

OMEM 150

Hardware Instructions

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1 Introducing Omex Engine Management

Thank you for choosing Omex Engine Management. This manual is written to help the user through the specifics of the OMEM150 ECU. **It is essential that the user reads all of the Omex manuals before attempting to install the system and before attempting to start the engine.** Incorrect use of the Omex system could potentially lead to damage to the engine and personal injury. If you have any doubts about fitting these parts or using the software then please contact Omex for help.

As the system is computer based, technical support is given on the assumption that the user is able to perform simple Windows based operations.

Omex may not be held responsible for damage caused through following these instructions, technical, or editorial errors or omissions. If you have any doubts about fitting these parts or using the software then please contact Omex for help.

1.1 Notation Used in This Manual

Menu commands are signified in bold type with a pipe symbol | between each level of the menu.

For example, **File | Open** indicates that you should click on the **Open** option in the **File** menu.

UPPER CASE TEXT is used to indicate text that should be typed in by the user.

2 Quick Start

This manual has been written to give all of the technical information required to map an engine and set up various controls such as idle. Most users however, only need to get the engine to the point where the vehicle can be carefully driven to a dyno, so this 'quick start' chapter has been written to direct you through the procedures needed to achieve this. It is still recommended that you read the manual in full before attempting to use your Omex ECU, but the following information will help you with the practicalities of setting up your system.

2.1 Software

- Install MAP2000 software onto your computer as described in the software manual. For more information about using the software refer to the software specific manual.

2.2 Trigger Wheel

This is only applicable to engines using crank triggering for engine speed and position. If distributor triggering refer to section 3.1.3.

- Accurately mark TDC.
- Turn the engine to approximately 60° BTDC.
- Mount your crank position sensor (CPS) around the perimeter of the timing wheel pointing towards the centre of the wheel with a sensor to wheel gap of approximately 0.5mm.
- One of the teeth must face the crank position sensor at this point.

2.3 Wiring

Wire your semi-assembled harness as described in section 8.

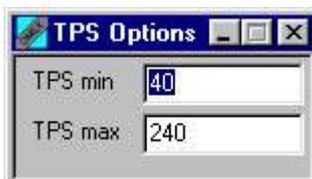
2.4 Throttle Position

The throttle position sensor outputs a raw number to the ECU. The ECU needs to know what this number means in relation to throttle position. We therefore have to use the MAP2000 software to give the ECU the required information.

- Connect the data lead between the Omex ECU and your computer's coms port.
- Click on the **START** button



- Ensure the vehicle's ignition is off.
- Open **ECU | Connect** and then turn on the vehicle's ignition. Do not crank the engine. The ECU should now be connected live to the computer.
- The **Parameters** window should now have a number for **TPS raw**. At the idle position, the throttle pot needs to be physically turned until this number is around 20. Tighten the throttle pot then open to WOT (wide open throttle) and check the **TPS raw** number. This number should be less than 255. If the number is 255, then the throttle pot is at its stop so needs to be turned back until it reads less than 255.



- The number for **TPS raw** at WOT needs to be inputted to the **TPS options** window as **TPS max**. The number for **TPS raw** at idle needs 4 taken from it, then inputting to the **TPS options** window as **TPS min**. In the **Parameters** window, **Throttle** should now read '1'. This is the number needed at idle NOT '0'. If the number shown is not '1' then change **TPS min** in the options table until it does. If the value of throttle reads '0', then this will give inconsistent idle. Therefore check that the value will always read '1' by snapping the throttle open and closed several times.

2.5 MAP Sensor

If fitted with a MAP sensor, then the MAP sensor will need calibration. The calibration varies depending on the range of the sensor. MAP sensor ratings are absolute rather than boost pressure so 1bar is for NA engines and barometric compensation, 2bar for up to 1bar boost, and 3bar for up to 2bar boost.

2.5.1 1 bar Sensor

- Enter a value for **MAP max** of 255.
- Enter a value for **MAP min** of 15.
- Vary **MAP min** until the engine has its idle on the 10% load site.

2.5.2 2 and 3 bar Sensor

- The value for **MAP max** can be calculated as follows.

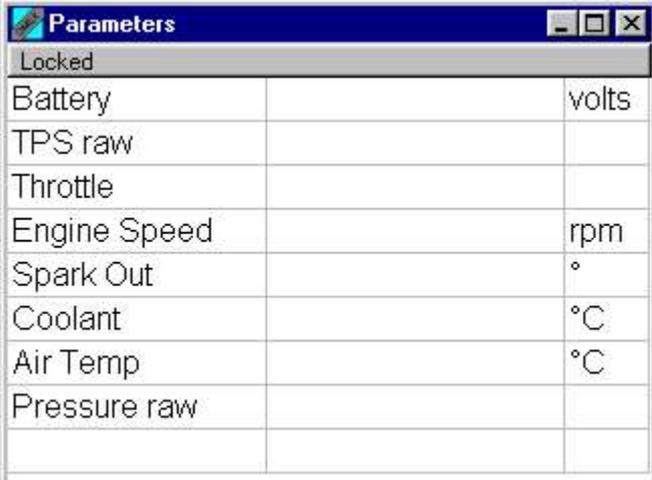
$$\text{MAP max} = \frac{\text{Boost in psi} + 14.7}{14.7 \times \text{bar rating of sensor}} \times 255$$

This value should then have 10 added to it to allow for overboosts.

- Alternatively pump the sensor up to the maximum expected boost pressure and read off the value of **pressure raw** in the parameters window. Enter this number as **MAP max**.
- Enter a value of **MAP min** of 2 bar sensor = 15
3 bar sensor = 5
- Vary **MAP min** until the engine has its idle on the 10% load site.

2.6 Sensor Testing

All of the sensors need to be tested before starting the engine. The inputs from the sensors can be seen in the **Parameters for Setup** window.



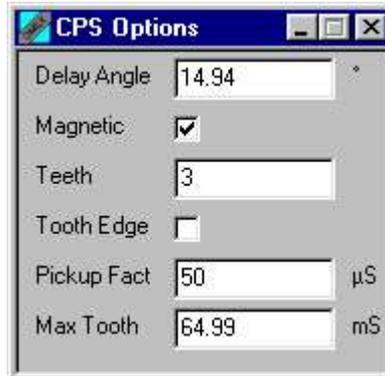
Parameters		
Locked		
Battery		volts
TPS raw		
Throttle		
Engine Speed		rpm
Spark Out		°
Coolant		°C
Air Temp		°C
Pressure raw		

As some of the sensors have been checked during calibration, there are only a few remaining. **Battery** is the battery voltage and should read between 9 and 16 v. The coolant and air temperatures should read sensible numbers, around room temperature if the engine has not been started. **Engine Speed** will show between 100 and 250 rpm under cranking. This can be checked when the timing is calibrated.

2.7 Timing

The ECU uses a crank position sensor and trigger wheel to sense engine speed and position. The ECU must therefore be told where the engine is in its cycle when it sees each tooth reference point.

- In the **CPS Options** window set **Delay Angle** to 15, as this value should be close enough to allow the engine to start.



- Open **Idle | Idle Options**, to find **Hi Idle Adv** and **Low Idle Adv**.
- Take note of these values as they are the idle stabilisation values. They will at idle govern the ignition timing changes allowed to maintain idle so set them to 0 to stop them from moving the ignition timing rapidly.
- Start the engine. As the timing is not correctly set, and the fuelling is yet to be mapped, this may require moving the throttle to find a point at which it will start. When the engine has started, find a point above idle where the engine runs smoothly and **Spark Out** is stable. This would normally be above 2000rpm. Using a timing light, compare the value of **Spark Out** to the timing value shown on the light.
- As the value for **Delay Angle** option is changed, the value of **Spark Out** will remain constant, but the timing figure shown on the timing light will change. You are aiming to have the timing light reading the same value as **Spark Out**.
- Reset **Hi Idle Adv** and **Low Idle Adv** to the original values.

3 Sensors

3.1 Timing

The ECU needs to know engine speed and position in order to supply the correct fuelling and ignition timing. This is often achieved using the standard sensors, but can involve putting new sensors on the engine.

3.1.1 Magnetic Variable Reluctance Sensor

Engine speed and position are sensed with a crankshaft mounted magnetic/reductance sensor. The sensor detects the movement of an iron tooth past its pole-piece. **Magnetic** in the options menu must be set to ON to use this type of sensor.

3.1.2 Trigger Wheels

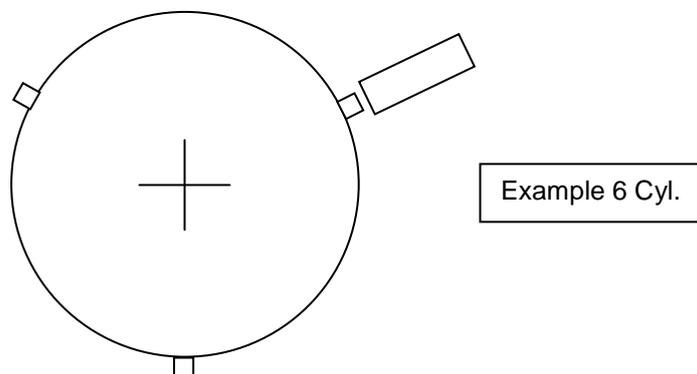
The crank trigger needs to provide one pulse per ignition event, ie

- 2 pulses / engine rev for a 4 cyl
- 3 pulses / engine rev for a 6 cyl
- 4 pulses / engine rev for an 8 cyl

The exact position of the first pulse is not critical as it can be adjusted in software but the second pulse must be **exactly x** degrees later and so on.

- 4 cyl $x=180$
- 6 cyl $x=120$ (as shown in diagram)
- 8 cyl $x=90$

The easiest way to do this is either to machine the front pulley or to have a timing disc made up. Remember that the timing disc must be made from a magnetic material if you are using the magnetic pickup (the preferred option for most engines). You will need to arrange for raised notches as below. Slots in the pulley can work but can be unreliable unless the machined finish of the pulley is very good.



To position the sensor and disc, firstly rotate the engine to approximately 60 degrees BTDC. Then choose where the sensor is to be mounted. At this position one of the lugs on the timing pulley must be facing the sensor. The timing disc is then fixed in that position.

The clearance between the disc and sensor is determined to some extent by experimentation but about 0.5mm is generally satisfactory.

When the engine is running, the option **Delay Angle** is then used to bring the mapped value into line with the real timing value.

3.1.3 Distributor Triggering

It is possible to give the engine its speed and position signal through distributor triggering instead of a crank trigger wheel. This option is however difficult to set up and not all distributors are suitable so is not usually advised. If this is the speed sensing used, then the type of sensor required is a Hall Effect sensor.

- Fit the distributor as normal, but with the cap removed
- Rotate the engine to approximately 55 BTDC, firing stroke cyl 1
- With the ECU connected, place a volt meter across the Hall Sensor to read its output voltage
- Rotate (advance) the distributor until the point where there is a change in voltage (this will be a switch from 0v to 5v or 5v to 0v)
- Lock the distributor in this position
- Rotate the engine to 20-30 BTDC
- If the rotor arm is still facing cyl 1 then this should work. If not, the sensor may need to be moved.

The timing now needs to be set as in section 2.7.

3.2 Load

The ECU needs an input of engine load. The Omex ECU can use an input of either throttle position or manifold absolute pressure (MAP). Most normally aspirated engines will use an input of throttle position as this gives excellent throttle response. Forced induction engines need to use MAP as there is no direct relationship between throttle angle and engine load due to the variable of boost pressure. However, forced induction still requires throttle position sensor (TPS) input for idle condition information.

3.2.1 TPS

Most throttle position sensors can be used with the Omex ECU. Many engines are fitted with these as standard, but some are fitted with throttle switches which cannot be used. See section 2.4 for setup information.

3.2.2 MAP

An external three wire 0 - 5 V output MAP sensor can be used to sense engine load. See section 2.5 for setup information.

3.3 Temperature

The air and coolant temperature sensors used by the Omex ECU are resistive sensors. The raw outputs of these sensors are calibrated in the ECU to give the information in a more usable form, °C. This means that not all temperature sensors are compatible with the Omex ECU, so we suggest the use of the Omex approved parts.

3.3.1 Air Temperature Sensors

The air temperature sensor (ATS) is used to give the ECU information on the temperature of the inlet air. This allows the user to make corrections to the fuelling and ignition timing. The air temperature should be measured as close to the inlet as possible, preferably in the inlet airbox.

3.3.2 Coolant Temperature Sensors

The coolant temperature sensor (CTS) is required to give the ECU information on the temperature of the engine's coolant, allowing the user to set up correction factors for cold starting and running.

3.4 Barometric

An external three wire 0 - 5 V output sensor with a full scale of 105 kPa absolute may be fed into the MAP input to measure barometric pressure. The ECU then has automatic corrections based on this data. This is only applicable to normally aspirated engines and is not used on most competition engines.

4 Ignition



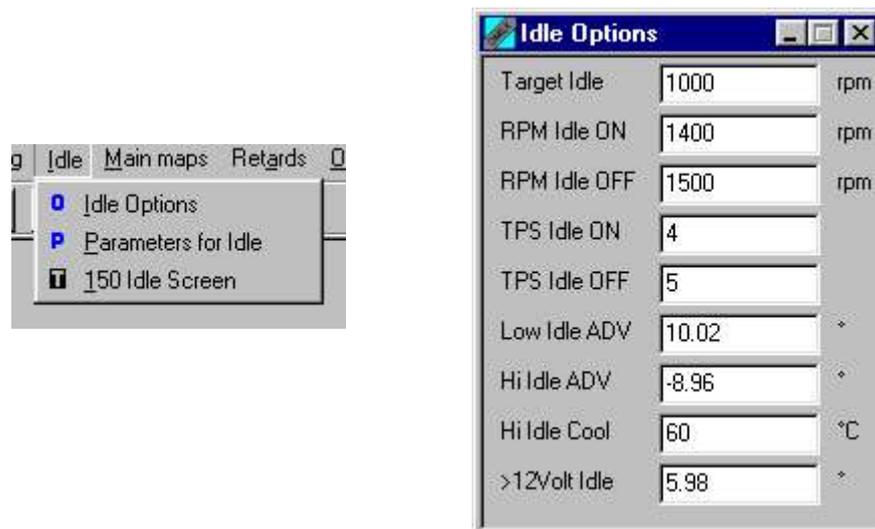
Ignition timing is controlled by a map of numbers. There are 11 load sites and speed sites are at every 400rpm. At each site the timing can be set from 0 to 45 degrees BTDC. Interpolation is used to ensure smooth curves.

4.1 Cranking



Whilst cranking, the ignition timing is determined by the **Start ADV** option. This is set in degrees.

4.2 Idle Stabilisation



An idle stabilisation algorithm has been included in the ECU to give a stable idle speed by adjusting the idle ignition timing. If the engine falls below the target idle speed, the ignition timing is advanced to accelerate the engine, and if the engine speed is too high the timing is retarded. A good natural idle without the idle stabilisation should be achieved first before enabling the idle stabilisation.

When the engine is at a minimum stable speed the engine is in the idle condition. The entry conditions for idle are:

Throttle < TPS Idle ON and Engine speed < RPM Idle ON

The exit conditions from idle are:

Throttle > TPS Idle OFF and Engine speed > RPM Idle OFF

The off conditions should be higher than the on conditions.

When in idle the spark advance may be adjusted to compensate for coolant temperature, battery voltage and engine speed.

When in the Idle condition:

$$\text{Spark Out} = \text{Spark}(\text{map}) + \text{Idle Spark}$$

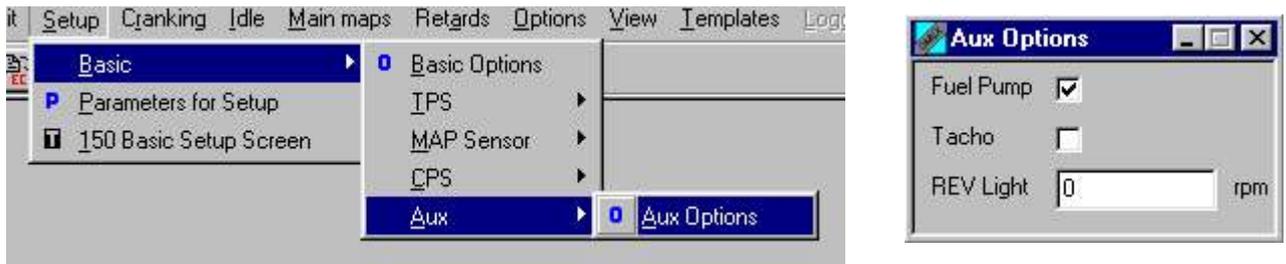
Idle Spark is made from:

$$\begin{aligned} \text{Idle Spark} = & \text{>12Volt Idle (if Battery is less than 12 Volts)} \\ & + \text{>12Volt Idle (if Coolant is less than Hi Idle Cool)} \\ & + \text{Low Idle ADV (if Engine speed is less than Target Idle speed)} \\ & + \text{Hi Idle ADV (if Engine speed is greater than Target Idle speed)} \end{aligned}$$

Hi Idle ADV is normally negative to slow the engine.

Low Idle ADV is normally positive to accelerate the engine.

5 Auxiliary Output



The OMEM150 ECU has a single auxiliary output which can be used as one of two options,

- Tacho controller
- Shift light output

Which of these is output is set in MAP2000.

The output is a low side switch, so the outputs need to be wired accordingly. Refer to the wiring section for diagrams to show how these are wired. This section also gives details next to the diagrams of the required options settings to enable the outputs.

Although there is only 1 auxiliary output from the OMEM150 ECU, it is possible to have both of these options available as they can be wired in different manners. Each output option can be wired in one of the following ways.

5.1 Tacho Controller

- As shown in the wiring diagram, using the ECU auxiliary output
- If single coil, then join the tacho to the coil negative
- If DIS then join the tacho to one of the coil negatives and select the 2cyl setting on the tacho, or if unavailable, use a pulse doubler available from Omex

5.2 Shift Light

- As shown in the wiring diagram, using the ECU auxiliary output
- Use an Omex stand-alone shift light unit. Contact Omex for details of available units

6 Options List

The options would normally be viewed from the menu structure. However, they can be viewed from the view menu. The following list is a reference for what the options do and how they should be set up. The options are ordered as they would appear in the **Options** list if alpha-sort were off.

Ign Offset	overall ignition map offset, should normally be set to zero.
CDI Invert	Not used. Set to OFF
Double cycle	Omex only. Set to OFF
Cylinders	determines the number of timing input pulses before the output sequence of ignition and injection repeat. Thus in systems with a single timing point per cylinder, this represents the number of cylinders.
MAP min	minimum value of the MAP sensor in normal operation.
MAP max	maximum value of the MAP sensor in normal operation. The raw MAP value parameter is called Pressure RAW .
TPS min	the value of TPS raw required for the ECU to know that the throttle is in the idle (fully closed) position. Set so that Throttle shows 1 at idle.
TPS max	should be programmed with the value of TPS raw at wide open throttle.
Spark Cut	the engine speed at which the ignition cut rev limit commences.
REV Light	the engine speed at which the LED output will come on at if set.
Pickup Fact	used to compensate for the systems timing pickup and ignition coil delays. All sensors have a small electrical delay that can cause a timing error at high speed. This error is particularly noticeable with magnetic detectors. This error is subtracted from the nominal timing point to give a virtual timing point, so the user need not compensate in their map for this sensor error. This gives a better match between the screen timing figures in the map and what the engine actually does as measured with a timing light. The pickup delay is in units of 2 microseconds. Maximum delay is 511 μ S, just over half a millisecond. A typical value is 50 μ Sec.
Start ADV	the ignition advance angle BTDC while cranking. This only applies when the Magnetic option is on. If Magnetic is off, then the starting advance is set with the timing sensor.
Coil Fact	controls the coil charge time. For Omex part OMEM3501 (a typical electronic, low impedance coil), a value of 20 should be used as this will prevent excessive thermal dissipation. However for coils that can not saturate with a normal battery supply then this value may be increased up to 255.
Tooth Edge	if set, then the rising rather than falling edge of the input signal is used as the significant edge at 45 degrees BTDC point. This would normally be set OFF.
Magnetic	if set uses a magnetic type input which only uses one edge of the input. Then it will use the starting ignition advance from the Start ADV option settings. Otherwise a logic type input is assumed as obtained from a Hall or Optical sensor. This changes the timing input switching point from the 0.5 volts appropriate for a variable reluctance sensor to 2.2 volts suitable for a logic type sensor.
Tacho	if set the then the auxiliary output will produce a tacho pulse for every timing event. Note that the Tacho will show 3,800 rpm if the engine is stopped and the throttle is at TPS min if Tacho is set. This is a TPS setting aid.
MAP for Load	if set, then LOAD will be calculated by scaling the pressure signal with MAP min and MAP max . If a 1 bar sensor is used then with this option set OFF, the ECU will apply automatic barometric compensations.
Delay Angle	electronic adjustment of timing.
Teeth	the number of teeth on the crank timing wheel including missing teeth.
Low Idle ADV	used to stabilise the idle. Usually positive to speed up the engine.
Hi Idle ADV	used to stabilise the idle. Usually negative to slow down the engine.
Target Idle	the desired idle speed when in the idle condition.
>12Volt Idle	will increase the ignition advance in idle if the battery voltage is low.
Hi Idle Cool	if the coolant temperature is below this value then the Idle Spark will be increased by >12Volt Idle degrees.
TPS Idle On	if the Throttle value is below this setting then Idle will be active if engine speed is less than RPM Idle On .
TPS Idle Off	if Throttle exceeds this value then the idle condition is not active.

RPM Idle On	if the Engine Speed is below this setting then Idle will be active if Throttle is less than TPS Idle On .
RPM Idle Off	if Engine Speed exceeds this value then the idle condition is not active.
Max Tooth	Omex only. Set to 65.
Min speed	the minimum engine speed for fuel and ignition to be active. Typically set to 50 RPM.
Air Rtd Strt	start temperature for ignition retard based on air temperature.
Air Rtd Rate	retard rate 'ignition degrees per degrees centigrade'.
Coolant Rtd	start temperature for ignition retard based on coolant temperature.
C Rtd Rate	retard rate 'ignition degrees per degrees centigrade'.

7 Parameters

The parameters window in the software allows the user to see all of the inputs, calculated values, and outputs of the ECU. They would normally be viewed through the set screens in the menu structure. The following are descriptions of the selectable parameters.

Parameter	Output	Range
Air Pressure	barometric air pressure	0-105 kPa
Air Prsr F	barometric correction factor	+/-15%
Air Temp	inlet air temperature in degrees Celsius	
Air Temp F	correction of fuel due to air temperature, and is automatic	+/-30%
Battery	current battery voltage	0-16 volts
Charge Time	coil on time	
Cool Tmp F	correction of fuel due to coolant warm-up	0-250%
Coolant	coolant temperature in degrees Celsius	
DEBUG1	Omex only	
DEBUG2	Omex only	
Dwell	coil dwell in msec	
Engine Speed	engine speed in RPM	Resolution 4 RPM
Error	Omex only	
Idle Spark	spark modifier due to idle condition	
LOAD	engine load used for maps	0-100
MAP AS LOAD	MAP signal scaled for load	0-100
Pressure raw	unscaled MAP/BAR	0-255
Spark (mod)	spark timing after Spark mod	
Spark adv	current ignition advance map value	0 to 45°
Spark mod	parameter that is affected by the trim control (virtual potbox) to vary the current spark advance	±22.5°
Spark out	includes any Idle Spark timing. i.e. the actual ignition timing	
Spark Rtd	ignition retard based on temperature	
Throttle	scaled throttle signal	0-100
Timer	Omex only	
TPS raw	unscaled throttle position sensor	0-255

8 Wiring

8.1 Semi Assembled Loom Construction

It is vital that the wiring loom is well terminated and fitted and can meet all normal running conditions.

- The wires must be crimped to the connector inserts with a suitable tool. Additional soldering is a bonus. Where possible strain relief clamps should be employed to retain the insulation.
- Cables of adequate current carrying capability must be used. High pressure fuel pumps can draw up to 15 Amps. Ignition coils can draw up to 10 Amps. Low impedance injectors up to 5 Amps. If the cable runs are long, as found in the dynamometer environment, then thicker conductors must be used to compensate for the increased length.
- Clamp the cables within a sheath to stop the cables flapping and adding additional stress to the wire joints. When fitting the harness into the car, ensure it is well cable tied onto suitable mounting points. Make sure that suitable grommets are fitted wherever the harness is fitted through panels. Do not bend the harness through very tight radius bends.
- Use suppressed ignition leads on distributor based systems. A suppressed king lead is usually all that is necessary to protect the system. Do not use solid copper leads under any circumstances.

8.2 Component Pin-outs

Throttle Position Sensors (TPS)			
Omex Part Number	Description	Pins	Omex Wire Colour
OMEM2001	General Purpose	1 Signal (green) 2 +5v (red) 3 Sensor Earth (Black)	Orange Pink Grey
OMEM2002 OMEM2003	DCOE Carbs	1 Signal 2 Sensor Earth 3 +5v	Orange Grey Pink
OMEM2004	DHLA Carbs	1 Signal 2 Sensor Earth 3 +5v	Orange Grey Pink
OMEM2005	Jenvey	1 Signal (red) 2 +5v (Green) 3 Sensor Earth (yellow)	Orange Pink Grey

MAP Sensors			
Omex Part Number	Description	Pins	Omex Wire Colour
OMEM2100	1 Bar	1 Signal	Green
OMEM2102	2 Bar	2 Sensor Earth	Grey
OMEM2103	3 Bar	3 +5v	Pink

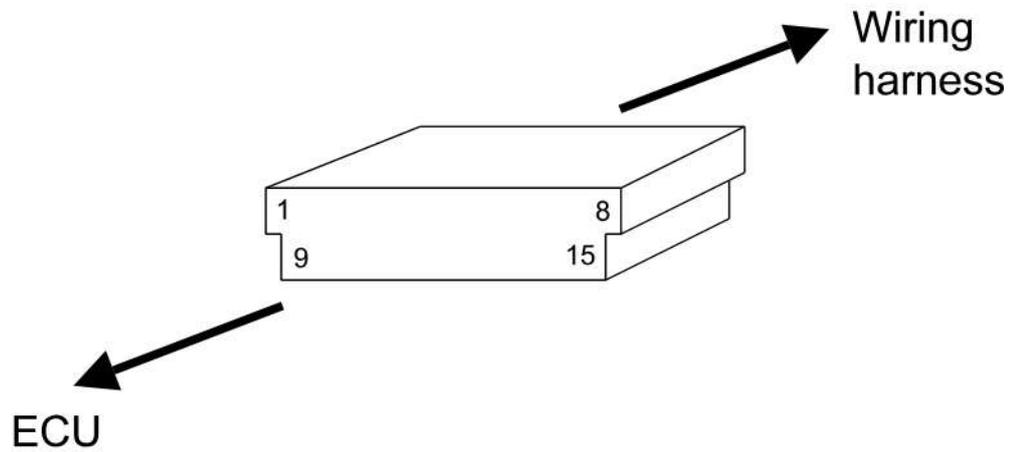
Coils			
Omex Part Number	Description	Pins	Omex Wire Colour
OMEM3501	4 Cyl DIS	1 Ign 1 2 Ign 2 3 +12v Supply 4 n/f	Violet Yellow Switched
Ford Coil	4 Cyl DIS 3 pin	1 Ign 1 2 +12v 3 Ign 2	Violet Switched Yellow

Temperature Sensors			
Omex Part Number	Description	Pins	Omex Wire Colour
OMEM2200	Coolant Temp (CTS)	1 Sensor Out 2 Sensor Earth	Green / Blue Grey
OMEM2201	Air Temp (ATS)	1 Sensor Out 2 Sensor Earth	Green / White Grey

Crank Position Sensors (CPS)			
Omex Part Number	Description	Pins	Omex Wire Colour
OMEM2400	Cylindrical	1 Sensor Out 2 Sensor Earth	Red Screened Black Screened
OMEM2401	2 hole mounting	1 Sensor Out 2 Sensor Earth	Red Screened Black Screened

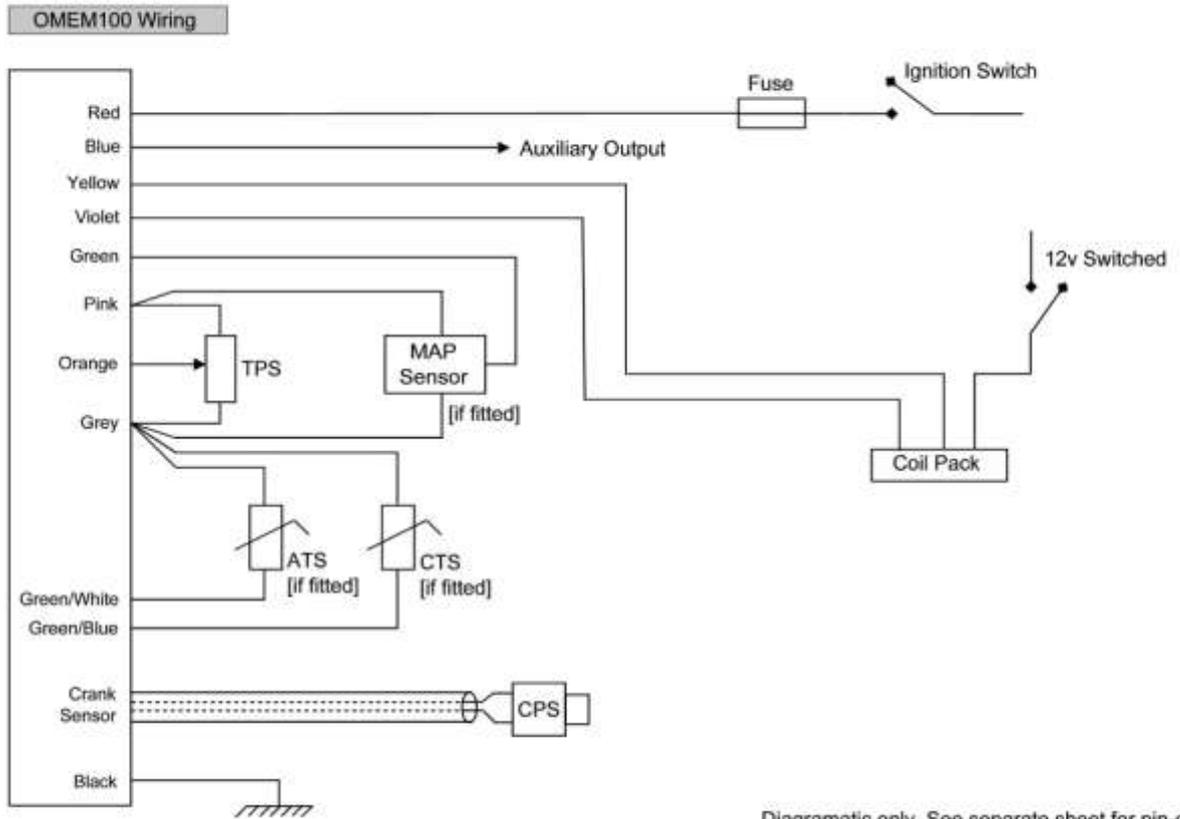
8.3 ECU Pin-outs

It is occasionally necessary whilst fault finding to trace through your wiring harness to check continuity. The following are the pin-outs for the ECU plug as found on the end of the wiring harness.



Pin	Colour code	Function
1	yellow	ignition driver 2 output
2	screened red	timing (CPS) pickup input
3	blue	auxiliary output
4	orange	throttle position sensor wiper input
5	pink	+5v sensor power output
7	green / white	air temperature sensor input
8	violet	ignition driver 1 output
11	green / blue	coolant temperature sensor input
12	green	MAP sensor input
13	grey	sensor returns
14	red	power input
15	black	power return

8.4 Wiring Diagrams



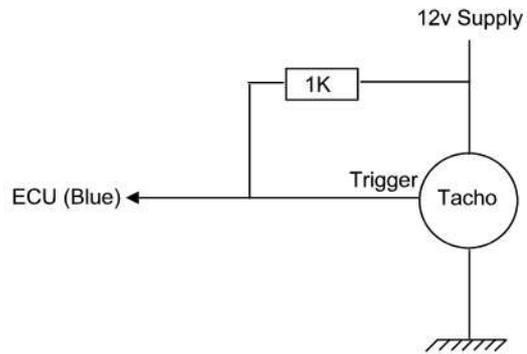
Diagrammatic only. See separate sheet for pin-outs

OMEM100 Auxiliary Output Wiring

Tachometer output

Fuel Pump - OFF
Tacho - ON
Rev Light - 0

1K not always required



Gear Shift Light Output

Fuel Pump - OFF
Tacho - OFF
Rev Light - [set to required rpm]

