LinkPlus
Engine Management
Wire-in, closed loop, sequential fuel & ignition control

LP V14 Software

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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 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.

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

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

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 LinkPlus 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 LinkPlus 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 - with appropriate trigger high hardware).

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 Ignition) consists of 200 zones each covering a narrow operating range. Each zone may be individually or group programmed to suit the application. In some cases (e.g. 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 LinkPlus 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 the user adjustable "COLD" value. For engine temperatures below an adjustable temperature threshold (default = 20°C), the Link Engine Management System automatically primes the engine with a short injector burst during the initial phase of cranking.

2. LinkPlus Features

The LinkPlus offers the following features:

- 8 Injector Drives with Group or Sequential fuel delivery
- 8 Ignition Drives for distributed or Multi-Coil applications
- Dual Input Knock Control for Ignition retard.
- Closed Loop Lambda Control
- Idle Speed Control for solenoid and stepper motors
- Electronic Boost Control with proportional TPS option
- Two high power drives switchable at a preset RPM or engine load
- Shift Light
- Air Conditioning Control
- Water Spray Control for turbo charged engines
- Purge Control
- Option of using an external 3 bar MAP sensor for high boost applications
- Laptop tuning using Windows and PCLink software

3. System Installation

This section describes how to connect all the LinkPlus functions, remembering that the required connections will depend on the application. Read this section carefully to ensure the correct devices are connected.

i) LinkPlus Installation

The LinkPlus 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 and radiators etc. Preferably mount the unit inside the vehicle cabin. It is preferable that the unit is 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, 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 and coaxial cables etc, where fitted. NEVER place next to an igniter module.
4. Four M4 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.

ii) Breakout Loom

The LinkPlus can be supplied with either a 2 or 5 metre breakout loom, used to connect various engine sensors and hardware devices. Some connections are made directly to the relevant device, while others require some form of interface such as relays or ballasting. Figure 3.0 illustrates the main header layout (& wire colours) when looking into the LinkPlus connector.

Injection, Ignition, Power Drives

Inj 5 Brown / Yellow	Inj 7 Brown / Blue	Pwr Gnd Black	Inj 2 Brown	Inj 4 Brown / Orange	Inj 6 Brown / Green	Inj 8 Brown / Purple	Ign Inv Pink	Aux 2 Yellow / Blue	Ign 5 Blue / Red	Ign 1 Blue	Ign 4 Blue / Brown	Ign 8 Blue / Green
Inj 1 Brown / Black	Inj 3 Brown / Red	Pwr Gnd Black	Drive B Orange / Black	ISC 1 Orange / Green	W Gate Orange / Yellow	ISC 2 Orange / Blue	Drive A Orange	Ign 3 Blue / White	Ign 7 Blue / Yellow	Ign 2 Blue / Black	Ign 6 Blue / Orange	FuelPmp Purple

Inputs, Outputs, Idle Stepper

Shift White / Black	Step D Grey / White	Step C Grey / Blue	Step A Grey	Aux 1 Yellow / Green	TPS Yellow / Orange	AC Req Yellow / Red	Tacho White / Green
AC On White / Blue	Purge White / Brown	Step B Grey / Black	Fan White / Red	Spray White / Yellow	MAP Yellow / Brown	A Temp Yellow / Black	E Temp Yellow

Trigger Signals, Knock Signals, Power Supplies, Earths

Trig 2 Blue Grey Shielded	Knock 1 Red shielded cable	Knock 2 Red shielded cable	5V Out Red / Blue	O2 White	Sig Gnd Black
Trig 1 Yellow Black Shielded	Shield Braded Wire	+5 Volts Red / Blue	12V Out Red or Green in trigger cables	Power Red	Sig Gnd Black

Ignition

Ign 1	Blue	0.5
Ign 2	Blue / Black	0.5
Ign 3	Blue / White	0.5
Ign 4	Blue / Brown	0.5
Ign 5	Blue / Red	0.5
Ign 6	Blue / Orange	0.5
Ign 7	Blue / Yellow	0.5
Ign 8	Blue / Green	0.5
Ign Inv	Pink	0.5

Injection

Inj 1	Brown / Black	0.5
Inj 2	Brown	0.5
Inj 3	Brown / Red	0.5
Inj 4	Brown / Orange	0.5
Inj 5	Brown / Yellow	0.5
Inj 6	Brown / Green	0.5
Inj 7	Brown / Blue	1.25
Inj 8	Brown / Purple	1.25

Inputs

E Temp	Yellow	0.5
A Temp	Yellow / Black	0.5
TPS	Yellow / Orange	0.5
AC Req	Yellow / Red	0.5
MAP	Yellow / Brown	0.5
O2	White	0.5
Aux 1	Yellow / Green	0.5
Aux 2	Yellow / Blue0.5	

Trigger Signals

Trig 2	Blue (Shielded cable)	0.5
Trig 1	White (Shielded cable)	0.5

Outputs

Fuel Pmp	Purple	0.5
Shift	White / Black	0.5
Purge	White / Brown	0.5
Fan	White / Red	0.5
Spray	White / Yellow	0.5
Tacho	White / Green	0.5
AC On	White / Blue	0.5

Idle Stepper Motor

Step A	Grey	0.5
Step B	Grey / Black	0.5
Step C	Grey / Blue	0.5
Step D	Grey / White	0.5

Knock Signal

Knk 1	Red (Shielded cable)
Knk 2	Red (Shielded cable)

Power Supply

Pwr	Red	0.85
12V Out	2 screened cables Red / Green	0.5
+5V	Red / Blue	0.5
+5V	Red / Blue	0.5

Ground

Sig Gnd	Black	0.85
Sig Gnd	Black	0.85
Pwr Gnd	Black	1.25
Pwr Gnd	Black	1.25

Power Drives

Drive A	Orange	0.5
Drive B	Orange / Black	0.5
ISC 1	Orange / Green	0.5
ISC 2	Orange / Blue	0.5
W Gate	Orange / Yellow	0.5

Caution:
Ensure that the +12V supplies in the trigger cables are cut at the connector (header), if not used.

LinkPlus -Header Pin Out (Wire Side)

15 July 2003

iii) Calculating Firing Sequence

The firing sequence is a standard pattern containing all cylinders in a specific order. The maximum length is 8 digits. It will only require calculation for sequential fuel or multi-coil applications. The first digit represents the 1st cylinder in the firing sequence and the second digit represents the 2nd cylinder in the firing sequence etc. Using this pattern the Injector and Ignition drives can be wired to the same format, as shown in Table 3.0.

Firing Sequence	Position	Ignition	Injection
	Cylinder 1	Ign 1	Inj 1
	Cylinder 2	Ign 2	Inj 2
	Cylinder 3	Ign 3	Inj 3
	Cylinder 4	Ign 4	Inj 4
	Cylinder 5	Ign 5	Inj 5
	Cylinder 6	Ign 6	Inj 6
	Cylinder 7	Ign 7	Inj 7
	Cylinder 8	Ign 8	Inj 8

Table 3.0

This firing sequence MUST be followed when wiring the LinkPlus, as the software bases ignition timing and fuel phasing on this pattern. Failure to do this will result in non-sequential fuel delivery and incorrect multi coil operation.

Definition

By definition the firing sequence is merely a shuffle of the firing order. The first cylinder to reach TDC (on compression stroke) after the synchronisation signal now becomes the 1st cylinder in the firing sequence. The next cylinder to arrive at TDC becomes the 2nd cylinder in the firing sequence and so on. The following two parameters are therefore required to correctly determine the firing sequence.

- The firing order of the engine.
- The position of the Synchronisation (Sync) signal. On some applications this information will not be obvious, so refer to the application specific information at the rear of this manual.

The following examples will help clarify this.

Example 1. 4 -Cylinder engine

Firing order: 1-4-3-2

(a) Sync Position: Between cylinders 4 and 3 on the camshaft.

The 1st cylinder to reach TDC after the sync pulse is cylinder 3, resulting in a firing sequence 3-2-1-4. See Table 3.1(a)

Firing Sequence	Position	Cylinder
	1st	3
	2nd	2
	3rd	1
	4th	4

Table 3.1(a)

(b) Sync Position: Between cylinders 3 and 2 on the camshaft.

The first cylinder to reach TDC after the sync pulse is cylinder 2. The firing sequence is 2-1-4-3. See table 3.1 (b)

Firing Sequence	Position	Cylinder
	1st	2
	2nd	1
	3rd	4
	4th	3

Table 3.1(b)

Examples a) & b) use the sync referenced to the camshaft, producing one pulse per engine cycle. If positioned on the crankshaft, two sync pulses per engine cycle will be generated. See example c).

c) A sync signal on the crankshaft occurring between 1-4 and 3-2. The firing sequence can therefore be 4-3-2-1 OR 1-4-3-2. See tables 3.1 (c) and (d).

Firing Sequence	Position	Cylinder	Position	Cylinder
	1st	3	1st	1
	2nd	2	2nd	4
	3rd	1	3rd	3
	4th	4	4th	2

Tables 3.1 (c) , (d)

Note - Part c) will only apply to Multi-Coil Wasted Spark setup.

3.1 Injectors

The LinkPlus offers 8 independent injector drives capable of running up to 8 cylinders sequentially. The wiring of individual injectors will depend on the required fuel delivery mode; Group or Sequential. See Table 3.2 for wire colours.

All 8 LinkPlus injector drives supply an EARTH for the injectors. DO NOT connect +12V directly to these drives, as permanent damage will result.

Measure Injector Resistance. Use an ohmmeter to measure the injector resistance. If this is less than 9 ohms external ballasting will be required. The type of ballasting will depend on injector resistance and fuel delivery mode (Group or Sequential).

Injector Drive	Wire Colour	mm
Inj 1	Brown / Black	0.5
Inj 2	Brown	0.5
Inj 3	Brown / Red	0.5
Inj 4	Brown / Orange	0.5
Inj 5	Brown / Yellow	0.5
Inj 6	Brown / Green	0.5
Inj 7	Brown / Blue	1.25
Inj 8	Brown / Purple	1.25

Table 3.2 Injector Drive Wiring.

3.2 Group Fire Multi-Point Injection

3.2.1 High Impedance Injectors

When group fire is selected ONLY use injector drives INJ7 and INJ8. The injectors can be connected in a single group (only using one injector drive), or in two groups using the two injector drives in an anti-phase mode. This setup can improve engine throttle response but does require extra wiring.

INJ7 (Brown/Blue) Injector drive group 1. When active, provides an EARTH supply for up to 6 injectors.

INJ8 (Brown/Purple) Injector drive group 2. This drive performs an identical action to INJ7, except the pulses are time displaced to provide smoother fuel delivery when both drives are used together.

- For 6 cylinders or less, the injectors can be fired in a single or two-group configuration. See Figure 3.1

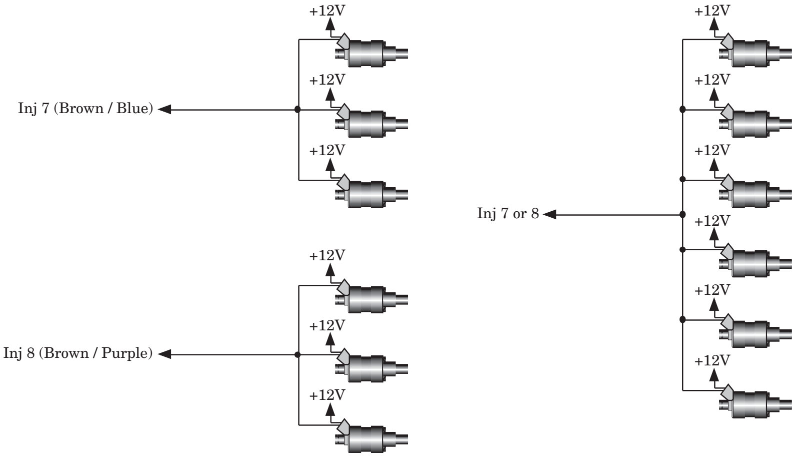


Figure 3.1. Group Fire wiring for 6 cylinders or less
(High Impedance Injectors)

- For an 8-cylinder engine and above the injectors MUST be wired in two groups as shown in Figure 3.2. An 8-cylinder engine for example should use 2 groups of 4 injectors, a 12-cylinder engine should use 2 groups each containing 6 injectors.

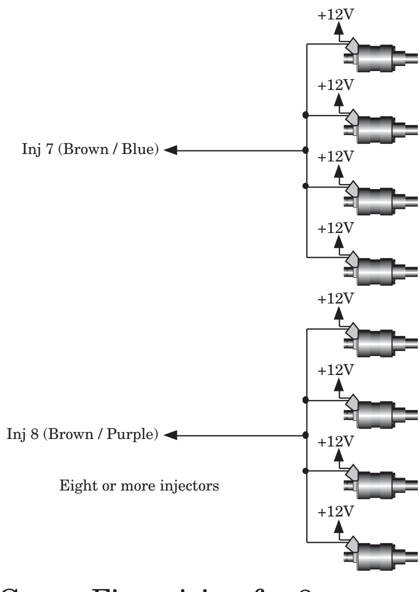


Figure 3.2. Group Fire wiring for 8 or more cylinders
(High Impedance Injectors)

3.2.2 Low Impedance Injectors

If the injector impedance (resistance) is less then 9 Ohms, external ballasting will be required. The injector resistance can be measured by using an ohmmeter and probing the injector terminals. In most applications factory ballasting can be used. The same wiring configurations can be used as described for high impedance injectors. The only exception is the insertion of a ballast resistor between the LinkPlus and injector. See Figures 3.3 and 3.4.

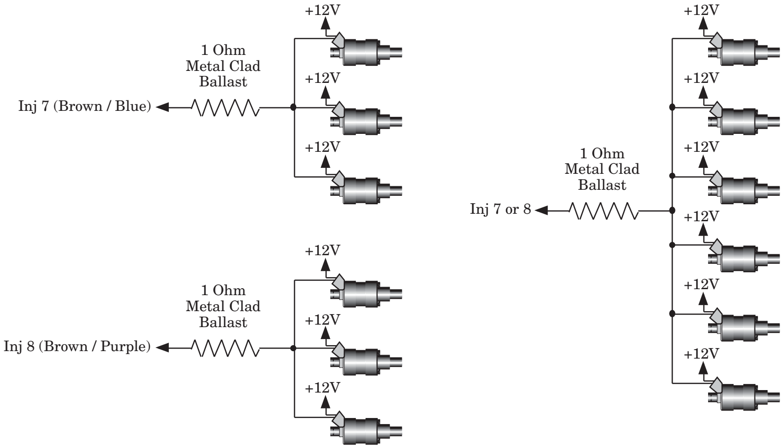


Figure 3.3 Group fire wiring for 6 cylinders or less
(Low Impedance Injectors)

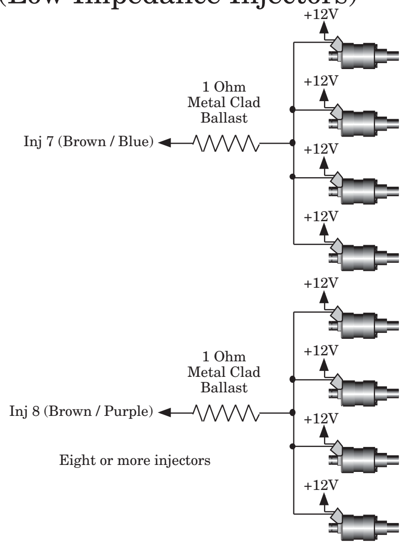


Figure 3.4 Group Fire wiring for 8 or more injectors
(Low Impedance Injectors)

3.3 Sequential Fire Multi-Point Injection

In sequential mode, each injector is individually wired back to the LinkPlus. The means the fuel delivery will be phased to the engine so the injector operates only while the inlet valve is open (i.e. sequential). To achieve this the LinkPlus assumes the injectors have been wired to the firing sequence. From this the LinkPlus calculates when to open the injectors, ensuring it occurs on the Inlet stoke. Failure to wire the injectors correctly will result in non-sequential fuel delivery.

Table 3.3 summarises how to connect the injector drives with respect to the firing sequence. The label "1st cylinder" represents the first cylinder in the firing sequence, the label "2nd cylinder" represents to second cylinder in the firing sequence and so on.

Firing	Cylinder Number					
Sequence	2	3	4	5	6	8
1st	Inj 1	Inj 1	Inj 1	Inj 1	Inj 1	Inj 1
2nd	Inj 2	Inj 2	Inj 2	Inj 2	Inj 2	Inj 2
3rd		Inj 3	Inj 3	Inj 3	Inj 3	Inj 3
4th			Inj 4	Inj 4	Inj 4	Inj 4
5th				Inj 5	Inj 5	Inj 5
6th					Inj 6	Inj 6
7th						Inj 7
8th						Inj 8

Table 3.3

3.3.1 Examples

• 4 Cylinder Firing Order: 1-4-3-2
Sync Position: Between cylinders 1 and 4 at cam speed

Cylinder 4 is first to reach TDC (compression stoke) after the sync. The firing sequence becomes 4-3-2-1. The injectors should be wired as shown in Table 3.4 (a).

Firing Sequence Position	Cylinder	Injector Drive
1st	4	Inj 1
2nd	3	Inj 2
3rd	2	Inj 3
4th	1	Inj 4

Table 3.4 (a)

• 8 Cylinder Firing Order: 1-8-4-3-6-5-7-2

Sync Position: Between cylinders 1 and 8.

Cylinder 8 is first to reach TDC (compression stoke) after the sync, starting the "firing sequence 8-4-3-6-5-7-2-1. Table 3.4 (b) shows how the injectors should be wired.

Firing Sequence Position	Cylinder	Injector Drive
1st	8	Inj 1
2nd	4	Inj 2
3rd	3	Inj 3
4th	6	Inj 4
5th	5	Inj 5
6th	7	Inj 6
7th	2	Inj 7
8th	1	Inj 8

Table 3.4 (b)

3.3.2 High Impedance Injectors

These are defined by an injector resistance of 9 ohms or greater, typically a value around 12 ohms will be seen. As each injector is controlled individually by the LinkPlus, wiring should be completed as shown in Figure 3.5 for up to eight cylinders.

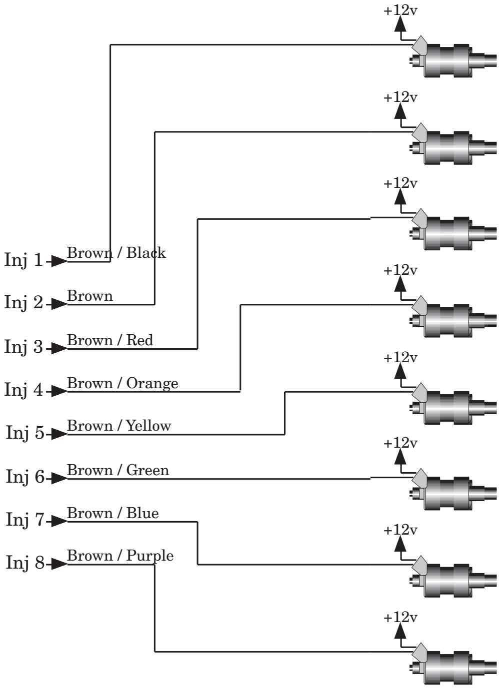


Figure 3.5. Sequential up to 8 cylinders, high impedance injectors

3.3.3 Low Impedance Injectors

When the injector impedance is less than 9 ohms, ONE ballast resistor for every injector is required. The type of ballast will depend on injector resistance.

- For injector resistance less than 2 ohms use single 2R2 ballasts
- For injector resistance between 2 and 9 ohms use single 4R7 ballasts

See Figure 3.6 for wiring information.

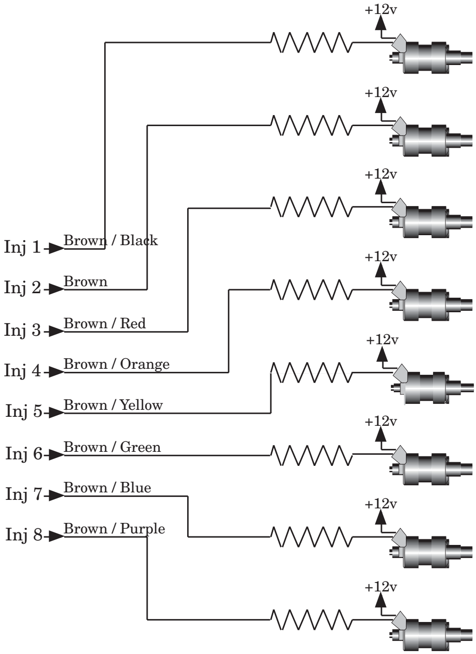


Figure 3.6 Sequential up to 8 cylinders, low impedance injectors.

3.4 Single-Point Injection

When using single point injection only one injection drive is required; either INJ 7 or INJ 8.

3.4.1 High Impedance Injectors

If the injector impedance is greater than 9 ohms, no ballasting is required. A maximum of 6 high impedance injectors can be connected to one Injection drive.

3.4.2 Low Impedance Injectors

The required ballasting will depend on the number of low impedance injectors. Figure 3.7 shows how to connect single point injection for low impedance injectors

1 Injector

Injector resistance less than 2 ohms use single 2R2 ballast.

Injector resistance between 2 and 9 ohms use single 4R7 ballast.

2 Injectors

Ballast = 2R2 ohm.

3 or more Injectors

Ballast = 1R0 ohm.

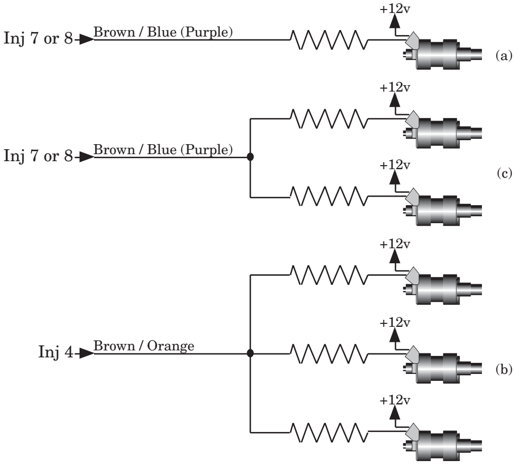


Figure 3.7. Ballasting for single point injection.

3.5 Ignition

The LinkPlus offers 8 Ignition drives which can be configured from a basic distributor setup through to the more complex Multi-Coil arrangements. Table 3.5 illustrates wire colours.

Ignition		
Ign 1	Blue	0.5
Ign 2	Blue/Black	0.5
Ign 3	Blue/White	0.5
Ign 4	Blue/Brown	0.5
Ign 5	Blue/Red	0.5
Ign 6	Blue/Orange	0.5
Ign 7	Blue/Yellow	1.25
Ign 8	Blue/Green	1.25
Ign INV	Pink	0.5

Table 3.5 Ignition Wire Colours.

DO NOT connect the ignition drives directly to ground, as this will cause permanent damage.

Before beginning any wiring, read Section 6 on Ignition. This provides information on the different configurations and the hardware requirements to make them run.

3.5.1 Igniter Mounting

Igniter(s) must be mounted well clear of the Link ECU, preferably under the bonnet, next to the coil(s). DO NOT mount inside the passenger compartment. 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).

3.5.2 Ignition Suppression

The LinkPlus employs very highspeed 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 Farads (most points condensers are suitable)).

3.6 Distributor

A distributed engine requires one single channel igniter. Connection to the LinkPlus Ignition drives will depend on the type of signal required to control the Igniter.

IGN 1 (Blue). This drive uses the conventional signal polarity to control ignition. A positive voltage on this pin will place the coil in dwell mode (i.e. Coil charging). The transition from positive to ground will switch the coil off, resulting in spark. All Link Igniters use this method. Use Ignition Drive 1 and connect as shown in Figure 3.8(a). The Link Igniter is used for illustration purposes. Most factory igniters can be used.

IGN INV (Pink). Some factory igniters such as Honda and some Ford devices use the opposite polarity. Dwell occurs when the signal is at ground, producing spark on the transition from 0V to positive supply. Use Ign Inv Drive and connect as shown in Figure 3.8(b)

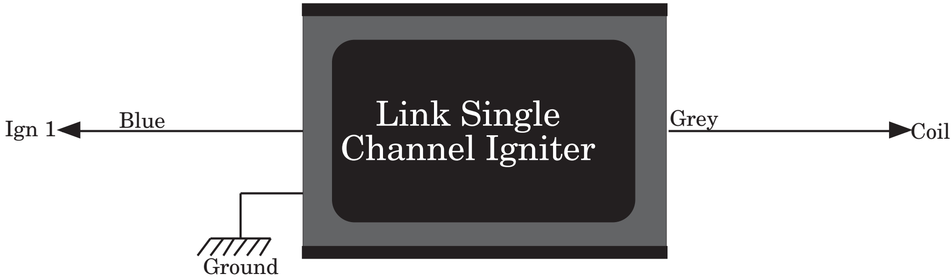


Figure 3.8 (a). Distributor setup with conventional igniter signal (Ign).

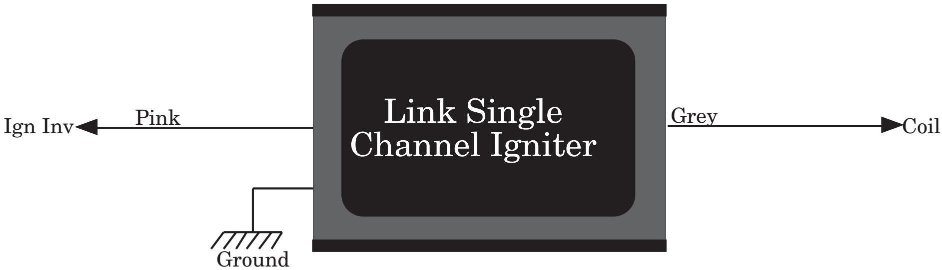


Figure 3.8 (b). Distributor setup with inverted igniter signal (Ign Inv).

3.7 Multi-Coil: Direct Spark

This section provides wiring information on the range of direct spark applications available with the LinkPlus. There are 8 ignition drives allowing 8 individual coils to be controlled. It is therefore important these drives are matched to control the correct cylinders. This is achieved by determining the firing sequence, and wiring to this pattern.

The first ignition drive is labelled "IGN 1". This drive will control the ignition on the first cylinder in the firing sequence. The ignition drive labelled "IGN 2" should be connected to the second cylinder in the firing sequence (i.e. 2nd cylinder positioned after the sync pulse). Table 3.6 summaries this for a range of cylinders. The left-hand column is the position of the cylinder with respect to the sync pulse. The 1st represents the first cylinder in the firing sequence, the 2nd represents the second cylinder in the firing sequence and so on. Refer to the next section 3.7.1.

Firing	Cylinder Number					
Sequence	2	3	4	5	6	8
1st	Ign 1	Ign 1	Ign 1	Ign 1	Ign 1	Ign 1
2nd	Ign 2	Ign 2	Ign 2	Ign 2	Ign 2	Ign 2
3rd		Ign 3	Ign 3	Ign 3	Ign 3	Ign 3
4th			Ign 4	Ign 4	Ign 4	Ign 4
5th				Ign 5	Ign 5	Ign 5
6th					Ign 6	Ign 6
7th						Ign 7
8th						Ign 8

Table 3.6

3.7.1 Wiring Example

(a) Direct Spark setup for an 8 cylinder Nissan VH45.

Firing order: 1-8-7-3-6-5-4-2.

Sync Position: Between cylinders 2 - 1 on the camshaft.

Cylinder 1 is the first cylinder to reach TDC (compression stroke) after the sync signal. The firing sequence will begin with cylinder 1 resulting in the following sequence 1-8-7-3-6-5-4-2. Table 3.7 illustrates the correct wiring.

Firing Sequence Position	Cylinder	Ignition Drive
1st	1	Ign 1
2nd	8	Ign 2
3rd	7	Ign 3
4th	3	Ign 4
5th	6	Ign 5
6th	5	Ign 6
7th	4	Ign 7
8th	2	Ign 8

Table 3.7

(B) Direct Spark setup for an 8 cylinder.

Typical firing order: 1-8-4-3-6-5-7-2.

Sync Position: Between cylinders 7 - 2 on the camshaft.

Cylinder 2 is the first cylinder to reach TDC after the sync signal.

The firing sequence will therefore begin with cylinder 2 resulting in the sequence 2-1-8-4-3-6-5-7. Table 3.8 illustrates the correct wiring.

Firing Sequence Position	Cylinder	Ignition Drive
1st	2	Ign 1
2nd	1	Ign 2
3rd	8	Ign 3
4th	4	Ign 4
5th	3	Ign 5
6th	6	Ign 6
7th	5	Ign 7
8th	7	Ign 8

Table 3.8

3.7.2 General Installation Guide

The following examples provide a general guide to direct spark installation. The label "coil 1st" represents the first cylinder in the firing sequence, "coil 2nd" represents the second cylinder in the firing sequence etc. All setups show the Link Igniter module, although most factory igniters can be used.

- 3 Cylinder

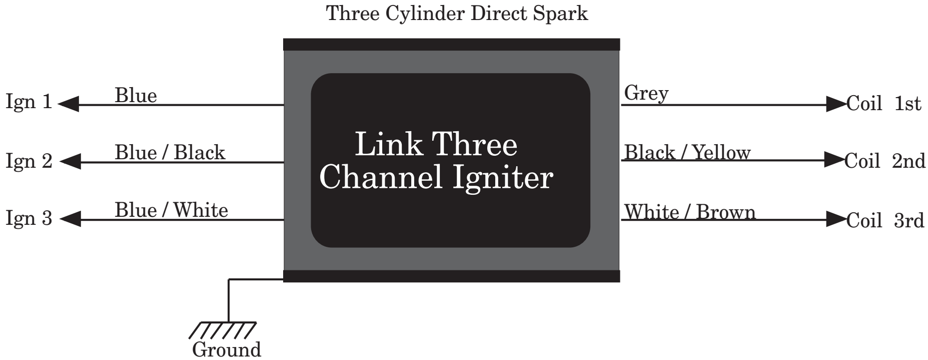


Figure 3.9

- 4 Cylinder

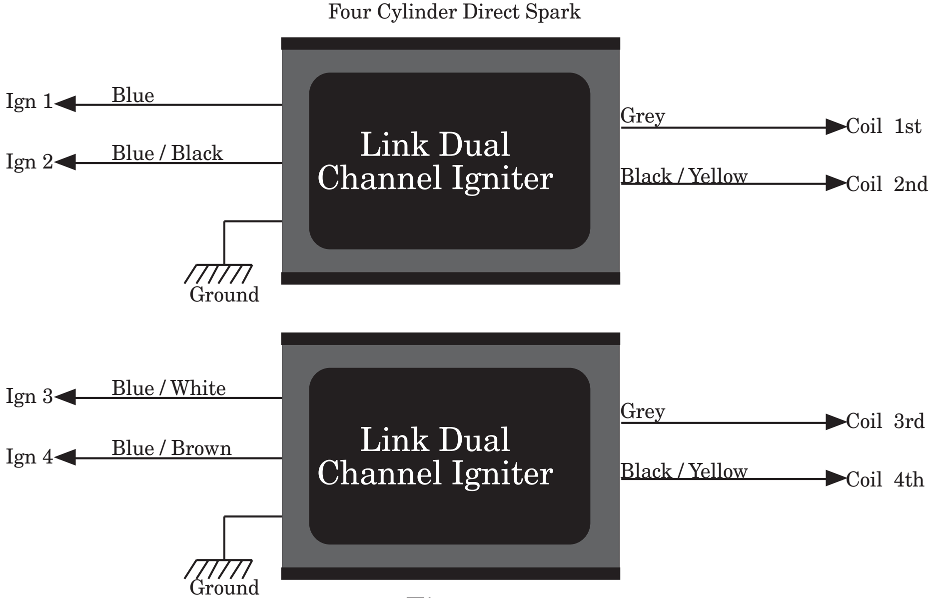


Figure 3.10

- 5 Cylinder

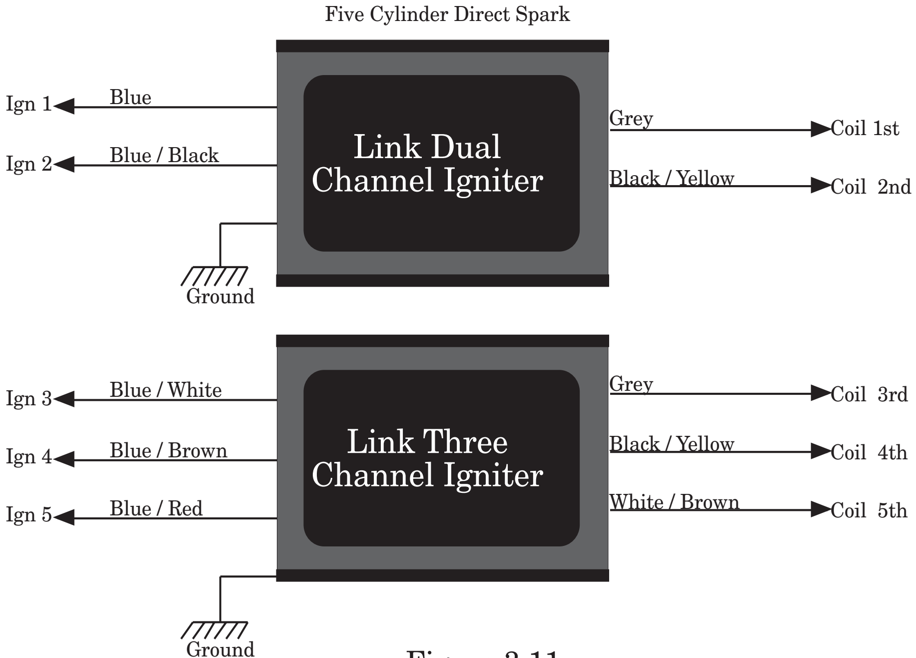


Figure 3.11

- ## 6 Cylinder

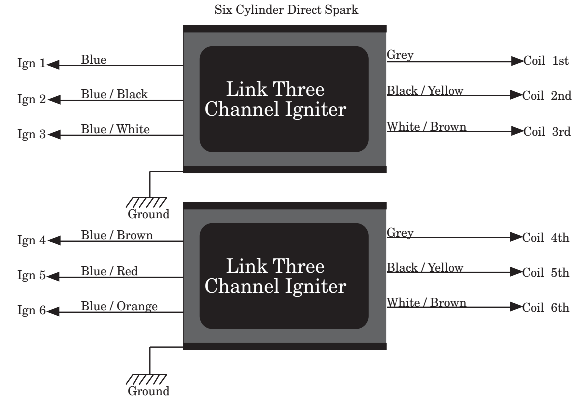


Figure 3.12

- ## 8 Cylinder

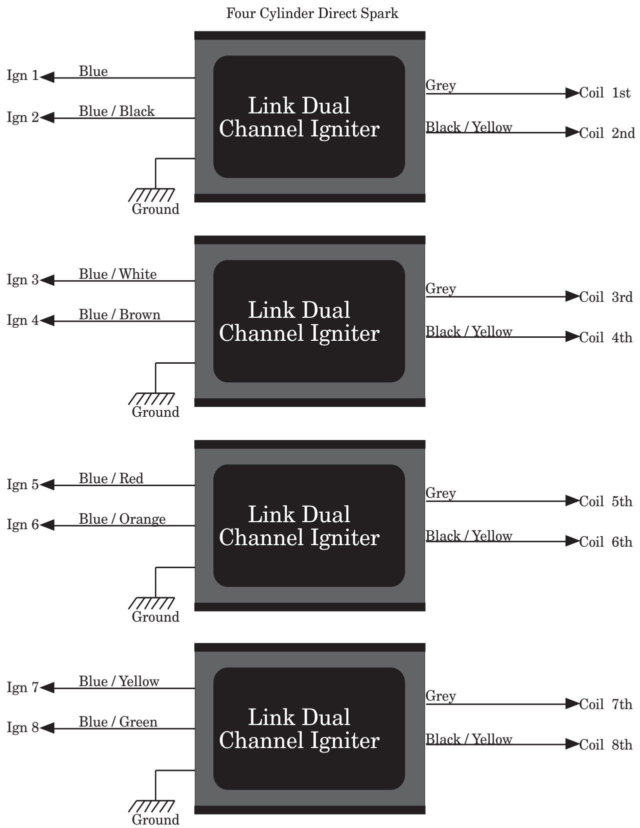


Figure 3.13

3.8 Multi-Coil: Wasted Spark

The following section illustrates how to wire for a wasted spark configuration. To ensure each ignition drive is matched to the correct cylinder, the firing sequence will need to be determined. Note this option is only possible when the engine has an even number of cylinders.

The first ignition drive is labelled "IGN 1". This drive will control the ignition on the first cylinder in the firing sequence (i.e. 1st cylinder to fire after the sync pulse). When using a wasted spark arrangement this drive will also control its opposing cylinder 360° ahead. The ignition drive labelled "IGN 2" should be connected to the second cylinder in the firing sequence (i.e. 2nd cylinder positioned after the sync pulse), and its opposing cylinder and so on. Table 3.9 summaries this for a range of cylinders. The left-hand column is the position of the cylinder with respect to the sync pulse. The 1st represents the first cylinder in the firing sequence, the 2nd represents the second cylinder in the firing sequence on so on. In most situations the location of this sync will be unknown so refer to the application specific diagrams at the end of this manual. See examples 3.4 for more information.

Firing	Cylinder Number					
Sequence	2	4	6	8	10	12
1st	Ign 1	Ign 1	Ign 1	Ign 1	Ign 1	Ign 1
2nd	Ign 2	Ign 2	Ign 2	Ign 2	Ign 2	Ign 2
3rd		Ign 1	Ign 3	Ign 3	Ign 3	Ign 3
4th		Ign 2	Ign 1	Ign 4	Ign 4	Ign 4
5th			Ign 2	Ign 1	Ign 5	Ign 5
6th			Ign 3	Ign 2	Ign 1	Ign 6
7th				Ign 3	Ign 2	Ign 1
8th				Ign 4	Ign 3	Ign 2
9th					Ign 4	Ign 3
10th					Ign 5	Ign 4
11th						Ign 5
12th						Ign 6

Table 3.9

3.8.1 Wiring Example

Wasted Spark setup for a 4 cylinder.

Typical firing order: 1-3-4-2.

(a) If the sync is on the crank there will be two signals per engine cycle. Otherwise the sync will be at camshaft speed and there will be only one signal per engine cycle.

Sync Position: Between cylinders 1 - 3 with sync on the camshaft.

OR: Between cylinder 1 - 3 & 4 -2 with sync on the crank.

The 1st cylinder to reach TDC after the sync signal is cylinder 3, resulting in the firing sequence 3-4-2-1. Figure 3.14 illustrates the correct connection.

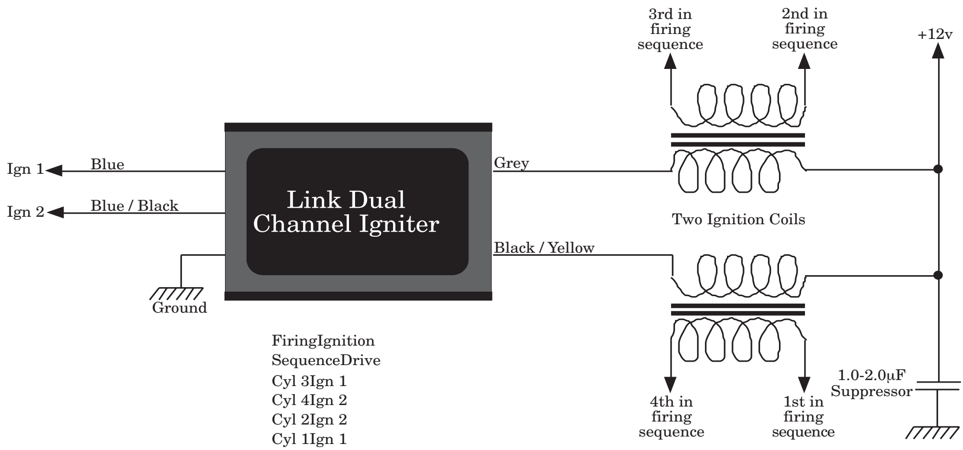


Figure 3.14. Wasted spark example for a 4 cylinder.

(b) Sync Signal - Between cylinders 3 - 4 with sync on the camshaft.

Between cylinders 3- 4 and 2-1 with sync on the crankshaft.

Cylinder 4 is the first to fire after the sync signal. The firing sequence will therefore begin with this cylinder and should be connected the “IGN 1”. The firing sequence is therefore 4-2-1-3. See Figure 3.15.

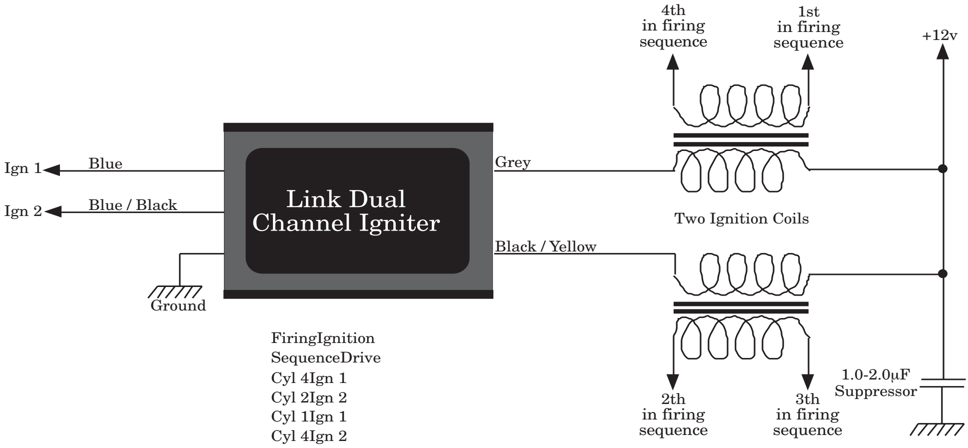


Figure 3.15. Wasted spark setup for a 4 cylinder.

3.8.2 General Installation Guide

The following examples provide a general guide to wasted spark installation. The label “1st cylinder” represents the first cylinder in the firing sequence, “2nd cylinder” represents the second cylinder in the firing sequence etc. All setups show the Link Igniter module, although most factory igniters can be used.

- 4 Cylinder

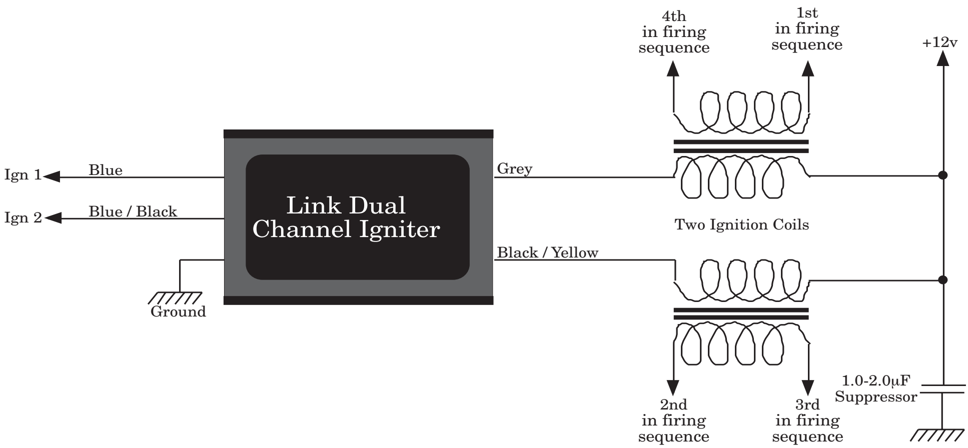


Figure 3.16 Wasted Spark 4 Cylinder

- 6 Cylinder

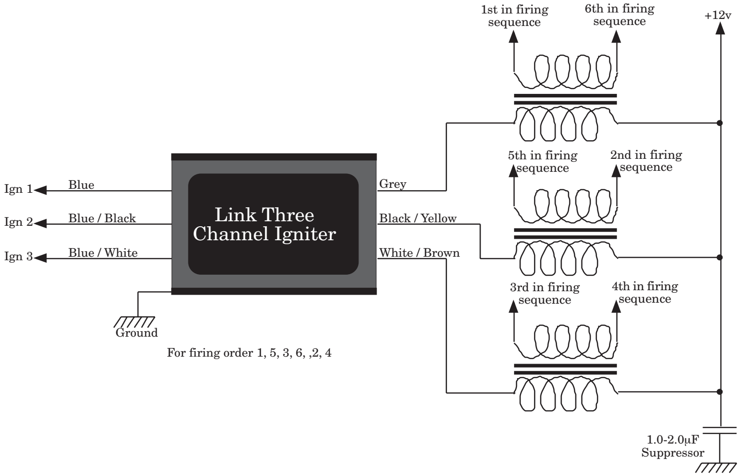


Figure 3.17 Wasted Spark 6 Cylinder

- 8 Cylinder

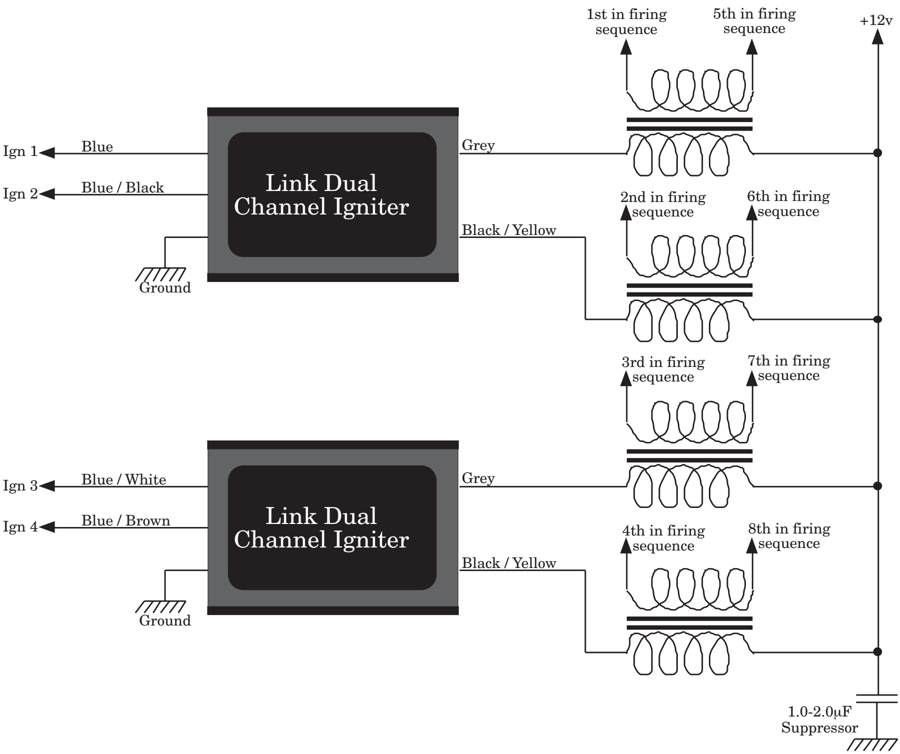


Figure 3.18 Wasted Spark 8 Cylinder

3.9 Low Power Drives

There are 7 low power drives used to switch currents less than 100mA. For this reason, these drives MUST only be used to switch a relay on by supplying an EARTH.

STOP

One relay per drive only

NEVER apply +12V directly. ALWAYS wire the drives to supply a relay earth for pins 85 or 86.

3.9.1 Fuel 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 to prime the fuel system.

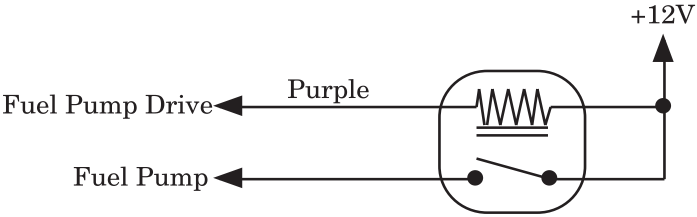


Figure 3.19

3.9.2 Fan (White / Red)

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 4 degrees below the preset value, to eliminate short fan cycles.

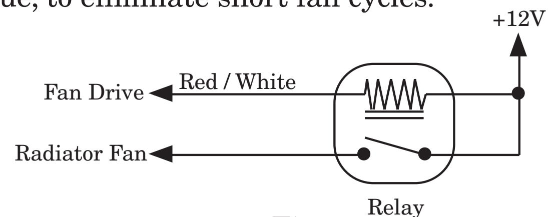


Figure 3.20

3.9.3 Air Conditioning Control (White / Blue)

This drive is used to switch the compressor clutch and AirCon fan via a relay when an air conditioning request is detected by the LinkPlus. This allows the LinkPlus to perform idle speed correction before latching the relay and loading the engine.

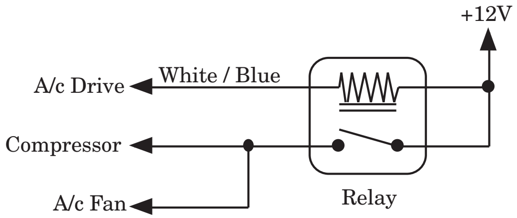


Figure 3.21

Note: This drive will NOT switch on below 500 RPM. Test with engine running.

3.9.4 Purge Control (White / Brown)

As fuel evaporates from the fuel tank, hydrocarbons are released into the atmosphere. In the interest of emissions, the fuel tank can be vented into a charcoal canister. As the canister is small it must be continually regenerated. When the engine is in vacuum (less than 90kPa), air is drawn through the canister and into the engine by switching the purge control relay on. At a manifold air pressure greater than 90kPa the relay will be switched off due to insufficient vacuum.

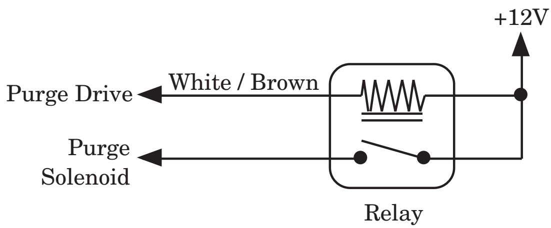


Figure 3.22

3.9.5 Shift Light (White / Black)

Used in conjunction with a dash mounted LED light, the shift light provides a programmable gear shift indicator for racing purposes. This drive is current limited and will supply power to a high intensity LED.

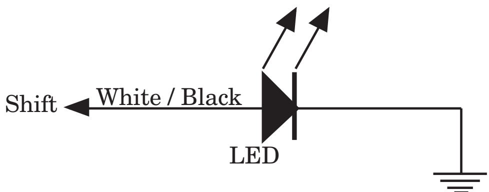


Figure 3.23

DO NOT connect a bulb style shift light to this drive directly, as permanent damage will result. For this type of shift light use either a change-over relay as shown in Figure 3.24 or Drive A or B as shown in Figure 3.25.

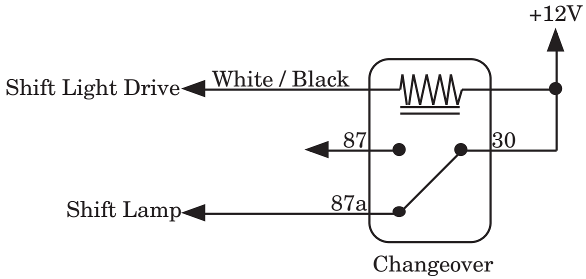


Figure 3.24

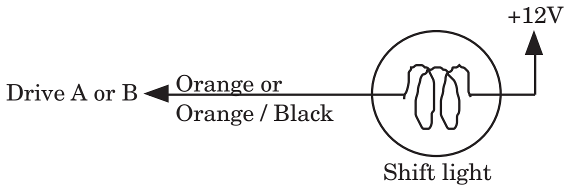


Figure 3.25

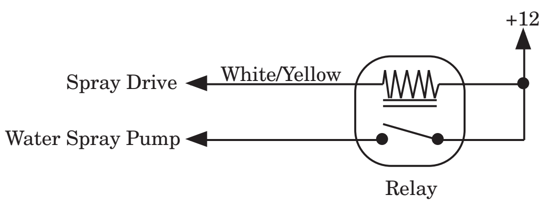
3.9.6 Tacho (White / Green)

Tachometer Drive produces a +12V Peak—Peak, two-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. Connect this wire directly to the tachometer. Two settings are available (refer to Section 13.1.16).

The LinkPlus tacho signal will NOT drive a tachometer designed to run from the coil negative.

3.9.7Water Spray (White/Yellow)

Water Spray Relay. Will provide an earth to activate a pump used to spray a water mist over the intercooler.



3.10 High Power Drives

Each of the following functions use high current drivers switching to EARTH. The amount of current flow is controlled entirely by the internal resistance of the device connected to a drive. If the current is excessive it will cause a PCB fusible link to rupture at approximately 5 Amps.

DO NOT connect +12V directly to these drives.

3.10.1 Drive A & B (Orange); (Orange / Black)

These are two user programmable drives that can be configured to switch at a preset RPM or engine load (% FF). Refer to Section 13 on Configuration for setup information. Figure 3.26(a) shows an example of switching an inlet solenoid or part (b), a VTEC solenoid, that requires a +12 supply. In example (b) DRIVE A or B supplies the earth for the relay and does not switch the solenoid directly.

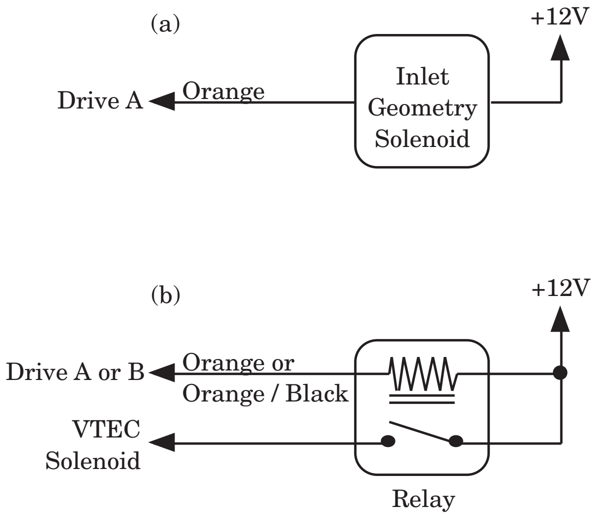


Figure 3.26

3.10.2 Waste Gate (Orange / Yellow)

When Electronic Boost Control is required this wire should be connected to the boost control solenoid. This will electronically modify the pressure signal produced at the compressor outlet to control the waste gate actuator. An optional "defeat" switch can be fitted which removes power from the solenoid, allowing the system to run at minimum boost. This may be useful if driving conditions are adverse, alternatively a hidden switch may be installed to prevent unauthorised high boost operation. For more information read Section 11. Connect as shown in Figure 3.27

Note: The W'GATE signal wire from the LinkPlus provides an EARTH for the solenoid.

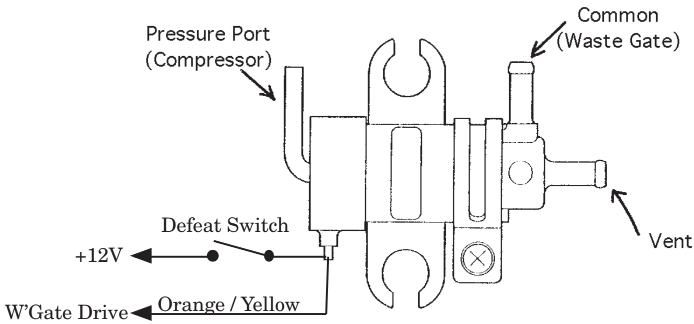


Figure 3.27 Three port boost control solenoid.

3.11 Power Supply

3.11.1 Positive 12 Volts (Red)

LinkPlus +12 volt supply input. This should be connected to an ignition switched 12-volt supply (i.e. always use a relay to supply +12V directly from the battery to the LinkPlus). 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 the voltage does not fall below 7.5 volts when the engine is cranked. This is a common fault causing the LinkPlus to reset and will prevent the engine from starting.

DO NOT use the Coil positive as a power supply for the LinkPlus. Wherever possible use a separate +12V supply.

3.11.2 Power Ground (BLACK)

LinkPlus 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 it is well terminated to a clean earth point, preferably the engine block, (see note in "Signal Ground" below).

3.11.3 Signal Ground (BLACK)

LinkPlus signal ground. This input supplies the low current earth supply for all low-level signal processing of the computer, and forms the reference value for all engine mounted sensors. As such, it is ESSENTIAL 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 run 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 the signal ground.

3.12 Trigger

3.12.1 Trig 1 (WHITE (Grey Screened Cable))

This is the cylinder pulse trigger input. This will come from either a distributor or Crank/Cam Angle Sensor (CAS) and is used to control injectors, ignition timing, RPM limits/switches and 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.

3.12.2 Trig 2 (BLUE (Grey Screened Cable))

Sync trigger input. Used for multi-coil and sequential fuel applications. This input provides a synchronising pulse(s) to establish the correct firing order for the ignition and fuel system. Information will be provided as above (TRIG1) when required.

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.

3.13 Power Outputs

The following are +5V and +12V supplies to power up external modules around the engine.

3.13.1 +5V Out (RED/BLUE) * 2

There are two independent power supplies, that provide a regulated +5 Volts to :

- Throttle Position Sensor (TPS)
- External Map sensor

The TPS is used in idle speed control, boost control, mixed mode scheduling and fuel cuts. It should be connected if any of these options are required. The external map sensor will only require connection if more than 1.5 bar boost is being requested. See Boost Control Section 11 for more information.

3.13.2 +12V Out

(Red – Trig1 Grey screened cable)
(Green – Trig2 Grey screened cable)

This provides a +12V regulated supply to power crank and cam angle sensors.

3.14 Inputs

The following table 3.10 is a summary of the LinkPlus inputs.

Inputs		
E Temp	Yellow	0.5
A Temp	Yellow / Black	0.5
TPS	Yellow / Orange	0.5
AC Req	Yellow Red	0.5
MAP	Yellow / Brown	0.5
O2	White	0.5
Aux 1	Yellow / Green	0.5
Aux 2	Yellow / Blue	0.5

Knock Signal		
Knk 1	Red	(Shielded cable)
Knk 2	Red	(Shielded cable)

Table 3.10

3.14.1 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 available if the factory unit is not suitable or unavailable. Connect the yellow wire to one terminal on the temperature sensor. The other terminal should be connected to an engine block ground.

Note: The orientation of the two wires is not important.

3.14.2 Atemp (Yellow / Black)

Ambient Air temperature input. This allows fuel corrections to be made for variations in air temperature entering the engine. The LinkPlus is setup to use a factory NTC type sensor. If the engine does not have one, and ambient correction is required, a suitable sensor can be supplied. Refer to the Sensor Installation & Wiring section 17 for information on where to place it for best effect.

3.14.3 TPS (Yellow / Orange)

Throttle Position Sensor input. This is used in a number of areas.

- Idle Speed Control
- Boost Control
- Fuel Cuts
- Mix Mode Scheduling

If any of the above options are required the TPS should be connected. To wire either the factory sensor or one provided by Link, an ohmmeter is required. Two of the terminals will show a fixed resistance as the TPS is moved. Connect these terminals to +5V and Ground. The orientation of the +5V and ground does not matter. The result is that the TPS output will either increase or decrease in voltage with throttle position. As the LinkPlus will automatically detect this, the +5V and ground can be connected to either of these two terminals. The last terminal must show a variable resistance between the +5V and the ground terminal. Refer to Figure 3.28.

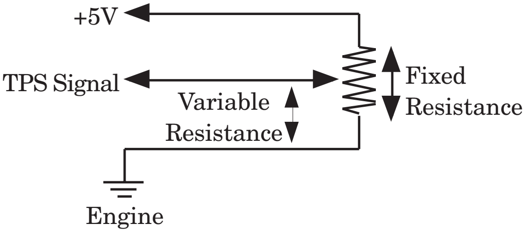


Figure 3.28. TPS Schematic.

IMPORTANT

On some factory systems a throttle switch is used instead of a variable resistance. This can NOT be used with the LinkPlus. If a TPS based function is required, a TPS must be fitted to the throttle shaft.

When a TPS is connected, the span MUST be setup to ensure the correct operation of a TPS based function. Take time to read the Utilities section 8, which explains in detail how to do this.

3.14.4 Air Conditioning Request (YELLOW/RED)

When +12V is supplied to this pin an Air Conditioning request is generated. This allows the LinkPlus to increase the engines idle speed (if connected), before engaging the compressor clutch. The required idle increase will vary with engine type, hence this value has been made adjustable.

3.14.5 External Map (YELLOW/BROWN)

On a turbo engine requiring more than 1.5 Bar of boost, an external map will need to be fitted. This will be a 3- Bar GM Map sensor and its output should be connected to this terminal. Remember to select the "External Map" from the * CONFIGURATION* heading. This map sensor will need to be mounted inside the engine compartment and wired to the LinkPlus as shown in Figure 3.29.

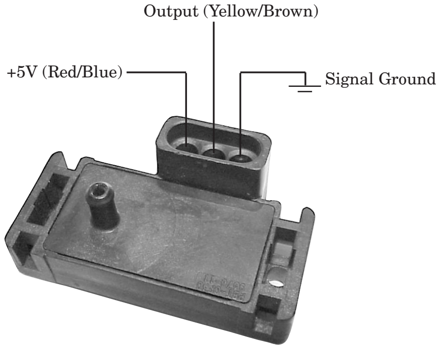


Figure 3.29. Three bar GM Map Sensor.

3.14.6 Oxygen Sensor (WHITE)

Oxygen sensor input. An optional input for those systems using closed-loop lambda control. Refer to section 10.

3.14.7 Aux 1 (YELLOW/GREEN)

This input is used to switch ON the Anti-lag systems and requires a +12V supply. Refer to section 11.6.4 for wiring options.

Note: READ section 11.6 carefully before wiring.

3.14.8 Aux 2 (Launch Control & Flat Shifting) (YELLOW/BLUE)

When using "Launch Control" or "Flat shifting", this wire can be connected to a switch on the clutch pedal, as shown in Figure 3.30 (A gear knob button would also be suitable and can be wired in the same manner). Connect the Yellow/Red wire to one terminal and ground the second terminal. With the pedal depressed the launch system is activated. When released the system is deactivated. This will allow launch control to function during takeoff and flat shifting.

Wiring Check – The LinkPlus AUX2 output supplies +12V on the Yellow/Blue wire. With the clutch pedal released use a multi-meter to confirm +12 Volts. Next with the pedal pressed to the floor, check that the voltage on the yellow/blue wire has dropped to 0V.

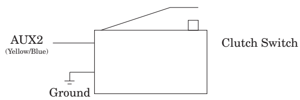


Figure 3.30. Clutch Switch

3.14.9 Knock Sensor.
The LinkPlus offers dual knock input. There are two single core, Grey screened cables for each knock sensor.

Single Terminal Knock Sensor: Connect the red wire to this terminal and the braid onto the engine block, close to the sensor.

Two Terminal Knock Sensor: Connect the red wire to one terminal, the other terminal to the braid. The orientation of these two wires does not matter.

The knock sensor should be tested before the Knock control systems is activated. See Section 9.3.

3.15 Idle Speed
The LinkPlus can be wired for solenoid or stepper type idle speed device.

3.15.1 Auxiliary Air Valve
Some engines use an auxiliary air bypass valve as a way of controlling the idle as the engine warms up. This allows air taken from before the butterfly to be bypassed into the inlet manifold as a function of temperature. This device contains a bimetallic strip, which is heated both from engine temperature and electrically. As the engine warms up the bypassed air is reduced and the idle is returned to its normal level. This type of device cannot be pulse width modulated to control idle. It is intended ONLY as an idle up when the engine is cold.

3.15.2 Solenoid
There are 2 pins dedicated to control either a 2 or 3 terminal idle speed control (ISC) solenoid. Figure 3.32(a) is a 2 terminal, part (b) is a 3 terminal solenoid.

ISCO (idle speed control open) – ORANGE/GREEN
ISCC (idle speed control closed) – ORANGE/BLUE

- 2 Terminal Solenoid
  Connect one terminal to a switched +12V supply and connect the remaining terminal to the ISCO wire. See Figure 3.32 (a). The orientation of these wires do not matter.
- 3 Terminal Solenoid
  If the solenoid is a 3 wire device the ISCO and ISCC will need to be connected to the correct terminals. This will prevent the ISC

system working in the reverse sense (i.e. engine idle increasing as the LinkPlus tries to reduce idle). The following test should be done.

Firstly use an ohmmeter to find the common terminal (usually the centre). Figure 3.31 shows the schematic. Next measure the resistance between the common and remaining two terminals. This number should be greater than 10 ohms. Now apply +12V to the common terminal of the solenoid. While viewing the outlet of the solenoid, ground one of the other terminals. If the solenoid valve closes, connect this terminal to ISCC (ISC – Closed). Likewise if the valve opens, connect this terminal to ISCO (ISC - Open). Apply ground to the remaining terminal to ensure it works in the opposite sense.

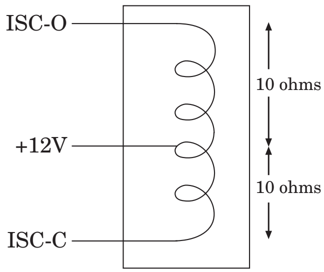


Figure 3.31. Three terminal ISC schematic .

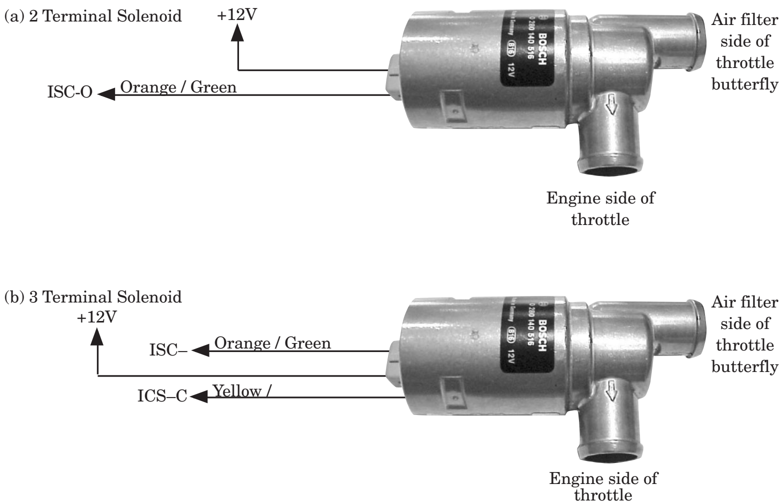


Figure 3.32. Idle Speed Control Solenoids

3.15.3 Stepper Motor

The LinkPlus can control 4 or 6 terminal idle speed stepper motors. The type must be known prior to delivery, as the appropriate module must be inserted into the LinkPlus.

DO NOT connect +12V directly to these terminals.

- 4 Terminal

  Figure 3.33 shows this type. Use an ohmmeter to find the 2 common coils. Note that Step A and B are paired to one coil and Step C & D on the second. The orientation of the pairing does not matter as idle speed direction can be altered via software.

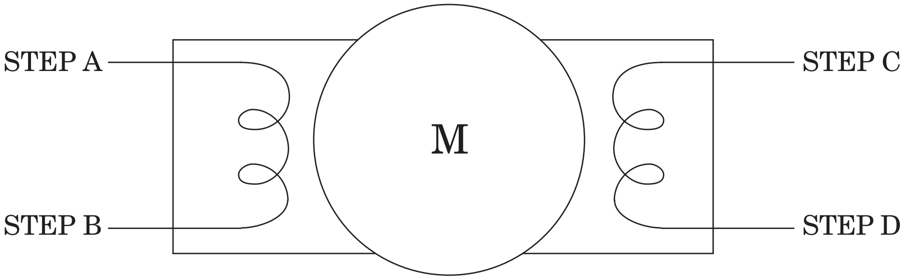


Figure 3.33. Four terminal stepper motor.

- 6 Terminal Stepper

  This type of stepper will have 2 centre tapped coils. Use an ohmmeter to find these (as shown in Figure 3.34). Note the centre of each coil is supplied with +12V. The coils will typically have a resistance of approximately 30 to 50 ohms. Pair Step A and B on one side and Step C & D on the second side.

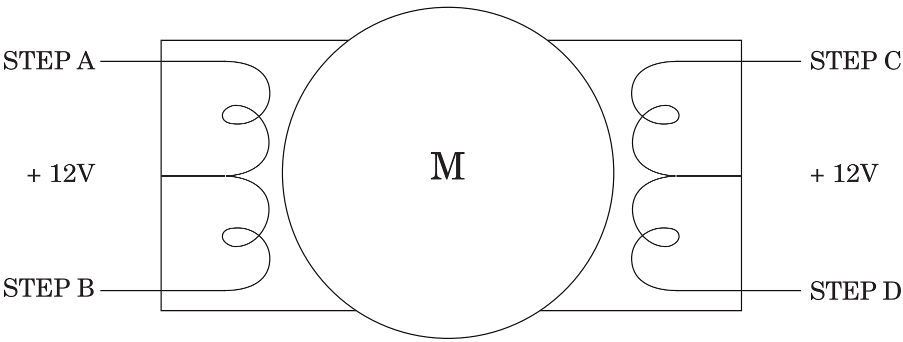


Figure 3.34. Six terminal stepper motor.

4. Fuel

The LinkPlus offers the option of either Group fire for up to 12 cylinders or Sequential fuel delivery for a maximum of 8 cylinders. The actual injection hardware for these two options is very similar with the exception that each injector for sequential mode is individually wired back to the ECU (All other aspects such as injector location, fuel supply and manifold layout remain the same). The main difference is that a Sequential system requires a more complex crank/cam-angle sensor, which ensures each injector is phased to the correct cylinder such that it opens on the inlet stroke.

i) Group Injection

The injectors are wired in either one single group, or more commonly in two groups for higher cylinder engines. Since several injectors are operating simultaneously, each inlet port will be on a different phase of the engine cycle i.e. some cylinders will be on intake phase while others may be on compression, exhaust etc. The injection rate is once per engine cycle and is locked to the engine RPM (synchronous), but not indexed (phased) to the engine cycle.

ii) Sequential Injection

Each injector is individually wired and controlled by the ECU, and can only inject once per engine cycle (2 rev. of crank). The injection is phased to the engine such that the injector operates only while the inlet valve is open so the fuel does not "reside" in the port. Secondly, some advantage may be had from the higher air velocity in the port during the induction stroke, which may improve air/fuel mixing to some extent. This may prove advantageous at idle, in engines required to meet stringent emissions regulations.

iii) Simultaneous Injection.

For every revolution of the crankshaft all injectors are opened together. This injection is used during crank when sequential fuel is selected. During the initial cranking phase the cylinder position has yet to be determined, so the LinkPlus cannot initiate sequential fuel. By using simultaneous injection, fuel can be introduced sooner, allowing the engine start quicker. Once running the fuel delivery is switched to sequential.

iv) Mixture Compensation at high altitudes

The low density at high altitudes requires a leaner air-fuel mixture. This is achieved by reducing the injector duration by a calibrated amount to maintain a constant AF ratio. As the LinkPlus operates from a speed-density principal, any change in altitude, hence density, is automatically compensated for.

4.1 Functions

To edit the following Fuel functions, connect the Link Tuning Module and move to the *   FUEL   * heading. The EDIT buttons can be used to scroll through this menu.

4.1.1 Master Fuel

Controls overall fuel injection scheduling and is effective throughout the entire operating range from idle to full power. The scale ranges from 0..255, the higher the value, the greater the overall fuel.

4.1.2 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..295) 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 wandering about the table making localised corrections. (It is quite difficult to hold the engine in any one of 200 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.

4.1.3 ZoneFuel

There are 200 fuel zones arranged in a rectangular grid consisting of 10 ROWS by 20 COLUMNS. The ROWS progress in steps of Manifold Air Pressure or Throttle Position 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. For example 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..255.

4.1.4 Injector Reference

This menu will only be adjustable if sequential fuel mode is selected. By using the cylinder number and assuming the injectors have been wired to the firing sequence, the LinkPlus will automatically open each injector on the inlet stroke. A small adjustment allows the injectors to be opened +/- one TDC either side of the inlet stoke. The Tuning module will display the current injection stroke. To change the setting use the ADJUST buttons.

4.2 Selecting Fuel Delivery Mode

To select this mode, connect the Link Tuning Module and move to the * CONFIGURATIONS * heading. Scroll down to the "Fuel = Group" menu using the EDIT DOWN button. Use the ADJUST buttons to select the required mode, Group or Sequential.

Note – Sequential Fuel Delivery can only be selected on 8 cylinders or less.

4.3 Synchronisation Signal

With sequential injection each injector must be phased correctly to the engine meaning a sync pulse is required to determine engine position and hence the firing sequence. The Sync pulse MUST ONLY appear ONCE per engine cycle (2 crankshaft revolutions). Hence the camshaft will need to provide a sync signal. If the sync is generated from the crankshaft the rate will be twice that required resulting in incorrect operation.

If the current engine configuration does not meet the requirements, a trigger wheel will need to be fabricated and driven from the camshaft.

5. Fuel Auxiliary

5.1 Functions

The following adjustable functions are available under the Fuel Auxiliary heading.

5.1.1 Clamp

This will clamp 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 volumes. The value shown in (xxx) is the actual MAP value and the far right value = the clamp value. Typical values range from 30. . 35 for normal engines. The clamp is only active below 1500 RPM.

5.1.2 Inlet Air Temperature (IAT)

Allows adjustment for compensation of inlet air temperature on air/fuel ratio. Cold air is denser, so for the same throttle position, the volumetric efficiency of the engine will reduce as air temperature increases. As inlet air temperature rises the fuel is reduced to compensate for the lower air density. The number in brackets shows the actual air temperature in degrees Celsius. The fuel correction number is displayed on the right and can be changed using the ADJUST buttons.

Note: The far right characters on the Tuning Module will display N/C if the sensor is not connected.

5.1.3 Accel

When the throttle is abruptly opened, the air-mixture is leaned out briefly. To achieve good throttle response acceleration, enrichment is required. There are 4 ACCEL zones, the first 3 covering a 2000 RPM span, the last zone covering a 4000 RPM span. By definition:

ACCEL zone 1 covers 0 - 2000 RPM
ACCEL zone 2 covers 2000 – 4000 RPM
ACCEL zone 3 covers 4000 – 6000 RPM
ACCEL zone 4 covers 6000 – 10000 RPM

By using 4 zones it allows the enrichment to be optimised and set for varying conditions. The two inputs available to calculate enrichment are MAP or TPS, selectable from the * Configuration* heading. The amount of enrichment is dependent on rate of change, and engine temperature. 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).

5.1.4 Accel Decay

Controls the rate at which the acceleration fuel is removed from the engine. The larger the number the longer it takes to remove the ACCEL fuel from the engine. Likewise, a smaller number will reduce the time it takes to remove this fuel. To change this setting use the ADJUST buttons. A typical value is 6; 15 represents a "very long" decay time, 1 represents a "very short" decay time.

5.1.5 WakeUp Width

WakeUp Injection will fire a short burst of injector pulses per engine TDC when transient enrichment is required. This will improve the engines throttle response and should be used in conjunction with the 4 existing ACCEL Zones. Adjustment is provided for both the width and number of pulses.

"WakeUp Width" will control the width of each WakeUp pulse. The default value is 210, giving a 1.1ms pulse width. To increase the width, increase this number.

5.1.6 WakeUp Pulse

This controls the number of additional pulses added when transient enrichment is required. The Default value is 4. This means 4 additional closely spaced pulses will be added, each 1.1ms in width.

To switch this function off set the number of pulses to zero.

5.1.7 Cold (Post-Start warm-up)

Controls cold start and warm up enrichment by adding extra fuel to the engine. The adjustment value is shown on the right hand side of the display and will gradually reduce to zero as the engine temperature rises towards 70°C. Note this is the temperature-decayed-value rather than the full cold value. The number shown in parenthesis (xxx) is the actual engine temperature for monitoring purposes.

Note: The far right characters on the Tuning Module will display N/C if the sensor is not connected.

5.1.8 Volts Correction

Provides a compensation value for fluctuations in battery voltage caused by heavy electrical loads being switched on and off e.g. headlights, heaters, fans or engine cranking. The opening time of the injector will vary with battery voltage. In order to compensate for this, the LinkPlus will increase injection duration with a falling voltage supply. This will prevent surging idle speeds and is of particular significance on crank when the battery voltage can drop as low as 8 Volts.

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 voltage is also displayed for monitoring purposes.

Note that the adjustable value does not represent actual voltage but is a trim value with no particular units.

5.1.9 Prime Temperature

This allows the pre-start injector prime temperature to be adjusted. At low temperatures the mixture formation is inadequate to start the engine. This is due to the poor mixing of air and fuel, as well as fuel condensation on the cylinder walls. To compensate for these losses, if the engine temperature is BELOW the prime threshold at key-on, the engine will receive a short injector shot to assist starting.

Note this setting is checked when the LinkPlus is powered up, so any adjustment will only take effect if the power is recycled. Use the ADJUST buttons to alter the temperature.

5.1.10 Air Conditioning Enrichment

From this menu extra fuel can be added when the Air conditioning is switched on, assuming it is controlled by the LinkPlus. When the AirCon compressor is engaged the extra load can cause unstable idle, so extra enrichment can be introduced to help stabilise this. The default value is 0 implying no added fuel. The enrichment is only active below 1500 RPM. To change this setting use the adjust buttons.

5.1.11 Crank Enrichment

This is the amount of extra fuel added while the engine is cranked and for a short period after starting. It is a temperature dependent enrichment and only effective when the engine temperature is below 50oC. The actual value used by the LinkPlus will provide more crank enrichment with decreasing engine temperature and will decay with time (see crank decay).

The SMALLER the number, the GREATER the enrichment. The base default value is 70.

5.1.12 Crank Decay

This controls the rate at which the crank enrich fuel is removed. The larger the number, the longer it will take to remove this fuel. Use the ADJUST buttons to change this number. A typical value is 20. Upper limit = 40 (Long decay period), Lower limit = 5 (Short decay period).

5.1.13 Hot Restart

When the engine temperature is above 80°C addition fuel can be added to help stabilise idle on a hot restart. The extra fuel will remain active for 1 minute after restart allowing time for under bonnet temperatures to reduce and the engines mixture to stabilise. The default setting is 0, which means no hot restart compensation.

5.1.14 Lag Fuel

Provides additional fuel for the cooling of exhaust gases. The default value is 8 which should be adequate. This function is only active when anti-lag is running in full retard mode.

6. Ignition

The LinkPlus offers 8 Ignition drives which can be configured from a basic distributor setup through to the more complex Multi-Coil arrangements. The following configurations in Table 6.0 are supported by the LinkPlus.

Cylinder Number	Distributor	Wasted Spark	Direct Spark
1	YES		1 Single Coil
2	YES	1 Dual Post Coil	2 Single Post Coils
3	YES		3 Single Post Coils
4	YES	2 Dual Post Coils	4 Single Post Coils
5	YES		5 Single Post Coils
6	YES	3 Dual Post Coils	6 Single Coils
8	YES	4 Dual Post Coils	8 Single Coils
12	YES	6 Dual Post Coils	

Table 6.0. LinkPlus Ignition Configurations

i) Ignition Drives

The igniter drives (labelled IGN1 – IGN8) are used to control an external igniter module producing ignition spark under programmed control. The output from these drives is a pulse waveform with the following features.

- The igniter signal can equal or be advanced in timing with respect to the input trigger signal.

  NOTE
  The LinkPlus may advance the timing but cannot retard beyond the base (input) timing).

  Below 500 RPM the engine will run ONLY on base timing. The LinkPlus will not generate electronic advance.

- The dwell angle varies with engine speed to produce maximum coil output with minimum wastage. Essentially the LinkPlus switches the coil current on at a calculated time before the spark is required, so 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.

- 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.

ii) Igniter

The Igniter module is a device used to switch the coils off or on by supplying a ground for the coil negative. A link igniter module is shown in Figure 6.0. 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 a high-tension lead become disconnected or similar.

The signal used to control this is fed from the ignition drives on the LinkPlus, labelled ‘IGN1 to IGN8’. If the factory igniter cannot be used, the Link igniter/s should be mounted inside the engine bay as these carry coil primary current. DO NOT mount the igniter inside the passenger compartment or close to hot engine components such as exhaust manifolds. NEVER mount the Igniter next to the LinkPlus

Figure 6.0 Link Igniter

iii) Coil Type

Low resistance coils (i.e. 1 ohm or less) must be used for maximum output energy, although higher resistance types will still function satisfactorily. This applies to both single and dual post coils in distributed and multi coil applications.

6.1 Tuning Module Functions

The LinkPlus contains all the necessary software to run any configuration from Table 6.0. To select a setup, plug in the Link Tuning Module and select the * IGNITION * heading. Press the EDIT DOWN button once to enter the ignition menu. Use the EDIT buttons to scroll through this menu. The Tuning Module functions appear in the following order.

6.1.1 Zone IGN

There are 200 ignition zones arranged in a rectangular grid consisting of 10 ROWS by 20 COLUMNS. The ROWS progress in steps of Manifold Air Pressure or Throttle Position to provide the "load" axis and the COLUMNS progress in steps of RPM. Each zone therefore represents a unique engine operating condition allowing ignition changes to be made in small, localised areas. The selection of zones is completely automatic, depending on the actual RPM and MAP/TPS 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 the 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.

The adjustment value is shown as degrees of advance, displayed on the right hand side of the display. This value is the actual interpolated number and hence the current advance generated by the LinkPlus. To change a setting use the ADJUST buttons. To edit any static advance angle (i.e. edit the actual zone advance), use the zone editor. The current operating zone is displayed in the centre of this menu.

6.1.2 Static IGN

This function is used to tell the LinkPlus what static (base) timing has been set. For example, if the static timing has been set at 10° BTDC (see 6.2), then 10° should be entered. The Static IGN number is added to all of the zone ignition numbers so that they represent the actual ignition advance received by the engine (not just the advance generated by the LinkPlus). This number is for display purposes ONLY and will NOT cause the LinkPlus to advance the ignition timing. The default value is zero.

6.1.3 Set Static-Timing

This allows the static (base) timing of the engine to be adjusted or checked (see 6.2). By pressing the ADJUST UP button, the Set Static function is switched on. This automatically sets the advance limit to zero so that the LinkPlus generates zero degrees of advance. When this function is switched ON, the Advance Limit menu will show 00°. This allows the static timing of the engine to be checked using a timing light.

Note: When power to the LinkPLus is removed this function will always return to the default OFF setting.

6.1.4 Dwell Time

Use with caution. Incorrect dwell (too long) may result in coil/igniter failure.

Typical settings

Distributor (1 coil)	=	5 - 5.5 mS
Multicoil (waste spark)	=	4 mS
Multicoil (coil per plug)	=	3 mS

Dwell set too short will result in the coil not fully charging. The engine may misfire at higher RPM. A hot igniter or coil <u>may</u> indicate too much dwell.

Note: Modern 'coil over plug' assemblies have very little heat soak ability and may fail while still relatively cool to the touch. This is due to the poor heat conductivity of the resins within the coil.

Note: 3 mS is the default value which <u>will</u> require adjusting for most applications.

6.1.5 Ignition Type

This menu allows the ignition setup to be selected. Before selecting one of these options ensure the necessary hardware has been installed and wired in. To prevent an accidental change to this setting, it cannot be altered while the engine is running.

The two options are:

Distributor
To select this option, press the EDIT UP button and the menu will display "Ign Type: Distributor".

Multi-Coil
To select this option press the ADJUST DOWN and the menu will display "Ign Type: Multi-Coil". If Multi-Coil is selected the option of Direct or Wasted spark is available.

NOTE. Any changes here will be automatically stored. This option cannot be changed while the engine is running.

6.1.6 Multi-Coil Type

When the ignition system is configured for Multi-Coil operation the following options are available:

Wasted Spark
To select this mode press the ADJUST DOWN button. The menu will display "x – Dual Coils", where 'x' represents the required number of dual post coils. This mode will only be permitted when using an even number of cylinders.

Direct Spark
In this mode there is one coil per cylinder. To select this mode press the ADJUST UP button to display " x – Single Coils", where 'x' represents the required number of coils.

NOTE: Any changes here will be automatically stored. This option cannot be changed while the engine is running.

6.2 Setting Static Timing

The static timing is defined as the ignition timing that will occur when the LinkPlus ignition timing is set at zero degrees (no electronic advance). The LinkPlus default ignition curve is based on a static timing of 10°BTDC. Therefore it is essential that this is checked before driving the vehicle. Any variation in the base timing will need to be considered when adjusting the zones of the ignition table. Note that below 500 RPM (while starting the engine) only the base timing is effective and should be set for optimum starting characteristics.

Adjustment
With the tuning module connected and the engine running, move to the * IGNITION * heading. Press the EDIT DOWN button twice to display the "SET STATIC: OFF" menu. Press the ADJUST UP button to turn the function on (This can only be done with the engine running). This will zero the electronic advance generated by the LinkPlus, allowing the

engines static timing to be checked with a timing light. To adjust the static timing, the distributor or crank angle sensor may be rotated on most engines. Once the desired static timing has been set, the Set Static function should be turned off by pressing the ADJUST DOWN button. The static timing number should then be entered into the Static IGN function (see 6.1.2).

6.3 Distributor

6.3.1 Definition

A distributor routes the high voltage generated by the coil to the intended spark plug via a rotor and HT wiring. It rotates at half the crankshaft speed.

6.3.2 Trigger Requirements

The only information required for ignition timing, is one signal representing every engine TDC. This can be generated from optical, hall, magnetic pick up etc.

6.4 Multi-Coil: Wasted Spark

6.4.1 Definition

Wasted spark will fire two cylinders simultaneously, using a common dual post coil. During a crankshaft revolution, one cylinder is fired on the compression stroke, the other offset by 360o crankshaft angle (i.e. the opposing stroke = exhaust stroke). One crankshaft rotation later, these two cylinders are two working stokes further ahead and the spark plugs fire again, but now with reversed roles. The result is that one coil will be fired twice per engine cycle hence the term "wasted spark". This setup can ONLY be used on engines with an even number of cylinders. The maximum number of cylinders the LinkPlus can drive on wasted spark is 12.

6.4.2 Trigger & Hardware Requirements

Cylinder Pulse

For the correct timing of ignition, the crank or cam sensor MUST provide a signal that can be decoded to produce one pulse per engine TDC. On a 4-cylinder engine for example, this is 2 TDC pulses per crankshaft revolution (4 per Camshaft revolution) and an 8-cylinder engine will have 4 TDC per crankshaft revolution (8 per camshaft revolution)

Sync Pulse

To determine the correct firing sequence, a sync pulse is required as a reference to determine engine position. The sync pulse can only appear once on the crankshaft (1 signal per engine revolution) or once on the camshaft (1 signal per engine cycle).

Dual Post Coils

One Dual post coil is required per 2 cylinders with a primary resistance less than or equal to 1 ohm. Figure 6.1 shows a typical coil. The coils should be positioned so they minimise the length of the HT Leads. This will help reduce the noise generated when the spark plugs are fired.

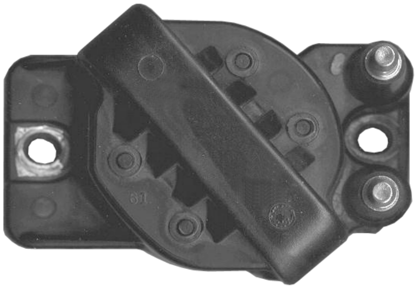


Figure 6.1 Dual Post Coil

Important Points for Wasted Spark

- When two spark plugs are fed from one dual post coil they are connected in series, meaning one plug is "incorrectly" polarised.
- The main concern when using dual post coils is the generation of interference. When two spark plugs are fired together there is twice the spark energy generated and hence twice the radiation produced per engine TDC. This noise level increase can interfere with ECU operation and cause unwanted static on car radios. The following precautions should be used to minimise these effects.

    First install 'Resistive Spark Plugs' if the engine does not currently use them. This will reduce radiation levels and also help even out spark energy distribution. Without it, the spark plug with the least load (exhaust stroke) tends to monopolise spark.

Secondly, ALWAYS use suppressed HT leads, which can be identified by measuring their resistance. Typically they vary from 1000 ohms to 5000 ohms depending on lead length. DO NOT use copper leads under any circumstances.

Lastly always fit a Coil suppresser to the coil positive. Any value between 1uF and 10uF will be suitable.

Therefore when using Dual Post Coils combine the following:

- Resistive sparks plugs
- Suppressed Leads
- Coil Suppresser (1uF – 10uF)

6.5 Multi-Coil: Direct Spark

6.5.1 Definition

Direct spark uses an ignition coil per cylinder, firing each cylinder once per engine cycle (2 crankshaft revolutions). If multi-coil operation is required for an odd number of cylinders, the only option is to use an ignition coil per cylinder. This mode is also suitable when the number of cylinders is even and 'wasted spark' has not been selected. The LinkPlus can drive a maximum of 8 cylinders with direct spark.

6.5.2 Trigger & Hardware Requirements

Cylinder Pulse
For the correct timing of ignition the crank or cam sensor MUST provide a signal that can be decoded to produce one pulse per engine TDC. For example, on a 4-cylinder engine this is 2 TDC pulses per crankshaft revolution and an 8-cylinder engine will have 4 TDC per crankshaft revolution.

Sync Pulse
When each cylinder is fired using individual coils a sync pulse is required to determine engine position and hence firing sequence. This signal must ONLY appear ONCE per engine cycle (2 crankshaft revolutions). Hence the camshaft will need to provide a sync signal. If the sync is generated from the crankshaft the rate will be twice that required resulting in incorrect operation.

Single Coils

On factory setups using direct spark, the coil and igniter is usually in one package, mounted over the spark plug. These are normally three terminal devices, +12V, Ground, and an igniter signal. If the coil is accessible, it should have a primary resistance less than or equal to 1 ohm. When using a non-factory arrangement the coils should be positioned so they minimise the length of the HT Leads. This will help reduce the noise generated when the spark plugs are fired.

7. Limits

7.1 Functions

The following functions are available from this heading.

7.1.1 Rpm Limit

Sets the RPM limit. Limiting is achieved by 100% fuel cut until the RPM drops below the preset value. A soft limit is evoked 200 RPM before this by removing alternative spark.

7.1.2 Advance Limit

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

7.1.3 Map Limit

Sets Manifold Air Pressure limit to prevent over boost. Values are expressed in absolute pressure so all values above 100 kPa represent boost pressures. The LinkPlus will 'soft' limit the engine 10kPa before the MAP limit. If the engine reaches the actual MAP limit a hard limit will be evoked, cutting all fuel and ignition.

e.g. 150 kPa = 9 psi boost

200 kPa = 15 psi boost

Upper limit = 300 kPa. (When using external MAP sensor)

7.1.4 Map Limit On/Off

This function allows the Map Limit to be switched OFF. This will prevent soft and hard engine limiting when the manifold pressure exceeds the map limit. To switch OFF press the ADJUST DOWN button or the ADJUST UP to switch back ON.

8. Utilities

8.1 Functions

The following functions are available under the Utilities heading.

8.1.1 Overrun Vacuum

This represents the engines MAP when it is running in overrun vacuum. It is a target value used by the LinkPlus to aid in idle speed and fuel control. When the engines manifold air pressure drops below this target, various tasks are actioned by the LinkPlus. As this value is a function of the engine modification state, it will vary, and should always be adjusted as described in section 8.1.1.1

8.1.1.1 Overrun Vacuum Setup

The engine must be at its normal operating temperature before adjusting this setting. With the engine idling observe the MAP value. The overrun vacuum number needs to be approximately 4-5 kPa below this value. As this value is mainly used to aid idle speed control it can be checked during the idle speed setup procedure. Remember that different fuelling and electrical load can vary the engine's MAP at idle. Keep this in mind when setting this value.

8.1.2 Drive A Setup

This is a power drive capable of switching up to 5 amps. It can be configured to turn ON at a preset RPM or engine load. This should be setup from the *Configuration* heading. This menu allows the switching point to the adjusted.

- Drive A : RPM configured

  The menu will display "Drive A 4000 RPM" by default. The drive will switch ON at 4000 RPM and OFF at 3800 giving 200 RPM of hysteresis. The RPM can be changed in steps on 100 by using the ADJUST buttons.

- Drive A: %FF (Fuel Flow) configured

  The menu by default will display "Drive A 15 %FF". When the engine load reaches 16%, fuel flow Drive A will be switched ON. The %FF can be changed by using the ADJUST buttons.

8.1.3 Drive B Setup

This drive performs exactly the same operation as Drive A but acts independently. Drive B configuration can be setup from the * Configuration * heading, using this menu to adjust the switching point.

8.1.4 Shift Light

This sets the RPM at which the shift light is turned ON. Use the ADJUST buttons to change the value in steps of 100RPM.

8.1.5 Temperature 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 that the fan will operate. Note that there is a 4-degree difference between switch on and switch off to prevent repetitive, short fan cycling.

8.1.6 TPS Range

From this menu the TPS range can be defined. This is where the TPS will point to from closed through to wide-open throttle (WOT). By default this menu will display "TPS RANGE 10 - xxx".

- 10 : At fully closed throttle the TPS will point 10 on the Zone Table load (vertical) axis. This is defined as the "TPS low" value and is NOT adjustable.
- xxx : When the throttle is fully depressed to its wide-open position the TPS will point to 'xxx' on the zone table, where 'xxx' can be between 45 & 255. This is defined as the "TPS high" value. The default value is 100.

Note this menu ONLY sets the range. To make the TPS span this range, read the next section (8.1.7).

Criteria to setup 'TPS High" value

DO NOT adjust the "TPS High" value unless ROW STEPS has been selected to:

- ROW STEPS = TPS or
- ROW STEPS = TPS + MAP

In all other modes the default setting of 100 should remain. For more information on selecting this value, view section 13.2 "Mixed Mode scheduling". If this value has been changed the TPS will need to be setup to span this new range. See section 8.1.7. The maximum "high" value is 255, which is the centre of row 8.

8.1.7 Throttle Position Sensor (TPS) Span

This allows the TPS to span the range defined in section 8.1.6. The menu will display "TPS Span   xxx" where ‘xxx’ represent the TPS span. For example if the TPS Range was 10 - 100, this menu will setup the TPS span ensuring it points to 10 at closed throttle (i.e. "xxx" = 10) and 100 at wide-open throttle (i.e. "xxx" = 100).

The throttle position sensor is used in the control of:

- Idle Speed Control
- Boost Control
- Fuel Cuts
- Mixed Mode Scheduling

If any of these functions are required, the TPS MUST be connected. Section 8.2 describes the setup procedure.

8.1.8 Water Spray

From this menu the switching point of the Water Spray can be adjusted. This function will ONLY be active under boost. The menu displayed will reflex its switching configuration. It can be setup to turn ON at a preset MAP or engine load. To adjust this use the *Configuration* heading.

- Spray ON 70 %FF (Default value)

  The Water Spray will switch on at 70% Fuel Flow. Use the ADJUST buttons to change the % FF.

- Spray ON 240kPa (Default value)

  The Water Spray will switch on at 240kPa. The MAP value where this function turns ON can be changed by using the ADJUST buttons.

8.1.9 Water Spray Duty Cycle

This setting controls the duty cycle (ON to OFF ratio) of the spray pump allowing a "soak and dry" period for the spray. This will greatly reduce the water required as no advantage results in continually drenching the inter-cooler. The cooling effect comes from the evaporation of the water rather than the temperature of the water itself. The total cycle time is 6 seconds (ON + OFF time). The default setting is 50%, meaning an equal ON and OFF time of 3 seconds. A value of 80% means an ON time of 4.8 seconds and OFF time of 1.2 seconds. To change the duty cycle use the adjust buttons.

8.1.10 Launch RPM

The Launch RPM can ONLY be adjusted if this function has been activated from the * CONFIGURATION * heading. This sets the RPM at which the engine will limit when the launch system is activated via a clutch switch or gear knob button. See section 8.3 for setup information.

8.1.11 Launch Rise

Sets the rate of rise of RPM after the clutch has been released. Effective range = 800/sec to 25,000/sec. Default = 3000/sec.

8.1.12 Launch Retard

Sets the amount of ignition timing retard while the clutch is depressed. This value is SUBTRACTED from the current advance angle value right down to zero degrees (TDC), but not beyond. This feature should help improve turbo spooling prior to launch. Set to 0 if no retard is required. Default value = 25 degrees.

8.2 TPS Span Adjustment

Switch the ignition on. DO NOT start the engine. Move to the * UTILITIES * heading and scroll down displaying the TPS Range menu. If required, adjust the 'TPS high' value, otherwise leave the default setting at 100. Press the EDIT DOWN button once to display the TPS span menu. The right side value represents the actual TPS Span value.

Setting TPS Span for Closed Throttle

> With the tuning module on the TPS menu and ensuring the throttle is closed, press and hold the ADJUST UP button. The menu will display "TPS – CLOSED xxx" where 'x' represents the throttle

voltage. The button can now be released which will store the closed throttle voltage. Now fully open the throttle.

Setting TPS Span for Wide Open Throttle

At Wide Open Throttle (WOT) press and hold the ADJUST DOWN button to display the menu "TPS – WOT xxx". Release the button and return the throttle to the closed position.

Note. These numbers will be automatically saved so a STORE is not required.

Checking the TPS Span

Once the TPS Span setup is complete the actual "low" and "high" values should be checked. With the throttle closed, the remote MUST show a "low" value of 10. With the throttle fully open the "high" value should show the required number (It will show 100 if the default setting is used).

8.3 Launch Control Setup

This function allows full throttle stationary launching and is controlled from Input Aux2. When launching a vehicle from stationary, the throttle fully open and the clutch engaged, the LinkPlus will limit the engine to an adjustable preset RPM. When the clutch is released, the hard limit is turned off, replaced by the "Launch Rise" function which controls the rise in engine RPM. When the next gear is selected by depressing the clutch, the driver can keep full throttle, as the LinkPlus limits the engine RPM while the clutch is engaged (flat shifting function — see Section 8.4).

Dash mounted switch: When using this setup the Launch Control Switch MUST be a NO (Normally Open Switch). With the switch in its ON position the launch-input line is pulled low to ground and the system activated. When the switch is in its resting position the launch input line returns to +5V deactivating the launch function.

Clutch switch: It should be positioned so the switch makes contact when the clutch pedal is fully released. This allows the clutch "weight" to be taken up when the launch system is activated. When the pedal is fully released the switch makes contact which deactivates the launch system. This MUST be a NC (Normally Closed) switch. With the clutch engaged, the switch should be closed circuit. With the clutch fully released the switch should be open circuit.

8.3.1 Arming Procedure

This function is intended for launching the vehicle from a stationary position. For this reason once the vehicle has been launched the launch function remains off until the system has been rearmed. A separate flat shifting function is available.

Check to ensure the launch function is switched ON. With the engine idling press the launch control button. This may be as switch on the dash or a switch positioned on the clutch pedal. Hold the switch for the arming period of 4 seconds. After this time to launch system will be armed. To indicate this the tacho output on the LinkPlus will be switched off for 1 second. If the vehicles tacho is controlled by the LinkPlus the tacho will momentary reset to zero indicating the launch system has been armed.

Alternatively, the "Launch Status" can be viewed from the Tuning Module under "Utilities" or from the runtime flags in PCLink.

The Launch control system is now armed. On the first time setup gradually apply throttle to ensure the engine RPM limits to the launch RPM. Releasing the switch starts the launch control system by controlling the engine RPM rate of rise. At this point the system becomes disarmed. To rearm the launch button must be pressed again for the arming period of 4 seconds.

The main advantage of this system is when the launch switch is positioned on the clutch pedal. The disarming prevents the system rearming when the clutch is pressed to select the next gear. This means the launch control is used for the initial launch but remains off for the remaining of the run until the system is rearmed.

Rate of Rise Use to control traction. Excessive wheel slip can be controlled by reducing the value which will slow the engine's rate of rise.

Retard On turbo charged engines this will allow boost to be generated at launch. The amount of retard will control the boost level. The more retard used the more heat will be generated so caution should be observed.

8.3.2 Disarming Procedure

Once the launch control system is armed it can only be disarmed by 3 methods:

1. Power down ECU.
2. Switch Function OFF with PCLink or Tuning Module.
3. Allow engine to reach its launch RPM. Release launch switch allowing launch system to activate.

8.4 Flat Shifting

It is a basic function that allows wide-open throttle gearshifts by using an ignition cut. It shares the same control input as launch control (Aux2). The effect of this is to limit the engine RPM until the next gear is selected. Ideally the switch should be mounted on the clutch pedal. The same switch used for launch control is used for flat shifting. Note that both the launch control and flat shifting can be used together.

Advantages

On a normally aspirated engine it allows smoother and quicker gearshifts with less wear on gearbox components. On a turbo charged engine as well as the above benefits, it allows boost to be maintained during gearshifts. If the throttle is temporary closed the air in the inlet manifold is stalled which means a small lag in boost recovery when the throttle is opened.

Remember. Launch Control is for stationary launching, Flat shifting is for WOT upshifts while the vehicle is moving.

8.4.1 Activation Procedures

Check to ensure the Flat shifting function is switched ON via the configuration menu

Check the TPS sensor is connected and spanned correctly. If the TPS is not currently used, set it to span the defaults setting of 10 to 100.

The function is now activated ONLY when the launch control is disarmed, the TPS is above 60% throttle, RPM >2000 and the launch/Flat switch is ON.

The "Flat Shifting" status can be viewed from the Tuning Module under "Utilities".

Note: The status will only indicate ON if ALL the activation settings are correct.

Combining Launch Control and Flat Shifting

If both functions are enabled they are activated as follows:

Launch Control: Aux2 input pulled and held to ground for >4 seconds.

Flat Shift Active: Launch control disarmed. TPS >60, RPM >2000.

In summary, if Aux2 is held low at any time for 4 seconds, the launch control system will arm. This condition should never occur during gear shifts when flat shifting is required.

9. Knock Control

Knock control uses a block mounted, piezo electric microphone (knock sensors) to "listen" for abnormal engine noise / vibrations which occur when the engine detonates (knocks). Analogue filters inside the ECU reject the majority of unwanted signals but the software processing this signal requires a certain amount of discrimination. Once a knock event has been detected, ignition timing is removed from the current ignition zone (1 of 200). The maximum amount of retard is six degrees from any one zone, although the system will not retard beyond zero degrees electronic advance (base timing).

E.g. If original zone value was 5 degrees, then at maximum retard produced by the LinkPlus would be ZERO, not -1 degrees.

All Corrections are temporary unless stored i.e. they will be lost when the key is turned off.

This arrangement allows the system to be more adaptive to the current conditions. For example, driving one day with poor fuel will cause the system to make corrections where necessary but with no long-term storage. This means when superior fuel is used or climatic conditions change, the ignition map will have a "clean slate" rather than previously compromised values.

The 3 main adjustments for the knock system are:

- Set Base Target
- RPM Target Correction
- RPM Start Point

9.1 Functions

The following functions are available from the Knock heading.

9.1.1 Knock Count

A "knock event" occurs when the engine noise, transmitted by the knock sensor exceeds the Knock target. Once detected, the current ignition zone has one degree of timing removed and the Knock Count is incremented by one. To switch OFF press the ADJUST DOWN button and the menu will display "Knock OFF   zzz". Pressing ADJUST UP will reactivate the knock control system displaying "KNOCK (xxx)   zzz".

- xxx = Knock Count. This is the total number of "knock events" detected by the system for the current run.

  zzz = Knock Signal. Shows the actual "processed" knock signal fed into the microprocessor. This value should be small at idle (typ. less than "10") and increase with RPM and load (boost) as the background noise rises i.e. The signal will always rise with increasing power at a PROGRESSIVE rate if there is no detonation. The amplitude of the Knock Signal will depend on knock sensor position and the engines type/modification state.

For example a Knock Count of 5 (xxx = 5) indicates the knock level processed from the engine, has exceeded the Knock target 5 times.

NOTE: Any changes (ON/OFF) are automatically stored.

9.1.2 Knock Base Target

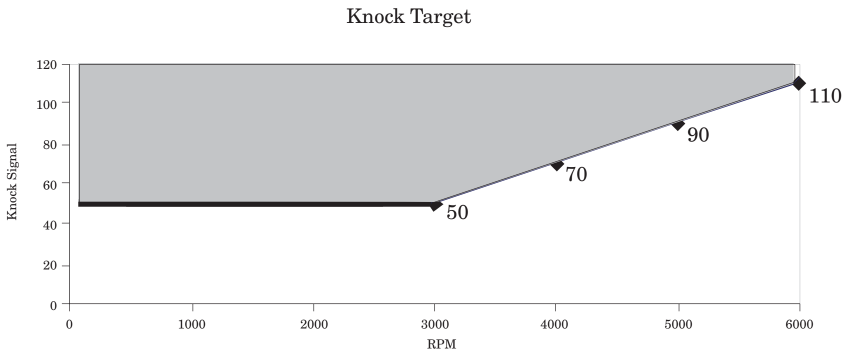
This allows the knock base target to be set. This is the amplitude of the Knock signal when the engine starts to generate noise. From this point, engine noise will normally rise as the RPM and load increases. To match the Knock target to the engines noise profile the target requires RPM correction.

9.1.3 Knock RPM Correction

The microprocessor uses the base target and RPM correction to produce a knock target that is proportional to RPM i.e. at higher engine RPM more "noise" is generated, hence the knock threshold needs to be increased. For every 1000 RPM the RPM correction value will be added to the Base Target. Intermediate values will also be calculated.

Example 9: Base Target of 50 starting at 3000 RPM.

RPM Correction = 20



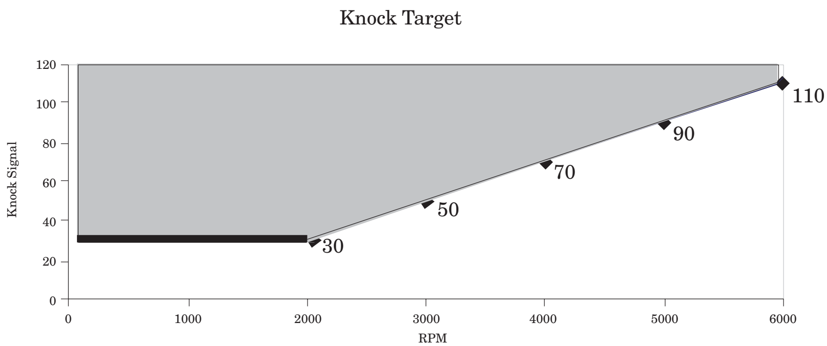
RPM	Knock Target
3,000	50
4,000	70
5,000	90
6,000	110

The example illustrates the knock target as it varies with RPM. If the Knock signal enters the grey region a knock event will be generated and timing will be removed. Note: Below 3000 RPM the LinkPlus uses the "base target", having no RPM compensation.

9.1.4 Knock RPM Start.

The last adjustable factor that will vary from engine to engine, is the RPM point where the engine begins to generate noise. It can range from 1000 through to 4000. See Example 9.1.

Example 9.1: Base Target of 30
RPM Correction = 20
RPM Start = 2000



RPM	Knock Target
2,000	30
3,000	50
4,000	70
5,000	90
6,000	110

If the knock level enters the "grey" region, ignition will be removed from the engines current ignition zone. Note below 2000 RPM the "base target" is used, having no RPM correction.

9.2 Knock Control Setup

To ensure the correct operation & setup of the knock control system, a scientific method is the most comprehensive approach to build up a noise profile of the engine. This involves using some form of data logging (e.g. SerialLink, PrintLink or PCLink) " to capture all the important ECU signals for in-depth analysis. This has the advantage of allowing plenty of time for analysis together with other information (RPM, MAP, OXY etc.) which all interact to some degree.

Detecting Detonation from data logging
Interpret detonation as a significant jump in value (say 30 –50 units) within one line of text. Note from Table 9.0 the abrupt level change (marked *****) in the KNK (knock) column indicating probable detonation.

Note: In some cases transient detonation (between gear shifts) is very difficult to eliminate completely without seriously affecting the power output of engine. The amount of acceptable detonation is a fairly complex issue beyond the scope of this simple guide.

RPM	MAP	WG%	OXY	INJ%	TEMP	KNK	ADV	
4617	151	31	75	44	78	12	13	
4807	193	31	91	66	78	46	9	*****
4994	226	29	89	70	78	25	8	
5131	215	28	89	68	78	25	9	
5344	215	26	88	70	78	30	8	
5453	218	25	88	72	78	31	8	
5651	219	23	87	75	78	40	8	
5800	222	21	88	77	78	33	8	
5976	224	18	87	81	78	45	8	
6103	224	16	89	85	78	49	8	
6288	226	13	89	86	78	56	8	
6418	227	10	89	87	78	58	8	
6542	227	10	90	90	78	63	8	
6706	228	10	89	94	78	71	8	
6779	227	10	91	94	78	75	7	
6917	228	10	90	94	78	79	6	
7034	229	10	17	96	78	85	6	
6892	131	39	78	12	78	70	25	
6225	32	37	68	4	80	46	25	
5711	20	35	73	1	80	33	25	
5124	19	32	2	1	80	17	25	
3728	92	28	4	16	82	4	23	
3750	99	28	5	17	82	4	21	
3839	110	28	4	21	82	6	18	
3907	129	28	5	25	82	8	16	
4025	150	28	9	32	82	7	13	
4159	176	29	84	45	82	10	12	
4353	211	29	90	62	82	33	9	*****
4506	218	27	91	59	82	18	9	
4687	210	26	89	60	82	21	9	
4870	214	25	88	63	82	26	9	
5048	215	24	86	66	82	26	8	
5239	216	22	86	68	82	26	8	
5398	219	20	84	71	82	34	8	
5542	221	18	85	75	82	38	8	
5747	223	16	85	76	82	47	8	
5901	224	14	84	81	82	53	8	
6054	225	11	86	84	82	73	8	*****

Knock Example for LinkPlus Engine management

Table 9.0. Data Log

EXAMPLE: The printout (Table 9.0) is an actual example of a vehicle accelerating during two runs. The easiest way to visualise this data is to graph it as shown in Figure 9.1. This provides a picture of the engines noise profile, clearly showing the contrast between engine noise and the three possible detonations. The "dashed line" shows one suggested knock target line. From this graph all the relevant parameters can be gather to correctly setup the knock system.

Selecting Base Target and RPM start point.

The engine does not start producing any significant noise until approximately 4000 RPM. This will be the starting RPM. The Knock level at this point is approximately 10 so a safe "base target" would be 20. As this value is open to some interpretation and there is no one correct answer.

Selecting Rpm Correction

From Figure 9.1 the engine noise increases approximately 25 unit per 1000 RPM. The overall knock target now represents the "grey" region. If the Knock signal from the engine enters this region, a knock event will be generated and timing will be removed.

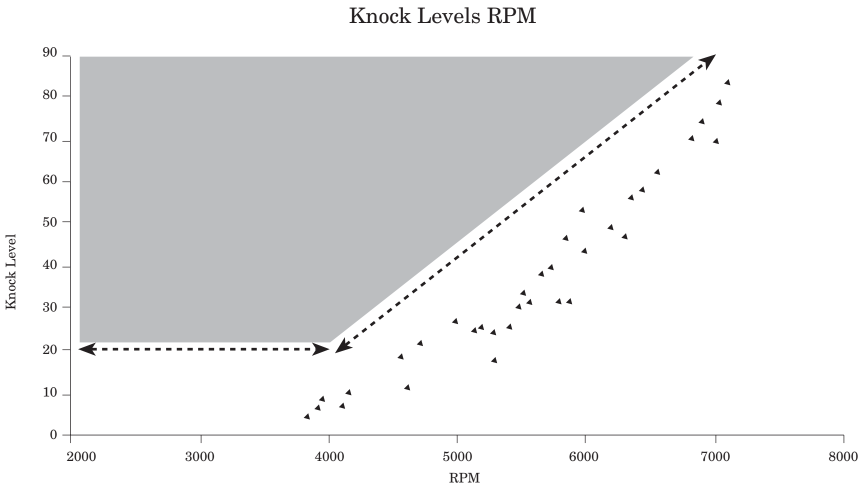


Figure 9.1

Summary Table

Base Target = 20

Start Rpm = 4000

RPM Correction = 25

RPM	Knock Target
4,000	20
5,000	45
6,000	70
7,000	95
8,000	120
9,000	145
10,000	170

9.3 Testing Knock Sensor Installation

Move the Knock Count menu and observe the Knock level (far right characters). Use a metal object such as a spanner and tap the engine block close to the sensor or the actual bolt securing a donut style sensor. The knock level will show a value proportional to how hard the block or sensor bolt is hit. No reading indicates a faulty sensor or a wiring problem.

10. Closed Loop Lambda Control

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, having 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.

When the Tuning Module is connected and Closed Loop lambda is activated, the LinkPlus will ONLY correct fuel if the following menus are selected.

- ZONE FUEL
- INJECTOR DUTY CYCLE
- TEST RPM
- CURRENT LAMBDA TARGET

If a different menu is selected closed loop control will be halted.

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.

In either mode, closed loop lambda will only change the current fuel zone to match the lambda target. There will be NO change to the MASTER value or ROW FUEL adjustment.

10.1 Functions

The following functions are available from the Lambda heading.

10.1.1 Lambda ON

Press the ADJUST UP button to switch ON the Closed Loop Lambda Control. To switch OFF press the ADJUST DOWN button.

The oxygen sensor (and associated wiring) must be 100% serviceable if the tuning option is to be used. Failure to meet this requirement may result in engine damage if not carefully monitored.

10.1.2 Current Lambda Target

From this menu the voltage generated by the oxygen sensor can be compared to the lambda targets used by the LinkPlus. The far right character displays the current system status. See section 10.7 for information on annunciators. The LinkPlus will perform closed loop lambda operation from this menu.

10.1.3 RPM LockOut

This will prevent the closed loop system operating below this target RPM, independent of manifold air pressure. The default value is 500 RPM. To change use the ADJUST button.

10.1.4 Lambda Target

The next 6 menus allow the lambda targets to be edited. Refer to 10.5 on how to adjust these.

10.1.5 MAP LockOut

Prevents lambda correction above the MAP lockout value set. Default = 300 kPa. E.g. To prevent lambda control under boost, set this value to 110 and STORE.

10.2 System Requirements.

Hardware for closed loop (LAMBDA = ON) operation is essentially the same as for open loop (LAMBDA = OFF) 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

2. 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 an 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.

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

10.3 Operation and Setup

1. The closed loop mode is enabled by moving to the " LAMBDA " heading on the Tuning Module and selecting LAMBDA = ON by pressing the ADJUST UP button.

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 should not 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 50C

   - Engine been running for 90 seconds after start

   - Manifold above overrun vacuum

   - No acceleration (transient) fuel pending

If the above conditions are met the system will automatically start adjusting the ZONE FUEL, matching the actual lambda voltage to the lambda targets. The system samples and corrects at a rate proportional to engine speed. This rate allows sufficient time for fuel changes to take effect and appear at the exhaust. (The feedback system is not instantaneous and therefore needs a short stabilising period)

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

   ZONE FUEL : Fully automatic zone fuel tuning. The current operating zone will be tuned to match the lambda targets. This means corrections will ONLY affect one zone at a time. While closed loop is switched ON the ADJUST switches have no effect.

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

10.4 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. Both engine RPM and manifold air pressure (MAP) are used to select one of six Lambda "target" values for the system to use as a reference.

10.5 Adjusting Lambda Targets

A separate block of zones are used to store the target values, adjustable from the * LAMBDA * heading on the tuning module. The default values loaded will depend on the type of "ROW STEPS" selected from the * Configurations * heading (For more information on ROW STEPS see section 13.2).

These values 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.

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.

10.5.1 Row Steps = Vacuum

In this mode the LinkPlus will use the Zone Sheet shown in Appendix B, allowing a maximum of 200 fuel zones on a normally aspirated engine. Figure 10.1 illustrates the zones covered by each lambda target.

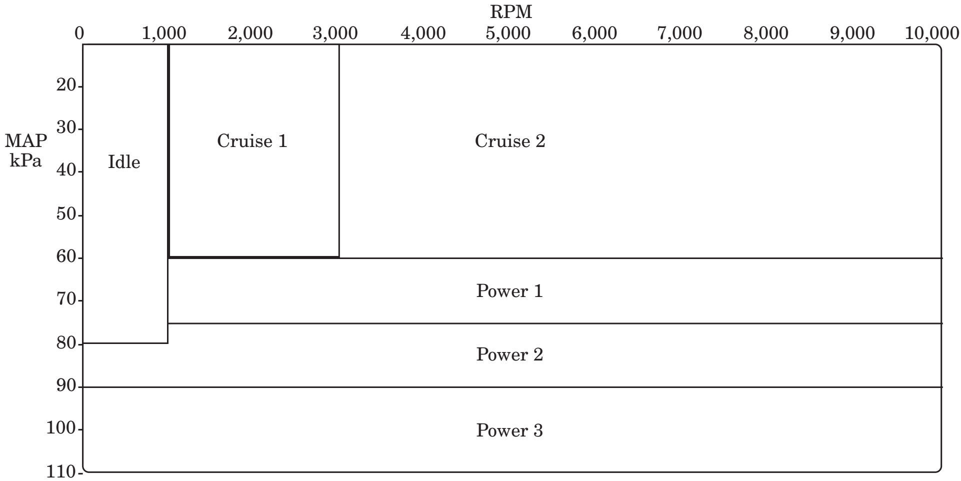


Figure 10.1. Lambda Target with Vacuum Row Steps selected.

Zone	Target Area	Target Value
26	Idle	84
27	Cruise 1	78
28	Cruise 2	79
29	Power 1	80
30	Power 2	81
31	Power 3	82

Table 10.0

The default lambda values are shown in Table 10.0

These values can be edited by moving to the * Lambda * heading on the tuning module, and selecting the appropriate zone.

10.5.2 Row Steps = Map, TPS, MAP+TPS

In this mode the LinkPlus will use the Zone Sheet shown in Appendix A. Figure 10.2 illustrates the zones covered by each lambda target.

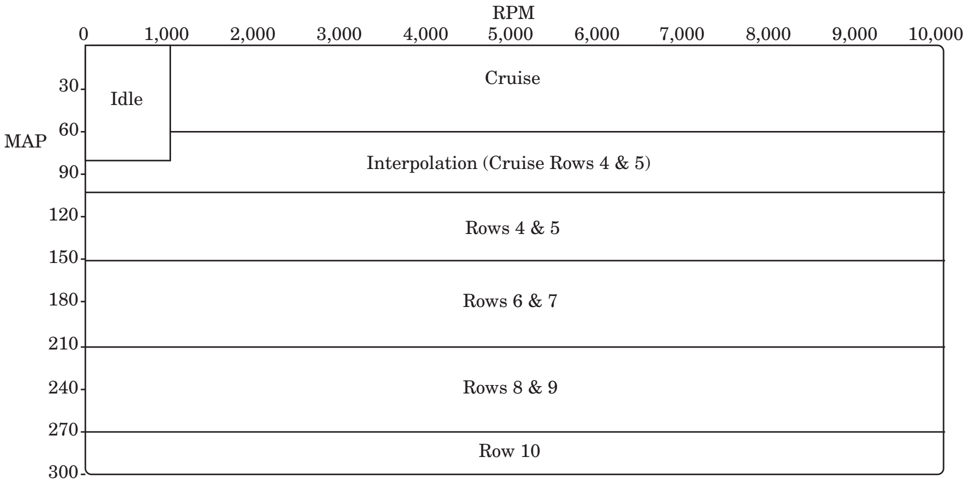


Figure 10.2 Lambda Target ROW STEPS = MAP, TPS, MAP+TPS

Zone	Target Area	Target Value
26	Idle	84
27	Cruise	78
28	Rows 4 & 5	82
29	Rows 6 & 7	83
30	Rows 8 & 9	85
31	Row 10	87

Table 10.1

The default lambda values are shown in Table 10.1

These values can be edited by moving to the * Lambda * heading on the tuning module, and selecting the appropriate zone.

10.6 Probe Voltage vs A/F Ratio

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) 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: Enrichment becomes fairly compressed at higher voltages i.e. small voltage changes = large ratio changes.

10.7 System Annunciators

LAMBDA has a series of indicators to show the systems status. These appear on the "ZnFuel" menu on the tuning module. The far right character will display one of eight possible annunciators:

T Timer. The system waits for 90 seconds after starting before becoming active.

E Engine temp. below 60°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 +/-

21 units with the remote connected. This will prevent gross errors due to failed probe etc. The system may be cleared by initiating a STORE, giving another 21 units of trim. Be suspicious of large corrections. There may be a fault somewhere in the system. (max. trim = 8 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.
R	RPM lockout. Indicates that RPM is below the threshold set by RPM lockout (see 10.1.3).
H	MAP lockout.

11. Boost Control

Wastegate Overview

Turbo charger boost control is achieved using a wastegate to bypass the correct amount of exhaust gas around the turbocharger. This can be achieved by employing either an integral wastegate (Fig 11.2) or an external wastegate (Fig 11.4).

In either case, the wastegate is opened and closed by a pneumatic actuator. When sufficient pressure reaches the actuator, the wastegate is opened to vent excess exhaust gas around the turbocharger. This has the affect of limiting boost pressure. If no pressure reaches the actuator then the wastegate never opens. As a result all exhaust gas must pass through the turbocharger. This causes the boost pressure to rise to whatever the turbocharger is capable of generating.

Electronic Boost Control Overview

Electronic boost control is achieved by modifying the pressure signal from the turbocharger compressor outlet to the wastegate actuator using a solenoid.

The minimum boost pressure that can be achieved occurs when the solenoid is de-energised. This pressure is entirely dependent on the wastegate/actuator construction.

The maximum boost pressure that can be achieved occurs when the solenoid is energised. This pressure is dependent on the turbocharger/ engine combination. Typically this pressure exceeds that which can be safely tolerated by the engine.

By varying the on/off ratio (duty cycle) of the boost control solenoid, a boost pressure between the minimum and maximum (outlined above) can be achieved. Since the ECU measures the manifold air pressure (MAP), this information is used to sense the current boost pressure so that changes are continuously made to achieve the target boost pressure.

11.1 Integral Wastegates

11.1.1 Three Port Solenoid

Figure 11.1 shows the recommended three-port solenoid for use with integral wastegates. These can be supplied by any Link dealer.

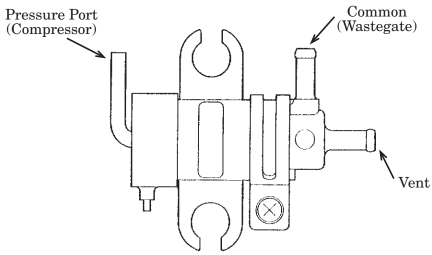


Figure 11.1 Nippon Denso Three-port Solenoid for use with an Integral Wastegate

This solenoid should be connected as described below and shown in Figure 11.2.

- common port is connected to the wastegate actuator
- pressure port is connected to the turbocharger's 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 wastegate. When the solenoid is energised the common and vent ports are connected and the air pressure in the actuator is bled off to atmosphere.

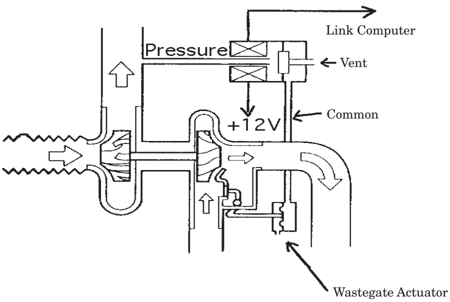


Figure 11.2 Fitment of three-port solenoid to Integral Wastegate

11.1.2 Two Port Solenoid

Some factory-fitted boost control systems use a simple two-port solenoid rather than the three-port type previously described (especially Nissan and Mitsubishi). These basically work as variable bleed and require some form of restrictor between the turbocharger's compressor (pressure source) and the boost control solenoid. This is shown in Figure 11.3.

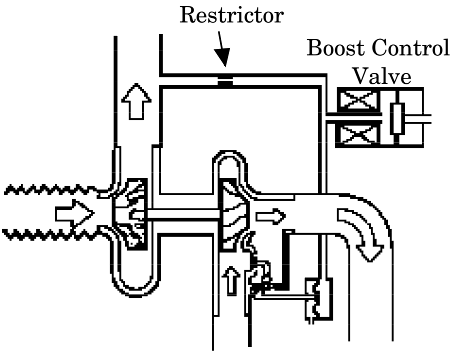


Figure 11.3 Fitment of two-port solenoid to Integral Wastegate

A typical size for the restrictor is 1.00 to 1.50 mm in diameter. The required size varies as it is dependent on factors such as the wastegate construction, the length of the hose and the diameter of the hose.

If the restrictor is too small then boost will tend to overshoot since it limits the rate at which the wastegate will fill and therefore move the actuator arm. If the restrictor is too large the ECU will be unable to achieve high boost operation. This is because the solenoid is unable to bypass sufficient pressure so the wastegate opens prematurely.

It is recommended that two-port solenoids are only used for small to moderate increases in boost pressures over the factory setting while the three-port types may be used for high boost applications requiring more precision and better control.

11.2 External Wastegate

In some applications, a factory-fitted integral wastegate in its fully open position may be unable to bypass a sufficient amount of exhaust gas to maintain the desired boost pressure. This condition is typically recognised when boost pressure rises uncontrollably at high engine speeds. In this case a larger diameter wastegate is required. Typically fitting an external wastegate is the easiest solution.

While both types of wastegates perform the same function, external wastegates have some important differences when compared to integral wastegates. Typical external wastegates actuators pull to open the wastegate rather than pushing it. Therefore, pressure must be applied to the bottom side of the diaphragm to open the wastegate. Either the 2-port or 3-port solenoids designed for integral wastegates can be used as long as the connection to the wastegate actuator is made beneath the diaphragm. However, this method is not recommended.

The preferred option is to use a second line from the compressor outlet to the topside of the actuator. It is recommended that the top and bottom of the wastegate actuator are fed by separate pressure lines. The boost control solenoid is then plumbed into the line connected to the top of the actuator as shown in Figure 11.4.

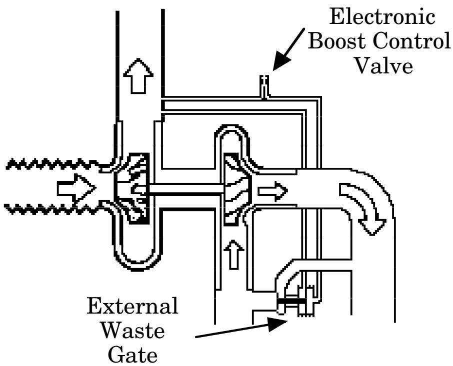


Figure 11.4 Fitment of three-port Parker solenoid to External Wastegate

However, the sense of operation is reversed with this system. Applying more pressure to the topside of the actuator CLOSES the wastegate and INCREASES boost pressure. Therefore a solenoid with reversed sense is required. This solenoid must allow the top of the wastegate actuator to vent to atmosphere when de-energised, and fill the top of the actuator with boost pressure when energised. Figure 11.5 shows the Parker solenoid that is suitable for this application. Conventional two-port and three-port solenoids may not be used.

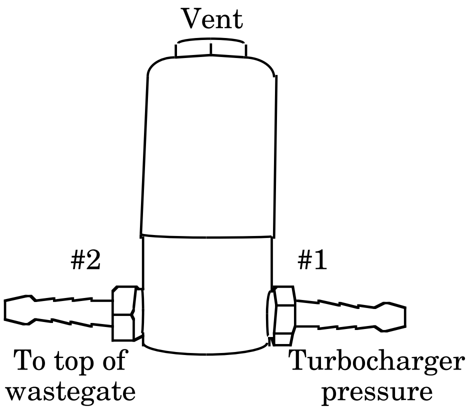


Figure 11.5 Parker Solenoid for use with external wastegates

Port #1 is plumbed to the turbocharger, while port #2 is plumbed to the top of the wastegate.

11.3 Wiring & Mounting of Boost Control Solenoid

It is important that the correct type of solenoid is used. Devices intended for electronic boost control should be used wherever possible. Some types of plastic bodied units may work effectively but may not withstand the constant cycling imposed upon them and subsequently fail after several hours of service.

A solenoid's operation can be checked by blowing through its ports with the solenoid both energised and de-energised.

For wiring information refer to section 3.10.2. Remember the throttle position sensor (TPS) MUST always be connected when using boost control. The solenoid should be mounted in the engine compartment as close to the wastegate as possible. This will keep the pressure line to the solenoid as short as possible and minimise any signal delay.

11.4 Setting up Boost Control Software

The computer software features a number of adjustment facilities for closed loop boost control and may be accessed using a Link Tuning Module or PCLink software.

11.4.1 Boost Target Values

An extra row of zones has been added to the zoning system to hold target boost values for each 500 RPM interval between 500 & 10000 rpm. This allows the boost curve to be tailored for the application. The boost may be held at lower levels through the mid range to suppress detonation and then allowed to rise at higher rpm where detonation is less likely. The target values may be changed by using the EDIT mode (for individual adjustment) or by selecting BOOST, which adjusts all 20 zones simultaneously (action similar to "ROW FUEL"). All boost targets are shown in kPa (absolute) and may be cross-referenced using Appendix C.

11.4.2 Waste Gate Settings

The following settings must be adjusted to achieve the required result. Turbochargers, wastegate actuators, control solenoids, and engine characteristics all have an effect on the dynamics of the system. Therefore each system must be configured differently. The recommended procedure is to make small adjustments and fully evaluate the result before further changes are made.

i) WGATE SENS. (Sensitivity Control)
All closed loop (feedback) 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 overshoot followed by oscillation around the target value. Low sensitivity values result in boost moving slowly towards the target.

Experience has shown that in most systems, a "WGATE SENS xx" value between 1 and 10 is used. Never set the value to 0.

ii) WG Base
This value is used for calculating the initial duty cycle that the ECU will apply to the boost control solenoid as a "first guess" when trying to control boost.

When the engine rpm increases above the value set by WG RPM and the throttle is increased above approximately three-quarters open, the ECU will change from its lockout state (where the ECU is not trying to control boost) to its active state where the ECU will begin to control boost.

Each time the ECU changes into its active state, the initial duty cycle applied to the solenoid is calculated using information including the WG Base. The WG Base is not equal to the initial duty cycle, however a higher WG Base will lead to a higher initial duty cycle and vice versa.

Ideally the WG Base is set so that the duty cycle required to maintain the desired boost is already being applied during lockout. Therefore when the ECU changes into its active state it does not need to significantly change the duty cycle being applied to the boost control solenoid.

If the WG Base is too high, then the initial duty cycle will be too high and the boost pressure will overshoot.

If the WG Base is too low, then the initial duty cycle will be too low and the boost pressure will increase slowly to its target value.

iii) WG RPM

WG RPM sets the engine rpm at which the boost control lockout will be disabled provided that the TPS value is also sufficient for the lockout to be disabled. The lockout is required because at low rpm there may not be sufficient exhaust gas to fully spool the turbo. Therefore, regardless of what the boost control system is doing, it would be impossible to reach the boost target. Under these conditions without a lockout feature, the ECU would try in vain to increase the boost by increasing the solenoid duty cycle. When enough exhaust gas is produced to spool the turbo the boost pressure would grossly overshoot since the solenoid would be continuously open (100% duty cycle) leading to the wastegate being fully shut.

The ideal WG RPM value is highly dependant on the turbo size in comparison to the engine it is being run on. The WG RPM should be set approximately equal to the engine RPM where the turbo begins to produce boost. Typical values usually fall between 3,000 and 4,500 rpm. If boost control is set up satisfactorily in low gears, but overshoots at low engine rpm when driving in higher gears (4th or 5th gear etc.) then the solution is usually to increase the WG RPM.

iv) Boost Hold (only available with some software)

This feature will hold the boost control solenoid fully open (and the wastegate fully closed) until the engine's manifold air pressure has reached a set percentage of the boost target. This feature is designed to improve the boost response times. The default value is

80%. Take for example a target of 200kPa (approximately 1Bar of Boost). The solenoid will be held fully open until 180kPa (approximately 0.8Bar of Boost). After this point the boost control system will revert to operation as normal.

v) Target Ref (only available with some software)
This feature allows selection of how the throttle position, as measured by a throttle position sensor or TPS, affects boost control. There are two options:

Normal (Nom) - The boost control system is in lockout until the TPS value reaches a non-adjustable threshold (usually at a TPS reading of 70 in most software variants).

Throttle Proportional (TPS) - The boost pressure is proportional to the throttle position. For example, at 70% throttle only 70% of the boost target should be achieved.

vi) Map Limiting
The MAP Limit is a safety feature, which prevents an engine being subjected to damagingly high boost pressures. The MAP Limit is in kPa (absolute) to allow correlation to the boost target values. This limit should be set about 10-15 kPa above the highest boost target value to allow for the slight overshoot which is inherent in closed loop systems. This can be adjusted from the Limits heading in LinkPlus/LEMV4.

11.5 Boost Control Diagnostics/Troubleshooting

The following diagnostic guide ranges from “no operation at all” through to tuning and fine adjustment of a serviceable system.

11.5.1 Installation Tests (Electrical)

i) Key ON, engine stationary, all devices connected. Apply boost pressure to Manifold Air Pressure sensor (MAP) using a “Mityvac” or similar pressure pump device. Set boost hold to 0 if applicable. Increase pressure to at least 0.4 Bar (1.4 Bar absolute or about 6 psi) and the Boost Control Solenoid should start “buzzing” at a moderately low frequency. If so, go to 11.5.2 Installation Tests (Mechanical). If not progress to the next step.

ii) Remove the pressure being applied to the map sensor. Locate the boost control solenoid (BCS) wire coming out of the ECU. With the key ON, engine stationary and with the ECU fully connected, measure the voltage by back-probing the ECU's connector. This should read about battery voltage (approx. 12 volts). If so, go to step iv). If not progress to the next step.

iii) Key off, remove the wire to the BCS from the ECU connector by lifting the pin retaining tab with a suitable needle/probe and sliding the connector pin out of the connector body. Reconnect the ECU connector with the BCS wire now free. Key ON, measure the voltage on BCS wire. If it now reads about 12 volts then there is a "drive" problem with the ECU. Return the ECU for repair. If not check the following:
- The wiring between ECU and BCS (open or short circuit to EARTH)
- The +12 volt supply to BCS (ensure all relays/fuses are intact)
- The BCS operating coil resistance (e.g. not open circuit)

iv) Use a suitable length of wire to EARTH the ECU to BCS wire. As the EARTH is applied and removed the solenoid should make a clicking sound. If so, go to Installation Tests (Mechanical), if not check the following:
- Excessively high BCS coil resistance (typically about 10-30 Ohms)
- BCS seized (disconnect from system and apply 12 volts directly across to the BCS to confirm)
- The +12 volt supply to the BCS cannot supply sufficient current.

11.5.2 Installation Tests (Mechanical)

A "Mityvac" or similar pressure/vacuum pump makes these tests a lot easier to perform.

<u>Integral Wastegates</u>:

i) Verify that with no pressure applied to the actuator, the wastegate is fully shut and sealing adequately.

ii) With the BCS de-energised (or BCS electrically disconnected), apply pressure to the solenoid "pressure" port. This port would normally be connected to the turbocharger compressor outlet or other source of boost pressure before the throttle butterfly. There must be a flow of pressure directly to the wastegate actuator with no bleeding-off. The wastegate should open if there is sufficient pressure applied to the system. Also note the pressure at which the wastegate opens since this is the minimum pressure that the system can operate at. The wastegate should remain open with pressure applied as the actuator should not leak over a reasonable period of time.

iii) Keep pressure applied as in the previous step so that the wastegate is open. Energise the solenoid by whatever means is convenient. The wastegate should now close.

External Wastegates:
The following test is for an external wastegate setup utilising both the top and bottom ports of the wastegate and a Parker BCS.

i) Apply pressure to the port on the bottom of the wastegate actuator. With sufficient pressure applied the wastegate should open. Many external wastegate actuators tend to leak pressure from the bottom side of the diaphragm. This makes it difficult to verify that the wastegate opens at the desired pressure.

ii) Energise the BCS. Apply pressure to the solenoid pressure port which normally connects to the to the turbochargers compressor outlet. The pressurised air should not leak over a reasonable period of time. A leak indicates a possible diaphragm failure.

iii) De-energise the BCS. The pressurised air in the top of the wastegate actuator should now be vented to the atmosphere through the BCS.

11.5.3 Further Troubleshooting

The following tests assume that the system passed the basic electrical and mechanical tests and that a Remote Tuning Module is connected and working.

Select "WG BASE (xxx%) " on the remote and observe the BCS duty-cycle figure (xxx%) during the following steps.

i) Symptom - Boost pressure is below the target value
Bring engine/vehicle up to about mid-range power and give engine full throttle. After a short delay, the ECU should sense that the boost pressure is below the target value and try to compensate for this by increasing the duty-cycle being applied to the BCS. If this occurs then the duty value should climb quickly to a high value

(over 95%) and remain so until the throttle is closed. This indicates that the system software is operating correctly, but a mechanical condition is limiting the boost pressure. In this case the following should be checked:

- Exhaust gas leaks ahead of turbocharger (e.g. cracked manifold, blown gasket, loose flanges)
- Boost leaks somewhere in the system (e.g. around hose clamps, inter-coolers, dump/blow-off valve leaking)
- Airflow restrictions (e.g. air-filter, throttle plate/butterfly area, FIA restrictor, collapsed hoses
- Exhaust restrictions (e.g. collapsed muffler/catalytic converter, impact damaged exhaust)
- Exhaust back-pressure opening the wastegate prematurely (especially external wastegates)
- Damaged turbocharger (internally)
- The turbocharger may not have sufficient flow for the task. Consult a turbocharger specialist for help.
- Damaged engine or associated systems
- Gross mis-tuning of fuel and/or ignition timing
- Control system limiting (MAP LIMIT or similar).

If duty-cycle stays low (or does not change) the following should be checked:

- MAP LIMIT is set too low. Set limit to at least 10 kPa ABOVE the HIGHEST boost target.
- TPS SPAN not exceeding at least 70 at full throttle.
- Minimum boost pressure not rising above the 0.4 Bar (about 6 psi) needed to activate the system.
- WG RPM set too high. System is active only when this rpm value has been exceeded
- WG SENS set to ZERO

ii) Symptom - Boost pressure is above the target value

- WG RPM may be set too low
- WG BASE may be set too high
- WG SENS may be set too high

- Boost Hold (if applicable) may be set too high
- Wastegate may not be able not flow sufficient amounts of exhaust gas to limit boost (normally seen as boost increasing from target at high rpm)

11.6 AntiLag

This Antilag system is primarily intended to reduce the spool time of a typical turbocharger thus improving throttle response. This is achieved by bypassing air into the engine and employing ignition retard to control engine output during low power operation.

The Antilag system is controlled by 2 parameters

- Engine RPM
- Throttle Position (measured using TPS)

The LinkPlus can generate maximum retard, proportional retard, proportional advance or full advance based on the value of the above 2 parameters (See Figure 11.7). When setting up the amount of retard and/ or bypassed air it is important the AntiLag system is running in full retard mode. The requirements for this mode are Engine RPM > 2000 and TPS < 30. This may not be possible during the initial stages of tuning so STEP 9-12 of the setup procedure will force the system into full AntiLag mode. The AntiLag Setup MUST be followed for the correct operation of the AntiLag system.

The two functions to control the aggressiveness of the Antilag are LAG FUEL (in the fuel menu) and IGN RETARD (in the antilag menu).

There are two methods used to control the amount of air bypassed into the engine.

a) Use the factory throttle-stop screw the permanently hold the throttle open.

b) Bypass air into the engine ONLY when Antilag is switched ON.

These two methods require the LinkPlus to offer two Antilag modes.

11.6.1 Antilag Mode 1

This Mode is typically used for Group N applications where regulations prevent the addition of separate devices to hold the throttle open or bypass air into the engine. The factory throttle-stop screw must be used to permanently hold the throttle butterfly slightly open with a typical TPS value of between 25 and 30. This now becomes the new "closed" position and should never go back past this point. The common method to achieve this is to use the factory throttle stop screw.

The problem with this method occurs when Antilag is switched OFF. This method prevents the throttle from being closed for idle and normal driving and thus requires a special mode. To control idle RPM cyclic fuel limiting is used so the engine will sound irregular. This will offer reasonable low speed driving despite the amount of open throttle.

11.6.2 Antilag Mode 2

In this Mode air is bypassed into the engine ONLY when Antilag is switched ON. The engine will run as normal with antilag switched OFF eliminating the need for cyclic fuel cuts as is used in Mode 1. A Solenoid is normally used to supply the bypassed air.

It can be configured to bypass air directly past the butterfly into the engine or, the solenoid when energised can be used to hold the throttle butterfly slightly open. Refer the Figure 11.6 for wiring information.

Note. One Solenoid may flow insufficient air to produce effective turbo spool. Two solenoids run in parallel may be required.

11.6.3 Antilag Setup

The first 3 steps require the engine to be run in non-Antilag mode so leave ALL antilag function OFF and DO NOT alter the engine hardware.

Step 1.

AntiLag Mode 1

Confirm the Sync pulse is being processed by scrolling to the * DIAGNOSTICS * heading and viewing the 'Cyl = Y Sync = Y' menu. This should be done while the engine is running. There MUST be a 'Y' on both Cyl and Sync labels. A 'N' indicates a missing signal. Once confirmed select sequential as the fuel delivery Mode. DO NOT use 'Group Fire'.

AntiLag Mode 2

The Fuel delivery Mode can be either group or sequential.

Step 2. Confirm the TPS is connected and spans 10-100 as described in Section 8.2. Also, the "enrichment mode" MUST be set to TPS (See section 13.1.7). The default mode is 'map' and this may result in poor throttle response between gearshifts when antilag is switched on.

Step 3. The engine should be at its normal operating temperature

Step 4. Air Bypass Setup for Mode 1 or Mode 2

Once Steps 1-3 have been completed the air bypass can be setup

Mode 1: With key on and engine stationary, open throttle with stop-screw until TPS SPAN = 28. This is about the correct amount of throttle opening required for Antilag and some sort of lock nut or similar should be used to ensure the setting remains stable.

Mode 2: Check the air bypass solenoid(s) have been wired as shown in Figure 11.6. This will ensure that air is only bleed into the engine when Antilag is switched ON.

Step 5. Switch Ignition ON. DO NOT start engine.

Step 6. AntiLag ON

The Antilag system may be switched on/off by moving to the * BOOST * heading and scrolling to the 'AntiLag' menu. Use the ADJUST UP key to switch Antilag = ON.

(Any changes are automatically stored).

Step 7. AntiLag Switch

View the 'AntiLag' menu from STEP 6. The symbol "*" is displayed when the AntiLag system is activated. Move the AntiLag switch to the ON position and check the "*" symbol appears. If not recheck wiring. Leave in the ON position.

Step 8. Select AntiLag Mode

Press the EDIT DOWN button once to display the Antilag Mode. Use to ADJUST keys as required and the display will show Mode 1 or Mode 2 accordingly. (Any changes are automatically stored). Ensure the system has been wired to the correct Mode as shown in Figure 11.6.

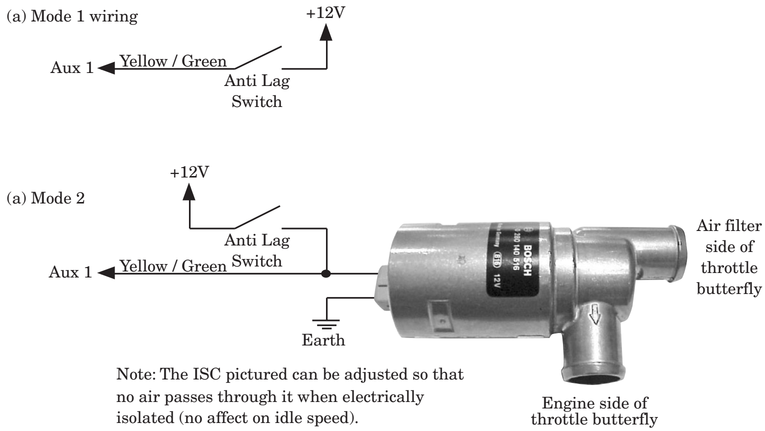


Fig 11.6

Step 9. Setup TPS OFFSET for Antilag.

Press the EDIT DOWN button once to display 'TPS SET(xx) = OFF' menu. Press the ADJUST UP button to display 'TPS SET(xx) = ON'. In PCLink select "TPS Lag set" under the Boost Control menu and switch on. This will force the system into full retard mode independent of engine RPM and throttle position.

Step 10. Target for adjusting AntiLag System (Retard & Air Bypass)

The target when setting up the Antilag system is a value of about 1900 to 2200 RPM @ 0 PSI (i.e no vacuum, no boost) with the throttle resting in its 'closed' position. This should be achievable by adjusting the amount of bypass air and IGN RETARD. Remember these two will interact. Ignition retard can be increased to reduce engine RPM at the expense of increased exhaust gas temperatures.

If the idle speed solenoid is a 2 or 3 wire solenoid, the duty cycle can be modified by using "Lag ISC DC xx%" to let additional air into the engine over and above the antilag air solenoids. The idle speed solenoid cannot flow all of the air necessary but is used to "trim" the extra air to provide an optimal level of antilag i.e. antilag solenoid is 100% activated when the antilag is switched on plus additional air via the original idle speed solenoid.

If a stepper idle speed is fitted, it cannot be employed for additional antilag air.

Antilag Mode 1.

If the gauge reads high e.g. 5 PSI, then too much throttle opening is being used. Back off stop-screw until "0" on the gauge. Likewise, if too low (showing vacuum) wind the stop-screw in to raise the pressure. Note if lag mode idle RPM is too high (to achieve the "0" PSI on gauge) the retard value may be increased to lower the RPM.

Antilag Mode 2.

If the gauge reads high e.g. 5 PSI, then too much air is being bypassed into the engine. Reduce the amount of bypassed air until "0" shows on the gauge. Likewise, if too low (showing vacuum) more air will need to be bypassed into the engine.

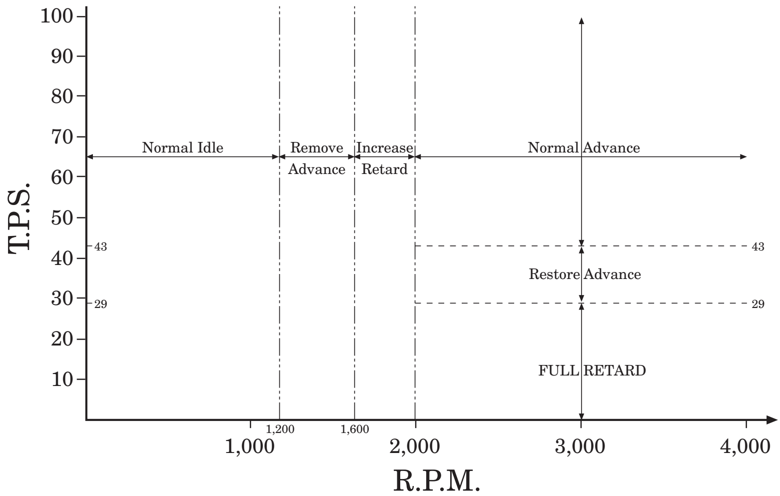


Fig 11.7

Step 11. Start the engine

When the engine starts the system will be in full Anti Lag Mode. The engine will run by default with 20 degrees of ignition retard. Adjust both Air bypass and retard as described in Step 10.

LAG FUEL provides additional fuel for cooling exhaust gases. Default value of "8" should be adequate. LAG FUEL is only active when running in full retard mode. Refer Fig. 11.7.

Step 12. Setup Complete

Once satisfied with the setup move to the 'TPS SET(xx) = ON' menu. Press the ADJUST DOWN button to display 'TPS SET(30) = OFF'. PCLink will display this menu under “Runtime Values” and is called “TPS Lag xx”. The 'xx' MUST display 30 on the 'closed' throttle position. The Antilag switch can now be switched OFF. If Mode 1 is used the engine RPM should stabilise at about 2000 RPM and running slightly irregular due to the cyclic fuel limiting used to control the "idle" RPM.

11.6.4 Antilag Cautions

- Take care during testing with the turbo and exhaust manifold temperature. Components get very hot under the bonnet so keep an eye on anything close to the turbo/manifold for signs of overheating.
- Also be aware that on vehicles with vacuum assisted brakes that the lack of vacuum will make the brakes very "heavy".

12. Idle Speed Control

The LinkPlus offers 4 idle speed control options:

- 2 Terminal Solenoid
- 3 Terminal Solenoid
- 4 Terminal Stepper Motor
- 6 Terminal Stepper Motor.

The 2 and 3 terminal Solenoid options can be driven directly from the LinkPlus, with no additional hardware required. The Stepper motor type however, will need to be known before the LinkPlus is dispatched. This allows the appropriate sub-board to be inserted. Refer to section 3.15.3 for information on how to wire these devices.

For the Idle speed system to function correctly, the TPS MUST be connected for both solenoid and stepper idle control devices. Ensure the TPS "low" value is set at 10. See section 8.0 for information on how to do this.

12.1 Functions

The following functions are available under the Idle Speed heading.

12.1.1 Idle RPM

The information displayed on this menu will depend on the type of idle speed device selected. When the engine is cold the idle speed is automatically increased on both setups, and will decay to normal as the engine warms up. Each menu contains annunciators at the far right character ("z"), used to show the idle speed status.

System Annunciator (z)
There are 6 annunciators used to define the idle speed status when the system is in correction or hold mode. These are as follows:

Correction Mode

=	Engine RPM = Target value
+	System is increasing idle
-	System is decreasing idle

Hold Mode

T	Throttle open (TPS Span greater than 12)
V	Engine vacuum less than overrun vacuum target
R	RPM > 1500

Hold Mode
In certain conditions when idle correction is not required, the ISC system will enter hold mode. The hold mode is controlled by the throttle position (T), RPM (R) and the engine MAP with respect to the overrun vacuum target. In this state the system will use default values only, identified by zones IDHOT and IDCOLD. With solenoid selected as the idle speed type these two values represent duty cycle. With stepper selected these values are the number of steps from a base value of 60.

12.1.1.1 Solenoid

This menu will display "Idle (xx%) yyy z" and sets the idle speed in steps of 50 rpm. 'xx' is the actual duty cycle of the idle speed actuator to assist setup and diagnostics. 'yyy' represents the required engine idle RPM and can be changed by using the ADJUST buttons.

12.1.1.2 Stepper Motor

This menu will display "Idle xxx yyy z" and sets the idle speed in steps of 50 rpm. 'yyy' represents the required engine idle RPM and can be changed by using the ADJUST buttons. "xxx" represents the number of steps.

12.1.2 ISC Type

This menu allows the Idle Speed device to be selected. Press ADJUST DOWN for a solenoid or ADJUST UP to select stepper motor. The setting will store automatically.

12.1.3 AirC Step

When an air conditioning request is generated, the LinkPlus will increase the engines idle (if ISC is connected) before engaging the compressor clutch. The amount of idle increase can be adjusted here. The default setting is 10. For a solenoid this implies a 10% increase in duty cycle, for a stepper motor this implies 10 steps before engaging the clutch. This compensates for the extra load preventing idle surge or the engine stalling. Note that extra enrichment can also be added from the * FUEL AUXILIARY * heading.

12.1.4 Idle Duty Cycle Defaults

This menu should only be adjusted if solenoid has been selected as the idle device. There are 2 default values labelled "Idle Hot" and "Idle Cold". These are used by the software to preset the ISC duty cycle during hold mode to about the correct value during gear shifts, over run vacuum, returning to idle etc.

12.1.4.1 Idle Hot

When the engine is above 50°C, the "Idle hot" value is the default duty cycle forced into the solenoid. This should provide an idle RPM close to the required value. To change use the ADJUST buttons.

12.1.4.2 Idle Cold

When the engine is below 20°C the "Idle Cold" value is the default duty cycle. Between this temperature and 50 the software will interpolate to create an intermediate duty cycle. To change use the ADJUST buttons.

12.1.5 Step Direction

This setting only applies if the idle control device is a stepper motor. It controls the direction of step ensuring the engine RPM is moving in the correct sense towards the idle target. The annunciator at the far right character represents the stepper direction. "N" represents normal, "R" represents reverse. See section 12.3 for setup information. Use the ADJUST buttons to alternate this setting. Any changes to this menu will be saved automatically.

12.2 Solenoid Idle Speed Setup

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

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

2. Two default values for cold and hot engines.

   Hot Engine

   Select "IDLE (xx%) yyy z" 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. Select the "Idle Hot xx%" menu and enter the recorded value + 2%.

e.g. Duty Cycle = 43% (stable hot idle) then enter a value of 45%

Cold Engine

Use the same procedure as above except note the duty cycle shortly after a cold start. Enter this value using the menu " Idle Cold xx%" under the "IDLE SPEED" heading. The engines idle will always be higher when it is cold implying the IDLE COLD value will be larger than IDLE HOT.

Store the new value by moving to a STORE menu and holding both ADJUST buttons until the display shows "********" and then release.

Note that the software also generates an intermediate (warm) value, which is the average of the cold and hot settings but is not independently adjustable. If the target rpm is changed at a later date, the HOT and COLD default values may require adjustment.

3. Hold Mode Setup — TPS

   To aid in the control of the Idle Speed solenoid the software uses TPS to determine throttle position. Always ensure the TPS "low" value is 10. This is the value used to determine closed throttle and MUST be set to ensure the correct operation of the Idle Speed system. See the * UTILITIES * Section 8 for TPS setup information.

   To test, press the throttle. The idle status should indicate a "T: for throttle open.

4. Hold Mode Setup — Overrun Vacuum

   When the engine's MAP reduces below the overrun vacuum target, the system will enter hold mode. To setup refer to Section 8.1.1.

   - To test allow the engine to reach 4000-5000 RPM then snap the throttle closed to put the engine in overrun vacuum. The idle status should indicate "V". As the RPM falls, the engine vacuum should reduce and go above the overrun vacuum target. The symbol "V" should be replaced with a "-", "+" or "=" symbol as the system begins to correct the idle.

     If the "V" remains, approximately 2 kPa should be subtracted from the overrun vacuum target and the test redone. The aim is to maintain the "V" status for as long as possible as the engine RPM returns to its normal value.

5. The Idle speed system will perform idle correction under the following conditions

- TPS < 13 (Throttle Closed)
- RPM < 1500
- Engine MAP > Overrun Vacuum Target

All other conditions will cause the idle system to enter hold mode, where "Idle Hot" and "Idle Cold" are used to determine duty cycle.

Note: Failure to setup any of the above parameters correctly will result in incorrect operation.

12.3 Stepper Idle Speed Setup

The Idle speed stepper control system has two main adjustments.

1. "IDLE xxx yyy z" sets the required idle speed in steps of 50 rpm. Use the ADJUST buttons to select the idle RPM.

   The value “xxx” represents the stepper position in units of steps and will change as the system performs Idle Speed Control.

   As the stepper motor provides no position feedback, the Idle Speed system needs a reference point from which to control the idle. It achieves this by assigning a value of “50” to the stepper motor position if the engine’s idle is stable and equal to its target (i.e. “=” symbol). This value may not actually represent 50 steps from closed throttle, but is used by the ISC system as a reference point.

   From this point the Idle Speed system will use IDHOT and IDCOLD during its hold phase. For example, with the current step position = 50 and IDHOT = 60, when hold mode is entered the stepper motor will be moved up 10 steps to the new position 60.

   When the engine returns to a condition that requires idle correction the RPM should be slightly higher than the required target. The step count will move from 60 towards 50 as the engine returns to its normal idle.

2. Select the required stepper direction. Monitor the character ‘z’ (annunciator) to observe what action the idle speed system is taking. The engine RPM should be moving in accordance with the annunciator displayed. There are 2 possibilities.

- z = '-'. This symbol implies the Idle Speed software is trying to reduce idle. If this is not occurring and the idle is increasing, the stepper direction is incorrect. Press the EDIT DOWN moving to the "Step Direction : x" menu. Press one of the ADJUST buttons to toggle the "x" character and reverse the stepper direction. The change in engine RPM should now match the annunciator.
- z = '+'. This symbol implies the Idle Speed software is trying to increase idle. If this is not occurring and the idle is decreasing, the stepper direction is incorrect. Press the EDIT DOWN moving to the "Step Direction : x" menu. Press one of the ADJUST buttons to toggle the "x" character and reverse the stepper direction. The change in engine RPM should now match the annunciator.

3. The default values are IDHOT = 60 and IDCOLD = 70. Use caution when adjusting these values. DO NOT use numbers less than 50 as this will drop below the reference point used by the ECU.

   Apply steps 2-4 as outlined in the previous Section 12.2. Any reference to "duty cycle" should be replaced by "step".

4. The Idle speed system will perform idle correction under the following conditions

   - TPS < 13
   - Engine MAP > Overrun Vacuum Target
   - Engine RPM < 1500

   All other conditions will cause the stepper motor to move to its hold position, until the idle correction requirements are detected.

13. Configuration

To edit any of the below settings scroll to the * CONFIGURATION * heading and use the EDIT buttons to move through this menu.

13.1 Functions

The following functions are available under the Configurations heading.

13.1.1 Cylinder Setting

Displays the current number of cylinders. Changes are made by pressing the ADJUST buttons and must be stored and power recycled before the new settings become active.

13.1.2 Aspiration

This will allow the engines aspiration to be selected. For a non-turbo engine press the ADJUST DOWN and the Tuning module will display "Asp:Non Turbo. For a turbo engine press the ADJUST UP to display "Asp: Turbo" This setting combined with the ROW STEPS selection will determine the Reload table.

13.1.3 Row Steps

This control allows the zone table row selection to be setup in one of four modes. These are Map, Vacuum, MAP+TPS, and TPS. To scroll through these modes used the ADJUST buttons. Not all options will be selectable as this well depend on the engine aspiration.

Non Turbo : Row Steps available – MAP, Vacuum, TPS

Turbo : Row Steps available – MAP , MAP+TPS

A Reload MUST always be performed after a change to ROW STEPS. This will ensure the correct base zone fuel numbers and lambda target are correct for the engines setup.

13.1.4 Fuel Mode

This menu allows the selection of "Group" or "Sequential " fuel. If sequential mode is required each injector MUST be wired individually back to the LinkPlus. Do NOT select sequential mode if the injectors are wired for group fire. Refer to Section 3.1 for more information. To select Group press the ADJUST DOWN button. To select Sequential press the ADJUST UP button.

13.1.5 Map Type

The option of using the on-board (internal) or external map sensor is available. The on-board map sensor should be used when the engine is normally aspirated or the required boost pressure is less than 250kPa absolute. When using this mode remember to connect the vacuum line from the engine to the sensor on the LinkPlus. If an engine requires more than 250kPa absolute boost pressure, the external map sensor option will need to be selected. The LinkPlus has been configured to use a GM 3 bar MAP sensor, capable of measuring 200kPa of boost (30kPa). See Installation section 3.8 for wiring information. To select internal map press the ADJUST DOWN button. To select external map press the ADJUST UP button.

13.1.6 Temperature Sensor

This selects either the factory negative temperature coefficient (NTC) or the Link IC type sensor. Confirm the correct choice by viewing the "TEST ENGT" or "COLD" menu on the tuning module. The displayed temperature should be approximately correct. (There is a huge difference between the two. The correct selection will be obvious). Press SELECT UP to select the Link temperature sensor or SELECT DOWN for the NTC sensor.

13.1.7 Enrichment Mode

For good throttle response enrichment must take place during acceleration (i.e. when the throttle is opening). This can be calculated for either the change in MAP or TPS. By default this is set to MAP mode. When this mode is used poor throttle response may be attributed to low idle vacuum, multiply butterfly setup, engine condition, or inlet geometry design. The cause is a delay in the MAP signal when the throttle is abruptly opened. To help overcome this problem press the ADJUST UP button on the tuning module to select TPS enrichment mode. As the TPS is directly connected to the throttle shaft there will be a minimum delay when the butterfly is opened.

Note: The TPS **MUST** be connected and span correctly before selecting TPS enrichment mode.

13.1.8 Drive A & B

There are two high power drives available, each capable of switching up to 5A continuous. The drives can be independently setup to turn ON using one of these two methods.

- RPM
  This will switch on a drive at a predetermined RPM utilising 200 RPM of hysteresis. To select this mode press the ADJUST DOWN button.

- %FF
  This will switch on at a preset injector duty and represents engine load. To select this mode press the ADJUST UP button.

  To adjust the actual switching RPM or %FF refer to section 8 on UTILITIES.

13.1.9 Drive A and B Sense

Controls the switching sense of Drive A and B. Both drives are independently adjustable.

Drive x OFF->ON. At the required switching point Drive A or B will switch from OFF to ON.

Dive x ON->OFF. At the required switching point Drive A or B will switch from ON to OFF.

13.1.10 Air Conditioning Request level.

The LinkPlus can use either a rising or falling edge on the Air Conditioning request input. The type of edge is adjustable.

- The voltage on the AirCon input moves from 0V to 12V when a request is generated. Press the ADJUST DOWN to display "AC Req Level L-H". L-H represents a low to high transition.
- The voltage on the AirCon input moves from 12V to 0V when a request is generated. Press the ADJUST UP to display "AC Req Level H-L". H-L represents a high to low transition.

13.1.11 Overrun Fuel Cut

During overrun vacuum when the engine is decelerating, the fuel supply to the engine can be completely cut. On closed throttle under high engine vacuum, there is a low oxygen content resulting in incomplete combustion and hence unburnt hydrocarbons. By removing fuel in an overrun condition emissions can be reduced and fuel economy can be improved. To switch press on the ADJUST UP button.

Note: The TPS **MUST** be connected and span correctly before turning this function ON.

13.1.12 Flat Shifting

This will activate the flat shifting function and shares the same control input as the launch control. Refer to section 8.4 for information.

13.1.13 Launch Ctrl

This will activate the launch control function. To switch ON press the ADJUST UP button. The required launch RPM can be adjusted from the * UTILITIES * heading. See section 8.5 for setup information.

13.1.14 Water Spray Configuration

The water spray can be switched on when the MAP or %FF reaches a target value. To select MAP mode press the ADJUST UP button and the menu will display "Spray Config=Map". To select %FF press the ADJUST DOWN displaying "Spray Config=%FF". See the * UTILITIES * section 8 on how the adjust the switching points and duty cycle settings.

13.1.15 Configurations

Used to configure the LinkPlus to engines with non-typical requirements. Options available for:

Lexus 1UZFE (two distributors)

MX5 (allows sequential fuel, idle, clamps, etc)

Honda (for the inverted ignition drive)

VR4 (allows sequential fuel)

13.1.16 Priority

If the sync and trigger pulse occur close together, this setting allows the user to set the primary to the more important pulse. Options are cylinder or sync.

13.1.17 Tacho Time

Allows the selection of standard or extended tacho signal. If the tacho is unstable with the TEST RPM menu stable, try selecting the extended tacho option.

13.1.18 Reload

This process presets all zones to typical values to allow a base for subsequent tuning. There are two separate reload tables available. The appropriate one will be loaded automatically, dependent on two factors;

- The engines aspiration: Turbo or Non Turbo.
- ROW STEPS

For example the fuel numbers and lambda targets for a normally aspirated engine running ROW STEPS = Vacuum will differ when compared to a turbo changed engine.

A Reload MUST ALWAYS be performed after a change to ROW STEPS or the Aspiration menu. This will ensure the base zone fuel numbers and lambda targets are correct for the engine setup.

For safety reasons a Reload CANNOT be executed while the engine is running.

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 LinkPlus memory and should only be used during initial setup or if you wish to restart the tuning procedure again from scratch.

13.2 Mixed Mode scheduling

Mixed mode scheduling refers to the way in which the zone table ROWS are selected. There are four options available, each one specific to an engine configuration. The default mode is MAP meaning ROW selection is based ONLY on the engines Manifold Air Pressure. When using high lift, long duration cams this can 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. The following options are available.

The actual injector pulse width is still a function of MAP at all times, so mixed mode scheduling will ONLY effect the zone table ROW selection.

13.2.1 MAP Mode

Application: Normally aspirated OR Turbo charged engine.

This allows Manifold Air Pressure to select the current zone table ROW. This will give 4 tuning rows for a normally aspirated engine and allow a maximum of 10 rows for a turbo charged engine. See Appendix A for the zone sheet. To effectively use this mode the engine should have good idle vacuum, operating in ROW1. This will maximise the number of rows available for tuning. If the engine exhibits poor vacuum as discussed in the introduction use one of the following modes.

13.2.2 MAP+TPS Mode

Application: Turbo Charged engines ONLY.

If the MAP of the engine is going to exceed 110kPa (1.5PSI boost) due to turbo charging or forced induction and the engine exhibits poor idle vacuum, this mode should be selected. The TPS is used to select the vacuum rows 1,2,3 and 4 helping to stabilise ROW selection. As soon as the engine comes on boost, greater than 1.5PSI (110kPa absolute), the row selection will automatically revert to MAP zoning. To ensure correct operation the TPS should be set to span 10-100. This means at the cross-over point (110kPa) there will be no sudden fuel steps in the selected zone, i.e. the "MAP" selected zone and the "TPS" selected zone should be the same.

13.2.3 VACUUM Mode

Application: Normally Aspirated engines ONLY

Use this mode ONLY on a normally aspirated engine. DO NOT select if the engine is turbo charged. The zone table has been scaled to span 10 ROWS of vacuum as shown in Appendix B. This structure provides more rows to tune with when compared to the default MAP Mode, which allows only 4 rows for a normally aspirated engine. These additional rows are useful on engines with low vacuum by providing finer control over idle and cruise mixtures

Note: Rows 5 - 10 of the zone table are configured by default for a turbo charged engine. When spanning 10 rows for a normally aspired a reload MUST be performed when the Vacuum mode is select. This ensures both the Fuel and Ignition default numbers are correct for a normally aspirated setup.

13.2.4 Throttle Position Sensor (TPS) Mode

Application: Normally Aspirated Mode

Use this mode ONLY if the engine is normally aspired and MAP or VACUUM modes have produced unsatisfactory results. The purpose of selecting rows using TPS is to provide stable zone selection when the MAP signal is fluctuating due to special cams etc. When using this mode ensure the TPS span is setup correctly as described in the next section.

Note: Do not select TPS mode unless the TPS sensor is fitted and wired.

The LinkPlus is supplied by default with ROW STEPS = MAP and a Zone Table configured for a turbo charged engine. This means with an adjustment to ROW STEPS, a Reload MUST be performed. This ensures the correct default fuel, ignition numbers, lambda target etc, are entered.

13.2.5 Selecting TPS Range

This section ONLY applies if the TPS option has been selected in ROW STEPS, i.e.ROW STEPS = TPS + MAP or

ROW STEPS = TPS

Before starting section, read section 8.16, which explains the TPS Range.

The "TPS low" value is fixed at 10 and cannot be adjusted. The "TPS high" value is user defined and controls the numbers of ROWS available for tuning. Hence the purpose of this step is to setup the number of ROWS required for tuning, by selecting a suitable "TPS high" value. For example a TPS range of 10 to 100 would access 4 ROWS, since three zone boundaries (30, 60, 90) were crossed, while a span of 10 to 200 would allow access to 7 ROWS.

The ROW boundaries are as follows;

ROW	SPAN	CENTRE	ZONES
ROW 1	0 to 30	(10)	[100..195]
ROW 2	31 to 60	(45)	[200..295]
ROW 3	61 to 90	(75)	[300..395]
ROW 4	91 to 120	(105)	[400..495]
ROW 5	121 to 150	(135)	[500..595]
ROW 6	151 to 180	(165)	[600..695]
ROW 7	181 to 210	(195)	[700..795]
ROW 8	210 to 240	(225)	[800..895]
ROW 9	241 to 270	(255)	[900..995]
ROW 10	271 to 300	(285)	[1000..1095]

NOTE - The zoning structure for ZONE ADVANCE is identical to ZONE FUEL.

ROW STEP = TPS+MAP

The TPS range MUST always be set between 10-100.

"TPS low" = 10

"TPS high" = 100

ROWSTEPS = TPS
The "high" value should be selected based on the required tuning Rows. For example:

1) 4 Rows Required for tuning

Set TPS span between 10 – 105

2) 6 Rows required for tuning

Set TPS span between 10 – 165

3) 10 Rows required for tuning

Set TPS span between 10 - 285

13.2.6 Adjusting TPS Span

Once the TPS range has been selected the TPS span can be set. Refer to Section 8.2 on how to do this.

14. Diagnostics

The section provides basic engine information for diagnostic and monitoring purposes. All information is temporary stored and will be lost when power is removed from the LinkPlus.

14.1 Trigger Signals

This menu will display "Cyl=xxx Sync=yyy". This provides conformation the LinkPlus is receiving the required trigger pulses. This menu will only function while the engine is running or being cranked.

xxx = YES : LinkPlus receiving correct cylinder pulse.

xxx = NO : No Cylinder pulse detected. This will also show up on the TEST RPM menu as zero RPM.

yyy = YES : LinkPlus receiving correct sync pulse.

yyy = NO : No Sync pulse detected.

Yyy = N/A : Sync pulse not required for current configuration.

14.2 Max RPM

This menu displays the engine maximum RPM. This menu is used to check for trigger glitches, indicated by an unrealistic RPM figure.

14.3 Max Map

Displays the maximum manifold air pressure for turbo charged engine.

14.4 Max Injector Duty Cycle

Displays the maximum duty cycle of the injector. If this value is between 90 – 95% the fuel system is struggling to supply enough fuel to the engine. A value of 99% means the fuel system cannot delivery the required fuel. See section 18.1 on how to check a fuel pump by performing a fuel flow test.

14.5 Sync/Cyl Ratio

If sequential fuel or multi-coil applications are selected, this menu is used to setup the "expected" ratio between Cylinder and Sync trigger pulses. This allows the LinkPlus to measure the "actual" Cylinder and Sync ratio and compare this to the "expected" value. If there are any inconsistencies between the ratios an error will be displayed (see next menu). Set Ratio value as shown in Table 11.1. Do a store after the number has been changed. To adjust using PCLink, move to the "Configuration Options" menu.

Cylinders	Sync/Cyl Ratio: 1 Sync pulse per engine cycle	Sync/Cyl Ratio: 2 Sync pulses per engine cycle
3	3	N/A
4	4	2
5	5	N/A
6	6	3
8	8	4
10	10	5
12	12	6

Table 11.1

14.6 Sync/Cyl Err. xx

The menu displays a counter, which is incremented every time any inconsistency is found between the "expected" Sync/Cyl Ratio and the measured ratio. A value of 1 or 2 may be observed on startup. This is normal as the ECU is just beginning its triggering sequence. 'xx' will display "NA" if the sync pulse is not required for the current configuration i.e. Fuel deliver mode = Group and Ignition = distributor.

This counter can be useful when trying to fault find engine misfire under load. Simply observe the counter value before and after misfire. If the value has increased a triggering anomaly has occurred.

15. First Time Setup

The following checks and adjustments are mandatory before attempting to start the engine. Connect the tuning module to the LinkPlus and switch the ignition key on. DO NOT attempt to start the engine before reading this section.

Move to the * IGNITION * menu and adjust the following

- Select the required Dwell time.
- Select the required ignition; Distributor or Multi-Coil.
- If Multi-Coil is required adjust for Wasted or Direct Spark.

Move to the * UTILITIES * menu.

- If the TPS is required adjusted the TPS Range and Span.

Move to the * IDLE SPEED * Heading

- Select the type of Idle Speed Control Device.

Adjust the following options from the *CONFIGURATION * heading.

- Select the correct number of cylinders
- Select the engine's aspiration
- Select the required ROWSTEPS
- Select the fuel delivery mode, group or sequential
- Select internal or external MAP sensor
- Select the correct temperature sensor
- Lastly perform a reload. The table loaded into the LinkPlus will depend on the Aspiration and Row Steps setting.

16. Tuning Port

The fourteen pin connector located at one end of the LinkPlus allows connection of various tuning and diagnostic tools to the system. All devices use a fourteen line flat ribbon cable, and connectors are keyed to prevent incorrect installation. The following devices are currently available.

Ignition switch (key) must be OFF before installing any device. When the key is switched on, the LinkPlus will automatically determine which device is fitted and run the appropriate software to support it.

16.1 Tuning Module

The Link Tuning module allows all aspects of fuel, ignition, boost and utility functions to be adjusted, edited and stored.

16.1.1 Menu Structure

Each function is allocated a menu from which adjustments can be made. The first 7 menus are read only providing real-time information about the engine. The remaining adjustable functions for simplicity have been grouped under an appropriate heading, designated by the '* ' symbol. For example, all functions related to the fuel map such as MASTER, ROWFUEL, ZONEFUEL have been grouped under one heading. These tuning functions can only be accessed from this heading using the EDIT buttons. All read only menus and headings are displayed in upper case and all adjustable functions displayed in lower case. Figure 17.1 illustrates this menu structure.

16.1.2 Tuning Module Buttons

The SELECT Buttons allow scrolling through the read only menus and main headings. From any main heading (shown by the * symbol), pressing EDIT down will allow access to the grouped tuning functions. Pressing EDIT up will return the menu to its main heading. The EDIT buttons are also used to move through the Zone Editor, which appears as the last menu. To change a value use the ADJUST buttons.

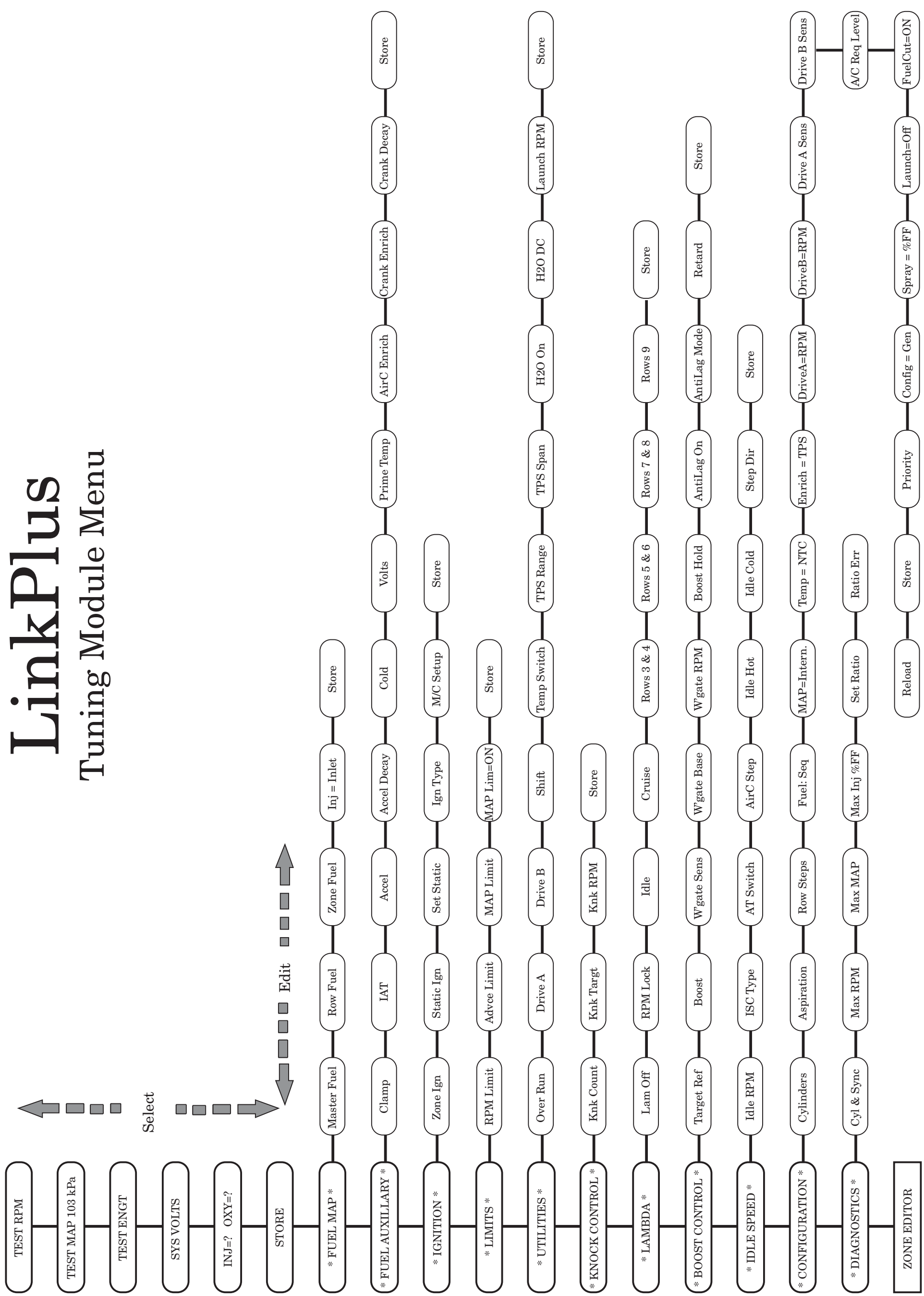
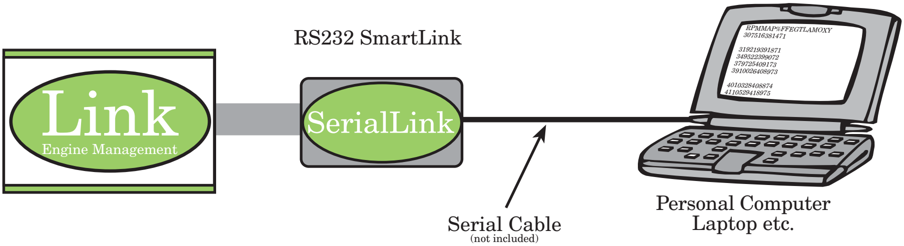


Figure 16.1. Tuning Module menu structure.

16.2 PCLink

This allows the LinkPlus and PC to perform 2-way communication using the SerialLink. Once the PCLink software has been installed from CD the LinkPlus can be tuned from laptop or personal computer. For more information see Section 17.

16.3 SerialLink



The SerialLink allows communication between the LinkPlus and a personal computer via the PC's RS232 serial port for data-logging and downloading of the LinkPlus settings. While the engine a stream sent to the PC shows all major engine parameters such as RPM, pressures, temperatures and flows. The information may be recorded using the PC's memory / disk drive. Graphs etc. may be created using spread sheets etc.

The Software used to view and store this data is called "Comlink" and can be copied from the CD supplied with the LinkPlus. (Alternatively it can be downloaded from our web site www.link-electro.co.nz.) Place the CD in the CD ROM drive and select the directory "PCLink\PCLink Software Installer\Comlink.exe". Copy comlink.exe to the hard drive where the program can be executed. Connect the 14 way flat ribbon cable between the LinkPlus and SerialLink. Next connect the standard serial cable between the SerialLink and an available COM Port on the PC. Now start Comlink. There are 2 setup options

- First select the correct COM Port. Use the keyboard buttons Q & A to change the settings. Once configured press the Enter button on the keyboard
- Next select the correct baud rate using the Q and A Keys.

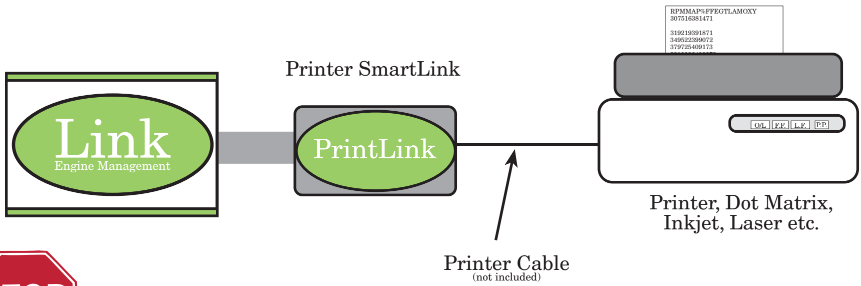
  The LinkPlus uses 14400.

  Once configured press the Enter key on the keyboard

- Switch the ignition key ON. The initial data dump will be in the same format as the Zone Table shown in Appendix A or B. The first 2 rows are configuration and tuning functions. Next is the Fuel table, followed by the ignition table, and lastly the boost table.
- Now start the engine and observe the runtime data. Follow the onscreen help for storing this data.

16.4 PrintLink

The PrintLink is similar to the SerialLink above except that the PrintLink connects directly to any type of printer for instant hard copy data. An alternative option is to use a battery backed "printer buffer" to store information while test driving and then downloading the buffer to a printer. Typical buffers allow in excess of one hours logging time.



STOP DataTrap is not compatible with the LinkPlus.

17. Windows Laptop Tuning

The LinkPlus offers PC/Laptop tuning using PCLink Software. A copy can be found on the CD supplied with the computer or from our web site: www.link-electro.co.nz. It allows real time 2-way communication between the LinkPlus and Laptop computer.

Installing PCLink Software from CD

- Insert PCLink CD into the CD ROM drive.
- The software in located in the "PCLink\PCLink Software Installer\Setup.exe" folder.
- Double click on the "setup.exe" file to start the installation process.

  During the installation process a PCLink icon will be generated and place on the desktop. To start, simply double click on this icon.
- For detailed information on the operation of the PCLink software, start the program and read the online Instructions.
- A Tutorial is also available and can be copied from the CD in directory, "PCLink\PCLink Tutorial\PCLink_Tute.pdf". This is PDF document, which requires Acrobat reader. A copy of this software is also available on CD if required.

PCLink hardware connection.

This requires one 14-way flat ribbon cable, one SerialLink, one standard serial cable and a PC.

- Connect one end of the ribbon cable to the Link Tuning Port, the other end should connect to the SerialLink.
- Take a standard serial cable and connect one end to the SerialLink. Connect the other end to an available COM Port on the PC.
- Start the PCLink Software by double clicking on the desktop icon or using the START, programs menu.
- Switch the ignition on which will power up the LinkPlus

  NOTE. The SerialLink should ALWAYS be connected before the ignition key is switched ON.

- The PCLink offers both mouse and keyboard control. To start the connection between PC and LinkPlus using the mouse, move to the "Link Control" menu and select "Connect Link". Using the keyboard, press and hold the Ctrl, Alt and L keys. This will bring up an "Options" box. Check the following settings
- Make sure the Link Connection shows "ONLINE"
- Select the correct COM Port
- Click the OK button. Once the PC is communicating with the LinkPlus, tuning can begin. Remember to STORE any changes before disconnecting the PCLink software from the LinkPlus.

18. Sensor Installation & Wiring

The following provides information on how to install additional hardware relating to LinkPlus engine management.

18.1 TPS

The Throttle Position sensor is connected directly to the throttle shaft on the butterfly. Ensure the mounting position allows the TPS to move through its range as the throttle is opened.

18.2 Knock Sensor

The knock sensor MUST be in direct contact with the engine block to ensure the noise signal is transmitted correctly. The after market sensor supplied by Link is a donut style (see Figure 18.1), approximately 25mm in diameter, with an internal size hole of 8mm. A suitable tapped hole or stepped stud will be required for mounting.

Figure 18.1

18.3 Ambient Temp Sensor

The ambient temperature sensor is shown in Figure 18.2 and should be mounted inside the airbox or point of entry for the air flow. For this reason the sensor has a hose tail type fitting allowing a hole to be drilled and the sensor inserted. Avoid the temptation to install after the turbo/super charger outlet since rapid and often unpredictable temperature extremes occur in this region. (It is highly unlikely that any practical temp. sensor will respond fast enough to track variations of boost pressure related temperature). Remember the sensor is measuring "ambient" air temperature.

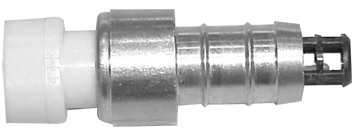


Figure 18.2

19. Fault Finding & Diagnostics

Before calling Link for technical support, have the following information available.

- Connect the Tuning Module and apply power. Press and hold the EDIT UP button on the "TEST RPM" menu. This will display the current software version. Take note of this.
- Press and hold both the ADJUST buttons on the TEST RPM menu. This will display the mode bytes and will allow the configuration of the LinkPlus to be quickly determined. Note these 3 numbers down.

19.1 Fuel Flow Check

A Fuel flow check should ALWAYS be done to ensure the fuel pump is capable of delivery the required fuel to the engine. This applies to both normally aspirated and turbo-charged engines. The test involves measuring the volume of fuel returning to the tank over a fix time period.

Symptoms: Engine missing under boost or high power

: Injector duty cycle greater than 95%

Before checking remove any possibility of spark by disconnecting the igniter(s).

Disconnect the fuel return line from the output of the fuel pressure regulator. Reconnect another (longer) fuel line to the output of pressure regulator and place the hose in a measuring vessel.

If the engine is normally aspirated leave the vacuum reference on the pressure regulator at atmosphere. If the engine is turbo charged place the desired boost on the pressure reference. This can be done using a mityvac.

19.1.1 Fuel Requirements

1 litre of fuel per minute per 200 hp. For a 200hp engine the fuel pump MUST be able to deliver 1 litre of fuel at the return line per minute. For 300hp the fuel requirements are 1.5Litres per minute etc.

The best method is to measure the volume of fuel over 10 seconds and multiply the volume by 6. Switch on the ignition key, with the Tuning

Module on the "TEST RPM " menu and press both edit buttons. This will activate the Fuel Pump so start timing once these buttons have been pressed.

Fuel Pressure is not a good indication of Fuel Flow. The fuel system can still have pressure with very little flow. The analogy of a garden hose can be used. Turn the garden tap on and block the end of the hose. There will be no flow but the hose will show good pressure.

19.2 Engine Misfire

- Check for stable "TEST RPM" on the Tuning Module
- Ensure the plug gap is not too large. Typical value range from 25 to 35 thou.
- Read Section 14.5 and 14.6.

19.3 Idle Surge

If fuel cannot smooth out an engines idle, one method is to advance the engine with falling idle speed. For example, if the engine is idling in zone 105, enter a larger advance number into zone 100 and perhaps zones 100 and 200.

19.4 Engine will not or hard to start

The first check is for low voltage on crank. Connect the Tuning Module and move away from the "TEST RPM " menu. Now try and start the engine. If the Tuning Module resets to the "TEST RPM" menu, the LinkPlus has been put through reset because the supply voltage has dropped below 7.5V. Check to ensure the power supply is not going through the ignition switch, as this can create voltage drops on crank. Wherever possible, always use a relay to supply +12V directly from the battery to the LinkPlus.

Appendix A: Vacuum/Turbo Zone Sheet

LinkPlus Engine Management (Boost)

										TPS		Targets							
Clamp 0	Master 1	R Lim 2	M Lim 3	A Lim 4	Mode1 5	Spray 6	Volt 7	Idle 8	Fan 9	Closed 10	Open 11	Sens 12	Knock 13	Base 14	RPM 15	Cold 16	Crank 17	Id Hot 18	IdCold 19

		Acceleration					Lambda Targets												
Cyl 20	Mode2 21	2,000 22	4,000 23	6,000 24	8,000 25	Idle 26	Cruise 27	Row4,5 28	Row6,7 29	Row8,9 30	Row10 31	Mode3 32	TPS H 33	Drive A 34	Drive B 35	Shift 36	Prime° 37	ACFuel 38	ACIdle 39

IAT 40	O Run 41	Crank↘ 42	K RPM 43	O^2 Lock 44	Launch 45	SprayC 46	Accel↘ 47	Boost H 48	Offset 49	AT Sw 50	Knk rpm 51	W Width 52	WPulse 53	HStart 54	Mode4 55	SyncRef 56	Fan Stp 57	Retard 58	59

Zone Fuel

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

kPa																				
30	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195
60	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	185	290	295
90	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395
120	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	185	490	495
150	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575	580	585	590	595
180	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675	680	685	690	695
210	700	705	710	715	720	725	730	735	740	745	750	755	760	765	770	775	780	785	790	795
240	800	805	810	815	820	825	830	835	840	845	850	855	860	865	870	875	880	885	890	895
270	900	905	910	915	920	925	930	935	940	945	950	955	960	965	970	975	980	985	990	995
300	1000	1005	1010	1015	1020	1025	1030	1035	1040	1045	1050	1055	1060	1065	1070	1075	1080	1085	1090	1095

Zone Ignition

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

kPa																				
30	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195
60	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	185	290	295
90	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395
120	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	185	490	495
150	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575	580	585	590	595
180	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675	680	685	690	695
210	700	705	710	715	720	725	730	735	740	745	750	755	760	765	770	775	780	785	790	795
240	800	805	810	815	820	825	830	835	840	845	850	855	860	865	870	875	880	885	890	895
270	900	905	910	915	920	925	930	935	940	945	950	955	960	965	970	975	980	985	990	995
300	1000	1005	1010	1015	1020	1025	1030	1035	1040	1045	1050	1055	1060	1065	1070	1075	1080	1085	1090	1095

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Boost

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195

Appendix B: Vacuum Zone Sheet

LinkPlus Engine Management (vacuum)

TPS Targets

Clamp	Master	R Lim	M Lim	A Lim	Mode1	Spray	Volt	Idle	Fan	Closed	Open	Sens	Knock	Base	RPM	Cold	Crank	Id Hot	IdCold
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Acceleration Lambda Targets

Cyl	Mode2	2,000	4,000	6,000	8,000	Idle	Cruise	Row4,5	Row6,7	Row8,9	Row10	Mode3	TPS H	Drive A	Drive B	Shift	Prime°	ACFuel	ACIdle
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39

IAT	O Run	Crank↘	K RPM	O^2 Lock	Launch	SprayC	Accel↘	Boost H	Offset	AT Sw	Knk rpm	W Width	WPulse	HStart	Mode4	SyncRef	Fan Stp	Retard	
40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59

Zone Fuel

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

kPa																				
20	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195
30	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	185	290	295
40	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395
50	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	185	490	495
60	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575	580	585	590	595
70	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675	680	685	690	695
80	700	705	710	715	720	725	730	735	740	745	750	755	760	765	770	775	780	785	790	795
90	800	805	810	815	820	825	830	835	840	845	850	855	860	865	870	875	880	885	890	895
100	900	905	910	915	920	925	930	935	940	945	950	955	960	965	970	975	980	985	990	995
110	1000	1005	1010	1015	1020	1025	1030	1035	1040	1045	1050	1055	1060	1065	1070	1075	1080	1085	1090	1095

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Zone Ignition

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

kPa																				
20	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195
30	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	185	290	295
40	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395
50	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	185	490	495
60	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575	580	585	590	595
70	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675	680	685	690	695
80	700	705	710	715	720	725	730	735	740	745	750	755	760	765	770	775	780	785	790	795
90	800	805	810	815	820	825	830	835	840	845	850	855	860	865	870	875	880	885	890	895
100	900	905	910	915	920	925	930	935	940	945	950	955	960	965	970	975	980	985	990	995
110	1000	1005	1010	1015	1020	1025	1030	1035	1040	1045	1050	1055	1060	1065	1070	1075	1080	1085	1090	1095

Appendix C: Pressure Conversion

kPa (Absolute)	InHg
32	20
35	19
39	18
42	17
45	16
49	15
52	14
55	13
59	12
62	11
66	10
69	9
72	8
76	7
79	6
83	5
86	4
89	3
93	2
96	1
100	0

kPa (Absolute)	Pressure (PSI)
100	0.00
105	0.73
110	1.45
115	2.18
120	2.90
125	3.63
130	4.35
135	5.08
140	5.80
145	6.53
150	7.25
155	7.98
160	8.70
165	9.43
170	10.15
175	10.88
180	11.60
185	12.33
190	13.05
195	13.78
200	14.50
205	15.23
210	15.95
215	16.68
220	17.40
225	18.13
230	18.85
235	19.58
240	20.31
245	21.03
250	21.76
255	22.48
260	23.21
265	23.93
270	24.66
275	25.38
280	26.11
285	26.83
290	27.56
295	28.28
300	29.01

Appendix D: Absolute to % Conversion

%	Absolute	%	Absolute
1	3	51	130
2	5	52	133
3	8	53	135
4	10	54	138
5	13	55	140
6	15	56	143
7	18	57	145
8	20	58	148
9	23	59	150
10	26	60	153
11	28	61	156
12	31	62	158
13	33	63	161
14	36	64	163
15	38	65	166
16	41	66	168
17	43	67	171
18	46	68	173
19	48	69	176
20	51	70	179
21	54	71	181
22	56	72	184
23	59	73	186
24	61	74	189
25	64	75	191
26	66	76	194
27	69	77	196
28	71	78	199
29	74	79	201
30	77	80	204
31	79	81	207
32	82	82	209
33	84	83	212
34	87	84	214
35	89	85	217
36	92	86	219
37	94	87	222
38	97	88	224
39	99	89	227
40	102	90	230
41	105	91	232
42	107	92	235
43	110	93	237
44	112	94	240
45	115	95	242
46	117	96	245
47	120	97	247
48	122	98	250
49	125	99	252
50	128	100	255

Appendix E: Zone Sheet Conversion

This section explains how to convert the zone numbers from a standard LEM to the LinkPlus. Firstly note the LinkPlus uses ALL absolute numbers and not percentage, as is the case with the LEM. Use Appendix D to convert any percentage to an absolute number.

> Example: Take a MASTER value of 50% on the LEM. This will require conversion, using Appendix D, giving a value of 128.
>
> Take the Accel Enrichment value of 8%. Conversion to an absolute number gives a value of 20.

The following items require conversion.

- Master
- Cold Start
- Accel Enrichment
- All Zone Fuel numbers

Note also the different zone structure. The LEM uses 6 rows spaced at 40kPa steps on the load axis. The LinkPlus uses 30kPa steps spanning 10 Rows. Keep this in mind when converting both the Fuel and Ignition tables.