EM-Tech ECU Manual
VERSION 2.0

Warning:
Please ensure all power supplies are disconnected before commencing work.

Failure to follow all the warnings in this manual may lead to ECU and engine damage and may also void your warranty.

Incorrect set-up of the ECU can also lead to engine and ECU damage.
Any damage due to incorrect set-up will not be regarded as repairable under warranty.

LIMITED WARRANTY
EMS Computers Pty Ltd warrants the EM-Tech Fuel Injection System to be free from defects in material or workmanship for a period of two years from the date of purchase. Proof of purchase must be provided indicating that the product is within the warranty period in order to receive warranty service. Removing the serial number affixed to the ECU will void any warranty.

If the EM-Tech Fuel Injection System is found to be defective within the rules mentioned above it will be replaced or repaired at no extra charge this constitutes the sole liability of EMS Computers.

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

Congratulations on purchasing an EMS Engine Management System.
This Installation and Wiring Guide will guide you through the installation of your EM-Tech ECU to your vehicle.

Warning:
Always disconnect the battery cables when doing electrical work on your vehicle. The EM-Tech ECU must be completely disconnected from the electrical system before doing any form of electrical welding on the vehicle.

Note:
Installing an engine management system is a complex exercise and should be done only after careful planning. Damage may be caused to engine components if care is not taken during the installation and set-up of any engine management system. If you are unsure about how to wire any components of your engine, please consult an experienced installer for advice.

Contents

ECU Installation and wiring

Flying Lead Loom Installation

The following outlines the procedure for installing the EM-Tech ECU with an open-ended loom.

Ensure that you have the following items in your kit
1. ECU
2. Main Wiring Loom
3. Programming Cable

Mounting the ECU and relays:

Find a suitable location for the ECU inside the cabin away from excessive heat.
Ensure that the loom will reach all of the components needed and mount the ECU
Find a suitable location for fitting a fuel pump relay and any additional relays used for auxiliary devices such as thermo fans, water injectors, etc. and mount them.
Run the loom into the engine bay leaving the ECU disconnected from the loom.
Connect the MAP sensor tube to the inlet manifold.
Connect the Coolant Temperature Sensor.
Connect the Throttle Position Sensor (TPS) (optional).
Connect the Air Temperature Sensor. (Optional)
Connect O2 sensor (optional).
Connect the crank angle sensors to the trigger input. Sometimes these are driven off the cam, but still give a crank position.
Connect any cam angle sensors if applicable to the sync inputs.
Run the injector wires to the corresponding fuel injectors.
Run the wires from all ignition outputs to the ignition modules
Connect your fuel pump to the fuel pump relay.
Connect idle control motors (if applicable).
Connect any other auxiliary devices such as thermo-fans.
Connect the thick ground (black) wire to the engine block or chassis.
Connect power from the battery's fusable link to the main relay(s).
Connect power from the main relay(s) to injectors, ignition modules, and any other auxiliary devices that require a switched 12V supply.
Connect the red +12V supply wire from the ECU to the ignition key power.
This needs to be able to supply 10A. If the Ignition power is unable to supply this current, Obtain ECU power through a Relay.
At this stage ensure that the ignition modules and fuel injectors are not connected.
Plug the ECU to the loom and connect the laptop computer to the ECU using the serial cable supplied.
Switch on the ignition key to power up the ECU.

WARNINGS: Neglecting these warnings may cause damage to the ECU board.
1. All unused stepper motor / e-throttle output wires must be insulated.
2. Unused regulated voltage output wires must be insulated. These wires are the red wire found inside the sub-loom and shielded cables and the orange wires found in the main loom.
3. Do not connect any sensor wire to the engine or any item that is connected directly on the engine block.

Connecting Sensors

Warning:
Do not ground any sensor to the engine or chassis. Always ground sensors directly to the signal grounds in the loom.

Manifold Absolute Pressure Sensor

EMS EM-Tech ECUs use a built-in MAP sensor. This sensor works in absolute pressures, meaning that it does not need calibration for different altitudes. The sensor accurately reads pressures from negative 100 Kpa gauge to positive 400 Kpa gauge, known as a 60psi (5 Bar) sensor. Connect a vacuum/boost hose to a suitable location on the inlet manifold plenum near as possible to the centre of the plenum. Do not connect it to any single runner, as this will give a reading more representative of that cylinder and not all cylinders.

Engine Temperature Sensor
Wire Colour: Grey B3 EM70 and EM80
Wire Colour: Grey AC2 EM100 series

EMS EM-Tech ECUs can use the original engine temp sensor on the engine. You can calibrate the sensor to the ECU. The calibration can also be saved as a file and reused on other EMS ECUs.
It is important that the engine temperature readings be reliable and accurate. This information is used to add extra fuel in situations like engine warm-up, cold starting, and post-start enrichment. Engine temperature is also used to compensate the ignition timing.

Inlet Air Temperature Sensor (optional)
Wire Colour: Grey C3 EM70 and EM80
Wire Colour: Grey AB2 EM100 series

The air temperature sensor is used to compensate the fuel delivery for changes in air density due to air temperature. The ignition timing can also compensated for varying air temperature. The sensor should be mounted where the air stream is moving fastest. Keep in mind the effects of heat soak and try to mount the sensor in a location where heat soak is minimised such as near the air filter. Small changes in climatic temperatures will have little effect on the tune.

EMS EM-Tech ECUs can use the original air temp sensor on the engine. You can calibrate the sensor to the ECU. The calibration can also be saved as a file and reused on other EMS ECUs.

Throttle Position Sensor (Optional)

Wire Colours: Grey D3 EM70 and EM80
Wire Colour: Grey AD2 EM100 series

Most modern engines have a throttle position sensor fitted. The sensor works by varying the voltage on the signal wire according to its angle of rotation. Most TPSs have three connections. One connection requires a constant voltage applied, the other is the varying voltage output of the TPS and the last is connected to ground. The EMS EM-Tech ECUs can supply a regulated 5 volts via the orange wire. The Grey wire must be connected to the signal output of the TPS, this will be the varying voltage and the black wire is used to ground the TPS.

Please note that the EMS EM-Tech ECU can read the TPS while it is still connected to the OEM ECU. In this case there is no need to connect the 5V or ground wires, only connect the TPS Input.

Note: If you are not using the 5V power wire then you must ensure that it is insulated to prevent short-circuiting.

Before you can use the TPS it must be spanned so that the ECU can determine the closed and open throttle positions and all positions between. This is done using the EM-Tech management software.

Variable potentiometer style Throttle position sensors are one of the most unreliable sensors on an engine. This is because of their mechanical nature. They are vulnerable to wear, water, mud, dust and other contaminants that get inside the TPS mechanism. In order to increase reliability EMS have made this an optional sensor. Providing that the engine is tuned with MAP as the main load source, if the TPS stops working the ECU will still continue to operate.

New Hall style sensor have been introduced and are used on eThrottle setups. These are contactless and designed to be reliable.

Trigger (Reference) and Sync (Home) Sensors

Wire colour for trigger input: Green G4 EM70 and EM80
Wire colour for sync (home) input: Yellow H4 EM70 and EM80

Wire colour for trigger input: Green AC1 EM100 series
Wire colour for sync1 (home) input: Yellow AB1 EM100 series
Wire colour for sync2 (home) input: Yellow BB4 EM100 series
Wire colour for sync3 (home) input: Yellow BC4 EM100 series
Wire colour for sync4 (home) input: Yellow BD4 EM100 series

EM-Tech ECUs can read hall, optical or magnetic signals using the same wire.

To fire injectors and igniters sequentially or control the cams VVT then you must use a sync (home) sensor and a trigger sensor. For cam control, each cam to be controlled needs a sync sensor.

The trigger and sync wires are found in separate shielded sub-looms inside the main loom. The sub-looms also have a red wire that can be used to supply a regulated 8 volts to power the sensor if they are hall or optical. The black wire is used for ground. If the sensors are to be shared with the OEM ECU then power and ground will not be required.

If the trigger or sync sensors are magnetic then power will not be required.

Note: If you are not using the red power wire in the sub-loom then you must ensure that it is insulated to prevent short-circuiting. Also DO NOT connect the shielding for the sub-loom to ground. This is already grounded through the loom near the ECU.

Some after market ECUs require a complex calibration procedure to calibrate a magnetic sensor to the ECU. With the EMS EM-Tech ECUs this is not necessary because it will automatically self-learn the magnetic sensor signals. Also, the ecu will trigger with a trace zero crossing signal. This method provides pin-point timing accuracy over the entire rev range.

When using a magnetic sensor on the trigger wheel or distributor, it is very important that the positive and negative polarity of the sensor is wired correctly to the ECU trigger inputs. The positive output of the magnetic sensor must connect to the trigger input wire of the ECU and the negative sensor wire must be connected the ground wire of the shielded cable. If this is not done then the ignition timing will drift as engine RPM changes. The same rule also applies to magnetic sync sensors.

Exhaust Gas Oxygen Sensors (O2) (Optional) for EM70 and EM80

Wire colours for sensor input: Positive – Grey F2 EM70 and EM80
Negative – Grey F3 EM70 and EM80

Wire colours for Analog input 1 option: Positive –Blue A2 EM70 and EM80
Wire colours for Analog input 2 option: Positive –Blue B2 EM70 and EM80
Wire colours for Analog input 3 option: Positive –Blue C2 EM80
Wire colours for Analog input 4 option: Positive –Blue D2 EM80
Wire colours for Analog input 5 option: Positive –Blue A3 EM80

EM-Tech ECUs have a few options for reading the O2 sensor.
Using a narrow band sensor.
Using an LSM11 wide band sensor.
Connecting an innovate LC1 to the lambda input
Or connecting the 0-5V output of an aftermarket controller to any of the
analogue inputs.
With the last option, there is a fully configurable table that you can use to calibrate
the ECU to the controller.

The O2 sensor must be mounted in the exhaust pipe near the exhaust header or
extractors after the collector. If the exhaust system does not have existing sensor
mount then a new mount must attached to the exhaust system. You can use a Bosch
4 Wire wideband sensor (Part Number 0 258 104 002) or the Innovate LC1 or LM1
O2 Kit. The Bosch sensor can be wired directly to the ECU without calibration. The
LC1 kit output voltage must be calibrated to work with the EM-Tech ECU. Use LM
Programmer software to calibrate the LC-1 so that the output of the LC1 reads 0.050
volts at 8.0 air-fuel-ratio and 0.950 volts at 22 air-fuel-ratio.

Exhaust Gas Oxygen Sensors (O2) LSU4.9 for EM100 Series (Optional)

Sensor 1

Wire colours for sensor input: VS1   – Grey AH2
IP1   – Grey AJ2
Cal 1 - Grey AE2
Signal Ground - Black BD2 or BE4
Heater 1 control PWM 1 – Yellow AJ4
Heater 1 power – from 12V ignition

Sensor 2

Wire colours for sensor input: VS2   – Grey BC2
IP2   – Grey BB2
Cal 2 - Grey BF3
Signal Ground - Black BD2 or BE4
Heater 2 control PWM 2 – Yellow AH4
Heater 1 power – from 12V ignition

Note:
Any of the PWM outputs can control either lambda sensor heater.
PWM 1 and 2 are shown above.

The Em100 series has 2 built in controllers that are designed to control 2
LSU4.9 sensors directly. No calibration is required. Also, no external controller is
needed.

History:
In the past versions of EMS ECU's, the LSM11 4 wire was used.
This sensor was a very accurate and robust sensor. In approx. 2015, Bosch moved the manufacturing of this model sensor from Germany to another country,
Thus, it lost its sensor to sensor repeatability. Due to this, EMS no longer recommends the use of the LSM 11.

LSU 4.0 to LSU 4.2.
These sensors, although very accurate when new, eventually fail due to contamination of the sensor's reference cell which is refenced to the air around the sensor. When it fails, it will read a rich mixture, we call it a rich death. This will have tragic consequences if used for tuning or closed loop operations, inadvertently leaning out the engine. For this reason, EMS have never incorporated these sensors as built in internal controllers.

The LSU 4.9 sensor was redesigned by Bosch and now is referenced to an internal source. This has solved the reference contamination to air problem, thus Bosch have given this sensor a 10 year life when used with unleaded fuels and this sensor has been successful and widely used with many OEM auto manufacturers.

The decision EMS made, to build in the costly Controllers into the EM100 ECU instead of allowing other brands Controllers to be connected, came after testing a number of aftermarket brand controllers. They did not conform to the Bosch specifications, thus would result in a possible error in their reading or the sensor life was shortened due to the miss management of the heater and / or the pump cell (IP).

In Short, the EMS LSU 4.9 controller was designed to conform 100% to the Bosch specifications.

Accuracy: Most controllers omit the used of the laser trimmed resistor that Bosch have on the sensor connector. This is used to feed back into the controller circuit, to calibrate the reading due to the sensor manufacturing variations.

These after market controller manufacturers are easy to recognise, as they will require an open air calibration to be perform. This open air calibration will help with the error, but it's an offset calibration to the infinity, open air is as far as you can get from where the sensor operates in your race car. (no exhaust gas present)

There are other methods. One is to calibrate with the use of a mixture of special calibration gases as outlined by the Bosch specification. This would require LAB conditions to perform.

The only other method where the sensor reading accuracy is guaranteed with the omission of the CAL wire, is done mathematically, as found on MOTEC tm ECU's. This method reduces the pin count on the ECU whilst maintaining the accuracy. The only down side to the Math method, is that the sensor cannot be replaced without knowing the predefined calibration number.

With the EM100 series, the LSU 4.9 sensor can be purchased from anywhere and replaced. Then the built in controller circuit will take care of the calibration differences of the new sensor by using the Bosch laser trimmed calibration resistor in the sensor connector.

Accurate Air / Fuel (Lambda) readings is one of the most important things you need in race engine tuning and data logging. EMS realises accurate readings are of the utmost importance, thus have designed an accurate controller built in.
To ensure the readings accuracy, every EMS ECU is fully tested and calibrated to ensure the accuracy and precision required.

Power Connections

Thick Black Wire (Main Ground) G2, H2, G3, H3 EM70 and EM80
Thick Black Wire (Main Ground) AF2, AG2, BE2, BF2 EM100 series

> Find a good ground point on the chassis and connect the black wire.
> The ECU activates relays, valves, solenoids and injectors by grounding them.
> This is why you must use the thick black grounding wire to ground the ECU.

Thin Black Wires (signal Grounds) BD2, BE4 EM100 series
Connect these to the sensors.
Never connect these signal grounds directly to the engine or chassis.

Red wire A1 EM70 and EM80
Red wire AK3, AK4 EM100 series

> The EM-Tech ECU does not need a permanent +12 volt supply. Connect this wire to the ignition switched + 12 volts.

Ignition Outputs

Wire colours for Ignition outputs

1: Pink B1	EM70 and EM80	
2: Pink C1	EM70 and EM80	
3: Pink D1	EM70 and EM80	
4: Pink E1	EM70 and EM80	
1: Pink AE4	All EM100 series	
2: Pink AD4	All EM100 series	
3: Pink AC4	All EM100 series	
4: Pink AB4	All EM100 series	
5: Pink BA1	EM160, EM180, some EM100 OEM	
6: Pink BA2	EM160, EM180, some EM100 OEM	
7: Pink BA3	EM180, some EM100 OEM	
8: Pink BA4	EM180, some EM100 OEM	

Warning:
These ECUs do not have built-in igniters. Do not connect any ignition output directly to a plain coil that does not have an igniter built in. You must use external ignition modules with plain coils. Connecting the ECU to an ignition module(s) before setting the ignition fire edge correctly may damage the module(s) and coils.

The EM70 and EM80 EM-Tech ECUs come with the same EM80 loom. This was done to future proof the customer. In case of an eventual upgrade from an EM70 to an EM80 ECU, you won't need to obtain a new loom as the unused wires will be present..

The same is true for the EM100 series ECU's. They all have the same EM180 fully pinned loom, in case of an eventual upgrade. Thus the EM160 and the EM140 will have spare wires.

EM-Tech ECUs can drive most OEM igniters but you must be aware of the trigger signal required to drive the igniter. Some igniters require a rising signal and others a falling signal. Getting this signal wrong can cause the igniter and coil to overheat and fail. EMS igniters and most OEM igniters are negative fire igniters (Falling edge).

These ECUs can control smart and dumb igniters. Smart igniters will self-dwell the coil, dumb igniters will follow the signal from the ECU. If you are using smart igniters then you must still set the dwell to the correct value for your coils and the igniter will follow the signal from the ECU. It is important to set the correct dwell via the management software. Over dwelling a coil will cause it to overheat, under dwelling will not allow the coil to build enough energy resulting in a weak spark.
A good starting point is from 2.5mS to 3.5mS.

The firing order of the ignition and injection outputs can be defined in the management software. However, the default order will be 1,2,3,4 on the EM70 and EM80 and up to 1,2,3,4,5,6,7,8 on the EM100 series.

Distributor Ignition wiring

Use ignition output 1. The ECU will fire the output on every ignition trigger.

1 COIL IGNITER
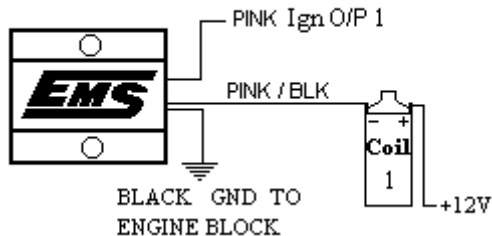
Wasted Spark Ignition

When set-up for wasted spark the outputs will be fired in numerical order starting with output 1. The following diagram shows an example of a 6 cylinder wasted spark set-up. To run wasted spark, set the number of igniters to be half the number of cylinders.

Wasted spark set-up with one coil per plug will produce the same horse power from the engine as full sequential coil per plug. However, it will be charging an extra coil every ignition fire. This will cause double current draw from the alternator (extra engine load) and double load on the igniter. Nissan igniters may suffer with reliability issues when used in wasted spark set-ups.

If you need to set up a wasted spark ignition system then you should use double ended coils. In this way the igniter will be igniting only one coil per ignition fire. EMS recommends to set-up your ignition with one coil per plug and one igniter per coil (Sequential ignition).
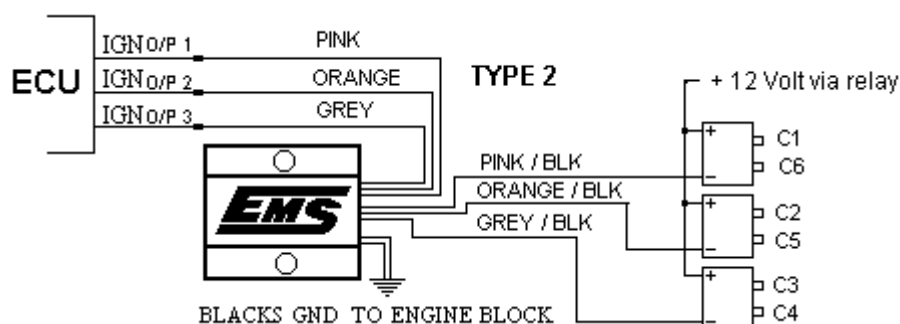
Direct Fire Multi-Coil Ignition (1 coil per plug)

EM70 and EM80 ECUs can fire up to 4 igniters individually.
EM140 series ECUs can fire up to 4 igniters individually.
EM160 series ECUs can fire up to 6 igniters individually.
EM180 series ECUs can fire up to 8 igniters individually.
EM100 OEM ECUs will vary on the Engine that it was designed for
and will fire from 4 to 8 igniters individually.

Wiring Injectors

Wire colours for injector outputs EM70 and EM80 ECU's

    1: White L1   EM70 and EM80
    2: White M1   EM70 and EM80
    3: White L2   EM70 and EM80
    4: White M2   EM70 and EM80
    5: White L3   EM80
    6: White M3   EM80
    7: White L4   EM80
    8: White M4   EM80

EM100 ECU's
Primary Injectors
    1: White AM4 All EM100 series
    2: White AL4 All EM100 series
    3: White AM3 All EM100 series
    4: White AL3 All EM100 series
    5: White BG1 EM160, EM180, some EM100 OEM
    6: White BH1 EM160, EM180, some EM100 OEM
    7: White BG2 EM180, some EM100 OEM
    8: White BH2 EM180, some EM100 OEM

Staged Injectors
    Staged 1: White AM2 All EM100 series
    Staged 2: White AL2 All EM100 series
    Staged 3: White AM1 All EM100 series
    Staged 4: White AL1 All EM100 series
    Staged 5: White BG3 EM160, EM180, some EM100 OEM
    Staged 6: White BH3 EM160, EM180, some EM100 OEM
    Staged 7: White BG4 EM180, some EM100 OEM
    Staged 8: White BH4 EM180, some EM100 OEM

EMS EM-Tech ECUs controls injectors by pulling the injector current to ground.
This means that all injectors have a common positive 12 volt rail. ECU's can be set to
fire injectors in Full Sequential or 2 group 360 Multipoint mode, or 2 group 720
Multipoint mode or 2 group Throttle body mode or 360 Batch mode or 720 Batch
mode.

Full sequential or Any 720 mode will fire all injectors once every 2 crank revolutions
(720 deg) Any 360 mode will fire all injectors once every crank revolution (360 deg).
In these modes the injectors must be mounted one injector per intake port or all
above the supercharger if full sequential mode for a blower that needs cooling.
If the blower does not need fuel to cool itself, then port mounted injectors are the
best.

Throttle body mode will fire all injectors in a way that all cylinders obtain the correct
amount of fuel.
Caution:
Do not select any 360 or 720 mode if you have something like a single 4 barrel
throttle body.

Sequential mode will fire each injector one at a time in a timed order according to the intake order of the engine.

Two methods to wire the injectors depending of the firing order set in the ECU.

1) To ensure that the injectors are wired in the correct sequence follow the engine firing order so that output 1 will inject cylinder 1, output 2 will inject the next cylinder in the firing order, output 3 will inject the next in the firing order and so on. If wired in this way, set the ECU firing order to 1,2,3,4 etc.

2) If ECU firing order is set to the engine firing order, eg(4cyl). 1,3,4,2,etc
   Wire
   Injector 1 to cylinder 1,
   Injector 2 to cylinder 2,
   Injector 3 to cylinder 3,
   Injector 4 to cylinder 4,
   etc

Although 90% of installations have the injectors already in the correct position from the OEM, custom installations such as a V8 with a 671 or 471 GM or a screw blower that requires fuel to cool it can cause some confusion. Although you can set the Injector arrangement parameter to throttle body mode and place all injectors above the blower, the best method by far would be sequential mode with an EM80 or EM180 ECU. In cases where the blower needs lubrication and cooling you can use 16 injectors by placing 8 sequentially above the blower and the other 8 sequentially below the blower or you can use 8 injectors and place them all above the blower. If you use 16 injectors then you must ensure that the injectors below the blower are in the correct firing sequence and placed 1 injector per intake port. If the blower does not need lubrication or cooling then its better to place all 8 injectors sequentially below the blower with one injector per intake port.

You must ensure that the combined injector resistance for each output is not less than 1.2 ohms. For example connecting 2 X 1.2 ohm injectors in parallel will give a resistance of 0.6 ohms. This would cause the injector output drive circuit very heavily loaded. Although the output drivers can easily handle this load, its close to the physical limit of the Printed Circuit Board. Its better to spread the load over more drivers.

EM 180 Injector Connections
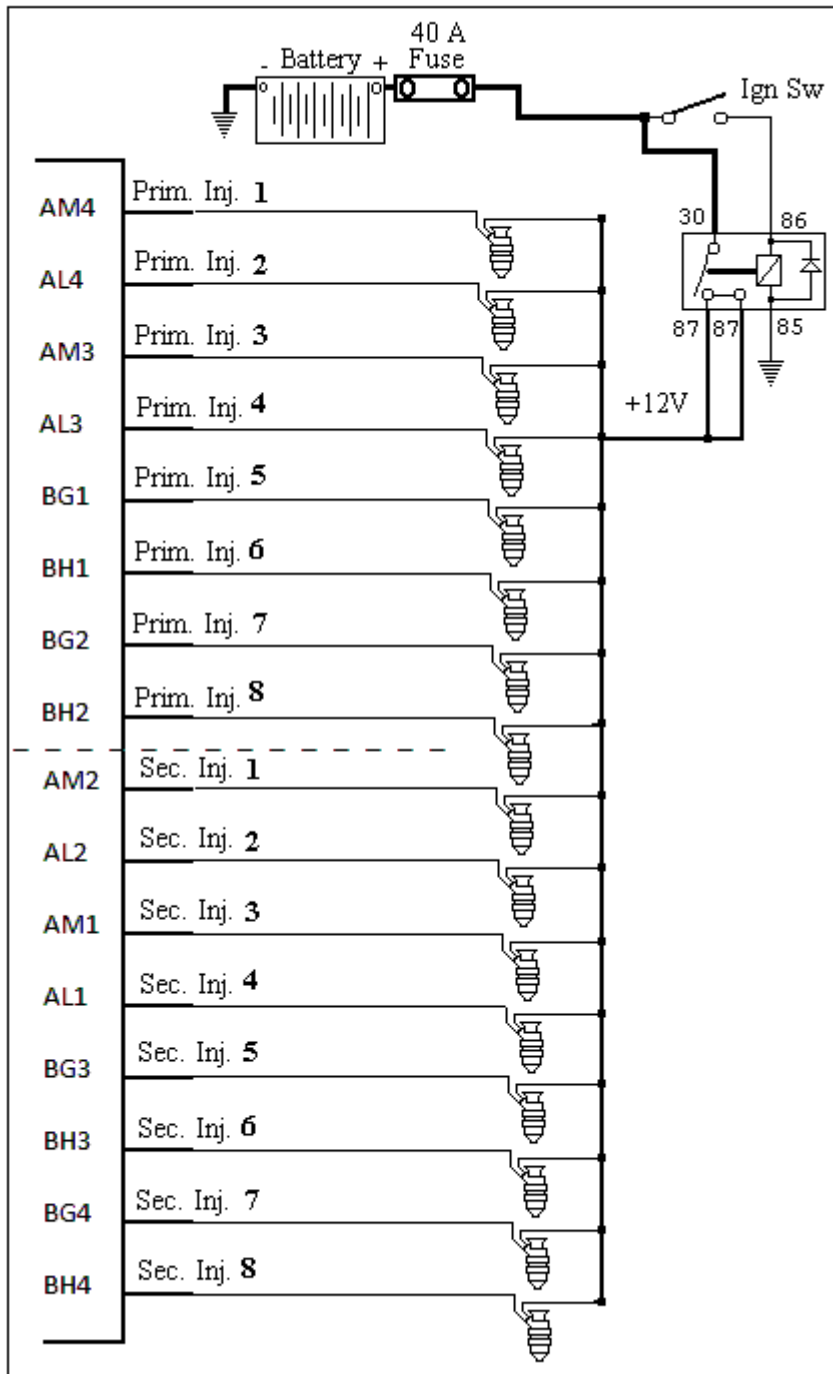
EM 160 Injector Connections
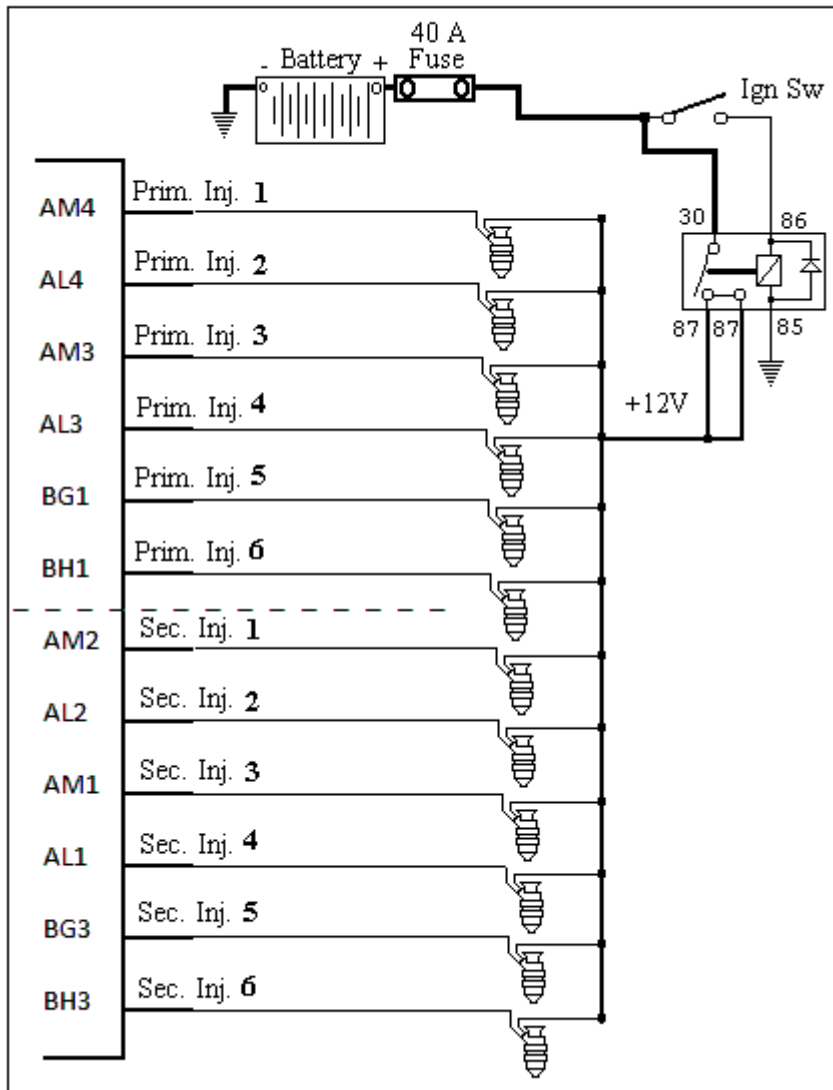
EM 140 Injector Connections
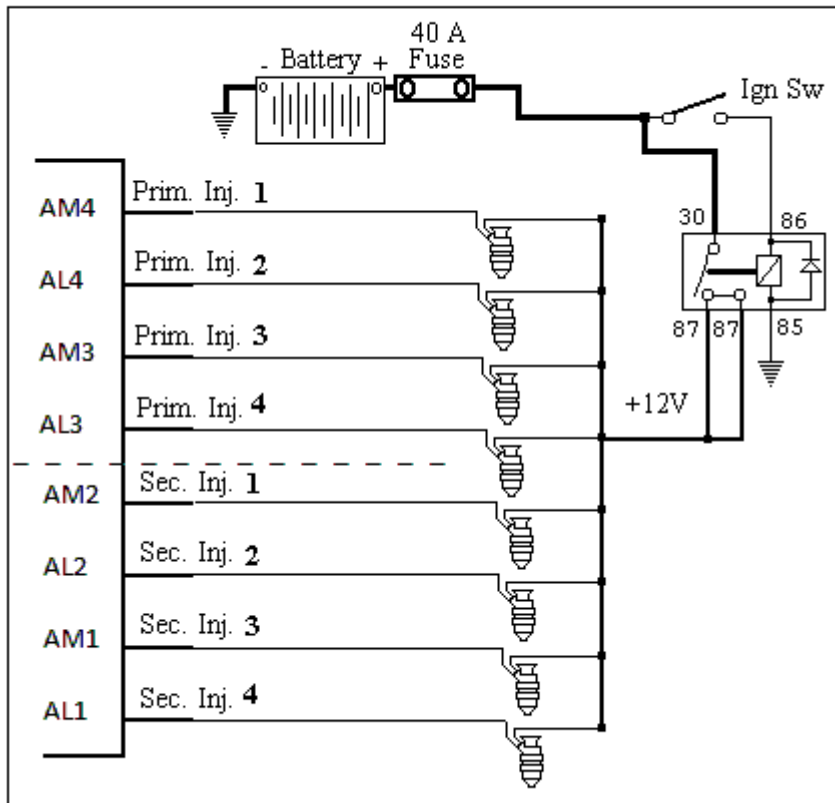
injector wiring diagram for EM80
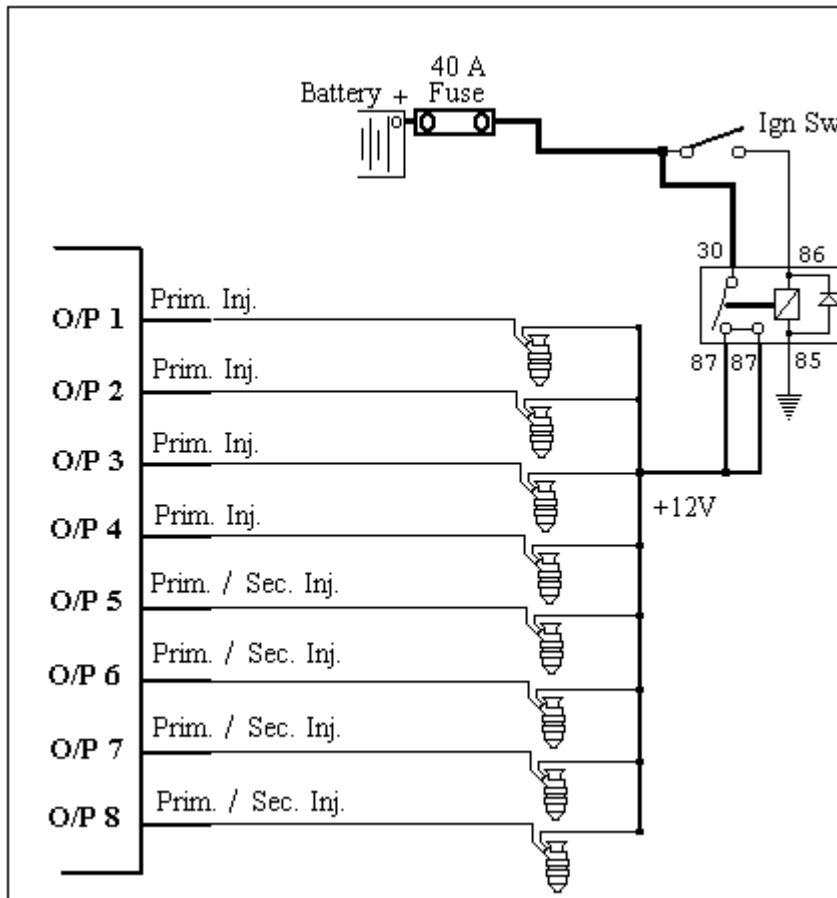
Injector wiring diagram for EM70
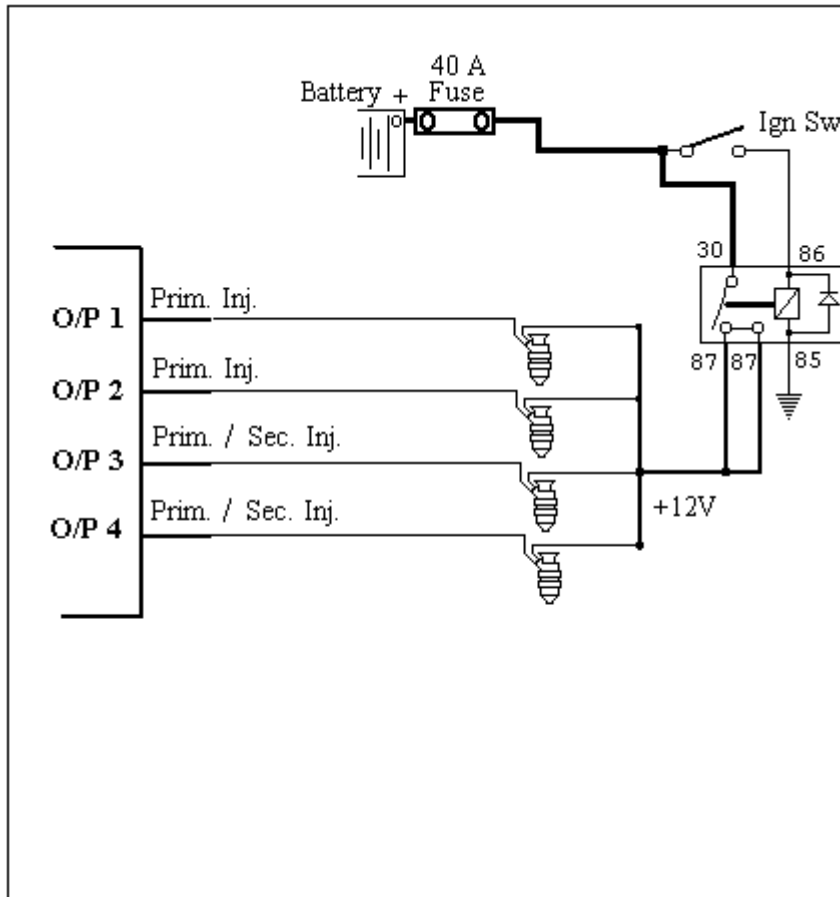
Auxiliary Outputs

Wire colours for auxiliary outputs	1: Yellow F1	EM70 and EM80
Digital and PWM and Tacho	2: Yellow G1	EM70 and EM80
	3: Yellow H1	EM70 and EM80
	4: Yellow J1	EM70 and EM80
Unused Injector outputs, can be	5: Yellow L3	EM80
Selected as digital Auxillary outputs	6: Yellow M3	EM80
For PWM or Tacho control,	7: Yellow L4	EM80
use outputs 1-4 above	8: Yellow M4	EM80
Wire colours for auxiliary outputs	1: Yellow AJ4	EM100 series
For Digital, PWM and Tacho	2: Yellow AH4	EM100 series
	3: Yellow AG4	EM100 series
	4: Yellow AF4	EM100 series
For Tacho control,	5: Yellow BB1	EM100 series
use outputs 1-4 above	6: Yellow BC1	EM100 series
	7: Yellow BD1	EM100 series
	8: Yellow BE1	EM100 series

The EM -Tech series ECUs have programmable auxiliary outputs that can be used to control many different items such as thermo fans, water sprays, idle motors, etc. These outputs can be programmed to output a pulse width modulated (PWM) signal or a digital (on/off) signal. Each output can also be programmed to reverse its output signal logic.

Example of auxiliary output connections
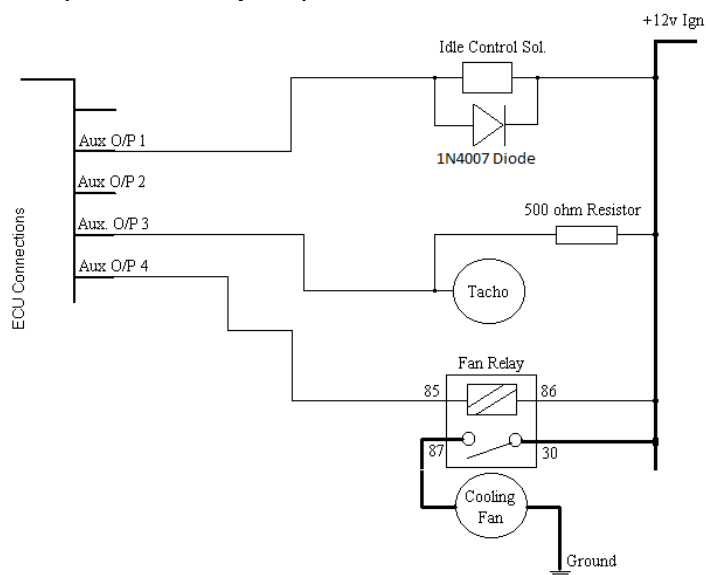
NOTE: All outputs actually connect to ground. This means that any device being controlled must be connected to power at the positive end and to the ECU output at the negative end. Each output can sink up to 1 amp.

Fuel Pump

All EM-Tech ECUs can control a fuel pump via one of the auxiliary outputs. All outputs can be programmed to function in various ways for controlling different devices. One way is to control a fuel pump. In this mode the ECU will turn on the fuel pump instantly when the ignition is turned on. If there is no attempt to start the engine then the pump will turn off again after 4 seconds. As long as the ECU detects a continuous trigger pulse from the engine it will keep the fuel pump on. Once the engine stops turning then the fuel pump will be turned off after 4 seconds.
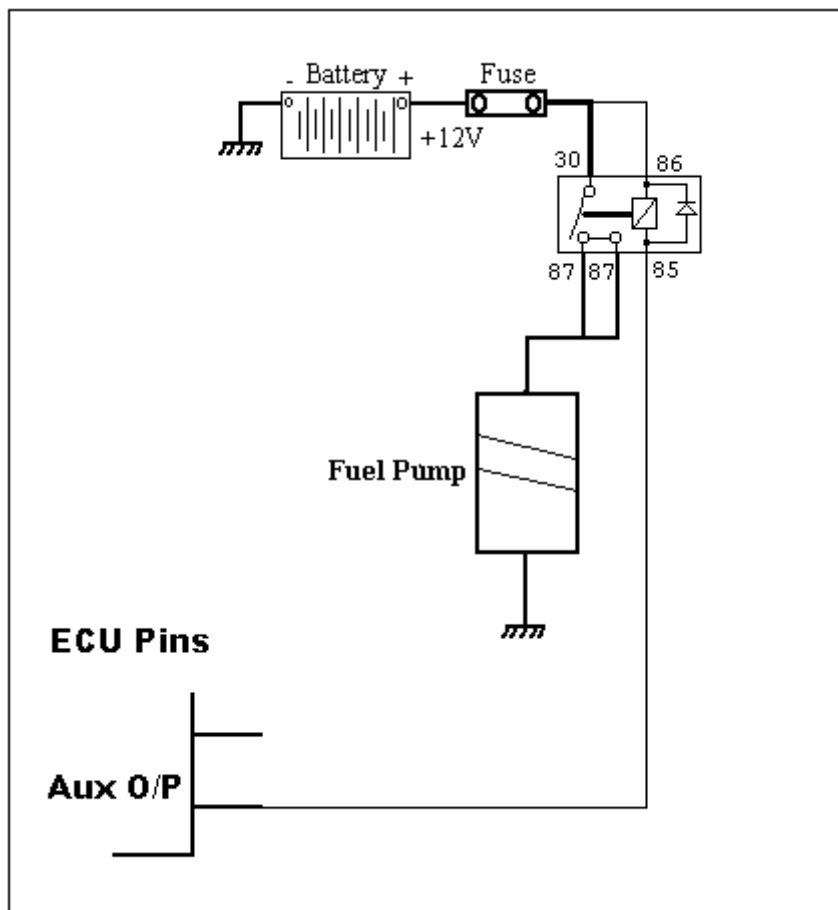
EM 100 Series VVT CAM Control

The CAM Control Solenoids can be connected to any Auxiliary output
and configured via the EM Tech Software.
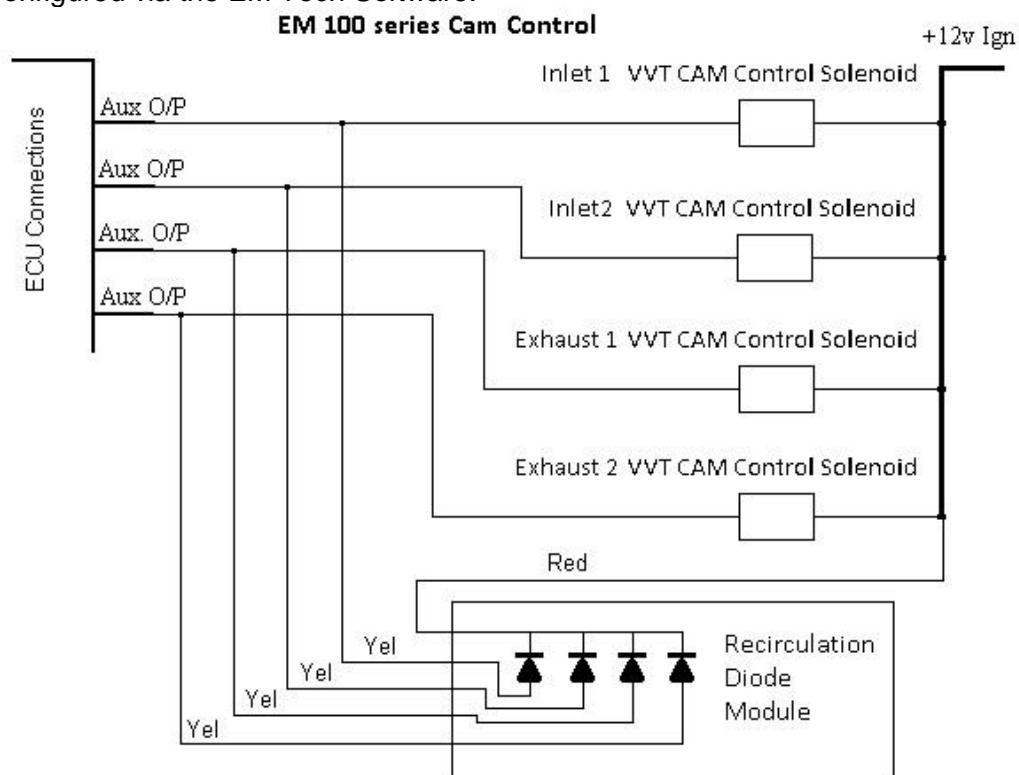
Cam control basics.

EMS Have developed for the EM100 series ECU's to control up to 4 Infinitely variable
camshafts that will move from the 0 deg stop position, up to 50 deg advance or retard
depending on the engine.
All manufacturers have built in different limits of movement for their cams. EMS has
designed the control firmware and software to meet these variable needs.

What is Cam Control? In the past, the CamShaft(s) were connected to the
crankshaft via a fixed gear, chain or belt. Where ever these were fitted when the
engine was assembled, their Valve timing would remain fixed at all times. Race
mechanics, would accurately degree the cam timing in, to obtain the most power
possible.

This all changed when BMW, Rolls Royce and Bosch ECU teamed up and made the
Inlet cam on the BMW M3 straight 6 cyl move its timing. At Idle and cruise, the inlet
cam would be in a position to maximise fuel efficiency and environmental protection.
Once the engine went onto load, the cam would move to maximise the power. As the
engine revved out, the inlet cam would adjust its position constantly to obtain max
power from a pre-determined tune MAP . It still has a Timing chain to connect the
cams to the crankshaft, but has an extra mechanism after the chain and inside the
front of the cam that can move the cam advance / retard, independently from the
Initial chain timing.

Later models moved both inlet and exhaust cams. The remainder of the world slowly followed this great concept.

With greatness comes complexity.
For this VVT system to function electronically, you need the following.
 A crankshaft sensor so the ECU knows where the engines crank rotational degrees are at any moment.
A cam position sensor, for each cam that is moveable, so it knows if the cam is advanced or retarded.
An oil control solenoid for each cam that needs controlling.
An ECU that has been design with the control algorithms to control variable cams.

In simple terms, the user tells the ECU where they want the cam to be. The ecu controls the oil solenoid and the cam moves. The ECU can see it move due to the signal returning from the cam position sensor and the cycle is complete.

Inside the EM100 ECU
There are 6 main 3D tables and many control settings that make up the Cam control Program.

Setpoint Tables.
The first 3D Table is the setpoints (target) for the Inlet Cams and can be set from 0 to 50 degrees of advance or retard in 0.2 deg increments. You can demand any cam position for any RPM and load. As with all 3D tables, the ECU will interpolate the different RPM and Load sites for a smooth transition of movement.

The second 3D Table, works just like the inlet table 1 but is the setpoints (target) for the Exhaust cams.

Below is a screen shot of the Inlet cams Setpoint 3D table. It is in Crank Degrees
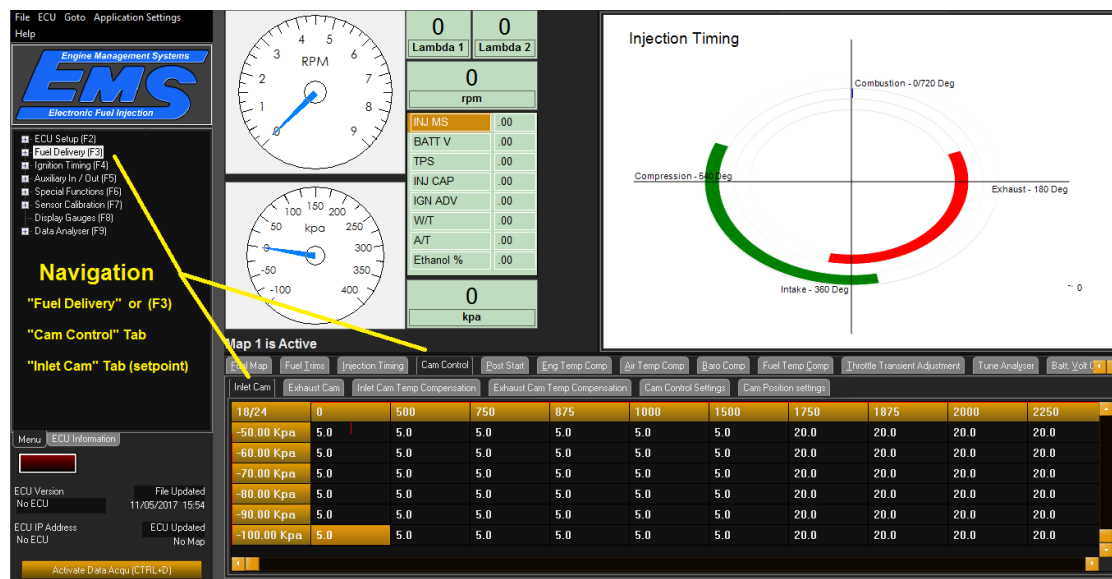
Feed Forward Oil Viscosity Tables

The third and fourth 3D Tables are the engine RPM / Oil viscosity feed forward tables for inlet Cam no.1 and inlet Cam no.2. They work from 0 to 100% duty in 0.5% increments. These tables must be set so that in each RPM/Temperature site, the Feed forward duty number is set to the threshold of where the Cam begins to move off its stop. It is critical that this table is set correctly, so that the feedback control can very rapidly obtain the Cam setpoint (target).

The fourth and fifth Tables are the engine RPM / Oil viscosity feed forward tables for Exhaust Cam no.1 and Exhaust Cam no.2.
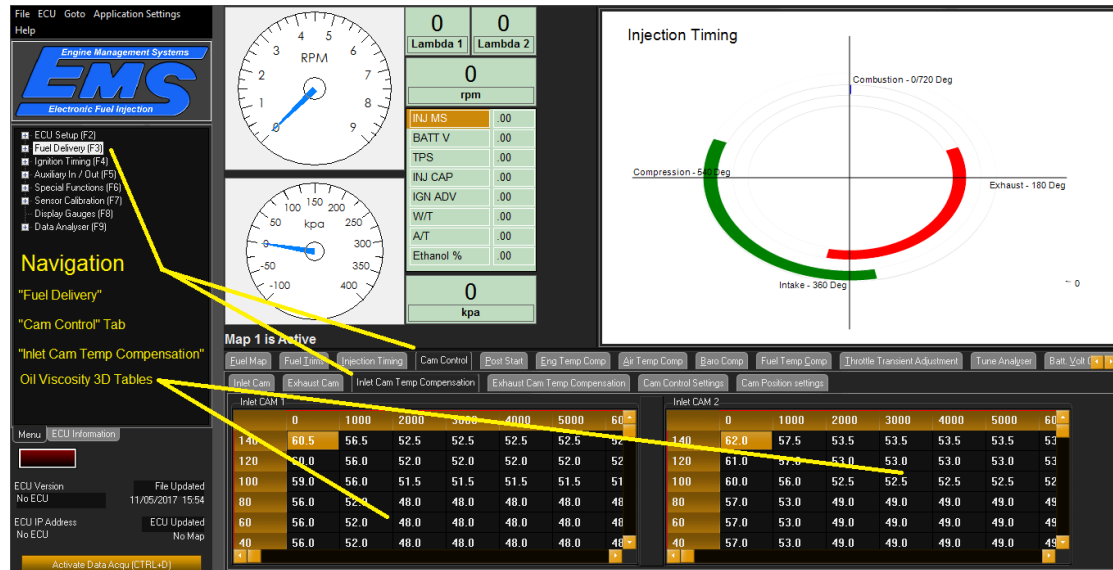
NOTE: When initially adjusting the feed forward tables, the PID feedback settings must be all set to 0 so that the feedback does not override your settings.

"Cam Control Settings" TAB

"Maximum Stop Position"
These Settings, tells the control, the mechanical maximum position where the cam will stop. It is in crank degrees.

"Control Limits"
As the Engine components slowly wear, oil seals leak etc, so the feed forward table will become slightly incorrect. Due to this, the feedback system will be altering the control output to compensate for these errors to hold the Cam on its setpoint (target). These settings will limit how far the control feedback is allowed to deviate from the original feed forward value. They are expressed as a limit in % of duty.

"PID Control"

These are the settings for the feedback control system. They change how the feedback reacts to the error deviation between the setpoint (target) and the actual Cam position.

Proportional, Integral and speed.

As all things to be controlled behave differently, the feedback settings must be adjusted to give the desired response to match the system it is controlling.
Due to this, these 3 settings must be found experimentally.
Set these to 0 until the feed forward tables have been finalised.

Initial settings to try are:
Proportional   = 1.5
Integral   = 0.02
Integral Speed = 1
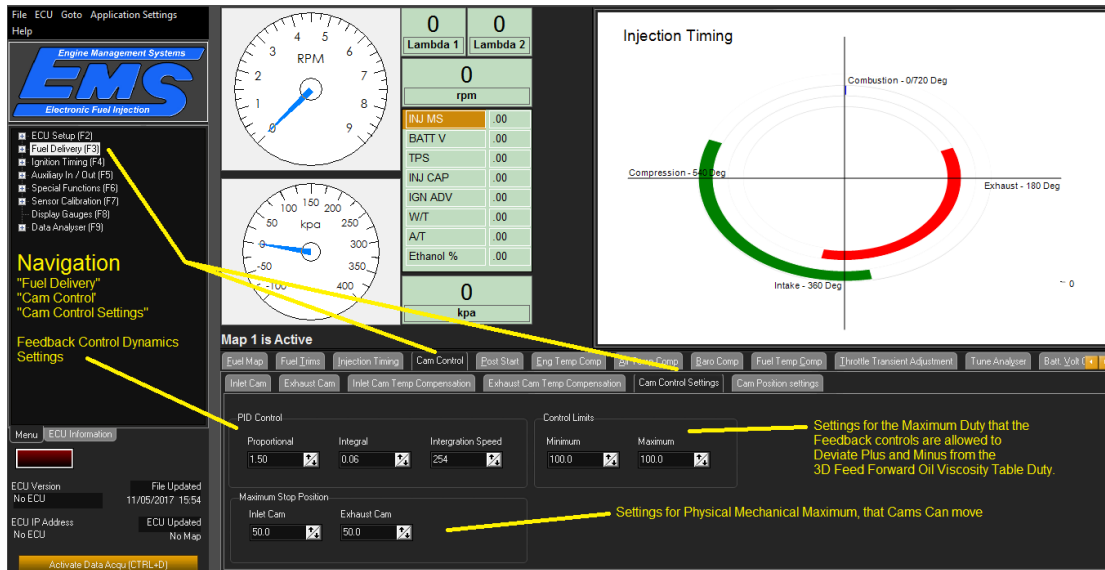
"Cam Position Settings" TAB

"Cam Profile at rest position"
These settings are solely for the indication on the EMS timing graphical display on the screen so you can get a visual representation of what is happening with your valve timing.

"Cam Movement from Rest Position"

These fields tell the control which way the cam will move and it depends on the engine manufacturer's design.

The logical way is for the Inlet cams to advance off their stop as the solenoid is powered and for the Exhaust cams to retard from their resting stop.

As with most things, manufacturers will sometimes switch up the design and reverse either one or both cams. You can find this experimentally, but it is easier to view the EMS base maps for your engine.

"TDC Cylinder Referencing" and "Cam Rest Position"(CRP)
NOTE:
The TDC Cylinder Referencing, Cam Rest Position and the Sync edges work together. The first thing, is to electrically unplug the Cam Control solenoid valves, to ensure that the cams mechanically fall back
onto the mechanical rest stop.

For the ECU to control the camshaft positions, first it must work out where they are. For 1 complete engine cycle, (1 cam rotation and 2 crank rotations) the crankshaft will rotate 720 degrees (2 revolutions).

The CAM rest position (CRP) is the position from 0 to 720 deg where the ECU will see the CAM signal (rising or falling). These edges found in the ECU setup under the "Triggering" tab.
The CRP is similar to the CRIP (crank index position) for the injection and ignition timing, but is to tell the ECU, the camshaft position in its resting state.

Each CAM will have its own CRP signal. These signals can be anywhere in the engine cycle and may occur multiple times for multi tooth cam signal wheels.

With the CRP signals, its almost impossible to guess or find it experimentally,
It must be viewed with an oscilloscope.
With most vehicles, EMS will already have this data in the base MAP but if you have an engine that is unique, you will need to look at the cam signal and the crank signal simultaneously with a 2-channel oscilloscope and determine the CRP and the TDC Cylinder Referencing.

The TDC Cylinder Referencing is the TDC sequence number in which the cam signal falls. The firing order does not come into this.
No.1 cylinder is always first, so it is TDC reference No.1, the next cylinder to fire will be TDC Ref No.2, then the next No.3 and so on.

When setting up VVT cam control, one sync signal I needed for each cam to be controlled.
You must connect the correct Cam sensor to the Sync inputs.
Inlet cam1 signal   to Sync 1 wire.
Inlet cam2 signal   to Sync 2 wire.
Exhaust cam1 signal to Sync 3 wire.
Exhaust cam2 signal to Sync 4 wire.

Eg.
If you only need to control 1 inlet cam, connect to Sync 1.
If you have 1 inlet cam and 1 exhaust cam to control,
Connect Inlet cam1 signal to Sync 1 wire and Exhaust cam1 signal to Sync 3 wire.
If you have 4 cams to control, follow the above connections.

Let's look at a full-blown example. The 2011 to 2014 ford Coyote V8 with 4 Cams to control. No matter how many cylinders your engine has, you will follow the same approach.
Before we get to the CAMs, let's see the engines main timing, the CRIP.

With this engine, it has 36-1 teeth on the crankshaft. i.e. would have had 36 teeth, but has 1 tooth missing, so it has 35 teeth. This is done so that the ECU can look at the gap between each tooth and lock on to the engines mechanical timing, when it sees the bigger gap of the missing tooth.

So, we set the EMS ECU, to lock onto the 4th tooth that passes after the missing tooth. We chose this tooth because it is when the engine is at 5 deg BTDC. The CRIP is set to 5 deg BTDC. One crankshaft revolution is 360 deg. This wheel having space for 36 teeth, each tooth passes the sensor every 10 degrees of crank rotation.

Knowing this information, we need to do some sums to calculate where each TDC is located in the 0 to 720 deg cycle.
Although the CRIP is expressed in deg BTDC, the CRP is expressed as deg After TDC. So TDC No.1 is 0 deg or 720 deg (same point). The CRIP is 5 deg BTDC so No1's location is 720 – 5 = 715.

Being a V8, the next cylinder is 90 degrees past this point so is happens at 715 + 90 = 85deg, the next at 85 + 90 = 175, and so on.

On this Coyote engine, the TDC sequence numbers starting from no1 happen at These deg ATDC :
No1 is at 715 deg
No2 is at   85 deg
No3 is at 175 deg
No4 is at 265 deg
No5 is at 355 deg
No6 is at 445 deg
No7 is at 535 deg
No8 is at 625 deg

Now we must choose a TDC No. for the ECU to reference from. You want to choose the closest TDC number that happens just before the Cam's CRP, but there is a catch.
The Cam's signal is not allowed to cross over this chosen TDC No. as the cam advances. With this coyote V8 engine, this is exactly what happens if you choose the wrong TDC number for that CRP.

After analysing the Crank / CAM signals with an oscilloscope while the engine is running, we have found that the CAMs in their resting positions are at locations:

Inlet 1 at 108 deg ATDC
Inlet 2 at 467 deg ATDC
Exhaust 1 at 30 deg ATDC
Exhaust 2 at 388 deg ATDC

Looking at Inlet cam 1, we see that it rests after cylinder TDC No2 but before TDC No3. Normally we would choose the cylinder before the cams 108 deg which is cylinder No2 located at 85 deg.

The problem with choosing No 2 is that when the Inlet 1 cam advances (up to 50 deg on this engine), it will advance through the 85 deg point all the way to 58 deg ATDC. For this reason, we choose cylinder No1 and not Cylinder No2, as cylinder 1 is the closest before the CAM's CRP that doesn't get crossed over when the CAM advances.

On this and most engines, the exhaust CAMs retard, so choose the TDC No. just before the Exhaust CAMs CRP. Due to them retarding, the Cams move away from the TDC No. and will never experience the cross over problem that you need to be cautious with on the inlet cams.

With these positions now known, the TDC Cylinder Referencing numbers for this engine are as follows:

Inlet 1 CAM = No1
Inlet 2 CAM = No5

Exhaust 1 CAM = No1
Exhaust 2 CAM = No5

Ford Coyote Engine 5.0 V8 Trigger and Sync Timing Signal Diagram (2011 -2014)
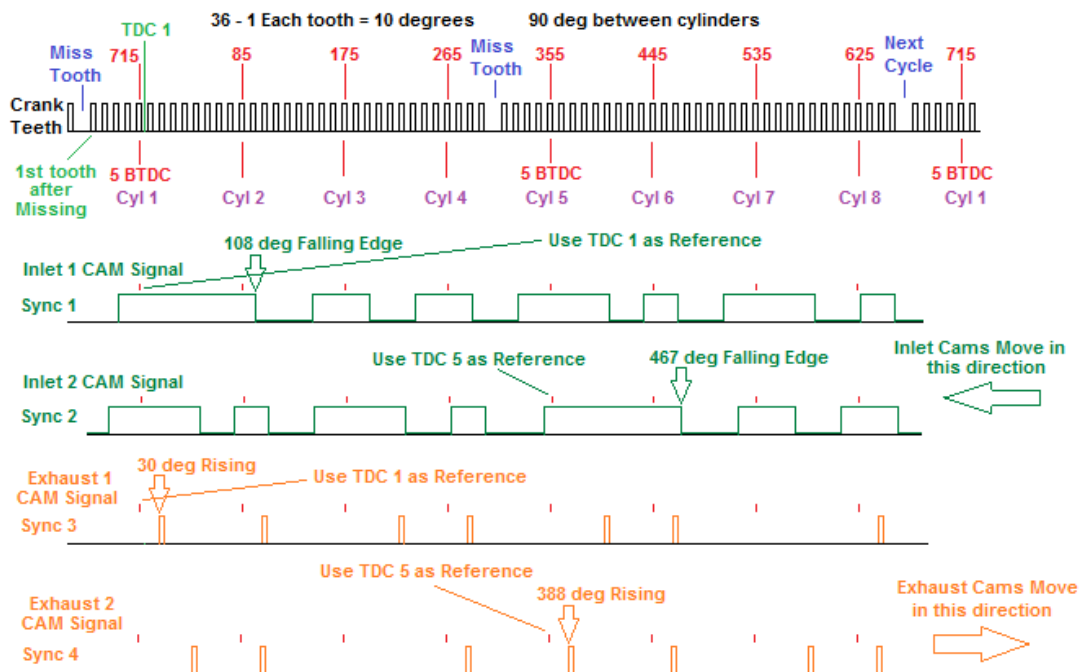
To summarise, view the timing waveforms above.
This snap shot is when the CAM solenoids are unplugged and all 4 CAMs are rested on the internal mechanical stops.
Picture in your mind, that the Top Crank signal is frozen in this position and the Inlet and Exhaust cams move in the direction of the arrows. i.e inlets advance and exhaust retards.

Looking at inlet cam 1, we chose TDC No1 and the falling cam signal at 108 deg.

Now picture that the inlet cams move the maximum 50 deg to the left (5 crank teeth), the falling chosen edge of inlet 1 will move thru the TDC No2 but will still remain approx. 6 crank teeth to the right side of the 715 deg TDC No1.
The same is true for inlet cam 2. The 467 falling edge has the same relationship and never crosses TDC No5.

With the exhaust cam 1, we chose TDC No1. It looks close on the waveform, but the exhaust cams move to the right away from the TDC so TDC No1 is a good choice.

VVT Cam control useful Data to view.

The EMS Timing Graph and settings.
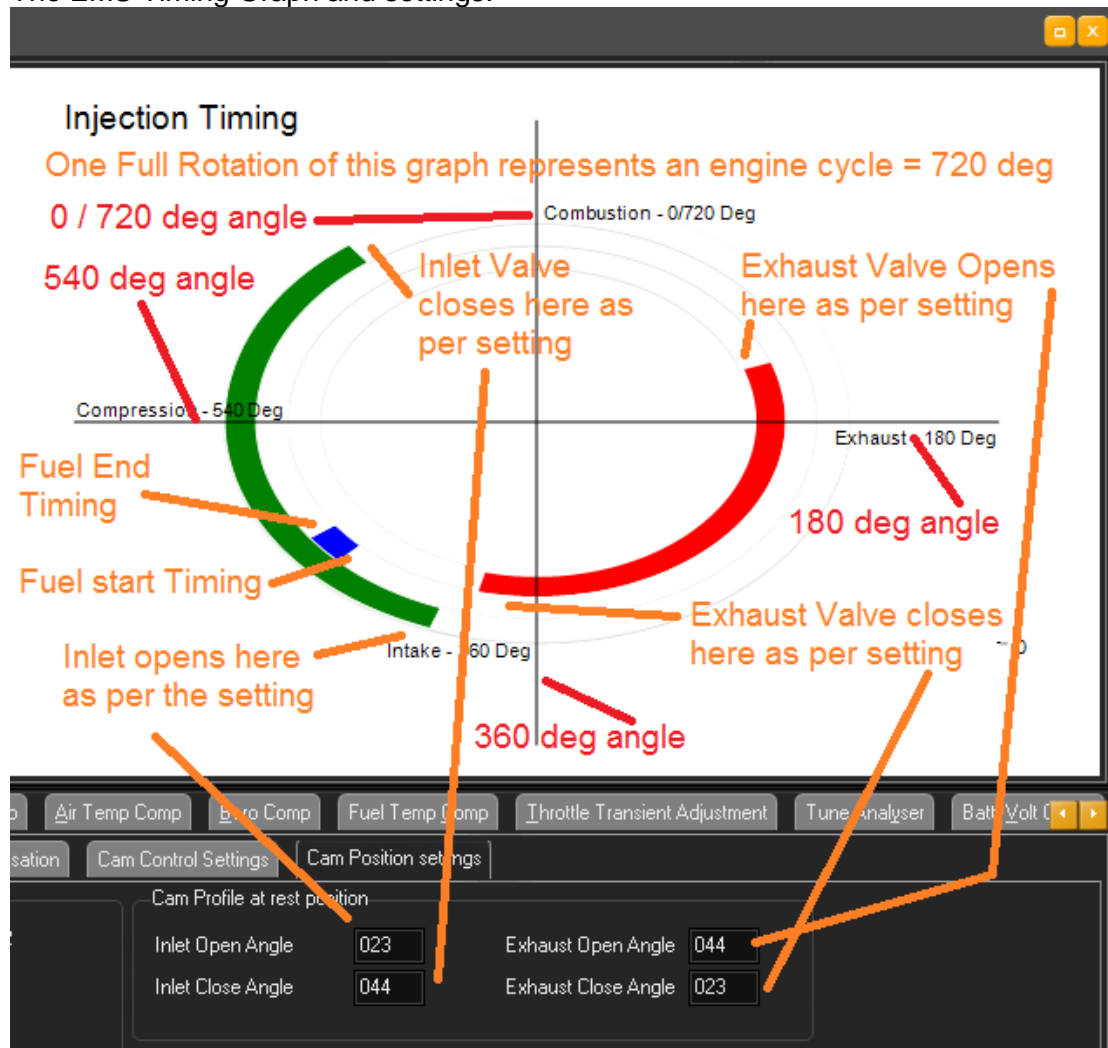
The EMS Timing Graph can be a very useful tool for tuning.
For the fuel (blue section) you can visually see when the fuel starts injecting and when it stops injecting relative to the position in an engines cycle.

In the above graph, the engine is at a minimum load and you can see the fuel only has a small Injection cycle time.

The green segment shows you where the inlet valve opens and closes. This segment Size will change as you alter the "inlet Open Angle" and "inlet Close angle"

Change these numbers to match your Camshaft duration.

In addition to the static timing position displayed for older engines, the whole green inlet timing segment will move with engines that have VVT CAM control.

The Red section of the graph represents the Exhaust valve opening and functions the same as the inlet segment.

Below is the same graph with the engine loaded. You can see that the blue section Fuel injected is bigger. That means that more fuel is being injected.

Injection Timing

Combustion - 0/720 Deg

Compression - 540 Deg

Exhaust - 180 Deg

Intake - 360 Deg

~ 0

| Air Temp Comp | Baro Comp | Fuel Temp Comp | Throttle Transient Adjustment | Tune Analyser | Batt. Volt ◄ ► |

| ...ion | Cam Control Settings | Cam Position settings |

Cam Profile at rest position

| Inlet Open Angle | 023 | Exhaust Open Angle | 044 |
| Inlet Close Angle | 044 | Exhaust Close Angle | 023 |

Another very useful tool that is a must when setting up cam control is the display gauges pop up. Press "F8" to display these configurable gauges anywhere in the EMS tuning software.
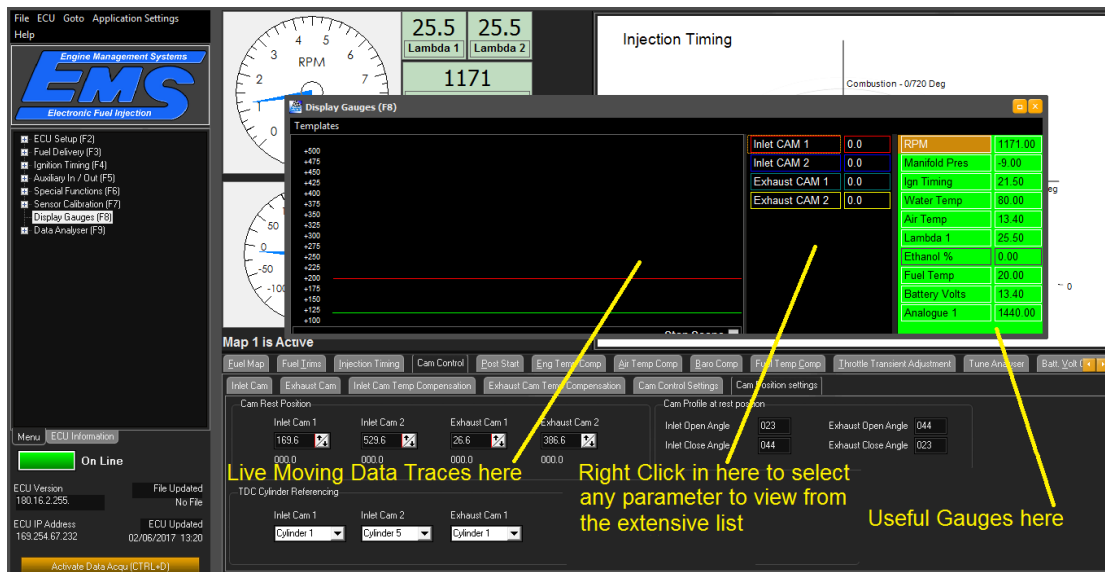
While setting the timing numbers for the CRP (cam rest positions) and Feed forward Oil Viscosity tables, the display gauges are great to use.

Setting VVT Cam control when a base MAP is available.

If there is a base MAP available for your engine, most of the tedious settings work Will have been done. In this case, this all that is required is to trim the feed forward Tables to suit the small tolerance variations that exist between production engines.

Follow these steps.

1) Unplug all the Cam control Solenoids.
2) Run the engine until it is up to operating temperature.

3) Go to the "Cam Position Settings" TAB
   Adjust the Cam rest position settings until the live readings all read approx. 0 – 0.2 deg as the stops on each engine have slight variations. As this is a 0 – 720 deg reading, as it goes backwards from 0, it will read 719 deg. Try adjust, so that the readings are on the 0 side and not the 719 side.

4) In the "Cam control settings" tab set the proportional, integral and integration speed to 0. Now the outputs are derived solely from the feed forward tables.

5) Go to the "Inlet Cam Temp Compensation" Tab. Due to slight engine variations, we are going to trim the whole Feed forward MAP up or down into It's perfect position where the cam just starts to move off the 0 deg stop.

   To do this, first call up the live gauges "press F8" Position the gauges so that it is does not obstruct the feed forward table that you are about to adjust.

Right click inside the gauge and change the viewed parameters to the cam positions in the selectable list. You should see the live cam position readings.

6) We want to highlight the **Whole** map. Click into the Feed forward Temp Compensation table for inlet 1 and arrow to the top left corner. (0 rpm, 140 Celsius). Hold the shift key and arrow down and across to the right bottom corner.(12000rpm, -20 deg). With the Whole map highlighted, when we use the PgUp and PgDn keys, the whole map will increase or decrease all the sites while remaining in proportion, but don't do that yet.

7) Watch the gauge as your helper plugs in the solenoid. Operate the up or down arrows to position the whole map in a duty position, where the cam just starts to move off the 0 deg stop.

8) Unplug this cam and move to the next Cam. Repeat 6 to 8 for all cams.

9) Once all the feed forward tables are all fine tuned, plug all solenoids in and Restore all the PID settings.

Auxiliary Analogue Voltage Inputs

Wire colours for auxiliary inputs
1: Blue A2   EM70 and EM80
2: Blue B2   EM70 and EM80
3: Blue C2   EM70 and EM80
4: Blue D2   EM70 and EM80
5: Blue A3   EM80

1: Blue BF4   EM100 series
2: Blue AJ3   EM100 series
3: Blue AH3   EM100 series
4: Blue AG3   EM100 series
5: Blue AF3   EM100 series
6: Blue AE3   EM100 series
7: Blue AD3   EM100 series
8: Blue AC3   EM100 series
9: Blue AB3   EM100 series
10: Blue BB3   EM100 series
11: Blue BC3   EM100 series
12: Blue BD3   EM100 series
13: Blue BE3   EM100 series

The EM100 ECU's has 13 voltage inputs, EM80 has 5 and the EM70 has 4. You can use the management software to calibrate each input to display a specific value from any 0 – 5 volt sensor output. For example, you can connect exhaust gas temperature sensors to each input and calibrate the voltage signals to display actual temperature on screen. The calibration for each sensor can be saved as a file and reused.

If load source 2 is set to (Barometer) then you must connect a GM 1 bar MAP sensor to input 5 (EM70 & 80), input 9 on EM100 series. The system will use this as a barometer input. EMS testing showed that the ECU tuned by a knowledgeable tuner,

would compensate for altitudes up to 3500 feet without the extra barometer sensor. If your application requires compensation up to 10,000 feet, this sensor be connected to trim out small errors and to maintain maximum power at high altitude.

NOTE: When the ECU is using a barometric sensor, it calculates the volumetric efficiency load point. This will cause the tuning grid and pressure gauge on the screen to be out of sync. Although this is the best way to it set up, it may cause confusion for the novice tuner.

An alternate function for input 5 (EM70 & 80) and input 9 on EM100 series, is for a higher boost sensor. The built in 5 Bar MAP sensor is designed to read from a full vacuum up to 410KPAA (60PSI) Boost. For applications higher than this, an external Sensor is available from EMS that will read up to 900KPAA (130PSI) boost.

If you connect the high boost sensor, there is a calibration table located in sensor calibration section "F7" of the management software.

Auxiliary digital Inputs

Wire colours for auxiliary inputs	1: Green B4 EM70 and EM80
	2: Green C4 EM70 and EM80
Digital 3 is the E85 Flex fuel sensor input	3: Green D4 EM70 and EM80
	4: Green E4 EM70 and EM80
	5: Green E3 EM80

Digital 1 is the E85 Flex fuel sensor input	1: Green AJ1 EM100 series
Digital 2 is the wheel speed input	2: Green AH1 EM100 series
	3: Green AG1 EM100 series
	4: Green AF1 EM100 series
	5: Green AE1 EM100 series
	6: Green AF1 EM100 series

The EM100 Series has 6 digital inputs, EM80 ECU has 5 and the EM70 has 4. Each input can be programmed to be active when grounded or when the input wire is released from ground and is internally pulled up to greater than 2.5 volts. The management software is used to program the ECU to respond differently for each input. For example, one input can be used to increase the idle speed if the air conditioner is turned on and another to adjust the fuel and ignition for nitrous oxide injection, etc.

Note: If you are using any digital input then you must ensure that the input wire is either grounded via a switch, released so it uses internal pullup or held at more than 5 volts via a 500 -1000 Ohm resistor. In the example shown below of a nitrous set-up there is no need to ground the input via a resistor because it is already grounded through the coil winding of the gas solenoid. When the gas solenoid is activated the input wire will read a voltage greater than 5 volts and enable the nitrous function in the ECU.

Example 1: Nitrous oxide control

Switched +12 Volts

Safety Switch

RELAY-DPST

EMS ECU

Aux Output

Aux Input

Ground

EMS MS ECU

Gas | Solenoid | Solenoid | Fuel

Example 2: Normal switching

Activate when grounded

This is a good e.g. of a clutch
Switch for antilag, or Bump
(inch) switch etc

EMS ECU

Digital Input

EMS ECU

Activation Switch

EM70/80 General Diagram

EM80 WIRING DIAGRAM

TITLE EM80 GENERIC DIAGRAM
Date 30-11-16 REV 2.0

EM100 Series General Diagram

EM 100 Series Diagram

Trigger & Sync inputs can be Mag, Hall, Optical. E.g. of Mag and Hall Shown below.

Insulate unused Red wires in the shielded cables

Shielded Trigger Cable

from ECU and Injector Relay — +12V — A

Connector	Signal	Wire	Output
AK2	+5V	Red	AM4 Injector output 1 White
AC1	Trigger Input Green		AL4 Injector output 2 White
	Yellow		AM3 Injector output 3 White
BD2 BE4	Signal Ground Black		AL3 Injector output 4 White

Crank Angle Sensor

EM140,160,180 Primary Injectors

	+5V Red		BG1 Injector output 5 White
	Green		BH1 Injector output 6 White
AB1	Sync 1 Input Yellow		BG2 Injector output 7 White
	Signal Ground Black		BH2 Injector output 8 White

Inlet Cam Angle Sensor 1 Cyl id 1
Shielded Sync 1 Cable

EM160,180

EM180

	+5V Red		AM2 Sec Inj output 1 White
	Green		AL2 Sec Inj output 2 White
BB4	Sync 2 Input Yellow		AM1 Sec Inj output 3 White
	Signal Ground Black		AL1 Sec Inj output 4 White

Inlet Cam Cam Angle Sensor 2
Shielded Sync 2 Cable

EM140,160,180 Optional Secondary Injectors

	+5V Red		BG3 Sec Inj output 5 White
	Green		BH3 Sec Inj output 6 White
BC4	Sync 3 Input Yellow		BG4 Sec Inj output 7 White
	Signal Ground Black		BH4 Sec Inj output 8 White

Exhaust Cam Angle Sensor 1 — Hall
Shielded Sync 3 Cable

EM160,180

+12V from Ignition Relay — B

	+5V Red		AE4 Ign1 Pnk - Pnk	Pnk / Blk Coil 1
	Green		AD4 Ign2 Pnk - Org	Org / Blk Coil 2
BD4	Sync 4 Input Yellow		AC4 Ign3 Pnk - Gry	Gry / Blk Coil 3
	Signal Ground Black		AB4 Ign4 Pnk - Yel	Yel / Blk Coil 4

Exhaust Cam Angle Sensor 2 — Hall
Shielded Sync 4 Cable

EMS 4 Coil Ignitor

			BA1 Ign5 Pnk - Pnk	Pnk / Blk Coil 5
			BA2 Ign6 Pnk - Org	Org / Blk Coil 6
AF2 AG2			BA3 Ign7 Pnk - Gry	Gry / Blk Coil 7
BE2 BF2			BA4 Ign8 Pnk - Yel	Yel / Blk Coil 8

EMS 4 Coil Ignitor

Large Black to Engine Block

Ground Igniters to Engine Head

EM180

Typical Ignition system shown.

EM140 = First 4 Ign outputs
EM160 = First 6 Ign outputs
EM180 = All 8 Ign outputs

	TITLE	EM180 dwg 1 of 2
EMS	Date 14-06-17	Rev 1.0	Drw

EM 100 Series Diagram

+12V from ECU and Injector Relay — (A) — Red — AK3 / AJ4 — Yellow Aux Output 1 — to Fuel Pump Relay control — (C)

AK4

Engine Temp — Grey — AC2 / AH4 — Yellow Aux Output 2 — All outputs are Configurable, but ECU's are sent out Mapped as shown

Air Temp — Grey — AB2 / AG4 — Yellow Aux Output 3

Signal Ground — Black — BD2 / AF4 — Yellow Aux Output 4 — to Fan relay control — (D)

BE4

+5V — Orange — AK2 / BB1 — Yellow Aux Output 5

Throttle Position — TPS Signal — Grey — AD2 / BC1 — Yellow Aux Output 6 — All Auxillary outputs will ground when active. 1 Amp current limit.

Knock Sensor 1 — Blk / Knock Shield — Yellow — AK1 / BD1 — Yellow Aux Output 7

Knock Sensor 2 — Blk / Knock Shield — Yellow — BF1 / BE1 — Yellow Aux Output 8

Flex Fuel Sensor — Pulse Input 1 — Green — AJ1 / AA1 — Yellow Throttle Motor 1 + — (M) — Also can be stepper motor

Speed sensor — Pulse Input 2 — Green — AH1 / AA4 — Yellow Throttle Motor 1 -

Switch — Digital Input 3 — Green — AG1 / AA3 — Yellow Throttle Motor 2 + — (M)

SW — Switch — Digital Input 4 — Green — AF1 / AA2 — Yellow Throttle Motor 2 -

Switch — Digital Input 5 — Green — AE1 / BF4 — Blue 0-5V input 1

Switch — Digital Input 6 — Green — AD1 / AJ3 — Blue 0-5V input 2 — Voltage inputs can be connected to many different sensors, e.g. Pressure, Exhaust gas Temperature, position sensors etc.

Signal Ground — Black — BD2 / BE4 / AH3 — Blue 0-5V input 3

+12V Ign — LA 1 IP — Grey — AJ2 / AG3 — Blue 0-5V input 4

Bosch LSU 4.9 Sensor — LA 1 Heater — Yel — PWM / AF3 — Blue 0-5V input 5

LA 1 CAL — Grey — AE2 / AE3 — Blue 0-5V input 6

LA 1 VS — Grey — AH2 / AD3 — Blue 0-5V input 7 — +5V — Optional 10 Bar Boost sensor or Baro Sensor

Signal Ground — Black — BD2 / BE4 / AC3 — Blue 0-5V input 8

+12V Ign — LA 2 IP — Grey — BB2 / AB3 — Blue 0-5V input 9

Bosch LSU 4.9 Sensor — LA 2 Heater — Yel — PWM / BB3 — Blue 0-5V input 10 — Sig

LA 2 CAL — Grey — BF3 / BC3 — Blue 0-5V input 11 — GND

LA 2 VS — Grey — BC2 / BD3 — Blue 0-5V input 12

Lambda sensors directly connected to ecu. — BE3 — Blue 0-5V input 13

Viewing rear of plugs

4	M	L	K	J	H	G	F	E	D	C	B	A
3												
2												
1												

A	B	C	D	E	F	G	H	
								1
								2
								3
								4

EMS

TITLE	EM180 dwg 2 of 2	
Date 14-06-17	Rev 1.0	Drw

Relay Connections

BATTERY + −

Battery Isolator

30 AMP FUSES

IGN SW

ECU and Fuel Injection Relay

30 87
86 85

(A)

Ignition Relay

30 87
86 85

(B)

Fuel Pump relay

30 87
86 85

Fuel pump

to ECU Aux output 1 (C)

Thermo Fan Relay

30 87
86 85

Radiator Fan

to ECU Aux output 4 (D)

Note: EMS Base maps are preset to use Auxillary outpus 1 and 4,
but any Auxillary output can be programmed for any available function

EMS	TITLE	Relay Connections	
	Date 14-06-17	Rev 1.0	Drw

ECU Programming and Configuration

Management Software

Operating system:
Windows 7 or newer
PC Requirements:
1.2 GHz processor
VGA colour display with 1024x768 resolution
128MB of memory
40 MB of free Disk space

Installing the software

Installation is similar to any other windows software.

1. Insert the CD-ROM into your PC's CD-ROM drive.
2. The CD should auto-run the installation software. If the installation software appears then go to step 6.
3. Double click on the "My Computer" icon on the desktop.
4. Double click on the CD-ROM icon to open the CD-ROM.
5. Double click on the "EMTECH_SETUP.EXE" icon to start the installation software.
6. Select install the EM-Tech software.
7. Follow the installation steps leaving the default values.

When the installation is complete you should find the EM-Tech Management Software icon on you desktop.

Going Online with the Software

First ensure that you have your programming cable attached to the ECU and the other end connected to your laptop.

Turn on the ignition to power up the ECU then double-click on the EM-Tech Management Software icon on your desktop to run the application. If all is well you should see the message "Read from ECU". Press the Yes button to read or NO if you do not want to read from the ECU. If all is not well then see the **Problem Solving** section of this manual.

Loading a base map

All EM-Tech ECUs come pre-loaded with a base map. If you requested a map for a particular engine then this would have been pre-loaded (if available). The software also has a selection of base maps for many different engines that you can choose from. Go-to the "File" then "Open Tune File" Option and then go-to the "Base Maps" folder, select a map that is suitable for your engine and press the "Open" Button. To write this map into the ECU go-to "ECU" then "Write to ECU" menu option. When the progress bars at the bottom of the screen have stopped the map will have been written to the ECU.

Warning:

The base maps are not intended for driving. These should only be used to ensure that the ECU is installed correctly and the engine starts. The engine must be properly tuned and tested at a mechanical workshop before attempting to drive the vehicle.

Setting engine parameters

If the map for your engine is not available, then you will need to set your own engine parameters via the ECU set-up screen.

Load Source

All EM-Tech ECUs have 2 load source selections, one for the fuel mapping and one for the ignition mapping. It is important to use them correctly. The table below will assist in understanding how to use them.

Load source setting	Result
Internal MAP sensor	Built-in MAP sensor that reads from -100kpaa to 410kpaa. (5 Bar or 60psi) It is used as load source
* Internal MAP sensor With Baro on **Analogue 9	Built-in Absolute MAP sensor is used as load source with Baro sensor on **Analogue9 for load point calcs and barometric compensation table.
External Map Sensor on **Analogue 9	Provision for (10Bar, 130Psi) Absolute External MAP sensor on **Analogue 9. (Internal Map sensor not used.)
TPS Sensor with External Map Sensor on **Analogue 9	TPS is used as primary load source with MAP sensor is connected on **Analogue 9 and functions as the 4th D via the override adjustments.
* TPS Sensor with Internal Map Sensor and Baro on **Analogue 9	TPS becomes the main load source with internal sensor as the override/Baro, but also has an external Baro sensor on **Analogue 9 for fine tune on the baro compensation page.
TPS with internal MAP Sensor	TPS is used as load source. If Built-in MAP sensor is also connected to the plenum then the ECU can be used on force inducted engines. The Fuel override table is used to determine correct fuel as pressure changes in the manifold. MAP sensor to air filter becomes a baro sensor.

* These 2 options do not apply to the Ignition Map load source selection.
** Analogue 9 on EM100 series but Analogue 5 on EM80.

Engine Set-up Parameters

Injector Arrangement

2 Group 360
For rotary and piston engines.
2 group 360 mode splits the injector outputs into 2 alternating groups.
Check the position of the fuel injectors. They must be fitted as Multi Point (1 injector per cylinder). When 2 group 360 is selected regardless of the number of cylinders, the computer will fire the injectors twice every engine cycle (once per crank revolution). This is done in 2 alternating groups.
NOTE: Throttle body should be selected for 2 strokes.

2 Group Throttle Body Mode
2 group throttle body mode splits the injector outputs into 2 alternating groups.
It will fire the injectors at different timings, depending on how many cylinders are selected.
This arrangement is used when the injectors are located inside a throttle body, as in a 4 barrel with 4 injectors mounted in it.
This mode can be used with positive displacement superchargers (blowers) when the injectors are mounted on top of the Blower. For this setup, the injectors must be also staged. The primaries inject fuel first and as the load increases, the secondary (staged) injectors will turn on.
On a Blown V8 with 8 or 16 injectors on top of the blower, it's much better to select sequential injection mode.

2 Group 720
For piston engines only.
2 group 720 mode splits the injector outputs into 2 alternating groups.
Check the position of the fuel injectors. They must be fitted as Multi Point (1 injector per cylinder). When Multi-point 720 is selected regardless of the number of cylinders, the computer will fire the injectors once every engine cycle, (two complete crank revolutions) this is similar to sequential injection. Using Multi point 720 will provide smoother idle and better light load transitions with larger injectors.

Sequential injection
For piston engines only.
Check the position of the fuel injectors. They must be fitted as Multi Point (1 injector per cylinder). Also check the wiring of the injectors. They must be wired in the same order as the firing order of the ignition. The ECU will fire each injector output one at a time sequentially from 1 to 8. Each output will be fired according to the output sequence defined in the Cylinder Sequencing table.

Batch 720
For piston engines only.
Check the position of the fuel injectors. They must be fitted as Multi Point (1 injector per cylinder runner). When Multi-point 720 is selected regardless of the number of cylinders, the computer will fire the injectors once every engine cycle, (two complete crank revolutions) this is similar to sequential injection. Using Multi point 720 will provide smoother idle and better light load transitions with larger injectors.

Batch 360 - Use this setting for rotary engines
Check the position of the fuel injectors. They must be fitted as Multi Point (1 injector per cylinder runner). When Multi-point 360 is selected regardless of the number of cylinders, the computer will fire the injectors once every crank revolution.

Number of Cylinders

Set this field to the number of cylinders or rotors for your engine. The ECU uses this to determine the correct firing sequence for igniters and injectors. Also for the RPM calculation and many other background calculations.

Number of igniters

The EM 180 ECU can fire up to 8 coils sequentially.
The EM 160 ECU can fire up to 6 coils sequentially.
The EM 140 ECU can fire up to 4 coils sequentially.
The EM 70/80 ECU can fire up to 4 coils sequentially.
By using multiple coils, you eliminate the need of a distributor cap and rotor button. More coils also lessen the load on each coil and give extra time between firing for dwelling.
1 coil for each cylinder is best for Max HP engines. If you have a missing tooth wheel on the crank, wasted spark is the easiest.
In this section you must set the correct number of Igniters to be sequenced.

E.g.   4 cyl with 4 coil sequential, select 4 igniters.
          4 cyl with 2 coil wasted spark select 2 igniters.

Ignition fire edge

This parameter must be set according to the igniter module you are using. EMS igniters and most OEM igniters work with a falling firing edge. This means that the ignition output of the ECU is held at a high voltage for the duration of the dwell period and then switched off when the coil needs to fire. Rising edge modules work in the opposite manner. It is important to set this correctly to prevent coils and igniters from being overloaded. If set incorrectly, igniter and coil destruction is very possible.

Ignition Delay Compensation

This parameter is set if you are using a CDI system. All CDIs have a delayed response from trigger to fire. This delay can cause your ignition timing to fire slightly retarded at high RPM. If you know the delay of your CDI then set it here so the ECU can compensate for the delay. A typical value would be around 16 to 30 microseconds.

Ignition Dwell

Ignition dwell time is the duration in milliseconds that the coil is charged before being fired. The time will vary for different ignition and coil systems. Typically 2.0 to 3.5mS is a good point to start.

Soft Rev Limit

Set this parameter to the RPM you want the engine limited. The rev limiter cuts the ignition in a specific sequence depending on how you set the misfire sequence. It should be set a little lower than the maximum RPM and the hard rev limiter can be set to the maximum RPM. This will give double protection from over revving an engine.

To disable the Soft Rev Limiter set it to 0 RPM.

Hard RPM Limit

Set this parameter to the absolute maximum RPM you want the engine limited. This method will completely cut the ignition at the selected RPM and enable it again when the RPM has dropped below the set value. This will prevent an engine from over revving if the driver is accelerating by applying throttle.
No rev limiter will prevent overrevving if the driver gears down too early, as the weight, momentum and gear ratio will force the engine to overrev.
To disable the Hard Rpm Limiter set it to 0 RPM.

Boost Cut

This parameter will prevent forced inducted engines from over boosting. Select the allowable pressure limit before cutting the ignition. The ignition will restart once the pressure has dropped below the value set.

If boost cut is not required select OFF.

Deceleration Fuel Cut (overrun)

This parameter is used to cut the fuel when the engine vacuum falls below the set value. This is useful for controlling emissions. You would use this parameter to stop injecting fuel when the engine is used to slow the momentum of the vehicle. An example would be decelerating the vehicle down a steep hill by closing the throttle.

Select at which vacuum value you would like the computer to cut fuel. The fuel injection is stopped when the vacuum is stronger than the selected value.

If this feature is not required select No Fuel Cut.

Throttle Transient Adjustment
Transient Detection

This parameter is used for controlling flood mode and to select the use of either TPS or MAP for fuel acceleration enrichment. Selecting the **Use Manifold** will use the MAP sensor for acceleration enrichment. Selecting the **Use TPS** will use the TPS sensor for acceleration enrichment.

When Use Manifold is selected, other selected functions elsewhere, like using the TPS as a main load source or special functions such as anti-lag and controlling auxiliary outputs etc will continue to function even though Use Manifold is selected.

If a throttle position sensor is fitted then it is recommended that you use it because it will enable the ECU to respond instantly to sudden changes in engine load.

In very dusty or muddy racing applications, as in sprint cars and off-road races, the TPS sensor will be less reliable, try and select Use Manifold in these cases. EMS have spent years of research to obtain excellent drivability when only the MAP sensor and no TPS is fitted.

If there is no TPS connected then ensure that this parameter is set to **Use Manifold**. In this setting, the ECU will detect throttle transients by monitoring the changes in manifold pressure.

Dead band

The actual adjustment number will depend on transient detection method. If Use TPS is selected then the number represents % of TPS. If the Use Manifold option is selected then the number will represent pressure in KPA.

Throttle Sensitivity
The Throttle sensitivity parameter works in conjunction with "aspiration" and "supercharger boost". These three parameters control the acceleration enrichment response to sudden changes in engine load. The throttle position sensor must be used for these parameters to have any effect.
This parameter has 3 settings to choose from, **Normal**, **Large** and **Multi Throttle**.

You may need to experiment with these to obtain the best response. The normal setting is used for standard throttle body sizes. large is for a large throttle bodies and multiple throttle is for very large throttle bodies or multiple throttle bodies. When deciding on which selection is appropriate, consider the ratio of size throttle body to the capacity(size) of the engine. This function will only appear on screen if Use TPS is selected I the Transient Detection.

Acceleration Enrichment
The amount of enrichment is determined by the 3D **Transient Enrichment Map**. Use this map to adjust the amount of extra fuel at different load points.

Enrichment Duration
Enrichment Duration sets the duration for which the fuel is added. Through acceleration testing, adjust this parameter until you have reached a satisfactory engine response.

Enrichment Duration is the number of cylinders fired with extra fuel being added. Normally set to 20 for 4 cyl or 30 for 6 cyl etc. but can be reduced or increased as needed. For example, setting a value of 20 for a 4 cylinder engine, the ECU will hold the enrichment on for 20 power strokes which is equivalent to 10 crank revolutions or 5 engine cycles.

When tuning the fuel maps at steady state, temporarily set this to 0 **and don't forget to reset it back afterwards.**

Aspiration
This parameter works in conjunction with Sensitivity. Acceleration enrichment responses are different for turbo charged or normally aspirated engines than for supercharged engines. There is a time delay between opening the throttle and the air rushing in to fill the manifold. For turbo charged or normally aspirated engines this may be only milliseconds but for supercharged engines it is almost instant. This parameter instructs the ECU to behave according to the aspiration of the engine.

Select **Normal / Turbo** for normally aspirated or turbo charged engines.
Select **Super Charged** for supercharged (positive displacement) engines.

Super Charger Boost

This parameter works in conjunction with Sensitivity and Intake Induction. It is only for supercharged engines, not for turbo charged engines.

Set this value to the max boost pressure that will be reached with supercharged engine.

Acceleration Enrichment

The amount of enrichment is determined by the **Transient Enrichment Map**. Use this map to adjust the amount of extra fuel at different load points.

Enrichment Duration

Enrichment Duration sets the duration for which the fuel is added. Through acceleration testing, adjust this parameter until you have reached a satisfactory engine response.

Enrichment Duration is the number of cylinders fired with extra fuel being added. Normally set to 20 for 4 cyl or 30 for 6 cyl etc. but can be reduced or increased as needed. For example, setting a value of 20 for a 4 cylinder engine will cause the enrichment to last for 20 power strokes which is equivalent to 10 crank revolutions.

When tuning the fuel maps at steady state, temporarily set this to 0 **and don't forget to reset it back afterwards.**

Throttle Position Sensor Calibration (only if a TPS is fitted)

EM 70 / 80

The closed throttle and open throttle settings cannot be adjusted manually. You must follow the procedure described below. It is important that the calibration be done if you will be using the TPS as the main engine load source.

Before commencing, while the engine is turned off, make a visual and physical check of the throttle to see that it does fully open and close.

From the Filing system in the left window, click on the "Sensor Calibration" (F7)
Then click on the "Throttle Position Calibration" tab

Calibrate Closed Throttle

With your throttle closed, press the "Read Closed Throttle" button. The system will place a number into the field. This is the TPS voltage represented as a number when the throttle is closed. You should see a number between 0 and 1000. This is a number that has been converted from the variable 0-5 Volts from the sensor.

Calibrate Open Throttle

Open your throttle fully, and then press the "Read Open Throttle" button. The system will place a number into the field. This is the TPS voltage represented as a number when the throttle is open. You should see a number between 0 and 1000.

One number should be form around 700 to 1000 and the other should be from 0-300.

e.g a typical span follows. 247 in one field and 907 in the other. This is a successful span. You can see there is a significant difference between the 2 numbers. This indicates that the voltage that the ECU is seeing, is varying between the 0% and 100% throttle press.

If for some reason, the number is very similar or the same in both fields, indicates that there is a wiring or sensor problem.

This function can only be used if a throttle position sensor has been fitted and the Use Throttle sensor check box is ticked.

NOTE: If, for any reason the TPS is moved then you should recalibrate the sensor.

While spanning the throttle position, calling up the gauges "F8" is a very useful tool For seeing the result and testing if the ECU can see a nice 0-100% movement as you press the throttle.

Closed Loop Lambda

All EM-Tech ECUs offer two closed loop lambda control modes. Narrow band and wide band.

Narrow Band

If you only have a narrow band sensor connected then set the Sensor type to Narrow Band. In this mode the system will only detect if the air/fuel ratio is above or below the stoic value and try to maintain this value. Stoic is equal to lambda value 1 or air/fuel ratio 14.7 for petrol engines.

The Target A/F Ratio cannot be selected in this mode.

Wide Band

By selecting either Bosch 4 wire or 5 wire adaptor will put the ECU into wide band mode. EM100 series has the LSU 4.9 wide band selection.

The Bosch LSU 4.9, 5 wire sensor can wire directly into the EM100 series ECU's Which have twin controllers built in. (Bosch Sensor Number 0 258 017 025)

The **Bosch 4 Wire** mode uses the Bosch 4 wire sensor (Bosch Sensor Number 0 258 104 002). EM70 / 80 ECUs can read this sensor directly and provide accurate air fuel ratio values that are compensated for sensor temperature variations.

The **Bosch 5 wire adapter** mode uses the LC1 or LM1 lambda kit from Innovate. This kit uses the Bosch 4.2, 5 wire sensor and a control unit. In this mode the ECU reads either Analogue output 1 or 2 of the LC-1 output. Before the LC-1 can be used it must be calibrated to produce a 0.05 to 0.95 voltage output. Use LM Programmer software to calibrate the LC-1. Set the output to read 0.050 volts for an air fuel ratio of 8.0 and 0.950 volts for an air fuel ratio of 22.

Programming the closed loop lambda function

This function is intended for light driving conditions and idle. It should be used to control exhaust emissions and fuel economy.

The Allowable Change parameter determines the maximum automatic fuel percentage adjustment allowed. This setting prevents the ECU form over-adjusting the fuel delivery if there is a lambda sensor failure.

The Operating Range parameter determines the vacuum range in which the closed loop function will work. The range starts from minus 100 kPa and ends at the value set by this parameter. The closed loop control will turn off when the engine is above

the selected vacuum (closer to zero) and start again once the engine vacuum goes below the selected level.

The Target A/F Ratio parameter sets the air fuel ratio you want to maintain. The ECU will automatically adjust the fuel delivery in order to achieve the selected target or is forced to stop when it reaches the allowable change limit.

Timing Sensor Set-up

The ECU uses the signals from the trigger and sync sensors to follow the engine cycle.

All EM-Tech ECUs can accept hall, optical and magnetic sensors using the same input wire. With the EMS EM-Tech ECUs, magnetic sensor calibration is not necessary because it will automatically self-learn the magnetic sensor signals. The ecu will trigger with a trace zero crossing signal providing pin-point timing accuracy over the entire rev range.

Trigger (Crank) sensor type

This parameter sets the ECU to use a Hall, Optical or magnetic sensor for the trigger signal. The same input wire can be used to read signals from any of these sensors.

Sync (CAM) sensor type

This parameter sets the ECU to use a Hall, Optical or magnetic sensors for the sync (home) signal. The same input wire can be used to read signals from any of these sensors.

If the sensor type is Hall or Optical then set this parameter to "Hall/Optical".
Hall and Optical sensors are usually 3 wire sensors that produce a square wave signal. These sensors usually require a regulated power supply that can be obtained from the red 5 volt wire inside the shielded sub-loom.

If the sensor type is magnetic then set this parameter to "Magnetic"
Magnetic sensors are 2 wire sensors. They produce a sine wave signal. No power supply is required for these sensors.

When setting up VVT cam control, one sync signal Is needed for each cam to be controlled.
You must connect the correct Cam sensor to the Sync inputs.
Inlet cam1 signal   to Sync 1 wire.
Inlet cam2 signal   to Sync 2 wire.
Exhaust cam1 signal to Sync 3 wire.
Exhaust cam2 signal to Sync 4 wire.

Eg.
If you only need to control 1 inlet cam, connect to Sync 1.
If you have 1 inlet cam and 1 exhaust cam to control,
Connect Inlet cam1 signal to Sync 1 wire and Exhaust cam1 signal to Sync 3 wire.
If you have 4 cams to control, follow the above connections.

WARNING: If the red 5 volt power supply wire is not being used then it must be properly isolated to prevent short-circuiting.

Trigger Edge

The trigger edge determines whether the computer is triggered by the positive or negative edge of the trigger signal if hall is selected. For magnetic sensors, Although the waveform trigger point is when the waveform falls thru the zero volt point, inside the ECU, this signal is inverted by the circuitry. So in the software, the trigger edge must be set to rising.

DANGER! Disconnect the ignition coils before rotating the engine by hand.

Depending on the sensor wheel slots or teeth, the signal will either be rising or falling. This timng point can be anywhere between 0-360deg if wasted spark is selected, or 0-720 deg if full sequential is selected. Although the EM tech is fully configurable and able to accept any timing signal, there is always a best practice (the ideal position) This is when the timing tooth occurs anywhere between 10deg BTDC and 10 ATDC. We always aim for 5 deg BTDC as this is the best ideal position. If unknown, connect a multi meter from the trigger wire to ground and watch the voltage level change while turning the engine slowly by hand to determine if the signal is rising or falling.

If rising, select Rising (+)
If falling, select Falling (-)

Sync Edge

The sync edge determines whether the computer is synchronised by the positive or negative edge of the sync signal. For magnetic sensors the sync edge must be set to rising.

DANGER! Disconnect the ignition coils before rotating the engine by hand.

Depending on the sensor wheel slots or teeth, the sync signal will either be rising or falling. If unknown, connect a multi meter from the sync wire to ground and watch the voltage level change while turning the engine slowly by hand to determine if the signal is rising or falling.

If rising, select Rising (+)
If falling, select Falling (-)

Trigger pull-up resistor

This parameter is only used for hall or optical sensors. It should be set to **ON** if the ECU is used as a stand-alone system and **OFF** it the trigger sensor is being shared with the OEM ECU.
Sometimes, if the sensor is shared then the signal may be a little weak. In this case you can set this parameter to ON. This will allow a little more current to flow and improve the rise time of the signal.

Sync pull-up resistor

This parameter is only used for hall or optical sensors. It should be set to **ON** if the ECU is used as a stand-alone system and **OFF** it the sync sensor is being shared with the OEM ECU.
Sometimes, if the sensor is shared then the signal may be a little weak. In this case you can set this parameter to ON. This will allow a little more current to flow.

Ignition Set-up

All EM-Tech ECUs can read one of many selectable trigger patterns. Each engine provides a trigger pattern that the ECU can use to synchronise itself to the engine cycle. Some engine manufacturers use patterns that are specific to their engines and other manufactures use systems developed by third party companies such as Bosch.

Ignition Patterns

The Ignition Type parameter allows you to select one of many trigger patterns available. This eliminates the need to install external trigger wheels and sensors. EMS is constantly adding more trigger patterns to their ECUs. Because of the number of selectable trigger modes, only the most common will be described in this guide.

Normal

In Normal Mode the trigger signal must consist of 1 tooth per cylinder. i.e. a 4 cyl engine will have 4 teeth per cycle. (Either 4 teeth in a distributor or 2 teeth on the crank). A 6cyl has 6 teeth in Distributor or 3 on crank. A v8 has 8 teeth in distributor or 4 on the crank.
If sequential coils or injection is required, a sync signal must be used to tell the ECU that the next trigger will be number one BTDC. See Ignition Patterns.

You set the static timing tooth in the Crank index position parameter.

Nissan mode 1

This is used for multi-coil applications using the Nissan cam mounted crank angle sensors e.g.: CA18, SR20, RB20, RB26, VG30. You can select to run wasted spark by setting the number of igniters to be half the number of cylinders or full coil-on-plug (sequential) by setting the number of igniters to be equal to the number of cylinders. These cam mounted sensors have 2 signals. The sensor that reads 180 teeth must connect to the sync wire and the one that reads 4 or 6 teeth (depending on number of cylinders) connect to the trigger wire.

```
R32,R33,R34 GTR
Teeth Per cam cycle  =      One tooth per cylinder
Index tooth          =      none
Sync sensor used     =      yes
Sync pulses per 720  =      1
Crank sensor         =      Hall
Crank Trigger Edge   =      +
Trigger Pull Up Res  =      On

Cam1&2 Sensor type   =      Hall
Cam1 Sync1 edge      =      -
Sync Pull up Res     =      On

CRIP                 =      105 deg BTDC
```

Nissan mode 2

This is used for multi-coil applications when a distributor is used instead of a cam mounted crank angle sensor e.g. FJ20, RB30, ET PULSAR. You can also choose to run wasted spark or full sequential by selecting the number of igniters and cylinders as per Nissan mode 1.

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	On
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	105 deg BTDC

Subaru Boxer Engines Pre 2001

This mode is used for 4 cylinder Subaru engines only. These have magnetic sensors. It is critical that they are connected with the correct polarity. If they are not connected correctly the engine will not run.
Set number of cylinders to 4, Number of igniter to 2, Trigger sensor to Magnetic, Sync sensor to Magnetic, Trigger edge to + (Rising) and Sync Edge to + (Rising). You can still use 4 coils with a 4 coil igniter and run either full sequential or run wasted spark.

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Mag
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	Off
Cam1&2 Sensor type	=	Mag
Cam1 Sync1 edge	=	+
Sync Pull up Res	=	Off
CRIP	=	10 deg BTDC

GM LS2 / L76 / LSA

This mode is used with the LS engines that had OEM Bosch. These engines have a 60-2 crank wheel.
The Sync signal has more than 1 tooth and has uneven spacing.
This special mode requires the following settings.

Teeth Per cam cycle	=	120
Index tooth	=	13
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	+

Trigger Pull Up Res	=	On
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	+
Sync Pull up Res	=	On
CRIP	=	3 deg BTDC

Volvo / Ford 5 Cyl (EM100 EM160 and EM180)

This mode is used for 5 cylinder Volvo / Ford engines. Set the number of cylinders to 5 . You mst set up as full coil-on-plug (sequential) by setting the number of igniters to be 5. Wasted spark is not physically possible on these engines.

Teeth Per cam cycle	=	120
Index tooth	=	15
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Mag
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	Off
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	5 deg BTDC

Note: (EM140, EM80 and EM70, Have 4 ignition outputs thus cannot be used on these engines)

Subaru WRX from 2001

This mode is used for 4 and 6 cylinder Subaru boxer engines. Set the number of cylinders to 4 or 6 and number of trigger teeth to "one tooth per cylinder". You can select to run wasted spark by setting the number of igniters to be half the number of cylinders or full coil-on-plug (sequential) by setting the number of igniters to be equal to the number of cylinders. If running sequential fuel or ignition then you must use a sync sensor and the Sync Sensor Used parameter must be ticked.

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Mag
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	Off
Cam1&2 Sensor type	=	Mag (2001), Hall (2005)
Cam1 Sync1 edge	=	+ (2001), Fall (2005)
Sync Pull up Res	=	Off (2001), On (2005)
CRIP	=	10 deg BTDC

Multi Tooth

This mode is used when there are more evenly spaced teeth occur per cycle, then there are cylinders. E.g. Toyota 2JZ and Toyota 4 cyl's. There are a few variants of these engines. One such has 12 evenly spaced teeth on the crank and 1 tooth on the

cam. It is very well manufactured by Toyota where the sync tooth timing is located perfectly in between 2 crank teeth.
If you start changing cams and using degree wheels to alter the timing, it is very important to check the Sync tooth timing in relation to the crank teeth.

If you are retro fitting your engine to a multitooth setup, the sync tooth must not occur at the same time, or anywhere close to any crank teeth. Due to backlash in the cam, belt, chain or gear, the sync tooth signal will suffer some mechanical jitter. This is ok if the signal is located perfectly in between 2 crank teeth. As soon as the sync signal occurs very close to the crank tooth, this will be a problem.

As the engine revs out, it will reach moments where there will be some mechanical resonance in the cam belt and will cause the sync signal to momentarily change its timing. Depending on which crank tooth it is closest to and crosses, the engine will either retard 30deg and miss fire, (lucky you, your engine survived) or will advance 30 deg with a 24 tooth wheel and throw a con rod and destroy the engine. This scenario will happen with any brand ECU in multi tooth mode.

This setup is mechanically critical. The more teeth the riskier this situation becomes. 12 teeth on the crank (24 per cam cycle) is the max EMS recommends as it will give you 15 deg of leeway either side of the sync tooth if positioned perfectly In between 2 crank teeth.

The index tooth is very important, it tells the ECU, which tooth is the CRIP for Cylinder No.1. Index tooth No.1 is the first crank tooth that passes the sensor immediately After the sync tooth. No.2 is the second tooth and so forth.
Index tooth 1 is recommended.

Toyota 2JZ engine
Teeth Per cam cycle =   24
Index tooth   =   1
Sync sensor used   =   yes
Sync pulses per 720 =   1
Crank sensor   =   Mag
Crank Trigger Edge   =   +
Trigger Pull Up Res =   Off

Cam1&2 Sensor type = Mag
Cam1 Sync1 edge   =   +
Sync Pull up Res   =   Off
CRIP   =   10 deg BTDC

Missing Tooth
This mode first seen in the early 1990's on vehicles fitted with Bosch OEM ECU's. They had 58 teeth on the Crank. i.e. 60 teeth with 2 missing teeth known as 60-2.

At first, you would think this is a strange number of teeth as each tooth is 6 deg? But when you consider 60 crank teeth is actually 120 teeth per cycle, it becomes obvious how fantastic this choice is. When it calculates out, all engines, 3,4,5,6,8,10 and 12 cylinder engines all divide evenly into 120 teeth. This was necessary at the time when microcontrollers were not advanced as today.

Since then, we have seen many other variants, eg. 36-1 or 36-2 etc. These are also great choices as each tooth is 10 deg apart. Where 36 teeth = 360 deg

The index tooth is very important, it tells the ECU, which tooth is the CRIP for Cylinder No.1.
The Index tooth No.1 is the first tooth that passes the sensor immediately
After the missing tooth/teeth. No.2 is the second tooth and so forth.

The table below shows the maximum number of teeth after missing allowed for different engines in missing teeth systems.

Tooth wheel	36 - 1	60 - 2	12 - 1
4 Cylinder	14	26	2
5 Cylinder	NS	NS	NS
6 Cylinder	7	16	NS
8 Cylinder	5	11	NS
10 Cylinder	NS	8	NS
12 Cylinder	2	6	NS

Below are 2 e.g.
Bosch 60-2 and a Ford 36-1

BMW M3
Teeth Per cam cycle =   120
Index tooth   =   11
Sync sensor used   =   yes
Sync pulses per 720 =   1
Crank sensor   =   Mag
Crank Trigger Edge   =   +
Trigger Pull Up Res =   Off

Cam1&2 Sensor type =   Mag
Cam1 Sync1 edge   =   +
Sync Pull up Res   =   Off
CRIP   =   10 deg BTDC

Ford V8
Teeth Per cam cycle =   72
Index tooth   =   4
Sync sensor used   =   yes
Sync pulses per 720 =   1
Crank sensor   =   Mag
Crank Trigger Edge   =   +
Trigger Pull Up Res =   Off

Cam1&2 Sensor type =   Mag
Cam1 Sync1 edge   =   +
Sync Pull up Res   =   Off
CRIP   =   10 deg BTDC

Another great feature with missing tooth is that you can have a very simple setup by not connecting the Sync sensor and selecting **No** to sync sensor used.
This setup can have 2 group injection and wasted spark. This can be achieved because the ECU will lock onto the missing tooth to form a 360 deg timing cycle.

E.g. Simple set up for a Ford V8
Teeth Per cam cycle =   72

Index tooth	=	4
Sync sensor used	=	**No**
Sync pulses per 720	=	1
Crank sensor	=	Mag
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	Off

Cam1&2 Sensor type	=	Hall (not fitted)
Cam1 Sync1 edge	=	+
Sync Pull up Res	=	On
CRIP	=	10 deg BTDC

E.g. Simple set up for a GM LS V8

Teeth Per cam cycle	=	120
Index tooth	=	11
Sync sensor used	=	**No**
Sync pulses per 720	=	1
Crank sensor	=	Mag
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	Off

Cam1&2 Sensor type	=	Hall (not fitted)
Cam1 Sync1 edge	=	+
Sync Pull up Res	=	On
CRIP	=	15 deg BTDC

For both these simple Ford and GM setups, select
8 cylinder
4 igniter (wasted spark)
2 group 720 (fuel injection mode)

GM LS1 / LS3
This was the last V8's that were controlled by the Delphi OEM ECU's.
Later models Used Bosch ECU's and use the GM LS2 mode.

The LS1 has 24 uneven teeth on the crank and 1 Sync tooth on the cam.
This is a special mode for this engine. **Do not use Multitooth mode**.

Teeth Per cam cycle	=	48
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	-
Trigger Pull Up Res	=	On

Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	5 deg BTDC

Nissan VQ
This mode is used for V6 cylinder Nissan VQ30 engines only. These have magnetic sensors. It is critical that they are connected with the correct polarity. If they are not connected correctly the engine will not run.

Set number of cylinders to 6, Trigger sensor to Magnetic, Sync sensor to Magnetic, Trigger edge to + (Rising) and Sync Edge to + (Rising).

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Mag
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	Off
Cam1&2 Sensor type	=	Mag
Cam1 Sync1 edge	=	+
Sync Pull up Res	=	Off
CRIP	=	15 deg BTDC

Nissan mode 3 V8
This is a special mode for Nissan V8 engines.

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	On
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	5 deg BTDC

Mitsubishi EVO 9
Evo 7,8,9 can use this mode.

They have a crank and cam teeth combination that requires this special mode.

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	On
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	5 deg BTDC

Mitsubishi EVO 10
This mode is specific to Evo 10 engines

They have a crank and cam teeth combination that requires this special mode.

Teeth Per cam cycle =   One tooth per cylinder
Index tooth   =   none
Sync sensor used   =   yes
Sync pulses per 720 =   1
Crank sensor   =   Hall
Crank Trigger Edge   =   +
Trigger Pull Up Res =   On

Cam1&2 Sensor type = Hall
Cam1 Sync1 edge   =   -
Sync Pull up Res   =   On
CRIP   =   5 deg BTDC

Mitsubishi 3000GT and 6G72 V6 engines
These engines require this special mode.

Teeth Per cam cycle =   One tooth per cylinder
Index tooth   =   none
Sync sensor used   =   yes
Sync pulses per 720 =   1
Crank sensor   =   Hall
Crank Trigger Edge   =   +
Trigger Pull Up Res =   On

Cam1&2 Sensor type = Hall
Cam1 Sync1 edge   =   -
Sync Pull up Res   =   On
CRIP   =   5 deg BTDC

Lotus Elise
This mode is used for 4 cylinder Lotus engines. These have magnetic sensors. It is critical that they are connected with the correct polarity. If they are not connected correctly the engine will not run.

Teeth Per cam cycle =   One tooth per cylinder
Index tooth   =   none
Sync sensor used   =   yes
Sync pulses per 720 =   1
Crank sensor   =   Mag
Crank Trigger Edge   =   +
Trigger Pull Up Res =   Off

Cam1&2 Sensor type = Mag
Cam1 Sync1 edge   =   +
Sync Pull up Res   =   Off

CRIP   =   10 deg BTDC

Chrysler SRT 4
This is a special mode for the Chrysler SRT4 engine.

It has a 36 tooth with missing and solid tooth.

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	On
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	5 deg BTDC

Chrysler SRT 8
This is a special mode for the Chrysler SRT8 engine.

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	none
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	+
Trigger Pull Up Res	=	On
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	5 deg BTDC

Nissan N16
This is a special mode for the Nissan N16 4 cyl engine. 4 igniters

Teeth Per cam cycle	=	One tooth per cylinder
Index tooth	=	5
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Hall
Crank Trigger Edge	=	-
Trigger Pull Up Res	=	On
Cam1&2 Sensor type	=	Hall
Cam1 Sync1 edge	=	-
Sync Pull up Res	=	On
CRIP	=	5 deg BTDC

Ford Coyote V8 (uses a sync sensor for each cam)

Teeth Per cam cycle	=	72
Index tooth	=	4
Sync sensor used	=	yes
Sync pulses per 720	=	1
Crank sensor	=	Mag
Crank Trigger Edge	=	+

Trigger Pull Up Res   =   Off

Cam1&2 Sensor type =   Hall
Cam1 Sync1 edge   =   -
Cam2 Sync2 edge   =   -
Sync Pull up Res   =   On

Cam3&4 Sensor type =   Mag
Cam3 Sync3 edge   =   +
Cam4 Sync4 edge   =   +
Sync Pull up Res   =   Off

CRIP   =   5 deg BTDC

Ford Barra 6 cyl (uses sync1 for inlet cam1 and sync3 for Exhaust cam 1)

Teeth Per cam cycle =   72
Index tooth   =   5
Sync sensor used   =   yes
Sync pulses per 720 =   1
Crank sensor   =   Mag
Crank Trigger Edge   =   +
Trigger Pull Up Res   =   Off

Cam1&2 Sensor type =   Mag
Cam1 Sync1 edge   =   +
Cam2 Sync2 edge   =   + (non fitted)
Sync Pull up Res   =   Off

Cam3&4 Sensor type =   Mag
Cam3 Sync3 edge   =   +
Cam4 Sync4 edge   =   + (non fitted)
Sync Pull up Res   =   Off

CRIP   =   5 deg BTDC

Other trigger pattern modes
Many Engines that are not mentioned are supported using various modes. Contact
EMS To check, if you do not see your engine above.

No. Of teeth per cam cycle

Use this parameter to set the number of teeth per cam cycle. Some trigger wheels run off the crank and others run off the cam. All EM-Tech ECUs are sequenced by cam cycles because this represents a full engine cycle. It is important that you enter the correct number of teeth in this parameter. If the trigger wheel is running off the crank then you must double the number of teeth counted. If the trigger wheel is running off the cam then count the teeth and use that number.

Many engines have the same amount of teeth per cycle as cylinders. In these cases, Select the first option "One tooth per cylinder" while using "normal" trigger mode

Sync Sensor Used

This parameter works in conjunction with a few modes, e.g. Missing tooth mode and Subaru from 2001 mode if you want to fire injectors and igniters sequentially (one coil per plug and one injector per port). Because most missing tooth wheels run from the crank or run the same RPM as the crank the ECU will receive 2 index signals per cam cycle and therefore true sequential is not possible. By reading a TDC sync signal from a cam or distributor wheel the ECU can then run in true sequential mode.

Sync Pulses Per 720 Deg

This parameter works in conjunction with Multi Tooth Mode. Some multi tooth trigger systems provide 2 sync signals per 720 degrees at 360 degrees apart. The ECU must know if it is receiving 2 sync signals per 720 degrees or only 1.
If there are 2 signals per 720 degrees then you can not run sequential ignition, you must run wasted spark.

Running more than 1 tooth per cylinder

Set the Ignition Type parameter to "Multi tooth". If there are more evenly spaced trigger teeth per cam cycle than cylinders, then set the number of teeth per cam cycle parameter to the number of teeth counted. It is important to remember that 1 cam cycle is equal to 2 crank revolutions therefore if the trigger wheel is running off the crank then you must double the count.

Note: The number of teeth per cam cycle must divide down equally by the number of cylinders. Below is an example for a 24-tooth wheel on a 4-cylinder engine.
e.g. 24 teeth divided by 4 cylinders = 6. This is ok.
e.g. 18 teeth divided by 4 cylinders = 4.5. WILL NOT WORK!
e.g. 16 teeth divided by 4 cylinders = 4. This is ok.

The teeth must be spaced evenly and a sync sensor MUST be used. The trigger tooth directly after the sync sensor tooth is usually the index tooth and is normally positioned in front of the trigger sensor when the engine is somewhere between TDC and 15 deg BTDC on cylinder number one. Aim for 5 deg BTDC (ideal).

Running 1 tooth per cylinder

In situations where there is 1 tooth per cylinder in a cam cycle you can select either "one tooth per cylinder" or a value equal to the number of cylinders in the "No of teeth per cam cycle" parameter. A sync sensor is not required if a single ignition coil with a distributor is used because the ECU will fire the ignition output once per trigger signal and the distributor will distribute the ignition to the correct cylinder. However, If you need to run coil-on-plug ignition or sequential injection then you must use a sync sensor on the cam. The trigger tooth directly after the sync sensor tooth is the index tooth and is usually positioned in front of the trigger sensor when the engine is somewhere between TDC and 15 deg BTDC on cylinder number 1.

Tuning an Engine

This is best done using an engine or chassis dyno. It is not good practice to try and tune an engine while driving on the road. This would be dangerous to yourself and others.

EM-Tech ECUs have 2 base fuel MAPs. These can be used as 2 separate tunes or MAP 2 can be used as the ethanol content compensation MAP. Each MAP allows you to define any load and RPM axis up to 32X48 load points. You can use any one of 3 tuning methods described below. All methods rely on EMSs variable resolution tuning algorithms to calculate injection pulse duration. This provides ultra fine injection control at low engine loads and idle.

- **Normalised VE tuning.** In this method every load point value is a number that is calculated into an injection pulse. Once completed, the MAP will represent the normalised efficiency curve of the engine. If the injector size is changed then you can change the Injector Scale value in proportion to the injector size change without needing to retune the engine. IE: If you tuned an engine with 500cc injectors and the injector scale was set to 20 then afterwards you install 1000cc injectors you would half the injectors scale to 10 in order to retain the same tune.

- **Actual injection pulse tuning.** In this method every load point value shows the actual milliseconds of injection pulse. Once completed, the MAP will not represent the efficiency curve of the engine but some tuners may know the required ms needed. This method was used in the pioneering days of fuel injection systems. Now days, N.V.E and V.E are the common methods used by tuners. If the injector size is changed then you can change the Injector Scale value in proportion to the injector size change without needing to retune the engine. IE: If you tuned an engine with 500cc injectors and the injector scale was set to 20 then afterwards you install 1000cc injectors you would half the injectors scale to 10 in order to retain the same tune.

- **Volumetric Efficiency Tuning (only available on MAP 1**). In this method of tuning the values in the MAP represent the engine efficiency as a percentage. Efficiency values should not go above 100%.VE tuning produces the same result as the other 2 methods. However, you now must enter the engine capacity, injector flow rate and number of cylinders. This method also relies on the Target AFR MAP. You will notice that after entering the engine capacity and injector flow rate, an injector scale value is automatically calculated. The advantage of this method is that once the efficiency curve is complete you can use the AFR MAP to change air fuel ratios at any load point. You can also change injector flow rate and press the re-adjust map button without needing to retune the engine. If parameters that affect the injection pulse such as injector flow, engine capacity and injector dead time are set accurately then the desired air fuel ratios set in the Target AFR MAP should be achieved.

The tuning method type is set in the Application Settings menu option.

Tuning Fuel and Ignition Maps

You can tune an engine by using the built-in MAP sensor, a Throttle position sensor or one of the Analogue inputs as a primary load source. The tuning processes for each method will be the same.

Using the internal MAP sensor to read engine load

The internal Manifold Absolute Pressure sensor is a 5 bar sensor that can read pressures from –100 Kpa (full vacuum) to 410 Kpa (60 Psi). The tuning grids have a possible 48 user definable R.P.M columns and 32 user definable load rows which give the tuner 1536 individual load points.

The ECU comes with pre-programmed fuel map settings at 500 R.P.M increment. These are only a starting point and can easily be changed.

If this is the first time you have set-up a particular engine you should use the Fuel Trim function in the Trims section of the tuning screen to help get the engine started.

Using a Throttle Position Sensor (TPS) to read engine load

A throttle position sensor can be used to read engine load by detecting the position of the throttle from fully closed to fully open. This is represented as a percentage from 0 to 100 percent. The tuning grids have a possible 48 user definable R.P.M columns and 32 user definable position percentage (load) rows.

It is extremely important that a good quality TPS be used when tuning using TPS load sensing. Make sure that the TPS is a variable resistance (potentiometer) type and that it is properly calibrated (see Throttle Position Sensor Calibration for details). Ensure that the sensor reading is repeatable after calibrating.

Watch the TPS gauge on the tuning screen and make sure that the reading follows your foot movement and reaches 100% when fully pressed, and then returns back to 0 %. Do this a number of times to ensure that the reading returns to 0% every time.

This load source selection relies heavily on the TPS sensor, so ensure it is operating before commencing to tune.

Using fuel trims for first time engine start up

It is much easier to get the engine running for the first time by using the fuel trim adjustment. This adjustment is found in the trims section of the tuning screen. If you see that the engine is difficult to start because it is too lean or too rich then you can increase or decrease the fuel delivery until the engine starts easily.

Adjusting Fuel / Ignition Maps

Bring the engine up to the desired R.P.M / load and press the space bar, this will position the cursor onto the R.P.M / load point that matches the actual engine R.P.M / Load. Adjust the fuel or ignition setting by the pressing the "Pg up" or "Pg dn" keys to increase or decrease the injector ms or Ignition timing until the desired value is reached. Repeat this for every load point on the tuning grid.

Using the cross hairs
Cross hairs are provided on the tuning grids to help you bring the engine load/RPM up to match the load cell being tuned. When the cross hairs are **centred** in the load cell this means that this is the best time to adjust the cell value.

IMPORTANT
- a) The engine must be up to operating temperature before tuning.
- b) The engine must be held as close as possible to load / Rpm point being adjusted.
- c) Temporarily disable the acceleration enrichment while tuning.

Clear Flood Mode
Clear flood mode is used when the engine is flooded. A throttle position sensor must be fitted for this feature. When the throttle is pressed passed 90% while cranking, the Ecu will not fire injectors. This allows the engine to clear any excess fuel in the manifold.

Tuning grid command keys
These commands are also available on a pop-up menu when you right-click on the tuning grid.

Page-Up and Page-Down Keys
Press the page-up key to increase the value of a cell by 1 and Page-down to decrease the value by 1.

You can also select a range of cells and increase or decease them by pressing the Page-up and Page-down keys. Use Shift and any combination of arrow buttons to highlight / Select a range of grid cells that you want to adjust and then press the Page-up or Page-down key to increase or decrease each cell by 1.

Auto Trace (Space Bar)
You can automatically position the cursor onto the load/rpm point of an engine while the engine is running by pressing the space bar. If you keep the space bar pressed then the system will trace the engine as it moves through each load point. Each load point will be highlighted with a green boarder indicating the load path of the engine.

You can clear the path by pressing the "Clear Trace" button or "alt + c"

NOTE: When barometric compensation is active the load point that the ECU is using may not match with the Manifold Pressure being displayed on the live gauges. This is because the ECU now determines the load point based on volumetric efficiently.

Insert RPM Column (Ctrl +Right Arrow   or   Shft+Alt+C)
Press Ctrl then Right Arrow to insert a new RPM column in between the current cursor position and the column to the left. This will push all RPM columns from the cursor (including the cursor) to the right and then insert a new one.

Insert Load Row (Ctrl + Down Arrow or Shft+Alt+R)
Press Ctrl then Down Arrow to insert a new load row (TPS/KPA/Analogue) in between the current cursor position and the row above. This will push all load rows from the cursor (including the cursor) down and then insert a new one.

Delete RPM Column (Ctrl + Left Arrow or Shft+Ctrl+C)
Press Ctrl then Left Arrow to Delete the RPM column immediately left of the cursor. This will pull all columns from the cursor (including the cursor) to the left one column.

Delete Row (Ctrl + Up Arrow or Shft+Ctrl+R)
Press Ctrl then Up Arrow to delete the load row (TPS/KPA) immediately above the cursor. This will pull all rows from the cursor (including the cursor) up one row.

Interpolate or Fill (Shift + Left or Right or Up or Down Arrows)
Use Shift and any combination of arrow buttons to highlight / Select a range of grid cells that you want to automatically fill or interpolate. Once selected, use Alt+Ctrl+R if you want to interpolate/fill using the top and bottom rows as the reference points. This means that the system will automatically calculate all the cell values for each cell in between the top and bottom selected rows. Or use Alt+Ctrl+C if you want to interpolate/fill using the left and right columns as the reference points. This means that the system will automatically calculate all the cell values for each cell in between the left most and right most selected rows.

Alt+Ctrl + R: Automatically fill all selected cells from left to right with values based on the value in the first (left) and last (right) selected cells.
Alt+Ctrl + C: Automatically fill all selected cells from top to bottom with values based on the value in the first (top) and last (bottom) selected cells.

Create new Tuning grid (Alt+Ctrl + T)
Create or change a tuning grid. This will allow you to change the number of columns or rows in a tuning grid. This is normally used on first time set-up.

Changing Existing RPM or Load index values (Alt+Ctrl + H)
Change the load and RPM value for the selected column/row.
Use this to adjust the RPM and load for the selected grid cell.
Instead of Ctrl + H, you can double click the grid in the correct row/column.

Changing the page-up & page-down resolution
This is only used on the ignition grid.

You can select the amount of degrees the system increments or decrements each time you press the page-up/down key.
Selecting 0.2 on the resolution selection box will cause each page-up/down key press to change the timing value by 0.2 degrees. If 2.0 degrees is selected then each press will cause a change of 2 degrees.

Changing a selected map area
You can select an area on the tune map and change the entire area by a percentage, a value or set all load positions to the same value.

Use Shift and any combination of arrow buttons to highlight / Select a range of grid cells that you want change. Press either "$","%","+","-"or "=" to select the function you want to apply to the selection. An input screen will appear where you enter a value and then press enter.

Decrease area by a percentage – "$"
After selecting an area press the "$" (shift+4) button to display the input screen. Enter the percentage that you want to decrease the selected area by and press enter. The change will be written to the ECU immediately.

Increase area by a percentage – "%"
After selecting an area press the "%" (shift+5) button to display the input screen.
Enter the percentage that you want to increase the selected area by and press enter.
The change will be written to the ECU immediately.

Decrease area by a value – "-"
After selecting an area press the "-" button to display the input screen. Enter the
value that you want to decrease the selected area by and press enter. The change
will be written to the ECU immediately.

Increase area by a value – "+"
After selecting an area press the "+" (shift+=) button to display the input screen. Enter
the value that you want to increase the selected area by and press enter. The
change will be written to the ECU immediately.

Set area to a value – "="
After selecting an area press the "=" button to display the input screen. Enter the
value that you want to set the selected area and press enter. The change will be
written to the ECU immediately.

Tune Analyser

NOTE: When barometric compensation is active the load point that the ECU is using
may not match with the Manifold Pressure being displayed on the live gauges. This is
because the ECU now determines the load point based on volumetric efficiently.

Tune Analyser is a feature designed by EMS to assist in tuning an engine to its peak
performance by allowing you to log the average A/F ratio at each load point. You can
then analyse the data and make adjustments to the fuel map or have the system
automatically adjust the fuel map by comparing the target A/F Ratios with the actual
A/F ratios and adjusting the fuel map accordingly.

Running the Analyser
You can have the system automatically adjust the fuel map if you want. First you
must set the target A/F ratio for each load point. To start the analyser you must first
press the analyser settings button and select to use either A/F input 1, 2 or both.
Then press the Run Analyser button while the engine is running so the system will
start to constantly monitor the A/F ratio at each load point. The accuracy of the
analysis will increase as you run the engine for longer periods. Press the Run
Analyser button again to stop monitoring. You can see how many times each load
point was recorded by placing the cursor on a grid cell and looking at the read count
field just above the buttons. The load points that have been analysed will show
highlighted on the Fuel Map grid.

Applying changes Automatically
You can have the system automatically adjust the fuel map if you want. First you
must set the target A/F ratio for each load point. Press the Target A/F Ratio tab and
enter the target A/F ratio for each load point you want adjusted. When you press the
Apply Changes button and the system will automatically adjust the fuel delivery table
by comparing the actual A/F ratios with the target ones and adjust the fuel map
accordingly. Do this repeatedly until you have achieved a good tune. You may still
need to smooth out some peaks and valleys if you want.

NOTE:
You can exclude cells from the being applied by selecting the cell and pressing ALT+X or the "Exclude from apply" button. This can be done from the either the Fuel grid or Tune Analyser grid.

Applying changes Manually
You can apply changes directly on the fuel grid. After you have analysed and set the A/F targets for the load points you want to adjust you will see that the cells on the fuel delivery grid will be highlighted with either blue or red. A blue highlight indicates that the actual A/F is within + or - 0.1 A/F of the set target. A red highlight indicates that there is more than + or – 0.1 points of difference. You can move to each red load point on the Fuel map and adjust the value up or down until the "Change required" field reads 0 (zero).

Auto Tune

The auto tune feature works with the tune analyser target A/F ratio grid

Using the Auto tune feature

1. Enter the target A/F ratios into the target A/F ratio grid in the tune analyser section.
2. Go to the main fuel grid section and press the auto tune button. This will display a box in the current load site.
3. Bring the engine RPM and Load to the site that you want to adjust. The cross-hairs must meet inside the box. The system will only adjust when the cross-hairs are inside the box.
4. Press the space bar for the system to begin adjusting the load site keeping it pressed until the target A/F ratio is achieved (+/- point 1). If you tick the auto trace tick box the system will automatically follow the engine load/RPM for you.

While the system is adjusting the load site a dot will appear in the bottom left corner of the site. A red dot indicates that the target A/F ratio is not reached. When the target A/F ratio is reached the dot will change to green. The A/F ratio is also saved in the actual A/F ratio grid in the tune analyser section.

Correction Tables

Barometric Compensation

NOTE: When barometric compensation is active the load point that the ECU is using may not match with the Manifold Pressure being displayed on the live gauges. This is because the ECU now determines the load point based on the barometric pressure. This will become noticeable when using the Tune Analyser and Auto Trace at high altitudes.

Although all EMS ECUs are engineered with an absolute Map sensor and can compensate for medium elevation / barometric changes without needing to use barometric compensation sensors, there are some applications that are subject to large altitude changes. In these cases, a Barometric sensor should be fitted.

NOTE: EM-Tech ECUs use a MAP sensor that is referenced to absolute zero barometric pressure (full vacuum). To make this value easier to understand it is converted to gauge PSI or kPa. Because of this feature, there is no need for barometric compensation in most situations. In most cases, the decreasing air temperature causes changes in fuel mixture at high altitudes. In this case you could install an air temperature sensor to measure the temperature at the air filter and use the air temperature compensation table for fuel adjustments. Be sure to try and minimise the effect of heat soak on the sensor by fitting it in the air filter box.

By using a barometer sensor as a compensation, the ECU can be programmed to sense barometric changes. It uses the G.M 1 bar map sensor; this is a 0 - 5 volt 1 bar sensor. G.M Part Number: 12569240 or AC Delco Part Number: 213-1545 Connect the sensor to Analogue input 9 (EM100 series) or Analogue 5 (EM80 series) and then set Load Source to include the baro sensor. Depending on the load source setting, the ECU will perform different background calculations. Use the Barometric Compensation table to adjust for barometric changes.

If you have the ECU built-in MAP sensor connected to the manifold either as a primary load source or as a MAP override (using TPS + MAP) then use the barometric compensation table values below as a starting point. This table determines the amount of fuel to add or subtract as a percentage of the base value in the fuel table.
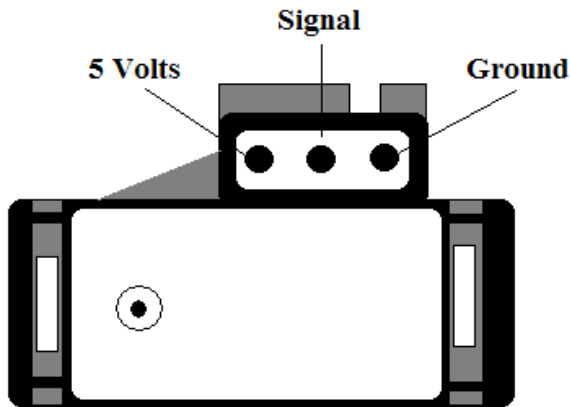
400 hpa	500 hpa	600 hpa	700 hpa	800 hpa	900 hpa	1000 hpa	1100 hpa
0	0	0	0	0	0	0	0

YES, these are all zeros because the ECU will automatically compensate for barometric changes. This table should be used if you find that the automatic compensation is not quite what you need.

If load source is NOT set to Manifold Pressure and the ECU in-built map sensor is NOT connected to the manifold then you DO NOT need to use the barometric compensation tables or sensor. The ECU will actually use the in-built map sensor to sense for barometric changes. You simply use the Fuel Override Table with the values below as a starting point. This table determines the amount of fuel to add or subtract as a percentage of the base value in the fuel table.

-100 kpa	-90 kpa	-80 kpa	-70 kpa	-60 kpa	-50 kpa
-95	-90	-80	-70	-60	-50

-40 kpa	-30 kpa	-20 kpa	-10 kpa	-0 kpa	25 kpa
-40	-30	-20	-10	-0	25

50 kpa	75 kpa	100 kpa	125 kpa	150 kpa	175 kpa
50	75	100	125	150	175

200 kpa	225 kpa	250 kpa	300 kpa	350 kpa	400 kpa
200	225	250	300	350	400

Signal

5 Volts   **Ground**

5 Volts connect to orange

Signal connect to Blue/White

Ground connect to any Black

G.M 1 Bar MAP sensor

Air Temperature Compensation

As the temperature of air changes, so does its density. This in turn, changes the air/fuel ratio. As the air temperature decreases, its density increases for any given altitude and therefore more fuel is needed to retain the desired air/fuel ratio. The same can apply to ignition timing. An increase in air temperature will increase the chance of detonation. You can compensate for these effects by using the air temperature compensation tables for fuel and ignition.

By installing a calibrated air temperature sensor to the manifold or air filter box you can measure the incoming air temperature and use the air temperature compensation tables to adjust the fuel delivery and ignition timing.

NOTE: You must ensure to minimise the effect of heat soak on the sensor by placing the sensor in a location where the airflow is maximum and it is not heavily effected by engine temperature.

The table below shows a good starting point for fuel compensation. We cannot recommend a starting point for ignition because this is different for each engine.

-20C	-10C	0C	10C	20C	30C	40C	50C	60C
12	9	5	2	0	-2	-5	-7	-9
70C	80C	90C	100C	110C	120C	130C	140C	150C
-11	-13	-13	-13	-13	-13	-13	-13	-13

CAUTION: If you will be using air temperature compensation then **DO NOT** start tuning while this table has zero values and then enter the values after.
You must calibrate the sensor and enter these values before you tune the engine.

Engine Temperature Compensation (Choke)
When an engine is below its optimum operating temperature it needs extra fuel to start and run smoothly. The same can apply to ignition timing. An increase in engine temperature will increase the chance of pre-mature detonation. You can compensate for these effects by using the engine temperature compensation tables for fuel and ignition.

By installing a calibrated engine temperature sensor to the engine's coolant system, you can measure its temperature and use the fuel and ignition compensation tables to adjust the fuel delivery and ignition timing.

CAUTION: Before tuning, ensure that the engine is at full operating temperature and that there is zero (0) compensation at that temperature. As a safeguard you can decrease the ignition advance at dangerously high engine temperatures.

NOTE 1: Both air and water compensation tables adjust the fuel delivery and ignition timing by the percentage entered for a particular temperature. A positive number will increase the fuel or timing by the specified percentage and a negative number will decrease the fuel or timing by the specified percentage.

NOTE 2: The values entered in these tables represent the compensation factor when the temperature matches the column heading. For temperatures in between column headings the ECU will apply an interpolation formula to obtain an exact compensation factor.

NOTE 3: If either air or engine temperature sensors are not connected then the values in the relevant tables must be set to zero (0).

Post/Cold Start Enrichment
The Post start enrichment table ensures the engine will start easily by allowing you to increase the amount of fuel for a specified duration after engine start. The increased percentage of fuel will be injected during cranking and decay down to zero percent over a specified time period after the engine starts.

When an engine is cold, extra fuel above the choke level is sometimes required for a short period to overcome fuel sticking onto the cold engine parts such as manifold and valves. Also, especially on hot days an engine may experience starting difficulties when trying to start after being stopped for a short time. This is caused when the fuel inside the fuel lines near a hot engine increase in temperature from heat soak. This effect causes the engine to run lean until the cool fuel reaches the injectors. To overcome this problem you can use the Post Start table to add fuel for a short time.

All EM-Tech ECUs allow you to specify a percentage of fuel increase at different engine temperatures over specific time duration. Using the Post Start grid, under each temperature column specify the increase fuel in percent and decay duration in seconds. The system will then apply the specified increase to the fuel delivery and gradually decay it over the duration period.

If you are using a Flex fuel sensor for the use of E85 fuels, the EM series has a second table for pure ethanol and will interpolate in between the 2 tables for when the ethanol % is anywhere in between 0-100% Ethanol.

Pre-Crank Primer Injection
You can inject fuel into the engine before cranking by pressing the throttle past the 90% open position while the engine is not cranking. Its mainly used when engines have the injectors mounted on top of a positive displacement Supercharger.

The injection pulse is calculated from the fuel delivery map load point value plus any added compensation from all of the fuel compensation tables, multipled by the adjustable "pre crank primer Injection".

You can add from 0 to 765% for 1 extra pulse calculated from the fuel delivery map load point. A value of zero (0) will disable this feature and any value greater than zero (0) will activate this feature. 100% is the factory recommended if using this feature.

Fuel MAP Boost Override
The ECU uses the values in this table internally to calculate a variable resolution fuel map. This enables the tuner to have very fine fuel adjustment over the entire fuel delivery table. Normally, you would not need to adjust these settings except in special situations.

Enter the increase or decrease percentage of fuel for each load position on the grid. This percentage change is based on the fuel delivery table. If these values have been removed or changed to the point where the engine is not operating correctly you can easily bring them back to the factory setting by entering the same value as the actual column heading at each point.

e.g.;   at the -50 KPA column heading enter -50
          At the -20 KPA column heading enter –20
          At the 0 KPA column heading enter 0
          AT the 25 KPA column heading enter 25
          AT the 50 KPA column heading enter 50.

You must do this for each grid position.

Caution:
If you have connected a 10 bar sensor to the hi boost analog input, and have selected to use this hi Boost sensor, the fuel override table headings automatically change in the boost region to match the hi boost. You **Must** change the corresponding fuel % to match the kpa in the heading. Failing to do so, will result in an engine leanout at high boost.

Ignition MAP Boost Override
This works in the same manner as the fuel map override but the correction occurs on the ignition table.

Normally the ignition MAP override values are all 0 (zero) but there are circumstances where they may need adjusting.

One situation where these values may need changing is for a Nissan GTR RB26 with multiple throttle bodies. The main load source might be TPS, but turbo boost also needs to be sensed. The fuel override will remain untouched as this keeps the variable resolution constant. The ignition, on the other hand, becomes complex and cannot be adjusted via TPS load map alone. This is because at 4500 RPM light cruising the TPS may be at 5% and the engine is pulling a high vacuum that is sensed by the MAP sensor. The driver may then request full 100% TPS. At this point

the MAP sensor will read 0 (zero) Kpa (atmospheric) as the turbos are still spinning at cruising speed. The engine, at this point, may require 30 Deg BTDC ignition timing. Within a second, the turbo(s) will have spooled up to maybe 200 Kpa (28 Psi) while the engine is still at 4500 RPM, TPS is still at 100% but the manifold pressure has increased considerably. The timing at this pressure must be reduced to a more retarded timing value of about 10 Deg BTDC, a reduction of 20 Deg.

To achieve this tuning scenario you would put 30 Deg BTDC timing in the 4500 RPM / 100% TPS load cell. The ignition MAP override will have 0% (zero percent) in the 0 Kpa (zero) cell and –66% in the +200 Kpa cell. This will reduce the 30 Deg BTDC ignition timing by 66% bringing the actual ignition timing to around 10 Deg BTDC. To achieve a smooth retard curve you must also adjust all of the cells between 0 Kpa and +200 Kpa of the ignition MAP override table. See the table below as an example.

0 KPA	+25 KPA	+50 KPA	+100 KPA	+150 KPA	+200KPA
0	-8	-16	-33	-50	-66

Other Correction trims and adjustments

The section below describes other trims and adjustments that are not tables.

Fuel Trim Percentage

This parameter applies an increase or decrease percentage on the entire fuel delivery table. This is useful when you need to change the fuel table and still leave the engine-breathing curve unchanged. When you are happy with the performance you can leave the trim value or apply the trim percentage directly to the fuel map by pressing the Re-Adjust Map button beside the Fuel Trim selector. This will adjust the map by the trim percentage and then zero the fuel trim value.

Ignition Trim Percentage

This feature behaves in the same way as the fuel trim parameter but on the ignition map.

It applies an increase or decrease percentage on the entire ignition table. It is useful when you need to change the ignition table and still leave the timing curve unchanged. When you are happy with the performance you can leave the trim value or apply the trim percentage directly to the ignition table by pressing the Re-Adjust Map button beside the Ignition Trim selector. This will adjust the map by the trim percentage and then zero the ignition trim value.

Injector Scale

The injector scale is used to set the resolution of each increment in the main fuel map. It must be set before tuning the engine.

The max injector on time is determined by this value. For example: setting this parameter to 40 will give a maximum injector on time of 20 milliseconds at 0 Kpa (zero). Each load point allows for 255 increments therefore this will allow you to divide 20 milliseconds into 255 increments.

Larger injectors would require less milliseconds of on duration to supply the same volume of fuel as smaller injectors. Using this parameter allows the tuner to adjust the fuel map resolution to give a very fine adjustment per increment.

Note: As a guide, the injector time scale should be set between 10 and 30 when in multi point 360 mode and between 40 and 80 when in multi point 720 mode or Sequential. If you find that you need to go above or bellow this range you may need to change injector size or there is a problem in the fuel delivery system.

Static Ignition Timing

Use this parameter to tell the ECU where the physical location of the trigger sensor is in relation to TDC. If the trigger sensor is 10 degrees BTDC then set this parameter to 10 deg BTDC. The ECU will use this value to calculate the exact ignition timing.

To ensure that the static timing is correct you may check it with a timing light. Follow the procedure set out below to check the timing with a timing light.

Set the Static Timing parameter to "Locked". You should hear the engine change note as the timing retards to static. Using a timing light, check the timing and record this value in the Static Timing parameter. Remember to press enter to save the changes to the ECU memory.

Caution: If the ignition is a wasted spark system and you are using an adjustable timing light that allows you to bring the timing mark to TDC, the reading will be wrong. This is because the timing light calculates for 1 ignition fire per 720 degrees but wasted spark systems fire every 360 degrees. With these timing lights you must set the adjustment to 0 (zero), to stop it trying to calculate and read the timing directly from the timing marks.

Staged Injection

All EM-Tech ECUs will allow you to install a secondary set of injectors that can be staged to start when the primary injectors reach over 80 percent duty.

For engine configurations where the primary and secondary injectors are the same size, set the staged number to 100%. This will cause the injector on-time duty to be halved once the staged injectors are activated. For secondary injectors of a differing size to the primary injectors you will need to adjust this parameter experimentally.

If the secondary injectors are smaller than the primary injectors then the number should be **smaller** than 100%, thus the ECU will not reduce the injection time as much when the secondary injectors are activated.

If the secondary injectors are larger than the primary injectors then the number should be larger than 100%, thus the ECU will reduce the injection time by a larger amount when the secondary injectors are activated.

Use the Injector ratio calculator to find a close number. From here, you can adjust This number to achieve the correct Air fuel ratio.

WARNING!!
DO NOT SELECT STAGED INJECTION FOR NON-STAGED INJECTED ENGINES, AS THIS WILL CAUSE ENGINE DAMAGE.

Injector Output Trims
You can compensate for airflow anomalies to each cylinder by trimming each injector output by a percentage. This allows you to increase or decrease the fuel delivery for each cylinder. This feature is only available if the injector arrangement is set to Sequential.

NOTE: The output number does not correspond to a cylinder number. This will depend on how the injectors have been wired to the ECU injection outputs.

Launch Control (Turbo Anti-lag)

All EM-Tech ECUs offer 2 launch control modes. One for drag racing and one for rally racing.

Note: Anti lag can be disabled via any digital input.

Rally Mode

Rally mode is designed for when the car is moving and approaching a curve. At this point the anti-lag function should be activated in order to keep the turbo spinning while the car is negotiating the curve. This will ensure minimal turbo lag when accelerating out of the corner.

When the throttle position signal is BELOW the pre-set TPS level AND the engines RPM is above the pre-set RPM level, the anti-lag function will be enabled causing the ECU to retard to the antilag table setting and misfire the Ignition to your selected pattern. The fuel delivery will also be adjusted according to the selected fuel trim percentage. This feature would be used in conjunction with an auxiliary o/p to energise a blow off solenoid valve to either bypass the throttle body, hold it open slightly or to blow air directly into the exhaust manifold near the exhaust ports.

Drag Mode

Drag mode is designed for drag racing where the engine is free revving while waiting for the signal to launch. At this point the engine does not have enough load to allow the turbo to produce full boost. Using this function will enable the turbo to produce boost.

When the throttle signal level is ABOVE the pre-set TPS setting AND the engines RPM is ABOVE the pre-set RPM setting AND the boost pressure is below the pre-set Kpa setting the anti-lag function will be enabled causing the ECU to misfire the ignition to the selected pattern. The ignition timing will follow the antilag table and fuel delivery will also be adjusted according to the selected fuel trim percentage.

Setting the boost pressure (Turn OFF Above KPA parameter) is the most critical parameter. This also requires very good driver control because the boost is maintained via the amount of throttle opening.

If you would like to launch at 50 Kpa (7Psi) of boost, you would set the Turn OFF Above KPA parameter slightly above 50 Kpa, maybe to 55 Kpa. While in gear, the driver holds the clutch down and revs the engine. Once the engine reaches above the Turn On above RPM parameter and the TPS reaches above the Turn On Above TPS parameter then Anti-lag will activate causing the boost to build up. By pressing the throttle to correct amount, the drive can maintain boost at the launch level. To launch the car the driver will release the clutch and open the throttle fully. At this point the boost will shoot up above the Turn Off Above KPA parameter causing the anti-lag to deactivate and allow the boost to build up to the higher pre-set waste gate level.

Caution: There is a chance of damaging the engine if the driver presses the throttle too far while free-revving the engine allowing the boost to build up above the Turn Off Above KPA parameter. This may cause the engine to over rev.
EMS recommends that you use one of the digital inputs connected to a clutch switch to deactivate the anti-lag system and set the Turn OFF Above KPA parameter to its

maximum value. This method will prevent the engine from over revving while the clutch is disengaged.

FUEL TRIM percentage
If this parameter is used then the setting should be a positive value (+) to increase the amount of fuel when the anti-lag function is active. This is normally set between 0 and +3%.

IGN TRIM percentage (EM70 only) see antilag map for EM80 and EM100 series. This setting should be a negative value (-) to retard the ignition timing as far as possible. This is normally set to –100%.

AntiLag Ignition map EM80 and EM100 series

This ignition map follows the load point selection of the Main Ignition Map. It differs as it can be selected to set the timing to any value from -64 degrees to +64 degrees. Negative numbers represent retard. E.g. -35 is actually 35deg after TDC. (retarded)
NOTE:
1. Try set the misfire pattern to prevent the spark plugs from fowling up.

Digital Inputs

All EM-Tech ECUs have digital inputs that can be used to activate different ECU functions. The inputs must be either left disconnected(high) and then switched to ground.

Reverse Acting

Input activation will be determined by the reverse acting parameter. If set to "normal" then the input will be active when it is grounded. If set to "reverse acting" then the input will be active when it is released (voltage > 3Volts).

Disable Anti lag

This mode will disable (turn off) the anti-lag if active. Most common use is to connect to a switch that is actuated by the Clutch pedal or thumb operated switch on the steering wheel. When the pedal or switch is released, the input will be activated thus disabling the anti lag. If you will use this method to disable the anti-lag then you must set the Turn OFF Above KPA parameter to its maximum value.

Two Step RPM limiter

This mode will enable the "Rpm Limit" field. In one switch position, the Ecu will engage the Soft RPM limit to the value selected in the field. In the other switch position, the Ecu reverts back to the normal RPM limits set in the main set-up page. This mode gives the user an extra stall Rpm limit.

Idle Up Percentage (Stall Prevention)

This mode is used in conjunction with whichever auxiliary output is set to Idle control. When this mode is selected then the In Gear Idle up % field will become active. The Input can be connected to an auto transmission or air conditioner compressor clutch so that if a gear is selected or the air conditioner cuts in, the idle valve will open by the In Gear idle up % value to help prevent the engine from stalling.

Nos Function

This mode is used when Nitrous oxide injection is activated. The auxiliary input would be connected to the Nos solenoid. When activated, the user can select the amount of Ignition retard in degrees and fuel enrichment in milliseconds. These two fields will become active when this mode is selected.

Note: It is recommended that the fuel portion required with the gas be injected by a separate fuel solenoid and only use the Nos Fuel Increase to trim if a little extra fuel is needed. If you use the Nos Fuel Increase to inject all the fuel required then you must ensure that the fuel injectors are large enough to provide the extra fuel.

Gear change ignition cut

This mode is used to cut the ignition for a specified duration in milliseconds. Connect one of the digital inputs to a switch in the gearbox or on the gear stick and set the input mode to "Gear change ignition cut". When the switch is activated, the ECU will cut the ignition for the specified duration. To prevent inadvertent re-activation you must specify the reset wait duration in seconds. The ECU will wait for the specified duration before another ignition cut can occur.

Switch to Tune Map 2

The EM-Tech ECUs can have 2 tune maps for both fuel and ignition so you can tune the engine to use 2 different fuels. The ECU defaults to map 1 and you need to use a switch connected to one of the digital inputs to activate map 2.
When you select this option on one of the digital inputs you must ensure that the selected input has a default voltage potential. The input must be either held high (connected to 12 volts though a resistor) and then switched to ground or held low (grounded though a resistor) and switched high to 12 volts. Depending on the method used you must set the reverse acting option accordingly. Switching the selected input will cause the ECU to use either map 1 or map 2.

Example: How to wire a digital input.
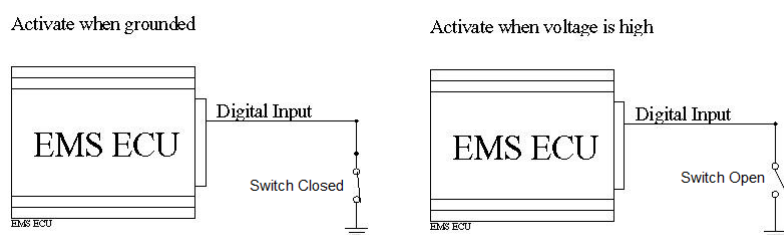
Analogue Inputs

All EM-Tech ECUs have Analogue inputs. These can be used to monitor many different sensors that provide a variable 0 - 5 volt output. The Analogue inputs can also be used as parameters in the engine protection system. The voltage output of these sensors can be translated to an engineering unit of measure such as temperature or pressure via the translation tables and displayed on-screen by defining a gauge for each input. You can change the gauge parameters and press the "Refresh Gauge" button to see the effect.

Analogue Input Translation Tables

You can define a translation table for each of the analogue inputs. Each input can read a voltage value from 0 to 5 volts (0 to 5000 millivolts) and convert it to a number from 0 to 1024, this is called an Analogue to digital (A to D) value.

The translation table is used to convert an input voltage to a meaningful value such as temperature or mass-air-flow volume. This value is used by the gauge displays and data logging. The translation tables are also used in the engine protection system and the tuning grids if an Analogue input is selected as the main load source.

Each table can have from 2 to 70 translation points with each point representing a voltage from 0 to 5 volts or an A to D number from 0 to 1024. For each point you must define what the technical unit of measure value will be (EG: Deg C, Psi). The system will automatically interpolate between each point to determine an exact translated value.

Creating a translation table

Most sensors have a linear voltage output. If the sensor you have is linear then you can use the **Automatic Table Creation** function to create a new translation table. Enter the minimum and maximum sensor voltage range, enter the minimum and maximum measurement range of the sensor, enter the number of translation point you want and press the **create table** button.

You must also enter a meaningful translation name and unit of measure.

If the translation table is activated then data from the selected channel will be translated. If not active then that data will be in raw A to D values.

The table can be saved into a translation table file so it can be recalled when defining other inputs that use the same sensor.
This table is saved into the ECU memory and also the tune file and is re-loaded whenever you read from ECU or open the tune file.

Calibrating an analogue input

You need to calibrate a sensor so that the software can translate the sensor signal into a technical value such as pressure or temperature.

To calibrate an analogue input you will need the sensor that will be connected to the ECU input and another calibrated sensor or gauge that will indicate the actual reading. Both sensors will need to be connected to the same source. The example below will describe how to calibrate a K type thermo couple and an EMS K Type amplifier but the same principle can be applied to any type of sensor.

1. Attach both sensors to the same heat source ensuring that both sensors can reach the same temperature as each other.
2. Connect the sensor for the EM-Tech ECU to one of the analogue input channels so that the ECU can read its voltage.
3. Connect the other sensor to a temperature gauge suited to reading a K type thermocouple. This will be used to monitor the temperature and calibrate the sensor connected to the ECU.
4. Power up the ECU and connect it to a laptop computer. Start the EM-Tech software and go to the analogue inputs screen. Select the input channel you will be calibrating.
5. Create a new translation table. Along the top row of the table you will see numbers from 0 (zero) to 1000. These are A to D numbers that the ECU reads from the sensor. Along the bottom row you will need to type in the temperature reading represented by each number.
6. Apply heat to the heat source allowing it increase in temperature slowly while watching the red cross hair on the translation table. When the cross hair is in the centre of the column record the temperature indicated on the second temperature gauge into that cell. Press the enter key after recording the reading so that the system will register the entry. You can also watch the actual A to D value on the screen. When this value matches a column heading then the cross hair is in the centre of the column.
7. Repeat step 6 for each column in the translation table.
8. Save the table so that you can reuse the data for other K type thermo couples.

NOTE: Press the "Refresh Gauge" button to display the defined gauges. You can then watch the gauge change as you calibrate the sensor. For the best accuracy you should calibrate the sensor when the cross hair is in the centre of the column.

Opening and saving translation tables

Press the Save Table button to save the translation table into a file. The system will display a save dialogue box where you can enter a file name and press the Save button. The system will save the translation table as well as the user defined gauge parameters. These translation tables can also be used in the data logger software for translating the analogue input channels.

Press the Open Table button to recall a saved translation table definition. You will be shown a list of previously saved files where you simply select one and press the Open button.

These tables are also saved in the main tune file when you save the tune map thereby ensuring that they are automatically reloaded when you re-open the tune file.

User defined Gauges

You can define a number of different gauges that can read information from any of the ECU data channels such as RPM, Load, TPS, Air/fuel ratio, analogue inputs, auxiliary outputs, etc. Each screen in the software has an area dedicated to gauges. You can customise each screen with different gauges that better suite the function of the particular screen. Once gauges are defined you can save them as a default screen template. The software will always use the default template when first opened. You can also define gauges for different cars. These templates are saved along with the tune file for the particular car. When you open a tune file that has a template then the screens will automatically change to the tune file template. This is useful because each car will have different gauge requirements. IE: if a car has a fuel pressure sensor, an oil pressure sensor and an O2 sensor then you will want to define gauges for these but another car may have other sensors so you would define a different template. Each time you read the tune file for the respective car then the screens will change according to the respective templates.

Defining a gauge

To put a gauge onto the gauge area of a screen press the right mouse button. This will display a pop up menu where you can select the gauge you want to place. Once selected you can position the gauge anywhere in the gauge area. To lock the gauge put the mouse pointer onto the gauge and press the right mouse button. A menu will pop up where you should select the "Move/Resize/Lock" option.

Setting gauge properties

To change the gauge parameters place the mouse pointer onto the gauge and press the right mouse button. This will display a pop up menu where you can select the "Gauge Properties" option. A different screen will be displayed depending on the type of gauge allowing you to set the relevant gauge properties.

Resizing and moving a gauge

To resize a gauge, place the mouse pointer onto the gauge and press the right mouse button. This will display a pop up menu where you select the "Move/Resize/Lock" option. The gauge border will change indicating that you can move and resize the gauge. To move the gauge put the mouse pointer on to the top border then press the left mouse button and drag the gauge to the desired position. To resize, put the mouse pointer onto the edge of the gauge and when the mouse pointer changes to the left/right arrows press the left mouse button and drag to the desired size. Once done, right click to show the pop up menu and select the "Move/Resize/Lock" option.

Auxiliary Outputs

There are 8 user programmable auxiliary outputs. 4 that can be used as either PWM or digital and another 4 that can be used only as digital outputs.

Digital outputs can be either ON or OFF depending on the programmable conditions. These outputs can be used to control relays that need to be turned on or off to control devices such as thermo fans or shift lights.

The pulse width modulated outputs (pwm) give a pulsing signal that varies the ratio of on and off time, this is referred to as duty. A signal that gives 75% on time and 25% off time is referred to as 75% duty. The ratio can be varied according to Load, RPM or TPS values via the user programmable table. This will give a varying average current to the device being controlled. Typically, these outputs are used to control devices such as idle control valves and boost control valves.

Reverse Acting

Ticking the reverse acting box will cause the output to reverse its state. When the activation criterion is true then the output will be OFF. This is useful when activating relays that are normally closed. When the output is used as a PWM output then this will reverse the duty.

Auxiliary Output Modes

Modes 8 to 12 can be programmed on the first 4 outputs (outputs 1 to 4).

Mode No	Output Mode	Activation criteria
0	Off	
1	Digital	RPM
2	Digital	Manifold Pressure
3	Digital	Throttle position
4	Digital	Engine temp
5	Digital	RPM and Manifold Pressure
6	Digital	RPM and throttle position
7	Fuel Pump o/p	Automatic
8	Tacho o/p	Automatic
9	PWM	RPM
10	PWM	Manifold Pressure
11	PWM	Throttle position
12	PWM OR Stepper motor control for idle control.	RPM, TPS and Load
13	Digital	Air conditioner clutch control
14	Digital	Air temp
15	Digital	Transbrake Inch Button
16	PWM	Ethanol % activated PWM
17	PWM Lambda 1 Heater control	Automatic
18	PWM Lambda 2 Heater control	Automatic
19	PWM Closed Loop Boost Control	Automatic
20	VVT inlet cam 1 solenoid Control	Automatic
21	VVT inlet cam 2 solenoid Control	Automatic
22	VVT exhaust cam 1 solenoid Control	Automatic
23	VVT exhaust cam 2 solenoid Control	Automatic

Digital Output modes 1, 2, 3, 4, 5, 6 and 14

All digital modes follow a set comparison sequence. If a comparison field is set to OFF then the system will skip to next comparison sequence.

Comparison Sequence.

1. Turn ON if greater than activation criterion.
2. If not already ON then turn ON if less than activation criterion.
THEN
3. Turn OFF if greater than activation criterion.
4. If not already OFF then turn OFF if less than activation criterion.

This sequence will ensure that an OFF activation will override an ON activation.

Example 1

To control a thermo fan set the output mode to 4 (Engine Temp.). If you want the fans to turn ON when the engine temperature is greater than 90°C and turn OFF again when the engine temperature is less than 84°C, the auxiliary output parameters should be set as follows:

Mode	4 (Temp activated relay)
Reverse Acting	OFF (Not Ticked.)
ON Above Temp	90 Deg C
ON Below Temp	Off
OFF Above Temp	Off
OFF Below Temp	84 Deg C

As the engine temperature rises, the output remains OFF until it reaches over 90 degrees, the fans will then turn ON and remain ON until the temperature goes below 84 degrees.
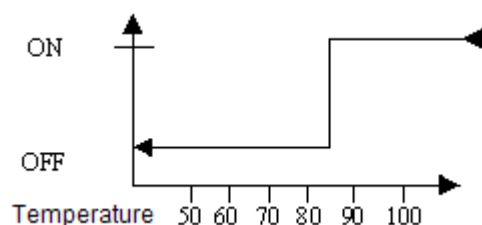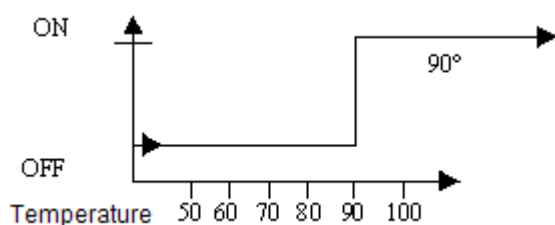
Example 2
You can even turn an output on within a specified zone. This might be useful for VTEC cam control where you may want an output to turn ON when the RPM is greater than 2000 and stay ON until the engine reaches over 4000 RPM then turn OFF again.
Set the output parameters as follows.

Mode   1 (RPM activated relay)
Rev Act   OFF (Not Ticked)
ON above RPM   2000 RPM
ON Below RPM   4000 RPM
OFF Above RPM   4000 RPM
OFF Below RPM   2000 RPM
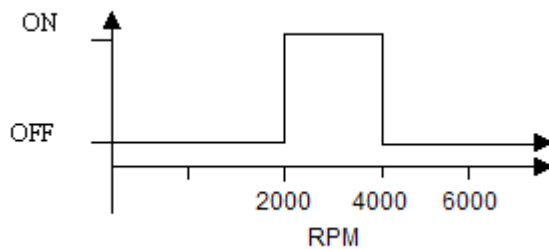
Example 3
Outputs can also be controlled by using 2 criteria.
If either of the comparison criteria produces an OFF result then the output will remain OFF.

For controlling NOS you can set the system to turn on at a certain engine rpm and manifold KPA. (Pressure). If you want to activate the NOS when the engine rpm is greater than 2850 and manifold pressure is greater than -10 KPA Set the output as follows.

Mode	5 (RPM & Load activated relay		
Rev Act	OFF (Not Ticked)		
ON Above RPM	2850	On Above KPA	- 10 KPA
ON Above RPM	OFF	ON Above KPA	Off
OFF Below RPM	OFF	OFF Below KPA	Off
OFF Below RPM	2800	OFF Below KPA	- 15 KPA

For the output to turn on, RPM must be greater than 2850 **AND** manifold pressure must be greater than -10 KPA.

Auxiliary output modes 7 and 8

Fuel Pump Relay Mode 7
The Fuel pump output is designed to drive a fuel pump relay.
When the ignition is turned on, the output will energise for approx. 4 seconds and then turn off again. While the ECU detects that the engine is running it will keep the fuel pump on. If the engine stalls or stops, the Ecu will turn the fuel pump off after 4 seconds. This is a safety feature that is required in some motor sports.

Tacho Output Mode 8
When this mode is selected the output will produce a signal that is compatible with most tachos. In some cases where the tacho does not have an internal resistor connecting its input to power you will need to connect an external 500 – 1000 ohm resistor from the tacho input to power.

PWM Output Modes 9 – 12

PWM Basics
A PWM (Pulse Width Modulated) signal is a pulsing voltage whose on-time/off-time ratio varies (duty). This effects the current being supplied to the device i.e.: A longer on–time will supply more current than a shorter on-time.

Frequency
Frequency is normally expressed in hertz (Hz). When a signal cycles from high to low then high again 8 times per second it is expressed as 8 Hertz. i.e.: 1 Hz = 1 cycle per second, 40 Hz = 40 cycles per second.

Setting the correct PWM output frequency will depend on the device being controlled and can only be obtained experimentally by examining the behaviour of the device.

Duty
Within the duration of each cycle the voltage signal will be high for a certain percentage and low for the remaining percentage. A signal whose voltage is high for 50 percent of the cycle duration has a 50 percent duty cycle and therefore supplies 50 percent of the available current.
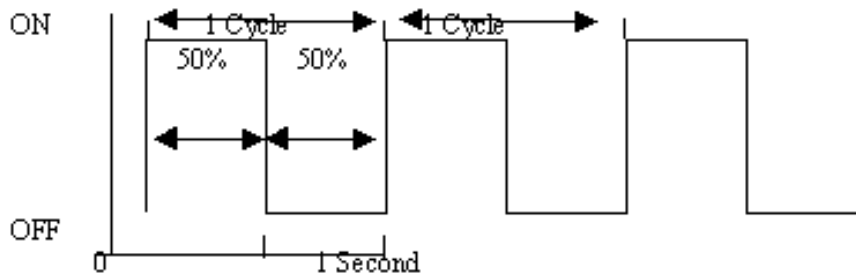
Fig A.
1 Cycle is from when a signal starts to when a signal begins to repeat itself.
In fig A. 1 cycle takes 1 second to complete so the frequency is 1 HZ.
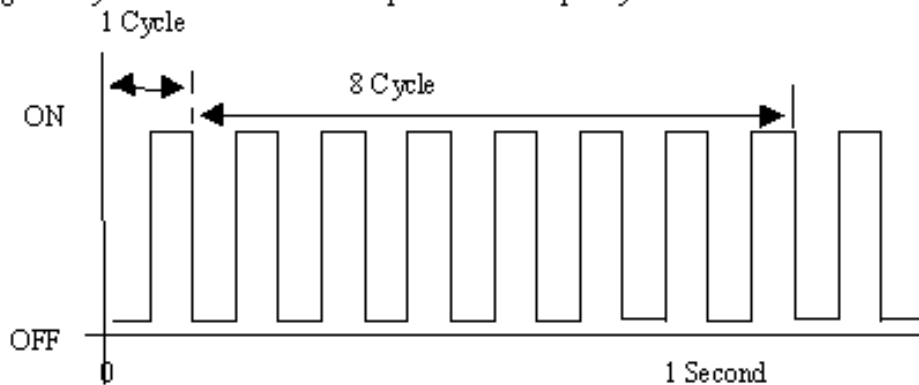
PWM Frequency Adjustments
All EM-Tech ECUs have 2 frequency adjustments for the PWM outputs. The first adjustment is the Base PWM Frequency. This is an overall adjustment and is applied to all PWM outputs. The second is the Aux PWM Frequency adjustment and there is one for each individual PWM output.

Base PWM Frequency
The base frequency is used to calculate the operating frequency of all PWM outputs.

Aux PWM Frequency
This setting should be set to 255 wherever possible. It determines the pulse frequency of each PWM output according to the following formula.

Output frequency = 255 / Aux PWM Frequency * Base PWM Frequency.
i.e.: By setting the Base PWM Frequency to 20 Hz and the Aux PWM Frequency to 200 will result in an output frequency of 25.5 Hz. (**255 / 200 * 20 = 25.5)**

NOTE: Reducing the Aux PWM Frequency number will increase the frequency for the output but there is a trade off. The duty cycle adjustment resolution of the output will be reduced. i.e.: If this frequency number is reduced to 100 for example, the output frequency would increase, but the adjustment resolution will be reduced from 255 to 100 increments.

Adjusting the Duty Cycle
PWM outputs are used to control devices that can vary their state like idle control valves, these devices can be fully closed, fully open or anywhere in between. This is achieved by varying the ratio of on-time and off-time of the output signal. This is referred to as duty cycle. Longer on-time will increase the supply of current therefore opening the valve further.

You can vary the duty cycle of a PWM output according to engine RPM, manifold pressure or throttle position by entering the amount of duty in the duty table. The maximum allowed number in this table is determined by the value of the Aux PWM Frequency. i.e.: if the Aux PWM Frequency is set to 120 then entering 120 in the duty table will result in maximum duty thereby supplying maximum current. A value of 60 will result in 50 percent duty and therefore 50 percent current.

Reverse Acting
The Reverse Acting function will reverse the duty cycle of the output.

This function is needed when a valve works backwards, e.g. Bosch BMW idle valve. With these types of valves, increasing the duty cycle will actually slow down the engine and reducing the duty cycle will increase the idle speed.

PWM Verses RPM Mode 9
In this mode you can set the PWM duty according to engine RPM in 500 RPM increments. The system will interpolate between RPM points to achieve a smooth transition.

For example, you can use this mode to control turbo boost level at 500 RPM increments and the system will provide a smooth transition between RPM points.

PWM Verses Kpa Mode 10
In this mode you can set the PWM duty according to manifold pressure in 20 Kpa increments from –100 Kpa to 400 Kpa. The system will interpolate between points to achieve a smooth transition.

For example to control a water injection D.C. motor, you can set a low duty value at low manifold pressure and increase it as manifold pressure increases thereby increasing the motor speed and in turn increasing the water injection.

PWM Verses Throttle Position Mode 11
In this mode you can set the PWM duty according to throttle position in 5 percent increments from 0 percent to 100 percent. The system will interpolate between points to achieve a smooth transition.

For example to control a water injection D.C. motor, you can set a low duty value at small throttle openings and increase it as the throttle increasingly opens thereby increasing the motor speed and in turn increasing the water injection.

Closed Loop Idle control Mode 12
Note: If the ECU is controlling an electric throttle, the idle control is not from an auxillary output, see electric throttle section.

The ECU must be sensing manifold pressure via the built-in MAP sensor.
In this mode you can select to control an auxiliary output or the dedicated stepper motor outputs by selecting either PWM control or Stepper Control.

Although idle control sounds simple to achieve, the parameters and mathematics involved are quite complicated. EMS has tried to make it as simple as possible to set-up by providing a simple set-up procedure to follow.

Step 1: Ensure the engine is well tuned

Ensure that the engine is properly tuned especially in the idle area. The automatic idle control will continually try to adjust a badly tuned engine around the idle RPM

Step 2: Select an output circuit to use
Now we will need to use the laptop software for these adjustments.
NOTE: Only one of the output circuits can be used as a PWM or stepper motor controller.
Set control mode to either Stepper motor or PWM control
Set Idle control to off (this ensures that the valve or motor will be closed)
Type in the target idle RPM
Set stepper motor speed to medium
Set Initial open position to around 20
Set Max Steps to 255
Set idle vacuum to whatever the engine is currently idling on while at operating temp
Set Additional Cold Open Position to around 60
These numbers are only starting points and will be adjusted to suit the engine.

Step 3: Set the mechanical idle speed adjustment
Set the mechanical idle screw until the engine idles 100 RPM lower than the Target RPM. This is a backup to prevent the engine from stalling if the idle control motor or valve fails.

Step 4: final adjustment
Set Idle Control to Manual
Adjust the Initial Open Position (higher or lower) until the engine idles at the Target RPM.
Set the Idle control to Automatic.

Step 5: Cold engine adjustment
Do this the next morning when the engine is fully cold.
Before starting the engine set Idle control to Manual.
Start the engine and adjust the Additional Cold Open Position only (higher or lower) until the engine idles at the Target RPM.
Set the Idle control to Automatic.

Target RPM
Set this to the RPM you would like the engine to idle at when hot.

Cold Idle RPM
Set this to the RPM you would like the engine to idle at when engine is cold.
This can be the same as hot or some users like the engine to idle higher when its first started in the morning until it warms up. E.g 900 RPM when hot an 1200RPM when cold. For this you would setTarget RPM to 900 and this Cold Idle RPM to 1200.

Initial Open
This is the amount of steps needed, for the engine to idle at the idle speed when Manual control is selected.

Additional Cranking Open
These steps add to the Initial open for extra air at cranking. These steps are totally removed when the Engine reaches the Target idle for the first time.

Additional Cold open position

When an engine is cold, extra fuel is injected. This extra fuel will make the engine idle lower. To compensate for this, extra air is required to help the engine idle at the desired idle speed.

This setting will add more steps, to open the idle valve further. It adds to the initial open and diminishes as the engine warms up.

Start up sustain

Some tuners like the engine to rev up when started and slowly lower to the idle speed.

The Start up sustain adds to the initial open, the is removed slowly by the Automatic feedback control.

Note: This is the last adjustment to make to the Idle control. While experimenting in Manuel mode, ensure this is set to 0.

Idle Vacuum

This setting helps the automatic control in its decision making.
Set this to the vacuum that he engine idles at when it is tuned well and idling.
This setting is when engine is hot.

Idle Gain

Normally from 2 to 15.

This is the amount of steps that the auto will add or subtract for every 100RPM of error from the Target Idle. If this value is too small, you will hear the automatic control Taking many attempts to reach target idle after a disturbance like turning the headlights on.

If this number is too large, the idle will hunt (rev up and down) and never able to stabilize.

Max steps

This setting is for stepper motors and tells the ECU how many steps it takes for the idle motor to go from fully closed to fully open.

Channel Frequency

If using PWM control. This is the frequency that will be sent to the idle valve.

Use TPS To detect Idle

To help the Idle control automatic program, It is recommended that a TPS sensor is used. When the ECU sees <=1 % throttle, it will enter the idle control program.

Air Con Clutch control 13

This selection is used to turn on the Air Conditioning compressor clutch when a A/C request signal is detected on an input.
Ensure that the RPM fields are filled in. E.G.
On > 600RPM
Off > 4300 RPM
On< 4250 RPM
Off < 550 RPM
This is so when the engine is < 550 rpm the clutch is off. To prevent engine stalling Also, when engine is > 4300 RPM it is also off. To prevent losing a race.
You can tailor these numbers to suit your engine's rev range, but ensure that the <'s Are at least 50 RPM less than the >'s. Study the e.g. and follow this format.

TransBrake Inch button15

The transbrake inch feature is used to stage an automatic transmission drag car from the first stage light to the second.
This feature works in conjunction with selecting the transbrake feature on a digital input. When the ECU receives an inch request, it will momentarily pulse this transbrake output for the milliseconds set in the input section.

Ethanol % activated PWM 16

Primarily used for Boost control.
This is where the boost can be changed at different ethanol % levels.
The settings go from 0% to 100%. At high ethanol levels, the boost can be higher
And when the ethanol fuel level is low %, the boost can be reduced to protect the engine from detonation due to the lower octane when less ethanol is present.

Lambda 1 Heater (EM100 series) Mode 17
The EM100 series has 2 built controllers for the Bosch 4.9 wide Band sensors. Part of the control of these sensors is the sensor temperature by controlling the heater. Once this option is selected, the ECU will control the temperature of the heater of Sensor 1 to the Bosch specification. Ensure that you have selected this option on the output that is connected to the heater of sensor 1.

Lambda 2 Heater (EM100 series) Mode 18
This option is for controlling the heater of sensor 2. Once this option is selected, the ECU will control the temperature of the heater of Sensor 2 to the Bosch specification. Ensure that you have selected this option on the output that is connected to the heater of sensor 2.

VVT Inlet 1 (EM100 series) Mode 20
This option works in conjunction with the Cam control settings under the Fuel Delivery section. Select this option when the Auxillary output is connected to
The solenoid of Inlet cam 1

VVT Inlet 2 (EM100 series) Mode 21
This option works in conjunction with the Cam control settings under the Fuel Delivery section. Select this option when the Auxillary output is connected to
The solenoid of Inlet cam 2.

VVT Exhaust 1 (EM100 series) Mode 22
This option works in conjunction with the Cam control settings under the Fuel Delivery section. Select this option when the Auxillary output is connected to
The solenoid of Exhaust cam 1.

VVT Exhaust 2 (EM100 series) Mode 23
This option works in conjunction with the Cam control settings under the Fuel Delivery section. Select this option when the Auxillary output is connected to
The solenoid of Exhaust cam 2

Air and Engine Temp Sensor Calibration

There are many different types of sensors with varying resistances by different manufacturers. This means that a sensor calibration table is needed to translate the output of the sensor being used into a meaningful temperature value.

If you do not find a file that gives you the correct temperature readings, you will need to either create your own new calibration or modify an existing file.

Some OEM sensors may have + or - 10% variation. In extreme cases, you may decide to recalibrate the file you are using.

Using an existing File

EMS provides some pre-defined sensor calibration files. You may download one of these files into your ECU.

To use an existing file, press the open calibration button. A dialogue box will open showing a list of pre-defined calibration tables. Select the one you want to use and press the open button. This will read the file and display the data in the calibration grid.

To download this calibration to the ECU, press the Write to ECU button. Once the progress bar has finished, the calibration has been sent to the ECU.

To view the current temperature as seen by the ECU, Go-to the tuning page or press the CTRL+G buttons to display the live gauges screen. If the temperature is not correct, try a different file or modify the table and Write it to the ECU again.

Creating your own File

To create a new calibration file for a sensor it must be connected to the ECU so that the ECU can read its signal voltage. You will also need a thermometer that can read the temperature of the sensor being calibrated. An easy way to do this is to place the sensor and thermometer in a tub of hot water. This will ensure that the thermometer is showing the temperature of the sensor. As the water cools down the sensor signal voltage will change giving a different A/D value for different temperatures.

NOTE: All numbers in the table MUST be in ascending or descending order.

Calibration Steps
This example describes how to calibrate a sensor using the method mentioned above. If you need to calibrate a sensor for temperatures that are beyond the scope of this method you will need to devise your own calibration method. Calibration must be done while the sensor is connected to the ECU.

Heat a tub of water to 100 deg C (boiling), place the sensor and thermometer in the water and allow it to cool down to room temperature. If you want to go below room temperature then you can add ice to the water after room temperature is reached. While it is cooling you will read the A/D value at each temperature interval.

1. Click on the 100 Deg C column of the calibration table.
2. Wait until the thermometer reads 100 Deg C
3. Press the Accept Reading Button to write the A/D value into the table.
4. Click on the 90 Deg C column of the calibration table.
5. Wait until the thermometer reads 90 Deg C.
6. Press the Accept Reading Button again to write the A/D value into the table.
7. Repeat this pattern until you have calibrated the desired temperature range.

If you could not obtain a reading for every temperature column then you can make an educated guess as to what the A/D value should be for the un-calibrated columns by studying the number pattern of the calibrated columns. i.e.: If you see that the A/D number increases by 100 for every 10 degrees in temperature increase then you could guess that the A/D value at 110 Deg should be 100 greater than the value at 100 Deg. You can then type this number in the 110 deg column.

Press the Save Calibration File button to save your new calibration table. A dialogue box will appear allowing you to enter a file name before you press the Save button. If a calibration table with the same name already exists then it will be over-written.

You can also download the new table to the ECU by pressing the Write to ECU button.

To see the current A/D value without writing it to the table press the Read A to D Button.

G-Sensor Calibration

The EM80 and 100Series has a built-in G-Force sensor that can read up to 6Gs in 3 axis. It is accurate to +0.022 and -0.022 Gs. The readings are in milli Gs (0.001 Gs). IE: 1000 mGs = 1G

The ECU can be mounted in any orientation and the G-sensor can then be calibrated to compensate for mounting orientation.

There are 2 parts in the calibration process. The first is **Sensitivity and Bias** which will remove any small voltage fluctuations in the sensor circuitry. Second is the **ECU orientation** which will compensate for the orientation of the ECU mounting angles. The Orientation calibration must be done with the ECU mounted in the car.

NOTE: Before calibrating the G-Sensor the **G-Sensor Calibration Mode** tick box must be ticked. Also, remember to un-tick the G-Sensor Calibration Mode for normal operation.

Sensitivity and Bias

There are 3 axis to consider.
The X axis runs through the end plates of the ECU.
The Y axis runs through the sides of the ECU
The Z axis runs through the top and bottom of the ECU.

A good starting point for the Sensitivity and Bias numbers for The EM80 are:
X Bias: 345
Y Bias: 345
Z Bias: 345

X Sensitivity: 45
Y Sensitivity: 45
Z Sensitivity: 45

- Starting point for the Sensitivity and Bias numbers for the EM100 series are:
- X Bias: 1335
- Y Bias: 1335
- Z Bias: 1335
-
- X Sensitivity: 180
- Y Sensitivity: 180
- Z Sensitivity: 180

- The X axis is commonly used as the forward / backward direction.
- The Y axis is commonly used as the left / right direction.
- The Z axis is commonly used as the up / down motion.

Please note that the G force values will always fluctuate plus 22 and minus 22 milli G's.

NOTE: The following procedure must be done while the **G-Sensor Calibration Mode** tick box is ticked.
Also, remember to un-tick the G-Sensor Calibration Mode for normal operation.

Adjusting Sensitivity and Bias

Select the *Sensitivity and Bias* Tab.
Ensure the *G-Sensor Calibration* Mode selector is ticked.

Step 1

This involves taking g-force measurements for each of the axis. During this process you will need to keep turning the ECU 180 degrees on each axis until the sensitivity and bias adjustments are correct.

Adjusting the Z Axis:
- Place the ECU flat on a level surface with the sticker facing upward. This should give a reading of 1000mGs (1G) on the Z axis.
- Rotate the ECU 180 degrees so the sticker is facing downward. This should give a reading of -1000mG (-1G) on the Z axis.
If you find that one reading shows a higher mG you can adjust the Z Bias and Z Sensitivity up or down and repeat the procedure until you see an equal plus and minus mG value.

Adjusting the X Axis:
- Sit the ECU on its end plate on a level surface with the loom plug facing upward. This should give a reading of 1000mGs (1G) on the X axis.
- Rotate the ECU 180 degrees so the loom plug is facing downward. This should give a reading of -1000mG (-1G) on the X axis.
If you find that one reading shows a higher mG you can adjust the X Bias and X Sensitivity up or down and repeat the procedure until you see an equal plus and minus mG value.

Adjusting the Y Axis:

- Sit the ECU flat on its side on a level surface with the loom plug facing towards your right hand side. This should give a reading of 1000mGs (1G) on the Y axis.
- Rotate the ECU 180 degrees so that it is sitting on its other side. The loom plug should be facing downward your left hand side. This should give a reading of -1000mG (-1G) on the Y axis.

If you find that one reading shows a higher mG you can adjust the Y Bias and Y Sensitivity up or down and repeat the procedure until you see an equal plus and minus mG value.

Step 2

While the ECU is sitting flat on a bench so that the Z axis is reading a positive value. The X and Y axis should read between -22 and 22 mGs and the Z axis should read between 978 and 1022. If they do not then you can change the bias adjustments for each axis until you see these values.

- Adjust the X axis bias until you see the X axis value jump from -22 to 22. The values you should see jump from -22 to 0 to +22. You may get the occasional spike to 44.
- Adjust the Y axis bias until you see the Y axis value jump from -22 to 22. Also with the Y axis you should see jump from -22 to 0 to 22. You may get the occasional spike to 44.
- Adjust the Z axis bias until you see the Z axis value jump from 978 to 1022. With the Z axis the values you should jump from 978 to 1000 to 1022. You may get the occasional spike to 1044.

ECU Orientation

This must be done with the ECU mounted in the car. If the mounting position is changed then this procedure must be repeated.

Select the *ECU Orientation* Tab.
Ensure the *G-Sensor Calibration Mode* selector is ticked.

Step 1. This will set the ECU orientation.

While the car is stationary on a level surface, take a reading by pressing the **Stationary Read** button.

Step 2. This will set the forward direction motion calibration.

This involves accelerating the Vehicle in a forward direction and logging the data. After the data is logged you select a data log that has the highest forward direction G-force. This will set the axis used for forward motion. The highest forward G-Force axis will depend on the orientation of the ECU and vehicle chassis. Once this is set the ECU will mathematically calculate the correct X,Y and Z axis to match the X,Y and Z axis of the ECU as it is mounted in the vehicle.

Knock Sensor Calibration.

Engine Knock is caused from premature combustion. This can be caused by a number of reasons. However, the ECU can only control knocking caused from prematurely igniting the fuel via the spark plug. Other causes such as compression being too high cannot be controlled via this method.

There are a number of parameters that must be set for knock control to work well.

Frequency.

The frequency of the knock in an engine varies according to many different parameters such as bore size, block size, piston size and so on. Select the frequency of knock for your engine in this field.

Gain.

The Knock sensor is like a microphone, it converts vibration into an electrical signal. The signal can be amplified or reduced before it is used. The gain sets the amount of amplification or reduction applied to the electrical signal before the ECU uses it.
A gain value of:

> 2.00 will double the electrical signal.
> 1.00 will not apply any amplification or reduction
> 0.500 will half the electrical signal
> 0.200 will reduce the signal to 1/5th of its original voltage

Integration.

Integration is the amount of time the knock processor will sample the signal to determine its strength over that time period. The longer the period the more samples and therefore more strength. However, if during the sample period there is a long duration of no signal then a very short duration of strong signal the resulting integration will be false because the short strong signal will be reduced when added to the long period of no signal.

Integration occurs over a very short time period measured in millionths of a second. A value of 40uS (Micro seconds) is 40 millionths of a second.

NOTE: This is not related to piston movement.

Knock Sensitivity.

Sensitivity can be set for each cylinder because some cylinders are further away from the sensor than others. The sensitivity must be adjusted so that the sound level from each cylinder is the same when the ECU read it.

Sensitivity Gain Offset.

This is also set for each cylinder because some cylinders are further away from the sensor than others. When you increase the sensitivity for each cylinder then the signal level for each cylinder will be different. However, the ECU expects to read the same level for each cylinder. The sensitivity gain offset is used to equalise each cylinder without changing sensitivity.

Match Cylinder to Sensor.

The EM80 has 1 knock sensor input and the EM100 series has 2. The ECU must know which cylinder the sensor is reading. Set the sensor number of each cylinder here.

Knock Threshold.

The ECU will register a knock only if the knock sound level is above the threshold level. This can be set at different levels to suit the engine RPM.

Reset Count.

The ECU will count the number of knocks that occurred over the counted engine cycles. After the reset count is reached the knock count will be reset and counting starts over. From this you can calculate the percentage of knocks that occurred. IE: if you set the count to 100 and 10 knocks occurred then this means that 10 percent of the power strokes have detected knocks.

Engine Protection System

NOTE: The Engine Protection System **CANNOT** always prevent engine damage. It is designed to minimise engine damage.

All EM-Tech ECUs have a programmable engine protection system that can monitor any or all analogue input channels and digital inputs channels as well as both lambda sensors and engine temperature. If any of these inputs exceed the programmed threshold value then the system will shut down the engine and log a warning to indicate which input caused the activation. The engine shut down will remain active until the offending input channel is within the set threshold.

Programming the protection system

There are two areas that need to be set-up for the system to work. First, you need to set-up the parameters that will enable monitoring. Secondly, you need to set-up the inputs and thresholds that will be monitored.

Protection Activation Parameters

These parameters determine when the system will begin to monitor the input channels. You can program the system to start when the RPM is above a value AND the Manifold pressure is above a value AND the TPS is above a value. The fourth parameter sets the duration that any offending input may remain outside its threshold before the protection is activated.

Activate protection system
This parameter must be ticked to activate the system.

RPM is greater than
This parameter sets the RPM limit before the system becomes active. Set this value to 0 if you want the system active though the entire rev range.

Load is greater than
This parameter sets the load limit (in Kpa) before the system becomes active. Set this value to negative 100 (-100) if you want the system active though the entire manifold pressure range.

TPS is greater than
This parameter sets the Throttle position limit before the system becomes active. Set this value to 0 if you want the system active though the entire throttle position range.

For duration greater than
This parameter sets the duration that the offending input must be outside the accepted threshold.
i.e.: If you want the system to activate when the RPM is greater the 3000 and any input channel is outside the acceptable threshold for 3 seconds. Then set the "RPM greater than" parameter to 3000, set the "load greater than" parameter to –100, set the "TPS greater than" parameter to 0 and "For duration greater than" parameter to 3. These settings will program the system to begin monitoring the input channels when the engine is revving faster then 3000 RPM and any protection threshold channel exceeds its threshold value for more than 3 seconds.

Protection Threshold channels

All EM-Tech ECUs can monitor all or any one of the analogue inputs channels, the 5 digital input channels as well as the engine temperature and both lambda channels. Once the protection system is activated it will monitor the protection threshold for each channel. If any of the channel readings go outside of their threshold for longer than the programmed duration the protection system will activate and cause the engine to shut down.

Setting the Analogue input threshold

You can set the system to activate when an input channel reads a value from a sensor that is above or below a threshold value. To activate a shut down when a value is above the threshold set the "When Analogue is" field to "Greater Than", to activate when below then set it to "Less Than". The threshold field value is an Analogue to digital value but it you have a translation table defined for the input channel then you can enter the actual unit of measure value and the system will translate it to the correct A to D value.

To ignore a particular input channel set the threshold A to D value to 0 (zero). If there is a translation table defined for the input you want to ignore then you must set it to a value that will be translated to a 0 (zero) A to D value.

Setting the Digital input threshold

The digital channels do not actually have a threshold. These inputs detect whether their potential is either 0 (zero) volts (grounded) or above 0 (zero) volts via a connection to a positive voltage of not more than 15 volts through a 1000 ohm resistor. You select which state you want to detect by setting the "Digital input is" field to either "Grounded" or "High Volts". If you want to ignore a digital input channel then set this field to "Ignore". If the input channel wire is left unconnected then you must set this field to "Ignore". The diagram below shows how to connect a digital input for both of the detection methods described.
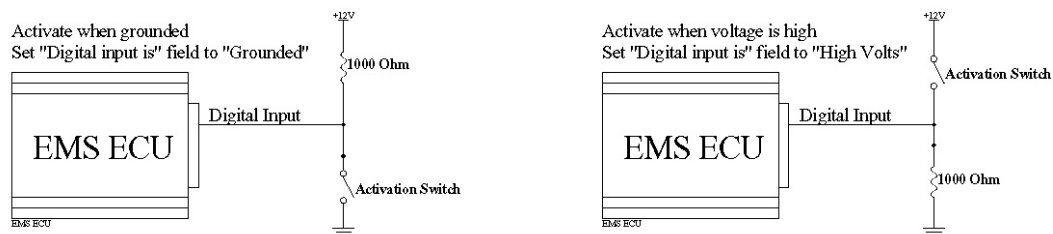
Setting the threshold for engine temp and Lambda

These parameters work by reading the standard ECU input channels for Lambda and Engine temperature. There is no need for translation tables for these parameters.

To activate the protection when the air/fuel ratio goes above 14.0 for either lambda input then enter 14.0 into the "A/F is greater than" field/s. If you want to ignore the lambda inputs then enter 0 (zero) in each field. If you are using only one lambda input then you must enter 0 (zero) for the input not being used.

Similarly, to activate the protection if the engine temperature goes above 120 Dec Celsius then enter 120 into the "Engine Temp is greater than" field. To ignore engine temperature then enter 0 (zero) into this field.

User Gauges

The new EM-Tech Management software allows you to create a screen layout for each of the main tuning screens. You can then save it as the default start-up layout, to a tune file and also directly into the ECU memory. This is useful because each ECU installation varies with different sensor inputs and output settings.

Setting Gauge Properties

Place the mouse pointer on the gauge you want to modify and press the right mouse button. Select the Gauge Properties option to display the property screen for the selected gauge

Repositioning and resizing Gauges

Place the mouse pointer on the gauge you want to modify and press the right mouse button and select the Move/Resize/Lock option. This will show a window border around the gauge. Use the top border to drag and side borders to resize the gauge. To lock the gauge position and size press the right mouse button again and select the Move/Resize/Lock option.

Removing Gauges

To remove a gauge place the mouse pointer on the gauge you want to remove and press the right mouse button and select the Remove Gauge option.

Adding Gauges to the screen

To add new gauges place the mouse pointer on an area of the screen that is clear of any gauge and press the right mouse button. A menu will be shown allowing for the selection of various gauges. Select the desired gauge to add. The gauge will be placed onto the current mouse cursor position.

Dial gauge
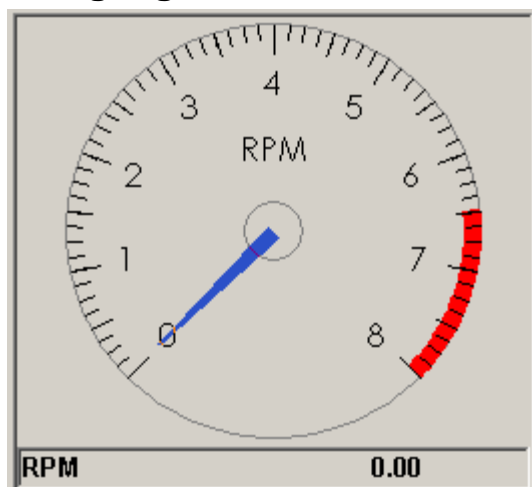
Data Channel

Select the data channel you want displayed on this gauge.

Minimum Value and Maximum Value

These values set the minimum and maximum number span for the gauge.
IE if this gauge is used to show Exhaust gas temperature then you will set the max value to 1200, Min value to 0, max danger zone to 1200 and Min danger zone to 750.

Number formatting

This describes the numerical formatting for text values.
# = Do not show leading zeros.
0 = Show leading zeros
. = Decimal place

This format "##0.00" will show numbers with 3 significant digits and decimal digits. The "#" symbols will only show numbers that are greater than zero.

Start and End Danger Zone

These numbers determine where to start and stop the danger zone for the gauge.

Divider

This allows you to show the full value in the text but a divided value on the gauge. This is useful when displaying RPM. If you want to show RPM in thousands (1 = 1000, 5 = 5000) then you set the divider to 1000, the Max Value to a value greater than your engine maximum RPM and the Min Value to 0.

IE: If you want the gauge to show a maximum of 8 for 8000 RPM then you would set the gauge parameters Max Value to 8000 and the divider to 1000. This will draw a gauge with numbers from 0 to 8 that represent 0 to 8000 RPM.

Number of Labels

This number of major marks visible on the gauge. Set this value to a number that divides evenly into the gauge span. This will provide an even range of numbers around the gauge.

To calculate the gauge span then subtract the gauge minimum from the gauge maximum. IE: if the gauge is used to show manifold pressure in KPA from -100 to +100 KPA then the gauge span is +100 – -100 = 200.

Number of Ticks

Set this number to a value that the Number of Marks can divide evenly into. This will give you an even number if small ticks between each mark.

Number of digits

This refers to the text value that is show on the bottom of the gauge. Set this to a value that can accommodate the maximum value of the channel plus a decimal point and the decimal precision.

Decimal places

This refers to the precision of the value being shown. If you only want to show whole numbers then set it to zero. If you want an accuracy of 100ths then set this value to 2.

Gauge Title

The text displayed on each gauge depends on the channel selected. This is set when you define the channel translation table. The gauge will display the Translation name and Unit of Measure (UOM) defined using the EDL7 Dash Manager option found in the Analysis Software.

Danger Colour

This allows you to choose the colour you want to display in the danger zone.

Gauge Face Colour

This is the colour for the round dial background colour.

Background Colour

This is the colour for the area of gauge outside of the round dial face.

Text Colour

This is the colour of the text and ticks of the gauge.

Show Danger Zone

Tick this field if you want to show the danger zone.

Number Gauge

Data Channel

Select the data channel you want displayed on this gauge.

Gauge Title

The title text displayed on each gauge. If this is left blank then the channel name will be displayed

Number formatting

This describes the numerical formatting for text values.
# = Do not show leading zeros.
0 = Show leading zeros
. = Decimal place

This format "##0.00" will show numbers with 3 significant digits and decimal digits. The "#" symbols will only show numbers that are greater than zero

Text Colour

The gauge will displayed in this colour when its value is below the danger limit.

Background Colour

This is the colour for the area behind the displayed value.

Show gauge tile

Tick this field if you want to show the gauge title.

Indicator gauge
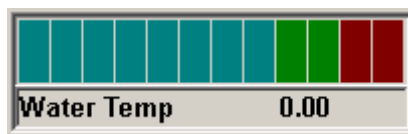
Data Channel

Select the data channel you want displayed on this gauge.

Minimum Value and Maximum Value

These values set the minimum and maximum number span for the gauge.
IE if this gauge is used to show Exhaust gas temperature then you will set the max value to 1200, Min value to 0.

Number formatting

This describes the numerical formatting for text values.
# = Do not show leading zeros.
0 = Show leading zeros
. = Decimal place

This format "##0.00" will show numbers with 3 significant digits and decimal digits. The "#" symbols will only show numbers that are greater than zero.

End of colour zone 1

The indicator gauge can display 3 colour zones. Set the value for the end of zone one. Gauge values below this value will be shown using the "**Zone 1 On Colour**"

End of colour zone 2

Set the value for the end of zone two. Gauge values below this value and above zone one value will be shown using the "**Zone 2 On Colour**". Any values above the "End of colour zone 2" will be shown using the "**Zone 3 On Colour**".

Number of Leds

This gauge shows a series of LEDs that span from left to right or bottom to top. Select the number of LEDs to use in span. More LEDs give a finer gauge. If you select too many compared to the length of the gauge then they will not be displayed

Gauge Title

The text displayed on each gauge depends on the channel selected. This is set when you define the channel translation table. The gauge will display the Translation name and Unit of Measure (UOM) defined using the EDL7 Dash Manager option found in the Analysis Software.

Background colour

This is the colour for the area of gauge outside of the round dial face.

Text Colour

This is the colour of the text and ticks of the gauge.

Show Value as text

Tick this field if you want to show the gauge value as text just above the gauge.

Show Gauge name

Tick this field if you want to show the gauge title just above the gauge.

LED Contrast

This is a number between 5 and 10 that controls the LED brightness difference between ON and OFF. A value of 5 will show the OFF LED brightness at half the level of the ON LED brightness. A value of 9 will show the LED at 9 times less bright and a value of 10 will completely turn the LED OFF.

Single LED

Tick this option if you want to display the gauge value as a single LED similar to many air-fuel ratio meters.

Text gauge

Use this style of gauge to display multiple channels at once. You can add up to 16 channels per gauge.

Inj mS	0.00
Ign Timing	0.00
Injector Capacity	0.00
Battery Volts	0.00

Data Channels

Select the channels you want shown from the **available channels** by double-clicking each channel or selecting it and pressing the >> button. The channel will be added to **display channels** list.

Number formatting

This describes the numerical formatting for text values.
# = Do not show leading zeros.
0 = Show leading zeros
. = Decimal place

This format "##0.00" will show numbers with 3 significant digits and decimal digits. The "#" symbols will only show numbers that are greater than zero.

Background Colour

This is the colour for the area of gauge outside of the round dial face.

Text Colour

This is the colour of the text. Be sure to not set this colour to be that same as the background colour.

Channel Colour

This option sets the border colour of each channel.

Channel Name

This defaults to the selected channel name but it can be changed if needed

Scope gauge

This gauge is similar to the Text Gauge. Use this style of gauge to display multiple channels at once as a running line. You can add up to 16 channels per gauge.

Data Channels

Select the channels you want shown from the **available channels** by double-clicking each channel or selecting it and pressing the >> button. The channel will be added to **display channels** list.

Number formatting

This describes the numerical formatting for text values.
# = Do not show leading zeros.
0 = Show leading zeros
. = Decimal place

This format "##0.00" will show numbers with 3 significant digits and decimal digits. The "#" symbols will only show numbers that are greater than zero.

Background Colour

This is the colour for the area of gauge outside of the round dial face.

Text Colour

This is the colour of the text. Be sure to not set this colour to be that same as the background colour.

Channel Colour

This option sets the border colour and line colour of each channel.

Channel Name

This defaults to the selected channel name but it can be changed if needed

Data Analyser

The Data Analyser allows you to view log data in a graphical form. You can view multiple log files together so you can compare two or more sessions.

When you select channels to display, the software will automatically display channels with the same name together in the same graph. This allows you to overlay similar data for easier comparison. The channel data is also shown in text form on the left side of the screen. As you move the mouse pointer over chart the text data changes to show the numeric value for each channel in the log pointed to by the mouse cursor.

Recording Data

A log file can be created in 2 ways:
1. Using the ECU management software.
2. Directly by the ECU onto the SD card.

Using the ECU management software.
1. Set the Start/Stop parameters using the application parameters screen. Here you will set at what RPM the logging should start and stop. This only needs to be done once.

2. Press **CTRL+D** to activate the data logging. Once the Engine RPM reaches above the selected start value logging will start. Logging will stop when the engine RPM falls below the stop RPM value or when you press **CTRL+D** again.

Logging directly to the SD Card in the ECU.
Before the ECU can start logging you must set the RPM at which logging will start and stop. To do this select **ECU Setup (F2)** then Logger settings and set the start/stop parameters.

Start/Stop Logging
This parameter sets the engine RPM at which logging begins and stops. To start logging when the engine RPM is above 2000 then enter this value into the Start/Stop setting. The ECU will stop logging when the RPM falls below this value.

Start/Stop Delay
This parameter sets the delay before logging starts and stops. If you want to start logging when the RPM is above the set value for longer than 1.5 seconds the enter this value into the delay setting. The ECU will also stop logging when the RPM is falls below the RPM set value for 1.5 seconds.

Before you can view a log file it must be extracted from the SD card using the SD card manager.
See **SD Card Management** topic for more information.
See **Viewing Log Files** for information on displaying the recorded data

Selecting a channel to display.

You can select as many channels as can reasonably fit onto the chart screen. If you are analysing multiple logs, the system will overlay data channels with the same name. If you select channels with different names then the software will create a new chart for each channel.

To display data for a channel first click on the desired channel then press the right mouse button. This will show a pop-up menu where you must select the **Add to Chart** option. Do this for each channel you want to view.

Remove a data channel from the chart

To remove a data channel from the chart, first click on the channel you want to remove then press the right mouse button to display the pop-up screen, now select the **Remove From Chart** option.

Sorting the data

The logged data is sorted in the same sequence that it was recorded; however there are times when you may want to sort the information in ascending order of a particular channel.
To sort the data according to a particular channel first click on the desired channel and press the right mouse button to display the pop-up menu. Select the Sort on Selected Channel option and wait for the software to re-sort the data. Once sorted the channel name of the sorted channel will be shown as a darker grey colour.

Un-Sorting the data

If you sorted the data but now want it sorted back into the default recorded sequence first click on any data channel, then press the right mouse button and select the Un-sort Data option. You must wait until the software re-sorts the data back to the default sequence.

Viewing Recorded data

Viewing data recorded by ECU management software.
1. Set the Start/Stop parameters using the application parameters screen. Here you will set at what RPM the logging should start and stop. This only needs to be done once.
2. Press CTRL+D to activate the data logging. Once the Engine RPM reaches above the selected start value logging will start. Logging will stop when the engine RPM falls below the stop RPM value or when you press CTRL+D again.

To view the log file, select the **Data Analyser (F9)** screen. The recorded log file will be displayed automatically. You can see the data on the chart by double clicking on the channel you want to display.

Viewing data recorded by the ECU.
Before you can view a log file it must be extracted from the SD card using the SD card manager. This converts the file into a windows readable format.
See **SD Card Management topic -> SD Card Log Files** for more information.

To open a log file, select the **Data Analyser (F9)** screen then go to menu option **File -> Open Log** and select the log you want to view then press the Open button. This will create a column of channel values. You also can open a second log file in the same way. The system will create a second column for the newly opened log. To display a channel you must double click on the channel you want displayed.
The amount of time to open a log file will depend on the amount of data recorded in the file.

Note: To open a log file use the File menu option on the data analyser screen.

Selecting different Chart options
You can display information is different ways.
You can display data channels overlayed on the same chart or view them in a different chart format such as scattered or as bars. You can do this by pressing the appropriate button just above the chart screen.

Separated charts
This is the default format. This mode is active when the **Separate** button is a light grey colour. In this mode each data channel with a different name will be show in a separate chart.

Overlayed charts
If you want to overlay every channel onto the same chart then press the **Overlayed** button before selecting the channels you want to view.

Line charts
This is the default data display. It shows recorded information as a line. This is the most common and easiest to understand chart form. This chart is selected when the **Line** button is shown as light grey.

SD Card Management

SD Card Manager

NOTE: For SD Card Manager to work you must have administrator privileges on your Laptop computer.

If you find that the SD Card does not appear on the list after you have inserted it into the Laptop SD card slot then go to the bottom of this page to see how to set administrator privileges for this software.

EM-Tech ECUs use the SD card for firmware updates and data acquisition. The SD Cards must be initialised using the EMS proprietary filing system. Data logging is limited to the size of the SD Card. A 2GB SD Card can log continuously for over 108 hours.

When an SD Card is detected by the software it will appear in the "SD cards" list. The list will indicate which cards are initialised with the EMS file system and all others will be noted as unrecognised.

Use the SD Card manager to:
- Initialise an SD card
- Load firmware to the ECU
- Clear all log files from the SD Card
- Put the ECU into firmware update mode
- Extract log files

Before you can do anything with an SD card you must first select it from the SD cards list.

Delete Logs
You cannot delete log files individually. You must delete all log files at once. Press the "Delete logs" button to clear the SD Card of all log files

Initialise SD Card
In order for the ECU to recognise an SD Card as valid it must be initialised with the EMS file structure. The card must also have a unique name. The Card Name is used so you can identify each card. When you extract a log file from the SD card the system will create a folder using the card name and save all log files inside this folder.

Load ECU Firmware

EM-Tech ECUs can be updated to the latest firmware through the SD Card. This button places the selected firmware version onto the SD card. When you press this button you will be prompted to select a firmware file. Each file is named according to the firmware version and ECU model. Select the version you want to install into the ECU and press Open.

Please Note:

- For all EM70 version 15 or later you now must use the EM80_XX_XX.FIM file.
- For all EM70 version 14 or earlier you must use the EM70_XX_XX.FIM file.
- If you want to upgrade any EM70 version 14 or earlier to version 15 or later, it must be sent back to EMS for new factory firmware to be installed. After this the ECU will be compatible with all newer firmware releases.

Enable Firmware Upload

Before you can load new firmware into the ECU you must first put the ECU into firmware upload mode. The ECU must be connected to the PC/Laptop so that you can do this.

- **Step 1.** Load ECU Firmware onto SD Card and leave card inserted in Laptop.
- **Step 2.** With ECU connected to the laptop press the Enable Firmware Upload button. After pressing this button you will be prompted to confirm twice. After confirming the second time the ECU will go into firmware update mode. The LED light nearest the Ethernet plug on the ECU will light up in orange to indicate that the ECU is in Firmware Upload Mode.
- **Step 3.** Remove SD card from Computer and place it into ECU card slot. The LED light should now change colour to red for a short while the ECU erases its memory. Then the opposite LED light will flash red while the ECU is loading its new firmware. When loading is successful both LED lights will change colour to orange and flash very quickly to indicate that the upload is complete. If the LED lights change colour to red and flash very quickly then this indicates that an error occurred.
- **Step 4.** If no error occurred power the ECU off and on. If all is ok, the LED closest the SD card will flash slowly in Orange and the LED nearest the Ethernet port will glow a steady red. If an error occurred you must repeat the firmware upload process with a different firmware file.

If an error occurred during step 4 then the most likely reasons could be:

- 1. Wrong firmware file for the ECU model.
- 2. The firmware file is corrupted*.*

SD Card Log Files

Data acquisition files are saved onto the SD Card. Each logging session will create one log file. The system will use the name of the SD Card to name each file. A number is also appended to the file name to indicate the session number. This also gives each log file a unique name. Data logging is limited to the size of the SD Card. A 2GB SD Card can log continuously for over 108 hours at 10 logs per second.

When the software detects an SD Card it will appear in the "SD cards" list. The list will indicate which cards are initialised with the EMS file system and all others will be noted as unrecognised.

To extract a log file:

- **Step 1.** Select the SD card from the SD Cards list. This will list all logs in the selected card.
- **Step 2.** Select the log file you want to extract and press the Extract Log File button. The system will create a folder using the name of the SD card and prompt you to save the extracted file into this folder. Press the Save button to save file.

ECU Tamper Lock

You can prevent others from accessing or changing the tune settings in the ECU.

The tamper lock for the EMXX ECUs work a little differently than most other systems. It was designed in a way so that you don't need to always enter a password each time you access an ECU tuned by you. If the ECU is accessed by another laptop then a password will be required before access is allowed.

To set up the password requires 2 steps:

Step 1. You must set a default password for your laptop via the **"Application Settings -> Operational Parameters - Tamper Password".** This is done only once, you don't need to keep setting your default password.

Step 2. Save the password into the ECU via the **"ECU -> Lock/Unlock ECU"** option and pressing the **"Save Password to ECU"** button. This only needs to be done once for each ECU.

The system compares the password in the ECU with your default password and if they match then access is allowed. If they don't match then a password must be entered before access is allowed.

WARNING: Unlocking an ECU will erase the tune data from the ECU.

To unlock the ECU go to the **"ECU -> Lock/Unlock ECU"** option and press the **"Unlock ECU"** button. This will unlock the ECU and erase the tune map.

Problem Solving

ECU not Communicating with Laptop

Ethernet communications is fast, robust and proven but there is a minor issue that is designed to protect your laptop but can also hinder you if you are not aware of it. The windows firewall can block your laptop from connecting to the ECU. If this occurred then follow the instructions below to fix the problem.

When you run the EM-Tech software for the first time the windows firewall will detect this and prompt you to allow this software access to the Ethernet ports. If you do not give the correct access level then the software is blocked and you will need to set the access levels via the windows firewall manager.

Step 1:

After starting the software for the first time you should be prompted with the screen below.
Ensure that both tick boxes shown in the red circle are ticked before you press the **Allow Access** button. If you missed doing this then go to step 2.

Step 2:

Setting the access level via the windows firewall manager.

Press the Start button and type the word **firewall** in the **search programs and files** field as shown in the screen image below. This will show a list of options from which you can select as show in step 3.
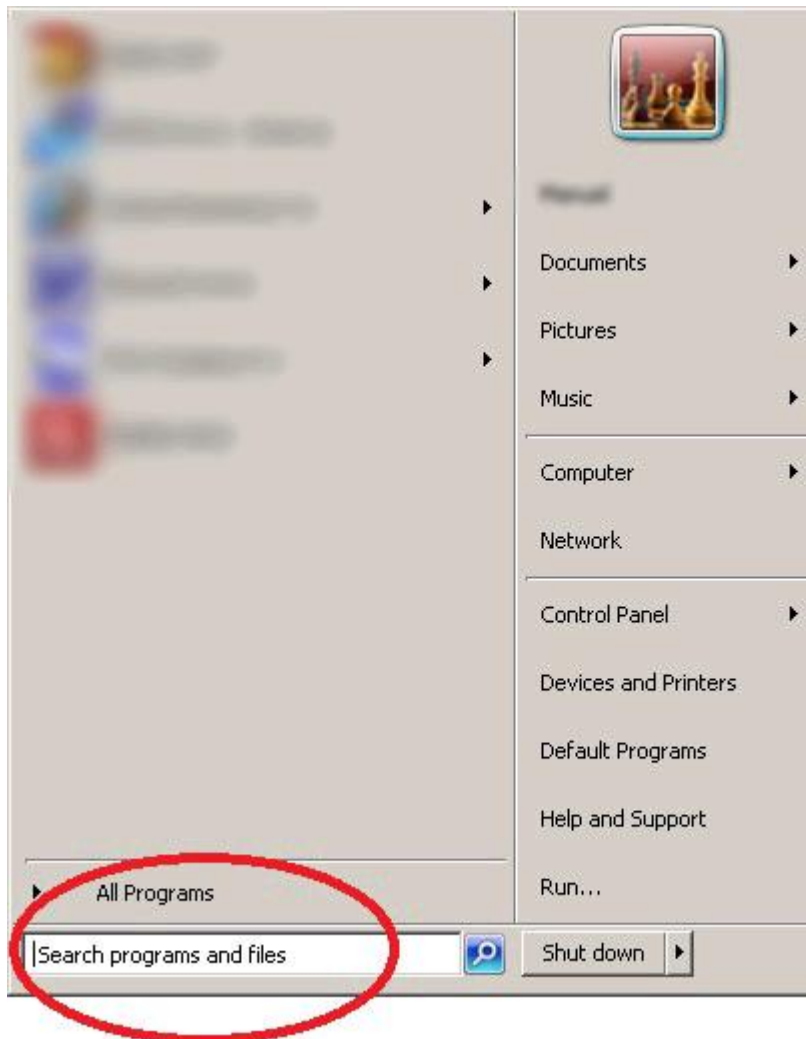
Step 3.

After typing the word firewall in the **search programs and files** field you will be show the screen image below. Select the **Allow a program through Windows Firewall** option to display the screen used to change access levels as shown in step 4.
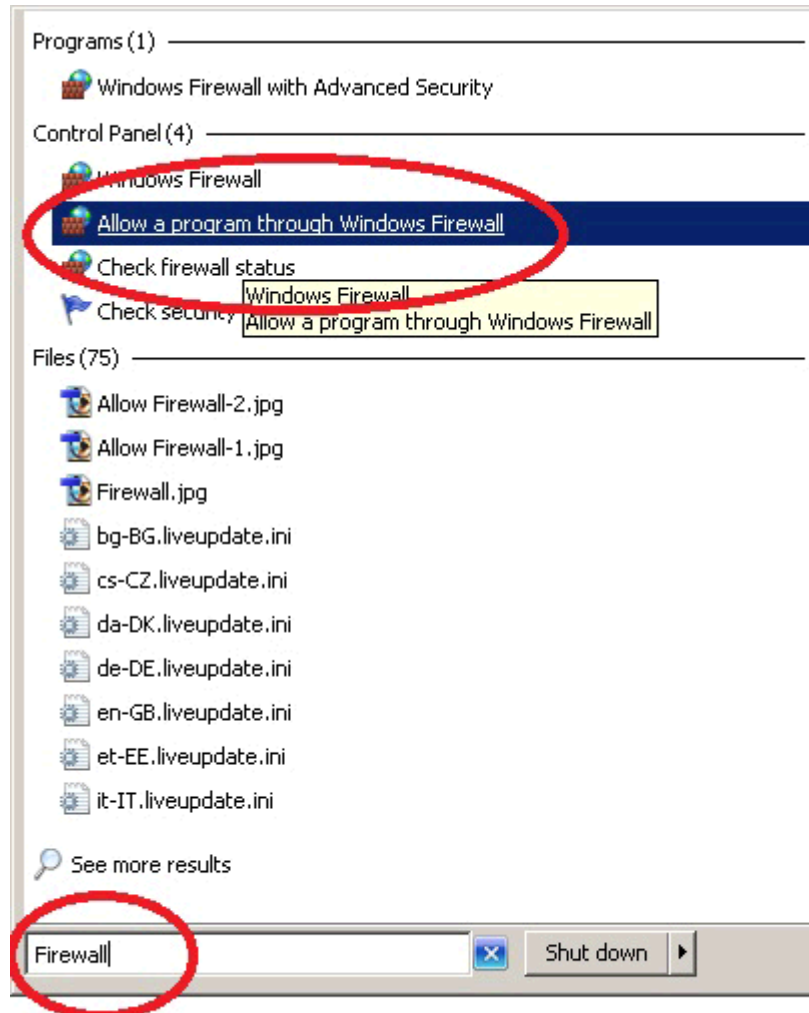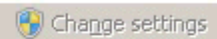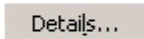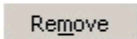
Step 4.
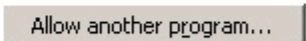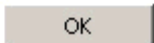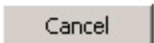
You may need to scroll though the **Allowed programs and features** list until you see the **EM-Tech management software** entries. When you find them ensure that all of the tick boxes shown in the red circles are ticked and then press the **OK** button. The windows firewall should now allow the EM-Tech software access to the Ethernet ports.
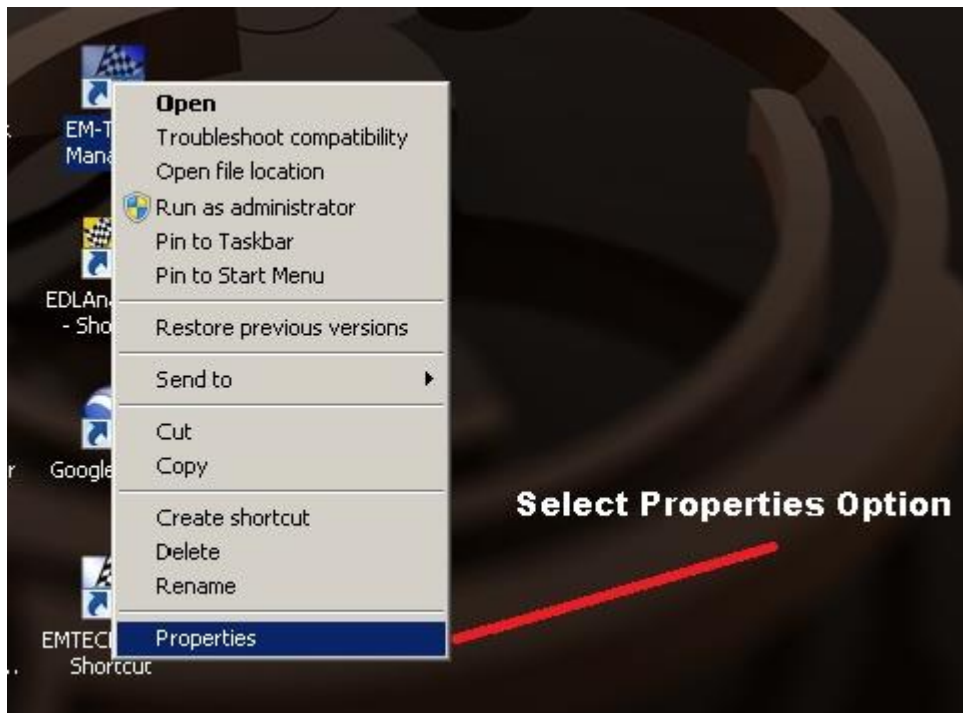
Issues with the SD Card

Administrator privileges sometime prevent the EM-Tech management software form functioning properly when reading and writing to SD cards. To overcome this follow the instructions listed below.
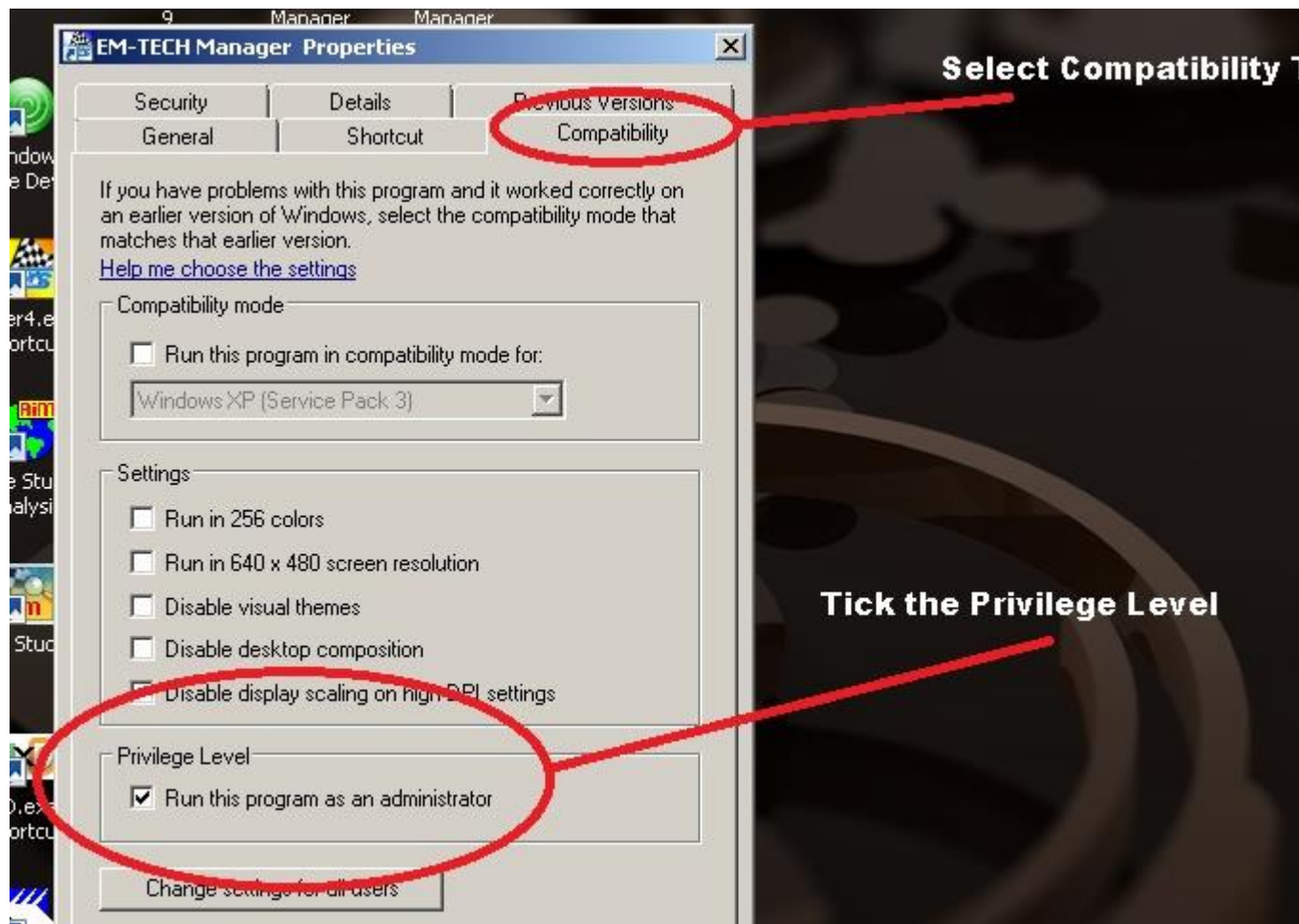
Step 1: Find the EM-Tech Manager icon and press the Right mouse button.
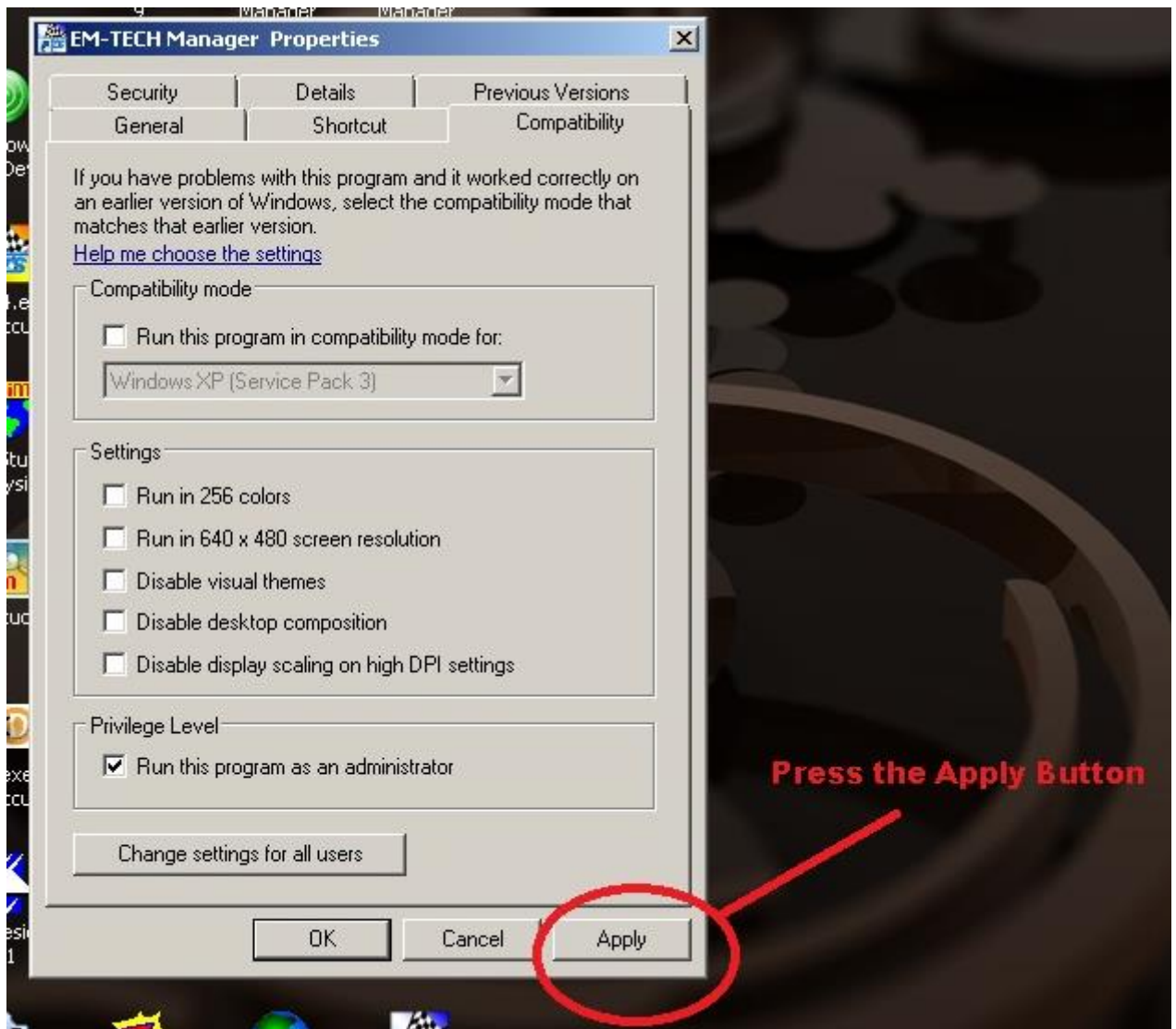

Step 2:A pop-up menu will appear. Select the Properties option.

Step 3: The properties windows will appear. Select the Compatibility Tab
then tick the Privileges Level tick box.

Step 4: Press the Apply button.

Now when you run the EM-Tech Manager it will have administrator privileges and the SD card manager will work.

Interactive help

Activate the interactive help to show usage information and instructions about specific elements of the software and ECU.

While the interactive help is active you can move the mouse cursor over any part of the screen to display help about that particular element.

You can lock the current help topic by right-clicking on the element. This will stop the interactive help from changing as you move the mouse pointer. To unlock the topic left-click anywhere outside the help screen.

Note: On some screens the Interactive help is only sensitive to area blocks and not the individual elements within each block. In these cases you must right-click on the grey area of the block to lock the help.