

FFH SYSTEM

6910-03

GENERAL

1. SPECIFICATIONS

| | | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------------|--------------------|
| Heater | | D 5 S-H | |
| Heating medium | | Coolant | |
| Control of the heat flow | | Large (full load) | Small (small load) |
| Heat flow | | 5000 W | 2300 W |
| Fuel consumption per hour | | ≈ 0.62 ℓ | ≈ 0.27 ℓ |
| Mean electric power consumption | in operation | 35 W | 11 W |
| | at start | 100 W | |
| | after-running | 12 W | |
| Rated voltage | | 12 V | |
| Operating range | | 10 V | |
| <ul style="list-style-type: none"> Lower voltage limit: An undervoltage protection device in the controller switches the heaters off at approx. 10 volt. Upper voltage limit: An overvoltage protection device in the controller switches the heaters off at approx. 15 volt. | | 15 V | |
| Tolerable operating pressure | | up to 2.5 bar overpressure | |
| Minimum water flow through the heater | | 200 L/h | |
| Fuel | | From main fuel tank | |
| Tolerable ambient temperature | operation | -40 °C ~ 80 °C | |
| | storage | -40 °C ~ 105 °C (2h for 125 °C) | |
| Weight (without coolant and mounted parts) | | approx. 2.7 kg | |

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| Modification basis | |
| Application basis | |
| Affected VIN | |

OVERVIEW AND OPERATION PROCESS

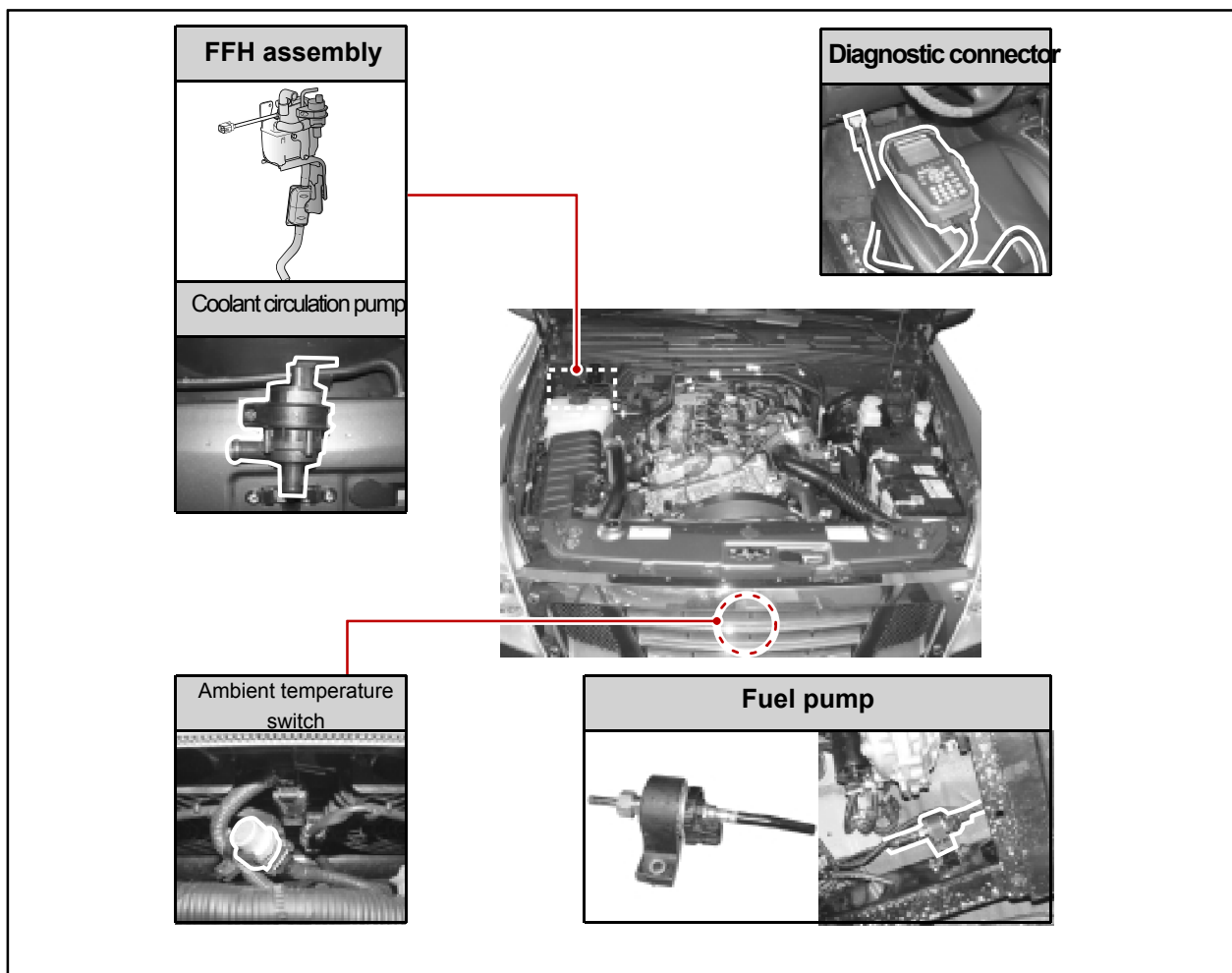
1. OVERVIEW

In fuel fired heater system equipped vehicle (D27DT engine equipped), when the ambient temperature and coolant temperature is low, the burner installed in engine cooling system increases the temperature of coolant that flows into heater by firing diesel fuel for a certain period of time. The D27DT engine equipped vehicle has the Positive Temperature Coefficient (PTC) system as a basic equipment. FFH is operated by the coolant temperature and ambient temperature while PTC is operated by the coolant temperature intake air temperature.

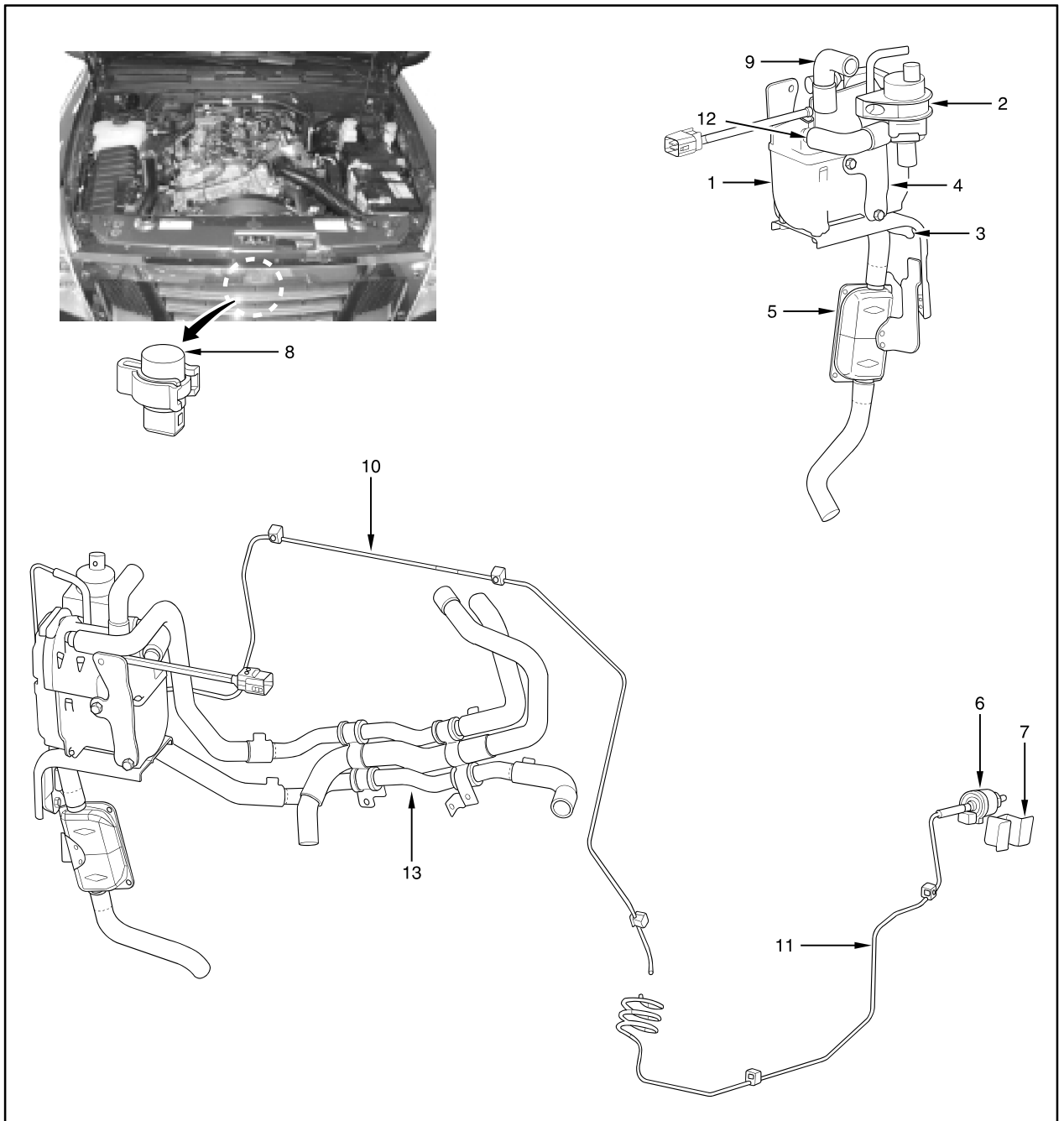
FFH system consists of independent fuel lines and fuel pump, coolant circuit and coolant circulation pump, electrical glow plug and exhaust system. It also provides the diagnostic function. FFH system cannot be operated or stopped by driver's intention. The FFH system is automatically operated by the coolant temperature and the ambient temperature.

The FFH system operates up to more 2 minutes to burn the residual fuel inside the system when stopping the engine during its operation. Therefore, a certain period of FFH operation after stopping the engine is not a malfunction.

2. COMPONENTS LOCATOR



3. SYSTEM LAYOUT

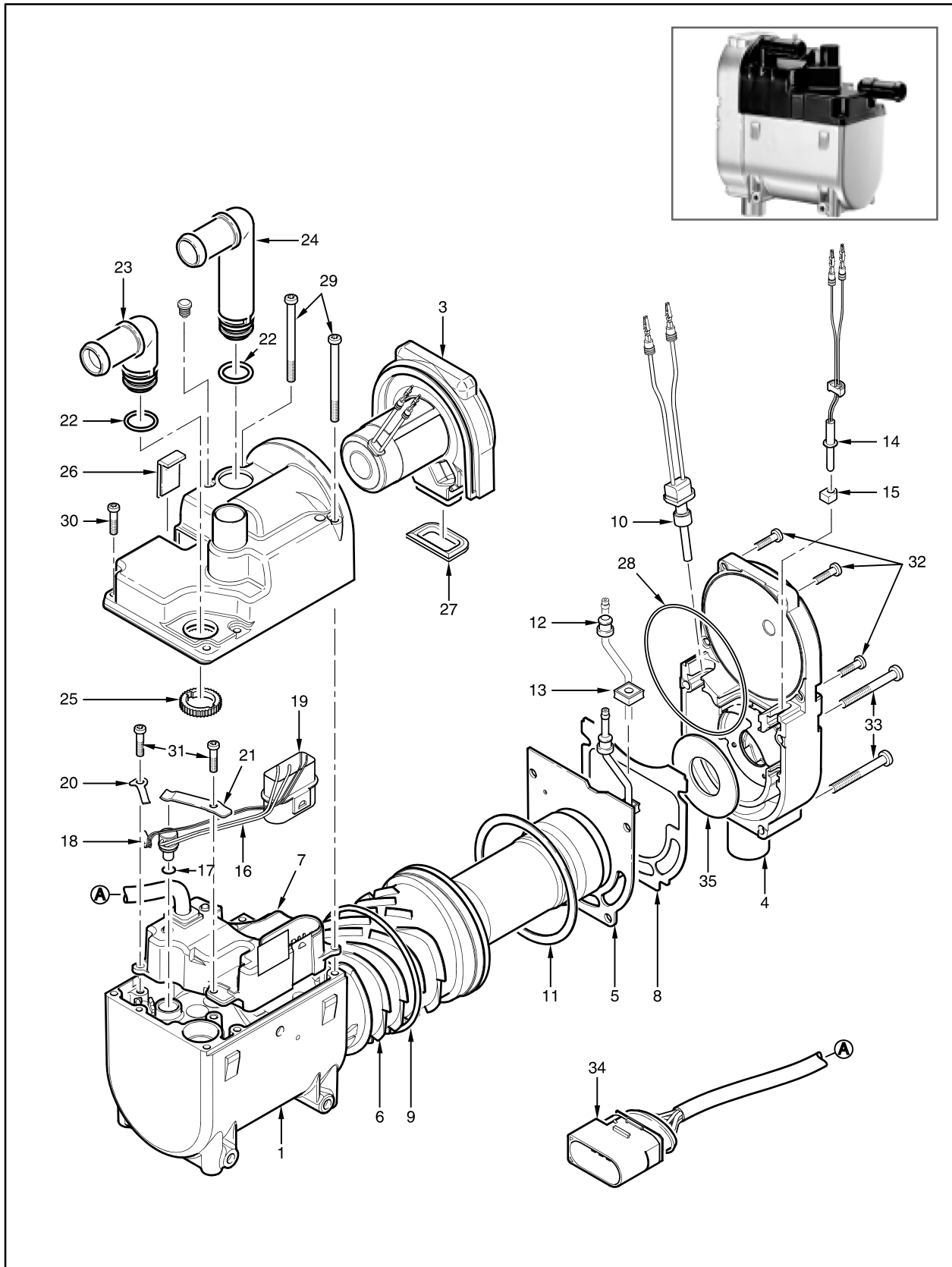


1. FFH assembly
2. Water pump and bracket assembly
3. FFH No.1 bracket assembly
4. FFH No.2 bracket assembly
5. Silencer and pipe assembly
6. Fuel pump assembly
7. Fuel pump bracket assembly

8. Temperature sensor assembly
9. Intake hose
10. Fuel pipe No.1
11. Fuel pipe No.2
12. Pump outlet hose
13. FFH inlet/outlet hose assembly

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| Modification basis | |
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► Exploded View



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| Modification basis | |
| Application basis | |
| Affected VIN | |

1. Jacket
2. Jacket cover
3. Combustion air fan
4. Combustion chamber
5. Combustion chamber with flame tube
6. Heat exchanger
7. Controller
8. Seal (between combustion chamber and combustion air fan)
9. O-ring
10. Glow plug with cable
11. Seal (between combustion chamber and heat exchanger)
12. Upper bush for fuel pipe
13. Lower bush for fuel pipe
14. Flame sensor
15. Bush for flame sensor (graphite)
16. Control and overheating sensor with cable
17. O-ring
18. Surface sensor with cable
19. Controller connector - 14-pin connector (waterproof)
20. Pressure spring for surface sensor
21. Pressure spring for control and overheating sensor
22. O-ring
23. Coolant hose (inlet)
24. Coolant hose (outlet)
25. Tooth ring (2x)
26. Cable harness cover
27. Rubber seal
28. O-ring
29. Screw (M4 x 55 TORX/2x)
30. Screw (M4 x 16 TORX/2x)
31. Screw (M4 x 12 TORX/2x)
32. Screw (M4 x 16 TORX/4x)
33. Screw (M4 x 44 TORX/4x)
34. Controller cable harness
35. Insulation washer

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4. FFH OPERATING PROCESS

FFH (Fuel Fired Heater) is operated according to the ambient temperature and coolant temperature.

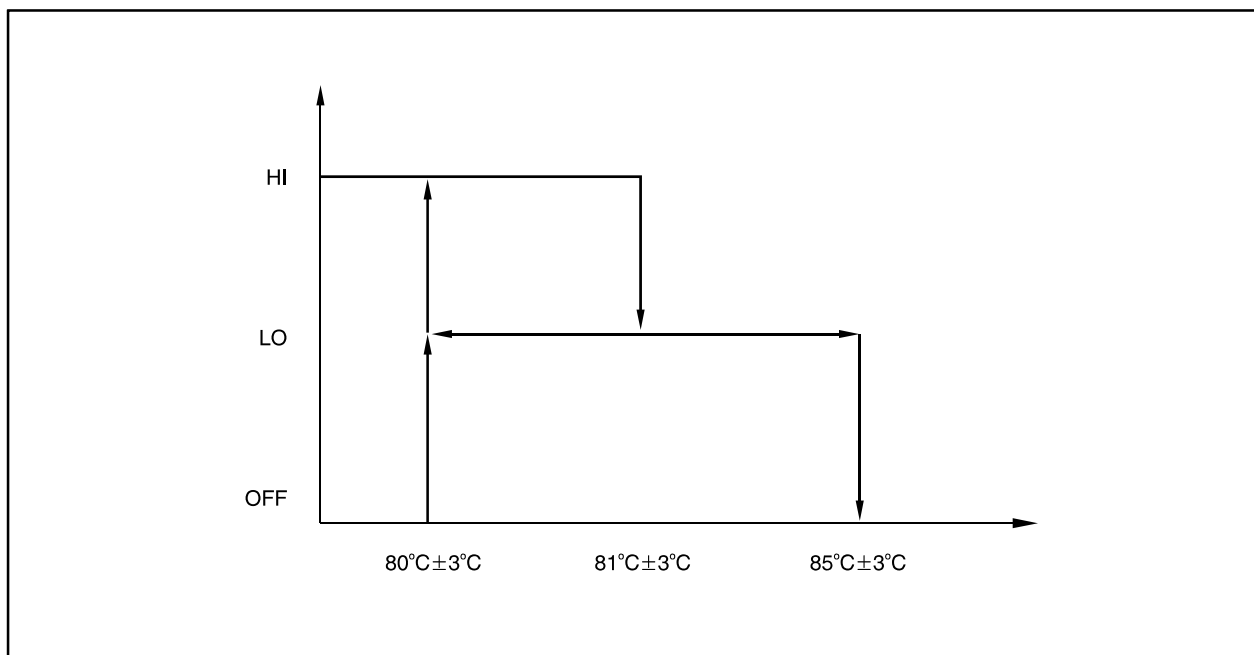
1) Initial and Repeat Operating Conditions of FFH

► **Initial** Operating Conditions of FFH:
Ambient temperature: below 5°C
Coolant temperature: below 75°C

► **Repeat** Operating Conditions of FFH:
Coolant temperature: below 75°C

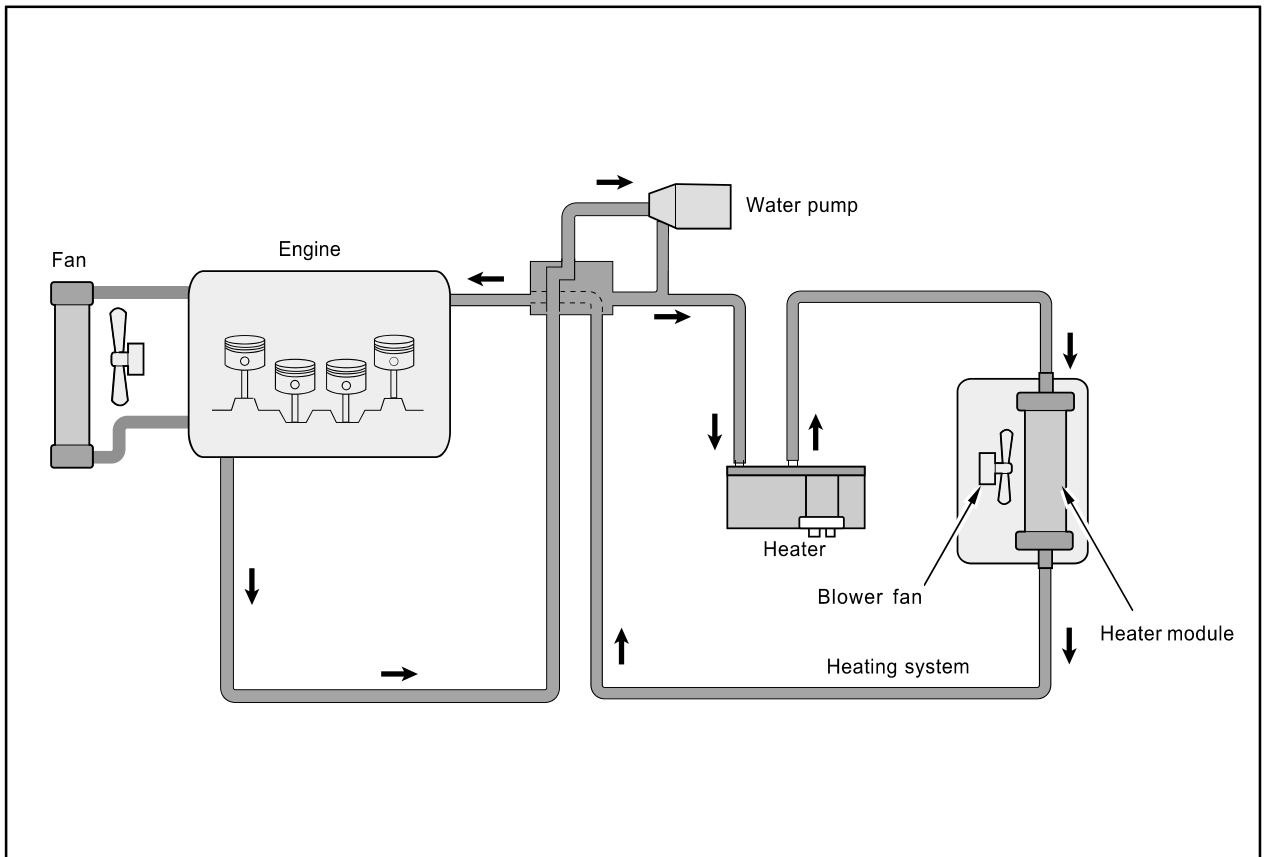
When the difference between the ambient temperature at initial operation and current ambient temperature is over 3°C (to reduce the hysteresis with the temperature difference when operating FFH), FFH is operated again. For example, if the initial operating temperature was 4°C, the ambient temperature at repeat operation should be below 1°C and the coolant temperature should be below 75°C.

2) FFH Operations According to the Changes of Coolant Temperature



Above graph shows the FFH control process while the FFH is operating. The control element is coolant as shown in the graph. The FFH is operated in HI mode (high output: approx. 5000 W) until the coolant temperature reaches at 80°C and starts to be operated in LO mode (low output: approx. 2300 W) from 81°C. When the coolant temperature reaches at approx. 85°C, FFH stops its operation until the operating conditions will be met again.

3) Coolant Circulating Route



4) Connecting the Coolant Circuit

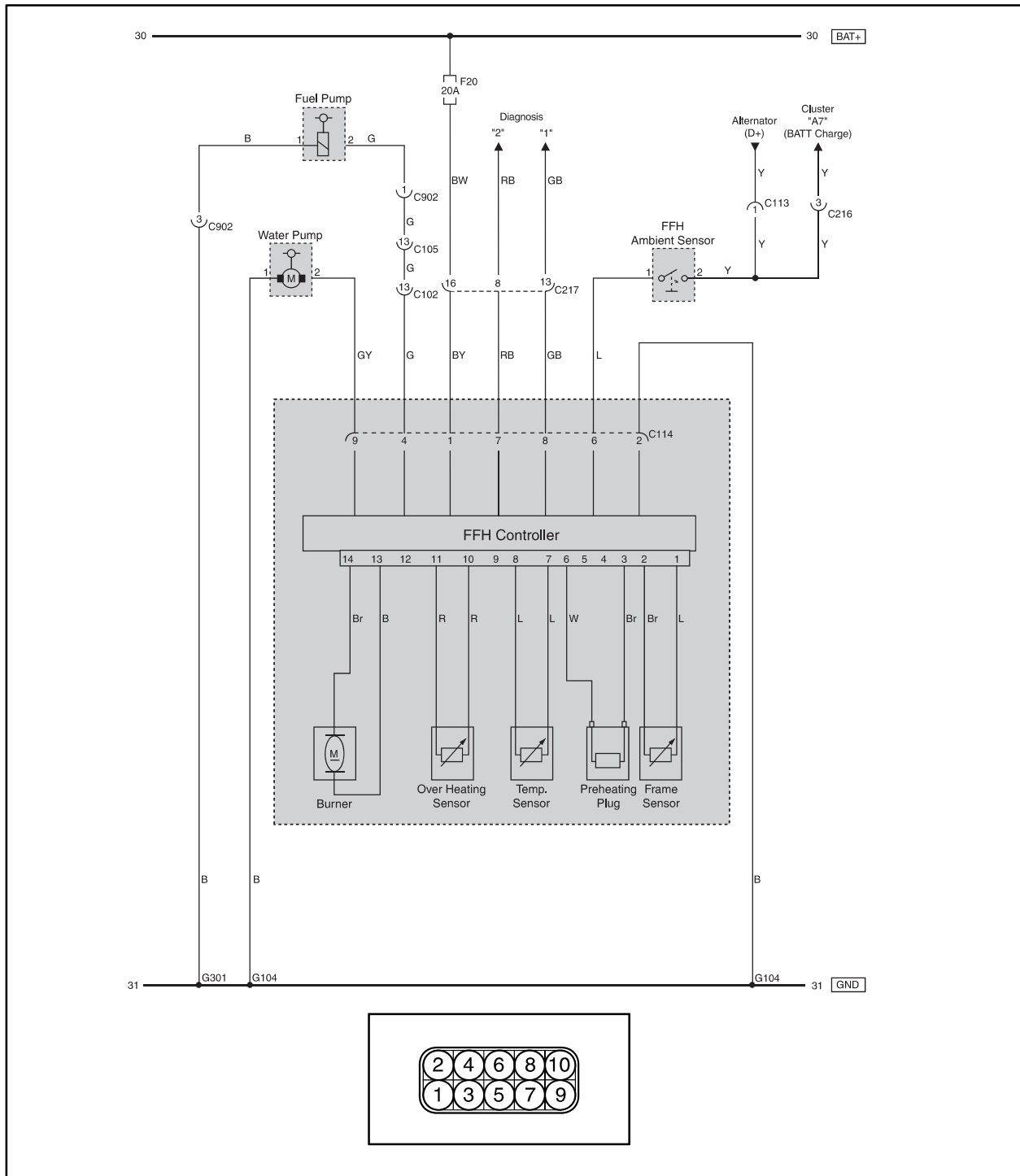
The heater is connected to the coolant circuit in the coolant feed pipe from the vehicle engine to the heat exchanger.

CAUTION

- Parts conveying coolant must be routed and fastened in such a way that they pose no temperature risk to person or material sensitive to temperature from radiation and direct contact.
- Before working on the coolant circuit, disconnect the negative battery cable and wait until all components have cooled down completely.
- When installing the heater and the water pump, note the direction of flow of the coolant circuit.
- Fill the heater and water hoses with coolant before connecting to the coolant circuit.
- When routing the coolant pipes, observe a sufficient clearance to hot vehicle parts.
- Protect all coolant hoses/coolant pipes from chafing and from extreme temperatures.
- Secure all hose connections with hose clips.

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5) Circuit Diagram



The FFH has various sensors in FFH unit, and the FFH unit is connected to the water pump, the fuel circulation pump and the ambient temperature sensor (switch) that provides important signals for the initial and repeat operations. For diagnosis, remove the FFH system connector and install the scan tool. Currently, the K-Line that is connected to the diagnostic connector is not available.

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6) Control and Safety Mode

Heater operations and safety mode

* If the fuel pump

1. If the fuel pump fails to ignite within 90 seconds after fuel pumping starts, the start procedure is repeated as described. If after a further 90 seconds fuel pumping the fuel pump still fails to ignite, the heater is switched off in fault mode. The controller is locked after a certain number of failed starts.
2. If the flame does out by itself during operation, firstly a new start is activated. If the fuel pump fails to ignite within 90 seconds after fuel pumping has started again, the heater is switched off.
3. If the heater is overheated (lack of water, poorly vented cooling circuit), the overheating sensor triggers, the fuel supply is interrupted and the heater is switched off.
4. The heater is switched off if the lower or upper voltage limit is reached.
5. The fuel pump does not start when the glow plug is defect or electrical lead to the dosing pump is interrupted.
6. The fan motor speed is monitored continuously. If the fan motor does not start up, the heater is switched off in fault mode after 120 seconds.
7. It is possible to diagnose the system by connecting the diagnostic device to controller. For details, refer to the "Diagnosis Procedures" section.

[Emergency shutdown]

If an emergency shutdown -EMERGENCY OFF- is necessary during operation, proceed as follows;

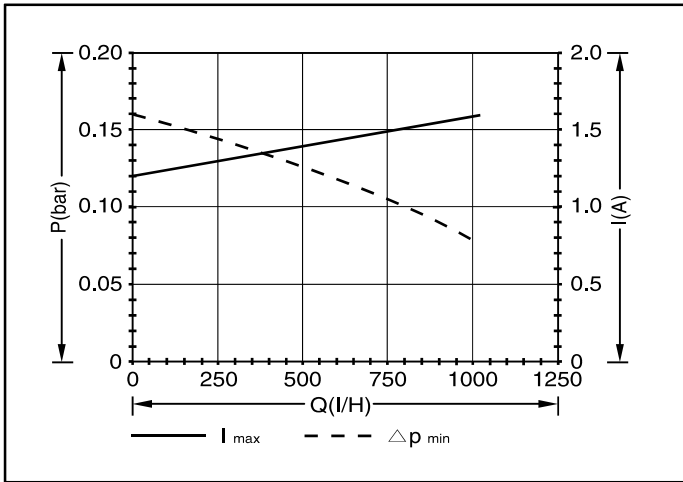
- Pull the fuse (Ef23: 20A) out.
- Disconnect the heater from the battery.

► Technical Data – Water Pump

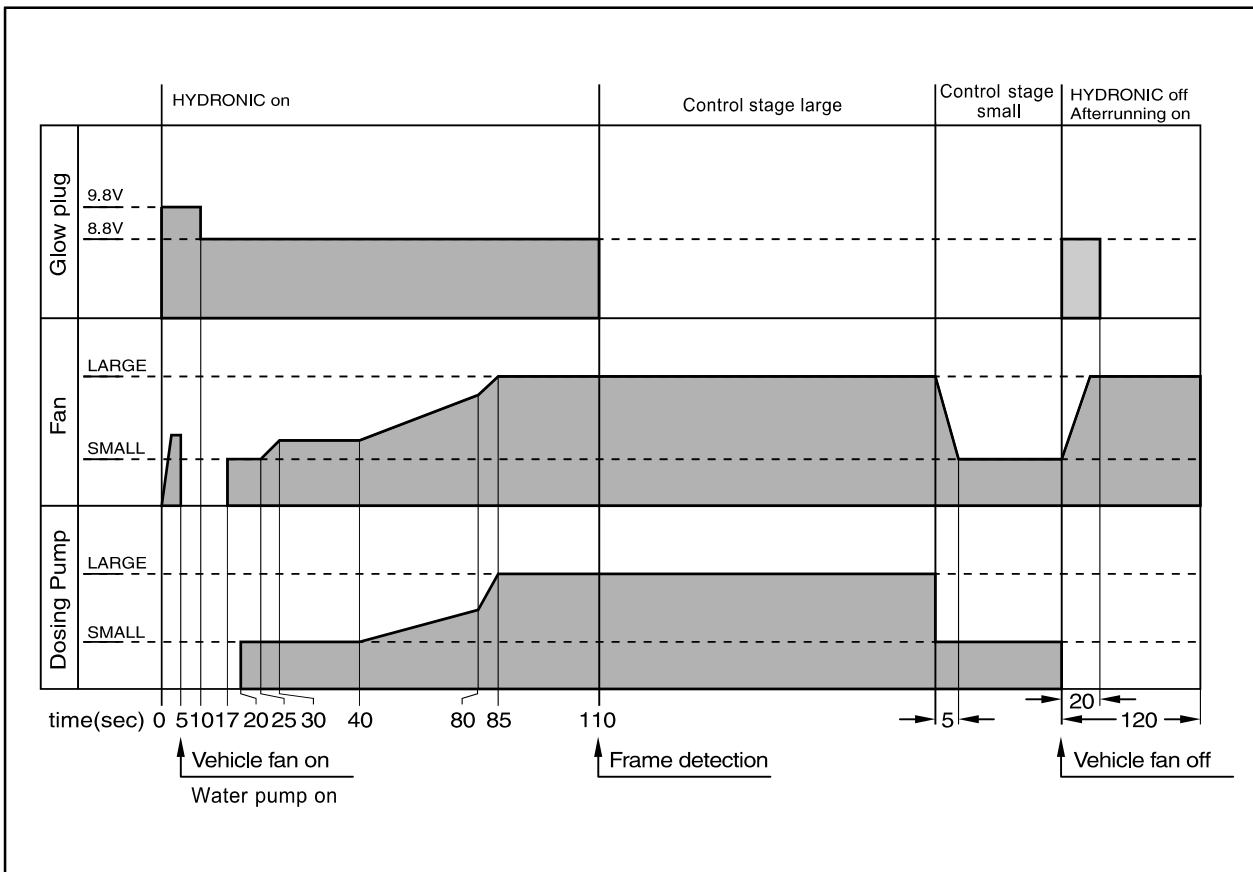
| | |
|----------------------------|-----------------|
| Rated voltage | 12 V |
| Operating voltage | 9 V ~ 15 V |
| Power consumption | 16 W |
| Pumping capacity (0.1 bar) | 800 l/h |
| Operating temperature | -40 °C ~ 135 °C |
| Weight | 0.28 kg |

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7) Characteristic Curve of Water Pump (12 V)

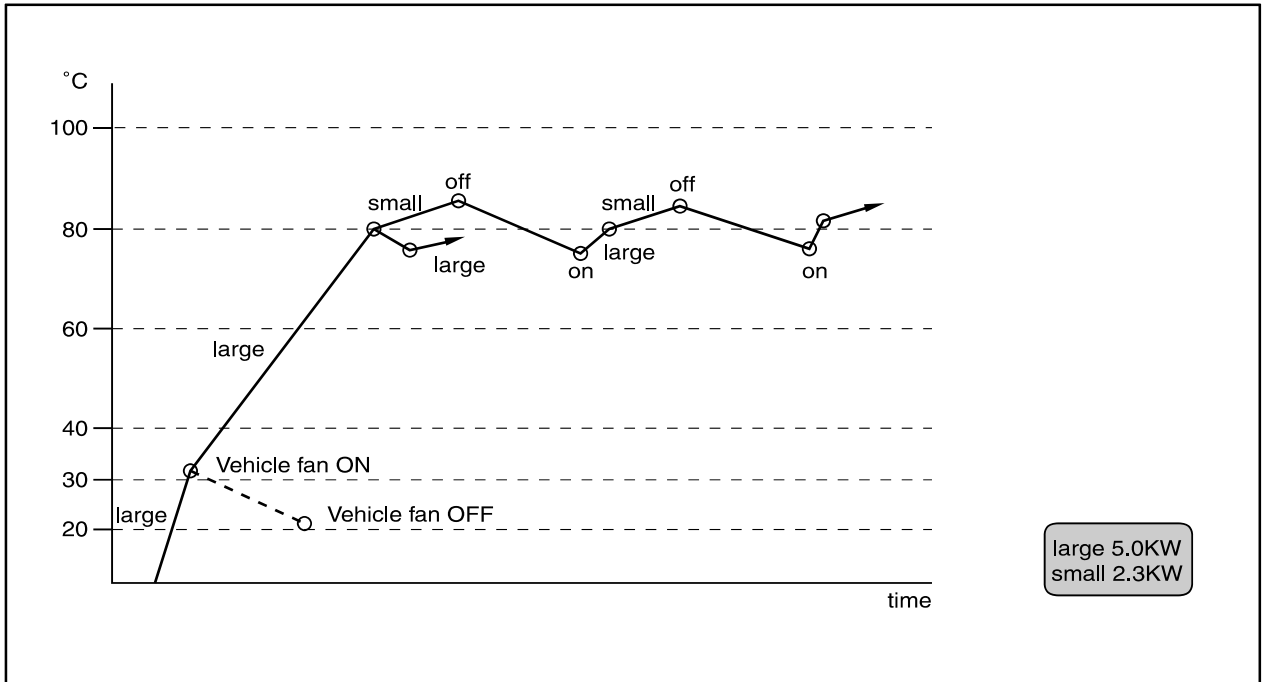


8) Function Diagram



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| Modification basis | |
| Application basis | |
| Affected VIN | |

9) Sectional Drawing according to the Temperatures



- AIR CONDITIO
- FULL AUTO
- FFH SYSTEM
- PTC SYSTEM
- AIR BAG AND
- SEAT
- SUN ROOF
- BODY INTERIOR
- BODY EXTERIO
- BODY REPAIR

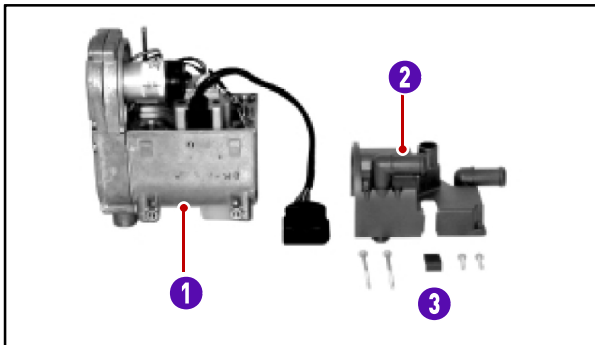
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5. COMPONENTS AND COMPOSITIONS

CAUTION

There is no need to disassemble the FFH unit for repair. This section is to show the internal components of the FFH unit.

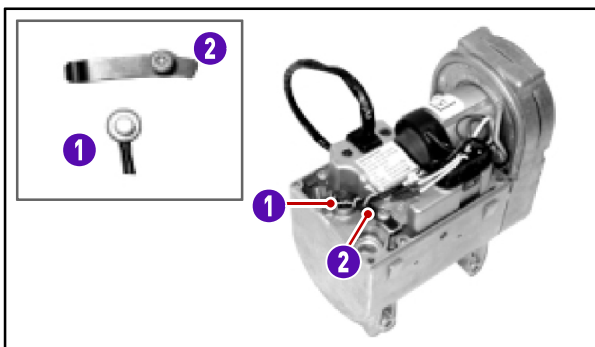
1) Jacket cover



- The O-rings are installed between jacket
 - cover and two coolant hoses.
- The coolant hoses should be connected to right side.

1. Jacket
2. Jacket cover
3. Cable harness cover

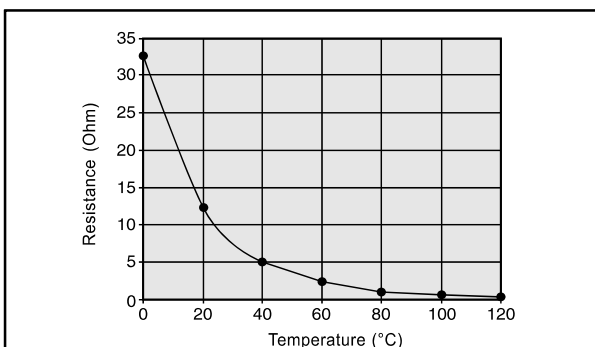
2) Control and overheating Sensor



The Control and overheating sensor and cable harness make up one component.

1. Control and overheating sensor
2. Pressure spring

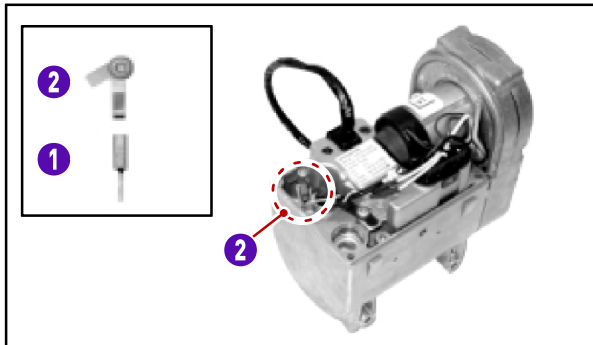
► Check control and overheating sensor



Check the control and overheating sensor with a digital multimeter. If the resistance according to the changes of flame sensor temperature is out of specified values, the flame sensor is defective.

| Temperature [°C] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
|------------------|-------|-------|-------|------|------|-------|-------|-------|------|-------|-------|-------|-------|
| Resistance [Ω] | 32.54 | 19.87 | 12.48 | 8.06 | 5.33 | 3.60 | 2.48 | 1.75 | 1.25 | 0.91 | 0.67 | 0.50 | 0.38 |
| | ±2.2 | ±1.0 | ±0.5 | ±0.4 | ±0.3 | ±0.25 | ±0.17 | ±0.13 | ±0.1 | ±0.08 | ±0.06 | ±0.05 | ±0.04 |

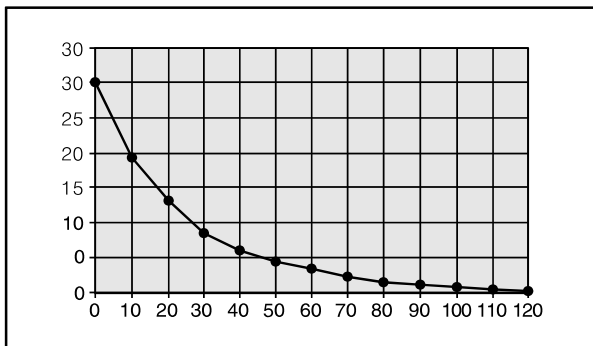
3) Surface sensor



The surface sensor and cable harness make up one component.

1. Surface sensor
2. Pressure spring

► Check surface sensor

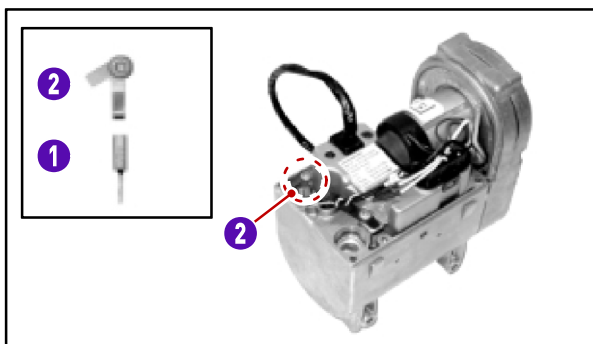


Check the surface sensor with a digital multimeter. If the resistance of flame sensor is out of specified values, the flame sensor is defective.

► Specified value

| Temperature [°C] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
|------------------|-------|-------|-------|------|------|------|-------|------|-------|------|-------|------|-------|
| Resistance [Ω] | 30.00 | 19.53 | 13.03 | 8.90 | 6.20 | 4.41 | 3.19 | 2.34 | 1.75 | 1.32 | 1.02 | 0.79 | 0.62 |
| | ±0.13 | ±1.6 | ±1.89 | ±2.2 | ±2.4 | ±2.9 | ±3.19 | ±3.6 | ±3.92 | ±4.4 | ±4.78 | ±5.3 | ±5.70 |

4) Controller

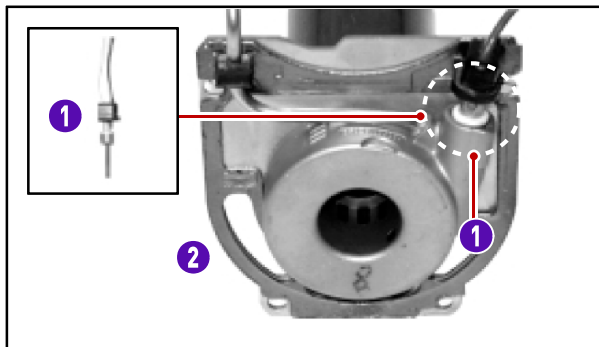


The surface heater and cable harness make up one component.

1. Controller
2. Jacket
3. Combustion chamber housing
4. Screw

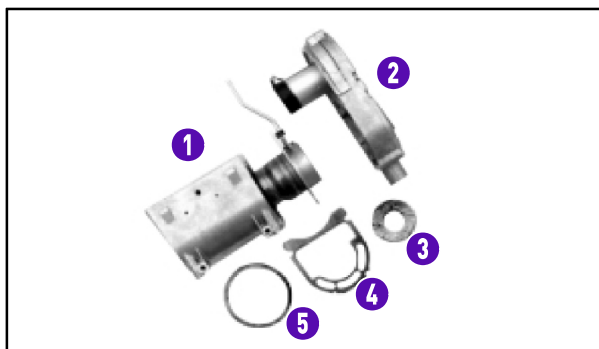
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| Modification basis | |
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5) Glow plug



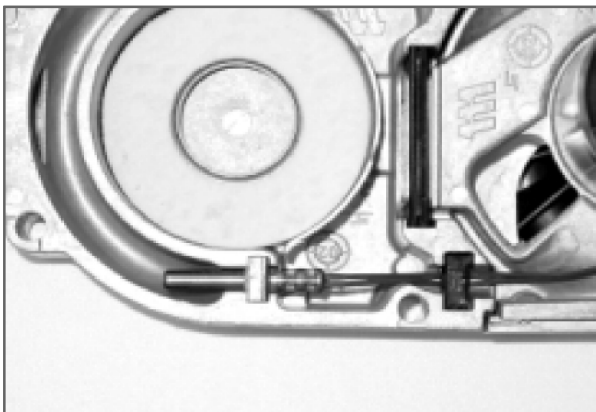
1. Glow plug
2. Combustion chamber with flame pipe

6) Combustion chamber housing



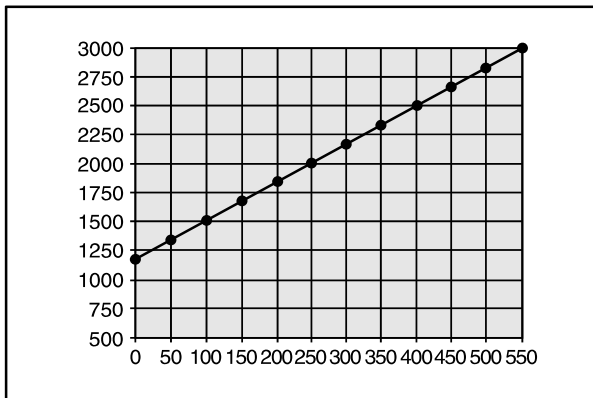
1. Jacket
2. Combustion chamber
3. Combustion chamber housing
4. Insulation washer
5. Seal -
combustion chamber / combustion air fan
6. Seal -
combustion chamber / heat exchanger

7) Flame sensor



1. Flame sensor
2. Graphite bush
3. Bush

► Check flame sensor

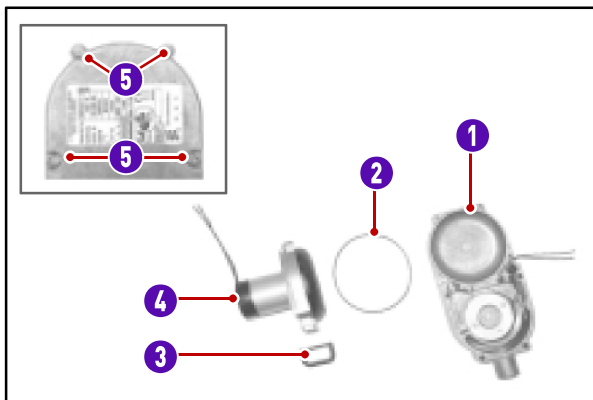


Check the surface sensor with a digital multimeter. If the resistance of flame sensor is out of specified values, the flame sensor is defective.

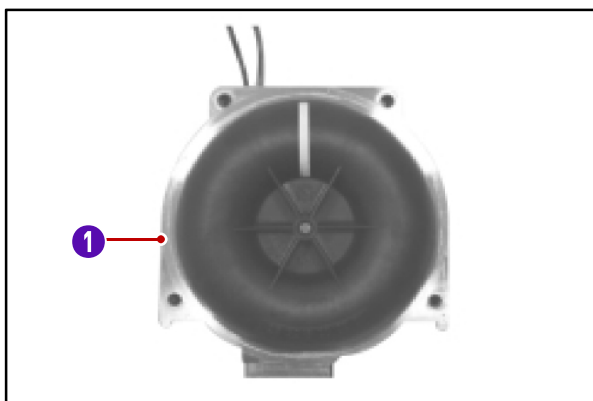
► Specified value

| Temperature [°C] | 0 | 10 | 20 | 30 | 50 | 80 | 90 | 100 | 130 | 150 | 200 | 250 | 300 | 350 | 400 |
|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Resistance [Ω] | 1000 | 1022 | 1062 | 1097 | 1194 | 1309 | 1347 | 1385 | 1498 | 1573 | 1758 | 1941 | 2120 | 2297 | 2470 |
| | ±10 | ±10 | ±11 | ±11 | ±12 | ±13 | ±14 | ±15 | ±17 | ±20 | ±24 | ±28 | ±32 | ±36 | ±40 |

8) Combustion air fan

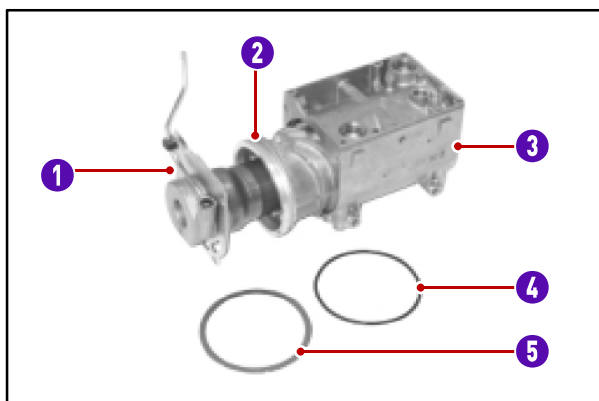


1. Combustion chamber
2. O-ring
3. Rubber seal
4. Combustion air fan



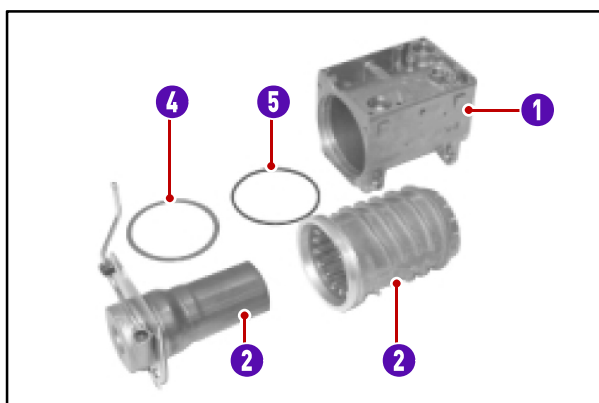
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| Modification basis | |
| Application basis | |
| Affected VIN | |

9) Combustion chamber



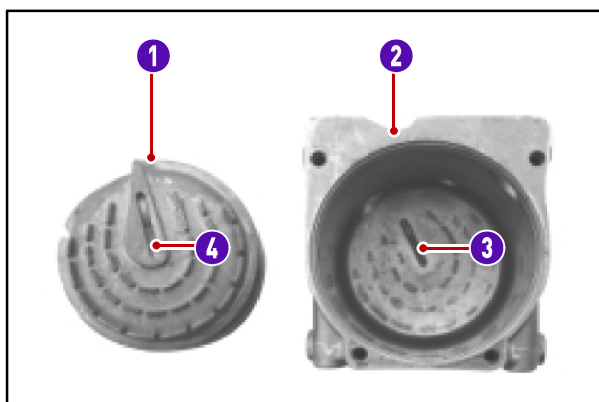
1. Combustion chamber
2. Heat exchanger
3. Jacket
4. O-ring
5. Seal - combustion chamber / heat exchanger

10) Heat exchanger



1. Jacket
2. Heat exchanger
3. Combustion chamber with flame tube
4. Seal - combustion chamber / heat exchanger
5. O-ring (for heat exchanger)

11) Heat exchanger



1. Heat exchanger
2. Jacket
3. Stopper
4. Groove (bottom of heat exchanger)