EmeraldM3D K6

Engine Management System

ECU Configuration Guide
V3.00

This ECU Configuration guide is intended to be used by K6 ECU owners and tuners who are already familiar with the basic operation of the K6 ECU and the Emerald PC software. A separate "Emerald K6 Quick Start Guide" is available for first time users and can be downloaded from our website – www.EmeraldM3D.com

This ECU Configuration guide has been written to provide a detailed insight into the parameters contained within the ECU Configuration and to provide the necessary information to enable the K6 ECU to be configured to suit your engine. The ECU Configuration is where details of your base engine and the various electrical systems, sensors and actuators that are fitted to your engine are entered. Once setup correctly and appropriately to suit your engine it should not be necessary to make adjustments to the ECU Configuration unless physical changes (further upgrades/modifications etc) are made to the engine.

It is strongly advised that during the initial ECU fitment and setup process, particularly when making changes to the ECU configuration, **both the engines ignition coils and fuel injectors are unplugged.** It is important to note that permanent damage to the ECU and/or engine components can result if the engine physical configuration (particularly the ignition system) does not match the ECU configuration correctly. **Please note that damage sustained in this way is not covered by the ECU's warranty.**

The ECU Configuration is saved to its own dedicated file within the ECU and uses the file extension .k03. This file can be retrieved from you ECU and it is advisable to save a copy to your PC.

The ECU Configuration and the parameters contained within it can be accessed through the PC software by selecting any of the drop-down options from the "ECU Configuration" menu. Once open you can navigate around the ECU Configuration window using the tabs found at the bottom of the window.

ECU configuration tabs

Example screen shots are provided over the next pages to illustrate each ECU Configuration tab and the specific parameters contained within them. Please note that these screen shots are not intended to represent your engines configuration.
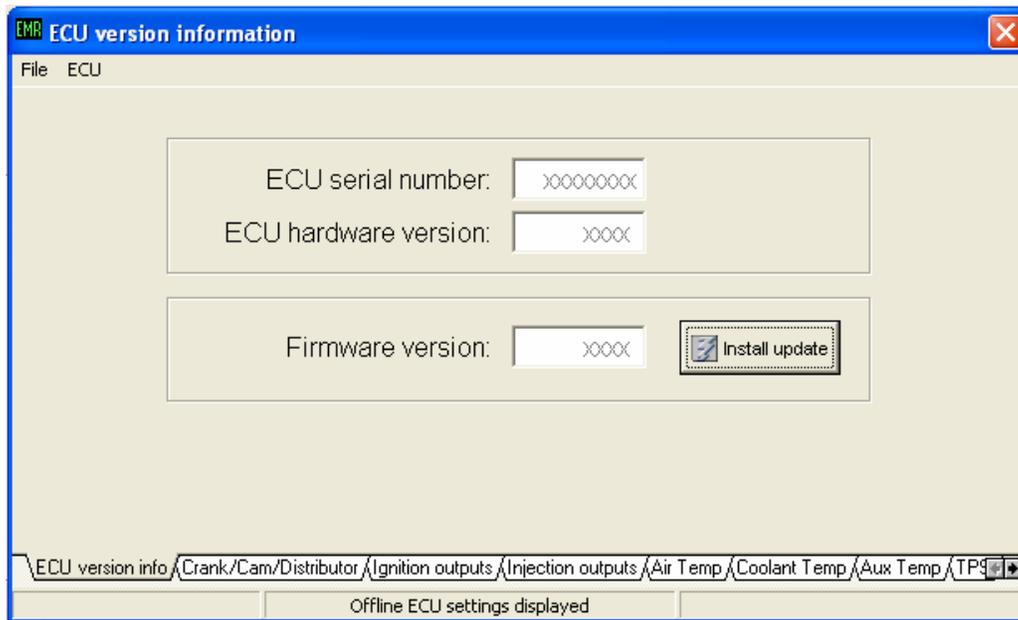
ECU version information: This tab contains information regarding your K6 ECU's serial number, hardware version and firmware version. When contacting EmeraldM3D regarding your K6 ECU always include your ECU's serial number in any communications.

Your hardware version number is a reference to the exact physical hardware level contained within your ECU. This is usually fixed at initial manufacture and would only ever be changed or updated following hardware modifications/additions made by EmeraldM3D.

Your Firmware version number indicates the level of the internal software your K6 ECU is operating with. From time to time EmeraldM3D may introduce firmware upgrades to provide more functionality and/or introduce new features. Specific engine configurations may require different firmware versions to others and may not be cross compatible. Therefore the firmware version number should be taken into account and considered when moving a K6 ECU from one engine configuration to another. This is especially relevant if the K6 ECU in question was first specified for a unique/bespoke application as custom hardware and/or firmware versions are not un-common under these circumstances.
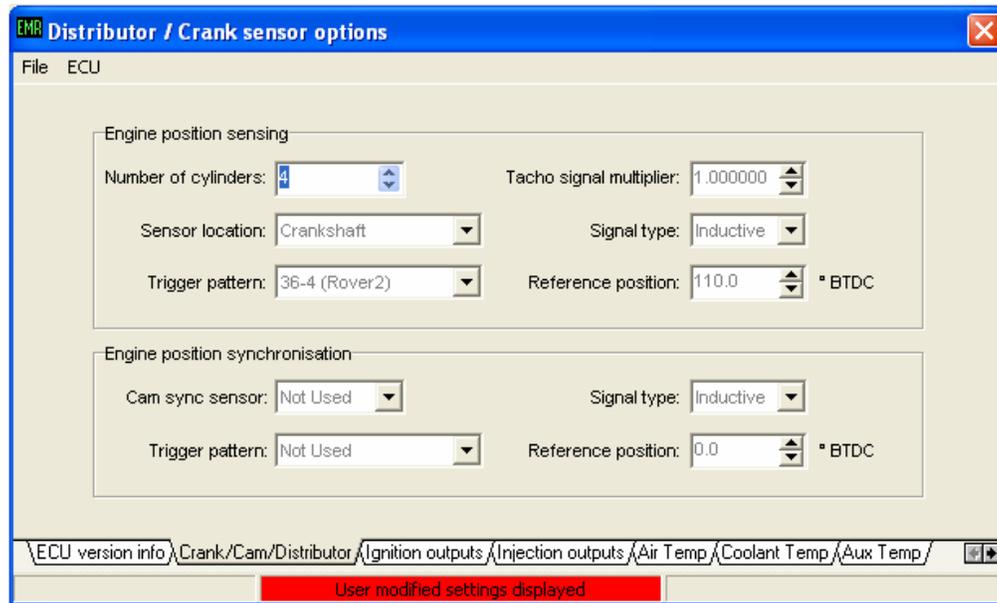
Distributor / Crank sensor options: This tab is split into 2 windows – relevant to Engine position sensing and Engine position synchronisation respectively.

Within the Engine position sensing window you are required to specify the "Number of cylinders" and where the engine speed pickup is on your engine, i.e. does it measure crankshaft speed or camshaft speed? Some engines may have a distributor/camshaft mounted trigger and others may have a crankshaft mounted trigger. Set the location of the trigger and the appropriate trigger pattern for your engine.

You will also need to specify the Signal type, whether it is Inductive or Digital, and the Reference position for the trigger that informs the ECU when cylinder 1 is at Top Dead Centre (TDC). This reference figure, especially when using a manufacturer's original speed pickup sensor and location, can usually be obtained through researching the engine type in question. For engines where crank trigger wheels have been retro-fitted the Reference position is usually more straight forward to determine – simply set the engine so cylinder 1 is at TDC and measure the gap, in degrees, from the crank sensor back to the trigger reference position - the unique gap/tooth/pip used to establish engine position.

A "Tacho signal multiplier" is also found within the Engine position sensing window and can be used to adjust the ECU's Tacho output signal in order to compensate for any tolerances/inaccuracies that may be present in the physical tachometer or for a tachometer that is preset for another engine type.

Parameters contained within the Engine position synchronisation window are relevant and required for engines that utilise sequential operation or a trigger system that uses two sensors to establish engine position, e.g. many Hondas have two sensors, the crank sensor reads 24 evenly spaced teeth and cam sensor reads a single sync tooth.

A cam or phase sensor is required to enable the ECU to "sync" with the engines firing stroke. The "Cam sync sensor" drop down option must be set to "Connected", the "Signal type" set appropriately and the relevant "Trigger pattern" selected. The Reference position in the case of the Cam sync sensor is only used in special cases so by default it should remain set to 0.0°BTDC unless advised otherwise.
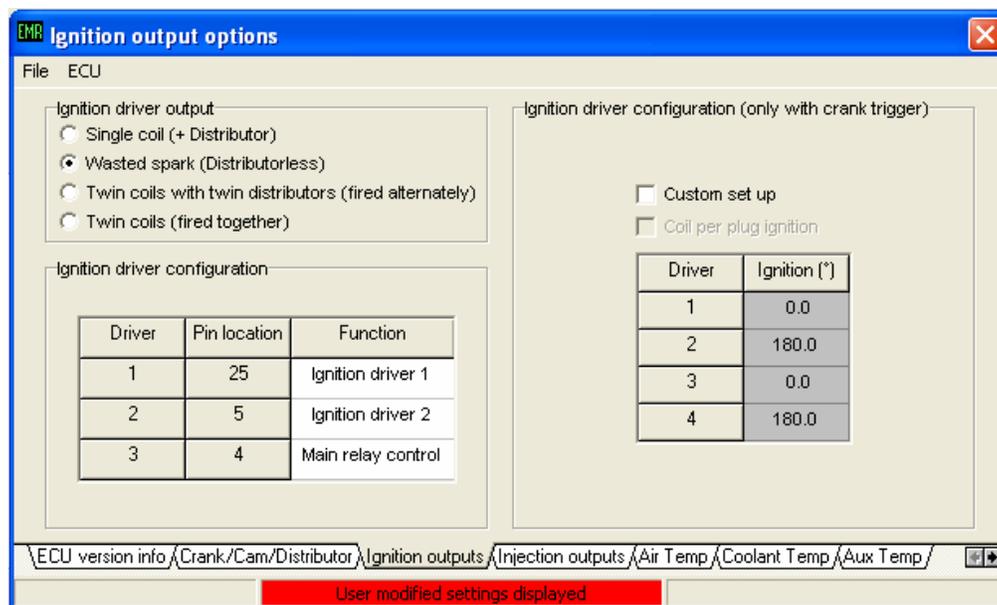
Ignition output options: This tab is used to configure the K6 ECU to suit various types of ignition system. The tab features an Ignition driver output window that allows the type of ignition system in use to be selected. Two further Ignition driver configuration windows are present and provide information on which ECU pin locations are applicable for the chosen combination of cylinder numbers and Ignition driver output. A custom set up window is also present for engines with special firing orders or Coil On Plug (COP) ignition.

Single coil (+ Distributor) is the simplest ignition system that can be driven by the K6 ECU. With this option selected the ECU will trigger the coil appropriately every time TDC for a cylinder occurs. Only 1 ignition driver is used. The distributor's job becomes to simply route or "distribute" the spark to the relevant cylinder. By nature of its design this type of system is sequential in its operation.

Wasted spark (Distributorless) ignition is utilised on engines with an equal number of cylinders and is not sequential in its operation. When configured for wasted spark, the ECU will trigger, inline with the firing order, the relevant double ended coil of the coil pack when TDC for a "pair" of cylinders is seen. The ECU does not know which of the two cylinders is on its power stroke, nor is it necessary for it to know.

The cylinder approaching its power stroke fires and the other spark is "wasted" as that cylinder will be on its exhaust stroke, hence the name – Wasted spark. Note: In the example screen shot, which is using wasted spark ignition, Pin location 5 is configured internally by the ECU to function as Ignition driver 2. If the ECU had been set to 6 cylinders on the Crank/Cam/Distributor tab then Pin location 4 would have been configured to function as Ignition driver 3 as opposed to functioning as a Main relay control.

Twin coils with twin distributors (fired alternatively) is an option primarily used on Jaguar V12 engines as they utilise unusual ignition system hardware. Early Porsche (928) and Audi V8's also require this ignition driver output option.

Twin coils (fired together) is a necessary option for engines which feature 2 spark plugs per cylinder such as certain Alfa Romeo engines and even Citroen 2CV engines!

Custom set up is applicable for engines with odd or unusual firing orders. This option also enables COP, providing the ECU is operating compatible firmware.
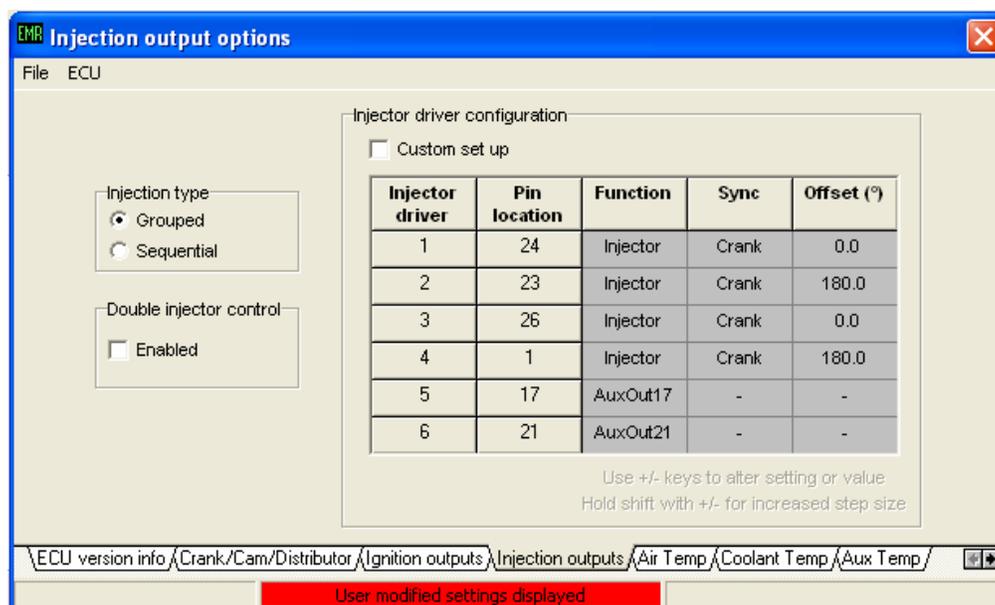
Injection output options: The layout of this tab is dictated by the number of cylinders selected in the crank/Cam/Distributor tab. The example above is representative for a 4 cylinder engine. A choice between "Grouped" or "Sequential" injection must be made from the Injection type window. Pin locations for each driver and the corresponding method of sync and the offset angle are then displayed in the Injector driver configuration window.

Irrespective of whether grouped or sequential fuel injection is chosen it is always preferable (where possible – up to 6 cylinder engines) to physically wire each injector trigger wire to an individual injector driver within the ECU – as shown in the above example screen shot. This provides more flexibility and enables the injector's mode of operation to be changed easily via the PC software.

The Double injector control window and check box option simply enables this feature and will also display the relevant Pin locations, sync and offset angle. The specific initiation and functionality of the double injector control can then be setup via the "Double injector control" option from the "Additional maps" menu in the main PC software.

By checking the Custom set up option the offset angle for each injector driver can be individually specified to suit engines with unusual firing orders or where there is a user preference to having specific injector driver numbers operating specific injectors.

Note: Sequential fuel injection operation will only synchronise correctly when a cam phase sensor is fitted.
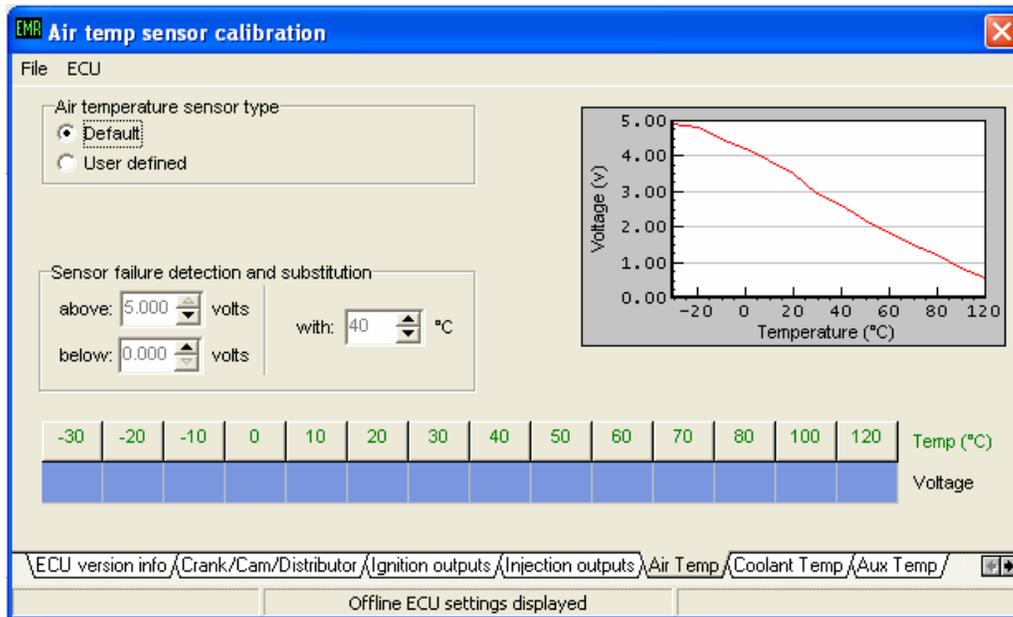
Air temp sensor calibration/Coolant temp sensor calibration /Aux temp sensor calibration: These 3 tabs are identical in function and operation and allow you to choose between the K6 ECU's default specifications for Air, Coolant and Aux temperature sensor characteristics or a user specified sensor calibration. User specified sensor parameters are simply entered into the 2D table – as voltages within the range of 0 to 5 volts. A graph is displayed to aide better visualisation of the sensors characteristic.

The Air and Coolant temp inputs on the ECU are predefined as pins 16 and 33 respectively and the Aux temp input terminal is user defined. The ECUs AuxIn10 and AuxIn35 input channels have optional internal pull-ups that make them ideal for reading temperature sensors so they are usually used for an Aux temp input.

For each sensor, pre-determined failure conditions can be set and substitute values specified for use when a sensor has failed. Aux temperature sensor input (such as pre intercooler, engine oil or trans oil temp etc) can be used, for example, to operate a secondary cooling fan to provide additional control over heat management.
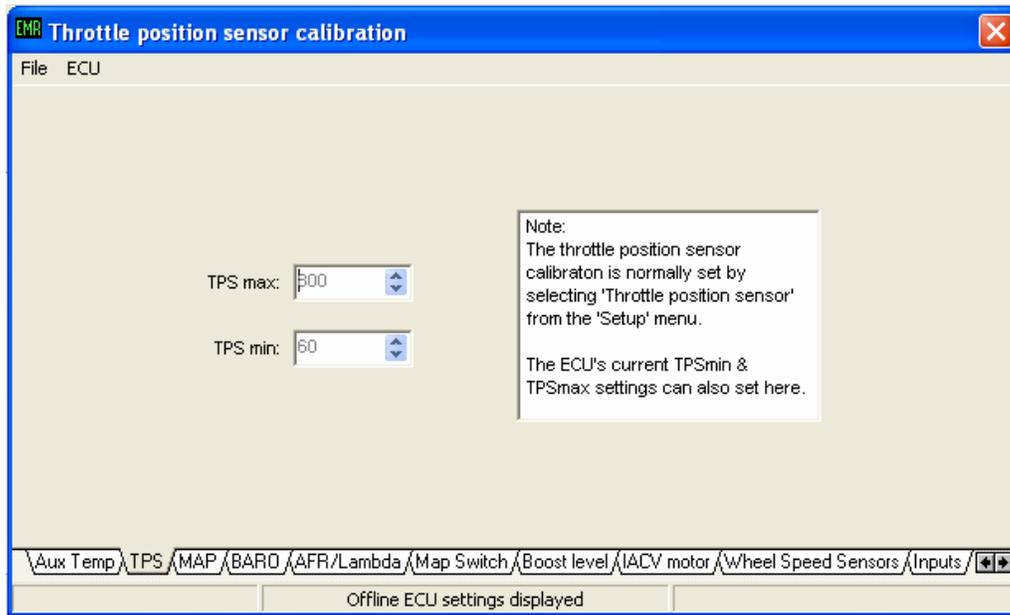
Throttle position sensor calibration: After the "Throttle Position Sensor" setup has been carried out via the main PC software the TPS max and min values are stored here. The figures can also be set / changed from this tab.
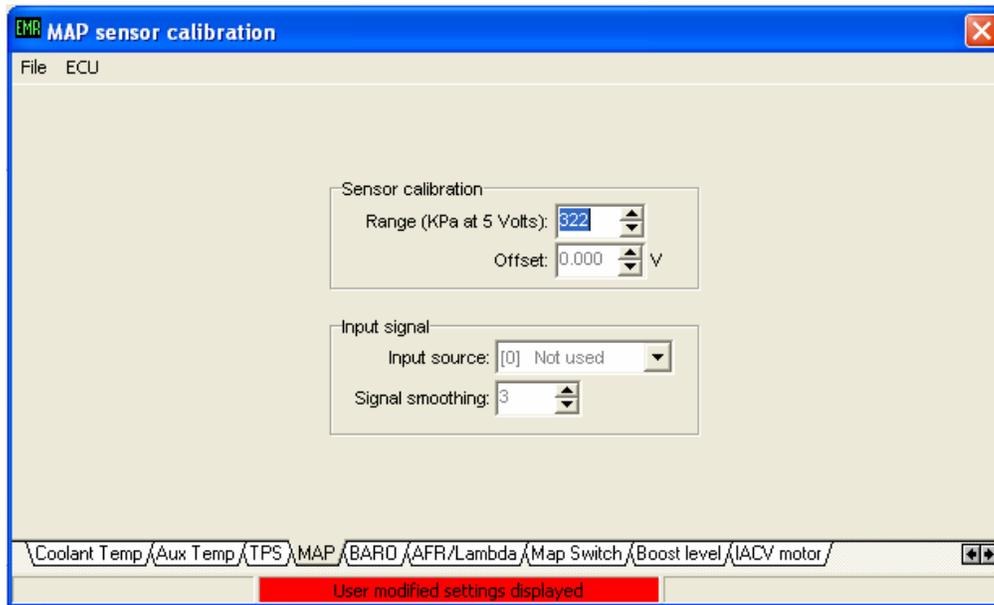
MAP sensor calibration: This tab should be used and appropriately configured when using a MAP sensor. The "Range" and "Offset" values can be determined by the MAP sensor datasheet, or provided by EmeraldM3D for commonly used sensors, and need to be entered into the respective boxes within the Sensor calibration window.

The parameters within the Input signal window, should be set to correctly represent the Pin location chosen for the MAP sensor signal input (usually pin 34). Signal smoothing can be used and is useful where the pressure tapping from the inlet plenum to MAP sensor is not ideally located and as such is subject to excessive pressure fluctuations which result in an unstable or "noisy" MAP reading.

BARO sensor calibration: An external Baro sensor may be used and if so is set up in a similar manner to a MAP sensor – see the BARO tab. Alternatively, the K6's Internal Baro may be used. To use the K6's Internal Baro, when viewing the BARO tab, select "K6 Internal" from the Input source drop down and set "Signal smoothing" to 1. "Range" and "Offset" figures are not required.

Note: When using either MAP and/or BARO sensors suitable Pressure compensation tables must be completed. The respective tables can be accessed via the main PC software under the "Additional Maps" menu (MAP compensation and BARO compensation respectively).

These pressure compensation tables should both be populated from the bottom to the top. Depending upon the range of the sensor being used the respective pressure compensation table may not be fully populated.
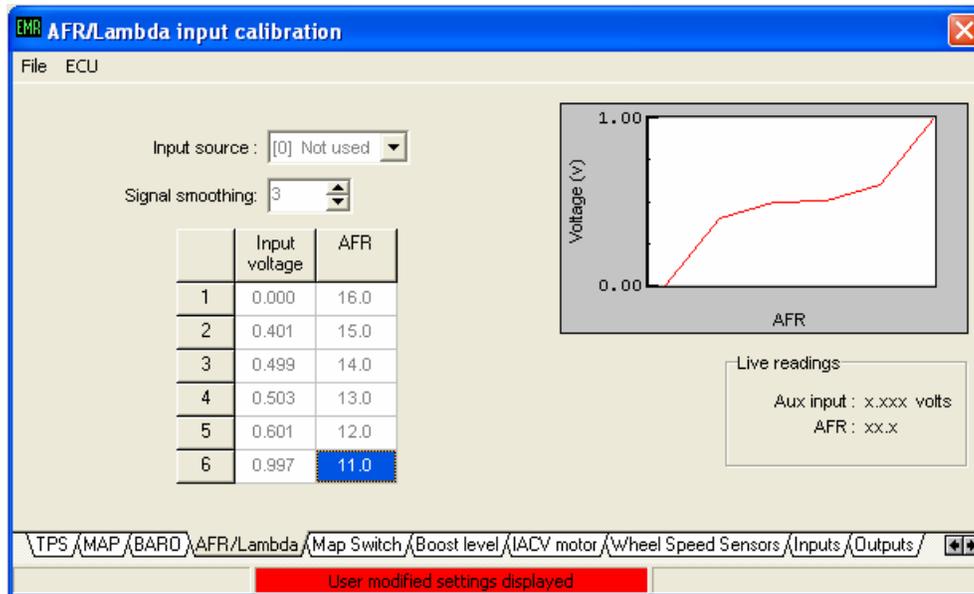
AFR/Lambda input calibration: This tab is used to provide the respective calibration curve for when a narrow or wide band lambda sensor is used.

Narrow Band Lambda sensor: To configure the K6 ECU for a narrow band lambda sensor set the "Input source" to "[0] Not used" and connect the narrow band lambda sensors signal wire to ECU Pin 7 and the sensor ground wire to Pin 18. Set the "Signal smoothing" to 3 and the table to the figures illustrated in the above screen shot.

The above process completes the configuration for a narrow band lambda sensor. However, in order to activate the sensor you must go to the "Sensor type" drop-down, found on the "Closed Loop settings" tab of the main "Fuel" tab (F4) in the PC software and select "Simple O2 sensor".

Note: For applications where the ECU controls the lambda sensor heater, e.g. Rover K Caterham/Elise, the "NB lambda heater control" output on the "Outputs" tab must be set to AuxOut36

Wide Band Lambda sensor: To configure the K6 ECU for a wide band lambda sensor set the "Input source" appropriately to read from the Pin connected to the wide band lambda sensor controllers 0 – 5 volt output – in most cases this is Pin 35. However, it can be any of the available Auxiliary inputs not in use else where. Set the "Signal smoothing" to 3 and input the respective Input voltage vs AFR figures supplied with your wide band lambda controller.

In order to activate the sensor and setup further parameters which control what the K6 ECU will do with the AFR reading (i.e. Open loop, Closed loop or adaptive control) go to the "Sensor type" drop-down, found on the "Closed Loop settings" tab of the main "Fuel" tab (F4) in the PC software and select "Wideband+Controller, AFR".

Refer to the K6 ECU manual for more information on setting up the available control states and mapping with a wide band lambda sensor.
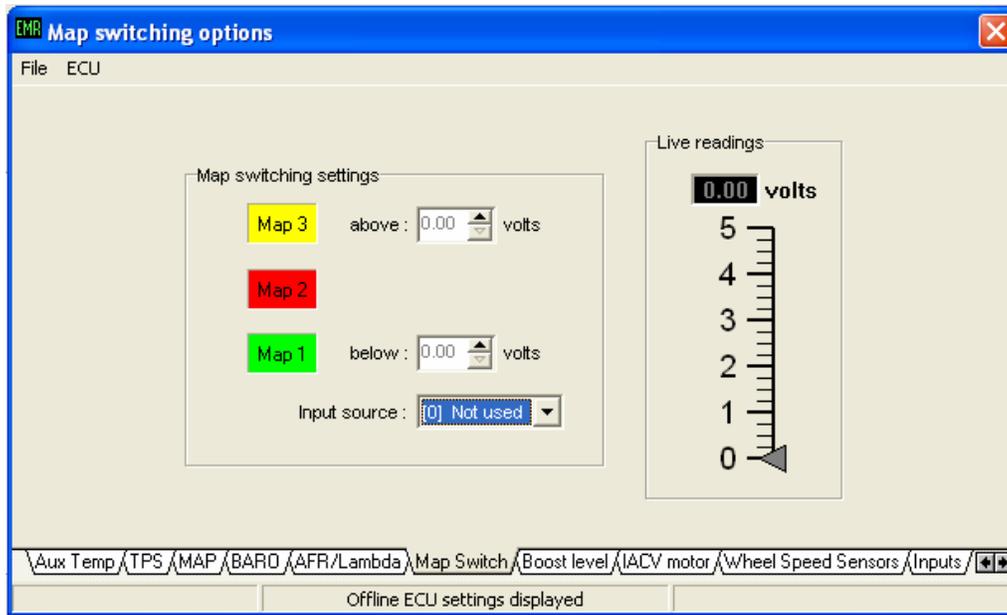
Map switching options: This tab allows the K6 ECU's map switching function to be configured. The map switching function allows the ECU to store up to 3 different maps which can be switched at any time, regardless of engine speed or load.

There are various ways of setting up the ECU to read the switching signal. Below are two examples of the most common ways.

Example 1 – This example demonstrates how to configure the ECU to switch between 2 maps via a user activated switch. In this particular example, AuxIn35 is unused so it is available as an input source for the map switching function. By enabling the internal pull-up resistor on the AuxIn35 input we can change maps using a simple switch to earth.
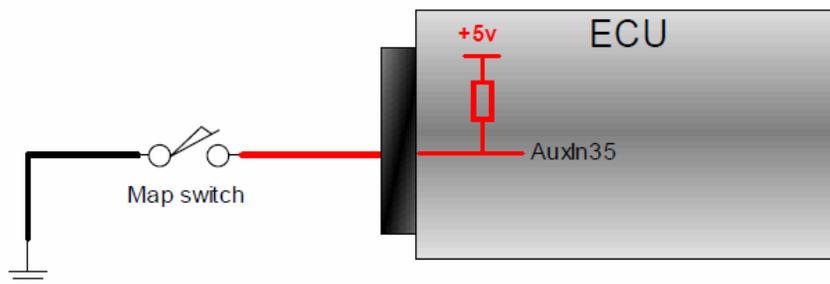
With the switch in the open position the internal pull-up resistor results in the ECU reading 5v at the AuxIn35 input. With the switch in the closed position the ECU will read 0v at the AuxIn35 input. The internal pull-up to +5v for AuxIn35 must be enabled via the "Input channels" tab.

To configure the map switching function for the above example set the "Input source" to "[2]AuxIn35". The two voltage levels used to determine which map the ECU should be using should be entered into the respective boxes for Map 1 and Map 3.

For this example the mid-point voltage of 2.51 volts is used as the above and below thresholds. Map 1 is selected if the voltage at AuxIn35 is below 2.51 volts (switch is in the closed position) and Map 3 is selected if the voltage at AuxIn35 is above 2.51 volts (switch is in the open position). Map 2 is not used and cannot be activated.

Example 2 - This example demonstrates how to configure the ECU to switch between 3 maps using a 3-way rotary position switch. As with the previous example, using an analogue input that has an internal pull-up resistor simplifies the map switch wiring.

Using such an input gives us two voltage levels with a switch to earth (open = 5 volts, closed = 0 volts). By switching this input to earth via a resistor we create a potential divider circuit which will result in a third voltage level of between 0 volts and 5 volts (depending on the value of the resistor used). As the ECU uses 1KΩ internal pull-up resistors we can switch the input to earth via another 1KΩ resistor to give a mid-point voltage level of 2.5 volts.
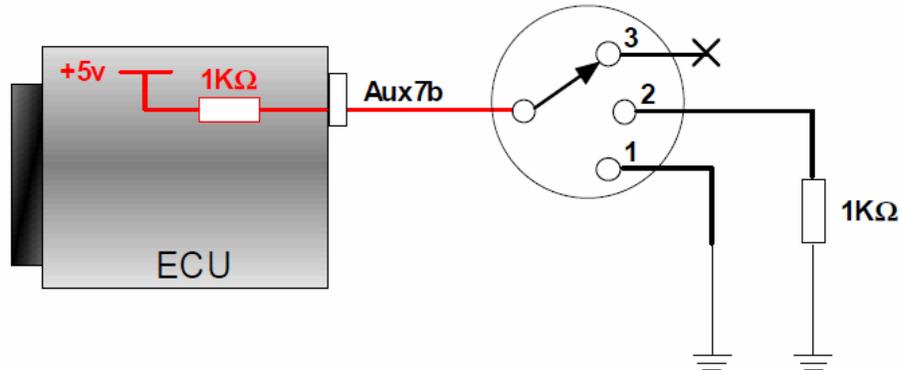
In this example Aux7b is free so will be assigned to the map switching function. With the rotary position switch at position 1 Aux7b is connected to earth which results in an input voltage of 0volts. At position 2 Aux7b is connected to earth via a 1KΩ resistor resulting in 2.5 volts at Aux7b. At position 3 Aux7b is unconnected so will be at 5 volts due to the internal pull-up resistor.

To configure the map switching function for the above example set the "Input source" to "[2]AuxIn7b". The two voltage levels used to determine which map the ECU should be using should be entered into the respective boxes for Map 1 and Map 3. Map 1 is selected if the voltage at AuxIn7b is below 1.67 volts (switch position 1) and Map 3 is selected if the voltage at AuxIn7b is above 3.33 volts (switch position 3). Map 2 is selected when the voltage is anywhere between 1.67 volts and 3.33 volts, which corresponds to switch position 2 – circa 2.5 volts.

Here the map switch thresholds have been set so that the boundaries are spaced evenly to give more than enough room for error. The map switching function monitors the input voltage approximately 5 times per second. Before changing maps the ECU will re-evaluate the new map according to the current running conditions to ensure the change is seamless. This process takes approximately 1- 2mS.

When the ECU is connected the live readings panel shows the real-time input voltage used for the map switching function. The bar graph has a vertical scale that displays 0 to 5 volts and is also colour coded to show the voltage to map selection relationship. The vertical colour coding of the bar graph is colour coded according to the map switching settings.
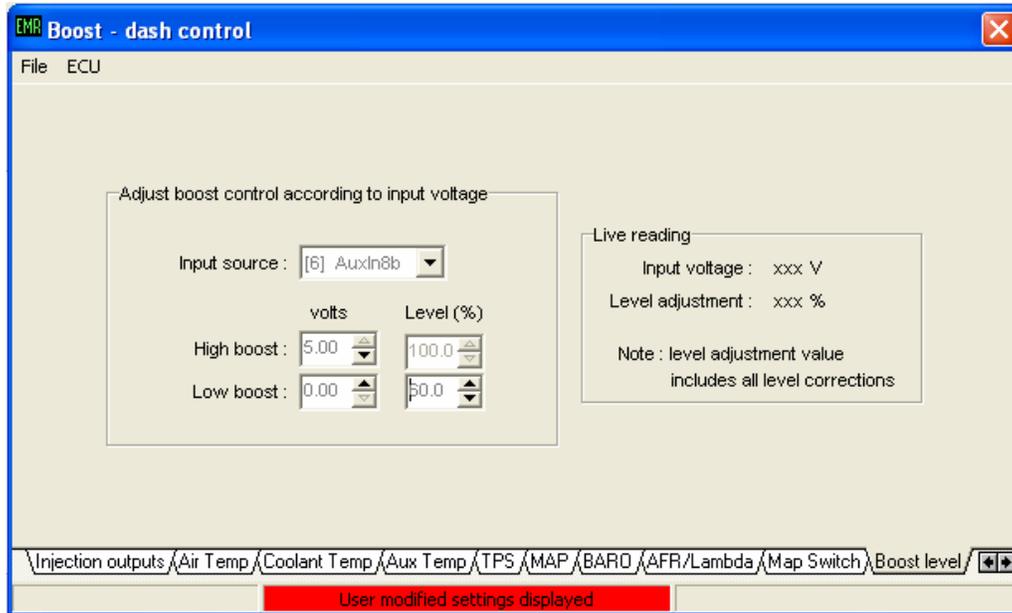
Boost – dash control: This tab can be used to configure a simple high/low boost switch that would ordinarily be dashboard mounted. By using an auxiliary input with a fixed or switchable 1KΩ internal resistor then the configuration becomes straightforward. In the above screen shot AuxIn8b has been used as it has a fixed 1KΩ internal resistor. The High boost voltage value has been set to 5 volts and the Low boost to 0 volts. The percentage of boost allowed for each switch position or voltage can then be entered to suit – in the case of the example it has been set to 60%.
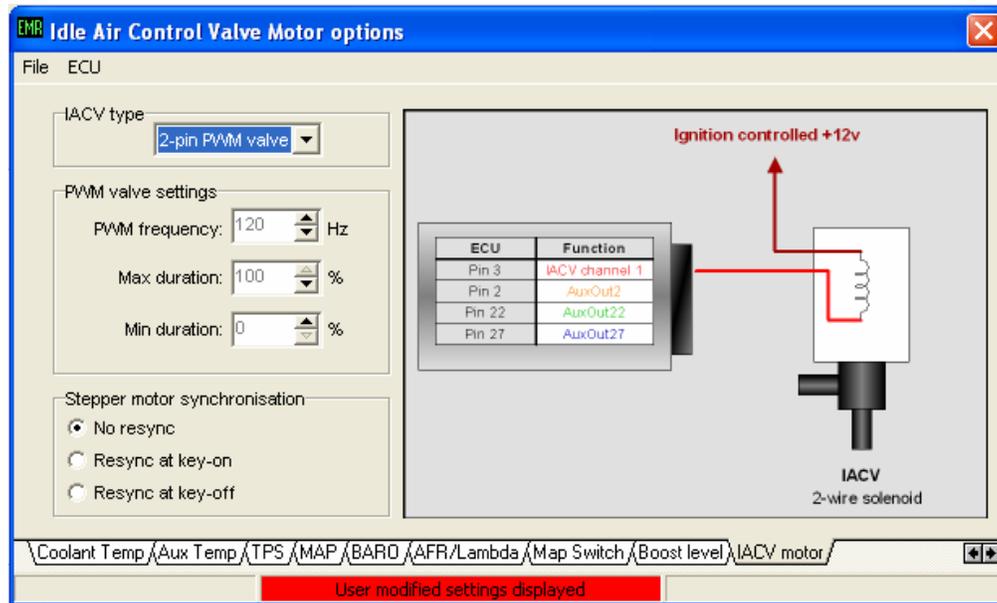
Idle Air Control Valve Motor options: This tab allows you to configure the K6 ECU to suit the type of Idle Air Control Valve (IACV) you choose to use from the available supported options. The tab is divided into 3 windows with an additional schematic display which provides information on typical wiring configurations for each type of idle air control valve supported. To configure the K6 ECU simply select the appropriate kind of IACV from the IACV type window.

If using a PWM type valve you can also specify the PWM frequency and Max and Min durations. The suggested PWM operating frequency for your chosen valve should be provided by the valve manufacturer. Max and Min duration values are typically as shown in the example screen shot above.

If using a 4 wire stepper motor then you can also specify whether the Stepper motor should re-sync it's home position at key-on, key-off or not at all. The re-sync routine is useful not only from the synchronisation point of view but also as it helps to keep the valve's working surfaces clean and free of deposits.
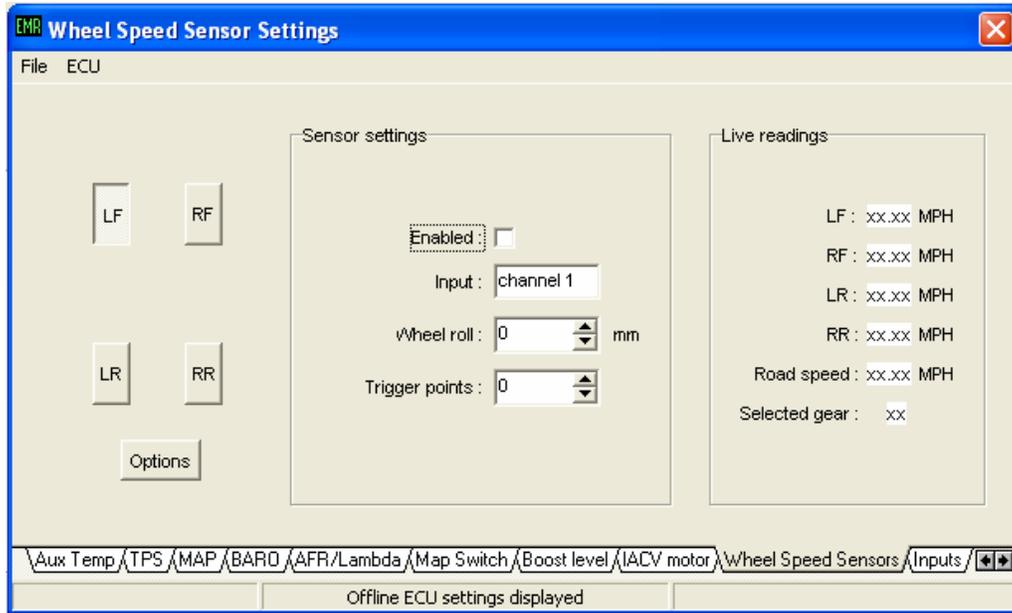
Wheel Speed Sensor Settings: This tab provides the K6 ECU with information regarding the type and number of wheel speed sensors fitted to the car. This information may be used for a variety of uses from simply driving a Speedometer to enabling the K6 ECU's sophisticated traction and launch control facilities.

Simply select the relevant button for the wheel/s where you have wheel speed sensors fitted and check the "Enabled box" within the Sensor settings window. Enter the appropriate "Wheel roll" and "Trigger points" values. The Wheel roll value should match the circumference of the wheel in millimeters and the Trigger points should equal the number of teeth on the relevant trigger wheel.
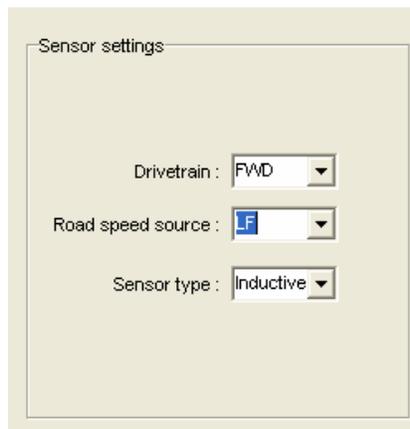
Clicking the "Options" button changes the displayed parameters with the Sensor settings window. Once the "Options" button has been clicked, 3 new drop down boxes will appear. Configure the "Drivetrain", "Road speed source" and "Sensor Type" appropriately to suit your application's drivetrain layout, which wheel speed sensor or combination of sensors should be used for the "Road speed source" and the type of speed sensors being used.

Input channel configuration: This tab offers confirmation of which Auxiliary Input channels are in use and for which purposes. It also has options for designating which Auxiliary Input channels are assigned to specific parameters for "A/C request", "A/C input 2", "Clutch switch" and "EGT interface". Depending upon the physical hardware in place all definable parameters listed, with the exception of the "EGT interface" can be set to have their "input active" either "High" or "Low".

Specific check boxes for the switchable Internal 1K Ω pull-up resistors on AuxIn channels 10 and 35 are also included on this tab.
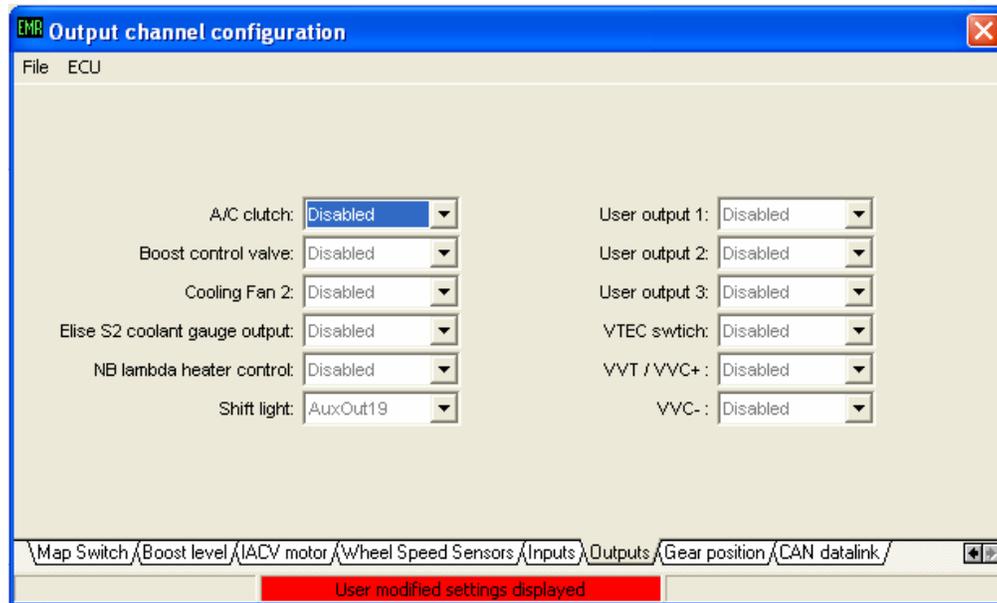
Output channel configuration: This tab provides overall control over all external components that the K6 ECU can drive/control, either directly or via relays. Simply select the relevant drop down menu for the output device or option in question and select an available AuxOut channel.

Note: Some channels have dual functionality and are able to be configured as either Auxiliary inputs or outputs. Once a channel has been configured to function as an Auxiliary Input, the Auxiliary Output capability of that channel should not be used with the same being true for the converse arrangement.
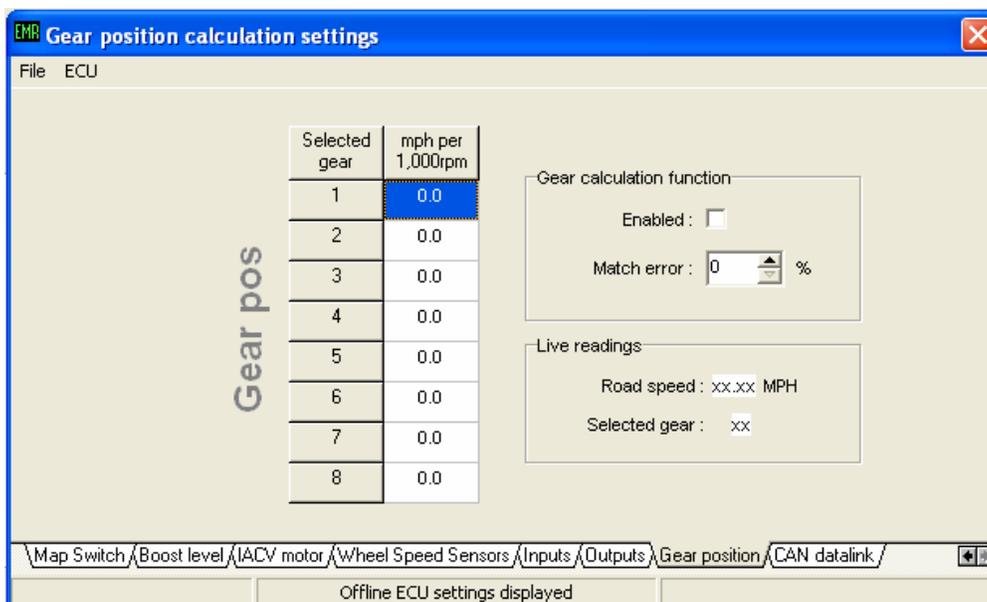
Gear position calculation settings: This tab allows the K6 ECU to determine which gear the vehicle is operating in via calculations based on known gear ratios, engine speed and road speed. Simply enter the relevant "mph per 1000rpm" figures for each of the vehicles gear ratios and check the "Enabled" box within the Gear calculation function window.

To take into account variations in road wheel sizes as a result of tyre wear or pressure variation a "Match error" value can be entered as a percentage to provide a tolerance for the Gear calculation function.
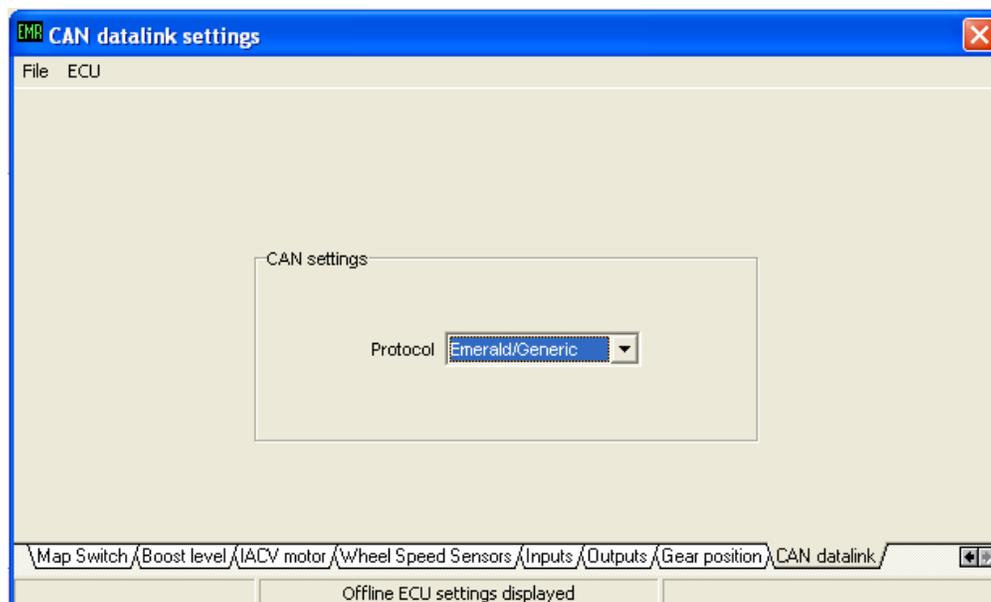
CAN datalink settings: This tab simply varies the way in which the K6 ECU outputs data on its high speed CAN datalink. With the "Protocol" option in the CAN settings window set to "Emerald/Generic", the K6 ECU will continuously output 21 channels of data onto the CAN datalink. A separate document, Emerald K3 & K6 CAN protocol.pdf, downloadable from out website provides more information about the data parameters available and also the specific CAN protocol used.

If using an AIM dashboard then the "Protocol" option should be set to "AIM dash" in order for the datalink to function correctly.