CITROËN TECHNICAL TRAINING

ENGINE MANAGEMENT SYSTEMS

PETROL ENGINES

CITROËN UK LTD
221 BATH ROAD
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DEALER PERSONNEL
DEVELOPMENT AND
TRAINING

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BROCHURE SUMMARY

ENGINE MANAGEMENT SYSTEMS

- PETROL ENGINES

The aim of this brochure is to define the petrol management system "in full".

It presents the various injection and ignition principles and the changes in the systems since injection was used as standard on engine management systems.

The operation of the following subjects is dealt with:

- General and presentation of injection and ignition principles,
- Sensors,
- Fuel circuits,
- Petrol vapour recirculating circuits,
- Additional air.

The aim of this document is to provide the reader with the basic knowledge required in order to study, explain and understand a new system.

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GENERAL

I - INTRODUCTION

Electronic petrol injection consists of an electronic control unit (ECU) which receives and processes information so as to control the injection and often the ignition.
These ECUs have become more and more precise with the change from "analogue electronics" to "digital electronics". The miniaturisation of electronic components means that more and more functions can be provided without increasing the size of the ECUs.

- Analogue electronics uses a calculation method and is based on the continuous presence of electrical input signals. Various electronic layouts allow various problems to be resolved and thus provide results which can be used straight away (injection time…). The inability to store this data in the memory means that this principle can no longer work when one input parameter is missing.
- In addition to its calculation functions, digital electronics allows the ECU to replace a missing input parameter with another one stored in the memory during its design stage. This system also allows faults linked to a possible breakdown to be stored in the memory.

ECUs now also have the possibility of working in a downgraded mode. This consists of replacing the faulty or missing parameters with pre-programmed values.
To locate possible faults and thus to achieve an optimum quality of repair, faults which occurred whilst driving can be stored in the memory. They are read using an auto-diagnostic test device.
However, although all injection systems fitted onto our vehicles use the same electronic control unit (computer) for injection and ignition, this has not always been the case.

- The first injection systems were mechanical whilst ignition was conventional.
- Injection become electronic but ignition remained conventional.
- In addition to electronic injection, the ignition was also controlled by an independent ECU.
- Then injection and ignition systems were controlled by the same ECU.

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II - MEASURING PRINCIPLES

All systems need one essential piece of information which is the quantity of air in the cylinders. They can then work out the amount of petrol to inject as a function of engine speed.
This quantity is measured by:

- a flowmeter (F/N),
- or a throttle angle (α/N), } where N = engine RPM
- or a pressure sensor (P/N).

III - SUPPLIERS AND NAMES

There are various suppliers:

- BOSCH,
- MAGNETI MARELLI,
- SAGEM LUCAS,
- BENDIX SIEMENS.

In the name of these systems, BOSCH specifies information relating to ignition measurement and management.

- L → Measurement using FLOW.
- A → Measurement using THROTTLE ANGLE.
- P → Measurement using PRESSURE.
- M → MOTRONIC; specifies a single ECU for injection and ignition.

Example: BOSCH LE2 → Analogue F/N

BOSCH L3.1 → Digital F/N

BOSCH ML4.1 → Digital - Motronic F/N

BOSCH A2.2 → Digital α/N

BOSCH MA3.0 → Digital - Motronic α/N

BOSCH MP3.1 → Digital - Motronic P/N

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IV - INJECTION PRINCIPLES

Current injection principles are INDIRECT.

A - MONOPOINT

MONOPOINT PETROL INJECTION

↓ (1 injector per cylinder set)

ANGLE/ENGINE SPEED or PRESSURE/ENGINE SPEED

↓

PHASED OR UNPHASED
INTERMITTENT INJECTION

↓

IGNITION

↙ ↘

DYNAMIC TRANSISTORISED | STATIC ELECTRONIC

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B - MULTIPOINT

MULTIPOINT PETROL INJECTION

(1 injector per cylinder)

FLOW/ENGINE SPEED or PRESSURE/ENGINE SPEED

INTERMITTENT AND PHASED INJECTION

SIMULTANEOUS INJECTION	**SEMI-FULL GROUP INJECTION**	**SEMI-SEQUENTIAL INJECTION**	**SEQUENTIAL INJECTION**
- All injectors at the same time - 2 injections per cycle	- 2 injectors / 2 injectors - 2 injections per cycle	- 2 injectors / 2 injectors - 1 injection per cycle	- 1 injector / 1 injector - 1 injection per cycle

IGNITION

DYNAMIC TRANSISTORISED

DYNAMIC or STATIC ELECTRONIC

Note: Continuous injections do exist (e.g.: BOSCH K. JETRONIC)

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V - IGNITION PRINCIPLES

CONVENTIONAL IGNITION	TRANSISTORISED IGNITION
• Ignition switching / timing. – contact breakers, – mechanical advance . vacuum . centrifugal. • High Tension Coil. • Distributor + rotor. • High Tension Leads. • Spark Plugs.	• Ignition switching / timing. – electromagnetically triggered, – mechanical advance. . vacuum . centrifugal. • Transistorised ignition module. – current regulation function. • High Tension Coil. • Distributor + rotor. • High Tension Leads. • Spark Plugs.

ELECTRONIC IGNITION

- Computer
  - ignition control,
  - cartographic advances.
- Transistorised ignition module
  - only current amplifier (MTR03 or MTR04)
  - High Tension Coil.
  - Distribution.

TWIN STATIC IGNITION	STATIC IGNITION	ELECTRONIC IGNITION WITH DISTRIBUTOR
• BAE 04 → High Tension Coil with 4 outputs • BBC 2.2 → Compact Coil Block with 4 outputs • BBC 3.2 → Compact Coil Block with 6 outputs • High Tension lead • Spark plugs	• BAE 01 → High Tension Coil with 1 output (1 coil per cylinder) • Spark plugs	• Coil with 1 output • Distributor + rotor • High Tension Leads • Spark plugs

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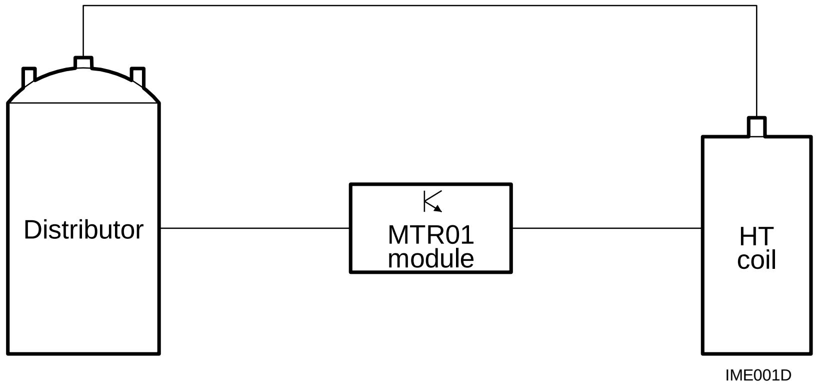
VI - LAYOUT TYPES

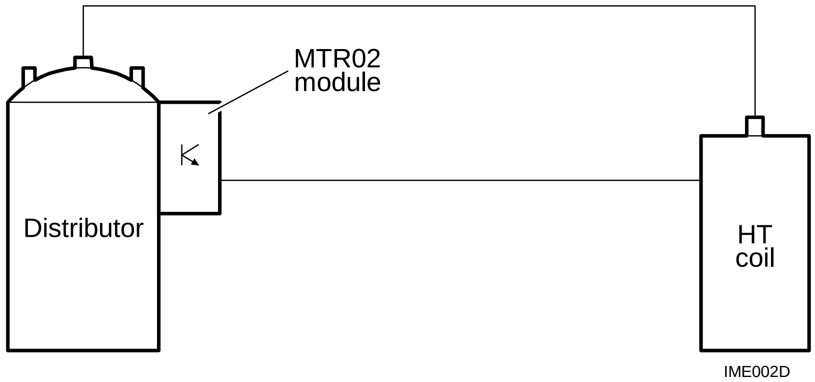
A - LAYOUT 1



The transistorised ignition module (7 track) MTR01 is secured to a cooling plate. It is located between the igniter and the coil. It is operated by a pulse (sinusoidal type) from the generator incorporated into the igniter (star).

MTR01 Type Module BTR01 Type Coil

B - LAYOUT 2



The ignition module (3 track) MTR02 is secured to the distributor. It is connected directly to the pulse generator. It is connected to the coil through a lead so as to control charging.

MTR02 Type Module BTR02 Type Coil

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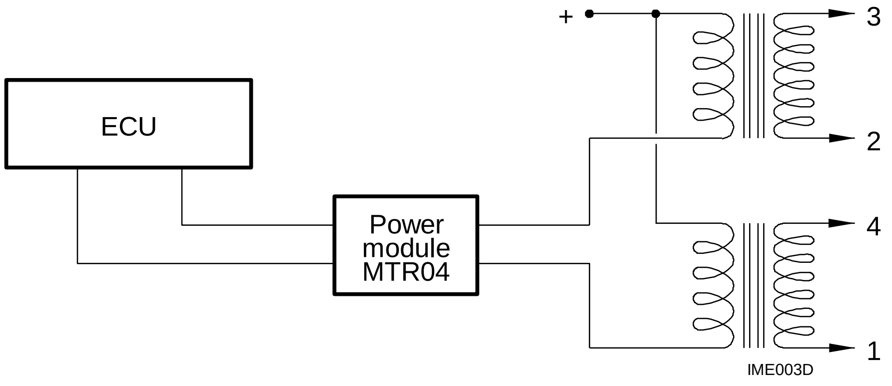
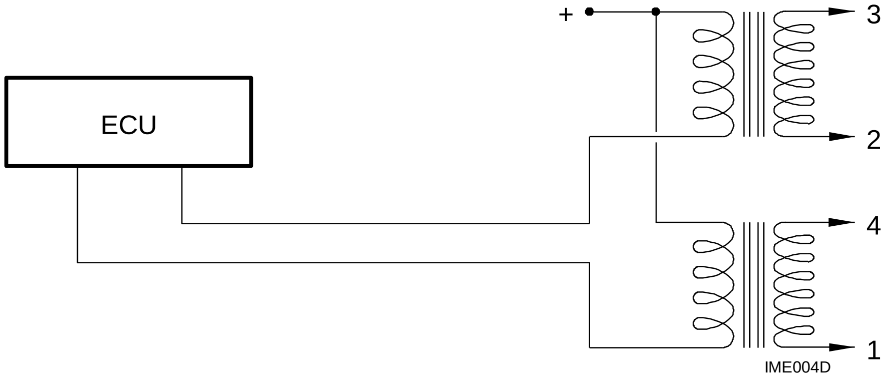
C - LAYOUT 3



The ignition module (7 track) MTR04 is external. The ECU controls the module using two separate circuits. This is connected to a twin-static coil through two distinct circuits.

MTR04 Type Module BAE04 - BBC 2.2 Type Coil

D - LAYOUT 4



The ignition module is incorporated into the ECU which controls the twin-static coil directly. This layout requires the calculation of the charge time to be managed in a specific way.

BAE04 - BBC 2.2 Type Coil

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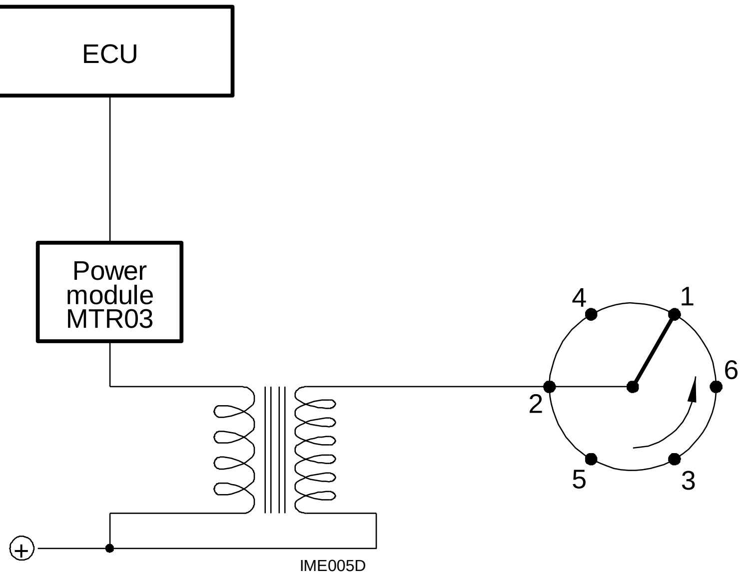
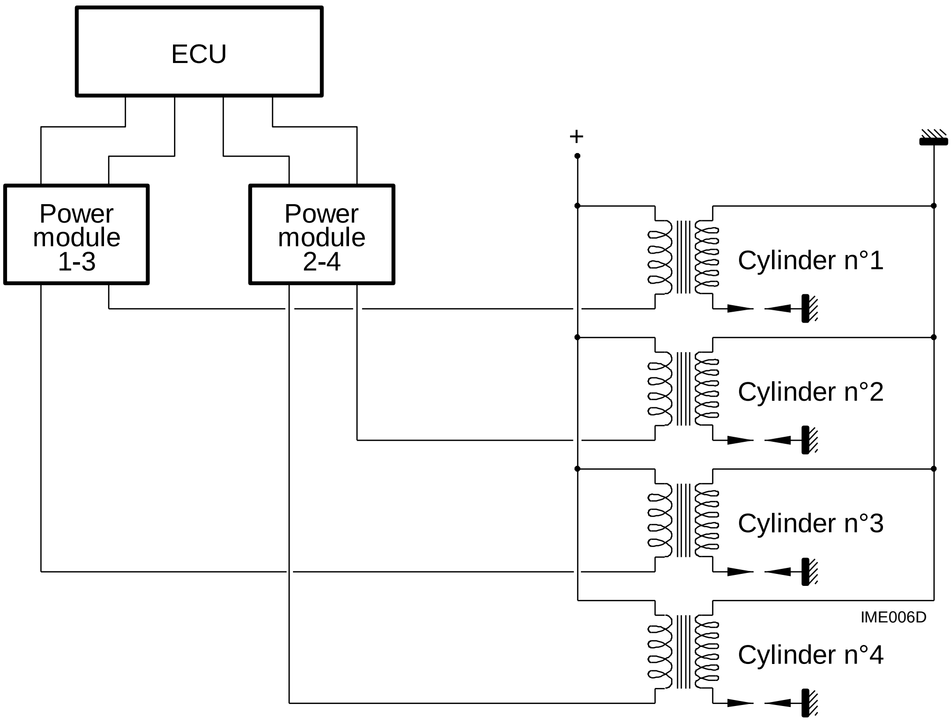
E - LAYOUT 5



The ignition module (7 track) MTR03 is external. It only has one power stage and is operated by the ECU. The coil HT output is connected to a distributor. This is electronic cartographic ignition with a distributor.

MTR03 Type Module BOSCH 0221122411 Type Coil

F - LAYOUT 6 (also exists without module)



Same as layout 3, but with 1 control and 1 coil per cylinder.

MTR04 Type Module BAE01 Type Coil

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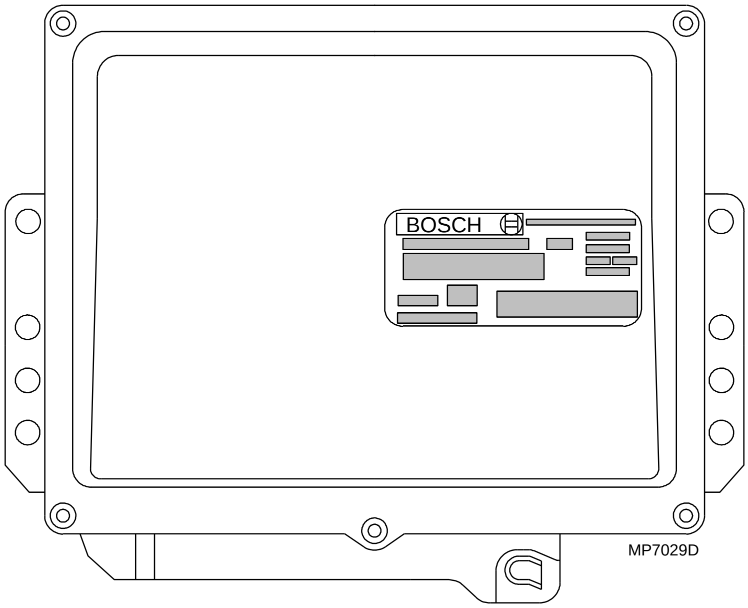
VII - THE ECU

A - PRESENTATION



The new injection-ignition ECUs use "FLASH-EPROM" technology.

This new technology means that the ECU can be updated without being removed following a calibration change.

In fact, instead of having to replace the ECU or the EPROM, the operation consists of "downloading" the ECU program into its memory using a suitable after-sales tool through the diagnostic socket.

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B - ROLE

The ECU receives the following pieces of information from the various sensors and probes:

- battery voltage,
- ignition on,
- cranking,
- engine speed and position,
- cylinder reference,
- coolant temperature,
- air temperature,
- amount of air drawn in,
- throttle position,
- vehicle speed,
- richness,
- knock detection,
- air conditioning,
- automatic transmission,
- CAS,
- diagnostic.

After having processed this input information, the ECU performs the following functions:

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1 - Calculates the injection time and controls the injectors

a - Working out the injection time

The basic time is worked out using the amount of air drawn in and engine speed information in order to:

- take the amount of air in the cylinders into account,
- have a richness of Lambda = 1.

The basic time is used for other calculations such as the "load" parameter.

The main corrections and strategies are:

- deceleration cut-off/power take-up,
- starting correction,
- warming up correction,
- richness correction,
- knock correction,
- richness regulation/richness auto-adaptation,
- correction during transitories,
- battery voltage correction.

⇒ Final injection time.

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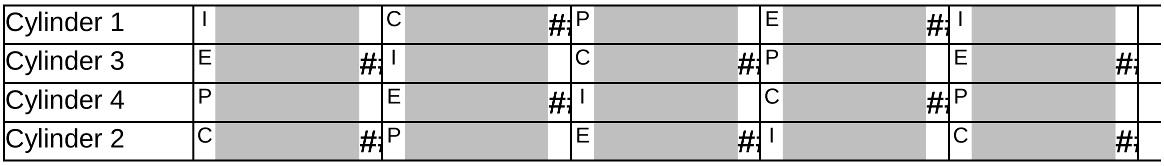
b - Table of the various Injector and Ignition Control Modes

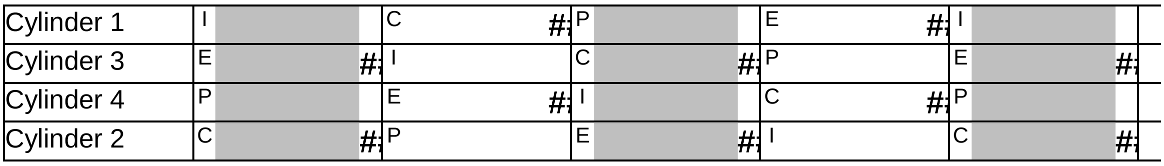
Phases TDC TDC TDC TDC TDC TDC

Cylinder 1	Inlet	Compression	Power	Exhaust	Inlet
Cylinder 3	Exhaust	Inlet	Compression	Power	Exhaust
Cylinder 4	Power	Exhaust	Inlet	Compression	Power
Cylinder 2	Compression	Power	Exhaust	Inlet	Compression

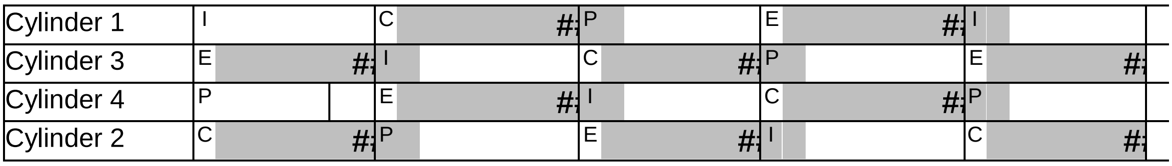
"INTERMITTENT" MONOPOINT injection = "Twin static" ignition



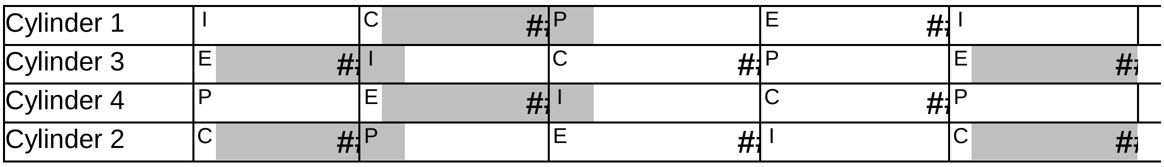
"FULL-GROUP" injection = "Twin static" ignition



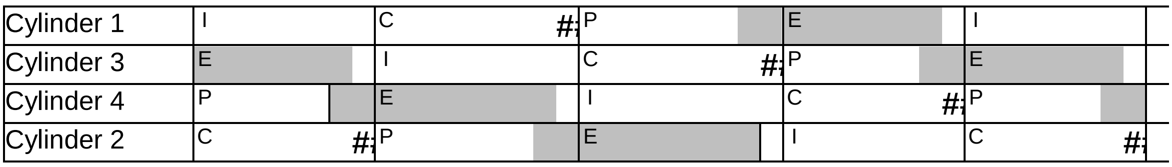
"SEMI FULL-GROUP" injection = "Twin static" ignition



"Semi-sequential" injection = "Twin static" ignition



"Sequential" injection = "Sequential" ignition



Key: ### Petrol injection
Ignition

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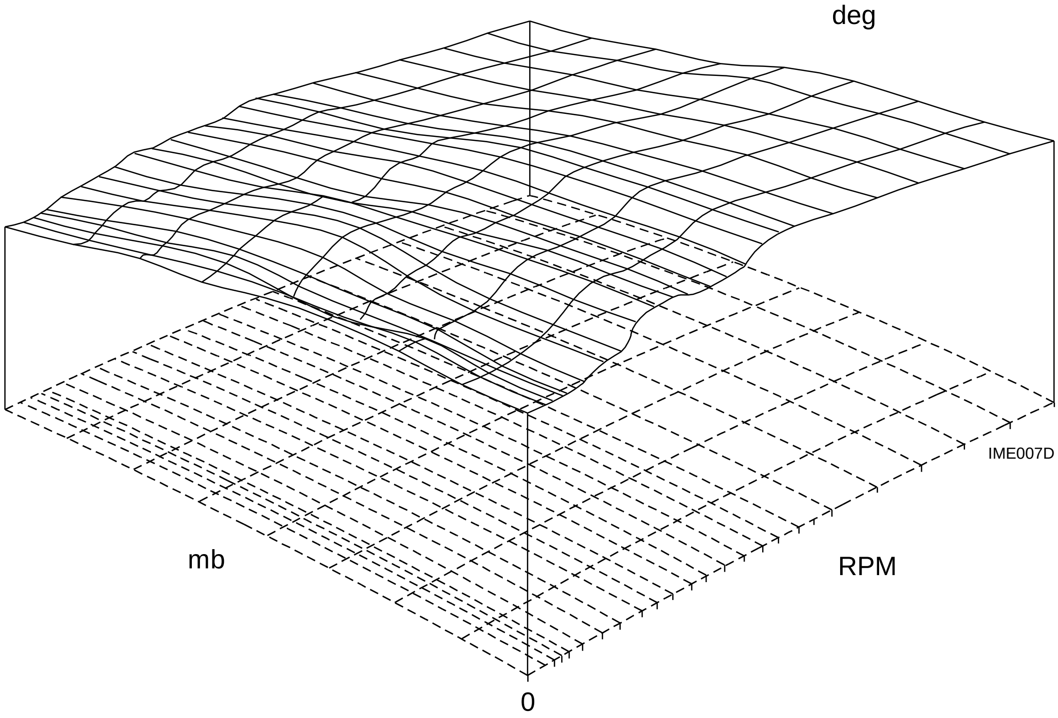
2 - Calculates the advance and controls ignition

- The ECU has to:
  - work out and generate advance curves,
  - provide constant power,
  - control the ignition coil directly or indirectly (through the module).

- Controlling the advance.

  The basic ignition advance is obtained from a cartographic map which is stored in the ECU's memory, the parameters of which are:
  - engine speed,
  - the quantity of air drawn in by the engine.



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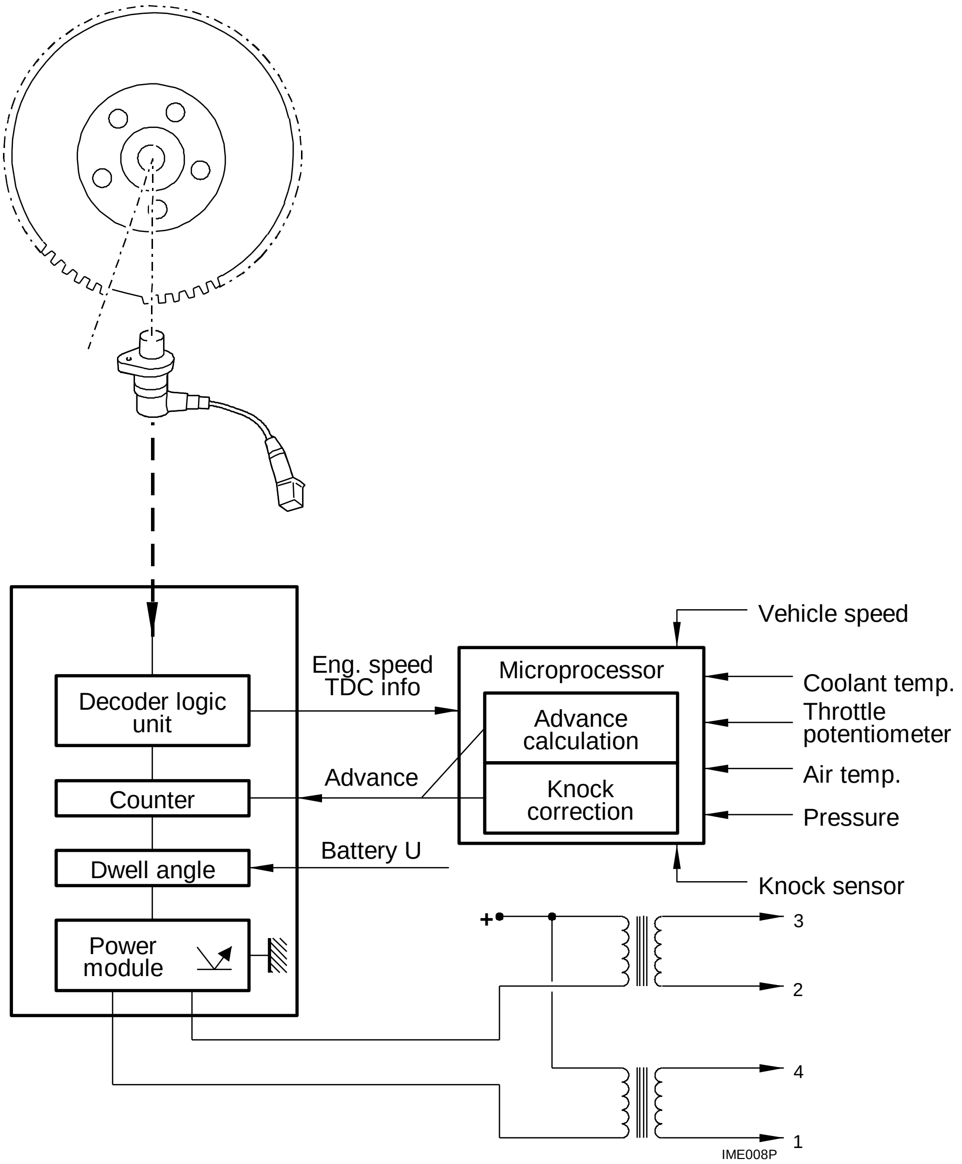
- In order to obtain optimum engine performance in all circumstances, the basic advance is corrected as a function of:
  - air temperature,
  - coolant temperature,
  - stability of engine speed when idling,
  - driving pleasure,
  - throttle position,
  - vehicle speed,
  - knock detection,
  - automatic transmission information,
  - air conditioning information,
  - battery voltage.



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- **Procedure**

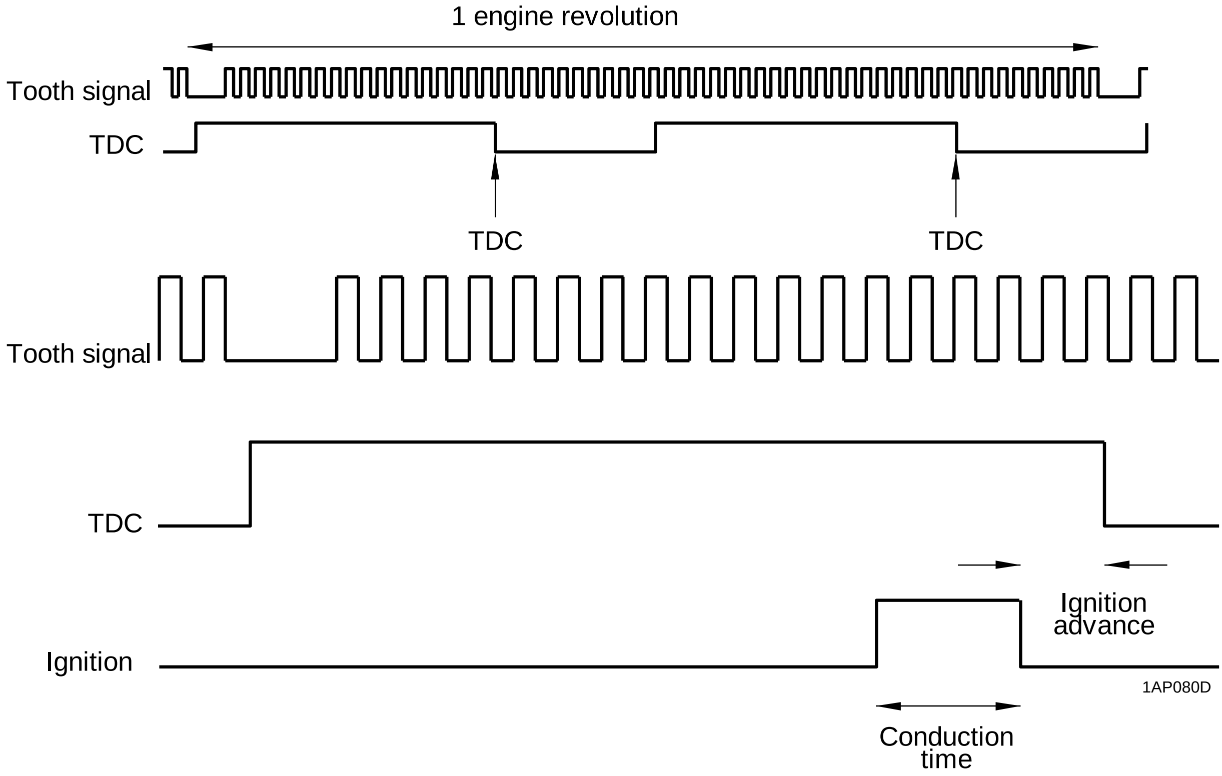
  The teeth passing in front of the TDC sensor create variations in the magnetic flux which cause a voltage at the terminals of the sensor winding. A circuit integrated into the ECU detects when this voltage is zero which occurs when the sensor detects the top of the teeth (maximum flux) and when it is at its maximum value which occurs when the sensor detects the middle of the gaps (minimum flux). As the sensor recognises when "two missing teeth" pass in front of it, it provides a reference signal with a longer period.

  The ECU then calculates the optimum advance then controls the coils.

  We have seen that the flywheel ring has a reference consisting of "two missing teeth"; the ECU therefore works out the first TDC using this reference and the second TDC by counting the teeth (29 teeth → ½ revolution).

  Using the reference signal, the ECU, which has worked out a certain advance depending on the various parameters, triggers ignition when the number of teeth which have passed in front of the sensor corresponds to the angle rotated through by the crankshaft, which the spark has to coincide with.

- **Diagram of the ignition process**



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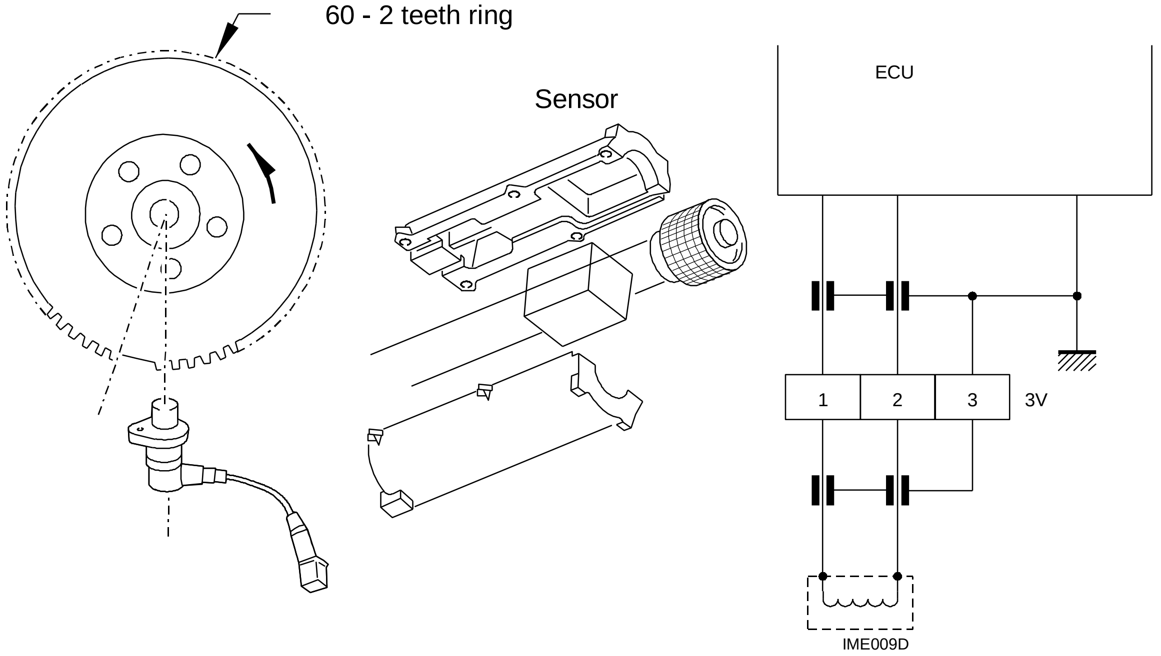
THE SENSORS

I - ENGINE SPEED AND POSITION SENSOR



A - ROLE

This is used to work out the engine speed as well as the crankshaft position. The information provided is transmitted to the computer in order to work out the ignition advance, coil charge, quantity of petrol to inject, idle speed regulation, injection rate...

B - OPERATION

The angular reference and rotational speed are measured by a passive sensor mounted onto the clutch housing opposite a 58 tooth ring located on the flywheel. It consists of a permanent magnet and a winding which cause an electromotive force induced by the variation in flux. This variation is caused by each of the teeth of the ring passing under the sensor.

The frequency at which the pulses caused by the 58 teeth on the ring occur represents the engine speed.

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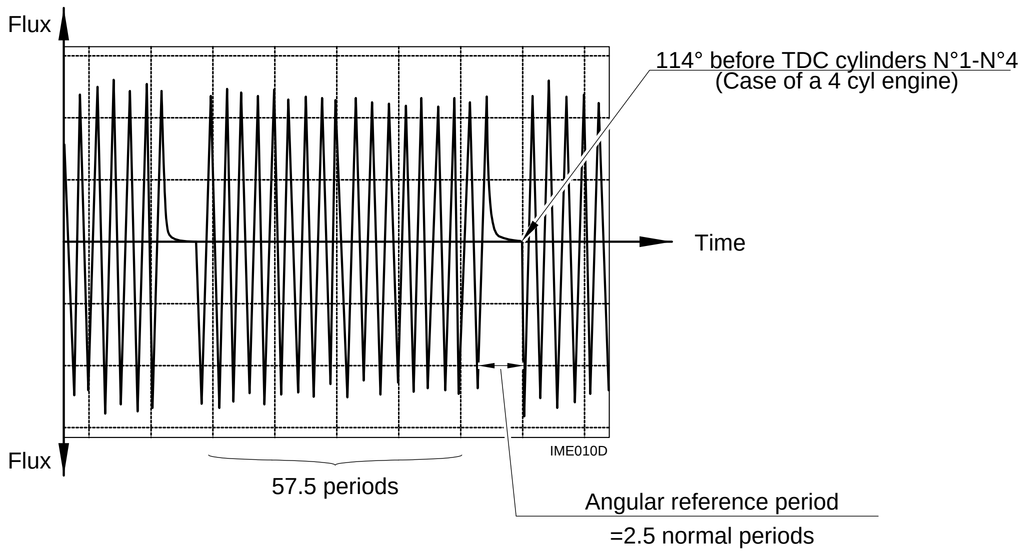
The reference mark represents the point at which the induced voltage is zero, caused by the two missing teeth. The first positive change which appears is located at 114° before TDC on a 4 cylinder engine.

Signals from the magnetic sensor

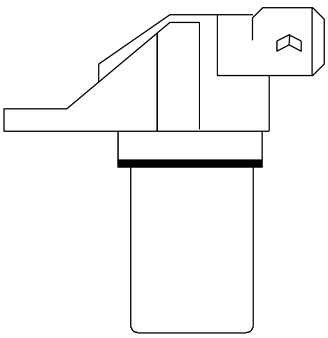


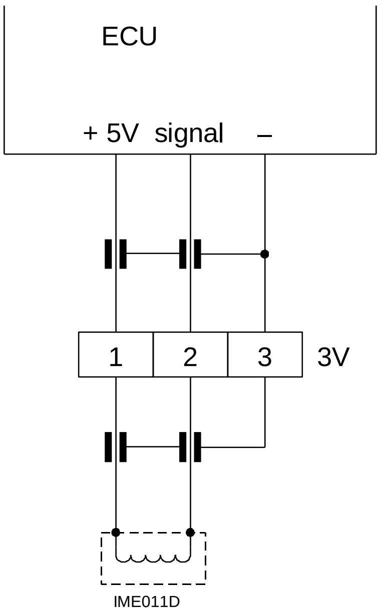
II - CAMSHAFT REFERENCE SENSOR

A - ROLE

The ECU needs a cylinder reference so as to be able to phase the orders to the ignition coils and the injectors in sequential mode (cylinder by cylinder in the firing order 1 - 3 - 4 - 2).

To do this, it recognises the TDC during ignition of cylinder n° 1.





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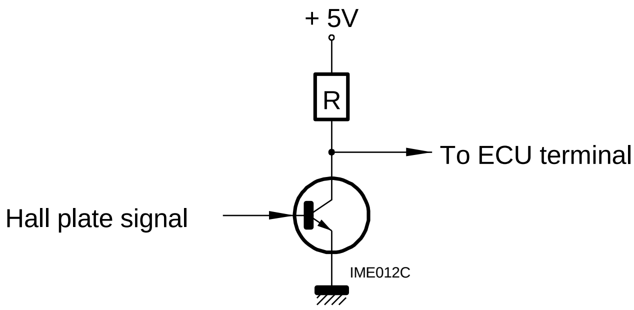
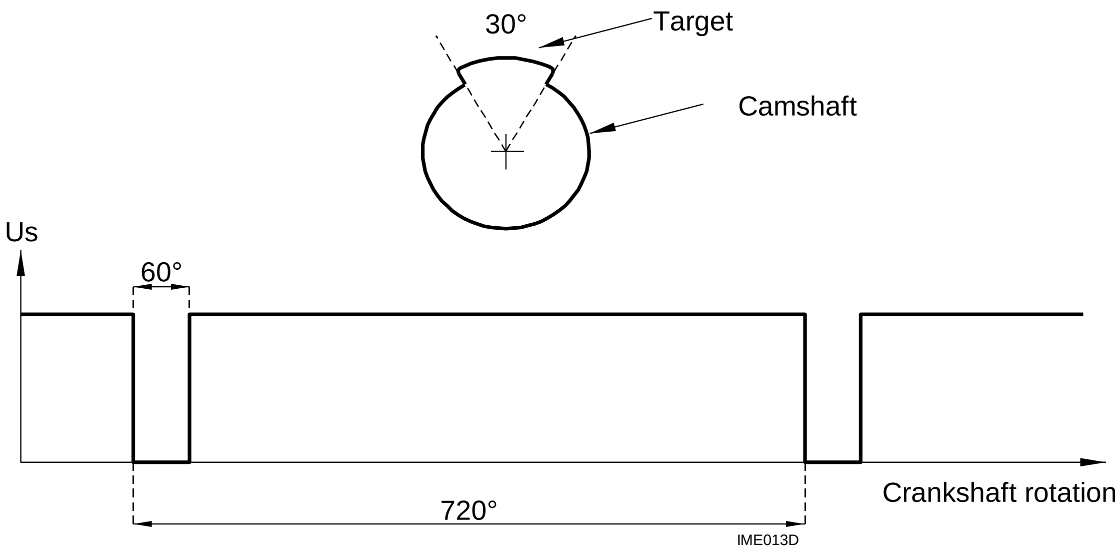
B - OPERATION

This Hall effect sensor is located on the cylinder housing opposite a target mounted on the end of the inlet camshaft.

Principle:



- If the Hall plate supplies a signal → the transistor is released → ECU terminal = 0 V.
- If the Hall plate does not supply a signal → the transistor is blocked → ECU terminal = 5 V.
- As the camshaft rotates at half the speed of the crankshaft, the camshaft reference signal only appears every two crankshaft revolutions; thus, the "two missing teeth" signal appears twice between two camshaft target detections.



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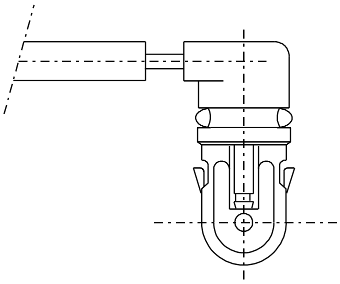
III - AIR TEMPERATURE PROBE

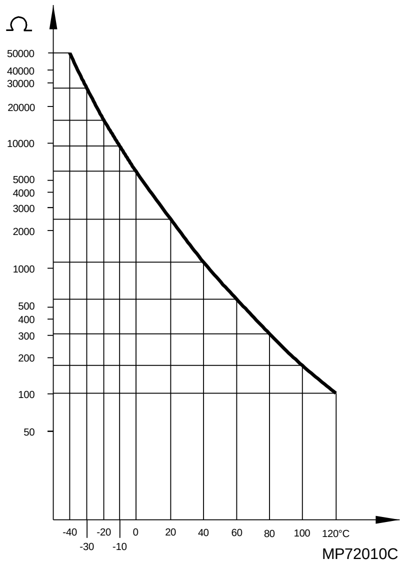
Air density varies with temperature so that the "quantity of air drawn in" information is no longer correct for large temperature variations.



MP72009C

A - ROLE

This informs the ECU of the temperature of the inlet air so that it can correct the injector opening time. When the air temperature drops, its density increases and the ECU increases the amount of petrol injected so as to restore the required air/petrol ratio. It is located on the air circuit.

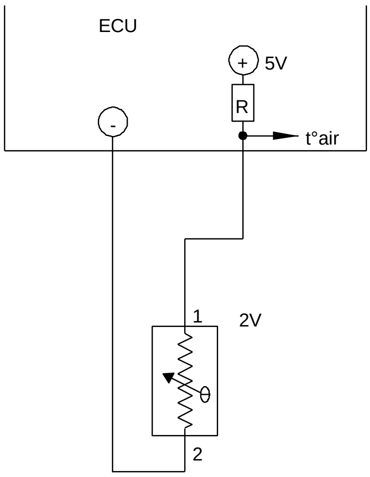


MP72010C

B - OPERATION

This is an NTC type thermistor (negative temperature coefficient) which means that when the temperature of the inlet air falls, the value of resistance rises and vice versa.

The probe circuit is supplied with five volts d.c. The ECU measures the voltage at the probe terminals which varies as a function of its resistance.



IME014C

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IV - PRESSURE SENSOR

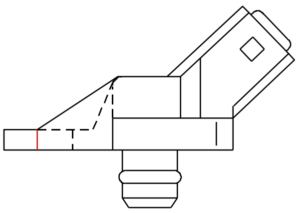
A - ROLE

This provides the ECU with the "load" information so that it can work out the optimum amount of petrol depending on the filling and required richness, as well as the ignition advance point suited to the engine operating conditions.

B - OPERATION

This is a piezoresistive type absolute pressure sensor which mainly consists of strain gauges connected to a measuring bridge.

These strain gauges deflect due to the action of the pressure causing a voltage signal which is proportional to this pressure.



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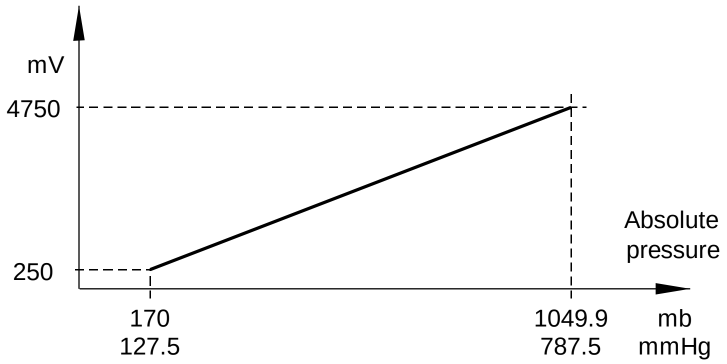

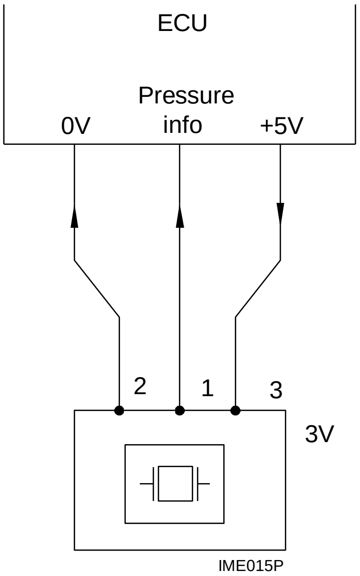

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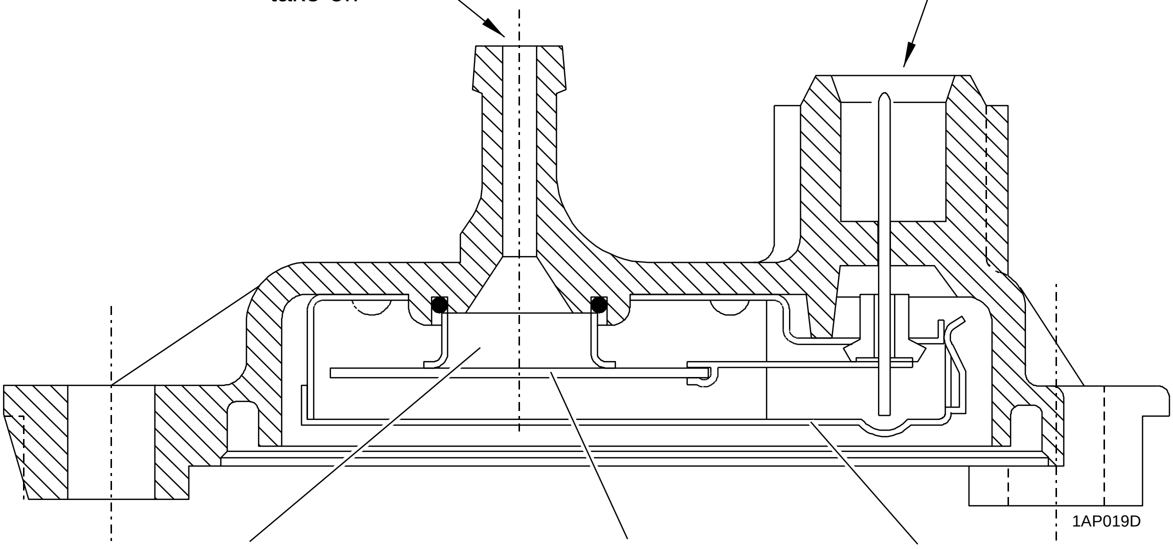
C - READING THE ATMOSPHERIC PRESSURE

The ECU takes the atmospheric pressure into account since it represents altitude which affects air density.

The atmospheric pressure is read and stored in the following cases:

- "Engine off" or "power latch" (Pa = current pressure)
- "Engine started" → If the value of manifold pressure is greater than the memorised value of atmospheric pressure, it becomes the new value of atmospheric pressure.
- In the full load position, at low engine speed (limit) for a certain calibrated amount of time → the atmospheric pressure is updated again.

PRT03 type pressure sensor (for example)



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V - FLOW METER

The flow meter is fitted into the inlet circuit between the air filter and the throttle.
It measures the quantity of air drawn in by the engine and converts this information into an electrical signal for the ECU.

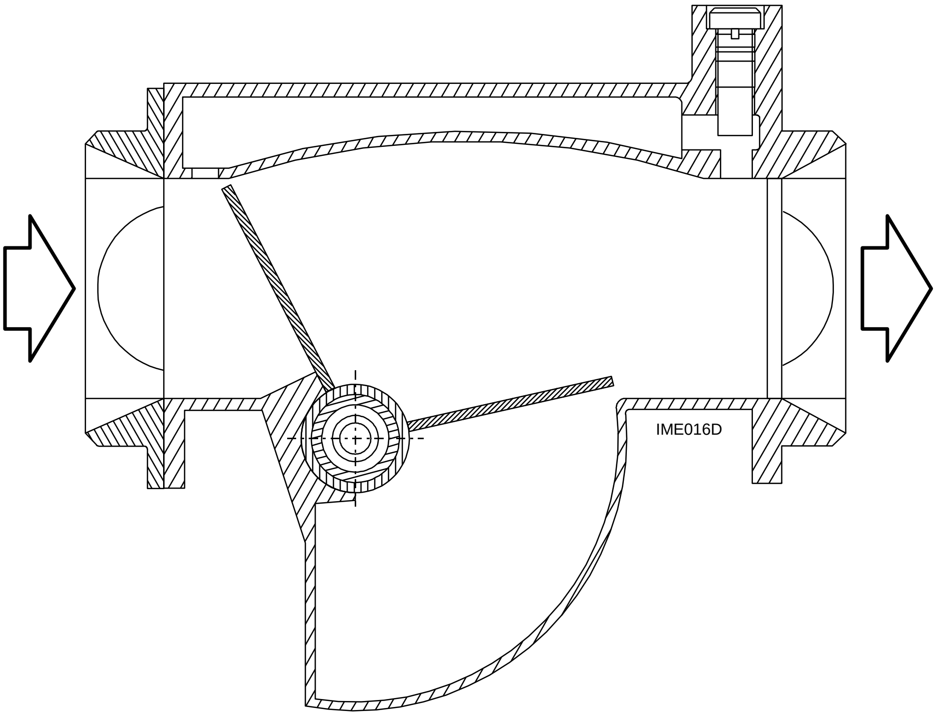
A - MECHANICAL PART

This consists of a rectangular moving flap controlled by the flow of air drawn in by the engine.

An end stop dampens the flap when it returns to its rest position.

A damping flap connected to the moving flap times the movements of the assembly.

A channel calibrated by a screw fitted with a tamperproof plug adjusts the richness of the mixture at idle speed.



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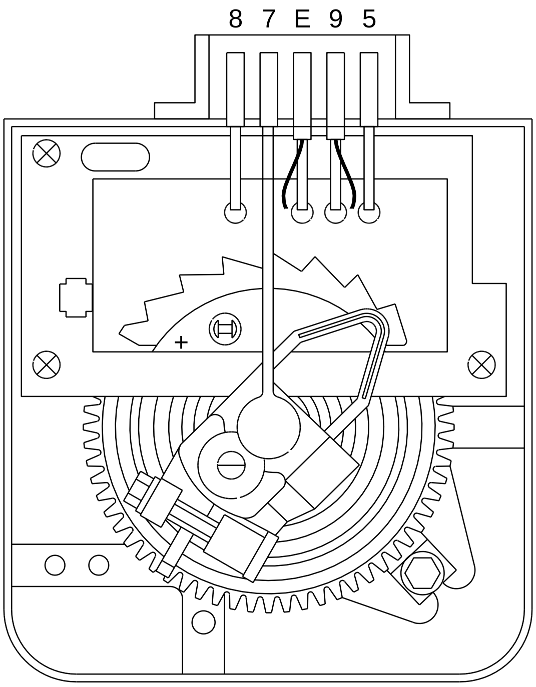
B - ELECTRICAL PART

This consists of a potentiometer. A slider with two contacts moves along a variable resistance track.

The slider is connected to the moving flap.



IME017D

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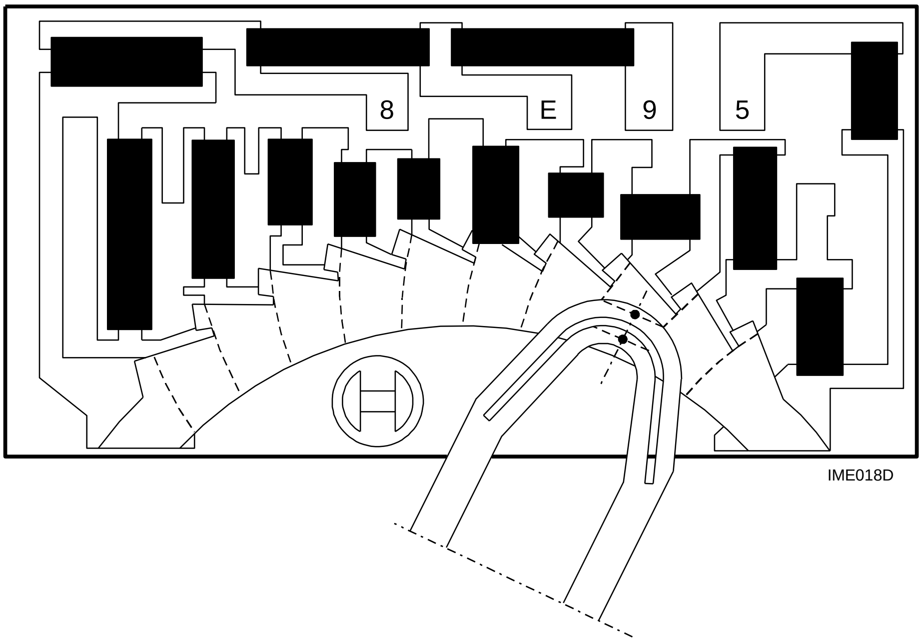
C - OPERATION

Due to the effect of the air flow, the moving flap moves. Its movement is braked by the action of the spiral return spring. The angular movements of the flap are damped by the rotation of the compensating flap in a chamber called a "compensation chamber". The moving flap does not move linearly. It moves a great deal at low engine speeds but this movement decreases as the engine speed increases.

Each quantity of air drawn in by the engine corresponds to a precise position of the moving flap, as well as a position of the moving contacts on the resistor.

Depending on the angular position of the flap, the potentiometer provides the ECU with a variable electrical signal.

This signal is essential for working out the injection time.



Resistor plate

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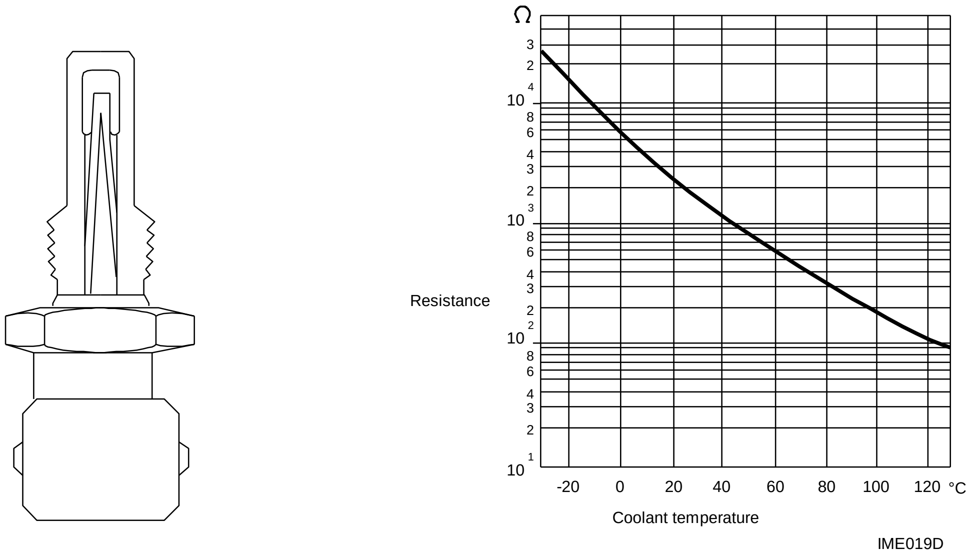
VI - COOLANT TEMPERATURE PROBE

A - ROLE

This informs the ECU of the temperature of the engine coolant. It allows the ECU to make corrections to the injection and the ignition.

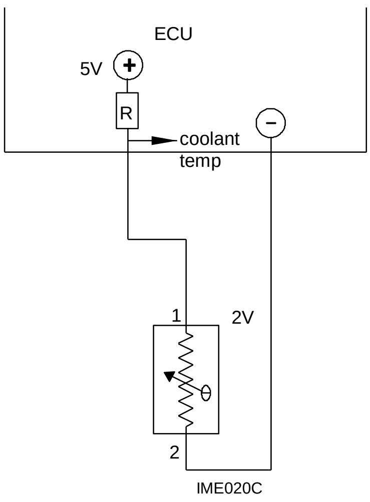
B - OPERATION

The value of the resistance decreases as the engine temperature increases. This is an NTC type thermistor (negative temperature coefficient resistor).



(Graph shows the variation of probe resistance as a function of temperature)

The probe circuit is supplied with five volts d.c. The ECU measures the voltage at the probe terminals which varies as a function of the resistance of the probe.



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VII - THROTTLE POTENTIOMETER

A - PRESSURE/SPEED INJECTION SYSTEM

1 - Role

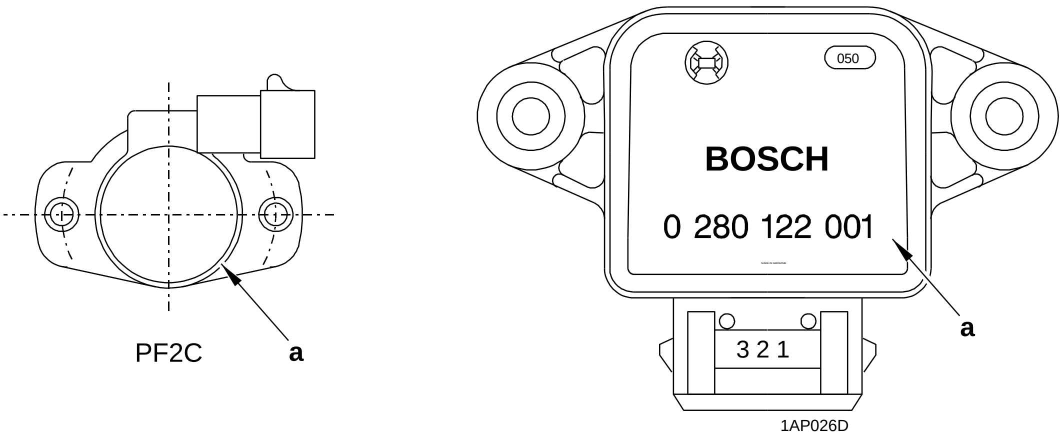
Mounted on the throttle housing, it informs the ECU of the angular position of the throttle.

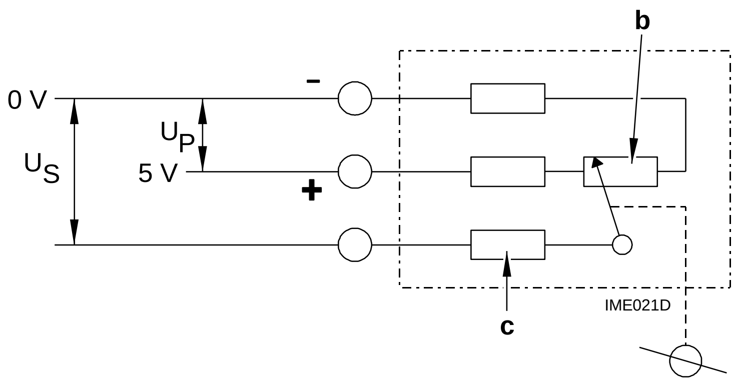
This information is used to recognise the "no load", "full load" and "transitories" positions.

Depending on this information, the ECU can recognise the operating mode and apply the advance and injection strategies.

Furthermore, it allows the ECU to calculate the injection time as a function of the throttle position in order to provide an emergency mode should a fault arise on the pressure sensor.

2 - Operation





It consists of:

- a resistive track (b),
- a slider which is connected to the throttle pin and which contains a fixed resistor (c).

This assembly forms the potentiometer (a).

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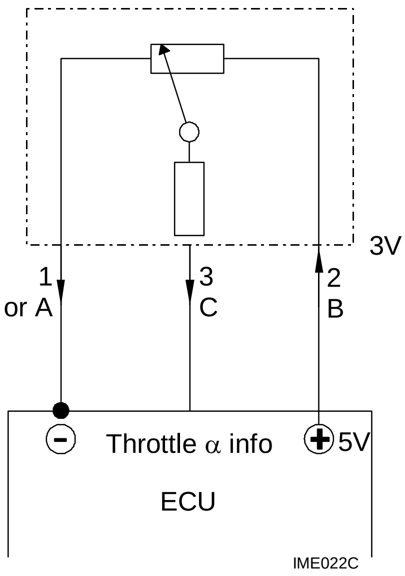


The ECU supplies a fixed 5 volt supply to the terminals of the resistive track (b).

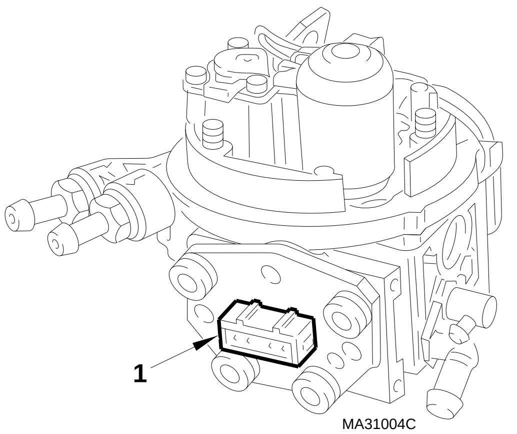
The slider moves on track (b) and transmits a voltage Vs to the ECU which varies linearly as a function of throttle position.

Note: The potentiometer cannot be adjusted.
If it is replaced, the auto-diagnostic memory must be erased.

B - THROTTLE ANGLE/ENGINE SPEED INJECTION SYSTEM

1 - Role

The potentiometer (1) works out the precise throttle position and passes this information onto the ECU.



2 - Operation

A single load state and consequently a single air flow correspond to a well defined throttle position as well as a determined engine speed. As fuel requirements do not vary linearly with throttle angle and engine speed, high precision is required, especially for low angles.

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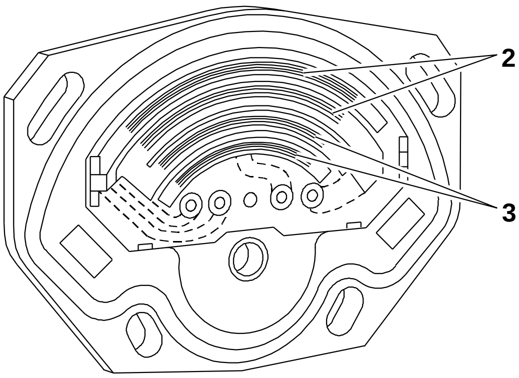
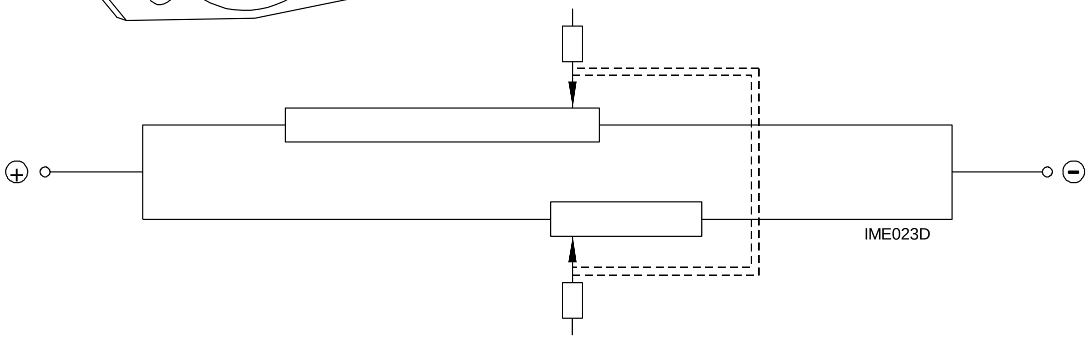
Low angle variations in the low load domain cause a large increase in air flow, which must correspond to the required fuel flow; the same variation in angle in the high load range barely modifies the air flow.

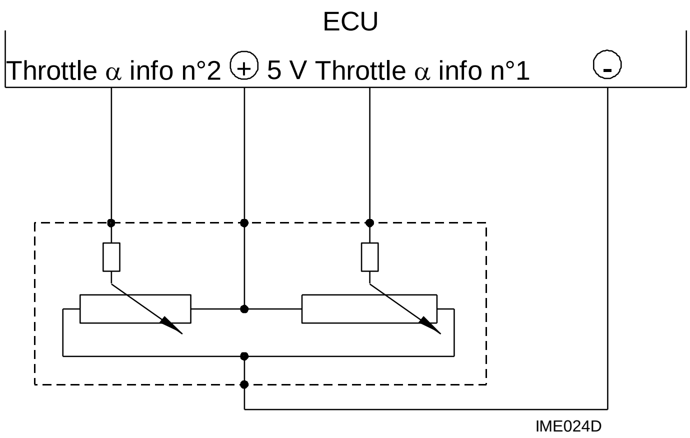


Due to the precision required for measuring the throttle opening angle, the potentiometer consists of:

- a track (2) measuring the throttle position between 0° and 24°,
- a track (3) measuring the throttle position between 18° and 90°.



The 6° overlap between the tracks ensures continuity of throttle position information when changing from one track to another.



Throttle potentiometer

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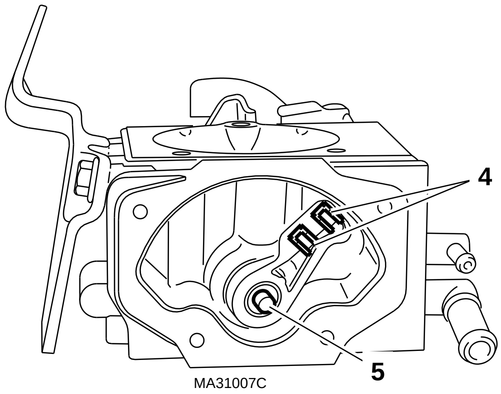
The slides (4) are connected to the throttle pin (5). The Ui information from the throttle position is transmitted to the ECU depending on the ratio of track voltage Up to supply voltage Ua, where:

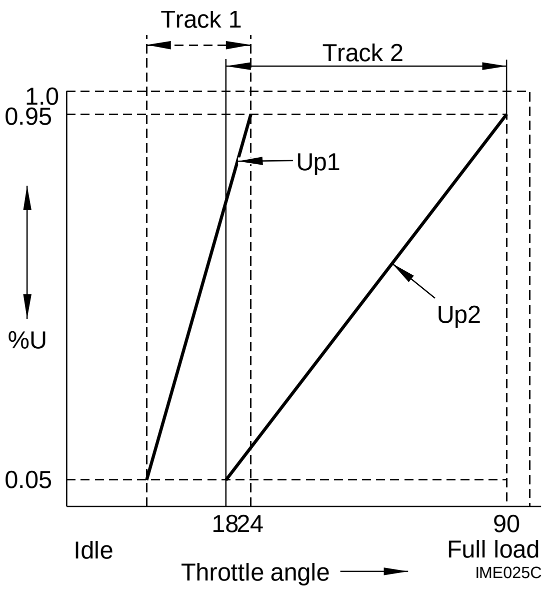
$$Ui = \frac{Up}{Ua} \text{ where } Ua = 5 \text{ Volts}$$



The value Ui is used for calculating the injection time Ti.

Comment: For some functions, the ECU uses an artificial track which it forms from two real tracks. It therefore obtains a theoretical throttle position.

Note: The position of the potentiometer cannot be adjusted since it is precisely set in the factory.



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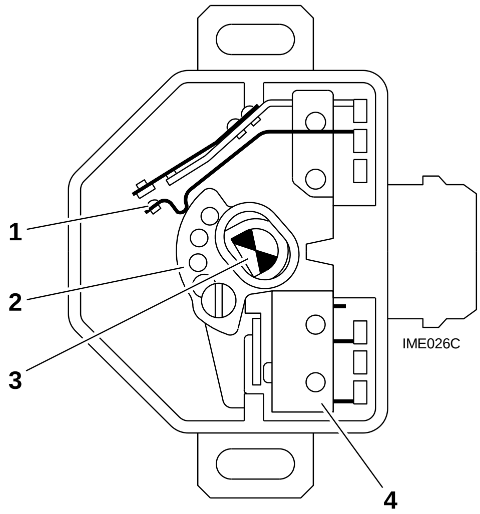
C - AIR FLOW/ENGINE SPEED INJECTION SYSTEM

The switch on the throttle pin informs the ECU of the position:

- when idling,
- at mid stroke,
- at full load.



1 - Full load contact
2 - Cam
3 - Throttle pin
4 - Idle micro-contact

1 - Description

The switch is located on the end of the throttle pin. Its position can be altered by means of two slots.

It consists of two contacts, one for full load (1) and an idle microcontact (4). They are operated by a cam (2) which is connected to the throttle pin (3).

2 - Operation

- **Idle contact:** for a throttle position between 0 and 1°, the idle microcontact is closed and informs the ECU on terminal 2 so as to control deceleration cut-off if the conditions so require.

- **Full load contact:** for a throttle opening greater than 60°, the full load contact is closed and the ECU is informed on terminal 3 which enriches the mixture by 15%.

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VIII - VEHICLE SPEED SENSOR (EATON)

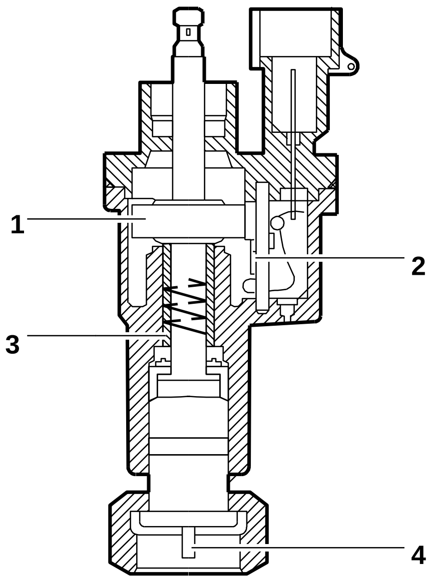
A - ROLE

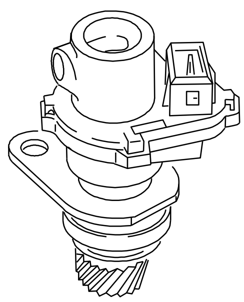
The sensor has to provide an electrical signal which is proportional to the rotational speed of the gearbox output shaft, and therefore the vehicle speed. In the no load position it allows the ECU to work out whether the vehicle is moving or not and also allows it to ascertain the gear engaged for certain functions.

B - LOCATION

It is located on the speedometer take-off on the gearbox.

C - OPERATION





1 - Polar wheel
2 - Hall sensor
3 - Bearing
4 - Drive

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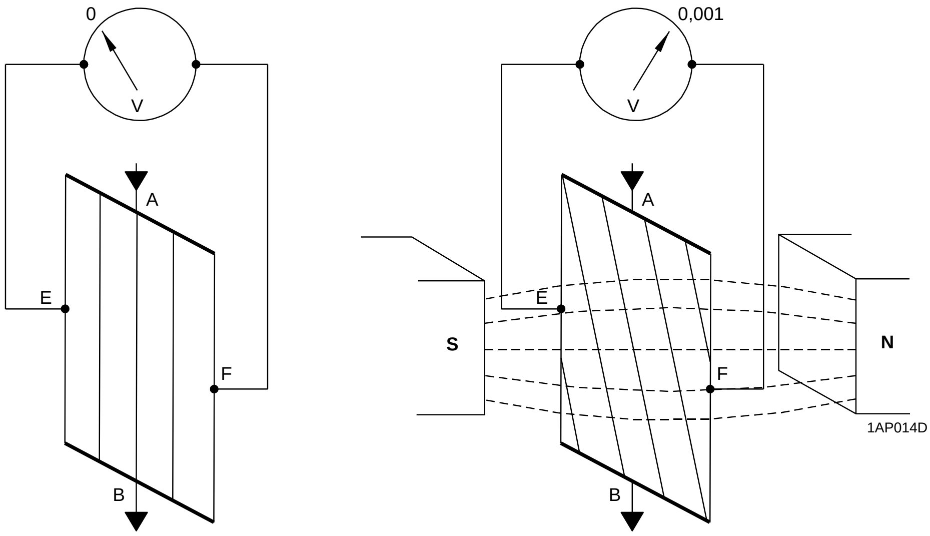
This sensor is a Hall effect pulse generator.

Principle of the Hall effect



The essential element of this system is an infinitely thin slice with a side length of 1.2 mm.

- A current passes over this slice between points A and B. When there is no magnetic field, no voltage is detected between the equidistant points E and F.
- When an S - N magnetic field is applied perpendicularly to the slice, a very low Hall voltage of 0.001 volts is detected between points E and F.

  (This comes from the variation in the current lines A.B by the magnetic field, provided that both electrical current and magnetic field conditions occur simultaneously).

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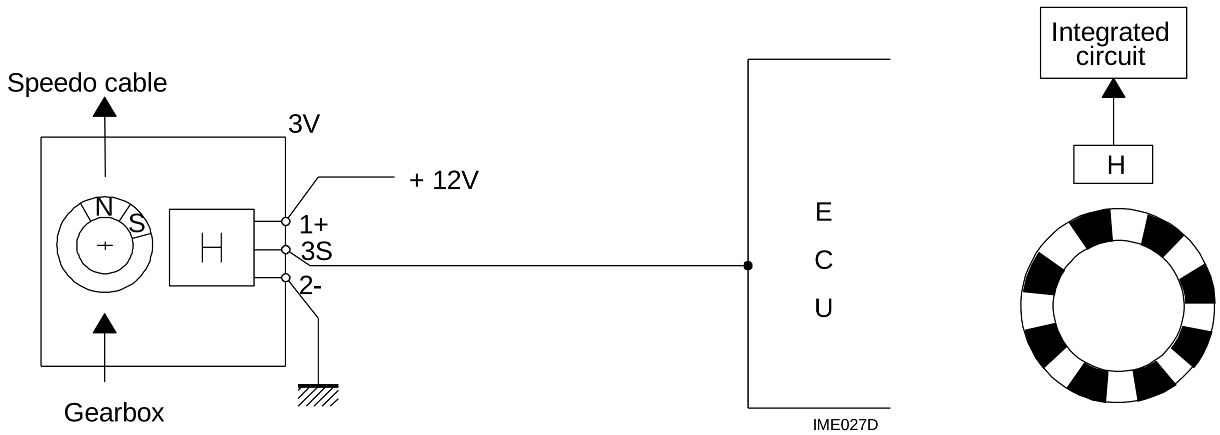
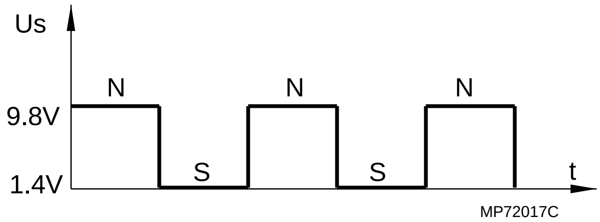
Construction



By rotating, the polar wheel passes a north pole, south pole, north pole, etc… in front of the Hall slice. The current supplied by the slice therefore changes direction. The integrated circuit which acts as a signal amplifier, supplies the ECU with a square signal, the upper limit of which corresponds to one direction of slice current and the lower limit of which corresponds to the inverse slice current depending on the pole passed in front of it.

Signal supplied by the sensor (for example).



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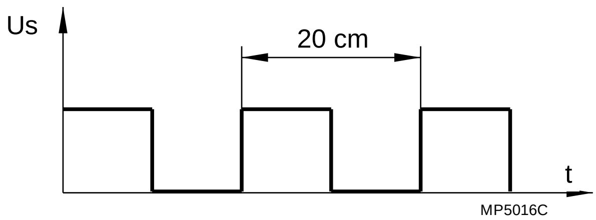
D - CALCULATING THE SPEED

The sensor supplies square signals, the frequency of which is proportional to the speed.

The signals emitted by the sensor can be used above 3 km/h.



Now, this sensor supplies eight pairs of poles:

- eight pulses per polar wheel revolution,
- five pulses per metre travelled.

Therefore, one pulse corresponds to 0.2 m travelled → 20 cm (1 m/5 pulses). Every time the vehicle travels 20 cm, the voltage reaches its peak (pulse). Therefore, to work out the vehicle speed, simply count the number of peaks per second.

Example:

The sensor supplies 50 pulses per second.

- 50 pulses → 50 x 20 cm = 1000 cm = 10 metres.

The vehicle is therefore travelling at 10 m/s.

- 10 m/s = 10 x 3600 = 36 000 m/h = 36 km/h.

Therefore, if the sensor supplies 50 pulses per second, the vehicle is travelling at 36 km/h.

- 50 pulses → 36 km/h
- 100 pulses → 72 km/h
- 10 pulses → 7.2 km/h

Warning: the sensor output signal is checked using a voltmeter in the "direct current" position.

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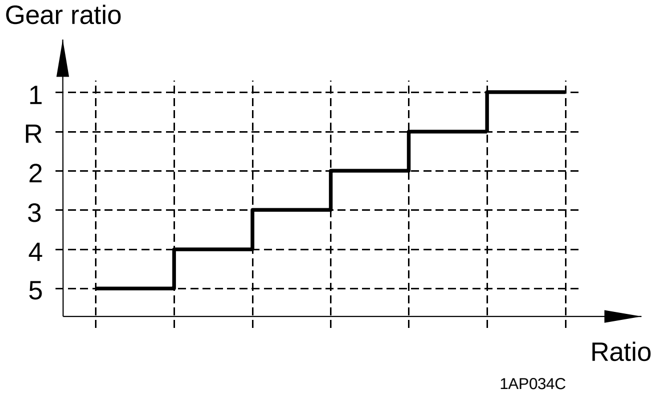
E - WORKING OUT THE GEAR ENGAGED

The ECU calculates the following ratio:

$$\frac{\text{Number of engine TDCs}}{\text{Number of sensor pulses}}$$

Then, a table gives the gear engaged depending on the calculated ratio.



F - WORKING OUT WHETHER THE VEHICLE IS MOVING OR NOT

- Vehicle moving ⇒### at least 2 sensor pulses every 150 ms.
- Vehicle stationary ⇒ no sensor pulse for 150 ms.

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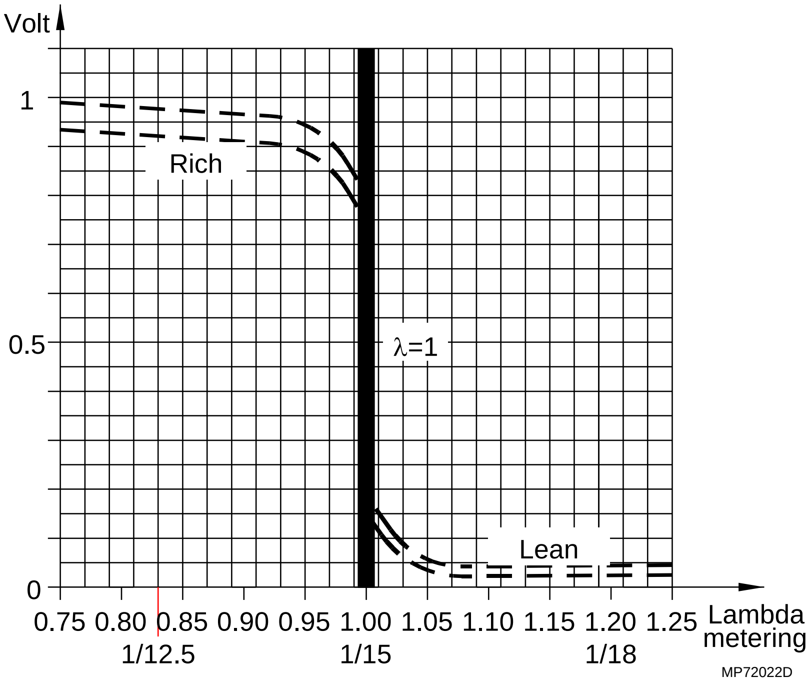
IX - OXYGEN PROBE

A - LSH6 TYPE

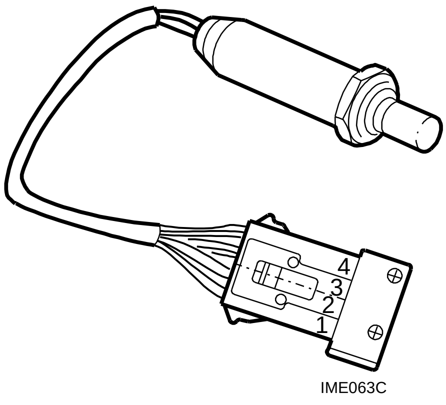
1 - Role

This provides the ECU with almost permanent information regarding the metering (air/petrol) of the fuel mixture. It has two possible states in order to provide rich or lean metering information, given by voltages of 1 volt and 0 volts respectively.



2 - Location

It is located on the exhaust pipe between the engine and the catalytic converter.



This voltage, which is analysed by the ECU, is used to correct the injection time so as to maintain a constant exhaust gas composition which is essential to ensure they are processed by the catalytic converter.

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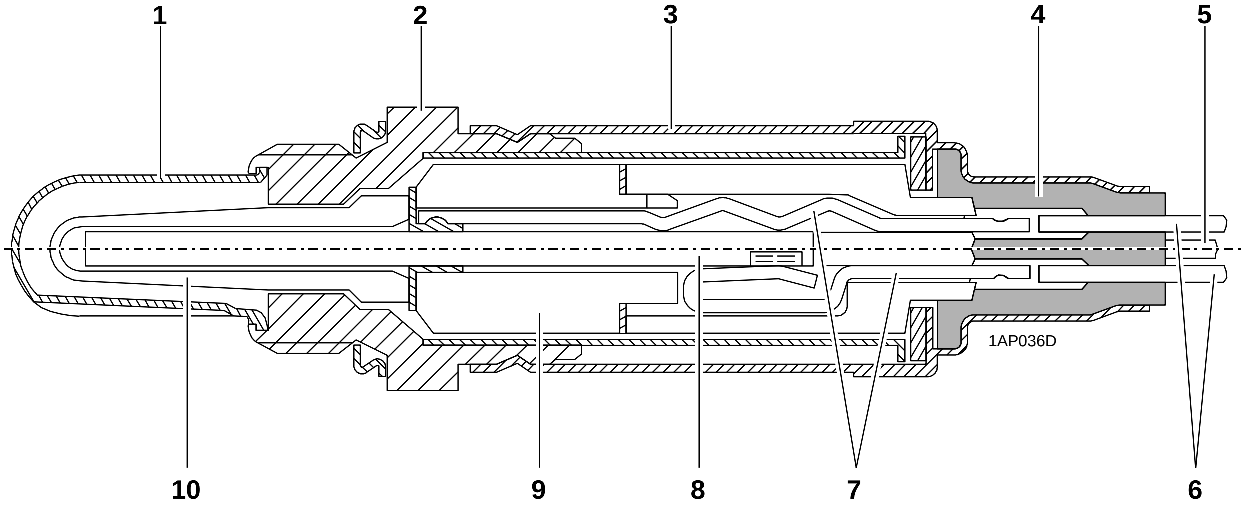
3 - Need

Reactions are not always optimum for the same richness. In fact, the conversion rate (or efficiency) for reducing NOx is at a maximum when there is no oxygen, therefore for rich mixtures ($\lambda < 1$) whilst the maximum oxidation efficiency of CO and HC is at a maximum in the presence of oxygen, therefore for lean mixtures ($\lambda > 1$).

The result is that, for oxidation and reduction reactions to be close to their optimum at the same time, the engine has to operate in a narrow richness window between $\lambda = 0.995$ and $\lambda = 1.005$.



4 - Description

1. Protection tube with slot (exhaust gas inlet)
2. Probe base
3. Cover (crimping not sealed)
4. Isolator
5. Electric wire (probe → ECU)
6. Probe reheating wire (+ off and earth)
7. Elements making the contact
8. Heating resistor
9. Ceramic support
10. Porous ceramic + platinum electrodes

5 - Operation

The probe consists of a special ceramic body the surface of which is fitted with gas permeable platinum electrodes. The way in which the probe operates lies in the fact that the ceramic used conducts oxygen ions at minimum temperatures of approximately 300 °C. One side of the porous ceramic is exposed to ambient air (through the wires or crimping of the probe). The other side of the ceramic is exposed to the exhaust gases. If the oxygen content is different at opposite ends of the probe, a potential difference occurs which forms the electrical signal.

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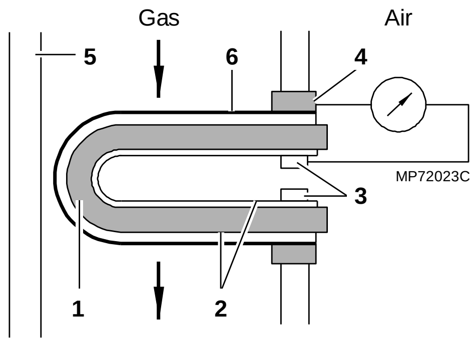
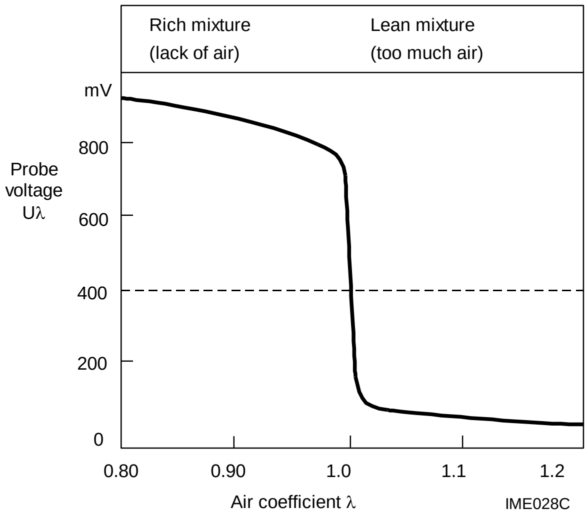


1 - Probe ceramic body
2 - Electrodes
3 - Contact
4 - Contact point of unit
5 - Exhaust pipe
6 - Porous ceramic protective layer

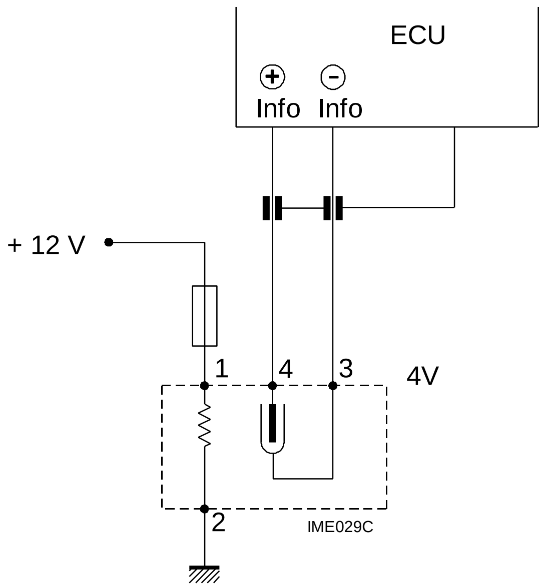


Characteristic curve of the voltage of the oxygen probe as a function of air coefficient at an operating temperature of 600 °C.

Note: The heating resistor incorporated into the probe keeps the temperature permanently above an operating limit (350 °C), independent to the temperature of the exhaust gases.

Advantages:

Efficient regulation of exhaust gases at low temperatures, lower sensitivity to variations in gas temperature, reduction in reaction time of oxygen regulation, improvement in probe dynamics.



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B - LSF TYPE (planar)

This probe is called planar; it operates in exactly the same way as the round LSH probe.

However, it uses very different technology. In effect, ceramic sheets are used to form a solid electrolyte. Each of these operational layers (electrodes, protective layers,…) is made by screen printing. Superposing the different screen printed sheets by laminating makes it easier to incorporate a reheater into the detection element.

1 - Main advantages

- Short operating time for oxygen regulation.
- Quick reactions to variations in mixture richness.
- Increased lifelength (≥ 160 000 Km)
- Can withstand high temperatures (1000°C)

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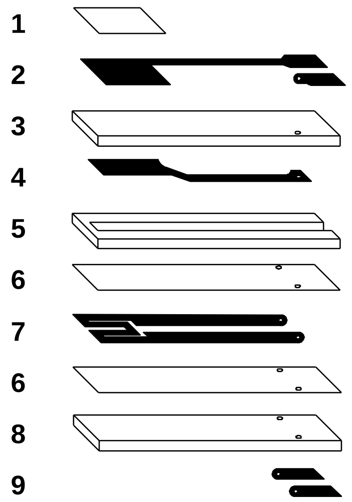
2 - Technology

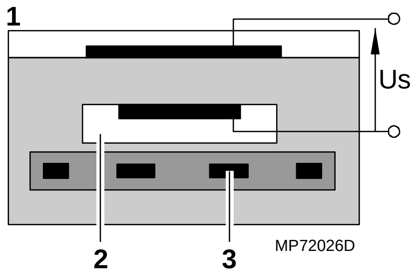
LSF planar oxygen probe (functional layers)

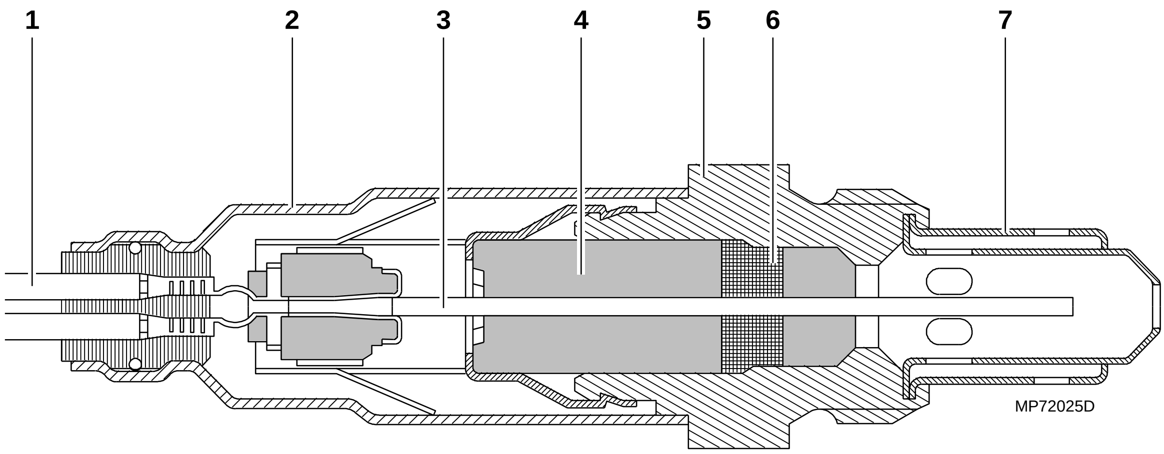
1 - Porous protective layer
2 - External electrodes
3 - Detecting layer
4 - Internal electrode
5 - Reference air channel layer
6 - Isolating layer
7 - Reheater
8 - Heating layer
9 - Connection contacts

LSF planar oxygen probe (stratification)

1 - Exhaust gases
2 - Reference air channel
3 - Reheater
Us - Probe voltage







1 - Connecting cable
2 - Protective housing
3 - Planar detection element
4 - Ceramic support tube
5 - Base
6 - Ceramic sealing lining
7 - Protection tube

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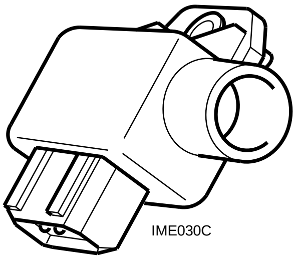
X - RICHNESS REGULATING POTENTIOMETER

A - ROLE

This potentiometer is used to adjust the richness (CO).



CO potentiometer

B - OPERATION

At idle speed, the richness is adjusted in a purely electronic manner, by adding or subtracting an imaginary injection time directly within the ECU and by acting on a potentiometer using a screw.

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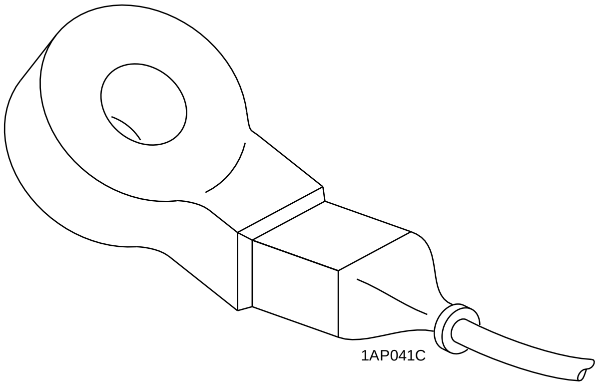
XI - KNOCK SENSOR

A - ROLE

The current trend for car manufacturers is to increase compression ratio so as to reduce consumption and to increase engine torque. Increasing this ratio does however risk causing the air/fuel mixture to combust explosively giving rise to knock.

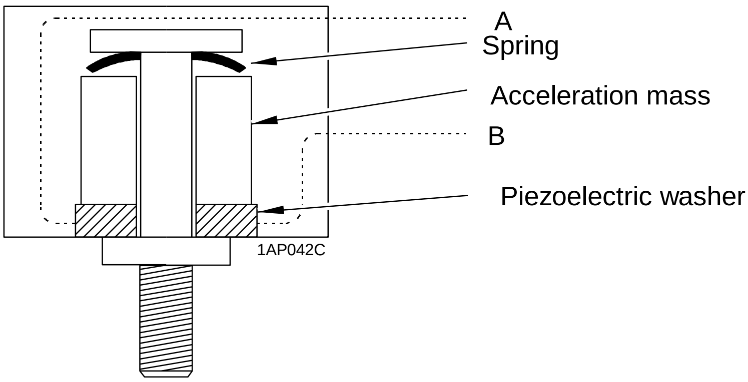
Using a sensor like this detects the phenomenon and provides a fast and efficient correction by electronically altering the ignition advance.



B - CHARACTERISTICS

The sensor is used to detect knock. It is of piezoelectric type. It is located on the engine block.

C - OPERATION



The sensor essentially consists of an acceleration mass held against a piezoelectric ceramic washer. The mechanical forces transferred to the mass under the effect of the vibrations create a variable voltage at terminals A and B of the washer.

Note: For this sensor to work correctly, it is essential that it is tightened to the correct torque and that the connection is perfect.

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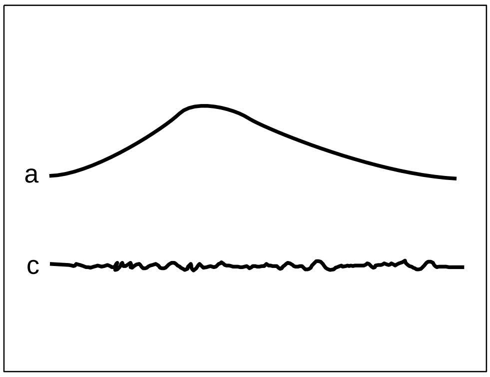

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Without knock:

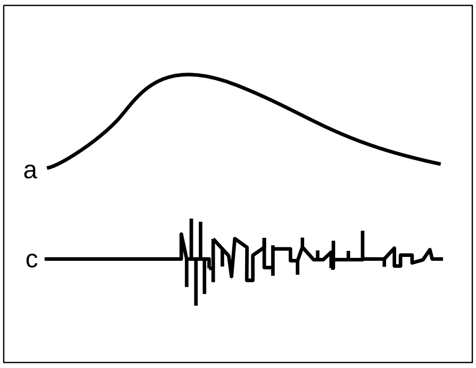
Curve (a) shows the change in pressure.

The knock sensor emits a signal corresponding to curve (c).

With knock:

A higher pressure can be seen.

The sensor signal is greater in both intensity and frequency.



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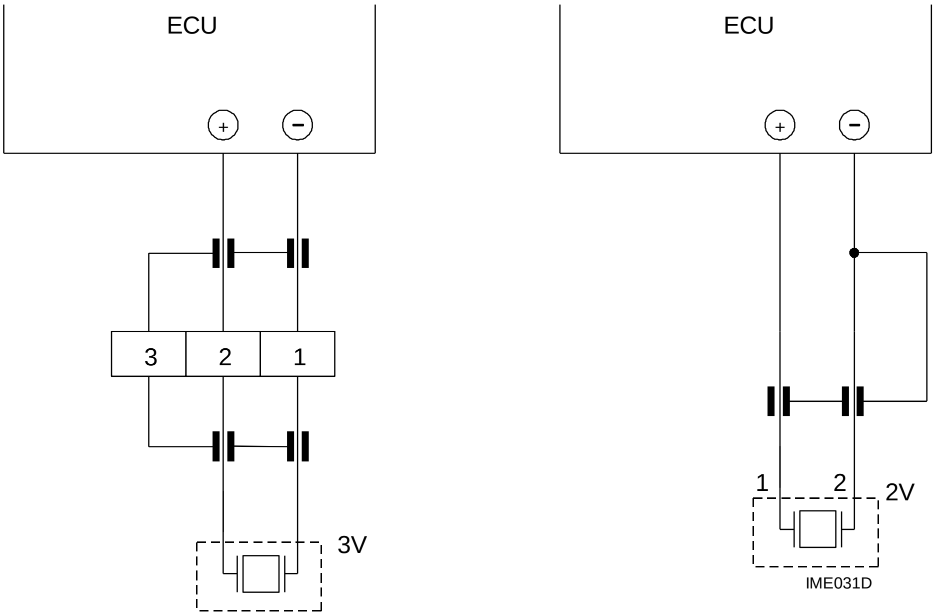
D - CONNECTION



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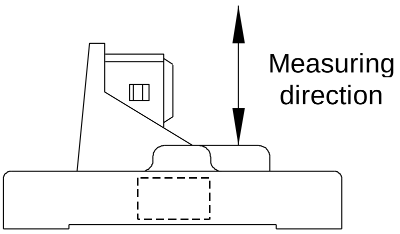
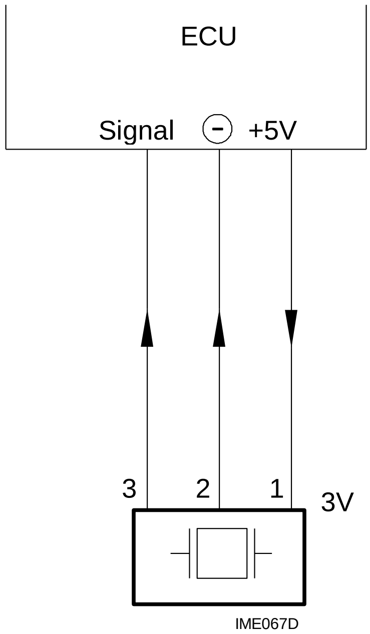
XII - ACCELEROMETER

This informs the ECU of the vertical accelerations of the vehicle body. In effect, within the scope of EOBD, the ECU has to detect misfires by analysing the signal from the engine speed/position sensor. However, the vertical accelerations of the body may cause the same phenomenon as misfires. The role of the accelerometer is therefore to provide "poor road" information and to prevent the ECU from wrongly detecting misfires and consequently illuminating the engine management light for no reason.





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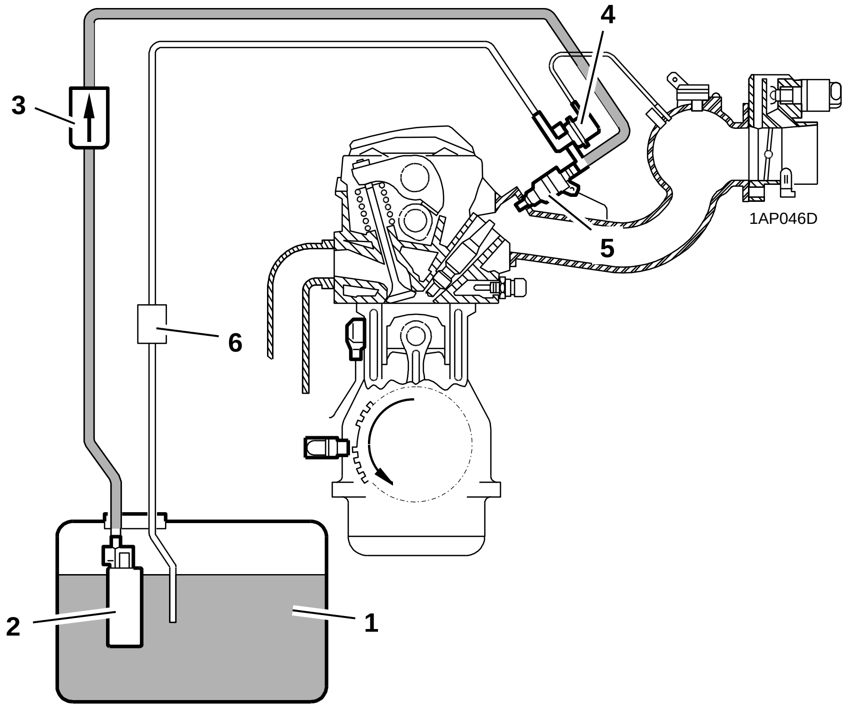
FUEL CIRCUIT

I - PRESENTATION



1 - Fuel tank
2 - Fuel pump
3 - Fuel filter
4 - Fuel pressure regulator
5 - Injector
6 - Non return valve

Fuel is drawn in from the tank by a submerged electric pump. It is supplied to the injector rail. A paper element filter is located between the pump and the injector rail.

The fuel pressure is regulated by a pressure regulator located at the end of the rail. Excess fuel is returned directly to the tank.

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II - MONOPOINT FUEL PUMP

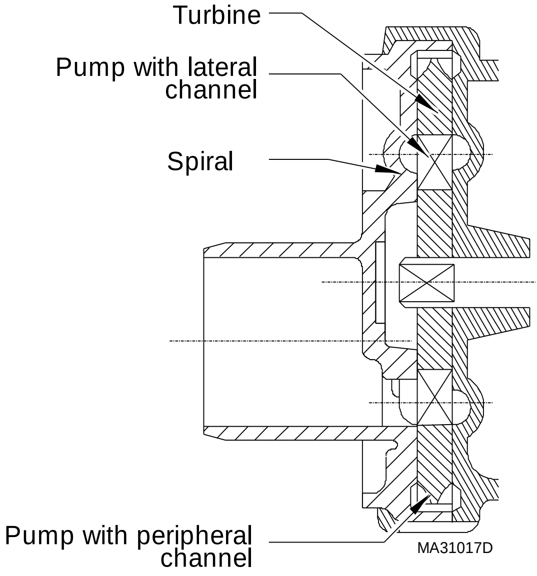
A - DESCRIPTION

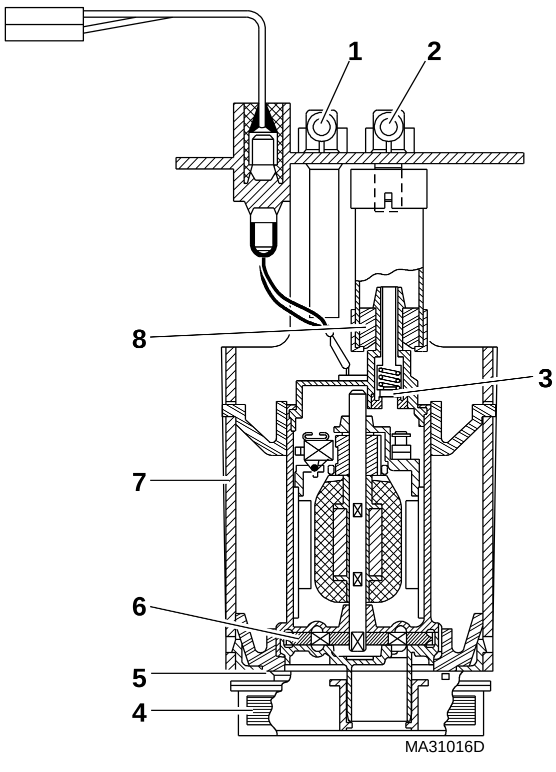
* Turbine pump submerged in the tank

The pumping element consists of a vane turbine which operates two stages. The inner stage operates using the lateral channel principle and the outer stage works using the peripheral channel principle.

B - SPECIFICATIONS

- Pressure : 1.1 bar
- Flow : 80 - 100 l/hour
- Max power : 60 W
- Supply : 12 V
- BOSCH reference : EKP 5





1 - Return
2 - Output
3 - Non return valve
4 - Strainer
5 - Degassing orifice
6 - Turbine
7 - Support housing
8 - Rubber sleeve

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C - OPERATION

The petrol is drawn in through the centre of the turbine and then enters a spiral; due to the centrifugal force, it is drawn towards the periphery of the turbine. The turbine is fitted with a number of peripheral vanes. In the housing there is a channel all the way round the periphery of the turbine vanes. The turbine projects petrol particles outwards towards the channel, where a continual pressure rise is produced.

The pump has degassing holes to prevent vapour bubbles forming even at high temperatures.

A non return valve on the pressure side prevents the pressure falling in the system after the engine has been switched off, making it easier to restart the engine.

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III - MULTIPOINT FUEL PUMP

A - DESCRIPTION

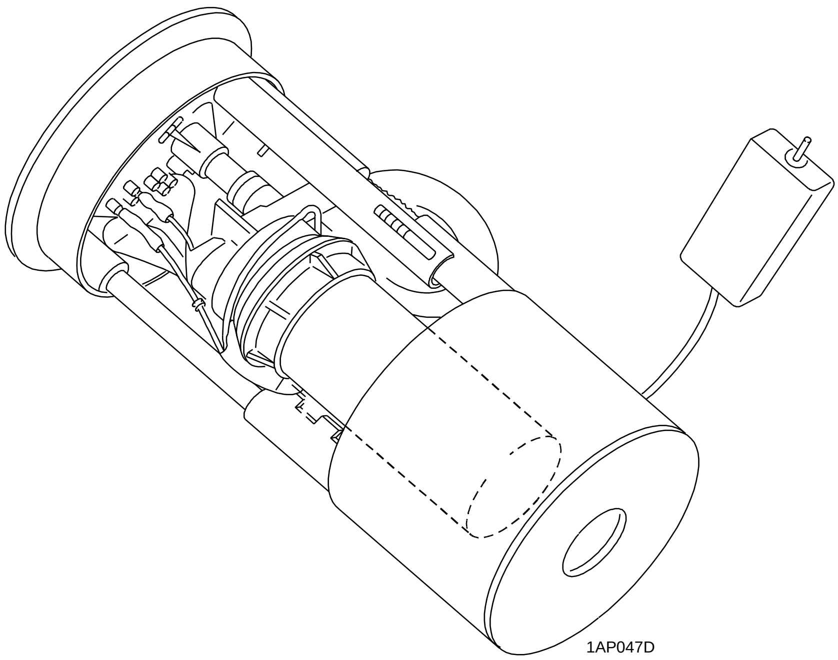
This is a Bosch EKP 10 type high pressure pump. It is submerged in the tank and connected to the sender unit but can be replaced on its own.

Its main feature is that it has two pressure stages. A booster stage consisting of a turbine draws in the fuel from the tank. A high pressure stage consisting of a gear pump supplies the pressurised fuel to a filter. The two stages are driven by a direct current electric motor.

The advantages of totally submerging the pump are noise reduction, better cooling and no internal leaks.

B - SPECIFICATIONS

Flow	:	120 l/hr at 3 bars
Power	:	approximately 50 watts
Resistance	:	0.8 Ω
Voltage	:	12 volts



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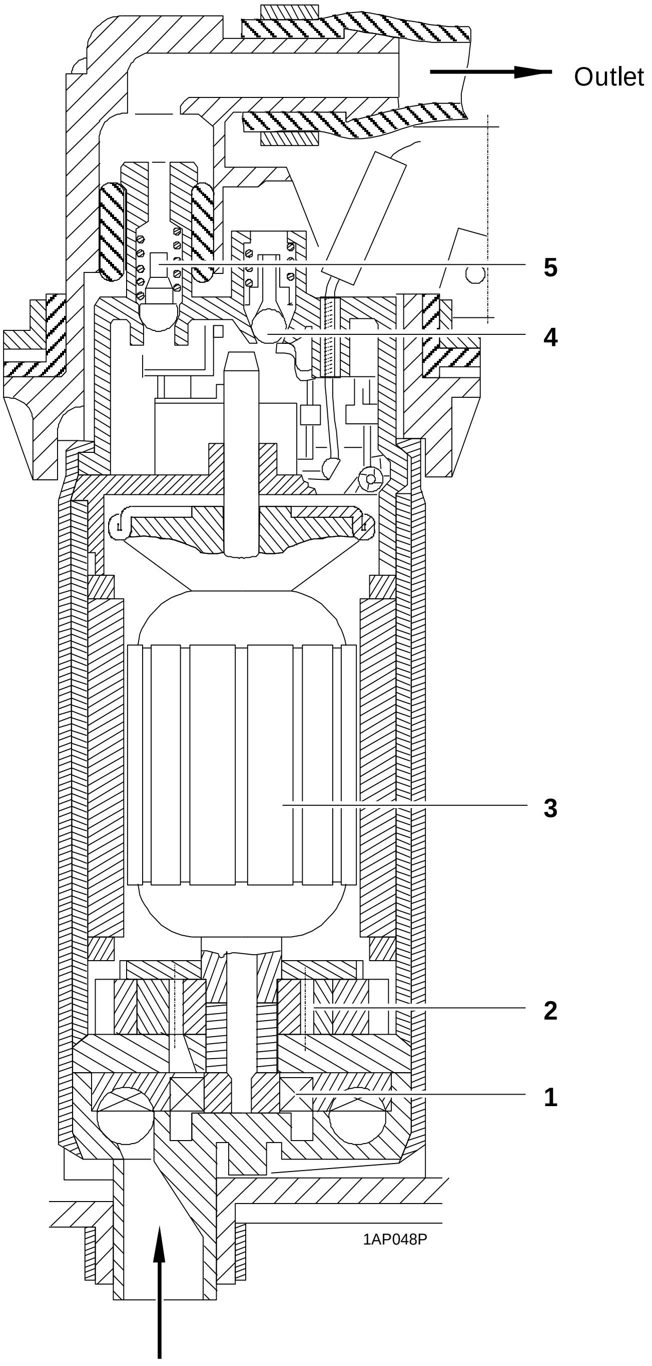
C - OPERATION



1 - Booster turbine

2 - High pressure gear pump

3 - Motor

4 - Pressure relief valve

5 - Residual pressure valve

As the turbine (1) rotates, fuel is drawn through the pump inlet. The fuel passes through the turbine and enters the chambers of the gear pump (2). By reducing the volume of the chambers, due to the rotation of the pump, the fuel is pressurised. This pressure causes the residual pressure valve (5) to open and the fuel passes through to the filter. When the pump is not working, the valve (5) closes thus maintaining a residual pressure in the supply circuit.

For a pressure increase of more than seven bar (increase caused by faulty operation of regulator or pipework accidentally blocked), the pressure relief valve (4) opens, causing the fuel to return directly to tank, limiting the pressure in the circuit.

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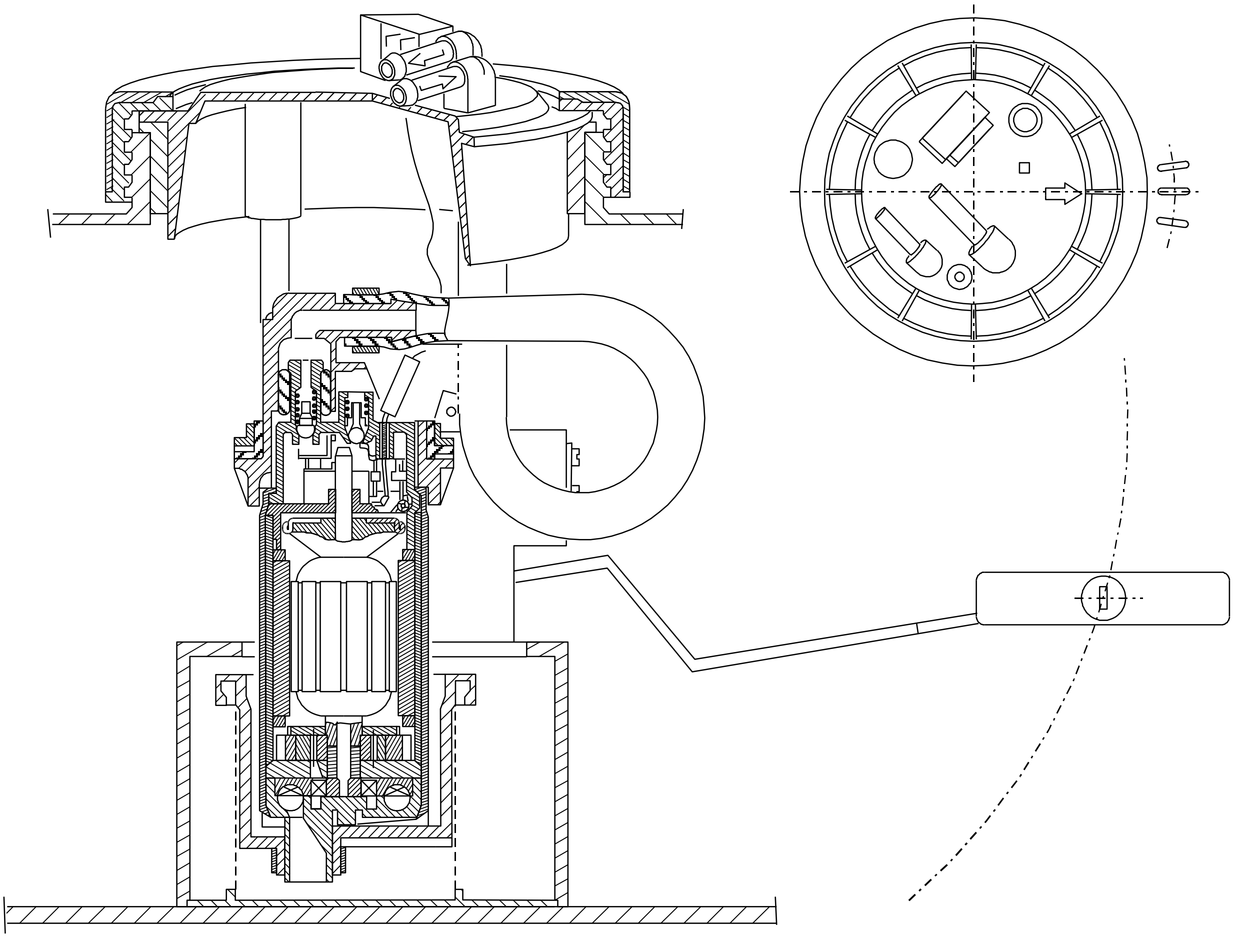
IV - ASSEMBLY FEATURE

The fuel pump and the sender rheostat have to be fitted into the tank to line up with the pump index and the reference marks on the tank.



MP5027P

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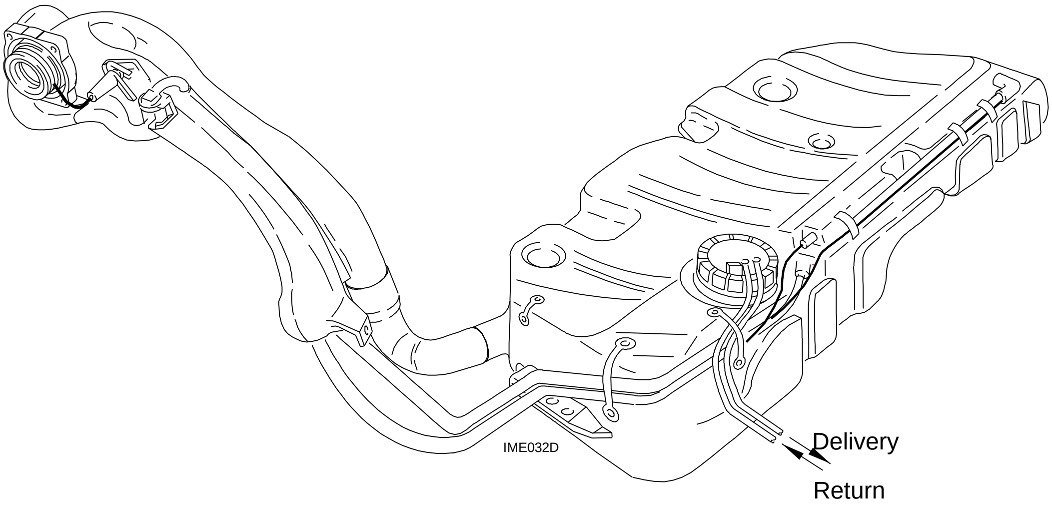
V - FUEL TANK

A - LAYOUT 1

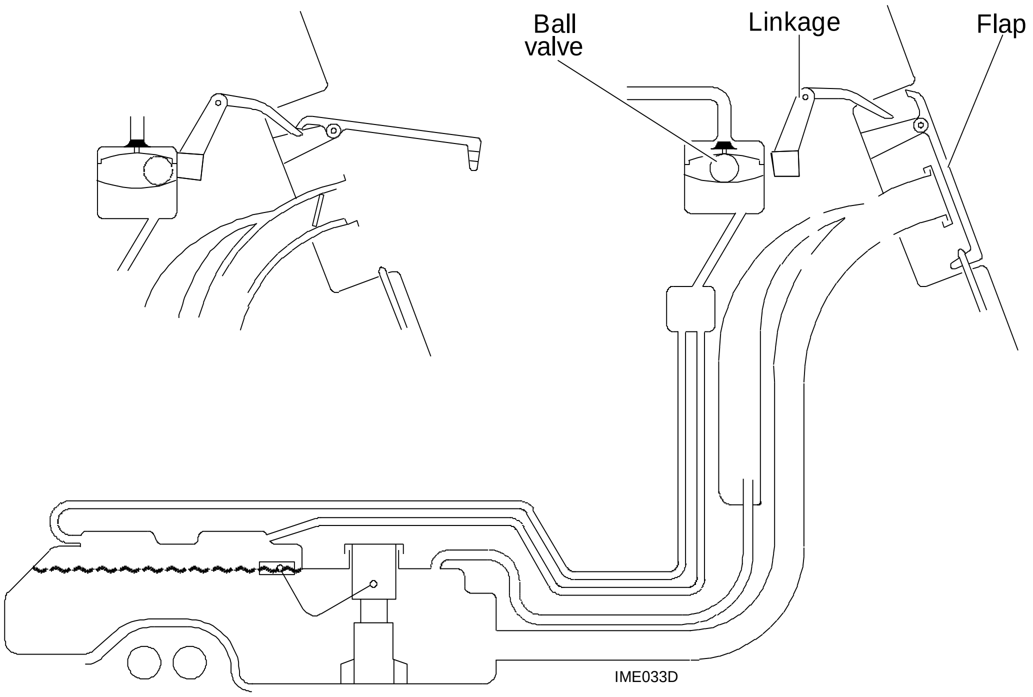


1 - Filler and breather circuit

The filler neck contains a breather ball valve. When filling with fuel, this valve is used to maintain a buffer volume of air in the tank which absorbs any expansion in the fuel caused by a rise in ambient temperature.

2 - Operation with magnetic valve

When the fuel filler flap is opened, a system of linkages causes a magnet to move which attracts the ball thus blocking off the breather valve.



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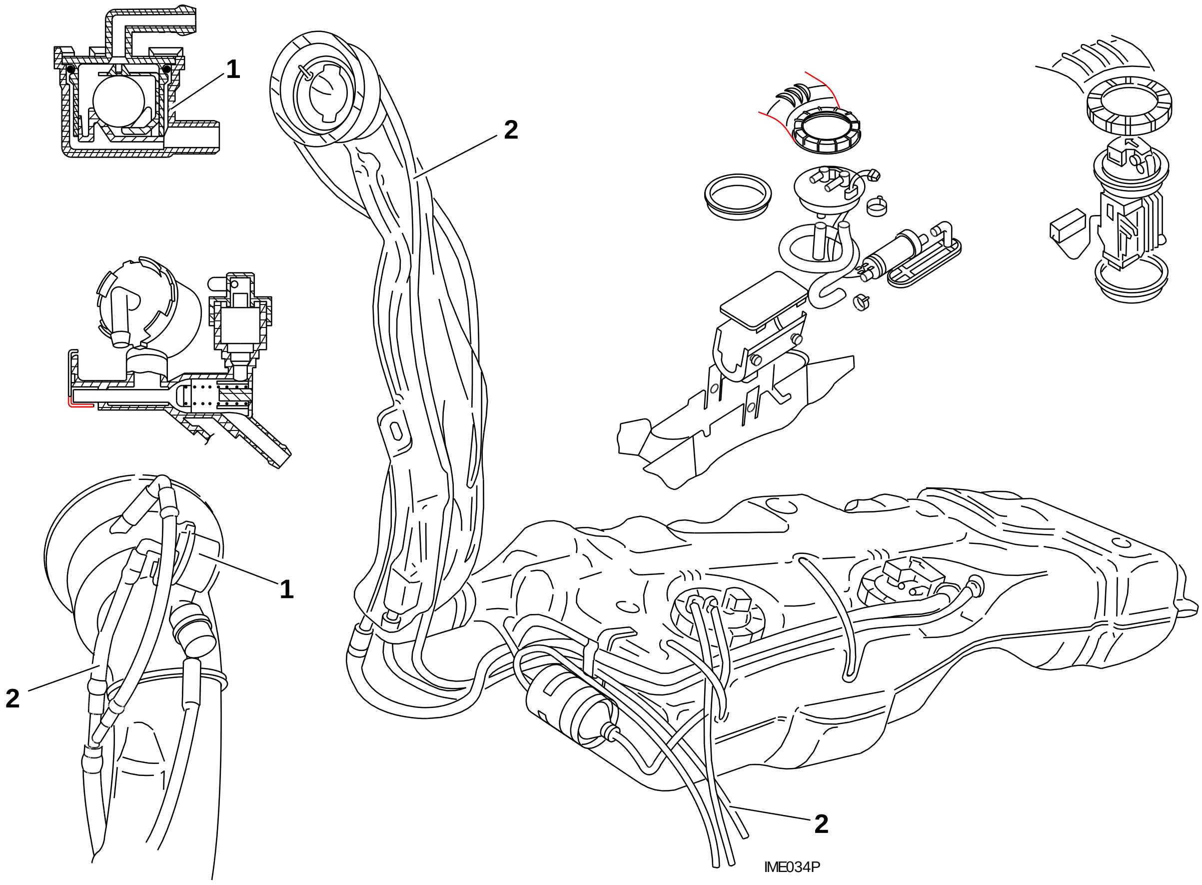
B - LAYOUT 2



1 - Filler and breather circuit

The filler neck contains a breather valve. When filling with fuel, this valve is used to maintain a buffer volume of air in the tank which absorbs any expansion in the fuel caused by a rise in ambient temperature.

2 - Operation

When the filler cap is removed, a piston moves under the action of a return spring thus blocking the breather valve. Replacing the filler cap pushes the piston back thus uncovering the breather valve.

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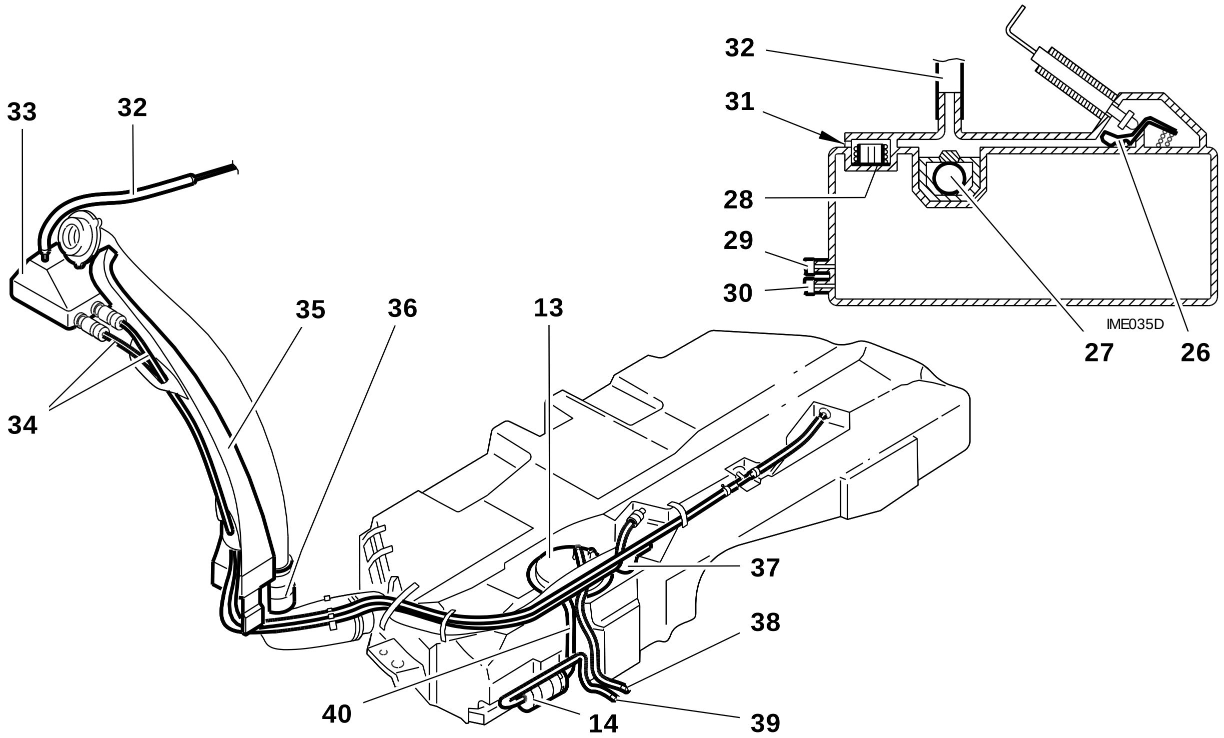
B - LAYOUT 3



1 - Operation

- Filler cap on:

The valve (26) is open and the tank breather operates through the pipes (34), the volume (33), the pipe (32) and the canister (18).

Note: Pipe (32) is connected to the canister (18) located in the engine compartment. If the tank becomes pressurised or depressurised due to a problem in the petrol vapour recirculation circuit, the valve (28) opens, thus forming a breather through the 2 orifices (31).
Should the vehicle overturn, the valve (27) prevents fuel from flowing out into the pipe (32) (depending on marketing country).

- Filler cap off:

The valve (26) is closed thus allowing a buffer volume of air to be maintained in the upper part of the tank.

When filling, degassing is obtained through the pipe (37) and the conduit (35). The filler neck is fitted with a non return valve at (36). The filler hole is reduced to a diameter of 21 mm so as to allow only the use of "unleaded" filler nozzles.

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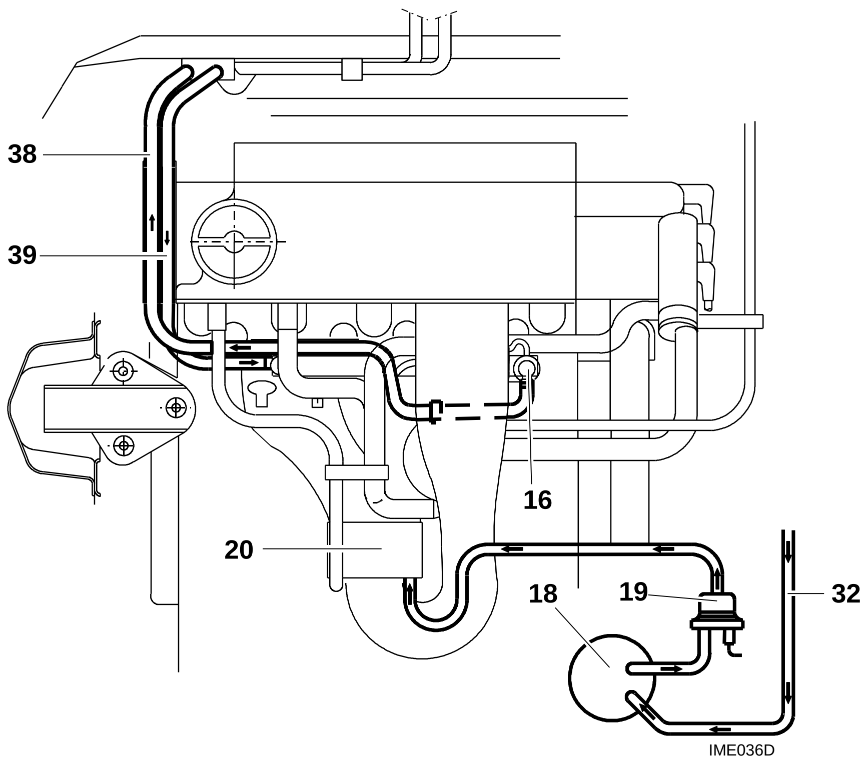


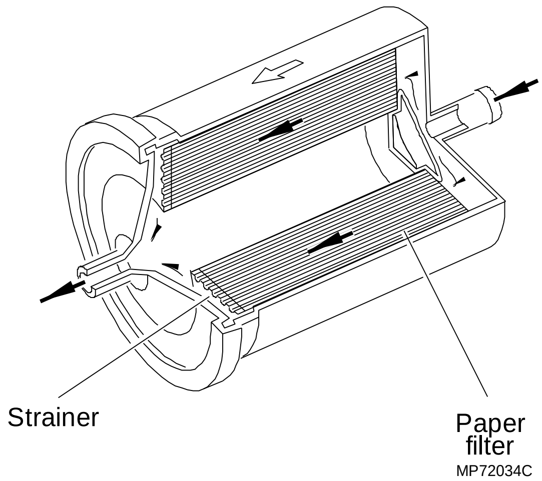
VI - FILTER

The fuel filter is located between the rubber tank outlet pipe and the rigid underbody pipe. It is secured to the right hand side of the rear sub-frame by means of a rubber mounting and is protected from the heat of the exhaust pipe by a thermal screen. It must be fitted the correct way round to ensure that the outlet strainer retains any paper debris (arrow pointing towards the front of the vehicle).

Filtration limit: 8 - 10 µ

Filtering area: Depending on engine

Replacement: Depending on engine



VII - INJECTION RAIL

In addition to distributing the fuel uniformly to all injectors, the injector rail also acts as an accumulator. In effect, its volume is sufficiently large with respect to the amount of fuel injected every engine cycle to prevent pressure fluctuations. The injectors are also supplied with fuel at a constant and uniform pressure.

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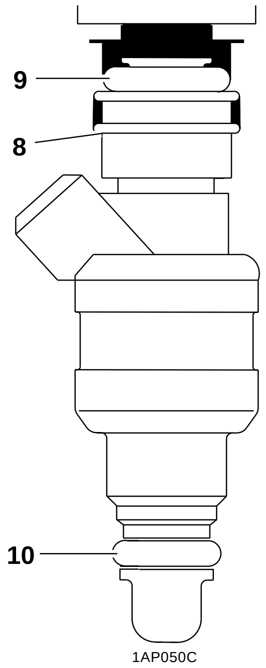
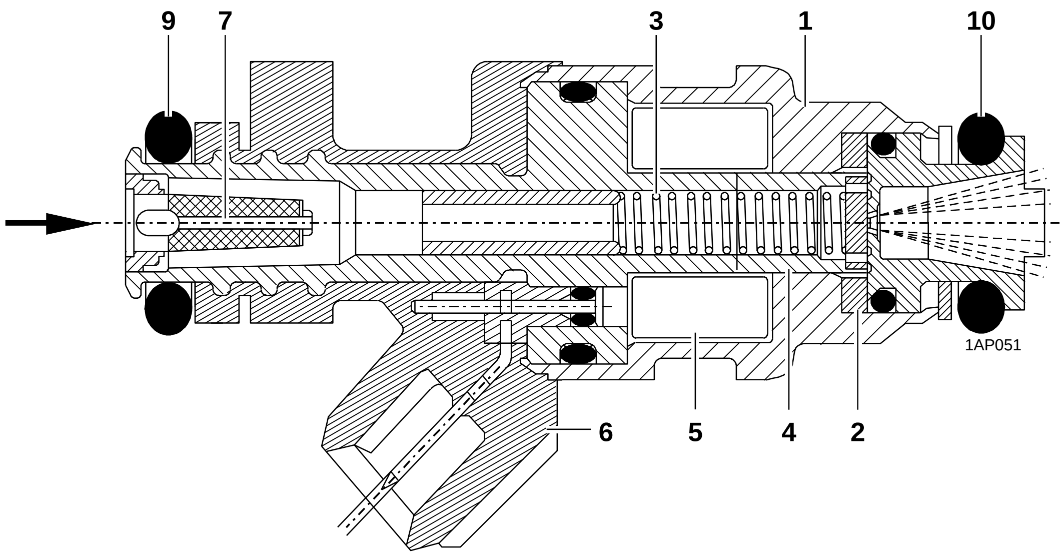
VIII - INJECTORS

A - MULTIPOINT INJECTORS

The Weber IW twin jet type injectors are secured and positioned angularly on the injection rail by a coupler (8). Seals (9) and (10) provide a seal as well as thermal insulation. The injector consists of a body (1) and a plate (2) which sits on top of a magnetic core (4). The body encloses the magnetic winding (5) and guides the plate. The supply is through the connector (6). When the ECU sends an electrical pulse, the electromagnet is energised and the plate rises from its seats thus compressing the return spring (3). After having passed through the filter (7), the fuel is released in two fine jets and accumulates in front of the inlet valve just before it opens.

When the inlet valve opens, the fuel is drawn in by the air flow into the combustion chamber.





The amount of fuel injected depends on how long the injector plate rises and therefore the time for which it is earthed.

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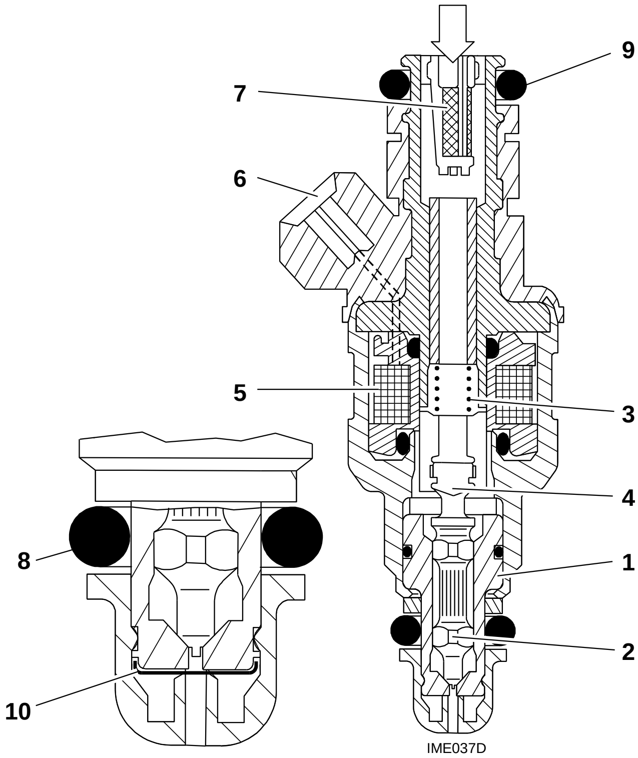
B - DIFFERENT TYPES OF INJECTORS

1 - Needle injector with vertical supply

BOSCH EV4.E

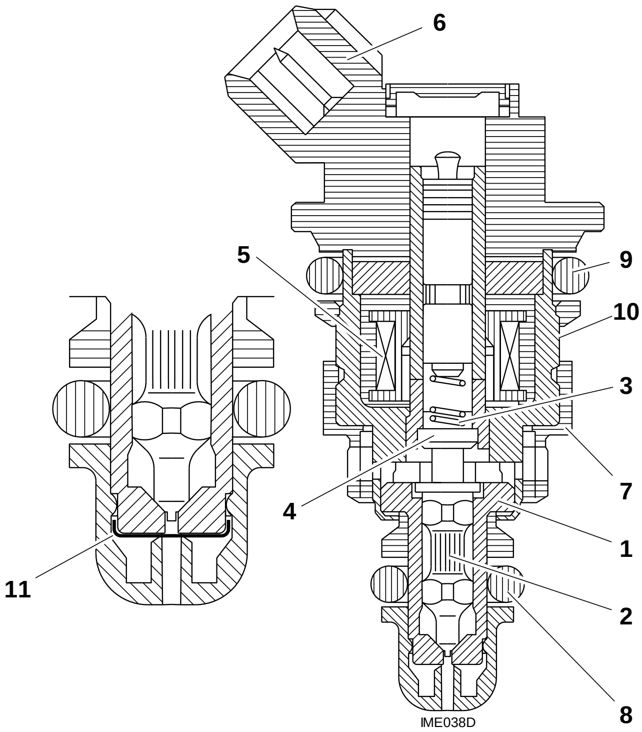
1 - Body
2 - Needle
3 - Return spring
4 - Magnetic core
5 - Magnetic winding
6 - Connector
7 - Filter
8 - Seal
9 - Seal
10 - Plate with holes



2 - Needle injector with lateral supply

BOSCH EV8.E

1 - Body
2 - Needle
3 - Return spring
4 - Magnetic core
5 - Magnetic winding
6 - Connector
7 - Filter
8 - Seal
9 - Seal
10 - Locating groove
11 - Plate with holes



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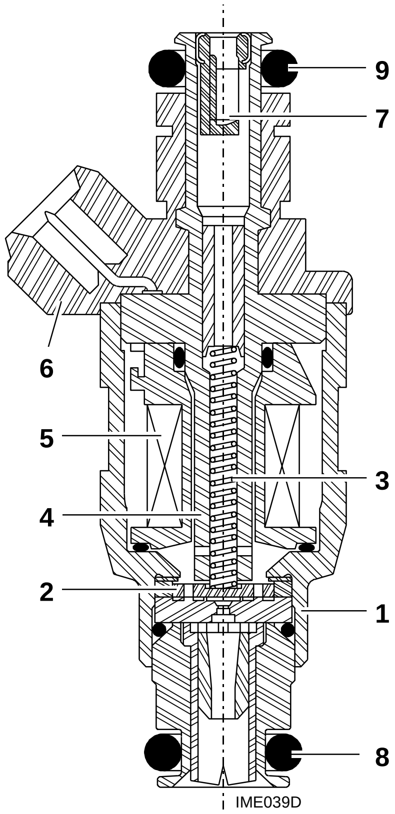
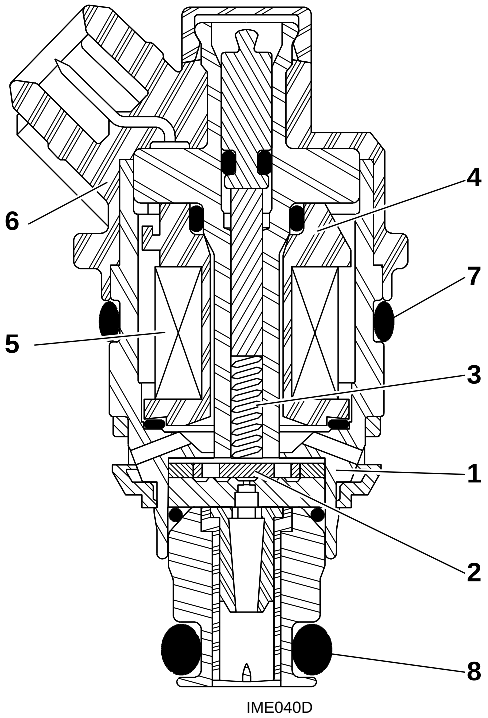
3 - Plate injector with vertical supply SAGEM D3MA2

1 - Body
2 - Plate
3 - Return spring
4 - Magnetic core
5 - Magnetic winding
6 - Connector
7 - Filter
8 - Seal
9 - Seal



4 - Plate injector with lateral supply SAGEM-LUCAS D2155 MA

1 - Body
2 - Plate
3 - Spring
4 - Magnetic core
5 - Magnetic winding
6 - Connector
7 - Seal
8 - Seal



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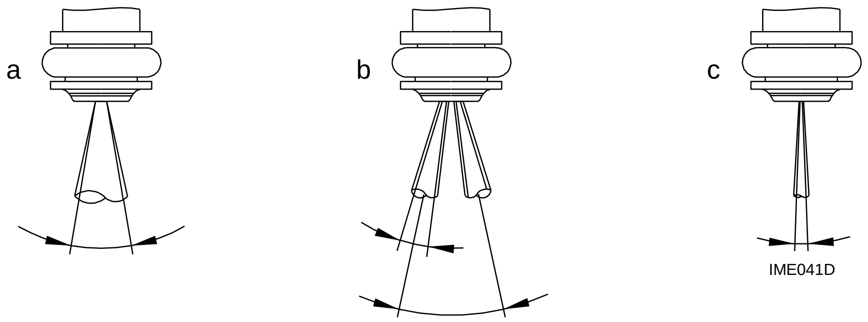
C - DIFFERENT TYPES OF JETS

The EV6 injector has different jet angles.

- a) tapered jet. 80% of fuel is within angle shown.
- b) twin jet. 50% of fuel is within angle shown.
- c) "narrow" jet. 70% of fuel is within angle show.



There are various types of injectors. Each type is suited to a particular engine, vehicle and system.

The main characteristics are:

- the flow,
- the engine type (one valve/cylinder or multivalve),
- the location.

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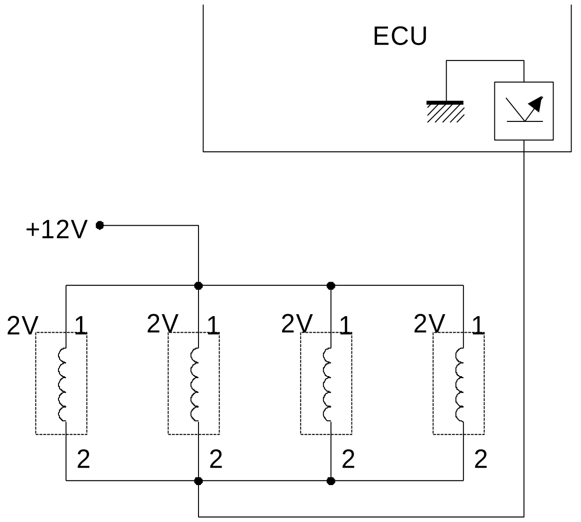
D - DIFFERENT TYPES OF CONTROL

The injectors can be controlled in different ways:

1 - Full Group
All injectors at the same time.



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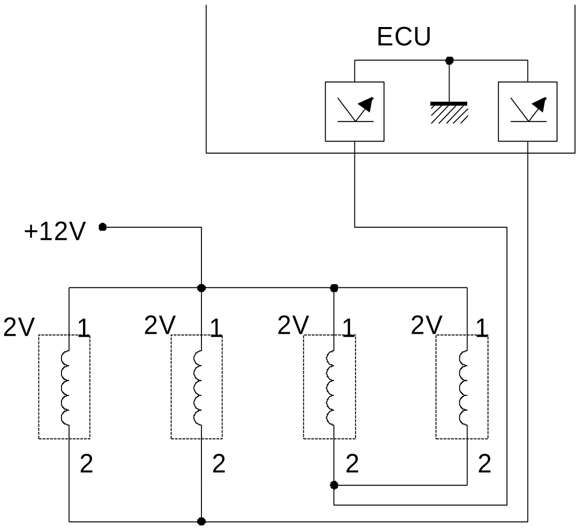
2 - Semi-Full Group or semi-sequential
Injectors controlled in pairs.



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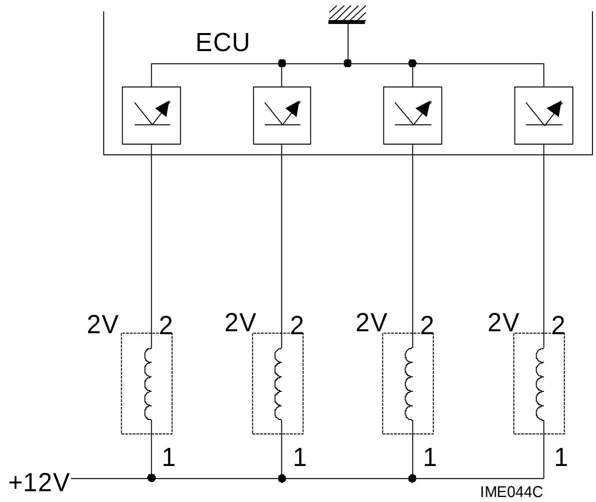
3 - Sequential

Injectors controlled individually.



E - MONOPOINT INJECTOR

1 - Description

1 - Electrical connection

2 - Fuel return

3 - Fuel inlet

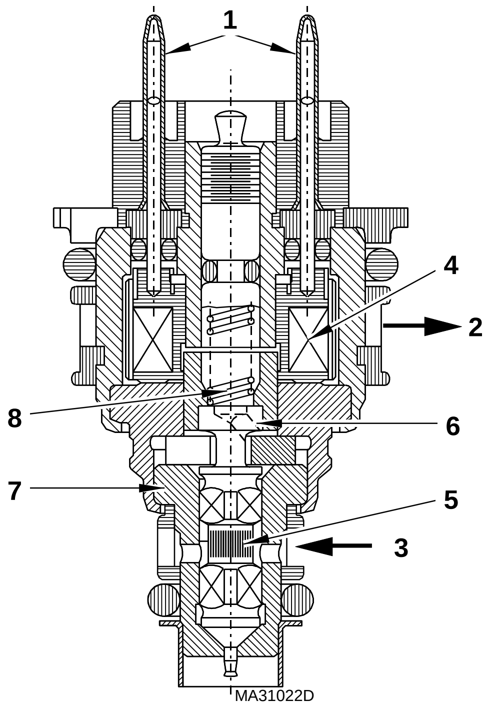
4 - Magnetic winding

5 - Injector needle

6 - Magnetic core

7 - Injector body

8 - Needle return spring



2 - Operation

When the ECU supplies the winding (4) by means of an electric pulse, a magnetic field is created in it. The needle (5) rises up from its seat and compresses the return spring (8). The fuel is released in a fine jet.

The amount of fuel injected depends on the time for which the needle rises and therefore the time for which the magnetic winding of the injector is earthed. The time for which the injector is energised varies from 1 to 5 ms when warm but may be 100 ms when starting from cold.

3 - Characteristic

Since the resistance of the injector is 1.4 Ω, an additional 3 Ω resistor is fitted in series with the injector.

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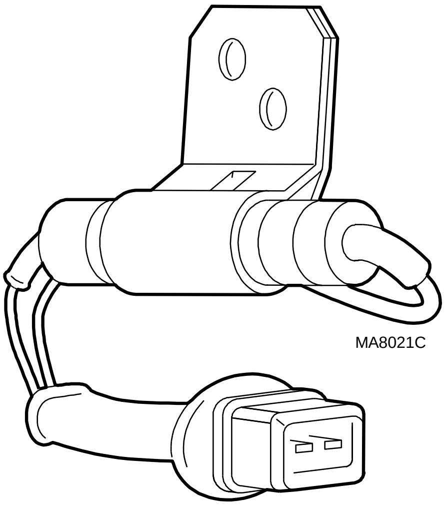

Additional resistor

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IX - THE FUEL PRESSURE REGULATOR

This is located on the end of the rail after the injectors. It regulates the pressure in the fuel circuit. The regulation value is kept constant if the injector is located before the throttle - fig A. In this case, there is no pressure difference between upstream and downstream sides of the injector (monopoint injection).

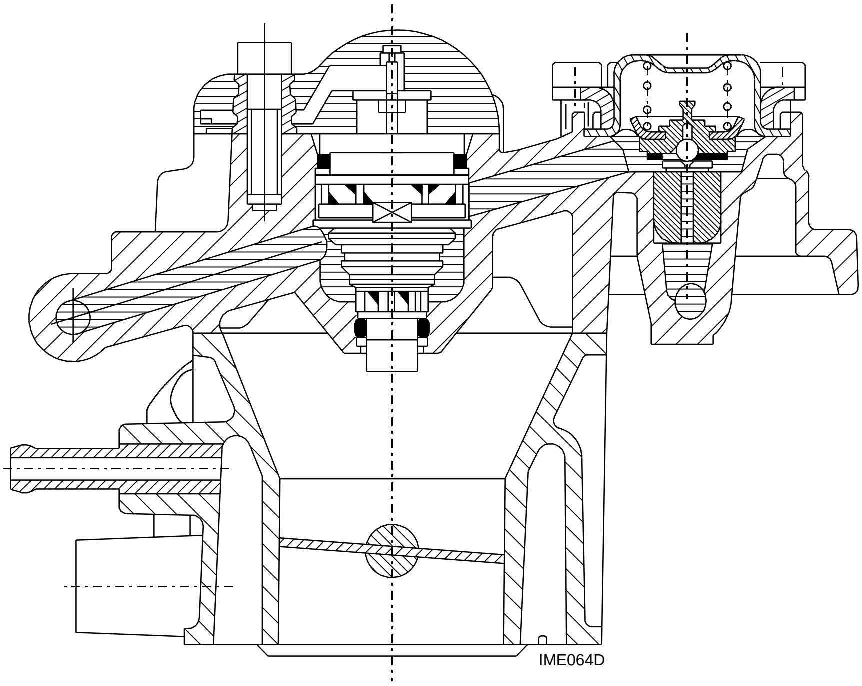

Figure A

If the injector is located after the throttle (fig B), it is subject to manifold pressure variations. In this case, the fuel pressure will be regulated depending on the variations in manifold pressure.

"The difference between the fuel supply pressure and the manifold pressure remains constant ".

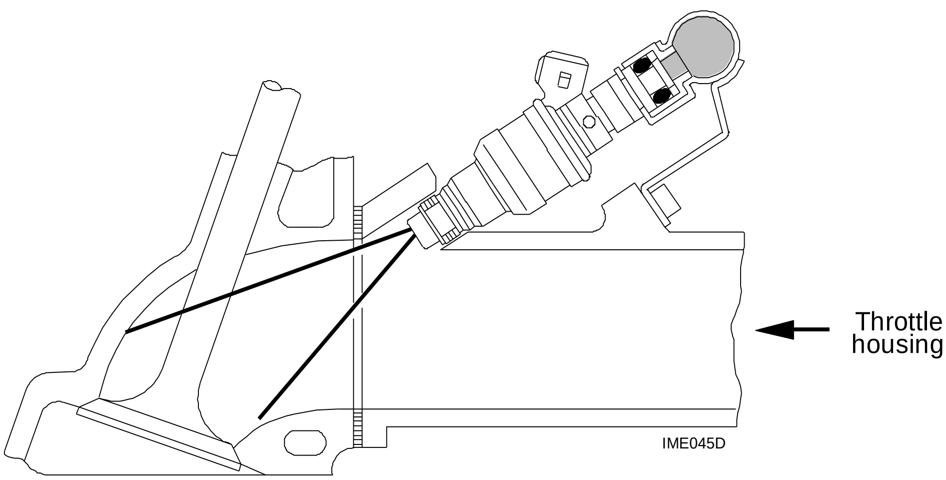

Figure B

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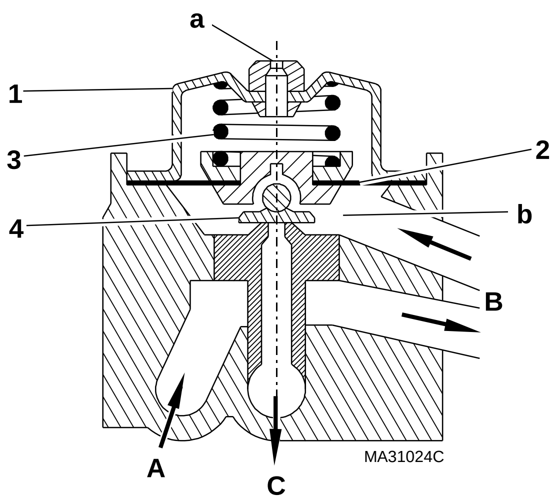
A - MONOPOINT REGULATOR

This is used to maintain the fuel pressure at a constant value.

1 - Description



1 - Metal housing with atmospheric pressure take-off (a)

2 - Membrane

3 - Return spring

4 - Valve

b - Fuel pressure chamber

A - Fuel inlet circuit

B - Supply and injector return circuit

C - Tank return circuit

2 - Operation

The spring (3) is rated to one bar. The fuel pressure is therefore one bar greater than atmospheric pressure.

When the pressure in chamber (b) increases and exceeds the value set by the spring rating, the valve (4) opens and the fuel returns to tank.

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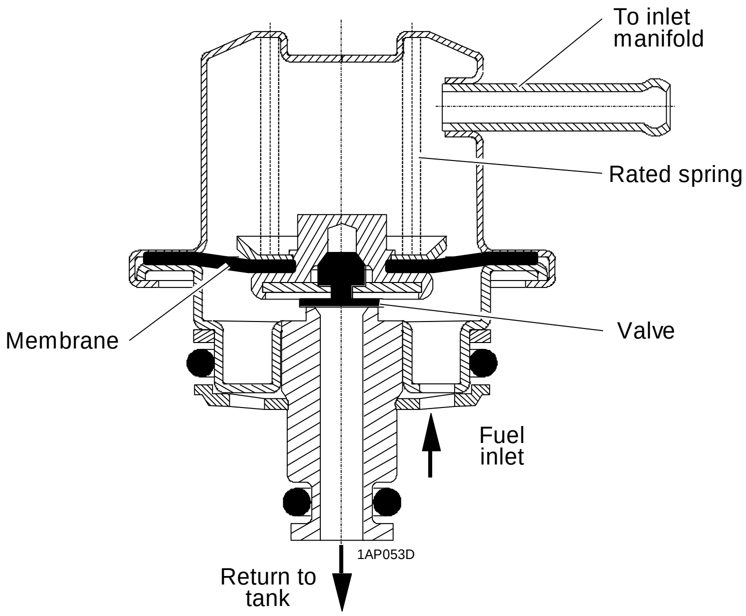
B - MULTIPOINT REGULATOR

1 - Description



This consists of two crimped capsules, enclosing a membrane onto which a spring is mounted. The rating of the membrane is set by a spring and the pressure from the manifold.

The rating pressure is engraved onto the regulator body.

2 - Operation

When the fuel pressure is sufficient to deflect the membrane, the valve lifts and fuel flows through the central conduit to tank. If the manifold pressure varies, the regulated value of fuel pressure will also vary accordingly. The fuel pressure at full load is therefore greater than when idling.

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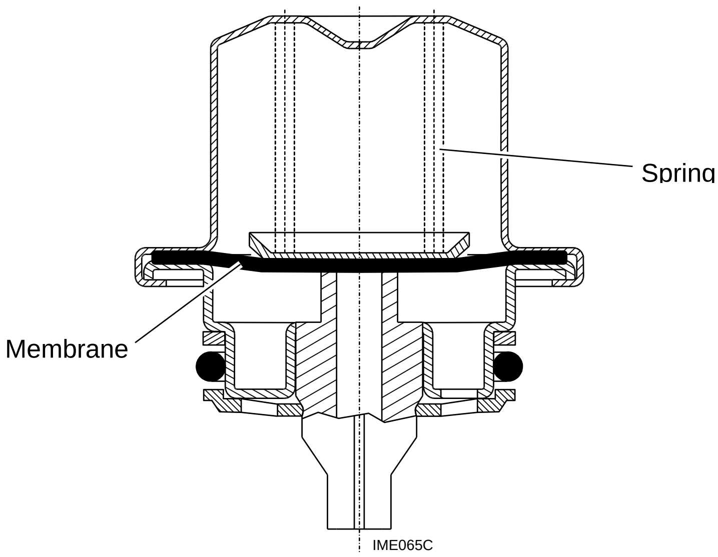
X - THE PULSE DAMPER

A - ROLE

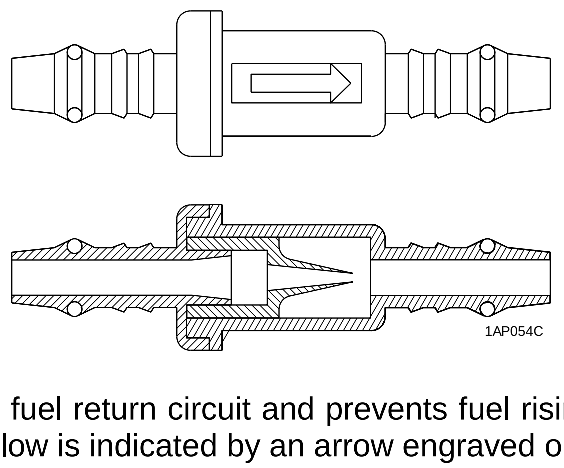
When the injectors or the pressure regulator open and close, pressure variations are created. Also, the flow and consequently the pressure is varied every time a gear in the pump makes contact. These variations in pressure cause pulses leading to resonance in the circuit. The role of the pulse damper is therefore to attenuate the pressure waves thus preventing pulsing noises from propagating.

B - CONSTITUTION

This is a pressure regulator which is not connected to the inlet manifold. A membrane separates the damper into two chambers. The fuel passes through one chamber. The other chamber contains a spring; when a pressure peak occurs, the membrane retracts and absorbs the pressure wave.



XI - NON RETURN VALVE



This is located in the fuel return circuit and prevents fuel rising up the return pipe. The direction of fuel flow is indicated by an arrow engraved on the valve body.

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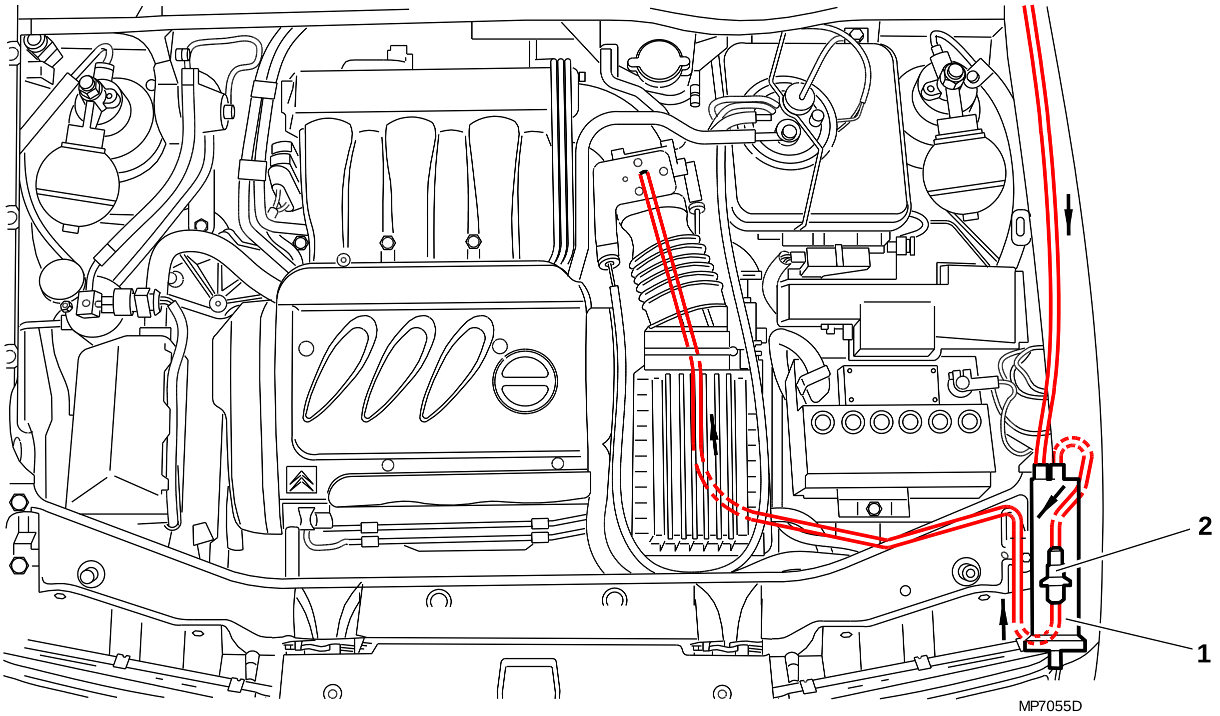
PETROL VAPOUR RECIRCULATION

I - INTRODUCTION

In addition to the standards relating to the emission of toxic exhaust gases, legislation includes regulations on the emission of gases from the fuel tank. In fact, when the fuel in the tank heats up due to a high ambient temperature or a high temperature in the fuel circuit, vapours are produced which are released freely into the atmosphere. Using a canister bleed circuit, the vapours are recuperated by an active carbon filter.

II - PETROL VAPOUR RECUPERATION CIRCUIT



1 - Active carbon filter (canister)

2 - Canister bleed valve.

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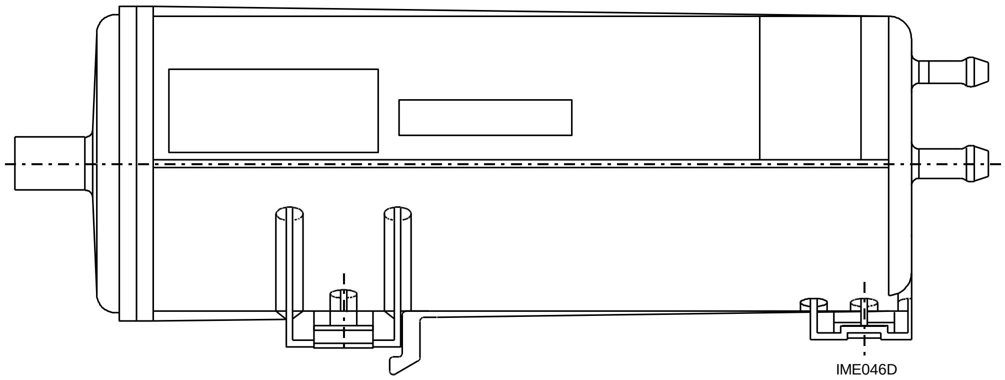
The air contained in the tank is released into the atmosphere through the canister when the engine is stopped. Petrol vapours are retained by the carbon and are temporarily stored there until the engine is started again. The vacuum inside the inlet manifold when the engine operates draws in fresh air through the carbon filter. This air flow carries the stored petrol vapours with it. In order to regulate this air flow, an OCR (opening cyclic ratio) valve, controlled by the computer, is positioned in the petrol vapour recirculating circuit. The bled gases may affect the richness. The valve opening must therefore be suited to the engine operating conditions.

III - ACTIVE CARBON FILTER (CANISTER)



This consists of carbon granules which retain the petrol vapours from the fuel tank. This prevents fuel vapours from being released into the atmosphere.
Recycling phases are worked out by the ECU which controls the canister bleed electrovalve.

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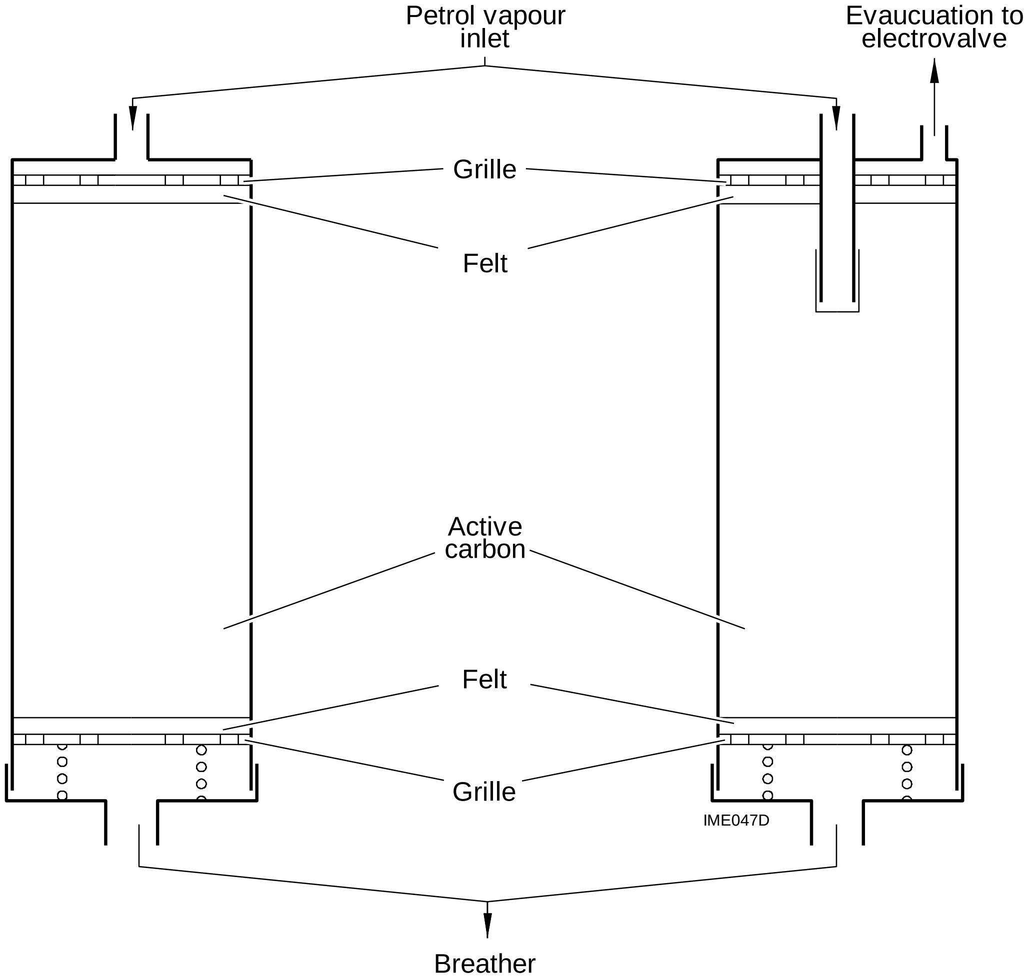
CANISTER (two way) / CANISTER (three way)



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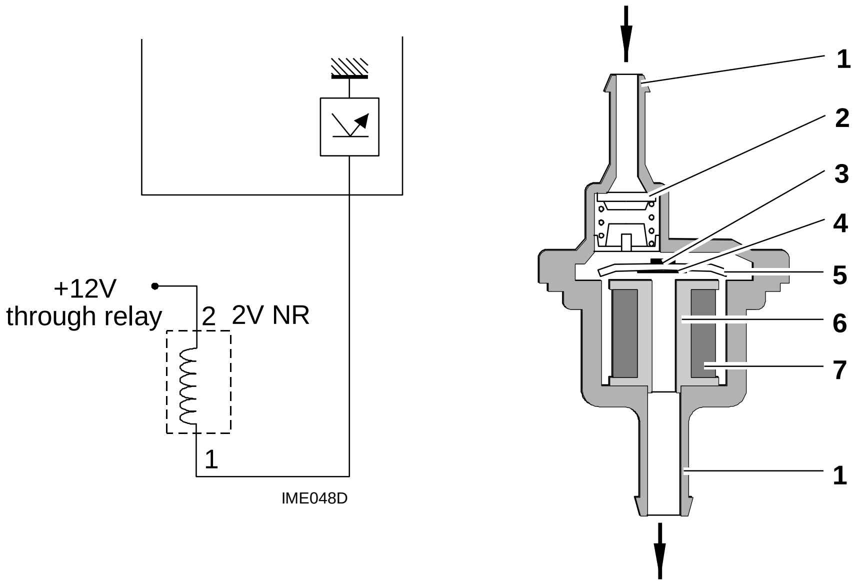
IV - CANISTER BLEED VALVE (NORMALLY OPEN TYPE)

A - DESCRIPTION



1 - Hose connector

2 - Non return valve

3 - Leaf spring

4 - Sealing element

5 - Plunger core

6 - Seal retainer

7 - Magnetic winding

The arrow engraved onto the body of the valve must be pointing towards the engine.

B - OPERATION

Engine off

The bleed electrovalve is open → the canister absorbs the petrol vapours released from the fuel tank. A non return valve incorporated into the electrovalve isolates the engine from the canister.

Ignition on

The ECU orders the bleed electrovalve to close.

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Engine running

The ECU controls the bleed electrovalve in specific cases so as to empty the canister; the petrol vapours are recycled to the inlet.

Note:
- *Bleeding is only authorised above a certain coolant temperature.*
- *When the engine is off, the electrovalve is closed for a few seconds to prevent self ignition.*

C - CONTROLLING THE BLEED ELECTROVALVE

This is of NO type, which stands for "Normally Open ".

An OCR controlled electrovalve is used. It is closed for an OCR of 100% and fully open for an OCR of 0%. It is open at rest, therefore when it is not energised. The system inverts the command so that the displayed OCR (diagnostic signal) is proportional to the opening.

0% $\rightarrow$ valve closed

100% $\rightarrow$ valve open

The OCR values are stored in a Pressure/engine speed cartographic map and are defined so as not to disturb oxygen probe regulation whilst ensuring sufficient recycling to comply with the standards. Bleeding is not authorised during the richness auto-adaptation phase. The flow depends on the differential pressure at the valve (ΔP) and the duration of the triggering pulses; this is why a pressure/engine speed map has been stored in the memory. In fact, as much as possible should be bled at high load, despite a lower pressure difference at the valve; however, when idling and at partial loads, the flow volume must be throttled as much as possible taking into account driving pleasure since the pressure difference is high in this range.

The OCR value calculated by the ECU therefore corresponds to the time for which the valve is not energised, and therefore the opening time.

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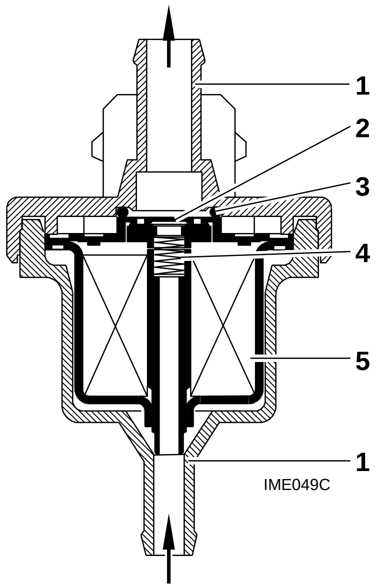
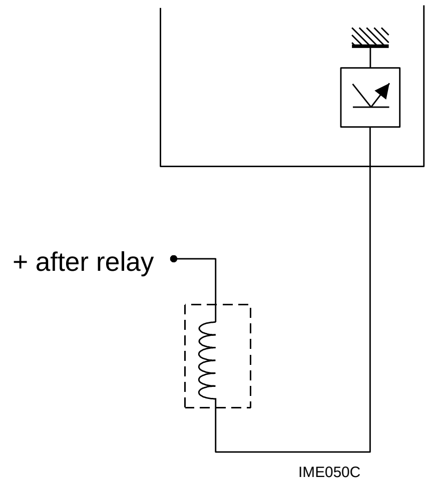
V - CANISTER BLEED VALVE (NORMALLY CLOSED TYPE)

A - DESCRIPTION



1 - Hose connection
2 - Valve
3 - Magnetic core
4 - Return spring
5 - Magnetic winding

The arrow engraved on the body of the valve must be pointing towards the engine.



B - OPERATION

This electrovalve is of NC type, which stands for "normally closed".

Therefore, when the engine is off and then the ignition is switched on, it closes and remains so.

When the engine is running, the ECU controls the bleed electrovalve in certain precise cases so as to empty the canister; fuel vapours are recycled to the inlet. The electrovalve is operated with an opening cyclic ratio (OCR) designed to regulate the amount of recycled gases depending on the engine operating conditions.

For an OCR of 0% (not energised), it is closed whilst for an OCR of 100% (permanently energised), it is fully open. By alternately activating and deactivating it with a precise ratio between the time it is energised and the time it is not energised, it adopts a certain opening position allowing a certain flow of gases from the canister.

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VI - BLEED STRATEGY

- The opening given to the bleed electrovalve by the ECU permanently changes depending on:
  - The amount of gases passing through the valve.
  - The engine operating range determined by the engine speed and the throttle position.
  - The amount of petrol vapours in the canister.
- By evaluating the quantity of petrol vapours recycled into the engine, the ECU makes the mixture leaner using a bleed auto-adaptation factor.

Note: The disturbance to richness regulation caused by recycling the canister vapours differs from that caused by non measurable external parameters both in duration and size. The ECU therefore applies the following alternating cycle:

- When normal richness auto-adaptation is active, canister bleed is cancelled.
- When bleed is active, normal richness auto-adaptation is suspended and replaced by a specific bleed auto-adaptation.

VII - CANISTER ISOLATION VALVE

In certain cases, an isolation electrovalve is placed in series with a bleed electrovalve. This ensures the valve is perfectly closed when the ignition is switched off. The isolation electrovalve is closed at rest and open when energised.

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ADDITIONAL AIR

I - INTRODUCTION

An air circuit is fitted as a branch circuit to the throttle and consists of hoses or a conduit which is machined directly into the throttle housing. This additional air is taken into account by the pressure sensor or the flow meter and a suitable quantity of fuel is combined with it. This additional mixture modifies the engine speed.

- There are several ways in which to alter the cross section of the circuit:
  - stepper motor,
  - idle electrovalve,
  - idle rotary actuator,
  - idle regulation motor acting on the throttle,
  - additional air control.
- The following advantages are provided:
  - idle speed changes as engine temperature changes,
  - idle speed maintained at a constant predetermined value,
  - compensation depending on air conditioning info, AC.ON (Switch request) or AC.Th (Pressure switch authorisation),
  - aids starting,
  - assistance when decelerating,
  - automatic transmission in drive,
  - compensation for power assisted steering.
- Operation

  It is controlled by the ECU using the following criteria:
  - engine speed,
  - idle position,
  - engine temperature,
  - vehicle speed or gear engaged,
  - whether the air conditioning is engaged or not,
  - automatic transmission status.

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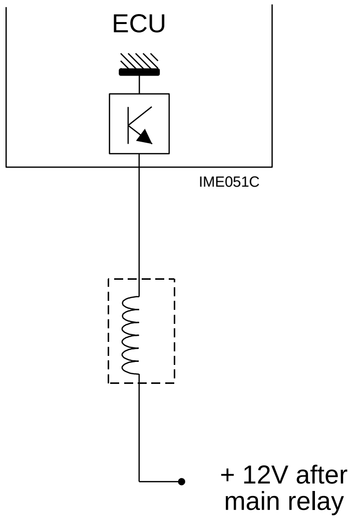
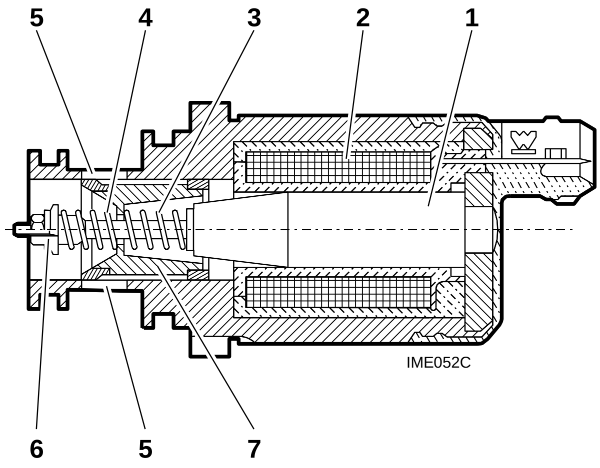
II - IDLE REGULATION ELECTROVALVE





1 - Magnetic core
2 - Winding
3 - Return spring
4 - Positioning spring
5 - Additional air cross section
6 - Nut for adjusting 0 position
7 - Cone

A - DESIGN

This consists of a winding (2), an electromagnetic core (1) and a cone (7), held at rest by springs (3) and (4). When supplied, the current causes a magnetic field in the winding. The cone is then attracted to the right, so as to open the additional air cross section (5). The ECU is used to send period earth signals.

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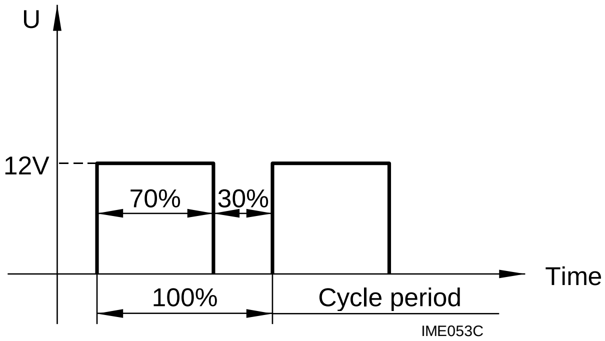
B - PRINCIPLE FOR REGULATING THE WINDING ENERGISING TIME



If the winding is constantly earthed, the actuator will always be fully open.

To give the cone a set position, the ECU sends an earthing pulse to the winding every x ms. In one cycle (period), the energised winding attracts the cone which opens it and when the winding is not energised, the cone closes under the action of the return spring. The position, and therefore the air cross section, obtained depends on the opening cyclical ratio, in other words the ratio between the percentage of time for which the winding is energised and the percentage of time for which it is not energised.

C - OPERATION

As soon as the engine is switched on, the ECU controls the actuator in order to adjust the idle speed exactly to the reference value as a function of the various criteria seen above.

Engine cold

When idling and through the coolant temperature probe, the idle speed is increased and, as the engine heats up, the cross section is progressively decreased.

Engine warm

When idling and through the engine speed information, the magnetic winding alters the air cross section so as to keep it at the reference value.

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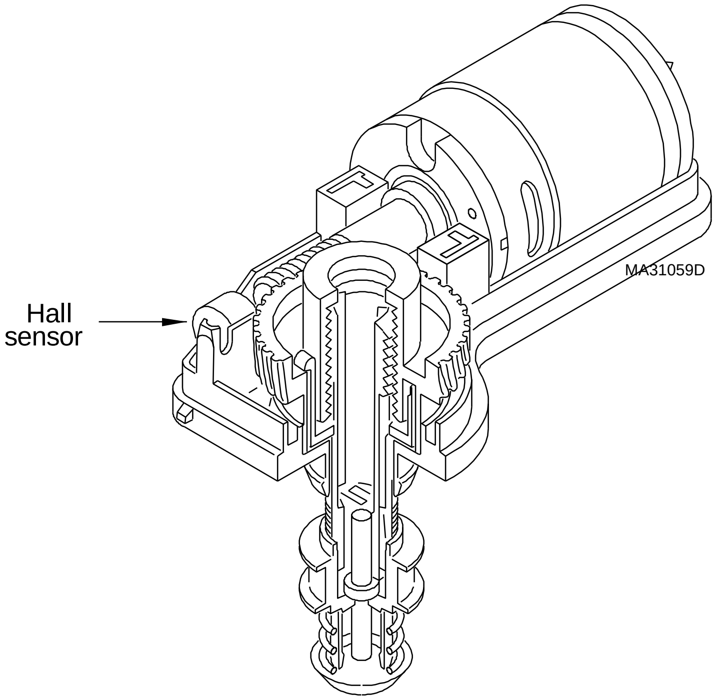
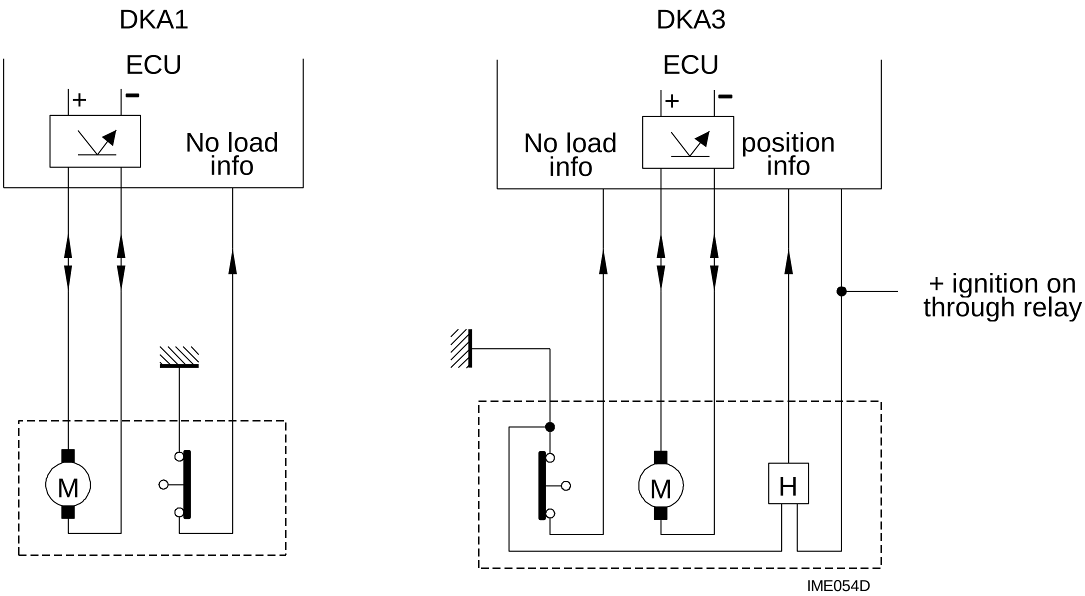
III - IDLE REGULATION MOTOR

There are two possible models for this motor:

- DKA1 → The motor itself + idle switch
- DKA3 → Same as DKA1 + Hall sensor





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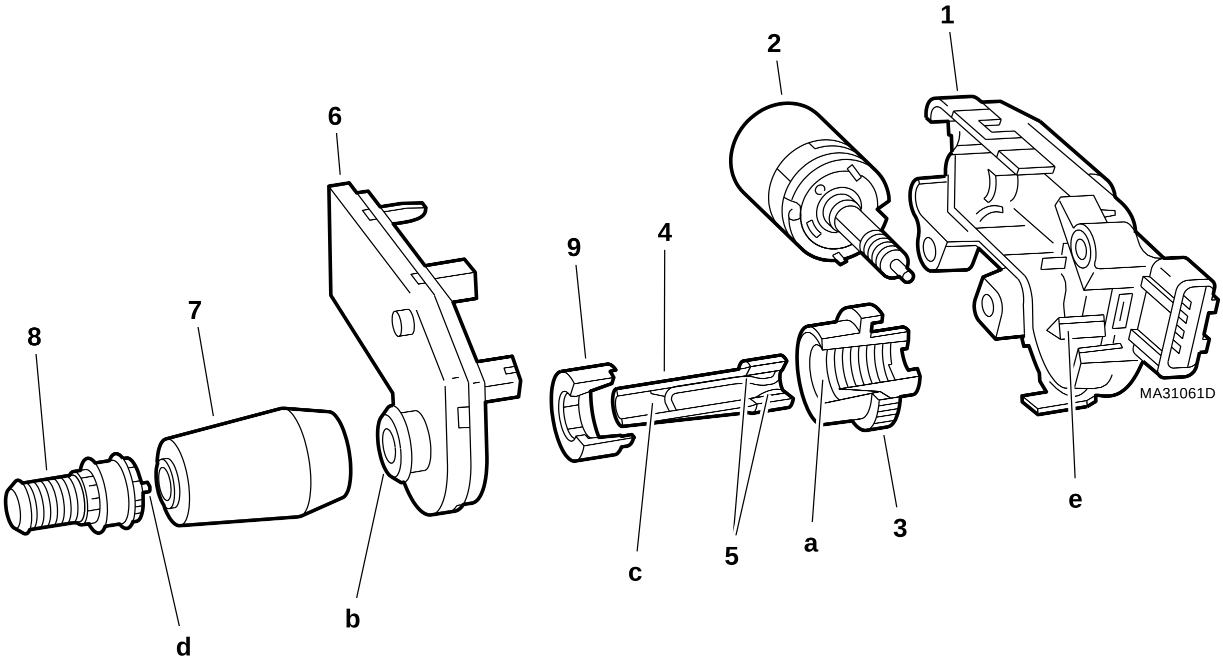
A - DESCRIPTION



1 - Rear casing
2 - Electric motor
3 - Gear
4 - Slide
5 - Bimetal strip
6 - Front casing
7 - Gaiter
8 - Switch
9 - Front stop

B - DESIGN

Using its internal thread (a), the drive gear, which is driven by an electric motor, moves the slide by means of the splines (b) of the front casing.

The switch, which is connected to the slide, presses against the throttle lever when idling which opens or closes the throttle.

Idle information is given by means of a bimetal strip (c) controlled by the end piece (d) and transmitted to the ECU by the two tracks (e) of the rear casing.

A gaiter seals the bimetal strip and the slide.

The travel of the slide between the end of the gear thread and the front end stop is 8 - 9 mm. The slide moves at a rate of 8 - 12 mm/s.

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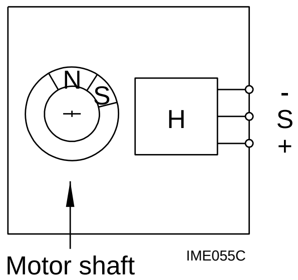
The Hall sensor:

This consists of:

- A fixed part containing the Hall slice and the electronic processing part
- A rotating part (polar wheel) linked to the threaded part of the motor shaft.

The operating principle is exactly the same as the principle used for the vehicle speed sensor.



C - CONTROL PRINCIPLE

The desired engine speed corresponds to a precise throttle opening position. The ECU therefore supplies the motor (by energising it) until the throttle potentiometer shows that it has the required opening. The motor is only controlled when the idle switch is working, except for the Dash-Pot function.

D - OPERATION

As soon as the engine is switched on, the ECU controls the motor in order to adjust the idle speed exactly to the reference value as a function of the various criteria seen above.

Engine cold:

When idling (no load) and through the coolant temperature probe, the idle speed is increased and, as the engine heats up, the throttle is progressively decreased.

Engine warm:

When idling and through the engine speed information, the magnetic winding alters the air cross section so as to keep it at the reference value.

Special corrections:

The idle motor compensates for when the air conditioning compressor is engaged.

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E - MANAGING THE IDLE MOTOR

The motor is controlled during the following functions:

- precontrol,
- starting correction,
- engine speed monitoring,
- dash-Pot,
- idle regulation,
- auto-adaptation.

1 - Precontrol

As soon as the idle switch is closed, the motor is controlled so as to provide a throttle angle which should provide an engine speed which is very close to the reference value. The desired throttle angle depends on coolant temperature.

2 - Starting correction

Depending on coolant temperature, this helps the rise in engine speed.

3 - Engine speed monitoring function

With the throttle closed, a fixed value is added to the precontrol then reduced progressively as a function of time.

4 - Dash-pot function

This avoids hesitation in the no load position and varies depending on the type of idle regulation motor used.

The principle is the same for both motors: when the throttle is almost closed, by releasing the pedal, the motor is operated so as to extend the slide then, when the idle switch closed information appears, the ECU controls the idle motor so as to progressively close the slide. The Dash-pot function is more precise with a DKA3 motor since, as it is fitted with a Hall sensor, the ECU knows the exact position of the slide.

With a DKA1 motor and with an open idle switch, the extension position of the slide is given by the time for which the idle motor is energised.

The Dash-pot function is applied before the engine speed monitoring function.

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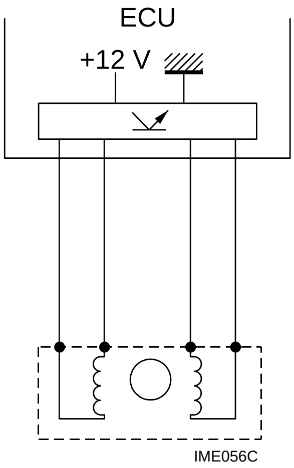
5 - Idle regulation

This consists of maintaining the engine speed as close as possible to the reference idle speed by checking the engine speed in a closed loop (idle switch closed information).

- The reference idle speed depends on:
  - the coolant temperature → Coolant temperature probe,
  - whether the air conditioning compressor is engaged or not → "AC-TH" information (thermostat),
  - the gear engaged (vehicle moving at idle speed).
- Regulation is a corrective action which is a direct function of the difference between the instantaneous engine speed and the reference engine speed. Regulation is of integral proportional type.
- Auto-adaptation: the ECU is capable of taking into account external parameters such as engine ageing. When the ECU notices that the idle speed is very different to the reference value, it modifies the throttle opening when the precontrol is applied.

IV - STEPPER MOTOR



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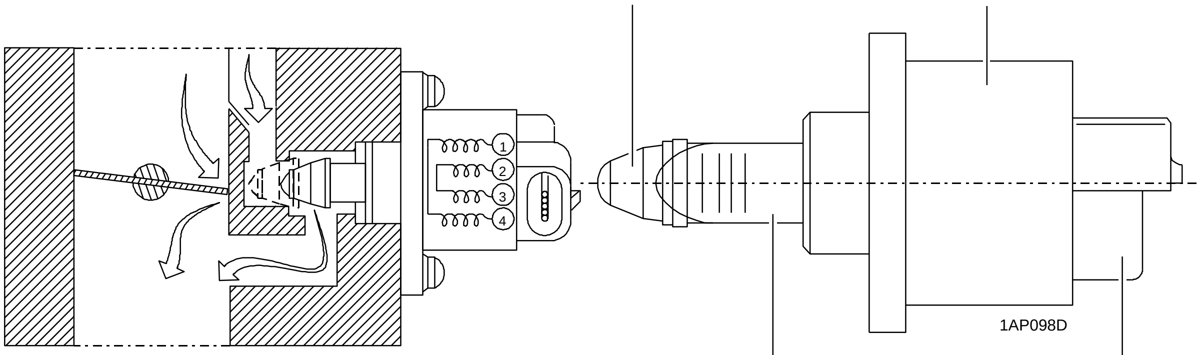
A - DESIGN



A worm screw machined into the end of the motor shaft provides the threaded slide with translation movement. A cone fitted onto the end of the slide can then alter the cross section of additional air.

When operating, the motor is supplied with current in the form of pulses. Every pulse, the rotor rotates through a fixed angle called a "step ".

B - OPERATION

As soon as the engine is switched on, the ECU controls the stepper motor in order to adjust the idle speed exactly to the reference value as a function of the various criteria seen above.

1 - Engine cold

When idling and through the coolant temperature probe, the idle speed is increased and, as the engine heats up, the cross section is progressively decreasing.

2 - Engine warm

When idling and through the engine speed information, the cone alters the air cross section so as to keep it at the reference value.

3 - Special corrections

The stepper motor compensates for when the air conditioning compressor is switched on.

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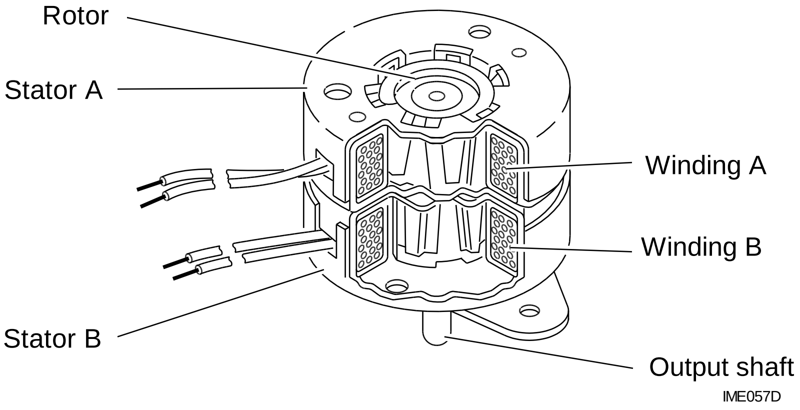
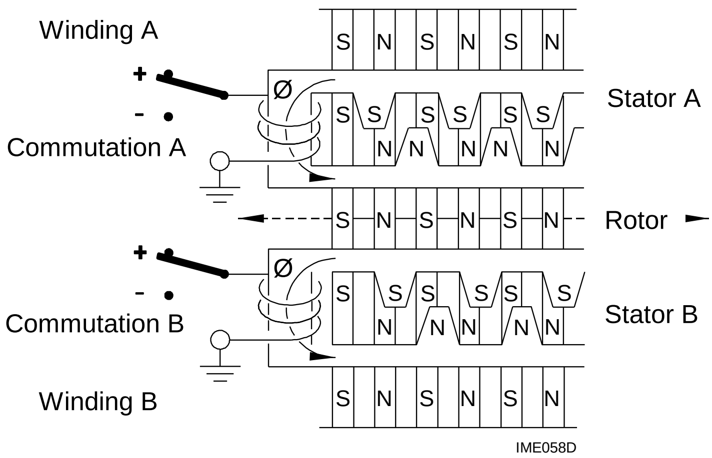
C - STEPPER MOTOR TECHNOLOGY



Stepper motors convert electrical pulses into an incremental rotary mechanical movement.

They have two fixed electromagnets and permanent rotating magnets. The poles of the permanent magnets which are attracted by the poles of the electromagnets move forward by one step every time the current is inverted in one of the windings.



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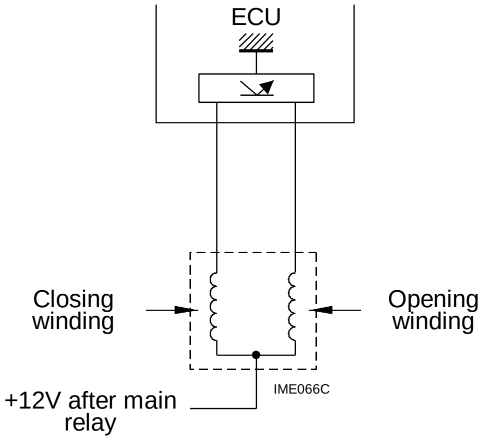
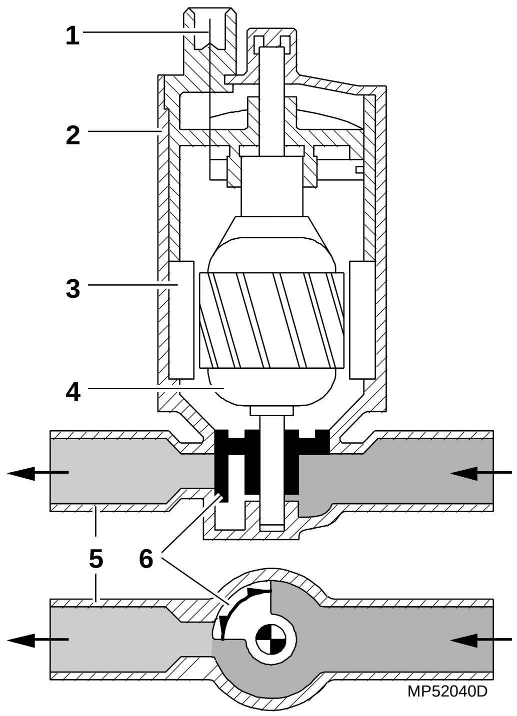
V - IDLE ACTUATOR

A - DESIGN





1 - Electrical connection
2 - Housing
3 - Permanent magnet
4 - Rotor
5 - Throttle take-off air channel
6 - Rotary slide valve

The actuator is a servomotor with a rotating register with two windings with a limited angle of movement (approximately 90°). The two windings are energised in turn every cycle which produces inverse forces in the rotor. The slide valve (6) then adopts a certain position which corresponds to the length of the pulses in each winding.

→ the first winding forces the slide valve to open,

→ the second winding forces the slide valve to close.

A force balance is set up which determines the size of the orifice through which air flows.

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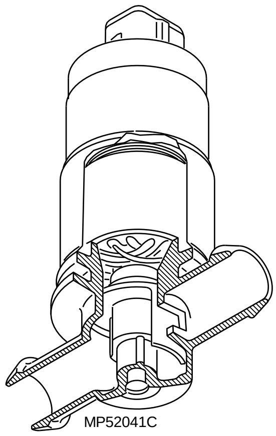
B - OPERATION



As soon as the engine is switched on, the ECU controls the actuator in order to adjust the idle speed exactly to the reference value as a function of the various criteria seen above.

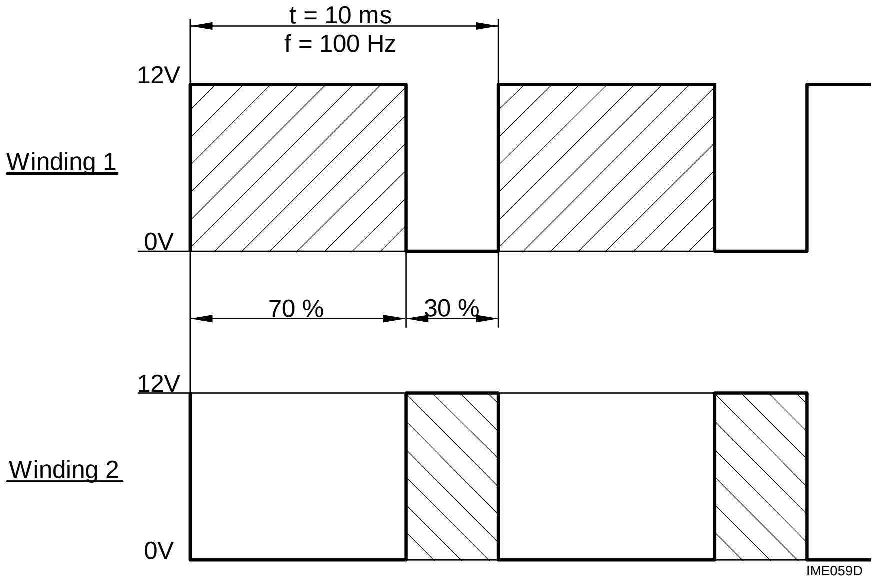
Engine cold

When idling and through the coolant temperature probe, the idle speed is increased and, as the engine heats up, the cross section is progressively decreasing.

Engine warm

When idling and through the engine speed information, the valve alters the air cross section so as to keep it at the reference value.

C - PRINCIPLE FOR REGULATING THE WINDING ENERGISING TIME



Every cycle, or every 10 ms, the two windings are energised (earthed) in turn. The slide valve is 25% open when the closing winding (2) is energised and 75% open when the opening winding (1) is energised. In the above example,

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the slide valve is no longer fully open. The operation of this actuator uses the OCR principle (opening cyclical ratio).

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VI - IDLE CONTROL STRATEGY

A - CONTROLLING THE ROTARY ACTUATOR OR STEPPER MOTOR

- Depending on the various criteria, the ECU works out a quantity of additional air which has to comply with engine requirements. Since the quantity of air is a direct function of the actuator or motor opening, the ECU converts the reference quantity of additional air into an operating parameter.

- The actuator or the motor is controlled using two operating methods:
  - open loop,
  - closed loop.

  Open loop operation (excluding idle mode) consists of prepositioning the actuator or the motor using various criteria so that when idle mode is entered, the engine speed is as close as possible to the reference idle speed.

  Closed loop operation is only used in idle mode and consists of altering the position of the idle actuator or motor depending on the difference between the actual engine speed and the reference engine speed. This allows the engine to run at the exact recommended idle speed and to maintain this speed.

B - OPEN LOOP MANAGEMENT

The actuator or the motor are given a position consisting of a static precontrol and a precontrol correction.

1 - Static precontrol

- Precontrol when driving: this depends directly on the reference idle speed.
- Precontrol when decelerating:
  - for deceleration cut-off → this reduces unburned matter and provides driving pleasure whilst decreasing the engine speed;
  - normal deceleration → depends on the engine speed and throttle position and allows engine speed to decelerate to maintain driving pleasure; this is the dash-pot function.
- Starting pre-reference value: this depends on the engine speed and coolant temperature and helps the engine to gain speed.

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2 - Precontrol correction

- Compensation depending on automatic transmission status
- Air conditioning compressor compensation:
  - static compensation and dynamic compensation for output AC OUT = 1 (compressor engaged),
  - dynamic compensation for output AC OUT = 0 (compressor off)
- Compensation for power assisted steering: This compensates for the load inflicted on the engine when the steering rises in pressure.
- Warming up compensation which is a direct function of the change in advance in order to heat up the catalytic converter.
- Battery voltage compensation: This allows the engine, and therefore the alternator, to rotate more quickly in order to recharge the battery when it seems to be slightly discharged. This may occur when power consumers have been left on and when the engine is left to run at idle speed for too long.
- Auto-adaptive compensation: This is calculated in closed loop.
- An offset depending on the engine speed and coolant temperature is used to take friction torques into account.

C - IDLE REGULATION

This consists of maintaining the engine speed as close as possible to the reference idle speed, by checking the engine speed in a closed loop. This is done using the additional air.

- The reference idle speed depends on:
  - the coolant temperature → coolant temperature probe,
  - whether the air conditioning compressor is engaged → AC-TH information (thermostat),
  - whether the automatic transmission is in the "drive" position → P.N/Drive information from the automatic transmission,
  - whether the power steering is on full lock,
  - the canister load,
  - the battery voltage,
  - the catalytic converter heating phase.
- Regulation is an active correction which is a direct function of the difference between the instantaneous engine speed and the reference engine speed. Regulation is of integral proportional type.
- Auto-adaptation: the ECU is capable of taking into account external parameters such as engine ageing. When the ECU notices that the idle speed is very different to the reference value, it modifies the opening of the rotary actuator or the stepper motor during open loop management

Note: In the closed loop engine speed zone, the engine is taken to its reference speed gently using a "follower" function.

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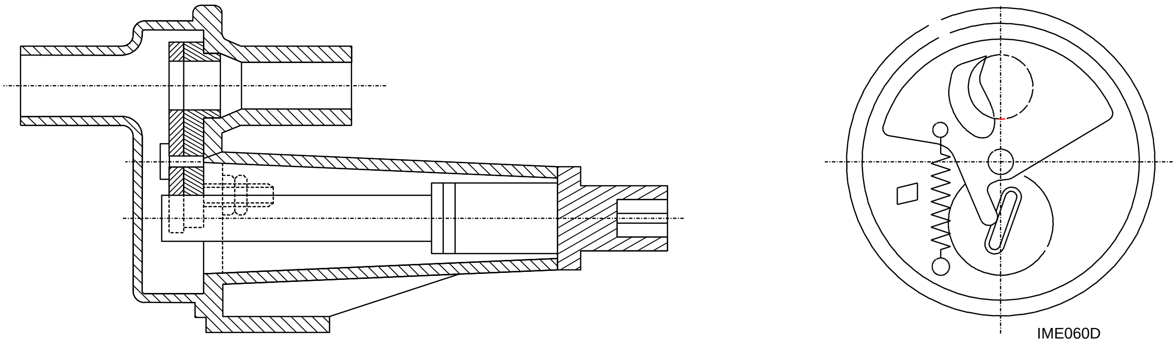
VII - ADDITIONAL AIR CONTROL

An additional air control provides the amount of air required by the engine when it is operating at idle speed and when cold.

A - DESCRIPTION



It is fitted in parallel to the idle air circuit. The air cross section is controlled by a pivoting plate. This plate is operated by a bimetal strip. The temperature of the bimetal strip is provided by a resistor which is supplied by the injector relay.

B - OPERATION

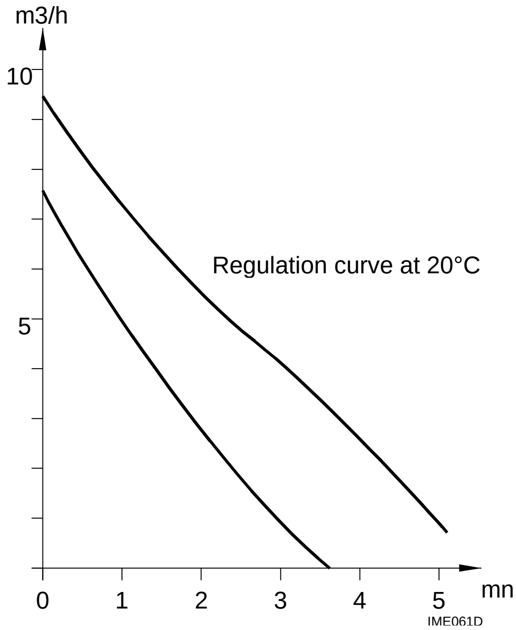
Engine warm

The air cross section is uncovered. When the bimetal strip rises in temperature, it deflects and acts on the flap. The plate pivots and progressively closes the air cross section.

When the engine temperature rises above 60°C, the orifice is closed.

C - SPECIFICATIONS

- Nominal voltage : 12 V
- Resistance : 50 Ω



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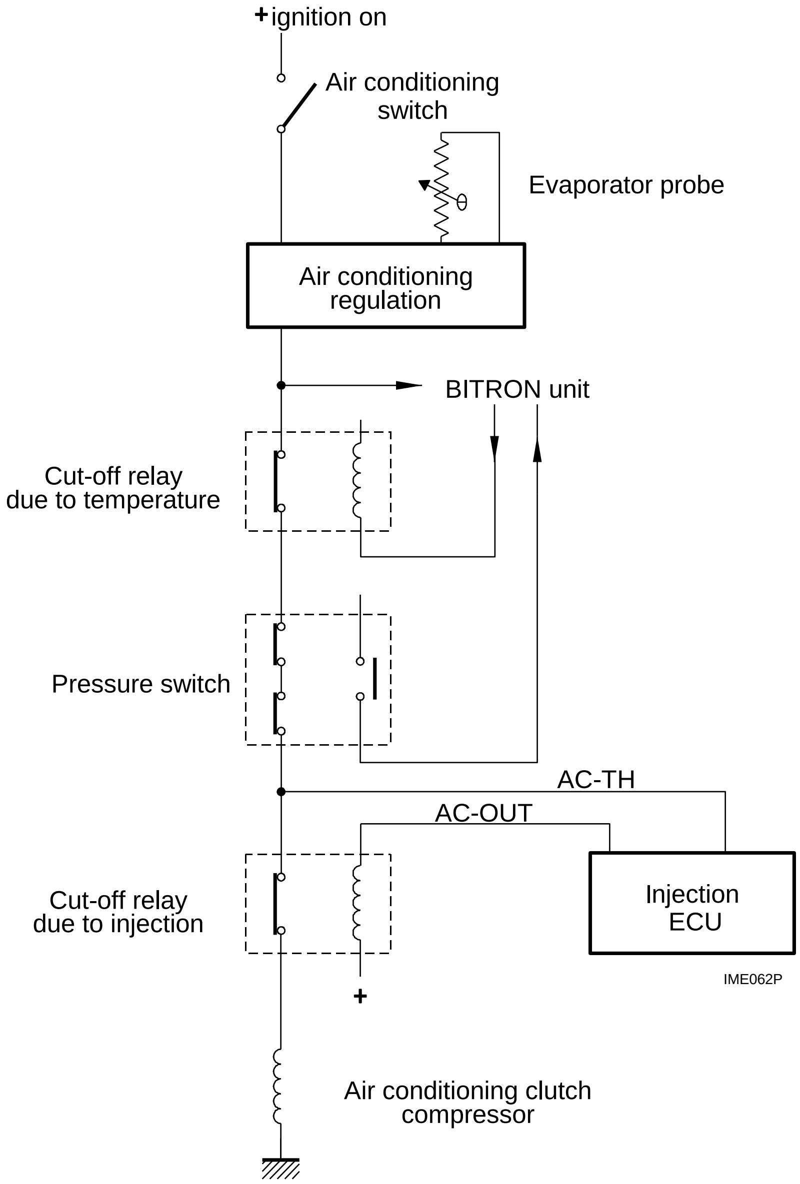
ADDITIONAL FUNCTIONS

I - CONTROLLING THE AIR CONDITIONING COMPRESSOR



- When the engine is stopped, the air conditioning cut-off relay is at rest and therefore closed.
- When starting → the air conditioning compressor cannot operate since the ECU controls the cut-off relay winding → its armature rises.

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The ECU receives the air conditioning authorisation information AC-TH from the small air conditioning regulation unit or the passenger compartment climate control ECU.

If conditions are favourable, the ECU controls the air conditioning compressor by setting AC-OUT to 1.

The ECU prevents the air conditioning compressor from working:

- when starting,
- when moving off,
- in certain engine operating ranges (engine speed, throttle position),
- at high engine speeds.

II - AUTOMATIC TRANSMISSION MANAGEMENT

A - TORQUE REDUCTION

In order to increase driving pleasure when changing gears, the ECU reduces the torque by reducing the advance. The advance retard is a function of the engine speed and load and varies depending on the direction in which the gear is being changed.

B - AUTOMATIC TRANSMISSION PROTECTION

When changing from P/N to D or 1, 2, 3, or R at low vehicle speed, if the driver accelerates and the engine speed or load exceed a limit, the ECU cuts off injection in order to cause the engine torque to fall significantly thus protecting the automatic transmission.

III - CONSUMPTION SIGNAL FOR THE ON-BOARD COMPUTER

IV - REV COUNTER SIGNAL

V - OXYGEN PROBE OPERATION

The amount by which the oxygen probe heats up can be controlled by the ECU so as to control the temperature of the catalytic converter.

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AUTO-DIAGNOSTIC

I - RECORDING FAULTS

The autodiagnostic records permanent faults as well as temporary faults in the operating system.

These faults, after having been recorded, are permanently memorised, even after the engine is switched off and can only be erased following a voluntary action by a repair technician; faults can only be erased after having been read so that memorised faults are displayed at least once by the repair technician.

Faults are memorised using a code in the chronological order in which they appeared.

All faults can be memorised at the same time (10 maximum).

II - CLASSIFYING FAULTS

Fault are classified into two categories:

- **Serious** faults requiring the vehicle to be repaired immediately (risk of damaging the engine or important effects on vehicle emissions or vehicle safety): as soon as they are detected, the warning light on the control panel illuminates permanently to warn the driver.
- **Minor** faults not requiring immediate action: when these appear, the warning light does not illuminate but the faults are stored in the computer's memory.

Major faults have priority over minor faults: in the case where the memory is full, if a major fault appears, it replaces a stored minor fault.

III - EMERGENCY OPERATION

The appearance of some faults triggers an emergency operating mode allowing the driver to get to the nearest repair centre.

After an amount of time following the detection of a fault, replacement functions or replacement values are put into operation, provided the system so allows.

If the fault disappears, the normal operating functions or values are restored; the fault is stored in the computer's memory and is managed as a temporary fault (warning light extinguishes if it was a major fault).

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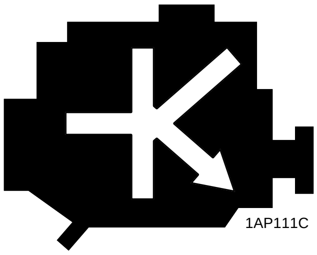
IV - ERASING FAULTS

Automatically: After 40 cycles (1 cycle consists of switching on the ignition and the engine warming up), temporary faults which have not reappeared are erased and the remaining faults are then shifted up in the computer memory.
Recorded faults can also be erased through the serial line.

V - INJECTION - IGNITION TEST LIGHT

This light (represented by an engine outline) is located on the control panel and is controlled by the computer.

When the ignition is switched on and for engine speeds lower than 24 rpm, the light illuminates.



Presence of a major fault	→	The light remains illuminated
No fault memorised or presence of a minor fault	→	The light extinguishes as soon as the engine is started.

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ALLOCATION TABLE

Allocation list of injection systems per vehicle:

AX - SAXO - ZX - XSARA - BX - XANTIA - XM - SYNERGIE.

- Vehicle → Marketing name.
- Date → System assembly date.
- Engine → Engine plate / engine type.
- Power → DIN power.
- Injection → System supplier and identification.
- Ignition control → Electronic control by ECU or by transistorised ignition
- Ignition type → dynamic or static.
- Module → Type.
- Coil → Type.

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AX

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
AX 1.0i	93MY →	CDZ	50	BOSCH MA3.0	Injection ECU	Static	/	BAE04
AX 1.1i	93MY →	HDZ	60	MMDCM G6.11	Injection ECU	Static	/	BAE04
AX 1.1i	95MY →	HDZ	60	BOSCH A2.2	Transistorised ignition	Distributor + assoc. module	MTR02	
AX 1.4i	93MY →	KDX	75	BOSCH MA3.0	Injection ECU	Static	/	BAE04
AX 1.4i	93MY →	KDY	75	BOSCH A2.2	Transistorised ignition	Distributor + assoc. module	MTR02	
AX Gti	92MY → 92MY	K6B	100	BOSCH MP3.1	Injection ECU	Static + module	MTR04	BAE04
AX Gti	93MY → 95MY	KFZ	95	BOSCH MP3.1	Injection ECU	Static + module	MTR04	BAE04

SAXO

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
SAXO 1.0i	96MY →	CDZ	50	BOSCH MA3.1	Injection ECU	Static	/	BAE04
SAXO 1.1i	96MY →	HDZ	60	BOSCH MA3.1	Injection ECU	Static	/	BAE04
SAXO 1.4i	96MY →	KFX	75	MMDCM 1AP40	Injection ECU	Static	/	BAE04
SAXO 1.6i	97MY → 98MY	NFZ	90	BOSCH MP5.2	Injection ECU	Static	/	BAE04
SAXO 1.6i	98MY →	NFZ	90	BOSCH MP7.2	Injection ECU	Static	/	BAE04
SAXO 1.6i (16V)	97MY →	NFX	120	MMDCM 1AP41	Injection ECU	Static	/	BBC2.2

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ZX

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
ZX 1.1	93MY → 94MY	HDZ	60	BOSCH A2.2	Transistorised ignition	Distributor + assoc. module	MTR02	
ZX 1.1	95MY → 96MY	HDZ	60	BOSCH MA3.0	Injection ECU	Static	/	BAE04
ZX 1.1	97MY →	HDZ	60	BOSCH MA3.1	Injection ECU	Static	/	BAE04
ZX 1.4	93MY → 94MY	KDY	75	BOSCH A2.2	Transistorised ignition	Distributor + assoc. module	MTR02	
ZX 1.4	93MY → 96MY	KDX	75	BOSCH MA3.0	Injection ECU	Static	/	BAE04
ZX 1.4	94MY → 96MY	KDX	75	MMDCM G614	Injection ECU	Static	/	BAE04
ZX 1.4	97MY→	KFX	75	MMDCM 1AP40	Injection ECU	Static	/	BAE04
ZX 1.6	91MY → 91MY	B4A	89	MMDCM G552	Injection ECU	Static	/	BAE04
ZX 1.6	92MY → 92MY	B4A	89	MMDCM G612	Injection ECU	Static	/	BAE04
ZX 1.6 AT	92MY →	BDY	89	MMDCM G610	Injection ECU	Static	/	BAE04
ZX 1.6	93MY → 93MY	BDY	89	MMDCM G610	Injection ECU	Static	/	BAE04
ZX 1.6	94MY → 94MY	BFZ	89	MMDCM 8P13	Injection ECU	Static	/	BAE04
ZX 1.6	95MY →	BFZ	89	SAGEM CCM4GJ	Injection ECU	Static	/	BAE04
ZX 1.8i	93MY → 96MY	LFZ	103	BOSCH MP5.1	Injection ECU	Static	/	BAE04
ZX 1.8i	95MY →	LFZ	103	MMDCM 8P.10	Injection ECU	Static	/	BAE04
ZX 1.8 (16V)	97MY →	LFY	103	BOSCH MP5.2	Injection ECU	Static	/	BAE04
ZX 1.9i	91MY → 92MY	D6E	130	BOSCH MP3.1	Injection ECU	Static + module	MTR04	BAE04
ZX 1.9i AT	92MY →	DKZ	122	BOSCH M1.3	Injection ECU	Distr. + module	MTR01	BTR05
ZX 2.0i	93MY →	RFX	123	MMDCM 8P20	Injection ECU	Static	/	BAE04
ZX 2.0i 16V	93MY → 94MY	RFY	155	BOSCH MP3.2	Injection ECU	Static + 2 modules	2 x MTR04	4X BAE01
ZX 2.0i 16V	95MY → 96MY	RFT	150	BOSCH MP3.2	Injection ECU	Static + 2 modules	2x MTR04	4X BAE01
ZX 2.0i 16V	97MY →	RFS	167	MMDCM 1AP10	Injection ECU	Static	/	4X BAE01

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XSARA

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
XSARA 1.4i	98MY →	KFX	75	MMDCM 1AP40	Injection ECU	Static	/	BAE04
XSARA 1.6i	98MY →	NFZ	90	BOSCH MP5.2	Injection ECU	Static	/	BAE04
XSARA 1.6i	98MY →	NFZ	90	BOSCH MP7.2	Injection ECU	Static	/	BAE04
XSARA 1.8i	98MY →	LFX	103	MMDCM 1AP20	Injection ECU	Static	/	BAE04
XSARA 1.8i AT	98MY →	LFZ	103	MMDCM 8P1A	Injection ECU	Static	/	BAE04
XSARA 1.8i 16V	98MY →	LFY	112	SAGEM SL96.2	Injection ECU	Static	/	BAE04

BX

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
BX 1.6i	93MY →	BDY	89	MMDCM G6.10	Injection ECU	Static	/	BAE04
BX Gti	87MY → 87MY	D6A	125	BOSCH L3.1	Transistorised ignition	Distributor + module ext.	MTR01	
BX Gti	88MY → 90MY	D6A	125	BOSCH L3.1	Transistorised ignition	Distributor + assoc. module	MTR02	BTR02
BX Gti	91MY → 92MY	D6D	123	BOSCH MP3.1	Injection ECU	Static + module	MTR04	BAE04
BX Gti	93MY →	DKZ	122	BOSCH MP1.3	Injection ECU	Distributor + module	MTR01	BTR05
BX 16 V	89MY → 90MY	D6C	160	BOSCH ML4.1	Injection ECU	Distributor + module	MTR01	BTR02
BX 16 V	91MY → 92MY	D6C	160	BOSCH M1.3	Injection ECU	Distributor + module	MTR01	BTR02
BX 16 V	93MY →	DFW	148	BOSCH M1.3	Injection ECU	Distributor + module	MTR01	BTR02

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XANTIA

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
XANTIA 1.6i	94MY → 97MY	BFZ	89	MMDCM 8P13	Injection ECU	Static	/	BAE04
XANTIA 1.8i	93MY →	LFZ	103	MMDCM 8P10	Injection ECU	Static	/	BAE04
XANTIA 1.8i	93MY → 95MY	LFZ	103	BOSCH MP5.1	Injection ECU	Static	/	BAE04
XANTIA 1.8 (16V)	96MY → 97MY	LFY	112	BOSCH MP5.1.1	Injection ECU	Static	/	BBC2.2
XANTIA 1.8 (16V)	97MY →	LFY	112	SAGEM SL96	Injection ECU	Static	/	BBC2.2
XANTIA 1.8i	98MY →	LFX	90	MMDCM 1AP20	Injection ECU	Static	/	BAE04
XANTIA 2.0i	93MY →	RFX	123	MMDCM 8P20	Injection ECU	Static	/	BAE04
XANTIA 2.0 (16V)	96MY →	RFV	135	BOSCH MP5.1.1	Injection ECU	Static	/	BBC2.2
XANTIA 2.0 (16V)	93MY → 94MY	RFY	155	BOSCH MP3.2	Injection ECU	Static + 2 modules	2 x MTR04	4x BAE01
XANTIA 2.0 (16V)	95MY →	RFT	155	BOSCH MP3.2	Injection ECU	Static + 2 modules	2 x MTR04	4x BAE01
XANTIA CT	96MY →	RGX	145	BOSCH MP3.2	Injection ECU	Static + module	MTR04	BAE04
XANTIA V6	97MY →	XFZ	194	BOSCH MP7.0	Injection ECU	Static	/	BBE3.2

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XM

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
XM 2.0i	89MY → 92MY	R6A	130	BOSCH LE2	Transistorised ignition	Distributor + assoc. module	MTR02	BTR05
XM 2.0i	91MY → 92MY	R6A	130	MMDCM G5M0	Injection ECU	Static	/	BAE04
XM 2.0i	93MY → 93MY	RFZ	122	BOSCH MP3.1	Injection ECU	Static + module	MTR04	BAE04
XM 2.0i	94MY → 94MY	RFZ	122	BOSCH MP5.1	Injection ECU	Static	/	BAE04
XM 2.0i (16V)	95MY → 97MY	RFV	132	BOSCH MP5.1.1	Injection ECU	Static	/	BBC2.2
XM 2.0i (16V)	97MY →	RFV	132	BOSCH MP5.2	Injection ECU	Static		BBC2.2
XM 2.0i CT	93MY → 94MY	RGY	145	BOSCH MP3.2	Injection ECU	Static	MTR04	BAE04
XM 2.0i CT	95MY →	RGX	150	BOSCH MP3.2	Injection ECU	Static	MTR04	BAE04
XM V6	89MY → 94MY	SFZ	170	BENDIX FENIX 3B	Injection ECU	Distributor + module	MTR03	
XM V6	95MY → 96MY	UFZ	170	BENDIX FENIX 3B	Injection ECU	Distributor + module	MTR03	
XM V6 (24V)	91MY → 94MY	SKZ	200	BENDIX FENIX 4	Injection ECU	Distributor + module	MTR03	
XM V6 (24V)	95MY → 96MY	UKZ	200	BENDIX FENIX 4	Injection ECU	Distributor + module	MTR03	
XM V6 24	97MY →	XFZ	194	BOSCH MP7.0	Injection ECU	Static	/	BBC3.2

SYNERGIE

Vehicle	Dates	Engine	P (hp)	Injection	Ignition control	Ignition type	Module	Coil
SYNERGIE 1.8i	97MY →	LFW	101	MMDCM 8P15	Injection ECU	Static	/	BAE04
SYNERGIE 2.0i	95MY →	RFU	123	MMDCM 8P20	Injection ECU	Static	/	BAE04
SYNERGIE 2.0i CT	95MY →	RGX	150	BOSCH MP3.2	Injection ECU	Static	MTR04	BAE04

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INITIALISING AN ECU

The engine management ECU has to be reinitialised after certain operations:

- erasing faults,
- disconnecting or replacing the battery,
- disconnecting or replacing the ECU,
- disconnecting the ECU supply relay(s),
- downloading the program to the ECU,
- replacing the idle regulation stepper motor,
- replacing the throttle potentiometer.

If the ECU is not reinitialised following one of the above operations, the following driving pleasure faults may occur:

- engine hesitation,
- the engine stalls when returning to idle speed,
- the engine stalls after being started.

The following procedures relate to the following suppliers:

- MAGNETI-MARELLI,
- SAGEM,
- BOSCH,
- SIEMENS.

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I - MAGNETI-MARELLI G5 ECU

Perform the following operations.

A - READ THE ADVANCE SETTING MEMORISED BY THE ECU (NOTE THE VALUE)

Read the faults.

Repair any faults.

Erase faults.

B - RICHNESS AUTO-ADAPTIVITY

Engine warm, coolant temperature above 60°C.

Perform a road test for at least 15 minutes using the various engine speeds:

- 2500 - 3500 rpm,
- idle speed,
- full load (for 2 seconds)

C - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operations A and B).

D - READ THE ADVANCE SETTING MEMORISED BY THE ECU

Where necessary, restore the setting to its original value.

E - ENGINE WITHOUT CATALYTIC CONVERTER

Use an exhaust gas analyser to adjust the richness using a diagnostic tool ("adjust richness" programme).

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II - MAGNETI-MARELLI G6 ECU

Perform the following operations.

A - READ THE ADVANCE SETTING MEMORISED BY THE ECU (NOTE THE VALUE)

Read the faults.

Repair any faults.

Erase faults.

B - RESET THE STEPPER MOTOR

Switch off the ignition (for 10 seconds).

Switch on the ignition (for 3 seconds).

Without accelerating, start the engine and let it run at idle speed.

C - RICHNESS AUTO-ADAPTIVITY

Engine warm, coolant temperature above 60°C.

Perform a road test for at least 15 minutes using the various engine speeds and in particular:

- 2500 - 3500 rpm,
- idle speed,
- full load (for 2 seconds)

D - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operations B and C).

E - READ THE ADVANCE SETTING MEMORISED BY THE ECU

Where necessary, restore the setting to its original value.

F - ENGINE WITHOUT CATALYTIC CONVERTER

Use an exhaust gas analyser to adjust the richness using a diagnostic tool ("adjust richness" programme).

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III - MAGNETI-MARELLI ECU 8P

Perform the following operations.

A - READ THE ADVANCE SETTING MEMORISED BY THE ECU (NOTE THE VALUE)

Read the faults.

Repair any faults.

Erase faults.

B - RESET THE STEPPER MOTOR

Switch off the ignition (for 10 seconds).

Switch on the ignition (for 3 seconds).

Without accelerating, start the engine and let it run at idle speed.

C - PERFORM THE GEAR RECOGNITION PROCEDURE (MANUAL GEARBOX)

A gear is recognised when the next gear up is selected, followed by a change down to the gear below.

Recognising 1st gear:

- start the engine,
- engage first gear and accelerate,
- accelerate to 3000 → 3500 rpm,
- engage second gear,
- accelerate to 3000 → 3500 rpm,
- put the gearbox in neutral,
- allow the engine speed to drop and engage first gear,
- perform these operations for the other gears.

Note: Use the ELIT unit to check whether the gears have been recognised by the ECU.

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D - RICHNESS AUTO-ADAPTIVITY

Engine warm, coolant temperature above 60°C.

Perform a road test for at least 15 minutes using the various engine speeds and in particular:

- idle speed,
- full load (for 2 seconds).

E - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operations B, C and D).

F - READ THE ADVANCE SETTING MEMORISED BY THE ECU

Where necessary, restore the setting to its original value.

G - ENGINE WITHOUT CATALYTIC CONVERTER

Use an exhaust gas analyser to adjust the richness using a diagnostic tool ("adjust richness" programme).

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IV - MAGNETI-MARELLI ECU 1AP

Perform the following operations.

A - READ THE ADVANCE SETTING MEMORISED BY THE ECU (NOTE THE VALUE)

Read the faults.

Repair any faults.

Erase faults.

B - RESET THE STEPPER MOTOR

Switch off the ignition (for 10 seconds).

Switch on the ignition (for 3 seconds).

Without accelerating, start the engine and let it run at idle speed.

C - PERFORM THE GEAR RECOGNITION PROCEDURE (MANUAL GEARBOX)

A gear is recognised when the next gear up is selected, followed by a change down to the gear below.

Recognising 1st gear:

- start the engine,
- engage first gear and accelerate,
- accelerate to 3000 $\rightarrow$ 3500 rpm,
- engage second gear,
- accelerate to 3000 $\rightarrow$ 3500 rpm,
- put the gearbox in neutral,
- allow the engine speed to drop and engage first gear,
- perform these operations for the other gears.

Note: Use the ELIT, Lexia or Proxia unit to check whether the gears have been recognised by the ECU.

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D - RICHNESS AUTO-ADAPTIVITY

Engine warm, coolant temperature above 60°C.

Perform a road test for at least 15 minutes using the various engine speeds and in particular:

- idle speed,
- full load (for 2 seconds).

E - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operations B, C and D).

F - READ THE ADVANCE SETTING MEMORISED BY THE ECU

Where necessary, restore the setting to its original value.

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V - SAGEM CCM4GJ ECU

Vehicles involved: ZX 1.6i.

Perform the following operations.

A - IN PARAMETER MEASUREMENT, READ THE OCTANE RATING SETTING FOR NOR 91 OR NOR 95 PETROL (NOTE THE VALUE)

Read the faults.

Repair any faults.

Erase faults.

B - RESET THE STEPPER MOTOR

Switch off the ignition (for 10 seconds).

Switch on the ignition (for 3 seconds).

Without accelerating, start the engine and let it run at idle speed.

C - IDLE AIR FLOW AUTO-ADAPTATION (REPLACEMENT ECU OR NEW ECU)

Start the engine and let it run at idle speed.

Leave the engine to run until the fan unit or units engage(s) at high speed.

D - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operations B and C).

E - IN PARAMETER MEASUREMENT, READ THE NOR 91 OR NOR 95 PETROL OCTANE RATING

Where necessary, restore the setting to its original value.

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VI - SAGEM SL96 ECU

Vehicles involved: XANTIA 1.8i 16V from 97 model year.

Warning: This ECU only accepts one gear recognition procedure before locking up. Do not interchange a "long" gearbox ECU for a "short" gearbox ECU (France fiscal power 07 HP and 09 HP).

Perform the following operations.

A - READ THE FAULTS

Repair any faults.

Erase faults.

B - RESET THE STEPPER MOTOR

Switch off the ignition (for 10 seconds).

Switch on the ignition (for 3 seconds).

Without accelerating, start the engine and let it run at idle speed.

C - IDLE AIR FLOW AUTO-ADAPTATION (REPLACEMENT ECU OR NEW ECU)

Start the engine and let it run at idle speed.

Leave the engine to run until the fan unit or units engage(s) at high speed.

D - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operations B and C).

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VII - BOSCH A2.2 - MA3.0 - MA3.1 - MP3.1 - MP3.2 - MP5.1 - MP5.2 - M1.3 - ML4.1 ECU

A - READ THE FAULTS

Repair any faults.

Erase faults.

B - RICHNESS AUTO-ADAPTIVITY

Engine warm, coolant temperature above 60°C.

Perform a road test for at least 15 minutes using the various engine speeds and in particular:

- 2500 - 3500 rpm,
- idle speed,
- full load (for 2 seconds).

C - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operation B).

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VIII - BOSCH MA1.7 ECU

Vehicles involved: JUMPY 1.6i.

Perform the following operations.

A - READ THE FAULTS

Repair any faults.

Erase faults.

B - RICHNESS AUTO-ADAPTIVITY

Start the engine.

Allow the engine to warm up until the fan units operate at high speed.

Switch off the ignition.

Disconnect the negative terminal of the battery.

Wait for at least 30 seconds.

Connect the negative terminal of the battery.

Start the engine.

Maintain the engine speed between 2000 and 3000 rpm until the fan units engage.

Allow the engine to run at idle speed for 2 minutes.

Accelerate fully (engine speed approximately 4000 rpm).

Release the accelerator.

The engine should not stall when it returns to idle speed: otherwise repeat the operation.

C - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operation B).

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IX - BOSCH MP7.0 ECU

Vehicles involved: XANTIA V6.

Perform the following operations.

A - READ THE FAULTS
Repair any faults.
Erase faults.

B - RICHNESS AUTO-ADAPTIVITY
Allow the engine to warm up (fan units switch on then off again).
Switch off the ignition.
Allow the engine to run at idle speed for 5 minutes.
Perform a road test for 5 minutes using various engine speeds.

C - READ THE FAULTS
Repair any faults.
Erase faults.
Start the ECU initialisation procedure again (operation B).

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X - BOSCH MP5.1.1 - MP5.2 ECU

Perform the following operations.

A - READ THE FAULTS

Repair any faults.

Erase faults.

B - RESET THE STEPPER MOTOR

Switch off the ignition (for 10 seconds).

Switch on the ignition (for 3 seconds).

Without accelerating, start the engine and let it run at idle speed.

C - READ THE FAULTS

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operation B).

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XI - SIEMENS FENIX 1B FENIX 3B FENIX 4 ECU

Perform the following operations.

A - READ THE FAULTS

Repair any faults.

Erase faults.

B - RICHNESS AUTO-ADAPTIVITY

Start the engine.

Allow the engine to warm up until the fan units switch on at high speed.

Switch off the ignition.

Switch on the ignition again.

Read the faults.

Erase faults.

Switch off the ignition.

Disconnect then reconnect the ECU.

Switch on the ignition for 10 seconds.

Switch off the supply to the current consumers (heated rear screen, air conditioning).

Without accelerating, start the engine and let it run at idle speed (for 2 minutes minimum).

Check the idle position of the throttle using the diagnostic tool in parameter reading mode: for the "throttle position status" parameter, the diagnostic tool should read "IDLING".

Adjust if necessary.

Engine warm, coolant temperature above 80°C.

Perform a road test for at least 15 minutes using the various engine speeds and in particular:

- 2500 - 3500 rpm,
- idle speed,
- full load.

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C - READ THE FAULTS

Vehicles involved: XM V6 (engine S6A).

Repair any faults.

Erase faults.

Start the ECU initialisation procedure again (operation B).

E - ENGINE WITHOUT CATALYTIC CONVERTER

Use an exhaust gas analyser to adjust the "Idle speed CO" using the richness potentiometer.

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