1. Introduction

a. Operational Outline: Fuel Injection

The Link-EMX Computer controls the engine fuel flow by sending electrical pulses of varying width and frequency to the injectors. When the injector is energised, a solenoid (electromagnet) opens the injector fully, and fuel flows into the intake system.

The amount of fuel injected over a period of time depends on how often the injectors are opened (pulse rate), and the duration of each injection (Pulse Width). The actual pulse widths are quite short, typically 1.5 to 10 milliseconds. (1 millisecond = 1/1000 second) The pulse rate varies with engine speed usually resulting in one injection for each crankshaft revolution. This injector timing strategy results in each cylinder receiving two injections per complete 4 stroke cycle (2 revolutions). If at the time of injection the inlet valve is closed, the fuel injected will reside at the inlet port until the next intake stroke. This arrangement permits all injectors to be fired together in groups thus reducing the number of drive amplifiers and also simplifies the injector wiring.

b. The Speed Density Principle

In order to inject the correct amount of fuel, the Link-EMX Computer must calculate the mass air flow of the engine and convert this air flow signal into a fuel flow signal.

The amount of air an engine is processing at any particular time depends on two main factors:

1. **Engine Speed**. The mass air flow increases in direct proportion to engine speed assuming all other factors are constant.

2. **Cylinder Air Density**. A measure of the air density in the cylinder when the inlet valve/port has just closed.

i. Determining the Speed

Engine R.P.M. is easily measured by feeding pulses from the ignition system to the Link-EMX Computer. This pulse rate in conjunction with the CYLINDER switch setting determines the rate at which the injectors are pulsed. This pulse also supplies information for the computer's zoning and RPM limit functions. The Link-EMX Computer will accept either low level pulses (TRIGGER LOW) from a crank-angle sensor, or high voltage pulses from the ignition coil negative terminal (TRIGGER HIGH).

ii. Determining the Density

Direct measurement of cylinder air density is not practical, but may be calculated by measuring the inlet manifold air density and applying a correct value. The manifold air density is determined (normally) by measuring manifold air pressure (MAP) with a pressure transducer, and air temperature with a suitable probe. The correction factor between manifold density and cylinder density (Volumetric Efficiency, V.E.) is found by the Link-EMX Computer looking up a table in its memory and doing a series of mathematical calculations.
This table (Zone Fuel) consists of 64 zones each covering a narrow operating range. Each zone may be individually or group programmed to suit the application. Refer to section six for further details.

In some cases eg. performance cams, manifold air pressure may not give an accurate indication of air density due to reversion flow out of the inlet ports. An alternative scheme is to measure the degree of throttle opening with a rotary position sensor. This mode, throttle position scheduling (TPS) is covered in detail in Section Ten.

c. Cold Starting

Almost without exception, all engines require additional fuel (rich mixture) during cold starting and the warm up period immediately following. This requirement can be met two ways.

i. Automatic. The Link-EMX Computer monitors engine temperature via a suitable probe and provides automatic (programmed) enrichment and pre-start priming.

ii. Manual. Driver variable control with a manual priming facility.

The automatic system (the normal system) monitors engine temperature and looks up an eight zone enrichment map. From this map a preprogrammed value of enrichment is employed. Each zone covers steps of 10^{o}c from -10^{o}c to 70^{o}c.. For engine temperatures below 40^{o}c, the Link-EMX Computer automatically primes the engine with a short injector burst prior to cranking.

The manual system basically replicates the automatic system except enrichment is driver selected and priming must be requested by pushing a button. For further details refer section six.

d. Ambient (Inlet Air) Temperature

As mentioned previously the air density calculation takes into account the manifold air temperature, or more commonly, the intake temperature measured at, or close to, the air cleaner. Since the density of air varies in proportion to the absolute temperature (ie reference to absolute zero or -273^{o}c) the effect of normal ambient temperature fluctuations are usually insignificant.

In extreme conditions the ambient temperature may be computer compensated, provided an ambient sensor is fitted and selected ON. The processing of this input is identical to the cold start system except "AMBIENT" has a separate 8 zone block to hold programmable correction values. Fuel may be added or removed as a function of ambient temperature.

e. Summary of Fuel Controls

The following functions may be selected via the tuning module or remote control in order to programme engine fuelling. Note that all corrections entered are temporary unless stored by the STORE function.

MASTER Controls overall fuel irrespective of current operating zone values. The value may be altered up or down using the push buttons while the display indicates a scale from 0 to 99. The scale does not represent any particular units other than a reference value for comparative purposes

OFFSET Adds a constant amount of time to the fuel injector pulse width. The offset value displayed represents units of 1/10 of a millisecond. This control is used mostly in Throttle Position Scheduling (TPS) mode to correct non-linear signals in the position sender.

RPM LIMIT Preset RPM limit value range from 0 to 9900 RPM. Display equals RPM x 100 eg "65" = 6,500 RPM. If limit is exceeded, fuel to the engine is cut off until the RPM has fallen below the limit value.

MAP LIMIT Preset manifold air pressure (Boost) limit protects engine from excessively high boost pressures when Turbocharged or Supercharged. Action is identical to RPM limit except display equals PSI of boost.

TRANSIENT This control is the electronic equivalent of the accelerator pump in a carburettor. When the throttle is snapped open, additional fuel is injected to obtain clean throttle response. TRANSIENT has eight zones each covering a 1,000 RPM range from 0 to 8,000 RPM. Display indicates a scale value from 0 to 99 as a setting guide.

COLD START Controls fuel enrichment when the engine is below normal operating temperature. COLD has eight zones each covering a ten degree span and ranges from -10 to 70^{o}c. Display indicates a 0-99 scale for setting purposes.

AMBIENT Action identical to cold function except this control responds to ambient (Inlet)air temperature. Zoning and indication is the same as COLD.

STORE Used to store corrections in memory. STORE is initiated by pressing both push buttons down together for about 1 second. (ENTER function) Display is normally blank but will show "00" while storing is in progress.

RELOAD Used during initial setup to transfer a default table into the Link-EMX Computer zoning system. The default table basically sets all zones to a typical average pattern which may then be fine adjusted to suit the application. RELOAD is initiated by pressing both buttons for about one second (ENTER function). Display is normally blank but will show "00" while storing is in progress.
NOTE: RELOAD will overwrite any values currently programmed.

ZONE FUEL (Allows fuel adjustments to be made in small specific areas). There are 64 zones arranged in a rectangular grid consisting of four rows by 16 columns. The rows represent the load "slopes" and the columns represent the 500 rpm steps. Therefore each 500 RPM section may have one of four different values depending on manifold pressure. Each zone may be individually adjusted on the scale of zero to ninety nine. Selection of the zone is automatic while the engine is running. Internally, the programme interpolates the zones to prevent steps in the fuel flow as the table is read. (This process is invisible to the user since the display shows only the centre value of each zone despite the processor working to an accuracy of 32,000 zones).

SLOPE This control is essentially a coarse version of ZONE FUEL which adjusts an entire row of zones simultaneously throughout the RPM range. This mode is normally used after the MASTER has been set to broadly shape the fuel curve in terms of engine load. Most applications will have row values increasing as manifold pressure (load) rises to produce an enrichment slope effect. (Slope may be considered as a four stage master if preferred).

% FUEL A read only function which displays actual injector duty cycle from 0 - 99%. This information is useful for checking that injectors have sufficient flow for the intended power output. Duty cycles in excess of 95% indicate inadequate injector capacity and may result in the engine "leaning out" at high power. The up and down buttons have no effect.

RUN The display reads RPM x 100 eg. "**42**" = 4,200 rpm.

ERASE This control erases all correction data entered since initial switch on. It does not affect the resident programme, only the pending corrections just entered. Press both buttons down for one second (ENTER) to initiate. Display indicates random information usually, but shows "**00**" after successful erasure.

A suggested tuning procedure for fuel controls is covered in section six.

2. Hardware Description

The Link Engine Management Computer is housed in an extruded aluminium chassis of dimension L230mm W110mm D30mm with removable alloy lid.

To fit control modules remove the smaller of the two front panels. To do this remove the two screws at the end of the case.

To tune the Link Engine Management system use the Remote Tuning Module. After tuning is complete and the information is stored into the processor, the tuning module may be removed if desired. This offers lower cost installations and prevents unauthorised tampering with the programme. Alternate function modules including zone programming modules, remote control, data logging, modems (tuning via telephone) etc will be available subject to demand and development time (modules simply slide into the extruded chassis and automatically connect via edge connectors).

Main wiring to the Link Computer is via a compact seventeen pin connector which conveys information into, and out of, the computer. The number of wires required depends on the intended application, and all are uniquely colour coded to aid interconnection. Some wires run directly to a particular device, while others employ "SmartLeads" to preprocess inputs, or modify outputs from the Computer. See section nine Interface Hardware.

Also included with the system is a Manifold Air Pressure (MAP) SmartLink which is usually connected to a source of manifold vacuum/pressure via a 3 m.m. rubber tube. The air pressure signal applied to this port is converted into an electrical signal and sent to the micro-processor. Some applications (Particularly T.P.S. mode) will require the port to be connected to a different source of pressure.

The remaining main board circuitry consists largely of interface electronics which condition signals entering or leaving the microprocessor.

a. Cylinder Switch

Used to select the number of engine cylinders, e.g. 4 cylinder engine, switch should be set to "4". Note that above position "9", the letters A, B, C, D, E, F appear. These are hexadecimal numbers (base 16) and may be related to decimal number as follows:

A = 10
B = 11
C = 12
D = 13
E = 14
F = 15

Therefore, a 12 cylinder engine should have switch set to "C".
For 2 rotor Wankel engines (e.g. Mazda rotaries) set switch to position "4".
For 3 rotor Wankel engines set switch to position "6".

b. Mode Switch

The mode switch provides the Link-EMX Computer with four different groups of information as shown in the mode table diagram (see page eight). Select the functions in the table according to the sensors and mode of operation required;

i. Limits Enable

Allows the three limits (RPM, MAP and Advance) to be selected or disabled.

ii. Over-run Cut

Selects the Over-run fuel cut feature. This inhibits fuel injection on trailing throttle if RPM is above one thousand RPM. This is to reduce fuel consumption and backfiring. Racing applications, particularly jet boats should have this feature switched off.

iii. Ambient

Informs Link-EMX Computer whether or not an ambient temperature sensor (or manual dash trimmer) is connected.

iv. Cold Start

Similar to ambient, but monitors engine temperature for cold start enrichment.

CAUTION - Selection of a sensor or mode which doesn't exist may result in erratic operation. Alternatively, failure of a sensor may bypassed by deselecting that function until repairs can be made, i.e. if engine temperature sensor fails, deselect that option so that faulty sensor will not interfere with other operations.

c. Mode Switch Table

Position Switch	Limits Cut	Over-run Sensor	Ambient Sensor	Cold Start
0	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	ON
2	OFF	OFF	ON	OFF
3	OFF	OFF	ON	ON
4	OFF	ON	OFF	OFF
5	OFF	ON	OFF	ON
6	OFF	ON	ON	OFF
7	OFF	ON	ON	ON
8	ON	OFF	OFF	OFF
9	ON	OFF	OFF	ON
A	ON	OFF	ON	OFF
B	ON	OFF	ON	ON
C	ON	ON	OFF	OFF
D	ON	ON	OFF	ON
E	ON	ON	ON	OFF
F	ON	ON	ON	ON

Example - Limits On, Over-run cut On, Cold Start On, No Ambient Sensor

Limits	=	ON
Over Run Cut	=	ON
Ambient	=	OFF
Cold Start	=	ON

Therefore, set mode switch to "D".

NOTE: The Link-EMX Computer is normally dispatched in this mode.

3. Link-EMX Installation

The Link-EMX Computer may be installed virtually anywhere but the following precautions must be observed.

1. Avoid areas of high ambient temperature such as exhausts, radiators etc. Preferably mount the unit inside the vehicle cabin. It is preferable that the unit be removable with sufficient cable length so that tuning may be performed while the vehicle is in motion.

2. If water immersion or spray is likely, then additional protection may be necessary. Several brands of self sealing plastic may be employed here, (e.g. Tupperware) particularly for marine applications.

3. Maintain maximum distance from radio transmitters, co-axial cables etc where fitted.

Ignition Suppression

The Link-EMX Computer employs very high speed processors which will behave erratically if subjected to strong radiated electromagnetic fields. These fields are generated by unsuppressed H.T. leads which act as aerials and radiate very powerful interference signals.

ALL applications must use suppression (resistance) leads.

All applications must employ a suppressor capacitor connected directly to the ignition coil(s) POSITIVE terminal (0.5 - 1.0 micro farad's (most points condensers are suitable)).

NOTE: **Do Not** run grey or green trigger wires with any other wires in the loom.
These wires are sensitive to picking up RF interference and every effort must be made to separate them from the rest of the loom, especially high current wires.

4. If vibration levels are high, some form of soft or rubber mounting is advisable to prevent component and wiring metal fatigue, (foam rubber blocks are recommended).

(Before mounting check that mode and cylinder switches have been correctly set).

The Link-EMX Computer is supplied with a breakout loom approx. 2 metres long to enable connection to the various input and output devices. Some connections are made directly to the relevant device, while others require some form of interface to maintain compatibility. This procedure entails the use of the Link ElectroSystems series of "SmartLeads" which incorporate signal conditioning circuitry built into the wiring loom to the device. (refer to section nine regarding "SmartLeads" description and usage.) Depending on the application, the appropriate sensors and output devices are connected to the breakout loom, the internal MODE switch is set, and the Link-EMX Computer is ready for programming. In all cases, the following connections must be made as follows:

+12 volts (RED) Power supply for the Link-EMX Computer from the ignition switch. Max current draw is approx 0.4 amps. A fuse of rating 2 5 amps may be used if desired.

SIGNAL GROUND (BLACK) Signal ground source for the Link-EMX Computer. Terminate this wire to a clean earth point.

POWER GROUND (BLACK) Power ground source for output drive transistors. Terminate this wire to a clean earth point as per GROUND 1. This wire carries substantial injector drive currents and must be run separately to the earth point. DO NOT be tempted to run a single earth wire for both GROUND connections otherwise erratic operation may result.

TRIGGER HIGH (GREY) High level trigger input from ignition coil negative (-ve) terminal. This trigger option is used when fuel injection is to be run in conjunction with an existing ignition system.

NOTE: **Do Not** run grey or green trigger wires with any other wires in the loom.

These wires are sensitive to picking up RF interference and every effort must be made to separate them from the rest of the loom, especially high current wires.

TRIGGER LOW (GREEN) Low level trigger input from distributor or crank angle sensor etc. This low level signal is used when programmed ignition advance is to be used. Signals from the sensor are conditioned by the appropriate "SmartLink" and sent to the Link-EMX Computer on this line. NOTE: Trigger low and Trigger high are only to be used separately, never together.

INJECTOR DRIVE 1 & 2 (ORANGE 1 & BROWN 2) High current (earth sourcing) output drive lines for solenoid operated fuel injectors. Drive 1 & 2 are identical in terms of injection rate and pulse width, but differ in their phasing. (ie they fire alternatively) This arrangement allows multi point injectors to be grouped, and throttle body (single point) injection to be used as follows:

1- 4 cyl.	Use any one drive and fire all injectors simultaneously.
6 cyl.	As above, or split injectors into 2 groups of 3.
8-12 cyl.	Split injectors into 2 groups of 4 or 6 .
Throttle body.	Drive each injector (2 usually) off each drive.

NOTE: Low resistance injectors (ie coil resistance 3 ohms or less) require ballast resistors to control the drive current. Refer to page 14 for ballast configuration. Injectors with high resistance coils (12 ohms or greater) may be driven directly. Maximum injectors of any type = 6 per drive.

The following input/outputs are optional depending on the application. Note that some inputs require that the internal MODE switch is set accordingly.

IGNITION DRIVE (BLUE) This output signal is used to trigger a remote igniter module to produce high voltage for ignition purposes. The timing of this signal is controlled by the programme held in the Link-EMX Computer and will vary depending upon engine RPM and load. Note that this output is not used when an existing ignition system is employed.

FUEL PUMP DRIVE (PURPLE) This output provides an earth signal for an external relay which controls fuel pump power. This output is active only during initial switch on or when the engine is running. Failure to use the relay will immediately burn out the driver and associated hardware requiring the Link-Computer to be returned to the manufacturer. This is not a warranty claim.

MAP INPUT (BLACK/WHITE) Manifold Air Pressure signal from "MAP SmartLead". Alternatively the signal may originate from a "TPS SmartLead" for special engine configurations.

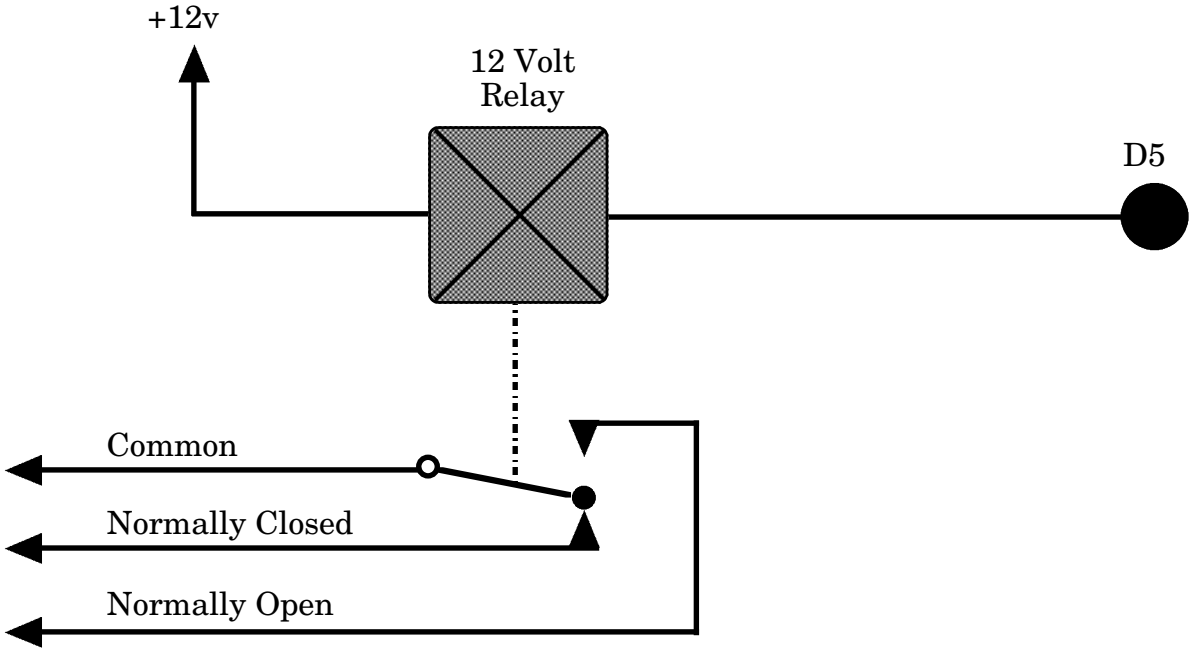
TEMP 1 & 2 (YELLOW 1, PINK 2) Temperature sensor or general purpose analogue inputs. TEMP 1 is normally used for Engine temperature sensing in order to control cold start programmes within the Link-EMX Computer. TEMP 2 is similar in operation, but normally used as an inlet air/ambient temperature compensator. Either channel may alternatively be used for any appropriately scaled analogue input voltage for control/ measurement purposes. Both channels are enabled separately via the MODE switch.

Trig 2, Trig 3 Special application trigger inputs used mainly when the EMX computer is in data logging mode. Not used for normal applications.

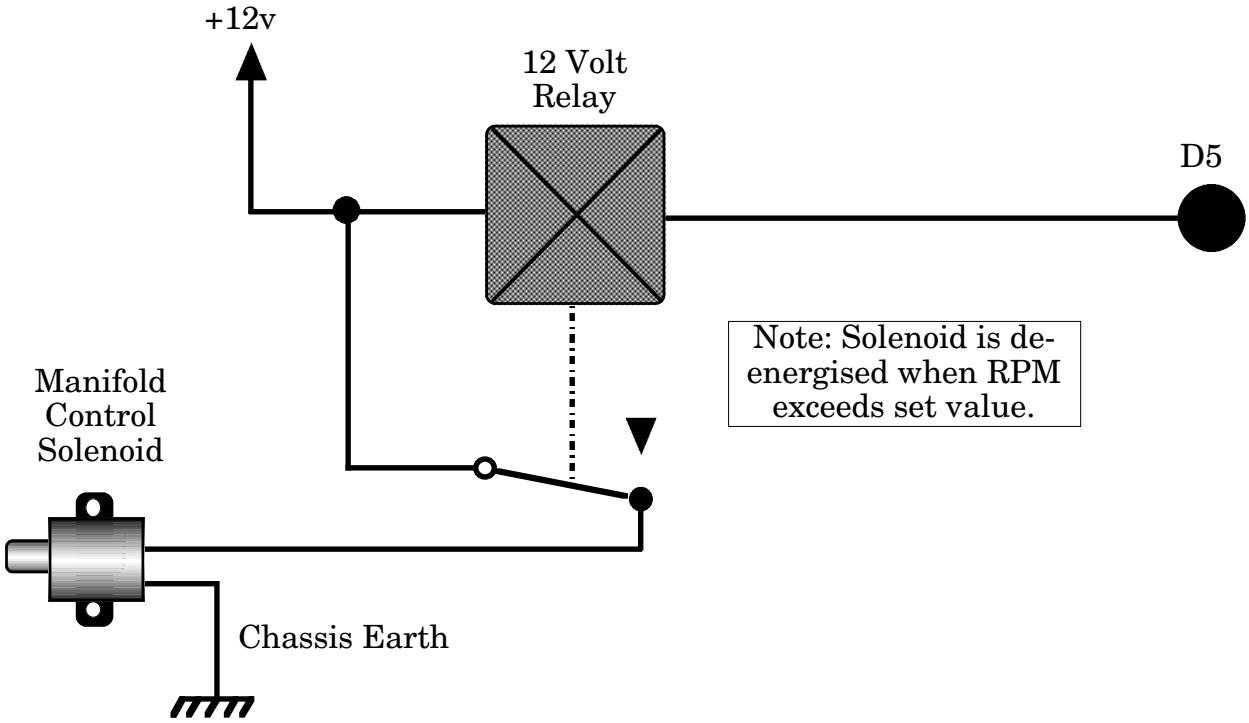
A/D Spare Special applications analogue input. See paragraph above.

D5 An earth sourcing output signal that provides an EARTH when engine RPM exceeds or equals the value programmed.The switch point may be changed by selecting the Link

Remote Tuning Module to the "RUN" position. The value shown on the display = rpm x 100 e.g. "**40**" = 4,000 rpm. D5 output signal is capable of supporting loads of up to one amp **maximum**. It is recommended that a "changeover" type relay is used to switch the actual device (solenoid, valve etc.) and also provides the option of "normally on" or "normally off" outputs.



Example: 4AGE Manifold Control



CAUTION

Take care when removing/applying the tubing to the transducer snout. If excessive force is applied, the snout WILL BREAK. In difficult cases, it may be advisable to remove Link-EMX Computer lid and cut the tubing off with a sharp blade.

17 Pin AMP Connector #172500-1 Wire Side

D3 Brown	D4 Purple	D5	D1 Blue		Trig Low Green	Trig 2	ETEMP Yellow	A Temp Pink
D2 Orange	PWR GND Black	PWR GND Black	+12 Red	SIG GND Black	Trig High Grey.	Trig 3	A/D Spare	MAP Blk/Wht

D1	Ignition Drive
D2	Injector Drive 2
D3	Injector Drive 1
D4	Fuel Pump Relay (ground)
D5	RPM switch (or special function) drive
Trig. High	Distributor Trigger
Trig. Low	Coil negative trigger SmartLink trigger input
A Temp	Ambient temperature sensor
E Temp	Engine temperature sensor
PWR GND	High Current Ground (Run seperatly from Signal Ground)
+12V	Main Power Supply (Switched)
SIG GND	Signal Ground (Low Current)
MAP	Manifold Air Pressure Sensor
Trig 2/3	Special Function trigger inputs

4. Ignition Overview

a. The Processing Chain

Signals from a distributor, or crank angle sensor, are sent to the Link-EMX Computer directly or via a SmartLead adapter. These pulse type signals give the Link-EMX a tuning reference from which the advance curve is built. The engine operating range is divided into 64 zones in exactly the same manner as Zone Fuel (See section six).

Each zone has a number which represents the required ignition advance angle and may be modified with the appropriate controller. The signals thus generated are fed out of the Link-EMX Computer to a single coil igniter (distributor ignition) or to a sequencer/multi-igniter combination for multiple coil operation.

b. Trigger Source

i. Distributor Systems

The management system requires only one input signal which may be generated in a number of ways eg. points, optical beam, magnetic pick up etc. Some of these devices are directly connected to the Link-EMX Computer, or in some cases, preprocessed by a SmartLead.

In either case, the output signal is a series of pulses at a fixed crank angle. There are no mechanical advance devices incorporated. Normally the output pulses are set to occur at approximately 10º BTDC for each cylinder, and is adjusted by rotating the distributor in the normal manner. This is referred to as either mechanical or base timing and must be added to the Link-EMX Computer advance figure to yield the total advance value. Note that below five hundred RPM (especially cranking) only the base timing is effective and should be set for optimum starting characteristics.

ii. Multi-Coil Systems

For Multi-Coil systems a signal must be generated, as above. A crank angle sensor must also provide a cylinder index signal to synchronise the sequencer so that the coils are fired in the correct order. This index information may be in the form of an extra signal line or encoded using a variety of formats, and may require a SmartLead for decoding. Advantages of a multi-coil operation include very high spark energy at high RPM, elimination of "cross-fire", and Multi-Coil systems are maintenance free. The additional hardware does however add weight, cost and complexity to the system.

c. Signal Processing

The pulse information from the trigger source is fed to the Link-EMX Computer which then carries out a sequence of operations to produce an output signal. The output is also a pulse wave form which controls switching of an igniter unit and has the following features.

i. The output signal may be equal to, or advanced in timing with respect to the input signal. (The Link-EMX Computer may advance the timing but cannot retard beyond the base (input) timing).

ii. The duty cycle or dwell angle varies with engine speed to produce maximum coil output with minimum wastage. Essentially the Link-EMX Computer switches the coil current on at a calculated time before the spark is required so that as to just reach maximum energy. This system eliminates holding the coil current at high levels thus greatly reducing heat build up and electrical power wastage.

iii. Under limiting conditions (excessive RPM or boost) the output pulses are progressively inhibited to provide a soft limiting feature. The limit values may be programmed using the appropriate controller.

d. The Igniter

The function of the igniter is to switch current in the primary winding on and off according to the pulses sent from the Link-EMX Computer. The igniter is basically a solid state switch which also limits the coil current to a predetermined value. This limiting feature eliminates ballast resistors and provides consistent output over a wide range of battery voltages. Over voltage clamping is also incorporated to prevent damage to the igniter should an high tension lead become disconnected or similar. Low resistance coils (ie 1 ohm) must be used for maximum output energy although higher resistance types will still function satisfactorily.

Particular attention must be paid to suppression of high tension leads and power supplies to the igniter coil. Inadequate suppression will cause erratic Link-EMX Computer operation.

e. Sequencer (Multi Coil Operation)

The sequence module performs a similar task to a distributor rotor arm by firing the cylinders in the correct firing order. Rather than switching the high tension voltage the sequencer controls which coil and associated cylinder(s) will be fired. Some multi systems use one coil per cylinder while others use one coil to simultaneously fire two cylinders. In the latter case, a spark occurs in one cylinder at the correct time on its compression stroke, while the other spark occurs on a cylinder during its exhaust stroke.

5. Tuning Procedure

The Link-EMX Computer has a default programme that provides a basic shell structure. This shell structure may be modified by the programming module to precisely dial in the required corrections. Any changes made are strictly temporary unless transferred to permanent memory by the "store" function. This permits a characteristic table to be entered and tested without modifying the basic table values. This facility allows full experimental tuning without disturbing the base programme. Should the modifications be unsatisfactory, then "Erase" may be selected and a new table subsequently entered. Data entry is controlled by two push buttons and a rotary selector switch, and appropriate data is displayed on a two digit readout to assist the person tuning.

a. Function Selector

A 16 position rotary switch is employed to select the appropriate tuning action required.

b. Up/Down, Enter

Two push buttons on the face of the Link-EMX Computer (under the smaller of the two front panels) allow selected values to be increased or decreased by the up and down switches. Alternatively a Remote Tuning Controller may be used. These buttons may be pressed momentarily or held down to provide the required action. ENTER function is achieved by pressing and holding both switches down for at least one second. ENTER is used only on some specific functions to initiate special tuning actions.

c. Display

Two digit LED readout displays information pertinent to the tuning action, e.g. when programming ignition advance, the display will read degrees of advance for that zone. Other display values are listed with the appropriate function switch settings as listed.

d. Zone Tuning System

Because fuel and ignition values continually vary as the engine RPM and load varies, the Link-EMX Computer divides this operating range into small zones which may be modified to obtain target performance. Zone Fuel and Zone Ignition each have 64 zones arranged as a 16 RPM steps by 4 load steps array. Full scale RPM zone equals 8000 RPM range with zone changing every 500 RPM. Operation beyond 8000 RPM is normal except the Link-EMX Computer will schedule on the last (highest) zone available. Load steps, (determined by throttle position or manifold air pressure) range from full vacuum to 20 psi boost for MAP, or from closed to wide open throttle (W.O.T.) for throttle position scheduling (TPS). Operation outside these zones uses the last (highest) correction zone available similar to RPM zoning. Therefore, fuel and ignition may be varied at 500 RPM intervals, in one of four load zones.

6. Typical Setup Procedure (Initial)

1. Switch on ignition.

2. Select RELOAD, press "ENTER" for one second. (Places default table into processor)

3. OFFSET and SLOPE will have default values. Do not adjust at this stage.

4. Select RPM LIMIT, and Set Limit as required.

5. Repeat above for MAP LIMIT and ADVANCE LIMIT.

6. TRANSIENT, COLD and AMBIENT will have default values. Do not adjust at this stage.

7. Select STORE and press ENTER for one second. (display = 00 for up to 20 seconds)

8. Select MASTER and start engine. Adjust value up or down as necessary to keep engine running smoothly. Allow engine to warm up fully.

9. Select ADVANCE LIMIT and set advance limit to zero. With engine at idle or low speed, set ignition initial timing by distributor position. This value will vary depending on engine type etc, but 10º BTDC (Before Top Dead Centre) would be a good starting point. Once set, reset ADVANCE LIMIT to required limit value, and check advance operation with timing light.

10. Select MASTER. Drive or dyno. load engine until engine is producing approximately 50% maximum power. Adjust MASTER for best running performance. Engine power should now be increased into the higher power ranges. Again adjust MASTER for best performance at highest practical power output. This setting is most important if zone tuning is to be successful.

11. Select SLOPE. Run engine in each of the four main blocks (load blocks) and adjust for optimum performance. The blocks roughly equate as follows:

    For Normally Aspirated Engines

    Block 1 = Idle, Cruise
    Block 2 = Power
    Block 3 = Not Used
    Block 4 = Not Used

    For Turbo/Super Charged engines

    Block 1 = Idle, Cruise
    Block 2 = Medium power, acceleration
    Block 3 = Low Boost (3-12 psi)
    Block 4 = High Boost (12 psi+)

12. Select Zone F. The engine should now be operated at low power and the UP/DOWN switches gradually tuning the zones as required. (It is advisable that a "STORE" is carried out after this to prevent loss of correction data (if ignition turned off)). Repeat the above as often as necessary until desired result is obtained.

13. Select Zone Advance. Repeat step 11 above but this time adjusting ignition advance. Caution should be observed to prevent over-advancing and thus possible detonation

action. Use with care! Store as previously described.

14. Select Transient. Run engine at idle and snap open throttle. Adjust for cleanest response. Repeat this at higher RPM (eight zones which will change as engine RPM increases). "STORE" after setting.

15. Assuming all the above operations are completed successfully, allow the engine to cool down completely. (preferable overnight). Select COLD a and restart engine. Adjust as required for clean operation remembering there are eight zones which will change as engine warms up. "STORE" after setting.

16. If Ambient Sensor is fitted, this may be used to compensate for varying ambient temperatures. If it is found that performance has changed with temperature, select AMBIENT and adjust to restore performance. There are eight zones for eight different temperatures. Adjust and STORE as required.

7. Additional Tuning Tips

1. Large steps between zones are permitted since the Link-EMX Computer interpolates (ie. calculates intermediate values) on all tabled data. The 64 adjustable zones effectively become 32,000 micro zones after interpolation .

2. Always STORE changes before turning off ignition or they will be lost.

3. TAKE NOTES as you go of the various settings and values to enable a logical picture to be built up for future reference. The Link-EMX Computer can produce over 10 million possible combinations so keep trace.

4. Cut required cables to length, fit heat shrink, and solder connections. The reliability of the system depends totally on the quality of the installation. All holes in metal panels must have grommets fitted to protect cables. All earths must be well prepared. This includes removal of paint and protectant. Ensure all the vehicle is well earthed.

8. Interface Hardware (SmartLeads)

In order to interface (ie connect to) the huge range of sensors and control devices found in modern cars, Link ElectroSystems have developed a modular interconnection system which offers unparalleled versatility. Unlike dedicated controllers with their inflexible input/output structure, the "SmartLead" system gives the user a variety of options and complexity levels without wastage. Only the components absolutely necessary for the task are used, each of which may serve many functions as the system grows. A SmartLead is basically a wiring loom (usually 3 wires) with built in active circuitry allowing it to process to some degree an input or output signal. Some of the many benefits are listed below:

All input signals are amplified and conditioned right at the sensor output, and sent to the control unit as large, clean signals. This greatly eliminates interference particularly when dealing with high sensitivity, low output sensors.

The fully buffered signals may be shared by any number of devices by simply splicing into the appropriate wire.

All leads are universally colour coded for instant function recognition anywhere in the system.

Most leads have simple built in test equipment (BITE) to indicate faults and aid diagnosis.

9. Throttle Position Scheduling (TPS mode)

This form of injection control is most suitable for engines that do not have significant light load manifold vacuum, due to radical cams or porting techniques causing reversion flow out of the inlet ports. As a result, manifold air pressure (MAP) is not a good indicator of engine load and should not be used for fuel flow determination. The manifold air pressure sensor does, however, provide compensation for variations in barometric or boost pressure if applicable. In lieu of the MAP SmartLead a TPS SmartLead is used which converts throttle shaft rotation into an electrical signal. The TPS SmartLead has internal adjusters to match any type of TPS sensor to the EMX computer.

In operation, the position sensor converts throttle plate opening (or angle) into a proportional voltage such that when the throttle is fully closed, the output voltage is low, and when fully open (WOT), the output is maximum. (typically 4 volts) This signal basically controls the injector pulse-width and therefore directly controls the fuel flow. An additional input into the TPS SmartLead allows a pressure sensor to be fitted if the engine is super/turbo charged.

The relationship between throttle plate angle and actual airflow is not linear and tends to show a falling characteristic as larger throttle openings are used. Also, compensation for injector opening times must be provided to maintain linear signals, right down to idle flows. The Link-EMX Computer provides a number of coarse and fine tuning facilities to shape the fuel curve to suit the engine. The order in which these corrections are made is very important if satisfactory results are to be obtained. The following procedure should be used, at least initially, to establish a good fuelling baseline, and subsequently fine tuned for maximum output.

1. If starting from scratch, or if the resident programme is entirely unsuitable; select RELOAD push both buttons for 1 second ("enter") Display will show 00 momentarily as table is transferred. Refer to the instructions enclosed within the TPS SmartLead for initial setup and off-set co-efficient.

2. Select OFFSET and set to 00

3. Select MASTER. Set to 50

4. Select RPM Limit, MAP Limit, and ADVANCE Limit in order and set the applicable values.

5. Select STORE. Push "enter" to store the new values. TRANSIENT, COLD,and AMBIENT will have default values at this point and should not require pre setting.

6. Select MASTER. Start engine, adjusting MASTER as required to maintain smooth running. Allow engine to warm up fully, again adjusting MASTER if necessary for best running. (if possible, run engine unloaded at about 2000 rpm when doing this initial setting. Hold throttle steady and adjust MASTER until the rpm peak is found. This usually equates to a moderately rich mixture (about 5% CO) for these light running conditions, but will be about right for the higher power ranges.)

7. Select OFFSET. Allow warm engine to come back onto the idle stop, and adjust OFFSET for optimum idle.

8. Repeat steps 6 and 7. (OFFSET and MASTER interact slightly so repeat the procedure until both settings are optimised.)

9. Gradually increase throttle opening to at least 75% if possible, and adjust MASTER for best output. (An engine or chassis dynamo meter is a very useful tool for this exercise since they provide relative power output figures useful for performance peaking). Alternatively, the vehicle must be driven to load the engine while tuning is being performed. Additional load may be introduced by using gradients, vehicle brakes, or dyne trailers.

10. Select SLOPE. This control adjusts entire rows of zones irrespective of the rpm. Each row covers 25% of the total throttle movement;

row 1	idle, light cruise.
row 2	power/acceleration (non boosted engine)
row 3	upper mid-range (boosted engine)
row 4	high power (boosted engine)

At this point, do not be concerned about acceleration lag or hesitation as this is corrected later. Adjust SLOPE in each of the 4 rows for optimum results by holding throttle steady in each of its 4 quadrants and adjusting the fuel accordingly.

11. Select ZONE FUEL. This is a fine tuning mode which allows changes to be made in very localised areas (zones) from idle to W.O.T. There are 64 zones arranged as 4 rows of load each subdivided into 16, 500 rpm steps. Use ZONE FUEL to correct small peaks and dips across the power range from idle to W.O.T.

12. Select TRANSIENT. This control provides additional fuel under acceleration similar in action to the pump in a carburettor.
TRANSIENT has 8 zones, each covering 1000 rpm, so that the dynamic fuel can be changed as engine rpm increases. Low rpm (<3000) usually requires more TRANSIENT fuel than does high rpm operation. Experiment by cracking throttle open abruptly and adjusting for cleanest acceleration.

13. If engine temperature sensor is fitted, the cold start programme may be adjusted after engine has cooled down completely. Refer to previous section for further information on cold start calibration.