OMEM 100

Hardware Instructions

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 OMEM100 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 ommisions. 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

Many engines already have a crank sensor inbuilt, but some require an external trigger wheel and sensor. If installing a trigger wheel,

- Accurately mark TDC.
- Turn the engine to approximately 90^{o} BTDC.
- Mount your crank position sensor (CPS) anywhere around the perimeter of the timing wheel pointing towards the centre of the wheel with a sensor to wheel gap of approximately 0.5mm.
- Mount the trigger wheel with the missing tooth pointing at the sensor.
- If machining a trigger pattern into the front pulley then it is usually easiest to machine all of the teeth in, mount the front pulley, and then remove the tooth pointing at the sensor at 90^{o} BTDC.

2.3 Wiring

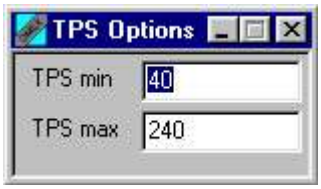
Wire your semi-assembled harness as described in section 8.

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.

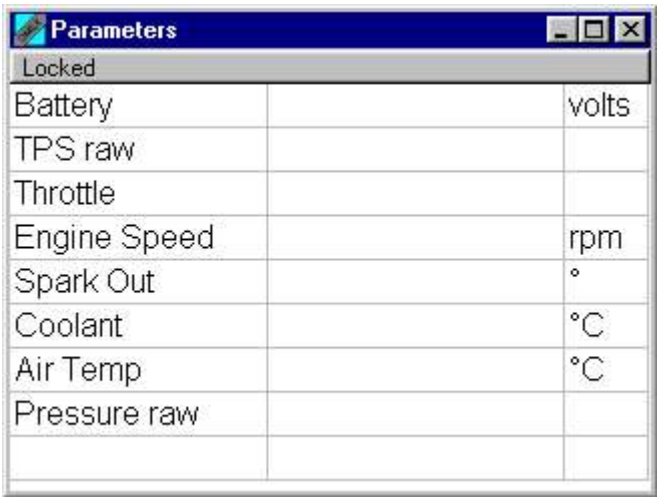
$$\textbf{MAP max} = \frac{\text{Boost in psi} + 14.7}{14.7 \times \text{bar rating of sensor}} \times 255$$

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.

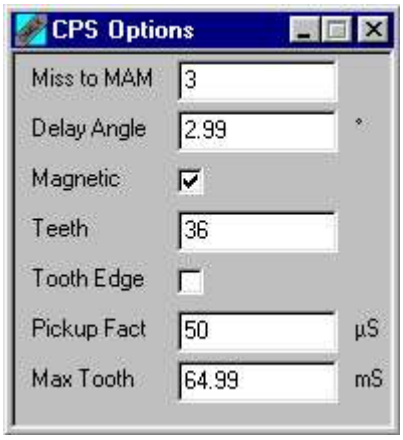


As some of the sensors have been checked during calibration, there are only a few remaining. **Battery** is the battery voltage and should read between 9 and 16 v. The coolant and air temperatures should read sensible numbers, around room temperature if the engine has not been started. **Engine Speed** 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, the missing tooth giving a position reference. The ECU must therefore be told where the engine is in its cycle when it sees the missing tooth reference point. Many engines with inbuilt sensors will already have the correct data on the supplied start up map (eg Ford CVH, Zetec, Vauxhall 16v, Peugeot etc), but some engines will need to be set, especially if your own timing wheel is fitted.

- If an external 36-1 trigger wheel has been mounted as described in section 2.2, then in **the CPS Options** window set **Miss to MAM** to 3 and **Delay Angle** to 3, as these values 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. Note that if using a DIS system, then the timing light may read double. To check this, look at the rpm reading on the timing light. If this is double the real engine speed, then the light needs to be set to ‘Distributorless/wasted spark’ or ‘2 cylinder’ if possible, or all figures halved.
- **Miss to MAM** works as a coarse adjustment, and **Delay Angle** as a fine adjustment. As the values for these two options are 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**.
- Adjust firstly **Miss to MAM** to get the timing numbers close to each other but less than 10 degrees over advanced, then **Delay Angle** to make the numbers match exactly.
- 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/reluctance sensor. The sensor detects the movement of an iron tooth past its pole-piece. The OMEM100 ECU works from a 36-1 trigger wheel or a 60-2 trigger wheel ie a 35 or 58 tooth wheel with a number of teeth missing as a crank position reference point. Many fuel injected engines such as the Ford Zetec (36-1) and Vauxhall XE (60-2), already have these trigger wheels and relevent sensors in place. However, older engines originally fitted with carburettors do not have these in place and many Japanese engines use specific trigger wheel patterns, so we have to install our own trigger wheel and sensor. **Magnetic** in the options menu must be set to ON to use this type of sensor.

3.1.2 Trigger Wheels

If an external trigger wheel is needed as discussed in 3.1.1, it is suggested that a 36-1 pattern is used. The diameter of this wheel can be a minimum of 80mm dependent on the sensor used and the engine operating speeds. The wheel needs to be mounted on the front pulley. It may also be possible to machine this pattern into the front pulley wheel, remembering that the pattern must be in a ferrous material for the sensor to work. Omex can supply general purpose trigger wheels in diameters of 100mm and 140mm.

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 acceleration fuelling and 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, ^{o}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.

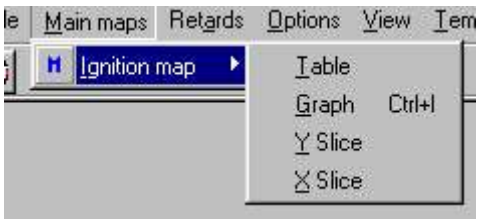
3.3.2 Coolant Temperature Sensors

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

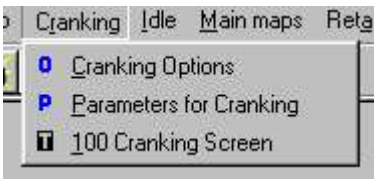
An external three wire 0 - 5 V output sensor with a full scale of 105 kPa absolute may be fed into the MAP input to measure barometric pressure. The ECU then has automatic corrections based on this data.This is only applicable to normally aspirated engines and is not used on most competition engines.

4 Ignition



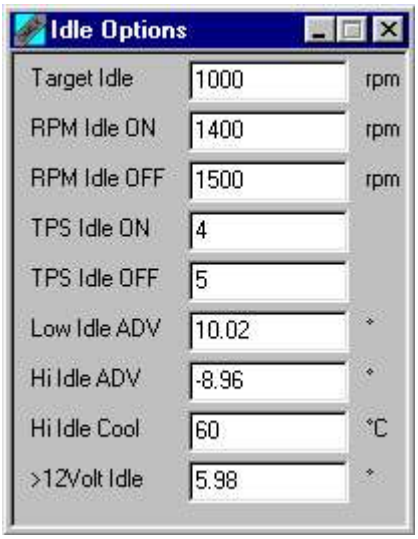
Ignition timing is controlled by a map of numbers. There are 11 load sites and speed sites are at every 400rpm. At each site the timing can be set from 0 to 45 degrees BTDC. Interpolation is used to ensure smooth curves.

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:

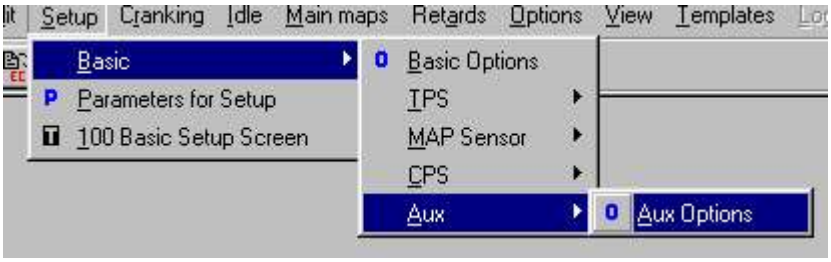
Spark Out = **Spark(map)** + **Idle Spark**

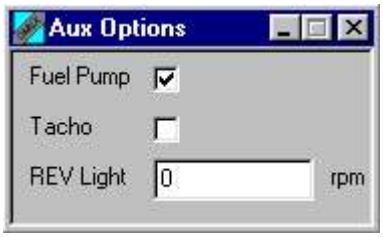
Idle Spark is made from:

Idle Spark = **>12Volt Idle** (if **Battery** is less than 12 Volts)
+ **>12Volt Idle** (if **Coolant** is less than **Hi Idle Cool**)
+ **Low Idle ADV** (if **Engine speed** is less than **Target Idle** speed)
+ **Hi Idle ADV** (if **Engine speed** is greater than **Target Idle** speed)

Hi Idle ADV is normally negative to slow the engine.
Low Idle ADV is normally positive to accelerate the engine.

5 Auxiliary Output





The OMEM100 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 OMEM100 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 µS, just over half a millisecond. A typical value is 50µSec.
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	the angle between the selected timing tooth and a point 45°BTDC. (the reference point). This is in degrees, and has a range of up to 45°. If high ignition advances at high speed are required then reduce the value of Miss to MAM and increase Delay Angle accordingly. This is in effect electronic adjustment of timing.
Teeth	the number of teeth on the crank timing wheel **including** missing teeth.
Miss to MAM	the number of teeth from the tooth after the missing teeth to a point less than a tooth angle from the most advanced ignition point at 45°BTDC.
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 2 Sensor Earth 3 +5v	Green Grey Pink
OMEM2102	2 Bar		
OMEM2102	3 Bar		

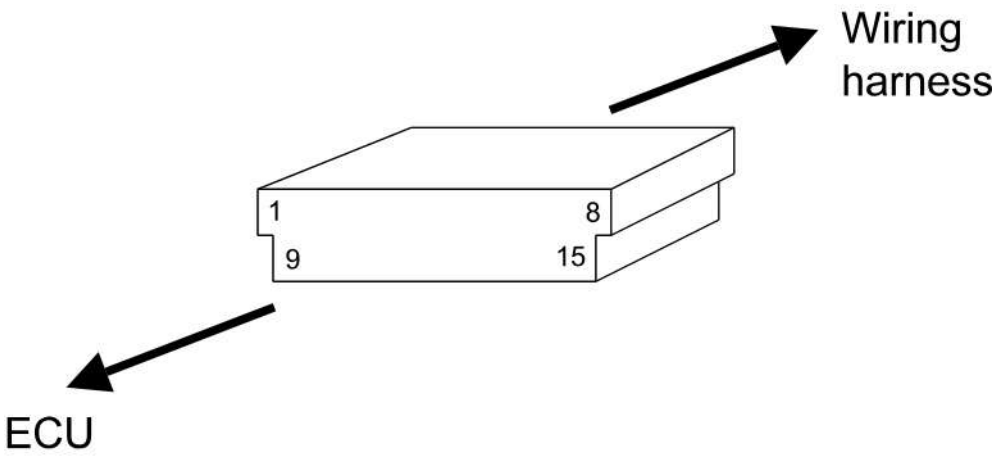
Coils			
Omex Part Number	**Description**	**Pins**	**Omex Wire Colour**
OMEM3501	4 Cyl DIS	1 Ign 1 2 Ign 2 3 +12v Supply 4 n/f	Violet Yellow Switched
Ford Coil	4 Cyl DIS 3 pin	1 Ign 1 2 +12v 3 Ign 2	Violet Switched Yellow

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

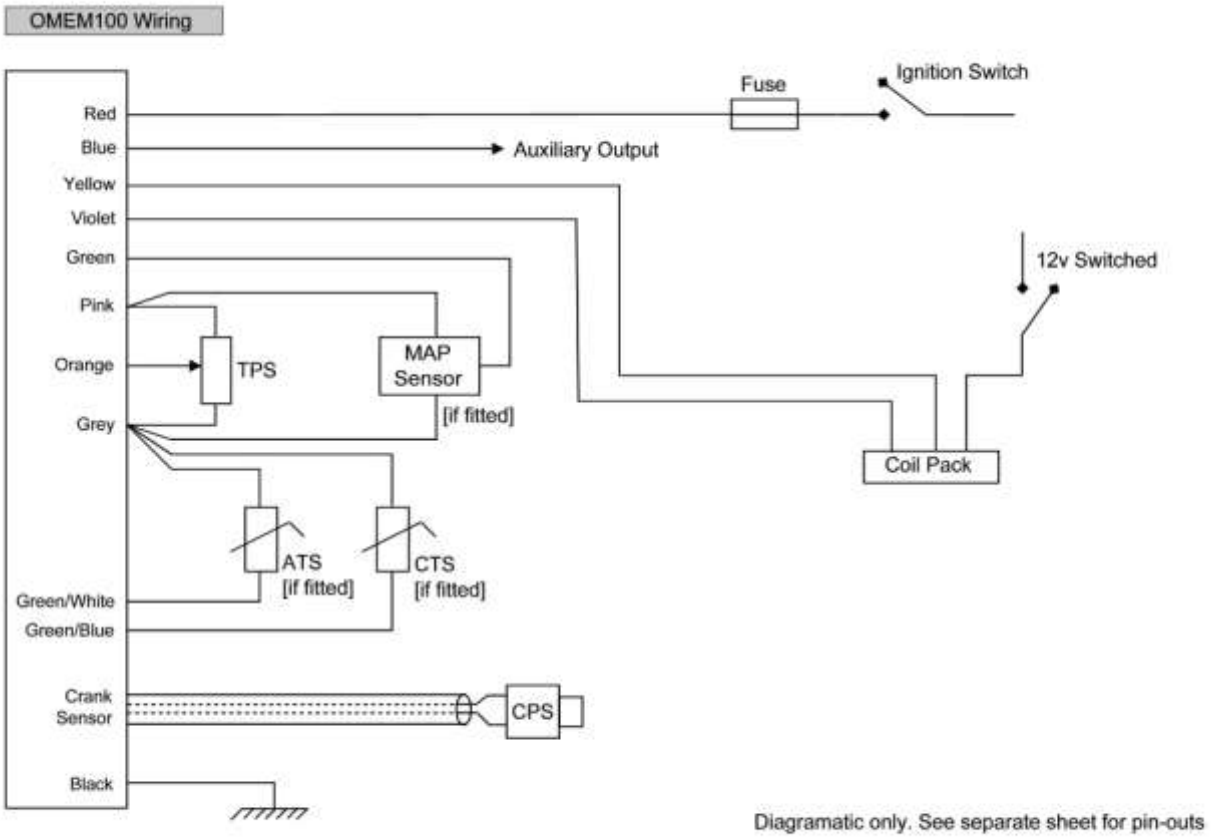
8.3 ECU Pin-outs

It is occasionally neccessary 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

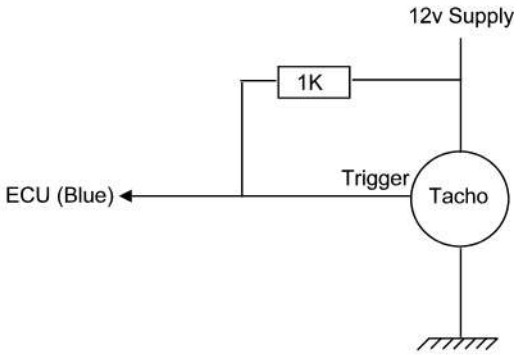


OMEM100 Auxiliary Output Wiring

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]