T-Win Manual

T-Series ECU configuration software manual

1.1.0

Table of Contents

1 Introduction

Welcome to the DTAFast T-Series ECU user manual.

This manual covers all the features and functions available for the T-Series ECUs.

1.1 What's New

DTA T-Win is a major new release of our control software to match the new T-series ECU's. It can only be used with T-series ECUs.

There are thousands of improvements which you will find in use. People already familiar with the old DTASwin software will have no difficulty in adapting to the new product.

Notes

- ECU communication with PC is now USB only. The serial port is just for the dyno control box 106 and does not require a connection to the PC
- ECUs must be on firmware 2.xx to communicate with T-Win software
- ECUs mapped on T-Beta will require Throttle Stops 56 to be re-set
- ECUs can be easily firmware-upgraded using the T-Flash tool.

Changes from S-Win

- Re-organisation of settings
- Soft RPM limit replaced with cut-patterns
- Coil dwell time replaced with Dwell Table (important for alternator-less cars)
- Injector dead time replaced with Dead Time Table (important for fuel compensations, start fuelling and alternator-less cars)
- Ignition 42 and Injection 47 pages now combine many previously separated settings
- Engine Protection 38 page combines previously separated settings

- Analogue Inputs[25] no longer tied to specific Outputs[26]
- Throttle Stop[56] voltages can be set manually or captured
- Real Time Mapping[14] has many new usability changes
- Compensations are now part of Sensor Configurations[49]
- Real Time Chart[19] now captures data at 15Hz, all data items are recorded and can be shown/hidden at will.

New

- Fully assignable inputs and outputs
- Individually testable outputs
- Pinouts and Support Documents[96] in the manual
- Flexible Analogues[27]
- Flexible Outputs[28]
- Real-time PC logging using the Real Time Chart[19]
- 1000Hz ECU Logging

1.2 Getting Started

Software/Firmware

The T-Win software requires ECUs to have a minimum of version 2.14 firmware installed. Updating firmware can be done from the Desktop using the "T-Flash" shortcut or from the file menu in the T-Win software. You will be notified of any available software updates when the program opens. There may be times when a software update also requires a firmware update due to added features.

Before updating firmware, we always recommend saving a copy of the current map first.

ECU Requirements

At a minimum, the ECU requires the following to run an engine:

- "Crank" Sensor with a minimum of 12 teeth on the trigger wheel
- Load Sensor (i.e. Throttle Position Sensor or Manifold Pressure Sensor)
- Resistor Spark Plugs Fitted (some engine will run fine with non-resistor plugs but it is not recommended and in extreme cases can damage the ECU)
- Ignition Coil

- Permanent 12v
- Switched (ignition) 12v
- Earth (ground) to cylinder head

We always recommend fitting as many sensors as you can, both as an aid to running and as an aid to tuning and diagnostics. Ensure that any temperature sensors you plan to use have a resistance vs temperature scale available for them. If in doubt, use one of the sensors listed in the software under Sensor Configuration 49. Most pressure sensors will have a linear 0-5v scale that is either supplied with them or written on them. Again, if in doubt, use a sensor listed in the software.

Water Temperature
At temperatures other than "operating temperature", the engine will have different fuel requirements. This is especially true of cold starting, where the engine requires considerably more fuel to be able to start and run smoothly. Similarly, it can be useful to add more fuel when the engine gets too hot to help with cooling and dull the performance to indicate to the driver that something is wrong (should they have no gauges). The ECU can also be set to reduce the RPM limit based on water temperature (see Engine Protection 38)

Air Temperature
The density of the fuel mixture will vary with air temperature. Hot air temperatures can induce knock. Having a sensor fitted allows for fuel and ignition compensations to be applied to the base map values.

Oil Temperature and Pressure
Less useful to the engine running than water or air temperature but still useful for logging purposes and can also be used for Engine Protection 38

Fuel Pressure
Useful for setup and diagnostics work.

Inlet Manifold Pressure (normally aspirated engines)
Generally not required unless the engine will experience extremes of altitude. However, can be useful on engines that use an idle control valve as the fuel requirements can be compensated for based on pressure.

Throttle Position (forced induction engines)
Useful for throttle transients, shift-cut and overrun when using a MAP sensor as load.

Ethanol Sensor
Allows an engine to run on fuel with varying concentrations of ethanol, allowing the same base map to be used with compensations based on the sensor output. Note: E5 requires 3% more fuel injection quantity than E0. E10, 6%, E85, 54%.

Lambda Sensor

All T-Series ECUs have a built-in Bosch wideband lambda sensor controller designed for the Bosch LSU 4.9 lambda sensor. We strongly recommend always fitting a lambda sensor, even on a race engine as it can be constantly logged and is a vital diagnostic tool. It also makes tuning the fuel table much quicker (go to the cell, hit enter, next).

Tuning

Communicating with a T-Series ECU is done via USB only. The serial port maintains compatibility with the dyno box[106] only.

Start by loading a base map. If one does not exist for the specific engine, try and find one close in type and specification or use the map shipped with the ECU, which is usually a good starting point.

Set the size of your main fuel and ignition tables then set the table axis, in Map Configuration[25]. Ensure the load and rpm axis are set correctly for the engine you are mapping. It is often useful/necessary to have smaller increments at the lower end of the scale than at the top. Keep the main map table size as small as necessary. A full 32x32 map can be difficult to work with on a smaller screen.

Setup your Inputs[25] and Outputs[26].

Set the crank sensor type. All 2-pin sensor are VR. 3-pin sensors can be VR or Hall Effect. If you are unsure, the Crankshaft Oscilloscope[20] can help.

Ensure the flywheel mode is correct and the tooth and missing tooth counts are correct in Engine Settings[32]. The gap tooth factor must also be set correctly.

A critical piece of information required by the ECU to run the engine is the crank sensor position in relation to TDC. If this value is not set correctly, the engine may run poorly or not at all. Instruction for measuring the angle accurately can be found in the Engine Settings[32] section. Always ensure this value is correct before attempting to map the engine. Adjusting this value after an engine has been mapped will require adjustments to the ignition map.

Run through the rest of the Engine Settings[32], followed by Engine Protection[38], Ignition Settings[42] and Injection Settings[47].

Ensure all the sensors the engine uses are accurately setup in Sensor Configuration[49].

Try starting the engine. If it does not fire after a couple of attempts, remove a spark plug and check the condition. If it's wet, remove fuel from the Main Fuel Map[62]. If it's dry, add fuel. You can also make adjustments to the Start Fuelling Map[63], using the shipped map on the ECU as a guide. However, the start fuelling map should not be fully tuned until the Main Fuel Map[90] is correctly setup at the engines operating temperature.

Once the engine starts, get it up to temperature, and adjust the Main Fuel and Ignition Maps 62 at idle. Ideally the engine should idle at the desired RPM, at operating temperature, with no intervention from the ECU. If individual throttle bodies are fitted, ensure they provide enough air when closed for the engine to idle at the desired RPM, at operating temperature, with no less than 8° of ignition advance.

Once the engine is happily idling at operating temperature, tune the Main Fuel and Ignition Maps 62. For fully variable cam engines, keep the fulling quite rich until the camshaft map(s) are setup correctly. If a lambda sensor is fitted, closed loop fuelling can make the process of fuel and cam tuning much quicker. Whilst tuning the main maps, you should also tune the hot Throttle Transients 69.

Only once the engine is fully mapped should you then tune the Start Fuelling Map 63 and Idle Control 65 settings fully. Idle control should be tuned first, whilst making manual adjustments to fuelling (either with the Dyno Box 106 or in Real Time Mapping 14 using the Map Editing Keys 10). Once you are happy with Idle Control, the Start Fuelling can be tuned. See the Guide to Start Fuelling 107 . During the start fuelling tuning process, you should also take time to tune the cold Throttle Transients 69.

1.3 Software Installation

Download the latest version of the software from the Downloads section of the website here:

http://www.dtafast.co.uk/downloads/

Simply run the T-Win installer file, and follow the instructions. After that the software will check for update automatically each time it is launched.

NOTE: In order to facilitate easy firmware upgrades, the main installer will also ask if you want to install additional software components (such as Memtool).

1.4 Definition of Terms

CALIBRATION UNITS USED

Temperature	degrees Centigrade	°C
Injection ms	injection pulse length in milli-seconds	ms
Engine speed	revs. per minute	RPM
Engine turns	rotations since synchronisation	Plain Number
Advance Degrees	degrees of ignition before TDC	°
Throttle	percentage of throttle opening	%

Dwell	ignition coil charge time in microseconds	µs
Pressure	kPa of inlet pressure	kPa
Lambda	Current AFR divided by stoichiometric AFR	Lambda
Frequency	Number of times per second something occurs	Hz
Duty Cycle	Percentage of "on-time" over a given frequency	%

GENERAL

Load site	A table cell
Traced cell	A table cell that has been saved or "mapped" in software but not yet sent to the ECU
Dyno control cox	A wired controller used to directly control the ECU while mapping
Synchronisation	Occurs once the ECU has recognised the crankshaft/camshaft trigger patterns

1.5 Map Editing Keys

General Keys

F1	Displays help manual relevant to the section of software you are currently in
F4	Store changes to engine
F5	Manipulate selected cells
Alt+R	Switch between current view and real time mapping
Ctrl+C	Copies selected
Ctrl+X	Copy and remove (cut) selected
Ctrl+V	Paste cut/copied cells
Ctrl+O	Open a map file
Ctrl+S	Save map to file

In Main Maps

Alt+Up Arrow	Fine adjust cell to higher value
Alt+Down Arrow	Fine adjust cell to lower value
Alt+Page Up	Coarse adjust cell to higher value
Alt+Page Down	Coarse adjust cell to lower value

Other Keys

Cursor Keys	Move about maps
Space Bar	Select the currently highlighted cell
Enter	Select/de-select current cell

In Real Time Mapping

Ctrl+Tab	Switch between the open windows
Enter*	When the Real Time Values window is selected, pressing Enter will add the current adjustment(s) to the map as a traced cell. Cell will turn brown but will not be applied to ECU map until F6 is pressed.
Ctrl+P	Dyno control box on/off*
Ctrl+D	Dyno control box coarse/fine
Ctrl+B	Change left dyno control box knob to Turbo Valve PWM
Ctrl+Q	Change left dyno control box knob to Injection Angle
Ctrl+K	Stop engine*
Ctrl+I	Interpolation on/off
Ctrl+L	Closed Loop Lambda on/off
Ctrl+T	Clear Traced Cells
Ctrl+M	Position trails
Ctrl+N	Clear position trails
F6	Send traced cells to ECU. Brown traced cells will turn green to indicate the values are now "in-use" by the ECU.
F7	Change left dyno control box knob to Cam 1 target
F8	Change right dyno control box knob to Cam 2 target

*These all function in the same way as using the dyno control box

2 Menu

The toolbar menu is located near the top of the window.

If you right-click in an empty area of the toolbar, a context menu appears. Clicking customise allows you to change icon sizes and allows you to edit the items in the toolbar or even create a custom toolbar. Custom toolbars can contain any menu item you like and can be dragged and docked with either the top, bottom, left or right side of the main window. They can also be dragged into the main window and persist as a floating toolbar.

To add commands to a toolbar, open the customise dialog and drag a command to the toolbar. To remove a command, drag it out of the toolbar and release.

2.1 File

This section covers all the items found in the File Menu section.

2.1.1 Open from File

NOTE: Opening a map file when connected to an ECU will automatically upload the map to the ECU. Ensure you have taken a backup of the map on the ECU first by using the save option first.

When opening a map, the comment for that map is displayed in the right hand panel. Clicking on any map in the available list will display its comment. Double clicking will open the map.

2.1.2 Lock ECU

Lock ECU is a way to ensure that no unintentional changes are applied to the map.

Due to the frequency of people forgetting PIN codes, we do not recommend using them unless absolutely necessary.

2.1.3 Update ECU Firmware

ECU firmware can be updated from here. Requires Memtool to be installed (which usually gets installed with the T-Win software unless specifically denied).

2.1.4 Save

Save the current map to disk.

2.2 Edit

This section covers all the items found in the Edit Menu section.

2.2.1 Cut

The cut function can be found under the Edit menu. Ctrl+X or right-click > cut can also be used.

The cut function copies and removes data. To use the cut function, select the area you wish to cut, then select cut or use the keyboard shortcut.

2.2.2 Copy

The copy function can be found under the Edit menu. Ctrl+C or right-click > copy can also be used.

To use the copy function, select the area you wish to copy, then select copy or use the keyboard shortcut.

2.2.3 Paste

The Paste function can be found under Edit. Alternatively Ctrl+P or right-click > paste can be used.

When you wish to place the item(s) you have cut or copied, select Paste or use the keyboard shortcut.

You can copy and paste the entire contents of a table. Click the top left cell you wish to paste into, select Paste and the rest of the table will fill with the copied values.

Similarly, if you only copied a section of a table, select where you would want the top left cell of the copied group to start and then paste.

2.3 Real Time Mapping

The real time mapping view has a huge amount of flexibility when it comes to organising the layout of the information you want displayed whilst mapping.

There are two main ways of displaying data; floating windows and tab groups. By default, all tables, charts and data views will open as floating windows that you can arrange and resize however you like. However, you can also dock these views to the left, right, top and bottom of the screen, which turns them into tab groups. You can have multiple tab groups and even dock tab groups to other tab groups. Each tab group can have one or multiple tabs displaying anything you like from the real time mapping menu.

However you choose to display the views, everything can be resized and the contents will scale to fit the size of the container it's in.

To resize a floating window, hover over a corner or an edge of the window and the mouse cursor icon will change from an arrow to a double arrow. Left-click, hold and drag to resize. Resizing a tab group is similar but you can only resize one edge at a time, not a corner.

To create a tab group from a floating window, left-click and hold the window title and start dragging it toward where you want it to be docked and a docking icon will appear. When the mouse pointer is on the docking icon, release left-click and the floating window will dock as a tab group.

Within a tab group, you can pin one or more tabs to the left-hand side of the group by right-click the tab and selecting "pin". Pinned tabs can be re-ordered by left-clicking and dragging. Non-pinned tabs cannot be dragged into the pinned tabs. If you drag a pinned tab into non-pinned tabs, it becomes unpinned.

2.3.1 Open/Close Real Time

Click to open or close the real time mapping view. This can also be done using the keyboard shortcut, Alt+R

2.3.2 Views

Contains all the tables, graphs and data views available for display in real time mapping

2.3.2.1 Tables

Select from the list of data tables to be displayed in real time mapping

2.3.2.2 Graphs

Select from the list of graphs to be displayed in real time mapping

2.3.2.3 Live Data

Select from the list of live data views to be displayed in real time mapping

2.3.2.4 Settings

Battery Limit
When voltage is below this value, a warning will display

Acceptable Load/RPM Deviation (Crosshairs)
These settings define when the crosshairs turn green during Real Time Mapping. When interpolation is off, the deviation settings define how far away from the middle of the cell the crosshairs can move before they are no longer green. When interpolation is on, these settings define how far into the cell (from the top-left corner of the cell), the crosshairs can go before they are no longer green.

2.4 Open (Folder Icon)

NOTE: Opening a map file when connected to an ECU will automatically upload the map to the ECU. Ensure you have taken a backup of the map on the ECU first by using the save option.

When opening a map, the comment for that map is displayed in the right hand panel. Clicking on any map in the available list will display its comment. Double clicking will open the map.

2.5 Save (Disc Icon)

Saves the current map to disk and allows you to enter a comment for the map. Note: you no longer have to press Ctrl+Enter for a new line in the comment box, just hit enter.

2.6 Lock ECU (Padlock Icon)

If you have been viewing a map offline and then connect an ECU, the ECU will not attempt to download the current map into the software until you click this button. Clicking this button will clear the offline map from the software.

3 Navigation

The treeview menu is located on the left-hand side of the main window.

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3.1.1 Dashboard

Displays various gauges displaying current engine data.

3.1.2 Diagnostic Display

Engine Statistics

RPM
RPM shows the current revolutions per minute of the engine. If the engine is not running this should read 0.

Crank Rotation Time (ms)
Crank Rotation time is the time for one revolution of the engine in milliseconds.

Time ECU On
This shows how long the ECU has been switched on (in total) since its initial production along with the date of production (these cannot be reset by the user).

Total Running Time
This shows the total time the ECU has run an engine for.

Time Above 75% RPM
The accrued time spent above 75% engine speed is displayed here.

Time Above 75% TPS
The accrued time spent above 75% throttle opening is displayed here.

Time Above 75% BOTH
The accrued time spent above both 75% engine speed and throttle opening is displayed here.

Run Time Last Reset
The date which the Total Running Time was last reset.

Lowest and Highest
This shows the highest and lowest values seen by the ECU since it was last reset.

Coil Driver C (coil temperature) is only shown on the T2 and T2i models.

Crank/Cam Sensor Errors

Rejected Crank Pulses
Signals received from the crankshaft sensor that the system does not recognise, based on the information entered in Engine Settings[32]. Signals may also be rejected because they represent over 20,000 rpm, are from electrical interference (from the HT leads for example), an off-center crank wheel or loose/damaged crank sensor.

Crank Wheel Teeth Errors
This value increments when an unexpected cam pulse is received based on the current crank tooth. This value only increments in flywheel mode 5, 6, 8 or 10. Usual cause of this error is electrical noise/interference.

Cam Sensor Errors
Only important when running unequal firing, coil on plug or sequential injection. Checks that the correct ratio of crank to camshaft pulses are received.

Synthetic Tooth Errors
These are manifestations of a combination of the above errors. Missing teeth are reconstructed by the ECU to ensure correct timing. These are called synthetic teeth. Errors during this process are recorded here.

Re-Synchronisations
If the ECU receives an incorrect crank or cam tooth count it will attempt to re-synchronise and increment this value.

Rejected Cam Pulses

Rejected cam pulses are signals received from the cam shaft sensor that the system does not recognise based on the information entered in engine settings. Signals may be rejected because they represent over 20,000 rpm, are from electrical interference (from the HT leads for example) or you have an off-centre cam wheel or loose/damaged cam sensor.

Starting Information

When the engine is stopped the message “Engine Not Turning” is displayed at the bottom of this box in RED. If the engine reads as turning it is likely their is a fault with the crank sensor or the wiring.

When the engine starts to crank the message “Turning – Attempting to Synchronise” appears in RED.

If this message is displayed the engine will not start. The injectors and coils will not fire until the ECU is synchronised.

If the message remains this implies a problem with the Engine Settings 32 (most likely flywheel mode, gap tooth factor or tooth count). Refer to the chapter on the Crankshaft Oscilloscope 20 to try to resolve the issue.

When synchronisation is achieved this box displays the message “Synchronised – Attempting to Start” in GREEN.

If the message “Synchronised – Attempting to Start” is displayed and the engine will not start, this suggests a fuel or timing issue, a problem with your coils or injectors or the unit is incorrectly wired.

Coils and Injectors can be tested in the Outputs 26 section.

Start Syncs

In order for the engine to run, the ECU must synchronise it's operations with the crank angle of the engine. This value increments on every successful synchronisation.

Turns Before Synchronisation

Number of engine revolutions before synchronisation was achieved. This does not automatically reset. If the engine takes longer than 2 turns to synchronise, you may have a wiring, sensor or mechanical issue.

Total Teeth Before Sync

Number of teeth counted before synchronisation was achieved. This does not automatically reset.

Total Attempted Starts
Total number of attempted and/or successful engine starts since the diagnostic data was last reset.

Sensor State

Displays the number of intermittent sensor errors and whether the sensor is currently functional. Note: unused sensors may display a high intermittent count.

Engine Information

Displays the information about the crank and cam synchronisation status, and whether sequential injection or ignition is active.

Current Values

Displays the current values of the listed items.

Lambda Information

Displays diagnostic information from the on-board lambda controller(s).

ECU Information

Displays the ECU information.

Serial Number The ECU serial number
Generation The ECU generation
Firmware Generation The firmware generation. This must match the ECU generation, or the engine will not run.
Hardware Version The ECU hardware version.

3.1.3 Real Time Chart

Shows, in real time, charts of data recorded by the PC from the ECU.

You can select which data charts are displayed by pressing the "add/remove items" button.

Items can be added or removed at any time, it will not effect the recording as all data is recorded.

To start recording data press "Start". To review the data, press "Pause".

Charts can easily be saved but only the selected data is saved. Ensure you have all the data items you may need selected before closing the software.

Navigation

The displayed data can be zoomed in and out and scrolled through.

To Zoom In, you can:

- Scroll up (on mouse wheel or trackpad)
- Shift+Left-Click
- Shift+Left-Click and Drag to zoom into a specific region of a selected chart

To Zoom Out, you can

- Scroll down (on mouse wheel or trackpad)
- Alt+Left-Click

To reset the zoom, press Ctrl+Z

To move back and forth through the chart, you can:

- Click and drag the charts left/right
- Click and drag the scroll bar at the bottom of the window
- Ctrl+Left/Right Arrow

3.1.4 Crankshaft Oscilloscope

The crankshaft oscilloscope allows you to do the following:

- Determine how many teeth are on the crank/cam trigger wheel(s) and the missing teeth (if any) i.e. the "trigger pattern"
- Determine approximately the crank/cam sensor angle in relation to TDC on the compression stroke of cylinder-1
- Determine if a VR sensor is wired correctly

This is designed as an aid to starting an engine for the first time. Press gather, crank the engine and you will get a visual representation of what the ECU is reading from the trigger wheel(s) via the crank/cam sensor(s).

If the ECU cannot “synchronise” – i.e. confirm that the tooth and missing tooth count set in Engine Settings32 matches what is being measured from the crank/cam sensor(s) – the engine will not run.

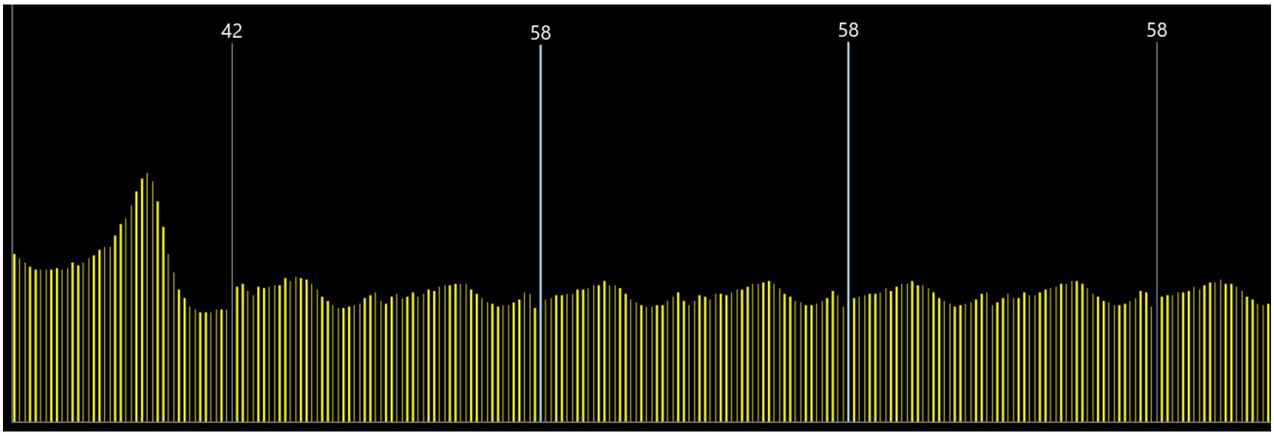
The ECU measures the time between the teeth passing the crank/cam sensor(s). If you tell the ECU that the engine is running a 36-1 crank trigger wheel, it will look for 35 small gaps and 1 big gap. If it sees something different, it will not synchronise.

Each vertical line represents the time taken between the falling edges of each tooth on the crank/cam wheel(s) passing the sensor. The taller the line, the longer the time between falling edges.

Note: if the trigger pattern is already set correctly, the engine will attempt to fire once gathering has finished.

Determine the Trigger Pattern

Below is an example of a 60-2 wheel on a 4-cylinder, 4-stroke, flat plane crankshaft engine (i.e. two pistons reach TDC at the same time per rotation and there are 2 compression strokes per rotation):



Above you can see the oscilloscope has identified that for every 360° rotation of the crank trigger, the time measured between the falling edge of the 58th tooth and the falling edge of the next tooth is much longer. Relative to the other measurements, it is double the length so the vertical line has been coloured blue to represent a double missing tooth gap. The line after it will be a representation the measured time between the falling edge of the first tooth after the gap and the falling edge of the second tooth. Note: The first blue line will (almost) always have an incorrect count. This is normal as the count starts as soon as the engine turns and the first count could be anywhere on the trigger wheel. The rest of the blue lines are counted relative to each other.

Between the blue lines, you will see two peaks in the measured gap times. These represent the slowest point in the engines rotation, which is usually TDC on the compression stroke. The higher the compression, the higher the peaks will be.

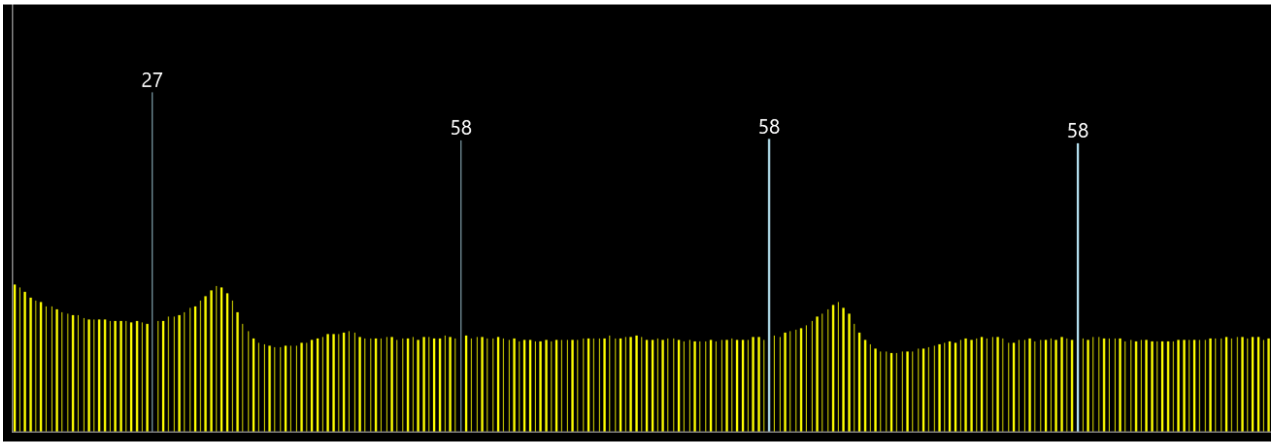
In summary, the number on top of the tallest line is essentially how many physical teeth the trigger wheel has. The colour of the line represents how many missing teeth the trigger has. The ECU needs to know how many teeth in total. 58 actual plus 2 missing (60). It also needs to know how many missing teeth (2). This is set in Engine Settings 32.

Determine Crank Sensor Position

In order to determine the sensor position in relation to TDC on the compression stroke:

- Set the trigger teeth count to an incorrect value in Engine Settings 32 to prevent the engine attempting to fire once gathering has finished.
- Remove all spark plugs except cylinder-1
- Fully open the throttle
- Click gather and crank the engine

Below is an example of a 4-cylinder engine, 60-2 trigger with only cylinder-1 spark plug installed:



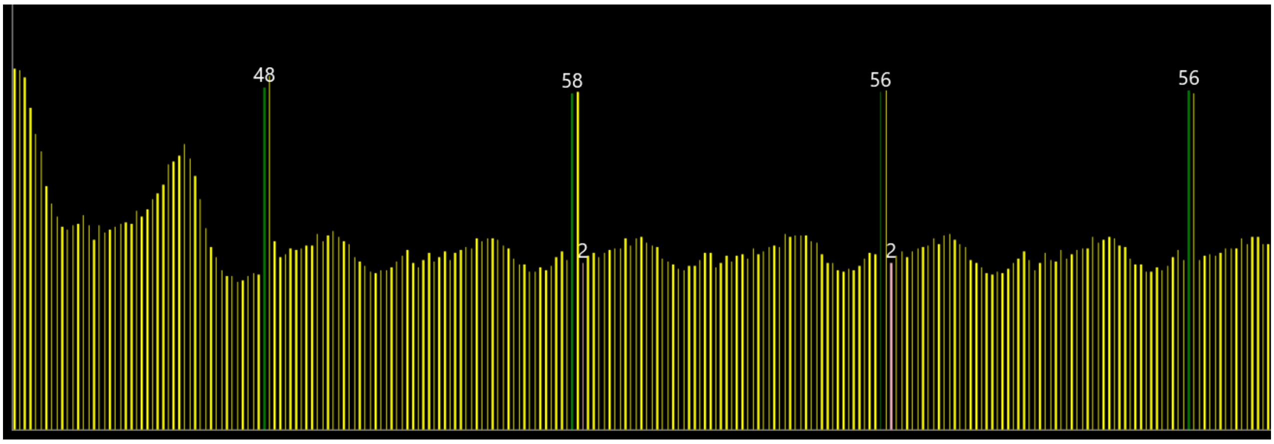
Each blue line (representing a double tooth gap) is 360° of crank rotation from the next. If you count the falling edge times measured, starting with missing tooth line, up to and including the longest measured time, that will give an approximate location for the crank sensor in relation to TDC on the cylinder-1 compression stroke.

In this case, there are 13 times measured. We know the trigger wheel has 60 teeth in total (58 actual, 2 missing). Each tooth represents 6° of crank rotation (360÷60=6). Therefore the approximate sensor position before TDC is 13x6°=78°. Note: it is always best practice to confirm this with a timing light as the actual figure could be +/- 1 tooth. In this case, the actual position could be anywhere from 72°-84°. However, as this was an OEM trigger setup (and OEMs usually line the sensor up with a falling edge of a trigger tooth), the figure of 78° is accurate and was verified with a timing light.

Note: this method is also useful for determining on which stroke a cam sensor pulse is received.

Determine if VR (magnetic) Sensor is Wired Correctly

Below is an example of the same engine and trigger, with its VR (magnetic) sensor connected the wrong way round:



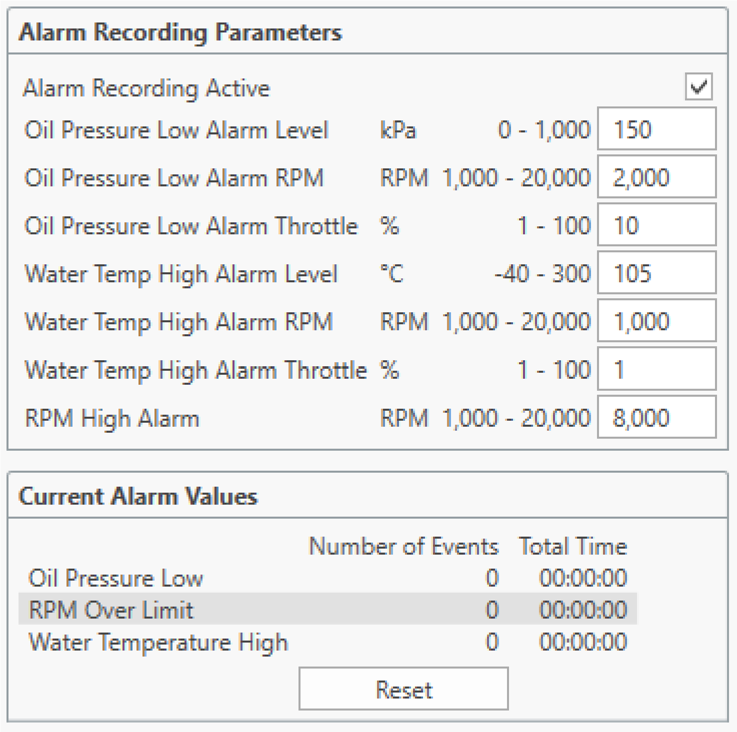
Note that the missing tooth gap appears as a single (green line) and the next gap after it is nearly as tall. This is due to the sensor being wired backwards. You may also see pink lines, representing "additional teeth".

Sending an Oscilloscope Capture to DTA

We may ask you to email us a crankshaft oscilloscope picture to aid in remotely debugging your installation. To do this generate the picture as we ask you (either running or cranking).

Press the Save button and save it to somewhere like the Desktop. Email it as an attachment to office@dtafast.co.uk.

3.1.5 Alarm Recording



Allows the recording of out-of-range engine operation, as described on screen. Alarms are only triggered above the RPM and throttle levels associated with the alarm. The whole function is turned on and off with a simple check mark.

3.1.6 ECU Diagnostics

This data on this page is for DTA diagnostic purposes.

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3.2.1 Map Configuration

In this page, you can define table axis parameter and select the strategy used for calculating engine load.

Main Map Axes

Here you define the axis parameters for the fuel and ignition tables. By default, main maps are usually 20x14 but you can define how much or little detail you need for the map here. The number of rows relates to RPM and the columns relates to load. It is recommended to define these parameters before anything else.

Other Map Axes

Here you define the axis parameters for "other" tables, such as: lambda target maps, PWM target maps, injection angle maps, start fuelling maps, compensation tables etc.

Map Load

Here you select the load calculation strategy. Alpha-N uses throttle position vs engine RPM to calculate load. Speed Density uses manifold pressure vs engine RPM to calculate load.

3.2.2 Inputs

The inputs pages allows you to configure and monitor the thermistor, analogue and digital inputs.

Thermistor Inputs

These are specifically for 2-pin NTC temperatures sensors. Polarity is generally not important. These inputs have a built-in 1kOhm pull-up resistor.

Analogue Inputs

These are generally for 0-5v output sensors but resistance based sensors (such as some fuel senders or NTC sensors) can be used with a pull-up resistor to 5v.

Digital Inputs

These are for switches and buttons. A digital input is activated when it is shorted to sensor ground.

Internal Pull Ups

Analogue 1 and 2 have switchable internal 1kOhm pull-up resistors, allowing them to be used for either 0-5v output sensor or resistance based sensors with no wiring changes.

Current Values

Shows the current values of the listed items. Note: unused analogue inputs will generally show around 21mV, unused thermistor inputs will show around 4998mV. This can also be an indication of a failed sensor or bad wiring.

Set to Default

This sets the inputs to their default configuration.

3.2.3 Outputs

The outputs page allows you to assign and individually tests all available outputs. Note: pinout tables are available in the Pinouts section.

Injector & Coil Outputs

Here you can assign ECU outputs are connected to which devices and test them individually. The ECU will always fire the injector and coil outputs in order (i.e. 1,2,3,4,5 etc.). If the engines firing order was 1-3-4-2, you would wire the outputs as follows:

Wasted Spark/Semi-Sequential Fuelling	
ECU Output	Engine Cylinder
Injector/Coil 1	Cylinder 1 & 4
Injector/Coil 2	Cylinder 2 & 3

Sequential Injection/Fuelling	
ECU Output	Engine Cylinder
Injector/Coil 1	Cylinder 1
Injector/Coil 2	Cylinder 3
Injector/Coil 3	Cylinder 4
Injector/Coil 4	Cylinder 2

Injector outputs can handle up to 4A and therefore can technically batch-fire 4 injectors at a time. This allows you to run two banks of injectors on a 4 cylinder engine on an ECU with only 2 injector outputs. If you want to do this, you would tell the ECU you have a 4-cylinder engine and enable twin-injectors.

Coil outputs can handle up to 10A but we would not recommend wiring more than 1 coil to an output unless it is an amplified coil or you are using an external amplifier. However, some amplified coils may require a pull-up resistor between 12v and signal in order for them to work correctly but only if wiring more than one to an output (for example, when you want to use 4 COP coils in an ECU with only 2 outputs).

Output Testing

Clicking the "lightning" icon next to the output you want to test will open the testing window. For coils and injectors, you set an RPM for them to be fired at. For PWM outputs, you can set both frequency and duty cycle, making it easier to tune your PWM Frequencies107. If you have a mechanical relay connected to the output, ensure the duty is set to 100, that way the frequency is irrelevant and the output is simply switched "on".

Set to Default

This sets all output assignments to the DTA default, as listed in the wiring diagrams.

3.2.4 Flexible Analogues

Flexible analogues allow you to add fuel and ignition compensations based on an analogue input voltage. They also allow the voltages to be assigned a meaningful value.
NOTE - all values are interpolated when the voltage value is between two rows, using a straight line interpolation.

Function Active

Enables or disables the function

Function Name

A 12 character description of the function

Use Map 2 Switch

Only enable this function if the Map 2 switch is turned on

Voltage

The voltage scale.

NOTE - this must increase row by row from top to bottom.

Fuel Compensation

The percentage fuel compensation applied for this voltage

Advance Compensation

The advance compensation applied for the voltage.

NOTE - This value can be either a percentage or a fixed amount. This is configured in Engine Settings32.

Ana Value

This is the converted human readable analogue value.

3.2.5 Flexible Outputs

The behaviour of the low-side, PWM capable outputs can be configured here. Outputs are able to function even when the ignition is turned off, so long as the ECU has a permanent 12v feed.

Settings

Output Active

If this is checked, the output will operate according to the configuration on it's page. If it is not checked, it will not operate.

Turn on with Map 2

If this is checked, the output will only operate once the Map 2 input is switched on. Once switched, it will operate according to the rest of the configuration on it's page.

Output Name

Give the output a meaningful name that summarises its purpose

Output Frequency

For PWM output type only, sets the frequency of the PWM duty cycle. See: PWM Frequencies107.

Switched Output

If this is selected, the output will act purely as an on/off switch, pulling whatever is connected to it to ground. This mode is ideal for grounding a mechanical relay coil, a Vtec solenoid etc.

Variable Output

If this is selected, the output can act either as a PWM output with a fixed frequency or a Frequency output with a fixed 50% duty.

Output Type

A PWM output allows you to vary the duty cycle of the output for a given frequency. For example, a 50% duty cycle @ 100Hz would mean that every 10ms, the output is on for 5ms and off for 5ms.
A Frequency output allows you to vary the frequency of the output with a fixed 50% duty cycle. This is useful for things like tachometers, where the duty needs to be a fixed 50% but the frequency needs to increase with RPM.

Primary/Secondary Trigger

If a secondary trigger is set, the output will only turn "on" once both primary and secondary conditions are met. Set the secondary trigger to "none" if you are not specifically using it.

Trigger

Select an input from which to trigger the output. Triggers can be voltages, temperatures, speeds, pressures, even wheel slip %

Turn On At

Switched output mode only. Set the value at which the output is pulled to ground. The on value must be less than the off value. Once the value drops below the "on" value, less the hysteresis value, the output will stop pulling to ground.

Turn Off At

Switched output mode only. Set the value at which the output stops pulling to ground after it has been pulled to ground. This value must be higher than the "on" value. If the output needs to stay "on" until the trigger value drops below the "on" value, set the "off" value to something that cannot be archived. E.g. for an electronic thermostat, you may want the output to turn on at 82°C but only turn off below that. In that case you could set the "off" value to the maximum 300°C

Hysteresis

Switched output mode only. If an output is triggered and then quickly falls below it's "on" point, turns "off" and then quickly rises past the "on" point, it can cause premature wear to the component being turned "on". By adding a hysteresis value, the output will continue to stay "on" until it reaches a value that is less the the trigger value, minus the hysteresis value. For example, a coolant fan may turn on at 93°C but quickly fall below and then turn off. By adding a 5°C hysteresis, the fan will stay on until the temperature drops below 88°C.

TPS Trigger

In addition to the primary and secondary triggers, you can also set the the output to only trigger above a certain throttle percentage. This should be set to 0 unless you are specifically using it as the output will only turn "on" once all primary, secondary and TPS trigger conditions are met.

3.2.6 CAN Setup

This page allows you to activate one of a selection of CANBUS data streams.

The standard CAN stream can be configured to the requirements of the receiving device.

If your receiving device has a DTAFast preset, the configuration will be as follows:

10Hz sample rate, 1Mbit data rate, Extended IDs on.

All Data Values 16 Bit Signed Sent LSB First (Little Endian)

The following items are available in the standard CAN stream:

CAN ID	Pos	Bytes	Sign	Name	Unit	Scale	Offset	Description
0x2000	0	2	1	RPM	rpm	1	0	RPM
0x2000	2	2	1	TPS	%	1	0	Throttle Position
0x2000	4	2	1	Water Temp	°C	1	0	Water Temperature
0x2000	6	2	1	Air Temp	°C	1	0	Air Temperature
0x2001	0	2	1	MAP	Kpa	1	0	Manifold Absolute Pressure
0x2001	2	2	1	Lambda	Lambda	0.001	0	Lambda
0x2001	4	2	1	KPH	kph	0.1	0	Kilometers Per Hour
0x2001	6	2	1	Oil Pressure	Kpa	1	0	Oil Pressure
0x2002	0	2	1	Fuel Pressure	Kpa	1	0	Fuel Pressure
0x2002	2	2	1	Oil Temp	°C	1	0	Oil Temperature
0x2002	4	2	1	Voltage	V	0.1	0	Voltage
0x2002	6	2	1	Fuel Con. Distance	L/100km	0.1	0	Fuel Consumption Per 100KM
0x2003	0	2	1	Gear	Gear	1	0	Gear Position
0x2003	2	2	1	Advance	°	0.1	0	Degreees of Ignition Advance
0x2003	4	2	1	Injection	ms	0.01	0	Injector opening time
0x2003	6	2	1	Fuel Con. Time	L/Hour	0.1	0	Fuel Consumption Per Hour
0x2004	0	2	1	Analogue 1	mV	1	0	Analogue 1 Voltage
0x2004	2	2	1	Analogue 2	mV	1	0	Analogue 2 Voltage
0x2004	4	2	1	Analogue 3	mV	1	0	Analogue 3 Voltage
0x2004	6	2	1	Cam Advance	°	0.1	0	Camshaft 1 Advance
0x2005	0	2	1	Cam Target	°	0.1	0	Camshaft 1 Target
0x2005	2	2	1	Cam PWM	%	0.1	0	Camshaft 1 Solenoid Duty
0x2005	4	2	1	Crank Errors		1	0	Crankshaft sensor signal error

ECU Flags

The ECU Flags byte consists of single bits indicating the state of a switch or flag:
Bit 0 - Launch Button Press
Bit 1 - Launch Active
Bit 2 - Traction On
Bit 3 - Traction Wet
Bit 4 - Fuel Pump On
Bit 5 - Fan output on

3.3 Engine Configuration

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3.3.1 Engine Settings

Engine Specific Information

Ensure that you check for any engine specific settings in the Engine Specific Information section at the end of this manual.

Engine Configuration

Number of Cylinders

Number of cylinder the engine has. Note: if using a 3 or 5 cylinder engine with no cam trigger, you can set the engine to 6 or 10 cylinders respectfully. However, coils and injectors must be wired in the order the pistons reach TDC, NOT the firing order. If using a 1 cylinder engine, set to 2.

Transition From Cranking

This is the speed at which the engine is recognised as successfully running. This should be at least 100RPM below the lowest idle speed you expect to see. If set too high, the engine can struggle to transition on cold start. If too low, lightweight engines, for example motor bike engines, can "kick back". Once this transition has taken place the engine remains in running mode until the speed drops below 500 rpm when cranking mode is resumed. Note: until the engine has "transitioned" it will be using fixed timing and variable dwell (based on the "Firing Tooth on Start Up" and "No. of Teeth Coils On When Cranking" settings in Ignition Settings) 42 and idle control will not work.

Tacho Pulses Per Rev

This sets number of pulses per revolution of the tachometer output. It must be set to the number of pulses the tachometer you are using expects to see per revolution. For wasted spark engines, this is usually half the number of cylinders.

Use 3 or 5 Cylinder Tacho Pattern

If running a 3 or 5 cylinder engine, you must check this box for the tachometer to work correctly. This overrides the Tacho Pulses Per Rev setting and ensure the tacho reads correctly when no cam sensor is used and the number of cylinders set does not match the actual number of cylinders.

Crank Sensor Setup

Crank Sensor Type

This sets which type of crank sensor the engine is using, Hall Effect or Variable Reluctance (magnetic). 2-pin sensors are always VR. 3-pin sensors with no lead are always Hall Effect and require either a 5v or 12v supply. Some Hall Effect sensors are very sensitive to whether 5v or 12v is used but most can use either. 3-pin sensors with a lead are usually VR, with the 3rd pin being a connection to the cable shield. However, they can also be Hall Effect. If you measure no resistance between any of the 3 pins, the sensor is Hall Effect. If two of the 3 pins have resistance in one direction, it should be Hall Effect. If two of the 3 pins have resistance in both directions, it could be Hall or VR - there is no definitive way to tell, aside from cutting open the cable and checking for a shield (Hall Effect sensors won't have a shield).

Number of Teeth on Wheel inc. Missing

Count the number of teeth on your trigger wheel and then add the number of missing teeth. For example, may Ford engines use a trigger wheel with 35 actual teeth a 1 missing, referred to as a 36-1 (thirty six minus one). You would set it to 36 in this case. Similarly, many Vauxhall engines use a trigger with 58 actual teeth and 2 missing, 60-2 (sixty minus two). You would set 60.

Number of Missing Teeth

The number of missing teeth on your trigger wheel.

Gap Tooth Factor

The missing teeth are detected by the time difference from the previous tooth to the current tooth being larger than an actual tooth. The gap tooth factor determines how much larger the missing tooth time is before it is recognised by the ECU as a missing tooth. This can be determined by cranking the engine and using the Crankshaft Oscilloscope[20]. Clicking on the missing tooth in the oscilloscope display will tell you how much longer the missing tooth is than the tooth immediately before it. Standard factors for 1, 2 and 3 missing teeth are as below. Clicking on the “Set to Standard Button” will set to these values automatically. Sometimes it may be beneficial to increase or reduce these.

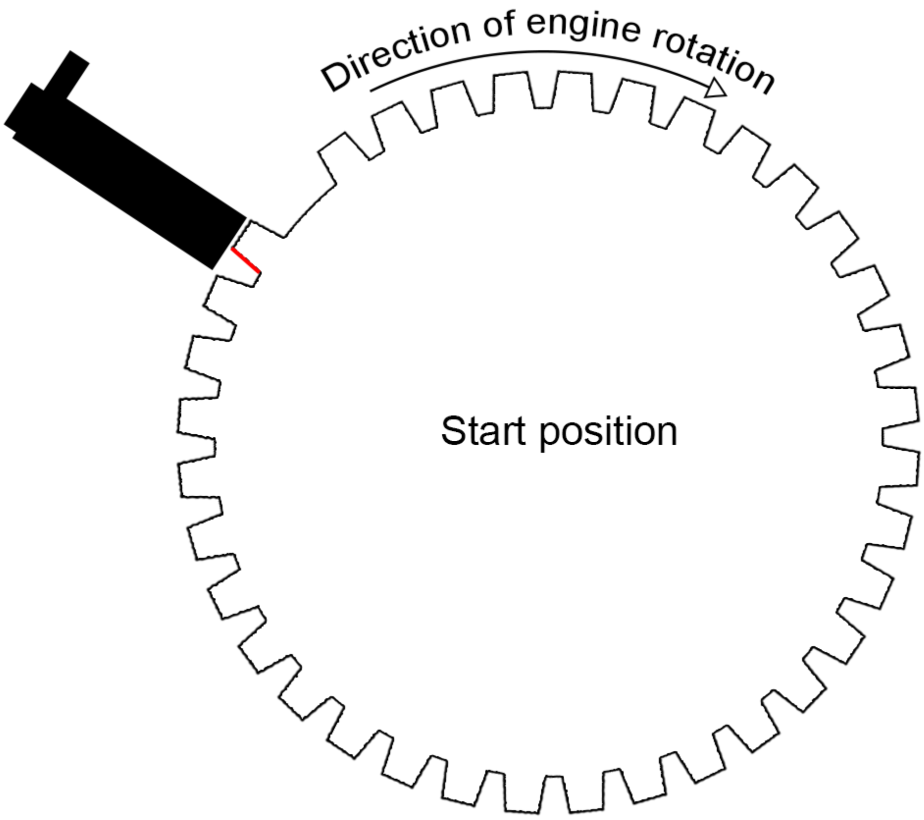
Missing Teeth (per gap)	Gap Tooth Factor
1	1500
2	2000
3	3000

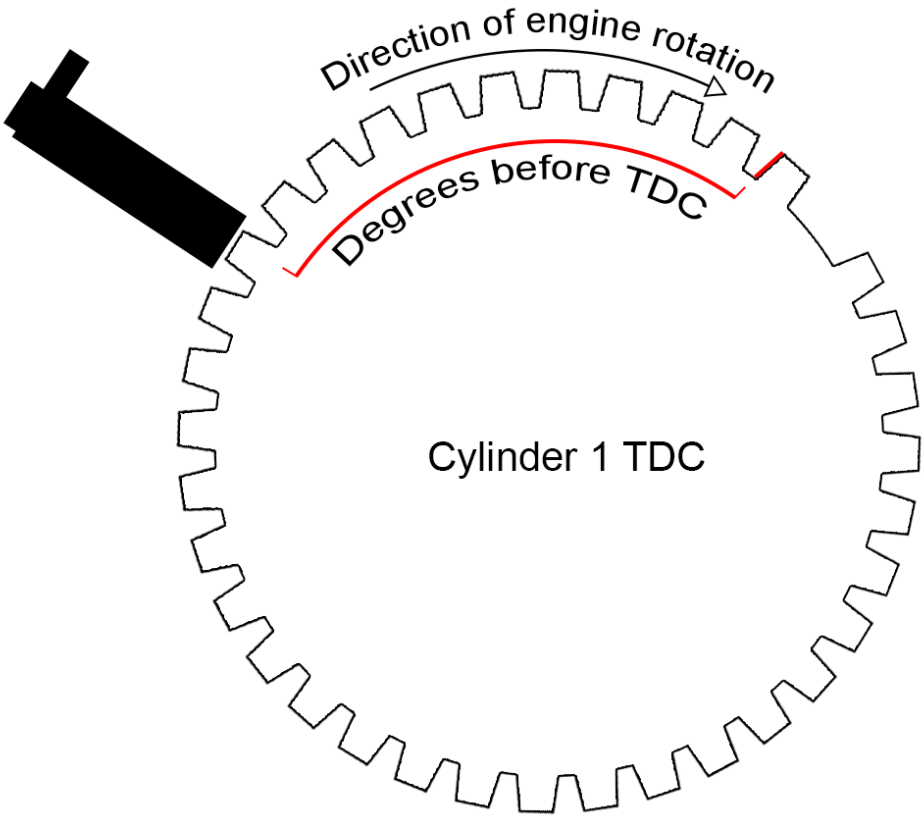
Sensor Position

This is the position of the crank sensor in relation to TDC on the compression stroke, in degrees BTDC. It's important to set this accurately (at least within a degree or two) as it can cause issues with cold starting and compensations if not.

For an approximate location, you can remove all spark plugs except cylinder 1 and crank the engine with the Crankshaft Oscilloscope [20] running. Then, starting with the longest yellow line (tooth time), which should coincide with TDC on cylinder 1, count backwards to the detected missing tooth line. Divide 360 by the number of teeth (including missing) on the trigger wheel and then multiply by the number lines you counted. I.e. on a 60-2 wheel, 360/60=6, each line represents 6° of crank angle. This will get you a rough value that should start the engine. You can then use a timing light to dial it in correctly.

To properly measure the correct angle for the Crank Sensor Position value, position the engine with the sensor opposite the first falling edge of the tooth following the missing tooth (as illustrated below in red). Mark the position. Turn the engine in it's normal direction of rotation to exactly TDC on the number 1 cylinder compression stroke (a DTI and degree wheel are useful here). The number of degrees you have to turn the engine is the correct figure. Enter that into the software and then verify with a timing light.


Direction of engine rotation
Start position


Direction of engine rotation
Degrees before TDC
Cylinder 1 TDC

Either way, a timing light and an accurate TDC mark are essential for verifying the sensor position. We would recommend having a 0° and 10° mark on your engine to help with verification.

To verify with a non "dial back" timing light, when the engine open Real Time Mapping and set the advance to 10°. Adjust the sensor position value until the TDC mark on the crank pulley lines up with the 10° mark on the engine. You can sometimes do this at 0° but not all engines like to idle at 0° and not all timing lights flash consistently at 0°.

If you only have a 0° mark and cannot add a 10° mark, you can use a "dial back" timing light. If you have a wasted spark engine and your "dial-back" timing light supports "wasted spark" or "two stroke" modes, set the ignition timing to 10° in Real Time Mapping, set the timing light to 10° and adjust the sensor position value until the 0° marks on the crank pulley and engine line up. If your "dial-back" light does not support "wasted spark" or "two stroke" modes, you must set the timing light to double the ignition timing. E.g. if you've set the timing to 10°, set the timing light to 20° and then adjust the sensor position value until the 0° TDC marks line up.

Common factory sensor positions (starting point only, always check with timing light):

Engine	Position
Vauxhall/Opel 4 Cylinder (e.g. C20XE)	117°
Ford Zetec/Duratec/ST170	90°/80°/80°
Porsche 6 Cylinder	83°
BMW S50/S54/M52/M54	80°/86°/80°/325°
VAG 1.8T 20v	84°
Hayabusa	100°
Rover K-Series (Mode 2/3)	286°/349°
Honda K-Series	320°
Honda F20C (Gen1/Gen2)	340°/320°
Toyota 2JZ (Non-VVT/VVT)	5°/155°
Toyota 1UZ (Non-VVT/VVT)	5°/125°
Toyota 2ZZ	215°
Nissan CA/SR/RB (CAS)	110°

It's also important to have the right amount of clearance between the sensor and the trigger wheel. See Crank/Cam Sensor Clearance Gaps 96.

Flywheel Mode

This setting tells the ECU what to expect in terms of the engine's trigger setup.

There's a huge variety of different crank/cam sensor trigger setups, many popular setups are listed in the dropdown box. Flywheel mode 0 is for simple trigger patterns, such as 36-1 or 60-2, with or without a single tooth cam trigger. Flywheel mode 26 97 is for a simple crank trigger with a more complex cam trigger. All other modes are engine specific.

There's a more detailed support document for the Rover K-Series 104 engine.

General Settings

Advance Compensations in Degrees not %

Ignition advance compensations, coming from air temp, water temp, manifold pressure and flexible analogues, are by default a percentage of the current advance figure. This check mark allows these to all be in degrees. Note: they are either all percentage or all degrees.

Cam Sensor Options

This section defines the type of cam sensors on the engine.

Cam Sensor Type

Sets the cam sensor type to Hall or VR.

Cam Profile

Select the correct cam trigger profile for the engine.

These are generally engine specific, but many OEM manufacturers use standard patterns for modern cars.

The most common is shown below:

As can be seen, there are two wide teeth, and two narrow teeth. The leading edges of the teeth are at 90 degrees to each other, and the trailing edges are not.
There are variations in the width of the teeth, but they all look similair.

This cam allows the engine phase to be determined on crank tooth 1, which is why it is the preferred option for OEMs.

If this pattern is used, then the Cam Profile option must be "Four Tooth Cam, Sync on Crank Tooth".
The Crank Tooth for Cam Sync will normally be 1 for this cam.

The half moon cam tooth works in the same way, except the Cam Profile is "Single Tooth, sync on Crank Tooth".

All single tooth VR sensors must use Cam Profile "Single Tooth, Sync on Edge".

All other cam patterns are specific, and the correct option must be selected from the drop down list.

Crank Tooth for Cam Sync

If the cam profile requires a crank tooth to sync on, then this must be set.
All known OEM patterns sync on crank tooth 1.

Engine Phase At Sync

This sets the engine phase when the ECU synchronises. This is either the Compression phase or the Exhaust phase.

3.3.2 Engine Protection

RPM Limits

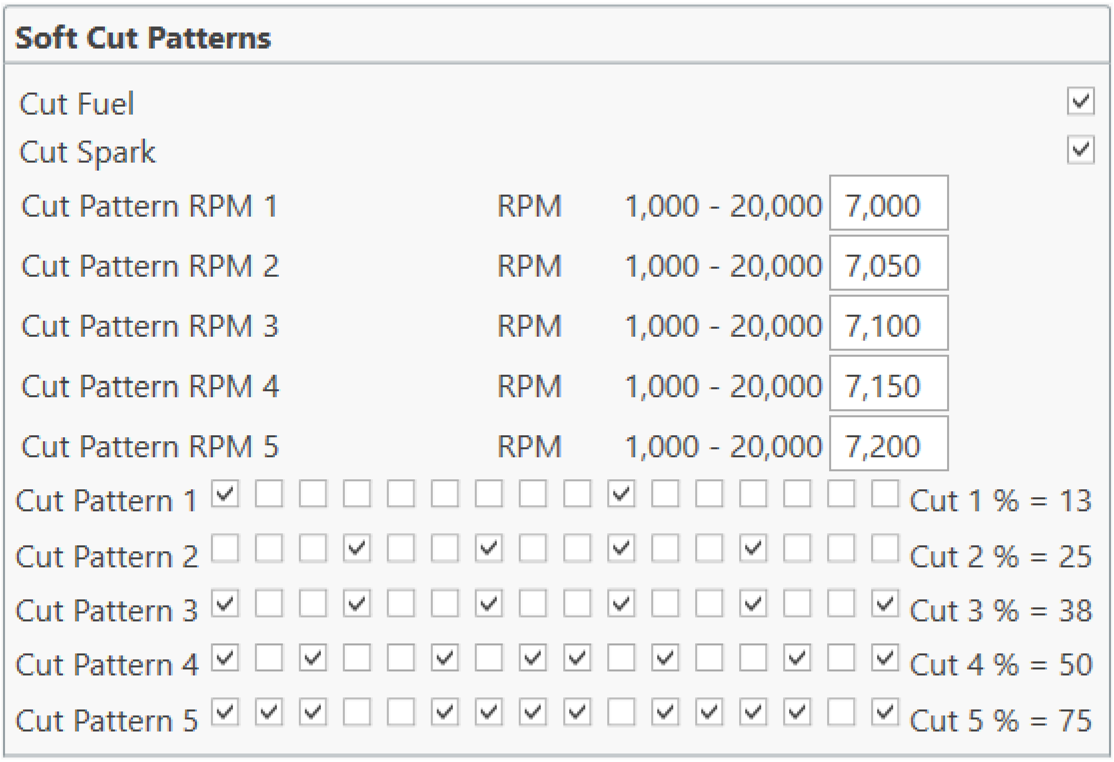
Ultimate RPM Limit

This is the hard rev limit. If the engine reaches this RPM, injector and coil output are turned off until the RPM drops back below the hard limit.

Gear Change Light

Set the RPM at which the shift light Output26 is activated.

Soft Cut Patterns



Hard limits alone can damage engine internals if the limit is breached regularly. Soft Limit Cut Patterns allow you do define whether you want fuel, spark or both cut and how they are cut. This allows you to tailor the cut to the engine and slow it down gradually before it reaches the hard limit.

Cut Fuel
If checked, the injector outputs will be turned off according to the defined patterns.

Cut Spark
If checked, the coil outputs will be turned off according to the defined patterns.

Cut Pattern RPM (1-5)
Set the RPM at which the corresponding cut pattern is activated.

Cut Pattern (1-5)
The cut patterns are a set of 16 check marks. Each check mark represents an ignition/injection event. For a 4-cylinder engine, 4 check marks would represent a single revolution of the engine and therefore, you could define how that pattern behaved over 4 revolutions. It's best practice to alternate the cylinders which are cut per revolution. For example, in a 4-cylinder engine, if you wanted to cut 1 event per rotation, in blocks 1-4 you would tick 1, in blocks 5-8 you would tick 6, 9-12 tick 11 and 13-16 tick 16. This would give you a 25% cut that moves to the next cylinder on each revolution.

Sensor Defaults

Here you set the desired "default" value that the ECU will use if a sensor fails. Note: it's best to think of the worst case scenario rather than drivability. E.g. if the TPS fails at high load and high RPM, the default value should in the 85-100% range to prevent engine damage. However, if the engine is unlikely to see regular and constant high load/high RPM (i.e. a road car), a value in the 15-30% range may be more suitable to allow for "limp-home".

Oil Pressure Shutdown

If the oil pressure drops below the Lower Warning Level value set in Sensor Scaling for the oil pressure sensor, you can set the ECU to kill the engine here. Requires an oil pressure sensor to be connected to the ECU and scaled 54 correctly.

Oil Pressure Shutdown Active

Activates the feature when checked.

No Oil Pressure Shutdown Below RPM

This sets the minimum RPM at which the engine will shut down if the oil pressure drops below the Lower Warning Level. Below this RPM, no shutdown will occur. Useful for engines with low "hot idle" oil pressure.

Oil Pressure Shutdown Delay

This delays the shutdown event by the specified time.

Low Temperature RPM Limit

Here you can limit the engine RPM based on oil or water temperature. Requires a water/coolant temperature sensor and/or oil temperature sensor to be connected to the ECU and scaled 49 correctly.

RPM Reduction

This reduces the Ultimate RPM Limit by the defined amount. E.g. if the Ultimate limit was 8500RPM, setting this value to 5000 would reduce the Ultimate Limit to 3500RPM. Set to 0 to deactivate.

Water/Oil Temperature Threshold

The temperature up until which the RPM limit will be in effect. Set to -40 to ignore a specific sensor.

Fan Control

This triggers the low side Output 26 assigned to Fan Control when the defined conditions are met. Requires a coolant temperature sensor to be connected to the ECU and scaled 50 correctly.

Fan Control On

Select to activate the feature.

Fan On At

Set the desired coolant temperature at which the fan control output is triggered.

Fan Switch Hysteresis

If the output is triggered and then quickly falls below it's "on" point, turns "off" and then quickly rises past the "on" point, it can cause premature wear to the component being turned "on". By adding a hysteresis value, the output will continue to stay "on" until it reaches a value that is less the the trigger value, minus the hysteresis value. For example, a coolant fan may turn on at 93°C but quickly fall below and then turn off. By adding a 5°C hysteresis, the fan will stay on until the temperature drops below 88°C.

Lean Cut Protection

Lean Cut Protection enables engine protection parameters to be applied, should a lean event be detected within certain parameters.

Lean Cut Protection Enabled

Enables the lean cut protection.

Minimum/Maximum Parameters

Minimum/Maximum values for a lean protection event to be considered. If the value is above the maximum value or below the minimum value, the lean event will be ignored.

For example, if the Minimum TPS is 5%, and the Maximum TPS is 95%, then a lean event will be ignored when the TPS is below 5%, and above 95%.

Lambda Difference Threshold

This is the deviation from the target lambda that is defined as a lean event.

Lambda Difference Time

This is the time a lean event must exist for before the corrections are applied.

Delay Parameters

Certain engine conditions will naturally cause the lambda to read lean, even if there is no genuine lean condition. The events catered for are:

- Shift Cut (Flat Shift)
- Throttle Transients
- Launch Control
- Traction Control
- Anti Lag

Each of these will show a lean condition for a period of time after the event has finished. The delay times are the time for which a lean event is ignored, after the event has finished.

Once this time has elapsed, the Lambda Difference Time must still also pass before a lean event is triggered.

For example, if the Throttle Transient Delay is set to 200ms, and the Lambda Difference Time is set to 150 ms, then a lean event will be ignored for 350 ms after the Throttle Transient event has ended.

Correction Parameters
These are the corrections that are applied when a lean event is detected.

The Fuel Correction is an increase, the others are reductions.

3.3.3 Ignition Settings

Coil Settings

External Coil Amplifiers
Activating this setting changes the coil driver mode from IGBT (low-side charge) to TTL (high-side charge).

This is a setting you must be extremely careful with. If you turn this setting on with a non-amplified (dumb/passive) coil, it can damage the ECU because the coil will be in a permanent state of "charging", drawing more and more current. If you do not activate this setting with an amplified (smart) coil, the ECU will be fine but the coils will get very warm (with ignition on and engine not running) and will eventually fail.

Coils that have a single trigger per output, a 12v supply and no ground pin (e.g. Bosch/Valeo 4-cyl and 6-cyl wasted spark, or 2-pin COPs) are non-amplified. A coil that has 2 ground pins is usually amplified (e.g. VAG 4-pin COP). However, a coil that has 1 ground pin can be either amplified or non-amplified - if in doubt, contact us.

Coils in Two Stroke Mode
Activate this setting if the engine is either a 2-stroke or a rotary engine.

No. of Teeth Coils On When Cranking
This sets the coil dwell time under cranking conditions using crank trigger teeth as a time reference. The length of dwell time will vary depending on how quickly the engine is rotating. This helps the coils to fire correctly under low voltage conditions.

Examples:

On a 36-1 trigger, each tooth is 10°. Setting this to 2 would mean the coils are charging for 20° of crank rotation, which at 300RPM would be 11ms and at 200RPM would be 16ms. In this case, 1 tooth would be sufficient.

On a 60-2 trigger, each tooth is 6°. Setting this to 2 would mean the coils charging for 12° of crank rotation, which at 300RPM would be 6.5ms and at 200RPM would be 10ms. In this case, 2 teeth would be sufficient.

For a 360 tooth trigger, the ECU converts it to 36, so setting to 1 tooth should be sufficient.

Note: excessive dwell can lead to increased current draw and wear on the coil. As a general rule, keep below 10ms when cranking.

Firing Tooth On Startup

This sets the ignition advance during the "attempting to start" phase.

On a 36-1 trigger, each tooth is 10° so setting this to 2 would mean the coils are firing is 20° BDTC

On a 60-2 trigger, each tooth is 6° so setting this to 3 would mean the coils are firing is 18° BDTC

For a 360 tooth trigger, the ECU converts it to 36, so a setting of 2 should be sufficient.

Twin Spark

This section allows the ECU to fire two coil outputs at the same time. This is mainly for engines with two spark plugs per cylinder but is also useful for running engines without a cam sensor on individual "COP" coils in a wasted spark arrangement and for engines with dual distributors.

If you had a 4-cylinder wasted spark engine, coil outputs 1&2 would be used for the primary spark plugs and coil outputs 3&4 would be used for the secondary spark plugs. Coil outputs 1&3 would fire together, as would 2&4.

For a wasted spark COP setup, you would wire each coil output to each cylinder.

Examples:

4-Cylinder Wasted Spark (COP)				
Cylinder	1	3	4	2
Output	1	2	3	4

4-Cylinder Wasted Spark (Twin Spark)				
Cylinder	1 & 4	2 & 3	1 & 4	2 & 3
Output	1	2	3	4
Coil Pack	1		2	

6-Cylinder Wasted Spark (COP)						
Cylinder	1	3	6	4	5	2
Output	1	2	3	4	5	6

6-Cylinder Wasted Spark (Twin Spark)						
Cylinder	1 & 4	3 & 5	2 & 6	1 & 4	3 & 5	2 & 6
Output	1	2	3	4	5	6
Coil Pack	1			2		

Twin Spark On

Activates twin spark mode.

Twin Spark Offset

This setting delays the firing of the secondary spark plug by the defined number of crank degrees.

Use Advance Map 2 for Twin Spark Offset

Setting this makes the ECU ignore the above offset and instead use the Map 2 Ignition62 table, allowing the offset to vary with engine load and RPM.

Distributor Fitted

This setting sends all ignition events to coil output 1. Generally for use with a single coil connected to a distributor.

If the engine has dual distributors for running 2 spark plugs per cylinder you can enable Twin Spark, then coil output 2 will duplicate coil output 1.

If the engine has dual distributors and 1 spark plug per cylinder, you should still use twin spark but you must set the offset to 90° and the number of cylinders in Engine Settings32 to half that of the actual number.

Example:

Rolls Royce dual distributor 90° V8, firing order 1-3-7-2-6-5-4-8	
ECU Output	Cylinders
Coil 1	1, 7, 6, 4 (distributor 1)
Coil 2	3, 2, 5, 8 (distributor 2)

In this case, the number of cylinders would be set to 4 and Coil 1 would fire every 180°. You would enable Twin Spark and set the offset to 90°. Coil 2 would then fire 90° after Coil 1. This also allows factory alignment marks on the distributor to be used.

Coil on Plug

This is used if an engine has individual coils, AND a cam profile has been selected in Engine Settings.
NOTE - If using coil on plug without a cam sensor, see the Twin Spark section above for configuring CoP in wasted spark mode.

Coil On Plug

Tick this to turn on sequential ignition.

Only Coil on Plug Above

Some cam sensors will not sync correctly at low RPM.
Use this setting to delay Coil on Plug until the RPM is high enough for the cam to synchronise. Below this RPM value, the ECU will run in wasted spark mode automatically, and then switch to sequential ignition once this threshold has been reached.

Unequal Firing Options

This section allows you to define the crank angle at which the ignition coils should fire, if the order in which the cylinders reach TDC is not in equal steps.

By default, the ECU assumes the firing angle will be 720 divided by the number of cylinders. However, if you have a V engine and the V angle is not equal to the default firing angle, you will need to use unequal firing angles in order for the engine to run.

For example, in most 6 cylinder engines, the pistons reach TDC every 120° and the ECU would fire at 0°, 120°, 240°, 360°, 480° and 600°. The Cosworth/Opel 2.5 V6 DTM engine fires the first 2 cylinders 75° apart but then rotates 165° to fire the next two 75° apart. I.e 0°, 75°, 240°, 315°, 480° and 535°.

In general, the odd firing cylinders (i.e. first to fire, third to fire etc.) should fire at an angle apart from each other that is equal to 720 divided by half the number of cylinders. In the case of the V6 above, this would be 720/3=240, so the first cylinder to fire would fire at 0°, the third cylinder to fire would be at 240° and the fifth cylinder to fire would be at 480°. The even firing cylinders should then fire at an angle equal to the previous firing cylinder plus the angle of the V. So in the case of this 75° V6, second to fire is 0°+75°, fourth to fire is 240°+75°, sixth to fire is 480°+75°.

There are of course exceptions to this; engines with offset crank pins, like the VR6 for instance. However, the above method should allow you to work out the firing angles for most cross plane and flat plane V engines.

Note: angles must be entered in firing order. Coil 1 is the first cylinder to fire, Coil 2 the second etc.

Dwell Compensations (Coil On Time)

The ignition coil's dwell time (charge time) will be supplied by the table. The Coil Dwell table allows you to define different dwell times (in microseconds) for different battery voltages. This is especially useful for engines that do not run an alternator or to safeguard against an alternator failing. In general, most coils will require more dwell time to maintain the same output at lower voltages.

Examples:

Bosch 3-pin 4 cylinder wasted spark coil pack		
Voltage	7A Draw Dwell (µs)	10A Draw Dwell (µs)
8.0	6700	12000
8.5	6175	10750
9.0	5650	9500
9.5	5125	8250
10.0	4600	7000
10.5	4325	6525
11.0	4050	6050
11.5	3775	5575
12.0	3500	5100
12.5	3325	4825
13.0	3150	4550
13.5	2975	4275
14.0	2800	4000
14.5	2700	3825
15.0	2600	3650
15.5	2500	3475
16.0	2400	3300
16.5	2325	3200
17.0	2250	3100
17.5	2175	3000

Bosch 4-pin 6 cylinder wasted spark coil pack		
Voltage	7A Draw Dwell (µs)	10A Draw Dwell (µs)
8.0	6600	11600
8.5	6075	10375
9.0	5550	9150
9.5	5025	7925
10.0	4500	6700
10.5	4250	6250
11.0	4000	5800
11.5	3750	5350
12.0	3500	4900
12.5	3325	4650
13.0	3150	4400
13.5	2975	4150
14.0	2800	3900
14.5	2700	3725
15.0	2600	3550
15.5	2500	3375
16.0	2400	3200
16.5	2300	3075
17.0	2200	2950
17.5	2100	2825

Note:

Whilst a 10A draw will give you the full 45kV and 90mJ output of these coils, most 4 cylinder normally aspirated engines run fine with a fixed 3000µs dwell. The 7A draw will give around 35kV and 60mJ.

It is recommend to measure your current draw at various voltages and dwells to ensure you are not overloading your wiring loom.

It is also worth bearing in mind that the engine's maximum RPM and ignition type can be a limiting factor to how much dwell can physically be used. Example:

4 Cylinder Engine	
Ignition Type	Dwell Limit @ 9000RPM (in microseconds)
Sequential Coil On Plug (fires every 720°)	13300
Wasted Spark (fires every 360°)	6650
Distributor (fires every 180°)	3325

3.3.4 Injection Settings

Injector Settings

Injector 1/2 Size

Enter the flow rate of your injectors. Used for fuel consumption calculations only.

Injector Start Pulse

When the engine first starts to turn on the starter motor this pulse is given to the injectors once. It is used to clear air from the fuel system. Use the minimum required to ensure good starting.

Pulse Injectors On ECU Power On

If this setting is enabled, the ECU will pulse the injectors when it is either powered on or rebooted. The Injector Start Pulse setting is used for duration.

Injectors In Two Stroke Mode

This fires the injectors once per revolution instead of the default, once per 4-stroke cycle. Only recommended for 2-stroke and rotary engines. Note: the maximum allowed injector duration in the fuel map will halved with this setting.

Twin Injectors Fitted

This allows the use of 2 injectors per cylinder. One injector can be blended to the other using the Twin Injector Blend Map89. Note: if using injectors with different flow rates, altering the blend map after the main fuel table is mapped will require the main fuel map to be mapped again.

Over Run Fuel Cut Off Setting

This section defines whether the injectors are turned off during over run, i.e. the vehicle is braking, engine RPM is dropping and there is no throttle input. Note: this can have detrimental effects to engine braking and will prevent anti-lag from working.

RPM To Turn Fuel Back On

If the engine enters over run condition, this setting defines when the injectors will be turned back on based on RPM. Generally, you would want to do this a few hundred RPM above the maximum idle speed. Set to 0 to disable overrun fuel cut.

Throttle To Turn Fuel Back On

If the engine enters an over run condition, this setting defines when the injectors will be turned back on based on throttle position. Regardless of the above RPM, if the engine is over running and the throttle position changes to a value equal or higher than this setting, the injectors will be turned back on. 2-3 is usually fine for this.

Unequal Injection Angles

See: Unequal Firing Angles in Ignition Settings 42.

Injector Trims

This allows injectors to be individually trimmed to compensate for variations in port flow. For trimming individual cylinders, you would need the ability to measure the AFR on each exhaust runner. You may also be able to trim the cylinders based on measured exhaust runner temperature. This is also useful for trimming a bank of cylinders in a V engine. In most circumstances, this table is set to 0. Note: injectors are listed in the order they fire, not the cylinders they are fitted to. I.e. if you wanted to trim cylinder 4 on a 1-3-4-2 firing engine, you would trim "Injector 3".

Injector Compensations (Dead Times)

This must be setup before mapping the engine.

Injectors have a small amount of lag before they open and also when they close, referred to as "dead time". In most cases, it is not critical to set the dead time accurately and setting the dead time table to 1ms for all voltages is usually fine - although accurate dead times allow sensor compensations, start fuelling and closed-loop lambda adjustments to remain accurate during voltage changes. In applications where an alternator is not fitted or a failed alternator would not necessarily lead to the vehicle being stopped, the table should be filled in accurately as an injectors dead time will increase as battery voltage drops and this will lead to leaner fuel ratios if not compensated for. A typical dead time is 0.77ms @ 13.5v and 3bar but this can increase to over 5ms at voltages as low as 6v. It's also important to note that dead time will vary with fuel pressure, i.e. a higher pressure will slightly increase dead time. Note: the dead time settings apply to all fuel injectors connected to the ECU. There are no additional settings for twin injectors, so if dead time is important for your application, ensure all injectors have the same dead time.

3.4 Sensor Configuration

3.4.1 Air Temperature

Sensor Configuration

For the sensor to provide meaningful information, its characteristics must be defined here. Never assume base maps have accurate scalings unless specifically mentioned in the comments.

You can either use a sensor that has a built-in preset in the software or define the scale yourself.

Temperature sensors are usually 2-pin NTC sensors whose resistance value changes with changes in temperature.

NTC sensors should use "Thermistor" Inputs 25. Thermistor inputs have a 1kOhm pull-up resistor to 5v built in. Analogue 1 and 2 can also be used as Thermistor inputs with their switchable pull-ups turned on.

If you do not have a scale for your sensor, measure the resistance at 3 temperatures (freezing, room and boiling) and send us the measurements along with the part number of the sensor and it's usual application.

Note: when measuring resistance, the temperature should be constant and you must wait until the resistance value settles. NTC sensors are slow to fully respond to large changes in temperatures.

Warnings Active and Upper/Lower Warning Level
Here you can set and enable warnings for values you define as too high or too low.

Warnings are displayed during Real Time Mapping[14], via the CANBUS and also via the shift light.

Warnings are only active above the transition from cranking RPM in Engine Settings[32].

Filter Value
This allows electrical noise that could interfere with the sensor reading to be filtered. If you do not see any random variations then leave the value set to 1. If you do then increase the filter value until the noise is gone.

Sensors are read every 1ms (1000Hz). The filter value is the number of samples that the sensor value is averaged over.

Setting the value to 20 would mean the sensor value that is displayed (and used by the ECU) has been averaged over the last 20 samples (20ms). Therefore it would update 50 times a second (50Hz).

Sensor Compensations

This table allows you to modify the fuel injection quantity and ignition advance according to air temperature.

The Set to Standard button sets the compensations to a universally accepted standard.

Note: compensations will only work correctly when a) the injector dead times are correctly defined in Injection Settings[47] and b) the sensor is mounted in an appropriate location, measuring the actual temperature of air entering the engine and not a temperature that may have been compromised by heat soak or stagnant air.

3.4.2 Water Temperature

Sensor Configuration

For the sensor to provide meaningful information, its characteristics must be defined here. Never assume base maps have accurate scalings unless specifically mentioned in the comments.

You can either use a sensor that has a built-in preset in the software or define the scale yourself.

Temperature sensors are usually 2-pin NTC sensors whose resistance value changes with changes in temperature.

NTC sensors should use "Thermistor" Inputs25. Thermistor inputs have a 1kOhm pull-up resistor to 5v built in. Analogue 1 and 2 can also be used as Thermistor inputs with their switchable pull-ups turned on.

If you do not have a scale for your sensor, measure the resistance at 3 temperatures (freezing, room and boiling) and send us the measurements along with the part number of the sensor and it's usual application.

Note: when measuring resistance, the temperature should be constant and you must wait until the resistance value settles. NTC sensors are slow to fully respond to large changes in temperatures.

Warnings Active and Upper/Lower Warning Level
Here you can set and enable warnings for values you define as too high or too low.

Warnings are displayed during Real Time Mapping14, via the CANBUS and also via the shift light.

Warnings are only active above the transition from cranking RPM in Engine Settings32.

Filter Value
This allows electrical noise that could interfere with the sensor reading to be filtered. If you do not see any random variations then leave the value set to 1. If you do then increase the filter value until the noise is gone.

Sensors are read every 1ms (1000Hz). The filter value is the number of samples that the sensor value is averaged over.

Setting the value to 20 would mean the sensor value that is displayed (and used by the ECU) has been averaged over the last 20 samples (20ms). Therefore it would update 50 times a second (50Hz).

Sensor Compensations

This table allows you to modify the fuel injection quantity and ignition advance according to water (coolant) temperature.

Note: compensations will only work correctly when a) the injector dead times are correctly defined in Injection Settings47 and b) the sensor is mounted in an appropriate location (usually thermostat housing), measuring the actual temperature of coolant leaving/circulating the cylinder head and not a temperature that may have been compromised by heat soak, stagnant flow or by measuring inlet flow from the radiator.

3.4.3 Oil Temperature

Sensor Configuration

For the sensor to provide meaningful information, its characteristics must be defined here. Never assume base maps have accurate scalings unless specifically mentioned in the comments.

You can either use a sensor that has a built-in preset in the software or define the scale yourself.

Temperature sensors are usually 2-pin NTC sensors whose resistance value changes with changes in temperature.

NTC sensors should use "Thermistor" Inputs[25]. Thermistor inputs have a 1kOhm pull-up resistor to 5v built in. Analogue 1 and 2 can also be used as Thermistor inputs with their switchable pull-ups turned on.

If you do not have a scale for your sensor, measure the resistance at 3 temperatures (freezing, room and boiling) and send us the measurements along with the part number of the sensor and it's usual application.

Note: when measuring resistance, the temperature should be constant and you must wait until the resistance value settles. NTC sensors are slow to fully respond to large changes in temperatures.

Warnings Active and Upper/Lower Warning Level

Here you can set and enable warnings for values you define as too high or too low.

Warnings are displayed during Real Time Mapping[14], via the CANBUS and also via the shift light.

Warnings are only active above the transition from cranking RPM in Engine Settings[32].

Filter Value

This allows electrical noise that could interfere with the sensor reading to be filtered. If you do not see any random variations then leave the value set to 1. If you do then increase the filter value until the noise is gone.

Sensors are read every 1ms (1000Hz). The filter value is the number of samples that the sensor value is averaged over.

Setting the value to 20 would mean the sensor value that is displayed (and used by the ECU) has been averaged over the last 20 samples (20ms). Therefore it would update 50 times a second (50Hz).

3.4.4 Inlet Manifold Pressure

Sensor Configuration

For the sensor to provide meaningful information, its characteristics must be defined here. Never assume base maps have accurate scalings unless specifically mentioned in the comments.

You can either use a sensor that has a built-in preset in the software or define the scale yourself.

Pressure sensors are usually a 3-pin sensor with a 0-5v output. We do not recommend the use of any other type (such as those that ground through the engine).

Most pressure sensors have a linear scale. If you do not have a scale for your sensor but can measure the voltage at a known high and low pressure, you can generally just Interpolate5 (Shift+F5) between the measured values and the rest will be correct.

Enter your lowest pressure at the top and highest at the bottom. Click the lowest value and drag down to the highest. Then press Shift+F5. Do the same for voltage and that should be correct.

Warnings Active and Upper/Lower Warning Level
Here you can set and enable warnings for values you define as too high or too low.

Warnings are displayed during Real Time Mapping14, via the CANBUS and also via the shift light.

Warnings are only active above the transition from cranking RPM in Engine Settings32.

Filter Value
This allows electrical noise that could interfere with the sensor reading to be filtered. If you do not see any random variations then leave the value set to 1. If you do then increase the filter value until the noise is gone.

Sensors are read every 1ms (1000Hz). The filter value is the number of samples that the sensor value is averaged over.

Setting the value to 20 would mean the sensor value that is displayed (and used by the ECU) has been averaged over the last 20 samples (20ms). Therefore it would update 50 times a second (50Hz).

Sensor Compensations

This table allows you to modify the fuel injection quantity and ignition advance according to intake manifold pressure.

The Set to Standard button sets the compensations to a universally accepted standard.

Note: compensations will only work correctly when a) the injector dead times are correctly defined in Injection Settings47 and b) the sensor is mounted in an appropriate location - ideally between the intake valves and the butterfly.

3.4.5 Exhaust Manifold Pressure

Sensor Configuration

For the sensor to provide meaningful information, its characteristics must be defined here. Never assume base maps have accurate scalings unless specifically mentioned in the comments.

You can either use a sensor that has a built-in preset in the software or define the scale yourself.

Pressure sensors are usually a 3-pin sensor with a 0-5v output. We do not recommend the use of any other type (such as those that ground through the engine).

Most pressure sensors have a linear scale. If you do not have a scale for your sensor but can measure the voltage at a known high and low pressure, you can generally just Interpolate 5 (Shift+F5) between the measured values and the rest will be correct.

Enter your lowest pressure at the top and highest at the bottom. Click the lowest value and drag down to the highest. Then press Shift+F5. Do the same for voltage and that should be correct.

Warnings Active and Upper/Lower Warning Level

Here you can set and enable warnings for values you define as too high or too low.

Warnings are displayed during Real Time Mapping 14, via the CANBUS and also via the shift light.

Warnings are only active above the transition from cranking RPM in Engine Settings 32.

Filter Value

This allows electrical noise that could interfere with the sensor reading to be filtered. If you do not see any random variations then leave the value set to 1. If you do then increase the filter value until the noise is gone.

Sensors are read every 1ms (1000Hz). The filter value is the number of samples that the sensor value is averaged over.

Setting the value to 20 would mean the sensor value that is displayed (and used by the ECU) has been averaged over the last 20 samples (20ms). Therefore it would update 50 times a second (50Hz).

Sensor Compensations

This table allows you to modify the fuel injection quantity and ignition advance according to exhaust manifold pressure.

Note: compensations will only work correctly when a) the injector dead times are correctly defined in Injection Settings 47 and b) the sensor is mounted in an appropriate location - usually between the exhaust valves and a turbo.

3.4.6 Oil Pressure

Sensor Configuration

For the sensor to provide meaningful information, its characteristics must be defined here. Never assume base maps have accurate scalings unless specifically mentioned in the comments.

You can either use a sensor that has a built-in preset in the software or define the scale yourself.

Pressure sensors are usually a 3-pin sensor with a 0-5v output. We do not recommend the use of any other type (such as those that ground through the engine).

Most pressure sensors have a linear scale. If you do not have a scale for your sensor but can measure the voltage at a known high and low pressure, you can generally just Interpolate [5] (Shift+F5) between the measured values and the rest will be correct.

Enter your lowest pressure at the top and highest at the bottom. Click the lowest value and drag down to the highest. Then press Shift+F5. Do the same for voltage and that should be correct.

Warnings Active and Upper/Lower Warning Level
Here you can set and enable warnings for values you define as too high or too low.

Warnings are displayed during Real Time Mapping [14], via the CANBUS and also via the shift light.

Warnings are only active above the transition from cranking RPM in Engine Settings [32].

Note: warning levels are also used for engine shutdown in the Engine Protection [38] settings.

Filter Value
This allows electrical noise that could interfere with the sensor reading to be filtered. If you do not see any random variations then leave the value set to 1. If you do then increase the filter value until the noise is gone.

Sensors are read every 1ms (1000Hz). The filter value is the number of samples that the sensor value is averaged over.

Setting the value to 20 would mean the sensor value that is displayed (and used by the ECU) has been averaged over the last 20 samples (20ms). Therefore it would update 50 times a second (50Hz).

3.4.7 Fuel Pressure

Sensor Configuration

For the sensor to provide meaningful information, its characteristics must be defined here. Never assume base maps have accurate scalings unless specifically mentioned in the comments.

You can either use a sensor that has a built-in preset in the software or define the scale yourself.

Pressure sensors are usually a 3-pin sensor with a 0-5v output. We do not recommend the use of any other type (such as those that ground through the engine).

Most pressure sensors have a linear scale. If you do not have a scale for your sensor but can measure the voltage at a known high and low pressure, you can generally just Interpolate [5] (Shift+F5) between the measured values and the rest will be correct.

Enter your lowest pressure at the top and highest at the bottom. Click the lowest value and drag down to the highest. Then press Shift+F5. Do the same for voltage and that should be correct.

Warnings Active and Upper/Lower Warning Level
Here you can set and enable warnings for values you define as too high or too low.

Warnings are displayed during Real Time Mapping 14, via the CANBUS and also via the shift light.

Warnings are only active above the transition from cranking RPM in Engine Settings 32.

Filter Value

This allows electrical noise that could interfere with the sensor reading to be filtered. If you do not see any random variations then leave the value set to 1. If you do then increase the filter value until the noise is gone.

Sensors are read every 1ms (1000Hz). The filter value is the number of samples that the sensor value is averaged over.

Setting the value to 20 would mean the sensor value that is displayed (and used by the ECU) has been averaged over the last 20 samples (20ms). Therefore it would update 50 times a second (50Hz).

3.4.8 Throttle Stops

This section defines the voltages the Throttle Position Sensor reads when the throttle is fully open and fully closed. The ECU interpolates between these values to determine the percentage of throttle position.

Ensure the throttle butterfly/slide/barrel is in the fully closed position (aside from idle requirements) and click the Closed button. Then open fully (wide open throttle) and click the Open button. Hit F4 to save changes to the ECU.

Reverse TPS Movement

If the TPS is incorrectly connected, that is 5v and Sensor Ground are the wrong way round, then the correct approach is to correct the wiring. In situations where this cannot be done, this setting will reverse the throttle position so that 0% before 100% etc.

3.4.9 Gear Potentiometer

If you have a sequential gearbox with a gear potentiometer and want to either display your gear number on a dashboard, or use the potentiometer for Shift Cut 83 or Paddle Shift 86, you can set it up here.

Fill the values in, matching the sensor mV of the gear you are in to the gear number.

Leave any unused gears at 0.

Note: the whole table MUST be filled in and voltage must go from low in first gear to high in top gear.
Reverse and Neutral can be at any value.

3.4.10 Lambda Sensor

All DTA T-Series ECUs include at least 1 on-board Bosch CJ125 wideband lambda controller, compatible with LSU 4.9 sensors. However, you can also use external wideband controllers. Narrowband sensors are not supported.

Sensor Configuration

Internal Sensor 1/2
Enables the internal wideband controller. No scaling is required.

External Sensor 1/2
Allows a 0-5v output from an external wideband controller to be used instead of the internal wideband controller. Scaling must be defined in the External Sensor Configuration.

External Sensor Configuration

This section allows you to define the scaling for the external wideband lambda controller output. Select one of the presets, use the output voltage documentation provided with your controller or if the controller allows, define your own scale and then enter it here.

Most wideband controllers output a linear voltage, where low voltage is rich and high voltage is lean. Some use the whole voltage range, others leave a few hundred mV at either end to act as voltages that report the state of the sensor (error, warm up etc.). When filling out the table, it is usually sufficient to enter the low voltage at the top, high voltage at the bottom and interpolate (Shift+F5) between them. Same for the corresponding lambda values.

If you have a controller with a display, it is important to ensure the display and the ECU display the same values - sometimes wiring issues can cause a voltage offset.

Some controllers may require being connected to the ECUs sensor ground but you must take care to ensure this doesn't allow the ECU sensor ground to then connect to power ground (with ECU connectors unplugged).

Closed Loop Settings

Close loop fuelling allows the ECU to use one or two lambda sensors to adjust fuelling automatically, based on the parameters set here and the Lambda Target Map70. Closed loop fuelling can be used as an aide to speed up fuel mapping (set lambda target, turned closed loop on, move from cell to cell in Real Time Mapping14 hitting enter). Note: closed-loop fuelling is not a substitute for mapping.

Closed Loop Fuelling On
Enables/disables closed loop fuelling.

Main Sample Rate
The number of times per second (Hz) the lambda sensor/controller voltage is sampled by the ECU. A Bosch LSU 4.9 sensor can respond to changes in air/fuel ratio in under 50ms. Setting this to 20Hz is usually sufficient, however some controllers may be slower by design and increasing the sample rate from say 5Hz to 20Hz may make little difference.

Minimum Water Temperature
Set the minimum coolant temperature at which closed loop fuelling is active.

Delay Lambda Control
Set the amount of time to wait before close loop fuelling is enabled, once the engine transitions from "cranking" to "running". This is mainly to allow externally controlled sensors time to heat up. For an LSU 4.9 this is usually around 20 seconds. If using the on-board controller, control is automatically delayed until the sensor has warmed up so there's not need to set this delay unless using you are using it for another reason, such as (very) cold starts, where the target lambda may need to be higher than specified for the engine to idle correctly.

PID Factors
See PID Control Loops[105].

Maximum Percentage Increase/Decrease In Fuel
A properly mapped engine should need very little in the way of fuel adjustment during its life. To allow adjustment but ensure adjustments cannot get out of control, you can set the maximum percentage the fuel can be increased or decreased by when closed loop fuelling is enabled.

If you plan to use closed loop during Real Time Mapping[14], you must ensure these values allow enough adjustment for the application.

Use MAP for Lambda 3D Target Map when Alpha-N
This allows you to use Alpha-N (RPM vs TPS) fuel and ignition tables but use Speed Density (RPM vs MAP) for the Lambda target table. This is mainly for forced induction engines.

Enable Lambda Switch
You can use one of the digital Inputs[25] to turn closed loop fuelling on/off. Enable the switch here.

Suspend Close Loop if Sensor Voltage Below 100mV
This will depend on the (external) Lambda controller used and its scaling. If you can set your controller so that voltages below 100mV are the result of an error or delayed warm up phase and then scale the output appropriately, this setting will ensure closed loop is turned off when that occurs. The on-board controller suspends closed loop automatically on sensor error or warm up.

Use modified PID
Alternative to the regular PID control method. This removes the Integral, leaving just Proportional and Differential.

Turn Control Off Above RPM/TPS

These allows you to use closed loop fuelling but then disable it above a certain RPM or throttle position. Set to an unreachable value to disable.

Idle Settings

These settings define whether the closed loop control uses the Main Sample Rate or the Idle Sample Rate and under which conditions to switch between them.

Idle Sample Rate

Sets the sample rate to be used during idle, in seconds. During idle, exhaust gasses flow more slowly so changes in fuelling take longer to detect. If the sample rate is too quick, the ECU may add too much fuel because it is not seeing a change. This can then lead to an oscillating over-fuel/under-fuel situation.

Idle Maximum Throttle/RPM

Above these values, the main sample rate is used.

Overrun Settings

Overrun is a condition where there is little-to-no throttle input and the momentum of the vehicle is maintaining the engine RPM and/or reducing its ability to decelerate as quickly as it normally would. During overrun, a lambda sensor will generally read lean but this does not mean the engine is actually running lean. Therefore, closed-loop fuelling should be temporarily disabled during overrun and the settings below define how and when that happens.

Overrun Throttle Position/RPM

Below these values, closed loop is disabled. We recommend setting these to a few hundred RPM above idle speed and 2-3% above idle throttle position.

Overrun Lock Time

This is the amount of time closed loop remains disabled once the engine is no longer in an overrun condition.

Throttle Reduction Lockout

Similar to overrun. When throttle input is reduced but not so much to enter an overrun condition, a lambda sensor will generally read lean, regardless of how well tuned the Transients69 are and therefore closed loop fuelling should be temporarily disabled.

Throttle Reduction To Lock

Sets how much of a reduction in throttle position is required to disable closed loop fuelling.

Throttle Reduction Lock Time

Sets how long closed loop fuelling remains disabled after the throttle position has increased.

Twin Lambda Settings

If you have two lambda sensors, here you can define which injector outputs are associated with which lambda sensor. Ideal for V engines.

3.4.11 Wheel Speed

Wheel Speed Sensor Settings

Number of Undriven Wheel Sensors

Select how many wheel speed sensors are fitted to wheels that are not driven by the engine. Note: you must have at least 1 undriven wheel speed sensor for traction control.

Undriven/Driven Pulses per Rev

How many "teeth" are on the sensor trigger.

Left/Right Undriven/Driven Wheel Sensor Type

Select the sensor type for the relevant sensor or "none" if not fitted/used.

Tyre Settings

Undriven/Driven Tyre Circumference

Measure the circumference of the tyre, fitted to a wheel, properly inflated and enter it here.

Gear Distance Settings

For setups that use only 1 wheel speed sensor, you can use engine RPM to act as "driven" wheel speed, providing you know the gear and final drive ratios.

Distance per Engine Rev in Gear x

Multiply your gear ratio by your final drive ratio, then divide your driven tyre circumference by that number. E.g. 2.4:1 1st gear ratio, a 4.1:1 final drive and a tyre circumference of 1806mm would be 1806 / (2.4 x 4.1) = 183mm

3.4.12 Gear by Shaft

Gear Position By RPM

This allows you to create a "virtual" gear position sensor based on the ratio of engine speed to shaft speed. The shaft speed should be taken from either the differential input shaft or the crown-wheel of the differential. It should not be taken by the output of the differential (i.e. a wheel speed sensor). Many modern gearboxes use an electronic speed sensor that is ideal for this. Alternatively a mechanical speed output can sometimes be connected to a rotary encoder for a similar effect.

Enable Gear By RPM
Enables the function.

Highest Gear
The number of forward gears the gearbox has.

Number of Teeth on Target Wheel
The number of teeth/pulses per revolution of the shaft.

Ratios

Enter the ratios recorded by the ECU in Current Values for the gear you are in.

Note: if you are using Traction Control 81 with 2 driven wheel speed sensors, you cannot use Gear by Shaft.

Note: on T2i/T2/T4/T4+ ECUs you can only use a hall effect sensor connected to a Digital Input 25.

3.4.13 Ethanol Compensations

An Ethanol sensor detects the percentage of Ethanol content in the fuel. If you plan to run fuels with higher Ethanol content than the engine was mapped on, or you plan to switch between fuels, an Ethanol sensor should be fitted as Ethanol has a higher stoichiometric ratio than gasoline and therefore, more fuel is required to achieve the same lambda value.

The T Series ECU supports both the GM and Continental sensors, although the Continental requires a 4.7k pull up resistor between the 12V supply and signal wires.

The Set Fuel Compensations to Standard button will fill the table with compensations based on the stoichiometric value of Ethanol. These can be adjusted if required but should be left as standard. You can also add increase ignition advance as the Ethanol content increases, should the engine allow.

3.4.14 Turbo Speed

A turbo speed sensor can be fitted to monitor turbo speed.
The most common is the sensor created by Garrett Turbos, which sends a signal to the ECU.
The only information the ECU requires to calculate the turbo speed is the number of blades on the turbo.

3.5 Engine Control

3.5.1 Main Fuel/Ignition Map

The cell values in the map table are colour coded. Green for a small value, red for a large value and a sliding scale/gradient between.

Injector values are in milliseconds of opening and represent the "base" opening time, i.e. the injection time with dead time and compensations removed. It is crucial to re-check the fuel map after any dead time or compensation modification.

Ignition values are in degrees before TDC (advance). Therefore a negative value would represent degrees after TDC (retard). These also represent the "base" timing.

By default, the sizes of these maps is 20 RPM rows by 14 load (TPS or MAP) columns. This can be changed in the Main Map Axes settings under Map Configuration 10.

Table cells can be manipulated in groups, either arithmetically or by interpolation. For example:

> To add 10% to a section, click the starting cell then drag to the finishing cell. Press F5, select Change by Percent, enter 10 and click ok. The selected values will then be increased by 10%. You can also use negative values and use the keyboards arrow keys and shift button to select cells.
>
> Similarly, you can interpolate between a starting cell and finishing cell by selecting the cells and clicking Shift+F5. Interpolation allows you to take two values and "fill in the blanks" between them in a linear fashion.
>
> You can also copy a cell or groups of cells (Ctrl+C or Edit > Copy) and paste (Ctrl+V or Edit > Paste) over other cells.

In addition to the map table is a 3D map graph that allows you to visualise the map more easily and spot any potential irregularities.

3.5.2 Start Fuelling Map

When an engine is running, injected fuel atomises with the air to form the air-fuel mixtures but a portion of this mixture condenses on to the walls of the intake runners and ports. This is generally referred to as "wall wetting". There is a constant cycle of wetting and evaporation. When the engine first starts, regardless of the temperature, the walls are dry and that portion of mixture will initially be "lost" to the walls and not enter the combustion chamber. At hot temperatures, this is less of an issue as the condensed fuel will evaporate and enter the combustion chamber quite quickly. However, at cold temperatures, evaporation is slower and the mixture defined when mapping the hot engine will tend to be much leaner as a result. In the days of carburettors, this was compensated for by using a "choke", which would lower the air pressure around the venturi and richen the mixture. In fuel injected engines, a start fuelling map is required to compensate.

The start fuelling map allows you to add a percentage of fuel (based on the current base injection amount set in the Main Fuel Map), depending on the number of turns of the engine (since synchronisation) and water temperature.

The map is 20 rows of engine turns by 14 rows of water temperature. The table axes can be set to your requirements however in most cases, start fuelling should not be required beyond 1000 turns and after that point, water temperature compensations can be used. It's also recommended to have the first 100 turns start with 1 and go to 100 in 10 turn steps as some engines require a large initial increase but then quickly require a smaller increase (usually when injectors are closer to the valves). Engines can run very rough and/or foul spark plugs if the mixture is too rich for too long.

The map can be manipulated the in the same way as the main fuel/ignition maps and a graph is provided for visualisation.

When in Real Time Mapping 14, the compensations provided by this map are shown against the Throttle row of the live data panel. If you blip the throttle during start fuelling, the Throttle Transient 69 values will be added/subtracted.

For more information, see the Guide to Start Fuelling 107.

Note: A lambda sensor will generally require 100-200 turns of the engine to warm up safely so the first 100-200 turns can be a bit of guesswork. If using an external lambda controller, you can preheat the sensor before starting (use a separate power supply or it may reset under cranking when the voltage drops) but this can damage the sensor and reduce its lifespan. It's often useful to target a richer measure mixture than you generally would - by that we mean, if you're having to add 50% more fuel to maintain lambda 1.00, add 60% instead and have the map maintain lambda 0.90. This will make for a smoother idle during very cold starts. For that reason, we'd also recommend turning closed loop lambda off below 60° if your target is lambda 1.00 when hot.

Note2: your idle control strategy will have a large influence on the start fuelling map, especially in cold start condition. An engine with an idle control valve or drive-by-wire idle strategy will have more airflow when cold (to raise the RPM) so will require considerably more fuel. Tuning the start fuelling map can be more difficult with drive by wire idle control as the base fuel quantity in the main map will move around with the throttle opening.

Below is an example of a 1.8L Zetec which uses an idle control valve, mapped down to 0°:

Start Fuelling - Crank Rotations vs Temperature °C

	-10	-5	0	5	10	15	20	25	30	35	40	50	60	80
1	300	300	300	275	250	250	225	225	225	225	200	200	200	100
3	220	220	220	220	220	100	70	55	42	28	11	11	11	11
5	165	165	165	165	100	65	50	42	28	16	11	11	11	6
7	110	110	110	110	65	65	35	16	11	11	11	11	11	6
10	82	82	82	82	65	55	26	22	22	22	11	11	11	6
20	55	55	55	55	55	55	20	13	10	10	10	10	6	1
30	55	55	55	55	55	55	20	13	10	10	10	10	6	1
40	55	55	55	55	55	30	15	10	10	10	10	10	6	1
60	55	55	45	35	25	25	15	10	10	10	10	10	6	1
80	35	35	25	25	25	25	15	10	10	10	10	10	6	1
100	35	25	25	25	25	25	15	10	10	10	10	10	6	1
200	25	20	20	15	15	15	15	10	10	10	10	10	6	1
300	10	10	10	10	10	10	10	10	10	10	10	10	6	1
400	10	10	10	10	10	10	10	10	10	10	10	10	6	1
500	5	5	5	5	1	1	1	1	1	1	1	1	1	1
600	1	1	1	1	1	1	1	1	1	1	1	1	1	1
700	1	1	1	1	1	1	1	1	1	1	1	1	1	1
800	1	1	1	1	1	1	1	1	1	1	1	1	1	1
900	1	1	1	1	1	1	1	1	1	1	1	1	1	0
10000	1	1	1	1	1	1	1	1	1	1	1	1	0	0

Main Table Axes

	Temp °C -40 to 300
1	-10
2	-5
3	0
4	5
5	10
6	15
7	20
8	25
9	30
10	35
11	40
12	50
13	60
14	80

	Turns 1 - 10000
1	1
2	3
3	5
4	7
5	10
6	20
7	30
8	40
9	60
10	80
11	100
12	200
13	300
14	400
15	500
16	600
17	700
18	800
19	900
20	10,000

3.5.3 Injector Angle Map

The injector angle is the point, in relation to TDC (on compression stroke), at which the injection event starts or stops.

Whether this map effects the start or stop of the injection event is defined under Injection Settings47.

The map can be manipulated the in the same way as the main fuel/ignition maps and a graph is provided for visualisation.

The Dyno Box106 can be used to manipulate the injection angle during Real Time Mapping by pressing Ctrl+Q. This will set left knob (normally fuel) to injector angle.

3.5.4 Idle Control

- Idle Parameters 65
- Idle Maps 68

3.5.4.1 Idle Parameters

Idle control enables the ECU to maintain a specific engine RPM when the throttle is closed. It is most useful for increasing the RPM during cold start situations, where an engine may naturally idle as much as 500rpm lower than it would when hot. The most effective method is generally an idle control valve but for best results, this should be paired with a MAP sensor with fuelling compensations. Drive-by-wire motors can be used for idle control but depending on their size, they can be a bit "all or nothing", like using a sledge hammer to tap in a nail. The other option is ignition timing and it generally works very well but depending on your base timing, it can only do so much with the air available to the engine. Some engines are happy idling with close to zero advance or even slight retard at idle when hot and this would allow the more advance during cold start phases. However, running less than 8° of base timing can lead to very hot exhaust manifold temperatures and risk damaging exhaust valves.

Idle Control Strategy

Idle Control On

Not all engines require idle control so it can be enabled/disabled as necessary. It is often useful and/or necessary to disable it when tuning the engine.

Strategies

You can use either an idle control vale, ignition advance or drive-by-wire throttle to control the idle speed. Each strategy has it's own specific settings. Note: all three strategies will share some values but the type of value (i.e. degrees, duty, position) will change. If changing from one strategy to another, ensure all values are corrected as necessary.

Max Throttle/RPM for Idle Control

Both engine RPM and throttle position must be below the value defined here for idle control to be active. If either goes above these values, idle control is disabled.

Ignition Advance Strategy

This uses ignition advance to control idle RPM. You can use either a 3D ignition advance map, closed loop PID control or a combination of both (recommended).

Ignition Control Settings

Use 3D Ignition Table

Uses the Idle Ignition Map 68 for ignition timing at idle.

Max/Min Idle Advance
Sets the global limits for idle control. Regardless of what is set anywhere else, when idle control is active the timing will not go below the minimum or above the maximum. We recommend not allowing the advance to drop too low as it can cause excessive exhaust gas temperatures. 5-10° of advance is generally a good minimum.

Air Con/Fan Uplift
If closed loop PID control is not enabled, you can set a fixed amount of advance to be added when the cooling fan is activated and/or when an Air Conditioning "on" signal is received.

Idle Air Control Valve Strategy
This uses a PWM duty cycle to operate an idle control valve which allows more air into the engine. You can use either a 3D valve PWM map, closed loop PID control or a combination of both (recommended).

Idle Valve Control Settings

Use 3D Base Duty Cycle
Uses the Idle Valve PWM Map 68 for controlling the idle valve base duty cycle.

Use Bosch 3-Pin Idle Valve
If you have an idle valve which requires a PWM signal on 1 pin and the inverse of that signal on another, check this box.

Idle Valve Frequency
Sets the frequency of the PWM duty cycle. See: PWM Frequencies 107.

Max/Min Duty Cycle
Sets the global limits for PWM control. Regardless of what is set anywhere else, when idle control is active the idle valve duty cycle will not go below the minimum or above the maximum. These values can help reduce current draw and also allow for smoother PID control.

Air Con/Fan Uplift
If closed loop PID control is not enabled, you can set a fixed amount of PWM duty to be added when the cooling fan is activated and/or when an Air Conditioning "on" signal is received.

Enrichment
An idle valve essentially allows "un-metered" air into the engine. Because of this the engine will run lean, so to compensate, the enrichment table allows you to add a percentage increase in fuel against the PWM duty.

Drive-by-Wire Strategy

This uses a throttle percentage to allow more/less air into the engine using the throttle motor. You can use either a 3D throttle position map, closed loop PID control or a combination of both (recommended). Note: this method can make start fuelling setup more involved as the base fuel quantity will change according to the main fuel map as the throttle position changes.

DBW Control Settings

Use 3D Throttle Table

Uses the Idle DBW Map 68 for controlling the throttle position at idle.

Max/Min Throttle Opening

Sets the global limits for throttle position. Regardless of what is set anywhere else, when idle control is active the throttle position will not go below the minimum or above the maximum.

Air Con/Fan Uplift

If closed loop PID control is not enabled, you can set a fixed amount of throttle position to be added when the cooling fan is activated and/or when an Air Conditioning "on" signal is received.

Closed Loop Settings

Use PID Loop

Enables closed loop control.

PID Factors

See PID Control Loops 105.

Control Loop Delay

This value restricts the frequency of changes that the PID loop can make. E.g. allowing the loop to make a change every 0.1 seconds may cause the engine RPM to oscillate rapidly. However, setting it to 2 seconds may cause the RPM to drop too low and generate a slow oscillation.

Max PID Adjustment

This value restricts how much adjustment (positive or negative) the PID loop is able to provide. No matter how large this value, the adjustment will never be allowed to exceed the global limits set above. Note: this value changes type depending on strategy (degrees, PWM duty or throttle position).

Closed Loop Idle Target RPM

If PID Loop enabled, regardless of which strategy is used, the idle target RPM must be set. The target is matched against water temperature. You can set a high target for low temperatures and a lower target for regular operating temperatures. As these values are in a table, you can interpolate between them with Shift+F5.

3.5.4.2 Idle Maps

A 20x14 map allowing you to set either the idle ignition timing, the base PWM duty of an idle control valve or throttle position against engine RPM and coolant temperature, depending on which idle control strategy is selected in Idle Parameters65. Note: all three strategies share the same map. If switching from one strategy to another, ensure the map has relevant values.

The map axes can be modified to suit your requirements. For convenience, the axes can be arithmetically modified (F5) or interpolated (Shift+F5), as can the table.

A graph is provided for data visualisation along with relevant live data values.

Below is an example of an idle control valve map from our 1.8L Zetec map:

Idle PWM % - RPM vs Temperature °C

	-20	-10	0	5	10	20	30	40	50	60	70	80	90	100
100	48	48	48	48	43	43	43	38	33	28	28	28	28	28
200	48	48	48	48	43	43	43	38	33	28	28	28	28	28
300	48	48	48	48	43	43	43	38	33	28	28	28	28	28
400	48	48	48	48	43	43	43	38	33	28	28	28	28	28
500	48	48	48	48	43	43	43	38	33	28	28	28	28	28
600	48	48	48	48	43	43	43	38	33	28	28	28	28	28
700	48	48	48	48	43	43	43	38	33	28	28	28	28	28
800	45	45	45	45	40	40	40	35	30	25	25	25	25	25
900	45	45	45	45	40	40	40	35	30	24	24	24	24	24
1000	45	45	45	45	40	40	40	35	30	23	23	23	23	23
1100	45	45	45	45	40	40	40	35	30	23	23	23	23	23
1200	45	45	45	45	40	40	40	35	30	23	23	23	23	23
1300	40	40	40	40	37	37	37	32	27	23	23	23	23	23
1400	40	40	40	37	35	35	35	23	23	23	23	23	23	23
1500	37	37	37	35	25	23	23	23	23	23	23	23	23	23
1600	35	35	35	25	23	23	23	23	23	23	23	23	23	23
1700	25	25	25	23	23	23	23	23	23	23	23	23	23	23
1800	23	23	23	23	23	23	23	23	23	23	23	23	23	23
1900	23	23	23	23	23	23	23	23	23	23	23	23	23	23
2000	23	23	23	23	23	23	23	23	23	23	23	23	23	23

Main Table Axes

	Temp °C -40 to 300
1	-20
2	-10
3	0
4	5
5	10
6	20
7	30
8	40
9	50
10	60
11	70
12	80
13	90
14	100

	RPM 0 - 6000
1	100
2	200
3	300
4	400
5	500
6	600
7	700
8	800
9	900
10	1,000
11	1,100
12	1,200
13	1,300
14	1,400
15	1,500
16	1,600
17	1,700
18	1,800
19	1,900
20	2,000

3.5.5 Throttle Transients

Transients add or subtract a percentage of fuel for a limited time as the throttle is opened or closed quickly. This is generally very difficult to quantify, often varying even between individual engines of the same type and capacity. If there is any hesitation or uncertainty when opening the throttle quickly, the transients will most likely need adjusting. If you have a very fast wide band sensor you can set the data log to 100Hz and record the percentage increase or reduction as it is happening, against throttle position, RPM and lambda. The object is to keep the lambda value as close to constant as possible through the transient condition.

There are four different RPM bands to which transients can be applied. Generally, you will need a higher percentage of fuel increase/decrease for a longer time at lower pedal speeds in the lower RPM bands and possibly nothing at all in the higher bands.

The pedal speed column is the percentage of throttle movement recorded during the Pedal Speed Measuring Time. If in doubt start at 5 for the lower bands increasing to 25/30 in the higher bands.

A very low figure will cause the transient compensations to occur even with very slow movements of the pedal and values above 50 will mean they will probably never come into operation at all depending on the pedal speed measuring time. Careful use of fast logging will help to identify the engine requirements.

The current percentage change being generated by the transients can be seen in real time mapping screen to the right of the throttle percentage in the sensor data panel. Note: this position is also used for start fuelling and the two values are combined during the start fuelling phase.

It is recommended that closed loop fuelling and idle control be disabled prior to transient tuning. The engine should also have finished the start fuelling phase or have the table zeroed out.

Tip In
These values are used when the throttle is opened. Without a sufficient increase in fuelling, the engine will run lean and hesitate.

Tip Out
These values are used when the throttle is closed. Without a sufficient reduction in fuel, the engine will run rich and may "bog down" when the throttle is re-applied. Note: The effect on closing the throttle completely on the overrun makes for lambda readings which indicate the engine is very lean. This is not the case and it should be ignored.

Pedal Speed Measuring Time
This is the time in ms over which the pedal movement is measured. 10 – 20 ms is a reasonable figure.

Turn Transients Off Above Throttle
Above this throttle position, transients will be disabled.

Switch to Hot Map At
Generally, an engine will need more transient fuelling when cold. We would normally switch maps at 45-60°C.

Disabling Transients For Mapping
Transients can interfere with mapping steady state. In Real Time Mapping[14] there is a toggle switch at the bottom of the window to turn them off. Remember to turn them back on after steady state mapping is finished.

3.5.6 Lambda Settings

- Lambda Target Map[70]

3.5.6.1 Lambda Target Map

A 20x14 map allowing you to set the target lambda value for a given engine speed and load. This map is only used when specified in the Lambda Sensor Configuration.[57]

A graph is provided for data visualisation along with relevant live data. The table can be arithmetically modified (F5) or interpolated (Shift+F5).

3.5.7 Turbo Control

- Turbo Parameters[70]
- Turbo Base PWM[73]
- Turbo Target Pressure[73]

3.5.7.1 Turbo Parameters

Turbo Settings

Turbo Control On
Activates the control strategy.

Turbo Valve Frequency
The frequency of the PWM duty cycle. See: PWM Frequencies[107] .

Turbo Max Pressure
Above this value, injection and ignition will be disabled to protect the engine from overpressure.

Min/Max Duty Cycle
Sets the global limits for PWM control. Regardless of what is set anywhere else, when turbo control is active the turbo valve duty cycle will not go below the minimum or above the maximum set here.

Reverse Valve Operation

This inverts the PWM signal to the valve. With some valves a lower PWM duty gives more pressure. Many prefer to have higher duty give more pressure. Turning this feature on achieves this. Note this purely a matter of preference and is not required.

Use 3D Base PWM Map

Essential that you use this. The base settings can be arrived at by using the alternate function of the left hand dyno box[106] knob in real time mapping. Run the engine at the required speed and load and swing the knob until the desired pressure is achieved, press enter just are you would do with fuel and ignition adjustment. This is a lot safer when the engine is running closed loop fuelling[57] so there is no chance of the engine being damaged by incorrect mixture.

Use Gear/Speed Based PWM Modifier

Once you have set the base PWM map, you can modify it based on vehicle speed or gear position. This can help with traction issues. At least one un-driven Wheel Speed Sensor[60] is required for speed. Gear position can be either from a Gear Position Sensor[56] or Gear by Shaft[60].

Use MAP for PWM X Axis

Allows the use of manifold pressure as load (instead of TPS) on the X (horizontal) axis in the base PWM map.

Closed Loop Control

Closed loop control relies on the Turbo Target Pressure map[73] being set correctly.

Closed Loop On

Enables PID loop control.

PID Factors

See PID Control Loops[105].

Control Loop Time

This value restricts the frequency of changes that the PID loop can make, to allow time for the engine to react properly to the change before more changes are attempted. E.g. allowing the loop to make a change every 0.1 seconds may cause boost to oscillate rapidly around the target. However, setting it to 2 seconds may cause the boost to lag behind the target. Heavily dependant on the plenum, turbo and engine capacity.

Max PID Adjustment

This value restricts how much adjustment (positive or negative) the PID loop is able to provide. No matter how large this value, the adjustment will never be allowed to exceed the global limits set above. Note: this value changes type depending on strategy (degrees, PWM duty or throttle position).

Electric Blow Off Settings

Electric Blow Off Valve Fitted

Enables the control strategy.

Blow Off Time

The maximum amount of time the valve will stay open after activation. If the throttle is pressed, the valve will close regardless of any time remaining.

Pedal Sensor Movement

The amount of reduction in throttle position required to activate the electric blow off valve. This setting uses the Pedal Speed Measuring Time defined in Throttle Transients 69.

Blanking Time

This is a period of time, after the blow off valve activation finishes, in which no further activation can take place.

Blow Off Limit

Below this pressure value, the blow off valve will not be activated.

Mapping a Turbo Engine

You have a choice with a turbo engine to map with manifold pressure as load or TPS as load, using manifold pressure compensations.

Using pressure as load will mean that only a very limited number of cells can be calibrated on the dyno, the rest will need to be estimated.

Using TPS as load with manifold pressure compensations allows many more cells to be calibrated accurately and the manifold pressure compensations will ensure that, regardless of boost pressure, the engine is still correctly fuelled.

If using TPS as load, It is essential that MAP compensations 52 are set before mapping commences. The software removes the compensation adjustment when mapping to make the map independent of manifold pressure, dead time or any other compensations.

Air temperature compensations must always be used, whichever method you are using. High inlet temperatures without compensation will cause the engine to run rich. Note: ensure the sensor is placed in the flow of the intake charge and not somewhere that air can stagnate or somewhere the sensor will be susceptible to heat soak, otherwise the engine can run lean.

Air pressure and temperature compensation maps have a “Set to Standard” button. Whilst the standard compensations are based on established science and are very accurate, they do require the injector dead times to be set correctly, otherwise they will not work.

3.5.7.2 Turbo Base PWM

A 20x14 map allowing you to set the base PWM duty value of the turbo pressure control valve for a given engine speed and load. This map is only used when specified in the Turbo Parameters [70].

A graph is provided for data visualisation along with relevant live data. The table can be arithmetically modified (F5) or interpolated (Shift+F5).

3.5.7.3 Turbo Target Pressure

A 20x14 map allowing you to set the target boost pressure value for a given engine speed and load. Closed Loop boost control [70] relies on this map being set correctly.

A graph is provided for data visualisation along with relevant live data. The table can be arithmetically modified (F5) or interpolated (Shift+F5).

3.5.8 Camshaft Control

- VTEC Parameters [75]
- VVT Control Parameters [76]
- Base PWM Maps [78]
- Cam Target Maps [78]

Camshaft Control

Sophisticated variable camshaft control is becoming an ever more present aspect of modern engines.

Some of the control aspects for these are very simple, such as the Honda VTEC or Audi 1.8T system. Simple switching systems like this can always be used via the VTEC output [26].

Continuously variable angle systems are more complex and usually requires us to have developed a solution especially for that engine. T-Series ECUs can control the vast majority of VVT systems available. The list is extensive but below is an example of the more popular ones:

- Audi 4.2 V8
- BMW M54 Twin VANOS
- BMW S50B30 Single VANOS
- BMW S50B32 Twin VANOS
- BMW S54B32 Twin VANOS
- BMW S65 Quad VANOS

- o BMW S85 Quad VANOS
- o Ford ST170
- o Honda K20A i-VTEC
- o Honda K24 i-VTEC
- o Mazda Duratec
- o Nissan 350Z
- o Nissan 370Z (except variable lift)
- o Porsche VarioCAM
- o Rover K-Series VVC
- o Toyota 2ZZ

The internal differences required to handle these various systems is effectively selected when the relevant flywheel mode is selected in Engine Settings32.

The cam control system is made up of several maps to control up to four camshafts. The parameter map is shared and common between the cams and each pair of cams has its own cam target map

and base PWM map. When four cams are being controlled on a V engine then Cams 1 & 3 are linked and 2 & 4 are linked, that is for example, 1 & 3 are the inlets, 2 & 4 are the exhausts. Note that the

base PWM map is not used for the following engines:

- o Rover VVC
- o BMW S50/S54

and is set to a fixed value for:

- o Honda K20A i-VTEC
- o Toyota 2ZZ
- o Ford ST170
- o Nissan 350Z

- Nissan 370Z

Setting The Camshafts

As with all the engine variables we control, the cam position must be optimized. This can be done in real time mapping using the dyno-box. By pressing F7 when in real time mapping the left hand knob of the dyno-box adjusts the target cam angle. This can then be rotated to find maximum power in real time just as you would with the advance and fuel knobs. This operation is safest when the engine is being run with closed-loop lambda. When the optimum angle has been found, pressing the enter button will record the current fuel and advance as normal and the cam target will also be recorded.

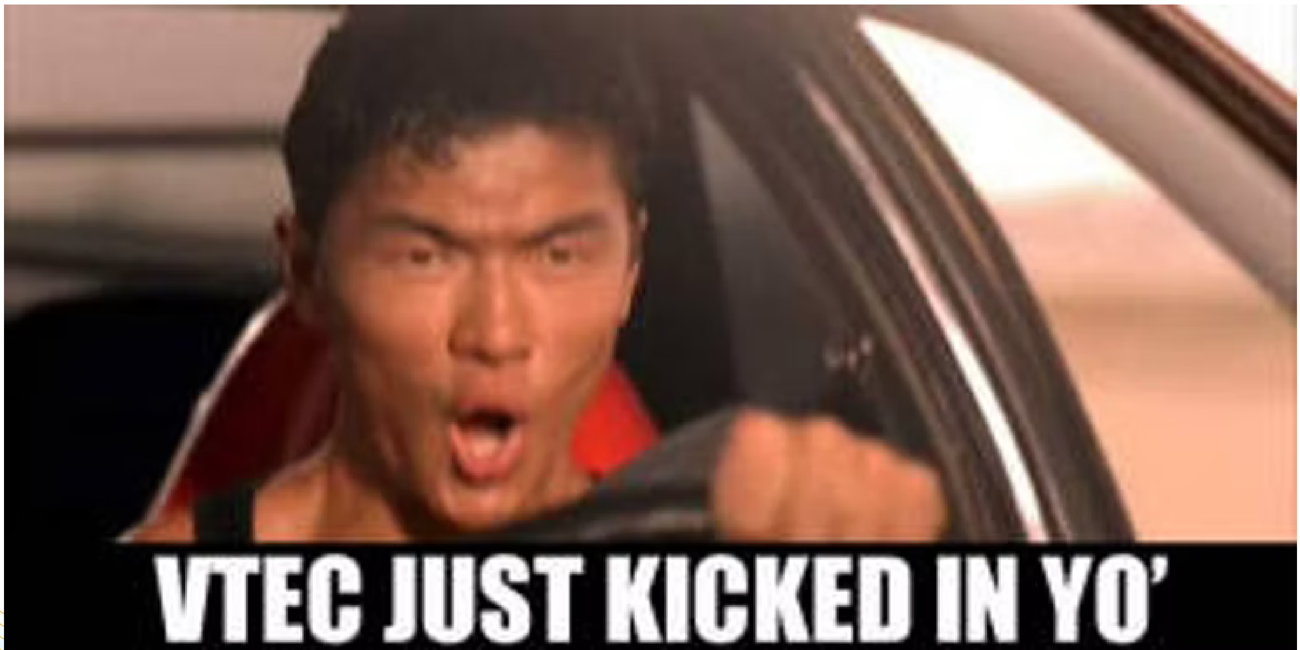
Pressing F8 will make the knob control cam 2 target position.

Once mapped, the cam position must accurately follow the target. This can be verified to be happening using the real time chart with the Cam Advance and Cam Target options checked. This should

result in the kind of picture below. The actual cam advance (blue line) follows the cam target (yellow line) closely:

NOTE: CAM I/O SYNC CAM1 ELABORATE

3.5.8.1 VTEC Parameters



VTEC Parameters

VTEC Control On

Enables the use of a simple on/off camshaft adjustment solenoid

Switch to Map 2 on VTEC

Switches to the second fuel/ignition map when VTEC is activated.

Use Cam 2 Advance Map

For variable lift and duration engines, such as the Honda K20A, you can use Cam 1 advance when VTEC is off and Cam 2 advance when VTEC is on with this setting.

VTEC RPM

Set the RPM at which VTEC kicks in, yo.

VTEC Throttle

VTEC will only activate when throttle position is greater than this value and the above RPM.

Minimum Oil/Water Temperature

Below these values, VTEC will not be activated. **NOTE**: it is best to use this feature in combination with a temperature based RPM limit (Engine Protection38) or Map 290 as the fuelling at the RPMs where VTEC is normally active will be very different when it is not active.

3.5.8.2 VVT Control Parameters

Variable Cam Control Settings

Cam Control On

Activates cam control strategy

Use 3D Base PWM Map

Depending on the type of VVT system you have, this option is either very useful or essential. In setups such as BMW Vanos, where a certain amount of PWM is required to get the valve to a "mid-point" between starting to open and starting to close, the base PWM map is essential. In other BMW Vanos implementations, such as the S54, the base map is not required as it uses 2 separate valves but it is useful to prevent the PID loop working too hard. It can also be useful for VTEC-style setups where a cam may need to turn on, then off.

Use Cam 1 Target advance for both cams (V Engine)

When enabled, cam outputs 1 and 3 will use the same advance map (i.e. two inlet cams on a v-engine).

Reverse Cam Operation

On some engines, inlet cams and exhaust cams operate in the opposite way to each other. These settings enable support for that.

Control Valve Frequency

See PWM Frequencies107.

Min/Max Valve Duty Cycle
Sets the global limits for PWM control. Regardless of what is set anywhere else, when cam control is active, the cam valve duty cycle will not go below the minimum or above the maximum. These values allow for smoother PID control.

Control Delay After Start
Useful for delaying cam control until oil pressure is built up.

Cam 1/2/3/4 Static Position
Position of the camshaft in relation to TDC on Cyl-1 compression stroke.

Minimum Water/Oil Temp
Water and Oil temperatures must be equal or higher than these values before cam control will activate. **NOTE**: it is best to use this feature in combination with a temperature based RPM limit (Engine Protection38) or Map 290 as the fuelling at the RPMs where cam control is normally active will be very different when it is not active.

Variable Cam PID Settings

Use PID Loop
Required for engines that need to use the base PWM map.

Use Modified PID
This ignores the Integral value in the PID factors. Required by most Denso-based systems (Honda, Toyota, ST170 etc,)

PID Factors
See PID Control Loops105

Control Loop Delay
This value restricts the frequency of changes that the PID loop can make. E.g. allowing the loop to make a change every 0.1 seconds may cause the cam angle oscillate rapidly. However, setting it to 2 seconds may cause the cam angle to change too slowly, generating a slow oscillation.

Max PID Duty Cycle
This value restricts how much adjustment (positive or negative) the PID loop is able to provide. No matter how large this value, the adjustment will never be allowed to exceed the global limits set above.

Cam Static Offset Table
Variable camshafts can move by themselves as the engine RPM changes. In order to ensure the Target cam advance tracks correctly with the Actual cam advance, it may be necessary to disconnect the cam solenoid(s) and log the cam position(s) in Real Time Chart19, across a low ramp rate power run, using closed loop fuelling to compensate for the cam not operating.

3.5.8.3 Base PWM Maps

For systems that require it (see Camshaft Control 73), the cam valve PWM can be mapped here. For most VVT applications, the whole map should be the same value. If you have a simple VTEC style system, you can define how it is activated more granularly here.

For systems that use a single valve to advance and retard the cam, this map should be filled with a PWM duty that is half way between:

- The duty required to start advancing the cam (starting from 0 and working your way up gradually), e.g. 87%
- The duty required to start retarding the cam (starting from 100 and working you way back down gradually), e.g. 83%

Which would mean a duty of 85% was required across the map.

For systems that use 2 valves per camshaft (e.g. BMW S50/S54, Rover K-Series), the base map is not used.

3.5.8.4 Cam Target Maps

This map allows you to define a target cam advance vs load and RPM.

3.6 Motorsport Functions

3.6.1 Launch Control Settings

Launch control is a feature that prevents excessive wheel spin off the start line by reducing engine torque. The aim being to get the best possible traction off the start line.

There are three scenarios for using launch control:

1. Launch by RPM only. In this scenario, the button is pressed, held and then released with the clutch. Whilst the button is held, the engine RPM will not exceed the Start Line RPM.

2. Launch by Elapsed Time. In this scenario, the button is pressed, held and then released with the clutch. Whilst the button is held the engine RPM will not exceed the Start Line RPM. After the button is released, the engine RPM limit will be maintained according to the Launch By Elapsed Time81 table for the specified duration.

3. Launch by target slip. In this scenario, the button is pressed to activate launch control. An un-driven wheel speed sensor is used to detect vehicle movement. When the vehicle begins to move, the ECU will dynamically reduce engine torque to maintain a defined difference in wheel speed between the driven and un-driven wheels (slip) up until a defined speed. To do this, the ECU calculates a target engine RPM. If this RPM is below the Start Line RPM, the Start Line RPM is used. If the calculated RPM is greater than the Start Line RPM, the calculated RPM is used. Note: Distance per Engine Rev must be set accurately.

Launch Control Parameters

Launch Control Enabled

Enables the feature.

Flash Shift Light When Active

When checked, this will cycle the Shift Light Output26 on and off rapidly. Can be used with Scenario 1,2 and 3.

Use Launch by Elapsed Time

Enables use of Launch by Elapsed Time81 table.

Start Line RPM Settings

Set Launch RPM When Button Pressed

This allows the Start Line RPM to be set to whatever the engine RPM is when the Launch Button input is shorted to sensor ground, usually by means of a momentary push button. Can be used for Scenario 1 and 3.

Set Launch RPM Using Potentiometer

This allows the Start Line RPM to be set based on a linear 0-5v input voltage, usually by means of a 0-5v rotary potentiometer. Can be used for Scenario 1, 2 and 3.

Only Limit RPM When Button Pressed

For use when no wheel speed sensor is fitted. RPM will be limited to Start Line RPM whilst button is held. Must be used for Scenario 1 and 2.

Start Line RPM

This sets the maximum RPM the engine will be allowed to reach whilst either the launch button is held (Scenario 1) or the calculated wheel slip is greater than the target wheel slip (Scenario 3).

Potentiometer Low/High RPM

When using *Set Launch RPM Using Potentiometer*, the lowest and highest output voltage from the potentiometer can be assigned a corresponding RPM.

Start Line Boost

For turbocharged engines only. Allows boost pressure to build whilst vehicle is stationary by retarding the ignition timing.

Start Line Ignition Retard

The amount of ignition timing removed from the base ignition timing in the Main Ignition Map62. E.g. if the base timing is 10° BTDC and you set this to 20, the timing with be 10° ATDC. Set to 0 to disable.

Start Line Ignition Retard RPM

This value is deducted from the *Start Line RPM* value to give a starting point for the retard to ramp up from. E.g. if *Start Line RPM* is 5000 and this value is 1000, the ECU will begin to retard the ignition at 4000, ramping up to full retard at 5000 RPM.

Launch Control Settings

Distance Per Engine Rev

The distance a driven wheel will travel, per engine rotation, in the starting gear. See: *Gear Distance Settings* in Wheel Speed Configuration60

Target Slip

This is the percentage increase in driven wheel speed allowed vs un-driven wheel speed. I.e. if set to 20, the driven wheels will be allowed to rotate up to 20% faster than the un-driven. This should be high enough so as not to let the engine "bog down" but low enough that the engine isn't stuck at the *Start Line RPM* for too long.

Minimum RPM

During a "launch", if the RPM drops below this value all limits and retardation of timing will be paused until the engine RPM increases back above this value. This helps prevent the engine "bogging down" as the traction increases.

Speed To Turn Off

Once above this speed, Launch Control will deactivate. This is based on the *Distance Per Engine Rev* setting and would generally be set to a speed just below the shift point of your starting gear.

Maximum Ignition Retard

This is the maximum amount of ignition retard allowed during the launch phase. This does not override the *Start Line Ignition Retard*.

PID Settings

See: PID Control Loops[105] . The control loop frequency is the amount of times per second the PID loop will attempt to correct the "error".

Cut Pattern Settings

These are the same cut patterns as set under Soft Cut Patterns in Engine Protection[38]. However, for Launch Control they only begin to come into effect either once the Start Line RPM has been breached or if the calculated target RPM is breached.

Cut Pattern 1-5 RPM Diff From Target RPM

Here you set how many RPMs above the target RPM are required for the cut pattern to activate. E.g. Pattern 1 is set to 20, the target RPM is 4750, the pattern would activate if the RPM reached 4770 etc.

3.6.2 Launch by Elapsed Time

This table can be enabled in Launch Control Settings[78]. This table allows you to define a target engine RPM against a combination of Elapsed Time (since the Launch Button was released) and Voltage (usually from a potentiometer).

The table axis can be configured to individual requirements. If a potentiometer is not fitted (and not enabled), the first voltage column will be used, regardless of its value.

Note: when this table is used, the first row is the Start Line RPM, regardless of any other settings.

3.6.3 Traction Control Settings

The traction control feature limits the difference in speed between the driven wheels and un-driven wheels using a percentage slip target - i.e. how much more the driven wheels are allowed to turn compared to the un-driven wheels. Once the target slip is exceeded, the ECU will reduce engine torque to regain traction.

There are 3 scenarios for enabling traction control:

1. Using 2 driven wheel speed sensors and 1 or 2 un-driven wheel speed sensors (T8 and above)
2. Using Left Driven wheel speed sensor (acting as "shaft speed") and Left Un-driven wheel speed sensor (T4 and above). Note: in this scenario the shaft speed should be taken from either the differential input shaft or the crown-wheel of the differential. It should not be taken from the output of the differential (i.e. a wheel speed sensor). Many modern gearboxes use an electronic speed sensor that is ideal for this. Alternatively a mechanical speed output can sometimes be connected to a rotary encoder for a similar effect. T4/T4+ ECUs must use a Digital Input[25] and a hall effect sensor for "shaft speed".
3. Using Left Un-driven wheel speed sensor only (T4 and above)

Two complete sets of parameters are available to be set, to allow for differing surface conditions (T8 and above only). These are controlled by the Traction Wet/Dry Switch Input 25. If no switch is used then the dry settings are used. In addition to the wet/dry switch, there is also an on/off switch and the option to use a 0-5v "aggression" potentiometer.

Note: on T4/T4+ ECUs, wet/dry and on/off switches are not used. Instead, to activate the feature, an "aggression" potentiometer must be connected to an Analogue Input 25. The traction control will be active at voltages below 4850mv. Therefore the "aggression" range is reduced slightly. A special 12-way, detented position switch with a 0-5v output is available from DTA.

Traction control is dependant on the Wheel Speed Configuration 60 being accurately set for all scenarios.

Traction Setup

Traction Active

Allows the use of the traction control feature

Use Un-driven Wheel Speed and Gear Distance Settings

This configures that traction control feature to use the gear/distance settings in Wheel Speed Configuration 60, to act as a "virtual" driven wheel speed sensor, alongside the left un-driven wheel speed sensor (Scenario 3).

Use Analogue to Set Aggression / No Analogue Input Set

A 0-5v potentiometer can be used to instantly vary the "aggression" of the traction control whilst in use. See: *Excess Slip to Hard Cut (Aggression)*. A spare Analogue Input 25 must be assigned to *Traction Aggression*.

Stopped Time To Reset

The ECU uses the un-driven wheel speed sensors to calculate vehicle speed. The Traction Control feature requires a minimum speed to activate. If the speed drops below this, Traction Control will deactivate. It will activate again once the required vehicle speed, engine RPM and throttle position are present. However, this re-activation will be delayed according to the *Delay After Start* setting. In the event of the un-driven wheels locking up under braking, a delay can be added to prevent the Traction Control feature being instantly deactivated. The prevents re-activation delay issues when the brake lock-up was brief.

Traction Settings

Minimum Speed/RPM/Throttle to Activate

Traction Control will only be active above these values. If any one value drops below, the feature is deactivated.

Balance to Faster Driven Wheel

This setting determines how the speed is averaged between driven wheels. It is the percentage of the difference between the faster and slower wheels that is then added to the slower wheel speed, resulting in the overall "driven speed". E.g. the slower wheel has a speed of 50kph, the faster wheel a speed of 100kph. If this value is set to 100%, the driven wheel speed will be 100kph. If it is set to 50%, the driven wheel speed will be 75kph. 0%, 50kph etc. An "open" differential vehicle should be set closer to 100%. A welded differential vehicle should be set closer to 0%.

Target Slip
This is the percentage increase in driven wheel speed allowed vs un-driven wheel speed. I.e. if set to 20, the driven wheels will be allowed to rotate up to 20% faster than the un-driven.

Excess Slip to Hard Cut (Aggression)
If Target Slip is exceeded, this value can be set to allow a percentage of slip where a "soft cut" occurs, before the eventual "hard cut". This is termed as "aggression" because a low number will result in a "hard cut" happening very quickly once the target slip has been exceeded, whilst a high number will allow more slip to happen for longer before the "hard cut". During "soft cut", the ECU will perform rolling ignition cut which varies in intensity depending on the percentage of excess slip. During "hard cut", ignition is cut according to the *Maximum Ignition Cut Percentage* setting.

Analogue Minimum/Maximum Aggression
These settings assign the minimum and maximum analogue voltages to corresponding "aggression" values. The low voltage should have a low percentage (high aggression) value and vice versa. Note: on a T4/T4+, you cannot use a voltage higher than 4850mv, otherwise Traction Control will deactivate.

Maximum Ignition Cut Percentage
The maximum percentage of ignition cut allowed during "soft/hard cut".

Note: if using Launch Control78, Traction Control will not activate until after the Launch Control phase completes.

3.6.4 Shift Cut Settings

Shift Cut Settings

Shift cut allows for full throttle gear changes. This is primarily for dog-engaged gearboxes where a reduction in engine torque is required to allow the dogs on the gear to disengage during a shift.

Shift Cut On
Activates the feature.

Minimum Throttle
Below this throttle position, shift cut is not active. Used to allow gear selection when vehicle is stationary without cutting the engine.

Number of Gears
The number of forward gears in the gearbox.

Time Out
The amount of time before a "shift" is considered failed and cut is terminated. A count of these events is kept and displayed on the right hand side of the screen.

Start/End Cut With
Allows you to select how a cut starts and ends. For sequential gearboxes. the recommendation is to always use a gear potentiometer. If one is already in use with another system, a dual output version may be available. For H-Pattern gearboxes, you could have a switch mounted to the gear knob that is pressed during the shift but that would be the only way unless you have a transverse gearbox and use something like an SQS shifter.

Potentiometer Settings
Gear Filter Depth
The gear potentiometer voltage is sampled every 1ms. This setting allows you to average the voltage, providing a "smoothing" effect. A starting figure of 10 is recommended, this would mean the voltage used by shift cut is the average of the last 10 samples.

Shift Cut Start Voltage
The shift cut start voltage is the number of mV after the "in-gear voltage" at which to trigger the cut. E.g. The gearbox is in 2nd, voltage is 2000mV. 3rd gear is 3000mV. The start voltage is set to 50mV. As the gear lever is pulled to shift up to 3rd, the voltage increases. When it reaches 2050mV the cut is started. The cut ends using the same value. In this case it would end at 2950mV. Think of this voltage as a buffer either side of the in-gear voltage.

Throttle Blip Band
This is a voltage detection band used for triggering a throttle blip on downshift. On downshift, the voltage decreases. Once the in-gear voltage drops below the start cut "buffer", the blip will be triggered. E.g. 3rd is 3000mV, the cut start voltage is 50mV and the blip band is 200mV. When downshifting to 2nd, when the voltage is detected between 2950mV to 2750mV, a blip will be triggered. However, due to varying speeds of downshifting, setting this to a small value could lead to a blip not being triggered if the shift was very quick and the detection band was passed before the ECU could detect it. 200mV should be sufficient.

Use Switch to Enable Pot
This allows the gear potentiometer to be enabled/disabled via the Shift Cut Switch Digital Input25. In some gearboxes, the selector mechanism that the gear pot reads from can have a significant amount of "free play" or "lash", making the in-gear voltage erratic, leading to false cut/blip detections. A workaround for this is having a switch on the lever that only enables the pot (and thus the shift cut feature) when the switch is "on". Then, once the shift has completed, the pot will be disabled again until the next switch activation. Alternatively, the switch can be

use as a fail safe to protect against a failing pot, allowing it to be disabled and for the vehicle to continue on without shift-cut.

Switch Settings

Blanking Window (Debounce)

This is the length of time, after the switch is pressed, that further switch presses will be ignored for. When a switch is pressed, the contacts inside can oscillate for a period of time, which to an electronic controller may look like a very rapid on/off/on/off cycle. To ignore that oscillation, a blanking window is used. 250ms should be sufficient.

Load Cell Settings

Load Cell Trigger Voltage

Set the voltage at which the load cell will trigger a cut.

Delay Settings

Delay Time

The time in milliseconds, after the shift cut start signal ends, to continue the cut. This is essentially the maximum amount of time it takes the gearbox to successfully complete a shift. Consult gearbox manufacturer for a suitable figure. If in doubt, 150ms is usually a good starting point. Note: setting this time too short can damage the gearbox. not every gear will have the same shift time, either set this value to the longest time or fill out the Gear Dependant settings.

Torque Reduction Strategy

Retard/Cut Ignition

Select the method of torque reduction. Retard is recommended for normally aspirated engines, cut may be required for forced induction engines to prevent an "anti-lag" situation occurring from excessive retard.

Retard Settings

Ignition Retard

The current ignition timing value will be retarded by this amount.

Retard Ramp-In Time

Retardation of the current ignition value will happen gradually over this time.

Cut Settings

Also Cut Fuel

Allows fuel to be cut in addition to spark.

Post Cut Fuel Increase

This is similar to cold start fuelling, in that the fuel on walls of the intake and ports will evaporate very quickly on a high revving, hot engine and when the fuel is cut, they may dry out completely, meaning an extra amount of fuel will be required to "wet" the walls again, otherwise the mixture will run lean. The only way to fill this value in accurately is with logging. Start with a very rich increase and review the logs to determine how much should be removed to maintain the lambda target. Note: log at the actual engine shift point, not at lower speeds as these will require different fuelling.

Post Cut Fuel Increase Time

The amount of time additional fuel is injected for, after the cut. Use logging to determine best value.

Gear Dependent

The gear dependant settings allow specific gear-based ramp-out retards and ramp-out times to be set. If using delay to end the cut, a specific delay for each gear can be set also.

Post Shift Options

Retard After Shift

Once a shift has completed, this setting allows the ignition to retard and then advance back of a period of time (ramp out) to the base timing. This prevents damage to the gearbox and can help reduce wheelspin.

Retard Ramp Out Time

The duration over which the retard amount advances back to the base timing.

Last 20 Shifts

This is a record of the last 20 shifts. Not the up and down times will only be an accurate representation of a shift if a position sensor is used. This is a diagnostic tool for setup work. Click the "Get Last 20" button to populate/update the table.

3.6.5 Paddle Shift Settings

The paddle shift system is designed to work in conjunction with the shift cut system and both need to run closed loop, i.e. Pot to Start, Pot To Finish in shift cut settings. The system expects to see an up paddle switch, a down paddle switch and a neutral button. Outputs26 are provided for an up valve, a down valve, a throttle blipper and a neutral interlock valve.

Any movement of gears below 1st requires the neutral button to be pressed e.g. 1st to N, N to R, R to N, N to 1st.

Paddle Shift Settings

Paddle Shift System On

Turns on the Paddle Shift system. Note: Shift Cut83 must be enabled and working in closed loop.

Gear Order

Allowable values are 0, 1 and 2. The gear layout these correspond to are on the screen. Note: Full Step means the full throw of the lever engages neutral. Half step means that neutral is between two gears and requires half a throw of the lever (usually on motorcycle gearboxes).

Upshift Timeout

Length of time before an attempted upshift is abandoned if the next gear has not been successfully reached. If Upshift Retries are enabled, the shift will be attempted again. Otherwise another pull on the paddle is required. Make this the same as shift-cut timeout in Shift Cut Settings83.

Upshift Retries

The number of retries allowed on a failed upshift.

Downshift Timeout

Length of time before an attempted downshift is abandoned if the next gear has not been successfully reached. If Downshift Retries are enabled, the shift will be attempted again. Otherwise another pull on the paddle is required.

Downshift Retries

The number of retries allowed on a failed downshift.

Delay Before Shift Retry

After a failed shift, if retries are enabled, this delay allows the valves to relax to their non-operative positions. 100ms should be enough but it can be quite difficult to test as failed shifts should be very rare.

Downshift Max RPM

If the engine RPM is above this value, a downshift request will be blocked and the attempt recorded in the status frame under Downshoft RPM Refusals

Downshift Throttle Blip Time

Length of time that the throttle blip valve is open for. Found by experiment on the vehicle. Around 50ms is a good starting point.

Downshift Throttle Blip Percent

Only applies if you are using Drive-By-Wire 92. This is the maximum throttle angle that will be achieved on blip.

Downshift Throttle Blip Delay

If this number is negative then after the down paddle is activated, the blip valve is activated for this length of time before the down valve goes active. If it is positive then the down valve is activated first before the blip. A negative value is normal.

Half Step Settings

Half Step PWM Gear Up/Down

A pneumatic valve cannot inherently do a half length step for engaging neutral on some gearboxes. By pulsing the valves the selection process can be slowed down such that the ECU can stop the action when neutral is reached. Too low a value and the change does not happen, too high a value and neutral will be bypassed and the next full step gear reached. Just experiment until the most suitable level is reached.

Half Step PWM Frequency

A good starting point is 20Hz. See: PWM Frequencies 107 .

Ignition Settings

Downshift Advance Uplift

During the blip the ignition advance can optionally be increased. This may help to unload the gearbox dogs. This is not often required.

Anti Push Cut/Retard Time

This will cut or retarded (depending on the choices in Shift Cut Settings 83) the ignition after a downshift has completed for the defined length of time. This may be required to stop the car "pushing on" after a downshift.

Downshift Ignition Cut Time

This will cut the ignition after the down paddle has been pulled but before the down valve is actuated. Some gearboxes require this when the throttle is closed to allow the dogs to disengage. 40-50ms of cut is normally sufficient.

Error Settings

Gear Pot Failure Low/High

This will disable Shift Cut and Paddle Shift if the gear position sensor reads too low or too high in voltage. Set these settings to values that your sensor cannot output in normal use.

Auto Up Change Settings

Auto Up Change Enabled

Enables automatic upshifts. Note: for the ECU to upshift automatically you must pull and hold the up paddle.

Auto Up Change RPM

Sets the RPM at which an upshift occurs.

Full Throttle Downshift Settings

WARNING - THIS CAN DAMAGE A GEARBOX. CONSULT THE GEARBOX MANUFACTURER BEFORE USING.

Full Throttle Downshift

This enables downshifts to occur when accelerating - for instance when the driver did not downshift enough under braking.

Full Throttle Downshift Max Throttle

This prevents a downshift happening above a defined throttle percentage.

STATUS PANEL

Most of these are self explanatory and show obvious error situations and counters. A few odd ones are listed below.

State Machine State

Internal number used by DTA during development, not of any interest to the end user.

Indicated Gear Valid

Shows if the gear position sensor is currently within the acceptance band of a gear centre as defined in Shift Cut Settings 83. If it is not, then it indicates the gear pot may not be functioning correctly and therefore retries are suspended. This does not stop you pulling for another gear but the system will go open loop effectively in this situation.

Note: the down paddle MUST be released between changes. Continuous down changes are not allowed for safety reasons.

3.6.6 Twin Injector Blend Map

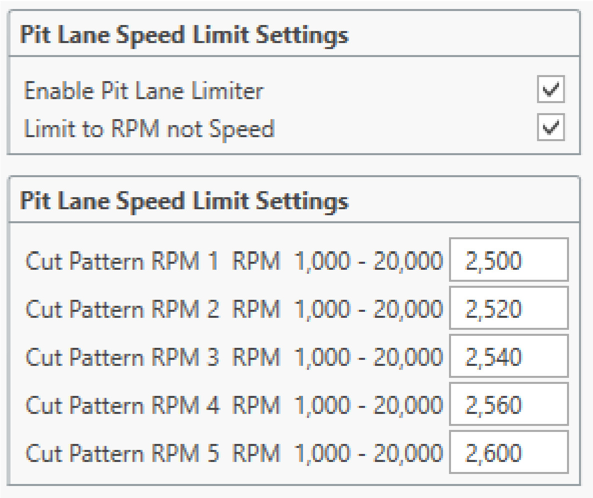
Second Injector Blend Map

Allocates a percentage of the current fuel pulse to the second injector. 0% means all the fuel is from the first (usually inner) injector, 100% means that all the fuel is from the second, usually outer injector.

If this map contains the value of 30% and the current fuel pulse is 10ms then 7ms pulses are given to the first injector and 3ms pulses are given to the second injector. If ,however, there is only 6ms available for a fuel pulse (this occurs naturally at 20000 rpm in a four stroke engine) then 6ms will be given to the first injector and 4ms to the second.

Note that any active Injector Dead Time is added to both injector pulses.

3.6.7 Pit Lane Speed Limiter



The pit lane speed limiter uses the Cut Patterns defined in Ignition Settings 42 to stop the engine exceeding a defined speed or RPM

Each cut pattern can be applied to a specific speed or RPM.

3.6.8 Map 2 Settings

3.6.8.1 Map 2/Anti-Lag Setup

Map 2 Settings

Map 2 Enabled

Enables the use of Map 2 and/or ALS

Always Switch to Map 2
When the Map 2 switch is used, the ECU will immediately switch to using Map 2 settings.

Use Anti-Lag
When the Map 2 switch is used, the ECU will switch between Map 1 and Map 2 automatically, depending on the ALS settings below. The ALS Output26 will be activated when Map 2 is active, to allow the use of an air-bypass valve or throttle blipper. Drive-by-wire can also be used.

WARNING:- TURBO ANTI LAG WILL RAISE THE EXHAUST VALVE, MANIFOLD AND TURBINE TEMPERATURES TO VERY HIGH VALUES. THIS MAY BE DETRIMENTAL TO THEIR LIFE. USE WITH CARE.

ALS Settings

Always Use TPS as Load when ALS Active
This forces the Map 2 load axis to use TPS (Alpha-N). Useful if Map 1 is using MAP (Speed Density) for load.

Maximum Throttle to Activate
Below this value and above the Minimum RPM to Active setting, ALS is active.

Minimum RPM to Activate
Below this value, ALS is not active.

Min Air/Water Temperature to Activate
Below these values, ALS is not active.

Max Air/Water Temperature to Activate
Above these values, ALS is not active.

Maximum Time for ALS
The maximum continuous time the ALS system is allowed to be active.

Penalty Time for ALS
If the conditions for ALS activation are met for longer than the Maximum Time for ALS, the ALS system will be deactivated and will not be allowed to activate again until this Penalty Time has elapsed.

Alternative ALS
Sometimes referred to as "Group N" ALS. If an air bypass valve or drive-by-wire cannot be used, this mode allows you to still use ALS. To do this you must mechanically ensure the throttle butterfly cannot close fully, leaving it "jacked open".

Alternative ALS On

To prevent an excessively high idle RPM when Map 1 is active (due to the partially always-open throttle), this mode uses the Minimum RPM to Activate setting as an RPM limit. This RPM limit is active when the throttle position is below the Maximum Throttle to Activate setting. When the throttle position is above the Maximum Throttle to Activate value, the regular RPM limit is used.

ALS Information

Real time information for ALS setup.

3.6.8.2 Fuel/Ignition Map 2

Duplicate of Main Fuel/Igntion Map 62

3.6.8.3 Turbo 2 Parameters

Duplicate of Turbo Parameters 70.

Note: Turbo Control On and Reverse Valve Operation can only be set in the main Turbo Parameters 70.

3.6.8.4 Turbo 2 Base PWM

Duplicate of Turbo Base PWM 73.

3.6.8.5 Turbo 2 Target Pressure

Duplicate of Turbo Target Pressure 73

3.7 Drive by Wire

- Setup 92
- Pedal Translation Maps 95

3.7.1 Setup

General Settings

Motor 1/2 Fitted

Enable the relevant Drive-By-Wire settings

Use Pedal Translation 1/2

Enable the Pedal Translation Map(s) 95

Switch Pedal Translation

Enable switching between Pedal Translation Map 1 and 2 using a digital Input 25.

Pedal/Butterfly Mode

Refer to the wiring diagram or contact us for the correct mode.

Dead Band
Within this percentage of motor position, the PWM will not change. This prevents oscillation.
Recommended setting is 0.2%

Pedal Settings

Drive-by-wire requires two pedal position sensors. The off-throttle (closed) and full throttle (open) position voltages must be set correctly here. The current values for the sensors are shown on the far right, providing they have been correctly assigned in the Inputs[25] section.

Blip Settings

Allows the DBW to be used to raise the RPM on downshift, for smoother paddle shift down shifts.
This is known as blipping the throttle.

Blip Enabled
Enable this function.

No Blip if Gear < 2
Don't blip the throttle if the current gear is less than second gear.
There is generally no need to blip when going from first to neutral, neutral to reverse, and vice versa.

Blip Amount
The percentage the throttle is opened to raise the RPM

Blip Time
This is the time the throttle will be opened for.

Externally Controlled
Select this option if there is an external system controlling the time the throttle is opened for.
NOTE - there is an absolute limit of 500ms. If the external system attempts to blip for longer than this, the throttle will close.

Time Based
The ECU will control the blip, using the time stipulated below.

Blip Time
The time the throttle is blipped for.

ALS Settings

The DBW system can be used override the user pedal demand, opening the butterfly to allow the extra required air when ALS is used.
NOTE - the ALS settings must be correctly configured for this to work.

ALS Uplift Enabled

Check this to use the DBW module for ALS uplift.

Throttle Uplift %

The percentage the butterfly is opened to allow extra air in to the system.

Motor 1/2 Settings

Motor Frequency

This sets the PWM frequency for the motor. See PWM Frequencies 107 for more information.

Butterfly 1/2 Open/Closed

Similar to the pedal settings. Drive-by-wire requires two butterfly position sensors (TPS). To set the open and closed voltages correctly, you must click the "Disable Motor(s)" button and fully open or fully close the butterfly by hand.

Closed Loop Settings

PID Pro/Int/Diff

See PID Control Loops for further information.

PID Max Increase/Decrease

This limits the amount of adjustment the PID loop can make beyond the base PWM settings. Set these as low as possible to avoid unwanted oscillating behaviour.

PID Delay

This is the time delay between each completion of the control loop. The lower the value, the faster the response rate of the control loop. However, this can lead to oscillation.

Map Columns

This table allows you to set both your pedal map sites and the motor PWM duty required for a given pedal position. The more accurate this table, the less work the PID loop will have to do and the less chance of oscillating behaviour.

Current Values

Displays all the current sensor values, motor current draw and the calculated position percentages as used by the ECU maps.

Diagnostic Values

This gives you a quick visual check of any errors. If an error occurs, the drive-by-wire system will enter "limp" mode. This will reduce the RPM limit to 2000RPM, preventing unintended acceleration. The errors can be quickly reset using the "Reset Errors" button.

3.7.2 Pedal Translation Maps

By default, the throttle pedal and butterfly motor will have a 1:1 correlation. The pedal translation map allows you to adjust that correlation. This can be useful for engines with a very large, single throttle body where even small amounts of throttle can make slow speed driving difficult. Some engines may prefer slightly less than 100% butterfly opening at certain loads. You can also use it as a rev limiter, preventing the engine from accelerating beyond a certain point regardless of the pedal input.

The X axis is the requested throttle.

The Y axis is the engine RPM

The values in the table are what the ECU will use as requested throttle.

Map 1 is used by default. You can switch to Map 2 using a digital Input25.

3.8 Data Logging

Enter topic text here.

3.8.1 Data Logging Setup

Data Logging Setup

Log Frequency
The frequency to record the data at.

Data Recording
Continuous Loop - data will constantly be written, with the oldest overwritten first. Logging will only occur if the engine is running.

Switched - Logging will only occur when the assigned digital switch is closed.

Log only when Left Undriven wheel turning - the engine must be running, and the left undriven wheel must be turning for the data to be logged.

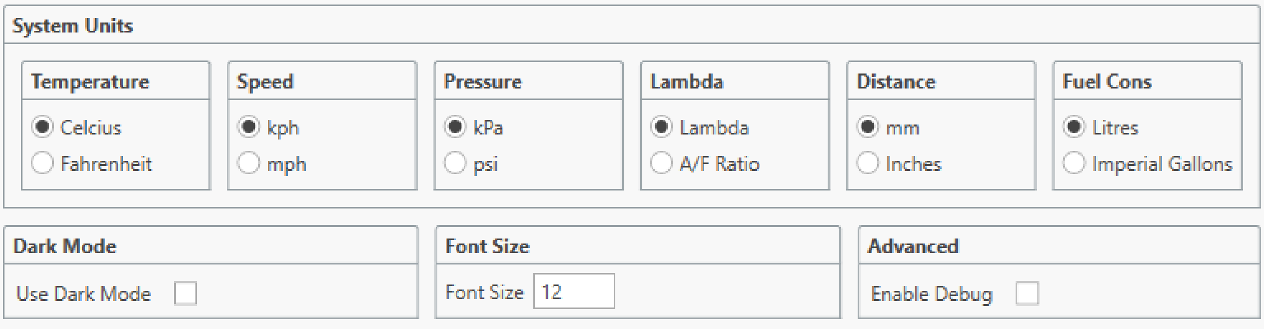
Data Volume
Select the maximum volume of data to be logged. The greater the volume, the longer the download time.

Clear Logs
Clears the entire log on the ECU. This is not reversible.

3.9 Options

- User Options96

3.9.1 User Options



User options is where you can set your units of measurement, font size and themes.

Note: the system units only apply to how values are displayed in the software. They will be stored in the map as default (i.e. celcius, lambda etc.)

4 Support Documents

4.1 Crank/Cam Sensor Clearance Gaps

For Hall Effect sensors, 1mm (0.040") should be sufficient, regardless of trigger wheel diameter.

For VR sensors, the gap should be set as follows:

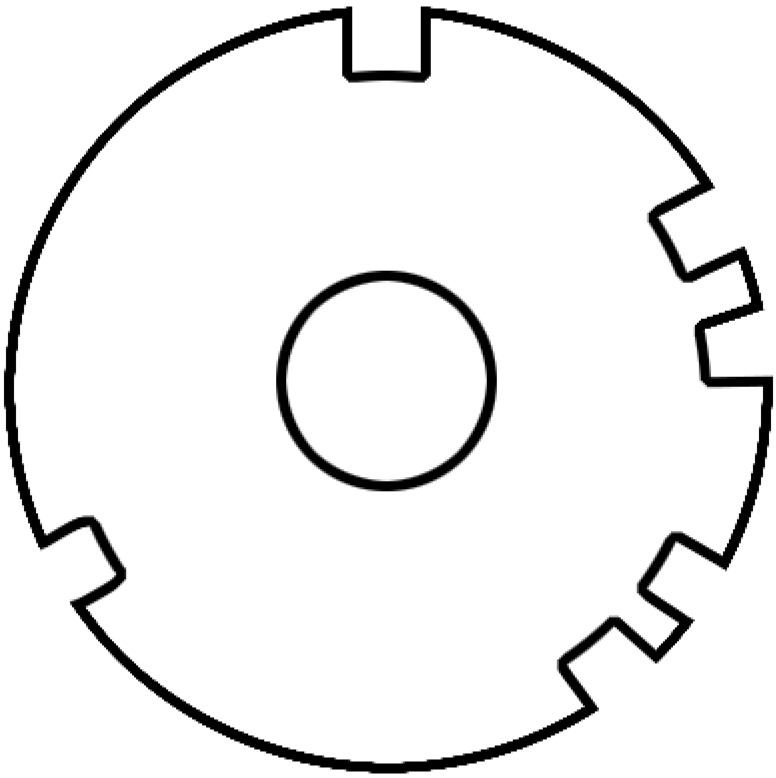
Trigger Wheel Diameter	Gap
138mm+	0.50-1.00mm (0.020-0.040")
100mm	0.25-0.70mm (0.010-0.030")
50mm	0.10-0.20mm (0.002-0.008")

4.2 Flywheel Mode 26

This mode is designed to be used with any crank trigger wheel or flywheel with missing teeth (24 - 1, 36 – 1, 60 – 2, etc), and a cam trigger pattern with multiple teeth.

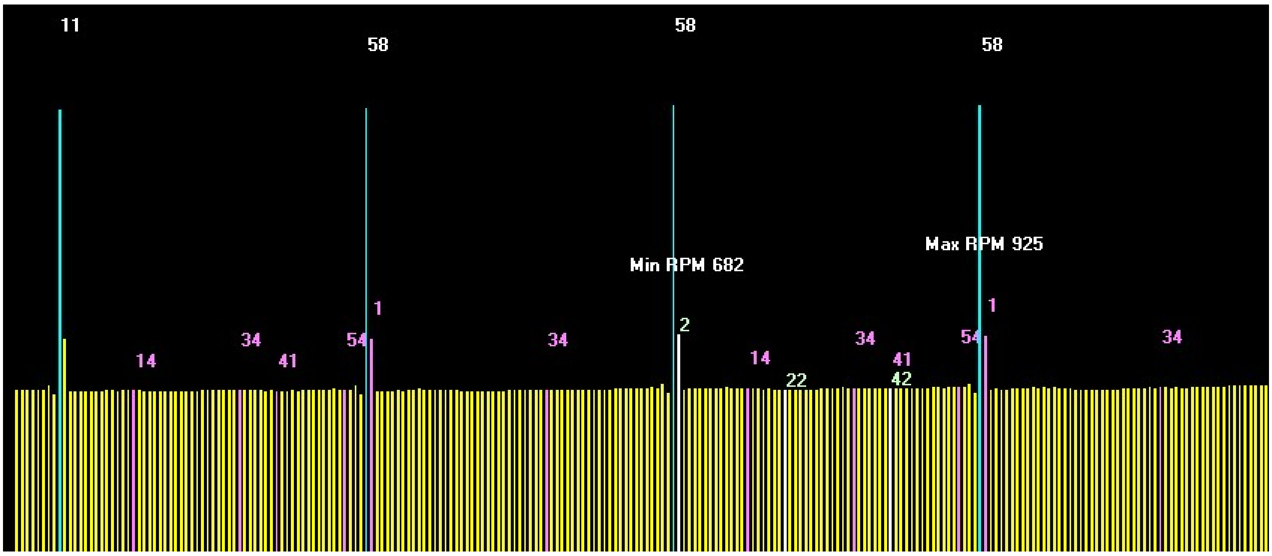
Note: there must be at least 1 unique count of crank teeth between at least 2 (consecutive) cam pulses.

In this example, we're setting up an engine with a 60 – 2 crank pattern, and a 6 tooth cam pattern, that looks like this:



There are unevenly spaced teeth on the cam, so we can easily pick out a single tooth to use as a reference point.

This is what the Crankshaft Oscilloscope looks like:

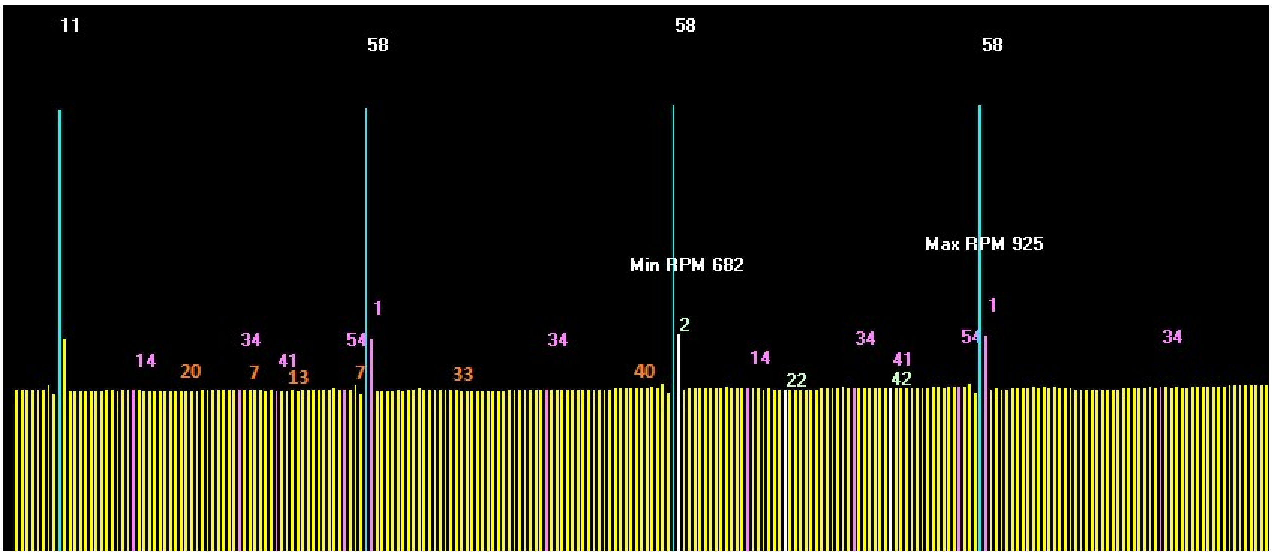


The 6 cam teeth are clearly visible, and occur for every two rotations of the crankshaft.

The first step is to calculate the number of crank teeth between each cam pulse. The table below shows the cam pulse tooth, and the corresponding number of teeth since the previous cam pulse.

Crank Rotation	Cam pulse tooth	Teeth to Previous Cam Pulse	Unique Gap?
1	14	N/A	N/A
1	34	34 – 14 = 20	Yes
1	41	41 – 34 = 7	No
2	54	54 – 41 = 13	Yes
2	1	(1 + 60) – 54 = 7	No
2	34	34 – 1 = 33	Yes
3	14	(14 + 60) – 34 = 40	Yes

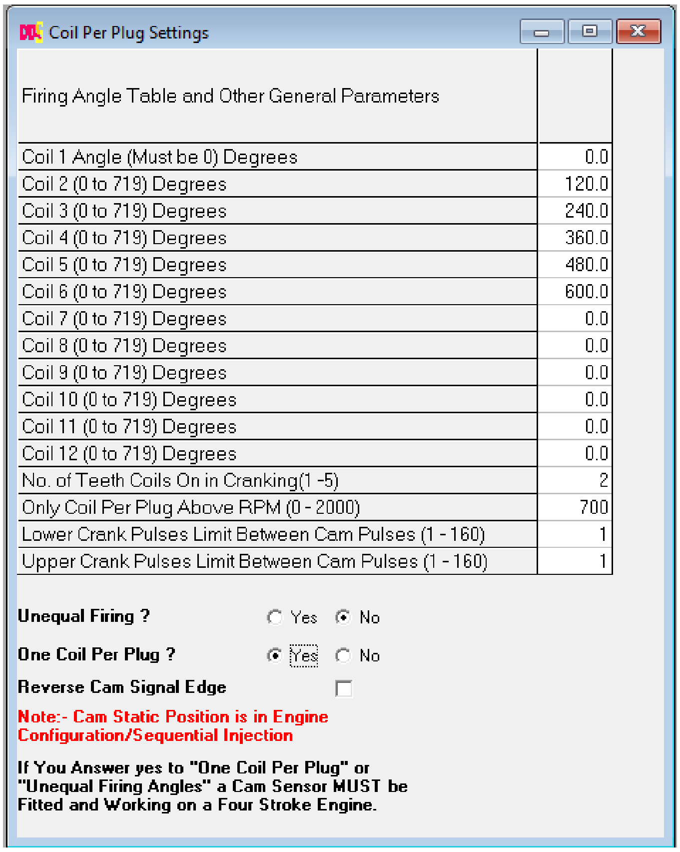
These are shown in orange in the image below:



Flywheel Mode 26 works by looking for a specific, unique number of crank teeth between each cam pulse. In this example, there are four options to choose from; 13, 20, 33 and 40. For this example we will use 40 (highest unique count is generally best), which is the cam pulse occurring on crank tooth 14. The other gaps of 13, 20 and 33 crank teeth will work in exactly the same way.

Make sure Flywheel Mode 26 is selected in General Engine Settings. Press F4 to update the map if you have to change this.

Open the Coil Per Plug Settings screen. It will look something like this:

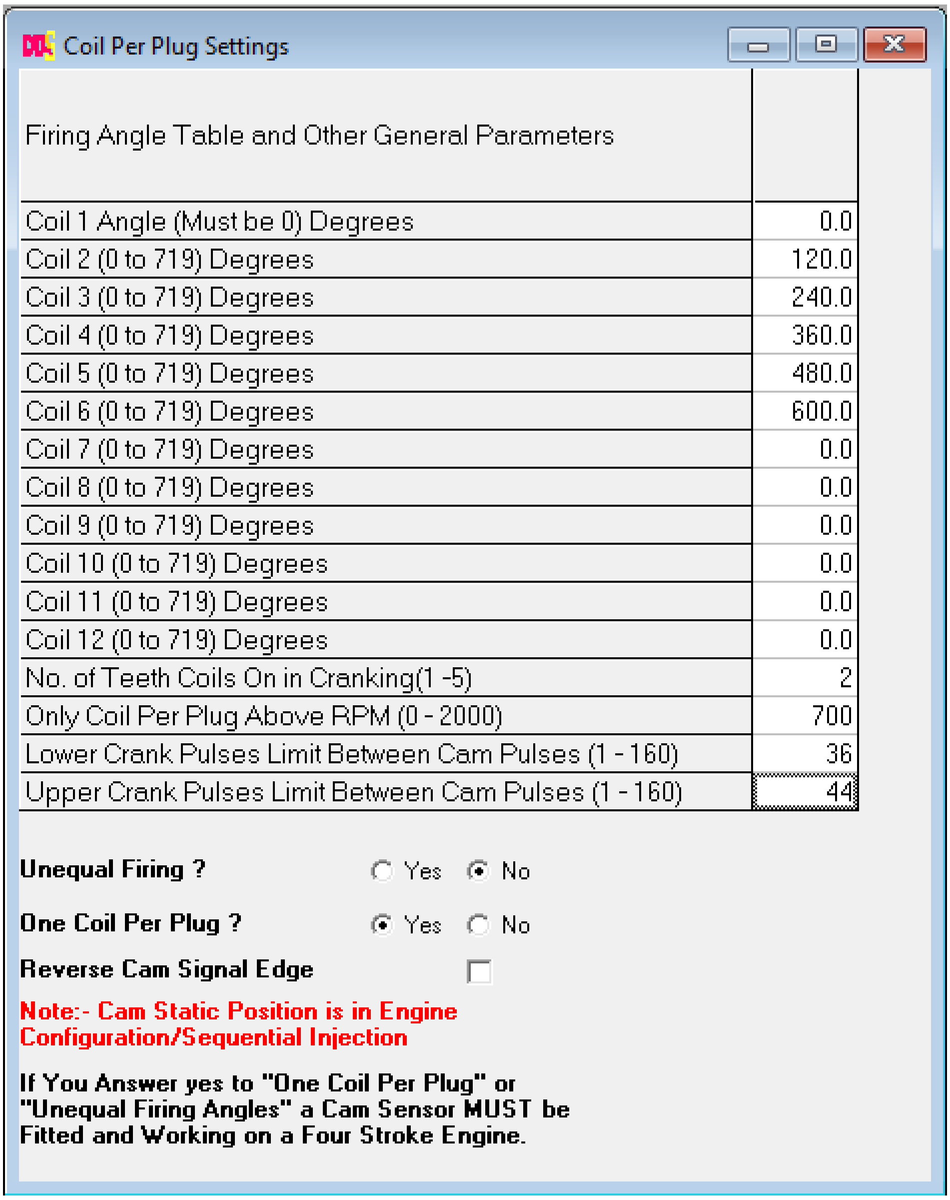


The boxes labelled Lower Crank Pulses Limit Between Crank Pulses and Upper Crank Pulses Limit Between Cam Pulses define the number of crank pulses the ECU will look for to pick out the cam pulse we have selected.

Ideally the actual number of teeth would be specified. However, the cam pulse can move between teeth, so a window has to be provided. This window must also ensure none of the other pulses are picked up.

The next lowest is number of crank teeth between cam pulses is 33, and there no higher values, which is what makes this a good choice. The window should therefore be from 36 to 44.

The easiest way to calculate this is to take the highest number of crank teeth between cam gaps (40), subtract the next highest number (33) and then divide by two. You can then add or subtract this number from the highest number of teeth to use as the upper or lower limit. E.g. (40-33)/2 = 3.5 – in this case, we need to round the number up (4) or down (3). It’s generally better to round up, so long as the upper/lower value doesn’t become too close to the tooth count of the next highest/lowest gap.


Coil Per Plug Settings

Firing Angle Table and Other General Parameters	
Coil 1 Angle (Must be 0) Degrees	0.0
Coil 2 (0 to 719) Degrees	120.0
Coil 3 (0 to 719) Degrees	240.0
Coil 4 (0 to 719) Degrees	360.0
Coil 5 (0 to 719) Degrees	480.0
Coil 6 (0 to 719) Degrees	600.0
Coil 7 (0 to 719) Degrees	0.0
Coil 8 (0 to 719) Degrees	0.0
Coil 9 (0 to 719) Degrees	0.0
Coil 10 (0 to 719) Degrees	0.0
Coil 11 (0 to 719) Degrees	0.0
Coil 12 (0 to 719) Degrees	0.0
No. of Teeth Coils On in Cranking(1 -5)	2
Only Coil Per Plug Above RPM (0 - 2000)	700
Lower Crank Pulses Limit Between Cam Pulses (1 - 160)	36
Upper Crank Pulses Limit Between Cam Pulses (1 - 160)	44

Unequal Firing ? ○ Yes ◉ No

One Coil Per Plug ? ◉ Yes ○ No

Reverse Cam Signal Edge ☐

Note:- Cam Static Position is in Engine Configuration/Sequential Injection

If You Answer yes to "One Coil Per Plug" or "Unequal Firing Angles" a Cam Sensor MUST be Fitted and Working on a Four Stroke Engine.

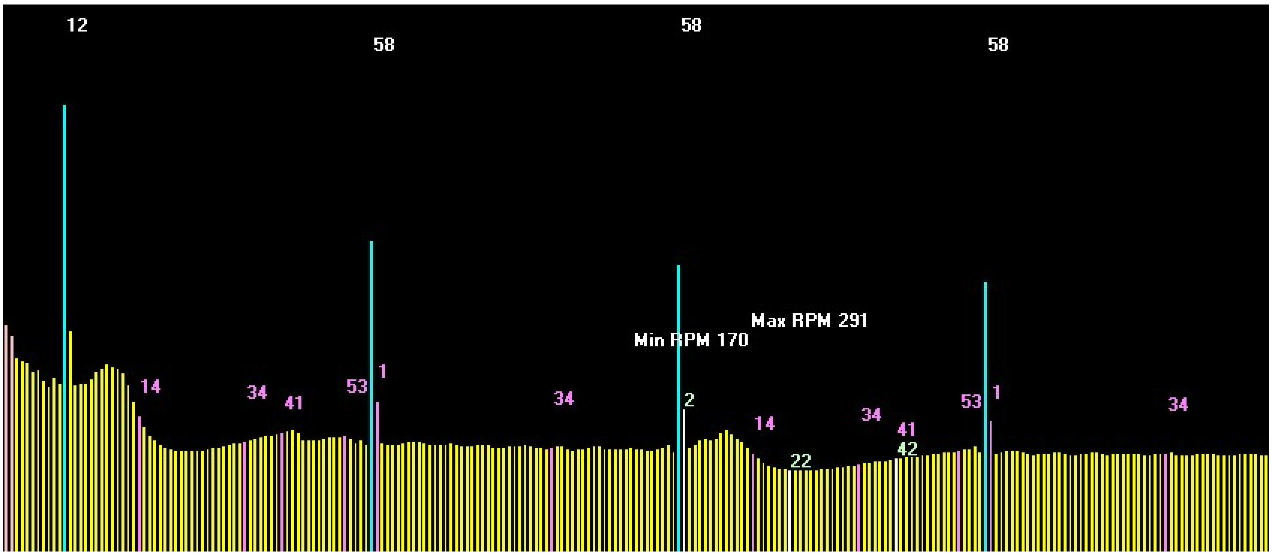
Now the correct cam angle needs to be calculated. This is the angle between TDC and the cam pulse when the cam is at it's static (usually most retarded) position.

For this particular engine, the crank sensor angle is 61 degrees (see manual for calculating this figure), which means TDC is on crank tooth 10. This is because the crank trigger disc has 60 teeth, which means each tooth represents 6 degrees of rotation. 61 degrees divided by 6 degrees/tooth = 10 teeth. Even if TDC was not exactly on tooth 10, maybe halfway between, it does not matter as the upper/lower limit will account for that.

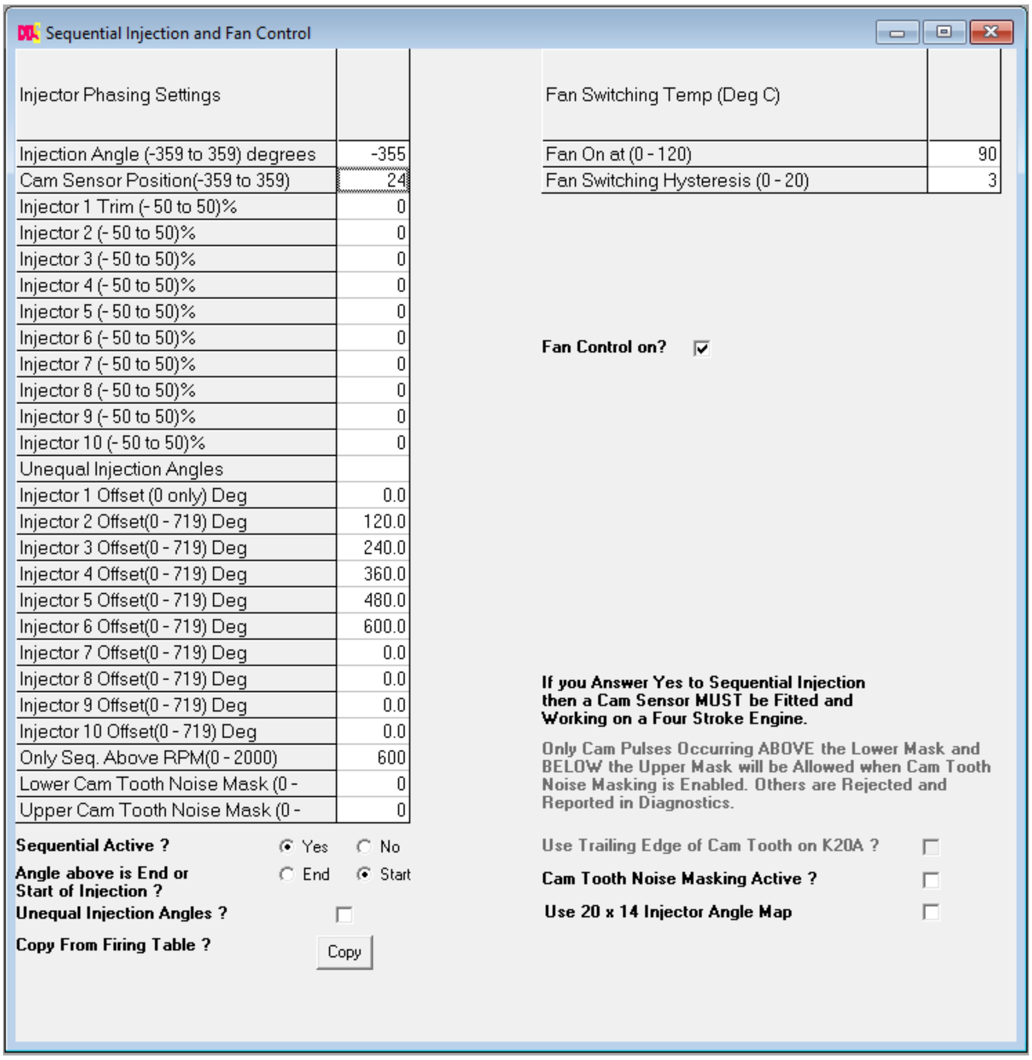
From the above graph (page 2), the cam pulse is on tooth 14.

This means the cam pulse must either be 4 teeth after the TDC crank pulse on tooth 10, which is 24 degrees, or it must be 56 teeth before the TDC crank pulse on tooth 10, which is -336 degrees. The minus signifies the cam pulse is before TDC.

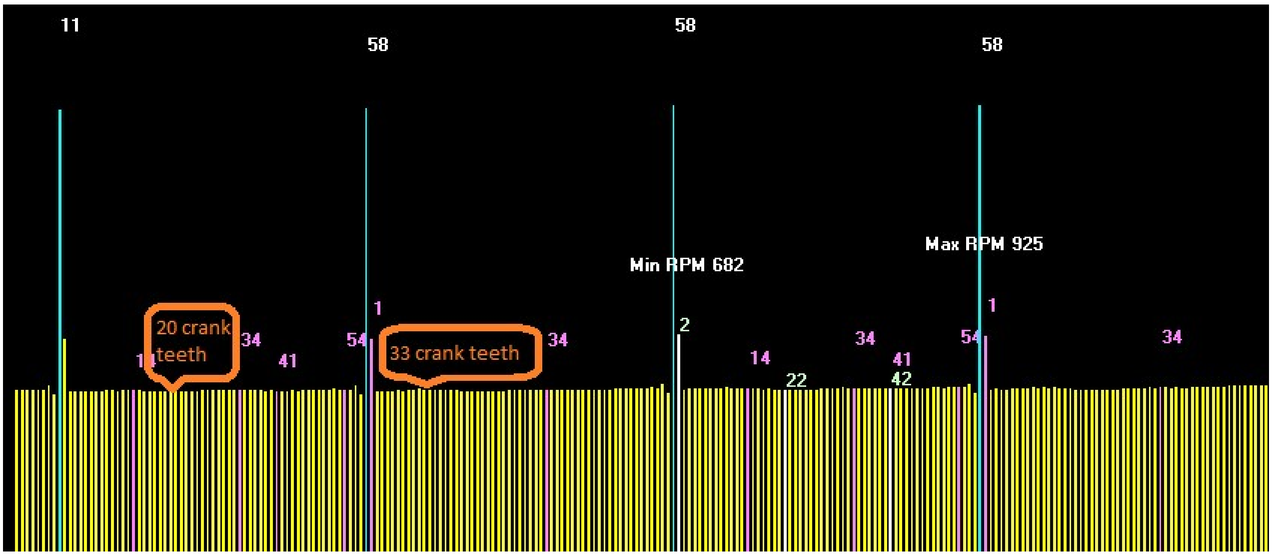
To verify which is the correct value, remove all spark plugs except those in cylinder 1. Re do the crank scope, and this will show which rotation crank rotation the TDC firing stroke is in.



This clearly shows the cam pulse is 4 teeth after TDC (highest point on graph), and the correct value to be entered in Sequential Injection -> Cam Sensor Position is 24 degrees.



The other three gaps would be calculated in the same way. Care must be taken, as there are two cam pulses occurring on tooth 34. These cam pulses have a different amount of crank teeth between them and the previous cam pulse, shown below:



If the 20 tooth gap was to be used, the correct angle would be 24 teeth x 6 degrees = 144 degrees. 24 because it's a 20 tooth gap + 4 teeth from TDC.

The 33 tooth gap would be slightly different, as this angle is negative. This is the cam pulse occurring on crank tooth 34. The maximum number of teeth the cam pulse can be from TDC is 60 teeth, one complete crank rotation. This means we need to use the cam pulse which is before TDC, meaning the angle is negative.

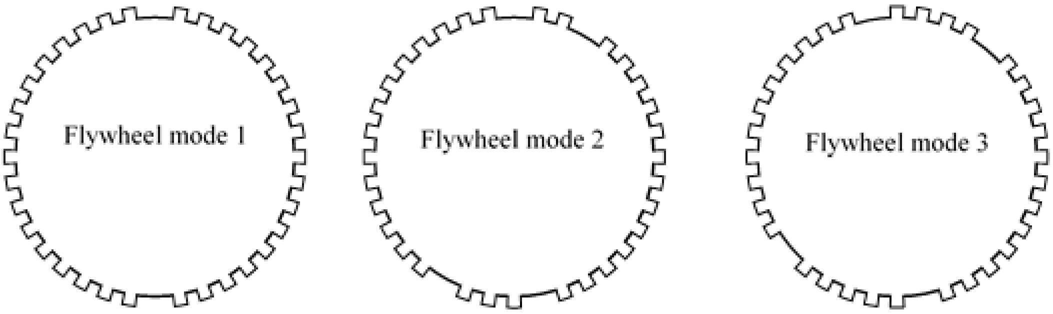
To complicate matters further, this cam pulse has the gap in the crank between it and TDC, so the number of crank teeth isn't as obvious. To calculate this, we add the crank teeth either side of the gap. TDC is 10 teeth after the gap, and the cam pulse is on tooth 34, which is 26 teeth before the gap (60 – 34).

The angle would be (10 + 26) x 6 degrees, giving an angle of -216 degrees.

The engine should now run in sequential mode.

4.3 Rover K-Series Flywheel Modes

All of the Rover K series flywheels have trigger teeth set at 10° this means a total of 36 teeth. However a number of these trigger teeth will be missing and which teeth are missing defines the flywheel type. The diagrams below show the three types of flywheel.



It is important that you check the flywheel configuration on your engine and make sure that the values in the General Engine Settings of your DTA ECU are correct. The following table provides a guideline

	Mode 1	Mode 2	Mode 3
No of teeth on gearwheel	NOT ALLOWED	36	36
No of missing teeth		1	1
Sensor position		286	349
Distributor fitted		Can be Y or N	Can be Y or N

Note: Mode 2 is generally the K series engine, and mode 3 is generally the T Series engine.

4.4 PID Control Loops

A closed-loop control strategy is one where a controller uses real time data to make a current value match a target value. Examples of this in an ECU can be idle control, boost control, fuelling corrections etc.

The most common way for a closed-loop system to make adjustments that bring the actual value to the target value is by using a PID algorithm.

The PID algorithm uses three modifiers (coefficients) to correct deviations between current and target values - a.k.a "the error":

Proportional dictates how fast/aggressive the error correction should be.

Integral dictates how persistent errors are corrected.

Derivative provides a damping effect to the correction, to help prevent overshoot and oscillation as the error becomes smaller.

There are no "correct" numbers for these modifiers - they require trial and error on your specific setup to get right. However, we can offer some guidance:

Start by ensuring all values are set to 0, then increasing the Proportional gain. If the error does not change, double the gain. Keep going until the current value begins to oscillate (overshoot/undershoot) around the target value in a constant and consistent manner. Then start increasing the Derivative gain in the same manner until the oscillation stops. If the current value does not match the target value after the P and D gains have been adjusted, you can try adding some Integral gain.

Ideally you want as little gain as possible in these modifiers to achieve the desired result. Starting small (i.e. 1) and then doubling the gain is a good way to get a rough idea of what the gain needs to be and gives you a good base to make smaller changes for better accuracy.

Two fantastic illustrations of how the individual gains interact with each other can be seen here: https://www.youtube.com/watch?v=qKy98Cbcltw and here: https://www.youtube.com/watch?v=fusr9eTceEo

4.5 Dyno Box

The Dyno Box consists of two potentiometers, three momentary push buttons and connects to the 15-pin serial port of the ECU.

The box is generally used to vary fuel injection quantity and ignition timing during mapping but can also be used for camshaft control, turbo valve control or injection angle.

Note: The dyno box controls the ECU, not the software. Adjustments made with the dyno box will not be committed to the ECU until F6 is pressed (cells go from brown to green).

4.6 PWM Frequencies

Some fan and fuel pump controllers can be in the 100Hz range. Some solenoids can be 50hz. Drive-by-wire motors can be 10kHz. If the item you are trying to control has OE origins, try and measure the control frequency using an oscilloscope on a factory setup. A lower frequency can reduce control accuracy at low duties. A high frequency will increase accuracy in these situations but too high a frequency can result in a narrow range of adjustment.

As a rule of thumb, use the lowest frequency you can while maintaining good control accuracy.

4.7 T-Flash Tool

The T-Flash tool is a firmware updater script. It asks you for the relevant firmware file, launches Memtool to flash the new firmware to the ECU and then reboots the ECU. You can then re-connect to the ECU with T-Win, without having to power-cycle the ECU.

Note: always make a backup copy of your map before upgrading firmware..

4.8 Guide to Start Fuelling

For best results, anything relating to the intake of air (idle cam timing, idle control valve. drive by wire opening, variable intake etc.) must be tuned fully before tuning Start Fuelling. Otherwise it is like chasing a moving goal.

Having a lambda sensor fitted is vital to proper tuning of the start fuelling.

First, setup the table axis. In most cases, you should not need more than 500 engine turns for the start fuelling process. The rest of the cold engine fuelling requirements can be handled by the the water temperature compensations. However, setting the last row to 10000 turns and 1% fuel will allow you to log the turns for about 10 minutes

Regardless of the engine temperature, the engine will always need a large initial amount of fuel to get started as most of the fuel will attach itself to the walls of the intake ports. When the engine is cold, the fuel evaporates more slowly and droplets form, which are difficult to combust. This is why cold engines must run significantly richer than hot engines. Once the engine is hot, fuel evaporates quickly and is not "lost" to "wetting" the walls. However, even a hot engine must "wet" the walls initially but it's a process that doesn't need to last a long as when it's cold.

Start by tuning the Start Fuelling at operating temperature. The Real Time Chart[19] is very useful here. You can log everything related to cold starting and monitor it all live. The first 100-200 turns of the engine will be guesswork as a lambda sensor needs time to heat up. If you heat up a lambda sensor too quickly or heat it up before a cold engine has started and condensation hits it, the sensor can be damaged and become useless very quickly. You could use an external lambda controller and pre-heat the sensor at the risk of damage. This would take a large chunk of the guesswork out of tuning the first 20-200 turns.

The first 10-20 turns, however, are primarily going to be guesswork. As a rough guide, you may want 100-150% more fuel for the first 1-5 turns, 50-75% for 5-10 turns, 30-50% for 10-20 turns and then decreasing amounts thereafter. At operating temperature, you should need start fuelling for no more than 100 turns.

The colder the engine. the higher those values will need to be and the longer the start fuelling period will be. For example, at 0°C (32F), the engine may want 300% more fuel for the first 10 turns, then 100% for the next 40 turns, then drop down to something a bit more reasonable like 30% up to around 100 turns, and then start decreasing gradually to nothing by around 200 to 500 turns, where the water temp compensations take over.

When tuning start fuelling, err on the rich side. If it's too rich but still idles, you can go back through the logs and calculate the adjustment. If it's too lean and stalls, you've lost an opportunity. If you have closed loop lambda on from cold, you can log the correction factor against engine turns and temperature.

Note: there are three ways to adjust the fuelling of a running engine: the Dyno Box106 , Map Editing Keys10 or Closed Loop Lambda57

5 Engine Specific Information

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5.1 Honda K20

The Honda K20/K24 engines have very specific configuration requirements to run correctly.
All the correct settings are in the Honda K20 map shipped with the T-Win software, so the simplest option is to use that as a base, and then alter the map to suit from there.
Alternatively setting the Flywheel Mode to 7 will cause a pop up to appear. Clicking Yes will default the values correctly as well.

The crank trigger pattern on the K20 is 12 evenly spaced teeth with one extra tooth used for synchronisation and TDC determination.
The T Series treats this as a 36 tooth crank trigger, so the Number of Teeth must be set to 36 in Engine Configuration32.

There are two cam sensors, one on the exhaust cam and one on the inlet cam.
The exhaust cam sensor is only used for engine synchronisation, and can be used to determine engine phase directly at start up.
The inlet cam sensor is only used for VVT control.

The exhaust cam sensor must be connected to Cam Sensor 1 on the ECU, which is Connector 2 Pin 22.
The inlet cam sensor must be connected to Cam Sensor 2 on the ECU, which is Connector 2 Pin 29.

The inlet cam valve must be connected to a PWM output. Any PWM is acceptable, although the default is PWM 1.
This PWM output must be assigned to Cam 2 Solenoid, not Cam 1 Solenoid in the Outputs[26] configuration, as shown below.

Assign Outputs

Fan	PWM 2
Fuel Pump	PWM 3
Tachometer	PWM 5
Shift Light	PWM 6
ECU Relay	Not Used
Idle Valve	Not Used
Turbo Valve	Not Used
Anti-Lag Valve	Not Used
Electric Dump Valve	Not Used
	Not Used
Paddle Down Valve	Not Used
Paddle Up Valve	Not Used
Paddle Neutral Interlock Valve	Not Used
Throttle Blip	Not Used
Paddle Compressor	Not Used
VTEC valve	PWM 7
Cam 1 Solenoid	Not Used
Cam 2 Solenoid	PWM 1
Cam 3 Solenoid	Not Used
Cam 4 Solenoid	Not Used
Bosch 3 Pin Idle Valve	Not Used
Flexible Output 1	PWM 4
Flexible Output 2	Not Used
Flexible Output 3	Not Used
Flexible Output 4	Not Used
Flexible Output 5	Not Used
Flexible Output 6	Not Used
Flexible Output 7	Not Used
Flexible Output 8	Not Used
Flexible Output 9	Not Used

5.2 BMW E46 M3 - S54 Engine

The BMW S54 engine has a unique cam pattern that is not used on any other engine.
The ECU must be configured to recognise this pattern.

Engine Configuration

The crank sensor is VR, and cam sensors on this engine are Hall Effect.

The crank mode for this engine is mode 0.

Cam 1 Profile must be set to BMW S54 Exhaust.

Cam 2 Profile must be set to BMW S54 Inlet.

ECU Outputs

This engine has four cam solenoids, two for each cam. Because of this, the only ECUs that support this engine are the T12 and T12+.

Any PWM output may be used for these solenoids, with the defaults shown below as per the base map.

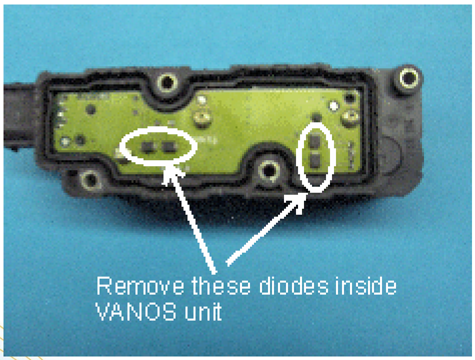
The valves are assigned as follows:
Exhaust Advance - Cam 1 Solenoid
Exhaust Retard - Cam 2 Solenoid
Inlet Advance - Cam 3 Solenoid
Inlet Retard - Cam 4 Solenoid

Below is an image of the default outputs used in the base map:

VTEC valve	Not Used
Cam 1 Solenoid	PWM 1
Cam 2 Solenoid	PWM 9
Cam 3 Solenoid	PWM 11
Cam 4 Solenoid	PWM 12

VANOS Modification

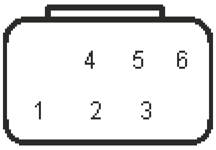
NOTE: The VANOS unit must be modified as per the image below to work with the T Series ECUs.



OEM Wiring Colours

The original connector pinouts and wiring colours are as follows. All wire colours noted below are the OEM wire colours on the original harness.

VANOS Solenoids Connector



Pin 1 - PWM 12, Inlet Retard (Green)
Pin 2 - Ignition Switched 12V (Brown)
Pin 3 - PWM 11, Inlet Advance (Black)
Pin 4 - PWM 9, Exhaust Retard (Green)
Pin 5 - Ignition Switched 12V (Brown)
Pin 6 - PWM 1, Exhaust Advance (Black)

Exhaust Cam Sensor

Pin 1 - Red/White to 12V
Pin 2 - Yellow to Cam 1
Pin 3 - Brown to Sensor Ground

Inlet Cam Sensor

Pin 1 - Red/White to 12V
Pin 2 - Yellow to Cam 2
Pin 3 - Brown to Sensor Ground

Crank Sensor

Pin 1 - Signal
Pin 2 - Sensor Ground
Pin 3 - Shield

TPS Sensor

Pin 1 - 5V
Pin 2 - Signal
Pin 3 - Sensor Ground