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This manual should accompany:

IBM compatible PC software	v7.08
Firmware Series	10
Firmware Version	8

Introduction

Congratulations on your decision to install a Haltech Engine Management System on your vehicle. Haltech EFI systems have been successfully installed on thousands of vehicles such as power offshore boats, twin-turbo Ferraris, pylon racing aircraft, jet skis and snowmobiles. Many motor sport enthusiasts have discovered that the Haltech computer is easy to use and gets the job done correctly. The Haltech ECU enables you to precisely control fuel-air mixtures that lead to consistent horsepower and torque from an engine. Precise mixture control also leads to excellent drivability and fuel economy, something that is often lacking in high-performance carburettor engines.

Haltech users have discovered that the flexibility of the Haltech Electronic Control Unit (ECU) and PC based programming software leads to easy installation on everything from traditional pushrod V8s to high performance turbocharged racing motorcycles. We are proud of the fact that some of the most respected professional racers and super-car builders in the world use Haltech equipment for the same reasons that Haltech is popular with performance enthusiasts: it is flexible and friendly; is installed easily; and you can tune your Haltech simply, without having to make the project a major research effort.

Installation Overview

The Haltech F10 system uses a special-purpose programmable microcomputer designed for engine management. The F10 system includes the ECU, engine sensors, a special wiring harness to connect them, programming software and cable for you to tune the system. In the course of the installation, you will mount four electronic engine sensors, two for temperature, one for throttle position, and one to sense vacuum/pressure. You will run the wiring harness through the vehicle, connecting the 12V, ground and signal wires, and plug the harness connectors into the engine sensors and fuel injectors. An ignition output module will be mounted in the engine bay and connected to the harness. Finally, you will mount and connect the ECU itself. The engine must already be configured with intake manifold and suitable injectors, a fuel rail with pressure regulator, and a high-pressure pump. If your vehicle lacks one or more of these components, your Haltech dealer can help you obtain them.

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

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

Before You Begin...

WARNING:
AVOID OPEN SPARKS, FLAMES, OR OPERATION OF ELECTRICAL DEVICES NEAR FLAMMABLE SUBSTANCES.

ALWAYS DISCONNECT THE BATTERY CABLES WHEN DOING ELECTRICAL WORK ON YOUR VEHICLE.

DO NOT CHARGE THE BATTERY WITH A 24VOLT TRUCK CHARGER OR REVERSE THE POLARITY OF THE BATTERY OR ANY CHARGING UNIT

DO NOT CHANGE THE BATTERY WITH THE ENGINE RUNNING AS THIS COULD EXPOSE THE ECU TO AN UNREGULATED POWER SUPPLY THAT COULD DESTROY THE ECU AND OTHER ELECTRICAL EQUIPMENT.

ALL FUEL SYSTEM COMPONENTS AND WIRING SHOULD BE MOUNTED AWAY FROM HEAT SOURCES, SHIELDED IF NECESSARY, AND WELL VENTED.

MAKE SURE THERE ARE NO LEAKS IN THE FUEL SYSTEM AND THAT ALL CONNECTIONS ARE SECURE.

DISCONNECT THE HALTECH ECU FROM THE ELECTRICAL SYSTEM WHENEVER DOING ANY ARC WELDING ON THE VEHICLE BY UNPLUGGING THE WIRING HARNESS CONNECTOR FROM THE ECU.

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

2) Read any additional material accompanying this manual that updates the document since it was written.

3) You may need special parts or additional tools or test equipment in order to complete installation. Make sure you have these items on hand before you begin to avoid frustration. Contact your Haltech dealer if you have difficulty.

4) Don't do the minimum work possible. Carelessness in the early stages of installation can cause you major headaches later on, be it in a few days' or a few months' time. Carelessness will cost you money and frustration in finding and fixing unnecessary problems. You have the opportunity to make sure your Haltech system's operation is extremely dependable and easy to use by doing it right the first time.
There is another reason to exercise care during this installation. You will be dealing with

explosive fuel under pressure, electricity and considerable heat. Inside the combustion chamber, this is a happy combination. In the garage, they are not. The same kind of danger exists when working underneath a jacked-up car. Please be careful.

5) Electromagnetic interference (EMI) from unsuppressed spark plugs and leads can cause the ECU to fail. Please do not use them.

6) In hot climates, or with turbocharged engines, you may need to employ heat shielding to prevent heat soak and damage to electrical and fuel parts. Use the coolest surfaces of the chassis as a heat sink for components and use thermally conductive brackets where appropriate.

7) We recommend having your system tuned by professionals. An exhaust gas analyser and fuel pressure meter make tuning easier and help avoid potentially disastrous lean conditions that could destroy your engine. Should you wish to tune this unit yourself, make sure you have some reliable means of determining whether your engine is running lean, Haltech offer the Haltuner for this purpose. The Haltuner is an inexpensive air-fuel ratio indicator that gives a full-scale deflection from rich to lean over a display of 30 bar segments. It is compatible with all Oxygen Sensors that output a 0-1V and can be configured upon request for other sensor ranges. If used in conjunction with a Haltech Oxygen Sensor, the Haltuner will provide air-fuel indication for a range of 11.5:1 to 17:1.

> Note: In this manual, reference will be made to <u>MAP</u> (Manifold Absolute Pressure - as in MAP sensor) and the fuel <u>maps</u> stored in the ECU. Both are common industry terms, with entirely different meanings.

Tool/Supply Requirements

Installation of this system can be easily carried out by professional mechanics and most experienced home mechanics if the following tools and components are available:

- Voltmeter or Test Light
- A selection of screwdrivers and spanners
- Soldering Iron and solder (we recommend soldering all connections)
- Wire Cutters and Pliers
- Crimping Tool and assorted terminals
- Drill with assorted drill bits
- 3/8" NPT Tap
- 14mm x 1.5 Tap
- Electrical Tape or Heat Shrink tubing
- Teflon pipe sealing tape
- Nylon cable ties
- Jeweller's file (may be needed for mounting Throttle Position Sensor)
- Mounting hardware for ECU and relays (mounts/bolts/screws)
- IBM-PC compatible computer (preferably laptop) with at least 640kb, one disk drive and an RS232 serial port.

How It Works

While the technology involved with electronic fuel injection is complex, the underlying principles of its operation are really quite straightforward. The object of any fuel delivery system in a gasoline engine is to determine the amount of air being drawn by the engine, and supply the appropriate quantity of fuel to "burn" all the oxygen in that mass of air.

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

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

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

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

The Haltech F10 uses a digital microcomputer to measure engine speed and load, and uses them to access the *base fuel map*. The base fuel map is a look-up table of injector opening times stored in non-volatile memory i.e. when power is switched off, the contents of the memory are retained. By using the programming software, the contents of this memory can be changed so that you can match injector opening times to the injectors you are using, and to suit the requirements of your engine.

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

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

The F10 and F10A

The F10 offers a basic fuel injection system with limited functionality for simple applications, the F10A offers optional outputs such as: Idle Speed Control and O2 Closed Loop fuel control which are dedicated outputs and four programmable outputs. The optional outputs available with the F10A allow the features available on modern cars such as idle control and thermo-fans be run by the F10A ECU. The F10 has no optional outputs.
(Refer *Chapter 16 PWM Outputs, 72*).

HALTECH F10 SPECIFICATIONS

Engine Suitability

- Up to 16,000 rpm
- 1, 2, 3, 4, 5, 6, 8, 10, 12 cylinders (1-2 rotors)
- 2 or 4 stroke
- Normally aspirated or supercharged up to 200 kPa (30psi) - Higher boost pressure MAP sensors available by special arrangement
- Load sensing by throttle position or manifold pressure
- Multipoint, batch-fire or staged

Power Requirements

- **Power Source**
  8.6 to 16 Volts DC
- **Consumption**
  Haltech ECU: 270 mA at 12 Volts
  Injector Load: Dependent on injector type
  approx. proportional to injector duty cycle
  (typically 0.6 Amps per injector)

Physical Specifications

- **ECU Dimensions**

Length:	140 mm (5 17/32")
Width:	145 mm (5 5/8")
Depth:	41 mm (1 5/8")

- **Weight**

ECU:	615g (1.35 lb)
Loom:	1.92kg (4.2 lb)
Sensors:	500g(1.1 lb)
Shipping Weight:	4.5kg (9.9 lb) (Including manual/packaging)

Input Sensors

- **Manifold Absolute Pressure (MAP) Sensor (supplied at extra cost)**

1 Bar	-100kPa to 0kPa	(Naturally Aspirated)
2 Bar	-100kPa to 100kPa	(up to 1 Bar or 15 psi boost)
3 Bar	-100kPa to 200kPa	(up to 2 Bar or 30 psi boost)

  Higher boost pressure MAP sensors available by special arrangement

- **Temperature Sensors (Air and Coolant)**
  NTC temperature dependent resistor type.
  Operating Range

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

- **Throttle Position Sensor**
  10 kΩ rotary potentiometer driven from throttle shaft

- **Engine Speed Pickup**
  Compatible with most "standard trigger" systems:
  - 5 or 12 volt square wave;
  - Pull-to-ground (open collector)
  - Coil Negative triggering

ECU Outputs

- **Injector Driver**

F10 and F10A Only

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

F10-8 and F10A-8 Only

8 x 4/1Amp peak-and-hold current limiting drivers:
- Up to 8 low-impedance injectors*
- Up to 16 high-impedance injectors*

(Expandable using optional Driver Box; Refer *B.3 Injector Driver Box, 88*)

F10A and F10A-8 Only

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

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

F10A and F10A-8 Only

- **Stepper Motor driver for idle control**
  Capable of driving bipolar stepper motors used for idle control.

* Additional hardware may be required

System Programming Requirements

- **Computer**
  IBM-PC or compatible, preferably laptop or notebooks
  CGA, EGA or VGA, colour or monochrome display
  640+ kb RAM

- **Disk Drive**
  3.5" Floppy Disk Drive
  (5.25" disk available on request)

- **Serial Port**
  Standard RS232C port - 9 pin D connector
  (25 pin cable available on request)
  COM1 or COM2 (selectable)

Adjustable Features

- **Base Fuel Map**
  22 Fuel ranges, every 500 RPM to 10,500, or
  17 Fuel ranges, every 1000 rpm to 16,000
  32 Load points per range, up to 16ms with 0.016ms resolution

- **Correction Maps**
  Cold Start Prime - 32 points
  Coolant Temperature Enrichment - 32 points
  Air Temperature Adjustment - 32 points
  Battery Voltage Correction - 32 points
  Closed Throttle (selectable) - 16 points
  Full Throttle (selectable) - 32 points

- **Programmable Rev-Limit** – fuel cut

- **Fuel Cut on Deceleration**

- **Accelerator Pump**
  Increase and sustain parameters
  Coolant enrichment factor
  Three speed ranges

F10A and F10A-8 Only

- **Idle Speed Control**
  Target Idle Speed
  Cold Idle-up Rpm
  Post-start Rpm setting

F10A and F10A-8 Only

- **Closed Loop Control**
  With both cruise and idle settings

F10A and F10A-8 Only

- **Programmable Output Options**

Miscellaneous

- **Data logging**
  Engine data information logged at a nominal rate of 10 times per second Stored to memory or disk
  Limited only by available memory (approx. 11k/minute).

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

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

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

- **US or Metric Units.**

- **Optional Boost Control Solenoid.**

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

- **Optional Extra Injector Driver Kit.**

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

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

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

F10A and F10A-8 Only
- **Optional Idle Air Control Motor Housing.**

F10A and F10A-8 Only
- **Optional Idle Air Control Motor.**

- **Optional Mixture / Boost Trim Module**
  Provides ±12½% or ±50% adjustment for fast tuning
  Provides ±100% adjustment.

SECTION 1 Getting Started

CHAPTER 1 HALTECH F10 INSTALLATION

1.1 Overview

The Haltech F10 system comprises the following components

- Haltech Electronic Control Unit (ECU)
- Coolant Temperature Sensor
- Inlet Air Temperature Sensor
- Throttle Position Sensor (TPS)
- Manifold Absolute Pressure (MAP) Sensor
  - (1,2 or 3 Bar Sensor - purchased separately to main kit at extra cost)
- Main Wiring Harness
- Haltech F10 system Instruction Manual
- Programming Cable
- Programming Disk
- Relays

Optional Items

- Fuel Mixture / Boost Trim Control
- Driver Box

F10A and F10A-8 Only

- Exhaust Gas Oxygen Sensor
- Idle Speed Control Motor

Other components not supplied as part of the F10 system include:

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

1.2 Installation Summary

- Mount Manifold Absolute Pressure Sensors
- Mount Coolant Temperature Sensors
- Mount Inlet Air Temperature Sensors
- Mount Throttle Position Sensors
- Mount optional Exhaust Gas Oxygen Sensor (if used)
- Route Main Wiring Harness and connect sensors
- Mount and connect Power Relays
- Mount Fuse Block
- Mount ECU inside passenger compartment
- Locate and connect flying wires:

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

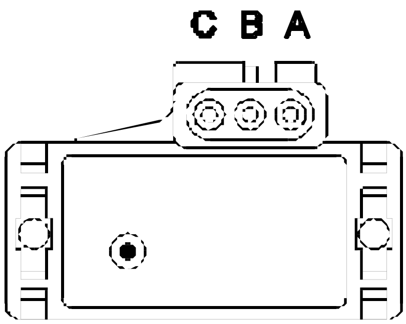
- Connect Trigger signal
- Connect ECU and test.

F10A and F10A-8 Only

- Install and connect the optional Idle Speed Motor
- Install and connect any Optional Outputs

1.3 Expanded Installation Guide

1.3.1. Manifold Absolute Pressure (MAP) Sensor



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

The MAP sensor is used to convert the manifold pressure into an electrical signal for the F10 ECU to use. The sensor works in absolute pressures, thus its calibration is not affected by changes in barometric pressure. The vacuum and, in the case of forced air induction engines, the pressure under boost, is proportional to the load under which the engine is operating and the ECU uses the electrical signal as a load reference.

There are three types of MAP sensors that can be used with F10 system. Which sensor is required depends on the engine set-up.

1 Bar Sensor (Part No. 039 4070)

(-100kPa to 0 kPa) Normally Aspirated Engines

2 Bar Sensor (Part No. 886 3189)

(-100kPa to 100kPa) Turbo or Supercharged Engines up to 100kPa boost (15 psi , 1 atmosphere)

3 Bar Sensor (Part No. 749 3169)

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

Note: Make sure you have the correct MAP sensor for your engine. The first three digits of the part number are stamped on the sensor housing.

If the engine is running in Throttle Position mode, a 1 Bar MAP sensor (left open to atmosphere) is used to measure the barometric pressure.

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

Mounting

The MAP sensor is usually mounted high on the engine bay firewall or inner guard using two screws and with the hose nipple facing outwards. Connect the sensor to the inlet manifold via a short length of vacuum hose and fasten with either hose clamps or nylon cable ties. Connect the sensor to the main wiring harness using the appropriate plug. (For 1 Bar sensors the plug is green, for 2 and 3 Bar sensors the plug is orange). Avoid mounting the sensor below the level of the fuel injectors, because fuel may collect in the vacuum hose and run down into the sensor. The sensor assembly is weatherproof but it is good practice to mount the sensor in a protected position away from moisture and heat.

1.3.2. Coolant Temperature Sensor

The coolant temperature is used to determine the fuel mixture corrections required when not at operating temperature.

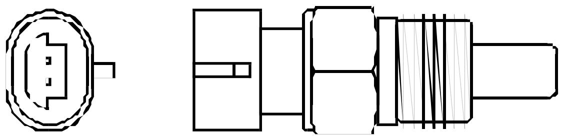
The coolant temperature sensor has a solid brass temperature sensing tip. Refer to the diagram below for technical details of the sensor. The coolant sensor supplied is an industry standard component and some engines may already have provision for this type of sensor.

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

Locate a suitable position on the engine which will allow the hole and thread to be machined, and which gives access to the coolant stream. The sensor should be mounted after the engine and before the thermostat in the coolant circuit. Since most engines have existing temperature sensor holes, it is often possible to mount the Haltech sensor in one of these holes. A thread adapter is sometimes necessary. In some engines only one temperature sensor hole exists and is used for the dashboard gauge sender. It is usually possible to install a tee-piece to allow both the dashboard sender and the Haltech sender to share access to the same threaded hole.

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

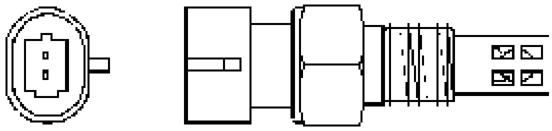
⅜" N.P.T. 18 Threads/Inch



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

1.3.3. Inlet Air Temperature Sensor

14mm x 1.5



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

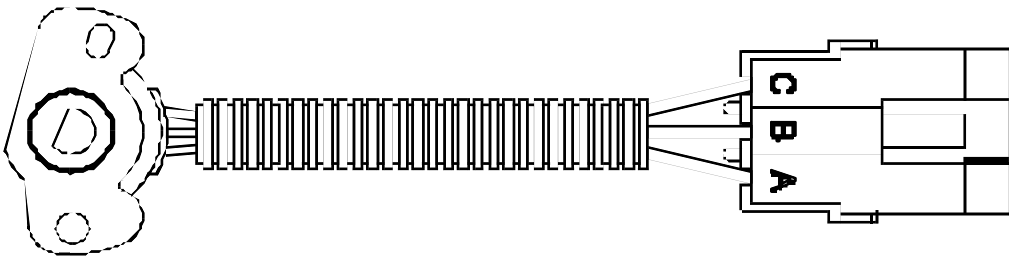
The air temperature sensor is used to compensate for changes in air density due to air temperature. Cold air is denser than warm air and therefore requires a greater volume of fuel to maintain the same air/fuel ratio. This effect is most noticeable in forced induction engines. The Haltech F10 will automatically compensate using the signal received from the air temperature sensor.

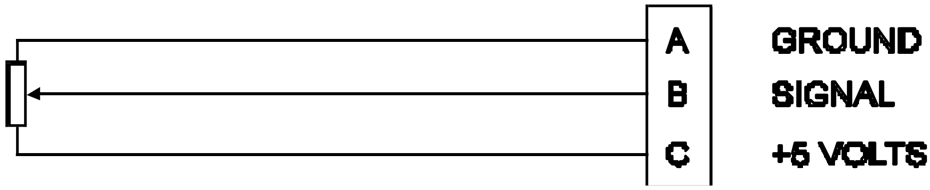
The sensor should be mounted to provide the best representation of the actual temperature of the air entering the combustion chamber, i.e. after any turbo or supercharger, and intercooler, and as close to the head as possible. The sensor needs to be in the moving air stream to give fast response times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

Note: The Haltech air temperature sensor will read temperatures up to 120° C and temperatures above this will be interpreted as a fault condition. The air temperature after some turbos and superchargers can exceed this. If this occurs with your engine you should consider fitting an intercooler to reduce air temperature and increase charge density. If this is not possible then the air temperature sensor should be placed upstream of the turbo or supercharger to monitor ambient air temperature.

Once a suitable position has been located for the air temperature sensor a hole should be drilled and tapped to accept the sensor. Remove the manifold or inlet tract from the engine before machining the sensor mount. Do not allow any metal particles to enter the inlet manifold of the engine as these will be drawn into the engine and damage it. Wash all components before reassembly.

1.3.4. The Throttle Position Sensor (TPS)





The throttle position sensor is mounted to the throttle butterfly shaft to measure its rotation. A TPS is common on many late model engines and the Haltech sensor should attach with little or no modification. The throttle shaft must protrude from the side of the throttle body. This may require the machining of the throttle body or the manufacture of a new throttle shaft. The inner mechanism of the sensor rotates with the shaft. If the shaft is round then file a flat surface on the shaft so that it will pass through the sensor assembly. The TPS should be mounted against the side of the throttle body, using two screws, such that the throttle shaft and the sensor mechanism can rotate freely. The absolute range of sensor movement is not important as the sensor can be calibrated using the programming software.
Your engine may have a Throttle position sensor already fitted and it is often possible to make use of this TPS. The Haltech supplied TPS has a resistance value ranging from 0 to 10kΩ. The resistance value of the installed TPS does not have to be the same since the ECU uses a throttle calibration function to determine the position of the throttle based on the signal received from the TPS. Be sure to wire the TPS so that the ECU sees a closed value when the throttle is closed, the Engine data page field "throttle position" should read "closed" or "0%" when the throttle is closed.

Note: Make sure that the axis of rotation of the shaft is exactly aligned with the axis of rotation of the sensor. Also, do not use the TPS as a throttle stop. In either case, the TPS will be damaged.

F10A and F10A-8 Only

1.3.5. Mount Optional Exhaust Gas Oxygen Sensor

The optional exhaust gas oxygen sensor must be mounted in the exhaust pipe near the exhaust header or extractors, usually after the collector. The sensor uses the exhaust gas to detect if the engine is lean or rich. Many late model engines already have provision for an exhaust gas oxygen sensor and the sensor provided should fit any standard exhaust mount. Some exhaust systems have the sensor mount up to around half a meter (2 feet) down stream from the exhaust headers.
If the exhaust system does not have an existing sensor mount then a new mount will have to

be welded to the exhaust system.
When routing the electrical connections to the exhaust gas oxygen sensor do not allow the harness to touch the exhaust pipe as the heat will damage them.
See Chapter 15 [15.3] for more information on exhaust gas oxygen sensors.

1.3.6. Route Wiring Harness and Connect Sensors

Lay the main wiring harness out in the engine bay with the sensors mounted to ascertain the best fit for the harness. Pass the wiring loom through a hole in the engine bay firewall and into the passenger compartment where the ECU will be mounted. Either use an existing hole or cut a new hole to suit. Use a rubber grommet or similar device to protect the harness from being damaged by rubbing on the sharp edge of the hole.

WARNING:
DO NOT ALLOW THE HARNESS TO TOUCH HOT EXHAUST PARTS INCLUDING MANIFOLDS OR TURBOCHARGERS.

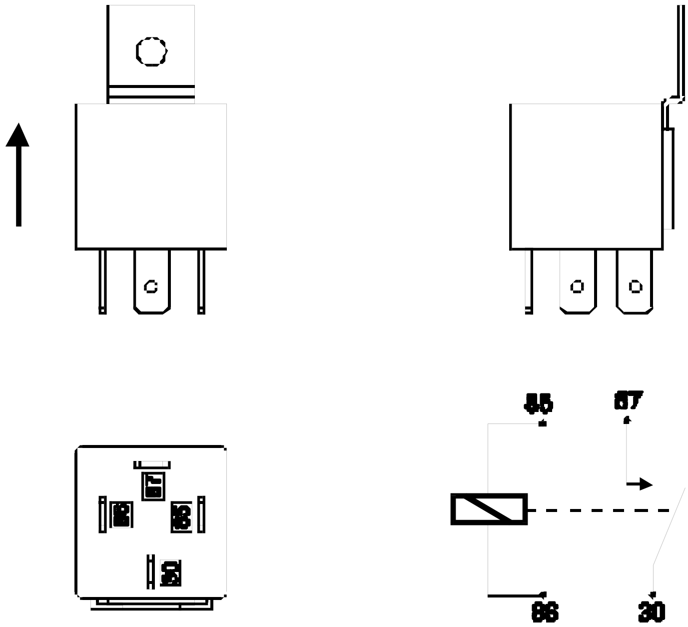
TRY TO ROUTE THE MAIN HARNESS AWAY FROM HIGH VOLTAGE IGNITION LEADS. UNDER NO CIRCUMSTANCES RUN ANY WIRING PARALLEL TO, OR IN CONTACT WITH THE IGNITION LEADS.

Note: Be neat. Run the harness in a tidy fashion. Try to run the harness along paths used by original wiring. Use nylon cable ties to secure the harness in place, but do not stress the wiring or connectors.

Once the harness is fitted, connect all the sensors to their appropriate plugs.

1.3.7. Power Relays

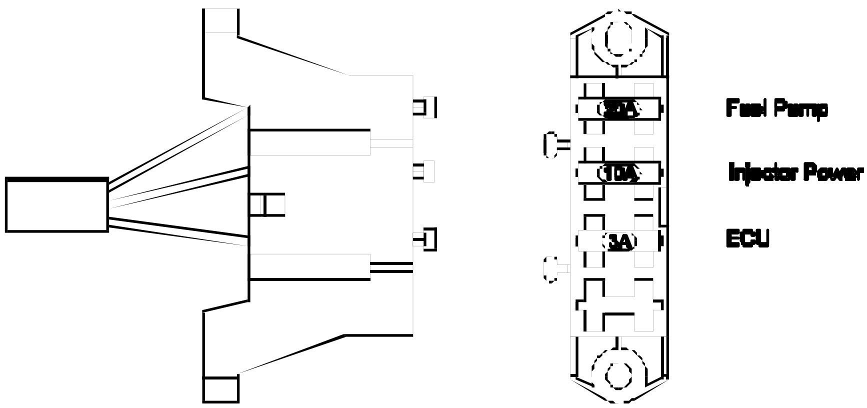
There are two relays used with the Haltech F10, the Main Power Relay (with a grey wire) and the Fuel Pump Relay (two orange wires). These relays are identical parts so it is not important which relay goes in what connector.



These relays should be mounted on the firewall or an inner guard. Do not mount the relays such that they could catch and collect splashed water. Residual water inside the relay housing will cause them to fail. Mount them with the tab upwards as shown in the diagram.

1.3.8. Fuse Block Assembly

The fuse block assembly holds the fuses that protect the various components of the Haltech F10 system.



The fuse block is supplied from the factory with fuses installed. The fuse ratings are shown in the diagram and should not be changed as these have been selected for best protection. Altering the fuse ratings could cause severe damage to the F10 system.

The fuse block should be positioned so that it can be easily accessed in case of fuse failure. Do not mount the fuse block where it could be exposed to water. Mount via the two screws holes in the block. Ensure that vibration will not cause the screws to vibrate loose.

Connect the Fuse Block assembly to the Main Harness.

1.3.9. Electronic Control Unit (ECU)

The Haltech F10 is not designed to be waterproof. It is desirable that the ECU be given as much protection from the environment as possible. It is recommended that the ECU be mounted inside the passenger compartment, either on the firewall, under the dashboard or under the passenger seat.

The ECU has four mounting holes that allow it to be mounted to most flat surfaces. In extreme cases of vibration, the ECU should be mounted on rubber anti-vibration pads. When mounting the ECU remember that the communications connector on the loom should remain accessible for ease of programming.

1.3.10. Flying Leads

Locate and connect the following flying leads.

Black (Ground)

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

Red

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

Grey

(Ignition Switched +12V) The grey wire is used to control the operation of the Haltech F10 power relay. It needs to be connected so that it sees 12V only when the ignition switch is on and during cranking. This wire does not draw a large amount of current (< 0.5A). Do not connect to the accessory outputs of the ignition switch.

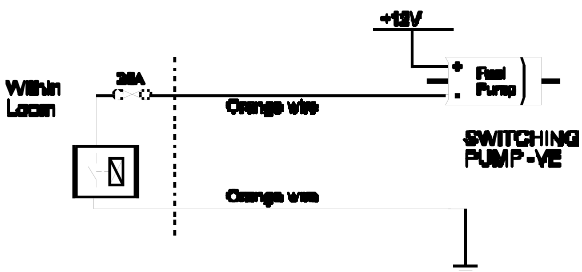
Green

(Aux In) The green wire is used as the Aux In channel. This is used if you wish to use the Aux Input for Torque Converter control, a turbo timer, etc (Refer *Chapter 16 PWM Outputs, 72*).

Orange

The two orange wires are used to operate the fuel pump. When the Haltech F10 ECU wants to operate the fuel pump it will close the fuel pump relay connecting the two orange wires together. The diagrams show two examples of wiring the fuel pump. Do not add extra relays to the fuel pump circuit.

Example 1: Connecting to the positive side of the fuel pump.



Example 2: Connecting to the negative side of the fuel pump.

Regardless of which example is used both will operate correctly. Note that the orange wires are connected internally within the loom when the relay is closed. As a result it does not matter which orange wire is used to connect to the fuel pump.

F10A and F10A-8 Only

1.3.11. Install and connect Optional Idle Speed Motor

If you are not using the Idle Speed Control, tie the loom connector back neatly in the engine bay. If the engine has a suitable Idle Speed Motor then you may connect it to the wiring loom, otherwise you can install a Haltech supplied idle air control motor. For details on how to install and plumb the Idle Speed Motor, see Chapter 14.

F10A and F10A-8 Only

1.3.12. Install and connect any Optional Outputs

If you are planning to use any of the Programmable Optional Outputs, install and connect them now. Depending on what options you are using, the wiring will be different.
(Refer *SECTION 4 F10 Inputs & Outputs, 61*)

1.3.13 Connect the Trigger Sensor

The F10 requires a trigger signal on each spark event in the engine rotation ie. A 4-stroke V8 will have 4 spark events per engine rotation (or 8 spark events per cam rotation). The trigger signal can be one of the following:

Coil Negative:

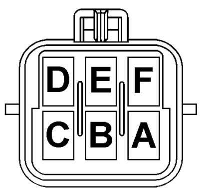
The F10 can use the switching voltage at the negative terminal of the ignition coil as a trigger signal in what is called a "coil negative" trigger set-up. To wire the F10 for this trigger set-up; connect the trigger wire in the Haltech loom to the negative terminal of the ignition coil.

Tacho Output:

Some popular ignition systems have a tacho output signal which can be used to trigger the F10. It is necessary to use this output if the ignition system used is a Capacitive Discharge Ignition system with a multiple spark function.

Hall Effect and Optical Triggers:

The F10 can also accept a signal from Hall Effect and Optical triggers systems. These trigger devices generally 3 have connections each - ground, power and the signal. The trigger connector on the Main Harness has six pins. These pins and their connections are shown in the diagram below.



PIN	FUNCTION
A	GROUND
B	MAIN TRIGGER
C	N/A
D	N/A
E	N/A
F	13.8 V DC

For more information on the F10 trigger system; (Refer *Appendix D Trigger Interface, 92*).

1.3.14 Connect the ECU

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

Now that your Haltech F10 is installed with all the sensors in place the system can be connected to the programming computer. This will allow the readings from all the sensors to be displayed on the screen and checked for correct operation.

To connect the PC to the Haltech F10 ECU you will need the programming cable and programming disk supplied.

2.1 Connecting the Haltech F10 to a Computer

The programming cable supplied with the Haltech F10 is a standard serial link extension cable. One end of the cable will plug into the Main Harness **PC Interface** connector (near the main connector). The other end should plug into the mating connector at the back of your computer. The plug on the computer may be marked "Serial", "Mouse" or "COM". Almost all laptops will have this plug. If there is no 9 pin plug which it will connect to, check to see if there is a 25 pin D-type plug available (some desk top computers will have this). If this is the case, an appropriate cable can be supplied on request. Alternatively, most electronic retailers will have a 25-pin to 9-pin converter.

Any time you wish to communicate with the F10 ECU it needs to be supplied with power. This usually involves just turning on the ignition switch. If at any stage power is not on, or the programming cable is disconnected while attempting to communicate, the programming software will display the message RECONNECT HALTECH. To rectify this, reconnect power and/or the programming cable.

2.2 Operating the Software

2.2.1 Computer Requirements

The computer required to program the Haltech F10 can be any IBM-PC compatible personal computer from the XT onwards (i.e. the AT, 386, 486 or Pentium computers). The requirements are fairly modest. The computer must have at least 640K of RAM (with about 590kb free for executable programs), one 3.5" disk drive and a CGA, EGA, or VGA screen. (Virtually all reasonably modern laptops running MS-DOS (version 5.00 or higher) will fit this description).

2.2.2 Installing the Software

The Programming Disk supplied with the Haltech F10 has an installation program that allows you to install the software onto the PC’s Hard Disk. Most modern PCs have a hard disk. If your PC does not have a hard disk, the F10 Program can run directly from the disk supplied. Installing the software on the Hard Disk will speed up the program and avoid having to fiddle around with floppy disks. The installation program need only be run once.

If you do not have a Hard Disk, go to the section titled **Running the Software from the Floppy Drive**.

To install the software follow these steps.

Boot up Computer

Turn your PCs power on and boot up MS-DOS as instructed by the computers Users Manual. If a shell program or menu utility runs automatically when you boot your computer, exit it now. You should see something like this:

C:\>_

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

A:\>_

Select the Drive

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

a : · or B : ·

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

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

Run the INSTALL Program

To run the Install program type :

i n s t a l l ·

The Install program will now run. Follow the instructions given. The program will suggest that the software will be placed in the HALTECH directory. You can change the destination directory, but it is not recommended that you do unless you understand how directories work. When it is finished, the installation program will tell you if the installation is successful. If it was not, consult the trouble shooting section of this manual.

The F10 Program is now ready to run.

2.2.3 Running the Software from the Hard Disk

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

cD \haltech ·

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

To start the program type :

F10 ·

The F10 program will now run. The next section is on running the software from a floppy drive. You can skip this section and go straight to the section entitled **Azerty Keyboards**.

2.2.4 Running the Software from the Floppy Disk

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

a: · or B: ·

You should now see the prompt :

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

To start the F10 program type :

F10 ·

The F10 program will now run.

2.2.5 Azerty Keyboards

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

qwerty

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

F10 ·

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

F 1 0 / a ·

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

2.3 The ONLINE and OFFLINE Modes

On the F10 system title page, the software asks whether to operate in ONLINE or OFFLINE mode. The OFFLINE mode is very useful to familiarise yourself with the Haltech software, but cannot be used to make lasting adjustments to the fuel maps except by modifying maps then saving those maps and re-loading them to the ECU in the on-line mode. Also lasting changes to the main, fuel and Main Set-up pages cannot be made in the OFFLINE mode. Do not attempt to make lasting changes to the ECU unless there is a special reason for doing so. If you wish to experiment and familiarise yourself with the software press N for OFFLINE mode, but if the ECU is installed and power is available then we suggest the ONLINE mode be selected. Press Y to select ONLINE mode.

2.4 Using the System ONLINE

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

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

RECONNECT HALTECH

If this message appears check all connections and ensure that the communications cable is not being interfered with. Also be sure that the Haltech F10 unit is receiving power. (i.e.. ignition switch is turned "on".)

2.5 The Main Menu

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

2.6 How to Quit

Throughout the program you can exit from any application by using the menu bars or hot keys. Pressing ² q in any page will prompt you to exit the program (i.e.. pressing q while holding down the ² key). If you wish to exit, press Y at the prompt.

2.7 Checking the Engine Data

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

This is a very useful function for analysing the engine sensors. To bring up the engine data press ² e from any application. Otherwise it can be accessed through the menu bar by pressing ± O and then E for Engine Data.

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

3.1 ECU Setup

The F10 ECU can be used to control fuel delivery to many different types of engines and requires specific information about the engine that it is to control. The F10 software has a series of set-up pages that allow the user to program the F10 with these settings, these are:

Main-Setup
Fuel Setup

3.1.1 Navigating the Set-up pages

The F10 Set-up pages are made up of a series of fields that define the characteristics of the engine that the F10 is to control. These fields can be navigated as follows:

Use the Up and Down arrow keys (- and ®) to move between fields. The fields are either *Selection* type, or *Text* type. The Selection type fields give you a number of valid entries for that field. For example, the valid number of cylinders can be set to 1, 2, 3, 4, 5, 6, 8, 10 or 12.

The Tab and Enter keys (´ and ·) keys are used to change this type of field. Each stroke of the Tab key will display the next selection. The Shift and Tab keys together will step backwards through the selections. Once the desired selection is displayed, the Enter key is pressed to program that selection. Text Fields require you to enter either text or numbers. Once the field is selected, the new text can be typed in, with the Enter key to finish. An example is the Rev Limit. This field can be set between 2000 and 16000 rpm. If you want the rev limit to occur at 7000rpm, then you would need to select this field using - or ® and then type 7 0 0 0 · .

3.1.2 Main Set-up

To access the Main Setup page press Alt – S to open the Set-up menu then scroll to the Main Set-up menu item and press enter.

Cylinders

The number of engine cylinders needs to be entered here. This parameter is used to determine the engine speed.
The valid values for this parameter are: 1,2,3,4,5,6,8,10,12 and 16

Load Sensing

The F10 can use either the manifold pressure or the throttle position as a means of determining the engine load. Most engines operate using manifold pressure to sense engine load. If your engine employs any form of supercharging, you must run in manifold pressure mode. Only wild cams, motorbikes or heavily ported rotaries require throttle mode - i.e. engines whose vacuum signal is small, or fluctuates greatly. If you are unsure what to use, contact your Haltech dealer.
The valid values for this parameter are: Throttle and Manifold

MAP Sensor

The F10 needs to know the type of Manifold Absolute Pressure (MAP) sensor being used. Enter the correct description here to match. If using throttle position mode, set this parameter to a 1 Bar sensor.

The valid values for this parameter are: 1 BAR, 2 BAR and 3 BAR

RPM Limit

The F10 can limit the maximum rpm at which the engine will operate. Above this level the F10 completely cuts fuel or ignition (see below) to the engine. When the engine speed drops below the RPM Limit the F10 will resume normal fuel or ignition delivery. This is known as hard limiting. If the RPM Limit is not needed then set this value above the highest operating point of the engine.

The valid values for this parameter are: 2,000rpm – 16,000rpm

Units

The Haltech F10 programming software can display parameters in either Metric or US units.

The valid values for this parameter are: Metric, US

RPM Mode

The F10 fuel and ignition maps may be arranged either in 500 rpm increments to 10,500 rpm, or in 1000 rpm increments to 16,000 rpm. Changing settings alters the way the ECU reads the Maps, and will change the tuning of the engine dramatically. Do not change this setting once tuned unless necessary.

The valid values for this parameter are: 10,500rpm – 16,000rpm

Road Speed Value

This parameter is a multiplier that allows the user to calibrate the road-speed input by comparing the road-speed value on the Engine Data Page with that of the vehicles speedometer. To calibrate the road-speed input, modify this value until the road-speed value on the engine data page matched that on the vehicle speedometer.

The valid values for this parameter are: 100 – 60,000

F10 Type

This field is only accessible by Haltech but serves as an indication of which of the 4 F10 variants is connected.

The valid values for this parameter are: F10, F10A, F10-8, and F10A-8

3.1.2 Fuel Setup

To access the Fuel Setup page press Alt – S to open the Set-up menu then scroll to the Fuel Set-up menu item and press enter.

Ign / By

Ignition Divide By is the number of ignition pulses that will be counted until the next injection pulse (remember the trigger wire for the F10 should ideally have one trigger event for each spark event). For almost all multipoint systems, injection should occur once per revolution and so Ignition Divide By should be set to half the number of cylinders. If the system is operating in Batch Fire mode, or is a rotary, then a value of 1 is suggested.

The valid values for this parameter are: 1, 2, 3, 4, 5 and 6

Decel Cut-Off

A common fuel saving feature in original equipment computers is a fuel cut-off on deceleration. This will cut fuel delivery to the engine while coasting down hills with a closed throttle. This feature can be enabled or disabled on the F10. It is better, when first tuning, to disable this function.
The valid values for this parameter are: Enable and Disable

Injection Mode

Depending on the ECU settings the F10 splits its four (*F10 and F10A*) or eight (F10-8 and F10A-8) injector driver outputs into two banks (see chapter 13, 13.1). INJ1 and INJ2 comprise the first bank. INJ3 and INJ4 form Bank 2. The fuel can be injected in three different modes.

Multipoint injection fires all the injectors together. This is the most common set-up and will normally be used on engines with multipoint injection manifolds (one injector per cylinder).

Batch-fire injection is usually used in throttle body or non-turbo rotary set-ups and fires the two banks of injectors alternately. On eight and twelve injector fuel rails, with high-flow injectors, this may also help reduce fuel pressure oscillations caused by all injectors pulsing together.

Staged injection is usually used on high boost turbo engines. Injector Bank 1 fires all the time, just as in a multipoint set-up. Beyond a set boost pressure, the second bank of injectors is enabled. These "staged" injectors are normally upstream of the primary injectors, adding to their fuel flow. The point at which the F10 switches in the secondary injectors is set via the Staging Bar Number field. Staging permits high fuel-flow capability, but maintains accuracy and controllability at light load and idle. (Refer *C.3 Injector Staging, 90*).

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

F10 AND F10A ONLY
THE F10 AND F10A ARE NOT CAPABLE OF DRIVING 8 LOW IMPEDANCE INJECTORS. THESE ECU DO NOT HAVE THE EXTRA INJECTOR DRIVERS MENTIONED ABOVE.

Post Start Temp Limit

This field sets the temperature at which the post start correction map is either enabled or disabled. The following field "Above/Below" allows the user to enable the Post map above or below the temperature set in Post Start Temp limit (this is particularly useful for engine, which when hot require extra fuel due to vapour lock. From when the motor is started to when the engine temperature reaches the Post Start Temp limit, the Post Start correction map will apply correction to the injection times.
The valid values for this parameter are: 0°C – 127°C (Above and Below)

Post Start Time Limit

This field sets the time for which the post start correction map adds corrections to the fuel from the post start map. Post Start is the period of time from when the motor is started to the Post Start Time limit.
The valid values for this parameter are: 1s – 120s

Staging Bar Number

This field sets the point at which the staged injectors are enabled (Refer *C.3 Injector Staging, 90*). If the injection mode is not "Staged Injection" then this field will not affect injection.
The valid values for this parameter are: 1-16

Zero Throttle Map

This feature allows the user to enable or disable a special fuel map that is used only when the throttle is closed. This feature should be used for engines that produce constant vacuum while cruising but irregular vacuum when idling. Typical engine configurations that fall into this category are multiple throttle body set-ups and wild cams. The zero throttle Map can allow a very quick and simple adjustment of the idle fuel settings. This option can be disabled if not required.
The valid values for this parameter are: Enable and Disable

Throttle Pump Deadband

This field defines the percentage change in throttle position that must occur before the throttle pump is activated. This feature allows for "jitter" in the throttle that would otherwise over-fuel the engine.
The valid values for this parameter are: 1% - 20%

Full Throttle Map

This feature allows the user to enable or disable a special fuel map that is used only when the throttle is wide open on normally aspirated engines. With some manifold and or throttle designs, pressures in the manifold can reach close to atmospheric pressure before full throttle is applied. This effect can make tuning difficult around full throttle. This map allows the full load settings to be easily set without interfering with lighter load settings. The throttle position above which this Map is used is set by the Full Throttle Threshold field.
The valid values for this parameter are: Enable and Disable

Full Throttle Threshold

See the Full Throttle Map field above for information on this field.
The valid values for this parameter are: 70% - 100%

Barometric Lock

If you wish to lock the barometric value that is stored by the ECU to a set value and override the start-up barometric correction, **enable** this option. Normally, unless you are using throttle position as a load reference or have another good reason to do so, leave this option **Disabled**. Configuring barometric compensation successfully requires an in depth knowledge of your engine and the environment in which it will be operating. (Refer *8.5 Barometric Correction, 48*)

The valid values for this parameter are: Enable and Disable

Barometric Pressure Lock at xxxx (mBars)

This field allows the user to set the barometric pressure value to which the ECU corrections will be locked. The default is 1013mBars (= 1 Atmosphere @ sea level). Again, unless you have sufficient knowledge about your engine characteristics and the environment it is operating in, leave this field as it is. (Refer *8.5 Barometric Correction, 48*)

The valid values for this parameter are: 523mbar – 1046mbar

Disable Injector Outputs

Allows you turn off all injector outputs. Setting the value to YES will cut all injector output which allows an easy way to check the trigger when cranking without having to locate the injector fuse and remove it. Normally this field should be set to NO to allow the injectors to fire.

The valid values for this parameter are: Yes and No

Over-boost Fuel Cut

This field enables or disables a feature which will cause the fuel to be cut when the manifold pressure exceeds a set pressure. If this field is enabled the following fields become visible:

Over Boost Limit

This is manifold pressure at which the fuel is cut.

Over Boost Restore

This is the manifold pressure at which the fuel supply is restored.

The “Over Boost Limit” must exceed the “Over Boost Restore” pressure by 12 kPa (2.3psi) to eliminate boost spikes.

3.1.3 Trigger Set-up

To access the Trigger Set-up page press Alt – S to open the Set-up menu then scroll to the Trigger Set-up menu item and press enter.

The following Trigger Set-up page description outlines the basic operation of each individual field, the table below give application information.

Switch 1 – Pull-Up 1

This switch adds a 6.2kΩ pull to +5V at the input to the trigger circuit.

Switch 2 – Pull-Up 2

This switch adds a 2.2kΩ pull to +5V at the input to the trigger circuit after a series input impedance.

Switch 3 – Pull to Ground
This switch adds a 4.7kΩ pull to ground opposing the Pull-Up 2 resistor.

Switch 4 – Filter Capacitor 1
This switch adds a 0.1uF filter capacitor to the input of the trigger circuit.

Switch 5 – Filter Capacitor 2
This switch adds a 0.001uF filter capacitor to the input of the trigger circuit after series impedance.

Switch 6 – Resistor Bypass
This switch applies a short circuit across a 4.7kΩ series resistance on the input of the trigger circuit.

Switch 7 – Input Impedance
This switch allows the user to set the input protection impedance to either low ore high. High is used in coil negative applications where low is used for Hall Effect or optical digital trigger applications.

Switch 8 – Input Threshold
This switch controls the threshold voltage at which the trigger circuit will switch state.

Typical Applications

	Software Switches							
Trigger Type	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Haltech S1/S3,S2/S4 Hall Effect Sensor	×	✓	×	×	✓	✓	LOW	3.4V
Ignition Coil Negative terminal	×	×	✓	✓	✓	✓	HIGH	3.4V
Driven 12V square wave (some tacho output signals)	×	×	✓	✓	✓	✓	HIGH	3.4V
								✓= On ×= Off

This Chapter describes the fuel maps that are the heart of the F10s ability to accurately deliver fuel to the engine.
The following instructions assume that the user has the software running ONLINE on a PC, with the ECU powered and connected via the supplied programming cable. It is also assumed that the user is familiar with the ECU Set-up described previously.

4.1 What are maps?

The injection times data required to fuel the engine properly at different engine load speed temperature etc.. are stored in the F10 ECU of numbers called a look-up table. The F10 determines the engine's load and speed, and uses these two parameters as an index to the table. This table is called the Fuel Map. For instance, at an engine speed of 4000 rpm and at -20kPa, the relevant number in the table may be 4.35. If the engine approximates -20kPa at 4000 rpm, then the computer will extract the value of 4.35ms from the table as the base injection time. This value is then adjusted to compensate for numerous conditions, such as temperature or acceleration, and then the ECU holds the injectors open for that time on the next injection.

It is possible to program the F10 by directly changing the value of each number by programming in the numerical mode (Refer *4.5.6 Numeric Mode, 37*), but this can be extremely difficult, so the Haltech allows you to change the numbers by manipulating graphics in maps presented as bar graphs. (This is much simpler and allows you to visualise the map)

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

There are other tables in the F10, such as those used for temperature corrections. They are indexed by only one parameter, and so are not divided into ranges. These tables are also called maps.

4.2 What is mapping the Engine?

Mapping the engine is filling the look-up tables with the correct values for your engine. This is done by adjusting the heights of the bars within the maps. Bars may be adjusted one at a time, or in groups. The Haltech programming software has been designed to make engine mapping as simple and intuitive as possible.

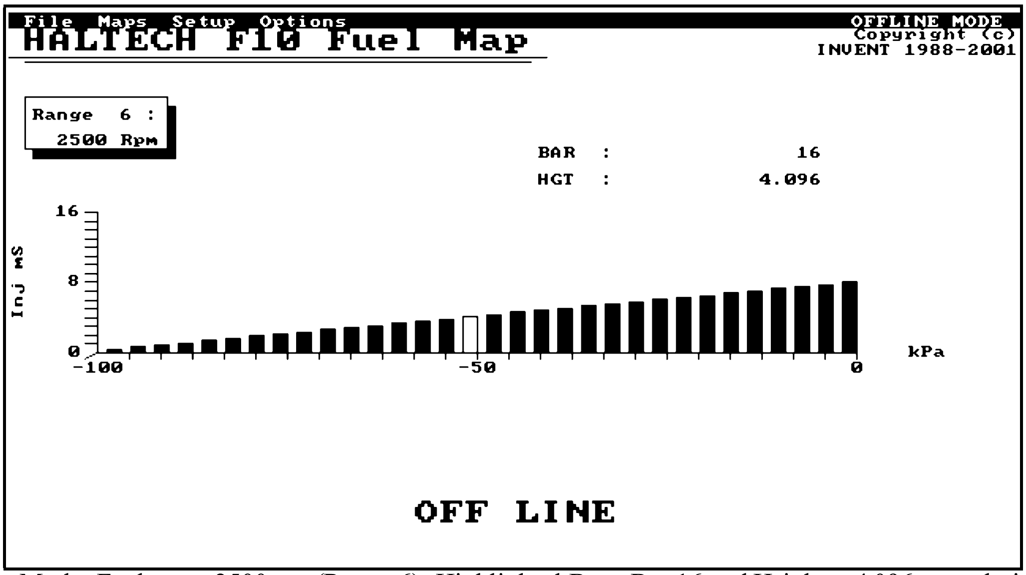
4.3 Using the Software

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

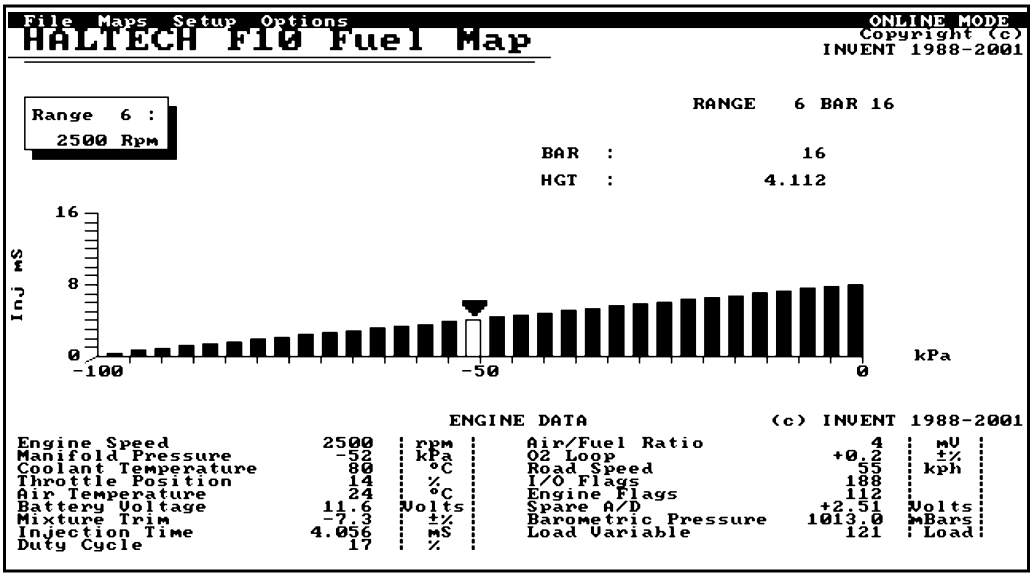
4.4 Accessing the fuel maps

To access all the fuel and compensation maps press ± m , this opens the Maps Menu. From the Maps Menu select the appropriate map using the cursor keys to scroll up or down the list and when the desired map title is highlighted press Enter. (Some maps such as the base fuel map have sub-menus for the different ranges if the maps.)

To view the base Fuel Maps specifically, press ± m then select “fuel map” from the menu and press · then select the desired range from the sub-menu and press · . While in the Fuel map, each range can be accessed by pressing the N, P and J keys to move to the next, previous range and jump to a particular range. See below for an example map:



Offline Mode: Fuel map: 2500rpm (Range 6), Highlighted Bar - Bar 16 and Height – 4.096 – as designated upper left corner



Online Mode: Fuel map: 2500rpm (Range 6), Highlighted Bar - Bar 16 and Hight – 4.096 – as designated upper left corner

4.5 Navigating the Map

For all maps whether single or multi ranged navigating the map is done in the same way (with multi-ranged maps the same navigation between ranges is the same as choosing another map.) Once a map is displayed on the screen by following the instructions above the bar heights can be adjusted to adjust the fuel delivered.

The height of the Bars is adjusted by using the up and down arrows keys, the PgUp and PgDn keys (¾ ¿) or a combination of these keys with the Shift and Ctrl keys. Increasing or decreasing the height of the bars increases or decreases the amount of fuel contributed to the total fuel by that bar of the displayed map. (See the command summary at the end of this section for a full list of key functions Refer *4.7 Command Summary for Maps, 40*).
The active bar (the bar that is affected by the up and down cursors) is highlighted on the computer screen to distinguish it from the remaining bars in the map. To change the active bar, use the left and right arrow keys (° ¯). The Haltech software ahs a number of time saving functions programmed to make mapping the engine simpler.

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

4.5.1 Current Location

Pressing ½ will take you to the range at which the engine is running, and highlight the bar that is currently being used. This bar is easily identified by an arrow directly above it pointing down. As the engine speed and load changes, the arrow moves with it. The Home key is useful for finding the engine's operation point very quickly.

4.5.2 All Ranges

Across the ranges, the curve of the fuel map does not change greatly. Usually the shape remains much the same, and the height changes according to the volumetric efficiency of the engine. In order for all the fuel ranges to initially be set up quickly, the Haltech F10 system allows you to program all rpm ranges simultaneously with the same data. ± r turns *All Ranges* on, and the words All Ranges appears under the title.
When the *All Ranges* function is active, a bar adjusted on one graph is copied to the same bar on all the ranges. If you use this option, you can set the shape of the map at any range, and all other ranges will be identical at every bar you adjusted. This feature enables all graphs to be given an initial shape that should run the engine, albeit rather roughly. Once you have used the *All Ranges* option for a starting point, press ± r once more to exit the *All Ranges* option and tailor each map individually.

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

4.5.3 Selecting Groups of Bars

Groups of adjacent bars may be highlighted and adjusted together.
Hold 2 while using the left or right arrow keys, ° ¯ , and you will highlight a group of bars. This group will now act in unison when increasing or decreasing the height of the Bars.

To de-select the highlighted Bars use the ± and arrow keys together.

4.5.4 Percentage Changes

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

4.5.5 Linearise

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

4.5.6 Numeric Mode

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

File Maps Setup Options OFFLINE MODE

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

In numerical mode only a fraction of the entire map is shown on the screen but the whole display can be accessed. To navigate the map use the cursor keys to move the highlighted cell, to change the value of a cell, highlight that cell, type the value required and then press the enter/return key. The values in the table must be a multiple of 0.016ms, if a different value is entered the program will round to the nearest valid value.

To exit from Numeric Mode and go back to using the maps press the » key.

4.5.7 Bar Increments

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

Normally, the bars are altered by adding or subtracting a fixed amount. The adjustment keys may instead apply a percentage change on each keystroke. ± p on the Bar Increment Screen will switch to percentage increments, ² f will return you to fixed increments.

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

4.6 Duty Cycles

Fuel is delivered to the engine by firing the injectors in sync with the engine, allowing fuel to flow during the period that the injector is open. The period of time the injector is open is called the injector pulsewidth. As rpm increases it is possible for consecutive pulses of the injectors to meet so that the injectors are effectively never switched off. This is referred to as 100% duty cycle.

When 100% duty cycle is reached the fuel flow from the injectors has reached its maximum. Increasing engine speed or load will result in a lean out condition.

> **WARNING:**
> **LEANING OUT AN ENGINE WILL CAUSE DAMAGE TO THE ENGINE IN MOST CASES.**
> **CARE SHOULD BE TAKEN THAT THE ENGINE CANNOT REV ABOVE THE POINT WHEN 100% DUTY CYCLE IS REACHED AS THERE IS A DANGER THAT DAMAGE WILL BE CAUSED TO THE ENGINE**

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

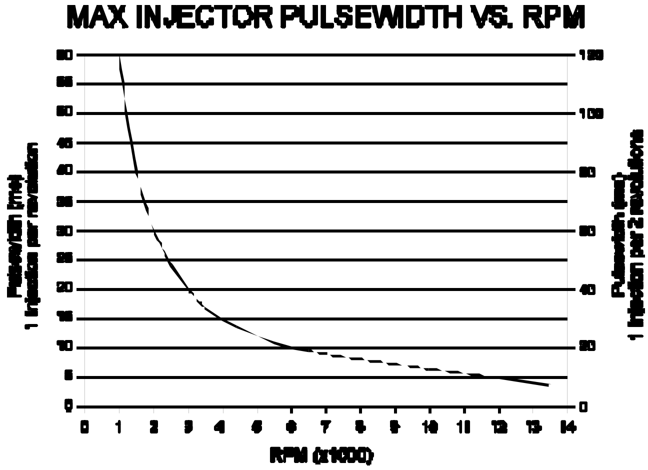
Maximum Injection Time (in milliseconds[ms]) =

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

eg. Maximum injection time for a four cylinder, on ign/by 2 red-lining at 6000rpm is:

(120,000 x 2)/(6000 x 4) = 10,

The maximum injection time at 6000rpm on this engine is 10ms. If the injection time needs to be greater than this, then your fuel system cannot meet the demands of the engine. You will need to increase the fuel supply, by increasing injector size, fuel pressure, or adding extra injectors. (Refer *Appendix C Fuel Systems & Staging, 89*). As a general rule of thumb, injectors should not run beyond 85% duty cycle.



Injector Duty Cycle appears on the Engine Data Page and on Data-logs for you to monitor the approach to maximum fuel flow.

MAXIMUM INJECTOR PULSE WIDTH
VERSUS ENGINE SPEED

SPEED (rpm)	1 Inj / Rev (ms)	1 Inj / 2 Rev (ms)
1000	60.00	120.00
1500	40.00	80.00
2000	30.00	60.00
2500	24.00	48.00
3000	20.00	40.00
3500	17.14	34.29
4000	15.00	30.00
4500	13.33	26.67
5000	12.00	24.00
5500	10.91	21.82
6000	10.00	20.00
6500	9.23	18.46
7000	8.57	17.14
7500	8.00	16.00
8000	7.50	15.00
8500	7.06	14.12
9000	6.67	13.33
9500	6.32	12.63
10000	6.00	12.00
10500	5.71	11.43
11000	5.45	10.91
11500	5.22	10.43
12000	5.00	10.00
12500	4.80	9.60
13000	4.62	9.23

4.7 Command Summary for Maps

° , ¯ - move left/right highlighted bar(s)

® , - - increase/decrease highlighted bar(s)

¾ , ¿ - increase/decrease highlighted bar(s)

3 ¾ ,

3 ¿ - increase/decrease highlighted bar(s)

2 ¾ ,

2 ¿ - increase/decrease highlighted bar(s)

2 ¯ ,

2 ° - select (highlight) next bar

± ¯ ,

± ° - de-select end bar

± P - enter Percentage change to highlighted bars

± L - Linearise between end points of highlighted bars or linearly interpolate the increment values in increment set-up

± I - set Increments

± N - enter Numeric mode

± R - toggle All Ranges mode

N - move to Next range

P - move to Previous range

J - jump to range of value entered

½ - go to current engine range/bar

´ - switches option in set-up pages

There are a few things that need to be done before the engine should be started. Make sure that the ECU is powered (ignition on) and the Haltech Software is ONLINE. Go to the Engine Data Page to check that the ECU is communicating properly, and that the sensors are reading correctly. Check that the ECU Set-up: Main Set-up and Fuel Set-up are correct.

5.1 Calibrating the Throttle Position Sensor

The throttle position sensor (TPS) must be calibrated so that the ECU closed throttle (0%) and wide open throttle (100%). Set the idle throttle opening using the idle adjust screw. If the required opening for idle is not known, make an estimate but keep in mind that this may be the reason for poor idle later on, and further adjustment may be needed. Choose the "calibrate throttle" option from the options menu and follow the instructions on the screen.

5.2 Checking the trigger

It is a good idea to check that the F10 is receiving a reliable trigger signal. Disable the injector outputs found in the Fuel Set-up page to cut all fuel delivery to the injectors. This will prevent the engine from starting. The engine should then be cranked over on the starter and the rpm displayed on the engine data page should read about 100 to 300 rpm. If the trigger is operating correctly then enable the injector output again on the Fuel Set-up page. (If the rpm reads “0” or is erratic; Refer *Appendix D Trigger Interface, 92*).

5.3 Determining Engine Fuel Needs

You should now be ready to start the engine. At this stage, you should not be using the Zero Throttle Map. Check that it is disabled in the Fuel Set-up.
Go to the Fuel maps and display the 0 rpm range. During cranking, the pointer will appear across this page, until the engine speed picks up and lifts into the 500 and 1000 rpm ranges. Press the ½ key to jump to the current load point immediately.

If you are using manifold pressure as the load sensor, the engine will be close to atmospheric pressure during cranking. If you are using throttle position, then the F10 will be using bar 1 while cranking and idling. Once the engine is tuned, you should not need to apply any throttle to get the engine to fire. When cranking the engine watch for the indicator arrow over the bars. This will tell you what bar the F10 is using to calculate the fuel. The bars around the position that the arrow indicates are the Bars that will need to be adjusted to get the engine to run.

Note: The bar that is indicated by the arrow is the bar that the ECU is referencing for its fuel needs whilst the bar that is highlighted is the bar that you are adjusting.

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

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

5.3.1 Tuning for Idle

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

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

Remember that the F10 interpolates against both rpm and load. If the engine is idling at 800 rpm, then the injection time is computed as 60% of the value from the 1000 rpm range, and 40% of the value from the 500 rpm range, so both ranges would have to be adjusted to get the correct mixture. Similarly, if the idle mixture is reacting poorly to changes of the bar indicated by the map pointer, then try adjusting the adjacent bars. Wait for the engine to heat to operating temperature before performing further changes to maps.

5.3.2 Tuning with No Load

Using the throttle only, increase the engine speed to 1000 rpm. If the engine is at exactly 1000 rpm then only that range needs to be adjusted. Adjust for the crispest engine response. Engines will usually idle rich, then head towards stoichiometric mixture at higher speeds. Repeat for 1500, 2000, 2500, 3000 etc. The engine should now start and fast-idle evenly. You should also have the engine running at operating temperature before going further. Go to the Engine Data Page at this point and check all the sensor inputs are reading correctly, and that the temperatures have stabilised before continuing.

While free-revving at higher engine speeds, check the Engine Rpm reading on the computer. If it becomes erratic, or fails to follow the actual engine speed correctly, check the section in Chapter 1 on setting the trigger. Also make sure that the information in the Set-up pages is correct.

5.3.3 Loading the Engine

Once the engine has been tuned properly for no load conditions it is possible to begin loading the engine. The best method of applying load to the engine is using a dynamometer. However, if access to a dyno is not possible the engine can be tuned on the road.

5.3.4 On the Dyno

Whether the vehicle is on a chassis dyno, or the engine on an engine dyno, the principles of programming the Haltech F10 are the same. Take the engine rpm up to 1000 and apply partial load and adjust the 1000 rpm range. Return the engine to idle and on the 1000 rpm range adjust the bars to draw a straight line from the idle point through the part load setting tested. Continue, adding more load, up to the full load settings. This should be a fairly good approximation to the required curve. Repeat this for the 1500 range, 2000, 2500 etc. The engine should be fairly drivable at this point.

Full load tuning should be approached with caution. An engine at full load that is too lean may begin to detonate and destroy pistons and crankshafts. Before loading the engine, increase the heights of the right-most bars so that they are higher than the line projected by drawing a straight line from the idle and free-rev settings and through the part-load settings.

> **WARNING:**
> **RUN THE MAP RICH, AND LEAN IT TO THE CORRECT MIXTURES. DO NOT RUN THE MAP LEAN AND ATTEMPT TO ENRICH TO THE CORRECT MIXTURES.**

5.3.5 On the Road

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

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

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

5.3.6 Fine Tuning the Engine

When fine-tuning the engine for the road, the same principles apply to all engines. Under full load at all rpm the fuel mixture should be rich. On non turbo cars an air to fuel ratio of around 12.5:1 to 13.5:1 is usually best (high performance turbo vehicles may go as low as 10.5). When cruising (light to medium load) the mixture should be as close to stoichiometric (best mixture) as possible and decelerating conditions may allow the engine to be run lean to save fuel. This will result in a particular shape for the map. A typical map is shown adjacent. The absolute values will vary greatly, but the shape should be similar.

SECTION 2 Other Adjustable Features

CHAPTER 6 THROTTLE EFFECTS

6.1 Throttle Response

Where the procedures described in the previous chapter tune for constant load running, the methods and features outlined in this section will improve the throttle response of your engine.

The manifold pressure sensor used with the F10 is very fast. It can respond much faster than is required to track any sudden changes in load on your engine. However the pressure seen at the sensor input does not change as quickly as that in the manifold due to the length of the connecting pipe and some other factors. The "lag" effect that occurs due to the connecting pipe can be limited by keeping the pipe as short as possible.

Sudden throttle movements which result in sudden manifold pressure changes will result in poor fuelling of the engine due to the pressure "lag" previously mentioned. This results in a lean fuel-air mixture when the throttle is opened. Another problem which contributes to a lean fuel-air mixture when the throttle is opened is the sudden change in pressure that forces fuel out of atomisation and onto the manifold walls this fuel is not drawn into the cylinder which results in a lean fuel-air mixture.

To overcome any lean fuel-air mixtures during sudden throttle movement, the Haltech system uses a throttle accelerator pump function or "Throttle-pump". This function delivers extra fuel during sudden throttle movements. The effect of sudden throttle movements varies across engine speed, the Throttle-Pump function offered in the F10 ECU allows for this.

6.1.1 Throttle-Pump software control

To access the Throttle-Pump page press Alt – O to open the Options menu then scroll to the Throttle-Pump menu item and press enter.

Six single bars will appear on the screen. The two bars on the left are used when the engine speed is below 1500 rpm. The two bars in the middle operate between 1500 and 3000 rpm and the two bars on the right are used above 3000 rpm. These bars set the amount of extra fuel that will be added to the current fuel value during a sudden change in throttle. This extra fuel is added progressively as the throttle movement continues.

The increase bars determine how much extra fuel the engine gets when you open the throttle. Once the throttle movement stops the extra fuel value decays at a rate set by the sustain bars.

The heights of the increase bars and the sustain bars are adjusted using the same keys that are used for adjusting the fuel curve bars. The left and right arrow keys allow you to move from one bar to the next.

The throttle pump values should be set up after the fuel and maps are correctly tuned for steady load running. Attempting to smooth out engine transients before the fuel maps have been optimised for steady state running may become confusing. The six throttle response bars should be adjusted by trial and error to give optimum throttle response in each rev range. Generally, you may not need much above 3000 rpm, but could expect much higher values below 1500 rpm.

Note that throttle response can also be affected by poor manifold design. If you have designed your own inlet manifold you may find that although the engine runs well at steady load it leans out if the throttle is opened suddenly. This will occur if the fuel injectors are poorly positioned and the fuel is wetting down the walls of the inlet manifold rather than remaining as a mist.

The final parameter on the Throttle Pump page is the Coolant Factor. Generally, when the engine is cold, accelerator pump values need to be increased slightly. The F10 therefore applies a coolant correction to the throttle pump in the same way as it does to the base map.

The Coolant Factor may be set with values from 0 to 4. Setting it to 0 will negate all coolant correction to the throttle pump. The default setting for this parameter is 0.5.

6.2 Zero Throttle Map

One problem that often occurs with performance engines is rough idling. The manifold design, cam characteristics, etc. can cause instability in the air flow. This makes fuel metering difficult. In particular, the Map sensor often cannot correctly read the manifold pressure, as it is either non existent, weak, or pulsing too much. In many cases though, once the engine has some speed, the manifold pressure signal is useable.

The best method of mapping the engine is using the manifold pressure as the load. If in this configuration idling is causing a problem, the Zero Throttle Map should be tried. This Map maps the fuel delivery at zero throttle below 2000 rpm. There are a few requirements that need to be met before you can use this Map. Firstly, your throttle position sensor must be calibrated properly. Secondly, the Map relies on there being a consistent air flow at zero throttle for a given engine speed. That means that devices such as idle speed motors that vary the air flow at zero throttle will not allow the Zero Throttle Map to operate correctly.

6.3 Full Throttle Map

The manifold and throttle body design can also cause problems tuning at full throttle on normally aspirated engines. In some cases, the manifold pressure can reach close to atmospheric pressure before full throttle is reached. This means that bars close to the full load bar on the Fuel Maps can interfere with the full load bar due to the interpolation between the two bars.

If you are experiencing difficulties maintaining air-fuel ratio at full throttle, it may be necessary to use the Full Throttle Map to set the full throttle mixtures. The Full Throttle Map is activated above the value set in the Full Throttle Threshold in the Fuel Set-up, and has one programmable bar every 500 rpm up to 16000 rpm.

The Haltech F10 has features to modify fuel delivery to aid in starting and running a cold engine. The Cold Start Prime map gives a cold engine an initial burst of fuel just as the engine begins cranking. The Coolant Correction Map modifies the normal fuel injection until the engine reaches normal operating temperatures.

7.1 Cold Cranking

At cold crank the air speed at the inlet manifold is very low. As a result a lot of fuel that would normally travel in the air, sticks to the manifold walls and doesn't enter the engine. The cylinder chamber temperatures are also low which leads to poor combustion. To overcome these inefficiencies, it is necessary to prime the engine with a long pulse of the injectors at the start of cranking to ensure that the engine has enough fuel in the cylinder to fire. The F10 ECU has a “Fuel Prime Map” to perform this function.

To access the Fuel Prime Map press Alt – M to open the Maps menu then scroll to the Fuel Prime menu item and press enter.

The fuel prime is adjustable at all engine temperatures. This allows the duration of the prime pulse to be optimised for cranking across all temperatures. The cold prime map specifies an injection time based on engine coolant temperature. The heights of the bars define the time that the injectors are open.

Over priming the engine will cause it to flood and not start. To clear a flooded engine, open the throttle fully and continuously crank the engine. Do not pump the throttle as this will only worsen the problem.

7.2 Cold Engine Operation

Once started, an engine requires more fuel when it is cold than when it is hot. This is a result of low manifold and combustion chamber temperatures where fuel sticks to the walls and doesn't burn properly. The Haltech system corrects for this by using the Fuel Coolant Map to supply the extra fuel required at different temperatures. The F10 will automatically reduce the amount of coolant correction applied to the engine as the throttle is opened and air speed increases. The Fuel Coolant Map should not be adjusted until the Fuel Maps are correctly tuned at operating temperature.

To access the Coolant Map press Alt – M to open the Maps menu then scroll to the Coolant Map menu item and press enter.

Access the Fuel Coolant Map from the Fuel Maps and Set-up Menu. The map defines the percentage increase in fuel at any given engine temperature. The F10 is supplied with a default coolant map which may not need to be modified. Start the cold engine and adjust the Fuel Coolant Map so that the engine idles evenly. You should not touch the throttle while adjusting this map. Follow the arrow as the engine warms to provide good running mixtures up to operating temperature, where there should be zero coolant correction.

Note: The following correction factors should not be altered unless you have a detailed knowledge of your engine and the environment in which it operates. Severe damage can be done to your engine if the correction factors are not set properly.

The Haltech F10 has two further correction maps to compensate the fuel for changes in inlet air temperature and battery voltage, and also two correction Maps to adjust ignition timing for coolant and inlet air temperatures.

WARNING:
MOST USERS SHOULD NEVER ADJUST THESE MAPS. THESE MAPS ARE FACTORY SET TO PROVIDE EXCELLENT CORRECTION FOR ALMOST ALL ENGINES. THESE MAPS SHOULD NOT BE ADJUSTED UNLESS THE USER HAS EXPERIMENTALLY DERIVED DATA THAT THE CORRECTION FACTORS COULD BE BETTER CUSTOMISED TO SUIT A PARTICULAR ENGINE.

When the F10 software is run in the OFFLINE mode, the software will load factory-set correction maps unless other maps are loaded.

8.1 Air Temp Fuel Map

The mass of air entering the inlet manifold varies with the temperature of the air. To compensate for this, the F10 uses the Fuel Air Correction Map. The values supplied in your ECU have been mathematically determined to give the optimal correction for most engines.

The Fuel Air Correction Map is accessed via the Fuel Maps and Set-up Menu. Across the bottom of the map displayed is the inlet air temperature. An arrow appears showing which bar the system is currently using.
The map displayed is split by a horizontal line. Bars above this line indicate a positive correction making the mixture richer. Bars below the line indicate a negative correction making the mixture leaner.

A typical Fuel Versus Air Temp Map was loaded into your F10 at the factory. You should not modify it unless you experience trouble with variation in engine performance with air temperature.

8.2 The Battery Voltage Map

The Haltech F10 uses intelligent fuel injection driver circuitry that compensates for changes in battery voltage. This compensation can be insufficient for the full range of battery voltages that a vehicle's electrical system may experience. As the battery voltage falls, the injectors will take longer to turn on and so reduce the effective open time. To compensate, the F10 applies the Battery Voltage Map to increase the injector on-time as the voltage drops. This map should not be altered unless the system is connected to a fuel injector test bench that will allow the injectors to be accurately flow tested over a range of battery voltages and the corrections calculated accordingly.

8.5 Barometric Correction

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

Fluctuations in barometric pressure vary the density of the intake air of the engine. At lower barometric pressure, the engine cannot breath in as much air, and therefore the amount of fuel delivered to the engine must be reduced. This is necessary when a large change in altitude is expected during a driving period (a Hill Climb event such as Pikes Peak in the USA is a good example). The barometric correction on the F10 is a powerful and therefore relatively complicated feature and this section aims to describe the different methods it can be implemented with. The above flowchart is an overview of the different barometric compensation methods available with the F10.

The F10 begins with the basic idea that there are three ways to compensate for barometric pressure variations.

- The first is to use a pressure sensor to continually supply the F10 with barometric pressure data and then the F10 can adjust the injection times based on this information.
- The second method takes a barometric pressure sample from the environment when the car is first turned on and uses this value for the remainder of the time the car is operated.
- The third method is to use a preset value for barometric pressure, irrespective of what is going on in the surrounding environment.

Method 3 is the most basic form of correction and will be our starting point. When the F10 is manufactured it is configured with a value of 1013mBars as the constant barometric pressure.

> NOTE: If you ever wish to return the F10 to the factory barometric pressure settings then enable the Barometric Lock in the Fuel Set-up page and set the Barometric Pressure Lock to 1013 mBars. These are the factory settings.

Method 3

Method 3 requires you to access the Fuel Set-up page and adjust two fields: "Barometric Lock" and "Barometric Pressure Lock at".

- Barometric Lock should be set to enabled, this tells the F10 that you are going to lock a particular value in as the measure barometric pressure.
- Barometric Pressure Lock at allows you to set a particular barometric pressure value. This value should be the average barometric pressure in which the engine will be operated.

Set the Barometric Pressure Lock at xxxx mBars, where xxxx is the pressure you require, for example 1000mBars. This setting will force the F10 to assume that the environment always operates at 1000mBars barometric pressure and will compensate the fuel for 1000mbar regardless of the actual barometric pressure.

Note: that barometric pressure changes regularly and that Method 3 is only a basic approach at barometric compensation.

Method 2

Note: Method 2 is used with engines that are using a MAP sensor to measure load.

Method 2 uses a constant barometric pressure value which is measured by the MAP sensor before the engine is started. As previously mentioned, the ECU switches the fuel pump on at start up (fuel pump prime). If the engine is not started, the fuel pump will be switched off. At this time, if the throttle position exceeds 96%, the measured manifold pressure is stored as barometric pressure since the manifold pressure in an engine that is not running with the throttle wide open is the same as the atmosphere. If at start up the engine is cranked before the fuel pump prime has finished the ECU cannot read the barometric pressure from the MAP sensor as the engine will create a vacuum in the intake manifold. In this case, the F10 will use the pressure value as set in Method 3. If you have not adjusted it from factory settings, this will be 1013 mBars.

To complete Method 2 follow these steps:

1. Set the Barometric Lock in the Fuel Set-up page to "disabled".

2. Make sure the throttle position sensor is properly calibrated. It must exceed 96% throttle for this to work. Also make sure that the MAP Sensor is set correctly in the Main Set-up.

3. Switch the ignition off.

4. Apply full throttle.

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

6. Wait till the fuel pump prime finishes (about 5 seconds) then release the throttle. The current barometric pressure as read by the MAP Sensor will be programmed

into the ECU's memory.

It is not necessary or advisable to perform this reset regularly. It should only be done if the vehicle's regular place of garage is moved or if problems are suspected in the barometric correction. For example, if an engine is tuned at sea level but is intended to be used mainly at a higher altitude, then the reset should be performed once it reaches its new regular location. After that, the automatic reading done at start up will be sufficient for the F10 to apply barometric compensation and Method 2 is complete.

Method 1

Method 1 is the most complex and allows continuous barometric pressure readings to be taken and fuel injection times can be adjusted based on these readings. This can only be done if an external 1 bar MAP sensor (left open to the atmosphere) is connected to the F10 ECU.
The connection differs depending on the method of load sensing: Throttle Position or MAP sensor. For this reason, Method 1 has been broken into two smaller sections.

Sensing Engine Load by TPS

When measuring engine load by Throttle position a 1 Bar MAP Sensor (left open to atmosphere) can be connected to either the MAP sensor input or the Spare A\D input on the wiring loom.

- If the MAP sensor is connected to the MAP sensor input ensure that the Spare Input function, in the Input/Output Set-up, ***is not*** set to "Baro. Sensor". The F10 will automatically recognise the 1 Bar MAP sensor and no further configuration is required.
- If the MAP sensor is connected to the Spare A\D input ensure that the Spare Input function, in the Input/Output Set-up, ***is*** set to "Baro. Sensor". The F10 will perform barometric compensation using th Spare A\D.

Sensing Engine Load by MAP Sensor

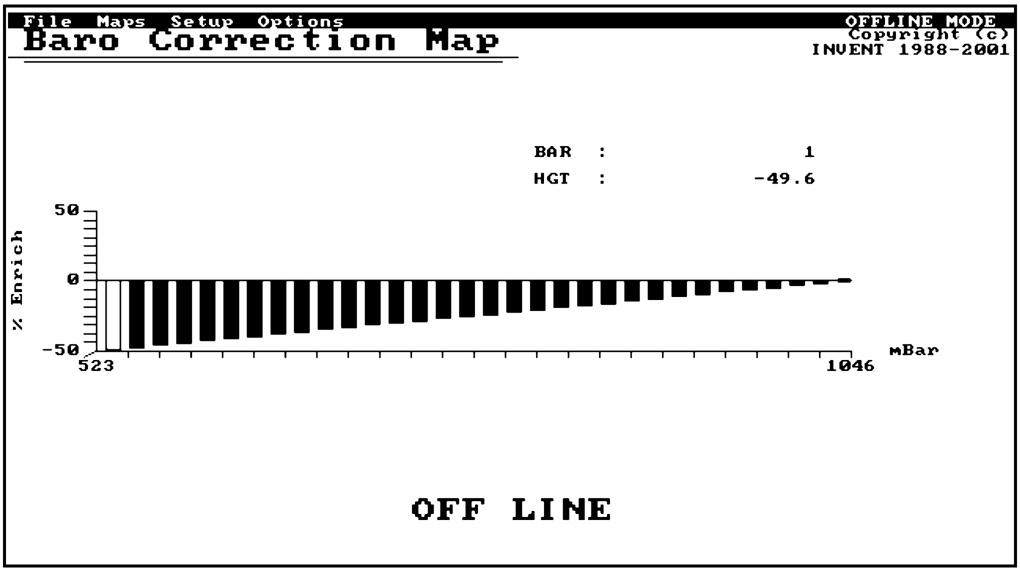
When measuring engine load by MAP sensor a 1 Bar MAP Sensor (left open to atmosphere) can be connected to either the MAP sensor input or the Spare A\D input on the wiring loom. Ensure that the Spare Input function ***is*** set to "Baro. Sensor". The F10 will perform barometric compensation using th Spare A\D.

To access the Input/Output Set-up page press Alt – S to open the Set-up menu then scroll to the Input/Output Set-up menu item and press enter.

Completing Method 1

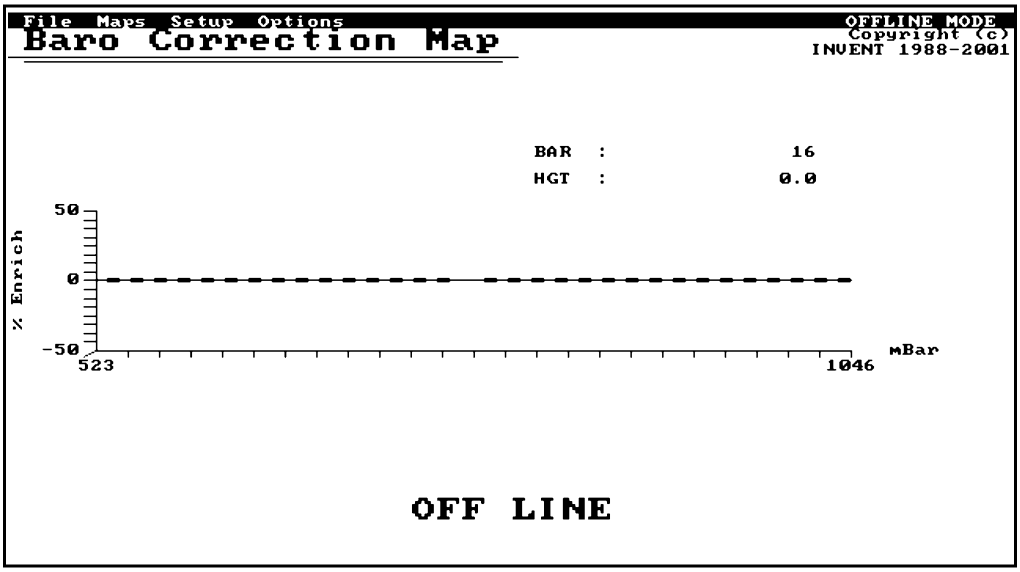
The F10 software contains a barometric compensation map that allows the fuel delivery to be reduced as the barometric pressure falls. As a final step to complete Method 1, you have the ability to adjust a dedicated barometric correction map. The fuel can be trimmed ±50%.

When sensing load by Throttle Position, the Barometric Correction Map should look similar to the map below:



Estimate of barometric correction using throttle position load sensing

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



Estimate of barometric correction using manifold pressure load sensing

8.6 Post Start Enrichment

On some engines, in particular rotaries there is a problem with vapour-lock (fuel which due to heating of the fuel rail has vaporised). The additional fuel at start up allows the vapour in the fuel rail to be purged through the injectors and also allow enough fuel to be injected into the motor to allow stable operation. Post start can also be used to give extra enrichment when the engine is cold to assist drivability.

To access the Post Start Map press Alt – M to open the Maps menu then scroll to the Post-Start Map menu item and press enter.

The Post-Start Map has sixteen bars each of which represents a sixteenth of "Post Start Time Limit".

Two adjustable parameters associated with Post-Start must be set:

- "Post Start Temp Limit" is the temperature threshold at which the Post Start map is switched.
- "Above" or "Below" defines whether the map is enabled above or below the temperature threshold "Post Start Temp Limit", for example a rotary engine could have the temperature setting of 60°C (to indicate that the motor is warm or has been running) and the operation setting to "Above". This means that Post Start will operate only when the coolant temperature is above 60°C.

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

CHAPTER 9 FILE STORAGE AND RETRIEVAL

Once your Haltech F10 system is configured you should store the entire set of maps and the Set-up to disk. In fact, it is wise to save maps regularly during tuning so that you can return to a known map while you are experimenting in different areas. You can use the file storage and retrieval to enhance the flexibility of your race engine by storing the optimum maps for each race track.

The File storage and retrieval functions can be accessed from the Main Menu by pressing ± f for files. This function allows you to load engine maps and set-up from computer disk. You can also save the engine maps and the set-up to computer disk.

9.1 Saving Maps and Set-up information

9.1.1 The Save Command

To store all the maps and set-up information to computer disk with the system running ONLINE, press ± f then S at the Files sub-menu. The list of maps already stored will appear on the screen.

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

9.1.2 Giving Your Map a Filename

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

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

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

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

9.2 Loading Maps and Set-up

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

To load new complete maps and set-up information into the ECU, you must first be ONLINE. Press ± f then l from the Files sub-menu. The load command erases the contents of the ECU and replaces it with the set of maps stored on the disk you are loading into the system.

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

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

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

9.3 Upgrading from F9

To make it easier to upgrade from the F9 systems to the F10, there is a function under the File menu called Convert F9 map. This feature converts all the maps but does not convert the Set-up information which will have to be re-entered.

9.4 File Management

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

9.4.1 Erasing Unwanted Maps

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

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

9.4.2 Changing Directories

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

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

10.1 The Print Function

You can print the maps and set-up information to a file or printers that accept IBM emulation mode, such as IBM compatible dot matrix printers (consult your printer manual). The Print function should work with other IBM compatible printers, but some special characters such as °, ±, etc. may not print correctly.

If you experience difficulties with printing directly to a printer, try printing to a text file and use a third party text editor to print this file.

To access the Print Option press Alt – O to open the Options menu then scroll to the Print ECU Information menu item and press enter.

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

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

Maps
This option prints all the maps in the system (Fuel, Coolant and Air temperature) as tables of text.

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

Print All Information
This will print all of the above information

The system will ask for a name to print at the top of the printed output. This allows you to differentiate between print-outs if you have printed more than one set of maps. The name can be up to ten characters in length. Type in the name and press Enter (▪).

The system pauses to allow you to set up the printer. If you do not want to print you can leave the print function by pressing », pressing any other key starts the printing. Before you start printing the printer must be ONLINE and must have power and paper. Once the printing has started you can abort the printing by pressing ».

11.1 The Data-log Option

Data logging records the Engine Data at a nominal rate of ten times per second while the ECU is online. This data-log is useful for recording the system's behaviour in any state of operation. It aids trouble-shooting as all the ECU's working parameters are recorded faster than they can be read on the Engine Data Page.

To access the Data-log Option press Alt – O to open the Options menu then scroll to the Data-log menu item and press enter. This opens a Data-log submenu from where all data-log options are selected.

11.1.1 Setting Up the Data-log Page

Before beginning a Data-log the data page can only display eight parameters which are selectable through a simple menu. To access the configuration menu press **C** and follow the instructions online.

11.1.2 Creating a Data-log

You can choose to record the Data-log either in memory or directly to disk. To record to memory, press **M** in the Data-log sub-menu. This will record engine data continuously for about 30 seconds and will then stop automatically. To log data for more than 30 seconds at a time, use logging to disk as described below.

Alternatively, you can Data-log directly to disk by pressing **D** in the Data-log sub-menu. The software will ask the user to supply a filename for the data-log file. When data-logging to disk, you are limited only to the free space left on the disk. The Data-log consumes about 11kbytes per minute, on the disk supplied there is over 20 minutes of Data-log space. The disadvantage in Data-logging in this manner is that there may be small "gaps" in the Data-log of a few seconds as blocks of information are written to disk, if Data-logging to hard disk, these gaps are insignificant.

To stop the Data-log press the Space Bar. If memory data-logging is used, the screen will return to the Data-log sub-menu. If disk data-logging is used, there will be a moment's pause as the file is closed.

The Maps being used at the time of the Data-log should be saved to disk. It is advised to do this before the Data-log is taken. Saving the Maps makes sure that all the engine information (including the set-up pages) are saved to disk. If the Data-log is viewed OFFLINE at a latter date, the Maps will need to be loaded so that the programming software knows the set-up of the ECU and can calibrate the data properly.

11.1.3 Viewing the Data-log

Once the data-log has finished or has been terminated by the user, the logged information is displayed on the data-log page.

At the bottom of the data-log page is a list of the command keys. They are described in detail here:

- ® - scroll up Data-log one line
- \- - scroll down Data-log one line
- ¾ - scroll up Data-log one page
- ¿ - scroll down Data-log one page
- ½ - jump to start of Data-log
- Á - jump to end of Data-log
- g - jump to page #
- t - show statistics (max., min. & avg. of each parameter)
- » - exit

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

11.1.4 Data-log File Management

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

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

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

Before loading a Data-log from disk, you should load the Maps that were saved with it so that the programming software knows the set-up of the ECU and can calibrate the data properly. **Do not load a Data-log when ONLINE to the ECU, or else the Maps you load will overwrite the Maps in the ECU. If you want to view a saved Data-log, switch to OFFLINE mode, load the appropriate map, and then load the Data-log.**

11.1.5 Printing Data-logs

You can print Data-logs to a ".txt" file or any ASCII parallel printer, such as IBM compatible dot matrix printers.

To print a Data-log, press **P** in the Data-log sub-menu or data-log page.

The software will prompt the user whether the data-log should be printed to the printer or to a text file. Press **F** to print to a file, or **P** to print to a printer. The software is designed to print to a dot matrix printer. If a dot matrix printer is not available, print the Data-log to a file and then print the file from DOS or from a word processor / editor. The text file can be loaded into a spreadsheet.

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

The system pauses to allow the user to set up the printer. To abort printing, press **»**. To re-enter the start and end page numbers press **R**, any other key begins the printing. Before printing commences, the printer must be ONLINE and have power and paper. T abort printing once it has started, press **»**.

12.1 The Program Set-up window

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

To access the Program Set-up window press Alt – S to open the Set-up menu then scroll to the Program Set-up menu item and press enter. This opens the Program Set-up window.

12.1.1 The Display

The Haltech programming software has been written to suit a graphical CGA, VGA or EGA monitor. In most cases, the programming software will detect what sort of display you have and select the appropriate mode.

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

12.1.2 Com Port

The programming software can communicate with the Haltech ECU through either COM 1 or COM 2. Select the com port you are using here.

12.2 Data Display Settings

To access the Data page Set-up window press Alt – O to open the Options menu then scroll to the Data page Set-up menu item and press enter. This opens the Program Set-up window.

The data page window will allow you to select the data which you wish to view in the data windows at the base of the maps and in the engine data page. This is particularly useful when using the CGA video mode as the size of the map is reduced to allow all the engine data to be viewed. By reducing the number of data parameters the size of the map is increased letting small changes in bars more visible.

CHAPTER 13 SOFTWARE ACCESS

13.1 The Input/Output Page

The Input/Output Page is where the F10 Aux In, Aux Out, Spare and Trim inputs and outputs are configured.

F10A and F10A-8 only
The F10A and F10A-8 also have the extra injector driver controls in the Input/Output page.

To access the Input/Output Set-up page press Alt – S to open the Set-up menu then scroll to the Input/Output Set-up menu item and press enter.

13.1.1 Trim Control and Spare A/D

The Trim Control and Spare Input Function fields can be programmed to broadly adjust fuel and ignition for tuning and boost for street or race driving. The set-up is as follows:

Trim Control

The optional Trim unit can be used to control one of several parameters. This field selects the controlled parameter. If there is nothing connected to the trim plug, the trim will have no effect (except with boost control). The available functions are :

Fuel (Fine) ±12.5% adjustment of fuel.
Fuel (Coarse) ±50% adjustment of fuel.
Boost Control Boost trim for Wastegate control only.

Spare Input Function

The Spare input is an analogue input similar to the Trim Control input that can be configured for one of several tasks. Its function is set by this field. The available functions are :

General 0-5 volt input; no effect on ECU operation.
Fuel (Fine ±12.5% adjustment of fuel.
Fuel (Coarse ±50% adjustment of fuel.
Baro Sensor Barometric Pressure Sensor.
Exhaust MAP Sensor Exhaust Pressure(does not affect ECU operation)
Aux RPM Limit Input switch for activating Aux RPM limit. Limit may be above/below the primary RPM limit. Useful for launching or allowing extra RPM momentarily for overtaking.

O2 Sensor Display only (does not affect ECU operation). The reading appears on the Engine Data Page as mV.
2nd MAP Sensor This field is only accessible when the Exhaust MAP Sensor is selected on the Spare Input Function. It tells the software what sensor is being used (either 1 Bar, 2 Bar, or 3 Bar sensor) and how to calibrate the reading.

WARNING:
WHEN CONFIGURING YOUR SYSTEM TAKE CARE TO SET THE SPARE INPUT FUNCTION CORRECTLY. IF THE SPARE INPUT FUNCTION FIELD IS SET TO BARO. SENSOR EXTERNAL AND THE BARO SENSOR IS DISCONNECTED THE ECU MAY PERFORM INCORRECT BAROMETRIC CORRECTION. IF YOU ARE USING AN EXTERNAL BARO. SENSOR AND REMOVE IT BE SURE TO RECONFIGURE THE SPARE INPUT FUNCTION TO GENERAL.

13.1.2 Aux In and Aux Out

The Aux in and Aux out functions are usually used in conjunction with other outputs or inputs.

Aux In Function

The Auxiliary Input on the F10 can be configured for one of several functions. Most of these functions relate to the configuration of the system. The available functions are:

Disabled No effect on ECU operation.

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

Turbo Timer This input is used in conjunction with 16.12 Turbo Timer (TT).

Aux Out Function

The Auxiliary Output on the F10 can be configured for one of several functions. They are all output to the Aux Out pin (pin A) on plug J7 in the wiring loom. The available functions are:

Disabled No effect on ECU operation.

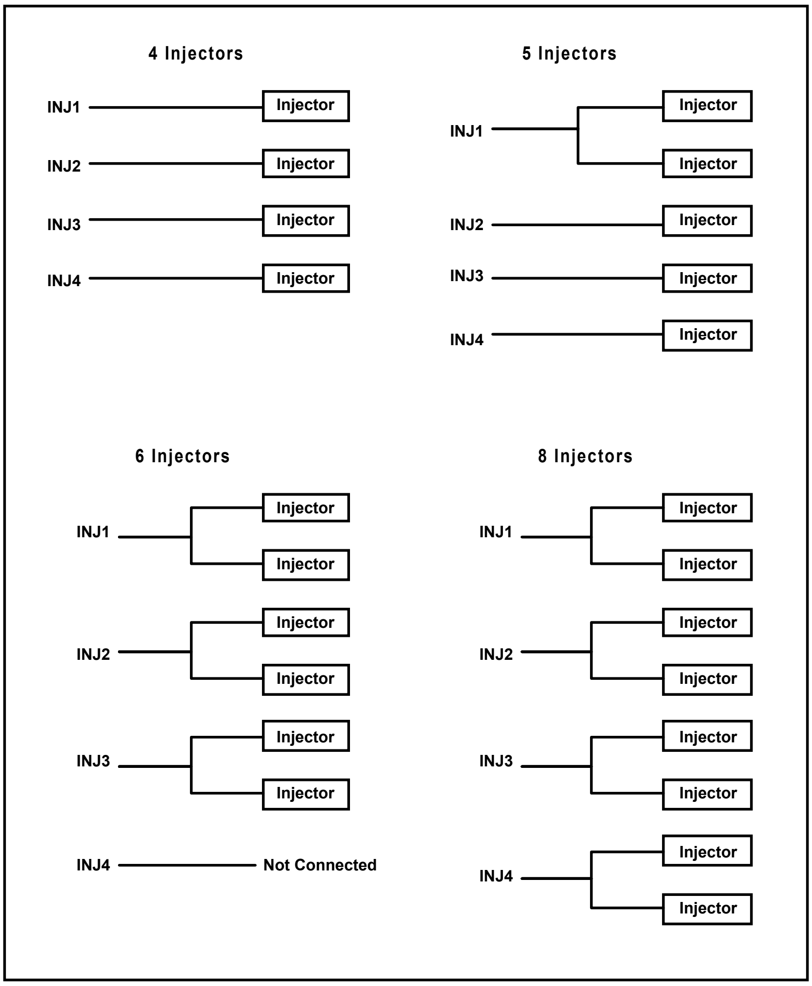
Staging Signal Logic output that indicates Staging conditions. If Staging is selected, and the Staged injector are firing, this signal will be high (5 volts), otherwise it will be low (~ 0 volts).

13.1.3 Extra Injector Driver Control

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

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

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



(For further information on Injectors and the F10 Injector drivers; Refer *Appendix B Fuel Injectors, 87*).

F10A and F10A-8 only

13.2 The Output Options Page

To access the Output options page press Alt – O to open the options menu then scroll to the Output Options menu item and press enter.

The Output Options page contains the controls for the F10 Idle Air Control and Closed Loop Control options. Use the left and right arrow keys to highlight the function you wish to modify, use the TAB key to cycle through the functions, and press ENTER to program the change. A keystroke guide is available at the bottom of the screen.

(For more detail on Idle Control; Refer *Chapter 14 Idle Speed Control, 65*)
(For more detail on O2 Closed loop; Refer *Chapter 15 Closed Loop Control, 69*)

F10A and F10A-8 ONLY

13.3 The PWM Options Page

To access the PWM Options page press Alt – O to open the options menu then scroll to the PWM Options menu item and press enter. Use the left and right arrow keys to highlight the function you wish to modify, use the TAB key to cycle through the functions, and press ENTER to program the change. A keystroke guide is available at the bottom of the screen.

(For more detail on PWM options; Refer *Chapter 16 PWM* Outputs*, 72*)

13.4 Enabling Options

Every option has an Enable flag at the top of its window. Toggling this flag allows you to "enable" and "disable" the output. The remaining control for an option that is disabled will not be changed. When a map is loaded from disk output functions are automatically disabled. After loading a map, return to the Output Options Page and check the functions you want enabled.

14.1 Description

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

14.2 Using the Idle Speed Motor

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

- a suitable idle speed stepper motor*; **OR** a suitable Bypass Air Control Valve**
- an idle air circuit bypassing the throttle plates;
- F10A programming software and cable.

***NB**: use only a bipolar stepper motor with two separate windings (four wire), each with at least 30 ohms resistance. Your Haltech™ representative can supply you with a suitable motor. Use of three- wire stepper motors may damage the F10A ECU.

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

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

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

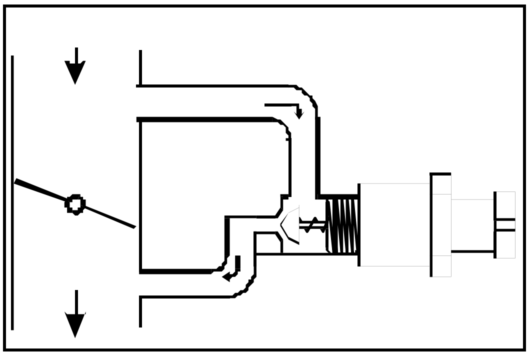


Fig 14.1. The idle-air circuit.
There should be sufficient airflow around the closed throttle plates to permit the engine to idle slowly even with no air passing through the idle bypass circuit. The throttle stop should be adjusted to ensure this is the case. Remember that the throttle position sensor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

Install the idle air circuit and the stepper motor, and attach the idle speed motor to its connection on the F10A harness. Run the F10A programming software ONLINE and go to the Output Options Page. Ignition will need to be switched on.

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

14.3 Adjusting the Idle Speed Control

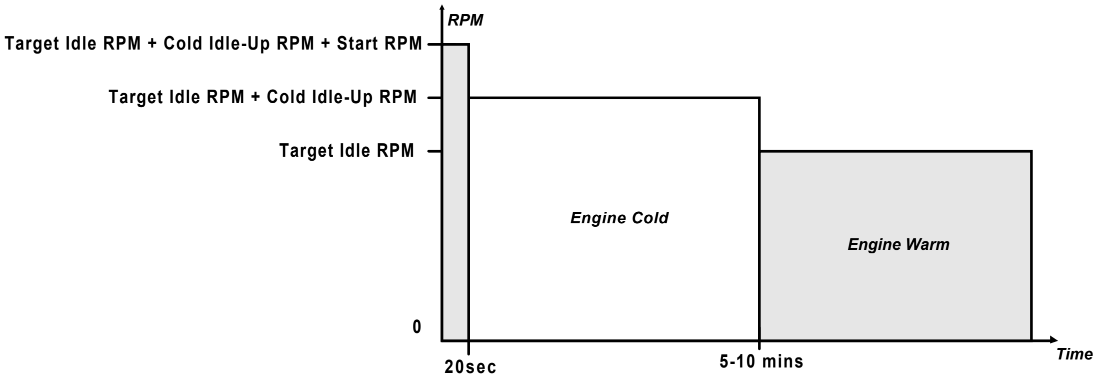
There are ten parameters to be adjusted in the idle speed control.

Enable/Disable
The Idle Speed Control can be switched on or off.

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

Cold Idle-Up RPM
This speed is added to the Target Speed when the engine temperature is cold.

Start RPM
For a period of around 20 seconds after the engine starts, you can specify an extra increase in idle rpm. Most factory cars will rev 200-300rpm above the cold idle-up RPM for a small time when they are first turned on. Setting the Start RPM to 0 will mean that the engine will rev to the Target Idle Speed + Cold Idle-Up RPM when turned on and resort back to the Target Idle Speed when warm. If you set the Start RPM to 200RPM, then the engine will rev to the Target Idle Speed + Cold Idle-Up RPM + 200RPM and resort back to the Target Idle Speed + Cold Idle-Up RPM after 20 seconds and then resort back to the Target Idle Speed when warm. Graphically, this can be represented as:



Number of Steps

This field controls the number of steps that the idle control will operate over. If you have a stepper motor that uses say 150 steps, you can either elect to operate the stepper motor over its entire range of steps by setting the value equal to the max number of steps the motor will do which is 150 in this case, or you can restrict the number of steps it can move through by making this field lower than 150. By restricting the number of steps you can change the time response of the Idle Control but can also affect the ability of the Idle Control to maintain control of the engine. This is because in extreme circumstances the Idle Control may wish to move the stepper motor through a large number of turns, but the Number of Steps on the stepper motor may restrict the number of turns the motor can physically be permitted to move through, thus reducing the Idle Control's ability to control the engine as it desires.

It is best to start with a smaller value around 100 and increase it until the stepper motor demonstrates that it is capable of bringing the engine to the target idle RPM. If the value is too low, the stepper motor will not open enough to maintain a consistent idle, or if it is too high, the stepper motor may actually miss pulses that are sent to it and therefore it will not operate correctly.

Cold Temperature Limit

This is the temperature below which the engine is defined as being cold, and thus the Cold Idle-Up and Cold Opening Steps would apply.

Cold Min Position

When the engine is cold, you can specify the minimum position the stepper motor will return to. This is useful in some applications where valves besides the Idle Air Control Motor can switch extra air flow into the engine that would otherwise confuse the Idle Control into thinking the engine is behaving in a way which it is not. Start with a large value around 80-90%% and reduce the value as you go. The idea is to move it down until the engine is idling at such a point where it is close to the target rpm. The target RPM is used to hold the idle once control of the engine has been established. Cold Min Position is used to restrict the position of the controlling valve so when the Idle Control wishes to regain control of the engine and bring it down to the target RPM it actually will be able to. If the values you are using are around 80-90%, the Idle Control will probably not be able to regain control of the engine and accurately bring it down to the target idle RPM. This is why you must start with a large value for Cold Min Position and reduce it until the engine is idling happily at the target RPM.

Hot Min Position

Exactly the same as for when the engine is cold, except the value is used for when the engine is hot, that is the temperature is above the Cold Temperature Limit.

Cold Opening position (%)

This is the opening position as a percentage of where the stepper motor will return to when it is about to attempt to gain control of the engine. When you hit the throttle the engine will accelerate and when it starts to decelerate again, there will come a point during the deceleration when the Idle Control should attempt to regain control of the engine and bring it to the target idle RPM. The value you set here will result in the stepper motor assuming a certain position, say 40% out. It will wait here until the decelerating engine comes within range and it feels it can take over control of the engine and bring it back to idle. It will then assume control of the engine with the valve open at 40%. This may be too high which will result in the engine momentarily holding at the RPM produced by the valve at 40% opening. This means that it will take a longer period of time to move the engine back down to target idle.

On the other hand, 40% may be too low and when the engine is decelerating, the Idle Control will try to regain control at a point where the valve is going to cause the engine to go very close to stalling. The secret is to start with a large value and reduce it until it takes a normal amount of time for the idle control to regain control of the decelerating engine and bring it back to target idle. A normal amount of time is a hazy description but it is somewhere in the vicinity of not too small so as to go close to stalling the engine and not too large as to take many seconds to return to target idle.

Hot Opening Position (%)

Exactly the same as for when the engine is cold, except the value is used for when the engine is hot, that is the temperature is above the Cold Temperature Limit.

15.1 Description

By fitting an oxygen sensor to the exhaust system of an engine, the F10A is able to perform a feedback correction to maintain a consistent air-fuel ratio around stoichiometric mix; i.e.. when exactly the correct amount of fuel is provided to consume all the oxygen of the air drawn into the engine, without any unburnt fuel remaining after combustion. Using closed loop fuel control adapts for small variations in fuel quality and day-to-day running, provides better fuel economy and lower emissions.

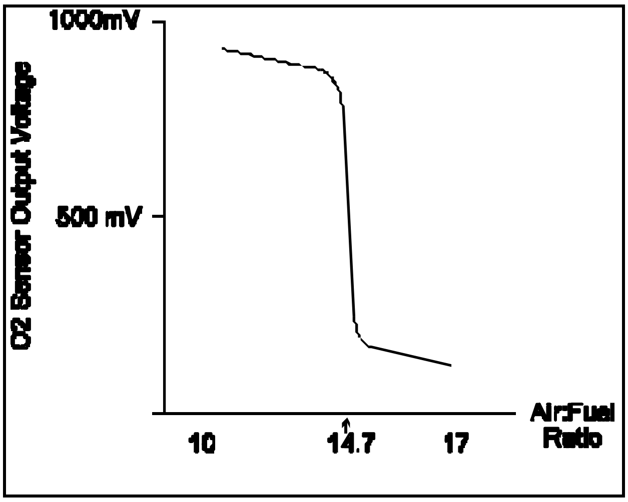


Figure 15.1 Typical lambda sensor output.

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

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

15.2 Using Closed Loop Control

In order to use the closed loop fuel control function, you must have the following:
- an appropriate lambda sensor mounted in the exhaust stream;
- F10A programming software and cable.

Mounting and connection of the sensor is all that is required in installation. Check figure 15-2 for appropriate wiring for different oxygen sensors. Run the F10A programming software

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

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

Lower RPM Limit

The engine must be running above this speed for the closed loop function to operate. Normally this would be set a few hundred rpm above or below idle, depending on whether you wish closed loop control to occur at idle speeds.

Upper Throttle Limit

It is generally undesirable to run an engine at stoichiometric air-fuel ratio when under load. This parameter is used to determine when the driver is demanding sufficient engine output to disengage the closed loop function. The smaller this number, the earlier the feedback control will drop out.

Engine Cycles Between Corrections

The oxygen sensor does not respond immediately to the exhaust gases of the combustion which has just taken place. There is a gas transportation time from the engine to the sensor, plus the sensor reaction time itself. Consequently, the ECU counts a number of engine cycles before accepting the reading from the oxygen sensor. If the closed loop function is responding erratically, constantly overdriving to the adjustment limits, or if there is insufficient oscillation in the air-fuel ratio for the catalytic converter to operate, increasing this parameter may help. If it is set too high, the feedback loop will be noticeably slow to respond to change.

O2 Sensor Threshold Voltage

This is the sensor voltage by which the F10A determines whether the engine is lean or rich; it is the target that is sought to be maintained. This is normally set to the voltage that corresponds to an air-fuel ratio of 14.7:1, the NGK heated 4-wire sensor threshold voltage is around 600mV this value will vary for different sensors. It is also known as the sensors reference voltage.

Maximum Fuel Increase

The closed loop algorithm will be permitted to increase the fuel injection time no further than this limit while attempting to enrich the mixture. The valid range for this limit is 5% to 12.5%.

Maximum Fuel Decrease

Again a range of 5% to 12.5% applies to this parameter which is the limit of correction permitted to the base fuel injection time when leaning the mix.

> Note: It is preferable to keep the increase and decrease limits small (say around 5-10%). Excessive swinging of the air-fuel ratio can result in surging and poor operation of the catalytic converter. The closed loop algorithm should never be used as means to correct bad mapping.

Engine Cycles at Idle

Exhaust gas transportation time is much higher at idle, when the engine is breathing the least. If running the closed loop at idle, a longer time must be allowed to pass before performing a feedback correction response.

O2 Sensor Threshold at Idle

It is unlikely that the engine will run at idle smoothly at the same air-fuel ratio as at cruise. Typically, a richer mix is necessary. This parameter allows a different threshold voltage to be targeted during closed loop correction at idle.

O2 Sensor Type

The type of sensor used should be selected here. Choose the sensor that best describes the sensor you are using. It is also possible to attach a 5 Volt sensor, such as a UEGO probe, to the F10A. Since these sensors are expensive, and have limited life, it is unlikely that they would be used in general running of the car for closed loop feedback control, but rather as an aid during tuning.

15.3 Using Different Oxygen Sensors

Almost any oxygen sensor can be used with the F10A. The sensor available from Haltech™ is an NGK heated four wire oxygen sensor or a Delco sensor these are the preferred sensors to use due to their temperature stability and the switch-like characteristic of their transfer function. Other sensors such as three-wire and single-wire units may also be used, but be wary of slow reaction times and poor repeatability with cheaper sensors. Wide-band oxygen sensors may also be used, and can be particularly useful as a tuning tool, both via the engine data page or in Data-logging. [When viewing O2 sensor voltage readings from a Data-log, remember to allow for sensor response time.]

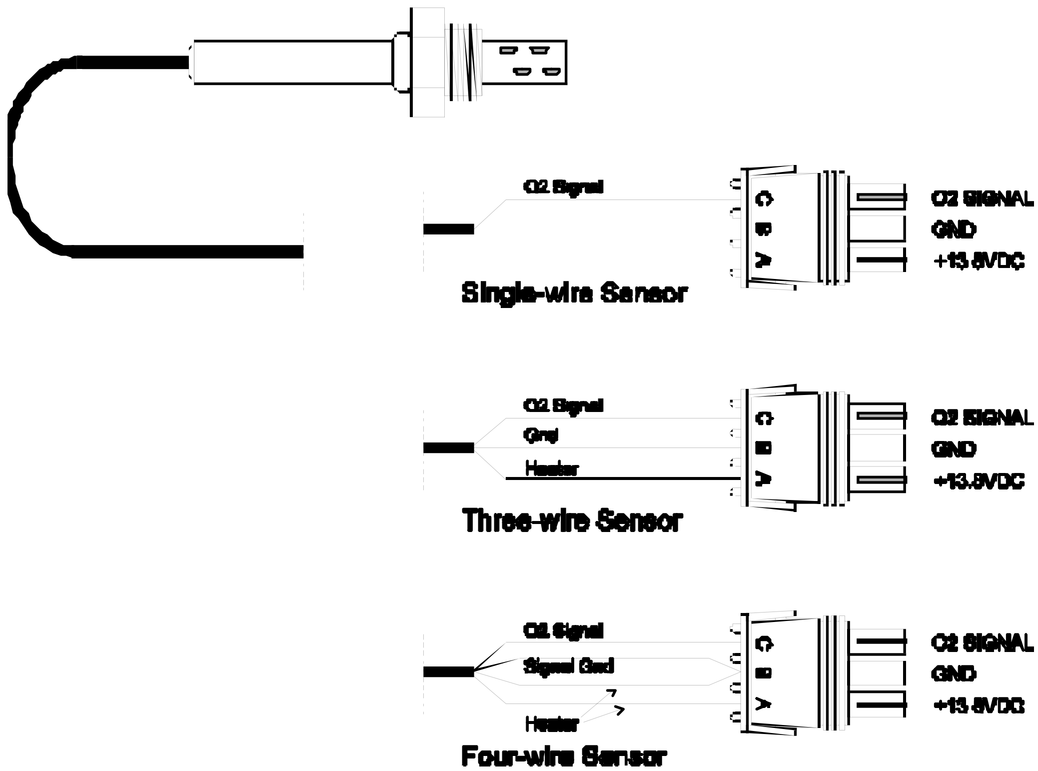


Figure 15.2. Wiring different oxygen sensors.

16.1 Description

The F10A has 4 dedicated PWM outputs; each PWM can draw current through a device at 1A continuously. Some outputs such as BAC control modulate the frequency and duty cycle of the current to control valve positions.

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

The list below shows the output functions that are available on each output, including the maximum number of outputs allowed:

Output Description	PWM 1 – 4	Max #
Turbo Waste-gate	●	2
Bypass Air Control (BAC)	●	1
Dual Intake Valve	●	Unrestricted
Torque Convertor Control	●	1
Thermofan	●	Unrestricted
Intercooler Fan	●	Unrestricted
Shift Light	●	Unrestricted
Aux Fuel Pump	●	Unrestricted
Stall Saver	●	1
Staging Signal	●	Unrestricted
Turbo Timer	●	1

16.2 Turbo Waste Gate Control (TWG)

16.2.1 Description

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

16.2.2 Using the Turbo Waste Gate Control

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

A suitable pressure solenoid valve (available from your Haltech Dealer);
Air hose and fittings;
F10A programming software and cable;
An overboost relief valve (strongly recommended).

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

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

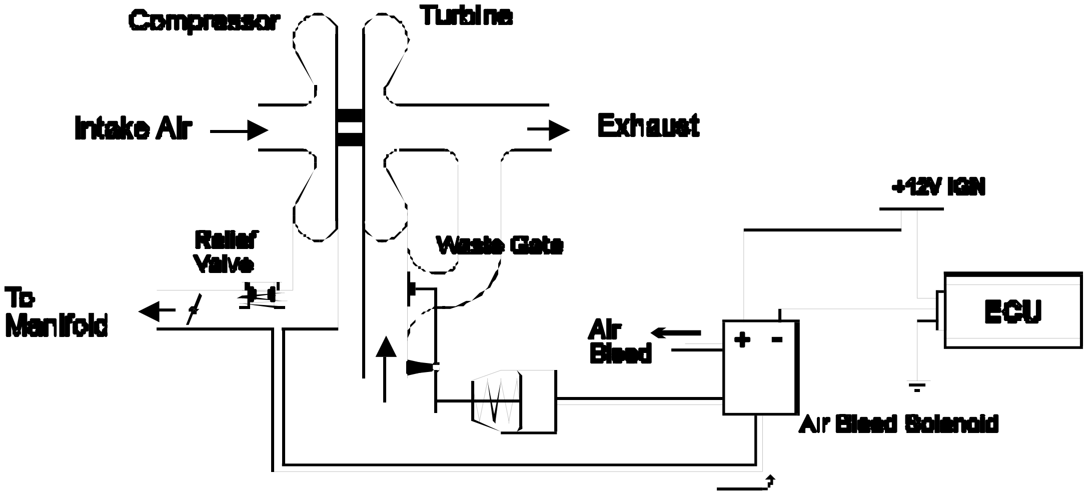


Figure 16.2. Diagram of Turbo with Wastegate Control Solenoid.

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

Once the solenoid installation is complete run the F10A software in ONLINE mode. Select the Turbo Wastegate Control Function on the appropriate output channel, and set the following parameters.

Period

This sets the period of oscillation of the solenoid. Most solenoids will operate at around 30Hz, which corresponds to a period of about 30ms. Enter the desired oscillation period in milliseconds here.

Use Map

This sets which map (map 1 or map 2) is used to perform waste gate control. The reason for having two maps is so one map can be tuned for street driving and the other for racing. The two turbo waste-gate maps are found in the Maps menu of the F10 software

Boost Limit

If the manifold pressure exceeds this limit, the solenoid valve will immediately be set with a duty cycle value of 5%. This will allow the full manifold pressure to act on the waste-gate actuator and force the waste-gate to open. This value should be set slightly higher than the desired boost pressure as a fail-safe in the event of an over-boost condition.

Update Engine Data

This field allows the waste-gate duty cycle to be displayed on the engine data page.

> **WARNING:**
> **WE STRONGLY RECOMMEND THE USE OF THE OVER-BOOST FUEL CUT FEATURE DESCRIBED IN THE FUEL SET-UP PAGE INSTRUCTIONS (REFER *3.1.2 FUEL SETUP, 28*).**

16.2.3 Using the Boost Controller

The F10 has a "Trim Input" that can be used in conjunction with the Haltech™ Trim module for boost control (Refer *13.1.1 Trim Control* and Spare A/D*, 61*).

In normal operation the F10 uses the appropriate bar from the active TWG map (map 1 or map 2) to drive the TWG solenoid. If the trim module is connected and set for "Boost Control" the duty-cycle used to drive the solenoid will be the multiplication of the TWG map value and the trim position.
For example:

If the active TWG map value was 60% and the trim module was set to 40% the actual duty-cycle driving the TWG solenoid will be 24%.

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

16.3 Bypass Air Control (BAC) Valve

16.3.1 Description

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

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

16.3.2 Using BAC Valves/Solenoids

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

16.4 Dual Intake Valve Control (DIV)

Some late model engines possess two tuned intake manifolds. One intake tract remains shut at lower rpm where there is less airflow, then opens as airflow demands increase. This provides a broader torque curve. The DIV function controls the solenoid that operates this valve.

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

- a two wire solenoid valve mounted in the air intake (already on the engine);
- F10 programming software and cable.

Wire the solenoid to the appropriate output, taking note of voltage polarity. (Some solenoids are non-polar.) Run the F10 programming software in ONLINE mode and select the Dual Intake Valve function on the appropriate channel. There are two values to be set.

Switch On RPM

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

Switch Off RPM

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

There are two ways in which this feature can be used:
The first application is to have two RPM ranges; one high and one low. In the lower range the solenoid is disabled and in the upper range the solenoid is enabled. Using this application the On RPM should be set to the lower RPM limit of the upper range and the Off RPM should be set to at least 200 RPM below On RPM, forcing hysteresis in the switching to prevent the solenoid from oscillating.
The second application is to enable the solenoid for a range of RPM and to disable the solenoid when the RPM falls outside this range. To do this the On RPM is set to the lower RPM limit of the range and the Off RPM is set at the upper RPM limit, when the RPM is lower than On RPM the solenoid is disabled, when the RPM is greater than On RPM but less than Off RPM the solenoid is enabled, when the RPM is greater than On RPM and Off RPM then the solenoid is disabled.

16.5 Torque Converter Clutch Lockup (TCC)

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

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

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

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

Access to the wiring of the torque converter lockup solenoid and 4th gear/overtemp switch;

F10 programming software and cable.

Wire the TCC solenoid to the appropriate output line on the output connector, and, if it is available, the 4th gear/overtemp signal to the Aux. In line (the blue flywire on the F10 main harness.) The 4th gear/overtemp signal must be a pull-to-ground style signal. If you are not using this feature, leave the blue flywire disconnected, but insulate the end to ensure sure that it will not short to the bodywork.

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

Once the wiring is complete, run the F10 software in ONLINE mode and go to the Main Set-up page. The parameter Road Speed Value must be set with the number of pulses expected per kilometre. If you are unsure of the exact value for this parameter, enter an approximate number and check against the vehicle's speedometer. Adjust the Road Speed Value until the road speed displayed on the Engine Data Page and the actual vehicle speed agree.

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

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

16.6 Electric Thermatic Fan Control (TF)

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

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

To use this function, you must have the following:

An electric thermofan, fused and relay switched;
F10 programming software and cable.

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

Run the F10 programming software and go to the Options page. Select the Thermofan function on the appropriate output and set the two temperatures as required.

Switch On Temperature

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

Switch Off Temperature

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

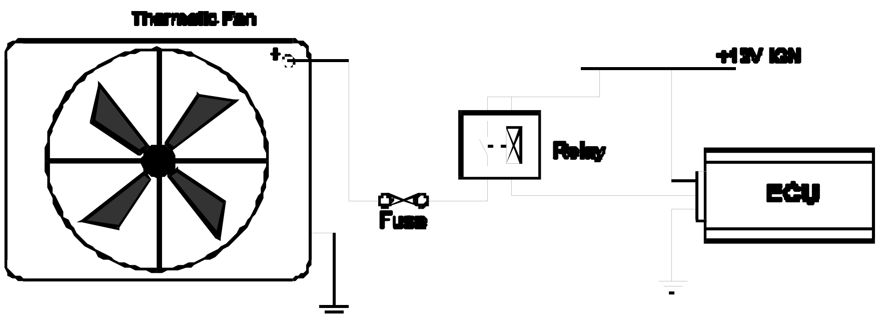


Figure 16.6. Example circuit for a Thermatic Fan.

16.7 Electric Intercooler Fan Control (IF)

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

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

To use this function, you must have the following:

An electric fan, fused and relay switched;
F10 programming software and cable.

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

Run the F10 programming software and go to the Options page. Select the Intercooler Fan function on the appropriate output and set the two temperatures as required.

Switch On Temperature

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

Switch Off Temperature

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

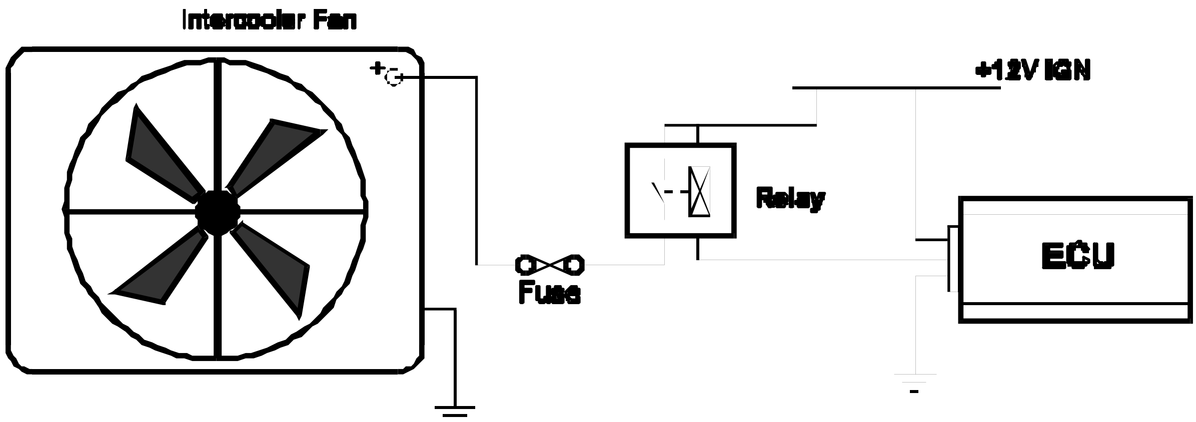


Figure 16.7. Example circuit for an Intercooler Fan.

16.8 Shift Light Illumination (SL)

The F10 can be used to activate a shift light or a piezo buzzer when engine speed exceeds the programmed activation speed.

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

A dashboard lamp or buzzer;

F10 programming software and cable.

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

Once the wiring has been installed, run the F10 programming software and go to the Options page. Select the Shift Light function on the appropriate output and set the value as desired.

16.9 Auxiliary Fuel Pump (AP)

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

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

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

A properly plumbed fuel pump, wired through a relay;

F10 programming software and cable.

The extra pump must be connected in parallel with the primary fuel pump. Figure 16.9 suggests a possible layout. The check valve is necessary to prevent fuel from being forced in the wrong direction. Connect the power to the pump via a relay as shown. Either the positive or negative side may be switched through the relay.
Run the F10 programming software ONLINE and select the Auxiliary Fuel Pump function on the appropriate output. There are two parameters that define when the Auxiliary Pump will be switched on.

Load Bar

This is the bar number on the fuel maps which must be exceeded for the extra fuel pump to be switched on. If you wish to switch the extra fuel pump only by engine speed, set this to 32.

Engine Speed

The extra fuel pump will turn on when the engine speed exceeds this parameter. If you wish to switch the pump only by load, set this parameter high.

Run Time

The auxiliary fuel pump will switch on if the engine exceeds the engine speed and/or the load bar set above. It will then stay on, even after speed and load have dropped below their respective limits, for a period of time specified by Run Time. A minimum Run Time of 5 seconds is permitted.

The Auxiliary Fuel Pump will prime with the main fuel pump, but will only run if the engine condition exceeds either limit. Since there may be a short delay from the time the fuel pump is switched on to the time the extra fuel becomes available, the Load Bar and Engine Speed settings above should be set below when that extra fuel is actually needed. The use of a good quality check valve and fuel pump will reduce the delay time by maintaining pressure in the secondary line. Nevertheless, the extra fuel will not be instantly available and care should taken when deciding the switch times. If these values are set too high, the engine may be momentarily starved of fuel when there is a sudden fuel demand.

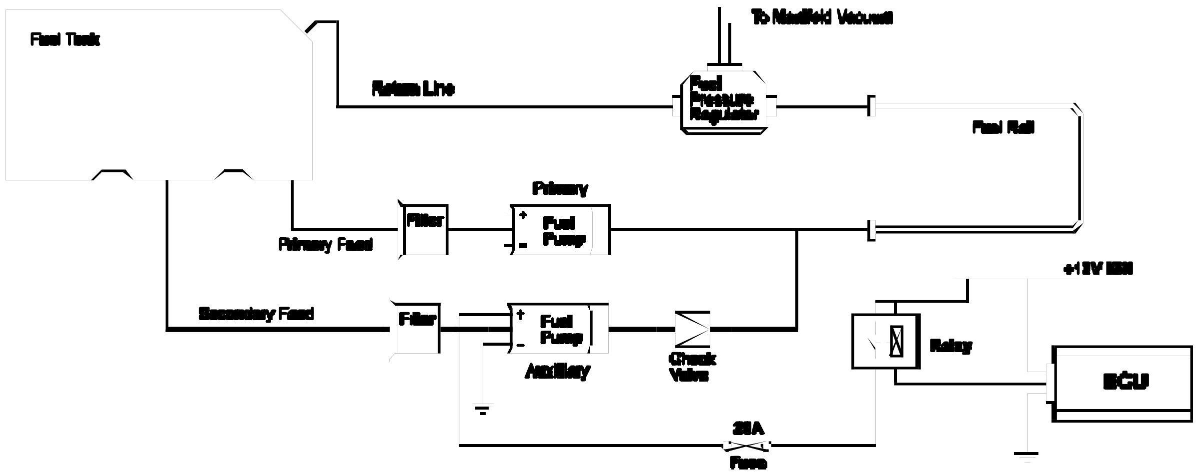


Figure 16.9. Example circuit for Auxiliary Fuel Pump.

16.10 Anti-Stall Solenoid Control (AS)

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

To use this function, you will need the following:
- a suitable solenoid air valve mounted to the manifold;
- F10 programming software and cable.

If the solenoid air valve is too large, the engine may stall because of its opening. The valve should be of appropriate size to increase the idle speed by several hundred rpm. Wire the solenoid through the output connector. Run the F10 programming software in ONLINE mode and select the Anti-Stall function on the appropriate output.

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

16.11 Staging Signal Function (SS)

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

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

There are no programmable parameters associated with this function.

16.12 Turbo Timer (TT)

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

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

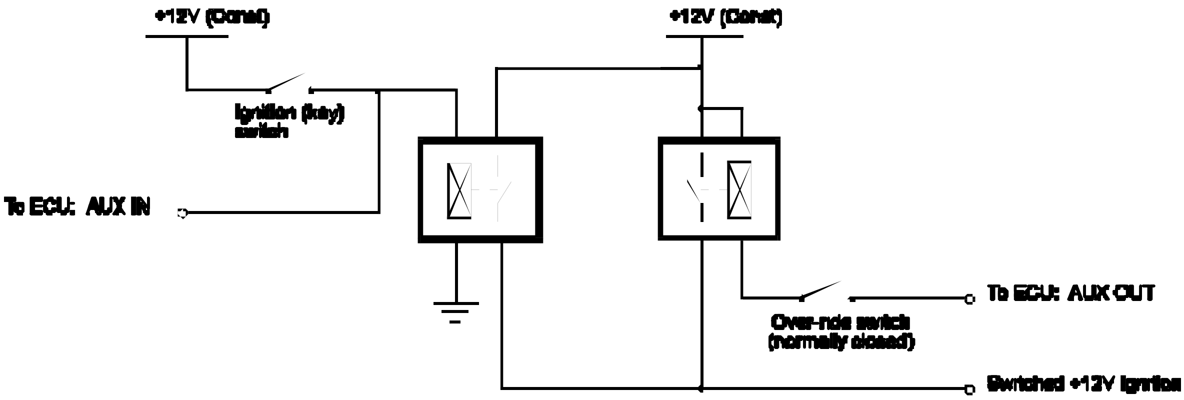


Figure 16.13 – Example of a Turbo Timer circuit.

Note: When using the Turbo Timer function, the **Aux. In Function** in the Input/Output Set-up page must be set for Turbo Timer. When using TT, other functions that use the Aux. Input line cannot be used.

SECTION 5 Appendices

APPENDIX A TROUBLESHOOTING

This Appendix is devoted to trouble shooting problems that may occur during installation of the F10 ECU. To use this Appendix, find the symptom or symptoms from the list below that best match the problem and then follow the checklist for possible solutions.

A.1 Overview

Control Program Problems

- The Haltech Programming Software will not load up
- The Haltech Programming Software will not operate in ONLINE mode.
- The Engine Data Page is displaying unusual sensor readings

Starting Problems

- Fuel Pump does not prime when ignition switched on.
- The engine makes no attempt to start

Idling Problems

- The engine will not idle when cold
- The engine idles too slow
- The engine idles too fast
- The engine surges at idle

Light Throttle and Cruising Problems

- Engine will not run at light throttle

Full Power Problems

- Engine dies under full throttle
- Engine surges under full throttle
- Engine lacks power at full throttle

Throttle Response Problems

- Poor throttle response
- Poor throttle response when cold

Cold running problems

- Engine runs poorly when cold

Fuel Economy problems

- Poor fuel economy - city cycle
- Poor fuel economy - Highway cycle

A.2 Control Program Problems

Haltech Programming Software will not start up

The Haltech programming software should run on any computer that meets the requirements in Chapter 2.2.1. If, after following the instructions in Chapter 2.2.1, the program will not run, the most likely cause will be insufficient memory. If this is the case, you must make more free memory available before running the software.

Do not try running the Haltech software from within a shell program - always start from the DOS prompt. If you are loading a number of TSR (Terminate and Stay Resident) utilities during boot-up, you may need to disable them before running the Haltech software. Refer to your computer and DOS reference manuals on memory management.

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

c:\> sys a:

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

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

Haltech Programming Disk will not run ONLINE

If the Haltech ECU does not respond to the Programming software requesting information, then the message RECONNECT HALTECH will be displayed. This situation will occur under the following conditions

ECU is not powered up
Programming Cable is not connected
Incorrect COM port selected
Wrong Programming Disk (i.e. disk does not match ECU)
Programming Cable is damaged
Serial port of programming computer is faulty.

If the disk is the wrong version or you suspect that the cable is faulty, contact your Haltech dealer.

Engine Data Page Displays Unusual Readings

If the air temperature sensor, or coolant temperature sensor is showing a FAULT condition then the sensors are either not operating correctly or are disconnected. Using the wiring diagram of the Haltech F10 Loom check that the sensor wires are not damaged. If the wiring is OK then contact your Haltech dealer regarding replacement of faulty sensor.

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

If the Manifold Absolute Pressure Sensor does not read near atmospheric pressure with the engine off, or if it shows a fault condition, then check that the sensor is connected correctly. Check that you have the correct model sensor and that the Main Set-up page information has been set correctly.

If the Engine Speed reading is erratic, the trigger is most likely picking up ignition noise from incorrect plugs or leads, electrical noise from cooling fans, starter motor, alternator or other electrical devices in the vehicle. Ensure that the trigger signal wire is properly shielded and that the shield is grounded securely.

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

If engine parameters are all showing unusual variation, make sure that the ECU is grounded properly. Also check the engine and chassis grounds to the battery.

A.3 Starting problems

Fuel Pump doesn't prime when ignition switched on

The Haltech F10 will attempt to run the Fuel pump for about 2 seconds just after the ignition is switched on. The fuel pump relay should be heard clicking in and out with the fuel pump. If the relay clicks but the fuel pump doesn't work then check the wiring of the fuel pump and the 20A fuse in the fuse block.

Engine makes no attempt to start

Check the following:

ECU is operating (will communicate ONLINE) during cranking
Battery voltage and connections
Fuel Pump runs
Injector fuse is OK and injectors fire
Ignition system is operating properly and spark is available
Ignition timing is correct

If the engine is flooding, reduce the bars in the fuel map that are being used during cranking in the fuel map, the coolant correction map and the cold prime map.
If the engine is not receiving enough fuel and increasing those bars does not help, check that fuel pressure is available and that the injectors operate properly (are cleaned and flow-tested).

A.4 Idling Problems

If the engine will not idle when cold but will when the engine is warm then the coolant correction map needs to be adjusted.

If the engine idles too fast or too slow, and you are using an Idle Air Control Motor, firstly check that the Idle Speed Control is enabled, and then lower the target idle setting if necessary. If not using the idle air control motor then adjust the idle using the idle adjust screw on the throttle body. Check for any air leaks in the manifold.

Check the ignition timing at idle and adjust if necessary.

If the engine surges or hunts at idle then the mixtures and timing are wrong. Readjust the fuel maps near idle conditions.

In some circumstances it may be necessary to use the Zero Throttle Map.

A.5 Light throttle and Cruising Problems

If the engine falters under light load then the mixtures might be too lean, check the Fuel Maps.

A.6 Full Power Problems

If the engine gasps under full throttle then the mixture may be too lean. If the engine bogs down and blows smoke then the mixture is rich. Recheck the fuel maps.

If the maps appear to be correct then ensure that the fuel pressure is not falling out of regulation by using a fuel pressure gauge. Flow test and clean the fuel injectors.

In some circumstances it may be necessary to use the Full Throttle Map.

A.7 Throttle Response Problems

Throttle response of the F10 is set using the three pairs of throttle pump settings. If the engine gasps and flat spots (misfires) when the throttle is suddenly opened then the throttle setting is not high enough or is much too high. If the engine bogs down but continues to run then the mixture is too rich. Experiment with the throttle pump settings to achieve the optimum.

The throttle pump coolant factor affects the throttle pump only when coolant correction is being applied, i.e. before the engine has reached operating temperature. Set the throttle pump increase and sustain figures only when the engine is warm. Wait until the engine is cold again, and the coolant correction map has been set for good stable running, before changing the coolant factor.

A.8 Cold Running Problems

If the engine idles poorly when cold then the coolant map may need adjusting. If the engine is hunting slightly when cold, then the coolant correction map is lean and fuel must be increased in this map. Ignition advance also has an effect on the idle speed.

If the engine is difficult to drive when cold, particularly with gear changes, try increasing the coolant correction factor for the throttle pump.

If an engine idles when warm, but fails to idle when cold without the throttle being opened slightly may require idle speed control. The F10 can control an Idle Air Control motor that will solve this problem.

A.9 Fuel Consumption

Poor fuel consumption is a result of an excessively rich mixture.

- If the fuel consumption in traffic is poor but the highway consumption is good, then the areas of the map used for accelerating will need to be reduced.
- The throttle pump will waste fuel if its values are too high.
- Try using the engine deceleration fuel cut-off feature.
- If the city consumption is fair but highway cruising uses too much fuel then lean out the light load bars on the 2000 rpm to 3000 rpm maps (This is where most cruising takes place).
- The cold start map may supply too much fuel on warm-up if this map is rich at low temperatures. Try tuning for cold start properly by leaving the engine stand over-night and perform the cold start tuning in the morning at a variety of temperatures.

This Appendix covers issues relevant to Injectors and their use with the F10 ECU.

B.1 Injector Impedance

Electrically, there are two different types of electronic fuel injectors:

Saturation

Saturation injectors have a high coil impedance (> 12Ω) and are common in average production cars. Saturation injectors, require a simple switch to operate. When a 16 ohm injector has 12V applied across its terminals, ultimately the current drawn is 0.75 amps (by Ohm's law), however the current in a coil cannot change instantly, when power is applied to this injector, the current builds in the coil over a period of around half a millisecond, until it reaches its maximum current or is “saturated” (0.75 A). The coils remain in saturation until power is switched off at the end of injection.

Peak-and-Hold

Peak and Hold injectors generally have a low coils impedance (< 6Ω) and are more common in motor-sport applications. In Peak-and-Hold injectors the coil impedance is reduced in order to reduce the injector opening time. If these injectors were allowed to remain saturated high continuous currents would flow resulting in a great deal of heat and wasted energy. A much smaller current is needed to hold the injector open than is needed to initially switch it on, because of this peak-and-hold injectors operate in two modes as their name suggests: a peak current for opening, and a hold current for maintaining the fuel flow. These peak-and-hold injectors are particularly good for high rpm engines needing large fuel-flow rates.

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

B.2 The F10 Injector Drivers

The solid state devices within the F10 ECU that are used to switch the injectors are known as the *injector drivers*.

- The F10 and F10A have 4 heavy-duty injector drivers.
- The F10-8 and F10A-8 have 8 heavy-duty injector drivers.

Each individual driver limits its current draw to 4 amps, and, upon reaching that limit, clamps the current to just 1 amp.

The drivers used in the F10 are each capable of firing two saturation injectors. Individual drivers are capable of firing one or two 2/0.5A peak-and-hold injectors. If using 4/1A peak-and-hold injectors, you should not employ more than one injector per driver. Most high current motors-port injectors can also be fired (one per driver) providing fuel pressures are not excessive (>5 Bar). Running two, high current, low impedance injectors from one driver can result in difficulty obtaining stable air:fuel ratios when injection times are short (around idle and light load).

In general, an injector driver will reliably fire two injectors with more than 2.5 ohms coil resistance. Coil resistance can be measured with an ordinary low-ohm resistance meter. If you are unsure which F10 model to choose contact your Haltech dealer for advice.

WARNING:
UNDER NO CIRCUMSTANCES SHOULD YOU MIX SATURATION AND PEAK-AND-HOLD INJECTORS ON THE ONE DRIVER. THIS WILL LEAD TO ERRATIC INJECTOR OPERATION.

B.3 Injector Driver Box

Should you need to drive more than 8 low impedance injectors or more than 16 high impedance injectors an extra driver box can be installed to meet the requirements. Your Haltech dealer can help you obtain the driver box.

Insufficient fuel flow can lead to lean fuel mixtures resulting in high chamber temperatures and detonation which could cause serious damage. For the safety of your engine, we urge you to check your fuel system's capacity and ensure that there will be sufficient supply at all times. A fuel pressure meter should be used during testing and tuning to ensure that fuel pressure does not fall out of regulation, that is, the fuel pressure does not drop or oscillate.

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

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

C.1 Fuel Requirement

If you can estimate the power output of a gasoline engine, you can make a reasonable guess at the fuel flow requirement. A good estimate may be expressed in metric or imperial units as follows:

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

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

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

C.2 Injector Flow Capacity

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

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

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

C.3 Injector Staging

Another way of increasing injector flow, without compromising good drivability and fuel economy is to employ staged injection. Injector staging allows the use of primary and secondary injectors and is usually only used on high boost turbo or supercharged engines. The ECU will fire only the primary set of injectors until a preset load point, where the ECU will control both primary and secondary injectors.

The turn on point for the secondary injectors depends on injector size and engine performance, but will usually occur just after the pressure in the intake manifold of the engine has reached atmospheric pressure. The staging point must occur before the primary injectors have reached 100% duty cycle, go to the highest speed range in the fuel map that the engine is using, and make sure that the last bar for primary injection is not too high. If it is, you must stage at a lower pressure. (Refer *4.6 Duty Cycles, 38*).

Adjust the bars around the staging point with extreme care to ensure that the engine does not lean out as the secondary injectors come in. When the Haltech ECU begins to stage it begins firing both sets of injectors at once and fires them with the same duration. This means that if both primary and secondary injectors are of the same flow rate then the first staged bar should theoretically be slightly more than half that of the last un-staged bar. Allow a safety margin by using 60% of the last bar.

(Staging is enabled in the Fuel Set-up page; Refer *3.1.2 Fuel Setup, 28*).

Once staging is enabled, the bars on the Fuel Maps will change appearance. The bars that indicate both sets of injectors firing are a different colour to those corresponding to primary injectors firing alone.

When staging injectors, drivers 1 and 2 (INJ1 and INJ2) are the primary drivers and drivers 3 and 4 (INJ3 and INJ4) are the secondary drivers. Since the number of primary drivers is halved, and since you may wish to employ higher power secondary injectors, ensure that you have sufficient driver power to run the injectors properly.
(Refer *Appendix B Fuel Injectors, 87*)

C.4 Fuel Pump Capacity

You should ensure that your fuel pump is capable of supplying sufficient fuel to feed the engine at maximum power. With the engine switched off (injectors closed) feed the return line of the fuel pressure regulator to a measuring container. In the case of a turbo- or supercharged engine, pressurise the manifold pressure port of the fuel pressure regulator to the maximum boost of the engine. This is necessary as the flow rate of the pump decreases with output pressure. Power the pump for one minute and calculate the hourly fuel flow rate of the pump.

Since the pressure regulator operates on a return system, there should always be fuel being returned to the tank, even when fuel flow to the engine has reached its maximum. If this fails to happen, the fuel pressure will fall out of regulation. Therefore the fuel pump must be capable of delivering significantly more fuel than the engine is going to use. As a guide, the pump should flow 30% more fuel than consumed by the engine.

If you cannot achieve the required fuel flow from one pump, you can employ two pumps in parallel.

If you choose to use a low pressure pump to augment the fuel flow of a high pressure pump, place a check valve after the low pressure pump and before the high pressure pump to prevent an overpressure condition at the output of the low pressure pump.

C.5 Fuel Rails and Pressure Regulators

A long fuel rail with narrow internal diameter will result in fuel pressure oscillations in the fuel rail. The internal rail diameter should be around 12mm (½"). Even so, oscillations may occur, particularly if the injectors are large. A fuel damper can help in removing these oscillations. If running a multipoint set-up, batch fire injection will also reduce oscillation amplitude. Oscillations may occur only within a certain rpm range, so a fuel pressure meter should be monitored across the range of the engine speed and load to detect such problems.

On V configuration engines, it may be more practical to employ two regulators, one on each bank's rail. The fuel from the pump can be split to the two rails, and the return line from the two regulators can be joined. Since pressure regulators work within certain flow limits, this may also save having to purchase an expensive high pressure / high flow regulator.

The flexibility of the F10 trigger input circuitry comes from the ability to switch certain components in and out of the circuit allowing the ECU to interpret a range of different inputs. (Refer *3.1.3 Trigger Set-up, 31*). This appendix describes some common application information for the trigger system of the F10 ECU.

D.1 Hall Effect and Optical Trigger Pick-ups

Hall Effect and optical trigger systems are common in factory EFI installations and come in a variety of forms. These systems generally have 3 wires: power, signal and ground, the power supply voltage required varies between sensors.

The Haltech S1/S3 Hall Effect trigger sensor can be used to trigger the F10. The principle behind its operation is quite simple, as a magnet passes the sensor the output state changes from high to low. The orientation of the magnets determines the output signals from the sensor.

> Note: The S1/S3 sensor is a two channel sensor (primary channel and secondary channel) the secondary channel is used produce a synchronisation signal. This feature is not available on the F10 ECU. The following instructions are applicable to Haltech ECU's with ignition control as well as the F10. If in the future the ECU is upgraded to an ECU with ignition control, the trigger system can be retained with a few additions

The S1/S3 Hall Effect Sensor

The original sensor, the S1, was modified to produce the S3 sensor. These two sensors operate identically in conjunction with the F10 and will be referred to from here on as the "S3" sensor. The S1/S3 sensor can be identified by a black cable gland. The S3 sensor has a red band near the cable gland and the S1 sensor does not.

The S3 sensor operates as follows:
As a South Pole passes the sensor face the signal in both the primary (PIN C) and secondary (PIN D) channels are switched to a low state. As a north pole passes the sensor a low state will only occur on the primary channel.

> Note: magnets should always be mounted in a non ferrous material such as aluminium, stainless steel or titanium.
> Many installers have successfully mounted the rare earth magnets in non-ferrous surrounds such as modified aluminium and stainless steel bolts, and installed the bolts into ferrous material.

Using the sensor on the crank

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

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

Identifying the magnets poles

If you need to identify the magnet poles this can be done easily with the use of a multimeter and +12V power supply. Power the sensor with 12 volts (PIN B) and ground (PIN A), the secondary trigger channel (PIN D) can be used to identify a south pole. When a south pole is placed in front of the sensor face, the voltage measured between the secondary channel (PIN D) and ground (PIN A) should be zero. When a north pole or no magnet is present the measured voltage will be +12V.

Fitting the magnets

We insist that only Haltech rare earth magnets (part number REM1) be used for the purpose of triggering the sensor. Rare earth magnets purchased from your local electronics store may be less expensive but they are not good enough! Haltech rare earth magnets are strong, stable at reasonably high temperatures and have a long service life. There are some rare earth magnets that are stronger magnetically, but these break down under excessive temperature, or are too brittle for the engine bay environment and do not have a long service life. Ordinary magnets i.e. not rare earth types, may not have the strength required for satisfactory triggering at high speeds.
Haltech (part number REM1) rare earth magnets are normally 5mmϕ x 2mm deep, although other sizes are available upon request.

The magnets should be fitted in non-ferrous surrounds such as aluminium, stainless steel or titanium. The trigger wheel is normally made of the chosen material but various users have reported good results when the magnets are set in a suitable non-ferrous surround and the surround is set into a ferrous material.
The magnets should be set flush with or slightly back from the surface of the trigger wheel or surround. If set too far back the magnetic signal may be too weak. The magnets should be set in place with a strong and durable fixing compound such as high strength epoxy, Loctite stud locking compound eg 603, or JBweld. Some users rely only on the fixing compound but to ensure that the magnets remain in place but many prefer that they be retained by mechanical means such as peening, and this gives an added safety factor.

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

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

Typical set-ups - S3

4 cylinder / 2 rotor engine

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

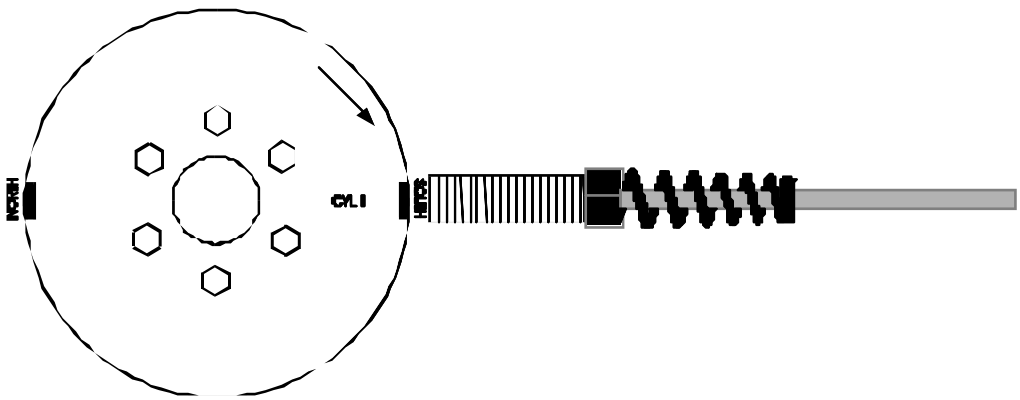


Figure 1: Typical 4 cylinder/ 2 rotor application

6 Cylinder / 3 Rotor Engine

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

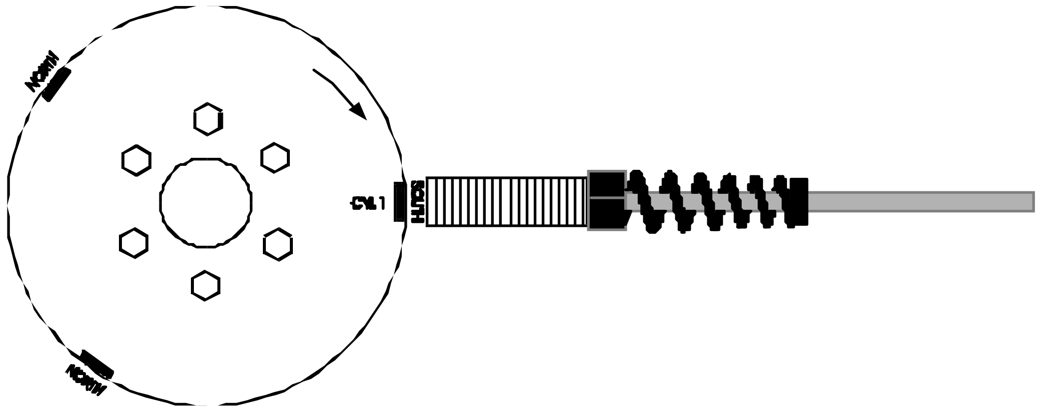


Figure 2: Typical 6 cylinder/ 3 rotor application

8 Cylinder

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

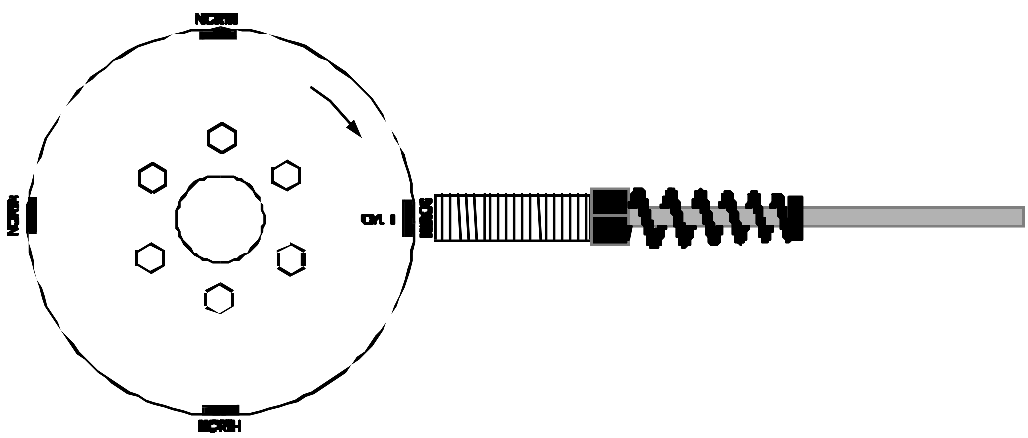
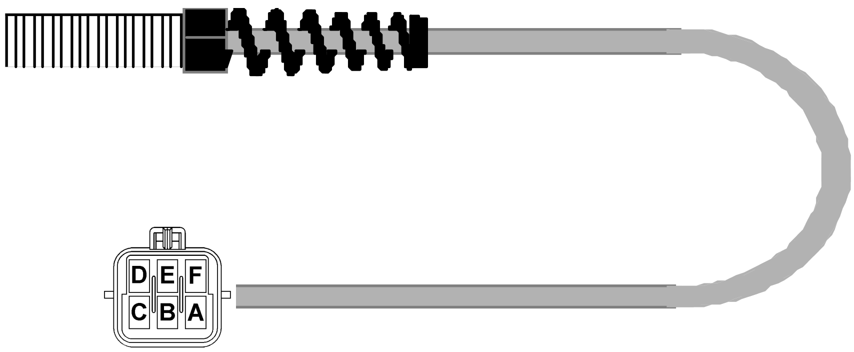


Figure 3: Typical 8 cylinder application

SENSOR PIN OUTS

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



LIMITED WARRANTY

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

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

If the Haltech™ Programmable Fuel Injection System is found to be defective as mentioned above, it will be replaced or repaired if returned prepaid along with proof of purchase. This shall constitute the sole liability of Invent Engineering Pty Ltd trading as Haltech.

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

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