



## E11/E8 INSTRUCTION MANUAL

Version 2.0 - 4 August, 2008

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## WARNING

This system is capable of controlling either "intelligent" ignitors which have in-built dwell control (commonly found on early EFI engines with electronic ignition) or "dumb" ignitors which contain no such control (modern ECU controlled ignition systems). This allows standard ignitors to be used in many cases. Most standard ignitors are dumb ignitors.

It is very important to set the system up to match the type of ignitor used!.

In the ignition set-up page the set-up should be:

To control intelligent ignitors set up as "Constant Duty"

To control dumb ignitors set up as "Constant Charge"

If the wrong set-up damage to the ignition system will occur.

Burning out ignitors due to wrong set-up will not be regarded as Warranty!

Please ensure all power supplies are disconnected before commencing any wiring.

Failure to follow all the warnings and precautions in this manual can lead to damage to engine components and may possibly void your warranty. Incorrect setup of the ECU can also lead to damaged engine components.

Damaged components due to incorrect setup will not be regarded as warranty repairs.

## LIMITED WARRANTY

Lockin Pty Ltd trading as Haltech warrants the Haltech<sup>TM</sup> Programmable Fuel Injection System to be free from defects in material or workmanship for a period of ninety days from the date of purchase.

Proof of purchase, in the form of a bill of sale or receipted invoice, which indicates that the product is within the warranty period, must be presented to obtain warranty service. Lockin Pty Ltd trading as Haltech suggests that the purchaser retain the dealer's dated bill of sale as evidence of the date of retail purchase.

If the Haltech<sup>TM</sup> Programmable Fuel Injection System is found to be defective as mentioned above, it will be replaced or repaired if returned prepaid along with proof of purchase. This shall constitute the sole liability of Lockin Pty Ltd trading as Haltech.

To the extent permitted by law, the foregoing is exclusive and in lieu of all other warranties or representations, either expressed or implied, including any implied warranty of merchantability or fitness. In no event shall Lockin Pty Ltd trading as Haltech, be liable for special or consequential damages.

## Installation and Wiring Guide

### Introduction

Congratulations on purchasing a Haltech Engine Management System. This fully programmable product opens the door to virtually limitless performance modification and tuning of your vehicle. Programmable systems allow you to extract all the performance from your engine by delivering precisely the required amount of fuel and ignition timing that your engine needs for optimum output under all operating conditions.

This Installation and Wiring Guide will guide you through installing your Haltech ECU onto your vehicle. This section accompanies the Setup Guide and Tuning Guide that you or your tuner will need to refer to before completing your installation and configuration.



### Before You Begin

#### IT IS BEST TO READ THIS ENTIRE MANUAL BEFORE STARTING.

At the very least, you should read Section One of the manual before you begin the wiring part of the installation. The greater your knowledge of the operation of the Haltech system, the easier you will find it to understand what you are doing, and why. Throughout the manual are Warnings and Notes that will help your installation run smoothly and indicate the dangers that can exist for you the installer and the Haltech ECU.

Read any additional material (if supplied) accompanying this manual that updates the document since it was written.

You may need special parts or additional tools or test equipment in order to complete installation. Make sure you have these items on hand before you begin to avoid frustration.

Don't do the minimum work possible. Carelessness in the early stages of installation can cause greater problems later on. Carelessness will cost you money and frustration in finding and fixing unnecessary problems. You have the opportunity to make sure your Haltech system's operation is extremely dependable and easy to use by Doing it right the first time !. Another reason to exercise care during this installation is make sure there is no Fuel leaks and no wiring un-insulated which can cause a spark or a short and cause a fire or an explosion. Also make sure you follow the proper workshop precautions like when working underneath a jacked-up car, make sure you use safety stands.

Electromagnetic interference (EMI) from unsuppressed spark plugs and high tension leads can cause the ECU to fail. Please do not use them.

In hot climates, or with turbocharged engines, you may need to employ heat shielding to prevent heat soak and damage to electrical and fuel parts. Use the coolest surfaces of the chassis as a heat sink for components and shield any wiring that may be affected by heat.

We recommend having your system tuned by a Haltech Dealer or by a Workshop that has the proper tuning equipment like exhaust gas analyser, fuel pressure meter, Dynamometer etc. Otherwise trying to guess or tune by ear can lead to disastrous lean out conditions that could destroy your engine.

Note: In this manual, reference will be made to MAP (Manifold Absolute Pressure - as in MAP sensor) and the fuel maps stored in the ECU. Both are common industry terms, with entirely different meanings.

### **WARNING**

**Avoid open sparks, flames or operation of electrical devices near flammable substances. Always disconnect the battery cables when doing electrical work on your vehicle.**

**Do not charge the battery with a 24 Volt truck charger or reverse the polarity of the battery or any charging unit. Do not charge the battery with the engine running as this could expose the ECU to an unregulated power supply that could destroy the ECU and other electrical equipment.**

**All fuel system components and wiring should be mounted away from heat sources, shielded if necessary and well ventilated. Disconnect the Haltech ECU from the electrical system whenever doing any arc welding on the vehicle by unplugging the wiring harness connector from the ECU.**

**After completing the installation, make sure that there are no fuel leaks, and no wiring left un-insulated in case a spark or short-circuit occurs and causes a fire. Also make sure that you follow all proper workshop safety procedures. If you're working underneath a jacked-up car, always use safety stands!**

### Tools and Materials that you will need

Installation of this system can be easily carried out by professional mechanic(s) and most experienced home mechanics if the following tools and components are available:

Voltmeter or Test Light

A selection of screwdrivers and spanners

Soldering Iron and solder

(It is recommended that all connections be soldered except where crimped terminations are used. Soldering crimped terminations can cause the wire at the crimp to become weak. Most crimped terminations have sufficient strength alone as long as the appropriate crimping tool has been used)

Wire Cutters and Pliers

Crimping Tool and assorted terminals

Drill with assorted drill bits

3/8" NPT Tap

14mm x 1.5 Tap

Electrical Tape or Heat Shrink tubing

Teflon pipe sealing tape

Nylon cable ties

Jeweller's file (may be needed for mounting Throttle Position Sensor)

Mounting hardware for ECU and relays (mounts/bolts/screws)

Personal Computer (preferably a laptop or portable computer) running Windows 95/98, Windows 2000 or Windows XP with an RS232 serial port. See section for the requirements of your PC.

A good quality Timing Light



# Installation Guide

**Note:** Installation of engine management systems is a complex exercise to be undertaken only after careful planning and research into the application for which the product is to be used. Damage to engine components is a distinct possibility if care is not taken during the installation and setup of the Haltech Engine Management System. If you are unsure about how to wire any components of your engine, please consult Haltech or an experienced installer for advice.

The installation guide will guide you through a typical installation. For details on the sensors and devices mentioned here, see section on Devices and Pin Outs.

## **Flying Lead Loom Installation on bare engine**

The following list outlines the procedure for installing the E11 ECU with a flying lead harness: Unpack your ECU and identify the following components (some components may vary if you ordered a specific kit):

ECU

Main Wiring Harness

Coolant Temperature Sensor (purchased separately)

Air Temperature Sensor (purchased separately)

MAP Sensor (1, 2 or 3 Bar – purchased separately)

ECU Instruction Manual (which you are reading)

Programming Cable

Programming Disc with Programming Software

Fuse blocks and relays (on wiring harness)

Throttle Position Sensor (optional)

Idle Stepper motor (Optional)

## **Mounting Devices:**

Locate a suitable location for the ECU. Ensure that the loom will reach the necessary parts of the engine and mount the ECU.

Locate a suitable location for your Fuse block, fuel pump relay, ignition relay, injector relay, ECU relay and any additional relays used for auxiliary devices (e.g. Thermofan, turbo timers, etc.). Mount all your relays. Run the loom into the engine bay, but leave the ECU connector disconnected.

## **Inputs:**

Connect the Throttle Position Sensor (TPS).

Connect the Coolant Temperature Sensor.

Connect the Air Temperature Sensor.

Connect the MAP sensor (optional).

Connect O2 sensor (optional).

Connect the crank angle sensor to Trigger (sometimes referred to as a crank trigger). Sometimes these are driven off the cam, but still give a crank position. Leave the wiring in such a way so that changes to sensor wiring can be made if required when setting up.

Connect any cam angle sensors if applicable to the Home input. Leave the wiring in such a way so that changes to sensor wiring can be made if required when setting up.

## **Outputs:**

When running the wiring for outputs, run any power and ground wiring back to the points where they will be connected, but do not connect power or ground connections yet.

Run the injector wires within the loom to the fuel injectors (each injector shares a common +12V with the

wires labelled "injector output" from the ECU providing the ground to switch the injector on and allow the fuel to flow).

Connect your fuel pump back to the fuel pump relay.

Run the loom from all ignition outputs to ignition modules (often called ignitors or spark amplifiers) but leave the ignition modules disconnected at this stage. See warning at beginning of manual. Connect ignition modules to coils and run wiring for coil(s) power supply back to the relay.

Connect idle control motors if applicable.

Connect any other auxiliary devices such as thermo-fans or turbo wastegate solenoids.

### **Power & Ground:**

Connect all ground connections to a central location, any unused black wires in the wire harness can be grounded.

Connect power from the battery to the fuse block. Try to keep the wires from the battery to fuse block short and ensure that this run of wire is well protected from damage to its insulation in case of a short circuit.

Connect power from the fuse block to each relay that supplies power to injectors, ignition, ECU and any other auxiliary devices that require a switch 12V supply.

Ensure that the ignition modules and fuel injectors are **disconnected** at this stage.

Connect the ECU to the loom and connect a laptop computer to the D9 serial connector. Proceed to the Setup Guide.

### **IMPORTANT INSTALLATION NOTE !!**

**To avoid damage to ignition components, never connect the ignition modules to the ECU until the ECU is configured. The same applies to the Fuel System, never connect fuel injectors until the ECU is configured, otherwise the engine may flood with fuel.**

**When wiring a Haltech ECU, it's extremely important that you have good connections to the vehicle's electrical ground and battery power. If possible, supply power to the fuel injectors, ECU and ignition system directly from the positive terminal of the 12V Battery (via relays). Don't just look for any wire that has 12 volts while the ignition is on, and assume that's good enough.**

**Trying to get power from unknown wires causes many problems and makes it very hard to diagnose a fault. That wire may have a large voltage drop, or be picking up electrical noise which can interfere with the ECU. Avoid running wires next to starter motor cables or ignition coils and their wiring, including high tension Leads. Also keep the ECU's wiring away from the antenna cables of radio transmitting equipment (e.g. CB, UHF radios) and cables from high powered car audio systems. All can cause ECU malfunctions.**

**When crimping cables, use a good crimp tool. After crimping each connector, pull on the cable and connector and make sure that it doesn't come loose. If you're soldering connections, make sure that you have a large enough soldering iron to ensure that the joint gets hot enough and allows a good flow of solder onto the wires. Some cheap or faulty irons just barely melt the solder, which only sticks to the wire instead of making a good solder connection. Properly insulate all connections.**

## Sensors and Device Pin Outs

### Manifold Absolute Pressure Sensor

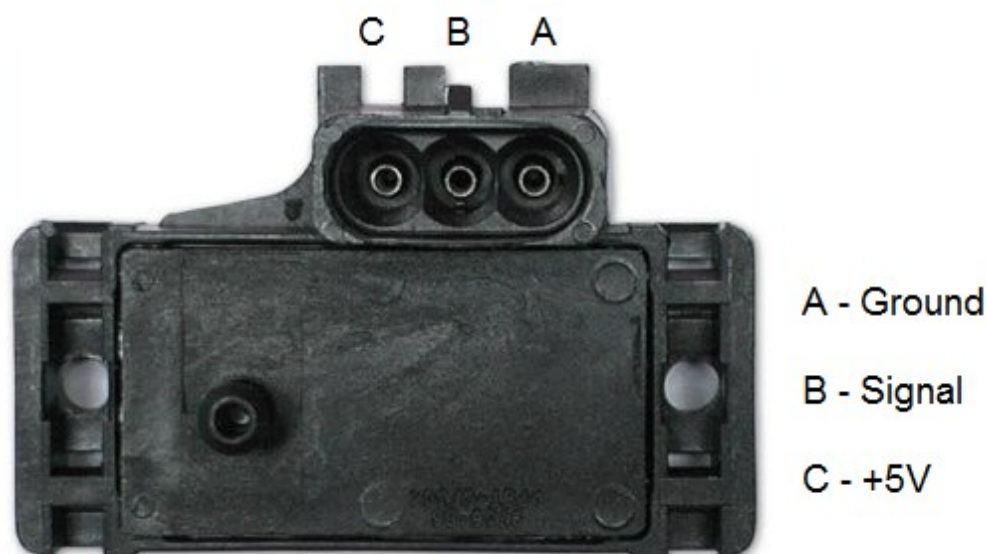


Figure 1 - MAP Sensor

The MAP sensor is used to convert the manifold pressure into an electrical signal for the ECU to use. The sensor works in absolute pressures, thus its calibration is not affected by changes in barometric pressure. The vacuum and, in the case of forced air induction engines, the pressure under boost, is proportional to the load under which the engine is operating and the ECU uses the electrical signal as a load reference.

There are three types of MAP sensors that can be used with the system. Which sensor is required depends on the engine set-up.

Sensor Name	Range of Operation	Application
1 Bar Sensor (Part No. 039 4070) (Green plug)	-100kPa to 0 kPa	Normally Aspirated Engines
2 Bar Sensor (Part No. 886 3189) (Orange plug)	-100kPa to 100kPa (15 psi of boost, 1 atmosphere)	Turbo or Supercharged Engines up to 100kPa boost
3 Bar Sensor (Part No. 749 3169) (Orange plug)	-100kPa to 200kPa (30 Psi of boost, 2 atmospheres)	Turbo or Supercharged Engines up to 200kPa boost

**Note:** Make sure you have the correct MAP sensor for your engine. The first three digits of the part number are stamped on the sensor housing.

The MAP sensor is usually mounted high on the engine bay firewall or inner guard using two screws and with the hose nipple facing outwards. Connect the sensor to the inlet manifold via a short length of vacuum hose and fasten with either hose clamps or nylon cable ties. Connect the sensor to the main wiring harness using the appropriate plug. Avoid mounting the sensor below the level of the fuel injectors, because fuel may collect in the vacuum hose and run down into the sensor. The sensor assembly is weatherproof but it is good practice to mount the sensor in a protected position away from moisture and heat.

### Coolant Temperature Sensor

The coolant temperature sensor has a solid brass temperature-sensing tip. Refer to the diagram for physical details of the sensor at the back of this manual. The coolant sensor supplied is an industry standard component and some engines may already have provision for this type of sensor.

The coolant temperature sensor is designed to screw into a threaded hole and protrude into the engine coolant stream. For air-cooled engines, the sensor can be embedded directly into the engine block or used to sense oil temperature.

Locate a suitable position on the engine which gives access to the coolant stream before you drill and tap the thread. The sensor should be mounted before the thermostat in the coolant circuit. Since most engines have existing temperature sensor holes, it is often possible to mount the Haltech sensor in one of these holes. If necessary drain the coolant from the vehicle to fit the temperature sensor then consult the factory manual on how to purge the cooling system of air and check the engine does not require topping-up with coolant after the engine has reached operating temperature.

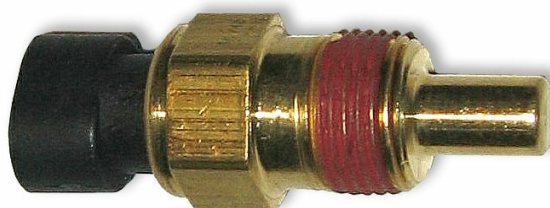


Figure 2 - Coolant Temp Sensor

### Inlet Air Temperature Sensor

The air temperature sensor is used to compensate for changes in air density due to air temperature. Cold air has a higher density than warm air and therefore requires a greater volume of fuel to maintain the same air/fuel ratio. This effect is most noticeable in forced induction engines. The Haltech ECU will automatically compensate using the signal received from the air temperature sensor (once the air temperature correction map is setup and enabled in the programming software).

The sensor should be mounted to provide the best representation of the actual temperature of the air entering the combustion chamber, i.e. after any turbo or supercharger, and intercooler, and as close to the head as possible. The sensor needs to be in the moving air stream to give fast response times and reduce Heat-Soak effects. Be aware in some situations, mounting the sensor into the inlet manifold (especially at the rear) may cause Heat Soak problems.

Once a suitable position has been located for the air temperature sensor a hole should be drilled and tapped to accept the sensor. Remove the manifold or inlet tract from the engine before this is done so you don't get any metal particles entering the inlet manifold, as these will be drawn into the engine and may cause damage.

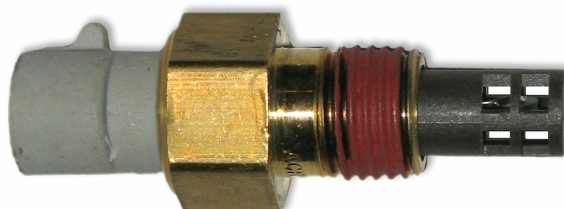


Figure 3 - Air Temp Sensor

Note: The Haltech air temperature sensor will read temperatures up to 120° C and temperatures above this will be interpreted as a fault condition. The air temperature after some turbo and superchargers can exceed this. If this occurs with your engine you should consider fitting an intercooler to reduce air temperature and increase charge density.

### Throttle Position Sensor



Figure 4 - Throttle Position Sensor

The throttle position sensor is mounted to the throttle butterfly shaft to measure its rotation. A TPS is common on many late model engines and the Haltech sensor should attach with little or no modification. The throttle shaft must protrude from the side of the throttle body. This may require the machining of the throttle body or the manufacture of a new throttle shaft. The inner mechanism of the sensor rotates with the shaft. If the shaft is round then file a flat surface on the shaft so that it will pass through the sensor assembly. The TPS should be mounted against the side of the throttle body, using two screws, such that the throttle shaft and the sensor mechanism can rotate freely. The absolute range of sensor movement is not important as the sensor can be calibrated using the programming software.

Your engine may have a Throttle position sensor already fitted and it is often possible to make use of this TPS. The Haltech supplied TPS has a resistance value ranging from 0 to 10k $\Omega$ . The resistance value of the installed TPS does not have to be the same since the ECU uses a throttle calibration function to determine the position of the throttle based on the signal received from the TPS. Be sure to wire the TPS so that the ECU sees a lower value when at zero throttle than at full throttle.

Note: Make sure that the axis of rotation of the shaft is exactly aligned with the axis of rotation of the sensor, otherwise some binding may occur. Also, do not use the TPS as a throttle stop. In either case, the TPS will be damaged.

### Ignition Modules

The Ignition Module should be mounted on a flat surface (eg. the firewall) to ensure proper heat dissipation and to avoid stress on the wiring connections. It is also important to prevent the module overheating by mounting it away from hot components such as exhaust manifolds and turbochargers.

Included with your ignition module, should be a wiring diagram for your ignition module. Follow the directions on these instructions to connect your ignition module(s) to your main wiring harness. Locate the ignition wires in the main loom. Using the supplied pins, crimp the pins onto the appropriate wires and insert them into the appropriate locations in the ignitor plug, but do not connect it to the ignitor until the ignition settings in the ECU are verified by connecting the ECU to a computer with Haltech programming software.



Figure 5 - Haltech Dual Channel Ignition Module

### Warning

**If using "Intelligent" ignitors such as the old Bosch 008 ignition module (rare), Constant Duty Cycle Mode should be selected in the Ignition Setup Page. If using a "Dumb" ignitor (Most standard ignitors are dumb, as are modern Haltech ignitors), the Constant Charge Mode should be selected in the ignition setup page.**

**Do not connect the ignition sub-loom to the main wiring loom until after you have configured the ECU by connecting it to a computer with Halwin programming software.**

### Exhaust Gas Oxygen Sensors (Optional)

The optional exhaust gas oxygen sensor must be mounted in the exhaust pipe near the exhaust header or extractors, usually after the collector. The sensor uses the exhaust gas to detect if the engine is lean or rich. Many late model engines already have provision for an exhaust gas oxygen sensor and the sensor provided should fit any standard exhaust mount. Some exhaust systems have the sensor mount up to around half a meter (2 feet) down stream from the exhaust headers.

If the exhaust system does not have an existing sensor mount then a new mount will have to be welded to the exhaust system. When routing the electrical connections to the exhaust gas oxygen sensor do not allow the harness to touch the exhaust pipe, as the heat will damage them.



Figure 6 - O2 Sensor



### Power Relays

There are three relays used with the Haltech ECU, the main power relay, the ignition relay and the fuel pump relay. These relays look almost identical, to determine which relay should go into which connector the diagram on the side or top of the relay will need to be compared to the diagram in the Haltech wiring diagram.

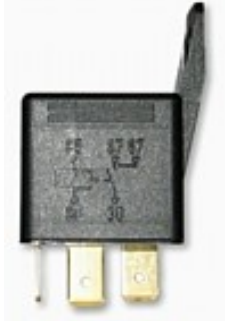


Figure 7 - Power Relay

These relays should be mounted on the firewall or an inner guard. Do not mount the relays such that they could catch and collect splashed water. Residual water inside the relay housing will cause them to fail. Mount them with the tab upwards as shown in the diagram.

### Fuse Block Assembly

The fuse block assembly holds the fuses that protect the various components of the engine management system.

The fuse block is supplied from the factory with fuses installed. The fuse ratings and connections are shown in the wiring diagram at the end of the manual. The fuse ratings have been selected to protect the Haltech ECU and the electrical systems that supply it. Fuse ratings should only be changed if the expected normal load current exceeds the factory specification. Altering the fuse ratings could cause severe damage to the system.

The fuse block should be positioned so that it can be accessed easily in case of fuse failure. Do not mount the fuse block where it could be exposed to water. Mount the fuse block using the two screws holes in the block ensuring that vibration will not cause the screws to vibrate loose.



Figure 8 - Fuse Block

### Trigger Wiring (Crank and Cam Angle Sensors)

The most critical sensor on the engine is the engine speed sensor, without this sensor the ECU would not know that the engine is moving and therefore it would never fire a spark nor inject any fuel.

The ECU gets information from the crankshaft and camshaft position sensors in the form of electrical impulses over a period of time. When the ECU knows what pulses to expect it can compare this to what pulses it receives and determine the engine speed and position at any point in time.

There are two main types of sensor used for this application;

## Reluctor Sensor Types

Variable Reluctance Transducers (VRT or simply reluctor) – this kind of sensor produces a sine wave output. Generally a VRT sensor will have only 2 wires (a third wire may be present but its generally a shield wire to help protect the signal from “noise”).

Figure 9: Reluctor Style Sensor

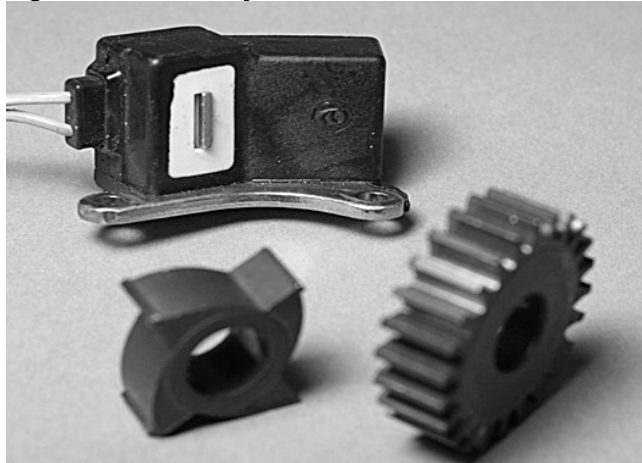
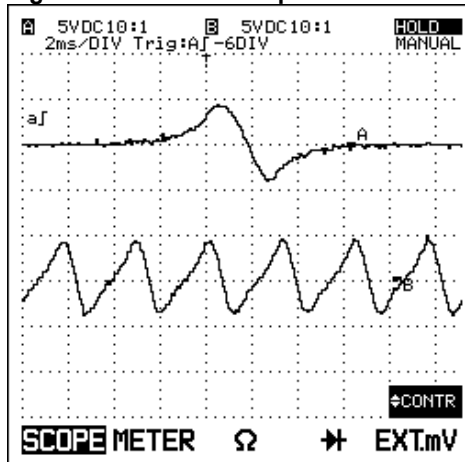


Figure 10: Reluctor Scope Trace

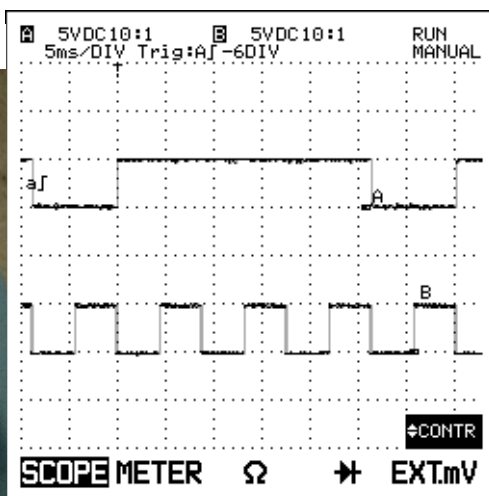
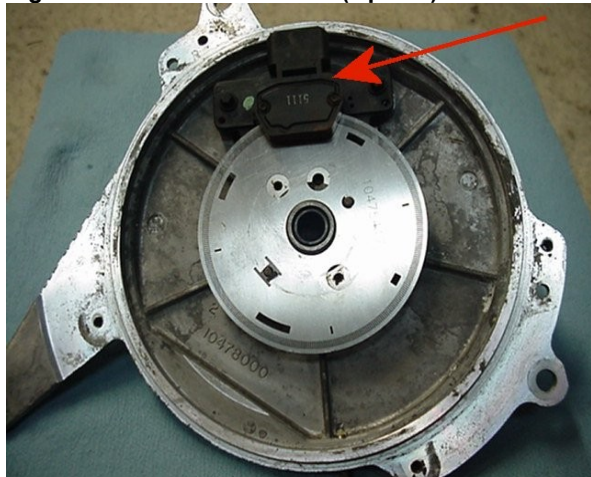


VRT sensors DO NOT require a power supply, they will have a signal wire and a ground wire only, the way they work is almost the opposite of an electric motor with only one brush where the sensor has a magnet inside with a coil of wire wrapped around it. As a ferrous material passes by the magnet the magnetic field is disrupted and a voltage spike is created in the coiled wires surrounding the magnet producing a sine wave. This signal is what is fed into the ECU. The ECU cannot interpret a sine wave directly and must first process the sine wave into a digital signal before it is able to use this information. The part of the ECU hardware that conditions the reluctor signal is called a reluctor adapter and it converts the reluctor signals shown above to a square waveform similar to that of the Hall effect trigger. The reluctor adapter and its tuning is dealt with in detail further later on.

## Hall Effect Sensor Types

The second type of sensor found on crank and camshafts known as a Hall Effect (this includes optical sensors) sensor. This style of sensor has a transistor and some electronics built into the sensor itself and will generally require a power supply and ground of some sort. For this reason a hall effect sensor usually has at least 3 wires. The output of this style of sensor is a digital square wave.

Figure 11: Hall Effect Sensor (Optical)





Because the output from a hall effect sensor is already in digital form the ECU does not need to do any signal conditioning to be able to use it.

When given the option a hall effect sensor is always the best option to put on an engine and it reduces the amount of work required of the ECU.

In applications where either direct fire ignition or sequential fuel injection is required the ECU must have a way of determining where it is in the firing order at any point in time and which cylinders are on compression and which are on exhaust. The only way of determining this is to use a sensor connected to the camshaft that sends a signal to the ECU when the engine is approaching cylinder 1 TDC on the compression stroke.

### Flying Leads

Locate and connect the following flying leads.

#### Black (Ground)

Locate a good chassis ground point or the negative terminal of the battery and connect the black wire.

#### Red

(Battery Supply +12V) Locate a source of continuous +12 volts and connect the red wire. Connecting direct to the positive battery terminal is suggested.

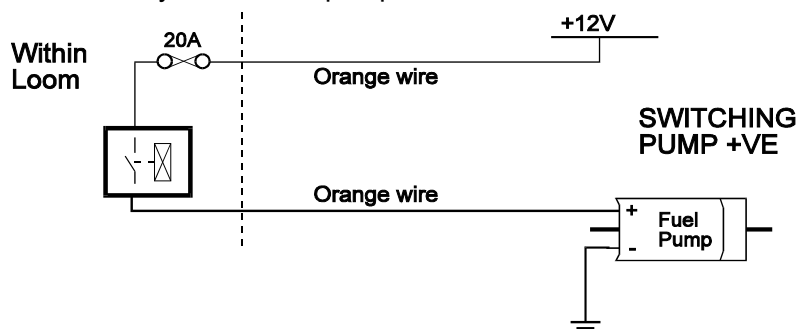
#### Grey

(Ignition Switched +12V) The grey wire is used to control the operation of the Haltech ECU power relay. It needs to be connected so that it sees 12V only when the ignition switch is on and during cranking. This wire does not draw a large amount of current (< 0.5A). Do not connect to the accessory outputs of the ignition switch.

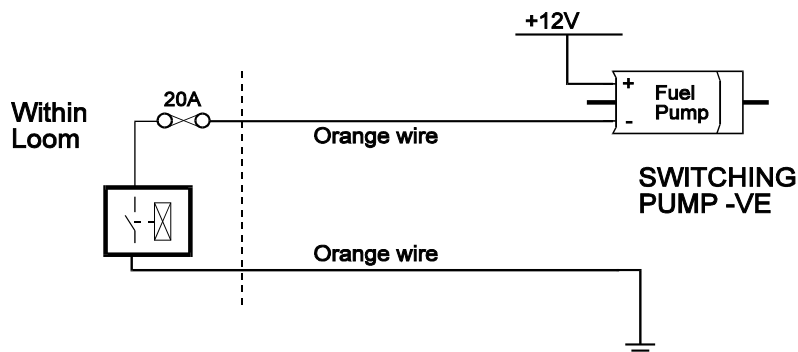
#### Orange

The two orange wires are used to operate the fuel pump. When the Haltech ECU wants to operate the fuel pump it will close the fuel pump relay connecting the two orange wires together. The diagrams show two examples of wiring the fuel pump. Do not add extra relays to the fuel pump circuit.

Figure 12 - Fuel Pump Wiring



It does not matter which example is used. Both will operate correctly. Note that the orange wires are connected internally within the loom when the relay is closed. As a result it does not matter which orange wire is used to connect to the fuel pump.



### Wiring Injectors

When wiring fuel injectors all Injectors share a common +12V supply voltage with the ECU INJ output supplying the ground for the injector when fuel delivery is required. It is also essential for the +12V supply voltage to the injector to be the same +12V supply that goes to the ECU. If using the Haltech long flying lead harness this is already preterminated, if you are wiring your own harness you will need to ensure you make this connection.

When wiring E8 or E11 for sequential fuel injection, fuel injectors should be wired with inj1 output to cylinder 1, inj2 output to cylinder 2 and so on, the injectors firing sequence will be set in the software via the firing order found on the advanced tab of the main setup page. If semi-sequential injection mode is used the injection sequence will always be Inj1, inj2, inj3 inj 4 etc regardless of the firing order set in the software.

### Wiring Ignition

See below for some tables describing typical ignition wiring layouts

On the E8 and E11v2 ECU's an external ignition amplifier (otherwise known as an ignition module, an ignitor or ignition power transistor) is required. Some Ignition coils have these modules built into the coil itself, others do not. As a general rule of thumb any coil with only 2 wires does NOT have the ignition module built into it, you will need an additional ignition amplifier on these coils. If in doubt of your ignition module requirements call your Haltech representative or the manufacturer of the ignition system.

When wiring E8 or E11 for direct fire ignition, ignition outputs should be wired with ign1 output to cylinder 1, ign2 output to cylinder 2 and so on, the ignition firing sequence will be set in the software via the firing order found on the advanced tab of the main setup page. If wasted spark ignition is used the ignition sequence will always be Ign1, ign2, ign3 ign 4 etc regardless of the firing order set in the software.

### Distributor Ignition

Distributor ignition output is always on IGN 1.

### Twin Distributor Ignition

Ignition output will always appear on IGN 1 and IGN 2 channels. In the majority of cases, IGN 1 will be the first output to fire.

### Waste Spark Ignition

When setup for waste spark ignitions, the order of the ignition outputs is simply in the order of the outputs. IGN 1 will fire first, then IGN 2 will fire next etc until the last ignition channel is reached regardless of engine firing order. The following example is for a 6-cylinder engine that fires 1-5-3-6-2-4.

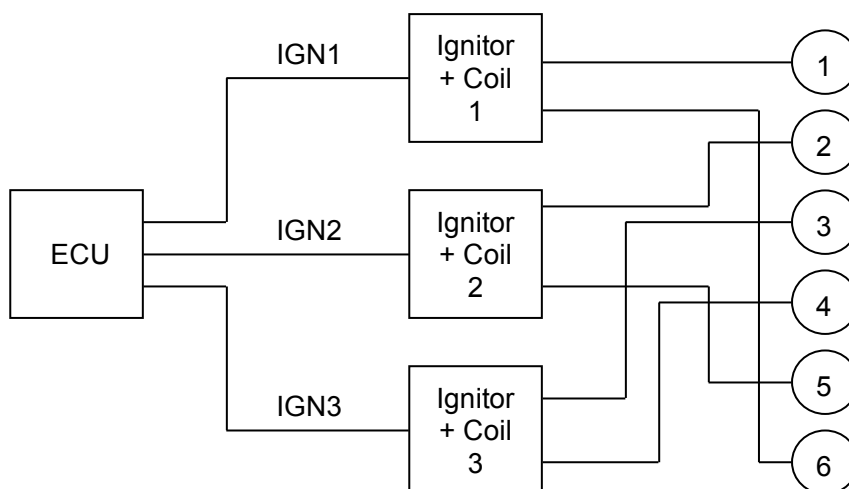


Figure 13 - Waste Spark Ignition Configuration

### Direct Fire Multi-Coil Ignition (1 coil per cylinder)

Wire each ignition output to its corresponding coil with IGN1 output wired to cylinder 1's coil/ignitor, IGN2 output wired to cylinder 2's coil/ignitor etc. The firing order for ignition will be taken from the firing order that is specified in the Main Setup in the programming software. Its important to note the difference in wiring order between direct fire and wasted spark – in direct fire mode the ECU will fire the ignition outputs according to the firing order entered into the software where as in wasted spark mode the ECU will disregard what is in the software and fire the ignition outputs in the order of the Haltech ignition output (ie IGN 1, IGN2, IGN3 etc.) Note: E8 ECU is only capable of driving 4 individual coil channels, and can therefore only do direct fire on a 4 (or less) cylinder engine.

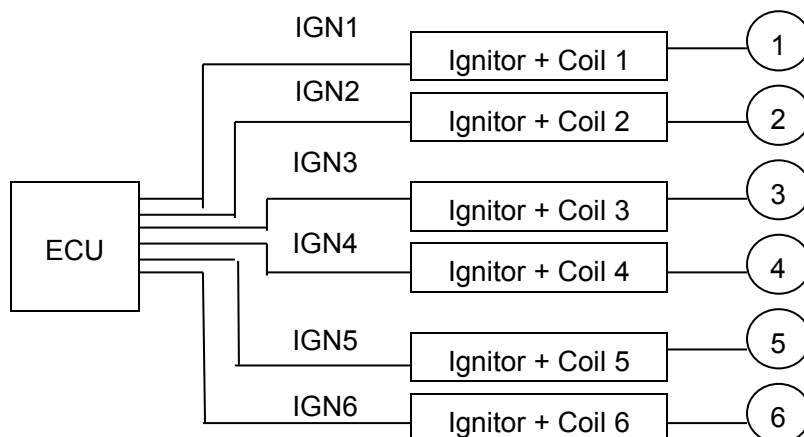


Figure 14 - Direct Fire Ignition Configuration

## Setup Guide

This section will guide you through setting up the software and calibrating the necessary values to enable you to start your engine and achieve a steady idle. By the end of this section, the vehicle will not be ready to be driven, but will be ready to be tuned which is described in the Tuning Guide in section 3.

This setup guide assumes basic knowledge of automotive fuel, ignition and triggering systems. If you find settings or concepts that are confusing or difficult to understand, please refer to the appendices of this manual for more background information on these topics.

It is assumed that you are competent with operating your personal computer and are familiar with the basic concepts of the Windows operating system environment. The Halwin software and this manual have made every possible attempt to keep the setup procedure simple. This section will cover only the bare minimum information required to operate the Halwin software package for the setup procedure outlined. For more details on the advanced features, make sure that you read section – The Halwin User Guide.

**Note:** Haltech will NOT provide support on operating your PC

## Halwin Programming Software

### Computer Requirements

The programming software requires a PC running Windows 95 release 2, Windows 98, Windows 2000, Windows Millennium or Windows XP with the following specifications.

Minimum Requirements:

233MHz processor

VGA colour display 800x600 (preferably 1024x768)

4Mb of memory

10 MB of free Disk space

### Installing Halwin

Installing Halwin onto your PC is performed similar to any other Windows software package. Installation is outlined below to ensure correct installation:

Insert the CD-ROM into your PC's CD-ROM drive.

Run the executable file "SETUP.EXE" from the CD-ROM drive. Continue at step 3. Otherwise, skip ahead to step 6. (Note: on some later Software versions, the disk may auto-run setup.exe)

Double click on the "My Computer" icon on the desktop.

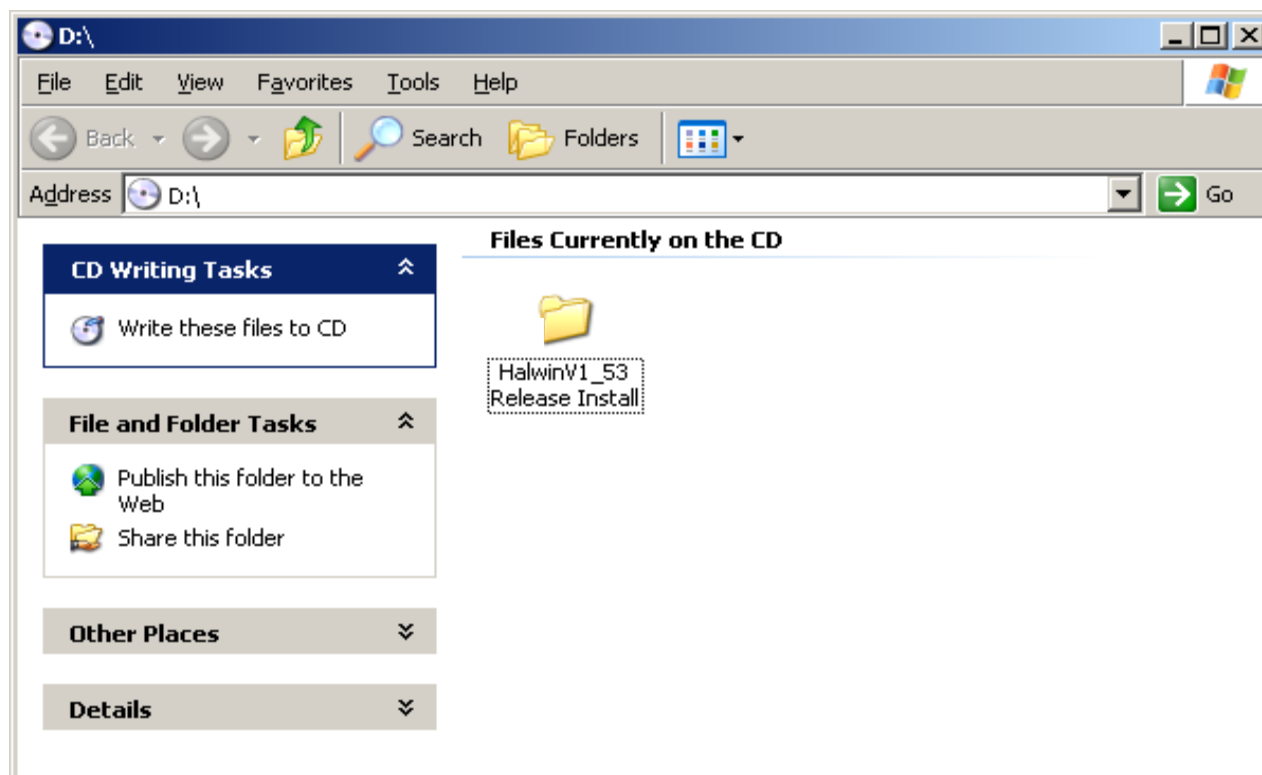


Figure 15 - Halwin Software Installation

Double click on the CD-ROM icon to open the CD-ROM. If the setup software does not automatically open, then double click on the "SETUP.EXE" icon to start the setup software.

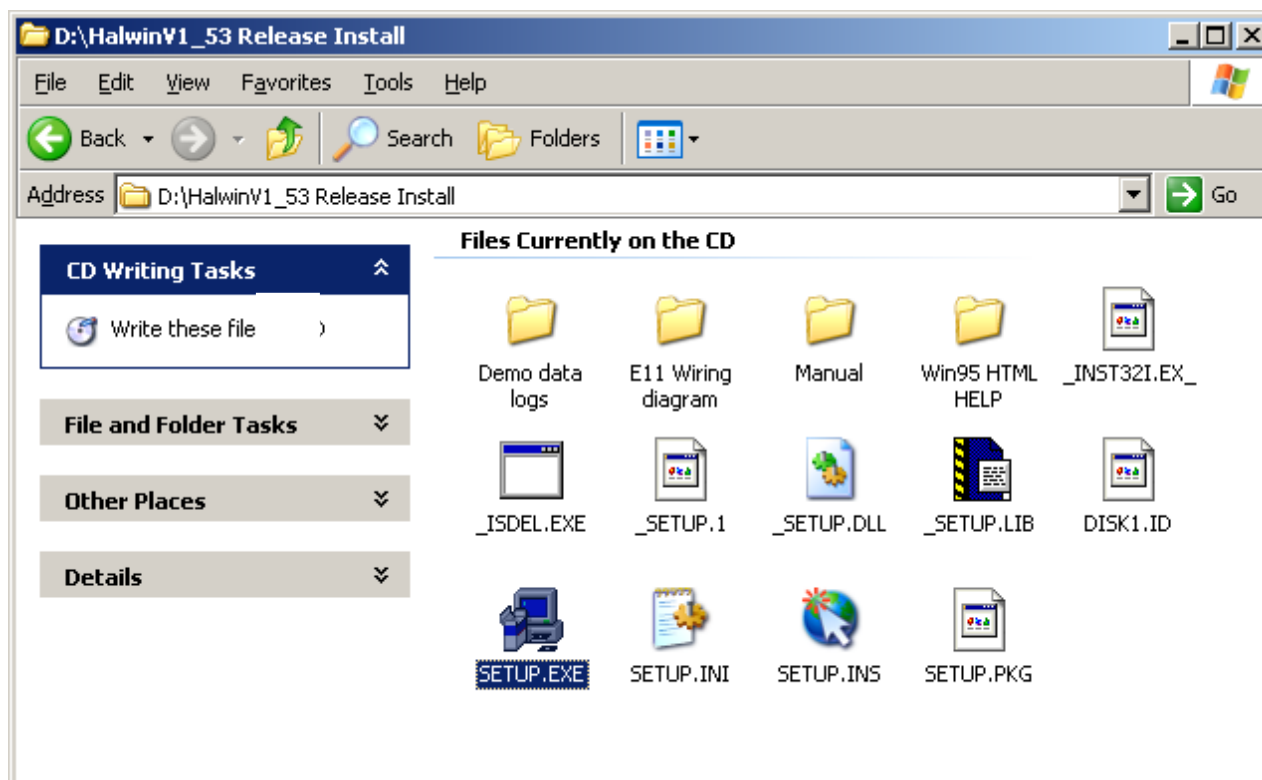


Figure 16 - Halwin Software Installation

After double clicking on the 'SETUP.EXE' icon, the following screens will appear.

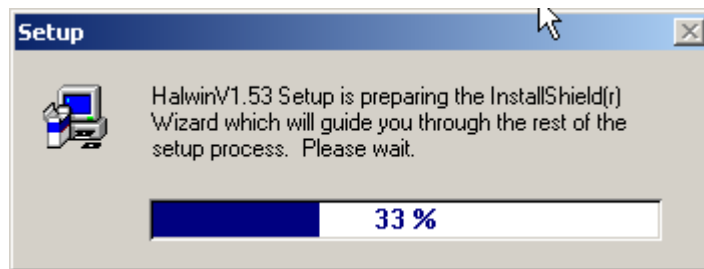


Figure 17 - Halwin Software Installation

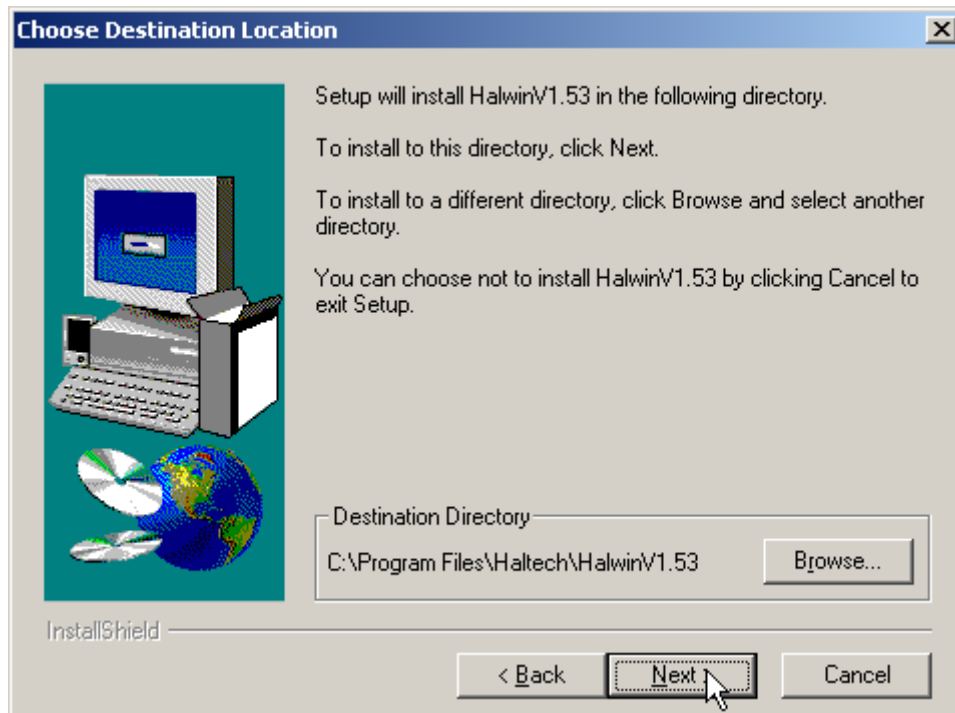


Figure 18 - Halwin Software Installation

Click on 'Next >' to continue and follow the instructions given to you on the windows that appear.

When prompted for which type of installation to perform, choose 'Typical' if you are unsure.

### Starting Halwin

After installing the software, an icon should appear on your desktop similar to the one shown in the picture below.



Figure 19 - Halwin Icon

Double click on the icon to start Halwin.

## Powering Up for the first time

### WARNING

**Now is the time to double check that your ignition modules and fuel injectors are not connected to the ECU. Powering up the ECU with the wrong configuration can lead to damage to your ignition modules and/or ignition coils or excessive fuel deposited in your engine if you leave these devices connected.**

## Going Online with the Software

With your programming cable (RS232) attached to your ECU and the other end connected to your laptop, power up the ECU by turning your key to IGN. Start the programming software on your PC. The following window will appear on the screen when the software detects the ECU connected and able to communicate with the software. If you do not get this window displayed, then check your ECU power and serial connection. If you are using a USB/Serial adaptor ensure that the adaptor is emulating the same port that you have selected for communications in the program setup tab of Halwin (default is COM1 in Halwin).

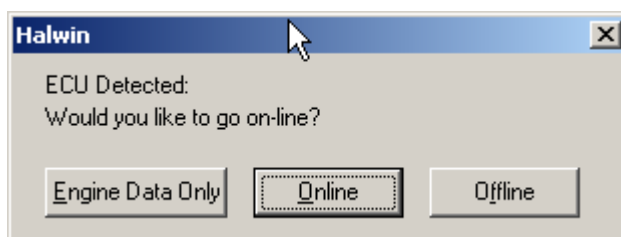


Figure 20 - Halwin Online Prompt

Select the option **Online**. This will load the map from the ECU into the programming software. The status indicator will show how much of the map has been loaded.

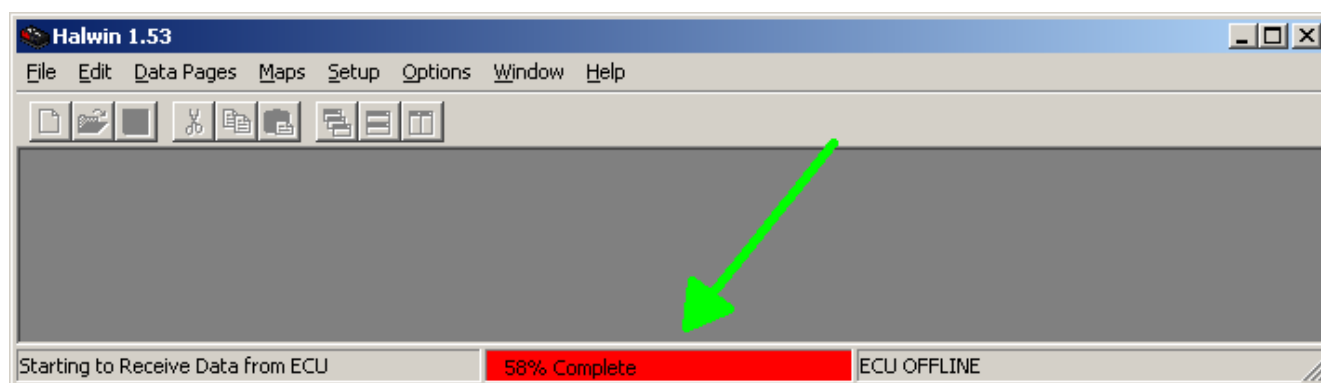


Figure 21 - Halwin loading map

After the map has been loaded into the ECU, the status indicator will show that the ECU is '**ONLINE**'. When Online, all changes made to the maps will be sent to the ECU. When operating the software Online, some caution is required as some changes are applied immediately in real time.

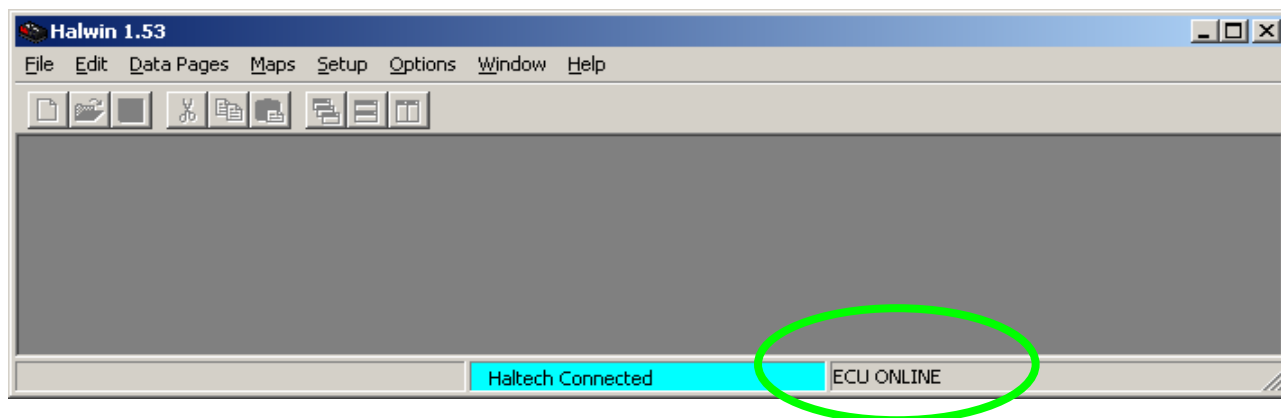


Figure 22 - Halwin Online

## Setup Menus

### Main Setup

If the map for your engine is unavailable for your vehicle, then you will need to create your own settings by following through the settings below.

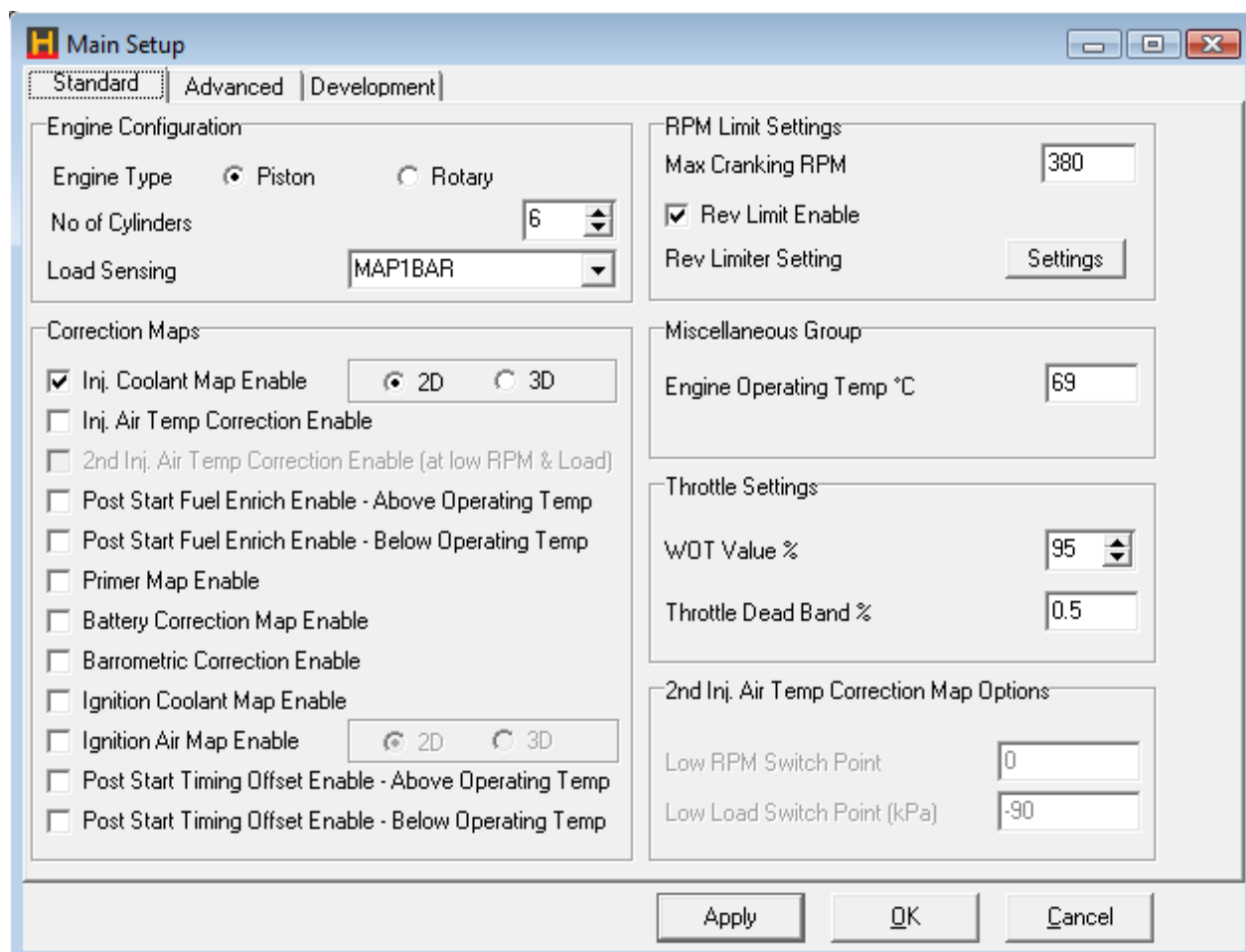


Figure 23 - Main Setup



## Engine Config Group

- **Engine Type** – Select your Engine type, Piston (reciprocating) engine or Rotary engine.
- **No of Cylinders** - Set this field to the number of cylinders your engine contains if you are configuring for a piston engine
- **No of Rotors** – Set this field to the number of Rotors when configured for a Rotary engine Type.
- **Load Sensing** - Set this to match the load sensing method you are using. Most engines will operate using manifold pressure to sense engine load. If your engine employs any form of supercharging or Turbo charging, select a suitable MAP sensor range. Engines with wild cams, most motorbikes, multi-throttle bodies or heavily ported rotaries will require a TPS as the load sensing. If you are unsure what to use, contact your Haltech dealer.

## Correction Maps Group

Click on the checkboxes on the left to place a tick next to the correction maps that you wish to have enabled. To disable a map, click on the checkbox to clear the tick. Choices are Inj Coolant Map, Inj Air Temp Correction Enable, Post Start Enrich Enable, Primer Map Enable, Post Start Type, Battery Correction Map Enable, Barometric Correction Enable, Ignition Coolant Map Enable. Ignition Air Map Enable and Post Start Timing Offset.

## RPM Group

- **Max Cranking RPM** - When the engine RPM is below this value, the engine is considered to be **cranking** under the starter motor power. When the RPM exceeds this value, the engine is considered to be started and **running**. This allows the ECU to determine what is Cranking and what is Running.
- **Rev Limit Enable** - Click on this checkbox if you want to enable the Rev Limiter.

## Rev Limiter Options Group

Rev Limiter Options		Rev Limiter Values	
Rev Limit Type	<input checked="" type="radio"/> Fuel <input type="radio"/> Ignition	Cut 1 Injectors at	4500 RPM
Rev Cut Type	<input type="radio"/> Hard <input checked="" type="radio"/> Soft	Cut 2 Injectors at	4700 RPM
Hard Cut RPM Limit	4500 RPM	Cut 3 Injectors at	4900 RPM
Start of Soft Cut RPM Limit	4500 RPM	Cut 4 Injectors at	5100 RPM
End of Soft Cut RPM Limit	5500 RPM	Cut 5 Injectors at	5300 RPM
<input checked="" type="radio"/> Linear Soft Cut <input type="radio"/> Hard to Soft Cut <input type="radio"/> Custom Soft Cut <input type="radio"/> Soft to Hard Cut		Cut 6 Injectors at	5500 RPM
		Cut 7 Injectors at	0 RPM
		Cut 8 Injectors at	0 RPM
		Cut 9 Injectors at	0 RPM
		Cut 10 Injectors at	0 RPM
		Cut 11 Injectors at	0 RPM
		Cut 12 Injectors at	0 RPM

Figure 24 - Rev Limiter Settings

- **Rev Limit Type** – Select which output the Rev Limiter will use - **Fuel** or **Ignition**.

**Note:** Be careful when using "Ignition" for Rev Limiting on vehicles with Catalytic Converters. Unburned fuel can overheat and damage the converter.

- **Rev Cut Type** – The method for cut-out to Ignition or Fuel can be either **Hard** or **Soft**. Hard cut is an instant stop to Fuel or Ignition and Soft Cut is a progressive or gradual cut (see figure xx). Selecting Hard Cut with Fuel as the Rev Limit Type, the injection time will be set to Zero if the RPM exceeds the value set in the RPM Limit field. If Ignition is used as the Rev Limit Type, then spark charge Time will go to Zero when RPM exceeds the value in the RPM Limit field. When using Soft cut, you can choose the type of sequence or aggressiveness of the cut by selecting Linear, Hard to Soft, Soft to Hard or a Custom style.

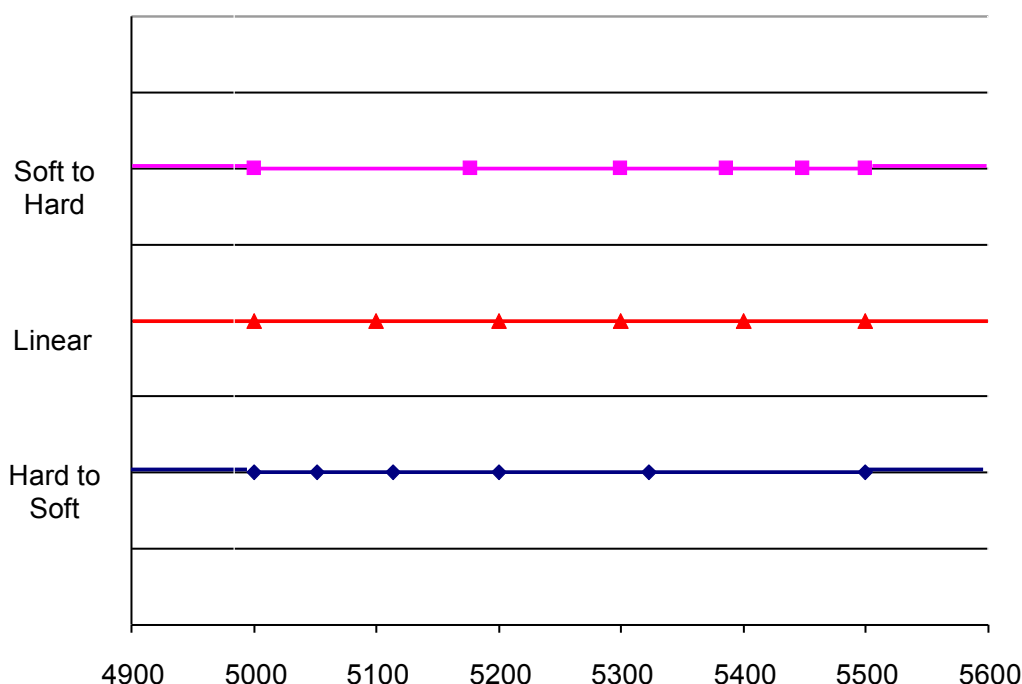


Figure 25 - Soft Cut Rev Limiter

### Miscellaneous Group

- **Engine Operating Temp** - When the coolant temperature is below this temperature, the engine is considered to be cold. Features such as injector primes that depend upon operating temperature will use this temperature to decide if the engine is at operating temperature.

### Throttle Group

- **WOT Value %** - Wide Open Throttle (WOT) value. When using Full Throttle Maps, this threshold defines over what percentage a full throttle map will work at. Example: if you set WOT value say 95% and WOT Map is enabled (Setup/Fuel Setup/Maps Group), when the Throttle position exceeds 95% the Full Throttle Map will take effect.
- **Throttle pump Dead Band** - Some Throttle Position Sensors (TPS) may have some residual noise. When watching the Engine Data page you may notice the TPS value move slightly even when no physical throttle movement is present. In some cases having a worn throttle shaft or multiple throttle bodies, engine vibration may cause throttle movement which can trigger a Throttle Pump Correction (causes an unexpected rich fuel mixture at idle or at a light load). If you think this

is causing a problem, then increase the Dead Band value slightly higher than the jitter or fluctuation value read from the TPS Engine Data Page reading. Typical values are around 0.5% to 2%.

### Main Setup - Advanced Tab

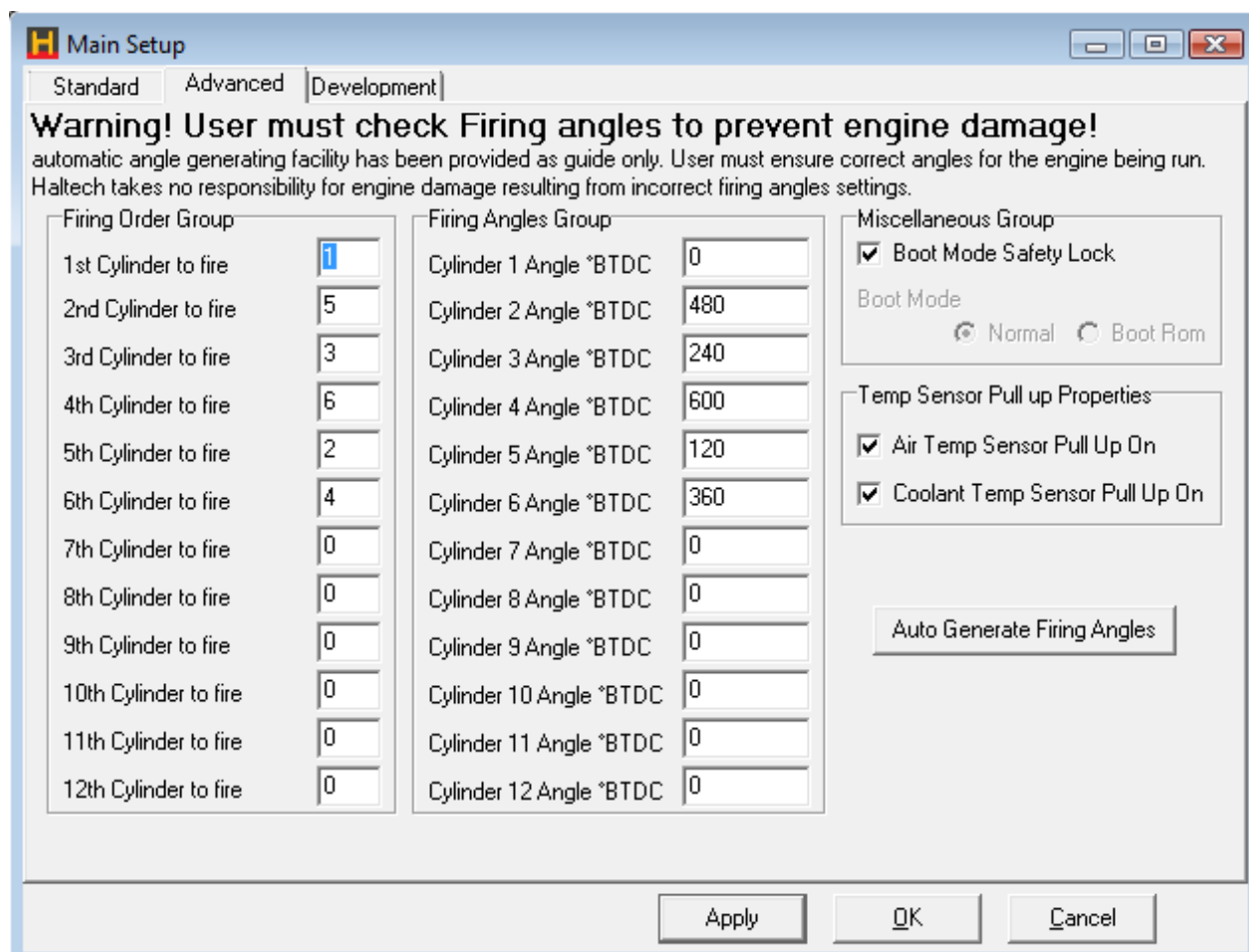


Figure 26 - Advanced Setup Window

## Firing Order

The firing order table is filled out with respect to cylinder number 1. Here are some examples of common engine firing orders:

4 Cylinder 4 stroke Piston	
1st Cylinder to fire	1
2nd Cylinder to fire	3
3rd Cylinder to fire	4
4th Cylinder to fire	2

6 Cylinder 4 stroke Piston	
1st Cylinder to fire	1
2nd Cylinder to fire	5
3rd Cylinder to fire	3
4th Cylinder to fire	6
5th Cylinder to fire	2
6th Cylinder to fire	4

8 Cylinder 4 stroke Piston	
1st Cylinder to fire	1
2nd Cylinder to fire	8
3rd Cylinder to fire	4
4th Cylinder to fire	3
5th Cylinder to fire	6
6th Cylinder to fire	5
7th Cylinder to fire	7
8th Cylinder to fire	2

## Firing Angles

To cater for 'odd fire' engines, certain triggers make use of the firing angles. To configure the firing angles, type in the angle at which the cylinder fires with respect to cylinder number 1. This means that Cylinder 1 Angle will always be zero.

### Example:

If you have an 'even fire' 4 cylinder engine with firing order 1-3-4-2, then the angles will be:

Cylinder 1 Angle = 0 Since the angles are with respect to cylinder 1, the definition means that this angle must be zero.

Cylinder 3 Angle = 180 With an even fire engine, all angles between all cylinders are always evenly spaced. Therefore, for a 4 cylinder engine will have  $720/4=180$  degrees between cylinder events. Since cylinder 3 is the next to fire, it will be 180 away from cylinder 1.

Cylinder 4 Angle = 360 Cylinder 4 will fire 180 degrees after cylinder 3, therefore it fires 360 degrees after cylinder 1.

Cylinder 2 Angle = 540 Cylinder 2 fires 180 degrees after cylinder 4, therefore it fires 540 degrees after cylinder 1.

For even fire engine applications (most engines) the cylinder firing angle does not need to be calculated by hand, simply press the "auto generate firing angles" button on the setup page and the correct firing angles will be generated. It is only in the case of an odd fire crankshaft that the firing angles need to be hand generated (ie where the angle between each cylinders TDC is not constant).

Listed below are typical cylinders angles for typical firing order, piston engines.

4 Cylinder 4 stroke Piston firing order 1-3-4-2	Cylinder Angle
Cylinder 1 Angle	0
Cylinder 2 Angle	540
Cylinder 3 Angle	180
Cylinder 4 Angle	360

6 Cylinder 4 stroke Piston firing order 1-5-3-6-2-4	Cylinder Angle
Cylinder 1 Angle	0
Cylinder 2 Angle	480
Cylinder 3 Angle	240
Cylinder 4 Angle	600
Cylinder 5 Angle	120
Cylinder 6 Angle	360

8 Cylinder 4 stroke Piston firing order 1-8-4-3-6-5-7-2	Cylinder Angle
Cylinder 1 Angle	0
Cylinder 2 Angle	630
Cylinder 3 Angle	270
Cylinder 4 Angle	180
Cylinder 5 Angle	450
Cylinder 6 Angle	360
Cylinder 7 Angle	540
Cylinder 8 Angle	90

**The Trigger and Ignition setup pages are the most Important part of any Installation!**

Getting these settings wrong or not understanding them will lead you into problems. The ECU has no idea what is connected to it or what it supposed to see. This is why the settings must be properly set to suit the application. The other issue is making sure the ECU can interface to the sensor(s) which different types of signals like Hall Effect signals and Reluctor (Magnetic sensor). Interfacing to these signals may require the use of external signal conditioners such as the Haltech RA10.

**Trigger Setup**

Trigger Setup

Trigger Group

Type of Trigger System **Standard Full Cycle**

Trigger Sensor Type ☐ Reluctor Mode ☒ Hall Effect Mode

Home Sensor Type ☐ Reluctor Mode ☒ Hall Effect Mode

Trigger Signal Edge ☒ Falling ☐ Rising

Home Signal Edge ☒ Falling ☐ Rising

Trigger Signal Pull up ☒ On ☐ Off

Pre-Gain Filter Group

Trigger Filter Level **0** Home Filter Level **0**

Trigger Gain Control 0 0 15

Home Gain Control 0 0 15

Apply OK Cancel

Figure 27 - Trigger Setup Screen

**Trigger Group**

- **Type of Trigger System** - Select the type of trigger that your engine uses from the options in the drop down menu.

Trigger System Type	Fuel Mode Supported	Ignition Mode Supported	Description
Standard No Home	Multipoint Batch	Distributor	Used for engines that run a standard trigger that provides a single pulse for each cylinders ignition event. i.e. A standard trigger for a 8-Cylinder engine will have 8 pulses, each with an edge that is always the same angle with respect to TDC of the next cylinder to reach TDC.
Standard Half Cycle	Multipoint Batch Semi-Sequential	Distributor Twin Distributor Waste Spark	Used for standard trigger engines that provide a Home signal on the crank. This provides enough information to do waste spark ignition and semi-sequential fuel injection.  Twin distributor mode is only possible for 8 cylinder engines and 12 cylinder engines (where supported) with this trigger.
Standard Full Cycle	Multipoint Batch Semi-Sequential Sequential	Distributor Twin Distributor Waste Spark Direct Fire	Used for standard trigger engines that provide a Home signal on the cam (720 degrees of engine rotation for 4-stroke engines).
Nissan Type 1	Multipoint Batch Semi-Sequential Sequential	Distributor Twin Distributor Waste Spark Direct Fire	Nissan triggers are optical triggers with a wheel with two tracks. One with large slots and another with 360 small slots.  Type 1 Nissan triggers have one unique slot and all remaining slots are the same size. The typical slot patterns for home window teeth are 2,2,2,8 for FJ20 engines or 2,2,2,2,2,8 for RB30 engines.
Nissan Type 2	Multipoint Batch Semi-Sequential Sequential	Distributor Twin Distributor Waste Spark Direct Fire	Type 2 Nissan triggers come with 2 unique windows. A typical pattern is 4,8,12,8 that can be found on most CA18 engines. Early RB series engines use this pattern also with six windows.
Nissan Type 3	Multipoint Batch Semi-Sequential Sequential	Distributor Twin Distributor Waste Spark Direct Fire	Type 3 Nissan triggers come with all unique window sizes. A typical pattern is 4,8,12,16 and is commonly found on SR20 and late RB series engines.  Choosing Type 1,2 or 3 will work with the ECU with a correctly setup 'Home Window' parameter. However choosing the correct type may assist in faster starting with less cranking.
Multi Tooth 24+1, Full Sync	Multipoint Batch Semi-Sequential Sequential	Distributor Twin Distributor Waste Spark Direct Fire	These are typically magnetic pickups with 24 teeth trigger with a single tooth home.  These are commonly found on Toyota and Honda engines.
	Multipoint Batch Semi-Sequential		

Motronic 60-2		Distributor Waste Spark	<p>These are typically magnetic pickups that are located on the crank. This style of pickup looks as if it should have 60 evenly spaced teeth however there are 2 teeth missing leaving only 58 teeth with a gap the width of 2 teeth at one location.</p> <p>These are commonly found on European cars such as Audi, BMW, Porsche and Volkswagon.</p>
Motronic 36-1	Multipoint Batch Semi- Sequential	Distributor Waste Spark	<p>These are commonly found on Ford engines. Typically magnetic pickups that are located on the crank. This style of pickup looks as if it should have 36 evenly spaced teeth however there is 1 tooth missing leaving only 35 teeth with a gap the width of 1 tooth at one location.</p>
Motronic 36-2	Multipoint Batch Semi- Sequential	Distributor Waste Spark	<p>These are sometimes found on Toyota engines. Typically magnetic pickups that are located on the crank. This style of pickup looks as if it should have 36 evenly spaced teeth however there are 2 teeth missing leaving only 34 teeth with a gap the width of 2 teeth at one location.</p>

Motronic 60-2 + Cam home	Multipoint Batch Semi- Sequential Sequential	Distributor Waste Spark Direct Fire	<p>With the addition of the Home signal on the cam, this trigger enables the support of full sequential injection and direct fire multi-coil ignition.</p> <p>These are commonly found on European cars such as Audi, BMW, Porsche and Volkswagon.</p>
Motronic 36-1 + Cam home	Multipoint Batch Semi- Sequential Sequential	Distributor Waste Spark Direct Fire	<p>With the addition of the Home signal on the cam, this trigger enables the support of full sequential injection and direct fire multi-coil ignition.</p> <p>These are commonly found on Ford engines.</p>
Motronic 36-2 + Cam home	Multipoint Batch Semi- Sequential Sequential	Distributor Waste Spark Direct Fire	<p>With the addition of the Home signal on the cam, this trigger enables the support of full sequential injection and direct fire multi-coil ignition.</p> <p>These are sometimes found on Toyota engines.</p>
Subaru	Multipoint Batch Semi- sequential Sequential	Distributor Twin Distributor Waste Spark Direct fire coils	For Subaru 4 cylinder EJ series engines.
		Distributor	



Subaru MY01	Multipoint Batch Semi-sequential Sequential	Twin Distributor Waste Spark Direct fire coils	For Subaru 4 cylinder EJ20 series engines in 2001 and later WRX and Forrester GT.
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Rotary Triggers	Fuel Mode Supported	Ignition Mode Supported	Description
2 or 3 pulse Trig Rotary	Multipoint Batch Sequential	Distributor (with toggle) Waste Spark Direct Fire	For rotary engines that have standard trigger style trigger adapted to them.
2 or 3 pulse Trig Rotary No Home	Multipoint Batch	Distributor	For rotary engines that have standard trigger style trigger adapted to them and no Home Signal.
Multi Tooth Rotary	Multipoint Batch Sequential	Distributor (with toggle) Waste Spark Direct Fire	The factory trigger for a Mazda rotary engine will be a 24 tooth magnetic trigger with a Home signal for every rotation of the crank.

Figure 28 - Trigger Type Options

- **Trigger Sensor Type** - If your Trigger Input Signal is a magnetic pickup type, then you will need to use the internal reductor by setting 'Reluctor Mode'. Otherwise, if you have a Hall effect sensor type that produces a digital square wave output, then select 'Hall Effect Mode'. Optical triggers also produce a square wave output and the input type should also be 'Hall Effect Mode'. Generally a "hall effect" trigger type will require power and ground, a reductor style sensor does not require power.
- **Home Sensor Type** - If your Home Input Signal is a magnetic pickup type, then you will need to use the internal reductor by setting 'Reluctor Mode'. Otherwise, if you have a Hall effect sensor type that produces a digital square wave output, then select 'Hall Effect Mode'. Optical triggers also produce a square wave output and the input type should also be 'Hall Effect Mode'.
- **Trigger Signal Edge** - The trigger signal from a crank or cam angle sensor will always be converted to a square wave signal. As a square wave, there will always be a rising and falling edge to every pulse received. Depending on the sensor, one of the edges may move with respect to the actual crank position as engine RPM changes. Set this parameter to select the edge that does not move with respect to the crank at all engine speeds. Set this edge to 'Rising' when using the internal reductor as a starting point.
- **Home Signal Edge** - Similarly with the home signal, one of the edges associated with this signal will have a fixed position with respect to the crank position, while the other edge may move slightly with RPM. Choose the edge that does not move with respect to the crank position when RPM is changed. Set this edge to 'Rising' when using the internal reductor as a starting point.
- **Trigger Signal Pull Up** - By default, this option should be left in the 'On' state. When using Hall effect input triggers from certain factory trigger systems however, it is sometimes required to turn this option 'Off'. Leave this feature in its default state unless you are sure that this needs to be turned off.

- **The Following Filter and Gain settings are only available in Reluctor Mode**

The ECU needs to see a clean Trigger signal before it can start controlling the engine. If you are having problems you have the option of adjusting the signal quality. In cases where the signal is too weak and or not enough signal strength, you can use the Gain settings to boost the signal. In some cases a high Gain setting may amplify noise, the same applies to the Filter Level adjustment if there is interference from Spark Noise the Filter Level may need to be used, ( too high value may cause problems at high RPM). Experiment until you get a stable RPM reading and check the readings from Trigger Diagnostic Data Page (Under Data Pages Menu).

Typical triggering symptoms are... if a Home signal has false triggered, it will cause synchronising problems and loose track of the start of the Engine cycle, a missing Trigger signal may loose count of which cylinder is to fire next. The end result can lead to a engine misfiring, running rough, backfiring hard to start or not starting at all.

*If you cannot get satisfactory results with the Filter/Trigger settings, contact your Haltech dealer and enquire about an external Reluctor Adaptor.*

- **Trigger Filter Level** – This filter setting allows you to clean up the Trigger signal before its processed by the ECU. You have the option of selecting a number from 0 to 2, 0 = no filter, 1 = low filter, 2 = high filter.
- **Home Filter Level** – This filter setting allows you to clean up the Home signal before its processed by the ECU. You have the option of selecting a number from 0 to 2, 0 = no filter, 1 = low filter, 2 = high filter.
- **Trigger Gain Control** – This Gain setting allows you to amplify the Trigger signal, the gain of the input stage to this reluctor can be set using this slider control. Start with low values and gradually increase the gain until you get a steady trigger signal throughout the rev range that you intend to operate your engine.
- **Home Gain Control** - When the internal reluctor adaptor is used to process the Home Input signal, the gain of the input stage to this reluctor can be set using this slider control. Start with low values and gradually increase the gain until you get a steady Home signal throughout the rev range that you intend to operate your engine. An unsteady Home Signal can lead to drastic changes in timing on multi-tooth triggers so check this with a timing light with Ignition Timing Lock turned on while you rev the engine.

## Ignition Setup

Figure 29 - Ignition Setup Page

### Timing Group

- **Lock Timing** - When this setting is checked, the ignition advance is fixed to the value described in Lock Degrees BTDC.
- **Lock Degrees BTDC** - The ignition advance angle used when Lock Timing is enabled.
- **Trigger Angle BTDC** - This is the angle between the trigger input and the corresponding piston's (or rotor's) TDC. For multi-tooth triggers such as those found on Toyota's, Honda's and Mazda's, the trigger point is the tooth defined by the Tooth Offset that is described below. The trigger angle must be between the largest intended advance angle and the angle between trigger events.

E.g. If the largest ignition advance angle you wanted to use was 32 degrees on a 4 cylinder engine, then your trigger angle must be between 32 to 180 degrees. Angle between triggers for a 4 cylinder is  $720/4 = 180$  degrees. For more information on how to set the tooth offset and trigger angle correctly please refer to the quickstart guide you received with your ECU.

- **Tooth Offset** - The tooth offset is the number of teeth from the Home signal to the tooth that is chosen to be the trigger tooth. The trigger tooth should be chosen so that the trigger angle can be dialled into the range described below. If this field is grey and not able to be changed, then ignore this parameter, as it does not apply for the given trigger.

### Setting the Base Timing

**Note:** Setting the base timing correctly is the most important step in getting the Haltech ECU to operate correctly. If the base timing is not set correctly none of the software settings will be correct. This is the most important step in the setup procedure.

### Tooth Offset and Trigger Angle Relationship

Tooth offset and trigger angle are closely related and are best explained visually so see below for a visual representation of the tooth offset.

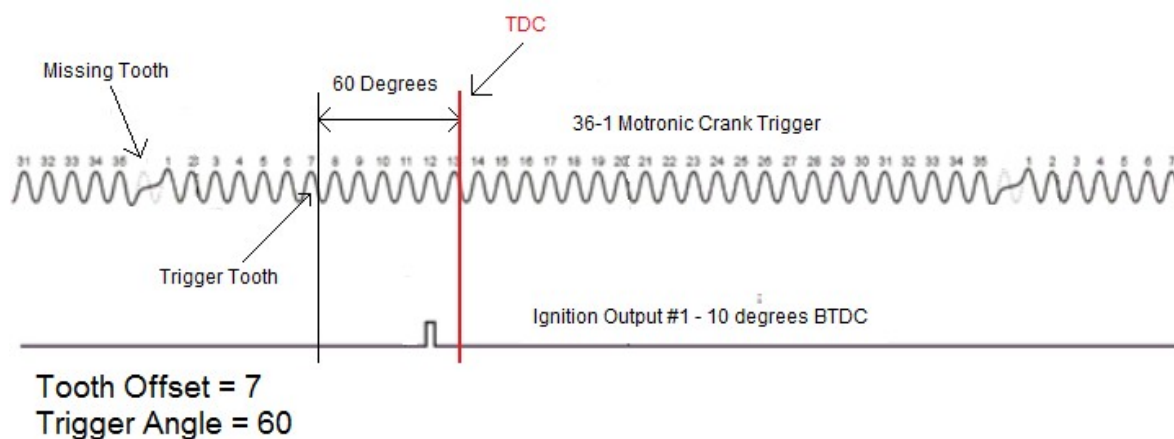


Figure 30: Trigger Angle and Tooth Offset Visually Outlined

The tooth offset is the number of teeth between the home event and the tooth that is chosen to be the trigger tooth. In the example above the home event is the missing tooth.

The trigger angle is the angle between the trigger tooth and TDC therefore the tooth offset plus the trigger angle equals the angle between the home event and TDC.

As can be seen above the trigger angle is simply the angle before top dead centre (TDC) at which the trigger event occurs (when the tooth selected to be the trigger tooth passes by the sensor). In the case of a multi tooth trigger without a missing tooth (such as a Toyota 24 trigger) the home event comes from a separate single tooth sensor usually located on the camshaft.

When using a custom trigger of any sort the sensor must produce at least one trigger event for each ignition event and each trigger must occur a constant angle BTDC (in other words the teeth must all be evenly spaced and the number of teeth an even multiple of the number of cylinders the engine has).

The trigger angle value must be greater than the maximum advance you wish to run, so if the maximum advance you wish to run is 40 deg, the Trigger Angle value needs to be at least 40 deg (its wise to have at least 10 degrees margin). If the Trigger Angle value is set too low, the ignition timing will not be able to achieve the full advance set in the ignition map/s.

By selecting the correct trigger tooth in the tooth offset field this should always be possible.

Setting the tooth offset and trigger angle on an engine where the location of the crankshaft position sensor and camshaft position sensor is unknown is very easy and requires only a timing light. The following procedures outlines how to achieve this:

Go to the fuel setup page and disable the fuel injectors (at this stage it is not desired that the engine attempts to start), to reduce stress on started motor it is also advisable to remove the spark plugs to help the engine crank more freely when setting base timing (be careful when doing this as spark from ignition coils have been known to cause severe injury and even death on some occasions).

Figure 31: Ignition Setup Page

Set lock timing to ON and lock timing angle to 10 degrees. Crank engine, using a timing light connected to ignition lead for number 1 cylinder adjust the tooth offset and trigger angle until timing reads 10 degrees as viewed with a timing light on crank pulley. Tooth offset gives large changes to timing, trigger angle is used to fine tune timing to exactly 10 degrees (any angle can be used as the lock timing angle. In this example 10 degrees was used. It is however possible to set the lock timing to zero degrees (or any other positive number) and adjust tooth offset and trigger angle until the crank pulley shows this value when viewed with a timing light).

- **Nissan Home Window** - Nissan trigger requires the detection of a particular sized window to establish the 'Home' position of the engine. Some Nissan triggers have several uniquely sized windows that can be used for this purpose. This parameter selects which of the unique windows to use. If this field is grey and not able to be changed, then ignore this parameter, as it does not apply for the given trigger.
- **Constant Charge Time** - The time used to charge the ignition coils when Constant Charge mode is selected. See Appendix D for more details on ignition systems.
- **Spark Break Time** - This is the minimum time between when the spark edge occurs and the next charging edge is allowed to occur. This time will depend on how quickly the coil can discharge to fire the spark. This threshold is only used when charging time is limited. This is only applicable in Constant Charge Mode. The default value is 600 µs.

## Ignition Mode Group

- **Spark Mode** - This mode must be set to the type of ignition system that is to be used on the engine.

### For Piston Engines

Trigger	Injection Mode
Standard Trigger Full Cycle, with home on the CAM 24 +1 Multi-Tooth trigger (Honda, Toyota) Nissan Trigger Motronic with home signal on the CAM Subaru Subaru MY01	Direct Fire Multi Coil
Standard Trigger Full Standard Trigger Half Cycle with home on the crank 24 +1 Multi-Tooth trigger (Honda, Toyota) Nissan Trigger Motronic Subaru Subaru MY01	Waste-Spark
All triggers	Distributor

### For Rotary Engines

Trigger	Injection Mode
Standard Trigger with crank home 24 +2 Multi-Tooth trigger	Direct Fire Wasted Spark Leading ignition Distributor (with toggle)
Standard Trigger with no home	Distributor (without toggle)

Figure 32 - Ignition Trigger Modes

## Ignition Spark Edge

The ignition spark edge determines the polarity of the waveform used to drive the ignition module. Falling edge ignition will use a zero voltage output at idle, a +12V signal for charging, and a falling edge to zero volts to fire the spark. Most factory ignition systems use falling edge. This is the default setting.

**Note:** Take care when setting the ignition spark edge, incorrect settings will damage the ignition system.

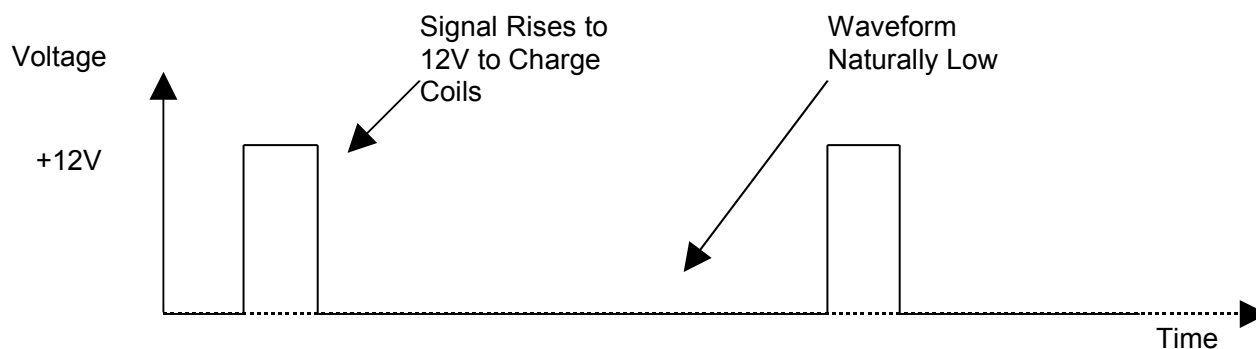


Figure 33 - Ignition Spark Edge Falling

**Rising Edge Triggered** - Some Honda and CDI style ignition modules are known to be rising edge triggered. These modules expect to see a naturally high signal. When the voltage falls to 0V, the module charges the coil. When the voltage returns to 12V, the spark is fired.

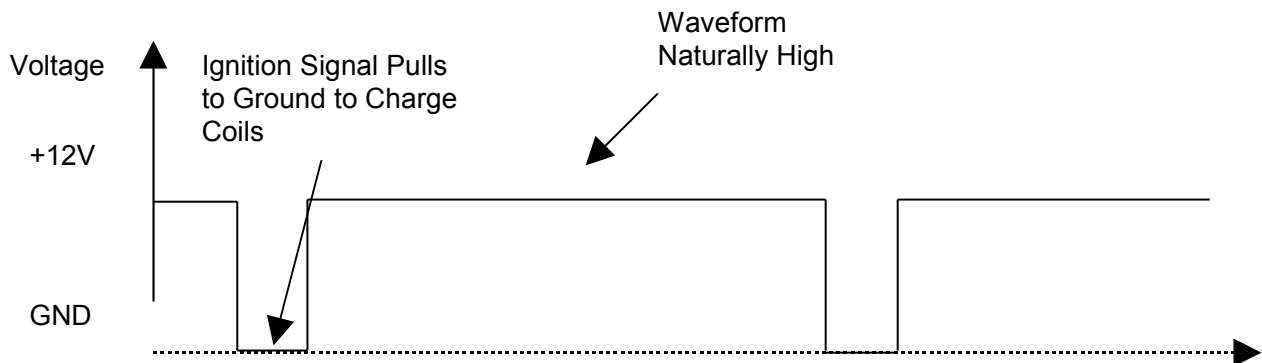


Figure 34 - Ignition Spark Edge Rising

**Note:** Take care when setting the ignition spark edge, incorrect settings will damage the ignition system.

### Trailing Spark Edge

This parameter is only available when in rotary mode. This parameter is the same as Ignition Spark Edge, but applies only to the trailing spark. The leading spark for a rotary engine is setup with Ignition Spark Edge. This feature allows for different ignition systems to be used on the leading and trailing coils.

### Dwell Mode

This mode must be set to the type of ignition module that it to be used on the engine, almost every ignition system that comes from a modern vehicle (i.e. an engine that has EFI as standard) uses constant a constant charge ignition system.

### Trailing Dwell Mode

This parameter is only available when in rotary mode. This parameter is the same as Dwell Mode, but applies only to the trailing spark. The leading spark for a rotary engine is setup with Dwell Mode. This feature allows for different ignition systems to be used on the leading and trailing coils.

### Ignition Map Selection

This selects which map to use. If an external input is used to select the map, then this setting is ignored.

### Ignition Trims

Allows ignition to be trimmed either as an overall trim, or as an individual cylinder trim.

### Zero Throttle Map Enable

Allows for a separate ignition map to be enabled when the engine's throttle is closed.

## Fuel Setup

**Fuel Setup**

**Decel Cut Parameter Group**

- ☐ Decel Cut Enable
- Fuel Return RPM: 1700
- Decel Cut Reset RPM: 2000
- Decel Cut Temp °C: 0
- Decel Cut Delay sec: 0.5
- Max Decel Cut Retard °BTDC: 8
- Decel Cut Enrich %: 10

**Closed Loop Oxygen Sensor**

- ☒ O2 Closed Loop Enable
- Low RPM Limit: 1600
- High RPM Limit: 3500
- Max Enrich Incr %: 10
- Max Enrich Decr %: 10
- ☐ Enable 3D Target AFR
- Target AFR: 14.0
- Target AFR @ Idle: 14.7
- Load Select: TPS
- Operating Temp °C: 69
- Throttle Limit (%): 20
- MAP Limit (kPa): 94.8
- Proportional: 0.00
- Integral: 1.00
- Sample Rate: 50 ms
- Idle RPM Below: 1000
- O2 Sensor Type: Wideband O2 Sensor on O2 Sensor Input
- O2 Warm-up Time (sec): 120
- Delay till Control (sec): 2.0

**Maps Group**

- ☐ WOT Map Enable
- ☐ Zero Throttle Map Enable
- Fuel Map Select: Fuel Map 1

**Throttle Pump Group**

- ☒ Throttle Pumps Enable
- Setup

**Selection Group**

- ☒ Injectors Enable
- Injection Mode:
  - ☐ Multipoint
  - ☐ Batch
  - ☐ Semi Sequential
  - ☒ Sequential
- Injector Current Setup
- Staged Injection Enable: ☐
- Staged Injection Setup: Edit
- Ignition Divide By: 2
- Fuel Scale Factor: 100
- Injection Angle: End of Injection
- Injector Trims: Edit

**Over Boost Group**

- ☐ Enable
- Over Boost Cut kPa: 4
- Over Boost Restore kPa: 4

**Fuel Pump Settings**

- ☐ Invert Fuel Pump Output
- Fuel Pump Prime Time: 5.0

Apply OK Cancel

Figure 35 - Fuel Setup Page

### Decel Cut Parameter Group

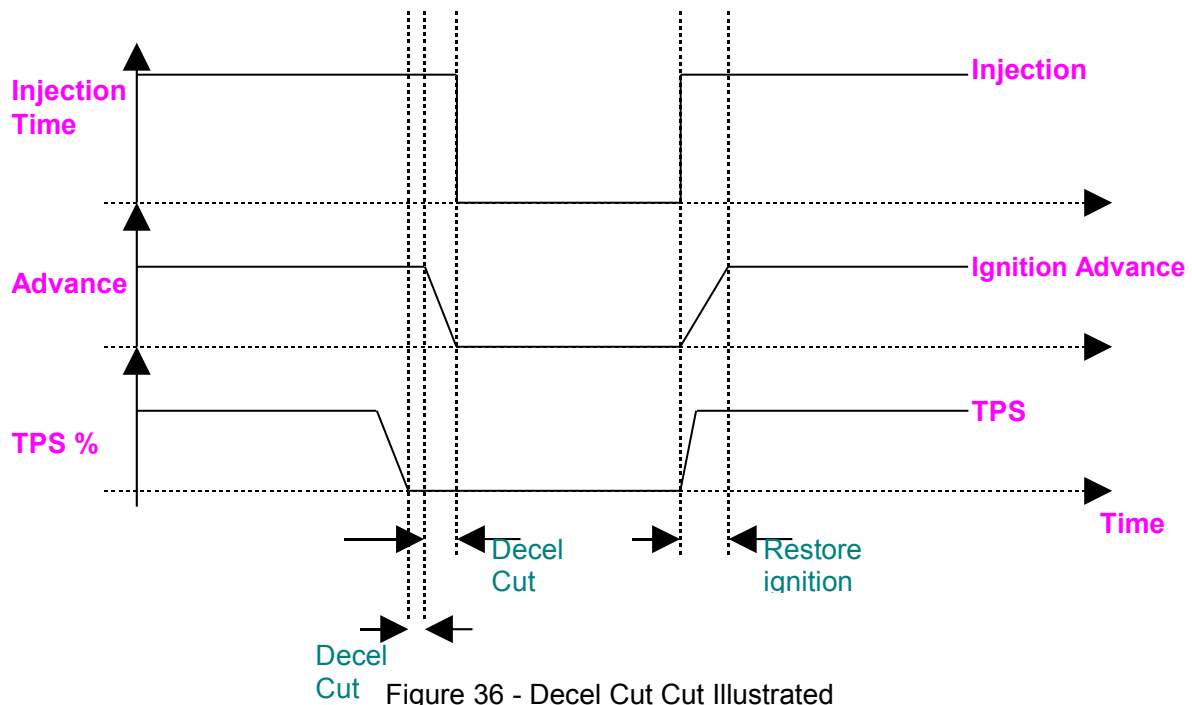
Deceleration cut is a feature that stops the fuel injectors from injecting fuel when the throttle position is zero and the engine speed is above the Decel Cut RPM. To ensure that the transition to fuel cut is smooth, the ignition timing is retarded slightly before the fuel is cut. Likewise, when the fuel is restored, the injectors resume normal injection and the ignition timing advances back to normal.

- **Decel Cut Enable** - This check box enables deceleration fuel cut. This feature is primarily used to save fuel when on a deceleration condition.
- **Decel Cut RPM** - Fuel is not cut when the engine speed falls below this RPM. Set this RPM to be above your idle RPM otherwise your engine will stall at idle.
- **Decel Cut Temp** - Fuel is not cut when the coolant temperature is below this temperature value. This is useful for cars with an idle up mechanism based on coolant temp that sets the idle speed above the RPM used for decel fuel cut. This is common in early EFI vehicles with 'wax pellet' style cold idle up.



- **Decel Cut Delay** - This is the time in seconds that the ECU will wait before starting the decel cut phase, after seeing a zero throttle condition. This delay stops any unwanted fuel cutting or ignition changes between gear changes or momentary zero throttle conditions.
- **Max Decel Cut Retard** - The amount of ignition retard used to smooth the transitions to fuel cut.
- **Decel Cut Enrich** - Upon restore of deceleration cut, the intake manifold walls will be completely dry. This enrichment factor will eliminate any lean conditions upon fuel being restored.

The following example assumes a constant load so that injection times and advance does not vary. Of course this is not realistic since load will change with movements in TPS. The example aims to simply demonstrate the timing interaction of fuel and ignition in the event of a deceleration cut condition.



### Maps Group

- **WOT Map Enrich** - Click on the check box to enable the use of the WOT map. When the throttle position exceeds the WOT value. When the WOT map is used and the WOT condition is met, the injection values are taken from this map and the base fuel map values are ignored.
- **Zero Throttle Map Enable** - Similar to the WOT map described above, but for a zero throttle condition. This can help some cars achieve a stable idle.
- **Fuel Map Select** - This selects which map to use. If an external input is used to select the map, then this setting is ignored.

### Throttle Pumps

Throttle pumps aid in improving engine response when the throttle on a conventional fuel injected vehicle is opened rapidly. The throttle pumps work by adding additional injection pulses (asynchronous enrichment) and enriching the current fuelling pulses (synchronous enrichment) when it sees a change in throttle position. The throttle pump setup allows the tuning of:

- \* How much enrichment is needed for a given **RPM, throttle position** and **TPS rate of change**.
- \* The biasing of the enrichment between asynchronous and synchronous types according to a given **RPM**.
- \* The speed at which the synchronous enrichment decays.

Note the rate of change of throttle position is how far the throttle moves over a 10ms time frame. A fast throttle movement could have a **TPS rate of change** of 15% this means that in a time frame of 10ms the throttle position moved 15%. A slow throttle movement could have a **TPS rate of change** of 1%, which means that in a time frame of 10ms the throttle position only moved 1%.

**Throttle Pump Setup**

**Throttle Pump Settings**

Max Asynchronous Pulses: 5 (0 - 10 Pulses)

Throttle Deadband: 0.5 (0.0 - 10.0 %)

Delay Between Enrich Events: 0.80 (0.00 - 2.00 sec)

Overall Trim: 100.0 (0.0 - 300.0 %)

**Engine Data**

Throttle Position: 0

TPS rate of change: 0

RPM: 0

Sync Enrichment: 0

Async Enrichment: 0

**Enrichment Sensitivity Map (ms)**

Throttle Position (%)

	0.0	10.0	25.0	50.0
1000 RPM	5.0	5.0	2.0	0.0
2000 RPM	5.0	5.0	2.0	0.0
3000 RPM	3.5	3.5	2.0	0.0
4000 RPM	2.0	2.0	2.0	0.0

☐ Edit Map Axes

**TPS Rate Of Change Sensitivity Map (%)**

TPS Rate of Change (%/10ms)

0.5	2.5	10.0	25.0
60.0	75.0	90.0	100.0

☐ Edit Map Axis

**Percentage Asynchronous Enrichment Map (%)**

RPM

1000	2000	3000	4000
75.0	50.0	40.0	30.0

☐ Edit Map Axis

**Synchronous Enrichment Decay Map (ms/engine cycle)**

Coolant Temp (deg C)

40.1	60.1	70.0	80.1
0.20	0.30	0.40	0.50

☐ Edit Map Axis

**Coolant Correction Map (%)**

Coolant Temp (deg C)

40.1	60.1	70.0	80.1
50.0	10.0	5.0	0.0

☐ Edit Map Axis

Apply OK Cancel

Figure 37 – Throttle Pump Setup Screen

## Throttle Pump Settings:

- Max Asynchronous Pulses** This is the maximum number of extra injector pulses that can happen per injector output during an enrichment event.  
**Range: 0 – 10 pulses.**  
**Default: 5.**
- Throttle Deadband** A rate of change of throttle position greater than this value will trigger an enrichment event.  
**Range: 0.0 – 10.0 %.**  
**Default: 0.5 %.**
- Delay Between Enrich Events** The minimum time between asynchronous enrichment events. This is to stop excess fuelling when constantly pumping the throttle.  
**Range: 0.00 – 2.00 sec.**  
**Default: 0.80 sec.**

- **Overall Trim** The trim value scales the fuel enrichment. 0% makes no changes to the fuel enrichment. 100% will add an extra 100% fuel to the enrichment.

**Range:** 0.0 – 300.0 %.

**Default:** 100.0 %.

### Throttle Pump Maps

#### Enrichment Sensitivity Map

This map allows for the tuning of the amount of enrichment needed according to a given **RPM** and **throttle position**. In general more enrichment is needed at a low **throttle position** because a change will cause a larger in rush of air than at a higher **throttle position**. At a low **RPM** more enrichment is needed because of low air speeds and the atomisation of fuel is poor. This becomes less of a problem as the engine goes up in **RPM** and airflow increases. The value in this map represents the enrichment needed at the maximum **TPS rate of change**. This map is the first to be tuned but also make sure that the right hand side of the **TPS Rate Of Change Sensitivity Map** equates to the maximum **TPS rate of change** achievable with a sensitivity value of 100%.

#### TPS Rate Of Change Sensitivity Map

With the **Enrichment Sensitivity Map** tuned for a maximum **TPS rate of change** slower throttle movements can be scaled accordingly with the **TPS Rate Of Change Sensitivity Map**. The right hand side of the map should contain the maximum **TPS Rate of change** in its axis value and 100% in its map value. For slower throttle movements (lower **TPS rate of change** values) a smaller percentage value can be put in the map.

#### Percentage Asynchronous Enrichment Map

This map determines what percentage of the fuel enrichment goes to the asynchronous type of enrichment. 0% in the map means that all of the fuel enrichment will be delivered synchronously (ie no additional fuel pulses will be added, the entire throttle pump enrichment will solely by extending the normal injection pulse). 100% in the maps means that all of the fuel enrichment will be delivered asynchronously (ie the normal injection pulse remains the same and all the enrichment fuel is added through extra pulses following the main injection pulse (these are called the asynchronous pulses)). Note that if the enrichment value exceeds 9.5ms (the maximum size of an asynchronous pulse) the rest will be delivered synchronously. In General at a low RPM, when the injection events are further apart, the asynchronous fuel enrichment helps deliver the extra fuel over a longer period. At a high RPM asynchronous enrichment is not needed because regular injection events are more frequent.

#### Synchronous Enrichment Decay Map

This map determines how fast the synchronous enrichment (ie the enrichment added by extending the normal injection pulse) decays back to zero (no additional enrichment). The units entered in are milliseconds per engine cycle. E.g. a value of 0.5 will mean that the enrichment will decay 0.5ms every engine cycle. The bigger the value the faster it will decay.

#### Coolant Correction Map

This map applies a correction factor to the fuel enrichment based on the coolant temperature. E.g. 100% gives 100% extra fuel enrichment.

### Shortcut Keys For Mini Maps

- **Page Up** Increments map value.
- **Page Down** Decrements map value.
- **L** Used to linearise between two points.
- **V** Used to change the value in a cell or multiple selected cells.

Other : **Ctrl T** Opens throttle pump setup page without having to open fuel setup.

**Throttle Pump Map Enable** - Click on this check box to enable throttle pumps enrichment.

- **Injectors Enable** - Click on this check box to enable the injectors. This feature is often used when setting up ignition timing.
- **Injector Current Setup** – Haltech ECUs have intelligent injector control circuitry that allows for many different makes and models of injectors to be run without the need for resistor packs. For this circuitry to control each injector correctly the ECU must have the injector current control programmed by the user for the injectors being used. To determine how much current each injector requires it is very simple. Current can be calculated using Ohms Law ( $V = I / R$ ), in an automotive electrical system the supply voltage is assumed at 12V. Using Ohms law R is simply the resistance of the injector. So to determine the peak current required for an injector simply take 12 divide by Injector Resistance (measure injector resistance between the two electrical connectors on the injector). For example, an injector with 4 Ohm resistance has a peak injector current draw of  $12 / 4 = 3$  Amps

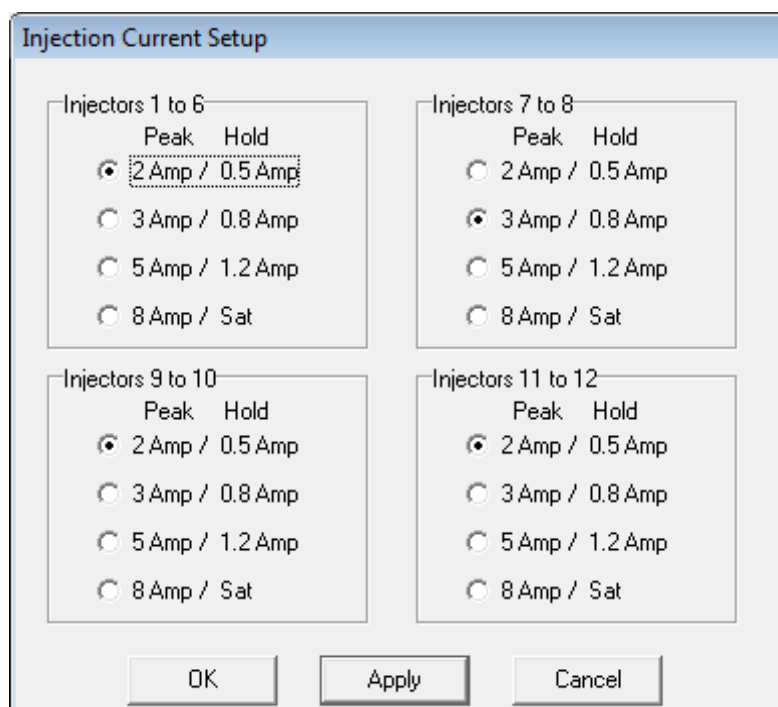


Figure 38 – Injector Current Control Setup Screen

- **Injection Mode** - Choose the mode of injection to run for your engine.
  - **Sequential mode** - Is the preferred mode wherever possible, which fires each injector individually in reference to the intake valve opening time, a crankshaft reference signal is required. Injection timing is tuned using the end of injection map found in the fuel maps menu.
  - **Semi-Sequential** - fires half the required fuel on the intake stroke and the remaining half on the opposing half of the stroke. This is the preferred mode when only a crank signal reference is available (ie no camshaft signal is required).
  - **Batch mode** - Injection fires the injectors in two even groups. This is aimed at reducing fuel rail pressure fluctuations. This mode of injection does not require any home (camshaft) signal to operate. The angle of injection is not defined, and the injection angle map is not used. The frequency of injection is defined by the Ignition Divide By parameter. Batch mode is not to be used on engines with odd numbers of cylinders or 6 cylinder engines. Ignition divide by should be set to number of cylinders / 4.

- **Multipoint mode** - Injection is the most basic form of injection that fires all injectors simultaneously. This mode of injection does not require any home or reference signal to operate. The angle of injection is not defined, and the injection angle map is not used. The frequency of injection is defined by the Ignition Divide By parameter.

#### For Piston Engines

Trigger	Injection Mode
Standard Trigger Full Cycle, with home on the CAM 24 +1 Multi-Tooth trigger (Honda, Toyota) Nissan Trigger Motronic with home signal on the CAM Subaru Subaru MY01	Sequential
Standard Trigger Full Cycle, with home on the CAM Standard Trigger Half Cycle, with home on the crank 24 +1 Multi-Tooth trigger (Honda, Toyota) Nissan Trigger Motronic Subaru Subaru MY01	Semi-Sequential
Standard Trigger 24 +1 Multi-Tooth trigger (Honda, Toyota) Nissan Trigger Subaru Subaru MY01	Batch
All triggers	Multipoint

#### For Rotary Engines

Trigger	Injection Mode
Standard Trigger with crank home 24 +2 Multi-Tooth trigger	Sequential
Standard Trigger with no home	Multipoint

- **Ignition Divide By** - This parameter is only used in batch and multipoint injection modes. The value of ignition divide by will determine the number of injections per engine cycle. E.g. If the engine is a 4 stroke 4 cylinder, then an ignition divide by of 2 will enable 1 injection for every 2 ignition events. This is the equivalent of one injection per crank rev. If you are unsure what to set this to, then leave the value set to the default of half the number of cylinders.

The following table is a recommended setting for Ignition Divide By values for various fuel injection modes and typical piston engines.

Number of Cylinders	Mode of Injection	Ignition Divide By	Injections per rev (per cylinder)
4	Multipoint	2	1
6	Multipoint	3	1
8	Multipoint	4	1
4	Batch	1	1
6	Batch	NA	NA*
8	Batch	2	1

\*Note: 6 cylinder batch injection is not suggested.

- **Fuel Scale factor** - The Fuel Scale Factor is the overall scaling factor for the fuel injection times. The allowable range is from 0% to 220%. A value of 100 is typical.
- **Injection Angle** - When sequential or semi-sequential injection is selected, the angle of injection with respect to the combustion process can be programmed (fuel correction maps - end of injection map). The angle in the maps can be used to determine when the start angle of an injection pulse, or the angle at which the injection pulse will finish. By default, leave this set to End of Injection.
- **Staged Injection Setup** - See section Staged Injection for more details on how to setup staged injection.
- **Injector Trims** - Injector trims allows you to adjust the fuel delivery between each individual injector to account for any minor differences between injectors or fuel rail design. The trims allow a maximum of  $\pm 12.5\%$  of injection time.
- **Closed Loop Oxygen Sensor** - Closed loop O2 control is used to improve economy, reduce emissions and assist catalytic converter operation if your vehicle has one fitted. See section in the tuning guide for more information on tuning the O2 parameters.

### Over Boost Cut Out

- **Enable** - Click on this check box to enable over boost cut off. This is only applicable to forced induction vehicles.
- **Over Boost Cut** - Fuel is cut when this boost pressure is reached.
- **Over Boost Restore** - Fuel is restored when the boost level falls back to this safe level. This value must be set to the less than the Over Boost Cut value.

### Fuel Pump Settings

- **Invert Fuel Pump Output** - Click on this check box to invert the output of the fuel pump control wire, when this option is selected the fuel pump control output will be at ground when the pump is not running and open circuit to run the pump. Rarely is this setting used.
- **Fuel Pump Prime** - Sets the time period the fuel pump primes for when the ignition first switched to the on position.

## Sensor Setup

The Haltech Halwin software allows the user to calibrate sensor inputs to their own calibration, this is useful when using a vehicles OEM sensors or when haltech sensors cannot be used for some other reason.

### Calibrating The Throttle

The throttle sensor must be calibrated so that the ECU knows the start and stop positions of the sensor. Always calibrate the throttle even if a map is supplied as the throttle calibration can vary between even identical models of cars.

Before you begin, ensure that the closed throttle position is in a position that you wish to leave it in. If you change the closed throttle position, re-calibrate your throttle. Usually, the throttle is set to ensure a slow idle when the throttle is closed. If the required opening for idle is not known, make an estimate but keep in mind that this may be the reason for poor idle later on, and further adjustment may be needed. Choose the "calibrate throttle" option from the options menu and follow the instructions on the screen.

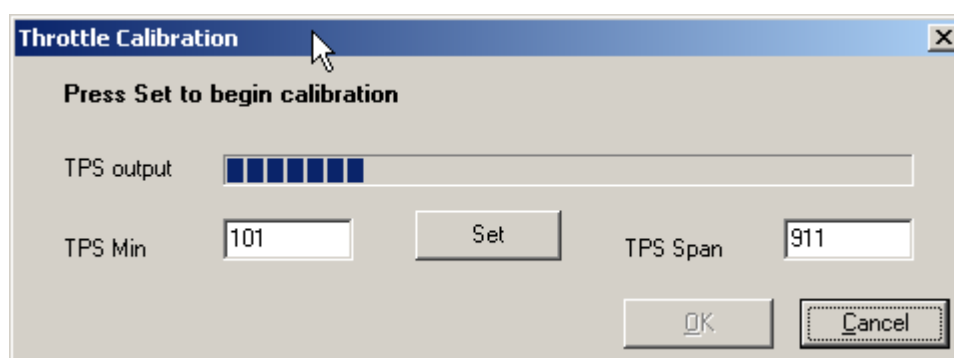


Figure 39 - Throttle Position Sensor Calibration

The calibration process begins by pressing the Set button as shown in Figure 39 above.

The dialog will ask you to set the minimum throttle opening. It is a good idea to give the throttle a quick press to see if it returns to the same position consistently without sticking. After you are happy that the throttle is returning consistently to the same zero position, press the Set button once more.

The dialog will then ask you to hold the throttle at full throttle. Whilst holding the throttle all the way down, press the Set button again on the dialog.

If the calibration process was smooth, commit the new calibration to the ECU by pressing the OK button.

### Sensor Filtering

Allows for the TPS and MAP sensor inputs to be filtered. This can help on applications where there is severe noise in the electrical system causing the TPS or MAP sensor to become unstable. If this occurs throttle pumps can be falsely triggered causing the engine to run poorly.

The lower the number in the filter level the less filtering that is applied, the higher the number the more filtering applied.

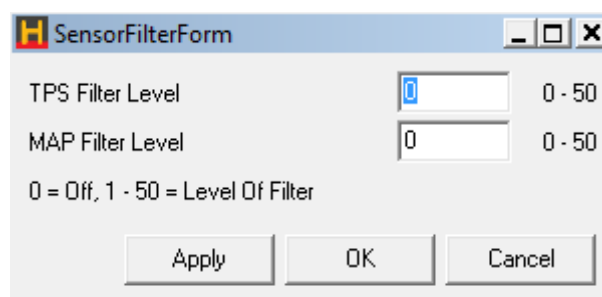


Figure 40 - Sensor Input Filtering

### Program Setup

Program Setup allows the Halwin software to be customised for your preferences. No settings in this dialog affect the operation of the vehicle. Currently, program setup allows the selection of which serial communications port to use and for selection of Imperial and Metric units.

### Configuration Text

The tuning of a map is dependent upon many factors that are outside the control of the ECU. In order to ensure that the map will suit a certain vehicle, these items must be checked manually. To assist in keeping track of the conditions under which the map was tuned, the Configuration Text allows some description of the engine and vehicle.

The text that is entered in this dialog is entirely optional, but it is highly recommended that this text be filled out as completely as possible to assist yourself and others when the map is next opened.

Parameter	Value
Engine Make	Make
Engine Code	Model
Cam Size	Standard
Fuel Pressure	Standard
Compression Ratio	Standard
Injector Size	Standard
Turbo Size/Info	n/a
Turbo Boost level	n/a
Fuel Type	PULP
Intercooler size	n/a
Exhaust size	Standard
Comments	Base Map Only - Please check ignition timing before use. Please adjust maps before applying load to engine.

Figure 41 - Engine Configuration Text Page



### Options Menu

#### Firmware Update

This option should not be used unless you are instructed to update your firmware to fix a problem, or you have purchased an upgrade that required firmware to be updated. Under no circumstances should firmware be updated to a more recent firmware just for the sake of using the latest firmware.

**Warning:** Before updating firmware, ensure that the ECU is turned on, but the engine is not running. The outputs from the ECU should change to a non-connected safe state, however, it is good practice to unplug the 34 pin connector on your ECU before beginning a firmware update operation.

#### Updating your ECU's firmware

Turn on your ECU, but do not start your engine. Start your laptop with Halwin software and go online. Check your firmware version and note the version information.

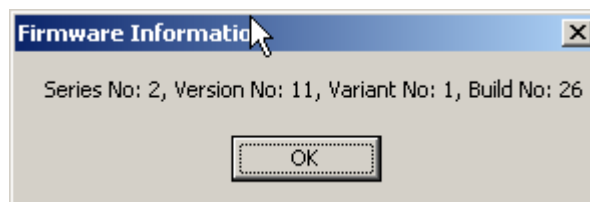


Figure 42 - Firmware Version Information

Before going any further, save the map that is currently in the ECU, this map will later be re-loaded into the ECU after the update is complete.

Select the Firmware Update option. After you have selected the Firmware Update option, you will be presented with the following dialog window:

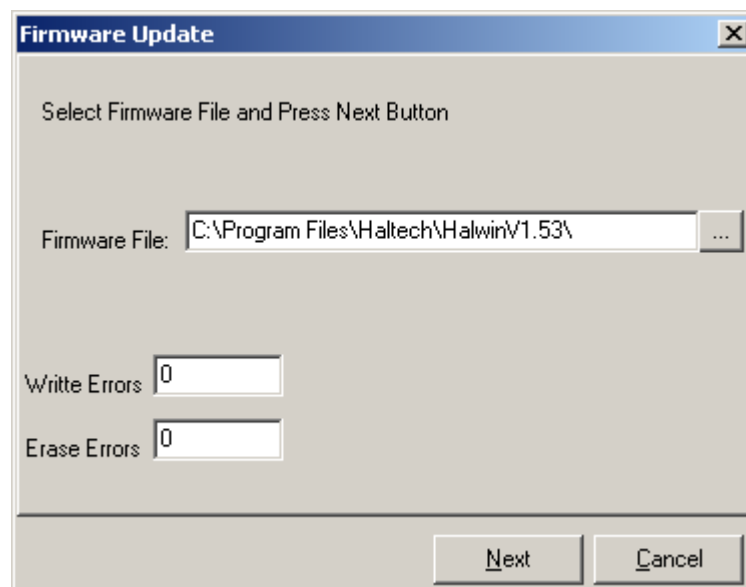


Figure 43 - Firmware Update

Click on the button to the right of the filename to select the binary firmware file (this file will have a .bin file extension) that you will use to update your ECU.

Make sure that your engine is not running. After the correct file appears in the 'Firmware File' field, press the Next button. The ECU will reboot before Halwin begins to write to the ECU. As the firmware is being written, a status message will inform you of what percentage of firmware writing is complete.

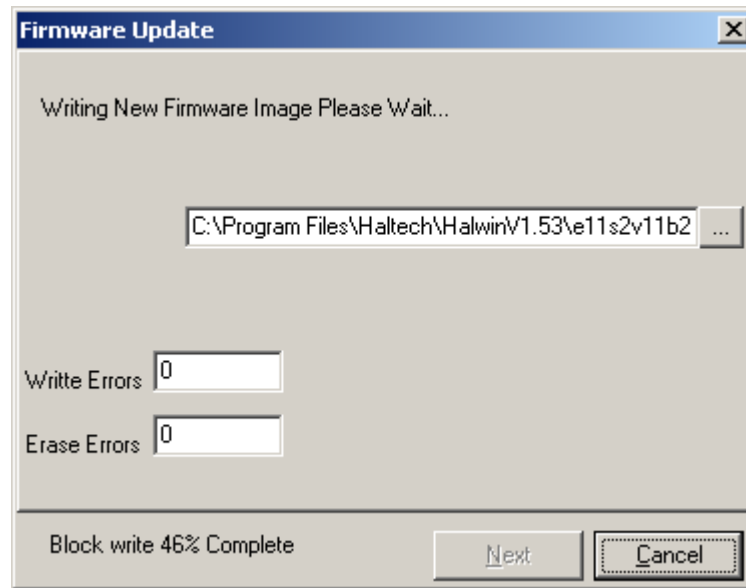


Figure 44 - Firmware Update 46% Complete

When the status reaches, 100% wait for the dialog to present an OK button. Press OK to complete the firmware update. You should now reset your ECU by turning the ignition off then back on. The new firmware should now be loaded into the ECU. The process is not yet finished.

Check your firmware information again to ensure that the firmware has indeed been updated to the correct version.

In most circumstances where the firmware is updated the software should also be updated (see Installing Halwin guide earlier in this chapter for more information on installing Halwin). It is essential that the firmware being used is being used with the software it was designed for.

Once the firmware has been updated within the ECU and the new version of Halwin loaded onto the laptop used for tuning the default map from the new software must be loaded into the ECU. This step enables the new features that the firmware update contains.

Once the default map from the new version of Halwin has been loaded the map that was originally in the ECU (this is the map that was saved at the beginning of the firmware update procedure) can be loaded back into the ECU. A quick summary of this procedure is as follows:

1. Save the current map in the ECU with previous version of Halwin.
2. Install the new version of software Halwin (e.g. Halwin\_1.89).
3. Disconnect the 34pin connector of the ECU, or disconnect the ignition modules.
4. Open the new version of Halwin (e.g. Halwin\_1.89).
5. Load in the new firmware (E11s2v11B35\_H185.BIN).
6. Load in the new default map (default.map).
7. (Located at C:\Program files\Haltech\HalwinV1.89\default.map) (use "default\_e8.map for E8 ECU's)
8. Now load in your previously saved map, from the older version of Halwin into the ECU.

If the firmware update fails, cancel the current firmware update. After cancelling successfully, shut down the Halwin software and turn off your ECU.

Turn on the ECU, restart the Halwin software and go online. The ECU is now in "boot-mode", while in this mode it will not run the engine. To get out of boot-mode attempt to update the firmware once again.

If the firmware update continues to fail please contact your Haltech dealer.

### Firmware Version Information

In order to assist in supporting our product, the firmware information may be necessary in order to diagnose any support issues that may arise. In addition to this purpose, the firmware information is also a useful way to verify that a firmware update operation has been successfully performed.

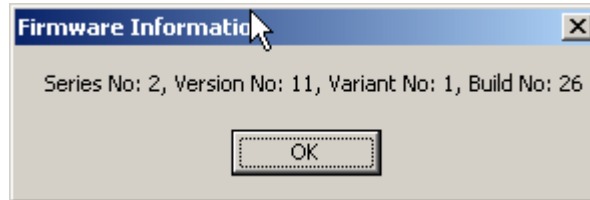


Figure 45 - Firmware Version Information

The convention for version numbers is as follows:

**Series Number** - This number will be incremented when a significant change to the product is made. Any changes to the map structure or format will result in a new series of firmware.

**Version Number** - This number will be incremented when a new feature is added or improvement is made to the firmware.

**Variant Number** - The variant number is used to distinguish mainstream firmware from specialised firmware used for special applications. Variant 1 is the normal variant number for general release firmware. Factory boot mode firmware has the variant number of zero.

**Build Number** - This number is incremented whenever a version of firmware is released. An increase in build number indicates a bug fix or minor revision to the operation of the ECU.

### Stepper Motor Control

- **Idle Control** - This section refers only to 4 wire stepper motor idle control. For this method of idle control the 2 wires labelled IDLE 1 – IDLE 4 are to be used. These wires can only be used to control a 4 wire stepper motor style idle speed controller. An idle speed controller with only 2 or 3 wires is a solenoid valve and programmed as a BAC (bypass air control) valve using PWM signals, this method of idle control is described in the Auxiliary Output Setup section. Refer to the tuning guide section for a description of how to program both types of idle speed controller.
- **Oil Metering Pump Control** - Some rotary engines have an oil pump for lubrication that can be controlled electronically to vary the amount of oil injected into the engine. If your rotary engine has this feature, enable this option. The Feedback Min and Feedback Max values should not need to change from the factory calibrated values. Setup an 'Analog Input' and connect the feedback from the oil metering pump controller to this input. See analog inputs section for details on setting up analogue inputs.  
Check the Oil Metering Pump map in the maps menu. The preset factory map will be adequate for most vehicles.

## Auxiliary Output Options

The Auxiliary output options page allows all spare ignition or injection outputs that are not used for ignition or injection duties, to be configured for auxiliary devices such as tachometer output signals and turbo wastegate solenoids. If the output is used by an ignition or fuel channel, then any auxiliary function configured for that channel will be ignored.

In addition to the ignition and injection outputs, there are 4 dedicated PWM channels that can produce PWM signals (pulsed width modulated wave forms) for BAC valves or switched style discrete outputs for thermo fans and on/off type devices. Engine control outputs such as Ignition and Injection always take precedence over auxiliary type outputs. All outputs are “pull to ground” style outputs which means when the output is in the “on” state it is grounded. Each output driver is capable of sinking a maximum of 900mA, anything drawing more current than this will need to be coupled to the ECU via a relay.

Channel	Enable	Function	Edit
Ignition1	<input checked="" type="checkbox"/>	NotUsed	Yes
Injection1	<input checked="" type="checkbox"/>	NotUsed	Yes
PWM Output 1	<input checked="" type="checkbox"/>	Tacho	Yes
Ignition2	<input checked="" type="checkbox"/>	NotUsed	Yes
Injection2	<input checked="" type="checkbox"/>	NotUsed	Yes
PWM Output 2	<input checked="" type="checkbox"/>	Thermo Fan	Yes
Ignition3	<input checked="" type="checkbox"/>	NotUsed	Yes
Injection3	<input checked="" type="checkbox"/>	NotUsed	Yes
PWM Output 3	<input checked="" type="checkbox"/>	BAC Valve	Yes
Ignition4	<input checked="" type="checkbox"/>	NotUsed	Yes
Injection4	<input checked="" type="checkbox"/>	NotUsed	Yes
PWM Output 4	<input checked="" type="checkbox"/>	Closed Loop Boost Control	Yes
Ignition5/Injection8	<input checked="" type="checkbox"/>	NotUsed	Yes
Injection5	<input checked="" type="checkbox"/>	NotUsed	Yes
Auxiliary 1	<input type="checkbox"/>	NotUsed	Yes
Ignition6/Injection7	<input checked="" type="checkbox"/>	NotUsed	Yes
Injection6	<input checked="" type="checkbox"/>	NotUsed	Yes
Auxiliary 2	<input type="checkbox"/>	NotUsed	Yes

Buttons: Apply, OK, Cancel

Figure 46 - Auxiliary Output Options Page

## PWM Output Types

PWM outputs are pulsed waveforms or varying duty and frequency. These are available on all channels, each output is capable of driving a maximum of 800mA, if more output current is required to drive the device connected to that output a relay is required.

All channels can be setup and disabled whilst keeping the setup information if required. In order to setup a channel, you must first enable that channel. After selecting a function for the channel, you may need to edit the parameters for the selected function. Edit these parameters by clicking on the Edit button. The

Edit panel contains the parameters required to be setup for each output function. Included in every set of parameters is the ability to invert the output of the signal. Inverting the output signal does not allow the output to drive a +12V signal, the output from the driver will still be a ground output when switched on – inverting the output swaps the “off” and “on” signals – so what would be “on” in normal mode is “off” in inverted mode.

### Discrete Output Types

These output types are on/off style outputs. These types are available on all channels, each output is capable of driving a maximum of 800mA, if more output current is required to drive the device connected to that output a relay is required.

### Air-Conditioning Control

The air conditioning control can perform two tasks.

Air conditioning control can be used to assist in turning off the air con compressor when under high loads. This allows more power to be used to drive the wheels.

The air con control output can also be used to trigger increased idle speed to accommodate the extra load from the air-con compressor.

The air-conditioning control requires input from either the air conditioning switch, or from the output of the thermostat that drives the air conditioner compressor clutch.

If this output is used for task 1 only, then it is possible to intercept the output from the switch and connect the output of the ECU to the air-con switch wire.

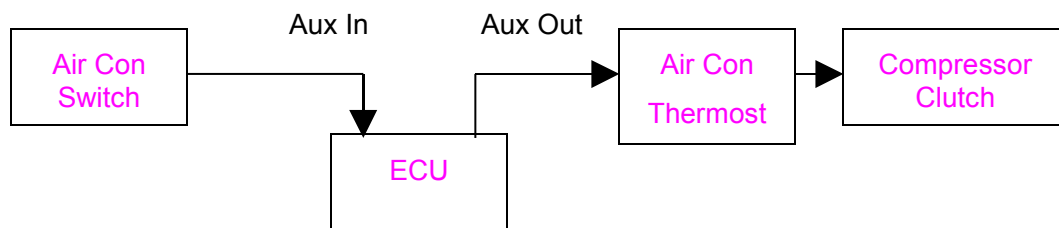


Figure 47 - AC Control Wiring Without Idle-up

If the idle control needs to be altered when the air-con compressor clutch is engaged, then the ECU must be connected between the air-con thermostat output and the compressor clutch to ensure that the output of the ECU has a direct relationship with the compressor clutch.

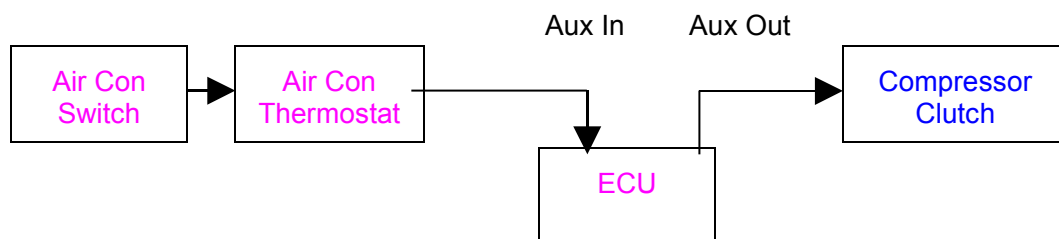


Figure 48 - AC Control Wiring With Idle-up

The A/C output control is disabled when engine speed is below the cranking RPM. This is to reduce the load when cranking and to help prevent stalling if engine RPM falls too low.

- **TPS Threshold** - AC output is disabled when TPS is above this value. This removes the air conditioning compressor load from the engine under high driver demand.

- **RPM Threshold** - A/C output is disabled when the engine speed exceeds this RPM. This is to prevent over revving the air con compressor on some high performance engines.
- **Time Interval (s)** - In order to prevent the A/C compressor from making rapid transitions with rapid changes in throttle, the minimum time interval between on and off transitions can be specified here.

See the Digital Inputs section for information on how to setup the input required for Air Conditioning control to function.

### Alternator Control (Mazda)

Some Mazda alternators require a PWM actuated signal to maintain a steady output voltage. This feature allows the ECU to control the PWM output to achieve the desired alternator output voltage

Actual alternator control values from a NB Mazda Miata MX5:

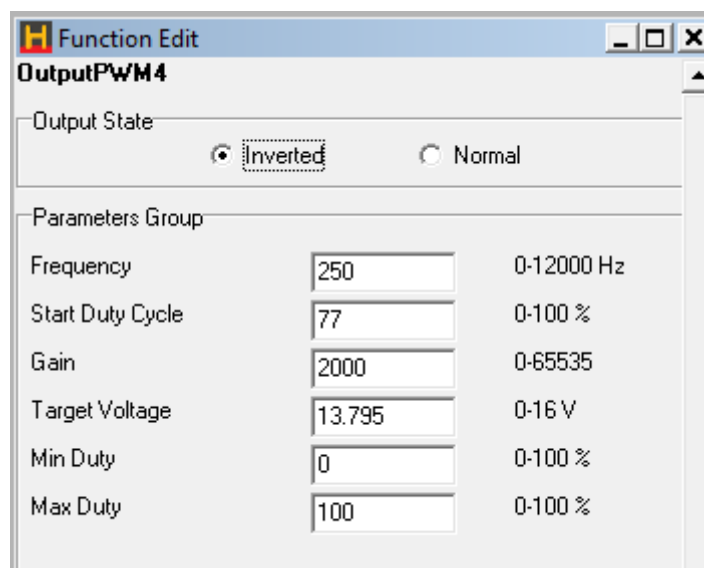


Figure 49

- **Frequency** – The frequency required to control the given alternator.
- **Start Duty Cycle** – This duty cycle will be run when the engine is cranking, this is also the duty cycle that the controller starts the control process at.
- **Gain** – Controls the sensitivity of the control system, the larger the gain the larger the change in duty when there is an error between the actual battery voltage and the desired battery voltage.
- **Target Voltage** – Sets the target output voltage of the system.
- **Min Duty** – The minimum duty cycle the control system will output.
- **Max Duty** - The minimum duty cycle the control system will output.

### Aux Fuel Pump

Running two fuel pumps continuously, or a single very large flow-rate pump means excessive noise and heating of the fuel. A street vehicle with very high potential output will not need a large fuel supply at all times. The second pump would only be activated when load demands require that the extra flow be available.

**Note:** The extra fuel pump cannot be driven directly by the ECU. The ECU can be made to drive a relay to power the pump.

The extra pump must be connected in parallel with the primary fuel pump. The Figure below suggests a possible layout. The check valve is necessary to prevent fuel from being forced in the wrong direction. Connect the power to the pump via a relay as shown. Either the positive or negative side may be switched through the relay.

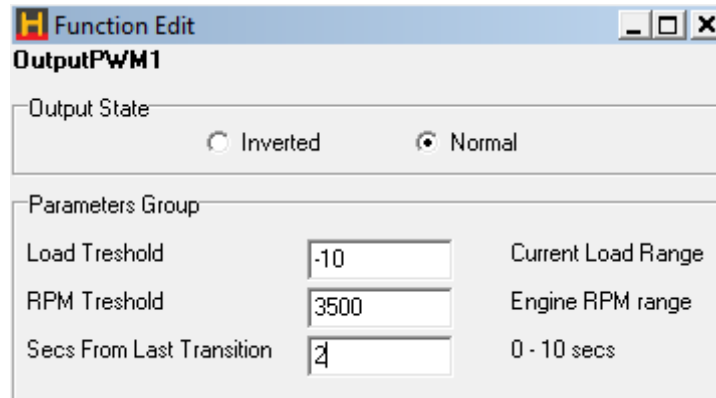


Figure 50

There are two parameters that define when the Auxiliary Pump will be switched on:

- **Load Threshold** - The load at which the pump will switch on.
- **RPM Threshold** - The RPM at which the pump will switch on.
- **Time** - The minimum time between successive on or off transitions.

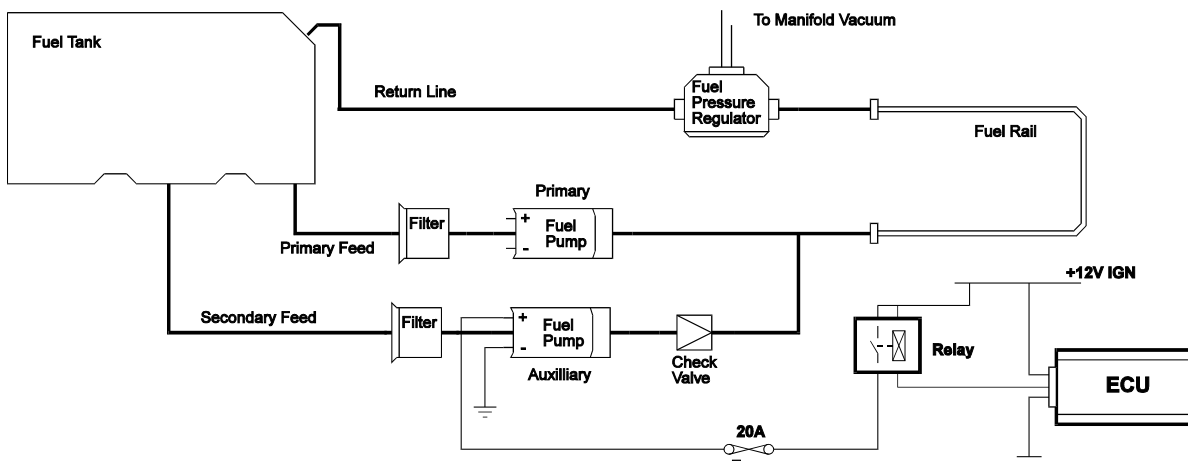


Figure 51

**BAC Idle Control** - BAC idle control uses a valve to allow air to bypass the throttle plate to control idle speed. The motor used is a solenoid style motor that moves according to the current flowing through the BAC motor. This is similar to a voice coil in an audio speaker. BAC valve idle control is used to hold steady the RPM when off the throttle. This method of controlling RPM at idle is done by looking at the difference between the target idle RPM and the current RPM and adjusting the BAC valve's output duty cycle until the difference is zero.

See tuning section for setting up and tuning the BAC valve idle control.

**BAC Hi** - BAC high is a form of BAC idle control that is used for 3-wire BAC valves with two coils. These valves are sprung so that when no coils are energised, the BAC valve sits at 50% open. Two PWM signals are used to move the coils. One signal moves the valve from 0% to 50% open, while the other signal moves the valve from 50% to 100% open. The BAC Hi output moves the valve from 50% to 100%. When the target position for the valve is between 50% and 100%, this output will provide a signal from 0% to 100% duty. All idle control tuning and setup is done with the BAC Hi output. Refer to tuning section below for details on how to tune your idle control.

**BAC Low** - The BAC low output is used to control the BAC valve when the target opening is 0% to 50% open. When the valve target position is 0%, the output duty is 100%. When the target is 50% open, the output duty is zero to allow the spring to return the valve to its default position.

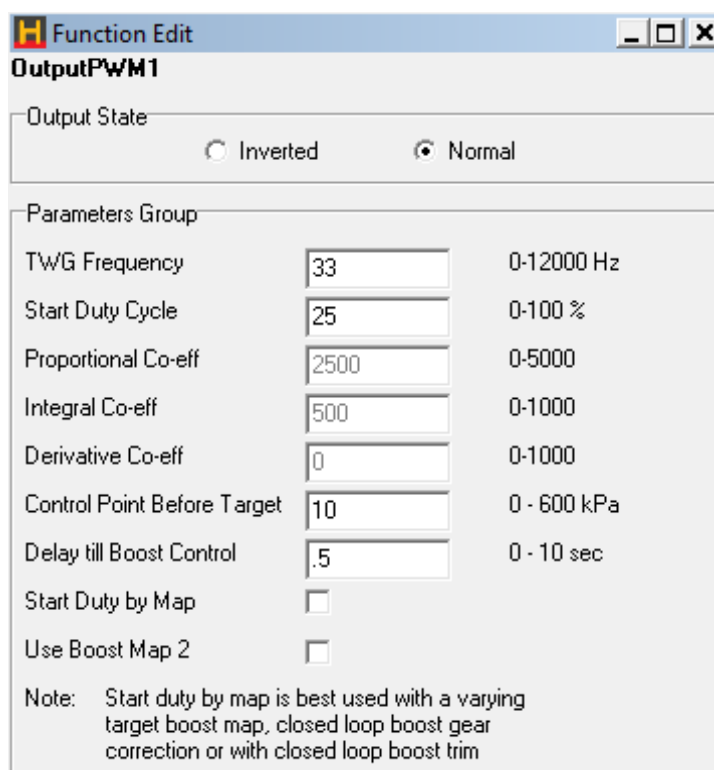
**BAC Inverted** - For 3-wire BAC valves that do not have a spring to return the valve to the centre position, use BAC and BAC Inverted to control the valve. Connect the BAC output to the coil that pulls the BAC valve open. Connect the BAC Inverted output to the coil that pulls the BAC valve closed. The BAC Inverted signal is a complementary signal to the BAC signal. If the BAC output is set to 70% duty, then the BAC Inverted signal is set to 30% duty. All idle control tuning and setup is done with the BAC output. Refer to tuning section for details on how to tune your idle control.

### Battery Light

This feature allows a warning light to be connected to alarm the vehicle operator that the vehicle battery voltage is below a certain voltage. The prescribed warning voltage level can be set in the edit menu of the battery light setup.

### Boost Control Closed Loop

Closed loop boost control allows the user to set a predefined boost level in the “closed loop boost control” map. The ECU will then adjust the control duty cycle of the boost control solenoid to adjust the actual boost level until the actual boost level equals the desired boost level.



The screenshot shows a software window titled "Function Edit" with a sub-header "OutputPWM1". Below this, there is a section for "Output State" with two radio buttons: "Inverted" (unselected) and "Normal" (selected). A "Parameters Group" section follows, containing several input fields and their corresponding ranges:

Parameter	Value	Range
TWG Frequency	33	0-12000 Hz
Start Duty Cycle	25	0-100 %
Proportional Co-eff	2500	0-5000
Integral Co-eff	500	0-1000
Derivative Co-eff	0	0-1000
Control Point Before Target	10	0 - 600 kPa
Delay till Boost Control	.5	0 - 10 sec
Start Duty by Map	<input type="checkbox"/>	
Use Boost Map 2	<input type="checkbox"/>	

At the bottom, a note states: "Note: Start duty by map is best used with a varying target boost map, closed loop boost gear correction or with closed loop boost trim".

Figure 52

Refer to section tuning for details on how to setup and tune closed loop boost control.



### Boost Control Open Loop

Open loop boost control allows the user to set a predefined duty cycle for the boost control solenoid to run at, this duty cycle is set in the “wastegate control map”. The ECU will run the boost control solenoid at the desired duty cycle regardless of the actual boost the engine is creating.

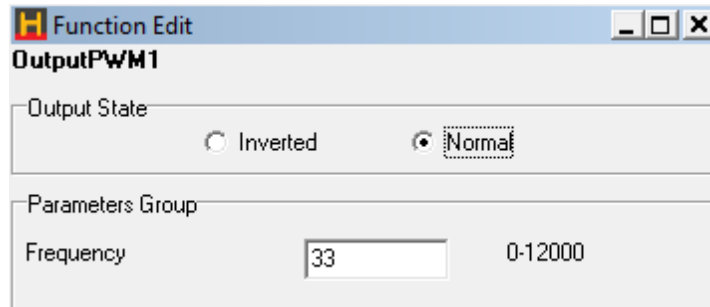


Figure 53

Refer to tuning section for details on how to setup and tune open loop boost control.

### Dual Intake Valve Control

Some late model engines possess two tuned intake manifolds separated by a set of butterfly valves. One intake tract remains shut at lower rpm where there is less airflow, then opens as airflow demands increase. This provides a broader torque curve. The DIV function controls the solenoid that operates this valve.

- **On RPM** - The RPM above which the solenoid is energised.
- **Off RPM** - The RPM below which the solenoid is not energised.

The Toyota TVIS system requires the solenoid to be energised at low RPM to close the secondary intakes and de-energised to open the secondary intakes. To achieve this logic, select the output to be inverted within the output options window.

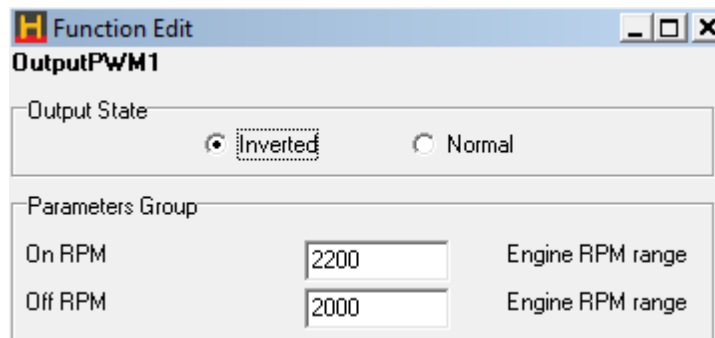


Figure 54

### ECU Diagnostics Light

This feature allows a warning light to be illuminated when certain sensor conditions are met. This output is useful for determining if a sensor has failed or been disconnected, it is also useful for setting a warning light if engine temperature goes above safe levels. To access the diagnostics limits for each sensor go to the setup menu -> sensor setup -> sensor diagnostics.

### Engine Control Relay

This feature allows the 12-volt supply to the engine to be disconnected when the ECU is not powered up. There are no parameters for this feature. The engine control relay should be wired as shown in the figure below. The ECU is not capable of supplying power to the relay or the components it drives but can sink the current required to energise the primary winding of the relay (ie the ECU is only capable of switching

the relay on not powering the engine or its components).

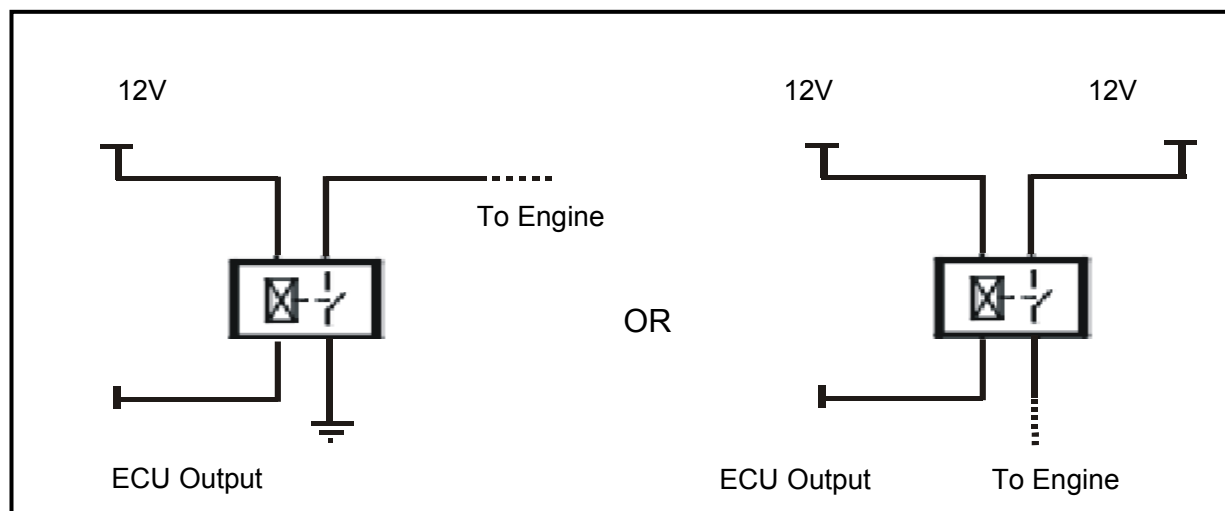


Figure 55 - Engine Control Relay Wiring

### Extra Injector

Select extra injector output for additional staged injection. You can select as many extra injectors as the number of free timed channels allows. The additional injector will pulse at the same time as injector 1. The injection mode is defined by the staged injection setup found in the fuel setup page. See section fuel setup page.

### Generic Switching Outputs

The generic switch outputs can be used to drive a relay, device or warning light for any application based on a generic ECU input. All generic switch outputs are simply on/off switches with the exception of the generic load PWM map, this output is a fully mappable 32x32 load RPM map.

**The generic switch options are as follows:**

**Generic Air Temperature Switch** – Allows the output to be switched on and off again at the users desired air temperatures as measured by the air temperature sensor.

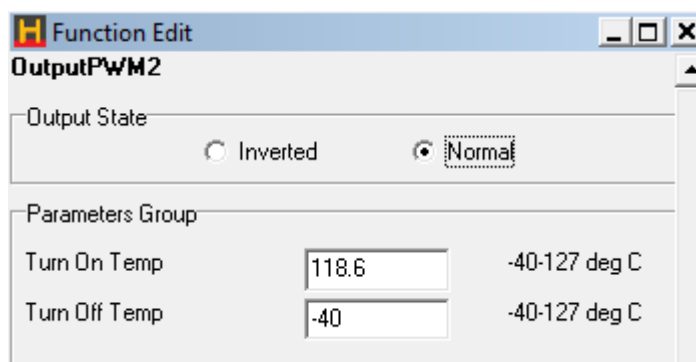


Figure 56 - Generic Air Temp Switch

**Generic Coolant Temperature Switch** - Allows the output to be switched on and off again at the users desired coolant temperatures as measured by the coolant temperature sensor.

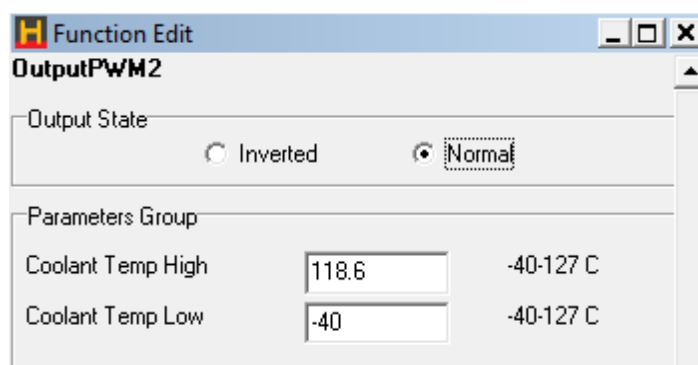


Figure 57 - Generic Coolant Temp Switch

**Generic Engine Time Switch** – Allows the output to be switched on after a prescribed period of time after the engine has started.

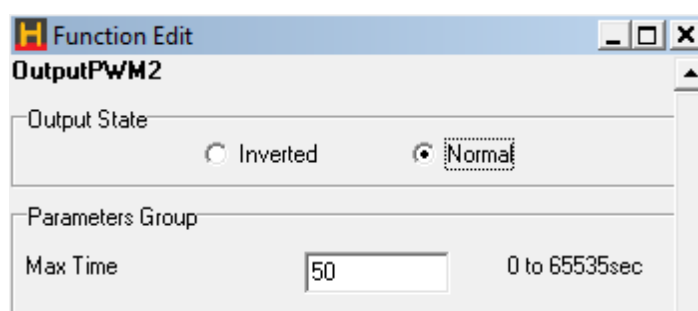


Figure 58 - Generic Engine Time Switch

**Generic Load Switch** – Allows the output to be switched on and off again at prescribed engine load, as measured by the engines load sensor (MAP sensor or TPS).

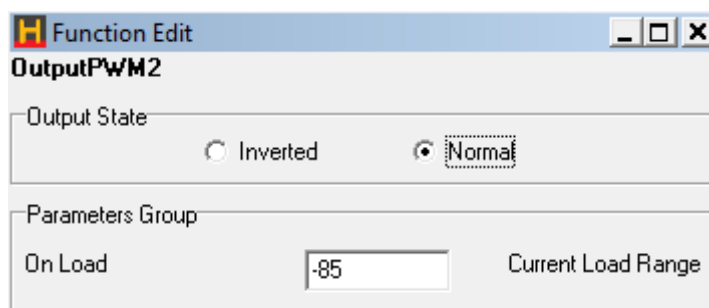


Figure 59 - Generic Load Switch

**Generic Load PWM Map** – Allows various duty cycles to be output based on the engine load and RPM, this map is a full 32x32 load cell map and can be found in the “maps” menu. The frequency set in the PWM output is the frequency at which the solenoid is to be pulsed at, typically between 30 – 300 hz depending on application.

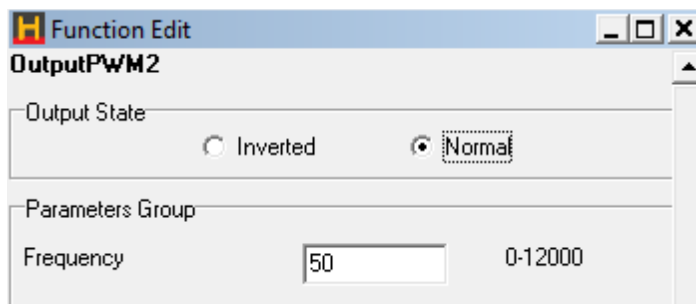


Figure 60 - Generic Load PWM Map Output

**Generic Road Speed Switch** - The output to be switched on once the programmed road speed has been reached and remain on until the vehicle drops below the programmed road speed.

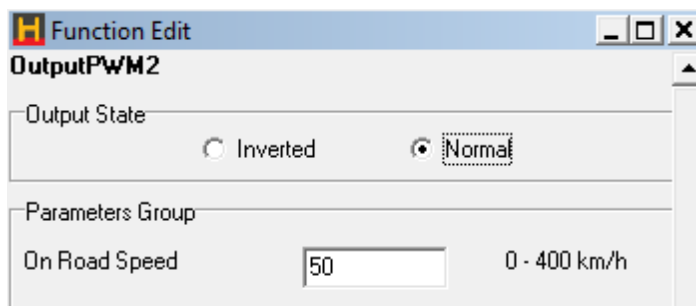


Figure 61 - Generic Road Speed Switch

**Generic RPM Switch** – Output is switched only once the programmed engine RPM is reached and remains on until the engine RPM drops below the programmed engine RPM..

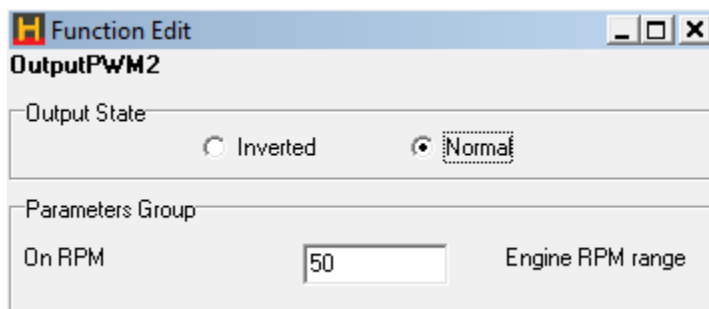


Figure 62 - Generic RPM Switch

**Generic TPS Switch** - Output is switched on after the programmed throttle position has been reached and remains on until the throttle position returns to a value below the programmed value.

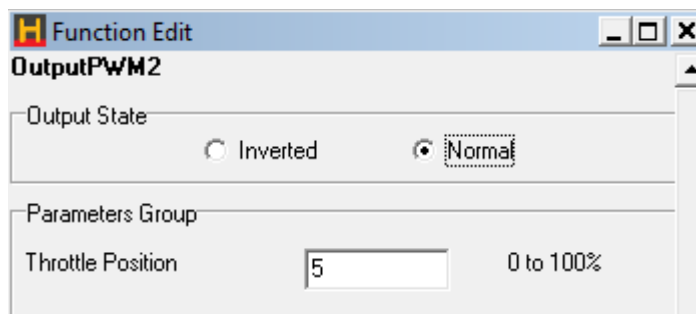


Figure 63 - Generic TPS Switch

## Ignition Bypass

Bypass signal compatible with some General Motors ignition systems. This function allows the ignition system to provide the spark at 10° BTDC at cranking speeds (below 500rpm). This aids starting, once the engine is running the bypass signal allows the ECU to have full timing control. This feature is only used on bypass line equipt GM ignition systems.

## Intercooler Fan

To assist in the operation of the intercooler, a fan can be setup to blow cool air through the intercooler. The intake air temperature activates this fan.

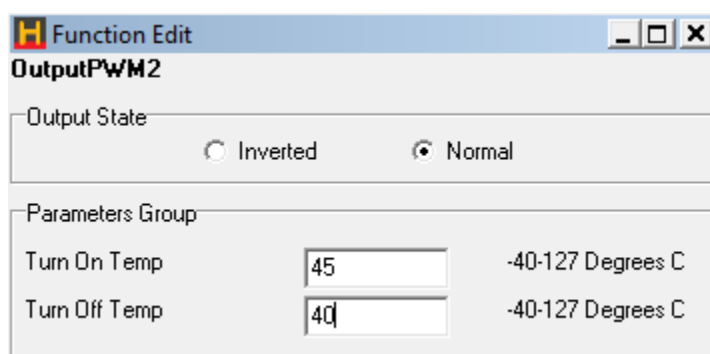


Figure 0-64 - Intercooler Fan Switch

- **Turn On Temp** - The intercooler fan operates when air temperature exceeds this temperature.
- **Turn Off Temp** -The intercooler fan stops when air temperature falls below this temperature.

## Intercooler Spray

To assist in the operation of the intercooler, a water spray can be setup to spray water onto the intercooler. The intake air temperature activates this spray.

- **Turn On Temp** - The intercooler spray operates when air temperature exceeds this temperature.
- **Turn Off Temp** - The intercooler spray stops when air temperature falls below this temperature.

## Intercooler spray advanced

The advanced intercooler spray requires the “intercooler spray input” to be setup and enabled. All of the conditions in the intercooler spray advanced page must be met for the output to switch on. This output is often used to control a CO2 intercooler cooling kit or even a methanol injection system.

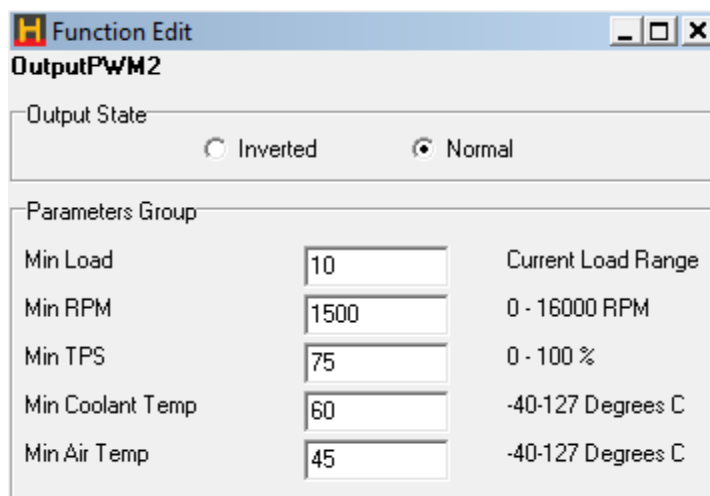


Figure 65 - Advanced Intercooler Spray Output

### Intercooler spray armed

When the "Intercooler Spray Input" is set to a "momentary switch" this output alerts the user to what state the input button is in (this feature is commonly used when connected to the factory mitsubishi evo 9 dash).

### Nitrous Activation Signal

This function controls the operation of a NOS system. It does not control the delivery of the Nitrous Oxide, but simply turns the system on or off in certain conditions, a relay is required to trigger the NOS solenoids the ECU output is used to trigger the relay only. The NOS system must control the delivery of the nitrous oxide and must also provide extra fuel delivery. A switch connected to the Auxiliary Input enables the function. Once enabled, if the conditions stated below are met, the NOS system will be activated. The Auxiliary Input Function in the Identification must be set to NOS Switch for the function to operate correctly.

The screenshot shows a software window titled "Function Edit" with a sub-header "OutputPWM2". Below this, there is a section for "Output State" with two radio buttons: "Inverted" (unselected) and "Normal" (selected). Underneath is a "Parameters Group" containing eight rows of adjustable parameters, each with a text input field and a description of the parameter's range or unit.

Parameter	Value	Range/Unit
Max Load	180	Current Load Range
Min Load	140	Current Load Range
Max RPM	7500	Current 16000RPM
Min RPM	3500	Current 16000RPM
Min Throttle	75	0-100%
Min Coolant Temp	80	-40 120 degrees C
Min Time	60	0-120 seconds
Ign Retard	20	0-20 degrees
% Fuel Enrich	20	0-50% enrichment

Figure 66 - Nitrous Control Output

There are eight adjustable parameters in the nitrous activation setup:

- **Max Load** - If the load exceeds this value, the NOS system will be turned off. This is used for turbo engines where the NOS system is used to help boost the turbo. Once on boost, the NOS can be turned off. Normally aspirated engines, on the other hand, can use NOS at full load, in this case the max load value should be set to 150kpa (ie the nitrous is always enabled). The max load value is an absolute pressure value in kpa.
- **Max RPM** - If RPM exceeds this value the NOS output will be switched off.
- **Min RPM** - If the RPM is below this value the NOS system will not be activated.
- **Min Throttle** - The NOS system will be turned on above this value.
- **Min Coolant Temp** - The NOS system will not be activated unless the engine coolant temperature is above this value.
- **Min Time** - Engine running time after which NOS can be activated.
- **Ign. Retard** - Amount of ignition retard when NOS is active.
- **% Fuel Enrich** - The percentage of fuel enrichment when NOS is activated. This is only a minor

correction to the mixtures in case there is a minor lean out. You must supply sufficient fuel for the NOS system by other means also to ensure that you have sufficient fuel.

### Shift Light

Shift lights can be setup for any RPM from 0 – 16000RPM. You can setup more than one shift light on separate outputs.

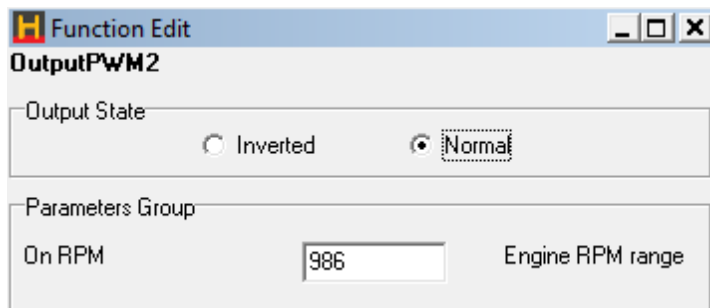


Figure 67 - Shift Light Output

**On RPM** - Output turns on when this RPM is exceeded

**Off RPM**- Output turns off when engine speed falls below this value

### Staging Signal

This function uses an output to indicate when the engine is in the staging section of map, i.e.. When the load has increased beyond the Staging Load Bar in the Fuel Setup page. There are no parameters to setup for this output. This output will not activate if staged fuel is not enabled.

**Note:** The staging signal does not pulse with the other injectors. It switches on and stays activated while the load is above the staging point. The pulsed outputs can be configured using the Extra Injector output type.

### Stall Saver

A solenoid air valve in the manifold may be used to allow extra air into the engine during cranking or extremely low rpm. This can aid in starting the engine, or in preventing it from stalling if engine revs drop too low. If the solenoid air valve is too large, the engine may stall because of its opening. The valve should be of appropriate size to increase the idle speed by several hundred rpm. Wire the solenoid through the output connector. There is only one parameter to be set with this function.

- **On RPM** - This is the rpm below which the valve will be opened. The default setting for this parameter is 500rpm.

### Tacho Output

The tacho output can be used to drive electronically controlled tachometers. The duty cycle of the waveform is fixed with a varying frequency that changes according to the RPM.

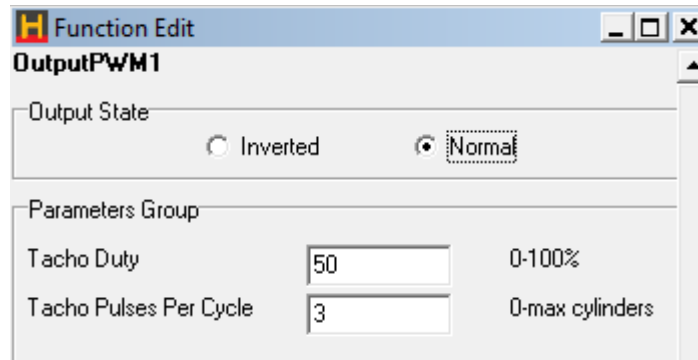


Figure 68 - Tacho output

- **Tacho Duty** - Duty cycle used to drive the tachometer.
- **Tacho Pulses Per Rev** - The number of pulses per engine revolution that the tachometer expects. On a 4-stroke piston engine, this is typically the number of cylinders divided by two.

PWM output #1 is suggested to be used as the tacho output as PWM 1 is the only output that has a programmable signal pullup required for some factory tachometers. The PWM 1 “pullup” controls the voltage level of the output signal, ie enabling the 12v pullup outputs a 0-12V square wave, the 8V pullup outputs a 0-8V square wave etc.

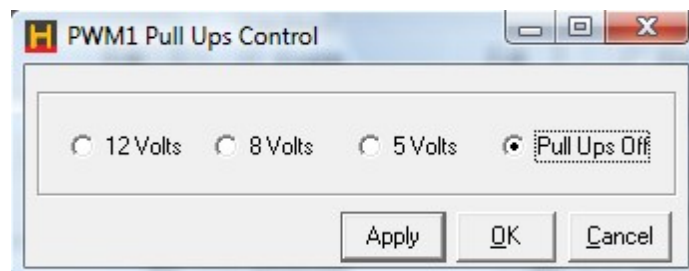


Figure 69 - PWM Output 1 Pullup Options

## Test

The test output is used to fault find wiring to test if an output is properly connected. The test output allows the user to control the output in real time from the front end at the touch of a keystroke.

## Thermo Fan

The thermo fan output function is used to run thermal cooling fans that circulate air through your radiator when coolant temperatures exceed the programmed value. You can setup more than one thermofan on separate outputs.

After selecting the Thermofan option, the temperatures must be programmed to select when the fan turns on and off. When wiring up a thermofan please use a relay to switch the fan power as the ECU itself is not capable of running the fan. The ECU output is only rated to switch a relay on and not the high current required by the fan itself.



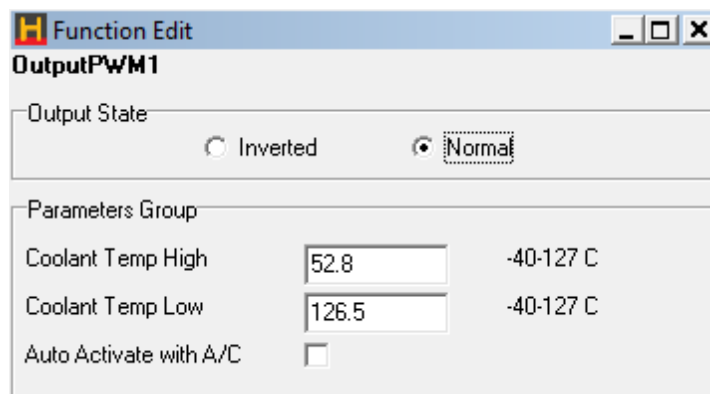


Figure 70 - Thermofan Output

- **Coolant Temp High** - Thermo fan turns on at this temperature
- **Coolant Temp Low** - Thermo fan turns off at this temperature. Must be set lower than the Coolant Temp High parameter.
- **Auto Activate with A/C** – When an input is correctly configured as A/C Request the thermofan can also be automatically be activated and deactivaed when the Air Conditioning is switched on and off.

### Thermofan (duty)

The thermo fan (duty) output function is used on certain thermal cooling fans that have intelligent control logic built into their control relays. Thermofans such these will vary their fan speed based on engine temperature, generally as the engine temperature increases so does the fan speed. This type of thermo fan control is often controlled by intelligent relay circuitry. The control output from the ECU varies output duty cycle with temperature, this in turn varies the speed of the fan. This form of fan control is found in some late model vehicles including some Mitsubishi Lancer EVOs.

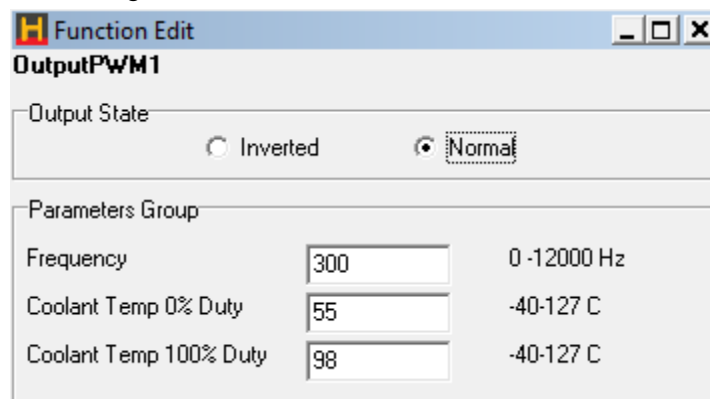


Figure 71 - Thermofan (duty) Output

### Torque Converter Lockup Control (TCC)

This function controls the clutch lockup solenoid on automatic transmissions that support this feature. Locking the torque converter reduces the amount of energy lost through the transmission, providing better fuel economy.

The solenoid activates whenever the road speed is greater than a programmed value for a given throttle position. With the default settings, the solenoid will only activate if the engine temperature is higher than 46°C (118°F), and will be disengaged if the throttle position exceeds 70% or road speed falls below 64kph. The TCC function also provides for a 4th gear/transmission over-temperature switch input. This signal indicates that the transmission is hot, and engaged in top gear. When this is the case, the lockup solenoid is activated regardless of road speed whenever the throttle is more than 4% opened.

### To use the TCC function, you must have the following:

A square wave signal road speed indicator whose frequency is proportional to road speed. (This may require a reductor adaptor for signal conditioning.)

Access to the wiring of the torque converter lockup solenoid and 4th gear/over-temp switch

Wire the TCC solenoid to the appropriate output line on the output connector, and, if it is available, the 4th gear/over-temp signal to the appropriately configured Input. The 4th gear/over-temp signal must be a pull-to-ground style signal.

To determine vehicle speed, a square wave signal must be applied to the road speed input connector. This connector possesses ground and 12 volt signals for powering a Hall effect or optical sensor. A magnetic or reductor type signal is incompatible, and you will need to convert the output from this style of pickup to a square wave.

Once the wiring is complete, run the ECU software in ONLINE mode and Options->Output Options page. The parameter Road Speed Value must be set with the number of pulses expected per kilometre. If you are unsure of the exact value for this parameter, enter an approximate number and check against the vehicle's speedometer. Adjust the Road Speed Value until the road speed displayed on the Engine Data Page and the actual vehicle speed agree.

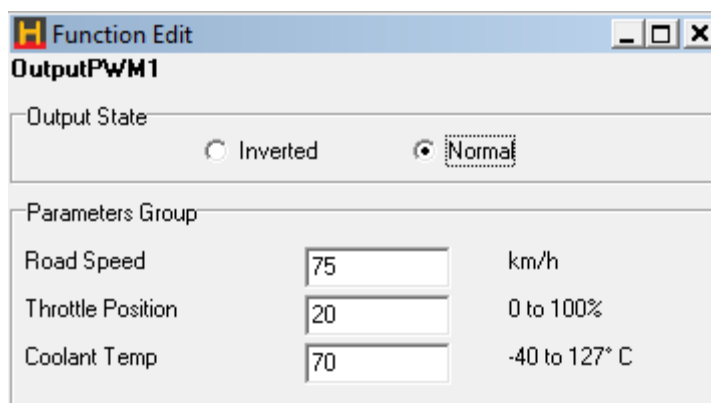


Figure 72 - Torque Converter Control Output

- **Road Speed** - The TCC output activates when the road speed exceeds this value.
- **TPS** - The TCC output activates when the TPS is less than this value.
- **Coolant Temp** - The TCC output activates when the coolant temperature exceeds this value.

When all the above conditions are met, the TCC output activates and locks the torque converter. It is advisable to never engage the lockup below 60 kph (40 mph).

### Turbo Timer

The turbo timer is used to help cool the turbo bearing by running the engine at idle for a short period after driving. If the engine is switch back to the ignition position whilst the car is running off the turbo timer, then all the timers get reset.

Care should be taken to make sure the relays are wired correctly, and that an over-ride switch has been fitted to allow the engine to be switched off manually while the turbo timer is active. See the figure below for the correct way to wire this output. The ECU detects if the ignition switch has been turned off via the Auxiliary Input. Therefore, the Auxiliary Input Function must be selected as Turbo Timer Input in the Digital Inputs page.

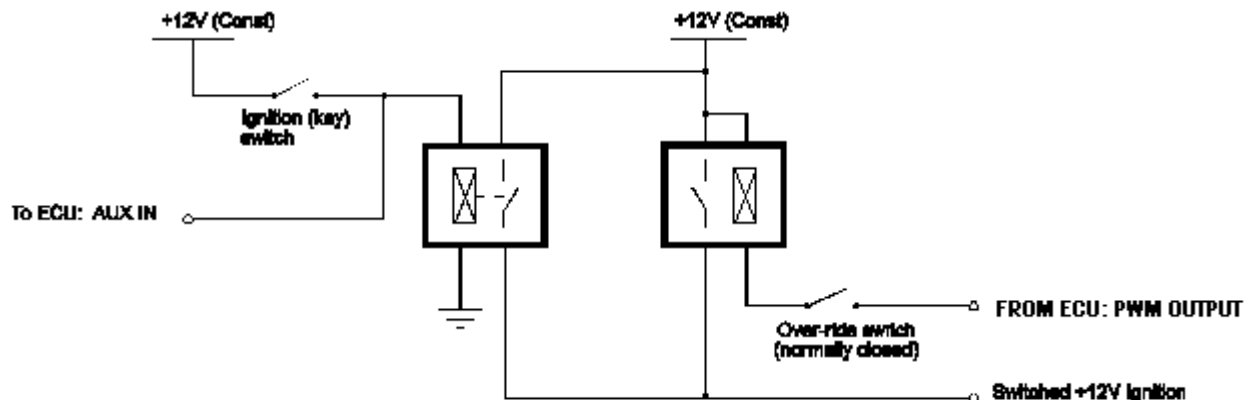


Figure 73 - Turbo Timer Output Wiring

Parameters Group		
Air Off Temp	35	-40-127 deg C
Coolant Off Temp	85	-40-127 deg C
Max Time	75	0 to 120sec
Max Rpm	3000	0 to 3000rpm

Figure 74 - Turbo Timer Output Setup Parameters

- **Air Temp** - The turbo timer keeps the engine on while the air temperature is above this temperature.
- **Coolant Temp** - The turbo timer keeps the engine on while the coolant temperature is above this temperature.
- **Max Time** - The turbo timer will turn the engine off when this time is exceeded after the ignition is turned off.
- **Rev Limit** - The engine speed is limited to this RPM when the turbo timer is operating with the ignition off.

### VANOS Advance and VANOS Retard

This feature allows the operation of the variable valve timing system developed by BMW called VANOS. This feature acts to control two solenoids on the camshaft, one solenoid advances the camshaft, the other retards the camshaft timing. For control of the VANOS system two PWM outputs and two digital timed inputs must be used for each camshaft controlled. One PWM will control the advance solenoid, the other PWM will control the retard solenoid, one digital timed input will read the fixed 8 pulse signal (VANOS Ref signal) on the camshaft, the other digital timed input will read the variable (moving) 8 pulse signal (VANOS Inlet Cam signal) on the camshaft.

- **VCT Frequency** - The frequency that the VANOS solenoid should operate at, typically xxx hertz.

- **Proportional Co-eff** - The speed at which the control system updates, typically between 10 – 50 depending on how quickly the system needs to react.
- **Minimum Coolant Temp** - The temperature at which the VANOS system will begin its operation, below this temperature the camshafts will remain in the fully retarded position.
- **Deadband** - The degree of accuracy required, a deadband of 3 and the system would control the camshaft position within 3 degrees of the target position. A deadband of 1 and the system would control the camshaft to within 1 degree of the target position. A value too high leads to poor accuracy, too low and the system may oscillate trying to achieve too stringent a result.

Refer to tuning guide section for details on how to tune variable cam timing.

### VCT Control Output

This feature allows the operation of the variable valve timing associated with some modern engines. This feature is designed to controlling continuously variable valve timing. There are multiple control outputs available as each camshaft to be controlled requires its own VCT control output wire.

For each VCT control output a VCT control input is required (setup in timed input functions), this input comes from the camshaft position sensor on the camshaft that is being controlled (most commonly the intake camshaft is variable and the exhaust cam remains static), in which case the exhaust cam sensor would be used as the ECUs “home” signal and the intake cam sensor is setup as the VCT control input.

The screenshot shows a software window titled "Function Edit" with a sub-header "OutputPWM1". Below the title bar, there is a section for "Output State" with two radio buttons: "Inverted" (unselected) and "Normal" (selected). Underneath is a "Parameters Group" containing a list of parameters, each with a text input field and a range indicator. The parameters and their values are: VCT Frequency (120, range 0-12000 Hz), Steady Cam Pos DC (50, range 0-100 %), Proportional Co-eff (25000, range 0-5000), Integral Co-eff (10, range 0-1000), Derivative Co-eff (0, range 0-1000), Min Duty (0, range 0-100 %), Max Duty (100, range 0-100 %), Deadband (1, range 0-360 deg), Minimum Coolant Temp (82.8, range -40-127 C), Max RPM (5500, range Current RPM Range), and Max Cam Angle (35, range 0-360 deg). At the bottom left of the window is the text "Adjust PID settings", and at the bottom center is an "Edit" button.

Parameter	Value	Range
VCT Frequency	120	0-12000 Hz
Steady Cam Pos DC	50	0-100 %
Proportional Co-eff	25000	0-5000
Integral Co-eff	10	0-1000
Derivative Co-eff	0	0-1000
Min Duty	0	0-100 %
Max Duty	100	0-100 %
Deadband	1	0-360 deg
Minimum Coolant Temp	82.8	-40-127 C
Max RPM	5500	Current RPM Range
Max Cam Angle	35	0-360 deg

Figure 75 - Variable Cam Timing Control Output

When setting up Variable Cam Control for the first time default values may need to be added into the “PID settings” These can be accessed by clicking on the “Adjust PID settings” button. Default values should be set as follows:

Proportional Coefficient  
Default Value: 50%

0% 50 100%

Integral Coefficient  
Default Value: 25%

0% 25 100%

Derivative Coefficient  
Default Value: 0%

0% 0 100%

Apply OK Cancel

Figure 76 - Variable Cam Timing Advanced PID Settings

Refer to tuning guide section for detailed instruction on how to setup and tune variable cam timing.

## VTEC (Load and RPM switch)

This feature allows the operation of the variable valve timing associated with some engines. This feature acts purely to control a switching solenoid and is not capable of controlling continuously variable valve timing.

Function Edit

OutputPWM1

Output State

☐ Inverted ☒ Normal

Parameters Group

On Rpm	2200	0 to 16000rpm
On Load	-40	Current Load Range
Off Rpm	4200	0 to 16000rpm
Off Load	140	Current Load Range

Figure 77 - VTEC Output

- **On RPM** - The VTEC output activates when the engine speed exceeds this RPM.
- **On Load** - The VTEC output activates when the engine load exceeds this value.
- **Off RPM** – The VTEC output de-activates when the engine speed exceeds this RPM
- **Off Load** – The VTEC output de-activates when the engine load exceeds this value.

Both Load and RPM conditions must be met before the VTEC output becomes active.

### Water Injection Activation

To help improve the detonation resistance of an engine, water injection is sometimes used. The water helps to cool the intake charge and increase the resistance to detonation when it forms a vapour in the combustion chamber. The water injection is activated by the following parameters.

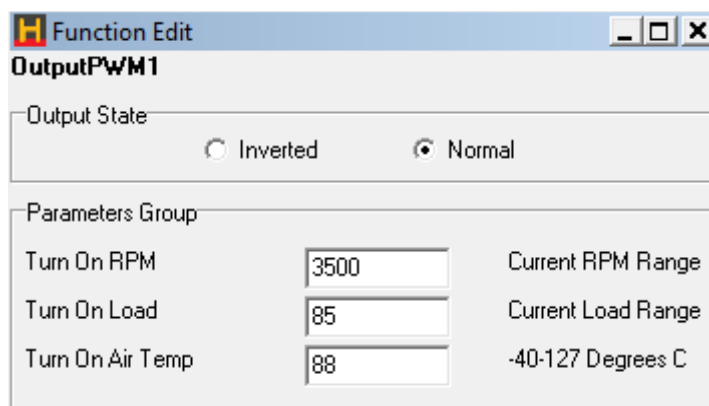


Figure 78 - Water Injection Control Output

- **Load** - The water injection enables when the load rises above this value.
- **RPM** - The water injection enables when the engine speed rises above this RPM.
- **Air Temp** - The water injection enables when the air temperature rises above this temperature.

The water injection output activates when all the above parameter conditions are met.

### Analogue Input Options

- **Fuel Trim** - With the optional trim module attached to an analogue input, the injection times can be adjusted with the trim module. Typically the trim module is used when firing up engines for the first time to make quick adjustments to fuel. The trim can be setup for Coarse ( $\pm 50\%$ ), Medium ( $\pm 25\%$ ) and Fine ( $\pm 12.5\%$ ) adjustment. Trims can also be dash mounted for changes to mixtures on the fly whilst driving if desired.
- **Ignition Trim** - With the optional trim module attached to an analogue input, the ignition advance can be adjusted with the trim module. Typically, ignition timing is only altered when tuning to allow for rapid changes to ignition advance. The trim can be setup for Coarse ( $\pm 12.5^\circ$ ), Medium ( $\pm 10^\circ$ ) and Fine ( $\pm 5^\circ$ ).
- **Turbo Wastegate Trim** - With the optional trim module attached to an analogue input, the wastegate duty cycle can be adjusted with the trim module. With the trim set to minimum, the boost level is restored to standard with the boost solenoid de-activated. As the trim is increased to maximum, the programmed boost from the maps is used to control boost.
- **External Baro** – Allows an external barometric pressure sensor (most commonly this is a 1 bar MAP sensor) to be added to the ECU, this is rarely used as the ECU has a barometric pressure sensor built in also.
- **Wideband O2 Input** - With the 5V output from a wide band A/F meter attached to this input, the A/F ratios can be viewed and data logged against the other engine parameters to aid in tuning and verification of the maps.
- **Manual Idle** - With the optional trim module attached to this analogue input, the idle control output can be controlled by this trim. With the trim set to minimum, the stepper motor will position itself according to the position described by Min Stepper Open Position in the idle control panel. The maximum position will be the minimum position plus the Stepper Motor Range.
- **Rotary Oil Metering Feedback** - This output is used exclusively for rotary engines that have an oil-metering pump for lubrication of the rotor. The oil-metering pump has a position sensor that is connected to this analogue input for feedback on its position. The Feedback Min must be set with the minimum raw count from the analogue input when the stepper motor is in the most closed position. The Feedback Max value must be set with the largest raw count value from the analogue input when the stepper motor is in the most open position.
- **External MAP Sensor** – This input enables an additional MAP sensor to be added to the system for comparison to the MAP sensor used for measuring load. This input is most commonly used in applications where pressure drop across a device is being datalogged. An example where this input is used is measuring the pressure drop across an intercooler, where the MAP sensor used to determine engine load is compared to an additional MAP sensor setup as the “external MAP sensor” and plumbed before the intercooler. The difference between the two readings is the pressure drop in the system. Similar methods can be used to determine throttle body efficiencies etc.

- **Fuel Pressure Sensor** – This input enables the ECU the display and datalog fuel pressure via a fuel pressure sensor.
- **Oil Pressure Sensor** – This input enables the ECU the display and datalog engine oil pressure via an oil pressure sensor.
- **Closed Loop Boost Trim** - With the optional trim module attached to an analogue input, boost levels can be trimmed down from the value set in the closed loop boost control map to a maximum of the amount set in the closed loop boost control trim input. With the trim turned all the way clockwise boost levels will be equal to the values found in the closed loop boost control map, with the trim turned all the way anti-clockwise the boost is reduced by the amount set in the trim input.
- **EGT Input** – This input allows an Exhaust Gas Temperature input to be entered into the ECU, this input requires the EGT thermocouple to be amplified externally (EGTs and amplifiers can be purchased through haltech). EGT can then be used to trim fueling requirements through the fuel correction maps.
- **Air Conditioning Request** - The ECU can intercept the air conditioning control to control when it is allowed to operate and to allow for any idle up requirements when air conditioning loads the engine. This input is connected to the switch that request air-conditioning function, or the output from the air conditioner thermostat control box, depending on the required function. See section for details on how to setup air conditioning control.
- **Nitrous Enable** - If the nitrous activation system requires an external input to arm the system, then select this function on the digital inputs. See tuning section for details on how to setup nitrous control.
- **Auxiliary Rev Limit** - To help some cars 'launch' from a standing start, an auxiliary rev limit can be set via an external input. This limits the power available from the engine that helps to minimise wheel spin. Typically, the auxiliary rev limit is set when the car is stationary and the engine is revved up to that limit. When the clutch is released, then car is moved using only the limited engine power until sufficient traction is gained, at which time the auxiliary rev limit is released.
- **Datalog activation** – To activate on board datalogging the channels need to be setup in the datalogging setup menu and the input needs to be enabled. When the input is grounded on-board datalogging is activated.
- **Map Selection** - The ECU has two sets of separate fuel and ignition maps that can be programmed. These can be tuned differently for different fuels or different conditions. E.g. Use fuel/ignition maps 1 for pump fuel and use fuel/ignition maps 2 for racing fuel. A switch can be connected to this digital input to select between the fuel maps only, the ignition maps only or both. Click on the Edit button to select which maps you wish to control with this input.
- **Turbo Timer Input** - When turbo timer is setup, the ECU requires an input to determine when the ignition is turned off to start the turbo timer. See auxiliary output options section on the Turbo Timer output for more details on how to wire the turbo timer system.
- **Anti-Lag Enable** - When turbo anti-lag is setup to require an external input to arm the anti-lag function, select this input function and connect your enable switch to this input. See section on anti-lag for details on how to setup anti-lag.



- **Transmission Overheat** – Some factory vehicles are fitted with a transmission overheat switch that alerts the user to the fact that the transmission temperature is high.
- **Anti-Lag Rally Application Switch** - When “antilag rally mode” is selected and the “switch” is required this input needs to be setup. The switch is “on” when grounded. See tuning section for more details of setting up and tuning antilag rally mode.
- **Anti-Lag Launch Application Switch** - When “antilag launch mode” is selected this input needs to be setup. The switch is “on” when grounded. See tuning section for more details of setting up and tuning antilag launch mode.

### Digital Input Options

The ECU has inputs capable of accepting on/off type of input information such as from a switch. The active state of these inputs is when the input is connected to GND. The inactive state is when the input is not connected to GND. The input active state can be inverted by selecting an option in the ‘Edit’ dialog, so that connecting an input to GND results in an inactive state and disconnecting the input results in an active state.

### Timed Inputs

These inputs are capable of accepting pulsed input information such as for a road speed sensor. These inputs measure the time periods between the pulses and can process this information to provide quantities such as Road Speed.

Input	Type
Aux Input 1	Digital Only (on/off)
Pulsed Digital Input 3	Digital or Pulsed input
Pulsed Digital Input 4	Digital or Pulsed input
Pulsed Digital Input 5	Digital or Pulsed input

- **Flatshift** – With this input setup on a clutch activated switch the ECU will retard timing preventing the engine from accelerating at its normal rate. This allows for the driver to remain at full throttle without over-revving the engine. The amount of ignition retard required can be setup in the edit menu of the aux input when enabled.
- **Road Speed Input** - To detect the road speed at which the vehicle is travelling, connect a square wave pulse signal to this input that has a frequency that is proportional to speed of the vehicle. To calibrate the road speed, click on the Edit button and set the field that specifies the number of pulses per km.
- **VCT Input** – Continuous variable cam timing generally requires two camshaft inputs, one input is a static input that does not vary with camshaft position (this input is wired to the ECU home input). The other input measures the camshafts true position and therefore varies as the camshaft position is changed, this signal is the VCT input and is required to be a digital 0-5V square wave pulse signal. If the factory sensor is a reluctor style sensor (sine wave) an external reluctor adaptor such as the haltech RA10 is required.

- **VANOS Ref Signal** - For control of BMWs VANOS system two signal inputs are required. The VANOS ref signal reads the fixed 8 pulse signal on the camshaft.
- **VANOS Inlet Cam Signal** - the VANOS Inlet Cam digital timed input can be connected to read the variable (moving) 8 pulse signal on the camshaft of a VANOS equipt engine.
- **Intercooler Spray Input –** When using intercooler spray advanced this input is required to be enabled before the intercooler spray will activate.

**Data Logging - See Datlogging section for Details.**

## Starting Your Engine

If your engine is a freshly built engine, make sure that you prime the engine oil system by cranking it with no spark plugs and the injectors disconnected. Crank until the engine oil pressure turns off any warning lights and oil pressure gauges (if fitted) read sufficient oil pressure.

**Disable Injectors** - To avoid accumulating unburnt fuel in your engine, make sure you disable your injectors before you crank the engine when setting up.

**Check for RPM** - With your trigger set-up correctly, cranking the engine should produce an RPM figure in the 80 – 300 RPM range depending on your engine. Make sure that the RPM reading is stable while cranking. If the RPM signal shows “0” or the signal is erratic check the wiring for the trigger is correct.

**Calibrating Ignition Timing** - Now is the time to triple-check your ignition settings in the software. If the settings are correct, turn off power to your ignition system and connect your ignition system to the ECU. It is a good idea to check your ignition coil temperatures periodically on a newly wired system. If you find that a coil is getting hot, then turn off the ignition power immediately and double check your wiring and ignition settings.

Setup the ignition lock timing to a value that corresponds to an easy to read timing mark on your crank pulley. Select a value that will allow you to easily start the engine too. Typically, engines will be clearly marked at 10 degrees BTDC, which will also allow for easy starting. Your injectors should still be disabled at this point.

Crank your engine while someone is watching the timing with a timing light. Check for consistent ignition pulses while watching at what engine position the spark occurs. Adjust the Trigger Angle and/or Tooth Offset to adjust the timing to correspond to the Lock Timing value that you have set. Typically you should select a tooth offset that gives you a trigger angle between 50-100 degrees. Once this is set, your ECU is now calibrated for ignition timing. Using the timing light, attach to each spark lead and check that every spark plug is firing a spark.

**Enabling Injectors** - With the ignition system now calibrated and firing, enable the fuel injectors. If you have purchased the optional trim module, now is a good time to setup the trim module to allow you to trim  $\pm 50\%$  fuel (See section for instructions on how to setup Trim Modules). With fuel enabled, crank your engine and adjust fuel until the engine starts. Adjust your fuel trim and fuel maps at the idle range and load until the engine idles smoothly. Typical engine idle RPM will be 1000 RPM at about -60 to -80 kPa of vacuum. Check that your ignition timing is still accurate and firing at the angle that is set in the Lock Timing parameter. For more detailed information on setting the base timing see Setup Guide section 'Setting the Base Timing'.

You are now ready to tune your engine. Proceed to the Tuning Guide.

If your engine fails to start, go to Appendix C for the faultfinding guide.

## Tuning Guide

### Introduction

Before you begin this section of the manual, make sure that you are able to start your engine and achieve a steady idle. This section of the manual will guide you through the tuning of your fuel, ignition and correction maps for your vehicle. The Halwin software controls for tuning maps will be covered in this section in detail.

This Tuning Guide assumes basic knowledge of automotive fuel, ignition and triggering systems. If you find settings or concepts that are confusing or difficult to understand, please refer to the appendices of this manual for more background information on these topics.

### What are maps?

The injection times needed by the engine at different conditions are stored by the ECU in a table of numbers called a look-up table. The ECU determines the engine's load and speed, and uses these two parameters as an index to the table. This table is called the Fuel Map. For instance, at an engine speed of 4000 rpm and at -20kPa, the relevant number in the table may be 4.35. If the engine approximates -20kPa at 4000 rpm, then the computer will extract the value of 4.35ms from the table as the base injection time. This value is then adjusted to compensate for numerous conditions, such as temperature. The ECU then holds the injectors open for that time on the next injection.

The Ignition Maps work in a similar way, except that it is the ignition advance that is stored in the look-up table instead of the injection time.

### Mapping an Engine

Mapping the engine involves filling the look-up tables with the correct values for your engine. Adjusting the heights of the bars within the maps does this. Bars may be adjusted one at a time, or in groups. The Haltech programming software has been designed to make engine mapping as simple and intuitive as possible.

### Using Halwin for Tuning

When referring to mappable points along the load axis, the convention is to refer to them as load 'Bars'. The convention for referring to mappable points along the RPM axis is to use the term RPM 'Ranges'.

#### Halwin 3D Maps

The 3D maps form the basis of the engine tuning process. From the basic 3D Fuel and Ignition maps, the ECU accesses the base fuel and ignition timing requirements for the engine for a give load and RPM. The E11 ECU allows for two base fuel maps, and two base ignition maps.

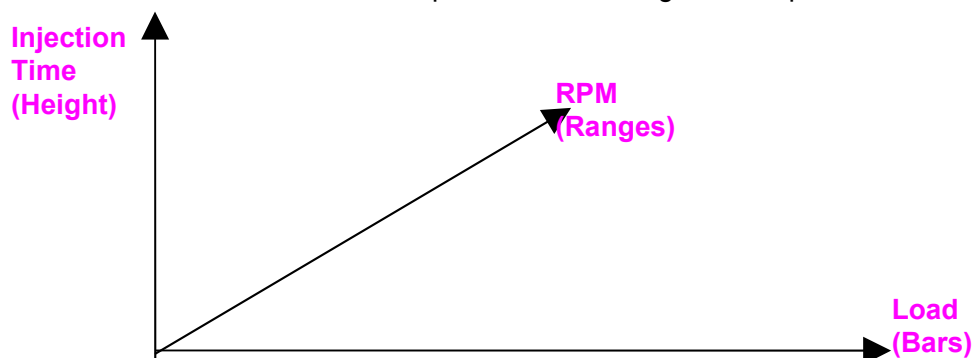


Figure 79

#### 3D Graphic Mode

To access the 3D maps, select Maps from the menu bar until the menu opens and drops down another selection of options. From these options, select one of the Fuel Delivery or Ignition maps. Clicking on one of these maps will reveal a second panel that will allow you to select the 3D view for the selected map.

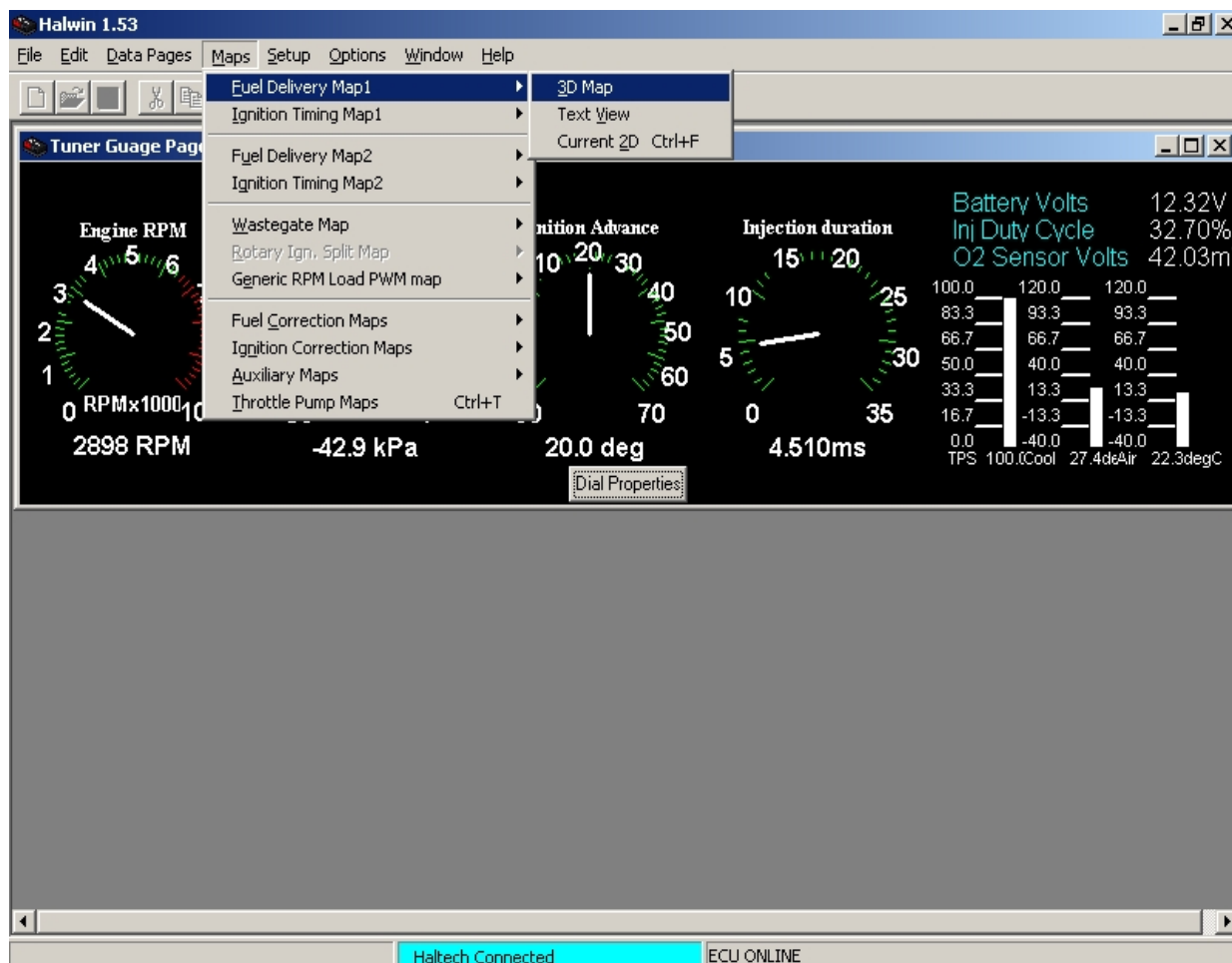


Figure 80 - 3D Maps

With the 3D map opened, you should see a screen similar to the one below

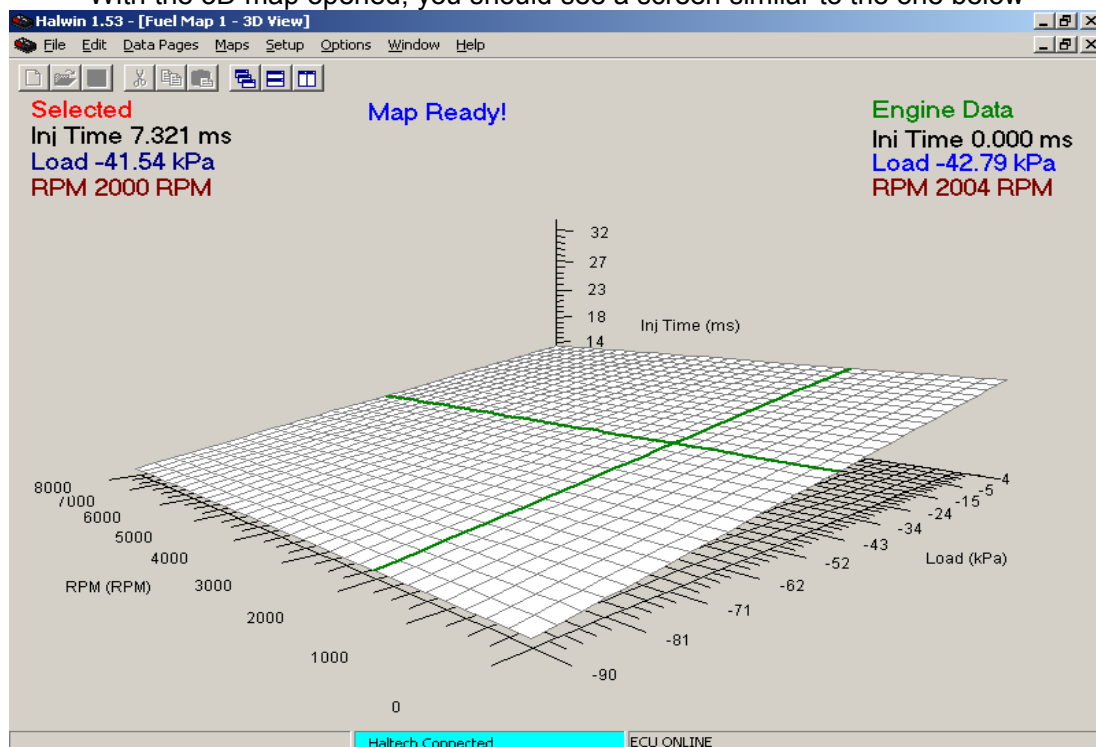


Figure 81 - 3D Maps

The axes of the map are Load and RPM. The height of the map represents the base injection time in milliseconds. The selected bar appears in yellow. The current engine load and RPM is indicated by the 'Home Pointer' arrow that hovers over the nearest corresponding bar.

2D Map Mode

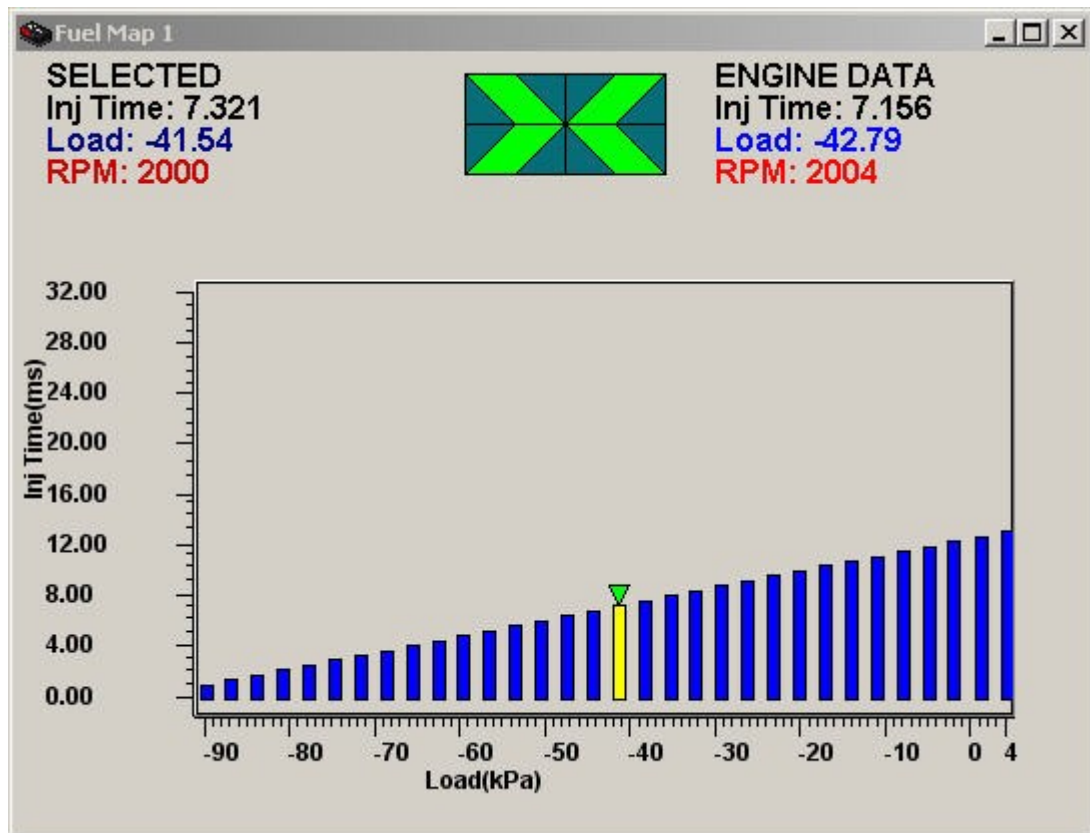


Figure 82 - 2D Maps

### Basic Software Keys

To modify the fuel and ignition maps the following keys will be the most commonly used commands to change a map value. A more detailed guide can be found below in the software setup section.

**Current selected bar** - The yellow bar shows the bar that is currently selected. Pressing the up/down arrow keys will raise and lower the height of this bar.

**Home Pointer** - The green pointer shows the bar nearest to the current engine speed and load. Hitting the 'Home' or 'spacebar' key will select the bar the engine is currently operating at.

**Left/Right Arrows** - These keys moves the bar selector so that you can work on all the bars individually.

**'n' key** - Shows the next RPM slice of the map. For example, if you are currently displaying the 2D slice representing the 500 rpm range, then pressing 'n' will move the display to show the next increment which will typically be the 1000 rpm range.

**'p' key** - Shows the previous slice of the 3D map.

**Up/Down Arrow** - Increase or decrease the height of the bar. Pressing Ctrl-Up/Ctrl-Dn will reduce the size of the increment to the finest resolution. Pressing Shift-Up/Shift-Dn will increase the size of the increment.

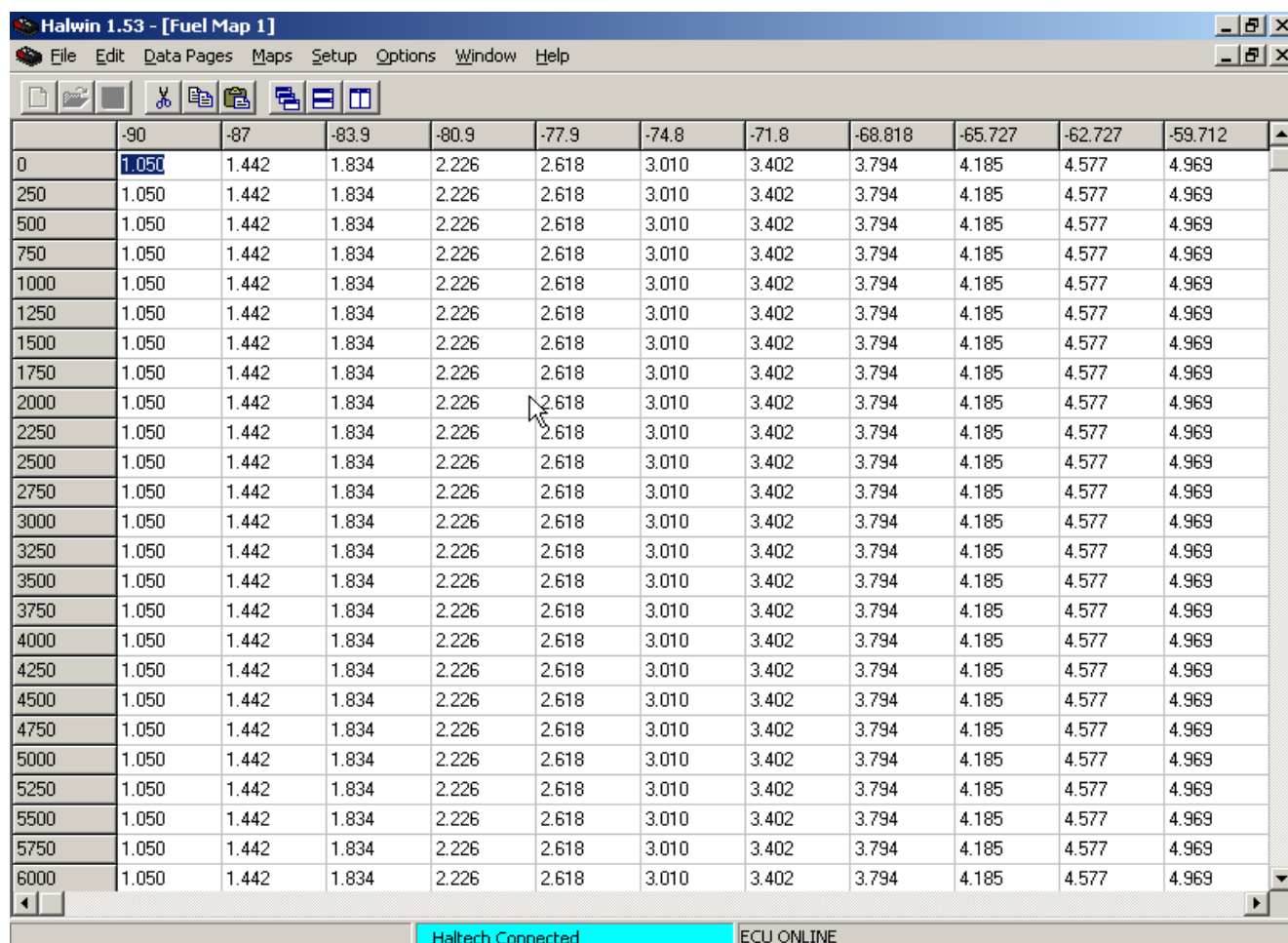
**PgUp/PgDn** - This increases or decreases the height of the bar in larger increments than the arrow keys.

**CTRL Arrow** - selects multiple load bars in the map.

**ALT Arrow** - deselects load bars that have been selected.

## Numeric Mode

To view the map data in its most basic form, the numeric values can be displayed and edited in table form. The highlighted green pointers to the right of the 2D map are the “Home” markers that indicates the value closest to the current engine operating parameters.



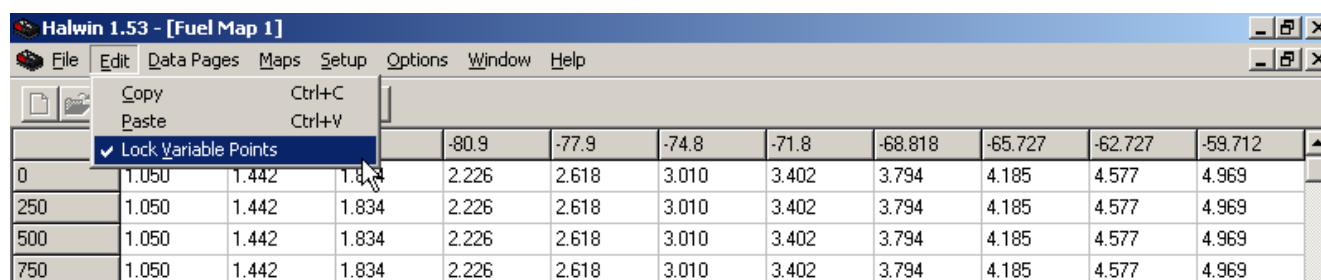
	-90	-87	-83.9	-80.9	-77.9	-74.8	-71.8	-68.818	-65.727	-62.727	-59.712
0	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
250	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
500	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
750	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
1000	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
1250	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
1500	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
1750	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
2000	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
2250	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
2500	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
2750	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
3000	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
3250	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
3500	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
3750	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
4000	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
4250	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
4500	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
4750	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
5000	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
5250	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
5500	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
5750	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
6000	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969

Figure 83 - Text View Maps

The values from this table can be copied and pasted into Microsoft Excel if required.

### Variable Load and RPM Points

To modify the variable load and RPM values for the given bar or range, select your map and display in Numeric Mode as described above. Edit from the menu bar and un-check the option Lock Variable Points. This will unlock the first row and column to allow you to change the load and RPM at which the given bar or range represents. By default the spacing for load values is evenly spaced load over 32 bars, for the given 1 Bar, 2 Bar or 3 Bar sensor. The default spacing for RPM ranges is 500rpm over the 32 bars to give ranges from 0 RPM to 15500 RPM. When modifying the variable load and range values, make sure that all values are always ascending as you move across the bars, or down the ranges.



	-90	-87	-83.9	-80.9	-77.9	-74.8	-71.8	-68.818	-65.727	-62.727	-59.712
0	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
250	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
500	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969
750	1.050	1.442	1.834	2.226	2.618	3.010	3.402	3.794	4.185	4.577	4.969

Figure 84 - Unlocking the load points



## Halwin 2D Maps

There are other tables in the ECU, such as those used for temperature corrections. They are indexed by only one parameter, and so are not divided into ranges. These tables are also called maps. An example of this is the 3D coolant temperature map as shown below.

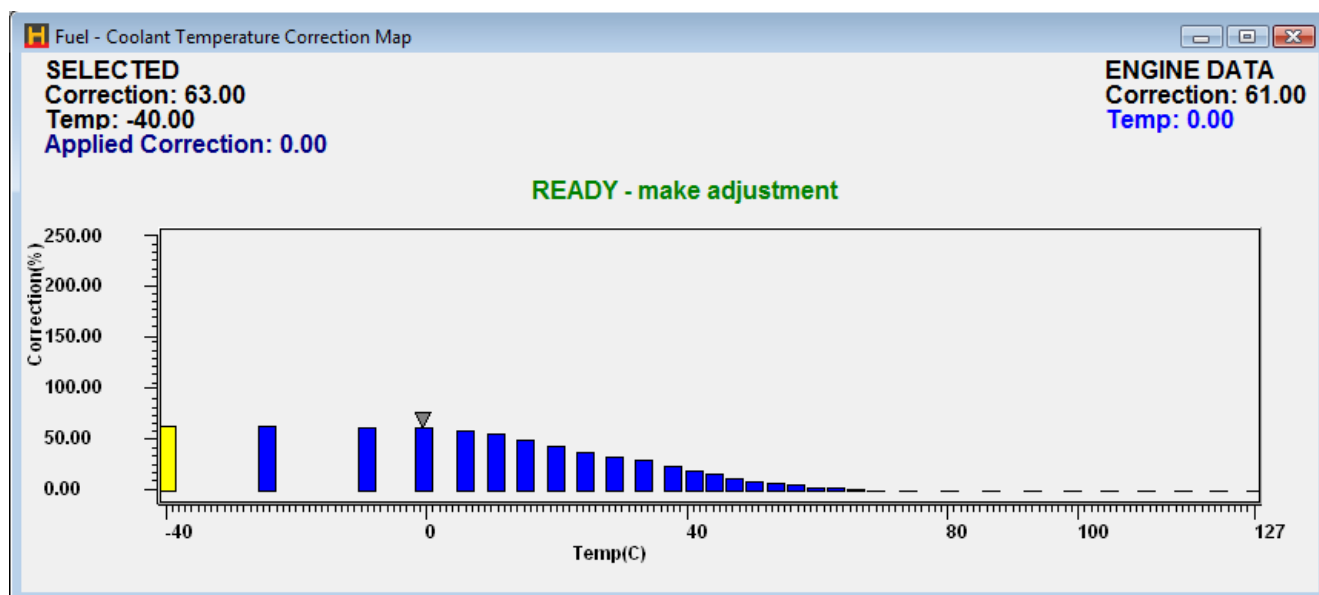


Figure 85 - 2D Temperature Correction Map

## Fuel Maps

### WARNING

**Driving a vehicle over time, on poorly tuned maps can lead to engine damage over that period. In order to ensure that your fuel maps are correct, a wide-band Air/Fuel ratio meter must be used at some stage to measure the Air/Fuel ratio over all engine loads and speeds at which you intend to operate the vehicle.**

The E11 ECU has two base fuel maps from which the injection is calculated (fuel map 1 and fuel map 2). These maps contain the base injection time for the given load and RPM at which the engine is operating. The base fuel map has the greatest influence on the air/fuel (A/F) mixtures. The base map that is used can be selected from the Main Setup page. The selection can also be made from an auxiliary input. See auxiliary inputs section for details on setting up dual mapping using an auxiliary input.

### Tuning Your Base Maps

To tune your base fuel map:

Setup your A/F ratio measuring equipment to measure the A/F for the engine that is to be tuned.

Check which base fuel map is used and select the appropriate map in the front-end software to tune.

Ensure that all correction maps such as coolant temp and air temp corrections are turned off or set to zero correction at this stage.

Confirm base timing is correct with timing light (for more information see setup guide section of manual).

Ensure that the ignition timing is set conservatively to ensure that it does not ping if a momentary lean condition is experienced.



Warm the engine up to operating temperature.

Adjust the idle control or throttle stops to enable the engine to idle at the desired engine speed.

While watching the A/F meter, adjust your idle mixtures as lean as possible whilst ensuring that you can maintain a steady idle without any misfiring.

While leaving the engine un-loaded, rev the engine in neutral through the rev range over which the engine will be operated. Set all the mixtures close to 14.7:1 in the non-loaded part of the load range.

With the aid of a dynamometer or an alternative method of applying load, step through the load range for each given RPM range and adjust your A/F ratio to suit. See the following sections for more details on tuning the various ranges of the base maps.

### Tuning for Idle

The idle mixture is very sensitive to correct bar height. Idle injection times are usually around 1.5 to 2.5 ms. If the injection time at idle is much lower than this, it may become difficult to set accurate idle and cruise air/fuel ratios.

If the engine is hunting at idle, then the map is probably too lean, particularly at the 500 rpm point. Watch the movement of the map arrow carefully. The map arrow should remain stable while the engine is idling. If the arrow is moving excessively in a MAP based system, then it may be necessary to use the Zero Throttle Map.

Remember that the ECU interpolates against both rpm and load. If the engine is idling at 800 rpm, then the injection time is computed as 60% of the value from the 1000 rpm range, and 40% of the value from the 500 rpm range, so both ranges would have to be adjusted to get the correct mixture. Similarly, if the idle mixture is reacting poorly to changes of the bar indicated by the map pointer, then try adjusting the adjacent bars. Wait for the engine to heat to operating temperature before performing further changes to maps.

### Tuning With No Load

Using the throttle only, increase the engine speed to 1000 rpm. If the engine is at exactly 1000 rpm then only that range needs to be adjusted. Adjust for the crispest engine response. Engines will usually idle rich, then head towards stoichiometric mixture at higher speeds. Repeat for 1500, 2000, 2500, 3000 rpm etc. The engine should now start and fast idle evenly. You should also have the engine running at operating temperature before doing any tuning of the base maps. Go to the Engine Data Page at this point and check all the sensor inputs are reading correctly, and that the temperatures have stabilised before continuing.

While free revving at higher engine speeds, check the engine speed on the computer. If it becomes erratic, or fails to follow the actual engine speed correctly, check Section 2 on setting the trigger.

#### Applying Load to the Engine

Once the engine has been tuned properly for no load conditions it is possible to begin loading the engine. The best method of applying load to the engine is using a dynamometer. However, if access to a dyno is not possible the engine can be tuned on the road.

### On the Dyno

Whether the vehicle is on a chassis dyno, or the engine on an engine dyno, the principles of programming the Haltech ECU are the same. Take the engine rpm up to 1000 and apply partial load and adjust the 1000 rpm range. Return the engine to idle and on the 1000 rpm range adjust the bars to draw a straight line from the idle point through the part load setting tested. Continue, adding more load, up to the full load settings. This should be a fairly good approximation to the required curve. Repeat this for the 1500 range, 2000, 2500 etc. The engine should be fairly drivable at this point.

## WARNING

**To avoid engine damage, an engine should always be tuned rich then slowly leaned out until the desired AFR is reached.**

Full load tuning should be approached with caution. An engine at full load that is too lean may begin to detonate and cause damage to engine components. Before loading the engine, increase the heights of the right-most bars so that they are higher than the line projected by drawing a straight line from the idle and free-rev settings and through the part-load settings.

### On the Road

Tuning on the road is similar to tuning on the dynamometer, but with hills, acceleration, gear-ratios and brakes providing the necessary retarding force. Although it is harder to maintain constant load and speed, it is still possible to use the same procedure used on the dyno. It will be necessary to have one person drive while another does the tuning.

Load the engine by selecting an appropriate gear and either driving up a constant grade hill, applying the brake or handbrake.

### WARNING

**Be very careful using the brake to load the engine. The brakes can get very hot and suffer from brake fade (reduced braking capability) and vehicle control may become unpredictable. All road testing should be done at low speed.**

**Road tuning should only be performed on a closed track or private road.**

### Fine Tuning the Engine

When fine-tuning the engine for the road, the same principles apply to all engines. Under full load at all rpm the fuel mixture should be rich. On naturally aspirated cars, an air to fuel ratio of around 12.5:1 to 13.5:1 is usually best. On forced induction vehicles (turbo or supercharged), the air to fuel ratio may go as rich as 10.5 but should not be leaner than approximately 12.5. Forced induction vehicles may make more power with leaner mixtures, but the excessive combustion chamber heat may cause damage to engine components.

When cruising (light to medium load) the mixture should be as close to stoichiometric (best mixture) as possible and decelerating conditions may allow the engine to be run lean to save fuel. This will result in a particular shape for the map.

**Note:** All maps for all engines should be smooth. A map with a "lumpy" curve is most likely wrong. If, when you have finished tuning, the map does have lumps in it, try to make it visually smooth.

### Using the Haltech Quicktune Feature

The Haltech Quicktune feature can be used only if the ECU has a calibrated wideband O2 Sensor input setup. The calibrated wideband O2 input will be the output of an external wideband O2 sensor product such as the Haltech wideband O2 controller, other wideband controllers that have a 0-5V calibrated output are also acceptable (INNOVATE, FJO, AFX, M&W Ignitions, TECH-EDGE and many other Wideband O2 controllers have this capability).

Once an auxiliary input has been correctly setup and calibrated with a wideband O2 sensor input (go to the setup menu -> sensor setup -> calibrate sensors -> wideband O2 controoler, to adjust the wireband O2 sensor calibration) the target air to fuel ratio table can be setup. This map is found in the maps menu under target AFR map:

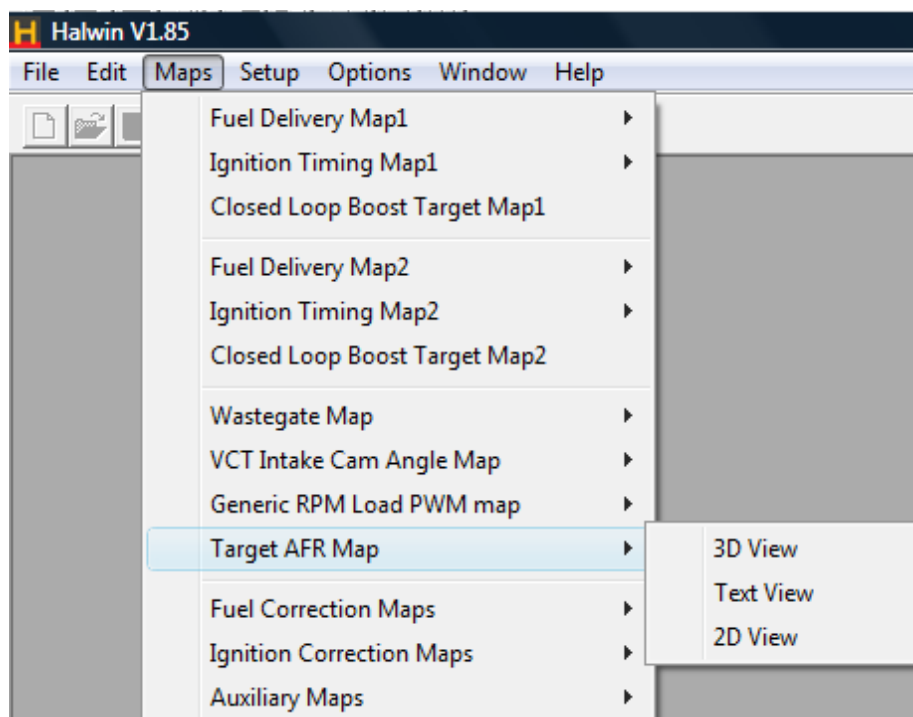


Figure 86 - Target AFR Map

With a correctly configured wideband O2 sensor input and the target AFR map set to the desired air to fuel ratio the quicktune feature is ready to be used. To use the quicktune feature open the fuel map, with the fuel map open pressing the “Q” key on the keyboard activates quicktune and adjusts the fuel map value for the current load point the engine is operating at. The ECU does this by comparing the actual AFR as measured by the wideband O2 sensor to the desired AFR as set in the target AFR map, the difference between these two values is added or subtracted from the value in the fuel map until the desired AFR is reached.

It is important to note that when the Q button is pressed the ECU only makes an adjustment to the load and RPM point the engine is actually operating at regardless of the number of mapping points you may have selected. For this reason best results are achieved when the RPM and load points are in the middle of a map cell when the Q key is pressed.

Tapping the Q button multiple times in quick succession will yield poor results as the system relies on accurate feedback from the wideband O2 sensor.

Pressing the 'W' key copies the calculated quicktune map value into the next load bar to the right of the adjusted load bar and the same two corresponding bars in the next RPM range.

## Ignition Maps

**WARNING**

**Driving a vehicle over time, on poorly tuned maps can lead to engine damage over that period. Before adjusting ignition, ensure that your fuel maps provide a safe operating Air/Fuel ratio. When adjusting ignition, always ensure that the engine does not detonate or ping over all the engine speeds and loads at which you intend to operate the vehicle.**

The E11 ECU has two ignition maps from which the ignition advance angle is calculated. These maps define the base ignition timing for the given load and RPM at which the engine is operating. The default ignition map that is used can be selected from the Ignition Setup page.

Figure 87 - Ignition Setup Page

The selection can also be made from an auxiliary input. See auxiliary inputs section for details on setting up dual mapping using an auxiliary input.

Make sure that your base fuel maps are fully tuned before attempting any mapping of ignition advance. Incorrect fuel requirements can cause pinging or detonation that is unrelated to incorrect or too much ignition advance.

If you have access to a dynamometer, use it to apply load to the engine and increase the advance from a conservative value until peak torque is attained for every load and RPM point. Avoid sustaining an engine under high load and engine speeds for any length of time.

It is good practice when tuning the high load bars to load the engine briefly before backing off and tuning the map while off load, then re-applying the load and comparing. Avoid holding the engine on high load whilst tuning to keep engine stress and heat to a minimum.

The process for tuning the load points and RPM ranges are very similar to tuning for fuel. Instead of aiming for good mixtures however, you should be aiming for maximum torque for the given load and

engine speed. You will achieve maximum power by aiming for maximum torque at all engine speeds.

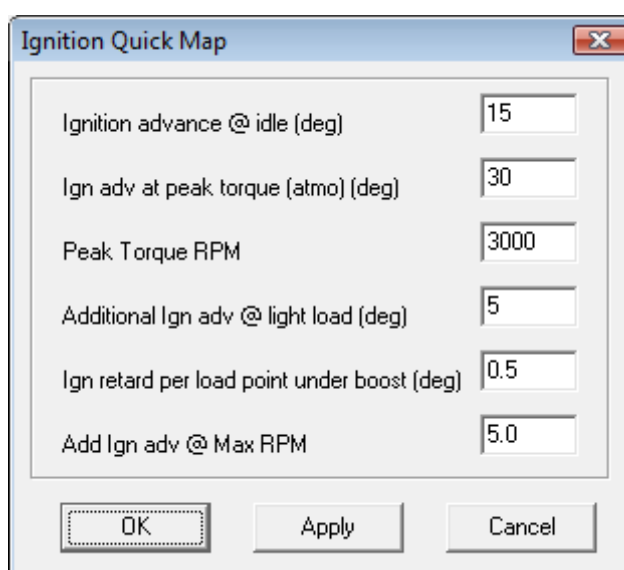
### Tuning For Idle

Typical idle speeds usually sit between 500 RPM and 1000 RPM. In order to assist the idle control mechanism to achieve a steady engine speed, it is advisable to ensure that the ignition advance at the idle loads between 500 and 1000 RPM are similar if not the same. It can be helpful to actually have the advance of the 500 RPM range to be slightly higher than the advance at 1000 RPM so that as engine speed dips, the increase in ignition advance tries to raise the engine speed. This will help the engine to find a stable equilibrium.

### Ignition Quickmap

To save time when tuning the ignition maps the ignition quickmap feature can be used to build a base ignition map before fine tuning on a dyno or the road. This feature can be found under the options menu.

The ignition quickmap has 6 user definable fields to be filled out that will set the basis for the base map to be built up upon, they are as follows:



Field	Value
Ignition advance @ idle (deg)	15
Ign adv at peak torque (atmo) (deg)	30
Peak Torque RPM	3000
Additional Ign adv @ light load (deg)	5
Ign retard per load point under boost (deg)	0.5
Add Ign adv @ Max RPM	5.0

Figure 88 - Ignition Quickmap

- **Ignition advance at idle** – Total ignition advance at idle.
- **Ignition advance at peak torque (atmo)(deg)** – Total ignition advance when the engine is at peak torque and manifold pressure is equal to atmospheric pressure (wide open throttle naturally aspirated).
- **Peak torque RPM** – The RPM at which peak torque occurs, this value is used to determine at which RPM point to use the 'ignition advance at peak torque' value.
- **Additional ignition advance at light load (deg)** – Addition ignition advance on top of the atmospheric (wide open throttle) advance to be added when the engine is at light load.
- **Ignition retard per load point under boost (deg)** – Ignition retard per load bar in the ignition map when an engine comes into positive pressure. Take care when setting this value as it the pressure variation in pressure between load points is dependant heavily on the MAP sensor used (ie a 2 bar MAP sensor has a load point every 6.4kpa whereas a 3 bar MAP sensor has a load point every 9.7kpa).
- **Additional advance at maximum RPM** – Additional ignition advance above the peak torque advance at the engines maximum RPM (maximum RPM is based on the value set in the rev limiter setup).

## Fuel Correction Maps

### Air Temperature Correction

This map compensates for the change in density of the intake air charge when the intake air temperature changes. Colder air is more dense which requires more fuel to be added in order to maintain a steady combustible mixture.

The Fuel Air Correction Map is accessed via the Fuel Maps and Set-up Menu. Across the bottom of the map displayed is the inlet air temperature. An arrow appears showing the closest bar that the system is using. A horizontal line splits the map displayed. Bars above this line indicate a positive correction making the mixture richer. Bars below the line indicate a negative correction making the mixture leaner.

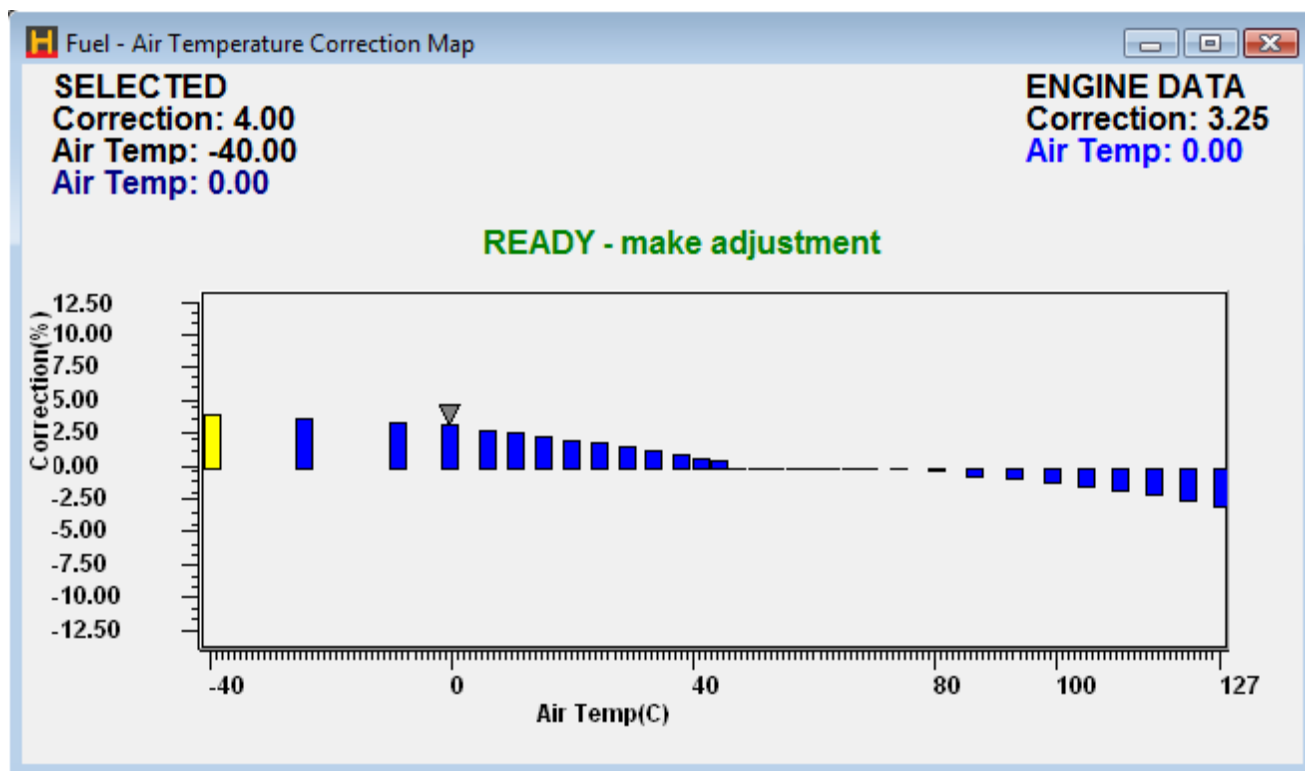


Figure 89 - 2D Air Temperature Compensation Map

### Coolant Temperature Correction

An engine requires more fuel when it is cold than when it is hot. This is a result of low manifold and in-cylinder temperatures where fuel sticks to the walls and doesn't atomise properly. The Haltech system corrects for this by using the Coolant Temp Map to define the relation between engine temperature and extra fuel required. The ECU will automatically reduce the amount of coolant correction applied to the engine as the throttle is opened and air speed increases. The Fuel Coolant Map should not be adjusted until the Fuel Maps are correctly tuned at operating temperature.

Access the Fuel Coolant Map from the Maps Menu. The map defines the percentage increase in fuel at any given engine temperature. The ECU is supplied with a default coolant map that may not need to be modified. If the coolant map requires modification, the changes should be done ONLINE and while the engine is warming. Start the cold engine and adjust the Fuel Coolant Map so that the engine idles evenly. You should not touch the throttle while adjusting this map. Follow the arrow as the engine warms to provide good running mixtures up to operating temperature, where there should be zero coolant correction.

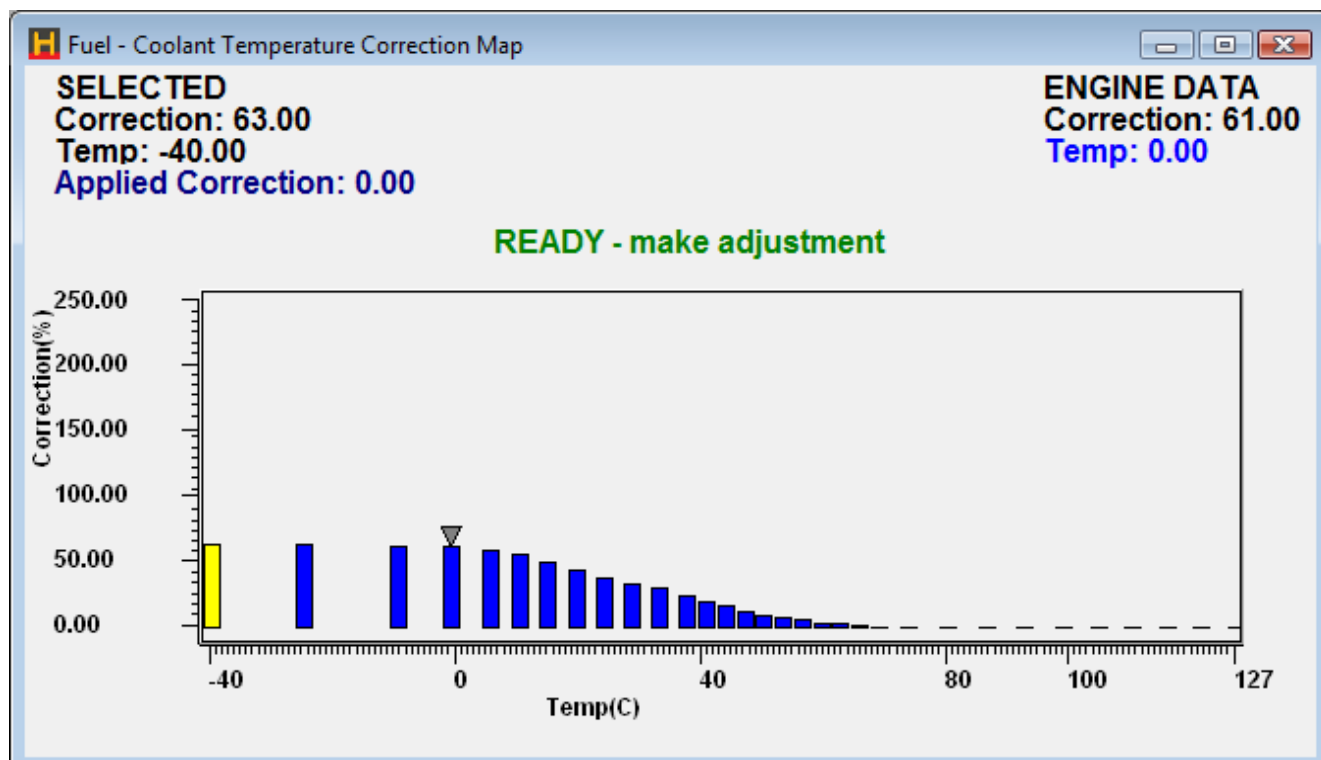


Figure 90 - Coolant Temperature Correction Map

### Battery Voltage

The Haltech ECU uses intelligent fuel injection driver circuitry that compensates for changes in battery voltage. As the battery voltage falls, the injectors will take longer to turn on and so reduce the effective open time. To compensate, the ECU applies the Battery Voltage Map to increase the injector 'on' time as the voltage drops. This map can also be considered as an injector dead time map.

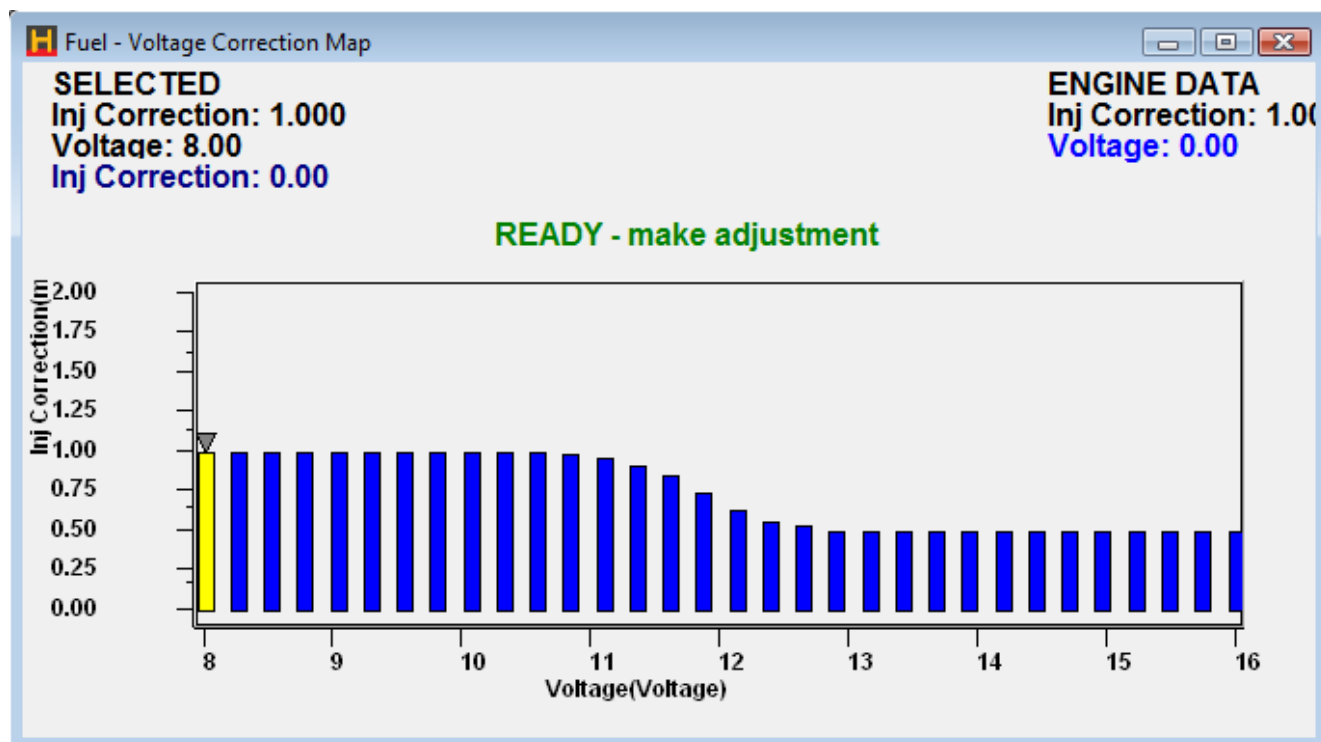


Figure 91 - Battery Correction Map (Injector Dead Time)

This map should not be used to compensate for a deficient electrical charging system on a vehicle.

## Prime

To aid in starting a cold engine, the prime map defines how much fuel to inject on the first cycle on injections for each cylinder or rotor. The fuel injection opening times in this map are much larger than what can be programmed in the base fuel maps. An A/F meter will not be very helpful in setting up this map since the time that this map is used is so short. A process of trial and error is the easiest way to set this map up. Simply increase the values in this map for the given temperature until the engine can be started easily.

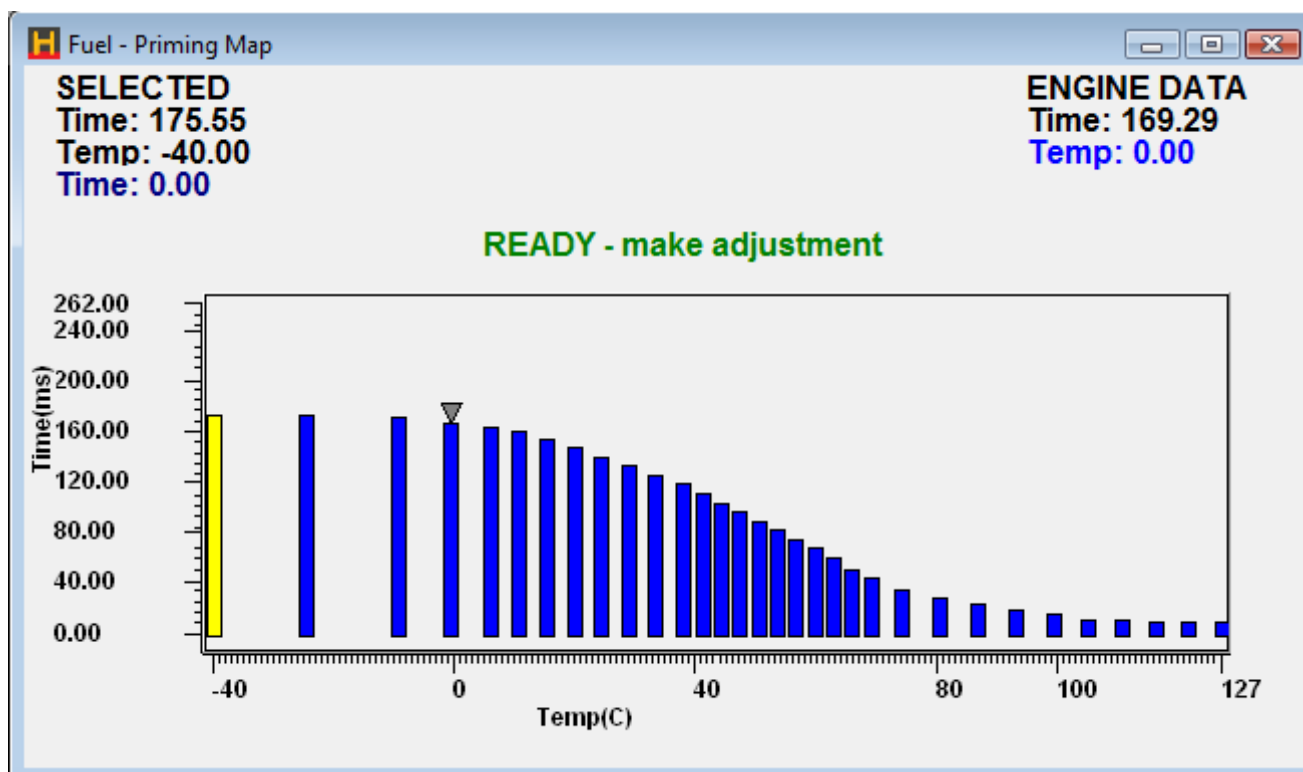


Figure 92 - Fuel Prime Map

Over priming the engine will cause it to flood and not start. To clear a flooded engine, open the throttle fully and continuously crank the engine. Do not pump the throttle, as this will only worsen the problem.

## Post Start

On some motors, in particular rotaries there may be a problem with vapour-lock (fuel which due to heating of the fuel rail has vaporised). The additional fuel at start up allows the vapour in the fuel rail to be purged through the injectors and also allow enough fuel to be injected into the motor to allow stable operation.

Post start can also be used to give extra enrichment when the engine is cold to assist drivability. When used for this purpose, try to do the majority of your compensation using the coolant temp map and only use the post start map after the coolant temp map is properly programmed.

The Post Start Map is accessed via the Maps menu. It covers a time of 128 seconds with each bar corresponding to 4 seconds of time. The time starts after the RPM exceeds the Max Crank RPM.

In the Main Setup, a post start correction above the operating temperature, and below the operating temperature are available. The operating temperature is also defined in the Main setup.

Separate maps are available for both above the operating temperature and below the operating temperature in the fuel correction maps page.



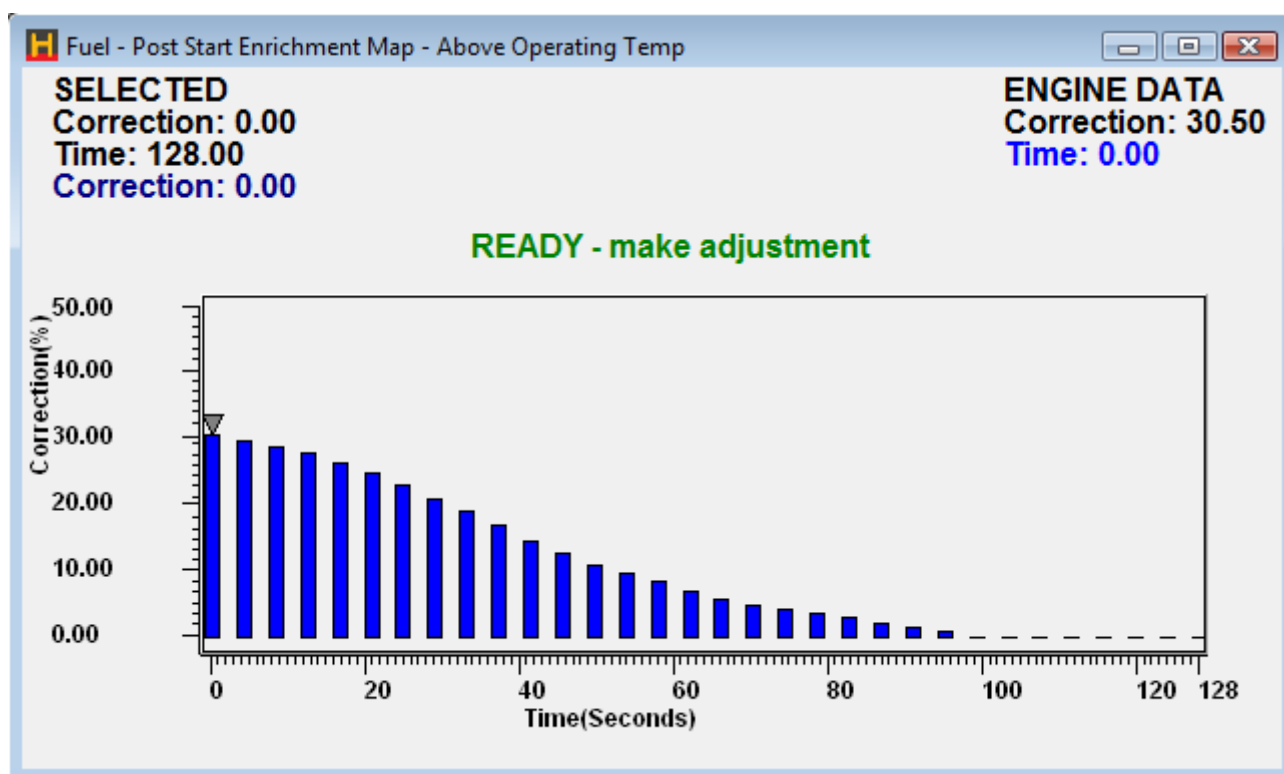


Figure 93 - Post Start Fuel Map

### Barometric Pressure

If you are using MAP for load sensing on your engine, then it is unlikely that you will need to worry about Barometric compensation for fluctuations in ambient barometric pressure. If you are using TPS for load sensing, Zero Throttle maps or Full throttle maps, then read on to learn how to configure Barometric Pressure compensation maps.

Fluctuations in barometric pressure vary the density of the intake air of the engine. At lower barometric pressure, the air density is lower (there is less oxygen in the air), and therefore the amount of fuel delivered to the engine must be reduced. This is necessary when a large change in altitude is expected during a driving period (a Hill Climb event such as Pikes Peak in the USA is a good example).

The ECU has an on board Barometric Pressure sensor that is used to measure the ambient air pressure. To compensate for the fluctuations in atmospheric conditions, the Barometric Correction map allows correction to your injection times of up to  $\pm 50\%$ .

### Zero Throttle

One problem that often occurs with performance engines is rough idling. The manifold design, cam characteristics, etc. can cause instability in the airflow. This makes fuel metering difficult. In particular, the Map sensor often cannot correctly read the manifold pressure, as it is non-existent, weak, or pulsing too much. In many cases though, once the engine has some speed, the manifold pressure signal is useable.

The best method of mapping the engine is using the manifold pressure as the load. If in this configuration idling is causing a problem, the Zero Throttle Map should be tried. This Map maps the fuel delivery at zero throttle below 2000 rpm. There are a few requirements that need to be met before you can use this Map. Firstly, your throttle position sensor must be calibrated properly. Secondly, the Map relies on there being a consistent airflow at zero throttle for a given engine speed. That means that devices such as idle speed motors that vary the airflow at zero throttle will not allow the Zero Throttle Map to operate correctly.

### Full Throttle

The manifold and throttle body design can also cause problems tuning at full throttle on normally aspirated engines. In some cases, the manifold pressure can reach close to atmospheric pressure before full throttle is reached. This means that bars close to the full load bar on the Fuel Maps can interfere with the full load

bar due to the interpolation between the two bars.

If you are experiencing difficulties maintaining air to fuel ratio at full throttle, it may be necessary to use the Full Throttle Map to set the full throttle mixtures. The Full Throttle Map is activated above the value set in the Full Throttle Threshold in the Fuel Set-up, and has one programmable bar every 500 rpm up to 15500 rpm.

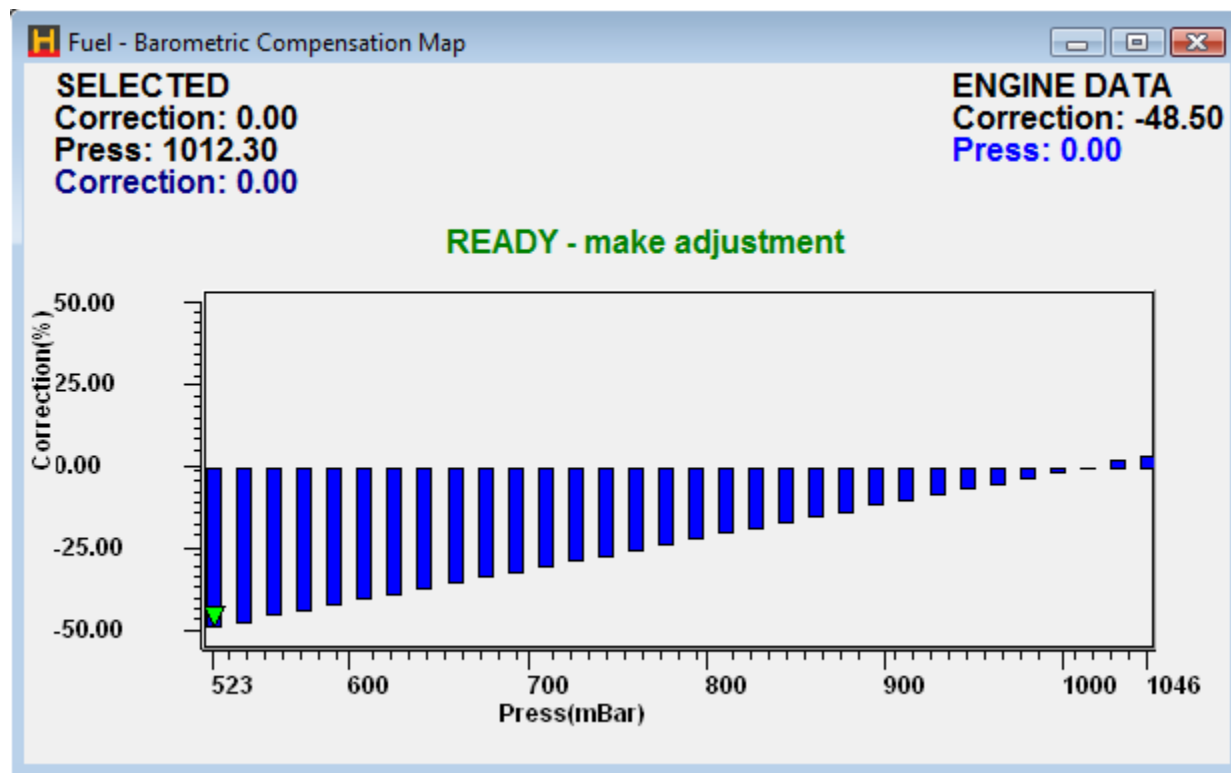


Figure 94 - Barometric Pressure Correction Map

### Throttle Pump Maps

The manifold pressure sensor used with the ECU is very fast. It can respond much faster than is required to track any sudden changes in load on your engine. However, the manifold pressure seen at the sensor input may not change as quickly as what is seen by the inlets to the combustion chamber, due partly to the length of the connecting pipe. This delay can be reduced by keeping the length of vacuum hose between the inlet manifold and the pressure sensor as short as possible. Even with very short vacuum hose lengths there may still be a lag between a transient pressure occurring and the pressure reaching the sensor.

Further, when the throttle is cracked open, the sudden change in pressure forces fuel out of atomisation and onto the manifold walls, so it fails to enter the combustion chamber properly atomised, and the engine hesitates. This can be corrected by adjustment of the Throttle Pump parameters.

To overcome any lean out during sudden throttle movement, the Haltech system uses a throttle accelerator pump function. This function delivers extra fuel during sudden throttle movements. The Throttle Pump is accessed from the Maps Menu.

The throttle pump values should be set up after the fuel and maps are correctly tuned for steady load running. Attempting to smooth out engine transients before the fuel maps have been optimised for steady state running may become confusing. The throttle pumps should be adjusted by trial and error to give optimum throttle response in each rev range. Generally, you may not need much above 3000 rpm, but could expect much higher values below 1500 rpm.

Note that throttle response can also be affected by poor manifold design. If you have designed your own inlet manifold you may find that although the engine runs well at steady load it leans out if the throttle is opened suddenly. This will occur if the fuel injectors are poorly positioned and the fuel is wetting down the walls of the inlet manifold rather than remaining as a mist.

The throttle pump setup allows the tuning of:

How much enrichment is needed for a given RPM, throttle position and TPS rate of change.

The biasing of the enrichment between asynchronous\* and synchronous\* according to a given RPM.

The speed at which the synchronous enrichment decays.

Note the rate of change of throttle position is how far the throttle moves over a 10ms time frame. A fast throttle movement could have a TPS rate of change of 15% this means that in a time frame of 10ms the throttle position moved 15%. A slow throttle movement could have a TPS rate of change of 1%, which means that in a time frame of 10ms the throttle position only moved 1%.

**Throttle Pump Setup**

**Throttle Pump Settings**

Max Asynchronous Pulses	5	0 - 10 Pulses
Throttle Deadband	0.5	0.0 - 10.0 %
Delay Between Enrich Events	0.80	0.00 - 2.00 sec
Overall Trim	100.0	0.0 - 300.0 %

**Engine Data**

Throttle Position	0
TPS rate of change	0
RPM	0
Sync Enrichment	0
Async Enrichment	0

**Enrichment Sensitivity Map (ms)**

**Throttle Position (%)**

	0.0	10.0	25.0	50.0
1000	5.0	5.0	2.0	0.0
2000	5.0	5.0	2.0	0.0
3000	3.5	3.5	2.0	0.0
4000	2.0	2.0	2.0	0.0

☐ Edit Map Axes

**Synchronous Enrichment Decay Map (ms/engine cycle)**

**Coolant Temp (deg C)**

	40.1	60.1	70.0	80.1
	0.20	0.30	0.40	0.50

☐ Edit Map Axis

**TPS Rate Of Change Sensitivity Map (%)**

**TPS Rate of Change (%/10ms)**

	0.5	2.5	10.0	25.0
	60.0	75.0	90.0	100.0

☐ Edit Map Axis

**Percentage Asynchronous Enrichment Map (%)**

**RPM**

	1000	2000	3000	4000
	75.0	50.0	40.0	30.0

☐ Edit Map Axis

**Coolant Correction Map (%)**

**Coolant Temp (deg C)**

	40.1	60.1	70.0	80.1
	50.0	10.0	5.0	0.0

☐ Edit Map Axis

Apply OK Cancel

Figure 95 – Throttle Pump Setup Screen

- asynchronous enrichment (additional injection pulses) is where the ECU adds additional injection pulses after the initial fuel injection event. Synchronous enrichment involves the ECU extending the original injection pulse – best results are achieved by using a combination of both synchronous and asynchronous enrichment.

### Throttle Pump Settings

- Max Asynchronous Pulses** This is the maximum number of extra injector pulses that can happen per injector output during an enrichment event.  
Range: 0 – 10 pulses.  
Default: 5.
- Throttle Deadband** A rate of change of throttle position greater than this value will trigger an enrichment event.

Range: 0.0 – 10.0 %.

Default: 0.5 %.

- **Delay Between Enrich Events** The minimum time between asynchronous enrichment events. This is to stop excess fuelling when constantly pumping the throttle.

Range: 0.00 – 2.00 sec.

Default: 0.80 sec.

- **Overall Trim** The trim value scales the fuel enrichment. 0% makes no changes to the fuel enrichment. 100% will add an extra 100% fuel to the enrichment.

Range: 0.0 – 300.0 %.

Default: 100.0 %.

### Throttle Pump Maps

#### Enrichment Sensitivity Map

This map allows for the tuning of the amount of enrichment needed according to a given RPM and throttle position. In general more enrichment is needed at a low throttle position because a change will cause a larger in rush of air than at a higher throttle position. At a low RPM more enrichment is needed because of low air speeds and the atomisation of fuel is poor. This becomes less of a problem as the engine goes up in RPM and airflow increases. The value in this map represents the enrichment needed at the maximum TPS rate of change. This map is the first to be tuned but also make sure that the right hand side of the TPS Rate Of Change Sensitivity Map equates to the maximum TPS rate of change achievable with a sensitivity value of 100%.

#### TPS Rate Of Change Sensitivity Map

With the Enrichment Sensitivity Map tuned for a maximum TPS rate of change slower throttle movements can be scaled accordingly with the TPS Rate Of Change Sensitivity Map. The right hand side of the map should contain the maximum TPS Rate of change in its axis value and 100% in its map value. For slower throttle movements (lower TPS rate of change values) a smaller percentage value can be put in the map.

#### Percentage Asynchronous Enrichment Map

This map determines what percentage of the fuel enrichment goes to the asynchronous type of enrichment. 0% in the map means that all of the fuel enrichment will be delivered synchronously. 100% in the maps means that all of the fuel enrichment will be delivered asynchronously. Note that if the enrichment value exceeds 9.5ms (the maximum size of an asynchronous pulse) the rest will be delivered synchronously. In General at a low RPM, when the injection events are further apart, the asynchronous fuel enrichment helps deliver the extra fuel straight away. At a high RPM asynchronous enrichment is not needed because regular injection events are more frequent.

#### Synchronous Enrichment Decay Map

This map determines how fast the synchronous enrichment decays back to zero. The units entered in are milliseconds per engine cycle. E.g. a value of 0.5 will mean that the enrichment will decay 0.5ms every engine cycle. The bigger the value the faster it will decay.

#### Coolant Correction Map

This map applies a correction factor to the fuel enrichment based on the coolant temperature. E.g. 100% gives 100% extra fuel enrichment.

### Shortcut Keys - For Mini Maps

- **Page Up** Increments map value.
- **Page Down** Decrements map value.

- **L** Used to linearise between two points.
- **V** Used to change the value in a cell or multiple selected cells.

## Other

- **Ctrl T** Opens throttle pump setup page without having to open fuel setup.

## Injector Phasing Map – for Sequential Fuel Injection

The timing (or phasing) of sequential or semi-sequential injections is set via the Injector Phasing Map.

If the Injection Angle field is set to 'End of Injection', then this map sets the End of Injection angle, in degrees BTDC compression, against the engine speed. This allows the injection to be completed before the inlet valve opens. The ECU then times the start of injection, based on the trigger, so that the injection is completed by the specified engine angle. If the ECU calculates that there is insufficient time to complete injection before the specified End of Injection time, then injection will continue past this time.

If the Injection Angle field is set to 'Beginning of Injection', then this map defines the angle at which the injection will begin BTDC compression. This mode is not often used, as the varying pulse width of the injections will not ensure that the injection pulse finishes before the valve closes. This could lead to fuel sitting in the manifold without any airflow to keep the fuel in suspension.

Engines with conservative cam profiles will notice very little difference between the injector phase angle settings.

For 4-stroke engines, the typical usable range for injection angle is from 180 to 540 degrees BTDC.

For rotary engines, the typical usable range for injection angle is from 90 to 270 degrees BTDC. Any angles greater than 360 degrees will be interpreted as 360 degrees BTDC.

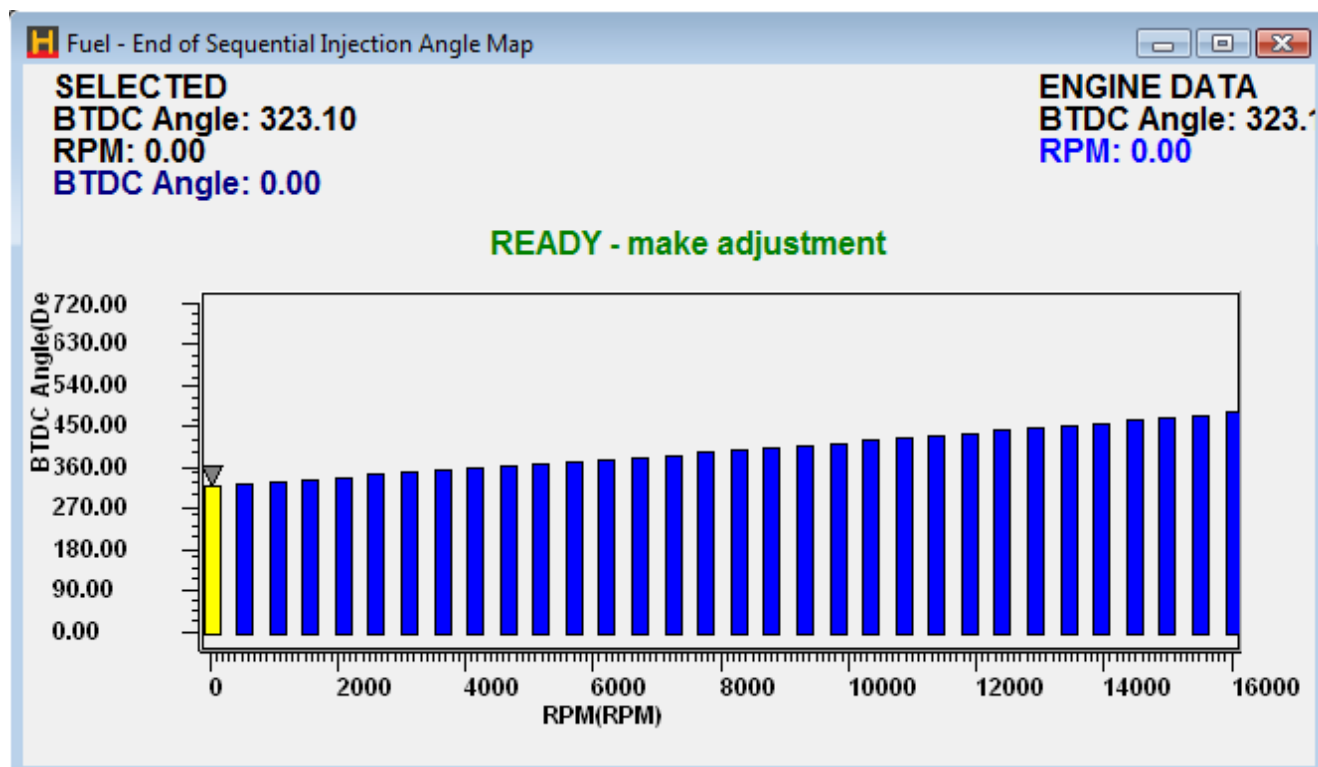


Figure 96 - Sequential Injection End of Injection Map

## Staged Injection

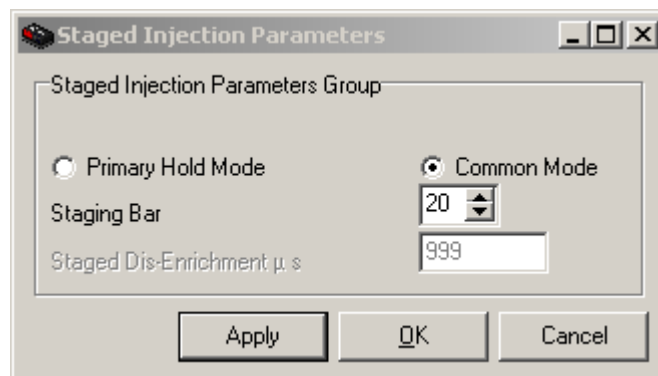


Figure 97 - Staged Injection Setup

Staged injection operates differently depending upon if the engine type is piston or rotary. When a rotary engine is selected and Staged injection is enabled, a second fuel channel for each rotor is automatically configured. Staged injection is much more common on rotary engines.

When using staged injection on a piston engine, you must configure Extra Injector outputs in the Auxiliary Outputs to designate how many secondary injectors are available and on which outputs they appear

### Staged Injection Modes

#### Primary Hold Mode

To minimise any step effect when the staged injectors begin, a Primary Hold Mode for staged injection is available.

In Primary Hold Mode, the primary injectors hold at the current pulse width when the staging bar is exceeded. The secondary injectors then begin to fire. However, when secondary injectors begin injection, they cannot begin to inject smoothly from zero injection time due to the injector dead time of the secondary injectors. This means that when the secondary injectors start, they must start from around 1ms of injection time to overcome the effects of the injector dead time.

The Staged Dis-enrichment field is the amount of injection time that the primary injectors are reduced when the secondaries begin. This is to compensate for the injector dead time of the secondary injectors.

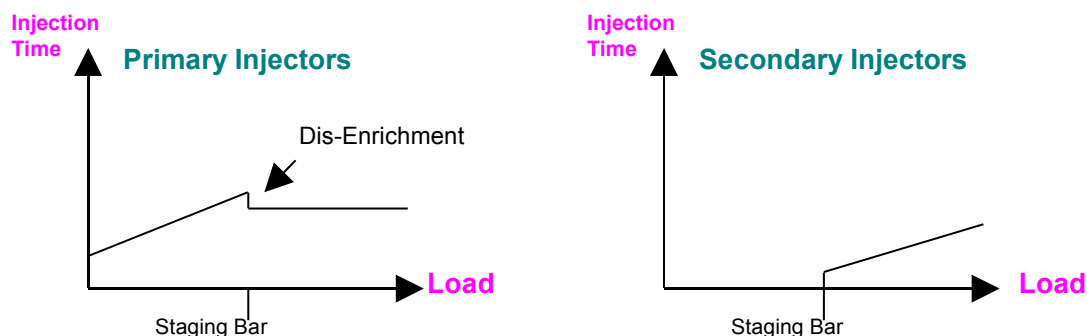


Figure 98

#### Common Mode

In Common Mode, the pulse width of the primary injectors increase up to the staging bar as normal. When the staging bar is exceeded, the secondary injectors begin to operate and both the primary and secondary injectors begin to pulse at the same pulse width.

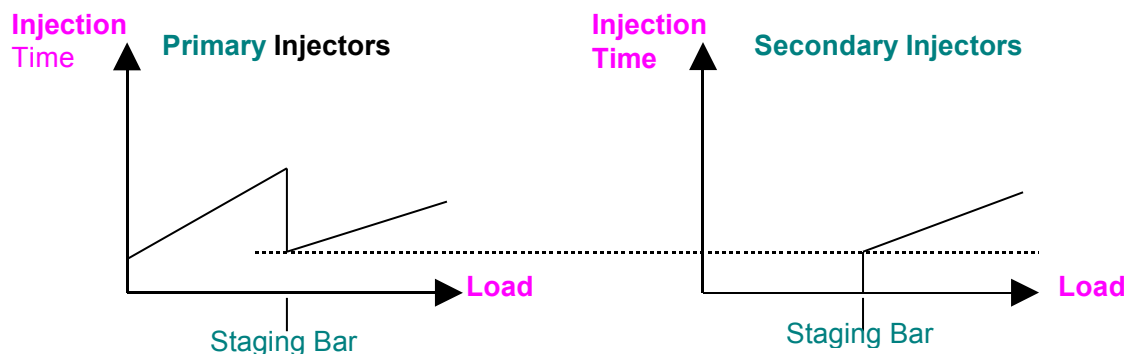


Figure 99

### Staged Injection Angle Split Map

This map only applies to Staged injection for rotary engines. When piston mode is used, the auxiliary injectors are pulsed at a fixed angle.

When staged fuel injection is enabled, the secondary injectors are often mounted further up the intake manifold tract. In order to tune the injection timing of the secondary injectors, it is desirable to fire them slightly ahead of the primary injectors. This map defines the timing split between the primary and secondary injectors. That is, a split angle of zero degrees will fire the secondary injectors at the same angle as the primary injectors. A value of 10 degrees in this map will cause the secondary injectors to fire 10 degrees after the primary injectors have fired.

### Staged Injection Map

The Staged Injection Map is a 32 bar map that goes across RPM. The bars in this map are additional load bars that are used in the interpolation on the way down from loads above the staging bar to loads below the staging bar.

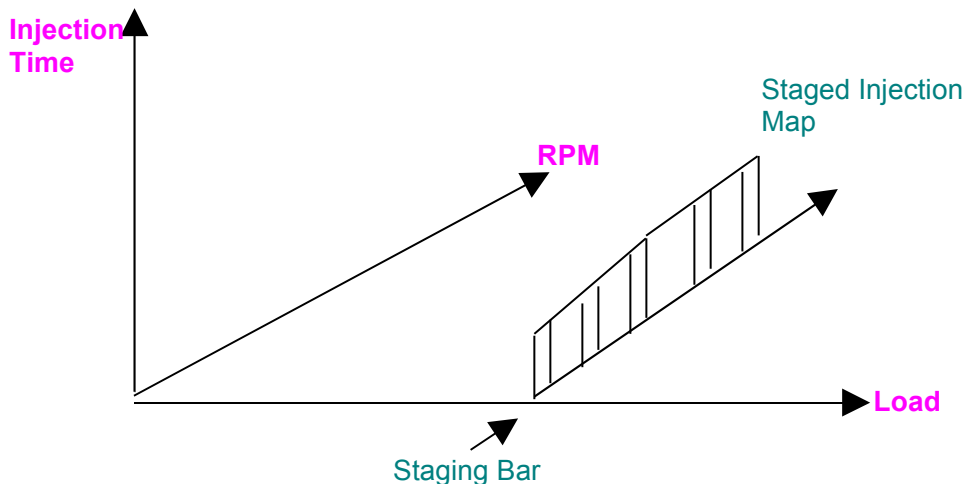


Figure 100

When setting up for staged injection, there is a discrete point at which the injection times must cross over when the secondary set of injectors turn on. In order to maintain steady mixtures, an additional load bar must be inserted for every RPM range, at the point where the staging injectors start. This is to allow the linear interpolation to calculate the correct fuel requirements when crossing the staging bar from low to high loads and when crossing from high to low loads.

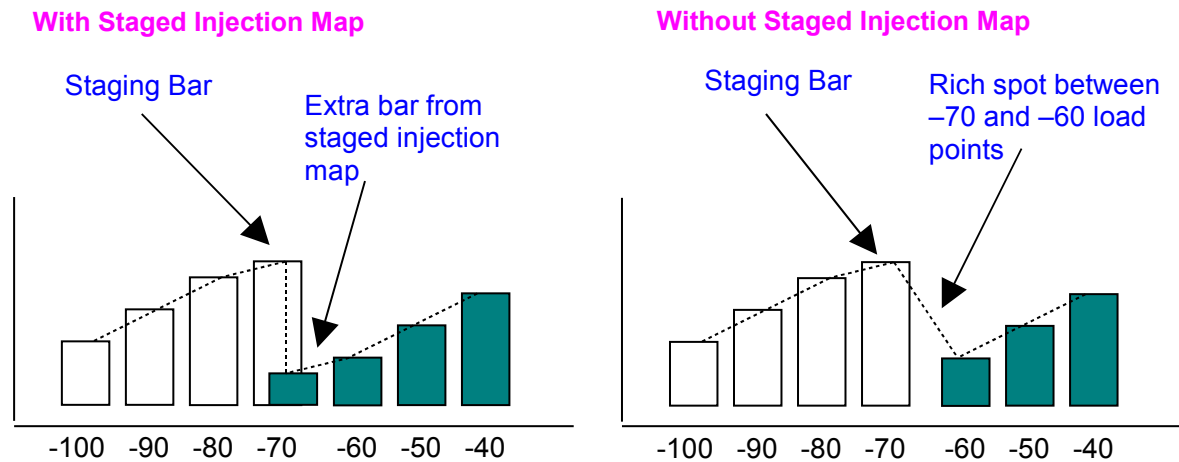


Figure 101

## O2 Closed Loop Tuning

### Narrow Band Sensors

By fitting an oxygen sensor to the exhaust system of an engine, the ECU is able to perform corrections based on feedback from the O2 sensor to maintain a consistent air-fuel ratio around the stoichiometric mixture. The stoichiometric mixture is when exact amount of fuel is provided to consume all the oxygen of the air drawn into the engine, without any unburnt fuel remaining after combustion. Using closed loop fuel control adapts for small variations in fuel quality and day-to-day running, provides better fuel economy and lower emissions. Closed loop control does not compensate for poor tuning however, and only allows for small mixture changes that are already close to the correct target mixture.

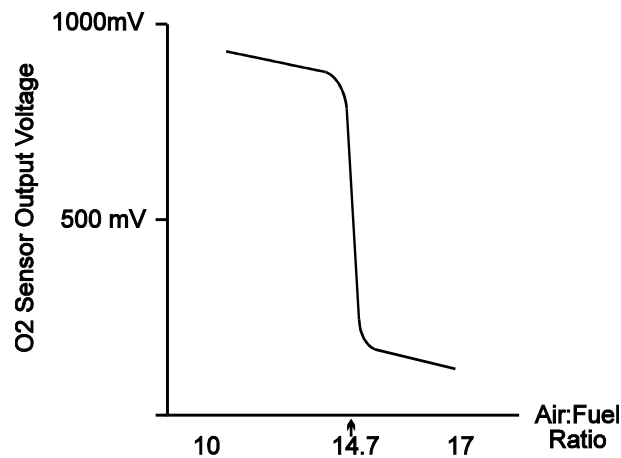


Figure 102 - Narrow Band O2 Sensor Output

### A Typical lambda sensor output

An oxygen sensor (or lambda sensor) is placed in the exhaust gas stream usually after the collector but before the catalytic converter. The O2 sensor possesses an output voltage characteristic similar to that in the diagram above. When the exhaust gas is free from oxygen (i.e.. mixture is rich), the sensor reads around 1 volt. When there is an excess of oxygen, the sensor reads closer to 0 volts. Most oxygen sensors' transfer curves change very suddenly around stoichiometric mixtures.

The object in closed loop control is to measure the voltage of the oxygen sensor, determine whether the engine is running lean or rich, and compensate accordingly by adjusting the injection time. The ECU may overcorrect slightly, and then will pull the mixture back towards the desired air-fuel ratio. This slight oscillation either side of stoichiometric mixture aids the function of the catalytic converter.

The characteristic of most narrow band sensors only enables accurate measurement about the stoichiometric mixture point. As a result, O2 closed loop is only useful under cruise and light load conditions where a stoichiometric mixture is desirable. Most narrow band O2 closed loop systems actively



detect only the cruise and light load conditions and only uses O<sub>2</sub> closed loop correction under these conditions. It is not recommended to use O<sub>2</sub> closed loop when under high loads and engine speeds where mixtures should be richer than stoichiometric to ensure cool operation of the engine and higher margins against detonation.

Closed loop operation is always disabled whenever there are other corrections operating such as throttle pump corrections, or deceleration cut enrichments. Closed loop control is also disabled until the Engine Operating Temperature threshold is exceeded.

In addition to above criteria, O<sub>2</sub> closed loop operation will not operate under the following conditions:

Throttle pump enrichment is active.

Engine is not above the operating temp threshold as defined in the Main Setup.

Deceleration Fuel cut is performing cut or enrichment operations.

**Fuel Setup**

**Decel Cut Parameter Group**

- ☐ Decel Cut Enable
- Fuel Return RPM: 1700
- Decel Cut Reset RPM: 2000
- Decel Cut Temp °C: 0
- Decel Cut Delay sec: 0.5
- Max Decel Cut Retard °BTDC: 8
- Decel Cut Enrich %: 10

**Maps Group**

- ☐ WOT Map Enable
- ☐ Zero Throttle Map Enable
- Fuel Map Select: Fuel Map 1

**Throttle Pump Group**

- ☒ Throttle Pumps Enable Setup

**Closed Loop Oxygen Sensor**

- ☒ O<sub>2</sub> Closed Loop Enable
- Low RPM Limit: 1600
- High RPM Limit: 3500
- Max Enrich Incr %: 10
- Max Enrich Decr %: 10
- ☐ Enable 3D Target AFR
- Target Volt (mV): 822.7
- Target Volt @ Idle (mV): 941.3
- Load Select: TPS
- Operating Temp °C: 69
- Throttle Limit (%): 20
- MAP Limit (kPa): 194.7
- Proportional: 0.00
- Integral: 1.00
- Sample Rate: 50 ms
- Idle RPM Below: 1000
- O<sub>2</sub> Sensor Type: Narrowband O<sub>2</sub> Sensor (0V to 1V)
- O<sub>2</sub> Warm-up Time (sec): 120
- Delay till Control (sec): 1

Figure 103 - Fuel Setup Page

## Settings

- **Low RPM Limit** - The minimum RPM at which O<sub>2</sub> control will happen. If this value is greater than 'Idle RPM Below' value then O<sub>2</sub> control at idle will be disabled.
- **High RPM Limit** - The maximum RPM at which O<sub>2</sub> control will happen. Having O<sub>2</sub> control off at RPM greater than this value will help to steady mixtures at high RPM, which are more sensitive to fluctuations.
- **Max Enrich Incr %** - Maximum percentage increase in fuel that is allowed by the O<sub>2</sub> controller. (Max 25%).
- **Max Enrich Decr %** - Maximum percentage decrease in fuel that is allowed by the O<sub>2</sub> controller. (Max 25%).
- **Target Volt (mV)** - This value is what the O<sub>2</sub> controller will try to target when at idle. Some engines require slightly richer mixtures to have a stable idle. With most sensors, this can be achieved by setting the target idle voltage slightly higher. The Haltech Wideband allows the user to enter in a target AFR instead.
- **Target Volt @ Idle (mV)** - This value is what O<sub>2</sub> controller will try to target. This is usually set to the

stoichiometric voltage of the O<sub>2</sub> sensor that is being used. Typically for a narrowband this is 600mV. The Haltech Wideband allows the user to enter in a target AFR instead.

- **Load Select** - Choose if TPS or MAP sensor or both will disable O<sub>2</sub> control. If set to both only one them has to fail for O<sub>2</sub> control to be disabled.
- **Throttle Limit (%)** - If load select is TPS or both, any throttle position above this percentage disables O<sub>2</sub> control.
- **MAP Limit (kPa)** - If load select is MAP or both, any MAP sensor reading above this value disables O<sub>2</sub> control.
- **Operating Temp °C** - O<sub>2</sub> control will only work above this coolant temperature.
- **Sample Rate** - The rate at which the controller will read the O<sub>2</sub> sensor and calculate the correction.
- **Proportional / Integral Settings** - Values are used to alter the gains and response of the controller.
  
- **Idle RPM Below** - When the engine speed is below this value and there is zero throttle then the O2 Target Idle Voltage is used. To disable the use of this parameter then set it lower than the '**Low RPM Limit**' value.
- **O2 Sensor Type** - Select the type of O<sub>2</sub> sensor that is being used.
- **O2 Warm-up Time (sec)** - A cold O<sub>2</sub> sensor voltage reading is always low. Set this value so that the sensor has enough time to reach operating temperatures.
- **Delay till Control (sec)** - This setting will delay when the closed loop O<sub>2</sub> control will start when all the conditions are met. This helps the controller stop cutting in and out when on the border of one of the conditions that need to be satisfied.

### Setup of Closed Loop O<sub>2</sub> Control

The following steps will guide you through methods to setup and tune your closed loop O<sub>2</sub>

#### Setup Using a Narrowband Sensor

- Ensure that your Fuel and Ignition maps are well tuned and warm your engine up to operating temperature.
- Tick the 'O2 Closed Loop Enable' checkbox and enter in values for the closed loop O<sub>2</sub> control. Check all the settings of the controller, the above values are a good place to start.
- Enter in the target voltage into the 'Target Volt (mV)' field and if being used the 'Target Volt @ Idle (mV)'.
- Reset the 'Integral' to zero.
- Adjust the 'Integral' until there is an oscillation at a frequency of 1 Hz (1 second to complete a cycle). A good way to check for this is to display the O<sub>2</sub> Correction in the trace view in the 'Data Log Page (Custom Engine Data)'.

#### Setup Using a Wideband Sensor

- Ensure that your Fuel and Ignition maps are well tuned and warm your engine up to operating temperature.
- Tick the 'O2 Closed Loop Enable' checkbox and enter in values for the closed loop O<sub>2</sub> control. Check all the settings of the controller, the above values are a good place to start.
- Enter in the target voltage into the 'Target AFR' field and if being used the 'Target AFR @ Idle'.
- Reset 'Proportional' and 'Integral' to zero.

- Increase the 'Proportional' value until the correction starts to oscillate. Bring the value back down to make it stop. A good way to check for this is to display the O<sub>2</sub> Correction in the trace view in the 'Data Log Page (Custom Engine Data)'.
- Repeat Step 5 for the 'Integral' value.

### 3D O2 Correction

If a calibrated wideband O2 sensor input is used with closed loop O2 control it is possible to have the ECU target different air to fuel ratios based on the engine RPM and Load conditions. The target AFR for each given load and RPM point is set in the 'target AFR map' found in the maps menu. To use this function the 'enable 3D target AFR map' checkbox must be ticked.

The 3D O2 correction map is not a replacement for correct engine calibration and relies on the base tune being close to the desired levels of fuel delivery.

## Ignition Correction Maps

### Air Temperature Correction

As the air temperature of the intake charge increases, so does the susceptibility of the engine to pinging or detonating. This Map allows up to 10° advance or retard of the spark timing based on the inlet air temperature. Normally this Map would not need to be used, but in some cases such as high inlet air temperatures on turbo/supercharged engine, retarding the spark may help preserve the engine.

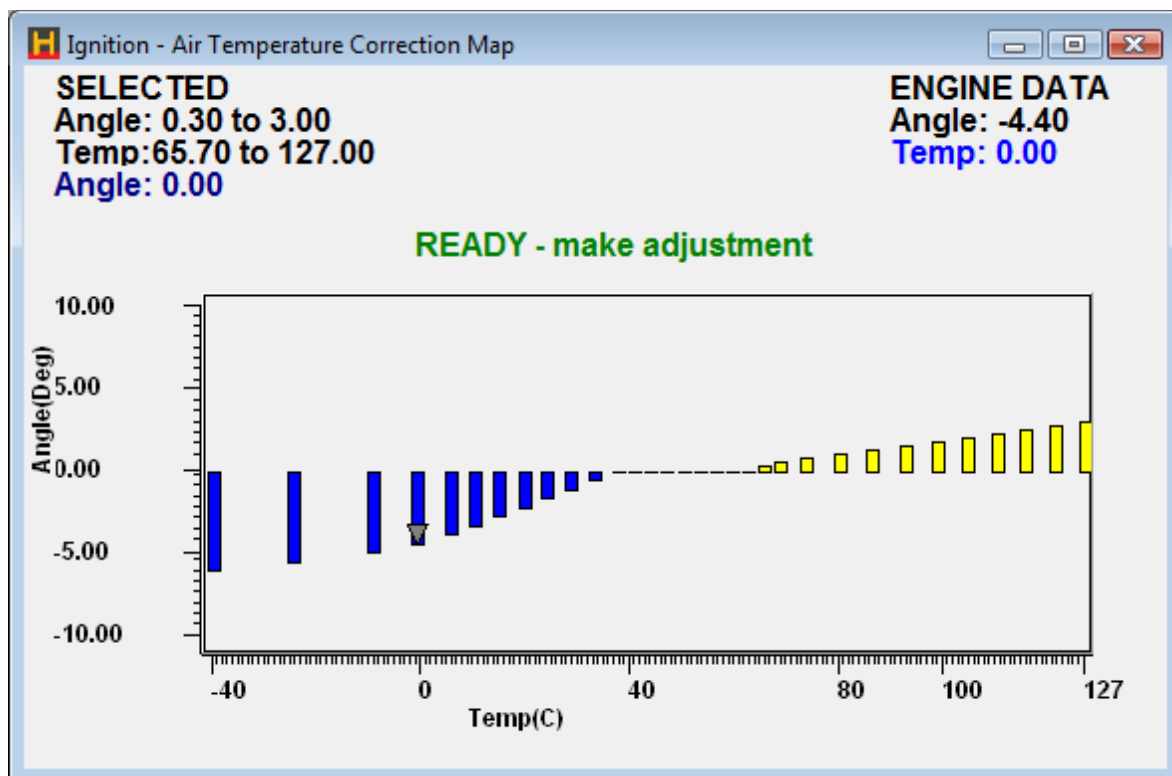


Figure 104 - Ignition Air Temperature Correction Map

### Coolant Temperature Correction

The Ignition Coolant Temp Map allows up to 10° advance or retard of the spark timing based on engine coolant temperature. This Map should only be used if there is a need to adjust the timing for low or high temperatures.

## Cranking Map

The ignition timing is taken from this map when the RPM is less than the value of the Max Cranking RPM parameter. See main setup section. If the timing is set too low, the engine will be difficult to start. If it is set too high, you may experience “back cranking” where an early ignition will cause the motor to stop cranking. Back cranking can cause damage to starter motors and the associated mechanism. Use extreme caution when raising the cranking ignition advance.

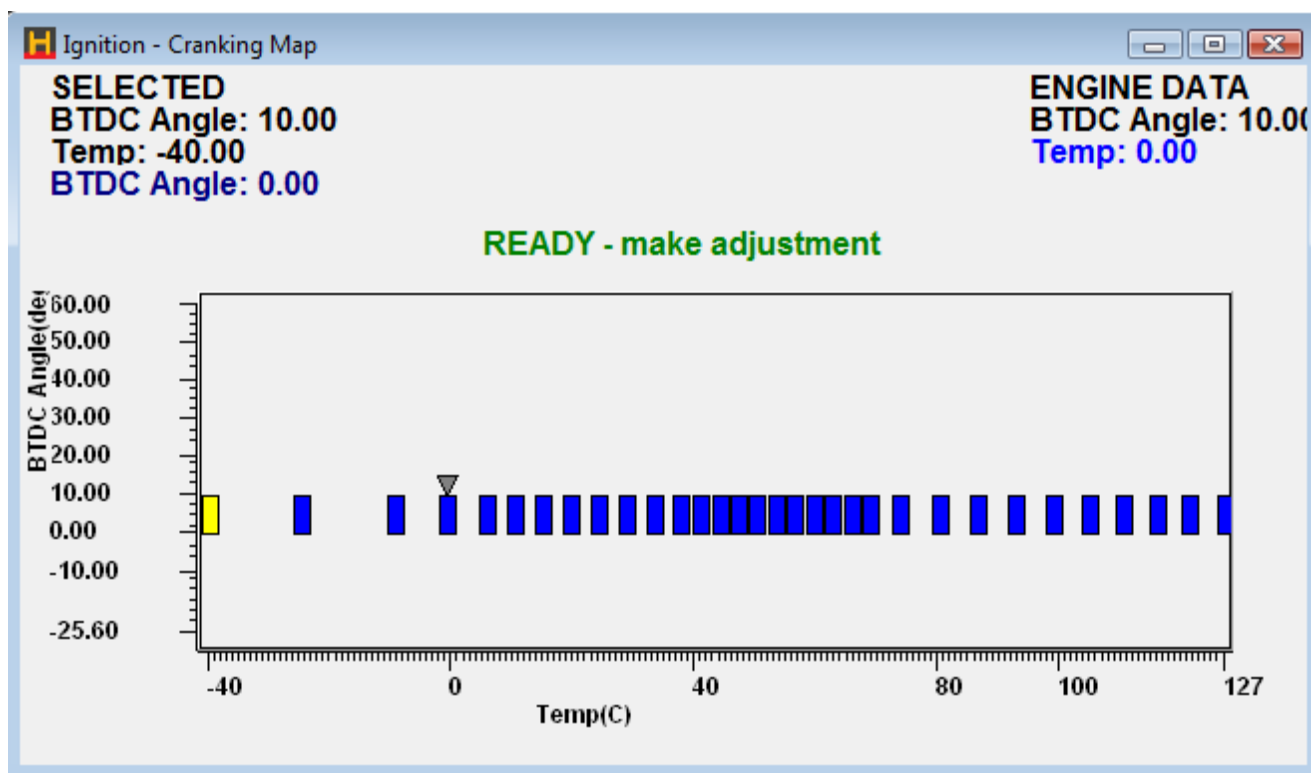
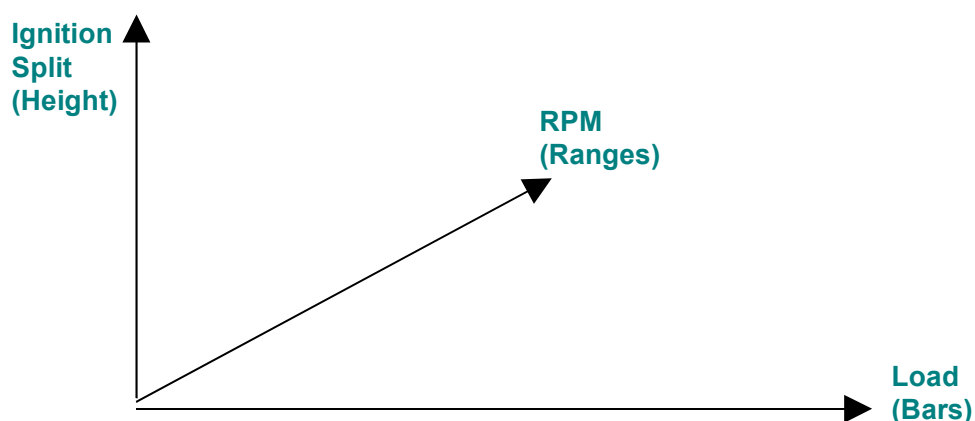


Figure 105 - Ignition Cranking Map

Use a conservative advance until the cold starting fuel requirements are well tuned.

## Rotary Engine Ignition Split Map



Common rotary engines run two spark plugs per rotor to ensure complete combustion in the relatively long combustion chamber. The primary aim of the trailing plug is to reduce emissions, but some minor power gains can be had from properly timing the trailing spark. The Rotary Engine Ignition Split Map allows you to program a split angle between when the leading spark is fired to when the corresponding trailing spark fires.

The height of this map is angle at which the trailing spark trails the leading spark. If a flat map at the height of 10 degrees is set, then the trailing spark will always fire 10 degrees after the leading spark. The Rotary Engine Ignition Split Map is a 3D map that allows adjustment depending upon load and engine speed. See Halwin User Guide section for details on the controls used to tune this map.

### Idle Control

#### BAC Idle Control Tuning

BAC valve idle control is used to hold steady the RPM when off the throttle. This method of controlling RPM at idle is done by looking at the difference between the target idle RPM and the current RPM and adjusting the BAC valve's output duty cycle until the difference is zero.

- **BAC Frequency** - Frequency that the BAC solenoid will run at.
- **Temperature Range** - There are two temperature values to be set, a cold temp and a warm temp. Coolant temperatures below the cold temp value will use target RPM, duty cycle and duty cycle offsets below it in the table. Coolant temperatures above the warm temp value will use target RPM, duty cycle and duty cycle offsets below it in the table. Any coolant temperatures between cold and warm temp will interpolate target RPM, duty cycle and duty cycle offsets between their cold and warm values.
- **Target RPM** - The RPM at which the Engine will idle.
- **Start Duty Cycle** - This is the duty cycle that the BAC valve will default to when the engine RPM is falling towards the 'Target RPM' and before it begins its idle control. This value should cause the engine to idle at a speed just above the 'Target RPM'. If this value is too low then the RPM will fall below the 'Target RPM'.
- **Minimum Duty Cycle** - The minimum duty cycle the BAC valve will reach when controlling the idle. Set so that the engine won't stall. This acts like a throttle stop.
- **Post Start Duty Cycle Offset** - On start up, this opens up the BAC valve to help start the engine by allowing more air. This value is added on to the 'Start Duty Cycle'. This new calculated value is used when the ECU is initialized and the engine is not running and also for the first three seconds of the engine running.
- **Air Con RPM Increment** - This value is added to the 'Target RPM'. It is done to handle the extra load when the air con is turned on. It is taken away again when the air con is turned off.
- **Air Con Duty Cycle Increment** - This value is added to the 'Start Duty Cycle'. It is done to handle the extra load when the air con is turned on. It is taken away again when the air con is turned off.
- **Idle Target Dead Band** - Used to stop the idle controller from 'over controlling' the idle due to the small fluctuations in RPM when idling. E.g. target RPM = 1000RPM, dead band = 50RPM, therefore if the engine RPM fall between 950RPM and 1050RPM then the idle controller will ignore any changes in RPM and considered it to be controlled. (E.g. 15 – 50 RPM).
- **Decel RPM Rate** - This value helps determine if the RPM is falling or steady when off the throttle. When the RPM is steady then it is ready to be controlled. If this value is set too low then the fluctuations of an RPM which is hovering consistently around one point will make the controller think that the RPM is never steady. If this is set too high then the RPM could be considered steady when it is still falling. (E.g. 25 – 50 RPM).
- **Decel to Idle Control Wait** - When the RPM has finished falling and has become steady, idle control will happen after this period of time.
- **On Throttle Duty Cycle** - When on throttle and off boost the BAC valve defaults to this duty cycle.

## Typical Values for BAC Valve

**Function Edit**  
**OutputPWM2**

Output State  
☐ Inverted ☒ Normal

Parameters Group

	Cold	Warm	
BAC Frequency	33		Hz
Temperature Range	60	80	°C
Target RPM	1100	850	RPM
Start Duty Cycle	70	50	%
Minimum Duty Cycle	1	1	%
Post Start Duty Cycle Offset	50	25	%
Air Con RPM Increment	100	100	RPM
Air Con Duty Cycle Increment	15	10	%
Idle Target Dead Band	50		RPM
Decel RPM Rate	25		RPM
Decel to Idle Control Wait	1		sec
On Throttle Duty Cycle	0		%

Adjust PID settings

Figure 106 - BAC Idle Control Parameters

**Setup of BAC Valve Idle Control**

The following steps will guide you through a method to setup and tune your idle control.

- Ensure that your Fuel and Ignition maps are well tuned and warm your engine up to operating temperature.
- Make sure that your throttle is properly calibrated so that throttle position in the engine data reads zero percent when you are completely off throttle.
- Check all the settings of the idle controller, the above values are a good place to start.
- The engine should idle around the 'Warm Target RPM', adjust this value to change at what RPM the engine will idle when warm
- Adjust the 'Warm Start Duty' so it is about 5 – 10% above where the BAC valve is sitting when the idle is controlled.

- Adjust the 'Warm Min Duty' so it is about 5% below where the BAC valve is sitting when the idle is controlled.
- Steps 4 – 6 will need to be repeated for when the engine is cold.

### Tuning Advance Sensitivity

#### *Starting Point for PID values*

- Proportional Co-efficient      50%
- Integral Co-efficient      50%
- Derivative Co-efficient      0%

### Tuning the PID Values

- Set all Proportional, Integral and Derivative to zero
- Bring up the Proportional in increments of 5% until you see a small oscillation in the RPM. Note: the RPM will not reach the target RPM with only the Proportional part of the controller being used.
- Bring up the Integral in increments of 5% until you cancel out the oscillation in the RPM. When the Integral part is introduced the RPM will go to the target.
- The Derivative term should remain at zero.

### Notes

If the idle speed fluctuates or oscillates, reduce the idle sensitivity parameters slowly until the oscillation stops. If the idle speed is slow to reach the target, increase the idle sensitivity parameters slowly until it begins to oscillate and then reduce the values slightly.

### Idle Troubleshooting

- When the engine is started check that the idle speed begins high and falls back to a stable idle speed around the target. Increase the '**Post Start Duty Offset**' if required to aid in starting.

### Stepper Motor Idle Control

Stepper motor idle control is used to hold steady the RPM when off the throttle. This method of controlling RPM at idle is done by looking at the difference between the target idle RPM and the current RPM and adjusting the stepper motor position until the difference is zero.

### Settings

**Stepper Motor Range** - The maximum travel in steps, which the stepper motor can move.

**Temperature Range** - There are two temperature values to be set, a cold temp and a warm temp. Coolant temperatures below the cold temp value will use target RPM, stepper position and stepper position offsets below it in the table. Coolant temperatures above the warm temp value will use target RPM, stepper position and stepper position offsets below it in the table. Any coolant temperatures between cold and warm temp will interpolate target RPM, stepper position and stepper position offsets between their cold and warm values.

**Target RPM** - The RPM at which the Engine will idle.

**Start Position** - This is the position that the stepper motor will default to when the engine RPM is falling towards the 'Target RPM' and before it begins its idle control. This value should cause the engine to idle at a speed just above the 'Target RPM'. If this value is too low then the RPM will fall below the 'Target RPM'.

**Minimum Position** - The minimum position the stepper motor will reach when controlling the idle. Set so that the engine won't stall. This acts like a throttle stop.



**Post Start Offset Position** - On start up, this opens up the stepper motor to help start the engine by allowing more air. This value is added on to the 'Start Position'. This new calculated value is used when the ECU is initialized and the engine is not running and also for the first three seconds of the engine running.

**Air Con RPM Increment** - This value is added to the 'Target RPM'. It is done to handle the extra load when the air con is turned on. It is taken away again when the air con is turned off.

**Air Con Steps Increment** - This value is added to the 'Start Position'. It is done to handle the extra load when the air con is turned on. It is taken away again when the air con is turned off.

**Idle Target Dead Band** - Used to stop the idle controller from 'over controlling' the idle due to the small fluctuations in RPM when at idle. E.g. target RPM = 1000RPM, dead band = 50RPM, therefore if the engine RPM fall between 950RPM and 1050RPM then the idle controller will ignore any changes in RPM and considered it to be controlled. (E.g. 15 – 50 RPM).

**Decel RPM Rate** - This value helps determine if the RPM is falling or steady when off the throttle. When the RPM is steady then it is ready to be controlled. If this value is set too low then the fluctuations of an RPM which is hovering consistently around one point will make the controller think that the RPM is never steady. If this is set too high then the RPM could be considered steady when it is still falling. (E.g. 25 – 50 RPM).

**Decel to Idle Control Wait** - When the RPM has finished falling and has become steady, idle control will happen after this period of time.

**On Throttle Stepper Position** - When on throttle and off boost the stepper motor defaults to this value.

**Stepper Motor Response** - Speed at which the stepper motor moves.

**Stepper Motor Control**

**Stepper Idle Control Group**

☒ Enable Stepper Idle Control

Stepper Motor Range: 200 Steps

	Cold	Warm	
Temperature Range	70.0	80.1	°C
Target RPM	1200	800	RPM
Start Position	100	50	Steps
Minimum Position	1	1	Steps
Post Start Position Offset	60	30	Steps
Air Con RPM Increment	100	100	RPM
Air Con Steps Increment	15	10	Steps
Idle Target Dead Band	25		RPM
Decel RPM Rate	25		RPM
Decel to Idle Control Wait	2		sec
On Throttle Stepper Position	0		Steps
Stepper Motor Response	Normal		
Advanced Sensitivity	Edit		

**Stepper Oil Control Group**

☐ Enable Stepper Oil Control

**Warning:** This feature is only applicable to rotary engines equipped with electronic oil metering pumps. Please ensure correct operation prior to starting your engine or contact Haltech technical support if you are unsure.

Feedback Min: 0 (default: 190)

Feedback Max: 1023 (default: 915)

☒ 2D Map ☐ 3D Map

**Note:** 3D Map uses the Generic Load RPM Map

**Manual Idle Stepper Motor Control**

☐ Enable Manual Stepper Motor Control

Current Stepper Motor Position: 0

closed ————— open

Apply OK Cancel

Figure 107 - Stepper Motor Idle Control Parameters

### Setup of Stepper Motor Idle Control

The following steps will guide you through a method to setup and tune your idle control.

1. Ensure that your Fuel and Ignition maps are well tuned and warm your engine up to above the warm temp in the 'Temperature Range'.
2. Make sure that your throttle is properly calibrated so that throttle position in the engine data reads zero percent when you are completely off throttle.
3. Tick the 'Enable Stepper Idle Control' checkbox and enter in values for the stepper motor. Check all the settings of the idle controller, the above values are a good place to start.
4. If the stepper motor range is unknown then tick the 'Enable Manual Stepper Motor Control' checkbox and hit the 'Apply' button. Start from about half way along the manual idle controller and increase the stepper motor position by 10 steps until there is no more change in RPM. Copy this value into the 'Stepper Motor Range'. If the end is reached of the manual controller, increase the 'Stepper Motor Range' value and continue increasing the stepper position.
5. Un-tick the 'Enable Manual Stepper Motor Control' checkbox and restart the engine. The engine should idle around the 'Warm Target RPM', adjust this value to change at what RPM the engine will idle when warm.
6. Adjust the 'Warm Start Position' so it is about 10 – 15 steps above where the stepper motor is sitting when the idle is controlled. The stepper position is shown in the 'Manual Idle Stepper Motor Control' box.
7. Adjust the 'Warm Min Position' so it is about 10 steps below where the stepper motor is sitting when the idle is controlled.
8. Steps 5 – 7 will need to be repeated for when the engine is cold.

### Tuning Advance Sensitivity

*Starting Point for PID values*

- Proportional Co-efficient      25%
- Integral Co-efficient      10%
- Derivative Co-efficient      0%

### Tuning the PID Values

1. Set all Proportional, Integral and Derivative to zero
2. Bring up the Proportional in increments of 5% until you see a small oscillation in the RPM. Note: the RPM will not reach the target RPM with only the Proportional part of the controller being used.
3. Bring up the Integral in increments of 5% until you cancel out the oscillation in the RPM. When the Integral part is introduced the RPM will go to the target.
4. The Derivative term should remain at zero.

### Notes

- If the idle speed fluctuates or oscillates, reduce the idle sensitivity parameters slowly until the oscillation stops. If the idle speed is slow to reach the target, increase the idle sensitivity parameters slowly until it begins to oscillate and then reduce the values slightly.

## Turbo Wastegate Control

### Description

The wastegate of a turbo is operated when the manifold pressure acting on the diaphragm within the wastegate actuator overcomes the return spring allowing exhaust gas to bypass the turbine. With electronic boost control, the object is to use a pulsating solenoid to bleed off the manifold pressure signal seen by the waste gate unit so that it can see only a fraction of the manifold pressure. The solenoid operates at constant frequency and the duty cycle is altered to control the drop in pressure signal through the device.

**Note:** Be sure to use air hose that is rated to the expected boost pressure. All fittings should be secured so that they will not disconnect under high pressures

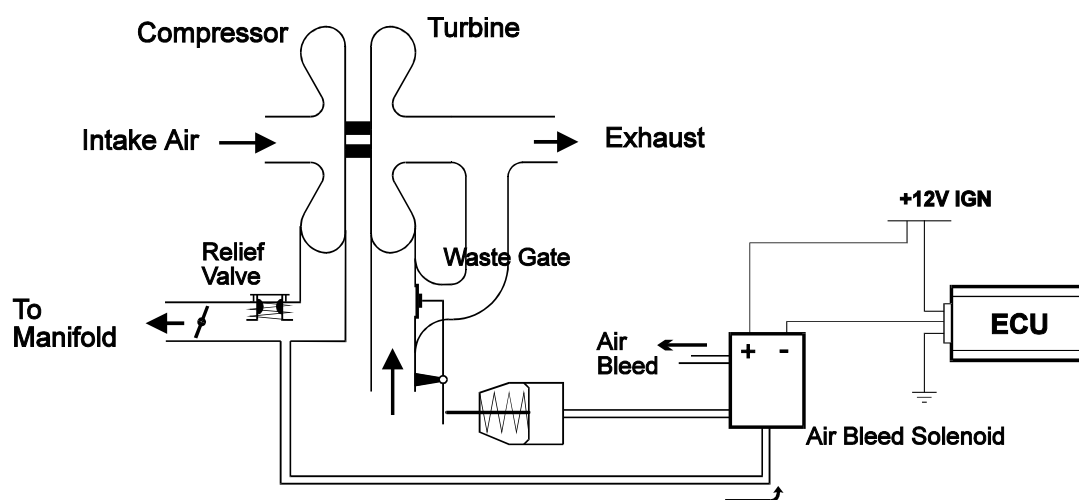


Figure 108 - Turbo Wastegate Control Plumbing

### Setting Wastegate control

See Auxiliary outputs section for details on how to setup wastegate control.

### Tuning the Wastegate map (open loop boost control)

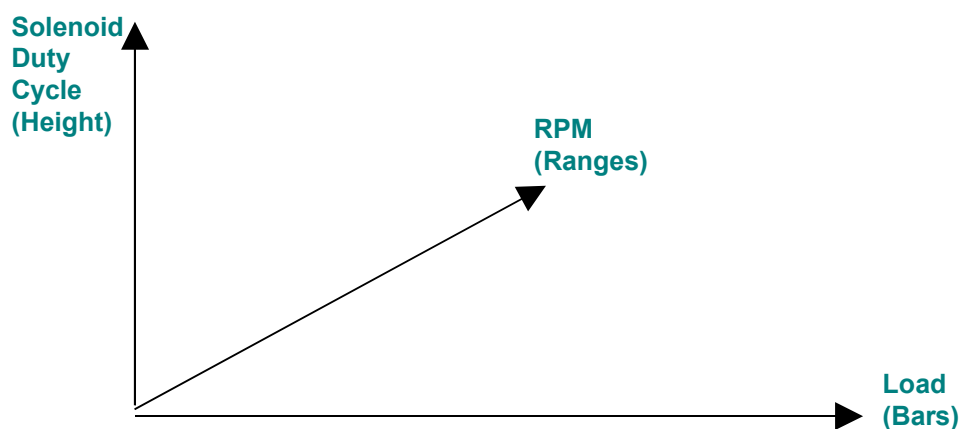


Figure 109

## WARNING

**Adjusting the boost levels for a turbo engine can alter its fuel requirements drastically. If the fuel requirements are not tuned simultaneously with changes in boost characteristics, engine damage could result. To avoid engine damage, watch your Air/Fuel ratios very carefully when increasing boost. Also check that your fuel system will be capable of delivering the required fuel for the increase in boost.**

The wastegate of a turbo is operated when the manifold pressure acting on the diaphragm within the wastegate actuator overcomes the return spring allowing exhaust gas to bypass the turbine. With electronic boost control, the object is to use a pulsating solenoid to bleed off the manifold pressure signal seen by the waste gate unit so that it can see only a fraction of the manifold pressure. The solenoid operates at constant frequency and the duty cycle is altered to control the drop in pressure signal through the device.

The turbo wastegate map allows boost to be increased over the standard boost that the turbo and wastegate combination provides. The turbo wastegate solenoid will only activate when it sees positive manifold pressure.

To setup the wastegate map, it will be necessary to iterate through several trial and error runs to ensure safe boost conditions. Use the following steps as a guide to setting up your Turbo Wastegate map:

Always start with small duty cycle settings and increase until the desired boost level is reached. Start with a flat map (same duty at all loads and speeds) at low duty settings and drive the car noting any increase in boost level. Watch you're A/F ratios very carefully when increasing boost for the first time as this part of the map will not have been tested if this engine has not been mapped at this boost level.

You can setup a flat map easily by selecting all bars then using 'v' to set a fixed value. Then use copy and paste to copy this range to all other ranges to achieve the flat map shape. Make sure you run the engine at the engine load and RPM at which maximum boost is typically reached.

Increase the duty of all the bars of the map and test-drive the engine once more. Again, make sure that your fuel maps are adjusted to ensure safe A/F ratios at every step. Repeat until the desired maximum boost is reached and not the duty cycle of the bars.

Now that you have set the maximum boost to the desired boost pressure, you can increase the duty cycle at all engine speeds and loads at which the boost pressure is below the desired maximum boost. This will help the engine reach its desired boost pressure quicker. This will alter the fuel requirements at these engine loads and speeds so watch you A/F ratios carefully and adjust your fuel maps to compensate if required.

### Closed Loop Boost Control

Closed loop boost control is a method of controlling boost where the difference between the target boost level and the current boost level is taken as an input to the controller and used to adjust the output, the duty cycle of the solenoid, accordingly. An advantage of closed loop boost control is it is more resilient to outside factors not part of the controller like air temperature making this form of control more consistent than the wastegate map.

**Function Edit**  
OutputPWM2

Output State  
☐ Inverted    ☒ Normal

Parameters Group

TWG Frequency	33	0-12000 Hz
Start Duty Cycle	65	0-100 %
Proportional Co-eff	2500	0-5000
Integral Co-eff	500	0-1000
Derivative Co-eff	0	0-1000
Control Point Before Target	20	0 - 600 kPa
Delay till Boost Control	0.5	0 - 10 sec
Start Duty by Map	<input type="checkbox"/>	
Use Boost Map 2	<input type="checkbox"/>	

Note: Start duty by map is best used with a varying target boost map, closed loop boost gear correction or with closed loop boost trim

Figure 110 - Closed Loop Boost Control Parameters

### Settings

- **TWG Frequency** - Frequency (Hz) that the waste gate solenoid will run at. A Typical value for the Haltech waste gate solenoid is a frequency of 20 – 30 Hz.
- **Start Duty Cycle** - This is the duty cycle that the waste gate will go to when closed loop boost control begins. This duty cycle should cause the boost to read somewhere below the target boost level. If this value is too high then the boost will overshoot the target boost level before it returns to the target. If too low the boost may dip down a bit before being controlled.
- **Control Point Before Target** - An offset in kPa or PSI from the target boost level at which boost control will begin. This value may be increased for applications where boost is made extremely quick and to give the controller more time to react. E.G. if the boost target is 120 kPa and the 'Control Point Before Target' is set to 20 kPa then boost control will begin at 100 kPa. Default 20 kPa or 3 PSI.
- **Delay till Boost Control** - Once the boost controller has reached the 'Control Point Before Target' it will hold at the start duty cycle for this amount of time before controlling boost. Default 0.5 sec.
- **Start Duty By Map** - When checked it will ignore the 'Start Duty Cycle' value above and base it off the Start Duty Map.
- **Use Boost Map 2** - Check this box to use 'Closed Loop Boost Target Map2' as the target map.
- **Start Duty Map** - Output Start Duty Cycle vs. Target Boost Level. This map can be used when the target boost level that the boost controller is aiming for changes each time it goes to control boost. Such situations where this map is needed are when using the closed loop boost control trim or gear boost correction.
- **Boost Target Map** - Output Target Boost vs. RPM. Allow the setting of different target boost levels over the range of RPM.
- **Proportional/Integral/Derivative** - Values are used to alter the gains and response of the controller. Derivative should remain at zero.

### Setup of Closed Loop Boost Control

- Set the 'Closed Loop Boost Target Map' at the boost level that you want to run across the whole RPM range.
- Setup the closed loop boost control in the *Auxiliary Outputs Page*. Click the 'Adjust PID settings' edit button and check that the Proportional, Integral and Derivative Coefficients are all set to their default values. (Proportional – 50%, Integral – 50% and Derivative – 0%)
- Set the frequency of the Turbo Waste Gate solenoid in the 'TWG Frequency' field. The Haltech waste gate solenoid runs at a frequency of 20 – 30 Hz.
- Set the 'Control Point Before Target' to the default value of 20 kPa (3 PSI).
- Set the 'Delay till Boost Control' to the default value of 0.5 sec.
- Set the 'Start Duty Cycle' to a duty cycle that should get you close to your boost target.
- Put the engine under sufficient load (i.e. on a dyno) to get it to reach the target boost level. Watch to make sure it does not over boost. Also make note of the duty cycle that the waste gate runs when at the target boost level, this can viewed in the *Auxiliary Output Data Page*. If the boost level exceeds the target boost level reduce the 'Start Duty Cycle', if the boost dips down before going back up then try increasing the 'Start Duty Cycle'.
- If you boost level oscillates around the boost target try reducing the Proportional and Integral values until the boost is more stable. Proportional and Integral can be reduce by the same amount.

### Setup of the Start Duty Map

If the boost target will be varying each time the engine goes on boost, by either a boost trim or gear boost correction then it is a good idea to setup the 'Start Duty Map'.

- At first leave the 'Start Duty By Map' un-ticked. Set the 'Closed Loop Boost Target Map' to control somewhere above the boost if only running off the waste gate spring.
- Repeat steps 5 and 6 above and record the 'Start Duty Cycle' and the corresponding boost target.
- Increment the 'Close Loop Boost Target Map' by about 25 kPa (3.5 PSI) and repeat until you reach the max boost that the engine is going to run.
- Fill out the 'Start Duty Map' with the data recorded. Run a duty cycle of zero below the spring pressure. Run a duty cycle of the max recorded 'Start Duty Cycle' above the max boost that the engine is run.
- Tick the 'Start Duty By Map' in the closed loop boost control setup.
- (Optional) To fine-tune the 'Start Duty Map' setup a closed boost control trim under the *analog input function page* and load up the engine at different boost levels to make sure that the boost control runs smoothly.



## Variable Cam Timing Control

Variable cam timing control will control the angle at which the cam operates according to what RPM and Load the engine is currently at. The idea behind cam control is to move the position of the cam to a certain angle that will change the efficiency of the engine and therefore improve the power made across a certain RPM range where the extra power wouldn't normally be made with a static cam. Variable cam timing control won't necessarily improve the maximum power but help stretch it out over a wider range of RPM.

**Figure 111** shows 4 dyno runs which held the cam at different positions, 0°, 10°, 20° and 30° cam degrees. The first run (in red) at 0 degrees shows the maximum power was made roughly at 6500 RPM whereas the last run (in purple) at 30 degrees shows its maximum power at about 5500 RPM. The runs at 10 degrees (in blue) and 20 degrees (in green) show their maximum power as being between the 0 degree run and the 30 degree run. With the variable cam timing it is possible to start the cam angle at 30 degrees up to 5500 RPM and gradually move it down to 0 degrees when the engine goes to 6500 RPM and therefore stretch out the RPM range where the maximum power is made. Note there is also extra power made in the mid range of the RPM with the cam advance to 30 degrees.

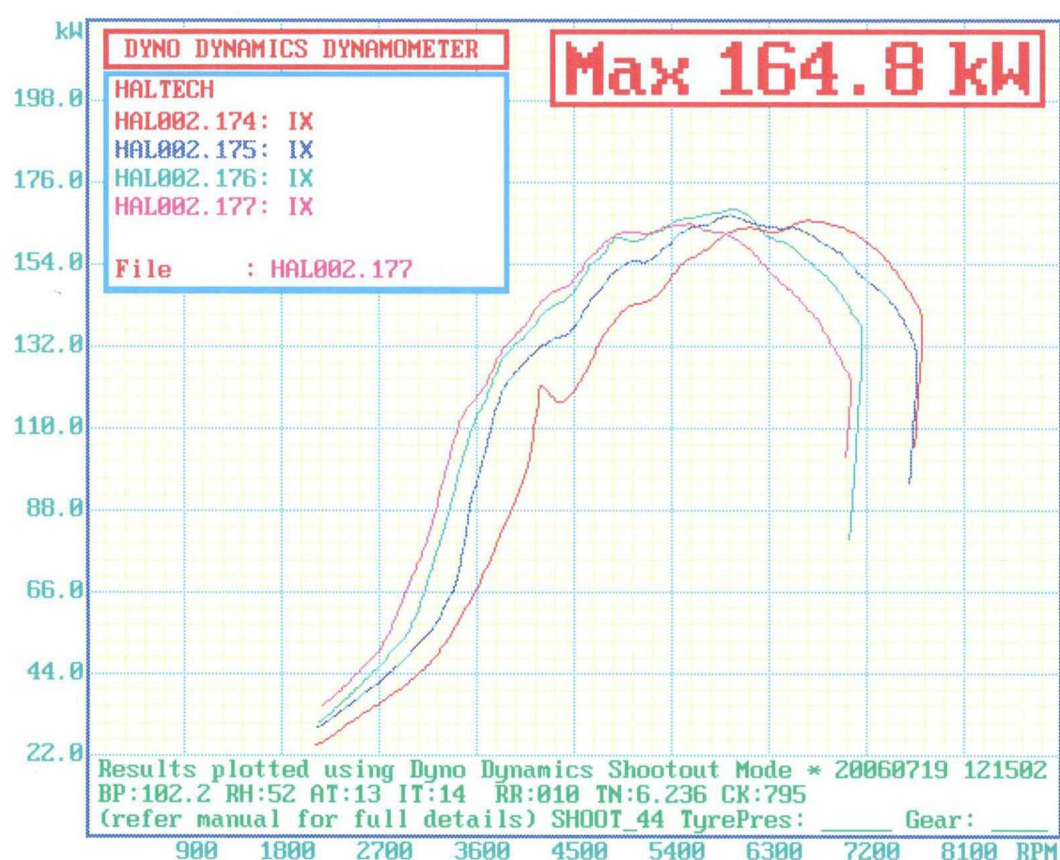


Figure 111 - Dyno runs at 0° (red), 10° (blue), 20° (green) and 30° (purple) cam degrees.

### **WARNING!!!**

Haltech provides the ability to control the cam timing but Haltech takes no responsibility for any damage that may occur due to the cam position causing valve to piston or valve to valve interference.

Cam input will require external hardware filtering and a flyback diode. Plug-in looms already have the hardware filtering and flyback diode built into them. If you are attempting variable cam control without the use of a plug-in loom please contact Haltech for assistance.

### Settings

#### *Cam Input Settings*

- **Edge** - Selects if the signal triggers off the falling or rising edge. Changing edges will require a reset.
- **Cam Trigger Angle** - The angle between TDC and when the intake cam is at its most retarded position.
- **RPM Filter Start** - The RPM at which the software filtering done by the ECU begins.
- **Min Angle** - When the software filtering starts any angle that the ECU sees below this value is considered erroneous.
- **Max Angle** - When the software filtering starts any angle that the ECU sees above this value is considered erroneous.

#### *Cam Output Settings*

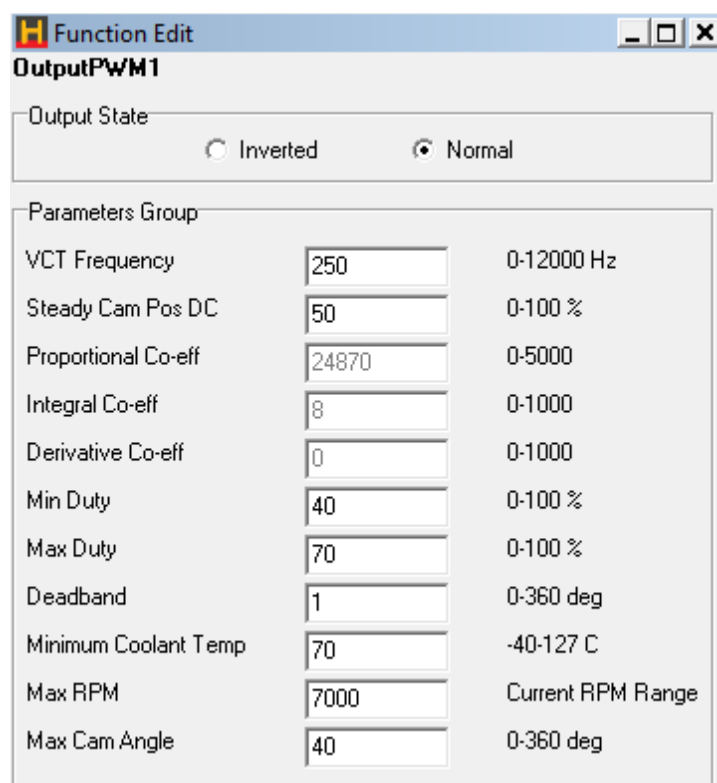
- **VCT Frequency** - Frequency at which the variable cam timing solenoid runs at.
- **Steady Cam Pos DC** - This value is the duty cycle that will keep the cam in a fixed position. Will be somewhere around the 50% point. This value is best set when the engine is up at operating temperatures.
- **Min Duty** - The minimum duty the controller will output to the VCT solenoid. Generally 10% less than the 'Steady Cam Pos DC'. I.e. if the 'Steady Cam Pos DC' is equal to 45% then the 'Min Duty' will equal 35%.
- **Max Duty** - The maximum duty the controller will output to the VCT solenoid. Generally 10% more than the 'Steady Cam Pos DC'. I.e. if the 'Steady Cam Pos DC' is equal to 45% then the 'Max Duty' will equal 55%.
- **Deadband** - Area around the target cam angle which the controller stops controlling. E.g. target cam angle = 10deg, deadband = 1deg, therefore if the cam angle falls between 9deg and 11deg then the variable cam controller will ignore any changes in cam angle and considered it to be controlled.
- **Min Coolant Temp** - The minimum coolant temp that the variable cam timing controller will work. Below this the output duty cycle will be zero.
- **Max RPM** - The maximum RPM that the variable cam timing controller will work. Above this RPM the output duty cycle will always be zero.
- **Max Cam Angle** - Any value in the '**VCT Cam Angle Map**' that goes above this will be clamped by the output to this value.

### Default Settings

#### *Cam Input Settings:*

- **Edge**    Vehicle Dependent
- **Trigger Angle**    Vehicle Dependent
- **RPM Filter Start**        3000    RPM





Parameters Group		
VCT Frequency	250	0-12000 Hz
Steady Cam Pos DC	50	0-100 %
Proportional Co-eff	24870	0-5000
Integral Co-eff	8	0-1000
Derivative Co-eff	0	0-1000
Min Duty	40	0-100 %
Max Duty	70	0-100 %
Deadband	1	0-360 deg
Minimum Coolant Temp	70	-40-127 C
Max RPM	7000	Current RPM Range
Max Cam Angle	40	0-360 deg

Figure 112 - Variable Cam Timing Control Parameters

### Variable Cam Timing Control Setup

If the cam timing fluctuates or oscillates, reduce the PID parameters slowly until the oscillation stops. If the cam timing is slow to reach the target, increase the PID parameters slowly until it begins to oscillate and then reduce the values slightly. The derivative term will usually stay at zero.

1. Zero the VCT Cam Angle Map and make sure the engine is up to operating temperatures.
2. Enable the VCT Control Input and set up the values or use the default values as stated above. Adjust the trigger angle value until the cam angle reads 0 degrees (Make sure that the VCT Control Output is off).
3. Enable the VCT Control Output and set up the values or use the default values as stated above. Make sure that the cam angle stays around 0 degrees. If you find the cam angle increasing before coming steady try decreasing the 'Steady Cam Pos DC'.
4. Increase the VCT Cam Angle Map by 10 degrees to make sure the cam position follows it.
5. Do dyno runs at 0 degrees cam angle and at every 10 degree increment up to the maximum cam angle that can be used.
6. Fill out the map so that the cam angle produces the maximum power at any given RPM and load.

### Tuning PID Settings

5. Set all Proportional, Integral and Derivative to zero
6. Bring up the Proportional in increments of 5% until you see a small oscillation in the cam timing. Note: the cam timing will not reach the target cam timing with only the Proportional part of the controller being used.
7. Bring up the Integral in increments of 5% until you cancel out the oscillation in the cam timing. When the Integral part is introduced the cam timing will go to the target.
8. The Derivative term should remain at zero.

## Tuning Tips

- If using a VCT input signal coming through on the home 'VCT Control Input 1' is disabled.
- The trace view in the 'Data Log Page' is a good tool to use to see the cam position follow the target position.
- In the area in the map where the load is equivalent to the engine at idle and a few bars above it, set it across the whole RPM range, to 0 degrees cam angle. Linearise between the edge of this section and about 20 kPa above it across the RPM range to smooth out the map. (Tip: Linearise each RPM section individually). This will help improve economy when cruising and also gives a smooth idle.

## Anti-Lag Output

Anti lag can be used in two ways Rally Mode and Launch Mode:

**Warning:** Using anti-lag on your engine can cause overheating of engine, exhaust system and valve train. Additional stresses on engine and driveline can cause damage and possible failure of gearbox, drive shafts, differentials, clutch and or crankshaft. **Only experienced operators should attempt to use this feature.**

The purpose of the **Rally Application** of anti-lag is to reduce turbo lag by keeping the turbo spinning during gear changes and off throttle situations. This is achieved by enriching fuel and retarding the timing under these conditions, to raise exhaust flow to keep the turbo spinning quickly.

To ensure that there is enough exhaust flow during gear changes when the throttle is closed, it is often required to setup the throttle plate, or idle control valve to flow a lot of air. To maintain a reasonable idle speed when the throttle/idle valve is setup in this manner, **Rotational Idle** can be activated. Rotational Idle keeps the RPM low, even with high airflow, by dropping injection events in a 'rotation' between the cylinders.

The screenshot shows the 'Anti-Lag Setup' window with the 'Rally Application' tab selected. The 'Rally Application Settings' section is expanded, showing various parameters for the Rally Application. The 'Activation Method' section at the bottom has three radio buttons: 'TPS Only', 'Switch Only', and 'TPS and Switch', with 'TPS and Switch' being selected.

Rally Application Settings					
<input checked="" type="checkbox"/> Rally Application Enable					
Fuel Enrichment	50.0	%	Absolute Ignition Retard	20.0	deg
Min Coolant Temp	90.4	°C	Max Coolant Temp	110.1	°C
Min Throttle Position	5.0	%	Max Throttle Position	70.0	%
Max Anti-Lag Time	5.0	sec	Min RPM for Anti-Lag	3000	RPM
Anti-Lag Idle Opening	50.0	%	Rot-Idle Idle Opening	90.0	%
Rot-Idle Start RPM Cut	1000	RPM	Rot-Idle End RPM Cut	1500	RPM

Activation Method:

☐ TPS Only   
 ☐ Switch Only   
 ☒ TPS and Switch

Figure 113 - Rally Application of the Anti-Lag System Setup Page

## Settings

- **Fuel Enrichment** - The percentage enrichment of fuel when anti-lag is on. Extra fuel is added to help reduce the combustion temps.
- **Absolute Ignition Retard** - The ignition timing in degrees after top dead centre when anti-lag is on.
- **Min Coolant Temp** - Anti-lag will only activate above this coolant temperature.
- **Max Coolant Temp** - Anti-lag will only activate below this coolant temperature.
- **Min Throttle Position** - Rotational idle will only activate below this throttle position. If anti-lag has been set it will start when below this throttle position.
- **Max Throttle Position** - If the activation method for the anti-lag is 'TPS Only' or 'TPS and Switch', the anti-lag will be set for use when it exceeds this value.
- **Max Anti-Lag Time** - If the activation method for the anti-lag is 'TPS Only' or 'TPS and Switch', the anti-lag will only run for this duration.
- **Min RPM for Anti-Lag** - Anti-Lag will only activate above this RPM.
- **Anti-Lag Idle Opening BAC idle control** - The solenoid will run at this duty cycle when anti-lag is on.
- **Stepper motor idle control** - The stepper motor will move to this percentage of the stepper motor range when anti-lag is activated.
- **Rot-Idle Idle Opening BAC idle control** - The solenoid will run at this percentage duty cycle during rotational idle.
- **Stepper motor idle control** - The stepper motor will be at this percentage of the stepper motor range during rotational idle.
- **Rot-Idle Start RPM Cut** - Rotational Idle begins at this RPM. Set this to your minimum desired idle speed. Set to zero to disable Rotational Idle.
- **Rot-Idle End RPM Cut** - Rotational Idle end at this RPM. Set this to your maximum desired idle speed. Set to zero to disable Rotational Idle.
- **Activation Method**
  1. *TPS Only* - By exceeding the Max Throttle Position the anti-lag is set and ready to use.
  2. *Switch Only* - Anti-lag is activated whenever the switch is turned on.
  3. *TPS and Switch* - The switch must be on and the throttle position must exceed the Max Throttle Position for the anti-lag to be set.

Antilag input should be wired as follows when using an additional air valve to increase airflow to the manifold. the Aux input needs to be set to "anti-lag enable" and the PWM output set to "antilag valve".

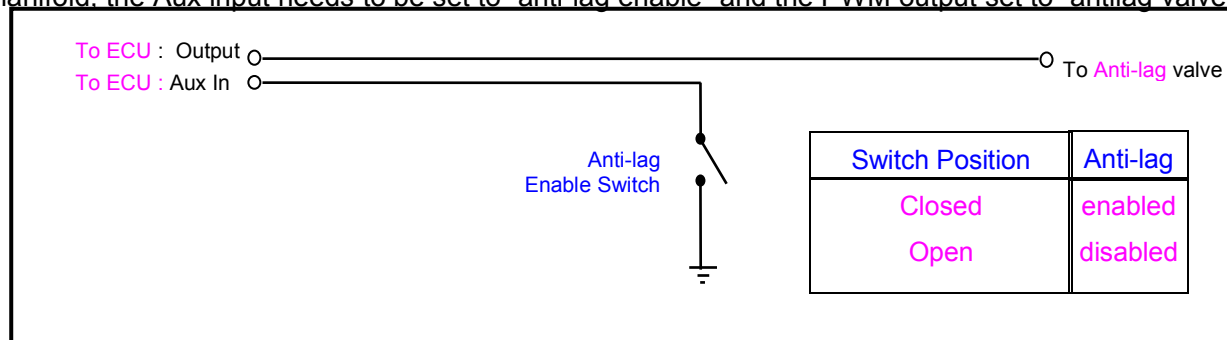


Figure 114 - Antilag Aux Input Wiring

**Warning:** Using anti-lag on your engine can cause overheating of engine, exhaust system and valve train. Additional stresses on engine and driveline can cause damage and possible failure of gearbox, drive shafts, differentials, clutch and or crankshaft. Only experienced operators should attempt to use this feature.

**Launch Application** of anti-lag is to help build boost when the throttle is open but the engine is not loaded. This is achieved by enriching fuel and retarding the timing under these conditions, to raise exhaust flow to the turbo. The engine speed is controlled to the desired RPM by dropping injection events in a 'rotation' between the cylinders.

Launch application of anti-lag will begin when the car is below a certain road speed, the throttle position is above a certain percentage and the '**Anti-Lag Launch App Switch**' digital input is on. This digital input is needed for it to work and is usually setup like a clutch switch.

**Anti-Lag Setup**

Rally Application | Launch Application

Launch Application Settings

☒ Launch Application Enable

Launch Start RPM Cut: 6000 RPM      Launch End RPM Cut: 6500 RPM

Fuel Enrichment: 50.0 %      Absolute Ignition Retard: 20.0 deg

Min Coolant Temp: 90.4 °C      Road Speed Threshold: 10.0 km/h

Max Throttle Position: 90.0 %

Enable On/Off Switch: ☐

Rev Limit Select:

☒ Fuel      ☐ Ignition

Apply      OK      Cancel

Figure 115 - Launch Application of the Anti-Lag System Setup Page

## Settings

**Launch Start RPM Cut** - The minimum desired RPM to launch to vehicle. Rotational fuel cut begins at this RPM.

**Launch End RPM Cut** - The maximum desired RPM to launch the vehicle. Fuel is hard cut to all cylinders above this RPM.

**Fuel Enrichment** - The percentage enrichment of fuel when anti-lag is on. Extra fuel is added to help reduce combustion temps.

**Absolute Ignition Retard** - The ignition timing in degrees after top dead centre when anti-lag is on.

**Min Coolant Temp** - The anti-lag will only work above this coolant temperature.

**Road speed Threshold** - The anti-lag can only activate below this road speed.

**Max Throttle Position** - The throttle position must be greater than this value for the anti-lag to turn on.

**Enable On/Off Switch** - This is a second digital input that can be enabled that acts as an override switch can be added to disable the launch application of the anti-lag system.

**Rev Limit Select** - Can select between a fuel or ignition soft cut for limiting the RPM during anti-lag.

Anti-Lag becomes operational when the TPS, RPM and Coolant Temp requirements are met. If you have enabled the "Use Aux In" parameter, then anti-lag will only operate an input is correctly configured for anti-lag enable, and the input is in the active state.

## Halwin User Guide

### Basic Windows Conventions

The Halwin software is written to run in the Windows Operating environment, which means that it follows the same basic conventions that most Windows applications use.

### Halwin Menu Structure

All of the windows, maps and settings can be accessed via the menu shown at the top of the Halwin software screen. These menus can be accessed in the usual methods with the mouse, or by pressing the 'Alt' key on the keyboard together with the letter that is underlined in the menu heading. Example: To access the Maps menu, press and hold down the 'Alt' key while pressing the 'M' key on the keyboard.

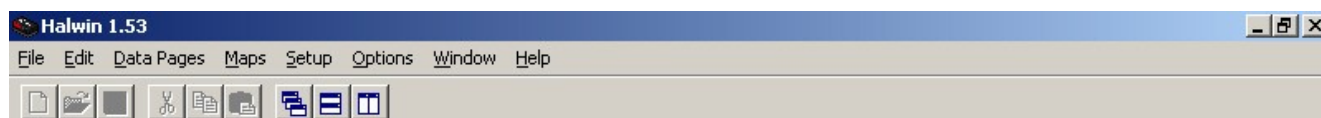


Figure 0-116

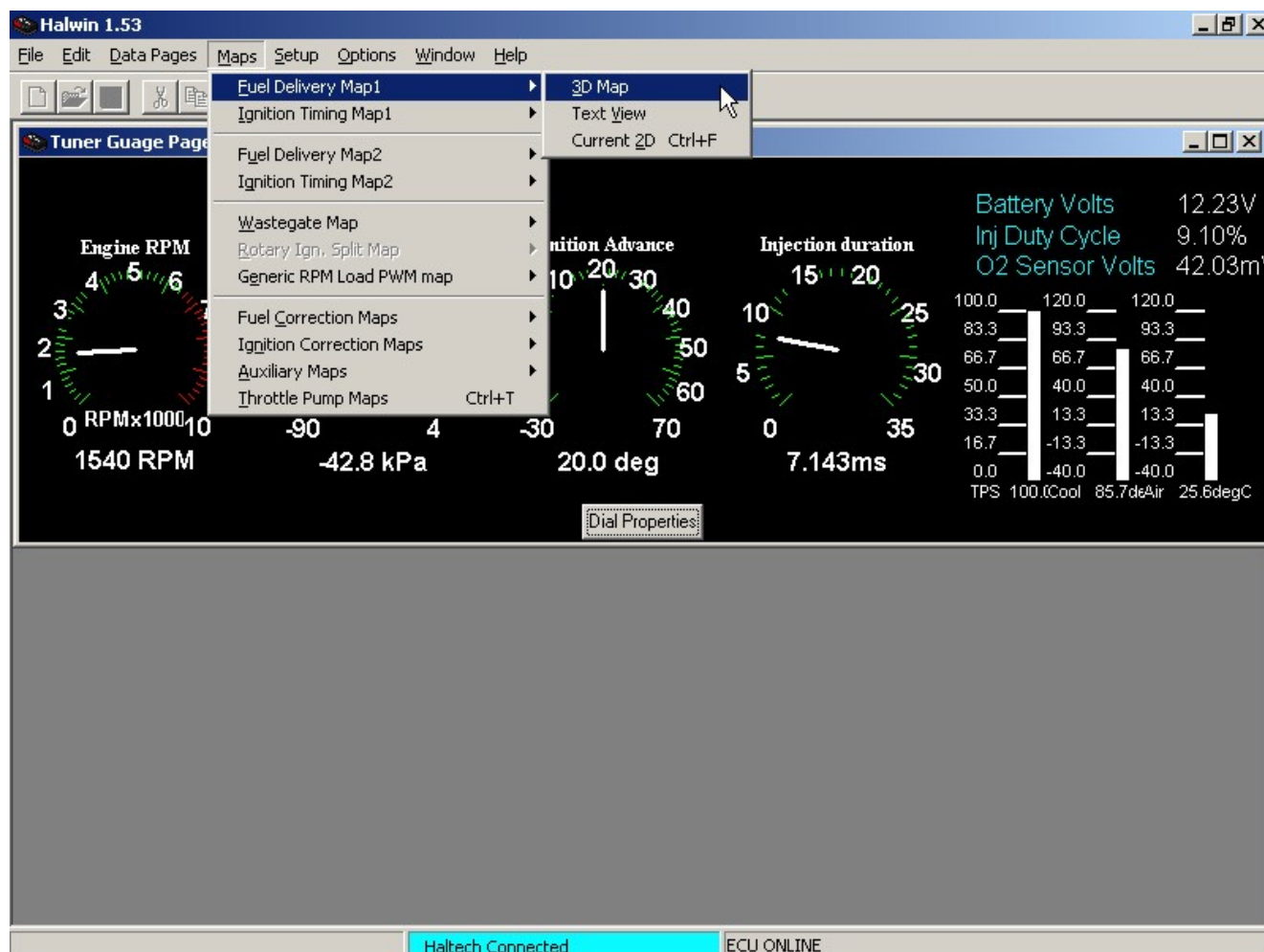


Figure 117 - Halwin Menu Structure

After opening the maps menu, you can open further sub menus by hitting the underlined letter of any sub menu that you wish to open. Example: Hitting 'Alt-M-F-2' will open a 2D view of Fuel Delivery Map 1.

### Managing Your Sub Windows

The Halwin software uses a 'Multiple Document Interface (MDI)' that allows many sub windows within the Halwin main window. To show what windows you have open, you can open the 'Window' menu to display

a list of sub windows that you can select from. When you select one of these windows from this menu, the program will bring it to the front of all the other windows.

To toggle through all the windows with keystrokes, you can use Ctrl-Tab to flip through all your open windows much like Alt-Tab is used for the main windows. Likewise Ctrl-F4 will close any sub window that you have open.

## Gauge and Engine Data Pages

### Gauge Page

The gauge page displays the most typical engine running information to allow you to see the general status of your engine. You can open this page by selecting it through the Page menu or by pressing 'Ctrl-G'.



Figure 118 - Gauge Page

#### Visual Features

The engine RPM gauge can be setup to show a Redline to suit the engine being tuned. The needle and the numeric display will turn red when this RPM is reached or exceeded. The scale will show the Redline at the nearest 1000 RPM.

The 'Dial Properties' button allows the Redline of the Engine RPM gauge to be altered to suit.

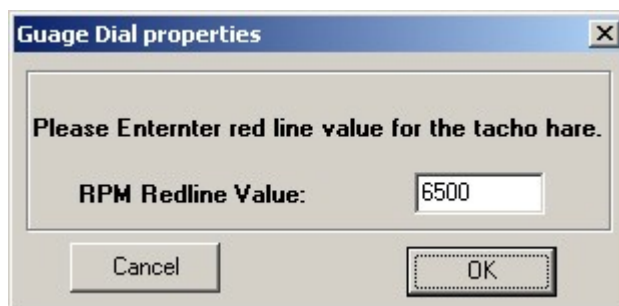


Figure 119 - RPM Gauge Redline Value

The temperature bar graphs will also turn red at fixed temperatures.

When coolant temperature exceeds 100 degrees, the coolant temperature bar will turn red. When air intake temperature exceeds 100 degrees, the air temperature bar graph will turn red.

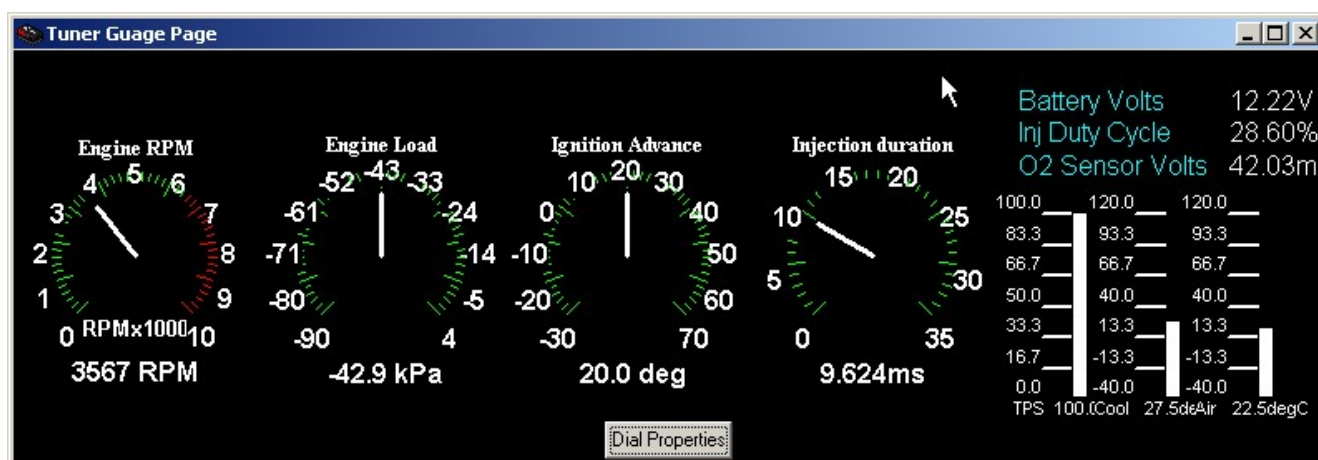


Figure 120 - Tuner Gauge Page

### Engine Data

The Engine Data panel displays the engine running data in numeric form. You can open this page by selecting it through the Page menu or by pressing 'Ctrl-E'.



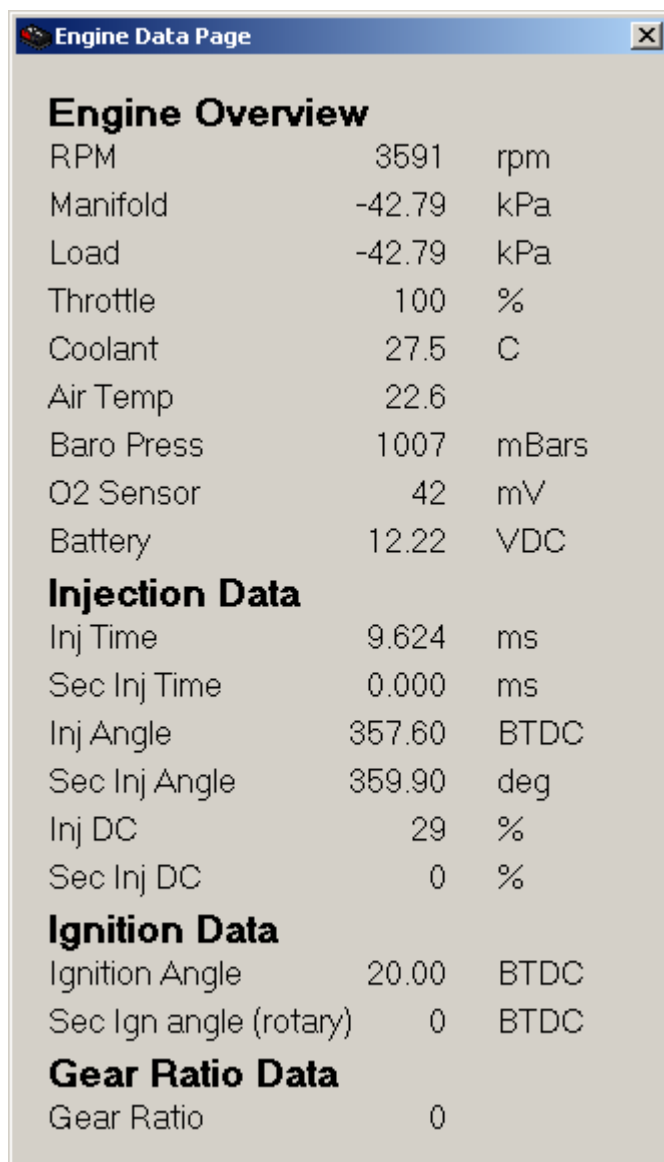


Figure 121 - Text Engine Data Page

### Correction Data Page

The Correction Data Page allows you to view all correction values at a glance. This is primarily used to aid in initial tuning to ensure that there are no corrections applied when tuning the base maps. In later tuning, this page gives a good overall view of how much interaction each correction map is playing during engine running.

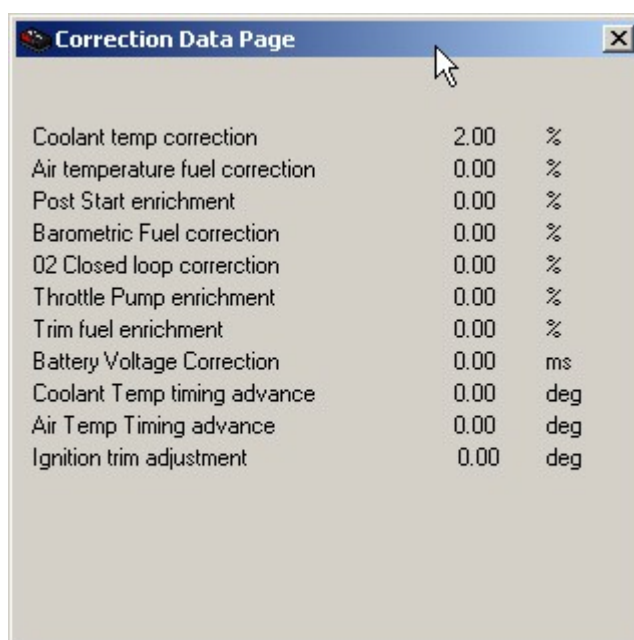


Figure 122 - Corrections Data Page

### Auxiliary Outputs Data Page

The Auxiliary Outputs Data Page gives the output status of all configured outputs that have been enabled. If the output channel has not been configured, that data will show the default status of zero frequency, zero duty and an off state.

If a channel is configured for a PWM function, then the digital state will remain in its default state of off.

If a channel is configured for a discrete (on or off) type of output, then the duty and frequency will remain in their default zero state.

Auxiliary outputs options data page			
Channel	Freq (Hz)	Duty (%)	Digital State
Ignition 1	0	0	Off
Ignition 2	0	0	Off
Ignition 3	0	0	Off
Ignition 4	0	0	Off
Ignition 5	0	0	Off
Ignition 6	0	0	Off
Injector 6	0	0	Off
Injector 5	0	0	Off
Injector 4	0	0	Off
Injector 3	0	0	Off
Injector 2	0	0	Off
Injector 1	0	0	Off
Aux ch 1	0	0	Off
Aux ch 2	0	0	Off
Pw/M Channel 1	0	0	Off
Pw/M Channel 2	0	0	Off
Pw/M Channel 3	0	0	Off
Pw/M Channel 4	0	0	Off
Stepper Motor Position	0		

Figure 123 - Outputs Data Page

### Digital Input Data Page

The Digital Inputs Data Page gives the input status of all configured inputs that have been enabled. If the input channel has not been configured, that data will show the default status of an off state and zero input period.

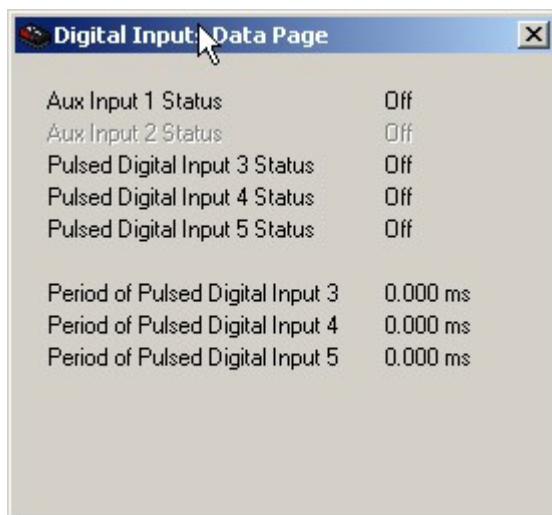


Figure 124 - Digital Inputs Data Page

### Trigger Diagnostics Page

The Trigger Diagnostics Page is used to aid in diagnosing input trigger and home signals. When a Home signal is detected, the Home Counter will increment. When a Trigger signal is detected, the Trigger Counter will increment. When a Home signal is detected, the number of triggers since the last home signal is recorded and displayed in the Trigger Count at last Home value.

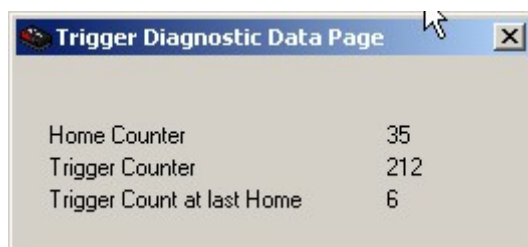


Figure 125 - Trigger Diagnostics Data Page

## Custom Engine Data

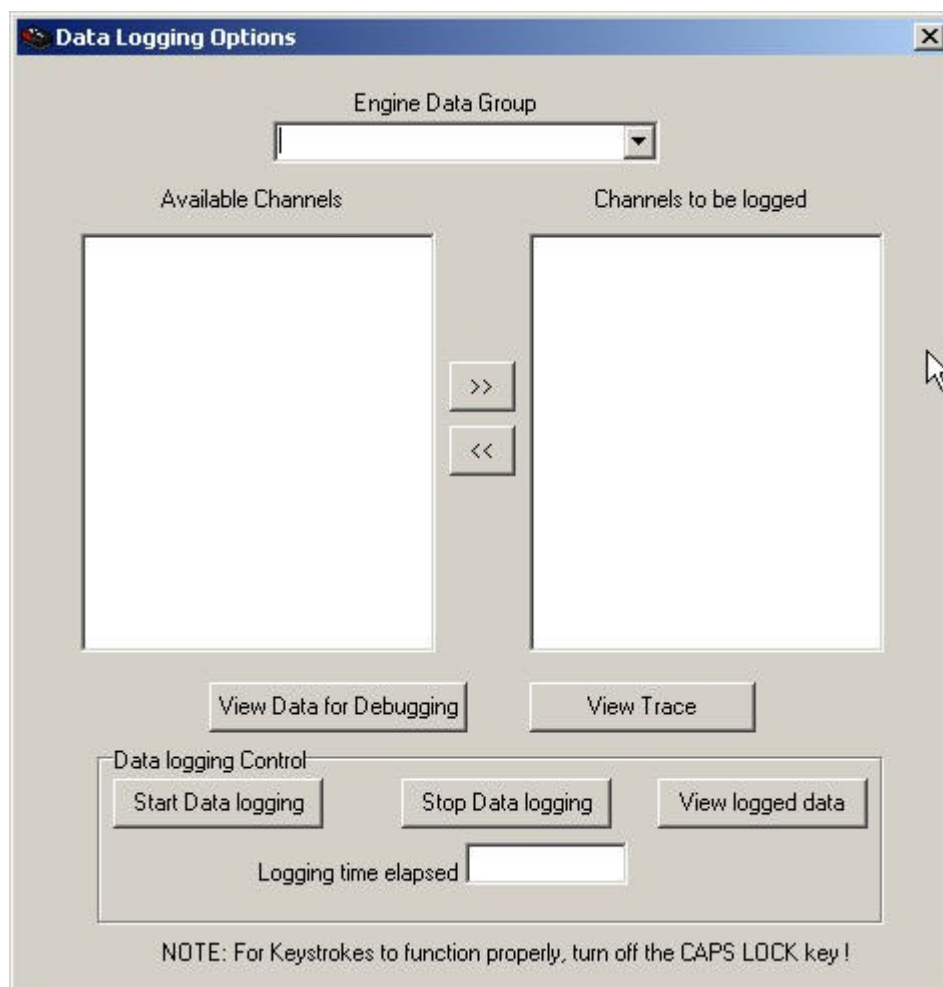


Figure 0-126

If you find that there isn't a suitable engine data page that suits the task at hand, then you can customise a page for your tuning task with this page.

Select the data that you wish to log by first selecting the 'Engine Data Group' that you wish to log.

After selecting the group, the available channels will appear in the left hand window.

Select the desired channels from this window and click on the '>>' button to add the channels to your custom display.

After you have selected all the channels, click the 'View Data' button to open your custom engine data page.

## Setup pages

**Main Setup**

Standard | Advanced | Development

**Engine Configuration**

Engine Type: ☒ Piston ☐ Rotary

No of Cylinders: 6

Load Sensing: TPS\_MAP1BARCORR

**RPM Limit Settings**

Max Cranking RPM: 380

☒ Rev Limit Enable

Rev Limiter Setting: Settings

**Correction Maps**

☒ Inj. Coolant Map Enable ☒ 2D ☐ 3D

☐ Inj. Air Temp Correction Enable

☐ 2nd Inj. Air Temp Correction Enable (at low RPM & Load)

☐ Post Start Fuel Enrich Enable - Above Operating Temp

☐ Post Start Fuel Enrich Enable - Below Operating Temp

☐ Primer Map Enable

☐ Battery Correction Map Enable

☐ Barometric Correction Map Enable

☐ Ignition Coolant Map Enable

☐ Ignition Air Map Enable ☒ 2D ☐ 3D

☐ Post Start Timing Offset Enable - Above Operating Temp

☐ Post Start Timing Offset Enable - Below Operating Temp

**Miscellaneous Group**

Engine Operating Temp °C: 69

**Throttle Settings**

WOT Value %: 95

Throttle Dead Band %: 0.5

**2nd Inj. Air Temp Correction Map Options**

Low RPM Switch Point: 0

Low Load Switch Point (%): 0

Apply OK Cancel

Figure 127 - Main Setup Page

All Halwin setup pages use standard Windows controls to edit the values. The settings on each page can be changed, but the values for the setup pages are only sent to the ECU when the 'Apply' or 'OK' buttons are pressed. The Enter key on the keyboard defaults to the Apply button that allows you to apply values instantly with the press of the Enter key.

If you make changes that you do not wish to keep, then either change them back to their previous setting, or hit Cancel before hitting the Enter key or clicking Apply or OK.

## 3D Maps

### The 3D View

The 3D maps are primarily used for displaying the fuel and ignition maps to enable you to see the contours of the map over both engine speed and engine load. This allows you to see any drastic changes in map shape that is often undesirable.

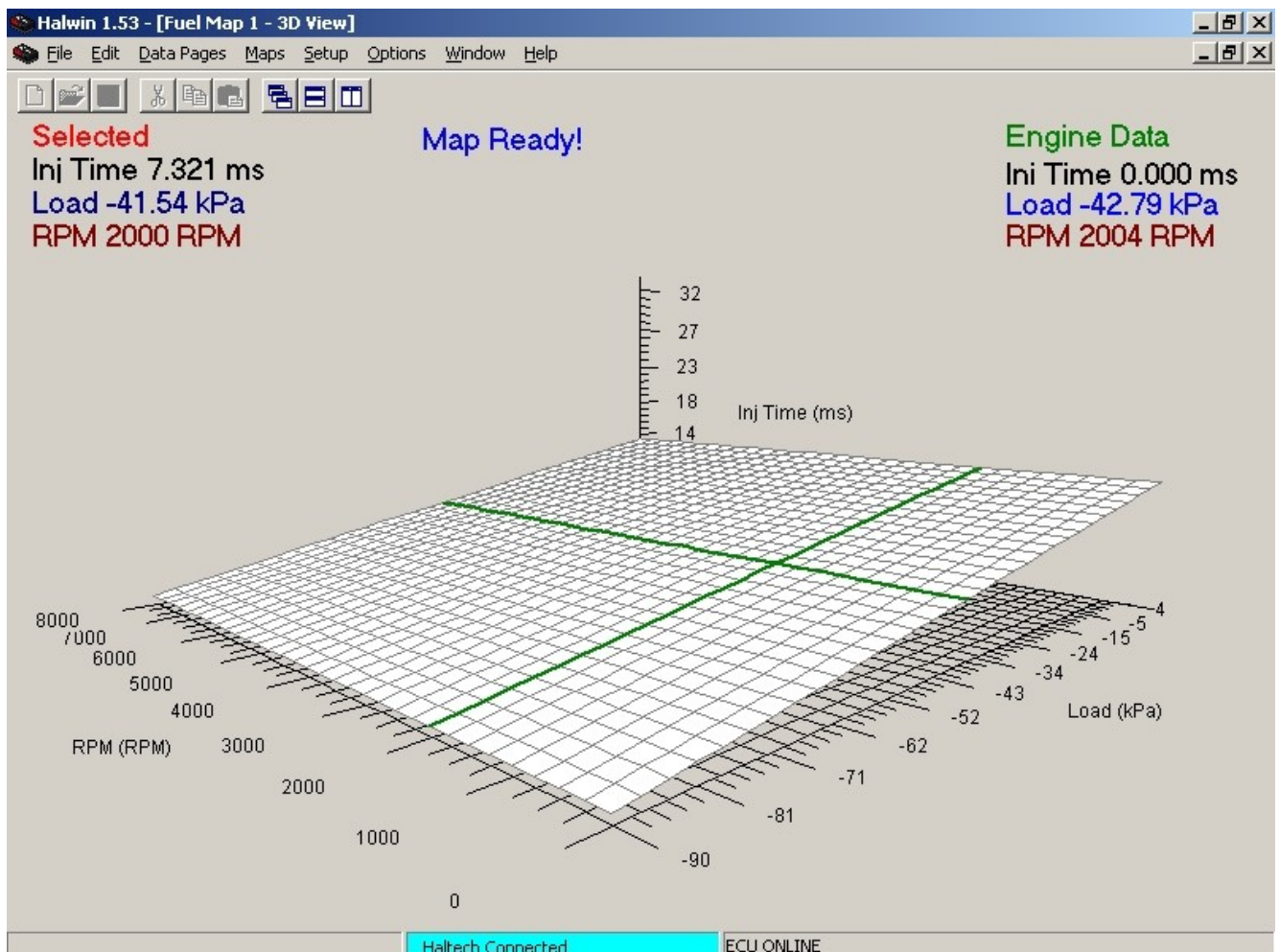


Figure 128 - 3D Fuel Map

### Visual Features

**Current selected bar** - The yellow bar shows the bar that is currently selected. Pressing the up/down arrow keys will raise and lower the height of this bar.

**Home Pointer** - The green pointer shows the bar nearest to the current engine speed and load. Hitting the 'Home' key will move the selected bar to the bar that the Home Pointer is pointing to.

**Controls** - The 3D map view has limited controls for browsing and for performing minor adjustments.

**Left/Right Arrows** - These keys moves the bar selector so that you can work on all the bars individually.

**'n' key** - Shows the next slice of the 3D map. For example, if you are currently displaying the 2D slice representing the 500 rpm range, then pressing 'n' will move the display to show the next increment which will typically be the 1000 rpm range.

**'p' key** - Shows the previous slice of the 3D map.

**Up/Down Arrow** - Increase or decrease the height of the bar. Pressing Ctrl-Up/Ctrl-Dn will reduce the size of the increment to the finest resolution. Pressing Shift-Up/Shift-Dn will increase the size of the increment.

**PgUp/PgDn** - This increases or decreases the height of the bar in larger steps than using the Up/Dn arrow keys. Similarly, pressing Ctrl-PgUp/Ctrl-PgDn will reduce the size of the increment and Shift-PgUp/Shift-PgDn will increase the size of the increment. See section for a complete reference on the default increment sizes.

### The 2D View

The 2D maps are where most users will spend most of their time tuning their maps. Do not confuse the 2D view of a 3D map with a 2D map. Despite only seeing the map in 2 dimensions, you must remember to think of this view as a slice of a 3D map.

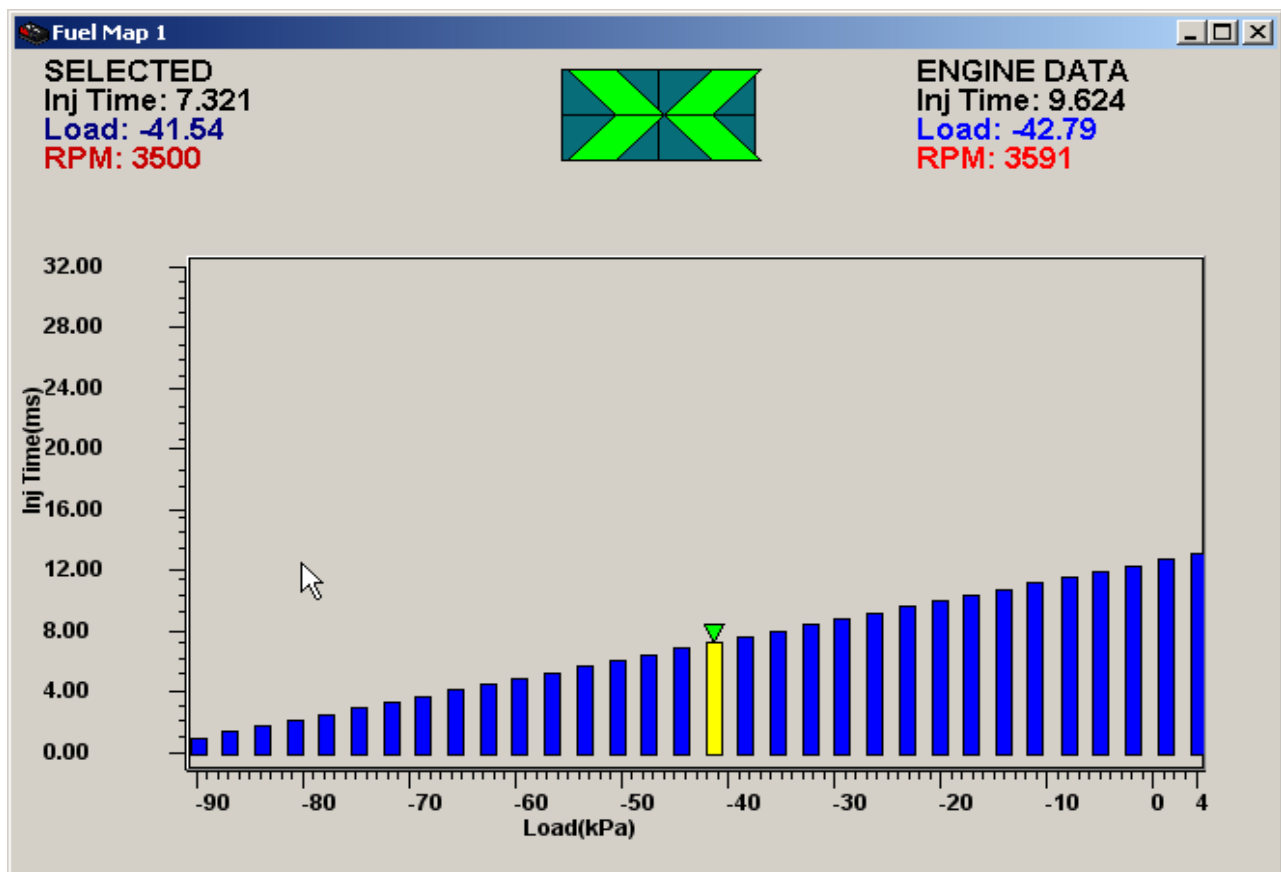


Figure 129 - 2D Fuel Map

### Visual Features

**Current selected bar** - The yellow bar shows the bar that is currently selected. Pressing the up/down arrow keys will raise and lower the height of this bar.

**Home Pointer** - The green pointer shows the bar nearest to the current engine speed and load. Hitting the 'Home' key will move the selected bar to the bar that the Home Pointer is pointing to.

**RPM Centre Marker** - The green arrow on the right hand side of the 2D view indicates how close the current engine speed is to the currently displayed range of the 3D map.

### Controls

**Left/Right Arrows** - These keys moves the bar selector so that you can work on all the bars individually.

**'n' key** - Shows the next slice of the 3D map. For example, if you are currently displaying the 2D slice representing the 500 rpm range, then pressing 'n' will move the display to show the next increment which will typically be the 1000 rpm range.

**'p' key** - Shows the previous slice of the 3D map.

**Up/Down Arrow** - Increase or decrease the height of the bar. This adjusts how much fuel to injector for

that selected bar. Pressing Ctrl-Up/Ctrl-Dn will reduce the size of the increment to the finest resolution. Pressing Shift-Up/Shift-Dn will increase the size of the increment.

**PgUp/PgDn** – This increases or decreases the height of the bar in larger steps than using the Up/Dn arrow keys. Similarly, pressing Ctrl-PgUp/Ctrl-PgDn will reduce the size of the increment and Shift-**PgUp/Shift-PgDn** will increase the size of the increment. See section for a complete reference on the default increment sizes.

**Ctrl-Left Arrow** – This selects multiple bars to the left of the current bar. When multiple bars are selected, any operation that you perform will affect all the selected bars. All bars that are selected will be highlighted in yellow. See section for a complete reference on the default increment sizes.

**Ctrl-Right Arrow** – This selects multiple bars to the right of the current bar. When multiple bars are selected, any operation that you perform will affect all the selected bars. All bars that are selected will be highlighted in yellow.

**Alt-Left Arrow** – This de-selects multiple bars from the right hand side.

**Alt-Right Arrow** – This de-selects multiple bars from the left hand side.

**Ctrl-Space bar** – deselects all multiple bars.

**Home** – Pressing the 'Home' key on the keyboard will instantly select the bar nearest to the current engine speed and load.

**'a' key** – Selects all bars

**ESC key** – turns off all bars selection if enabled.

**Ctrl-End** – Move to the last bar on the right.

**Ctrl-Home** – Move to the first bar on the left.

**Ctrl-C** – Copy the selected bars

**Ctrl-V** – Paste the selected bars that are in the copy buffer. If the selection is different to what is in the buffer, the data will paste from the left most selected bar.

The Numeric View

The numeric view allows you to view the 3D map in its most raw form.

Visual Features

The numeric mode displays the table of injection time or ignition advance with the engine speed against the engine speed and engine load axes.

**The Green highlight** shows the nearest point to the current engine operating parameters and is equivalent to the 'Home' pointer in the 2D and 3D views.

**The Blue highlight** shows the currently selected value. This is the value that will be edited if numeric digits are typed.

### Controls

**Left/Right/Up/Down Arrows** – These keys moves the bar selector so that you can work on all the bars individually.

Typing any numeric digits will drop the selected box into edit mode. After typing the required injection time, ensure that you press the 'Enter' key to update the value.

**Shift Left/Right/Up/Down Arrows** - Selects multiple cells for copy/paste.

**Home** – Pressing the 'Home' key on the keyboard will instantly select the cell nearest to the current engine speed and load.

**Ctrl-C** – Copy the selected bars.

**Ctrl-V** – Paste the selected bars that are in the copy buffer. (Data can also be pasted into other Windows

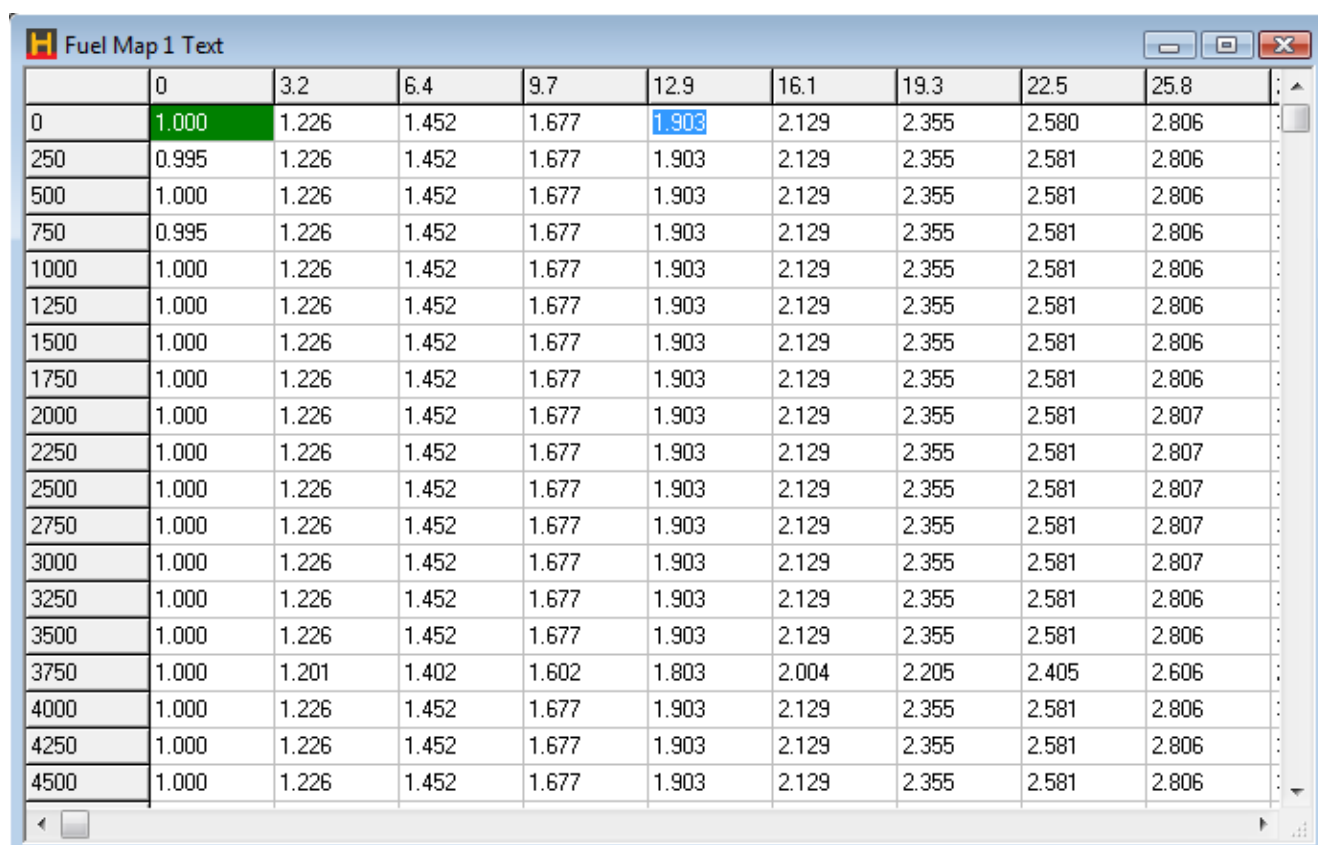


applications if required).

**Home** – Pressing the 'Home' key on the keyboard will instantly select the bar nearest to the current engine speed and load.

**Ctrl-Home** – Move to the first cell in the top left (lowest load and RPM).

**Ctrl-End** – Move to the last cell in the bottom right (highest load and RPM).



	0	3.2	6.4	9.7	12.9	16.1	19.3	22.5	25.8
0	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.580	2.806
250	0.995	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
500	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
750	0.995	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
1000	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
1250	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
1500	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
1750	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
2000	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.807
2250	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.807
2500	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.807
2750	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.807
3000	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.807
3250	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
3500	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
3750	1.000	1.201	1.402	1.602	1.803	2.004	2.205	2.405	2.606
4000	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
4250	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806
4500	1.000	1.226	1.452	1.677	1.903	2.129	2.355	2.581	2.806

Figure 130 - Text View Fuel Map

## 2D Maps

### Visual Features

**Current selected bar** – The yellow bar shows the bar that is currently selected. Pressing the up/down arrow keys will raise and lower the height of this bar.

**Home Pointer** – The green pointer shows the bar nearest to the current engine speed and load. Hitting the 'Home' key will move the selected bar to the bar that the Home Pointer is pointing to.

**Text Data** – The text data on the right hand side of the window shows two groups of information. The 'Home' group show the current value of the x-axis parameter. In the example below, this is the coolant temperature. The Home Correction is the correction applied at the current operating value.

The 'Selected' group shows the corresponding temperature that the selected bar represents, and the correction that this bar will apply when the x-axis variable is exactly at the selected temperature.

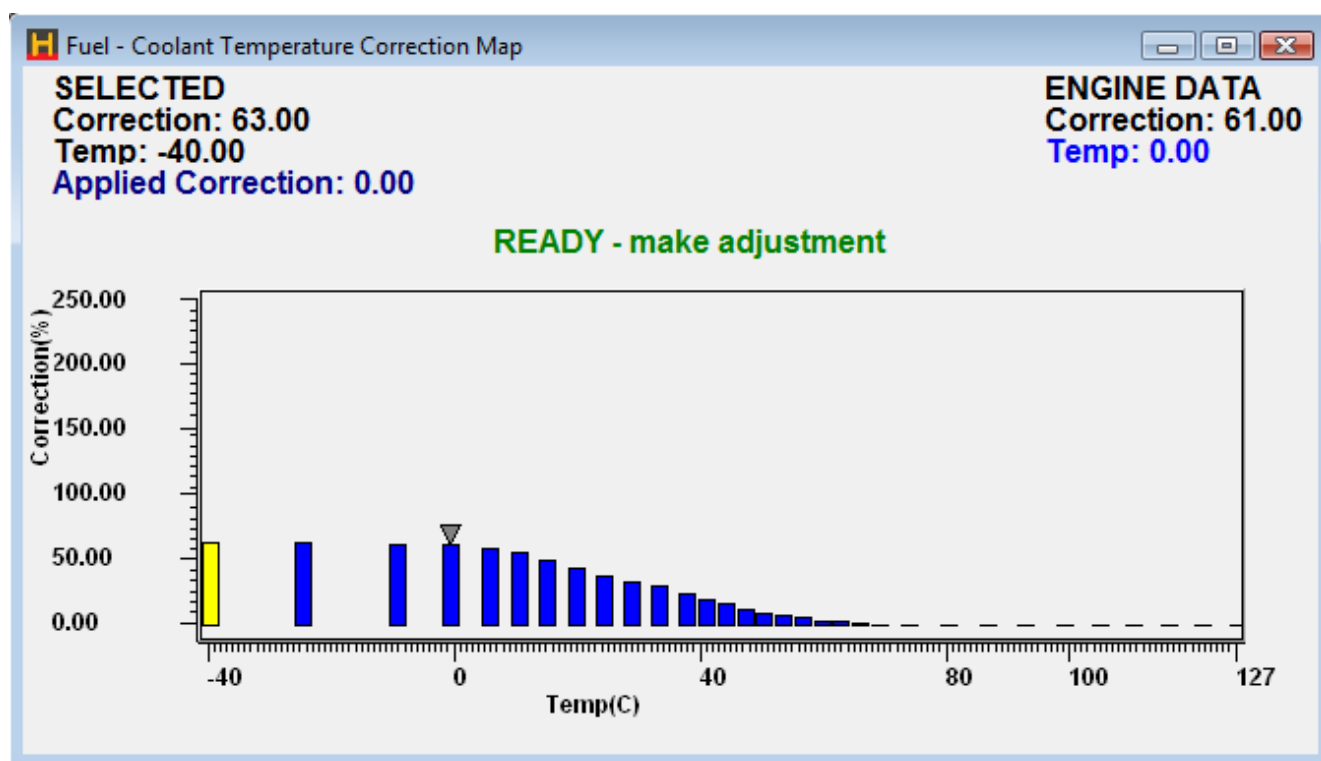


Figure 131 - Fuel Coolant Temperature Correction

### Controls

**Left/Right Arrows** – These keys moves the bar selector so that you can work on all the bars individually.

**Up/Down Arrow** – Increase or decrease the height of the bar. This adjusts how much correction to apply for that selected bar. Pressing Ctrl-Up/Ctrl-Dn will reduce the size of the increment to the finest resolution. Pressing Shift-Up/Shift-Dn will increase the size of the increment. See section for a complete reference on the default increment sizes.

**PgUp/PgDn** – This increases or decreases the height of the bar in larger steps than using the Up/Dn arrow keys. Similarly, pressing Ctrl-PgUp/Ctrl-PgDn will reduce the size of the increment and Shift-PgUp/Shift-PgDn will increase the size of the increment. See section for a complete reference on the default increment sizes.

**Ctrl-Left Arrow** – This selects multiple bars to the left of the current bar. When multiple bars are selected, any operation that you perform will affect all the selected bars. All bars that are selected will be highlighted in yellow.

**Ctrl-Right Arrow** – This selects multiple bars to the right of the current bar. When multiple bars are selected, any operation that you perform will affect all the selected bars. All bars that are selected will be highlighted in yellow.

**Alt-Left Arrow** – This de-selects multiple bars from the right hand side.

**Alt-Right Arrow** – This de-selects multiple bars from the left hand side.

**Ctrl-Space bar** – deselects all multiple bars.

**Home** – Pressing the 'Home' key on the keyboard will instantly select the bar nearest to the current engine speed and load.

**'a' key** – Selects all bars

**ESC key** – turns off all bars selection if enabled.

**Ctrl-End** – Move to the last bar on the right.

**Ctrl-Home** – Move to the first bar on the left.

**Ctrl-C** – Copy the selected bars

**Ctrl-V** – Paste the selected bars that are in the copy buffer. If the selection is different to what is in the buffer, the data will paste from the left most selected bar.

## Options Pages

### Auxiliary Output

The Auxiliary Output Options page uses standard Windows controls and conventions. These pages are designed to be used with the mouse pointer and mouse clicks, however, the page can be navigated using the 'Tab' key to move around the page, the 'Space Bar' to enable/disable the check boxes, the 'Enter' key to open the Edit dialogs, and the 'ESC' key to close the Edit dialogs. Pressing the 'Enter' key on an open dialog will automatically 'Apply' the changes on that page.

Output channels that are used by Ignition or Injection functions are 'greyed' out and locked out from auxiliary function configuration.

Channel	Enable	Edit	Dropdown
Ignition1	<input checked="" type="checkbox"/>	Edit	NotUsed
Ignition2	<input checked="" type="checkbox"/>	Edit	NotUsed
Ignition3	<input checked="" type="checkbox"/>	Edit	NotUsed
Ignition4	<input checked="" type="checkbox"/>	Edit	NotUsed
Ignition5/Injection8	<input checked="" type="checkbox"/>	Edit	NotUsed
Ignition6/Injection7	<input checked="" type="checkbox"/>	Edit	NotUsed
Injection1	<input checked="" type="checkbox"/>	Edit	NotUsed
Injection2	<input checked="" type="checkbox"/>	Edit	NotUsed
Injection3	<input checked="" type="checkbox"/>	Edit	NotUsed
Injection4	<input checked="" type="checkbox"/>	Edit	NotUsed
Injection5	<input checked="" type="checkbox"/>	Edit	NotUsed
Injection6	<input checked="" type="checkbox"/>	Edit	NotUsed
PWM Output 1	<input type="checkbox"/>	Edit	NotUsed
PWM Output 2	<input type="checkbox"/>	Edit	NotUsed
PWM Output 3	<input type="checkbox"/>	Edit	NotUsed
PWM Output 4	<input type="checkbox"/>	Edit	NotUsed
Auxiliary 1	<input type="checkbox"/>	Edit	NotUsed
Auxiliary 2	<input type="checkbox"/>	Edit	NotUsed

Apply OK Cancel

Figure 132 - Output Options Page

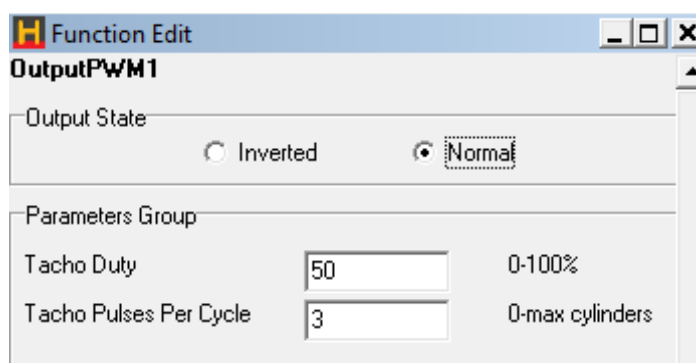


Figure 133 - Tacho Output Edit Menu

The Edit dialog allows you to configure the parameters for the selected function. These dialogs change according to which function the channel is performing. All outputs have an option to invert the output signal.

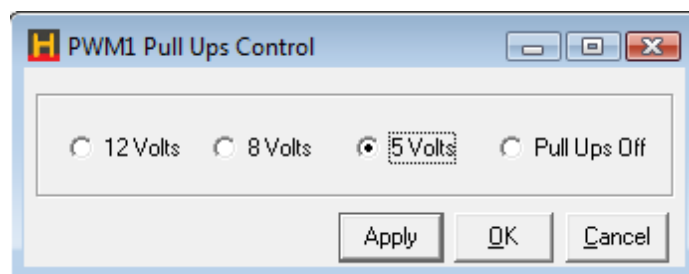


Figure 134 - PWM 1 Pullup Options

A function that is unique to PWM 1 output channel, is the ability to vary the voltage of its output. This output is typically used for electronic tachometers that require different output voltages.

### Analogue Inputs

The Analogue Input Options page uses standard Windows controls and conventions. These pages are designed to be used with the mouse pointer and mouse clicks, however, the page can be navigated using the 'Tab' key to move around the page, the 'Space Bar' to enable/disable the check boxes, the 'Enter' key to open the Edit dialogs, and the 'ESC' key to close the Edit dialogs. Pressing the 'Enter' key on an open dialog will automatically 'Apply' the changes on that page.

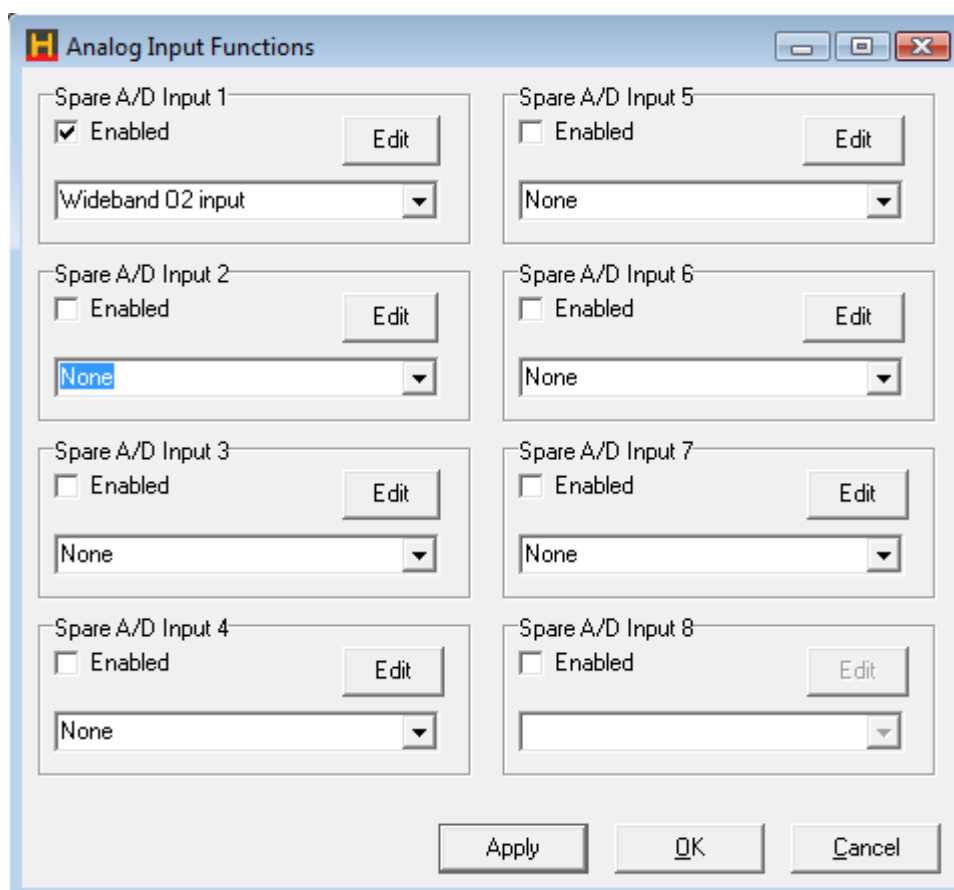


Figure 135 - Analog Input Functions Page

### Digital Inputs

The Digital Input Options page uses standard Windows controls and conventions. These pages are designed to be used with the mouse pointer and mouse clicks, however, the page can be navigated using the 'Tab' key to move around the page, the 'Space Bar' to enable/disable the check boxes, the 'Enter' key to open the Edit dialogs, and the 'ESC' key to close the Edit dialogs. Pressing the 'Enter' key on an open dialog will automatically 'Apply' the changes on that page.

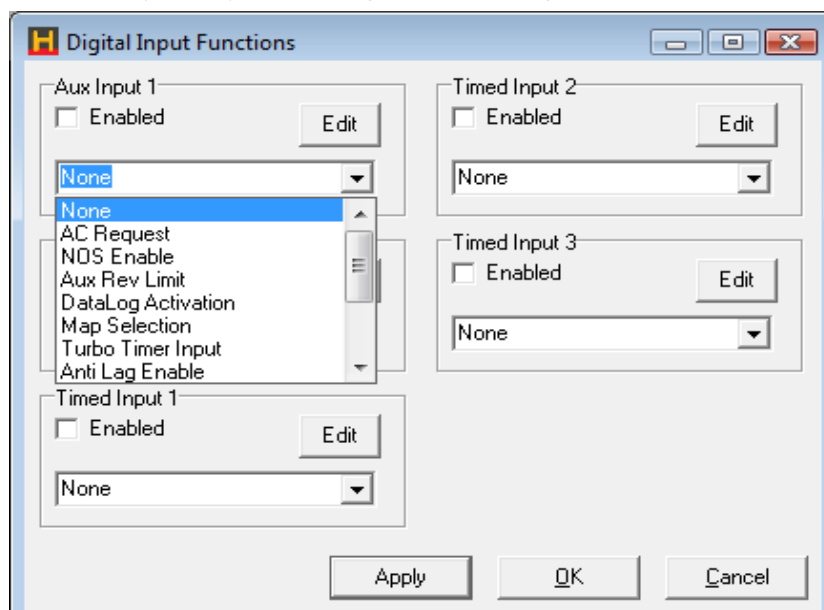


Figure 136 - Digital Inputs Functions Page

## Data Logging (PC)

### Collecting The Data

From the Options menu, select Data Logging and then Log Data to bring up the following window. The user can also activate the window by pressing "Ctrl + D".

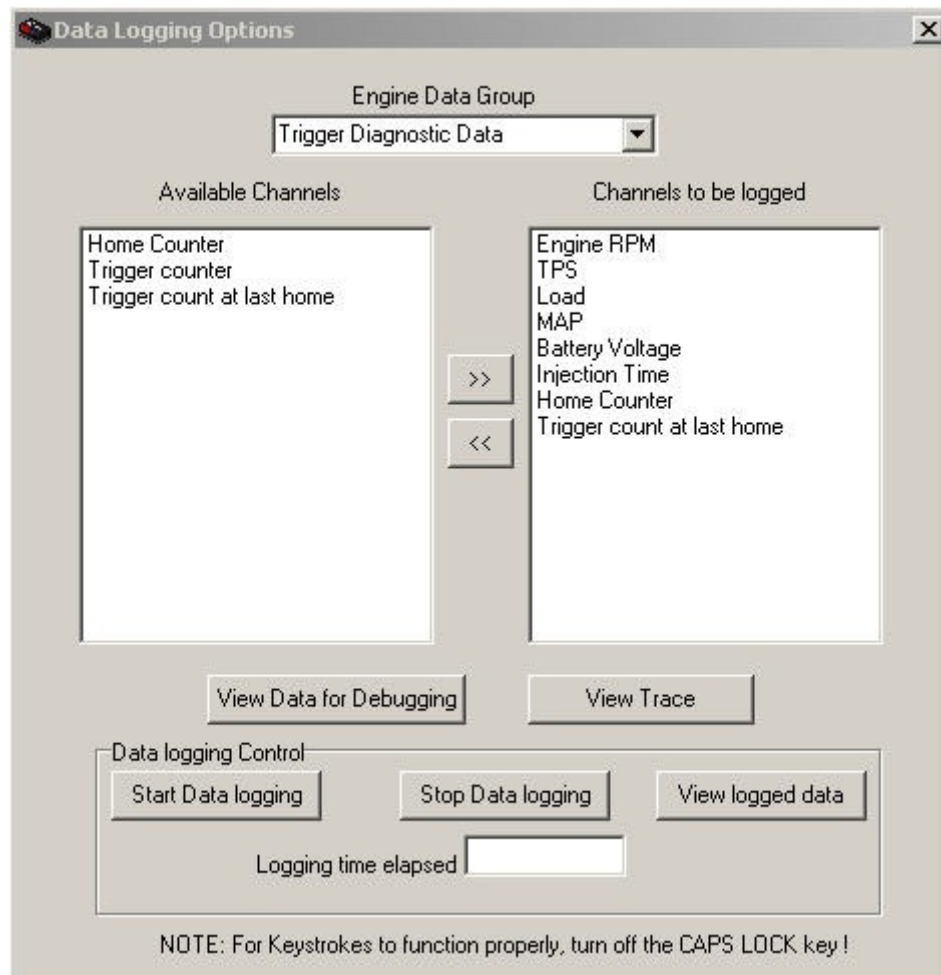


Figure 137 - Data Logging Options Page

### Selecting the Data Channels

Once you have opened the Log Data window, you will need to select which channels to log. Select the type of data to log from the Engine Data Group. Changing the Engine Data Group will change the available channels that appear in the left hand side column. Select a channel by clicking on the items in the left hand side window. To select more than one item to add, hold down the 'Ctrl' key on the keyboard while clicking on additional items.

Once you have selected the items that you wish to add, press the '>>' button or press the enter key to add the channel that you have selected from the left hand side column. When you have added the item, the item will appear in the right hand side column.

With the Auxiliary Channels, only channels that are enabled will be available for data logging. When the user shuts down the data logging window, the channels that have been selected will be recalled for future use.

### Logging the Data

Once you have selected all the channels that you wish to log, press the 'Start Data logging' button or press the F7 key. To stop the Data log press the 'Stop Data logging' button or press the F8 key. Note hitting F7 and F8 while the data logging window is closed will start the data logging provided the user has

channels loaded into the data logging window when the window was closed.

While the data is being logged, the Logging time elapsed will show how long the data logging has been running for. The logging time is limited by your hard disk space, but be aware that excessively large log files may be slow to view or require large amounts of resources from your PC to process.

When the data log is terminated the following dialog box will appear.



Figure 138 - Datalog File Options

The comment field can be used to store a brief description of what type of data is logged. This field is optional and can be left blank, but it is advisable to put some text in here.

The second field that appears is for a file name that the data logger will save the information in. The default filename extension will be '.csv'. As an example, if you type "lap1" in the filename field, then a file will be saved as "lap1.csv" in the directory in which Halwin was started. If you wish to choose which directory to save the log files to, then press the "Save File As" button to open the following dialog.

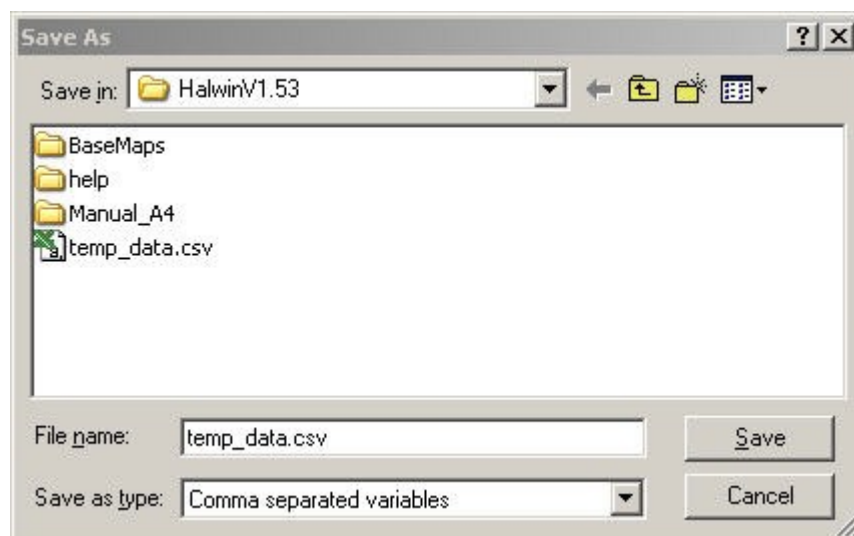


Figure 139 - Datalog File Save Location

This dialog will be familiar to experienced users of the Windows operating system. Type the file name that you wish to save your logged data to in the 'File name' field. You can choose which directory to save the file to by clicking on the 'Save in' drop down menu. After selecting your file name, click on the 'save' button which will close that window.

### Displaying The Data

To open the Haltech Data Viewer, click on the View logged data button on the Data Logging Options window. Note that this only applicable for the data you have just logged.

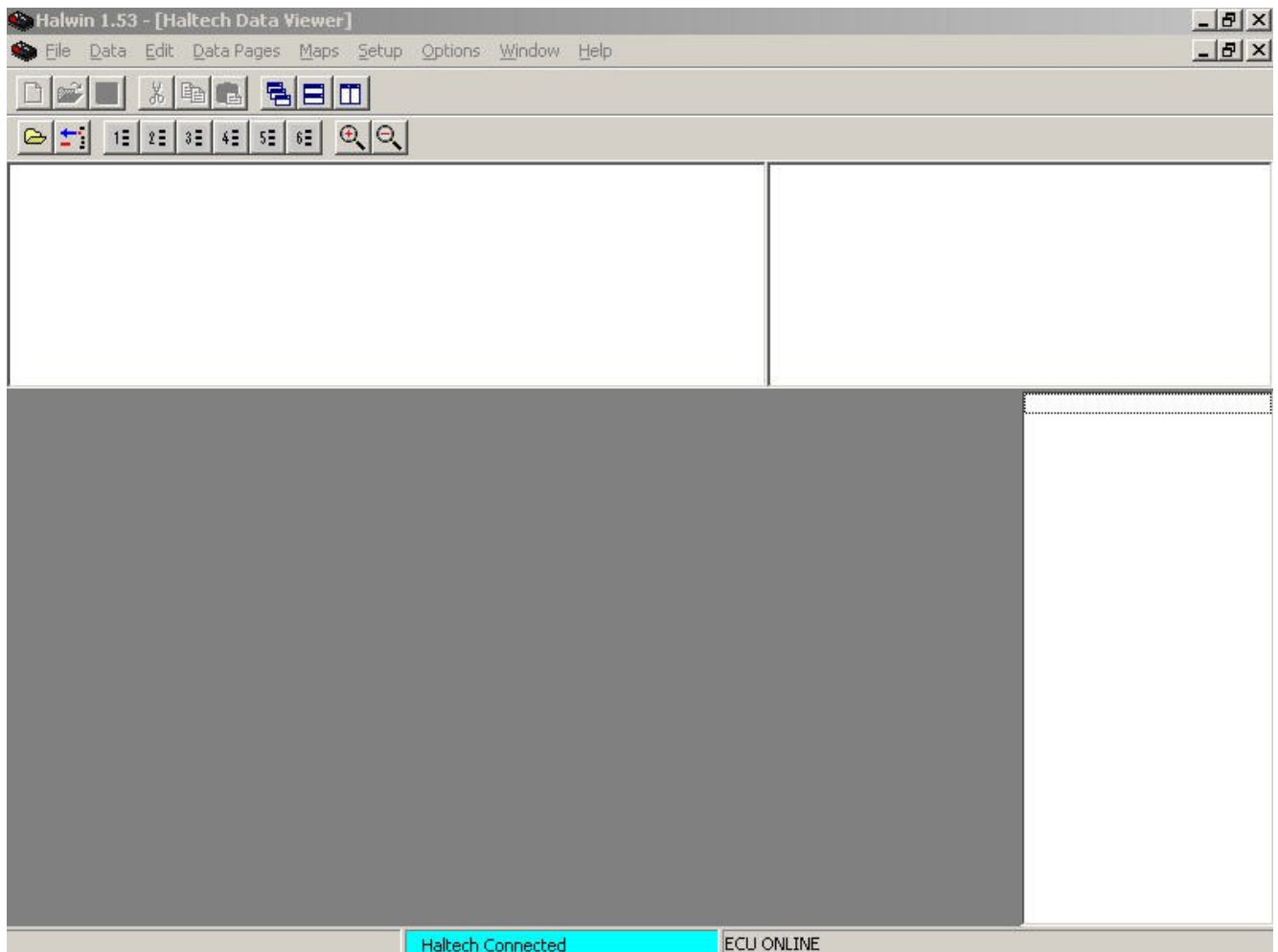


Figure 140 - Halwin Data Viewer

Alternatively, you can open the Haltech Data Viewer from the Options->Data Logging->View Data Log menu. To open a Dataset the user can click on File->Open Data File or the user can click on the folder button on the toolbar. This will open a dialog similar to Figure 4-24 where the user can select the appropriate Dataset.

Once you have selected a Dataset and opened it, you will be presented with a window similar to that shown below. The data viewer will display the first channel logged from the Dataset that you have opened.



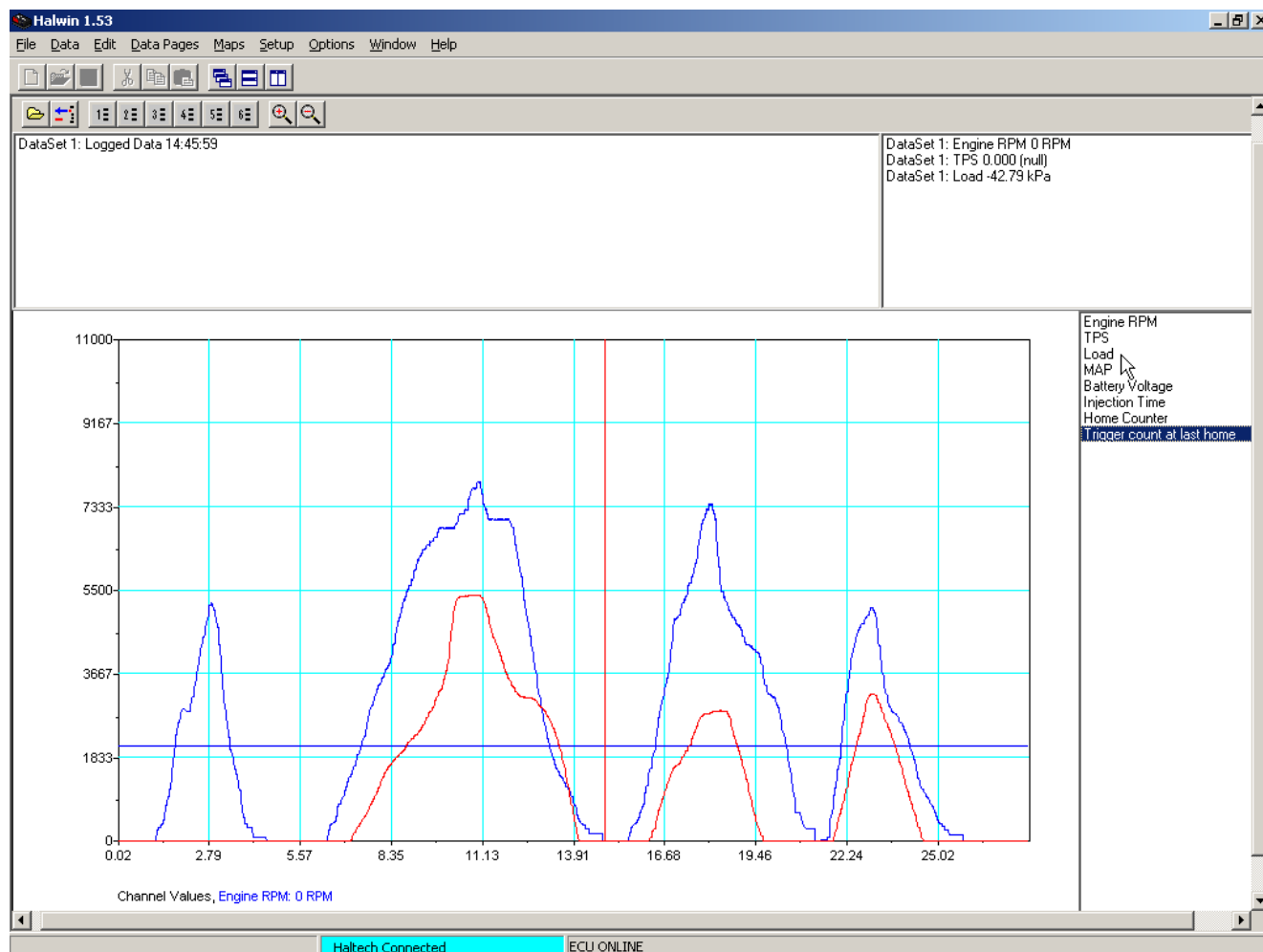


Figure 141 - Halwin Data Viewer

## Displaying Channels

To display one of the channels that you have logged in section , click on one of the view buttons. Alternatively the user can press Ctrl 1 to 6 to bring up the appropriate view.

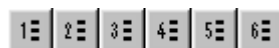


Figure 142 - Display Channels

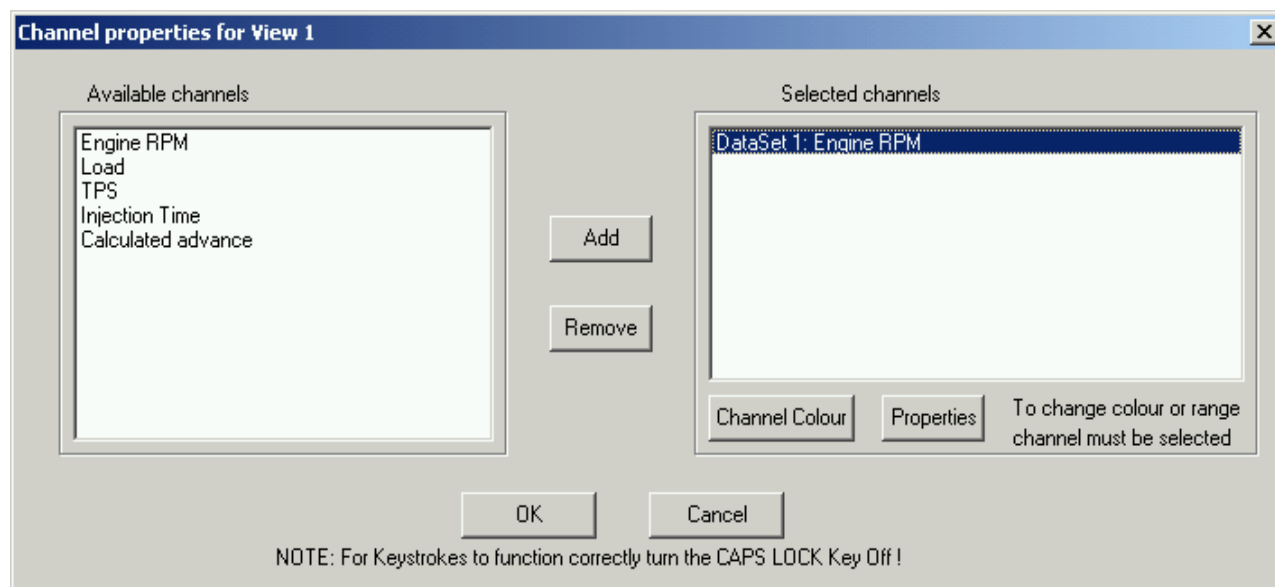


Figure 143 - Viewing Logged Channels

When a view is selected, a dialog will be presented which allows you to select which channels are to be displayed on each view. To add or remove channels the user can select the appropriate window ("Available channels" or "Selected channels") and add or remove channels using the enter key.

To adjust the colour or channel properties the user selects the desired channel and can then select the Channel Colour button or Properties button to adjust the channel colour and ranges. The Properties button controls the range of the view (min and max scale), the unit name and precision. Note if the user wishes to use manual scaling, then min and max numbers selected must be different. It should be noted that with the exception of colour, Halwin will save these settings so they can be reused.

Another method of displaying channels is to double click on channels on the right hand side of the view. As the user selects a Dataset the channels associated with the view appear to the right hand side of the view. To add the channel to the view the user simply double clicks on the channel and to remove it from the view the user double clicks on the channel already loaded. Note displaying the channels this way implies that the channels from Dataset 1 to 5 are mapped to views 1 to 5 respectively.

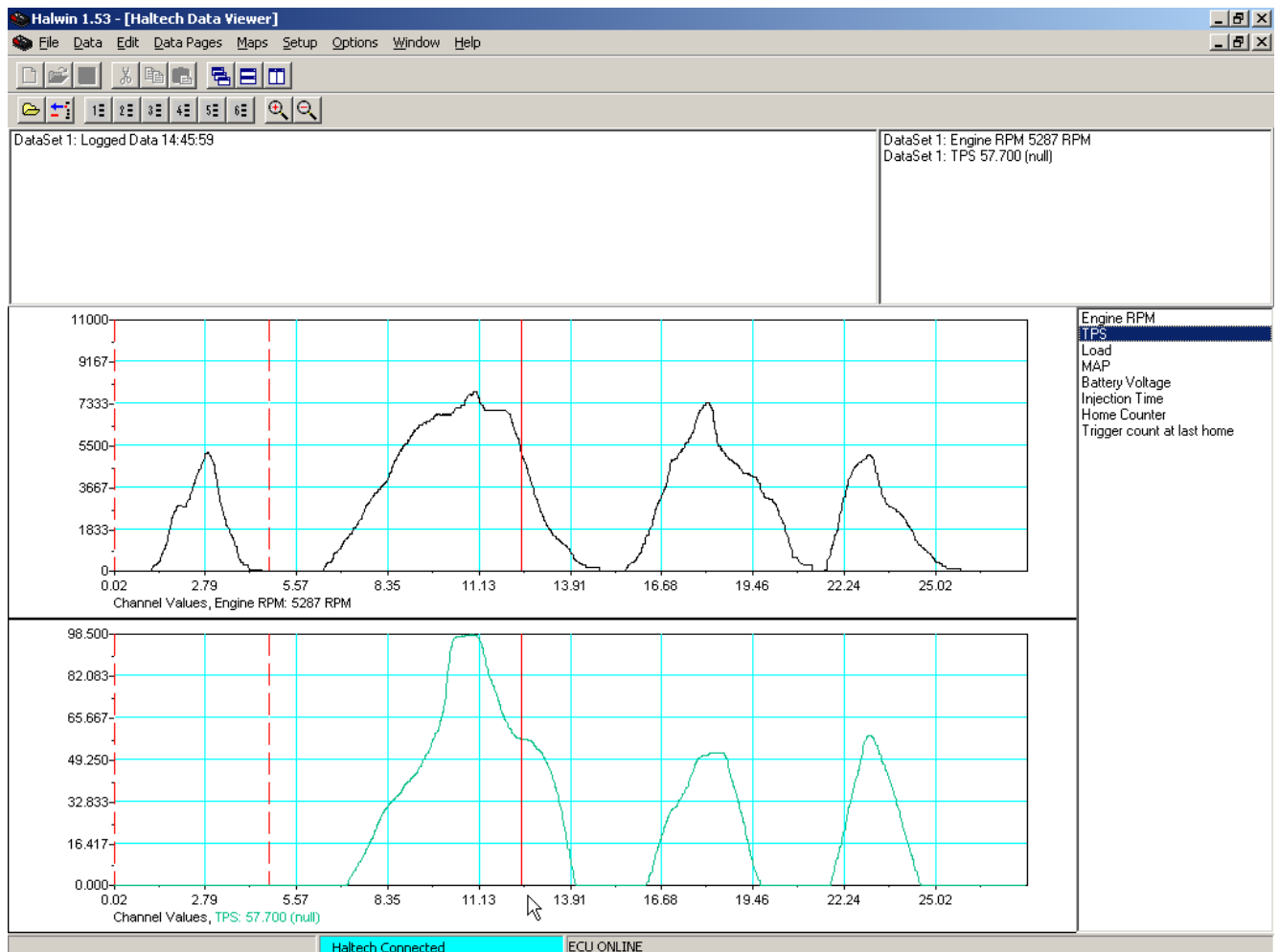


Figure 144 - Viewing Data Logs

## Changing scales on a View

If the user has multiple scales loaded onto a view then the user can change scales and units by using the Pg Up and Pg down keys.

## Viewing Multiple Datasets

The Data Viewer allows you to load more than one Dataset. Each Dataset is kept in a separate file. This allows you to compare the Datasets. The channels from each Dataset can be accessed by selecting the relevant Dataset from the 'Loaded Data Sets' window.

## Removing A Dataset

To remove a loaded data set, select the 'Dataset Window' and select the Dataset you wish to remove. The 'Dataset Window' can be displayed by selecting Data->Show Data Window or by pressing Ctrl+Alt+D. To remove the selected Dataset, return to the Data Viewer window and select Data->Remove Dataset or by pressing the 'Remove Dataset' button (Next to the file open button) or by pressing 'Alt+BkSp'.

## Data Values

The Data Values window displays the numerical values of each data trace at the cursor position. The cursor is displayed as a red line and can be moved with the mouse or by using the arrow keys.

## Zooming

The user has a number of options to zoom in and out of the views. The following options are available to zoom in and out at the cursor:

## Zooming In

Press the 'Up Arrow' key.

Click the  icon with the mouse pointer

Press Ctrl-Alt-I

Select Data->Zoom In from the Data menu.

### Zooming Out

Press the 'Down Arrow' key

Click the  icon with the mouse pointer

Press Ctrl-Alt-O to zoom all the way out

Select Data->Zoom Out from the Data menu. This will zoom all the way out

Alternatively you can select a section to zoom using the right mouse button. Move the cursor to the desired position and hold the right mouse button down to select and releases at the end of the selection. Red dotted lines indicate the region used for zooming. This is illustrated below.

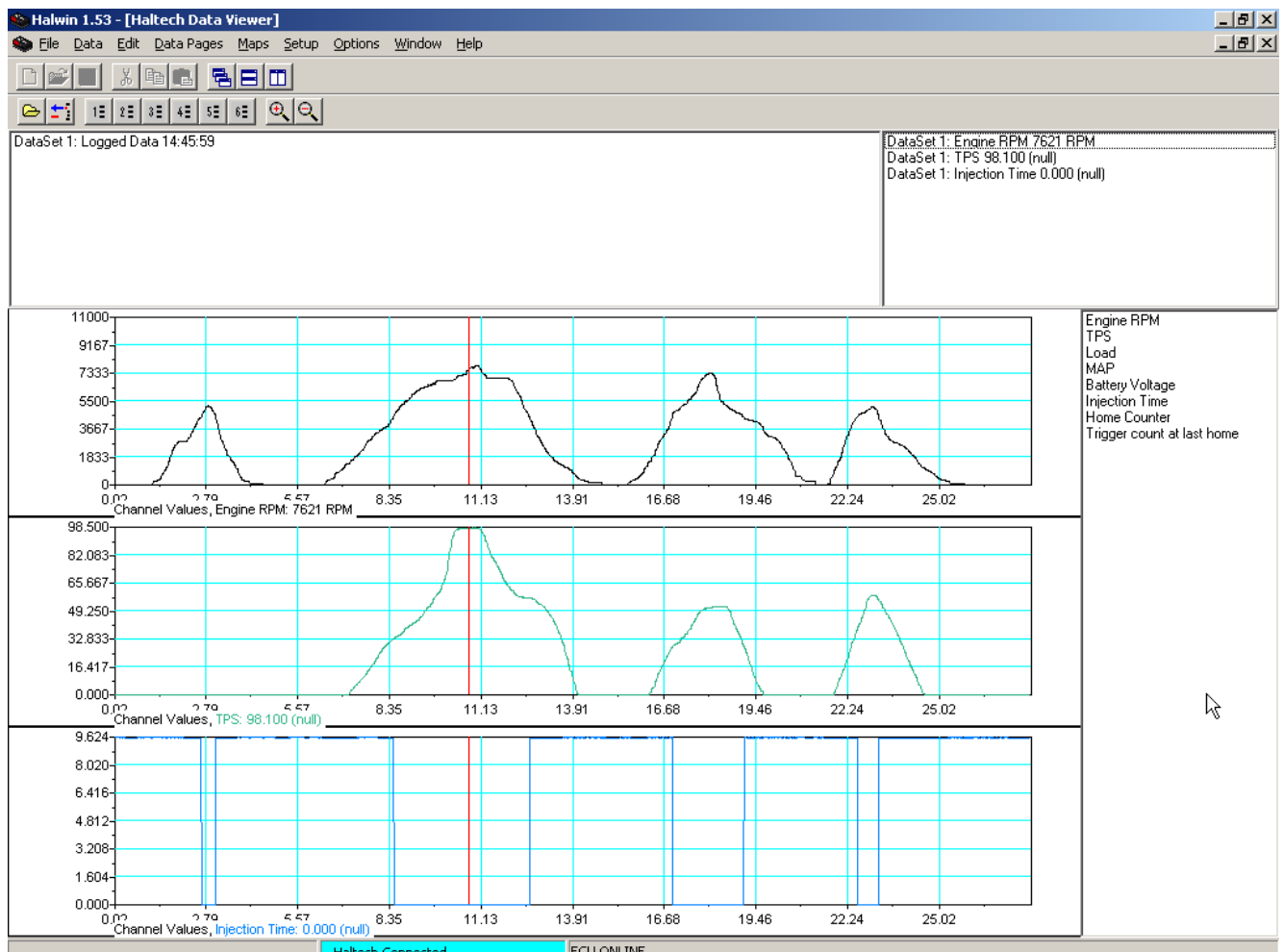


Figure 145 - Datalog Display

### Changing the Trace Width

To modify the width of the traces the user can select Data->Select Pen Width or the user can press Ctrl - W. This brings up a dialog where the user can type in the trace width in pixels. The user applies these changes by selecting enter.

Finally to bring up the text view of the selected information the user can select Data->Select Pen Width or the user can press Ctrl-Alt-C.

### Data Logging (On Board)

The ECU contains 448 kilobytes of Flash memory that can be used to store data gathered whilst the ECU is running. Data logging is typically used to measure the performance of the engine or driver during an event and the data is usually downloaded after the event when the car returns to the pits.

### Recording Data

#### Selecting Data Channels

The data channels are the quantities that you wish to log, such as engine speed in RPM. The on board data logging allows you to record all channels that are selected. To setup the channels you wish to log, select Options->Data Logging->OnBoard Logging. Note that you must be online to open this window. Once this is done select the required Data Group from the Available Channel Groups box. There are 11 groups to choose from and the user can use the up and down arrow keys to browse the available channels for each group.

Once the desired group is selected, select the desired channels by clicking on each channel, then clicking on the '>>' button to add the channel to the list of logged channels. You can select multiple channels to be added by clicking on each channel while holding down the 'Ctrl' key.

The channels displayed in the "Channels to be logged" window will be logged when data logging is enabled. There is a limit of 10 channels that can be logged at any one session. To remove channels from the channels to be logged, select the channels in the Channels to be logged window and use the left arrow button '<<' or the Enter key to remove desired channels. This is illustrated in Figure 146 below.

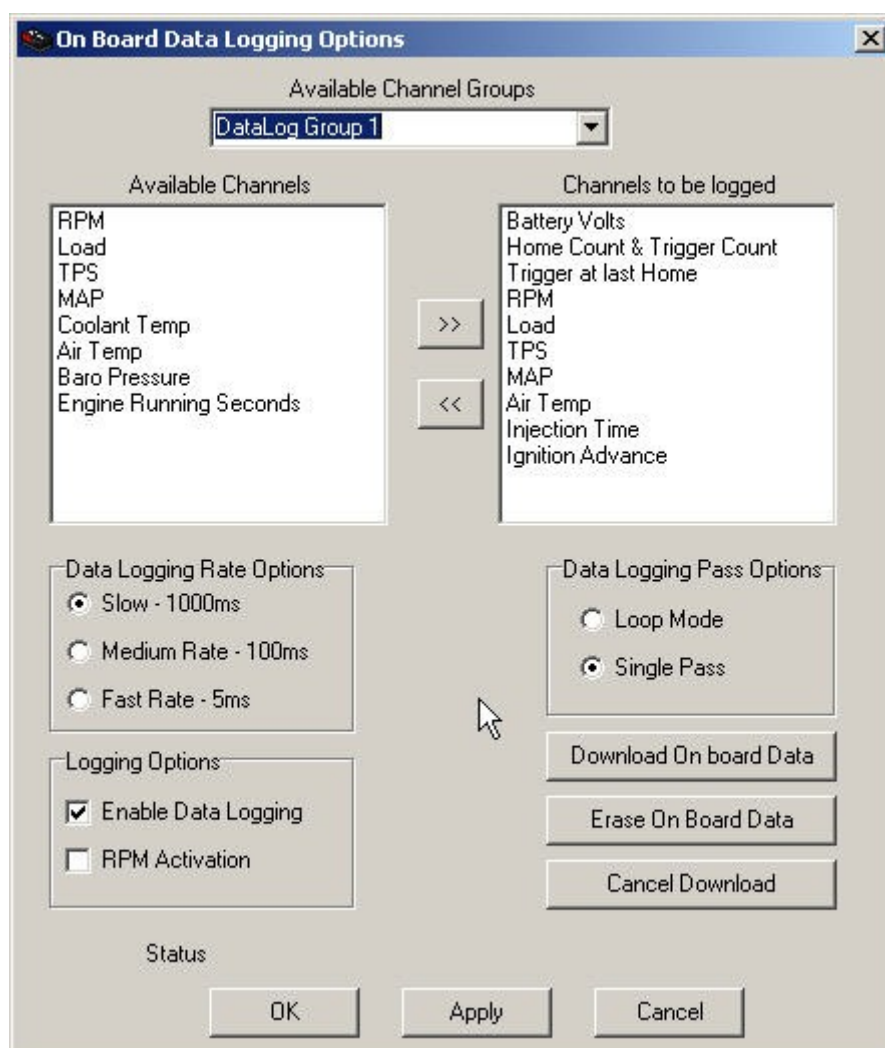


Figure 146 - Channels to be Logged

### Data Logging Rate

To select the Data logging rate, the user can click on the desired rate in the Data Logging Rate Options Group Box. See Figure 146. The user has the option of selecting either 1 sample/sec, 10 samples per sec or 200 samples/sec.

The available logging time is dependent on the rate that you log at, as well as the number of channels that will be logged. The following table shows some typical logging times.

Number of Channels	Sample Rate	Logging Time (for a single pass)
10	1 sample / second	4.9 hours
10	10 samples / second (100ms)	29 mins 24 seconds
10	200 samples / second (5ms)	1 min 28 seconds
4	200 samples / second (5ms)	2 mins 43 seconds

### For Advanced Users:

Each sample has a 6-byte overhead and each channel uses 2-bytes to store its data. Data storage time can be calculated using 448kB as the storage size.

### Logging Options

The Logging Options group allows the user to select whether the Data logging will be enabled, and

whether it will be activated by RPM. The user selects these options by clicking on the checkboxes as seen in Figure 146.

### Logging Mode

The logging mode is selected in the Data Logging Pass Options group box.

In Single Pass Mode, data is logged until all available memory is filled. At this point, Datalogging will stop until more free memory is made available by erasing the current logged data. (You would typically download your data before erasing it, unless you are certain that the logged data is not useful).

In Loop Mode, the data logging will log data until all blank memory is filled, after which, the data logging will pause momentarily to erase the first 64kB of logged data. The data logging will then continue into this space. This means that Datalogging will continue indefinitely until stopped. The data in memory will be the most recent data that will fit into 448kB of memory.

The user selects these options by selecting the radio buttons in Figure 146.

### Downloading Data

**NOTE:** Before downloading data, the user must Apply their changes using the apply button. The user must also configure Data log Activation, and actually have some Data to download that is relevant to their settings.

To download the data, click on the "Download On Board Data" button. Should you wish to cancel the download while the data is being downloaded from the ECU, click the "Cancel Download" button. While the data is being downloaded, the window will show a percentage to indicate the progress of the download. Typically the download should take about 2-4 minutes.

When the data has been downloaded from the ECU dialogs identical to Figure 138 and Figure 139 will appear. Save the file with the appropriate comments. This will save the file to a \*.csv format which can be viewed using the Data Viewer. The status bar will indicate the file is being processed and when it is finished it will display the file.

### Erasing On Board Data

To erase the data stored on the ECU the user can click on the "Erase On Board Data" button. The window will display the status of the erase process.

**NOTE:** Once a data is downloaded from the ECU, it is good practice to remove the data from the ECU. This will ensure the user does not download old data, which could lead to confusing results in analysing the data.

## Keystrokes Reference

### Windows Keystrokes

Key Stroke	Function
Ctrl-C	Copy
Ctrl-V	Paste
Ctrl-Tab	Switch windows/map within Halwin
Alt-F4	Quit
Enter	Apply button if available. OK button if no Apply button.
ESC	Cancel button if available Close button if available
F1	Open Help window

### General Shortcut to Screens/Maps

Key Stroke	Function
Ctrl-M Alt-S-M	Main Setup
Alt-S-T	Trigger Setup
Alt-S-F	Fuel Setup
Alt-S-I	Ignition Setup
Ctrl-G Alt-P-G	Display Gauge Page
Ctrl-F Alt-M-F	Display Fuel map1 (2D, first range if just started, last range it was left at if used before)
Ctrl-I Alt-M-I	Display Ignition Map1 (2D, first range if just started, last range it was left at if used before)
Ctrl-E Alt-P-E	Display Engine Data Panel
Ctrl-O Alt-O-O	Display Output Options Panel
Ctrl-A Alt-O-A	Display Analogue Input Panel
Ctrl-N Alt-O-D	Display Digital Input Panel
Ctrl-Q	Quit
Ctrl-Alt-S	Switch offline if online Switch online (and load map) if offline
Ctrl-D	Datalog
Ctrl-T	Display throttle pumps maps



## Keystrokes used in general tuning (2D Maps) Legacy Keys

### Keystrokes Common to all 2D maps

Key Stroke	Function
Left Arrow	Move selection bar left on load axis
Right Arrow	Move selection bar right on load axis
n	Next range on RPM axis
p	Previous Range on RPM axis
v function key F2	Edit value of selected bars directly by typing in a value (bring up a dialog box if necessary)
5 (not keypad) % (shift-5)	Increase or decrease as a percentage of the selected bars.
L	Linear-ise between the ends of the selected range.
'a' or 'A'	Select all bars
'i' or 'I'	Open increment adjustments window
ESC	Turn off 'all bars' selection
Ctrl-Left Arrow	Select multiple bars to the left of current bar
Ctrl-Right Arrow	Select multiple bars to the right of the current bar
Alt-Left Arrow	Deselect bars from the right
Alt-Right Arrow	Deselect bars from the left
Ctrl-Space	Turn off multiple bars selection
Home	Move selection to home pointer
Ctrl-Home	Move to first bar
Ctrl-End	Move to last bar

### Fuel Injector Time Maps (use same increments for Batt Voltage map)

Key Stroke	Increment	Function (default increments)
Ctrl-Up Arrow	Mini	Increase fuel by 0.005ms
Ctrl-Down Arrow	Mini	Decrease fuel by 0.005ms
Up arrow	Small	Increase fuel by 0.050 ms
Down Arrow	Small	Decrease fuel by 0.050ms
Shift-Up Arrow	Medium	Increase fuel by 0.100ms
Shift-Down Arrow	Medium	Decrease fuel by 0.100ms
Pg Up	Large	Increase fuel by 0.200ms
Pg Down	Large	Decrease Fuel by 0.200ms
Shift-Pg Up	Very Large	Increase Fuel by 0.500ms
Shift-Pg Down	Very Large	Decrease Fuel by 0.500ms

### Ignition Angle Maps

Key Stroke	Increment	Function (default increments)
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Ctrl-Up Arrow	Mini	Increase ignition by 0.1 degrees (0.5 degrees in correction maps)
Ctrl-Down Arrow	Mini	Decrease ignition by 0.1 degrees (0.5 degrees in correction maps)
Up arrow	Small	Increase ignition by 0.5 degrees
Down Arrow	Small	Decrease ignition by 0.5 degrees
Shift-Up Arrow	Medium	Increase ignition by 1.0 degrees
Shift-Down Arrow	Medium	Decrease ignition by 1.0 degrees
Pg Up	Large	Increase ignition by 2.0 degrees
Pg Down	Large	Decrease ignition by 2.0 degrees
Shift-Pg Up	Very Large	Increase ignition by 5.0 degrees
Shift-Pg Down	Very Large	Decrease ignition by 5.0 degrees

### Percentage Maps

Key Stroke	Increment	Function (default increments)
Ctrl-Up Arrow	Mini	Increase Percentage by 0.1 percent
Ctrl-Down Arrow	Mini	Decrease Percentage by 0.1 percent
Up arrow	Small	Increase Percentage by 0.5 percent
Down Arrow	Small	Decrease Percentage by 0.5 percent
Shift-Up Arrow	Medium	Increase Percentage by 1.0 percent
Shift-Down Arrow	Medium	Decrease Percentage by 1.0 percent
Pg Up	Large	Increase Percentage by 2.5 percent
Pg Down	Large	Decrease Percentage by 2.5 percent
Shift-Pg Up	Very Large	Increase Percentage by 5.0 percent
Shift-Pg Down	Very Large	Decrease Percentage by 5.0 percent

### Keystrokes used in general tuning (3D Maps) Legacy Keys

#### Keystrokes Common to all 3D maps

Key Stroke	Function
Up Arrow	Same as up arrow in 2D maps. See tables above.
Down Arrow	Same as down arrow in 2D maps. See tables above.
Left Arrow	Move selection bar left on load axis
Right Arrow	Move selection bar right on load axis
n	Next range on RPM axis
p	Previous Range on RPM axis
L	'Linearise' between the ends of the selected range.
Home	Move selection to home pointer
1	Rotate map down.
2	Rotate map up.
3	Rotate map to the left.
4	Rotate map to the right

7	Zoom map in.
8	Zoom map out.

**Keystrokes used for Data Viewer**

<b>Key Stroke</b>	<b>Function</b>
Ctrl 1 to 6	Displays the view properties for views 1 to 6
Ctrl – Alt - D	Displays the DataSet window
Ctrl – Alt – C	Displays the channel values in text form
Right or left Arrow	Moves the cursor to the right or the left
Up and down arrow	This zooms you in (up key) out (down key) at the cursor point
Ctrl – Alt - I	Zoom in command with appropriate cursors selected.
Ctrl – Alt - O	Zoom out command with appropriate cursors selected.
Alt- Backspace	Removes the selected DataSet in the data window
Shift - Z	Turn on/off cursors for zooming in and out. It is the equivalent of using the right arrow key to zoom in and out.
Ctrl - W	Brings up dialog to select Pen Width.
Ctrl - O	Brings up dialog to open a DataSet.

### Glossary

A/F	Air/Fuel Ratio
ALS	Anti Lag System
ATDC	After Top Dead Centre
BAC	Bypass Air Control
BTDC	Before Top Dead Centre
ECU	Engine Control Unit
EMI	Electromagnetic Interference
IAC	Idle Air Control
MAP	Manifold Absolute Pressure
NOS	Nitrous Oxide
PC	Personal Computer
PWM	Pulse Width Modulation
RPM	Revolutions Per Minute
TDC	Top Dead Centre
TPS	Throttle Position Sensor
VTEC	Variable Valve-Timing and Lift Electronic Control

### Appendix A: Electronic Engine Management Overview

While the technology involved with electronic fuel injection is complex, the underlying principles of its operation are really quite straightforward. The object of any fuel delivery system in a gasoline engine is to determine the amount of air being drawn by the engine, and supply the appropriate quantity of fuel to "burn" all the oxygen in that mass of air.

A carburettor uses primarily only one parameter to determine fuel metering: air speed. Higher air speeds through the carburettor result in larger pressure drops across the venturis, and thus more fuel is sucked through the jets.

Electronic fuel injection revolves around the use of solenoid-actuated injectors. These devices employ a coil attached to a valve. When the coil is energised, the valve opens and fuel is allowed to flow. As long as the pressure between the fuel and the air in front of the injector nozzle is held constant, the rate of fuel flow will remain the same. By accurately controlling the length of time the injector remains open, precise quantities of fuel can be metered to the engine.

Since we have no convenient means of directly measuring the amount of air entering the engine to determine the amount of fuel to deliver, we use a number of engine parameters to determine an injection opening time. We build a table that breaks the engine's operation into a series of rpm ranges. At each range, we consider the load on the engine, using either the position of the throttle or the manifold pressure as a reference to the load on the engine.

Collectively, the ranges in this table (also called a look-up table), form a map of the volumetric efficiency for the engine. Our standing assumption, therefore, is that for any combination of engine speed and load, we have a direct reference to the amount of air that is being drawn into the engine by means of this map.

The Haltech ECU uses a digital microcomputer to measure engine speed and load, and uses them to index to the base fuel map. The base fuel map is a look-up table of injector opening times stored in non-volatile memory. Non-volatile memory simply means when power is switched off, the contents of the memory are retained. By using the Halwin programming software, the contents of this memory can be changed so that you can match injector opening times to the injectors you are using, and to suit the requirements of your engine.

Having programmed the base injection times, the microcomputer is able to perform a number of adjustments to this value. Corrections for air temperature and barometric pressure can be applied, since these variables affect the density of air. Extra injection time is also added, when necessary, for transient throttle movement and the temperature of the engine. At the end of all these calculations, the final injection time is determined: the time for which the injectors are actually held open.

Injection pulses usually occur one or more times per engine cycle. The ECU uses a trigger signal locked to engine speed in order to determine when to inject. When it receives an appropriate trigger, the ECU applies a magnetising current to the injector coils for precisely as long as the final computed injection time, providing an extremely accurate delivery of fuel that will exactly suit the engine's needs.

The ignition timing is determined in a similar way to the fuel needs. The Haltech ECU has a look-up table configured in the same way as for the fuel, but instead of the fuel delivery in the table the Ignition Map contains the Ignition Advance for that point. This means that the ignition point can be controlled with much greater accuracy than ever possible with bob-weights and vacuum advance in a distributor.

### Fuel Systems

The best EFI installation will yield poor results if the fuel system does not meet the demands of the engine. Insufficient fuel flow can lead to engine lean out and detonation that could cause serious damage. For the safety of your engine, we urge you to check your fuel system's capacity and ensure that there will be sufficient supply at all times. A fuel pressure meter should be used during testing and tuning to ensure that fuel pressure does not fall out of regulation i.e. that the pressure does not drop or oscillate.

This appendix offers guidelines to testing your fuel system and suggests some solutions if there are supply problems. If you find you need to modify your fuel system and are unsure what to do, contact a Haltech dealer for advice.

### **WARNING**

**Fuel is dangerous. Beware of flames, cigarettes, electrical sparks, etc. Whenever you are working with exposed fuel, make sure you are working in a well-ventilated environment.**

### Flow Estimation

If you can estimate the power output of a gasoline engine, you can make a reasonable guess at the fuel flow requirement. A simple rule of thumb, thus, may be expressed in metric or imperial units.

Note: Every 100 hp needs around 50 lb/hr (8.0 US gal/hr) of fuel  
(6.6 Imp gal/hr)

Every 100 kW needs around 670 cc/min (40 L/hr) of fuel

This assumes a brake specific fuel consumption of 0.50. The actual fuel flow necessary by injectors and pump are likely to exceed a figure derived this way. This is due to the overheads in injector dead time and pumping return fuel to maintain regulation.

### Injector Flow Capacity

If you have purchased second hand injectors, or have removed the current injectors while doing work on the engine, we strongly recommend that you clean and flow test them. If you have bought new injectors, it is worth flow testing them anyway if you do not know their flow rate. Make sure that you test the injectors at the fuel pressure that your regulator is operating.

Your total injector flow capability is given by the sum of the injector flow rates. Injector flow rates are usually specified in either cc/min or lb/hr. Check that you have enough injector flow to match the estimated power output comfortably. Keep in mind that you do not want to exceed 85% duty cycle injection on time, and that at high rpm, injector dead time can consume a significant amount of available injection time.

If you find that your injector flow is insufficient, you can change to larger injectors, add extra injectors, or increase fuel pressure. Raising fuel pressure to increase injector flow rate is not recommended if the desired flow is more than 20% than the system currently achieves. Fuel flow is not in direct proportion to fuel pressure. Increasing fuel pressure will increase injector dead time and reduce the flow rate of the pump.

### Fuel Pump Capacity

You should ensure that your fuel pump is capable of supplying sufficient fuel to feed the engine at

maximum power. With the engine switched off (injectors closed) feed the return line of the fuel pressure regulator to a measuring container. In the case of a turbo- or supercharged engine, pressurise the manifold pressure port of the fuel pressure regulator to the maximum boost of the engine. This is necessary as the flow rate of the pump decreases with output pressure. Power the pump for one minute and calculate the hourly fuel flow rate of the pump.

Since the pressure regulator operates on a return system, there should always be fuel being returned to the tank, even when fuel flow to the engine has reached its maximum. If this fails to happen, the fuel pressure will fall out of regulation. Therefore the fuel pump must be capable of delivering significantly more fuel than the engine is going to use. As a guide, the pump should flow 30% more fuel than consumed by the engine.

If you cannot achieve the required fuel flow from one pump, you can employ two pumps in parallel. If you choose to use a low-pressure pump to augment the fuel flow of a high-pressure pump, place a check valve after the low-pressure pump.

### Fuel Rail and Pressure Regulators

A long fuel rail with narrow internal diameter will suffer from pulsation in the fuel rail. The internal rail diameter should be around 12mm ( $\frac{1}{2}$ "). Even so, oscillations may occur, particularly if the injectors are large. A fuel damper can help in removing these oscillations. If running a multipoint set-up, batch fire injection will also reduce oscillation amplitude. Oscillations may occur only within a certain rpm range, so a fuel pressure meter should be monitored throughout the driving range of the engine.

On V configuration motors, it may be more practical to employ two regulators, one on each bank's rail. The fuel from the pump can be split to the two rails, and the return line from the two regulators can be joined. Since pressure regulators work within certain flow limits, this may also save having to purchase an expensive high pressure / high flow regulator.

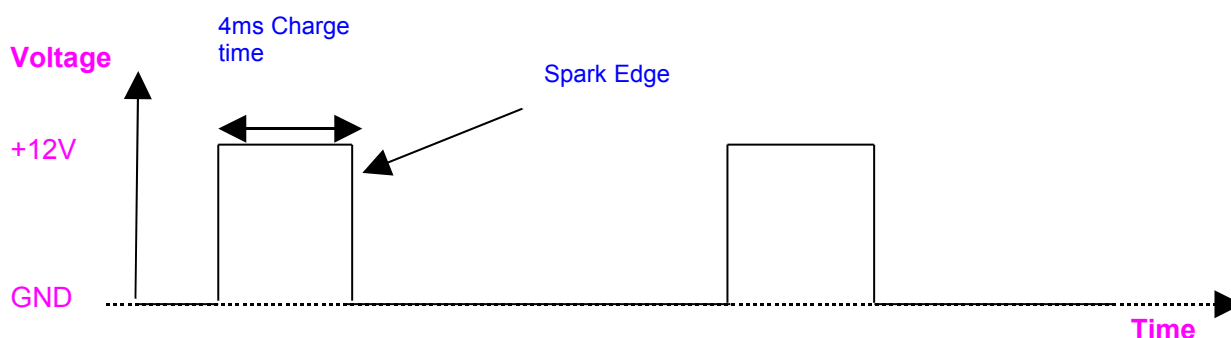
### Ignition Systems

The ECU's interface to the ignition system is through the Ignition Module (sometimes referred to as an Ignitor or Spark Amplifier). There are two distinct types of Ignition Module available in common use on factory ignition systems.

#### Dumb Ignitors

The Dumb Ignitors are found on nearly all engines that have an existing engine management system that controls spark timing, they require the ECU to perform the dwell control or charge time of the ignition coils. The signal from the ECU determines the charge time of the coil and tries to maintain a constant charge time at all engine speed where possible.

For a dumb ignitor with a falling edge spark edge, with 4ms of coil charge time, the ECU ignition output waveform will look like the following waveform:



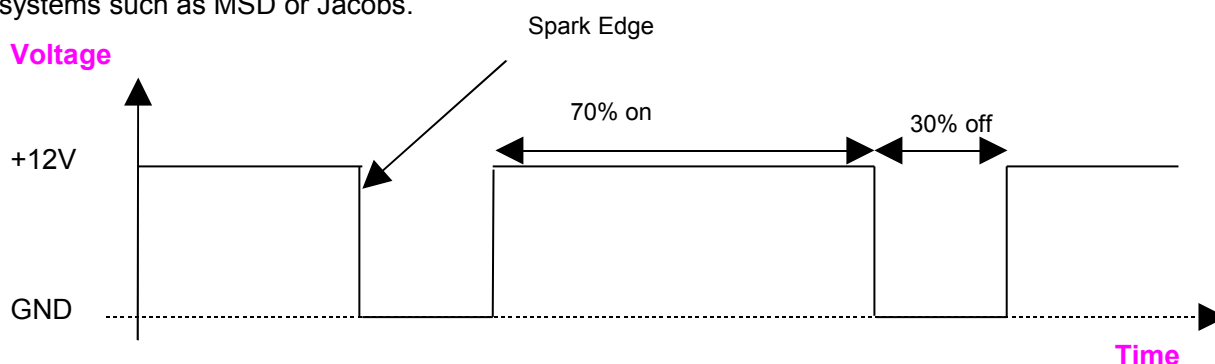
## WARNING

**Never send a constant duty cycle waveform to a *Dumb Ignition Module*. Using a constant duty cycle signal on a dumb ignition module will cause the ignition coils to be damaged from overcharging. Ignition modules will be damaged as a consequence.**

### Smart Ignitors

Smart ignition modules are less common and control the dwell or charge time for the coils automatically. They require a different signal from the ECU. Smart ignitors require a constant duty cycle waveform, with the appropriate edge setup to trigger to module to fire a spark from the coils.

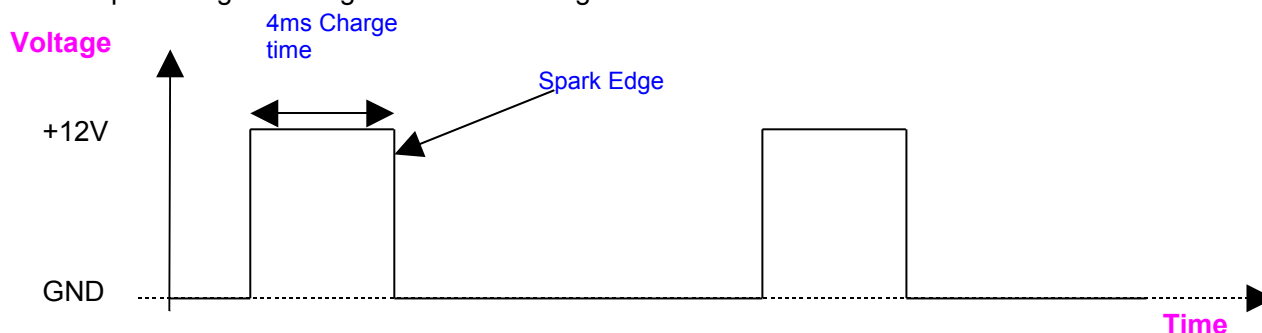
The duty cycle of a square wave is the ratio of its high time to its period. E.g. a 70/30 duty cycle signal is high for 70% of its period and low for the remaining 30% regardless of frequency, as shown in the diagram below. Constant duty can also be used on aftermarket capacitive-, inductive- or multiple-spark discharge systems such as MSD or Jacobs.



### Falling edge and Rising edge Ignition Modules

The waveform that the ignition module expects can vary depending on which edge the module fires a spark.

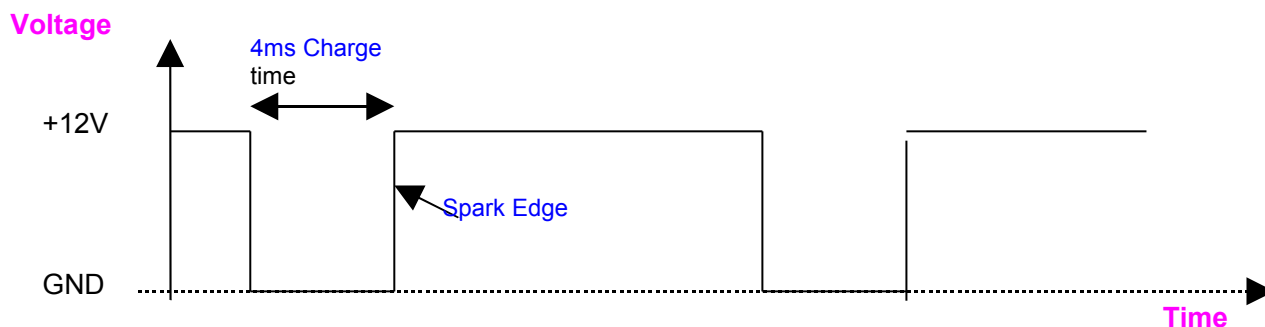
- Falling Edge Triggered** – Most factory ignition modules are falling edge triggered. These modules expect a 0V input signal when the ignition system is idle. When the voltage rises to 12V, the coil is being charged. When the input voltage returns to 0V, a spark is fired and the coil sits idle until the input voltage to the ignition module is again raised to 12V.



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- **Rising Edge Triggered** – Some Honda and CDI style ignition modules are known to be rising edge triggered. These modules expect a 12V input signal when idle. When the voltage falls to 0V, the module charges the coil. When the voltage returns to 12V, the spark is fired.



### The Coil Negative Signal

The coil's charge time can be determined from the coil -ve signal. When the coil switches on, voltage at the coil negative terminal drops to zero. As the coil charges, the voltage rises slightly, until a sharp rise where the ignitor current limits. Leaving the coil switched on any longer will not increase the energy in the coil or of the spark. See figure D7.

When the ignition firing frequency is high, there will not be enough time to charge the coil completely. After firing the spark, the ECU will wait for a short period, and then switch the coil on again, regaining much of the lost energy in "ringing". This break time should normally be 0.7 to 1.5ms.

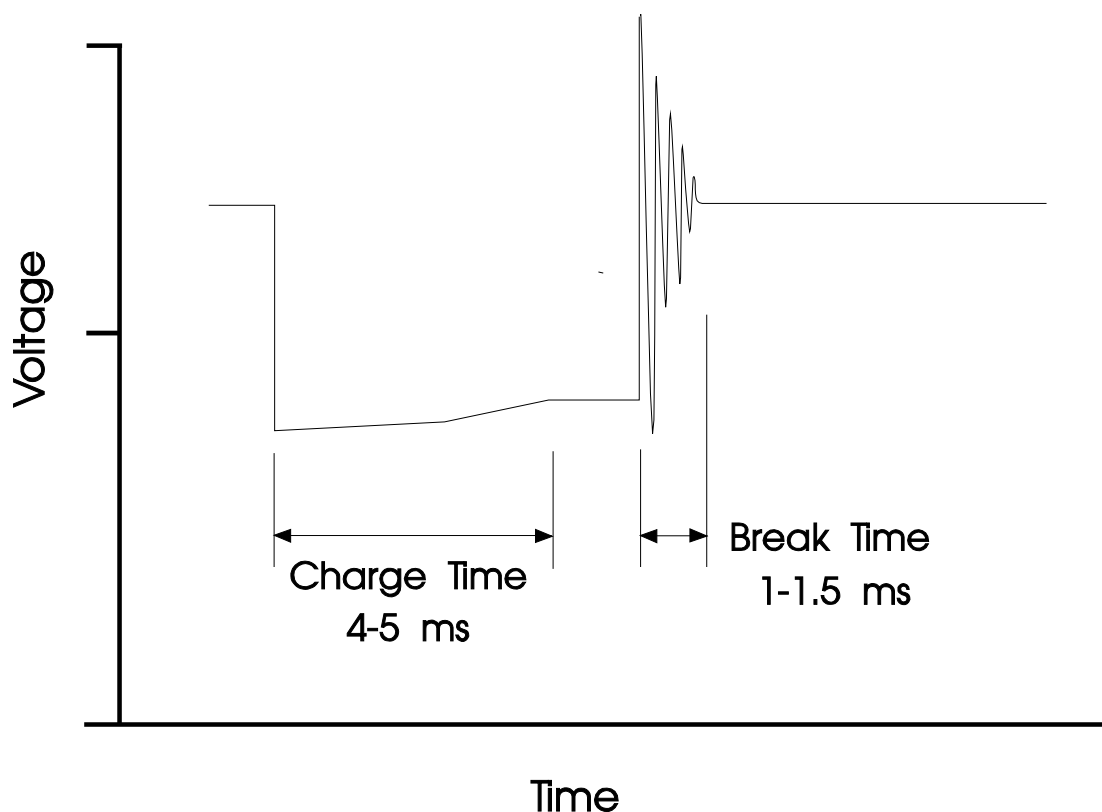


Figure D7. Illustrates Charge Time & Break Time

Note: For safety and reliability, always use igniters that are internally current limited.

Make sure that you set the ignition output trigger edge correctly. If set to the wrong edge, the timing will be out by significant amount and engine damage may result.

### Appendix B: Trigger Sensors (Crank Sensors)

#### Rotor Phasing

One of the most important aspects to consider when modifying a distributor or trigger is the Rotor Phasing. As an example, consider a distributor that uses a Hall effect sensor with a chopper wheel attached to the distributor shaft. The Hall effect sensor is mounted to a plate that is rotated by a vacuum advance mechanism and by centrifugal bob weights. This is a fairly conventional set up used in many vehicles with electronic ignition. Simply removing the advance mechanisms and locking the plate so that it can't move may not be all that is required. The trigger edges generated by this modified distributor may fall outside the trigger angle window allowed by the ECU. Something will have to be moved to allow the trigger edges to fall within the required window.

If the distributor shaft is rotated so that the chopper wheel now triggers the sensor at 70° BTDC then a problem of rotor phasing may have been induced. By the time the ignition pulse occurs, which could be up to 60° later, the rotor button would have passed the plug lead terminal in the rotor cap and this could lead to arcing in the distributor cap. The arcing could even be to the wrong plug lead terminal. If arcing doesn't occur, then the back EMF in the ignition coil primary could damage the ignition module or the ignition system. Either way, the engine is not going to run correctly, if at all.

If the trigger sensor and rotor button phasing does not allow for usable ignition angles, the correct way to fix the problem is to move the plate that the sensor is mounted on. Remember that all degrees referred to here are crankshaft degrees, distributor degrees would be half those numbers referred to. Our example is an engine that has the following timing requirements:

Minimum Timing        10° BTDC

Maximum Timing        40° BTDC

This gives a mid point, half way between the minimum and maximum timing, of 25°. Align the centre of the rotor button with one of the plug lead terminals. It does not matter which one. This is where the rotor button has to be when the engine is 25° BTDC. Now rotate the distributor shaft so that the rotor button is where it should be when the engine is at 70° BTDC. i.e. move it back 45° crank degrees. This is where the rotor button has to be when the chopper wheel triggers the sensor. Let's assume that the trigger point of the sensor is exactly in its centre. Move the plate the sensor is mounted on so that one of the vanes of the chopper wheel is leaving the sensor. Adjust the position of the plate so that when the shaft rotates in its normal direction, the centre of the sensor will become exposed. If it is not possible to move the sensor, it will be necessary to rotate the trigger wheel relative to the shaft and the sensor.

Rotor phasing is not only a problem on distributors with advance mechanisms. Several factory distributors have their triggers at points outside 60 - 100°. It is not advisable to just rotate the distributor until the trigger is within this window. Care must be taken to ensure that the rotor phasing will not cause a problem.

#### Trigger Interface

Interfacing the ECU with your particular trigger system may be fairly straightforward or it may be complicated. The variety of trigger designs available is the primary source of complication. This appendix contains a lot of useful information about the different approaches to trigger design and is essential information to anyone installing an ECU.

#### The Input Trigger

The ECU has been designed to trigger from either a square wave signal that varies from a 'low' of zero volts (ground) to a voltage between 5 and 15 volts or from a magnetic inductive (reluctor) signal in

conjunction with the internal reluctor adaptor or an optional external reluctor adaptor. A reluctor adaptor converts the sine-like wave signal from the reluctor sensor to a square wave signal. The actual value of this 'high' voltage is not important because it is the transition from 'low' to 'high', or 'high' to 'low' that is used to trigger the ECU. This transition is referred to as the Trigger Edge and will be shown in the following illustrations as an upward or downward facing arrow. An upward facing arrow would indicate that the trigger edge is the transition from low to high and this is called a Rising Edge trigger. If the trigger edge occurs on the transition from high to low, it will be shown as a downward facing arrow, and would be called a falling edge trigger. See Figure E.1.

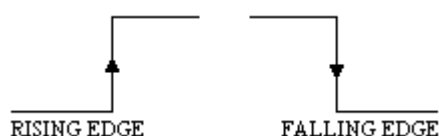


Figure E.1

In order for the ECU to operate correctly a trigger edge must be generated. This edge must occur a fixed number of degrees before top dead centre (BTDC) and must not change. The position of the trigger is given in crankshaft degrees and is called Trigger Angle. In addition there should not be any variation in the trigger angle between cylinders. The ECU can be set by the user to have its trigger edge occur between  $60^{\circ}$  and  $100^{\circ}$  BTDC.

In the example shown in figure E.2 the trigger occurs on a rising edge at  $70^{\circ}$  BTDC. This assumes that you are using a Standard Trigger pattern with one pulse per ignition event. The second transition, from high to low, could occur any time after the rising edge. In some installations the second transition will coincide with  $10^{\circ}$  BTDC or TDC itself, or it could happen as close as a few degrees after the trigger edge. This second edge will have no effect on the correct operation of the ECU. It is only the position of the triggering edge that is of importance.

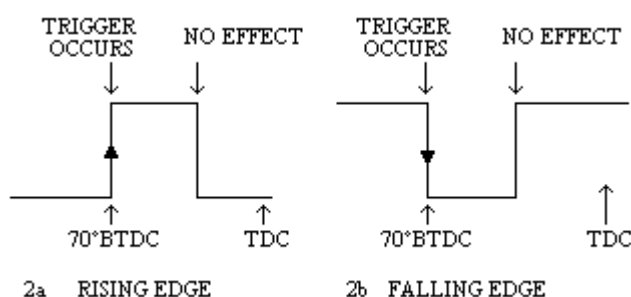


Figure E.2

In the previous examples the trigger edge has been shown as the first edge of the trigger pulse. The trigger does not necessarily have to be the first edge of the trigger pulse. Consider the example shown in figure E.3. In some trigger devices the pulse given for cylinder one would be a different width than the pulses given for all the other cylinders. If the first, in this case, rising edges were used as the trigger edge then there would be a variation of  $20^{\circ}$  between the trigger for cylinder one and all other cylinders. This would lead to cylinder one being  $20^{\circ}$  more advanced than all the other cylinders and obviously this would be unacceptable. The solution in this case would be to set the trigger point so that it is at a falling edge and to have the trigger degrees set to  $60^{\circ}$  BTDC.

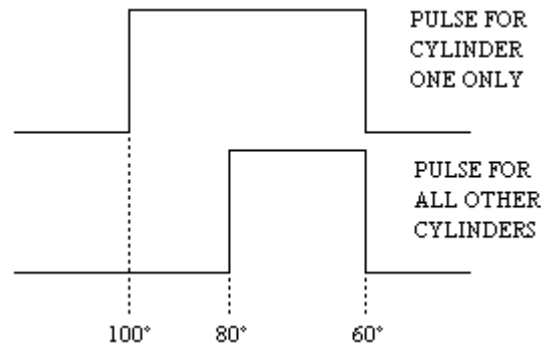


Figure E.3

### Trigger Devices

The output of Hall effect, Optical, or Magnetic Inductive (Reluctor) sensors could normally be connected directly to the input trigger pin of the ECU. Many distributors used in original equipment manufacturer's computer controlled ignition systems would be fitted with Hall / Optical triggers. The internal structure of such distributors is usually configured so that a chopper wheel attached to the distributor shaft passes through a gap in the sensor. These devices require three connections:

Power (normally +12V)

Ground, and signal;

### Trigger signal output.

Assuming that the timing edges conform to the details set out above, a distributor such as this would connect directly into the ECU. Often these distributors have a rising edge trigger at 70° BTDC.

Many distributors used in electronic ignition systems contain internal components and layouts the same as the distributor described above, but are fitted with mechanical and/or vacuum advance mechanisms which are much less effective and flexible than electronic timing as in the ECU. If these mechanisms can be defeated or removed, and the timing edges set correctly, then they can successfully be used to trigger the ECU.

A third type of pickup, the magnetic inductive (reluctor) is used in distributors as well as on crank trigger units. It is possible to use this type of trigger on the ECU using it's own internal reluctor adapter to convert the signal into the square wave required to trigger the ECU. The Primary input is used for the main trigger, and the secondary is used for the Home (Sync. Event).

Note: Any combination of Hall effect, optical or Reluctor type pick-up may be used for the "trigger" (main ignition event) and "home" (sync. event) inputs. However, Reluctor type pick-ups must be connected to their respective Reluctor adaptor input.

The onboard Reluctor adaptor actually has two independent channels. One is for the "trigger" signal. The second is for the "home" signal. Each Reluctor adaptor channel used requires two wire connections.

The magnetic pickup is basically a piece of wire wrapped around a magnetic core and attached to the sensor face, which is called the pole piece. The physical size and shape of such a pickup can take many forms. This type of pickup has either two wires (one positive (+), and the other negative (-)), or three wires with the third being a shield. The wires are sometimes marked as such, but more often than not they are unmarked. See the Wiring Diagram and any relevant application notes for how to connect up magnetic pickups.

If you cannot tell which wire is the positive from markings or wire colour, then it would be necessary to check the signal going into the ECU using an oscilloscope.

When ferrous metal (metal that a magnet will attract) is passed very close to the pole piece, the pickup will

generate a voltage similar to figure E.5 on the positive wire. The amplitude of the signal will vary with the speed at which the ferrous metal passes the pole piece. At low speeds the signal may only be several hundred millivolts, but at high speeds it could rise to 20 volts or more. The sudden drop in the signal from positive to negative seen in figure E.5 corresponds to the metal being directly in line with the sensor. As can be seen, the signal is not a square wave required by the ECU, and at low speeds the signal amplitude is too low.

The voltage input of the reluctor adapter must first go to a positive peak, which arms the circuit. When the signal rises to approximately 70 - 80% of the peak value the reluctor adapter will generate a falling edge, and when the signal crosses zero volts a rising edge triggers the Haltech ECU. If the wires are reversed and the signal goes negative first, the Reluctor adapter will generate a pulse but it will NOT trigger the ECU correctly resulting in incorrect ignition timing.

### **WARNING**

**An incorrectly wired reluctor will retard ignition timing as RPM increases or generate multiple triggers. Incorrect wiring of a reluctor trigger can cause major problems. If you are using a reluctor pickup ensure that they are wired with the correct polarity.**

### **Standard Trigger**

The simplest form of trigger pattern is what we refer to as Standard Trigger. With standard trigger, there is a synchronising pulse that precedes each ignition event for the engine. For a 4-cylinder engine, the trigger signal will have 4 pulses with each pulse occurring before the spark event. Typically, this angle will be 65° to 70° BTDC. Ignition events typically occur at less than 45° BTDC.

The standard trigger pattern can be as simple as one pulse per ignition event on the trigger channel only, but there are variations on this trigger that allows for varying degrees of engine synchronisation to allow for more complex fuel and ignition outputs. The 3 variants of standard trigger are as follows:

**Standard with No Home signal** – This type of signal gives only a single pulse per ignition event on the trigger channel. This type of trigger signal is suitable for running distributor ignition systems only. With this information, the ECU only knows when a piston is approaching TDC. It does not know which piston, but the distributor will distribute spark to the correct cylinder. The only possibility for injection mode is multipoint injection where all injectors fire at the same time.

**Standard with Home on the Crank** – This type of signal uses a single pulse per ignition event on the trigger channel, but supplements this information with a home pulse just before the pulse for cylinder 1 approaches TDC. Since the home signal comes from the crank, there is insufficient information for the ECU to determine if the crank is at TDC compression, or TDC exhaust. As a result, the most complex ignition mode that can be used is Wasted-Spark ignition mode where a spark always fires as a piston approaches TDC of either stroke. The best fuel mode that can be used is "Semi-Sequential" injection where half of the fuel pulse is fed to the cylinder on the correct cycle of the stroke (i.e. Just before or during the intake stroke) and half the fuel is injected at the wrong half of the cycle (i.e. During the compression stroke). Semi-sequential injection has the advantage that at least half of the fuel is injected on the correct part of the cycle leading to better atomisation than with multipoint. In addition, the fuel is always injected in the same positions for every cylinder, thus leading to smoother, more even running of the engine.

**Standard with Home on the Cam** – This type of signal gives a single pulse per ignition event on the trigger channel, but supplements this information with a home pulse just before the pulse for cylinder 1 as it approaches TDC of compression. With this information, the ECU knows exactly the position of each piston and which part of the 4-stroke combustion cycle that it is on. With this information, direct-fire multi-coil ignition is possible along with Sequential fuel injection.

If the vehicle that you are fitting a Haltech ECU to does not have one of the supported triggers, then fitting of a Hall effect, standard trigger setup is quite simple and straightforward. Contact Haltech for

more information on S3 and S4 Hall effect trigger systems.

### Multi-Tooth Trigger

These triggers are typically found on Toyota, Honda and Mazda rotary engines.

The ECU is capable of triggering from multi-tooth pickups, as used on a number of production vehicles. The ECU employs software signal conditioning to convert the multi-tooth trigger to standard form. This is done by counting teeth from a “synchronisation event” (or Home signal), until a certain tooth is reached which corresponds to the engine location specified as the Trigger Angle. The ECU then performs ignition and possibly injection in the same fashion as the standard trigger.

After recognising the synchronisation event, the ECU will locate the first “standard” engine trigger by the tooth indicated as Tooth Offset in the Ignition Set-up page. To find the remaining “standard” engine triggers, the ECU counts a number of teeth equal to the total teeth in one CAM revolution, divided by the number of cylinders.

For Example a 4-cylinder engine with a 24-tooth wheel on the cam and a corresponding home would have the following setup values:

Trigger Angle: 65° (10° to 90° as required)

Trigger Type: Multi-tooth

Total Teeth: 24

Tooth Offset: 2 (1 to Total Teeth)

With these setup values, when the Home signal occurs the ECU will start counting the trigger teeth (24-tooth wheel), when it reaches the tooth offset it will operate as a standard trigger. The position of the remaining triggers is determined by taking the number of teeth in the trigger wheel (24) divided by the number of cylinders (4). This number (6) is the number of teeth that is counted between triggers.

In this case the triggers will occur at the following teeth: 2,8,14,20. Each trigger occurs 65° (Trigger Angle) BTDC of the current cylinder and will perform ignition based on this angle.

### Nissan Trigger

The Nissan optical trigger sensor is used by almost every ECU controlled Nissan engine. It is a sensor that spins at half the engine speed, and is therefore able to measure the engine cycle position. It can be used as a trigger for direct fire and sequential injection applications. The sensor consists of two signals that will from now on be referred to as home and trigger.

The trigger signal consists of 360 evenly spaced pulses, where each falling edge represents 2 degrees of engine movement.

The home signal consists of the same number of pulses as the engine has cylinders, so on a 4 cylinder there are 4 pulses, and on a 6 cylinder there are 6 pulses. The rising (leading) edge of each slot is evenly spaced, but the falling (trailing) edge is not evenly spaced. The differing pulse widths enables the ECU to determine which pulse occurs immediately before cylinder number 1, the ECU does this by counting the number of 360 pulses that occur during the trigger pulse.

There are 3 common patterns for Nissan triggers, but for each pattern, there is always a unique window. You do not need to know what the patterns are, but you need to know which unique window size to use for a given sensor. The sizes are described by the number of small teeth that it inside of the window of the large slots. The following styles of Nissan sensor have been recognised:

Pattern 1 – The unique slot sizes are of pattern 8,2,2,2 for a 4-cylinder engine. Typically these are found on early generation Nissan motors such as FJ20, RB30ET.

Pattern 2 – The unique slot sizes form pairs with two unique slots at opposite ends. Typical patterns are 4,8,12,8 for a 4-cylinder motor. For 6-cylinder motors of this pattern type, typical patterns are 4,8,12,16,12,8. These patterns are typically found in CA18 and RB20 motors.

Pattern 3 – All the large slot sizes are unique. A typical pattern is 4,8,12,16. This is commonly found on SR20 motors.

### Subaru Trigger

All factory injected 4 cylinder Subaru engines use a combined crank-angle/cam-angle trigger system. If a Subaru trigger is being used, select the Trigger type as Subaru and connect the Cam angle sensor to the Home Input and the Crank angle sensor to the Trigger Input. Both the Trigger and Home Input should be set to Reluctor and the “Trigger angle” should be approximately  $65 \pm 2^\circ$  BTDC. The fields “Tooth Offset” and “Number of Teeth” will not affect the operation of the ECU in a standard Subaru set-up.

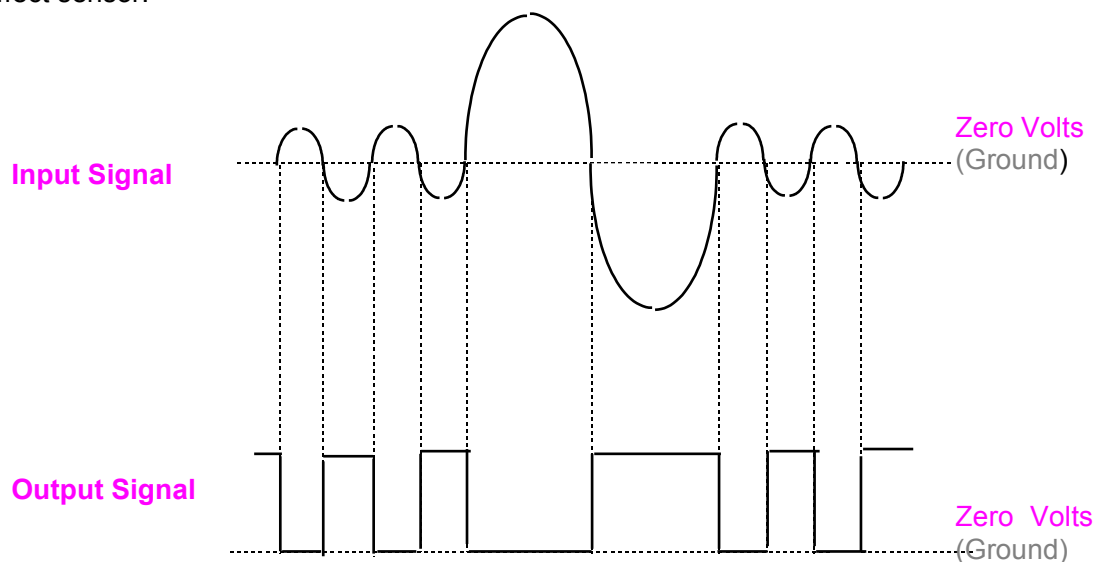
If your Subaru engine is from an MY01 or later model WRX, then your trigger angle will be  $68 \pm 2^\circ$  BTDC. The fields “Tooth Offset” and “Number of Teeth” will not affect the operation of the ECU in a standard Subaru set-up.

### Motronic Trigger

The Bosch Motronic sensor system comprises a toothed wheel, generally 60 teeth, with 2 teeth missing and a sensor that counts the passing teeth. The Ford system with 36 teeth and 1 tooth missing is generally similar. The teeth provide the means for generating trigger signals and the missing teeth are detected and provide a home reference. Most Motronic type sensors are Reluctor (**magnetic**) type sensors that give out a signal that is similar to a sine wave. A Reluctor adaptor must condition this signal.

Please note that some Motronic sensors are of the Hall effect type that gives out a square wave signal and there is therefore no necessity for signal conditioning. These sensors have to be configured differently to so you will need to establish which type of Motronic sensor is on your engine.

If there are 2 wires per pickup, then this will almost certainly be a Reluctor type (isolated loop). If there are 3 wires it could be either a Reluctor type (signal, ground and shield grounded to sensor) or Hall effect type in which case the Motronic trigger should be connected as a Hall effect type input. If in doubt as to the type of sensor, check with the engine manufacturer. Also please note that if you elect to use an external Reluctor adaptor rather than the internal Reluctor adaptor of the ECU the signal will already be conditioned to square wave and the connection to the ECU should then be treated in the same manner as a Hall effect sensor.



If the wires are reversed and the signal goes positive (+) first then the on-board reluctor adaptor will still generate a pulse but it will not trigger the ECU correctly resulting in incorrect ignition timing. So please make sure it is wired correctly.

Note that when using Motronic type sensors it is only necessary to use the Home channel (i.e. a separate

Home signal to that provided by the missing teeth in the Motronic system) when using the Sequential mode of operation or when controlling direct fire ignition where 4 coils are used (including 4 cylinder configurations where one ignition coil per cylinder is used but excluding 4 cylinder direct fire waste spark where 2 ignition coils are used) and 3 and 5 cylinder applications. The Home channel is independent of the Trigger channel and can use either reluctor type sensors or Hall effect type sensors.



### Appendix C: Fault Finding

#### No communications.

Check communications cable. Check that it is plugged in firmly and does not have damage. Cables are easily damaged when shut in car doors.

Check power to ECU. Check that the car's ignition is turned on to supply power to the ECU.

Check software for correction ECU type. Make sure the software corresponds to the ECU type.

Check that no other software is using the COM port that the Haltech programming software intends to use. Some software used for synchronising palmtop computers can often open the port and may block Halwin from accessing that particular COM port.

Make sure you are using a supported operating system. Check the System requirements in Appendix D.

If using a USB/Serial Adaptor ensure that the driver has been correctly installed and the device is setup as the same COM port as the Halwin software is trying to communicate on.

#### No RPM signal

Check power to the Hall effect or optical sensor if either of these types of sensors are used for crank position/speed detection.

Check the power to the ECU when the car is cranking. Some vehicles disconnect power to accessory devices when cranking to minimise power draw from these devices. If your ECU power relay is switch by this source, then the ECU will lose power when cranking.

Check the trigger wiring. If you have access to an oscilloscope, then check the input to the ECU.

Check trigger configuration. Ensure that you have selected and configured the correct trigger for the vehicles trigger type.

#### No Spark or No Injection Pulses

Check that you have a good RPM signal. You should see a cranking speed of between 100 – 250 RPM. See trigger setup if you do not have a good RPM signal.

Check power to your ignition coils and injectors. Re-check them while cranking if there is any doubt.

Check all fuses.

Check power to the ECU.

If you have an oscilloscope, check the ignition and injection output from the ECU for a pulsing signal.

Check that the ignition mode or injection mode is correct for the type of trigger. For example, if you have a trigger system that does not provide a Home signal, then only Multipoint or Batch Fire fuel modes will work.

### Appendix D: E11v2 ECU Specifications

#### Engine Suitability

- Up to 16,000 rpm
- 4, 5, 6, 8, 12 cylinders
- 2 – 3 rotors
- Normally aspirated or supercharged up to 200 kPa (30psi) - Higher boost pressure MAP sensors available by special arrangement
- Load sensing by throttle position or manifold pressure
- Multipoint, Staged or Sequential injection patterns
- Distributed ignition systems, or direct fire systems with 1 to 6 coils

#### Power Requirements

Power Source - 8.6 to 16 Volts DC

Consumption - Haltech ECU: 470 mA at 12 Volts (12 V supply cable may carry as much as 20 A instantaneously).

Injector Load: Dependent on injector type. Approx. proportional to injector duty cycle (Typically 0.6 Amps per injector)

#### Physical Specifications

##### ECU Dimensions

Length:	195 mm
Width:	145 mm
Depth:	42 mm

##### Weight

ECU:	620g (1.4 lb)
Loom:	1.92kg (4.2 lb)
Sensors:	500g(1.1 lb)

#### ECU Inputs

Manifold Absolute Pressure (MAP) Sensor (supplied separately at extra cost)

1 Bar -100kPa to 0kPa (Naturally Aspirated)

2 Bar -100kPa to 100kPa (up to 1 Bar or 15 psi boost)

3 Bar -100kPa to 200kPa (up to 2 Bar or 30 psi boost)

Higher boost pressure MAP sensors available by special arrangement

Temperature Sensors (Air and Coolant) - NTC temperature dependent resistor type.

#### Operating Range

Continuous -40°C to 100°C (-40°F to 212°F)

Intermittent up to 125°C (257°F)

Throttle Position Sensor - 10 k rotary potentiometer driven from throttle shaft

Internal Barometric Pressure Sensor - Barometric pressure compensation only

Trigger (Engine Speed Pickup)

Compatible with most trigger systems:

5 or 12 volt square wave;

Pull-to-ground (open collector)

The ECU has an internal reluctor adaptor for magnetic (or 'reluctor') triggers.

The ECU supports most standard tooth patterns.

Digital Inputs - 3 x timed digital inputs capable of measuring the period of the incoming signal. Can also be used to measure the state of a connected switch.

1 x digital input used to measure the state of the connected switch.

Spare Analogue/Digital Converters - 7 x Analogue input channels to measure 0-5V analogue signals.

### ECU Outputs

Injector Driver - 12 x 4/1Amp peak-and-hold current limiting drivers:

Up to eight low-impedance injectors

Up to sixteen high-impedance injectors

### Ignition Output

2 x 0 – 12V ignition outputs (when more than 2 ignition outputs are required the injection outputs are used). These outputs are capable of driving smart and dumb ignition modules.

### WARNING

Do not use the IGNITION outputs to drive the coil directly. An ignition module must be used.

Pulse Width Modulated (PWM) Output - 4 x Dedicated PWM outputs

Suitable for controlling turbo wastegate, solenoids, valves, shift lights, etc.

Special Purpose Digital Output - Up to 9 special purpose digital outputs. These outputs are taken from any unused injection and ignition outputs. Suitable for switching fans (through a relay), shift lights, anti-lag, NOS, etc.

### WARNING

Do not connect loads with a resistance of less than 13 $\Omega$  (except injectors), SUCH a LOAD can cause damage to the ECU.

**Stepper motor driver** - The 4 outputs associated with this control (IDL1-IDL4) are capable of driving a four-wire stepper motor commonly used to control the engine idle speed.

**Fuel Pump Control** - 20A fused relay, features automatic priming and switch-off controlled by the ECU fuel pump output.

## System Programming Requirements

### Computer

IBM-PC or compatible, preferably laptop or notebooks with Windows 95, Windows 98, Windows 2000 or Windows XP

Minimum Requirements:

233MHz processor

VGA colour display 800x600 (preferably 1024x768)

4Mb of memory

20 MB of free Disk space

Recommended:

400MHz processor

VGA colour display 1024x768

4Mb of memory

10 MB of free Disk space

Disk Drive - CD-ROM drive

Serial Port - Standard RS232C port - 9 pin D connector

### Adjustable Features

#### Base Fuel Map

32 Fuel ranges, default 500 rpm to 16,000rpm (with programmable ranges)

32 Load points per range, up to 32ms with 6.4us resolution

#### Ignition Map

32 Ignition ranges, default 500 rpm to 16,000rpm (with programmable ranges)

32 Load points per range, up to 60° advance, with 0.1° resolution

#### Correction Maps

##### Fuel

Cold Start Prime - 32 points

Coolant Temperature Enrichment - 32 points

Air Temperature Adjustment - 32 points

Battery Voltage Correction - 32 points

Closed Throttle (selectable) - 32 points

Full Throttle (selectable) - 32 points

##### Ignition

Crank Advance - 32 points

Coolant Temperature Advance/Retard - 32 points

Air Temperature Advance/Retard - 32 points

Programmable Rev-Limit - selectable as either fuel or ignition Soft/Hard Cut

Fuel Cut on Deceleration

Accelerator Pump - for transient throttle situations

#### Idle Speed Control

Target Idle Speed

Cold Idle-up RPM

Post-start RPM setting

Closed Loop O2 Control - With both cruise and idle settings, wideband and narrowband

#### Programmable Output Options

Data logging - Engine data information logged at a nominal rate of 10 times per second Stored to memory or disk Limited only by available memory.

On Board Data logging - Engine data information logged at 1,10 or 200 samples per second. 448kB of Flash memory storage.

Map Storage and Retrieval - Maps may be stored to disk and re-used.

Real Time Programming - Instant, hesitation free adjustment while engine is running.

Rugged Aluminium Casing - Black anodised with integral cooling fins and mounting brackets.

Optional Boost Control Solenoid.

Optional Dual Hall Effect Sensor Kit.

Optional Four Wire Heated Oxygen Sensor.

Optional Idle Air Control Motor Housing.

Optional Idle Air Control Motor.

Optional Ignition Coils - Available as Single and dual.

Optional Ignition Igniter with Dwell Control - Available as single and dual igniters.

Optional Ignition Igniter without Dwell Control - Available as single, dual and triple igniters.

Optional Mixture / Ignition / Boost Trim Module - Provides  $\pm 12\frac{1}{2}\%$ ,  $\pm 25\%$  or  $\pm 50\%$  injection time adjustment for fast tuning. Provides  $-10^\circ$  to  $+10^\circ$  ignition advance adjustment for fast tuning Provides 0 - 100% boost trim adjustment.

## Output Channel Electrical Characteristics

The following table describes the electrical characteristics of the output channels when used for Auxiliary devices that are assumed to be small solenoids, automotive relays, or constant loads.

The complex drive characteristics for driving injectors are not described here.

Auxiliary Channel	Output Type
IGN 1	12V 5mA low current drive output / 1A sink current to GND
IGN 2	12V 5mA low current drive output / 1A sink current to GND
IGN 3	12V 5mA low current drive output / 1A sink current to GND
IGN 4	12V 5mA low current drive output / 1A sink current to GND
IGN 5 / INJ 8	12V 5mA low current drive output / 1A sink current to GND
IGN 6 / INJ 7	12V 5mA low current drive output / 1A sink current to GND
INJ 6	1A sink current to GND
INJ 5	1A sink current to GND
INJ 4	1A sink current to GND
INJ 3	1A sink current to GND
INJ 2	1A sink current to GND
INJ 1	1A sink current to GND
Aux 1	1A sink current to GND
Aux 2	1A sink current to GND
PWM1	12V/8V/5V 1mA current drive output / 1A sink current to GND
PWM2	1A sink current to GND
PWM3	1A sink current to GND
PWM4	1A sink current to GND

## Input Channel Electrical Characteristics

Input Channel	Input Type
Aux In 1	0 – 12V (Input is active when input is GND)
Timed Input 1	0 – 12V
Timed Input 2	0 – 12V
Timed Input 3	0 – 12V

Input Channel	Input Type
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All Analog Input Channels	0 – 5V
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### Typical Engine Configurations

Table applicable for E11, E8 May Have Additional Limitations Based on the Number of Drivers on Board.

#### 3 Cylinder Engines

Output Pin	3 Cyl Sequential Distributor		3 Cylinder Sequential Direct Fire
Home	Home / Nissan Large Tooth	Waste spark not applicable	Home / Nissan Large Tooth
Trigger	Trigger / Nissan Fine Tooth		Trigger / Nissan Fine Tooth
IGN 1	Ignition 1		Ignition 1
IGN 2	Dig Out/PWM/Aux Injector		Ignition 2
IGN 3	Dig Out/PWM/Aux Injector		Ignition 3
IGN 4	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
IGN 5 / INJ 8	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
IGN 6 INJ 7	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
INJ 6	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
INJ 5	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
INJ 4	Dig Out/PWM/Aux Injector		Injector 3
INJ 3	Injector 3		Injector 2
INJ 2	Injector 2		Injector 1
INJ 1	Injector 1		Dig Out/PWM/Aux Injector
Aux 1	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector		Discrete Out/PWM Out
PWM1	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out		

4 Cylinder Engines

Output Pin	4 Cyl Sequential Distributor	4 Cylinder Sequential Waste Spark	4 Cylinder Sequential Direct Fire
Home	Home / Nissan Large Tooth	Home / Nissan Large Tooth	Home / Nissan Large Tooth
Trigger	Trigger / Nissan Fine Tooth	Trigger / Nissan Fine Tooth	Trigger / Nissan Fine Tooth
IGN 1	Ignition 1	Ignition 1	Ignition 1
IGN 2	Dig Out/PWM/Aux Injector	Ignition 2	Ignition 2
IGN 3	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Ignition 3
IGN 4	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Ignition 4
IGN 5 / INJ 8	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
IGN 6 INJ 7	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
INJ 6	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
INJ 5	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
INJ 4	Injector 4	Injector 4	Injector 4
INJ 3	Injector 3	Injector 3	Injector 3
INJ 2	Injector 2	Injector 2	Injector 2
INJ 1	Injector 1	Injector 1	Injector 1
Aux 1	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
PWM1	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out



## 5 Cylinder Engines

Output Pin	5 Cyl Sequential Distributor		5 Cylinder Sequential Direct Fire
Home	Home / Nissan Large Tooth	Waste spark not applicable	Home / Nissan Large Tooth
Trigger	Trigger / Nissan Fine Tooth		Trigger / Nissan Fine Tooth
IGN 1	Ignition 1		Ignition 1
IGN 2	Dig Out/PWM/Aux Injector		Ignition 2
IGN 3	Dig Out/PWM/Aux Injector		Ignition 3
IGN 4	Dig Out/PWM/Aux Injector		Ignition 4
IGN 5 / INJ 8	Dig Out/PWM/Aux Injector		Ignition 5
IGN 6 INJ 7	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
INJ 6	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
INJ 5	Injector 5		Injector 5
INJ 4	Injector 4		Injector 4
INJ 3	Injector 3		Injector 3
INJ 2	Injector 2		Injector 2
INJ 1	Injector 1		Injector 1
Aux 1	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
PWM1	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out		Discrete Out/PWM Out

6 Cylinder Engines

Output Pin	6 Cylinder Sequential Distributor	6 Cylinder Sequential Waste Spark	6 Cylinder Sequential Direct Fire
Home	Home / Nissan Large Tooth	Home / Nissan Large Tooth	Home / Nissan Large Tooth
Trigger	Trigger / Nissan Fine Tooth	Trigger / Nissan Fine Tooth	Trigger / Nissan Fine Tooth
IGN 1	Ignition 1	Ignition 1	Ignition 1
IGN 2	Dig Out/PWM/Aux Injector	Ignition 2	Ignition 2
IGN 3	Dig Out/PWM/Aux Injector	Ignition 3	Ignition 3
IGN 4	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Ignition 4
IGN 5 / INJ 8	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Ignition 5
IGN 6 INJ 7	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Ignition 6
INJ 6	Injector 6	Injector 6	Injector 6
INJ 5	Injector 5	Injector 5	Injector 5
INJ 4	Injector 4	Injector 4	Injector 4
INJ 3	Injector 3	Injector 3	Injector 3
INJ 2	Injector 2	Injector 2	Injector 2
INJ 1	Injector 1	Injector 1	Injector 1
Aux 1	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
PWM1	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out

8 Cylinder Engines

Output Pin	8 Cylinder Sequential Distributor	8 Cylinder Sequential Waste Spark	8 Cylinder Sequential Twin Distributor
Home	Home / Nissan Large Tooth	Home / Nissan Large Tooth	Home / Nissan Large Tooth
Trigger	Trigger / Nissan Fine Tooth	Trigger / Nissan Fine Tooth	Trigger / Nissan Fine Tooth
IGN 1	Ignition 1	Ignition 1	Ignition 1
IGN 2	Dig Out/PWM/Aux Injector	Ignition 2	Ignition 2
IGN 3	Dig Out/PWM/Aux Injector	Ignition 3	Dig Out/PWM/Aux Injector
IGN 4	Dig Out/PWM/Aux Injector	Ignition 4	Dig Out/PWM/Aux Injector
IGN 5 / INJ 8	Injector 8	Injector 8	Injector 8
IGN 6 INJ 7	Injector 7	Injector 7	Injector 7
INJ 6	Injector 6	Injector 6	Injector 6
INJ 5	Injector 5	Injector 5	Injector 5
INJ 4	Injector 4	Injector 4	Injector 4
INJ 3	Injector 3	Injector 3	Injector 3
INJ 2	Injector 2	Injector 2	Injector 2
INJ 1	Injector 1	Injector 1	Injector 1
Aux 1	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
PWM1	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out

## 10 Cylinder Engines

Only available for Standard and Multi-tooth triggers.

Output Pin	10 Cylinder Sequential Distributor	10 Cylinder Sequential Waste Spark	10 Cylinder Sequential Twin Distributor
Home	Home	Not yet available	Home
Trigger	Trigger		Trigger
IGN 1	Ignition 1		Ignition 1
IGN 2	Dig Out/PWM/Aux Injector		Ignition 2
IGN 3	Injector 10		Injector 10
IGN 4	Injector 9		Injector 9
IGN 5 / INJ 8	Injector 8		Injector 8
IGN 6 INJ 7	Injector 7		Injector 7
INJ 6	Injector 6		Injector 6
INJ 5	Injector 5		Injector 5
INJ 4	Injector 4		Injector 4
INJ 3	Injector 3		Injector 3
INJ 2	Injector 2		Injector 2
INJ 1	Injector 1		Injector 1
Aux 1	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
PWM1	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out		Discrete Out/PWM Out

## 12 Cylinder Engines

Only available for Standard and Multi-tooth triggers.

Output Pin	12 Cylinder Sequential Distributor	12 Cylinder Sequential Waste Spark	12 Cylinder Sequential Twin Distributor
Home	Home	Not yet available	Home
Trigger	Trigger		Trigger
IGN 1	Ignition 1		Ignition 1
IGN 2	Dig Out/PWM/Aux Injector		Ignition 2
IGN 3	Injector 10		Injector 10
IGN 4	Injector 9		Injector 9
IGN 5 / INJ 8	Injector 8		Injector 8
IGN 6 INJ 7	Injector 7		Injector 7
INJ 6	Injector 6		Injector 6
INJ 5	Injector 5		Injector 5
INJ 4	Injector 4		Injector 4
INJ 3	Injector 3		Injector 3
INJ 2	Injector 2		Injector 2
INJ 1	Injector 1		Injector 1
Aux 1	Injector 12		Injector 12
Aux 2	Injector 11		Injector 11
PWM1	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out		Discrete Out/PWM Out

**2 Rotor Engines**

<b>Output Pin</b>	<b>2 Rotor Sequential Direct Fire</b>	<b>2 Rotor Sequential Waste Spark</b>	<b>2 Rotor Distributor</b>
Home	Home	Home	Home
Trigger	Trigger	Trigger	Trigger
IGN 1	Ignition 1 Leading	Ignition 1 & 2 Leading	Ignition Leading
IGN 2	Ignition 2 Leading	Dig Out/PWM/Aux Injector	Ignition Trailing
IGN 3	Ignition 1 Trailing	Ignition 1 Trailing	Toggle
IGN 4	Ignition 2 Trailing	Ignition 2 Trailing	Dig Out/PWM/Aux Injector
IGN 5 / INJ 8	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
IGN 6 INJ 7	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
INJ 6	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
INJ 5	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
INJ 4	Injector 2 Secondary	Injector 2 Secondary	Injector 2 Secondary
INJ 3	Injector 1 Secondary	Injector 1 Secondary	Injector 1 Secondary
INJ 2	Injector 2 Primary	Injector 2 Primary	Injector 2 Primary
INJ 1	Injector 1 Primary	Injector 1 Primary	Injector 1 Primary
Aux 1	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector	Dig Out/PWM/Aux Injector
PWM1	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out	Discrete Out/PWM Out	Discrete Out/PWM Out

3 Rotor Engines

Output Pin	3 Rotor Sequential Direct Fire	3 Rotor Waste Spark	3 Rotor Sequential Distributor
Home	Home	Illegal Combination	Home
Trigger	Trigger		Trigger
IGN 1	Ignition 1 Leading		Ignition 1 Leading
IGN 2	Ignition 2 Leading		Ignition 2 Leading
IGN 3	Ignition 3 Leading		Dig Out/PWM/Aux Injector
IGN 4	Ignition 1 Trailing		Dig Out/PWM/Aux Injector
IGN 5 / INJ 8	Ignition 2 Trailing		Dig Out/PWM/Aux Injector
IGN 6 INJ 7	Ignition 3 Trailing		Dig Out/PWM/Aux Injector
INJ 6	Injector 3 Secondary		Injector 3 Secondary
INJ 5	Injector 2 Secondary		Injector 2 Secondary
INJ 4	Injector 1 Secondary		Injector 1 Secondary
INJ 3	Injector 3 Primary		Injector 3 Primary
INJ 2	Injector 2 Primary		Injector 2 Primary
INJ 1	Injector 1 Primary		Injector 1 Primary
Aux 1	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
Aux 2	Dig Out/PWM/Aux Injector		Dig Out/PWM/Aux Injector
PWM1	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM2	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM3	Discrete Out/PWM Out		Discrete Out/PWM Out
PWM4	Discrete Out/PWM Out		Discrete Out/PWM Out

Primary Connector (34 Pins)			Secondary Connector (26 Pins)		
Pin #	Function	Wire Colour	Pin #	Function	Wire Colour
1	PWM2	Violet/Brown	1	Trigger	4core (W) White
2	5V	Orange	2	Home	4core(W/B)White/ Green
3	IGN1	Yellow/Black	3	Air Temp	Grey
4	IGN2	Yellow/Red	4	Coolant	Violet
5	IGN3 / INJ10	Yellow/Orange	5	N/C	-
6	IGN4 / INJ9	Yellow/Green	6	N/C	-
7	IGN5 / INJ8	Blue/Violet	7	Auxin1	Grey/Green
8	IGN6 / INJ7	Blue/Green	8	Timed Input 1	White
9	5V	Orange	9	Timed Input 2	White/Black
10	GND (0V)	Black/White	10	Timed Input 3	White/Brown
11	GND (0V)	Black/White	11	13.8V Battery	Red/White
12	8V	Orange/White	12	02A	White/Orange
13	8V	Orange/White	13	Spare AD 1	White/Yellow
14	TPS	White	14	GND (0V)	Black/White
15	MAP	Yellow	15	GND (0V)	Black/White
16	Spare AD 2	Orange/Black	16	GND (0V)	Black/White
17	Spare AD 3	Orange/Red	17	TX	5 core shield Red
18	PWM1	Violet/Black	18	RX	5 core shield Yellow
19	INJ1	Blue	19	PWM4	Violet/Orange
20	INJ2	Blue/Black	20	Spare AD 5	Orange/Green
21	INJ3	Blue/Brown	21	Spare AD 6	Orange/Blue
22	INJ4	Blue/Red	22	Spare AD 7	Orange/Violet
23	PWM3	Violet/Red	23	CAN H	5 core shield Blue
24	Fuel Pump	Black/Yellow	24	CAN L	5 core shield Green
25	Spare AD 4	Orange/Yellow	25	N/C	-
26	13.8VDC	Red/White	26	N/C	-
27	INJ5	Blue/Orange			
28	INJ6	Blue/Yellow			
29	INJ12	Blue/White			
30	INJ11	Blue/Grey			
31	IDL1	Green			
32	IDL2	Green/Black			
33	IDL3	Green/Brown			
34	IDL4	Green/Red			



Loom Wire Color	Description
Red/Blue	Injector +12V 20A fused
Red/Yellow	Ignition +12V 20A fused
Black/White	Sensor Ground
Black	Main Ground
Grey/Red	Sensor Power 10A fused
Grey	+12 Ignition Switched
Red	Battery +12V
Orange	Fuel Pump Input
Orange	Fuel Pump Output
Brown/Orange	Spare Fuse 1
Brown/Black	Spare Fuse 2
Brown/Red	Spare Fuse 3