PEUGEOT Motocycles

SALES DIVISION
NETWORK TECHNICAL INFORMATION

WORKSHOP MANUAL

EFI

4-STROKE INJECTION SYSTEM FUNCTIONING PRINCIPLE
(Electronic fuel Injection)

CONTENTS

TDSI INJECTION SYSTEM FUNCTIONING PRINCIPLE

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ADVANTAGES OF THE INJECTION SYSTEM

Peugeot Motocycles has developed a new generation engine. Cleaner, more reliable, more economical, this engine complies with the most stringent emission control standards, whilst maintaining a very high level of performance. There are multiple advantages, reduction of polluting emissions, fuel-savings, improved driving comfort.

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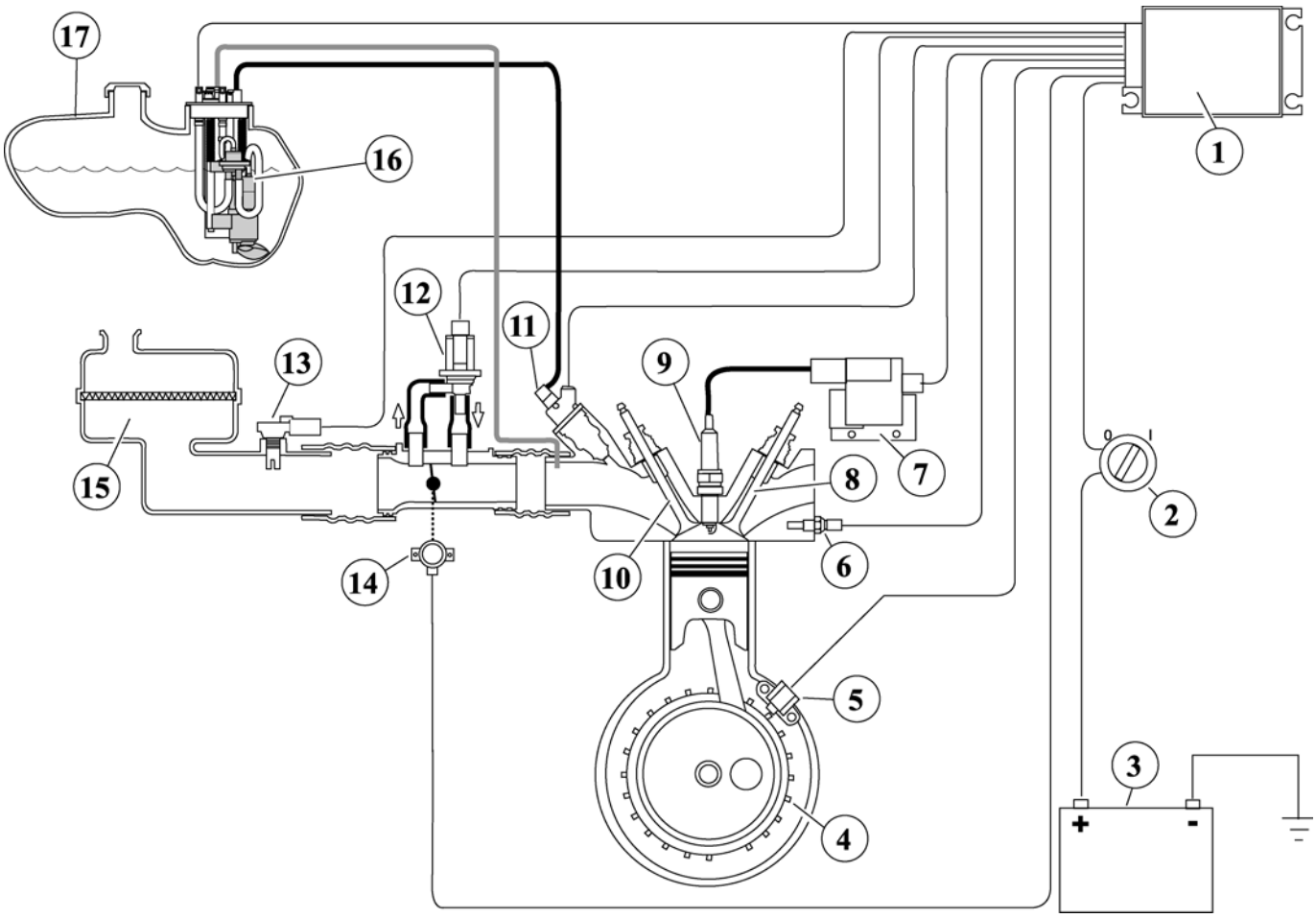
FUNCTIONING PRINCIPLE



1. ECU.
2. Ignition key.
3. Battery.
4. Toothed wheel.
5. Engine speed sensor.
6. Temperature sensor.
7. Ignition coil.
8. - Exhaust valve.
9. Spark plug.
10. Inlet valve.
11. Fuel injector.
12. Idle valve.
13. Inlet temperature and pressure sensor.
14. Throttle potentiometer.
15. Air filter.
16. Fuel pump.
17. Fuel tank.

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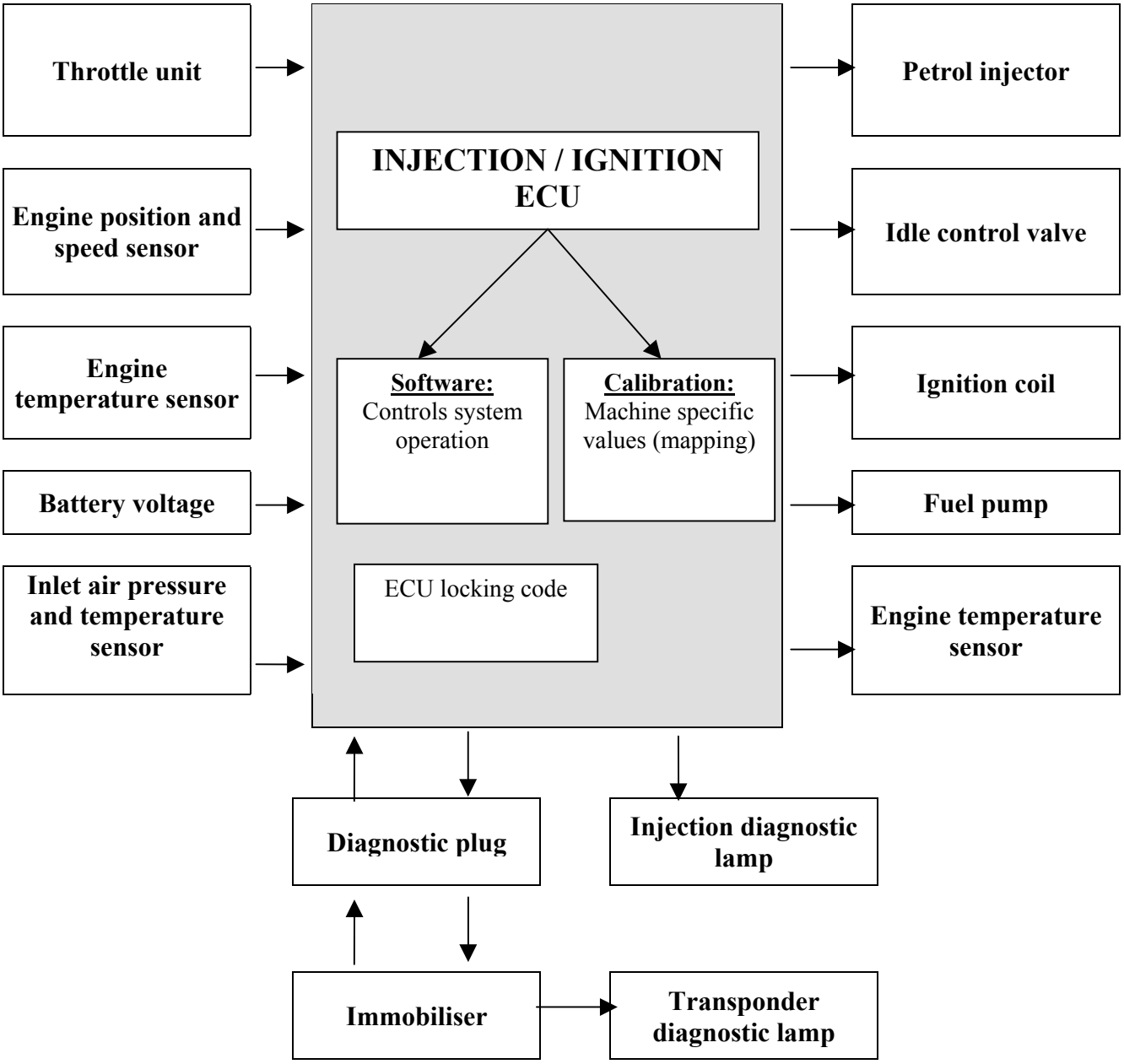
SYNOPTIC



The system basic principle consists in measuring the engine speed and load (throttle opening) in order to determine the optimum quantity of fuel to be injected as well as the optimum ignition advance to be applied.
An immobiliser is added to the system for the transponder antitheft function. This immobiliser communicates with the injection ECU via the diagnostic plug.

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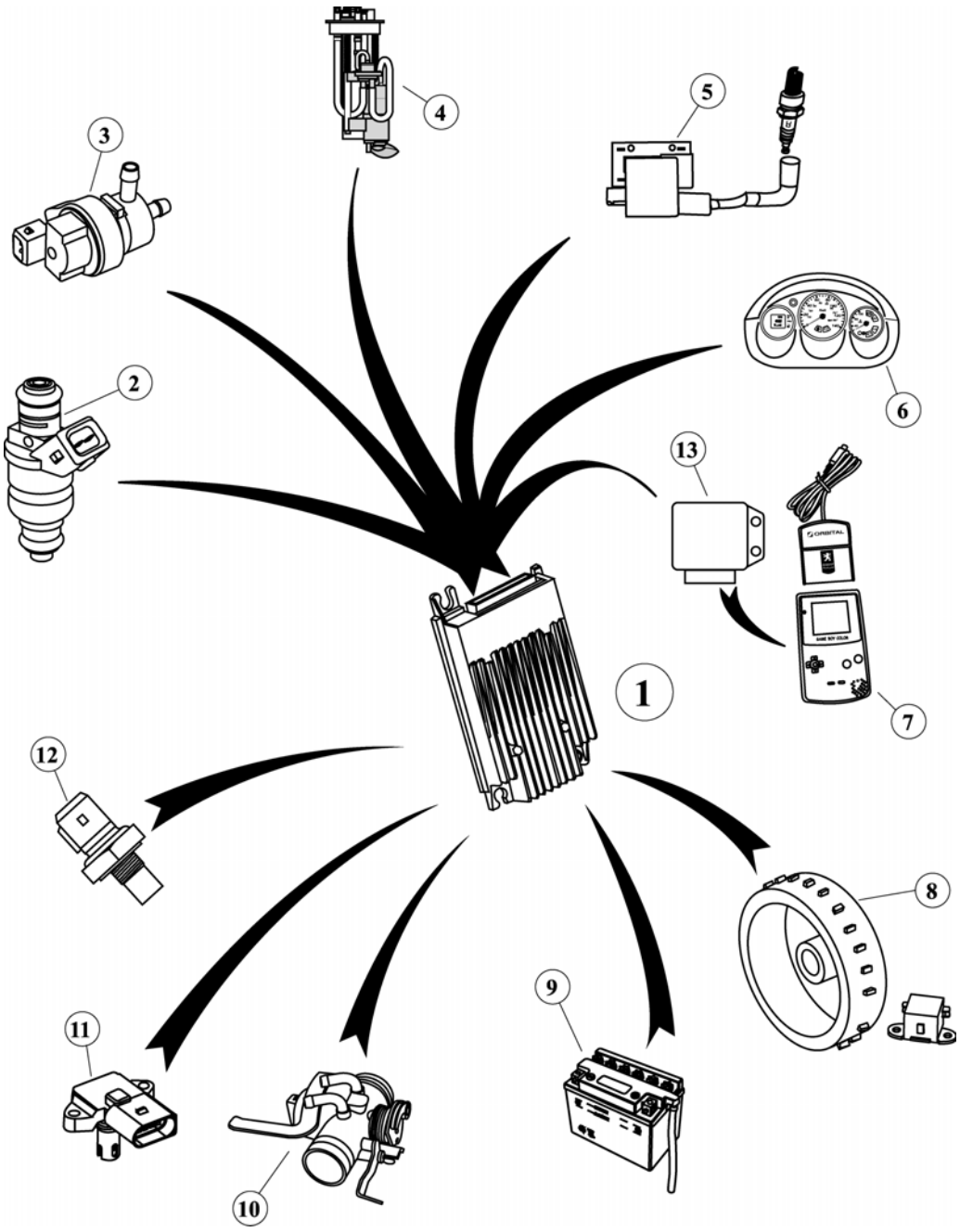
GENERAL VIEW



1. Injection ECU.
2. Fuel injector.
3. Idle valve.
4. Fuel pump.
5. Ignition coil.
6. Diagnostic light.
7. Diagnostic tool.
8. Magneto flywheel.
9. Battery.
10. Throttle unit.
11. Air pressure and air temperature sensor
12. Engine temperature sensor.
13. Immobiliser.

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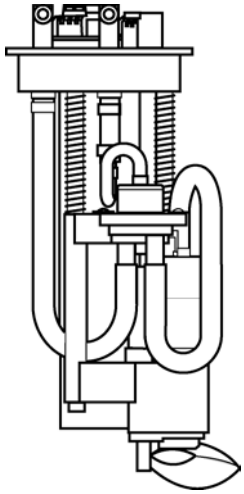
DETAILED DESCRIPTION OF COMPONENTS

Fuel supply



Pump flow rate: 5.2 litres/hour.

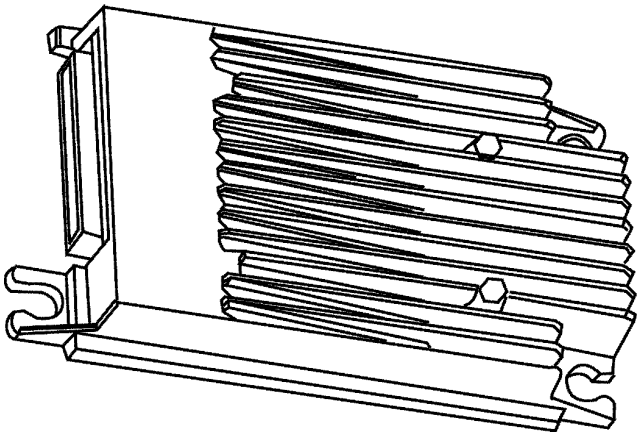
Connection:
Terminal 1: to fuel pump relay.
Terminal 2: to + battery.

The fuel pump is controlled by the ECU (terminal 14) via a relay.

Check: R = 1.5 $^{\pm 10\%}$ Ω.

An electric pump controlled by the ECU supplies fuel to the injector. This fuel is supplied with a 2.5 bar pressure; the pressure is limited and regulated by a pressure regulator integrated in the pump This regulator depends on the air pressure to continually maintain a pressure difference of 2.5 bars between the inlet air and the fuel. The regulator guarantees a fuel delivery proportional to the injector opening time. The pump functions for 3 seconds when the ignition is turned on in order to pressurise the fuel system. The strainer is located in the tank

Fuel metering:



Connection: 22 pins

Operating voltage: between 8 and 18 Volts

Protection against over voltage up to 24 Volts

Note: To avoid any risk of damaging the ECU, the ECU or the components of the circuit must never be disconnected when the vehicle is under power.
Fuel metering is controlled by the ECU. The ECU determines the fuel injector opening time (injection time) according to the engine air intake (measured by the throttle unit), the engine speed (measured by the speed sensor) and the necessary corrections (cold start, acceleration, idle, etc.) The fuel is injected into the inlet manifold towards the inlet valve. The injection ECU also controls the ignition system thanks to the information provided.

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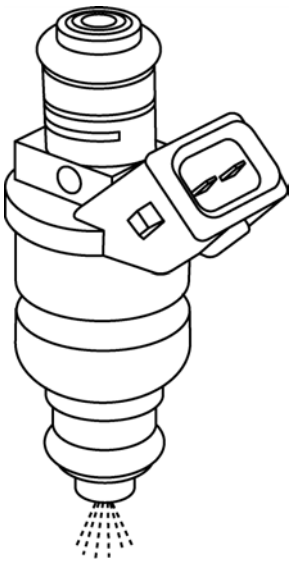
Petrol injector



Flow rate: 1.3 g/s at 2.5 bars

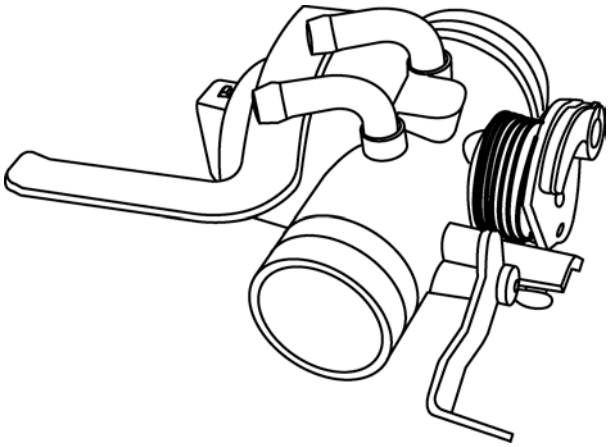
Connection:
Terminal 1: to ECU terminal 3
Terminal 2: + battery

Check: R = 14.5 $^{\pm 10\%}$ Ω.

Identification: black colour

The fuel injector, controlled by the ECU, injects the required quantity of fuel into the inlet manifold, behind the inlet valve.
The injection time is corrected according to the battery voltage.

Throttle unit



Diameter 29 mm

Connection:
Terminal 1: to ECU terminal 18, potentiometer power supply
Terminal 2: to ECU terminal 7, potentiometer signal
Terminal 4: to ECU terminal 16, potentiometer power return.

Check between terminals:
1 and 2 R = 1700 $^{\pm 40\%}$ Ω.
1 and 4 R = 1000 $^{\pm 40\%}$ Ω.

The air inlet is through a throttle valve unit which measures the quantity of air taken in by the engine. The air quantity is measured (throttle valve angle) by a potentiometer mounted on the valve spindle.

Throttle potentiometer

- It informs the ECU on the engine load (idle, full load, partial load).
- It informs the ECU on the load variation rate (acceleration, slowing down).

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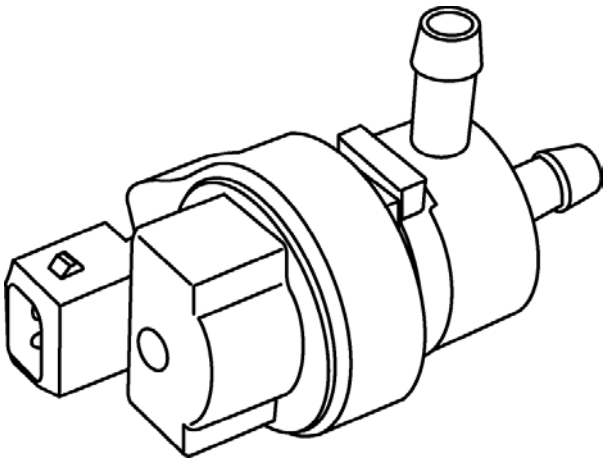
Idle valve



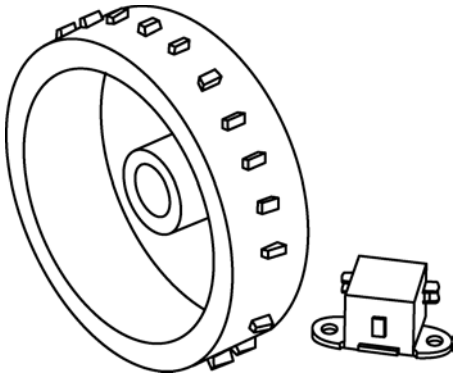
Solenoid valve regulating the air flow rate in order to maintain the engine at idle speed.

Connection:
Terminal 1: to ECU terminal 13.
Terminal 2: to + battery.

Valve check: R = 25 $^{\pm 20\%}$ Ω.

The ECU controls the idle valve (opening angle) in order to maintain the engine at idle speed (throttle closed) independently of the external conditions (cold or warm). Furthermore it controls the transient phase between the idle speed and the beginning of acceleration (changeover from the idle circuit through the by-pass to the main circuit through the throttle unit).

Engine speed sensor



Toothed wheel located on the magneto flywheel.

Connection:
Terminal 1: to ECU terminal 19
Terminal 2: to ECU terminal 20

Sensor check: R = 110 $^{\pm 2\%}$ Ω.

Signal voltage from 0.9 to 75 volts depending on engine speed.

It is located opposite a toothed wheel driven by the crankshaft. This toothed wheel is composed of 24 teeth, one of which has been eliminated to mark the position of the toothed wheel in relation to the top dead centre (TDC). The missing tooth is positioned 298°30' before the TDC.

- The sensor informs the ECU of the engine speed (by counting the number of teeth per minute).
- It informs the ECU of the engine position (position of the missing tooth).

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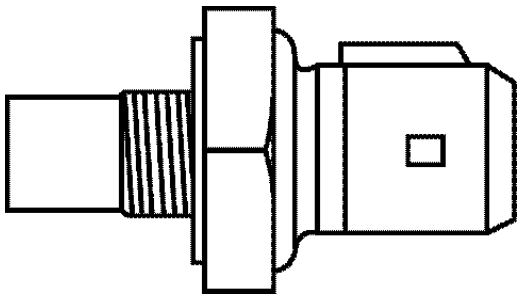
Engine temperature sensor



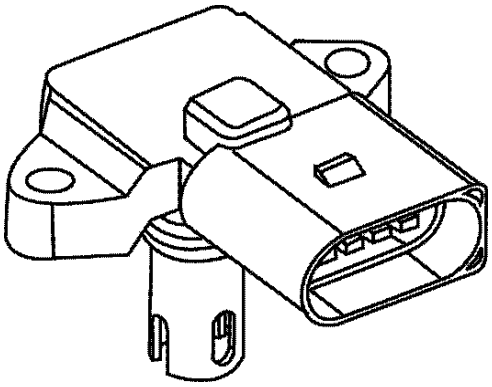
Negative temperature coefficient thermistor.

Connection:
Terminal 1: to ECU terminal 16.
Terminal 2: to ECU terminal 9.

Sensor check:
at - 10° R = 14079 to 18588 Ω.
at + 20° R = 3280 to 3770 Ω.
at + 25° R = 2613 to 2992 Ω.
at + 100° R = 164 to 190 Ω.

It informs the ECU of the engine temperature, so that the ECU can control cold starts, cold operation etc.

Atmospheric pressure sensor.



Connection:
Terminal 1: to ECU terminal 16.
Terminal 2: to ECU terminal 22.
Terminal 3: to ECU terminal 18.
Terminal 4: to ECU terminal 8

Sensor check:
Between terminals 3 and:4 290 $^{\pm 20\%}$ Ω
0.25 V at 15 kPa, 4,75 V at 120 kPa.

Air temperature sensor check:
Between terminals 1 and 2 2353 at 2544 Ω at 20°c.

This sensor is used to correct the quantity of fuel injected on the basis of:
- the atmospheric pressure (the higher the atmospheric pressure, the greater the air mass for a given volume, the better the filling)
- the inlet air temperature (the lower the air temperature, the greater the air mass for a given volume, the better the filling).

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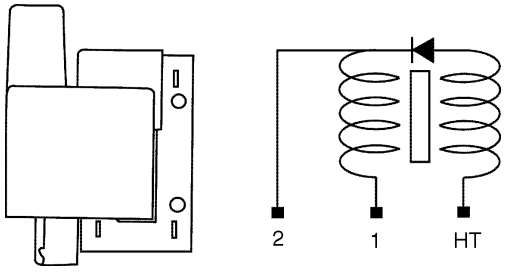
Ignition coil



Connection:
Terminal 1: to ECU terminal 12.
Terminal 2: to + battery.

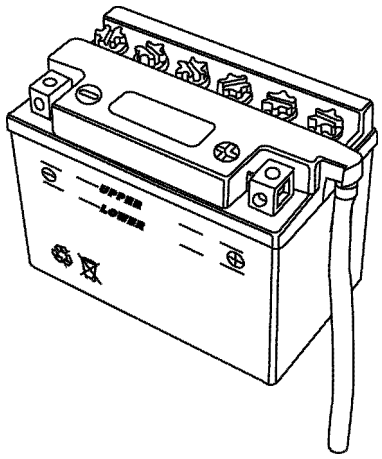
Check:
1 and 2 R = 0.63 $^{\pm 0,03}$ Ω primary coil.

The secondary winding of the coil cannot be measured as the circuit features a capacitor and a diode. The ECU controls the ignition; it uses the speed sensor to determine the ignition point (in relation to the missing tooth on the speed sensor wheel)
It calculates the ignition advance taking into account parameters such as load, engine speed, engine temperature, etc…

Dwell time (coil charging time) is adjusted according to the battery voltage.

The use of a resistive suppressor and resistive spark plug is imperative

Battery



The system cannot function without the battery.
The minimum battery voltage required for the ECU to function is 8.5 volts.
The ECU needs constant battery voltage information in order to adapt the components command signal length.
The response time of an injector, for example, is directly linked to its supply voltage. Hence the ECU modifies the injector signal length to compensate for battery voltage variations. (A weak battery delays the injector opening).

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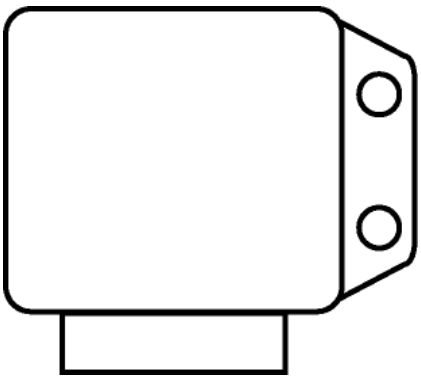
Immobiliser



AEC400.type

Antitheft device fitted with a transponder key which can be identified by the immobiliser module via an antenna.

Number of programmable keys: 8.

Master key (red) enabling the keys to be programmed.

Diagnostic system via the deterrent warning LED being lit.

This is an electronic module connected in parallel to the diagnostic plug and which communicates with the injection / ignition ECU and the ignition key in order to enable the engine to be started or not by identifying the ignition key using a transponder system.

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FUNCTIONING STRATEGIES

ECU software

This is the program which manages functioning of the system as from the data supplied to it.

ECU calibration

Adaptation of the system to the machine is by determining a certain number of machine specific values. These values are determined by bench testing, and entered into the calculation tables which the ECU uses to adapt the system to the machine.
Example: table for the engine temperature, quantity of fuel, engine speed, throttle valve position, etc...

Cut off during deceleration

Under harsh deceleration, the system cuts off the injection in order to save fuel. In this case, the petrol injector is closed.

Idle control

The idle speed is controlled entirely by the ECU which determines the corrections to be applied and how to apply them to obtain a correct idle speed whether the engine is cold or hot. No adjustment is necessary.
In order to obtain a correct idle speed in all cases, the ECU adapts:

- the idle valve position
- the ignition advance.

Diagnostic lamp

The light comes on when the ignition is turned on to check it is operational and comes off as soon as the engine starts if there is no incident.
If an incident occurs, the driver is informed by the light.
Three types of faults may occur on the vehicle

1. Serious safety fault or fault which could lead to destruction of the engine, **the vehicle must be stopped**
   The light comes on and stays on.
2. Serious fault affecting machine operation or riding comfort.
   The light flashes.
3. Minor fault.
   The light remains off. The fault will be processed during servicing.

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DIAGNOSTIC

Faults codes and priorities

Fault code	Description	Priority level
1	Engine overheating:	1
2	Speed sensor circuit fault	2
3	Potentiometer adaptation fault	2
6	Potentiometer variation fault	2
8	Potentiometer fault	1
9	Battery voltage fault	1
12	Petrol injector fault	2
13	Ignition fault	2
14	Petrol pump relay fault	2
15	Engine overspeed	3
16	Faulty power supply to sensors	3
17	Engine speed incoherent fault on start-up	2
18	Engine temperature sensor circuit fault	3
19	Air temperature sensor fault	3
20	Temperature gauge fault	3
21	Warning light fault	3
23	Altimetric sensor circuit fault	3
24	Idle valve fault	2
25	Idle adaptation fault	3

Diagnostic tools

A diagnostic light informs the driver of a fault. This warning light enables the mechanic to "read" a memory in which the fault codes are stored.
A diagnostic tool may be connected to the ECU to "read" this memory, i.e the fault codes, vehicle operating parameters, etc…

The system diagnostic is carried out by the ECU which controls all the elements connected to it.
The ECU memorises all detected faults and classifies them in three categories according to their importance or their impact on the vehicle functioning.
The system diagnostic may be carried out in two ways:

1. Manually via the warning light.
2. Automatically via the diagnostic tool.

DIAGNOSTIC PROCEDURE USING THE DIAGNOSTIC TOOL

Refer to the workshop manual "Use of the diagnostic tool for the injection system".

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MANUAL PROCEDURES

Fault reading,

Fault reading is carried out by "reading" the diagnostic warning light flashes. The number of flashes is a code that corresponds to an incident indicated in the workshop manual.

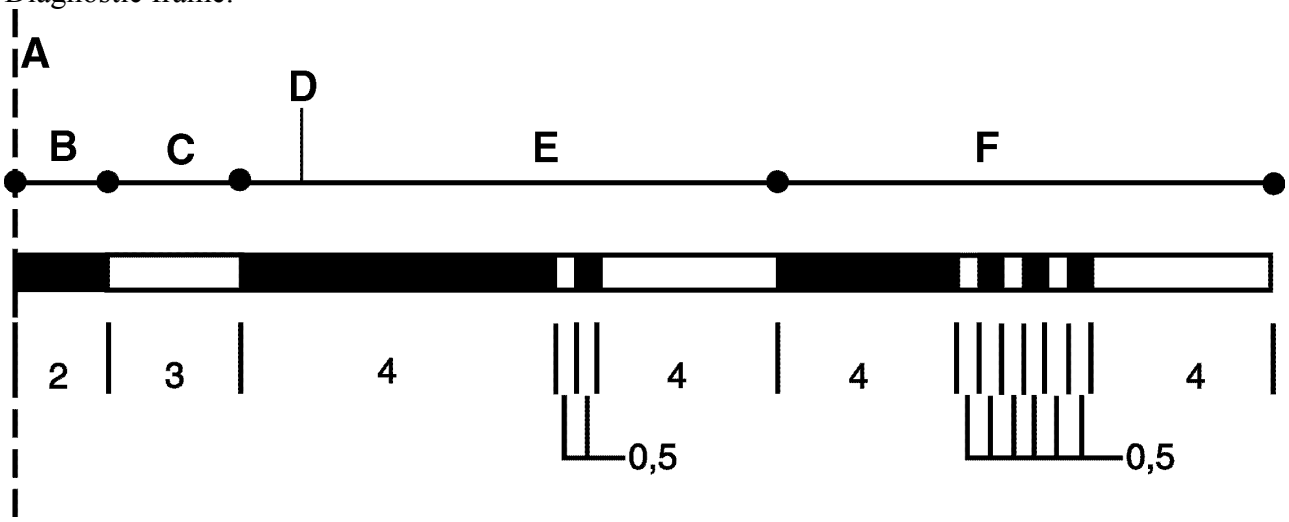
Procedure:

1. Check the ignition is off.
2. Open the throttle and maintain it fully open (accelerator cable properly adjusted).
3. Turn the ignition on while maintaining the throttle open.
4. The warning light comes on for 2 seconds and then goes out for 3 seconds.
5. As soon as the warning light comes back on (for 4 seconds), release the throttle grip to close the throttle.

The warning light comes on for 4 seconds prior to each diagnostic code (x flashes of 0.5 seconds) and goes out for 4 seconds afterwards.
The codes recorded by the ECU are sent one after the other and the whole series of codes is repeated 4 times.

6. Note the fault codes indicated by the warning light.
7. Process faults.
8. Carry out a fault code clearing as indicated in the fault clearing procedure.
9. Test the vehicle and check that the codes do not reappear.

Diagnostic frame:



A- Ignition.
B- Diagnostic light test.
C- Diagnostic light off.
D- Closing of throttle.
E- 1st code.
F- 2nd code.

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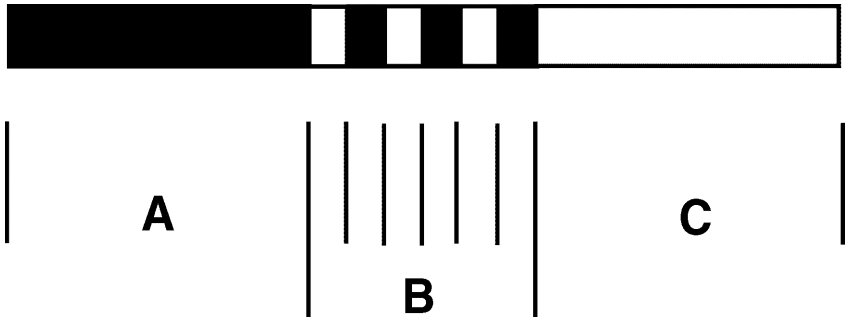
Code detail



A- Start of code (the warning light comes on for 4 seconds).
B- Code (number of flashes corresponding to the code) (for example: 3 flashes).
C- End of code (the warning light goes off for 4 seconds).

Note:
If the vehicle is started during diagnostic, the procedure is interrupted and the vehicle functions normally.

Clearing fault codes

Clearing occurs after 4 consecutive readings of the fault frame without cutting off the ignition or starting the engine, provided there are no more faults.

Procedure:
1. Start a fault code reading procedure.
2. Wait for the 4 fault code readings to be completed without cutting off the ignition.
3. Start the vehicle, the faults are cleared automatically.
4. Turn off the ignition.
5. Start a new fault code reading procedure.
6. Check the warning light is off, which indicates that the faults have been cleared.

Initialisation of the throttle unit

Initialisation is necessary in the following cases:
1. After changing the ECU.
2. After changing the throttle unit.

Note: The engine must not be started during the procedure as this would cancel the procedure.

Procedure:
1. Turn on the ignition
2. Disconnect the throttle unit.
3. Wait for the diagnostic warning light to come on (after 2 seconds minimum).
4. Turn off the ignition.
5. Reconnect the throttle unit and turn the ignition back on.
6. Fully open the throttle (accelerator cable properly adjusted) and return to the idle position (full throttle stroke identified by the ECU).
7. Check that no fault code is recorded using the manual procedure.
8. Clear fault codes if necessary.
9. Turn off the ignition.

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Engine de-flooding

1. Turn on the ignition
2. Fully open the throttle (accelerator cable properly adjusted).
3. Maintain the throttle fully open and press the starter button for 5 seconds, thus cutting off the injection, ventilating the cylinder with air only and evacuating excess fuel.
4. Close the throttle and start the engine without accelerating.

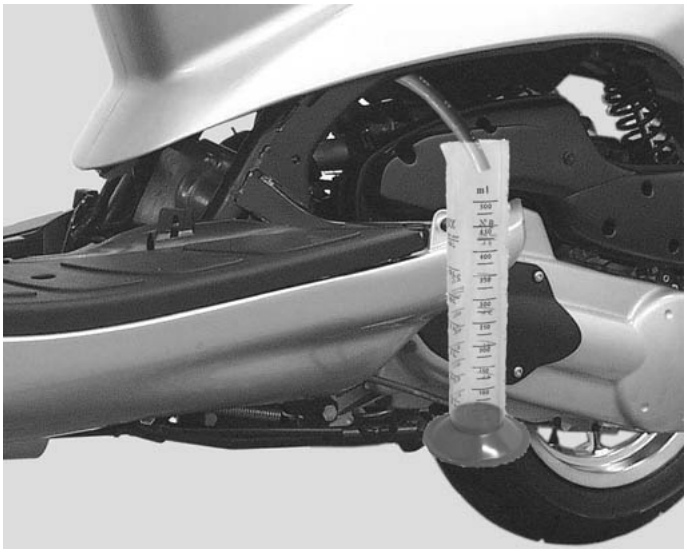
Draining the fuel pump

The fuel pump functions as soon as the engine is running.
It also functions when the ignition is turned on for a short time (3 seconds) in order to fill and pressurise the fuel circuit.

Procedure:

1. Turn on the ignition.
2. The pump functions for a short time (3 seconds).
3. Repeat the operation until the circuit has been drained completely (the ignition must be turned on approximately 3 times).

Fuel pump flow rate checking procedure



1. Disconnect the fuel injector pipe and place it in a graduated recipient.
2. Turn the ignition on to start the fuel pump (when the ignition is turned on, the pump functions for 3 seconds).
3. Measure the quantity of fuel. This quantity must be 35 ml minimum for 3 seconds.

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EMERGENCY STRATEGIES

In case of a fault, an emergency strategy is applied whenever possible, so that the driver can reach the nearest sales point.

Example: in case of a fault on the engine temperature sensor, a standard temperature value of 35°C is applied. (in this case cold starting is impossible but if a fault occurs while the vehicle is running, this will not lead to a breakdown).

Precautions during use:

Never accelerate to start the engine (hot or cold).

Never run the machine with a petrol/oil mixture, as the fuel pump and the injector are not designed to operate with oil.

Use only 95 or 98 unleaded petrol.

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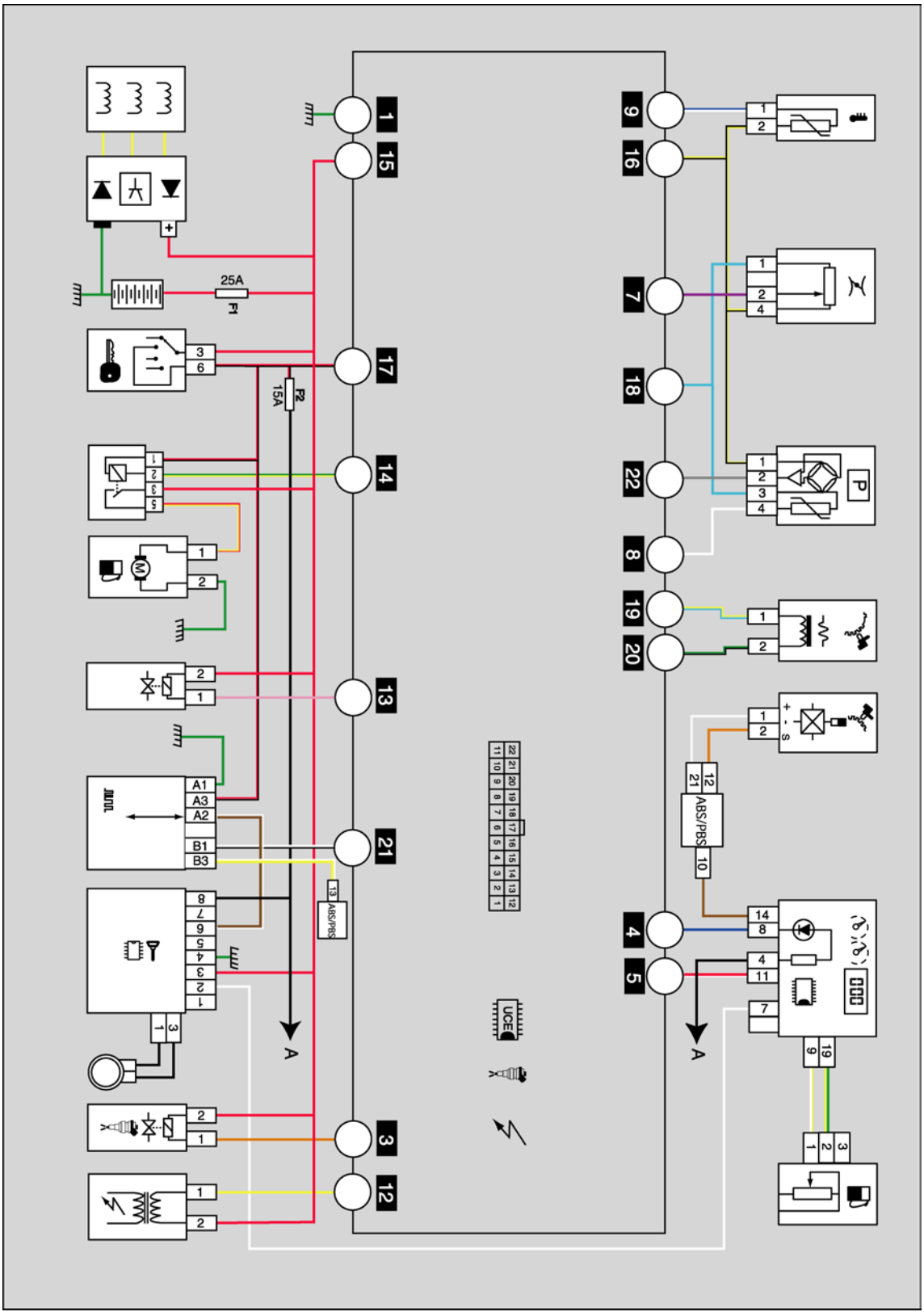
WIRING DIAGRAM



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