| JOHNSON CONTROLS | ENGINEERING RESEARCH AND DEVELOPMENT<br><br>BIRMINGHAM | Filename: English guide for paykan & RD<br>Project: 2-12-01-00-01A<br>Date: 8 February, 2008 |
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# SL96

## ENGINE MANAGEMENT SYSTEM

## FOR

## PAYKAN & PEUGEOT RD

# SERVICE WORKSHOP MANUAL

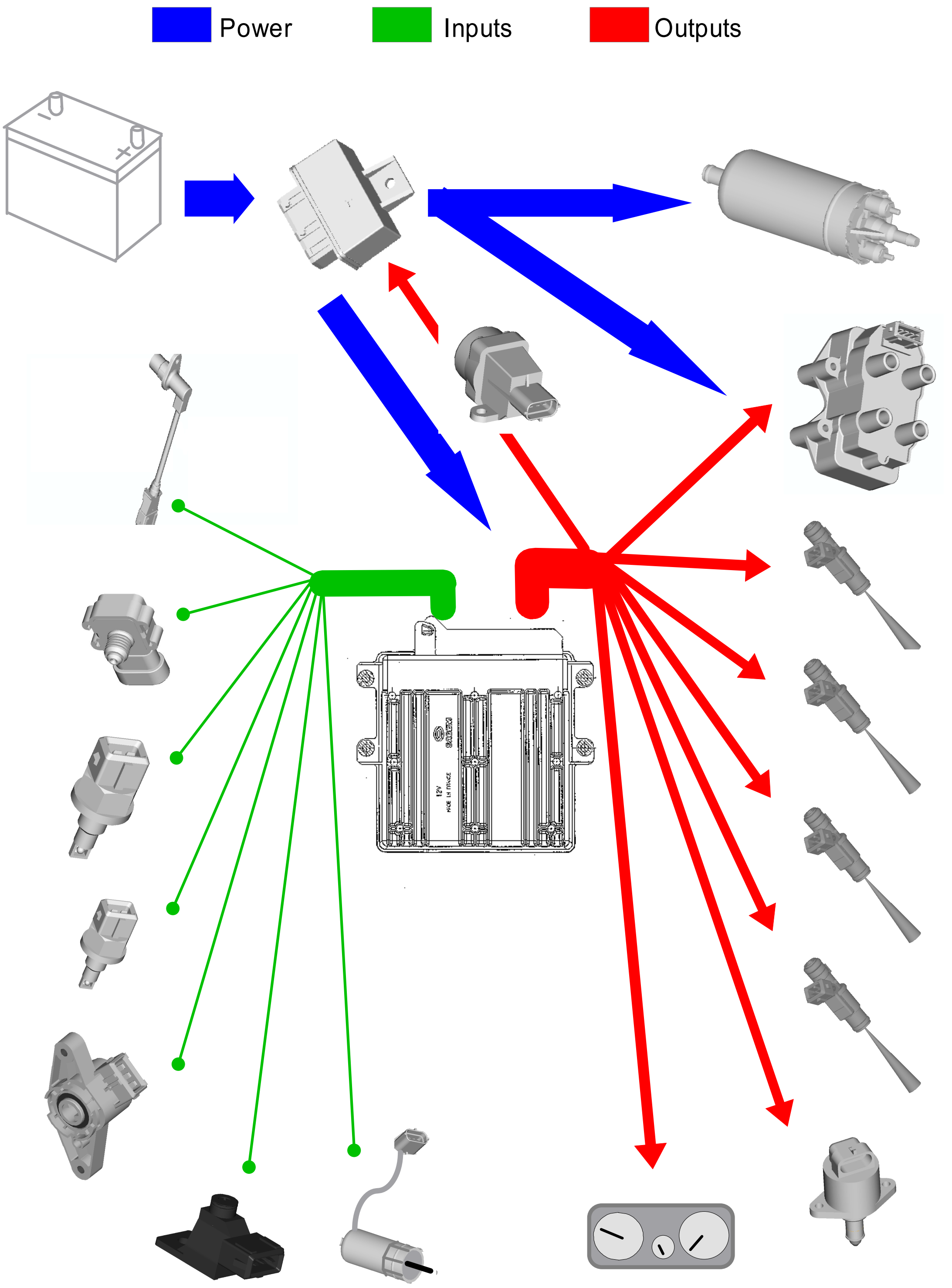
## Table Of Contents

## 1. Introduction

The following document contains details of the Model Year 2001 SL 96 Engine Management System as designed for Paykan & Peugeot RD containing descriptions of the components forming the system, service fault finding, and installation photographs.

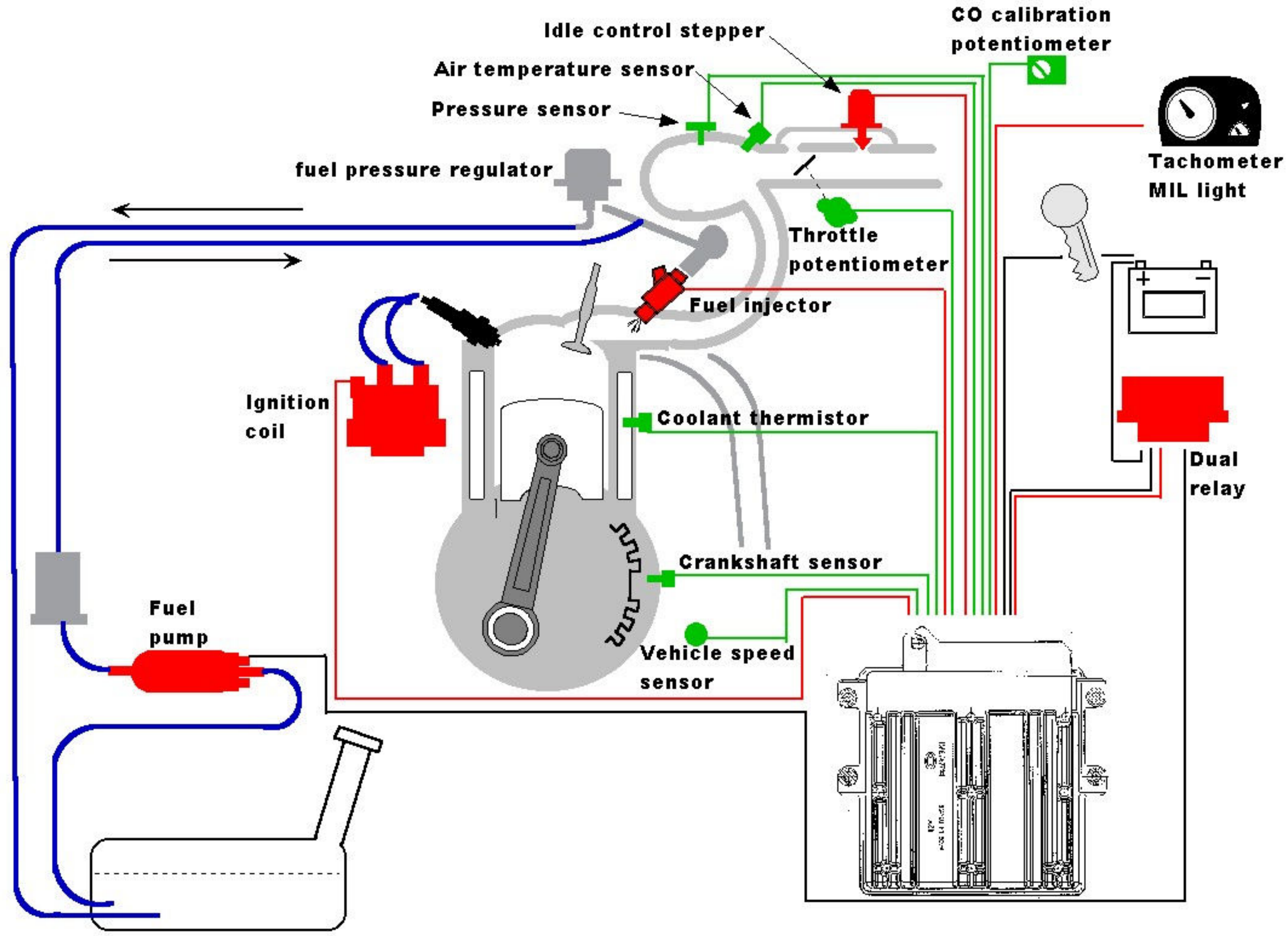
## 2. System description

The diagram below shows input and output components that make up the full Engine Management System.



Power
Inputs
Outputs

The physical schematic below shows the function of the Engine Management System components.




At the heart of the system, is the Engine Control Module (ECM). It controls all of the inputs and outputs in order to optimise the engine performance.

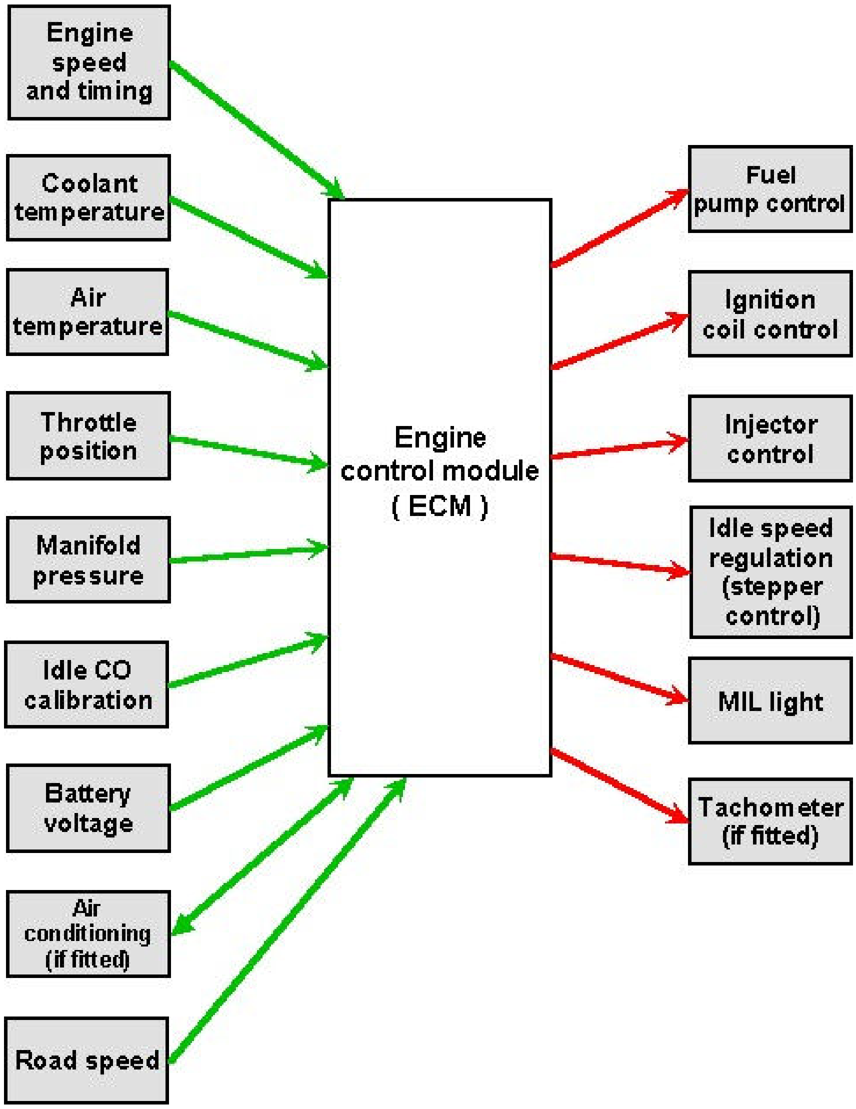
The system can be divided into the following categories:

- Fuel delivery
- Air delivery
- Ignition
- ECM, sensors and actuators

| Group | Part | Comment |
|---|---|---|
| Fuel delivery | • Fuel tank Assembly<br>• Fuel pump (in-line)<br>• Fuel filter<br>• Fuel lines<br>• Fuel line clips (line to body)<br>• Fuel line/hose clamps<br>• Fuel rail<br>• Fuel pressure regulator<br>• Fuel pressure regulator clip<br>• Fuel injectors<br>• Fuel injector clips<br>• M20x1.5 swivel female 90˚ elbow connectors | |
| Air delivery | Air ducts<br>Air filter housing<br>Air filter<br>Worm screw hose clamps<br>Throttle body<br>Inlet manifold | |
| Ignition | Ignition coils<br>Spark plugs<br>HT leads | |
| ECM, sensors and actuators | ECM<br>Harness<br>Engine speed sensor<br>Air temperature sensor<br>Water temperature sensor<br>Manifold pressure sensor<br><br>Road speed sensor<br>Inertia switch<br>Double relay<br>CO potentiometer | |
| | • Throttle potentiometer<br>• Air bypass valve | Fitted to throttle body |

## 2.1. System operation

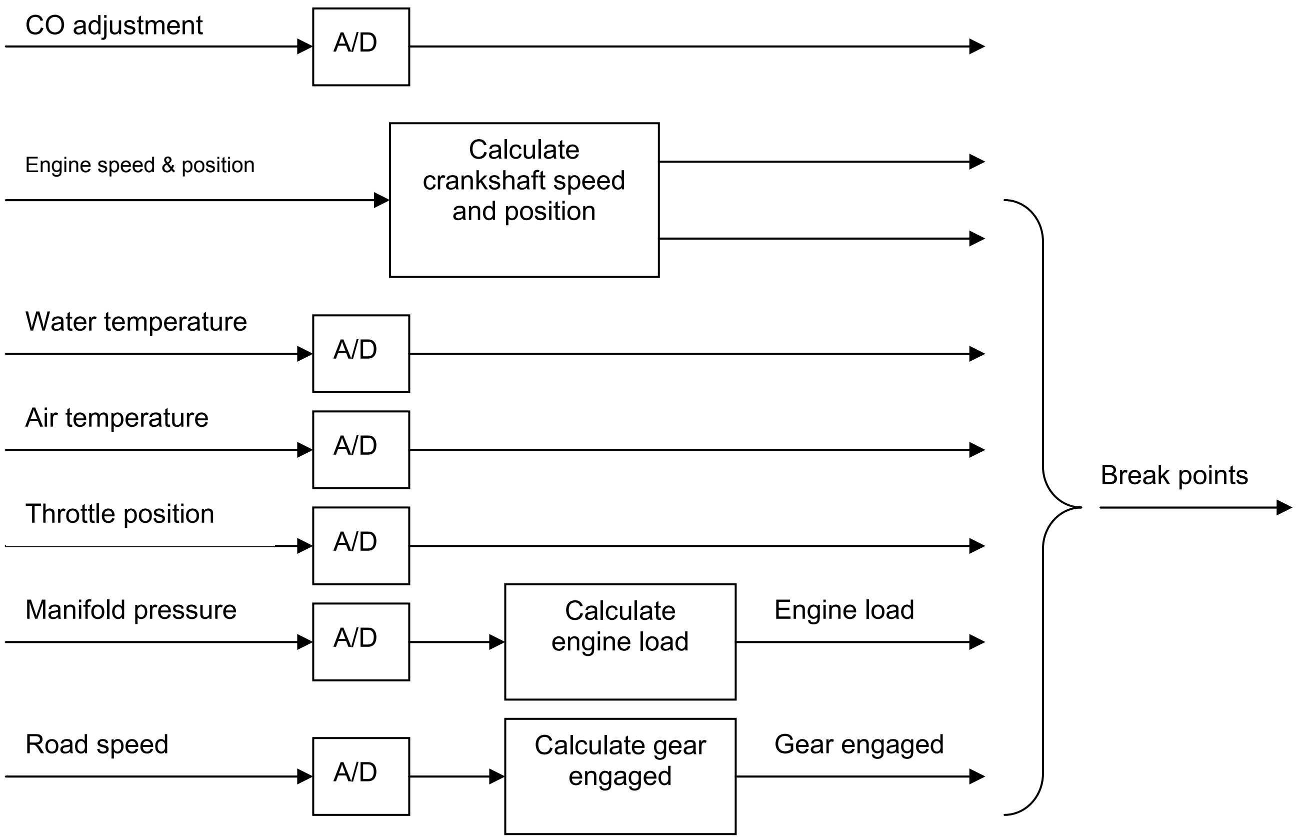
The engine management system is controlled by the SL96 ECM. The microprocessor and its associated components are mounted on a printed circuit board within the ECM. Input and output functions are summarised below:




Under most operating conditions, the amount of air delivered to the engine is determined by the position of the butterfly valve on the throttle body, which is controlled by the vehicle's driver. In order to monitor the engine's operating conditions, the ECM receives inputs from a number of sensors, as shown in the following figure. Raw voltage inputs from the sensors are converted to digital parameters.

Fuel injectors and ignition coils are controlled by the EMS to provide optimum performance at all times.

The EMS can also modify air delivery by controlling the position of the idle air control valve. This is used to enhance driveability and idling performance and to ensure reliable closed throttle starts.




Compared to the original carburated engine, inlet manifold design is new (optimised to improve torque and power).

Fuel delivery is by four injectors (one per cylinder) connected to a fuel rail.

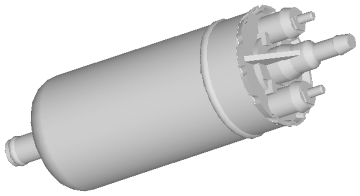
Injection is semi-sequential, two injectors being actuated together.

A 4-output ignition coil comprising 2 double-ended coils provides ignition in a wasted spark configuration.

# 3. Components description

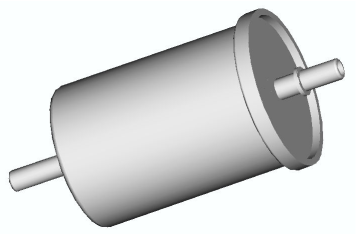
## 3.1. Fuel delivery

### 3.1.1. Fuel pump



The in-line fuel pump is situated under the floor of the car, on the right hand side (passenger) near the fuel tank. This is an electric fuel pump located outside the fuel tank.

### 3.1.2. Fuel filter



The fuel filter is situated on the bulk-head at the rear of the engine bay. Fuel flows through the fuel filter which captures small particles of contaminant, with the primary function of protecting the fuel injectors.

A coarse filter is also fitted inside the fuel tank. Note: lubrication **<u>must not</u>** be applied to the fuel filter when fitting hoses.

### 3.1.3. Fuel lines and hoses

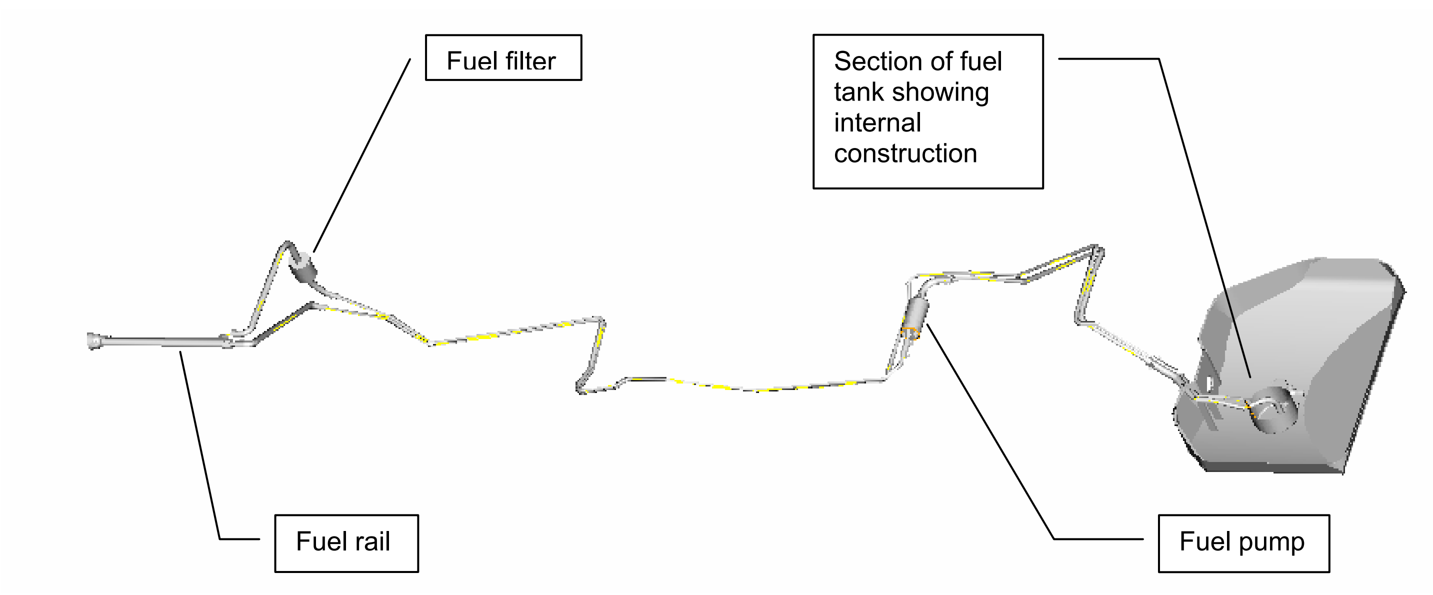
Fuel delivery system
Steel fuel lines and synthetic hoses run from the fuel tank to the engine bay where the filter is situated. . Fuel is then carried to the fuel rail from the filter by synthetic hose, which is connected to the fuel rail by a M20x1.5 swivel female 90˚ elbow connector.

Fuel return system
Steel fuel lines and synthetic hoses run from the fuel rail to the petrol tank. The connection between the fuel rail and hose is by a M20x1.5 swivel female 90˚ elbow connector

All connections between the steel fuel lines and synthetic hoses are by relevant spring band clamps

Note: lubrication **<u>must not</u>** be applied to either the synthetic hoses or the fuel lines when fitting.

## Fuel lines layout diagram (Paykan)



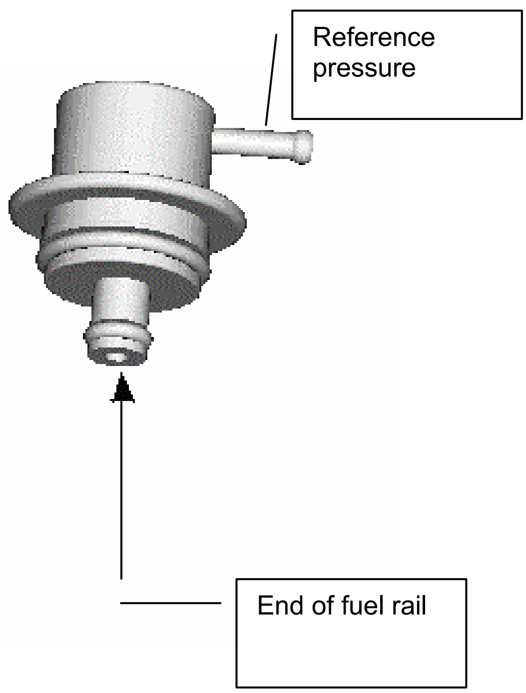

### 3.1.4. Fuel rail

The fuel rail is situated centrally in the engine bay inside the curve of the inlet manifold, near the cylinder head. It holds the four injectors, the fuel pressure regulator and their clips. The fuel rail is bolted to the inlet manifold. Both fuel feed and return lines are connected to the fuel rail, the feed enters at the side of the rail and the return leaves from the end.

### 3.1.5. Fuel pressure regulator

A diaphragm operated valve that is mounted on the side of the fuel rail. The reference pipe on the valve is connected to the inlet manifold allowing the valve to maintain the fuel pressure in the fuel rail relative to the inlet manifold pressure.

The regulator comprises a seating valve joined to an elastic membrane by means of a compression spring, when the pressure on the membrane exceeds that of the reference pressure and the spring, then some pressure is released.



## 3.2. Fuel injector

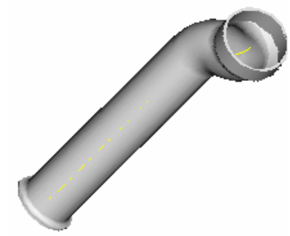
The fuel injector is an electromechanical device designed to accurately meter fuel delivery to match engine requirements and satisfy normal operating conditions in an automotive port injection system.

It is connected between the fuel rail and the inlet manifold. The injector is sealed by an o-ring at each end and secured in position with an injector clip

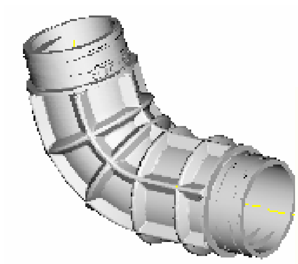
## 3.3. Air delivery

### 3.3.1. Air ducts

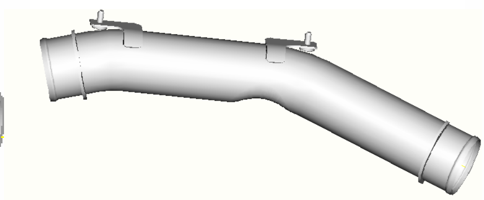
The air ducts conduct air from the outside environment through the air filter then into the throttle body.



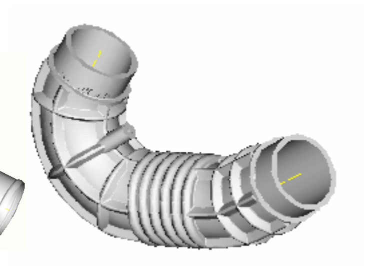
*Air filter inlet pipe(outside air to air filter)*



*Elbow (joins air filter to transverse pipe)*



*Transverse pipe (example shown is Peugeot RD pipe)*

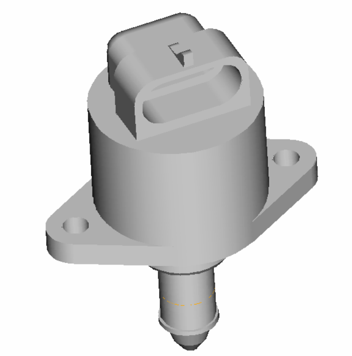


*Elbow (joins the transverse pipe to the throttle body)*

### 3.3.2. Throttle body

The throttle body is actuated using a cable and cam to operate a butterfly. It is fitted with a throttle potentiometer to measure the butterfly angle, and idle actuator with a conical pintle valve, which alters the idle airflow via a bypass circuit.

### 3.3.3. Air by-pass valve (stepper motor)

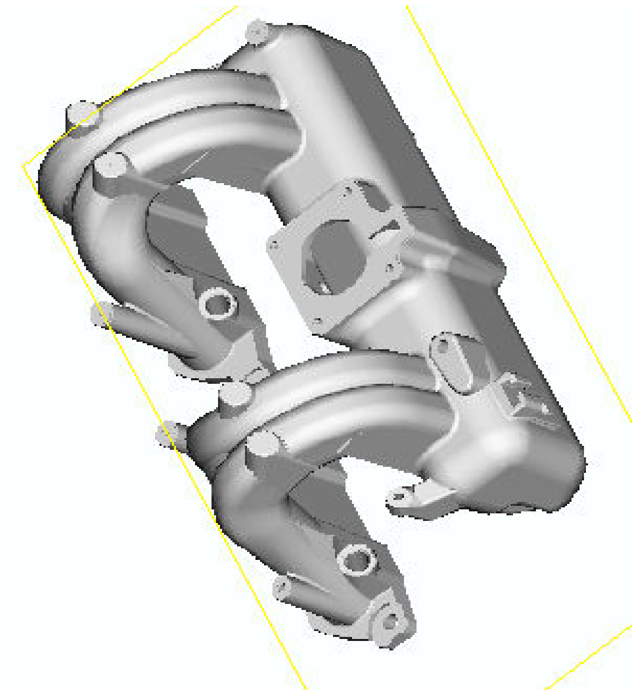


The throttle body has a channel incorporating a stepper motor and pintle that allows air to bypass the throttle butterfly, therefore controlling idle speed. The pintle on the end of the shaft seals against the bypass channel to cut off idle air when closed.

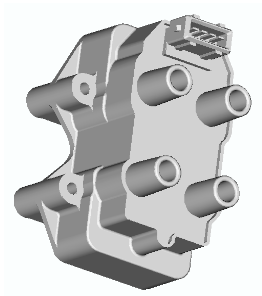
The position of the stepper motor is controlled by the ECM, which thus retains control of a limited airflow into the engine even when the throttle is closed. The valve is used to govern the idle speed and to improve driveability when the throttle is opened or closed. It also controls the air supply when the engine is started.

### 3.3.4. Inlet manifold

The intake manifold is designed to support the throttle body, to convey the fuel/air mixture to the inlet ports in the cylinder head and to support the fuel rail and injectors.

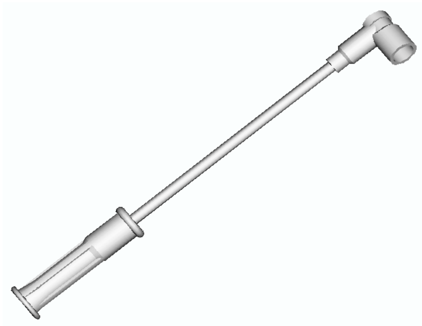


## 3.4. Ignition



### 3.4.1. Ignition coil

The Ignition coil (which contains two coils in a single unit) is used to supply power to the spark plugs and consists of four HT (high tension) outputs which are driven by the two double ended coils to provide four cylinder wasted spark ignition. The ECM controls the charging of the coil and the timing of the sparks.
The coil is mounted on a bracket on the engine cylinder block.



### 3.4.2. HT (high tension) leads

These are flexible, with resistive and inductive characteristics for suppression. High-tension leads are used to connect the ignition coil outputs to the spark plugs.

## 3.5. ECM, sensors and actuators

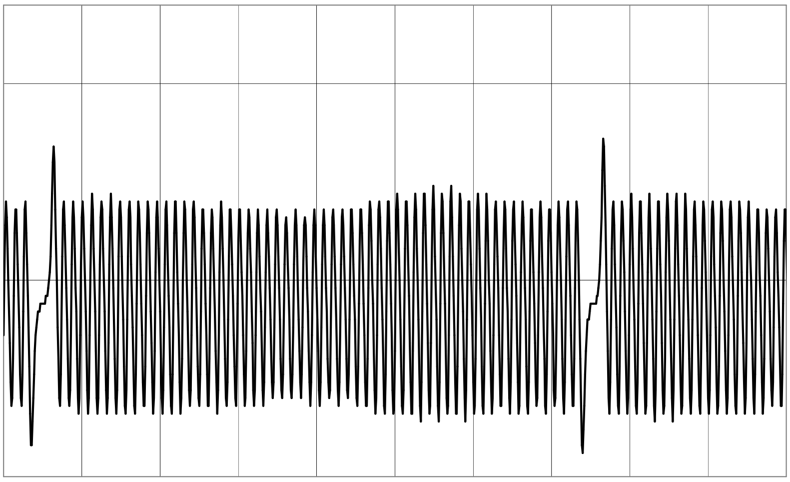
### 3.5.1. ECM

Described in the system description (Section 2.2).

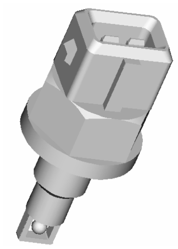
### 3.5.2. Engine speed & position sensor

Engine speed sensor is mounted on the top of the bell housing approximately 30 degrees from the vertical. This device determines the engine speed and position for events that must be synchronised to the crankshaft's position, e.g. injection of fuel, spark etc.
A toothed ring is mounted on the crankshaft. The teeth pass a variable reluctance sensor, which detects the rate of change in the reluctance of the magnetic circuit formed by the sensor.
The missing teeth on the sensor target wheel produce an index pulse for as shown in the diagram below. The sensor output waveform can be measured by connecting a high impedance oscilloscope as follows: One connection can be made to the speed sensor positive terminal, the other to chassis ground (it is important that neither terminal is connected to ground). The diagram below shows a waveform at 1000 rpm, voltages of 30-50 Volts are typical,

but these depend on the airgap: The output voltage from the sensor is used by the ECM to determine the engine position.

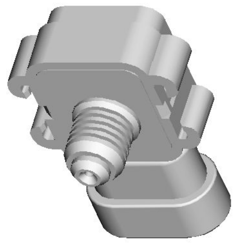


### 3.5.3. Air & Water temperature sensors



The air temperature sensor is positioned under the plenum of the intake manifold. It is a negative temperature coefficient thermistor with an operating temperature range of -40°C to 150°C is used to measure the temperature of the air flowing into the engine.
The water temperature sensor is a similar sensor, but is positioned in the coolant circuit allowing it to measure coolant temperature.

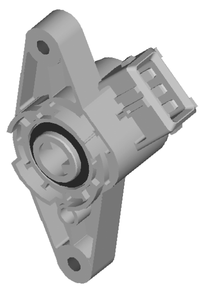
### 3.5.4. Manifold pressure sensor



The MAP sensor is positioned on top of the inlet manifold plenum chamber. The sensor is a silicon diaphragm type. It requires a 5V-dc power supply and produces an analogue voltage proportional to pressure of the air in the manifold plenum and ratiometric to the reference voltage. When combined with engine speed, the engine load can be determined by the ECM.

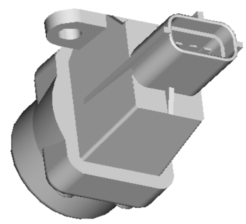
### 3.5.5. Throttle potentiometer

The throttle potentiometer is mounted at the side of the throttle body and is basically a potentiometer used to relate actual throttle position into a proportional voltage signal to be used by the ECM.



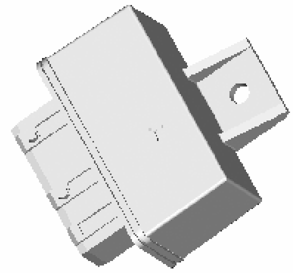
### 3.5.6. Inertia switch

The inertia switch is mounted on a specially selected rigid part of the vehicle. The contacts are normally closed, and they open when the switch it is subject to specific acceleration loads (eg, in an accident), this causes the switch to remove voltage from the fuel pump circuit and other vital circuits. The switch is reset by pressing the rubber top.



### 3.5.7. Road speed sensor

This sensor is fitted in the speedometer drive cable and produces an electrical output frequency proportional to that of the gearbox output shaft which is used by the ECM.



### 3.5.8. Double relay

Contains two relays with diode protection for the ECM. This is controlled via the ECM, and it switches the electrical supply to the ECM and fuel pump and other engine management system electrical loads.

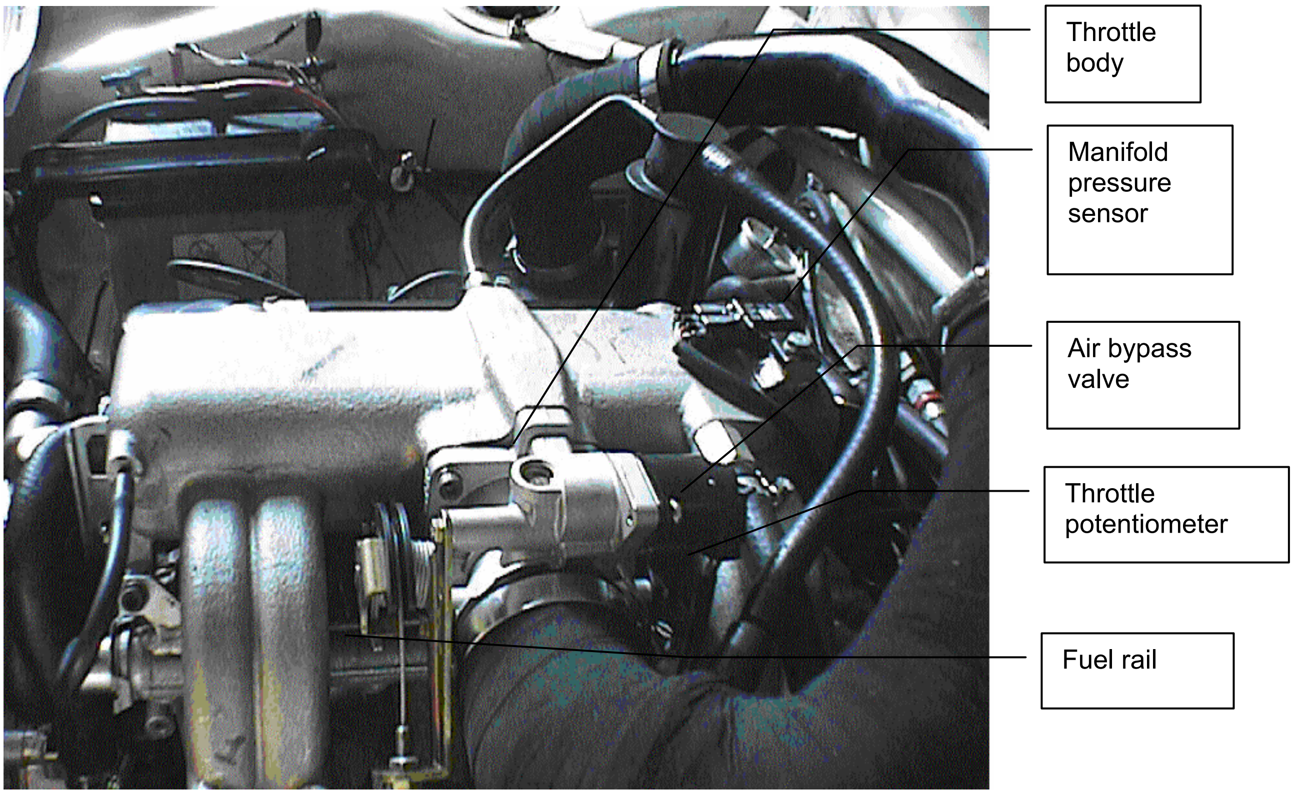
### 3.5.9. CO adjustment potentiometer

A multi-turn potentiometer which is adjusted via a screwdriver slot. This device is intended for adjustment of EMS idle fuelling.

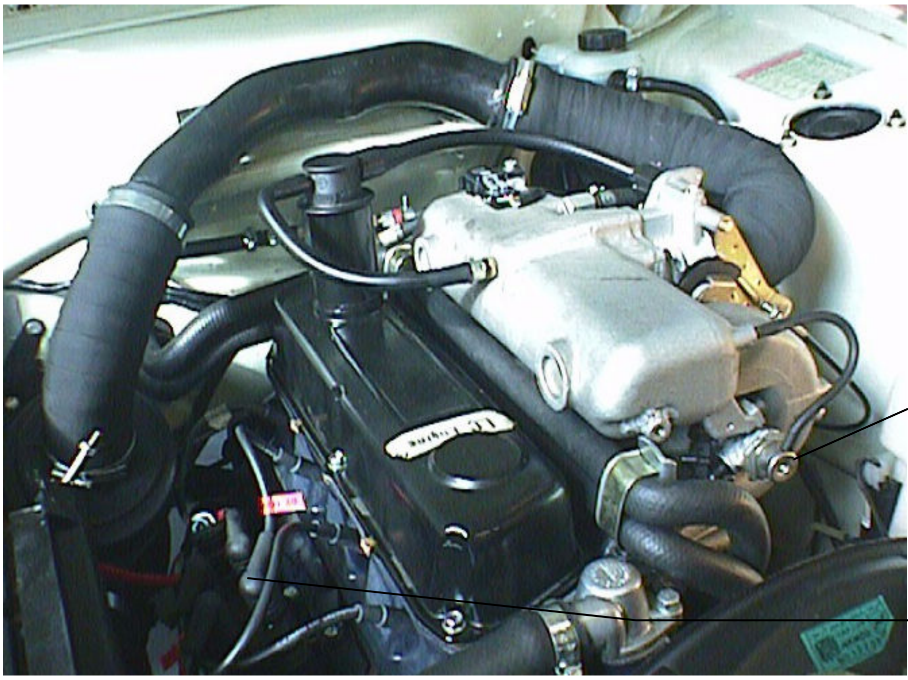
## 4. Engine compartment photographs

Prototype vehicles are shown which are not fully representative.

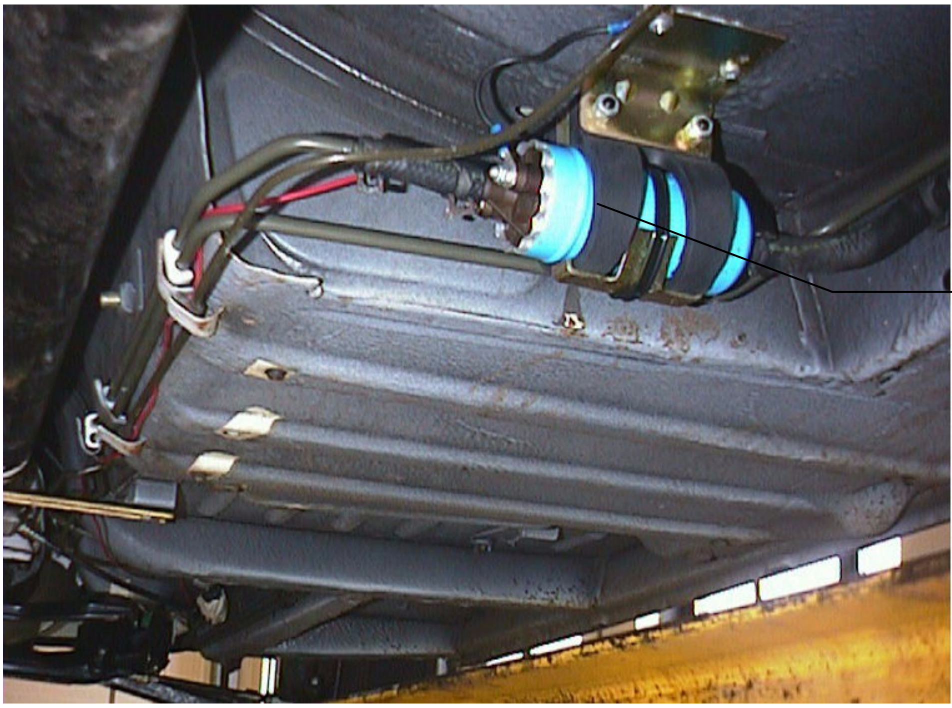
### 4.1. Paykan



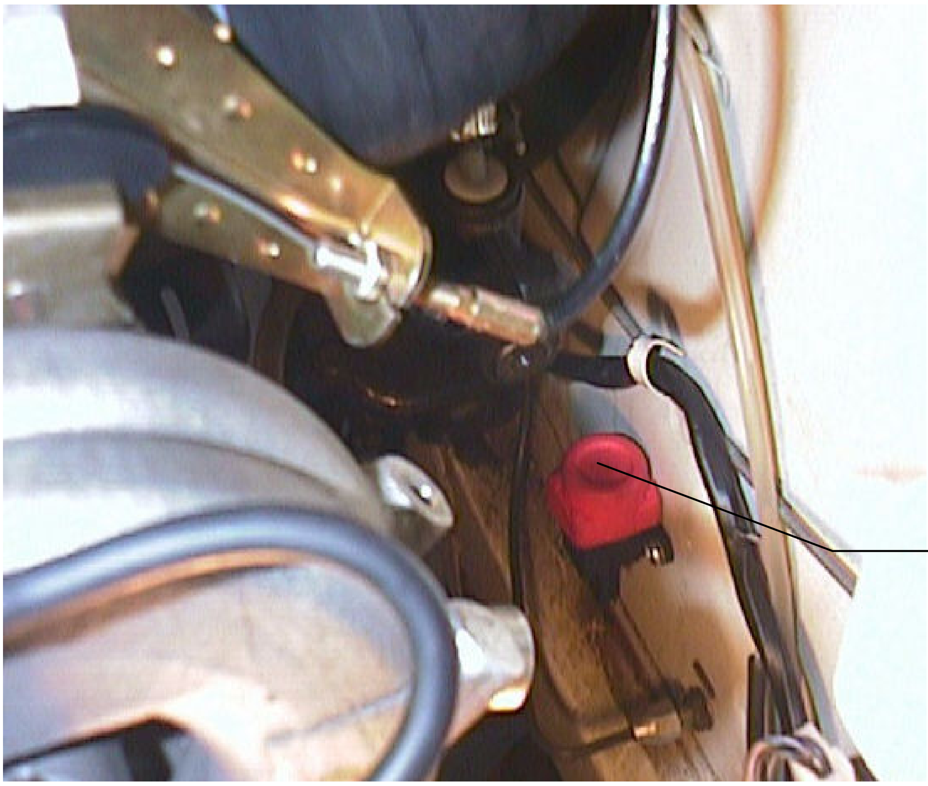
Spark plugs and HT leads
Ignition coil

Fuel pressure regulator
Ignition coil



Fuel pump

Inertia switch position (TBA)

## 5. Electronic system fault finding

Electrical circuit tests, component checks and power supply circuit tests are described in section 5.1, 5.2 and 5.5 respectively.

Connector pin numbers are shown in section 5.3 and the electrical schematic diagram in section 5.4.

### 5.1. Table of circuit tests

The following tables should be used in order to make a continuity check after unplugging the ECM connector, the relay connector, and the manifold pressure sensor connector. Connect a DMM (digital multimeter) of 10 M Ohm impedance between the points listed. Typical resistance values are given in the tables for guidance.

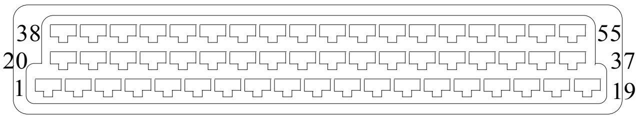
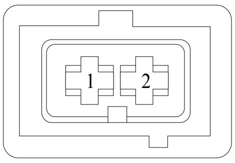
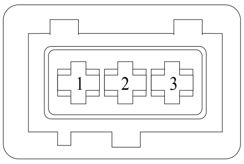
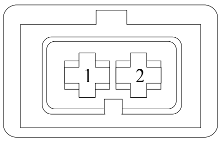
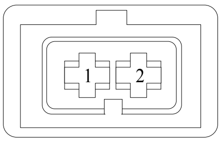
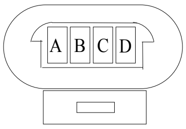
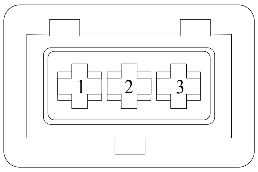
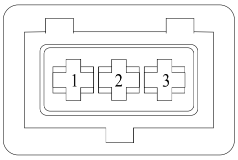
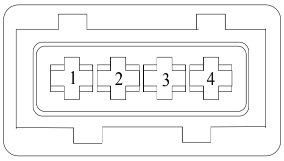
| Component | Continuity check | | Component check |
| --- | --- | --- | --- |
| | **+Ve Probe** | **-Ve Probe** | **Resistance approx.** |
| Fuel pump | Ground | Double relay pin 5 | 1 Ω |
| Fuel injector 1 and 4 | 2 | Double relay pin 4 | 6 Ω |
| Fuel injector 2 and 3 | 1 | Double relay pin 4 | 6 Ω |
| Ignition coils | 37 | 55 | 1.2 Ω |
| Ignition coils | 37 | Double relay pin 13 | 0.6 Ω |
| Crankshaft sensor | 49 | 30 | 400 Ω |
| Air thermistor | 29 | 17 | 2375 Ω at 20°C |
| Manifold pressure sensor | 34 | Manifold pressure sensor connector pin C | Unplug the component connector. Check continuity of wire. |
| | 41 | Manifold pressure sensor connector pin B | Unplug the component connector. Check continuity of wire. |
| | 17 | Manifold pressure sensor connector pin A | Unplug the component connector. Check continuity of wire. |
| Throttle potentiometer | 16 | 53 | Unplug the calibration potentiometer 4000 Ω |
| Throttle potentiometer | 23 | Throttle potentiometer connector pin 2 | Unplug the component connector. Check continuity of wire. |
| Dual coolant thermistor | 47 | 53 | 2500 Ω at 20°C |
| Purge valve (option) | Double relay pin 9 | 24 | 25 Ω |
| Road speed sensor | Double relay pin 9 | Road speed sensor connector pin 1 | Unplug the component connector. Check continuity of wire. |
| | Ground | Road speed sensor connector pin 2 | Unplug the component connector. Check continuity of wire. |
| | 28 | Road speed sensor connector pin 3 | Unplug the component connector. Check continuity of wire. |
| Inertia switch | Double relay pin 7 | 7 | Check that switch is reset |
| Calibration potentiometer | 16 | 53 | Unplug the throttle potentiometer 13.3 kΩ |
| | 6 | Calibration potentiometer connector pin 2 | Unplug the component connector. Check continuity of wire. |
| Air bypass valve | 3 | 40 | 52 Ω |
| | 21 | 20 | 52 Ω |

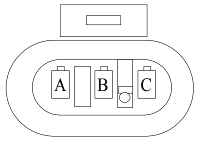
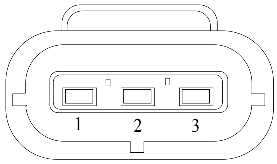
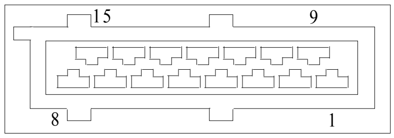
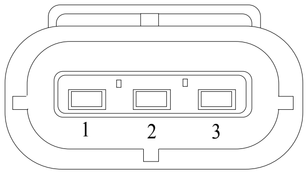
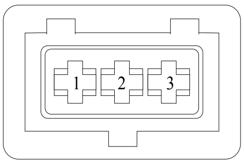
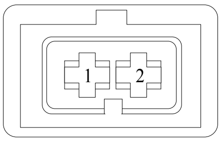
## 5.2. Table of component tests

These values show tests for correctly functioning components. A DMM (digital multimeter) of 10 M Ohm impedance should be used for resistance tests. Typical resistance values are given for guidance.

| Component | Approximate resistance |
|---|---|
| Fuel pump | <1 Ω |
| Fuel injectors | Coil DC Resistance = 12.25±0.50 Ω at 20°C±2°C |
| Ignition coils | Primary resistance = 0.6 Ω<br>Secondary resistance = 7.35 k Ω (HT output 2 to 3 and HT output 1 to 4) |
| Air thermistor | Resistance/Temperature Characteristic<br>0°C → 5457 Ω<br>100°C → 176.7 Ω |
| Manifold pressure sensor | 4.75 V at sea level between SIG and –Ve when connected to the harness and ignition on ( also, there should be +5V between +Ve and –Ve) |
| Dual coolant thermistor | Resistance/Temperature Characteristic<br>0°C → 5896 Ω (approx.)<br>100°C → 186.6 Ω (approx.) |
| Road speed sensor | Sensor unpowered and unloaded and disconnected. Room temperature.<br>Using a digital voltmeter (10 M Ω impedance).<br>Output resistance to be 15 k Ω ± 20% (between pin 3 and pin 2) |
| Inertia switch | Pins 1 to 3 short circuit when reset (and open circuit when crashed) |
| Throttle potentiometer | 4000 Ω between pins 1 and 3 |
| Calibration potentiometer | 3.3 k Ω to 13.3 k Ω at each extreme of the adjustment between pins 1 and 2<br>13.33 k Ω between pins 1 and 3 |
| Air bypass valve | 52 Ω between pins A and D<br>and<br>52 Ω between pins C and B |
| | |

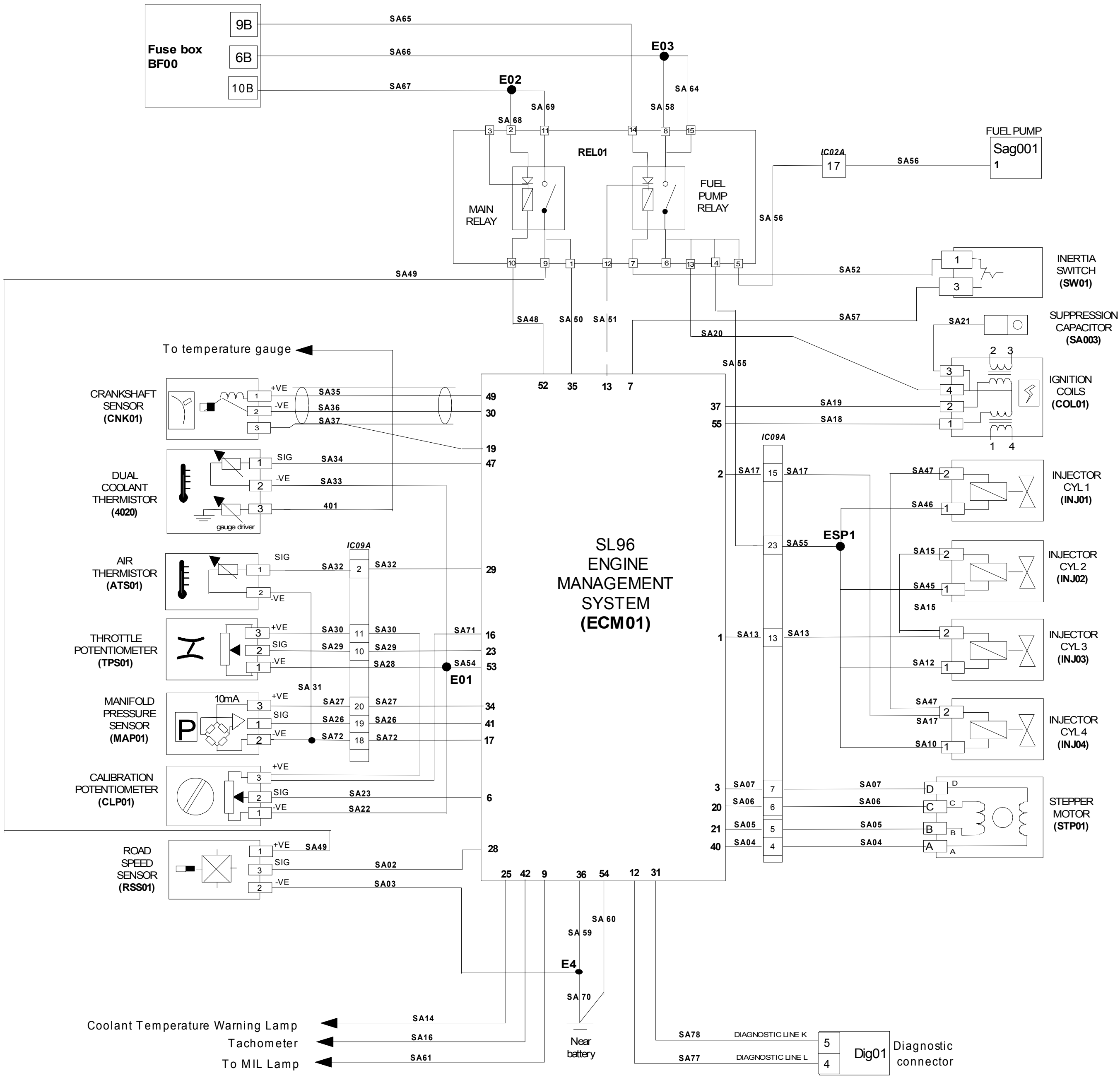
## 5.3. Number of pins and pin function description

| Component | Ways | View of the mating surface of the harness connector | Pin function |
|---|---|---|---|
| ECM - SL96 | 55 |  | See schematic |
| Diagnostics connector | 16 |  | 1→ L<br>2→ K |
| Crankshaft sensor | 3 |  | 1→ +Ve<br>2→ -Ve<br>3→ screen |
| Fuel injectors | 2 |  | |
| Air thermistor | 2 |  | |
| Stepper motor | 4 |  | |
| Coolant thermistor | 3 |  | 1→SIG<br>2→-Ve<br>3→gauge driver |
| Throttle potentiometer | 3 |  | 1→-Ve<br>2→SIG<br>3→+Ve |
| Ignition coil | 4 |  | See schematic |

| | | | |
|---|---|---|---|
| Manifold pressure sensor | 3 |  | A→-Ve<br>B→SIG<br>C→+Ve |
| Road Speed Sensor | 3 |  | 1→+Ve<br>2→-Ve<br>3→SIG |
| Relay | 15 |  | See schematic |
| Inertia switch | 3 |  | 1 to 3 short circuit when reset |
| Calibration potentiometer | 3 |  | |
| Purge valve | 2 |  | |

## 5.4. System Schematic diagram

Paykan



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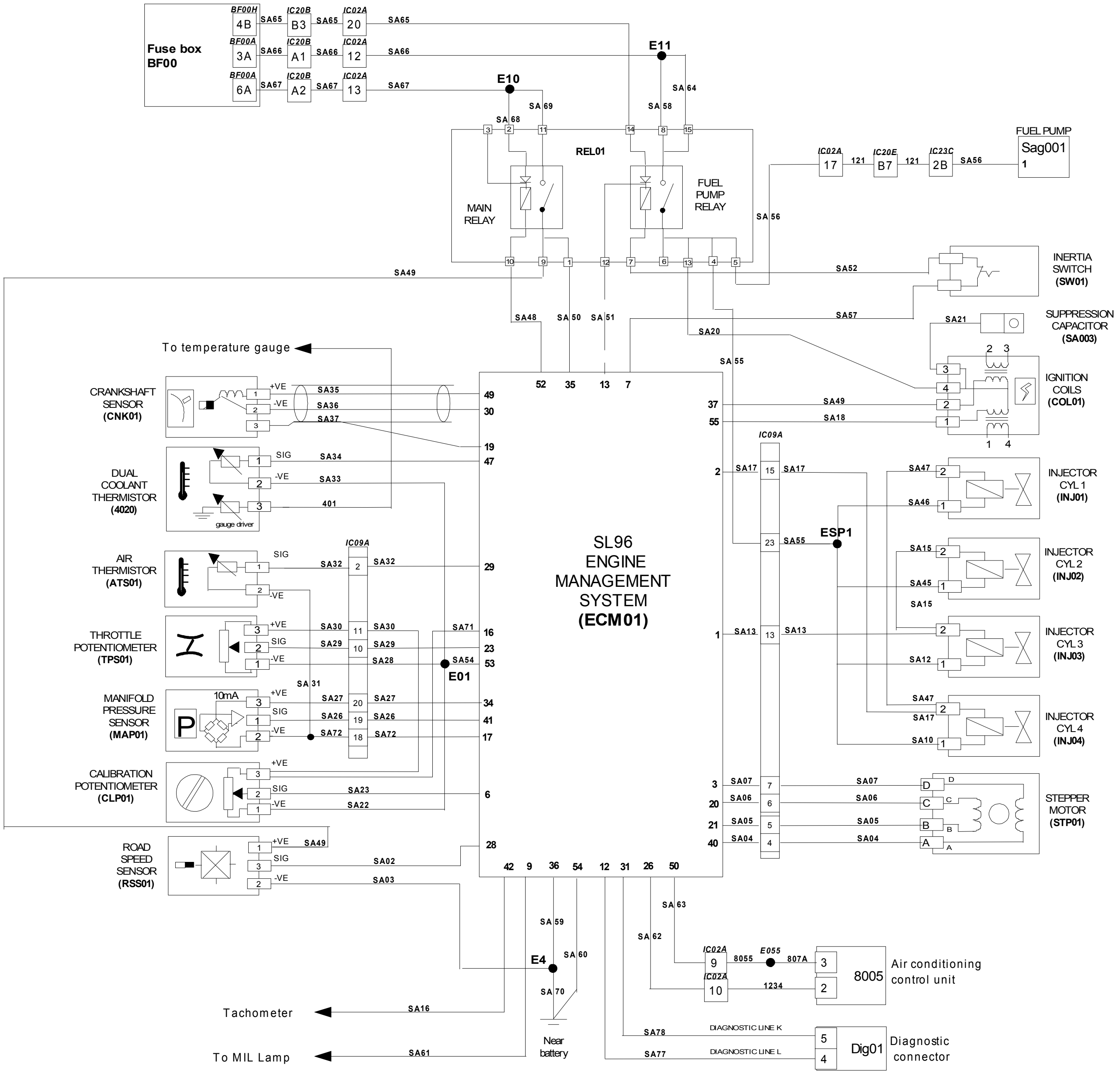
|---|---|---|

Peugeot RD



## 5.5. Power supply currents and fault finding.

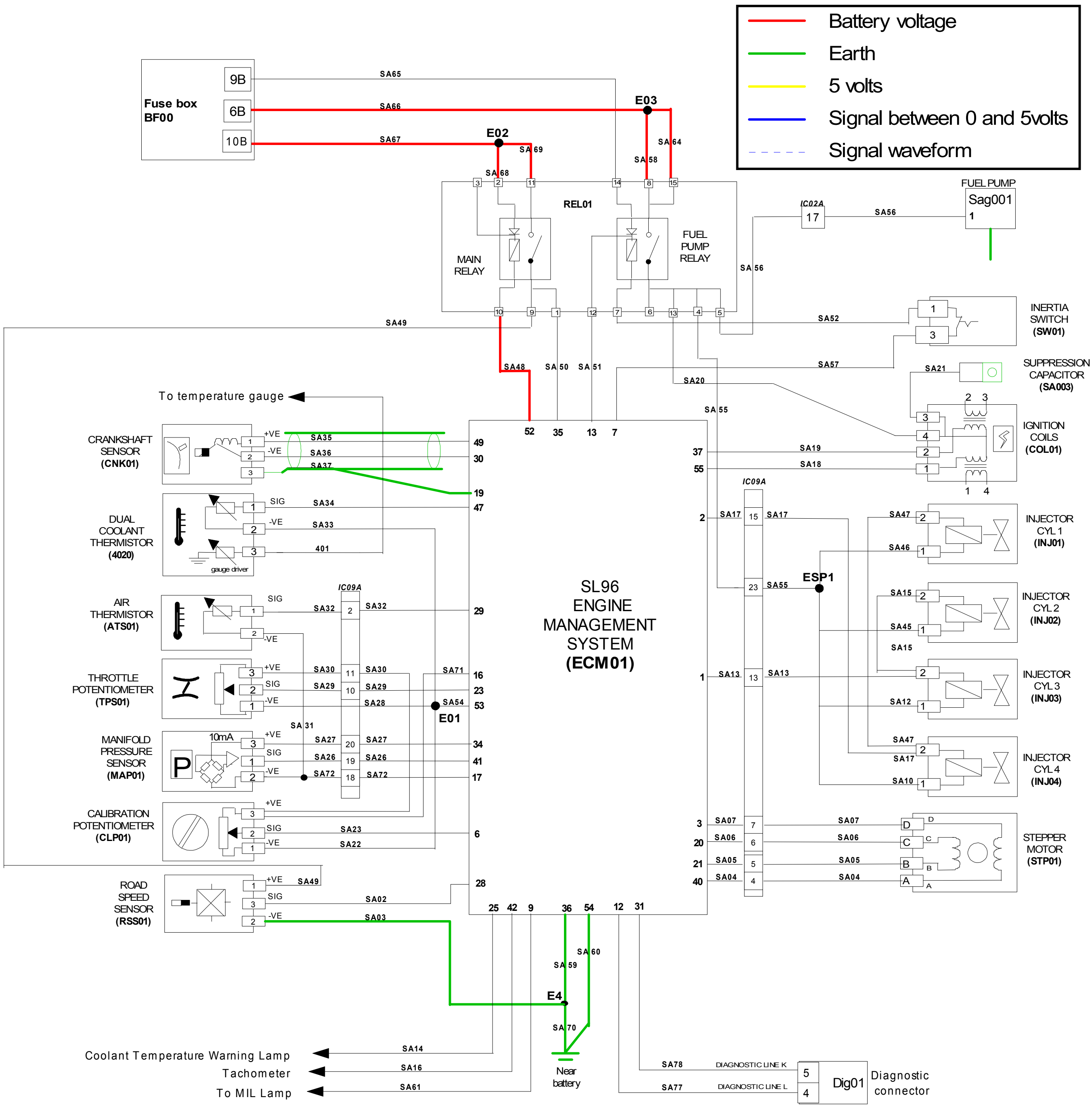
When the ignition switch is turned on, the ECM circuit energises, the main relay energises, and the fuel pump relay energises for a few seconds (to prime the fuel rail). The fuel pump relay is then engaged when ignition turns to cranking to supply power to the fuel pump.

When the ignition switch is turned off to stop the engine, the main relay remains energised for a few seconds then it de-latches removing supply voltage to from the ECU.
The circuits controlled by these relays are shown below.

The following diagrams summarise the voltages in the EMS harnesses. The sensor grounds are connected to pins 17 and 53 of the SL96 connector (they are not shown coloured on these diagrams).

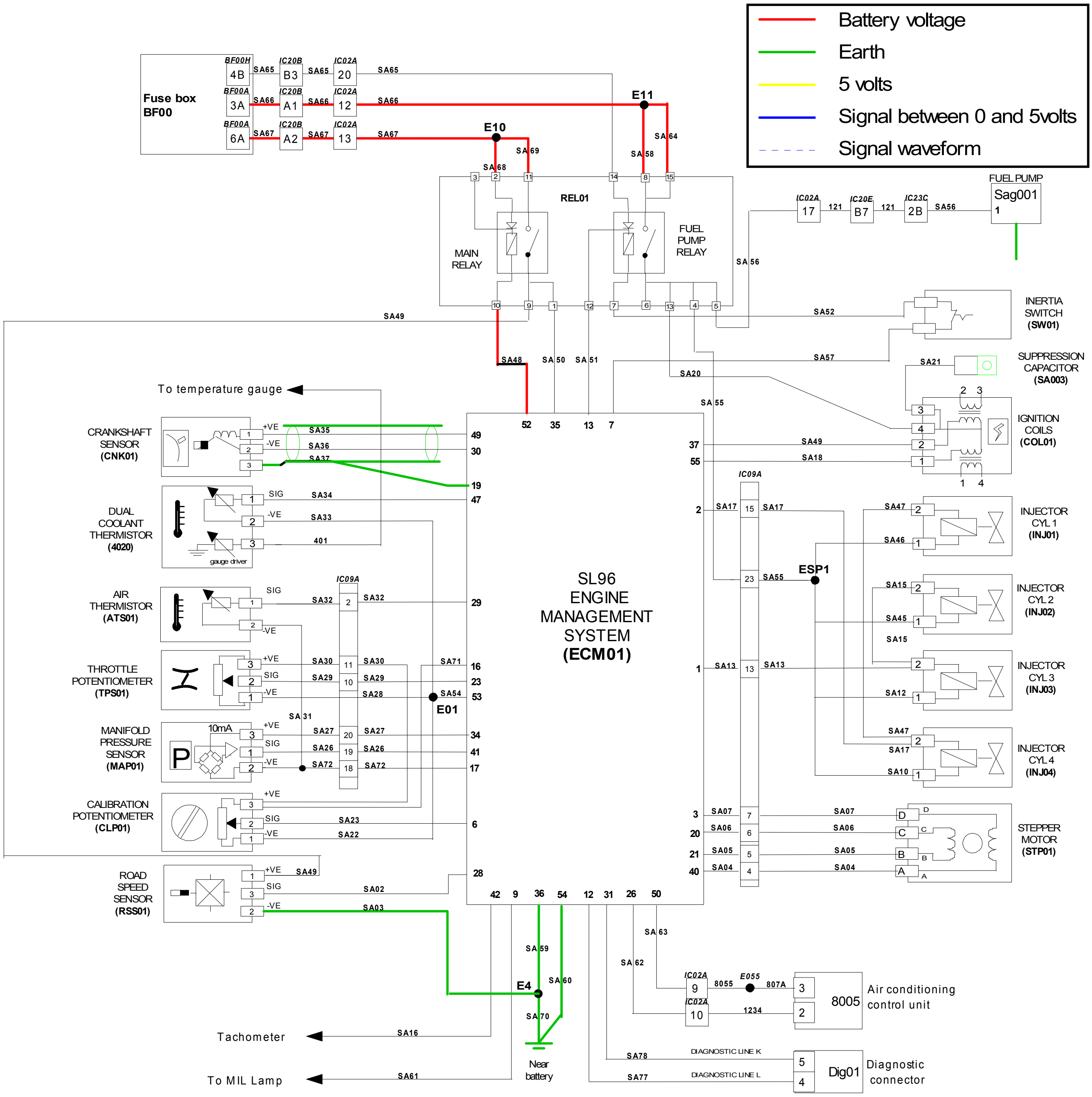
## 5.5.1. Ignition off, engine stopped

Paykan



| JOHNSON CONTROLS | ENGINEERING RESEARCH AND DEVELOPMENT<br>BIRMINGHAM | Filename: English guide for paykan & RD<br>Project: 2-12-01-00-01A<br>Date: 8 February, 2008 |
|---|---|---|

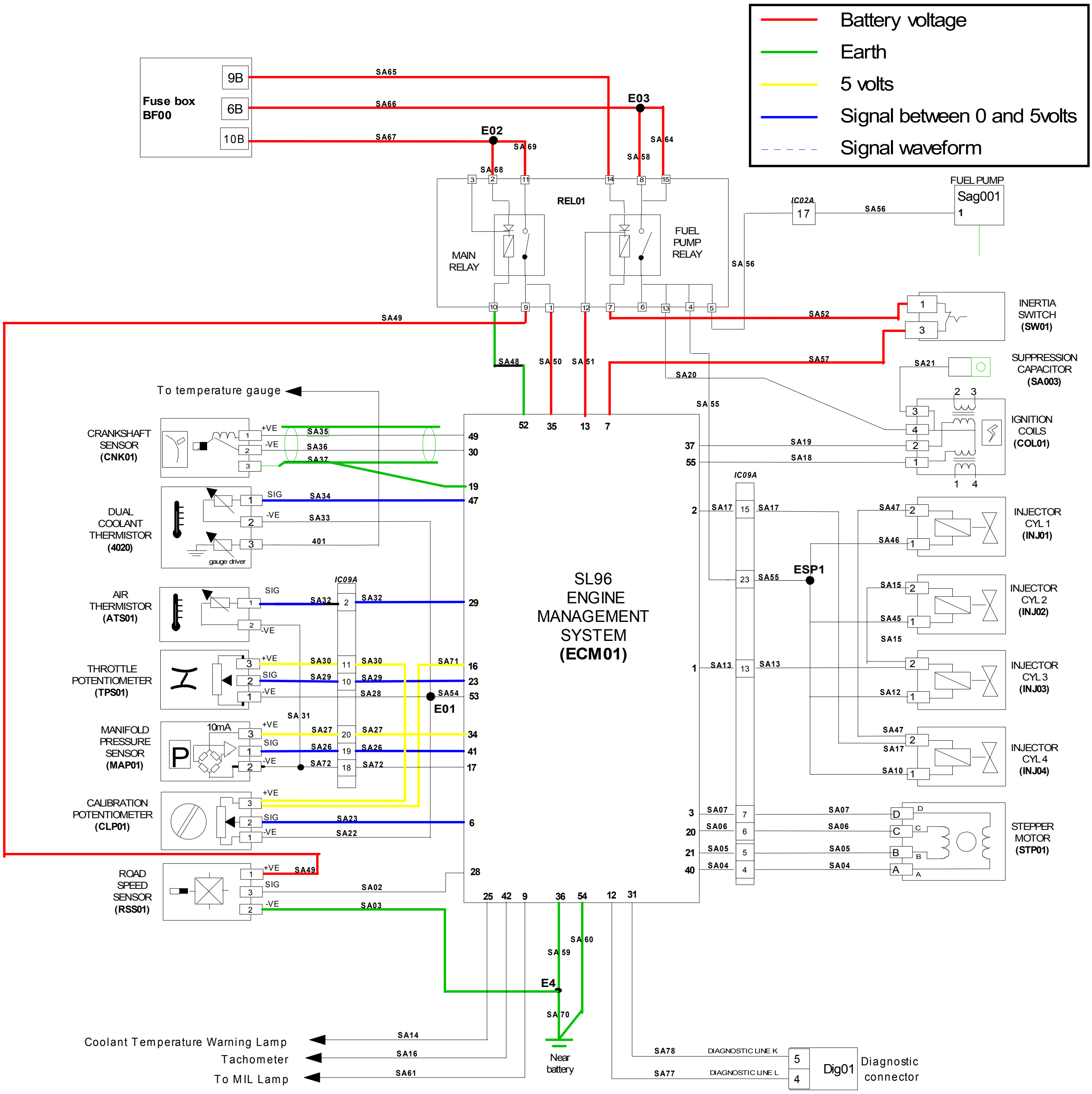
# Peugeot RD



## 5.5.2. Ignition on, engine stopped.

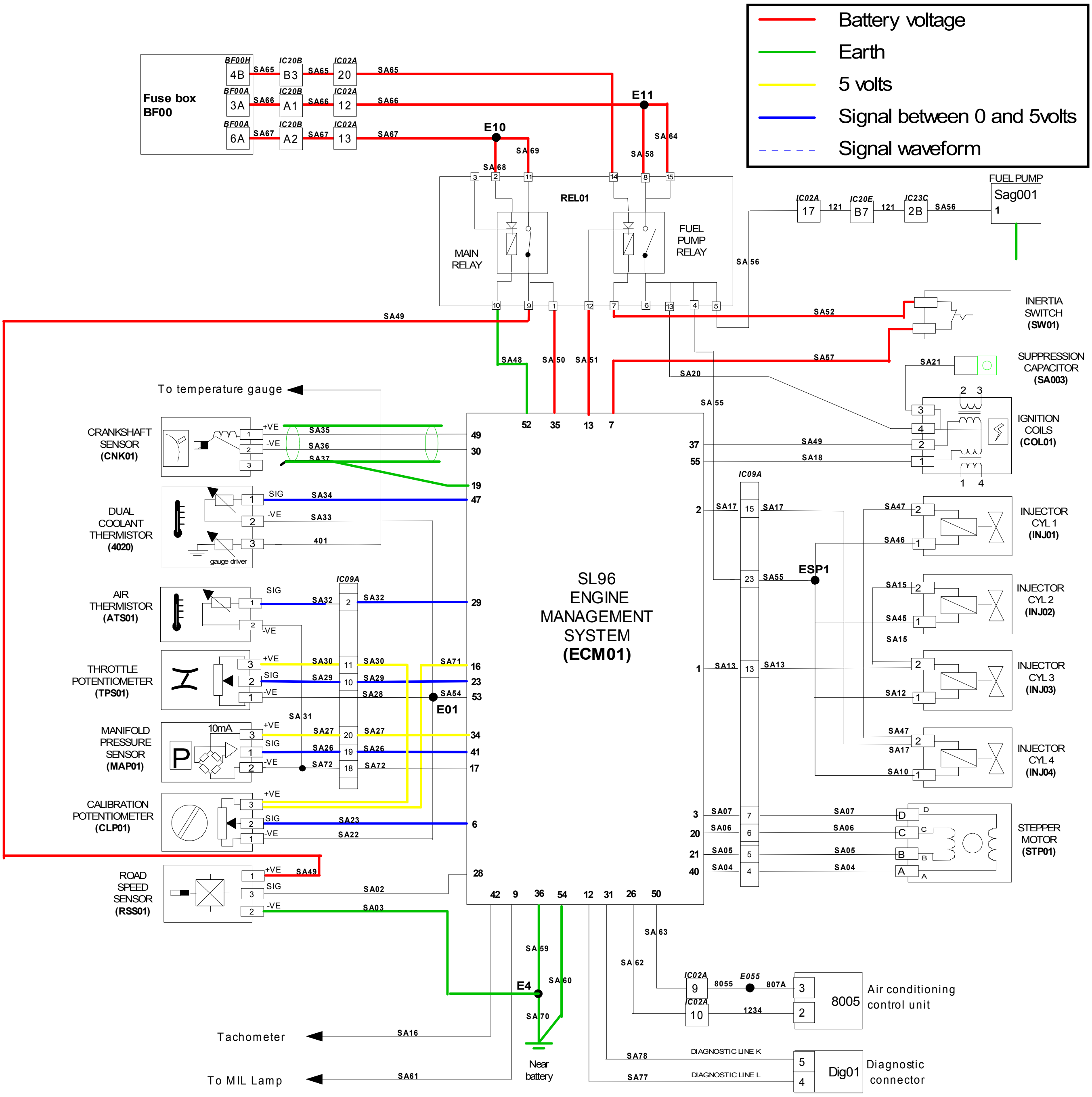
The main relay is closed. The fuel pump relay closes for a short time only. The ECM and its sensors are energised.

Paykan



| JOHNSON CONTROLS | ENGINEERING RESEARCH AND DEVELOPMENT<br>BIRMINGHAM | Filename: English guide for paykan & RD<br>Project: 2-12-01-00-01A<br>Date: 8 February, 2008 |
|---|---|---|

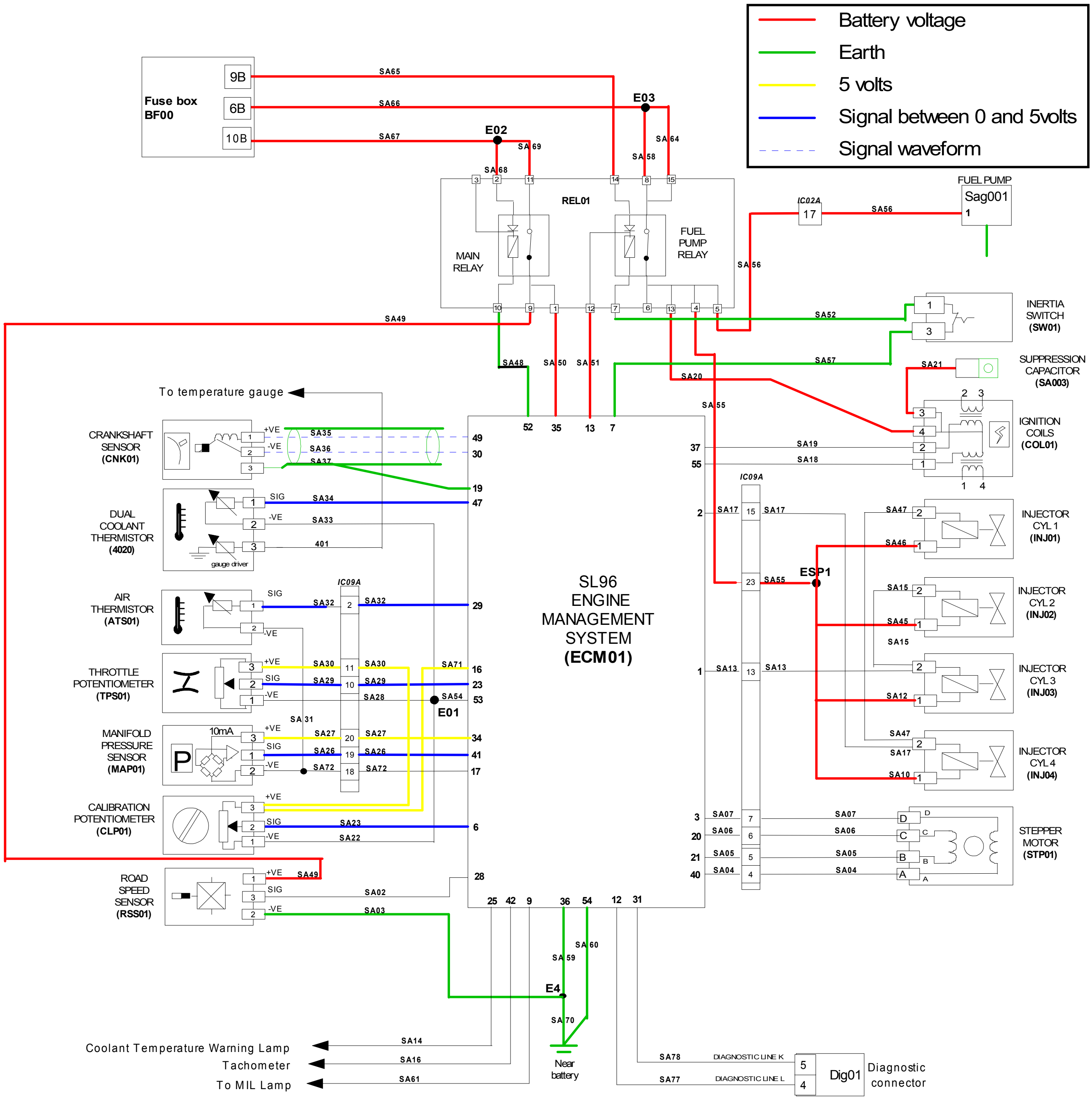
# Peugeot RD



### 5.5.3. Engine running

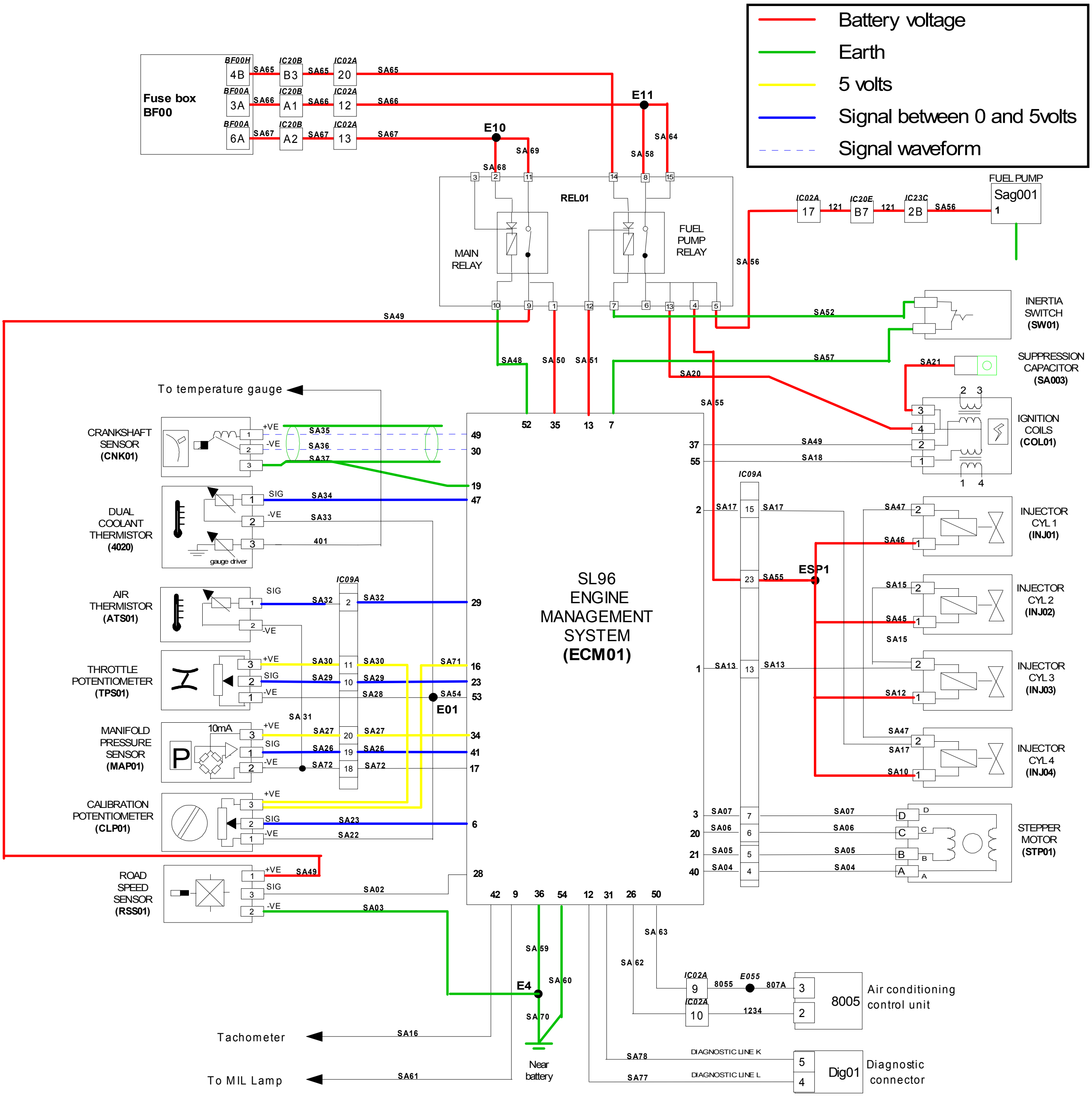
Main and Fuel pump relays are closed. All components are supplied.

Paykan



| | ENGINEERING RESEARCH AND DEVELOPMENT<br>BIRMINGHAM | Filename: English guide for paykan & RD<br>Project: 2-12-01-00-01A<br>Date: 8 February, 2008 |
|---|---|---|

## Peugeot RD

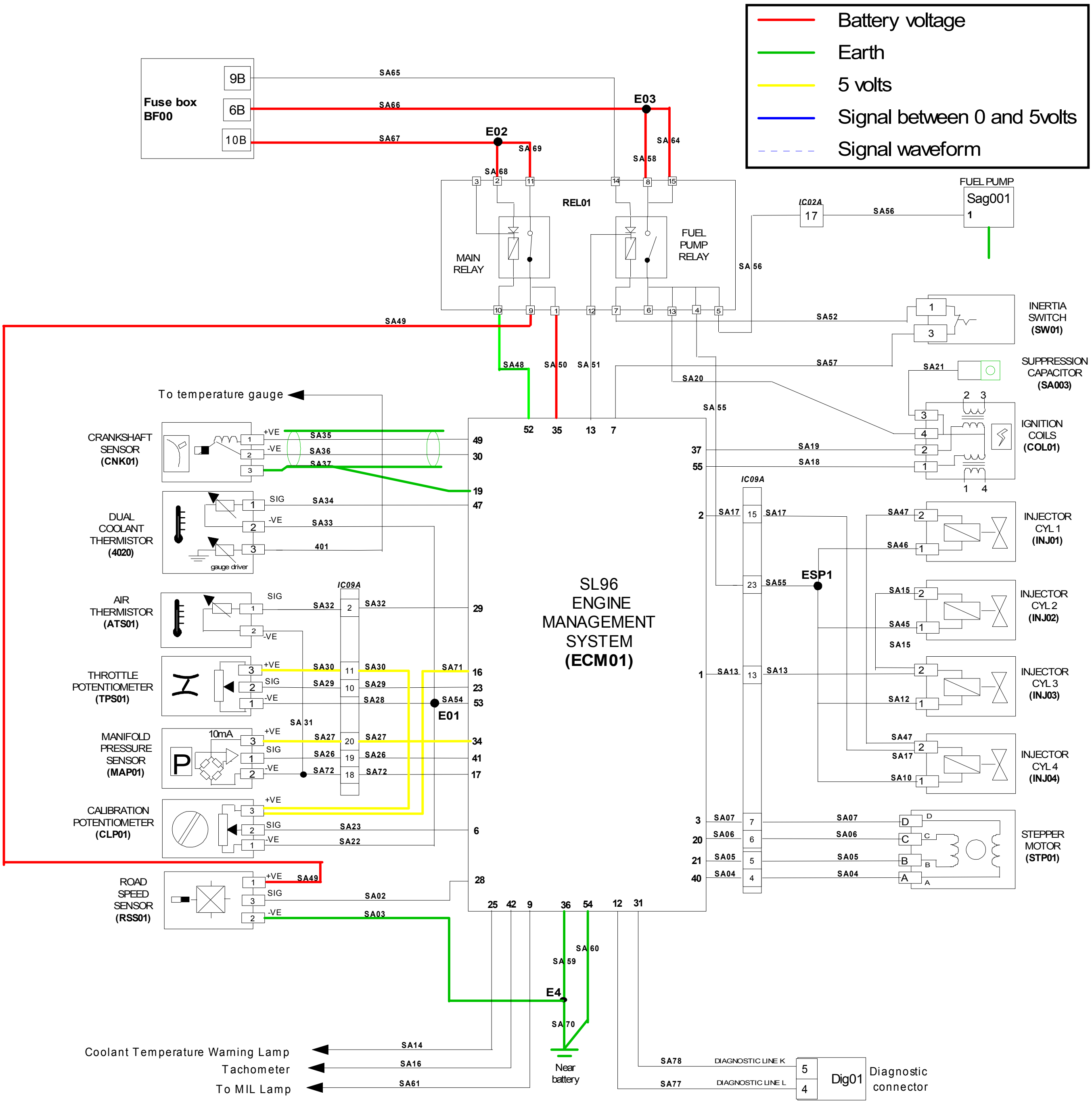



**Restricted Circulation**

## 5.5.4. Power latch

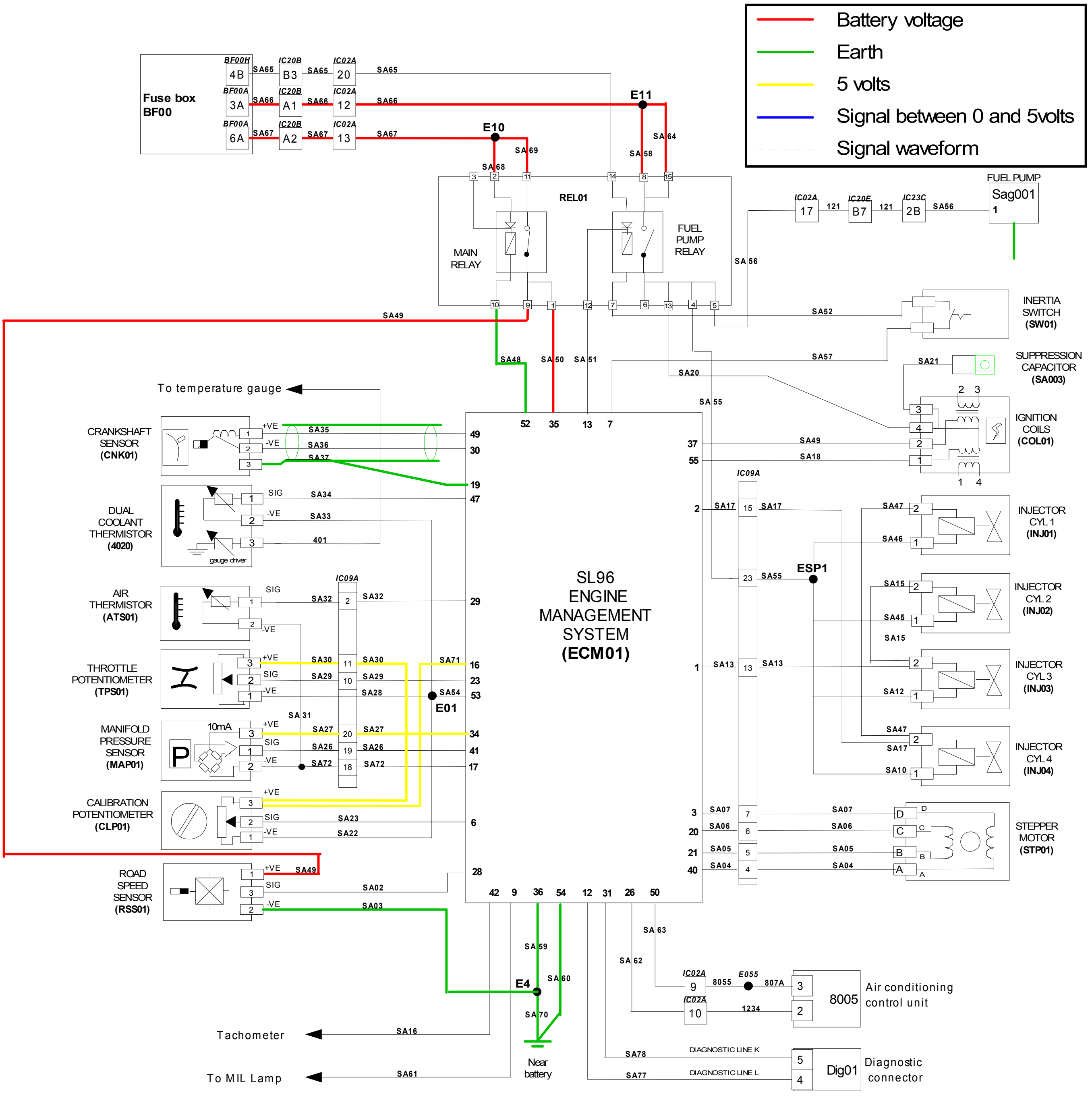
When the switch is turned off the fuel pump Relay opens. But ECM holds the Main Relay closed for a short time as shown below.

Paykan



| JOHNSON CONTROLS | ENGINEERING RESEARCH AND DEVELOPMENT<br>BIRMINGHAM | Filename: English guide for paykan & RD<br>Project: 2-12-01-00-01A<br>Date: 8 February, 2008 |
|---|---|---|

## Peugeot RD



## 6. Fuel system fault finding

The following notes detail how to test fuel pressure in the system.

**WARNING:** Under normal operating conditions the fuel injection system is pressurised by the fuel pump, operating at a typical pressure of 3.5 bar. When the engine is stationary, this pressure is maintained within the system. To prevent fuel escaping, and to avoid personal injury, it is necessary to depressurise the fuel system before any service operations are carried out.

### Step 1: To de-pressurise the fuel system

**Warning:** Spillage of fuel is unavoidable during this operation. Ensure that all necessary precautions are taken to prevent fire or explosion.

1. The fuel pump is located under the floor of the vehicle, close to the rear axle.
2. Disconnect the fuel pump electrical connections. Insulate the wires to ensure they do not make accidental contact with any parts of the vehicle, or each other.
3. Start and run the engine.
4. When sufficient fuel has been used up, the fuel system pressure will drop, causing the engine to stall. Once this has happened, switch the ignition off.
5. Disconnect the battery negative terminal.

### Step 2: To test the fuel system pressure

1. Disconnect the fuel pipe between the fuel filter outlet and the inlet to the fuel rail on the engine. **Note:** fuel at low pressure will remain in the system. To remove this fuel, place an absorbent cloth around the fuel feed hose as the pipe is being removed.
2. Connect a pressure gauge into the fuel system between these two points, making sure that the fuel system does not leak.
3. The fuel pressure gauge should read zero.
4. Refit the fuel pump electrical connections and reconnect the battery negative terminal.
5. Turn on the ignition then crank the engine. The engine should fire within approximately 10 seconds.
6. Check the reading on the fuel pressure gauge. The nominal pressure should be 3.5 bar, however this will vary ±10% depending on engine operating conditions.
7. Once this test is complete, turn off the ignition and repeat the fuel system depressurisation procedure before removing the fuel pressure gauge from the fuel system.

**Note:** because the engine has been run with the fuel pump disconnected for this test, the engine management system may report open circuit faults on the fuel pump. Before returning the vehicle to normal use, clear these faults once all the tests have been completed. Then run the engine for a short period (approx. 2 minutes) and check that the faults are still cleared.

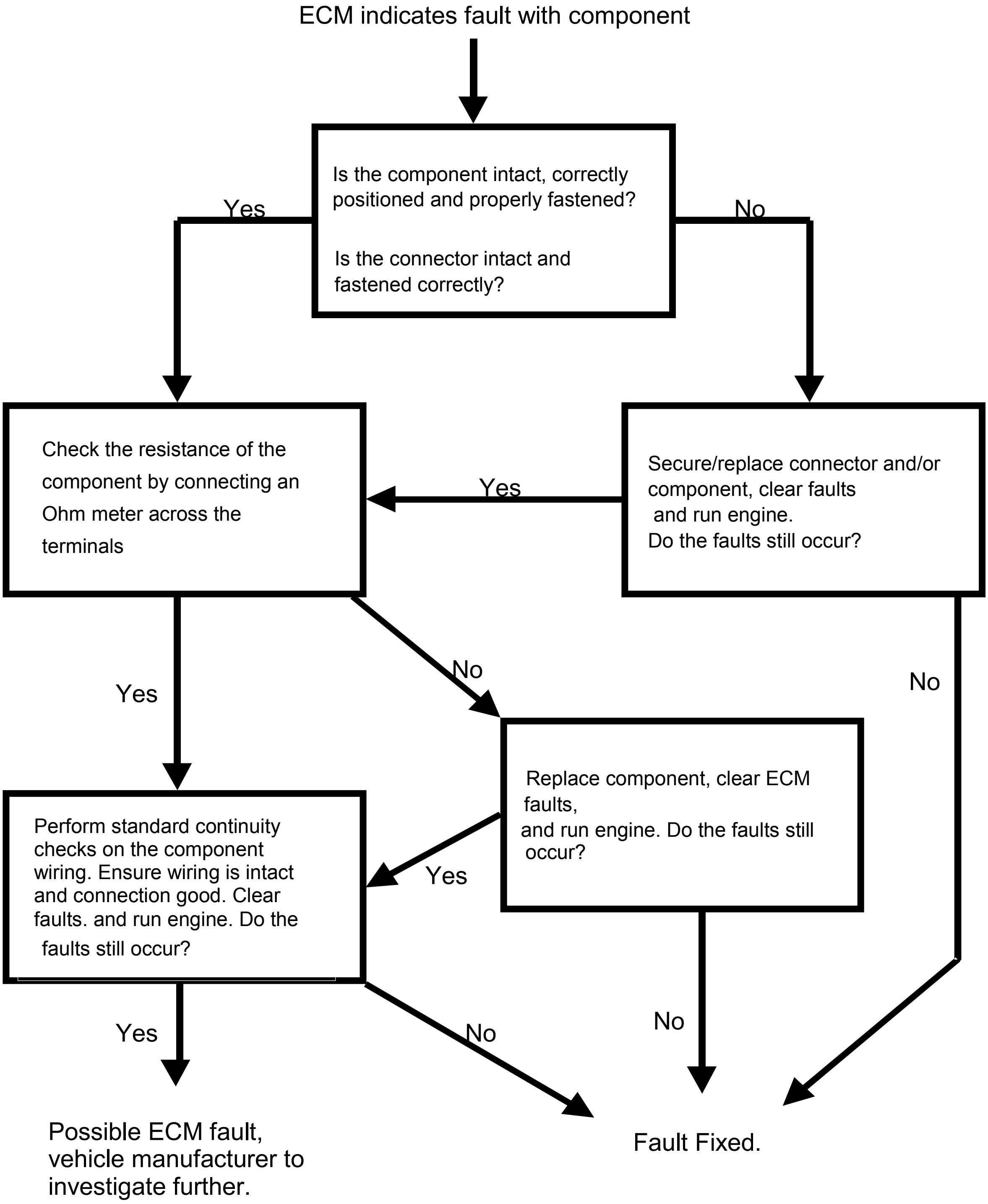
## 7. Assembly

### 7.1. Bolt torques

| Component | Fitting details |
|---|---|
| **Map sensor**<br>Bolt (Torque 4.35∀0.3)<br>Washer | <br>M6x10-8.8 DIN 933 (Fe Zn 12C DIN 50961)<br>6x12x1 C70 UNI 8836 (Fe Zn 8C DIN 50961) |
| **Air filter bracket (Paykan)**<br>Bolts (Torque 15Nm)<br>Cup Washers<br>Spring washers<br><br>Nut (16.24∀0.6) | <br>M8x20 8.8 DIN 933 (Fe Zn 12C DIN 50961)<br>6x12x1 C70 UNI 8836 (Fe Zn 8C DIN 50961)<br>Single coil rectangular section spring washer, type A, BS4464 (Fe Zn 8C DIN 50961)<br>M8 BS3692 (Fe Zn 12C DIN 50961) |
| **Air filter bracket (RD)**<br>Bolts (Torque 15Nm)<br><br>Cup Washers<br>Spring washers<br><br>Nut (16.24∀0.6) | <br>M8x20 8.8 DIN 933 (Fe Zn 12C DIN 50961)<br>M8x50 8.8 DIN 933 (Fe Zn 12C DIN 50961)<br>6x12x1 C70 UNI 8836 (Fe Zn 8C DIN 50961)<br>M8mm Single coil rectangular section spring washer, type A, BS4464 (Fe Zn 8C DIN 50961)<br>M8 BS3692 (Fe Zn 12C DIN 50961) |
| **Fuel filter clamp (Paykan)**<br>Ø5mm Stud included on Air filter bracket<br>Spring washers<br>Nut (Torque 4.04∀0.3) | <br>M5mm Single coil rectangular section spring washer, type A, BS4464 (Fe Zn 8C DIN 50961)<br>M5 BS3692 (Fe Zn 12C DIN 50961) |
| **Fuel filter clamp (RD)**<br>Bolt (Torque 4.04∀0.3)<br>Spring washers<br><br>Nut (Torque 4.04∀0.3) | <br>M5x20 (Fe Zn 12C DIN 50961).<br>M5 Single coil rectangular section spring washer, type A, BS4464 (Fe Zn 8C DIN 50961)<br>M5 BS3692 (Fe Zn 12C DIN 50961) |
| **Fuel pump bracket**<br>Iran Khodro to specify fixing details | |
| **Air intake transverse metal pipe** (Paykan)<br>Nut (Torque7.3∀0.5)<br>Washer | <br>¼ UNF, + Torque as currently used to secure suspension support to body at rear of engine bay.<br>¼ plain washer (Fe Zn 8C DIN 50961) |
| **Air intake transverse metal pipe** (RD)<br>Nut (Torque 6.52∀0.5)<br>Spring washers | <br>M6 DIN 933 (Fe Zn 12C DIN 50961)<br>M6 Single coil rectangular section spring washer, type A, BS4464 (Fe Zn 8C DIN 50961) |
| **15TT Air temperature sensor** | Tightening torque 8Nm |
| **03VR Engine speed sensor** | The sensor should be secured by the use of a bolt tightened to a torque; 6 to 10 Nm. |
| **02RA Double relay** | Bolt/nut fixing torque 0,6 Nm |
| **BAE 04 Ignition coil** | Screw tightening torque 4,5 Nm |
| **01IS Inertia switch** | **The position must not be altered.**<br>Fixing screw torque: not greater than 3Nm<br>Screw head dimensions:10mm nominal diameter<br>Washers, if used, should be plain, wavy or crinkle style (NOT coiled or serrated washers). |
| **09TB Throttle body** | Manifold mounting flange screw torque: 6 Nm<br>Manifold mounting flange screw thread: M6x22 8.8<br>Cup washer: ∅6x12,5x1,2 - C70 |

| | |
|---|---|
| **06TP Throttle potentiometer** | **Service only**<br>The potentiometer must be pressed using an appropriate fixed tool.<br>Mate the ‘O’ ring with the butterfly valve body (max. pressure F = 100n). The tool used must keep the two bearing surfaces parallel. The bearing surfaces are the same as the diameter of the U bushes. The mounting screws used to fix the potentiometer must have a diameter of ∅ = 12 mm and a tightening torque of 2.5±0.5Nm |
| **01SM003 Air bypass valve (stepper motor)** | **Service only**<br>Fastening should be via two M5 x 0.8 x 14 screws to a torque of 4 ±0.4Nm. Lock washers and thread locking adhesive shall be used to prevent loosening. |
| **SL96 Engine control module** | Maximum tightening torque 8Nm for M6 screws. |
| **Spark plugs (RFN58LZ)** | Tightening torque 20 to 40 Nm |

## 8. Fault finding



## 8.1. Fault Messages

The following table shows the faults that will be diagnosed by the Diagnostic Tool and the associated messages that will be displayed on the screen.
*Note: Italicised items are not fitted to Paykan and Peugeot RD but are included in the list for completeness.*

| Type of fault that is present | Fault description displayed on screen |
| --- | --- |
| *Open or short circuit fault on the oxygen sensor* | *OXYGEN SENSOR* |
| Open or short circuit fault on the air temperature sensor | FAULT:AIR TEMPERATURE SENSOR |
| Open or short circuit fault on the water temperature sensor | FAULT: COOLANT TEMPERATURE SENSOR |
| Open or short circuit fault on the throttle position sensor | THROTTLE POTENTIOMETER FAULT |
| Open or short circuit fault on the vehicle speed sensor | FAULT: VEHICLE SPEED SENSOR |
| Open or short circuit fault on the manifold pressure sensor | PRESSURE SENSOR |
| Open or short circuit fault on the engine speed & position sensor | ENGINE SPEED FAULT |
| *Open or short circuit fault on the knock sensor* | *KNOCK SENSOR FAULT* |
| *Open or short circuit fault on the power assisted steering sensor* | *POWER ASSISTED STEERING SENSOR* |
| *Fault on the automatic transmission line* | *AUTOMATIC TRANSMISSION LINE* |
| *Fault on the cruise control* | *CRUISE CONTROL FAULT* |
| Fault on the fuel pump relay | FUEL PUMP RELAY |
| Open or short circuit fault on the air bypass valve | IDLE ACTUATOR |
| *Open or short circuit fault on the purge valve* | *CANISTER SOLENOID VALVE FAULT* |
| *Fault on the oxygen sensor heater relay* | *OXYGEN SENSOR HEATER RELAY* |
| *Fault on the air conditioning* | *AIR CONDITIONING* |
| Open or short circuit fault on injector 1 or 4 | INJECTEURS 1/4 |
| Open or short circuit fault on injector 2 or 3 | INJECTEURS 2/3 |
| Open or short circuit fault on ignition coil 1 or 4 | IGNITION COIL 1/4 COMMAND FAULT |
| Open or short circuit fault on ignition coil 2 or 3 | IGNITION COIL 2/3 COMMAND FAULT |
| *Open or short circuit fault on the oxygen sensor* | *RICHNESS ADAPTATION (ADDITIVE)* |
| *Open or short circuit fault on the oxygen sensor* | *RICHNESS REGULATION FAULT* |
| Fault with the ECU | ECU FAULT |
| Battery voltage is too high or too low | FAULT: BATTERY VOLTAGE |
| *Fault with heated windscreen input* | *HEATED WINDSCREEN INPUT* |
| The ECU is currently being programmed | ECU DOWNLOADING |

| Type of fault that is present | Fault description displayed on screen |
|---|---|
| A short circuit fault is confirmed on the water temperature warning output | Short circuit Vbat fault memorised, coolant temperature warning output |
| A short circuit fault is present on the water temperature warning output | Short circuit Vbat fault present, coolant temperature warning output |
| An open circuit fault is confirmed on the water temperature warning output | Open circuit fault memorised, coolant temperature warning output |
| An open circuit fault is present on the water temperature warning output | Open circuit fault present, coolant temperature warning output |
| A short circuit fault is present on the CO calibration potentiometer input | Short circuit Vbat fault present, CO potentiometer input |
| An open circuit fault is present on the CO calibration  potentiometer input | Open circuit fault present, CO potentiometer input |

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# Paykan and Peugeot RD SL96 normal operating conditions.

**AUTHOR: ERIK VAN DER STERREN**

## CONTENTS

# 1 introduction

This document describes the normal operating conditions for the Paykan and Peugeot RD vehicles equipped with the SL96 engine management system (or EMS), manufactured by Johnson Controls Automotive Electronics. It describes the range within which certain engine specific parameters will operate for a correctly functioning EMS.

The document is intended to be used as a support when performing quick checks on a vehicle to determine whether the EMS is functioning correctly. Out of range values for any of the parameters can give a first indication of where in the system a fault may be present, but for dedicated fault-finding the proper diagnostic tools and manuals are essential and will have to be used.

The document first of all specifies the preconditioning procedure for the system and vehicle that should be carried out before measurements are taken. This procedure must be adhered to very strictly, as non-conformity will lead to certain parameters failing to fall within the specified range, even though the system is functioning correctly: for example, injector opening time and engine speed are dependent on engine coolant temperature, so failing to warm the engine up sufficiently can lead to out of range values being measured.

Subsequently, a listing is provided of all the available system parameters that are accessible by the diagnostic tool and the range within which these parameters should be operating is given. Ambient conditions play a big part in the final value of most parameters and this is accounted for when the ranges are quoted. The parameters are specified for a new, or nearly new, vehicle. The normal operating range for some engine parameters will change as the vehicle condition changes with age/mileage.

In the remainder of the document, these parameters are elaborated on individually and the preconditioning important for the parameter in question is specified. In case of an out of range measurement, a list of components and parameters is provided that are likely to be the cause for the faulty measurement and that should be checked first of all.

# 2 vehicle details

| | | |
|---|---|---|
| VEHICLE TYPE: | Paykan: | Peugeot RD: |
| VEHICLE MILEAGE: | | |
| ECU IDENTIFICATION / NUMBERS: | | |
| | | |
| | | |
| | | |

## 3 preconditioning

The following conditions have to be met before measurements can start on a vehicle:

- Check / adjust CO to specified value.
- The engine must be fully warmed up.
- The engine is in the idling phase.
- There must be no additional electrical load on the engine. (eg: lights, radio etc. switched off).

# 4 SYSTEM PARAMETERs listing

## 4.1 checks with high atmospheric pressure

The listing below gives the range for the parameters at high atmospheric pressure encountered at sea level. Typically this would be around 97 – 101 kPa.

| PARAMETER | MANUFACTURERS RANGE | UNITS | MEASURED VALUE |
|---|---|---|---|
| ENGINE SPEED | 820 – 880 | rpm | |
| BATTERY VOLTAGE | 13.3 – 14.3 | volt | |
| IGNITION ADVANCE | 14 – 35 | °BTDC | |
| COIL DWELL TIME | 3.2 – 4.4 | ms | |
| INJECTOR PULSE TIME | 5.8 – 7.6 | ms | |
| MANIFOLD PRESSURE | 44 – 51 | kPa | |
| THROTTLE POSITION | 0 | % | |
| COOLANT TEMPERATURE | 70 – 85 | °C | |
| AIR TEMPERATURE (manifold) | 35 – 40 | °C | |
| STEPPER MOTOR POSITION | 34 – 45 | steps | |
| ATMOSPHERIC PRESSURE | 97 – 101 | kPa | |
| GEAR ENGAGED (MANUAL) | 0 | - | |

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## 4.2 checks with low atmospheric pressure

The listing below gives the range for those system parameters that are affected by changes in atmospheric pressure. The data used for this listing was gathered during Hot Environment Testing (or HET) in Iran with atmospheric pressure ranging from 72 – 101 kPa. The ranges are specified for an engine at idle speed.

| PARAMETER | MANUFACTURERS RANGE | UNITS | MEASURED VALUE |
| --- | --- | --- | --- |
| INJECTOR PULSE TIME | 5.0 – 7.6 | ms | |
| MANIFOLD PRESSURE | 37 – 51 | kPa | |
| COOLANT TEMPERATURE | 70 – 89 | °C | |
| AIR TEMPERATURE | 35 – 63 | °C | |
| STEPPER MOTOR POSITION | 34 – 54 | steps | |
| ATMOSPHERIC PRESSURE | 72 - 101 | kPa | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# 5 system parameters

This chapter lists every engine parameter in turn. Every subchapter first states the preconditioning that has to be in place before measurements can be made on the parameter concerned. The conditions stated under heading 3 also have to be in place. The normal operating range for each parameter is also reiterated and finally a listing is given of the components and parameters that should be looked at in the case that the parameter value in question is found to be out of range. Before any of the components that are mentioned below are checked, it is recommended that a fault-reading is taken of the system using a diagnostic tool. Any component that is found to be faulty must first be repaired or replaced before further analysis of the system can commence.

## 5.1 ENGINE SPEED

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle.<br>• Accelerator pedal at rest.<br>• Engine fully warm.<br>• No electrical load. |
| MANUFACTURERS RANGE: | 820 – 880 rpm. |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Stepper motor.<br>• Air temperature sensor.<br>• Coolant temperature sensor.<br>• Check inlet manifold assembly for airleaks.<br>• Ignition advance. |

## 5.2 BATTERY VOLTAGE

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle. |

| | |
|---|---|
| | • No electrical load. |
| MANUFACTURERS RANGE: | 13.3 – 14.3 V. |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Alternator functioning.<br>• Battery condition.<br>• Battery wiring and circuitry. |

## 5.3 coolant temperature

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle.<br>• Accelerator pedal at rest.<br>• Battery voltage within specified range.<br>• Engine fully warm.<br>• No electrical load. |
| MANUFACTURERS RANGE: | 70 – 90 °C (expect higher values after heat soak) |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Coolant temperature sensor function.<br>• Engine cooling system.<br>• Sensor wiring and connection. |

## 5.4 IGNITION ADVANCE

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle.<br>• Accelerator pedal ar rest.<br>• Battery voltage within specified range.<br>• Engine fully warm.<br>• No electrical load. |

| | |
|---|---|
| MANUFACTURERS RANGE: | 14 – 35 °BTDC. |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Coil conforms to specified parameters.<br>• Ignition circuit (harnesses).<br>• Spark plug conformity and condition. |

## 5.5 coil dwell time

| | |
|---|---|
| PRECONDITIONING: | • Engine running.<br>• Battery voltage within specified range.<br>• Engine fully warm.<br>• Injection pulse time correct. |
| MANUFACTURERS RANGE: | 3.2 – 4.4 ms. |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Coil conforms to specified parameters.<br>• Ignition circuit (harnesses).<br>• Spark plug conformity and condition. |

## 5.6 INJECTOR PULSE TIME

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle.<br>• Accelerator pedal at rest.<br>• Battery voltage within specified range.<br>• Engine fully warm.<br>• No electrical load. |
| MANUFACTURERS RANGE: | 5.0 – 7.6 ms. |

| | |
|---|---|
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Injectors conform to specified parameters.<br>• Coolant temperature sensor.<br>• Fuel system. |

## 5.7 MANIFOLD PRESSURE

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle.<br>• Accelerator pedal at rest.<br>• Battery voltage within specified range.<br>• Engine fully warm.<br>• No electrical load. |
| MANUFACTURERS RANGE: | 37 – 51 kPa depending on altitude. |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Manifold pressure sensor conforms to specified parameters. |

## 5.8 THROTTLE POSITION

| | |
|---|---|
| PRECONDITIONING: | • Engine stopped or running at idle.<br>• Accelerator pedal at rest.<br>• No electrical load. |
| MANUFACTURERS RANGE: | 0 % |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Attachment of throttle position sensor to throttle body.<br>• Adjustment and routing of throttle cable. |

| | |
|---|---|
| | • Throttle position sensor function. |

## 5.9 AIR TEMPERATURE

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle.<br>• Accelerator pedal at rest.<br>• Battery voltage within specified range.<br>• Engine fully warm.<br>• No electrical load.<br>• Bonnet closed. |
| MANUFACTURERS RANGE: | Lower limit heavily dependent on ambient temperature and upper limit on operating conditions of engine prior to measurement (ie heat soak).<br><br>-30 – 80 °C |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Air temperature thermistor function.<br>• Sensor wiring and connection. |

## 5.10 STEPPER MOTOR POSiTION

| | |
|---|---|
| PRECONDITIONING: | • Engine running at idle.<br>• Accelerator pedal at rest.<br>• Battery voltage within specified range. |

| | |
|---|---|
| | • Engine fully warm.<br>• No electrical load. |
| MANUFACTURERS RANGE: | 34 – 54 steps |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Check throttle body and inlet manifold for airleaks.<br>• Check MAP sensor function and wiring. |

## 5.11 ATMOSPHERIC PRESSURE

| | |
|---|---|
| PRECONDITIONING: | • Engine stalled.<br>• Accelerator pedal at rest.<br>• Battery voltage within specified range.<br>• **NOTE:** Atmospheric pressure is measured using the map sensor with the engine stalled |
| MANUFACTURERS RANGE: | 72 – 101 kPa. |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Check MAP sensor function and wiring. |

## 5.12 GEAR ENGAGED (MANUAL geaRBOX)

| | |
|---|---|
| PRECONDITIONING: | • Manual gearbox fitted. |
| MANUFACTURERS RANGE: | 0 |
| CHECKS TO PERFORM IN CASE OF OUT OF RANGE VALUE: | • Possible ECU fault – replace. |