Warnings

1. This system is capable of controlling either “intelligent” igniters which have in-built dwell control or “dumb” igniters which rely on the ECU to control dwell. This allows standard igniters to be used in many cases. Most standard igniters are dumb igniters. However, it is very important to set the system up to match the type of igniter used. In the ignition set-up page the set-up should be:

   To control **intelligent igniters** set up as “**Constant Duty**”
   To control **dumb igniters** set up as “**Constant Charge**”

   If the wrong set-up is used the system will not function correctly and it is possible that the igniters may burn out as a result. Burning out of igniters due to incorrect set-up will not be regarded as warranty.

2. **The E6X ECU must only be used with an E6X wiring harness.** The E6K ECU must only be used with an E6K wiring harness. Note that the wiring harness of the E6K will physically plug into the E6X 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 E6X wiring harness is clearly labelled as “E6X” near the main ECU connector.

Contents

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Print Version: 3.02a...Date: 27 February 2004

This manual should accompany:

IBM compatible PC software v8.02
Firmware Series 11
Firmware 9

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, from pylon racing aircraft 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 or 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

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.
The ignition timing is determined in a similar way to the fuel needs. The ECU has a table configured for ignition instead of fuel and applies corrections in a similar way.

SECTION 1 Getting Started

CHAPTER 1 HALTECH ECU INSTALLATION

1.1 The ECU and associated hardware

The Haltech E6X system comprises the following components

Haltech Electronic Control Unit (ECU)
Coolant Temperature Sensor
Inlet Air Temperature Sensor
Throttle Position Sensor (TPS)
Manifold Absolute Pressure (MAP) Sensor
(1,2 or 3 Bar Sensor - purchased separately to main kit since it is optional in some applications)
Main Wiring Harness
Haltech E6X 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.

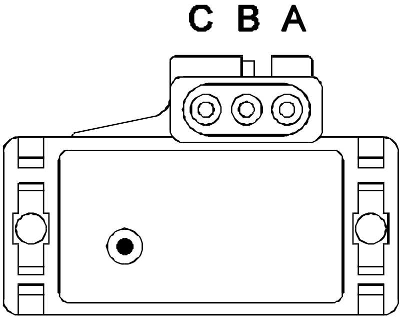
1. Mount Manifold Absolute Pressure Sensors.
2. Mount Coolant Temperature Sensors.
3. Mount Inlet Air Temperature Sensors.
4. Mount Throttle Position Sensors.
5. Mount Ignition Modules
6. Mount optional Exhaust Gas Oxygen Sensor (if used)
7. Route Main Wiring Harness and connect sensors and ignition module.
8. Mount and connect Power Relays.
9. Mount Fuse Block.
10. Mount ECU inside passenger compartment.
11. Locate and connect flying wires:

RED	+ 12 volts battery
GREY	Ignition on 12 volts
BLACK	Chassis ground
ORANGE	(2 wires) Fuel Pump Circuit

12. Install and connect the optional Idle Speed Motor
13. Install and connect any Optional Outputs
14. Connect Trigger signal
15. Connect ECU and test.

1.3 Expanded Installation Guide

1.3.1 Manifold Absolute Pressure (MAP) Sensor



PIN DESIGNATION
A - GROUND
B - SENSOR OUTPUT
C - +5 VOLT

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, p74*).

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 or 16137039)
(-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 or 16040749)
(-100kPa to 200kPa) Turbo or Supercharged
Engines up to 200kPa boost
(30 Psi, 2 atmospheres)

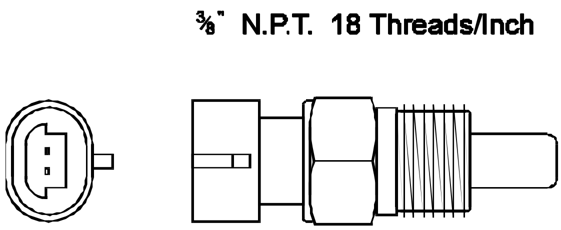
Note: Make sure you have the correct MAP sensor for your engine. The first three digits of the part number are stamped on the sensor housing.
Engines that use Manifold Pressure as a load reference require an appropriate MAP sensor to be connected to the MAP Input plug on the wiring loom.
Engines that 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, p74*)

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.



Temp to Resistance Value Approx

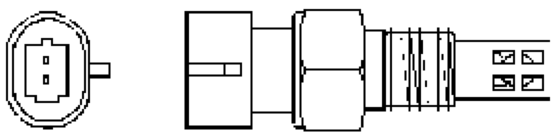
°F	°C	Ω
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-10	-40	100,700

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

14mm x 1.5



Temp to Resistance Value Approx

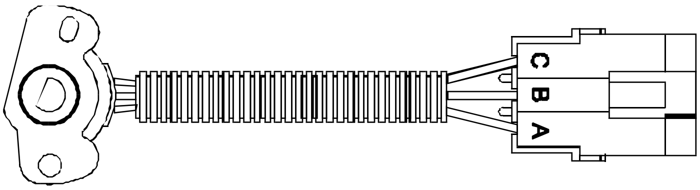
°F	°C	Ω
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-10	-40	100,700

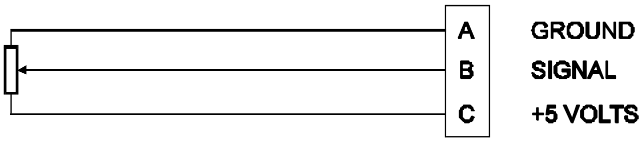
The air temperature sensor is used to compensate for changes in air density due to air temperature. Cold air is denser than warm air and therefore requires a greater volume of fuel to maintain the same air/fuel ratio. This effect is most noticeable in forced induction engines. The ECU will automatically 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 10kΩ. 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, p65*)
> 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 Ignition Module.

The ignition module is used to drive the high currents required to energize the ignition coils. All vehicles that have electronic ignition control will have an ignition module or ignitor that may be compatible with the ECU's ignition outputs, if the existing ignition module is not compatible (if you are not sure please contact your haltech dealer) installation of a new ignition module will be required.

Mounting

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

Connections

Included with the Haltech wiring harness is the Ignition Sub-loom that allows the ignitor to be isolated from the main loom until the ECU has been configured for the specific ignition system.

WARNING:
DO NOT CONNECT THE IGNITION SUB-LOOM TO THE MAIN LOOM UNTIL THE ECU HAS BEEN CONFIGURED FOR THE IGNITION SYSTEM USED. INCORRECT IGNITION CONFIGURATIONS MAY RESULT IN DAMAGE TO IGNITION COMPONENTS

1.3.6 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.

1.3.7 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.

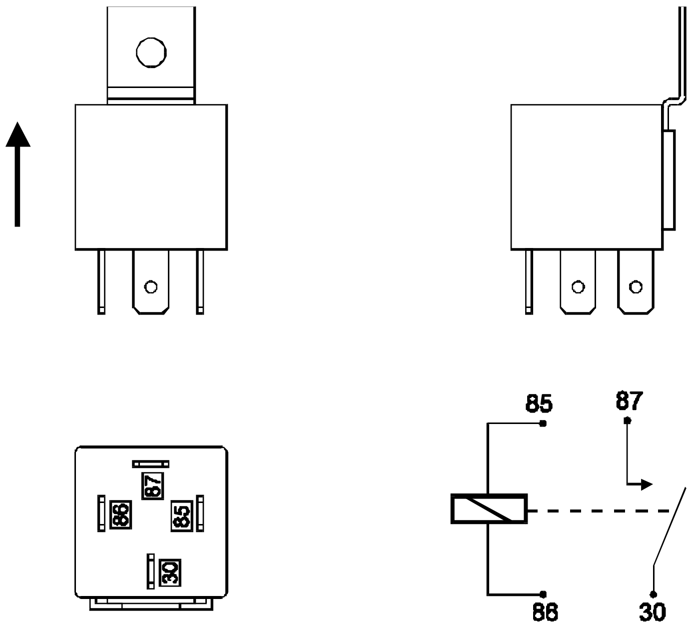
TRY TO ROUTE THE MAIN HARNESS AWAY FROM HIGH VOLTAGE IGNITION LEADS. UNDER NO CIRCUMSTANCES RUN ANY WIRING PARALLEL TO, OR IN CONTACT WITH THE IGNITION LEADS.

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.

1.3.8 Power Relays

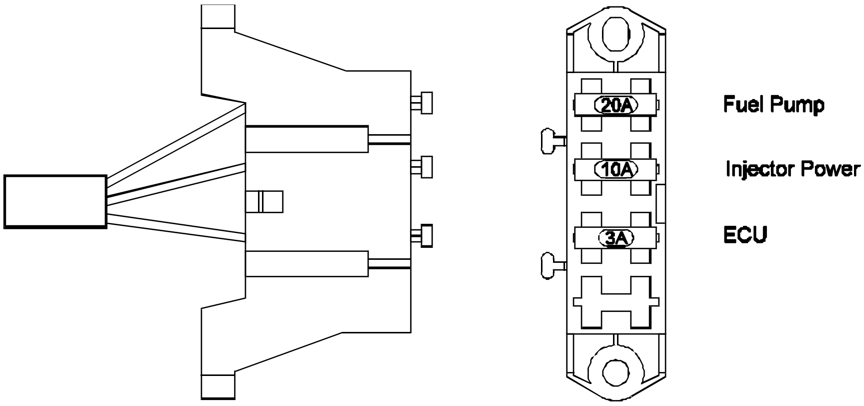
There are two relays used with the ECU, the Main Power Relay (with a grey wire) and the Fuel Pump Relay (two orange wires). These relays are identical parts so it is not important which relay goes in what connector.



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.

1.3.9 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.

1.3.10 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.

1.3.11 Flying Leads

Locate and connect the following flying leads.

Black (Ground)

Locate a good chassis ground point and connect the black wire.

Red

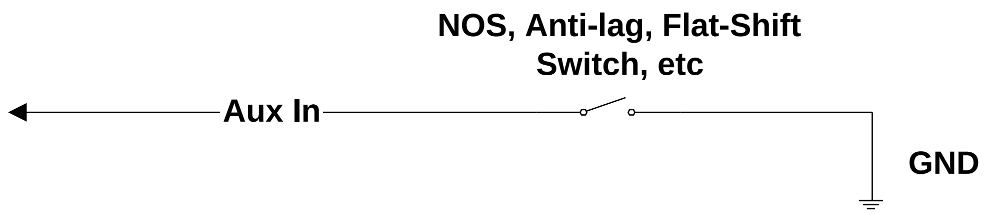
(Battery Supply +12V) Locate a source of continuous +12 volts and connect the red wire. Connecting direct to the positive battery terminal is suggested.

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.

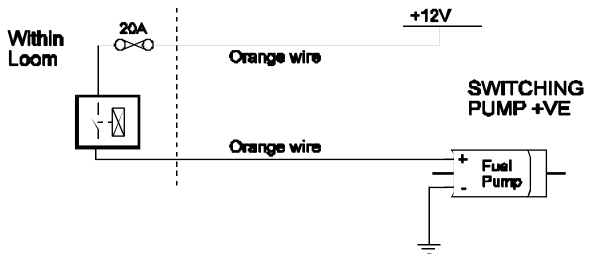
Green

(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, p49*) The following diagram is an example of how to wire the Aux In circuit:

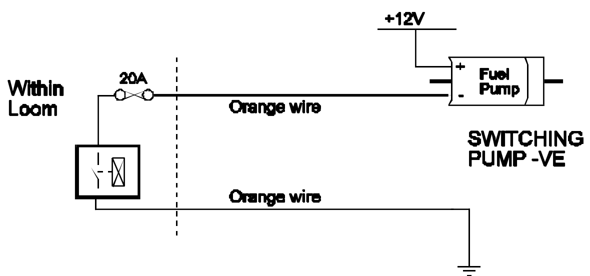


Orange

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, 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.

1.3.12 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.

1.3.13 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 13 Digital Outputs & PWM Outputs, p88*.

1.3.14 Connect the Trigger Sensor

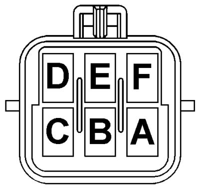
The Trigger is used by the ECU to determine Engine Speed and Position. Some engines have a second trigger that is used to act as a position reference and is called the "home" signal. For more information on trigger systems refer *4.2.3 Ignition Set-up Page, p46*
When connecting the trigger sensors it is important to identify the type of sensor being used to measure engine speed and position from the following options: Optical, Hall effect or Reluctor.

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. As indicated by the table below, the Power terminal would connect to PIN F, the Ground to PIN A and the signal to PIN B. If a home or synchronising signal is required the signal terminal would be connected to PIN E and the Power and Ground to PINF and PIN A respectively.

Reluctor Triggers

Reluctor triggers operate differently and require different wiring and set-up. Reluctor trigger sensors generally have two connections: Positive and Negative (often labelled "+" and "-"). As indicated by the table below, the positive connection would connect to PIN B, the negative to PINC. If a home or synchronising signal is required the positive terminal of the home sensor connects to PIN E and the negative to PIN D.



PIN	FUNCTION
A	GROUND
B	Trigger or Trigger Positive
C	Trigger Negative
D	Home Negative
E	Home or Home Positive
F	+13.8 V DC

1.3.15 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 the Haltech Programming Software.

2.1 Computer Requirements

The computer required to program the Haltech E6X can be any IBM-PC compatible personal computer from the XT onwards (i.e. the AT, 386, 486 or Pentium computers). The requirements are fairly modest. The computer must have at least 640K of RAM (with about 590kb free for executable programs), one 3.5" disk drive and a CGA, EGA, or VGA screen. (Virtually all reasonably modern laptops running MS-DOS (version 5.00 or higher) will fit this description).

The Haltech Software will work under Windows 95, 98, 98SE and ME. The software was originally designed to run under a MS-DOS operating system. If problems occur running the program in a windows environment refer to *2.3 Using the Software in Windows, p24*

2.2 Using the Software with MS-DOS

The following explains how to use the software in MS-DOS, if you are running a Windows Operating system skip ahead to *2.3 Using the Software in Windows, p24*.

2.2.1 Installing the Software

The Programming Disk supplied with the ECU has an installation program that allows you to install the software onto the PC's Hard Disk. Most modern PCs have a hard disk. If your PC does not have a hard disk, the Program can run directly from the floppy disk supplied. Installing the software on the Hard Disk will speed up the program and avoid having to fiddle around with floppy disks. The installation program need only be run once.
If you do not have a Hard Disk, go to the section *2.2.3 Running the Software from the Floppy Disk, p23*

To install the software follow these steps:
Turn your PCs power on and boot up MS-DOS as instructed by the computers Users Manual. If a shell program or menu utility runs automatically when you boot your computer, exit it now. You should see the MS_DOS prompt as follows:

C:\>_

To select the floppy disk drive type

A: and then press the Enter Key.

The MS-DOS Prompt should change as shown below

A:\>

To run the Install program type:

__INSTALL__ and then press the Enter Key.

The Install program will now run. Follow the instructions given. When it is finished, the installation program will tell you if the installation is successful. If it was not, consult the trouble shooting section of this manual in the Appendix.

The Programming software is now ready to run.

2.2.2 Running the Software from the Hard Disk

Start you computer, at the MS-DOS prompt (***C:\>***) type:

CD \HALTECH and then press the Enter Key.

Your should then see an MS-DOS prompt that appears as:

C:\HALTECH>

Then type:

CD \E6X

At this prompt type:

E6X and then press the Enter Key.

2.2.3 Running the Software from the Floppy Disk

If you have installed the software as described previously you can skip ahead to *2.2.4 Azerty Keyboards in MS-DOS, p23*.

To run the software from a floppy drive, start your computer, when the MS-DOS prompt appears:

A:\>

Insert the Programming disk in the disk drive, to start the E6X program type:

E6X then press the Enter Key.

The programming software will now run.

2.2.4 Azerty Keyboards in MS-DOS

Most countries use a keyboard where the first six letter keys across the top row are:

"***QWERTY***"

This is called a "Qwerty" keyboard. Some countries use an alternative, which is called an "Azerty" keyboard, where the Q and W keys are swapped with the A and Z keys respectively. If you have an Azerty keyboard, you need to start the software differently. When you would normally type:

E6X and then press the Enter Key.

You must now type:
E6X/A and then press the Enter Key.

The "/A" tells the program you have an Azerty keyboard. The program will adjust accordingly.

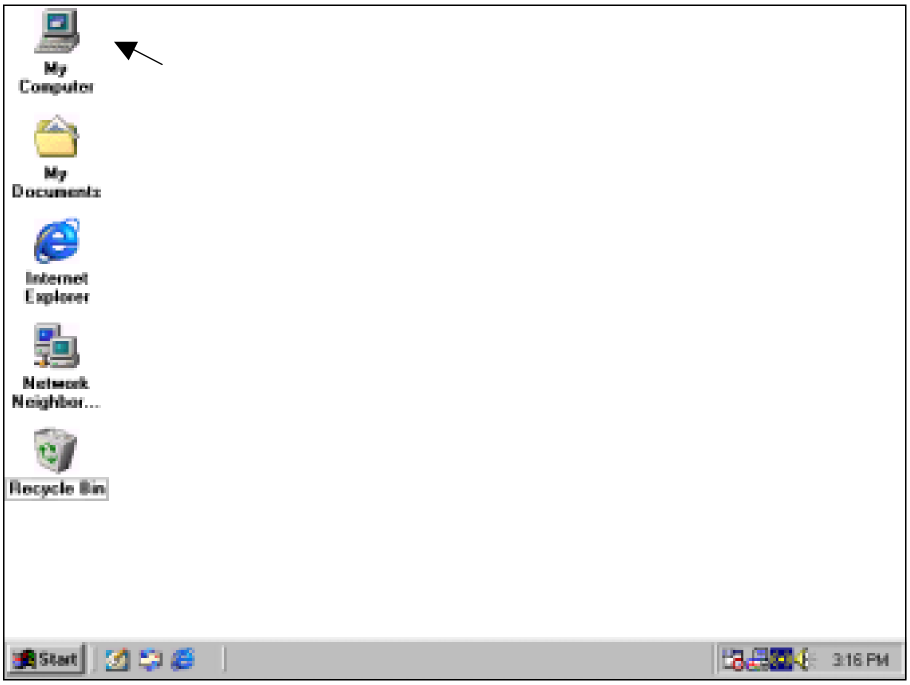
2.3 Using the Software in Windows

The following explains how to use the programming software in a windows 95 or later operating system, if you are running the software in MS-DOS, windows 3.x or if you have any problems running the software in the windows environment, follow the instructions in *2.2 Using the Software with MS-DOS, p22*

2.3.1 Installing the Software

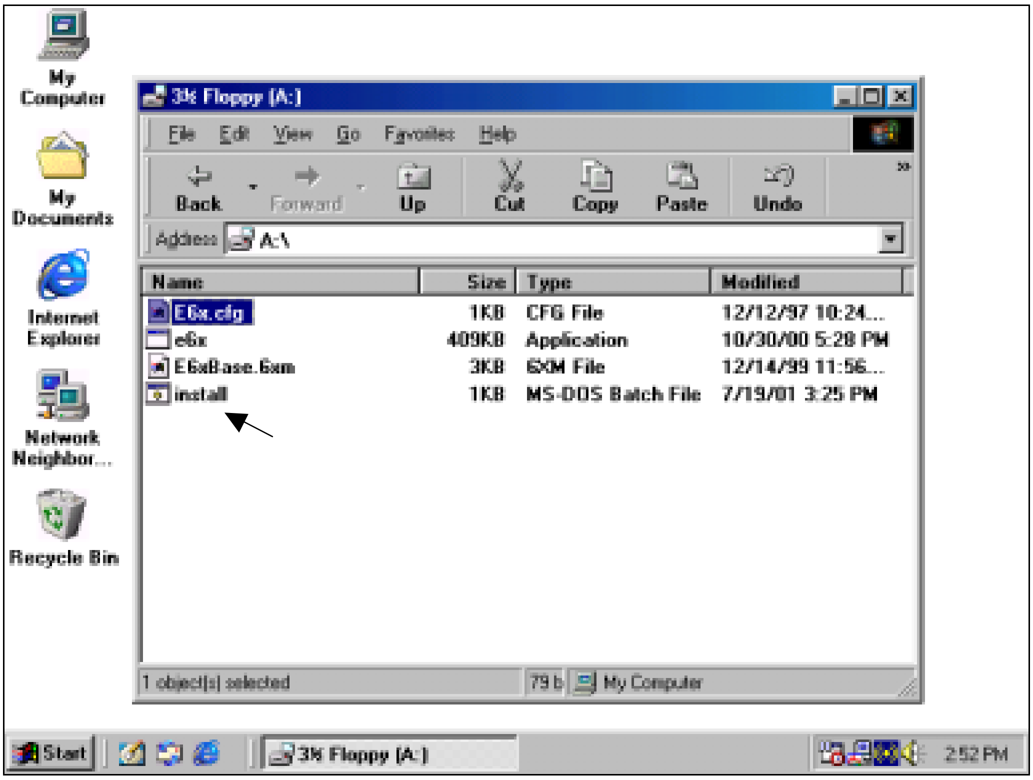
To install the software in windows you can either; start the computer in MS-DOS mode and follow the instructions for MS-DOS above or follow the instructions below.

Start the computer; when the desktop appears double click the "My Computer" Icon in the top left of the screen (as shown below).

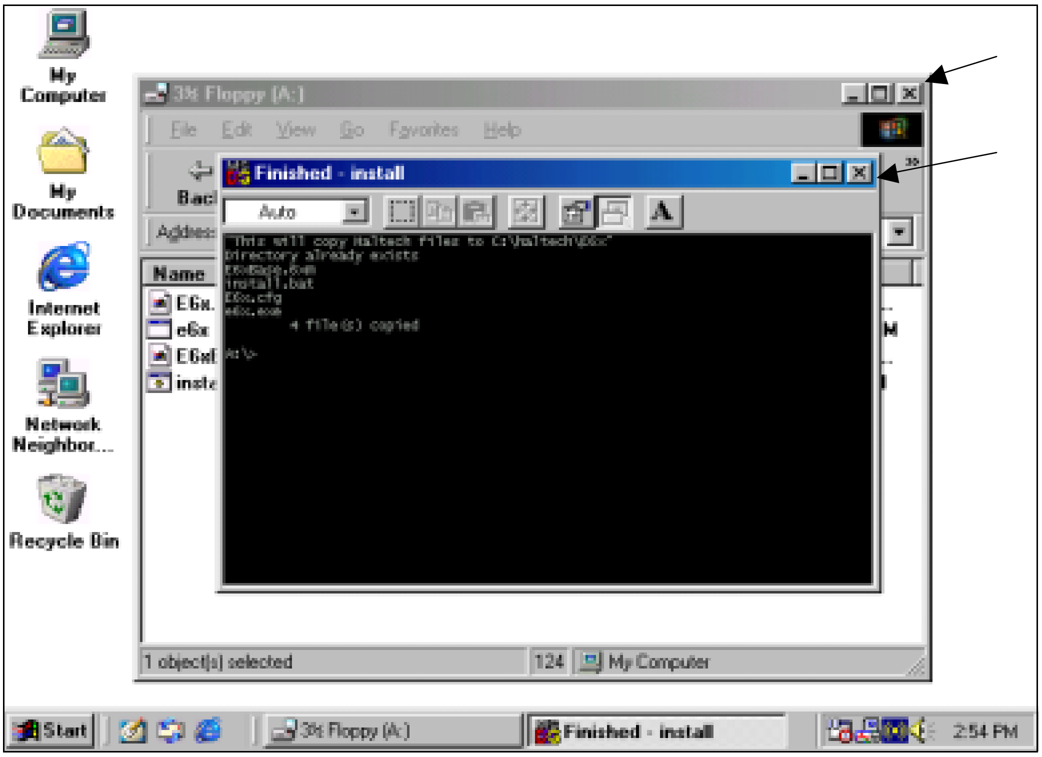


A window will appear (as shown below). Double click the icon labeled “3½ Floppy (A:)”.

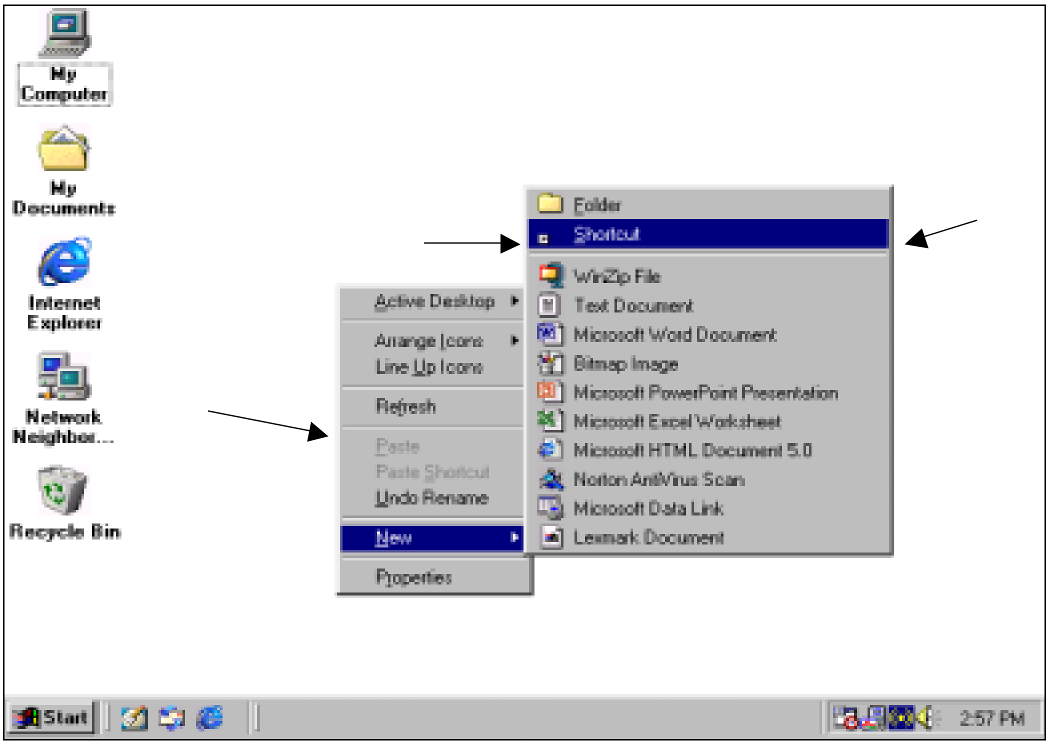
A window will appear (as shown below). Double click the file icon labeled “install”.



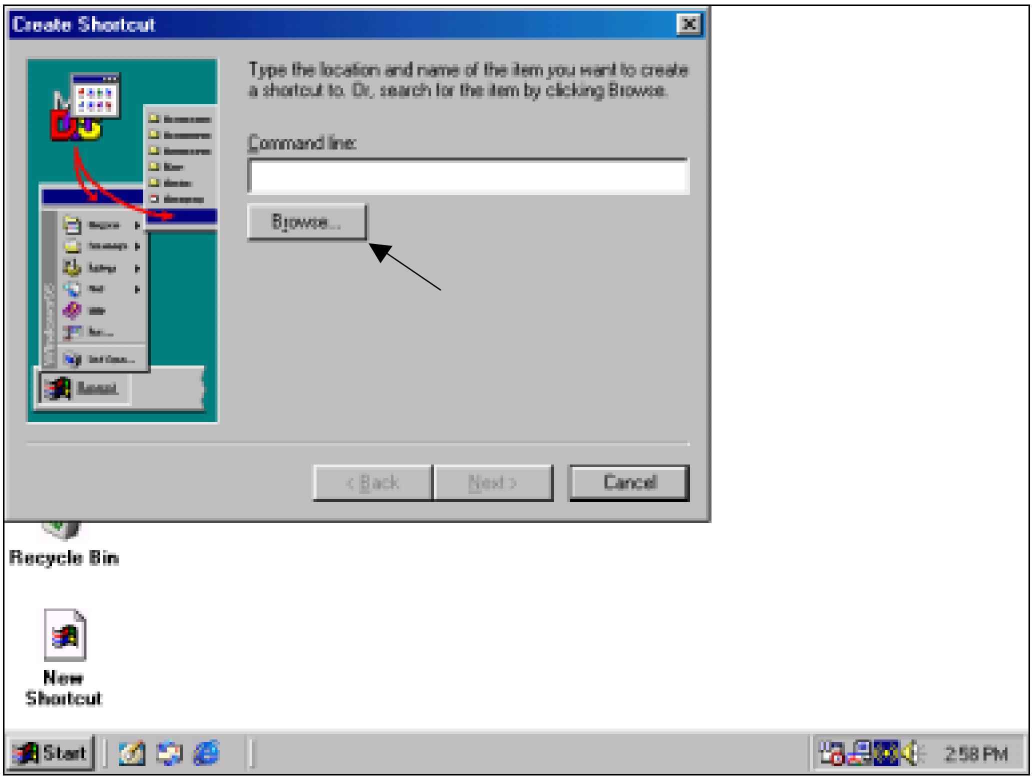
A window will appear (as shown below). This is a MS-DOS window. When the window shows finished in the window title bar (as shown below), dismiss all the windows by clicking the “X” button at the top right hand corner of each window.



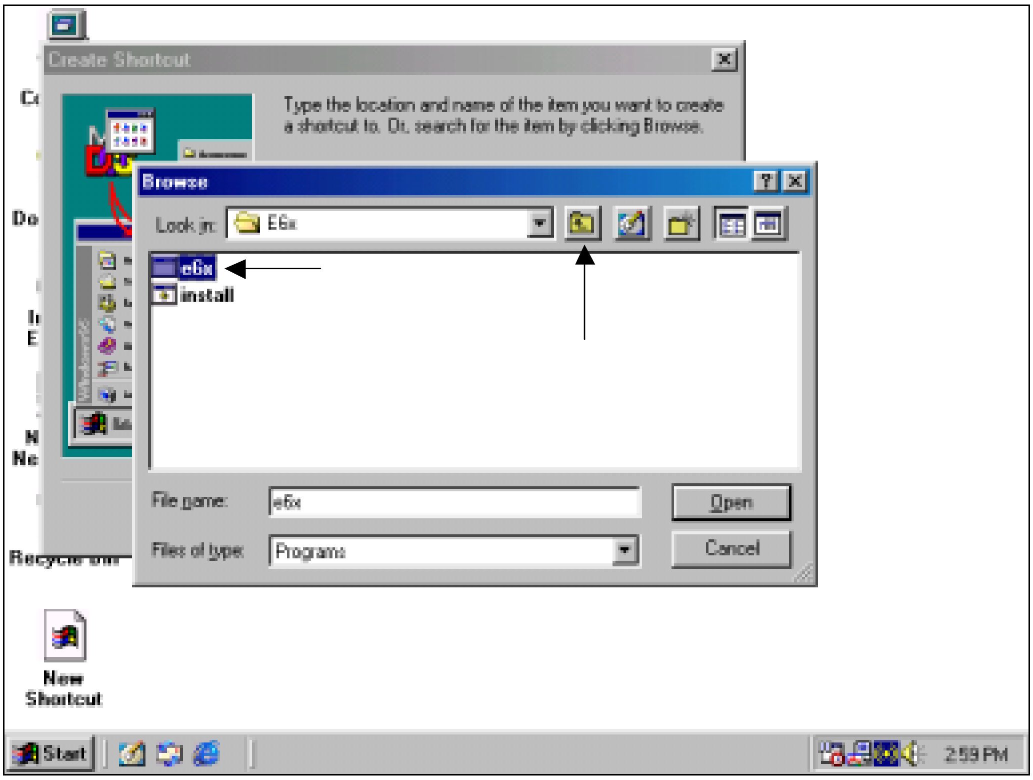
Now that the Software has been installed a shortcut can be created and placed on the desktop that will launch the installed software. Right click in the empty desktop and a small menu will appear (like that shown below on the left). Move the pointer down the menu and left click “New” and a second larger menu will appear (like that shown below on the right). Left click the menu item “Shortcut” (as shown below).



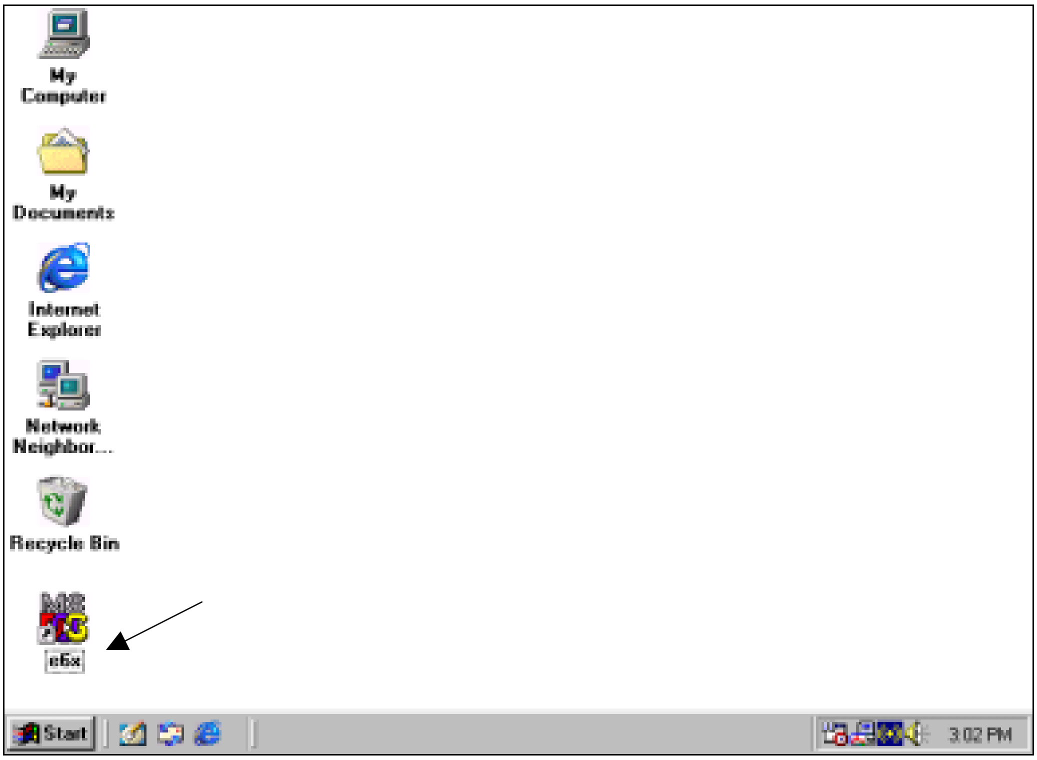
Single click the "Browse" button to navigate to the location of the programming software.



Use the "Parent Folder Button" (shown below on the right) and the folders that appear in the window to navigate to the "Haltech" folder and then the "E6X" folder created by the "install" program. Select the "E6X" icon (shown below left) and click the "Open" button at the bottom right of the window.



The two remaining windows that appear can be dismissed using the "Next" or "Finish" buttons found at the bottom of the windows. Now the Desktop should have an icon similar to that shown below in addition to all the previously existing icons.



Now that the software is installed and a shortcut has been placed on the desktop the software can be launched by double left clicking the shortcut icon.

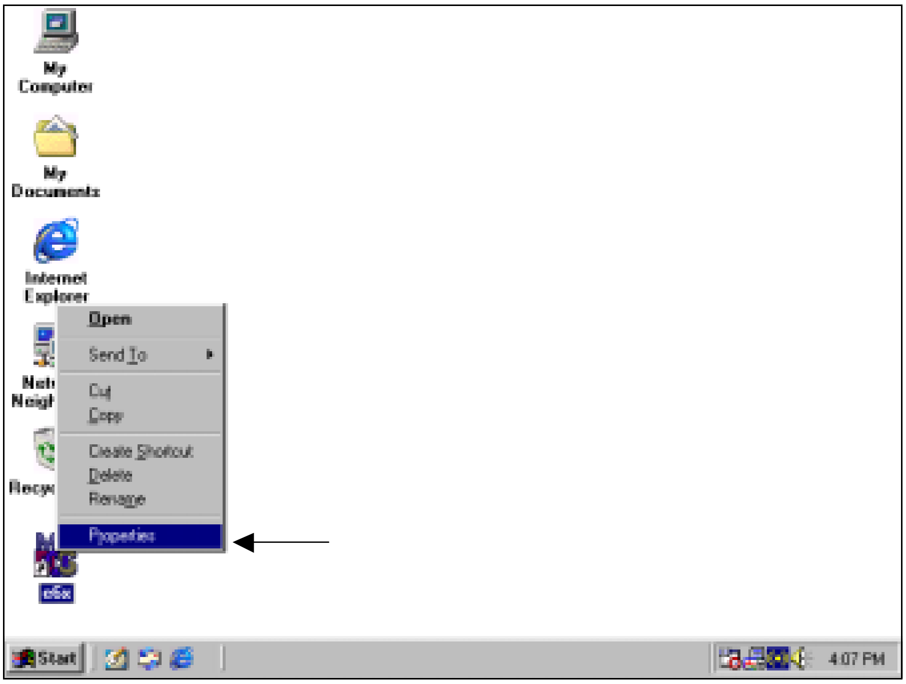
2.3.2 Azerty Keyboards in Windows

Most countries use a keyboard where the first six letter keys across the top row are:

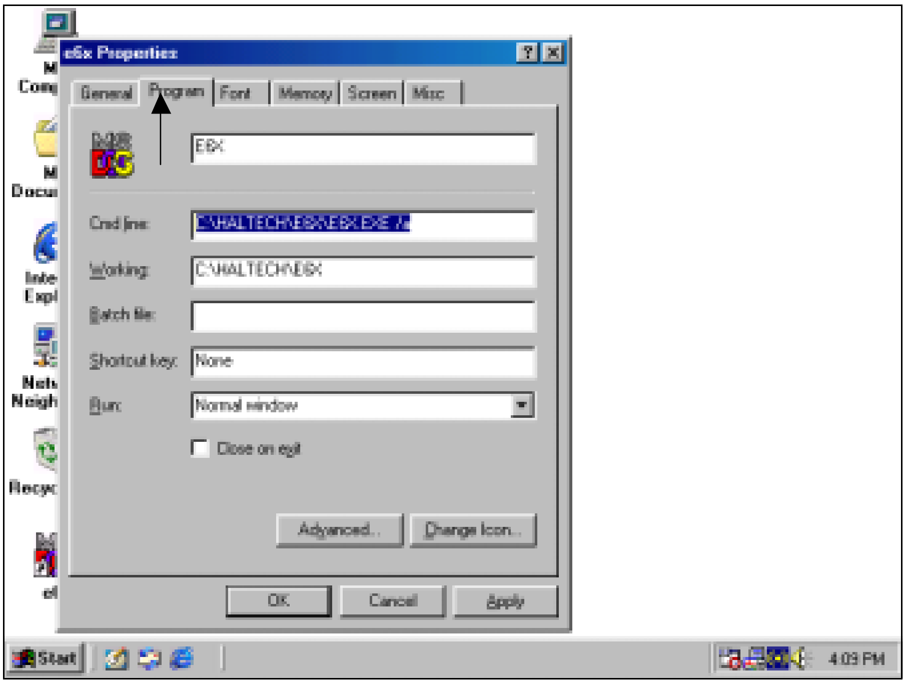
“***QWERTY***”

This is called a “Qwerty” keyboard. Some countries use an alternative, which is called an “Azerty” keyboard, where the Q and W keys are swapped with the A and Z keys respectively. If you have an Azerty keyboard, you need to make a change to the settings of the Shortcut file created previously.

Single right click the shortcut icon and a menu will appear (as shown below) and select properties from the menu.



A new window will appear (as shown below) te see the information shown below single left click the “Program” tab. Change the text in the box titled “Cmd line:” so that it reads “C:\HALTECH\E6X\E6X.EXE /a”. Click the OK button.



Now when the shortcut is used to launch the programming software the software will recognise the "Azerty" Keyboard.

2.4 The Program Set-up Page

To complete the installation of the programming software the Program Set-up page must be configured to suit the computer you are using.
Start the Software as described above. When the Title page appears:

Press ***N***

This will start the Software in the “Offline” mode. The Set-up Window is accessed from the Set-up menu:

Press ***ALT-S***

There are two setting in the programming set-up page: The display options and the communications port configuration.

2.4.1 The Display

The Haltech programming software has been written to suit a graphical CGA, VGA or EGA monitor. In most cases, the programming software will detect what sort of display you have and select the appropriate mode: “colour” or “monochrome”.
You can also choose to operate in colour or monochrome. Since some older laptop computers do not have a colour monitor, the monochrome setting should provide better contrast to read the screen.

2.4.2 Com Port

The programming software can talk to the Haltech ECU through either COM1 or COM2. Select the communications port you are using here.

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, p42* and *CHAPTER 5 Haltech Maps, p53*

3.1 The Menu Structure

After the title page has been cleared the programming software appears as a menu-based program that allows the user to access pages that contain "set-up" and "map" information.

To access the menu structure:
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***.
The file menu contains the following items:

- Load Map
- Save Map
- Import Map
- Erase Map
- Quit ***CTRL-Q***

3.1.1.1 Load Map

Load Map 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 E6X 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 all information previously stored in the ECU will be lost.

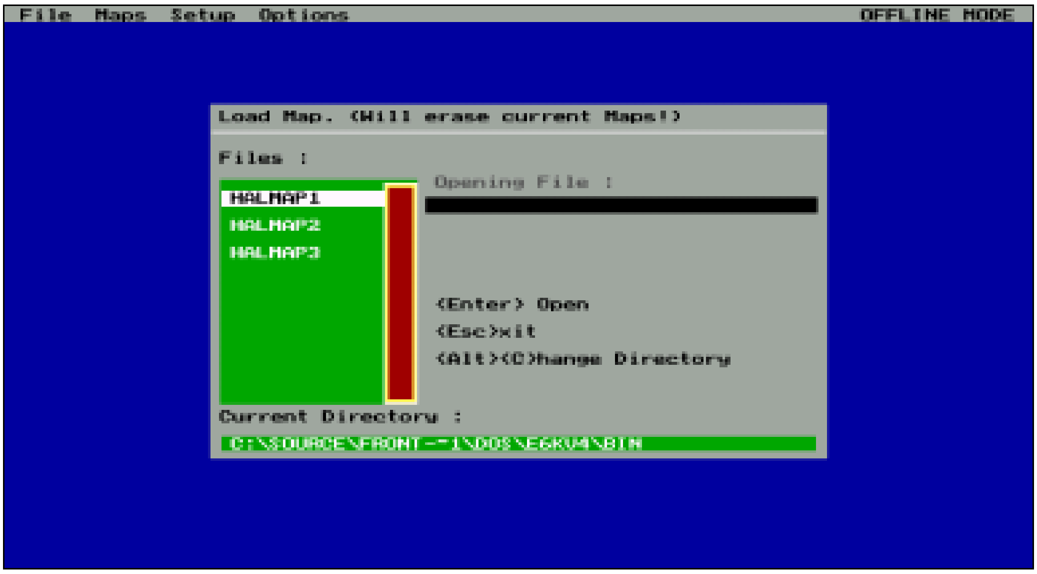
NOTE:
When using the load function be aware that when the ECU is online all "set-up" and "map" data currently stored in the ECU will be overwritten.

When you choose the "Load Map" menu item a file window will appear in the centre of the screen. On the left side of the window is a list of ECU map files available in the current directory. To select the appropriate map from the list use the up and down cursor keys:

↑, ↓

Once the desired map is selected:

Press ***Enter***



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

Press ***Enter***

When the ECU is "Offline" a window will appear with the map details:

Press ***Enter***

The screen will flash and then return to the title page.

When the ECU is "Online" the horizontal black bar will gradually change colour from left to right indicating the progress of the load process. When the load process is complete a window will appear with the map details:

Press ***Enter***

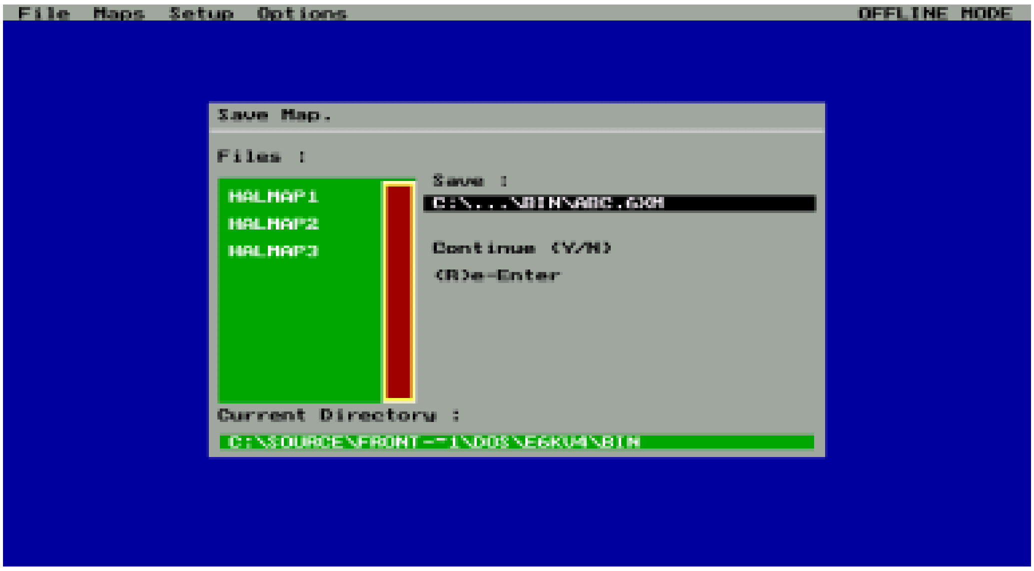
The screen will flash and then return to the title page.

3.1.1.2 Save Map

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 Map" menu item a file window will appear in the centre of the screen. On the left side of the window is list of ECU map files available in the current directory.



Type a filename for the map. The typed filename will be displayed in the horizontal black bar below the text "Save":

Press ***Enter***

The text "Continue (Y/N)" will appear below the horizontal black line:

Press ***Y*** to continue, ***N*** to cancel the save or ***R*** to re-enter the filename.

The screen will flash and then return to the title page.

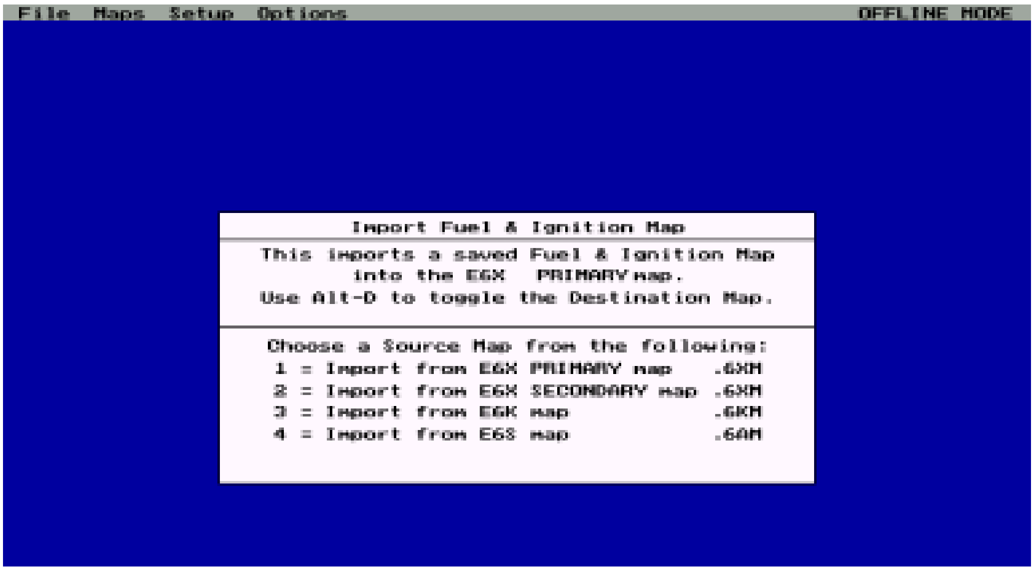
3.1.1.3 Import Map

Import Map allows the user to import "map" data from other Haltech ECU maps such as E6K, F9, IG5, E6S, E6A and E6 map files. When the Import Map item is selected a sub-menu will appear to the right of the current menu. This menu has the following items:

- Import Dual Map
- Import Fuel and Ignition
- Import Fuel Map
- Import Ignition Map

When any of these sub-menu items is selected a window will appear with a series of numbered options (as shown below). Choose the appropriate option and a file window will appear. Follow the instructions as described in *3.1.1.1 Load Map, p33*.

> NOTE:
> This function requires the user to have the appropriate map files available. If you have problems loading the map files make sure that the files are in the same directory as the ECU programming software.



3.1.1.4 Erase Maps

Erase Maps allows the user to delete old map files from within the ECU programming software. When the Erase Maps item is selected a file window similar to the "Load Map" file window will appear. The file to be deleted is selected as described in *3.1.1.1 Load Map, p33*. When the file is selected:

Press ***Enter***

The text "Continue (Y/N)" will appear below the horizontal black line:

Press ***Y*** to continue, ***N*** to cancel.

The screen will flash and then return to the title page.

3.1.1.5 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

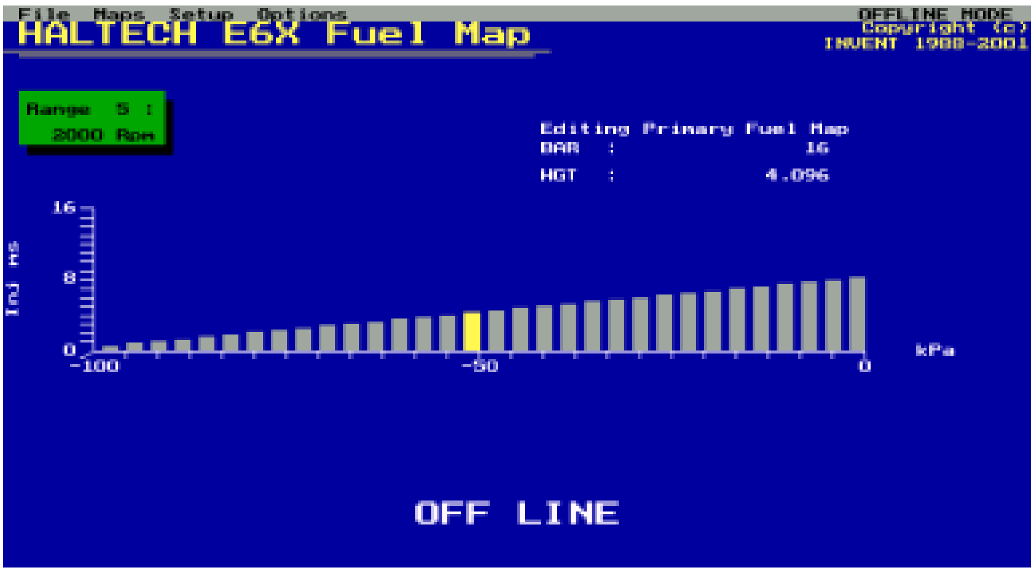
The map menu allows access to the maps contained in the ECU. The following is a description of the map menu and is not a complete description of the maps, for more information on all the maps available and their function refer to

To open the map menu Press ***ALT-M***.
The map menu contains the following items:

- Fuel Map ***CTRL-F***
- Ignition Map ***CTRL-I***
- Ignition Quick Map
- Fuel Correction Maps
- Ignition 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 below 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.

3.1.2.2 Ignition Maps

The ignition maps menu item allows access to the ignition maps in the same way as the fuel maps.

3.1.2.3 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)

3.1.2.4 Ignition Correction Maps

Ignition correction maps allow the ECU to calculate corrections to the ignition timing based on the information received from the engine sensors.
The ignition correction maps menu item will open a sub-menu that allows access the ignition correction maps:

- Coolant Temperature
- Air Temperature
- Coolant Cranking

For an individual description of the above maps refer to - *Haltech Maps, p51.*

3.1.3 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
- Ignition Set-up ***CTRL-G***
- In/Out Set-up ***CTRL-N***
- Program Set-up ***CTRL-P***
- Dual Map Set-up
- Switch Mode ***CTRL-S***
- Calibrate Throttle

The contents of the set-up pages and the usage of “Switch Mode” and “Calibrate Throttle” are described in *CHAPTER 4 Configuring the* ECU*, p42*

3.1.4 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:

- Engine Data Page
- Engine Data Set-up Page
- Output Options
- PWM Options
- Throttle Pump
- Data-log
- Injector trims
- Print ECU Information

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

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 top right of the screen in the grey bar that shows "Offline Mode" or "Online Mode".

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, when the title page appears as shown:

Press:

Y

This will start communications with the ECU.

The programming software requests the ECU to send the current firmware series and version numbers and then the maps currently stored in the ECU. The maps will take a short time to upload to the programming PC (as shown):

When the progress bar reaches 100% the programming software has finished uploading the data from the ECU and the user can start to use the programming software to set-up and tune the engine. If the text “RECONNECT HALTECH” 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 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.

If a sensor reading displays a fault condition like that of the coolant temperature in the above picture it means that the ECU has detected that there is a problem with the sensor or the wiring and that that part of the installation should be checked. In the case above the coolant sensor has been disconnected and the circuit is open. Check all the sensors for operation as far as is possible.

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-I - Ignition Maps
- CTRL-M - Main Set-up
- CTRL-G - Ignition set-up
- CTRL-N - In/Out set-up
- CTRL-P - Program Set-up
- CTRL-S - Switch Mode
- CTRL-E - Engine Data Page
- CTRL-O - Output Options
- CTRL-W - PWM Outputs
- 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.

The set-up page is made up of "fields". Each field can have a number of settings.
To navigate through the field use the up and own cursor keys:

↑, ↓

The fields are either "Selection" type or "Text" type. The Selection type fields give you a number of valid entries for that field, for example: the valid number of cylinders can be set to 1, 2, 3, 4, 5, 6, 8, 10 or 12. To change this type of field use:

TAB to change the field value
Enter to confirm the change.

Each stroke of the Tab key will display the next selection. To step backwards through the selection field options use:

SHIFT-TAB

Text Fields require you to enter either text or numbers. Once the field is selected, the new text can be typed. An example is the Rev Limit field found in the Main set-up page. This field can be set between 2000 and 16000 rpm. If you want the rev limit to occur at 7000rpm, then you would need to select this field and type the following:

7000
Enter

4.2 The ECU Set-up Pages

There are 4 main set-up pages that define way the ECU operate. These are:

- Main Set-up
- Ignition Set-up
- Fuel Set-up
- In/Out 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 supercharging, 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 E6X will resume normal fuel or ignition 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.

RPM Limit Type

The RPM Limit can either be a fuel cut or an ignition cut. This field determines what form of limit will be used. Be careful using an ignition cut since the unburnt fuel can damage the catalytic converter.

Units

The programming software can display parameters in either Metric or US units.

RPM Mode

The ECU fuel and ignition 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 and ignition Maps, and will change the tuning of the engine dramatically.

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.

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:

Ign / By

Ignition Divide By is the number of ignition 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 or Sequential mode, or is a rotary, then a value of 1 is suggested.

Decel Cut-Off

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.

Injection Mode

The ECU can operate in 4 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.

Sequential injection fires the injectors sequentially meaning the fuel can be injected at precisely the right time, this is particularly useful for engines with large duration cams. This not a straightforward set-up, it requires more outputs for fuel than normally used.

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.

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 *9.5 BAROMETRIC CORRECTION, P74***

Disable Injector Outputs

This field allows the user to turn off all injector outputs. Setting the value to YES will disable all injector output which allows easy checking if the trigger and ignition timing when cranking without having to locate the injector fuse and remove it. Normally this field should be set to NO to allow the injectors to fire.

4.2.3 Ignition Set-up Page

The Ignition set-up page contains the information about the ignition and trigger system the ECU is to control. The Ignition Set-up Page is accessed via the set-up menu or using: ***CTRL-G*** from anywhere in the programming software.

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

Trigger Input

This field defines the type of pickup used to trigger the ECU. Select *Int. Reluctor* or *Hall effect* depending on the trigger being used. As both Hall effect and optical trigger sensors generate a square wave select Hall effect for optical sensors.

Trigger Edge

This field is only applicable if you are using a Hall effect pickup as the "Trigger Input". The trigger edge defines whether the ECU sees a *rising* or *falling* signal from the pickup. For a further description on trigger edge see the appendix.

Motronic Mode

This field allows the user to enable or disable trigger filtering when using the built-in RA8 reluctor adaptor. Typically this field is set to “OFF” to maximise noise suppression. Many missing tooth triggers such as late model Subaru and Bosch 60-2 motronic require this field set to “ON” to maintain a good trigger signal.

Trigger Gain

This field is only applicable if you are using a Reluctor pickup as the "Trigger Input". The Trigger Gain defines the amplification of the signal from the Internal Reluctor pickup required to trigger to the ECU. This function has been developed to allow a wide range of Internal Reluctor pickups of varying signal amplitude to drive the ECU. When choosing the Trigger Gain start at *zero* and increase the gain until a steady trigger signal is seen, this can be done when the timing is checked for the first time.

During cranking check that there is ignition and that the timing mark on the pulley wheel does not jump erratically, if there is no ignition or the timing mark jumps erratically increase the gain until the timing mark is steady. This should only be done when the installation is complete.

Home Input

This field is only applicable in some direct fire ignition, sequential or batch injection installations. This field has the same options as "Trigger Input".

Home Edge

This field is only applicable in some direct fire ignition, sequential or batch injection installations. This field has the same options as "Trigger Edge".

Home Gain

This field is only applicable in some direct fire ignition, sequential or batch injection installations. This field has the same options as "Trigger Gain".

Trigger Angle - °BTDC

This field defines the angle in °BTDC at which the ECU will be triggered. The ECU uses this value to calculate the time for the next ignition so it is important that this value is correct since it will affect the base ignition timing.

Lock Timing

This field allows the Timing to be locked at a specified angle regardless of engine speed. Select *Yes* or *No* to enable or disable Timing Lock.

Lock Timing Angle - °BTDC

This field defines that angle in °BTDC at which the timing is locked. 10° is common but this value can be in the range 0-25°BTDC to suit the timing marks that are available on the timing pulley.

Trigger Type

This field defines the trigger pattern the ECU will see coming from the crank or camshaft angle sensors. The E6X currently supports the following trigger types:

Standard
Multi-tooth
Motronic
Subaru (Early and late)
Twin Trigger
Daihatsu (extra tooth)
Nissan
Mazda (FS)

Number of Teeth

This field is only applicable if the trigger type is: Multi-tooth, Motronic. The Number of teeth:

Multi-tooth The number of teeth on the multi-tooth wheel
Motronic The number of teeth on the Motronic wheel including the missing teeth in each 720° engine cycle.

Tooth Offset

This field is only applicable if the trigger type is: Multi-tooth or Motronic. The offset is the number of teeth the synchronisation event occurs prior to the trigger

Home Window Teeth

This field is only applicable if the trigger type is Nissan. The "home window teeth" is the number of teeth counted during the home window.

Nissan Tooth Offset

This field is only applicable if the trigger type is Nissan. The Nissan tooth offset is used to delay the trigger event after the synchronisation event defined by home window teeth.

Spark Mode

This field defines the ignition delivery used, the options are: Distributor, Direct Fire or Twin Distributor.

Coils on 4-cylinder motor

This field is only applicable if the spark mode is Direct Fire and the number of cylinders in the main set-up is 4. The options for this field are: 2 or 4. If 2 is selected waste spark is used. If 4 is selected there is one coil for each cylinder.

Engine Type

This field defines the engine type: Piston or Rotary.

Output Type

This field defines the type of ignition signal with which the ECU will drive the igniter. The options are:

Constant Duty This signal is used to drive intelligent igniter with internal dwell control.

Constant Charge This signal is used to drive dumb igniters without internal dwell control. This output type will not accurately control intelligent igniters.

WARNING:
THE CONSTANT DUTY OUTPUT TYPE SHOULD NOT BE USED TO DRIVE DUMB IGNITERS SINCE SUCH IGNITERS DO NOT HAVE DWELL CONTROL. DOING SO WILL RESULT IN TOTAL FAILURE OF THE IGNITER.

Coil Charge Time (ms)

This field is only applicable when constant charge is selected. The value of this field is a measure of time in milliseconds and can range from 0.1ms - 8.2ms Typical values are about 4-5ms.

Output Edge

This field defines which edge of the signal defines the ignition event: falling or rising. The EB023 smart igniter uses a falling edge.

Duty Cycle (and will fall after xx% of its period)

This field defines the duty cycle high time when using the constant duty output type with a smart igniter. For the EB023 smart igniter the duty cycle high time is 70% with a corresponding 30% low time.

NOTE:
Now that the ignition set-up is correct the ignition system may be connected to the ECU. Be sure that the ECU is reset (by turning the key "off" then "on") before you connect the ignition system to be sure that the ECU has enabled any changes made to the set-up.

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)	±12.5% adjustment of fuel.
Fuel (Coarse)	±50% adjustment of fuel.
Ignition	+7 to -8 degrees adjustment of ignition advance.
Ignition Trailing	+7 to -8° adjustment for Rotaries only
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	±12.5% adjustment of fuel.
Fuel (Coarse	±50% adjustment of fuel.
Ignition Trim	+7 to -8 degrees adjustment of ignition advance.
Ign Trailing Trim	+7 to -8° adjustment for Rotaries only.
Baro Sensor	Barometric Pressure Sensor (internal/external).
Exhaust MAP Sensor	Exhaust Pressure(does not affect ECU operation)
Aux RPM Limit	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.
O2 Sensor	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:

Disabled	No effect on ECU operation.
NOS Input	This input is used in conjunction with *NOS Switch, p92*
TCC Input	This input is used in conjunction with *Torque Converter Clutch Lockup (TCC), p90*
Turbo Timer	This input is used in conjunction with *Turbo Timer (TT), p92.*
Anti-Lag Switch	This input is used in conjunction with *13.13 Anti-Lag Switch, p93.*
Flat Shift Switch	This input does not operate in conjunction with any output. It is used by the ECU to retard ignition timing to 15° ATDC, allowing the throttle to be held wide open whilst changing gears. This reduces engine deceleration so gear changes will be quicker, but it also prevents the engine from over-revving when the clutch is disengaged. The driver normally depresses the switch just as they are going to disengage the clutch and then releases the switch just after the clutch is re-engaged. The driver can therefore keep the throttle wide open throughout the gear change.
Air Conditioning Request	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 *13.14 Air Conditioning, p94*
Dual Maps	This input is used to swap between the primary and secondary maps. See section *5.4 Dual Maps, p62*

Aux. Out Function

The Auxiliary Output on the E6X 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:

Disabled	No effect on ECU operation.

Ignition Bypass	Bypass signal compatible with some General Motors ignition systems. This function allows the ignition system to provide the spark at 10° BTDC at cranking speeds (below 500rpm). This aids starting.
Staging Signal	Logic output that indicates Staging conditions. If Staging is selected, and the Staged injector are firing, this signal will be high (5 volts), otherwise it will be low (~ 0 volts).
Tacho Output	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.
Ignition Toggle	This output is used for rotary set-ups where both the primary and secondary trailing ignition signals are connected on the single channel. This minimises the amount of outputs needed to run this engine configuration.

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 CORRECTLTY.
EXCESSIVE CURRENT PASSED THROUGH AN INJECTOR LOAD FOR A LONG PERIOD OF TIME MAY DAMAGE THE INJECTORS

4.2.5 Dual Map Set-Up

The ECU is capable of storing two sets of base fuel and base ignition maps. These two sets of maps allow the user to map the ECU for different engine conditions such as:

- If a user wishes to use racing fuel on race day but standard pump fuel map can be tuned for a specific fuel.
- Vehicles that have variable valve timing and/or lift require different fuelling at the same load and rpm point for different valve timing and lift positions.

The dual map set-up pages have the following fields:

Currently Editing

This field allows the user to select which set of fuel and ignition maps they wish to edit. This field has the following options:

Primary Map	This selects the primary maps for editing.
Secondary Map	This selects the secondary maps for editing

Use of Secondary Map

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

Never This causes the ECU to only use the primary base fuel and ignition maps.

Always This causes the ECU to only use the secondary base fuel and ignition maps.

Enable with Aux. In This causes the ECU to use the primary base fuel and ignition maps when the Aux. In *is not connected to ground*. The ECU uses the secondary base fuel and ignition maps when the Aux. In *is connected to ground*.

> Note:
> The Aux. In field in the Input/Output Set-up page must be set to Dual Maps Input. Refer to *4.2.4 The In/Out Set-up Page, p49*

Enable with VTECH This causes the ECU to use the primary base fuel and ignition maps when the VTECH Output is *inactive*. The ECU uses the secondary base fuel and ignition maps when the VTECH Output is *active*.

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 The In/Out Set-up Page, p49*.

The options are:

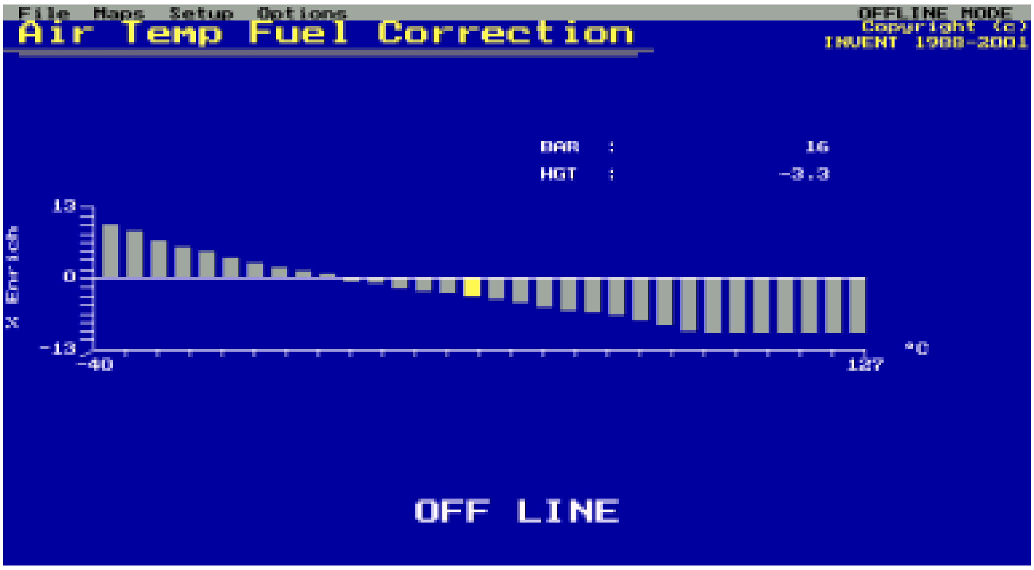
Always The gas compensation maps will always be used.

Enable with Aux. In The gas compensation maps will only be used if the Aux. In. line *is connected to ground*. The gas compensation maps will not be used if the Aux. In. line *is not connected to ground*.

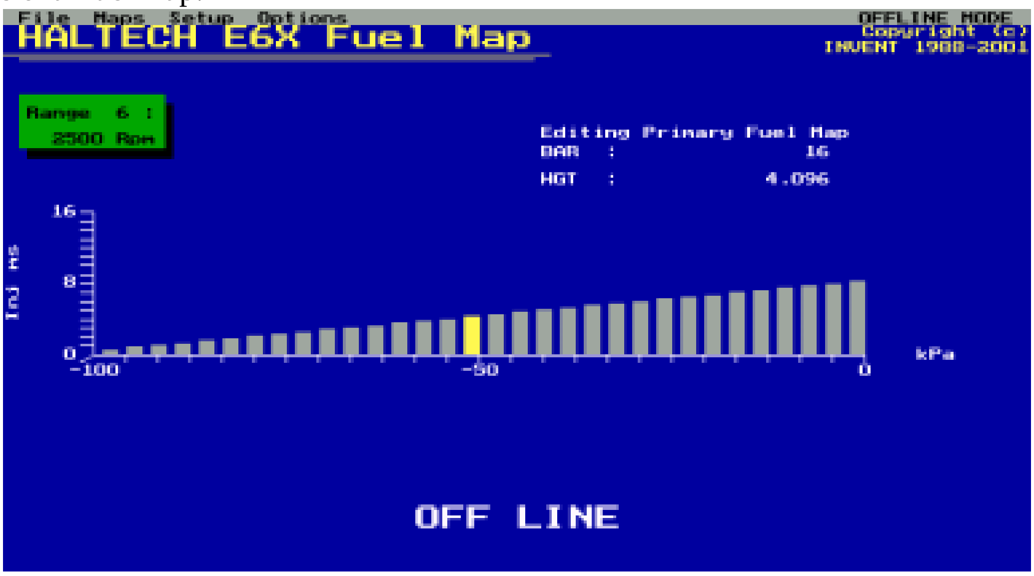
CHAPTER 5 HALTECH MAPS

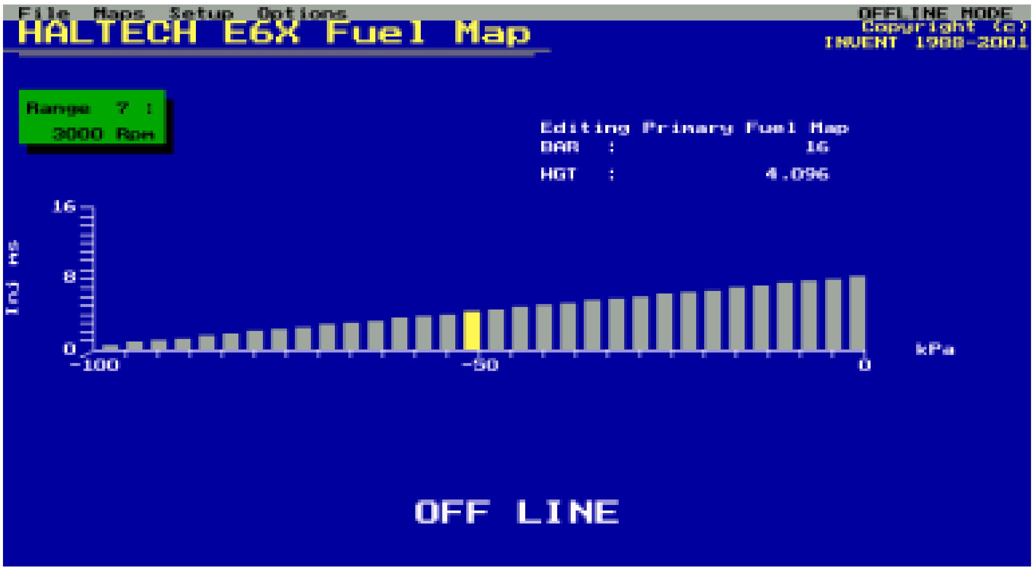
5.1 What are maps?

The Fuel and Ignition 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 and the base ignition map that maps ignition vs. engine load and engine speed. These 3-dimesional 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 3000rpm. The yellow bar shows that the engine requires 4.096ms of fuel at –50kPa and 3000rpm.

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

The programming software presents the maps in a bar graph formation to make it easy to visualise fuelling and ignition.

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, p38*

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 The 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 4 key combinations that allow different increments in bar height.

The key combinations and bar increments:

Key Combination	Increment
↑ or ↓	0.016ms
PgUp or PgDn	0.128ms
Shift-PgUp or Shift-PgDn	0.5120ms
Ctrl-PgUp or Ctrl-PgUp	1.0240ms

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 change select the bars that need to be changed and press:

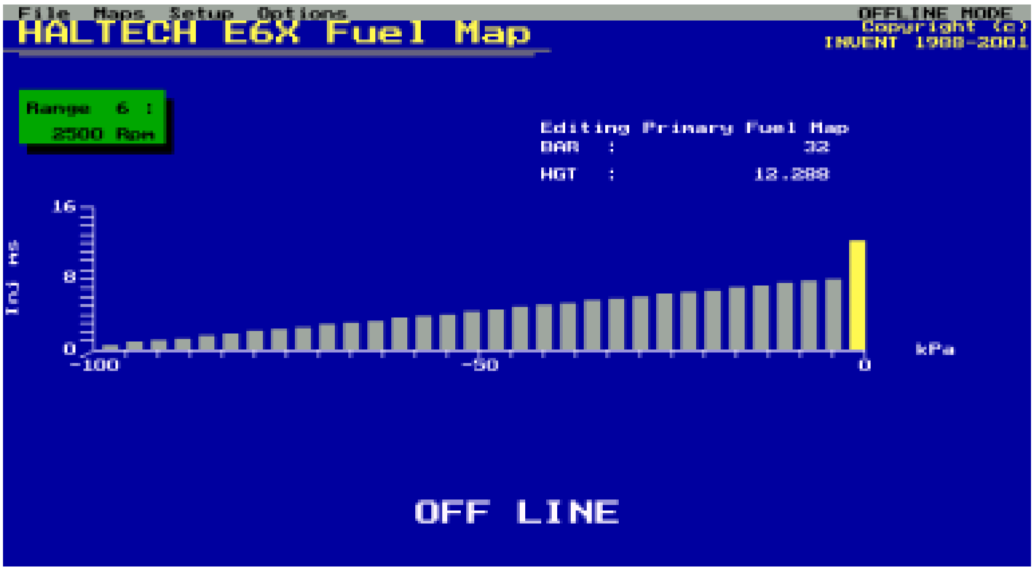
ALT-P

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.

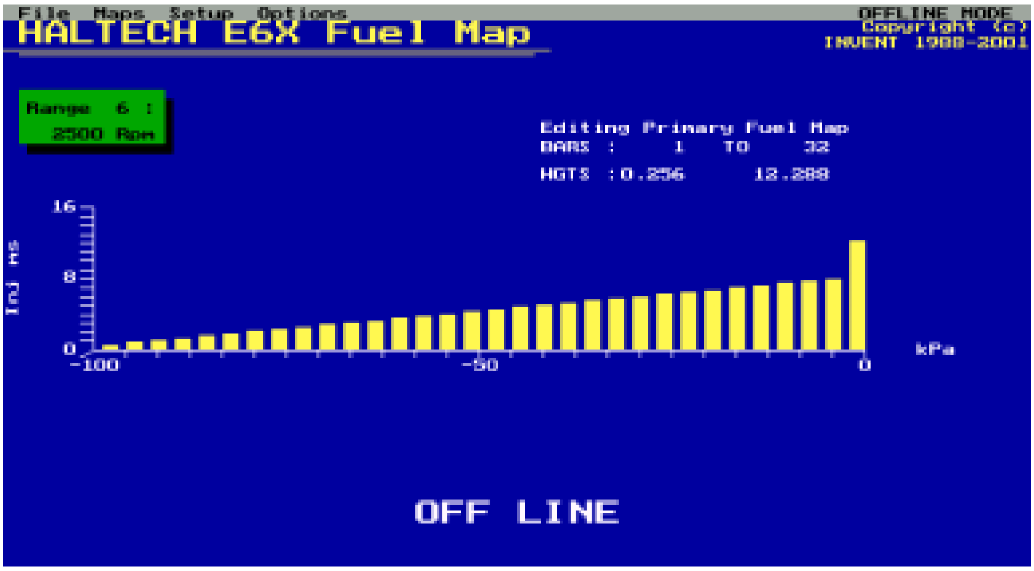
NOTE:
The percentage increase and decrease calculations are based on the current height of the selected bars. This means that if a bar has a 50% increase applied and the user wishes to reverse this increase, a decrease of 33% is required. For example: if a bar had a height of *4ms* and it has a 50% increase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

5.2.4 Linearise

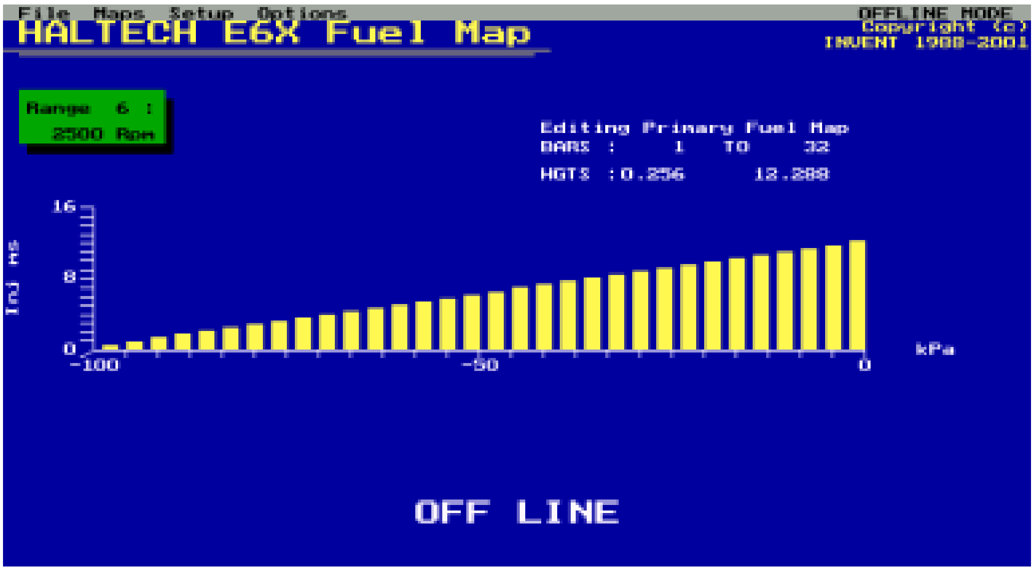
When tuning it is often useful to be able to set two load points with a given value and approximate the fuel requirements between those two points with a straight line. The linearise function allows the user set approximate fuel values based on a straight-line approximations as shown below:



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 12.288ms, 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:

ALT-N

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.

5.3 The Haltech Maps

The Maps that the ECU uses to calculate fuel and ignition 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-key ***CTRL-F.***
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 uncorrected quantity of fuel that is to be injected for the given load and rpm in the range 0ms to 16ms.

5.3.2 Ignition Map – 3-Dimensional

The ignition map is accessed through the menu structure under the maps menu or using the hot-key ***CTRL-I.***
The Base ignition map represents the reference on which all ignition corrections are made to calculate the final ignition timing requirement for the given engine load and engine speed. This map should closely reflect the engines ignition timing requirements at optimum operating temperature and average operating and environmental conditions. This map is where the most tuning is carried out.
The ignition map comprises a series of 2-dimesional maps of ignition timing 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 ignition 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 uncorrected ignition timing that is to be used for the given load and rpm in the range 0°BTDC to 50°BTDC.

5.3.3 Trailing Ignition Map – 3-Dimensional

The Ignition trailing map is accessed through the menu structure under the maps menu.
The ECU uses the trailing ignition map for the ignition angle split between the leading and trailing ignition events on a rotary engine. Refer to *4.2.3 Ignition Set-up Page, p46*
The trailing ignition map comprises a pair of 2-dimensional maps of ignition timing split versus engine load in the range 0° to 20 °. The first 2-dimensional map represents ignition timing split for engine speeds below 2000rpm and the second map represents ignition timing split for engine speeds above 2000rpm.

5.3.4 Fuel Correction Maps

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

5.3.4.1 Coolant Temperature Correction

The coolant temperature correction map is accessed through the menu structure and can be found under "Fuel Correction Maps" 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 –40°C to 127°C and each bar represents a percentage correction to the current calculated fuel.

5.3.4.2 Air Temperature Correction

The air temperature correction map is accessed through the menu structure and can be found under "Fuel Correction Maps" 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.

5.3.4.3 Battery Voltage Correction

The battery voltage correction map is accessed through the menu structure and can be found under "Fuel Correction Maps" 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.

5.3.4.4 Primer Map

The primer map is accessed through the menu structure and can be found under "Fuel Correction Maps" in the maps menu.
The primer map is used to add a quantity of fuel based on coolant temperature when the first 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.

5.3.4.5 Post Start Map

The post start correction map is accessed through the menu structure and can be found under "Fuel Correction Maps" 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, p44*) and each bar represents a percentage correction to the current calculated fuel.

5.3.4.6 Barometric Pressure Map

The barometric pressure correction map is accessed through the menu structure and can be found under "Fuel Correction Maps" 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.

5.3.4.7 Gas Pressure Map

The gas pressure correction map is accessed through the menu structure and can be found under "Fuel Correction Maps" 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.

5.3.4.8 Gas Temperature Map

The gas temperature correction map is accessed through the menu structure and can be found under "Fuel Correction Maps" 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 are are normally not used unless gas injection has been employed.

5.3.5 Ignition Correction Maps

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

5.3.5.1 Coolant Temperature Correction

The coolant temperature correction map is accessed through the menu structure and can be found under "Ignition Correction Maps" in the maps menu.
The coolant temperature correction map is used to adjust the ignition timing based on the coolant temperature measured 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 percentage correction to the current calculated ignition angle.

5.3.5.2 Air Temperature Correction

The air temperature correction map is accessed through the menu structure and can be found under "Ignition Correction Maps" in the maps menu.
The air temperature correction map is used to adjust the ignition timing 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 ignition angle.

5.3.5.3 Coolant Temperature cranking map

The coolant temperature cranking map is accessed through the menu structure and can be found under "Ignition Correction Maps" in the maps menu.
The coolant temperature cranking map is used to apply a set ignition angle based on the coolant temperature measured by the ECU at engine speeds below 380rpm, which are considered to be cranking speeds. The map has 32 bars distributed across coolant temperature in the range –40°C to 127°C and each bar represents an ignition angle.

5.3.6 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.

5.3.7 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, p44*) and applies a set amount of fuel in place 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.

5.3.8 Injector Phase Map

The injector phase map is accessed through the menu structure under the maps menu.
When sequential injection is used, the ECU uses the injector phase map to determine the "end of injection" angle. The map has 32 bars distributed across engine speed in the range 0rpm to 16000rpm and each bar represents an angle before top dead centre exhaust in the range 0°BTDC (exhaust) to 120°BTDC (exhaust).

5.3.9 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 *13.1 Turbo Waste Gate Control (TWG), p88.*.
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%.

5.3.10 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 *13.4 Torque Converter Clutch Lockup (TCC), p90.*
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 100% and each bar represents the road speed at which the clutch lock-up should be engaged in the range 0k/h to 300k/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 and ignition 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 VTECH 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 and ignition 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 and ignition maps allows both states of variable valve control to be mapped correctly. Refer to *4.2.5 Dual Map Set-Up, p51*. The turbo waste-gate control solenoid maps can also be configured such that waste-gate Map 1 is used with the primary fuel and ignition maps and waste gate Map 2 is used with the secondary fuel and ignition maps. This allows different boost levels for different fuels and environments. Refer to *13.1 Turbo Waste Gate Control (TWG), p88*.

5.4.1 Editing Dual Maps

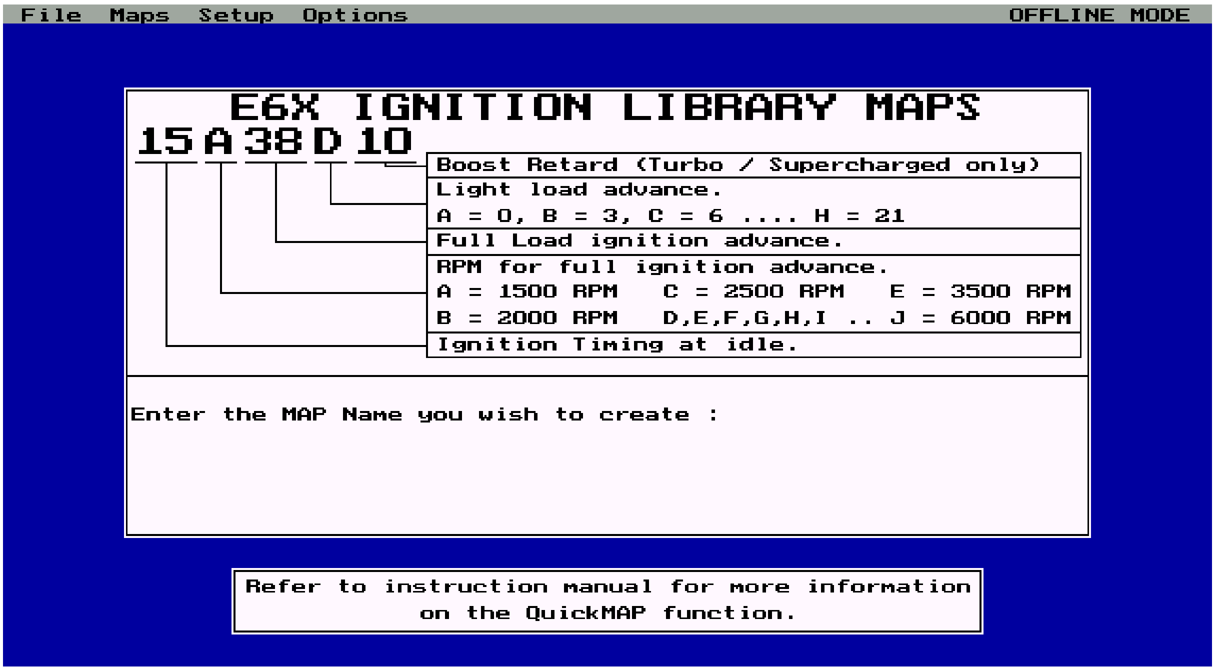
When modifying the fuel and ignition maps the user can swap between editing the primary and secondary map by pressing *Alt-D*, The current map is displayed on the screen and it is identified by:
“Editing Primary Map” for the primary map or “Editing Secondary Map” for the secondary map.

This only identifies the map being edited, not the map being accessed by the ECU to run the engine.
The active editing map can also be selected through the Dual Map set-up page.

5.5 Ignition Quick-Map

Often when mapping ignition it is simpler to start with a basic ignition profile which takes into account the basic ignition requirements with respect to engine speed and load. The ECU programming software has a feature called the *Ignition Quick-map* which allows the user to profile a map quickly to speed the ignition tuning process.

The ignition timing library Maps use these eight characters as shown below. The first character is always a number.



- The first two characters in the ignition timing map name specify the ignition timing to be used at idle. The example map name shown has 15 degrees of advance at idle.
- The third character in the ignition timing map name specifies the Rpm at which maximum advance occurs (i.e.. how quickly advance changes with engine speed). This character is a letter of the alphabet. Option A has full advance in by 1500 Rpm. Option B has full advance in by 2000 Rpm. Option C at 2500, etc. up to J for 6000 Rpm.
- The fourth and fifth characters in the ignition timing map name specify the maximum advance at atmospheric pressure in the inlet manifold. Cruise or light load advance is added to this value, while retard on boost for turbocharged or supercharged engines is subtracted from it.
- The sixth character in the ignition timing map name specifies the extra ignition advance to use at light loads such as highway cruise. This is equivalent to the vacuum advance on a distributor. If this character is A, there is no extra advance under light load. Each successive letter of the

alphabet after A adds 3 degrees of ignition advance to the full load advance under light load, up to the letter H. (H = 21°)

- If the engine is turbocharged or supercharged then the seventh and eighth characters specify the ignition retard the engine is to get under boost. This value is subtracted from the atmospheric pressure advance value. If the engine is not turbocharged or supercharged, then leave the name only six characters in length.

A description of each parameter is displayed on the Library Maps page to save you referring to this manual.

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 "calibrate throttle" option from the options 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.

6.3 Checking the Base Timing

The ECU uses an engine position reference taken from a cam angle sensor or crank angle sensor. This allows the ECU to calculate ignition timing and fuel events. If the trigger angle is wrong then the ECU cannot function correctly. To ensure that this trigger angle is correct a base timing test is carried out. The E6X has a "Lock Timing" setting that allows the user to program the computer to cause all ignition events to occur at a constant angle regardless of timing information in the ignition maps.
The Lock Timing can be set between -5° to +25° Before Top Dead Centre (BTDC)).
The Lock timing setting is accessed through the ignition set-up.

To check the base timing you should now start the engine with the Timing Lock "on" and set to an angle that allows the user to accurately measure the ignition timing with a stroboscopic timing light. Crank the engine and check for spark (easily checked with a timing light). Now crank the engine and look for the timing mark with the timing light (ensure you have the timing light connected to the correct cylinder). If the timing is wrong change the trigger angle (in the ignition set-up page) until the timing reads correctly. If you cannot see the timing mark you may need to estimate the trigger angle based on the relative positions of the engine and the crank position or cam position sensors and then try the test again.

NOTE:
Some triggers have a tooth offset setting that gives greater flexibility in setting the trigger angle. Check to see if this setting can be used to obtain good timing.
DO not crank the engine for prolonged periods. To conserve the battery remove the spark plugs to take some of the load off the starter motor during cranking.

WARNING:
WHEN CONDUCTING A TIMING CHECK IT IS ADVISABLE THAT TWO PEOPLE BE PRESENT, ONE TO CHECK THE TIMING AND THE OTHER TO CRANK THE ENGINE. BE SURE TO COMMUNICATE PROPERLY ESPECIALLY WHEN DOING THE TIMING CHECK NEAR MOVING BELTS.

Once the trigger angle is set correctly lock timing should be disabled and fuel injectors enabled so an attempt may be made to start the engine.

6.4 Determining Ignition Timing

The default ignition timing loaded into the ECU at the factory is 15°BTDC across load and engine speed. This map is often sufficient to get the engine started. If this ignition map is not suitable a basic timing curve should be constructed, this can be done manually or the *Ignition Quick-Map* function can be used to automatically create a full ignition map based on basic information about the engines ignition requirements.

6.5 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, p49*.

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.

6.5.1 Starting the using Manifold Pressure Load Sensing

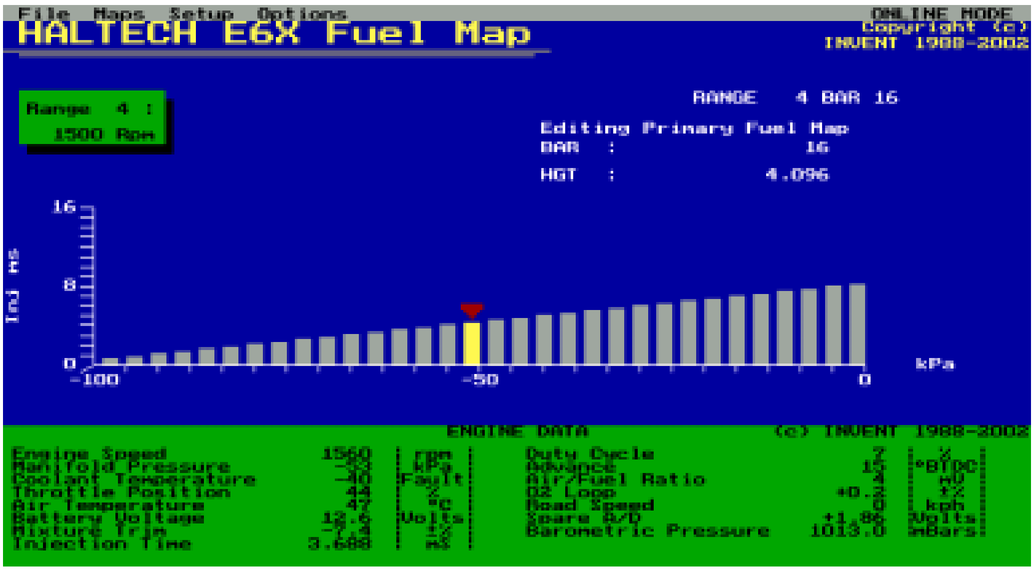
Try to start the engine. At cranking speeds the manifold pressure will be close to atmospheric due to the low airflow around the throttle plate and through the idle passages. This means that the ECU will use the bars at and just below atmospheric pressure. When the engine fires and the engine speed starts 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 no should be further to the left again.

6.5.2 Starting the using 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.

6.5.3 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 red arrow (called the map pointer) that points to the current bar in the map the ECU is using for fuel calculations as shown below.



The Home Key that automatically jumps to the current range in a 3-dimensional map. To jump to the current range press:

HOME

This will take you to the current range used at the time the Home Key was pressed.

6.5.4 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 *5.3.6 Zero Throttle Map, p61*.
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.

6.5.5 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 ignition set-ups is correct. If you continue to have problems refer to the troubleshooting guide in the appendix.

6.5.6 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.

6.5.6.1 On the Dyno

Whether the vehicle is on a chassis dyno, or the engine on an engine dyno, the principles of programming the Haltech E6X 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 pistons and crankshafts. 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.

6.5.6.2 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.

6.5.7 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 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 E6X 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 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 E6X 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 air flow. This makes fuel metering difficult. In particular, the Map sensor often cannot correctly read the manifold pressure, as it is either 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 air flow at zero throttle for a given engine speed. That means that devices such as idle speed motors that vary the air flow 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. The ignition-cranking map sets the crank advance for different coolant temperatures and the ignition coolant map corrects the ignition advance from the Ignition Map for different coolant 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.

The ignition timing can also be set for cold cranking. As with the Cold Prime Map, the Crank Ignition Map sets the ignition timing to be used while cranking according to the coolant temperature. This Map is set flat to 15° at factory, but it can be adjusted to give better starting at all temperatures.

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 and coolant temperature and inlet air temperature ignition 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 E6X 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 The Ignition Coolant Map

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

9.4 The Ignition Inlet Air Temperature Map

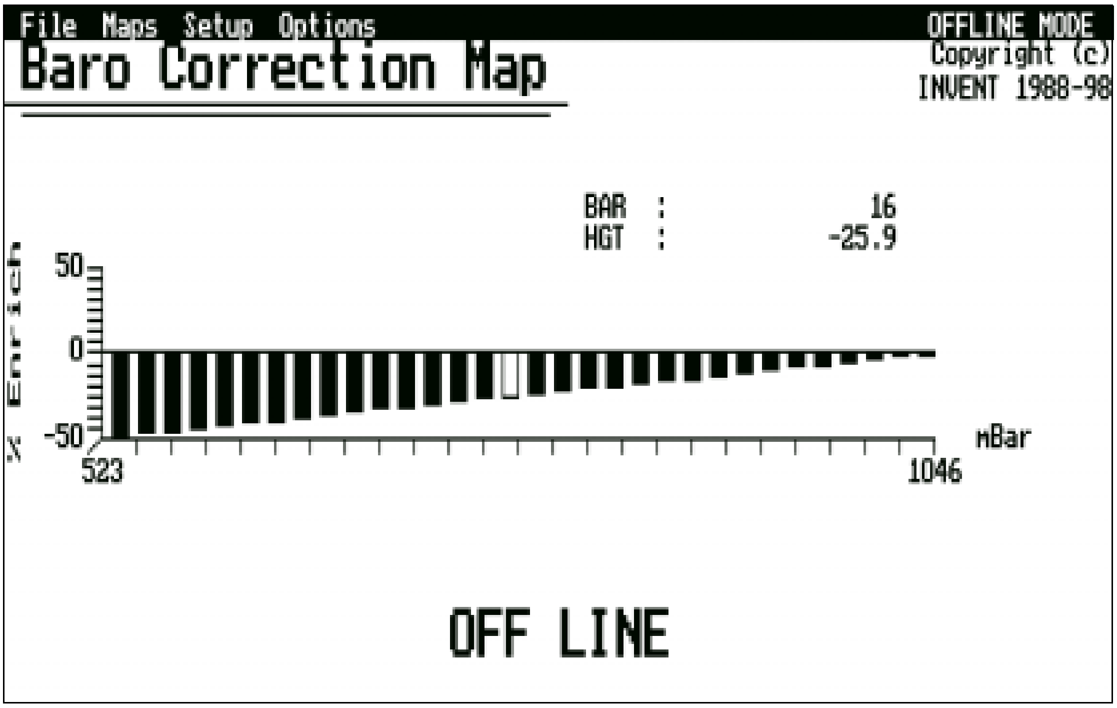
This Map allows up to 10° advance or retard of the spark timing based on the inlet air temperature. Normally this Map would not need to be used, but in some cases such as high inlet air temperatures on turbo/supercharged engine, retarding the spark may help preserve the engine.

9.5 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 breath 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.

9.5.1 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 %.

9.5.2 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 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.

9.5.3 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, p49*.

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.

9.6 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, p44*.

SECTION 3 Software Features

CHAPTER 10 PRINTING MAPS

You can print the maps and identification information to printers that accept IBM emulation mode, such as IBM compatible dot matrix printers (consult your printer manual). The Print function should work with other IBM compatible printers, but some special characters such as °, ±, etc. may not print correctly. The print function is accessed through the menu structure under the options menu.

There are four options for printing:

Set-up Information
This will print only the set-up pages

Maps
Prints all the maps in the system (i.e. Fuel, Ignition and Coolant).

Output Options
This function will print the current settings and the status of the output options of the ECU. (i.e. turbo waste-gate).

Print All Information
This will print all of the above information

The system will ask for a name to print at the top of the printed output. This allows you to differentiate between print outs if you have printed more than one set of maps. The name can be up to ten characters in length.
The system pauses to allow you to set up the printer. Press any key to start printing. Before you start printing the printer must be ONLINE and must have power and paper. To abort the print job press ***ESC***.

CHAPTER 11 DATA LOGGING

11.1 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 submenu is accessed through the menu structure under the options menu.

11.1.1 Creating a Data log

There are two methods of logging the engine data; logging to memory or logging to disk. When logging to memory the data log is limited to 10 pages, which equates to about three minutes of logged engine data. Logging to disk is only limited by the available space on the disk from which the software was started.

To start a data-log Start the software in the online mode. The data-log sub-menu is accessed in the options menu. Select either "Data-log to memory" or "Data-log to disk"

11.1.2 Viewing the Data log

To view the data log you have just taken, press **V** from the Data log sub-menu. The Engine Data information will appear as rows across the screen, with a time index at the end of the row.

At the bottom of the screen is a list of the command keys. They are described in detail here:

↑	- scroll up data log one line
↓	- scroll down data log one line
PgUp	- scroll up data log one page
PgDn	- scroll down data log one page
Home	- jump to start of data log
End	- jump to end of data log
?	- jump to page #
S	- show statistics (max., min. & avg. of each parameter)
ESC	- exit

If the power to the ECU is interrupted while a data log is running, the data log will stop until the power resumes. This will save memory while ignition is switched off.

11.1.3 Data log File Management

Data log files may be saved to disk, loaded and erased in exactly the same manner as maps. From the Data log sub-menu, you can do the following:

S - save data log to disk. This function is only relevant if you have previously performed a data log to memory.
L - load a data log from disk.
E - erase a data log from disk.

When saving a Data log to disk, you should also save the Maps being used at the time of the Data log. It is advised to do this before the Data log is taken. Saving the Maps makes sure that all the engine information (including the Identification and the set-ups) is saved to disk.
Before loading a Data log from disk, you should load the Maps that were saved with it so that the programming software knows the set-up of the ECU and can calibrate the data properly.

WARNING:
DO NOT LOAD A DATA LOG WHEN ONLINE TO THE ECU, OR ELSE THE MAPS YOU LOAD WILL OVERWRITE THE MAPS IN THE ECU. IF YOU WANT TO VIEW A SAVED DATA LOG, SWITCH TO OFFLINE MODE, LOAD THE APPROPRIATE MAP, AND THEN LOAD THE DATA LOG.

11.1.4 Printing Data logs

You can print Data logs to any ASCII parallel printer, such as IBM compatible dot matrix printers. **This will print the current view only.** If you wish to print another view, switch to that view and print again. To print a Data log press **P** in the Data log sub-menu.

The software will ask if you wish to print to the printer or to a text file. Press **F** to print to a file, or **P** to print to a printer. The software is designed to print to a dot matrix printer. If you do not have a dot matrix printer, print the Data log to a file and then print the file from DOS or from a word processor / editor. Also, the text file can be loaded into a spreadsheet if extra analysis is required.

The information in the Data log is divided into pages of data. The total number of pages in the current Data log is displayed. The software will ask for the numbers of the first and last pages you want to print. If you want to print the entire Data log, enter 1 for the first page, and the number displayed as the last page.

The system pauses to allow you to set up the printer. If you do not want to print you can leave the print function by pressing **ESC**. If you want to re-enter the start and end page numbers press **R**. Any other key begins the printing. Before you start printing the printer must be ONLINE and must have power and paper. Once the printing has started you can abort the printing at any time by hitting **ESC**.

11.1.5 Setting Up the Data log Page

A data-log the data page can only display eight parameters simultaneously. To access the configuration menu press **C** and follow the instructions that are presented with the selection menu.

SECTION4 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:
- O_2 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, p49*
- The Digital Outputs and PWM Outputs are functionally described in the table below. In some applications the Digital Outputs may be used for fuel or ignition and will not be available.

- The O_2 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, p49*

Output Description	**General Purpose Outputs**	
	Digital Out 1–2	**PWM 1 – 4**
Turbo Wastegate	NO	●
Bypass Air Control (BAC)	NO	●
Dual Intake Valve	●	●
Torque Convertor Control	●	●
Thermofan	●	●
Intercooler Fan	●	●
Shift Light	●	●
Aux Fuel Pump	●	●
Stall Saver	●	●
Staging Signal	●	●
Turbo Timer	●	●
NOS Switch	●	●
Anti-Lag Switch	●	●

For further detail on the operation of the PWM outputs and digital outputs refer to *CHAPTER 13 Digital Outputs & PWM Outputs, p88*.

CHAPTER 12 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, p42*.

12.1 The Output Options Page

The output options page contains the set-up information for idle control, O2 closed loop fuel control and the digital 1 and digital 2 outputs. The output options page is accessed via the options menu or using: ***CTRL-O*** from anywhere in the programming software.

12.1.1 Idle Control

The idle control window of the output option page 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

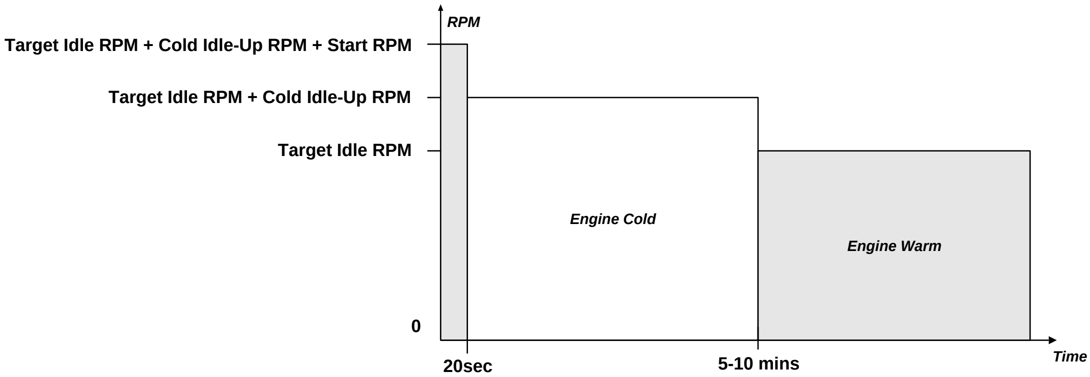
This is the engine speed that the ECU attempts to maintain at idle.

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.

12.1.2 O2 Closed Loop Fuel Control

The O2 closed loop fuel control window of the output option page 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 E6X 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 algorithm 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 algorithm 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 E6X. 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.

12.1.3 The Digital Outputs

The digital output window contents change depending on the function it is to perform. A comprehensive description of these functions can be found in *CHAPTER 13 Digital Outputs & PWM Outputs, p88*.

To change the digital output function change the title field at the top of the digital output window. When the title is changed the remaining fields in the window will also change to reflect the parameters of the new selected option.

12.2 The PWM Options Page

The PWM options page contains the set-up information for the four PWM (pulse width modulation) outputs. The PWM options page is accessed via the options menu or using: ***CTRL-W*** 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 13 Digital Outputs & PWM Outputs, p88*.
To change the PWM output function change the title field at the top of the PWM output window. When the title is changed the remaining fields in the window will also change to reflect the parameters of the new selected option.

CHAPTER 13 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	Digital Out 1–2	PWM 1 – 4	Max #
Turbo Wastegate	N/A	•	2
Bypass Air Control (BAC)	N/A	•	1
Dual Intake Valve	•	•	Unrestricted
Torque Convertor 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
Anti-Lag Switch	•	•	1
BAC2	N/A	PWM 3 & 4	1
BAC2/BAC Slave	N/A	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.

13.1 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 *4.2.5 Dual Map Set-Up, p51*.

Boost Limit *0 – 209kPa / 0 – 30 psi*
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 *ENABLED* or *DISABLED*
This field defines whether the duty cycle being used to drive the solenoid is displayed in the engine data page.

13.2 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 *1 – 50 ms*
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.

The remaining parameters for idle control can be found in the output options page and are described in *12.1.1 Idle Control, p83*.

13.3 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 *0 – 16000 RPM*
This is the engine speed at which the solenoid is to be energised.

Switch Off RPM *0 – 16000 RPM*
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.

13.4 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 *5.3.10 Torque Converter Control Map, p62* - and the Aux. In function - refer to *4.2.4 The In/Out Set-up Page, p49*.

13.5 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.

13.6 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.

13.7 Shift Light Illumination (SL)

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

Light On RPM	*0 – 16000 RPM* This parameter sets the engine speed at which the output will be enabled.

13.8 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.

Load Bar	*Bar 1 – 32* 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.
Engine Speed	*0 – 16000 RPM* 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.
Run Time	*0 – 70 s* 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.

13.9 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.

Lower RPM Limit	*0 – 16000 RPM* This parameter defines the engine speed at which the output will turn on.

13.10 Staging Signal Function (SS)

This function causes the output to turn on when the engine load exceeds the "Staging Bar" value. The staging bar is set in the fuel set-up page refer to *4.2.2 Fuel Set-up Page, p44*.

There are no programmable parameters associated with this function.

13.11 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. line. Refer to *4.2.3 Ignition Set-up Page, p46*.

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

13.12 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	*Bar 1 – 32* 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	*100 – 16000 RPM*

	If the RPM exceeds this value the NOS system will be switched off.
Min. Rpm	*100 – 16000 RPM* 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* The ECU will provide an ignition retard whenever the NOS system is engaged.
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.

13.13 Anti-Lag Switch

WARNING:
DO NOT OPERATE ANTI-LAG FOR PROLONGED PERIODS. EXHAUST AND TURBO TEMPERTAURES RISE, WHICH MAY CAUSE ENGINE DAMAGE.

The Anti-Lag switch function allows turbo-charged vehicles to decrease the “lag” associated with boost when the motor is not under full load.

Retard Value	*0 – 70 °BTDC* The ignition timing is retarded by this angle when the Anti-Lag conditions for operation are met.
% Inc. Fuel	*1 – 50 %* The percentage of fuel increased during Anti-Lag operation.
Zero TPS ONLY	ON or OFF If the Anti-Lag function is to be used when the Throttle Position Sensor value is zero then turn this function ON.
Zero Inj Time	*1 – 16 ms* If the zero TPS only function is ON then this value determines the amount of fuel injected at zero or no throttle. The valid range is (1-16) ms.
Throttle Perc.	*5 – 80 %* The throttle position value below which Anti-Lag is operational. The valid range is (5-80)%.
On RPM	*100 – 16000 RPM* This field specifies the RPM above which Anti-Lag is operational.

On Coolant Temp *0 – 127 °C / 32 - 261 °F*
This field defines the coolant temperature above which Anti-Lag is operational

The anti-lag system is can be enabled by a switch connected to Aux. In or by meeting all three operating conditions stated above (the last 3 fields). Once the switch is enabled, if the Throttle condition is met, the anti-lag system will be activated. The last two fields allow the ALS to be activated when all three conditions are met regardless of the AUX In setting; this allows the AUX In to be used for another purpose.

13.14 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, p49*).

13.15 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.

13.16 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.

On RPM	*0 – 16000 RPM* This field defines the engine speed above which the VTECH is enabled. This field must be greater than Off RPM or it will be ignored.
Off RPM	*0 – 16000 RPM* This field defines the engine speed below which the VTECH 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.
On Load Bar	*Bar 1 - 32* This field defines the engine speed above which the VTECH is enabled. This field must be greater than Off Load Bar or it will be ignored.
Off Load Bar	*Bar 1 - 32* This field defines the engine load below which the VTECH 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.

13.17 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, p49*), 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:

Period (ms)	*1 – 51 ms* This defines the period of the signal used to drive the BAC valve.

Cold Idle Temp. *0 – 127 °C / 32 - 261 °F*
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.

Cold Duty: *0 – 100 %*
This is the base duty cycle used when the coolant temperature is below the Cold Idle Temp value.

Hot Duty: *0 – 100 %*
This is the base duty cycle used when the coolant temp is above the Cold Idle Temp value.

A/C Load Duty: *0 – 100 %*
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, p49*).

Start-Up Duty: *0 – 100 %*
This is a duty value added to the current base value and any other additions to make the total duty cycle. Which is enabled during the first 20 seconds after the engine has started.

Active (Aux In): *HIGH* or *LOW*
This is the Active signal level received from the A/C line when it is making a request (opposite of idle position).

13.18 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.

Slave Channel *PWM3 or PWM4*
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.

13.19 TPS Switch

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

Switch On *0 – 100 %*
This is the throttle position at which the output produces and active level.

Switch Off *0 – 100 %*
This is the throttle position at which the output produces and in-active 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 the 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, p22*. If after following the instructions outlined the program will not run, the most likely cause will be insufficient memory. If this is the case, you must make more free memory available before running the software.

Run the Haltech software from the DOS prompt. If you are loading a number of TSR (Terminate and Stay Resident) utilities during start up, you may need to disable them before running the Haltech software. Refer to your computer and DOS reference manuals on memory management.

Alternatively, you may make your Haltech disk bootable by placing it in floppy drive A: and typing:

c:\> sys a:

We recommend that you make a backup of the original disk before trying this. You should then be able to restart your computer with the disk in drive A:, and the Haltech software will load and run automatically.

If the software still does not run, and you see the message "Error ### at xxxx:xxxx", record these numbers (or letters) and contact your Haltech dealer.

Haltech programming software will not run ONLINE
If the Haltech ECU does not respond to the Programming software requesting information, then the message RECONNECT HALTECH 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 FAULT condition then the sensors are either not operating correctly or are disconnected. Using the wiring diagram of the ECU Loom check that the sensor wires are not damaged. If the wiring is OK then contact your Haltech dealer regarding replacement of faulty sensor.

If the Throttle Position Sensor is showing a fault condition then re-calibrate the throttle sensor and check the wiring

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 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 grounded securely.

If the Engine Speed is steady but wrong, check that the Identification page contains the correct information regarding number of cylinders. Make sure the Multi-tooth trigger type is not selected unless the engine has a multi-tooth wheel. If using a multi-tooth trigger, make sure the number of teeth is correctly set for the number of teeth per **cam** revolution.

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 E6X 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.

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 needs 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. Readjust 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 might be 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 E6X 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 E6X 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 cutoff on deceleration feature.

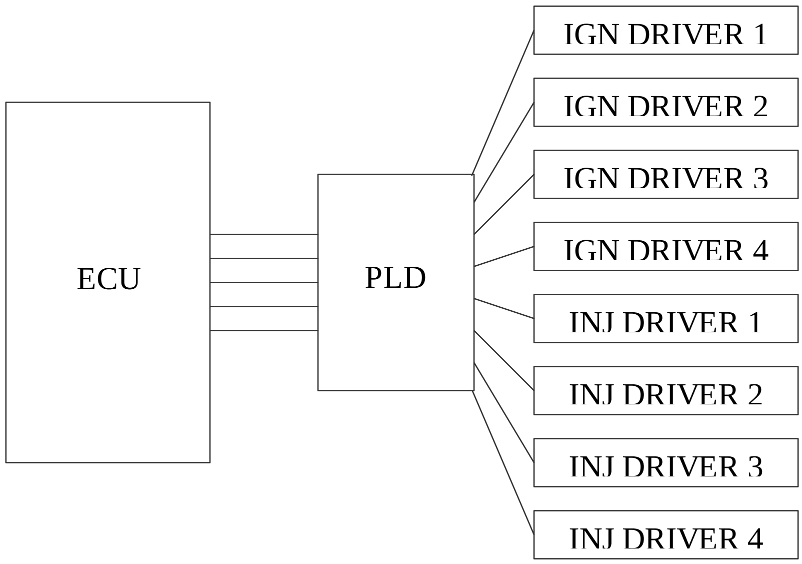
If the city consumption is fair but highway cruising uses too much fuel then lean out the light load bars on the 2000 rpm to 3000 rpm maps (This is where most cruising takes place).

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 IGNITION AND INJECTION OUTPUTS

B.1 Distribution of Outputs

The ECU has five injection/ignition outputs, or channels. These five channels are distributed to the ignition and injection drivers that in turn are connected to IGN1-IGN4 and INJ1-INJ4 respectively.



This configuration gives the user 4 injection drivers and 4 ignition drivers.

B.2 Direct Fire Ignition

There are two forms of Direct Fire Ignition: the first method is to have one coil per cylinder (usually mounted on top of the plug), the second method is to use a wasted spark; the cylinders are paired (cylinders with the same TDC but on different strokes) and fired together each time one of the cylinders requires ignition which means each cylinder has an ignition event as it approaches TDC compression (the ignition required for that cylinder) and TDC exhaust (the ignition required for the paired cylinder).
Each method requires the ECU to know how many coils it must drive. Each coil needs its own ignitor and ignition output. The ECU also need to know the current engine position, it obtains this from a synchronisation signal known commonly as a “home” signal.

The ECU is capable of driving up to 4 coils. This means that engines with more than 4 cylinders are limited to waste spark ignition. Waste spark ignition systems can ignite 2 cylinders for each ignition output consequently direct fire ignition cannot be used on engines with more than 8 cylinders.

Note:
Engines with an odd number of cylinders cannot use waste spark ignition since these engines cannot pair cylinders.

If a 6 or 8 cylinder engine is equipped with a single coil per cylinder these coils can be paired and driven as a waste spark configuration. Each coil requires an ignitor but the ignitor inputs can be paired as cylinders are paired in the above description.

B.2.1 Waste Spark configuration

A V8 with a firing order of: 1-2-7-8-4-5-6-3 has the following cylinder pairs: Coil1-1/4, Coil 2-2/5, Coil 3-7/6, Coil 4-8/3. The coil numbers then match up with the ignition output numbers. The diagram below shows how the coils would be connected.

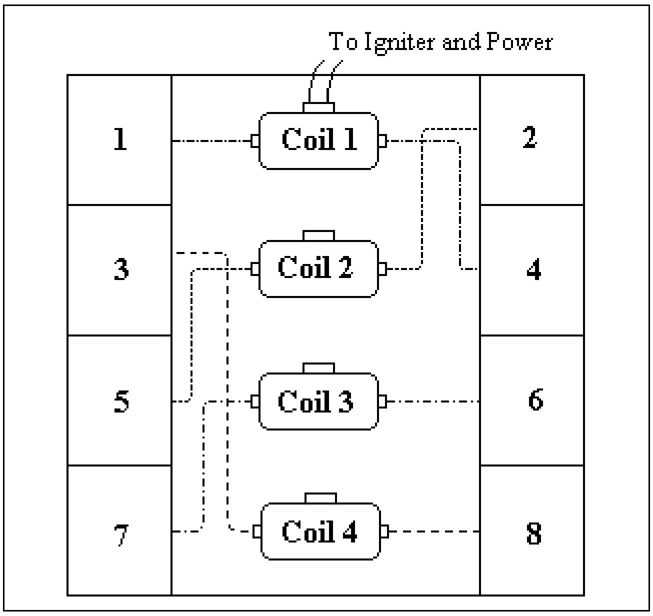


Figure B1. Coil layout for V8 with firing order 1, 2, 7, 8, 4, 5, 6, 3.

B.2.2 Ignition Order

The ECU's fires the ignition outputs as follows:

IGN1
IGN2
IGN3
IGN4

The cycle starts after a synchronisation or home signal is detected. Refer to *4.2.3 Ignition Set-up Page, p46*.

B.3 Sequential Injection

Sequential injection allows fuel to be delivered to the engine at a time that produces best combustion. Since this time is different for each cylinder, sequential systems inject fuel at different engine angles for each cylinder. The ECU will control up to four separate fuel channels. This provides full sequential injection for engines up to 4 cylinders, and semi-sequential for 6 and 8 cylinders engines.

B.3.1 Injector Phasing

The timing (or phasing) of these injections is programmed through the Injector Phasing Map. This Map sets the angle of the End of Injection, in degrees BTDC exhaust against engine speed. This allows the injection to be completed before the inlet valve opens. If the ECU computes that there is insufficient time to complete injection before the specified End of Injection time, then injection will continue past this time.

B.3.2 Injector Trims

With multiple injector channels, it is possible to trim the fuel injection time to each channel. The ECU has the ability to adjust each channel by ± 12.5%. This is meant primarily to equalize distribution of fuel to individual cylinders due to limitations in inlet manifold design or to ‘equalize’ flow rates between injectors with marginally different flow rates.

B.3.3 Sequential Injection Order

The ECU’s fires the injection outputs as follows:

INJ1
INJ2
INJ3
INJ4

The cycle starts after a synchronisation or home signal is detected.

The ECU can only provide 4 separate fuel outputs. For engines with more than 4 cylinders configured for sequential injection, the ECU will operate in a semi-sequential mode.

There are 2 options for semi-sequential injection:
The first requires the user to pair the cylinders adjacent in the firing order. A 6-cylinder engine with firing order 1-5-3-6-2-4 would have the following injector pairs:

INJ1	cyl 1 and cyl 5
INJ2	cyl 3 and cyl 6
INJ3	cyl 2 and cyl 4

This fuel scheme requires a home signal that is driven by the cam so that the ECU knows what the engine position is in its 720° cycle. The second requires the user to pair the cylinders opposite in the firing order. A 6-cylinder engine with firing order 1-5-3-6-2-4 would have the following injector pairs:

INJ1	cyl 1 and cyl 6
INJ2	cyl 5 and cyl 2
INJ3	cyl 3 and cyl 4

This fuel scheme requires a home signal that is driven by the crank or cam since the ECU needs to know what the engine position is in its 360° cycle.

Note:
Sequential injection on 5 and 10 cylinder motors is not possible with the E6X.

The ECU has no means of programming the firing order of the engine in software. It uses the channels sequenced in the order mentioned previously. Therefore, it is necessary to wire the injectors according to the firing order.

B.4 Synchronising

When the ECU is configured to operate an engine that uses direct fire ignition or sequential injection, the ECU needs a reference for engine position often referred to as a “synchronising” signal or a “home” signal.

When the ECU is configured to perform full sequential injection or full direct fire ignition it requires a home signal that occurs once in the full cycle (720° of crank rotation and 360° of cam rotation). If the ECU is configured for waste spark direct fire the ECU requires a home signal that occurs once in the half cycle (360° of crank rotation).

On a distributed engine the ECU does not need to know the engine position, it simply generates a spark that is mechanically distributed to the correct cylinder. Direct Fire ignition systems need to know which cylinder to fire next. The same principles of timing and sequence apply to sequential injection. When the ECU sees a home signal it assumes that the cycle for ignition and injection has restarted.

B.5 Summary Table

The list that follows shows the different types of output configurations that may be employed. Note that in some cases, an Extra Driver Box is needed to provide sufficient driver power. “Standard” fuel injection is multipoint, staged or batch fire. DF is for Direct Fire.

# Cyl.	Ignition	Fuel	Dig. Out 1	Dig. Out 2
1	Distrib*	Any	Yes	Yes
2	Distrib**	Standard	Yes	Yes
2	Distrib**	Sequent.	Yes	Yes
2	DF - 2 coil	Standard	No	Yes
2	DF - 2 coil	Sequent.	No	Yes
3	Distrib	Standard	Yes	Yes
3	DF	Standard	No	No
3	Distrib	Sequent.	Yes	No
4	Distrib	Standard	Yes	Yes
4	DF - 2 coil	Standard	No	Yes
4	DF - 4 coil	M’Point	No	No
4	Distrib	Sequent.	No	No
5	Distrib	Standard	Yes	Yes
6	Distrib	Standard	Yes	Yes
6	DF	Standard	No	No
8	Distrib	Standard	Yes	Yes
8	DF	Standard	No	No
8	Twin Dist	Standard	No	Yes
10	Distrib	Standard	Yes	Yes
12	Distrib	Standard	Yes	Yes
12	Twin Dist	Standard	No	Yes

* Although strictly there is no distributor on a 1 cylinder engine, selecting Direct Fire will cause the E6X to wait for a Home signal.
** This configuration could also be used for waste-spark direct fire ignition.

B.6 Rotary Engines

The ECU is capable of providing fuel and spark to twin-rotor Wankel engines. The leading and trailing sparks are generated separately, with a programmable ignition split time. The split is programmed through the Rotary Trailing Map.

There are two ranges to the Rotary Trailing Map, below 2000 rpm and above 2000 rpm. This map is a measure of split, or delay, from the leading spark, which is computed from the base ignition map normally with all corrections. The map indexes split against the engine load. When displayed on the Engine Data Page, or in Data logs, the trailing spark timing is shown as an absolute advance in degrees BTDC.

If using a distributor, there are two ignition outputs, one for the leading and one for the trailing coils. If using direct fire, the two leading sparks are fired together, as in a waste-spark set-up. Two individual coils must be used for the trailing sparks, as these are fired separately.

Each coil igniter will have its own trigger. If using direct fire, a Home signal is needed for trailing ignition to be generated.

	Distributor	Direct Fire
Output	**Function**	**Function**
INJ1	Fuel (Primary)	Fuel (Primary)
INJ2	Fuel (Secondary)	Fuel (Secondary)
IGN OUT	Leading Spark	Leading Spark (both)
IGN 2	Trailing Spark	Trailing Spark front rotor
IGN 3	Digital Output	Trailing Spark rear rotor

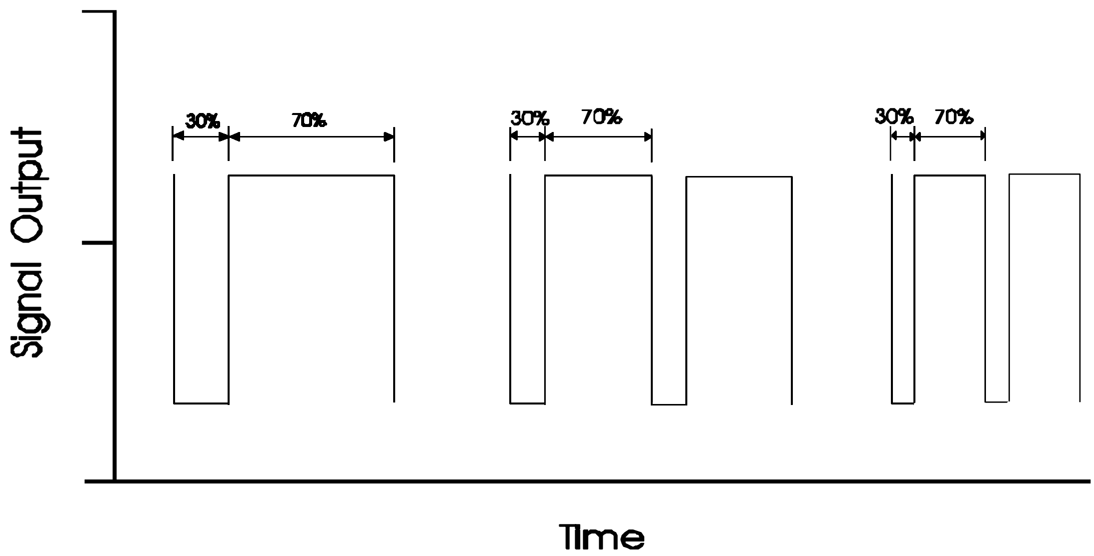
B.7 Ignition Outputs

The ignition outputs of the ECU are designed to provide the appropriate signal to drive an ignitor. The ECU is capable of driving either smart (constant duty) or dumb (constant charge) ignitors.

WARNING:
UNDER NO CIRCUMSTANCES SHOULD THE IGNITION OUTPUTS OF THE ECU BE USED TO DRIVE THE COILS DIRECTLY. THE IGNITION OUTPUTS OF THE ECU ARE INCAPABLE OF SINKING SUFFICIENT CURRENT TO GENERATE SPARK AND WILL SIMPLY FORCE THE IGNITION DRIVERS INTO SHUTDOWN

B.7.1 Constant Duty vs. Constant Charge

Constant Duty ignitors contain circuitry that will optimise the dwell for the next ignition and consequently the ECU only needs to provide a signal that has a constant duty cycle and a timed edge for ignition. A constant duty ignition signal will appear as below:



A constant charge ignitor requires the ECU to control dwell as well as ignition timing, the *dumb* ignitor as it is commonly referred to is basically just a high current switch for the coil.

The ECU must calculate the time at which to switch the coil on to maximise energy stored in the coil just before the spark is to occur. The coil's charge time can be determined from the coil negative signal: when the coil switches on, the coil negative voltage drops to zero, as the coil energises the voltage rises slightly until a sharp rise where the ignitor current has reached the upper limit. When the current ceases to increase the coil has maximum energy and any more energy applied by leaving it switched on will be wasted as heat. It is at this point that the coil is switch off and the coil is fired.

Note: For safety and reliability, always use igniters that are internally current limited.

B.7.2 Alternate Ignition Systems

The output of the Haltech Ignition Module can be used to trigger after-market ignition systems such as MSD or Jacobs. There are several reasons why it is not normally possible to directly connect the ignition output of the E6X ECU to the trigger input of one of these systems. The main reasons are lack of dwell control and the signal polarity is the inverse of the polarity required by most of these systems. It is possible to invert the ignition output of the E6X through the Ignition Set-up [4.6.1], which makes the output suitable for ignition systems that do not need dwell control.

G.M. Direct Fire Ignition

The G.M. Direct Fire Ignition module (DFI), as used in the V6 Buick, can be connected directly to the E6X ECU. This module serves both as a trigger device and as an igniter. The DFI module has an ignition bypass input from the ECU. This input tells the DFI module to ignore the ECU's timing signal and fire its own spark at 10° BTDC. This gives a more reliably timed spark for cranking. This input is controlled by the E6X through the **Aux. Out Function**. To use the bypass, this function should be set in the Identification to **Bypass**. See Chapter 3 [3.1]. The bypass will allow the DFI module to control spark below 450 rpm.

Ford Thick Film Ignition (TFI)

The Ford TFI module is fitted to distributors used with Ford's EEC IV engine management computer system. The E6X ECU can connect directly to this module; however, the TFI module requires a trigger signal, called the SPOUT (see below), that has a 50/50 duty cycle, which is not the standard 70/30 duty cycle of the E6X. To use the Ford TFI module you will have to adjust the Ignition Output Duty Cycle in the Ignition Set-up (see Chapter 4 on Accessing the Ignition Map) to 50.

Signal Names for TFI Module

PIP	Profile Ignition Pickup (trigger pulses from the Hall Effect Sensor)	Output
SPOUT	Spark Out (Igniter output from the ECU)	Input
POWER	+ 12 volts from starter circuit Input	
POWER	+ 12 volts from ignition switch	Input

COIL -	Negative terminal of coil	Output
GND	Ignition system ground	

There are several versions of the Ford TFI module but these notes only refer to the type IV module. This TFI module is physically attached to the side of the distributor and connects directly to the HALL Effect pickup within the distributor.

To further complicate matters there are two types of chopper wheels used inside the distributor, one that generates a normal’ PIP signal and one that generates a ‘signature’ PIP signal. With the signature PIP, the pulse for cylinder one is shorter than the pulses for the remaining cylinders. This is similar to Figure E.3 except that the cylinder one pulse is shorter rather than longer. Unfortunately the edges where the pulses do coincide occur at 10° BTDC. Therefore the E6X cannot be used with a signature PIP unless the trigger point is moved. If the trigger is modified be wary of rotor phasing (See Appendix F). The trigger edge for the Ford TFI module is falling edge. For 8 cylinder engines the Trigger Angle is 55° and for 6 cylinder engines it is 70° BTDC.

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 > 12Ω, this means that if 12V is applied across the coil the current will not exceed 1A.

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 < 3Ω

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 ground and 12V 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 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, 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 while 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.

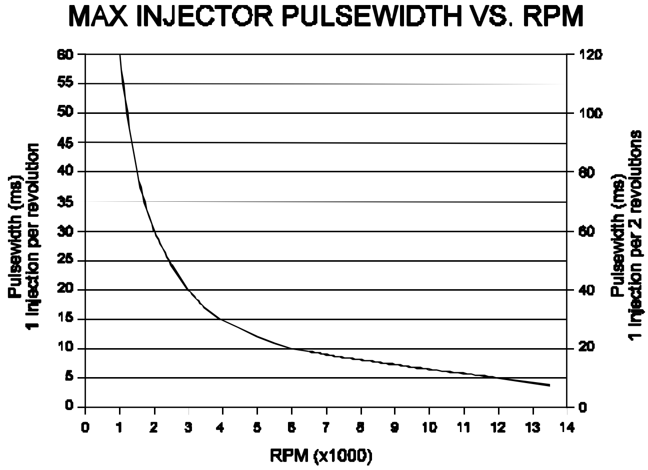
The tables and graph below show the point at which the injectors will reach 100% duty cycle. It is not common for this to happen but the potential for damage under these circumstances is strong so care should be taken to check this factor.

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 x 2)/(6000 x 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.3 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, p44*).

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 are primary and drivers 3 and 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.4 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.5 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 (½"). 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 many different trigger patterns and trigger types. This appendix will explain the various trigger systems the ECU supports.

The following fields configure the trigger input: (Refer to *4.2.3 Ignition Set-up Page, p46*)

Trigger Input
Trigger Angle
Trigger Edge
Trigger Gain
Trigger Type

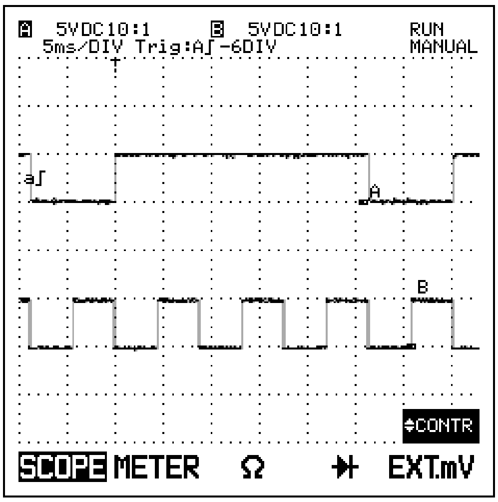
The trigger interface will be described below in terms of the above fields to simplify configuration of the ECU trigger interface.

E.1 The Trigger Input

The 3 common trigger sensors used to trigger the ECU are: reluctor, 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. Reluctor trigger sensors produce a different signal to that of Hall effect sensors.

E.1.1 Hall effect and Optical Triggers

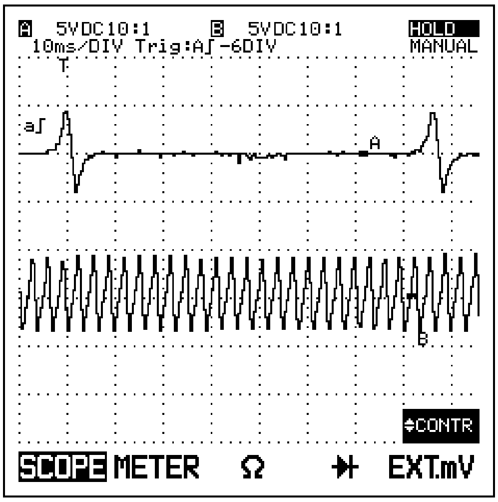
Hall effect and optical triggers produce a square wave signal when connected to the ECU and can be treated the same electrically. The ECU specification allows the use of a Hall effect device that outputs a low of 0V and high of between 5V and 12V, the switching threshold is set to 2.5V. Hall effect sensors normally have 3 or 4 connections: power, signal (x2) and ground, this is by no means the only classification that should be used for sensor identification, if in doubt contact your haltech dealer.
Below is a trace of the signal of a "Standard Trigger" for a 4-cylinder distributor. The trigger device has 2 signal channels and would have 4 connections: power, trigger, home and ground.



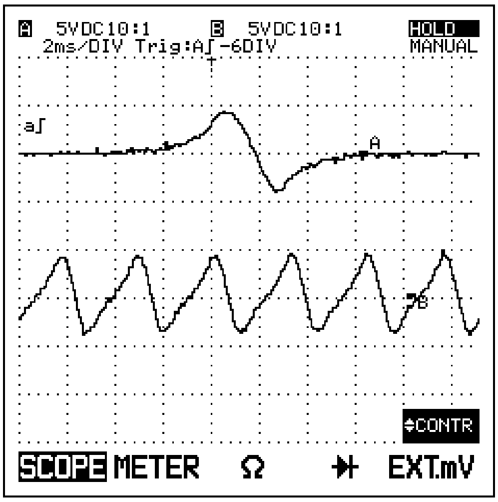
E.1.2 Reluctor Triggers

A reluctor trigger produces a signal trace that looks like an upward or positive pulse followed immediately by a downward or negative pulse and then remains flat until the next trigger tooth passes. These sensors normally only have 2 or 4 connections: trigger positive and trigger negative (home positive and home negative).

A common reluctor trigger is the 24-1 trigger used on some Toyota engines. This trigger has 4 connections: trigger positive, trigger negative, home positive and home negative. Below is an example of a Toyota 24-1 trigger; both the single tooth home and the 24-tooth trigger are shown.



A closer view of the single home tooth shows the shape of the signal:



Notice how the signal rises and then fall below its origin and then rises to settle where it started. The 24-tooth signal follows the same cycle as that of the single tooth home but does this at such a frequency that it settling point is not clear.

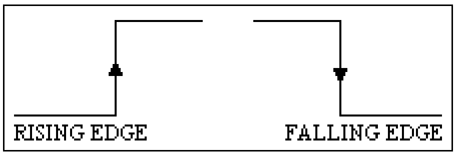
The reluctor trigger requires signal conditioning that often requires some tuning. The part of the ECU hardware that conditions the reluctor signal is called a reluctor adaptor and it converts the reluctor signals shown above to a square waveform similar to that of the Hall effect trigger. The reluctor adaptor and its tuning is dealt with in detail in *4.2.3 Ignition Set-up Page, p46*.

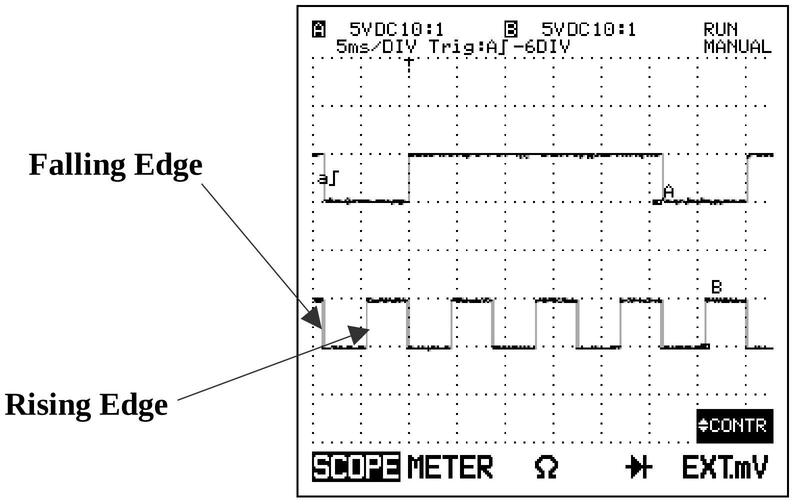
E.2 Trigger Angle

The trigger angle is simply the angle before top dead centre (BTDC) at which the trigger event occurs. The trigger device used must produce at least one trigger event for each ignition event and each trigger must occur a constant angle BTDC. See *Appendix E.6 Trigger Type*

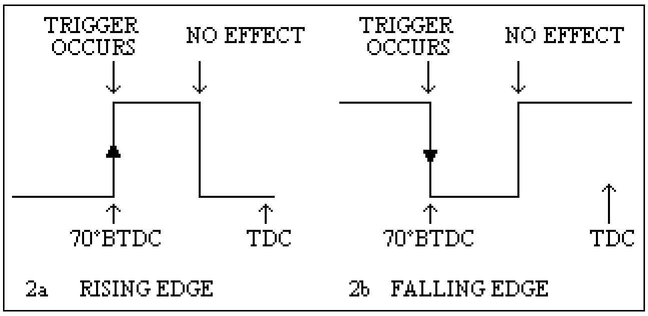
E.3 Trigger Edge

The ECU uses the signal transitions from *low* to *high* called *rising edges* and *high* to *low* called *falling edges* to determine engine position, these transitions occur at specific angles across the rotation of the crank (half cycle) or cam (full cycle). In most instances the ECU will only uses one type of transition (rising or falling) for a trigger and this is known as the *Trigger Edge*.

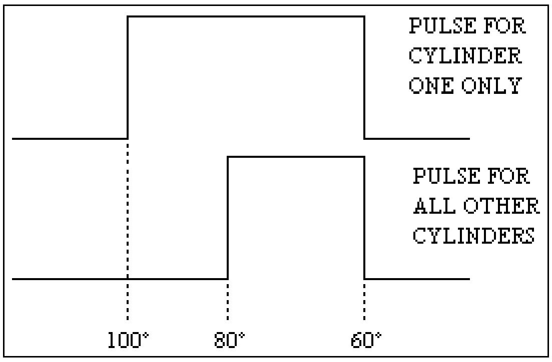




In the example 2(a) shown below the trigger occurs on a rising edge at 70° BTDC. The second edge, a falling edge, could occur any time after the rising edge, in some installations the second transition will coincide with 10° BTDC or TDC. This second edge will have no effect on the operation of the ECU. It is only the position of the triggering edge that is of importance. Example 2(b) shows the same trigger angle but with the opposite trigger edge.



Some trigger devices have uneven pulse widths to indicate the position of a specific cylinder (often cylinder 1). If rising edges were used as the trigger edge then there would be a variation of 20° between the trigger for cylinder 1 and all other cylinders. This would lead to cylinder 1 being 20° more advanced than all the other cylinders. To ensure even ignition timing the trigger edge would be the falling edge and the trigger angle would be 60° BTDC.



As describe above, Hall effect triggers produce a signal that is made up of transitions or edges and these edges correspond to a specific angle and as a result the ECU need to be configured to trigger on a specific edge. As illustrated earlier, reluctor triggers produce a different signal trace and the ECU uses signal conditioning to produce a rising edge to trigger the ECU, consequently the trigger edge does not need to be defined for reluctor signals.

E.4 Trigger Gain and Reluctor Adaptor Tuning

The trigger gain is only applicable when a reluctor sensor is used. The nature of the reluctor trigger and variations of sensor performance across the range of available sensors requires some tuning of the hardware for a specific application. Certain reluctor sensors require the amplitude of the reluctor signal to be amplified, the ECU offers 8 gain settings for both the trigger and home channel.

Note: Any combination of hall effect, optical or reluctor type pick-up may be used for the “trigger” (main ignition event) and “home” (sync. Event) inputs. However, reluctor type pick-ups must be connected to their respective reluctor adaptor input.

E.5 Synchronisation

When the ECU is configured to operate an engine that uses direct fire ignition or sequential injection, the ECU needs a reference for engine position often referred to as a “synchronising” signal or a “home” signal.

When the ECU is configured to perform full sequential injection or full direct fire ignition it requires a home signal that occurs once in the full cycle (720° of crank rotation and 360° of cam rotation). If the ECU is configured for waste spark direct fire the ECU requires a home signal that occurs once in the half cycle (360° of crank rotation).

On a distributed engine the ECU does not need to know the engine position, it simply generates a spark that is mechanically distributed to the correct cylinder. Direct Fire ignition systems need to know which cylinder to fire next. The same principles of timing and sequence apply to sequential injection. When the ECU sees a home signal it assumes that the cycle for ignition and injection has restarted.

E.6 Trigger Type

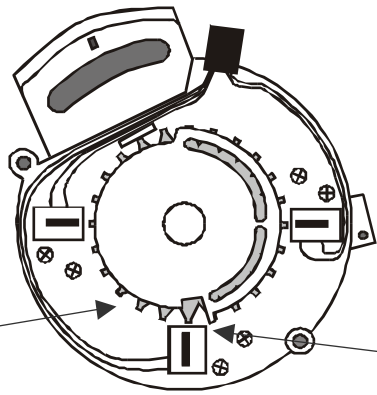
The ECU is capable of triggering from various trigger formats as used on a number of production vehicles other than standard trigger. The trigger types are as follows:

- Multi-tooth
- Motronic
- Twin Trigger
- Nissan
- Subaru A (1989 – 2000)
- Subaru B (2001 –)
- Mazda A
- Daihatsu
- MGF

The ECU uses these triggers to internally produce a “standard trigger” pattern to make timing calculations for ignition and injection. The ECU uses the extra information associated with some of these triggers to allow the user to set the trigger angle to suit the operation of the haltech regardless of factory trigger positioning.

E.6.1 Multi-tooth

The multi-tooth trigger type supports any trigger system that has multiple evenly spaced trigger events connected to the trigger channel and one home event connected the home channel. An example of this type of trigger is the Toyota 24 and 1 cam sensor.



After recognising the home event, the ECU will locate the first "standard" engine trigger by the tooth indicated as "Tooth Offset" which can be programmed via the Ignition Set-up page. To find the remaining "standard" trigger events, the ECU counts a number of teeth equal to the total teeth in one cam revolution, divided by the number of cylinders.

For Example a 4-cylinder engine with a 24-tooth wheel on the cam and a corresponding home would have the following setup values:

Trigger Angle:	65°	(10° to 100° as required)
Trigger Type:	Multi-tooth	
Total Teeth:	24	
Tooth Offset:	2	(1 to Total Teeth)

With these set-up values, when the home signal occurs the ECU will start counting the trigger teeth (24-tooth wheel), when it reaches the tooth offset it will operate as a standard trigger. The position of the remaining triggers is determined by taking the number of teeth in the trigger wheel (24) divided by the number of cylinders (4). This number (6) is the number of teeth that is counted between triggers.
In this case the triggers will occur at the following teeth: 2,8,14,20. Each trigger occurs 65° (Trigger Angle) BTDC of the current cylinder and will perform ignition based on this angle.

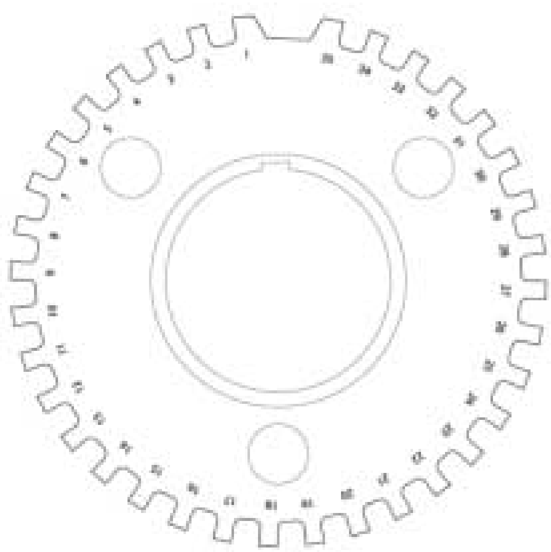
Due to the high frequency of multi-tooth signals the maximum Rpm to which the ECU will operate is 10,500 rpm. This rpm value is based on the above-mentioned 24-tooth trigger.

E.6.2 Motronic Style Triggers

Motronic style triggers are a type of multi-tooth trigger but are distinct in that they use a missing tooth instead of a separate home signal to synchronise the ECU with engine position. The motronic wheels supported by the ECU to date are those driven by the crank only and are limited to wheels with 60 teeth with 2 missing and 36 teeth with 1 missing. The motronic wheel operates identically to any other multi-tooth wheel with the following exceptions:
Care must be taken when selecting a "Tooth Offset", if the tooth offset is selected such that it will cause the missing tooth to be required to perform a trigger, incorrect trigger timing and poor engine operation will result.

Note:
Since the missing tooth only gives the crank position (360° crank) and not the cam position (720° crank and 360° cam) this type of trigger cannot support full sequential fuel injection or full direct fire ignition unless a cam sensor is used in conjunction with the motronic wheel.

Due to the high frequency of the motronic signal and complexity of detecting the missing tooth, the maximum rpm to which the ECU will operate is 9000 rpm.



Ford 36-1 motronic style wheel

E.6.3 Twin Triggers

The Twin Trigger is designed for two purposes. It can be used to provide direct fire ignition on 2 cylinder engines (most motorbike twins) without the use of a Home sensor. The ECU Main Trigger input fires coil 1, and the Home input is used to fire coil 2. The Twin Trigger can also be used to differentiate between coils on an 8 or 12 cylinder using twin distributors. Two four (or six) cylinder distributors, complete with trigger wheels can be used. No home is required in this configuration.

E.6.4 Nissan Triggers

The Nissan optical trigger sensor is used by almost every ECU controlled Nissan engine. It is a cam sensor and consequently spins at half the engine speed, and is therefore able to measure the full engine cycle position, so can be used as a trigger for direct fire and sequential injection applications. The sensor consists of two signals which will from now on be referred to as home and trigger.

The home signal consists of 360 evenly spaced pulses, where each falling edge represents 2 degrees of engine movement.

The trigger signal consists of the same number of pulses as the engine has cylinders. The beginnings of the pulses (rising edge) are evenly spaced, but the ends of the pulses (falling edges) are not evenly spaced. The differing pulse widths enables the ECU to synchronise engine position with ignition and fuel timing, the ECU does this by counting the number of home pulses that occur during the trigger pulse.
There are a number of different trigger window patterns, two common patterns are described below:

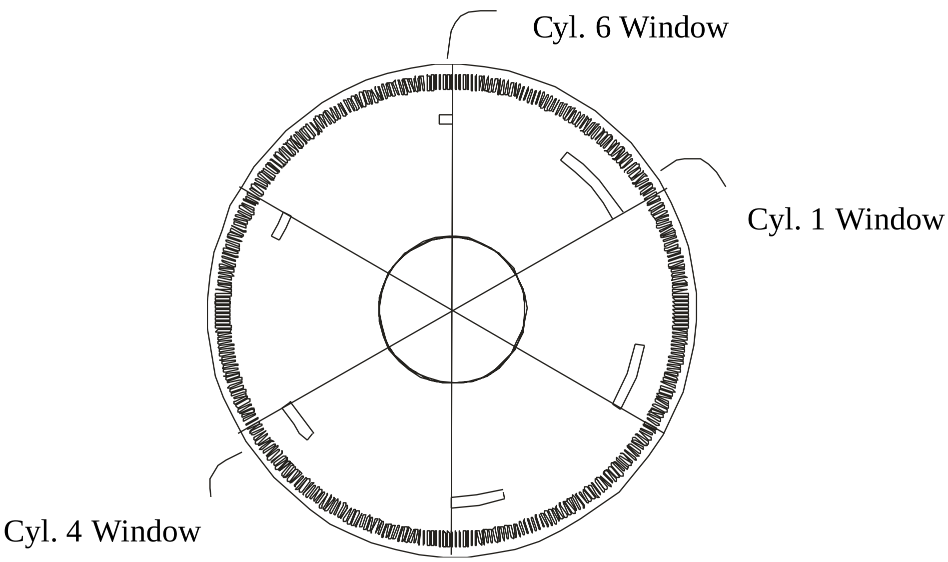
Pattern 1

The first pattern has trigger windows sizes that are related to the cylinder number which they precede and can be calculated using the following equation:

$$Number\ of\ Pulses = (Number\ of\ cylinders - (Cylinder\ Number - 1)) \times 4$$

For Example: A 4-cylinder engine that is to be synchronised before cylinder 2 would have a trigger window as follows:

$$\begin{aligned} Number\ of\ Pulses &= (4 - (2 - 1)) \times 4 \\ &= 12 \end{aligned}$$



6-Cylinder Nissan Trigger 1

Pattern 2

The second pattern is similar to the first but instead of having different size trigger windows for each cylinder it has pairs of trigger windows matching the two cylinders that are approaching TDC together on opposite strokes (i.e. compression-combustion and exhaust-induction). The first pair is not a true pair; the two windows differ by a number of home pulses in size, all successive pairs are identical in trigger window size so a 4-cylinder engine has one odd pair and one true pair.

$$if\ Cylinder\ Number = 1$$

$$Number\ of\ Pulses = \left(\frac{Number\ of\ cylinders}{2} + 1 \right) \times 4$$

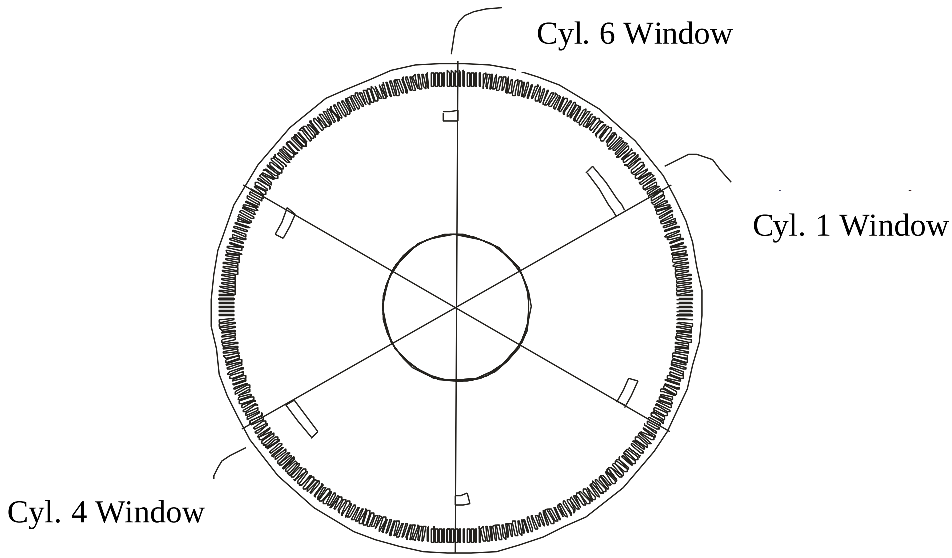
$$if\ Cylinder\ Number\ is\ opposite\ of\ Cylinder\ number\ 1$$

$$Number\ of\ Pulses = \left(\frac{Number\ of\ cylinders}{2} \right) \times 4$$

$$if\ (Cylinder\ Number = 2\ and\ Number\ of\ Cylinders = 4)$$

$$or\ (Cylinder\ Number = (2\ or\ 3)\ and\ Number\ of\ Cylinders = 6)$$

$$Number\ of\ Pulses = \left(\left(\frac{Number\ of\ cylinders}{2} \right) - (Cylinder\ Number - 1) \right) \times 4$$



Nissan 6-Cylinder Trigger 2

Because this trigger point normally falls well before the ideal position for the ECU to trigger, a second parameter is added which allows the actual trigger position to be offset. This parameter is labelled “Tooth Offset” and it allows the ECU to process the trigger at a position given by a set number of home pulses after the trigger rising edge. So that the home will be processed before the trigger is processed for cylinder number 1, the pulse offset must force the trigger to occur after the end of the trigger pulse. For this reason, the actual pulse offset is equal to the number of pulses set from the “Home Window Teeth” parameter added to the number of pulses specified by the “Tooth Offset” parameter. So if the “Home Window Teeth” parameter is set to 16, and the “Tooth Offset” parameter is set to 10, then the actual trigger will occur at 10+16=26 pulses after the rising edge of the trigger. In this way, even if the “Tooth Offset” parameter is set at 1 (the minimum value allowable), the home will always be processed before the trigger. A major advantage of being able to specify this Tooth Offset, is that the actual trigger position can be retarded so that the “Trigger Angle” can be set to a value of approximately 50 degrees which is ideal for good acceleration ignition response, especially during start-up.

E.6.5 Subaru A Triggers (1989-2000)

All factory-injected 4-cylinder Subaru engines manufactured before 2001 use a combined crank-angle/cam-angle trigger system. If a Subaru trigger is being used, select the Trigger type as “Subaru A” and connect the Cam angle sensor to the Home Input and the Crank angle sensor to the Trigger Input. Both the Trigger and Home Input should be set to Reluctor and the “Trigger angle” should be approximately 65±2° BTDC. The fields “Tooth Offset” and “Number of Teeth” will not affect the operation of the ECU in a standard Subaru set-up.

E.6.6 Subaru B Triggers (2001 -)

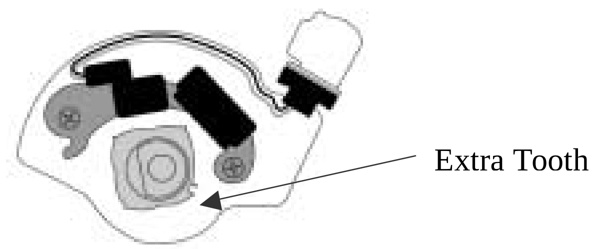
The operation of the Subaru B trigger is quite different to that of the Subaru A trigger but the installation is identical with the following exception; select the Trigger type as “Subaru B” and the trigger angle should be set to 62° BTDC.

E.6.7 Mazda A Triggers

Some factory-injected 4-cylinder Mazda and Ford engines use a unique trigger system similar to that of the Subaru engines. This trigger system uses a combined crank-angle/cam-angle trigger system. Select the Trigger type as “Mazda A” and connect the Cam angle sensor to the Home Input and the Crank angle sensor to the Trigger Input. Both the Trigger and Home Input should be set to Reluctor and the “Trigger angle” should be approximately 65±2° BTDC. The fields “Tooth Offset” and “Number of Teeth” will not affect the operation of the ECU in a standard Mazda set-up.

E.6.8 Daihatsu Triggers

Some Daihatsu engines use an extra tooth cam sensor that can synchronise the ECU with the engine without using a separate home channel. This type of trigger operates as a standard trigger but intercepts an extra trigger immediately after the final trigger in the cycle.



E.6.9 MGF Trigger

The 4-cylinder MG-F uses a unique trigger system similar to that of the Subaru engines. This trigger system uses use a crank-angle trigger system. Select the Trigger type as “MGF” and connect the Crank angle sensor to the Trigger Input. The Trigger Input should be set to Reluctor and the “Trigger angle” should be approximately 65±2° BTDC.

APPENDIX F ROTOR PHASING

One of the most important aspects to consider when modifying a distributor or trigger is the Rotor Phasing. Take, as an example a distributor that uses a Hall effect sensor with a chopper wheel attached to the distributor shaft, the Hall effect sensor being mounted to a plate that is rotated by a vacuum advance mechanism and by centrifugal bob weights. This is a fairly conventional set up used in many vehicles with electronic ignition. Simply removing the advance mechanisms and locking the plate so that it can't move may not be all that is required. The trigger edges generated by this modified distributor will probably fall outside the 60° to 100° BTDC window allowed by the E6X. Something will have to be moved to allow the trigger edges to fall within the required window.

If the distributor shaft is rotated so that the chopper wheel now triggers the sensor at 70° BTDC then a problem of rotor phasing may have been induced. By the time the ignition pulse occurs, which could be up to 60° later, the rotor button would have passed the plug lead terminal in the rotor cap and this could lead to arcing in the distributor cap. The arcing could even be to the wrong plug lead terminal. If arcing doesn't occur, then the back EMF in the ignition coil primary could damage the igniter or the ignition system. Either way, the engine is not going to run correctly, if at all.

The correct way is to move the plate that the sensor is mounted on. *Remember that all degrees referred to here are crankshaft degrees, distributor degrees would be half those numbers referred to.* Our example is an engine that has the following timing requirements :-

Minimum Timing	10° BTDC
Maximum Timing	40° BTDC

This gives a mid point, half way between the minimum and maximum timing, of 25°. Align the centre of the rotor button with one of the plug lead terminals. It does not matter which one. This is where the rotor button has to be when the engine is 25° BTDC. Now rotate the distributor shaft so that the rotor button is where it should be when the engine is at 70° BTDC. i.e. move it back 45° <u>crank</u> degrees. This is where the rotor button has to be when the chopper wheel triggers the sensor. Let's assume that the trigger point of the sensor is exactly in its centre. Move the plate the sensor is mounted on so that one of the vanes of the chopper wheel is leaving the sensor. Adjust the position of the plate so that when the shaft rotates in its normal direction, the centre of the sensor will become exposed. If it is not possible to move the sensor, it will be necessary to rotate the trigger wheel relative to the shaft and the sensor.

Rotor phasing is not only a problem on distributors with advance mechanisms. Several factory distributors have their triggers at points outside 60 - 100°. It is not advisable to just rotate the distributor until the trigger is within this window. Care must be taken to ensure that the rotor phasing will not cause a problem.

APPENDIX G HALTECH E6X 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 or sequenced (up to 4 banks) injection patterns
- Distributed ignition systems, or direct fire systems with 1 to 4 coils

NB: Sequential and Direct Fire can only be used together in limited set-ups.

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 kΩ 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)
- Most inductive/magnetic triggers

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 2.2~2.4Ω injectors, 16 x saturation style injectors (High Impedance) or 4 x ~0.5Ω.
CAUTION: Ensure software settings are correct since excessive current for long periods may damage injectors.

• **Ignition Output**
0-12V square-wave output used to drive an ignitor. Capable of driving 'Smart' and 'Dumb' ignitors.
CAUTION: This output cannot be used to drive coils directly an ignitor must be used to supply the high coil currents

• **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.

• **Special Purpose Digital Output**
Up to 2 special purpose digital outputs capable of driving: 1A continuous pull to ground or low current 0-12V voltage level signal.
(actual number available dependant on Injection and Ignition configuration
- 12Volt logic outputs
- Suitable for switching fans, shift lights, anti-lag, NOS, relaysetc.

• **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
(25 pin cable available on request)
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

- **Ignition Map**
  22 Ignition ranges, every 500 RPM to 10,500, or
  17 Ignition ranges, every 1000 rpm to 16,000
  32 Load points per range, up to 50° advance, with 1° resolution

- **Correction Maps**

  - **Fuel**
    Cold Start Prime - 32 points
    Coolant Temperature Enrichment - 32 points
    Air Temperature Adjustment - 32 points
    Battery Voltage Correction - 32 points
    Closed Throttle (selectable) - 16 points
    Full Throttle (selectable) - 32 points
  - **Ignition**
    Crank Advance - 32 points
    Coolant Temperature Advance/Retard - 32 points
    Air Temperature Advance/Retard - 32 points

- **Programmable Rev-Limit** - selectable as either fuel or ignition

- **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**
  Black anodised with integral cooling fins and mounting brackets.

- **US or Metric Units.**

E6X Hardware Options

- **Boost Control Solenoid.**

- **Dual 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.**

- **Ignition Coils**
  Available as Single, Dual and Rotary Pack (4).

- **Ignition Igniter with Dwell Control**
  Available as single and dual igniters.

- **Ignition Igniter without Dwell Control**
  Available as single, dual and triple igniters.

- **Mixture / Ignition / Boost Trim Module**
  Provides ±12½% or ±50% adjustment for fast tuning Provides -8° to +7° adjustment for fast tuning Provides ±100% adjustment.

LIMITED WARRANTY

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

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

If the Haltech™ 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