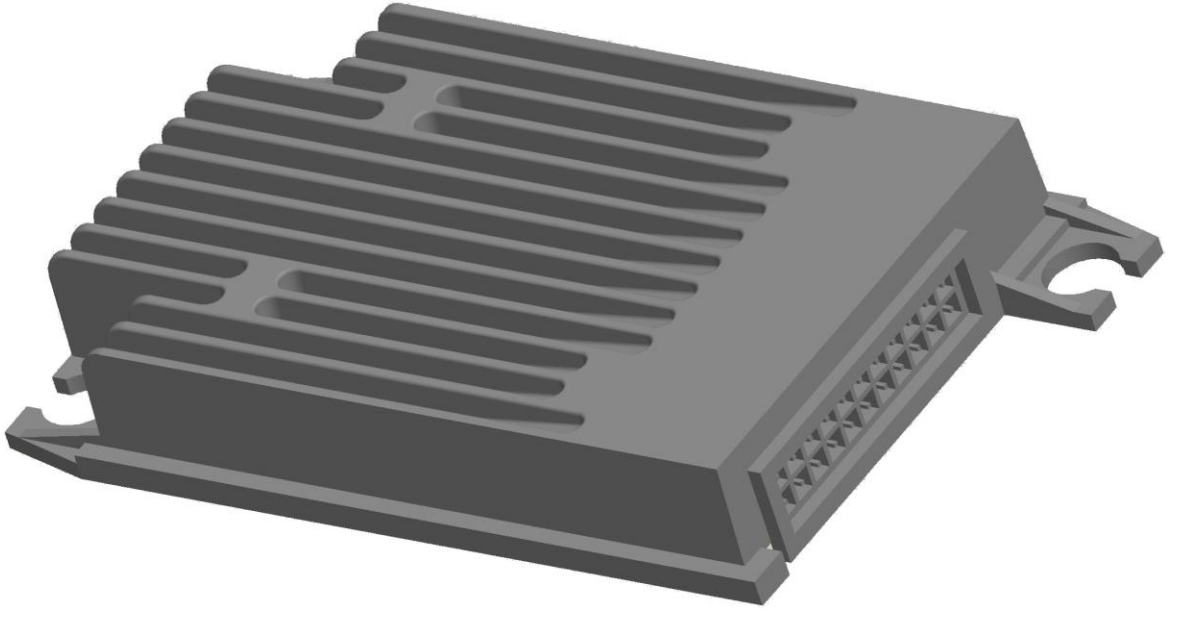
Pure Jet Injection

E = ELECTRONIC
M = MANAGEMEN
S = SYSTEM



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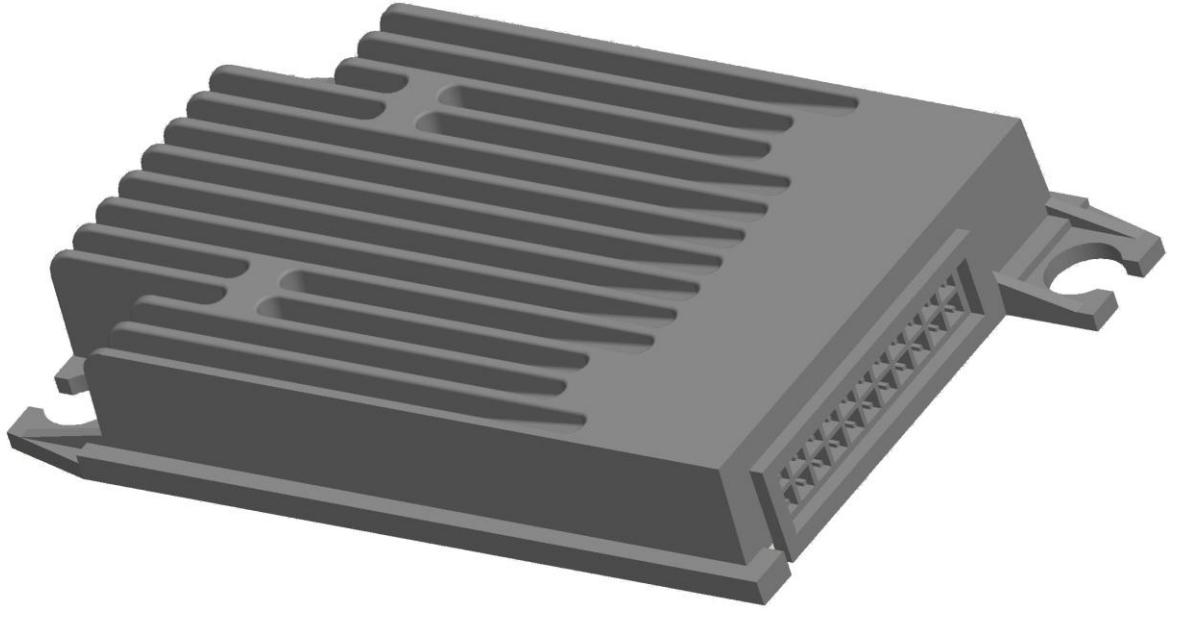
Control unit



Control unit: Operation logic

LEARNING CENTRE

The (**EMS**) injection system is an injection-ignition integrated system in one digital control unit (**ECU**) with microprocessor.

The control unit is permanently battery-powered via a 20 Ampere fuse and is fully activated when the key switch is set to “ON”.

The input signals are

- Revolution timing sensor (pick-up)
- Coolant temperature
- Throttle valve position (TPS)

Control unit: Operation logic

LEARNING CENTRE

Should any input signals fail, an acceptable engine working order is ensured to allow the user to reach the repair shop.

Naturally, this cannot occur when the revolution timing signal is missing and/or when failures concern the control circuits:

- **Fuel pump**
- **HV Coil**
- **Injectors**
- **TPS (Throttle Position Sensor)**

When Pure Jet engines operate at idle speed, they use an extremely lean air-fuel mixture whose value varies according to engine temperature.

The throttle body provides a very high air supply and the idle speed is kept at 2000 rpm, causing the mixture to get lean at the right moment by affecting the fuel injection time.

The ECU manages ignition by properly controlling the advance (before TDC) and the coil magnetisation time.

Control unit: Operation logic

LEARNING CENTRE

The fuel supply circuit consists of

- Positive displacement compressor
- Flexible connection pipes to injectors support
- Pressure regulator
- Air injector

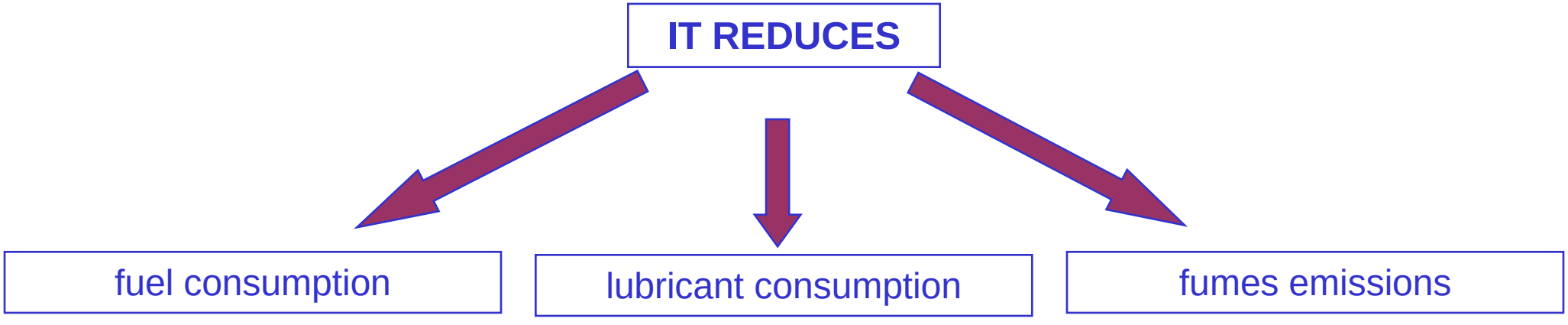
The ignition circuit consists of

- ECU
- HV Coil
- HV Cable
- Shielded cap
- Spark plug

Control unit: Operation logic

LEARNING CENTRE

The injection-ignition system, without compromising torque and power supply characteristics, allows to obtain the following results:



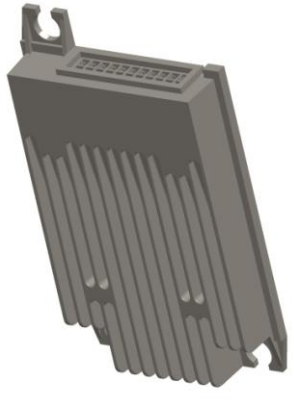
Control unit: Operation logic

LEARNING CENTRE

INPUT DATA

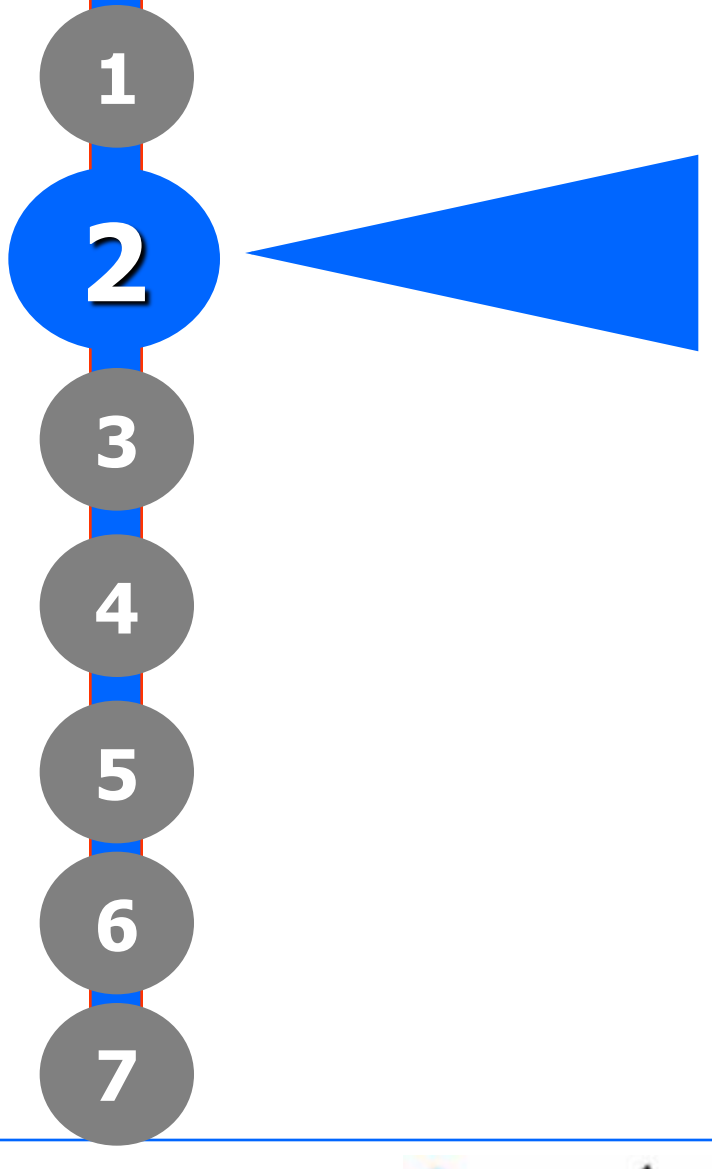
- Revolution timing sensor
- Throttle valve position
- Coolant temperature

SURGE TANKS



OUTPUT DATA

- Air injector opening time
- Fuel injector opening time
- Ignition



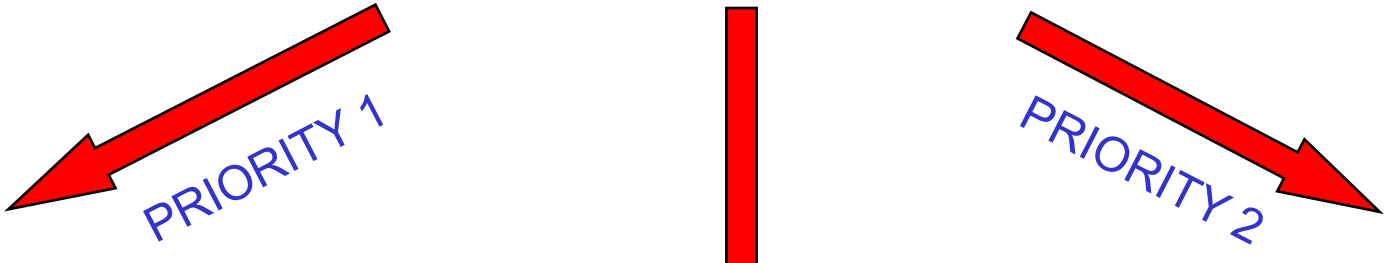
Self-diagnosis

Self-diagnosis

LEARNING CENTRE

The control unit is fitted with a self-diagnosis system and provides information to users by means of the instrument panel warning light.

There are 3 warning indication modes:



FLASHING WARNING LIGHT

(identifies a failure that may severely damage the engine if the vehicle is not stopped)

STEADILY ON FIXED WARNING LIGHT

(identifies a failure that compromises vehicle use as the engine may get stopped or remain idling)

PRIORITY 3

(failures not indicated to the rider through the injection telltale light but that may be perceived by the evident engine malfunction)

Troubleshooting Tips

1) Failures in the injection system are more likely to be due to connections than to components.

2) Failures in the injection system may be caused by loose connections.

Diagnostic Tester Menu

The diagnostic tester is fitted with a specific diagnosis software for Pure Jet injection systems.

The tester foresees a menu of the base settings:

PARAMETERS, ERRORS, STORED PARAMETERS, ERROR CLEARING, ACTIVE DIAGNOSES, TPS RESET, ADJUSTMENT AND ECU DATA.

To access each function, the tester must be connected to the vehicle diagnosis socket (placed behind the battery cover under the saddle) and the control unit must be powered.

Self-diagnosis

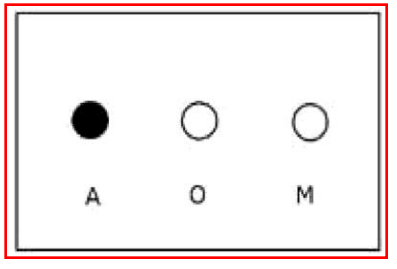
LEARNING CENTRE

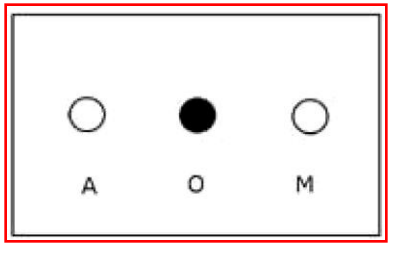
Failures are indicated by means of a darkened dot placed on one of the reference columns:

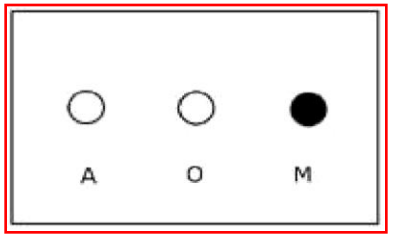
A = Current failure (present when check is carried out).

O = Taking place (intermittent and not present when check is carried out).

M = Stored failure (at end of the period of use).







The failure may be indicated by only one mode, for example condition **A** (current) and **M** (stored) can not coexist.

The system recognises failures by means of an analysis and a comparison of the electric signals.

This allows to recognise a missing or a non-expected signal.

Self-diagnosis Functions

LEARNING CENTRE

Stores parameters: this function allows to view the previously stored parameters.

The diagnostic tester may have only one value stored that is automatically cleared when the tester is unplugged from its power source.

Error clearing: this function allows to clear failures detected by the ECU self-diagnosis.

Active diagnoses: this function allows to perform efficiency checks on the main system components and their related circuits.When the different diagnoses are activated, the tester displays “TEST SUCCESSFUL” or “FAILED”. The tester result is combined to sound and/or visual checks.

TPS Reset: this function allows to link the throttle body to the ECU.

Adjustment: this function allows to enter new calibrations in the ECU.

ECU data: the tester allows to view the following information:

S/N = ECU serial number

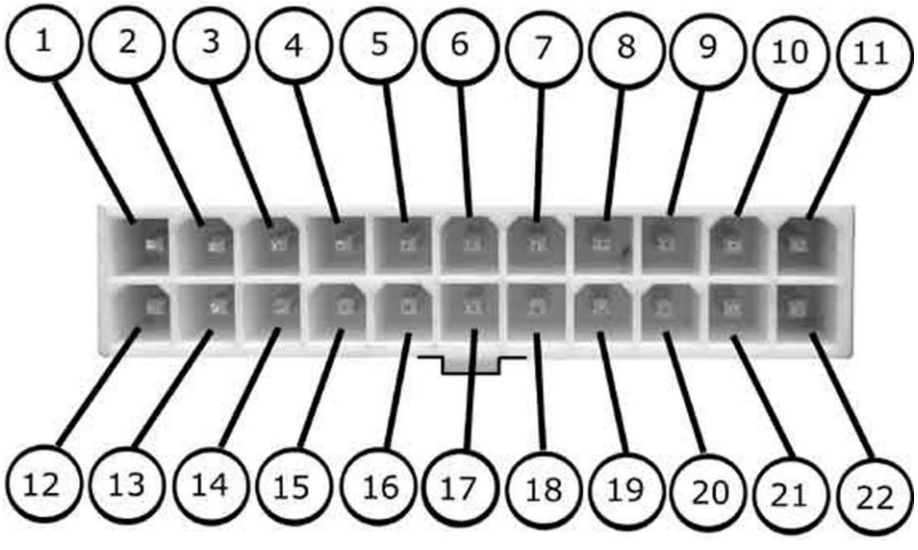
HW REV = hardware revision No.

ECU SW = ECU software reference

CALIBR = calibration reference

Terminal layout

LEARNING CENTRE



1 = Ground

2

3 = Fuel injector (negative)

4 = To diagnosis warning light (negative)

5 = Coolant temperature gauge (negative button)

6 = Rpm indicator

7 = TPS 1 Signal

8

9 = Coolant temperature sensor (positive)

10 = TPS 2 Signal

11

12 = HV coil (negative)

13 = Air injector (negative)

14 = Fuel pump (negative)

15 = Base control unit power supply (+12V)

16 = Coolant sensor and TPS sensor ground lead

17 = Live power supply (+12V)

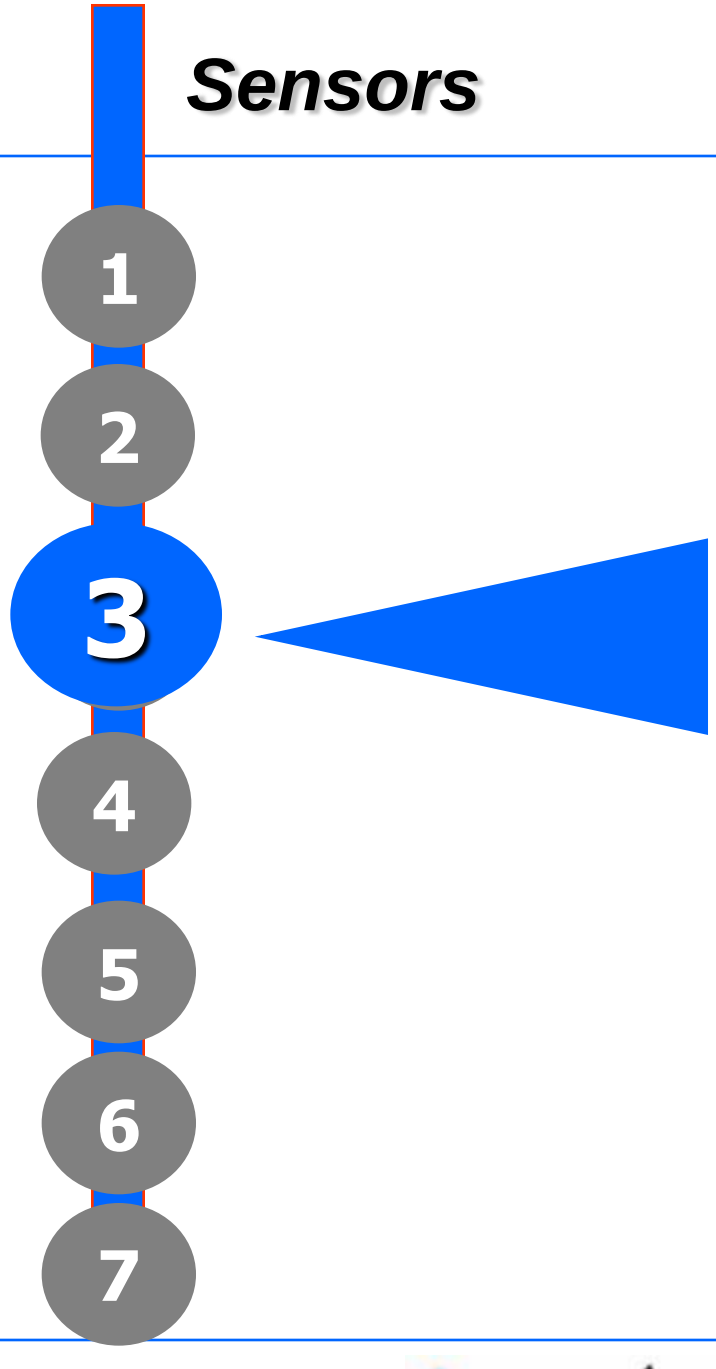
18 = TPS sensor positive (+5V)

19 = Revolution timing sensor positive

20 = Revolution timing sensor negative

21 = Diagnostic tester serial line

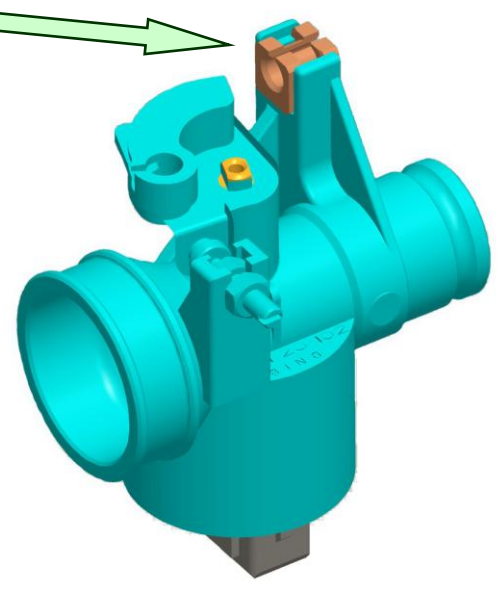
22



Sensors

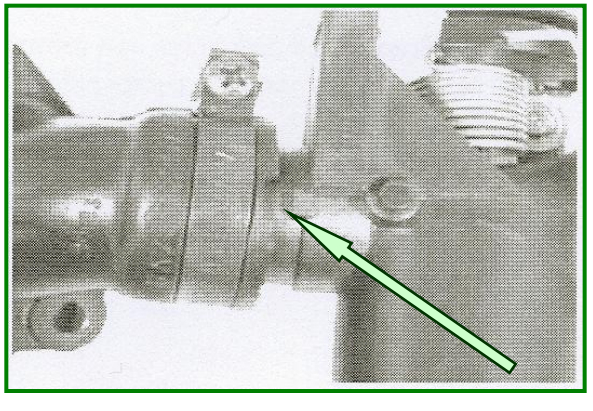
Throttle body

The throttle body is fitted with **a throttle valve position sensor** (TPS) that allows the control unit to detect the throttle valve opening angle at all times.



CHECKS ON THE THROTTLE BODY:

- Check that the throttle valve movement does not present anomalous clearances and/or loosening;
- Check that the electrical contacts are not rusted and/or dirty;
- Thoroughly clean the Venturi pipes interior.



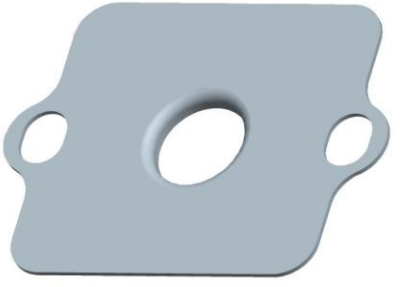
To fit the throttle body on the inlet manifold, insert the reference notch found on the throttle body in its seat on the manifold.

Throttle body - diaphragm - reed support

LEARNING CENTRE

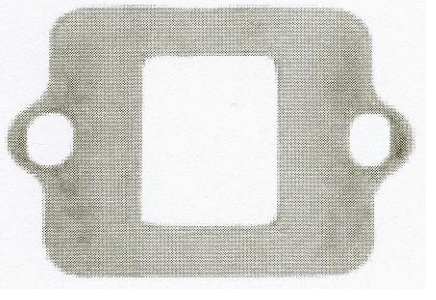
Checks:

1) Check that the diaphragm has no failures.



2) Clean the seal surface carefully.

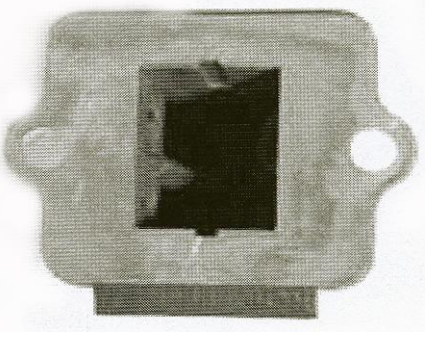
3) Check that the petals are not deformed in the supporting surfaces. Otherwise, replace the whole reed support.



4) Check that the paper gasket is not broken. Otherwise, replace it.

5) Check the reed support for wear on the seal surface.

6) Check that the petals are not deformed in the supporting surfaces. Otherwise, replace the whole reed support.



NB: a small light gap between the petals and the supporting surfaces does not compromise engine operation.

Fitting order: after inserting the reed support in the crankcase, place the paper gasket and the diaphragm with the moulding edges facing towards the reed support.

Throttle valve position sensor

LEARNING CENTRE

The throttle valve position sensor is pre-calibrated, and it forms an integral part with the throttle body, it cannot be removed.

The TPS sensor is a dual track sensor (with 2 resistive tracks) that produce 2 opposite TPS 1 and TPS 2 signals.

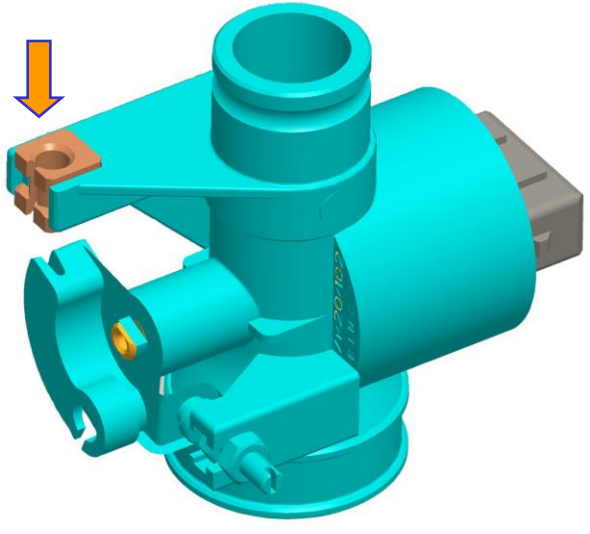
TPS 1 increases as the throttle valve opening increases, and TPS 2 decreases as the throttle valve opening increases.

Both signals are equivalent at only one point corresponding to half opening (50%).

Both signals are converted into a % value for throttle valve opening.

The double track system allows for a better control since signals TPS 1 and TPS 2 are compared between them with a reference map.

When measuring missing or disordered TPS signals, the self-diagnosis as well as failure coding are activated.



Terminals 16 (-) - 18 (+)
Conditions: Key switch set to On
Standard values: 5 V
Terminals 16 - 7
Conditions: Key switch set to On
Conditions: Opening throttle progressively → V progressive increase (TPS 1)
Terminals 16 - 10
Conditions: Key switch set to On
Conditions: Opening throttle progressively → V progressive decrease (TPS 2)

Throttle valve position sensor

LEARNING CENTRE

NB: For a more precise control, open the valve progressively, operating directly on the throttle body since using flexible transmission involves a non linear opening.

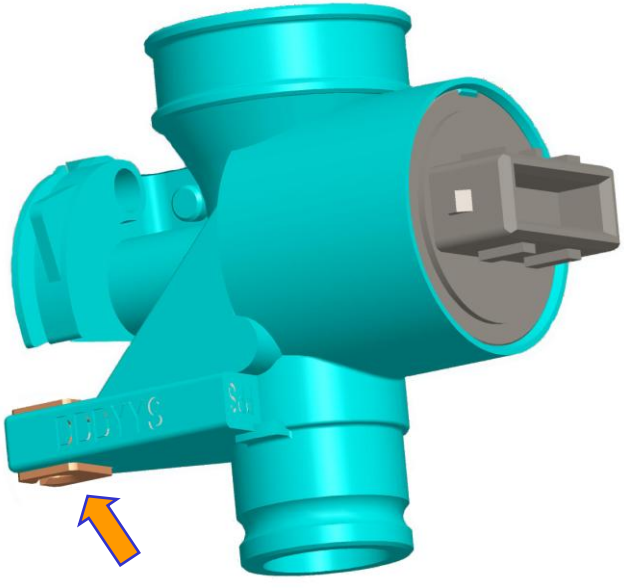
Pre-calibration of the throttle valve position sensor consists in adjusting the minimum throttle valve opening to obtain a specific air flow rate in pre-set reference conditions.

This is done by resetting TPS 1 and TPS 2 signals.

TPS 1 and TPS 2 signals resetting is foreseen in 2 ways:

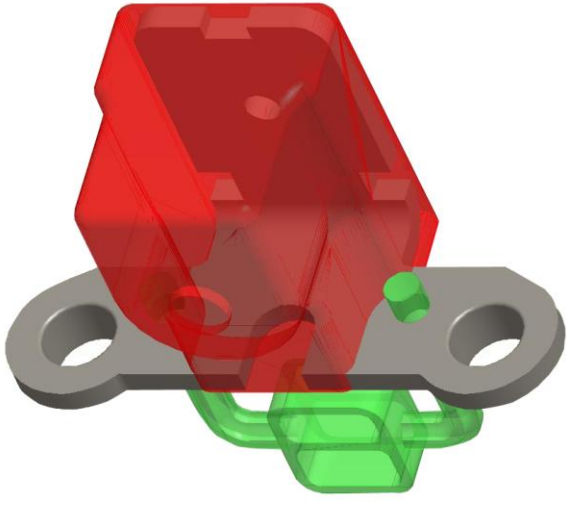
automatic reset

manual reset



The pre-calibration set screw of the throttle body is sealed with paint and under no circumstances should it be tampered.

Revolution timing sensor



Each actuator is managed with a specific timing.
This operation is made possible by the revolution timing signal coming from a tone wheel found on the outer diameter of the magneto flywheel rotor, subdivided in 24 sections but fitted with 23 control teeth.
Through these teeth, the flywheel controls a variable reluctance sensor that has its own magnetism and produces an alternating voltage.
When the flywheel turns, each teeth modifies the magnetic activity of the core and produces a complete alternance.

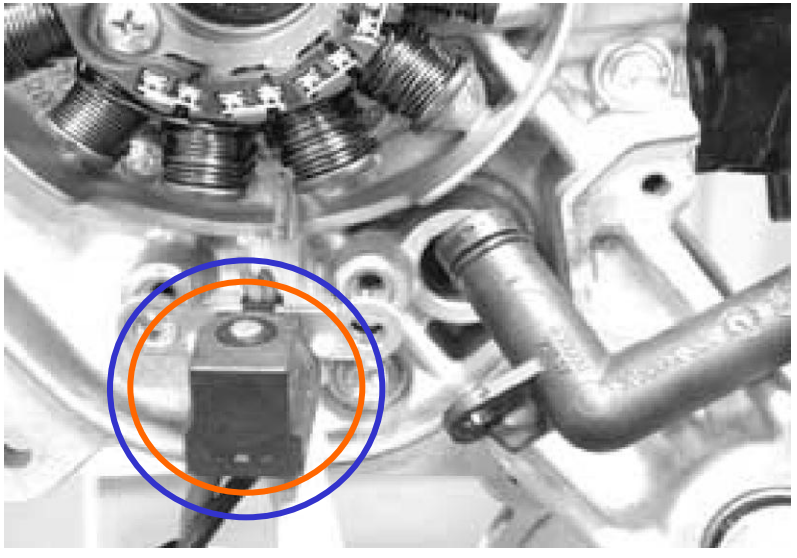
The self-diagnosis is limited to the recognising any possible signal irregularities that occur in one engine cycle, that can be verified by loss of ignition plus a signal to the rider when the injection telltale light comes steadily on.
Conversely, a total signal interruption leads to engine shut off without the self-diagnosis even noticing a failure, so **when the revolution timing signal is missing, the actuators management is also interrupted: air injector, fuel injector, HV coil and fuel pump.**

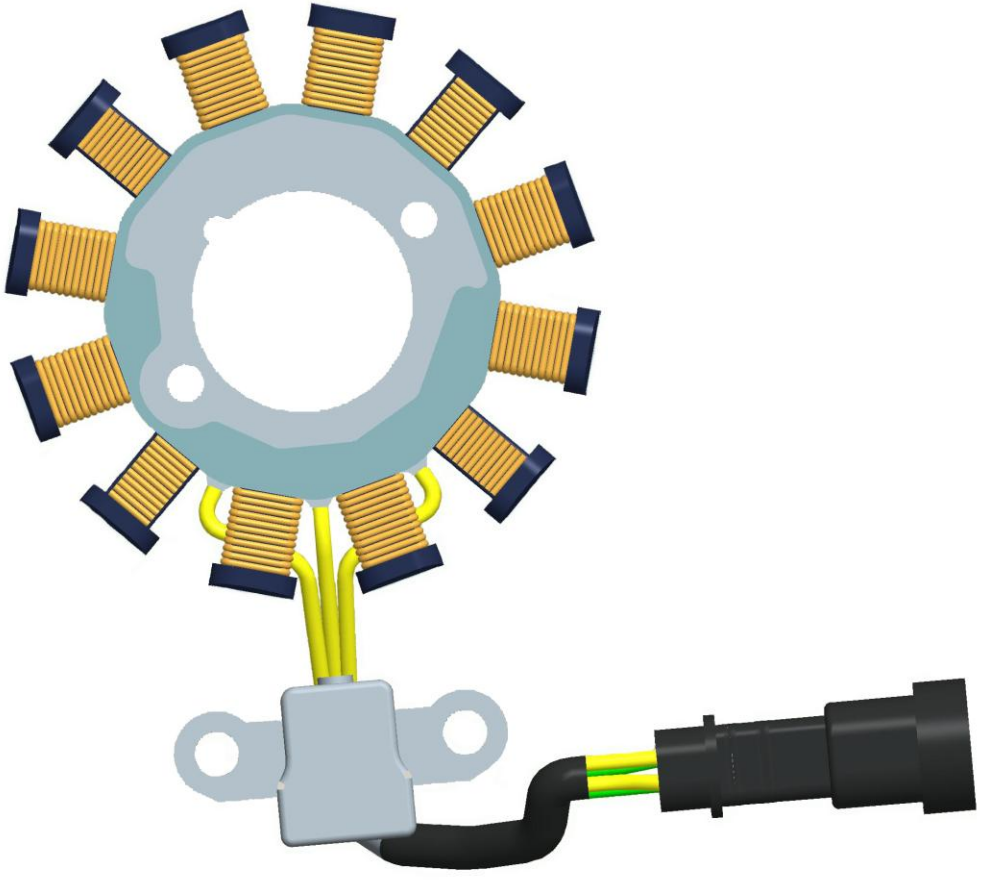
Revolution timing sensor

LEARNING CENTRE

Terminals 19 - 20
Conditions: Engine driven by starter motor (500 ÷ 600 rpm)
Standard values: 3.5 ÷ 4 V

Terminals 19 - 20
Conditions: Engine at idle
Standard values: 11 ÷ 12 V

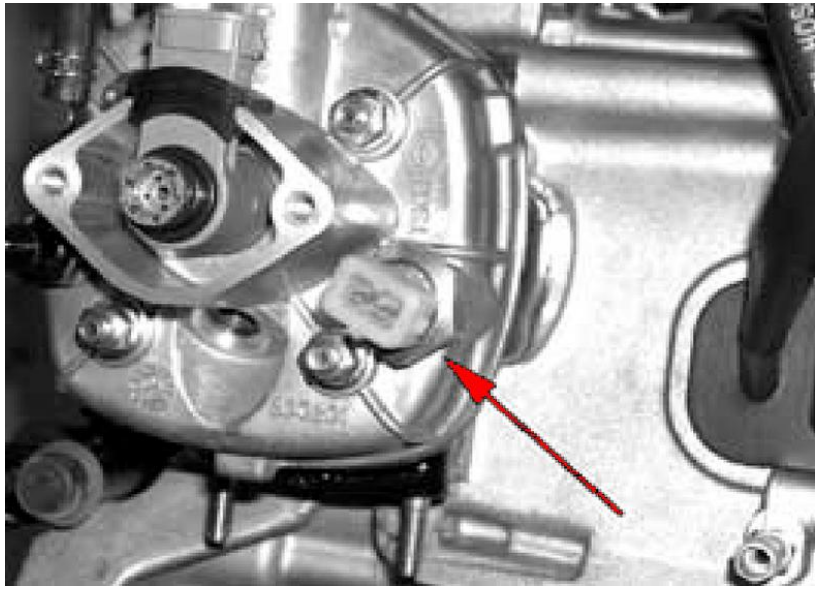


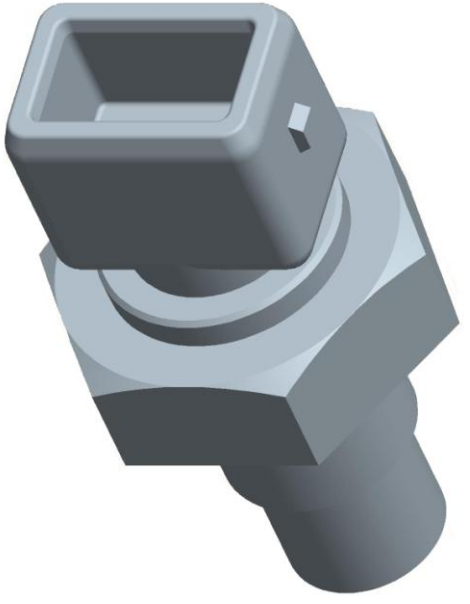


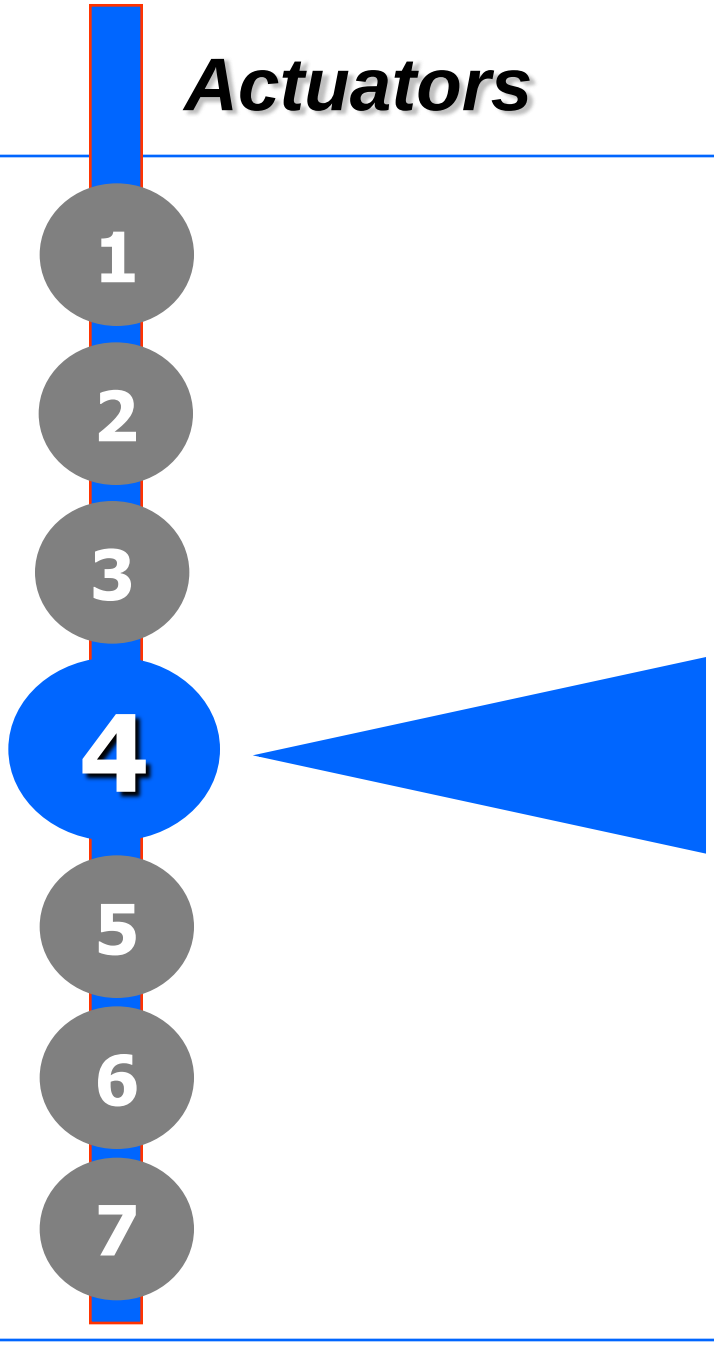
Coolant temperature sensor

LEARNING CENTRE

The sensor receives a 5 V power supply from the ECU, the same power that is also used by the throttle valve position sensor circuit .







Actuators

Air injector

LEARNING CENTRE

The ECU controls both when the air injector has to open and how long this should last.
The ECU self-diagnosis also controls the air injector circuit.
A failure is recognised when the circuit is interrupted or there is a short circuit (either towards the ground or the positive) and the driver is signalled this failure when the injection telltale light comes steadily on.
If there is a failure, the engine can not function.
A failure is recognised only when the revolution timing signal is present.
During engine operation the air injector opening time may be viewed.

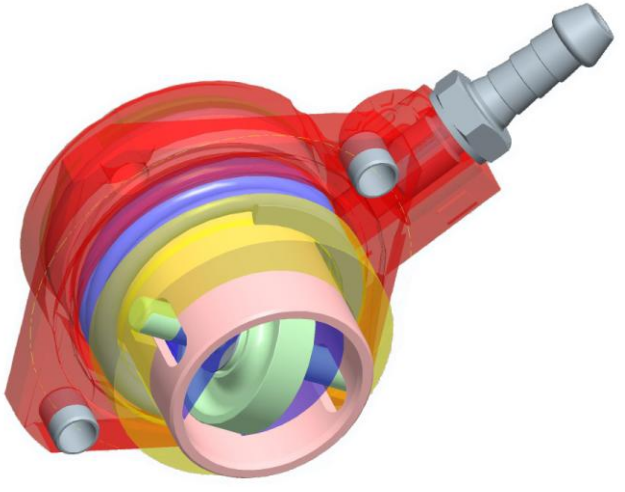
Terminals: 1 - 13
Conditions: Engine off, switch at any position

AIR INJECTION TIME
6 ÷ 7 ms (start-up at 20 °C)
approx. 1.6 ms (at 20 °C minimum)
approx. 1.4 ms (at 60 °C minimum)
(merely indicative values but useful for diagnosis).

Compressed air system

LEARNING CENTRE

Engine revs ≥ 500 rpm → Air pressure at end of test ≥ 4 BAR



Correct engine revs and pressure, check if the pressure is stable throughout time.

Standard air pressure: 5 ÷ 5.5 BAR

HV Coil

LEARNING CENTRE

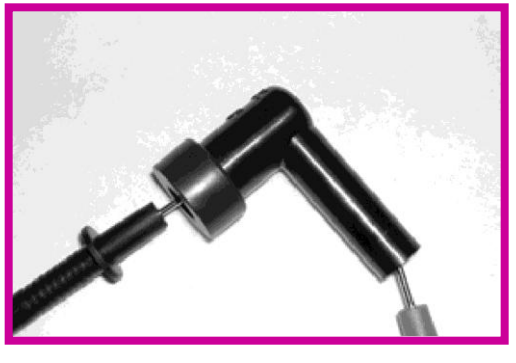
Terminals 1 - 12
Conditions: Engine off, switch at any position.
Standard values:

- Coil winding resistance:

0.63 ± 0.03 Ω (at 23 °C)

- Resistance between one of the primary pole and the coil supporting bracket to the chassis > 1 MΩ

- Shielded cap resistance approx. 5 KΩ



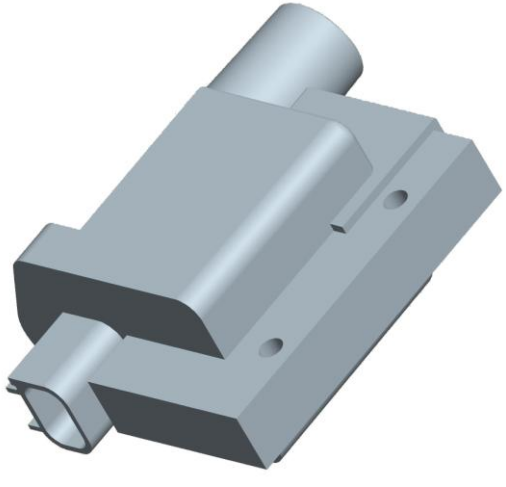
HV Coil

LEARNING CENTRE

This is an inductive integrated ignition-injection system.
Ignition is managed by 2 parameters:

Ignition advance
(the ignition advance curve is optimised according to the rpms and the engine load perceived by means of the TPS 1 and TPS 2 signals).

Magnetisation time of the "DWELL" core
(the core magnetisation time is optimised according to the required HV coil power).



Naturally, long magnetisation times are used during the start-up phase.

The self-diagnosis also controls the coil power supply circuit measuring interruptions or short circuits (only when there is a revolution timing signal, therefore, with rotating engine).
Any possible failure is signalled to the rider when the injection telltale light comes steadily on and, to safeguard the vehicle, the injector supply is interrupted.

HV Coil

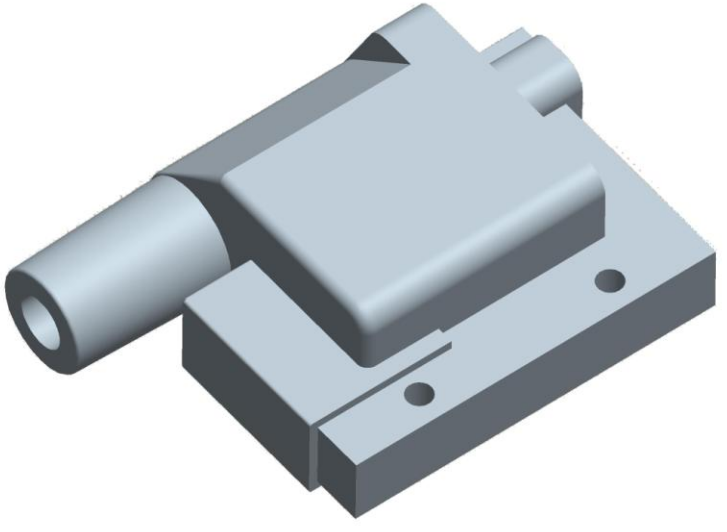
LEARNING CENTRE

Once the engine is at idle, and using a digital multimeter and the adaptor for peak voltage, measure the voltage induced by the HV coil primary:

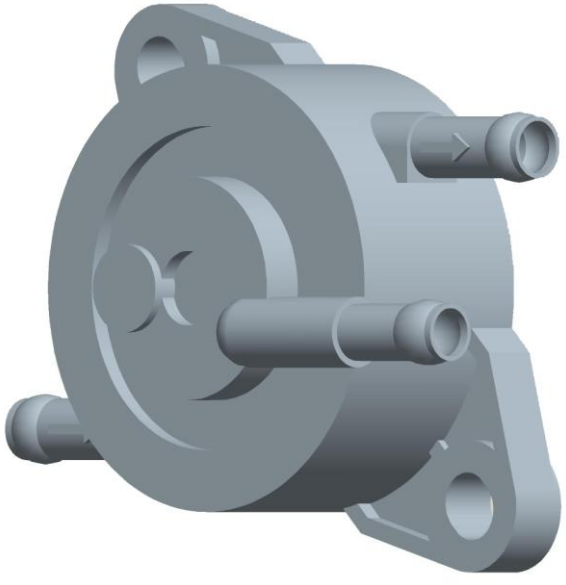
Terminals: 1 - 12 ⇨ approx. 300 V (peak)
Allowed min voltage ≥ 200 V (peak)
Standard start-up voltage approx. 350 V (peak)

If voltage values much lower than the allowed minimum are found, proceed to check the magnetisation time:

DWELL TIME
6 ms (start-up)
2 ÷ 3 ms (at idle)



Fuel pump



The fuel pump is a piston system powered by a direct current motor.

It has been designed to supply high pressures but with small capacities and inputs.
For this reason the pump is powered directly by the ECU, without the need of remote controls.

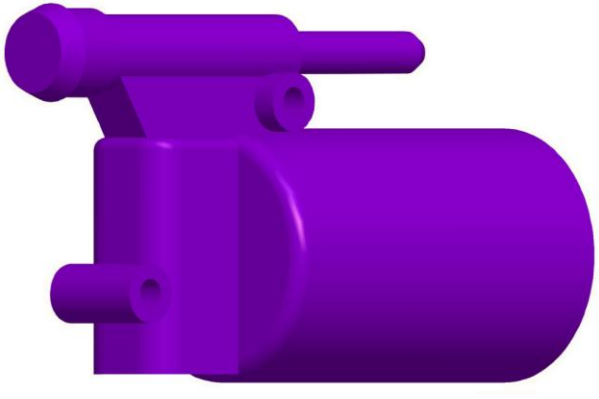
The pump operates constantly.

Constant circulation avoids risk of fuel boiling.

The pump is powered for 4 ÷ 5 seconds after switching to “ON”, this allows circuit bleeding and disposal of the fuel "aged" by boiling inside the injector support.

The pump is fitted in an oblique position to make automatic bleeding more efficient.

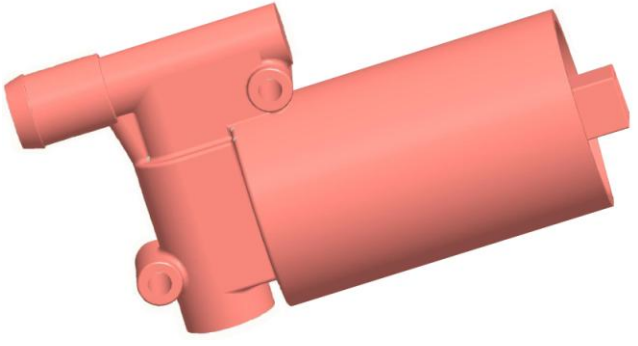
Immediately after, the pump is coupled to the presence of the revolution timing signal.

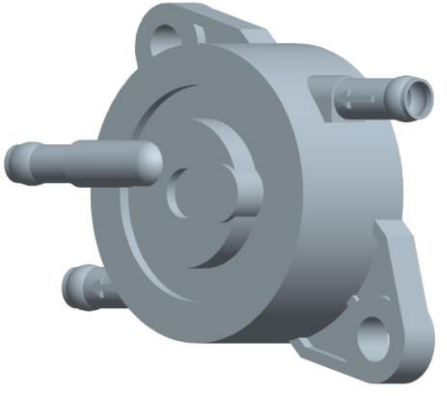


Fuel pump

LEARNING CENTRE

ECU self-diagnosis also controls the pump electric circuit.
Failure identification occurs when the circuit is interrupted or shorted.
Failures are identified with priority level 3 (not signalled by the injection telltale light).





Terminals 1 - 14
Conditions: Switch set to “ON” after timing with engine running.
Standard values < 0.1 V

Terminals 1 - 14
Conditions: Switch set to “ON” after timing with engine off.
Standard resistance: 5 Ω (if the check is carried out on a new pump, high resistive values may be found caused by a non run-in manifold).

Fuel injector

LEARNING CENTRE

The fuel injector receives pressurised fuel by means of the fuel supply system.

The ECU controls both when the air injector has to open and how long this should last.

The fuel is injected in the compressed air chamber creating a rich air-fuel mixture that is then injected in the cylinder by means of the air injector.

The fuel injector prepares the mixture when the air injector is closed and the air injector injects the mixture when the fuel injection has finished.

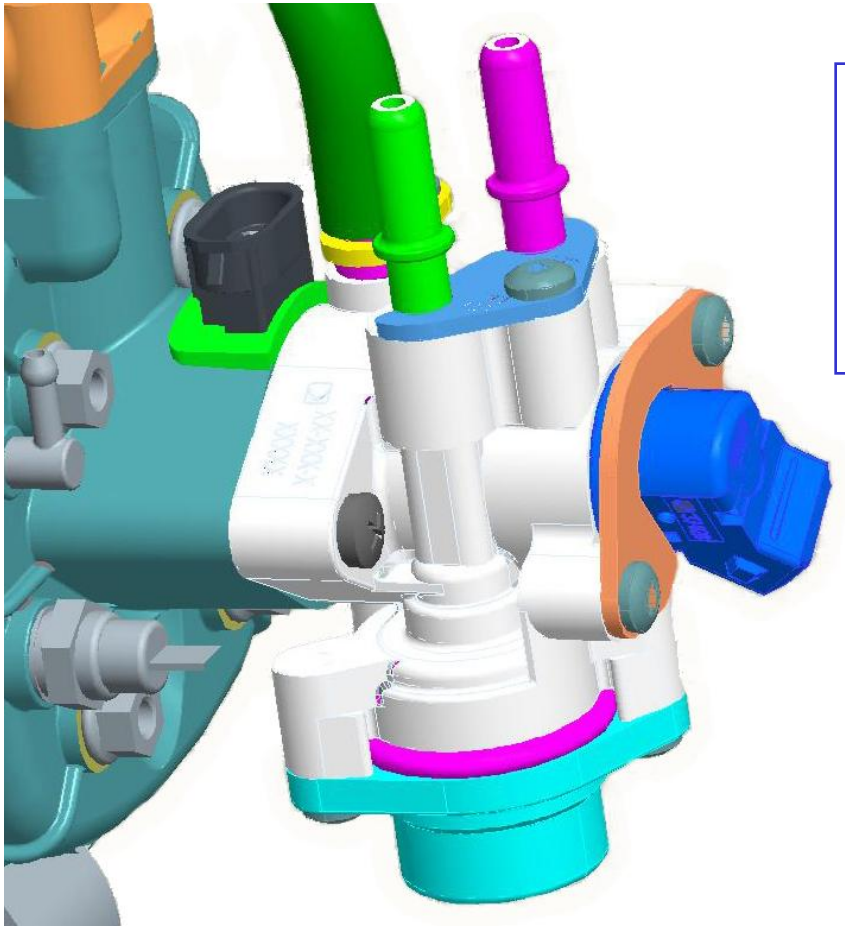
The fuel injector function is important in all engine operating stages and especially at idle and start-up.

The ECU self-diagnosis also controls the fuel injector control circuit.
Failures are identified if the circuit is interrupted or there is a short circuit either towards the ground or the positive.
The rider is signalled this failure when the injection telltale light comes steadily on.
If there is a failure, the engine can not function.
Failures are only recognised when the revolution timing signal is present, that is, when the ECU controls the injector opening.

Fuel injector

LEARNING CENTRE

Terminals: 1 - 3
Conditions: Engine off, switch at any position.



FUEL INJECTION TIME
approx. 6 ms (start-up at 20 °C)
approx. 1.8 ms (at 20 °C minimum)
approx. 1.5 ÷ 1.6 ms (at 60 °C minimum)
(merely indicative values but useful for diagnosis).

Fuel supply system

LEARNING CENTRE

The pressurised circuit involves the fuel injector and the pressure regulator sealings.
The regulator keeps the fuel injection pressure constant at 2.5 BAR (250 kPa).
Since the fuel injector injects inside the compressed air chamber, the true fuel pressure will depend on the air pressure + 2.5 BAR (250 kPa).

When the system is efficient, the injected amount of fuel depends on the injection time variations only.

The circuit foresees constant fuel circulation in the tank to ensure cooling and constant de-aeration of the injector support, thus guaranteeing a better mixture consistency.

Fuel return pipe from injector to tank

Fuel supply system

LEARNING CENTRE

The system is able to provide the correct fuel supply pressure if:

Air pressure for injection	→	**5 ÷ 5.5 BAR**
Fuel pressure	→	**7.5 ÷ 8 BAR**

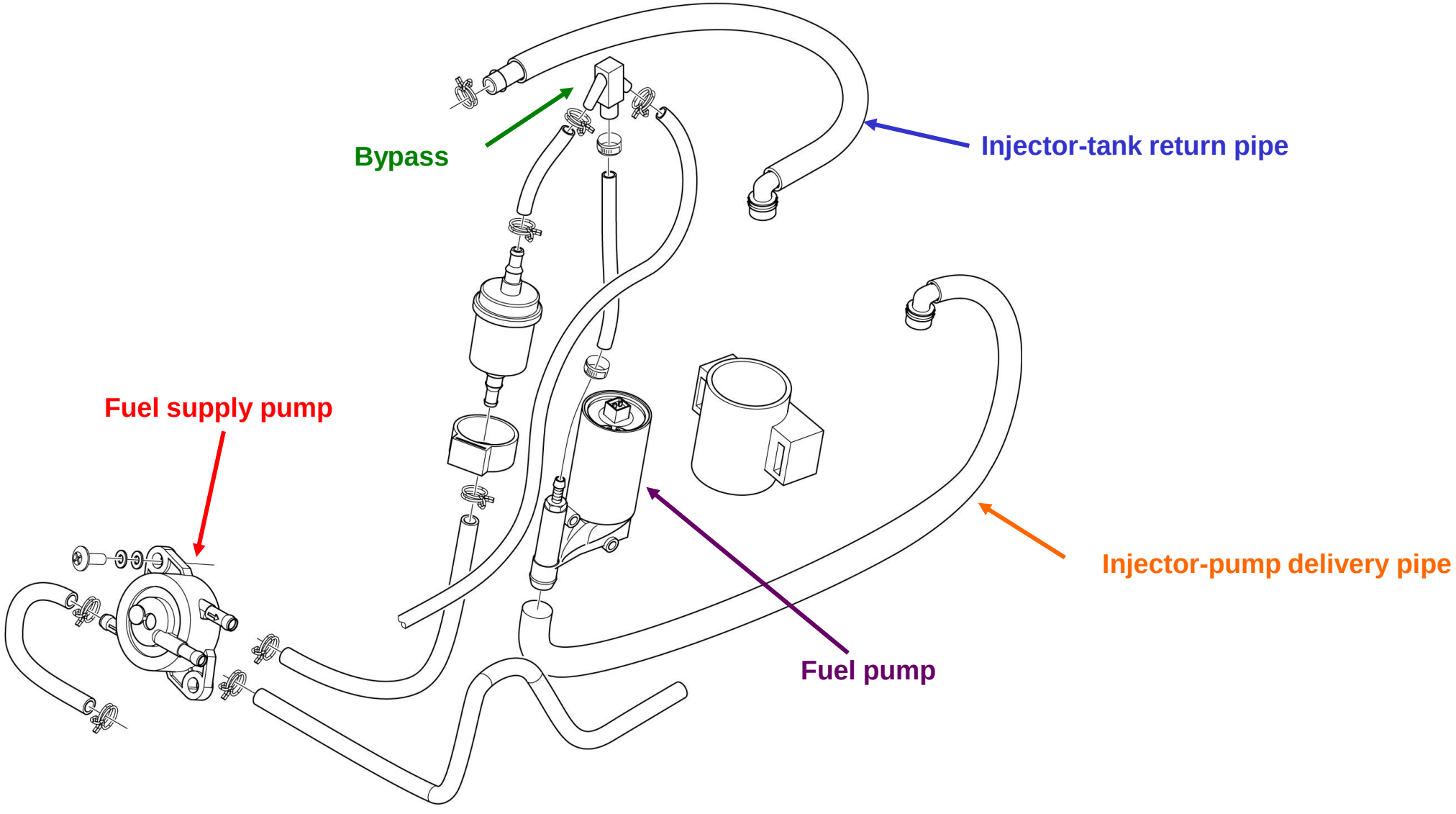
(pressures mentioned refer to a warm engine).

FUEL PRESSURE

2.5 BAR ABOVE AIR

Once the engine is cold and at idle, the pressure values may be reduced by 0.5 bar due to longer injection times.
Accelerating a warm engine or immediately after start-up, the air bubbles in the pipe returning to the tank.
This should be considered normal after injectors activity in combination with pressure pulses.

Supply system diagram



Ignition timing check

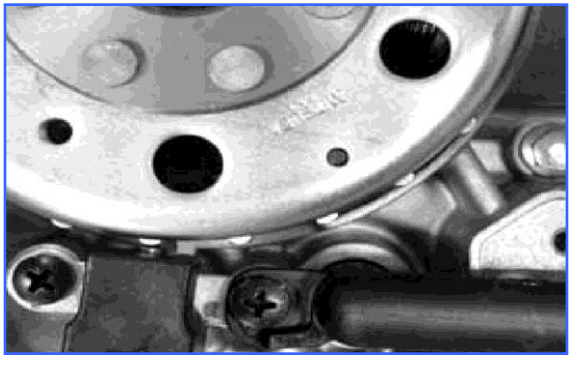
LEARNING CENTRE

The ignition advance is electronically determined on the basis of the parameters known by the ECU.

For this reason, it is not possible to assert reference values based on engine rpms.

The ignition advance value can be measured using the diagnostic tester by checking the correspondence of displayed degrees with true degrees of ignition control.

Check that the last but four teeth in the direction of rotation is aligned with the revolution timing sensor core.
(This position identifies the TDC).



EMS Electric system diagram

LEARNING CENTRE

1= Voltage regulator

2 = Pick up magneto flywheel

3 = Control unit

4 = Fuel injector

5 = Coolant temperature sensor

6 = Throttle body pos.

7 = Resistance

8 = Diagnosis warning light

9 = Coolant temperature gauge

10 = Fuel pump

11 = 5A Fuse

12 = Air injector

13 = HV coil

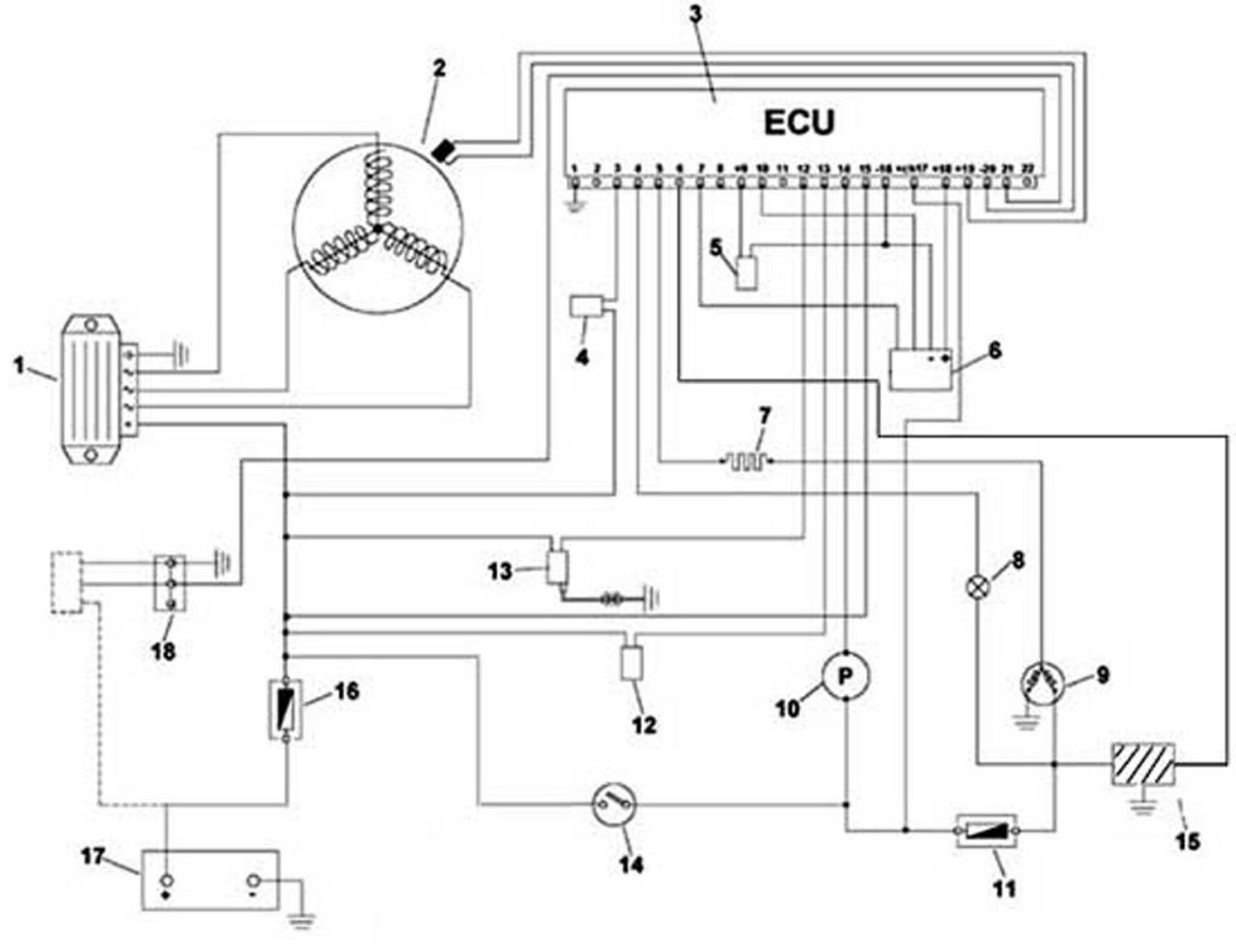
14 = Key switch contacts

15 = Rpm indicator

16 = 20A Fuse

17 = Battery

18 = Diagnosis output



Pure Jet Injection