

INTRODUCTION

The E.G.R. system is used on engines to reduce nitrogen oxide (NOx) emissions.

The mass of recirculated gases basically comprises air, which has been part of the combustion process and combustion products (carbon dioxide, water vapour, etc.).

These last two types of chemicals have a greater thermal capacity than the air they replace and therefore the average thermal capacity of the charge will be higher.

With the development of rules concerning harmful emissions, E.G.R. technology has undergone a notable development: there has been a move from the simple on-off valve to the gas modulating valve and then the introduction of the heat exchanger to lower the temperature of the recirculated gases.

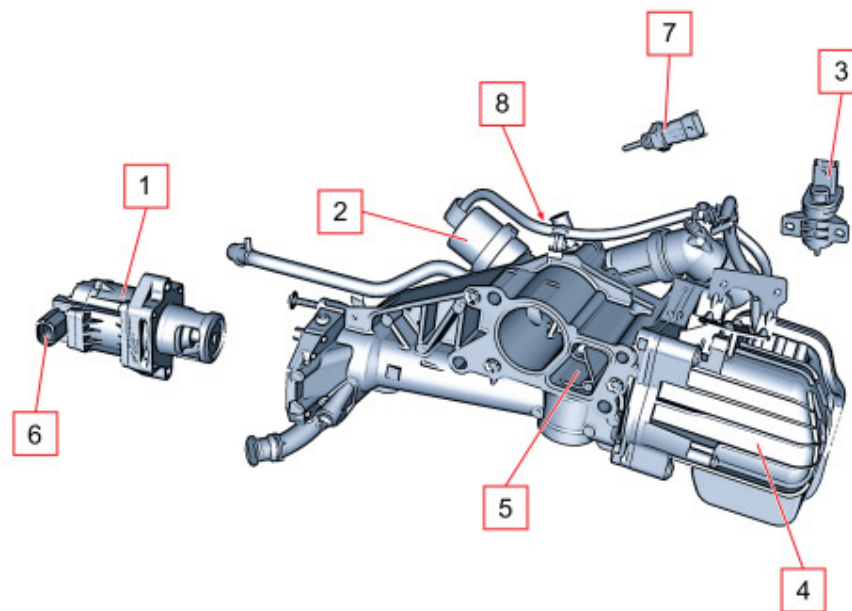
The use of a heat exchanger has been necessary because the recirculated gases, finding themselves at a higher temperature than the intake air, increase the temperature of the charge entering the combustion chamber and decreasing volumetric efficiency.

Directing the exhaust gases into a heat exchanger lowers the temperature thereby allowing a greater flow rate and a lower charge temperature with obvious benefits in terms of restricting NOx emissions.

E.G.R. MODULE

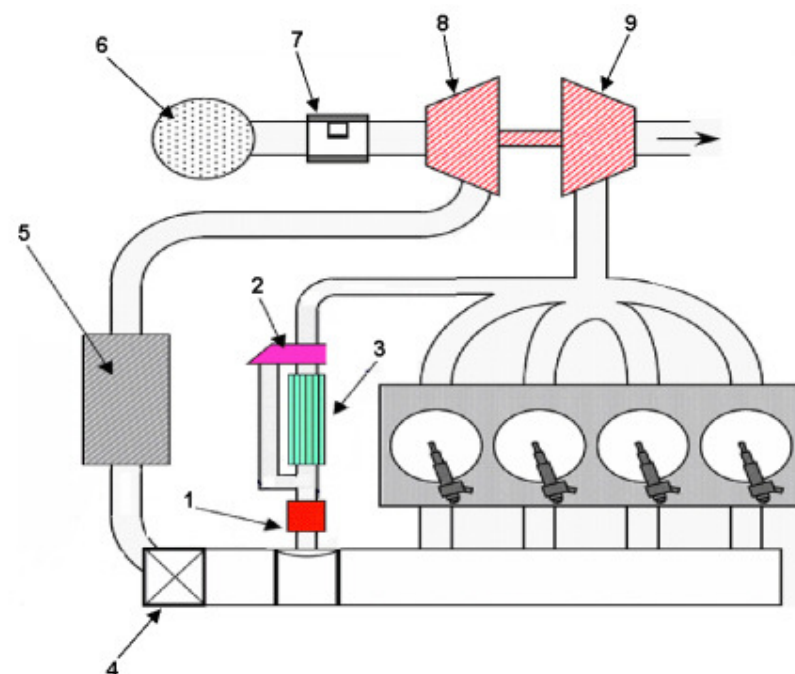
The new E.G.R. module fitted on this engine, in addition to having a new modulating valve, makes it possible to choose whether to cool the exhaust gases or exclude the cooling process by means of a by-pass.

This operation, managed entirely by the engine management control unit, makes it possible to ensure optimum operation of the E.G.R. in terms of nitrogen oxide reduction without adversely affecting hydrocarbon (HC) and carbon monoxide (CO) emissions.



1. EGR valve
2. E.G.R. by-pass actuator
3. E.G.R. by-pass actuator solenoid valve
4. E.G.R. heat exchanger
5. E.G.R. by-pass valve
6. E.G.R. valve position sensor
7. Engine coolant temperature sensor
8. Thermostat

Diagram showing e.g.r. system on engine



1. EGR valve
2. E.G.R. by-pass valve
3. E.G.R. heat exchanger
4. Throttle body

- 5. Intercooler
- 6. Air filter
- 7. Flow meter
- 8. Compressor
- 9. Turbine

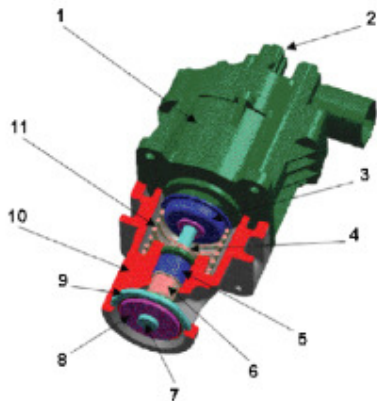
Components

The E.G.R. system consists of:

- E.G.R. modulating valve
- E.G.R. heat exchanger
- E.G.R. by-pass actuator
- E.G.R. by-pass actuator solenoid valve

E.G.R. MODULATING VALVE

The modulating valve used on this engine is based on a new operating principle where the movement of the plate is activated by a direct current motor and a dedicated sensor detects the position.



- 1. Direct current motor
- 2. Valve position sensor
- 3. Spring sealing plug
- 4. Seal system
- 5. Sliding guide
- 6. Filter seal
- 7. Valve stem
- 8. Valve
- 9. Valve bore
- 10. Valve body
- 11. Return spring

The new valve offers the following advantages:

- greater activation force, therefore less sensitivity to locking
- single plate with less sensitivity to seepage
- presence of a plate position sensor which allows improved control and diagnosis of operation
- less dispersion of performance with consequent calibration consolidation.

E.G.R. system operating strategies

The control of the air intake mass and consequently the quantity of exhaust gases recirculated is determined by a theoretical map dependent on the engine speed and torque; later on the value is corrected taking into account ambient pressure, intake air temperature and engine temperature.

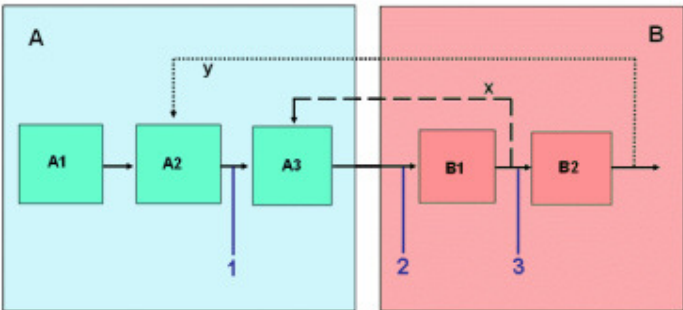
The quantity of gas to be recirculated is determined by the engine management control unit in two stages:

- closed loop check between intake air and target air;
- closed loop check between electrical control and effective movement of E.G.R. valve stem

During the first stage the flow rate measured by the flow meter is subtracted from the target air flow rate. The percentage opening of the E.G.R. valve required for implementing the desired gas flow rate is determined through a map in the engine management control unit.

During the second stage a further map is used to transform the required position into the actual activation command depending on the engine speed and also the effective battery voltage.

The E.G.R. system control logic is illustrated in the diagram below.



- A. Engine management control unit
- B. Components on the engine
- A1. Target air flow rate
- A2. Air control
- A3. E.G.R. valve control
- B1. EGR valve
- B2. Engine
- 1. E.G.R. valve opening percentage request
- 2. E.G.R. valve electrical control
- 3. E.G.R. valve measured mechanical opening
- X. E.G.R. valve opening signal

Y. Air flow rate signal from flow meter

The air mass value determined until now corresponds to the target quantity of air to be introduced.

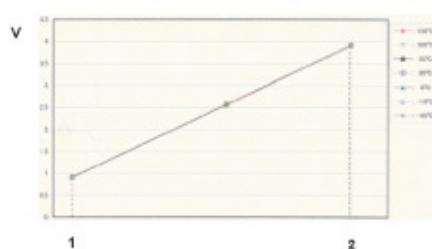
The control of the E.G.R. includes the limitation strategies and can be disabled or restricted when:

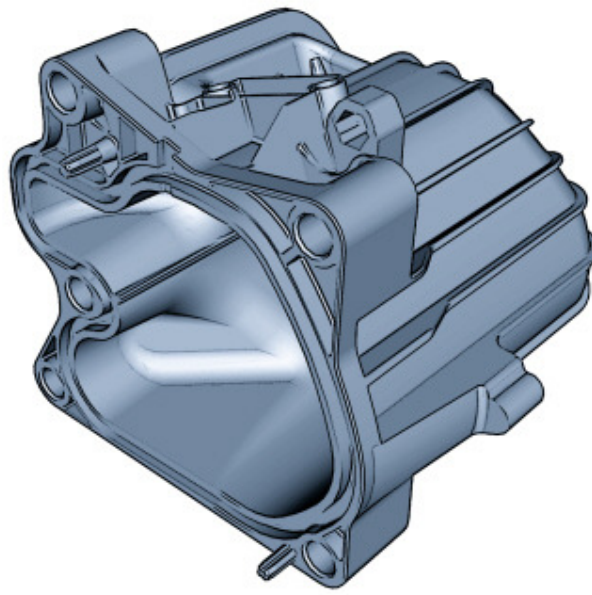
- prolonged stationary period whilst idling: after a calibration period if the E.G.R. remains active there may be problems maintaining the set speed;
- starting the engine when cold: the air/fuel mixture is enriched during starting which makes the use of the E.G.R. system harmful;
- high quantities of fuel injected: the E.G.R. is only applied for low loads with corresponding modest quantities injected. Beyond a certain injection value the E.G.R. system should be deactivated;
- in cranking;
- corresponding to a request for greater torque than the predefined level;
- in cut-off;
- engine temperature too low or too high;
- intake air pressure too low;
- battery voltage too low;
- with fault diagnosis activated at flow meter or at E.G.R. valve;
- engine warming up.

VALVE POSITION SENSOR

This sensor detects the actual position of the valve plate, providing voltage information of between 0.5 and 4.5 V.

Sensor with supply voltage of 5V





Technical specifications

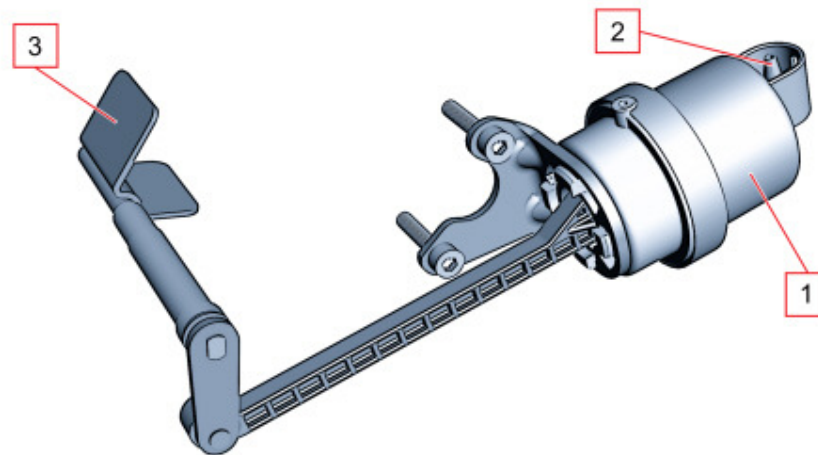
- Maximum temperature of inlet exhaust gas = 350 °C
- Maximum temperature of outlet exhaust gas = 200 °C

E.G.R. COOLING BY-PASS ACTUATOR

The actuator is the pneumatic type and works with the vacuum from the reservoir incorporated in the E.G.R. heat exchanger

There are only two positions for the actuator: in the rest position the recirculated gases pass through the heat exchanger, when the by-pass is activated the deflector directs the gases, via a duct that is not cooled, directly to the E.G.R module outlet.

The engine management control unit controls the by-pass position by means of a pneumatic ON-OFF solenoid valve.



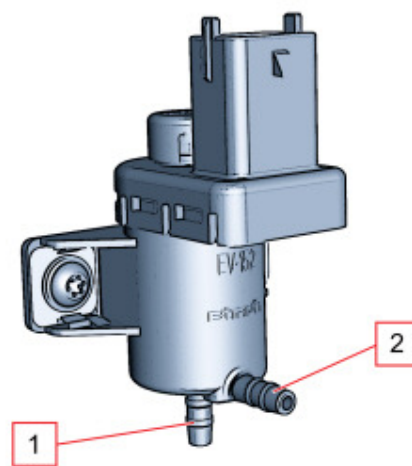
1. Pneumatic actuator
2. Connector for actuator vacuum pipe
3. Deflector

E.G.R. BY-PASS ACTUATOR SOLENOID VALVE

This is an electropneumatic switch that allows the movement of the by-pass actuator to be controlled.

The solenoid valve is controlled by the engine management control unit by an ON-OFF control.

When it is supplied the vacuum reaches the actuator, whilst if there is no supply the ambient pressure acts on the actuator and it is in the rest position.



1. Connector for connection to vacuum reservoir
2. Connector for connection with by-pass actuator