E6K Manual

Warning

This system is capable of controlling either “intelligent “ igniters such as the Haltech EB023 igniter, which has in-built dwell control or “dumb” igniters which contain no such control. 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, also it is possible to burn out the igniters as a result. Burning out igniters due to wrong set-up will not be regarded as warranty

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This manual should accompany:

IBM compatible PC software v6.34
Firmware Series 8
Firmware v14

Introduction

Congratulations on your decision to install a Haltech Engine Management System to your vehicle. Haltech EFI systems have been successfully installed on thousands of vehicles, from power off-shore boats to twin-turbo Ferraris, from pylon racing aircraft to jet skis and snowmobiles. Over the past decade, many motorsport enthusiasts have discovered that the Haltech computer is easy to use and gets the job done correctly - that job being to reliably make a lot of horsepower and torque in an engine by enabling users to precisely control ignition timing and fuel-air mixture. Precise ignition and mixture control also 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 supercar builders in the world use Haltech equipment for the same reasons that Haltech is popular with motorsports 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.

Installation Overview

The Haltech E6K system utilises a special-purpose programmable microcomputer designed for engine management. The E6K system includes the ECU, engine sensors, and a special wiring harness to connect them, plus programming software and cable for you to tune the system. In the course of the installation, you will mount four electronic engine sensors, two for temperature, one for throttle position, and one to sense vacuum/pressure. You will run the wiring harness through the vehicle, connecting the 12V, ground and signal wires, and plug the harness connectors into the engine sensors and fuel injectors. An ignition output module will be mounted in the engine bay and connected to the harness. Finally, you will mount and connect the ECU itself. Haltech systems provide electronic fuelling control. The engine must already be configured with intake manifold and suitable injectors, a fuel rail with pressure regulator, and a high-pressure pump. To control ignition timing, the ECU requires a <u>fixed</u> trigger from a distributor, crank angle sensor, or cam angle sensor. If your vehicle lacks one or more of these components, your Haltech dealer can help you obtain them.

With the Haltech system installed, you tune it by connecting the ECU to an IBM compatible PC via the supplied communications cable. The Haltech Programming software allows you to configure and modify the ignition and fuelling data stored in the ECU: it's as simple as adjusting the heights of the bar graphs displayed on your PC screen. Collectively, the bar graphs form the "Maps" that instruct the ECU how to inject fuel and when to fire the spark under different conditions. The programming software has been designed to be functional, "friendly" and intuitively easy to use.

When the time comes to start your engine, the base fuel map already loaded in the system could get you going immediately. If not, a little alteration with some assistance from this manual should get your vehicle running. You then work on fine tuning your maps to suit your engine exactly. An air:fuel ratio meter and a dyno make tuning easiest, but many people use the traditional method of "seat of the pants" feel and tuning by ear, possibly checking spark plug colour as an indication of fuel mixture. Whichever method you use, you will find that the ability to instantly change mixtures by the stroke of a key, or the twist of a knob, will make tuning your Haltech system far easier than tuning a carburettor or mechanical injection system, and with much better results.

Before You Begin...

1) **IT IS BEST TO READ THIS ENTIRE MANUAL BEFORE STARTING.**
At the very least, you should read **Section One** of the manual, and any of the Appendices that are relevant to your installation. The greater your knowledge of the operation of the Haltech system, the easier you will find it to understand what you are doing, and why. Throughout the manual are Warnings and Notes that will help your installation run smoothly and indicate the dangers that can exist for you the installer and the Haltech ECU.

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 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.
There is another reason to exercise care during this installation. You will be dealing with explosive fuel under pressure, electricity and considerable heat. Inside the combustion chamber, this is a happy combination. In the garage, they are not. The same kind of danger exists when working underneath a jacked-up car. Please be careful.

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 vastly 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 in a gasoline engine is to determine the amount of air being drawn by the engine, and supply the appropriate quantity of fuel to "burn" all the oxygen in that mass of air.

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

Electronic fuel injection revolves around the use of solenoid-actuated injectors. These devices employ a coil attached to a valve. When the coil is energised, the valve opens and fuel is allowed to flow. As long as the pressure between the fuel and the air in front of the injector nozzle is held constant, the rate of fuel flow will remain the same. By accurately controlling the length of time the injector remains open, precise quantities of fuel can be metered to the engine.

Since we have no convenient means of directly measuring the amount of air entering the engine to determine the amount of fuel to deliver, we use a number of engine parameters to determine an injection opening time. We build a table that breaks the engine's operation into a series of rpm ranges. At each range, we consider the load on the engine, using either the position of the throttle or the manifold pressure as a reference to the load on the engine.

Collectively, the ranges in this table (also called a look-up table), form a *map* of the volumetric efficiency for the engine. Our standing assumption, therefore, is that for any combination of engine speed and load, we have a direct reference to the amount of air that is being drawn into the engine by means of this map.

The Haltech E6K 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.

Having determined the base injection time, the microcomputer then performs a number of adjustments to this value. Corrections for air temperature and barometric pressure are applied, since these variables affect the density of air. Extra injection time is also added, when necessary, for transient throttle movement and the temperature of the engine. At the end of all these calculations, the final injection time is determined: the time for which the injectors are actually held open.

Injection pulses usually occur one or more times per engine cycle. The ECU uses a trigger signal locked to engine speed in order to determine when to inject. When it receives an appropriate trigger, the ECU applies a magnetising current to the injector coils for precisely as long as the final computed injection time, providing an extremely accurate delivery of fuel that will exactly suit the engine's needs.

The ignition timing is determined in a similar way to the fuel needs. The Haltech E6K ECU has a look-up table configured in the same way as for the fuel, but instead of the fuel delivery in the table the Ignition Map contains the Ignition Advance for that point. This means that the ignition point can be controlled with much greater accuracy then ever possible with bob-weights and vacuum advance in a distributor.

The Advanced Mode Features of the E6K

The E6K is designed to be easily programmed, but also be capable of being used on a wide variety of applications. A typical E6K installation could be : 4, 6 or 8 cylinders, turbo/supercharged or normally aspirated, distributed ignition (only one ignition output), and possibly using Closed Loop Control and/or Idle Speed Control. The E6K will control this ‘typical’ engine without problem. It will also provide the ability to control some other features, such as Turbo Wastegate Control, Thermofans, Torque Converter Clutch Lockup, etc. (For a full list of Optional Outputs, see Chapter 16). This is what we would call a ‘Basic’ set-up.

Of course there are some exceptions to this basic set-up. One of the most obvious examples is the Rotary engine. The ignition system for a Rotary is more complex than a piston engine. There are also piston engines without distributors. These are known as Direct Fire engines. They use multiple coils, either one for each plug or one for each pair of plugs. These are just a couple of examples of non-basic set-ups. For the purposes of the E6K, we call these ‘Advanced’ set-ups.

The E6K can be programmed in either **Basic** or **Advanced** modes. The software is identical for both, but in Advanced Mode, the special engine configurations can be employed. The table below sets out what features are particular to the Advanced Mode. If your engine meets any of the criteria, you should use the Advanced Mode when programming the E6K. If your engine does not meet any of the criteria, program in Basic Mode. The Advanced Mode will not provide you with any extra abilities or features, but may only complicate some issues.

Setting the programming mode is described in Chapter 3 **Engine Identification** [3.1]. Once the Advanced Mode is set when the PC is on line to the Haltech, it will not need to be switched on again, even if you exit the program. When the program is started, it will detect the mode and use it accordingly. You will need to be aware of what mode you are using during installation. If you are using Basic Mode, ignore any references to Advanced Mode settings.

The following features are available through the Advanced Mode.

Sequential Injection
Direct Fire Ignition
Rotary Engines
Twin Triggers
Twin Distributors
Multi-tooth Trigger Systems

The use of these features will be determined by your engine configuration. If your engine has no distributor, for example, you will need to use Direct Fire. The sequential mode is optional. If you have the hardware and the available outputs you can use sequential if you wish. All the other features will be determined by your engine.

> Note: If you need to use any of these features, you should read Appendix B before you install the system to be fully aware of your hardware and installation requirements.

HALTECH E6K 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
approx. proportional to injector duty cycle
(typically 0.6 Amps per injector)

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)

  A Reluctor adaptor is available for magnetic (or 'reluctor') triggers supporting most standard tooth patterns. Applications requiring a motronic trigger input need to be specified at the time of order. Only the 60 tooth wheel with 2 teeth missing and 36 tooth wheel with 1 tooth missing are supported.

ECU Outputs

- **Injector Driver**
  8 x 4/1Amp peak-and-hold current limiting drivers:
  - Up to eight low-impedance injectors*
  - Up to sixteen high-impedance injectors*

  (Expandable using optional Driver Box. See Appendix C)

- **Ignition Output**
  To optional Haltech Ignition Module, trigger by ECU, for directly firing the coil.
  (May also be compatible with other igniters. Ask your Haltech dealer.)

- **Pulse Width Modulated (PWM) Output**
  4 x Dedicated PWM outputs
  - Suitable for controlling turbo wastegate, solenoids, valves, shift lights, etc.

- **Special Purpose Digital Output**
  Up to 2 special purpose digital outputs
  - 12Volt logic outputs
  - Suitable for switching fans, shift lights, anti-lag, NOS, etc.

- **Fuel Pump Control**
  20A fused relay, features automatic priming and switch-off.

* Additional hardware may be required

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
  (5.25" disk available on request)

- **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.**

- **Optional Boost Control Solenoid.**

- **Optional Dual Hall Effect Sensor Kit.**

- **Optional Extra Injector Driver Kit.**

- **Optional Four Wire Heated Oxygen Sensor.**

- **Optional Fully Terminated and Sheathed Wiring Harness**
  In Lieu of Flying Wire Lead Harness.

- **Optional Haltuner**
  Inexpensive dash mounted Air-Fuel Ratio Meter.

- **Optional Idle Air Control Motor Housing.**

- **Optional Idle Air Control Motor.**

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

- **Optional Ignition Expander**
  Toggles ignition output freeing one ignition output for systems requiring maximum outputs For example it allows a 4 cylinder engine to operate with full sequential injection and waste spark direct fire since the ignition requires only one of the ECU's outputs.

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

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

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

SECTION 1 Getting Started

CHAPTER 1 HALTECH E6K INSTALLATION

1.1 Overview

The Haltech E6K 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 at extra cost)
- Main Wiring Harness
- Haltech E6K system Instruction Manual
- Programming Cable
- Programming Disk
- Relays

Optional Items

- Ignition Module
- Fuel Mixture / Ignition Timing / Boost Trim Control
- Exhaust Gas Oxygen Sensor
- Idle Speed Control Motor
- Driver Box

Other components not supplied as part of the E6K system include:

- Inlet Manifold
- Throttle body
- Throttle linkages
- Velocity stacks
- Injector Mounts
- Fuel injectors
- High-pressure fuel pumps
- Inlet Air Cleaners
- Performance ignition systems
- Trigger System
- Haltuner Air/Fuel Ratio Meter

1.2 Installation Summary

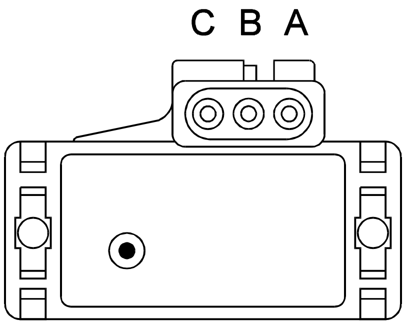
1. Mount Manifold Absolute Pressure Sensors.
2. Mount Coolant Temperature Sensors.
3. Mount Inlet Air Temperature Sensors.
4. Mount Throttle Position Sensors.
5. Mount Ignition Modules
6. Mount optional Exhaust Gas Oxygen Sensor (if used)
7. Route Main Wiring Harness and connect sensors and ignition 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 E6K ECU to use. The sensor works in absolute pressures, thus its calibration is not affected by changes in barometric pressure. The vacuum and, in the case of forced air induction engines, the pressure under boost, is proportional to the load under which the engine is operating and the ECU uses the electrical signal as a load reference.

There are three types of MAP sensors that can be used with E6K system. Which sensor is required depends on the engine set-up.

1 Bar Sensor (Part No. 039 4070)	
(-100kPa to 0 kPa)	Normally Aspirated Engines
2 Bar Sensor (Part No. 886 3189)	
(-100kPa to 100kPa)	Turbo or Supercharged Engines up to 100kPa boost (15 psi , 1 atmosphere)
3 Bar Sensor (Part No. 749 3169)	
(-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.

If the engine is running in Throttle Position mode, it can either use the internal barometric pressure sensor located inside the E6K or use a 1 Bar MAP sensor (left open to atmosphere) to measure the barometric pressure.

If the engine is running in Manifold Pressure Mode, at least one MAP sensor must be used. The first MAP sensor must be connected to the MAP Input plug on the wiring loom and provides an indication of the engine load. The second MAP sensor is used for barometric compensation and is optional. The internal barometric pressure sensor can be used inside the E6K or if desired an external 1 Bar MAP sensor (left open to atmosphere) can be fitted. It connects to the *Spare Input* plug near the Main Connector.

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

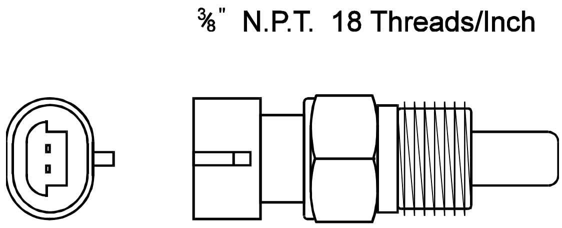
The coolant temperature is used by the computer to determine warm up corrections and adjust fuel mixtures.

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

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

Locate a suitable position on the engine which 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.

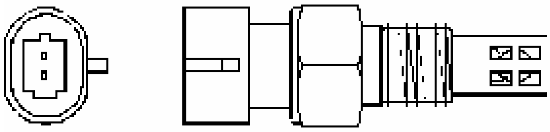


Temp to Resistance Value Approx

°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

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

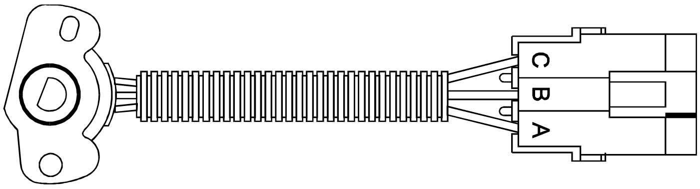
The air temperature sensor is used to compensate for changes in air density due to air temperature. Cold air is denser than warm air and therefore requires a greater volume of fuel to maintain the same air/fuel ratio. This effect is most noticeable in forced induction engines. The Haltech E6K will automatically compensate using the signal received from the air temperature sensor.

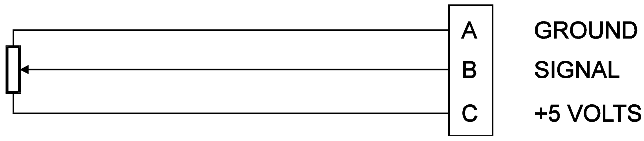
The sensor should be mounted to provide the best representation of the actual temperature of the air entering the combustion chamber, i.e. after any turbo or supercharger, and intercooler, and as close to the head as possible. The sensor needs to be in the moving air stream to give fast response times and reduce heat-soak effects.

Note: The Haltech air temperature sensor will read temperatures up to 120° C and 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 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 the position of the throttle based on the signal received from the TPS. Be sure to wire the TPS so that the ECU sees a closed value when the throttle is closed, the Engine data page field “throttle position” should read “closed” or “0%” when the throttle is closed.

Note: 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.

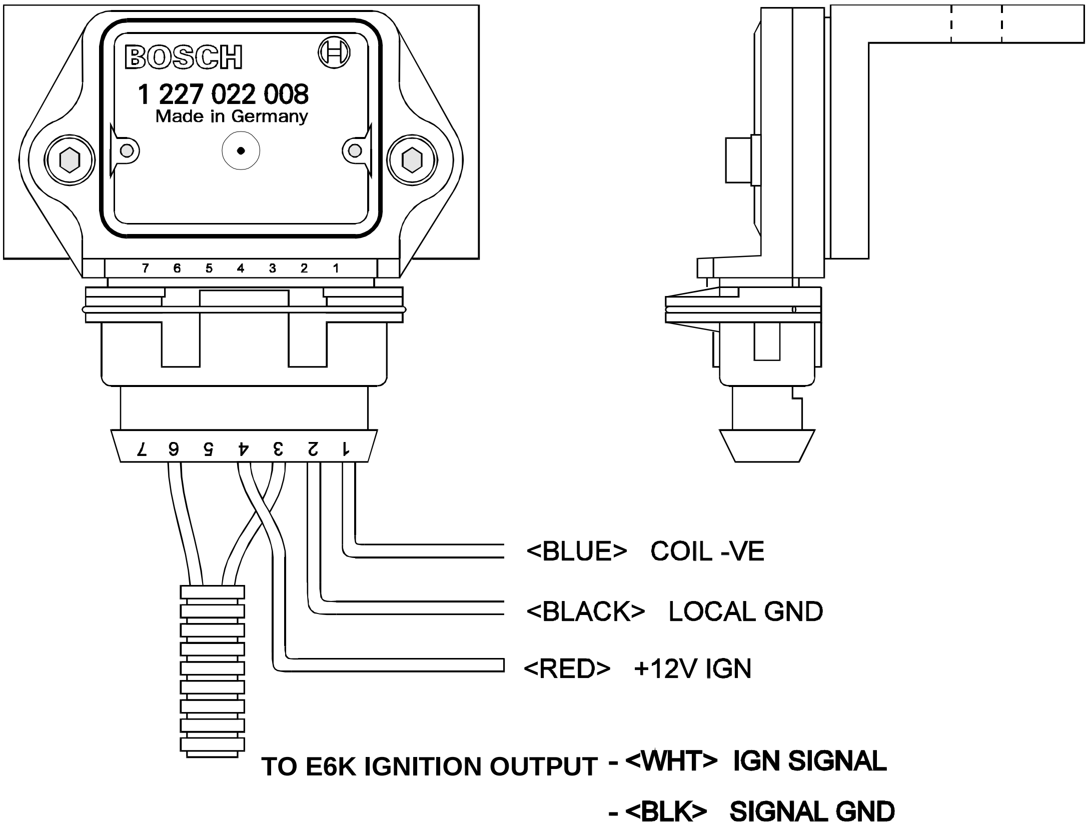
1.3.5. Mount Ignition Module.

The Ignition Module 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.

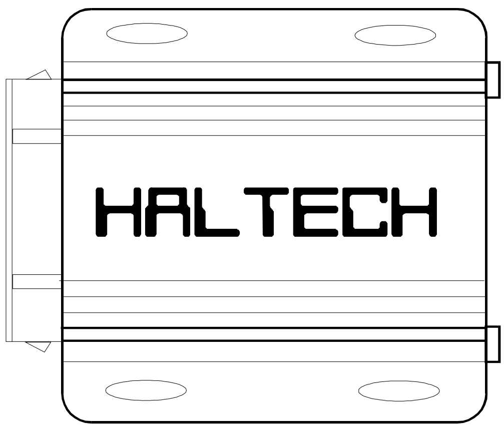
Included with the Haltech wiring harness is the Ignition Sub-loom. This connects the Ignition module to the Main Harness. Locate this loom and connect it to the ignition module but **do not connect the ignition sub-loom to the main loom until the ignition settings in the ECU are verified by connecting the ECU to a computer.**

Connect the 3 flying leads. The black wire with the eye terminal is a ground connection. This should NOT be grounded to the same point as the ECU to prevent ignition noise getting into the power supply circuit of the ECU. The blue wire goes to the negative side of the coil. The red wire should be supplied with Ignition On 12 volts. This can often be obtained from the positive side of the coil.

WARNING:
IF USING “INTELLIGENT” IGNITERS SUCH AS THE HALTECH EB023 IGNITION MODULE CONSTANT DUTY CYCLE SHOULD BE SELECTED IN THE IGNITION SET-UP PAGE. IF USING A “DUMB” IGNITER (MOST STANDARD IGNITERS ARE DUMB) THE CONSTANT CHARGE CYCLE SHOULD BE SELECTED
DO NOT CONNECT THE IGNITION SUB-LOOM TO THE MAIN WIRING LOOM UNTIL AFTER YOU HAVE CONNECTED THE E6K TO A COMPUTER (SEE PG 30)!



Bosch Ignition Module (Supplied as Haltech part EB023): The module must be mounted on the bracket, and the bracket must be mounted to a suitable surface. It behaves and is configured in the same fashion as the Haltech module as seen below.



Haltech Ignition Module (part number HIM1).

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.

See Chapter 15 [15.3] for more information on exhaust gas oxygen sensors.

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.

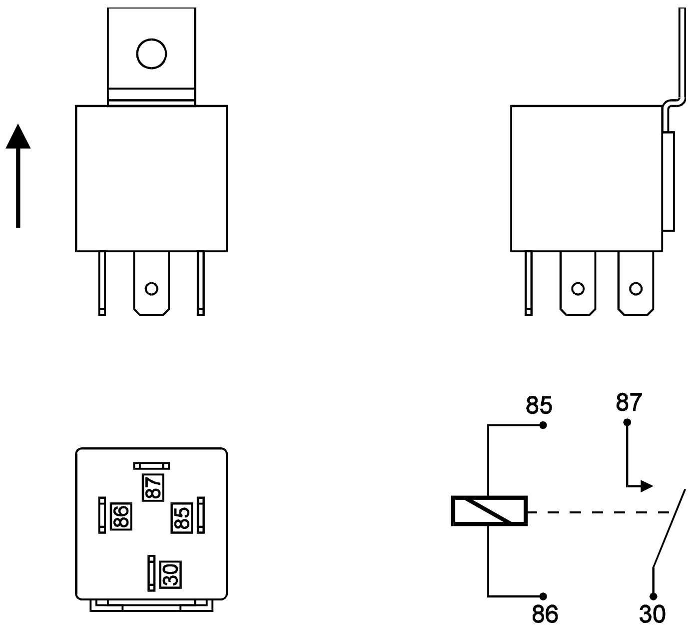
TRY TO ROUTE THE MAIN HARNESS AWAY FROM HIGH VOLTAGE IGNITION LEADS. UNDER NO CIRCUMSTANCES RUN ANY WIRING PARALLEL TO, OR IN CONTACT WITH THE IGNITION LEADS.

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

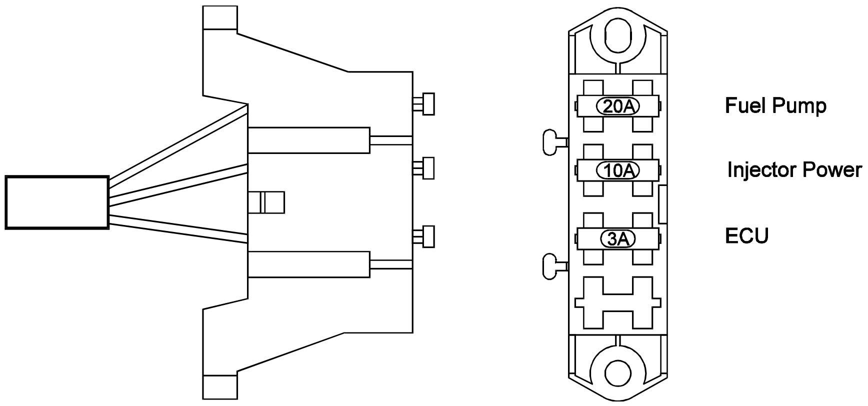
There are two relays used with the Haltech E6K, the Main Power Relay (with a grey wire) and the Fuel Pump Relay (two orange wires). These relays are identical parts so it is not important which relay goes in what connector.



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 E6K 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 as these have been selected for best protection. Altering the fuse ratings could cause severe damage to the E6K system.

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 Haltech E6K 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

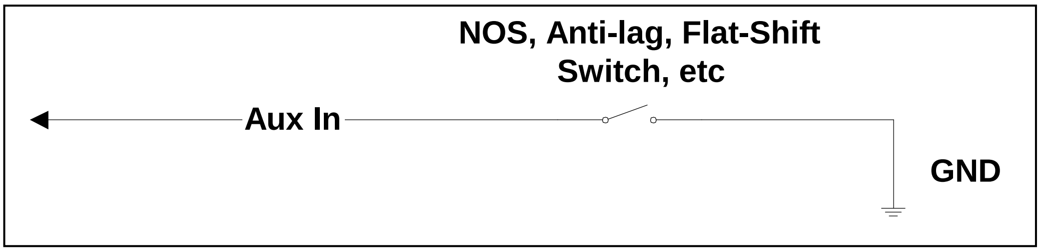
(Battery Supply +12V) Locate a source of continuous +12 volts and connect the red wire. Connecting direct to the positive battery terminal is suggested.

Grey

(Ignition Switched +12V) The grey wire is used to control the operation of the Haltech E6K 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.

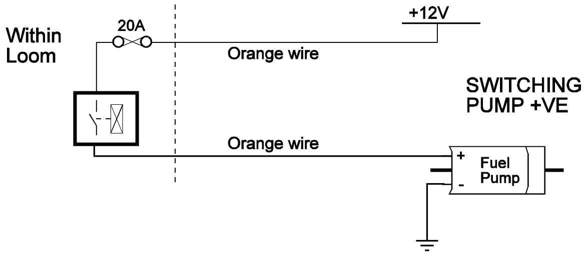
Green

(Aux In) The green wire is used as the Aux In channel. If you wish to use the Aux Input for NOS, Torque Converter control, a turbo timer, anti-lag switch, etc consult Section 4 – E6K Inputs and Outputs, Section 13.1 for further information. The following diagram is an example of how to wire the Aux In circuit:

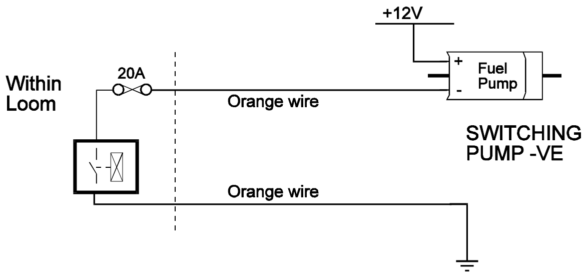


Orange

The two orange wires are used to operate the fuel pump. When the Haltech E6K 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. For details on how to install and plumb the Idle Speed Motor, see Chapter 14.

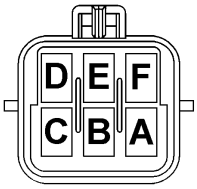
1.3.13. Install and connect any Optional Outputs

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 Section 4, **E6K Outputs**.

1.3.14 Connect the Trigger Sensor

If the engine has a reluctor type magnetic trigger device for either the main Trigger or the Home signal, you will need to connect to the reluctor adaptor input wiring now. For details on how to connect the main loom to the trigger, refer to **Error! Reference source not found.**.

Hall Effect and Optical triggers need three connections each - ground, power and the signal. The trigger connector on the Main Harness has six pins. These pins and their connections are shown in the diagram below. The Secondary (Home) Trigger is used for Direct Fire or Sequential Applications. (See Appendix B). If your wiring harness is of the flying wire type you should ensure that the trigger wire is shielded and that the shielding is properly grounded to protect against external interference to the signal from “noise”.



PIN	FUNCTION
A	GROUND
B	MAIN TRIGGER
C	INPUT A (RELUCTOR)
D	INPUT B (RELUCTOR)
E	HOME
F	13.8 V DC

You will need to know what wiring your trigger requires. Some triggers need a series resistor on the power line in order to limit current. Check your trigger system thoroughly. An incorrectly wired trigger can cause damage, usually to the trigger.

The E6K requires one trigger per ignition event. For example, a V8 engine will require 4 triggers per engine revolution. It is recommended the you read Appendix E, **Trigger Interface** for more detailed information on the trigger requirements of the E6K.

Note: If you are using a motronic sensor read appendix E.2.2 Motronic Trigger

1.3.15 Connect the ECU

The ECU can now be connected and tested. Be sure to engage the clip on the main connector. This will make sure the main connector parts mate correctly and reduces the mechanical strain on the connector bodies. The system can now be tested as described in the following chapters.

Now that your Haltech E6K is installed with all the sensors in place the system can be connected to the programming computer. This will allow the readings from all the sensors to be displayed on the screen and checked for correct operation.

To connect the PC to the Haltech E6K ECU you will need the programming cable and programming disk supplied.

2.1 Connecting the Haltech E6K to a Computer

The programming cable supplied with the Haltech E6K is a standard serial link extension cable. One end of the cable will plug into the Main Harness **PC Interface** connector (near the main connector). The other end should plug into the mating connector at the back of your computer. The plug on the computer may be marked "Serial", "Mouse" or "COM". Almost all laptops will have this plug. If there is no 9 pin plug which it will connect to, check to see if there is a 25 pin D-type plug available (some desk top computers will have this). If this is the case, an appropriate cable can be supplied on request. Alternatively, most electronic retailers will have a 25-pin to 9-pin converter.

Any time you wish to communicate with the E6K ECU it needs to be supplied with power. This usually involves just turning on the ignition switch. If at any stage power is not on, or the programming cable is disconnected while attempting to communicate, the programming software will display the message RECONNECT HALTECH. To rectify this, reconnect power and/or the programming cable.

You may now connect the Ignition Sub-Loom to the main wiring loom

2.2 Operating the Software

2.2.1 Computer Requirements

The computer required to program the Haltech E6K 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).

2.2.2 Installing the Software

The Programming Disk supplied with the Haltech E6K 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 E6K Program can run directly from the 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 titled **Running the Software from the Floppy Drive**.

To install the software follow these steps.

Boot up Computer

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 something like this:

C:\>_

This is the 'DOS Prompt'. It is DOS' way of indicating that it is waiting for a command. The **C:** indicates that the C drive is the drive currently selected. If you do not have a hard disk, your prompt will probably look like this :

A:\>_

Select the Drive

To run the INSTALL program, you must insert the supplied disk in the disk drive. If the drive is the A drive, then it must be currently selected. To select the A drive (or B drive if it is the required drive) type :

A : ↵ or B : ↵

The ↵ key is the Enter Key. On some keyboards it may be called the Return key. You should now see the prompt :

A:\>_ or **B:\>_**

Run the INSTALL Program

To run the Install program type :

I N S T A L L ↵

The Install program will now run. Follow the instructions given. The program will suggest that the software will be placed in the HALTECH directory. You can change the destination directory, but it is not recommended that you do unless you understand how directories work. 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.

The E6K Program is now ready to run.

2.2.3 Running the Software from the Hard Disk

Boot your computer up as described earlier. If your computer is already on, make sure the C drive is currently selected. To change to the HALTECH directory type :

CD \HALTECH ↵

or, if you used a different destination directory, type that path.

To start the program type :

E6K ↵

The E6K program will now run. The next section is on running the software from a floppy drive. You can skip this section and go straight to the section entitled **Azerty Keyboards**.

2.2.4 Running the Software from the Floppy Disk

To run the software from a floppy drive, boot your computer up as described earlier. Insert the Programming disk in the disk drive. If the drive is the A drive, then it must be currently selected. To select the A drive (or B drive if it is the required drive) type :

A: ↵ or B: ↵

You should now see the prompt :

A:\>**_** or **B:**\>**_**

To start the E6K program type :

E6K ↵

The E6K program will now run.

2.2.5 Azerty Keyboards

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

[Q] [W] [E] [R] [T] [Y]

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 run the software slightly differently. When you would normally type:

[E] [6] [K] [↵]

to run the programming software (not the installation software), you need to instead type :

[E] [6] [K] [/] [A] [↵]

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

2.3 The ONLINE and OFFLINE Modes

On the E6K system title page, the software asks whether to operate in ONLINE or OFFLINE mode. The OFFLINE mode is very useful to familiarise yourself with the Haltech software, but cannot be used to make lasting adjustments to the fuel maps except by modifying maps then saving those maps and re-loading them to the ECU in the on-line mode. Also lasting changes to the main, fuel and identification pages cannot be made in the OFFLINE mode. Do not attempt to make lasting changes to the ECU unless there is a special reason for doing so. If you wish to experiment and familiarise yourself with the software press N for OFFLINE mode, but if the ECU is installed and power is available then we suggest the ONLINE mode be selected. Press Y to select ONLINE mode.

2.4 Using the System ONLINE

In the ONLINE mode there is a two-way flow of information between the ECU and the programming computer. The communication cable must be installed and power must be available to the ECU before the system can communicate. The ONLINE mode will be used most frequently. While using the system ONLINE, you can view engine information directly and make adjustments. Any changes or modifications made on the computer are instantaneous and will be immediately recorded in the ECU. When the programming cable is removed and the ignition switched off, the ECU will retain all of its memory. The maps do not need to be saved, but keeping a copy on disk is always good practice and is recommended. (See 9.1)

> Note: If power is removed or the communication cable is disconnected or interfered with, the following message will be displayed on the computer screen.
>
> **RECONNECT HALTECH**

If this message appears check all connections and ensure that the communications cable is not being interfered with. Also be sure that the Haltech E6K unit is receiving power. (i.e.. ignition switch is turned "on".)

2.5 The Main Menu

When you select ONLINE or OFFLINE mode the Haltech MAIN MENU bar appears. This menu bar allows access to submenus giving access to maps, file storage/retrieval, engine data and options.

2.6 How to Quit

Throughout the program you can exit from any application by using the menu bars or hot keys. Pressing [Ctrl][Q] in any page will prompt you to exit the program (i.e.. pressing [Q] while holding down the [Ctrl] key). If you wish to exit, press [Y] at the prompt.

2.7 Checking the Engine Data

The engine data option can only be used when the system is ONLINE. This function allows all of the engine data variables to be displayed on the screen

This is a very useful function for analysing the engine sensors. To bring up the engine data press [Ctrl][E] from any application. Otherwise it can be accessed through the menu bar by pressing [Alt][O] and then [E] for Engine Data.

Do not attempt to start the engine if the Engine Identification has not been set up. Before continuing check to see if all the sensors are operating correctly by viewing the engine data page.

2.8 Online Help

Software version 6.32 offers the “help shortcut key”: [Ctrl][H] unfortunately this feature is not available. Please refer to your manual for help with aspects of installation and operation of your Haltech system.

CHAPTER 3 ENGINE IDENTIFICATION

3.1 Checking the Identification

The Identification page tells the E6K essential information about the engine characteristics. Without this information being correct the engine cannot run properly. The Identification is made up of several *fields*. Each field can have a number of settings, and you can change most of the fields.

Use the Up and Down arrow keys (↓ and ↑) to move between fields. 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. The Tab and Enter keys (Tab and ↵) keys are used to change this type of field. Each stroke of the Tab key will display the next selection. The Shift and Tab keys together will step backwards through the selections. Once the desired selection is displayed, the Enter key is pressed to program that selection. Text Fields require you to enter either text or numbers. Once the field is selected, the new text can be typed in, with the Enter key to finish. An example is the Rev Limit. 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 using ↓ or ↑ and then type 7000↵.

Here is a description of each of the Identification fields:

Cylinders

The number of engine cylinders needs to be entered here. This parameter is used to determine the engine speed.

Load Sensing

The E6K 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 wild cams, 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 E6K needs to know the type of Manifold Absolute Pressure (MAP) sensor being used. If you do not know what sensor you have refer to Chapter 1 [1.3.1]. Enter the correct description here to match. If using throttle position mode, set this parameter to a 1 Bar sensor.

RPM Limit

The E6K can limit the maximum rpm at which the engine will operate. Above this level the E6K completely cuts fuel or ignition (see below) to the engine. When the engine speed drops below the RPM Limit the E6K 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 on an engine with a catalytic converter, as the unburnt fuel can damage it.

Units

The Haltech E6K programming software can display parameters in either Metric or US units.

RPM Mode

The E6K fuel and ignition maps may be arranged either in 500 rpm increments to 10,500 rpm, or in 1000 rpm increments to 16,000 rpm. Select the high - or low - rpm mode here. Changing settings alters the way the ECU reads the Maps, and will change the tuning of the engine dramatically. Do not change this setting once tuned unless necessary.

Road Speed Value

This value calibrates the Road Speed reading. Some applications in Advanced Mode cannot use the Road Speed input trigger, and this field will not be displayed.

System Mode

This field sets the operating mode for the software. The software can be used in either Basic or Advanced Mode. Most installations will only require the Basic Mode. To determine if you need to use the Advance Mode, see the **Introduction**.

The tutorials presented in this chapter are examples of how you might use the available functions to make typical modifications to the maps. These tutorials are aimed at explaining both why and how some typical changes might be made. They assume that you have the software running ONLINE on your PC, with the ECU powered and connected via the supplied programming cable.

4.1 What are maps?

The injection times needed by the engine at different conditions is stored by the E6K in a table of numbers called a look-up table. The E6K determines the engine's load and speed, and uses these two parameters as an index to the table. This table is called the Fuel Map. For instance, at an engine speed of 4000 rpm and at -20kPa, the relevant number in the table may be 4.35. If the engine approximates -20kPa at 4000 rpm, then the computer will extract the value of 4.35ms from the table as the base injection time. This value is then adjusted to compensate for numerous conditions, such as temperature or acceleration, and then the ECU holds the injectors open for that time on the next injection.

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

It is possible to program the E6K by directly changing the value of each number by programming in the numerical mode (see 4.7.6), but this can be extremely difficult, so the Haltech allows you to change the numbers by manipulating graphics in maps presented as bar graphs. (This is much simpler and allows you to visualise the map)

Since it is difficult to interpret all the table's values at once, the programming software divides the map by engine speed into a series of rpm ranges. Within the range, each load point is represented by a vertical bar. Thus, when you view a range from the Fuel Map, you see a bar chart of injection time versus load for all the load points in the table at that speed.

There are other tables in the E6K, such as those used for temperature corrections. They are indexed by only one parameter, and so are not divided into ranges. These tables are also called maps.

4.2 What is mapping the Engine?

Mapping the engine is filling the look-up tables with the correct values for your engine. This is done 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 as simple and intuitive as possible.

4.3 Using the Software

In order to make the software easy to use, the program presents you with a menus bar at the top of the display. The menu bar is accessed through simple combinations of keystrokes. Once the appropriate menu has been accessed a sub-menu appears giving choices on available page heading. To increase efficiency there are also a number of hot-keys that allow you movement between pages without accessing the menu bar.

4.4 Accessing the fuel maps

Pressing Alt M will take you to the Maps Menu. From the Sub-menu choose the fuel maps option by using the cursor keys to move the highlighted bar or pressing the underlined letter of the option required, in this case F. This will produce a further sub-menu that will allow you to choose a range to be viewed.

4.4.1 Fuel Set-up

The Fuel Set-up works in an identical way to the Identification. It's fields are different and relate to the way the fuel is delivered to the engine. Enter the Fuel Set-up by pressing Alt S and then by pressing F key. The fields in the Fuel Set-up are:

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 and 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 on the E6K. It is better, when first tuning, to disable this function.

Injection Mode

Depending on the ECU settings the E6K splits its four/eight injector driver outputs into two banks (see chapter 13, 13.1). INJ1 and INJ2 comprise the first bank. INJ3 and INJ4 form Bank 2 (refer to the wiring diagram at the back of this manual.) In Basic Mode, Fuel can be injected in three different modes.

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 Bank 1 fires all the time, just as in a multipoint set-up. Beyond a set boost pressure, the second bank of injectors is enabled. These "staged" injectors are normally upstream of the primary injectors, adding to their fuel flow. The point at which the E6K switches in the secondary injectors is set via the Staging Bar Number field. Staging permits high fuel-flow capability, but maintains accuracy and controllability at light load and idle. See Appendix D [D.3] for more details on staging.

In Advanced Mode, ***Sequential*** Injection can also be selected. This option is not a straight-forward set-up. It requires more outputs for fuel than normally used. Before selecting this option carefully read the section on sequential injection in **Appendix B - The Advanced Features.**

WARNING:
WHEN FINISHED SETTING THE INJECTION MODE, SEE CHAPTER 13.1
(INPUT/OUTPUT PAGE) TO SET THE INJ 1 - 4 DRIVERS TO THE CORRECT STATE: ENABLED OR DISABLED:
THIS IS IMPORTANT AS THE ECU WILL NOT OPERATE CORRECTLY IF THE INJ 1-4 DRIVERS HAVE NOT BEEN CONFIGURED PROPERLY. AT WORST, SOME INJECTORS MAY NOT FIRE OR THE INJECTOR DRIVERS MAY DESTRUCT AFTER A PERIOD OF TIME.

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 or not the enabling is corresponding to a temperature above or corresponding to a temperature below the Post Start Temp Limit. From when the motor is started to when the engine temperature reaches the Post Start Temp limit, the Post Start correction map will apply correction to the injection times.

Post Start Time Limit

This field sets the time after start-up to when the post start correction map is disabled. From when the motor is started to when the time reaches the Post Start Time limit, the Post Start correction map will apply correction to the injection times.

Staging Bar Number

This field sets the point at which the staged injectors are enabled. See Appendix D [D.3] for more details on staging. 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. Typical engine configurations that fall into this category are multiple throttle body set-ups and wild cams. The zero throttle Map can allow a very quick and simple adjustment of the idle fuel settings. This option can be disabled if not required.

Throttle Pump Deadband

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. The throttle position at which this Map is used is set by the Full Throttle Threshold field. The Full Throttle Map can be disabled if not required.

Full Throttle Threshold

See the Full Throttle Map field above for information on this field. This field can be set between 70 and 100.

Barometric Lock

If you wish to lock the barometric value that is stored by the ECU to a set value and override the start-up barometric correction, **enable** this option. Normally, unless you are using throttle position as a load reference or have another good reason to do so, leave this option **Disabled**. Configuring barometric compensation successfully requires an in depth knowledge of your engine and the environment in which it will be operating. Chapter 8 [8.5] contains more information on barometric correction and how it is applied by the E6K.

Barometric Pressure Lock at xxxx (mBars)

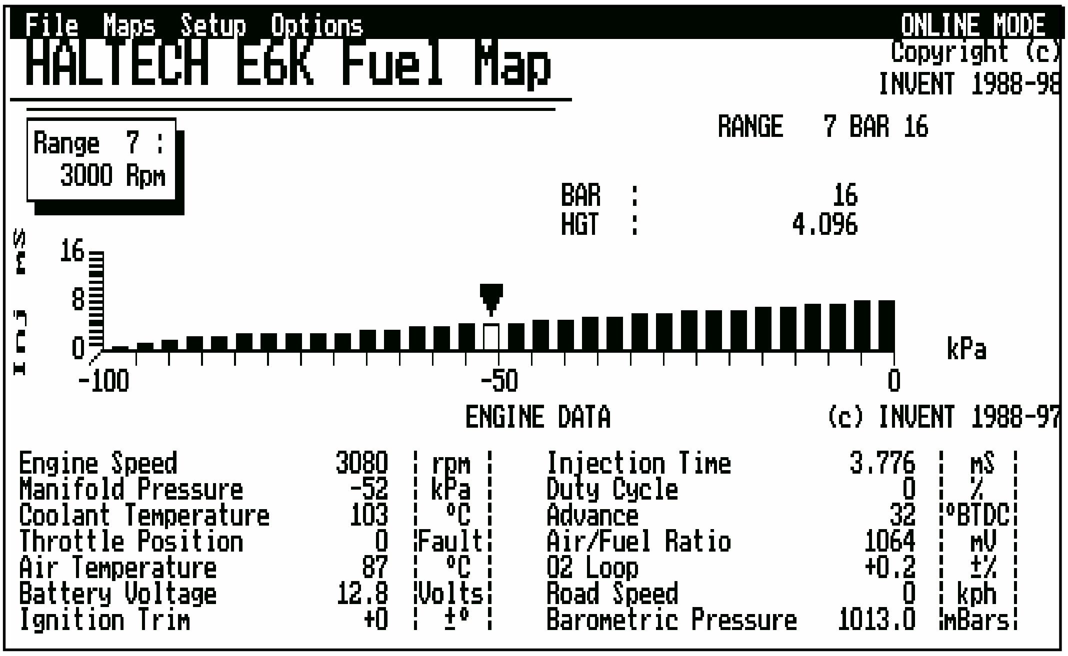
Allows you to set the barometric pressure value to which the ECU corrections will be locked. The default is 1013mBars (= 1 Atmosphere @ sea level). Again, unless you have sufficient knowledge about your engine characteristics and the environment it is operating in, leave this field as it is. Refer to Chapter 8.5 for more information.

Disable Injector Outputs

Allows you turn off all injector outputs. Setting the value to YES will cut all injector output which allows an easy way to check the trigger 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.

See Chapter 3, **Engine Identification** for information on how to adjust (using the software) all of the parameters mentioned above.

Once you have set up the fuel delivery via the Fuel Set-up, you can view the Fuel Maps. Press [Alt][M] then [F] to view the Fuel Sub-Menu. Then choose the range you wish to view by using the function keys. While in the Fuel map, each range can be accessed by pressing the [N],[P] and [J] keys to move to the next, previous range and jump to a particular range. To view the map at the 3000 rpm range, press [F3]. When in the Fuel Maps sub-menu your display should look similar to this:



Values from this bar chart would be used whenever the engine speed falls in the range between 2750 and 3250 rpm (or, if in high-rpm mode, between 2500 and 3500 rpm).
In the top left is the range number and the speed range to which it corresponds. The bar chart shows injection time (up to 16ms) against the load parameter, either throttle position or manifold pressure. The axes are scaled appropriately from the information in the Identification Page. Across the bottom of the screen are the engine data parameters. The Range, Bar number and Height (HGT) of the bar being adjusted is shown on the right hand side of the screen.

4.4.2 Adjusting Bar Height In The Map

The height of the Bars in the map can be readily adjusted by using the up and down arrows keys, and the PgUp and PgDn keys ( ). See the command summary at the end of this section for a full list of key functions. The bar that is highlighted on the computer screen indicates the bar that you are currently adjusting. To change the highlighted bar, use the left and right arrow keys ( ).

Try pressing the Up arrow ( ) once. Notice that the outlined bar gets taller. Now try pressing the Down arrow ( ) once. You are now changing the fuel delivery at 3000 rpm at the load shown for the bar you have selected. Make sure you move the bar back to its original height once you have tried adjusting it so as not to destroy the map you have loaded.

Now try using the key. The outlined bar should jump up 0.096 ms. As the bar gets taller, the fuel delivery is increased and the engine is enriched at that speed and load. Now press the key and the highlighted bar should move down 0.096 ms. Note that the fuel delivery for the outlined bar is shown beneath the bar number on the centre of the display. Note also that the injection time does not necessarily match the bar height as the injection time is the actual injection time after various corrections have taken place. Also, the arrow indicates the bar (i.e. number) currently being accessed by the engine. If the arrow was not over the highlighted bar this would also cause the bar height and injection time to be different as the bar height is the height of the bar being adjusted, not necessarily the value of the bar currently being accessed by the engine. Try using the Control key and the Page Up key together, [Ctrl][Page Up] ,to move the bar up by 2ms. Move the Bar back down by using [Ctrl][Page Down]. The changes you made took effect the instant you pressed the keys. You do not have to do anything else to save these changes.

4.5 How To Quit

To return to the Fuel Map Menu from any of the map display pages press [Ctrl][F] .Or through the menus at the top of the display. Pressing [Ctrl][Q] keys simultaneously at any page or map will allow you to exit the Haltech program and will return you to MS-DOS. You should always exit the program before switching off your computer.

4.6 Accessing the Ignition Maps

Pressing [Alt][M] from any page will take you to the Maps Menu. From here you choose [I] for the Ignition maps. Or you can access the ignition maps directly through [Ctrl][I] from any other application.

4.6.1 Ignition Set-up

The Ignition Set-up works in an identical way to the Identification. Its fields are different and relate to the way the ignition advance is determined for the engine. Enter the Ignition Set-up by pressing [Alt][S] then [I]. The fields in the Ignition Set-up for Basic Mode are:

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.

Trigger Gain

This field is only applicable if you are using an Internal 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.

Trigger Mode

This field is only applicable if you are using an Internal Reluctor pickup as the "Trigger Input". The Trigger has two modes: constant mode and adaptive mode adaptive mode uses software to filter out noise at low RPM when the reluctor signal is weak. If you are having problems maintaining a clean trigger at low RPM the adaptive mode may solve this problem. See also Trigger Gain in the Ignition Set-up.

Home Input

This field is only applicable in advanced mode if direct fire or sequential or batch injection is required. This field has the same options as "Trigger Input".

Home Edge

This field is only applicable in advanced mode if direct fire or sequential or batch injection is required. This field has the same options as "Trigger Edge".

Home Gain

This field is only applicable in advanced mode if direct fire or sequential or batch injection is required. 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.

Trigger Type

This field defines the trigger pattern the ECU will see coming from the crank or camshaft angle sensors. The E6K currently supports the following trigger types:

Standard This trigger pattern sends one trigger for each spark event. For example a V8 has 4 firing strokes for each crank revolution, for this engine the ECU would expect to see 4 trigger events for each crank revolution or 8 events for each cam revolution.

Multi-tooth This trigger pattern is the same as that for the Standard Trigger except that there are multiple trigger events for each spark event. The number of teeth for a multitooth trigger must be a multiple of the spark events. This trigger requires a home signal for synchronisation of the trigger and engine position.

Motronic This trigger is a variation of the multitooth trigger pattern. This setting is compatible with the BOSCH Motronic controlled engines. The Motronic wheel has multiple teeth with a set number of teeth missing for synchronisation removing the need for a separate home signal. The BOSCH Motronic wheel usually has 60 teeth positions with 58 teeth and 2 missing teeth.

Subaru This trigger should be used when the standard Subaru trigger is used.

Twin Trigger This trigger is used in conjunction with twin distributor ignition systems. Since it is s distributed system there is no requirement for a home signal so this channel is used to carry the second trigger.

Nissan This trigger should be used when the standard Nissan trigger is used.

Number of Teeth

This field is only applicable if the trigger type is: Multitooth, Motronic. The Number of teeth :
Multitooth The number of teeth on the multitooth wheel
Motronic The number of teeth on the motronic wheel including the missing teeth

Tooth Offset

This field is only applicable if the trigger type is: Multitooth, 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

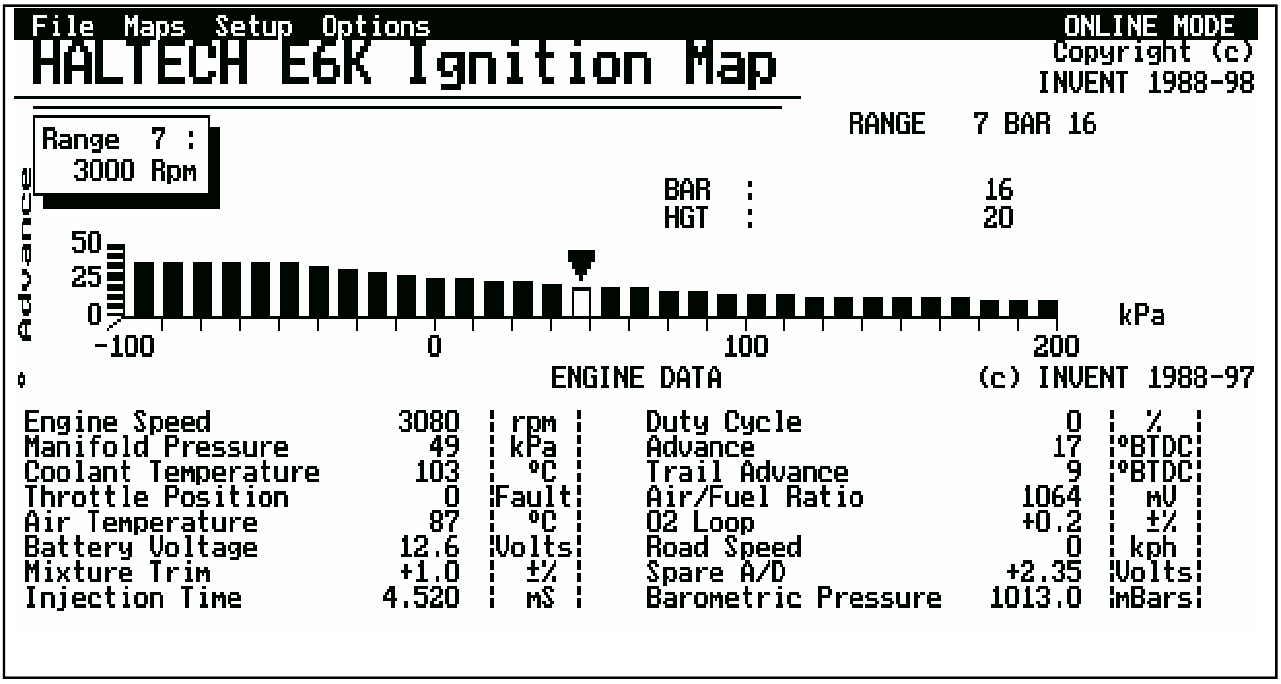
This field defines which edge of the signal defines the ignition event: falling or rising. The EB023 smart igniter uses a falling edge.

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 30% with a corresponding 70% low time.

The Ignition Map is adjusted in a similar way to the Fuel Map. The keystrokes are the same, except that one increment is one whole degree advance or retard. The best way to initially set up the Ignition Map is to use the Library Maps, and then return to the Ignition Map later if the ignition curve needs modification. Ignition Library Maps are explained in Chapter 5 [5.4], Starting the Engine.

An example of an ignition range for a turbocharged engine could look like this :



4.7 Time Saving Functions

The following list of commands can be used whenever the graphs for most of the maps are being displayed by the Haltech programming software.

Note: When two keys are displayed together, such as [Alt][R] , this means that the second key must be pressed while the first key is held down. In this case, the [Alt] key would be held down while the [R] key is pressed.

4.7.1 Current Location - [Home]

Pressing [Home] will take you to the range at which the engine is running, and highlight the bar that is currently being used. This bar is easily identified by an arrow directly above it pointing down. As the engine speed and load changes, the arrow moves with it. The Home key is useful for finding the engine's operation point very quickly.

4.7.2 All Ranges - [Alt][R]

Across the ranges, the curve of the fuel map does not change greatly. Usually the shape remains much the same, and the height changes according to the volumetric efficiency of the engine. In order for all the fuel ranges to initially be set up quickly, the Haltech E6K system allows you to program all rpm ranges simultaneously with the same data. [Alt][R] turns *All Ranges* on, and the words All Ranges appears under the title.

When the *All Ranges* function is active, a bar adjusted on one graph is copied to the same bar on all the ranges. If you use this option, you can set the shape of the map at any range, and all other ranges will be identical at every bar you adjusted. This feature enables all graphs to be given an initial shape that should run the engine, albeit rather roughly. Once you have used the *All Ranges* option for a starting point, press [Alt][R] once more to exit the *All Ranges* option and tailor each map individually.

This option is only available on the Base Fuel and Ignition Maps.

4.7.3 Selecting Groups of Bars

Groups of adjacent bars may be highlighted and adjusted together.
Hold [Ctrl] while using the left or right arrow keys, [←] [→], and you will highlight a group of bars. This group will now act in unison when increasing or decreasing the height of the Bars. To de-select the highlighted Bars use the [Alt] and arrow keys together.

4.7.4 Percentage Changes - Alt P

Using this function will prompt you to enter a percentage change to the selected bars. An entry of "20" will increase each bar by 20%, while an entry of "-15" will decrease the bars by 15%. This change only affects the highlighted bar(s).

4.7.5 Linearise - Alt L

When a group of bars is selected (more than two), this function can be used to set the values between the end points. Highlight the bars between two load points that are known to be correct and press Alt L . The programming software will automatically adjust all the bars between the two end points to form a straight line. This feature facilitates fast programming and the smoothing of maps.

4.7.6 Numeric Mode - Alt N

This will take you into numerical mode, displaying the map as a spreadsheet. This mode is available if required, but graphical mapping is normally exercised as it is much easier to use. Numeric mode allows you to enter the precise injection values across all the rev and load ranges as seen in the diagram below:

File Maps Setup Options OFFLINE MODE

	1	2	3	4	5	6	7	8
500 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
1000 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
1500 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
2000 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
2500 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
3000 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
3500 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
4000 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
4500 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
5000 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048
5500 Rpm	0.256	0.512	0.768	1.024	1.280	1.536	1.792	2.048

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 the enter/return key. 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.
To exit from Numeric Mode and go back to using the maps press the Esc key.

4.7.7 Bar Increments - [Alt][I]

The Up and Down arrows, [↑] [↓], normally change the bar height in the maps by a pre-determined amount, usually the smallest possible increment. PgUp and PgDn change the bars also by a pre-determined amount. These increments (the value of the keystroke) can be changed by the user. [Alt][I] will bring you to a screen where the increments themselves can be changed.

Normally, the bars are altered by adding or subtracting a fixed amount. The adjustment keys may instead apply a percentage change on each keystroke. [Alt][P] on the Bar Increment Screen will switch to percentage increments, [Ctrl][F] will return you to fixed increments.

[Alt][L] will space out increments evenly between the Up/Down Arrows field and the Ctrl PgUp/PgDn field. The result of this operation will be displayed once the field is refreshed, this can be done by highlighting the field.

4.8 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 whilst open is called the injector pulsewidth. As rpm increases it is possible for pulsewidths 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.
CARE SHOULD BE TAKEN THAT THE ENGINE CANNOT REV ABOVE THE POINT WHEN 100% DUTY CYCLE IS REACHED AS THERE IS A DANGER THAT DAMAGE WILL BE CAUSED TO THE ENGINE

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.

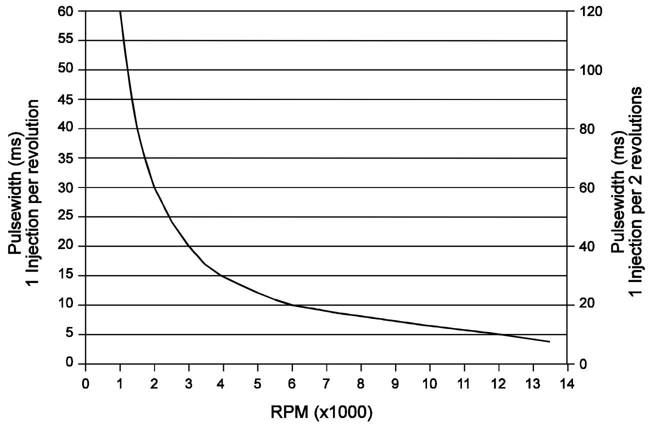
Maximum Injection Time (in milliseconds[ms]) =

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

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.

MAX INJECTOR PULSEWIDTH VS. RPM



Injector Duty Cycle appears on the Engine Data Page and on Datalogs 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

4.9 Command Summary for Maps

←, →	- move left/right highlighted bar(s)
↑, ↓	- increase/decrease highlighted bar(s)
Page Up, Page Down	- increase/decrease highlighted bar(s)
Shift Page Up, Shift Page Down	- increase/decrease highlighted bar(s)
Ctrl Page Up, Ctrl Page Down	- increase/decrease highlighted bar(s)
Ctrl →, Ctrl ←	- select (highlight) next bar
Alt →, Alt ←	- de-select end bar
Alt P	- enter Percentage change to highlighted bars
Alt L	- Linearise between end points of highlighted bars or linearly interpolate the increment values in increment set-up
Alt I	- set Increments
Alt N	- enter Numeric mode
Alt R	- toggle All Ranges mode
N	- move to Next range
P	- move to Previous range
J	- jump to range of value entered
Home	- go to current engine range/bar
Tab	- switches option in set-up pages

CHAPTER 5 STARTING THE ENGINE

There are a few things that need to be done before the engine should be started. 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 Identification, the Fuel Set-up and the Ignition Set-up are all set correctly. In particular, check the No. Cylinders, Ign Div/By, Load Sensor and Injection Mode parameters. If any of these are incorrect, the engine may run, but proper tuning will be impossible.

5.1 Calibrating the Throttle Position Sensor

The throttle sensor must be calibrated so that the ECU knows the start and stop positions of the sensor. 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.

5.2 Checking the trigger

It is a good idea to check that the E6K is receiving a reliable trigger signal. Disable the injector outputs found in the Fuel Set-up page to cut all fuel delivery to the injectors. This will prevent the engine from starting. The engine should then be cranked over on the starter and the rpm displayed on the engine data page should read about 100 to 300 rpm. If the engine speed is zero or is erratic then refer to the section in Chapter 1 [1.3.14] regarding trigger set-up. If the trigger is operating correctly then enable the injector output again on the Fuel Set-up page.

5.3 Checking the Base Timing

The E6K uses a timing reference taken from either the cam angle sensor or flywheel sensor. This gives the E6K the reference on which to position all ignition timing. If the timing is wrong then the E6K cannot function correctly. To ensure that this base timing is set correctly the E6K has a **LOCK TIMING** setting.

When the Lock Timing is set, the ignition timing is forced to the Lock Timing Angle (this is a preset value between -5° to +25° Before Top Dead Centre (BTDC)). This is regardless of whatever ignition timing Maps are currently in the E6K.

To enable this flag, press [Alt][S] from the Sub-Menu to select the Ignition Set-up. Using the arrow keys move to the Timing Lock option. If it reads **Lock Timing On**, the flag is enabled. If it reads **Lock Timing Off**, then the flag is disabled. The flag is toggled by pressing [Tab]. If the Timing Lock is on, the ECU will lock the timing to where it believes the Lock Timing Angle advance to be.

To check the base timing you should now start the engine with the Timing Lock on. The engine should now start and run although with only Lock Timing Angle° of ignition advance the idle speed may be lower than usual.

<u>If the engine does not start</u> it may be because the fuel requirements are not right. If this is the case, it is suggested that you disable the injector output and do the timing check while cranking. This will require two people : one to crank the engine and one to operate the timing light. It can be difficult to check the timing accurately at cranking speeds. Removing the spark plugs will help the engine to rotate at an even speed. Once you have checked the timing at crank, leave the Timing Lock on, skip the next section on loading an Ignition Library Map and go to the section on Determining Engine Fuel Needs. Once you have the engine starting and idling, return to this section, check the timing again, and then load the Library Map.

Use an ignition timing light to check that the ignition timing is set to the angle that you have entered for **Lock Timing Angle °BTDC** (a common value is 10° BTDC). See the workshop manual for your engine for details on checking ignition timing and the use of a timing light.

The timing should be locked at Lock Timing Angle° BTDC. If it is not then the angle at which the ECU is being triggered is not the same as the angle in the **Trigger Degrees** field in the Ignition Set-up. If the timing is miles out, go back and check all the angles again. If you have guessed the trigger angle, try and calculate it properly. Remember that the angle is in crank degrees, not distributor degrees. Also make sure the trigger edges are correct. These can have a very large affect on the trigger angle.

If the angle is a little out, it is just a matter of aligning up the actual trigger angle with the angle in the **Trigger Degrees** field. There are a few ways to do this :

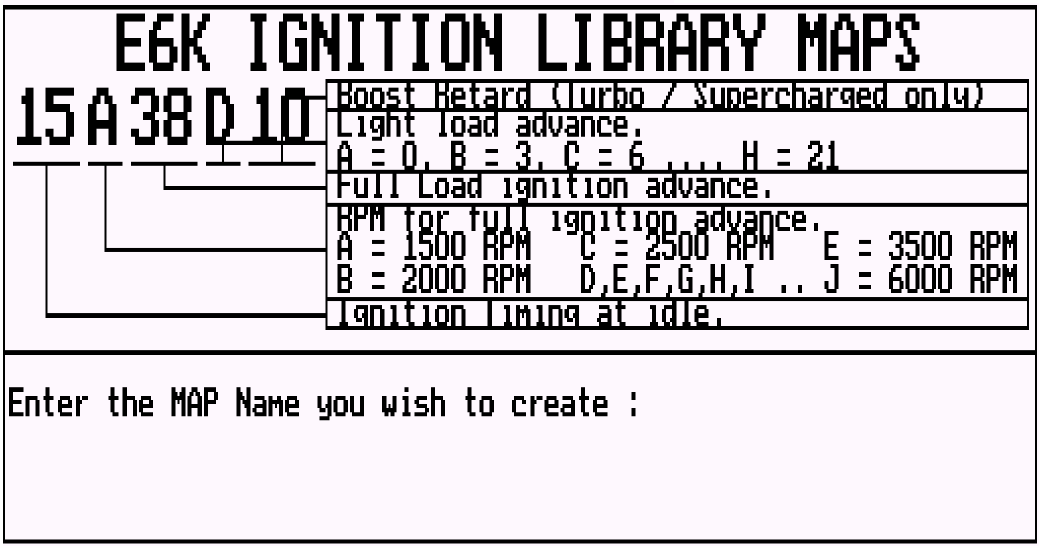
- If the timing reference is taken from a distributor, then you may be able to rotate it while using the timing light until the engine is at Lock Timing Angle ° BTDC. Be wary about adjusting the base timing in this manner by any more than a few degrees as it can upset the rotor phasing. For details on rotor phasing, see Appendix F.
- If the reference is taken from a cam angle sensor (such as in a distributor-less direct fire engine), then if it is possible, rotate the sensor while using the timing light until the engine is at Lock Timing Angle° BTDC. With a cam angle sensor, there is no need to worry about rotor phasing.
- The last method is to change the **Trigger Degrees** field in the Ignition Set-up. (See the previous Chapter for details on how to change this field). If you are using a crank angle sensor then this is the easiest way to adjust the base timing. The Trigger Degrees field tells the ECU where the trigger is occurring. Once the ECU receives this trigger, it calculates how many engine degrees to delay until it has to fire the spark. For example, if the trigger is at 70° BTDC, and the Timing Lock is on and the timing lock angle is set to 10° BTDC, the ECU will delay 60° and then fire the spark at Lock Timing Angle° BTDC. If however, the trigger was actually at 80° BTDC, but the Trigger Degrees had a value of 70, the ECU would still delay the 60° and the engine would fire at 20° BTDC. Changing the value of the Trigger Degrees field to 80 would increase the delay from 60° to 70°, and the engine would now fire at Lock Timing Angle° BTDC. When adjusting the parameter, do so in small steps, say 5 or 10 degrees at a time. This will allow you to check that you are moving in the right direction.

You must now ensure that the timing does not move as the engine speed changes. Give the engine a few quick revs while using the timing light to check that the ignition timing stays at Lock Timing Angle ° BTDC. If the base timing is locked at Lock Timing Angle ° BTDC and does not change with engine speed then you are ready to load an Ignition Timing Map and clear the Timing Lock Flag.

If the ignition timing does change with engine speed then see the Troubleshooting procedure in Appendix A

5.4 Loading an Ignition Library Map

The E6K has an effective and time saving method of programming the ignition curve using Library Maps. Each ignition timing Map in the library is slightly different. By becoming familiar with the library you should be able to select an ignition timing Map that will suit your engine. Each ignition timing Map in the library is accessed by a different name. The name reflects the characteristics of the Map. Names can be up to eight alphabetic or numeric characters in length. The ignition timing library Maps use these eight characters as shown, where 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.

As mentioned above, it is suggested that the timing be checked before starting the engine. If the ECU successfully locks the timing at Lock Timing Angle° then you should load a library map that will get the engine started. Try be conservative - you should not be looking to gain the last few percent in performance immediately. If you know the factory settings for idle, vacuum and full load advance for your engine you can use those values to load an extremely effective Library Map. N.B. The "Lock Timing On" field in the ignition set-up (4.6.1) needs to be set to "Disabled" for the ignition advance and retard feature to work.

5.5 Determining Engine Fuel Needs

You should now be ready to start the engine. At this stage, you should not be using the Zero Throttle Map. Check that it is disabled in the Fuel Set-up. Go to the Fuel maps and display the 0 rpm range. During cranking, the pointer will appear across this page, until the engine speed picks up and lifts into the 500 and 1000 rpm ranges. Press the 

key to jump to the current load point immediately.

If you are using manifold pressure as the load sensor, the engine will be close to atmospheric pressure during cranking. If you are using throttle position, then the E6K will be using bar 1 while cranking and idling. Once the engine is tuned, you should not need to apply any throttle to get the engine to fire. When cranking the engine watch for the indicator arrow over the bars. This will tell you what bar the E6K is using to calculate the fuel. The bars around the position that the arrow indicates are the Bars that will need to be adjusted to get the engine to run. N.B. The bar that is indicated by the arrow is the bar that the ECU is referencing for its fuel needs whilst the bar that is highlighted is the bar that you are adjusting.

If the engine is not firing at all, check that spark is available. Also check that the spark plugs are clean and are not wet. It is unwise to crank on the starter motor for extended periods. The engine should fire and run within the first few seconds of cranking.

If the engine misfires and blows black smoke then the mixture is rich and the bars need to be lowered. If the engine will not fire or fires but will not continue to run then the mixture could be lean and the bars need to be increased.

5.5.1 Tuning for Idle

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

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

Remember that the E6K interpolates against both rpm and load. If the engine is idling at 800 rpm, then the injection time is computed as 60% of the value from the 1000 rpm range, and 40% of the value from the 500 rpm range, so both ranges would have to be adjusted to get the correct mixture. Similarly, if the idle mixture is reacting poorly to changes of the bar indicated by the map pointer, then try adjusting the adjacent bars. Wait for the engine to heat to operating temperature before performing further changes to maps.

5.5.2 Tuning with No Load

Using the throttle only, increase the engine speed to 1000 rpm. If the engine is at exactly 1000 rpm then only that range needs to be adjusted. Adjust for the crispest engine response. Engines will usually idle rich, then head towards stoichiometric mixture at higher speeds. Repeat for 1500, 2000, 2500, 3000 etc. The engine should now start and fast-idle evenly. You should also have the engine running at operating temperature before going further. 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 Rpm reading on the computer. If it becomes erratic, or fails to follow the actual engine speed correctly, check the section in Chapter 1 on setting the trigger. Also make sure that the information in the Identification and Set-ups is correct.

5.5.3 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.

5.5.4 On the Dyno

Whether the vehicle is on a chassis dyno, or the engine on an engine dyno, the principles of programming the Haltech E6K 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.

5.5.5 On the Road

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

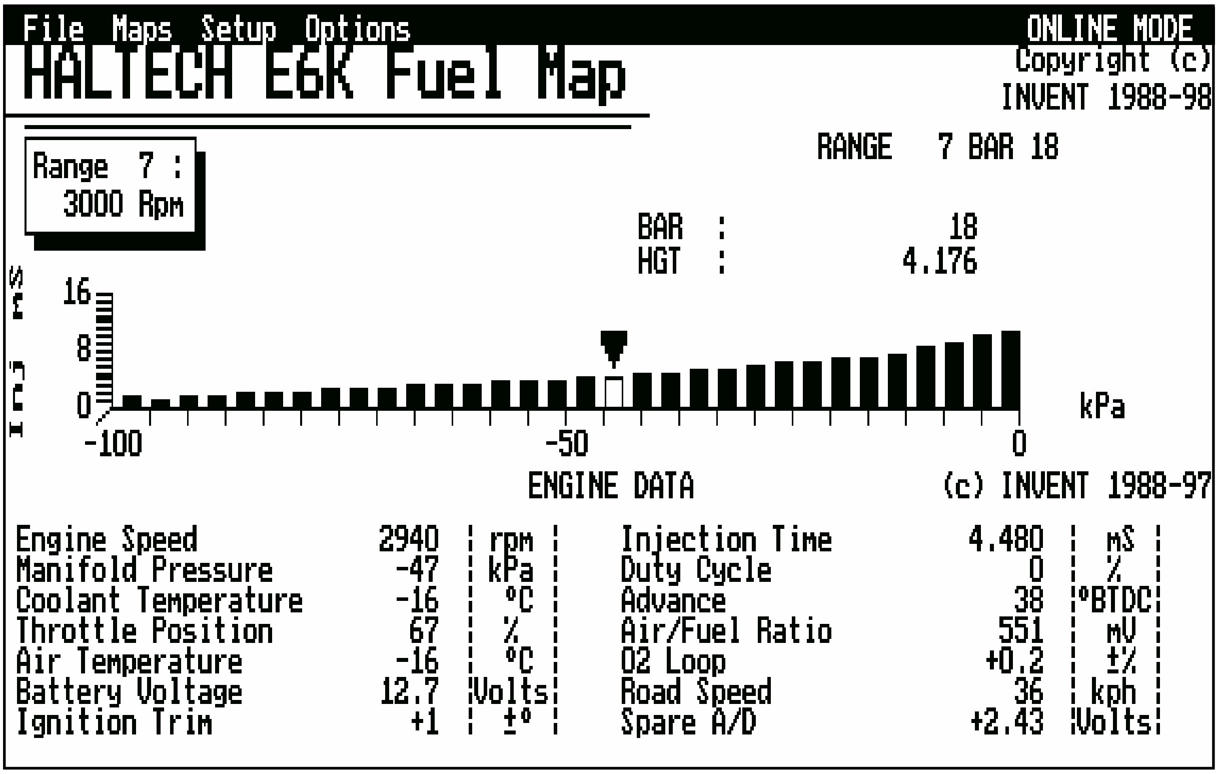
Load the engine by selecting an appropriate gear and either driving up a constant grade hill, applying the brake or handbrake.

WARNING:
BE VERY CAREFUL USING THE BRAKE TO LOAD THE ENGINE. THE BRAKES CAN GET VERY HOT AND SUFFER FROM BRAKE FADE (REDUCED BRAKING CAPABILITY) AND THE CARS HANDLING MAY BECOME UNSTABLE. ALL ROAD TESTING SHOULD BE DONE AT LOW SPEED.

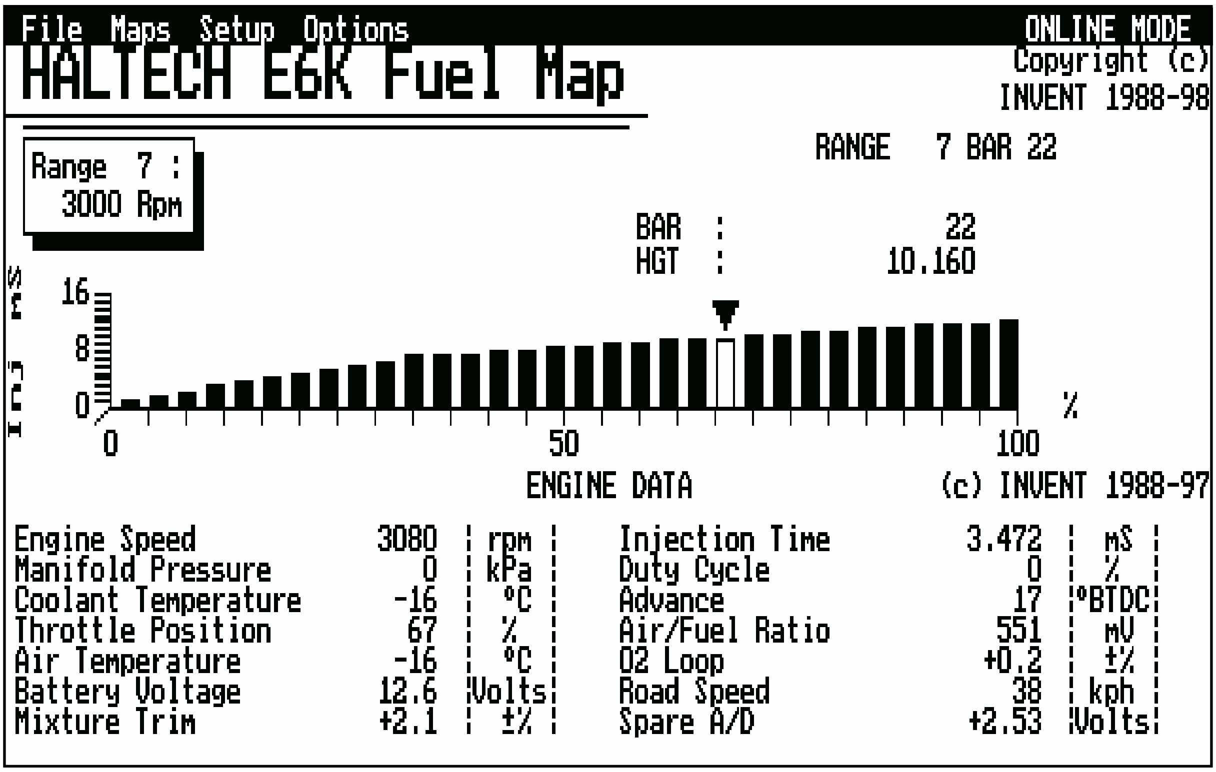
5.5.6 Fine Tuning the Engine

When fine-tuning the engine for the road, the same principles apply to all engines. Under full load at all rpm the fuel mixture should be rich. On non turbo cars 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 (best mixture) as possible and decelerating conditions may allow the engine to be run lean to save fuel. This will result in a particular shape for the map. A typical map is shown adjacent. The absolute values will vary greatly, but the shape should be similar.

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.



A typical fuel curve for a normally aspirated engine sensing load via the MAP sensor



A typical fuel curve for a normally aspirated engine sensing load via the TPS sensor

SECTION 2 Other Adjustable Features

CHAPTER 6 THROTTLE EFFECTS

6.1 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 E6K 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 E6K 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.

6.2 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.

6.3 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 7 COLD STARTING AND RUNNING

The Haltech E6K has four features to modify 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 set the crank advance for different coolant temperatures. And finally, the Ignition Coolant Map modifies the ignition advance from the Ignition Map for different coolant temperatures.

7.1 Cold Cranking

At cold crank the air speed at the inlet manifold is very low. As a result a lot of fuel that would normally travel in the air, sticks to the manifold walls and 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 E6K provides a cold start fuel prime that is adjustable at all engine temperatures. This allows the duration of the prime pulse to be optimised for cold cranking under a wide variety of conditions. Access the Cold Start Prime function from the Fuel Maps and Set-up Menu.

The cold prime map specifies an injection time based on engine coolant temperature. The height of the bars define the actual duration that the injectors are open. A typical map is already loaded into your E6K and this should not need to be modified unless you are having trouble cold starting the engine. Any changes like this should be done ONLINE, so the change can be reversed if the engine becomes harder to start.

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.

7.2 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 Haltech system corrects for this by using the Fuel Coolant Map to define the relation between engine temperature and extra fuel required. The E6K will automatically reduce the amount of coolant correction applied to the engine as the throttle is opened and air speed increases. The Fuel Coolant Map should not be adjusted until the Fuel Maps are correctly tuned at operating temperature.

Access the Fuel Coolant Map from the Fuel Maps and Set-up Menu. The map defines the percentage increase in fuel at any given engine temperature. The E6K is supplied with a default coolant map which may not need to be modified. If the coolant map requires modification, the changes should be done ONLINE and while the engine is warming. Start the cold engine and adjust the Fuel Coolant Map so that the engine idles evenly. You should not touch the throttle while adjusting this map. Follow the arrow as the engine warms to provide good running mixtures up to operating temperature, where there should be zero coolant correction.

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 Haltech E6K has two further correction maps to compensate the fuel for changes in inlet air temperature and battery voltage, and also two correction Maps to adjust ignition timing for coolant and inlet air temperatures.

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.

When the E6K software is run in the OFFLINE mode, the software will load factory-set correction maps unless other maps are loaded.

8.1 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 E6K 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 Fuel Air Correction Map is accessed via the Fuel Maps and Set-up Menu. Across the bottom of the map displayed is the inlet air temperature. An arrow appears showing which bar the system is currently using.

The map displayed is split by a horizontal line. Bars above this line indicate a positive correction making the mixture richer. Bars below the line indicate a negative correction making the mixture leaner.

A typical Fuel Versus Air Temp Map was loaded into your E6K at the factory. You should not modify it unless you experience trouble with variation in engine performance with air temperature.

8.2 The Battery Voltage Map

The Haltech E6K uses intelligent 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 E6K 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.

8.3 The Ignition Coolant Map

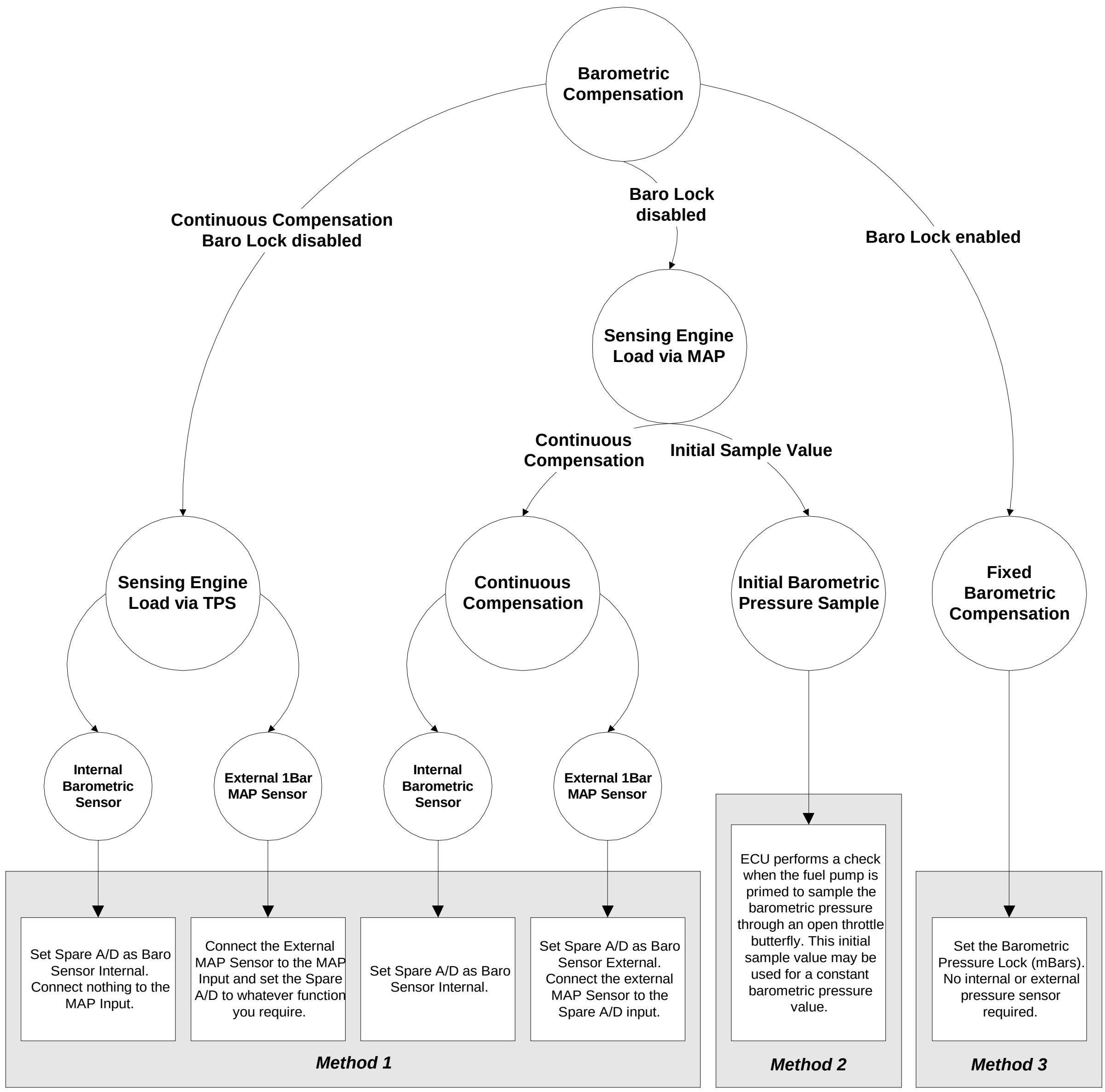
The Ignition Coolant Map allows up to 10° advance or retard of the spark timing based on engine coolant temperature. This Map should only be used if there is a need to adjust the timing for low or high temperatures.

8.4 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.

8.5 Barometric Correction

Note: The description that follows is targeted at advanced applications and unless you wish to compensate for exhaust back pressure or are using the throttle position 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 a MAP sensor for load sensing, barometric compensation is automatic as map sensors are manifold absolute pressure sensors and the readings compensate for barometric fluctuations. The only application using MAP sensors that would require barometric compensation would be when the exhaust back pressure must be taken into account. If using a MAP sensor we recommend that you set "Barometric Lock" in the fuel set up page to "disabled" (i.e. barometric compensation is enabled). However please note that if you are using throttle position load sensing, instead of a MAP sensor, barometric compensation is always required. Please note that the default map for barometric compensation is flat and a barometric compensation map must be compiled. See the sample map at the bottom of page 70. The barometric compensation map should be compiled as shown on Page 70 before any tuning takes place to ensure proper compensation.



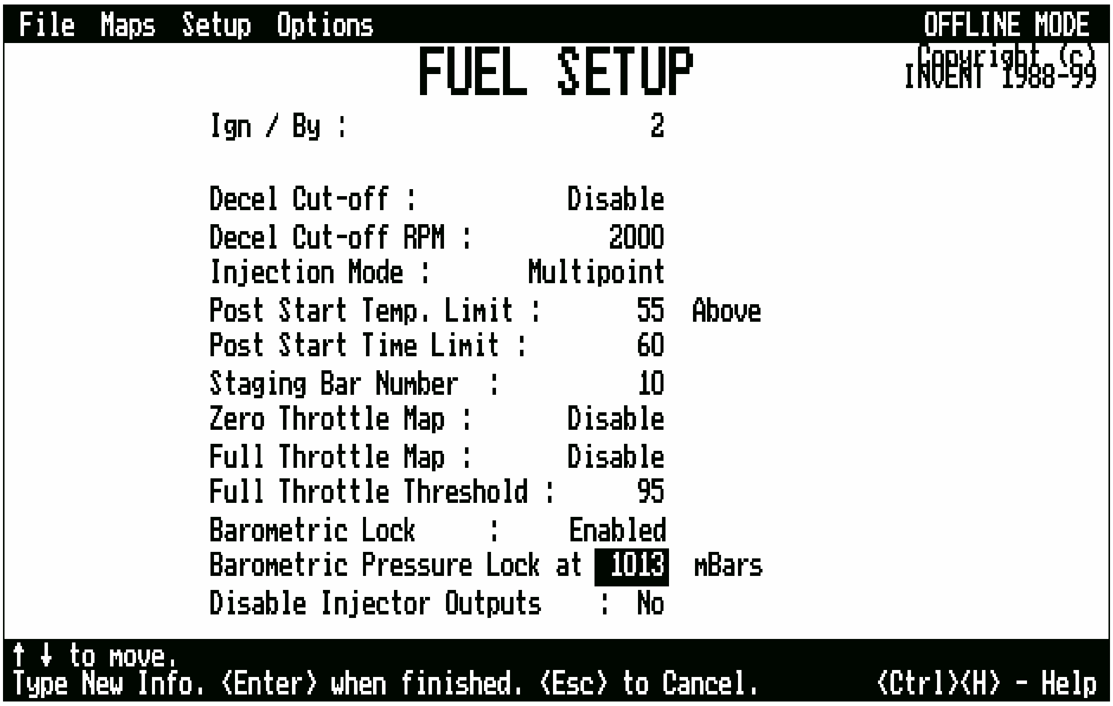
Fluctuations in barometric pressure vary the density of the intake air of the engine. At lower barometric pressure, the engine cannot breath in as much air, and therefore the amount of fuel delivered to the engine must be reduced. This is necessary when a large change in altitude is expected during a driving period (a Hill Climb event such as Pikes Peak in the USA is a good example). The barometric correction on the E6K is a powerful and therefore relatively complicated feature and this section aims to describe the different methods it can be implemented with. The above flowchart is an overview of the different barometric compensation methods available with the E6K.

The E6K begins with the basic idea that there are three ways to compensate for barometric pressure variations. The first is to use a pressure sensor to continually supply the E6K with barometric pressure data and then the E6K can adjust the injection times based on this information. The second method takes 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. The final method is to use a preset value for barometric pressure, irrespective of what is going on in the surrounding environment.
Method 3 is the most basic form of correction and will be our starting point. When the E6K is manufactured it is configured with a value of 1013mBars as the constant barometric pressure.

NOTE: If you ever wish to return the E6K to the factory barometric pressure settings
then enable the Barometric Lock in the Fuel Set-up page and set the Barometric Pressure Lock to 1013 mBars. These are the factory settings.

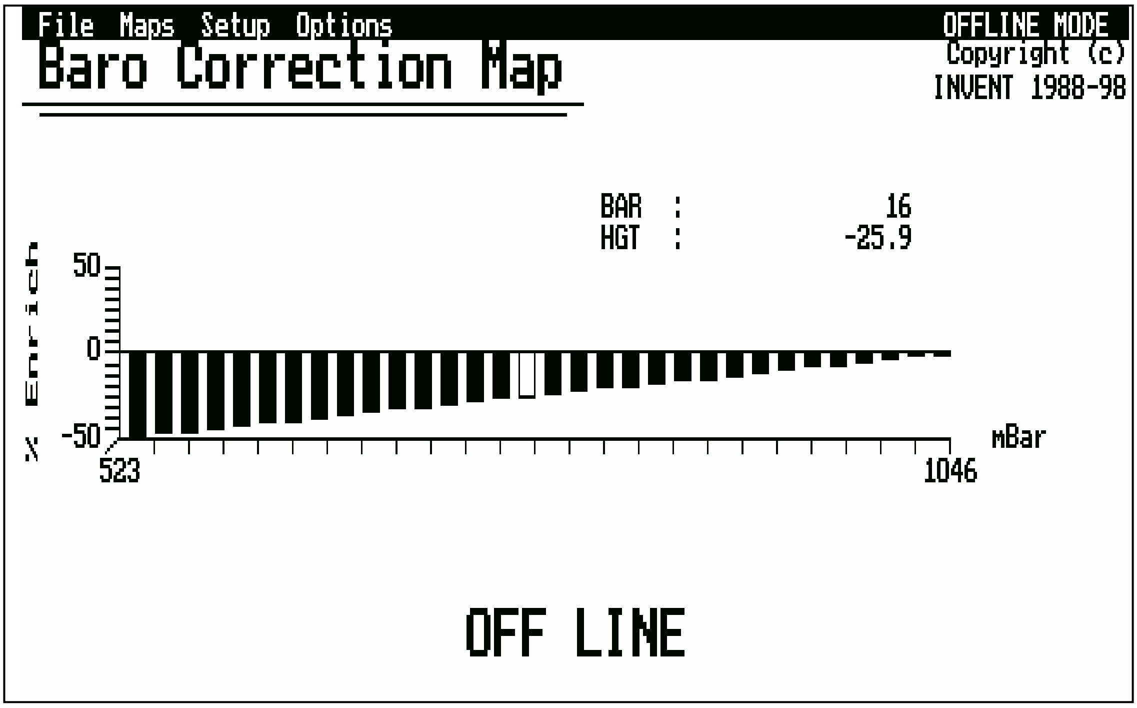
Method 3

Method 3 requires you to access the Fuel Set-up page and adjust two fields. Make sure the Barometric Lock is Enabled. This tells the E6K that you are going to lock a particular value in as the barometric pressure value. The next field down allows you to set a particular value. This value should be the average barometric pressure the engine will be operated in. These two fields are located at the bottom of the Fuel Set-up page:



Note that barometric pressure changes regularly and that Method 3 is only a basic approach at barometric compensation. Set the Barometric Pressure Lock at xxxx mBars, where xxxx is the pressure you require, say 1000mBars. When completed the E6K will assume that the environment always operates at 1000mBars barometric pressure. It will then look at the Barometric Correction Map located under the Maps pull down menu and locate the 1000mBars section of the correction map. Whatever the height of the bar corresponding to 1000mBars will be taken as the overall enrichment %.

For example, 1000mBars might correspond to the following highlighted bar on the Barometric Correction Map:



This bar has a height of –25.9%, so the E6K will provide an enrichment of –25.9%. Changing the pressure value that is locked in as Barometric Pressure Lock will obviously move the corresponding bar on the Barometric Compensation Map. Once the bar is highlighted you can elect to use the height of the bar as it already is or you can change the height of the bar by using the up and down arrow keys, exactly the same as you would when tuning the fuel/ignition maps. This will of course change the enrichment % used by the E6K.

Note: The bar height should only be adjusted if your environment requires it. Reducing the fuel enrichment may cause your engine to run lean and damage will occur. Only adjust the height of the bar if you are confident in what you are doing and have sufficient knowledge about your engine and the environment in which it is operated.

Method 2

Method 2 is similar to Method 3 as it uses a constant value as the barometric pressure but Method 2 is restricted only to engine mapped via the MAP sensor. The other difference is the way it gets this barometric pressure value. In Method 3 you are required to enter a value as the Barometric Pressure and the E6K will lock to it. Method 2 requires you to open the throttle butterfly and force the manifold to contain the same pressure as the ambient environment which will be read by the MAP sensor and used by the E6K.

When the E6K is powered on, it will run a small test to determine the barometric pressure. As you should have read earlier, the ECU switches the fuel pump on at start up (fuel pump prime). 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 prevailing 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 to it. In this case, the E6K will use the pressure value as set in Method 3. If you have not adjusted it from factory settings, this will be 1013 mBars. To complete Method 2 follow these steps:

1. Firstly 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.

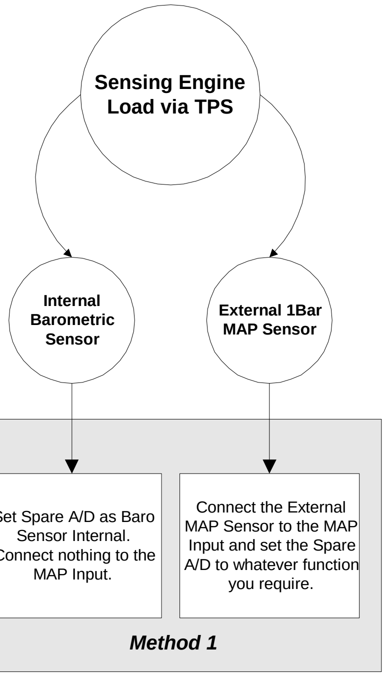
It is not necessary or advisable to perform this reset regularly. It should only be done if the vehicle’s regular place of garage is moved or if problems are suspected in the barometric correction. For example, if an engine is tuned at sea level but is intended to be used mainly at a higher altitude, 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 E6K to apply barometric compensation and Method 2 is complete.

Method 1

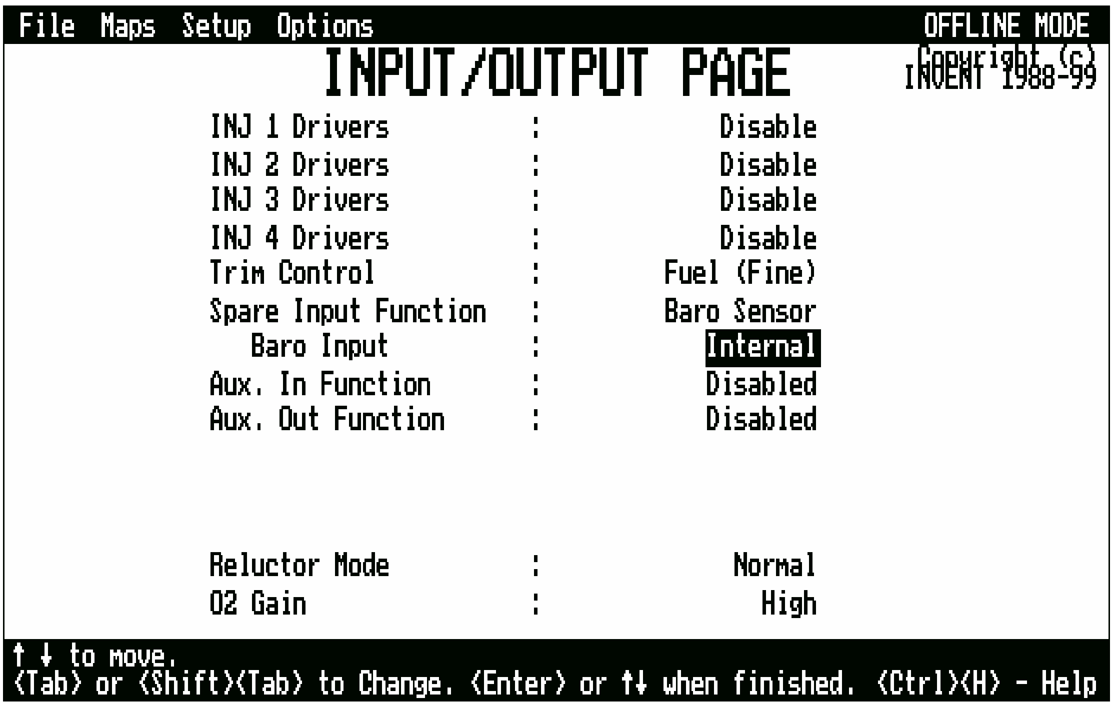
Method 1 is the most complex and allows continuous barometric pressure readings to be taken and fuel injection times can be adjusted based on these readings. This can only be done if using an internal or external sensor to provide barometric pressure readings. The E6K contains an internal Barometric Pressure sensor or otherwise an external 1 Bar MAP Sensor (left open to atmosphere) may be used instead. The set-up differs depending on whether or not the engine is being mapped via Throttle Position or MAP sensor. For this reason, Method 1 can be broken up into two smaller sections: Sensing Engine Load via TPS or Sensing Engine Load via MAP.

Sensing Engine Load via TPS

The relevant section has been extracted from the main flowchart and reproduced for clarity. Make sure that the Barometric Lock has been disabled in the Fuel Set-up page. The next step is to tell the E6K if you wish to use an internal or external sensor.



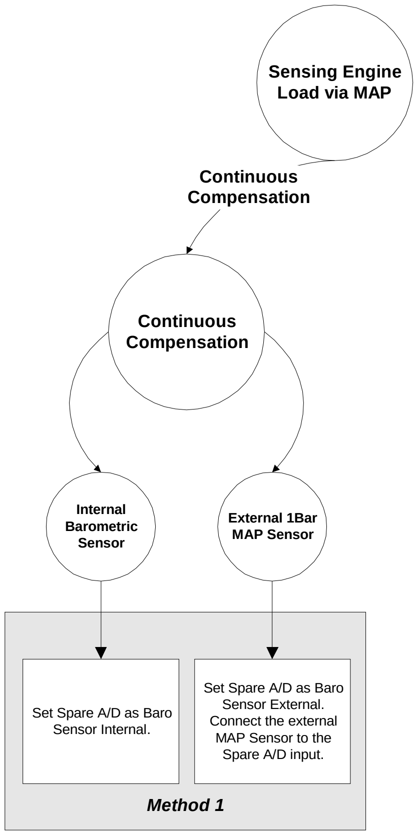
If you wish to use the internal sensor to compensate, then go to the Input/Output page which is reached using the hotkey Ctrl N. Select the Spare Input field and change it to “Baro Sensor”. When you press enter, a field will appear below that allows you to select either an internal or external sensor. Selecting “internal” will use the barometric pressure sensor located inside the E6K to provide compensation:



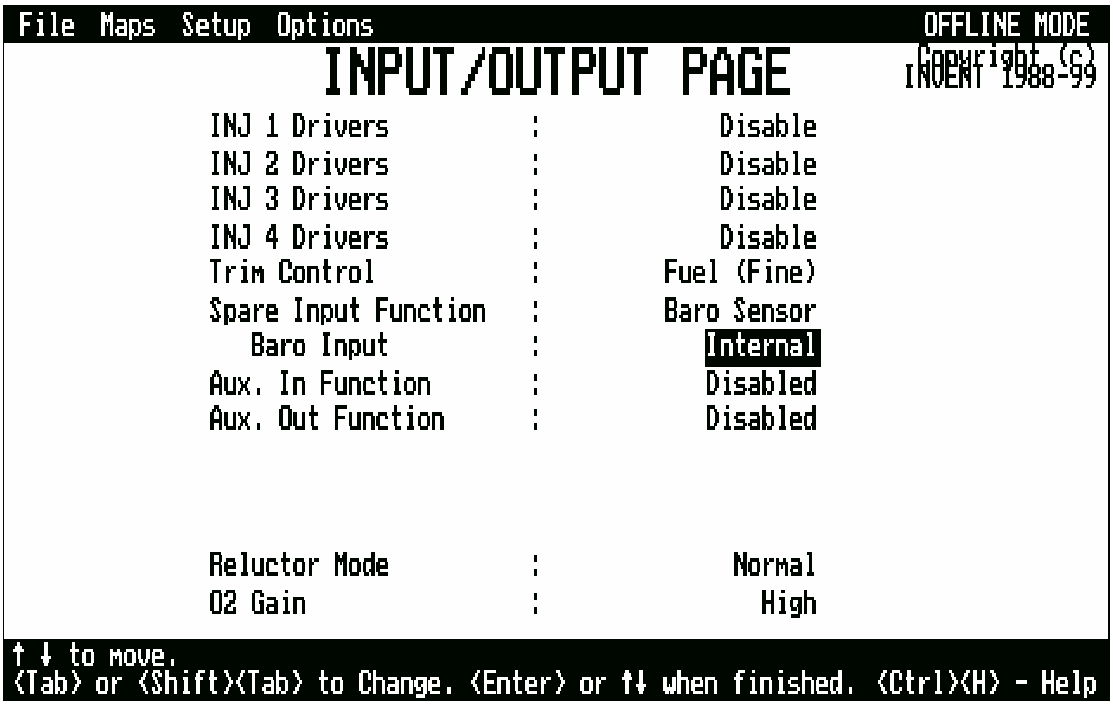
If you wish to use an external 1 Bar MAP Sensor (left open to atmosphere) in addition to the one used to measure engine load (if using manifold absolute pressure to measure engine load) then connect this sensor to the MAP input on the wiring loom and make sure that the Spare Input function is **not set** to Baro Sensor. The E6K will automatically recognise the external 1 Bar MAP sensor and no further configuration is required.

Sensing Engine Load via MAP Sensor

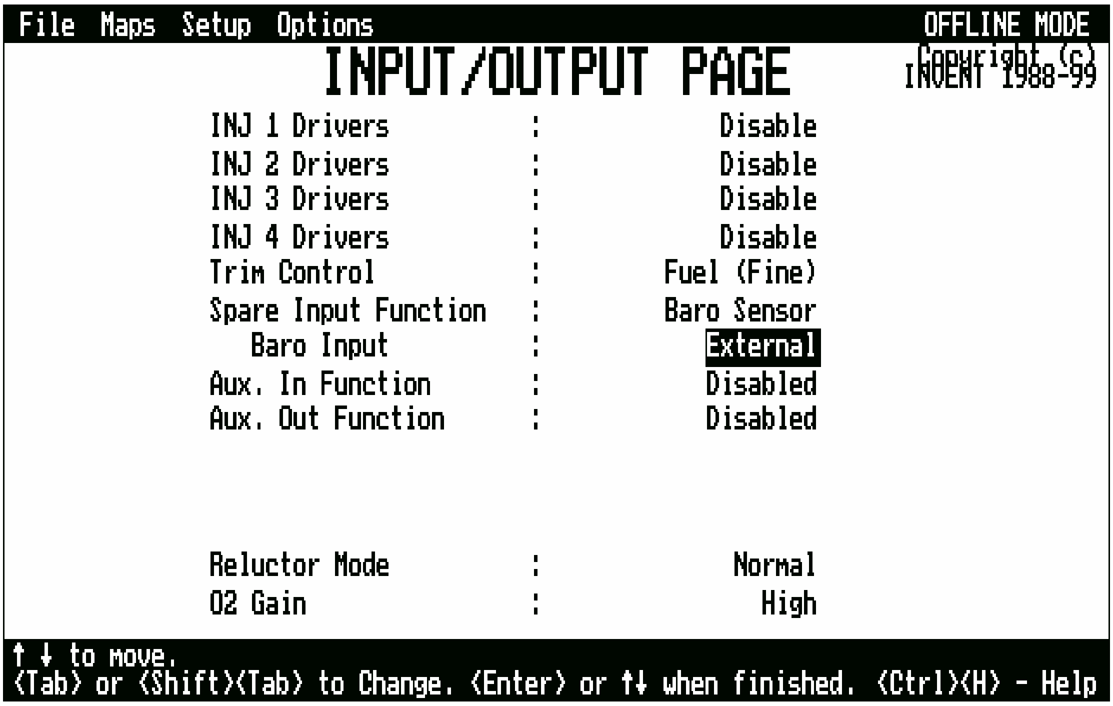
The relevant section has been extracted from the main flowchart and reproduced for clarity. Make sure that the Barometric Lock has been disabled in the Fuel Set-up page. The next step is to tell the E6K if you wish to use an internal or external sensor.



Go to the Input/Output page which is reached using the hotkey Ctrl N. Select the Spare Input field and change it to “Baro Sensor”. When you press enter, a field will appear below that allows you to select either an internal or external sensor. Selecting “internal” will use the barometric pressure sensor located inside the E6K to provide compensation:

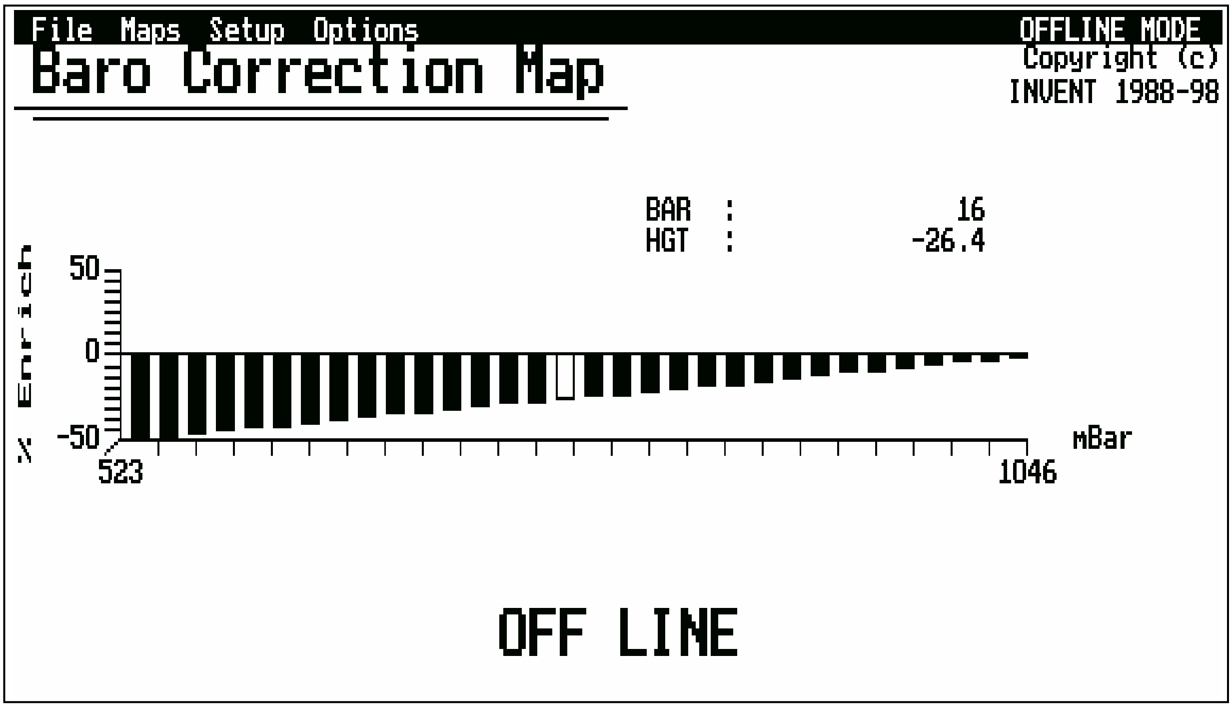


If you wish to use an external 1 Bar MAP Sensor (left open to atmosphere) then connect this sensor to the Spare A/D input on the wiring loom and select “external” in the Baro Input as follows:

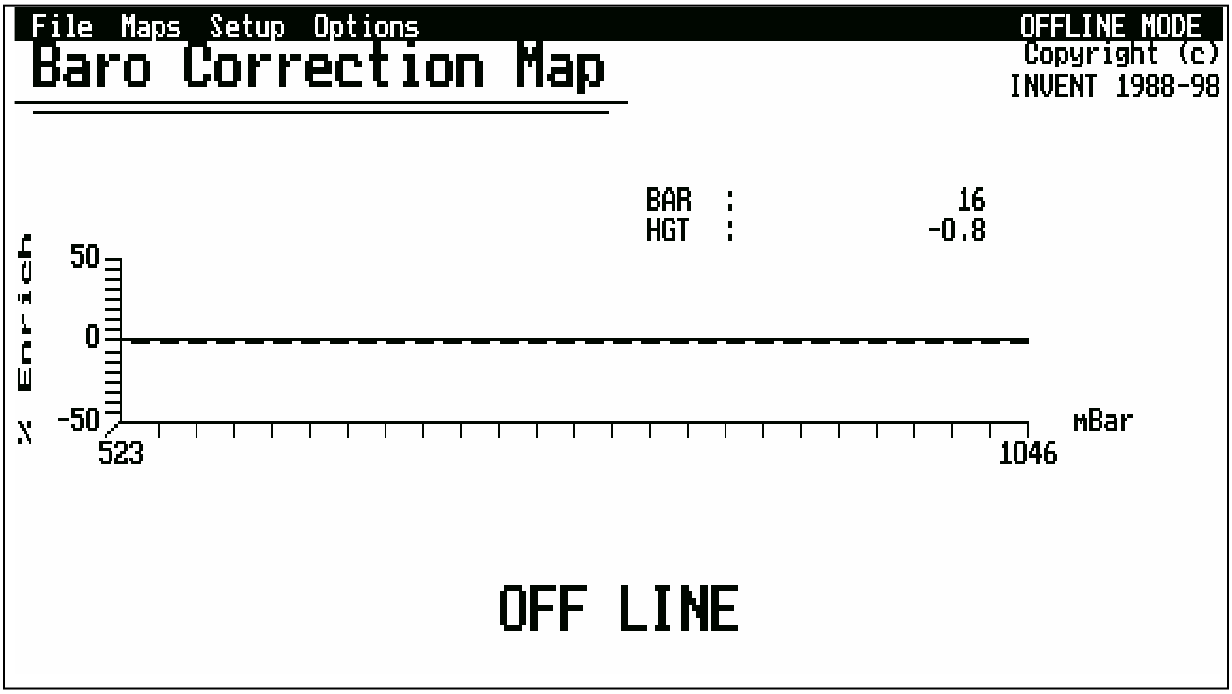


Completing Method 1

The E6K software contains a barometric compensation map that allows the fuel delivery to be reduced as the barometric pressure falls. As a final step to complete Method 1, you have the ability to adjust a dedicated barometric correction map. The fuel can be trimmed ±50%. When sensing load via Throttle Position Mode, the Barometric Correction Map should look something like the following:



When sensing load via Manifold Pressure Mode the Barometric Map Should be very close to zero fuel reduction. In theory a Manifold Pressure tuned engine will not require any barometric pressure compensation, but in practice it has been found that slight compensation is required. The barometric compensation map should therefore be very close to a straight line at zero fuel enrichment/reduction:



8.6 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 time of sixty seconds with each bar corresponding to 4 seconds of time. The time starts after the first input trigger is received.

Two extra parameters are adjustable. The first is the Temperature setting and the second indicates whether it operates Above or Below the Temperature setting. As an example, for a rotary the temperature setting could be set at (say) 60°C (to indicate that the motor is warm or has been running) and the operation setting to **Above**. This means that Post Start will operate only when the coolant temperature is above 60°C.

When operation Above is selected, the enrichment only operates at idle. For below settings, though, the enrichment operates at all throttle positions.

SECTION 3 Software Features

CHAPTER 9 FILE STORAGE AND RETRIEVAL

Once your Haltech E6K system is configured you should store the entire set of maps and the Identification to disk. In fact, it is wise to save maps regularly during tuning so that you can return to a known map while you are experimenting in different areas. You can use the file storage and retrieval to enhance the flexibility of your race engine by storing the optimum maps for each race track.

The File storage and retrieval functions can be accessed from the Main Menu by pressing [Alt][F] for files. This function allows you to load engine maps and identification from computer disk. You can also save the engine maps and the identification to computer disk.

9.1 Saving Maps and Identification

9.1.1 The Save Command

To store all the maps and identification to computer disk with the system running ONLINE, press [Alt][F] then [S] at the Files sub-menu. The list of maps already stored will appear on the screen.

You can save maps that you have generated OFFLINE to later be loaded into the ECU. You can also save different versions of a map to save time while tuning track-side. You can even have different maps for different circuits.

9.1.2 Giving Your Map A Filename

Choose a name to identify your saved file. If you choose the same name as a map that has already been saved, the old file will be overwritten and replaced with the file you are currently saving with the same name. If you do not wish to erase any files already saved, choose a new filename - one that does not appear on the screen.

The name you choose should not include any spaces or full stops and can be up to eight characters in length. The name must start with a letter from the alphabet, not a number. For the sake of your own memory, try to select a name that you will be able to recognise in six months time.

As you perfect the maps for a particular application you might add a number to the end of the name to indicate which map is most recent. For example you might call the maps for a Turbo, Turbo1, Turbo2, etc.

After you have chosen a name for the maps, you must enter the name in the space provided. The system will pause and ask if it is OK to continue with the save. If everything looks correct, continue by pressing [Y]. If you entered the name incorrectly, abort the Save function by pressing [N], or [R] to re-enter a name.

9.2 Loading Maps and Identification

While the ECU system is ONLINE, you can load previously saved map information from computer disk into your Haltech ECU. The contents of the ECU are erased and replaced with the new maps you have chosen. If you are OFFLINE, you can load previously stored maps, view and edit them, then save them for later use.

To load new complete maps and identification into the ECU, you must first be ONLINE. Press [Alt][F] then [L] from the Files sub-menu. The load command erases the contents of the ECU and replaces it with the set of maps stored on the disk you are loading into the system.

> Note: Remember to save any maps currently in the ECU that you wish to retain before loading new maps from a disk since this action will overwrite any maps currently in the ECU.

Although the loading of the maps should not affect the running of the ECU, it is best that the engine is not under load while maps are being loaded.

Select the name of the map you wish to load by using the arrow keys to highlight that name and press return. If there are more files then will fit in the window, you can scroll down through the extra files using the arrow keys. If you know the name of the file, you may type it in. The computer will then pause to ask if everything is OK before continuing the load. If you are ready to proceed, press [Y]. If there is an error, abort by pressing [N]. The load will take approximately two minutes.

9.3 Upgrading from E6S

To make it easier to upgrade from the E6S family of systems to the E6K, there is a function under the File menu called Import E6S maps. This allows you to connect an E6K to an existing E6S wiring loom and load E6S maps into an E6K. All information in the E6S maps will be retained and loaded into the E6K.

Note that the Output Options information will be lost and you will have to reset the outputs you require. This is due to the new hardware in the E6K. Unfortunately, an entire E6S map import is not possible. Your new E6K should now have all the information loaded into it and can be operated as normal.

9.4 File Management

The ECU's map information is stored as a file on disk. You may think of these files as books in library, where the filename is the title of the book. So that the books do not become difficult to find as your library grows, there are a few features that help you to organise your files.

9.4.1 Erasing Unwanted Maps

The Erase function in the Files sub-menu will delete old files from disk. Press E from the Files sub-menu to enter this function. The list of maps stored on the disk will appear. Use the Up and Down Arrows to select the map you wish to erase, or else type in the name of the map, then press return (↵). The computer will pause to check that everything is OK. Press Y to continue to erase, or else N to abort.

It is a good idea to erase old maps as soon as they become obsolete. This is particularly true if you are trying to build a library of maps. It can become difficult to remember later which maps are current and which are obsolete.

9.4.2 Changing Directories

If files can be likened to books in the library, then directories are analogous to names on the shelves. Directories can be used to group related files together.

To change directories when loading, saving or erasing maps, press Alt C. The Files List will now display all directories in square brackets. Select the directory you want using the Up and Down arrows, and pressing Return. Directories can exist within other directories, so you may change several times before reaching the directory you seek. Once you have found it, hit Esc. The symbol [..] indicates the parent directory to the one you are in

CHAPTER 10 PRINTING MAPS

10.1 The Print Function

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. Select the print function by pressing P from the ***Options*** sub-menu

The system will present you with options on which data you wish to print. There are four options. Their meaning is as follows:

Set-up Information

This will print only the set-up pages (ie. Fuel, Main and Ignition pages).

Maps

Prints all the maps in the system (ie. Fuel, Ignition and Coolant).

Output Options

This function will print the current settings and the status of the output options of the ECU. (ie. Turbo Wastegate).

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. Type in the name and press Enter ( ).

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. Pressing any other key starts 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 by pressing Esc.

CHAPTER 11 DATALOG

11.1 The Data log Option

This option records the Engine Data information at a nominal rate of ten times per second while the engine is running. This datalog is useful for tracking the system's behaviour through changing rpm. It also facilitates trouble-shooting, as all the ECU's working parameters are recorded faster than they can be read on the Engine Data Page.

The Datalog Menu is accessed through the ***Options*** Menu. (Press [Alt][O]). Then select the [D] key to make a datalog, the IBM software must be running and ONLINE. Or it can be accessed directly by using [Ctrl][D]

11.1.1 Setting Up the Datalog Page

Before beginning a datalog the data page can only display eight parameters which are selectable through a simple menu. To access the configuration menu press [C] and follow the instructions that are presented with the selection menu.

11.1.2 Creating a Datalog

You can choose to record the datalog either in memory or directly to disk. To record to memory, press [D] in the Datalog sub-menu. This will record engine data in a continuous loop, up to about three minutes i.e.. when you stop the datalog, it has a record of the previous three minutes of engine data.

Alternatively, you can datalog directly to disk by pressing [A]. The software will ask you for a filename to enter. When recording to disk, you are limited only to the free memory left on disk. The datalog consumes about 11kbytes per minute of running. Thus, on the disk supplied, there is over 20 minutes of datalog space. The disadvantage in datalogging in this manner is that there will be small "gaps" in the datalog of a few seconds as blocks of information are written to disk. If datalogging to hard disk, these gaps become insignificant.

You should save the Maps being used at the time of the Datalog to disk. It is advised to do this before the Datalog is taken. Saving the Maps makes sure that all the engine information (including the Identification and the set-ups) are saved to disk. If the Datalog is viewed OFFLINE at a latter date, the Maps will need to be loaded so that the programming software knows the set-up of the ECU and can calibrate the data properly.
To stop the datalog press [Space Bar]. If you are performing a datalog to memory, the screen will instantly jump back to the Datalog sub-menu. If you have been recording to disk, there will be a moment's pause as the file is closed.

11.1.3 Viewing the Datalog

To view the datalog you have just taken, press [V] from the Datalog 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 datalog one line
- [↓] - scroll down datalog one line
- [Page Up] - scroll up datalog one page
- [Page Down] - scroll down datalog one page
- [Home] - jump to start of datalog
- [End] - jump to end of datalog
- [?] - jump to page #
- [S] - show statistics (max., min. & avg. of each parameter)
- [Esc] - exit

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

11.1.4 Datalog File Management

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

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

When saving a Datalog to disk, you should also save the Maps being used at the time of the Datalog. It is advised to do this before the Datalog is taken. Saving the Maps makes sure that all the engine information (including the Identification and the set-ups) are saved to disk.

Before loading a Datalog 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. **Do not load a Datalog 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 Datalog, switch to OFFLINE mode, load the appropriate map, and then load the Datalog.**

11.1.5 Printing Datalogs

You can print datalogs 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 datalog press P in the Datalog 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 datalog 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 datalog is divided into pages of data. The total number of pages in the current datalog 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 datalog , 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.

CHAPTER 12 CUSTOMISING THE SOFTWARE

12.1 The Set-up Page

The Set-up window allows you to change the way the software works for you. If you alter any of the parameters on this page, the programming software will remember the changes you have made and they become the default settings. The next time you run the Haltech program, the settings will be as you left them.

The Set-up Window is accessed from the Set-up menu by pressing Alt S. Or by pressing Ctrl P. Then follow the keystroke instructions outlined at the base of the windows to make your settings.

The Data Set-up window is accessed through the Options Menu by pressing Alt O. Then selecting D. the data page window will allow you to select the data which you wish to view at the base of the maps. This is particularly useful when using the CGA video mode as the size of the map is reduced to allow all the engine data to be viewed. By reducing the number of data parameters the size of the map is increased letting small changes in bars more visible.

12.1.1 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.

You can also choose to operate in colour or monochrome. Since many laptop computers are not in colour, the monochrome setting should provide better contrast to read the screen.

12.1.3 Com Port

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

SECTION 4 E6K Inputs & Outputs

The E6K has several types of optional inputs and outputs. These are:

- Idle Speed Control
- O_2 Closed Loop Control
- Auxiliary In (Aux In)
- Auxiliary Out (Aux Out)
- Digital Output (Digital Out 1-2)
- Pulse Width Modulated Output (PWM 1-4)

Every output except the Digital Outputs are available all the time – irrespective of the engine configuration. Idle Speed and O_2 Closed Loop Control are not general purpose outputs – they can only be used for the stated purpose. Aux Out, Digital Out 1-2, and PWM 1-4 are general purpose outputs – they can be selected to control any devices from a list of options.

Depending on whether or not the ECU is operated in the Advanced mode, the Digital Outputs may or may not be available. If they are not available, then this is because the configuration you have chosen has consumed all of the output lines from the microprocessor. This means you are limited to the 4 x PWM outputs and the Auxiliary Output to control output devices. If you are operating the ECU in Basic mode, then you will have up to 2 Digital Outputs available, depending on your configuration.

Below is a summary of the general purpose outputs and the options list they contain:

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

13.1 The Input/Output Page

The Input/Output Page is where E6K injector driver options are enabled/disabled and the Aux In and Aux Out functions are programmed. This page may be accessed in either ONLINE or OFFLINE mode. Remember that any changes you make in OFFLINE mode will not affect the ECU.

Pressing Alt S will take you to the Set-up Menu. Press N to go to the Input/Output Page. Alternatively use the Ctrl N hot key combination.

The “INJ 1-4 Driver” fields allow you to enable and disable injector drivers depending on their type and the configuration you are using:

		Number or Injectors						
		4	**5**	**6**	**8**	**10**	**12**	**16**
Injector Impedance (Ω)	**Low Impedance**	Disable INJ 1-4	Enable INJ 1 Disable INJ 2-4	Enable INJ 1-3 Disable INJ 4	Enable INJ 1-4	Enable INJ 1-4 Plus use DB3 Driver Box	Enable INJ 1-4 Plus use DB3 Driver Box	Enable INJ 1-4 Plus use DB3 Driver Box
	High Impedance	Disable INJ 1-4	Disable INJ 1-4	Disable INJ 1-4	Disable INJ 1-4	Enable INJ 1 Disable INJ 2-4	Enable INJ 1-2 Disable INJ 3-4	Enable INJ 1-4

Consult Appendix C for further information on Injectors and the E6K Injector drivers as well as how to test for an Injector’s Impedance.

Following is a summary extracted from the wiring diagram in Appendix G which should provide a simple guide in how to physically connect different high impedance injector configurations:

The remaining fields allow you to program the Trim Control, Spare Input Function, Aux In and Aux Out Functions. The Trim Control and Spare Input Function fields can be useful when tuning the car initially as they can provide both a fuel and ignition trim that can be applied to selected fuel/ignition maps for easy tuning:

Trim Control

The optional Trim unit can be used to control one of several parameters. This field selects the controlled parameter. 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 Wastegate control only.

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. Its function is set by this field. 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 E6K 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 16.14 NOS Switch

TCC Input This input is used in conjunction with 16.5 Torque Converter Clutch Lockup (TCC)

Turbo Timer This input is used in conjunction with 16.13 Turbo Timer (TT).

Anti-Lag Switch This input is used in conjunction with 16.15 Anti-Lag Switch

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 16.16 Air Conditioning

Aux. Out Function

The Auxiliary Output on the E6K 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.

A keystroke guide is available at the bottom of the screen. Further, a simple Help window may be opened by pressing [Alt][H]. This will describe the function you are currently looking at, and offer some explanation as to how its parameters are to be used.

13.2 The Output Options Page

The Output Options Page is where all E6K options are enabled/disabled and programmed. This page may be accessed in either ONLINE or OFFLINE mode. Remember that any changes you make in OFFLINE mode will not affect the ECU.

Pressing [Alt][O] will take you to the Options Menu. Press [O] to go to the Output Options Page. Alternatively use the [Ctrl][O] hot key combination

Here, the E6K Idle Air Control and Closed Loop Control options as well as up to 2 Digital Outputs (depending on engine configuration) are shown in four windows. Current settings are displayed for each of the options. Use the left and right arrow keys to highlight the function you are interested in. In the case of selecting the Digital Outputs, use [Tab] to cycle through the functions, and press [↵] to select the one you want. Some options cannot be used together because they use the same hardware. These are noted in the detailed descriptions in Chapter 16. Other restrictions apply when using the Advanced Mode. If you are using this mode, consult **Appendix B** for details on these restrictions.

To adjust the parameters of the Idle Speed Control or the Closed Loop Control functions, hit [↵] when that function is highlighted. In the case of the two Digital Outputs, highlight the channel, then use the up and down arrows to move through its parameters. Strike [↵] if you wish to make a change. Some functions have maps associated with them, which are accessed through their Options' windows.

A keystroke guide is available at the bottom of the screen. Further, a simple Help window may be opened by pressing [Alt][H]. This will describe the function you are currently looking at, and offer some explanation as to how its parameters are to be used.

13.3 The PWM Options Page

The PWM Options Page is where all E6K PWM options are enabled/disabled and programmed. This page may be accessed in either ONLINE or OFFLINE mode. Remember that any changes you make in OFFLINE mode will not affect the ECU.

Pressing [Alt][O] will take you to the Options Menu. Press [W] to go to the Output Options Page. Alternatively use the [Ctrl][W] hot key combination

Here, the four E6K PWM options are shown in four windows. Current settings are displayed for each of the options. Use the left and right arrow keys to highlight the function you are interested in. In the case of selecting the PWM Outputs, use [Tab] to cycle through the functions, and press [↵] to select the one you want.

A keystroke guide is available at the bottom of the screen. Further, a simple Help window may be opened by pressing [Alt][H]. This will describe the function you are currently looking at, and offer some explanation as to how its parameters are to be used. For more detail on PWM options see chapter 16

13.4 Enabling Options

Every option has an Enable flag at the top of its window. Toggling this flag allows you to switch that option on and off. The settings for an option that is switched off will not change when you switch it back on later. When a map is loaded from disk, output functions that do not match what is in the ECU are automatically disabled. After loading a map, return to the Output Options Page and check the functions you want enabled.

Any change you make in the Options page will not affect the ECU unless you are ONLINE. If you are making changes OFFLINE, then be sure to save your data to disk so that it may be later up-loaded.

14.1 Description

A bipolar stepper motor may be used to control the ingress of additional air to the engine while the throttle is closed. This is useful for maintaining steady idle under changing load conditions, e.g. as air conditioner compressors or headlights are switched on and off. The stepper motor may also be programmed to increase the idle rev-rate just after starting, or while the engine is still cold.

14.2 Using the Idle Speed Motor

In order to use the idle air control function, you must have the following:

- a suitable idle speed stepper motor∗; **OR** a suitable Bypass Air Control Valve∗∗
- an idle air circuit bypassing the throttle plates;
- E6K programming software and cable.

∗**NB**: use only a bipolar stepper motor with two separate windings (four wire), each with at least 30 ohms resistance. Your Haltech™ representative can supply you with a suitable motor. Use of three- wire stepper motors may damage the E6K ECU.

∗∗**NB**: If you wish to use a Bypass Air Control (BAC) valve to operate Idle Control, you must carry out all of the same settings as what one would do for a normal stepper motor. The only difference is that you should disable Idle Speed in the first entry in the Idle Control software and select BAC as one of the four PWM outputs instead. This will ensure that you are using a BAC valve to do Idle Control and have turned the stepper motor output off. See Section 16 for more detail on the BAC option and PWM outputs.

The idle air circuit draws filtered air into the engine around the throttle plate, as suggested in figure 14-1. Normally this is done via an air bleed into the manifold. A valving arrangement is used so that the idle speed motor pinches off the air into the engine. When the engine is below the desired idle speed, the stepper motor's plunger retracts to allow more air to enter the engine. When the idle speed is too high, the plunger extends. If your engine does not already possess an idle air bypass circuit, a suitably machined aluminium block is available to mount the idle speed motor. A balancing system or plenum arrangement should be used if employing individual throttle bodies, so that all cylinders benefit equally from the additional air.

NOTE: You must ensure that the manifold's air bypass aperture is sufficiently small so as to not over-rev the engine when stepper motor is fully retracted. Fitting a large idle air valve to a small capacity engine can lead to poor idle control and dangerously high engine rpm with no throttle control.

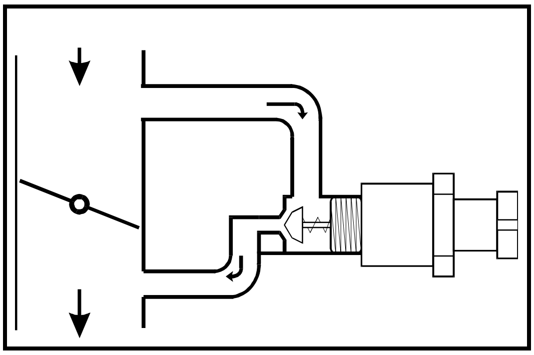


Fig 14.1. The idle-air circuit.
There should be sufficient airflow around the closed throttle plates to permit the engine to idle slowly even with no air passing through the idle bypass circuit. The throttle stop should be adjusted to ensure this is the case. Remember that the throttle position sensor will need re-calibration if the throttle limits are altered.

Install the idle air circuit and the stepper motor, and attach the idle speed motor to its connection on the E6K harness. Run the E6K programming software ONLINE and go to the Output Options Page. Ignition will need to be switched on.

The idle speed motor is only adjusted when the ECU determines that the engine is in an idle condition; that is, throttle closed (0%), and engine speed and manifold pressure within limits (see below).

14.3 Adjusting the Idle Speed Control

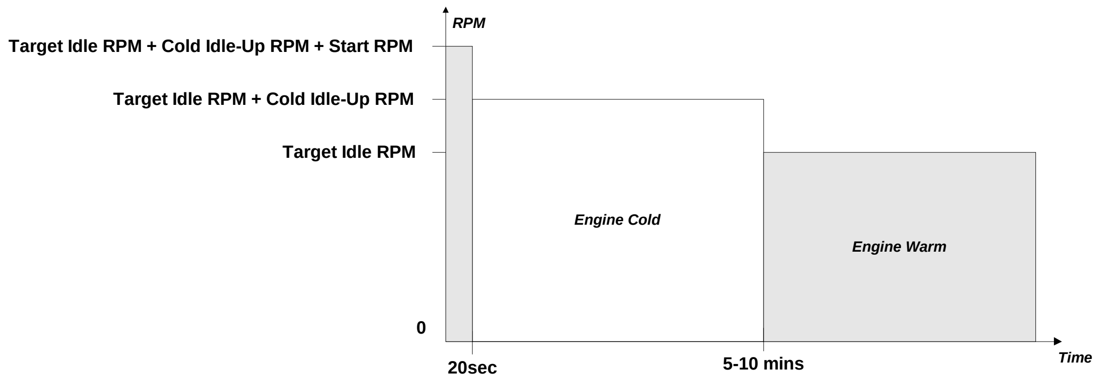
There are ten parameters to be adjusted in the idle speed control.

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.

15.1 Description

By fitting an oxygen sensor to the exhaust system of an engine, the E6K is able to perform a feedback correction to maintain a consistent air-fuel ratio around stoichiometric mix; i.e.. when exactly the correct amount of fuel is provided to consume all the oxygen of the air drawn into the engine, without any unburnt fuel remaining after combustion. Using closed loop fuel control adapts for small variations in fuel quality and day-to-day running, provides better fuel economy and lower emissions.

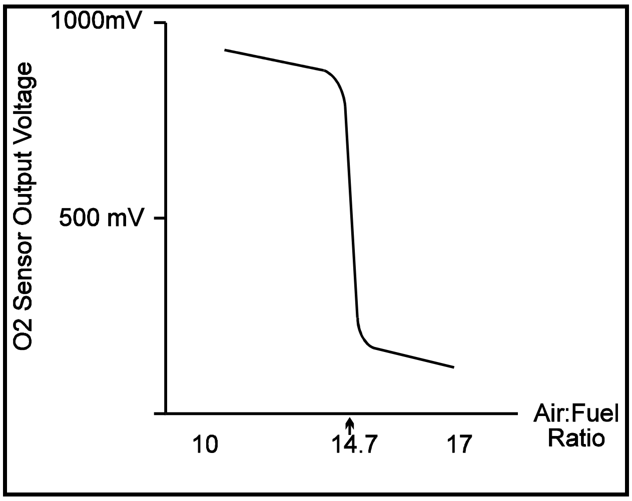


Figure 15.1 Typical lambda sensor output.

An oxygen sensor (or lambda sensor) is placed in the exhaust gas stream usually after the collector but before the catalytic converter. The O2 sensor possesses an output voltage characteristic similar to that in figure 15-1. When the exhaust gas is free from oxygen (i.e.. mixture is rich), the sensor reads around 1 volt. When there is an excess of oxygen, the sensor reads closer to 0 volts. Most oxygen sensors' transfer curves change very suddenly around stoichiometric mixtures.

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

15.2 Using Closed Loop Control

In order to use the closed loop fuel control function, you must have the following:
- an appropriate lambda sensor mounted in the exhaust stream;
- E6K programming software and cable.

Mounting and connection of the sensor is all that is required in installation. Check figure 15-2 for appropriate wiring for different oxygen sensors. Run the E6K programming software

ONLINE and go to the Output Options Page. Ignition will need to be switched on. Select Closed Loop Control, and adjust the following parameters as necessary.

Note: The closed loop control will not work for the first 2 minutes after the ECU is switched on; this allows sufficient time for the oxygen sensor to reach operating temperature.

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 E6K 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 E6K. 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.

15.3 Using Different Oxygen Sensors

Almost any oxygen sensor can be used with the E6K. The sensor available from Haltech™ is an NGK heated four wire oxygen sensor or a Delco sensor these are the preferred sensors to use due to their temperature stability and the switch-like characteristic of their transfer function. Other sensors such as three-wire and single-wire units may also be used, but be wary of slow reaction times and poor repeatability with cheaper sensors. Wide-band oxygen sensors may also be used, and can be particularly useful as a tuning tool, both via the engine data page or in datalogging. [When viewing O2 sensor voltage readings from a datalog, remember to allow for sensor response time.]

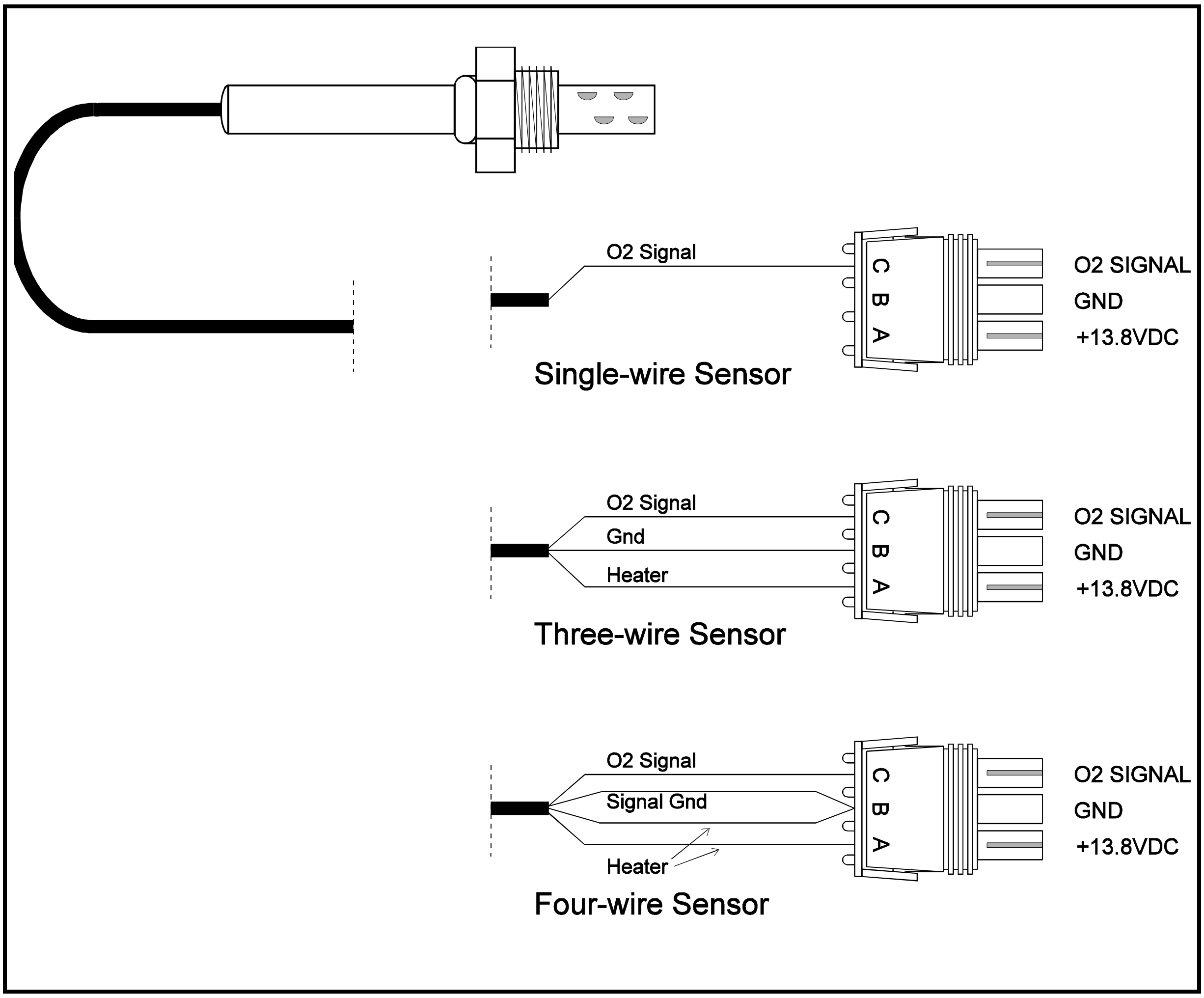


Figure 15.2. Wiring different oxygen sensors.

CHAPTER 16 DIGITAL OUTPUTS & PWM OUTPUTS

16.1 Description

The E6K possesses up to two special purpose digital output channels (depending on whether or not the ECU is operated in Advanced Modes), each of which may be programmed to perform a certain function. Each output channel is a pull-to-ground style signal suitable for switching solenoids, relays or low-power dashboard lamps. The E6K also possesses 4 dedicated PWM outputs that are available all the time, irrespective of engine configuration. Each PWM output is a 12V square waveform that is modulated in both frequency and duty cycle.

Each channel employs a 4.0A peak / 1A hold current driver. This is suitable for driving most relays, solenoids, and other low power devices. Do not connect any device which requires more than 1 amp continuous current directly to the ECU - it will not operate properly. If you are switching high currents, use a suitable relay, either mechanical or solid state, and control the operation of the relay with the ECU.

A number of output functions exist within the E6K ECU. You may select any function to be executed on any output channel, but there are restrictions on how many times a function can be selected across all four PWM channels and the two Digital Out channels, eg: a maximum of two wastegate channels may be selected to control a twin turbo engine configuration. Following is a list of available functions to choose from:

Output Description	Digital Out 1–2	PWM 1 – 4	Max #
Turbo Wastegate	NO	•	2
Bypass Air Control (BAC)	NO	•	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
Ignition Bypass	NO	NO	Restricted
Tacho Output	NO	NO	Restricted
Ignition Toggle	NO	NO	Restricted

Note : In some Advanced mode applications, one or two of the Digital Outputs are not available. Torque Converter Clutch Control cannot be used if a Home Trigger is being used in Advanced Mode.

16.2 Turbo Waste Gate Control (TWG)

16.2.1 Description

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

16.2.2 Using the Turbo Waste Gate Control

In order to use the Turbo Waste Gate Control function, you will need the following:

A suitable pressure solenoid valve (available from your Haltech Dealer);
Air hose and fittings;
E6K programming software and cable;
An overboost relief valve (strongly recommended).

The air circuit to the waste gate must be configured appropriately, as in figure 16.2. Install the solenoid valve securely, and power and signal from the output connector on the harness. The wastegate should be re-set so that its operation point is very low, around 20kPa (3 psi).

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

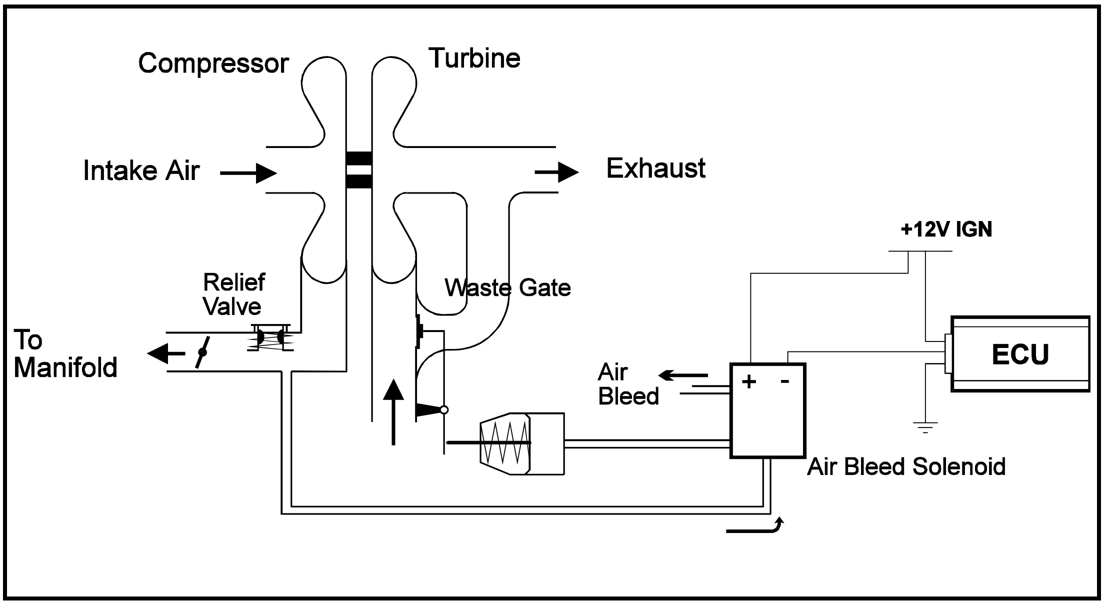


Figure 16.2. Diagram of Turbo with Wastegate Control Solenoid.

A relief valve should be fitted to the manifold as a backup in case of an air hose failure and uncontrolled boost.

Once the solenoid installation is complete run the E6K software in ONLINE mode. Select the Turbo Wastegate Control Function on the appropriate output channel, and set the following parameters.

Period

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.

Boost Limit

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 wastegate regulator to the full manifold pressure and force the wastegate to open. This value should be set slightly higher than the desired boost pressure as a fail-safe in the event of an overboost condition.

Primary Map

There are two maps associated with the TWG control function. Both set the duty cycle of the solenoid against the engine rpm. The base duty cycle value applied to the solenoid is derived from either the Standard Boost Map, or the Maximum Boost Map. Toggling this parameter selects the map from which will be derived the base duty cycle. The state of this flag also affects the way the Boost Controller (if selected) operates. See Using the Boost Controller below for more information.

Map Programming

Selecting the Maps heading will bring up the primary boost map, as selected by the Primary Map flag. The boost maps indicate %duty cycle ON time of the solenoid against the engine speed. A programmable bar exists every 500 rpm. Increasing the duty cycle bleeds off more air from the manifold, resulting in a higher boost pressure. Each bar is adjustable from 5% to 95%. Mapping against rpm permits a varying boost level with engine speed, so the torque curve for the engine may be customised. These maps should start with all values at 5%. Load the engine at a constant rpm and observe the resultant boost pressure at that speed. If the boost pressure is lower than that desired, increase the height of the bar a small amount. Pressing the Tab key switches between the Maximum and Minimum Maps.

16.2.3 Using the Boost Controller

The optional Haltech™ Trim Module may be used as an electronic boost controller if selected in the TWG function Options menu. The way the boost controller operates depends on the which Boost map is selected as the primary map.

If the **Maximum Boost Map** is selected as the primary map, the duty cycle of the solenoid will be determined by multiplying the base value from the map by the position of the controller. Fully anti-clockwise, the controller reads 0%, and fully clockwise the controller reads 100%. Thus if a value of 60 is derived from the Maximum Boost Map, and the Controller is set to 40%, the solenoid will operate with a duty cycle of 24%.

If the **Standard Boost Map** is selected as the primary map the duty cycle applied to the solenoid is computed differently. With the controller at its centre position, the solenoid's duty cycle will be taken directly from the Standard Boost Map. As the controller is rotated anti-clockwise, the duty cycle is linearly reduced to 0%. When the controller is rotated clockwise from the centre position, the duty cycle is linearly increased to the value in the Maximum Boost Map. The Maximum Boost Map should always contain values greater than or equal to the corresponding values in the Standard Boost Map.

The use of two independent boost maps allows an engine to be set up for maximum boost conditions, but driven safely at lower boost pressures without the need of re-loading maps. The boost controller may be used by the driver to match the engine's power output to the current demand: higher boost pressures for qualifying speeds, lower boost levels for engine preservation or wet roads.

If time constraints do not permit the complete mapping of the TWG function, waste gate control may be executed from just one map. Select the Maximum Boost Map as the primary map and the Standard Boost Map is never accessed.

16.3 Bypass Air Control (BAC) Valve

16.3.1 Description

The BAC is a PWM output allowing you to use a valve to operate Idle Air Control. Traditionally, Idle Air Control (IAC) motors have been used but require knowledge of either how many steps they have or experimentally finding the correct operation. BAC valves only require a period (ms) setting as opposed to the number of steps, min steps in, max steps out, etc as required with stepper motors. The period in milliseconds is the operating frequency for the particular valve/solenoid. This frequency can be approximated but an accurate value will help by giving the best response times. Consult factory information on your particular/solenoid valve if the operating frequency is unknown: a typical value is approx 10ms.

The operation is fairly straightforward: each BAC solenoid/valve will have its own operating frequency. By continually operating the valve at this frequency, you can then vary the duty cycle to move the valve in or out. The duty cycle will therefore vary from 0 to 100% whilst the operating frequency is maintained constant.

16.3.2 Using BAC Valves/Solenoids

The BAC settings are mostly done in the Idle Air Control section on the Output Options Page. Firstly, set a PWM output to operate as BAC and set the operating period. Then go to the Output Options Page. Select the Idle Air Control. Note that the Idle Speed will be disabled because you are using a BAC output to do Idle Control and not an IAC Stepper motor. Go through the settings as you would do if you were configuring Idle Control for a stepper motor. A full description of the procedure is available in Section 14.2. Remember that you are using a BAC valve/solenoid and not a stepper motor so not all of the settings in 14.2 will relate to BAC.

16.4 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.

In order to use the DIV function, you will need the following:

- a two wire solenoid valve mounted in the air intake (already on the engine);
- E6K programming software and cable.

Wire the solenoid to the appropriate output, taking note of voltage polarity. (Some solenoids are non-polar.) Run the E6K programming software in ONLINE mode and select the Dual Intake Valve function on the appropriate channel. There are two values to be set.

Switch On RPM

This is the engine speed at which the solenoid is to be energised.

Switch Off RPM

This is the engine speed at which the solenoid is to be de-energised.

There are two ways in which this feature can be used:
The first application is to have two RPM 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 application 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.
The second application is to enable the solenoid for a range of RPM and to disable the solenoid when the RPM 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 RPM is greater than On RPM and Off RPM then the solenoid is disabled.

16.5 Torque Converter Clutch Lockup (TCC)

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

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

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

A square wave signal road speed indicator whose frequency is proportional to road speed; (this may require a unit for signal conditioning, such as the Haltech™ RA7)

Access to the wiring of the torque converter lockup solenoid and 4th gear/overtemp switch;
E6K programming software and cable.

Wire the TCC solenoid to the appropriate output line on the output connector, and, if it is available, the 4th gear/overtemp signal to the Aux. In line (the blue flywire on the E6K main harness.) The 4th gear/overtemp signal must be a pull-to-ground style signal. If you are not using this feature, leave the blue flywire disconnected, but insulate the end to ensure sure that it will not short to the bodywork.

To determine vehicle speed, a square wave signal must be applied to the road speed input connector. This connector possesses ground and 12 volt signals for powering a Hall effect or optical sensor. A magnetic or reluctor type signal is incompatible, and you will need to convert the output from this style of pickup to a square wave. The Haltech™ RA7 Reluctor Adapter would perform satisfactory conditioning.

Once the wiring is complete, run the E6K software in ONLINE mode and go to the Identification page. The parameter Road Speed Value must be set with the number of pulses expected per kilometre. If you are unsure of the exact value for this parameter, enter an approximate number and check against the vehicle's speedometer. Adjust the Road Speed Value until the road speed displayed on the Engine Data Page and the actual vehicle speed agree.

Go to the Options page in the software, and select the Torque Converter Lockup function on the appropriate output. The map for the TCC function indexes the vehicle road speed against the throttle position. When, for any given throttle position, the road speed is greater than that displayed in the map, the solenoid will be energised. The road speed must then fall 8 kph (5mph) for the clutch to be disengaged. This 8 kph hysteresis should prevent solenoid oscillation during cruising near the cut-off point. The default map activates the solenoid at 70 kph at smallest throttle opening, and increases the activation threshold to 160kph at 70% throttle. Although this map may be customised as required, it is advisable to never engage the lockup below 60 kph (40 mph).

Note: When using the TCC function, the **Aux. In & Aux. Out Function** in the Identification must be set for Torque Converter Control. When using TCC, other functions that use the Aux. Input line cannot be used.

16.6 Electric Thermatic Fan Control (TF)

This function can be used to switch on a thermofan when the engine temperature exceeds a certain value. The fan will stay on until the engine temperature drops below a second value.

Note: The electric fan cannot be driven directly by the ECU. A relay must be used to switch the high currents drawn by the fan.

To use this function, you must have the following:
An electric thermofan, fused and relay switched;
E6K programming software and cable.

Install the wiring for the thermofan to one of the Digital/PWM outputs as described in figure 16.6. Be sure that the relay contacts are rated higher than the current drawn by the thermofan.

Run the E6K programming software and go to the Options page. Select the Thermofan function on the appropriate output and set the two temperatures as required.

Switch On Temperature

The temperature the engine coolant must exceed to switch the fan on.

Switch Off Temperature

The temperature the engine coolant must drop below before the fan will be switched off. This parameter should be at least 5° lower than the Switch On temperature to prevent the fan from switching in and out repeatedly.

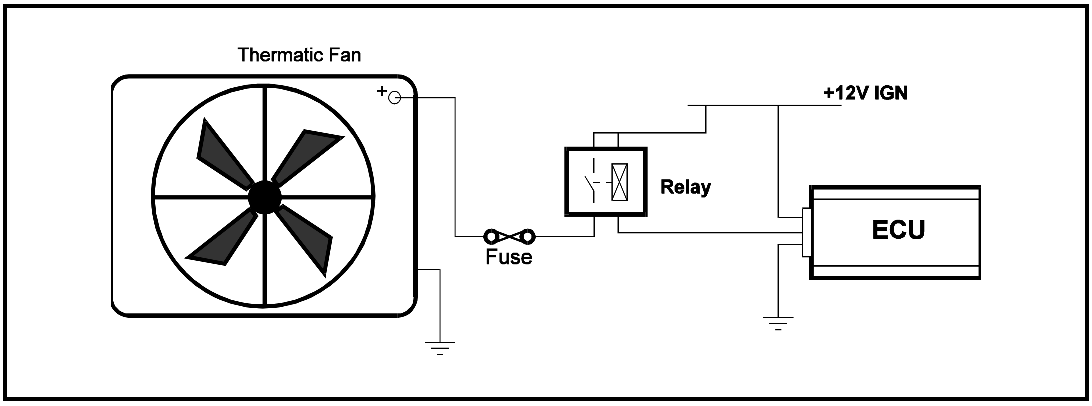


Figure 16.6. Example circuit for a Thermatic Fan.

16.7 Electric Intercooler Fan Control (IF)

This function can be used to switch on an electric fan on the intercooler when the inlet air temperature exceeds a certain value. The fan will stay on until the temperature drops below a second value.

NB: The electric fan cannot be driven directly by the ECU. A relay must be used to switch the high currents drawn by the fan.

To use this function, you must have the following:

An electric fan, fused and relay switched;
E6K programming software and cable.

Install the wiring for the intercooler fan to one of the Digital/PWM outputs. This should be done as described in figure 16.7 for the intercooler fan. Be sure that the relay contacts are rated higher than the current drawn by the fan.

Run the E6K programming software and go to the Options page. Select the Intercooler Fan function on the appropriate output and set the two temperatures as required.

Switch On Temperature

The inlet air temperature that must be exceeded to switch the fan on.

Switch Off Temperature

The temperature the inlet air must drop below before the fan will be switched off. This parameter should be at least 5° lower than the Switch On temperature to prevent the fan from switching in and out repeatedly.

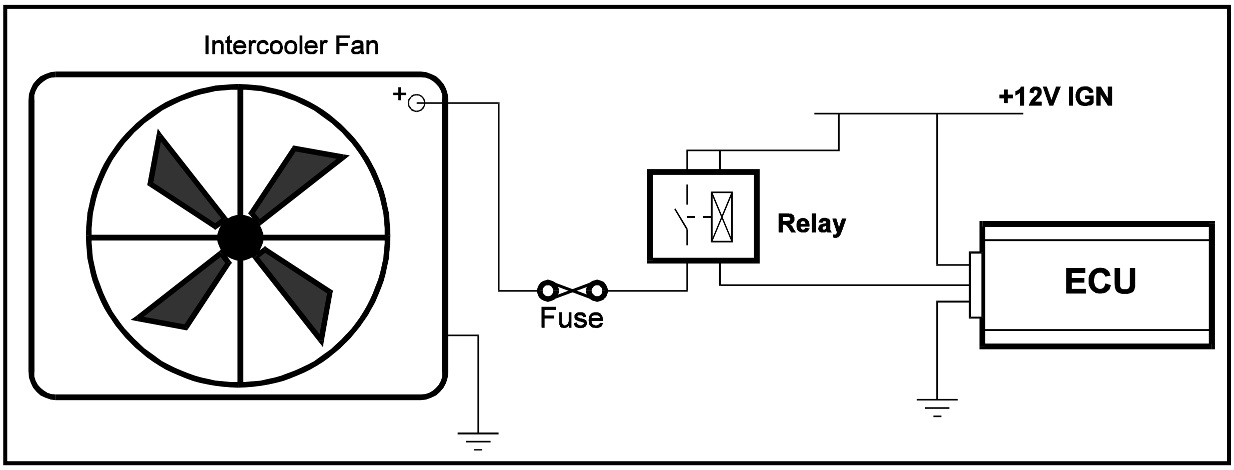


Figure 16.7. Example circuit for an Intercooler Fan.

16.8 Shift Light Illumination (SL)

The E6K can be used to activate a shift light or a piezo buzzer when engine speed exceeds the programmed activation speed.

To use the shift light function, you will need the following:

A dashboard lamp or buzzer;
E6K programming software and cable.

The lamp or buzzer should be wired to +12V on one side, and the other to the ECU. The lamp used must not draw more than 0.5 amp of current (i.e. a 6 Watt globe). Alternatively, a high intensity LED may be used. If so, use a series resistor of 330 ohms to limit the current through the LED to around 40mA.

Once the wiring has been installed, run the E6K programming software and go to the Options page. Select the Shift Light function on the appropriate output and set the value as desired.

16.9 Auxiliary Fuel Pump (AP)

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

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

To use the Auxiliary Fuel Pump function, you must have the following:

A properly plumbed fuel pump, wired through a relay;
E6K programming software and cable.

The extra pump must be connected in parallel with the primary fuel pump. Figure 16.9 suggests a possible layout. The check valve is necessary to prevent fuel from being forced in the wrong direction. Connect the power to the pump via a relay as shown. Either the positive or negative side may be switched through the relay.
Run the E6K programming software ONLINE and select the Auxiliary Fuel Pump function on the appropriate output. There are two parameters that define when the Auxiliary Pump will be switched on.

Load Bar

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 32.

Engine Speed

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 high.

Run Time

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 engine condition exceeds either limit. 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 below when that extra fuel is actually needed. The use of a good quality check valve and fuel pump will reduce the delay time by maintaining pressure in the secondary line. Nevertheless, the extra fuel will not be instantly available and care should taken when deciding the switch times. If these values are set too high, the engine may be momentarily starved of fuel when there is a sudden fuel demand.

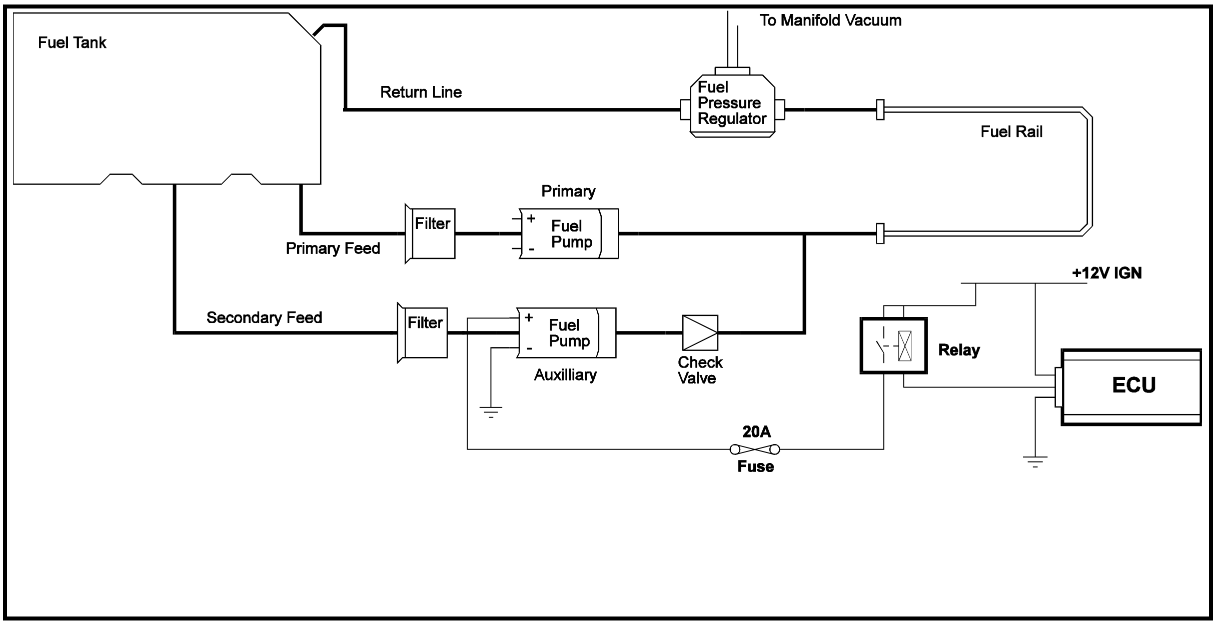


Figure 16.9. Example circuit for Auxiliary Fuel Pump.

16.10 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.

To use this function, you will need the following:
- a suitable solenoid air valve mounted to the manifold;
- E6K programming software and cable.

If the solenoid air valve is too large, the engine may stall because of its opening. The valve should be of appropriate size to increase the idle speed by several hundred rpm. Wire the solenoid through the output connector. Run the E6K programming software in ONLINE mode and select the Anti-Stall function on the appropriate output.

There is only one parameter to be set with this function. That is the rpm below which the valve will be opened. The default setting for this parameter is 500rpm.

16.11 Staging Signal Function (SS)

This function uses an output to indicate when the engine is in the staging section of map, i.e.. when the load has increased beyond the Staging Load Bar in the Identification Page. If enabled, this signal will operate regardless of whether the ECU is running in Staged Injector Mode.

Note: The staging signal does not pulse with the other injectors. It switches on and stays activated while the load is above the staging point.

There are no programmable parameters associated with this function.

16.12 Driver Box (DB3) Staging Signal Function

This function is similar to the previous Staging Signal, except that the signal is inverted so that it is compatible with the Haltech DB3 Driver Box, used for controlling extra injectors. There are no programmable parameters associated with this function.

16.13 Turbo Timer (TT)

Care should be taken to make sure the relays are wired correctly, and that an over-ride switch has been fitted to allow the engine to be switched off manually while the turbo timer is active. See figure 16.13 for the correct way to wire this output. The ECU detects if the ignition switch has been turned off via the Auxiliary Input. Therefore, the Auxiliary Input Function must be selected as Turbo Timer in the Identification.

There are three programmable parameters. The first two are the minimum Air Temp. and the minimum Coolant Temp. If the inlet air and the coolant temperatures drop below their respective values, the output will switch off. The last parameter is the Run Time. This is the maximum time the ECU will allow the engine to continue to run after the ignition switch has been turned off. If either of the temperature conditions are meet before this time, the output (and therefore, the engine) will switch off. The Run Time is set to the nearest half minute.

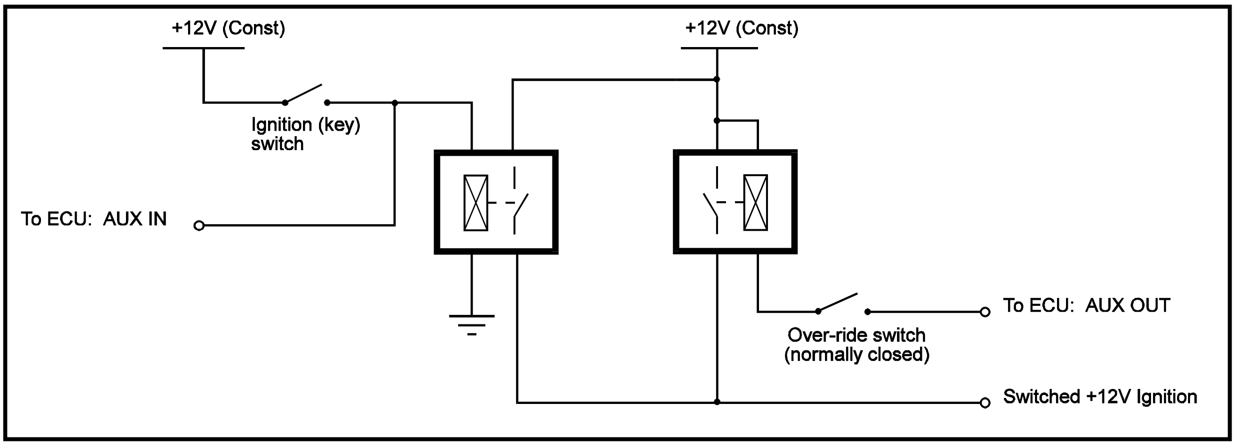


Figure 16.13 – Example of a Turbo Timer circuit.

> Note: When using the Turbo Timer function, the **Aux. In Function** in the Identification must be set for Turbo Timer. When using TT, other functions that use the Aux. Input line cannot be used.

16.14 NOS Switch

This function controls the operation of a NOS system. It does not control the delivery of the Nitrous Oxide, but simply turns the system on or off in certain conditions. The NOS system must control the delivery of the nitrous oxide and must also provide extra fuel delivery. The output is enabled by a switch connected to the Auxiliary Input. 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. There are five adjustable parameters :

Load Bar

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

If the RPM exceeds this value the NOS system will be switched off.

Min. Rpm

If the RPM is below this value the NOS system will not be activated.

Minimum Throttle

The NOS system will be turned on above this value.

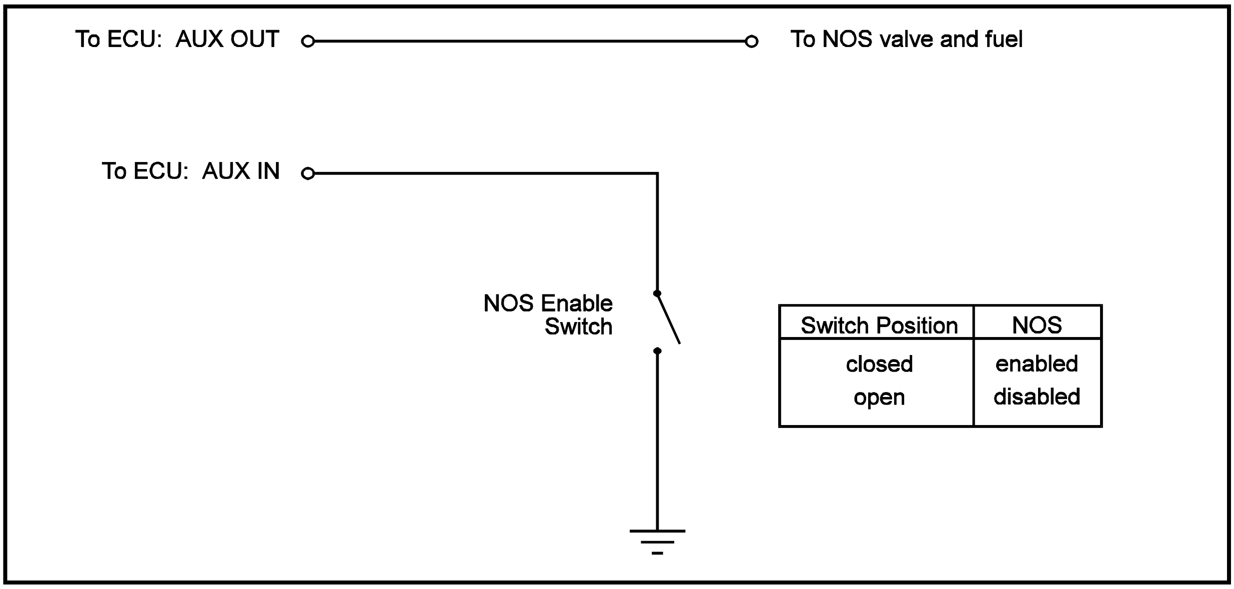
Minimum Temp

The NOS system will not be activated unless the engine coolant temperature is above this value.

Ignition Retard

The E6K will provide an ignition retard whenever the NOS system is engaged. The number of degrees retard is set by this field.

Note: When using the NOS function, the **Aux. In Function** in the Identification must be set for NOS. When using NOS, other functions that use the Aux. Input line cannot be used.
FOR SAFETY REASONS THE NOS FUNCTION IS ENABLED ONLY AFTER THE ECU IS ON FOR MORE THAN 2 MINUTES.



Switch Position	NOS
closed	enabled
open	disabled

Figure 16.14. Example circuit for a NOS switch.

16.15 Anti-Lag Switch

The Anti-Lag switch function allows turbo-charged vehicles to decrease the “lag” associated with boost when the motor is not under full load.
There are 5 adjustable parameters:

Retard Value

The ignition timing is retarded by this angle when the Anti-Lag conditions for operation are met. The valid range for the Retard value is (-70° to 70°)

% Inc. Fuel

The percentage of fuel **increased** during Anti-Lag operation. The valid range for this function is (1 to 50)%.

Zero TPS ONLY

If the Anti-Lag function is to be used when the Throttle Position Sensor value is zero then turn this function **ON**. Otherwise select **OFF**.

Zero Inj Time

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

The throttle position value below which Anti-Lag is operational. The valid range is (5-80)%.

On RPM

This field specifies the RPM above which Anti-Lag is operational.

On Coolant Temp

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 the Auxiliary Input 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. In some systems the switch is activated by the clutch. 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. If the AUX In is set to Anti-Lag, it can override the last two field conditions and enable the system based on throttle position alone. (See 13.1 The Input/Output Page)

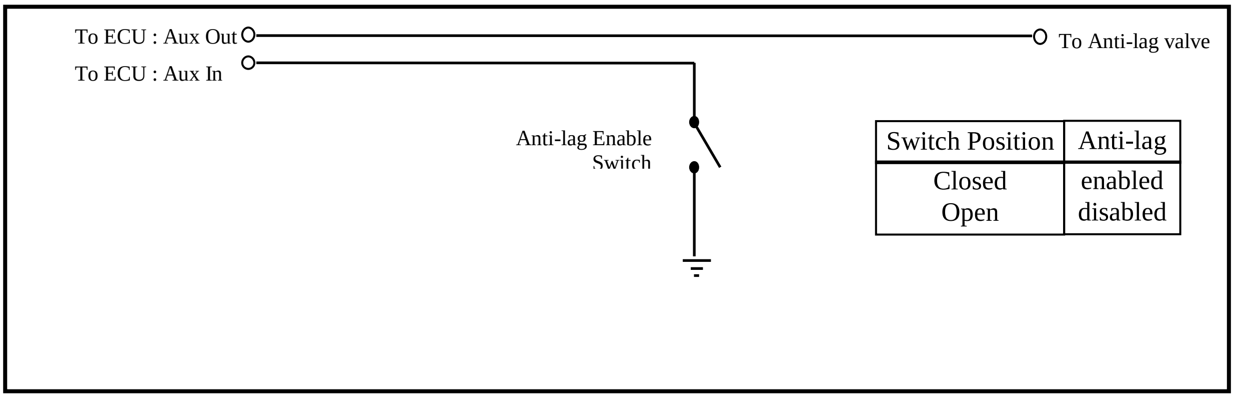


Figure 16.15. Example circuit for an Anti-Lag switch.

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

16.16 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. %

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

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)

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.

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. (see 13.1 The Input/Output Page)

16.17 Engine Control Relay

This feature allows the 12 volt supply to the engine to be disconnected when the ECU is not powered up. There are no parameters for this feature. The engine control relay should be wired as shown in figure 16.17. The ECU is not capable of supplying power to the relay or the components it drives but can sink the current required to energise the primary winding of the relay.

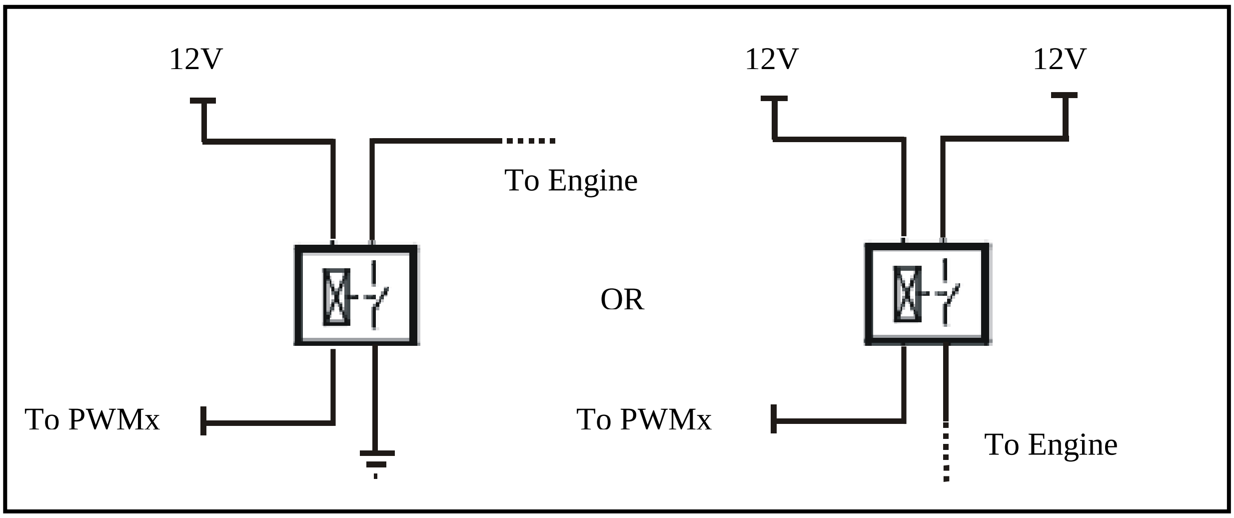


Figure 16.17 Engine Control Relay wiring diagram

16.18 VTECH

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

On 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

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

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

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.

SECTION 5 Appendices

APPENDIX A TROUBLESHOOTING

This Appendix is devoted to trouble shooting problems that may occur during setting up the E6K on your engine. To use this Appendix, firstly identify the closest symptom or symptoms from the list below, and then follow the checklist for possible solutions.

A.1 Overview

Control Program Problems

- The Haltech Programming Software will not load up
- 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.2 Control Program Problems

Haltech Programming Software will not start up

The Haltech programming software should run on any computer that meets the requirements in Chapter 2.2.1. If, after following the instructions in Chapter 2.2.1, 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.

Do not try running the Haltech software from out of another shell program - always start from the DOS prompt. If you are loading a number of TSR (Terminate and Stay Resident) utilities during bootup, 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 Disk 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 - see Chapter 13
Wrong Programming Disk (i.e. disk does not match ECU)
Programming Cable is damaged
Serial port of programming computer is faulty.

If the disk 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 Haltech E6K 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 Multitooth trigger type is not selected unless the engine has a multitooth wheel. If using a multitooth 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 E6K 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 E6K 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 E6K 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).

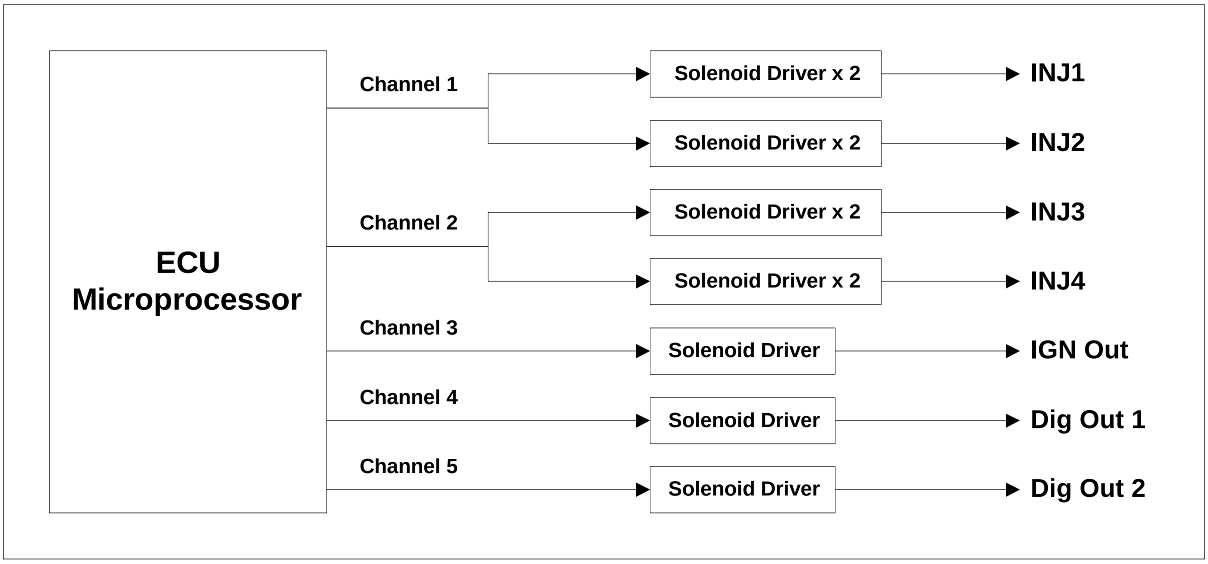
If the cold start map is supplying too much fuel on warm-up this will also affect the fuel consumption of the vehicle.

The Advanced Mode of the E6K offers the user extra flexibility in setting the system up for multiple injection/ignition outputs (i.e. more than one ignition channel and one or two fuel channels). To understand exactly what is available in the Advanced Mode, a brief description of how the system and its injection/ignition output operate is required.

B.1 The E6K Injection/Ignition Outputs

The E6K has five injection/ignition outputs, or channels. **In Basic Mode**, the channels are configured as follows:

- Two outputs drive two solenoid drivers each. These two outputs define the four injector drivers used for fuel in a standard set-up. These two fuel channels are either fired together (Multipoint Injection Mode) or alternately (Batch Fire Injection Mode). We will call these channels 1 and 2. Channel 1 is connected in the loom to the outputs marked INJ1 and INJ2. Channel 2 is connected to INJ3 and INJ4.
- Channel 3 is the ignition channel. On a basic set-up it would provide the output for an igniter firing one ignition coil connected to a distributor.
- Channels 4 and 5 are the Digital Output channels. They provide outputs such as Turbo Wastegate, Thermofans, Shift Light, etc.. The user can select these outputs to be one of several available. These output are also called Digital Out 1 and Digital Out 2, and are marked similarly on the loom:



In the **Advanced Mode**, we change the function of these outputs a little to give the extra abilities. We use the Digital Output channels to provide more ignition channels or more fuel channels.

B.2 Direct Fire Ignition

B.2.1 Ignition Outputs

There are two forms of Direct Fire Ignition. One is to have one coil per spark plug (usually mounted on top of the plug.) Each cylinder is individually controlled by its own coil.

The second method is to use a waste spark. The plugs are paired into companion cylinders (cylinders with the same TDC but on different strokes). Each coil fires sparks on a pair; one into the compression stroke, one into the exhaust stroke (the waste spark). Both methods mean that the distributor can be discarded.
With either method, the importance of the set-up to the E6K is the number of coils. Each coil needs its own igniter and ignition output. On a four cylinder using waste spark, two coils are used, and, therefore, two ignition outputs are needed. In this case, channel 4 is used as the second ignition channel, making it unavailable for digital outputs. The six cylinder with waste spark is similar. It requires 3 coils and 3 ignition channels. For this set-up, channels 4 and 5 become ignition channels 2 and 3 respectively, and neither is available for Digital Outputs.

A V8 becomes a little difficult. It requires 4 coils and 4 ignition outputs, but we have no more available outputs. Therefore, we take one of the fuel drivers and use it as an ignition channel. The E6K uses channel 1 (marked on the loom as) for this purpose. This channel becomes ignition channel 4. There is some trade offs with this though. Multipoint is the only available injection mode. The batch fire and staged modes are not available. If 8 low impedance injectors are used in combination with 4 ignition coils then a Haltech External Driver Box is needed.

There are some other cylinder configurations to consider. 1, 2 and 3 cylinder engines need 1, 2 and 3 ignition outputs respectively. Alternatively, a two cylinder can use one ignition output and use a direct fire coil with a waste spark. The Direct Fire Option should not be chosen. This can only be done if the engine is not odd fire. Five cylinder engines cannot run Direct Fire as they cannot use waste spark and therefore need 5 ignition outputs. Also, there are not enough outputs to run Direct Fire on 10 and 12 cylinder engines.

B.2.2 Synchronising

On a distributed engine the E6K does not need to know the engine position. It is told to generate a spark which the distributor sends to the correct spark plug. With Direct Fire, the E6K needs to know engine position so that it knows what coil to trigger next. To do this, the ECU needs to receive a **Synchronisation Event** (Sync. Event). One form of Sync Event is missing teeth on a multitooth wheel. The most common Sync Event though, is a **Home** trigger. This trigger needs to occur before the main trigger for cylinder (or coil) one, indicating that the next main trigger is for cylinder one. This trigger should not occur at the same time as the main trigger.

When the engine is started, the ECU will not generate a spark until it receives a Sync Event. After that, the ECU fires each ignition output sequentially until it gets to the last output. It then expects to receive another Sync Event. If it does not receive a Sync, it will not fire another spark until it does. If the Sync is received, ECU ignition is set back to coil one and the sequence continues.

The Home trigger must occur before the main trigger each time coil one is to be fired. For example, on a four cylinder with waste spark, coil one needs be fired once every revolution. With 4 coils, though, coil one fires once every two revolutions. A cam trigger would be required for the Home.

The Home trigger is wired to the same input as the Road Speed. This means that the Road Speed input, and consequently the Torque Converter Output, cannot be used with Direct Fire.

B.2.3 Coil Set-up

To give an example of how to match up the coils to the ignition outputs, we will use an example of a V8 with an arbitrary firing order of : 1, 2, 7, 8, 4, 5, 6, 3. The companion cylinders are the corresponding cylinders in each half. Therefore the companion pairs and their coil numbers would be : Coil One, cylinders 1 and 4; Coil Two, cylinders 2 and 5; Coil Three, 7 and 6; Coil Four, 8 and 3. The coil numbers then match up with the ignition Channel numbers. The diagram below shows how the coils would connect up.

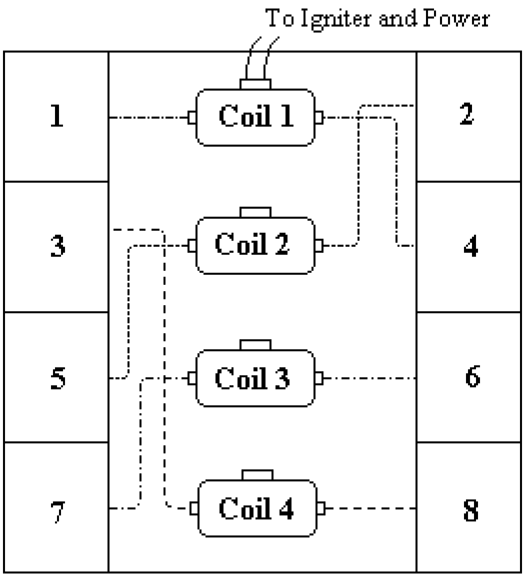


Figure B1. Coil layout for V8 with firing order 1, 2, 7, 8, 4, 5, 6, 3.

It is not necessary for coil one to connect to cylinder one. If, for instance, the original Home trigger occurs before cylinder 6 (not common, but possible) then coil one would need to connect to cylinder 6. The coil order would still be the same.

B.2.4 Converting Individual Coils to Waste Spark

One way of overcoming the problem of individual coils on 6 and 8 cylinder engine (and 4 cylinders if required) is to pair the cylinders up in the same way, but run 2 igniters (one for each plug) to one ignition output. For example, on a six cylinder six igniters would be required but only 3 ignition outputs, which is within the scope of the E6K.

B.2.5 Ignition Outputs

The E6K will always use its outputs in the same order. It will use up to 4 outputs, and what outputs it does not use are available for other purposes. The output order is :

Channel 3	IGN OUT
Channel 4	Digital Out 1
Channel 5	Digital Out 2
Channel 1	INJ1/INJ2

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 Sequential Injection Mode of the E6K will control up to four separate fuel channels. This provides full sequential for engines up to 4 cylinders, and semi-sequential for 6, 8 and 12 cylinders engines.

B.3.1 Sequential Features on the E6K

Injector Phasing

The timing (or phasing) of these injections is set via the Injector Phasing Map. This Map sets the angle of the End of Injection, in degrees BTDC *exhaust* (not compression), against the engine speed. This allows the injection to be completed before the inlet valve opens. The E6K then times the start of injection, based on the trigger, so that the injection is completed by the specified engine angle. If the E6K computes that there is insufficient time to complete injection before the specified End of Injection time, then injection will continue past this time.

Injector Trims

With multiple injector channels, it is possible to trim the fuel injection time to each channel. The E6K 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. These trims are accessed through the Fuel Maps and Set-up Menu.

B.3.2 Sequential Outputs

The E6K can run full sequential on an engine with up to four cylinders. When the Ign / By is set to 1 in the Fuel Set-up, injection will occur once per engine cycle (every second revolution) for each channel. The output channels used and the order of injection are :

Channel 1	INJ1/INJ2
Channel 2	INJ3/INJ4
Channel 5	Digital Out 2
Channel 4	Digital Out 1

If you have less than 4 cylinders, you will not need all four outputs. A 3 cylinder engine, for example, will only use channels 1, 2 and 5. Channel 4 is then left available as a Digital Output.

The E6K can only provide 4 fuel outputs, therefore it cannot control each cylinder's injection on an engine with more than 4 cylinders. For 6 or 8 cylinder engines, the E6K can operate in a semi-sequential mode. With the Ign / By set to 2, each injection will occur once per engine cycle. The injectors need to be paired to cylinders adjacent in the firing order. For example, on a six cylinder engine with firing order 1-5-3-6-2-4, the injectors would be paired to fuel channels as follows :

Channel 1	INJ1/INJ2	cyl 1 and cyl 5
Channel 2	INJ3/INJ4	cyl 3 and cyl 6
Channel 5	Digital Out 2	cyl 2 and cyl 4

Channel 4 is not used for fuel and is therefore left available as an Digital Output.
The Sequential Injection Mode on a 12 cylinder engine is not really sequential at all, but a form of extended Batch Fire. The E6K will fire the injectors as three groups of four injectors (uses three outputs.) With the Ign / By set to 2, the injectors will each fire once per revolution. This injection mode has proved useful in reducing fuel pressure fluctuations in the fuel rails on V12 engines. The Individual Injector Trim is still applied to each channel, so group the injectors by flow rate and set an appropriate correction.

Sequential injection on 5 and 10 cylinder motors is not possible with the E6K.

Important Notes

1. The E6K as yet 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.

2. The Sequential Injection Mode cannot be used in conjunction with Direct Fire Ignition Mode except on 1 or 2 cylinder engines unless an optional ignition toggle is used in which case 4 cylinder direct fire waste spark is possible. If both modes are selected with more than 2 cylinders, the E6K will choose the ignition function in preference to the fuel function.

3. The Appendix B.10 Summary Table should be consulted to determine if a particular configuration is possible.

B.3.3 Synchronising

To be able to synchronise the injectors with the motor, the E6K needs a **Synchronisation Event**, usually in the form of a 'Home' Trigger to operate in sequential mode. The Home trigger is separate from the main trigger and it tells the ECU that the next injection is to be for channel 1. Each injection is calculated from a main trigger. The first trigger after a Home trigger calculates injection for channel 1. Each main trigger after that will sequence through the channels in the order mentioned earlier. i.e. the order will be channels 1, 2, 5 and lastly 4 (if all four are used). If the Home trigger does not occur, however, injections will continue, but injector synchronisation cannot be assured until the home pulse is received again.

B.4 Multi-tooth Triggers

The E6K is capable of triggering from multi-tooth pickups, as used on a number of production vehicles. The E6K employs software signal conditioning to convert the multi-tooth trigger to standard form. This is done by counting teeth from a "synchronisation event" (or Home signal), until a certain tooth is reached which corresponds to the engine location specified as the Trigger Angle. The E6K then performs ignition (and possibly injection) in the same fashion as the standard trigger.

After recognising the synchronisation event, the E6K will locate the first "standard" engine trigger by the tooth indicated as Tooth Offset in the Ignition Set-up page. To find the remaining "standard" engine triggers, the E6K 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 setup values, when the Home signal occurs the ECU will start counting the trigger teeth (24-tooth wheel), when it reaches the tooth offset it will operate as a standard trigger. The position of the remaining triggers is determined by taking the number of teeth in the trigger wheel (24) divided by the number of cylinders (4). This number (6) is the number of teeth that is counted between triggers.
In this case the triggers will occur at the following teeth: 2,8,14,20. Each trigger occurs 65° (Trigger Angle) BTDC of the current cylinder and will perform ignition based on this angle.

Due to the high frequency of multi-tooth signals the maximum Rpm to which the ECU will operate is 10,500 rpm.

B.5 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 E6K 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. In figure B5.1 the solid lines show where a 4 cylinder cannot select a tooth offset and the dashed line shows where a 6 cylinder cannot select a tooth offset. These teeth will cause a trigger at the missing tooth. This rule applys for all motronic style wheels.
- Synchronisation required for sequential fuel injection or full direct fire cannot be accomplished without a Home signal driven by the Cam.
- 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.

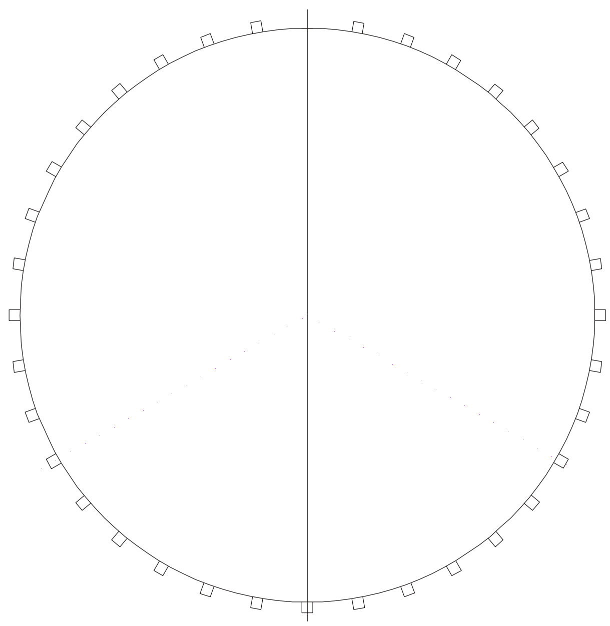


Figure B5.1 – Ford 36-1 motronic style wheel

B.6 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 E6K 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.

B.7 Rotary Engines

The E6K is capable of providing fuel and spark to twin-rotor Wankel engines, both in direct fire form or with a distributor. The leading and trailing sparks are generated separately, with a programmable split between them. 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 datalogs, 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/INJ2	Fuel (Primary)	Fuel (Primary)
INJ3/INJ4	Fuel (Secondary)	Fuel (Secondary
IGN OUT	Leading Spark	Leading Spark (both)
DIGITAL OUT 1	Trailing Spark	Trailing Spark front rotor
DIGITAL OUT 2	Digital Output	Trailing Spark rear rotor

B.8 Nissan Triggers

The Nissan optical trigger sensor is used by almost every ECU controlled Nissan engine. It is a sensor that spins at half the engine speed, and is therefore able to measure the engine cycle position, 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, so on a 4 cylinder there are 4 pulses, and on a 6 cylinder there are 6 pulses. The beginning of the pulses (rising edge) are evenly spaced, but the end of the pulses (falling edges) are not evenly spaced since the trigger pulses are of different sizes as described below. The differing pulse widths enables the ECU to determine which pulse occurs immediately before cylinder number 1, the ECU does this by counting the number of home pulses that occur during the trigger pulse.

There are a number of different trigger window patterns, two common patterns are described below:

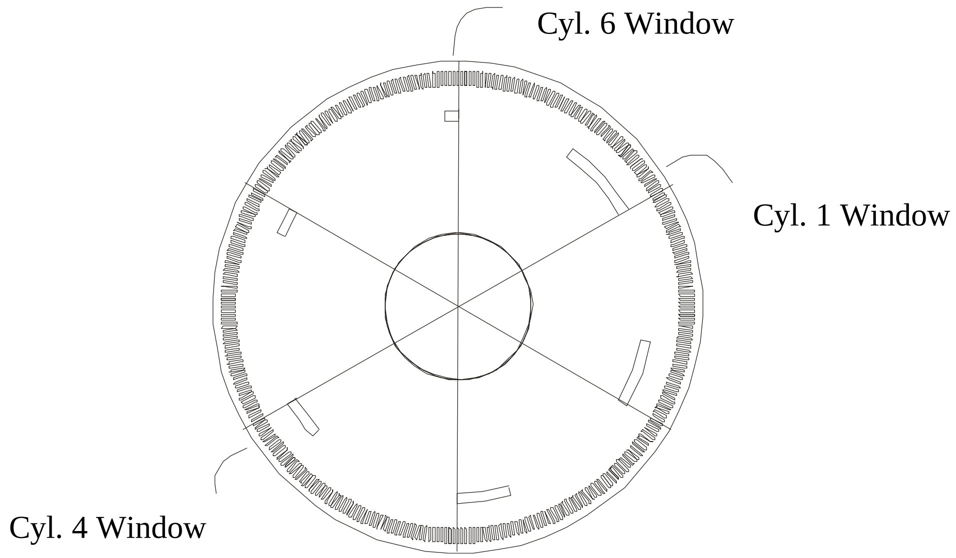
Pattern 1

The first pattern has trigger windows 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 triggered by 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

$$if\ Cylinder\ Number = 1$$

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

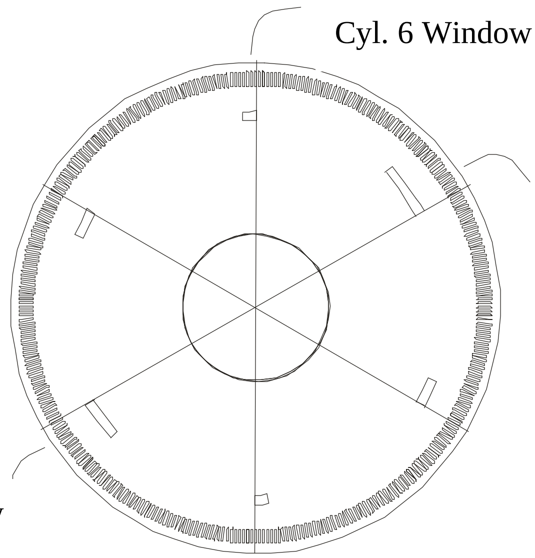
$$if\ Cylinder\ Number\ is\ opposite\ of\ Cylinder\ number\ 1$$

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

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

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

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



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 labeled “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.

B.9 Subaru Triggers

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

B.10 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 E6K to wait for a Home signal.

** This configuration could also be used for waste-spark direct fire ignition.

APPENDIX C INJECTOR IMPEDANCE

Electrically, there are two different types of electronic fuel injectors. One type of injector, characterised by a high coil impedance (> 12Ω) is known as *saturation* injectors. The other sort of injector, typically with coils of less than 6 ohms impedance, is known as *peak-and-hold* injectors. The names are derived from the current waveform that accompanies the injector when it is switched on.

Saturation, or high impedance, injectors, require a simple switch to operate. When a 16 ohm injector has 12V applied to it, the current that is expected to be drawn is 0.75 amps (by Ohm's law). However, the current in a coil cannot change instantly. When power is applied to this injector, the current builds in the coil over a period of around half a millisecond, until it reaches its 0.75 Amp maximum, i.e. saturation. The coils remain in saturation until power is switched off at the end of injection.

In order to reduce opening time, the coil impedance can be reduced. Very low impedance would result in very large continuous currents, resulting in a great deal of heat and waste of energy. However, a much smaller current is needed to hold the injector open than is needed to initially switch it on. Thus, such an injector is described by two currents: a peak current for opening, and a hold current for maintaining the fuel flow. These peak-and-hold injectors are particularly good for high rpm engines needing large fuel-flow rates.

Peak-and-hold injectors come with a wide variety of current requirements. Most peak-and-hold injectors need 2A to switch on with 0.5A hold current (2/0.5A peak-and-hold), or are 4/1A peak-and-hold. Some very high performance injectors need as much as 6A to switch on, especially under high fuel pressures.

C.1 The E6K Injector Drivers

The solid state devices within the E6K ECU that are used to switch the injectors are known as the *injector drivers.* The **E6K** possesses eight heavy-duty injector drivers and can use either saturation or peak-and-hold injectors. Each individual driver limits its current draw to 4 amps, and, upon reaching that limit, clamps the current to just 1 amp.

The drivers used in the **E6K** are each capable of firing two saturation injectors. Individual drivers are capable of firing one or two 2/0.5A peak-and-hold injectors. If using 4/1A peak-and-hold injectors, you should not employ more than one injector per driver. Most high current motorsport injectors can also be fired (one per driver) providing fuel pressures are not excessive (>5 Bar). Running two high current, low impedance injectors from one driver can result in difficulty in obtaining stable air:fuel ratios when injection times are short (around idle and light load).

In general, an injector driver will reliably fire two injectors with more than 2.5 ohms coil resistance. Coil resistance can be measured with an ordinary low-ohm resistance meter. If you are unsure which E6K model to choose contact your Haltech dealer for advice.

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 an extra driver box can be installed to meet the requirements. Your Haltech dealer can help you obtain the driver box.

The best EFI installation will yield poor results if the fuel system does not meet the demands of the engine. Insufficient fuel flow can lead to engine lean out and detonation which could cause serious damage. For the safety of your engine, we urge you to check your fuel system's capacity and ensure that there will be sufficient supply at all times. A fuel pressure meter should be used during testing and tuning to ensure that fuel pressure does not fall out of regulation i.e. that the pressure does not drop or oscillate.

This appendix offers guidelines to testing your fuel system and suggests some solutions if there are supply problems. If you find you need to modify your fuel system and are unsure what to do, contact a Haltech dealer for advice.

WARNING:
FUEL IS DANGEROUS. BEWARE OF FLAMES, CIGARETTES, ELECTRICAL SPARKS, ETC.

D.1 Fuel Requirement

If you can estimate the power output of a gasoline engine, you can make a reasonable guess at the fuel flow requirement. A simple rule of thumb, thus, may be expressed in metric or imperial units.

Note: Every 100 hp needs around 50 lb/hr (8.0 US gal/hr) of fuel (6.6 Imp gal/hr)

Every 100 kW needs around 670 cc/min (40 L/hr) of fuel

This assumes a brake specific fuel consumption of 0.50. The actual fuel flow necessary by injectors and pump are likely to exceed a figure derived this way. This is due to the overheads in injector dead time and pumping return fuel to maintain regulation.

D.2 Injector Flow Capacity

If you have purchased second hand injectors, or have removed the current injectors while doing work on the engine, we strongly recommend that you clean and flow test them. If you have bought new injectors, it is worth flow testing them anyway if you do not know their flow rate. Make sure that you test the injectors at the fuel pressure that your regulator is operating.

Your total injector flow capability is given by the sum of the injector flow rates. Injector flow rates are usually specified in either cc/min or lb/hr. Check that you have enough injector flow to match the estimated power output comfortably. Keep in mind that you do not want to exceed 85% duty cycle injection on time, and that at high rpm, injector dead time can consume a significant amount of available injection time.

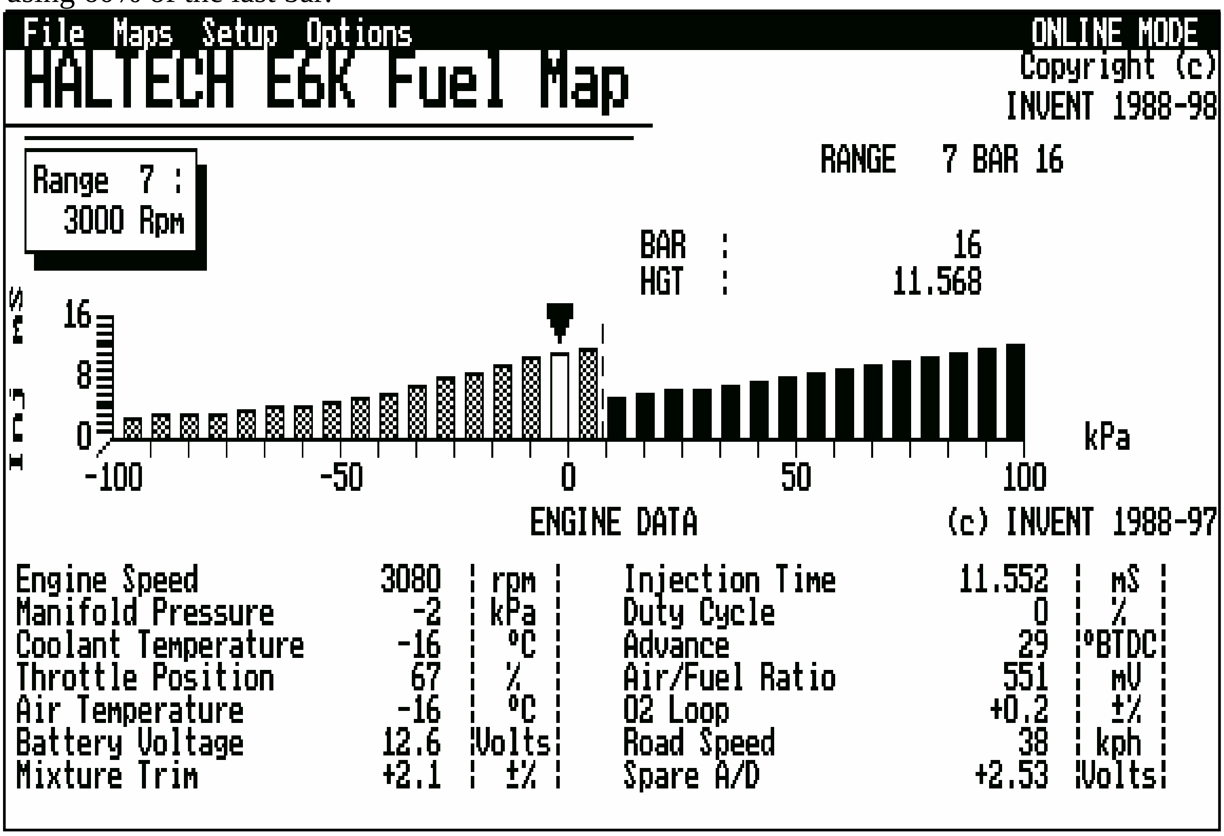
If you find that your injector flow is insufficient, you can change to larger injectors, add extra injectors, or increase fuel pressure. Raising fuel pressure to increase injector flow rate is not recommended if the desired flow is more than 20% than the system currently achieves. Fuel flow is not in direct proportion to fuel pressure. Increasing fuel pressure will increase injector dead time and reduce the flow rate of the pump.

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. Typically bar number 14 to 16 will work well in most applications. 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. (Refer to section 4.8 Duty Cycles).

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 (4.4.1 Fuel Set-up).

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. (See Appendix C)

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

Interfacing the E6K with your particular trigger system may be fairly straightforward or it may be complicated. The variety of trigger designs available is the primary source of complication. This appendix contains a lot of useful information about the different approaches to trigger design and is essential information to anyone installing an E6K.

E.1 The Input Trigger

The E6K ECU has been designed to trigger from either a square wave signal that varies from a ‘low’ of zero volts (ground) to a voltage between 5 and 15 volts or from a magnetic inductive (reluctor) signal in conjunction with the internal reluctor adaptor or an optional external reluctor adaptor. A reluctor adaptor converts the sine-like wave signal from the reluctor sensor to a square wave signal. The actual value of this ‘high’ voltage is not important because it is the transition from ‘low’ to ‘high’, or ‘high’ to ‘low’, that is used to trigger the E6K ECU. This transition is referred to as the **Trigger Edge** and will be shown in the following illustrations as an upward or downward facing arrow. An upward facing arrow would indicate that the trigger edge is the transition from low to high and this is called a *Rising Edge* trigger. If the trigger edge occurs on the transition from high to low, it will be shown as a downward facing arrow, and would be called a *falling edge* trigger. See Figure E.1.

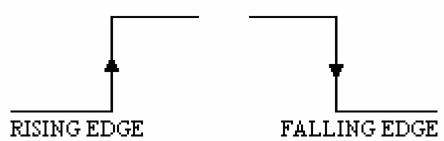


Figure E.1

In order for the E6K to operate correctly a trigger edge must be generated for each spark. This edge must occur a fixed number of degrees before top dead centre (BTDC) and must not change. The position of the trigger is given in crankshaft degrees and is called **Trigger Angle**. In addition there should not be any variation in the trigger angle between cylinders. The E6K can be set by the user to have its trigger edge occur between 60° and 100° BTDC.

In the example shown in figure E.2a the trigger occurs on a rising edge at 70° BTDC. The second transition, from high to low, could occur any time after the rising edge. In some installations the second transition will coincide with 10° BTDC or TDC itself, or it could happen as close as a few degrees after the trigger edge. This second edge will have no effect on the correct operation of the E6K ECU. It is only the position of the triggering edge that is of importance.

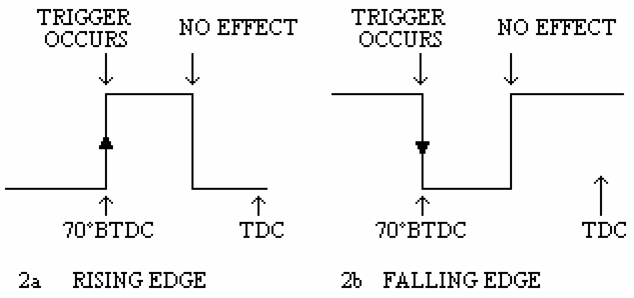


Figure E.2

In the previous examples the trigger edge has been shown as the first edge of the trigger pulse. The trigger does not necessarily have to be the first edge of the trigger pulse. Consider the example shown in figure E.3. In some trigger devices the pulse given for cylinder one would be a different width than the pulses given for all the other cylinders. If the first, in this case, rising edges were used as the trigger edge then there would be a variation of 20° between the trigger for cylinder one and all other cylinders. This would lead to cylinder one being 20° more advanced than all the other cylinders and obviously this would be unacceptable. The answer in this case would be to set the trigger point so that it is at a falling edge and to have the trigger degrees set to 60° BTDC.

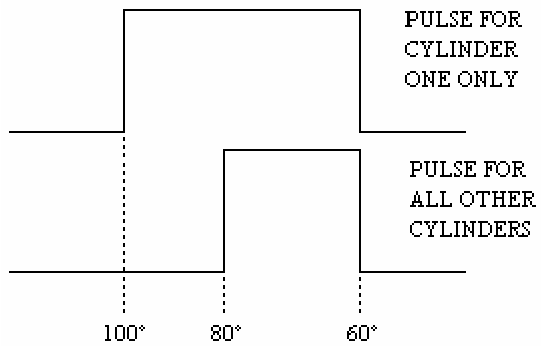


Figure E.3

E.2 Trigger Devices

The output of Hall Effect, Optical, or Magnetic Inductive (Reluctor) sensors could normally be connected directly to the input trigger pin of the E6K ECU. Many distributors used in original equipment manufacturer's computer controlled ignition systems would be fitted with Hall / Optical triggers. The internal structure of such distributors is usually configured so that a chopper wheel attached to the distributor shaft passes through a gap in the sensor. These devices require three connections :

Power (normally +12V)
Ground, and
Trigger signal output.

Assuming that the timing edges conform to the details set out above, a distributor such as this would connect directly into the E6K ECU. Often these distributors have a rising edge trigger at 70° BTDC.

Many distributors used in electronic ignition systems contain internal components and layouts the same as the distributor described above, but are fitted with mechanical and/or vacuum advance mechanisms which are much less effective and flexible than electronic timing as in the E6K. If these mechanisms can be defeated or removed, and the timing edges set correctly, then they can successfully be used to trigger the E6K.

A third type of pickup, the magnetic inductive (reluctor), is used in distributors as well as on crank trigger units. It is possible to use this type of trigger on the E6K using it's own internal reluctor adapter to convert the signal into the square wave required to trigger the E6K. The Primary input is used for the **main trigger**, and the secondary is used for the **Home**(Sync. Event) or Road Speed input.(See Syncronising Events, Appendix B2.2, B3.3 and E.3).

> Note: Any combination of hall effect, optical or reluctor type pick-up may be used for the "trigger" (main ignition event) and "home" (sync. Event) inputs. However, reluctor type pick-ups must be connected to their respective reluctor adaptor input.
>
> The onboard reluctor adaptor actually has two independant channels. One is for the "trigger" signal. The second is for the "home" signal.
> Each reluctor adaptor channel used requires two wire connections.

The magnetic pickup is basically a piece of wire wrapped around a magnetic core and attached to the sensor face, which is called the pole piece. The physical size and shape of such a pickup can take many forms. This type of pickup has either two wires (one positive (+), and the other negative (-)), or three wires with the third being a shield. The wires are sometimes marked as such, but more often than not they are unmarked.

> Note: If using a "reluctor" type for the TRIGGER signal input:
> The Positive pin from the "Trigger" reluctor pick-up connects to the input of the onboard reluctor adaptor (PIN B (***TRIGGER***), on the Trigger Input plug).
> The Negative pin from the "Trigger" reluctor pick-up must connect to the negative reluctor adaptor input (PIN D (***INPUT B***), on the Trigger Input plug).
>
> If using a "reluctor" type for the HOME signal input:
> The Positive pin from the "Home" reluctor pick-up must connect to the input of the onboard "HOME" reluctor adaptor (PIN E (***HOME***), on the Trigger Input plug).
> The Negative pin from the "HOME" reluctor pick-up must connected to the negative "HOME" reluctor adaptor input (PIN C (***INPUT A***), on the Trigger Input plug).

> Note: If a motronic trigger is being used refer to section E.2.2 Motronic Trigger as the wiring has some variation.

If you cannot tell which wire is the positive from markings or wire colour, then it would be necessary to check the signal going into the E6K using an oscilloscope.

When ferrous metal (metal that a magnet will attract) is passed very close to the pole piece, the pickup will generate a voltage similar to figure E.5a on the positive wire. The amplitude of the signal will vary with the speed at which the ferrous metal passes the pole piece. At low speeds the signal may only be several hundred millivolts, but at high speeds it could rise to 20 volts or more. The sudden drop in the signal from positive to negative seen in figure E.5a corresponds to the metal being directly in line with the sensor. As can be seen, the signal is not a square wave required by the E6K, and at low speeds the signal amplitude is too low.

The voltage input of the reluctor adapter must first go to a positive peak, which arms the circuit. When the signal rises to approximately 70 - 80% of the peak value the reluctor adapter will generate a falling edge, and when the signal crosses zero volts a rising edge triggers the Haltech ECU. If the wires are reversed and the signal goes negative first, the Reluctor adapter will generate a pulse but it will NOT trigger the E6K correctly resulting in incorrect ignition timing.

WARNING:
AN INCORRECTLY WIRED RELUCTOR WILL RETARD IGNITION TIMING AS RPM INCREASES OR GENERATE MULTIPLE TRIGGERS. INCORRECT WIRING OF A RELUCTOR TRIGGER CAN CAUSE MAJOR PROBLEMS. IF YOU ARE USING A RELUCTOR PICKUP ENSURE THAT THEY ARE WIRED WITH THE CORRECT POLARITY.

E.2.1 E6K Internal Reluctor Adaptor

Normal configuration of the E6K is for a Hall Effect input. To configure the E6K for a reluctor type pickup it is necessary to change the Trigger Input on the Ignition Set-up page to Int. Reluctor. This tells the E6K to use the internal reluctor adaptor to convert the trigger input into a square wave for processing. When this is selected, the Trigger Gain may be adjusted in the line below the Trigger Input. This gain is used to adjust the electronics inside the E6K to provide the best conversion of the reluctor input signal. Different types of reluctor sensors will provide different levels of signal amplitude and this software adjustable gain is designed to allow the user to adjust the sensitivity of the Reluctor Adaptor. Start with a smaller gain and increase the value until the Reluctor Adaptor is reading Engine RPM correctly. When the desired level is achieved the Internal Reluctor Adaptor is now fully configured and ready to convert reluctor signals for processing.

Following is a diagram showing the trigger input into the internal reluctor adaptor and the square wave output it provides for processing.

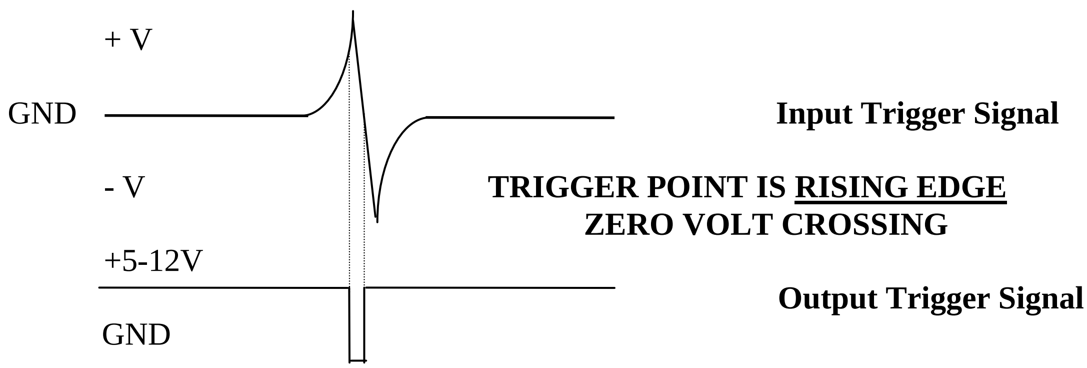


Figure E.5. Top diagram is the signal from the magnetic reluctor sensor. Bottom diagram is the signal after modification by the on-board Reluctor Adapter circuit.

A variation on this type of pickup uses a magnet moving past the pole piece, instead of ferrous metal, but generating the same wave form. An example of this type is the MSD flying magnet crank trigger. This pickup can be used to trigger the E6K ECU.

For the E6K to detect the home signal from a motronic trigger it uses slightly altered hardware. If you are using a motronic trigger your Haltech dealer will help you obtain this hardware.

Note: Since there are a large number of diverse reluctor distributors it may be necessary to connect an external custom reluctor adapter unit if the on board circuitry cannot be configured satisfactorily. Please contact your nearest Haltech dealer if you are experiencing reluctor configuration problems.

E.2.2 Motronic Trigger

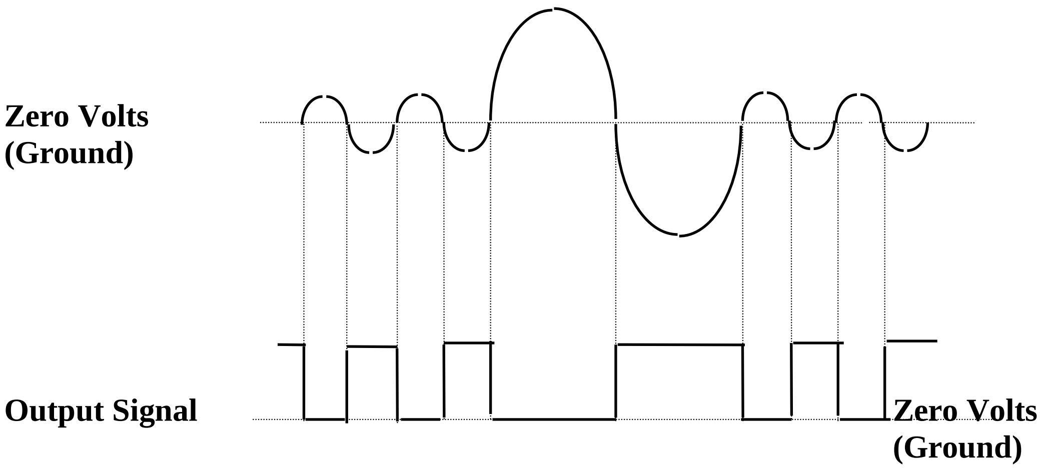
The Bosch Motronic sensor system comprises a toothed wheel, generally 60 teeth, with 2 teeth missing and a sensor which counts the passing teeth. The Ford system with 36 teeth and 1 tooth missing is generally similar. Please note that early versions of software such as 6.09 does not support the Ford 36 teeth wheel and version 6.32 (with matching firmware) or a subsequent version is necessary. The teeth provide the means for generating trigger signals and the missing teeth are detected and provide a home reference. Most Motronic type sensors are reluctor (magnetic) type sensors which give out a signal which is similar to a sine wave and this signal must be conditioned by a reluctor adaptor. **The Haltech E6K system has an in-built reluctor adaptor but please note that this reluctor adaptor is based on microprocessors and at the date of publication it is necessary to specify that the system will be interfacing with a Motronic type trigger system to ensure that the chips are programmed to suit Motronic. The programming in the chips for Motronic systems is different for that of other systems.** We normally discourage opening the case of the ECU particularly as this can affect warranty but if in doubt that the correct version of reluctor adaptor chips are installed this can be checked by carefully removing the 4 screws from the end plate with no connector and sliding the removable lid from the box. You will note 2 chips marked PIC16C711 and these should be marked with the letter "M". If not it is probable that the correct chips are not installed and you should contact your Haltech supplier. At the date of publication only Motronic type systems of 60 teeth and less are supported but higher teeth numbers will be supported at a later date.

Please note that some Motronic sensors are of the Hall effect type which give out a square wave signal and there is therefore no necessity for signal conditioning. These sensors have to be configured differently to the E6K system (ie treated as a square wave input, not a reluctor type input) so you will need to establish which type of Motronic sensor is on your engine. If 2 wires this will almost certainly be a reluctor type (isolated loop). If 3 wire it could be either a reluctor type (signal, ground and shield grounded to sensor) or Hall effect type in which case the Motronic trigger should be connected as a Hall effect type input (see table under 1.3.14 ie connect power, ground and main trigger). If in doubt as to the type of sensor check with the engine manufacturer. Also please note that if you elect to use an external reluctor adaptor rather than the internal reluctor adaptor of the E6K the signal will already be conditioned to square wave and the connection to the E6K should then be treated in the same manner as a Hall effect sensor.

The Motronic magnetic sensor has two wires, one positive (+), and the other negative (-). The wires are sometimes marked as such, but more often they are not. It is very important that the positive wire connects to the **Input B (Pin D** of a fully terminated harness). The negative wire connects to **Trigger input (Pin B** on the Trigger Input plug on a fully terminated harness). If you cannot determine which wire is positive or negative from the marking or wire colour, then it would be necessary to check the signal going into the E6K using an oscilloscope.

A Motronic wheel more than often has 60 teeth of which two teeth are missing which will often give a larger signal. The input to the E6K trigger circuit must first go negative (-); when the signal rises approximately 50 mV a falling edge is generated, and when the signal crosses zero volts a rising edge is generated. Missing teeth in the Motronic wheel provide a larger pulse in the output waveform which is recognised by the Haltech ECU as the home position.

<u>Output Signal from the Motronic Sensor</u>



If the wires are reversed and the signal goes positive(+) first then the on-board reluctor adaptor will still generate a pulse but it will not trigger the Haltech correctly resulting in incorrect ignition timing. So please make sure it is wired correctly.

Note that when using Motronic type sensors it is only necessary to use the **Home** channel (ie a separate Home signal to that provided by the missing teeth in the Motronic system) when using the Sequential mode of operation or when controlling direct fire ignition where 4 coils are used (including 4 cylinder configurations where one ignition coil per cylinder is used but excluding 4 cylinder direct fire waste spark where 2 ignition coils are used) and 3 and 5 cylinder applications. The Home channel is independent of the Trigger channel and can use either reluctor type sensors or Hall effect type sensors.

Wiring a reluctor (magnetic) type Motronic Sensor:
Positive wire: Connect to “Input B” on the Haltech flying wire harness or “Input B” (**which is Pin D, confusing but note the difference, one is an input as shown on the wiring diagram and the other is a pin number on the plug)** of the Trigger input plug of the fully terminated harness.
Negative wire: Connect to "Trigger" on the Haltech flying wire harness (**Pin B** on the Trigger input plug of the fully terminated harness).

Note: The polarity conflicts with Appendix E.2 as regards connection of a reluctor adaptor. Due to hardware constraints of the E6K the polarity is in fact reversed when connecting a reluctor type Motronic sensor.
The reversal of polarity is applicable only to the Trigger circuit. The Home circuit polarity is not reversed.

When the Haltech E6K is triggered by a Motronic reluctor type sensor an external in-line resistor is needed. This resistor links trigger Input B to a Motronic sensor. This resistor is 2.4kΩ **but please note that some installers have found that a higher resistance to 2.4 K ohm is needed for certain installations.** Should you find that the engine will not rev beyond certain limits we suggest you temporarily install a rotary potentiometer in line of around 20 K ohm and increase the resistance until you find that the motor revs out smoothly to maximum rpm. Then measure the resistance and substitute the rotary pot with a hard set resistance of the same value (1/4 watt min.). There is a zero ohm link within the E6K ECU which can be substituted for the correct resistance once known. As the components are surface mount we suggest that the ECU be returned to Haltech if an internal rather than an external resistor is required. (a 2.4 K ohm resistor cannot be fitted as standard on the E6K as some applications require a zero ohm link).

As a guide we have found that BMW installations require around 2.4 kΩ resistance, Porsche around 17 kΩ, and Opel around 3.5 kΩ, however different installations and different types of Motronic sensors may require a variation to the above. The purpose of the in-line resistance is to load the pick-up coil to give it a high immunity to radio frequency (RF) noise. Generally the engine will start and run correctly and the problem of the in-line resistance will only manifest itself in that the revs will be limited if the correct resistance is not set, generally by limiting the amount of revs obtained.

In the main set-up page set the number of cylinders and set the system mode at the bottom of the page to “Advanced”. Now go to the Ignition set-up page and under “Trigger Type” select “Motronic”. As soon as you do the “Trigger Edge” option will disappear as the ECU will set the correct edge.

Please note that the number of teeth entered in the software by means of the ignition set-up page should be set to reflect the number of teeth that pass the sensor in one <u>camshaft</u> revolution. For example, for a motronic wheel with 60 teeth less 2 missing teeth this entry should be 120. The number of teeth should be directly divisible by the number of cylinders. Further note that early versions of software such as 6.09 do not support motronic type sensors of more than 60 teeth please contact Haltech as it is the intention to extend the range of support in the future.

Set the “Trigger Input” to “Internal Reluctor” **but only if the Motronic sensor is of the reluctor type. If it is of the Hall effect type set “Trigger Input” to “Hall Effect”.**

Set the “Trigger Gain” to suit. This number can be set between 0-7. A lower number will make it less sensitive and a higher number will make it more sensitive. Start around 2 and increase from there.

If using a reluctor type sensor go to the “Ignition” set-up page and set the “Trigger Mode” to “Constant”.

Please note that if you wish to use sequential type fuel injection a separate "Home" input is required when using the Motronic type triggers. As the home signal will not be a Motronic type signal no in-line resistance will be required. If the sensor delivering the home signal is of the reluctor type it is not necessary to reverse the polarities ie
Positive would go to the "Home" (Pin E on terminated harnesses) and negative would go to negative "Home" reluctor adaptor input A (PIN C on the terminated harness).

Wiring a Hall effect type Motronic sensor.

Hall effect type sensors have 3 wires, signal, power, and ground. Provide a power signal to the power wire (must be switched ie no power when the ignition is off but do not connect to an accessory line as power will disappear when the ignition key is turned), ground the ground wire to a good grounding point, and the output wire should be connected to the Haltech "Trigger Input" (Pin B on fully terminated harnesses). No in-line resistance is required for Hall effect type Motronic sensors.

Hints for Setting up Motronic

The first thing required is to obtain a good RPM signal which can be checked by viewing on the engine data in the Haltech software. With no fuel injectors connected or with the fuel injectors disabled through the Haltech software you should get a steady 120-180 rpm signal on cranking. Then set the "Timing Lock" to "On" and adjust the trigger angle/tooth offset until you read the correct timing on the engine with a timing light ie if the timing lock is set to 10 degrees then adjust until you see 10 degrees BTDC timing. At this point set the "Timing Lock" to "Off", re-connect the injectors or enable the injectors through the software and start the engine.

Note: For sequential fuel injection the Haltech will fire the INJ 1 channel as the first to fire **AFTER** it has received a home signal. Therefore if you have a firing order of 1,3,4,2 the INJ 1 channel would be the correct channel to use for the car's Injector 3 injector and so on.

E.2.3 Hall Effect Sensors

The Haltech hall effect sensor is a two channel device that can be used to trigger the Haltech range of ECU's in a wide range of applications.

The most common application is in a direct fire configuration where a synchronisation event is required. As the Haltech hall effect sensor is dual channel, it can provide this synchronisation pulse as well as the trigger signal.

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

There are two types of hall effect sensors available from Haltech

The S3 Hall Effect Sensor

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

As a south pole passes the sensor face the signal in both the primary (PIN C) and secondary (PIN D) channels are switched to a low state. As a north pole passes the sensor a low state will only occur on the primary channel.

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

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

With these characteristics a direct fire can be set up in the following way:

Using the sensor on the crank

After a suitable mounting location for the sensor has been found the engine should be positioned at approximately 75° BTDC on cylinder no.1 compression. The magnet should now be placed in the aluminium disk with the south pole facing towards the sensor, making sure the magnet is in line with the sensor when the engine is in this position. This is now the reference point for all the other magnets. The number of cylinders will determine the number of magnets required and the angle of installation. The remainder of the magnets to be fitted will all have a north pole facing the sensor.

The adjustment of the air gap will be determined by the strength of the magnets used. This should be tested once the wheel assembly has been installed. Checking the Engine Data page for steady RPM is usually a good indication that the airgap is acceptable.

Identifying the magnets poles

If you need to identify the magnet poles this can be done easily with the use of a multimeter. By powering up the sensor, using 12 volts (PIN B) and ground (PIN A)
the secondary trigger channel (PIN D) can be checked to identify a south pole. Connecting the multimeter between PIN D and ground, 12 volts should be present. When a South pole is placed in front of the sensor this value will go to 0 volts.

Fitting the magnets

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

Haltech REM1 rare earth magnets are normally 5mm dia x 2mm depth, although other sizes are available upon special order.

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

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

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

If installed correctly the magnets will have a long life.

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

Typical set-ups – S3

4 cylinder / 2 rotor engine

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

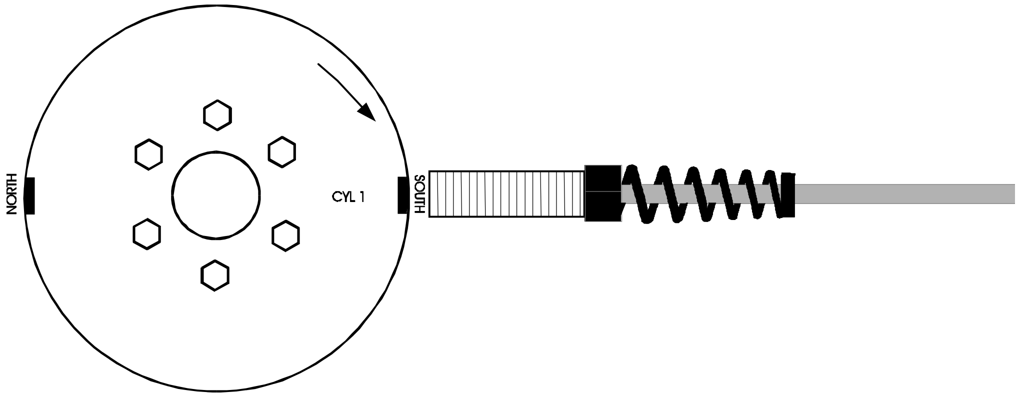


Figure 1: Typical 4 cylinder/ 2 rotor application

6 Cylinder / 3 Rotor Engine

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

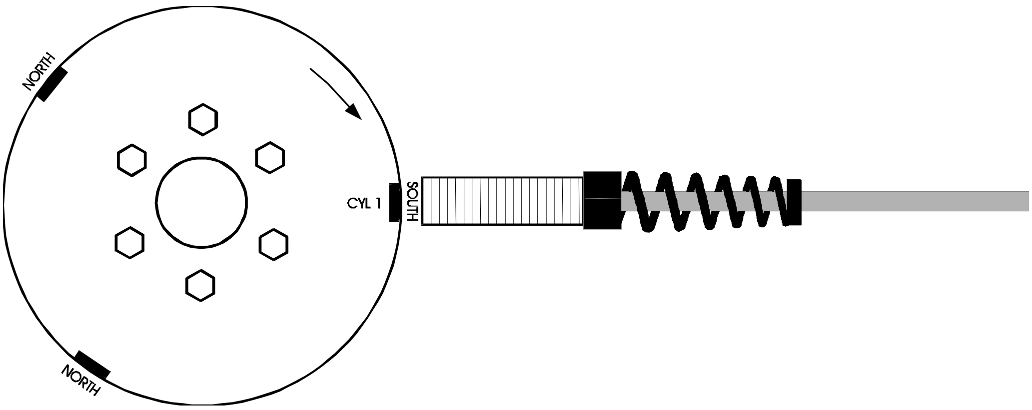


Figure 2: Typical 6 cylinder/ 3 rotor application

8 Cylinder

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

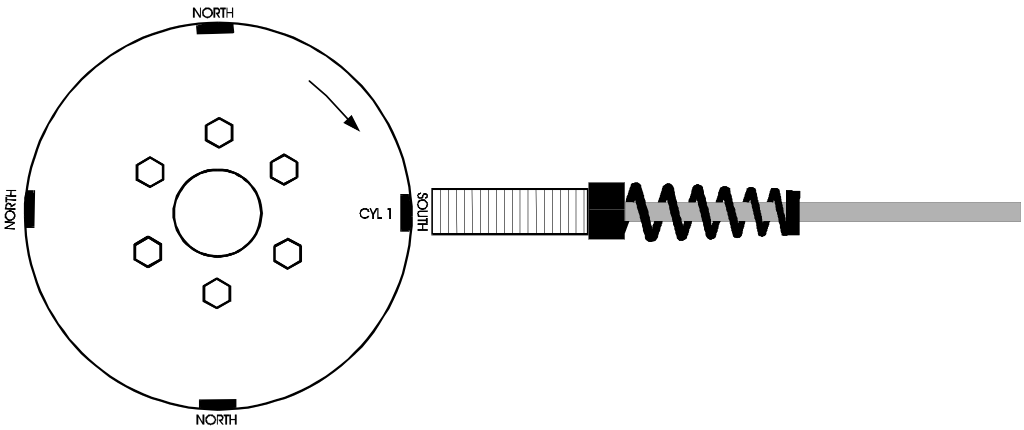


Figure 3: Typical 8 cylinder application

The **ignition set-up** for the **S3** needs to be configured in the following way:

Trigger Edge: Rising
Trigger type: Standard
Home Edge: Falling

The S4 Hall Effect Sensor

The **S4** sensor which is identified by a **grey** cable gland operates in the following way:

As a south pole passes the sensor face the signal in the secondary (PIN D) channel is switched to a low state. As a north pole passes the sensor a low state will only occur on the primary channel (PIN C).

The set-up for this sensor is similar to the S3 except that one extra magnet is required as well as the orientation being changed. The north pole of the magnet is used to generate the main trigger while a south pole is used to generate the home or synchronisation pulse.

Typical set-ups – S4

4 cylinder / 2 rotor engine

For a four cylinder 3 magnets are required in total. Two north poles positioned exactly 180° apart while a south pole needs to trigger the sensor before the trigger for cylinder No 1. The positioning of the magnet for cylinder one is done the same way as the for the S3 making sure the north pole is triggering the sensor at approximately 75° BTDC.

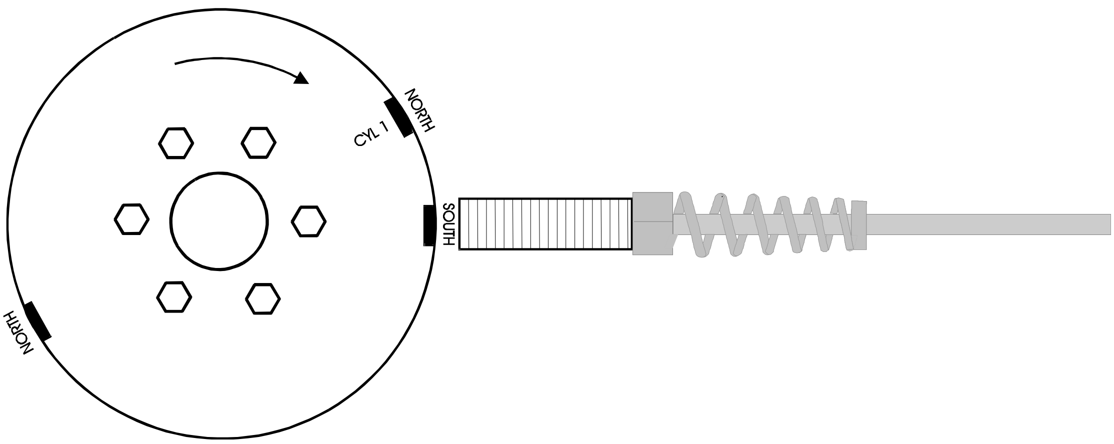


FIGURE 4: TYPICAL 4 CYLINDER/ 2 ROTOR APPLICATION

6 CYLINDER / 3 ROTOR ENGINE

For a six cylinder 4 magnets are required in total. The three north poles are positioned exactly 120° apart while a south pole need to trigger the sensor before the trigger for cylinder No 1.

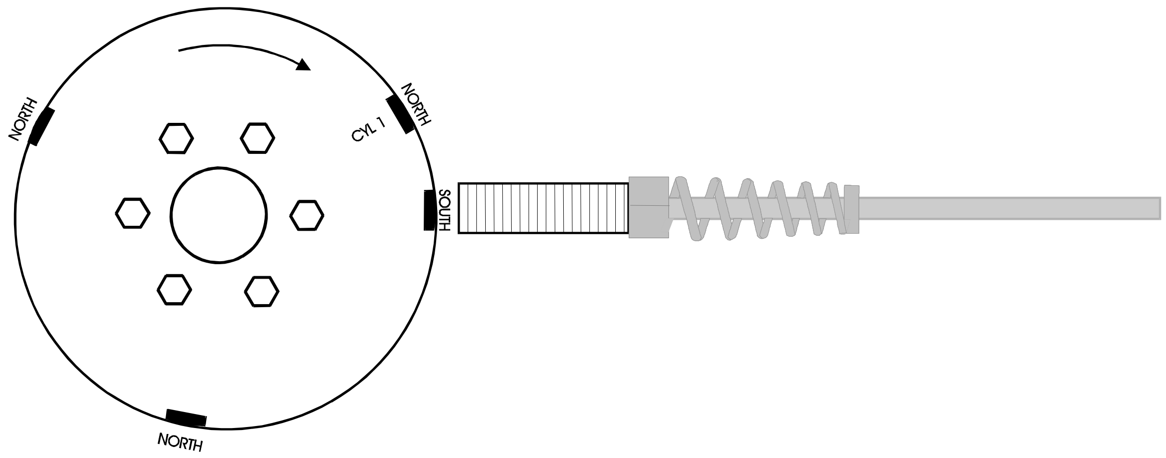


Figure 5: Typical 6 cylinder/ 3 rotor application

8 Cylinder

For an eight cylinder 5 magnets are required in total positioned exactly 90° apart. A south pole needs to trigger the sensor before the trigger for cylinder No 1.

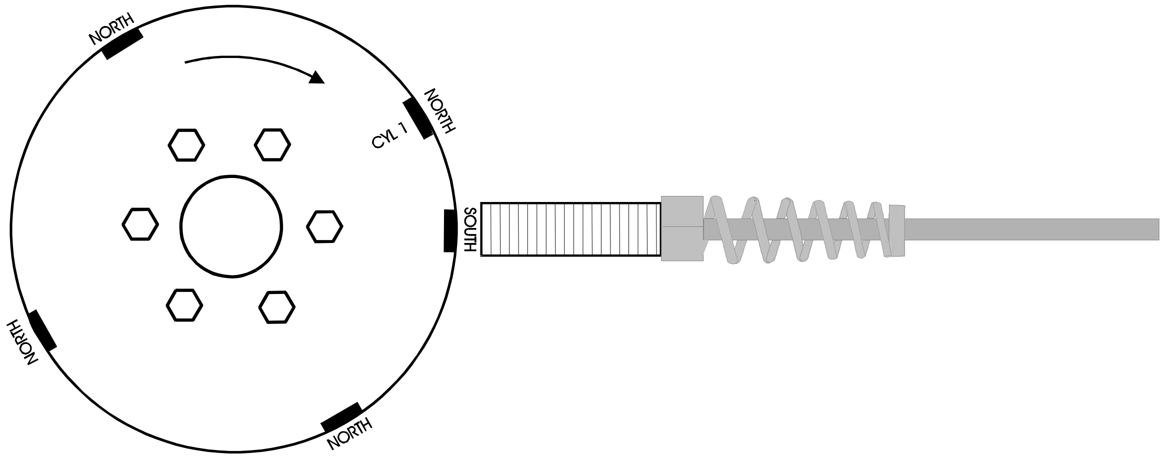


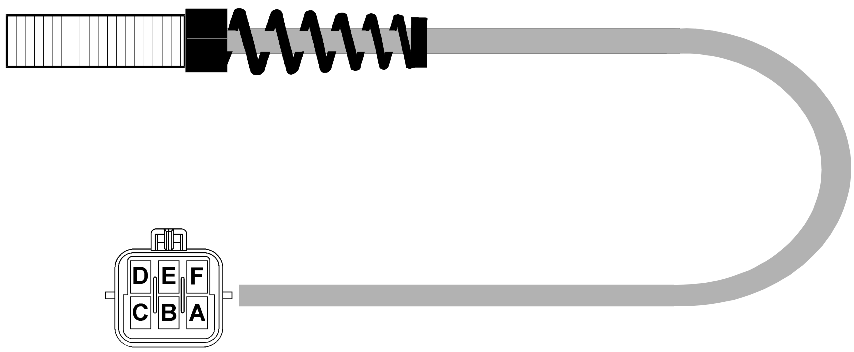
Figure 6: Typical 8 cylinder application

The **ignition set-up** for the **S4** needs to be configured in the following way:

Trigger Edge: Falling
Trigger type: Standard
Home Edge: Falling or Rising

SENSOR PIN OUTS

A	BLUE	GROUND
B	YELLOW	PRIMARY TRIGGER
C	N/C	
D	N/C	
E	GREEN	SECONDARY (HOME) TRIGGER
F	RED	+ 12 VOLTS



E.3 Synchronisation Events

Synchronisation Events (Sync Events) are required for sequential and direct fire systems. The Sync Event gives the ECU in indication of the engines position. The most common form of Sync Event is a Home Trigger. Other Sync Events are the missing teeth on multitooth triggers. A Home Trigger is usually a separate trigger from the main trigger, but some special trigger sensors, such as the Haltech Hall Effect Sensor, can generate both signals from the one sensor.

For a direct fire system the home trigger tells the ECU that the next trigger is for coil one (which is usually connected to cylinder one). The ECU then cycles through its ignition outputs until it expects a Home trigger again. If it receives a Home it will cycle again. If it does not receive a Home before the next trigger, it will not output a spark until the Home is received.

Home triggers for the E6K do not need to be accurately timed. All it does is tell the ECU that the next main trigger is significant. Usually, but not necessarily, the significance is that the next main trigger is for cylinder one. Therefore, the Home trigger must occur before the main trigger for cylinder one and after the main trigger preceding the cylinder one trigger. (See Figure 6). The Home trigger should not occur at the same time as any other trigger. Check that the trigger and Home Edges are set correctly.

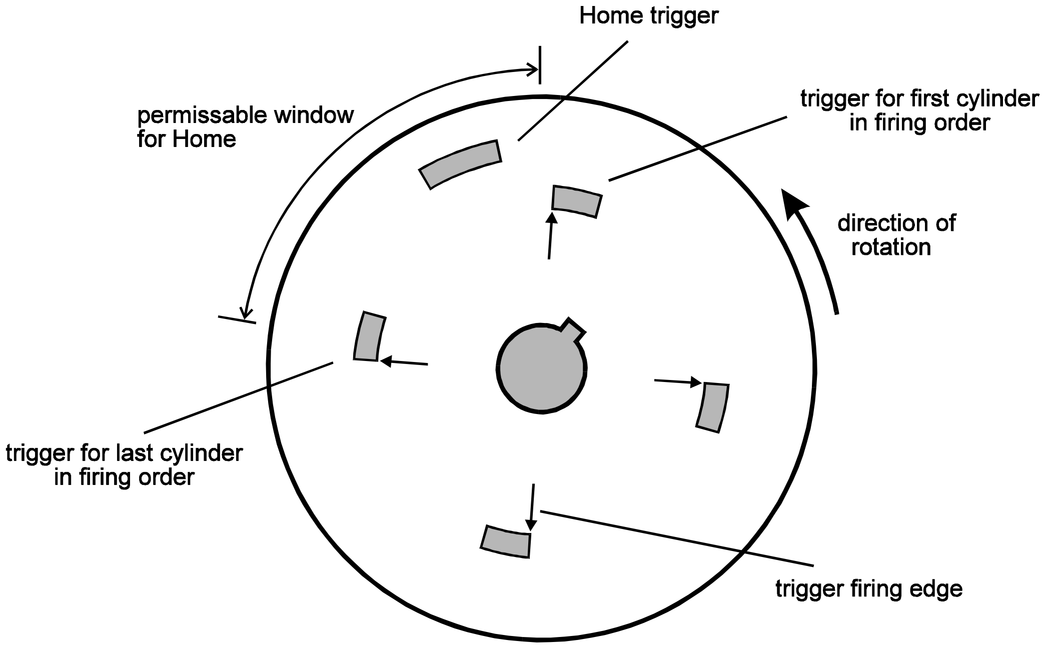


Figure 6. Home Trigger position on a cam angle sensor for 4 cylinder with a home trigger occurring every cam revolution.

E.4 Ignition Output

The E6K ECU has one dedicated ignition output, but the two **Digital Outputs** can also be used for ignition outputs to allow for some Direct Fire applications (See Appendix B). Twin spark engines that fire two spark plugs within one cylinder simultaneously (with two coils, twin distributors and two spark plugs per cylinder) need only one output channel but two igniters (one for each coil) both connected to the same ignition output.

The ignition signals on the E6K are generated by the same type of drivers as the injectors ie. the output pulls to ground when it is switched on. **These output signals cannot be used in any circumstances to drive an ignition coil directly: they must drive some form of igniter.** An igniter is a device which is capable of sinking the large currents required to charge the coil. The Haltech igniter module part number EB023 is available as an optional extra. These "intelligent" igniter modules perform current limiting and dwell control on their own. The back of the igniter can become extremely hot. Refer to Chapter 1 for details on mounting.

The Regitar equivalent part, 1G-H004, has been tested and found NOT to work satisfactorily with the E6K ECU. Please do not use it.

So called "dumb" igniters (i.e. having no dwell control) are also available from Haltech. Standard igniters already installed on engines are often dumb igniters and the E6K can control a wide range of such igniters. Set the "Output Type" to "Constant Charge" in the ignition set-up page for dumb igniters.

Tailoring the Ignition Output Signal

The E6K has the flexibility to tailor the ignition output signals to suit different ignition systems. The parameters that may be adjusted can be found in the Ignition Set-up, area (see sec.4.6.1). The default setting for the ignition output, selected to suit the supplied Bosch igniter, is a 70/30 constant duty cycle signal firing on the falling edge.

The E6K is suited to both intelligent igniter modules that perform their own dwell control (use constant duty output) as well as "dumb" igniter modules that require dwell control (use constant charge output)

The duty cycle of a square wave is the ratio of its high time to its period. E.g. a 70/30 duty cycle signal is high for 70% of its period and low for the remaining 30% regardless of frequency, as shown in figure E7. Constant duty can also be used on aftermarket capacitive-, inductive- or multiple-spark discharge systems such as MSD or Jacobs.

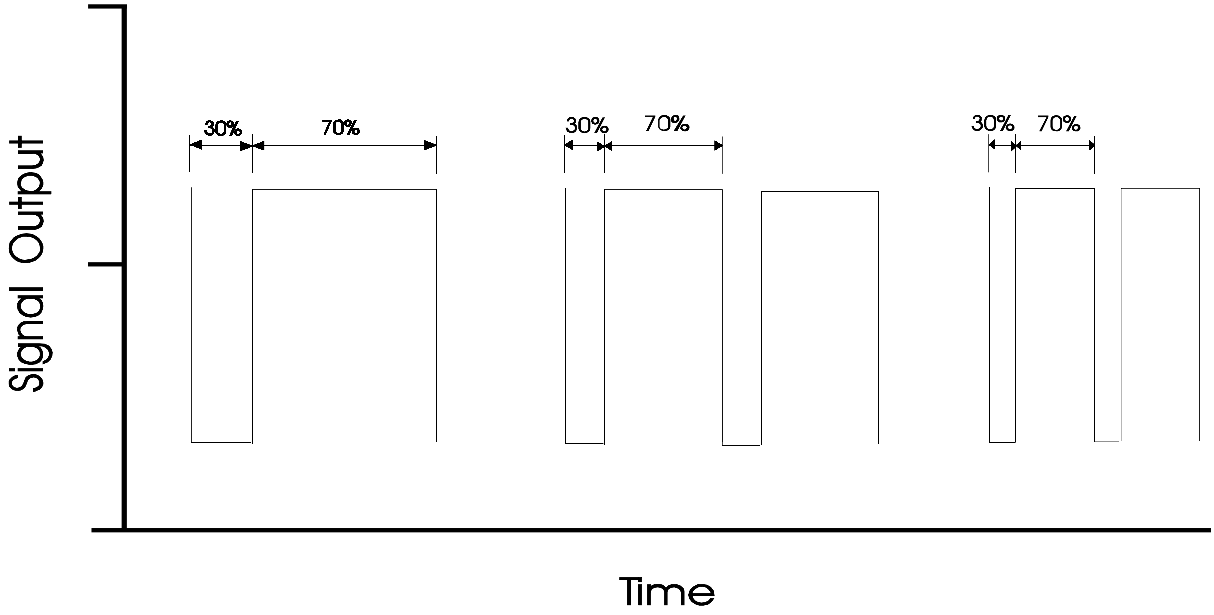


Figure E7. Illustrate constant duty against frequency

A "dumb" igniter is one that does not perform any sort of dwell control, thus input signal directly controls switching of the coil. A constant duty cycle signal is the wrong signal to use with this sort of igniter as it will overheat the coil at low frequencies (ie low revs), and not allow enough charge time at high frequencies (ie high revs) Since the coil charge time remains approximately the same regardless of frequency, it is appropriate for the ECU to constantly charge the coil for exactly that time before firing.

The coil’s charge time can be determined from the coil -ve signal. When the coil switches on, voltage drops to zero. As the coil charges, the voltage rises slightly, until a sharp rise where the igniter current limits. Leaving the coil switched on any longer will not increase the energy in the coil or of the spark. See figure E8.

When the ignition firing frequency is high, there will not be enough time to charge the coil completely. After firing the spark, the E6K will wait for a short period, then switch the coil on again, regaining much of the lost energy in “ringing”. This break time should normally be 1 to 1.5ms.

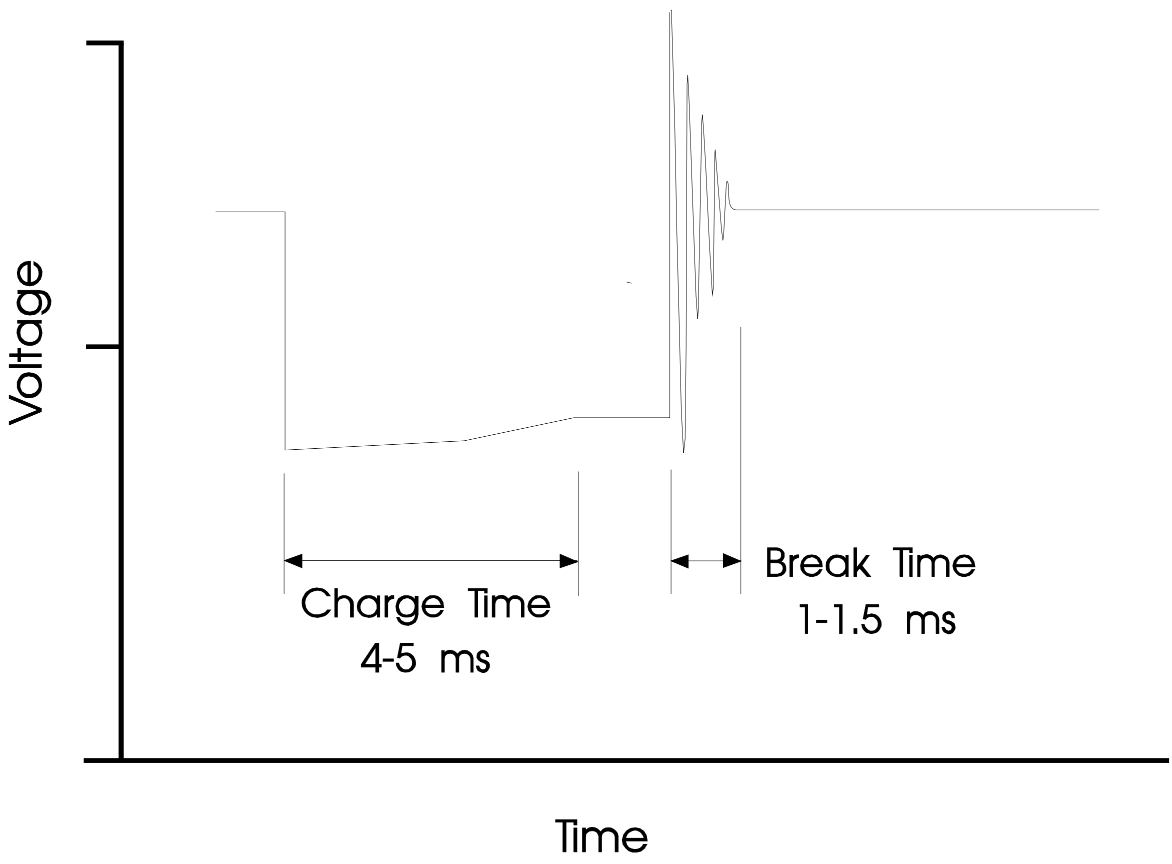


Figure E8. Illustrates Charge Time & Break Time

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

The Haltech EB023 Ignition Module operates on a falling edge. This means that the spark is fired when input trigger signal drops to 0 V. Many, but not all, OEM ignitions operate with the same trigger logic. Most after-market ignition systems fire their spark on the rising trigger edge (same as points). Make sure that you set the ignition output trigger edge correctly. If set to the wrong edge, the timing will be out by significant amount and engine damage may result.

E.5 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 E6K 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 E6K 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 E6K ECU. This module serves both as a trigger device and as an igniter. For a wiring diagram, see Appendix G. 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 E6K 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 E6K ECU can connect directly to this module, however, the TFI module requires a trigger signal, call the SPOUT (see below), that has a 50/50 duty cycle, which is not the standard 70/30 duty cycle of the E6K. 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 E6K 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.

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 E6K. 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° crank degrees. This is where the rotor button has to be when the chopper wheel triggers the sensor. Let's assume that the trigger point of the sensor is exactly in its centre. Move the plate the sensor is mounted on so that one of the vanes of the chopper wheel is leaving the sensor. Adjust the position of the plate so that when the shaft rotates in its normal direction, the centre of the sensor will become exposed. If it is not possible to move the sensor, it will be necessary to rotate the trigger wheel relative to the shaft and the sensor.

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

LIMITED WARRANTY

Rockin 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. Rockin 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 Rockin 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 Rockin Pty Ltd trading as Haltech be liable for special or consequential damages.

WIRING DIAGRAMS