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For racing and off highway use only

Not legal on emissions controlled vehicles unless appropriately certified

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While every effort is taken to ensure correctness, no responsibility will be taken for the consequences of any inaccuracies or omissions in this manual.

11 April, 2014

Introduction

Thank you for purchasing a MoTeC Engine Management System.

This manual will help you understand the installation and calibration requirements of your MoTeC Engine Management System.

Additional Documentation

Additional documentation is available in the form of Drawings and Tech Notes. These can be downloaded from the MoTeC website at www.motec.com.au. They are also available on the MoTeC Resource CD.

Drawing Categories

- Accessories
- ECUs
- Looms
- Ignition Modules
- Combined Module & Trigger Systems
- Trigger Systems
- Valves
- Sensors
- Miscellaneous

Tech Notes

- Traction Control
- Boost Control
- Idle Speed Control
- Closed Loop Lambda Control
- Wideband Lambda Sensor
- Others

Overview

The MoTeC M84 ECU is a powerful and compact programmable Engine Control Unit (ECU). The M84 is characterised by the following features:

- 1, 2, 3, 4, 5, 6 and 8 Cylinder/ 2, 3 and 4 rotor operation
- 8 injector outputs
- 6 ignition outputs
- 8 Auxiliary outputs
- Waterproof plastic connector with gold plated contacts
- 512 kByte logging memory
- Single Wideband Lambda input

Data Logging

Allows logging of the ECU sensors and operating parameters to the internal data logging memory. The logged data may then be analysed in graphical format using the MoTeC i2 Software.

Wideband Lambda

Allows Wideband Lambda (Air Fuel Ratio) measurement, which may be used for data logging or closed loop control of the Air Fuel Ratio. The ECU is compatible with Bosch LSU 4.0, 4.2 and 4.9 or NTK Wideband Lambda sensors.

Options

A number of options are available which allow the ECU to be configured for a particular need and can also be updated later if necessary.

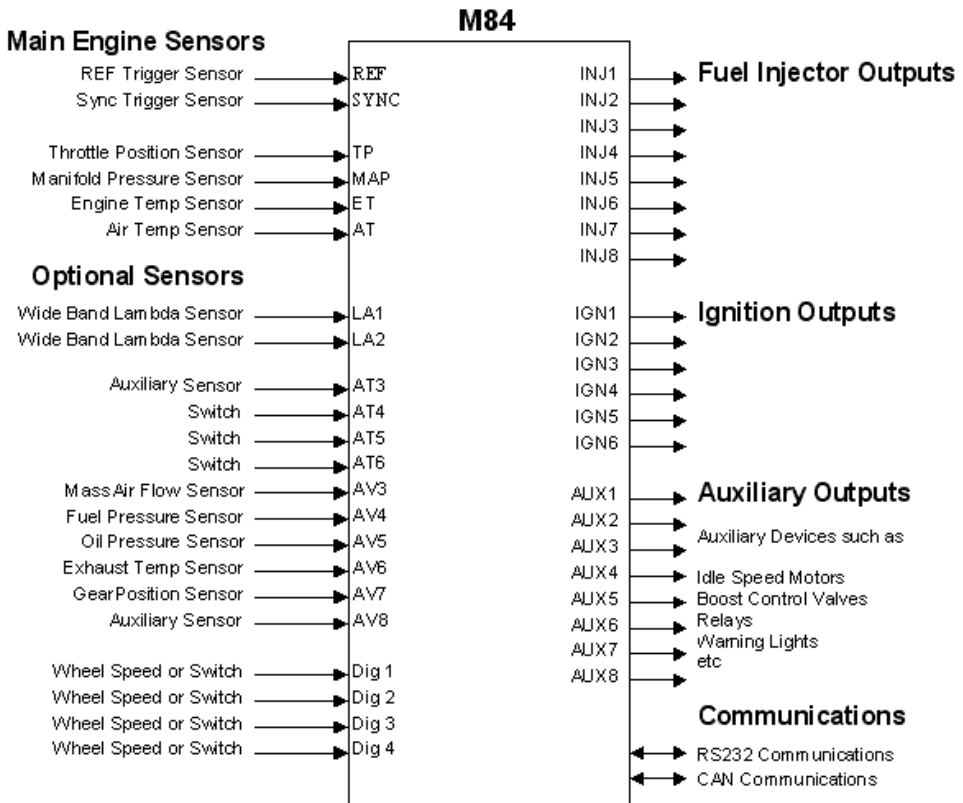
The options may be enabled at any time by entering an enable password. Optional functions include:

- Traction Control
- Boost Enhancement (Anti-lag)
- Hi/Lo Injection
- Gear Change Ignition Cut
- Advanced Functions (Traction Control, Boost Enhancement (Anti-lag), Hi/Lo Injection, Gear Change Ignition Cut)
- Dual Wideband Lambda Inputs

ECU Inputs & Outputs

The ECU analyses signals from the sensors, then controls the Fuel Injectors, Ignition System and other auxiliary devices according to the Calibration and Setup Data which is stored in the ECU's programmable memory.

The Inputs and Outputs are shown below.



Main Engine Sensors

The Main Engine Sensors are required for correct operation of the ECU.

The engine RPM is derived from the REF trigger sensor.

The SYNC trigger sensor is required to synchronise the Fuel and Ignition to the correct engine cycle for sequential injection and correct firing of multicoil ignition systems.

The Throttle Position, Manifold Pressure, Air Temp and Engine Temp are used as inputs to the various calibration tables.

Optional Sensors

The Optional Sensors are not required for basic operation of the ECU.

The Lambda Inputs may be used for Wideband air fuel ratio measurement or Wideband or Narrowband closed loop Lambda control.

The Digital Inputs may be used for wheel speed measurement or to activate functions such as Dual RPM Limit.

The other inputs may be used for data logging (e.g. Exhaust Gas Temp, Fuel Pressure etc.) or for special calibration features.

Fuel Injector Outputs

Up to eight injectors may be driven fully sequentially including very low ohm types (0.5 ohms).

Ignition Outputs

The Ignition Outputs may be used to drive many different types of ignition systems, which are detailed in the various ignition system drawings.

Up to six ignition outputs are available for multicoil applications.

- Up to 8 coils may be driven from one Ignition Output using a MoTeC CDI8 or MoTeC Ignition Expander.

Auxiliary Outputs

The M84 has eight Auxiliary Outputs that may be used for:

Turbo Waste Gate Control, Idle Speed Control, Gear Change Light, Driver Warning Alarm (plus many others).

CAN Communications

The CAN Communications system is a high speed network communications system that allows multiple devices to be connected and communicate with each other.

The CAN connection is used for all communications with the PC via the ***ECU Manager*** software which includes calibration, diagnostics checking, retrieving the logged data, firmware upgrading and enabling options.

CAN may be used to communicate with the MoTeC ADL & SDL Dash Loggers, PLM, LTC and SLM.

RS232 Serial Communications

Used for receiving GPS data input and transmitting MoTeC Data Set 1 for use with dash displays and loggers.

Calibration & Setup

Calibration Tables

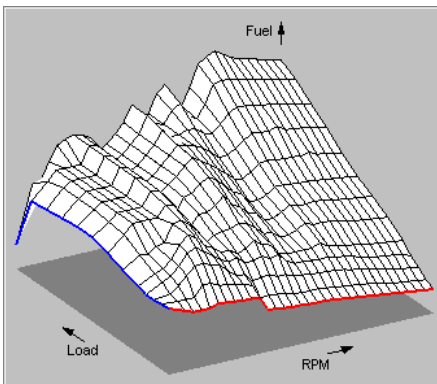
The Calibration Tables determine how the output devices should be controlled for various sensor readings. For example, the fuel calibration table determines the base injector pulse width for all combinations of RPM and Load. Other calibration tables will also affect the fuel injector pulse width such as Air Temperature compensation and Engine Temperature compensation.

The ECU determines the amount of fuel to inject by first calculating the RPM and Load then extracting the corresponding value from the table. If the RPM and Load do not match an RPM and LOAD point exactly then the values from the closest sites are mathematically interpolated to arrive at an intermediate value.

A typical 3 dimensional fuel calibration table is shown below.

| Fuel Main (% of IJPU) | | RPM | 0 | 500 | 750 | 1000 | 1250 | 1500 |
|-----------------------|------|-----|------|------|------|------|------|------|
| Load % | 50.0 | | 35.0 | 40.5 | 44.0 | 44.0 | 44.0 | 44.0 |
| | 40.0 | | 32.5 | 39.5 | 44.0 | 44.0 | 44.0 | 44.0 |
| | 30.0 | | 29.5 | 35.0 | 34.5 | 37.0 | 38.0 | 46.0 |
| | 20.0 | | 27.0 | 31.0 | 32.5 | 36.0 | 42.0 | 46.0 |
| | 15.0 | | 25.5 | 29.5 | 31.5 | 35.5 | 40.5 | 42.5 |
| | 10.0 | | 25.5 | 26.5 | 29.5 | 33.5 | 37.0 | 37.5 |
| | 5.0 | | 26.0 | 25.5 | 25.5 | 25.5 | 30.5 | 30.5 |
| | 0.0 | | 26.5 | 23.5 | 22.0 | 22.0 | 22.0 | 23.5 |

The calibration tables may also be represented graphically as shown below.



Setup Parameters

The Setup Parameters allow the ECU to be configured for almost any engine. The Setup Parameters include Number of Cylinders, Ignition Type, Sensor Types, Injector Current, Auxiliary Output Functions etc.

- The Setup Parameters must be correct before attempting to start the engine.

ECU Functions

The ECUs can perform a large number of functions in addition to the normal Fuel and Ignition control capabilities including; Hi /Lo injection, Individual Cylinder tables for Fuel and Ignition, Rotary Ignition Split and various sensor compensations

The functions are setup using **ECU Manager** either in the **Functions** menu, the **Digital Input Functions** menu or the **Auxiliary Output Functions** menu.

Help on each function is available from within **ECU Manager** by pressing the F1 key when the appropriate screen is shown.

Tech Notes are available from MoTeC on the more complicated functions such as Traction Control.

The functions are as follows:

Functions

The following functions are setup in the Functions menu

- Boost Control **
- Warning Alarms **
- Gear Detection *
- Overrun Fuel Cut
- Ground Sped Limiting *
- Gear Change Ignition Cut *
- Boost Enhancement (Anti-lag) *
- Lambda Control
- Traction Control *
- Idle Control

* must also be setup in the Digital Input Functions

** must also be setup in the Auxiliary Output Functions

Digital Input Functions

The following functions are setup in the ***Digital Input Functions*** menu

- Speed Measurement
- Period Measurement
- Pulse Measurement
- Dual RPM Limit
- Air Conditioner Request
- Ignition Switch
- Brake
- Logging Enable
- Clutch
- Overrun Boost Enhancement
- Traction Control Enable
- Ground Speed Limiting
- Power Steering

Auxiliary Output Functions

The following functions are setup in the ***Auxiliary Output Functions*** menu

- Boost Control
- Idle Speed Control
- Aux Table Controlled Output
- Tacho Signal
- Stepper Idle Speed Control
- Lambda Sensor Heater
- Fuel Pump Control
- Thematic Fan Control
- Air Conditioner Fan Control
- Air Conditioner Clutch Control
- RPM / Load Table Output
- Gear Change Light Output
- Fuel Used Pulse Output
- Slip Warning Output
- Alternator Control
- Spray Bars Output
- Status Output
- Thermo Pump

MoTeC Software

The following software is available for the M84 ECU.

ECU Manager: Used for calibration, setup, diagnostics, output testing, upgrading, unloading the logged data and enabling ECU options.

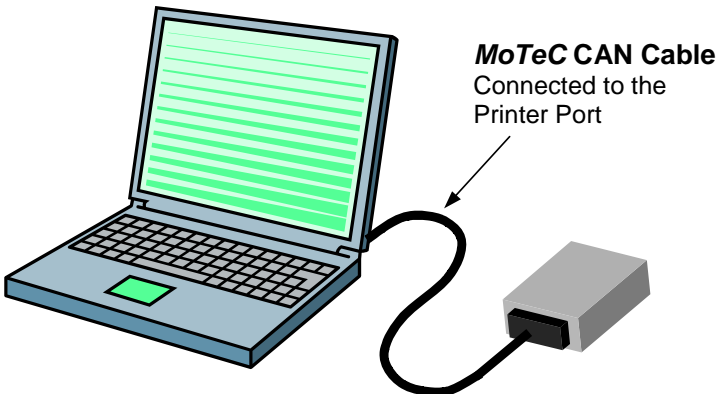
i2: Used to analyse the logged data.

PC Requirements

- IBM PC compatible
- 200 MHz Pentium or faster
- Operating System: Windows XP, Windows Vista, Windows 7

Connecting a PC to the ECU

The PC must be connected to the ECU by a MoTeC UTC or CAN Cable. Note that the ECU must be wired with the mating connector.



Installing the Software

The MoTeC Software must be installed on to the PC hard disk before it can be used.

The main software required is the **ECU Manager** software, if Data Analysis is required then the **i2** software should also be installed.

The software can be downloaded from the MoTeC website at www.motec.com.au . It is available on the MoTeC Resource CD.

MoTeC is continually updating the software and newer versions may be downloaded from the website at no charge.

To install the software after downloading from the web, double click on the downloaded file and follow the instructions.

Note that a separate folder (directory) is automatically created for each version of the software. Old versions are kept so that they may be used if necessary.

- Do not change the MoTeC directory structure or move the software to a different directory, otherwise the software will not operate correctly.

Starting the Software

To start the MoTeC Software double click the appropriate icon on the desktop or select the appropriate program from the Start menu. For example: Start / Programs / MoTeC / M84 / ECU Manager 1.0

ECU Manager Software

The **ECU Manager software** is covered in more detail later in this manual.

Data Logging

Data Logging allows the ECU operational data to be recorded in a memory chip inside the ECU. The data may then be extracted for analysis on a PC. Data logging is extremely useful for checking mixture readings, sensor readings, diagnostics errors and other operating information.

The items to be logged and the logging rates must be setup using the MoTeC **ECU Manager** software. This is done in the **Data Logging Setup** screens.

The ECU will remember the logged data even if the ECU power is turned off.

- If the logging memory becomes full, the oldest data is overwritten so that the most recent data is always available.

Unloading the Logged Data

The logged data can be extracted by connecting the MoTeC UTC or CAN Cable to the ECU and selecting ***Utilities / Get Logged Data*** from the ***ECU Manager*** menu.

Data Logging Analysis

The MoTeC ***i2*** software may be used to analyse the logged data.

The ***i2*** software is supplied separately to the ***ECU Manager*** software.

The ***i2*** software makes it easy to analyse mixture readings and other sensor readings by presenting the data in various graphical formats.

Refer to the ***i2*** help screen for more detail.

Installation

Throttle Position or MAP Load Sensing

The load point for the fuel and ignition calibration tables may be based on any defined load measuring sensor.

The most commonly used are the Throttle Position sensor or the MAP (Manifold Pressure) sensor.

Turbo Charged Engines

Normally use Manifold Pressure load sensing (connect the MAP sensor to the inlet manifold).

A Throttle Position sensor is optional and will be used for acceleration enrichment if fitted.

Normally Aspirated Engines

Normally use Throttle Position load sensing.

The MAP sensor may be used to compensate for barometric pressure changes by venting it to atmospheric pressure.

If Idle Speed Control is used then the MAP sensor should be connected to the plenum or Manifold Pressure load sensing should be used. This is required so that the fuel is varied as the idle speed control valve opens and closes.

Sensors

Throttle Position Sensor

The Throttle Position sensor must be a potentiometer type, older switch types are not suitable. The sensor will produce a voltage proportional to the angle of the throttle plate.

Throttle sensors generally have a dead band at either end and must be pre-loaded to avoid the dead band.

The Setup Parameters ***TPHI*** and ***TPLO*** must be set to indicate the fully closed and fully open positions. These parameters must be set any time the

sensor is moved or replaced. It is very important to set these parameters with the butterfly in exactly the same place each time.

The resistance element inside the sensor may wear due to vibration in high performance engines which can cause erratic readings. It is best to replace the throttle position sensor periodically.

Avoid high pressure washing as this may penetrate the seals and damage the sensor.

For wiring details refer to the appropriate MoTeC drawing.

MAP Sensor

The MAP (Manifold Absolute Pressure) sensor measures Absolute Pressure (i.e. pressure relative to a vacuum).

0 kPa Absolute = Complete Vacuum

100 kPa = 1 Bar = 14.5 PSI

Atmospheric Pressure at sea level is approximately 100 to 102 kPa, depending on the weather.

MAP sensors normally produce a voltage between 0 and 5V, depending on the pressure.

The pressure sensor may be used to measure the inlet manifold pressure or to measure the barometric pressure depending on the Load Sensing arrangement detailed earlier.

The ECU Sensor Setup parameters must be set to indicate the type and pressure range of the sensor.

Avoid severe vibration of the sensor as this can cause fluctuations in the reading. Do not mount rigidly to the engine. Normally the pressure sensor is mounted to the vehicle body.

If Used for Manifold Pressure Sensing

For normally aspirated engines use a 100 kPa sensor.

For turbo charged engines a 300 kPa absolute sensor will measure up to 200 kPa (29 psi) of boost (above Atmospheric). If higher boost will be achieved, a sensor with a higher pressure range will be needed.

The sensor should be connected to the inlet manifold plenum via a short hose (less than 1m). The sensor should be mounted above the level of the plenum with the port facing down to avoid moisture accumulating on the sensor element. The hose should run downwards all the way to the plenum.

The plenum take off point should be at a position that best represents the average manifold pressure and has minimal pressure pulsations. A small restrictor may be needed at the manifold end of the hose to help reduce pressure pulsations. The take off point should not be teed in with other items such as idle speed control valves as they can affect the pressure reading.

If used for Barometric Pressure Sensing

Use a 105 kPa sensor.

Vent the sensor to the atmosphere with the port facing down.

Avoid mounting at a point where air buffeting occurs. Any pressure fluctuations will directly affect the mixture.

It may be desirable to sense the pressure at the air intake as the pressure may vary due to aerodynamic effects.

Air Temp Sensor

The Air Temperature sensor is mainly used to correct for air density change due to air temperature variation.

The sensor contains a temperature dependant resistor and is designed for high speed response in an air flow.

The Air Temp sensor must be placed to measure the air temperature before the butterfly (and after the intercooler on turbo charged engines).

Avoid placing the sensor too close to the stand-off vapour in a multi-runner manifold as this will cool the sensor and give a false reading.

The ECU Sensor Setup parameters must be set to indicate the particular type of sensor.

Engine Temp Sensor

The Engine Temperature sensor is mainly used for cold start enrichment.

The sensor contains a temperature dependant resistor and is designed for water immersion.

The ECU Sensor Setup parameters must be set to indicate the particular type of sensor.

Trigger Sensors (REF & SYNC)

The trigger sensors supply the necessary timing information to the ECU so that it knows when to fire the fuel injectors and ignition system. Normally two sensors are used, REF and SYNC.

Many different types of trigger sensors and chopper patterns may be used.

The wiring and ECU setup information for the trigger sensors are specific to the particular system. Refer to the appropriate MoTeC drawing.

Home made sensor systems often cause problems. Do not use Chrome molly for chopper disks as it is a non magnetic material. Runout of the disk, imperfections and bolt heads are also potential sources of problems. Where possible it is best to use the manufacturer's trigger system.

REF Sensor

Supplies the crank position information.

Some sensors supply one pulse per Top Dead Centre (4 pulses per engine rev on a V8), others supply as many as 360 pulses per engine revolution.

The Engine RPM is derived directly from this signal.

SYNC Sensor

Used to indicate each engine cycle, which is required for sequential injection and multicoil operation.

Generally supplies one pulse per engine cycle (i.e. once every 2 revs on a 4 stroke engine).

On some special trigger systems the ECU can be synchronised using the REF sensor only (e.g. Ford Narrow Tooth)

REF / SYNC Alignment

Most modern distributors supply both REF and SYNC signals in which case the alignment is pre-set.

When using separate REF and SYNC sensors the alignment of the two sensors relative to one another is critical. Ensure that the sensors are aligned correctly for the type of trigger system being used. Refer to the appropriate drawing. Allow for any mechanical play in the distributor drive system if the SYNC signal is derived from the distributor.

Exhaust Gas Sensor (Lambda Sensor)

The ECU may optionally use a wideband exhaust gas sensor for data logging or closed loop control of the Air Fuel Ratio.

The ECU is compatible with the Bosch LSU Wideband sensor and the NTK Wideband sensor. These sensors are different to the sensors used on previous model ECUs.

Note that the sensor heater must be connected to these sensors at all times and must be controlled by the ECU by connecting it to one of the Auxiliary Outputs.

The sensor should preferably be placed within 0.5 m of the collector pipe on a normally aspirated engine or 0.5 m of the turbo on a turbo charged engine. If placed too close to the exhaust outlet, the reading may be affected by the outside oxygen.

The sensor can be contaminated by exhaust manifold sealant - use an exhaust gas sensor friendly sealant.

The lifetime of the Sensor will be significantly reduced by leaded fuels.

Refer to the MoTeC Tech Notes and Drawings for more details.

Wiring

Wiring Drawings

For general wiring details refer to the following drawing; M84 Wiring.

The wiring details for the REF and SYNC Trigger Sensors and the Ignition Module are specific to the type of sensors and Ignition system. MoTeC can provide wiring diagrams for most Trigger Sensors and Ignition systems.

Wiring details for other sensor types are available from MoTeC.

Wiring Reliability

The wiring is critical for reliable operation of the ECU. The following points will help to ensure that the wiring is reliable.

Ground Wiring

One of the most common wiring problems is poor ground wiring.

The ground wire must be grounded properly to the engine block. There should be no paint or anodising between the ground wire and the engine block.

Temporary wiring is likely to cause problems: use a proper eyelet terminal that is securely crimped to the ground wire. Studs fixed in place by Loctite® can also cause a problem as the Loctite® becomes an insulator. These comments apply to both the ECU ground wire and the Ignition system ground wire.

The ground wire must be at least 12# (3.3 mm²) and must be kept as short as possible.

Power Wiring

The power wire must be wired by the shortest path possible to the battery via a 30 Amp relay and a 20 Amp fuse. The relay and fuse must be in good condition and the wires must be crimped securely to the appropriate terminals. The relay should be activated by the Ignition Switch. The ECU power must NOT be fed directly from the Ignition switch because it probably won't handle the required current.

The power wire must be at least 12# (3.3 mm²) and must be kept as short as possible.

Spark Plug Leads

The spark plug leads can cause interference in the ECU wiring. Keep the ECU wires away from the plug leads wherever possible (at least 100mm). If it is necessary to cross the plug leads, cross at right angles.

Terminal Crimping

Use the correct crimping tool for each type of terminal. Do a pull test on a sample wire and terminal to verify that the crimp is sound. In theory the wire should break before the wire pulls out of the crimp.

Most crimp tools are only designed for a certain range of wire sizes so be sure to test the crimp with the particular wire size being used.

Soldering the terminal is a last resort if the correct crimping tool is not available. Soldering will cause a stress point where the solder wicks up the wire which is likely to fracture unless all movement is avoided. Solder flux can also cause corrosion and may affect the contacts.

Terminal Damage

The various connector terminals are easily damaged if probes are inserted into them. Do not insert probes of any kind into the terminals. If checking a circuit for continuity, gently touch the side of the terminals only, or preferably attach a mating connector.

Wire Splicing

Preferably use a crimp splice. If soldering a wire splice, wire movement near the joint must be avoided otherwise a fracture may occur at the stress point created by the solder. Use heatshrink sleeving to insulate and provide support to the wires.

Wire Strain

Avoid pulling the wires tight at the connectors.

Wire Movement

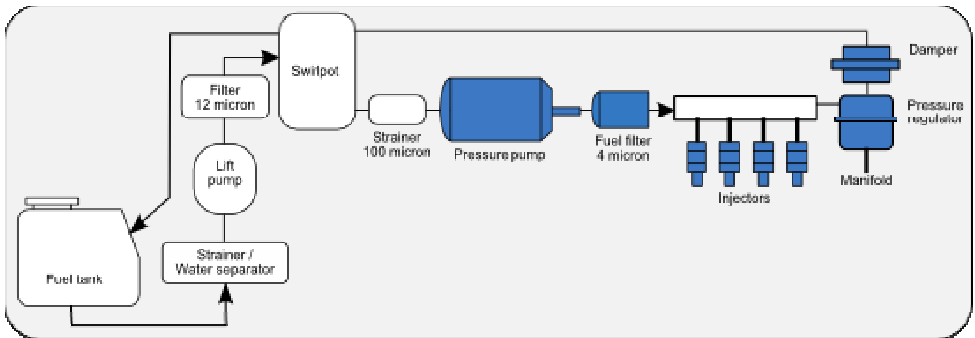
Avoid wire fatigue by tying the wires down close to the connectors.

Heat

Keep the ECU wires away from the exhaust system.

Fuel System

An ideal race fuel system is shown below



Lift Pump

The Lift Pump is a low pressure pump designed to lift the fuel from the fuel tank to the swirl pot (header tank).

The Lift Pump must be capable of flowing enough fuel for full power operation.

Swirl Pot

The swirl pot (header tank) maintains a reserve of fuel to avoid fuel starvation to the engine during cornering and acceleration. Fuel starvation can also cause damage to the pressure pump as it relies on the fuel for cooling, lubrication and speed limiting.

The swirl pot also forms a header tank for the pressure pump since the pressure pump is not capable of lifting the fuel from the tank if the tank is lower than the pump. Place the swirl pot at the same level, or higher than the pressure pump.

Pressure Pump

The Pressure Pump is a high pressure pump that must be capable of delivering the required amount of fuel at the correct pressure at full power.

It is very important that the pump is capable of maintaining the correct fuel pressure at full power otherwise the engine could be damaged due to a lean mixture.

A 600 hp engine requires a flow rate of approximately 250 lb/hr for petrol or gasoline.

Notes

- The pressure pump must be lower than the outlet of the swirl pot.
- Prime the pump with fuel before use.
- The pump's flow capability is dependant on the required pressure, the flow capability of the pump will be less at higher pressures. A small pump will maintain correct pressure at light load but will not maintain correct pressure as the flow requirement increases.
- On boosted engines the pressure required from the pump increases with boost pressure because the regulator maintains constant pressure above manifold pressure.
- Avoid running the pump dry as this may destroy the pump.

Filters

The filters are necessary to ensure that the fuel pump is not damaged and to ensure that the injectors do not become blocked.

- The strainer before the pressure pump is essential to prevent the pump from seizing. A strainer is used because the pressure pump won't suck through a paper filter.

Fuel Lines

The fuel feed lines must be high pressure type and should be at least 8mm (5/16 inch) diameter. The return lines should also be at least 8mm (5/16 inch) diameter to ensure that the fuel is easily returned to the tank.

Use proper high pressure hose clamps to ensure that the lines do not blow off under pressure.

Keep the fuel lines as cool as possible to avoid fuel vaporisation. The temperature of the fuel will also affect the mixture due to the change in fuel density.

Avoid fire risk by ensuring that all hoses and fittings are in good condition and installed correctly.

Fuel Rails

The fuel rails must be free of any debris that could block the injectors. Welded fuel rails can often cause a problem unless they have been properly treated to remove all scale and debris and even then they may corrode and cause problems. Aluminium fuel rails mounted directly on the injectors are recommended as they do not suffer these problems.

The fuel rails must have sufficient volume to minimise fuel pressure pulsation and resonance problems.

Fuel Pressure Regulator

The fuel pressure regulator maintains constant fuel pressure to the injectors which is necessary to ensure constant metering of the fuel. Any variation in the fuel pressure will cause a corresponding mixture change.

The fuel pressure regulator should be mounted at the end of the fuel rail so that fuel is always flowing through the rail. This helps to avoid vapour locks.

Adjustable pressure regulators are available.

If Using Manifold Pressure Load Sensing

Connect the regulator port to the plenum as this ensures that constant pressure is maintained across the injectors.

Note that this will cause the fuel pressure required from the pump to increase as the manifold pressure increases.

If Using Throttle Position Load Sensing

Leave the regulator port open to the atmosphere, unless the MAP sensor is connected to the manifold as is recommended when using idle speed control, in which case the regulator port should be connected to the manifold.

Fuel Injectors

The fuel injectors meter the fuel by opening for a short but defined time once per engine cycle (sequential operation).

The injectors must be wired in the firing order of the engine.

Sizing

The size of the injector determines the maximum amount of fuel that can be delivered to the engine.

As a rule of thumb the engine will require about 5 cc per minute per horse power for petrol or gasoline. For alcohol a higher flow rate is required.

For example: A 600 hp V8 will require each injector to flow at least
 $600 \text{ hp} \times 5 \text{ cc/min/hp}/8 \text{ injectors} = 600 \times 5/8 = 275 \text{ cc/min}$.

Note that the flow rate of any particular injector is dependant on the fuel pressure applied to it.

Sometimes oversize injectors are used to maintain lower duty cycles, since high duty cycles reduce the effect of sequential injection, because the injectors are turned on for most of the time. However this can affect idle fuelling as the injector may have trouble delivering small amounts of fuel.

Flow Rate Matching

The flow rate of injectors can vary between injectors of the same type. It is advisable to match the flow rates of injectors by testing each injector on a flow bench.

Fuel Pressure

The fuel pressure applied to the injector will directly affect the amount of fuel that the injector delivers. Doubling the pressure however only increases the fuel flow by about 1.4 times.

Most injectors will only operate correctly over a certain range of fuel pressures. If the pressure is too low then the fuel may not atomise properly. If the pressure is too high then the injectors may not turn off fully. Many injectors

will operate correctly at 2.5 bar (29 psi) and some will operate up to 5 bar (73 psi).

Current

Different injectors require different operating currents. The ECU injector drives must be programmed to suit the injector using the Injector Current setup parameter.

Pulse Width

The amount of time that the injector spends open during each injection pulse is called the Injector **Pulse Width** and is measured in milliseconds (thousandths of a second), abbreviated as **msec**.

The injector pulse width is controlled by the ECU according to the ECU,s calibration data.

Duty Cycle

The Injector **Duty Cycle** is a measure of the ratio of the time the injector is open (pulse width) to the available time per engine cycle. For example, if the injectors were on for half the available time then the duty cycle would be 50%.

The maximum allowable duty cycle is about 85 percent, beyond this the injector does not have time to open and close and is therefore open continuously and cannot deliver more fuel.

The ECU will set a Diagnostics Error if the duty cycle exceeds the maximum allowed duty cycle.

Ignition System

Ignition System Types

Many different types of ignition systems are available with some better suited to different applications than others.

CDI Distributed

CDI systems are suited to high revving engines with 8 or more cylinders and are generally capable of at least 12,000 RPM on an 8 cylinder. CDIs are also good at firing fouled plugs.

HEI Distributed

High Energy Inductive (HEI) distributed ignition systems are generally limited to about 8000 RPM on an 8 cylinder engine but will run a 6 cylinder to 11,000 RPM and a 4 cylinder to 15,000 RPM.

Most modern road cars run HEI ignition systems that are equally well suited to high performance engines as long as the above RPM restrictions are observed.

Multicoil (HEI or CDI)

HEI or CDI multicoil systems will generally run any engine to 15,000 RPM.

Two types of Multicoil systems are possible:

Coil per plug

One coil for each spark plug, fired sequentially.

Double Ended Wasted Spark

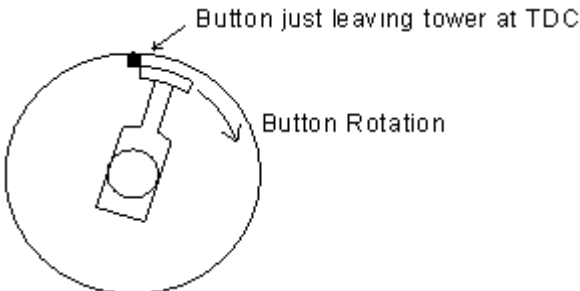
Double ended coils have two high tension towers and fire two plugs at the same time, one on the compression stroke and the other on the exhaust stroke. Each coil is fired sequentially twice per engine cycle and must feed the appropriate two cylinders.

Ignition System Wiring & Setup

The wiring and setup parameters are specific to the particular ignition system. Refer to the appropriate MoTeC Ignition System or Ignition Module drawing.

Distributor Button Alignment

If using a distributor, the button must be aligned so that it is leaving the tower at Top Dead Centre for that cylinder.



The button must be a wide tip type to cater for a wide range of advance points since the advance is changed electronically rather than mechanically.

Make sure that the button still overlaps the tower at the maximum advance point.

The distributor should have no mechanical or vacuum advance as this is provided by the ECU.

Spark Plug Leads

The spark plug leads should be high quality Inductive Suppression leads such as Magnicor® leads and must be in good condition.

- Do not use wire leads as they can cause interference.
- Do not use resistive suppression leads as they will reduce the spark energy.

Auxiliary Valves

The ECU can control various auxiliary devices such as Idle Speed or Turbo Boost control valves.

Refer to the appropriate **MoTeC** drawing for setup and wiring details. Refer also to any relevant Tech Notes.

ECU Mounting

The ECU should be mounted in an area where the internal temperature of the ECU will not exceed 85 °C. Generally this is in the passenger compartment. Allow for adequate air circulation around the ECU. The ECU internal temperature may be viewed using the **ECU Manager** software or it may be recorded using the data logging.

Mount so as to minimise vibration, this will help to prolong the ECU's life.

ECU Cleaning

Avoid high pressure washing or degreasing of the ECU.

Initial Setup

Before attempting to start the engine the setup parameters must be correct.

Use the MoTeC **ECU Manager** software to adjust the setup parameters.

Preferably start with a calibration file from a similar engine as this will make setup faster and easier.

Main Setup

Injectors

Injector Scaling (IJPU)

Injector Current

Injector Battery Compensation

Refer to the **ECU Manager** help screens for details.

Calculation Methods

Efficiency Calculation Method.

Load Calculation Method.

Refer to the **ECU Manager** help screens for details.

Number of Cylinders

CYLS 4 Stroke engines: use positive numbers e.g. 8 for 8 cyl.
 2 Stroke engines: use negative numbers e.g. -2 for 2 cyl.
 Rotary engines: use -2 for 2 rotor and -3 for 3 rotor.

Trigger Setup

Ref / Sync Mode (REF)

Crank Reference Teeth (CRT)

Crank Index Position (CRIP)

These parameters are dependant on the type of trigger system. Refer to the appropriate MoTeC Trigger drawing or Ignition System drawing.

Note that the trigger sensor type (Hall / Mag, Edges etc.) must be setup in the Sensor Setup screens.

Ignition

Ignition Type (IGN)

Number of Coils (COIL)

Ignition Dwell Table

Ignition Delay Time

These parameters are dependant on the type of Ignition Module. Refer to the appropriate MoTeC Ignition Module drawing or Ignition System drawing.

Sensor Setup

Throttle Position Sensor Hi / Lo

TPLO Throttle Position LO (Closed Throttle)

TPHI Throttle Position HI (Wide Open Throttle)

The Throttle HI and LO points must be set every time the throttle position sensor is moved or replaced so that the throttle can be correctly scaled between 0 and 100%.

REF / SYNC Sensor Setup

The REF/SYNC setup parameters must be set to suit the trigger sensors.

Refer to the MoTeC Trigger drawings for details.

Sensor Calibrations

The sensors calibrations must be set to suit the connected sensors.

Refer to the *ECU Manager* help screens for details.

Input / Output Functions

Setup any essential Input / Output functions.

It may be best to start with any non essential functions turned off (e.g. Idle Speed Control, Dual RPM Limit etc.).

Refer to the **ECU Manager** help screens for details.

Other Functions

Ensure any other functions such as Boost Control, Traction Control etc. are all set appropriately.

It may be best to start with any non essential functions turned off (e.g. Traction Control, Lambda Control etc).

Refer to the **ECU Manager** help screens for details.

Initial Calibration

Before attempting to start the engine the calibration tables should be initialised to sensible values.

Use the MoTeC **ECU Manager** software to initialise the ECU calibration tables.

Preferably start with a calibration file from a similar engine as this will make initial calibration faster and easier.

Clear any *s from the tables by selecting **Clear *s** from the **ECU Manager** software **Tools Menu** (Press the **F9** key). The *s indicate values that have been set correctly, which is inappropriate at this stage.

Fuel Tables

Fuel - Main Table

Check the Fuel - Main Table.

The table should be smooth.

In general, turbo tables look quite different from throttle position tables, so it is wise to start with a table from a similar engine.

Fuel - Air Temp

Check the Fuel - Air Temp compensation table.

Typically the following table can be used :

| | | | | | | | | | | | | |
|-----|-----|-----|-----|---|----|----|----|----|----|----|-----|-----|
| -40 | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80+ |
| 10 | 9 | 8 | 6 | 4 | 2 | 0 | -2 | -4 | -6 | -8 | -10 | -12 |

Fuel - Engine Temp

The Fuel - Engine Temp compensation table may be used instead of the cold start warm up parameter.

If using Engine Temp compensation the following table can be used :

| | | | | | | | | | | | | |
|-----|----|----|----|----|----|----|----|----|----|----|-----|------|
| -10 | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110+ |
| 60 | 50 | 40 | 30 | 20 | 10 | 5 | 2 | 0 | 0 | 0 | 0 | 5 |

Fuel - MAP

Check the Fuel - MAP compensation table.

The fuel must be increased by 100% every 100 kPa increase in air pressure.

Normally the MAP table should contain the following values, with a straight line increase between values.

| | | | | | |
|-------|---------|---------|---------|---------|---------|
| 0 kPa | 100 kPa | 200 kPa | 300 kPa | 400 kPa | 500 kPa |
| -100 | 0 | 100 | 200 | 300 | 400 |

This table is equally applicable whether the MAP sensor is used for barometric pressure measurement or for manifold pressure measurement.

Note that the higher pressure sites will only be available if a high pressure MAP sensor is used.

Fuel - Cold Start

Start with the typical values listed in the help.

Fuel - Acceleration Enrichment

Start with the typical values listed in the help.

Generally acceleration enrichment is not required above 4000 RPM.

Other Fuel Compensation Tables

Typically all other compensation tables should be set to zero.

Ignition Tables

Ignition - Main Table

The table should be smooth.

Make sure that the Ignition - Main Table is initialised with a conservative curve for the particular engine, not too advanced and not too retarded.

Ignition - Air Temp

Check the Ignition - Air Temp compensation table.

Typically the following table can be used :

| | | | | | | | | | | | | |
|-----|-----|----|----|----|----|----|----|----|----|----|-----|------|
| -20 | -10 | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100+ |
| -12 | -9 | -6 | -3 | 0 | 0 | 0 | 0 | -3 | -6 | -9 | -12 | -15 |

Other Ignition Compensation Tables

Typically all other ignition compensation tables should be set to zero.

Initial Starting Procedure

The **ECU Manager software** should be used to assist during starting.

The **ECU Manager software** allows all diagnostic errors and sensor readings to be checked and allows the injectors, ignition system and auxiliary outputs to be tested while the engine is stopped. The calibration tables and setup parameters should also be checked.

Pre Start Checks

Calibration Tables & Setup Parameters

Check that all setup parameters have been set appropriately.

Check that all calibration tables have sensible values in them.

Check that any advanced functions such as Traction Control are turned off.

Power to the ECU

If the ECU has power then the **ECU Manager** software should indicate that the ECU is connected (at the bottom left corner of the screen).

Diagnostic Errors

Before starting the engine check the diagnostic errors on the **ECU Manager Diagnostic Errors** screen. Any errors must be rectified before starting the engine.

To clear any non current errors press the **Enter** key on the PC while viewing the **Diagnostics Errors** screen.

- Note that the diagnostic errors are lost if the ECU power is turned off.

Sensor Errors

If an error is shown for a sensor that is not fitted, the sensor should be disabled by setting the sensor setup number to zero.

Sensor Errors may be due to bad wiring to the Sensor (either short circuit or open circuit).

Test the Sensors

Before starting the engine, test that all sensors are giving sensible readings by viewing their values on the **ECU Manager : View** screen. Vary the sensor readings if possible to check for correct operation.

Check that the Throttle Position Sensor varies smoothly from 0 to 100% when moved from fully closed to fully open. Note that the **TPHI** and **TPLO** setup parameters must have been set correctly for correct operation of the Throttle Position sensor.

The MAP sensor should read barometric pressure when the engine is stopped (approximately 100 to 102 kPa at sea level depending on the day).

The Engine Temp and Air Temp sensors must give correct readings.

Test the Ignition

Use the **ECU Manager : Ignition Test** (in the **Utilities** menu) to ensure that the Ignition System is functioning correctly.

Notes

- Some special ignition systems do not work in the Ignition Test screen. e.g. Mazda Series 4 and 5 and other direct fire ignition systems.
- If the Ignition System is wired via the Fuel Pump relay then the ignition test will not work unless this relay is activated.
- It will be necessary to place a spark plug on the lead from the ignition coil if the ignition system uses a distributor.

Test the Injectors

Use the **ECU Manager : Injector Test** (in the **Utilities** menu) to ensure that all injectors are working and that they are wired in the correct firing order for sequential operation.

WARNING: Ensure that the fuel pump is off during this test.

Initial Cranking

Crank the engine without fuel pressure and check the RPM reading.

Check that the RPM reading is sensible, if the RPM is too high or too low or is erratic then the Setup may be incorrect or there may be a problem with the REF sensor signal. If there is no RPM reading then the REF sensor is not working.

Check that no REF or SYNC Diagnostic Errors occur during constant cranking. Diagnostic errors may occur as cranking winds up; this is OK, but the errors need to be cleared by pressing the **Enter** key while viewing the **ECU Manager : Diagnostics Errors** screen, so that constant cranking may be checked for errors. Diagnostic errors may occur as cranking winds down, this is also OK.

Cranking Ignition Timing

Check that the Ignition Timing is correct during constant cranking.

This can best be done in the Crank Index Position setup screen under the ignition menu. While in this screen the ignition timing will stay fixed at the value set under 'Test Advance'. This allows the CRIP to be adjusted if necessary until the timing matches the Test Advance.

Notes

- Dial back timing lights such as the Snap-On® brand may not work correctly at cranking - use a traditional timing light.
- For some trigger modes (one tooth per firing) the Ignition Timing is set by the sensor position only. In this case the ECU only controls the timing above 500 RPM.
- If the spark is going to the wrong cylinder on a Direct Fire Ignition the ignition may be wired incorrectly or the CRIP (Crank Index Position) setup parameter may be out by a multiple of the angle between cylinders.

Starting

Fuel System

Power up the fuel pumps and check the fuel system for leaks before attempting to start the engine.

Fuel Overall Trim

Use the **FUEL - Overall Trim** to vary the mixture when trying to start the engine to see if the engine needs more or less fuel, This ensures that the mixture is varied equally for all RPM and Load points.

Establish how much trim the engine needs on average then trim this out by adjusting the setup parameter **IJPU** (Injector Pulse Width Scaling), or by using the **Overall Trim Table** item in the Tools Menu.

If the engine won't start

- Check for correct fuel pressure.
- Check for fouled plugs.
- Re-check for diagnostics errors.
- Re-check the Ignition Timing with a Timing Light.
- Check the setup parameters against the drawings.
- Check that the ignition is wired in the correct firing order.
- Check that the ignition is firing on the compression stroke, not the exhaust stroke.

After Start Checks

Ignition Timing Check

Check the Ignition Timing with a Timing Light to ensure that the actual Ignition Timing corresponds to the ECU Ignition Timing as shown on the **ECU Manager : View** screen. Check the timing at high and low RPM to ensure that it is correct at all revs. If the timing is correct at one RPM but incorrect at another RPM and the REF sensor is a magnetic type then the trigger edge may be incorrect or the sensor may be wired in the wrong polarity.

Adjust the setup parameter **CRIP** (Crank Index Position) to correct for small variations in the REF sensor positioning.

Adjust the **Ignition - Individual Cylinder Trim** for cylinder number 1 and verify that it changes the ignition timing for cylinder number 1 rather than any other cylinder. If not the **CRIP** is incorrect and needs to be adjusted by multiples of the angle between cylinders.

Fuel Pressure

Check that correct fuel pressure is maintained under all load conditions.

Operational Diagnostics Errors

After the engine has started check for diagnostics errors.

To clear any non current errors press the **Enter** key while viewing the **ECU Manager : Diagnostics Errors** screen.

The following operational errors may occur in a new installation:

Injector Errors

Open The Injector is open circuit - check the wiring.

Short The Injector is short circuit - check the wiring.

Peak The Injector peak current was not reached.

Possible causes:

- The Injector Current Setup Parameter IJCU is set too high.
- The battery voltage is too low.

Over Duty

The injector duty cycle is too high, typically the duty cycle should not exceed 85%.

If the injectors exceed their maximum duty then larger injectors or higher fuel pressure is needed.

REF / SYNC Errors

The possible causes of the various errors are detailed below:

REF Error

Too many REF pulses have occurred between SYNC pulses.

Possible causes:

- A bad REF signal has caused extra pulses or a SYNC pulse has been missed - check voltage levels with a scope
- Bad REF / SYNC alignment
- Incorrect Setup

No REF

Two SYNC signals have occurred without a REF signal.

Possible causes:

- If the RPM is 0 then there is no signal - check the wiring and sensor voltage levels with a scope.
- If RPM is not 0 then a bad SYNC signal has caused extra pulses - check voltage levels with a scope.
- If RPM is low the REF and SYNC signals may have been swapped.
- Incorrect Setup

SYNC Error

The SYNC signal has occurred before expected.

Possible causes:

- A bad SYNC signal has caused extra SYNC pulses - check voltage levels with a scope.
- A bad REF signal has caused missing REF pulses - check voltage levels with a scope.
- Bad REF / SYNC alignment.
- Incorrect Setup

No SYNC

Two or more consecutive SYNC pulses are missing.

Possible causes:

- No SYNC signal - check the wiring and SYNC sensor voltage levels with a scope.
- A bad REF signal has caused many extra pulses - check voltage levels with a scope.
- Incorrect Setup

Multiple REF / SYNC Errors

Multiple REF / SYNC errors may occur. Often the first error to occur is the correct error.

Multiple errors may also occur due to incorrect Setup.

Calibration

The Calibration Tables determine how the output devices should be controlled for various sensor readings. For example the **Fuel - Main Table** determines the pulse width for the Fuel Injectors for all combinations of RPM and Load.

The **ECU Manager** software should be used to adjust the various calibration tables to suit the engine.

Warning Alarms

Set the Warning Alarms to warn if the engine temperature goes too high. (The warning alarms may be set in the **Functions** menu).

Ensure that the engine is “On Site”

The engine must be “On Site” for changes to the table values to affect the tuning. This means that the engine must be operating at the same RPM and Load as the currently selected site in the calibration table.

Note that when the engine RPM (or Load) is between table sites the current fuel value (or Ignition value etc.) is affected by the sites to either side. For this reason, when adjusting the calibration values it is important that the engine RPM and Load are centred on the current adjustment site to ensure that the values from the adjacent sites have minimal influence on the value being adjusted. Use the Target (at the left of the table) to ensure that the engine operating point is centred on the site being adjusted.

During initial tuning, if large adjustments are required to a particular site ensure that the sites around it are also adjusted to a similar value so that the adjacent sites have minimal influence.

Use the **SPACEBAR** key to quickly move the adjustment cursor to the engine's current operating point.

Site Tables

The RPM and Load sites for the various calibration tables may be modified in the **Setup Sites** screen.

A number of site tables are available which affect different calibration tables. Use the help to check which calibration tables are affected by which site tables.

To insert or delete sites use the **Tools** menu (press the **F9** key). When sites are inserted or deleted, the calibration tables may be adjusted so that the new sites do not affect the tuning.

Dyno Calibration

The alternator should be connected while tuning the engine to ensure that the injectors are working at normal operating voltage.

The exhaust system should be the same as that in the vehicle as it will affect the engine tuning.

On multi runner intake manifolds the air box should be fitted as it is an integral part of the intake system and will affect the engine tuning.

The fuel pressure is critical to the injector flow and should be monitored during dyno tuning. Incorrect fuel pressure will result in incorrect tuning. Note that on turbo engines the fuel pressure will vary as the manifold pressure varies because the regulator maintains a fixed pressure above manifold pressure.

Fuel - Main Table

The **Fuel - Main Table** allows adjustment of the fuel at various RPM and Load points.

Work through all the table values systematically so that all points are adjusted for the correct Air Fuel Ratio reading.

Use **extreme caution** when adjusting the fuel to ensure that the engine does not run lean at high loads. It is best to start rich. A temperature compensated Wideband Air Fuel Ratio Meter is essential to ensure correct air fuel ratio.

Note: If the engine is misfiring for any reason (including over rich) the sensor may falsely read lean due to the oxygen in the unburnt mixture.

The Air Fuel Ratio should be adjusted according to the engine load and the desired results, for example, power, economy, emissions etc. At high loads the mixture should be approximately 0.89 Lambda for maximum power. On turbo charged engines a richer mixture may be required to reduce exhaust temperatures and help avoid knocking. At lighter loads the mixture may be adjusted for best emissions (1.00 Lambda) or best economy (1.05 Lambda).

The cranking (starting) fuel may be changed by adjusting the 0 RPM load sites. Typically more fuel is required at cranking than at idle RPM.

The **Quick Lambda** feature may be used to quickly adjust each table value with one key stroke (Press the **Q** key). The adjustment is made to the value

closest to the current engine operating point. The Quick Lambda feature may only be used if the ECU is directly measuring the Lambda reading. The desired Lambda value must be set in the **Functions - Lambda Control Table**.

If the maximum value in the table falls below 60 then the setup parameter **JPU** should be decreased to increase the table values. This ensures that the table has sufficiently fine resolution. Similarly, if the table values reach the maximum table value then the **JPU** setup parameter should be increased to decrease the table values.

Use the **F5** key to change quickly between the Fuel - Main Table and the Ignition - Main Table.

Use the **F6** key to change quickly between the Fuel - Main Table and Fuel - Timing Table.

Use the **View - Fuel** Screens to check that all the fuel trims and compensations are correct (press the **V** key).

Refer to the **ECU Manager** software help for more details (Press **F1**).

Ignition - Main Table

The **Ignition - Main Table** allows adjustment of the Ignition Timing at various RPM and Load points.

Start with a conservative curve for the particular engine, not too advanced and not too retarded.

Use **extreme caution** when adjusting the Ignition Timing to ensure that the engine does not knock due to excessive advance. Re-check the Ignition Timing with a Timing Light to ensure that what the ECU thinks is the ignition advance is in fact the actual advance.

The Ignition Timing should be adjusted for maximum torque without knocking, by increasing the advance until the torque stops increasing. Make sure there are at least 3 or 4 degrees margin to the knock limit.

Too much retard will cause excessive exhaust gas temperature.

At idle, a more retarded ignition setting is desirable (approximately 10 to 15 degrees). This makes the idle speed less sensitive to load changes. Also the ignition should be flat over the idle RPM range so that timing variations do not cause the engine to hunt, since variations in the timing will vary the engine torque.

The **Quick Lambda** feature may also be used from the Ignition Main Table, which allows ignition timing adjustments to be made while also maintaining correct mixture readings.

Use the **View - Ignition** Screen to check that all the fuel trims and compensations are correct (Press the **V** key).

Refer to the **ECU Manager** software help for more details (Press **F1**).

Fuel - Injection Timing

The **Fuel - Injection Timing** table allows adjustment of the Fuel End of Injection Timing at various RPM points and optionally at various Load points.

This table is only effective if the injectors are fired sequentially.

Adjusting the Injection Timing ensures that the fuel is injected at the optimum point in the engine cycle, so that the engine makes best use of the fuel. In theory the fuel should end injection at a point where all the fuel will be sucked into the current induction stroke, therefore the end of injection point should be some time before the intake valve closes. The optimum point depends on the engine RPM and load.

Torque, economy, emissions and idle quality are all affected by the Injection Timing.

At high duty cycles the Injection Timing will have minimal influence since the injectors are on for most of the engine cycle.

Refer to the **ECU Manager** software help for more details (Press **F1**).

Fuel - Cold Start

The **Cold Start** parameters may be adjusted after the **Fuel - Main Table** has been tuned and the 0 RPM sites have been set for good hot starting.

Refer to the **ECU Manager** software help for more details (Press **F1**).

Other Calibration Tables

The other calibration tables may be adjusted as necessary.

Refer to the **ECU Manager** software help for more details (Press **F1**).

Data Logging & Road Testing

The calibration must be verified on the road. This is best done by logging the air fuel ratio and other sensors and checking them using the MoTeC **i2** software.

Data Logging is also very useful for identifying unexpected problems such as an incorrect air temperature reading due to fuel vapour cooling the sensor or excessive air temperature due to hot air entering the intake system.

Data logging may also be used to verify and fine tune the operation of the various advanced functions such as traction control.

The light load and overrun calibration must also be completed on the road as these areas cannot be adjusted on a dyno.

ECU Manager Software

Introduction

The following is an overview of the main concepts of the **ECU Manager** software. More detailed information is available from the online help.

The **ECU Manager** software is used for :

- Calibration and Setup
- Sending calibration files to the ECU
- Viewing Sensor readings
- Viewing Diagnostics information
- Testing the Outputs
- Unloading the logged data
- Upgrading the ECU firmware
- Enabling ECU options.

PC Requirements

See the MoTeC **Software** section.

Connecting a PC to the ECU

See the MoTeC **Software** section.

Installing the Software

See the MoTeC **Software** section.

Basics

Starting ECU Manager

To start **ECU Manager** double click the icon on the desktop or select **ECU Manager** from the Start menu, for example: Start / Programs / MoTeC / M84/ ECU Manager 1.0

Note that the desktop icon will start the latest version of ECU Manager.

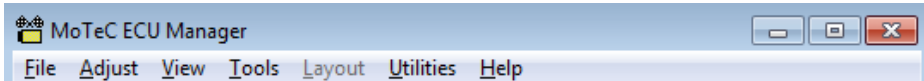
Online Help

Online help is available in two forms:

Context sensitive help is available by pressing **F1** or clicking on the help button, this shows help that is relevant to the current screen.

General help is available from the **Help** menu.

Main Menu



The Main Menu is used to access all of the features of the **ECU Manager** software.

Select a menu item by using the mouse or use the keyboard by holding down the **Alt** key followed by the keys corresponding to the underlined letter of the menu items to be selected. For example to select **File / Exit** hold down the **Alt** key then press **F** then **X**. Alternatively press the **F10** key then use the arrow keys and the **Enter** key to select the desired menu item.

Unavailable Menu Items

Note that some menu items may be unavailable if the ECU is not connected or a file is not opened.

Unavailable items appear grey.

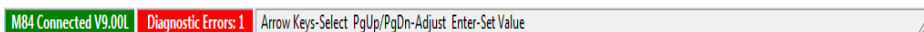
Button Bar (Toolbar)



The Button Bar provides an alternative way of activating some of the commonly used items on the main menu. To find out what each item does hold the mouse pointer over the button of interest until a hint appears.

Note that some items will not be available depending on whether the ECU is connected and if a calibration file is open.

Status Bar



The bottom line on the screen is called the Status Bar and shows the following:

ECU Status: Connected or NOT Connected (if the ECU is connected the ECU firmware version is also shown). If the ECU is not connected the reason that it is not connected is shown where the Diagnostics Errors are normally shown.

The number of diagnostics errors (if the ECU is connected)

Calibration Files

ECU Manager records the ECU calibration and setup data in files that are stored on the PC hard disk, this ensures that a permanent record of the data is kept. The files also record comments to allow easy identification of each file. Any file may be sent to any ECU which will totally re-configure the ECU according to the calibration and setup data contained in the file.

Creating a New Calibration File

To create a new calibration file open an existing file and save it to a new file by selecting **Save As** from the **File** menu.

Sending a Calibration File to the ECU

To send a calibration file to the ECU select **Send File to ECU** from the **File** menu. Note that the ECU must be connected to the PC using a MoTeC UTC or CAN Cable.

Changing the Comments

To change the file comments select **Edit Comments** from the **File** menu.

Versions & Upgrading

MoTeC is continually updating the software and newer versions may be downloaded from the website at no charge www.motec.com.au

The software consists of the **ECU Manager** software that runs on the PC and the control software (firmware) that runs inside the ECU.

The ECU firmware may be updated at any time by the user which allows the latest features to be used.

The **ECU Manager** version may be viewed by selecting **About** from the **Help** menu.

The ECU firmware version is shown on the **ECU Manager** status line when the ECU is connected.

Matching Versions

The version of **ECU Manager** and the version of the firmware in the ECU must match in order to be able to communicate with each other.

To communicate with an ECU that has older firmware in it, either the matching **ECU Manager** software must be used or the ECU firmware must be upgraded to match the version of **ECU Manager** on the PC.

Upgrading the ECU

To upgrade the ECU firmware select **Upgrade ECU Version** from the **Utilities** menu. This will send the new firmware to the ECU and automatically convert the calibration data in the ECU to ensure it is compatible with the new firmware.

Calibration File Versions

The calibration files that are stored on the PC must also match the version of software being used.

To ensure that older version calibration files are not rendered useless, the older version calibration files may be converted in order to be used with the new version of the software. To convert older files select **Convert** from the **File** menu.

Minor Version Updates

Minor version updates do not require the calibration data to be converted but still require the firmware to be sent to the ECU by selecting **Upgrade ECU Version** from the **Utilities** menu.

Minor updates usually contain bug fixes or minor enhancements.

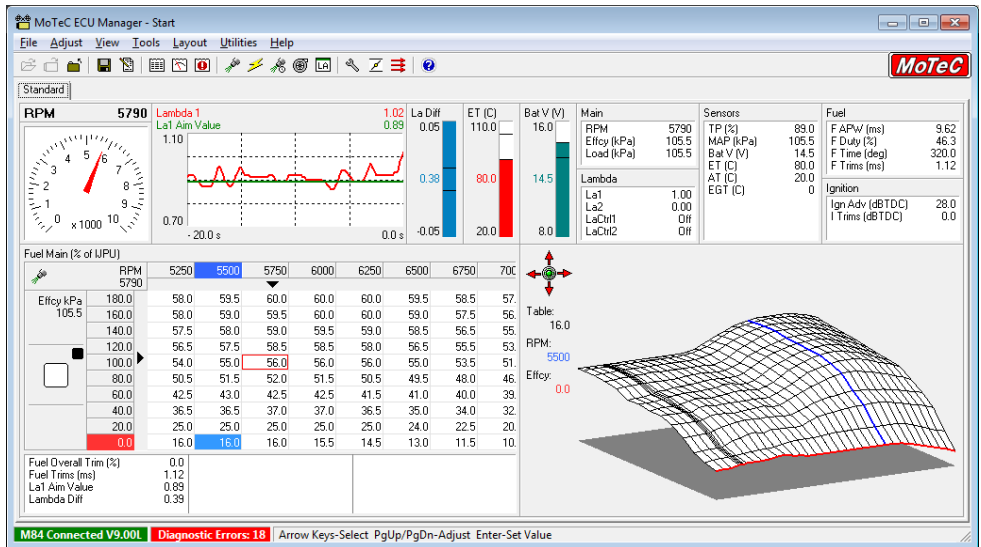
A minor update is one where the number before the decimal point and immediately after do not change, for example 1.00A, 1.00C, 1.01A are all minor updates of version 1.0.

Software Version Release Notes

The changes between the various software versions may be viewed by selecting **Release Notes** from the **Help** menu.

Screen Layouts

The screen layouts are completely user definable and may be optimised to suit the user's preference, the screen resolution and the task to be performed. For example it may be useful to have screen layouts to suit different types of engines or to perform particular tasks such as Idle Control or individual cylinder tuning.



The image above shows one possible screen layout that suits an 800x600 screen.

Layout Pages

Separate layouts may be defined on separate pages. A number of pages may be loaded at once and may then be selected by clicking on the tabs at the top of the pages or by pressing the **Tab** or the **Ctrl+Tab** keys.

The layout pages are saved to files. To open, close or create new pages select the appropriate menu item from the **Layout** menu.

Layout Objects

To add an object to the layout page select **Add** from the **Layout** menu or right click on an empty space in the layout page and select **Add**.

To change the properties (settings) of any object, right click on the object and select **Properties**.

To delete an object, right click on the object and select **Delete**.

Adjust Tables and Adjust Graph Objects

In order to make adjustments the layout page must contain an Adjust Table or an Adjust Graph or both.

Note that only one Adjust Table and one Adjust Graph are allowed per page.

Adjust Tables

Adjust Tables show the values for the currently selected table and allow adjustments to be made. They also show axis indicators and a target to help positioning of the engine operating point.

| Fuel Main (% of IJPU) | | RPM | 5500 | 5750 | 6000 | 6250 | 6500 | 6750 | 7000 |
|-----------------------|------|-----|------|------|------|------|------|------|------|
| 5740 | | | | | | | | | |
| Effcy % 79.5 | 90.0 | | 75.0 | 75.0 | 75.0 | 75.0 | 75.0 | 75.0 | 75.0 |
| | 80.0 | ▶ | 62.0 | 62.0 | 62.0 | 62.0 | 62.0 | 62.0 | 62.0 |
| | 70.0 | | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| | 60.0 | | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 |
| | 50.0 | | 43.0 | 43.0 | 43.0 | 43.0 | 43.0 | 43.0 | 43.0 |
| | 40.0 | | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 |
| | 30.0 | | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 |
| | 20.0 | | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 |
| | 10.0 | | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 |
| | 0.0 | | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 |

Adjust Graphs

The table values may also be shown graphically in an Adjust Graph.

The graph may be rotated if necessary by clicking on the rotation buttons or by holding down the **Ctrl** key while using the arrow keys.

Graph Table

If there is no graph displayed, the table object may be switched between table mode and graph mode by pressing the **G** key.

Y Axis Reversing

On certain graphs it may be desirable to reverse the Y axis so that the graph surface is easier to see.

To do this select **Reverse Y-Axis** on the **Tools** menu or press the **Y** key.

Making Adjustments

On Line / Offline

Changes may be made directly to the ECU (Online) or to a file (Offline).

Online (ECU Connected)

To make changes directly to the ECU, connect the ECU then select **Open ECU** from the **File** menu.

When the ECU is opened the calibration data is first retrieved from the ECU then matched to a file. If the ECU data does not match an existing file then a new file will be created, at which point an Engine Description and Comment should be entered to describe the file.

Changes to the ECU are also saved to this file when the ECU is closed.

Offline (ECU not Connected)

To make changes to a file with the ECU offline, select **Open** from the **File** menu.

The file may be sent to the ECU at a latter date by selecting **Send File to ECU** from the **File** menu.

Closing the ECU or File

When the changes are completed, the ECU or file should be closed by selecting **Close** from the **File** menu. This will ensure that changes are saved to the associated file.

Warning Alarms

If the Warning Alarms have been set a warning screen will be displayed if any sensor goes outside its alarm limits. This can be particularly useful for automatically monitoring engine temperature during a dyno session. The alarms can be configured in the **Functions** table.

Help

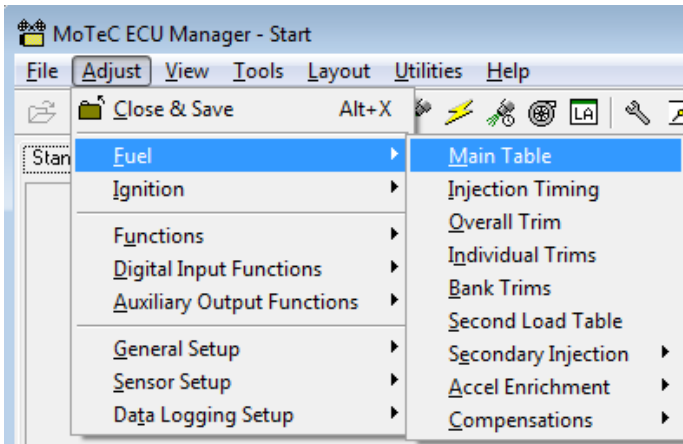
Context sensitive help is available by pressing **F1** or clicking on the help button. This shows help that is relevant to the current screen.

Selecting the Adjust Table

Once a file or the ECU has been opened, the appropriate table or setup screen may be selected from the **Adjust** menu by using the mouse or the keyboard.

To select the **Adjust** menu using the keyboard hold down the **Alt** key followed by the **A** key then use the arrow keys and the **Enter** key to make a selection.

Alternatively, the **Adjust** menu may be displayed by pressing the **Esc** key. This has the advantage that it shows the **Adjust** menu with the current table selected, which often makes it easier to select the next table.



Fuel / Ignition Toggle (F5 key)

The **F5** key will quickly toggle the screen between the current Fuel table and the corresponding Ignition table or vice versa.

F6, F7, F8 Key Assignment

The **F6**, **F7** or **F8** keys may be assigned to any table by pressing **Alt+F6**, **Alt+F7** or **Alt+F8**. This assigns the current table to the **F6**, **F7** or **F8** keys which allows that table to be returned to quickly.

Changing Table Values

Selecting the Item to be Adjusted

The cursor selects the table value that may be adjusted.

The cursor may be moved using the arrow keys, or by pressing the **Spacebar** which will automatically move the cursor to the current engine operating point.

Note that the table does not show all values at once. To view the additional values move the adjustment cursor to the edges of the table using the arrow keys, this will cause the table to scroll and show the hidden values.

Make sure the engine is “On Site”

For adjustments to affect the current engine operation the engine operating point must be at the centre of the selected site. The Adjust Table object provides Indicators and a Target to assist in this.



| Fuel Main (% of IJPU) | | 4500 | 4750 | 5000 | 5250 | 5500 |
|---|-------------|------|------|------|------|------|
|  | RPM 5320 | | | | 5250 | |
| Efcty % 77.5 | 90.0 | 46.8 | 49.0 | 50.8 | 52.3 | 53.3 |
| | 80.0 | 45.5 | 47.0 | 49.0 | 50.5 | 51.5 |
| | 70.0 | 42.8 | 44.0 | 45.3 | 46.5 | 47.3 |
| | 60.0 | 40.0 | 41.0 | 41.5 | 42.5 | 43.0 |
|  | 50.0 | 37.3 | 38.3 | 38.8 | 39.5 | 39.8 |
| | 40.0 | 34.5 | 35.5 | 36.0 | 36.5 | 36.5 |
| | 30.0 | 29.8 | 30.3 | 30.5 | 30.8 | 30.8 |
| | 20.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| | 10.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| | 0.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |

Table Indicators

Indicators are shown at the top and side of the table (the black triangles). The indicators show the current engine operating point and therefore indicate which table value (or values) the ECU is currently using. The indicators must point to the same site as the adjustment cursor for any adjustments to the current engine tuning.

The site that is closest to the current operating point is also indicated by a red rectangle.

Table Target

A target is shown at the left of the table. This allows more accurate positioning of the engine operating point.

For best calibration the indicator should be within or close to the centre rectangle, this ensures that the ECU tuning is determined mainly by the site being adjusted and not by the adjacent sites.

Up / Down Adjustment

Up or Down adjustments may be made to the selected table value using the **PgUp** and **PgDn** keys.

Fast adjustments may be made by holding the **Ctrl** key down while pressing the **PgUp** or **PgDn** keys. This will increment the value by ten times the normal amount.

If the **PgUp** or **PgDn** keys are held down the value will continue to change until the key is released.

Locking in the New Value

When the desired adjustment has been made, the new value must be locked in ("Set") by pressing the **Enter** key. This stores the new adjustment in the ECU's programmable memory.

- If the cursor is moved before pressing the **Enter** key the value will revert to its previous unadjusted value.

Direct Entry

The table values may also be entered directly using the number keys followed by the **Enter** key.

Maths Operations

Mathematical operations may be performed on the currently selected value or the WHOLE table or a BLOCK within a table.

To perform a maths function enter the value followed by an operation key (+, -, *, /). For example **2.5+** will add 2.5 to the current table value.

To apply the maths operation to the whole table type a **T** before pressing the operation key. For example; **2.5T+** will add 2.5 to the whole table.

Block Operations

To perform maths on a block, mark the block by holding down the **Shift** key while pressing the **arrow** keys, then perform the maths operation.

Quick Lambda

The Quick Lambda feature allows the **Fuel - Main Table** values to be adjusted to the correct Lambda by simply pressing the **Q** key. This feature uses the Wideband Lambda reading and the value from the **Lambda Table** to calculate the new fuel table value. The Lambda Table may be accessed by

pressing the **F8** key. The adjustment is made to the value closest to the current engine operating point.

This feature may be performed from the **Fuel - Main Table** or from the **Ignition - Main Table**.

Quick Lambda can also be used to trim the **Fuel - Individual Cylinder Tables** by pressing the **Q** key while the particular table is selected.

Note that this feature requires a Wideband Lambda sensor or meter to be connected to the ECU.

Set Indicators (*)

An * will appear next to items that have been set, with the exception of tables that are dependent on the engine operating point where a * will only appear if the engine operating point corresponds to the currently selected site. The * indicates that the point has been tuned.

The 's may be cleared individually or all * may be cleared at once.

To clear an individual * press the **Delete** key. To clear ALL * select **Clear ALL*** from the **Tools** menu.

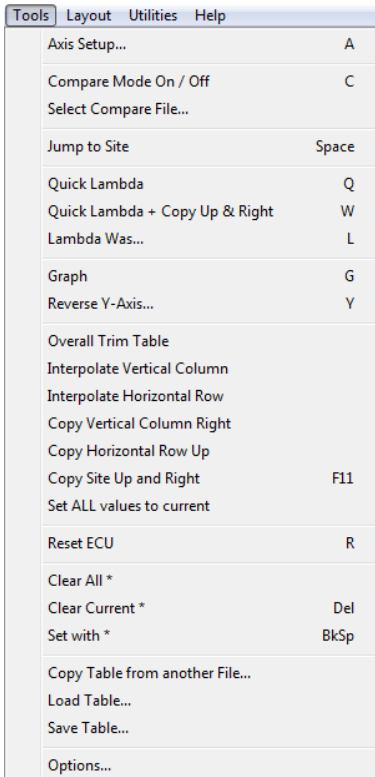
Tools

The Tools Menu allows selection of various functions as listed on the menu below.

The Tools Menu may also be displayed by pressing the **F9** key, in this case the previously selected item will be highlighted which makes it easier to do repetitive operations.

Note that the items on the menu will change depending on which adjust table is shown. For example, Quick Lambda is not available for all tables.

The letter to the right of some menu items is the “hot key”. Pressing this key will activate the item without selecting the Tools menu.



Compare Mode On / Off

Turns **Compare Mode** on or off.

Compare Mode shows the difference between the current file and the selected comparison file.

When **Compare Mode** is turned on, the selected compare file description is shown on the status line at the bottom of the screen.

The comparison file may be selected by choosing **Select Compare File** from the **Tools** menu.

When **Compare Mode** is turned on, an icon will appear at the left of the **Adjust** Menu items that contain differences.

Select Compare File

Selects the file used for **Compare Mode**.

Jump to Site

Moves the Cursor block to the Site closest to the current engine operating point.

Quick Lambda

Adjusts the fuel value to achieve the Lambda value in the Wideband Lambda table.

The new fuel value is calculated by checking the difference between the Lambda sensor reading and the value in the Wide Band Lambda Table.

The Lambda reading may be either Lambda 1, Lambda 2 or the Average of both. This is configured in the Wideband Lambda setup.

The engine must be operating near the centre of the site for the calculation to give correct results.

Quick Lambda may be used from the Fuel Main Table, Fuel Injection Timing Table, Ignition Main Table, Fuel Second Load Table and Fuel Individual Tables.

When used from the Fuel Main Table the cursor jumps to the closest site if the cursor is not on site.

When used from the Ignition Main Table or Fuel Injection Timing Table the Fuel Main Table site closest to the current operating point is adjusted.

When used from the Fuel Second Load Table or the Fuel Individual Tables the change is made to that table rather than the Fuel Main Table.

Quick Lambda + Copy Up & Right

As for Quick Lambda except that the new value is copied to the sites immediately above, right and diagonally above and right if the sites do not contain a *.

Lambda Was

Adjusts the fuel table value by an appropriate amount by comparing the value entered by the user to the desired Lambda value in the Lambda Table.

The value that is entered may be either the current Lambda reading from a lambda meter if tuning online or the Lambda reading from the logged data if tuning offline.

Note that if a Lambda sensor is directly connected to the ECU then online tuning may be performed more easily using the Quick Lambda function.

Overall Trim Table

Trims the whole table by the percentage indicated by the Overall Trim then sets the Overall Trim back to 0.

This is useful during initial tuning of the Fuel Main Table since an existing table can be used then trimmed to take into account variations in injector sizing etc. Note that it is better to change the IJPU setup parameter if large changes are required as this will ensure that the table numbers maintain sufficient range and resolution, i.e. ensures that the table numbers do not become too small or too large.

Note that during interpolation the engine may run incorrectly. It is therefore best if the engine is stopped during the interpolation. If the engine is running, a warning will be given before the interpolation is started.

Interpolate Vertical Column

Linearly interpolates the current column between the upper most value and the lower most value leaving the upper most value, the lower most value and points marked with an * unchanged.

Note that it may be necessary to use the **Backspace** key to mark the desired points with an *.

Interpolate Horizontal Row

Linearly interpolates the current row between the left most value and the right most value leaving the left most value, the right most value and any points marked with an * unchanged.

Note that it may be necessary to use the **Backspace** key to mark the desired points with an *.

Copy Vertical Column Right

Copies the data in the current column to the column immediately to its right.

Copy Horizontal Row Up

Copies the data in the current row to the row above.

Copy Site Up And Right

Copies the value of the current site to the sites immediately above, right and diagonally above and right if the sites do not contain an *.

Reverse Y-Axis

Reverses the Y axis for the Graph or Table or both. This makes some graphs easier to see.

Toggle Table Mode

If a table is displayed and there is no graph displayed this will switch the table between table mode and graph mode.

Set All Values To Current

Set all values in the current table to the value of the current site.

Reset ECU

Resets the ECU. This can be useful if changes have been made to a setup item that requires the ECU to be reset, normally this does not happen until a different screen is selected.

Clear All *

Clears all *s in either the currently displayed table or all tables.

The *s are normally used to indicate which sites have been tuned.

Clear Current *

Clears the * on the current site.

Set with *

Sets an * on the current site whether or not the engine is currently at that site.

Copy Table from Another File

Copy a table from another calibration file into the current table.

Warning - The current table data will be overwritten.

Import CSV File

Read a CSV (Comma Separated Value) file into the current calibration table.

Normally the CSV file is one that has been written out from another configuration file, possibly for a different ECU type.

Warning - The current table data will be overwritten.

Note that the CSV file must be for the same type of table.

Note also that the site values are not imported, therefore the site values must be the same as the sites in the CSV file for the table to have the same result.

Export CSV File

Write the current table to a CSV (Comma Separated Value) file.

May be used to transfer data between different ECU types or for use in a spreadsheet.

Insert Site

Insert a site to the left of the current site.

The new site value will be half way between the value of the current site and the value of the site to the left.

(Available only in the Site setup screens)

Delete Site

Delete the current site.

(Available only in the Site setup screens)

View Screen

The View Screen may be shown by pressing the **V** key or by selecting the desired view page from the **View** menu. The View Screen displays all the operating details of the ECU including:

- Sensor data
- Diagnostics errors
- Fuel injection detail including all trims and compensations
- Ignition detail including all trims and compensations
- Boost control detail
- Status information
- Output Status
- Internal voltages etc.

The View Screen has a number of pages that may be accessed by pressing **Tab** while holding down the **Ctrl** key or by pressing the first letter of the screen name.

It also allows resetting of Diagnostic Errors, Maximum RPM and Fuel Used. The Diagnostic Errors Screen may be accessed directly by pressing the **F3** key.

Note that the View Screen may be viewed with or without the ECU open (but only if the ECU is connected).

The screenshot shows the 'View Screen' window with a menu bar at the top containing: Sensors, Diagnostic Errors, Fuel, Ignition, Boost, Calculated, Status, Outputs, Internal, and GPS. The main content area is divided into several sections:

| Trigger Sensors | | Main Sensors | | | Gear Sensors | | |
|-----------------|-------|--------------|-------|-----------|--------------|--------|------|
| RPM | 5780 | Bat V (V) | 14.5 | FP (kPa) | 385.1 | Gear V | 0.00 |
| Max RPM (rpm) | 14192 | La1 | 0.92 | OP | 0 | Gear | 0 |
| SyncPos (%) | 38.6 | La2 | 0.00 | EGT | 0 | | |
| Ref V (V) | -0.28 | TP (%) | 63.5 | User 1 | 0 | | |
| Sync V (V) | -0.07 | MAP (kPa) | 100.0 | User 2 | 0 | | |
| Ref Max (V) | 5.42 | ET | 0.0 | ECU T (C) | 36.9 | | |
| Ref Min (V) | -5.54 | AT (C) | 36.7 | | | | |
| SyncMax (V) | 4.91 | | | | | | |
| SyncMin (V) | -5.00 | | | | | | |

| Sensor Supplies | | Speed Sensors | |
|-----------------|------|---------------|-----|
| 5V Aux (V) | 5.00 | Gnd Spd | 0.0 |
| 5V Eng (V) | 4.98 | Drv Spd | 0.0 |
| 8V Aux (V) | 7.97 | LD Spd (km/h) | 0.0 |
| 8V Eng (V) | 7.98 | RD Spd (km/h) | 0.0 |
| | | LG Spd (km/h) | 0.0 |
| | | RG Spd (km/h) | 0.0 |
| | | Slip | 0.0 |

| Input Positions | |
|-----------------|-----|
| SySnPos (deg) | 0.0 |

At the bottom of the window, there are four buttons: 'Reset Errors' (highlighted), 'Reset Fuel Used', 'Reset Max RPM', 'Close', and 'Help'.

Testing the ECU Outputs

The ECU Outputs (Fuel Injectors, Ignition Outputs and Auxiliary Outputs) may be tested by selecting **Test Outputs** from the **Utilities** menu.

This allows verification of the operation of the wiring and actuators. It is also very useful in checking that the injectors are wired in firing order.

ECU Password

A password may be set in the ECU to stop unauthorised access to the ECU configuration data.

The password may be set by selecting **Adjust | Security Setup** from the main menu.

File Encryption

File Encryption allows a configuration file to be distributed to a customer without the customer being able to view the contents of the file.

An encrypted file can only be sent to an ECU that has its password set to the same value as the Encryption Number that was used to encrypt the file. An encrypted file cannot be sent to an ECU with no password.

The data in an encrypted file cannot be viewed.

The comments for an encrypted file are the same as those of the file from which it was created. The comments cannot be edited. It is possible to create files with the same comments so care needs to be taken to ensure the correct files are used. Any unnecessary files should be deleted.

Enabling ECU Options

A number of options are available which allow the ECU to be configured for a particular need or updated later if necessary

The options may be enabled at any time by selecting **Utilities | Enable ECU Options** from the main menu and entering the enabling password.

Keyboard Reference

| | |
|------------------|---|
| PgUp | Adjust Up |
| PgDn | Adjust Down |
| Ctrl+PgUp | Fast Adjust Up |
| Ctrl+PgDn | Fast Adjust Down |
| Shift+PgUp | Slow Adjust Up (Not available on all tables) |
| Shift+PgDn | Slow Adjust Down (Not available on all tables) |
| Enter | Set the adjusted Value |
| Alt+X | Close the ECU or File |
| Esc | Show the Adjust menu with the current screen item highlight |
| Tab | Select the next Layout page |
| Spacebar | Jump the cursor to the site closest to the current engine operating point |
| F1 | Show Help |
| F3 | Show the Diagnostics Errors screen |
| F5 | Toggle between the Fuel and Ignition screens |
| Alt+F6 | Remember the current screen, show it when F6 is pressed |
| Alt+F7 | Remember the current screen, show it when F7 is pressed |
| Alt+F8 | Remember the current screen, show it when F8 is pressed |
| F6 | Select the Fuel Timing screen (or the remembered screen) |
| F7 | Select the Boost Limit screen (or the remembered screen) |
| F8 | Select the Lambda Table screen (or the remembered screen) |
| F9 | Show the Tools menu |
| F10 | Select the Main menu |
| F11 | Copy site up and right |
| C | Turn Compare Mode Off / On |
| E | Edit the File Comments |
| G | Switch table between table mode and graph mode |
| L | Lambda Was |
| Q | Quick Lambda |
| W | Quick Lambda plus copy up and right |
| V | Show the last View screen |
| S | Show the sensors tab on view screen |
| Y | Reverse the Y axis on the table, graph or both |
| Delete | Delete * at the current site |
| Backspace | Place * at the current site |
| Home | Select one of a number of default view angles for the graph |
| Ctrl+Arrow | Change the view angle of the graph |
| Shift+Arrow | Mark a block on the table (mathematics may be applied to the block) |
| Ctrl+Shift+Arrow | Copy the current table value to an adjacent cell |

Appendices

Appendix A: General Specifications

Physical

| | |
|------------|--|
| Case Size: | 147mm x 105mm x 40mm (5.8in x 4.1in x 1.6in) |
| Weight: | 0.50 kg (1.10lb) |

Power Supply

| | |
|-------------------------------|---|
| Operating Voltage: | 6 to 22 Volts DC |
| Operating Current: | 0.5 Amps Max (excluding sensor and load currents) |
| Reverse Battery Protection: | Via External Fuse |
| Battery Transient Protection: | Internal Clamp |

Operating Temperature

| | |
|-----------------------------|--|
| Internal Temperature Range: | 10 to 80°C (14 to 176°F) |
| Ambient Temperature Range: | 10 to 70°C (14 to 158°F) typical depending on output loading |

Appendix B: Sensor Supplies

Maximum Current

5V ENG Sensor Supply: 0.20 Amps Max

5V AUX Sensor Supply: 0.15 Amps Max

8V ENG Sensor Supply: 0.30 Amps Max

8V AUX Sensor Supply: 0.30 Amps Max

Accuracy / Temp Drift

5V ENG Sensor Supply: $\pm 0.5\%$ max at 25°C + 100ppm/°C max

5V AUX Sensor Supply: $\pm 0.5\%$ max at 25°C + 100ppm/°C max

8V ENG Sensor Supply: $\pm 5\%$ max over entire temperature range

8V AUX Sensor Supply: $\pm 5\%$ max over entire temperature range

Protection

Short circuit

Thermal overload

Connection to battery

Appendix C: Input Characteristics

Analogue Voltage Inputs

Suitable for: Potentiometers, voltage output sensors and Variable resistance sensors.

Measurement Voltage Range: 0 to 15 V

Input Resistance: 100k ohms to 0 V

Resolution: 3.74 mV

Filter: 150Hz 1st order

Measurement Method: Absolute

- Note that variable resistance sensors require a pullup resistor to the 5V sensor supply. (Normally a 1000 ohm resistor is used)
- Note that voltages outside the input voltage range may affect the readings on other inputs.

Analogue Temp Inputs

Suitable for: 2 wire variable resistance sensors and some voltage output sensors

Measurement Voltage Range: 0 to 15 V

Input Resistance: 1000 ohms to the 5V sensor supply and 100k ohms to 0V.

Resolution: 3.74 mV

Filter: 150Hz 1st order

Measurement Method: Absolute

- Note that some voltage output sensors may not be able to drive input resistance.
- Note that voltages outside the input voltage range may affect the readings on other inputs.

When used as Switch Inputs

The Analogue Temp Inputs may also be used as Switch Inputs

Trigger Levels: Programmable 0 to 15V

Hysteresis: Individually programmable high and low levels.

Lambda Inputs

Wideband

Sensor Type: NTK or Bosch LSU 4.0, 4.2, 4.9

Measurement Range : 0.70 to 32.0 Lambda

Narrow Band

The LA1S and LA2S inputs may be used to measure the voltage of normal narrow band oxygen sensors.

If closed loop control is to be used then an external 33k ohm bias resistor from the input to 0V is required to bias the input to Stoichiometric (0.45V) while the sensor is cold.

Digital Inputs

| | |
|-----------------------------|---|
| Suitable for: | Switch to 0V, logic signal and open collector device (e.g. Hall Switch) |
| Pullup Resistor: | 4700 ohms to 5 V |
| Voltage Range: | 0 to 15 V |
| Positive Trigger Threshold: | 3.5 V max |
| Negative Threshold: | 1.0 V min |
| Hysteresis: | 0.5 V Min |
| Filter Time Constant: | 22 usec |
| Trigger Edge: | Programmable |
| Measurement Methods: | Switched, Speed / Frequency, Period, Pulse Width |

Appendix D: Auxiliary Output Characteristics

The following tables list the characteristics for the Auxiliary Outputs.

| Output | Low Side Driver | | High Side Driver | | General | |
|--------|-------------------------|-----------------------|-------------------------|-----------------------|---------------------|---------------|
| | Nominal Max Current (A) | Min Current Limit (A) | Nominal Max Current (A) | Min Current Limit (A) | Flyback Voltage (V) | Max Freq (Hz) |
| AUX1 | 5 | 7 * | 5 | 7 | Recirculate | 10000 |
| AUX2 | 5 | 7 * | 5 | 7 | Recirculate | 10000 |
| AUX3 | 1 | 3 | - | - | 60V | 10000 |
| AUX4 | 1 | 3 | - | - | 60V | 10000 |
| AUX5 | 1 | 3 | 0.7 | 0.7 * | Recirculate | 200 |
| AUX6 | 1 | 3 | 0.7 | 0.7 * | Recirculate | 200 |
| AUX7 | 1 | 3 | 0.7 | 0.7 * | Recirculate | 200 |
| AUX8 | 1 | 3 | 0.7 | 0.7 * | Recirculate | 200 |

Normally the current should not exceed the *Nominal Max Current* but in some circumstances it may exceed this value for a short period of time as long as it does not exceed the *Min Current Limit* and as long as the duty cycle is low. The limiting factor is thermal dissipation in the output driver.

- The total maximum low side current should not exceed 15A (all outputs added together).
- The minimum frequency for all outputs is 15Hz (except when used as a switched output).
- Items marked * use a linear current limit. All other outputs shutdown at the current limit.

Appendix E: Ignition Output Characteristics

Source Current: 20mA (Single Coil / Coil per Plug) / 40mA (Wasted Spark)

Source Voltage: 5.7V max at 20mA, 4.6V max at 40mA

Sink Current: 1 Amp max nominal (3 Amp current limit)

Appendix F: Injector Output Characteristics

The Injector outputs can operate in two modes: Peak and Hold mode and Saturated mode.

Peak and Hold Mode

This mode is normally required for low resistance injectors (5 ohms or less). This mode allows the injector current to build up to a high value to open the injector and is then reduced to minimise power dissipation in the injector. Normally this means that the ECU has to dissipate a large amount of power. MoTeC uses a switch mode technique to minimise power dissipation in the ECU. The opening current is referred to as the *Peak* current and the reduced current as the *Holding* current.

The peak current is fully programmable and is suitable for very low ohm injectors including 0.5 ohms.

| | |
|------------------|---|
| Peak Current: | Programmable from 0 to 6 Amps |
| Holding Current: | 25% of Peak Current |
| Flyback Voltage: | 60V |
| Diagnostics: | Open Circuit, Short to Battery, Peak current not reached. |

Saturated Drive Mode

This mode is normally used for high resistance injectors (12 ohms or greater).

| | |
|--------------------------|--------------------------------|
| Nominal Maximum Current: | 2 Amps |
| Current Limit: | 4 Amps |
| Flyback Voltage: | 60V |
| Diagnostics: | Open Circuit, short to Battery |

High / Low Injection

The injector output characteristics may be set independently for High/Low injectors allowing two different types of injectors to be used.

Appendix H: Wire Specifications

M22759/16 Wire Ratings (For Various Wire Gauges)

| | |
|---------------------|-------------------|
| Insulation Material | Tefzel |
| Conductor | Tin Plated Copper |
| Voltage Rating | 600 V |
| Maximum Temperature | 150 °C |

| Wire Gauge (AWG) | Cross Sectional Area (mm ²) | Max Current at 100 °C Ambient (Amps) | Resistance (ohm / m) | Resistance (ohm / 1000 ft) |
|------------------|---|--------------------------------------|----------------------|----------------------------|
| 22 | 0.38 | 5 | 0.045 | 14 |
| 20 | 0.61 | 6 | 0.028 | 8.5 |
| 18 | 0.96 | 9 | 0.018 | 5.5 |
| 16 | 1.2 | 12 | 0.014 | 4.3 |
| 14 | 1.9 | 18 | 0.009 | 2.7 |
| 12 | 3.0 | 24 | 0.006 | 1.8 |

Appendix J: CAN Wiring - Multiple Devices

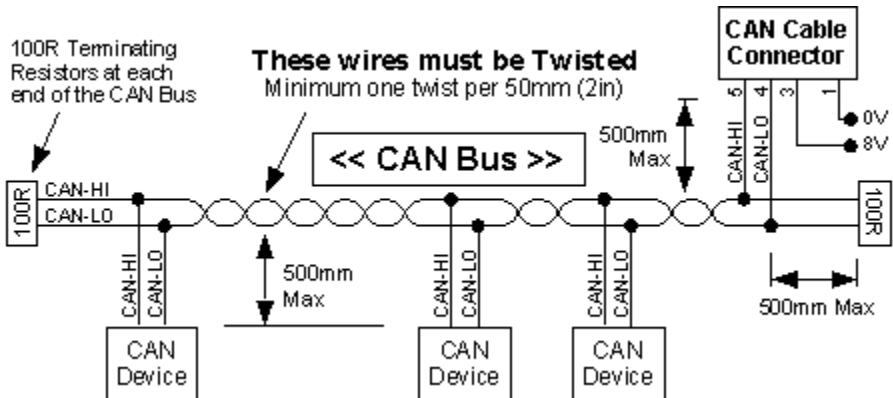
The CAN bus should consist of a twisted pair trunk with 100R (0.25Watt) terminating resistors at each end of the trunk.

The preferred cable for the trunk is 100R Data Cable but twisted 22# Tefzel is usually OK.

The maximum length of the bus is 16m (50ft) including the MoTeC CAN Cable (PC to CAN Bus Communications Cable)

CAN Devices (such as MoTeC ADL, BR2 etc.) may be connected to the trunk with up to 500mm (20in) of twisted wire.

The connector for the CAN Communications Cable may also be connected to the trunk with up to 500mm (20in) of twisted wire and should be within 500mm of one end of the trunk. If desired, two CAN Cable connectors may be used so that the MoTeC CAN Cable may be connected to either side of the vehicle. Both connectors must be within 500mm of each end of the trunk.



Short CAN Bus

If the CAN Bus is less than 2m (7ft) long then a single termination resistor may be used. The resistor should be placed at the opposite end of the CAN Bus to the CAN Cable connector.

Single Device

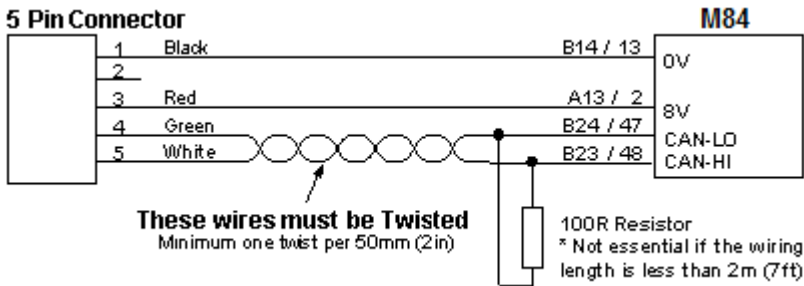
See Appendix K: CAN Bus Wiring - Single Device.

Appendix K: CAN Bus Wiring - Single Device

When a single device (such as an ECU) is connected to the CAN bus the wiring scheme shown below may be used to provide a connection point for the MoTeC CAN cable.

If the wiring length is less than 2m (7ft) the terminating resistor is recommended but not essential.

If other devices are connected to the CAN bus a special wiring scheme is required. See CAN Bus Wiring Multiple Devices.



5 Pin Connector Type :

| | | |
|---------|------------|----------------|
| Deltron | 716-0-0501 | (Non Latching) |
| Neutrik | NC5FDL1 | (Latching) |

Appendix L: Pin list by Function

M84

| Pin No | Abbrev | Description |
|--------|--------|-------------|
|--------|--------|-------------|

Battery

| | | |
|---------|------|------------------|
| A26 | VBAT | Battery Positive |
| A10,A11 | GND | Battery Negative |

Sensor Supplies

| | | |
|-----|--------|------------------------------------|
| A12 | 8V-ENG | 8V Engine Sensor Supply |
| A2 | 5V-ENG | 5V Engine Sensor Supply |
| B16 | 0V-ENG | 0V Engine Sensor Supply |
| A13 | 8V-AUX | 8V Auxiliary Sensor and CAN Supply |
| A9 | 5V-AUX | 5V Auxiliary Sensor Supply |
| B15 | 0V-AUX | 0V Auxiliary Sensor Supply |

Auxiliary Outputs

| | | |
|-----|------|--------------------|
| A18 | AUX1 | Auxiliary Output 1 |
| A1 | AUX2 | Auxiliary Output 2 |
| A23 | AUX3 | Auxiliary Output 3 |
| A24 | AUX4 | Auxiliary Output 4 |
| A31 | AUX5 | Auxiliary Output 5 |
| A32 | AUX6 | Auxiliary Output 6 |
| A33 | AUX7 | Auxiliary Output 7 |
| A34 | AUX8 | Auxiliary Output 8 |

Ignition Outputs

| | | |
|----|------|-------------------|
| A3 | IGN1 | Ignition Output 1 |
| A4 | IGN2 | Ignition Output 2 |
| A5 | IGN3 | Ignition Output 3 |
| A6 | IGN4 | Ignition Output 4 |
| A7 | IGN5 | Ignition Output 5 |
| A8 | IGN6 | Ignition Output 6 |

Injector Outputs

| | | |
|-----|------|-------------------|
| A19 | INJ1 | Injector Output 1 |
| A20 | INJ2 | Injector Output 2 |
| A21 | INJ3 | Injector Output 3 |
| A22 | INJ4 | Injector Output 4 |
| A27 | INJ5 | Injector Output 5 |
| A28 | INJ6 | Injector Output 6 |
| A29 | INJ7 | Injector Output 7 |
| A30 | INJ8 | Injector Output 8 |

M84

| Pin No | Abbrev | Description |
|--------|--------|-------------|
|--------|--------|-------------|

Analogue Voltage Inputs

| | | |
|-----|-----|--------------------------|
| A14 | AV1 | Analogue Voltage Input 1 |
| A15 | AV2 | Analogue Voltage Input 2 |
| A16 | AV3 | Analogue Voltage Input 3 |
| A17 | AV4 | Analogue Voltage Input 4 |
| A25 | AV5 | Analogue Voltage Input 5 |
| B20 | AV6 | Analogue Voltage Input 6 |
| B21 | AV7 | Analogue Voltage Input 7 |
| B22 | AV8 | Analogue Voltage Input 8 |

Analogue Temp Inputs

| | | |
|-----|-----|------------------------------|
| B3 | AT1 | Analogue Temperature Input 1 |
| B4 | AT2 | Analogue Temperature Input 2 |
| B5 | AT3 | Analogue Temperature Input 3 |
| B6 | AT4 | Analogue Temperature Input 4 |
| B7 | AT5 | Analogue Temperature Input 5 |
| B19 | AT6 | Analogue Temperature Input 6 |

Digital Inputs

| | | |
|-----|------|-----------------|
| B8 | DIG1 | Digital Input 1 |
| B9 | DIG2 | Digital Input 2 |
| B10 | DIG3 | Digital Input 3 |
| B11 | DIG4 | Digital Input 4 |

Trigger Inputs

| | | |
|----|------|------------------------------|
| B1 | REF | Crank Reference Timing Input |
| B2 | SYNC | Cam Sync Timing Input |

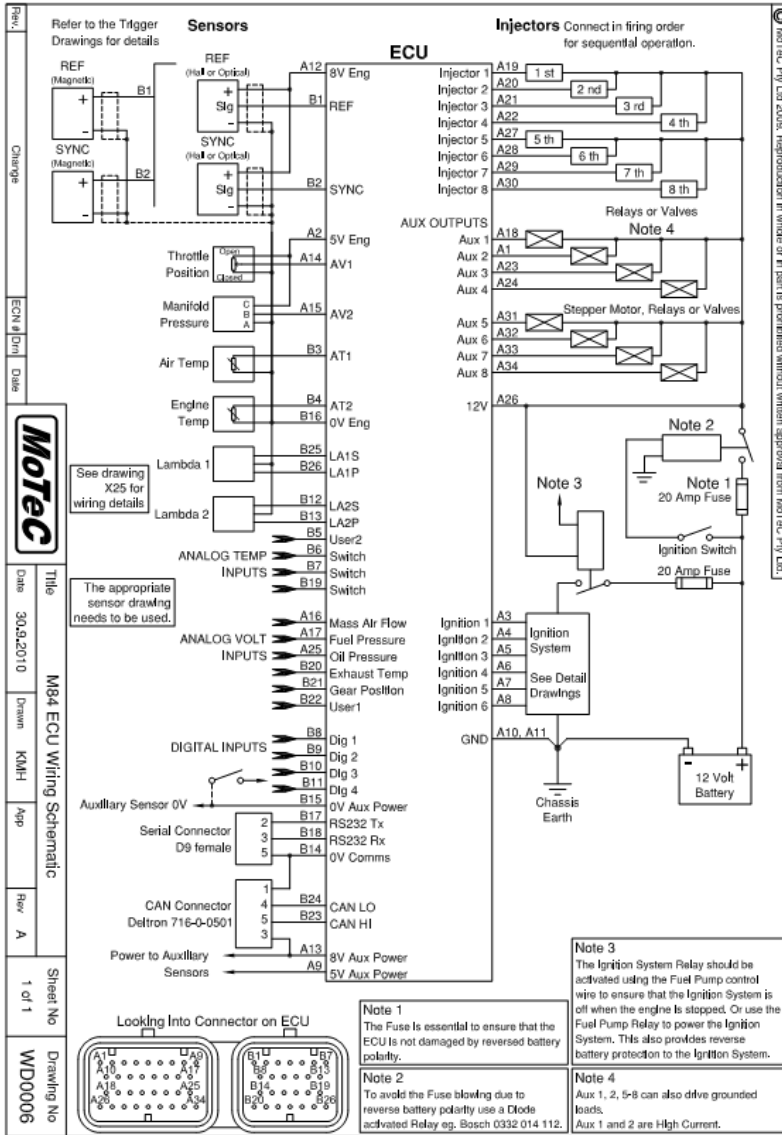
Lambda Inputs

| | | |
|-----|-------|-----------------------|
| B26 | LA1-P | Lambda1 Pump Current |
| B25 | LA1-S | Lambda1 Sense Voltage |
| B13 | LA2-P | Lambda2 Pump Current |
| B12 | LA2-S | Lambda2 Sense Voltage |

Comms

| | | |
|-----|--------|------------------------------------|
| B17 | TX-232 | RS232 Transmit Data |
| B18 | RX-232 | RS232 Receive Data |
| B24 | CAN-LO | Can Bus Low |
| B23 | CAN-HI | Can Bus High |
| B14 | 0V-COM | 0V Comms |
| A13 | 8V-AUX | 8V Auxiliary Sensor and CAN Supply |

Appendix M: Wiring Schematic



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| | | | | |
|--------------|--------------------------|------------|---------|------|
| Rev. | Change | ECN # | DN | Date |
| MoTeC | | | | |
| Date | Title | Drawn | App | Rev |
| 30.9.2010 | M84 ECU Wiring Schematic | KKAH | | A |
| Street No | 1 of 1 | Drawing No | WDD0006 | |

