Haltech E6 Instruction Manual

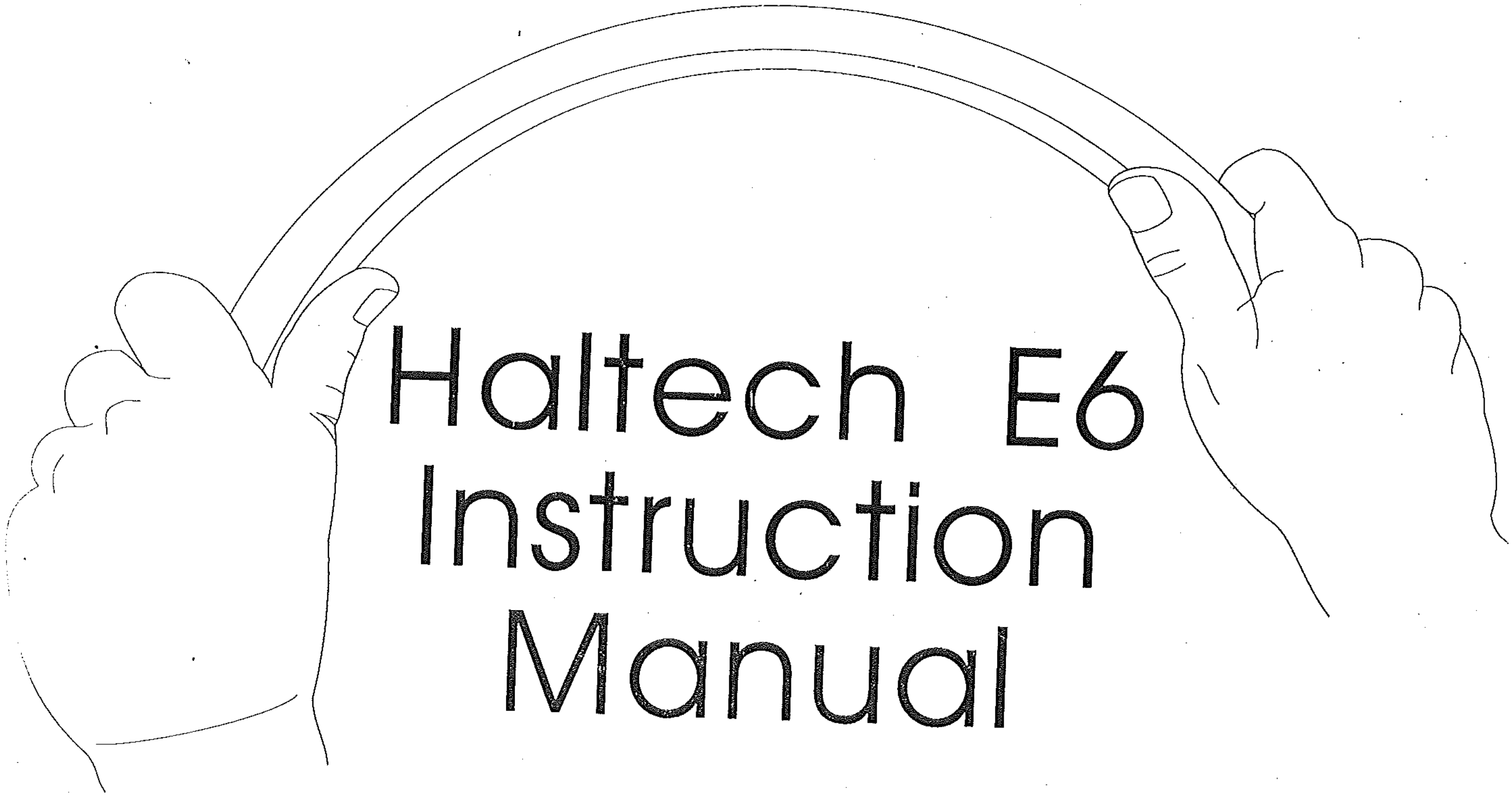


Table of Contents

Introduction to the Haltech E6

Thank you for purchasing a Haltech E6 system. We believe that the quality, versatility and affordability of the Haltech E6 make it the best programmable engine computer on the market for a wide range of applications. The Haltech E6 system optimises performance with the following capabilities :

- ignition timing control
- fuel control
- idle speed control
- closed loop capability

The Haltech E6 is a universal fuel injection computer designed to control electronic fuel injection systems and ignition systems on most ignition type engines. One basic design can control a four, six or eight cylinder engine. It does not matter if the engine is naturally aspirated or turbo or supercharged, the Haltech E6 can control it.

The Haltech E6 is more than a programmable fuel injection computer - it provides for data logging of engine data and allows access to engine data in real time for diagnostics. These characteristics can be vital to maximise performance and trouble-shoot problems in the vehicle.

Typical Applications

The Haltech E6 has many applications including

- Control system for conversion from carburetion to fuel injection.
- Control of fuel injection on modified engines (the vehicle's standard computer is designed to control a standard engine and is not suitable to control modified engines).
- Race and rally applications of all descriptions.
- Use in kits by kit manufacturers.
- Design and development purposes.
- Educational use by technical colleges and universities.
- Original equipment in cars and motor cycles.
- For use in cars, motor cycles, boats, jet skis and outboards.

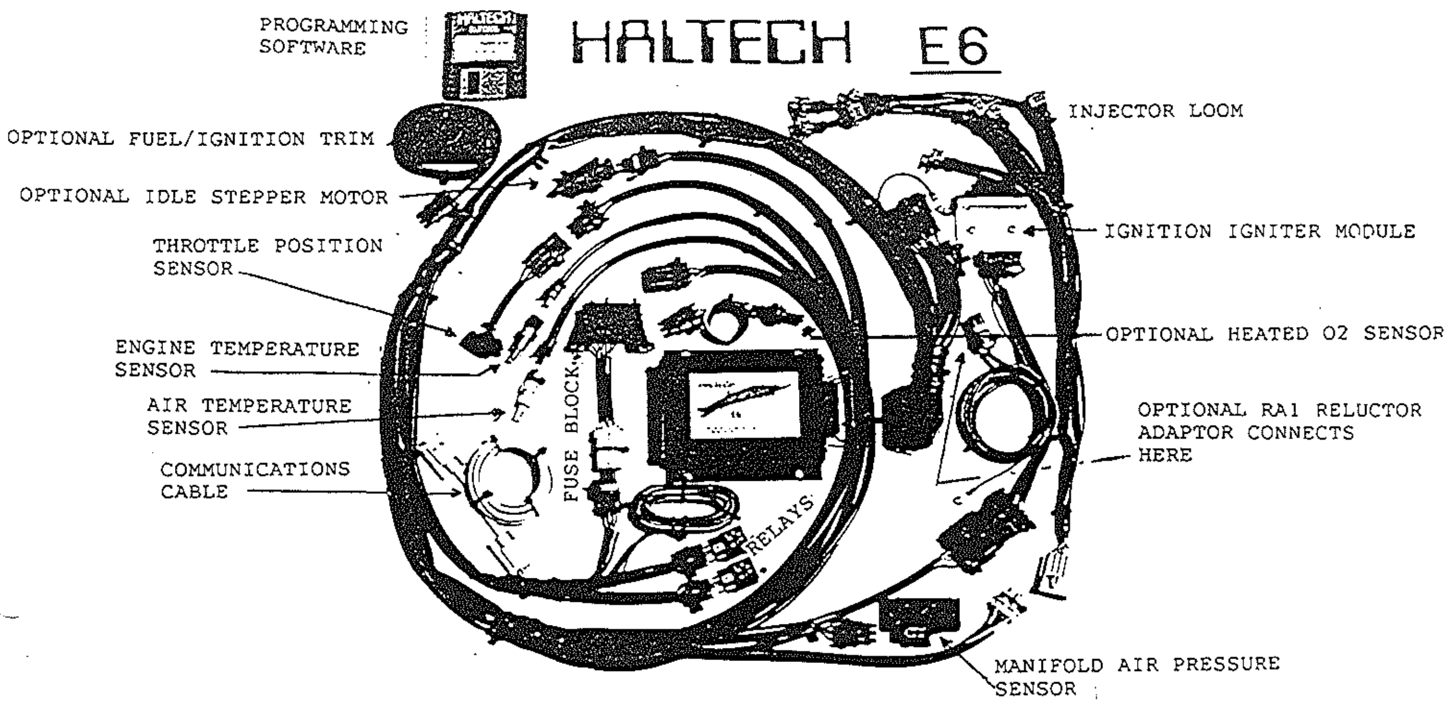
The Haltech is being used for all of the above applications through out the world including the U.S.A., Japan, Germany, U.K., Australia, S.E. Asia, New Zealand and other countries.

The Haltech E6 system of programming has been described as "10 times easier to program than any other system!". The reason is that the patented Haltech system virtually eliminates the input of numbers. You simply manipulate graphics in the form of bar graphs by pressing arrows to increase or decrease the height of the bar and in the process, the amount of fuel is increased or decreased at that particular load point. The process in repeated for all load points in each rev range. The values are shown numerically but very few inputs of numbers are required. Programming of the ignition timing, warm up and accelerator cycles is just as easy. The engine can be programmed on the dyno or on the road and the engine will not even hesitate as each change is made!

This instruction manual has been written to minimise the time it takes to get the Haltech E6 installed and running on your engine. The QuickMAP function and the provision of a library of ignition timing MAPs makes setting up the Haltech E6 even quicker! Time taken reading this manual will save you many hours as you become familiar with the many time saving functions available.

U. S. PATENT 5,056,026
CANADIAN PATENT 1,307,846
AUSTRALIAN PATENT 612191
OTHER PATENTS PENDING

Haltech E6 Engine Management System



The Haltech E6 System

The Haltech E6 is the ideal Programmable Engine Management System for the driver seeking optimum engine performance. No other system is as adaptable or easy to install and configure in its class. The Haltech system has been fitted to professional and semi-professional racing engines for years and the result has been countless racing successes including National and World speed records. The E6 has been adding impressive wins to this record.

The Haltech E6 is a fully programmable fuel injection computer with a great many abilities allowing precise control of fuel delivery under all conditions. Many correction factors are available to the user such as cold start prime, warm-up and many more. The E6 also offers programmable closed loop (feedback from an oxygen sensor) as an option, very important for any application where the meeting of emissions standards is an objective. The E6 also doubles as a fully mappable ignition timing computer so that the user is able to fully map the ignition timing precisely through the rev range so that the exact timing required to obtain optimium performance is applied in every RPM and load range.

Programming the HALTECH E6

The Haltech system of programming has been described as "10 times easier to program than any other system!". The reason is that the patented Haltech system virtually eliminates the input of numbers. You simply manipulate graphics in the form of bar graphs by pressing arrows to increase or decrease the height of the bar and in the process, the amount of fuel or ignition advance is increased or decreased at that particular load point. The process is repeated for all load points in each rev range. The values are shown numerically for reference but very few inputs of numbers are required. Ignition timing is programmed in a similar manner to fuel delivery by means of graphics. Programming of the warm-up and accelerator pump cycles and other correction factors is just as easy. The engine can be programmed on the dyno or on the road.

The programmer can switch to numeric mode and program with numerals if he wants to but the fact is that you would never want to!

The Haltech was described in one magazine article as "Fuel Injection for the 21st Century". We would not disagree!

Performance For the 90's And Beyond!

The HALTECH™ E6 System

SPECIFICATIONS

System Programming Requirements

- **Computer**
  IBM compatibles including laptops
  512K Memory preferred
- **Disk drive**
  3 ½" or 5 ¼" floppy disk drive
- **Serial port**
  Standard RS232C port 9 pin D connector
  25 pin cable supplied on request
- **Power source**
  8.6 - 16 volts
- **Power consumption**
  Haltech™ ECU
  270 mA at 12 volts
  Injector Load
  proportional to duty load
  Typical
  0.6 AMPS holding current injector

Input Sensors

- **Manifold Pressure Sensor**
  -100 KPa-0
  1 Bar: -30" hg to 0 Psi
  -100 KPa to 100 KPa
  2 Bar: -30" hg to 15 Psi
  -100 KPa to 200 KPa
  3 Bar: -30" hg to 30 Psi
- Programmable General Purpose Input (Nos etc)
- **Temperature Sensors**
  Temp. dependent resistor type.

Maximum Operating Range
Engine temperature:

Continuous	Intermittent
-40° F to 212° F	212° F to 257° F
-40° C to 100° C	100°C to 125°C

- **Throttle Position Sensor**
  Rotary potentiometer off throttle shaft
- **Engine Speed Pick-up**
  Tach adapters available to suit most applications.
  For fuel control only.
  Tachometer pick-up from negative side of coil, or original ECU tachometer output.
  For fuel and ignition control.
  Tachometer pick up from distributor or crank pick up.
- **Optional Heated Exhaust Oxygen Sensor**

Haltech™ ECU Outputs

- **Injector Drivers**
  1 to 8 Multipoint injectors can be directly driven from the ECU.
  Racing version for high fuel flow applications requiring more than eight injectors available.
- **Idle Air Control**
- **Ignition Drive Out**
- Programmable General Purpose Output (Nos etc)
- **Fuel Pump Power**
  Fused 20 Amp pump switch circuit, automatically controlled by ECU which will power standard EFI fuel pump directly.

Adjustable Features

- **Fuel and Ignition control.**
  . 18 speed ranges of 500 RPM separation with 32 load points per range.
- Programmable General Purpose Output (Nos etc)
- **Real Time Emulation**
  Haltech™ can be programmed while the engine is running
- **Fuel Cut On Deceleration**
  Fuel may be cut on deceleration with throttle closed.
- **Datalog**
  Engine parameters are saved to IBM memory eight times per second for future recall by ECU.
- **Closed Loop**
- Battery Voltage Correctic
- **RPM Limit**
- **Idle Speed Strategy**
- **Switchable metric or US units on all displays**
- **Adjustable Accelerator Pump**
- **Engine Warm-up Cycles**
  temperature range:
  -40° F to 235°F
  -40°C to 127°C

KIT CONTENTS

- **Haltech™ E6 ECU**
  (Electronic Control Unit)
- **Main Loom**
  Includes power relay wiring, engine sensor wiring. OEM-style all water resistant ECU connector and sensor connectors.
- **Injector Loom**
- **Two power relays**
- **One serial cable:** PC to ECU
  (9 pin is standard; request 25 pin.)
- **Engine temperature sensor**
  (GM# 25036979)
- **Air temperature sensor**
  (GM# 25036751)
- **Throttle shaft rotary position sensor**
- **Manifold Absolute Pressure Sensor**
  1 Bar, 2 Bar, 3 Bar to suit application.
- **Tach adaptor**
- **Programming software**
  (3½ is standard; request 5 ¼")
- **Instruction manual**

OPTIONAL EXTRAS

- **Heated exhaust oxygen sensor.**
- **Idle air control motor**
  (GM# 25527077)
- **Fuel Injectors**
  Wide range of flow rates available.
- Fuel Pumps
  Pre-pumps and high pressure pumps available.
- Throttle Bodies
  To suit varied applications
- Injector mounts
  Alloy body including "O" ring.
- Fuel Filters
  Various flow rates.
- Pressure Regulators
  Boost-referenced and fixed pressure regulators.
- Fuel Lines
  High pressure fuel line and fuel distribution equipment

PHYSICAL SPECIFICATIONS

Dimensions

Length	Width	Depth
6 ⅝"	5 ⅝"	1⅝"
168 mm	145 mm	41 mm

Weight

ECU	Loom	Sensors
1 ½ lb	5 lb	5.3 oz
740 g	2.03 Kg	170 g

Shipping Weight

7 lb 3.2Kg (including manual/package)

Casing

Black anodised aluminum with built-in cooling fins/mounting brackets

Haltech E6 Specifications

System Programming Requirements

- **Computer**

  IBM compatibles including laptops with 512K memory or more.

- **Disk Drive**

  3 1/2" or 5 1/4" floppy disk drive

- **Serial Port**

  Standard RS232C port 9 pin D connector
  25 pin cable supplied on request

Power Requirements

- **Power Source**

  8.6 to 16 Volts

- **Power Consumption**

  Haltech ECU : 270 mA at 12 Volts
  Injector Load : proportional to duty cycle (typical 0.6 amps per injector)

Input Sensors

- **Manifold Pressure Sensor**

  -100 KPa to 0 KPa
  1 Bar: -30"hg to 0 Psi
  -100 KPa to 100 KPa
  2 Bar: -30"hg to 15 Psi
  -100 KPa to 200 KPa
  3 Bar: -30"hg to 30 Psi

- **Programmable General Purpose Input (NOS etc)**

- **Temperature Sensors**

  Temp. dependant resistor type.
  Maximum Operating Range Engine Temperature
  Continuous
  -40 deg F to 212 deg F
  -40 deg C to 100 deg C
  Intermittent
  212 deg F to 257 deg F
  100 deg C to 125 deg C

- **Throttle Position Sensor**

  Rotary potentiometer off throttle shaft

- **Engine Speed Pick-up**

  Tach Adapters available to suit most applications

- **Optional Heated Exhaust Oxygen Sensor**

Haltech E6 ECU Outputs

- **Injector Drivers**

  1 to 8 multipoint injectors can be directly driven from the ECU.

- **Idle Air Control**
- **Ignition Drive Out**
- **Programmable General Purpose output (NOS etc)**
- **Fuel Pump Power**

  Fused 20 Amp pump switch circuit automatically controlled by ECU which will power standard EFI fuel pump directly.

Adjustable Features

- **Fuel and Ignition Control**

  18 speed ranges of 500 RPM separation with 32 load points per range.

- **Programmable general purpose output (NOS etc)**
- **Real Time emulation**

  Haltech E6 can be programmed while the engine is running

- **Fuel Cut on Deceleration**

  Fuel may be cut on deceleration with throttle closed.

- **Datalog**

  Engine parameters are saved to IBM memory eight times per second for future recall.

- **Closed Loop**
- **Battery Voltage Correction**
- **RPM limit**
- **Idle Speed Strategy**
- **Switchable metric or US units on all displays**
- **Adjustable Accelerator Pump**
- **Engine Warm-up cycles**

Physical Specifications

- **ECU Dimensions**

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

- **Weight**

  ECU : 1 1/2 lb (740 g)
  Loom : 5 lb (2.03 Kg)
  Sensors : 5.3 oz (170 g)
  Shipping weight : 7 lb (3.2 Kg) (including manual/package)

Casing

Black anodised aluminium with built-in cooling fins/mounting brackets

CHAPTER ONE

HALTECH E6 INSTALLATION

Overview

The Haltech E6 system comprises the following components

- Haltech ECU
- Coolant temperature sensor
- Inlet air temperature sensor
- Throttle position sensor
- Either 1, 2 or 3 BAR Manifold Absolute Pressure (M.A.P.) sensor
- Tachometric adaptor to suit engine ignition

  * Note - Only required when using magnetic or reluctor trigger.
- Main wiring harness
- Fuse block
- Injector wiring Harness
- Haltech E6 system Instruction Manual
- Haltech Tachometric Adaptor Instruction sheets
- Programming Cable
- Computer Disk

Optional Items

- Exhaust gas oxygen sensor
- Idle speed control motor
- Fuel injection trim
- Ignition timing trim
- Ignition module

You should identify and check all the above components as per drawings throughout this chapter. The Haltech E6 system comprises the electronic components required to measure the engine's operating parameters and provides the electronic signals required to control the engine. The output of the E6 is compatible with most electronic fuel injectors and high pressure pumps available. The tachometric adaptor is required to make your ignition system compatible with the E6 system. The tachometric adaptor you have been supplied is labelled with the type of ignition it was intended to be used with. You should check that you have the correct tachometric adaptor for your ignition.

Other components not supplied as part of the E6 system include

- Inlet manifold
- Throttle body
- Throttle linkages
- Injector mounts
- Fuel injectors
- High pressure fuel lines
- High pressure fuel pumps
- Pre pumps (if required)
- Inlet air cleaners
- Idle speed regulators (if required)
- Performance ignition system

To Install a Haltech E6 System you must

1 : Mount Manifold Absolute Pressure sensor part #32560 or #32586 or #32549

* Note - This component not required when using Throttle Position Mode

2 : Mount Coolant Temperature Sensor

3 : Mount Inlet Air Temperature Sensor

4 : Mount Throttle Shaft Position Sensor

5 : Mount Exhaust Oxygen Gas Sensor

6 : Mount Power Relays part #36434

7 : Route wire harness and connect engine bay sensors

8 : Mount fuse block

9 : Mount Electronic Control Unit (ECU) inside passenger compartment

10 : Connect suitable Tach Adaptor as explained in separate Tach Adaptor instructions

*** Note - Only required when using magnetic or reluctor trigger.**

11 : Locate and connect the following wires -

- RED - Always + 12 volts
- GREY - Ignition ON +12 volts
- BLACK - Chassis ground
- ORANGE (2 wires) - Fuel pump

12 : Connect Injector wiring Harness

13 : Mount Ignition Module

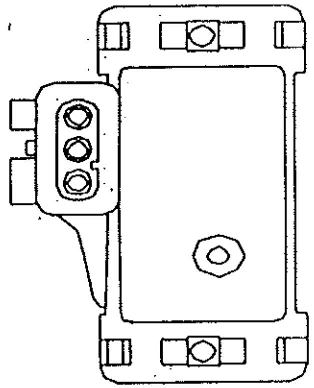
14 : Connect OPTIONAL Idle Speed Motor

15 : Connect optional fuel and ignition trims and mount trims inside cabin.

16 : Connect ECU and test.

Expanded Installation Guide

WARNING : The manifold air pressure sensor senses barometric conditions as well as manifold vacuum/pressure. WHEN THE E6 IS USED IN "THROTTLE POSITION" MODE THE MAP SENSOR MUST BE LEFT IN PLACE BUT THE VACUUM/PRESSURE LINK TO THE MANIFOLD MUST BE DISCONNECTED AND THE MAP SENSOR INLET LEFT OPEN TO ATMOSPHERE.



NOTES:

GM MAP SENSOR PN: 16040749 = 3 BAR (ORG)
GM MAP SENSOR PN: 16009886 = 2 BAR (ORG)
GM MAP SENSOR PN: 16137039 = 1 BAR (GRN/NONE)

MAP SENSOR PIN OUT
A - GROUND
B - MAP SENSOR OUTPUT
C - +5 VOLT

1. Mount Manifold Absolute Pressure (MAP) Sensor Part #32560, 32586 or 32549

The MAP sensor allows the Haltech E6 ECU to measure the Inlet Manifold Pressure. There are three types of MAP Sensors available

1 BAR - For non Turbocharged/Supercharged engines part # 32560 - COLOR CODE GREEN

2 BAR - For Turbocharged/Supercharged engines boosted up to 15 PSI (100KPa) part # 32586 COLOR CODE YELLOW

3 BAR - For Turbocharged/Supercharged engines boosted up to 30 PSI (200 KPa) part # 32549 COLOR CODE RED

Make sure that you have the correct MAP sensor to suit your engine.

The MAP Sensor is designed to mount on the firewall of the engine bay with the hose barb facing outward. The MAP SENSOR has two mounting screw holes. Locate a suitable position on the engine bay firewall, so that the sensor can be mounted and attach the sensor to the firewall. The barb on the sensor is connected to the inlet manifold vacuum through a short length of hose. Locate a suitable vacuum port on the inlet manifold that sees continuous manifold vacuum. Attach a hose to this port. Secure the hose to the port with a hose clamp or nylon tie. Cut the hose to length so that the other end connects neatly to the barb on the MAP sensor. Connect the hose to the MAP sensor and secure with a hose clamp or nylon tie.

NOTE : Do not position the MAP sensor too close to any Turbocharger. Avoid damage to the sensor from the extreme heat generated by a turbocharger.

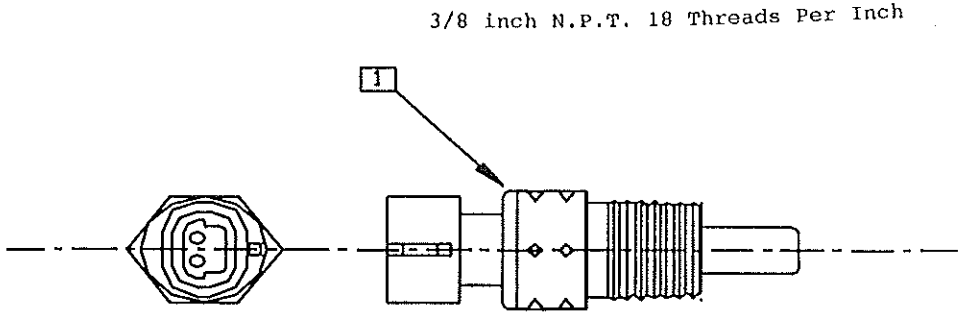
2. Coolant Temperature Sensor

There are two temperature sensors supplied with the E6. The inlet air temperature sensor has a small plastic cage around the temperature sensing tip. The coolant temperature sensor has a solid metal temperature sensing tip. Refer to the diagram to identify the coolant temperature sensor.

The coolant temperature sensor is designed to screw into a threaded hole in the engine to gain access to the engine's coolant stream. The sensor supplied is an industry standard component and some engines may already have provision for this type of engine sensor.

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. Since most engines have existing temperature sensors holes, it is usually possible to fit the Haltech ™ sensor in one of these holes. A thread adaptor is sometimes necessary. In some engines only one temperature sensor hole exists and it is used by the sensor for the dashboard temperature gauge sender. It is usually possible to install a tee-piece to allow both the dashboard gauge sender and the Haltech™ sender to share access to the same threaded hole.

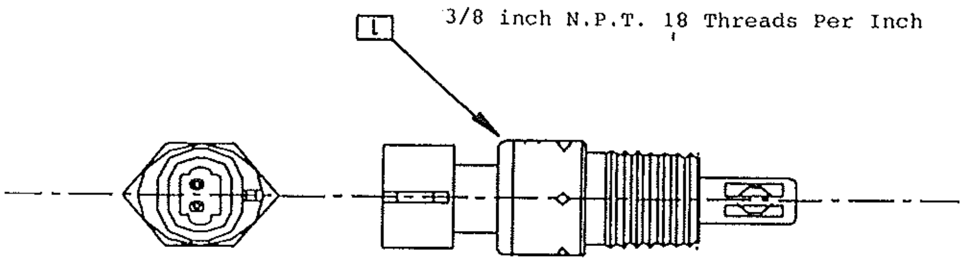
If it is necessary to drain the coolant from the vehicle to fit the coolant temperature sensor then the factory manual for the engine should be consulted for correct procedure to restore the coolant and purge the cooling system of air.



REFERENCE ONLY		
COOLANT SENSOR		
TEMP. TO RESISTANCE VALUE APPROX		
°F	°C	OHM
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
-40	-40	100,700

3. The Inlet Air Temperature Sensor

Refer to the diagram below and identify the inlet air temperature sensor.



Inlet Air Temperature Sensor

REFERENCE ONLY		
AIR TEMPERATURE SENSOR		
TEMP. TO RESISTANCE VALUE APPROX		
°F	°C	OHM
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
-40	-40	100,700

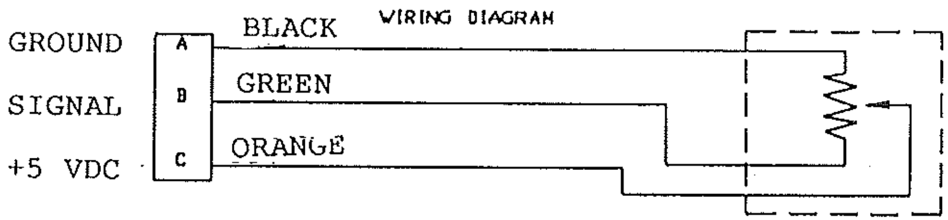
The inlet air temperature sensor is designed to sense changes in air temperature in the inlet manifold and is used by the ECU to calculate the density of the air within the manifold. This sensor measures the temperature of the air that the engine is drawing. It is desirable to install the sensor downstream from any turbocharger, intercooler or supercharger however the air temperature sensor has a finite response time to sudden changes in inlet manifold temperature. If an engine is turbocharged or supercharged with high boost pressures and/or no intercooler, so as to produce sudden extreme changes in inlet manifold temperature, you should contact your Haltech distributor for advice on where best to mount the inlet air temperature sensor.

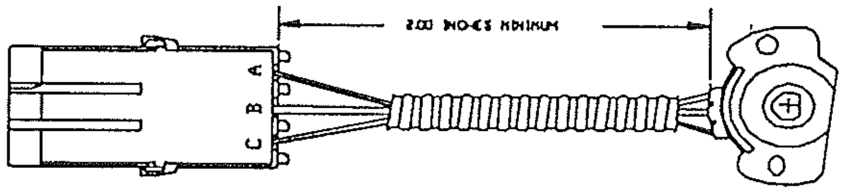
It is important to stop heat soak from the manifold to the air temperature sensor. When heat soak occurs, the readings the ECU receives will be for the temperature of the inlet manifold, rather than for the air within the manifold. The inlet air temperature sensor is designed to prevent heat soak because the sensor element protrudes into the air stream away from the manifold wall.

Aim to have the air flowing past the air temperature sensor the same temperature as the air that is being drawn into the cylinders for best operation.

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 inlet manifold or inlet ducting from the engine before attempting to machine the air temperature sensor mount. Do not allow any metal particles to enter the inlet manifold of the engine as these particles will be drawn into the engine and damage it. Wash all components before re-assembly.

4. The Throttle Position Sensor





The throttle position sensor measures the amount of throttle shaft rotation at the throttle body. The throttle position sensor supplied is common on many late model vehicles and may attach to your throttle body with little or no modification. The throttle shaft must extend to protrude from the side of the throttle body. This may require the machining of the existing throttle shaft or the manufacture of a new throttle shaft. The rotary position sensor is mounted so the shaft passes through it. The inner mechanism of the position sensor rotates with the shaft. File the surface of the shaft so that it is flat. This allows the shaft to pass through the hole in the sensor.

Two holes should be drilled and tapped to mount the throttle position sensor to the throttle body while allowing the centre of the sensor mechanism and the shaft to rotate. The absolute range of movement of the throttle position sensor is not important. The sensor movement is calibrated by software to accommodate a wide range of absolute sensor movements.

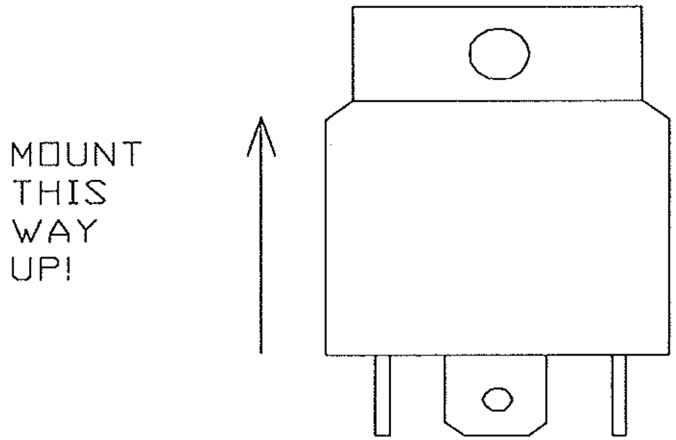
5. Mount the OPTIONAL Exhaust Gas Oxygen Sensor

The optional exhaust gas oxygen sensor must be mounted in the exhaust pipe near the exhaust header or extractors. 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 several feet (0.5 metres) down stream of 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. Your Haltech distributor can supply exhaust gas oxygen sensors ready to weld to your exhaust system.

When routing the electrical connections to the exhaust gas oxygen sensor do not allow the connections to touch the exhaust pipe as the heat of the exhaust pipe will damage them.

6. Mount the Power Relay to the firewall



The two relays are the MAIN POWER RELAY (Grey wire) and the FUEL PUMP RELAY (two orange wires). The relays have a steel tab to allow them to mount with single screws to a semi flat surface. Locate a suitable place on the firewall or on the inner fender to mount the relays.

Do not mount the relays upside down such that they catch splashed water. Residual water inside the relay housings will cause them to fail.

7. Route Wire Harness and Connect Engine Bay Sensors.

Lay the main harness out in the engine bay with the sensors mounted to ascertain the best fit for harness in the bay.

Punch a hole in the firewall to allow the harness to pass into the passenger compartment.

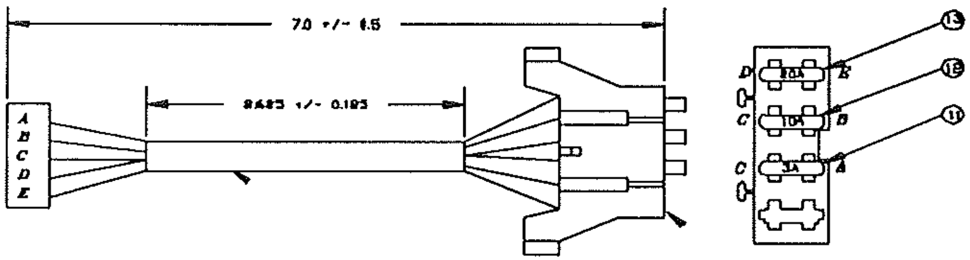
IMPORTANT

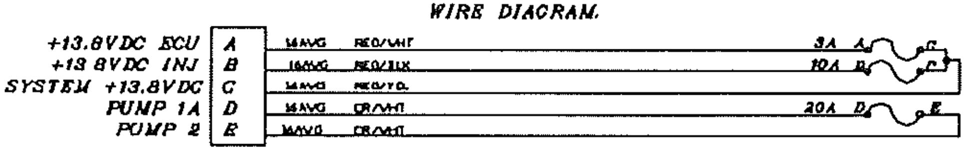
DO NOT allow the harness to touch hot exhaust parts including headers and turbochargers

BE NEAT. Run the harness in a tidy fashion. Try to run the harness along paths used by stock harnesses. Do not run the harness in close proximity to high tension spark plug leads. Use nylon cable ties to hold the harness in place. Pass the harness through the fire wall with a rubber grommet or other protection against rubbing. Ensure that the hole through the fire wall will not allow water or dirt into the cabin.

With the main harness fitted connect the M.A.P. sensor, coolant temperature sensor, air temperature sensor, throttle position sensor and optional exhaust gas oxygen sensor.

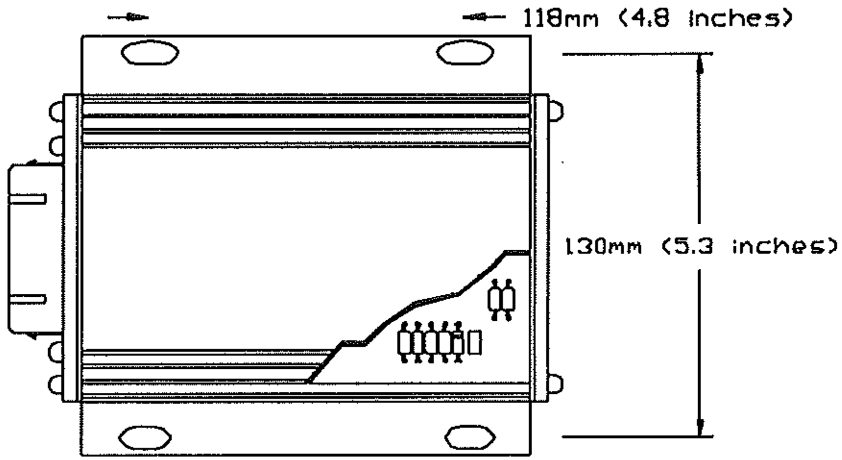
8. Mount the Fuse Block





The fuse block holds the main system fuse, the ECU power fuse and the fuel pump fuse. The position of the fuse block will be partly determined by the position of the main harness. 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 will be exposed to excess water. Mount the fuse block with two screws or nuts and bolts. Ensure that vibration will not cause the screws to vibrate loose.

9. Mount the ECU inside the passengers compartment



The Haltech E6 ECU is not designed to be water proof. 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.

The ECU has four mounting holes that allow it to be mounted to most flat surfaces. In cases of extreme vibration use anti-vibration mounts which incorporate rubber mouldings to absorb vibration (ie Lord mounts etc). When mounting the ECU remember that the communications connector should remain accessible for ease of programming.

10. Connect Suitable Tach Adaptor

The tachometric adaptor is ***only*** required for reluctor trigger pick-ups and for FUEL-ONLY applications. Hall Effect and Optical pick-ups can be connected without a tach adaptor. The instructions for connecting and mounting the tach adaptor are supplied separately to this instruction manual. The tach adaptor has a single connector that connects to the main E6 harness.

11. Locate and Connect the Following Wires

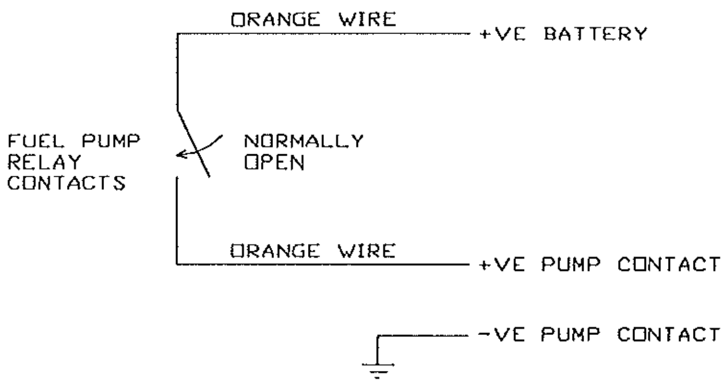
Note : These connections are the same on every E6.

BLACK - Locate a good chassis ground point and connect the BLACK WIRE. Note the Haltech E6 system's noise immunity is enhanced if the chassis ground is improved. Negative battery terminal is best.

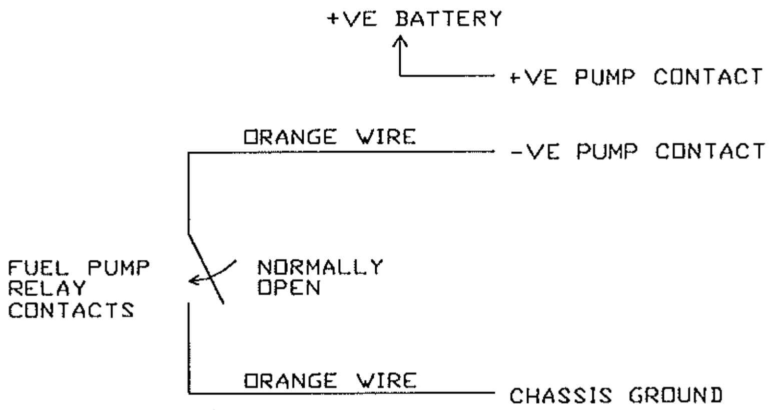
RED - Locate a source of continuous +12 volts and connect the RED WIRE. Positive battery terminal is best.

GREY - Locate a switched source of +12 volts and connect the GREY WIRE. This wire should see +12 volts only when the ignition key is turned ON.

ORANGE - The two ORANGE WIRES form the contacts of a normally open switch. Two connections are possible depending on whether the positive or negative connection to the pump is to be switched. The following diagram shows an example of switching the positive connection to the fuel pump(s).



The following diagram shows an example of switching the negative connection to the fuel pump(s).



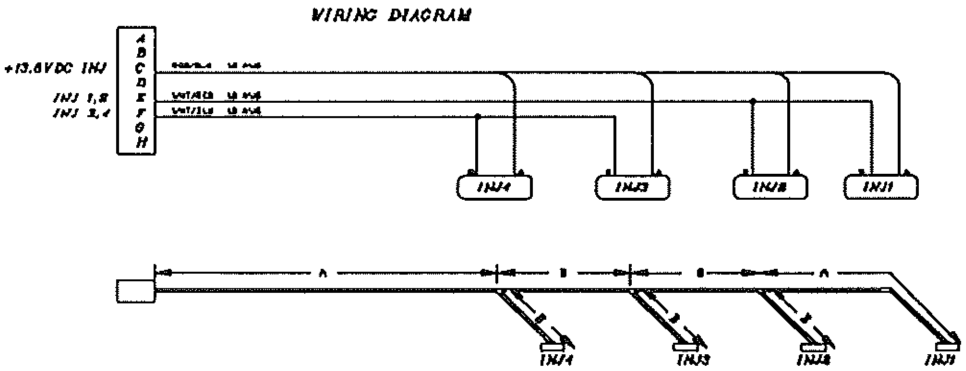
Remaining Connections

Each E6 is preconfigured for the application required. Refer to the application sheet attached for special connections.

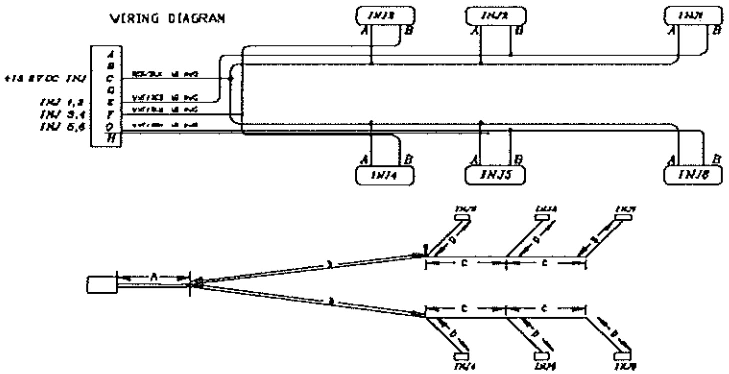
12. Connect Injector Wiring Harness

The fuel injectors are connected to the main E6 harness by the Injector harness. The injector harness supplied should have one main connector and the same number of fuel injector connectors as your engine has cylinders. Lay the Injector harness on your engine to determine the best way to run the harness. There is no order in which the fuel injector connectors connect to the fuel injectors. Any fuel injector connector can connect to any fuel injector.

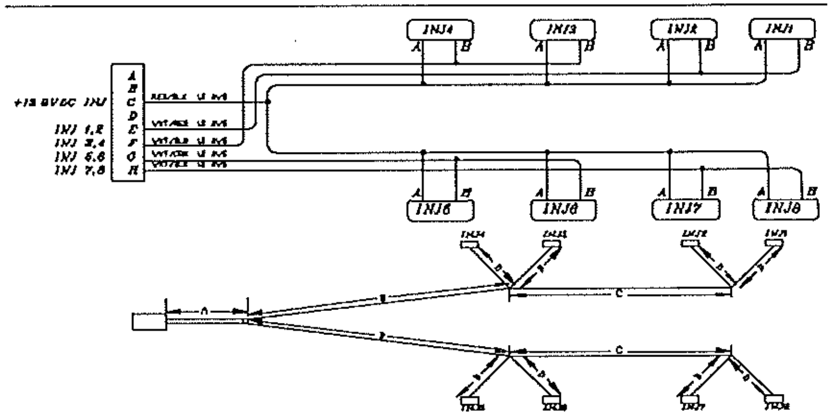
Connect the Injector wiring harness to the main E6 harness.



A typical Four Cylinder Injector Wiring Harness



A typical Six Cylinder Injector Wiring Harness



A typical Eight Cylinder Injector Wiring Harness

13. Connect the OPTIONAL Idle Speed Motor

If your engine has a suitable Idle Speed Motor (sometimes called Idle Air Control or IAC motor) then connect it now. If you do not have an Idle Speed Motor tie the connector off neatly in the engine bay.

14. Connect OPTIONAL trim modules

The OPTIONAL fuel trim module gives +/- 10% to the fuel mixtures across all engine speeds and loads. The OPTIONAL ignition trim module gives +8 to -7 degrees of ignition advance. Both trims are identical and may be used for either fuel or ignition trimming. Both trim modules connect to the main harness near the ECU connector. When a trim module is disconnected no trim to that function is applied. i.e. The fuel trim remains at 0% trim until a trim module is connected. The ignition trim remains at 0 degrees until a trim module is connected.

15. Connect the ECU and test

With the ignition switch in the off position connect the ECU to the main harness. Turn the ignition switch to the ON or RUN position. DO NOT ATTEMPT TO START THE ENGINE AT THIS STAGE. When the ignition is switched on the fuel pump should run for several seconds and then stop. If the fuel pump does not run or fails to stop running then refer to the TROUBLE SHOOTING section of this manual.

CHAPTER TWO

Getting ON LINE

Now that your Haltech E6 system is wired with all sensors in place, the system can be connected to a personal computer. This will allow the readings from the sensors you have connected to be tested and the results displayed on the computer's screen.

What You Will Need

To connect the PC to the Haltech™ ECU you will need the program disk and communication cable provided.

Computer Compatibility

The computer you use can be any MS DOS compatible personal computer (PC) or IBM PC AT, XT or clone. As a minimum, your computer must have 512 Kilobytes (512K) of Random Access Memory (RAM), a CGA,EGA or VGA screen driver and at least one disk drive. In addition, it is usually more convenient if you use a laptop computer. Most laptop computers have a suitable screen driver and 3-1/2 inch floppy disk drive as standard equipment.

MS DOS stands for "MICROSOFT™ DISK OPERATING SYSTEM" and is the standard program used by IBM™ compatible computers. It runs in conjunction with the program currently chosen for use in the personal computer at any time. A copy of MS DOS is usually supplied with the computer either built in so that it "boots up" automatically when the PC is switched on or on a separate floppy disk which must be booted up before other programs such as the Haltech program is run. In the latter case, the MS DOS disk can be copied on to the Haltech disk by following the instruction manuals that come with the PC so that both programs boot up from one disk automatically. If you are not particularly familiar with computers, ask someone who is to configure your Haltech disk so that it runs automatically.

STEP ONE

Connecting the Haltech™ ECU to a Computer

The D connector end of the communication cable connects to the RS232C port on your computer. The other end plugs into the D connector on the main loom. Communications cables are supplied standard with a 9 pin D connector. This is the format most laptop computers use. Some desktop computers have a 25 pin RS232C port. Communications cables with 25 pin connectors are available on request.

The programming cable can be up to 100 feet in length if you need it. This can be handy in dynamometer room situations where the Haltech ™ system is in the Dyno room with the engine and you wish to adjust it from the dyno control room.

Power Requirements

Anytime you want to communicate with Haltech ECU through your computer the ECU must have power. This usually involves turning on the ignition switch. The grey and red wires must have +12 volts and the black wire must go to ground.

If power is lost in any way, the message "Reconnect Haltech" will appear on the computer screen.

STEP TWO

Installing The Software

When you turn on your computer, it should "boot up". If you already have MS DOS installed in your computer or on your "booting up" disc, you will see one of the following (or a simple variation) on your computer screen. This is called the DOS prompt:

A:\> B:> C:\> or D:\>

If your screen gives you the message "Please Insert a System disk" and the Haltech disk is NOT in the floppy drive it is necessary to run a registered copy of MS DOS according to the instructions that come with your computer.

Switching disk drives

Once you have the DOS prompt visible on your screen, you must ensure that you are working in drive "B". To do this, type the following command after your DOS prompt: (Note some systems use **A:** not **B:**)

B: <Enter>

You should then see the following DOS prompt (or a simple variation):

B:\>

You are now ready to install, or run, the Haltech™ software

How to run your Haltech™ software

Insert the Haltech disc into Drive A or B.

Type the following command:

Autoexec

and then press the ENTER key.

STEP THREE

Acknowledging the Risks

The program will run automatically. The title page should appear on the screen briefly before the software starts to run. A screen warning will then appear. Read the warning and discontinue running the software and return your Haltech system to a Haltech distributor for professional installation if you are not prepared to accept the risks involved in tuning your own engine. Incorrect setting of your ignition or fuel system can seriously damage your engine. The correct ignition timing settings for one type of engine can destroy a different type of engine.

STEP FOUR

The Online and Offline Modes

A screen will appear which gives the option of using the system in ONLINE MODE or OFFLINE MODE. The OFFLINE MODE option is very useful to familiarise yourself with the Haltech software but should not be used to make lasting adjustments to fuel or ignition MAPs unless there is a special reason to make these changes OFFLINE and until you gain more experience. If you wish to experiment press "N" for OFFLINE MODE but if the Haltech ECU is installed and power is available to it we suggest that you first try using the ONLINE MODE. Press "Y" on the keyboard for ONLINE MODE.

Using The System Online

In the online mode there is a two-way flow of information between the ECU and your computer. The online mode is used to program the Haltech™ system. The communication cable must be connected and the ECU must have power.

The online mode is the one that you will use most frequently. While using the system online, you can view engine information directly and make adjustments. Any changes or modifications you make will immediately be recorded by the ECU and implemented. Changes made online are instantaneous. There is no need to save these changes. Once you unplug the communication cable, the ECU will remain in the configuration you have set up.

NOTE: If there is a power shortage or the communication cable is disconnected or interfered with, the following message will be displayed on your computer screen:

RECONNECT HALTECH

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

The Main Menu

When you select online mode the Haltech MAIN MENU screen appears. This menu allows access to the fuel injection curves, ignition timing curves, file storage/retrieval functions, System Identification page, Engine Data screen and the options page.

How To Quit

Throughout the program you can return from any function by pressing either the spacebar or the escape key depending on the screen you are in. Press it again to return to the main menu. Pressing the <CRTL> key and the Q key simaltaneously at the Main Menu will allow you to exit the Haltech program and will return you to MS-DOS.

Checking the Engine Data

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

This is a very useful function for analyzing the engine sensors. To bring up the engine variables press "E" when the MAIN MENU is being displayed. To return to the MAIN MENU press any key.

You should NOT start the engine yet because you still have to set up the fuel injection and ignition timing curves. You should view the engine data and see that the engine sensor readings look reasonable for a stopped cold engine before continuing.

CHAPTER THREE

The QuickMAP Function and Starting the Engine

How the Haltech E6 stores Information

The characteristics you set for a particular engine are saved in the memory of the Haltech™ ECU. If you make a change while in the ONLINE MODE the memory of the ECU is permanently altered to reflect the change. This occurs immediately even when the engine is running.

You don't have to do anything more to hold the information in the ECU. You can make a copy of the information in an ECU and store this information to computer floppy disk as explained later in this manual. This information can be moved back and forth between floppy disk and ECU as desired. Getting the information from the floppy disk into the ECU is called LOADING. Storing the information from the ECU to floppy disk is called SAVING.

Checking the IDENTIFICATION

The Identification tells the E6 important information about your engine. For an E6 to work on your engine it needs both an IDENTIFICATION section and fuel and ignition MAPS to suit your engine. You can LOAD the IDENTIFICATION and the MAPs or you can LOAD the ignition timing MAPs separately. LOADING MAPs separately is used for loading MAPs from the MAP library when you don't want to alter the IDENTIFICATION.

When you receive your Haltech E6 the IDENTIFICATION should show information that matches the configuration of your engine. Do not alter the IDENTIFICATION unless it appears incorrect for your engine. You should check that the information in the IDENTIFICATION looks correct. To see the IDENTIFICATION press I at the MAIN MENU.

To change any field in the Identification use the arrows to highlight the field you want to change and then press enter. Type in the new information and press ENTER again. Some of the fields in the Identification relate to advanced functions discussed later in this manual that are not critical to getting the engine running for the first time. The following items on the Identification screen must be correct for the engine to run

- The number of cylinders shown should match the number of cylinders in your engine.
- The Map sensor should suit your engine

  1 BAR = Naturally aspirated
  2 BAR = Turbo to 15 lb (100 KPa) boost
  3 BAR = Turbo to 30 lb (200 KPa) boost

- Load sensing should be MANIFOLD if you have fitted a MAP sensor or THROTTLE if you are using throttle position to determine load on naturally aspirated engines ONLY.
- Trigger degrees should be set to the number of degrees of engine rotation before each piston reaches top dead centre that the E6 is triggered. This is determined by the position of the trigger pickup in the distributor or crank trigger. See tach adaptor instruction sheets.
- Trigger edge determines whether the E6 is to trigger on a rising or falling edge from the tach adaptor. See the tach adaptor instruction sheets for how to set this field.

The rest of the fields in the identification are not as critical. These fields and their meanings are briefly listed here for completeness and are discussed more fully in later chapters

- The RPM limit should be set to the maximum RPM that your engine will be allowed to see.
- The Units field sets whether the information presented to you is presented in US or Metric units. This field has NO effect on the operation of the E6.

- Decel Cut-off should be turned off during initial set up. The Decel Cut-off shuts the fuel to the engine off when decelerating with the throttle closed.

Once the information displayed matches your engine then exit the IDENTIFICATION by pressing the ESCAPE KEY and proceed to create a fuel MAP.

Programming Fuel Delivery with the QuickMAP Function

The easiest way to set up your E6 fuel delivery is by using the QuickMAP Function. The QuickMAP function creates a fuel MAP from four or five pieces of information that you give it. By becoming familiar with the QuickMAP function you should be able to create a MAP that will suit your engine.

To access the QuickMAP function press O when the MAIN MENU appears and then press Q when the OPTIONS MENU appears. The QuickMAP screen has four fields if the system is configured for a 1 BAR MAP sensor and five fields if the system is configured for a 2 BAR or 3 BAR MAP sensor. Before starting the QuickMAP function you should enter information in each of the fields.

- The first field specifies the fuel injection period used at idle.
- The second field specifies the fuel injection period to be used at peak load and at peak torque. This is the peak injection period the engine will see. For turbo or supercharged engines this is at peak boost pressure.
- The third field specifies how much affect the camshaft timing has on fuel delivery over the RPM range of the engine. Enter a percentage of extra fuel that the engine is to receive at peak torque than at 1500 RPM.
- The fourth field specifies where the peak torque is in the RPM range.
- The fifth field will only appear if the system is not configured for a 1 BAR MAP sensor i.e. the engine is turbocharged or supercharged. The fifth field is the maximum boost pressure the engine will see from a turbocharger or supercharger. This tells the QuickMAP function the pressure to apply the peak torque/peak load milliseconds.

The quickest way to set up an E6 is to use the QuickMAP function to build a MAP that is close to the needs of your engine. Once you have refined the engine running as far as possible using the QuickMAP function you may further customise a QuickMAP to suit your engine using the instructions in chapter five.

Using the QuickMAP Function

The E6 was loaded with a fuel MAP that should be close to the needs of your engine.

While the ECU system is online, you can create a set of fuel MAPS using the QuickMAP function. To do this, press "O" when the Main Menu appears then press "Q". The QuickMAP function erases the contents of the ECU's fuel MAPs and replaces it with the fuel MAPs created to your specifications.

Highlight the QuickMAP field that you want to change by using the UP ARROW and DOWN ARROW keys. Type in the new information for that field. Press the ENTER key again. Once you have changed all the fields press S to start creating the QuickMAP.

The QuickMAP function is an aid to set up a series of fuel MAPs to help you get started quickly. The resulting fuel MAPs may be the optimum fuel MAPs for your engine although further customising is often required for optimum results. You should use the feedback from an exhaust gas analyser to ensure that the fuel mixtures are correctly set at every load/speed point.

Starting the Engine

Now that you have checked the Identification and either created a fuel MAP or decided to use the factory loaded fuel MAP, you are ready to start the engine. To make it easier to get started the E6 is shipped with the ignition timing locked at ten degrees before top dead centre. This is sufficient ignition advance to allow the engine to start and run. As you attempt to start the engine for the first time you should check that this BASE timing is set to ten degrees.

Checking the Base Timing

The E6 uses a timing reference taken either from the distributor or from a flywheel sensor. This gives the E6 the reference on which to position all ignition timing. If this timing is wrong then the E6 cannot function correctly. To ensure that this base timing is set correctly the E6 has a TIMING CHECK FLAG.

When the TIMING CHECK FLAG is set the ignition timing is forced to 10 degrees before top dead centre. This is regardless of what ignition timing MAPs are currently in the E6. You must check the base ignition timing before clearing this flag.

To check the base timing you should now start the engine. The engine should start and run although with only ten degrees of ignition advance the idle speed may be lower than usual. Use an ignition timing light to check that the ignition timing is set to ten degrees before top dead centre. See the workshop manual for your engine for details on checking ignition timing and the use of a spark timing light.

The timing should be locked at ten degrees B.T.D.C.. If it is not then it will be necessary to shift the base timing. If your engine uses a timing reference taken from the distributor then loosen the lock mechanism on your distributor to allow it to rotate. Rotate the distributor slowly while using the spark timing light until the spark timing is set to 10 degrees B.T.D.C..

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 ten degrees B.T.D.C.. If the base timing is locked at ten degrees B.T.D.C. and does not change with engine speed then you are ready to load the ignition timing MAPs and clear the Timing Check Flag.

If the ignition timing does change then see the trouble shooting procedure in chapter 13.

Determining the Engine's Fuel Needs

The fuel Map you create using the QuickMAP function depends on the needs of your engine and on the capacity of your fuel injectors. A fuel MAP was loaded into the E6 before it left the factory. The characteristics of the factory selected fuel MAP are written on the label on the ECU.

If the engine starts and blows black smoke then it is rich and you should load a fuel MAP with less injection duration. If the engine "gasps for air" as the throttle is opened then it is lean and you should create a richer MAP. The fuel needs of the engine will change as the engine warms up so wait until the engine is at operating temperature before fine tuning the fuel delivery. If you decide to change MAPs then do so in small increments. You should not attempt to load the engine until you have loaded an ignition timing MAP. The engine will not make any useful power with the ignition timing locked at ten degrees B.T.D.C.. Once you have a fuel MAP loaded that lets the engine idle and rev under no load you should stop the engine and proceed to LOAD an Ignition Timing Library MAP. The following paragraphs assume that you have an ignition MAP loaded.

Using A Dynamometer And Exhaust Gas Analyser

One of the best ways to set the fuel curves up is with an automatic engine or chassis dynamometer. This will allow the engine to be held accurately at each operation point while it is being tested. Combined with feedback from an exhaust gas analyser this gives excellent results. This will give the feedback you need to refine your use of the QuickMAP function.

Performance Engine Considerations

If you regularly set up performance engines your Haltech™ Dealer can supply a high speed exhaust gas analyser. These analysers give a reading in approximately one quarter of a second for a change in mixtures from 10% to 90% of full deflection. The speed of response on exhaust gas feedback is very important. For instance, an analyser that takes ten seconds to read mixtures would endanger the engine by leaving it run too long with potentially incorrect fuel mixtures.

Performance engines can not be held at incorrect mixtures for ten seconds while they are being adjusted. If the air-fuel ratio leans out too far the heat generated can damage the engine by melting the pistons or warping the exhaust valves.

Varying The Air-Fuel Ratio

Air-fuel ratios must vary across the operating range of the engine depending on the power that the engine is producing. The heat that the combustion is producing rises as the air-fuel ratio approaches stoichiometric (ie. ideal proportions of air-fuel, or 14.7:1). An engine can run closer to stoichiometric air-fuel ratios if it is under light loads. As the load is increased, the air-fuel ratio must drop.

Under very light loads, such as highway cruising, the air-fuel ratio can be close to stoichiometric. For naturally aspirated engines full load mixtures should be held around 12.5:1. At this mixture the engine will be crisp and responsive but should not cause overheating problems. Running the engine rich will make it "doughy" (unresponsive), give poor fuel economy and shorten spark plug life. Extended running with the mixtures too rich will cause the oil on the cylinder bores to wash down and will lessen piston ring life. The only justification for lowering air-fuel ratio past 12.7:1 is to stop excessive cylinder temperatures which may damage the engine.

Turbocharged engines may have to use richer full load mixtures to offset the high inlet charge temperature and detonation. Racing engines running very high boosts may have to see air-fuel ratios as low as 11:1 to stop excess engine heat causing detonation. This will sacrifice power because, although the engine is running rich, it may give back more power than is sacrificed by allowing higher boosts to be run.

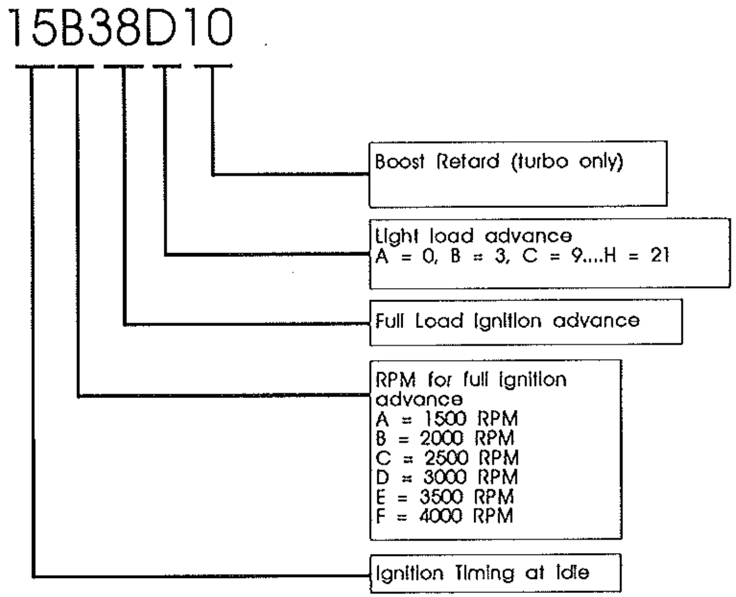
CHAPTER FOUR

Setting up Ignition Timing using Library MAPs

Now that your engine is running with the ignition timing locked to ten degrees you should load an ignition timing MAP from the library and unlock the ignition timing.

Programming with the Library of Ignition Timing MAPS

The easiest way to set up your E6 ignition is by LOADING one of the igntion timing MAPS from the MAP library supplied on the computer disk. 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 stored under a different file name. The file name reflects the characteristics of the ignition timing MAP. File names can be up to eight alphabetic or numeric characters in length. The ignition timing library MAPS use these eight characters as shown where the first character is always a number.



- The first two characters in the ignition timing MAP name specify the ignition timing to be used at idle. The example MAP name shown has 15 degrees of advance at idle.

- The third character in the ignition timing MAP name specifies how quickly the ignition is to advance with RPM. Option A has full advance in by 1500 RPM. Option B has full advance in by 2000 RPM. Option C has full advance in by 2500 RPM. Option D has full advance in by 3000 RPM.

- The fourth and fifth characters in the ignition timing MAP name specify the full load advance. The cruise or light load advance used on non turbo engines is added to the full load advance. The retard under boost used on turbocharged or supercharged engines is subtracted from the full load advance.

- The sixth character in the ignition timing MAP name specifies the extra ignition advance to use at light loads such as highway cruise. The sixth character is a letter of the alphabet. If the sixth 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 under light load up to the letter H.

- If the engine is turbocharged or supercharged then the seventh and eighth characters specify the retard the engine is to get under boost. If the engine is not turbocharged or supercharged then leave the filename only six characters in length.

There are several thousand ignition timing library MAPs supplied. The ignition timing MAPs are spaced to represent a cross section of different engine needs. The quickest way to set up the ignition timing in an E6 is to find the ignition timing MAP to suit your engine from the library. Ignition timing library MAP filenames always start with a number. You may further customise an ignition timing MAP to suit your engine using the instructions in chapter five. MAPs that you create or customise must be stored with filenames that start with a letter of the alphabet. This convention shows if the engine is using a library MAP or a customised MAP.

Selecting the MAP from the library

Why is Ignition Timing so Important?

Engines compress fuel and air on the compression stroke and ignite the compressed mixture with an electrical spark. The mixture burns and the force of the expanding gases forces the piston back down the bore. This downward power stroke is when the cylinder does all its work.

The burning is not instantaneous. It takes a finite amount of time from when the spark occurs for the flame to get going. The pressure in the cylinder due to the burning builds up over a fraction of a second after the spark has occured.

If the spark occured when the piston reached top dead centre on it's compression stroke the piston would be well on it's way back down the bore by time the expanding gases reached peak pressure. To harness the power of the expanding gas it is necessary to get the explosion to be almost reaching peak pressure as the piston gets to top dead centre on the compression stroke. This confines the maximum gas pressure in the smallest cylinder volume to do useful work. As the piston goes down the bore the pressure is maintained by the on-going burning even though the cylinder chamber is effectively getting bigger.

To achieve this it is necessary to start the burning some time before the piston reaches top dead centre on the compression stroke. It is not normal to measure engine movement in units of time before top dead centre. If it were then we might say that we wanted the spark to occur, say, one hundredth of a second before top dead centre and ignition timing would be simpler to understand. Instead it is normal to define the spark firing position in degrees of engine rotation before top dead centre on the compression stroke.

An engine turning at 1000 RPM takes twice the time to travel the same number of degrees of engine rotation as an engine at 2000 RPM. The burn takes the same time for both engine speeds so if the burn required 10 degrees of engine travel at 1000 RPM it will need 20 degrees at 2000 RPM. As the engine speed gets higher the spark must be fired earlier and earlier to get maximum power. Correctly setting when the spark occurs gives power and efficiency.

If the burn always took exactly the same time to occur then we could work out the timing for an engine using a calculator and get it right every time. Unfortunately, the time that the burn takes is affected by the type of fuel, the ratio of fuel to air, the temperature of the cylinder and the cylinder pressure in the engine. The pressure in the cylinders goes up as the throttle is opened allowing the engine to draw more air per cycle. The burn takes less time for higher cylinder pressures. Different fuels burn at different speeds. Fuel mixtures slightly richer than stoichiometric (i.e. just enough fuel to burn up all the air in the mixture) burn faster than fuel mixtures that are rich or lean. These effects make setting ignition timing a matter of what works for your engine, however there are some rules of thumb.

Pre-ignition and Detonation

Increasing the speed at which the flame front travels increases engine power. Starting the spark early (i.e. more advanced) lets the burn develop more before the cylinder reaches top dead centre and gives faster flame speed. So why not run lots of advance and make lots of power?

As the flame speed in your engine approaches the speed of sound the mixture stops burning in an orderly way and starts to explode instead. This explosion puts shock loadings on the components in your engine. The flamefront in a normal engine travels at about 100 feet per second (30 metres per second). The flamefront can travel as fast as 4000 feet per second (1200 metres per second) under the wrong conditions. This can smash holes in the top of pistons, crack piston rings and lift head gaskets.

There are two ways in which the flame speeds can get out of control and damage your engine. The first of these occurs in two stages. First the engine starts to KNOCK. Knock is the early warning sign of DETONATION and occurs because the heat of the flamefront causes the gases in the cylinder far away from the spark plug to explode. After KNOCK the flame speed gets so fast that the mixture stops burning at all and just explodes. This is called DETONATION.

The spark plug still ignites the mixture when KNOCK and DETONATION occur. Knock and detonation can result from the spark being too far advanced (i.e. too early). If this is the case then you can control knock and detonation by retarding (i.e. making later) the spark. Knock and detonation can also be caused by lean fuel mixtures and compression ratios that are just too high.Compression ratios can be incorrect if the engine block or cylinder head have been machined.

The second way cylinder pressures can get out of control is if the cylinder pressure on the compression stroke is high and a piece of carbon or a sharp edge inside the cylinder head gets very hot. This point acts as a spark plug and ignites the mixture. This has the same effect as having the ignition timing very advanced. This is called pre-ignition and moving the spark timing can have little effect because the mixture ignited before the spark occurred. Pre-ignition can be caused by the compression ratio of the engine being too high, by running spark plugs with a heat range that is too hot, by poor fuel or by running too much turbo boost pressure.

Detonation can lead to pre-ignition. If the engine starts to detonate at one engine speed then the heating that this causes in the cylinder chamber can cause further detonation or even pre-ignition to occur at other speed ranges not normally affected if the engine is held under load. Once detonation or preignition starts they will normally not stop until the load is removed from the engine.

Both pre-ignition and detonation have similar symptoms. The engine makes a muffled rattling noise not unlike the sound a pressurised can of spray paint with a marble in it makes when you shake it. The sound of detonation is hard to hear over the sound of normal engine sounds. If the engine has sports exhaust it may not be possible to hear it at all. Both pre-ignition and detonation usually occur when the engine is labouring under high loads. It is critical that the engine is not allowed to pre-ignite or detonate during tests. Pre-ignition or detonation will not usually damage the engine if they occur for a fraction of a second during testing so long as the load is removed as soon as the pre-ignition or detonation starts, however this is highly dependant on the type of engine. The best way to avoid mechanical failure is to not let the engine detonate or pre-ignite.

Choosing the ignition timing MAP

Your Haltech E6 has been supplied with an ignition timing MAP that should allow your engine to start and run. The name of the ignition timing MAP that was loaded into your E6 at the factory is written on a label on your ECU. This is the factories' best guess at the requirements of your engine from the information you have supplied and may not be the optimum for your engine. The most important characteristics of any ignition timing MAP are the maximum ignition advance it allows under full load and how quickly the ignition timing is allowed to advance with engine speed. You can tell how much maximum advance the engine gets under load by the 4th and 5th characters of the ignition timing MAP name.

The library of ignition timing MAPs has a range of MAPs with the same characteristics but different maximum advance. For example, if the ECU has the ignition timing MAP 15B34C10 which gives 34 degrees of full load advance and you decide that you want more full load advance you might choose 15B38C10 which gives 38 degrees of full load advance. For less full load advance you might choose 15B30C10 which gives 30 degrees of full load timing.

You can also vary how quickly the engine reaches full load advance with speed. The ignition timing MAP 15B34C10 reaches 34 degrees of advance at 2500 RPM. If this is too quick then you could try 15D34C10 which reaches 34 degrees of advance at 3000 RPM. Or if you want the advance to come on quicker you might try 15B34C10 which reaches 34 degrees of full load advance at 2000 RPM.

Manufacturers specifications for engines usually specify the maximum advance for an engine and the engine speed by which the full load advance is to be all in. Increasing the ignition timing past the manufacturer's specifications may give some more power however you risk damaging your engine. The power the engine makes will increase as you advance the ignition. Further advancing the ignition timing will see no further increase in power. Still further advancing the ignition timing will result in detonation. Ideally the full load advance should be enough to get optimum power while remaining 4 degrees or more retarded from where the engine starts to detonate. Any experimentation to find where an engine wants to run should start retarded and slowly advance in small steps monitoring for detonation at each step. Once the power stops increasing take a step back toward retarded. Atmospheric conditions like air temperature and humidity which vary from day to day can push an engine that is set too close to detonation to detonate so do not advance the engine too close to detonation.

Retard Under Turbocharger/Supercharger Boost

Unlike naturally aspirated engines the cylinder pressure in a turbocharged or supercharged engine keeps going up as the boost pressure goes up. This pushes the engine into detonation or pre-ignition. This is made worse because turbochargers and superchargers heat the air as they compress it.

The detonation can be stopped by retarding the ignition timing as the boost pressure increases. The E6 ignition timing library MAPs for boosted engines have eight characters. The seventh and eighth characters in these ignition timing MAPs specify the ignition retard to be used under boost. The ignition retard is subtracted from the full load ignition advance. For example, The ignition timing MAP 15C38C10 reaches 38 degrees full load advance with zero boost pressure. Under 3 pounds (20 kPa) or more boost pressure the ignition timing is retarded by 10 degrees to 28 degrees B.T.D.C..

Please note that retarding the ignition timing under boost can stop detonation but will not stop pre-ignition. Retarding the ignition will normally allow a few more pounds of boost to be run safely before detonation or pre-ignition occurs. To stop pre-ignition you must lower the cylinder pressure by lowering the engine's compression ratio, lowering the maximum boost pressure or cooling the inlet air by intercooling or water injection. Detonation or pre-ignition will limit the maximum boost that most boosted engines can run.

Cruise Advance under Light Load

Under light load the cylinder pressures are very low because the throttle plate is nearly shut. This allows the ignition timing to be well advanced without fear of detonation. Advancing the engine under light load can considerably improve the fuel consumption of the engine.

Ignition timing library MAPs for naturally aspirated engines have a letter of the alphabet as the sixth character in their name. This character specifies the light load advance to be added to the full load advance.

Sixth Character of Filename	Ignition Advance added under light Load
A	0
B	3
C	6
D	9
E	12
F	15
G	18
H	21

For example, the ignition timing MAP 15B34D will give 34 + 9 = 43 degrees of advance under light loads.

Ignition Advance at Idle

The ignition advanced used at idle can help stabilise and smooth the idle quality. The idle speed will increase as more advance is used at idle. This is because the engine becomes more efficient at idle with more advance. This lowers the fuel consumption at idle and can help cold starting. Too much advance at idle can lead to the engine wanting to idle too high and "popping" in the exhaust. If the idle speed is then lowered by closing off the throttle the engine can become unstable and stall if sudden loads such as air conditioning are engaged.

The library of ignition timing MAPs covers a range of different ignition timing values. The first two characters in the ignition timing MAP name set the ignition timing at idle. For example 15A34C12 will use 15 degrees of advance for cranking and at idle.

Loading an Ignition Timing MAP from the MAP Library

The E6 was loaded with an ignition timing MAP that should be close to the needs of your engine. The filename of the ignition timing MAP loaded at the factory is written on the label of the E6 casing. You may wish to try this ignition timing MAP before loading any library MAPs.

Loading Ignition timing MAPS: Floppy Disc To Haltech™ ECU

While the ECU system is online, you can load an ignition MAP from the MAP library. To do this, press "F" when the Main Menu appears then press "M". The load command erases the contents of the ECU's ignition timing MAPs and replaces it with the set of ignition timing MAPS taken from the library.

The engine should not be running under load while ignition timing MAPS are being loaded.

Select the name of the ignition timing MAP you wish to load by using the arrow keys to highlight that name and press return. Your computer will then pause to ask if everything is OK before continuing the load. If you're ready to proceed, press "Y" to continue. If there is an error, abort by pressing "N". The load will take approximately thirty seconds.

You can now load the ignition timing library MAP best suited to your engine. If you decide to change ignition timing MAPs then do so in small increments. If you have a dynamometer then use it to test one part of the engines cycle at a time. Do not experiment unless you are sure you can detect detonation or pre-ignition. If you are unsure about any aspect of tuning then seek professional advice.

Clearing the Timing Check Flag

Once you have completed the necessary checks with the TIMING CHECK FLAG set and all appears to be correct then you should clear the flag. With the MAIN MENU displayed press T. This will clear the TIMING CHECK FLAG and enable the ignition timing MAPs. The ignition timing will jump from ten degrees B.T.D.C to whatever ignition timing you have defined with the ignition timing MAPs. Pressing T again will set the TIMING CHECK FLAG again and lock the ignition timing to ten degrees again.

To see the ignition timing currently being used by the E6 go to the MAIN MENU and press E. This will display the engine data gathered by the E6. Use the spark timing light to check that the ignition timing shown on the E6 engine data and the timing actually being used are the same.

CHAPTER FIVE

Customising the Library MAPs

Now that your Haltech E6 system is loaded with QuckMAP fuel MAPs and ignition timing MAPs from the MAP library, and the engine is running, the advanced user may further customise the MAPs by the features presented in this chapter. Before using any of the features presented please record the name of your best QuickMAP and library MAPs so that you may return to them at any time.

The ignition timing library MAPs have been created to suit a wide range of engines. You should be able to choose QuickMAPs and library MAPs that come close to the needs of your engine. The library MAPs are limited in the way they can be chosen to match your engine by the number of characters in the library filenames. SImilarly, the QuickMAPs are limited by the number of pieces of information that you supply. Your engine may benefit from changes that are more subtle than you can get by going to another QuickMAP fuel MAP or ignition timing library MAP.

The tutorials presented in this chapter are examples of how you might use the advanced functions to make typical modifications to the MAPs. These tutorials are aimed at explaining both why and how some typical changes might be made.

What are MAPs?

The E6 measures the engines speed and load. Ignition timing MAPs are the look-up tables that the E6 uses to relate the engine speed and load to the ignition timing to apply at that engine speed and load. Fuel MAPs are the look-up tables that the E6 uses to relate the engine speed and load to the fuel delivery to apply at that engine speed and load. Each look up table is called a MAP. For both fuel and ignition timing the engine speed determines which MAP is being used. The values within the MAP are called BARs. The engine load determines which BAR in that MAP is being used.

Every speed and load combination is represented by one BAR. The height of the BAR represents the ignition timing or fuel delivery to apply at that speed and load.

What is MAPPING the Engine?

MAPPING the engine is setting the height of all the BARs so that the ignition timing and fuel delivery is correct at every speed and load combination. The easiest way to MAP an engine for fuel delivery is to use the QuickMAP function. The easiest way to MAP an engine for ignition timing is to load an ignition library MAP. When you use the QuickMAP function or load an ignition timing library MAP you have adjusted every BAR for fuel or ignition timing. You can now alter the MAP by individually altering the height of any BAR in any MAP. This will alter the fuel delivery or ignition timing the engine gets at that speed and load.

The Main Menu

When you select online mode the Haltech MAIN MENU screen appears. This menu allows access to the fuel MAPs, ignition timing MAPs, Correction MAPs, file storage/retrieval functions, System Identification page, Engine Data screen and the options page.

Press M to see the list of fuel MAPs or press A to see the list of ignition timing MAPs.

Accessing The Fuel and Ignition MAPs

Both fuel and ignition timing MAPs are accessed in the same way. The function keys marked X, F1 to F8 and <ALT> are used to bring up the different MAPs. These keys are usually found in a block to one side or above the keyboard.The keys F1 to F8 bring up the ten ignition timing curves from 0 RPM to 8000 RPM in even 1000 RPM intervals. Pressing ALT and F1 to F8 brings up the odd ignition timing curves from 500 RPM to 8500 RPM. .i.e. If you want the 4000 RPM map you press F4. If you want the 8500 RPM MAP you press ALT and F8. The zero RPM or cranking map is displayed by pressing X. Return to the main menu from any fuel map by pressing the space bar.

Finding the MAP Currently being Used

Pressing the HOME key brings up the MAP currently being used by the engine. This works for both the fuel and ignition MAPs. This is ideal for tracking in on the engine's current operating point quickly. Pressing any of the keys displayed on the menu page, while in any of the MAPs, will bring up the appropriate MAP. This includes the home key. Also pressing "P" and "N" while in any graph will bring up the previous and next range respectively.

Adjusting Bar Height In The MAPs

The height of the BARs in the MAPs can be readily adjusted by using the keys identified below. The bar that is outlined on the computer screen indicates the bar that you are currently adjusting.

To move the adjusting bar, use the left and right arrow keys. If the engine is using one of the values in the graph you are currently viewing then an arrow will appear on the screen above the value being used. If the engine is operating outside the speed range that is being displayed on the screen then the arrow will disappear until the engine again enters the speed range being viewed. To adjust the height of the bar being viewed use the following keys:

up arrow raises the height of a bar one increment
down arrow lowers the height of a bar one increment

PgUp raises the height of a bar five increments
PgDn lowers the height of a bar five increments

While holding the SHIFT key down:

PgUp raises the height of a bar ten increments
PgDn lowers the height of a bar ten increments

While holding the CONTROL key down:

PgUp raises the height of a bar thirty increments
PgDn lowers the height of a bar thirty increments

Size Of Increments

For the ignition timing MAPs each increment is one degree of engine crankshaft rotation. For the fuel MAPs each increment is 0.064 milliseconds of injector ON time.

How To Quit

To return to the main menu from any of the MAP displays press the spacebar on the PC. Throughout the program you can return from any function by pressing either the spacebar or the escape key depending on the screen you are in. Press it again to return to the main menu. Pressing the <CRTL> key and the Q key simultaneously at the Main Menu will allow you to exit the Haltech program and will return you to MS-DOS.

Tutorial on Adjusting a Bar

When the MAIN MENU appears press M. The list of fuel MAPs will appear. Press F5 to make the 5000 RPM MAP appear. You should see a BAR graph. Try using the left and right arrow keys to move the outlined BAR left or right. The outlined BAR is the BAR you are currently adjusting. If the engine were between 4750 RPM and 5250 RPM an arrow would appear above a BAR on this graph. This arrow will point to the BAR currently being used by the system. If the engine is not between 4750 and 5250 RPM then the arrow will disappear.

The arrow lets you relate real engine load to a BAR so that you know what BAR needs adjusting form the way the engine is running. The outlined BAR is the BAR you are adjusting. If you want to adjust the BAR the engine is currently using the arrow has to point to the outlined BAR.

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 5000 RPM at the load shown for the BAR you have selected. Make sure you move the BAR back to it's original height once you have tried adjusting it so as not to destroy the MAP you now have loaded. Now try using the SHIFT key and the PAGE UP key together. The outlined BAR should jump up five increment (5 * 0.064 = 0.32 milliseconds). As the BAR gets taller, the fuel delivery is becoming richer at that engine speed and load. Now press the SHIFT key and the PAGE DOWN key and the height of the outlined bar should move down five increments.

Note that the fuel delivery for the outlined BAR is shown in the bottom corner of the display. Try using the CONTROL key and the PAGE UP key together to move the BAR up by 30 increments (30 * 0.064 = 1.92 milliseconds). Move the BAR back down by using the CONTROL key and the PAGE DOWN key.

To leave this MAP press the SPACE BAR. This will return you to the list of fuel MAPs. To return to the MAIN MENU press the SPACE BAR again. The ignition timing MAPs can be changed in the same way except each increment is one degree of engine rotation.

Tutorial on changing the ignition advance at idle

This tutorial leads you through a typical change that you might make to an ignition timing library MAP. All ignition timing library MAPs use the ignition timing at idle to set all BARs in the 0 RPM, 500 RPM and 1000 RPM ignition timing MAPs. This forces the engine to use the idle ignition timing until it gets over 1000 RPM. This assumes that your engine does not idle over 1000 RPM and that your engine will not want more ignition timing below 1000 RPM.

Many Larger capacity engines idle much lower than 1000 RPM. V8 engines can be doing useful work at 1200 RPM and would like some more advance by 1000 RPM. To achieve this we need to change the 1000 RPM ignition timing MAP.

When the MAIN MENU appears press A for ignition timing MAPs. The list of ignition timing MAPs will appear. To display the 1000 RPM MAP press the F1 key. The MAP used at 1000 RPM will appear. The load on the engine increases as the BARS go from the left hand side to the right hand side of the graph. The lightest engine load is on the far left hand side.

For this tutorial we will advance the ignition timing by five degrees under light load and three degrees under full load at 1000 RPM. Press the CONTROL key and the LEFT ARROW key at the same time. The outlined bar should jump to the left several places. Keep doing this until the left most BAR is outlined. The left hand most BAR is BAR number one. The system will BEEP if it is told to go still further left since it cannot do so.

Press the SHIFT key and the PAGE UP key at the same time. This will advance the ignition timing by five degrees at that load at 1000 RPM. Now move to the next BAR to the right by pressing the RIGHT ARROW key. Again press the SHIFT key and the PAGE UP key at the same time. Repeat this procedure to raise the height of all the bars up to BAR twenty by five degrees.

Move to outline BAR 21. This is about where the load on the engine starts to become significant and you only want three degrees of advance. Press the UP ARROW key three times. This advances the ignition timing three degrees. Press

ARROW key to outline BAR 22. Again press the UP ARROW key three times. Repeat this procedure for the remaining BARs.

The changes you made during this tutorial took effect the instant you pressed the UP or DOWN arrow keys. You don't have to do anything else to save these changes. If you start the engine and rev it to 1000 RPM you should see the arrow appear above the BAR that the system is currently using.

Time Saving Functions

All Ranges Option - Press <ALT> and <R>

In order to allow all eighteen ignition timing MAPs or all eighteen fuel MAPs to initially be set up as quickly as possible, the Haltech™ E6 system has an ALL RANGES function which allows all BARs of the same number in all eighteen MAPs to be set up at the same time.

When the ALL RANGES function is active, adjustment of a bar on one graph is duplicated to the same bar on all the ignition curves. If you use the all ranges option, you can set the shape of any one, say, ignition timing MAP and all other ignition timing MAPs will be identical at every bar you adjusted. This feature enables all graphs to be given some rough initial shape quickly if you do not want to make use of the MAP library. Once you have used the ALL RANGES Option for a starting point, exit the ALL RANGES option to tailor each MAP individually.

Half BARs Mode

Most fuel MAPs and ignition timing MAPs are very smooth curves. They often do not need all thirty two BARs to convey the resolution required by the engine. To speed the set up time, the number of BARs displayed can be halved. Pressing ALT and B with any MAP displayed halves the number of BARs displayed. Every second BAR is hidden although it is still used by the ECU. As you make adjustments, the hidden BARs are set to the average of the BARs on either side of the hidden BAR.

You can switch back and fourth between NORMAL and HALF BAR MODE as much as required to save effort.

GROUP CHANGES TO SELECTED RANGES OF BARS

To make the process of adjusting bars easier, more than one bar can be changed at once in any particular MAP. By pressing the CTL and the LEFT ARROW keys together, the next bar to the left of the currently selected bar will be chosen as the left hand extremity of the group of bars to be adjusted as a group. The same process can be used to select the right-most bar of the group by pressing CTL and RIGHT ARROW simultaneously at the appropriate bar. In the bottom left hand corner of the screen, the first and last bar numbers of the group are displayed, along with their respective heights. If only one bar is selected, then only this bar appears in the display. IF MORE THAN ONE BAR IS SELECTED THEN ALL ALL ADJUSTMENTS ARE CARRIED OUT ON ALL OF THE BARS IN THE SELECTED GROUP.

The extremity of the selected group of bars can be moved to the left or right by using the LEFT and RIGHT arrow keys until it reaches the end of the graph. To decrease the width of the group of bars selected, use the ALT and LEFT or RIGHT ARROW keys together.

PERCENTAGE CHANGE OF THE GROUP OF BARS

For a quick percentage change of the group of selected bar(s), press the CTL and P keys together. Enter the percentage change that you require and then hit ENTER. To decrease the size of the group enter the percentage change as '-' e.g. '5' and then press ENTER.

VIEWING AND MAKING CHANGES TO LOOK-UP TABLES NUMERICALLY

You may never need to use the facilities to view and make changes numerically but they are included for those who may to wish to use the facility. The big advantage of the patented Haltech system is that you do not need to input or view a mass of numbers. In the normal Haltech mapping mode the height of the bar simply represents a numerical value and the value of that bar is shown on the screen as it is high-lighted. The value represents the time in milliseconds that the injectors will open and the computer will access that number under the correct conditions of RPM you had selected 1.51 and RETURN or ENTER or pressed an arrow then the value actually entered would have been 1.54. The new value entered will then be the current value for that part of the table and when you return to the bar graph displays you will find the relevant bar will have increased or decreased in height.

This facility can be used whilst in any part of the fuel map menu. To return to the point at which you switched to numerical form press ESC.

CHANGE TO NUMERICAL TABLES- IGNITION

When you select ignition maps it is possible to view the chart of look-up tables in numerical form and also to make changes numerically. From the main menu press I and then press ALT and N simultaneously. A table of numbers will appear which represent the numerical values of the look-up tables set out by groups of RPM and BAR ranges. It is not practical to display the total ignition map look-up tables on one page so only 10 RPM and and 10 BAR RANGES are displayed at any one time. To view other parts of the table press the UP or DOWN arrows or PAGE UP or PAGE DOWN to view other RPM ranges. Press sideways arrows to view other BAR RANGES.

Numbers can be changes by inserting a value and pressing RETURN or ENTER or by pressing an arrow to move to a different location. The program will select the nearest valid value and enter it into the program. Only whole numbers will be accepted and only those numbers within a valid range. The new value entered will then be the current value for that part of the table and when you return to the bar graph display you will find that the relevant bar will have increased or decreased in height.

This facility can be used whilst in any part of the ignition map menu. To return to the point at which you switched to numerical form press ESC.

DUTY CYCLES

Fuel delivery is obtained by opening and closing of the injectors allowing fuel to flow during the period that the injector is open. The period when open is called the pulse width. As RPM's increase it is possible for pulse widths to overlap so that the injectors are open all the time at higher RPM. This is referred to as a 100% duty cycle.

To digress for a moment, the reason that sequential injection does not give the benefits that most imagine is that the benefit of sequential is only obtained when the pulse width is small enough to fire the injector so that the firing co-incides with the opening of the inlet valve. As RPM increase the injectors can be open for a good portion of the revolution, so the benefit of sequential is lessened or lost. To take it to an extreme, when the point is reached when the injector is hard open (not that uncommon) the benefits of sequential injection are totally lost This happens at high RPM, the time when most power is looked for, so sequential injection gives only marginal benefits in most cases.

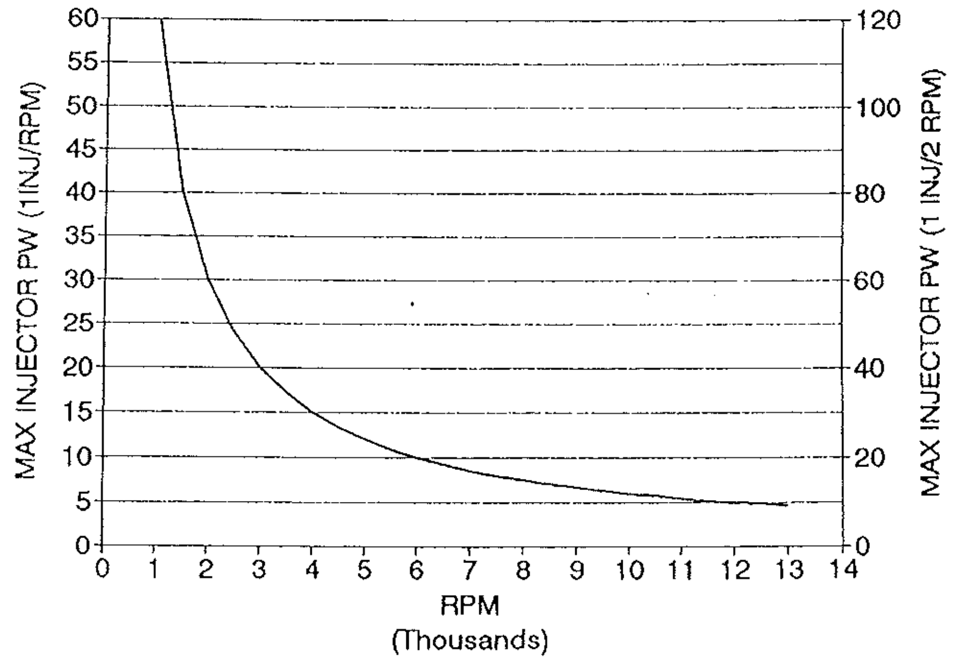
When 100% duty cycle is reached there is no more flow to be had from the injectors and increasing revs brings with it the danger that the engine will lean out. LEANING OUT AN ENGINE WILL CAUSE DAMAGE TO THE ENGINE IN MOST CASES. The following tables and graph show the point at which the injectors will 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.

In the table there are 2 columns, one for each injector firing once per revolution and the second for once every 2 revolutions. This is determined in the setting up of the engine parameters in the identification page. (see section regarding setting up of identification page and 'ignition divide by').

MAXIMUM INJECTOR PULSE WIDTH
VERSUS SPEED AND IGNITION DIVIDE

SPEED RPM	1 INJ/RPM MSEC	1 INJ/2RPM MSEC
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

MAX INJECTOR PULSE WIDTH VS. RPM



CHAPTER SIX

Throttle Response

You should now have the optimum fuel and ignition timing MAPs loaded for constant load running. The functions outlined in this chapter will improve the throttle response of your engine.

The manifold pressure sensor used with the E6 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. This can be improved by keeping the length of vacuum pipe 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 occurring and the pressure reaching the sensor. This can be masked by using the throttle accelerator pump option.

Calibrating the Throttle Position Sensor

The throttle position sensor movement may vary from engine to engine depending on the type of throttle body and how the sensor was mounted to the throttle body. To overcome this variation the software in the Haltech E6 can compensate so that the sensor is seen as 0% open when the throttle is shut and 100 % open at full throttle.

To calibrate the throttle position sensor press O when the MAIN MENU appears and C when the OPTIONS MENU appears. The system will ask you to fully close the throttle and then press S. This defines throttle closed. The system then asks you to open the throttle fully and press S again. This defines full throttle. You can check the throttle calibration by viewing the ENGINE DATA. To view ENGINE DATA press E when the MAIN MENU appears. Both IDLE SPEED CONTROL and CLOSED LOOP functions use the throttle calibration. If the throttle body is changed or the E6 MAPs are used on a similar engine it will be necessary to re-calibrate the throttle position sensor.

Throttle Accelerator Pump Option

To overcome any lean out during sudden throttle movement the Haltech™ system uses a throttle accelerator pump function. This ability delivers extra fuel during sudden throttle movements.

To change the values used in this function, press O when the MAIN MENU appears and then T when the OPTIONS MENU appears. Four single bars will appear on the screen. The two bars on the left called lo increase and lo sustain are used below 1800 RPM. The two bars on the right called hi increase and hi sustain are used above 1800 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 will be dependent on manifold design and engine inertia.

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 toggle between the four bars.

The throttle pump values should be set up after the fuel and ignition timing MAPs are correctly tuned for steady load running. Attempting to smooth out engine transients before the fuel and ignition MAPs have been optimised for steady state running may become confusing. The four throttle response BARs should be adjusted by trial and error to give optimum throttle response both above and below 1800 RPM. Generally, you may not need much above 1800 RPM. You could expect much higher values below 1800 RPM. i.e. lo increase and lo sustain much bigger than hi increase and hi sustain.

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.

CHAPTER SEVEN

Cold Starting and Running

The Haltech E6 system applies a three part strategy to cold engine starting and running. The COLD START PRIME function gives the engine the initial burst of fuel it needs to start at cold crank. The FUEL COOLANT MAP controls the addition fuel required when the engine is not at operating temperature. The IGNITION COOLANT MAP controls the extra ignition timing required when the engine is not at operating temperature.

Cold Cranking - The COLD START PRIME function

At cold crank the air speed in the inlet manifold is very low. The fuel injected is poorly atomised and tends to wet down the walls of the inlet manifold rather than getting carried into the cylinders as a mist. The cylinder chamber temperatures is also low causing poor combustion. To overcome these inefficiencies, it is necessary to inject a prime pulse of fuel at the start of cold cranking to ensure that the engine sees enough fuel in the cylinder chambers to start.

The E6 provides a cold start prime pulse 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. To access the COLD START PRIME function press C when the MAIN MENU appears and then C when the CORRECTION MAPS MENU appears. Across the bottom of the MAP displayed is the engine temperature. The engine temperature increases from left to right. An arrow appears showing which bar the system is currently using. Each BAR represents a different engine temperature. The height of each BAR controls the duration of the prime pulse at that temperature. The higher the BAR the longer the prime pulse.

A typical COLD START PRIME MAP was loaded into your E6 at the factory. You should not modify it unless you experience trouble with cold cranking. If you do modify the cold start prime duration then it is best to have a laptop computer connected to allow the changes to be made during cold starting.

Typically the engine will need prime pulses around 20 milliseconds at around 0 degrees celsius (32 F). The engine will probably not need any pulse at all once the engine is close to operating temperature. Over priming the engine will flood it. If you flood the engine, continuously crank the engine with the throttle wide open to allow the excess fuel to clear. The prime pulse only occurs when you first turn the ignition to the crank position.

The Fuel Coolant MAP

Once started, an engine needs more fuel when it is cold than when it is hot. The Haltech™ system does this by using a curve to give a percentage increase in the amount of fuel delivered over the entire engine operating range versus engine temperature.

To access the Fuel Coolant MAP press C when the MAIN MENU appears and then press F when the CORRECTION MAPS MENU appears. The warm up graph is thirty two bars wide. Each bar sets the amount of extra fuel at a given temperature. The temperature increases from left to right. An arrow appears showing which bar the system is currently using. Adjusting the height of the bar immediately adjusts the percentage of extra fuel the engine is receiving.

Your Haltech™ ECU comes supplied with a warm up curve. Before adjusting this function, you should leave the engine overnight to cool. Before the engine is started from cold have the Haltech™ system online. As the engine warms up it will select each of the bars from left to right. Adjust the height of each bar so that engine performance is optimised. A time dependent warm-up function is triggered when the ECU is first powered. This gives an initial 10% enrichment for the first 256 fuel injections decreasing to 0% (approximately 16 seconds idling).

The Ignition Coolant MAP

Once the engine is started, cold engine performance can often be enhanced by advancing the ignition timing by a few degrees until the engine reaches operating temperature. The Haltech E6 allows for this through the IGNITION COOLANT MAP. To access the IGNITION COOLANT MAP press C when the MAIN MENU appears then press I when the CORRECTION MAPS MENU appears.

Across the bottom of the MAP display is the engine temperature. The engine temperature increases from left to right. An arrow appears showing which bar the system is currently using. Adjusting the height of the bar immediately adjusts the ignition timing the engine will see at that temperature. Each BAR represents a different engine temperature. The height of each BAR controls the ignition timing adding to or subtracted from the hot engine ignition timing. The BAR display is broken by a horizontal line. BARs grow up or down from this line. If the BAR grows above the line the ignition timing is advanced at that temperature. If the BAR grows below the line the ignition timing is retarded at that temperature.

It is typical to advance the ignition timing by three to five degrees when the engine is well below its operating temperature. The graph should return to zero degrees of advance as the engine nears its operating temperature.

CHAPTER EIGHT

Fuel Saving and Closed Loop Feedback

The Haltech E6 system has two features designed to conserve fuel. The CLOSED LOOP FEEDBACK function uses the oxygen content in the exhaust gases to determine whether the engine is rich or lean and then corrects the mixture accordingly. The CUT OFF FUEL ON DECELERATION function cuts the fuel to the engine when the engine is decelerating toward idle. Both of these functions can be disabled if required.

The Closed Loop Feedback Function

If you have an exhaust gas oxygen sensor fitted to your engine then you can activate the CLOSED LOOP FEEDBACK function. The exhaust gas oxygen sensor detects the presence of oxygen in the exhaust gases. Oxygen in the exhaust gases indicates that there was insufficient fuel in the combustion to use up all the oxygen and hence the engine was lean.

The output of the sensor is a voltage around one volt when the engine is rich and around 0 volts when the engine is lean. Exhaust gas sensor are like a switch in that their output only has two conditions. The sensor switches very rapidly with changing fuel mixtures near stoichiometric (just enough fuel to use up all the oxygen).

The Haltech E6 use the output of the exhaust gas sensor to tell if the engine is rich or lean. It does this by setting a reference voltage that it compares the output of the sensor to. If the sensor voltage is above the reference voltage then the engine is seen as rich. If the sensor voltage is below the reference voltage then the sensor is seen as lean. The reference voltage is not too critical since the voltage switches between two extremes. Typically a reference voltage of around 500 - 600 mV (about half a volt) can be used with almost all exhaust gas sensors available. The reference voltage is user adjustable to cater for sensors not available at the time the Haltech E6 was designed.

The closed loop feedback can only be applied at light throttle. The exhaust gas feedback will pull the fuel mixture to stoichiometric. This is too lean for heavy loads. You can adjust the amount of throttle the engine is to see before the exhaust gas feedback is stopped. Typically this is set to around 25% of full throttle. This means that the exhaust gas feedback can operate until the driver exceeds 25% throttle. The function resumes after the throttle comes back down below 25%. NOTE : This function uses the throttle position sensor which must be calibrated to suit your engine as outlined in chapter six.

The exhaust gas feedback can also be shut off below a user defined RPM. This can be used to stop the exhaust gas feedback at idle if required. Some modified engines, including engines with performance camshafts, cannot idle satisfactorily with stoichiometric fuel mixtures. These engines may still benefit from the use of exhaust gas feedback at higher RPM. The defined RPM should be set to 200 RPM above target idle speed if you do not want exhaust gas feedback at idle. If you do want exhaust gas feedback at idle then set the defined RPM to 200 RPM below target idle speed.

The CLOSED LOOP FEEDBACK FUNCTION will not operate until the engine is at operating temperature. To determine this the function looks at the FUEL COOLANT MAP. If any extra fuel is still being fed to the engine from the FUEL COOLANT MAP the exhaust gas feedback will not operate.

If the engine is at operating temperature and the engine throttle is light and the RPM is above the defined RPM then the exhaust gas feedback will start to operate.

Consider the engine at light throttle cruise with the fuel mixture slightly rich. The Haltech E6 looks at the exhaust gas sensor to check if the engine is rich or lean and by comparing the sensor output to the reference voltage it determines that the engine is rich. The fuel mixture is then the fuel mixture is made leaner by one percent. The E6 then counts several engine cycles and looks again to see if the engine is still rich or if it has become lean. If it is still rich then the fuel mixture is again made one percent leaner. This loop is repeated until the fuel mixture becomes lean.

When the E6 determine the engine is lean it makes the fuel mixture two percent richer. The E6 then counts several engine cycles and looks again. By continuously repeating this loop the fuel mixture is forced to oscillate around stoichiometric.

Typically the fuel mixture will oscillate a few percent either side of stoichiometric fuel mixtures. This ensures that the average fuel mixture to your engine is optimised under light loads.

You can set a safety net either side of stoichiometric which the closed loop function cannot exceed. If your fuel MAPs are correctly set up the exhaust gas feedback should never have to correct more than 8 or 9 percent to get the fuel mixture to stoichiometric. Ideally the fuel MAPs should be a few percent richer than stoichiometric at light throttle and the exhaust gas feedback should lean the mixture just those few percent at cruise. The safety nets are user limits on how much the exhaust gas feedback can affect the fuel mixtures as determined from the fuel MAPs. Typically a lower limit of 90 percent and an upper limit of 110 percent allow the exhaust gas feedback to work well. If the exhaust gas feedback has to work harder than this to correct your fuel mixture then you should re-map your fuel MAPs.

Adjusting the Closed Loop Feedback

To alter CLOSED LOOP FEEDBACK FUNCTION press O when the MAIN MENU appears and then press L when the OPTION MENU appears. All the closed loop function controls appear on one screen.

To adjust any control use the arrow keys to highlight the control that you want to change. For the non-graphical information type in the new information as instructed by the prompts at the bottom of the screen and press ENTER again. For the single BARs use the arrow keys to adjust the height of the BAR. The following is a description of each control and a typical setting for that control that should work on most engines.

- **CLOSED or OPEN**

This control appears as a single field. It can either read Closed or Open. If it reads Open then the closed loop is always turned OFF and will not function. If it reads Closed then the closed loop will function. Turn the closed loop on only once you have set the rest of the CLOSED LOOP controls.

- **RPM**

The RPM field defines the lowest RPM at which the closed loop will function. The closed loop will work only when the engine is above this RPM. Typically this is set to 200 RPM above the target idle speed if the closed loop is not to function at idle or 200 RPM below target idle speed if the closed loop is to function at idle. If in doubt set this field to 1200 RPM.

- **Cycles**

This BAR sets how many engine cycles the E6 is to wait between looking at the exhaust gas sensor output. This is typically set to between 4 and 10 cycles and must be a whole number of cycles. The smaller the number of cycles the faster the exhaust gas feedback will occur. This number must be set large enough to allow the exhaust gases to travel down the exhaust pipe from the engine and for the sensor to have time to take a reading. If in doubt set this field to 8 cycles.

- **Reference Voltage**

This is the threshold that the E6 compares the sensor output to. Almost always this is set to 600 mV (for optional NTK sensor supplied).

- **Limits**

The L limit is the lean limit. The R limit is the rich limit. These limits are the maximum (R) and minimum (L) that the E6 can correct through the CLOSED LOOP function. If in doubt set these to L = 90% and R = 110%.

Cut Off Fuel On Deceleration

The Cut Off Fuel On Deceleration function will shut off the fuel to the engine when the engine is decelerating and is at more than 1800 RPM. The fuel is turned on again as the engine speed falls below 1800 RPM to allow the engine to idle. This can stop engine surge at low speeds and at very light throttle.

This function will only function correctly if the throttle position sensor has been calibrated as described in Chapter 6. To activate the function go to the IDENTIFICATION screen by pressing I when the MAIN MENU appears. Use the arrow keys to highlight the "Decel Cut-off : " field. Press the ENTER key. Pressing the DOWN ARROW key alternates the field between off (no cut-off) and on (cut-off operating). Press the ENTER key. Leave the IDENTIFICATION screen by pressing the ESCAPE key.

CHAPTER NINE

Idle Speed Control

The Haltech E6 system has the ability to trim the idle speed if the engine is fitted with a stepper motor type Idle Speed Control motor. This motor regulates the amount of air that is allow to bypass the throttle plate. Opening the motor allows more air to bypass the throttle plate and allows the engine speed to increase. Closing the motor decreases the amount of air that bypasses the throttle plate and decreases the engine speed.

NOTE: If you have fitted your own Idle Speed Control motor then you must ensure that the total amount of air that can bypass the throttle plate is limited to sufficient to vary the engine speed by 500 RPM total. Fitting a large Idle Speed Motor to a small capacity engine can result in dangerously high engine speeds without throttle control. You must use a fixed restriction to limit the total amount of air that can bypass you throttle plate unless your Idle Speed Motor was specifically designed for your engine.

The Idle Speed Control Function

If you have an Idle Speed Motor fitted to your engine then you can activate the Idle Speed Control function. The E6 measures engine speed and compares the engine speed to a target engine speed that you have defined. If the engine speed is above the target engine speed then the Idle Speed Motor is closed to lower the engine speed. If the target engine speed is below the target engine speed then the Idle Speed Motor is opened to increase the engine speed. There is a small band of 50 RPM around the target idle speed at which the Idle Speed Motor will not be varied.

Adjusting the Idle Speed Control Functions

All of the Idle Speed Control functions are accessible by pressing O when the MAIN MENU appears then pressing I when the OPTIONS MENU appears.

To adjust any control use the LEFT AND RIGHT arrow keys to highlight the control that you want to change then use the UP and DOWN arrow keys to change the height of the BAR. The following is a description of each control and a typical setting for that control that should work on most engines.

- **Idle Speed Damping**

The Speed of response of the Idle Speed Motor to changes in engine speed is determined by the Idle Speed Damping field. If the Idle Speed Damping is set too high the engine may take an unacceptible length of time to find the target engine speed. If the Idle Speed Damping is set too high then the Idle Speed Motor will over correct causing the engine speed to oscillate around the target engine speed. Try an Idle Speed Damping of 25.

- **Target Idle Speed**

This is the Idle speed in RPM that you want your engine to idle at when the engine is at operating temperature. Try 1000 RPM for a four cylinder engine or 700 RPM for a V8 engine.

- **Cold Idle-Up RPM**

This is the extra idle speed that will be added to the target idle speed you have defined to let the engine idle faster when below operating temperature. Try 500 RPM for a four cylinder engine or 300 RPM for a V8 engine.

CHAPTER TEN

Correction Factors

The Haltech E6 system uses three correction MAPs to automatically compensate for changes in inlet air temperature and battery voltage. MOST USERS SHOULD NEVER ADJUST THESE MAPS. These MAP's 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 E6 software is run in the OFFLINE mode the software defaults to include the factory correction MAPs unless other MAPs are LOADED.

Fuel from Air Temp MAP

The mass of air entering the inlet manifold varies with changes in the temperature of the air. To compensate the E6 applies a correction factor taken from the Fuel from Air Temp MAP. The values supplied in your ECU have been experimentally determined to give the optimum correction for most engines.

To access the Fuel from Air Temp MAP press C when the MAIN MENU appears and then press ALT and F together when the CORRECTION MAPS MENU appears. Across the bottom of the MAP displayed is the inlet air temperature. The inlet air temperature increases from left to right. An arrow appears showing which bar the system is currently using. Each BAR represents a different inlet air temperature. The BAR display is broken by a horizontal line. BARs grow up or down from this line. If the BAR grows above the line the fuel mixture is richer at that temperature. If the BAR grows below the line the fuel mixture is leaner at that temperature.

A typical Fuel from Air Temp MAP was loaded into your E6 at the factory. You should not modify it unless you experience trouble with variation in engine performance with air temperature. If you do modify the Fuel from Air Temp MAP then it is best to have a laptop computer connected to allow the changes to be made with real time feedback. Typically the engine will need leaner fuel mixtures as the inlet air temperature increases.

Ignition from Air Temp MAP

The speed of the flame front in the combustion chambers varies with changes in the temperature of the air. To compenstae the E6 applies a correction factor taken from the Ignition from Air Temp MAP. The values supplied in your ECU have been experimentally determined to give the optimum correction for most engines.

To access the Ignition from Air Temp MAP press C when the MAIN MENU appears and then press ALT and I together when the CORRECTION MAPS MENU appears. Across the bottom of the MAP displayed is the inlet air temperature. The inlet air temperature increases from left to right. An arrow appears showing which bar the system is currently using. Each BAR represents a different inlet air temperature. The BAR display is broken by a horizontal line. BARs grow up or down from this line. If the BAR grows above the line the ignition timing is advanced at that temperature. If the BAR grows below the line the ignition timing is retarded at that temperature.

A typical Ignition from Air Temp MAP was loaded into your E6 at the factory. You should not modify it unless you experience trouble with variation in engine performance with air temperature. If you do modify the Ignition from Air Temp MAP then it is best to have a laptop computer connected to allow the changes to be made with real time feedback. Typically the engine will need more retard as the inlet air temperature increases.

The Battery Voltage MAP

The Haltech E6 uses intelligent fuel injector driver circuitry that compensates for changes in battery voltage. This compensation is insufficient for the full range of battery voltages that a vehicle electrical system can experience. As the battery voltage falls the effective injector ON time decreases and the fuel mixture becomes leaner. To compensate the E6 applies a correction taken from the Battery Voltage MAP. 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 rated over a range of battery voltages and the corrections calculated accordingly. The E6 was factory loaded with a Battery Voltage MAP determined in this way. To access the Battery Voltage MAP press C when the MAIN MENU appears and then press V when the CORRECTION MAPS MENU appears. The Battery Voltage MAP is thirty two bars wide. Each bar sets the amount of extra fuel at a given Battery voltage. The battery voltage increases from left to right. An arrow appears showing which bar the system is currently using. Adjusting the height of the bar immediately adjusts the extra fuel in milliseconds that the engine is receiving.

CHAPTER ELEVEN

Disk Storage and Retrieval

Now that your Haltech E6 system is configured you should store the entire set of MAPs and the IDENTIFICATION to floppy disk. You can use the disk storage and retrieval to enhance the flexibility of your race engine by storing the optimum MAPs for each race track.

Disk Storage And MAP Retrieval

The Floppy Disk storage and retrieval functions can be accessed from the Main Menu by pressing "F" for files. This function allows you to either load ignition timing MAPs only, load fuel MAPs only or load the complete set of MAPs and IDENTIFICATION from computer disk. You can also save the fuel MAPs, the ignition MAPs and the IDENTIFICATION to computer disk.

Saving MAPS and IDENTIFICATION:

Haltech™ ECU to Floppy Disk

The Save Command

To store the all the MAPS and identification to computer disk with the system running online press "F" at the Main Menu then press "S". The list of MAPS already stored will appear on the screen.

Giving Your MAP A Filename

Choose a name to call 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 should be up to eight characters in length. The name must start with a letter from the alphabet, not a number. The name cannot contain a full stop. 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 to save the MAPS under, 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 OK, continue by pressing "Y". If you incorrectly enter the name, abort the storing function by pressing "N" or "R" to re-enter a name.

The store function takes a few seconds to complete and then the program returns to the Files Menu. To return to the MAIN MENU press the <SPACE BAR> key.

Tutorial on Saving MAPs and IDENTIFICATION to Disk

With the MAIN MENU displayed press F for files. Press S for save. For this example use the name TEST1 to save the MAPs and IDENTIFICATION now stored in your E6 to computer disk. Type TEST1 and press enter. The system will ask if you want to continue. It does this in case you made a mistake. Press Y for yes to continue. The saving takes a few seconds.

Loading MAPS and IDENTIFICATION:

Floppy Disk To Haltech™ ECU

While the ECU system is online, you can load previously saved MAP information from computer disk into your Haltech ECU in three ways. You can load fuel MAPs only or load ignition timing MAPs only or load complete MAPs and IDENTIFICATION. All three ways take information from files that you have previously saved with MAPs and IDENTIFICATION using the SAVE command. If you are loading either fuel MAPs or ignition timing MAPs the system will ignore the unwanted sections of the previously saved file and LOAD only that part you have requested.

To load complete MAPs and IDENTIFICATION press "F" when the Main Menu appears then press "C". To load fuel MAPs only press "F" when the Main Menu appears then press "F". To load ignition timing MAPs only press "F" when the Main Menu appears then press "I". The load command erases the contents of the ECU and replaces it with the set of MAPS stored on the floppy disk you are loading into the system. To view the list stored, press "S".

Remember to save any MAPS currently in the ECU that you wish to retain before loading new MAPS from a disk.

The engine should not be running 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. Your 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 thirty seconds.

Tutorial on Loading Complete MAPS and IDENTIFICATION

With the MAIN MENU displayed press F for files. Press C for LOAD COMPLETE MAPs AND IDENTIFICATION. For this tutorial load the complete MAPs and IDENTIFICATION you saved as TEST1 from the last tutorial. Highlight TEST1 using the arrow keys and press ENTER. The system will warn you that loading the MAPs and IDENTIFICATION called TEST1 will erase the contents of the E6 and replace it with TEST1. If you have MAPs or IDENTIFICATION in the E6 that you want to keep and haven't saved then you should save it to disk before loading a new MAP or it will be lost.

Continue by pressing "Y". The loading takes a few seconds.

Erasing Unwanted Maps

To remove unwanted MAPS from the floppy disk press "F" when the Main Menu appears and then "E". The list of MAPS stored on the disk will appear. Type in the name of the MAP(S) you wish to erase and press return. The computer will pause to check that everything is OK. Press "Y" to continue to erase, if in error press "N" to abort the erasure.

Tutorial on ERASING Unwanted MAPs

When the MAIN MENU appears press F for files. Press E for erase. For this tutorial erase the MAP TEST1 that we created in previous tutorials. Type TEST1 and press ENTER. The system will warn you that once you have erased TEST1 it is erased from the computer disk. Continue by pressing Y for yes.

CHAPTER TWELVE

Data Recording and Print Functions

The Print MAPs and Identification 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) To print a datalog press O when the MAIN MENU appears then press P when the OPTIONS MENU appears.

The system will ask for a name to print at the top of the printed output. This allows you to differentiate between printed MAPs after you have many print outs. 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 the ESCAPE key. Pressing any other key starts the printing. Before you start printing the printer must be ON-LINE and must have power and paper. Once the printing has started you can abort the printing by pressing the ESCAPE key.

The Datalog Engine Option

This option allows the engine's performance to be accurately recorded. All of the engine variables can be recorded approximately eight times per second while the engine is running. This information is presented in one of two views. You can switch between views by pressing N when the DATALOG MENU appears. The following information is presented in the two views:

View A	View B
Engine Speed In RPM	Engine Speed In RPM
Manifold Pressure	Manifold Pressure
Coolant Temperature	Coolant Temperature
Throttle Position	Throttle Position
Inlet Air Temperature	Inlet Air Temperature
Battery Voltage	Battery Voltage
Fuel Mixture Trim	Exhaust Sensor voltage
Ignition Timing Trim	Closed loop percentage correction
Injected Milliseconds of fuel	Injected Milliseconds of fuel
Ignition Timing	Ignition Timing
Map number being used	Map number being used
BAR number being used	BAR number being used
Time of Reading	Time of Reading

To do a datalog the system must be online to the ECU. There are two ways to datalog the engine. To bring up the datalog options press "O" when the MAIN MENU appears and then press "D" when the OPTION MENU appears. Pressing "D" again starts a normal datalog running.

A normal datalog records the information from the engine into the memory of your IBM computer. This will record engine data for about three minutes. This is an endless loop process. When you stop the datalog, it has a record of the previous three minutes of engine data.

To stop a normal datalog press the spacebar. To view the datalog, press "V" from the DATALOG MENU . To scroll up and down the pages of data use the up and down arrow keys or the "page up" and the "page down" key. The information in the datalog is divided into pages. By pressing ? you can enter the number of the page you want to view. To go to the beginning of the data press <HOME>. To go to the end of the data, press <END>. Pressing <S> brings up a display of the maximum, minimum and average of all engine variables recorded over the three minutes. To stop viewing the datalog press ESC.

If the power to the ECU is interrupted while a datalog is running, the datalog will stop until the power resumes. This can be useful because you can start the DATALOG going though not have information recorded until the ignition is switched on.

Saving Datalogs

The datalog can be recorded to computer floppy disk if required. To do this press Esc to return to the datalog options page and then press "S". The system will display the list of current stored datalogs. Choose a name for the datalog file. The name must be no more than eight characters and must begin with a letter of the alphabet.

Unless you intend to overwrite an existing datalog, the name you choose for the datalog you are saving must be a new name not already contained in the list of stored datalogs. Type in the name for the datalog and press ENTER. The system will ask you to confirm that you have entered the file name correctly. To continue press Y. To stop saving press N. To re-enter the file name press R.

Loading Datalogs

Stored datalogs can be loaded by pressing "L" when the datalog options menu appears. The computer will display the list of stored files. Select the name of the datalog you want to load by using the arrow keys to highlight the name of the appropriate file and press return. The system will ask you to confirm that you have highlighted the file name correctly. To continue press Y. To stop loading press N. To re-enter the file name press R. The datalog can be viewed by pressing "V" when the datalog options page is displayed.

Datalog to Disk

Your computer can also datalog to disk. As your PC memory becomes full it can store each block of data it records to disk until you press the space bar or until the disk is full. This is used if you need to store more than three minutes of data from the engine.

To start press "A" when the datalog options page is displayed. The system will ask for a name to identify the stored datalogs. This name is similar to the names used to store normal datalogs to disk. Type in the name and press ENTER. The system will ask you to confirm that you have entered the file name correctly. To continue press Y. To stop dataloging press N. To re-enter the file name press R. Stored datalogs can be loaded and viewed as desired. If the datalog is longer than three minutes, there will be a small delay viewing some pages as the PC reads the next block from disk.

Erasing Stored Datalogs

Unwanted datalogs can be removed from the floppy disk by typing "E" when the datalog options page is displayed. The datalogs stored on the disk are listed. Highlight the name of the datalog that you want to erase using the arrow keys and press ENTER.

The computer will pause for you to check that the name has been entered correctly. If everything is OK then type "Y" to continue. To abort the erase command type "N". To Re-enter the file name type R.

Displaying File Information

All Datalogs are stored with a convenient header that gives you some useful information about the datalog. This can serve to remind you about datalog information when many datalogs have been recorded. The datalog header information includes the time and date at which the datalog was originally recorded. This relies on your PC having the correct real world time and date in its CMOS clock. You should see your PC instruction manuals on how to set and test the CMOS clock in your PC.

You can view the header information when loading or storing datalog files by press ALT and I at the same time.

Printing Datalogs

You can print datalogs to printers that accept ASCII file format such as IBM compatible dot matrix printers. To print a datalog press P when the DATALOG MENU appears. The information in the datalog is divided into pages of data. The total number of pages in the current datalog is displayed. The system then asks for the number of the first page you want to print. The first page in the datalog is page number one so if you want to print the entire datalog type 1 and press ENTER. The system then asks for the second page number. This will be the last page printed. If you want to print the entire current datalog type in the number of the last page of the datalog 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 the ESCAPE key. If you want to re-enter the starting and ending page numbers press R. Pressing any other key starts the printing. Before you start printing the printer must be ON-LINE and must have power and paper. Once the printing has started you can abort the printing by pressing the ESCAPE key.

CHAPTER THIRTEEN

Trouble Shooting

This Chapter is devoted to trouble shooting problems that may occur in setting up your engine. To use this chapter first identify the closest symptom or symptoms that you have from the list below and then go to that section of this chapter and follow the problem solving flow chart.

Control Program Problems

* Haltech control program will not operate on your IBM Personal Computer
* The control program will not operate in ONLINE MODE
  ie. The message "Reconnect Haltech" appears.
* In ONLINE MODE the control program displays bad sensor readings.

Starting Problems

* Fuel Pump does not prime when ignition switched on.
* The engine makes no attempt to start
* The engine is difficult to start
* Timing does not remain at 10 degees BTDC with timing check flag on.

Idling Problems

* The engine will not idle at all when cold
* The engine will not idle at all when hot
* The engine idles too slow
* The engine Idles too fast
* The engine surges at idle
* Engine detonates at full throttle

Light Throttle / Cruise Problems

* Engine will not run at all at light throttle
* Engine surges 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 everywhere
* Poor throttle response when engine cold
* Poor throttle response when throttle just cracked

Cold Running Problems

* Engine runs poorly when engine cold

Fuel Economy Problems

* Poor fuel consumption

Haltech Control Program will not operate on your IBM Personal Computer

Possible Problem / Symptom	Probable Cause / Cure
No MS DOS on your system. This will cause an error message such as "Non System Disk or disk error" to appear.	Run MS DOS before attempting to run the Haltech Control Program or copy the Haltech Control Program to an MS DOS formatted SYSTEM disk. Read the MS DOS manual supplied with your personal computer.
Your personal computer is of the wrong type or is configured incorrectly to run the Haltech control program	Check that your computer is an XT or AT IBM compatible computer with more than 512K of memory and a CGA, EGA or VGA video screen and driver. NOTE : Most laptop computers emulate CGA or VGA drivers.
The Haltech Control Disk is Damaged	Request a new copy of the Haltech control disk from your Haltech dealer
The message "INVALID FILENAME" appears when loading or saving maps.	Disk "write protect" tab is on. Change write protect tab see MS DOS manual supplied with your personal computer.

HALTECH control program will not operate in ONLINE MODE. The Message "RECONNECT HALTECH" appears.

Possible Problem / Symptom	Probable Cause / Cure
Damaged Communications Cable	Get a new communications cable from your Haltech distributor
Ignition not switched on	Switch ignition on.
Haltech loom incorrectly wired	Check black wire connects to ground, red wire to Battery +ve and Grey wire to switched +ve battery.
Haltech system fuse blown	Replace fuse(s)
Haltech power relay damaged or defective.	Check relay makes "click" sound when switched power is turned on and off. 1.Check for water damaged power relay. 2.Check for defective relay. 3.Check for corrosion damage at relay terminals.
Haltech Harness damaged	Replace or repair harness.

Possible Problem / Symptom	Probable Cause / Cure
RS232C port on personal computer not configured properly	Check communications cable is connected to COM1 on personal computer.
Personal computer damaged	Check PC and serial interface card.
Damaged Haltech ECU	Replace ECU.

Fuel Pump doesn't prime when ignition is switched on

Possible Problem / Symptom	Probable Cause / Cure
Fuel pump wiring incorrect. Pump not getting power.	Check pump wiring. Test for power at pump connections with volt meter.
Poor connections to pump. Pump not getting power.	Replace electrical terminals to pump connections.
Blown Haltech system and / or pump fuse. Pump not getting power.	Replace fuse(s).

Possible Problem / Symptom	Probable Cause / Cure
Dead battery. Pump not getting power.	Recharge or replace battery. Check charging system.
Faulty fuel pump. Mechanical problem in pump.	Power pump directly with suitable jumper cables and ensure pump works or replace pump. Check filter. Check for water in fuel.

Engine will not crank.

Possible Problem / Symptom	Probable Cause / Cure
Dead battery. Starter motor not getting power.	Recharge / replace battery.
Battery terminal connections poor. Starter motor not getting power.	Repair / replace / clean battery terminals.
Starter solenoid not getting crank signal. Starter motor not getting power.	Test for power at solenoid crank wire. Consult engine repair manual.

Possible Problem / Symptom	Probable Cause / Cure
Engine mechanically inhibited from cranking.	Check engine wants to turn over. Use socket/driver on front crankshaft bolt to turn engine by hand. Check for mechanically damaged engine. Check for cylinder bores filled with fuel from leaking injector(s) or water from damaged head gasket.

The engine makes no attempt to start when cranking

Possible Problem / Symptom	Probable Cause / Cure
Engine not getting fuel. No fuel pressure.	Check for fuel in tank. Check fuel rail pressure with fuel pressure gauge. If insufficient fuel pressure check pump is running. Check pump is priming (high pressure pumps require either gravity feed or a primer pump in order to prime). Check connections to pressure regulator. Check for bad pressure regulator. Check for clogged fuel filter.

Possible Problem / Symptom	Probable Cause / Cure
Engine not getting fuel. Water in fuel.	Drain contents of fuel filter to verify water present in fuel. Drain fuel tank. Blow fuel lines out with compressed air. Replace fuel pump. Replace fuel filter. Replace fuel injectors. Replace fuel pressure regulator. Ensure water is totally removed from fuel system components. Refill tank.
Engine not getting fuel. Fuel injectors not firing at all.	Check for water damaged injectors. Check Haltech ECU gets power. Check Haltech ECU communicates in ONLINE MODE with Haltech IBM control program. Check Haltech ECU is getting tachometric signal from tach adaptor by viewing engine speed on engine data screen whilst engine is cranking or cranking engine whilst running datalog. Check Injector loom is plugged in. Check for valid fuel maps in ECU. Check for blown fuses. Check for damaged power relays. Check battery voltage to ECU remains above 8 volts whilst cranking.

Possible Problem / Symptom	Probable Cause / Cure
Engine getting too much fuel. Engine flooded.	Remove one spark plug and look for presence of excessive fuel. If flooded remove all plugs and allow to dry then replace in engine. CAUTION FUEL IS HIGHLY FLAMMABLE. Check fuel maps and cold start settings in ECU for cause of flooding. Check for leaking injectors.
Engine not getting compression.	Check compression using compression gauge. See repair manual on engine for correct compression and test methods. Check camshaft timing. Check valves. Check piston rings. Check for damaged pistons.
Engine not getting ignition spark.	Check that spark is present by disconnecting high tension lead from one spark plug and connecting to spare spark plug grounded to engine bay / engine. Alternatively use engine ignition system analyser. Check for bad ignition amplifier / igniter. Check for bad high tension leads. Check for bad / leaking distributor cap / rotor. Check connections to ignition amplifier / igniter. Check for valid signal to ignition amplifier / igniter from distributor / ECU.

Possible Problem / Symptom	Probable Cause / Cure
Engine not getting ignition spark. Ignition spark mis-timed.	Check firing order of engine against firing order of high tension leads. Check base timing of engine. Use spark timing strobe light to check actual firing position of engine.
ECU disrupted. Engine is fitted with solid core ignition leads.	Replace high tension leads with suppression type high tension leads.

Engine is difficult to start.

Possible Problem / Symptom	Probable Cause / Cure
Engine not getting enough fuel to start cold. Bad cold start settings in ECU.	Check cold start primer value. Check cold start settings.
Engine getting too much fuel to start cold. Bad cold start settings in ECU.	NOTE : Engine may clear by several seconds of continuous cranking with throttle wide open. ECU primes engine when ignition is first turned to crank position and will not prime again until key released and reengaged. Check cold start primer value. Check cold start fuel MAP settings.

Possible Problem / Symptom	Probable Cause / Cure
ECU disrupted. Battery voltage too low at cold crank.	Check cold cranking voltage to ECU with voltmeter during cold crank. Check ECU continues to communicate with IBM control program in ONLINE MODE whilst cold cranking. If ECU drops out due to insufficient voltage the message "Reconnect Haltech" will appear. Replace / Upgrade battery.
Engine not getting Ignition spark. Battery voltage too low at cold crank.	Check for spark present during cold crank using ignition analyser. Replace / upgrade battery.
Bad Haltech engine sensor.	Check sensors by viewing sensor readings on engine data page using Haltech control program. Check engine temperature sensor reading agrees with actual temperature of engine. Check vacuum hose from inlet manifold to Manifold absolute pressure sensor.

Possible Problem / Symptom	Probable Cause / Cure
The cold crank voltage is too low. ECU intermittent.	Check for consistent ECU operation during crank by having control program ONLINE while cranking. Intermittent operation will show "Reconnect Haltech" on engine data screen. Replace / Upgrade battery. Upgrade gauge of power wire connections to ECU.
Injectors fire intermittently. Tach signal to ECU intermittent at crank.	Check for consistent tach at crank by having control program connected ONLINE while cranking. View engine tach on engine data screen.
Engine too lean to start. Poor cold start settings in ECU.	Check cold start primer value. Check cold start MAP values.
Engine too lean to start. Poor fuel MAP settings.	Check 0 and 500 RPM MAPs for sufficient fuel to start engine.
Engine too rich to start. Poor cold start settings.	Check start primer value. Check cold start MAP values.

Timing does not stay locked at ten degrees BTDC with the timing check flag on

Possible Problem / Symptom	Probable Cause / Cure
Incorrect tach adaptor for the distributor/crank trigger used	Get correct tach adaptor from your Haltech distributor
Wires to reluctor pickup reversed to reluctor type tach adaptor.	Reverse reluctor wires.
Tach adaptor faulty.	Replace tach adaptor.
Reluctor/crank pickup allowed to move by poor mounting/damaged distributor.	Replace crank pickup mount/distributor.
Electrical noise on wires from pickup to tach adaptor due to spark system noise.	Move tach adaptor wires away from high tension spark plug cables. Shield tach adaptor wires by running shielded cables.

Idling Problems

Possible Problem / Symptom	Probable Cause / Cure
Engine surges at idle. Engine too rich.	Overly rich idle mixtures will cause engine to surge at idle and blow black smoke from exhaust pipe. Adjust idle mixture in ECU MAPs.
Engine surges at idle. Engine too lean.	The engine is unable to remain operating at any point in the fuel MAPS that is too lean. The engine will hesitate and lose manifold vacuum and engine speed causing the ECU to track to a different (richer) value in the ECU maps. The richer conditions will let the engine partially recover until it again attempts to operate at the lean "hole" in the fuel MAPs. This condition manifests itself as a repetitive surge.

Possible Problem / Symptom	Probable Cause / Cure
Engine surges at idle. Ignition timing values poorly selected.	Ignition timing too retarded at idle causes flat idle and poor off idle throttle response. Ignition timing too advanced at idle causes the engine to race unstably at idle. Also note a slight misfiring when idle ignition timing is over-advanced. Typically idle ignition timing is in the range 12 to 22 degrees for a typical four stroke petrol engine. Note that ignition timing values should be selected to be constant around target hot engine idle point to avoid surge from varying idle ignition values.
Engine surges at idle. IAC air control feedback too fast.	Idle speed motor feedback sets speed of response of the motor to incorrect idle speeds. If set too fast the idle speed motor will consistently overshoot the target speed causing a repetitive surge. Increase the idle speed motor feedback value in the ECU.

Possible Problem / Symptom	Probable Cause / Cure
Engine unable to idle with closed loop exhaust feedback.	Some engines have difficulty idling at stoichiometric air/fuel ratios. The ECU will attempt to maintain stoichiometric air/fuel ratios if the closed loop is enabled at idle speeds. To disable closed loop at idle select closed loop only 200 RPM or more above your target idle speed.
Engine idles too low/high when hot.	Adjust target engine idle speed in ECU.
Engine idles too low/high when cold.	Adjust cold engine idle target speed in ECU.

Light Throttle/Cruise Problems

Possible Problem / Symptom	Probable Cause / Cure
Engine falters at light throttle. Spark plugs damaged / worn / fouled.	Replace spark plugs.
Engine falters at light throttle. Cruise mixture too lean.	Check MAP values at cruise.

Possible Problem / Symptom	Probable Cause / Cure
Poor light throttle cruise. Poor Injector placement / manifold design.	Rethink manifold design / injector placement.
Poor cruise fuel consumption.	Cruise mixtures too rich or ignition timing too retarded at cruise. Check cruise MAP values in ECU. (Some petrol four stroke engines can use a total ignition advance of up to 50 degrees at very light throttle cruise.)

Full Power Problems

Possible Problem / Symptom	Probable Cause / Cure
Engine dies under full throttle. Hole in MAP.	Check that fuel MAPs are correct in full power band.
Engine dies under full power. RPM limit set too low.	Check RPM limit in ECU and adjust if necessary.

Possible Problem / Symptom	Probable Cause / Cure
Engine lacks power at full throttle. Engine too rich or too lean.	Adjust fuel MAPs in full power band. If still too lean check that the fuel system is maintaining correct fuel pressure at full load. Use pressure gauge to check fuel pressure. Fuel pressure should be stable and should not pulse. Check that injectors flow enough for engine. Is fuel pump large enough? Does engine require two fuel pumps? Two fuel pressure regulators? Is the fuel line large enough diameter to flow the fuel required by the engine? Is the fuel filter clogged?
Engine lacks power at full power. Engine too retarded.	Increase ignition timing to manufacturers recommended setting for engine.
Engine lacks power at full power. Engine detonates at high loads.	Ignition timing is over advanced. THIS CONDITION CAN CAUSE SERIOUS ENGINE DAMAGE IF ALLOWED TO CONTINUE! Retard ignition timing in ECU ignition timing MAPs until detonation disappears. NEVER ADJUST IGNITION TIMING WITH THE ENGINE UNDER HIGH LOADS.

Possible Problem / Symptom	Probable Cause / Cure
Engine lacks power at full power. Mechanical problem.	Check cylinder compressions as per manufacturer's engine manual. Check for mistimed/worn camshafts. Check for worn/bent valve timing components. Check for worn/broken compression rings. Check for holes in piston tops. Check for warped valves. Check for blocked exhaust system.

Throttle Response Problems

Possible Problem / Symptom	Probable Cause / Cure
Poor throttle response. Throttle pump values poorly set.	Change throttle pump settings in ECU.
Poor throttle response. Ignition timing too retarded.	Ignition timing may be too retarded to allow the engine to cleanly pull from problem area. Check / alter ignition timing values.
Poor throttle response. MAP values too lean.	If MAP values are set too lean then poor throttle response may result. Check fuel Map values in problem areas.

Possible Problem / Symptom	Probable Cause / Cure
Poor throttle response. Engine over aspirated.	Throttle size is too large for injectors used. When the throttle suddenly opens the injectors are unable to supply sufficient fuel to mask the transient lean condition. Choke throttle(s) down or increase injector size.
Poor throttle response. Injectors poorly positioned.	If the extra fuel added by the throttle pump function of the ECU wets down the walls of the manifold or is poorly distributed across all cylinders then poor throttle response will result. Redesign manifold / injector placement.

Cold Running Problems

Possible Problem / Symptom	Probable Cause / Cure
Engine dies when loaded cold. Engine too lean.	Check cold start MAP values and adjust as necessary.

Fuel Consumption Poor

Possible Problem / Symptom	Probable Cause / Cure
Poor fuel consumption. Fuel system leak.	Check fuel hoses and components/hoses for leaks. Repair as necessary.
Poor fuel consumption. Insufficient ignition timing.	Too retarded ignition timing will cause poor fuel consumption. Check ignition timing MAPs in ECU against manufacturers ignition timing specifications for engine. Adjust as required.
Poor fuel consumption. Leaking fuel injector(s).	Test / replace fuel injectors as required.
Poor fuel consumption. Poor fuel map values.	Check fuel MAP values in ECU.
Poor fuel consumption. Closed loop exhaust feedback not working.	Turn closed loop exhaust feedback on in ECU. Check exhaust sensor readings are valid on engine data screen once engine up to temperature and at cruise conditions.

Possible Problem / Symptom	Probable Cause / Cure
Poor fuel consumption. Throttle pump too rich.	If throttle pump is set too rich then fuel is wasted during transients. Optimise throttle pump settings for best engine response while not wasting fuel.
Poor fuel consumption. Cold start cycle too rich.	Check cold start MAP settings and adjust as necessary. Check also cold start primer value in ECU.

APPENDIX ONE

Components in the Fuel Line

Fuel Pumps

Electric Fuel Pumps

Electric fuel pumps have been used on standard electronically fuel injected and mechanically fuel injected vehicles since the late 1960s. There are many different types that have been produced to suit original equipment system requirements. Electronically fuel injected vehicles are designed to operate at pressures around 40 psi/275 kPa. The components readily available for tailoring your own fuel injection system are generally sold as replacement parts for original equipment systems.

Mechanical Fuel Pumps

Mechanical fuel injection is considerably cheaper than electronic injection for car manufacturers although it is not as accurate and far more difficult to apply in aftermarket situations. Mechanically injected vehicles have an electric fuel pump rated at around 75 psi. These pumps often have banjo bolt pressure fittings rather than barbs. They are robust in design but have different pressure and flow ratings than the pumps designed for electronically injected vehicles.

As fuel injection has become more and more popular the variations on the simple electric fuel pump have been increased. To insure the best and most accurate results when working with the Haltech™ ECU you should test the fuel pump you now have. An explanation of this testing procedure is explained in Appendix Two.

Fuel Filters

Low pressure fuel filters will swell and explode when used in high fuel pressure applications. They will also restrict fuel flow rate. Low pressure filters are generally designed to flow the fuel volume being used by the engine. Fuel injection systems return the bulk of the fuel back to the fuel tank through a return line. The flow rate through the injection filter is far greater than for a low pressure filter. In addition, the injectors have a fine wire mesh filter in the inlet tube. A filter is used to avoid clogging.

High pressure fuel filters are readily available and are not expensive. They generally have an all metal casing and the filter element has a good cross sectional area.

WARNING: Do not attempt to use a fuel filter designed for low pressure applications.

Fuel Lines And Hoses

To run the fuel lines the length of the vehicle, metal or high pressure plastic fuel lines should be used. Do not use rubber fuel hose to transport high pressure fuel any distance. There is often a metal fuel line from the fuel tank to the engine which can be used for the high pressure line when converting carburetted vehicles to fuel injection. In this case a single high pressure plastic/metal fuel line need only be run as the low pressure line returns to the tank.

NOTE: Where flexible fuel hose is necessary, a good quality high pressure fuel hose designed for fuel injection should be used. *The use of standard low pressure fuel line will result in disaster.* Over a period of time the hose will swell and burst under pressure. Purchase good quality fuel injection hose marked with a suitable pressure rating.

Fuel Pressure Regulators

Fuel pressure regulators for electronically injected cars have rated pressure around 36 to 40 psi. (275 kPa). Most late model regulators are manifold referenced and will operate well under vacuum. The regulator should be flow tested with the pump you intend to use. Adjustable pressure regulators are available to allow you to set your fuel pressure.

Fuel Injectors

Early Model

Early fuel injection systems discharge only half the injectors every engine revolution. Early model injectors had to discharge twice the amount of fuel per injection. Early model injectors flow around 280cc to 480cc per minute.

Late Model

Late model injectors typically flow from 180cc to 340cc per minute. The major difference between the older and newer versions, apart from the flow rate, is the electrical connector used on each. Early model injectors use a very simple slide fit plug which is covered by a rubber boot for water resistance. Later models use a more elaborate plug, with a locking clip, designed to be water resistant without making it necessary to cover the entire connector with a rubber boot.

Competition Injectors

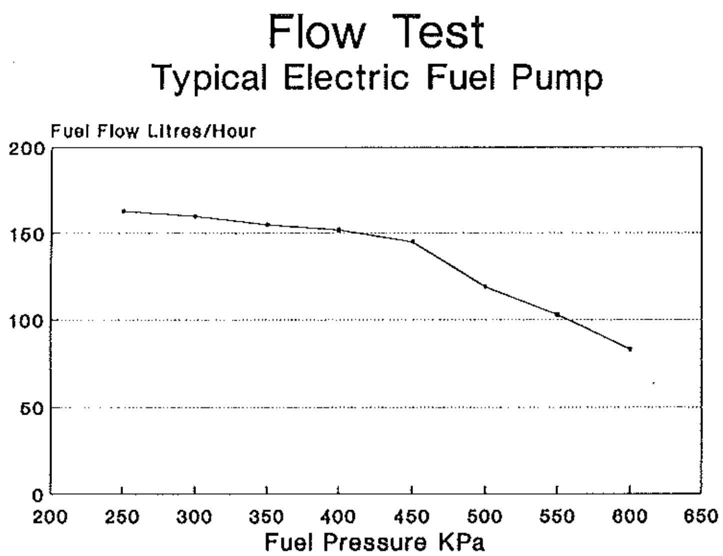
Your Haltech™ dealer can supply a range of high flow rate injectors for competition racing.

APPENDIX TWO

FUEL FLOW PRINCIPLES

The Haltech™ ECU can control the opening time of the injectors down to 0.064 milliseconds per division which gives you accurate control over how long the injectors are open. The accuracy and advanced features of the Haltech™ system are wasted if the fuel pressure behind the injectors is not stable.

Fuel Pump & Injector Flow Vs Fuel Pressure



The fuel pump is a positive displacement pump driven by a DC motor. As the work that the motor has to do to turn the pump increases, the motor slows down. As the motor slows down, the volume of fuel being pumped falls off. Graph #1 shows fuel pump flow capacity versus fuel pressure for a typical electric fuel injection pump.

Measuring Flow Capacity

One method of measuring the flow capacity of a pump at a given pressure is to connect it to a pressure regulator. With the pump connected to a pressure regulator, measure how much fuel comes out of the return line over sixty seconds. This is the volume of fuel that can be taken from the fuel system, at that pressure, without any pressure drop.

"In Regulation"

For example, if the flow capacity of the pump is 2.5 liters per minute at 40 psi/275 kPa fuel pressure. Fuel injectors connected to this pump can take up to 2.5 liters per minute and the fuel pressure will remain at 40 psi/275 kPa. As the injectors take fuel from the system, the regulator closes proportionally and the fuel pressure stabilizes at 40 psi/275 kPa. The system is then said to be "in regulation".

"Out Of Regulation"

If the injectors take any more than 2.5 liters per minute from the system, the regulator shuts completely and no fuel goes down the return line. The regulator can no longer act to stabilize the fuel pressure and the fuel pressure falls. In this situation the system is "out of regulation". All the fuel the pump can flow is being used by the injectors. When the injectors shut, the fuel pressure will build up until the regulator opens. As soon as the injectors open the system will again drop out of regulation and the fuel pressure will fall.

The characteristics of an engine running on a fuel system that falls out of regulation are wild pulsations in fuel pressure, erratic behavior, and loss of fuel-air mixture control under load.

Naturally Aspirated Engines

For a naturally aspirated engine, it is quite straightforward to determine if the fuel system has the capacity to remain in regulation. Test the flow capacity of the pump with the fuel pressure regulator manifold reference open to the atmosphere. This can be compared to how much fuel the injectors will take from the system.

For example, if the fuel pump has the capacity to flow 2.5 liters per minute at 40 psi (274 kPa) and there are six injectors rated at 180 cc/min, then the injectors will dump 6 x 180cc = 1080 cc/min. The fuel pump can flow 2.5 liters/min. at 40 psi and the injectors can take only 1.08 liters at 40 psi., so the system will remain well within regulation.

Testing the flow capacity of the system is done with the engine stopped so that the injectors are closed. Since it is necessary to make the fuel pump run with the engine stopped, you must bridge out the contacts of the fuel pump relay or run power directly to the pump.

How To Test Fuel Pump Flow Capacity

(Naturally Aspirated Engines)

1. Connect a fuel pressure gauge to the high pressure side of the fuel circuit.

2. Feed the return line from the regulator into a suitable measuring container. Leave the pressure port on the regulator open to the atmosphere.

3. Feed twelve volts to the pump and collect the fuel from the return line over sixty seconds. Note that the fuel pressure shown on the pressure gauge is the same as the rated pressure of the regulator.

4. Measure the volume of fuel flowed in the sixty seconds. This is the flow capacity of the pump at the pressure Indicated.

Turbocharged / Supercharged Systems

The fuel pressure regulator is referenced to the manifold pressure. When the engine has 15 psi/100 kPa of manifold boost, the fuel pressure will rise by 15 psi/100 kPa above the rated pressure of the regulator.

Applying Pressure To The Manifold Pressure Port

The maximum operating fuel pressure of the system will only be tested if pressure is applied to the manifold pressure port on the fuel pressure regulator during the test. It is convenient to use a 25ml syringe to do this. Connect the syringe to the regulator with a short piece of small diameter rubber hose By depressing the syringe you can raise the regulator pressure. If you wish you can put a small tee-piece in the hose from the syringe to the regulator and use a manifold pressure gauge to note the boost pressure.

Let's assume that you have a turbocharged engine that you wish to run to 15 psi/100 kPa of boost. The manifold reference fuel pressure regulator you have is rated at 40 psi/275 kPa so that the maximum fuel pressure you expect to see is 55 psi/375 kPa. ie 40 psi + 15 psi = 55 psi or 275 kPa + 100 kPa = 375 kPa. You must hold the fuel pressure at 55 psi/375 kPa by pressurizing the regulator with the syringe and measure the fuel from the return line over sixty seconds.

Test Overview

(Turbocharged / Supercharged Engines)

This test is done with the engine stopped so that all injectors are closed. The maximum operating pressure should be calculated as previously explained. Run the fuel pump with the engine turned off. Either bridge the fuel pump relay contacts or run twelve volts directly to the pump. This tests requires two people. One person must pressurize the regulator and monitor the fuel pressure gauge while the other switches the fuel pump on and off for the sixty second period.

How To Test Fuel Pump Flow Capacity

(Turbocharged / Supercharged Engines)

1. Connect a fuel pressure gauge to the high pressure side of the fuel pressure circuit.

2. Run the return line from the pressure regulator into a suitable measuring container.

3. Run the fuel pump.

4. Pressurize the regulator with the syringe until the maximum fuel pressure you have calculated appears on the fuel pressure gauge.

5. Measure the volume of fuel flow in sixty seconds. This is the fuel flow capacity of the pump at the maximum fuel pressure seen. Comparing this to the total fuel flow requirements of your injectors will determine whether this system will drop out of regulation or not.

Testing Injector Flow Capacity

If you already have injectors and you do not know their flow rate it will be necessary to find out. If the injectors are secondhand it is good practice to flow them to be sure they are functioning correctly. It is common for secondhand injectors to have been mistreated or water damaged and there is no way of assessing their quality without flowing them first.

Of course, it is very annoying to get the fuel injection manifold in place and everything ready to go only to find that you have one dead injector. A pretest of your injectors will avoid this annoyance.

To test an injector's flow it is necessary to get fuel at the rated pressure of the system to the injector you wish to test while aiming the injector into a suitable measuring container. Most fuel injection repair shops have a flow bench which allows easy testing of injectors; it may be worth hiring their services.

Given that you get fuel to the back of the injector, the injector should be held open for sixty seconds into the measuring container. To hold the injectors open the current to the injector must be limited to prevent the injector from overheating. Connecting an injector directly to twelve volts will certainly destroy it. The use of two 1.5 volt "D" cell batteries in series is recommended. This gives three volts to the injector - a safe current level to hold the injector open for the sixty second test.

REMEMBER: If the fuel pump flow capacity is greater than the total injector flow capacity, (at the maximum fuel pressure that the system will see) then the system will remain in regulation.

When the fuel pressure is present and the injector is closed there should be no leakage from the injector. When the injector is open the spray pattern should be even and highly atomized. Clogged injectors can develop a poor spray pattern which will result in the wetting down of the inlet manifold. Various cleaning agents can be flowed through clogged injectors to clean them. A fuel injection service center should also have an injector cleaning machine which could prove useful.

WARNING: Fuel is flammable. Beware of electrical sparks, flames, cigarettes, etc.

Raising the Rated Pressure Of The Fuel System

On some high horsepower racing cars even the largest multipoint injectors available will not flow enough fuel to meet the power requirements of the engine. This is particularly true for systems running on methanol. There are three options open to the racing engineer in this case:

1. Use one more injector per cylinder, which involves costly re-designing of the inlet manifold.

2. Use throttle body type injectors in place of the multipoint injectors.

Throttle body injectors have higher flow rates than the multipoint injectors; however, they are usually physically different requiring machining on the injector mounts. Throttle body injectors are also electrically different a nd you must specify whether you wish to drive multipoint or throttle body injectors when ordering your Haltech™ System.

3. Raise the rated pressure of the fuel system by modifying the fuel pressure regulator.

This will raise the flow rate of the injectors. It will also lower the flow capacity of your fuel pump. Raising the rated pressure of your system will take you closer to the limits of your fuel system. It is a valid way of increasing the capacity of the fuel system. However,the principles of remaining in regulation still apply.

The Principle Of Regulation

If the fuel pump flow capacity is greater than the total injector flow capacity (at the maximum fuel pressure that the system will see) the system will remain in regulation.

Be aware that when you are increasing the pressure of the fuel system you are tilting the regulation equation on both sides at once. You are increasing the injectors ability to take fuel from the system at the same time you are lowering the pumps ability to supply it.

Maintaining Constant Injector Flow

As discussed, the difference in pressure across an injector is held constant by varying the fuel pressure in regard to the manifold pressure. This keeps the injector flow constant regardless of manifold pressure or vacuum.

Rated System Pressure

The difference in pressure across the injector is referred to as the "rated system pressure". It is determined by the rated pressure of the regulator. The injectors are rated by their flow over sixty seconds at 40 psi (275 kPa) fuel pressure when held open continuously. Raising the rated system pressure does increase the injector flow rate. Doubling the rated pressure, however, does not necessarily double the injector flow rate.

The relationship between the rated pressure of the system and injector flow is shown below.

Suppose you have a turbocharged four cylinder engine present and the injector is running an intercooler and 30 psi (210 kPa) of boost. To run the engine at an 11.5:1 air-fuel ratio, the maximum RPM used will be 7500. The fuel required per cylinder is 560 cc/min. The car is currently running one 480cc/min injector per cylinder. The suggestion is that the rated pressure of the system could be raised to make the injectors flow 560 cc/min. As can be seen from the table above, the rated fuel pressure of the system would have to be raised to 65 psi (445 kPa) to raise the flow rate of the injectors to 560 cc/min each. The total injector flow from four injectors is 4 x 560cc = 2240 cc/min.

Maximum fuel pressure = Rated pressure + Highest boost pressure

ie: 65 psi + 30 psi = 95 psi or 445 kPa = 210 kPa = 655 kPa.

Using Parallel Pumps

If you wanted to use the later model pump, the fuel flow capacity at 95 psi is only 1.3 liters/min. This is well below the total injector flow and the system would drop out of regulation severely if only one of these pumps were used. A common solution is to parallel two pumps to effectively double the flow capacity of the system. The combined flow capacity of two pumps at 95 psi (655 kPa) fuel pressure is 2.6 liters/min which is greater than the total injector flow. Using two pumps, the system would stay in regulation.

A single fuel pressure regulator may not be able to return enough fuel to the tank when the engine is idling, causing excessively high fuel pressure. It may be necessary to run two fuel pressure regulators modified to have a rated pressure of 65 psi (445 kPa). Remember the current that is drawn from the charging system will run two pumps. Also, consider proper fuel line diameter and the effect on fuel temperature caused by increased fuel circulation through the system. In addition, assess the reliability of your fuel flow system since it w ill now have twice the number of components.

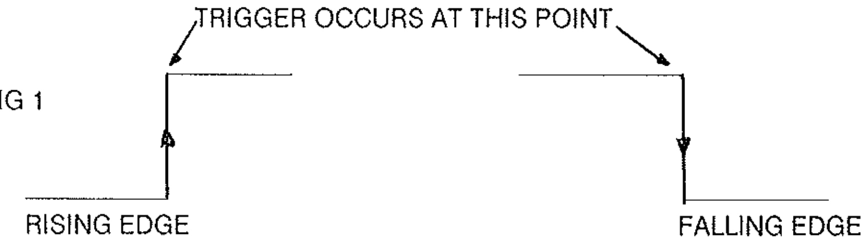
INTERFACING WITH THE E6

Input Trigger

INTERFACING THE E6 WITH YOUR PARTICULAR IGNITION SYSTEM MAY BE FAIRLY STRAIGHTFORWARD OR IT MAY BE COMPLICATED. THE VARIETY OF IGNITION DESIGNS AVAILABLE IS THE PRIMARY SOURCE OF COMPLICATION. THIS APPENDIX CONTAINS A LOT OF USEFUL INFORMATION ABOUT THE DIFFERENT APPROACHES TO IGNITION DESIGN AND IS PARTICULARLY USEFUL FOR PROBLEM SOLVING.

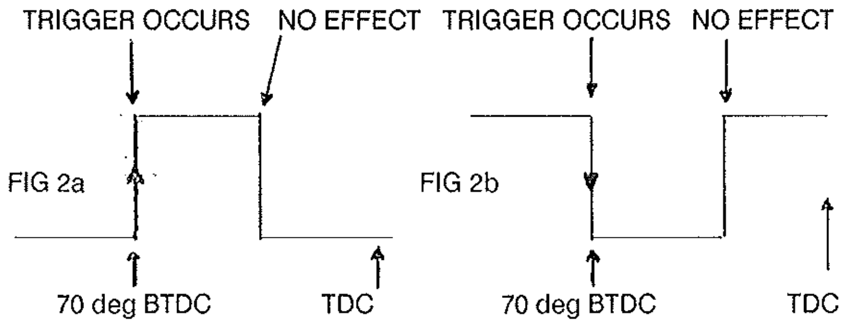
The E6 ECU has been designed to trigger from a square signal that varies from a 'low' of zero volts (ground) to a voltage between 5 and 15 volts. The actual value of this 'high' voltage is not important because it is the transition from 'low' to ;high', or 'high' to 'low', that is used to trigger the E6 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. If the trigger edge occurs on the transition from high to low, it will be shown with a downward facing arrow, and would be called a falling edge. See FIG 1.

FIG 1



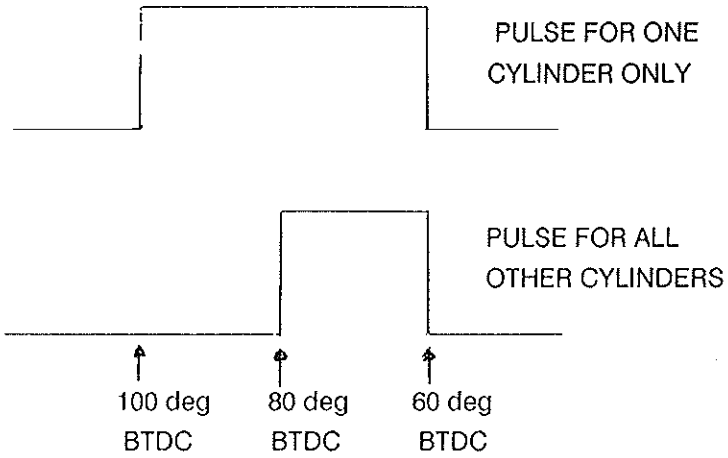
In order that the E6 operate correctly a trigger edge must be generated each time a spark is required. This edge must occur a fixed number of degrees before top dead centre (BTDC) and must not change as the engine operates. The position of the trigger edge is given in crankshaft degrees and is called 'trigger degrees'. In addition there should not be any variation in the trigger degrees between cylinders. The E6 can be set by the user to have its trigger edge occur between 60 deg. and 100 deg. BTDC.

In the example shown in Fig 2a the trigger occurs on a rising edge at 70 deg. BTDC. The second transition, from high to low, could occur any time after the rising edge. In some installations this second transition will coincide with 10 deg. BTDC or TDC itself, or it could happen as close as a few degrees after the trigger edge. The point is that this second edge will have no effect on the correct operation of the E6 ECU, it is only the position of the trigger edge that is of importance.



In the previous examples the trigger edge has been shown as the first edge of the trigger pulse. The trigger edge does not necessarily have to be the first edge of the pulse. Consider the example shown in FIG 3. In some trigger devices the pulse given for cylinder one would be a different width than the pulses given for all other cylinders. If the first, in this case, rising edges were used as the trigger edge than there would be a variation of 20 deg between the trigger degrees for cylinder one and all other cylinders. This would lead to cylinder one being 20 deg more advanced than all 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 60deg BTDC. It would be rare that someone installing an E6 would come across such a situation but it does happen, and it serves as a good example of how important selection of the correct trigger edge is.

FIG 3



TRIGGER DEVICES

The output of a Hall effect or optical sensor could normally be connected directly to the input trigger pin of the E6 ECU. Many distributors used in original equipment manufacturer's computer controlled ignition systems would be fitted with Hall/optical triggers. The internal structure of such distributors is usually configured so that a slotted 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 to an E6 ECU. Often these distributors have a rising edge trigger at 70 deg BTDC.

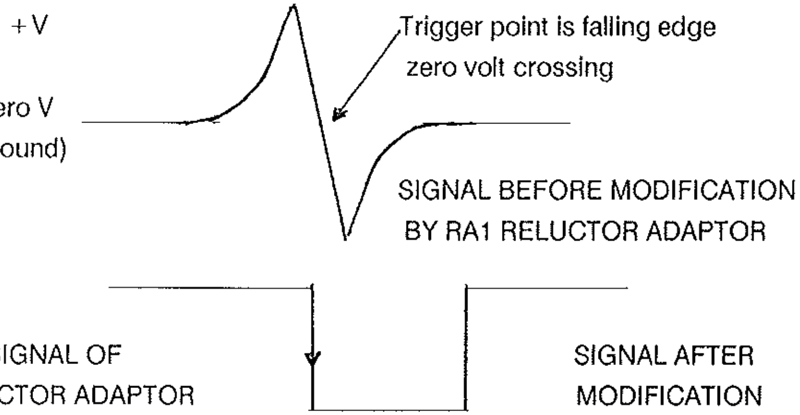
Many distributors used in electronic ignition systems contain internal components and layouts the same as the distributors described above but are fitted with mechanical and/or vacuum advance mechanisms which are much less efficient and flexible than electronic timing as in the E6. If these mechanisms can be defeated or removed and the timing edges set correctly then distributors like these can successfully be used to trigger the E6.

A third type of pickup, the magnetic reluctor, is also used in distributors as well as on crank trigger units. This 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 two wires, one positive (+), and the other negative (-). The wires are sometimes marked as such, but more often than not they are not marked. It is very important that the positive wire go to the input pin of the reluctor adaptor, and that the negative go to the ground reference pin. If you cannot determine which wire is positive, from markings or wire color, then it would be necessary to check the signal going into the RA1 reluctor adaptor 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 FIG 4a 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 speed the signal may only be several hundred mV, but at high speed it could rise to 20 volts or more. This signal does not have the vertical rising or falling edge that is required to trigger the E6, so we have to convert it into a square signal pulse using a Haltech RA1 reluctor adaptor. The input of the reluctor adaptor must first go positive (+), which arms the circuit in the RA1. When the signal falls and crosses zero volts the RA1 will generate an output pulse of a fixed width which can be used to trigger the E6. If the wires are reversed and the signal goes negative (-) first, the the RA1 will generate a pulse but it will NOT trigger the E6 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. Obvously these things cause major problems so if you are using reluctor pickups ensure that they are wired in the correct polarity.

The pulse generated by the RA1 reluctor adaptor is a falling trigger edge as seen in FIG 4b. It has a fixed duration of around 500 microseconds.

FIG 4a

FIG 4b



There is a variation on this type of pickup which uses magnets moving past the pole piece instead of ferrous metal. An example of this type is the MSD flying magnet crank trigger. This pickup can also be used with the RA1 reluctor adaptor to the trigger the E6 ECU

IGNITER OUTPUT

The E6 ECU has only one ignition output channel and would normally drive a single ignition coil (Note 1). This means that the E6 must be used with a distributor to distribute the spark. Unless a method is devised to switch the multiple igniters and coils, an E6 ECU cannot be used on 'direct fire' engines or rotaries (Note 3).The output signal of the E6 to the igniter is a square edge signal with a 70/30 duty cycle i.e 70% off time, 30% on time and the falling edge indicates the the required ignition point. This signal cannot be used to drive an ignition coil directly, it must drive some form of igniter. The E6 ECU does not control dwell (coil on time). The E6 has been designed to work in conjunction with a Bosch igniter module part # 9 222 067 023 (Note 2) which is a current limiting igniter with dwell control. If supplied with the E6 kit this igniter would be fitted to a small angle bracket which acts as a heat sink. If you remove the igniter from its bracket and mount it on something else, you must ensure that what it is mounted to can conduct and dissipate the heat generated by the igniter as the rear of the igniter gets quite hot. The three wires from the igniter need to be connected. The black wire with a loop goes to ground and this should NOT be grounded at the same point as the ECU is grounded to prevent ignition noise getting into the power supply circuit of the ECU. The blue wire goes to the negative side of the coil. This wire is probably the noisiest wire in the vehicle (i.e. gives off most radio frequency interference) with the exception of the ignition plug leads so try to avoid running it long distances and bunching it in with other wires. The red wire goes to ignition power, usually +12 volt when the ignition is on and normally this would come from the positive side of the coil. This wire does not supply power to the coil. You must supply power to the positive side of the coil and the red wire then draws power from that point.

NOTE 1: Two igniters can be parallelled together to drive engines with twin distributors and two plugs per cylinder.

NOTE 2: The number 1 227 022 008 stamped on the device is the German part number for the plastic case only. The Regitar equivalent part is IG-H004 but this part has been tested and found NOT to work satisfactorily with the E6 ECU, so use this part at your own risk i.e. don't use it.

NOTE 3: There are ways to direct fire some 4 cylinder engines with the E6, or 6 and 8 cylinder engines in conjunction with other equipment, and if you are interested in doing this you should contact your Emtech distributor to find out whether your application can be direct fired. Alternatively, if you require direct fire, you can purchase a direct fire version of the Emtech ignition timing computer.

ALTERNATE IGNITION SYSTEMS

The output of the Bosch 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 output of the E6 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. When the Bosch module is connected to the E6 ECU, the signal coming from the Bosch module will appear to the after-market system to be identical to a signal generated by points.

G.M. DIRECT FIRE IGNITION

The G.M. direct fire ignition module, as used in the V6 Buick, can be connected directly to the E6 ECU. This module serves both as a trigger device and as an igniter.

FORD THICK FILM IGNITION (TFI)

The FORD TFI module is fitted to distributors used with Ford's EEC IV engine management computer system. The E6 ECU can connect directly to this module, however, the TFI module requires a trigger signal, SPOUT (Note 1), that has a 50/50 duty cycle and as a result a special Ford only version of firmware exists for this applications (Note 2). This firmware is incorporated in a microprocessor chip inside the E6 ECU and the change to this version is not a dealer accessible upgrade. If you wish to use the E6 with the Ford TFI module then you must order the E6 for that application and the firmware will be fitted at the factory, alternatively you can return your E6 to the factory for the upgrade but this will attract an extra cost. There are several versions of the Ford TFI module but these notes refer only 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.

NOTE 1: Signal name for TFI module IN/OUT

PIP	Profile Ignition Pickup (trigger pulses from the Hall effect sensor)	OUTPUT
SPOUT	Spark Out (Igniter Output from the ECU)	INPUT
POWER	+ 12 volt from starter circuit	INPUT
POWER	+ 12 volt from ignition switch	INPUT
COIL-	Negative terminal of coil	OUTPUT
GND	Ignition system ground	

NOTE 2: Firmware is the computer program stored within the ECU that instructs the ECU how to operate. The 50/50 duty cycle is not the only change, there are several other changes specific to the Ford DFI module.

To further complicate matters there are two types of chopper wheels used, one that generates a 'normal' PIP signal and one that generates a 'signature' PIP signal. The signature is a shortened pulse on cylinder one, being shorter than the pulses for the remaining cylinders. Unfortunately the edges where the pulses do coincide occur at 10 deg BTDC (Note 1). The E6 Ford firmware is therefore only suitable for use with normal or non-signature distributors. At engine speeds below 500 RPM the E6 ECU will not generate a SPOUT signal. The TFI module has circuitry to sense the absence of a SPOUT signal and will generate its own spark at 10 deg BTDC in those circumstances. The trigger edge for Ford TFI modules is the falling edge. For 8 cylinder engines the trigger degrees is 55 deg and for 6 cylinder engines it is 70 deg BTDC.

NOTE 1: If you attempt to overcome the problem above by rotating the distributor shaft so that the 10 deg point occurs at 60 deg BTDC you will induce another problem because if you rotate the shaft the rotor phasing will be thrown out and the rotor button will not line up with the plug lead terminal within the distrbutor cap

ROTOR PHASING

Rotor phasing must be taken into account. Take as an example a distributor that uses a Hall effect sensor with the 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 setup 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. If the trigger edges generated by this modified distributor fall outside the 60 deg to 100 deg BTDC window, and this will normally be the case, then 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 deg BTDC then a problem of rotor phasing may have been induced. By the time the ignition pulse occurs, which could be up to 60 deg later, the rotor button would have passed the plug lead terminal in the rotor cap and this could lead to arcing within the distributor cap and the arcing could even be to the wrong plug lead terminal. If it doesn't arc then the back EMF in the ignition coil primary could damage the the igniter or the igniter system. Either way the engine is not going to run correctly, if at all.

The correct method 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 REFRRED TO. Our example is an engine that has the following timing requirements-

Minimum Timing = 10 deg BTDC

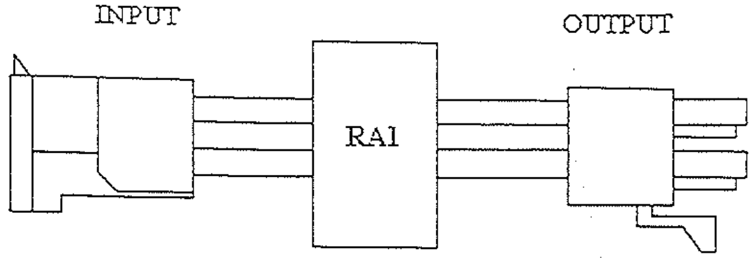
Maximum Timing = 40 deg BTDC

This gives a mid point, half way between the minimum and maximum timing, of 25 deg. 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 deg BTDC. Now rotate the distributor shaft so that the rotor button is where it would be when the engine is at 70 deg BTDC I.E. move it back 45 deg, remembering that this is engine degrees. This is where the rotor button has to be when the chopper wheel triggers the sensor. For ease of explanation, 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.

AFTER-MARKET DISTRIBUTORS

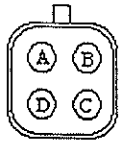
A variety of after-market distributors such as Mallory are available which are designed to minimise interface problems. Your supplier may be able to help with information in this regard.

RELUCTOR ADAPTOR: RA1



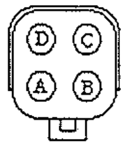
4 WAY PACKARD
SHROUD PN. 1201 5024

A	BLACK	GROUND
B	WHITE	PRIMARY TRIGGER
C	GREEN	SECONDARY (HOME) TRIGGER
D	BLACK	GROUND



4 WAY PACKARD
TOWER PN. 1201 5798

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



The **Reluctor Adaptor**, or **RA1**, is used with magnetic reluctor pickups used in as crank triggers and some distributors. This pickup is basically a coil of wire wrapped around a magnetic core and attached to a sensor face, which is called the pole piece. The physical size and shape of such a pickup can take on many forms.
A magnetic pickup has two wires, one positive (+), and the other negative (-). The wires are sometimes marked as such, but more often then not they are not marked. It is very important that the positive wire go to the input pin of the reluctor adaptor (pin B for primary trigger, C for secondary), and that the negative go to the ground reference pin (pin A for primary trigger, D for secondary). If you can not determine which wire is positive, from marking or wire colour, then it would be necessary to check the signal going into the RA1 using an oscilloscope.
When ferrous metal, ie. metal which a magnet will attract, is passed very close to the pole piece, the pickup will generate a voltage signal, similar to figure 2a, 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 mV, but at high speed it could rise to 20 volts or more. This signal does not look very much like the signal we need to trigger the HALTECH™, so we have to convert it into a square signal pulse using the RA1 Reluctor Adaptor.
The input to the reluctor adaptor must first go positive (+), this arms the circuit in the RA1. When the signal falls and crosses zero volts the RA1 will generate an output pulse of a fixed width which an be used to trigger the HALTECH™. If the wires are reversed and the signal goes negative (-) first, then the RA1 will generate a pulse but it **will NOT trigger the HALTECH™ correctly** and very weird things happen to the ignition timing. Usually this causes the timing to be retarded as revs increase, but sometimes multiple triggers can occur. Both of these are things to avoid, so if your using reluctor pickups make sure they are wired correctly.
The pulse generated by the RA1 is a falling edge trigger as seen in figure 3. It has a fixed duration of around 500 microseconds.

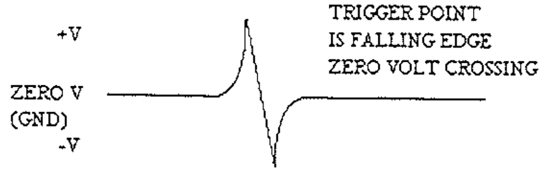


FIGURE 2a

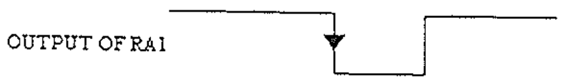


FIGURE 2b

There is a variation on this type of pickup which uses magnets moving pass the pole piece instead of ferrous metal. An example of this type is the MSD flying magnet crank trigger. This pickup can also be used with the RA1 to trigger the HALTECH™ ECU.

APPENDIX V

STAGING INJECTORS

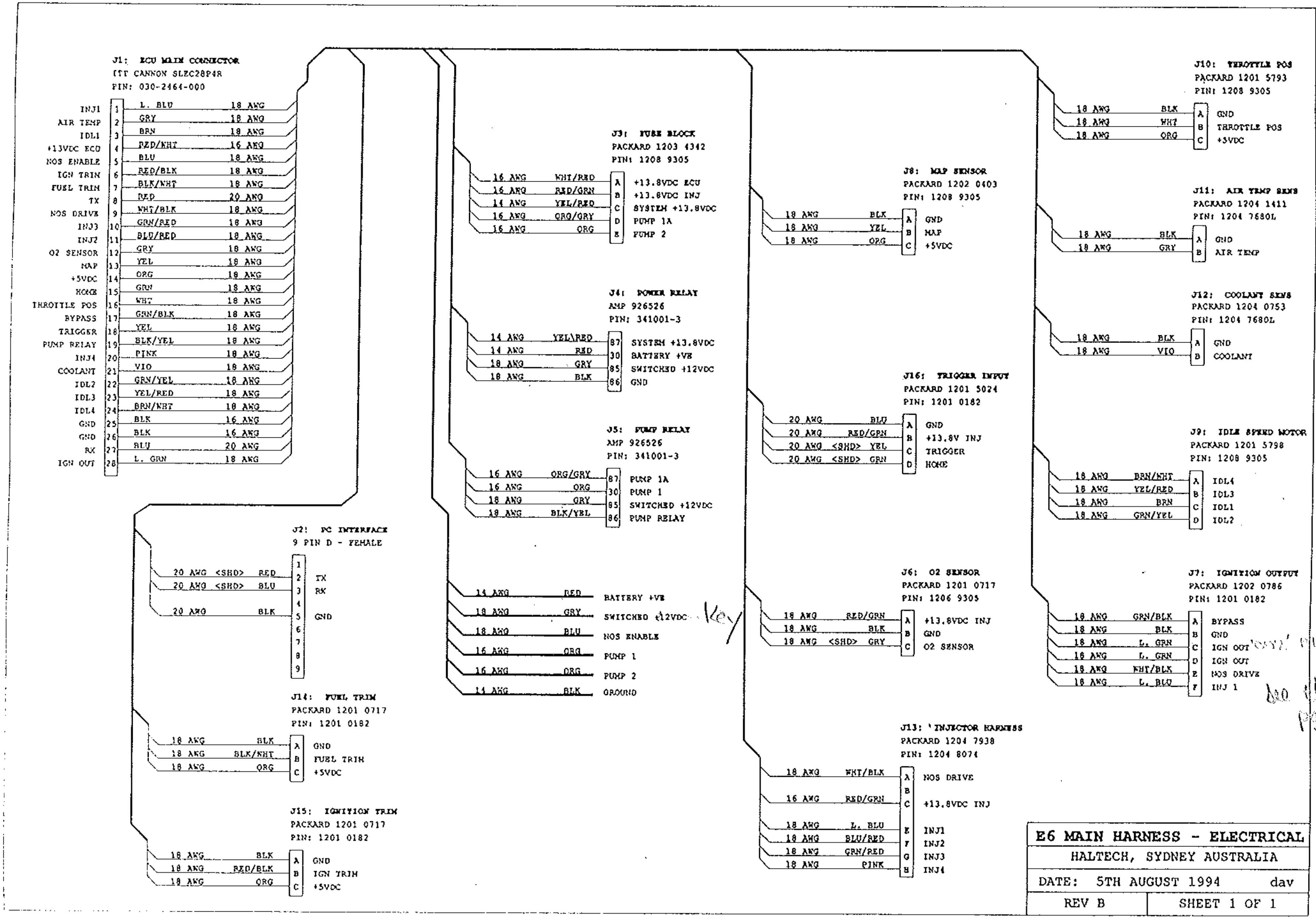
Injector staging allows the use of primary and secondary injectors and is usually used only on turbo/supercharged engines. The ECU will fire only the primary set of injectors until a preset loading point, then begin simultaneously firing both primary and secondary injectors.

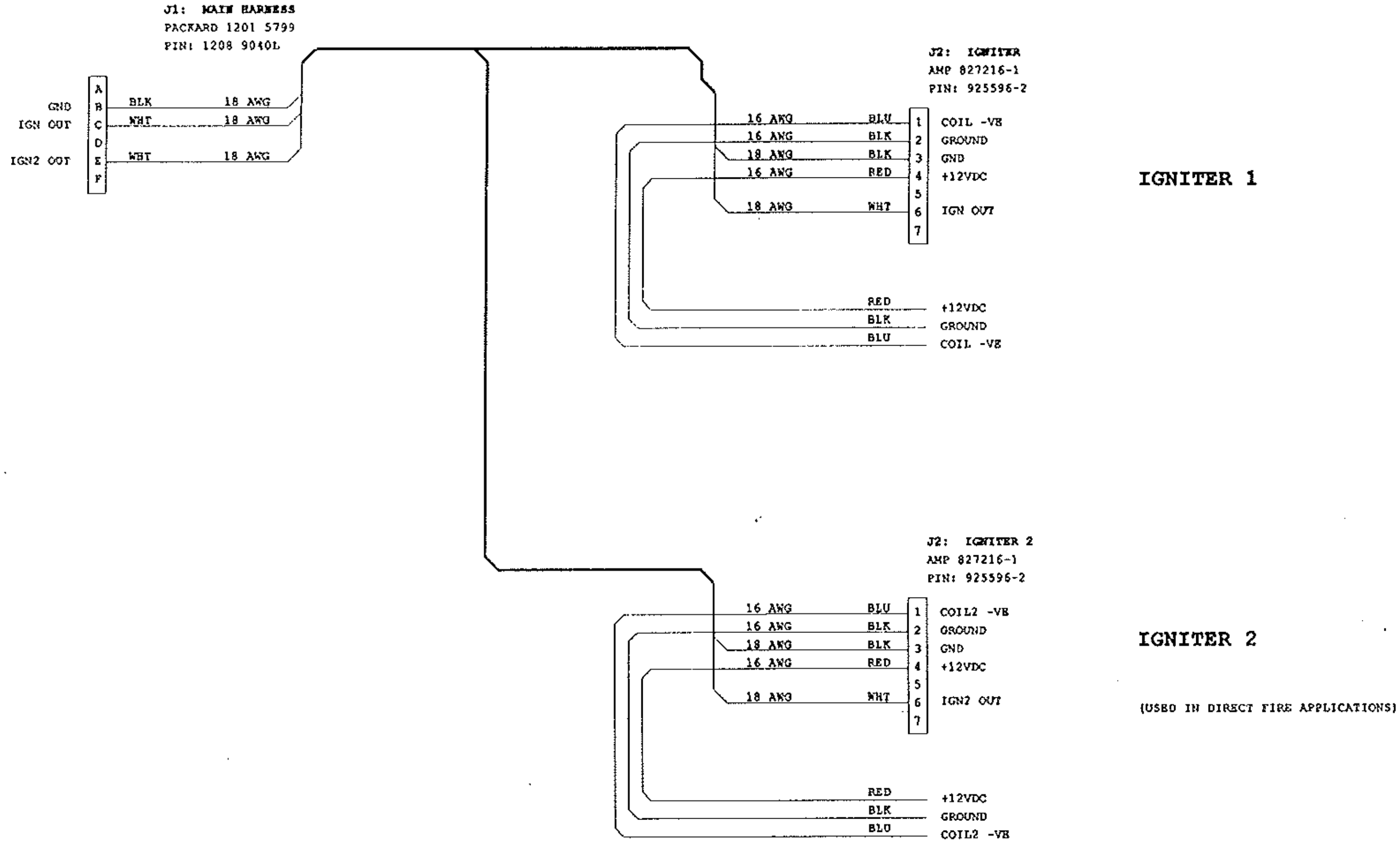
The turn-on point for secondary injectors depends on injector size and engine performance. Typically, bar number 14 to 16 will work well on most turbocharged applications. On some engines, the staging point may need to be higher or lower to achieve a smooth transition to all-injector operation.

Adjust the change over pulse duration from primary-only to both sets of injectors with extreme care to ensure that pulse duration provides adequate fuel delivery to the engine! When the HALTECH ECU begins "secondary" operation, it begins firing both sets of injectors at once and it fires them for the same duration. This means that; if both injector sets are equal in flow rate, a secondary pulse width beginning at 60% of the primary pulse width before staging (allowing a little extra fuel to start staging safely) is a good starting point. Always keep injector flow rates in mind when adjusting the drop from primary injector pulse duration as secondary staging begins. A smooth transition will only be possible with a smooth progression in fuel delivery. If much more fuel is suddenly switched on, the engine will bog. If fuel delivery is suddenly reduced engine damage may result.

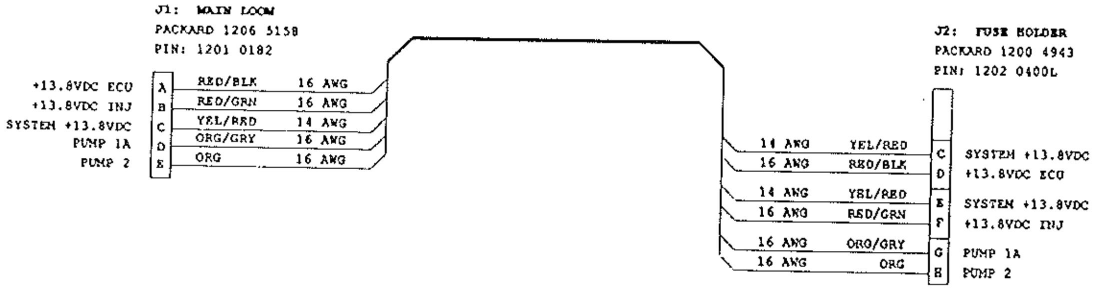
Staging is enabled by means of the Identification Page. When in the Main Menu press "I" for Identification and when the Identification page appears press the Down arrow until the display opposite "Staging" is highlighted. Press Enter to change the mode and the Down arrow to make the change. As you press the Down arrow you will see the display toggle between "Off" and "On" When "On" is displayed press the Enter key and the staged injector mode is selected. Next press the down arrow until the display opposite "Staging Bar Number" is highlighted. Press the Enter key and then press the up or down arrow until the bar where you require staging to begin is selected. Press the Enter key and that bar will become the point at which staging begins. Press "ESC" to return to the Main Menu and press M for Fuel Maps. Select a fuel map from the Map Menu and you will notice that the bars to the left are shaded differently to those on the right. The left hand bars control primary injection. The right hand bars are separated by a line which denotes the change-over point between primary and secondary.

The HALTECH E6 has 4 heavy duty injector drivers, each capable of controlling 2 high impedance injectors or 1 low impedance injector. ("Extra Driver" boxes are available as optional extras for applications requiring additional injectors). When injector staging is enabled injector drivers 1 and 2 are grouped to control primary injectors and injector drivers 3 and 4 are grouped to control secondary injectors. On connector J13 (See Wiring harness diagram in Appendix 1V) Pins E and F control primary and Pins G and H control secondary.


J1: ECU MAIN CONNECTOR
ITT CANNON SLEC28P4R
PIN: 030-2464-000
1 INJ1 L. BLU 18 AWG
2 AIR TEMP GRY 18 AWG
3 IDL1 BRN 18 AWG
4 +13VDC ECU RED/WHT 16 AWG
5 NOS ENABLE BLU 18 AWG
6 IGN TRIM RED/BLK 18 AWG
7 FUEL TRIM BLK/WHT 18 AWG
8 TX RED 20 AWG
9 NOS DRIVE WHT/BLK 18 AWG
10 INJ3 GRN/RED 18 AWG
11 INJ2 BLU/RED 18 AWG
12 O2 SENSOR GRY 18 AWG
13 MAP YEL 18 AWG
14 +5VDC ORG 18 AWG
15 HOME GRN 18 AWG
16 THROTTLE POS WHT 18 AWG
17 BYPASS GRN/BLK 18 AWG
18 TRIGGER YEL 18 AWG
19 PUMP RELAY BLK/YEL 18 AWG
20 INJ4 PINK 18 AWG
21 COOLANT VIO 18 AWG
22 IDL2 GRN/YEL 18 AWG
23 IDL3 YEL/RED 18 AWG
24 IDL4 BRN/WHT 18 AWG
25 GND BLK 16 AWG
26 GND BLK 16 AWG
27 RX BLU 20 AWG
28 IGN OUT L. GRN 18 AWG
J3: FUSE BLOCK
PACKARD 1203 4342
PIN: 1208 9305
16 AWG WHT/RED A +13.8VDC ECU
16 AWG RED/GRN B +13.8VDC INJ
14 AWG YEL/RED C SYSTEM +13.8VDC
16 AWG ORG/GRY D PUMP 1A
16 AWG ORG E PUMP 2
J4: POWER RELAY
AMP 926526
PIN: 341001-3
14 AWG YEL\RED 87 SYSTEM +13.8VDC
14 AWG RED 30 BATTERY +VE
18 AWG GRY 85 SWITCHED +12VDC
18 AWG BLK 86 GND
J5: PUMP RELAY
AMP 926526
PIN: 341001-3
16 AWG ORG/GRY 87 PUMP 1A
16 AWG ORG 30 PUMP 1
18 AWG GRY 85 SWITCHED +12VDC
18 AWG BLK/YEL 86 PUMP RELAY
14 AWG RED BATTERY +VE
18 AWG GRY SWITCHED +12VDC Key
18 AWG BLU NOS ENABLE
16 AWG ORG PUMP 1
16 AWG ORG PUMP 2
14 AWG BLK GROUND
J2: PC INTERFACE
9 PIN D - FEMALE
20 AWG <SHD> RED 2 TX
20 AWG <SHD> BLU 3 RX
20 AWG BLK 5 GND
J14: FUEL TRIM
PACKARD 1201 0717
PIN: 1201 0182
18 AWG BLK A GND
18 AWG BLK/WHT B FUEL TRIM
18 AWG ORG C +5VDC
J15: IGNITION TRIM
PACKARD 1201 0717
PIN: 1201 0182
18 AWG BLK A GND
18 AWG RED/BLK B IGN TRIM
18 AWG ORG C +5VDC
J8: MAP SENSOR
PACKARD 1202 0403
PIN: 1208 9305
18 AWG BLK A GND
18 AWG YEL B MAP
18 AWG ORG C +5VDC
J16: TRIGGER INPUT
PACKARD 1201 5024
PIN: 1201 0182
20 AWG BLU 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: 1206 9305
18 AWG RED/GRN A +13.8VDC INJ
18 AWG BLK B GND
18 AWG <SHD> GRY C O2 SENSOR
J13: INJECTOR HARNESS
PACKARD 1204 7938
PIN: 1204 8074
18 AWG WHT/BLK A NOS DRIVE
B
16 AWG RED/GRN C +13.8VDC INJ
18 AWG L. BLU E INJ1
18 AWG BLU/RED F INJ2
18 AWG GRN/RED G INJ3
18 AWG PINK H INJ4
J10: THROTTLE POS
PACKARD 1201 5793
PIN: 1208 9305
18 AWG BLK A GND
18 AWG WHT B THROTTLE POS
18 AWG ORG C +5VDC
J11: AIR TEMP SENS
PACKARD 1204 1411
PIN: 1204 7680L
18 AWG BLK A GND
18 AWG GRY B AIR TEMP
J12: COOLANT SENS
PACKARD 1204 0753
PIN: 1204 7680L
18 AWG BLK A GND
18 AWG VIO B COOLANT
J9: IDLE SPEED MOTOR
PACKARD 1201 5798
PIN: 1208 9305
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: 1201 0182
18 AWG GRN/BLK A BYPASS
18 AWG BLK B GND
18 AWG L. GRN C IGN OUT
18 AWG L. GRN D IGN OUT
18 AWG WHT/BLK E NOS DRIVE
18 AWG L. BLU F INJ 1
E6 MAIN HARNESS - ELECTRICAL
HALTECH, SYDNEY AUSTRALIA
DATE: 5TH AUGUST 1994 dav
REV B
SHEET 1 OF 1



E6 IGNITION SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994	dav
REV A	SHEET 1 OF 1



E6 FUSE BLOCK - ELEC	
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DATE: 2ND AUGUST 1994	dav
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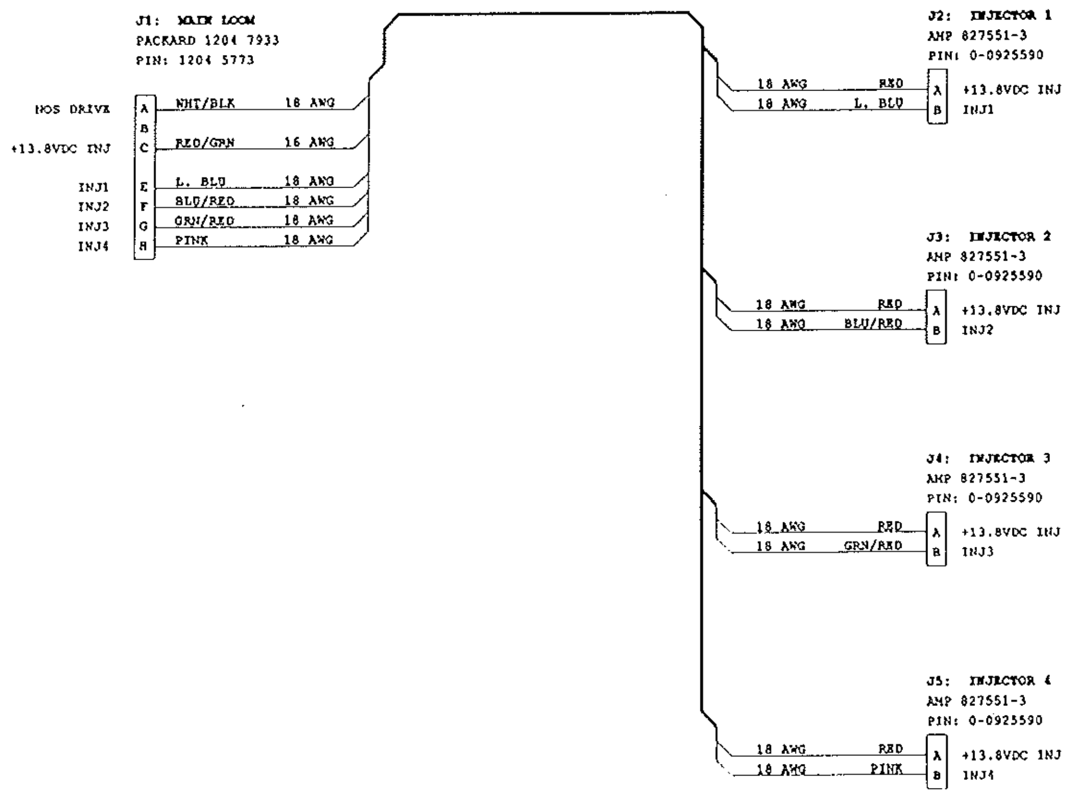
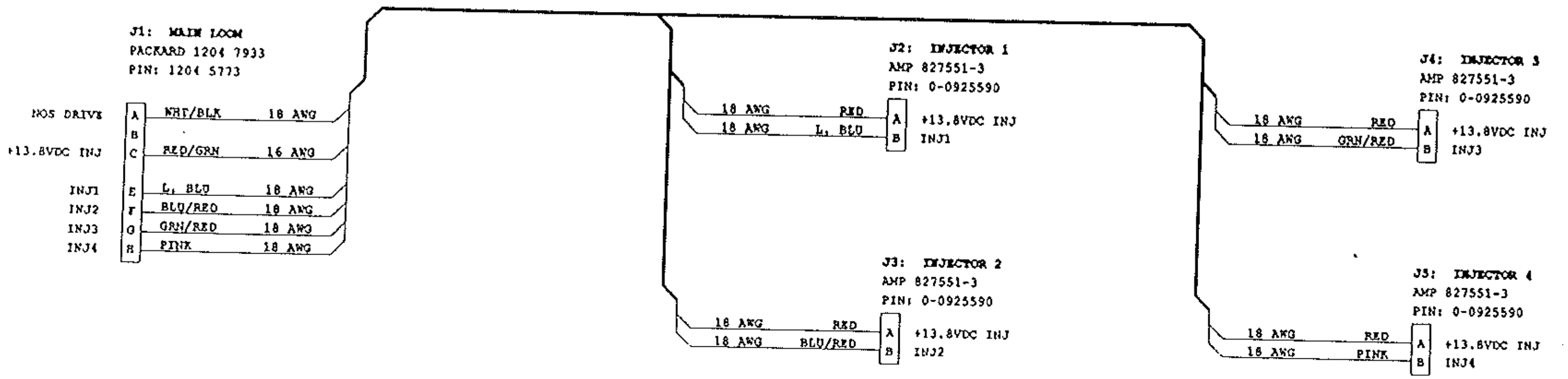
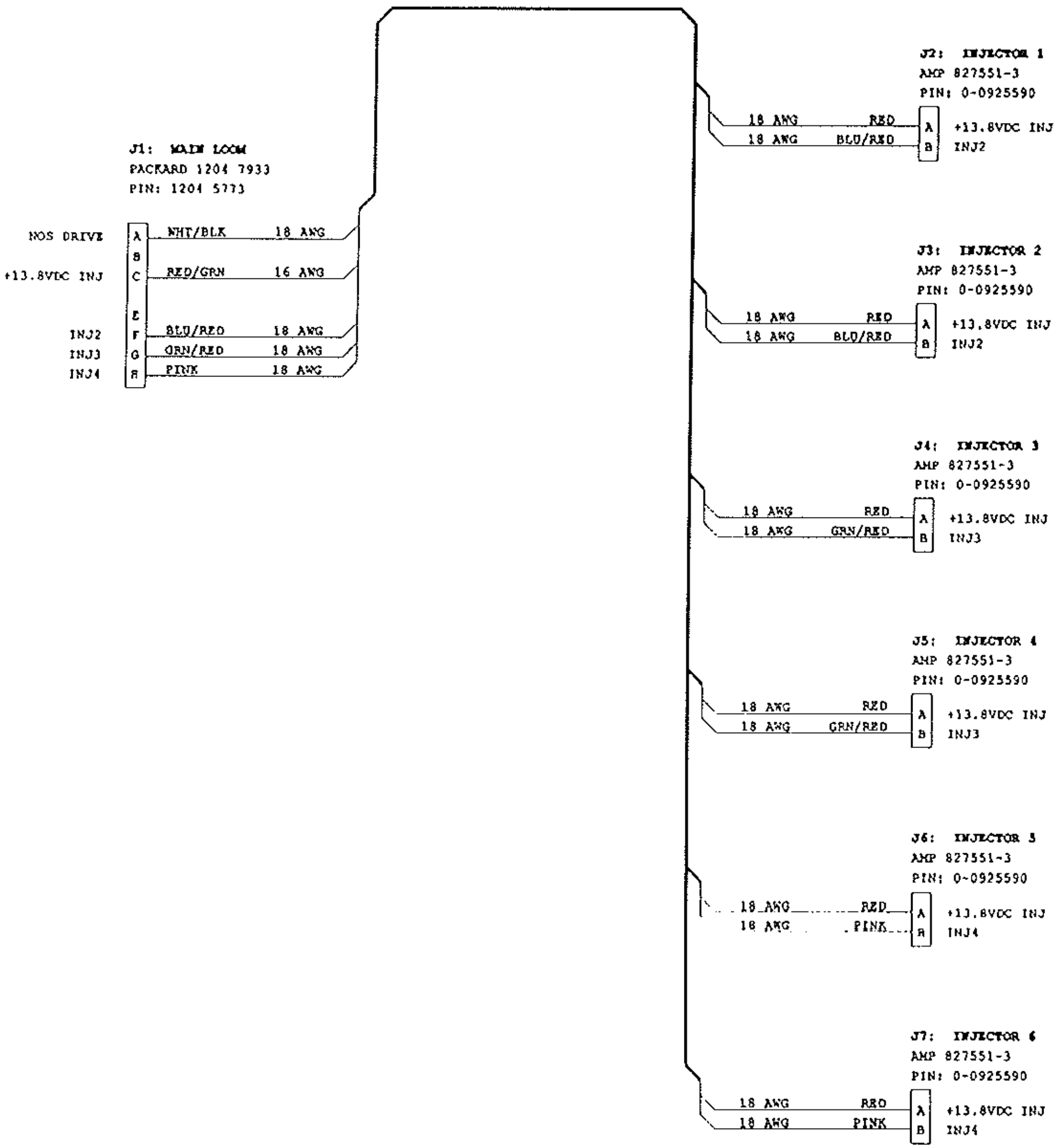


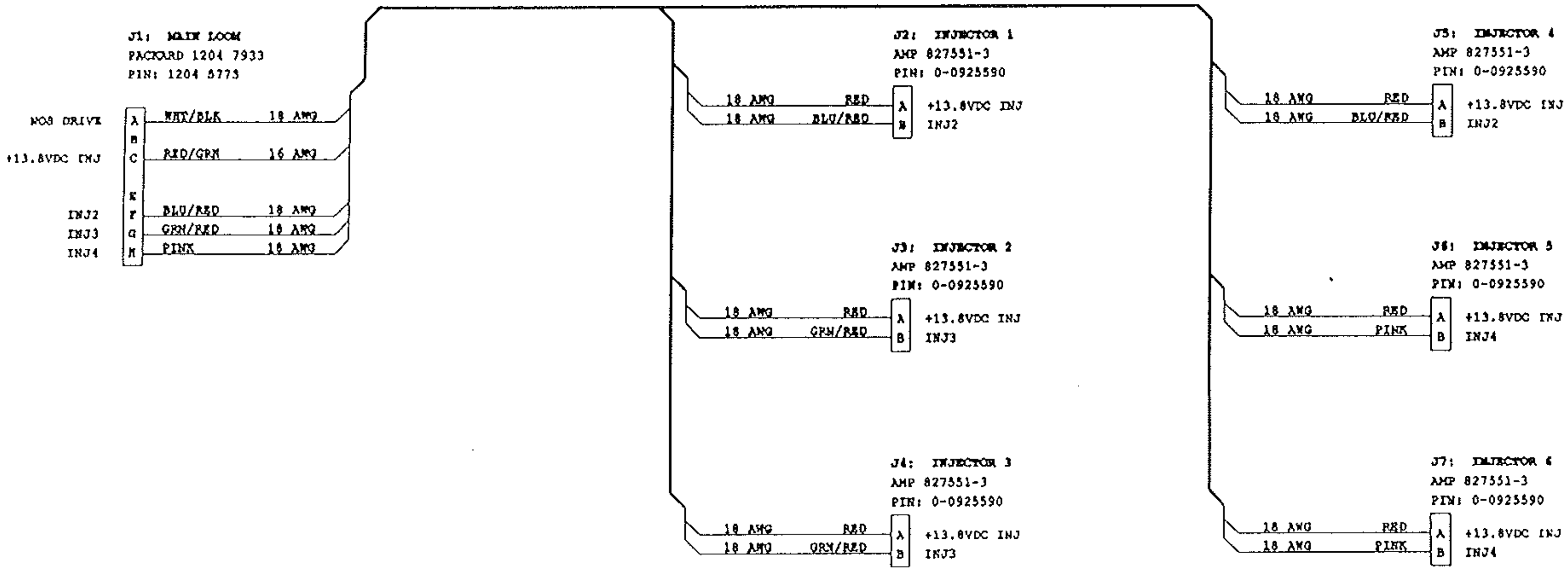
S4 INJECTOR SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994	dav
REV A	SHEET 1 OF 1



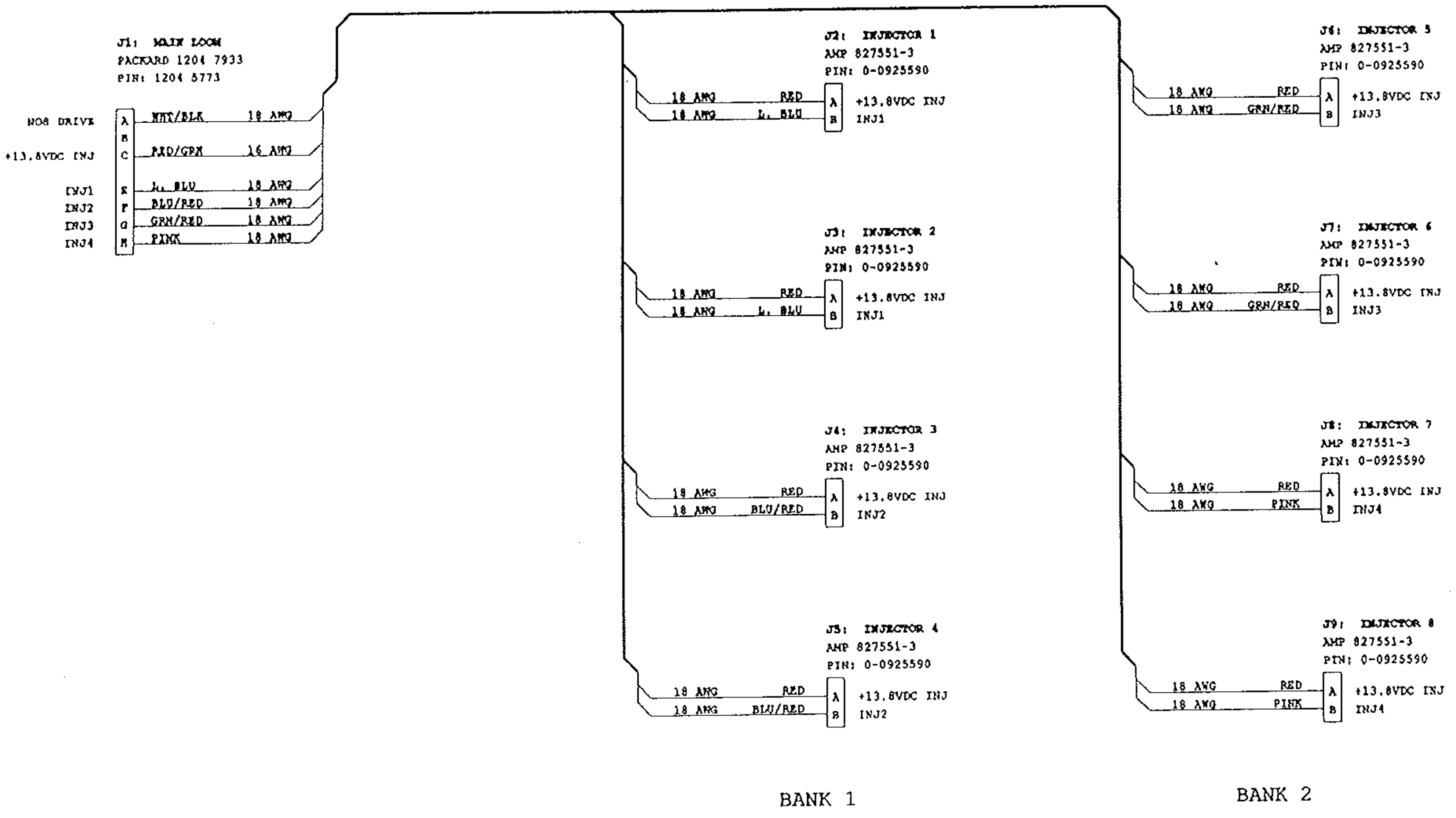
V4 INJECTOR SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994 dav	
REV A	SHEET 1 OF 1



S6 INJECTOR SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994	dav
REV A	SHEET 1 OF 1

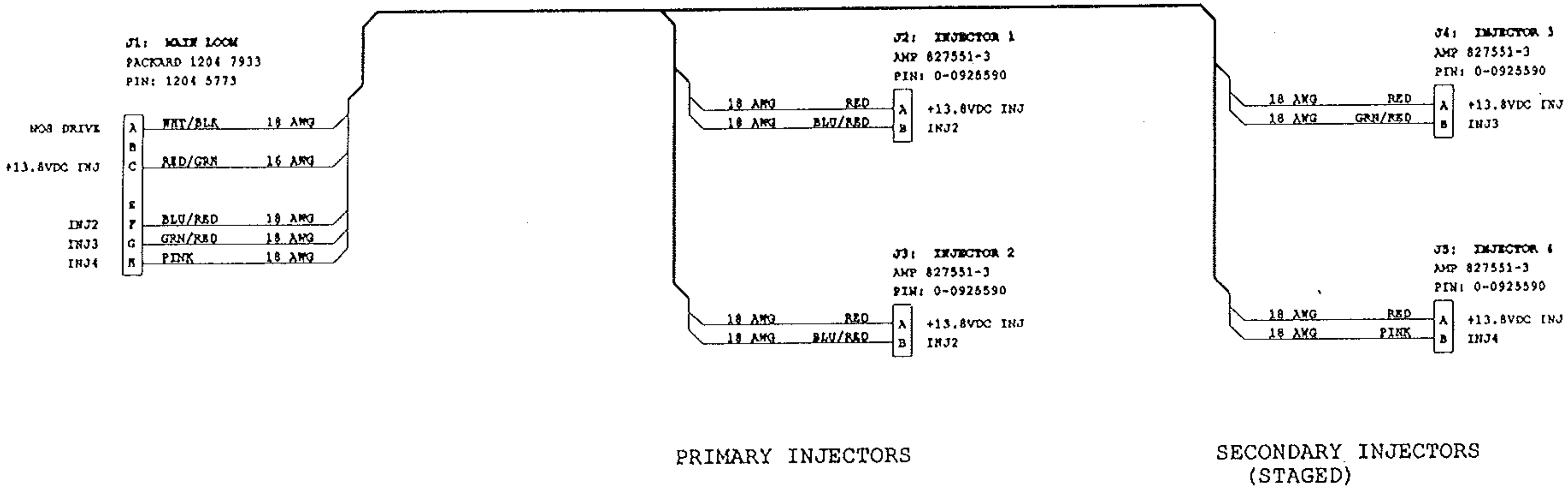


V6 INJECTOR SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994	dav
REV A	SHEET 1 OF 1



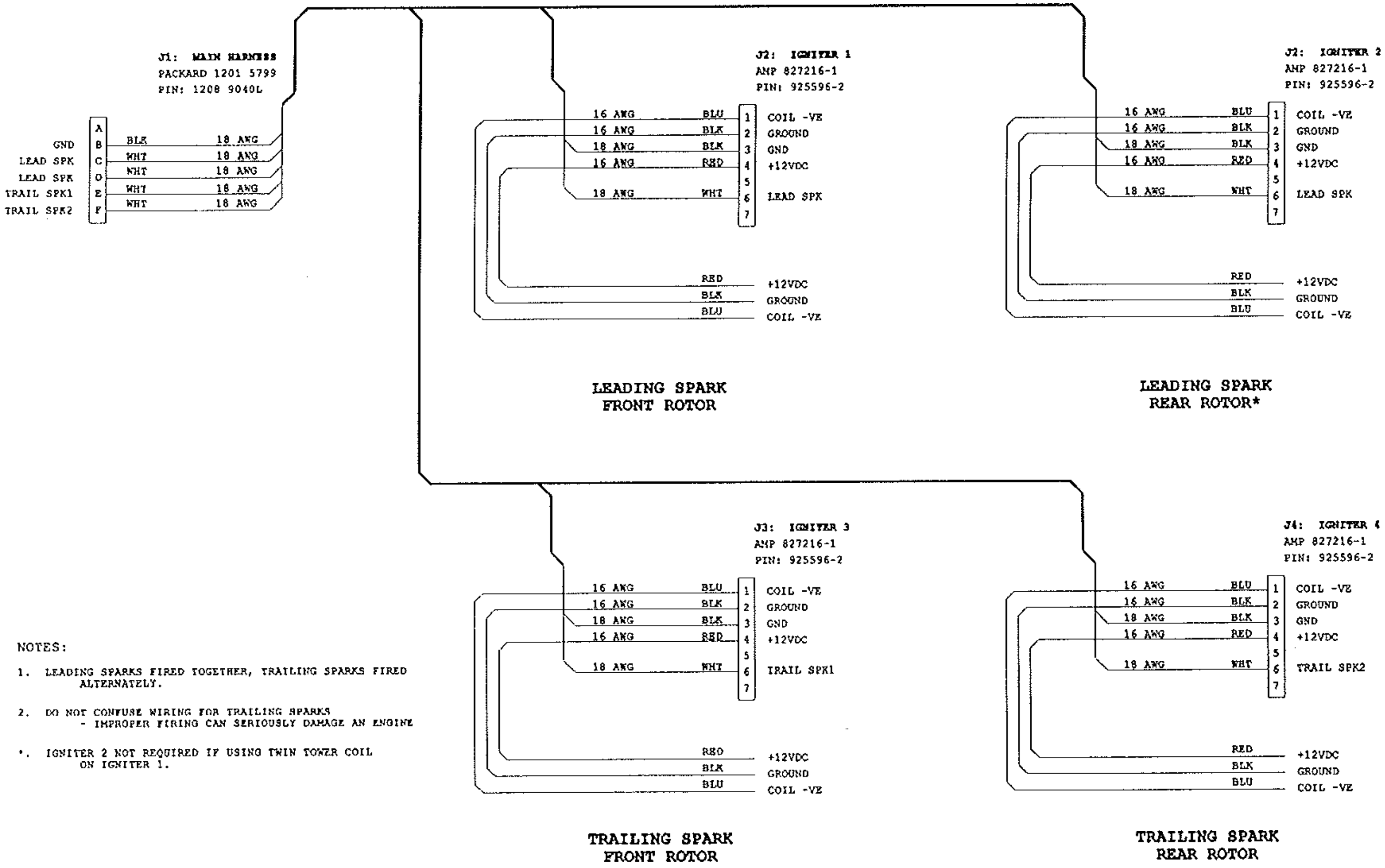
NOTES:
1. SUITABLE FOR STAGED INJECTION ON 4 CYLINDER MOTORS:
   BANK 1 - PRIMARY INJECTION
   BANK 2 - SECONDARY (STAGED) INJECTORS

V8 INJECTOR SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994	dav
REV A	SHEET 1 OF 1



NOTE:
1. TO BE USED WITH ROTARY DIRECT FIRE E6.
2. NB: INJ1 CHANNEL EMPLOYED FOR IGNITION

R4 INJECTOR SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994	dav
REV A	SHEET 1 OF 1



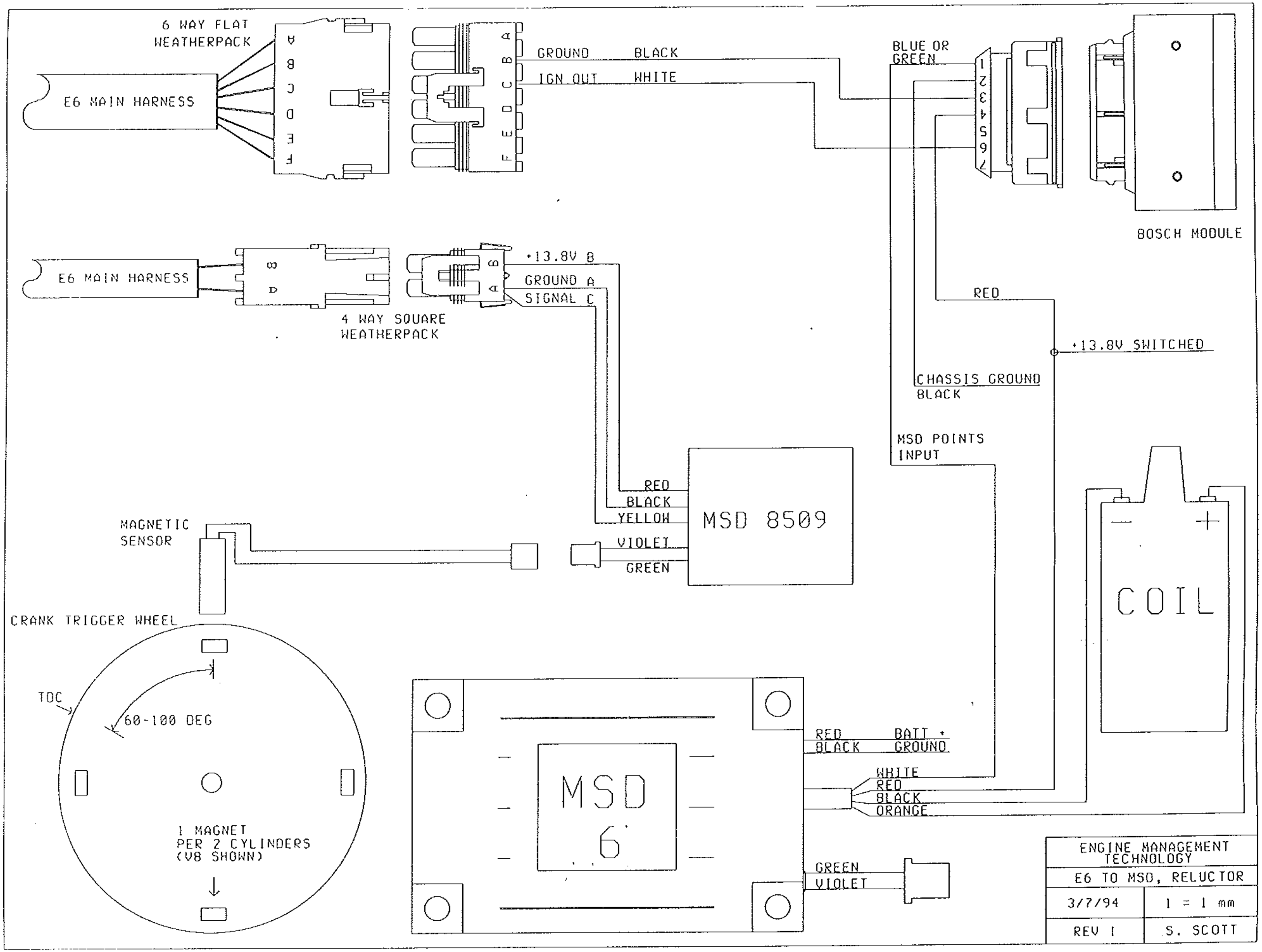
NOTES:

1. LEADING SPARKS FIRED TOGETHER, TRAILING SPARKS FIRED ALTERNATELY.

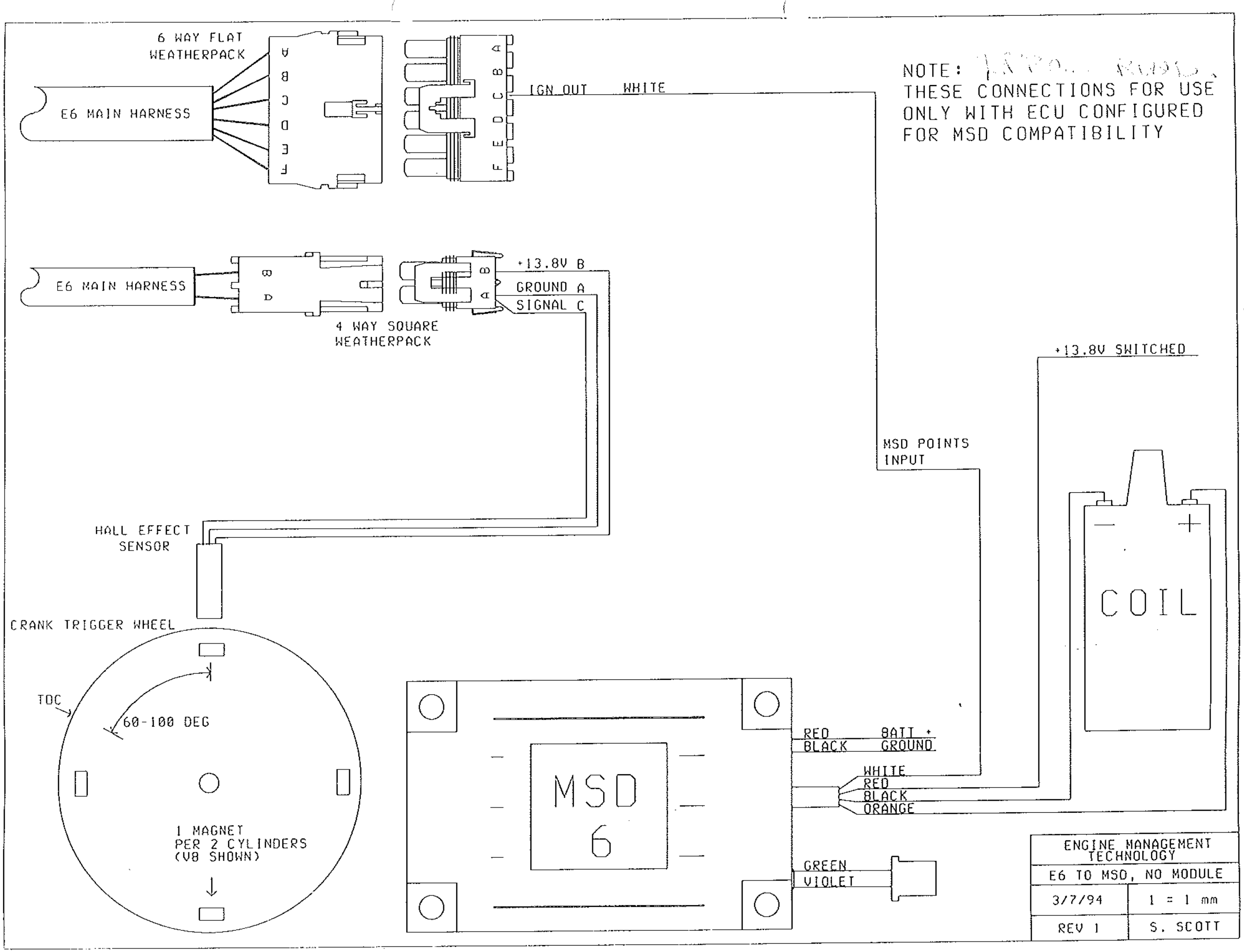
2. DO NOT CONFUSE WIRING FOR TRAILING SPARKS
   - IMPROPER FIRING CAN SERIOUSLY DAMAGE AN ENGINE

*. IGNITER 2 NOT REQUIRED IF USING TWIN TOWER COIL ON IGNITER 1.

E6RDF IGN SUBLOOM - ELEC	
HALTECH, SYDNEY AUSTRALIA	
DATE: 25TH JULY 1994	dav
REV A	SHEET 1 OF 1



6 WAY FLAT
WEATHERPACK
E6 MAIN HARNESS
A
B
C
D
E
F
GROUND
BLACK
IGN OUT
WHITE
BLUE OR
GREEN
1
2
3
4
5
6
7
BOSCH MODULE
E6 MAIN HARNESS
B
A
+13.8V B
GROUND A
SIGNAL C
4 WAY SQUARE
WEATHERPACK
RED
+13.8V SWITCHED
CHASSIS GROUND
BLACK
MSD POINTS
INPUT
RED
BLACK
YELLOW
MSD 8509
VIOLET
GREEN
MAGNETIC
SENSOR
CRANK TRIGGER WHEEL
TDC
60-100 DEG
1 MAGNET
PER 2 CYLINDERS
(V8 SHOWN)
COIL
−
+
MSD
6
RED
BATT +
BLACK
GROUND
WHITE
RED
BLACK
ORANGE
GREEN
VIOLET
ENGINE MANAGEMENT
TECHNOLOGY
E6 TO MSD, RELUCTOR
3/7/94
1 = 1 mm
REV 1
S. SCOTT


6 WAY FLAT
WEATHERPACK
E6 MAIN HARNESS
A
B
C
D
E
F
IGN OUT
WHITE
NOTE:
THESE CONNECTIONS FOR USE
ONLY WITH ECU CONFIGURED
FOR MSD COMPATIBILITY
E6 MAIN HARNESS
B
A
+13.8V B
GROUND A
SIGNAL C
4 WAY SQUARE
WEATHERPACK
+13.8V SWITCHED
MSD POINTS
INPUT
HALL EFFECT
SENSOR
CRANK TRIGGER WHEEL
TDC
60-100 DEG
1 MAGNET
PER 2 CYLINDERS
(V8 SHOWN)
COIL
MSD
6
RED
BATT +
BLACK
GROUND
WHITE
RED
BLACK
ORANGE
GREEN
VIOLET
ENGINE MANAGEMENT
TECHNOLOGY
E6 TO MSD, NO MODULE
3/7/94
1 = 1 mm
REV 1
S. SCOTT

LIMITED WARRANTY

Invent Engineering Pty Ltd trading as EFI Technology warrants the Haltech™ Programmable Fuel Injection System to be free of 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 EFI Technology 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 EFI Technology.

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