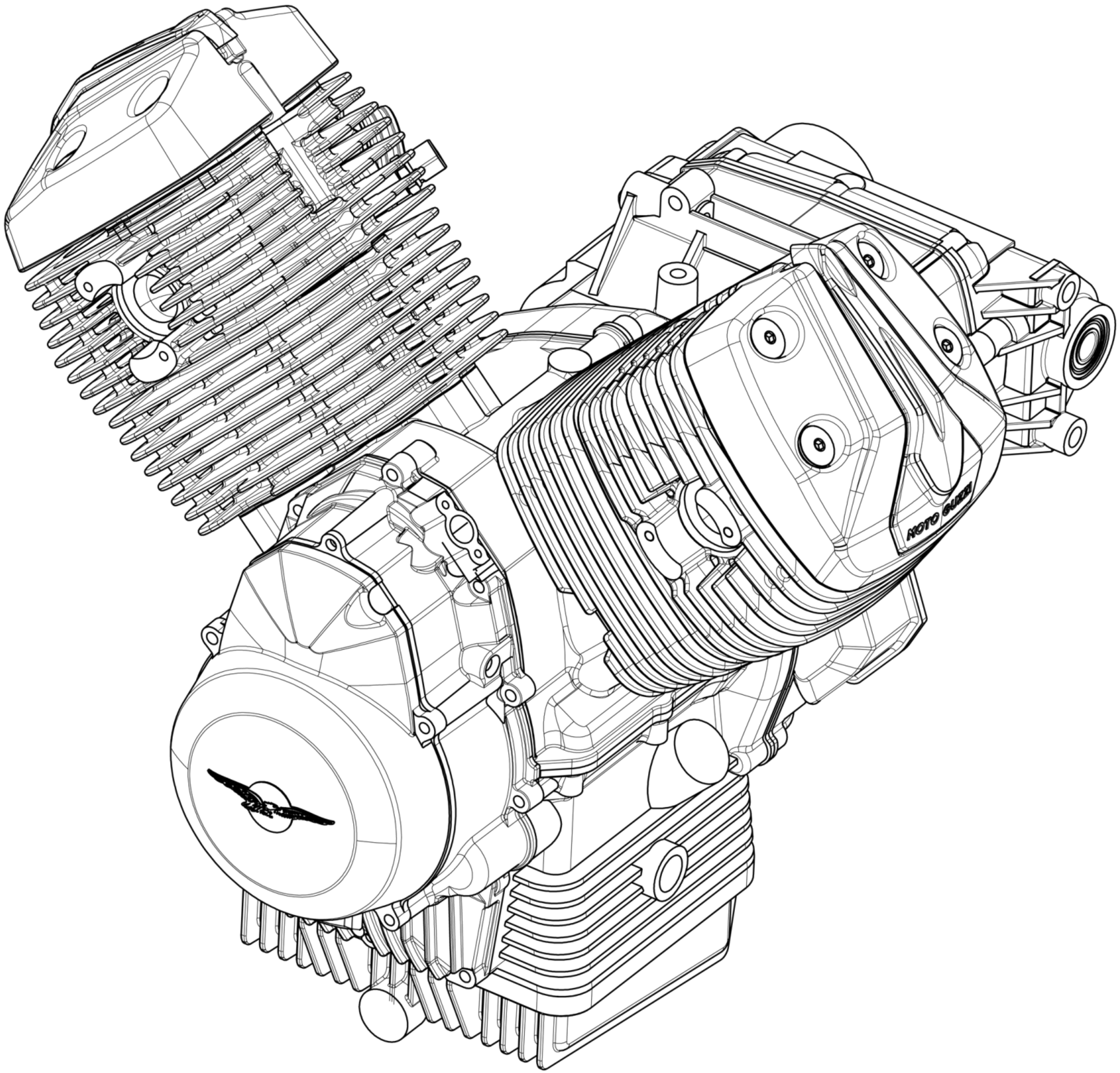


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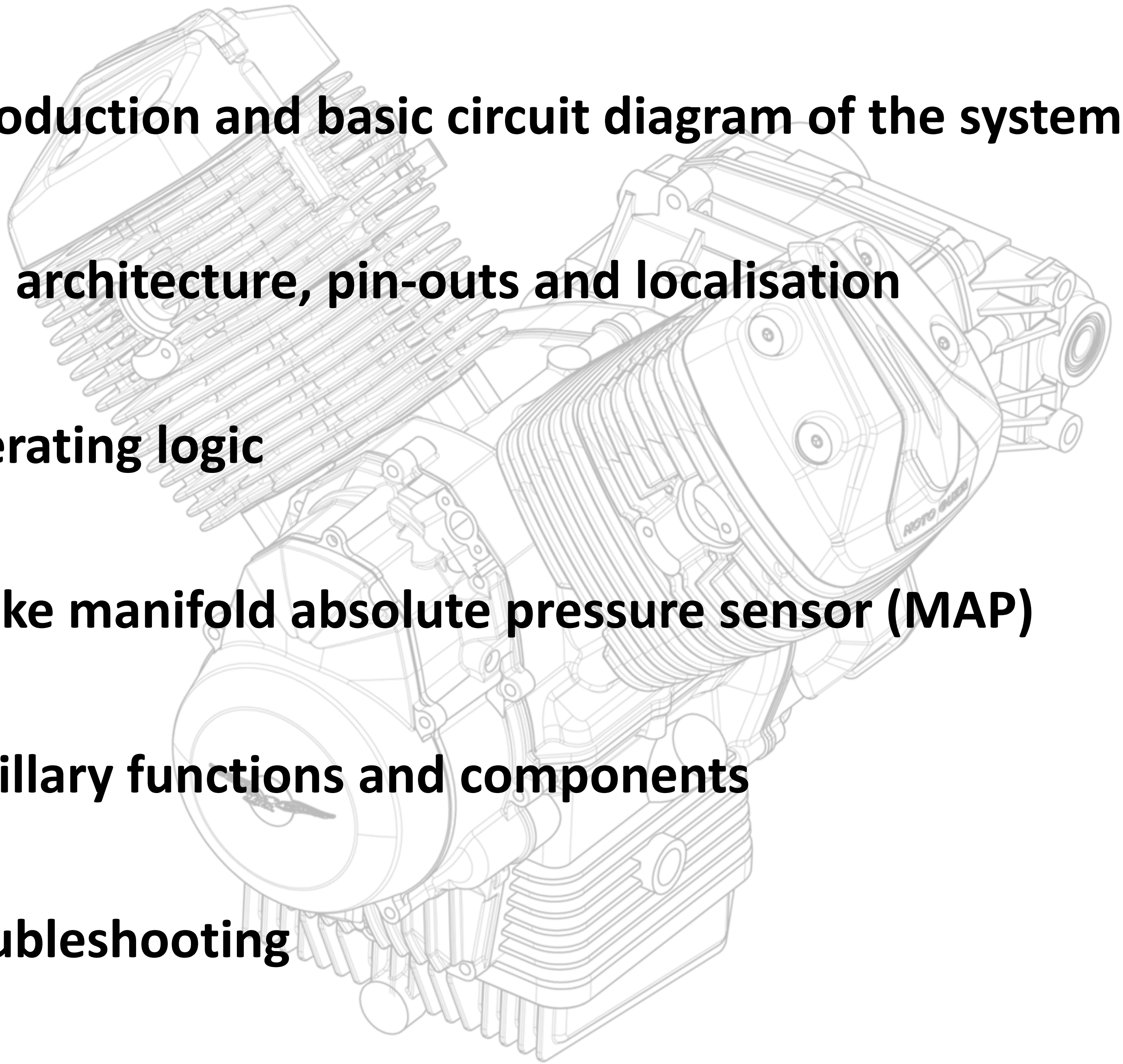

1. Introduction and basic circuit diagram of the system
2. ECU architecture, pin-outs and localisation
3. Operating logic
4. Intake manifold absolute pressure sensor (MAP)
5. Ancillary functions and components
6. Troubleshooting

1 Introduction and basic circuit diagram of the system

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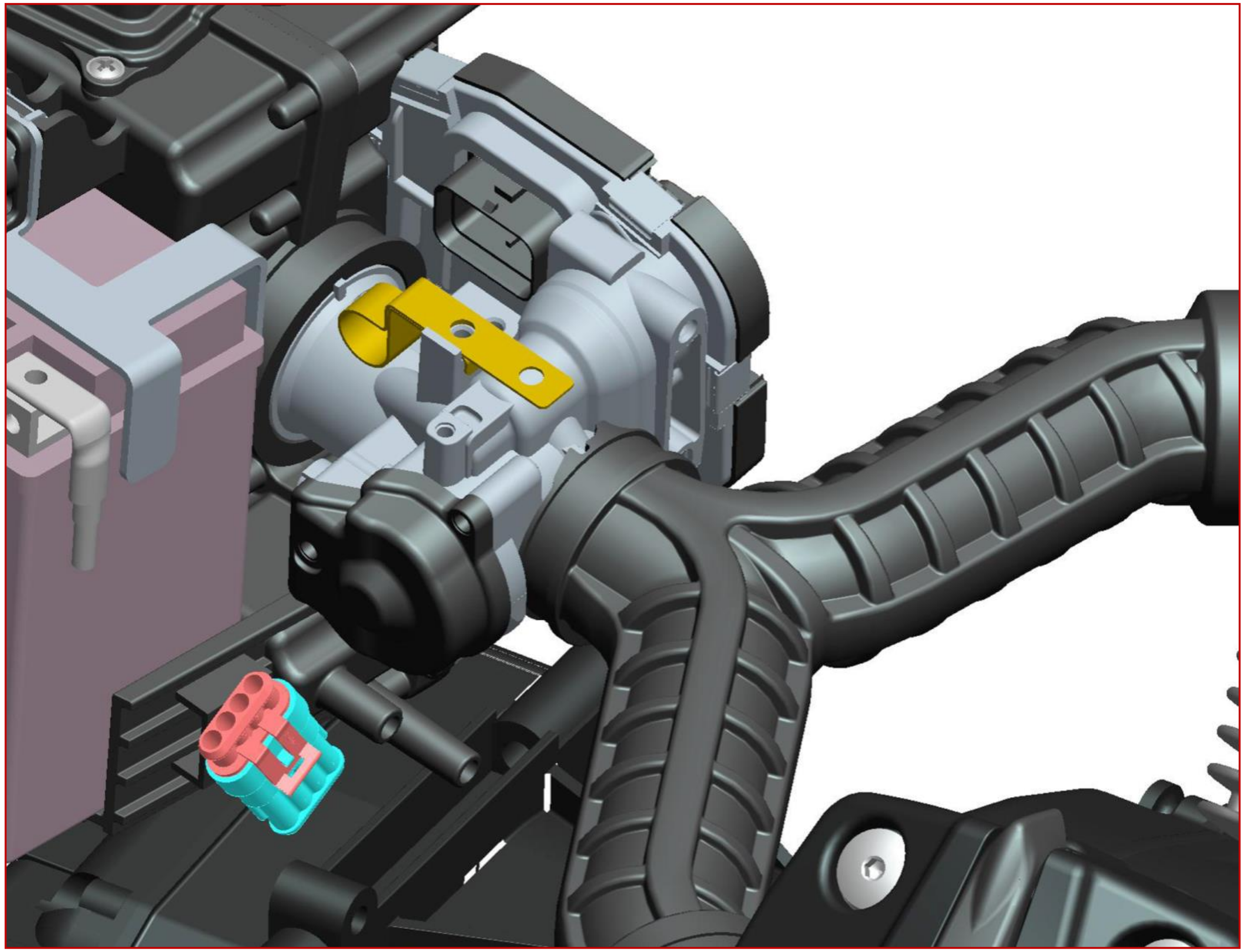
# 1. Introduction

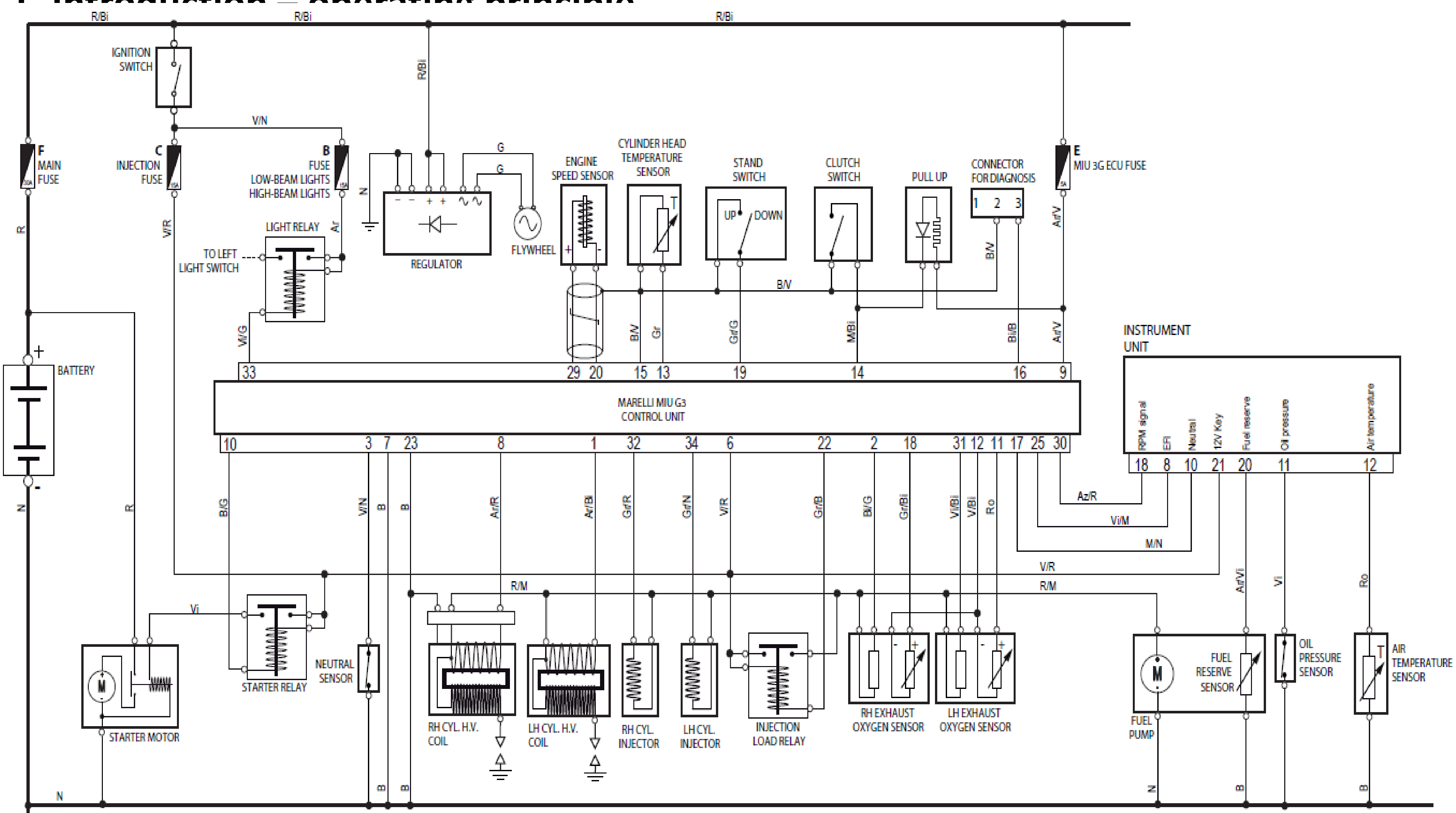
The **Marelli MIU G3** injection system is the latest generation of the MIU series (Marelli Integrated Unit). This is a conventional system (alpha-n management), which integrates the injection and ignition ECU, the throttle body and a number of inlet sensors in a single housing.



Engine management is optimized through the use of a MAP (Manifold Absolute Pressure) sensor.

The ECU receives the input signal from two oxygen sensors (one per cylinder), and, by driving the two coils and the two injectors separately, manages the two cylinders independently.

# 1 Introduction – operating principle

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2 ECU architecture, pin-outs and localisation

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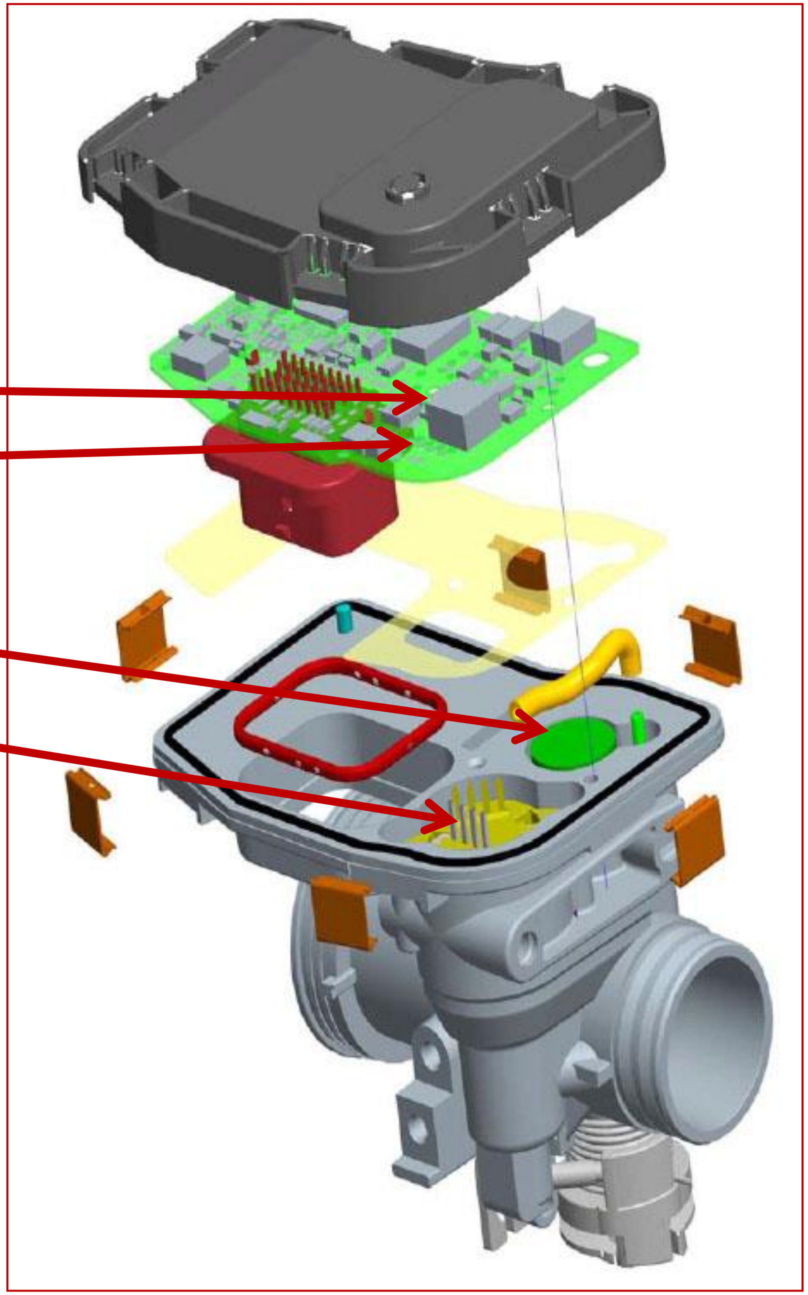
## 2. ECU architecture

The electronic control unit is integrated in the throttle body. This solution has made it possible to integrate the following devices within the unit:

- MAP intake manifold pressure sensor
- Intake air temperature sensor
- TPS throttle position sensor
- Stepper motor for idle speed control.

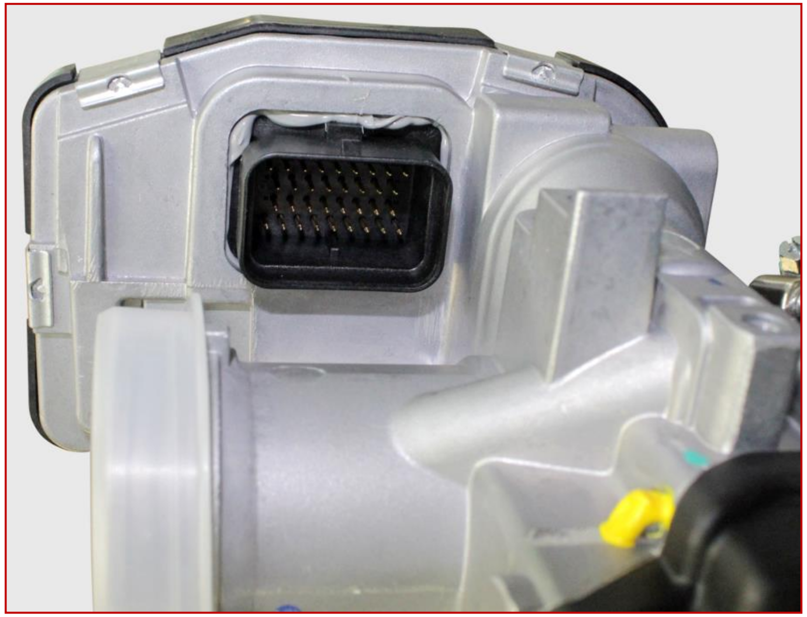
As a result, the functionality of these devices can only be tested with the diagnostic software.

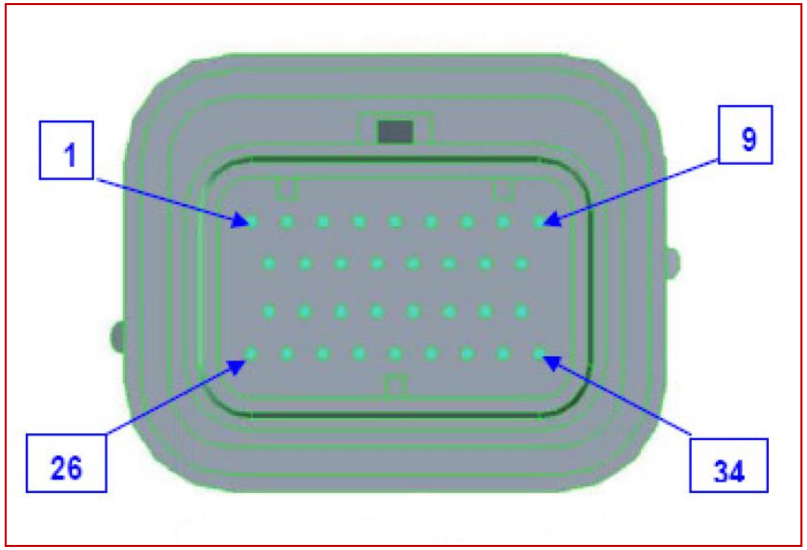
The unit is contained in a sealed casing. In the event of malfunction of any of the internal devices, the entire unit must be replaced.



# 2. ECU architecture – pin outs ({I} input – {O} output)

1. {O} HT coil 1 (LH cyl.)
2. {O} Oxygen sensor λ 2 heater
3. Neutral sensor
4. {I} "RUN-OFF" consent
5. {I} Starter button
6. {I} Ignition switched live
7. Power ground connection 1
8. {O} HT coil 2 (RH cyl.)
9. battery +
10. {O} Starter relay
11. sensor + λ 1
12. sensor – λ
13. {I} Engine temp. sensor
14. Clutch switch
15. Sensor ground
16. Serial K-Line
17. {O} Neutral indicator lamp
18. sensor + λ 2
19. {I} Side stand switch
20. {I} engine speed/timing sensor –
21. N/C
22. Injection load relay
23. Power ground connection 2
24. N/C
25. {O} EFI indicator lamp
26. N/C
27. N/C
28. N/C
29. {I} engine speed/timing sensor +
30. {O} Rev counter output
31. {O} Oxygen sensor λ 1 heater
32. {O} Fuel injector 2
33. {O} Lights relay
34. {O} Fuel injector 1

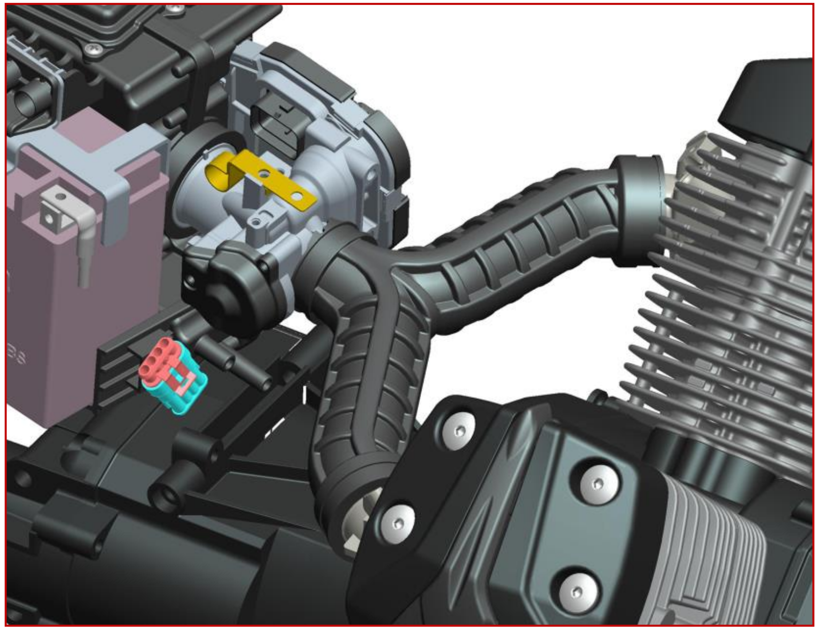




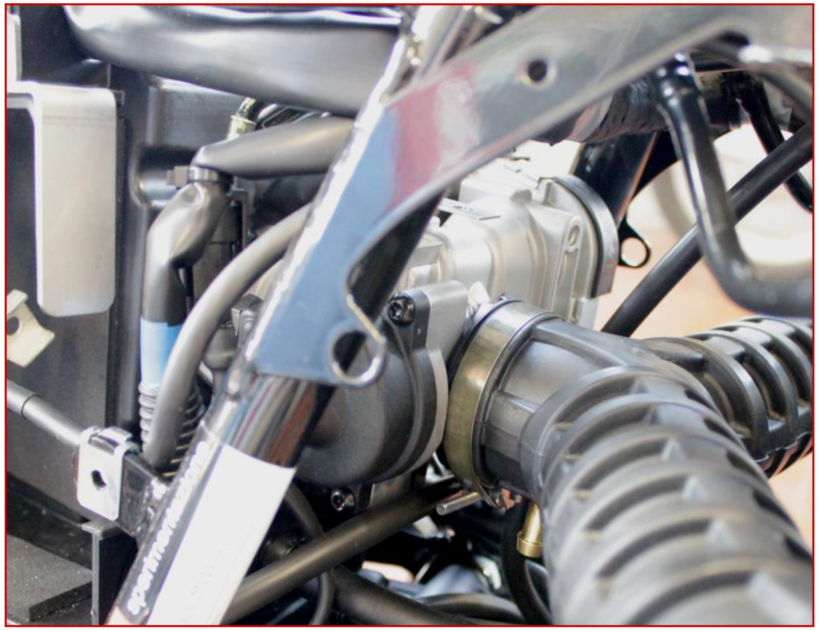
## 2. ECU architecture – position

The body of the MIU unit is located at the intersection of the new Y shaped air duct.

The new V7 is in fact the first Moto Guzzi engine with a single throttle body for both cylinders.



The throttle body is located immediately under the tank and next to the battery.



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3 Operating logic

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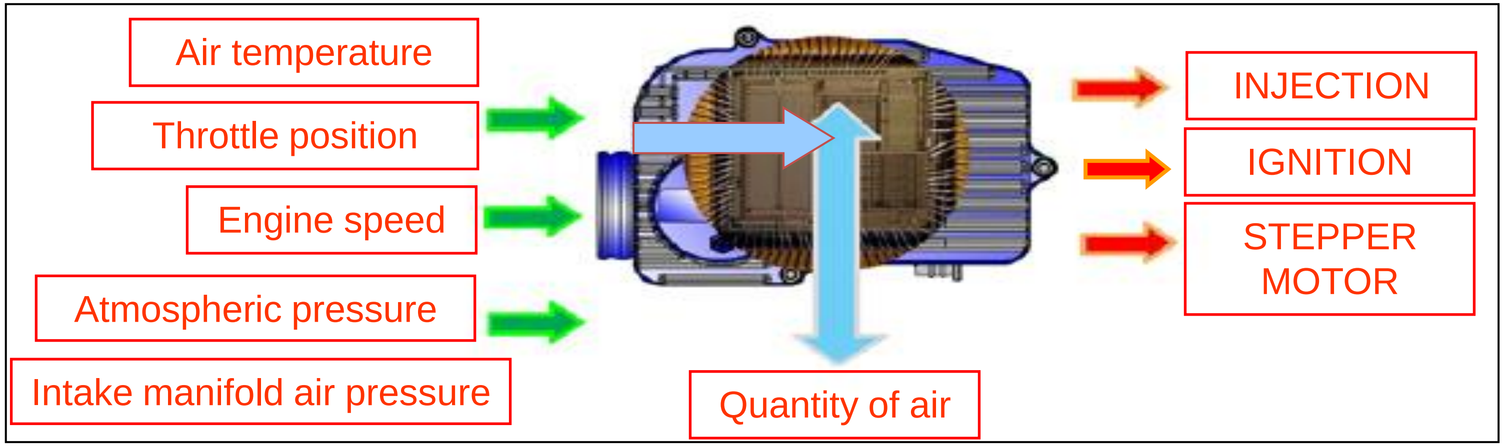
# 3. Operating logic

## Injection times and ignition advance

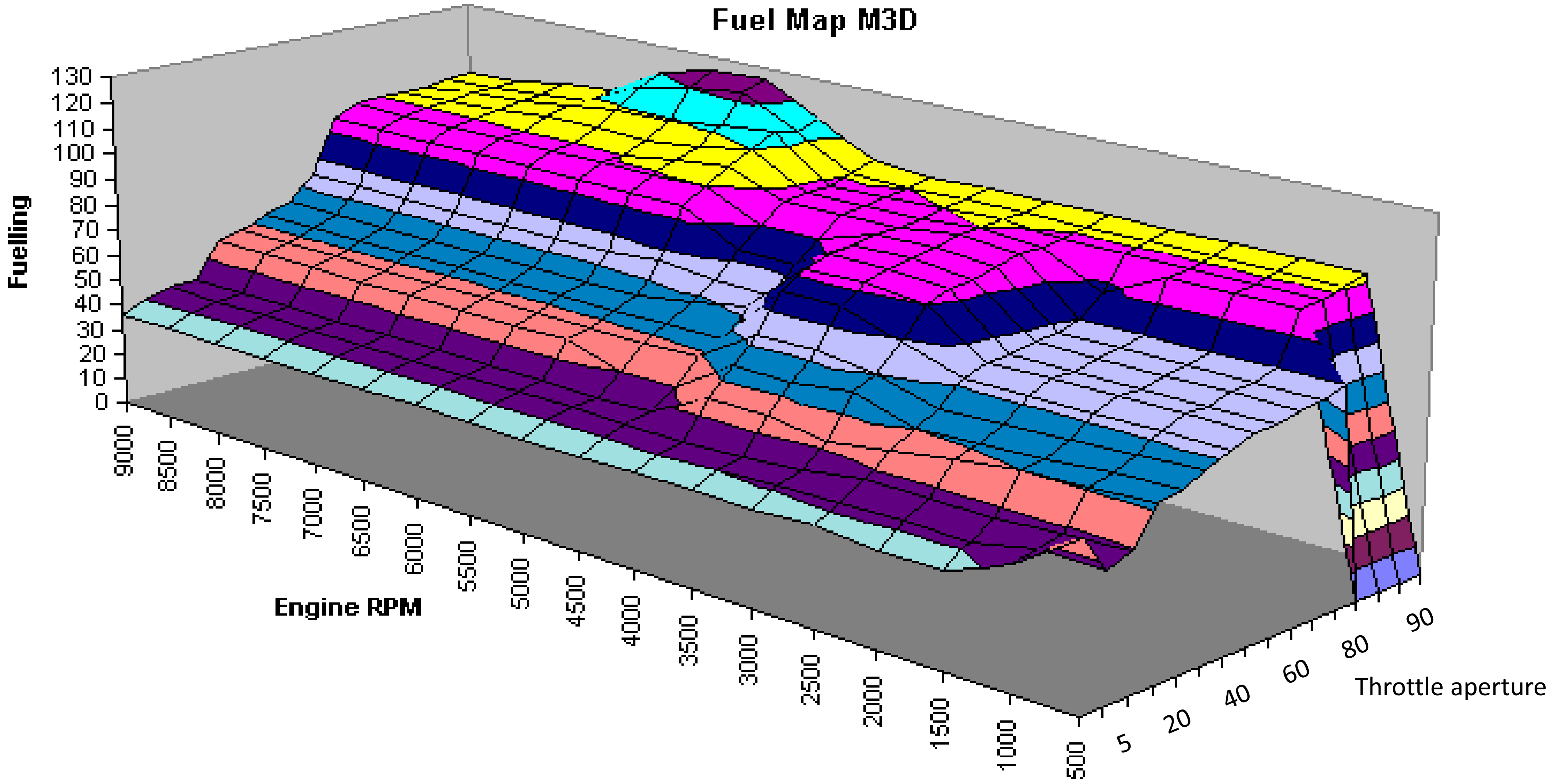
The MIU ECU uses a conventional Alpha-n strategy to manage the engine. This means that injection times and ignition advance values are defined on the basis of the two primary parameters: throttle aperture and engine speed.

A correction factor is applied to these values (injection time and ignition advance), which is calculated on the basis of the secondary parameters atmospheric pressure, ambient temperature, engine temperature and effective absolute intake manifold pressure.



# 3. Operating logic

## Example injection map



# 3. Operating logic

**New self-adaptive engine management (air/fuel ratio) strategy**

The G3 unit used with this engine features a self-adaptive engine management function.

This allows the ECU to adapt to the effective needs of the engine, and even compensate for engine deteriorating factors such as, for instance, fouling of the air filter or throttle body.

To do this, the ECU uses feedback from the **oxygen sensors** or the **MAP sensor** in relation to the effective operating conditions. In the latter instance, the effective absolute manifold pressure is used to calculate the effective mass of air aspirated into the cylinder.

The correction factor is calculated and applied by compiling and continuously updating two 10x10 self-adaptive matrices, with one for cold engine conditions and the other for hot engine conditions.

At each reference point (rpm – throttle aperture), the injection time is increased or reduced by a percentage equal to the value of the corresponding correction parameter.

The diagnostic tool may be used to read the ADAPTIVE FUEL CORRECTION parameter, which is expressed as a **percentage** of the base map injection time.

# 3. Operating logic

Example of a 10x10 self-adaptive matrix (cold engine).

Each element of the matrix is a correction percentage applied to the base injection time.

| **COLD** | | **RPM** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1.250** | **1.500** | **2.000** | **3.000** | **…** | **…** | **…** | **…** | **…** | **…** |
| | **1°** | 1,2 | 1,3 | … | … | … | | | | | |
| **T** | **4°** | 1,1 | … | … | … | … | | | | | |
| **H** | **8°** | … | … | … | 1,2 | … | | | | | |
| **R** | **15°** | … | | | … | | | | | | |
| **O** | **…** | … | | | | … | | | | | |
| **T** | **…** | … | | | | | … | | | | |
| **T** | **…** | … | | | | | | … | | | |
| **L** | **…** | … | | | | | | | … | | |
| **E** | **…** | … | | | | | | | | … | |
| | **…** | … | | | | | | | | | … |

# 3. Operating logic

**Notes:**

1. Oxygen sensor-based correction has priority over MAP sensor-based correction.

2. The correction factor is updated when operating conditions are stable - in other words, when neither the throttle aperture nor the engine speed vary excessively rapidly.

3. If the correction factor requested exceeds ±25%, the EFI warning lamp on the instrument panel is activated, the self-adaptive matrices are reset to zero and the error is memorised in the ECU.

# 3. Operating logic

**Idle speed management:**

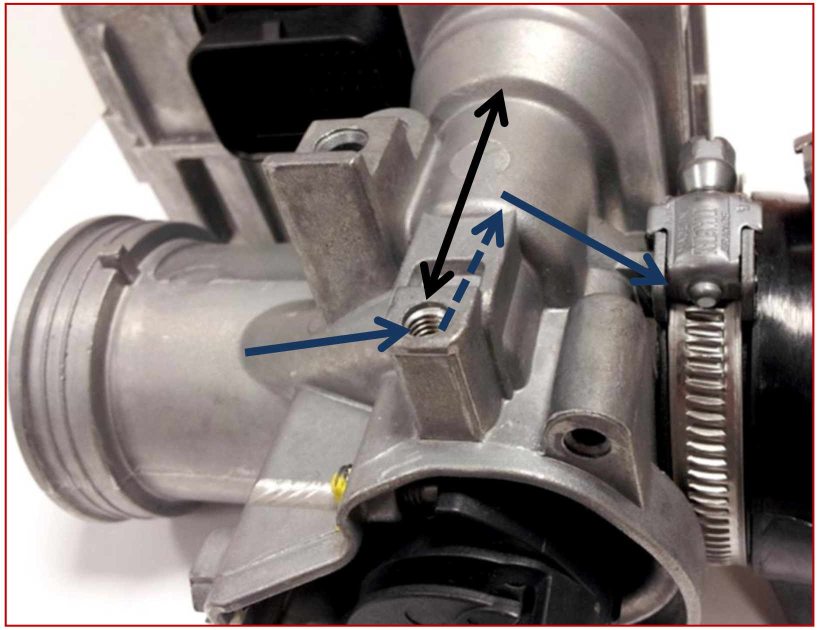
The ECU manages idle speed completely automatically.

To allow idle speed management, the throttle body has a throttle valve by-pass duct controlled by a stepper motor.

The ECU defines a target idle speed in relation to operating conditions (engine temperature, ambient temperature etc.), and actuates the stepper motor accordingly to maintain the idle speed at this target value.

The idle speed is therefore calculated by the ECU and cannot be modified.

**The calibration screw is sealed and must not be tampered with for any reason.**



# 3. Operating logic

Tampering with the setting of the calibration screw will compromise the ability of the ECU to maintain a correct and stable idle speed.

In the event of tampering, the MIU unit must be replaced as it will not be possible to restore the original calibration.

**Notes:**

1. At key-on, the stepper motor is completely open to facilitate starting (kick-down position).

2. At each stepper motor step, the injection time is also altered to maintain a constant air/fuel ratio.

3. Only **oxygen sensor**-based or **MAP sensor**-based correction influences injection time independently of stepper motor aperture.

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4 Intake manifold absolute pressure sensor (MAP)

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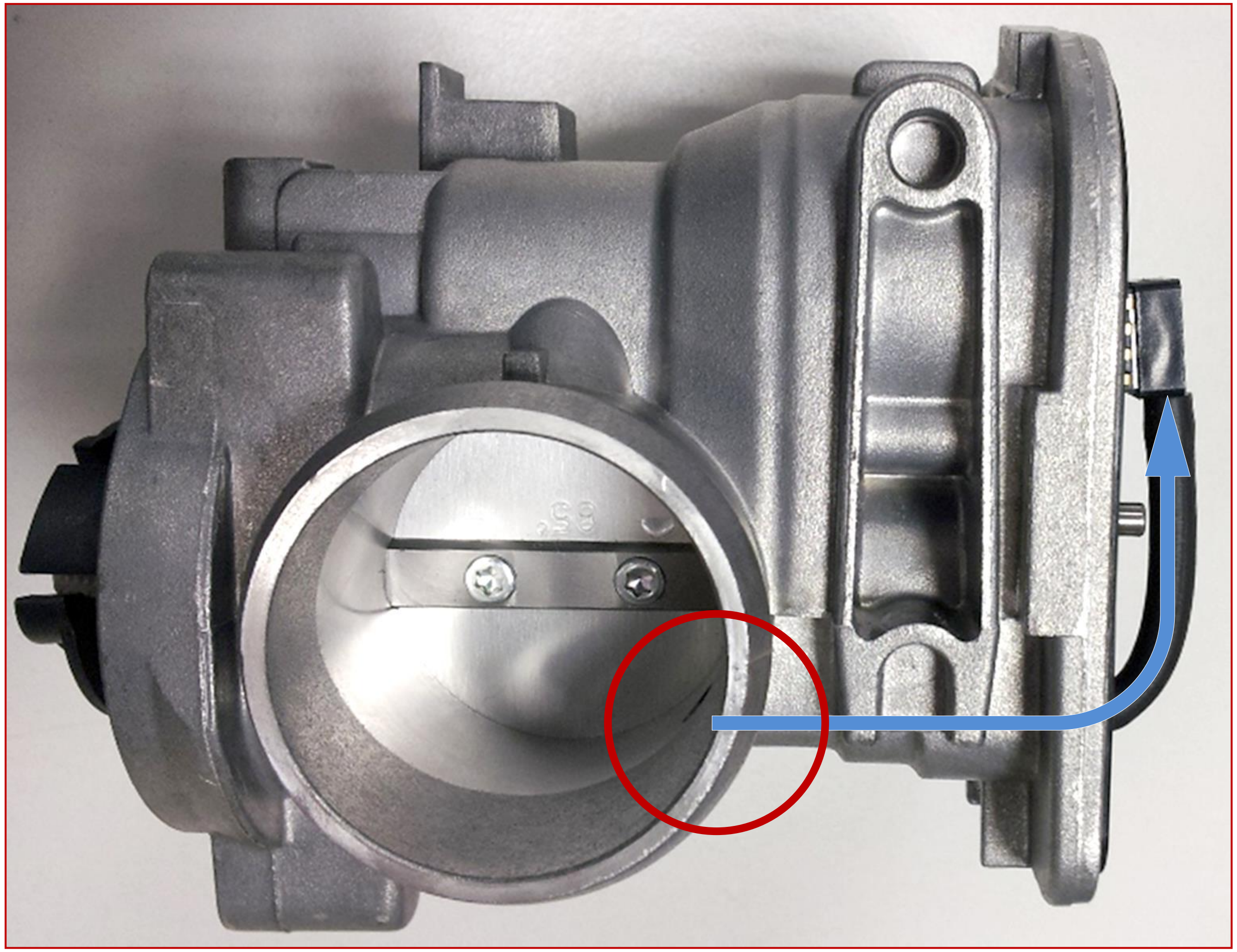
# 4. Intake manifold absolute pressure sensor (MAP)

The sensor is completely integrated in the throttle body.

This sensor measures the pressure in the intake manifold in real time, and this parameter is used by the ECU to:

1. Measure atmospheric pressure
2. Identify compression stroke TDC
3. Correct base map injection times by comparing the effective intake manifold pressure against the predicted pressure.

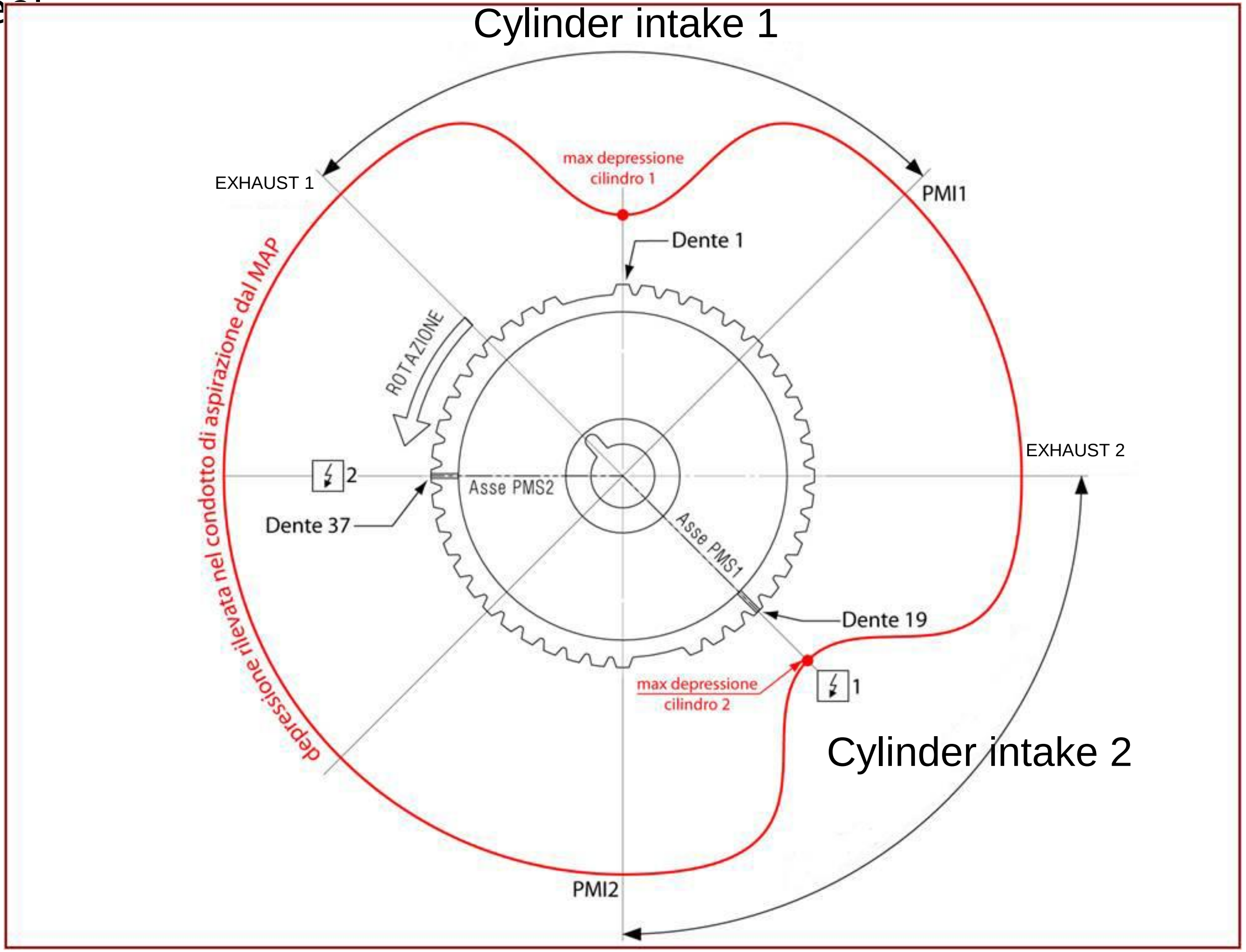


**Any fault in this circuit activates the EFI warning light and triggers the recovery strategy.**

# 4. Intake manifold absolute pressure sensor (MAP)

At each key-on, the ECU reads the pressure in the manifold and stores this value as the atmospheric pressure. This is because, when the engine is at rest, the pressure in the manifold is equal to the external atmospheric pressure. Compression stroke TDC recognition is necessary because the engine speed/timing sensor reads the position from the tone wheel mounted on camshaft, with a gap of 2 teeth every 24 teeth and a total of 48 teeth; this means that the sensor identifies 2 gaps for every revolution of the tone wheel (4 stroke cycle), and it is therefore necessary to read the MAP value to identify the intake stroke during cranking as a negative pressure peak in the intake manifold.

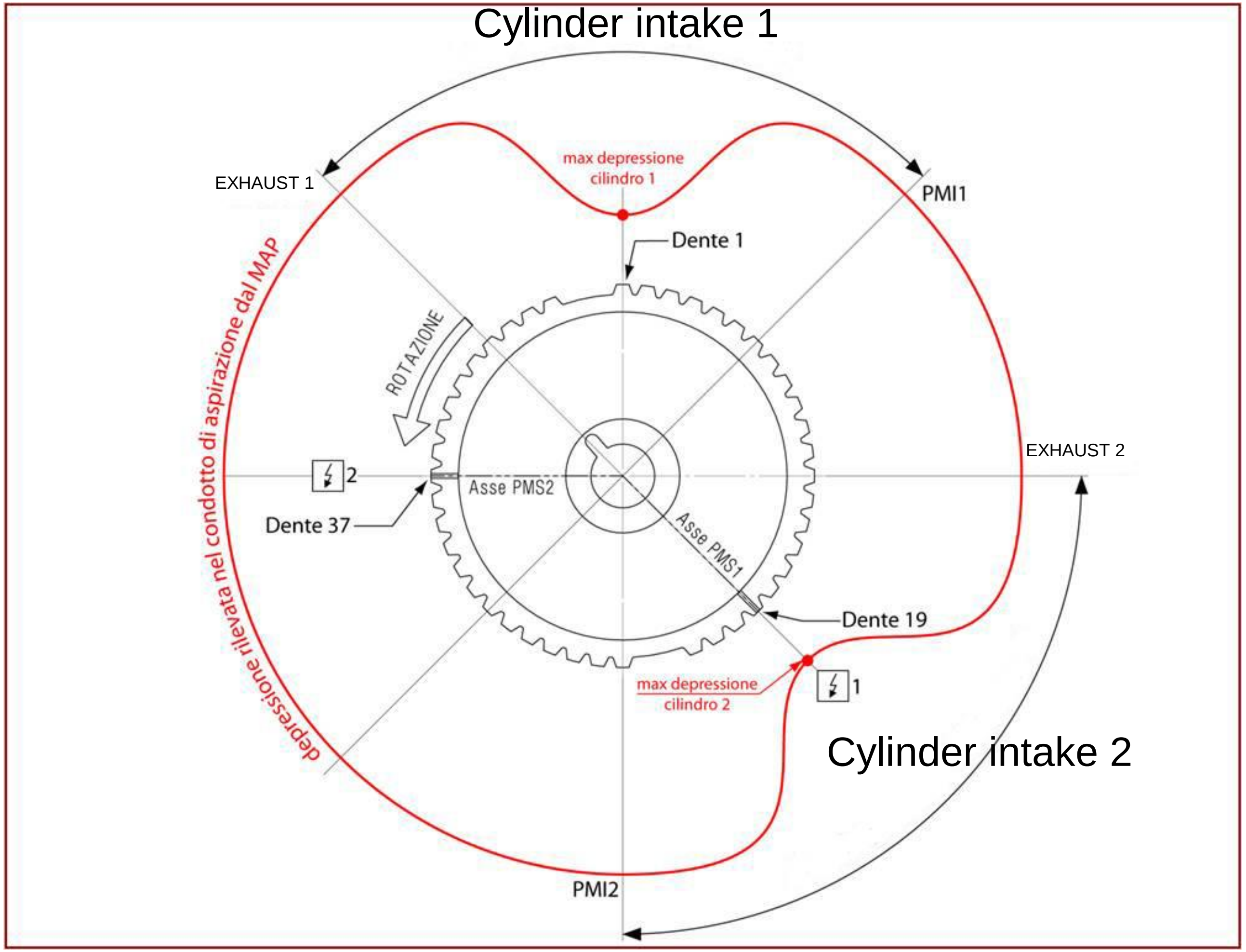
The next TDC is therefore the compression stroke TDC. This allows the system to synchronise injection and ignition correctly.



# 4. Intake manifold absolute pressure sensor (MAP)

The engine will still start in the event of a MAP sensor malfunction. In recovery strategy, the ECU initially activates the coil and injector at each TDC.

At both compression and combustion TDC, the crankshaft has a high angular acceleration value. Once the compression TDC has been identified, the redundant injections and ignitions (performed at exhaust TDC) are stopped.



# 4. Intake manifold absolute pressure sensor (MAP)

The MAP sensor is also used to correct the fuel/air ratio in conditions when the oxygen sensors do not provide a signal (e.g. when the engine is cold).

The ECU compares the predicted pressure (vacuum) value stored in its memory against the pressure effectively read by the MAP sensor, and compensates the injection time accordingly.

- More vacuum = **less** aspirated air, necessitating a **reduction** in injection time
- Less vacuum = **more** aspirated air, necessitating an **increase** in injection time

**Notes:**

1. At key-on, the stepper motor is completely open to facilitate starting.
2. At each stepper motor step, the injection time is also altered to maintain a constant air/fuel ratio.
3. Only oxygen sensor-based or MAP sensor-based correction influences injection time independently of stepper motor aperture.

# 4. Intake manifold absolute pressure sensor (MAP)

The sensor communicates directly with the intake manifold via a small rubber tube.

**Notes:**

1. Use a cloth moistened with gasoline or other suitable solvent to clean the throttle body. Clean the by-pass with compressed air
2. Do not spray solvent near the MAP sensor intake area.

**The MAP sensor cannot be repaired/serviced. In the event of malfunction, replace the complete MIU unit.**

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5 Ancillary functions and components

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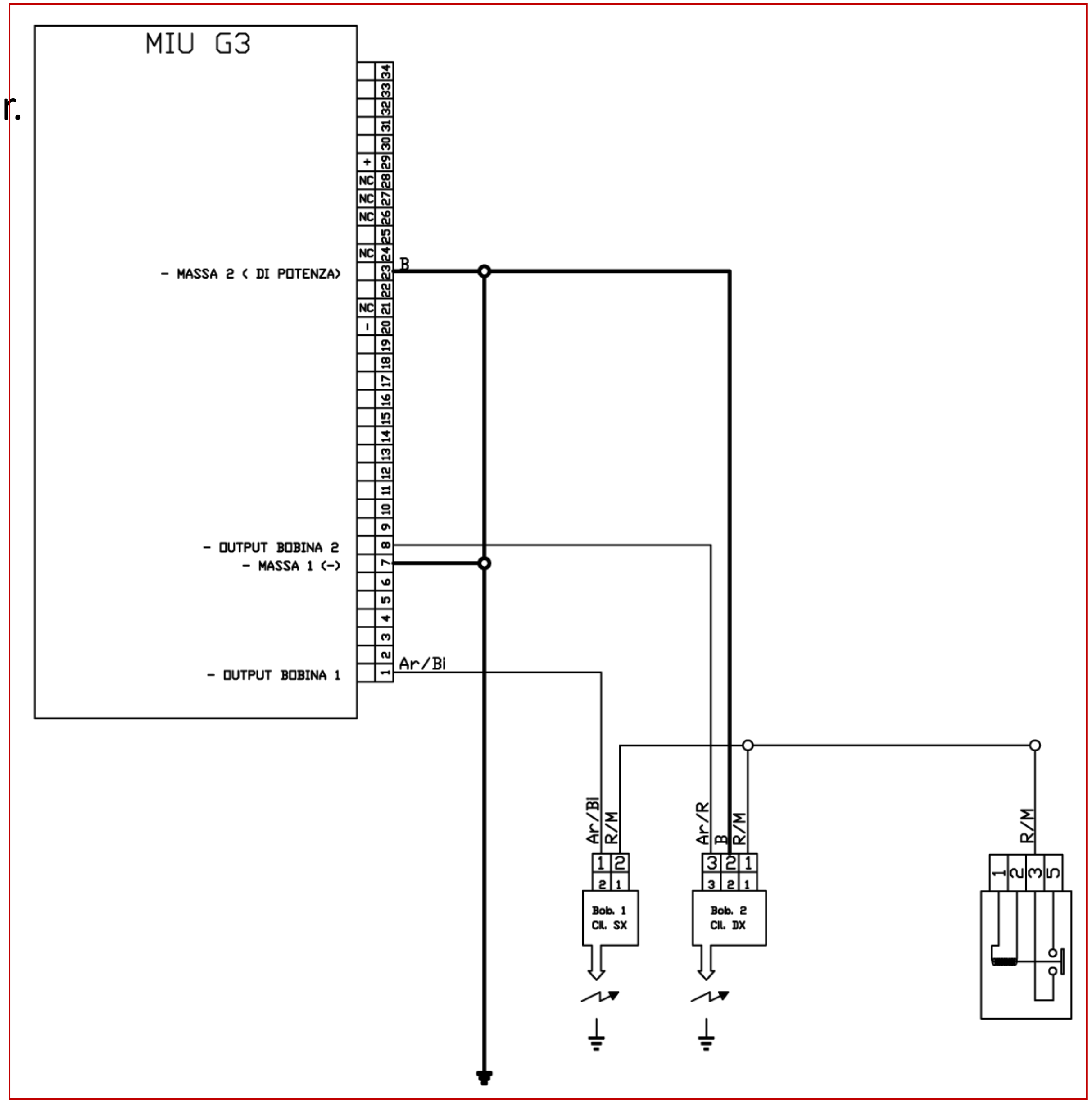
# 5. Ancillary functions and components

## Ignition coils

The ignition coils are different from one another.

The left cylinder coil is a conventional unit (passive). It has a primary winding powered by the injection load relay, and a ground connection controlled by the engine ECU (pin 1).

The right cylinder coil is an active coil. It has an integrated electronic module and a 3-pin connector: with one pin for power (from injection load relay), a ground pin connected to pin 23 of the ECU, and a control signal pin connected to the engine ECU (pin 8).



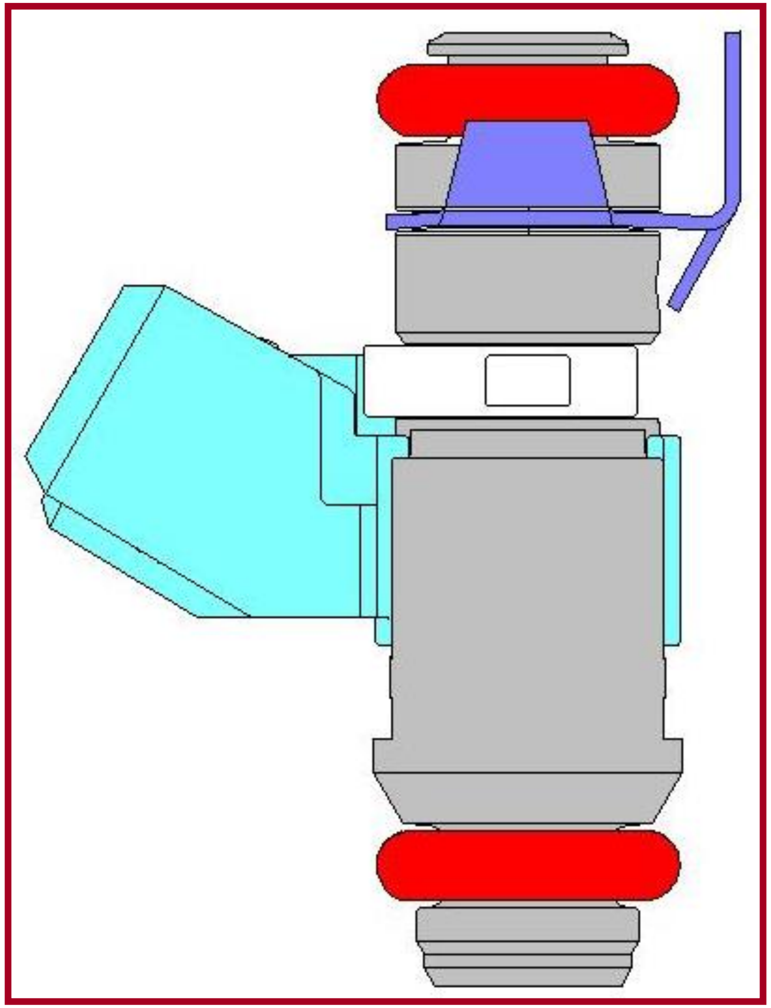
# 5. Ancillary functions and components

## Injectors

The injectors are identical (same part number). Injectors may be tested electrically and for flow rate.

Before testing injector flow rate, it is necessary to check that the system operating pressure is 3 bar. Once this has been verified, power the injector and activate the fuel pump.

Refer to the service station manual for the resistance and flow rate specifications of the injector.



# 5. Ancillary functions and components

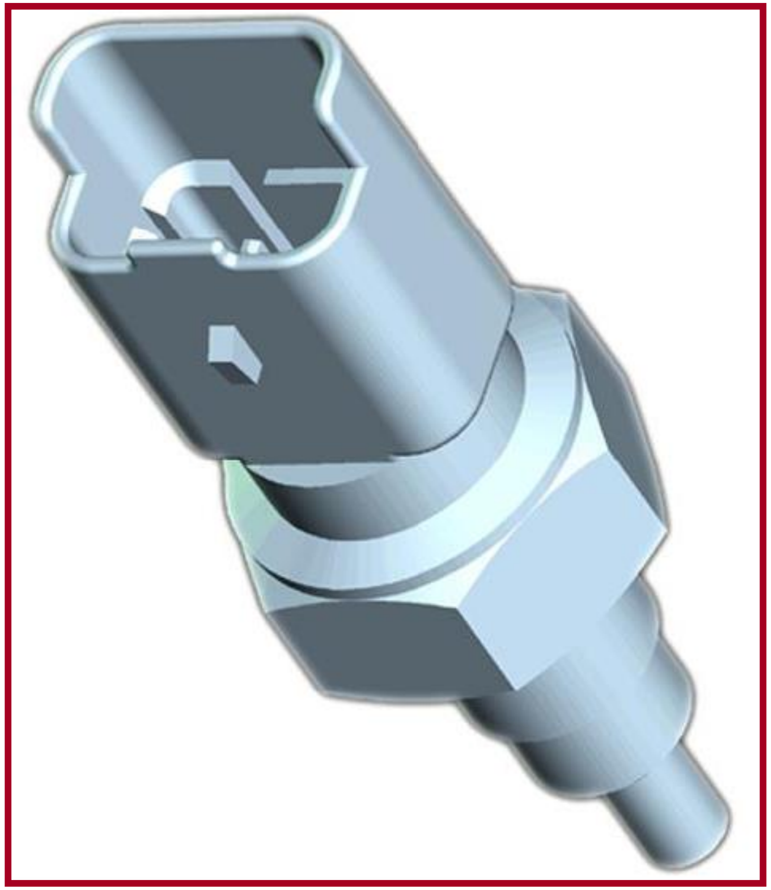
## Engine temperature sensor

This is a two-pin single NTC sensor (sensor with resistance varying inverse proportion to temperature).

This sensor measures the temperature of the right hand cylinder head, and the ECU uses this information to correct engine management in relation to temperature (e.g. for managing cold starts).

The relationship between engine temperature and sensor resistance is as follows:

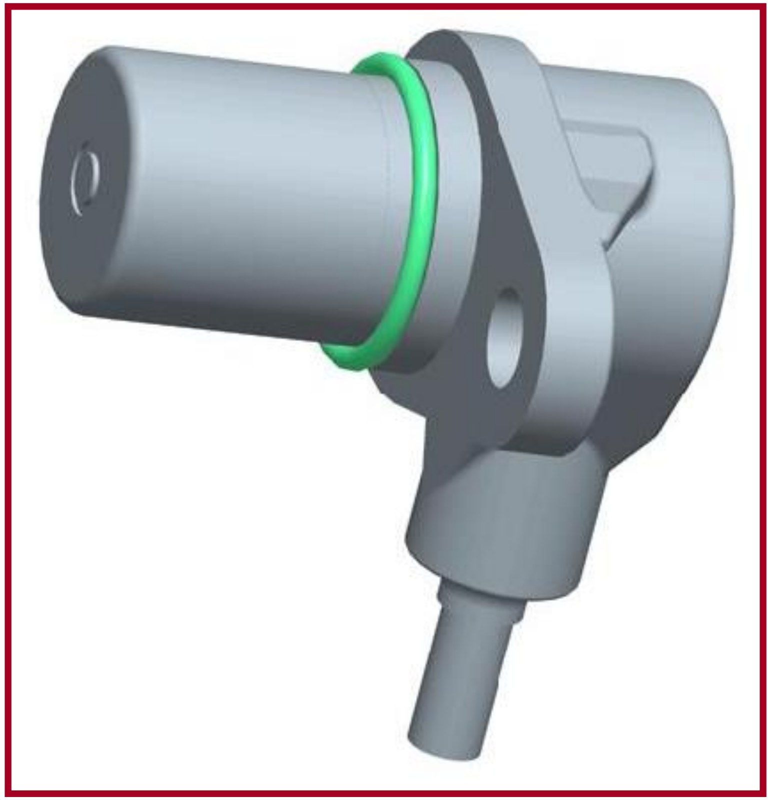
- Resistance at 0°C: 9.75 kΩ ± 5%
- Resistance at 20°C: 3.747 kΩ ± 5%
- Resistance at 40°C: 1.598 kΩ ± 5%
- Resistance at 60°C: 0.746 kΩ ± 5%
- Resistance at 80°C: 0.377 kΩ ± 5%
- Resistance at 100°C: 0.204 kΩ ± 5%



# 5. Ancillary functions and components

## Engine speed/timing sensor (pickup)

This is the same component used on the previous model. It is a passive sensor consisting of a magnetic core surrounded by a coil.



The «north» pole of the core faces the tone wheel (with 48 - 4 teeth) fixed to the camshaft. As the engine turns, the sensor produces an alternating current signal.

- Winding resistance 650 Ω ± 15%

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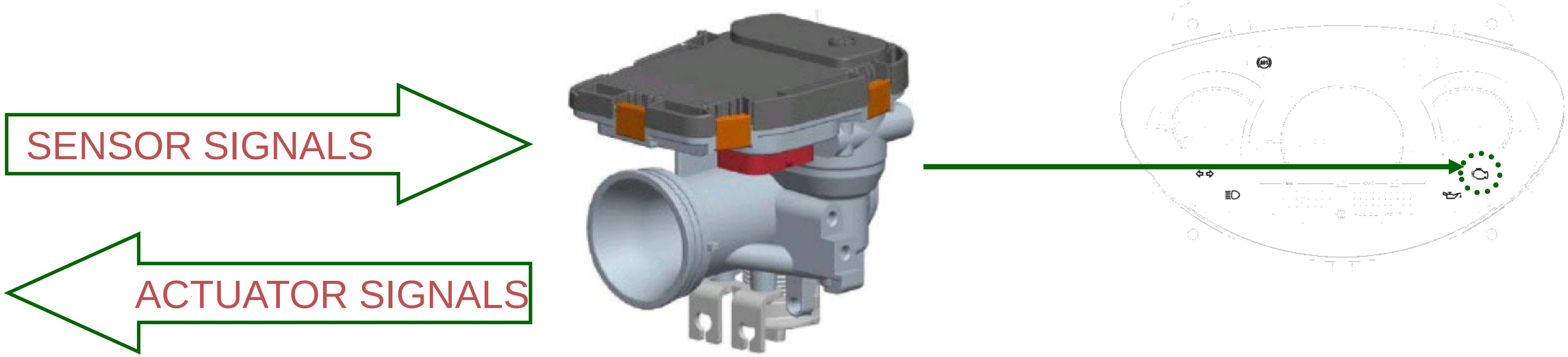
6 Troubleshooting

# 6. Troubleshooting

## Self-diagnostics

The ECU includes a self-diagnostic system which checks that the devices in the system function correctly electrically and/or logically. A fault is indicated by the EFI warning lamp on the dashboard.




- Failures are detected and deleted by means of the diagnosis software.
- When a fault has been resolved, the respective stored error is deleted automatically after a predetermined number of usage cycles (warm up-operation-cool down).

# 6. Troubleshooting

Regardless of the diagnostic tool used, parameters, errors and all diagnostic functions in general must also be supported by the ECU itself, otherwise it will not be possible to view them.

The dedicated pamphlet lists the following in order: the parameters, errors, ECU info, active diagnosis cycles and settings supported by the MIU G3 ECU in Moto Guzzi V7 configuration.

Additional information concerning some of these outputs is given below.

# 6. Troubleshooting

## Parameters

| RLI (Hex) | Description | Notes |
|---|---|---|
| *31* | *Manifold Pressure* | *[mBar]*<br>*A parameter valid only when the engine is off.*<br>*To check sensor function, compare the parameter read with the engine off to the effective atmospheric pressure.*<br>*Other faults can only be identified by the ECU, and are indicated as errors.* |
| *32* | *Air Temperature* | *[ºC]*<br>*The air temperature sensor is integrated in the MIU unit. It is normal for the temperature reading to be higher than the effective ambient temperature for a few minutes after key-on, and this does not compromise system functionality.* |
| *35* | *Base Spark Advance* | *[º]*<br>*Base ignition advance as defined in map* |
| *37* | *Applied Spark Advance* | *[º]*<br>*Effective Ignition Advance. The idle speed is also regulated by the ECU by varying the ignition advance angle.* |
| *3A* | *Target Engine Speed* | *[rpm]*<br>*The target engine speed is normally higher when the engine is cold. This is to prevent stalling and to warm the engine to operating temperature more rapidly.*<br>*The target lowers progressively as the engine warms.* |
| *45 / 46* | *Oxygen Sensor Voltage* | *[mV]*<br>*0V = Lean*<br>*1V = Rich* |
| *47 / 48* | *Oxygen Sensor Control* | *[%]*<br>*Percentage variation applied to injection time* |

# 6. Troubleshooting

## Parameters

| RLI (Hex) | Description | Notes |
|---|---|---|
| *47 / 48* | *Oxygen Sensor Control* | *[%]*<br>*Percentage variation applied to injection time* |
| *49 / 4A* | *Oxygen Sensor Mixture Control Status* | *Indicates that the oxygen sensor is used to control the fuel/air ratio* |
| *4B / 4C* | *Oxygen Sensor OBDI Diagnostic Status* | *Provides information on the state and functionality of the oxygen sensor.*<br>• *'Sensor active' indicates that the oxygen sensor signal is being used to maintain a stoichiometric fuel/air ratio.*<br>• *'Sensor not active' indicates that the oxygen sensor signal is not considered* |
| *62* | *Stepper Motor Control State* | • *'Kick down' indicates the wide open position, for facilitated engine start*<br>• *'Closed loop' is the normal operating state*<br>• *'Open loop' is normally associated with a stepper motor or ECU fault* |
| *6B* | *Base Stepper Opening* | *Necessary aperture to obtain target rpm estimated by ECU* |
| *6C* | *Closed Loop Stepper Opening* | *Aperture effectively needed by engine to maintain target rpm* |
| *61 / 78* | *Engaged Gear Clutch Status* | *The ECU provides consent for engine start only if at least one of the following conditions is met:*<br>• *Gearbox in neutral*<br>• *Gear engaged and clutch lever pulled* |

# 6. Troubleshooting

## Errors

| Value | Description | Notes |
|---|---|---|
| *P0611* | *Data buffer full and triggered by special events* | *The data buffer stores the engine operating parameters in the event of UNFORESEEN engine cut-out.*<br>*The contents of the buffer must be downloaded for further analysis.*<br>*An error can only be cancelled after the buffer has been downloaded.* |

## Active diagnoses

| IOLI (Hex) | Description | Notes |
|---|---|---|
| *0x7E* | *Auto-adaptive parameters reset* | *It is advisable to reset the parameters after an engine service and after cleaning the air filter and/or the throttle body.* |

## Settings

| RELI (Hex) | Description | Notes |
|---|---|---|
| *21* | *Throttle position sensor zero position setting* | *This must only be performed when strictly necessary.*<br>*The TPS signal is self-acquired by the ECU. If the throttle valve is not in the position set in the factory, the new calibration will compromise ECU functionality.* |
| *24* | *Data Buffer Transfer* | *See error P0611* |

# Thanks for your attention