SUBJECT: Euro 1 User Manual

AUTHORS: C. Galletti, O. Buhl and R.O'Hagan

VERSION: Euro 1 – 430

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

1. ABBREVIATIONS AND SYMBOLS

A/D	Analogue/Digital converter.
d(TPS)	Throttle position derivative, i.e. rate of change of throttle position.
ECU	Fuel injection / ignition computer - Electronic Control Unit
Editor	The editor allows you to configure your engine map to your specific requirements. It can be run online with the ECU or a file can be loaded from your hard drive. In the editor you can configure a large range of engine parameters by adjusting either, limits, constants, vectors or tables.
ANTAV	Angle in degrees between crank tooth passing directly under the sensor to the point at which the reference cylinder is in TDC.
DTW	Duty Cycle
SMOT	Crankcount
SCAM	Camshaft Count
SA	Ignition Spark Advance is expressed in crankshaft degrees in respect to TDC.
T90	The time period between 2 pulses SMOT.
TEROG	Fuel injection erogation time. This expresses the basic fuel injection value from the table corrected with all corrections except the battery voltage correction.
TINJ	Actual opening of the fuel injector: TINJ = TEROG + (Battery Voltage Correction).
T90	Time between 2 pulses smot - crank

2. INTRODUCTION

This document describes the function of the EURO1 engine management system, which adapts easily to a 4 cylinder engine, aspirated as well as turbo charged.
All new EFI Technology engine management systems operate with the benefits from the use of CAN communication between components. **C**omputer **A**rea **N**etwork (CAN) is a new high speed communication protocol standard specifically developed to meet the harsh conditions found in a modern race car. It provides automatic error corrected communication even in very noisy environments.
The communication between different EFI Technology devices is provided via a 2-wire bi-directional serial bus. To ensure a quick and easy expansion, the CAN line is always left open-ended.

2.1. General

EURO1 is an integrated injection/ignition system with semi sequential fuel injection.
The ECU incorporates 2 ignition drivers allowing the construction of a static spark advance using wasted-spark principle. The use of inductive ignition power amplifiers are preferred due to their high energy, long duration spark and is widely used in Formula 1 engine management systems.
It is possible to select different engine load configurations. The load can be selected either as Speed-Density (air pressure) or Alpha-N (throttle position). The ECU is provided with a built-in 1 bar absolute manifold air pressure sensor
All configurations include boost pressure control for turbo charged engines, idle speed and closed loop lambda control. Alternatively, the aspirated engines can benefit from programmable variable inlet manifold length. Euro1 controls high impedance fuel injectors.
The ECU benefits from the following fully programmable inputs:

- - Throttle position sensor (TPS)
- - Auxiliary air pressure sensor
- - Air and water temperature sensors
- - Standard, heated lambda sensor

Euro1 has been developed for possible connection with several interesting accessories:

2.1.1. CAN Interface

The Euro 1 system is based on a CAN communication line between the Euro1 ECU and a PC executing the supplied EFI Technology software. The CAN interface can be provided for either parallel or USB port configurations and with either a DB 9 or Lemo loom connection.

N.B: The wiring loom has a separate power supply connector to power the CAN interface, marked "DIR +12 VOLT" Without this power supply the CAN interface does not function.

2.1.2. AMC - active mapping controller

The **A**ctive **M**apping **C**ontroller enables real time adjustments to the fuel injection and spark advance, waste gate boost pressure electrovalve and idle speed air valve duty cycle.
It is a console fitted with 2 large potentiometers which - in real time - alters the spark advance and the fuel injection. Furthermore, another 4 smaller potentiometers are fitted allowing adjustments to other control features.

Using the STORE push button it is possible to:

- Storing all data displayed on the PC screen in a file for later analysis, eventually in a spreadsheet.
- Storing the actual corrections made by the AMC directly into the ECU (see Automatic Mapping).The AMC connects to the PC's communication port, either COM1 or COM2. To become active it requires an external 12 volt power supply.

2.1.3. Dashboard and Datalogger

The ECU can export data on the CAN bus to a dashboard or datalogger. This can be very useful for monitoring engine performance and analysing the data that is collected. If you are interested in using a dashboard or logging system with your Euro 1 ECU please contact us at OBR, Tel: +44 (0) 1425 47 88 22

2.2. System Set-up

To configure your engine map to your engine you must define your expected injection time and engine speed range.

2.2.1. Measuring crankshaft position (ANTAV)

An inductive or Hall effect sensor is triggered by teeth on the flywheel (or crankshaft pulley) to provide an engine speed signal (SMOT). The number and relative spacing of these teeth is referred to as the triggering (or encoder) pattern. The Euro 1 will currently operate with the following patterns:

- Standard EFI (4+ 1)
- 36 – 1 (typically Ford)
- 36 – 4 (typically Rover K-series)
- 60 – 2 (typically Bosch)
- 44 – 4 (Renault Clio)
- Honda Civic Type R
- Yamaha R6
- Ducati

When using a hall effect sensor the ECU is triggered by a falling edge signal.
When using an inductive sensor a sinusoidal curve is produced and the ECU is triggered when the signal switches from the positive to the negative voltage signal (i.e. at the point of 0v). This normally happens when the tooth is centred on the speed sensor element.

Ideally the crankshaft speed sensor - SMOT - should be positioned such that the trigger tooth for cylinder # 1 passes the speed sensor close to TDC.

When designing or specifying a trigger disc use the following criteria:

- Each tooth should protrude 4 mm from the flywheel surface and should be square angled, measuring maximum 4 x 4 mm.
- The clearance between the electromagnetic sensor and each pin depends of the sensor type and manufacturer. A standard value should be 0.4..0.8 mm. Pins must be manufactured from soft iron.

These markers pass under the crank (SMOT) sensor ANTAV degrees before the top dead centre (TDC) of the corresponding cylinder (see section **3.26**.).

If high engine speed problems are experienced – in particular with the 60-2 software and a high output speed sensor like a typical Bosch sensor – the problem can be eliminated by fitting a resistor in the signal line from sensor to the ECU. The resister should be 33 to 68 kOhm, ¼ Watt.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3. SOFTWARE DESCRIPTION

3.1. Boost control

The intention of this strategy is to obtain a boost pressure unaffected by variations in engine load. The following strategy is based upon a well-determined pneumatic circuitry controlling the waste gate valves. A 3-way solenoid valve controlled at a fixed frequency with a square edge signal. By altering the open length period (duty cycle) the air pressure into the waste gate can be altered. A closed valve (0% duty cycle) gives maximum boost pressure. An open valve (100% duty cycle) gives minimum boost pressure.

Waste Gate Duty Cycle = 0	Corresponding stable feeding of valve >>	maximum boost pressure
Waste Gate Duty Cycle = 100	Corresponding disabled feeding of valve >>>	minimum boost pressure

Similar to the idle speed regulation, the boost pressure strategy operates with an Open Loop section and a Closed Loop section (PI regulation).
Calculation of the waste gate duty cycle DTW follows:

Waste Gate Duty Cycle (DTW) =

- *Open loop DTW for boost control f(RPM)* Open Loop basic duty cycle value
- *+ DTW proportional step* Proportional DTW correction based on pressure error
- *+ DTW integral step* Integral DTW correction based on pressure error, saturated to MAXEIW (**3.1.7**), and calculated every BTINWG time interval (**3.1.4**).

N.B. The part expressing integral correction never resets.

The first part of the equation expresses the initial set points, the second part expresses the proportional correction and the third expresses the integral correction.

Pressure error in closed loop is defined as: (Actual boost pressure) **-** (Target boost pressure)

3.1.1. Boost control valve fully open below target pressure offset (+/- mbar)

The closed loop controls are activated within this offset around the target boost pressure, i.e. If you enter an offset of 0.5 bar (500mbar) and you have a target boost of 1 bar the closed loop will start working if the actual pressure is between 0.5 and 1.5 bar. A typical value for the target offset would be half the range of the map sensor.

3.1.2. Proportional correction enabled within percentage of sensor range (%)

The boost control works by correcting in a proportional step and then smaller integral steps. The proportional step is a large initial correction used to get close to target boost before employing the integral steps to achieve a finer regulation.

This parameter refers to the maximum size of correction allowed by the system on the proportional step. The correction is expressed as a percentage of the range of the pressure sensor.
E.G. If the range of the sensor is 2600 mbar and the value entered for this parameter is 10% then the limit to the correction is equivalent to a pressure error of 260 mbar.

The actual duty cycle correction itself is limited by a function of this parameter and **3.1.3**.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

Maximum change to applied duty cycle as configured in 3.1.9.

$$= \frac{\text{Sensor Range (mbar)} \times \text{max percentage of sensor range } (\mathbf{3.1.2.})}{\text{100 mbar}} \times \text{Proportional DC max step } (\mathbf{3.1.3}) \times \text{base duty cycle}$$

E.G, If:

- Parameter 3.1.2. = 10 %
- Parameter 3.1.3. = 5 %
- Base duty cycle applied in load condition (see **3.1.9.**) = 30%
- Sensor range = 2600 mbar

$$= \frac{2600 \times 0.10}{100} \times 0.05 \times 30 = 3.9\% \text{ duty cycle.}$$

Therefore the closed loop boost control allows a duty cycle of **26.1% to 33.9%** be applied in that load condition.

3.1.3. Proportional DC step relative to base duty cycle per 100mbar pressure error (%)

If the actual boost pressure in a given RPM break point does not match the target boost pressure, the ECU corrects the applied duty cycle to adjust the boost pressure. Detecting a boost pressure error, the system first applies a large correction step to the waste gate solenoid valve duty cycle.
This correction is applied only once and is the proportional correction.

If the actual boost pressure is below the target value (negative pressure error), the proportional correction is negative and thus subtracted from the actual applied duty cycle obtaining a higher boost pressure.
If the actual boost pressure exceeds the target value (positive pressure error), the proportional correction is positive and thus added to the actual applied duty cycle obtaining a lower boost pressure.

This parameter defines the maximum value of the proportional correct (in conjunction with **3.1.2.** as can be seen at the top of the page) relative to the base duty cycle (**3.1.9.**) per 100 mbar error in boost.
The regulation value is configurable in terms of percentage of the duty cycle A typical starting value would be around 10%

3.1.4. Time interval for integral corrections (msec)

If the proportional duty cycle correction was not sufficient to equalise the actual and the target boost pressure, the ECU applies small increments to the duty cycle. This is referred to as the **integral correction**. The integral correction is activated with the offset pressure range defined below in **3.1.5.**

The time interval parameter defines the duration between calculations of the integral boost pressure correction. A typical value is 40 msec. Decreasing the time interval will mean the corrective steps occur at a higher frequency.

3.1.5. Closed loop integral control within target boost pressure offset (+/-mbar)

This parameter defines the operating range of the integral steps. Normal values would be about half the range of the map sensor. Also see **3.1.1**, the primary threshold for the closed loop in both proportional and integral trims.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.1.6. Integral step of waste gate duty cycle regulation (%)

This defines the size of the step made by the integral correction in terms of the base duty cycle. This should be about 1/10 of the size of the proportional step, **3.1.3**.

3.1.7. Maximum integral duty cycle correction (%)

Definition of the maximum alteration of the duty cycle applied to the solenoid valve by the integral correction as a percentage of the base duty cycle.

3.1.8. Boost control valve piloting frequency (Hz)

Several types of solenoid valves can be chosen. Their individual characteristic is defined by the recommended duty cycle frequency.

3.1.9. Open loop waste gate valve duty cycle f(RPM)

The intention of this strategy is to obtain a precise regulation of the turbo charger boost pressure in both engine load configurations. An efficient and repeatable regulation must be guaranteed at part load as well as in full load condition.
The open loop duty cycle values define the required value in each engine speed breakpoint allowing the engine to reach its target boost pressure. If this is well tuned it will match to the target boost pressure and negate the need for the proportional and integral error correction. It is also the base duty cycle from which the closed loop system is then operating.

3.1.10. Target boost pressure f(RPM) [BAR]

This defines the target boost pressure as a function of engine speed used for regulating the closed loop control. The boost control (when active) tries to obtain the boost pressure values expressed in this vector.

3.1.11. Decrease abs waste gate boost pressure f(WATER TEMP) [BAR]

In this vector it is possible to decrease the boost pressure as a function of coolant water temperature.
N.B.: This decrease only has an influence if the closed loop regulation is active, see **3.1.1.**

3.1.12. Decrease abs waste gate boost pressure f(AIR TEMP) [BAR]

In this vector it is possible to decrease the boost pressure as a function of inlet air temperature (or air temperature after the intercooler).
N.B.: This decrease does only have an influence if the PI regulation is active, see **3.1.1.**

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.2. Car speed

The ECU can calculate the actual car speed from an input sensor. The value can be used for internal calculations or references or be sent to dashboard for driver information or to the data acquisition system.

3.2.1. Circumference of wheel [mm]

Enter the rolling diameter expressed in MM of the wheel in use.

3.2.2. Number of pulses each wheel RPM

Enter the number of pulses sent to the ECU each wheel revolution. This is determined by the number of teeth on the triggering wheel.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.3. Cranking

When the ECU power is switched on, but the engine is not rotating the ECU collects data from all inputs and in particular expects the first signs of crankshaft rotation.
In this state (Key-On) the ECU performs only 2 operations:

- Activating the fuel pump relays for 3 seconds to prime the fuel system.
- Collecting and transmitting data on its communication lines.

The engine exits the Key-On condition passing into Cranking upon reception of the first pulse from the crankshaft speed sensor.

3.3.1. Prime (grouped) injection pulse width on first crank pulse [uSec]

At the first received crank signal (SMOT) signal the ECU executes a synchronous injection (simultaneously on all injectors) with a fixed duration. This injection is referred to as Prime Injection and in this parameter you specify its magnitude.

3.3.2. Switch from Crank to Run mode above RPM threshold [RPM]

Determines the engine speed at which the ECU switches over from the cranking strategy to the main engine map.

3.3.3. Switch from Run to Crank mode below RPM threshold [RPM]

Determines the engine speed at which the ECU switches over from the main engine map back to the cranking strategy.

3.3.4. Cranking fuel injection multiplication

The fuel injection in Cranking is calculated based on the values listed in the basic fuel map. Acting on these values (apart from relevant correction factors) is a multiplier, which is able to deliver a considerable enrichment necessary for starting the engine and keeping it running the first seconds. The multiplication depends on the water temperature and may vary between 0 and.8.
COUNTER is the counter of the engine revolutions. It initiates from 0 and increases in steps of 1 each crankshaft rotation. The strategy is cancelled upon reaching 2040.

NOTE: The cranking map should always end with a multiplication of **1**. This way the fuelling is controlled by the base fuel map and the relevant compensations. See section **3.14.**

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.4. Diagnostics

The ECU is capable of performing a control of the consistency of the information's provided by the attached sensors. In the case of a malfunction being detected a “flag” occurs in the associated memory location. The diagnostics utilises up to 16 parameters and errors can be found from diagnostic reports produced as a function within ECT.

3.4.1. Diagnostic channel configuration:

Euro1 is currently supplied with the following configuration of the diagnostic channels:

3.4.2. Channel 1: Ignition retardation

TMDGON	Ignition retardation

3.4.3. Channel 2: RPM Over rev

SGERRO	The value at which an over rev is considered to occur [RPM]
TMKERO	Mask time registering over rev, i.e. SGERRO value ignored for time before registering as an error.

3.4.4. Channel 2: MAP sensor error

SGERR2	Registration if manifold air pressure (MAP) drops below this limit [mBar]
TMKER2	Mask time for MAP pressure below SGERR2 [sec]
SGERR3	Registration if manifold air pressure (MAP) exceeds this limit [mBar]
TMKER3	Mask time for MAP pressure above SGERR3 [sec]

3.4.5. Channel 3: Throttle potentiometer error

SGERR4	Registration if throttle positions drops below this limit (%)
TMKER4	Mask time for if TPS goes below SGGER4 [sec]
SGERR5	Registration if throttle positions exceeds this limit (%)
TMKER5	Mask time for if TPS goes above SGGER5 [sec]

3.4.6. Channel 4: Battery voltage error

SGERR6	Threshold for low battery voltage [Volt]
TMKER6	Mask time if VBatt drops below SGERR6 [sec]
SRPMVB	Minimum RPM limit for low VBatt reading [RPM]
SGERR7	Threshold for high battery voltage [Volt]
TMKER7	Mask time if VBatt rises aboveSGERR6 [sec]

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.4.7. Channel 5: Water temperature sensor error

SGERR8	Registration if water temperature drops below this limit [˚C]
TMKER8	Mask time if water temperature drops below SGERR8 [sec]
SGERR9	Registration if water temperature exceeds this limit [˚C]
TMKER9	Mask time if water temperature exceeds SGERR9 [sec]

3.4.8. Channel 6: Air temperature sensor error

SGER10	Registration if air temperature drops below this limit [˚C]
TMKE10	Mask time if air temperature drops below SGER10 [sec]
SGER11	Registration if air temperature exceeds this limit [˚C]
TMKE11	Mask time if air temperature exceeds SGER11 [sec]

3.4.9. Channel 7: Open loop lambda sensor error

TOUTM	Time out before register lambda failure with a lean reading (high) [sec]
TOUTR	Time out before register lambda failure with a rich reading (low) [sec]

3.4.10. Channel 18: Oil pressure sensor error

SGER16	Registration if oil pressure drops below this limit [mBar]
TMKE16	Mask time if oil pressure drops below SGER16 [sec]
SGER17	Registration if oil pressure exceeds this limit [˚C]
TMKE17	Mask time if oil pressure exceeds SGER17 [sec]

3.5. Digital Input – Configuration

The euro 1 has 2 digital switches available. Switch1 and Switch2. The activation of these 2 switches can be used to control the 5 features as listed below. Each feature is disabled with a 0, activated on switch 1 with a 1 entered and activated on switch 2 with a number 2 entered.

NOTE: Do not assign more than one feature to each switch.
If unused "Switch 1" functions as a 0 to 5 volt analogue input. See section **3.22.5**

3.5.1. Kill Switch

A digital input switch can be used to activate an immediate engine kill.

3.5.2. Injection / ignition trim switch

A digital input switch can be used to activate an injection or ignition trim. The trim is defined in either section **3.14.2.** fuel – main maps, or in section **3.25.6 -** spark advance settings.

3.5.3. Launch Control

A digital input switch can be used to activate a launch control strategy. The strategy itself works on a rev limitation controlled by a fuel cut trim. This is defined in section **3.9.**

3.5.4. Power Shift

A digital input switch can be used to activate a power shift strategy. A "power shift" is used to allow a full throttle gear change. Power from the engine is reduced in a controlled manor by cutting the ignition. See section **3.19.**

3.5.5. Air condition switch

A digital input switch can be used to activate compensation to the engine's idle control when the air conditioning is running. An input is produced by the air conditioning compressor on activation. If fed into the ECU as one of the digital inputs it can modify the idle control strategy to allow for the increased load.

3.6. Digital Input 'Air Condition'

3.6.1. Switch Polarity

Having assigned which digital switch you are using for the idle control you need to specify the activation polarity. Enter 0 for the activation of the modified idle control at a low polarity or 1 for activation on a high polarity.

3.7. Digital Input "INJ / IGN Trim by Switch"

3.7.1. Switch Polarity

Having assigned which digital switch you are using for the injection / Ignition trim you need to specify the activation polarity. Enter 0 for the activation of the injection / Ignition trim at a low polarity or 1 for activation on a high polarity.

3.8. Digital Input 'Kill Switch'

3.8.1. Switch polarity

Having assigned which digital switch you are using for the kill switch you need to specify the activation polarity. Enter 0 for the activation of the kill switch at a low polarity or 1 for activation on a high polarity.

3.8.2. Kill switch activation delay [sec]

Delay time between the activation of the switch and the resulting ECU power off.

3.9. Digital Input 'Launch Control'

3.9.1. Switch Polarity

Having assigned which digital switch you are using for the launch control you need to specify the activation polarity. Enter 0 for the activation of the launch control at a low polarity or 1 for activation on a high polarity.

3.9.2. Launch Control Limiter (fuel cut) [RPM]

The launch control system works by limiting RPM. This allows full throttle starts at a controlled engine speed. Enter your limited engine speed in RPM.

3.10. Digital Input 'Power shift'

3.10.1. Switch Polarity

Having assigned which digital switch you are using for the power shift you need to specify the activation polarity. Enter 0 for the activation of the power shift at a low polarity or 1 for activation on a high polarity.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.11. Drive By Wire

The drive by wire throttle control works in three stages. The first step is a position sensor on the pedal itself. This measures the driver input and sends a signal to the electronic throttle body controller (ETB). The ETB then computes the signal and sends a calculated output to the throttle controller module on the engine. This is then opened or closed as directed by the ETB.

3.11.1. Drive by wire

Select 0 to disable the drive by wire system or select 1 to enable it.

3.11.2. Desired TPS Target f(PPSA)

The PPSA is the pedal position sensor input. This allows a calibration between actual throttle position and corresponding voltage reading from the throttle position sensor.

3.12. Fuel – cut-off (FCO)

The ECU is capable of switching off the fuel injection if required during deceleration or sudden closing of the throttle valve.
The ECU enters the Cut Off status if the water temperature is above 40 degrees C and the following conditions are found:

3.12.1. FCO activated if RPM exceeds upper threshold [RPM]

If the throttle position is below the limit defined in section **3.12.3** and the engine speed exceeds this limit the fuel cut-off strategy is active.

3.12.2. Lower RPM limit exit fuel cut-off [RPM]

If the throttle position is below the limit defined in section **3.12.4**. and the engine speed is below this limit the fuel cut-off strategy is disabled and fuel injection is re-established.

3.12.3. FCO activated if throttle position is below threshold [%]

Throttle position below which fuel injection cut-off can be activated. If the throttle position exceeds this limit the cut-off strategy is switched off. No hysteresis is acting on the throttle position limit.
Both engine speed and throttle position conditions must be fulfilled in order to enable the fuel cut off.

3.12.4. Mixture enrichment when FCO is de-activated

When exiting from fuel cut off it may be necessary to introduce a correction to the fuel injection for several crank (SMOT) pulses. This compensates the fuel condensing on the inlet ports, which have dried during the deceleration. This fuelling correction is controlled by a multiplication constant with a value between 0 and 2.

3.12.5. Injection enrichment active in number of engine cycles

The fuel injection correction **(3.12.4**) during exit from fuel cut-off status is active for a number of engine cycles defined by this constant. Values between 0 and 255 can be selected.

3.13. Fuel – Limits

General Fuel Information

The fuel injector is a miniaturised lightweight solenoid valve. As the ECU sends injection signals to the injector, a valve is pulled back and fuel is released into the intake manifold. The amount of fuel injected is controlled by the ECU in terms of the injection pulse duration.

Euro-1 ECU's can handle fuel injectors with an impedance exceeding 12 Ohm (termed high impedance). Before initiating mapping the engine it is important to consider the flow range of the fuel injector and the fuel pressure. This calculation is in particular important on turbo charged engines configured using the Alpha-N mapping system (throttle based). When the absolute air pressure is doubled from 1 to 2 bar (1 bar boost pressure), twice the amount of fuel is required. The injection time must be tripled in case the engine is intended to run up to 3 bar absolute pressure (2 bar boost pressure). It is very important that the actual injector opening (TINJ) always is kept lower than the time available for the engine cycle. Remember that it takes 10 mSec to perform 1 engine revolution at 6.000 RPM. You may have to consider using 2 or more fuel injectors per cylinder.

When calculating the available injector opening time (TINJ) – Remember that the fuelling is semi sequential and hence injects every revolution.

Engine Speed (RPM)	Available Injector Period (TINJ) less than (mSec's)
3000	20
4000	15
5000	12
6000	10
7000	8
8000	7
9000	6

The recommended fuel pressure depends on the selected fuel injector and in general, the manufacturer recommendations should be followed.
Increasing the fuel pressure increases the injector flow rate. It can be estimated that the flow rate links to fuel pressure change as:

$$\text{New flow rate} = \sqrt{(\text{New fuel pressure}) / (\text{Nominal fuel pressure})} * (\text{Nominal flow rate})$$

As a thumb rule it can be assumed that an engine consumes 500 cm^3/min pr. 100 developed horsepower.

3.13.1. Maximum Injection time [μ sec]

The minimum and maximum fuel injection time defines the values of the basic fuel injection map. All further corrections are based on these values.
The fuel injection range is selected as close as possible to the actual fuel requirement of the engine. The injection calculation is based on a resolution of 255 steps between minimum and maximum injection time.

Note:

Changing these limits will modify the overall fuelling of the engine.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

- Increasing the maximum injection time, the mixture gets richer according to the ratio between the original and the modified value.
- Reducing the maximum injection time leans out the mixture accordingly.

Increasing the minimum injection time, the mixture turns richer progressively from maximum engine load site towards the minimum load site.

3.13.2. Minimum Injection time [µ sec]

See **3.13.1**.above. In addition set the minimum injection time as close to your lowest used value as possible. This way you have a smaller operating range and hence reduce the magnitude of each of the 255 resolution steps.

3.13.3. Water temperature threshold (TH20WA) cancels warmup phase [deg]

During the warm-up phase the engine needs enrichment in its fuel mixture to compensate the fuel condensing on cold surfaces in the intake system. The vector expressing the injection time multiplier *Fuel injection correction f(TH20)* can be found in the section **3.14.9.**

The warm-up phase terminates when the water temperature exceeds this limit. Once the water temperature has passed this limit, the correction is completely cancelled and will not be return to Warm-up unless the engine has been switched off and re-started.

Note: The fuelling compensation for water temperature is also cancelled at this point. See section **3.14.4.**

3.13.4. Cancel warmup phase if water temperature exceeds threshold (TH20WA) for [sec]

When the water temperature has been above the limit described in section **3.13.3**. for this period of time the warm-up phase terminates.

3.14. Fuel – Main Maps

The Injector opening programmed into the main fuel table will be corrected by a series of multiplier coefficients:

TINJ	**=**	**Actual duration of pulse applied to the fuel injector**

TINJ is calculated by:

Fuel injection table	Opening time from main Fuel Table
* *Fuel injection correction from switch*	Correction depending switch input (see **3.5.2.**)
* *Fuel injection correction f(MAP)*	Correction depending on manifold air pressure (or TPS in SD)
* *Fuel injection correction f(WATER)*	Correction depending on cooling water temperature
* *Fuel injection correction f(AIR TEMP)*	Correction depending on air temperature
* *Fuel injection correction f(BARO)*	Correction depending on barometric pressure.
* *Fuel injection for warm-up*	Correction depending on warm up strategy and activation.
+	
Fuel injector offset f(VBATT)	Fuel injector correction depending on battery voltage
	(This value is supplied by fuel injector manufacturer)

In the calculation chain it is possible to introduce other coefficients (i.e. transition coefficients) or switching the calculateeon result to zero (i.e. fuel cut-off condition), all depending upon the actual engine state and load.

3.14.1. Injection phase (in steps of 90 degrees) [deg]

Euro-1 can operate with different settings for the fuel injection phase. The beginning of an injection period is programmable in steps of 90 degrees between 0 to 360 degrees (where 0 degrees is TDC in combustion phase according to the constant:

3.14.2. Fuel Injection trim by switch [0 to 2]

A switch can be used to apply a fuel injection correction to the map. This is a multiplier correction ranging from 0 to 2. i.e. 2 = double the fuelling in the main map. See section **3.5.2.**

3.14.3. Fuel injection correction f(MAP) [0 to 4]

This correction follows physical laws. The vector corrects the fuel injection time depending on manifold absolute air pressure by a multiplier with a value between 0 and 4. The breakpoints reconfigure automatically when a new sensor is calibrated in Sensor Calibration.
It is recommended to configure the correction in the following linear manner:

MAP value (mBar)	Compensation
500	0.50
1000	1.00
1500	1.50
2000	2.00 etc

The characteristic of the MAP sensor in use is configured in section **3.22.1 and 2** under Sensor Calibration.

3.14.4. Fuel injection correction f(WATER TEMP) [0 to 2]

During the warm-up phase the engine needs enrichment in its fuel mixture to compensate for fuel condensing on cold surfaces in the intake system.
A typical correction should range from about +20% (enter value 1.2) at -10˚C to 0 correction at 60˚C (enter value 1).

Any corrections entered in this parameter will be cancelled after the point determined in **3.13.3**

3.14.5. Fuel injection correction f(AIR TEMP) [0 to 2]

This correction follows physical laws and is based on variation in air density. The variation is expressed as the square root of the ratio between 20 deg. C and the actual inlet air temperature. The ratio is calculated in absolute temperatures. The reference air temperature is T_{20} = 273 + 20 and the actual temperature is T_{ABS} = 273 + T_{AIR}.

E.g. If the air temperature = 40 ˚C the compensation = $\sqrt{(293 / 313)}$ = 0.968

3.14.6. Fuel injection correction f(BARO PRESS) [0 to 2]

Corrections dependent on barometric pressure. The range of this vector is corrected when a pressure transducer is configured in section **3.22.** under Sensor Calibration.

3.14.7. Battery Voltage injector offset f(VBATT) [mSec's]

To compensate for the fuel injector activation time, an **additional** fuel injection correction is used. The injector manufacturer normally supplies the data. The vector only has to be modified in case of a change of fuel injector type used.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.14.8. Fuel injection map [μ Sec]

The calculation of the erogation time (termed **TEROG)** always initiates from the basic fuel table:

Fuel injection table 32 RPM x 32 THR Alpha-N configuration, throttle position versus engine speed

Or

Fuel injection table 32 RPM x 32 MAP Speed-Density configuration, manifold air pressure versus engine speed

3.14.9. Fuel Injection multiplication factor during warm-up f (TH20) [0 to 2]

This relates back to the parameters in the fuel limits section, **3.13.3** and **4**. The warm up phase is activated when the engine first fires up until a water temperature threshold is exceeded for a given time period. A fuel correction multiplication table is used to control the fuelling relative to throttle position and engine speed.

3.14.10. Fuel injection correction f(TPS) [0 to 2]

Injection time correction by a multiplier 0 to 4 depending on throttle position. Normally used for slight fuel corrections to basic table. Only valid in Speed-Density systems. (using sd descriptor file)

3.14.11. Fuel Injection correction f (THROT) if RPM < Crank-to-Run threshold.

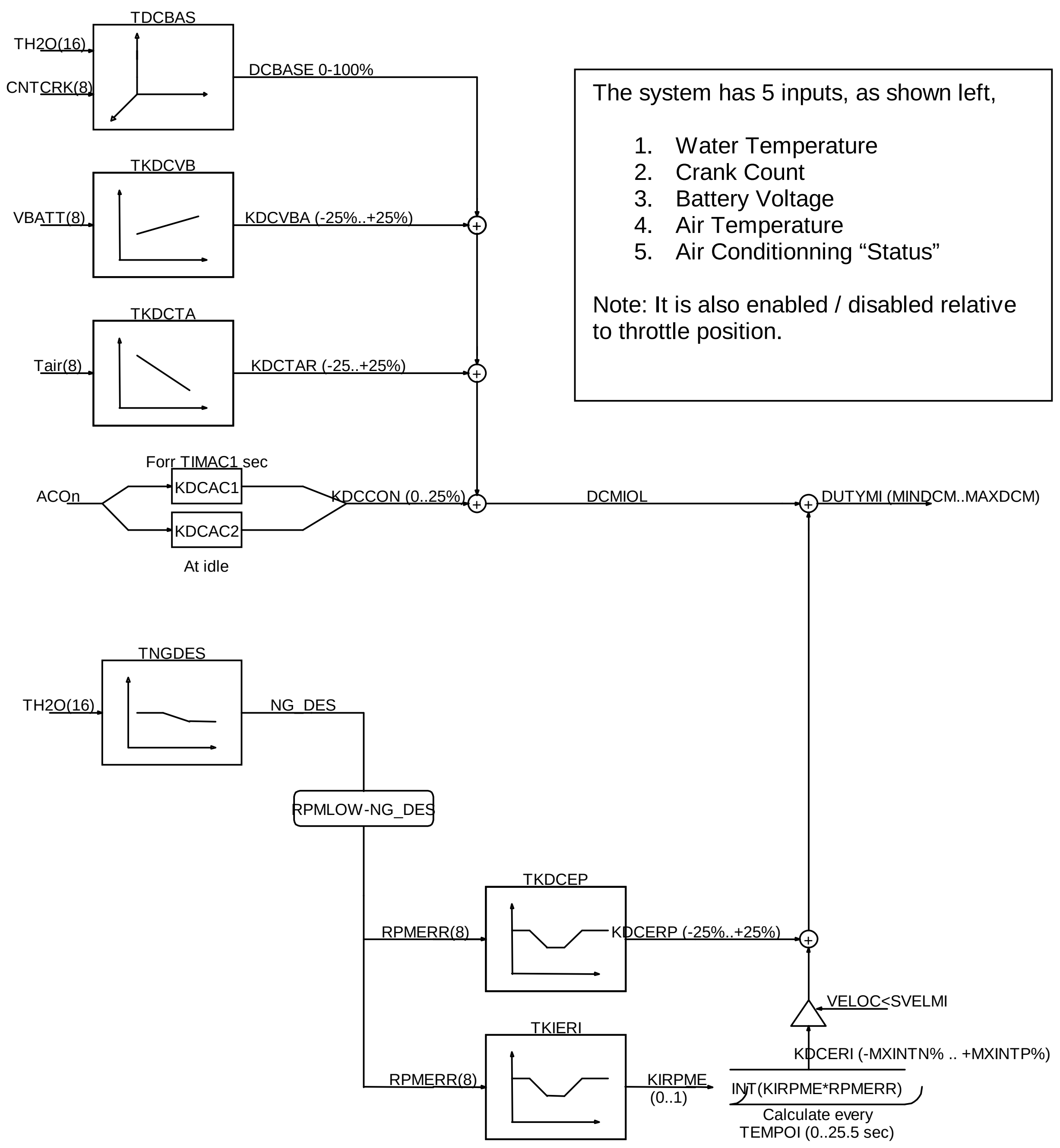
Throttle position dependent correction to the main fuel map when RPM is below the threshold set in section **3.3.2.** Cranking fuel is based on the first engine speed breakpoint in the map, multiplied by "Cranking fuel injection multiplication" – Section **3.3.4.** then multiplied by this parameter.

3.14.12. Fuel Injection correction on cylinders 2+3 f(THROTTLE) [0 to 2]

This parameter allows you to apply additional fuel to just 2 cylinders (numbers 2 and 3) relative to throttle position. This can be used to even out the engine if required.

3.15. Idle speed

The intention of this strategy is to obtain an idle speed unaffected by the applied variations in engine load caused by power steering, alternator etc. Applying this strategy the ECU regulates both on the idle bypass airflow as well as on the spark advance.
A solenoid air valve controlled at a fixed frequency regulates the idle bypass airflow. The length of the open period is referred to as the duty cycle. The ECU driver is capable of controlling 2 valves in parallel.
Similar to the boost pressure regulation, the idle speed strategy operates with an Open Loop (pre defined) section and a Closed Loop section (Proportional, Integral self regulation).



The system has 5 inputs, as shown left,

1. Water Temperature
2. Crank Count
3. Battery Voltage
4. Air Temperature
5. Air Conditionning “Status”

Note: It is also enabled / disabled relative to throttle position.

The idle control is managed in two separate phases, the proportional and integral steps. The proportional step is an initial one time correction. It acts to perform a large correction after which integral corrections are used to further refine the idle speed with small repeated adjustments.

The Idle air valve can be controlled by two forms of output either a PWM (pulse width modulator) or by a stepper motor control.

The PWM controls a valve that continually opens and closes, the signal repeated by the frequency configured in section **3.15.9**. The open time of the valve within that frequency is called the duty cycle. This duty cycle is configured relative to engine revolutions from start up and water temperature. A closed loop correction is applied to the duty cycle relative to error in the target idle rpm. (**3.15.19**)

The stepper motor works by closing off the air flow in controlled increments. The valve can be fully open, fully closed, or at 1 of a number (see section **3.15.15.**) intervals in between. A stepper motor can either be 2 or 4 phase. Typically a 2 phase stepper motor has 5 wires and a 4 phase stepper motor has 4 wires (see section **3.15.14)**

Note: The output of the idle control air valve is configured in section 3.20.1

3.15.1. Spark advance offset it air condition switch is ON [deg]

Refers to section **3.6.1.** If the car is equipped with an air condition system, the ECU can correct and stabilise the idle speed to compensate for the higher power consumption. If the triggering signal from the air condition system is connected to e.g. Switch 2 it can be used to alter the idle spark advance by the degrees defined by this constant.

3.15.2. Idle condition set within RPM offset to target idle speed [+/- RPM]

The idle speed condition is activated when the engine speed is within the offset specified here of the idle target speed (defined in section **3.15.22.**). The throttle position must also be below the value set in section **3.15.3**.

A high RPM offset can be a help in stabilising the idle speed.

3.15.3. Idle speed condition enabled below Throttle position [%]

The idle speed condition is activated if the throttle position is below this limit AND within the RPM offset from section **3.15.2**, above.

3.15.4. Time interval between integral corrections [1/10 Secs]

This function defines the time interval in seconds between calculations of the integral correction step of the idle duty cycle.

3.15.5. Negative integral duty cycle correction cancelled above threshold [Km/h]

In case the actual car speed exceeds this limit the calculation of negative integral gain is cancelled.

3.15.6. Initial idle duty cycle correction timer (TIMAC1) if Switch 2 = ON [sec]

The correction to the duty cycle described in section **13.15.7** is limited to the time period listed here. Exceeding this period, the duty cycle correction is then defined by the constant in section **13.15.8.**

Refer to section **3.5**. for configuring switch 2

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.15.7. Initial idle duty cycle Correction if Switch 2 = ON [%]

If the triggering signal from an input connected to Switch 2 is activated it can be used to alter the idle speed duty cycle applied to the idle air valve. It is increased by the percentage defined by this constant

Refer to section **3.5**. for configuring switch 2

3.15.8. Idle duty cycle correction if switch 2 = ON after TIMAC1 interval [%]

This constant sets the correction to the applied duty cycle if switch 2 is activated and the time since activation has exceeded the time set in section **3.15.6.**

3.15.9. Idle air valve duty cycle frequency [Hz]

The piloting frequency varies from model to model of air valve. The idle air valve operating frequency (in Hz) can be obtained from the manufacturer.

3.15.10. Maximum positive duty cycle integral regulation [%]

The integral duty cycle correction is limited at this value. The positive integral correction is the increase in the duty cycle applied when the actual engine idle speed is below the target idle speed.
A typical value is between 5 and 15%.

3.15.11. Minimum negative duty cycle integral regulation [%]

The integral duty cycle correction is limited at this value. The negative integral correction is the decrease in the duty cycle applied when the actual engine idle speed is above the target idle speed.
A typical value is between 10 and 20%.

3.15.12. Maximum actuated idle speed duty cycle [%]

This limit defines the maximum allowed duty cycle applied to the idle air valve. This threshold is the limiting factor and will override all other limits.

3.15.13. Minimum actuated idle speed duty cycle [%]

This limit defines the minimum allowed duty cycle applied to the idle air valve. This threshold is the limiting factor and will override all other limits.

3.15.14. Stepper motor: 1 = Two Phase; 2 = Four Phase

Rather than a PWM output the idle control can be regulated with a stepper motor output. The PWM continually opens and closes

3.15.15. Total stroke of stepper motor

This determines how many steps are between fully open and fully closed. Typically about 200.

3.15.16. Idle speed spark advance correction f(RPM-TARGET)

In order to further stabilise the idle engine speed it is possible to activate a function based upon variation of the spark advance. In practice, should the engine speed drop below the target idle speed it is possible to increase the spark advance to increase the engines torque. The opposite applies should the idle speed be too high. The offset is applied to the idle spark advance defined in section **3.15.23** below.

3.15.17. Idle speed duty cycle correction f(VBATT) [%]

This vector performs a correction to enable the idle speed to retain a constant airflow at varying battery voltages. The design of this vector is solely depending upon the constructive characteristic of the selected idle air valve.

3.15.18. Idle speed duty cycle correction f(AIR TEMP) [%]

This vector handles correcting the idle duty cycle for variations in air density. It keeps the idle air mass flow constant within variations of the air temperature.

3.15.19. Proportional correction of idle speed duty cycle f(RPM-TARGET)

The proportional correction is a positive or negative change of the applied duty cycle. It is applied once when an error between the target and the actual idle engine speed is detected.
The error in obtained idle speed is expressed by:

RPMERR = RPMLOW - [*Target idle engine speed f(TH2O)*]

When the RPMERR (rpm error) is positive, the proportional correction decreases the idle duty cycle in order to decrease the actual idle speed.
When the RPMERR is negative, the proportional correction increases the idle duty cycle in order to increase the actual idle speed.

3.15.20. Integral idle speed duty cycle gain f(RPM-TARGET)

See section **3.13.4** for the basic time interval between calculations of the integral correction step.

Each time interval the integral correction is calculated as

KIRPME * RPMERR where the gain KIRPME is defined within the vector

Integral idle DC gain f(RPMERROR) Gain for integral expression (0..255 = 0..1)

N.B.: The integral expression is locked each time the ECU returns to idle speed condition.

The integral expression is never reset unless at Key - On or when ECU power is switched off.

3.15.21. Open loop idle valve duty cycle f(TH20.CRANKING)

The table is used to assign the necessary duty cycle values as a function of water temperature and engine phases. The phases are included allowing an increased idle speed straight after the start of the engine. After the first 2000 RPM the duty cycle applied is the value assigned to the breakpoint=2040 in the table. The duty cycle is required to obtain the target engine idle speed. To this initial value will be added corrections for air density differences, activation of power steering or air-condition and the influence from variations in battery voltage. The resulting idle duty cycle following these corrections is **DCMIOL.**

3.15.22. Target Idle engine speed f(TH20) [RPM]

The desired engine idle speed is defined here solely as a function of the water temperature. During the warm-up phase it is possible to specify a higher engine speed.
The idle speed condition is also defined by use of this vector in combination with the throttle position setting in section **3.15.3** and the engine RPM offset defined in section **3.15.2**.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.15.23. Spark advance in idle speed condition f(TH20)

Further to the duty cycle control an ignition trim can also be applied to the idle condition. The advance applied is relative to water temperature.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.16. Lambda Auto Mapping

EURO-1 is equipped with a facility offering automatic re-mapping of the fuel map utilising a **linear lambda sensor in closed loop configuration**. The control strategy is based on integral correction steps of the basic fuel injection time. The actual lambda value of the exhaust gas is compared with a target value listed in a 16 x 8 matrix combining the engine speed and engine load. The integral correction values for each combination of the fuel table breakpoints are stored in a learn table created in the ECU RAM with the same breakpoints as the fuel map. These corrections are constantly updated.

The linear lambda closed loop self-mapping strategy can only be activated if a linear lambda sensor has been selected in the System Setup (section **3.26.9**).

Note:

The opening time of the injector is a multiplication of main fuel map and the learn map. It is very important that the learn map is reset before running the engine again.

3.16.1. Closed loop lambda Learn: Disable =0; Enable =1; 2 = Deactivate

Option 1 enables the self learn. Option 0 disables just the self learn function. Option 2 disables the learn function and removes the multiplication of the learn map.

WARNING - Remember to disable the system if you disconnect the linear lambda kit from the ECU!

3.16.2. Active if throttle position exceeds limit [%]

Self-mapping is activated when the throttle positions exceeds this limit.

3.16.3. Active if engine speed exceeds limit [RPM]

Self-mapping is activated at engine speeds exceeding this limit.

3.16.4. Active if water temperature exceeds limit [˚C]

Self-mapping is activated when the water temperature exceeds this limit.

3.16.5. Active if d(tps%) transient is less than [BIT]

Self-mapping is cancelled during throttle transition. This sets the upper limit for d(tps%) (rate of change of throttle) in which to keep the self mapping active

3.16.6. Maximum lambda to target error [+/-]

Self-mapping is activated when the recorded lambda differs from the target lambda by this value. A typical offset would be around 0.008.

3.16.7. Activate within RPM breakpoint offset [+/- RPM]

Self-mapping is activated if the actual engine speed is within this offset to the nearest fuel table speed breakpoint. Be careful to select quite a narrow offset to reduce errors from neighbour breakpoints. A typical value is about 50 to 100 RPM.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.16.8. Active within TPS breakpoint offset [+/- %]

Self-mapping is activated if the TPS is within this offset to the nearest throttle position breakpoint. Be careful to select the offset quite narrow in order to reduce errors from neighbour breakpoints (around 2%)

3.16.9. Integral fuel correction step [+/- %]

Integral correction steps (in %) of the basic fuel injection times. Typical value for initiative dyno mapping is 0,5..0,8% while a value of 0.1 to 0,2 is recommended for in-car fine-tuning. The fuel injection time is corrected each 100 mSec.

3.16.10. Maximum allowed fuel mixture correction [+/- %]

Re-mapping of a fuel table breakpoint is limited to a maximum percentage correction . Typically the offset could be set to between 5 and 10%. The dyno operator can override this safety limit for real time mapping.

3.16.11. Target lambda value f(RPM.THR)

The exhaust gas target lambda value is defined within a 16 x 8 matrix with selectable breakpoints for engine speed and engine load:

Target lambda value f(RPM,TPS) Desired lambda values - Alpha-N system

Or

Target lambda value f(RPM,MAP) Desired lambda values - Speed-density system

This matrix defines the intervals within the existing fuel maps in which different lambda values are required. The actual re-mapping is performed within the breakpoints defined for the fuel map.

3.16.12. Lambda Control: 0= Disable; 1= Enable

This is an overall control for all lambda control functions, standard regulation and self learn. It is linked to the same option in the Lambda calibration menu section **3.17.1.** The values are common and change in both simultaneously.

3.17. Lambda Calibration

The exhaust gas sensor, located in the exhaust manifold, monitors the oxygen level in the exhaust gas. The sensor is made of zircon. The potential differences across the sensor changes with the density of oxygen and supplies a voltage signal to the ECU.

EURO-1 is equipped with an input for a **standard** (above or below λ=1), preferably heated, sensor with a switching output signal between 0 and 1,25 Volt.
Using the standard sensor a closed loop fuel control is available. The combustion signal is supplied from a standard type lambda sensor connected to pin 2 in the ECU's main 35-pin connector.
The lambda closed loop control for lambda =1 strategy outlined in this section can only be activated if a standard lambda sensor has been selected in the System Setup (section **3.26.9**).

3.17.1. Lambda control; 0= Disable; 1 = Enable

This is an overall control for all lambda control functions, standard regulation and self learn. It is linked to the same option in the Lambda auto mapping section **3.16.12.** The values are common and change simultaneously.

3.17.2. Lean mixture below sensor output voltage [mVolt]

A standard type of lambda sensor detects either rich or lean mixture. When the mixture is rich, the sensor output signal is approximately 1 volt. When the mixture is lean, the sensor output signal is approximately 0 volts. To adapt the system to various types of sensors and to influence the mixture control, two voltage limits are required to configure the sensor:

If the lambda sensor fails to operate or is not connected, the Euro-1 sets the input value to 480mVolt.

This parameter defines when the fuel mixture is considered to be lean.
Set the voltage level between 0 and 480mV. Voltage levels between the defined value and 480mV are considered neutral lambda zone and will not initiate any correction to the fuel mixture.

3.17.3. Rich mixture above sensor output voltage [mVolts]

A standard type of lambda sensor detects either rich or lean mixture. When the mixture is rich, the sensor output signal is approximately 1 volt. When the mixture is lean, the sensor output signal is approximately 0 volt. To adapt the system to various types of sensors and to influence the mixture control, two voltage limits configure the sensor:

If the lambda sensor fails to operate or is not connected, the Euro-1 sets the input value to 480mVolt.

This parameter defines when the fuel mixture is considered to be rich.
Set the voltage level between 480mV and 1240mVolts. Voltage levels between the defined value and 480mV are considered neutral lambda zone and will not initiate any correction to the fuel mixture.

3.17.4. Maximum enrichment of fuel mixture

This constant defines the maximum allowed enrichment of the fuel mixture when the system is working in closed loop correction (CLC). An allowed enrichment of i.e. 25% is set as 1.25.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.17.5. Maximum lean-out of fuel mixture

This constant defines the maximum allowed leaning out of the fuel mixture when the system is working in closed loop correction (CLC). An allowed decrease of i.e. 25% is set as 0.75.

3.17.6. Closed loop mixture correction enabled if air temperature exceeds [˚C]

To activate the CLC lambda strategy the measured ambient air temperature must exceed this limit. A typical value could be –10..0 degrees C.

3.17.7. Closed loop mixture correction disabled if d(TPS) exceeds [BITS]

To avoid any undesired leaning out of the fuel mixture during any engine acceleration phase, the CLC strategy can be cancelled momentarily. The value could be set equal to the transient fuel enrichment activation level with a typical value of 0 to10. See section **3.28.3.**

3.17.8. High water temperature threshold for closed loop activation [˚C]

To allow the engine and the lambda sensor to warm up and reach the temperatures required for good performance, the ECU's switching to closed loop control is regulated by 2 temperature limits and 3 timers. The strategy requires a definition of a temperature level at which the engine unconditionally has finished its warm-up phase. A typical value is 60 to 85 degrees C.

3.17.9. Low water temperature threshold for closed loop activation [˚C]

To allow the engine and the lambda sensor to warm up and reach the temperatures required for good performance, the ECU's switching to closed loop control is regulated by 2 temperature limits and 3 timers. The strategy requires a definition of a temperature level at which the engine is considered in cold start phase. A typical value is 0 to25 degrees C.

3.17.10. Timer 1: Delay activation of CLC if water temp is below low threshold [sec]

Timer 1 sets the time for activating the CLC strategy if the water temperature is below the **low** water temperature limit set in section **3.17.9.** A typical time is 50 to 180 seconds.

3.17.11. Timer 2: Delay activation of CLC if water temp is between thresholds [sec]

Timer 2 sets the time for activating the CLC strategy if the water temperature is above the low water temperature limit (**3.17.9.)**, but below the high water temperature limit (**3.17.8.)** A typical time is 40 to 90 seconds.

3.17.12. Timer 3: Delay activation of CLC if water temp exceeds high threshold [sec]

Timer 3 sets the time for activating the CLC strategy if the water temperature is above the high water temperature limit set in section **3.17.8.** A typical time is between 20 and 50 seconds.

3.17.13. Open loop lambda control map (0=closed; 1= Open loop; 4 = Self Learn)

When adapting the lambda control to the various engine conditions (idle speed, partial load, full load etc.) the parameters can be assigned in a bi-dimensional table with 5 engine speed and 5 throttle position breakpoints. The map can be defined as a part of the fuel map (recommended) or equal to the full map.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

TPS (%) \ RPM	(500)-1343.75	(1343.75)-1750	(1750)-2250	(2250)-3406.25	(3406.25)-4000
(0)-1.953	0	0	0	0	1
(1.953)-9.766	0	0	0	0	1
(9.766)-18.75	0	0	0	0	1
(18.75)-30.469	0	0	0	0	1
(30.469)-46.094	1	1	1	1	1

You can enter the following options:

In each of the available 25 zones it is possible to control the CLC strategy. The 25 zones are defined for operating with the following available options:

Select	Constant
- Unconditionally closed loop – CLC strategy active	0
- Unconditionally open loop – CLC strategy deactivated	1
- CLC strategy deactivated if air temp is below limit, (**section 3.17.9**)	2
- CLC strategy deactivated after terminating idle self-learning **(section 3.18)**	4

3.17.14. Time interval between integral fuel corrections [msec]

The lambda closed loop fuel control is regulated by 3 parameters:

- Time interval between integral fuel correction steps
- Proportional fuel mixture correction step first time the mixture is detected being rich
- Proportional fuel mixture correction step first time the mixture is detected being lean

When the lambda sensor detects that the mixture is lean, the ECU responds by introducing a percentage enrichment of the fuel mixture. This is the proportional step for detected lean mixture.

From that moment on, the integral correction enriches the fuel mixture by fixed 0.8 % steps every time interval in mSec's. The longer the time interval between corrections, the slower the enrichment.

At a certain point the mixture reaches a rich level so high that the lambda sensor voltage signal exceeds the limit indicating the mixture being too rich. The ECU responds by introducing a percentage lean-out of the fuel mixture. This is the proportional step for detected rich mixture.

From that moment on, the integral correction reduces the fuel mixture by 0,8% steps every time interval in mSec's.

This table allows you to set the time intervals relative to engine speed and throttle.
Typical values would be around 50 msec for high engine speeds down to 200 msec at low speeds.

3.17.15. Proportional fuel correction step first time lean

This correction is a percentage increase of the fuel mixture applied only in the instant when the mixture is detected being lean. It is important that the 5 engine speed and the 5 throttle position breakpoints are identical to those defining the open loop table – see section **3.17.13**

3.17.16. Proportional fuel correction step first time rich

This correction is a percentage decrease of the fuel mixture applied only in the instant when the mixture is detected being rich. It is important that the 5 engine speed and the 5 throttle position breakpoints are identical to those defining the open loop table – see section **3.17.13.**

3.18. Lambda calibration – self learn (Standard Lambda sensor only)

To avoid instability problems when the engine is **idling** and to better adapt the mixture control at the low throttle positions, the ECU is capable of an automatic correction of the fuel injection during the idle speed condition.
This automatic compensation is to consider a digital equivalent to the idle mixture adjuster screw found in old ECU's.
The intention is to be able to control the idle speed mixture even in open loop status in case the lambda regulation introduces variations in the engines idle speed.

The self-learn strategy can only be activated if a standard lambda sensor has been selected in the System Setup (section **3.26.9.**) and only if the value of the first breakpoint of the closed loop lambda map (RPM,TPS) has been set to **4** (see section **3.17.13**)

All the following conditions must be fulfilled to activate the strategy:

3.18.1. Water temperature threshold activates self learn strategy [˚C]

The actual water temperature has to exceed this limit to activate the self-learn strategy.

3.18.2. Throttle position threshold activates self learn strategy [%]

The self-learn strategy is active only if the actual throttle position is **below** this limit.

3.18.3. RPM threshold activates self learn strategy [RPM]

The self-learn strategy is active only if the actual engine speed is **below** this limit.

3.18.4. Delay to activate self learn [sec]

This timer defines the delay in seconds for activation of the self-learn strategy after the start of the engine. The above-mentioned conditions must all remain valid minimum for this time. Otherwise the self-learning strategy will not initiate. A typical value is 10 to 20 seconds.

3.18.5. Duration of self learn calculation [sec]

This timer defines the active time period for the self-learn strategy. A typical value is 90 to180 seconds.

When the strategy is active, the ECU starts to analyse the correction introduced by the closed loop lambda control. Based on these corrections an offset to the fuel injection time is calculated for an exact equilibrium of the corrections from the lambda control system.
Supposing an exact symmetrical lambda regulation has been selected at termination of the procedure the regulation circuit can maintain a mixture very close to the stoichiometric air/fuel ratio.

3.18.6. Time interval between integral correction steps [sec]

This constant defines how often to update the results of the calculations.

3.18.7. Self-learning weighting diagram

During the idle self-learn process the ECU tries to obtain as small oscillations as possible in the idle speed lambda value. It does this by running a learn function in the idle speed condition. The calculated corrections of that breakpoint are then stored in the ECU. That learnt correction can then be applied to a range of breakpoint settings by the use of a multiplication factor ((0 to 1) as defined in this parameter. At engine speeds close to target idle (where the correction has been learnt) the correction value is 1. It should also be set at 1 for speeds below the target idle but decreasing from 1 at speeds above target.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.19. Power Shift

If a dog clutch type or sequential gearbox is used, it is possible to use an **ignition cut** to allow full throttle gearshifts.

3.19.1. Power shift cut time (ignition) [msec]

This constant interrupts the ignition pulses for a given time period (mSec) once the power shift has been activated. The activation can come from a micro switch or strain gauging system on the lever. Connected to either switch 1 or 2 an input pulling to ground will activate the gear cut (see section **3.5**).

The cut is activated only once the switch connects to GND. Keeping the switch connected, does not repeat the function. See section **3.19.2.**

A typical cut time when using a sequential gearchange is 50 to.60 mSec.

3.19.2. Power shift reset time [msec]

The ignition power shift can be re-activated after this time interval.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.20. Programmable output configuration

The Euro 1 has five programmable outputs; two pulse width modulators (PWM), a stepper motor controller, and two "On / OFF" switches (named OUTP3 and WarLit). The "On / Off" switches are grounded by the ECU when activated, i.e. in section 3.23. where the shift light settings are configured. When the rpm threshold is activated the assigned switch will turn to ground.

3.20.1. Idle Output: 0= Disable; 1= PWM2; 2= Stepper

This parameter allows you to configure the output driver being used to regulate the idle control. See section **3.15.**

3.20.2. Boost Output: 0= Disbale; 1= PWM1

This parameter allows you to configure the output driver being used to regulate the Boost control. See section **3.1.**

3.20.3. Warning Light: 0= Disabled; 1 = PWM1; 2= PWM2; 3=OUTP3; 4= Warlit

The warning light is activated by the diagnostics settings in section **3.4.** This parameter allows you to configure what, if anything, you want to activate when the thresholds (and timers) exceed their settings. Selecting option 3 (OUTP 3) or 4 (WARLIT) allows an LED to be configured.
Once you have assigned the output you must then turn the ignition on and off four times for the light to become active to the thresholds.

3.20.4. Universal Output: 0= Disabled; 1 = PWM1; 2= PWM2; 3=OUTP3; 4= Warlit

The universal output is controlled by a number of programmable thresholds. See section **3.29. Universal Output** This parameter is used to assign an output to those thresholds. Selecting option 3 (OUTP 3) or 4 (WARLIT) allows an LED to be configured.

3.20.5. Shift Light: 0= Disabled; 1 = PWM1; 2= PWM2; 3=OUTP3; 4= Warlit

This parameter is used to assign an output to the threshold condition set in section **3.19. Shift Light** Selecting option 3 (OUTP 3) or 4 (WARLIT) allows an LED to be configured.

3.20.6. Power Latch: 0= Standard; 1= Idle (PWM2); 2=Waste Gate (PWM1); 3= Universal; 4=Warlit

The "**Power Latch**" is activated when the ignition is live. This can be used to control any additional circuitry using option 3 or 4.

3.21. RPM limiter

Euro-1 is supplied with 2 different engine speed limiters:

- Limiter acting on fuel injection pulses.
- Limiter acting on a sequence of ignition pulses.

Note: On cars equipped with catalytic converters only use the fuel injection cut strategy.

3.21.1. Fuel hard cut above engine speed threshold [RPM]

The fuel injection RPM hard cut limiter eliminates fuel injection pulses when the engine speed exceeds the limit. There is no hysteresis acting on the limit.

3.21.2. Ignition soft cut above engine speed threshold [RPM]

Euro-1 has a programmable RPM limiter acting on the spark advance. The strategy is to allow a gradual cutting of ignition pulses, which will be felt by the driver without a considerable loss of traction.
The strategy is activated at engine speeds exceeding this limit.

3.21.3. RPM offset for ignition hard cut [RPM]

RPM offset above 'soft cut limit' at which to activate all ignition pulses.

3.22. Sensor Calibration

This section configures the selected pressure, temperature and lambda sensors.

Selecting pressure transducers

The Euro-1 ECU has a built-in absolute pressure sensor. In the System Setup section is it possible to configure this sensor as the primary manifold air pressure sensor (select internal – to use the ECU's pressure sensor for MAP readings) or as a barometric sensor (hence select external to configure use of additional MAP sensor) See section **3.26.7.**

Two additional 0 to 5 Volt sensor inputs are also available. The system can be configured for almost any commercially available transducer having 5 or 12 Volt excitation voltage and a 0 to 5 volt output signal. The basic software operates with a pressure input up to 12 bar.

Note:
Pay attention to the sensors temperature range. Our recommended transducers are guaranteed to + 125 degrees C.

3.22.1. Maximum absolute manifold air pressure at 5 volts sensor signal [mbar]

The first two parameters allow configuration for an external map sensor. Here you enter the calibration value of your pressure sensor relative to a 5v output. For input values see instructions under **3.22.2.**

Remember to select 0 =external MAP sensor in section 3.26.7 to activate the external MAP sensor. When the external sensor is used the ECU's internal sensor becomes a Barometric sensor.

3.22.2. Minimum absolute manifold air pressure at 0 volts sensor signal [mbar]

Here you enter the calibration value of your pressure sensor relative to a 0v output.

In order to make the configuration of the pressure sensors easy the following list contains the minimum and maximum limits for various recommended transducers:

Manufacturer	Type	Min. pressure, 0 Volt	Max. Pressure, 5 Volt
Bosch 1 bar MAP sensor	0261230004	120 mbar	1120 mbar
OBR 1 bar MAP sensor	OB2259	**-** 125 mbar	1125 mbar
OBR 5 bar MAP sensor	OB2260	**-** 625 mbar	5625 mbar
OBR 10 bar oil/fuel pressure	OB1752	- 1250 mbar	11250 mbar
Marelli 1 bar MAP sensor	PRT 03	126 mbar	1102 mbar
Marelli 2.5 bar MAP sensor	PRT 06	82 mbar	2607 mbar
Internal pressure transducer	1,0 bar	105 mbar	1216 mbar

Note when using 'external from ECU' MAP sensor:

In a Speed-Density system the pressure is measured after the throttle valve (between throttle butterfly and inlet valves) and in an Alpha-N system the pressure is measured before the throttle valve. The signal from the MAP sensor is recorded by the ECU synchronous with SMOT signals.

Upon changing the pressure limits, the pressure span in Vectors and in Tables is corrected accordingly, but NOT the output variable. Check each Vector and Table after a change in pressure sensor.

3.22.3. Maximum absolute auxiliary pressure at 5 volts sensor signal [mbar]

The euro 1 can run two additional pressure sensor's further to its own inbuilt device. This first is specified as the MAP sensor as described above. The second is configurable on "switch 1" if isn't already being used. See section **3.5.** If un-assigned the input functions as a 0 to 5 volt analogue input suitable for a pressure sensor.

This parameter configures the pressure reading of the sensor equivalent to 5 volts.
Refer to the earlier tables or sensor documentation for calibration details.

3.22.4. Maximum absolute auxiliary pressure at 0 volts sensor signal [mbar]

Configures the pressure reading of the sensor equivalent to 0 volts.

3.22.5. Maximum Oil pressure at 5 volts sensor signal [mbar]

Configure the reading of the oil pressure sensor when at 5 volts. (Using Switch 1 as an analogue input)

3.22.6. Minimum oil pressure at 0 volts sensor signal [mbar]

Configure the reading of the oil pressure sensor when at 0 volts. (Using Switch 1 as an analogue input)

3.22.7. Air temperature linearization table [-30 to 130]

The linearization table represents the relationship between the recorded values in bits 0 to 255 from the temperature sensor to the actual temperature. This is configurable over 16 breakpoints and specific to the sensor type.

Below is a list of common temperature sensors

Temperature deg. C	EFI Technology	Bosch	Marelli
0			
10	156	155	152
20	143	117	132
30	124	99	111
40	104	84	93
50	88	71	76
60	73	61	65
70	64	52	55
75	58	49	51
80	54	45	48
85	50	43	45
90	47	41	42
95	44	39	40
100	42	37	38
110	38	35	36

3.22.8. Water temperature linearization table [-30 to 130]

Same procedure as above in **3.22.7,** but for your water temperature sensor.

3.22.9. Linearization lambda sensor 'LINEAR'

A **linear** lambda sensor for exhaust gas monitoring is a valuable aid in engine mapping. Using a standard type of lambda sensor for monitoring lambda values is not recommended. A considerable change in lambda value is reflected by a change of only a few mV in output signal and is also dependent on the actual exhaust gas temperature.
Therefore a **linear** lambda sensor is strongly recommended. Its output voltage changes between 0.50 and 5.0 volt and its readings do not alter with variations in exhaust gas temperature.

We have provided linearization tables for the two main liner lambda sensors below:

Linearization for our 2 types of controllers follows:

'D' Type Controller (EFI Controller)	
Lambda	**Volt**
0.65	0.64
0.70	1.15
0.71	1.27
0.74	1.58
0.77	1.89
0.80	2.23
0.83	2.52
0.86	2.83
0.89	3.14
0.90	3.22
0.93	3.46
0.97	3.77
1.00	4.00
1.10	4.36
1.20	4.65
1.30	4.92

OB650 Controller	
Lambda	**Volt**
0.70	1.872
0.75	2.340
0.78	2.652
0.80	2.808
0.84	3.120
0.86	3.276
0.88	3.432
0.91	3.588
0.93	3.744
0.96	3.900
1.00	4.056
1.04	4.212
1.08	4.368
1.13	4.524
1.24	4.836
1.33	4.992

When using a linear lambda sensor ensure you have configured the system to recognise it. See section **3.26.9**

Using the linear lambda sensor enables the user to the auto mapping function. See Section 3.16.

3.23. Shift Lights

The EURO 1 can operate a LED as a function of RPM to give a shift light option. This is enabled using either OUTP3 or WarLiT from the option in section **3.20.5** (set as either 3 or 4).

3.23.1. Shift light 0ff→ON if RPM above limit [RPM]

Set the upper limit at which you want to activate the LED.

3.23.2. Shift light 0ff→ON if RPM below limit [RPM]

Set the lower limit at which you want to activate the LED.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.24. Spark Advance – Main Maps

EURO-1 uses two internal (inductive or digital) drivers for direct ignition coil control.
From the 35-pin main connector IGN1 (pin 25) control ignition on cylinder 1+4 and IGN2 (pin 26) controls ignition on cylinder 2+3.

The ECU can control the ignition in 3 different ways:

- 1 ignition coil with 1 HT outlet using a distributor for spark distribution (connect IGN1 and IGN2 together in the wiring loom).
- 1 ignition coil with 4 HT outlets for direct connection to the respective plugs.
- 1 ignition coil on each cylinder – the coil-on-plug principle. The positive connector on the coil on cylinder 1 is connected to battery power supply. The negative terminal is connected to the positive terminal on the coil fitted on cylinder 4. The negative terminal from this coil is connected to the ECU on IGN1. The coils on cylinder 2 and 3 are wired likewise and then connected to the ECU on IGN2.

3.24.1. Spark advance offset f(AIR TEMP)

This vector allows an adjustment between -32.+32 degrees of the spark advance as a function of air temperature. (+ve = advance , -ve = retardation). These values operate as an addition to the base spark map.

3.24.2. Dwell time f(BATT VOLTAGE) [msec]

To obtain the maximum performance of the selected ignition coil, the ECU allows a dwell time variation according to the battery voltage. The dwell time determines the ignition coils electrical power consumption. The more demanding the energy of the coil for the well functioning of the engine, the higher must be the power consumption of the ignition coil.

The correct dwell time for various ignition coils can be supplied on request.

3.24.3. Spark Advance in Idle speed condition f(TH20)

This compensation vector is the same as in section **3.15.23.** This is simply another access point to same chart. It specifies the base spark advance for running in idle condition relevant to water temperature.
The idle speed is then kept at its target value by offsetting the base spark advance value defined by the amounts defined in section **3.15.16.**

3.24.4. Spark advance correction f(MAP)

Spark advance correction between -32. + 32 degrees depending on manifold absolute air pressure. Valid for Alpha-N (throttle, not pressure based maps) only.
This vector allows spark advance correction due to a change in manifold air pressure. It is in particular important when the ECU is configured as a turbo charged Alpha-N system. A typical correction for a turbo charged engine retards the ignition 10 degrees for each 1 bar increase in boost pressure.

3.24.5. Spark advance map

This is the default condition of the system. The spark advance value is found in the tables:

Spark advance table 32 RPM x 32 THR Or	Alpha-N configuration, throttle position versus engine speed
Spark advance table 32 RPM x 32 MAP	Speed-Density configuration, manifold air pressure versus engine speed

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.24.6. Spark advance correction on cylinder 1+4 f(RPM.THR)

Spark advance correction can be made to either cylinder pairing 1 and 4 or 2 and 3. This allows compensation for differing cylinder temperatures and detonation thresholds.
The correction is defineable relative to engine speed and throttle position.

3.24.7. Spark advance correction on cylinder 2+3 f(RPM.THR)

As above in **3.24.6**. but for cylinder pairing 2 and 3.

3.24.8. Idle speed spark advance correction f[RPM.THRS]

Same parameter as **3.15.16**:

In order to further stabilise the idle engine speed it is possible to activate a function based upon variation of the spark advance. In practice, should the engine speed drop below the target idle speed it is possible to increase the spark advance to increase the engines torque. The opposite applies should the idle speed be too high. The offset is applied to the idle spark advance defined commonly in section **3.15.23** and **3.24.3.**

3.25. Spark Advance - Setting

3.25.1. Spark advance time delay correction [usec]

This calibration constant compensates the delays generated by the system in creating the actual spark.

It is set to obtain a correct reading of the spark advance using a stroboscopic light at higher RPM. The actual spark advance is first checked at low RPM. If it does not correspond with the value indicated on the engine data display, correct it by altering the ANTAV - crank pickup position (see **3.26.3**) Now check the spark advance at high engine speeds. If the visualised and actual spark advance differs, change the delay correction time. Once configured, this constant never has to be changed for the selected set-up.
A typical value for Marelli SEN 8 electromagnetic sensors is 100 uSec.

3.25.2. Time after start with mapped spark advance [sec]

When starting the engine the oscillating revolutions of the crankshaft do not allow a reasonable calculation of the spark advance. For this reason the spark advance is fixed synchronous to the crankshaft pulses. Being positioned by the ANTAV (crank pickup position before TDC of their corresponding cylinders) the given spark advance when starting is exactly equal to ANTAV.
It is possible to correct the initial spark advance, but only after the time interval set by this constant has passed.

3.25.3. If water temperature is <TH2OSA: Offset spark advance ANTACC in [sec]

A correction to the initial spark advance can be applied to more rapidly build up engine and exhaust temperature. This offset is applied if the initial water temperature is below the level (TH2OSA) defined in section **3.25.4.** If the water temperature is below that threshold then a spark offset (ANTACC set in section **3.25.5.)** This parameters defines the time period the offset is applied for.

3.25.4. Water temperature threshold (TH20SA) cancels spark advance correction [˚C]

The spark advance correction set in section **3.25.5** for time defined above in **3.25.3** is cancelled when the water temperature exceeds the temperature limit set by this constant.

3.25.5. Spark advance offset (ANTACC) [deg]

If the actual water temperature is below the limit defined in section **3.25.4.** it is possible to alter the initial start-up spark advance. By use of this constant it is possible to correct the spark advance timing set by the crank sensor position by a value between –20 to +20 degrees.

3.25.6. Spark advance correction by switch [deg]

See sections **3.5, 3.7**. and **3.14.2.**

3.25.7. Spark advance offset if air conditioning is ON [deg]

A spark advance offset can be introduced to the idle control when the air conditioning is activated. This is the same parameter as in section **3.15.1**

3.26. System Setup

The “System Setup” menu provides the main configuration platform for the operating parameters of the engine. The most important aspect is selecting the type of crank trigger disc being used. Along with the type of trigger disc you also need to configure the timing of the engine by giving information about the trigger pattern relative to TDC. The menu option allows three methods of doing so. Only one is relative for any given trigger disc pattern.

3.26.1. Maximum RPM for use in tables [RPM]

The minimum and maximum engine speeds defines the minimum and maximum values of the basic fuel injection and sparks advance maps as well as numerous correction diagrams.
The engine speed range is selected as closed as possible to the actual requirement of the engine. The range is divided onto 255 steps and in order to optimise the calculation resolution it is recommended to select a RPM range as close as possible to the actual required engine speed range.

3.26.2. Minimum RPM for use in tables [RPM]

See description above.

3.26.3. Crankshaft sensor pulse (cylinder 1) detected ANTAV degrees before TDC [deg]

Note: Applicable for an EFI style trigger disc (enter **0** for section **3.26.6.**)

The crankshaft engine speed sensor (SMOT) records pulses at a fixed angular position before TDC. This position is used for calculating the correct injection phase and spark advance. Measure in degrees the angular position of the crankshaft marker pin indicating cylinder #1 passing the sensor in relation to TDC position.
When starting the engine the oscillating revolutions of the crankshaft do not allow a reasonable calculation of the spark advance. For this reason the spark advance is fixed synchronous to the crankshaft pulses. Being positioned by the ANTAV (crank pickup position before TDC of their corresponding cylinders) the given spark advance when starting is exactly equal to ANTAV.
Check the position when the engine is idling. Measure the actual engine spark advance and compare with the value indicated on your engine data screen when working in real time. If there is a difference, subtract or add the difference in degrees to the pickup position.

3.26.4. Crankshaft pickup position before TDC; only CLIO [deg]

As above but only for use with a Renault Clio engine. Select option 4 in section **3.26.6**. to select a Clio engine configuration.

3.26.5. First SMOT detected after missing teeth in 36-1/60-2 before TDC

This constant replaces the parameter described in section **3.26.3 ONLY** when the configuration of the crankshaft signal frame in section **3.26.6** has been set to **“36-4”, “60-2” or “36-1” (options 1, 2, or 3)**. The value is the position of the missing teeth before TCD of cylinder #1. (Reference to the leading edge of the tooth when using a hall effect crank sensor or the middle of the tooth for an inductive sensor).
When starting the engine the oscillating revolutions of the crankshaft do not allow a reasonable calculation of the spark advance. For this reason the spark advance is fixed synchronous to the crankshaft pulses. Being positioned by the ANTAV (crank pickup position before TDC of their corresponding cylinders) the given spark advance when starting is exactly equal to ANTAV.
Check the position when the engine is idling. Measure the actual engine spark advance and compare with the value indicated on your engine data screen when working in real time. If there is a difference, subtract or add the difference in degrees to the pickup position.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England
Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk
Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.26.6. Crank trigger disc: 0 = 4+1, 1 = 36-4, 2 = 60 – 2, 3 = 36 – 1, 4 = CLIO

Select the type of crankshaft sensor trigger disc fitted to your engine.

4+1: Standard EFI Technology with 4 pins spaced 90 degrees and 1 additional pin 12 to 20 degrees after the pin indicating TCD for cylinder #1. (use section **3.26.3.)**
36-4: Rover K-type signal frame. (use section **3.26.5**)
60-2: Typical Bosch-style configuration found in many standard applications. (use section **3.26.5**)
36-1: Typical Ford style configuration. (use section **3.26.5**)
CLIO: Specific configuration for a Renault Clio.

3.26.7. Select MAP sensor: 0 = External (internal is BARO) ; 1 = Internal

Select between the internal or an external pressure sensor as the MAP sensor. When an external sensor has been chosen, the internal sensor (inbuilt into the ECU) is configured as a barometric pressure sensor.

3.26.8. Select engine load: 0 = Alpha-N; 1 = Speed-density

The calculation of the fuel injection time and spark advance always initiates from the basic engine load expression. This can be defined as either throttle based (Alpha-N) or pressured based (Speed-density).

- Alpha-N configuration, throttle position versus engine speed **(use "an" descriptor file)**
- Speed-Density configuration, manifold air pressure versus engine speed **(use "sd" descriptor file)**

3.26.9. Select lambda sensor: 0 = Start (0 to 1 volt); 1= Linear (0 to 5 volts)

Select the type of lambda sensor used with the system.

Standard: Lambda =1 Used for closed loop control in general running. **See section 3.17**
It can also be used to run a self learn function in the idle condition. See section **3.18.**
All parameters under lambda – Auto Mapping are disabled

Linear: A linear lambda sensor is used to accurately measure real time lambda values. Using this type of sensor and a corresponding control box the Euro 1's auto mapping feature can be used. See section **3.16.**
All parameters listed under Lambda Calibration and Lambda Self Learn are disabled

3.26.10. Duration RPM tachometer pulse [usec]

The pulse length activating an external RPM tachometer can be adjusted to suit different types of instruments.

3.26.11. Number of impulses for RPM tachometer each engine revolution

The number of pulses activating an external RPM tachometer can be adjusted to suit different types of instruments.

3.27. System Setup – Data Export

3.27.1. CAN bus data export: 0= Logger UDA91; 1=Extended

The Euro 1 has a CAN bus data line. This is used for communication between a PC and the ECU as well as for data transfer for logging or display systems. Option 0 is a pre-defined setting for a Magnetti Marelli logger. Option 1 gives an extended CAN bus data stream.

For more information about running a data logger or dashboard with the Euro 1 please contact OBR directly.

3.28. Transient Fuel

Whilst driving movements of the throttle valve are always present. The positive transition (during acceleration) and the negative transition (during deceleration) require regulation of the injected fuel since the basic fuel table is based on static values. This correction can decrease or increase the amount of additional required fuel in order to maintain the driveability of the engine.
When driving on a road or track the engine will almost never be in a steady state condition, but continues to experience variations in engine speed and engine load due to inputs from the driver.
The ECU checks the speed and the amount of the introduced variations of the throttle position for equalising the fuelling. The velocity of the throttle position variation is calculated as the derivative of the throttle position. (change in position / time taken for position change).

N.B: The calculated transient fuel is an additive and not a multiplier.

3.28.1. Time interval for d(TPS) derivative calculation [msec]

To calculate the throttle position derivative (DFARF) the computer records the throttle position (TPS) every 10msec in a stack of 10 positions: The stack works as a ring memory of the last 10 readings and is continuously updated.

TPS(0)
TPS(10)
TPS(20)
TPS(30)
TPS(40)
TPS(50)
TPS(60)
TPS(70)
TPS(80)
TPS(90)

The time interval used for calculating the throttle valve derivative is given by this constant - selected as 10, 20, 30,..90 mSec. This can only be in steps of 10msec as to coincide with the recordings of the throttle position.

So if time interval = 20msec then d(TPS) = { [TPS(20) – TPS(0)] / 20 }

Note:
d(TPS) is measured in none specific unit of bits.

From the d(TPS) value a calculation of a value named DFARF is used to give the additional injector opening time:

DFARF = d(TPS) * KDIN, (in µsec as on the main fuel map)

Where KDIN is a scaling factor. See section **3.28.5.**

3.28.2. Maximum d(TPS) derivative value used in calculation [bit]

For any throttle valve movement, the throttle position derivative value is calculated. The higher the value, the more fuel is added during the transition stage. In order to limit the fuel enrichment a limit on DFARF is imposed by setting an upper limit for the d(TPS) value to be used in the calculation. This upper limit is defined here. A limiting value of DFARF should be about one third of your maximum base map injector opening time.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

3.28.3. d(TPS) derivative value enable transient fuel **[bit]**

The calculated throttle position derivative value must exceed this limit to activate the transient enrichment system. A typical initial value could be 5 to 20. Also refer to section **3.16.5.**

3.28.4. Time interval for transient fuel decay calculation **[msec]**

Immediately after calculating the transient fuel addition the ECU establishes a decay rate to 'slope' the fuelling back down to normal map value before d(TPS) comes back to 0.

This constant sets the time interval between calculations of fuel decrease. The longer the intervals, the slower the reduction is to the transient fuel.

3.28.5. Scaling factor for d(TPS) derivative calculation **[µsec/BIT]**

The scaling factor (KDIN) converts the calculated value in bits of the throttle position derivative into uSec's. It has an overall control of the transition fuel strategy. Increasing the scaling factor increases both the added fuel and the decay strategy. Multiplying KDIN by the maximum allowable d(TPS) value (section **3.28.2.**) calculates the maximum transient fuel injector opening time (µsec).

3.28.6. Transition fuel decay f(RPM) in d(TPS) units **[0 to 255]**

The decrease of the added transition fuel is a function of the engine speed. The decay is set by a reduction of the calculated throttle position derivative in a time interval defined in section **3.28.4.**

The enrichment in positive transition phase is cancelled immediately if the throttle valve returns to idle position or if the fuel cut-off phase is being activated.

3.28.7. Transient fuel correction f(RPM) **[0 to 2]**

This multiplier allows a correction of the transient fuel as a function of the engine speed. It can be weighted to give a greater effect (more than 1) at lower RPM to compensate for reduced air flow into the engine.

3.28.8. Transient fuel enrichment multiplier f(TH20)

This multiplier allows a correction of the transient fuel as a function of the water temperature.

3.29. Universal output

The universal output (positioned on pin 9 in the main connector) is available for use i.e. with variable inlet length and variable camshaft position. When activated pin 9 is grounded.
To activate the output, all the following conditions must be fulfilled:

Also see section **3.20.4**

3.29.1. Activation delay time from engine start [sec]

The output can be activated after this time delay from the start of the engine.

3.29.2. Enable output if MAP exceeds limit [mbar]

The output can be activated if the manifold air pressure (MAP) exceeds this limit.

3.29.3. Enable output if air temperature exceeds threshold [˚C]

The output can be activated if the inlet air temperature exceeds this limit.

3.29.4. Enable output if water temperature exceeds threshold [˚C]

The output can be activated if the water temperature exceeds this limit.

3.29.5. Enable output if throttle position exceeds threshold [%]

The output can be activated if the throttle position exceeds this limit.

3.29.6. RPM limit #1 switches output OFF à ON [RPM]

The output is activated if the engine speed is above this value and below **3.29.7.**

3.29.7. RPM limit #2 switches output ON à OFF [RPM]

The output is de-activated when the engine speed is above this parameter but below **3.29.8.**

3.29.8. RPM limit #3 switches output OFF à ON [RPM]

The output is activated again when the engine speed is above this parameter.

Ole Buhl Racing (UK) Ltd.
Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE
England

Telephone : (+44) (0)1425 47 88 22
Telefax : (+44) (0)1425 47 88 66
sales@efitechnology.co.uk
www.efitech.co.uk

Registered Office: Windover House
St. Ann Street, Salisbury SP1 2DR
Registered in England No.:3635953
V.A.T. Nr. GB 722 5686 27

4. PIN OUT

PINOUT NEW EURO1 from version 1.30 - Alpha-N / Speed-Density versions

Pin	Name	Type	Note
1	GND	Sensor ground	CAN
2	Lambda	Linear input	Standard lambda sensor
3	STEP_A	Output	Stepper motor control
4	SMOT	Electromagnetic	RPM crankshaft sensor
5	SCAM	Electromagnetic	Car speed sensor
6	CAN_L	CAN line	CAN low
7	Warning Light	Open collector	Diagnostic warning light
8	STEP_B	Output	Stepper motor control
9	OUT_3	On/Off	Universal output / Purge valve
10	STEP_C	Output	Stepper motor control
11	GND	Sensor ground	Ground on engine block, lambda sensor ground
12	VBATT Key	Key On	Power supply via ignition key
13	SW2	Input On/Off (Pull up)	Switch 2 - Air-conditioner ON
14	SW1	Input On/Off (Pull up)	Correction Fuel / Spark advance maps
15	MAP	Linear input	External manifold air pressure sensor
16	PWM1	Output PWM	Waste gate boost pressure / Camshaft phase activator
17	FARF	Linear input	Throttle position sensor
18	INJ3	Injector driver	Fuel injector on cylinder 2
19	GND	Sensor ground	Ground for MAP and throttle potentiometer
20	VBATT DIR	Power supply	Direct +12 volt ECU power supply
21	WR/En	Write enable	Write Enable
22	CAN_H	CAN line	CAN High
23	GND	Sensor ground	Ground for temperature sensors
24	GND ECU Power(*)	Ground	GND - connect to engine
25	IGN1	Ignition driver	Ignition cylinder 1 + 4
26	IGN2	Ignition driver	Ignition cylinder 2 + 3
27	STEP_D	Output	Stepper motor control
28	OUTP2	OUT	RPM signal / Fuel pump relay
29	TH20	Input NTC	Water temperature sensor
30	Vref	5 Volt reference	Reference voltage for sensors
31	TAIR	Input NTC	Air temperature sensor
32	INJ4	Injector driver	Fuel injector on cylinder 3
33	INJ2	Injector driver	Fuel injector on cylinder 4
34	PWM2	Output PWM	Idle speed air valve
35	INJ1	Injector driver	Fuel injector on cylinder 1

*) Separate from other GND. Minimum wire 1,5 mm^2.

5. COMMUNICATION CONNECTORS

5.1. PIN CONFIGURATION – CAN Interface

DB9

Pin	Description
1	Ground
2	n.c.
3	Write Enable
4	n.c.
5	n.c.
6	CAN Hi
7	CAN Lo
8	VBATT Direct
9	n.c.

LEMO

Pin	Description
1	Ground
2	Write Enable
3	CAN Hi
4	CAN lo
5	VBATT Direct
6	n.c.

5.2. PIN CONFIGURATION - Sensors and accessories

SENSOR	PIN 1	PIN 2	PIN 3
Marelli air pressure ABS 02-03-05	Signal - to ECU pin 15	GND	VREF
Marelli PF throttle potentiometers	GND	Signal - to ECU pin 17	VREF
Bosch air pressure 0261230004	VREF	GND	Signal - to ECU pin 15
Bosch ignition coil 0221503407	IGN 2 - to ECU pin 26	VBATT	IGN 1 - to ECU pin 25
Temperature sensor - air	GND	Signal - to ECU pin 31	
Temperature sensor - water	GND	Signal - to ECU pin 29	
Fuel injector driver 1	Signal - to ECU pin 35	VBATT	
Fuel injector driver 2	Signal - to ECU pin 33	VBATT	
Fuel injector driver 3	Signal - to ECU pin 18	VBATT	
Fuel injector driver 4	Signal - to ECU pin 32	VBATT	
Marelli SEN 8D pickup - SMOT	GND	Signal - to ECU pin 4	
Bosch lambda 0258004001 - sensor	GND	Signal - to ECU pin 2	
Bosch lambda 0258004001 - heating	GND	VBATT	

6. Error resolving

No display, error message 68	Check PC port driver configuration
Error asking static table address to device 127	No connection to ECU Check ECU power supply Check CAN interface direct power supply Check parallel port address Check that the parallel port is configured as ECP
Cannot send firmware to ECU	Check power connection to ECU Check independent CAN interface power supply Try increasing the Time Delay
"Error CAN" message when on-line	PC communication speed
AMC connected, but not active	Check COM port address Check baud rate Check power supply to AMC Check PC port driver configuration
AMC cuts out while on-line	PC communication speed
Engine does not start - no crank counting	Check SMOT sensor connection Check SMOT polarity
Engine does not start with new ECU	Check firmware version via CAN line information
Engine does not start after loading map to new ECU	Check learn table values
Engine with twin injectors runs very bad and lean	Check fuel injector impedance and ECU version
Engine misfires badly at high RPM	Check sensor clearance Check Maximum Injector time
Engine is fitted with Bosch inductive pickup(s) and misfires at higher engine speeds	Fit a ¼ Watt 33..68 kOhm resister in line with the signal wire in the wiring loom.