TurboLink

Turbo Charger System Control

Link ElectroSystems Ltd. Limited Warranties Statement
Effective April 5,1992 5 p.m.

All products manufactured or distributed by Link ElectroSystems Ltd. are subject to the following, and only the following, LIMITED EXPRESS WARRANTIES, and no others:
For a period of one (1) year from and after the date of purchase of a new Link ElectroSystems Ltd. product, Link ElectroSystems Ltd. warranties and guarantees only to the original purchaser - user that such a product shall be free from defects of materials and workmanship in the manufacturing process. A product claimed to be defective must be returned to the place of purchase. Link ElectroSystems Ltd., at its sole option, shall replace the defective product with a comparable new product or repair the defective product. This expressive warranty shall be inapplicable to any product not properly installed and properly used by the purchaser - user or to any product damaged or impaired by external forces. This is the extent of warranties available on this product. Link ElectroSystems Ltd. shall have no liability whatsoever for consequential damages following from the use of any defective product or by reason of the failure of any product. Link ElectroSystems Ltd. specifically disclaims and disavows all other warranties, express or implied including, without limitation, all warranties of fitness for a particular purpose (except for those which apply to product or part thereof that is used or bought for use primarily for personal, family, or household purposes), warranties of description, warranties of merchantability, trade usage or warranties of trade usage.

Link ElectroSystems Ltd. Licence Agreement
The programme in this system is licensed not sold. Link ElectroSystems Ltd. grants you a license for the programme only in the country where you acquired the programme. You obtain no rights other than those granted under this license. Under this license you may use the programme on only one machine at any one time. If you transfer the Programme you must transfer a copy of this license and all other documentation. Your license is then terminated. You may terminate your license at any time. Link ElectroSystems Ltd. may terminate your license if you fail to comply with the terms and conditions of this license. In either event you must destroy your copies of the programme.

By Link ElectroSystems Ltd.

Index

1. I/O Pin Descriptions

Input Pin Descriptions

+12V 12 Volt power supply ignition switch. Current drain is in the order of 0.2 amps.

SIG GND Signal ground for the internal processing. This wire must be connected to the engine block and run as a independent wire from the PWR GND.

PWR GND High current ground for internal power drivers. Use the engine block for a good earth point. This wire must be run separately from the signal ground. NEVER connect the two grounds together and run as a single wire.

Trigger RPM and ign

TPS (Optional) Throttle Position Sensor input. Normally shares the signal with the factory TPS or may be used to form an independent sensor / switch input. Used exclusively for boost control purposes.

Note: The boost control system will operate without a TPS sensor provided the internal switch #2 (SW2) is set to ON and no connection to the TPS wiring input. Not using the TPS sensor may result in boost overshoots under certain conditions. If there is a factory TPS signal available it should be used.

Output Pin Descriptions

Fuel High current Earth sourcing drive for the auxiliary injector(s). Capable of driving up to six high resistance injectors or four low resistance injectors with appropriate ballast resistors. Maximum continuous current equal to eight Amps.

RPMSW Earth sourcing, rpm dependent drive intended for cam solenoids, manifold control valves etc. May require a relay to "invert" the signal for those devices requiring +12V rather than ground e.g. Honda VTEC solenoids.

Wastegate Earth Sourcing drive intended to operate a wastegate solenoid control valve thus allowing programmable turbo boost control. (See later section regarding valve types and installation).

Ignition Out Used as the output signal when the system is in timing intercept mode. Refer to subsequent chapter "Timing Intercept" for further details.

2. Installation

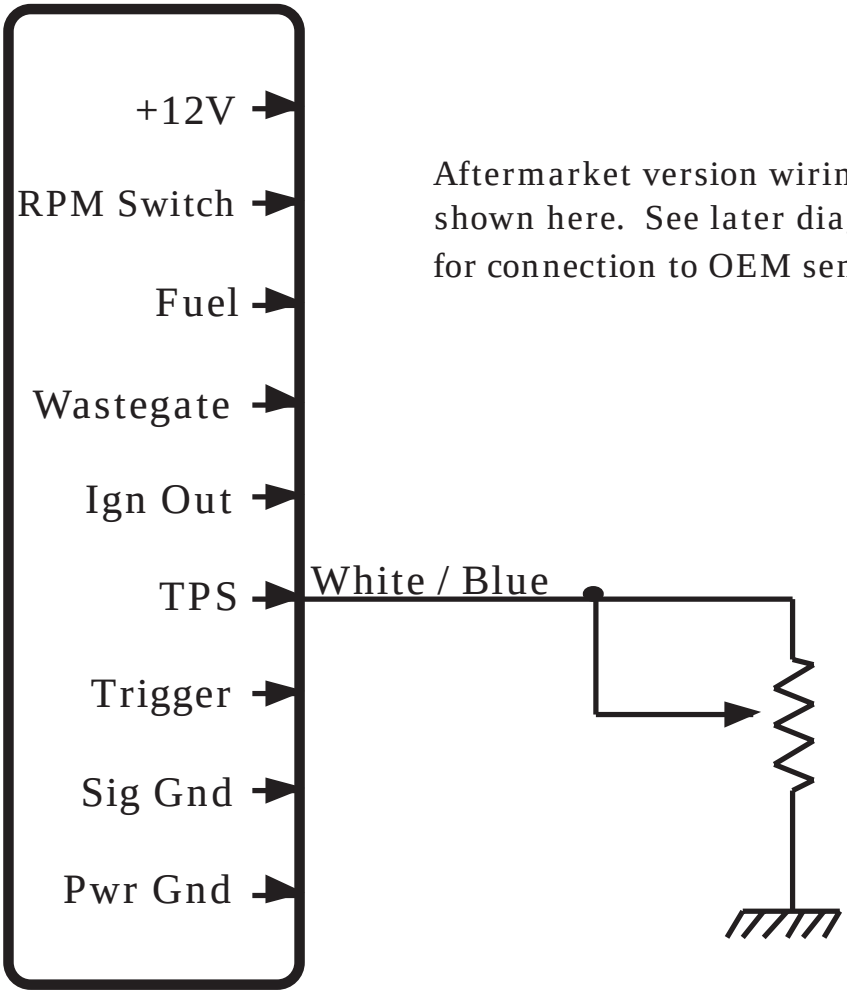
Each function (auxiliary fuel, boost control, rpm switching etc.) may be used independently or all together as required. In all cases, the primary inputs of +12V, grounds and trigger must be connected as shown in the accompanying diagrams. The output wiring will depend on which options are used.

MAP Sensor

The pressure port of the on-board MAP sensor must be connected to a source of vacuum / pressure via a 4 mm vacuum line. This should be taken from the inlet manifold plenum chamber or from a “mini-manifold” joining together individual runners of a multi-butterfly engine. (Never connect the vacuum line to a single manifold runner. This may damage the MAP sensor).

Throttle Position Sensor (TPS)

The TPS is used exclusively for boost control at present. This signal indicates to the software that the throttle is open sufficiently for accurate boost control. Refer to the TPS SPAN menu for details on the span calibration. The suggested figures of 10 (closed) and 100 (open) are not critical since the system is really only looking for the above / below “60” transition point. Normally the TurboLink will share the TPS signal with the factory ECU so provision has been made for selecting the correct sense of operation (TPS MODE).
If an after market switch or potentiometer is used then the internal supply voltage needs to be switched on via the small PCB switch (SW2) inside the controller enclosure. Move the switch to the ON position. CAUTION: Do not close the switch if sharing the TPS signal with the factory ECU. This could upset the factory calibration value.



Aftermarket version wiring shown here. See later diagram for connection to OEM sensor.

Rheostat suggested value = 5k Ohm (5000 Ohms)

3. Tuning Module Functions

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

TEST All functions in this mode are "read only" and have no effect on the operation of the system. There are 3 functions selected by pressing and holding the appropriate push switch;

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

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

TPS throttle position sensor.

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

CYLINDERS Informs the computer as to the number of engine cylinders and should be set accordingly.

Multi coil engines:	1 coil per cylinder	=	1
	1 dual coil per 2 cylinders	=	2

ONSET Sets the value (manifold air pressure) at which the auxiliary injection commences. The value is expressed in kPa and may be cross referenced as follows.

kPa	Non turbo Vacuum (“Hg)
0	29”
20	23”
40	17”
80	6”
100	0”

kPa	Turbo Boost (psi)
100	0
120	3
140	6
160	9
180	12
200	15
220	18
240	21

When the MAP (shown in parentheses (xxx)) exceeds the ONSET value, fuel will start to flow from the auxiliary injectors. As the MAP or RPM increases, fuel flow will increase proportionally.

TPS Mode Sets the operating “sense” for the throttle position sensor (TPS)input. Some TPS sensors have inverse output signals (voltage decreases as throttle opens). Select the TPS SPAN function and observe the displayed value as the throttle is opened. The number should increase. If not, select TPS MODE and press ADJUST UP or ADJUST DOWN to change the sense of operation. (Any changes are automatically stored).

TRIGGER MODE Selects between normal and ignition intercept mode. If ignition timing retard (intercept) is to be used then “TRIG = INTERCEPT”. Otherwise use the adjust buttons to select “TRIG = NORMAL”. Changes are stored automatically.

TPS SPAN Allows the Throttle Position Sensor (TPS) span to be set. The ADJUST switches are used to set the "low" (throttle closed) and "high" (throttle fully open) values. With the throttle fully closed, note the displayed value on the Link Tuning Module. This will typically be in the region of 10 to 50. Use the ADJUST buttons to set the "low" value to 10, then fully open the throttle and note the new value, this will be about

90 to 150. Use the ADJUST buttons again to set the "high" value to 100, and then fully close the throttle and observe the "low" value. This will probably have changed so reset to 10 again. The "low" and "high" interact, so it will be necessary to repeat the procedure until the required values are achieved. Select STORE and store the settings before proceeding

MASTER Controls overall fuel injection scheduling and is effective throughout the entire operating range from idle to full power. The scale ranges from 5..30, the higher the value, the greater the overall fuel.

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

RELOAD Used during initial setup to transfer a default table into the computer zoning system. This process presets all the zones to typical values to allow a base for subsequent tuning. RELOAD is initiated by pressing BOTH ADJUST buttons together until the display shows "**********" and then released.

CAUTION:RELOAD will over-write all values currently stored in the computer memory and should only be used during initial setup or if you wish to restart the tuning procedure again from scratch.

ZONEFUEL There are 96 fuel zones arranged in a rectangular grid consisting of 6 ROWS by 16 COLUMNS. The ROWS progress in steps of Manifold Air Pressure to provide the "load" axis, and the COLUMNS progress in steps of RPM. Therefore, each zone represents a unique engine operating

condition allowing fuel changes to be made in small, localised areas. The selection of zones is completely automatic, depending on the actual RPM and MAP values at that instant. The current (active) zone is identified to allow correlation to the zone sheet and to give an indication of where you are in the table.

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

ZONE IGN There are 96 ignition retard zones arranged in an identical manner to the fuel zones (see above). The zone identification system is also the same as ZONE FUEL except it applies to the ignition retard table instead. The adjustment value is shown as degrees of retard. NOTE:The retard is limited to 30º. Larger numbers than 30º may be entered but will be limited to 30º.

INJ / MAP This is a read-only function which displays the actual injector duty-cycle as a percentage of maximum. e.g. 28% indicates that the injectors are flowing 28% of their maximum volume. The MAP displays shows the current manifold air pressure (MAP) value.

RPM SWITCH Allows the value of the RPM sensitive drive to be changed. The RPM drive will become active above the programmed value to control the appropriate device. e.g. manifold runner, VTEC etc. 300 rpm of hysteresis has been added to the switch point to prevent cycling around the switch point. eg. ON at 4,000 rpm, OFF at 3,700 rpm.

EDIT Enables the zone editor function which allows random access to all zones for viewing and editing. The EDIT function may be used at any time, with or without the engine running. Use the EDIT push buttons to select the appropriate

zone(s) and the ADJUST buttons to change the selected zone. The zone is identified by a number which may be correlated to its function by consulting the zone editor sheet. ZONE FUEL and ZONE IGN are identified by an "F" or "I" respectively to discriminate between fuel and ignition values. Storing of edited values may be done by pressing BOTH EDIT buttons together until display shows "**********" and then releasing. Alternatively, STORE may be selected and used as normal.

Storing Values

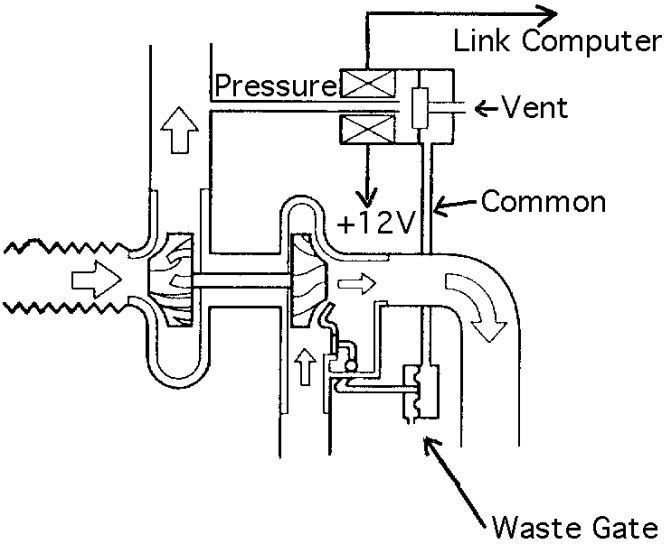
To Store select STORE. Pressing both ADJUST buttons together until display shows "**********" and then release.

4. Closed Loop Boost Control

Operation

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

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



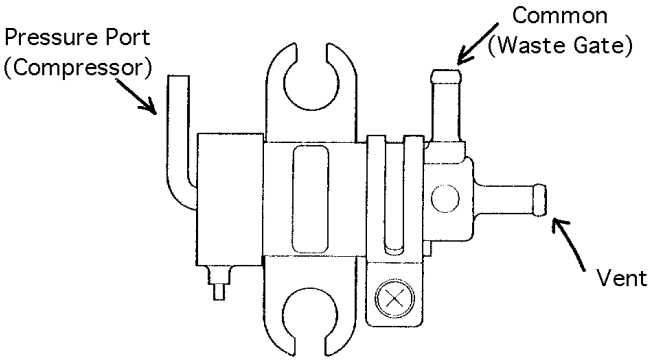
When the solenoid is de-energised the common and pressure ports are connected and compressor pressure is allowed to fill the actuator and open the waste gate. The actual boost pressure that results is entirely dependent on the waste gate construction and therefore determines the minimum boost for the system.

When the solenoid is energised the the common and vent ports are connected and the air pressure in the actuator is bled off to atmosphere causing the waste gate to close and boost pressure to

rise. By varying the ON / OFF ratio of the solenoid (duty cycle) any level off boost may be achieved and since the manifold air pressure (MAP) is being measured by the Link computer the boost may be precisely programmed and controlled.

Solenoid Types

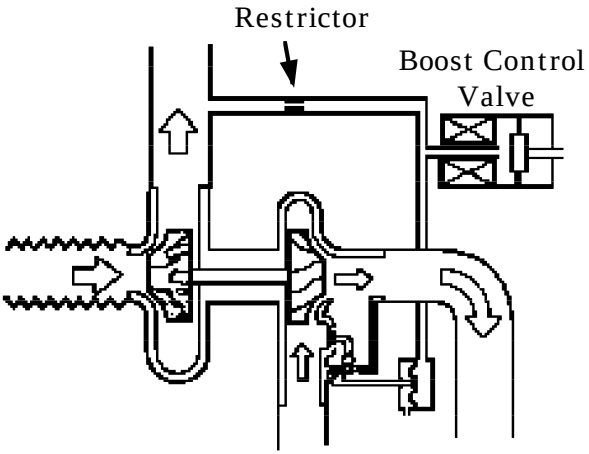
The correct type of solenoid valve must be used and devices intended for this purpose should be used wherever possible. Some types of plastic bodied units may work satisfactorily but may not withstand the constant cycling imposed upon it and subsequently fail after several hours of service. In either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



Three port example

Two Port Control Valves

Some OEM 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 bleeds" and require some form of restrictor between the compressor (pressure source) and the boost control solenoid.



Typical size for the restrictor is 1.00 to 1.50 mm. The actual size varies somewhat depending on the wastegate construction, length of tubing between the pressure source and the solenoid, diameter of tubing etc.
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 the TurboLink will be unable to achieve high boost operation. The solenoid is unable to bypass sufficient pressure so the wastegate opens prematurely.
It is recommended that two port type solenoids be used for small to moderate increases in boost over the normal wastegate operating pressure and the three port types for high boost applications requiring higher precision and better control.

Boost

Boost target values: An extra ROW of sixteen zones has been added to the zoning system to hold the target boost value for each 500 rpm interval between 500 and 8,000 rpm. This allows the boost “curve” to be tailored to suit the application. This flexibility may be used to hold the boost at lower levels through the rpm mid range to suppress detonation and then allowed to rise at higher rpm where detonation is less likely. These target values may be changed by

using either the EDIT function at any time or using the “Boost = xx” mode for making changes while actually operating in that zone. Note that any changes are temporary until STORED.

Waste Gate Controls

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

i) WG BASE

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

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

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

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

ii) WG SENS

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

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

iii) WG RPM

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

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

Note: A throttle position lockout also exists which inhibits the control system when the throttle is less than 60% open. This feature is not adjustable and will only have affect when TPS is wired and the switch (SW2) is set accordingly.

5. Auxiliary Fuel Setup

1. Decide on the point at which auxiliary injection is required and set this point using the ONSET menu. EG a turbo engine may require extra fuel from 7 psi of boost and upwards. Set the ONSET to about 150 kPa. See the conversion tables to assist selection.

2. Select MASTER FUEL and operate the engine at about 75% maximum power (above the onset point). Adjust the MASTER to obtain the required fuel flow at this point. Note: MASTER fuel has a limited range of 5..30 with fairly coarse steps. It is primarily used to get the system approximately correct then use the ZONE Fuel for fine tuning.

   Select INJ / MAP menu to observe the injector flow versus manifold air pressure. If injector % exceeds about 95% then larger or extra injectors may be required.

3. Select ZONEFUEL and use this control to make changes in any zones as required. ZONEFUEL has 96 zones at 500 rpm intervals arranged as a three dimensional array to allow the fuel “curve” to be tailored as required. Remember that the base fuel line has already been established using ONSET and MASTER so use ZONEFUEL only if you wish to deviate from the baseline. ie. it is not necessary to have rising values across the zones to establish proportional fuel flow.

   The default values (after RELOAD) for all fuel zones = 50. Note that this does not mean that fuel flow will = 50% but rather that ZONEFUEL trim factor is at its centre value (0 = very low flow, 100 = very high flow.

6. Ignition Retard (Intercept)

This sub-system allows the ignition timing to be modified in order to control the detonation (knock) especially on turbo charged engines. The system works by applying a precision programmable delay on the signal between the factory ECU and the factory igniter. This applies to distributor based ignitions only. due to the single channel nature of the controller.

Wiring details for Intercept mode

Important: Take care to identify the correct wire between the ECU and the igniter. Refer to the factory (OEM) wiring diagram for further details. Also check that the internal switch #1 (SW1) = OFF.

Setup and Adjustment

1. Using the Link Tuning Remote, select the TRIGGER option menu. When using the intercept mode this must be set to TRIG = INTERCEPT. Use the ADJUST buttons to select the above. Any changes are automatically stored.

   While the engine is stationary (i.e. no trigger pulses from the factory ECU) the software will measure the “rest” state of the igniter signal and automatically configure the input and output drives accordingly. (There are two conventions for igniter drive signals).

2. Ensure CYLINDERS is correctly set.

3. On dispatch the ZONE IGNITION table is filled with zeros at all locations. Therefore the ignition timing remains unchanged. Programme values into the appropriate zones either by using “Zone IGN” while the engine is running or “EDIT Zi” at any time. The numbers entered represent degrees of retard over factory values.

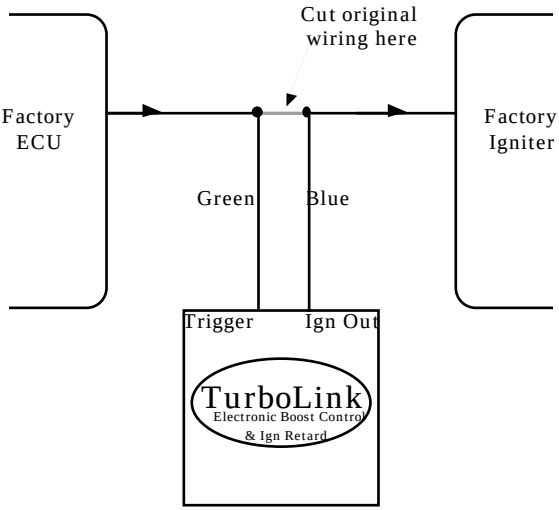
4. The maximum retard value is 30º irrespective of any higher values programmed into the ZONE IGNITION table. Note also that no retard action occurs until 2,000 rpm. This ensures that the engine will start, idle and run at low speed without any intervention from the TurboLink (failsafe mode).

5. A small amount of ADVANCE may be added by moving the distributor or crank angle sensor to achieve (typically) an extra 5º of base timing then writing an extra 5º of retard to all (96) zones. If any zone is now set less than 5º retard then this will advance the ignition slightly.

e.g. -5º (at distributor) + 5º (zone retard) = 0º (no difference)

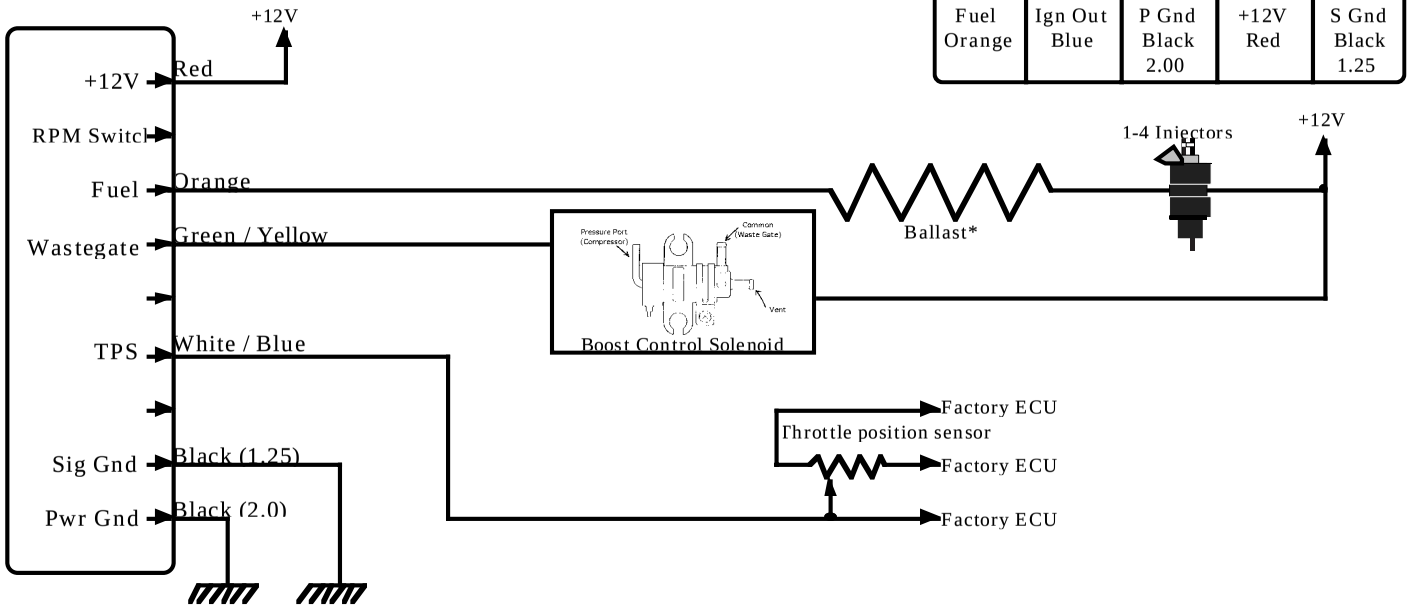
-5º (at distributor) + 2º (zone retard) = -3º (3º advance)

Note: The system is primarily intended for retarding purposes so apply the above with caution.



9 Pin Connector - (looking into male pins)

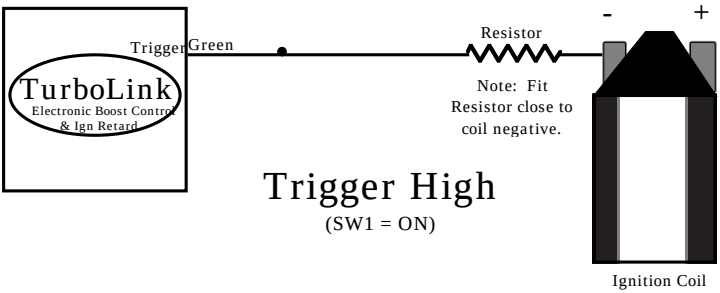
RPM Brown / White	W Gate Green / Yellow		Trig Green	TPS White / Blue
Fuel Orange	Ign Out Blue	P Gnd Black 2.00	+12V Red	S Gnd Black 1.25



* Required if injector resistance (each) is less than six Ohms.

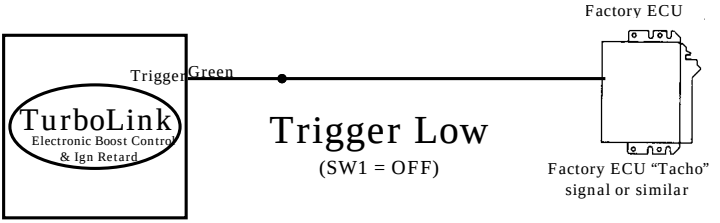
TurboLink

Trigger Options



Trigger High

(SW1 = ON)

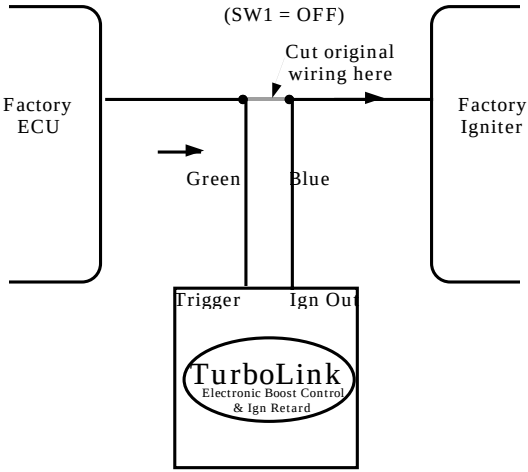


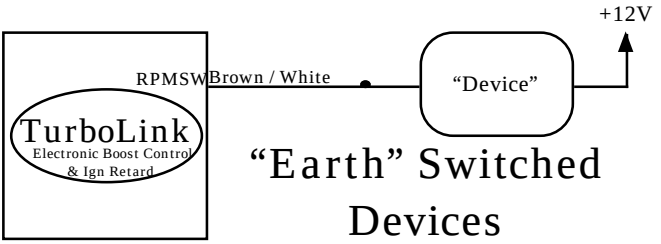
Trigger Low

(SW1 = OFF)

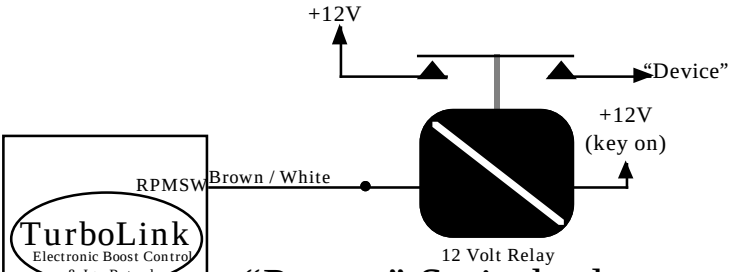
Intercept Trigger

(SW1 = OFF)





"Earth" Switched Devices



"Power" Switched Devices

TurboLink Zone Sheet

TurboLink

ONSET	MAST	RPM SW	TPS LOW	TPS HIGH	CYL	WGRPM	WGBASE	WGSEN		Mode											
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Zone Fuel

Bar	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000
0.4	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
0.8	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275
1.2	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375
1.6	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475
2.0	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575
	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675

Zone Ignition

Bar	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000
0.4	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
0.8	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275
1.2	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375
1.6	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475
2.0	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575
	600	605	610	615	620	625	630	635	640	645	650	655	660	665	670	675

Boost Targets

0	1,000	2,000	3,000	4,000	5,000	6,000	7,000
700	705	710	715	720	725	730	735	740	745	750	755	760	765	770	775