

Warning

1. **The F10X ECU must only be used with an F10X wiring harness.** Note that the wiring harness of the F10 will physically plug into the F10X ECU (and vice-versa), however, the pin connections are different and this will lead to improper operation of the ECU and possible damage to it. The F10X wiring harness is clearly labelled as “X” near the main ECU connector.

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This manual should accompany:

IBM compatible PC software	HalwinX V1.0
Firmware Series	11
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Introduction

Congratulations on your decision to choose a Haltech Engine Management System. Haltech EFI systems have been successfully installed on thousands of vehicles, from power offshore boats to twin-turbo Ferraris to jet skis and snowmobiles. Over the past decade, many motor-sport enthusiasts have discovered that the Haltech computer is easy to use and performs well by enabling users to precisely control ignition timing and fuel delivery. Precise ignition and mixture control leads to excellent drivability and fuel economy, something that is often lacking in high-performance carburettor engines.

Haltech users have discovered that the flexibility of the Haltech Electronic Control Unit (ECU) and PC based programming software leads to the easiest possible installation on everything from traditional pushrod V8s to high performance turbocharged racing motorcycles. We are proud of the fact that some of the most respected professional racers and super-car builders in the world use Haltech equipment for the same reasons that Haltech is popular with motor-sports enthusiasts: it is flexible and friendly; is installed easily; and you can tune your Haltech simply, without having to make the project a major research effort.

Before You Begin...

1) IT IS BEST TO READ THIS ENTIRE MANUAL BEFORE STARTING.

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.

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

3) You may need special parts, additional tools or test equipment in order to complete the installation. Make sure you have these items on hand before you begin to avoid frustration. Contact your Haltech dealer if you have difficulty.

4) Don't do the minimum work possible. Carelessness in the early stages of installation can cause you major headaches later on, be it in a few days or a few months time. 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.

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 24VOLT TRUCK CHARGER OR REVERSE THE POLARITY OF THE BATTERY OR ANY CHARGING UNIT

DO NOT CHANGE 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 VENTED.

MAKE SURE THERE ARE NO LEAKS IN THE FUEL SYSTEM AND THAT ALL CONNECTIONS ARE SECURE.

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.

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

6) 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 use thermally conductive brackets where appropriate.

7) We recommend having your system tuned by professionals. An exhaust gas analyser and fuel pressure meter make tuning easier and help avoid potentially disastrous lean out conditions that could destroy your engine. Should you wish to tune this unit yourself, make sure you have some reliable means of determining if your engine is running lean. Haltech offer the Haltuner for this very application. The Haltuner is an inexpensive air-fuel ratio indicator that gives a full-scale deflection from rich to lean over a display of 30 bar segments. It is compatible with all Oxygen Sensors that output a 0-1V and can be configured upon request for other sensor ranges. If used in conjunction with a Haltech Oxygen Sensor, the Haltuner will provide air-fuel indication for a range of 11.5:1 to 17:1.

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.

Tool/Supply Requirements

Installation of this system can be easily carried out by professional mechanics 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 (we recommend soldering all connections)

- 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)
- IBM-PC compatible computer (preferably laptop) with at least 640kb, one disk drive and an RS232 serial port.
- A good quality Timing Light
- An oscilloscope would be a useful tool, but not always required.

How It Works

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 of 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 generally only one parameter to determine fuel metering: air speed. Higher air speeds through the carburettor result in larger pressure drops across the venturis, resulting in more fuel being drawn through the jets.

Electronic fuel injection is based on 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 difference 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 delivered to the engine.

Since there is no convenient means of directly measuring the amount of air entering the engine to determine the amount of fuel to deliver, the injection opening time can be calculated using a number of engine operating conditions. The ECU uses a table that breaks the engine's operation into a series of rpm ranges, each range has a series of points that represents the different loads on the engine, using either the position of the throttle or the manifold pressure as a load reference.

The ranges in this 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 ECU uses a digital microcomputer to measure engine speed and load, and uses them to access the *base fuel map*. The base fuel map is a look-up table of injector opening times stored in non-volatile memory i.e. when power is switched off, the contents of the memory are retained. By using the 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.

Corrections for air temperature and barometric pressure are applied to the base fuel value, 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. Once these corrections have been applied the ECU knows the amount of fuel the engine requires.

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.

SECTION 1

Getting Started

CHAPTER 1

HALTECH ECU INSTALLATION

1.1 The ECU and Associated Hardware

The Haltech F10X system comprises the following components

- Haltech Electronic Control Unit (ECU)
- Main Wiring Harness
- Haltech F10X system Instruction Manual
- Programming Cable
- Programming Disk
- Relays

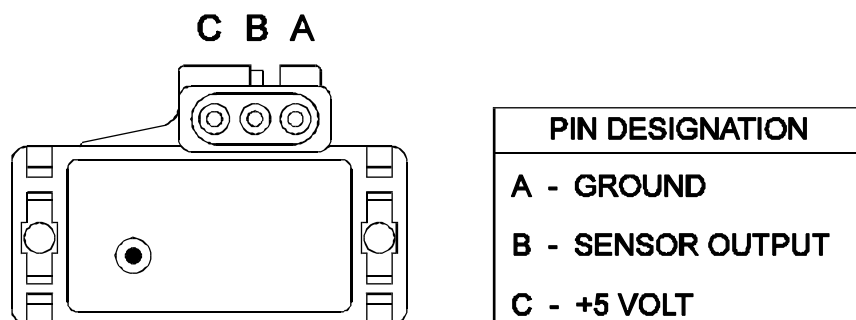
1.2 Installation Summary

The Following is a list of the procedures that will be followed in the installation of the ECU.

1. Mount Manifold Absolute Pressure Sensors.
2. Mount Coolant Temperature Sensors.
3. Mount Inlet Air Temperature Sensors.
4. Mount Throttle Position Sensors.
5. Mount optional Exhaust Gas Oxygen Sensor (if used)
6. Route Main Wiring Harness and connect sensors.
7. Mount and connect Power Relays.
8. Mount Fuse Block.
9. Mount ECU inside passenger compartment.
10. Locate and connect flying wires:
 - RED + 12 volts battery
 - GREY Ignition on 12 volts
 - BLACK Chassis ground
 - ORANGE (2 wires) Fuel Pump Circuit
11. Install and connect the optional Idle Speed Motor
12. Install and connect any Optional Outputs
13. Connect Trigger signal
14. Connect ECU and test.

1.3 Expanded Installation Guide

1.3.1 Manifold Absolute Pressure (MAP) Sensor



The MAP sensor is used to convert the manifold pressure into an electrical signal for the ECU to use. The MAP sensor is used to measure engine load or barometric pressure depending on the application. The sensor works in absolute pressure that means when the sensor is used to measure manifold pressure, the pressure reading in the manifold does not need compensation due to changes in barometric pressure. Since the MAP sensor is an absolute pressure sensor it can be used in some situations to measure changes in barometric pressure that in some applications will have a great affect on air-fuel mixtures (Refer *Barometric Correction*, p62).

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

1 Bar Sensor (Part No.: 039 4070, 16137039 or 12569240)

(-100kPa to 0 kPa)

Normally Aspirated Engines

2 Bar Sensor (Part No.: 886 3189 or 16254539)

(-100kPa to 100kPa)

Turbo or Supercharged

Engines up to 100kPa boost

(15 psi , 1 atmosphere)

3 Bar Sensor (Part No.: 749 3169, 16040749 or 12223861)

(-100kPa to 200kPa)

Turbo or Supercharged

Engines up to 200kPa boost

(30 Psi, 2 atmospheres)

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.

Engines that use Manifold Pressure as a load reference require an appropriate MAP sensor to be connected to the MAP Input plug on the wiring loom.

Engines that use Throttle position load sensing do not need a MAP sensor to measure Manifold pressure but require barometric correction. A MAP sensor can be used for barometric compensation in the place of the barometric pressure sensor inside the ECU. This MAP sensor must be a 1 Bar MAP sensor (left open to atmosphere) and is connected to the *Spare Input* plug near the Main Connector. For more information about barometric compensation

(Refer *Barometric Correction*, p62)

Mounting

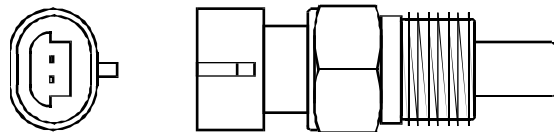
The MAP sensor is usually mounted high on the engine bay firewall or inner guard using two screws and with the hose nipple facing outwards. Connect the sensor to the inlet manifold via a short length of vacuum hose and fasten with either hose clamps or nylon cable ties. Connect the sensor to the main wiring harness using the appropriate plug. (For 1 Bar sensors the plug is green, for 2 and 3 Bar sensors the plug is orange). 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 weather-proof but it is good practice to mount the sensor in a protected position away from moisture and heat.

1.3.2 Coolant Temperature Sensor

The ECU uses the coolant temperature to determine warm up corrections to adjust fuel mixtures.

The coolant temperature sensor has a solid brass temperature-sensing tip. The coolant sensor supplied is an industry standard component and some engines may already have provision for this type of sensor.

$\frac{3}{8}$ " N.P.T. 18 Threads/Inch



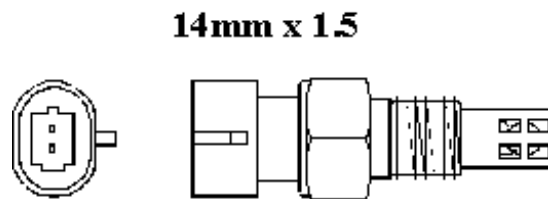
Temp to Resistance Value Approx		
°F	°C	Ω
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-10	-40	100,700

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 will allow the hole and thread to be machined, and which gives access to the coolant stream. The sensor should be mounted after the engine and 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. A thread adapter is sometimes necessary. In some engines only one temperature sensor hole exists and is used for the dashboard gauge sender. It is usually possible to install a tee-piece to allow both the dashboard sender and the Haltech sender to share access to the same threaded hole. If it is necessary to drain the coolant from the vehicle to fit the temperature sensor then the factory manual for the engine should be consulted for the correct procedure to restore the coolant and purge the cooling system of air.

1.3.3 Inlet Air Temperature Sensor



Temp to Resistance Value Approx		
°F	°C	Ω
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-10	-40	100,700

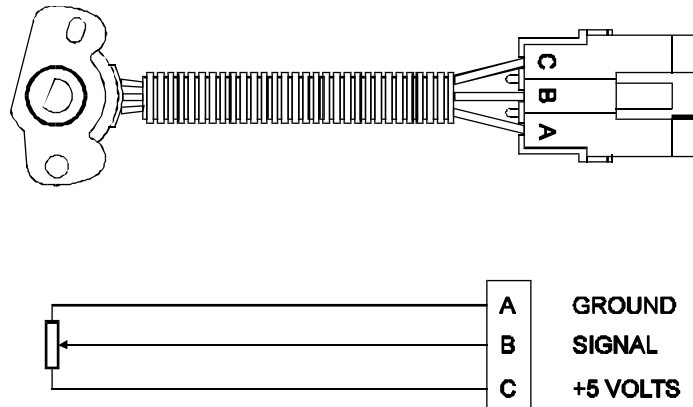
The air temperature sensor is used to compensate for changes in air density due to air temperature. Cold air is denser than warm air and therefore requires a greater volume of fuel to maintain the same air/fuel ratio. This effect is most noticeable in forced induction engines. The ECU will automatically compensate using the signal received from the air temperature sensor.

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.

Note: The Haltech air temperature sensor will read temperatures up to 120°C, temperatures above this will be interpreted as a fault condition. The air temperature after some turbos 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. If this is not possible then the air temperature sensor should be placed upstream of the turbo or supercharger to monitor ambient air temperature.

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 machining the sensor mount. Do not allow any metal particles to enter the inlet manifold of the engine as these will be drawn into the engine and damage it. Wash all components before reassembly.

1.3.4 The Throttle Position Sensor (TPS)



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 maybe compatible with the Haltech ECU, if it is not, 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 Ω . The resistance value of the installed TPS does not have to be the same since the ECU uses a throttle calibration function to determine actual throttle position.

Note:

Be sure to wire the TPS so that The Engine Data page shows “0%” for throttle position when the throttle is closed. (Refer to *6.1 Calibrating the Throttle Position Sensor*, p53)

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

1.3.5 Mount Optional Exhaust Gas Oxygen Sensor

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.

1.3.6 Route Wiring Harness and Connect Sensors

Lay the main wiring harness out in the engine bay with the sensors mounted to ascertain the best fit for the harness. Pass the wiring loom through a hole in the engine bay firewall and into the passenger compartment where the ECU will be mounted. Either use an existing hole or cut a new hole to suit. Use a rubber grommet or similar device to protect the harness from being damaged by rubbing on the sharp edge of the hole.

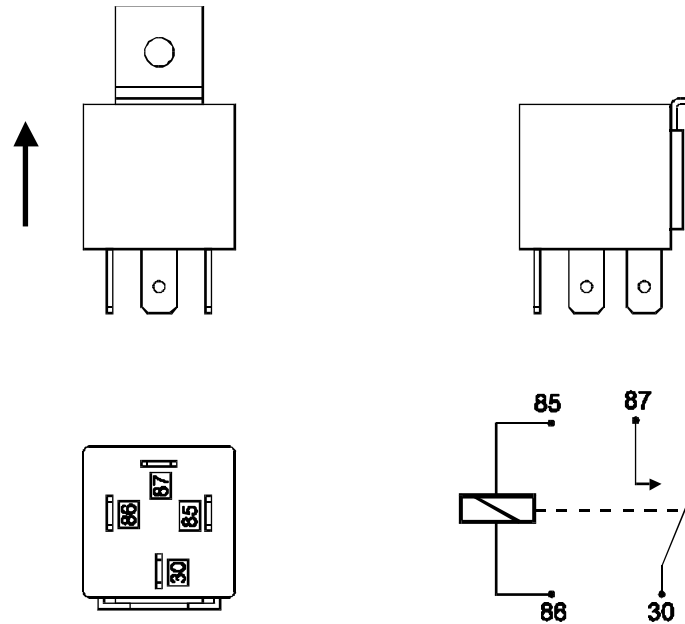
WARNING:
DO NOT ALLOW THE HARNESS TO TOUCH HOT EXHAUST PARTS INCLUDING MANIFOLDS OR TURBOCHARGERS.
TRY TO ROUTE THE MAIN HARNESS AWAY FROM HIGH VOLTAGE IGNITION LEADS. UNDER NO CIRCUMSTANCES RUN ANY WIRING PARALLEL TO, OR IN CONTACT WITH THE IGNITION LEADS.

Note: Be neat. Run the harness in a tidy fashion. Try to run the harness along paths used by original wiring. Use nylon cable ties to secure the harness in place, but do not stress the wiring or connectors.

Once the harness is fitted, connect all the sensors to their appropriate plugs.

1.3.7 Power Relays

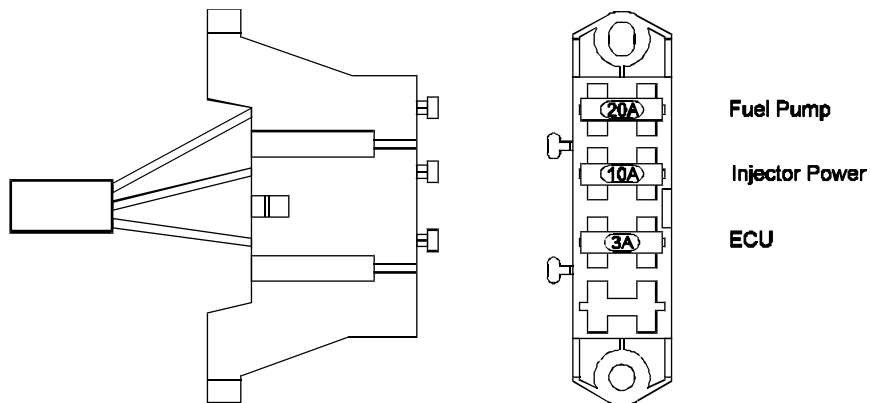
There are two relays used with the ECU, the Main Power Relay (with a grey wire) and the Fuel Pump Relay (two orange wires). These relays are identical parts so it is not important which relay goes in what connector.



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.

1.3.8 Fuse Block Assembly

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



The fuse block is supplied from the factory with fuses installed. The fuse ratings are shown in the diagram and should not be changed except in special circumstances, as these have been selected for best protection. In some applications where multiple low impedance injectors are being used, the main 3A ECU fuse may blow. In such applications, please replace this fuse with a 10A fuse.

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

Connect the Fuse Block assembly to the Main Harness.

1.3.9 Electronic Control Unit (ECU)

The ECU is not designed to be waterproof. It is desirable that the ECU be given as much protection from the environment as possible. It is recommended that the ECU be mounted inside the passenger compartment, either on the firewall, under the dashboard or under the passenger seat.

The ECU has four mounting holes that allow it to be mounted to most flat surfaces. In extreme cases of vibration, the ECU should be mounted on rubber anti-vibration pads. When mounting the ECU remember that the communications connector on the loom should remain accessible for ease of programming.

1.3.10 Flying Leads

Locate and connect the following flying leads.

Black (Ground)

Locate a good chassis ground point 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.

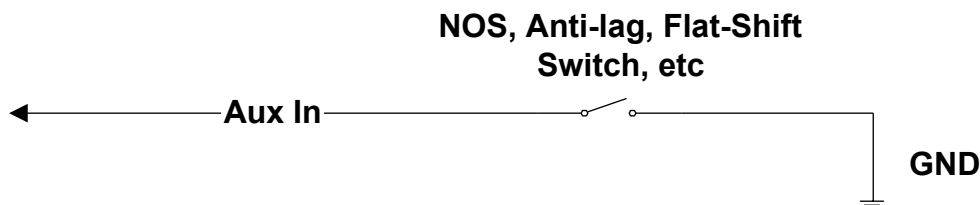
Grey

(Ignition Switched +12V) The grey wire is used to control the operation of the 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 since +12V is not available during cranking in many cases.

Green

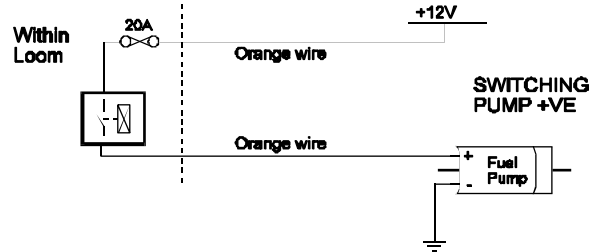
(Aux In) The green wire is used as the Aux In channel. The Aux In channel is used by a number of functions and is further described in *4.2.4 The In/Out Set-up Page, p39*

The following diagram is an example of how to wire the Aux In circuit:

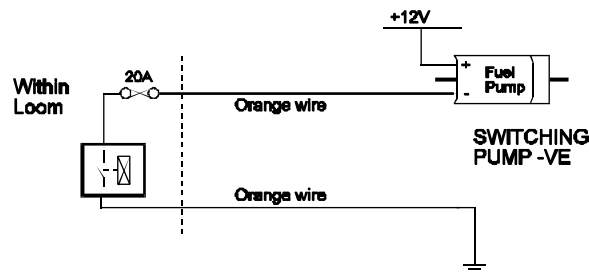


Orange

The two orange wires are used to operate the fuel pump. When the 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.



Example 1: Connecting to the positive side of the fuel pump.



Example 2: Connecting to the negative side of the fuel pump.

It does not matter which example is used, as 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.

1.3.11 Install and Connect Optional Idle Speed Motor

If you are not using the Idle Speed Control, tie the loom connector back neatly in the engine bay. If the engine has a suitable Idle Speed Motor then you may connect it to the wiring loom, otherwise you can install a Haltech supplied idle air control motor.

1.3.12 Install and Connect any Optional Outputs

If you are planning to use any of the Programmable Optional Outputs, install and connect them now. Depending on what options you are using, the wiring will be different. For details on wiring your particular options, refer to *CHAPTER 12 Digital Outputs & PWM Outputs*, p79.

1.3.13 Connect the Trigger Sensor

The Trigger is used by the ECU to determine Engine Speed and Position.

When connecting the trigger (crank or cam position) sensors it is important to identify the type of sensor being used to measure engine speed and position from the following options: Optical, Hall Effect or Coil Negative.

Optical and Hall effect Triggers

Optical and Hall effect triggers behave in a similar way and are treated the same by the ECU and the term “Hall Effect” should be taken to include Optical triggers.

Hall Effect triggers generally have 3 connections: power, ground and signal and the output of the sensor is a square wave digital signal.

Coil Negative Trigger

The F10X can be triggered by the signal found on the negative side of an Ignition Coil. The F10X has a sole purpose input wire for this signal called “Negative Coil” which is Pin 36 on the F10X ECU. Please make sure that in the Trigger Setup page, the Trigger Type is set to Coil Negative if this type of trigger is to be used.

Tacho Output Trigger

Some popular ignition systems have a tacho output signal, which can be used to trigger the F10X through the Coil Negative Trigger Input. It is necessary to use this tacho output if the ignition system used is a Capacitive Discharge Ignition System with multiple spark function.

For more information on trigger systems Refer to *Appendix E*

1.3.14 Connect the ECU

The ECU can now be connected, be sure to engage the clip on the main connector. The system can now be tested as described in the following chapters.

CHAPTER 2

INSTALLING THE SOFTWARE

Now that your ECU is installed the programming software must be installed so that tuning can begin.

This Chapter will explain how to install and run HalwinX, the Haltech Programming Software.

2.1 Computer Requirements

HalwinX 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)

4 MB of memory

10 MB of free Disk space

Recommended:

PIII 500MHz processor

VGA colour display 1024x768

16 MB of memory

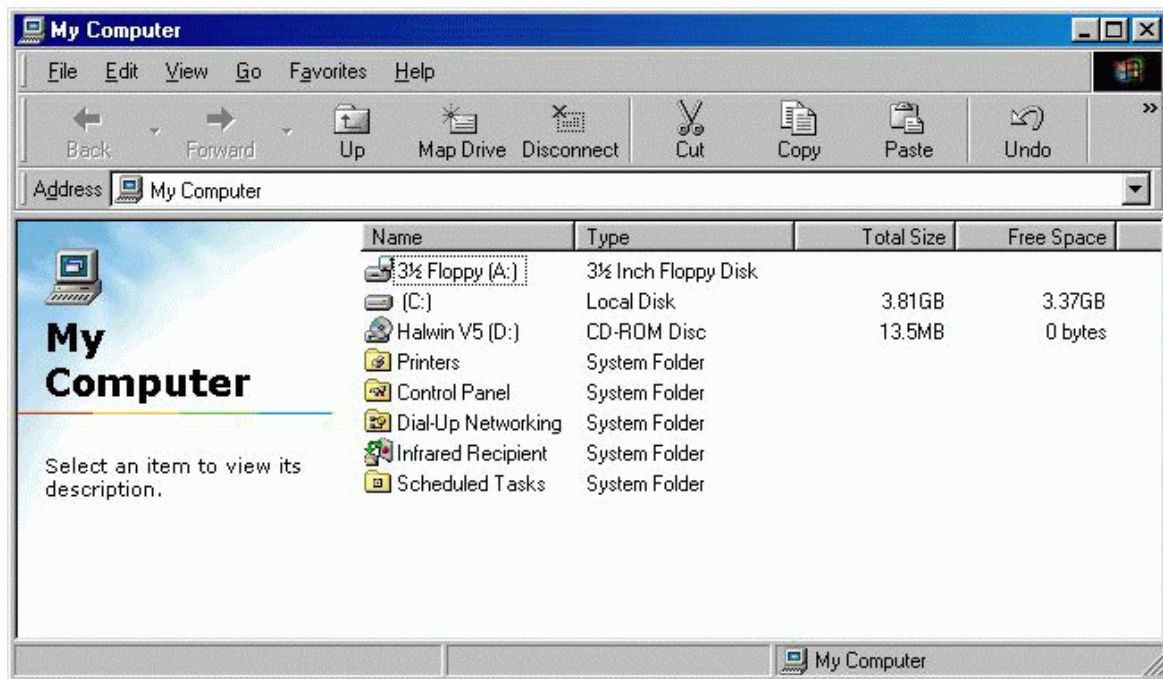
10 MB of free Disk space

2.2 Operating the Software

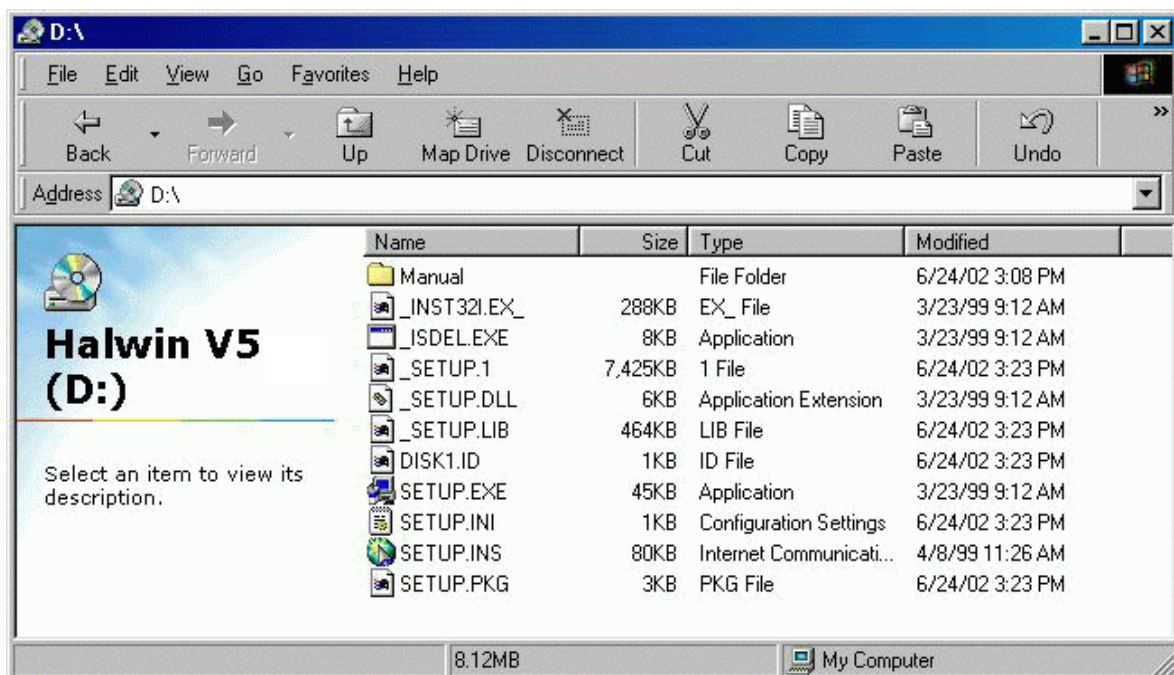
2.2.1 Installing the Software

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

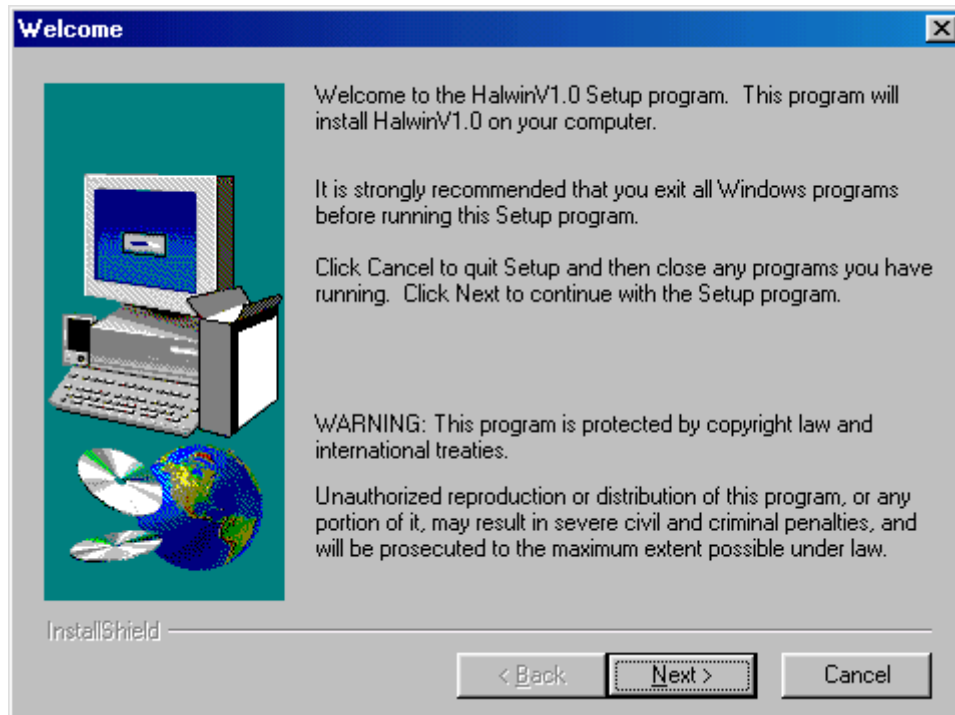
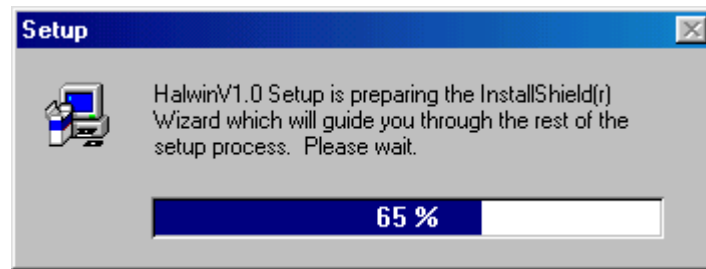
1. Insert the CD-ROM into your PC's CD-ROM drive.
2. Double click on the "My Computer" icon on the desktop



- 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.



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



5. Click on 'Next >' to continue and follow the instructions given to you on the windows that appear.
6. When prompted for which type of installation to perform, choose 'Typical' if you are unsure.

2.2.2 Running the Software

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



Double click on the icon to start Halwin.

CHAPTER 3

OPERATING THE SOFTWARE

Once the ECU is installed, the programming software allows the user to change the settings currently stored in the ECU. The ECU requires information about the engine it is to operate such as:

- Number of cylinders (or rotors): it needs this to calculate engine speed, ignition timing and fuel quantity
- Engine Type: Piston or Rotary, the ECU requires this information since the ignition system for a rotary engine is significantly different from that of a piston engine.

This information is called set-up information.

The ECU also requires information about the amount of fuel or ignition timing it must supply based on various engine-operating conditions. An example of this is the amount of fuel the engine requires based on the current intake air temperature, this information is stored in a "Map". As the intake air temperature changes so do the fuel requirements of the engine, so the ECU has data for the amount of fuel injected for various different temperatures, this set of data is known as a "Map". These ideas of data storage are discussed further in *CHAPTER 4 Configuring the ECU, p34* and *CHAPTER 5 Haltech Maps, p43*

3.1 The 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 keyboard

To access the menus via keyboard press and hold **ALT** and then Press the key corresponding to the first letter of the menu title which you wish to access **F**, **M**, **S** or **O**. This will cause a menu to appear from which a series of menu item are available. To choose a menu item use the up and down cursor keys:

↑, ↓

When the desired menu item is highlighted:

Press **Enter**

When a key combination like:

Press and Hold **ALT** and then Press **F**

Is required it will be abbreviated in the manual to **ALT-F**.

The following describes the individual Menus and their contents.

3.1.1 The File Menu

To open the File menu Press **ALT-F** or alternatively use the mouse to select the File menu.

The file menu contains the following items:

- Load From File
- Load E6K/F10/E6GM Fuel and Ignition Maps
- Save to File
- Quit (Ctrl Q)

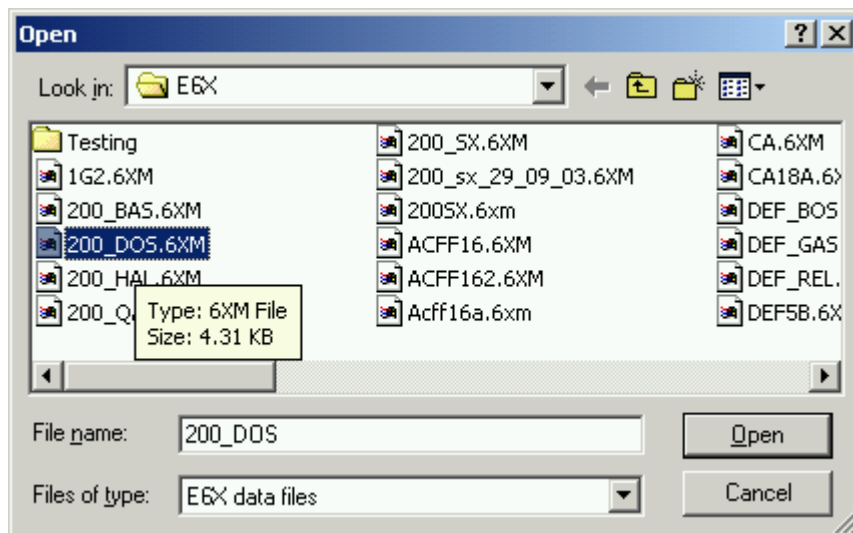
3.1.1.1 Load From File

Load From File allows the user to load a file that contains all the “set-up” and “map” data the ECU requires to run a particular engine. This file has been saved during a previous tuning session when the programming PC was connected to the ECU. When the ECU is “Offline”, the Load Map function can be used to load the information from an F10X map file (denoted by the .6XM file extension) into the front-end software to view its contents. If the ECU is “Online” using the Load Map function will cause the ECU to be loaded with the information stored in the file and all information previously stored in the ECU will be lost.

NOTE:

When using the load function be aware that when the ECU is online all “set-up” and “map” data currently stored in the ECU will be overwritten.

To choose the desired map simply select the desired file from the dialog and press enter. This is illustrated below,



The selected filename will be displayed in the horizontal black bar below the text “Opening File”:

Press ***Enter***

When the ECU is “Online” the central Status Bar will turn red and indicate the load status of the map.

3.1.1.2 Save To File

The ECU programming software allows the user to save all the information in the ECU to a file on the programming PC. This allows the user to save a map and continue tuning and then, if required, revert to a previous map.

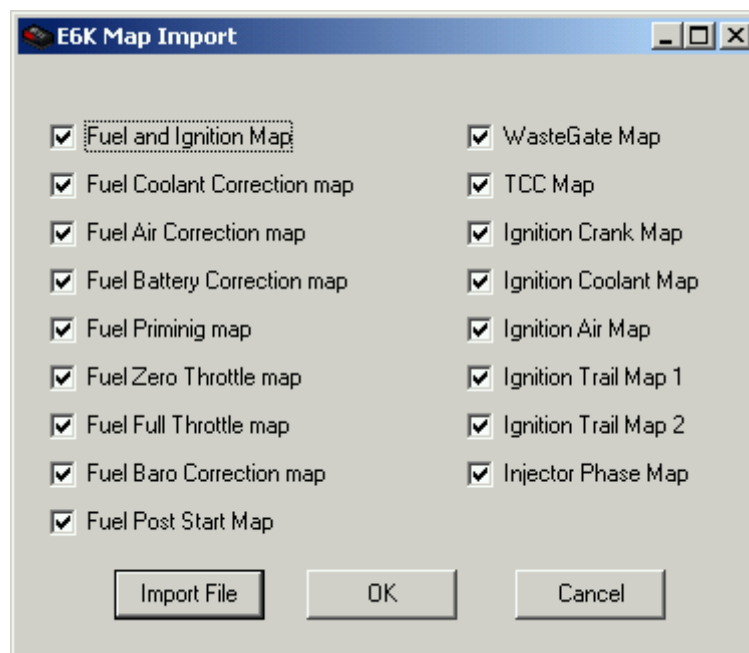
NOTE:

When the save function is used it saves the current map loaded in the programming software. If the ECU is “Offline” the map available in the programming software may not be the map that is stored in the ECU.

When you choose the “Save To File” menu item a file dialog similar to the Load map will be displayed. In this case you navigate to the directory of your choosing and type in the filename of your choice.

3.1.1.3 Load E6K/F10/E6GM Fuel Maps

This option allows the user to import all the fuel and ignition maps from an E6K/F10/E6GM into the F10X user map. To select this the user selects File -> Load Fuel Maps. The following form shall be displayed to the user,



The user selects the maps they wish to import by selecting the appropriate items by clicking on them. In the example shown above all items have been selected. Once the user has selected the items needed, the user clicks on the Import File button. This brings up the file dialog box and the user selects the desired unit file. Please note: this feature will only import maps and NOT set up details.

3.1.1.4 Quit

Quit allows the user to leave the programming software and return to the operating system. The user can also quit the software using the quit “Hot-Key”:

Press **CRTL-Q**

3.1.2 The Map Menu

The map menu allows access to the maps contained in the ECU. The following is a description of the map menu and is not a complete description of the maps, for more information on all the maps available and their function refer to *CHAPTER 5 Haltech Maps, p46*.

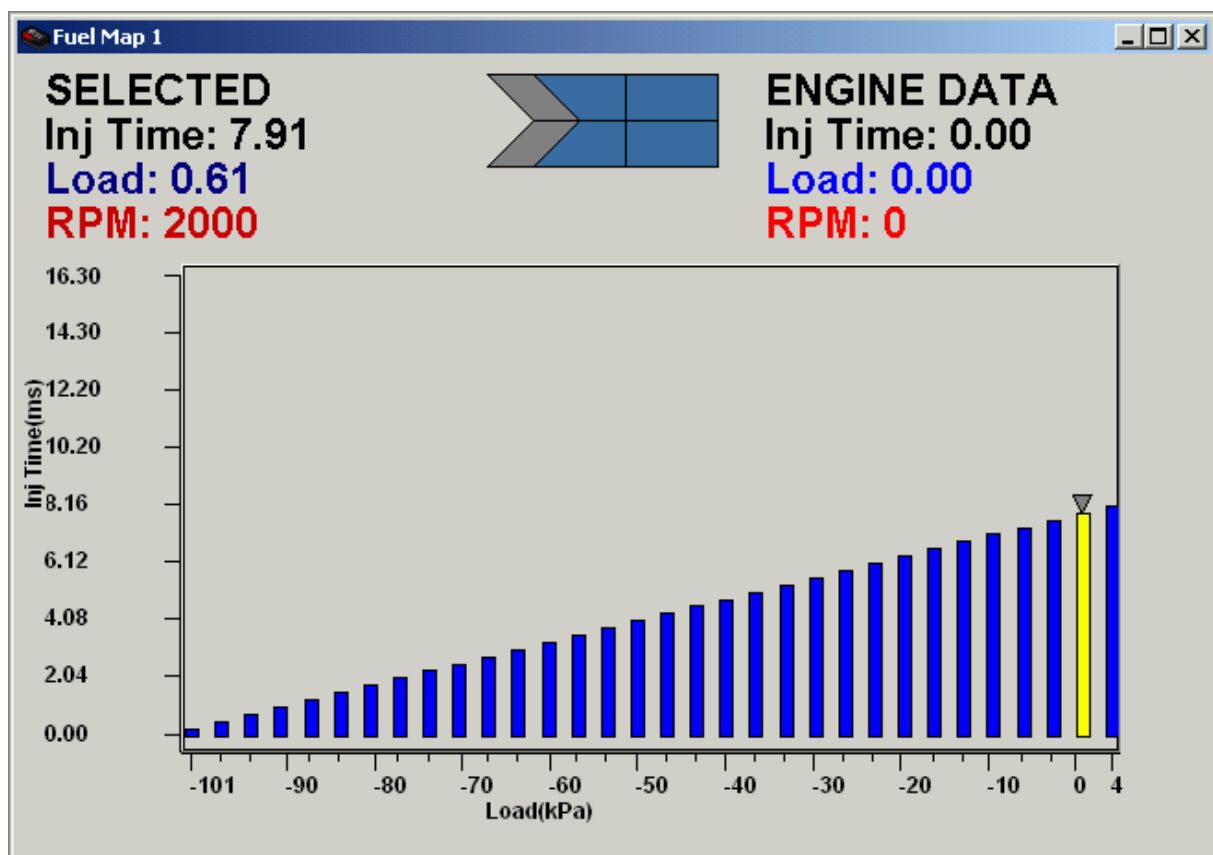
To open the map menu Press **ALT-M**.

The map menu contains the following items:

- Fuel Map **CTRL-F – 2D View, CTRL – ALT - F – 3D View**
- Fuel Correction Maps
- Zero Throttle Map
- Full Throttle Map
- Injector Phase Map
- Waste-gate Map 1
- Waste-gate Map 2
- Torque Converter Map

3.1.2.1 Fuel Maps

The Fuel Map is constructed of individual ranges containing Injector Pulse Width against Engine Load as shown below.



The individual ranges represent different engine speeds; in the example above the map shown is from the 2000rpm range.

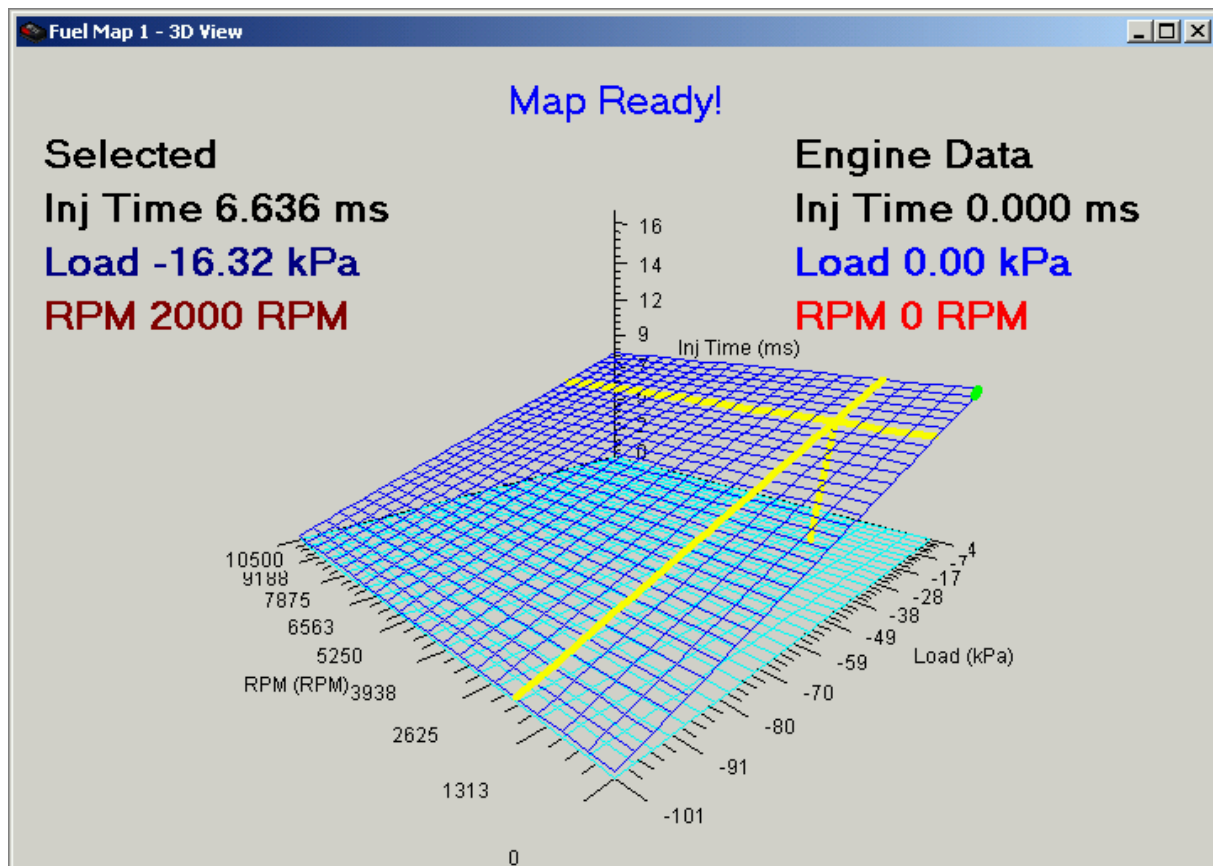
The Fuel map menu item will open a sub-menu which allows access to all the fuel map ranges from 0 –8500rpm. The keys:

N for Next and

P for previous

Allow the user to cycle through all the available rpm ranges and allows access to the rpm ranges not accessible via the sub-menu.

The 3D view is shown below,



To go through the load ranges the user uses the left and right arrow keys. To cycle through the RPM range the user uses the up and down arrow keys. To select multiple bars the user presses the Ctrl arrow keys to select the bars they wish to tune. To change the bars the user can use "a" and "s" to change the fine increments and Pg-Up and Pg-Down for the rest of the increments.

3.1.2.2 Fuel Correction Maps

Fuel correction maps allow the ECU to calculate corrections to the amount of fuel injected based on the information received from the engine sensors.

The fuel correction maps menu item will open a sub-menu that allows access the fuel correction maps:

- Coolant Temperature
- Air Temperature
- Battery Voltage
- Coolant Temperature Prime
- Post Start
- Barometric Pressure
- Gas Temperature (used for Gas (LPG or similar) fuel vehicles)
- Gas Pressure (used for Gas (LPG or similar) fuel vehicles)

The Set-up Menu

The set-up menu allows access to the ECU set-up pages (which contain most of the information about the engine that the ECU is to control) and the program set-up page.

The set-up menu contains:

- Main Set-up ***CTRL-M***
- Fuel Set-up
- Trigger Setup
- In/Out Set-up
- Throttle Setup
- ComPort Setup
- Set Password
- Screen Colour

3.1.3 The Options Menu

The options menu allows access to the option pages. The options set-up pages allow the user to modify the setting for idle control, closed loop O₂ Control and the 4 PWM channels and any available digital outputs.

The options menu contains:

- Idle Speed Control
- Closed Loop O₂ control
- PWM and Digital Output options
- Throttle Pump
- Injector trims
- Log Data (CTRL – D)
- View Data Log

Further description of the contents of the options menu is distributed throughout the manual.

3.1.4 Data Page Menu

This allows the user to access the engine data in online mode so they can deduce how their engine is performing. The menus that access this are,

- Gauge Page
- Engine Data page.
- Firmware Version Info.

These shall be discussed in detail further on.

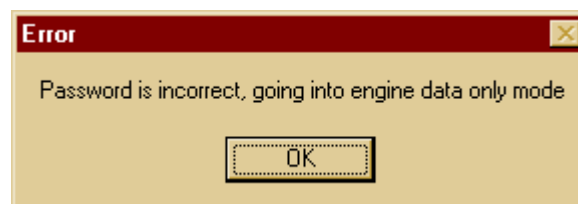
3.1.5 Password Protection

The maps in the ECU can be password protected at the user's choice. To Set the password the user selects Setup-> Set Password where the user must enter an 8 character password such as "haltech1" or "Beatrice". The user must use an 8 character password and this password is case sensitive. The dialog for this is illustrated below, and is activated by pressing OK.



If at any time the user wishes to remove the password protection, they may do so by selecting Setup-> Null Password.

When a ECU that has been password protected is first connecting to the laptop, the data will transfer 99% of the data before prompting the user for the password to continue. If the password is correct, the user will be given full access to the ECU, if the password is incorrect, the user will only be given access to Data pages and diagnostic data.



3.2 Online and Offline Operation

The programming software can be used in two ways: “Online” and “Offline”. In the Online mode, all the changes made to the maps and set-up data in the software will be transmitted to the ECU. This is what is called online programming and it is in this mode that most tuning is carried out. In the offline mode, making changes to the maps and set-up data will not affect the ECU since communication between the programming PC and the ECU is not active. Working in the offline mode is a convenient way of checking maps that have been stored to disk and reviewing Data-logs that were taken when in the Online mode.

It is advised that first time users familiarise themselves with the software in the “Offline” mode before “Online” operation is attempted. Most features of the software are available in the “Offline” mode so that the user can learn the controls for navigating the software. The only features not available “Offline” are: The Engine Data Page and the Calibrate Throttle function, these features require communications with the ECU.

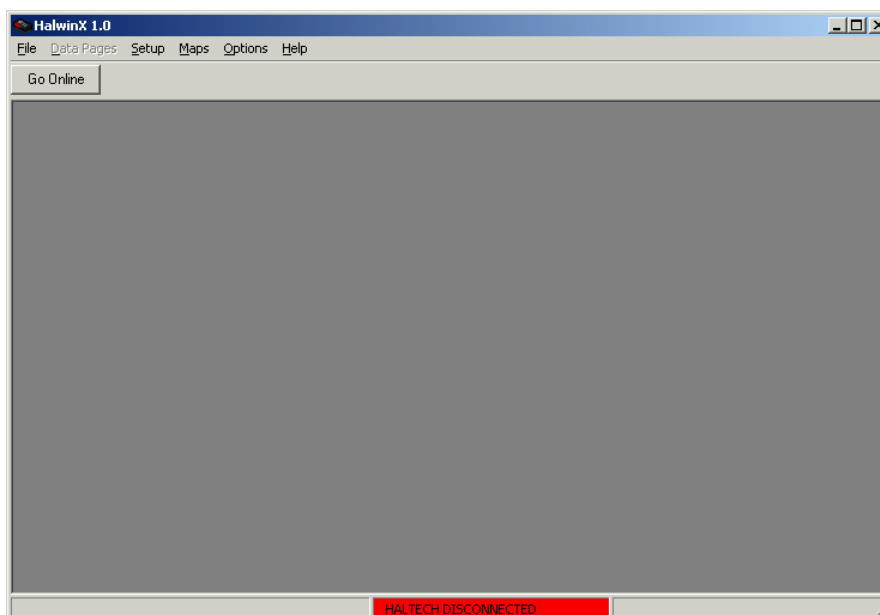
The Software can be identified as “Online” or “Offline” by the label in the middle status bar that indicates whether the software is on or offline. The other indicator is the Go – Offline/Online button. When offline the button displays Go – Online. When online the button displays Go offline.

NOTE:

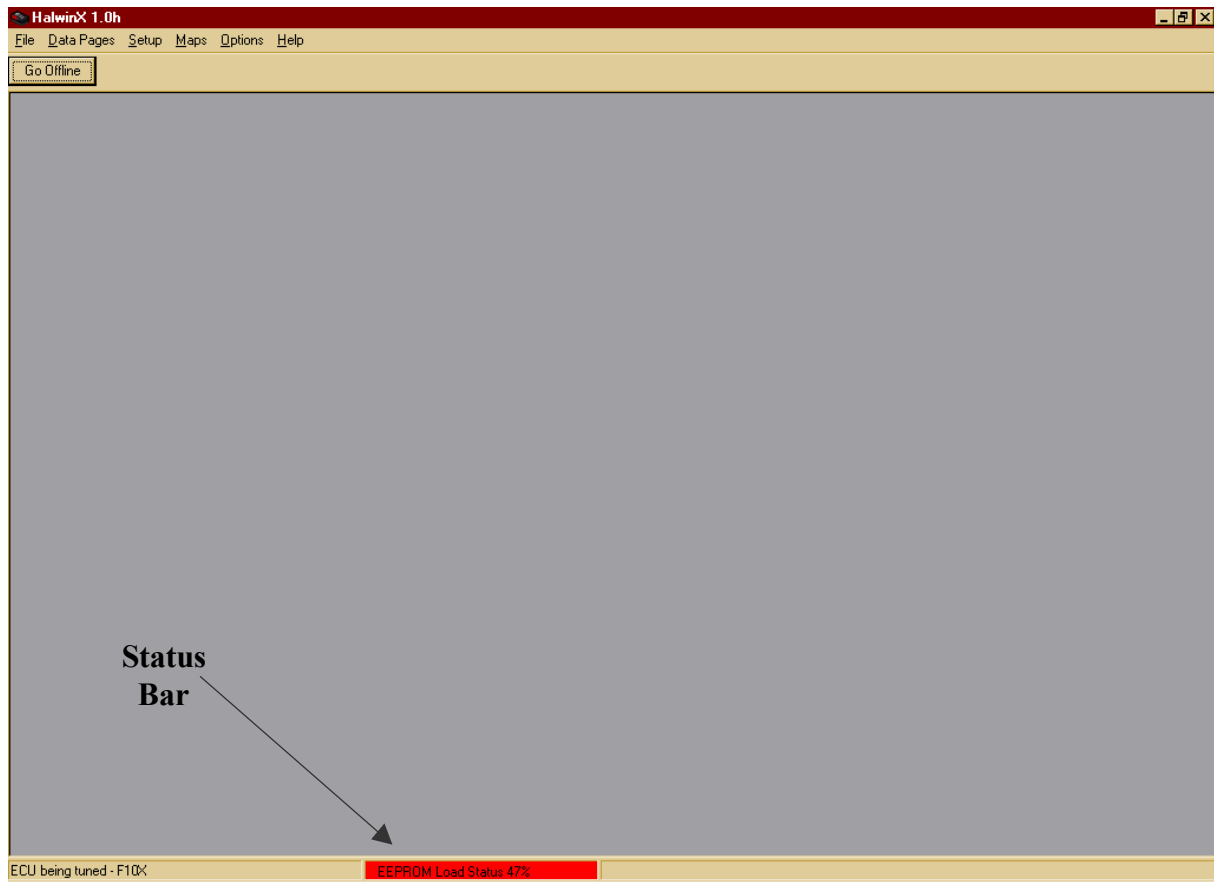
For changes made in software to be transmitted to the ECU the programming software should be online.

3.2.1 Going Online

To go “Online” the ECU must have power and there must be a RS-232 communications cable (supplied with most kits) connected to the ECU loom and the programming PC. Start the programming software and the following will appear:



Press the Go Online button in the top left hand corner. This will start communications with the ECU. The Status bar will indicate the load status, which is illustrated below,

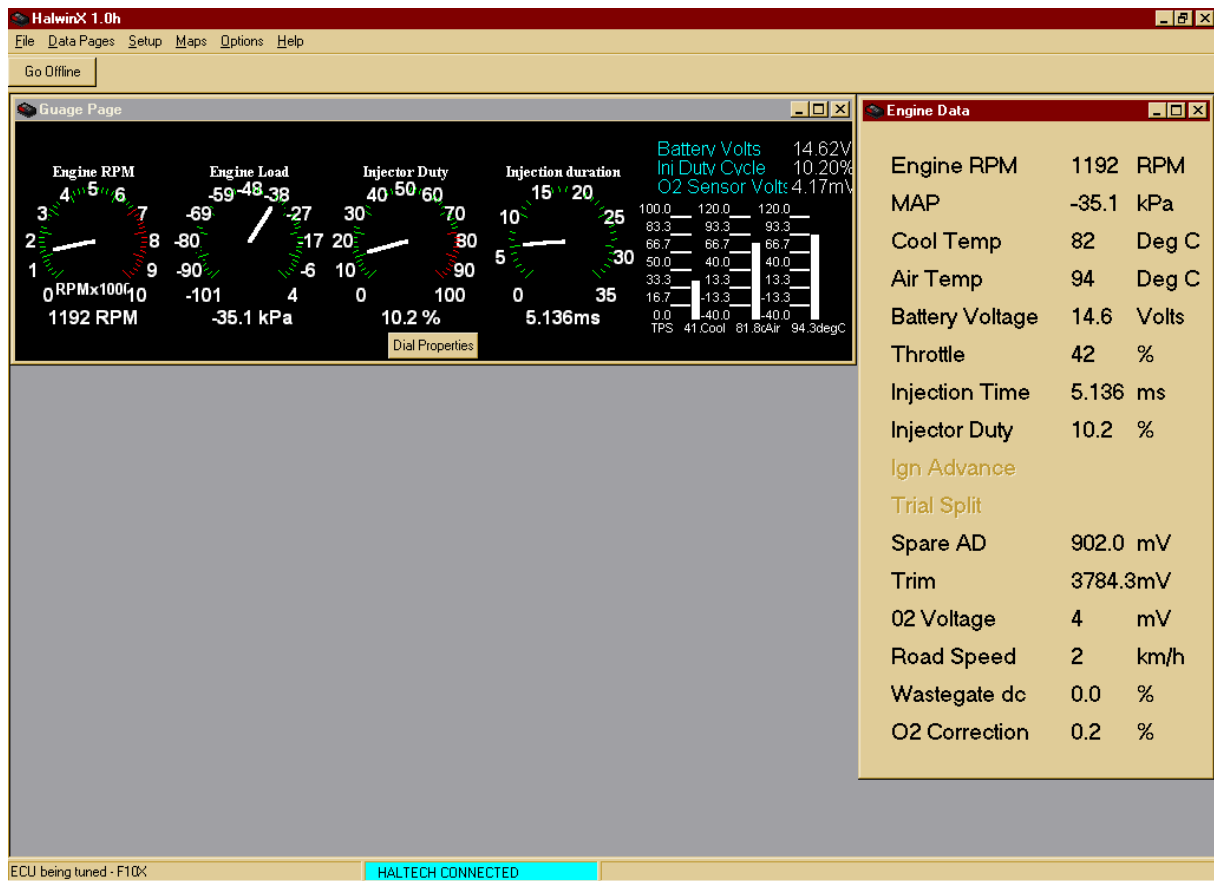


When the progress bar reaches 100% the programming software has finished uploading the data from the ECU and the status bar will show “HALTECH CONNECTED” and the status bar will be blue. If the text “HALTECH DISCONNECTED” flashes this means that the programming PC cannot communicate with the ECU, check:

- The ECU has power
- The communications cable is connected
- The communications cable is free from faults

3.2.2 The Engine Data and Gauge Page

The Engine Data page, as its title suggests, displays engine information in real time so the user knows the operating conditions of the engine at all times. The engine data page can be used to test that the ECU and its sensors are working correctly. There are two forms of the Engine Data page, the Text view and the gauge page. Both views are shown below,



3.3 Hot Key Summary

Many of the menu items have shortcut keys or “Hot Keys” which allow the user to access a menu item directly from anywhere in the programming software eliminating the need to navigate the menu structure. These “Hot Keys” are as follows:

- CTRL-Q - Quit the Programming Software
- CTRL-F - Fuel Maps
- CTRL-M - Main Set-up
- CTRL-G - Gauge Page
- CTRL-E - Engine Data Page
- CTRL-O - Output Options
- CTRL-T - Throttle Pump
- CTRL-D - Data log

CHAPTER 4

CONFIGURING THE ECU

4.1 Using the ECU Set-up Pages

The Set-up pages of the programming software tell the ECU essential information about the engine which it is to control.

NOTE:

The set-up pages are where tuning should begin, it is important to configure the ECU before any attempt is made to start and operate the engine.

Each setup page consists of dialog boxes where the user enters the desired values and settings. To navigate between the settings the user can use the mouse or press the Tab key and either types in the required value or presses on a check boxes. To apply the changes the user presses the Enter key or clicks on the OK button

4.2 The ECU Set-up Pages

The main set-up pages that define the way the ECU operate. These are:

- Main Set-up
- Trigger Set-up
- Fuel Set-up
- In/Out Set-up
- Ignition Set-up

These set-up pages must be configured before the engine is even started to insure the following: the engine will run, no damage will be caused to the engine or engine components and no damage will be caused to the ECU. In addition to these set-up pages are the options set-up pages that configure the following: idle control, closed loop O2 control and the PWM outputs. These outputs are not critical to starting the engine and are usually left until the engine has been roughly tuned to allow it to idle.

4.2.1 Main Set-up Page

The main set-up page contains basic engine information. The Main Set-up Page is accessed via the set-up menu or using: **CTRL-M** from anywhere in the programming software.

The fields in the main set-up page are as follows:

Cylinders

The number of cylinders needs to be entered here. This parameter is used to determine the engine speed and other fuel and ignition requirements.

Load Sensing

The ECU can use either the manifold pressure or the throttle position as a means of determining the engine load. Most engines operate using manifold pressure to sense engine load. If your engine employs any form of forced induction, you must run in manifold pressure mode. Only engine with long duration cams or multiple throttle bodies, motorbikes or heavily ported rotaries require throttle mode - i.e. Engines

whose vacuum signal is small, or fluctuates greatly. If you are unsure what to use, contact your Haltech dealer.

MAP Sensor

The ECU needs to know the type of Manifold Absolute Pressure (MAP) sensor being used. If you do not know what sensor you have refer to *1.3.1 Manifold Absolute Pressure (MAP) Sensor, p12*. Enter the correct description here to match. If using throttle position mode, set this parameter to a 1 Bar sensor.

RPM Limit

The ECU can limit the maximum rpm at which the engine will operate. Above this level the ECU completely cuts fuel or ignition (see below) to the engine. When the engine speed drops below the RPM Limit the F10X will resume normal fuel delivery. This is known as hard limiting. If the RPM Limit is not needed then set this value above the highest operating point of the engine.

Road Speed Value

This value calibrates the Road Speed reading. The value represents the number of pulses received from the road-speed sensor over a distance of 1 km.

Rotary/Cylinder mode

This allows the user to choose between whether they are running a rotary or cylinder mode.

RPM Limit Type

The RPM Limit can only be set to fuel cut for this unit.

Units

The programming software can display parameters in either Metric or US units. At present HalwinX is fixed to SI units.

RPM Mode

The ECU fuel maps may be arranged either in 500 rpm increments from 0 rpm to 10,500 rpm, or in 1000 rpm increments from 0 rpm to 16,000 rpm. Select the *high* or *low* rpm mode here. Changing this setting alters the way the ECU reads the fuel Maps, and will change the tuning of the engine dramatically.

ECU Mode

The user has the option to choose between basic and advanced mode. This is a legacy component from the DOS software and the user is advised to choose advanced mode.

Dual Map Setup

This allows the user to switch between Fuel map 1 and Fuel map 2. If Dual Map disable is selected, Fuel map 1 is selected.

Use of Secondary Map

This defines the method by which the ECU determines which base map to use. The options are:

<i>Never</i>	This causes the ECU to only use the primary base fuel map.
--------------	--

<i>Always</i>	This causes the ECU to only use the secondary base fuel map.
<i>Enable with Aux. In</i>	This causes the ECU to use the primary base fuel map when the Aux. In <i>is not connected to ground</i> . The ECU uses the secondary base fuel map when the Aux. In <i>is connected to ground</i> .

Note: The Aux. In field in the Input/Output Set-up page must be set to Dual Maps Input. Refer to 4.2.4 <i>The In/Out Set-up Page</i>, p39
--

<i>Enable with VTECH</i>	This causes the ECU to use the primary base fuel map when the VTECH Output is <i>inactive</i> . The ECU uses the secondary base fuel map when the VTECH Output is <i>active</i> .
---------------------------------	---

Use of Gas Compensation Maps

This field tells the ECU how to use the gas compensation maps.

Note: The gas compensation maps can only be used if the spare A/D and the Trim input are configured for gas pressure and gas temperature. Refer to 4.2.4 <i>The In/Out Set-up Page</i>.
--

The options are:

<i>Always</i>	The gas compensation maps will always be used.
<i>Enable with Aux. In</i>	The gas compensation maps will only be used if the Aux. In. line <i>is connected to ground</i> . The gas compensation maps will not be used if the Aux. In. line <i>is not connected to ground</i> .

4.2.2 Fuel Set-up Page

The fuel set-up page contains information about the fuel system. The Fuel Set-up Page is accessed via the set-up menu.

The fields in the fuel set-up page are as follows:

Decel Cut Enable/Disable

A common fuel saving feature in original equipment computers is a fuel cut-off on deceleration. This will cut fuel delivery to the engine while coasting down hills with closed throttle. This feature can be enabled or disabled. It is better, when first tuning, to disable this function.

Decel Cut RPM

This is the RPM above which the Fuel cut out will be applied.

Injection Mode

The ECU can operate in 3 different injection modes depending on the application these are:

Multipoint injection fires all the injectors together. This is the most common set-up and will normally be used on engines with multipoint injection manifolds (one injector per cylinder).

Batch-fire injection is usually used in throttle body or non-turbo rotary set-ups and fires the two banks of injectors alternately. On eight and twelve injector fuel rails, with high-flow injectors, this may also help reduce fuel pressure oscillations caused by all injectors pulsing together.

Staged injection is usually used on high boost turbo engines. Injector outputs 1 and 2 fire all the time, just as in a multipoint set-up. When the boost pressure exceeds a programmed value, injector outputs 3 and 4 are enabled.

The *staged* injectors are normally upstream of the primary injectors. The point at which the ECU switches in the secondary injectors is set via the Staging Bar Number field which is described below. Staging permits high fuel-flow capability, but maintains accuracy and controllability at light load and idle.

Enable Injectors

This field allows the user to turn on all injector outputs. Turning this checkbox off will disable all injector outputs.

Post Start Temp Limit

This field sets the temperature at which the post start correction map is either enabled or disabled. The following field "Above/Below" sets whether the enabled state corresponds to a temperature above or below the Post Start Temp Limit. The Post Start correction map will apply correction to the injection times from when the motor is started to when the engine temperature reaches the Post Start Temp limit.

Post Start Time Limit

This field sets the period of time across which the Post-start map is to operate.

Ignition Divide By

Ignition Divide By is the number of Ignition / Trigger pulses that will be counted until the next injection pulse. For almost all multipoint systems, injection should occur once per revolution so Ignition Divide By should be set to half the number of cylinders. If the system is operating in Batch Fire mode, or is a rotary, then a value of 1 is suggested.

Staging Bar Number

This field sets the point at which the staged injectors are enabled. If the injection mode is not "Staged Injection" then this field will not affect injection.

Zero Throttle Map

This feature allows the user to adjust a special fuel map that is used only when the throttle is closed. This feature should be used for engines that produce constant vacuum while cruising but irregular vacuum when idling. The zero-throttle Map can

allow simple adjustment of the idle fuel settings. This field enables or disables the use of this map.

Throttle Pump Dead-band

This field defines the percentage change in throttle position that must occur before the throttle pump is activated. This feature allows for “jitter” in the throttle that would otherwise over-fuel the engine. The valid range of values is 1-20%.

Full Throttle Map

This feature allows the user to adjust a special fuel map that is used only when the throttle is wide open on normally aspirated engines. With some manifold and or throttle designs, pressures in the manifold can reach close to atmospheric pressure before full throttle is applied. This effect can make tuning difficult around full throttle. This map allows the full load settings to be easily set without interfering with lighter load settings. This field enables or disables the use of this map.

Full Throttle Threshold

This field defines the throttle position at which the ECU considers to be full throttle. This field can be set between 70 and 100.

Barometric Lock

This field allows the user to base the barometric corrections on a single point in the barometric correction map. This function is used rather than using the barometric pressure sensor in the ECU if the spare A/D is required for another purpose. The ECU now requires the user to provide a barometric pressure value for performing barometric corrections. This value is programmed via *Barometric Pressure Lock at xxxx (mBars)*.

Barometric Pressure Lock at xxxx (mBars)

This field contains the barometric pressure value at which the ECU is to be locked if enabled by the field “Barometric Lock”.

WARNING:

BAROMETRIC CORRECTION IS A POWERFUL TOOL WHEN USED PROPERLY BUT CAN CAUSE SERIOUS DAMAGE TO ENGINES WHEN IT IS CONFIGURED INCORRECTLY. FOR A FULL DESCRIPTION OF THE BAROMETRIC CORRECTION AVAILABLE WITH THIS ECU REFER TO 9.3 BAROMETRIC CORRECTION, P62

4.2.3 Trigger Setup

Trigger Input Type

This field defines the type of pickup used to trigger the ECU. Select *Hall Effect* or *Coil Negative/Tacho Output* depending on the trigger being used. As both Hall Effect and optical trigger sensors generate a square wave select Hall Effect for optical sensors. Please note that the ECU connections will change depending on which trigger you have.

Hall Effect Trigger = Connect to Pin 6 (Trigger) or Pin B on Connector J16 for terminated harness.

Coil Negative/Tacho Output Trigger = Connect to Pin 36 (Coil Negative) or Pin C on Connector J7 for terminated harness.

Trigger Input Pull up options

This field is used to pull-up the voltage of the trigger circuit when in Hall Effect mode. For most applications, this setting will need to be switched on.

Trigger Edge

The trigger edge defines whether the ECU uses a *rising* or *falling* signal from the pickup. For a further description on trigger edge see

4.2.4 The In/Out Set-up Page

The In/Out set-up page contains the information about auxiliary components the ECU is to control. The In/Out Set-up Page is accessed via the set-up menu or using: **CTRL-N** from anywhere in the programming software.

The fields in the ignition set-up page are as follows:

Trim Control

The optional Trim is a useful tuning and control unit and can be used to control one of several parameters. If there is nothing connected to the trim plug, the trim will have no effect (except with boost control). The available functions are:

Fuel (Fine) $\pm 12.5\%$ adjustment of fuel.

Fuel (Coarse) $\pm 50\%$ adjustment of fuel.

Boost Control Boost trim for Waste-gate control only.

BAC2 This trims the idle speed by modifying the duty cycle driving the BAC valve through PWM 3 or 4 when set to BAC2 Valve (open loop idle control). When the spare A/D is set to BAC2 it overrides all BAC2 PWM parameters and drives the channel with a duty cycle proportional to the trim position.

Spare Input Function

The Spare input is an analogue input similar to the Trim Control input that can be configured for one of several tasks. The available functions are :

General 0-5 volt input; no effect on ECU operation.

Fuel (Fine) $\pm 12.5\%$ adjustment of fuel.

Fuel (Coarse) $\pm 50\%$ adjustment of fuel.

<i>Baro Sensor</i>	Barometric Pressure Sensor (internal/external).
<i>Exhaust MAP Sensor</i>	Exhaust Pressure(does not affect ECU operation)
<i>Aux RPM Limit</i>	Input switch for activating Aux RPM limit. Limit may be above/below the primary RPM limit. Useful for launching or allowing extra RPM momentarily for overtaking.
<i>O2 Sensor</i>	Display only (does not affect ECU operation). The reading appears on the Engine Data Page as mV.

WARNING:
WHEN CONFIGURING YOUR SYSTEM TAKE CARE TO SET THE SPARE INPUT FUNCTION CORRECTLY. IF THE SPARE INPUT FUNCTION FIELD IS SET TO BARO. SENSOR EXTERNAL AND THE BARO SENSOR IS DISCONNECTED THE ECU MAY PERFORM INCORRECT BAROMETRIC CORRECTION. IF YOU ARE USING AN EXTERNAL BARO SENSOR AND REMOVE IT BE SURE TO RECONFIGURE THE SPARE INPUT FUNCTION TO GENERAL.

2nd MAP Sensor

This field is only accessible when the Exhaust MAP Sensor is selected on the Spare Input Function. It tells the software what sensor is being used (either 1 Bar, 2 Bar, or 3 Bar sensor) and how to calibrate the reading.

Aux. In Function

The Auxiliary Input on the E6X can be configured for one of several functions. Most of these functions relate to the configuration of the system. The available functions are:

<i>Disabled</i>	No effect on ECU operation.
<i>NOS Input</i>	This feature is not available for F10X.
<i>TCC Input</i>	This input is used in conjunction with <i>Torque Converter Clutch Lockup (TCC)</i> , p84
<i>Turbo Timer</i>	This input is used in conjunction with <i>Turbo Timer (TT)</i> , p81.
<i>Anti-Lag Switch</i>	This feature is not available for F10X.
<i>Flat Shift Switch</i>	This feature is not available for F10X.
<i>Air Conditioning Request</i>	This allows the ECU to intercept the vehicle's Air conditioning request signal and grant or refuse the request based on the current engine operating conditions. See section 12.13 <i>Air Conditioning</i> , p84
<i>Dual Maps</i>	This input is used to swap between the primary and secondary maps. See section 5.4 <i>Dual Maps</i> , p52

Aux. Out Function

The Auxiliary Output on the F10X can be configured for one of several functions. They are all output to the Aux Out pin (pin A) on plug J7 in the wiring loom. The available functions are:

<i>Disabled</i>	No effect on ECU operation.
<i>Ignition Bypass</i>	This feature is not available for F10X.
<i>Staging Signal</i>	Logic output that indicates Staging conditions. If Staging is selected, and the Staged injectors are firing, this signal will be high (5 volts), otherwise it will be low (~ 0 volts).
<i>Tacho Output</i>	Used for driving tachometers when running a multicoil ignition set-up. This output combines all of the multicoil signals into one output and this is used to provide an RPM measurement.
<i>Ignition Toggle</i>	This feature is not available for F10X.

Baro Input

Select either the internal barometric sensor or to use another external barometric sensor.

INJ x Current

The ECU has four injector outputs: INJ1-INJ4. These have the ability to drive up to 8A peak and 2A hold current through the injector load. The current control options must be set properly for the number and type of injectors connected to the specific output (INJ1-INJ4). The appropriate injector current control settings are further described in the appendix

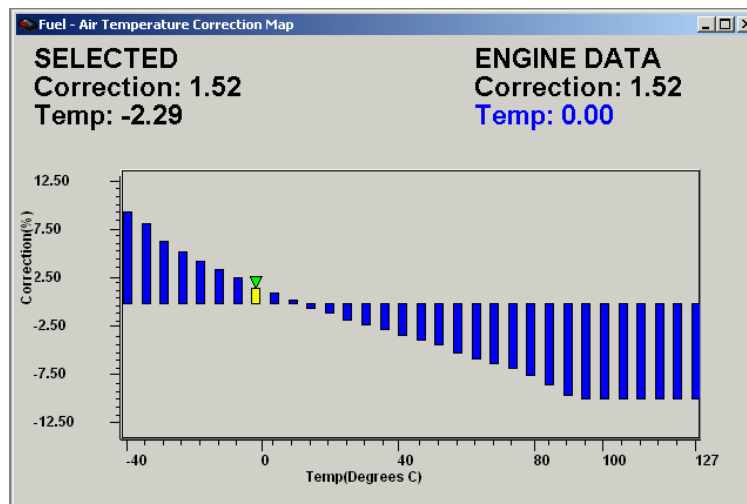
WARNING:
THE CURRENT CONTROL MUST BE SET CORRECTLY.
EXCESSIVE CURRENT PASSED THROUGH AN INJECTOR LOAD
FOR A LONG PERIOD OF TIME MAY DAMAGE THE INJECTORS

CHAPTER 5

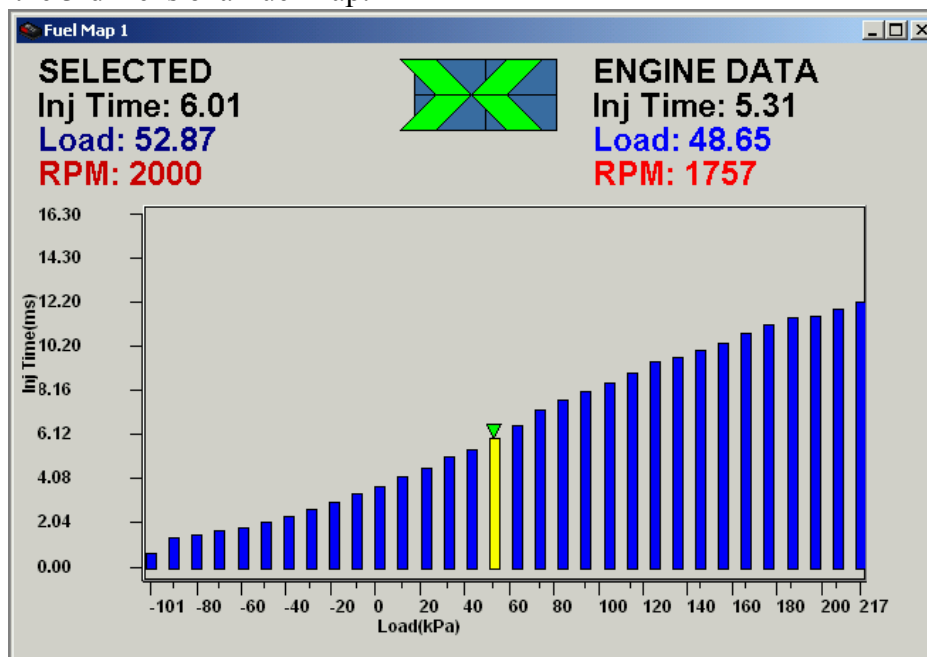
HALTECH MAPS

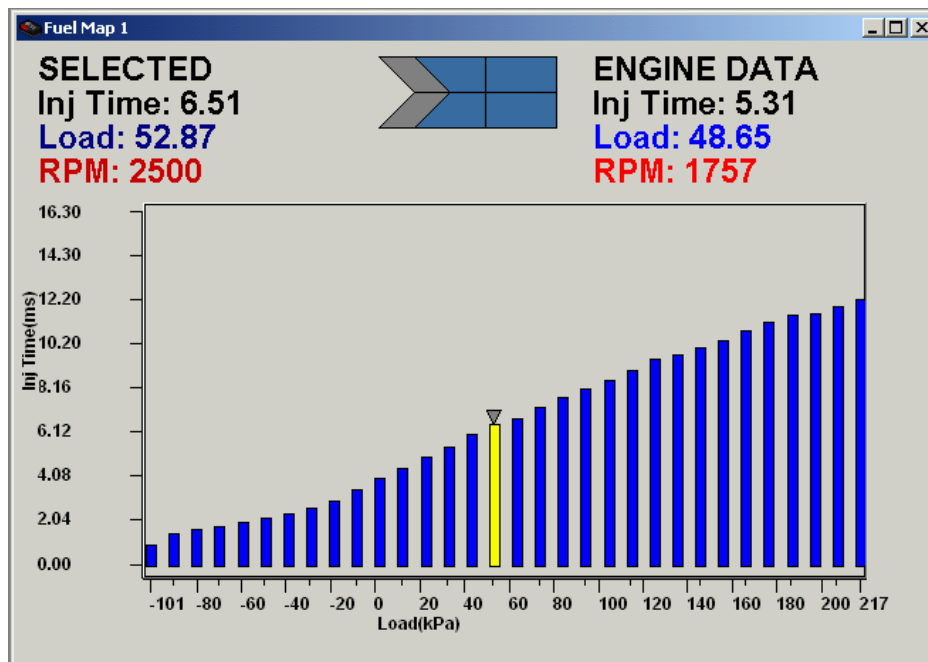
5.1 What are Maps?

The Fuel requirements of an engine at a given point in time are based on the operating conditions at that time. The operating conditions the ECU uses are: manifold pressure, barometric pressure, air temperature, coolant temperature, throttle position and engine position. The fuel requirements of an engine are dependant on the engine load and as air temperature changes (assuming all other values remain the same) so does the quantity of fuel required. These changes are stored in the ECU in a table of numbers called a *map*. Most Maps are 2-dimensional like the “fuel air temperature” which maps fuel vs. air temperature.



The ECU has two 3-dimensional maps: the base fuel map that maps fuel vs. engine load and engine speed. These 3-dimensional maps are made up of a series of 2-dimensional maps, which make up a range of maps. Below are two consecutive 2-dimensional maps that make up part of the 3-dimensional fuel map:





The map above shows the fuel requirements for the engine across the load range at 2500rpm. The yellow bar shows that the engine requires 6.51ms of fuel at 52.87kPa and 2500rpm (This is displayed in the top left corner of the screen as selected data). At the top right corner of the screen, the actual engine data is shown, ie what the engine is currently running.

The programming software presents the maps in a bar graph formation to make it easy to visualise fuelling and ignition. Numeric mode can also be selected through the maps menu.

Some of the fuel maps have “Hot-Keys” which eliminate the need to navigate the menu structure to access the maps. Refer to 3.2 *Online and Offline Operation*, p31

5.2 What is Mapping the Engine?

“Mapping the engine” is the process of modifying the maps to suit the requirements for your engine by adjusting the heights of the bars within the maps. Bars may be adjusted one at a time, or in groups. The Haltech programming software has been designed to make engine mapping simple and intuitive.

5.2.1 Adjusting Bar Height In a 2D Map

The height of the highlighted bars in the map can be readily adjusted by using the up and down cursor keys:

↑, ↓

Multiple bars can be selected to apply changes to a set of bars. This is achieved by highlighting the first bar in a series of bars by using the left and right cursor keys:

←, →

Then hold down the control key while pressing the left or right cursor key:

Ctrl - ←, Ctrl - →

This will leave the selected bar highlighted and will cause the next bar to the left or right to become highlighted.

The up and down cursor key result in a relatively small change in height of the bar or bars selected. To facilitate quick tuning there are a number of ways that allow different increments in bar height.

Some key combinations and bar increments are:

Key Combination	Increment
↑ or ↓	0.048ms
PgUp or PgDn	0.207ms
Shift-PgUp or Shift-PgDn	0.495ms

5.2.2 All Ranges

When tuning 3-dimensional maps it can often be useful to make changes to the same bar in all the ranges of the map. This allows the user to tune basic fuel values across load in one engine speed range for all the ranges so the fuel will be at least close to the requirements across the full range. “All Ranges” is enabled and disabled by pressing:

ALT-R

When the software is in any of the ranges of a 3-dimensional map. The text “All Ranges” will appear in the middle left of the screen and will remain there until the All Ranges function is disabled. When All Ranges is enabled all changes made in any range of a three dimensional map will affect the corresponding bar in all the other ranges of that map.

5.2.3 Percentage Changes

When tuning it can be useful to apply a percentage change to all or part of the maps. An example of this would be when the injectors are changed for units with a higher or lower flow rate. To make a percentage changes select the bars that need to be changed and press:

Shift-5 or 5 (5 being the same key containing the % symbol)

The software will then prompt the user to type a percentage change, if a positive number is typed then a percentage increase will result, if a negative number (any number with a ‘-’ prefix) is typed a percentage decrease will result.

NOTE:

The percentage increase and decrease calculations are based on the current height of the selected bars. This means that if a bar has a 50% increase applied and the user wishes to reverse this increase, a decrease of 33% is required. For example: if a bar had a height of 4ms and it has a 50% increase applied:

$$4ms \times 50\% = 2ms$$

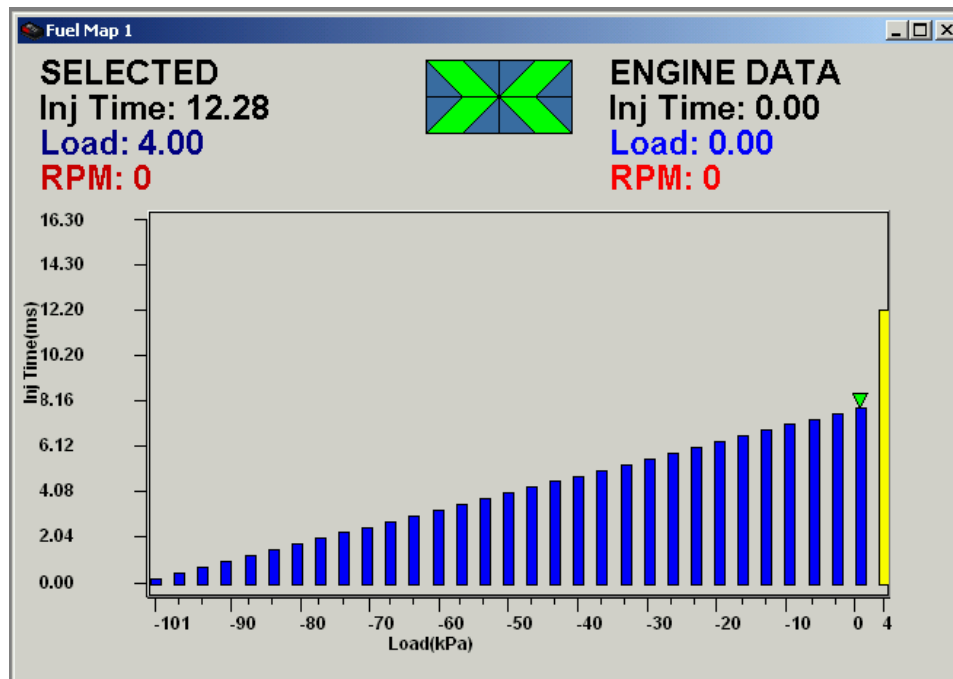
The new height of the bar will be 6ms.

To reduce the bar to 4ms again by using the percentage change function 33% must be used since.

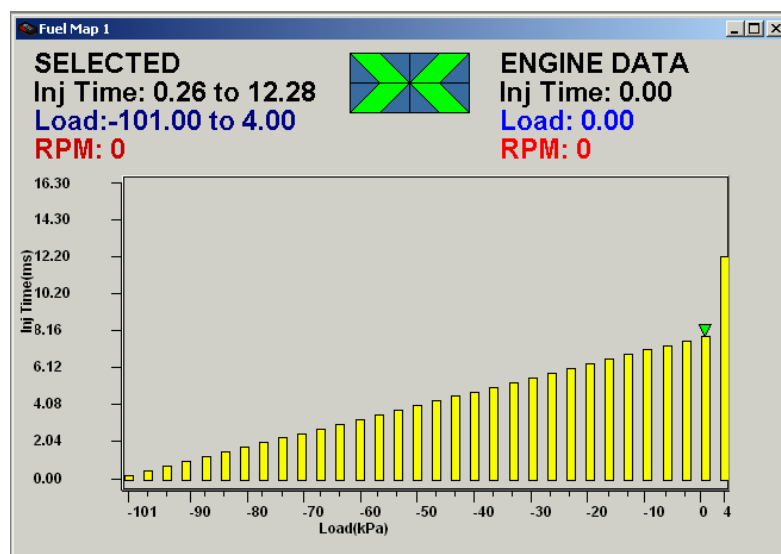
$$6ms \times -33\% = 4ms$$

5.2.4 Linearise

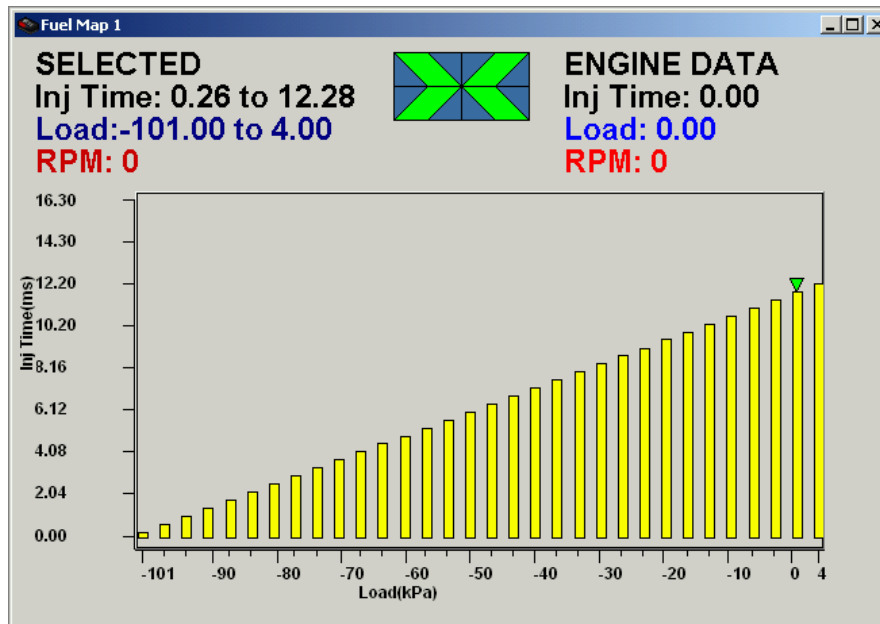
When tuning it is often useful to be able to set two load points with a given value and approximate the fuel requirements between those two points with a straight line. The linearise function allows the user set approximate fuel values based on a straight-line approximations as shown below:



The above map shows the highlighted bar as much higher than the rest. In this case the estimated fuel requirements for full load operation in this range is 12.28ms, it is unlikely that the load point to the left of this bar would require such a significant reduction in fuel, it is more likely that a straight line approximation across the load points would be closer to the basic fuel requirements. In this case a straight-line approximation will be applied between the 2 extreme bars as follows:



All the bars between the 2 extreme bars are highlighted:



The map above shows the heights of the bars after the linearise function has been applied. The linearise function calculates the height of the bars between the two extreme bars based on a line drawn between tops of the two extreme bars; the result is a linear fuel map.

5.2.5 Numeric Mode

The programming software offers the ability to tune the maps using a spreadsheet style map called “Numeric Mode”. Numeric mode is accessed by pressing:

File -> Fuel Map1->Text View

A table of numbers will appear, as shown below, displaying the map as a spreadsheet. Visual mapping is preferred to tuning in numeric mode since the visual representation shows obvious lumps in the map that are not so obvious in numeric mode.

In numerical mode only a fraction of the entire map is shown on the screen but the whole display can be accessed. To navigate the map use the cursor keys to move the highlighted cell:

↑, ↓, ←, →

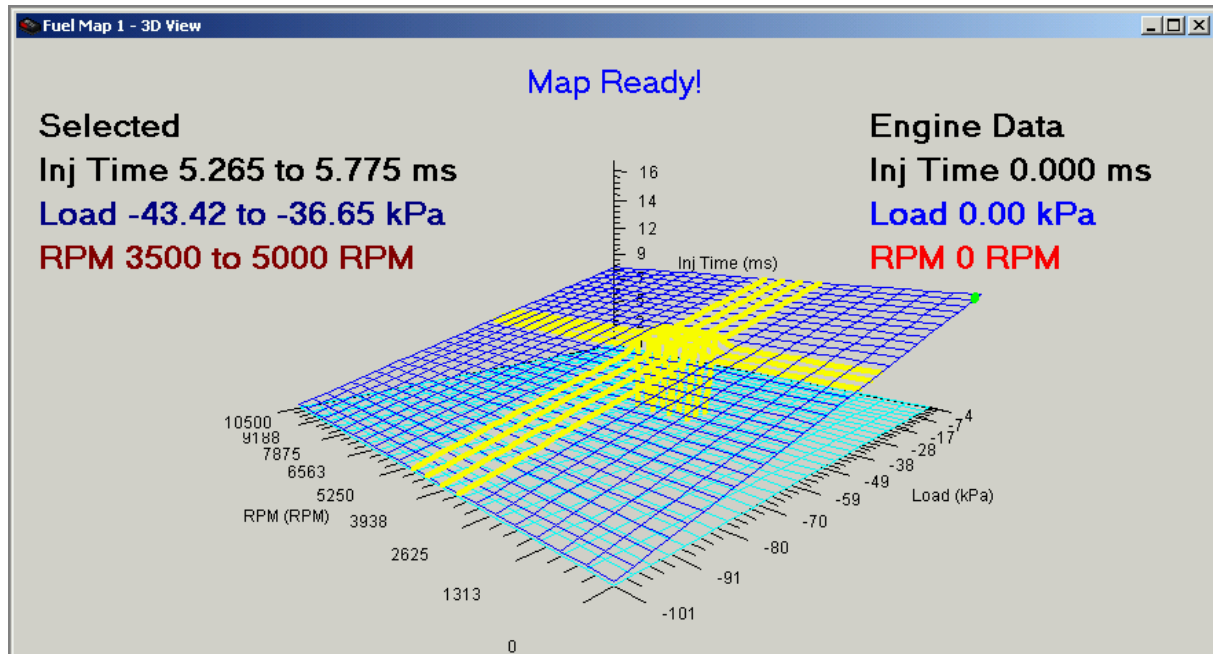
To change the value of a cell, highlight that cell, type the value required and then press:

Enter

The values in the table must be a multiple of 0.016ms, if a different value is entered the program will round to the nearest valid value.

5.2.6 3D View

The 3D view is available for the 3D Fuel maps. An example of the 3D maps is shown in this figure below.



The adjustments for these maps is similar to the 2D view with the following differences,

- To move up and down the RPM range the up and down arrow keys are used instead of N and P.
- To move up and down the Load range the left and right arrow keys are used.
- The fine increments are controlled by "A" for add and "S" for subtract.
- The copy and paste functions are not available for this view.

To access these views the user can do the following,

- Use the Maps Menu by selecting **Maps->Fuel Map 1 / 2 -> 3D View**
- **Ctrl – Alt – F**

5.3 The Haltech Maps

The Maps that the ECU uses to calculate fuel requirements are explained in detail here.

5.3.1 Fuel Map – 3-Dimensional

The fuel map is accessed through the menu structure under the maps menu or using the hot-keys ***CTRL-F (2D) or CTRL-ALT-F (3D)***.

The Base fuel map represents the reference on which all fuel corrections are made to calculate the final fuel requirement for the given engine load and engine speed. This map should closely reflect the engines fuel requirements at optimum operating temperature and average operating and environmental conditions. This map is where the most tuning is carried out.

The fuel map comprises a series of 2-dimesional maps of fuel quantity versus engine load across the range of engine speed. If the “RPM Mode” in the main set-up page is set to 10500 there are 22 engine speed ranges in the fuel map from 0rpm in 500rpm increments, if it is set to 16000 there are 17 engine speed ranges from 0rpm in 1000rpm increments. Each range has 32 bars distributed across load and each bar represents the quantity of fuel that is to be injected prior to any corrections. For any given load and rpm the range for the injection time is 0ms to 16ms.

5.3.2 Fuel Correction Map

The following is an explanation of maps that are used to correct the base fuel quantity based on the environmental conditions.

5.3.2.1 Coolant Temperature Correction

The coolant temperature correction map is accessed through the menu structure and can be found in the maps menu.

The coolant temperature correction map is used to adjust the fuelling based on the coolant temperature measured by the ECU. The map has 32 bars distributed across coolant temperature in the range of -40°C to 127°C and each bar represents a percentage correction to the current calculated fuel.

5.3.2.2 Air Temperature Correction

The air temperature correction map is accessed through the menu structure and can be found in the maps menu.

The air temperature correction map is used to adjust the fuelling based on the air temperature measured by the ECU. The map has 32 bars distributed across air temperature in the range -40°C to 127°C and each bar represents a percentage correction to the current calculated fuel.

5.3.2.3 Battery Voltage Correction

The battery voltage correction map is accessed through the menu structure and can be found in the maps menu.

The battery voltage correction map is used to adjust the fuelling based on the battery voltage measured by the ECU. The map has 32 bars distributed across battery voltage in the range 8V to 16V and each bar represents an addition correction to the current calculated fuel. The battery voltage correction is applied after all other corrections take place.

5.3.2.4 Fuel Priming Map

The primer map is accessed through the menu structure and can be found in the maps menu.

The primer map is used to add a quantity of fuel based on coolant temperature when the first crank trigger is detected by the ECU. The map has 32 bars distributed across coolant temperature in the range -40°C to 127°C and each bar represents a set quantity of fuel injected prior to and independent of any other injection event. The primer injection will only inject fuel once on the first crank trigger event.

5.3.2.5 Post Start Map

The post start correction map is accessed through the menu structure and can be found in the maps menu.

The post start correction map is used to adjust the fuelling based on the time since the engine was first started. The ECU has a time reference for the first 120s of engine operation. The map has 16 bars distributed across time in the range 0s to “Post Start time Limit” (refer to *4.2.2 Fuel Set-up Page, p36*) and each bar represents a percentage correction to the current calculated fuel.

5.3.2.6 Barometric Pressure Map

The barometric pressure correction map is accessed through the menu structure and can be found in the maps menu.

The barometric pressure correction map is used to adjust the fuelling based on the barometric pressure measured by the ECU. The map has 32 bars distributed across barometric pressure in the range 523mBar to 1046mBar and each bar represents a percentage correction to the current calculated fuel.

5.3.2.7 Gas Pressure Map

The gas pressure correction map is accessed through the menu structure and can be found in the maps menu.

The gas pressure correction map is used to adjust the fuelling based on the gas pressure measured by the ECU. The map has 32 bars distributed across gas pressure in the range 0Bar to 12 Bar and each bar represents a percentage correction to the current calculated fuel.

5.3.2.8 Gas Temperature Map

The gas temperature correction map is accessed through the menu structure and can be found in the maps menu.

The gas temperature correction map is used to adjust the fuelling based on the gas temperature measured by the ECU. The map has 32 bars distributed across gas temperature in the range -40°C to 127°C and each bar represents a percentage correction to the current calculated fuel.

NOTE:

The gas correction maps are designed to be used with gas injection systems.
They are normally not used unless gas injection has been employed.

5.3.3 Zero Throttle Map

The zero throttle map is accessed through the menu structure under the maps menu.

The zero throttle map is used with engines that use Manifold pressure load sensing but cannot produce a stable manifold pressure signal at idle. The zero throttle map is used when the throttle position reads 0% and applies a set amount of fuel in place of the fuel quantity normally extracted for the base fuel map. The map has 16 bars distributed across engine speed in the range 0rpm to 2000rpm and each bar represents a quantity of fuel measured in milliseconds.

5.3.4 Full Throttle Map

The full throttle map is accessed through the menu structure under the maps menu.

The full throttle map is used with engines that use Manifold pressure load sensing but cannot produce a stable manifold pressure signal at full throttle. The full throttle map is used when the throttle position reads higher than “Full Throttle Threshold” (refer to *4.2.2 Fuel Set-up Page, p36*) and applies a set amount of fuel in which the ecu will inject, regardless of the fuel quantity normally extracted for the base fuel map. The map has 32 bars distributed across engine speed in the range 0rpm to 16000rpm and each bar represents a quantity of fuel measured in milliseconds.

5.3.5 Turbo Waste-gate Maps

The ECU has access to two turbo waste-gate maps that are used to control boost pressure. The two maps are labelled “1” and “2” which operate identically but whose usage differs. For information on map usage refer to *12.1 Turbo Waste Gate Control (TWG), p79*.

The waste-gate maps are accessed through the menu structure under the maps menu.

When turbo waste-gate control is used, the ECU uses the waste-gate maps to determine the duty cycle with which to drive a solenoid that is used to bleed pressure from the waste-gate diaphragm to control the boost pressure. Each map has 32 bars distributed across engine speed in the range 0rpm to 16000rpm and each bar represents a duty cycle fed to the bleed valve in the range 5% to 95%.

5.3.6 Torque Converter Control Map

The torque converter control map is accessed through the menu structure under the maps menu and is used in conjunction with the torque converter control. Refer to *12.4 Torque Converter Clutch Lockup (TCC), p81*

When the torque converter clutch control is used, the ECU uses the torque converter control map to determine whether the clutch lock-up should be engaged. The map has 24 bars distributed across throttle position in the range 0% to 70% and each bar represents the road speed at which the clutch lock-up should be engaged in the range 0km/h to 300km/h.

5.4 Dual Maps

A second set of Fuel and ignition maps is provided for use with dual fuel vehicles or for users who wish to use pump fuel day to day and race fuels at the track. The same engine running on different fuels will almost always require some modification to the fuel maps to produce maximum power (or efficiency), and rather than loading and reloading different maps, the user can simply switch between the two maps which best suit their driving requirements.

Dual maps can be used in conjunction with the variable valve controlled engines. Variable valve control changes the engines operation when engaged, consequently a second map can be tuned to suit this change so that the engine will operate correctly at all points on the load and speed ranges with the variable valve control engaged or disengaged. The Haltech VTEC control feature can be programmed to have hysteresis on the output to prevent oscillations at the switching point (load or speed), consequently there is a range of speed and or load points at which the engine operates with both the variable valve control engaged and disengaged, this means that the fuel can only be optimised for one state of the variable valve control engagement if only one map is used, this may result in the other state having poor fuel and ignition tuning. Switching between the primary and secondary fuel maps allows both states of variable valve control to be mapped correctly. The turbo waste-gate control solenoid maps can also be configured such that waste-gate Map 1 is used with the primary fuel maps and waste gate Map 2 is used with the secondary fuel map. This allows different boost levels for different fuels and environments. Refer to *12.1 Turbo Waste Gate Control (TWG)*, p79.

5.4.1 Editing Dual Maps

The dual maps can be edited by selecting Maps-> Fuel Map 2 and selecting the 2D, 3D or text view. The map will then be edited in the same way as the primary fuel and ignition maps.

SECTION2

Tuning The Engine

CHAPTER 6

STARTING THE ENGINE

Once the ECU is installed and the set-up has been completed it is time to try to start the engine. Before cranking the engine there are a few things that need to be done. Make sure that the ECU is powered (ignition on) and the Haltech Software is online. Go to the Engine Data Page to check that the ECU is communicating properly, and that the sensors are reading correctly. Check again that the set-up information is correct.

6.1 Calibrating the Throttle Position Sensor

The throttle sensor must be calibrated so that the ECU knows the start and stop positions of the sensor. First, set the idle throttle opening using the idle-adjust screw. 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 "Throttle Setup" item from the setup menu and follow the instructions on the screen.

Finally test the throttle calibration by opening the engine data page checking that when the throttle is closed the throttle position reads "0%" and when the throttle is opened it reads "100%". If this test fails try recalibrating the throttle. If you continue to have problems refer to the troubleshooting guide in the appendix.

6.2 Checking the Trigger

It is a good idea to check that the ECU is receiving a reliable trigger signal. Disable the injector outputs in the Fuel Set-up page to cut all fuel delivery to the injectors. The engine should then be cranked over on the starter. The engine speed is displayed on the engine data page and should read about 100 to 300 rpm. If the engine speed is zero or is erratic then there is a problem with the trigger set-up, check for these problems and rectify any faults found. If you continue to have problems refer to the troubleshooting guide in the appendix. should be disabled and fuel injectors enabled so an attempt may be made to start the engine.

6.3 Determining Engine Fuel Needs

The ECU should now have sufficient set-up information to start and control the engine. The basic fuel map loaded into the ECU at the factory may allow the engine to start and run. The following paragraphs should offer enough information to get the engine running and idle smoothly.

WARNING:

WHEN TUNING AN ENGINE, ESPECIALLY UNDER LOAD, IT IS ADVISABLE TO HAVE AN INDICATION OF THE AIR-FUEL RATIO AT WHICH THE ENGINE IS RUNNING. IT IS RECOMMENDED THAT A WIDE-BAND OXYGEN SENSOR BE USED FOR THIS SINCE IT DISPLAYS THE AIR-FUEL RATIO QUICKLY.

It is helpful, when first starting the engine, to have a “Trim Control” connected to the ECU loom to allow quick changes to fuelling refer to *4.2.4 The In/Out Set-up Page, p39*.

Before starting the engine, go to the fuel map Range 1 (0 rpm), it is this map that the ECU will use to calculate fuel requirements during cranking. The behaviour of fuel calculation around cranking and idle differs depending on the type of load sensing used.

6.3.1 Starting using the Manifold Pressure Load Sensing

Try to start the engine. At cranking speeds the manifold pressure will be close to atmospheric due to the low airflow around the throttle plate and through the idle passages. This means that the ECU will use the bars at and just below atmospheric pressure. When the engine fires and the engine speed starts to rise the vacuum developed in the manifold will increase due to the increased airflow, the bars used for fuel calculation in this area will be further to the left of those used at cranking. When the engine is at idle the manifold pressure should be fairly steady, the bars used should be further to the left again.

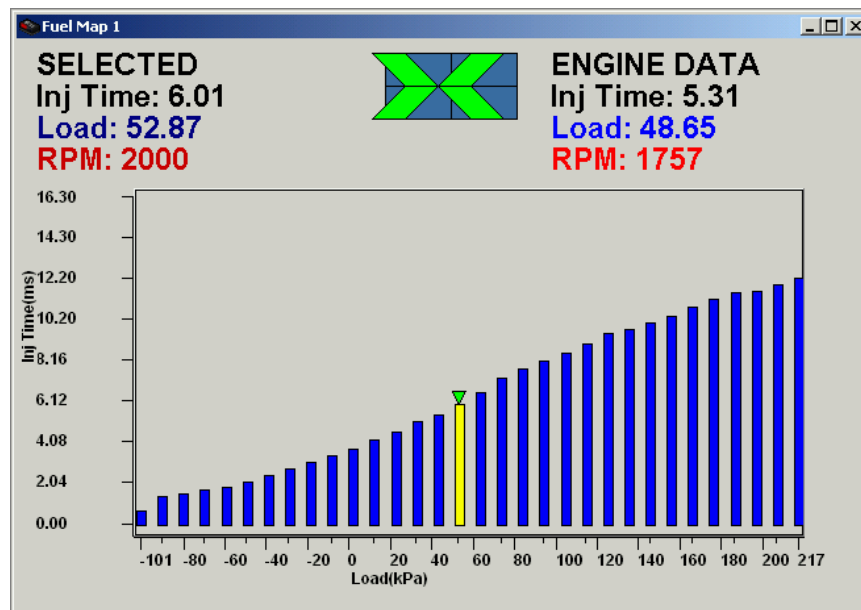
6.3.2 Starting using the Throttle Position Load Sensing

Try to start the engine. Starting the engine in throttle load sensing mode is easier since the throttle stays closed, the bar that is used for calculation of fuel is the left most bar, When the engine fires the speed will increase and the fuel requirement will change from the 0 rpm range through to the appropriate idle range.

6.3.3 Useful Software Mapping features

It is important to identify the bars which affect the fuel or you could spend time adjusting the wrong bars and upset fuelling under a totally different load or speed condition.

A useful tool for identifying the active fuel bar is the small green arrow (called the map pointer) that points to the current bar in the map the ECU is using for fuel calculations as shown below.



To jump to the current range in a 2-dimensional and 3-dimensional map press:

HOME

6.3.4 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 mixtures.

If the engine is hunting at idle, then the map is probably too lean, particularly in the 500rpm range. Watch the movement of the map arrow carefully. The map arrow pointer 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 refer to 5.3.3 *Zero Throttle Map*, p51.

Once the engine will idle it is a good idea to wait for the engine to reach operating temperature before performing further changes to maps. This can be established by checking the coolant temperature reading in the engine data page.

6.3.5 Tuning with No Load

Using the throttle only, increase the engine speed to 1000 rpm. When the engine speed is exactly 1000 rpm the ECU will use only the bars in the 1000rpm range for fuelling calculations meaning no interpolation from adjacent ranges will affect the mixtures. Repeat this process for engine speeds 1500, 2000, 2500, 3000 etc. The engine should now start and fast idle evenly. 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 engine data page. If it becomes erratic, or fails to follow the actual engine speed correctly, check the trigger wiring and make sure that the information in the Trigger set-up page is correct. If you continue to have problems refer to the troubleshooting guide in the appendix.

6.3.6 Loading 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.

6.3.6.1 On the Dyno

Whether the vehicle is on a chassis dyno, or the engine on an engine dyno, the principles of programming the Haltech F10X 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.

Full load tuning should be approached with caution. An engine at full load that is too lean may begin to detonate and destroy the engine. 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.

WARNING:
RUN THE MAP RICH, AND LEAN IT TO THE CORRECT MIXTURES. DO NOT RUN THE MAP LEAN AND ATTEMPT TO ENRICH TO THE CORRECT MIXTURES.

6.3.6.2 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 a similar 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 THE CARS HANDLING MAY BECOME UNSTABLE. ALL ROAD TESTING SHOULD BE DONE AT LOW SPEED.

6.3.7 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. Naturally aspirated engines use an air to fuel ratio of around 12.5:1 to 13.5:1 is usually best (high performance turbo vehicles may go as low as 10.5). When cruising (light to medium load) the mixture should be as close to

stoichiometric (14.7:1 AFR) 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.
--

CHAPTER 7

THROTTLE EFFECTS

7.1 Throttle Response

Where the procedures described in the previous chapter tune for constant load running, the functions outlined in this section will improve the throttle response of your engine.

The manifold pressure sensor used with the F10X is very fast. It can respond much faster than is required to track any sudden changes in load on your engine. The manifold pressure seen at the sensor input does not change as quickly, due partly to the length of the connecting pipe. This can be improved 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 **Fuel Maps and Set-up Menu**.

Six single bars will appear on the screen. The two bars on the left are used below 1500 rpm. The two bars in the middle operate between 1500 and 3000 rpm and the two bars on the right are used above 3000 rpm. These bars set the amount of extra fuel that will be added to the current fuel value during a sudden change in throttle. This extra fuel is added progressively as the throttle movement continues.

The increase bars determine how much extra fuel the engine gets when you open the throttle. Once the throttle movement stops the extra fuel value decays at a rate set by the sustain bars. This feature is used to allow the engine to catch up to the transient that has occurred and, consequently, its value will be dependent on manifold design.

The heights of the increase bars and the sustain bars are adjusted using the same keys that are used for adjusting the fuel curve bars. The left and right arrow keys allow you to move from one bar to the next.

The throttle pump values should be set up after the fuel and ignition 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 six throttle response bars 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 final parameter on the Throttle Pump page is the Coolant Factor. Generally, when the engine is cold, accelerator pump values need to be increased slightly. The F10X therefore applies a coolant correction to the throttle pump in the same way as it does to the base map.

The Coolant Factor may be set with values from 0 to 4. Setting it to 0 will negate all coolant correction to the throttle pump. The default setting for this parameter is 0.5.

7.2 Zero Throttle Map

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.

7.3 Full Throttle Map

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 : 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 16000 rpm.

CHAPTER 8

COLD STARTING AND RUNNING

The ECU has four features to correct fuel delivery and ignition timing to aid in starting and running a cold engine. The cold start prime map gives a cold engine an initial burst of fuel just as the engine begins cranking, the coolant correction map modifies the normal fuel injection until the engine reaches normal operating temperatures.

8.1 Cold Cranking

At cranking speeds the air speed at the inlet manifold is very low. This combined with the low temperature results in much of fuel that would normally travel in the air sticking to the manifold walls and consequently it doesn't enter the engine. The cylinder chamber temperatures are also low which leads to poor combustion. To overcome these inefficiencies, it is necessary to prime the engine with a long pulse of the injectors at the start of cranking to ensure that the engine has enough fuel in the cylinder to fire.

The ECU provides a cold start fuel prime that is adjustable across coolant temperature. This allows the duration of the prime pulse to be optimised for cold cranking under a wide variety of conditions. 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.

8.2 Fuel Correction Versus Coolant Temperature

Once started, 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 burn properly. The ECU corrects for this by using the fuel coolant map to determine extra fuel required based on the coolant temperature. 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 base fuel maps are correctly tuned at operating temperature.

The fuel coolant map should be tuned during the engine warm-up. Start the cold engine and adjust the fuel coolant map by following the map pointer and adjusting the bars of the map that the ECU is using to obtain a smooth idle. Do not touch the throttle while adjusting this map. The coolant correction map should be at zero for normal engine operating temperatures.

CHAPTER 9

CORRECTION FACTORS

Note: The following correction factors should not be altered unless you have a detailed knowledge of your engine and the environment in which it operates. Severe damage can be done to your engine if the correction factors are not set properly.

The ECU has further correction maps: inlet air temperature and battery voltage fuel correction.

WARNING:
MOST USERS SHOULD NEVER ADJUST THESE MAPS. THESE MAPS ARE FACTORY SET TO PROVIDE EXCELLENT CORRECTION FOR ALMOST ALL ENGINES. THESE MAPS SHOULD NOT BE ADJUSTED UNLESS THE USER HAS EXPERIMENTALLY DERIVED DATA THAT THE CORRECTION FACTORS COULD BE BETTER CUSTOMISED TO SUIT A PARTICULAR ENGINE.

9.1 Fuel Versus Air Temp Map

The mass of air entering the inlet manifold varies with the temperature of the air. To compensate for this the ECU uses the fuel air correction map. The values supplied in your ECU have been mathematically determined to give the optimal correction for most engines. The map allows the user to set positive and negative corrections.

9.2 The Battery Voltage Map

The ECU uses fuel injection driver circuitry that compensates for changes in battery voltage. This compensation can be insufficient for the full range of battery voltages that a vehicle's electrical system may experience. As the battery voltage falls, the injectors will take longer to turn on and so reduce the effective open time. To compensate, the F10X applies the Battery Voltage Map to increase the injector on-time as the voltage drops. This map should not be altered unless the system is connected to a fuel injector test bench that will allow the injectors to be accurately flow tested over a range of battery voltages and the corrections calculated accordingly.

9.3 Barometric Correction

NOTE:

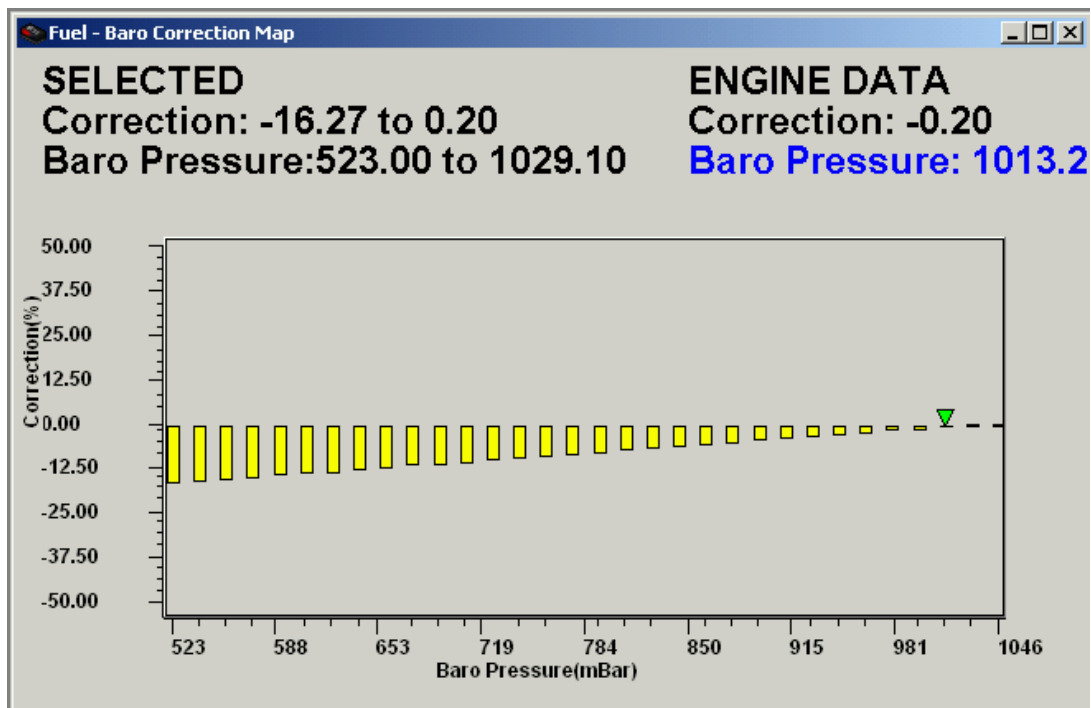
The description that follows is targeted at advanced applications. Only limited installations use barometric compensation.

If you are using a MAP sensor as your load reference we suggest that you set the barometric lock in the fuel set-up to “disabled” and bypass this section. If using throttle position for load sensing barometric compensation is required.

Please note that the default map for barometric compensation is flat and a barometric compensation map must be compiled. See the sample map below.

Fluctuations in barometric pressure vary the density of the intake air of the engine. At lower barometric pressure, the engine cannot breathe in as much 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 barometric correction map is used by the ECU to determine the fuel adjustments required for the given barometric pressure. The map shown below is typical of a barometric map used in conjunction with throttle position load sensing.



The ECU begins with the basic idea that there are three ways to measure barometric pressure variations.

1. The ECU uses a user programmable value for barometric pressure, regardless of the current environmental conditions.
2. The ECU uses a pressure sensor to take a barometric pressure sample from the environment when the car is first turned on and uses this value for the remainder of

the time the car is operated. This method of compensation is limited to applications that use a MAP sensor for load sensing.

3. The ECU uses a pressure sensor to continually measure the barometric pressure during operation of the engine.

9.3.1 Barometric Correction - Method 1

This method requires the user to access the Fuel Set-up page and adjust two fields.

- Set “Barometric Lock” to “Enabled”. This tells the ECU that you are going to lock a particular value in as the barometric pressure value.
- Set “Barometric Pressure Lock at” to “xxxx mBar”. This field tells the ECU the barometric pressure as measured by the user. This value should be the average barometric pressure the engine will be operated in.

Barometric pressure changes regularly and Method 1 is only a basic approach at barometric compensation. Set the Barometric Pressure Lock at xxxx mBars, where xxxx is the pressure you require, for example the measured barometric pressure is 1000mBars. When the fields have been set (as described above) the ECU will assume that the environment always operates at 1000mBars barometric pressure. The ECU will look at the Barometric Correction Map and locate the 1000mBars section of the map. The height of the bar corresponding to 1000mBars will be taken as the overall enrichment %.

9.3.2 Barometric Correction - Method 2

This method uses a barometric pressure reading taken prior to cranking the engine. This method is restricted to applications that use MAP sensors for load sensing.

This method requires the user to access the Fuel Set-up page and a field.

- Set “Barometric Lock” to “Disabled”.

When the ECU is powered up, it will run a small test to determine the barometric pressure. During power up the ECU switches the fuel pump. If the engine is not started, the fuel pump will be switched off. At this time, the ECU also reads the MAP Sensor. If the engine is not running, the MAP sensor will indicate the current barometric pressure. The ECU remembers this pressure and uses it to perform a barometric correction on the fuel delivery.

If at start up the engine is cranked before the fuel pump prime has finished the ECU cannot read the barometric pressure from the MAP sensor, as the engine will be applying a vacuum. In this case, the ECU will use the last measured pressure, which is stored in memory with the maps.

To complete Method 2 follow these steps:

1. Set the Barometric Lock in the Fuel Set-up page to “disabled”.
2. Make sure the throttle position sensor is properly calibrated. It must exceed 96% throttle for this to work. Also make sure that the MAP Sensor is set correctly in the Identification.
3. Switch the ignition off.
4. Apply full throttle.
5. Switch the ignition on but DO NOT crank the engine.
6. Wait till the fuel pump prime finishes (about 5 seconds) then release the throttle. The current barometric pressure as read by the MAP Sensor will be programmed into the ECU’s memory.

It is not necessary or advisable to perform this reset regularly. It should only be done if the vehicle’s regular place of garage is moved or if problems are suspected in the barometric correction. For example, if an engine is tuned at sea level but it is intended to be used mainly at a higher altitude, then the reset should be performed once it reaches its new regular location. After that, the automatic reading done at start up will be sufficient for the ECU to apply barometric compensation.

9.3.3 Barometric Correction - Method 3

This method of barometric compensation allows the ECU to continuously measure barometric pressure and adjust the fuelling throughout the period of operation.

This method requires the user to access the Fuel Set-up page:

- Set “Barometric Lock” to “Disabled”.

This method can only be used if a barometric pressure sensor is connected to the ECU to provide continuous barometric pressure readings. The ECU contains an internal barometric pressure sensor for this purpose. To configure the internal barometric pressure sensor refer to *4.2.4 The In/Out Set-up Page, p39*.

An external 1 Bar MAP Sensor (left open to atmosphere) can be used in place of the internal barometric pressure sensor. The hardware connection of this sensor differs based on the method of load sensing used:

When the ECU is configured to measure load by throttle position, the external MAP sensor is connected to the MAP sensor input. The ECU will automatically use the signal on the MAP sensor input for barometric correction.

When the ECU is configured to measure load by MAP sensor the external MAP sensor is connected to the Spare A/D input.

9.4 Post Start Enrichment

On some motors, in particular rotaries there is 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.

The Post Start Map is accessed via the Maps menu. It covers a programmable period of 1- 120 seconds. The time starts after the first input trigger is received.

Post Start has two programmable settings accessible in the fuel set-up page:

- Post Start Time Limit

- Post Start Temp. Limit

Post Start Temp Limit has a secondary field that defines whether post start operates above or below the programmed temperature. For more information on these parameters refer to 4.2.2 *Fuel Set-up Page, p36*.

SECTION 3

Software Features

CHAPTER 10

DATA LOGGING

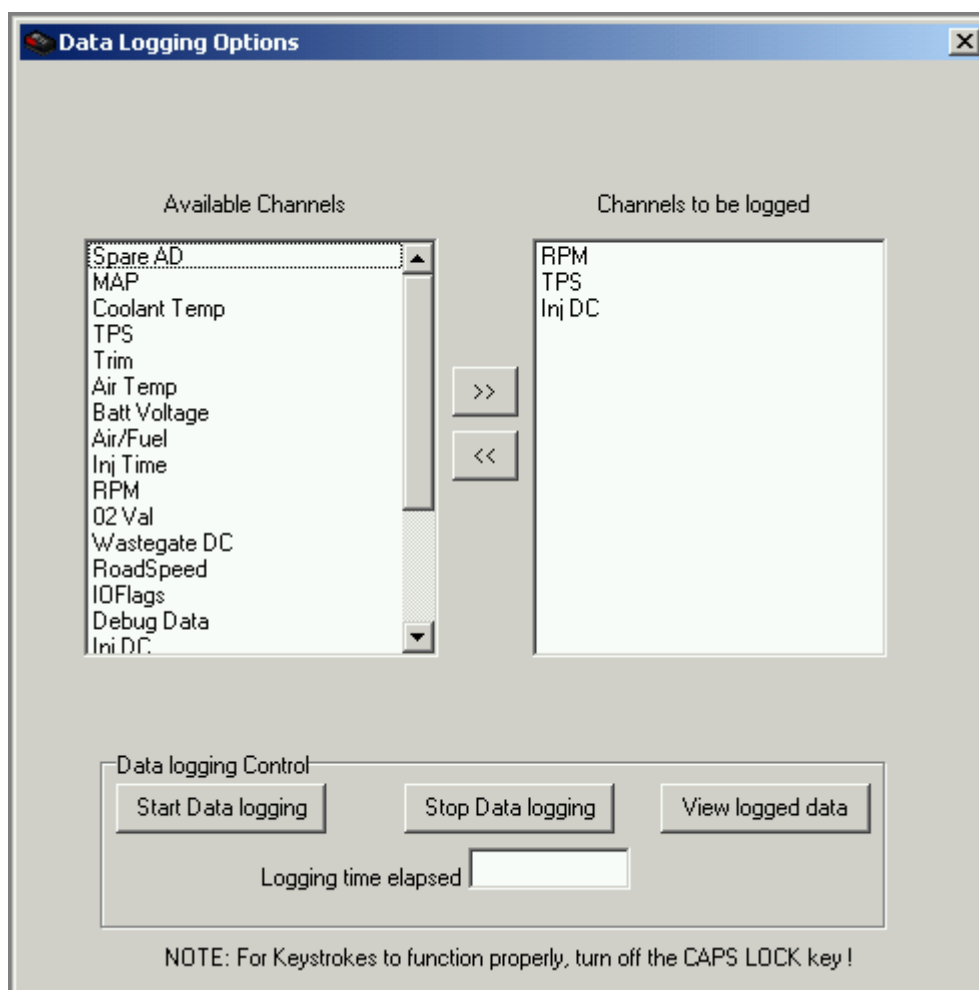
10.1 The Data log Option

Data logging is simply recording the engine data as it is received by the programming PC so that operation of the vehicle can be assessed. Data logging is particularly useful for diagnosing problems. The data log records at a nominal rate of ten times per second while the ECU is online with the programming PC.

The data-logging is accessed through the menu structure under the options menu.

10.1.1 Creating a Data log

From the Options menu, select *Log Data* to bring up the following window. The user can also activate the window by pressing “Ctrl + D”.



10.1.2 Selecting the Data Channels

Once you have opened the Log Data window, you will need to select which channels to log. 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.

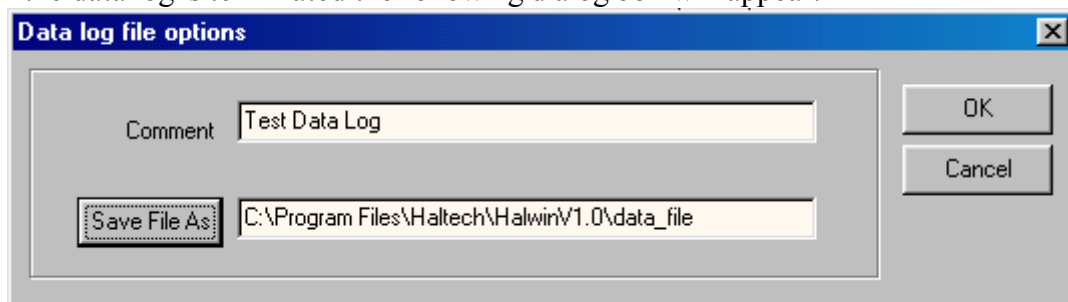
Once you have selected the items that you wish to add, press the '>>' button or press the enter key to add the channels that you have selected from the left hand side column. When you have added the items, the items will appear in the right hand side column. When the user shuts down the data-logging window, the channels that have been selected will be recalled for future use.

10.1.3 Logging the Data

Once you have selected all the channels that you wish to log, press the 'Start Data logging' button. To stop the Data log press the 'Stop Data logging' button.

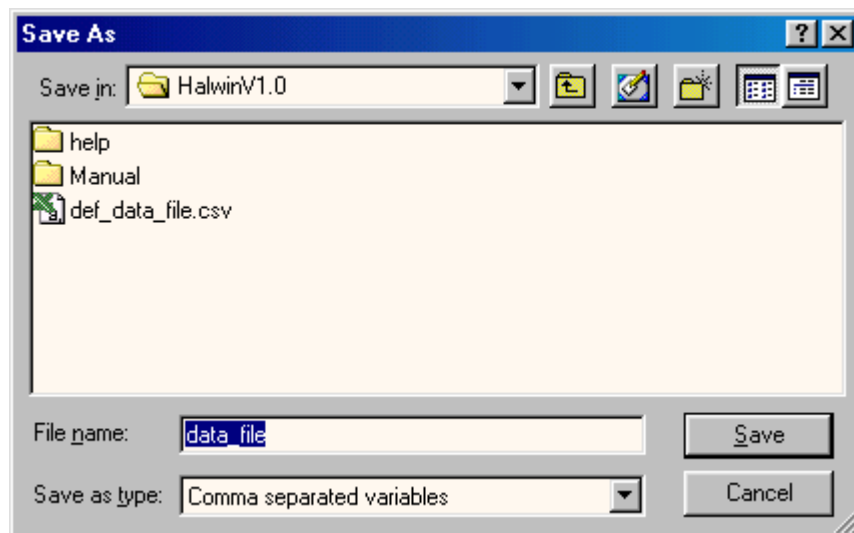
While the data is being logged, the *Logging time elapsed* will show how long the data logging has been running for. The logging time is limited by your hard disk space, but be aware that excessively large log files may be slow to view or require large amounts of resources from your PC to process.

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



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.

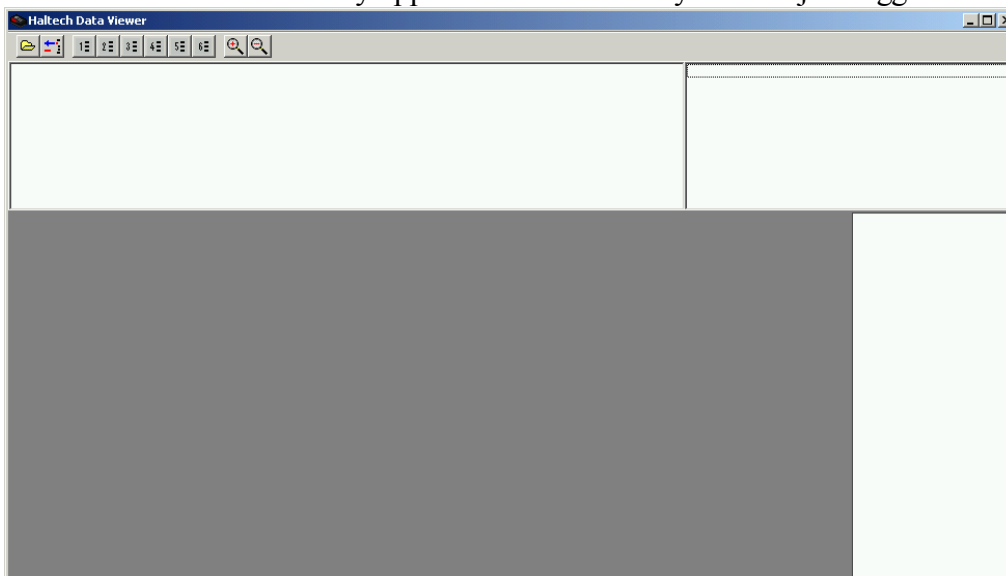
The second field that appears is for a file name that the data logger will save the information in. The default filename extension will be '.csv'. As an example, if you type "lap1" in the filename field, then a file will be saved as "lap1.csv" in the directory in which Halwin was started. If you wish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



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.

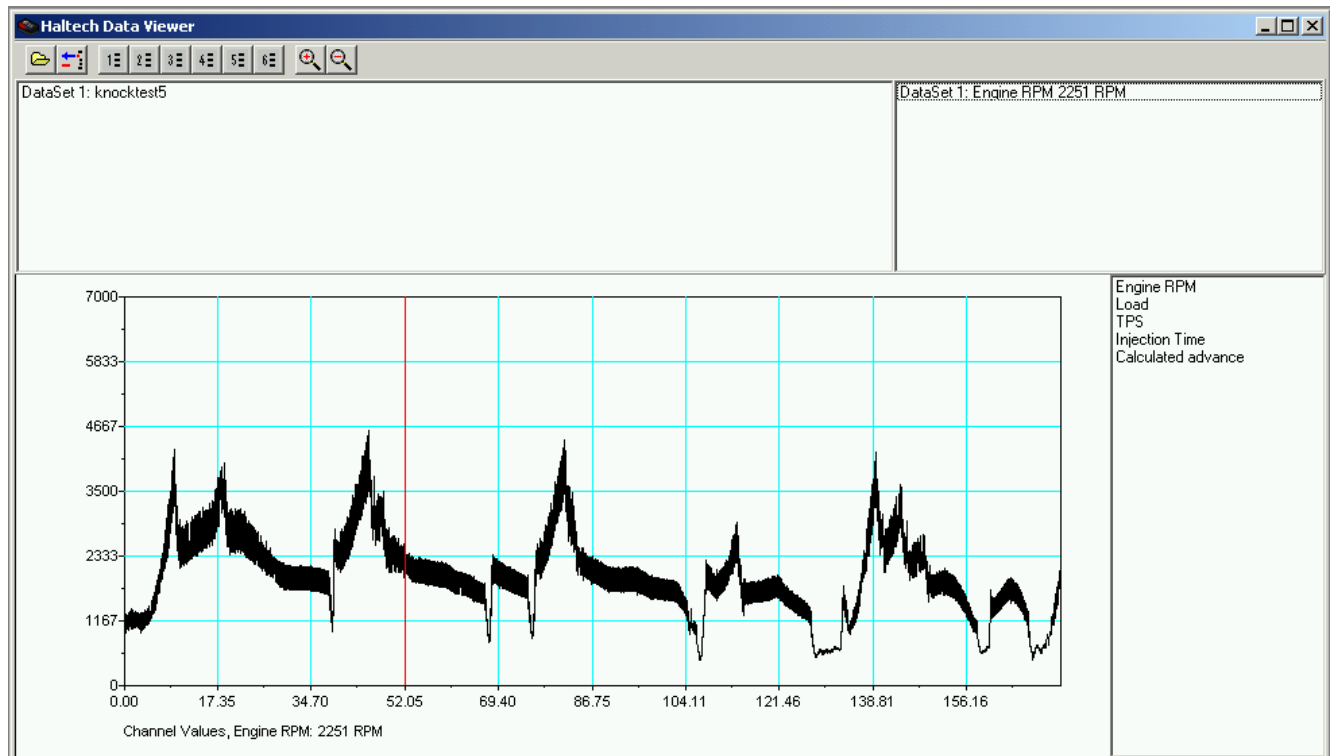
10.1.4 Displaying The Data

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.



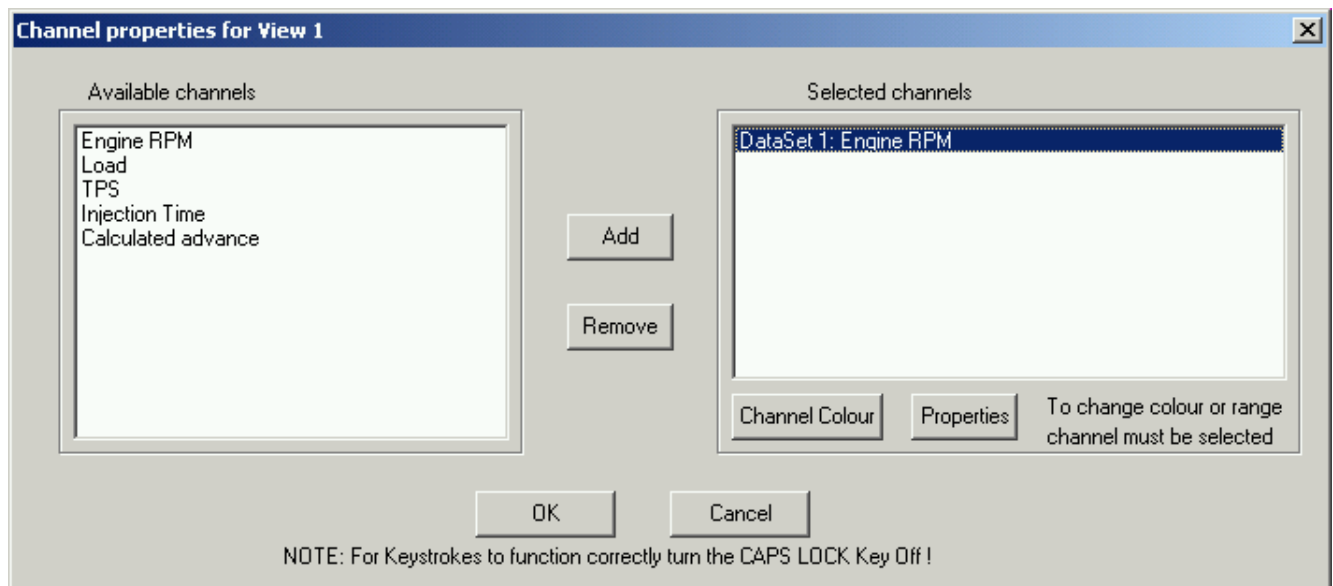
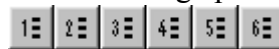
Alternatively, you can open the Haltech Data Viewer from the *Options->View Data Log* menu. To open a Dataset the user can click on *File->Open Data File* or the user can click on the folder button on the toolbar. This will open a dialog where the user can select the appropriate Dataset.

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.



10.1.4.1 Displaying Channels

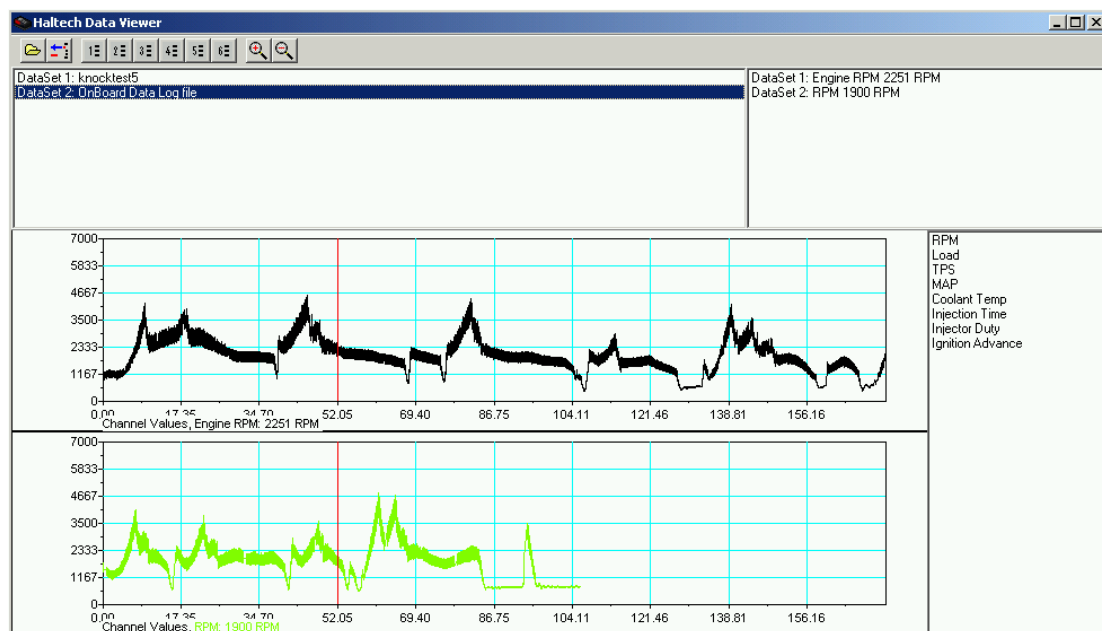
To display one of the channels that you have logged, click on one of the view buttons. Alternatively the user can press Ctrl 1 to 6 to bring up the appropriate view.



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, HalwinX 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.



10.1.4.2 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.

10.1.4.3 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.

10.1.4.4 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'.

10.1.4.5 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.

10.1.4.6 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:

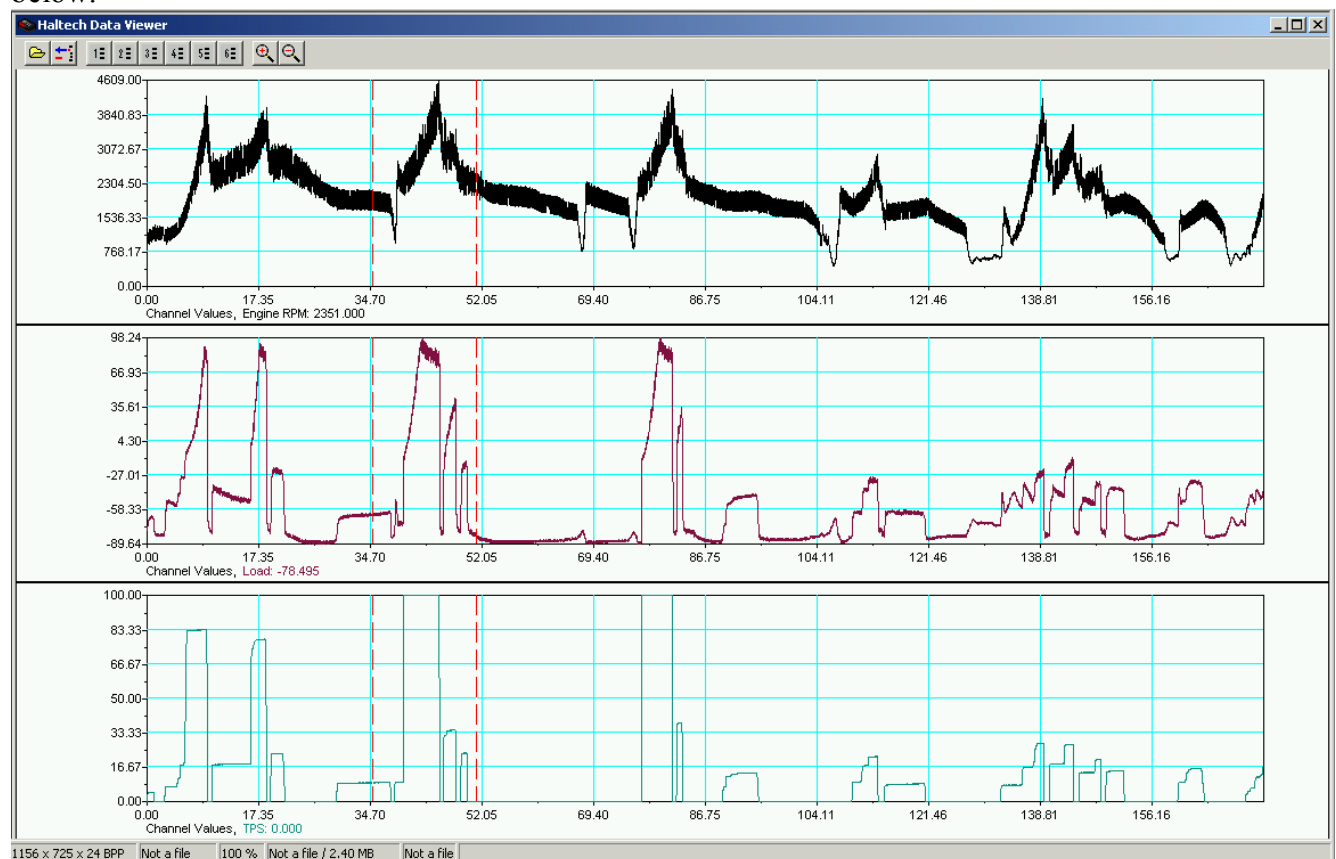
Zooming In

- ❑ 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.



10.1.4.7 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.

SECTION 4

Inputs & Outputs

The ECU has a number of optional inputs and outputs other than the available injection and ignition channels. These are:

OUTPUTS:

- Idle Speed Control
- Auxiliary Out (Aux Out)
- Digital Output (Digital Out 1-2)
- Pulse Width Modulated Output (PWM 1-4)

INPUTS:

- O₂ Closed Loop Control
- Auxiliary In (Aux In)

All the inputs and outputs have different functions:

- The Idle Speed control outputs can only be used to drive a stepper motor idle control valve.
- For the Aux Out functions refer to *4.2.4 The In/Out Set-up Page, p39*
- The Digital Outputs and PWM Outputs are functionally described in the table below.
- The O₂ Closed Loop Control uses the input signal on the O2 pin for O2 corrections only.
- For the Aux In functions refer to *4.2.4 The In/Out Set-up Page, p39*

Output Description	General Purpose Outputs
	PWM 1 – 4
Turbo Wastegate	•
Bypass Air Control (BAC)	•
Dual Intake Valve	•
Torque Converter Control	•
Thermofan	•
Intercooler Fan	•
Shift Light	•
Aux Fuel Pump	•
Stall Saver	•
Staging Signal	•
Turbo Timer	•
NOS Switch	•

For further detail on the operation of the PWM outputs and digital outputs refer to *CHAPTER 12 Digital Outputs & PWM Outputs, p85*.

CHAPTER 11

OUTPUT OPTIONS SET-UP

The output options and PWM set-up pages are used to program settings for the output functions of the ECU in a similar way as the set-up pages are programmed. Refer to 4.1 *Using the ECU Set-up Pages, p34*.

11.1 Idle Speed Control and O₂ Closed Loop Control.

11.1.1 Idle Control

The idle control dialog is accessed by selecting **Options->Idle Speed Control**. The idle control dialog has a series of fields common to the 4-wire bipolar stepper motor control and BAC idle control.

There are ten parameters to be adjusted in the idle speed control:

Enable/Disable

The Idle Speed Control can be switched on or off.

Target Idle Speed

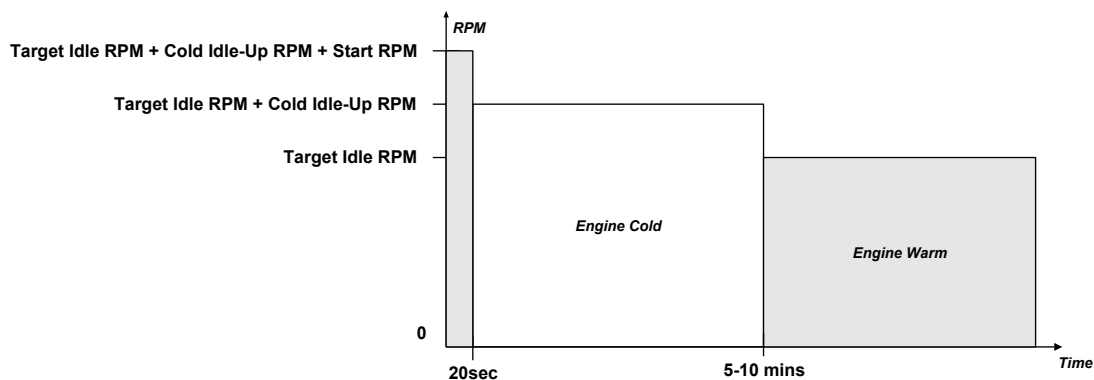
This is the engine speed that the ECU attempts to maintain at idle.

Cold Idle-Up RPM

This speed is added to the Target Speed when the engine temperature is cold.

Start RPM

For a period of around 20 seconds after the engine starts, you can specify an extra increase in idle rpm. Most factory cars will rev 200-300rpm above the cold idle-up RPM for a small time when they are first turned on. Setting the Start RPM to 0 will mean that the engine will rev to the Target Idle Speed + Cold Idle-Up RPM when turned on and resort back to the Target Idle Speed when warm. If you set the Start RPM to 200RPM, then the engine will rev to the Target Idle Speed + Cold Idle-Up RPM + 200RPM and resort back to the Target Idle Speed + Cold Idle-Up RPM after 20 seconds and then resort back to the Target Idle Speed when warm. Graphically, this can be represented as:



Number of Steps

This field controls the number of steps that the idle control will operate over. If you have a stepper motor that uses say 150 steps, you can either elect to operate the stepper motor over its entire range of steps by setting the value equal to the max number of steps the motor will do which is 150 in this case, or you can restrict the number of steps it can move through by making this field lower than 150. By restricting the number of steps you can change the time response of the Idle Control but can also affect the ability of the Idle Control to maintain control of the engine. This is because in extreme circumstances the Idle Control may wish to move the stepper motor through a large number of turns, but the Number of Steps on the stepper motor may restrict the number of turns the motor can physically be permitted to move through, thus reducing the Idle Control's ability to control the engine as it desires. It is best to start with a smaller value around 100 and increase it until the stepper motor demonstrates that it is capable of bringing the engine to the target idle RPM. If the value is too low, the stepper motor will not open enough to maintain a consistent idle, or if it is too high, the stepper motor may actually miss pulses that are sent to it and therefore it will not operate correctly.

Cold Temperature Limit

This is the temperature below which the engine is defined as being cold, and thus the Cold Idle-Up and Cold Opening Steps would apply.

Cold Min Position

When the engine is cold, you can specify the minimum position the stepper motor will return to. This is useful in some applications where valves besides the Idle Air Control Motor can switch extra air flow into the engine that would otherwise confuse the Idle Control into thinking the engine is behaving in a way which it is not. Start with a large value around 80-90% and reduce the value as you go. The idea is to move it down until the engine is idling at such a point where it is close to the target rpm. The target RPM is used to hold the idle once control of the engine has been established. Cold Min Position is used to restrict the position of the controlling valve so when the Idle Control wishes to regain control of the engine and bring it down to the target RPM it actually will be able to. If the values you are using are around 80-90%, the Idle Control will probably not be able to regain control of the engine and accurately bring it down to the target idle RPM. This is why you must start with a large value for Cold Min Position and reduce it until the engine is idling happily at the target RPM.

Hot Min Position

Exactly the same as for when the engine is cold, except the value is used for when the engine is hot, that is the temperature is above the Cold Temperature Limit.

Cold Opening position (%)

This is the opening position as a percentage of where the stepper motor will return to when it is about to attempt to gain control of the engine. When you hit the throttle the engine will accelerate and when it starts to decelerate again, there will come a point during the deceleration when the Idle Control should attempt to regain control of the engine and bring it to the target idle RPM. The value you set here will result in the stepper motor assuming a certain position, say 40% out. It will wait here until the decelerating engine comes within range and it feels it can take over control of the engine and bring it back to idle. It will then assume control of the engine with the valve open at 40%. This may be too high which will result in the engine momentarily holding at the RPM produced by the valve at 40% opening. This means that it will take a longer period of time to move the engine back down to target idle.

On the other hand, 40% may be too low and when the engine is decelerating, the Idle Control will try to regain control at a point where the valve is going to cause the engine to go very close to stalling. The secret is to start with a large value and reduce it until it takes a normal amount of time for the idle control to regain control of the decelerating engine and bring it back to target idle. A normal amount of time is a hazy description but it is somewhere in the vicinity of not too small so as to go close to stalling the engine and not too large as to take many seconds to return to target idle.

Hot Opening Position (%)

Exactly the same as for when the engine is cold, except the value is used for when the engine is hot, that is the temperature is above the Cold Temperature Limit.

11.1.2 O2 Closed Loop Fuel Control

The O2 closed loop dialog is accessed by selecting *Options -> Closed Loop O2*. The dialog has a series of fields that require configuration:

Lower RPM Limit

The engine must be running above this speed for the closed loop function to operate. Normally this would be set a few hundred rpm above or below idle, depending on whether you wish closed loop control to occur at idle speeds.

Upper Throttle Limit

It is generally undesirable to run an engine at stoichiometric air-fuel ratio when under load. This parameter is used to determine when the driver is demanding sufficient engine output to disengage the closed loop function. The smaller this number, the earlier the feedback control will drop out.

Engine Cycles Between Corrections

The oxygen sensor does not respond immediately to the exhaust gases of the combustion which has just taken place. There is a gas transportation time from the engine to the sensor, plus the sensor reaction time itself. Consequently, the ECU counts a number of engine cycles before accepting the reading from the oxygen

sensor. If the closed loop function is responding erratically, constantly overdriving to the adjustment limits, or if there is insufficient oscillation in the air-fuel ratio for the catalytic converter to operate, increasing this parameter may help. If it is set too high, the feedback loop will be noticeably slow to respond to change.

O2 Sensor Threshold Voltage

This is the sensor voltage by which the F10X determines whether the engine is lean or rich; it is the target that is sought to be maintained. This is normally set to the voltage that corresponds to an air-fuel ratio of 14.7:1, the NGK heated 4-wire sensor threshold voltage is around 600mV this value will vary for different sensors. It is also known as the sensors reference voltage.

Maximum Fuel Increase

The closed loop mode will be permitted to increase the fuel injection time no further than this limit while attempting to enrich the mixture. The valid range for this limit is 5% to 12.5%.

Maximum Fuel Decrease

Again a range of 5% to 12.5% applies to this parameter which is the limit of correction permitted to the base fuel injection time when leaning the mix.

Note: It is preferable to keep the increase and decrease limits small (say around 5-10%). Excessive swinging of the air-fuel ratio can result in surging and poor operation of the catalytic converter. The closed loop mode should never be used as means to correct bad mapping.

Engine Cycles at Idle

Exhaust gas transportation time is much higher at idle, when the engine is breathing the least. If running the closed loop at idle, a longer time must be allowed to pass before performing a feedback correction response.

O2 Sensor Threshold at Idle

It is unlikely that the engine will run at idle smoothly at the same air-fuel ratio as at cruise. Typically, a richer mix is necessary. This parameter allows a different threshold voltage to be targeted during closed loop correction at idle.

O2 Sensor Type

The type of sensor used should be selected here. Choose the sensor that best describes the sensor you are using. It is also possible to attach a 5 Volt sensor, such as a UEGO probe, to the F10X. Since these sensors are expensive, and have limited life, it is unlikely that they would be used in general running of the car for closed loop feedback control, but rather as an aid during tuning.

11.2 The PWM Options Page

The PWM options page contains the set-up information for the four PWM (pulse width modulation) outputs and the Digital output options. The PWM options page is accessed via the options menu or using: **CTRL-O** from anywhere in the programming software.

The PWM output window contents change depending on the function it is to perform. A comprehensive description of these functions can be found in *CHAPTER 12 Digital Outputs & PWM Outputs, p85*.

To change the PWM output function select the required parameter from the drop down box. When the user clicks on the Properties button the parameters pertaining to that function will be displayed. Once the desired properties have been entered the user click on the Apply or OK button, or they hit the enter key. Note this has to be done for both the PWM options and the properties.

CHAPTER 12 DIGITAL OUTPUTS & PWM OUTPUTS

The digital outputs and PWM outputs can be programmed to operate a wide variety of functions. Some of the functions have restrictions to their operation. The functions and their restrictions are described in the table below:

Output Description	PWM 1 – 4	Max #
Turbo Wastegate	•	2
Bypass Air Control (BAC)	•	1
Dual Intake Valve	•	Unrestricted
Torque Converter Control	•	1
Thermofan	•	Unrestricted
Intercooler Fan	•	Unrestricted
Shift Light	•	Unrestricted
Aux Fuel Pump	•	Unrestricted
Stall Saver	•	1
Staging Signal	•	Unrestricted
Turbo Timer	•	1
NOS Switch	•	1
BAC2	PWM 3 & 4	1
BAC2/BAC Slave	PWM 3 & 4	1
TPS Switch	•	Unrestricted

For installation information regarding any hardware associated with the described output functions refer to *CHAPTER 1 Haltech ECU Installation, p11*. Each individual function and its parameters are described below.

12.1 Turbo Waste Gate Control (TWG)

The turbo waste-gate control function controls a solenoid that bleeds air from the waste-gate diaphragm preventing the waste-gate from opening.

Period

1 – 50 ms

This sets the period of oscillation of the solenoid. Most solenoids will operate at around 30Hz, which corresponds to a period of about 30ms. Enter the desired oscillation period in milliseconds here.

Use Map

One or Two or Advanced

There are two maps associated with the TWG control function. Both set the duty cycle driving the solenoid versus engine rpm. This parameter selects which map the ECU will use to drive the bleed solenoid.

“One” and “Two” refer to the waste-gate maps one and two respectively. The “advanced” option refers to conditional use of map one and map two. The conditions for waste-gate map usage when “Advanced” is selected are:

	If the ECU is using the primary fuel and ignition maps then the ECU will use waste-gate map one to control boost. If the ECU is using the secondary fuel and ignition maps then the ECU will use waste-gate map two to control boost. Refer to 4.2.1, <i>Main Set-up Page p35</i> .
Boost Limit	<i>0 – 209kPa / 0 – 30 psi</i> If the manifold pressure exceeds this limit, the solenoid valve will immediately be set with a duty cycle value of 5%. This will expose the waste-gate diaphragm to the full manifold pressure and force the waste-gate to open. This value should be set slightly higher than the desired maximum boost pressure as a fail-safe in the event of an over-boost condition.
Update Eng. Data	<i>ENABLED or DISABLED</i> This field defines whether the duty cycle being used to drive the solenoid is displayed in the engine data page.

12.2 Bypass Air Control (BAC) Valve

The bypass air control function controls a solenoid that regulates air around the throttle to control the idle speed of the engine. This option has only one parameter:

Period	<i>1 – 50 ms</i> This sets the period of oscillation of the solenoid. BAC solenoids will operate across a range of frequencies. Enter the desired oscillation period in milliseconds here.
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The remaining parameters for idle control can be found in the output options page and are described in *11.1.1 Idle Control, p74*.

12.3 Dual Intake Valve Control (DIV)

Some late model engines possess two tuned intake manifolds. 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.

Switch On RPM	<i>0 – 16000 RPM</i> This is the engine speed at which the solenoid is to be energised.
Switch Off RPM	<i>0 – 16000 RPM</i> This is the engine speed at which the solenoid is to be de-energised.

There are two configurations in which this feature can be used:

The first configuration is to have two engine speed ranges; one high and one low. In the lower range the solenoid is disabled and in the upper range the solenoid is enabled. Using this configuration the On RPM should be set to the lower RPM limit of the upper range and the Off RPM should be set to at least 200 RPM below On RPM, forcing hysteresis in the

switching to prevent the solenoid from oscillating when the engine speed is at the switch point.

The second configuration is to enable the solenoid for a range of engine speed and to disable the solenoid when the engine speed falls outside this range. To do this the On RPM is set to the lower RPM limit of the range and the Off RPM is set at the upper RPM limit, when the RPM is lower than On RPM the solenoid is disabled, when the RPM is greater than On RPM but less than Off RPM the solenoid is enabled, when the engine speed is greater than On RPM and Off RPM then the solenoid is disabled.

12.4 Torque Converter Clutch Lockup (TCC)

This function controls the clutch lockup solenoid on automatic transmissions. The function has no control parameters and is simply enabled or disabled. This function is used in conjunction with the torque converter clutch lockup map - refer to 5.3.6 *Torque Converter Control Map, p51* - and the Aux. In function - refer to 4.2.4 *The In/Out Set-up Page, p39*.

12.5 Electric Thermo Fan Control (TF)

This function can be used to switch a thermo-fan on when the engine temperature exceeds a certain value. The fan will stay on until the engine temperature drops sufficiently.

Switch On Temp. *0 – 127 °C / 32 - 261 °F*
The temperature the engine coolant must exceed to switch the fan on.

Switch Off Temp. *0 – 127 °C / 32 - 261 °F*
The temperature below which the coolant must drop before the fan will be switched off. This parameter should be around 3-5° lower than the “Switch On temperature” to prevent the fan from switching in and out repeatedly.

12.6 Electric Intercooler Fan Control (IF)

This function can be used to switch an intercooler fan on when the intake-air temperature exceeds a certain value. The fan will stay on until the engine temperature drops sufficiently.

Switch On Temp. *0 – 127 °C / 32 - 261 °F*
The temperature the intake-air must exceed to switch the fan on.

Switch Off Temp. *0 – 127 °C / 32 - 261 °F*
The temperature below which the intake-air must drop before the fan will be switched off. This parameter should be around 3-5° lower than the “Switch On temp.” to prevent the fan from switching in and out repeatedly.

12.7 Shift Light Illumination (SL)

This function can be used to drive a light or buzzer to indicate the engine speed exceeds a programmed level.

<i>Light On RPM</i>	<i>0 – 16000 RPM</i> This parameter sets the engine speed at which the output will be enabled.
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12.8 Auxiliary Fuel Pump (AP)

This function causes the output to turn on when the measured engine load *or* engine speed exceed the programmed values. The output remains on while these conditions are met and for the programmable period of time after which the conditions are no longer valid.

<i>Load Bar</i>	<i>Bar 1 – 32</i> This is the bar number on the fuel maps which must be exceeded for the extra fuel pump to be switched on. If you wish to switch the extra fuel pump only by engine speed, set this to 0.
<i>Engine Speed</i>	<i>0 – 16000 RPM</i> The extra fuel pump will turn on when the engine speed exceeds this parameter. If you wish to switch the pump only by load, set this parameter to 0 rpm.
<i>Run Time</i>	<i>0 – 70 s</i> The auxiliary fuel pump will switch on if the engine exceeds the engine speed and/or the load bar set above. It will then stay on, even after speed and load have dropped below their respective limits, for a period of time specified by Run Time. A minimum Run Time of 5 seconds is permitted.

The Auxiliary Fuel Pump will prime with the main fuel pump, but will only run if the above conditions are met. Since there may be a short delay from the time the fuel pump is switched on to the time the extra fuel becomes available, the Load Bar and Engine Speed settings above should be set to enable the auxiliary fuel pump before the primary pump runs out of flow.

12.9 Anti-Stall Solenoid Control (AS)

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.

<i>Lower RPM Limit</i>	<i>0 – 16000 RPM</i> This parameter defines the engine speed at which the output will turn on.
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12.10 Staging Signal Function (SS)

This function causes the output to turn on when the engine load exceeds the “Staging Bar” value.

Staging Bar No This is the engine load bar at which the output produces and active level.

12.11 Turbo Timer (TT)

The turbo timer function allows the ECU to continue running the engine after the ignition has been switched off. This function allows the engine to idle until the coolant and air temperature have fallen below programmable values or a programmable period of time has elapsed. The output is turned on until the programmed conditions are met. This output is used in conjunction with the Aux In. input.

Air Temp	<i>0 – 127 °C / 32 - 261 °F</i> This parameter defines the temperature below which intake-air must fall before the output will be turned off.
Coolant Temp	<i>0 – 127 °C / 32 - 261 °F</i> This parameter defines the temperature below which coolant must fall before the output will be turned off.
Run Time	<i>0 – 5 mins</i> This parameter defines the maximum time for which the output will remain on regardless of the temperature parameters.

12.12 NOS Switch

This function controls the operation of a NOS system.

Note:

It does not control the delivery of the Nitrous Oxide, but simply turns the system on or off in certain conditions. 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 output. 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.

Load Bar	<i>Bar 1 – 32</i> If the Fuel Map Bar Number exceeds this value, the NOS system will be turned off. This is used for turbo engines where the NOS 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, so this value should be set to bar 32.
Max. Rpm	<i>100 – 16000 RPM</i> If the RPM exceeds this value the NOS system will be switched off.
Min. Rpm	<i>100 – 16000 RPM</i>

	If the RPM is below this value the NOS system will not be activated.
Minimum Throttle	0 – 100 %
	The NOS system will be turned on above this value.
Minimum Temp	0 – 127 °C / 32 - 261 °F
	The NOS system will not be activated unless the engine coolant temperature is above this value.
Ignition Retard	0 – 20 °BTDC
	This setting is not available with this unit.
Start-up Delay	0 – 120 s
	The ECU will prevent the NOS system operating regardless of the above conditions until the period of time programmed in this field has elapsed.

12.13 Air Conditioning

The Air conditioning function allows the ECU to intercept the vehicles Air Conditioning request and grant or refuse the request based on the current operating conditions.

Throttle Pos.	5 – 100 %
	This field defines the throttle position above which the Air conditioning request is disabled. This condition is independent of any other fields.
Engine Speed RPM	1000 – 15000 RPM
	This field defines the engine speed above which the Air conditioning request is disabled. This condition is independent of any other fields.
Off Time (s)	0 – 70 s
	This field defines a delay after which an Air conditioning request will be allowed once the above conditions fall below the set values.
Active AUX In.	HIGH or LOW
	This field defines the active state of the Air conditioning request line installed in your vehicle. If the line is active high this means that the signal on the line when an Air conditioning request is made is ~5 volts and when the line is idle the voltage is ~0 volts. If the line is active low this means the Air conditioning request is ~0 volts and the idle line is ~5 volts (refer to 4.2.4 The In/Out Set-up Page, p39).

12.14 Engine Control Relay

This feature causes the ECU to turn on the output when the ECU has power. This input can be used to drive a relay that supplies power to the engine bay.

This input has no parameters.

12.15 VTECH

This function controls the solenoid used to control the variable valve timing with which some engines are equipped. This feature acts purely to control a switching solenoid and is not capable of controlling continuously variable valve timing.

<i>On RPM</i>	<i>0 – 16000 RPM</i> This field defines the engine speed above which the VTEC is enabled. This field must be greater than Off RPM or it will be ignored.
<i>Off RPM</i>	<i>0 – 16000 RPM</i> This field defines the engine speed below which the VTEC is disabled. This field must be less than Off RPM or it will define both the switch on and switch off RPM forcing the ECU to ignore On RPM.
<i>On Load Bar</i>	<i>Bar 1 - 32</i> This field defines the engine speed above which the VTEC is enabled. This field must be greater than Off Load Bar or it will be ignored.
<i>Off Load Bar</i>	<i>Bar 1 - 32</i> This field defines the engine load below which the VTEC is disabled. This field must be less than Off Load Bar or it will define both the switch on and switch off Load forcing the ECU to ignore On Load Bar.

The above Load and RPM conditions that control the VTECH function are independent of one another and will switch the VTECH on if either On load or On RPM conditions are met. The function will turn VTECH off when both Off Load and Off RPM conditions are met. Off RPM should be set to at least 200 RPM below On RPM, forcing hysteresis in the switching to prevent the solenoid from oscillating. The same switching gap should be applied to Off Load Bar and on Load Bar.

12.16 BAC2

Open Loop idle control is an alternative to closed loop idle control offered in the Output Options page. This method of control is easier to tune but less accurate and may result in the idle speed drifting from the set point by ~100rpm. The control looks at a set of engine conditions and drives the BAC valve with a duty cycle programmed by the user based on these conditions. This function supports the “BAC2 Idle” trim function (refer to 4.2.4 *The In/Out Set-up Page, p39*), which overrides all the parameters below if it is engaged. The idle trim is designed as a tuning aid rather than a full time idle control solution.

The following user programmable parameters determine the period and duty cycle applied to the BAC Valve:

<i>Period (ms)</i>	<i>1 – 51 ms</i> This defines the period of the signal used to drive the BAC valve.
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<i>Cold Idle Temp.</i>	<i>0 – 127 °C / 32 - 261 °F</i> This value is the coolant temperature above which the “hot” base duty cycle value is used and below which the “cold” base duty cycle will be used.
<i>Cold Duty:</i>	<i>0 – 100 %</i> This is the base duty cycle used when the coolant temperature is below the Cold Idle Temp value.
<i>Hot Duty:</i>	<i>0 – 100 %</i> This is the base duty cycle used when the coolant temp is above the Cold Idle Temp value.
<i>A/C Load Duty:</i>	<i>0 – 100 %</i> This is a duty value added to the current duty cycle to increase the opening size to compensate for the load change associated with the A/C compressor. This is enabled when the A/C makes a request. (Aux. In must be selected as A/C request. Refer to 4.2.4 The In/Out Set-up Page, p39).
<i>Start-Up Duty:</i>	<i>0 – 100 %</i> This is a duty value added to the current base value and any other additions to make the total duty cycle. This is enabled during the first 20 seconds after the engine has started.
<i>Active (Aux In):</i>	<i>HIGH or LOW</i> This is the Active signal level received from the A/C line when it is making a request (opposite of idle position).

12.17 BAC/BAC2 Slave (Bipolar idle valves)

The BAC/BAC2 Slave offers the extra control signal required for Bipolar BAC Valve. This function is used in conjunction with the “BAC Valve” and “BAC2” PWM functions. This signal is the inverse of the primary signal produced by the BAC or BAC2 PWM channel.

<i>Slave Channel</i>	<i>PWM3 or PWM4</i> This parameter defines the channel from which the Slave is driven. If the only option is “None” then there are no PWM functions selected that support “BAC/BAC2 Slave”. The options in this list are limited to the PWM channels that are set with valid BAC/BAC2 Slave functions.
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12.18 TPS Switch

The TPS switch output switched based on the current throttle position.

<i>Switch On</i>	<i>0 – 100 %</i> This is the throttle position at which the output produces and active level.
<i>Switch Off</i>	<i>0 – 100 %</i> This is the throttle position at which the output produces and inactive level.

Active Sw. Posn.***HIGH or LOW***

This defines the active level or polarity of the signal. When this field is set to HIGH the active output is 12V, when the field is set to LOW the active output is 0V.

There are two possible configurations for this feature:

The first configuration is to have two throttle position ranges; one high and one low. In the lower range the output is inactive and in the upper range the solenoid is active. Using this configuration the “Switch On” field should be set to the throttle position limit of the upper range and the “Switch Off” should be set about 5% below “Switch On”, forcing hysteresis in the switching to prevent the output from oscillating around the switch point.

The second configuration is to set the output in the active state for a range of throttle position and to set the output inactive outside this range. To do this the “Switch On” is set to the lower throttle limit of the range and the “Switch Off” is set at the upper throttle limit, when the throttle position is lower than “Switch On” the solenoid is disabled, when the throttle position is greater than “Switch On” but less than “Switch Off” the solenoid is enabled, when the throttle position is greater than “Switch On” and “Switch Off” then the solenoid is disabled.

SECTION 5

Appendices

APPENDIX A

TROUBLESHOOTING

This Appendix is devoted to trouble shooting problems that may occur during installation and configuration of the ECU. To use this Appendix, identify the symptom or symptoms that best describe your problem from the list below, then follow the checklist for possible solutions.

Control Program Problems

- The Haltech Programming Software will not start
- The Haltech Programming Software will not operate in ONLINE mode.
- The Engine Data Page is displaying unusual sensor readings

Starting Problems

- Fuel Pump does not prime when ignition switched on.
- The engine makes no attempt to start

Idling Problems

- The engine will not idle when cold
- The engine idles too slow
- The engine idles too fast
- The engine surges at idle

Light Throttle and Cruising Problems

- Engine will not run at light throttle

Full Power Problems

- Engine dies under full throttle
- Engine surges under full throttle
- Engine lacks power at full throttle

Throttle Response Problems

- Poor throttle response
- Poor throttle response when cold

Cold running problems

- Engine runs poorly when cold

Fuel Economy problems

- Poor fuel economy - city cycle
- Poor fuel economy - Highway cycle

A.1 Control Program Problems

Haltech Programming Software will not start

The Haltech programming software should run on any computer that meets the requirements outlined in *2.1 Computer Requirements, p21*. If for any reason the programming software will not start up reinstall the software and double check the computer specifications.

Haltech programming software will not run ONLINE

If the Haltech ECU does not respond to the Programming software requesting information, then the message HALTECH DISCONNECTED will be displayed. This situation will occur under the following conditions

- ECU is not powered up
- Programming Cable is not connected
- Incorrect COM port selected
- Wrong Programming Software
- Programming Cable is damaged
- Serial port of programming computer is faulty.

If the software is the wrong version or you suspect that the cable is faulty, contact your Haltech dealer.

Engine Data Page Displays Unusual Readings

If the air temperature sensor, or coolant temperature sensor is showing a continuous maximum or minimum then the sensors are either not operating correctly or are disconnected. Using the wiring diagram of the ECU Loom (wiring diagram can be found at the back of this manual) check that the sensor wires are not damaged. Check for continuity or high resistance with a multimeter. If the wiring is OK then contact your Haltech dealer regarding replacement of faulty sensor.

If the Throttle Position Sensor is unresponsive or is erratic then re-calibrate the throttle sensor and check the wiring. Erratic readings can be caused by damaged sensor or electrical noise.

If the Manifold Absolute Pressure Sensor does not read near atmospheric pressure with the engine off, or if it shows a fault condition, then check that the sensor is connected correctly. Check that you have the correct model sensor and that the Identification page information has been set correctly.

If the Engine Speed reading is erratic, the trigger (crank or cam signal) is most likely picking up ignition noise from incorrect plugs or leads, electrical noise from cooling fans, starter motor, alternator or other electrical devices in the vehicle. Ensure that the trigger signal wire is properly shielded and that the shield is not grounded at the sensor end.

If the Engine Speed is steady but wrong, check that the Identification page contains the correct information regarding number of cylinders, crank sensor set-up and crank sensor wiring is correct.

If engine parameters are all showing unusual variation, make sure that the ECU is grounded properly. Also check the engine and chassis grounds to the battery.

A.3 Starting problems

Fuel Pump doesn't prime when ignition switched on

The Haltech F10X will attempt to run the Fuel pump for about 2 seconds just after the ignition is switched on. The fuel pump relay should be heard clicking in and out with the fuel pump. If the relay clicks but the fuel pump doesn't work then check the wiring of the fuel pump and the 20A fuse in the fuse block.

If relay does not click ensure power is getting to pin 7 and 25 on the main wiring plug when the ignition is in the on position.

Engine makes no attempt to start

Check the following:

ECU is operating (will communicate ONLINE) during cranking

Battery voltage and connections

Fuel Pump runs

Injector fuse is OK and injectors fire

Ignition system is operating properly and spark is available

Ignition timing is correct

If the engine is flooding, reduce the bars in the fuel map that are being used during cranking in the fuel map, the coolant correction map and the cold prime map.

If the engine is not receiving enough fuel and increasing those bars does not help, check that fuel pressure is available and that the injectors operate properly (are cleaned and flow-tested).

A.4 Idling Problems

If the engine will not idle when cold but will when the engine is warm then the coolant correction map may need to be adjusted.

If the engine idles too fast or too slow, and you are using an Idle Air Control Motor, firstly check that the Idle Speed Control is enabled, and then lower the target idle setting if necessary. If not using the idle air control motor then adjust the idle using the idle adjust screw on the throttle body. Check for any air leaks in the manifold.

Check the ignition timing at idle and adjust if necessary.

If the engine surges or hunts at idle then the mixtures and timing are wrong. Adjust the fuel maps near idle conditions.

In some circumstances it may be necessary to use the Zero Throttle Map. Consult Chapter 6 [6.2] for information on using the Zero Throttle Map.

A.5 Light throttle and Cruising Problems

If the engine falters under light load then the mixtures may be incorrect – most likely too lean, check the Fuel Maps.

A.6 Full Power Problems

If the engine gasps under full throttle then the mixture may be too lean. If the engine bogs down and blows smoke then the mixture is rich. Recheck the fuel maps.

If the maps appear to be correct then ensure that the fuel pressure is not falling out of regulation by using a fuel pressure gauge. Flow test and clean the fuel injectors.

In some circumstances it may be necessary to use the Full Throttle Map. Consult Chapter 6 [6.3] for information on using the Full Throttle Map.

A.7 Throttle Response Problems

Throttle response of the F10X is set using the three pairs of throttle pump settings. If the engine gasps and flat spots (misfires) when the throttle is suddenly opened then the throttle setting is not high enough or is much too high. If the engine bogs down but continues to run then the mixture is too rich. Experiment with the throttle pump settings to achieve the optimum.

The throttle pump coolant factor affects the throttle pump only when coolant correction is being applied, i.e. before the engine has reached operating temperature. Set the throttle pump increase and sustain figures only when the engine is warm. Wait until the engine is cold again, and the coolant correction map has been set for good stable running, before changing the coolant factor.

A.8 Cold Running Problems

If the engine idles poorly when cold then the coolant map may need adjusting. If the engine is hunting slightly when cold, then the coolant correction map is just too lean, and so needs a small amount of enrichment. Slight advance with the coolant temp. can help. If the engine is difficult to drive when cold, particularly with gear changes, try increasing the coolant correction factor for the throttle pump.

An engine that will idle when warm, but fails to idle cold unless a tiny amount of throttle is applied may require idle speed control, with a fast-idle function for when the engine is cold. The F10X can control an Idle Air Control motor that will perform this function.

A.9 Fuel Consumption

Poor fuel consumption is a result of a too rich mixture. If the fuel consumption in traffic is poor but the highway consumption is good, then it could be the areas of the map used for accelerating that need to be leaned out. The throttle pump may also waste fuel if its values are too high. Also try using the fuel cut off on deceleration feature.

If the city consumption is fair but highway cruising uses too much fuel then lean out the light load bars on the 2000 rpm to 3000 rpm maps (This is where most cruising takes place).

If the cold start map is supplying too much fuel on warm-up this will also affect the fuel consumption of the vehicle.

APPENDIX B**INJECTION OUTPUTS****B.1 Distribution of Outputs**

The ECU has four injection outputs:

INJ1
INJ2
INJ3
INJ4

These outputs can be fired differently, depending on the Injection mode, which can be found in the Fuel Setup page.

**Injection
Mode**

Fuel Setup

Deceleration Cut Parameters

Enable/Disable
☐ Enable ☒ Disable Decel Cut RPM

Injection Parameters

Injection Mode
☒ Multipoint ☐ Batch ☐ Staging ☐ Sequential

☒ Enable Injectors

Post Start Temperature Limit (deg C)

☐ Temp Limit is below

Post Start Time

Ignition Divide By

Staging Bar Number (1- 32)

☐ Enable Over Boost Fuel Cut

Over Boost Press Limit (kPa)

Over Boost Restore (kPa)

Throttle Maps

☐ Enable Zero throttle map Full Throttle Threshold (%)

☐ Enable Full throttle Map Throttle Pump dead band (%)

Barometric Lock

☒ Enabled Barometric Pressure Lock (mbar)

OK Apply Cancel

B1.1 Multipoint Injection

Multipoint mode injection fires all of the injectors simultaneously. Below is how they should be wired for typical applications.

4 Cylinder Engine

INJ1 = Cylinder 1 Injector
INJ2 = Cylinder 2 Injector
INJ3 = Cylinder 3 Injector
INJ4 = Cylinder 4 Injector

6 Cylinder Engine

INJ1 = Cylinder 1 & Cylinder 2 Injectors
INJ2 = Cylinder 3 & Cylinder 4 Injectors
INJ3 = Cylinder 5 & Cylinder 6 Injectors

8 Cylinder Engine

INJ1 = Cylinder 1 & Cylinder 2 Injectors
INJ2 = Cylinder 3 & Cylinder 4 Injectors
INJ3 = Cylinder 5 & Cylinder 6 Injectors
INJ4 = Cylinder 7 & Cylinder 8 Injectors

B1.2 Batch Injection

Batch mode injection fires the injectors in two even groups. This is aimed at reducing fuel pressure rail fluctuations. The F10 will fire INJ1 & INJ2 as one group and INJ3 & INJ4 as the second group. Below is how they should be wired for typical applications.

4 Cylinder Engine

INJ1 = 1st cylinder in firing order
INJ2 = 2nd cylinder in firing order
INJ3 = 3rd cylinder in firing order
INJ4 = 4th cylinder in firing order

6 Cylinder Engine

INJ1 = 1st, 3rd and 5th cylinder in firing order
INJ2 = 1st, 3rd and 5th cylinder in firing order
INJ3 = 2nd, 4th and 6th cylinder in firing order
INJ4 = 2nd, 4th and 6th cylinder in firing order

8 Cylinder Engine

INJ1 = 1st and 5th cylinder in firing order
INJ2 = 2nd and 6th cylinder in firing order
INJ3 = 3rd and 7th cylinder in firing order
INJ4 = 4th and 8th cylinder in firing order

B1.3 Staged Injection

Staged injection mode allows the use of two individual injector banks, one for light to medium loads (Primary), then as fuel requirements increase a second bank are switched on (Secondary) Staged injection and is usually only used on high boost or turbo charged engines. Below is how they should be wired for typical applications. Please refer to *section Appendix D3, Staged Injection p100*

4 Cylinder Engine

INJ1 = Cylinder 1 & Cylinder 2 Primary Injectors
INJ2 = Cylinder 3 & Cylinder 4 Primary Injectors
INJ3 = Cylinder 1 & Cylinder 2 Secondary Injectors
INJ4 = Cylinder 3 & Cylinder 4 Secondary Injectors

6 Cylinder Engine

INJ1 = Cylinder 1, Cylinder 3 & Cylinder 5 Primary Injectors
INJ2 = Cylinder 2, Cylinder 4 & Cylinder 6 Primary Injectors
INJ3 = Cylinder 1, Cylinder 3 & Cylinder 5 Secondary Injectors
INJ4 = Cylinder 2, Cylinder 4 & Cylinder 6 Secondary Injectors

8 Cylinder Engine

Please contact Haltech with regards to this setup.

B.2 Rotary Engines

The ECU is capable of providing fuel to twin-rotor Wankel engines. Please make sure that the Injection mode is set to staged Injection. For further information on Staged injection, please see *Appendix D.3 Staged Injection ,p100*

2 Rotor Engine

INJ1 = Rotor 1 Primary Injector
INJ2 = Rotor 2 Primary Injector
INJ3 = Rotor 1 Secondary Injector
INJ4 = Rotor 2 Secondary Injector

APPENDIX C

INJECTORS

C.1 Injector Impedance

Injectors, when classified electrically, fall into 2 categories:

Saturation Injectors this type of injector derives its name from the method used to drive it open, the coil is saturated with current to create the magnetic force used to open the injector until the injector is to be closed. This type of injector has a coil impedance $> 12\Omega$, this means that if 12V is applied across the coil the current will not exceed 1A. Commonly known as high impedance injectors.

Peak and Hold this type of injector also derives its name from the method used to drive the injector open. The coil is saturated with current until the ECU detects the current has reached a “Peak” value (4A), at this point the ECU limits the current to a “Hold” value (1A). The Peak and Hold currents can vary from injector to injector, the ECU supports 4A Peak - 1A Hold and 8A Peak – 2A Hold per driver. This type of injector has a coil impedance $< 3\Omega$, commonly known as low impedance injectors.

C.2 The Injector Drivers

The ECU uses switched injector drivers that can control the current passing through an injector by switching the low side of the injector between 12V and ground while the injector is open. When it is required that the injector be turned off, the low side of the injector is left floating which will prevent any current from flowing in the coil.

The ECU has 4 separate drivers that are capable of driving injectors at 2 current levels, either 4A peak - 1A hold or 8A peak - 2A hold. Each driver can be programmed to drive at either current level by the programming software. The 8A peak – 2A hold is generally used to drive 2 injectors in parallel that each require 4A peak – 1A hold drive (low impedance), this method of connection would be used with an 8-cylinder engine which used 4A peak – 1A hold injectors.

WARNING: UNDER NO CIRCUMSTANCES SHOULD YOU MIX SATURATION AND PEAK-AND-HOLD INJECTORS ON THE ONE DRIVER. THIS WILL LEAD TO ERRATIC INJECTOR OPERATION.

Should you need to drive more than 8 low impedance injectors or more than 16 high impedance injectors contact your Haltech dealer.

APPENDIX D**FUEL SYSTEMS & STAGING**

The best ECU installation will yield poor results if the fuel system does not meet the demands of the engine. Insufficient fuel flow can lead to lean fuel mixtures and detonation that will ultimately cause serious damage to the engine. 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.

D.1 Duty Cycles

Fuel delivery is obtained by pulsing the injectors synchronised with the engine speed, allowing fuel to flow during the period that the injector is open. The time period the injectors are open is called the injector pulse width. As engine speed increases it is possible for pulse widths to overlap so that the injectors are effectively switched completely on. This is referred to as 100% duty cycle.

When 100% duty cycle is reached the fuel flow from the injectors has reached its maximum. Increasing revs brings with it the danger of an engine lean out.

WARNING:
LEANING OUT AN ENGINE WILL CAUSE DAMAGE TO THE
ENGINE IN MOST CASES.

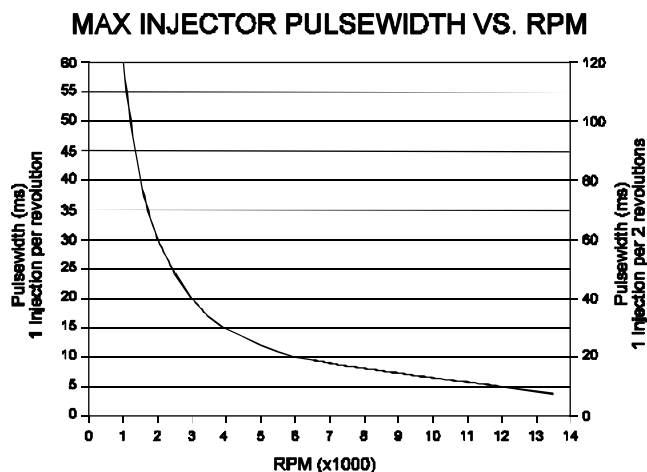
The tables and graph below show the point at which the injectors will reach 100% duty cycle. It is not common for this to happen but the potential for damage under these circumstances is strong so care should be taken to check this factor.

Maximum Injection Time (in milliseconds[ms]) =

$$\frac{(120,000 \times \text{IgnDivideBy})}{(\text{Rpm} \times \text{No. Cylinders})}$$

eg. Maximum injection time for a four cylinder, on ign/by 2 red-lining at 6000 RPM is
 $(120,000 \times 2) / (6000 \times 4) = 10,$

so the absolute maximum injection time at 6000 RPM on this engine is 10 ms. If the injection time needs to be greater than this, then your fuel system cannot meet the demands of the engine. You will need to increase the fuel supply, by increasing injector size, fuel pressure, or adding extra injectors. Refer to Appendix D for details on how to increase fuel supply. As a general rule of thumb, injectors should not run beyond 85% duty cycle.



Injector Duty Cycle appears on the Engine Data Page and on Data logs for you to monitor the approach to maximum fuel flow.

**MAXIMUM INJECTOR PULSE WIDTH
VERSUS ENGINE SPEED**

SPEED (rpm)	1 Inj / Rev (ms)	1 Inj / 2 Rev (ms)
1000	60.00	120.00
1500	40.00	80.00
2000	30.00	60.00
2500	24.00	48.00
3000	20.00	40.00
3500	17.14	34.29
4000	15.00	30.00
4500	13.33	26.67
5000	12.00	24.00
5500	10.91	21.82
6000	10.00	20.00
6500	9.23	18.46
7000	8.57	17.14
7500	8.00	16.00
8000	7.50	15.00
8500	7.06	14.12
9000	6.67	13.33
9500	6.32	12.63
10000	6.00	12.00
10500	5.71	11.43
11000	5.45	10.91
11500	5.22	10.43
12000	5.00	10.00
12500	4.80	9.60
13000	4.62	9.23

D.2 Fuel Requirement

If you can estimate the power output of a gasoline engine, you can make a reasonable guess at the fuel flow requirement. The following is a guide to the quantity of fuel required:

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.

D.3 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, 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.

D.4 Injector Staging

Another way of increasing injector flow, without compromising good drivability and fuel economy is to employ staged injection. Injector staging allows the use of primary and secondary injectors and is usually only used on high boost turbo or supercharged engines. The ECU will fire only the primary set of injectors until a preset load point, where the ECU will control both primary and secondary injectors.

The turn on point for the secondary injectors depends on injector size and engine performance, but will usually occur just after the pressure in the intake manifold of the engine has reached atmospheric pressure. The staging point must occur before the primary injectors have reached 100% duty cycle. Go to the highest speed range in the fuel map that the engine is using, and make sure that the last bar for primary injection is not too high. If it is, you must stage at a lower pressure.

Adjust the bars around the staging point with extreme care to ensure that the engine does not lean out as the secondary injectors come in. When the Haltech ECU begins to stage it begins firing both sets of injectors at once and fires them with the same duration. This means that if both primary and secondary injectors are of the same flow rate then the first staged bar should theoretically be slightly more than half that of the last un-staged bar. Allow a safety margin by using 60% of the last bar.

Staging is enabled on the Fuel Set-up by selecting the "Staged" Injection Mode. The Staging Bar is also defined on the Set-up (Refer to *4.2.2 Fuel Set-up Page, p36*).

Once staging is enabled, the bars on the Fuel Maps will change appearance. The bars that indicate both sets of injectors firing are a different colour to those corresponding to primary injectors firing alone.

When staging injectors, drivers 1 and 2 (Inj 1 & Inj 2) are primary and drivers 3 and 4 (Inj 3 & Inj 4) are secondary. Since the number of primary drivers is halved, and since you may wish to employ higher power secondary injectors, ensure that you have sufficient driver power to run the injectors properly.

D.5 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.

D.6 Fuel Rails 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.

APPENDIX E

TRIGGER INTERFACE

The ECU is capable of accepting two different trigger types. This appendix will explain the trigger systems the ECU supports.

The following fields configure the trigger input:

Trigger Type
Trigger Edge
Trigger Pull-up

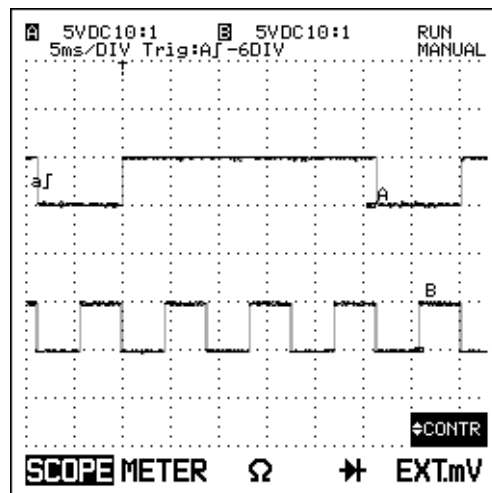
The trigger interface will be described below in terms of the above fields to simplify configuration of the ECU trigger interface.

E.1 The Trigger Type

The 3 types of trigger signals used to trigger the ECU are: Coil Negative/Tacho Output, Optical and Hall Effect. Optical and Hall Effect trigger sensors are electrically identical when used with the ECU and from here on any reference to Hall Effect triggers refers to optical triggers also. The Coil Negative and Tacho Output triggers produce a different signal to that of Hall Effect sensors and therefore require a different input and different ECU settings.

E.1.1 Hall Effect and Optical Triggers

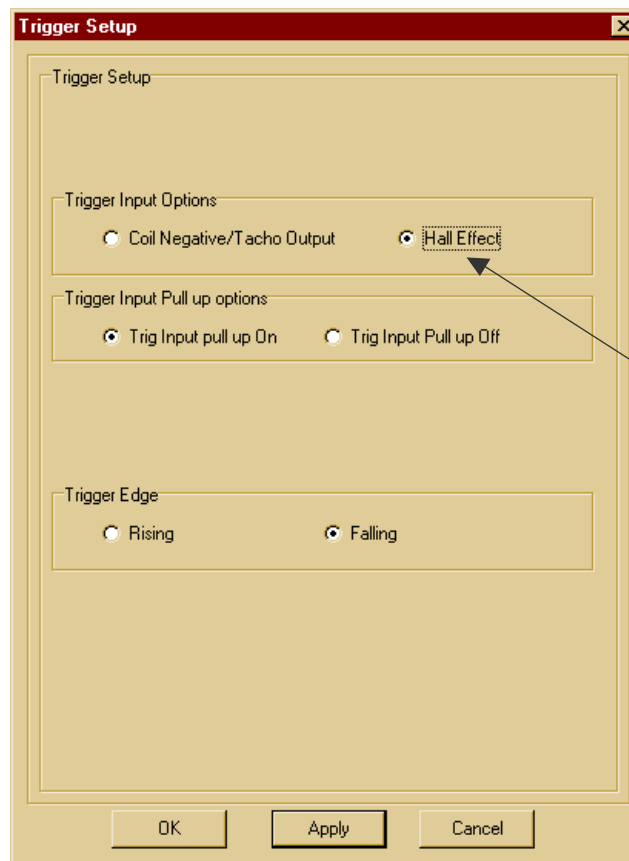
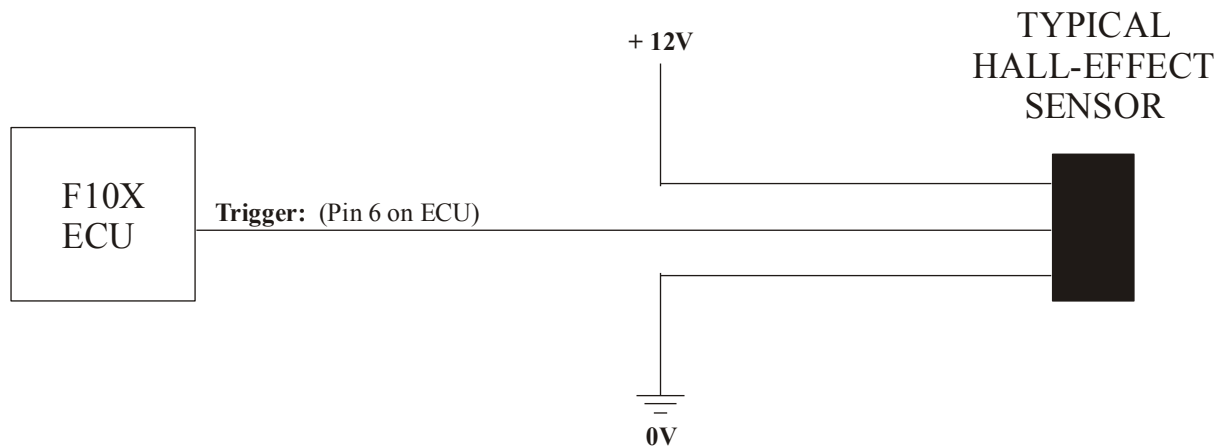
Hall effect and optical triggers produce a square wave signal when connected to the ECU and can be treated the same electrically. The ECU specification allows the use of a Hall effect device that outputs a low of 0V and high of between 5V and 12V, the switching threshold is set to 2.5V. Hall effect sensors normally have 3 connections: power, signal and ground, this is by no means the only classification that should be used for sensor identification, if in doubt contact your Haltech dealer. Please note that the Haltech S3 & S4 Hall Effect sensors have 4 connections, one of which is a synchronisation signal, which is not required by the F10X. Below is a trace of the signal of a “Standard Trigger” for a 4-cylinder distributor.



E.1.2 Hall Effect Sensors

The F10X can be triggered using the output from various Hall Effect sensors. Some OEM engines as well as aftermarket triggering devices produce the square wave signal the F10X requires.

Normally a Hall Effect sensor will require at least 3 connections, power, signal and ground. The power and ground can be sourced from the F10X harness, and the Hall Effect sensor output signal wire should be connected to the Trigger wire of the F10X (Pin 6 on ECU) or (Pin B on J:16 Trigger Input for the Terminated Harness). Please note that most Hall Effect sensors will require the Trigger Pull-up to be switched on in the Trigger Set-up menu.



Hall Effect
Setting

E.1.3 Haltech Hall Effect Sensors

The Haltech Hall Effect sensor is a two-channel device that can be used to trigger the Haltech range of ECU's in a wide range of applications. As the Haltech Hall Effect sensor is dual channel, it can provide this synchronisation pulse as well as the trigger signal. The synchronisation pulse is not required when using the F10X. Due to this fact, no further reference will be made to the synchronisation pulse.

The principle behind its operation is quite simple. As a magnet passes the sensor, the output state of the sensor, changes from high to low. The position of the magnets determines the output signals from the sensor.

The S3 Hall Effect Sensor

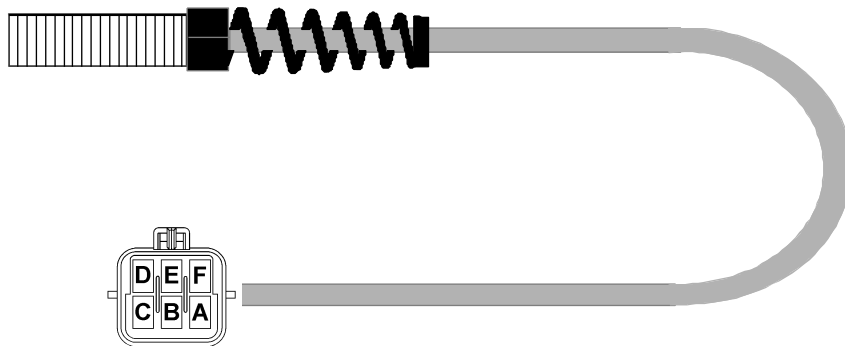
The **S3** sensor which is identified by a **black** cable gland, operates in the following way:

As a North pole or South pole passes the sensor face the signal in the primary channel (PIN B) is switched from a high to a low state.

Note: Due to the way the F10X is triggered, the Rare Earth Magnets can be placed in the trigger wheel with either North or South pole facing the sensor.

Note: magnets should always be mounted in a non-ferrous material such as aluminium, stainless steel or titanium.

Many installers have successfully mounted the rare earth magnets in non-ferrous surrounds such as modified aluminium and stainless steel bolts, and installed the bolts into ferrous material.



SENSOR PIN OUTS

A	BLUE	GROUND
B	YELLOW	TRIGGER
C	N/C	
D	N/C	
E	GREEN	NOT USED ON F10X
F	RED	+ 12 VOLTS

E.1.4 Using the Sensor on the crank

After a suitable mounting location for the sensor has been found the engine should be positioned at approximately 75° BTDC on cylinder no.1 compression. The magnet should now be placed in the aluminium disk, making sure the magnet is in line with the sensor when the engine is in this position. This is now the reference point for all the other magnets. The number of cylinders will determine the number of magnets required and the angle of installation. If the sensor is to be used on the Camshaft, the number of magnets will need to be doubled. The adjustment of the air gap will be determined by the strength of the magnets used. This should be tested once the wheel assembly has been installed. Typical air gap is (2 – 8mm) Checking the Engine Data page for steady RPM is usually a good indication that the air gap is acceptable.

E.1.5 Typical set-ups – S3

4 cylinder / 2 rotor Engine

For a four cylinder 2 magnets are required in total, positioned exactly 180° apart.

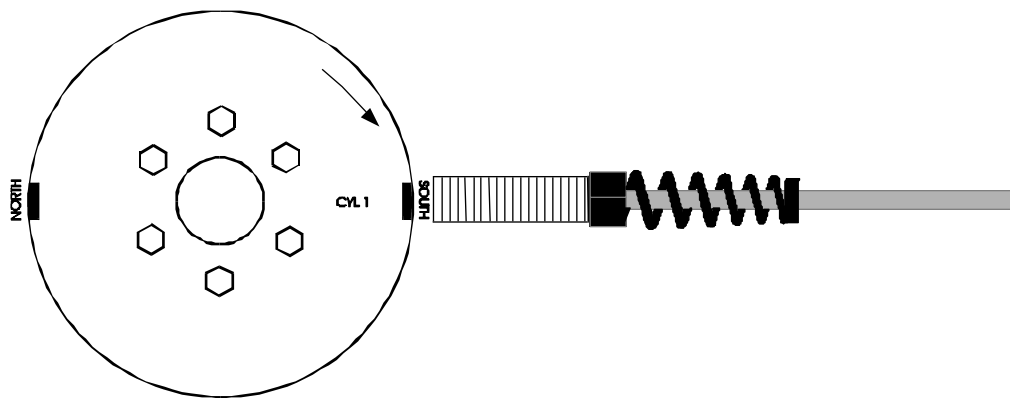


Figure 1: Typical 4 cylinder/ 2 rotor application

6 Cylinder / 3 Rotor Engine

For a six cylinder 3 magnets are required in total, positioned exactly 120° apart.

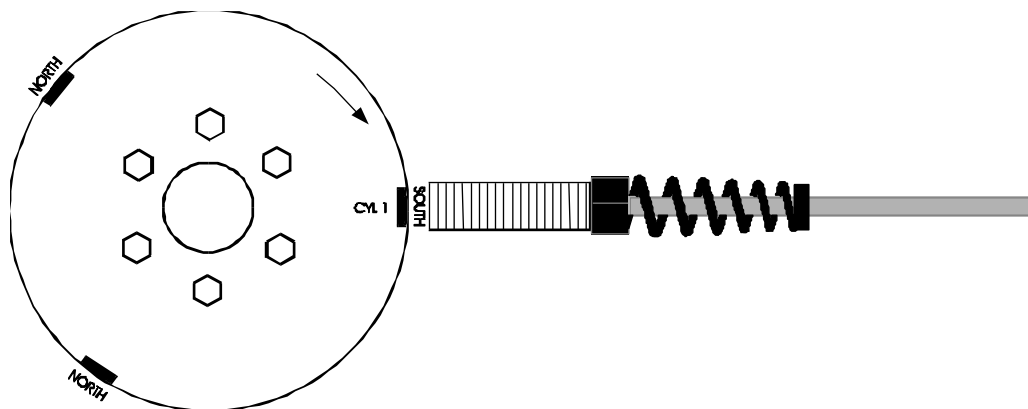


Figure 2: Typical 6 cylinder/ 3 rotor application

8 Cylinder Engine

For an eight cylinder 4 magnets are required in total, positioned exactly 90° apart.

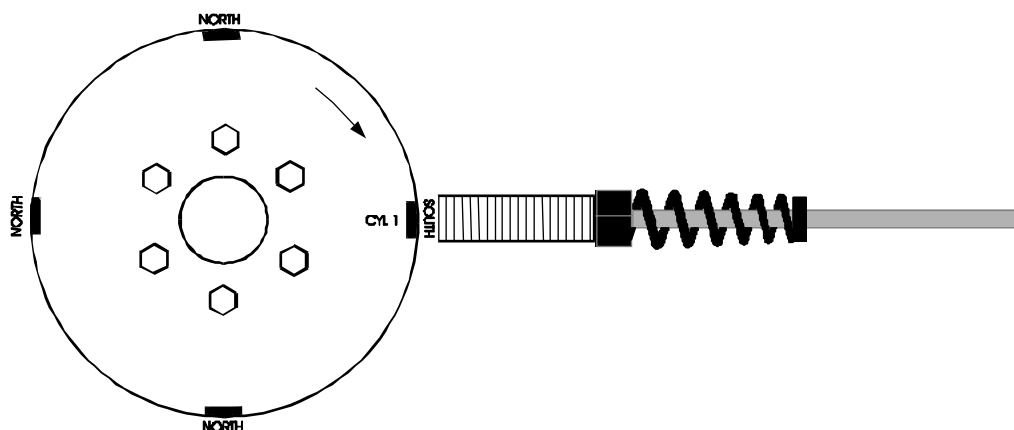
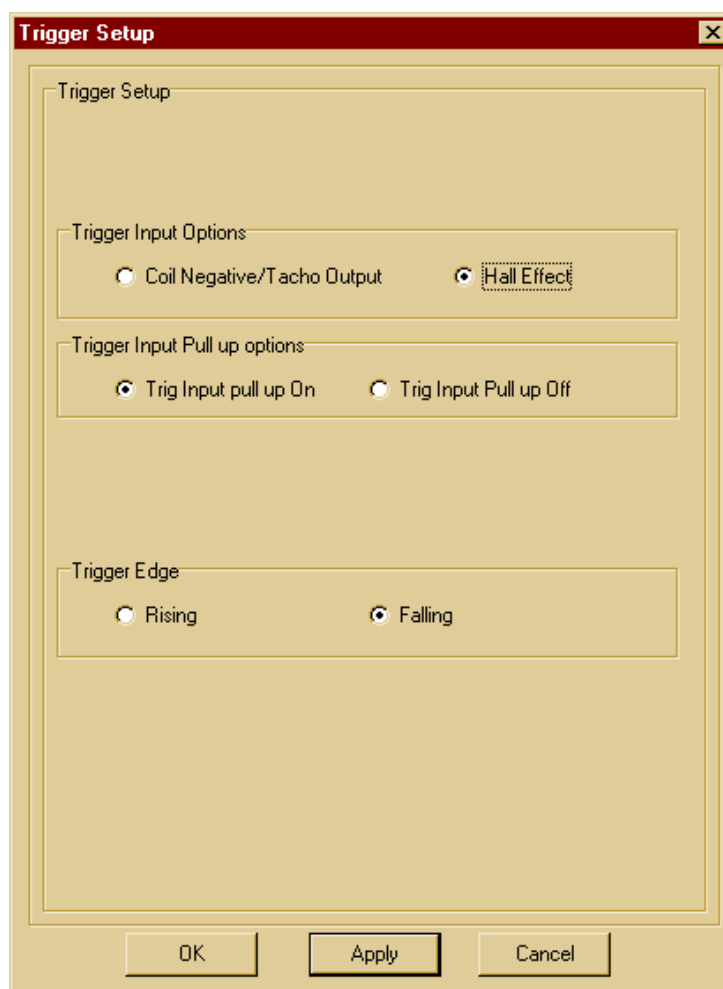


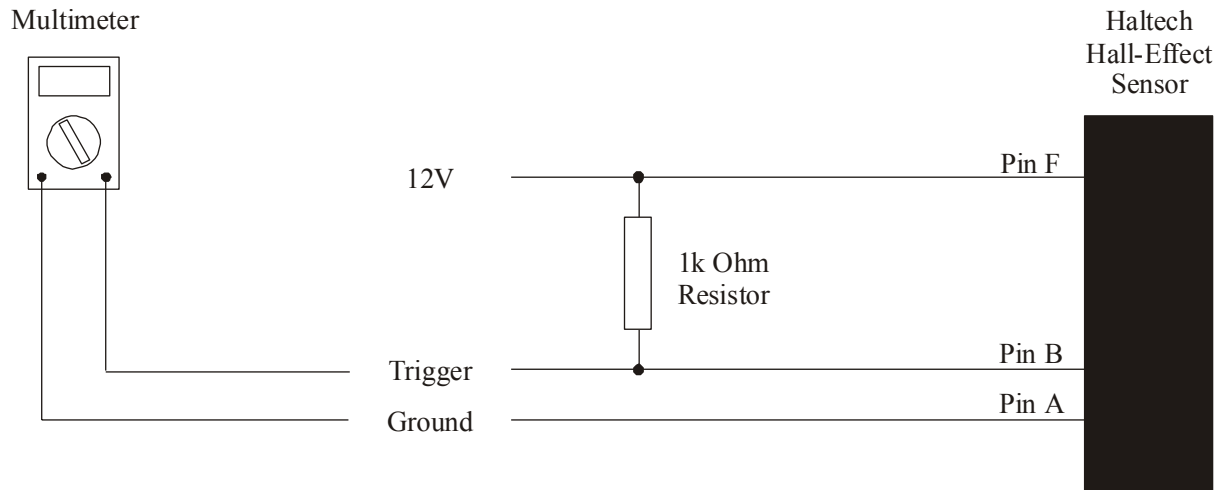
Figure 3: Typical 8 cylinder application

Below is how to configure the Trigger Setup page for S3 Hall Effect triggering



E.1.6 Checking the Sensor

If you need to check that the Haltech Hall Effect sensor is operating correctly, then this can be done easily with the use of a multimeter, a magnet and a 1000 Ohm resistor. By powering up the sensor, using 12 volts (PIN F) and ground (PIN A), and connecting the 1K Ohm resistor between 12 volts (PIN F) and the Trigger channel (PIN B), we can be checked to confirm correct operation.



Connecting the multimeter between PIN B and ground, 12 volts should be present. When magnet is placed in front of the sensor this value should go to 0 volts.

Fitting the magnets

We insist that only Haltech rare earth magnets (part number REM1) be used for the purpose of triggering the sensor. Rare earth magnets purchased from your local electronics store may be less expensive but they are not good enough! Haltech rare earth magnets are strong with good stability to withstand reasonably high temperatures and give a long service life. Some rare earth magnets are stronger but break down under excessive temperature, or are too brittle for the purpose, or do not have a long service life. Ordinary magnets ie not rare earth types, may not have the strength required for satisfactory triggering at high speeds. Haltech REM1 rare earth magnets are normally 5mm dia x 2mm depth.

The magnets should be fitted in non-ferrous surrounds such as aluminium, stainless steel or titanium. The trigger wheel is normally made of the chosen material but various users have reported good results when the magnets are set in a suitable non-ferrous surround and the surround is set into a ferrous material.

The magnets should be set flush with or slightly back from the surface of the trigger wheel or surround. If set too far back the magnetic signal may be too weak. The magnets should be set in place with a strong and durable fixing compound such as high strength epoxy, Loctite stud locking compound eg 603, or JBweld. Some users rely only on the fixing compound but to ensure that the magnets remain in place but many prefer that they be retained by mechanical means such as peening, and this gives an added safety factor.

WARNING:
RARE EARTH MAGNETS ARE EASILY DAMAGED AND THE PEENING PROCESS (OR LOCATION BY GRUB SCREWS ETC) SHOULD BE VERY CAREFULLY CARRIED OUT SO AS NOT TO DAMAGE THE MAGNETS. IF DAMAGED THEY WILL NOT HAVE SUFFICIENT MAGNETIC STRENGTH OR MAY FAIL MAGNETICALLY OR PHYSICALLY AFTER A PERIOD OF TIME.

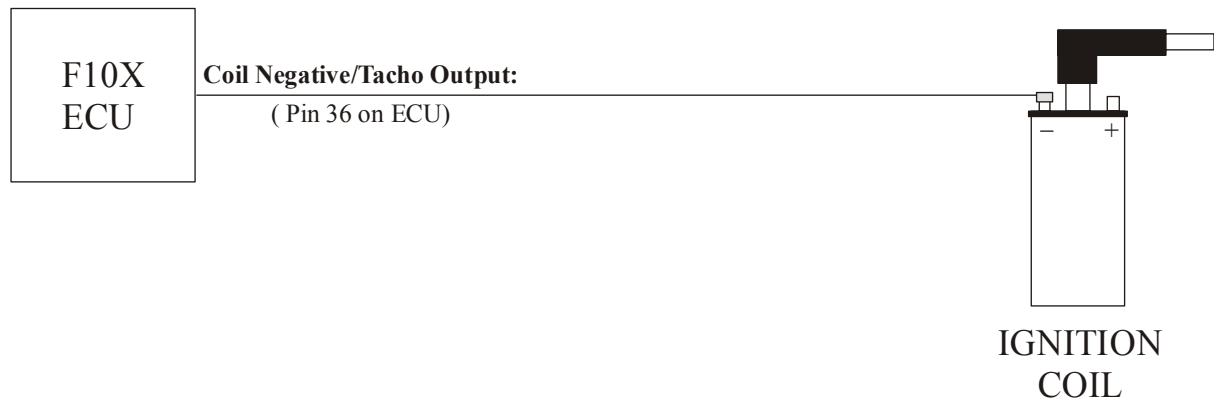
If installed correctly the magnets will have a long life.

Note: In the previous examples, for ease of reference, the magnets are shown mounted on the circumference of a wheel with the Haltech Hall effect sensor oriented to one side. If so mounted the magnets need to be mounted with sufficient strength to resist centrifugal force. In practice the magnets are often mounted within the circumference of the wheel and the sensor is mounted so that its base is pointed towards the magnets in the face of the wheel.

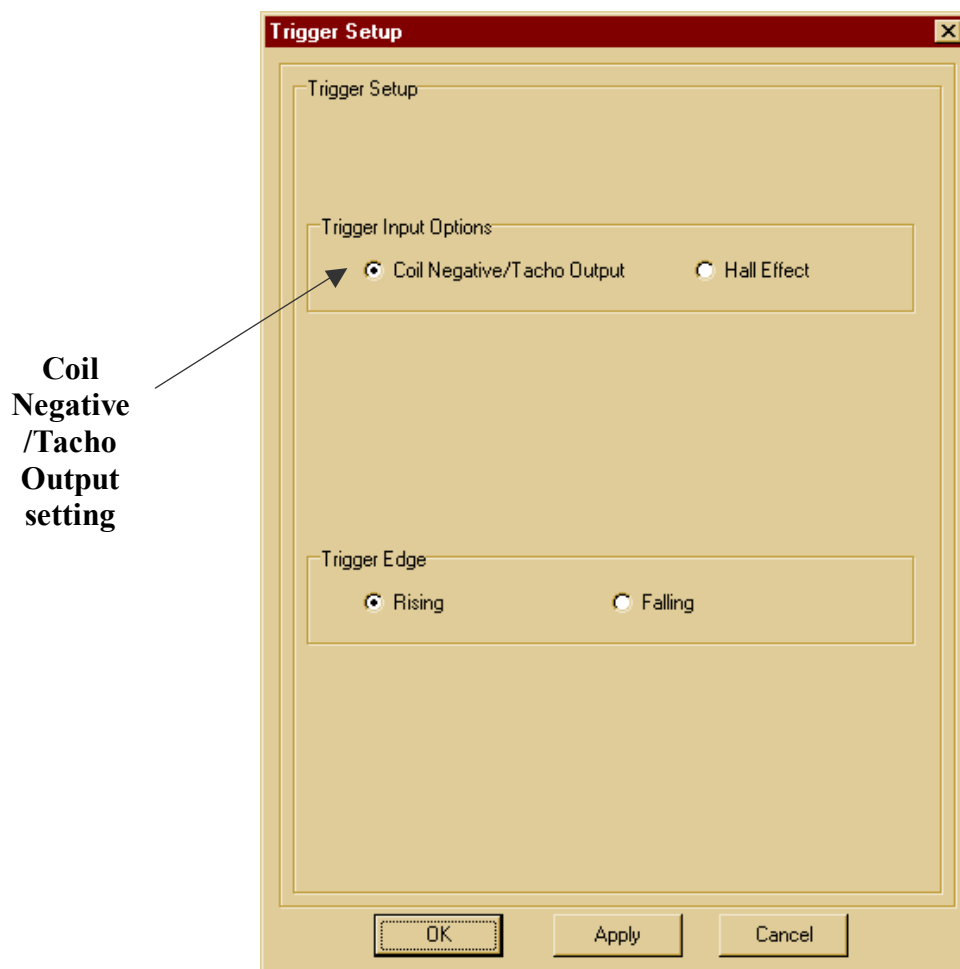
E.2 Coil Negative Triggering

The F10X can be triggered by the signal found on the negative side of an Ignition Coil. The F10X has a sole purpose input wire for this signal called “Negative Coil/Tacho Output” which is Pin 36 on the F10X ECU. Please make sure that in the Trigger Setup page, the Trigger Type is set to Coil Negative/Tacho Output if this type of trigger is to be used.

Below shows how the coil negative trigger wire should be connected.



Below is how to configure the Trigger Setup page for Coil Negative triggering

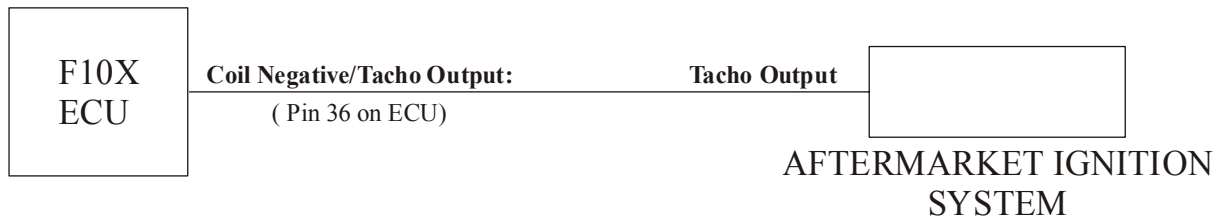


E.3 Tacho Output Triggering

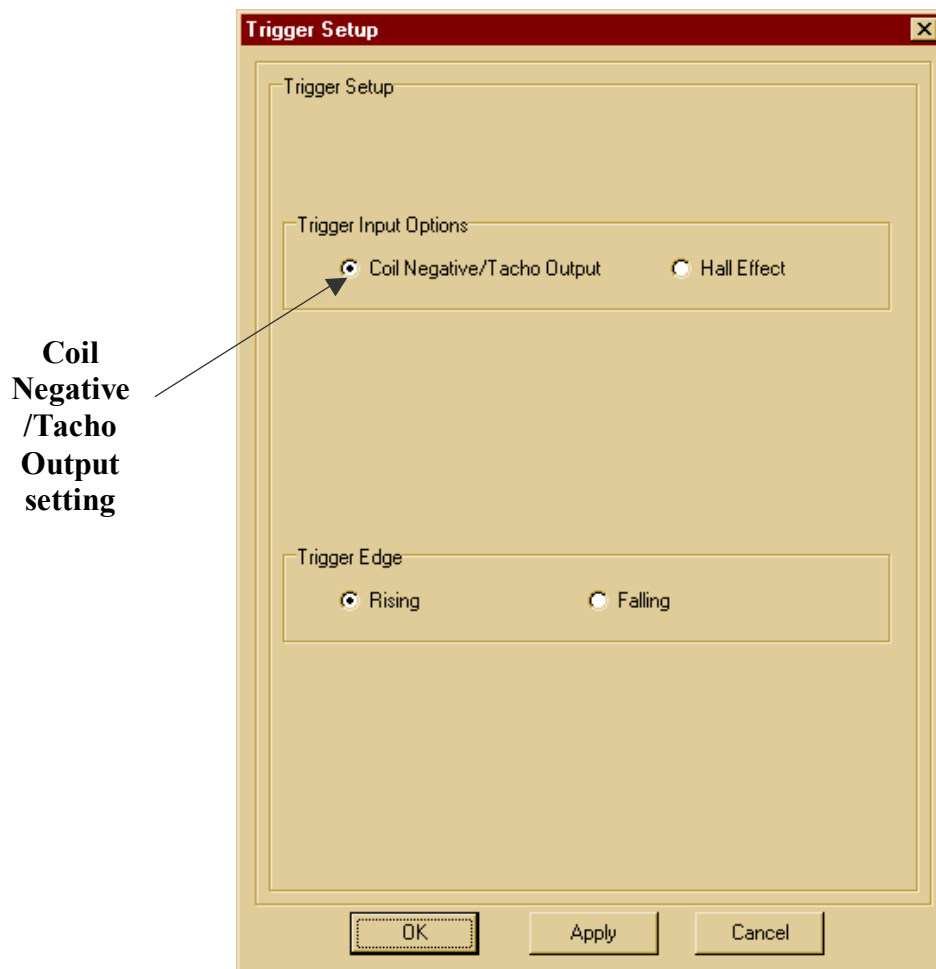
The F10X can be triggered by the signal found on the Tacho output of many aftermarket Ignition systems, such as a MSD, Jacobs & Crane. The Tacho output must be used if the ignition system used is a Capacitive Discharged Ignition system with the multiple spark discharge.

The Tacho Output wire must be connected to “Negative Coil/Tacho Output” input, which is Pin 36 on the F10X ECU. Please make sure that in the Trigger Setup page, the Trigger Type is set to Coil Negative if this type of trigger is to be used.

Below shows how the Tacho Output trigger wire should be connected.



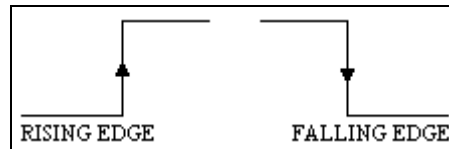
Below is how to configure the Trigger Setup page for Tacho Output triggering



WARNING:
DO NOT CONNECT ECU TO NEGATIVE POST OF COIL IF
AFTERMARKET CDI UNIT IS IN PLACE.

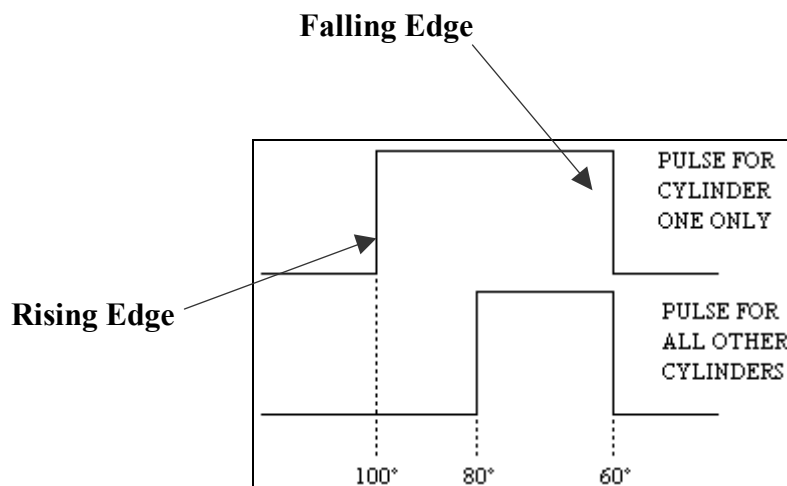
E.4 Trigger Edge

The ECU uses the signal transitions from *low* to *high* called *rising edges* and *high* to *low* called *falling edges* to determine engine position. In most instances the ECU will only use one type of transition (rising or falling) for a trigger and this is known as the *Trigger Edge*.



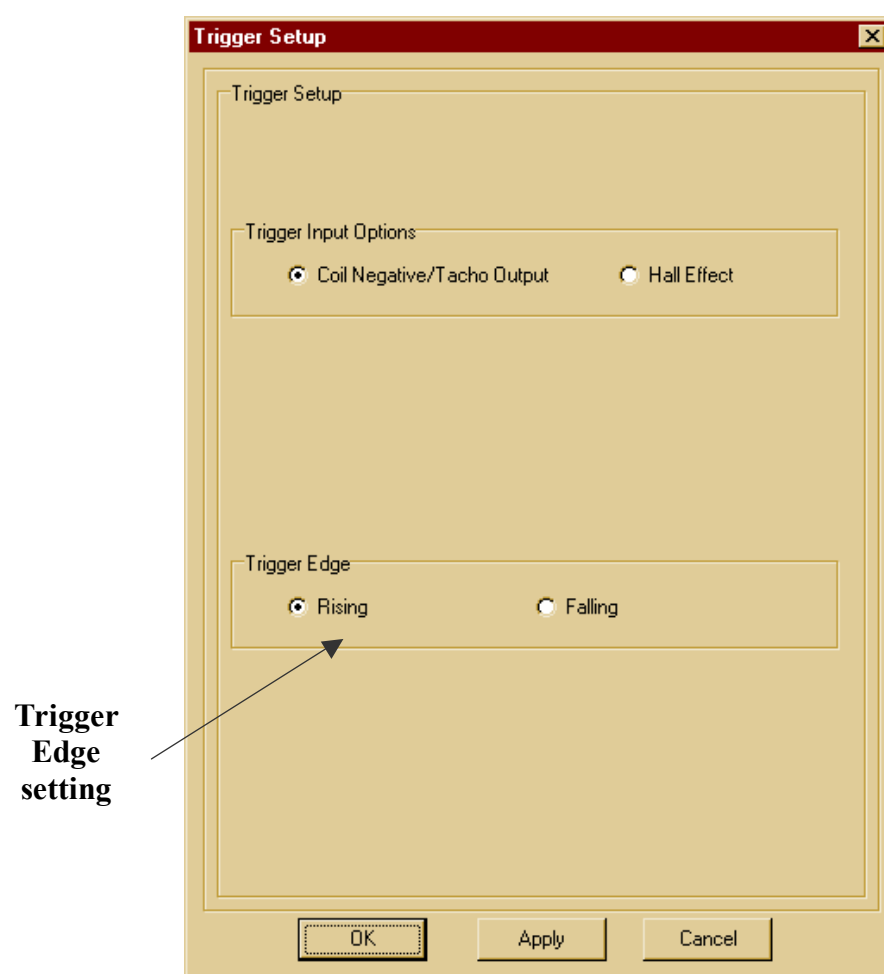
It is only the position of the triggering edge that is of importance.

Some trigger devices may have uneven pulse widths to indicate the position of a specific cylinder (often cylinder 1). If this edge was used as the trigger edge then there would be a variation between the trigger position for cylinder 1 and all other cylinders. This would lead to unstable RPM and ECU operation. To ensure even injection timing and RPM the trigger edge in this case would need to be changed.



As shown above, the Rising edge of the pulse for cylinder number one occurs 20 degrees before the Rising edge pulse for all other cylinders, but the Falling edge occurs at the same position, regardless of cylinder. In this case the Trigger edge would need to be set to Falling in the Trigger Setup page.

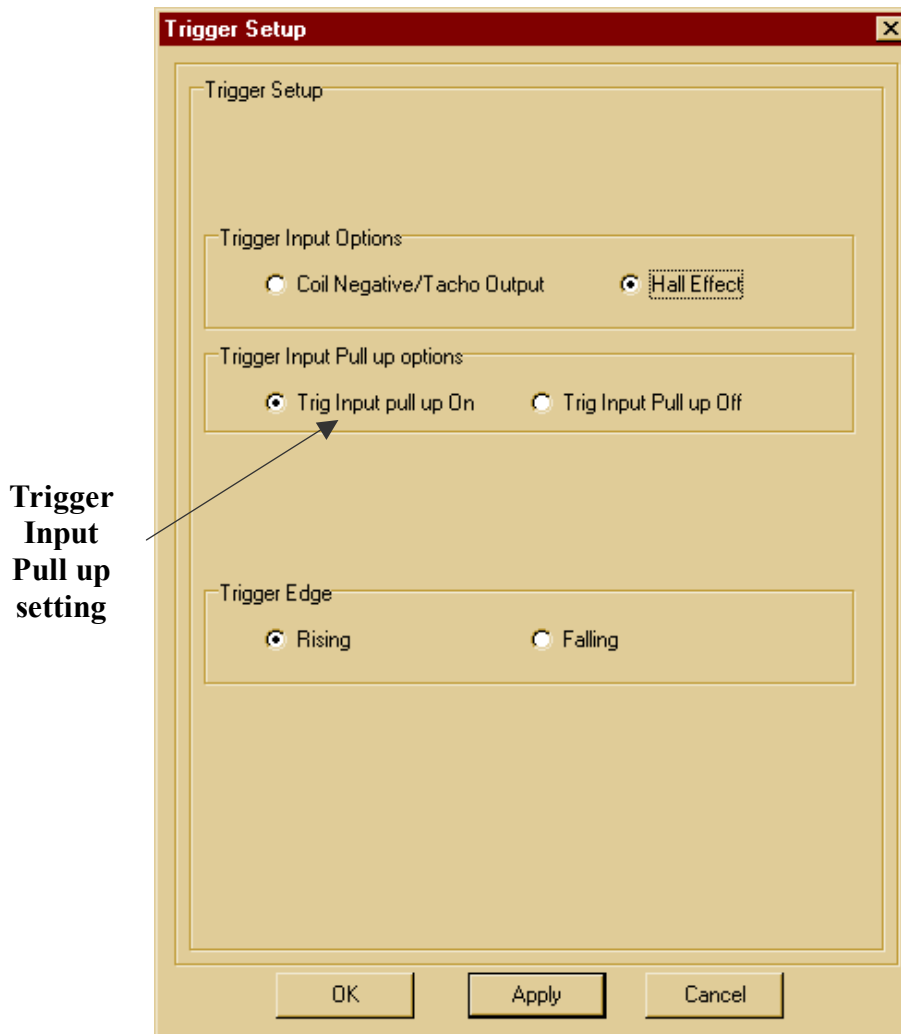
Below is how to change the Trigger Edge setting in the Trigger Setup page.



E.5 Trigger Pull up

The Trigger Pull up setting is only used when in Hall Effect mode. The Trigger pull up is needed for most Hall Effect sensors to make sure the input signal operates of the full 0 – 5v range. This will keep the trigger signal high, until the Hall effect sensor pulls the signal low when a trigger event occurs. Without this setting activated, ECU may not read RPM, no RPM will be displayed on the Gauge page.

Below is how to change the Trigger Pull up setting in the Trigger Setup page.



APPENDIX G**HALTECH F10X SPECIFICATIONS****Engine Suitability**

- Up to 16,000 rpm
- 1, 2, 3, 4, 5, 6, 8, 10, 12 cylinders (1-2 rotors)*
- 2 or 4 stroke
- 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, batch-fire, staged injection patterns

Power Requirements

- **Power Source**
8.6 to 16 Volts DC
- **Consumption**
Haltech ECU: 270 mA at 12 Volts
Injector Load: Dependent on injector type used - Max : 8A pk 2A hold per driver

Physical Specifications

- **ECU Dimensions**
Length: 140 mm (5 17/32")
Width: 145 mm (5 5/8")
Depth: 41 mm (1 5/8")
- **Weight**
ECU: 615g (1.35 lb)
Loom: 1.92kg (4.2 lb)
Sensors: 500g(1.1 lb)
Shipping Weight: 4.5kg (9.9 lb)
(Including manual/packaging)

Input Sensors

- **Manifold Absolute Pressure (MAP) Sensor (supplied 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 Ω rotary potentiometer driven from throttle shaft
- **Internal Barometric Pressure Sensor**
Barometric pressure compensation only
- **Engine Speed Pickup**
Compatible with most trigger systems:
 - 5 or 12 volt square wave;
 - Pull-to-ground (open collector)

ECU Outputs

- **Injector Driver**
4 x Two State Programmable Peak-and-hold current limiting drivers capable of driving at:
 - 4Apk/1Ahold
 - 8Apk/2Ahold

The above current specifications allow the drivers to drive up to 8 x 2.2~2.4 Ω injectors, 16 x saturation style injectors (High Impedance) or 4 x ~0.5 Ω .
CAUTION: Ensure software settings are correct since excessive current for long periods may damage injectors.
- **Pulse Width Modulated (PWM) Output**
4 x Dedicated PWM outputs capable of driving: 1A continuous pull to ground
 - Suitable for controlling turbo waste-gate, solenoids, valves, shift lights, relays etc.
- **Fuel Pump Control**
20A fused relay, features automatic priming and switch-off.

System Programming Requirements

- **Computer**
IBM-PC or compatible, preferably laptop or notebooks
CGA, EGA or VGA, colour or monochrome display
640+ kb RAM
- **Disk Drive**
3.5" Floppy Disk Drive
- **Serial Port**
Standard RS232C port - 9 pin D connector
COM1 or COM2 (selectable)

Adjustable Features

- **Base Fuel Map**
 - 22 Fuel ranges, every 500 RPM to 10,500, or
 - 17 Fuel ranges, every 1000 rpm to 16,000
 - 32 Load points per range, up to 16ms with 0.016ms 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) - 16 points
 - Full Throttle (selectable) - 32 points
- **Programmable Rev-Limit**
- **Fuel Cut on Deceleration**
- **Accelerator Pump**
 - Increase and sustain parameters
 - Coolant enrichment factor
 - Three speed ranges
- **Idle Speed Control**
 - Target Idle Speed
 - Cold Idle-up Rpm
 - Post-start Rpm setting
- **Closed Loop Control**
 - With both cruise and idle settings
- **Programmable Output Options**

Miscellaneous

- **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 (approx. 11k/minute).
- **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**

Red anodised with integral cooling fins and mounting brackets.

F10X Hardware Options

- **Boost Control Solenoid.**

- **Hall Effect Sensor Kit.**

- **Extra Injector Driver Kit.**

- **Four Wire Heated Oxygen Sensor.**

- **Fully Terminated and Sheathed Wiring Harness**

In Lieu of Flying Wire Lead Harness.

- **Haltuner**

Inexpensive dash mounted Air-Fuel Ratio Meter.

- **Idle Air Control Motor Housing.**

- **Idle Air Control Motor.**

- **Mixture / Ignition / Boost Trim Module**

Provides $\pm 12\frac{1}{2}\%$ or $\pm 50\%$ adjustment for fast tuning.

LIMITED WARRANTY

Lockin Pty Ltd trading as Haltech warrants the HaltechTM 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 HaltechTM 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.

APPENDIX H**WIRING DIAGRAMS**

Pin #	Function	Wire Colour
1	SPARE A/D	RED/BLK
2	O2 SENSOR	GRY <SHD>
3	PWM OUT 2	PINK/BLK
4	PWM OUT 1	VIO/WHT
5	ROAD SPEED	GRY/YEL <SHD>
6	TRIGGER	YEL <SHD>
7	+13VDC ECU	RED/WHT
8	TX	RED <SHD>
9	RX	BLU <SHD>
10	TRIM	BLK/WHT
11	MAP	YEL
12	N/C	-
13	N/C	-
14	IDL4	BRN/WHT
15	IDL3	YEL/RED
16	IDL2	GRN/YEL
17	IDL1	BRN
18	+5VDC	ORG
19	INJ1	L. BLU
20	INJ2	BLU/RED
21	INJ3	GRN/RED
22	INJ4	PINK
23	PWM OUT 3	BLU/GRN
24	PWM OUT 4	GRN/WHT
25	+13VDC ECU	RED/WHT
26	GND	BLK
27	AUX OUT	GRN/BLK
28	AUX IN	GRN
29	AIR TEMP	GRY
30	COOLANT	VIOLET
31	TPS	WHITE
32	GND	BLK
33	PUMP RELAY	BLK/YEL
34	N/C	-
35	N/C	-
36	COIL NEG/TACHO OUT TRIGGER	L. GRN