

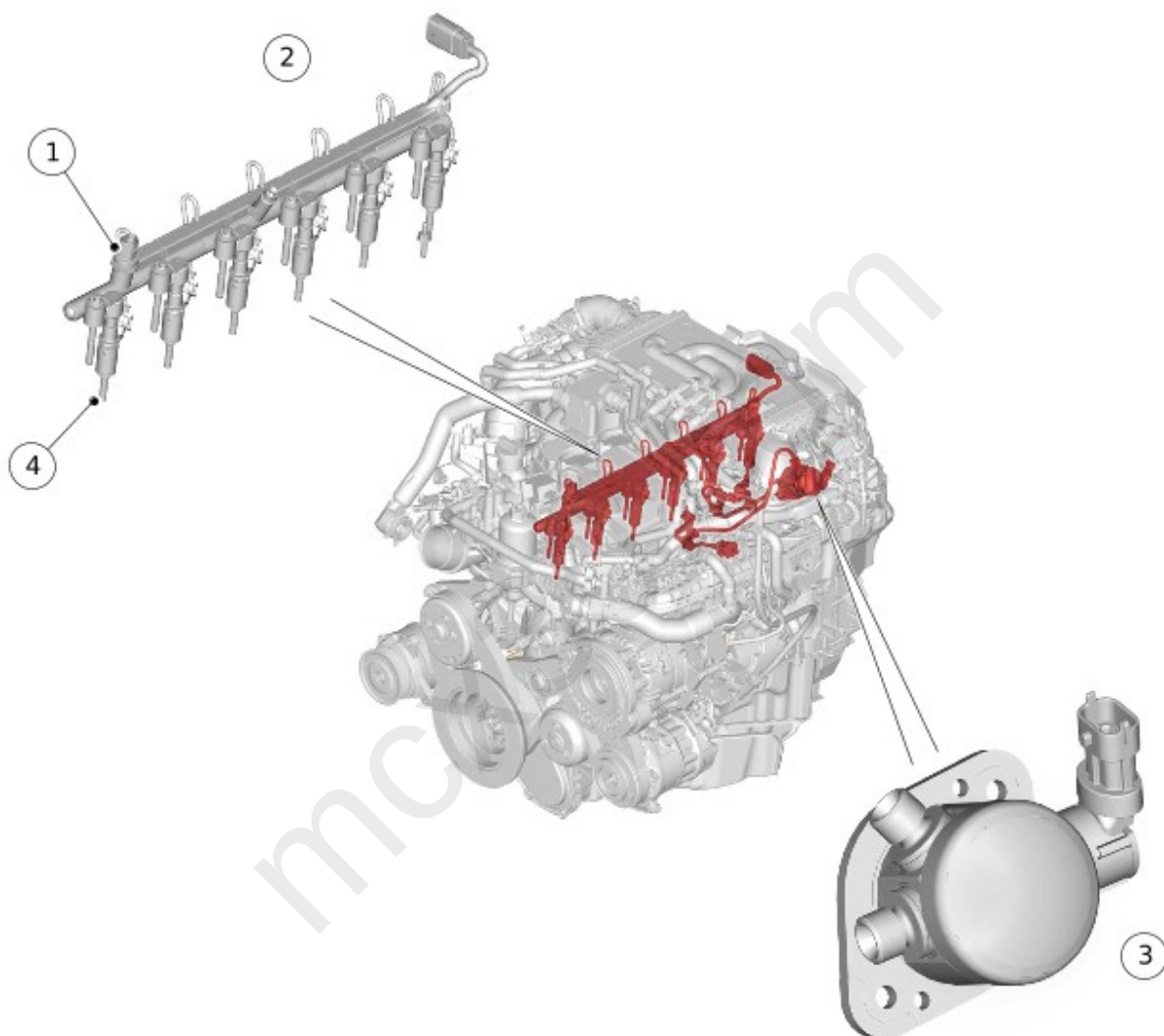
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FUEL CHARGING AND CONTROLS - INGENIUM I6 3.0 L PETROL (G2341935)

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COMPONENT LOCATION



E242847

ITEM	DESCRIPTION
1	Fuel Rail Pressure and Temperature (FRPT) sensor
2	Fuel rail
3	High Pressure (HP) fuel pump

ITEM	DESCRIPTION
4	Fuel injector (quantity 6)

OVERVIEW

The Ingenium I6 3.0L Petrol engine is equipped with a HP Direct Injection (DI) system, controlled by the Powertrain Control Module (PCM). A HP fuel pump delivers a uniform level of pressure to the shared fuel rail, which serves all 6 fuel injectors. Pressure is controllable, to the optimum level for smooth operation, up to 250 bar (3,626 psi). Low Pressure (LP) fuel from the fuel pump in the fuel tank is pressurized by the HP fuel pump and supplied to the fuel injectors through the fuel rail. The PCM controls the fuel injectors and HP fuel pump to inject the required volume of fuel into the combustion chambers.

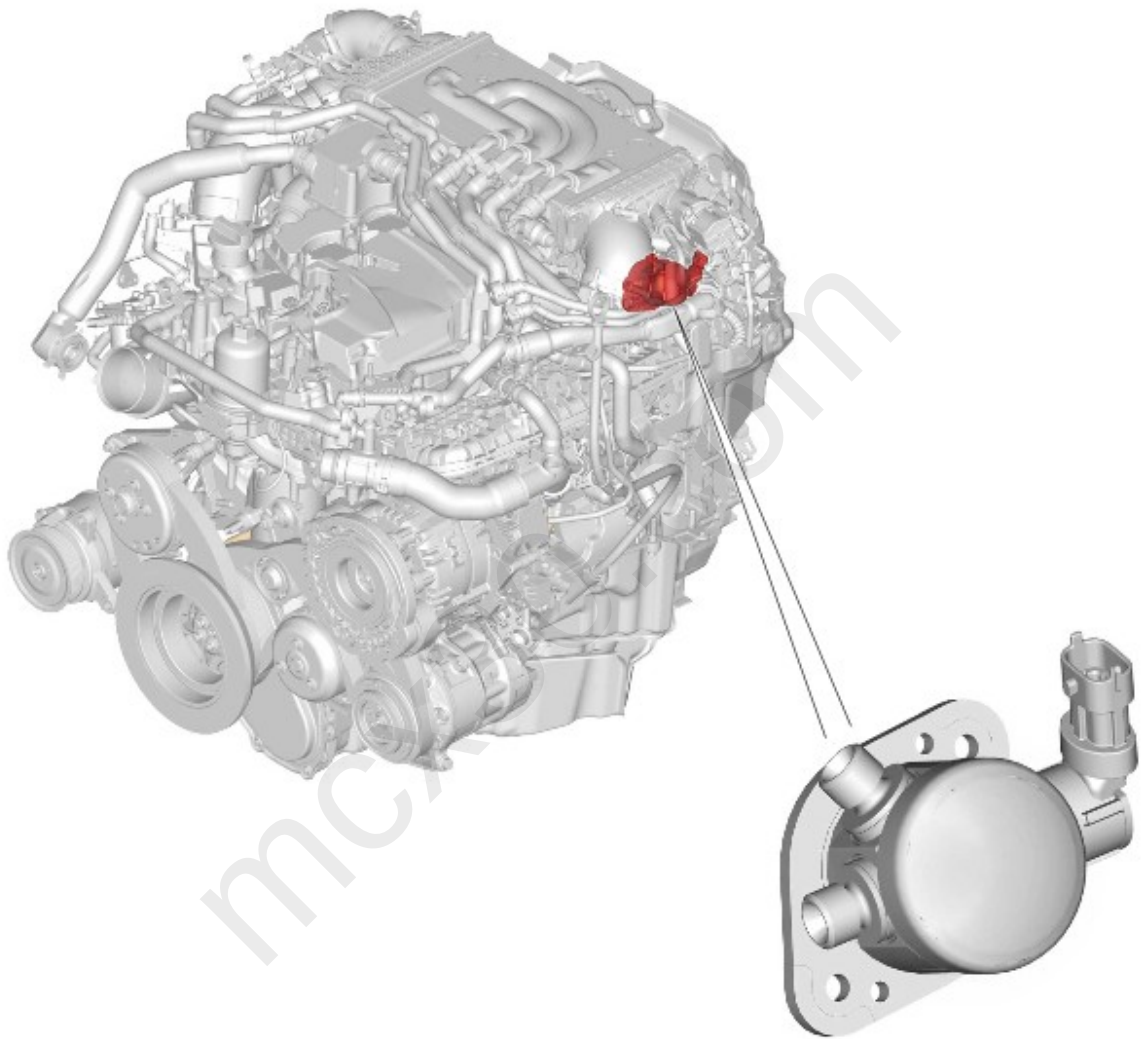
The fuel charging and controls system consists of the following components:

- LP and HP fuel lines
- HP fuel pump
- Fuel rail
- FRPT sensor
- The 6 fuel injectors.

The LP fuel system is covered in the Fuel Tank and Lines section.

For additional information, refer to: [Fuel Tank and Lines](#) (310-01B Fuel Tank and Lines - INGENIUM I6 3.0L Petrol, Description and Operation).

HIGH PRESSURE FUEL PUMP



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The HP fuel pump is located on the top left of the engine. The HP fuel pump is attached to the camshaft carrier with 2 bolts and sealed with an O-ring seal.

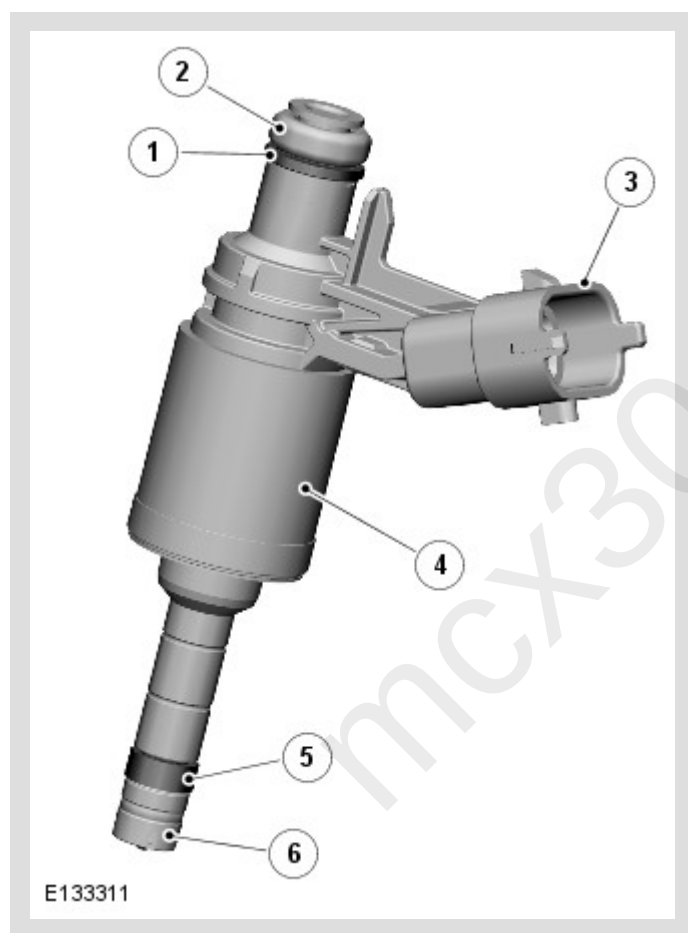
The HP fuel pump is a single cylinder pump which meters the fuel pressure according to demand requirements for correct fuel injection. The delivery rate of the fuel pump is adjustable by means of a fuel metering valve which is controlled by the PCM with a Pulse Width Modulated (PWM) signal.

The HP fuel pump is mechanically driven by the intake camshaft through a tappet. The tappet is operated by a 3 lobe cam on the intake camshaft. A spring installed on the outside of the plunger holds tight the plunger and the tappet

remains in contact with the camshaft. During the downward stroke of the pump piston, fuel is delivered to the cylinder at a pressure supplied by the fuel tank mounted LP fuel pump. On the upward stroke of the piston the fuel in the cylinder is compressed. If the pressure from the pump exceeds the pressure in the fuel rail the fuel is delivered into the fuel rail through a single HP fuel line.

The cylinder and low pressure fuel supply are connected through the fuel metering valve. If the fuel pressure in the fuel rail is sufficient, the PCM opens the fuel metering valve during the compression stroke of the piston. The fuel is then directed from the cylinder back into the low pressure supply to decrease the pressure in the fuel rail. A check valve is located between the fuel rail and the HP fuel pump. This prevents pressure dropping in the fuel rail due to fuel metering valve operation. The delivered fuel quantity depends on the engine speed and the actuation of the fuel metering valve.

FUEL INJECTORS



ITEM	DESCRIPTION
1	Support disc
2	O-ring seal
3	Electrical connector
4	Injector solenoid
5	Combustion seal ring
6	Injector nozzle

The 6 HP fuel injectors spray fuel from the fuel rail directly into the combustion chambers. The fuel injectors are installed close to the center of the combustion chambers, between the intake valves and next to the spark plug. On each fuel injector, an O-ring seal and support disc seals the head of the fuel injector in the fuel rail. A Teflon combustion seal ring seals the nozzle of the fuel injector in the cylinder head.

Each fuel injector contains a solenoid-operated needle valve, which opens when the solenoid winding is energized. While the needle valve is open, fuel is sprayed into the combustion chamber. There are 6 holes around the tip of the nozzle through which the fuel is sprayed. From the 6 holes 2 holes directs fuel below the spark plug. The other 4 holes direct fuel evenly around the remainder of the combustion chamber.

The solenoid winding is connected to a power feed and a ground from the PCM, which operates the fuel injectors with a 2 stage power supply. Initially the PCM supplies the fuel injectors with 65V, then when the boost current reaches 11.5A the power supply is switched to startup battery voltage. When the fuel injector is opened, the PCM controls the current flow at approximately 3.1A. The PCM meters the amount of fuel injected into the combustion chambers by adjusting the time that the solenoid winding is energized.

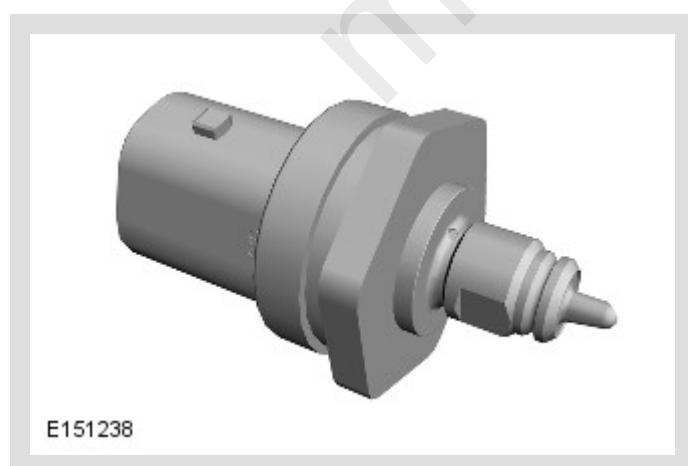
If a fuel injector fails, the engine will suffer from unstable idle speed, poor Noise, Vibration and Harshness (NVH) and poor emissions performance. The Malfunction Indicator Lamp (MIL) in the Instrument Cluster (IC) will also be illuminated.

FUEL RAIL

The fuel rail is located on the top of the engine and it is attached to the cylinder head with 6 bolts. The fuel rail also secures the 6 fuel injectors in position. An O-ring seal on each injector locates in a bore in the fuel rail. As the fuel rail is tightened to the cylinder head the fuel injectors are retained between the fuel rail and the cylinder head.

The fuel rail incorporates a threaded boss for connection of the HP fuel line.

FUEL RAIL PRESSURE AND TEMPERATURE SENSOR



The FRPT sensor is located at the top of the fuel rail. The FRPT sensor is screwed into a threaded port and sealed with a mating taper in the fuel rail. The sensor is connected directly to the PCM.

The FRPT sensor is a metal thin film technology type sensor. The sensor is connected with 4 wires to the PCM. The PCM supplies a 5V reference voltage to the sensor. The pressure measurement is based on the expansion of a thin

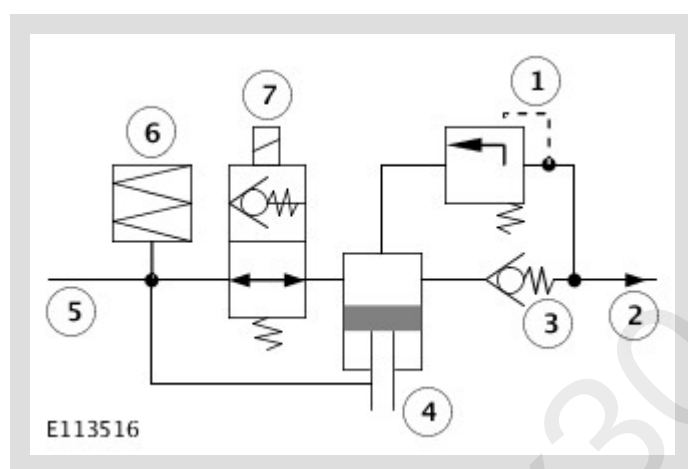
steel diaphragm which is sensed by the PCM on a return signal wire which is proportional to the fuel pressure in the fuel rail.

The PCM compares the sensor signal voltage to stored memory values, to calculate the actual fuel pressure present in the fuel rail. The PCM then uses the fuel rail pressure information to control the operating position of the fuel metering valve.

The FRPT sensor contains a Negative Temperature Coefficient (NTC) sensor which allows the PCM to determine the fuel temperature.

OPERATION

HIGH PRESSURE FUEL PUMP



ITEM	DESCRIPTION
1	Pressure Relief Valve (PRV)
2	HP fuel line connection
3	Check valve
4	Pump plunger
5	LP fuel line connection
6	Damper chamber
7	Fuel metering valve

In addition to the plunger, the HP fuel pump contains:

- A damper chamber
- A fuel metering valve
- A check valve

- A Pressure Relief Valve (PRV).

The damper absorbs pressure pulses from the LP fuel system. The fuel metering valve regulates the output pressure from the HP fuel pump. The fuel metering valve is a normally open solenoid valve controlled by the PCM with a PWM signal. During the inlet stroke of the plunger the fuel metering valve is de-energized, and fuel flows into the pumping chamber. The PCM energizes the fuel metering valve closed during the delivery stroke of the plunger. The pressurized fuel in the pumping chamber flows through the check valve into the fuel rail through the HP fuel line.

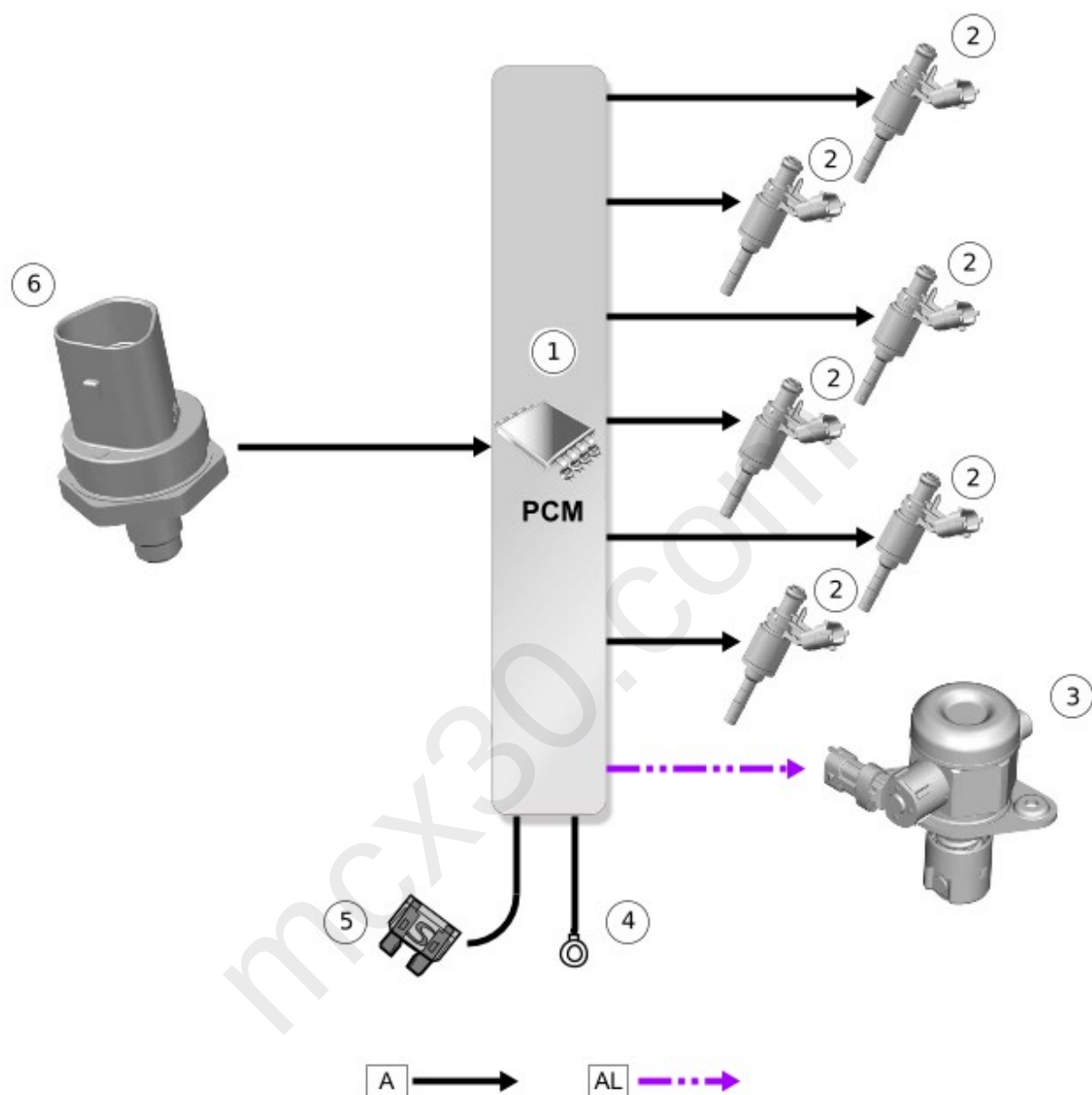
By changing the closing point of the fuel metering valve, the PCM can determine the volume of fuel output during the delivery stroke, and thus the fuel pressure in the fuel rail. The check valve prevents the return of HP fuel to the pumping chamber during the inlet stroke of the plunger.

The Pressure Relief Valve (PRV) protects the HP side of the system from excessive pressure if there is a failure of the fuel metering valve. If the HP fuel pump delivery pressure increases to 298 bar (4,322 psi), the PRV opens and returns fuel to the inlet side of the plunger.

The PCM controls the output from the HP fuel pump to deliver the required volume of fuel at pressures up to 250 bar (3,626 psi).

The PCM compares the fuel temperature information from the FRPT sensor to the data in the maps. Using this information the PCM adjusts the time the fuel injectors need to be energized to deliver the correct mass of fuel to the combustion chambers.

CONTROL DIAGRAM



E242846

A = HARDWIRED: AL = PWM.

ITEM	DESCRIPTION
1	PCM
2	Fuel injector
3	Fuel metering valve - HP fuel pump
4	Ground

ITEM	DESCRIPTION
5	Power supply
6	FRPT sensor

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