SMT 5
DEVELOPERS MANUAL

Perfect Power

Product Marketing
by:

Digital
TECHNOLOGY (pty) ltd

SMT 5 DEVELOPERS MANUAL

Index: **Page no:**

1. FEATURES AND BENEFITS

Feature	Benefit
Throttle sensor-learning	Fits to any throttle position sensor
RPM calibration	To suit your installation
High RPM range	Racing?
Fuel map with 128 sites	Smooth programming
Ignition map with 128 sites	Fine ignition resolution
Injection map with 128 sites	For extra (boost!) injection
0-10 volt analog range	Allows tuning of all models
High analog output drive	For low impedance ECU inputs
6 Amp injector drive	Handles 6 x 16 ohm injectors
Various ignition outputs	For the most stringent applications
Selectable trigger points	To suit
Programmable cylinders	It works on 9 cylinders!
Selectable polarity	To suit
Can handle interlaced signal	For 4 cylinders ignition output tuning
Balanced trigger inputs	Inverted outputs available
Missing tooth signal	For up to 2 teeth advance/retard
Ignition output limit	Limits max. advance and retard
Fuel high low limit	Prevents overdriving the ECU
Small size	Fits anywhere
Low battery drain	Simple installation
Self checking test available	For extra confidence
Map switcheable	While you drive
All inputs protected	No mishaps!
Crystal controlled	For stability
Encapsulated	Against moisture and dust
Easy tuning software	DOS or WINDOWS
Low component count	High MTBF
10 MIPS computing	To facilitate quick engine response
Signal conditioning	To prevent miss-trigger
Engine profiles (library)	Easy set up

Not all of the above features are available simultaneously. Check with the OPERATING MODES.

2. DEVELOPING AN APPLICATION

The SMT 5 is shipped to end customers with a WIRING DIAGRAM. The purpose of this manual is to help a developer to develop such wiring diagram for a particular engine, if it is not available from PERFECTPOWER.

A copy of a blank wiring diagram template is included in the back of this manual, and must be filled out and returned to PERFECTPOWER. See DEVELOPING A LIBRARY.

Manufacturers do not like the SMT, for obvious reasons. It adds, "tune ability" to the engine, which in the wrong hands can damage the engine. Therefore, manufacturers PROTECT the engine against intrusion by the SMART TUNER.
A developer is therefore faced with 2 challenges:

2.1 Can the SMT be applied to the engine

This is a very technical decision, and requires knowledge of the standard ECU, electronic knowledge, an oscilloscope, patience, the wiring diagram of the particular model, and a good understanding of the engine (ECU) theory. Some engines you can't "break" in because all wires are "protected". As the engine manufacturer designs new protection in, PERFECTPOWER invents the counter measure. There is a continuous updating of SMT models to take care of new model cars. Therefore, this step confirms that the engine does not detect the SMT, and that the input/output signals are compatible with the ECU. The items to watch for are: polarity, trigger level, drive impedance, balanced inputs and offset.

2.2 Can the SMT achieve a desired effect

This depends largely on the desired effect one requires. Some engines are PERFECT, and there is nothing one can do to improve it. However, once the air filter, exhaust, or cams are changed, then the SMT can tune the engine to the new operating conditions. Assuming that the SMT can be applied to it (step 1). Engines are very often not perfect, or can be improved easily. That is because engine manufacturers have different design criteria. Sometimes engines are de-tuned to make them or the gearbox safe. Or they have to fall in a required performance bracket for tax purposes in a different country, or they are simple "Monday" cars, or the engine tolerances play up (or down), or a better fuel is used. The reasons are endless, and the price of the ECU, and it capabilities, play a major role. Any ignition modification may be counteracted by knock-sensor technology if it results in detonation. If a 50% increase in fuel is required (boosted engines), then it is very likely that the ECU will not allow this, because it was not designed for it. The extra fuel can be added with the EXTRA injector placed in the air-intake.

We are often asked if the SMT violates the emission rules. Most countries have something against "tuning" the engine, and therefore the SMT is illegal. But this does not mean that it violates the emission standards.

To the contrary, it most of the time improves the emission, because an engine is "PERFECTLY" tuned. Of course this MUST be verified with proper instrumentation (gas analyzer?) and in the extreme cases certified by the authorities.

The SMT5 is a great tool to tune standard engines, and achieve small gains (5-25%) in power and/or fuel consumption. Best fitted to smaller engines, which have less protection, and are not well tuned.

The PURPOSE of the SMT5 is to add TUNEABILITY or ACESSEBILITY to and otherwise "SEALED" ECU without "chip" changes. The PURPOSE of this manual is to facilitate this.

The tuning (for whatever purpose!) is not covered by this manual.

2.3 Instruments Required

- Normal workshop tools
- A dual trace oscilloscope, preferred with storage
- A Multimeter
- An OXYGEN (Lambda, AFR) Scanner (if the engine has not got one!)
- Resistors: 100 to 4k7, 1/4 watt
- A Dyno is not absolute necessary, but map help to "iron" out flat spots, or to hold the engine at a particular spot for some time.
- A wiring diagram of the ECU connections is nice!

3. FUEL MODIFICATIONS

Most engines operate in "closed loop" oxygen (lambda) control up to a certain RPM (2500!) and a certain throttle position for partial power. More modern engines run closed loop at full power with a different (wide band) oxygen sensor.

3.1 Lambda Tuning

This is required if tuning is needed in the "closed loop" operating mode of the engine. The oxygen sensor has a voltage output of 0.2 to 1.25 volts, which can be "tuned" up or down as required. Some ECU's respond slowly to the input, some are fast! Locate sensor, and trace wire to the ECU. Measure with voltmeter while engine idles: it should read 0.5 volts, or fluctuate up/down around 0.5 volts.

3.2 Airflow Meter Tuning

This is required for tuning outside the closed loop-operating mode of the ECU. There are THREE kinds of AIRFLOW meters:

A) The voltage output meter Output is from 0.5 to 7.5 volt according to airflow.
B) The frequency output meter Output is a frequency according to airflow
C) The current output meter. The current changes according to airflow

Locate airflow meter and output wire. Then measure with scope.

If B) frequency meter: use MODE=10
If A) voltage meter: use any MODE.
If a wire is not found which changes with airflow, then it may be a type C) current meter. Place a 100-470 ohm in SERIES with the wire (from ECU wiring diagram) and measure the voltage ACCROSS the resistor. If it changes with airflow, then it is a type C) current meter. Use any MODE.

3.3 Manifold Pressure Tuning

This is required for tuning outside the closed loop operation of the ECU. The output of a manifold pressure sensor is normally 0.2 to 4.8 volts with 5 volts feed. This range corresponds to the full (vacuum to atmospheric or boost) pressure range. Use any MODE.

3.4 Extra Injector Tuning

This is required for tuning outside the closed loop operations of the ECU and when the ECU fuel is limited by fuel pressure, injector size, and mapping or otherwise. It is recommended for large power increases as a result of SUPERCHARGING or fitting a TURBO.

An Extra injector (up to 6 x 16 ohms) is placed in the manifold and activated under the (F2) injection map from the SMT5.

3.5 Engine Temperature Tuning

Most ECU's enrich the fuel mixture and advance the timing for cold engines. The engine temperature sensor must be routed through the SMT5. Before doing that, check if the sensor requires a "pull-up" by measuring the sensor output with the ECU connected, and without. If the voltage drops to zero, then a pull-up is required (to +5V, or to +12V) which restores the voltage to the level it was with the ECU connected. Some ECU's detect the low engine temperature after 30 minutes as "illogical" and indicate a "service fault".

3.6 Air Temperature Tuning

Some engines don't have air temperature sensors and rely on warmed up manifolds and other mechanical means to keep the air at a relative constant temperature. Turbo charged and intercooled engines will have an air temperature sensor because the temperature varies by a considerate amount. Most ECU's make the mixture leaner at higher temperatures, because the air density is less. This can be used for tuning. The air temperature sensor may require a pull-up as above.

4. IGNITION MODIFICATIONS

This requires patience.

The word pickup is used often: it means a pickup sensor, either magnetic (reluctance), Optical, or Hall sensor. The SMT5 can handle all types.

Engines, which operate on a “closed loop” knock sensor system, can't be ignition tuned, unless the knock sensor is disabled, which is not desirable!

Engines with distributor require one pickup: Use any MODE!

Engines without distributor require two pickups, or one missing tooth pickup (which transmits TDC and firing information). Locate pickup(s) and check: If it is missing tooth: Use MODE=1

If it is not, use: MODE=10, 11, or 12.

The choice of mode depends on the nature of the signals.
Put an oscilloscope on both signals, and trigger on the "TDC" or reference signal. Then count teeth in-between, and relate everything to a single RPM. If the distance (in degrees) between the reference signal and the firing signal is smaller than the intended modification, then use MODE=10 or 11.
If not, use MODE=12 (two ignitions).

In some instances it may be advisable to shift the reference signal only. Consult PERFECTPOWER!

A special circumstance exists if the missing tooth "gap" is more than once per revolution. Consult PERFECTPOWER for advice.

In order to confirm that the SMT5 can handle the ignition signals, it is advisable to "TEE" in the SMT5 inputs, and monitoring the inputs and outputs of the SMT5 in the correct mode. Confirm this on all signals and change polarity, trigger level and mode until the signal outputs are confirmed.

5. PROTECTION

A complete engine setup consists of:

LIBRARY (global) section, containing:

Technical parameters
Throttle calibration
RPM scale calibration

MAPS, containing:

128 fuel map values
128 injection values
128 ignition values

Library and Map data are stored inside the SMT5 and can be stored in separate files on your hard disk. A library file describes how the engine signals look like; the map file describes how the engine is tuned.

The SMT5 is shipped "OPEN" from PERFECTPOWER to DEALERS: That is to say the global (technical) settings (parameters) are open for access, and can be changed. That means also that such a unit can be applied to all engines, and it can be used for development of a new application.

Once a SMT5 is programmed with a library file, then the global parameters are no longer accessible. Dealers and distributors invoke this global protection when they customize the UNI5 for a specific engine. The three tune maps are not affected by this global parameter protection.

The SMART TUNER UNI5 is shipped "PROTECTED" from DEALERS and PERFECTPOWER to END-CUSTOMERS. With this protection, the global parameters are not accessible.

A UNI5, which was customized to a particular engine, can only be changed to a different engine with the use of LIBRARY file. Library files are linked to wiring diagrams, and are protected against in adverted changes. Library files are only available from PERFECTPOWER.

Once a new application is running, the developer can send the saved files to PERFECTPOWER for inclusion in the LIBRARY CATALOG, and will receive a complete LIBRARY setup file. This process sounds a little complicated, but the developers files must fit in with worldwide naming conventions.

In addition to the above, a SMT5 can be "BRANDED" to a dealer name. This function can only be invoked by PERFECTPOWER, by enabling the branding option in the dealer’s software.

Then a "NO TUNE" option can be implemented (again enabled by PERFECTPOWER), which prevents any further tuning, and general access to the SMT5. The loaded LIBRARY and MAPS can't be viewed, copied or saved. Once invoked, the NO TUNE option can only be overwritten by a LIBRARY file and software with the NO TUNE option disabled.

6. OPERATING MODES

The SMT5 has various input and output signals, which are assigned to a specific function (operation) by a MODE specification. A wrong mode is indicated on the PC display.
Note: that some inputs are "re-assigned" by a mode change. The mode setup is in the LIBRARY section.

The AIN to AOUT signal path is always assigned to the FUEL MAP, regardless of the operating mode.

The following modes can be specified:

MODE=1 Missing tooth operation

The pickup is from a multi-tooth wheel, with one or two teeth missing. The output signal can be advanced or retarded to a max. of 2 teeth.

MODE=10 Single ignition advance and retard + frequency fuel

The ignition pickup is from a single sensor, magnetic or optical, which can be advanced or retarded. The signal must be "uniform", and it must repeat every engine turn (or very two turns). Multiple "teeth" or trigger points per firing are allowed. The frequency signal of an airflow meter can be tuned for fuel.

MODE=11 Single ignition advance and retard + road speed governor

The ignition pickup is from a single sensor, magnetic or optical, which can be advanced or retarded. The signal must be "uniform", and it must repeat every engine turn (or very two turns). Multiple "teeth" or trigger points per firing are allowed. The road speed governor allows to move gear-switching points and remove (or shift) the road speed governor.

MODE=12 Two ignition advance and retard

Both ignition inputs can be advanced or retarded. The RPM is derived from the CB1 (RPM Deflection) input, and the ignition advance and retard timing is calculated from it, and then applied to BOTH ignition outputs.

One of the preceding modes must be specified in the GLOBAL SCREEN (F4). Details of the various UNI functions are provided in the following pages.

MODE=13 Single ignition advance and retard + PWM fuel

The ignition pickup is from a single sensor, magnetic or optical, which can be advanced or retarded. Same as mode=10 or mode=11. The duty cycle of a frequency signal (CAM or boost control) can be controlled from the fuel map.

7. GENERAL CONNECTIONS

POWER

The SMT is powered from a "switched" +12V (+8 to +16V) battery. It takes, depending on the operating mode, 0.02 - 0.1 Amps.

Ground, Chassis, -12V:	Black	Pin	1
+Battery, +12V:	Red	Pin	13

RS232 CONNECTIONS

Once the SMT has power, the RS232 port to the computer (PC) or laptop is working. A three-pin connector provides:

Ground, Chassis, -12V:	Pin	1
UNI RX (input):	Pin	2
UNI TX (output):	Pin	3

The protocol to the unit is propriety, and the unit will only respond to the UTUNE DOS or the WINDOWS program, which can be downloaded from the www.perfectpower.com Website.

A connection cable, SMT to D9 PC, is available from the manufacturer.

A good communications link up is indicated by the display of some numbers in the left side of the screen.

8. MAP DEFLECTION SIGNALS

The SMT5 has three maps, one for fuel injection and ignition. Each map holds 128 "sites", organized in an 8 (throttle, load) by 16 (RPM) matrix. In order to select one of the map points, and use it for the modification of the fuel and ignition, the DEFLECTION signal inputs are used. The SMT5 has a:

ANALOG DEFLECTION INPUT:	BROWN	Pin	7
IGN1IN DEFLECTION INPUT:	YELLOW	Pin	8

ANALOG DEFLECTION:

The signal input range is from 0 to +5 Volts. The map deflection can be "calibrated" to respond to any portion of the input range. See: DOS or WINDOWS manuals. The analog deflection is normally connected to the throttle or the manifold pressure sensor. It can be connected to an ANALOG airflow meter, which gives a DC voltage out proportional to the airflow. Important is that the analog deflection input somehow shows the engine "loading". If the analog deflection is not used, then it should be connected to ground.

RPM DEFLECTION:

This input serves also as the IG1IN (Ignition #1 input). It must be connected to a signal, which repeats every 360 degrees. The pickup level can be specified on the global (F3) screen:

Magnetic pickup: 0	0.5 volts
Magnetic pickup: 1	2.5 volts

In addition, the input polarity of the signal can be specified as the EDGE at which the SMT triggers.

Input polarity: 0	Negative edge, from positive to zero
Input polarity: 1	Positive edge, from zero to positive

The RPM deflection input needs a signal, which repeats at least once per firing, except when using "Interlaced mode". See: INTERLACED INPUT AND OUTPUTS. When using multiple trigger signals per firing, then the

TEETH PER FIRING: x

must be set to it. Everything is set correctly when the RPM are indicated correctly!

The RPM range can be set (calibrated) to span the desired tuning range. The DOS program sets it linearly, the WINDOWS program sets it the way you specify it. SEE: DOS and WINDOWS manuals.

The lowest RPM position is not used. Instead the output is a copy of the input. The polarity specifications apply in RPM position zero!

One thing to note is that when setting up the rpm scale you cannot set the lower limit to less than 600rpm.

9. ANALOG FUEL TUNING

This function is included in every SMT mode. It also includes the EXTERNAL INJECTOR ACTIVATION. SEE: Next section.

The analog input range is 0 to +10 Volts, corresponding to the same output range. Higher signals cannot be accommodated without external circuitry. The connections are:

ANALOG INPUT	:	BLUE	PIN	6
ANALOG OUTPUT	:	VIOLET	PIN	18

The analog output is derived:

ANALOG OUTPUT = ANALOG INPUT +- OFFSET +- FUEL MAP VALUE

The offset is specified on the global (F3) screen, and the fuel map value is the value selected by the ANALOG and RPM DEFLECTION signals.

The output can be limited by the two global (F3) screen parameters:

UPPER ANALOG LIMIT	:
LOWER ANALOG LIMIT	:

The entry is in volts!

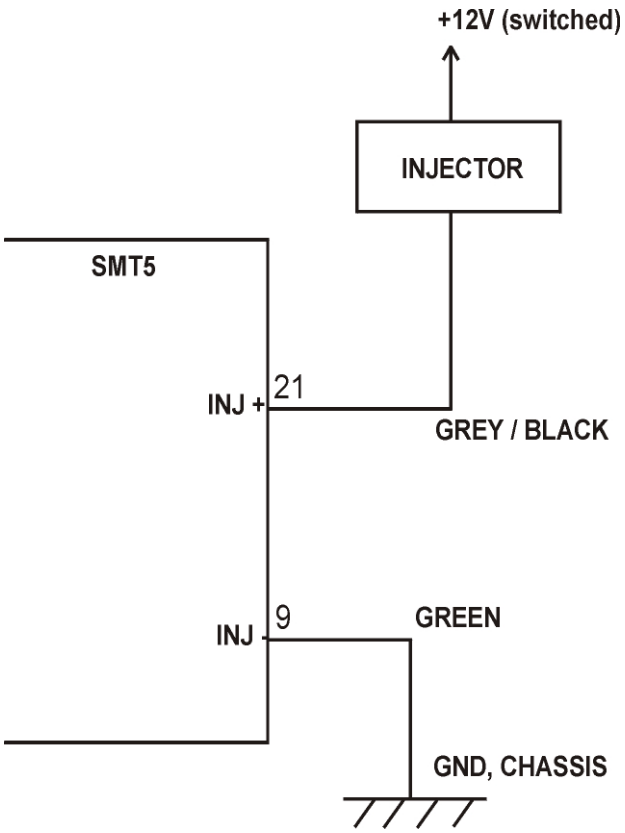
10. EXTERNAL INJECTOR ACTIVATION

The SMT5 has one injector output, which can drive one to eight injectors of 16ohms. The total injector current is limited to 7 Amps, and an optional heatsink must be installed on the cooling tab (if the injector current is too high). However, since the extra injector(s) is not activated continuously, it is advisable to measure (touch!) the cooling tap during injector activation, and if touchable, no heatsink is required. The injector output driver is temperature protected, and will switch "OFF" if it gets approx. 100 degree C.

The outputs are:

+INJ	Grey/Black	Pin	21
-INJ	Green	Pin	9

The following diagram explains the connection:



Note: The INJ – Connection draws the injector current of 1-7 Amps. This wire should be connected to the chassis or battery – away from the SMT-UNI GND (Black) wire.

The injector activation is specified on the INJECTOR screen (F2).

Injection length per ignition is:

INJLENGTH = MAP * 0,1ms

11. FREQUENCY FUEL TUNING

The UNI MODE = 10 activates a single ignition signal retard/advance AND the FREQUENCY FUEL modification. In this mode the frequency on the IG2IN is copied to the IG2OUT with the fuel modification applied. This mode of fuel tuning is needed for frequency airflow meters, which output a frequency signal proportional to the airflow.

The SMT5 has the following operating range:

High freq or speed: Ø (=Low)
10Hz to 3300Hz (3.3kHz)

High freq or speed: 1 (=High)
80Hz to 18000Hz (18kHz)

The active parameters are:

Cylinders	:	sets rpm of fuel map
Teeth per firing	:	as above
Fuel map	:	
Frequency deviation	:	changes the IMPORTANCE of the fuel mod

Note: The UNIVERSAL SMT Version 5 does not require ignition input or analog deflection, except to select a fuel map modification value. The analog fuel tuning output is active.

Frequency input	:	White / Red	Pin	5
Frequency output	:	White / Blue	Pin	17

Note: A pull-up (blue / black, pin 14, 15) may be used on the input for optical or hall sensors.

Note: A positive number increases the frequency and the fuel.

12. ONE IGNITION INPUT SIGNAL

In UNI MODE=10, 11, and 12 and 13

IG1IN	YELLOW	Pin	8
IG1OUT	WHITE	Pin	20

are the prime ignition (CB1) input and output signals. The input trigger level (SEE: RPM DEFLECTION) and input and output polarity can be specified.

The IG1IN signal serves as a map deflection input, and it requires that the signal repeats every engine turn.

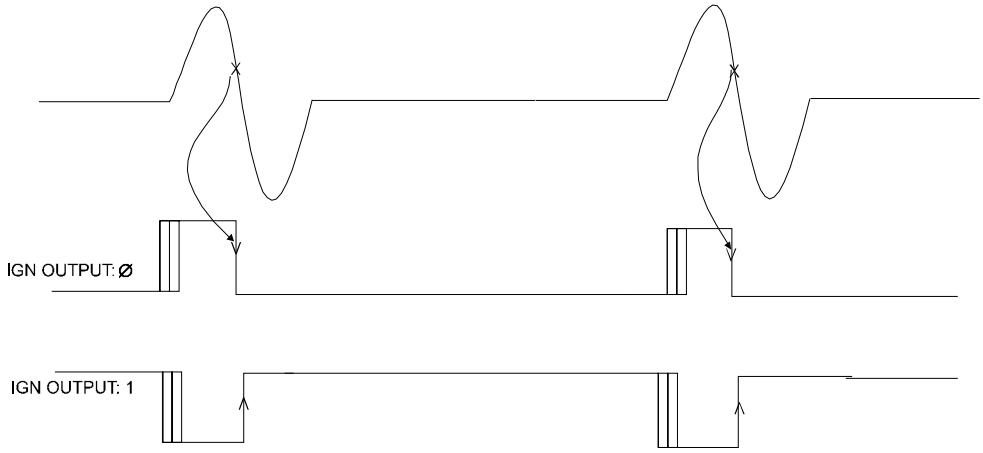
The output is affected by:

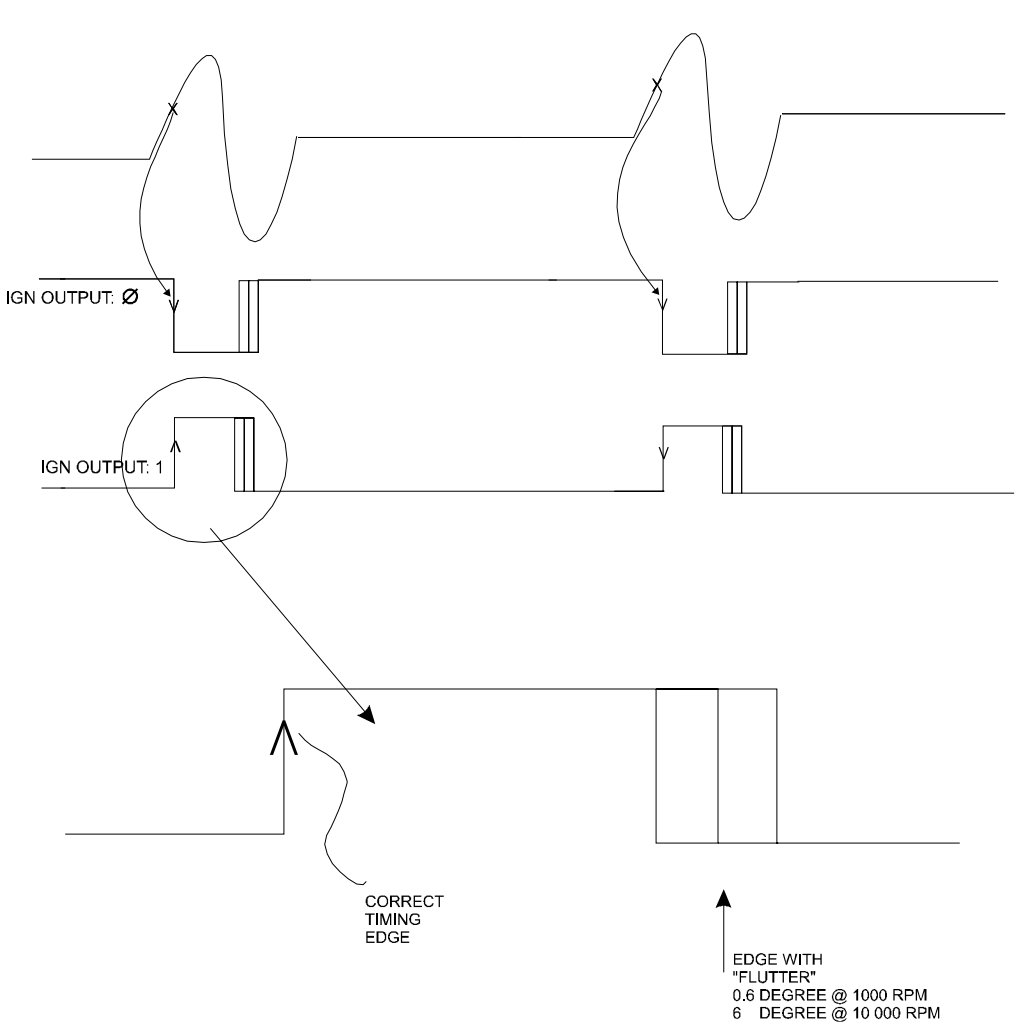
Cylinders:
Teeth per firing:
Input polarity
Output polarity
Interlaced

At RPM position zero (bottom map row) the output signal is copied from the input, and no timing is applied. This allows the changing of input and output polarity, until the engine starts and runs. At this point the RPM indication should be correct.

The BIPOLAR (MAGN) INP parameter is active, but does not change the output drastically; it only changes the input trigger level.

Ign input: polarity ∅ Uni Mode = 10





It is obviously from the above that an input and output edge combination is chosen from the one that does not have the “flutter” at the firing edge (trigger edge).

13. TWO IGNITION INPUT SIGNALS

The second ignition input and output is available in UNI MODE=12. For the first ignition input and output, SEE: ONE IGNITION INPUT SIGNAL

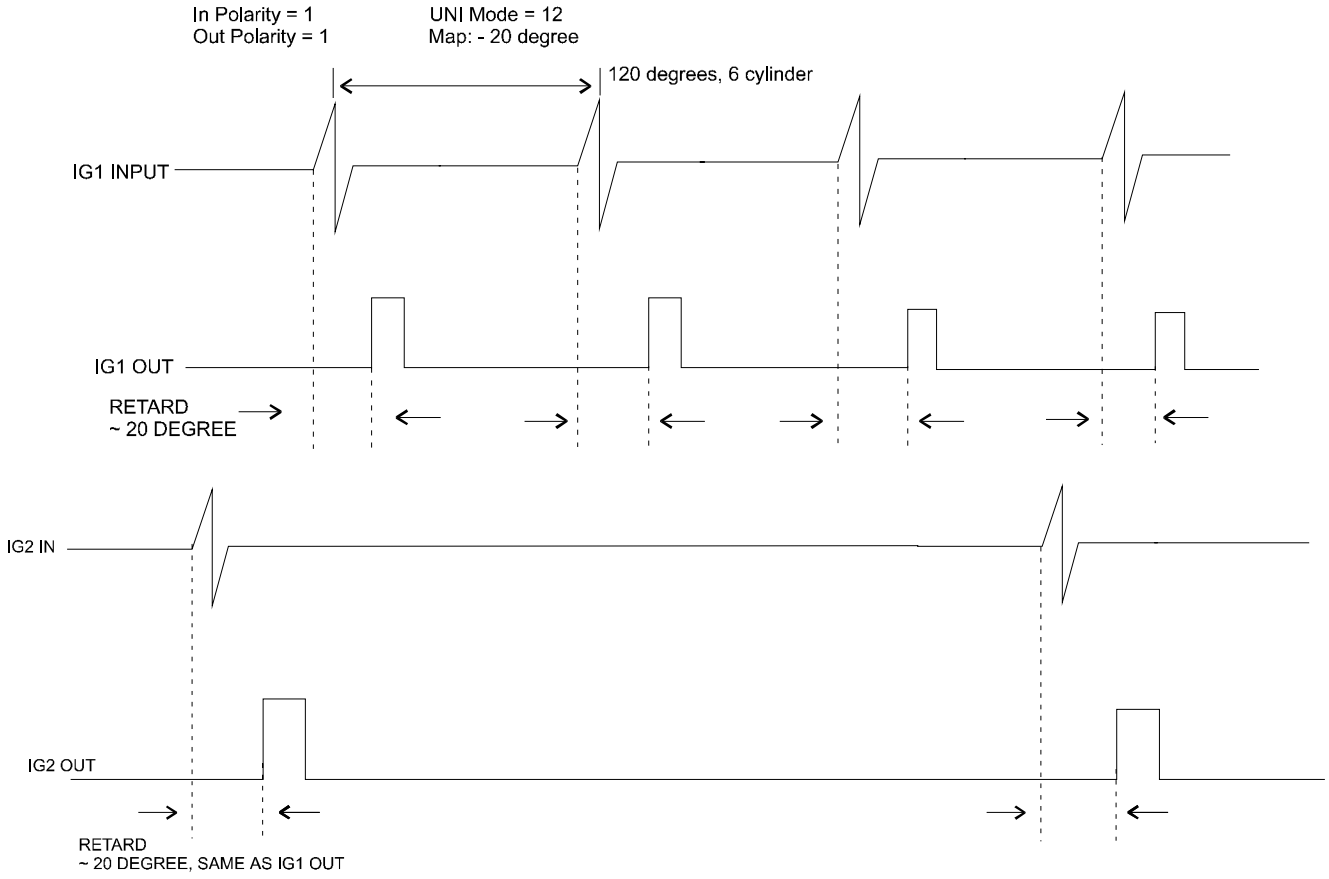
The connections are:

IG2IN	WHITE/RED	Pin	5
IG2OUT	WHITE/BLUE	Pin	17

The timing for this output is calculated from CB1 (IG1IN) and applied to the IG2OUT. That is to say that the IG2IN signal can be any signal (Cam?) but it will be advanced or retarded in SYNCH with the IG1OUT signal.

The polarity and level settings in the global (F4) screen apply to the second ignition.

A timing diagram shows it.



14. MISSING TOOTH APPLICATIONS

This operation is specified with MODE=1.

	INPUT:	IG1IN	yellow	pin 8
	OUTPUT:	IG1OUT	white	pin 20
Secondary	OUTPUT:	IG2OUT	white/blue	pin 17
Bipolar	OUTPUT:	IG1SP	pink	pin 19

The IG1IN signal serves as a map deflection input, and requires that the signal repeats every engine turn. This is normally the case with crankshaft triggers. Consult the factory if you have a missing tooth CAM trigger, which repeats every two turns.

The output has the same characteristics as the input signal, but it is a 12V square wave.

The input/output is affected by:

- Ign input polarity:
- Ign output polarity:
- Bipolar (Magn.) inp:
- One missing tooth:
- Teeth per turn:
- Teeth per firing:

At RPM position zero (bottom map row) the output signal is copied from the input to the output and timing is applied (regardless of your map entry!). This is particular convenient for starting the engine, and for "first time" testing.

Set the bottom RPM scale to 3000 RPM (RS 3000), and try to start the engine. Change polarity and trigger level until the engine runs smoothly. You may "tee" in the IG1IN signal first, and then monitor the output IG1OUT for matching the input.

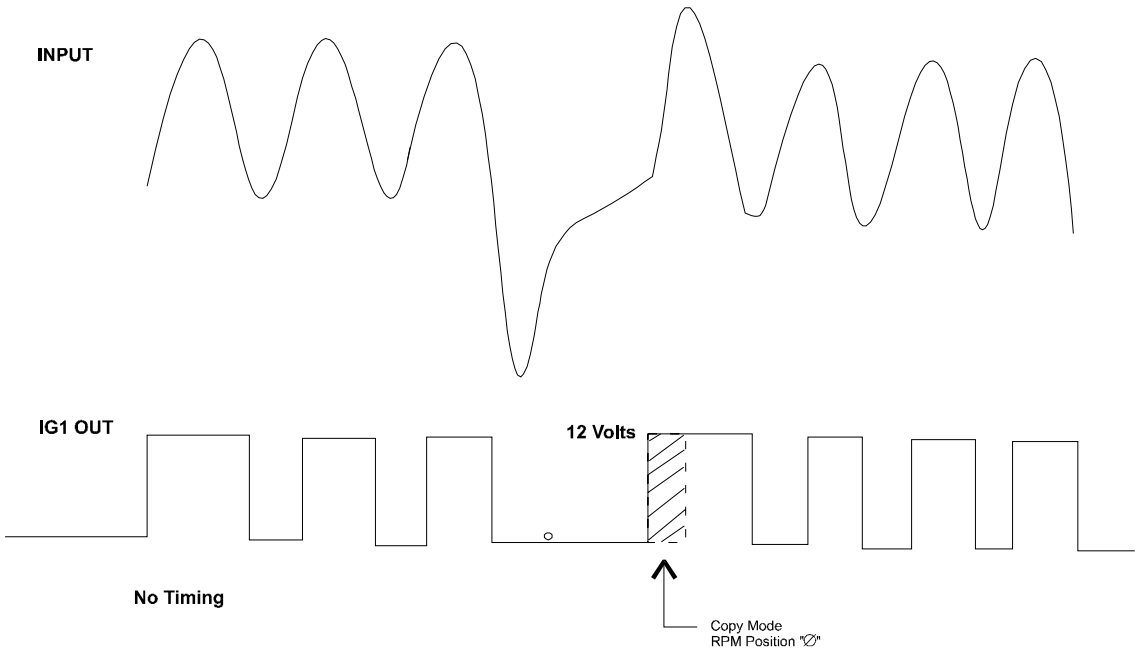
Depending on what signal your ECU requires, you may try the alternative output:

Bipolar OUTPUT:	IG1SP	pink	pin 19

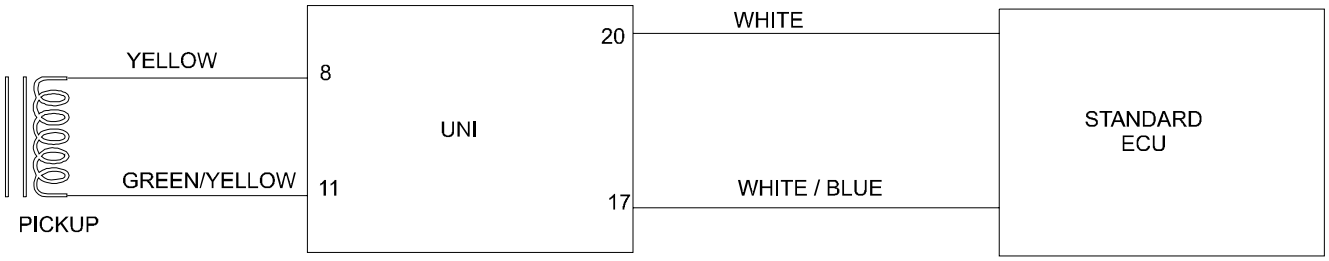
This IG1SP signal swings from -8 volts to +8 volts.

The second output is IG2OUT. It is an INVERSION of the IG1OUT signal. Some ECU's with "balanced" inputs require two "opposing" input signals to trigger.

The following picture shows a good input trigger signal, with the output shown without any timing applied. The output can be retarded and advanced by up to two teeth (minus one degree). The output contains one or two missing teeth as specified, regardless of the input signal.



Wiring for "Balanced" output:



15. ROAD SPEED GOVERNOR

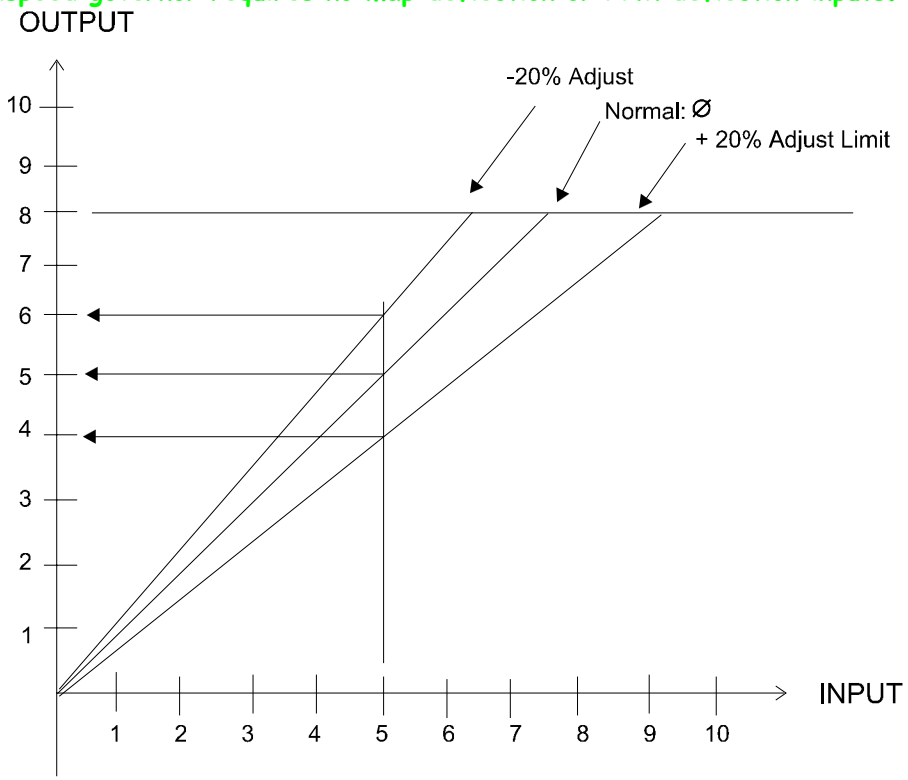
The road speed governor is selected with MODE=11. That is to say it works with the single ignition system.

Input:	IG2IN	WHITE/RED	Pin	5
Output:	IG2OUT	WHITE/BLUE	Pin	17

The following parameters are active for ROAD SPEED GOVERNOR ONLY:

HIGH FREQ OR SPEED:
UPPER SPEED LIMIT:

Note: The roadspeed governor requires no map deflection or RPM deflection inputs.



Physical frequency limit of the output signal:

High freq or speed:	0	1
Output frequency limit:	3kHz	17kHz

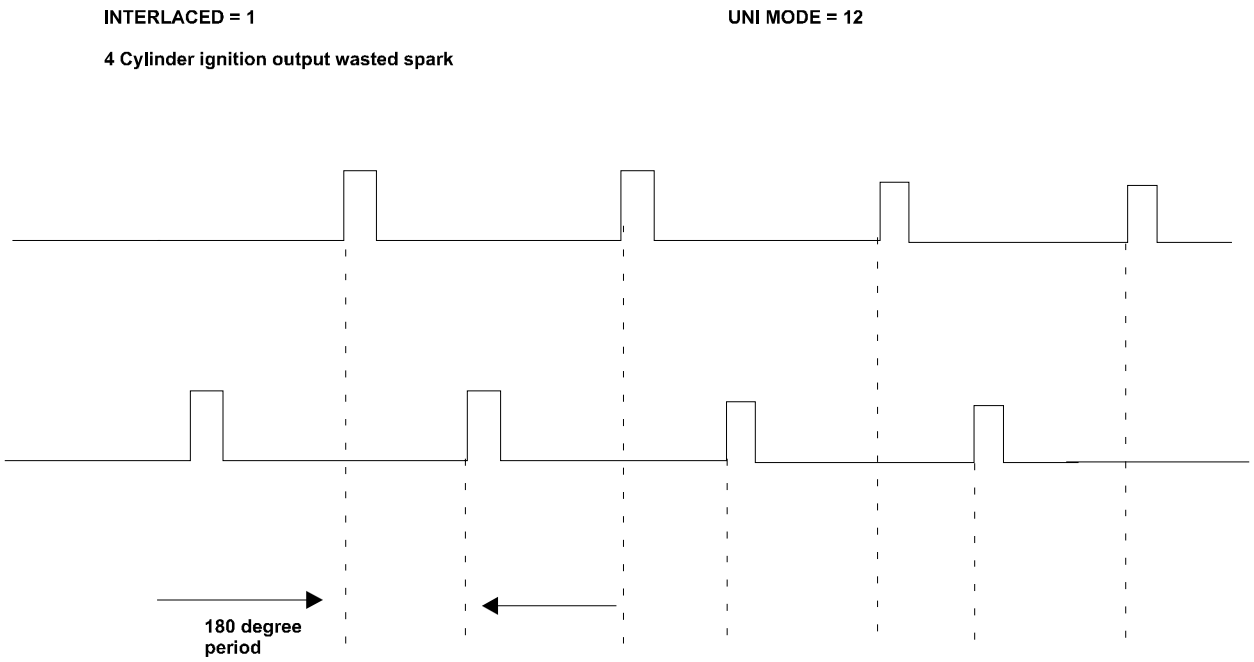
Note: The upper limit on the global screen (F4) is a "period" measurement, but the preceding graph depicts it as a "frequency" limit. By using the "SS" SET SPEED command while the vehicle is travelling just before the Actual speed limit, the period is properly calculated and set.

The above graph shows that the output "slope" can be proportionally adjusted, which would affect the gear-change points and the road speed governor. By limiting the output frequency, only the road speed governor is affected. However, both the frequency (speed) adjusts AND the speed limit can be used simultaneously to achieve any desired effect.

To deviate the upper speed limit: enter Ø. A very low speed limit is a large number.

16. INTERLACED INPUTS (AND OUTPUTS)

The INTERLACED operation is specified on the global (F4) screen. It assumes that the RPM per firing is measured over TWO input trigger points. This is normally the case with a 4 cylinder wasted spark ignition signal, which looks like:



Therefore, the interlaced operations mode is the same as specifying:

TEETH PER FIRING: 0.5

Which is not possible, of course. However, the following results in the same RPM indication:

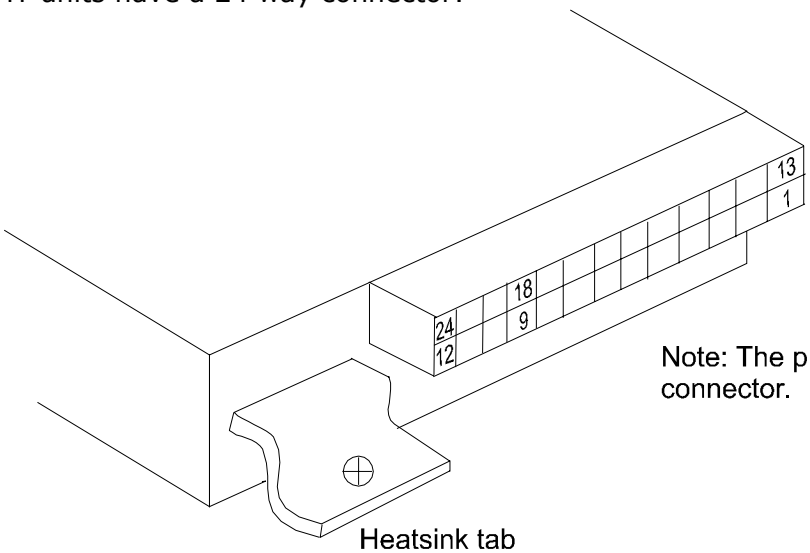
TEETH PER FIRING: 2	INTERLACED: 1
TEETH PER FIRING: 1	INTERLACED: 0

The interlaced mode applies to 4 cylinder wasted spark output modification! Other applications were not envisaged!

If the advance / retard of the two ignition signals is required, then mode = 12 must be specified.

17. ALL WIRING

The SMT units have a 24 way connector:



Note: The pin numbers are on the male connector.

UNI5	DESCRIPTION	COLOUR
1	Ground, GND, Chassis	Black
2	RX-Input	
3	TX-Output	
4	Map switching	Grey
5	IG2IN	White / Red
6	AIN, Analog input	Blue
7	A-DEFL, Analog deflection input	Brown
8	IG1IN, Also RPM deflection	Yellow
9	Injector, chassis, current	Green
10	Spare	Black / White
11	GND	Green / Yellow
12	NC	
13	+13V, Battery	Red
14	Pull-up 4K7	Blue / Black
15	Pull-up 4K7	Blue / Black
16	IG3OUT	Orange
17	IG2OUT	White / Blue
18	AOUT, Analog output	Violet
19	IG1SP, Bipolar output of IG1	Pink
20	IG1OUT	White
21	Injector +, to injector, current	Grey / Black
22	Oxygen display input	Black / Brown
23	NC	
24	NC	

18. PULSE WIDTH MODULATION

The Uni Mode = 13 activates a single ignition retard/advance AND the PWM FUEL modification. In this mode of fuel tuning an independent input frequency is copied to the output, but the DUTY CYCLE of the input is modified with a value from the fuel map.

This mode is called for tuning values and solenoid opening times, such as proportional CAM control, and boost regulation control.

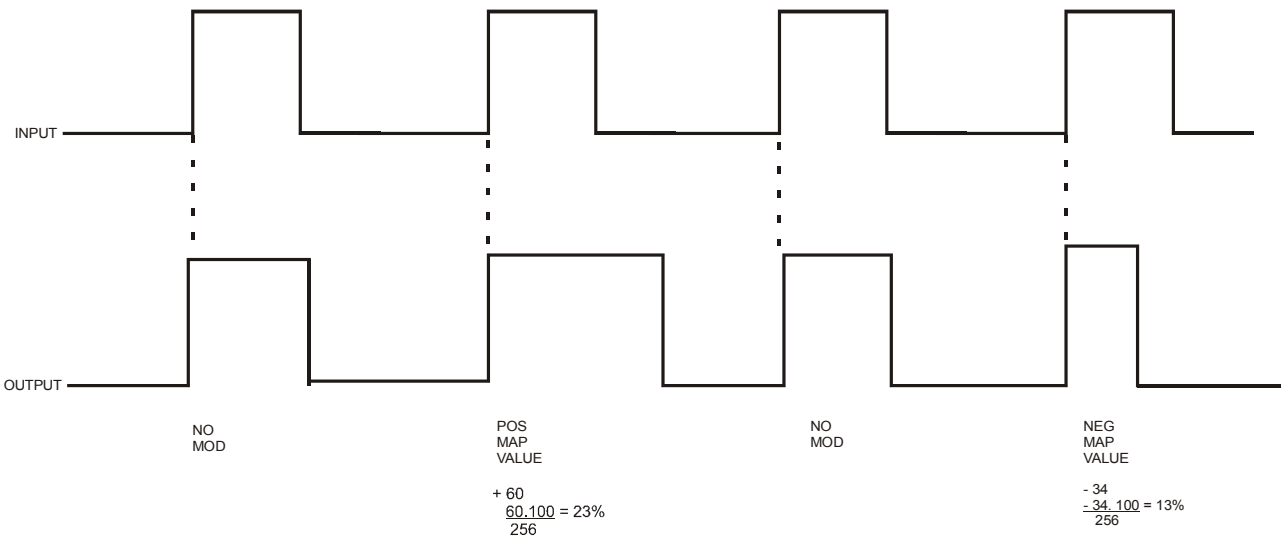
The following parameters are active:

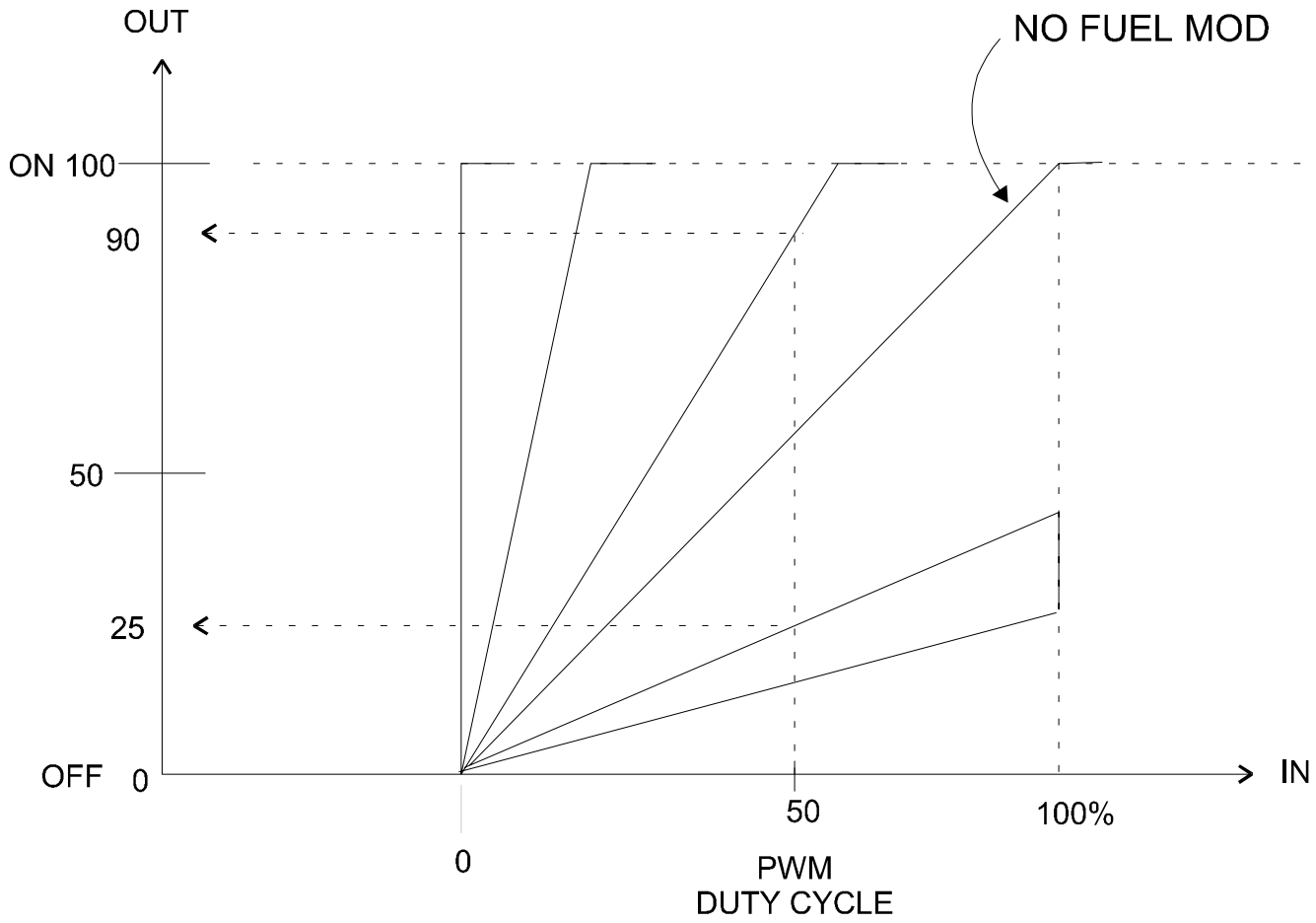
High freq or speed:
Fuel map values:

Note: The Universal SMT Version 5 does not require rpm or analog deflection, except to select a fuel map value other than in the bottom row.

PWM input	:	White/Red	pin 5
PWM output	:	White /Blue	pin 14

Note: A positive number lengthens the duty cycle.





Samples:

Input duty cycle = 50%
A output: Positive modulation + 40% = 102 results in 90% out
B output: Negative modulation – 25% = 54 results in 25% out

19. SELF TESTING

The SMT5 can be tested by unskilled personal without any test equipment, but a special test connector. The test connector is available from your supplier, or it can be made as follows:

TUNI5: SMT UNIVERSAL (5) SELF TEST Digital Technology PTY Ltd

AnaDefl :4.57
Delay: 57.60

Input 1:0.08
Output 1:0.00
Input 2:2.02

Type "G"
To start TEST

Initials: dds

Port = 1

StoreSel: B

Test	Pt	Output	U-Lim	L-Lim	Input	Result
AI-DEFL/PUP	1	0.500	4.850	4.200	4.569	PASSED
AI-INPUT	2	0.500	0.600	0.400	0.471	PASSED
AI-INPUT	3	2,500	2.600	2.400	2.431	PASSED
AI-INPUT	4	7.500	7.600	7.400	7.451	PASSED
AI-INP	5	9.500	9.600	9.400	9.451	PASSED
IGISP-OXYIN	6	5.000	3.200	2.700	3.020	PASSED
LOW POS CB17	33.000	18.000	12.000	14.900	PASSED	
LOW NEG CB1	8	44.000	200.000	150.000	177.300	PASSED
LOW POS CB29	55.000	18.000	11.000	14.200	PASSED	
LOW NEG CB2	10	11.000	200.000	150.000	169.300	PASSED
HIGH NEG CB1	11	22.000	80.000	30.000	55.400	PASSED
HIGH NEG CB2	12	33.000	80.000	30.000	57.600	PASSED
INJECT ACT.	13	40.000	120.000	STORE B		

Command: Error: ALL PASSED, DONE!
Test: dds

Install the test program (DOS:TUNI5) and
Run it TUNI5
Start a test by "G" (Enter)
The unit must pass all tests!

The following test connections are required:

Source	**pin**	**via**	**pin**	**Destination**	**Via**	**To**
INJGND	9	to	11	GND		
AOUT	18	to	6	AIN		
IG1OUT	20	10K	5	IG2IN		
IG2OUT	17	10K	8	IG1IN		
IG3OUT	16	10K	10	SPARE IN		
INJECT21	to	4	MAP	3E3	+13V	
IG1SP	19	rect	22	OXYIN		
PU1	15	to	14	PU2		
			7	A-DEFL	1.2K	GND
GND	1	to	SUPPLY			
+13	13	to	SUPPLY			

20. KEYWORD INDEX

Pickup	A device which produces an output (change) in relation to the crank position.
Optical pickup	Normally located in a distributor. It has three wires, +12 signal, GND. The signal output requires a "pull-up" resistor to + 12 Volts (4k7 to 10k) and then the signal wire "jumps" between GND and +10 volts when the crank turns.
Magnetic pickup	Has 2 wires + a shield. The shield (screen) must be connected to the ECU GND and not to the engine. One wire goes to the GND of the ECU, the other has positive/negative signal (See: section 12) when the shaft is turned. These pickups are found on the crank or in the distributor.
Missing tooth Pickup	Located on the crank, it has multiple teeth (24-60) per turn and one or two teeth missing. The missing teeth (gap) signifies a defined crank position (TDC or other).
Interlinked signals	This means that a crank trigger signal has a defined relationship to a cam signal, and if this relationship is "modified" then the ECU assumes that the cam has slipped and the ignitions are stopped, or the ECU "misbehaves" otherwise.
Analog fuel tuning	An analog signal (e.g.: 0-10V) is modified via the fuel map.
Frequency fuel Tuning	A frequency signal (e.g.: 10Hz to 18kHz) is modified via the fuel map.
PWM fuel tuning	A PWM signal is modified via the fuel map.
PWM signal	A signal with an unimportant frequency, where the information is contained in the "duty cycle". The SMT copies the frequency, but modifies the duty cycle. Used for proportional CAM variations and boost control.
Injector activation	The SMT can drive up to 7 amps, which are 8 x 16ohm, or 4 x 8 ohm, or 2 x 4 ohm injectors. The injectors are activated proportional to Rpm and the map values.
Road speed governor	This is not the RPM limit of the ECU, but a signal derived from the transmission train, which changes proportional to the road speed. This signal is used for automatic gearbox shifting and to limit the max. wad speed via the ECU.
Interlaced	The ignition on a 4 cylinder wasted spark system is "interlaced". See section 2.

Self Test	The SMT performs an internal self test when power is applied. However, a special self test feature can be performed via a PC and a test harness which checks every input / output for the correct performance.
Injection	A method to add more fuel to the engine through an ADDITIONAL injector(s) which must be mounted somewhere in the manifold, preferable BEFORE the butterfly. The injection output is optional and must be ordered.
Library	A file, which can be loaded in to the SMT5, describing the global (technical) setup pertaining to the engine, such as Cylinders, Trigger level, Teeth per firing, mode, etc. The SMT5 can hold ONE library file.
Map	A file, which can be loaded in to the SMT5, describing the modification done to the fuel, injection, and ignition. The UNI5 can hold two MAP sets, each set has a fuel injection and ignition map.
Mode	A method to "configure" the SMART TUNER SMT5 to perform a specific task.
No Tune	A method to prevent any tuning. The library and map Displays are disabled, and keyboard entry is prevented. The downloading function is active.
Branding	The dealers name is stored in the SMT5 when customizing the SMT5 to a particular engine.
Developer	A dealer or user who wants to develop his own application for an engine without a WIRING DIAGRAM.
Wiring diagram	A standard form of SMT5 wiring, which shows all wires, location of ECU, ECU connector, and library used for setup.

21. TECHNICAL (GLOBAL) LIBRARY SETTINGS

All setup parameters contained on the F4 global screen are explained here. These details are only available to the developer. The can be made visible by PERFECTPOWER, and they can be OVERWRITTEN by any valid library setup (file).

21.1 Road Speed Governor

Road speed deviation:
In mode=11, which activates the road speed circuit, the output frequency (road speed signal) can be deviated by the specified percentage.

Road speed limit:
This restricts the output frequency (road speed signal) to the specified "period". For details see: Road speed tuning.

21.2 Fuel Affecting Variables

Fuel zero:
This is the "offset" between the analog input (AIN) and the analog output (AOUT).It can be used to make the complete fuel map richer or leaner.

Fuel upper limit:
This is a voltage specification, which restricts the output to rise above the specified value. This is good for tuning "LAMBDA", or it prevents the ECU from displaying a "service fault".

Fuel lower limit:
Same as above, but the lower limit. The output voltage is prevented from falling below this value.

Fuel freq. limit:
In mode=10, the map values are applied to the frequency signal. This specification prevents the output signal (frequency) to rise above the limit.

21.3 General System Variables

Operating mode:
1 Missing tooth operation
10 Single ignition + frequency fuel
11 Single ignition + road speed governor
12 Two ignition
13 Single ignition + PWM fuel

The operating modes must be set to one of the above numbers. Any other entry results in a "BAD MODE" display.

System bit config:
This variable is the SUMM of the following values, which one by one enables or disable the following functions. The entry is the SUMM of all enabled items!

(1) Ignition input polarity: Adding 1 enables the positive edge for input trigger

(2) Ignition output polarity: Adding 2 enables a positive output signal.

(4) Low input trigger level: Adding 4 specifies a low trigger threshold level of 0.5 volts, otherwise a high level of 4.5 volts is effective.

(8) High frequency range: Adding 8 specifies the high frequency range.

(32) Interlaced inputs: add 32 to enable it. see: interlaced in puts

(64) One missing tooth: Add 64 if one missing tooth is on the pickup wheel.
a. Add 0 for two missing teeth.

Cylinders:
Any amount of cylinders can be specified. This entry affects the RPM indication, and the ignition calculation in degrees.

Teeth per revolution:
The amount of trigger signals per revolution (360 degrees), including any missing teeth!

Teeth per firing:
Amount of trigger signals between firings.

21.4 Ignition

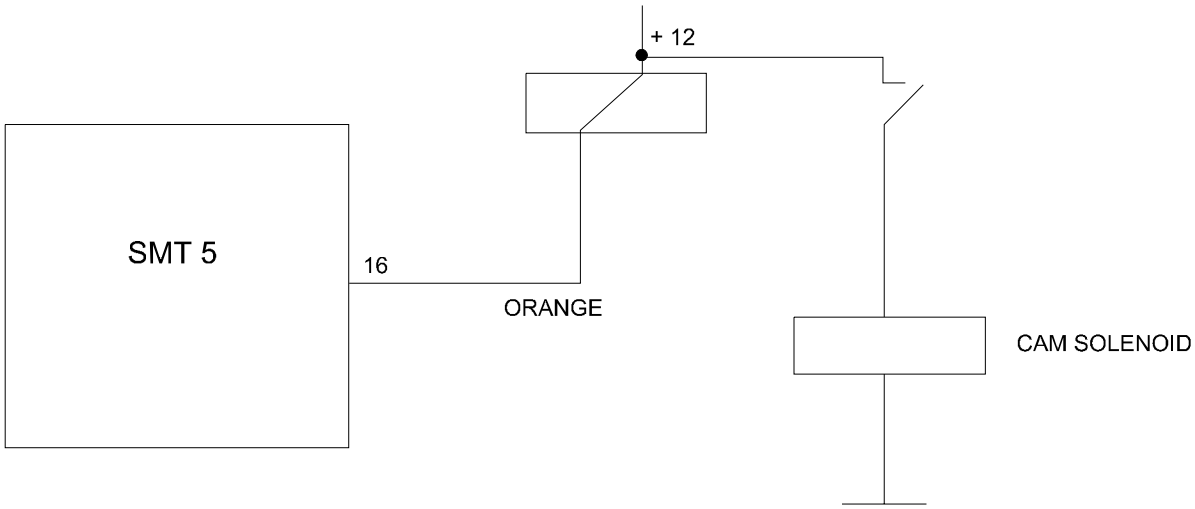
The ignition modification is specified in the IGNITION screen (F3). The maximum deviation is:
Mode=1: +- 2 teeth
Mode>1: +-180/cylinders.

Ign. adv. limit: This entry restricts the ADVANCE map entry.

Ign. ret. limit: This entry restricts the RETARD map entry.

21.5 CAM Switching

All units (SMT 5, SMT5-I) can switch the IG3OUT wire (orange) according to the CAM RPM variable on the global screen. The output is rated at 100mA, and it goes low when the RPM is higher than the limit. A suitable relay should be used as follows:



The Switching is NON-Proportional.

22. WIRING DIAGRAM AND LIBRARY

Once a development is complete, then the attached WIRING TEMPLETE must be filled out, and checked for correctness. If the same setup should be used in the future, then the library and map information must be saved. It is important to describe the library with the

LI text (text= max 64)

command and the map information with the

MI text (text= max 64)

command. Then Save the info to your hard disk with

SF name (name= max 8 characters)

This saves two files on your hard disk:

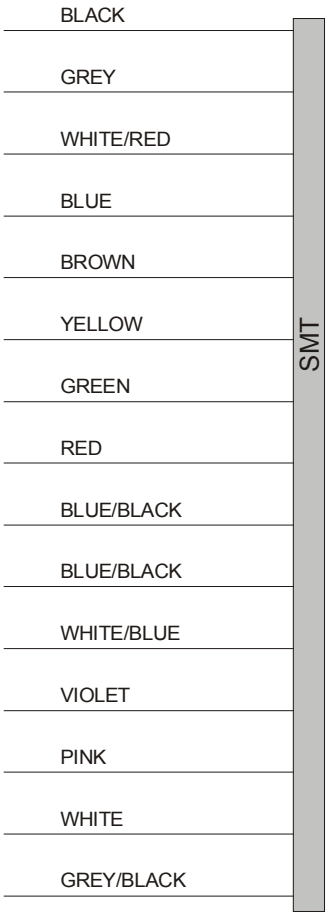
A) The setup file: name.TMP
B) The map file: name.UMP

Please email the WIRING DIAGRAM and the name.TMP (+name.UMP) files to info@perfectpower.com We will make a library out of all, and send you all files back, properly cataloged, but with possible different names.

Wiring diagram Template:

Vehicles Year:	Perfect Power	Model:	Manufacturer:
Is your unit a UNI 4 or 5? ___.	www.perfectpower.com		

ECU pins.



Engine connections.

Ref: 1-00000

23. APPENDIX A

23.1 Turbo Fueller application using the Smart Tuner 5 (Smt5)

The purpose of this application is to demonstrate the use of a SMT5 in a turbo fueller application, which requires the injection of extra fuel once the turbo starts boosting (where the standard ECU can't inject more fuel). The additional fuel is injected via an extra injector(s) placed near the throttle body.

TRADITIONAL:

PerfectPower made the TURBO FUELLER (TF4). This was a small device, which could drive 2 injectors, and had a build in AMP sensor. It had the following tuning map display, in which I have loaded a TYPICAL map without any ignition mapping.

SMART TUNER:

This new device is well suited for turbo fuel applications, and the price is comparable. The SMT5 is almost half the size and far more durable to rough conditions that the older TF4 unit.

TECHNICAL DIFFERENCES:

	TF4	SMT5
Injector drive outputs:	2	1
Drive type:	Step	ON
Drive current (AMP):	3	6
RPM map steps:	16	16
AMP map steps:	16	8 <----!
Total tuning sites:	32	128
Size:	?	Smaller

CONCLUSION:

The Injector drive difference is small or non-existent. The AMP step difference is significant on paper, but in practice the SMT5 is better, because the 8 AMP steps can be distributed over the USEFULL range (non linear). This will be shown later or refer to the Windows Manual, section 9.6 Analog Deflection. The increased overall tuning sites make the SMT5 a better choice for TURBO FUELLER application in future.

TF4: TURBO FUELLER SCREEN

		Frpm		Famp		Fairt		Irpm		Iamp
AMP:		Rpm		bar				Rpm		bar	
AirTemp:	øC	9700	100	2.50	1.60	130	0	9700	0	2.50	0
Inject:		8800	100	2.34	1.55	120	0	8800	0	2.34	0
RPM:		7900	100	2.18	1.50	110	0	7900	0	2.18	0
Retard:	ø	7050	50	2.02	0.99	100	0	7050	0	2.02	0
		6250	50	1.86	0.90	90	0	6250	0	1.86	0
		5500	50	1.70	0.60	80	0	5500	0	1.70	0
		4800	45	1.54	0.40	70	0	4800	0	1.54	0
		4150	40	1.38	0.20	60	0	4150	0	1.38	0
CYlinders:	4	3550	35	1.22	0.10	50	0	3550	0	1.22	0
Inj.Open:	1.50 ms	3000	30	1.06	0.00	40	0	3000	0	1.06	0
POlarity:	1	2500	20	0.90	0.00	30	0	2500	0	0.90	0
BLanking:	1.00 ms	2050	10	0.74	0.00	20	0	2050	0	0.74	0
Inp.Levl:	0	1650	5	0.58	0.00	10	0	1650	0	0.58	0
		1300	0	0.42	0.00	0	0	1300	0	0.42	0
		1000	0	0.26	0.00	-10	0	1000	0	0.26	0
		<850	0	0.10	0.00	-20	0	<850	0	0.10	0

Command: Error: File:

Notes to the above map: The engine is "flooded" above 7000 RPM and 1 bar boost. Injection starts at 1650 RPM and 1.22 bar. Air temperature compensation is not used! The injector open times are: (Frpm * Famp *0.032)+Inj.Open/2

NEW SMT5:

This unit has three maps, but only the INJECTOR map of the SMT5-I is used and shown. Of course, the other maps and functions can be used at the same time, but they are not explained in this application. Again I have loaded a TYPICAL map, which injects the same fuel as the above TF4 map.

SMART TUNER UNI(5):

Lib:
Map: Testing TF4 compatible operation on a 4 cylinder engine !

		Analog deflection (%)							
AnaDefl:	%	60	65	71	77	82	87	92	99	INJECT
Rpm:		0	30	30	35	40	45	50	50	7000
Input #1:	V	0	8	10	12	14	16	18	19	6630
#2:	V	0	8	10	11	12	14	17	18	6260
Output#1:	V	0	8	9	10	11	13	16	17	5900
		0	7	9	9	10	13	15	17	5530
		0	7	9	9	10	12	14	16	5160
Fuelmod1:		0	7	9	9	10	12	13	16	4800
Inject:		0	7	9	9	10	12	13	15	4430
Ignmod:		0	7	9	9	10	11	12	15	4066
		0	6	9	9	10	11	12	14	3700
No tune:		0	6	8	9	9	11	12	14	3330
Mode bad:		0	6	8	9	9	10	11	13	2960
RPM bad:		0	6	8	9	9	10	11	13	2600
Ign. bad:		0	6	7	8	9	10	11	13	2230
StoreSel:		0	6	7	8	9	10	11	13	1860
Version:		0	0	0	0	0	0	0	0	1500 RPM
Error:										
Command:										

Notes to the above map: The RPM range is set up linear in the useful operating range and gives finer steps. The steps can be set un-linear with the WINDOWS software. The AMP steps (Analog deflection in %) are set up from 1 bar to 1.7 bars on a 1.7 bar AMP sensor linearly. Dyno performance was measured and equaled the TF4 performance on the same engine on full throttle.

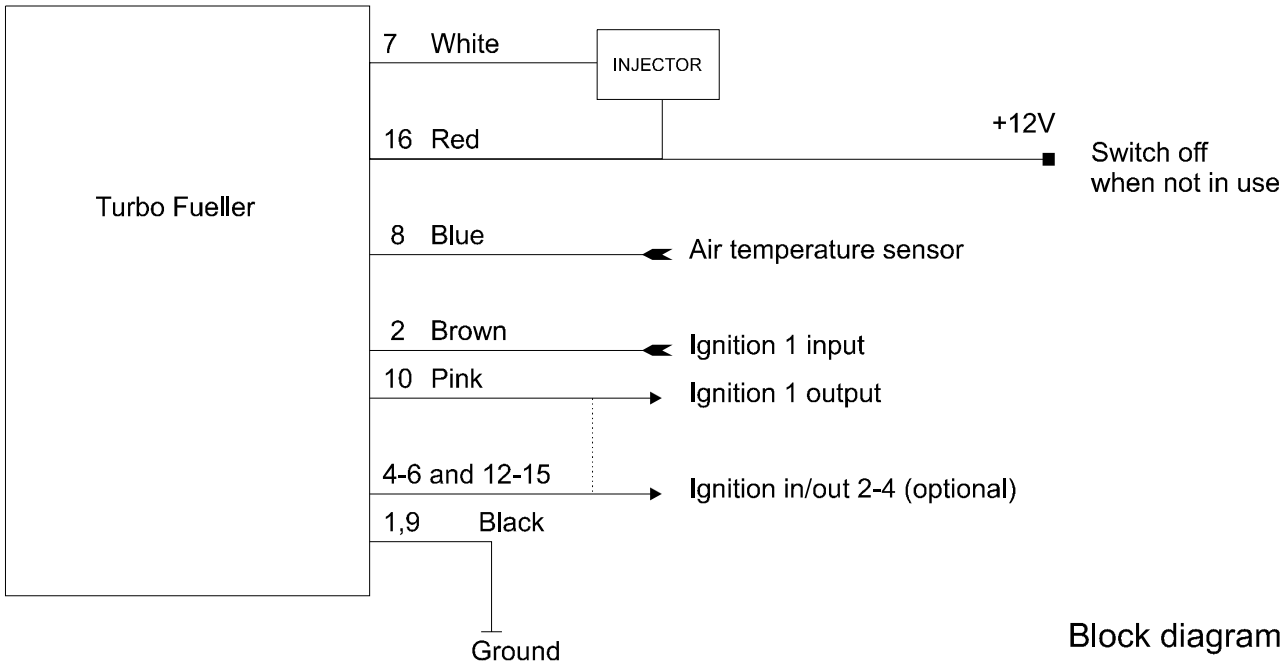
Injector open times are: N * 0.1024

CONCLUSION:

The SMT5 can be used as a TURBO FUELLER. The two maps are NOT compatible, but can be converted by hand, as I have done above. The SMT5 gives better alignment resolution, but this is NOT noticed on the DYNO or on the road. For all practical purposes the performance was identical, and the car owner could not feel any difference either. It worked. The SMT5 is more economical if combined with an existing AMP sensor. If the external Perfect Power AMP sensor Part No “AMP” is used, then the SMT5 system is the same price as the older TF4 unit.

WIRING DIAGRAMS:

TF4: Turbo fueller block diagram



SMT5: The wiring diagram for the SMT5 is very dependant on the vehicle. Please enquire for a wiring diagram for your vehicle from Perfect Power or visit www.perfectpower.com.

OPTIONAL PERFORMANCE EXPANSION:

1) Ignition mapping: No extra cost.
2) Existing AMP output limiting: no extra cost. For ECU's which throw a code when the boost pressure exceeds 1.05 bar.
3) Increasing boost: requires a suitable external AMP sensor, and ignition mapping.
4) Low octane fuel: Use the second map ! No extra cost.