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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 several years, 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 carburettored 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 E6A system utilises a special-purpose programmable microcomputer designed for engine management. The E6A 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 fixed trigger from either a distributor, crank angle sensor, or cam angle sensor. If you 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.

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.

Avoid open sparks, flames, or operation of electrical devices near flammable substances.

Always disconnect the Battery cables when doing electrical work on your vehicle.

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.

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
- 1/4" GAS 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 E6A 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 E6A 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 E6A

The E6A is designed to be easily programmed, but also be capable of being used on a wide variety of applications. A typical E6A 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 E6A 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’ setup.

Of course there are some exceptions to this basic setup. 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 setups. For the purposes of the E6A, we call these ‘Advanced’ setups.

The E6A 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 E6A. If your engine does not meet any of the criteria, programme 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** [4.1]. 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 programme 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
Multitooth 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. **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 E6A 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 (30 psi)
- 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 not be used together.

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:	168 mm (6 5/8")
Width:	145 mm (5 5/8")
Depth:	41 mm (1 5/8")

- **Weight**

ECU:	760g (1.68 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**

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)

- **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

• **Engine Speed Pickup**

Compatible with most trigger systems:

- 5 or 12 volt square wave;
- pull-to-ground (open collector)

Tach adaptor available for magnetic (or ‘reluctor’) triggers

ECU Outputs

• Injector Driver

4 x 4/1Amp peak-and-hold current limiting drivers:

- up to four low-impedance injectors*
- up to eight high-impedance injectors*

(Expandable using optional Driver Box. See Appendix C)

• Ignition Output

Haltech Ignition Module, trigger by ECU, for directly firing the coil.
(may also be compatible with other igniters. Ask your Haltech dealer.)

• 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**

<u>Miscellaneous</u>

• **Map Storage and Retrieval**
Maps may be stored to disk and re-used

• **Datalogging**
Engine data information saved 5 times per second
Store to memory or disk
Limited only by available memory (approx. 11k/minute)

• **US or Metric Units**

• **Real Time Programming**
Instant, hesitation free adjustment while engine is running

• **Optional Mixture Trim Module**
Provides ±12½% or ±50% adjustment for fast tuning

• **Optional Ignition Trim Module**
Provides -8° to +7° adjustment for fast tuning

• **Rugged Aluminium Casing**
Black anodised with integral cooling fins and mounting brackets.

SECTION ONE
Getting Started

CHAPTER 1
Haltech E6A Installation

1.1 Overview

The Haltech E6A 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)
- Ignition Module
- Main Wiring Harness
- Haltech E6A system Instruction Manual
- Programming Cable
- Programming Disk
- Relays

Optional Items

- Fuel Mixture / Ignition Timing Trim Control
- Exhaust Gas Oxygen Sensor
- Idle Speed Control Motor
- Reluctor Adapter - for magnetic triggers
- Driver Box

Other components not supplied as part of the E6A 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

1.2 Installation Summary

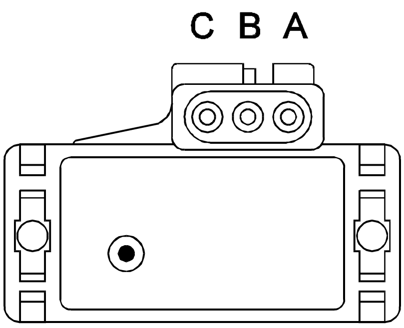
1. Mount Manifold Absolute Pressure Sensor.
2. Mount Coolant Temperature Sensor.
3. Mount Inlet Air Temperature Sensor.
4. Mount Throttle Position Sensor.
5. Mount Ignition Module
6. Mount optional Exhaust Gas Oxygen Sensor (if used)
7. Route Main Wiring Harness and connect sensors and ignition module.
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 E6A ECU to use. The sensor works in absolute pressures, thus its calibration is not affected by changes in barometric pressure.

There are three types of MAP sensors that can be used with E6A system. Which sensor is required depends on the engine setup.

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 is stamped on the sensor housing.

Engines running in Throttle Position Mode must use a 1 Bar sensor, not connected to the manifold, so as to measure the barometric pressure.

Installations using a Barometric Pressure sensor will have two MAP sensors to connect. One sensor will be for the Manifold pressure, the other will be for Barometric pressure. The Barometric sensor must be a 1 Bar sensor. It connects to the *Spare Input* plug near the Main Connector. This sensor can be mounted with the ECU and must be left open to the atmosphere.

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.

Note: Throttle position mode installations.
If you are using the throttle position to determine engine load, a 1 Bar MAP sensor ***must*** *be used, disconnected from the manifold and open to the surrounding air. The E6A will use the sensor signal to compensate for barometric pressure.*

1.3.2. Coolant Temperature Sensor

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

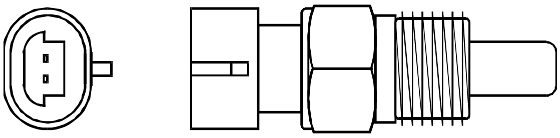
The coolant temperature sensor has a solid brass temperature sensing tip. Refer to the diagram for technical details of the sensor. The coolant sensor supplied is an industry standard component and some engines may already have provision for this type of sensor.

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.

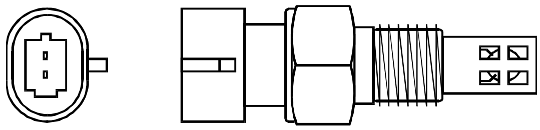
⅜" N.P.T. 18 Threads/Inch



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

1.3.3. Inlet Air Temperature Sensor

¼" G.A.S. 18 Threads/Inch



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

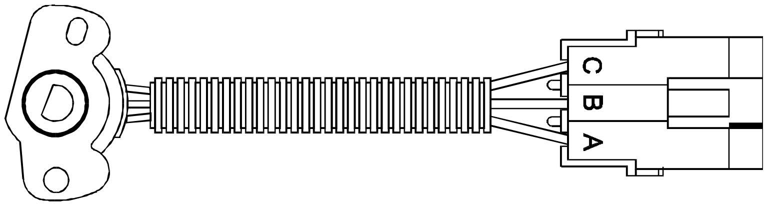
The air temperature sensor is used to compensate for changes in air density due to air temperature. Cold air is denser than warm air and therefore requires a greater volume of fuel to maintain the same air/fuel ratio. This effect is most noticeable in forced induction engines. The Haltech E6A will automatically compensate using the signal received from the air temperature sensor.

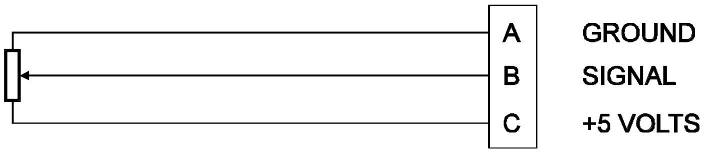
The sensor should be mounted to provide the best representation of the actual temperature of the air entering the combustion chamber, i.e. after any turbo or supercharger, and intercooler, and as close to the head as possible. The sensor needs to be in the moving air stream to give fast response times 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. **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.** The absolute range of sensor movement is not important as the sensor can be calibrated using the programming software.

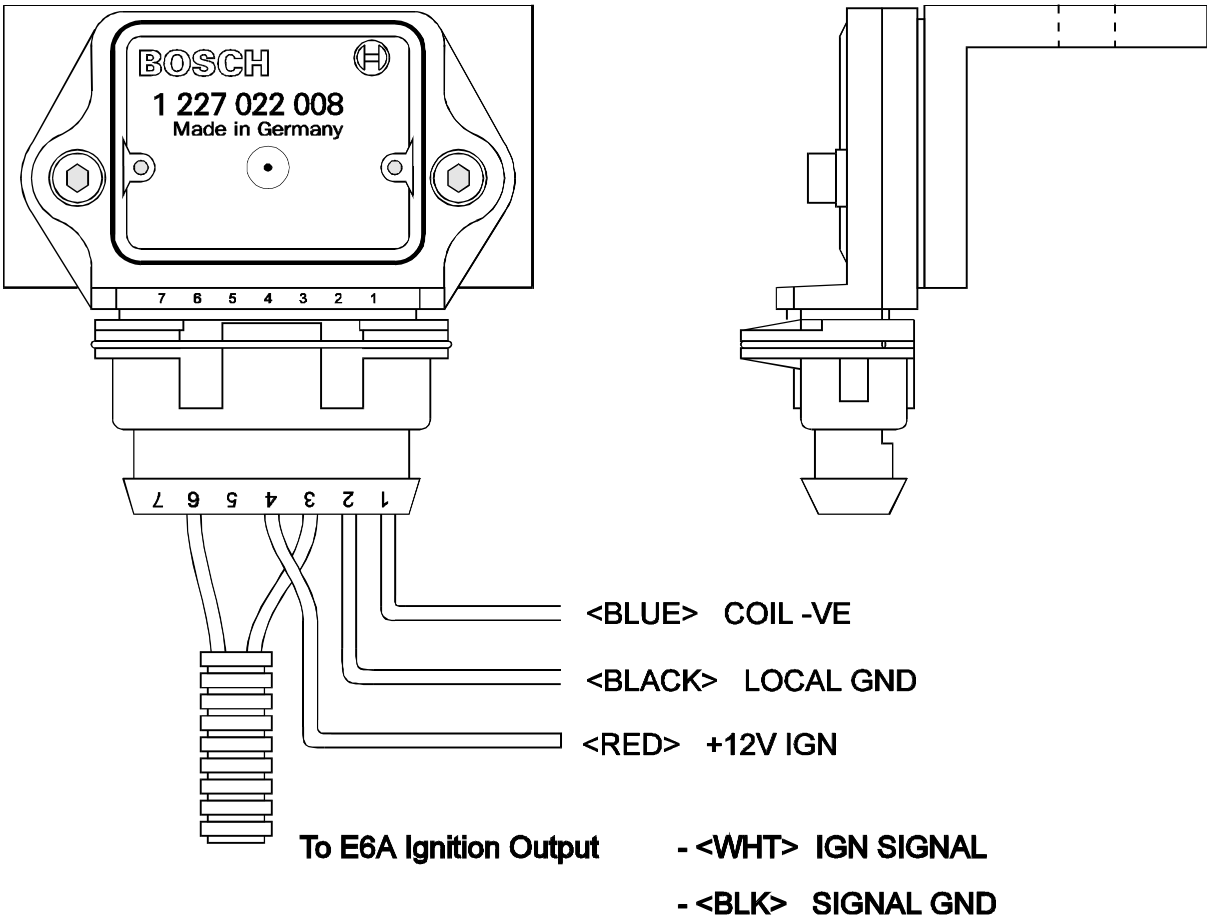
1.3.5. Mount Ignition Module.

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 preventing the module overheating by mounting it away from hot components such as exhaust manifolds and turbochargers.

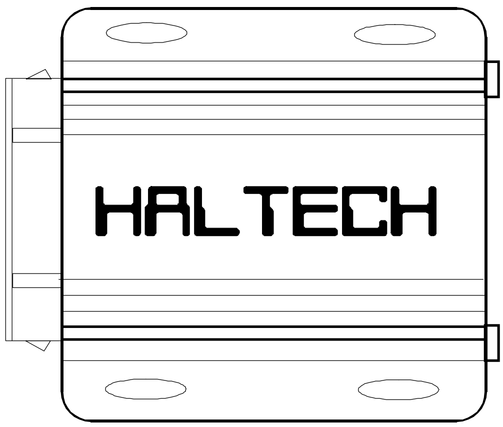
Included with the Haltech wiring harness is the Ignition Sub-loom. This connects the Ignition module to the Main Harness. Locate this loom and connect it to the ignition module.

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.

NOTE: IF USING THE HALTECH IGNITION MODULE CONSTANT DUTY CYCLE SHOULD BE SELECTED IN THE IGNITION SETUP PAGE.



Bosch Ignition Module. The module must be mounted on the bracket, and the bracket must be mounted to a suitable surface.



Haltech Ignition Module (part number HIM1) supplied with all E6A kits.

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.

IMPORTANT

- **Do not allow the harness to touch hot exhaust parts including manifolds or turbochargers.**

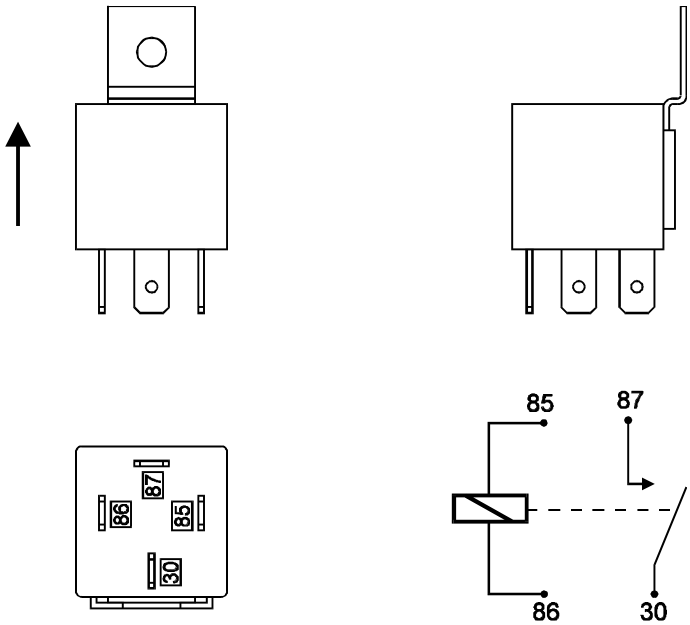
- **Try to route the main harness away from high voltage ignition leads. Under no circumstances run any wiring parallel to, or in contact with the ignition leads.**

Hint: 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

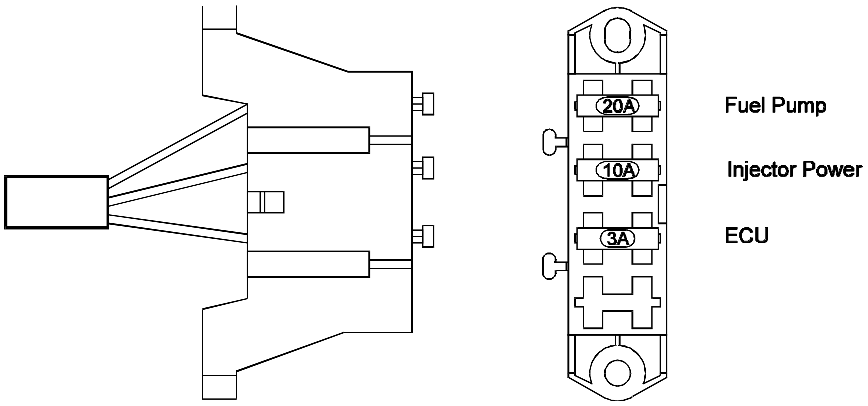
There are two relays used with the Haltech E6A, the Main Power Relay (with a grey wire) and the Fuel Pump Relay (two orange wires). These relays are identical parts so it is not important which relay goes in what connector.



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 E6A 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 E6A 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 E6A 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

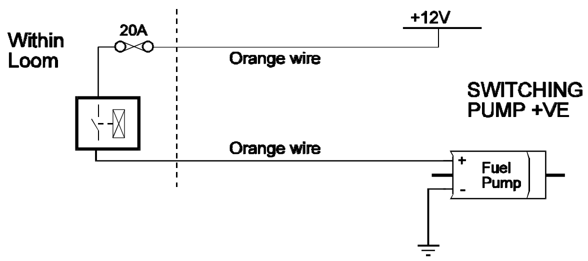
Locate and connect the following flying leads.

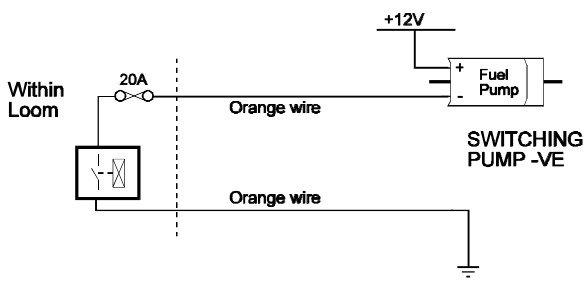
Black - (Ground) Locate a good chassis ground point and connect the black wire. The best spot is direct to the battery negative terminal.

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

Grey - (Switched 12V) The grey wire is used to control the operation of the Haltech E6A power relay. It needs to be connected so that it sees 12V only when the ignition is on and during cranking. This wire does not draw a large amount of current (< 0.5A). Do not connect to the accessory outputs of the ignition switch.

Orange - The two orange wires are used to operate the fuel pump. When the Haltech E6A 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.





1.3.12. Install and connect Optional Idle Speed Motor

If you are not using the Idle Speed Control, tie the motor connector back neatly in the engine bay. If the engine has a suitable Idle Speed Motor, connect it now. If you have to install the motor, install and connect it now. 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 Chapter 16, **Auxiliary Outputs**.

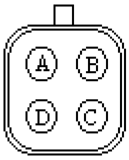
1.3.14 Connect the Trigger Sensor

If the engine has a magnetic trigger input, you will need to connect the Reluctor Adapter now. For details on how to connect the Reluctor Adapter to the main loom and to the trigger, refer to Appendix G, **Wiring Diagrams**, and to Appendix E [E.2].

Hall Effect and Optical triggers need three connections - ground, power and the signal. The trigger connector on the Main Harness has four 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). The secondary input can also be used as the Road Speed input if it is not being used as a home trigger.

4 WAY PACKARD
SHROUD PN. 1201 5798

A	BLACK	GROUND
B	RED	+12 VOLTS
C	WHITE	PRIMARY TRIGGER
D	GREEN	SECONDARY (HOME) TRIGGER



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 E6A 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 E6A.

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.

CHAPTER 2
Getting Online

Now that your Haltech E6A 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 E6A ECU you will need the programming cable and programming disk supplied.

2.1 Connecting the Haltech E6A to a Computer

The programming cable supplied with the Haltech E6A 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 E6A 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.

2.2 Operating the Software

2.2.1 Computer Requirements

The computer required to program the Haltech E6A 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 programmes), 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 E6A has an installation programme 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 E6A Programme can ran directly from the disk supplied. Installing the software on the Hard Disk will speed up the programme and avoid having to fiddle around with floppy disks. The installation programme 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 programme 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 programme, 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 Programme

To run the Install program type :

i n s t a l l ¬

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

The E6A Programme 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 programme type :

e6a¬

The E6A programme 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 E6A program type :

e6a¬

The E6A 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 :

qwerty

This is called a Qwerty keyboard. Some countries use an alternative, which is called and 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 a ¬

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

e 6 a / a ¬

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

2.2.6 Acknowledging the Risks

Once the program begins running a title page should appear briefly and then a warning screen will be displayed. Read the warning and only proceed if you are prepared to accept the risks involved in tuning your own engine. Faulty tuning can be dangerous and/or can damage your engine.

2.3 The Online and Offline Modes

On the E6A 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 should not be used to make lasting adjustments to the fuel maps 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 E6A 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 § q in any page will prompt you to exit the program (i.e.. pressing q while holding down the § key).If you wish to exit Y press 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 § e from any application. Otherwise it can be accessed through the menu bar by pressing ¦ O and then E for Engine Data.

Do not attempt 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.

CHAPTER 3
Engine Identification

3.1 Checking the Identification

The Identification page tells the E6A 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 (© 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 programme 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 **7 0 0 0 ¬** .

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 E6A 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 E6A 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 [illegible] Ensure [illegible] Bar sensor.

RPM Limit: The E6A can limit the maximum rpm to which the engine will operate to. Above this level the E6A completely cuts fuel or ignition (see below) to the engine. When the engine speed drops below the RPM Limit the E6A 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 E6A programming software can display parameters in either Metric or US units.

RPM Mode: The E6A 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 can not use the Road Speed input trigger, and this field will not be displayed.

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.
Ign 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.
Exhaust MAP Sensor	Exhaust Pressure.(does not affect on ECU operation)

Care must be taken when setting this field. The circuit is biased to 2.5 volts. Therefore, if there is nothing connected to the plug, the input will read 2.5 volts. If one of the trims is selected, there will be no effect. But if the Barometric Sensor is selected, the reading will be incorrect, and will have a large effect on the operation of the ECU.

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/Out Function: The Auxiliary Input/Output on the E6A 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.
Ignition Bypass	**Output** - 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	**Output** - 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).
Nos Input	**Input** - This input is used in conjunction with the Nos Optional Output. [16.13]
TCC Input	**Input** - This input is used in conjunction with the TCC Optional Output. [16.4]
Turbo Timer	**Input** - This input is used in conjunction with the Turbo Timer Optional Output. [16.12]
Anti-Lag Switch	**Input** - This input is used in conjunction with the Anti-Lag Optional Output. [16.14]

Since the Auxiliary Input/Output line can only perform one duty, all of the above functions are mutually exclusive. i.e. although two programmable outputs exist on the E6A, only one of the Nos, TCC and Turbo Timer may be chosen. None may be used if the line is needed for Ignition Bypass. Keep this function in mind when deciding on the E6A configuration you wish to run.

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**.

Chapter 4
Adjusting Haltech Maps

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 E6A in a table of numbers called a look-up table. The E6A 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 programme the E6A by directly changing the value of each number by programming in the numerical mode, 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 E6A, 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 programme presents you with a menus bar at the top of the display. The menu bar is accessed through simple combinations of key strokes. Once the appropriate menu has been accessed a sub-menu appears giving choices on available page heading. To increase efficiency there is also a number of hot-keys that allow you movement between pages without accessing the menu bar.

4.4 Accessing the fuel maps

Pressing ¦ 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 highlight bar or pressing the underlined letter of the option required in the case F. This will produce a further sub-menu that will allow you to choose a range to be viewed.

4.4.1 Fuel Setup

The Fuel Setup 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 Setup by pressing ¦ s and then by pressing F key. The fields in the Fuel Setup 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 E6A. It is better, when first tuning, to disable this function.

Injection Mode: The E6A splits its four injector driver outputs into two banks. 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 setup 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 setups 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 setup. 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 E6A 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 setup. It requires more outputs for fuel then normally used. Before selecting this option carefully read the section on sequential injection in **Appendix B - The Advanced Features.**

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 can allow a very quick and simple adjustment of the idle fuel settings on engines with difficult idle characteristics. This option can be disabled if not required.

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.

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

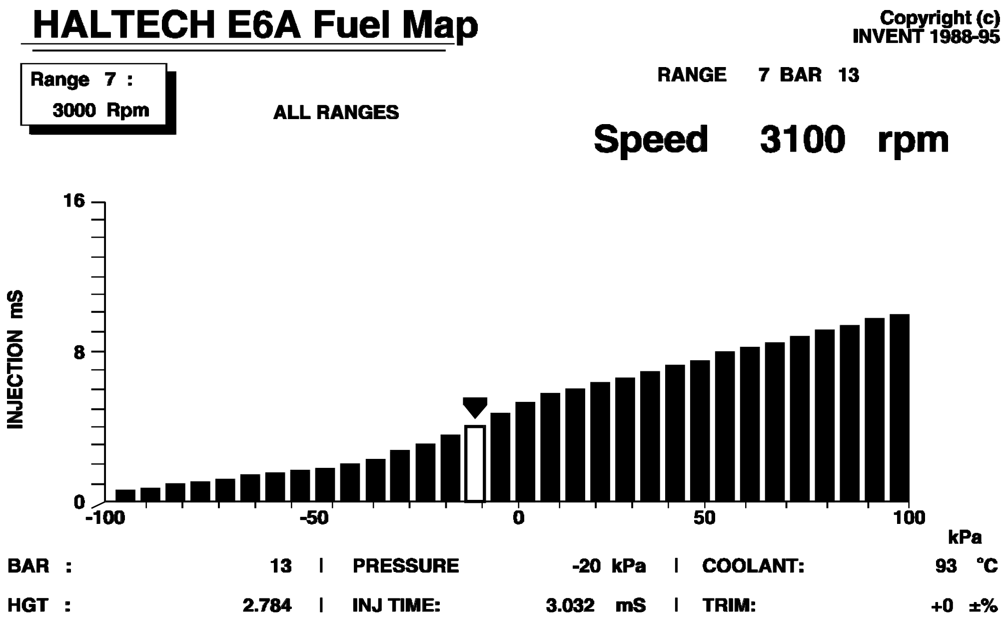
Barometric Lock: If you wish to lock the barometric value that is stored by the ECU to a set value and overide the start-up barometric correction, enable this option.

Barometric Pressure Lock at (mBars): Allows you to set the barometric value to which the ECU corrections will be locked. Default is 1013mBars (= 1 Atmosphere @ sea level)

See Chapter 3, **Engine Identification** for information on how to adjust these parameters.

Once you have set up the fuel delivery via the Fuel Setup, you can view the Fuel Maps. Press ¦ m then F to view the Fuel Sub-Menu. Then chose 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 “ . When in the Fuel Maps sub-menu your display should look like 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. Opposite, in large numerals, is the current engine rpm. 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 is written the number and height of the bar being adjusted, and other engine data. Above the engine speed reading is the Range and Bar number that the ECU is currently using to calculate injection time.

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 (³ ´). 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 ³ 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 in the bottom corner 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, § ³ ,to move the bar up by 2mS. Move the Bar back down by using § ´ .

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 § f .Or through the menus at the top of the display. Pressing § 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 ¦ 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 § I from any other application.

4.6.1 Ignition Setup

The Ignition Setup 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 Setup by pressing ¦ s then I . The fields in the Ignition Setup for Basic Mode are:

Trigger Degrees : This field tells the ECU where to expect the Main Trigger to occur. This field is very important for the correct operation of the ignition. If it is incorrect, the spark advance will also be incorrect, which could lead to engine damage. The ECU needs to receive an input trigger at a fixed engine angle Before Top Dead Center (BTDC) for each spark. This trigger may be set between 60° and 100° BTDC. See Chapter 5 [5.2-3] for detail on how to check the timing and this field.

Lock Timing at 10 Degrees: This field is used for testing the trigger input. It allows the timing to be locked at ten degrees regardless of the engine speed and ignores the ignition map settings. This feature is further discussed in **Appendix E**

Trigger Edge : This field determines whether the E6A is to trigger on a rising or a falling edge. Refer to **Appendix E - Trigger Interface** for details on how to determine this setting. If a Reluctor Adapter is being used, this field should be set to Falling.

Output Type: This field is used to determine how the ignition output signal is to be defined. ***Constant Duty*** **should only be used with the <u>Haltech Ignition Module</u>** or other "intelligent" igniters and special aftermarket systems that perform dwell control. *Constant Charge* may be selected if the igniter operates simply as a switch (ie a "dumb" igniter) and requires a dwell signal.

Coil Charge Time: Only required if Constant Charge selected as Output Type. This is the time require to charge the coil fully, or until the igniter's current limit is reached, typically 4-5 ms. Refer to Appendix E for additional information.

Coil Break Time: Only required if Constant Charge selected as Output Type. This is the minimum time the E6A should allow before the coil is switched on again, usually 1-2 ms. Coil Break Time defines the ignition output signal when there is insufficient time to charge the coil fully. refer to Appendix E for additional information.

Output Edge: The Output Edge should be falling with a 30% switch when using a Haltech igniter as supplied with the E6A kit (This is the default setting). If you are using any other igniter, refer to Appendix E [E.4] for details on how to set this field for the igniter used.

In Advanced Mode, several other fields are available. Some of them are fairly complex and should not be changed unless you are totally familiar with their operation. Consult **Appendix B - The Advanced Features**, to familiarise yourself with their functions. The Advanced Mode fields are :

Trigger Type : There are three settings for this field :

The ***Standard*** trigger sends one trigger to the ECU for each spark event. On a V8, for instance, there are 4 firing strokes for each revolution and, therefore, the E6A would be expecting 4 triggers each revolution. These triggers should occur between 60 - 100° BTDC (as described under Trigger Degrees above) and can be generated by either a crank angle sensor or cam angle sensor in a distributor.

A ***Multitooth*** trigger has multiple triggers for each ignition event. The number of teeth must be a multiple of the number of cylinders. For instance, on a V8 for each engine cycle (2 revolutions) you would expect there to be 8, 16, 24, 32 etc. The ECU needs to know if this is the type of trigger being used or else too many sparks and fuel pulses will be delivered. A multitooth trigger also requires a Synchronisation Event (usually a Home Trigger) to give the ECU a reference to its position. For more information on Synchronisation Events consult Appendix E [E.3]. For multitooth triggers, consult **Appendix B - The Advanced Features**.

A variation on the multitooth trigger is the ***Motronic*** trigger. This setting is designed to be compatible with the trigger wheel used for Bosch Motronic controlled engines.

These wheels have 58 teeth with a two tooth gap (i.e. 60 teeth positions, with 2 missing). The missing teeth perform the task of the synchronisation event, eliminating the need for a Home Trigger. Consult **Appendix B - The Advanced Features** [B.4] for more information.

Number of Teeth : This field is only available for the Multitooth and Motronic trigger settings. It is the number of 'effective' teeth per cam revolution (2 crank revolutions). 'Effective' teeth means to include missing teeth. In the case of the Motronic trigger, the 2 missing teeth are counted, giving 120 teeth per cam revolution.

Tooth Offset : This is the number of teeth from the synchronisation event to the trigger angle. (For a more involved definition, consult **Appendix B - The Advanced Features** [B.4]).

Home Edge : Similar to the Trigger Edge field, this field determines the edge for the Home signal. If a Reluctor Adapter is being used, this field should be set to Falling.

Spark Mode : The E6A can have multiple ignition outputs. This field indicates if more than one ignition output is required. See **Appendix B - The Advanced Features** [B.4] for more information. The available settings are :
Distributor - This is for a single distributor, single coil ignition system. A slight variation is the twin spark per cylinder engines, which use two coils and either one or two distributors, but fire the sparks together.

Twin Distributor - Some V8 and V12 engines use two distributors, one on each bank. Each distributor has its own coil, and they fire alternately.

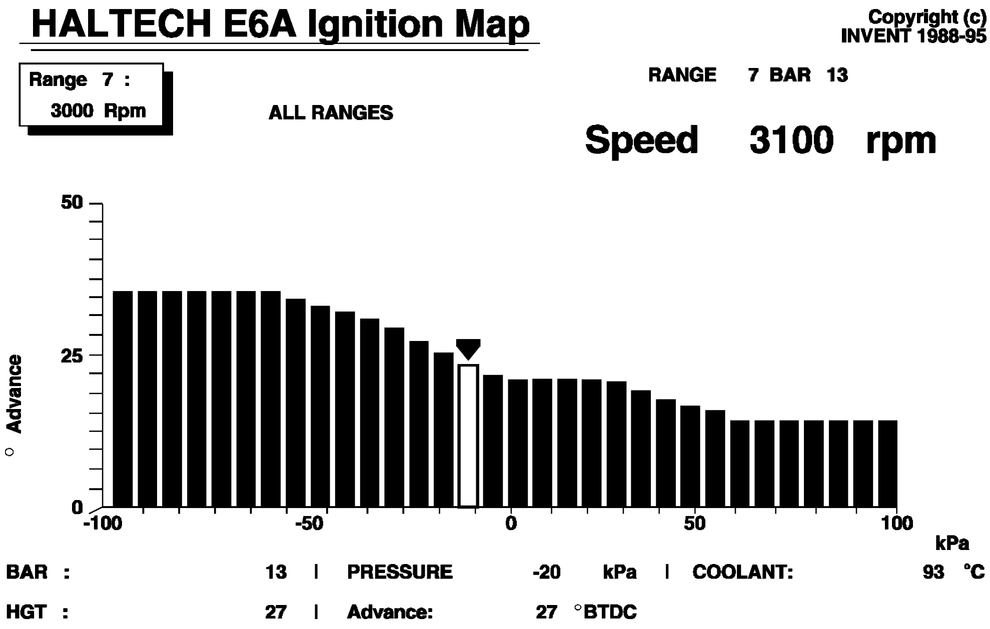
Direct Fire -Direct Fire systems do not use a spark distributor. Each spark plug is fired from its own coil, or (more often than not) companion cylinders are fired together using twin tower coils Consult **Appendix B - The Advanced Features** for details on the requirements for Direct Fire.

Coils on 4Cyl Motor : It is possible to Direct Fire a 4 cylinder engine with either two coils firing waste spark or 4 coils without waste spark.. This field tells the ECU to use either 2 ignition outputs or 4. (Consult **Appendix B - The Advanced Features** for details)

Engine Type : Two engine types are selectable through this field - ***Piston*** and ***Rotary***. This field should be set according the to engine type you are using. Rotary must be selected for the E6A to generate trailing spark ignition signals.

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 :


HALTECH E6A Ignition Map
Copyright (c)
INVENT 1988-95
Range 7 :
3000 Rpm
ALL RANGES
RANGE 7 BAR 13
Speed 3100 rpm
50
25
0
° Advance
-100
-50
0
50
100
kPa
BAR : 13 | PRESSURE -20 kPa | COOLANT: 93 °C
HGT : 27 | Advance: 27 °BTDC

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 ¦ r, this means that the second key must be pressed while the first key is held down. In this case, the ¦ key would be held down while the r key is pressed.

4.7.1 Current Location - ²

Pressing ² 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 - ¦ 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 E6A system allows you to programme all rpm ranges simultaneously with the same data. ¦ 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 ¦ 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 § 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 ¦ and arrow keys together.

4.7.4 Percentage Changes - ¦ 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 - ¦ 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 ¦ 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 - ¦ n

This will take you into numerical mode, displaying the map as a spreadsheet. This mode is available if wanted, but graphical mapping is recommended as it is much easier to use. To exit from Numeric Mode and go back to using the maps press the ° key.

4.7.7 Bar Increments - ¦ 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. ¦ 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. ¦ p on the Bar Increment Screen will switch to percentage increments, § f will return you to fixed increments.

¦ l will space out increments evenly between the Up/Down Arrows field and the Ctrl PgUp/PgDn field.

4.7.8 Help Function - ¦ h

A simple help screen can be pulled up at any time by pressing ¦ h. All key commands are summarised and listed here.

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.

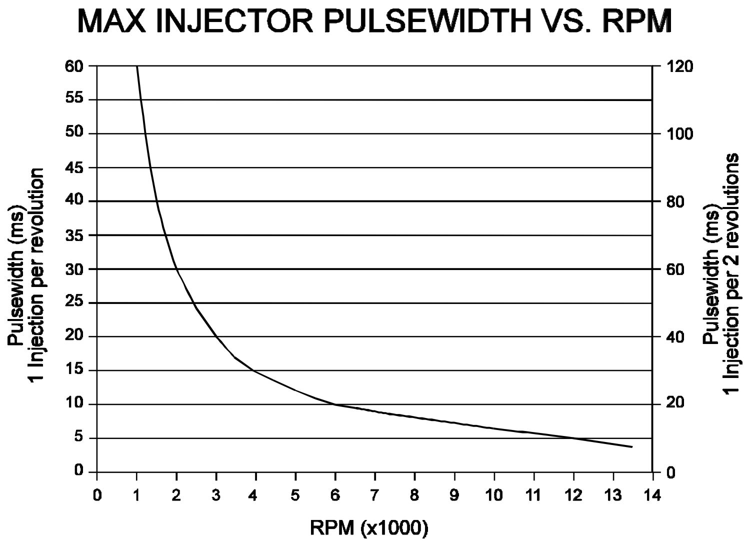
When 100% duty cycle is reached the fuel flow from the injectors has reached its maximum. Increasing revs brings with it the danger of an engine lean out. LEANING OUT AN ENGINE WILL CAUSE DAMAGE TO THE ENGINE IN MOST CASES.

The tables and graph below show the point at which the injectors will reach 100% duty cycle. **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.** 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]) =

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

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.



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)
³ , ´	- increase/decrease highlighted bar(s)
¨ ³ , ¨ ´	- increase/decrease highlighted bar(s)
§ ³ , § ´	- increase/decrease highlighted bar(s)
§ ¤ , § ¥	- select (highlight) next bar
¦ ¤ , ¦ ¥	- de-select end bar
¦ P	- enter Percentage change to highlighted bars
¦ L	- Linearise between end points of highlighted bars
¦ H	- bring up Help screen
¦ I	- set Increments
¦ N	- enter Numeric mode
¦ R	- toggle All Ranges mode
N	- move to Next range
P	- move to Previous range
J	- jump to range of value entered
²	- go to current engine range/bar
©	- switches option in setup 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 Setup and the Ignition Setup 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 E6A is receiving a reliable trigger signal. Remove the 20A fuse from the fuse block. This will prevent the fuel pump from running and 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 setup. If the trigger is operating correctly then replace the 20A fuel pump fuse.

5.3 Checking the Base Timing

The E6A uses a timing reference taken from either the cam angle sensor or flywheel sensor. This give the E6A the reference on which to position all ignition timing. If the timing is wrong then the E6A cannot function correctly. To ensure that this base timing is set correctly the E6A has a **TIMING CHECK FLAG**

When the Timing Check Flag is set, the ignition timing is forced to 10° Before Top Dead Center (BTDC). This is regardless of whatever ignition timing Maps are currently in the E6A.

To enable this flag, press ¦ S from the Sub-Menu select the Ignition Setup. Using the arrow keys move to the Timing Lock option. If it reads **Timing Check On**, the flag is enabled. If it reads **Timing Check Off**, then the flag is disabled. The flag is toggled by pressing © . If the Timing Check is on, the ECU will lock the timing to where it believes 10° advance to be.

To check the base timing you should now start the engine with the Timing Check on. The engine should now start and run although with only 10° of ignition advance the idle speed may be lower than usual.

If the engine does not start it may be because the fuel requirements are not right. If this is the case, it is suggested that you remove the 20Amp fuse for the fuel pump 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 Check 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 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 10° 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 Setup. 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 10° 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 distributorless direct fire engine), then if it is possible, rotate the sensor while using the timing light until the engine is at 10° 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 Setup. (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 Check is on, the ECU will delay 60° and then fire the spark at 10° 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 10° 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.

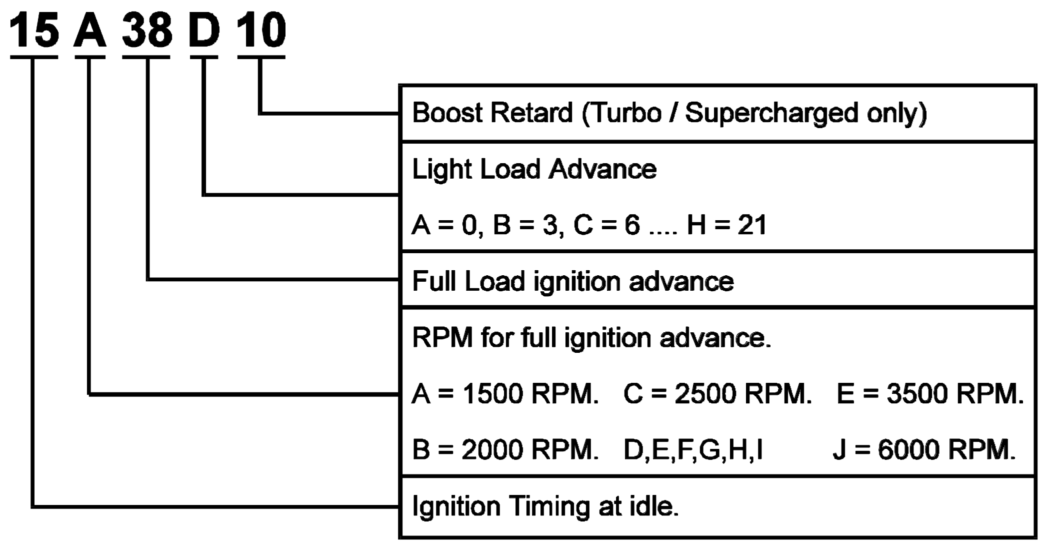
You must now ensure that the timing does not move as the engine speed changes. Give the engine a few quick revs while using the timing light to check that the ignition timing stays at 10° BTDC. If the base timing is locked at 10° BTDC and does not change with engine speed then you are ready to load an Ignition Timing Map and clear the Timing Check Flag.

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

5.4 Loading an Ignition Library Map

The E6A 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.

E6A IGNITION LIBRARY MAPS.



Enter the map name you wish to load :

- 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 specifies the maximum advance at atmospheric pressure. 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 10° 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.

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 Setup. 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 2 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 E6A 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 E6A is using to calculate the fuel. The bars that the arrow indicates are the Bars that will need to be adjusted to get the engine to run.

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 E6A 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 Setups 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 E6A 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. **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

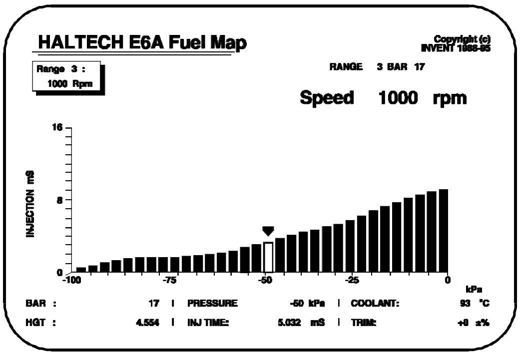
Tuning on the road is similar to tuning on the dynamometer, but with hills, acceleration, gear-ratios and brakes providing the necessary retarding force. Although it is harder to maintain constant load and speed, it is still possible to use the same procedure used on the dyno. It will be necessary to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

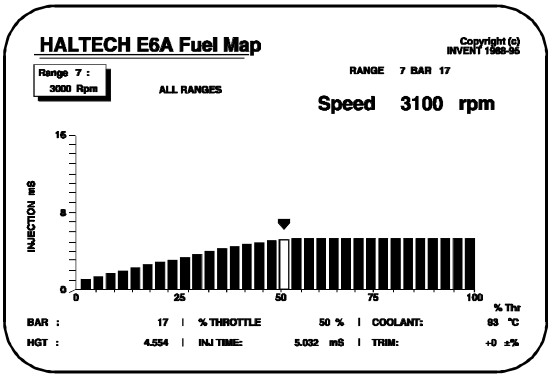
5.5.6 Fine Tuning the Engine

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 below. 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.



Left: a typical fuel curve for a normally aspirated engine at idle speeds.



Right: a typical fuel curve for a TPS mapped engine.

SECTION TWO
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 E6A 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 Setup 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 E6A 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 can not 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 Setup, and has one programmable bar every 500 rpm up to 16000 rpm.

Chapter 7
Cold Starting and Running

The Haltech E6A 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 E6A 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 Setup 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 E6A 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 E6A 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 no be adjusted until the Fuel Maps are correctly tuned at operating temperature.

Access the Fuel Coolant Map from the Fuel Maps and Setup Menu. The map defines the percentage increase in fuel at any given engine temperature. The E6A 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.

Chapter 8
Correction Factors

The Haltech E6A 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. 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 E6A 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 E6A 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 Setup 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 E6A 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 E6A 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 E6A 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

Fluctuations in barometric pressure varies the density of the intake air of the engine. At lower barometric pressure, the engine can not breath in as much air, and therefore the amount of fuel delivered to the engine must be reduced. In mapping in Throttle Position Mode, the Map sensor provides a reading used for Barometric Correction. When in Manifold Pressure Mode, there are three forms of Barometric Correction performed by the E6A.

The Manifold Absolute Pressure Sensor (MAP Sensor) supplied with the E6A measures the absolute pressure of the air in the inlet manifold, and therefore automatically correct for small changes in barometric pressure. For a given geographical area, small fluctuations in the barometric pressure can be adequately handled by the MAP Sensor. This is the first form of correction performed.

Larger fluctuations in barometric pressure are usually caused by a change in altitude. When the E6A is powered on it runs 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. Small changes in the barometric pressure from that point are then handled by the MAP Sensor. This is the second form of barometric correction the E6A performs.

If at start up the engine is cranked before the fuel pump prime has finished the ECU can not read the barometric pressure from the MAP sensor as the engine will be applying a vacuum to it. In this case, the E6A will use a pressure reading stored in its memory. This reading is set to one atmosphere at sea level (1013 millibars) at the factory. This value can be reset to a pressure that is close to what is expected in the geographic area the engine will be used in. To reset this value, follow these steps :

1. Firstly 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.

2. Switch the ignition off.

3. Apply full throttle.

4. Switch the ignition on but **DO NOT crank the engine.**

5. 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.

The third form of Barometric Correction is performed using a separate Barometric pressure sensor. With a 1 Bar MAP Sensor (left open to atmospheric pressure) connected to the Spare Input, any changes in barometric pressure can be compensated for immediately. 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).

8.6 Post Start Enrichment

On some motors, in particular rotories 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 THREE
Software Features

Chapter 9
File Storage and Retrieval

Once your Haltech E6A 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 ¦ 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 ¦ 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 **¦ 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. **Remember to save any maps currently in the ECU that you wish to retain before loading new maps from a disk.**

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 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.

9.3.1 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.

9.3.2 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 ¦ **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 °. 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 dot matrix 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:

1) **Setup Information** - this will print only the setup pages (ie. Fuel, Main and Ignition pages).

2) **Maps** - Prints all the maps in the system (ie. Fuel, Ignition and Coolant).

3) **Output Options** - This function will print the current settings and the status of the output options of the ECU. (ie. Turbo Wastegate).

4) **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 **°** . 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 **°** .

Chapter 11
DataLog

11.1 The Datalog Option

This option records the Engine Data information at approximately five 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 ¦ 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 § 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 setups) are saved to disk. If the Datalog is view offline at a latter date, the Maps will need to be loaded so that the programming software knows the setup 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
³ - scroll up datalog one page
´ - scroll down datalog one page
² - jump to start of datalog
¶ - jump to end of datalog
? - jump to page #
S - show statistics (max., min. & avg. of each parameter)
° - 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 setups) 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 setup 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 **°** . 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 **°** .

Chapter 12
Customising the Software

12.1 The Setup Page

The Setup 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 programme, the settings will be as you left them.

The Setup Window is accessed from the Setup menu by pressing ¦ s. Or by pressing § p. Then follow the keystroke instructions outlined at the base of the windows to make your settings.

The Data Setup window is accessed through the Options Menu by pressing ¦ 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 an 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 FOUR
E6A Optional Outputs

Chapter 13
Software Access

13.1 The Output Options Page

The Output Options Page is where all E6A 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 ¦ o will take you to the Options Menu. Press O to go to the Output Options Page. Alternatively use the § o hot key combination

Here, the four E6A 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 Auxiliary Outputs, use © to cycle through the functions, and press ¬ to select the one you want. Although any channel may perform any function, each function may be selected only once. Some options cannot be used together because they use the same hardware. These are noted in there 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 three Auxiliary 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 ¦ 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 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.

Chapter 14

Idle Speed Control

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*;
- an idle air circuit bypassing the throttle plates;
- E6A 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 E6A ECU.

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.

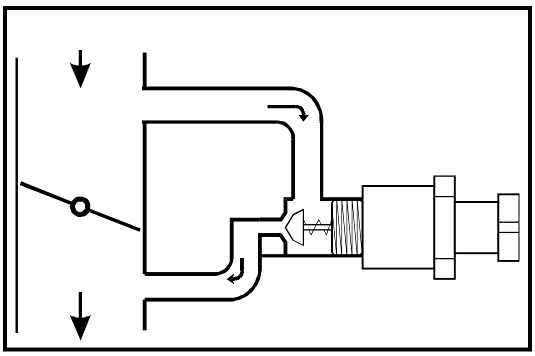


Fig 14.1. The idle-air circuit.

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 E6A harness. Run the E6A 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 switch 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.

Pulse Divider: With a value of 1, the stepper motor would be pulsed every 4mS. In some cases this may be faster than the motor is capable of reacting, or may cause the engine speed to oscillate. Increasing this parameter reduces the rate at which the stepper motor is pulsed.

Post-Start RPM: This value is added to the Target Idle Speed for the first 20 seconds after starting. It is of particular use in preventing stalling due to heat soak when starting a warm engine.

Norm Idle Bar: When manifold pressure is used as the load sensor, excessive vacuum can be used as an indication that the engine is not at idle (i.e.. the wheels are driving the engine), and so the E6A will not alter the idle speed motor. To determine this value, go to the fuel maps while the engine is idling and press **2** . The range and bar numbers will appear in the top right corner of the screen. Enter that bar number in this field - the idle motor will be ignored at a lower manifold pressure.
NB: If using throttle position as the load parameter, set this value to 1.

Cold Temperature Limit: the temperature below which the engine is defined as being cold, and thus the Cold Idle-Up would apply.

Rpm Operation Limit: If the engine rpm is above this speed, the idle motor will not be moved. To ensure the system will never "hang" with the idle valve open, choose a speed higher than that at which the engine will run with the idle air-bypass passage fully open.

Hot Opening Value: The Idle Speed Motor can be opened up by a programmable amount when the ignition is first turned on. The Hot Opening value determines what amount to open when the engine is above the Cold Temperature Limit. The value is a number between 1 and 100, but is not a percentage of the total opening range. The value should be set to give the desired flare up Rpm when the engine is hot.

Cold Opening Value: The Cold Opening value determines what amount to open the Idle Motor when the engine is below the Cold Temperature Limit. The value is a number between 1 and 100, but is not a percentage of the total opening range. The value should be set to give the desired flare up Rpm when the engine is cold.

Chapter 15
Closed Loop Control

15.1 Description

By fitting an oxygen sensor to the exhaust system of an engine, the E6A 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.

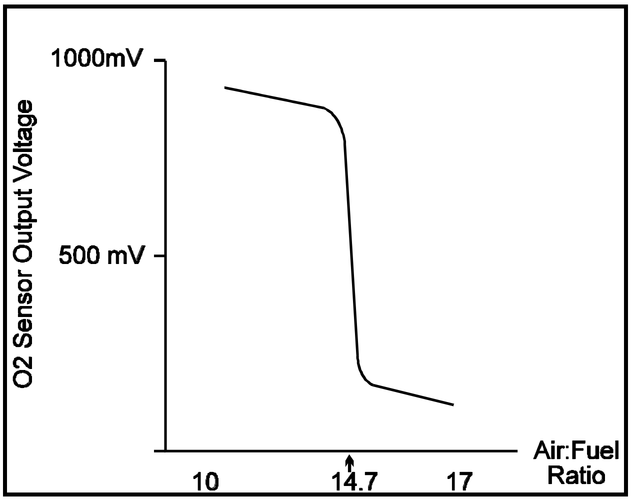


Figure 15.1 Typical lambda sensor output.

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;
- E6A 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 E6A 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: CLOSED LOOP CONTROL WILL NOT WORK FOR THE FIRST 2 MINUTES THE ECU IS ON, THIS ALLOWS SUFFICIENT TIME FOR THE OXYGEN SENSOR TO WARM UP TO 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 E6A 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, around 600mV. 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.

NB: 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 E6A. 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. To use a 5 volt sensor, a jumper shunt needs to be installed on the E6A circuit board. This shunt may be later removed when the UEGO probe is replaced by the standard 1 Volt sensor once tuning is complete. Please contact your Haltech™ representative for details on using this feature. The type of oxygen sensor used is

15.3 Using Different Oxygen Sensors

Almost any oxygen sensor can be used with the E6A. The sensor available from Haltech™ is an NGK heated four wire oxygen sensor. This is the preferred sensor to use due to its temperature stability and the switch-like characteristic of its 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.]

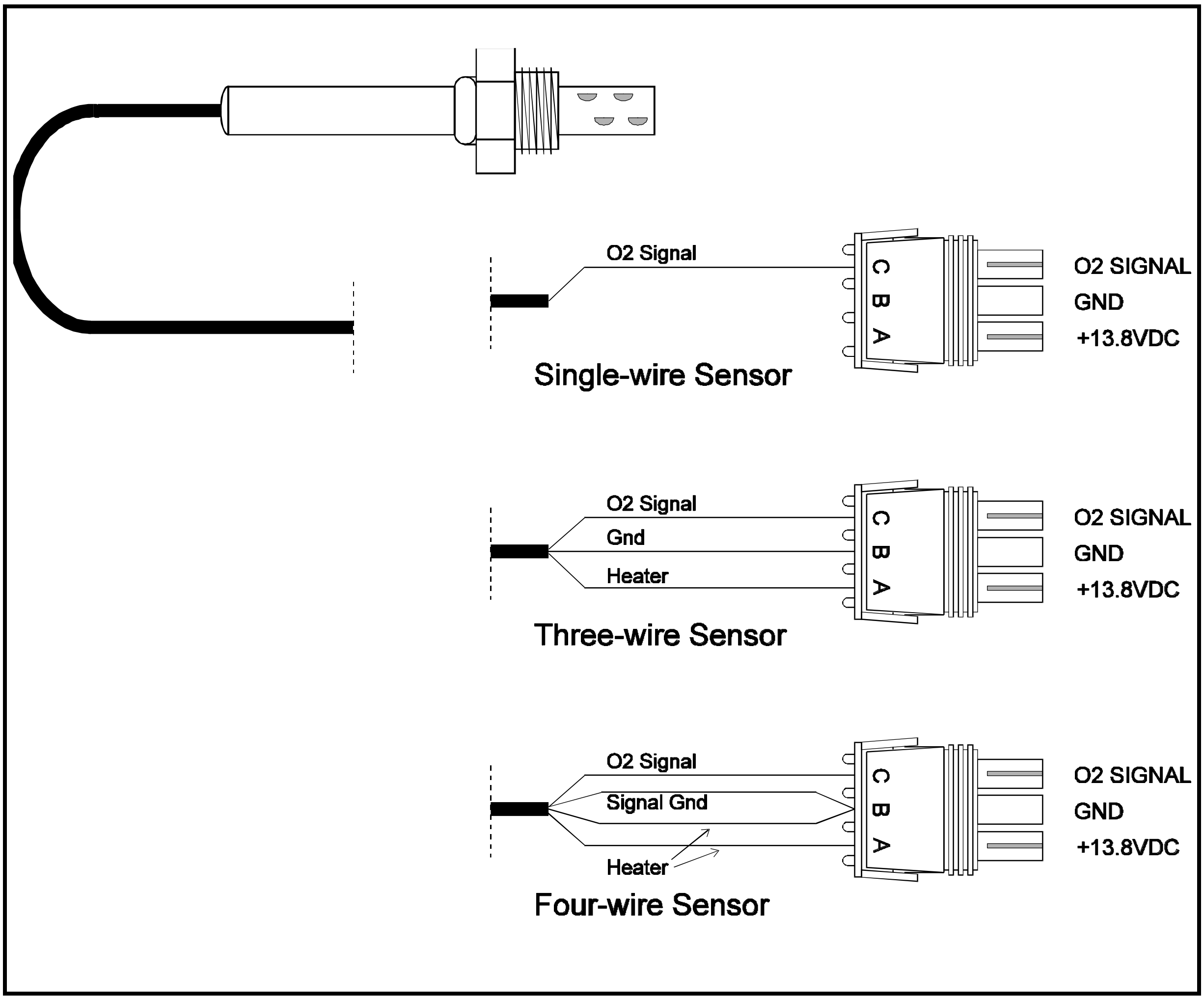


Figure 15.2. Wiring different oxygen sensors.

Chapter 16
Auxiliary Outputs

16.1 Description

The E6A possesses two output channels, 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.

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 function programmes exist within the E6A ECU. You may select any function to be executed on any output channel, but no two channels may perform the same function.

Following is a list of available functions to choose from. This list will grow with further development of the E6A system. You may choose any two functions from this list.

Turbo Waste Gate Control
Dual Intake Valve Control
Torque Converter Clutch Lockup
Electric Thermatic Fan Control
Electric Intercooler Fan Control
Shift Light Indicator
Auxiliary Fuel Pump Switch
Stall Saving Solenoid Control
Staging Signal
Driver Box (DB3) Staging Signal
Turbo Timer
NOS Switch
Anti-Lag Switch

Note : In some Advanced mode applications, one or two of the Auxiliary Outputs are not available.

Torque Converter Clutch Control cannot be used if a Home Trigger is being used in Advanced Mode.

Torque Converter Clutch Control, Turbo Timer and Nos can not be used together as they use the same hardware. Choose only one of these. The **Aux. In/Out Function** in the Identification must be set for the correct function hen using any one of these 3 functions.

16.2 Turbo Waste Gate Control (TWG)

16.2.1 Description

The wastegate of a turbo is operated when the manifold pressure is sufficiently high to force the diaphragm within the wastegate unit. 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;
- air hose and fittings;
- E6A programming software and cable;
- an overboost relief valve (strongly recommended).

The air circuit to the waste gate must be configured appropriately, as in figure 16.1. If it is not directly filtered, the air bleed line to the solenoid should run to the airbox or into the car body, free from road dust. Install the solenoid valve securely, and power and signal from the Auxiliary I/O connector on the harness. The wastegate should be re-set so that its operation point is very low, around 20kPa (3 psi).

NB: 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.

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

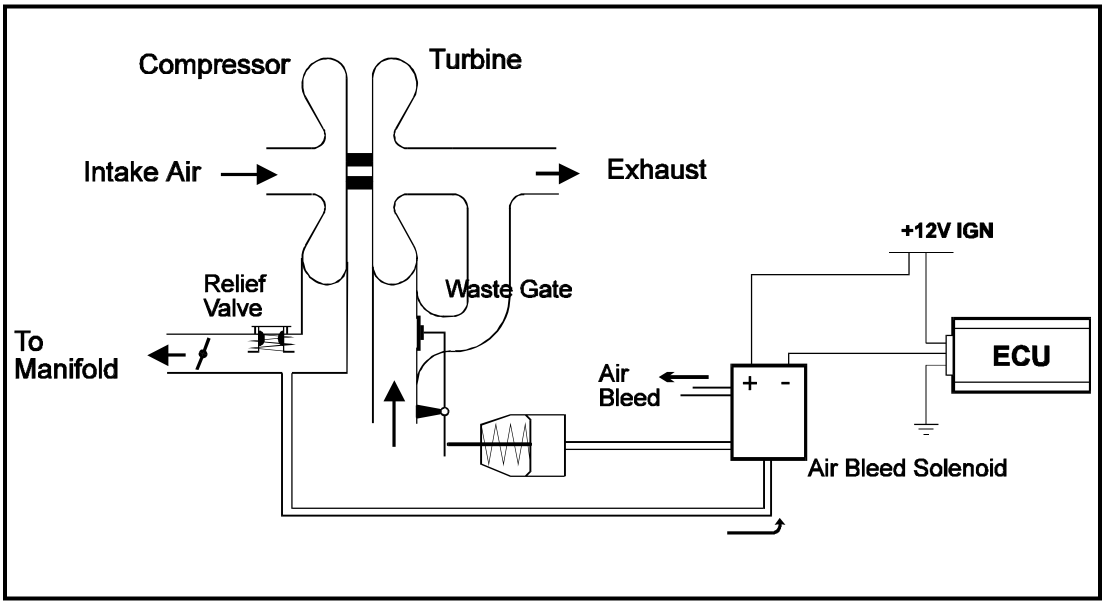


Figure 16.1. Diagram of Turbo with Wastegate Control Solenoid.

Once the solenoid installation is complete run the E6A 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 © key switched 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 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);
- E6A programming software and cable.

Wire the solenoid to the appropriate output, taking note of voltage polarity. (Some solenoids are non-polar.) Run the E6A 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. This value should be 200-500 rpm lower than the Switch On Rpm - a small amount of hysteresis will prevent the solenoid from oscillating.

16.4 Torque Converter 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^{TM} RA1)
- access to the wiring of the torque converter lockup solenoid and 4th gear/overtemp switch;
- E6A programming software and cable.

Wire the TCC solenoid to the appropriate output line on the Auxiliary I/O connector, and, if it is available, the 4th gear/overtemp signal to the Aux. In line (the blue flywire on the E6A 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^{TM} RA1 Reluctor Adapter would perform satisfactory conditioning.

Once the wiring is complete, run the E6A 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).

NB: When using the TCC function, the **Aux. In/Out Function** in the Identification must be set for Torque Converter Control. When using TCC, other function that use the Aux. Input/Output line can not be used.

16.5 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.

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:

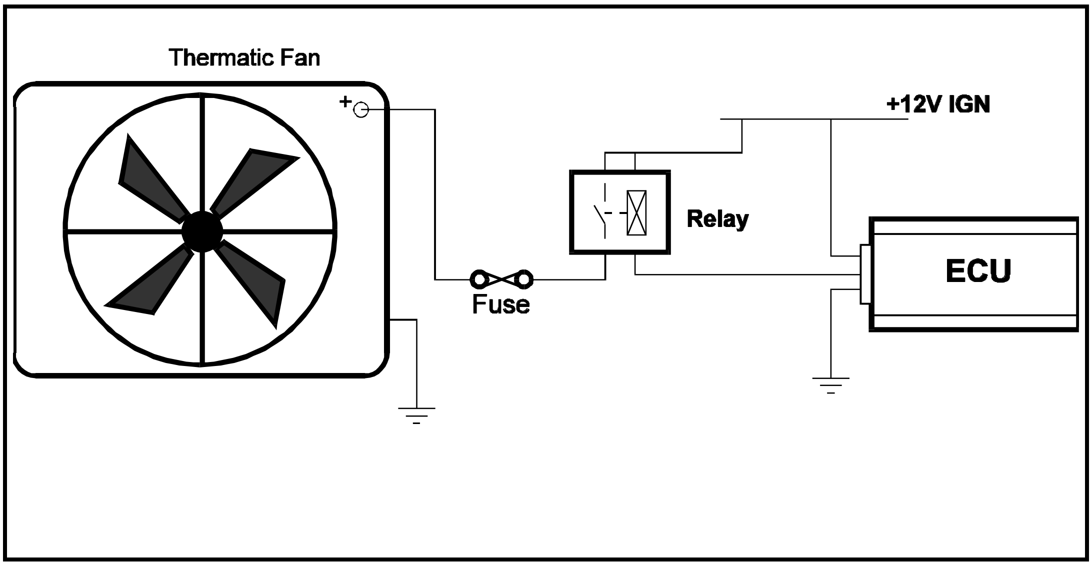
- an electric thermofan, fused and relay switched;
- E6A programming software and cable.

Install the wiring for the thermofan to one of the Auxiliary outputs as described in figure 17.4-1. Be sure that the relay contacts are rated higher than the current drawn by the thermofan.

Run the E6A 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.



16.6 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;
- E6A programming software and cable.

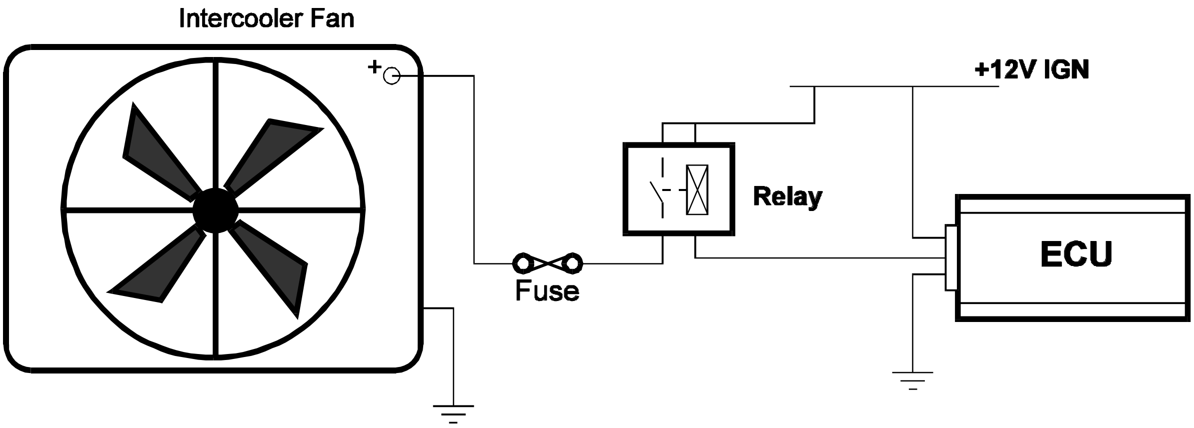
Install the wiring for the thermofan to one of the Auxiliary outputs. This should be done in the same way as described in figure 17.5 for the Thermofan. Be sure that the relay contacts are rated higher than the current drawn by the fan.

Run the E6A 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 exceed 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 16.5. Example circuit for an Intercooler Fan.



16.7 Shift Light Illumination (SL)

The E6A 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;
- E6A 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 E6A programming software and go to the Options page. Select the Shift Light function on the appropriate output and set the value as desired.

16.8 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.

NB: 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;
- E6A programming software and cable.

The extra pump must be connected in parallel with the primary fuel pump. Figure 16.6 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.

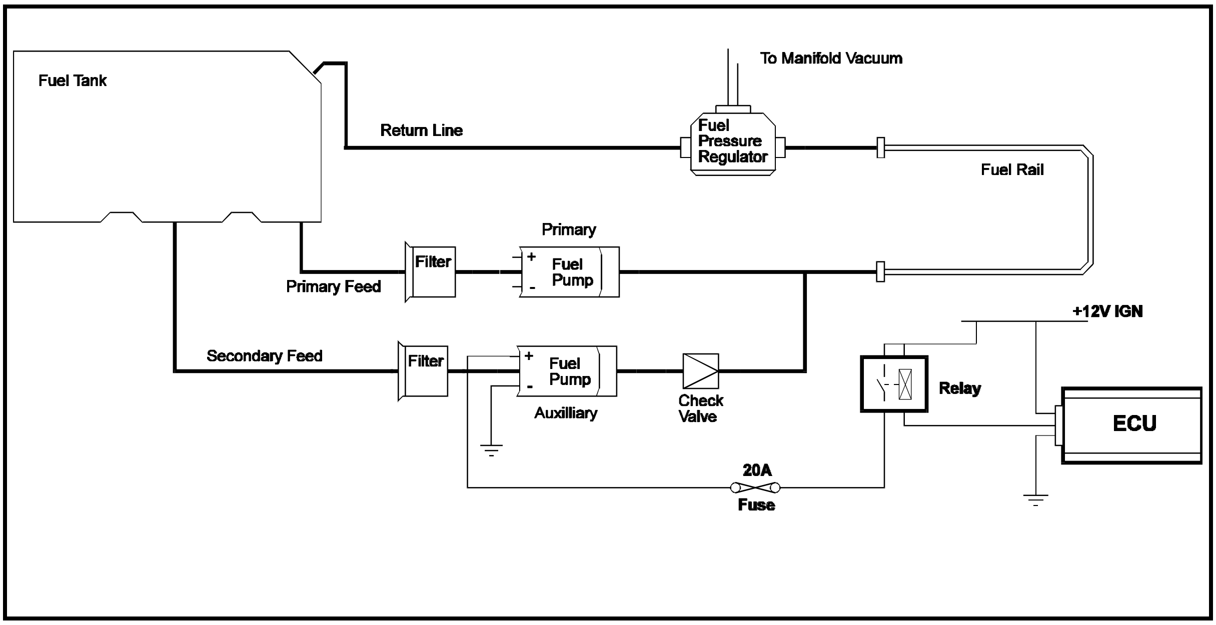
Run the E6A programming software Online and select the Auxiliary Fuel Pump function on the appropriate output. There are two parameters that define when the Auxiliary Pump will be switched on.

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.



16.9 Anti-Stall Solenoid Control (AS)

A solenoid air valve in the manifold may be used to allow extra air into the engine during cranking or extremely low rpm. This can aid in starting the engine, or in preventing it from stalling if engine revs drop too low.

To use this function, you will need the following:
- a suitable solenoid air valve mounted to the manifold;
- E6A 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 Auxiliary I/O connector. Run the E6A 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.

16.10 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.
NB: 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.

16.11 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.

16.12 Turbo Timer (TT)

When an engine is switched off, oil is no longer being pumped to the turbocharger. This is common cause of turbo wear if the turbocharger is no allowed to slow down before an engine is switched off, cause it to spin for an extended time unlubricated. This function controls the ignition power via relays to keep the engine running for a period of time after the ignition switch has been turned off.

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 17.6 for the correct way to wire this output. The ECU detects if the ignition switch has been turned off via the Auxiliary Input/Output. Therefore, the Auxiliary Input/Output 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.

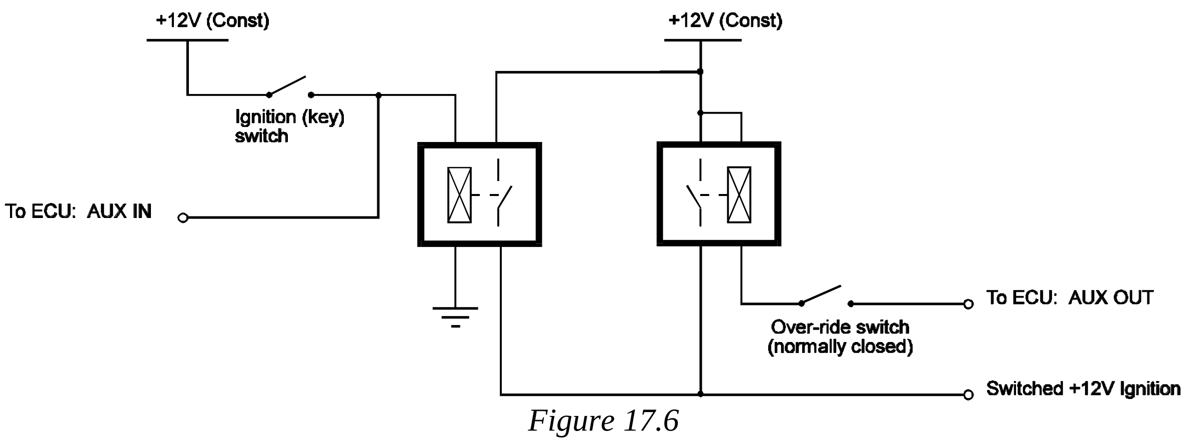


Figure 17.6

NB: When using the Turbo Timer function, the **Aux. In/Out Function** in the Identification must be set for Turbo Timer. When using TT, other functions that use the Aux. Input/Output line can not be used.

16.13 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/Output. Once enabled, if the conditions stated below are met, the NOS system will be activated. The Auxiliary Input/Output 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 bar 32.

Max. Rpm : If the Rpm exceeds this value the NOS system will be switch off.

Min. Rpm : If the Rpm is below this value the NOS system will not be activated.

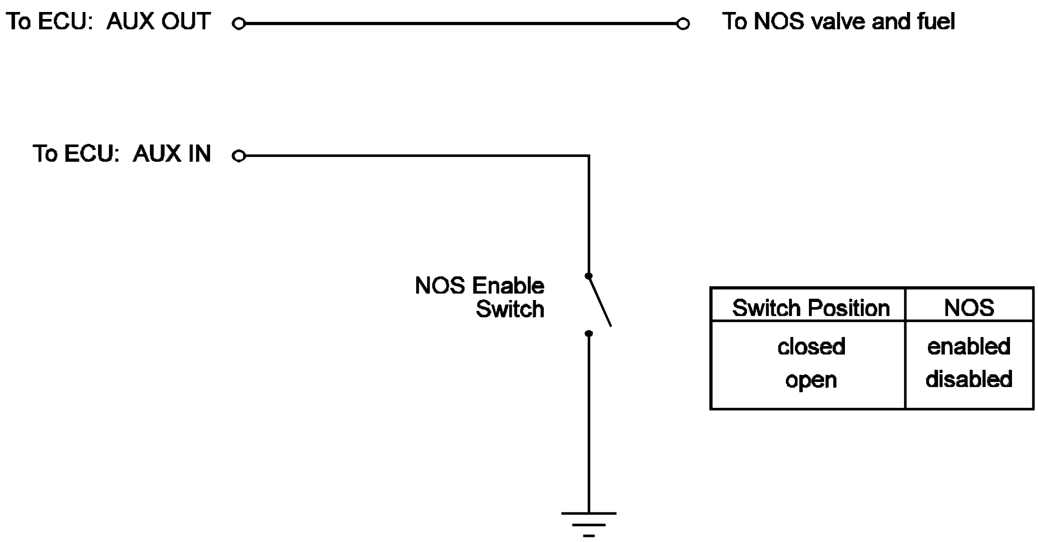
Minimum Throttle : The NOS system will be turned on above this value.

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

Ignition Retard : The E6A will provide an ignition retard whenever the Nos system is engaged. The number of degrees retard is set by this field.

NB: When using the Nos function, the **Aux. In/Out Function** in the Identification must be set for Nos. When using Nos, other functions that use the Aux. Input/Output line can not be used.

FOR SAFETY REASONS THE NOS FUNCTION IS ENABLED ONLY AFTER THE ECU IS ON FOR MORE THAN 2 MINUTES.



16.14 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 6 adjustable parameters:

Enabled / Disabled : This either enables or disables this function.

Retard Value : The ignition timing is retarded by this amount when the Anti-Lag conditions for operation are met. The valid range for the Retard value is (1 to 20)° ATDC.

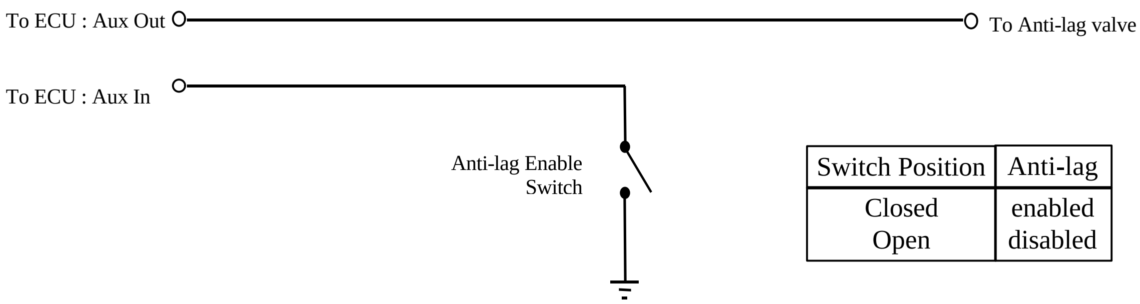
% Inc. Fuel : The percentage of fuel **increased** during Anti-Lag operation. The valid range for this function is (1 to 50)%.

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)%.

The anti-lag system is enabled by a switch connected to the Auxiliary Input/Output. Once enabled, if the conditions in the anti-lag parameters are met, the anti-lag system will be activated. In some systems the switch is activated by the clutch.



Switch Position	Anti-lag
Closed	enabled
Open	disabled

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

SECTION FIVE
Appendices

Appendix A
Troubleshooting

This Appendix is devoted to trouble shooting problems that may occur during setting up the E6A 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 Programme 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 Programme Problems

Haltech Programming Software will not start up

The Haltech programming software should run on any computer that meets the requirements in Chapter 3. If, after following the instructions in Chapter 3, the programme 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 programme - 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 E6A 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.

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 be **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 E6A 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

Throttle response of the E6A 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 E6A can control an Idle Air Control motor that will perform this function.

A.9 Fuel Consumption

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

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

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

Appendix B
The Advanced Features

The Advance Mode of the E6A offers the user extra flexibility in setting the system up for multiple 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 output work is required.

B.1 The E6A Outputs

The E6A has five 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 setup. 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 setup it would provide the output for an igniter firing one ignition coil connected to a distributor.

Channels 4 and 5 are the Auxiliary 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 call Aux Out 1 and Aux 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 Auxiliary 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 setup to the E6A 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 auxiliary outputs. The six cylinder with waste spark is similar. It requires 3 coils and 3 ignition channels. For this setup, channels 4 and 5 become ignition channels 2 and 3 respectively, and neither is available for Auxiliary 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 E6A 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. Also, because there are only two injector drivers left of controlling fuel, an Extra Driver Box (or possibly 2) will be needed to provide enough power for all the injectors.

Using the same configuration also gives us another possibility. Since there are four ignition outputs it is possible to use them to control 4 coils on a 4 cylinder. This option is selectable through the Ignition Setup.

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 can not run Direct Fire as they can not 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 E6A 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 E6A 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 Setup

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.

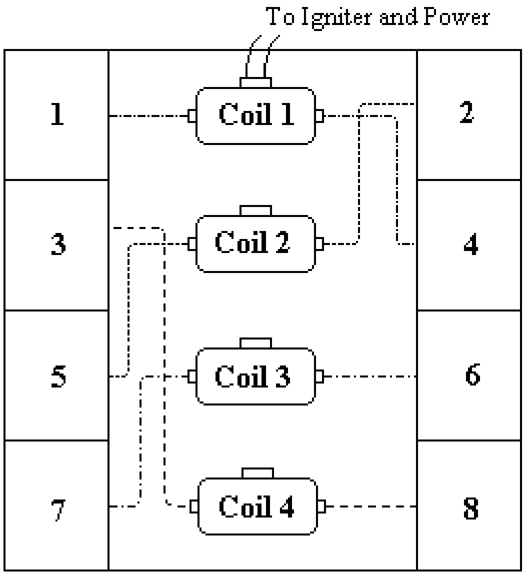


Figure B1. Coil layout for V8 with firing order 1, 2, 7, 8, 4, 5, 6, 3.

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 E6A.

B.2.5 Ignition Outputs

The E6A will always use it 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	Aux Out 1
Channel 5	Aux 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 E6A 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 E6A

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 E6A then times the start of injection, based on the trigger, so that the injection is completed by the specified engine angle. If the E6A 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 E6A has the ability to adjust each channel by ± 12.5%. This is meant primarily for the ‘equalization’ of flow rates between injectors with marginally different flow rates. These trims are accessed through the Fuel Maps and Setup Menu.

B.3.2 Sequential Outputs

The E6A can run full sequential on an engine with up to four cylinders. When the Ign / By is set to 1 in the Fuel Setup, 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	Aux Out 2
Channel 4	Aux Out 1

If you have less then 4 cylinders 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 an Auxiliary Output.

The E6A 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 E6A 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 injector 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	Aux Out 2	cyl 2 and cyl 4

Channel 4 is not used for fuel and is therefore left available as an Auxiliary Output.

The Sequential Injection Mode on a 12 cylinder engine is not really sequential at all, but a form of extended Batch Fire. The E6A 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 E6A.

Important Notes

1. The E6A 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 can not be used in conjunction with Direct Fire Ignition Mode except on 1 or 2 cylinder engines. If both modes are selected with more the 2 cylinders, the E6A will choose the ignition function in preference to the fuel function.

3. The Table in section **B.7** 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 E6A 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 Multitooth Triggers

The E6A is capable of triggering from multitooth pickup, as used on a number of production vehicles. The E6A employs software signal conditioning to convert the multi-tooth trigger to standard form. This is done by counting teeth from a "synchronisation event" (be it a Home signal for normal multi-tooth triggers, or by missing teeth on the Motronic systems), until a certain tooth is encountered which corresponds to the engine location specified as the Trigger Angle. The E6A then conducts ignition (and possibly injection) timing as normal.

After recognising the synchronisation event, the E6A will locate the first "standard" engine trigger by the tooth indicated as Tooth Offset in the Ignition Setup. To find the remaining "standard" engine triggers, the E6A counts a number teeth equal to the total teeth in one CAM revolution, divided by the number of cylinders, e.g. on a four cylinder Motronic engine, the following parameters might be set:

Trigger Edge:	Rising / **Falling** (using RA4)
Trigger Angle:	65 (60 to 100° as required)
Trigger Type:	Standard / MultiTooth / **Motronic** / Twin
Total Teeth:	120
Tooth Offset:	5 (0 to [Total Teeth/ # cylinders] as required)

After finding the missing teeth, the E6A will count 5 teeth then produce an internal trigger at 65° BTDC to perform ignition for cylinder 1 (or 4). It will then count 30 teeth and generate a second internal trigger at 65° BTDC for cylinder 2 (or 3).

Due to the high frequency of multitooth signals, there is a maximum Rpm to which the E6A ECU will operate. For the Motronic signal, this limit is 9000 rpm. For other multitooth signals, the limit is 10,500 rpm.

NB: a) A Home signal is required with the Motronic trigger for sequential injection or Direct Fire 4 cylinder with 4 coils. It is not needed if using wasted spark direct fire, as the missing teeth act as the Synchronisation Event.

b) When non-sequential injection is chosen with a Motronic type trigger, fuel injection occurs on detection of the missing teeth. This is done to ensure injection once per revolution on engines with an odd number of cylinders. Always set Ign/By on Motronic set-ups to 1.

B.5 Twin Triggers and Twin Distributors

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 E6A 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, thus again obviating the need for a Home.

B.6 Rotary Engines

The E6A 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)
AUX OUT 1	Trailing Spark	Trailing Spark front rotor
AUX OUT 2	Auxiliary Output	Trailing Spark rear rotor

Expanded Mode

Since direct fire on rotary engines will rob the E6A of an auxiliary output to run one of the programmable functions (all five outputs used: two for fuel, three for ignition), a special configuration may be used to “steal” one of the fuel injector drivers to run a different function.

By moving jumpers on the circuit board, the injector driver on INJ2 can be isolated from Output Channel 1, which would then control INJ1 alone. INJ2 is then controlled by Output Channel 2, and is used for Primary fuel injection. The Bypass line is employed internally as a staging signal to enable INJ3 and INJ4 as secondary injectors. Thus Output Channel 1 on INJ1 is free to run an auxiliary function. Note that the function list is now limited: the Turbo Timer, NOS and Torque Convert Clutch functions cannot be used since each requires use of the Auxiliary Input/Output line.

An output summary for expanded mode operation follows. This configuration has been designed specifically for 13B turbo rotary engines with two primary and two secondary injectors, with the limitation that the primary injectors do not require high opening currents.

Output	Function
INJ1	Spare function
INJ2	Fuel (primary)
INJ3	Fuel (secondary)
INJ4	Fuel (secondary)
IGN OUT	Leading spark (both)
AUX OUT1	Trailing spark front rotor
AUX OUT2	Trailing spark rear rotor

B.7 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	Aux. Out 1	Aux 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
6	Distrib	Sequent.	Yes	No
8	Distrib	Standard	Yes	Yes
8	DF	Standard	No	No
8	Distrib	Sequent.	No	No
8	Twin Dist	Standard	No	Yes
10	Distrib	Standard	Yes	Yes
12	Distrib	Standard	Yes	Yes
12	Distrib	Sequent.	Yes	No
12	Twin Dist	Standard	No	Yes
12	Twin Dist	Sequent.	No	No

* Although strictly there is no distributor on a 1 cylinder engine, selecting Direct Fire will cause the E6A 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, or low impedance, 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 E6A Injector Drivers

The solid state devices within the E6A ECU that are used to switch the injectors are known as the *injector drivers*. The E6A possesses four heavy-duty injector drivers that can be used on either saturation or peak-and-hold injectors. Each 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 E6A are each capable of firing two saturation injectors. Thus, with four drivers, a total of eight injectors can be used. Each is also 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 E6A 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 do not have enough driver power then you will require an Extra Driver Box. If unsure, contact your Haltech dealer for advice. NB: Under no circumstances should you mix saturation and peak-and-hold injectors on the one driver. This will lead to erratic injector operation.

Appendix D

Fuel Systems & Staging

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.

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.

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.

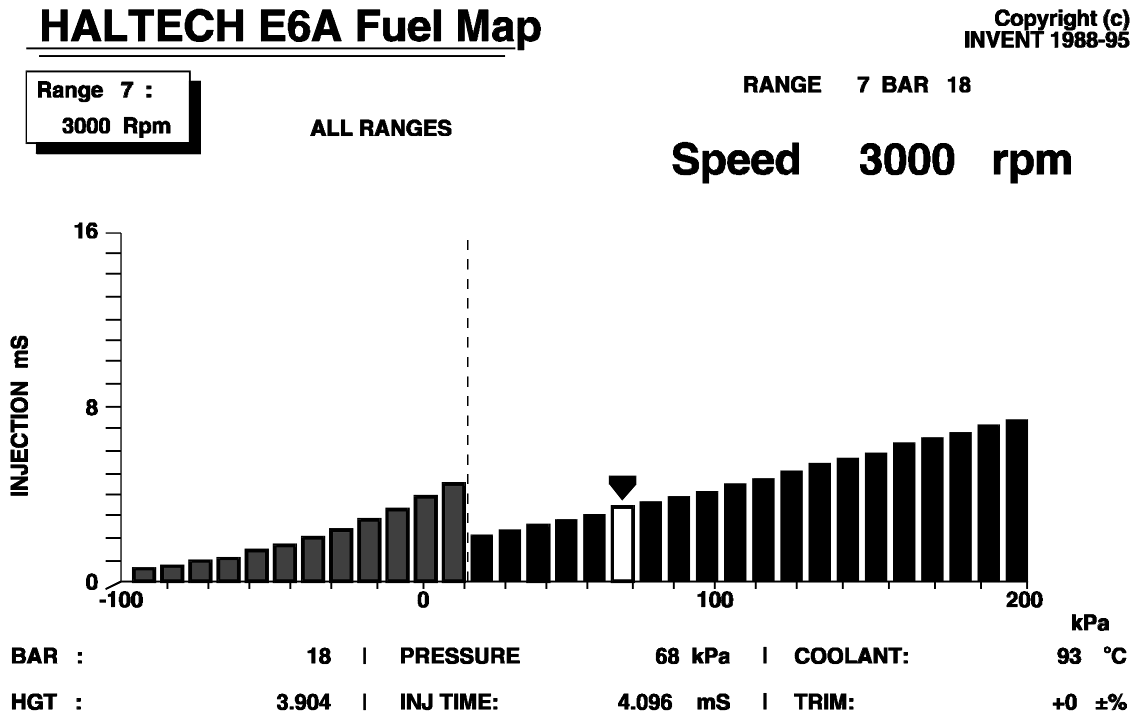
If you find that your injector flow is insufficient, you can change to larger injectors, add extra injectors, or increase fuel pressure. Raising fuel pressure to increase injector flow rate is not recommended if the desired flow is more than 20% than the system currently achieves. Fuel flow is not in 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 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 the section on duty cycles in Chapter 4).

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 unstaged bar. Allow a safety margin by using 60% of the last bar.



Staging is enabled on the Fuel Setup by selecting the "Staged" Injection Mode. The Staging Bar is also defined on the Setup (see Chapter 3).

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 setup, 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 E6A 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 E6A.

E.1 The Input Trigger

The E6A ECU has been designed to trigger from a square signal that varies from a ‘low’ of zero volts (ground) to a voltage between 5 and 15 volts. 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 E6A 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.

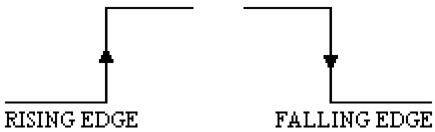


Figure E.1

In order for the E6A 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 E6A 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 E6A ECU. It is only the position of the triggering edge that is of importance.

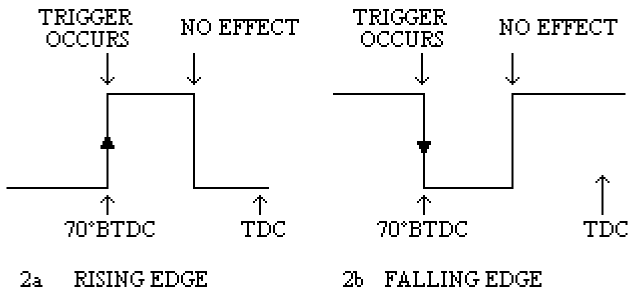


Figure E.2

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.

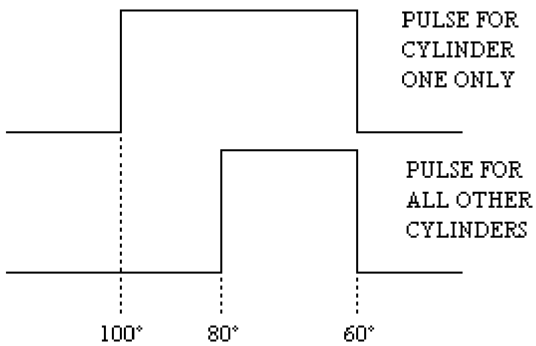


Figure E.3

E.2 Trigger Devices

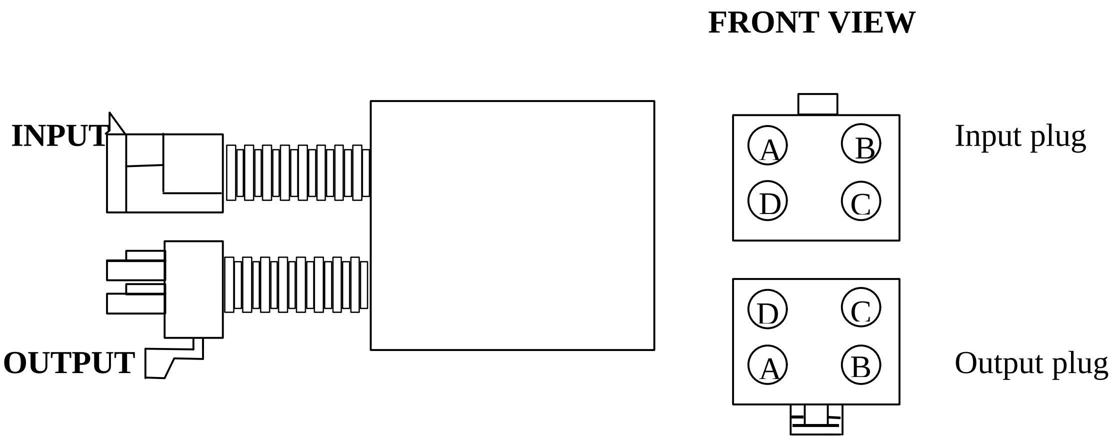
The output of Hall Effect or Optical sensors could normally be connected directly to the input trigger pin of the E6A ECU. Many distributors uses in original equipment manufacturer's computer controlled ignition systems would be fitted with Hall / Optical triggers. The internal structure of such distributors 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 E6A 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 E6A. If these mechanisms can be defeated or removed, and the timing edges set correctly, then they can successfully be used to trigger the E6.

A third type of pickup, the magnetic reluctor, is used in distributors as well as on crank trigger units. It is possible to use this type of trigger on the E6A, but a signal conditioner is needed to convert the signal into the square wave required to trigger the E6A. Haltech can supply such a conditioner called a **Reluctor Adapter**, and coded **RA3**. The RA3 has two input channels, a Primary input and a Secondary input. The Primary input is used for the main trigger, and the secondary is used for the Home or Road Speed input. The RA3 plugs directly into the input trigger connector on the main harness.



INPUT PLUG **OUTPUT PLUG**

Pin	Colour Wire	Function		Pin	Colour Wire	Function
A	BLUE	Primary Trigger (-)		A	BLACK	Ground
B	WHITE	Primary Trigger (+)		B	RED	+12 Volts
C	GREEN	Secondary Trigger (+)		C	YELLOW	Primary Trig
D	GREY	Secondary Trigger (-)		D	BROWN	Secondary Trig

Figure E.4

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.

It is very important that the positive pin go to the input pin of the reluctor adapter (pin B for Primary trigger, pin C for Secondary trigger), and that the negative go to the ground reference pin (pin A for Primary trigger, pin D for Secondary trigger).

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 reluctor adapter using an oscilloscope.

When ferrous metal i.e. 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 the square wave signal that is requires by the E6A, plus at low speeds the signal is too low. This is why the RA3 is used.

The voltage input of the reluctor adapter must first go to a positive peak, which arms the circuit in the RA3. When the signal rises to approximately 70 - 80% of the peak value the RA3 will generate a falling edge, and when the signal crosses zero volts the RA3 will generate a rising edge which is used the trigger the Haltech ECU. If the wires are reversed and the signal goes negative first, the RA3 will generate a pulse but it will NOT trigger the E6A correctly and some strange things can happen to the ignition timing. For instance, the timing may retard as revs increase or multiple triggers can be generated. 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.

NOTE: In the IGNITION SETUP page Trigger Edge should be set to RISING.

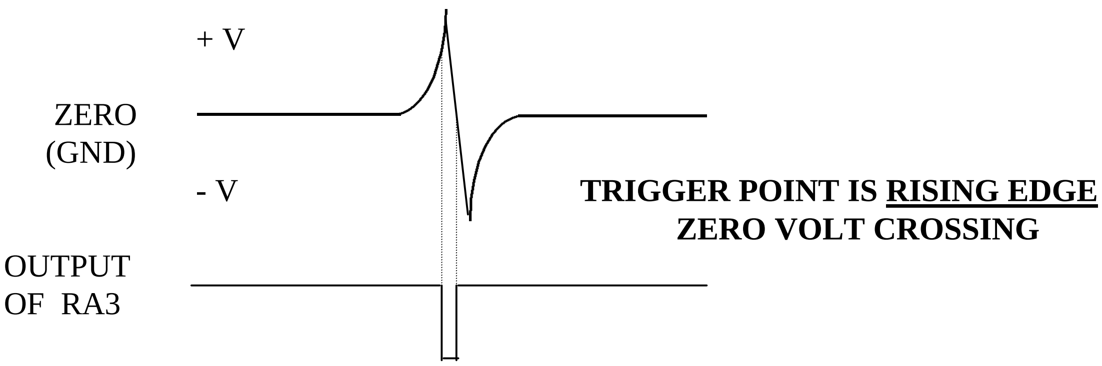


Figure E.5. Top diagram is the signal from the magnetic reluctor sensor. Bottom diagram is the signal after modification by the RA3.

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 with the RA3 reluctor adapter to trigger the E6A ECU.

Motronic Trigger

The Reluctor Adaptor, (RA4) is used for Motronic trigger wheels only. There are two channels in the RA4, the primary and secondary.

RA4 Wiring Details

INPUT PLUG **OUTPUT PLUG**

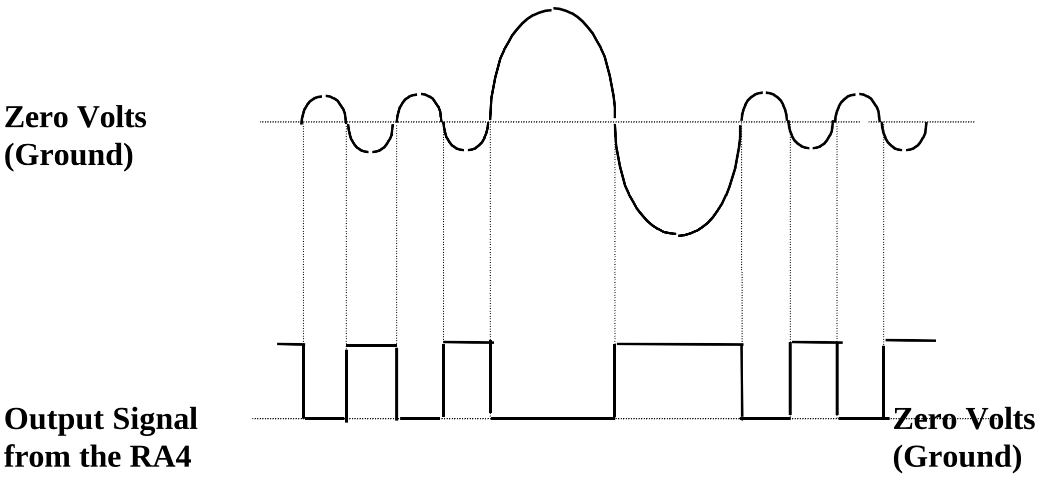
Pin	Colour Wire	Function		Pin	Colour Wire	Function
A	BLUE	Primary Trigger (-)		A	BLACK	Ground
B	WHITE	Primary Trigger (+)		B	RED	+12 Volts
C	GREEN	Secondary Trigger (+)		C	YELLOW	Primary Trig
D	GREY	Secondary Trigger (-)		D	BROWN	Secondary Trig

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 goes to the input pin B and negative wire goes to the input pin A. If you can not determine which wire is positive or negative from marking or wire colour, then it would be necessary to check the signal going into the RA4 using an oscilloscope.

A Motronic wheel more than often has 60 teeth (some are more or less), among them there are two missing teeth which will often give a larger signal. The input to the RA4 must first go positive(+), this arms the circuit in the RA4. When the signal rises about 50 mV, the RA4 will generate a falling edge and when the signal crosses zero volt, the RA4 will generate a rising edge. The larger pulse in the output of the RA4 for the missing teeth is recognised by the Haltech ECU as the home position.

NOTE: In the IGNITION SETUP page Trigger Edge should be set to FALLING.

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



If the wires are reversed and the signal goes negative (-) first, or a rising edge is selected to trigger the Haltech ECU, then the RA4 will still generate a pulse but it will not trigger the Haltech correctly and very strange things will happen to the ignition timing. So please make sure the RA4 is wired correctly.

E.2.1 Hall Effect Sensors

There are two types of Hall effect sensors available.

S1 Black sheathed Hall effect sensor: 2 Dependent Channels. In the **Ignition Setup page** set **Home Edge** to **<u>Falling</u>** and **Trigger Edge** to **<u>Rising</u>**.

S2 Grey sheathed Hall effect sensor: 2 Independent Channels. In the **Ignition Setup page** set **Home Edge** and **Trigger Edge** to **<u>Falling OR Rising</u>**.

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 E6A 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 over the page). The Home trigger should not occur at the same time as any other trigger. Check that the trigger and Home Edges are set correctly.

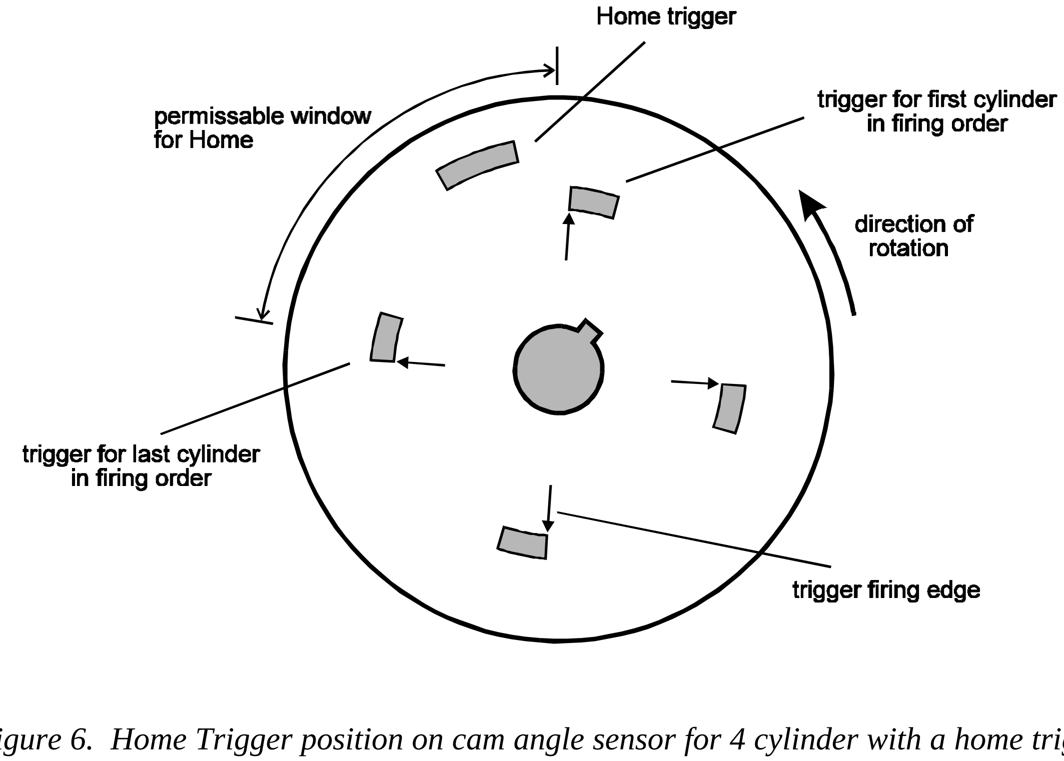


Figure 6. Home Trigger position on cam angle sensor for 4 cylinder with a home trigger every cam revolution.

E.4 Ignition Output

The E6A ECU has one dedicated ignition output, but the two **Auxiliary 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 E6A 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 E6A kit is normally supplied with a **Haltech igniter module**. This "intelligent" igniter module performs current limiting and dwell control on its own, and is the preferred ignition module to be used with the E6A system. 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 E6A ECU. Please do not use it.

Tailoring the Ignition Output Signal

The E6A 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 Setup, 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.

Constant Duty Cycle vs Constant Charge

The E6A is best suited to intelligent igniter modules that perform their own dwell control.

NOTE: IF USING THE HALTECH IGNITION MODULE SET THE OUTPUT TYPE TO <u>CONSTANT DUTY</u>.

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.

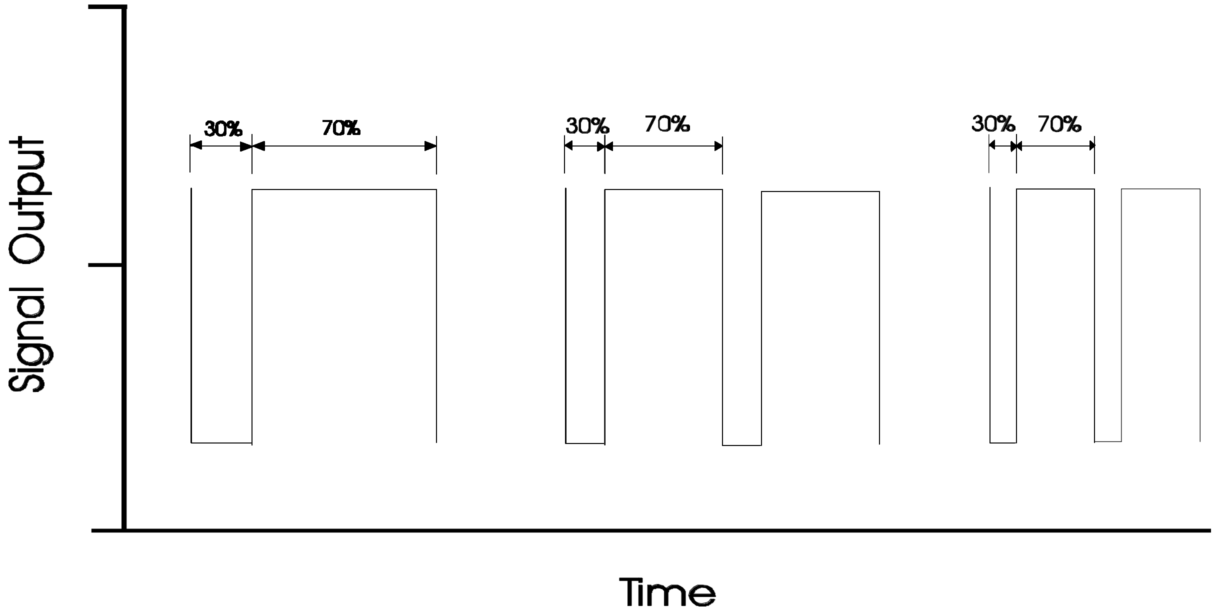


Figure E7. Illustrate constant duty against frequency

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 not the best 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 E6A 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.

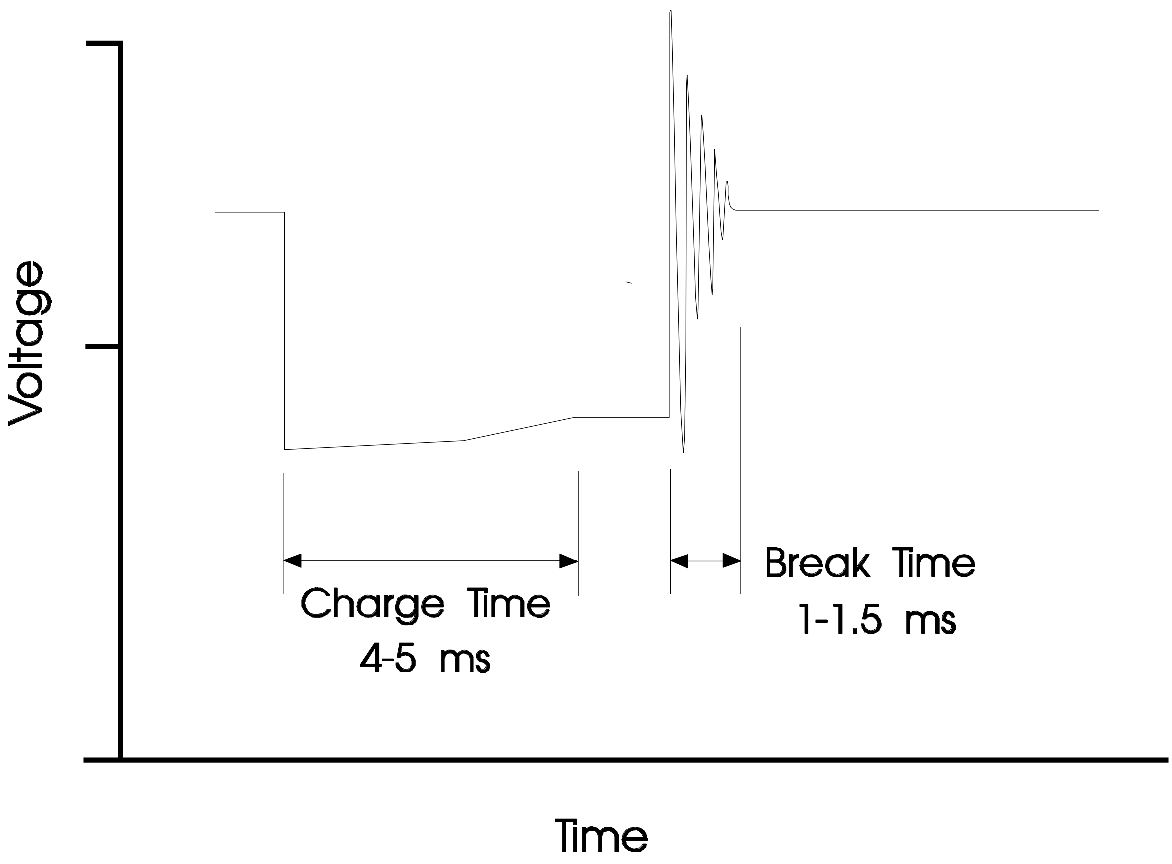


Figure E8. Illustrates Charge Time & Break Time

Constant charge time ignition using a dumb igniter is moderately inferior to that using an intelligent igniter with dwell control as it does not compensate for power variations or thermal effects.

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

The Output Trigger Edge

The Haltech 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 E6A 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 E6A through the Ignition Setup [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 E6A 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 E6A through the **Aux. In/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 E6A ECU can connect directly to this module, however, the TFI module requires a trigger signal, call the SPOUT (see next page), that has a 50/50 duty cycle, which is not the standard 70/30 duty cycle of the E6A. To use the Ford TFI module you will have to adjust the Ignition Output Duty Cycle in the Ignition Setup (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 sorter 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 E6A cannot be used with a signature PIP unless the trigger point is moved. If the trigger is modified be wary of rotor phasing (See Appendix F). The trigger edge for the Ford TFI module is falling edge. For 8 cylinder engines the Trigger Angle is 55° and for 6 cylinder engines it is 70° BTDC.

Appendix F
Rotor Phasing

One of the most important aspects to consider when modifying a distributor or trigger is the Rotor Phasing. Take, as an example a distributor that uses a Hall effect sensor with a chopper wheel attached to the distributor shaft, the Hall effect sensor being mounted to a plate that is rotated by a vacuum advance mechanism and by centrifugal bob weights. This is a fairly conventional set up used in many vehicles with electronic ignition. Simply removing the advance mechanisms and locking the plate so that it can't move may not be all that is required. The trigger edges generated by this modified distributor will probably fall outside the 60° to 100° BTDC window allowed by the E6A. 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 :-

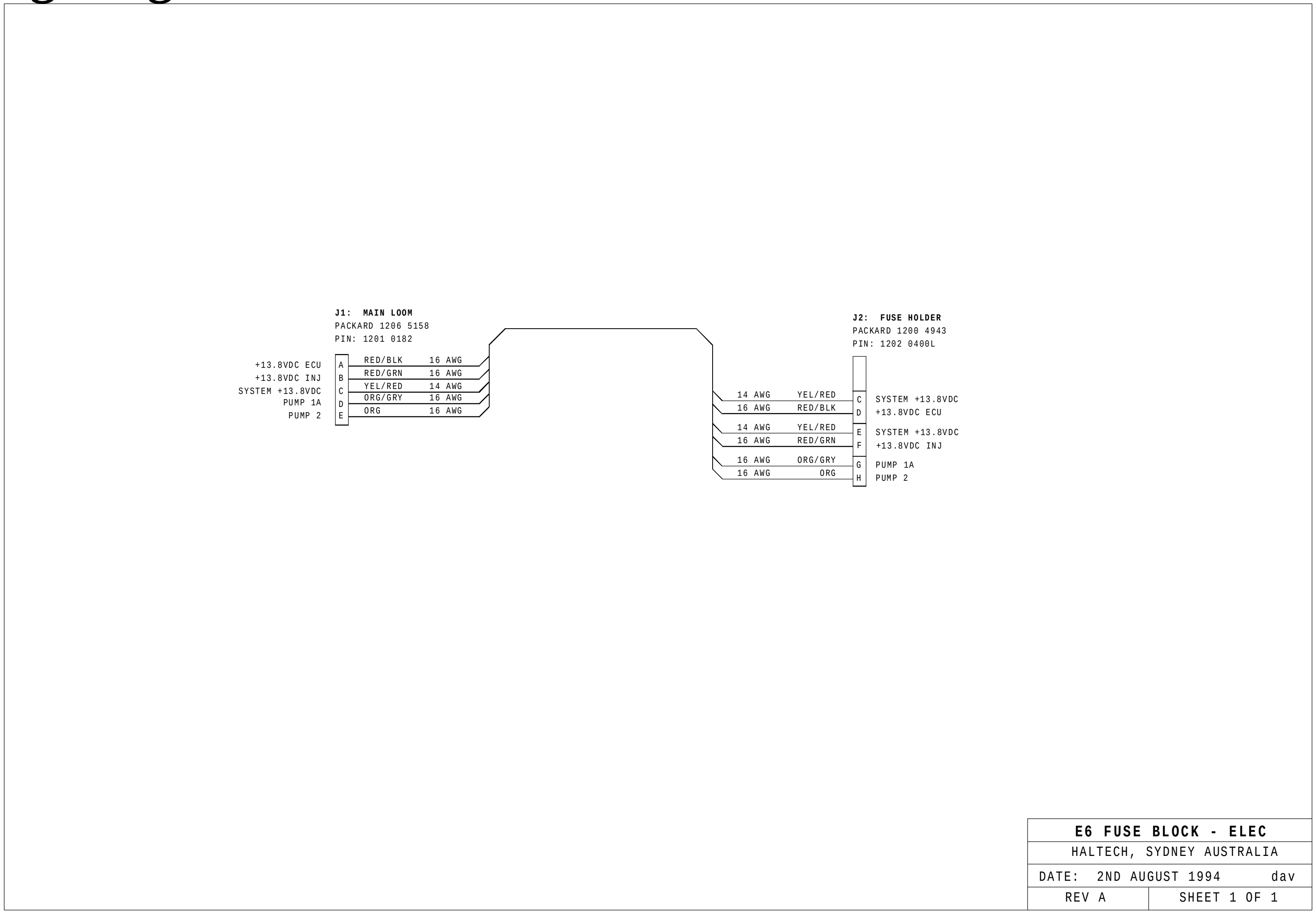
Minimum Timing	10° BTDC
Maximum Timing	40° BTDC

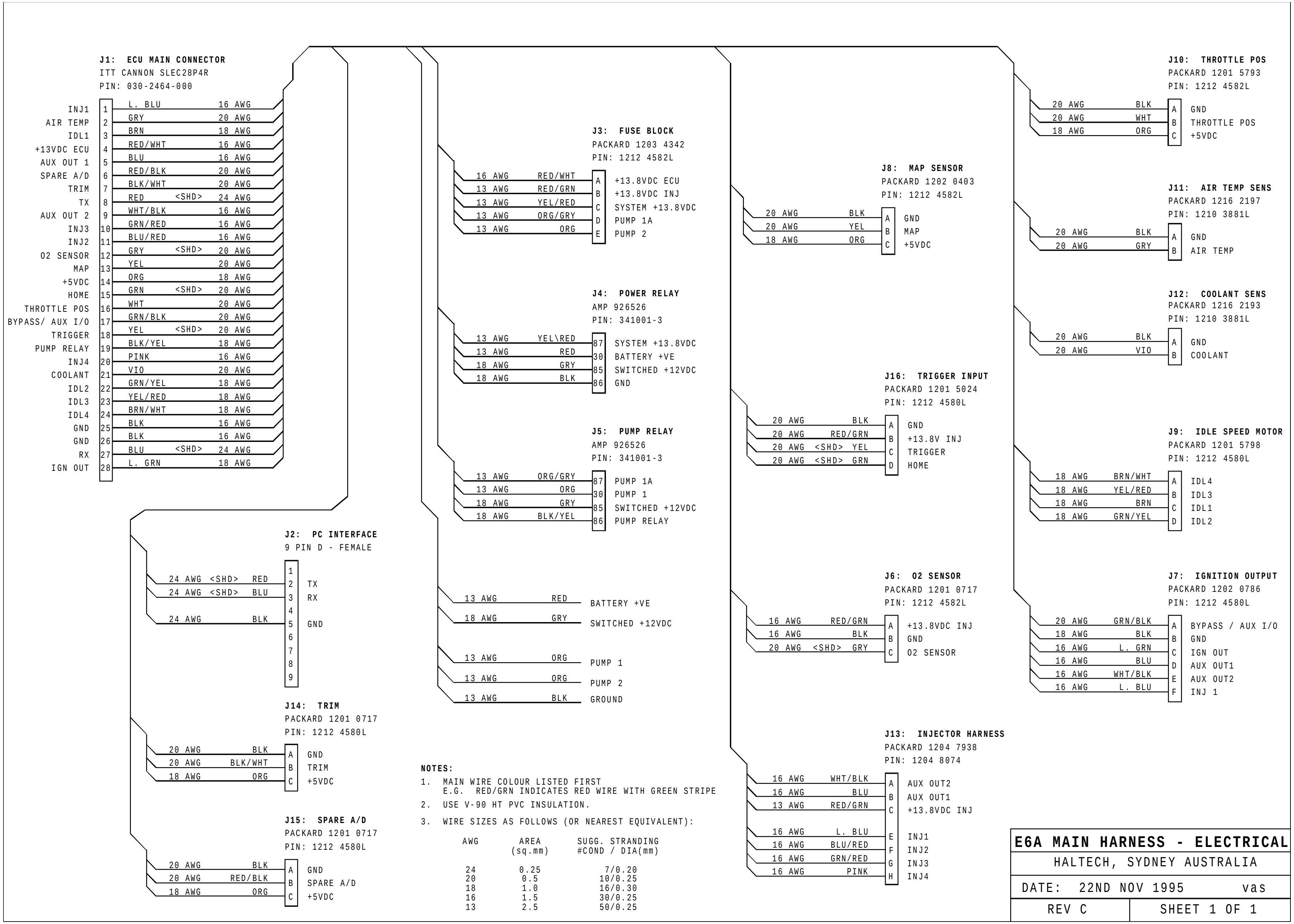
This gives a mid point, half way between the minimum and maximum timing, of 25°. Align the center of the rotor button with one of the plug lead terminals. It does not matter which one. This is where the rotor button has to be when the engine is 25° BTDC. Now rotate the distributor shaft so that the rotor 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 center. 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 center of the sensor will become exposed. If it is not possible to move the sensor, it will be necessary to rotate the trigger wheel relative to the shaft and the sensor.

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

Appendix G

Wiring Diagrams




J1: ECU MAIN CONNECTOR
ITT CANNON SLEC28P4R
PIN: 030-2464-000
INJ1 1 L. BLU 16 AWG
AIR TEMP 2 GRY 20 AWG
IDL1 3 BRN 18 AWG
+13VDC ECU 4 RED/WHT 16 AWG
AUX OUT 1 5 BLU 16 AWG
SPARE A/D 6 RED/BLK 20 AWG
TRIM 7 BLK/WHT 20 AWG
TX 8 RED <SHD> 24 AWG
AUX OUT 2 9 WHT/BLK 16 AWG
INJ3 10 GRN/RED 16 AWG
INJ2 11 BLU/RED 16 AWG
O2 SENSOR 12 GRY <SHD> 20 AWG
MAP 13 YEL 20 AWG
+5VDC 14 ORG 18 AWG
HOME 15 GRN <SHD> 20 AWG
THROTTLE POS 16 WHT 20 AWG
BYPASS/ AUX I/O 17 GRN/BLK 20 AWG
TRIGGER 18 YEL <SHD> 20 AWG
PUMP RELAY 19 BLK/YEL 18 AWG
INJ4 20 PINK 16 AWG
COOLANT 21 VIO 20 AWG
IDL2 22 GRN/YEL 18 AWG
IDL3 23 YEL/RED 18 AWG
IDL4 24 BRN/WHT 18 AWG
GND 25 BLK 16 AWG
GND 26 BLK 16 AWG
RX 27 BLU <SHD> 24 AWG
IGN OUT 28 L. GRN 18 AWG
J3: FUSE BLOCK
PACKARD 1203 4342
PIN: 1212 4582L
16 AWG RED/WHT A +13.8VDC ECU
13 AWG RED/GRN B +13.8VDC INJ
13 AWG YEL/RED C SYSTEM +13.8VDC
13 AWG ORG/GRY D PUMP 1A
13 AWG ORG E PUMP 2
J4: POWER RELAY
AMP 926526
PIN: 341001-3
13 AWG YEL\RED 87 SYSTEM +13.8VDC
13 AWG RED 30 BATTERY +VE
18 AWG GRY 85 SWITCHED +12VDC
18 AWG BLK 86 GND
J5: PUMP RELAY
AMP 926526
PIN: 341001-3
13 AWG ORG/GRY 87 PUMP 1A
13 AWG ORG 30 PUMP 1
18 AWG GRY 85 SWITCHED +12VDC
18 AWG BLK/YEL 86 PUMP RELAY
13 AWG RED BATTERY +VE
18 AWG GRY SWITCHED +12VDC
13 AWG ORG PUMP 1
13 AWG ORG PUMP 2
13 AWG BLK GROUND
J2: PC INTERFACE
9 PIN D - FEMALE
1
24 AWG <SHD> RED 2 TX
24 AWG <SHD> BLU 3 RX
4
24 AWG BLK 5 GND
6
7
8
9
J14: TRIM
PACKARD 1201 0717
PIN: 1212 4580L
20 AWG BLK A GND
20 AWG BLK/WHT B TRIM
18 AWG ORG C +5VDC
J15: SPARE A/D
PACKARD 1201 0717
PIN: 1212 4580L
20 AWG BLK A GND
20 AWG RED/BLK B SPARE A/D
18 AWG ORG C +5VDC
NOTES:
1. MAIN WIRE COLOUR LISTED FIRST
E.G. RED/GRN INDICATES RED WIRE WITH GREEN STRIPE
2. USE V-90 HT PVC INSULATION.
3. WIRE SIZES AS FOLLOWS (OR NEAREST EQUIVALENT):
AWG | AREA (sq.mm) | SUGG. STRANDING #COND / DIA(mm)
24 | 0.25 | 7/0.20
20 | 0.5 | 10/0.25
18 | 1.0 | 16/0.30
16 | 1.5 | 30/0.25
13 | 2.5 | 50/0.25
J8: MAP SENSOR
PACKARD 1202 0403
PIN: 1212 4582L
20 AWG BLK A GND
20 AWG YEL B MAP
18 AWG ORG C +5VDC
J16: TRIGGER INPUT
PACKARD 1201 5024
PIN: 1212 4580L
20 AWG BLK A GND
20 AWG RED/GRN B +13.8V INJ
20 AWG <SHD> YEL C TRIGGER
20 AWG <SHD> GRN D HOME
J6: O2 SENSOR
PACKARD 1201 0717
PIN: 1212 4582L
16 AWG RED/GRN A +13.8VDC INJ
16 AWG BLK B GND
20 AWG <SHD> GRY C O2 SENSOR
J13: INJECTOR HARNESS
PACKARD 1204 7938
PIN: 1204 8074
16 AWG WHT/BLK A AUX OUT2
16 AWG BLU B AUX OUT1
13 AWG RED/GRN C +13.8VDC INJ
16 AWG L. BLU E INJ1
16 AWG BLU/RED F INJ2
16 AWG GRN/RED G INJ3
16 AWG PINK H INJ4
J10: THROTTLE POS
PACKARD 1201 5793
PIN: 1212 4582L
20 AWG BLK A GND
20 AWG WHT B THROTTLE POS
18 AWG ORG C +5VDC
J11: AIR TEMP SENS
PACKARD 1216 2197
PIN: 1210 3881L
20 AWG BLK A GND
20 AWG GRY B AIR TEMP
J12: COOLANT SENS
PACKARD 1216 2193
PIN: 1210 3881L
20 AWG BLK A GND
20 AWG VIO B COOLANT
J9: IDLE SPEED MOTOR
PACKARD 1201 5798
PIN: 1212 4580L
18 AWG BRN/WHT A IDL4
18 AWG YEL/RED B IDL3
18 AWG BRN C IDL1
18 AWG GRN/YEL D IDL2
J7: IGNITION OUTPUT
PACKARD 1202 0786
PIN: 1212 4580L
20 AWG GRN/BLK A BYPASS / AUX I/O
18 AWG BLK B GND
16 AWG L. GRN C IGN OUT
16 AWG BLU D AUX OUT1
16 AWG WHT/BLK E AUX OUT2
16 AWG L. BLU F INJ 1
E6A MAIN HARNESS - ELECTRICAL
HALTECH, SYDNEY AUSTRALIA
DATE: 22ND NOV 1995 vas
REV C
SHEET 1 OF 1

LIMITED WARRANTY

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