Link
Engine Management Ltd

LEMV3

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By Link ElectroSystems Ltd.

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1. INTRODUCTION

Operational Outline: Fuel Injection

The Link Engine Management System 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. Alternatively, the injectors may be phased to the engine and inject only while the inlet valve is open. This is sequential injection mode which overcomes problems associated with large valve overlap times for some performance engines. The implementation however requires additional external processing modules and special crank angle sensors.

The Speed Density Principle

In order to inject the correct amount of fuel, the Link Engine Management System 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.

Determining the Speed

Engine R.P.M. is easily measured by feeding pulses from the ignition system to the Link Engine Management System. This pulse rate in conjunction with the CYLINDER 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 Engine Management System 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).

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. The correction factor between manifold density and cylinder density (Volumetric Efficiency, V.E.) is found by the Link Engine Management System looking up a table in its memory and doing a series of mathematical calculations. This table (Zone Fuel) consists of 96 zones each covering a narrow operating range. Each zone may be individually or group programmed to suit the application. 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.

Cold Starting

Almost without exception, all engines require additional fuel (rich mixture) during cold starting and the warm up period immediately following. The Link Engine Management System monitors engine temperature via a suitable probe and provides automatic (programmed) enrichment. This automatic system (the normal system) monitors engine temperature and adds extra fuel at a rate proportional to the engine temperature and t user adjustable "COLD" value. For engine temperatures below 12°C, the Link Engine Management System automatically primes the engine with a short injector burst prior to cranking.

2. Ignition Overview

The Processing Chain

Signals from a distributor, or crank angle sensor, are sent to the Link Engine Management System directly or via a SmartLink adapter. These pulse type signals give the system a tuning reference from which the advance curve is built. The engine operating range is divided into 96 zones in exactly the same manner as Zone Fuel.

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 Engine Management System to a single coil igniter (distributor ignition) or to a sequencer/multi-igniter combination for multiple coil operation.

Trigger Source

a. Distributor Systems

The Link Engine Management system requires only one input signal which may be generated in a number of ways eg. points, optical beam, magnetic pick up etc.

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 10° 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 Engine Management System 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.

b. 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.

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.

Signal Processing

The pulse information from the trigger source is fed to the Link Engine Management System 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 Engine Management System 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 Engine Management System 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.

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 Engine Management System. 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 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 Engine Management System operation.

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.

3. System Installation

The Link Engine Management System 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.

4. Four M3 tapped holes in the sides of the enclosure provide a mounting point for brackets etc. DO NOT drill holes in the case as this will probably cause internal damage.

5. The MAP sensor (inside the ECU) MUST be connected to a source of vacuum (and pressure for turbo applications) via a suitable length of 3..4 mm vacuum hose. The fuel pressure regulator air pressure port is usually a good source of vacuum pressure.

Ignition Suppression

The Link Engine Management System 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)).

Igniter(s) must be mounted well clear of the Link ECU, preferably under the bonnet, next to the coil(s).

NOTE: Trig 1 and Trig 2 are both within the earthed screened cable. This is to reduce the chance of any interference entering the system at this point. The wires are differentiated by the “1” and “2” printed on the cable.

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).

The Link Engine Management System 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 "SmartLinks" which incorporate signal conditioning circuitry built into the wiring loom to the device. Depending on the application, the appropriate sensors and output devices are connected to the breakout loom the Link Engine Management System is ready for programming.

4. OUTPUTS.

17 Pin AMP Connector - Wire Side

Inj 1 Brown	Ig 1 Blue	Ig 2 Blue / Black	Ig 3 Blue / White		+12 V Red	Trig 1 Yellow Grey Screen	E Temp Yellow	TPS In White / Blue
Inj 2 Orange	Pump Purple	RPM Brown / White	Fan Brown / Black	P Gnd Black 2.00 mm	S Gnd Black 1.25 mm	Trig 2 Black Brown Screen	O2 White	TPS +5 Red / Blue

INJ1 - BROWN:Injector drive group 1. When active, provides an EARTH supply for up to 6 injectors.

INJ2 - ORANGE:Injector drive group 2. Identical action to INJ1 above except the pulses are time displaced to provide smoother fuel delivery when both drives are used together.

PUMP - PURPLE, fuel pump relay drive. This output provides an EARTH to activate the fuel pump relay only while the engine is running, or when the key is first switched on.

RPM - BROWN/WHITE, A multi-function, user programmable, EARTH sourcing driver which may be configured as a RPM switch (RPMSW), boost control (WSTGATE) or idle speed control (IDLE). The required mode is selected using the Link Tuning Module which will then cause the appropriate menu items to be displayed.

This driver is a high current switch to EARTH which will normally be used to switch a solenoid, or similar, to +12V. The amount of current flow is controlled entirely by the solenoid (etc) resistance, and if excessive will cause a PCB fusible link to rupture at approximately 5 Amps.

Refer to chapter 6 “Tuning Module Functions” for setting and adjustment of these options.

FAN - BROWN/BLACK, radiator fan relay. This output provides an EARTH to activate the radiator fan relay when a preset engine temperature is exceeded. The fan will continue running until the temperature has fallen by 4 degrees below the preset value to eliminate short fan cycles.

IG1 - BLUE, ignition drive #1. This output signal is used to drive an external igniter module to produce ignition sparks under programmed control. IG1 is the output used when distributor based ignition systems are using the LINK, or similar factory igniters. When the signal is positive (+12 volts) then the coil will be in dwell, and when changing from positive to negative the spark will occur. This is the most common convention, but for igniters that require the opposite polarity use "IG2".

IG2 - BLUE/BLACK, ignition drive #2. Similar to "IG1" above except the polarity is reversed to cater for unconventional igniters (Esp. FORD). Dwell occurs while the signal is "low", and spark occurs on the negative to positive transition. Multi-coil ignition:This drive serves as the second output when using more than one coil to fire the igniter in sequence. NOTE:Special software and triggering sources are needed for multi- coil operation. These requirements will be met on request, prior to shipment.

IG3 - BLUE/WHITE, ignition drive #3 for multi-coil ignitions. Special instructions and wiring diagrams will be included for this mode of operation as required. When not used for ignition this drive has 2 user selectable options:

Shift Light Used in conjunction with a dash mounted LED light this provides a programmable gear shift indicator for racing purposes.

Tachometer Driver Produces a 12V P–P, one millisecond wide pulse train to drive low level tachometers etc. There is one output pulse for every spark produced irrespective of the number of cylinders.

TPS+5 - RED/BLUE, Throttle Position Sensor (TPS) 5 volt supply. This provides a regulated 5 volt supply for the TPS sensor. Only systems with poor or irregular idle vacuum will use the TPS sensor, so for the majority of applications, no connection should be made. (See section regarding TPS scheduling

5. INPUTS.

+12 - RED, computer 12 volt supply input. This should be connected to an ignition switched 12 volt supply. Current drain is quite low (approx. 0.5 Amps) and may be fused if required. This input is polarity and over- voltage protected, but take the usual precautions when arc-welding on the vehicle.

Check that this voltage does not fall below 9 volts when engine cranked. This is a common fault.

PWR GND - BLACK (2.0 mm), computer high current ground. This input supplies the high current earth supply for the injector and other output drives. Since this wire will carry substantial currents, ensure that it is well terminated to a clean earth point, preferably the engine block. (see note in "SIG GND" below)

SIG GND - BLACK (Screened Cable), computer signal ground. This input supplies the low current earth supply for all the low-level signal processing of the computer, and forms the reference value for all engine mounted sensors. As such, it is ESSENTIAL that this wire is connected to the ENGINE BLOCK rather than the chassis or battery negative. Failure to do so will result in unstable sensor readings causing erratic computer operation.

IMPORTANT!

SIG GND and PWR GND MUST be ran as SEPARATE wires. DO NOT be tempted to join both together at the computer and run as a single wire. Also beware of poor earth points around the engine. Some manifolds and other attaching parts may be rubber mounted and therefore have poor earth bonding. A good rule of thumb is to use the engine BLOCK rather than attaching parts. The screened cable is earthed to signal ground.

TRIG1 - Grey Screened Cable Yellow wire, trigger input #1. This input will come from either a distributor or Crank Angle Sensor (CAS) and is used to control injectors, ignition timing, RPM limits/switches, fuel pump etc. The actual type of signal and its origin is specific to the application and the computer will be dispatched with the appropriate internal module fitted to process the signal, as well as the corresponding wiring diagram and any other special information required. This is a very important signal and must arrive at the computer free of noise and interference.

TRIG2 - Brown Screened Cable Black wire, trigger input #2. Normally used for multi-coil applications, this input provides a synchronising pulse(s) to establish the correct firing order for the ignition system, but may be used on some distributor applications. Information will be provided as above (TRIG1) when required.

ETEMP - YELLOW, Engine Temperature input. Provides engine temperature information to control cold starting and radiator fan control. Normally the factory NTC type sensor is suitable and should be used if present. An optional Link Temperature Sensor is availiable if the factory unit is not suitable or availiable.

TPS IN - WHITE/BLUE, Throttle Position Sensor input. Used in some applications only (see "TPS +5" above), and is normally not required.

02 - WHITE, Oxygen sensor input. An optional input for those systems using closed-loop control. See section regarding "Closed-Loop Control" elsewhere in this manual.

6. Tuning Module Functions

NOTE: Ensure that computer power (key) is OFF before connecting any style of Link Tuning Module or improper operation will result.

TEST All functions in this mode are "read only" and have no effect on the operation of the system. There are four functions selected by pressing and holding the appropriate push switch;

RPM (default) displays engine RPM. Erratic or incorrect readings indicate a triggering fault or interference.

MAP (ADJ DOWN) displays Manifold Air Pressure in units of kPa. Engine stationary, value = 102 +/- 5 at sea level, typical idle = 30..40, boost pressure = >102, e.g. 200 = 15 PSI boost.

TEMP (ADJ UP) displays engine coolant temperature in degrees Celsius. Readings increment in steps of 2 degrees.

TEST FUEL PUMP (EDIT DOWN) forces operation of the fuel pump drive. Useful for checking fuel flow.

SOFTWARE ID (EDIT UP) displays the software code and programming date.

CYLINDERS Informs the computer as to the number of engine cylinders and should be set accordingly. Rotary engines; Two rotor = 4. Three rotor = 6.

RPMSW Options: Allows selection of the required RPMSW functions. On dispatch, the RPM SWITCH (RPMSW=RPMSW) is selected. Use the ADJUST buttons to select IDLE (idle speed control) or WSTGATE (turbo boost control) as required. Any changes are automatically stored and not affected by “RELOAD”.

Note: RPM switch function is not availiable when using boost control. WSTGATE must be selected for boost control.

(The simple RPMSW mode is described below. Refer to Chapter 10 and Chapter 11 for details on the Idle and Boost Control options).

RPM SWITCH Allows the value of the RPM sensitive drive to be changed. The RPM drive will become active above the programmed value to control the appropriate device. e.g. manifold runner, VTEC, cam control etc. An external relay may be used to “invert” the signal if the device being controlled requires +12V rather than earth (especially Honda VTEC solenoids).

IG3 Options IG3 (the third ignition drive) may be configured as either a gear shift light (IG3 = SHIFT LITE) of as a tachometer drive (IG3 = TACHOMETER). Any changes are automatically stored and are not affected by RELOAD. A suitable LED light is available from Link ElectroSystems for dashboard mounting.

ROW STEPS This control allows selection of either Manifold Air Pressure (MAP) or Throttle Position Sensor (TPS) zone control. In TPS mode, the zone ROWS are selected by the TPS sensor to provide stable zoning if the MAP signal is fluctuating due to special cams etc. Do not select TPS mode unless the TPS sensor is fitted and wired.

TPS SPAN (when "ROW STEPS" = TPS or when RPMSW = WSTGATE) Allows the Throttle Position Sensor (TPS) span to be set according to the number of ROWS/ZONES required. The ADJUST switches are used to set the "low" (throttle closed) and "high" (throttle fully open) values. Refer to section "Mixed mode scheduling" for further details.

CLAMP or TPS SPAN (depends on "ROW STEPS" selection) Clamps the Manifold Air Pressure signal to a minimum value (high Vacuum) to stabilise the RPM at idle. This helps prevent idle surge present in some engines with large intake manifold volumes. The value shown in (xxx) is actual MAP and the far right value = the clamp value. Typical settings range from 30..35 for normal engines.

MASTER Controls overall fuel injection scheduling and is effective throughout the entire operating range from idle to full power. The scale ranges from 0..99, the higher the value, the greater the overall fuel.

RPM LIMIT Sets the RPM limit to prevent engine damage. For systems using programmable advance, the RPM limit has a soft limit at 200 RPM below the set value, and hard limiting (fuel and ignition cut) at the preset value. Note that "Fuel Only" systems feature hard limiting only.

MAP LIMIT Set Manifold Air Pressure limit for turbo/super charged engines, expressed in units of kPa. Limiting action identical to RPM limit above except soft limiting occurs 10 kPa below set limit. MAP LIMIT may be disabled by setting a value greater than 254 kPa. An “OFF” message will appear if this is the case.

ADVANCE LIMIT Sets the absolute maximum ignition advance irrespective of any value programmed into the ZONE ADVANCE table. Note that this is a numeric limiter only and does not invoke any actual ignition or fuel cuts.

ACCEL Controls acceleration enrichment during abrupt opening of the throttle. There are 4 zones each covering a 2000 RPM span to allow optimum enrichment figures to be set for varying conditions. Note that ACCEL is only effective during the actual movement of the throttle to cover any brief flat spots occurring at that time. The actual zone is selected automatically, and is shown as Z=x where x = the currently active zone. e.g. Z=2 indicates transient zone 2 (2000..4000 RPM range).

ENG TEMP = LINK or NTC Selects either the factory negative temp. co-efficient (NTC) sensor or the Link IC type sensor. Confirm the correct choice by selecting TEST ENGT or COLD menu and check that the displayed temperature is approximately correct. (There is a huge difference between the two. The correct selection should be obvious).

COLD Controls cold start and warm up enrichment by adding extra fuel to the engine. A single zone controls the effective amount of cold enrichment which decays to zero as the engine temperature rises to 70ºC. A separate crank enrichment value controls the critical cranking fuel of the engine. This value can only be adjusted in EDIT mode (zone #17). Note that larger numbers = less cranking fuel. It is recommended that this adjustment is best left alone if unsure of operation. For more details contact your Link agent).

VOLTS Provides a compensation value for fluctuations in battery voltage caused by heavy electrical loads being switched on and off e.g. headlights, heaters, fans etc. These voltage fluctuations cause the injector opening time to vary, resulting in erratic, surging idle speeds. Initially set the value to "15" (STORE) and tune the engine with minimum electrical loads switched on. Once a satisfactory tune is found, allow engine to idle and switch on maximum electrical loads. Readjust the VOLTS value to restore the "unloaded" idle quality and STORE the result. The actual battery (computer) voltage is also displayed for monitoring purposes. Note: The value discussed here is a trim value, not a voltage value.

STORE Used to store corrections into the semi-permanent memory. STORE is initiated by pressing BOTH ADJUST buttons together until the display shows "****************" and then releasing. The process will take from 2..30 seconds depending on the number of corrections to be stored. Note that the engine may run a bit rough during STORE so it is advisable to do so only at idle. If engine stops running during STORE, allow the process to finish before turning off key or trying to restart the engine.

RELOAD Used during initial setup to transfer a default table into the computer zoning system. This process presets all the zones to typical values to allow a base for subsequent tuning. RELOAD is initiated by pressing BOTH ADJUST buttons together until the display shows "****************" and then released. CAUTION:RELOAD will over-write all values currently stored in the computer memory and should only be used during initial setup or if you wish to restart the tuning procedure again from scratch.

ZONEFUEL There are 96 fuel zones arranged in a rectangular grid consisting of 6 ROWS by 16 COLUMNS. The ROWS progress in steps of Manifold Air Pressure to provide the "load" axis, and the COLUMNS progress in steps of RPM. Therefore, each zone represents a unique engine operating condition allowing fuel changes to be made in small, localised areas. The selection of zones is completely automatic, depending on the actual RPM and MAP values at that instant. The current (active) zone is identified to allow correlation to the zone sheet and to give an indication of where you are in the table.

The zone numbering system is not linear, but designed to provide a clearer indication as to effective location. e.g. zone 110 = ROW 1, 1000..1500 RPM zone 255 = ROW 2, 5500..6000 RPM zone 545 = ROW 5, 4500..5000 RPM etc. Adjustments are made by operating the ADJUST buttons as required, and the actual value is displayed on the right hand side of the display. Adjustment scale = 0..99

ZONE IGN There are 96 ignition advance zones arranged in an identical manner to the fuel zones (see above). The zone identification system is also the same as ZONE FUEL except it applies to the ignition advance table instead. The adjustment value is shown as degrees of advance. NOTE:The ADV LIMIT control has priority over any ZONE IGN value in excess of the limit value. The limiting value does not inhibit entry of ZONE IGN values in excess of the limit, rather it limits the value displayed and actually used at the time.

ROWFUEL Allows the ZONE FUEL table to be adjusted a WHOLE ROW at a time. i.e. All values on the current ROW will be adjusted up or down irrespective of the RPM. e.g. current zone = 230 (ROW 2, RPM = 3000..3500), 4 units are added (UP) to zone 230, then ALL zones along ROW 2 (200..275) will have 4 units added to their current values. ROWFUEL is primarily intended as a coarse adjustment to allow broad shaping of the ZONE FUEL table during initial tuning, and would normally be used after MASTER has been set, but before ZONE FUEL is used. Careful use of ROWFUEL will eliminate the need to spend large amounts of time in ZONEFUEL trying to make major changes overall by wondering about the table making localised corrections. (It is quite difficult to hold the engine in any one of 96 zones while corrections are made even under the most favourable conditions.) The current ROW is displayed in parenthesis to show the currently active ROW, but the RPM information is suppressed since this feature is not RPM dependent.

INJ / OXY This is a read-only function which displays the actual injector duty-cycle as a percentage of maximum. e.g. 28% indicates that the injectors are flowing 28% of their maximum volume. The OXY displays shows the output signal of oxygen sensor in volts. Refer to "Closed Loop" information for the significance of these readings.

TEMP SWITCH Sets the value at which the temperature sensitive drive becomes active. This drive is primarily intended for radiator fan control and uses the engine temperature sensor to measure coolant temperature. The value is displayed in degrees Celsius, above which the fan will operate. Note that there is a 4 degree difference between switch on and switch off to prevent repetitive, short fan cycling.

LAMBDA This control allows the closed-loop oxygen system to be selected on or off. Press ADJUST UP to enable, and ADJUST DOWN to disable the closed loop system. The display will show ON or OFF accordingly, and the change is automatically stored. (no need to select STORE etc.)

CAUTION:Do not select closed loop ON unless lambda probe is correctly installed and wired.

EDIT Enables the zone editor function which allows random access to all zones for viewing and editing. The EDIT function may be used at any time, with or with out the engine running. Use the Edit push butttons to select the appropriate zone(s) and the ADJUST buttons to change the selected zone. The zone is identified by a number which may be correlated to its function by consulting the zone editor sheet. ZONE FUEL and ZONE IGN are identified by an "F" or "I" respectively to discriminate between fuel and ignition values. Storing of edited values may be done by pressing BOTH EDIT buttons together until display shows "**************" and then releasing. Alternatively, STORE may be selected and used as normal.

Storing Values

To Store select STORE. Pressing both ADJUST buttons together until display shows "**************" and then release.

7. Typical Setup Procedure

1. Switch on ignition. The fuel pump should run for approximately two seconds and then switch off.
2. Select CYLINDERS, RPMSW options, IG# options and adjust accordingly.
3. CLAMP and MASTER 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. ACCEL, COLD and VOLTS will have default values. Do not adjust at this stage.
7. Select STORE and press and hold both Adjust buttons until "****************" is shown on the display, then release buttons. Prior to the engine start do the following checks.
   a. Select the TEST RPM menu. This should currently read zero.
   b. Press and hold ADJ DOWN button. TEST MAP should read 101 kPa ± 5 kPa (at sea level).
   c. Press and hold ADJ UP button. TEST ENGT should read the temperature of the day assuming the engine has not been running.
   d. Select TPS SPAN (only if in TPS or WASTEGATE mode) and set the TPS SPAN as required.
   e. Select VOLTS It should read V = 11.5 to V = 12.5 (engine stationary).

   If any of these tests fail then rectify the problem before attempting to start the engine.
8. Select the TEST RPM menu and crank the engine. If the engine does not start check that the rpm value is showing the crank rpm (typically 200–300 rpm). If no rpm signal is

shown, then cease cranking and rectify the cranking problem.

Note: The engine will not start if trigger system is inoperative.

Select MASTER and start engine. Adjust value up or down as necessary to keep engine running smoothly. Allow the 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 10° 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 ROWFUEL. Run engine in each of the six main rows (load rows) and adjust for optimum performance. Refer to the Zone Sheet for explanation of "row" values.

12. Select ZONEFUEL. 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 ACCEL. Run engine at idle and snap open throttle. Adjust for cleanest response. Repeat this at higher RPM

(four 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 and restart engine. Adjust as required for clean operation without hesitation or stumbling during warmup.

    Remember to store any changes.

8. Additional Tuning Tips

1. Large steps between zones are permitted since the Link Engine Management System 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 Engine Management System can produce over ten 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.
5. All holes in metal panels must have grommets fitted to protect cables.
6. All earths must be well prepared. This includes removal of paint and protectant. Ensure all the vehicle is well earthed.
7. Ensure that the MAP line is connected to a true source of vacuum at the inlet manifold. ie at idle the system should be in row one moving to row three for wide open throttle (assuming TPS is off and engine develops vacuum).

Link Engine Management

Miscellaneous / TPS / Wastegate

CLMP	MAST	R.LIM	M.LIM	A.LIM	MODE	CYL	VOLT	RPM	FAN	LOW	HIGH	SENS		BASE	RPM
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Accel / Lambda Targets

COLD	CRKE	IDHOT	IDCLD	IDLE	SHIFT					IDLE	CRUS	ROW3	ROW4	ROW5	ROW6
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Accel: 0 2 4 6 — RPM x 1,000

Lambda Targets: 0 40 80 120 160 200 — MAP (kPa)

Zone Fuel

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000

Bar																
	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
0.4	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275
0.8	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375
1.2	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475
1.6	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575
2.0	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675

Zone Ignition

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000

Bar																
	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
0.4	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275
0.8	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375
1.2	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475
1.6	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575
2.0	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675

Boost Targets

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000

700	705	710	715	720	725	730	735	740	745	750	755	760	765	770	775

9. Closed Loop Operation.

Closed loop operation involves the use of an exhaust gas oxygen sensor (Lambda probe) to provide the computer with a feedback signal indicating the actual fuel/air ratio. This signal allows the computer to make instantaneous corrections to the injector fuel flow until the required air/fuel ratio is achieved. This automatically compensates for all the variables that may cause incorrect fuel scheduling, and has two modes of operation;

1. Automatic programming: (Tuning Module Connected).The computer is able to "tune" itself throughout the entire operating range simply by driving the vehicle and allowing the computer to do all the work. The air/fuel ratio "targets" may be set to any required value depending on the application.

2. Continuous mode: (No Tuning Module) The computer normally operates in continuous mode after Auto or manual tuning is complete and compensates for all the day-to-day variables that cause the air/fuel ratio to drift, resulting in absolutely consistent running and low exhaust emissions.

System Requirements.

Hardware for closed loop operation is essentially the same as for open loop with the following exceptions;

1. An exhaust gas oxygen sensor (Lambda probe) mounted in the exhaust manifold as close as possible to the cylinder head (rather than down the tail-pipe) to ensure fast response. The probe temperature must exceed 300 degrees Celsius for normal operation, and most types have a built-in electrical heater to assist with this requirement. The heater also allows the system to come on line faster after a cold start and ensures that temperature is always adequate during prolonged idle running. Connect the heater wires to earth and an ignition switched +12 volt supply. Typical current draw is 1 to 2 amps.

Wire colours vary between manufactures, but the following colours are fairly common;

Bosch	White wires	=	heater (polarity not important)
	Black wire	=	output signal
Nissan	Red and Black wire	=	heater
	White wire	=	output signal

All sensors have M18 x 1.5 metric threads, and a boss will need to be welded into the exhaust manifold for mounting purposes. Handle the probe CAREFULLY since the internal ceramic material is easily cracked if sharp blows are applied. For prolonged operation on leaded fuels, a lead tolerant sensor must be used. These have a extra shroud with small gas sampling hole around the sensing tip to prevent lead deposits from fouling the sensitive material. Failure to use this type will result in inaccurate readings after several hours of running with subsequent incorrect operation.

2.The computer must have closed loop software installed for operation. Early models may be upgraded for a nominal charge.

3.A Link Tuning Module will be required for setting up all aspects of operation including both manual and automatic tuning modes.

Operation and setup.

1. The closed loop mode is enabled by selecting LAMBDA on the Link Tuning Module and switching to "ON".
2. The system should first be tuned in open loop mode (LAMBDA = OFF) until a reasonable state of tune is achieved. This step allows the subsequent AUTO-TUNE system to achieve a faster lock-on since it shouldn't have to make major corrections if the initial tune is about right. Closed loop operation will only occur if the following conditions are met:

   - Engine temperature above 50 C

   - Engine been running for 90 seconds after start

   - Manifold vacuum above 22 kPa (ie not in over-run vacuum)

- No acceleration (transient) fuel pending

The system samples and corrects at a rate of twice per second. This rate allows sufficient time to elapse for the fuel correction effect to appear at the exhaust and be measured. (The feedback system is not instantaneous and therefore needs a short stabilising period)

3. The following Link Tuning Module function will change when the LAMBDA control is switched on:

ZONE FUEL:Fully automatic zone fuel tuning. Operation identical to ROWFUEL except corrections effect ONE zone only, rather than the entire row. There are no RPM restrictions, but normal closed loop criteria apply

NOTE:All corrections made by the AUTO-TUNE system are temporary until a STORE is carried out. All other Tuning Module functions remain unchanged.

Lambda "target" system.

The actual required fuel/air ratio is dependent on the operating conditions prevailing at the time, and is generally "load" sensitive. During operation at idle and light throttle cruise, the A/F ratio should be fairly lean in the interests of fuel economy and low exhaust emissions. At high power however, the A/F ratio needs to be richer to produce satisfactory horsepower, reduce cylinder head temperature, and control detonation. The manifold air pressure (MAP) is a good indication of engine load and is used to select one of eight Lambda "target" values for the system to use as a reference. Each target covers an MAP span of 40 kPa which corresponds to each ROW of zones. A separate block of zones (26 .. 31) are used to store the target values, and may only be changed in the EDIT mode. The default values loaded on dispatch were determined after much testing and should be correct for the majority of applications. The target values are displayed as a voltage which the software compares to the actual probe voltage and makes the necessary correction. e.g. 60 = 0.6 volts. Default values are shown below:

ZONE	kPa	TARGET	COMMENTS
26	0.. 40	75	high vacuum
27	40.. 80	78	idle/cruise vacuum
28	80..120	80	WO (n/a engines)
29	120..160	84	low boost (turbo engines)
30	160..200	87	med boost (turbo engines)
31	200+89	high	boost (turbo engines)

The relationship between Lambda probe voltage and the A/F ratio is not very linear since the Lambda probe shows a steep voltage step at stoichiometric mixtures. This transition voltage indicates that no excess oxygen or fuel is present i.e chemically perfect combustion, and is the desired voltage for minimum exhaust emissions. At low to medium power, the system should be "rocking" back and forth over this transition line so that the catalytic converter can do its job. The actual voltage at which this occurs lies between 0.4 to 0.6 volts. Tests have shown that if the target is set much below 60 (.6 volts) that undesirable idle surging will result in some engines. Some experimentation may be necessary. Above the stoichiometric point the curve flattens out as the A/F ratio becomes richer. The maximum voltage produced is normally about 0.92 volts which equates to VERY rich A/F ratios. The targets should never be set above 90 (.9 V) for this reason. As a rough guide.

VOLTAGE	%CO	A/F RATIO (approx)
< 0.6	< 1.0	>15:1
0.72	1.0	14:1
0.76	2.0	
0.80	3.0	
0.84	5.0	13:1
0.86	6.0	12:1
0.88	8.0 +	11:1

Note that the enrichment becomes fairly compressed at higher voltages i.e. small voltage changes = large ratio changes

LAMBDA has a series of indicators to show the system's status. Note that closed-loop tuning is only available in ZONEFUEL, TEST XXX, and INJ/OXY display modes. (MASTER and ROW auto-tune have been removed.) The sampling (and correction) rate is now indexed to the injector fuel flow so that the rate is quite slow at idle (1 correction. every 2 seconds), and faster at medium/high power (4 correction. per second).

T	Timer. The system waits for 1 minute after starting before becoming active.
E	Engine temp. below 70 C. System = standby
A	Acceleration fuel is present. System = standby
V	Vacuum is abnormally high (over-run condition). System = standby
X	maX allowable correction. System is limited to a maximum of +/- 8% to prevent gross errors due to failed probe etc. This may be cleared by carrying out a STORE function which will give another 8% of trim. Be suspicious of large corrections. There may be a fault somewhere in the system. (max. trim = 3% if remote is not connected)
=	Exhaust oxygen = target value. This should flash up fairly regularly.
+	System is increasing the fuel.
-	System is decreasing the fuel.

NOTE: The "cruise" target (zone 27) MUST be smaller than or equal to the "power" target (zone 28). The simple interpolator used on the lambda targets will not handle negative (reverse) trends.

10.Idle Speed Control (ISC) Setting

The idle speed control system has three main adjustments for correct operation.

1. "IDLE (xx%) yyyy" sets the required idle speed in steps of 50 rpm. The (xx%) value shows the actual duty cycle to assist settings and monitoring.

2. Two default values for cold and hot engines. These default values are used by the software to pre-set the ISC duty cycle to about the correct value during gear shifts, over run, aircon switching etc. The correct values may only be changed using EDIT mode as follows:

<u>Hot Engine</u>

Select "IDLE (xx%) yyyy" on the remote and set the required idle speed. Once the idle rpm has stabilised note the duty cycle value shown in parentheses (xx%) and record the value. Using EDIT mode select zone #18 (IDHOT) and set this zone to the recorded value plus about 2%. Store the new value by holding BOTH EDIT switches down until the display shows "*********************" and then release.

e.g. Duty cycle = 43% (Stable hot idle)

then EDIT zone #13 to a value of 45.

<u>Cold Engine</u>

Same procedure as above except note the duty cycle shortly after a cold start and EDIT zone #19 (IDCLD) this time.

Note that the software also generates an intermediate (warm) value which is the average of the hot and cold settings but is not independently adjustable.

<u>Over-Run Vacuum</u> (EDIT only, zone #13)

Sets the vacuum value BELOW which the idle speed system will pre-set the ISC to a default (constant) position. This will occur while the vehicle is coasting on closed throttle and normal ISC operation will resume when vacuum rises upward toward normal idle values.

Default value = 26 (kPa). If this value is set too low, then the idle system may try to make corrections while the vehicle is coasting to a stop, usually resulting in the engine stalling. If set too high, the ISC will maintain a constant position resulting in high, fixed idle speed.

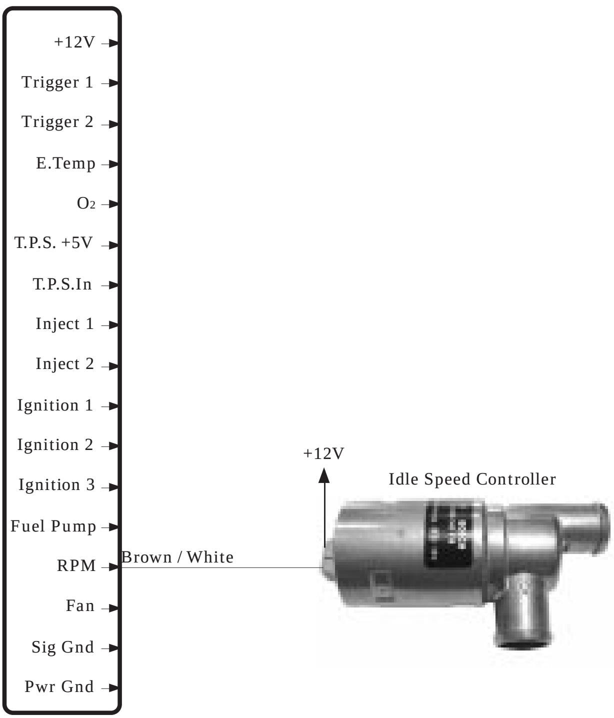
3. The system status is shown by a symbol at the far right character:

D Default Mode. The system is using default values only (ie IDHOT / IDCLD). This will occur during transition phases and acceleration.

= Idle speed equals target value

+ System is increasing idle speed

– System is decreasing idle speed

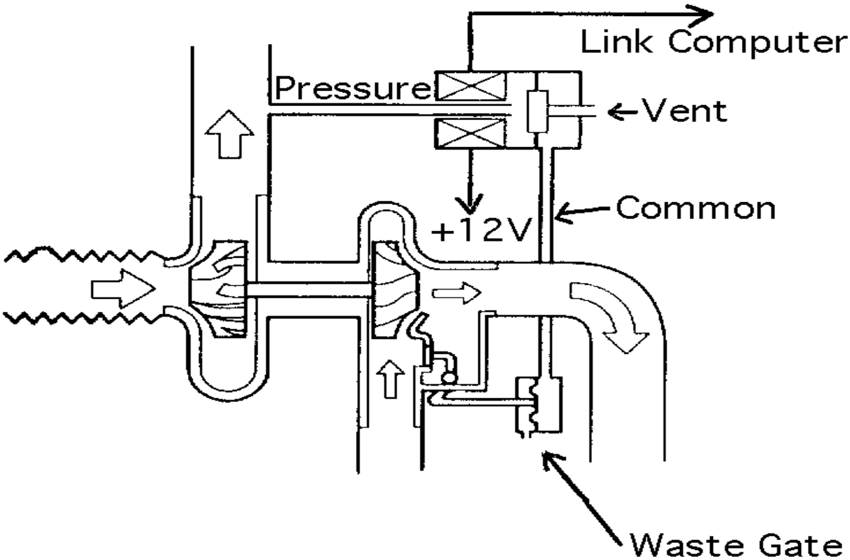


11. CLOSED LOOP BOOST CONTROL

Operation

Boost control is achieved by modifying the pressure signal between the waste gate actuator and the compressor outlet using a solenoid assembly. The valve has three ports arranged as follows:

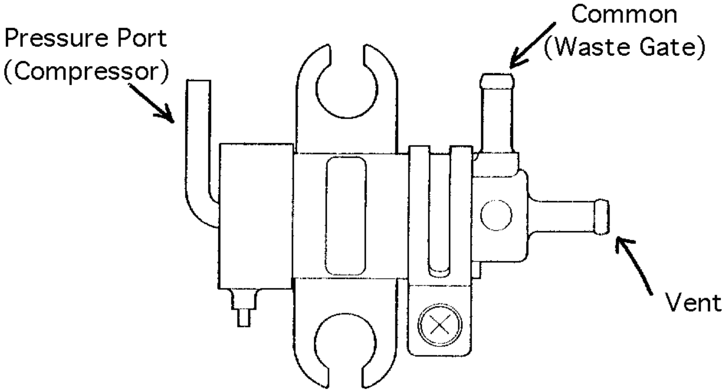
- common port is connected to the actuator
- pressure port is connected to the compressor outlet
- bleed port is vented to the atmosphere (usually via a filter)



When the solenoid is **de-energised** the common and pressure ports are connected and compressor pressure is allowed to fill the actuator and open the waste gate. The actual boost pressure that results is entirely dependent on the waste gate construction and therefore determines the **minimum** boost for the system.When the solenoid is **energised** the the common and vent ports are connected and the air pressure in the actuator is bled off to atmosphere causing the waste gate to close and boost pressure to rise. By varying the ON / OFF ratio of the solenoid (duty cycle) any level off boost may be achieved and since the manifold air pressure (MAP) is being measured by the Link computer the boost may be precisely programmed and controlled.

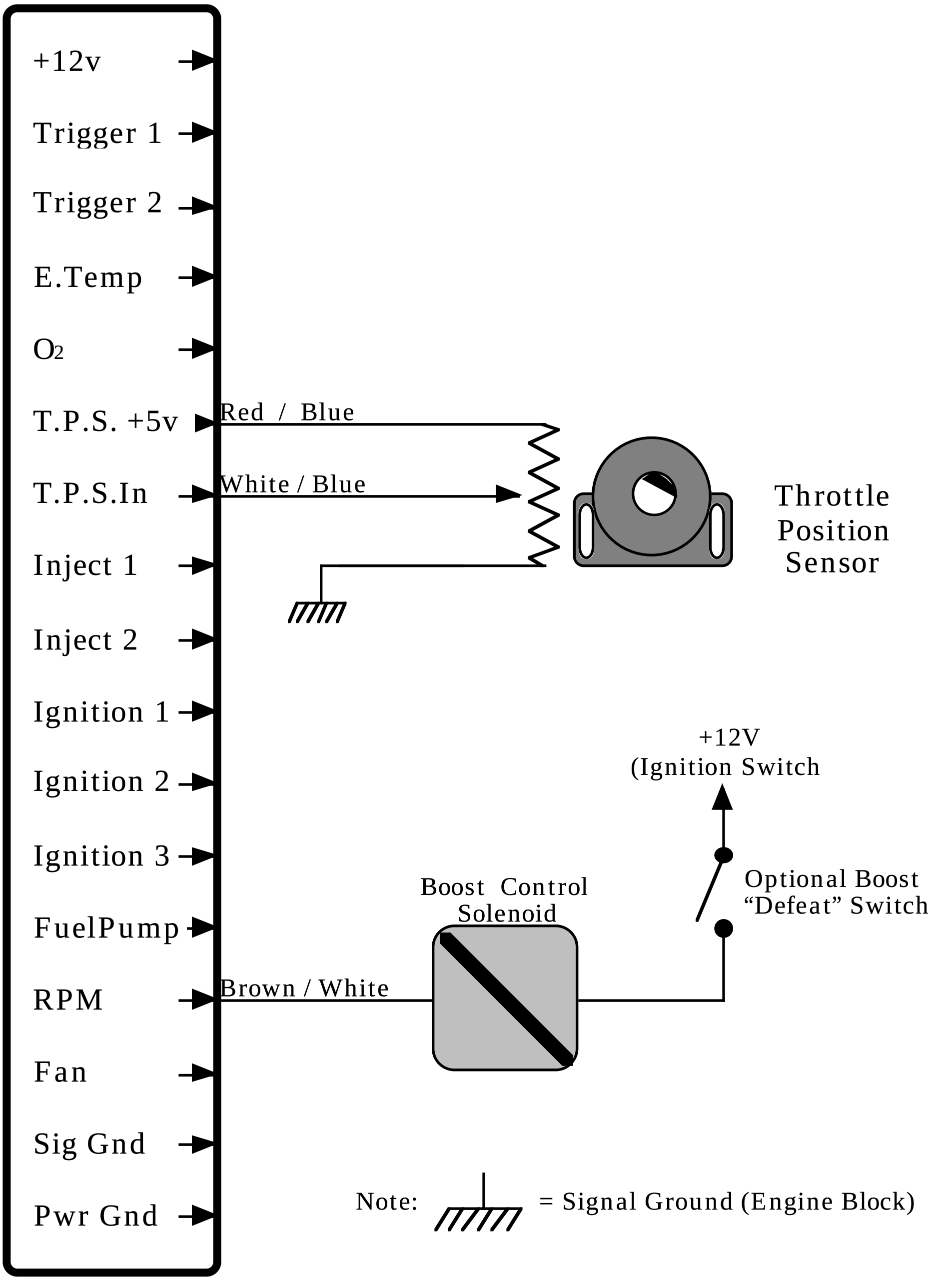
Solenoid Types

The correct type of solenoid valve must be used and devices intended for this purpose should be used wherever possible. Some types of plastic bodied units may work satisfactorily but may not withstand the constant cycling imposed upon it and subsequently fail after several hours of service. In either case do check that the "sense" of operation is correct by blowing through the ports with the solenoid both energised and de-energised to confirm correct operation.



Wiring

Follow the wiring diagram shown below noting the optional "defeat" switch which will force the system into a minimum boost mode. This may be useful if driving conditions are adverse, alternatively a hidden switch may be installed to prevent unauthorised high boost operation.


+12v
Trigger 1
Trigger 2
E.Temp
O2
T.P.S. +5v
T.P.S.In
Inject 1
Inject 2
Ignition 1
Ignition 2
Ignition 3
FuelPump
RPM
Fan
Sig Gnd
Pwr Gnd
Red / Blue
White / Blue
Throttle Position Sensor
+12V
(Ignition Switch
Optional Boost "Defeat" Switch
Boost Control Solenoid
Brown / White
Note:
= Signal Ground (Engine Block)

Control

The computer software features a number of adjustment facilities for closed loop boost control and may be accessed by plugging in the Link Tuning Module before switching on the ignition.

Boost

Boost target values: An extra ROW of sixteen zones has been added to the zoning system to hold the target boost value for each 500 rpm interval between 500 and 8,000 rpm. This allows the boost "curve" to be tailored to suit the application. This flexibility may be used to hold the boost at lower levels through the rpm mid range to suppress detonation and then allowed to rise at higher rpm where detonation is less likely. These target values may be changed by using either the EDIT function at any time or using the "Boost = xx" mode for making changes while actually operating in that zone (rather like ZONE FUEL or ZONE IGNITION). Note that any changes are temporary until STORED.

The displayed values are shown in kPa (absolute) and may be cross referenced using the following table. Note that the values must always be greater than 100 since below 100 represents vacuum.

kPa (absolute)	psi (boost)
100	0
120	3
140	6
160	9
180	12
200	15
220	18
240	21
250	23

Waste Gate Controls

The following controls may be adjusted to provide the required result. Waste gate actuators, control solenoids and engine configuration all have an effect on the response ”ballistics” of the system, and some controls interact to a certain degree. The recommended procedure is to make small adjustments and fully evaluate the result before further changes are made. The suggested starting values are based on the “pressure – bleed” type of solenoid (described earlier) rather than the simpler “bleed only” type solenoid.

i) WG BASE

This value is used for calculating a base line duty cycle which the software uses to initially guess the final value. This base line is used mainly during the turbo spool up time when the system is unable to control the boost and holds the waste gate setting close to the final (settled) value.

Drive the engine at Mid to high rpm (eg. 5,000 rpm) and snap open the throttle. Watch the boost gauge and as soon as the boost stabilises at the target value read the wastegate duty cycle shown in parenthesis (xxx). Return to 5,000 rpm and again snap open the throttle while watching the duty cycle window (xxx). Use the ADJUST buttons to change the BASE value until the settled duty cycle noted initially is forced into the duty cycle window.

e.g. Settled duty cycle = 75% (at 5,000 rpm).

Adjust WGBASE until a value of 70–75% is forced into the duty cycle window at throttle snap.

ii) WG SENS

Sensitivity Control: All closed loop (feed back) systems require an optimum sensitivity level which is a compromise between fast response time and overall stability. High sensitivity values produce fast response at the expense of instability (hunting or oscillation around the target value) and low sensitivity may result in slow settling times.

Experience has shown that a “WGATE SENS xx” value of about 5 to 10 is fairly close. Never set the value to 0. Generally “”soft” waste gates require higher numbers especially when operating at high boost levels (> 1,0 Bar).

iii) WG RPM

WG RPM sets the engine rpm at which the Link Engine Management System will start controlling the boost. At low rpm (about 3,000 rpm) there may not be sufficient exhaust gas to fully spool the turbo thus limiting the amount of usable boost. Under these conditions the control system would attempt to increase the boost by increasing the solenoid duty cycle without effect and when the boost does arrive would grossly over shoot since the waste gate would be fully shut down.

Rpm lock out values typically depend somewhat on the turbo size and match to the application. A typical value usually falls between 3,500 and 4,000 rpm. If boost over shoots at low rpm when driving in higher gears (4th or 5th gear etc) try raising the rpm point.

Note: A throttle position lockout also exists which inhibits the control system when the throttle is less than 60% open. This feature is not adjustable.

iv) MAP LIMITING

The MAP limiting function has been re-scaled to kPa (rather than psi) to allow co-relation to the boost “target” values. The limit should be set about 10-15 kPa above the highest target value to allow for some over shoot inherent in closed loop systems.

12. Typical Tuning Procedure.

1. Tune engine manually until reasonable results are achieved.

2. Turn on closed loop system (LAMBDA = ON).

3. Select CLAMP or RPM limit (either side of MASTER) and bring vehicle up to a medium power cruise on a suitable road (preferred) or dyno. Select MASTER and observe the display. After a few seconds the numbers will start to change as the system starts auto-tuning.

   Try and maintain a steady power setting until the display stabilises, then select CLAMP or RPM limit to cease the MASTER auto-tune. Try not to let the system auto-tune in unrealistic driving situations (idle or full power) since the purpose of MASTER setting is to find a value that represents a good compromise value at medium power.

   If at any time you are unable to maintain steady conditions (traffic, corners etc.) then shift the Link Tuning Module off MASTER until you regain suitable conditions.

4. Select ROWFUEL and basically repeat the above (3) procedure remembering that slope has 3 stages (normally aspirated) or up to 6 stages (turbo). Once again, drive the vehicle to allow some stabilisation time for each ROW until the display numbers stabilise.

   You will probably notice some interaction between ROWS as the system zeros in so repeat the exercise until things look fairly stable. A STORE operation at this point may be advisable to lock in the corrections so far.

5. Select ZONE FUEL and continue the process. Zone Fuel makes localised corrections throughout the entire operating range so be prepared to spend some time exploring the range, especially at low speed, light throttle where the majority of driving will occur for a street car. Remember to STORE all the corrections BEFORE turning off the engine!

6. Once tuning is complete, select the TEST function, INJ/OXY, or disconnect the Link Tuning Module. This will enable the "continuous" closed loop function to make the necessary day to day corrections on a limited range basis.

The limited tuning range of this mode is sufficient to compensate for normal variations in temperature, fuel types, engine aging etc., but limited to prevent gross misfueling should the oxygen sensor or associated wiring develop a fault.

Periodic "tune- ups" may be done by connecting the Link Tuning Module and driving the vehicle while TEST or INJ/OXY is selected, and then initiating a STORE function.

The temporary corrections made during the calibration drive will then be stored, and the Link Tuning Module may then be removed.

13. TPS/MAP MIXED MODE .

Engines using high lift, long duration cams create problems for EFI systems due to irregular, low manifold vacuum at low RPM. This results in the engine being "over fuelled" since the MAP sensor interprets the poor vacuum as the throttle being mostly open, when in fact, the throttle is closed on the idle stop. Although the over-fuelling can be tuned out using the ZONE FUEL table, the actual zone selected by the software is incorrect since the zone in use is also a function of the "incorrect" MAP signal.

To overcome the zoning problem, a Throttle Position Sensor (TPS) is used to select the current operating zone. This results in stable zone selection to allow the necessary corrections to be made in the problem areas, particularly at low RPM "idle" settings. The actual injector pulse width is still a function of MAP at all times.

TPS sensor description.

The TPS sensor is a potentiometer (variable resistor) mechanically linked to the throttle plate shaft. As the throttle is opened, the TPS output voltage rises in a linear fashion directly proportional to the degree of opening.

A stable reference voltage is supplied to the TPS sensor to eliminate any variations due to battery voltage, engine RPM etc. Typical output voltage ranges from 1.0 volts at idle (closed throttle) through to 5.0 volts at wide open throttle (WOT). This voltage range, after internal scaling, roughly emulates that produced by a MAP sensor running on a conventionally "cammed" engine.

pressure.(perfect vacuum = 0 volts output, no vacuum = 2.5 volts output, 15 PSI / 1 Bar boost = 5.0 volts output etc.) This signal is primarily used to control the injector pulse-width, and therefore the fuel flow into the engine. Secondary functions include boost limiting, and zoning control if engine is running with positive manifold pressure. (Turbo-charged etc.)

Setup and tuning.

1. Wire the TPS sensor as shown on the accompanying wiring diagram.

2. Test wiring by connecting a voltmeter to the TPS sensor output wire and operate the throttle over the full range. The TPS sensor normally has slotted mounting tabs to allow for adjustment of position and should be set so that 4.0 - 5.0 volts is achieved at full throttle. The closed throttle value will vary depending on type of sensor used but will typically be about 1.5 to 2.0 volts. This value is not too important since the computer provides two adjustment points to correct this end of the range. Do check that the voltage range is smooth over the whole range without sudden jumps or drop- outs.

3. The MAP sensor pressure line should be connected to the manifold plenum chamber, or to a mini "manifold" made from small diameter pressure line from each port runner in the case of individual (multiple) throttle butterflies. Do not be tempted to use one runner only for the vacuum signal since this will pulsate considerably over the engine cycle and not provide a stable MAP reading.

4. Install and connect all other engine management components in accordance with the instructions, plug in the Link Tuning Module control prior to switching on the ignition. Select "RELOAD" on the Link Tuning Module, press both buttons for 1 second, ONLY if this is the first start up since installation.

5. With engine stationary, key on, select ROW STEPS on the Link Tuning Module and press ADJUST UP. The display should now read "ROW STEPS = TPS".

6. Select TPS SPAN on the Link Tuning Module and observe the value. The purpose of this step is to set the span range of the TPS signal to ensure that all zones are covered from closed to fully open throttle. Ideally, an indicated span of 20 to 100 is preferred, since this makes three ROWS of zones active,

with the start (20) and end (100) in the exact ROW centres of the 1st and 3rd ROWS. The ROW boundaries are as follows;

ROW	SPAN	CENTRE	ZONES
ROW 1	0 to 40	(20)	[100..175]
ROW 2	41 to 80	(60)	[200..275]
ROW 3	81 to 120	(100)	[300..375]
ROW 4	121 to 160	(140)	[400..475]
ROW 5	161 to 200	(180)	[500..575]
ROW 6	181 and above	(220)	[600..675]

The actual start and end values are not critical, but will ultimately determine the number of ROWS (zones) available. For example, a span of 25 to 48 would only access 2 ROWS since only one zone boundary (40) was crossed. This may, in some cases, be intentional if only 2 ROWS are required for the application. The interpolation software which fills in "gaps" between adjacent zones will work with best accuracy when start and end values fall on ROW centres. This is not critical, and considerable deviation is allowed.

(NOTE:The zoning structure for ZONE ADVANCE is identical to ZONE FUEL.)

With the throttle fully closed, note the displayed value on the Link Tuning Module. This will typically be in the region of 20 to 50. Use the ADJUST buttons to set the "low" value (e.g. 20), then fully open the throttle and note the new value, this will be about 90 to 150. Use the ADJUST buttons again to set the "high" value (e.g. 100), and then fully close the throttle and observe the "low" value. This will probably have changed so reset to 20 (say) again. The "low" and "high" interact, so it will be necessary to repeat the procedure until the required values are achieved.

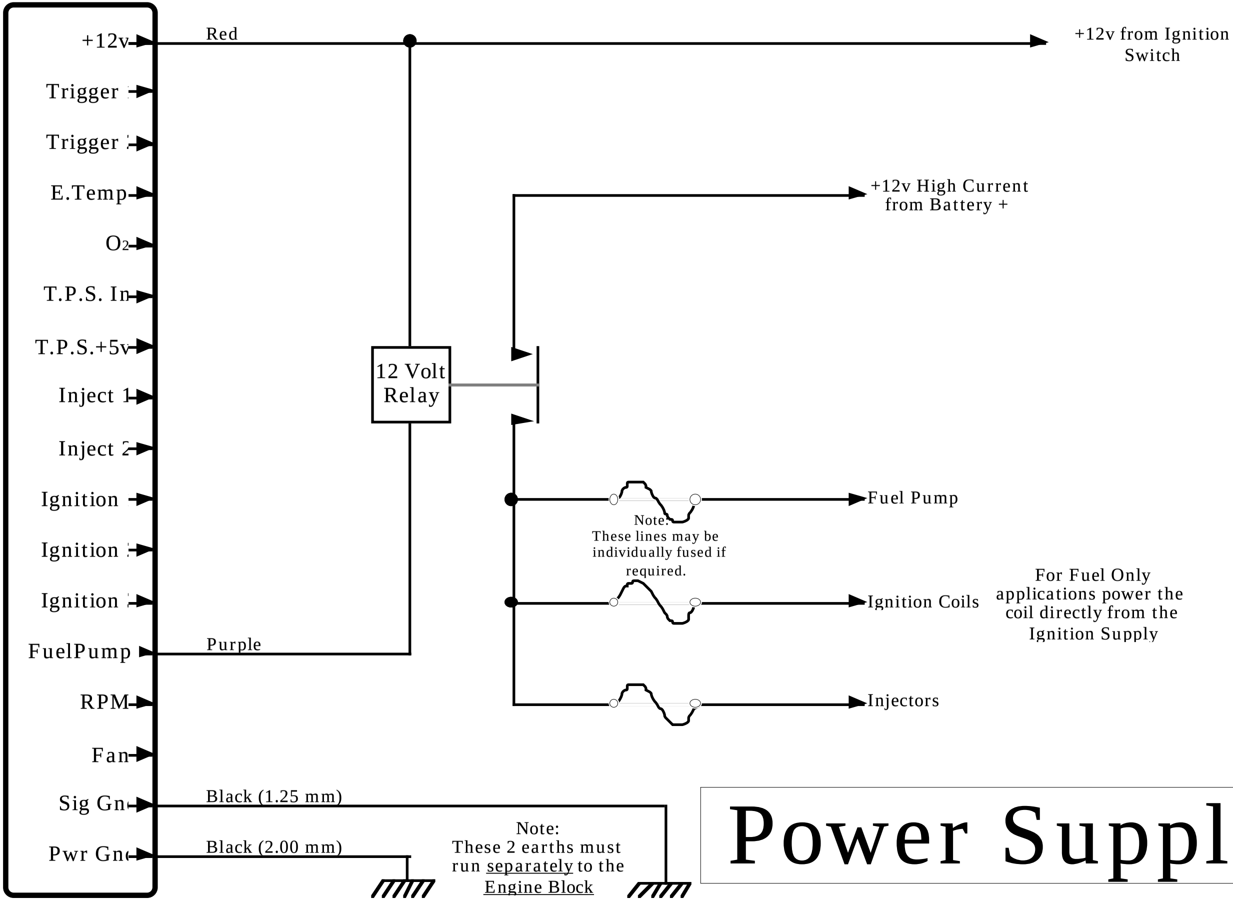
Select STORE and store the settings before proceeding.

7. At this stage, refer to “tuning instructions” and follow accordingly. Note however, the following points;

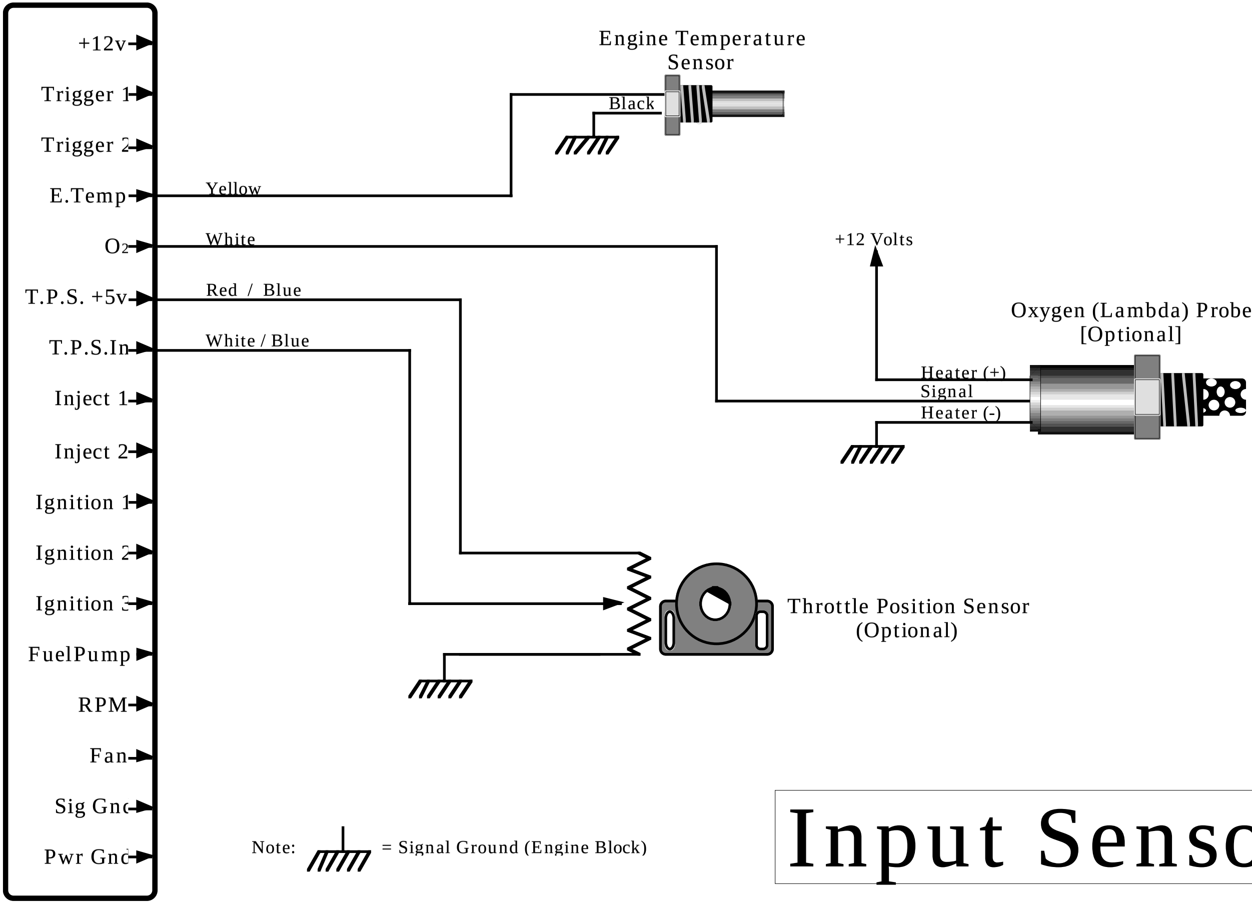
   a. If Manifold Air Pressure (MAP) ever exceeds 110 kPa (1.5 PSI boost), the system will revert to MAP zoning above this value. This is to accommodate turbo/super charged engines. If this is the case, then a span of 20/100 should be used so that at the cross-over point (110 kPa) there will be no sudden steps in the selected zone. I.E. The "MAP" selected zone and the "TPS" selected zone should be the same.

   b. If all six ROWS are required (span = 20/220), and you are unable to set this using "TPS SPAN", then it may be necessary to move the TPS sensor on its slotted mounts to achieve this figure. In any case, values falling outside the preferred zone centres will have little consequence on general operation.

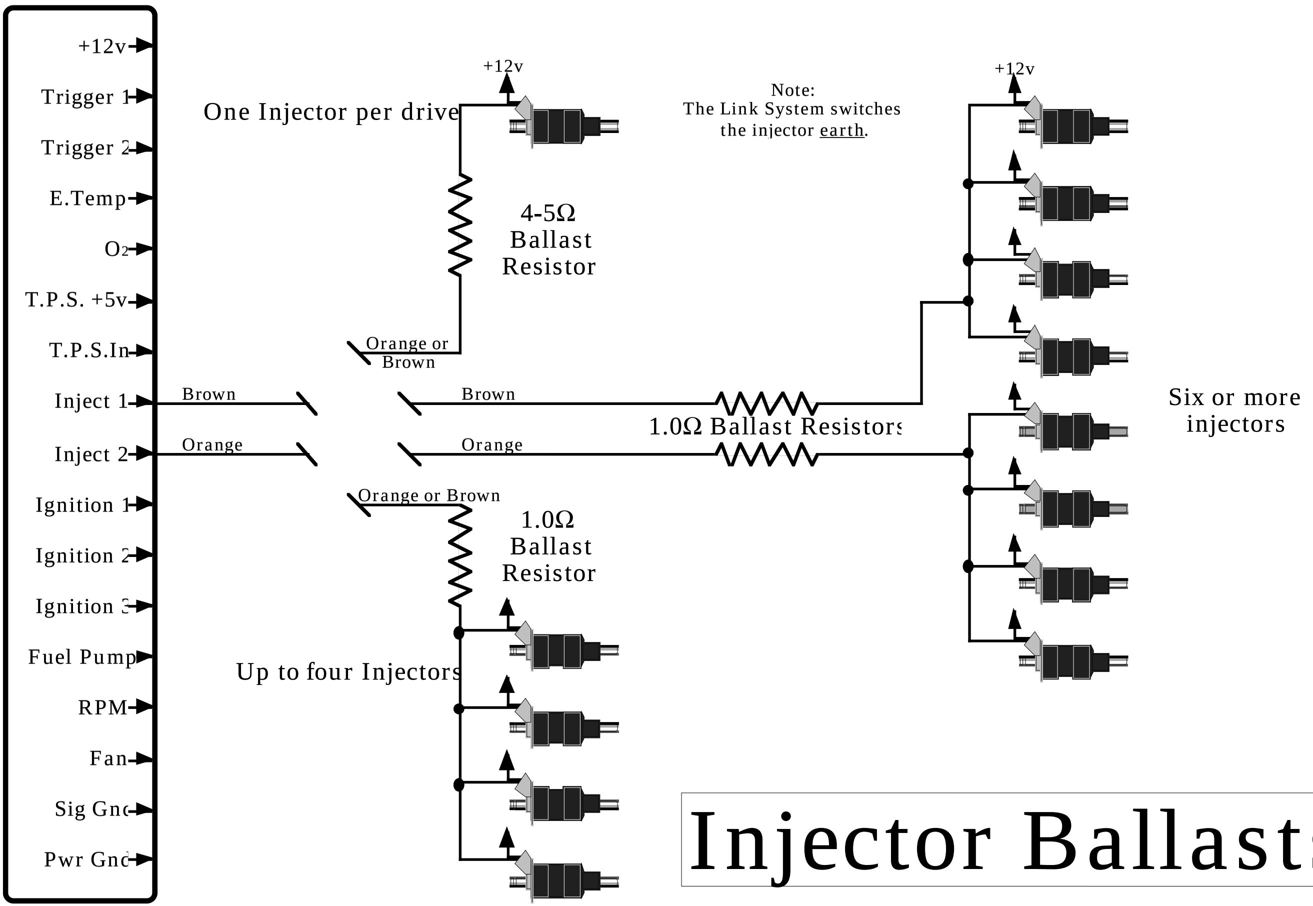
Power Supplies



Input Sensors



Injector Ballasts



Output Drives