F3 INSTRUCTION MANUAL

OFFICE COPY:
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Introduction to the Haltech F3

Thank you for purchasing a Haltech F3 system. We believe that the quality, versatility and affordability of the Haltech F3 make it the best programmable fuel injection computer on the market for a wide range of applications. The Haltech F3 is a universal fuel injection computer designed to control electronic fuel injection systems on most engines. One basic design can control a four, six, eight or twelve cylinder engine. It does not matter if the engine is naturally aspirated or turbo or supercharged, the Haltech F3 can control it.

The Haltech F3 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 F3 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 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 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 F3 installed and running on your engine. 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 F3 Specifications

System Programming Requirements

- **Computer**

  IBM compatibles including laptops with 640K 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**

Standard

-100 KPa to 150 KPa
-30"hg to 22 Psi

High Pressure

-100 KPa to 250 KPa
-30"hg to 36 Psi

- **Temperature Sensors**

  Temp. dependant diode 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 Ignition Pick-up**

  Versions available to be compatible most ignition systems

Haltech F3 ECU Outputs

- **Injector Drivers**

  1 to 16 multipoint injectors can be directly driven from the ECU.

- **Fuel Pump Power**

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

Adjustable Features

- **Fuel Control**

  8 speed ranges of 1000 RPM separation with 32 load points per range

- **Real Time emulation**

  Haltech F3 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

- **Battery Voltage Correction**
- **Switchable metric or US units on all displays**
- **Adjustable Accelerator Pump**
- **Engine Warm-up cycle**

Physical Specifications

- **ECU Dimensions**

  Length : *8 1/2" (220mm)*
  Width : *5 3/4 " (145mm)*
  Depth : *1 3/8 " (35 mm)*

- **Weight**

  ECU : *1 lb 14 Oz (850 grams)*
  Loom : *2 lb 5 Oz (1.05 Kg)*
  Sensors : *4.5 Oz (130 grams)*
  Shipping weight : *6 lb 4 Oz (2.9 Kg) (including manual/package)*

Casing

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

CHAPTER ONE

HALTECH F3 INSTALLATION

Overview

The Haltech F3 system comprises the following components

- *Haltech ECU*
- *Coolant temperature sensor*
- *Inlet air temperature sensor*
- *Throttle position sensor*
- *Wiring harness*
- *Haltech F3 system Instruction Manual*
- *Programming Cable*
- *Computer Disk*

Optional Items

- *Fuel injection trim*
- *Ignition module*

You should identify and check all the above components. The Haltech F3 system comprises the electronic components required to measure the engine's operating parameters and provides the electronic signals required to control the fuel injectors and fuel pump. The output of the F3 is compatible with most electronic fuel injectors and high pressure pumps available. You must order your F3 system to be compatible with the ignition system fitted to your engine. The F3 system 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 F3 ECU for your ignition.

Other components not supplied as part of the F3 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 F3 System you must

1 : *Mount Coolant Temperature Sensor*

2 : *Mount Inlet Air Temperature Sensor*

3 : *Mount Throttle Shaft Position Sensor*

4 : *Mount Power Relays part #36434*

5 : *Route wire harness and connect engine bay sensors*

6 : *Mount Electronic Control Unit (ECU) inside passenger compartment*

7 : Locate and connect the following wires -

- RED - Always + 12 volts
- GREY - Ignition ON + 12 volts
- BLACK - Chassis ground
- Brown - Connect ignition trigger
- ORANGE - Fuel pump + 12 Volts

8 : Connect wiring harness to fuel injectors.

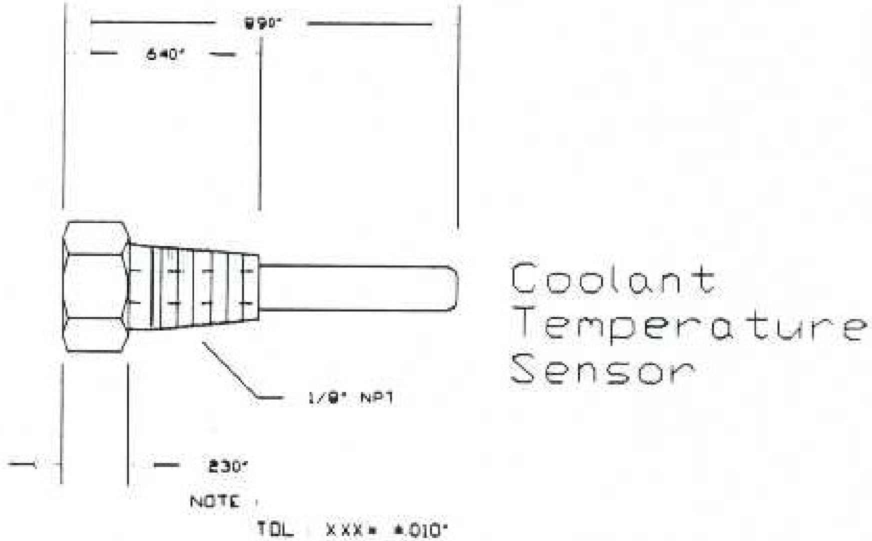
9 : Connect optional fuel trim and mount trim inside cabin.

10 : Run vacuum hose from ECU to vacuum port on inlet manifold.

11 : Connect ECU and test.

Expanded Installation Guide

1. Coolant Temperature Sensor



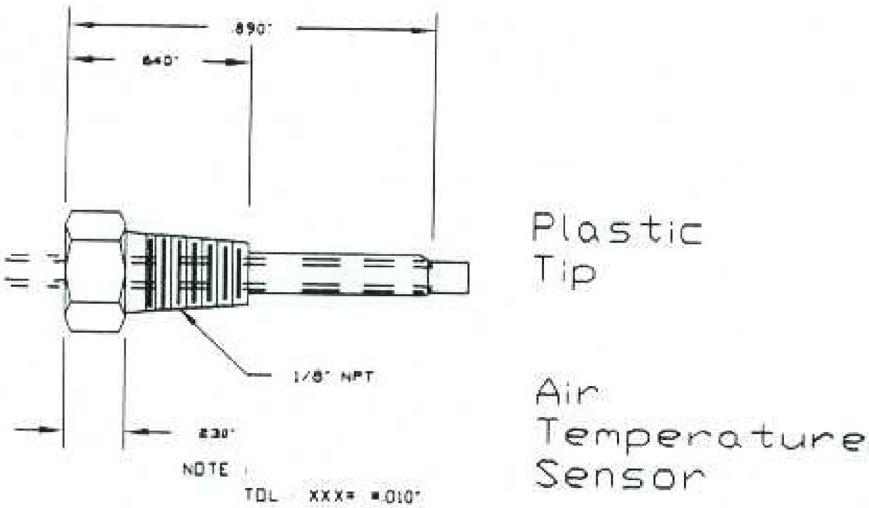
There are two temperature sensors supplied with the F3. The inlet air temperature sensor has a small plastic temperature sensing tip. The coolant temperature sensor has a solid metal temperature sensing tip.

The coolant temperature sensor is designed to screw into a threaded hole in the engine to gain access to the engine's coolant stream. 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.

2. The Inlet Air Temperature Sensor



The inlet air temperature sensor has an exposed plastic tip to make it more sensitive to changes in air temperature. 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.

3. 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.

4. Mount the Power Relays to the firewall

The two relays are the MAIN POWER RELAY (Grey wire) and the FUEL PUMP RELAY (pink wire). 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.

5. 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 coolant temperature sensor, air temperature sensor and throttle position sensor.

6. Mount the ECU inside the passengers compartment

The Haltech F3 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.

7. Locate and Connect the Following Wires

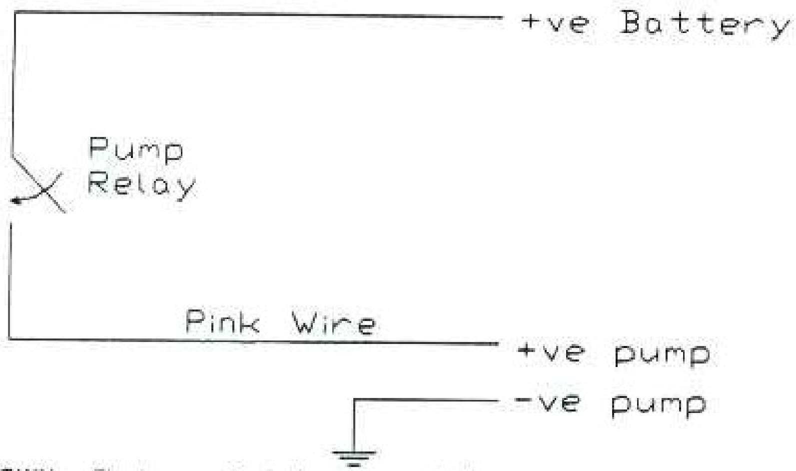
Note : These connections are the same on every F3.

BLACK - *Locate a good chassis ground point and connect the BLACK WIRE. Note the Haltech F3 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.*

PINK - *The PINK WIRE is the positive connection to the fuel pump. The following diagram shows an example of switching the positive connection to the fuel pump(s)*



BROWN - *The brown wire is the tachometric input to the Haltech F3. Connect it to the negative side of the ignition coil or the tachometric output of your ignition system*

8. Connect Wiring Harness to Fuel Injectors

Connect the fuel injectors to the main F3 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.

9. Connect OPTIONAL trim module

The OPTIONAL fuel trim module gives +/- 10% to the fuel mixtures across all engine speeds and loads. The trim module connects to the main harness near the ECU connector. When the trim module is disconnected no trim function is applied. i.e. The fuel trim remains at 0% trim until a trim module is connected.

10. Connect vacuum hose from the ECU to the inlet manifold.

Locate a point of constant vacuum on the inlet manifold. Connect a length of vacuum hose from the barb on the ECU to the point on the inlet manifold. Keep the length of the vacuum hose as short as possible. Be careful to ensure that the vacuum hose will not be crushed by wire ties, hood hinges or by passing it through the firewall etc.

11. 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 F3 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 640 Kilobytes (640K) 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. Be aware that there are risks in tuning any engine 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 fuel system can seriously damage your engine. The correct fuel 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 an advanced mode. If you are using the system for the first time 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, 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 simultaneously 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 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

Fuel Delivery and the Identification Screen

Determining the Engine's Fuel Needs

The fuel Map you will create depends on the needs of your engine and on the capacity of your fuel injectors. A fuel MAP was loaded into the F3 before it left the factory. The characteristics of the factory selected fuel MAP were selected to allow most engines to start and run sufficient to allow further fuel MAP refinement.

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 and fuel but, although the engine is running rich, it may give back more power than is sacrificed by allowing higher boosts to be run.

If when the engine starts it blows black smoke then it is rich and you should adjust the fuel BARs for 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 with more fuel injection duration. 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. Ensure the ignition timing is correct before tuning fuel delivery. The engine will not make any useful power with the ignition timing incorrectly set.

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 fuel MAPs.

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.

How the Haltech F3 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 F3 important information about your engine. For an F3 to work on your engine it needs both an IDENTIFICATION section and fuel MAPs to suit your engine.

When you receive your Haltech F3 the IDENTIFICATION should show information that matches the configuration of 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 follow the instructions at the bottom of the screen. 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.*

- **Ign/By** *(Ignition Divide By) sets the number of trigger pulses the ECU counts between fuel injection pulses. For example, if the engine has an ignition divide by of four then the ECU will give one fuel injection pulse for every four times the ignition system fires. If the engine has eight cylinders, then the ECU will give one fuel injection pulse every revolution of the engine. The Ignition Divide By is usually set to half the number of engine cylinders (Multipoint Mode) or one quarter the number of engine cylinders (Throttle Body Mode).*

- *The* **Mode** *function sets whether all the fuel injectors fire at once* **(Mode = Multipoint)** *or whether half the injectors fire on alternate pulses* **(Mode = Throttle Body)** *or whether the system is using* **Staged Injection Mode**. *It is usual to set the injectors to fire all at once by selecting the Multipoint Mode. The Throttle Body Mode is used when more even fuel delivery is required at low engine speeds. Throttle Body Mode can help to even fuel delivery in situations where the position of the fuel injectors has been compromised. This is often the case when all the fuel injectors are centrally located in a single throttle body rather than being located at each inlet port. Throttle Body mode gives half the fuel delivery of Multipoint Mode for the same ignition divide because it fires only half the fuel injectors every* **Ign/By** *counts. To compensate for this you should set the ignition divide to one quarter of the number of engine cylinders when using Throttle Body Mode.*

- **Staged Injection Mode** *uses half the fuel injectors until a user defined manifold pressure is reached and then all the injectors are fired. Staged Injection is usually used on turbocharged or supercharged engines that require two fuel injectors per cylinder to span the wide range of fuel delivery needed.* **Staged Mode** *is activated by selecting* **STAGED** *as the* **MODE** *and setting the manifold pressure at which the second set of fuel injectors is to start operating. This is set by setting the STAGE BAR NUMBER using the arrow keys. When the STAGED MODE is selected a dashed line will appear across every fuel MAP to show where the second set of fuel injectors starts to operate.*

- *The* **Decel Cut-off** *function turns the fuel injectors off if the throttle is closed and the engine speed is above 1800 RPM. These conditions occur when the engine is decelerating. The fuel injectors start to operate again when the engine speed falls below 1800 RPM so that the engine does not stall.*

as it appraoches idle. When you activate the Decel Cut-off function the system will ask you to return the throttle to the closed position. This tells the system where the closed throttle position is. Decel Cut-off should be turned off during initial set up.

The rest of the fields in the identification are not critical. These fields are for describing the main features of the set-up that you have used. If someone other than yourself tries to service the system in years to come these fields will tell them how the system was configured. These fields are not used by the ECU and only contain information for display on the identification screen.

- *Enter the name of the owner of the system in the field* **Owner**. *e.g. Mr R. Smith.*
- *Enter the make of the vehicle in the field* **Make**. *e.g. Ford, BMW etc.*
- *Enter the model of the vehicle in the field* **Model** *e.g. Mustang, 323i etc.*
- *Enter the number plate number of the vehicle in the field* **Rego**.
- *Enter the engine displacement in the field* **Engine Size**. *e.g. 5800cc or 351ci etc.*
- *Enter the continous flow rate of the fuel injectors over sixty seconds in the field* **Injector Size**. *e.g. 480cc/min.*
- *Enter the static fuel pressure of the fuel rail in the field* **Fuel Pressure**. *e.g. 280kPa or 40psi etc.*
- *Enter your name or your company's name in the field* **Programed By**.
- *Enter today's date in the field* **Date**.
- *Enter any special note in the field* **Note**.

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

CHAPTER FOUR

Setting up the Fuel MAPs

Now that your Haltech F3 system has correct IDENTIFICATION you can set up the Fuel MAPs by using the features presented in this chapter. The tutorials presented in this chapter are examples of how you might use the 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 F3 measures the engines speed and load. A fuel MAP is a graphical representaion of a table of numbers and the F3 will access a particular number in a particular MAP under a given set of conditions of engine speed and load. The number that it accesses represents the time in milliseconds that it will fire the injectors at that moment but before using the number the F3 will correct the number for temperature conditions, throttle movement etc etc.. Each look up table is called a MAP and the MAPS are divided into engine speed or RPM RANGES and the engine speed determines which RANGE 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 fuel delivery (before corrections for temperature etc) to apply at that speed and load.

NOTE- The term MAP has a second usage as applied to fuel injection. The Maniifold Air Pressure sensor is also commonly called a MAP sensor. Care should be taken to identify which usage is meant in each case.

What is MAPPING the Engine?

MAPPING the engine is setting the height of all the BARs so that the fuel delivery is correct at every speed and load combination. You can now alter the MAP by individually altering the height of any BAR in any MAP. This will alter the fuel delivery that 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 various ranges of fuel MAPs, file storage/retrieval functions, System Identification page, Engine Data screen and the options page

Press M to see the list of fuel MAPs

Accessing Fuel MAPs

Fuel MAPs are accessed using the function keys marked X and F1 to F7 to bring up the different RANGES of MAPs. These keys are usually found in a block to one side or above the keyboard. There are eight ranges in total. The keys F1 to F7 bring up the seven Fuel MAPs from 1000 RPM to 7000 RPM in even 1000 RPM intervals i.e. If you want the 4000 RPM RANGE you press F4. If you want the 7000 RPM RANGE (i.e. the 7000 to 8000 RPM RANGE) you press F7. 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 RANGE currently being used by the engine 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 RANGES, will bring up the appropriate RANGE. 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 each MAP 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 fuel MAPs the minimum increment is 0.064 milliseconds of injector ON time. The size of the increment can be changed to suit you, as follows:

CHANGING THE INCREMENTS FOR EACH KEY STROKE

Pressing the ALT and I keys simultaneously will bring up the BAR INCREMENTS PAGE. The first column of this table lists the four key combinations used to adjust the height of the bars. The adjustments can work in two modes: Fixed Increments, or Percentage Increments. One of these headings at the top of the table will be highlighted. This is the mode currently selected. To change the selection, press the CTL and F keys to select Fixed Increments, or the CTL and P keys to select Percentage Increments.

The Fixed Increments are listed in the second column of the table. Each value in this column represents the increment/decrement for the corresponding key combination. For example, if the number 0.064 appears in the first row of the column, then an Up Arrow key stroke will increase the height of the bar (i.e. the numeral in the look-up table represented graphically by the bar) by 0.064ms, and a Down Arrow key stroke will decrease the height of the bar by 0.064ms. Below the main part of the table are listed the minimum and maximum increments available.

The Percentage Increments are listed in the last column of the table. Each value in this column represents the percentage increment/decrement for the corresponding key combination. For example, if the number 0.5 appears in the first row of the column, then an UP Arrow will increase the bar height by 0.5%. The decrease keys work slightly differently. A Down Arrow, in this case, will decrease the height of the bar so that the old bar height is 0.5% greater than the new bar height. Again, below the main part of the table are listed the minimum and maximum percentage increments available.

The values for each key stroke can be easily changed. One of the values should be highlighted. By using the arrow keys, this highlight can be moved around the table. To change a value, move the highlight to the value you wish to change. Enter new value for the increment. You can correct errors by using the Backspace key, or by pressing ESC to return without changing the value. When you have finished entering the value, press the ENTER key. If the number is invalid, a beep will be given and the value will not be changed.

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 4500 RPM and 5500 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 4500 and 5500 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 from 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. 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.

Time Saving Functions

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

In order to allow all eight fuel RANGES to initially be set up as quickly as possible, the Haltech™ F3 system has an ALL RANGES function which allows all BARs of the same number in all eight 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 MAPs in each RANGE. If you use the ALL RANGES option, you can set the shape of any one fuel MAP in a RANGE and all other fuel MAPs in each RANGE 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 in the various RANGES individually.

Double BARs Mode

Most fuel MAPs are very smooth curves although some turbo charged fuel MAPs need more than thirty two BARs to convey the resolution required by the engine. To improve resolution the number of BARs displayed can be doubled. Pressing O when the MAIN MENU appears and then pressing B doubles the number of BARs displayed. Normally every second BAR is hidden although it is still used by the ECU.

As you make adjustments in thirty two BAR mode the hidden BARs are set to the average of the BARs on either side of the hidden BAR. The DOUBLE BAR mode can also be set from any of the graphs by pressing the ALT and B keys simultaneously.

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 simultaneoulsy 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 THAN 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 increase 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 percntage change as '-'. E.G '5' and then press ENTER.

NUMERIC MODE

The Fuel MAP has a special mode which allows the fuel values to be viewed and altered numerically, rather than by adjusting the height of each bar. If you know what fuel values are required, or are translating a map from other information, this can be a useful facility.

To enter the NUMERIC MODE , press the ***ALT*** and N keys simultaneously whilst in the FUEL MAP MENU or from any of the fuel graphs. The highlighted value in the middle of the screen is the currently selected bar in the current range, which we will call the selected point. The BAR numbers are listed across the top of the table, and the RANGES are listed down the left hand side. To change the selected point whilst in the NUMERIC MODE, use the left, right, up or down arrow keys. The selected point will remain in the middle of the screen and the table will move around this point. To change the value of the selected point, type in a new value. When entered, hit the ENTER key or use the arrow keys to move to the next point to activate the new value at the selected point.

If the MAP is in the 32 Bar mode, then the words 'Half Bars' will appear at the top of the screen. To switch between 64 and 32 Bar Modes, press the ALT and B keys simultaneously.

CAUTION- If the MAP is in the ALL RANGES mode, the words will appear at the top of the screen. If the ALL RANGES mode is activated, then any point that is changed will be mirrored in all of the points in that column (i.e. in all RANGES). To switch ALL RANGES on or off, press the ALT and B keys together.

To exit the NUMERIC MODE, press the ESC key.

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.

ALWAYS ADJUST STAGED UNITS IN DOUBLE BAR MODE! Normally fuel MAPS are adjusted in the 32 bar mode but for staging they must be adjusted in the 64 bar, or Double Bar Mode. This can be activated by pressing "O" for Options when in the Main Menu then "B" for Bars when in the options Menu. The display will toggle between "32" and "64". Select "64". When programming in 32 bar mode, which is usually more convenient and quicker than programming in 64 bar mode, the actual programming is carried out in 64 bar mode even though the display is shown in 32 bar mode. The HALTECH interpolates (or averages)automatically from bar to bar. When staging, interpolation is carried out from the primary to secondary MAPS unless programming is done in 64 bar mode. When programmed in the 32 bar mode the last bar in the primary set may be averaged low, and the result will be a lean point which could damage the engine.

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 "Mode" 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 "Multipoint", "Throttle Body" and "Staged Injectors". When "Staged Injectors" 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.

CHAPTER FIVE

Throttle Response

You should now have the optimum range of fuel 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 F3 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 inside the ECU 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.

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. Two single bars will appear on the screen. The bar on the left is called increase. The bars on the right is called sustain. 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 BAR determines 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 BAR. 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 BAR and the sustain BAR 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 two bars.

The throttle pump values should be set up after the fuel MAPs are correctly tuned for steady load running. Attempting to smooth out engine transients before the fuel have been optimised for steady state running may become confusing. The two throttle response BARs should be adjusted by trial and error to give optimum throttle response.

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 SIX

Cold Starting and Running

The Haltech F3 system applies a special strategy to cold engine starting and running. The COOLANT MAP controls the addition fuel required when the engine is not at operating temperature.

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. 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.

CHAPTER SEVEN

Disk Storage and Retrieval

Now that your Haltech F3 system is configured you should store the entire set of fuel 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 load the complete set of MAPs and IDENTIFICATION from computer disk. You can also save the fuel 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.

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 save 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 F3 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. To load complete MAPs and IDENTIFICATION press "F" when the Main Menu appears then press "L". 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 "L".

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 MAPS and IDENTIFICATION

With the MAIN MENU displayed press F for files. Press L for LOAD MAPs AND IDENTIFICATION. For this tutorial load the 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 F3 and replace it with TEST1. If you have MAPs or IDENTIFICATION in the F3 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 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 EIGHT

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 the MAPS and IDENTIFICATION information 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. The information presented is tabled below.

Datalog Information
Engine Speed in RPM
Manifold Pressure
Coolant Temperature
Throttle Position
Inlet Air Temperature
Battery Voltage
Fuel Mixture Trim
Injected Milliseconds of fuel
Map number being used
BAR number being used
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 NINE

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

Idling Problems

* The engine will not idle at all when cold
* The engine will not idle at all when hot
* The engine idles too slowly
* 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 640K 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
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 ignition system 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.
Engine not getting ignition spark. Ignition spark mis-timed.	Check firing order of engine against firing order of high tension leads. Check 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 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. 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 ECU.
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.

Possible Problem / Symptom	Probable Cause / Cure
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 RPM MAP (cranking range) for sufficient fuel to start engine.
Engine too rich to start. Poor cold start settings.	Check start primer value. Check cold start MAP values.

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 set.	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.

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.*

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 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 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. 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.*

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 Emtech™ 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

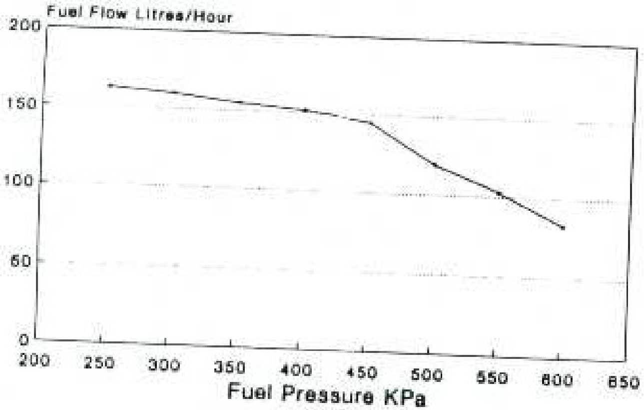
Your Haltech™ dealer can supply a range of high flow rate injectors for competition racing.

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.

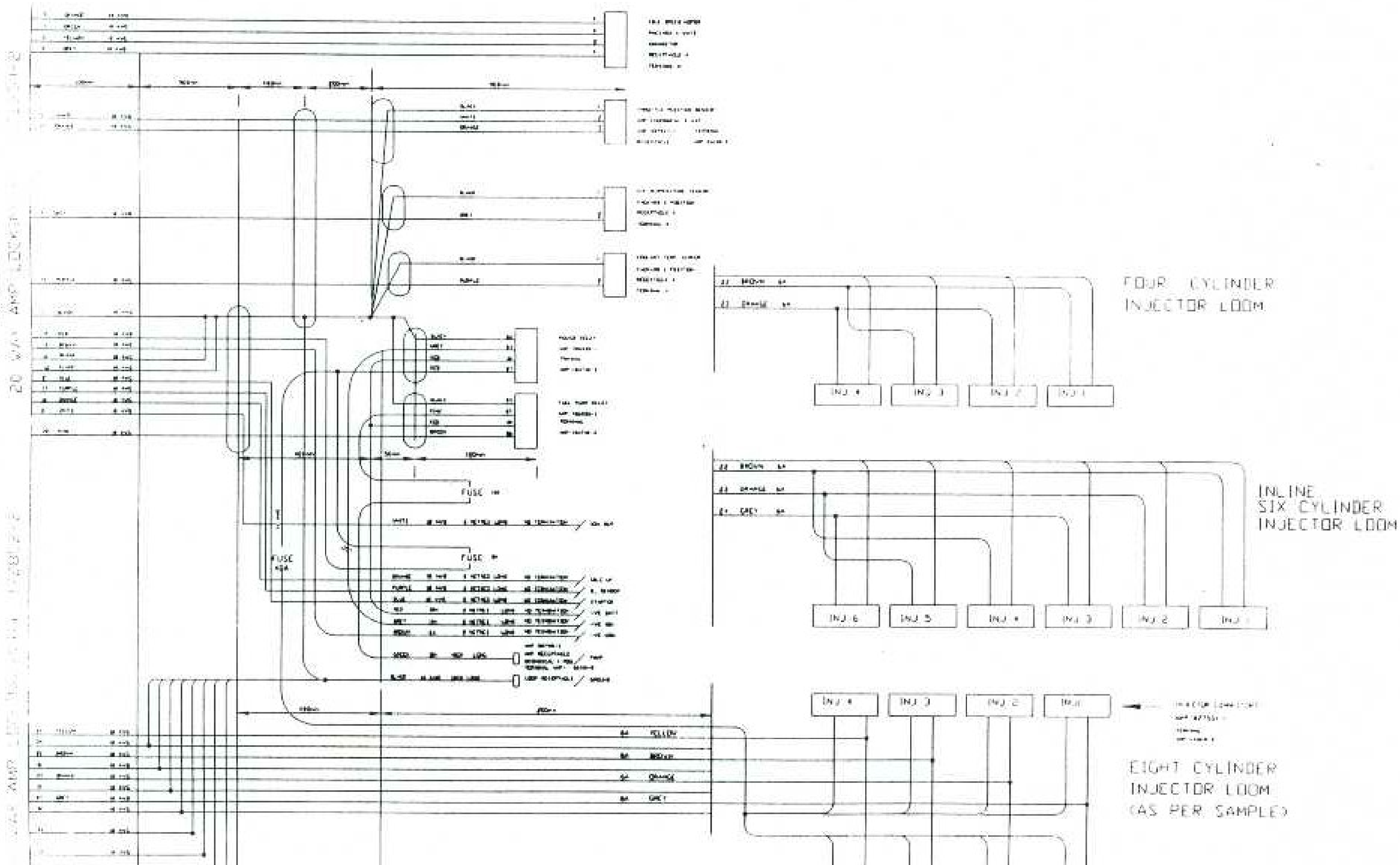
Maximum fuel pressure = Rated pressure + Highest boost pressure

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

Using Parallel Pumps

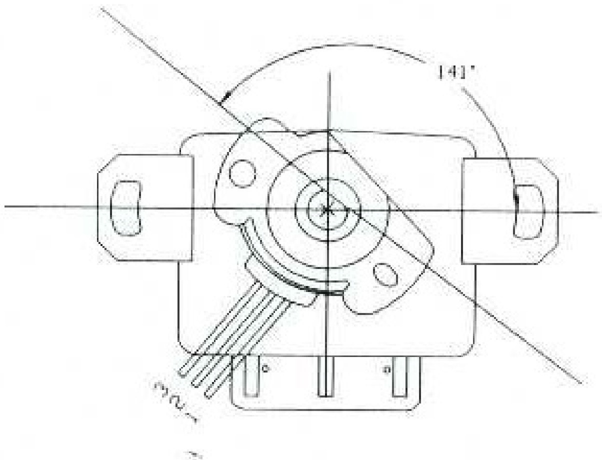
If you wanted to use the later model pump, the fuel flow capacity at 95 psi (655 kPA) is only 1.3 liters/min (2.75 pints/min). This is well below the total injector flow and the system would drop out of regulation severely if only one of these pumps were used. A common solution is to parallel two pumps 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 (5.5 pints/min) which is greater than the total injector flow. Using two pumps, the system would stay in regulation.

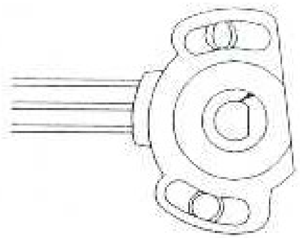
A single fuel pressure regulator may not be able to return enough fuel to the tank when the engine is idling, causing excessively high fuel pressure. It may be necessary to run two fuel pressure regulators modified to have a rated pressure of 65 psi (445 kPa). Remember the current that is drawn from 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 will now have twice the number of components.



INJECTOR CABLE

REV A





TOP VIEW

PIN	DESIGNATION
1	GND
2	OUTPUT
3	+5V

THROTTLE POSITION SENSOR	
DATE	
DRAWING NO.	

F3 DLI Connector P-1

1	2	3	4	5	6	7	8	9	10
GND	GND	O2 Sensor	Idle Trigger	Spare	Spare	Air Temp	Mixture Trim	Throttle Position	Coolant Temp
11	12	13	14	15	16	17	18	19	20
GND	GND	Spare	+5V	+5V	Ignition Trigger	Spare	+13.8V	+13.8V	Fuel Pump Relay

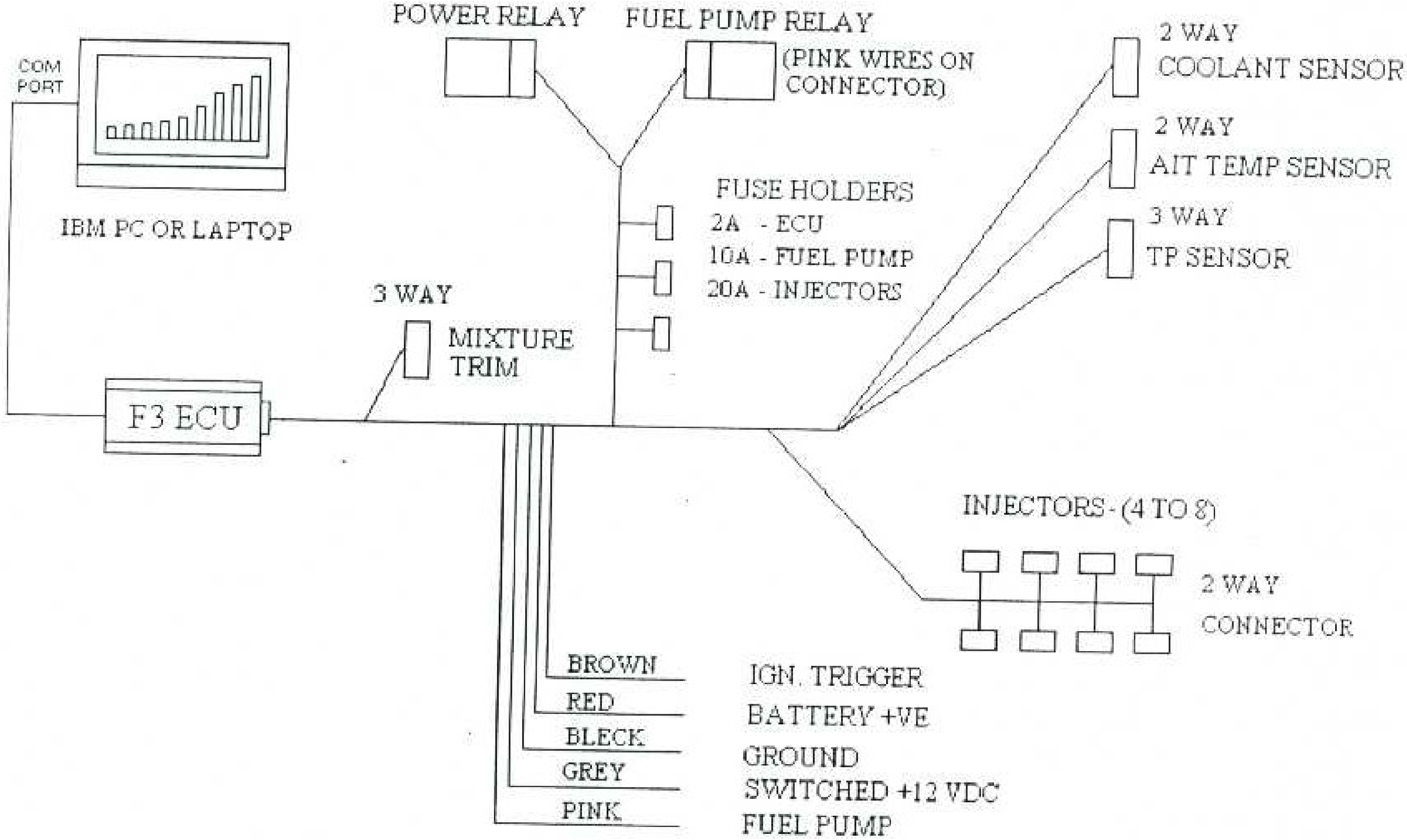
21	22	23	24	25	26	27	28
Injector-4	Injector-3	Injector-2	Injector-1	Injector-8	Injector-7	Injector-6	Injector-5
29	30	31	32	33	34	35	36
GND	GND	GND	GND	GND	GND	GND	GND

SDL Connector P-2

Type A

1	2	3	4	5	6
RX DATA	TX DATA	Spare	Spare	GND	GND

COMMS	TX	RX	GND
9-PIN	2	3	5
25-PIN	3	2	7



F3 BLOCK WIRING DIAGRAM

18 NOVEMBER 1993

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 mechantibility or fitness. In no event shall Invent Engineering Pty Ltd trading as EFI Technology be liable for special or consequential damages.