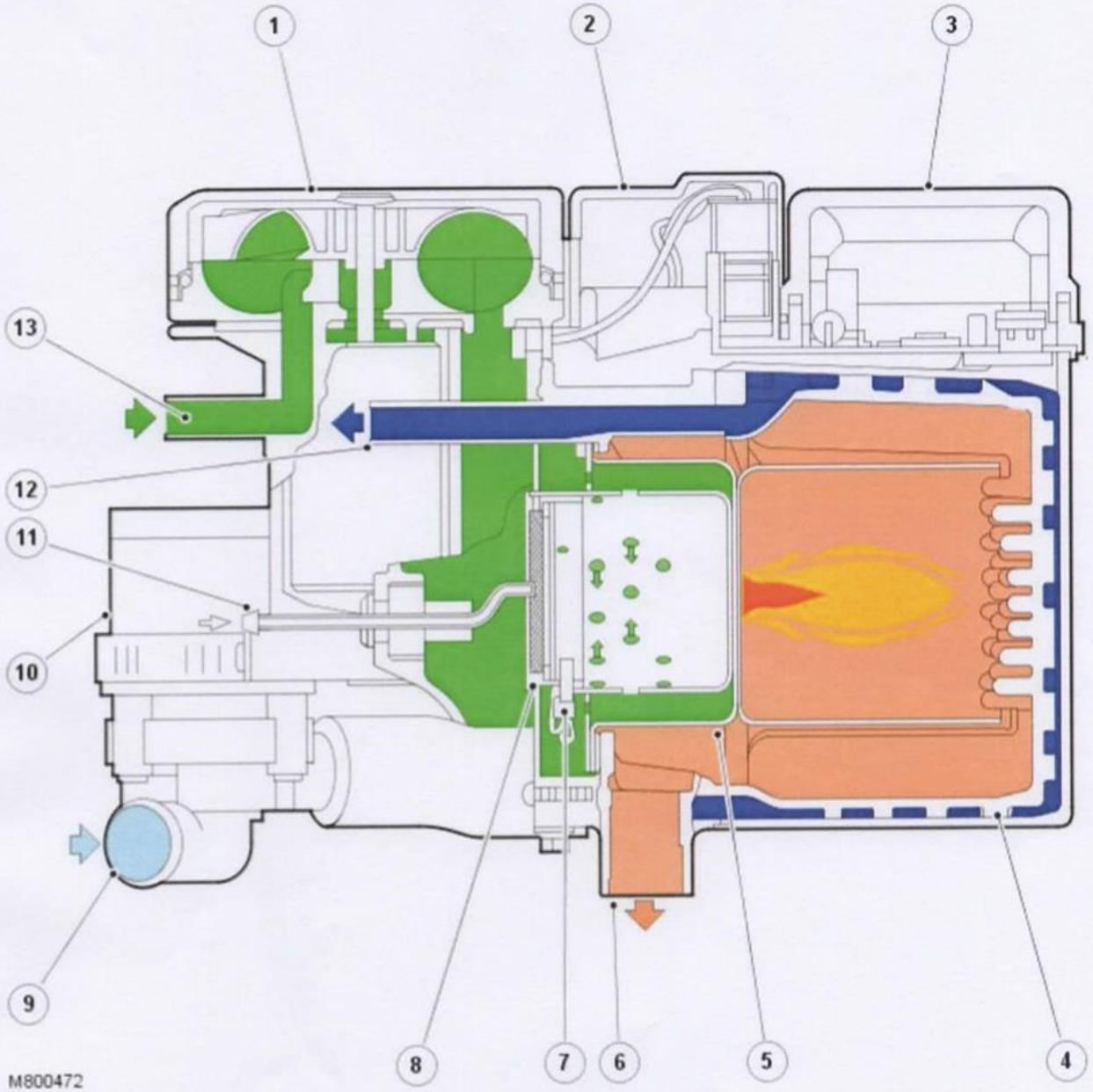
Item	Description
1	Coolant outlet hose
2	Electrical connectors
3	Air inlet filter
4	Mounting bracket
5	Exhaust pipe
6	Fuel supply line
7	Coolant inlet hose

Sectioned View of FFBH Unit



Item	Description
1	Combustion air fan
2	Burner housing
3	Control module
4	Heat exchanger
5	Burner insert
6	Exhaust
7	Glow plug/flame sensor
8	Evaporator
9	Coolant inlet
10	Circulation pump
11	Fuel inlet
12	Coolant outlet
13	Air inlet

Circulation Pump

The circulation pump is installed at the coolant inlet to the FFBH unit to assist the coolant flow through the FFBH unit and the heater assembly. The pump runs continuously while the FFBH unit is in standby or active operating modes. While the FFBH unit is inactive, coolant flow is reliant on the engine coolant pump and the auxiliary coolant pump.

Combustion Air Fan

The combustion air fan regulates the flow of air into the unit to support combustion of the fuel supplied by the FFBH pump and to purge and cool the FFBH unit. A canister type filter is included in the air inlet supply line to prevent particulates entering and contaminating the FFBH unit.

Burner Housing

The burner housing contains the burner insert and also incorporates connections for the exhaust pipe, the coolant inlet from the circulation pump and the coolant outlet to the heater assembly. The exhaust pipe directs exhaust combustion gases to atmosphere through a pipe below the FFBH unit.

The burner insert incorporates the fuel combustion chamber, an evaporator and a glow plug/flame sensor. Fuel from the FFBH fuel pump is supplied to the evaporator, where it evaporates and enters the combustion chamber to mix with air from the combustion air fan. The glow plug/flame sensor provides the ignition source of the fuel:air mixture and, once combustion is established, monitors the flame.

Control Module/Heat Exchanger

The control module controls and monitors operation of the FFBH system. Ventilation of the control module is provided by an internal flow of air from the combustion air fan. The heat exchanger transfers heat generated by combustion to the coolant. A sensor in the heat exchanger provides the control module with an input of heat exchanger casing temperature, which the control module relates to coolant temperature and uses to control system operation. The temperature settings in the control module are calibrated to compensate for the difference between coolant temperature and the heat exchanger casing temperature detected by the sensor. Typically, as the coolant temperature increases, the coolant will be approximately 7 °C (12.6 °F) hotter than the temperature detected by the sensor; as the coolant temperature decreases, the coolant will be approximately 2 °C (3.6 °F) cooler than the temperature detected by the sensor.

CHANGEOVER VALVE

The changeover valve is a normally open solenoid valve installed between the supply and return sides of the heater coolant circuit. The changeover valve is located in the engine compartment on the engine bulkhead. 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.

The changeover valve is controlled by a power feed from the ATC module.

FFBH RECEIVER

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

The FFBH receiver has a permanent power feed from the AJB (auxiliary junction box) and is connected to the TV antenna amplifier by a coaxial cable.

FFBH REMOTE HANDSET

E103416

Item	Description
1	On button
2	Off button
3	light emitting diode (LED)
4	Antenna

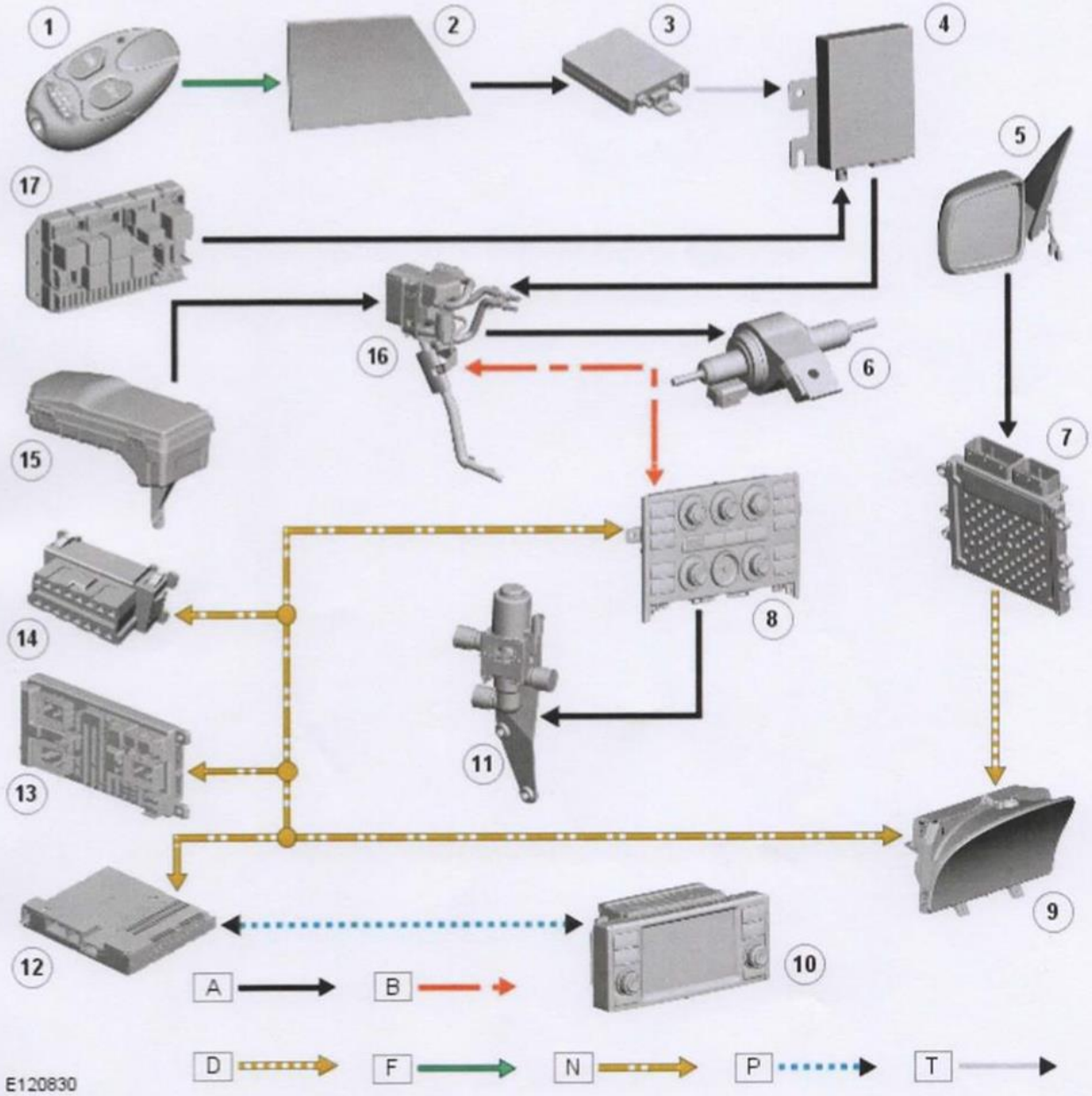
The FFBH remote handset allows parked heating to be remotely controlled up to a minimum of 100 m (328 ft) from the vehicle. On and off buttons activate and de-activate parked heating.

An LED (light emitting diode) flashes green when parked heating is active. If the LED flashes red after a start selection, then communication has not been established with the vehicle. If the LED flashes orange, the battery needs replacing.

The FFBH remote handset is powered by a 3.3 V CR1/3N battery located under a cover on the rear of the handset.

CONTROL DIAGRAM

NOTE: A = Hardwired; B = K bus; D = High speed CAN (controller area network) ; F = RF transmission; N = Medium speed CAN bus; P = MOST ring; T = Coaxial cable.



Item	Description
1	FFBH remote handset
2	RH side window antenna
3	TV antenna amplifier
4	FFBH receiver
5	LH door mirror (ambient air temperature sensor)
6	FFBH fuel pump

7	ECM
8	ATC module
9	Instrument cluster
10	TSD
11	Changeover valve
12	IHU
13	CJB (central junction box)
14	Diagnostic socket
15	EJB (engine junction box)
16	FFBH
17	AJB (auxiliary junction box)

OPERATION

The FFBH system operates in two modes:

- Parked heating, to heat the passenger compartment while the vehicle is parked with the engine off.
- Additional heating, to boost heater performance while the engine is running.

The ATC module disables FFBH operation if battery voltage is too low, as determined from an ambient air temperature dependent voltage map. Where fitted, the battery monitoring system can also disable FFBH operation based on the battery charge state with the engine off.

During FFBH operation, with or without the engine running, the coolant valves of the climate control system remain de-energized and heater core temperature is directly related to the temperature of the coolant coming from the FFBH unit.

Parked Heating/Ventilation

Parked heating works in conjunction with parked ventilation. When parked heating/ventilation is selected, the vehicle interior is either heated by parked heating or cooled by parked ventilation, depending on the ambient temperature. Parked heating occurs if the ambient temperature is less than 16 °C (61 °F); parked ventilation occurs if the ambient temperature is 16 °C (61 °F) or more.

Parked heating/ventilation is controlled by direct selection on the TSD, by using the TSD to program one or two on/off cycle start times in the following 24 hour period, or by using the FFBH remote handset. 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. In all operating modes, parked heating/ventilation is automatically de-activated after 30 minutes (20 minutes for UK diesel vehicles) to prevent excessive drain on the battery. Parked ventilation is automatically de-activated when the ignition is switched on.

When programmed start times for parked heating/ventilation are entered on the TSD, the times are stored in the CJB .

If the engine is started while parked heating is on:

- If the engine coolant temperature is equal to or more than the heater coolant temperature, parked heating is switched off.
- If the engine coolant temperature is less than the heater coolant temperature, parked heating remains on 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, except on 5.0L vehicles, where the changeover valve is always open when the engine running (due to the positioning of the ECT (engine coolant temperature) sensor).

Programmed Parked Heating/Ventilation

At a programmed parked heating/ventilation start time, the EJB (engine junction box) sends a start signal to the ATC module on the medium speed CAN .

On receipt of the message:

- If the ambient temperature is less than 16 °C (61 °F) and, on diesel models, more than -20 °C (-4 °F), the ATC module initiates parked heating and:
  - Energizes the changeover valve.
  - Sends a K 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.
  - Flashes the auto blower LED at 2 Hz.
  - On diesel models, if the ambient temperature is -20 °C (-4 °F) or below, the ATC module sends a K 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.

- If the ambient temperature is 16 °C (61 °F) or more, the ATC module 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.
  - Flashes the auto distribution LED at 2 Hz.

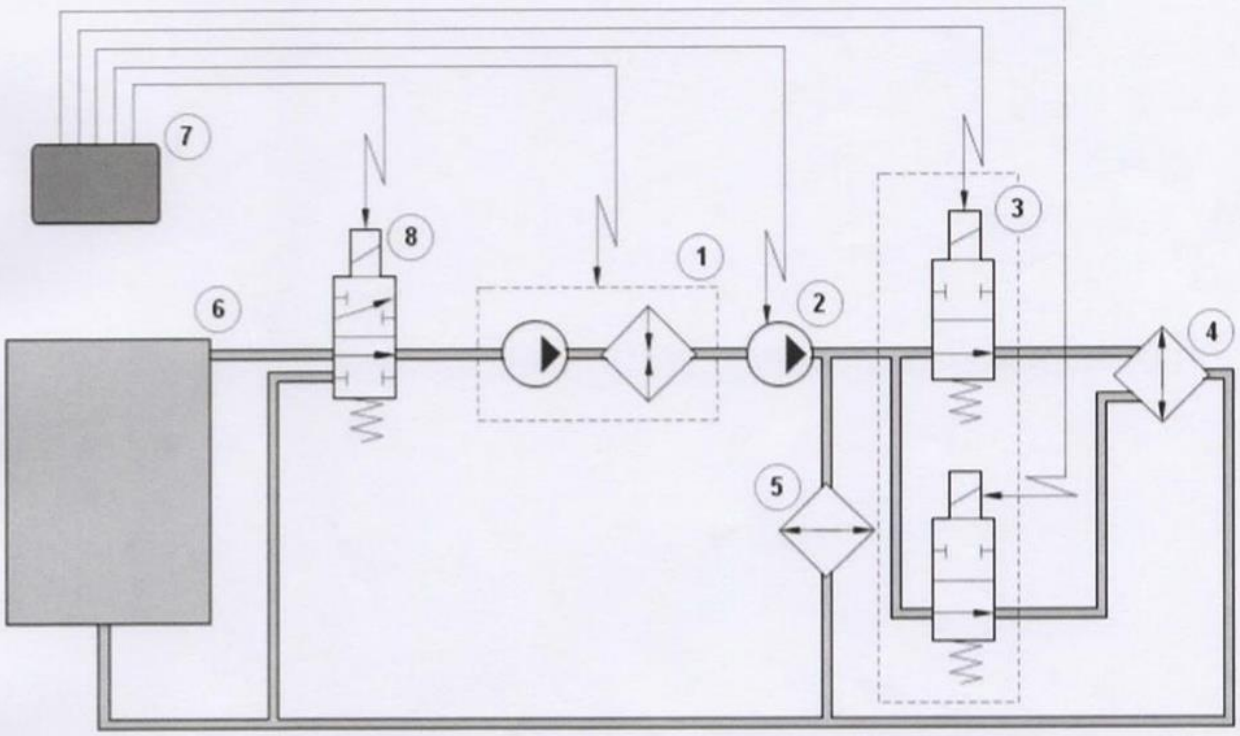
After 30 minutes (20 minutes for UK diesel vehicles), the ATC module stops the parked heating/ventilation:

- If parked heating is active, the ATC module:
  - Sends a K 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.
- If parked ventilation is active, the ATC module:
  - Switches off the blower.
  - Returns the distribution doors to the previous settings.

Remotely Selected Parked Heating/Ventilation

When parked heating/ventilation is selected on with the remote handset, the request is received by the FFBH receiver via the TV antenna and 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 ATC module on the K bus. The ATC module then determines if parked heating or ventilation is required and operates as detailed above.

Heater Coolant Circuit



E120831

Item	Description
1	FFBH unit
2	Auxiliary coolant pump
3	Coolant valves
4	Heater core
5	Rear heater core (four zone climate control only)
6	Engine cooling system
7	ATC module
8	Changeover valve

Additional Heating

Additional heating reduces the heater warm-up time and is also used to maintain heater performance throughout the drive cycle.

The ATC module activates the additional heating mode when the engine is running and the following conditions coexist:

- The ambient temperature is less than 1 °C (34 °F) on petrol vehicles or 8 °C (41 °F) on diesel vehicles.
- The engine coolant temperature is less than 75 °C (167 °F).
- The heater coolant temperature is less than 70 °C (158 °F).
- The heat demand is more then 75%.
- The blower is on.

To activate the additional heating mode, the ATC module energizes the auxiliary coolant pump and sends a K bus message to the FFBH unit to start/continue operation (the changeover valve remains de-energized).

The ATC module stops the FFBH and de-energizes the auxiliary coolant pump when any of the following occur:

- The engine stops.
- The ambient temperature increases to more than 3 °C (37 °F) on petrol vehicles or 15 °C (59 °F) on diesel vehicles.
- The engine coolant temperature increases to more than 75 °C (167 °F).
- The heater coolant temperature increases to more than 70 °C (158 °F).
- The heat demand decreases to less than 70%.
- The blower is selected off.

FFBH Unit

Once initiated by a message from the ATC module, FFBH operation is controlled by the control module in the FFBH unit. The control module controls the FFBH unit at one of two heat output levels, 2.5 kW at part load combustion and 5 kW at full load combustion.

Start Sequence

At the beginning of the start sequence the control module energizes the glow plug function of the glow plug/flame sensor, to preheat the combustion chamber, starts the combustion air fan at slow speed and energizes the coolant circulation pump. After approximately 30 seconds, the control module energizes the FFBH fuel pump at the starting sequence speed. The fuel delivered by the FFBH fuel pump evaporates in the combustion chamber, mixes with air from the combustion air fan and is ignited by the glow plug/flame sensor. The control module then progressively increases the speed of the FFBH fuel pump and the combustion air fan. Once combustion is established the control module switches the glow plug/flame sensor from the glow plug function to the flame sensing function to monitor combustion. From the beginning of the start sequence to stable combustion takes approximately 90 seconds for a start to part load combustion and 150 seconds for a start to full load combustion.

Coolant Temperature Control

When the control module first enters the active mode, it initiates a start to full load combustion. Full load combustion continues until the heat exchanger casing temperature reaches 72 °C (162 °F), at this point the control module decreases the speed of the FFBH fuel pump and the combustion air fan to half speed, to produce part load combustion. The control module maintains part load combustion while the heat exchanger casing temperature remains between 68 and 76 °C (154 and 169 °F). If the heat exchanger casing temperature decreases to 68 °C (154 °F), the control module switches the system to full load combustion again. If the heat exchanger casing temperature increases to 76 °C (169 °F), 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 2 minute cool down period, the control module switches the combustion air fan off and then remains in the control idle phase while the heat exchanger casing temperature remains above 71 °C (160 °F). If the heat exchanger casing temperature decreases to 71 °C (160 °F), within 15 minutes of the control module entering the control idle phase, the control module initiates a start to part load combustion. If more than 15 minutes elapse before the heat exchanger casing temperature decreases to 71 °C (160 °F), the control module initiates a start to full load combustion.

In order to limit the build up of carbon deposits on the glow plug/flame sensor, the control module also enters the control idle phase if the continuous part and/or full load combustion time exceeds 72 minutes. After the cool down period, if the heat exchanger casing is still in the temperature range that requires additional heat, the control module initiates an immediate restart to part or full load combustion as appropriate.

Shutdown

When the ATC module sends a K bus message to de-activate the FFBH operation, the control module de-energizes the FFBH fuel pump to stop combustion, but continues operation of the combustion air fan and the circulation pump to cool down the FFBH unit. The cool down time depends on the combustion load at the time the message is received.

Combustion Load	Cool Down Time, Seconds
Part	100
Full	175

Diagnostics

The control module monitors the FFBH system for faults. Up to six FFBH faults can be stored in a volatile memory in the control module, and up to 10 FFBH faults together with freeze frame data can be stored in the ATC module. If a further fault is detected, the oldest fault is overwritten by the new fault. The fault data can be retrieved using the Land Rover approved diagnostic equipment.

The control module also incorporates an error lockout mode of operation that inhibits system 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 circulation pump after a cool down time of approximately 2 minutes. Error lockout occurs for start sequence failures and/or combustion flameouts, heat exchanger casing overheat and out of limit input voltage. The error lockout mode can be cleared using the Land Rover approved diagnostic system, or by disconnecting the battery power supply for a minimum of 10 seconds.

Start Failure/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 casing temperature exceeds 105 °C (221 °F).

Out of Limit Voltage: The control module enters the error lockout mode if the battery or alternator power input is less than 10.5 ± 0.3 V for more than 20 seconds, or more than 15.5 ± 0.5 V for more than 6 seconds.