



SXTune

User Manual

Revision 4

Introduction

Specialist Components are leaders in the design, manufacture and development of engine management systems for port injection and direct injection petrol engines and common rail diesel engines for on-road, off-road, motorsport, industrial, marine and aviation markets. SC ECUs provide cutting edge functionality, for example gasoline direct injection, variable valve timing control and drive-by-wire throttle at a competitive price. Typhoon 2 weighs just 228g with a 160x100mm footprint, but features up to 8 cylinder injection and ignition control, launch control, lambda auto-mapping, dual variable cam timing and on-board 100Hz, 24 channel data logging.

Tornado 2 brings additional features over Typhoon 2 including drive-by-wire throttle control, traction control and map switching with sequential injection for up to 8 cylinders, all for a weight of just 440g and a 160x160mm footprint. Both ECUs are sealed and suitable for engine bay mounting, with a common 35 way connector enabling simple upgrade from Typhoon to Tornado without major wiring changes.

Real time calibration is achieved via SC's own PC software 'SXTune' communicating via SC's bespoke micro-USB CAN bus interface. This is the smallest and lowest cost USB-CAN interface in the marketplace and it provides robust, fast data transfer even in noisy environments.

All SC ECUs support industry standard CAN 2.0B protocols at 1Mbit, 500kb/s or 250kb/s with a published data stream that can be received by most aftermarket data loggers and dashboards. User selectable CAN data streams are available to support original equipment instrumentation and EPAS systems from many manufacturers including BMW, Renault and Ford. New protocols are added constantly and ECU firmware can be uploaded by the end user in the field to upgrade the functionality.

About This Manual

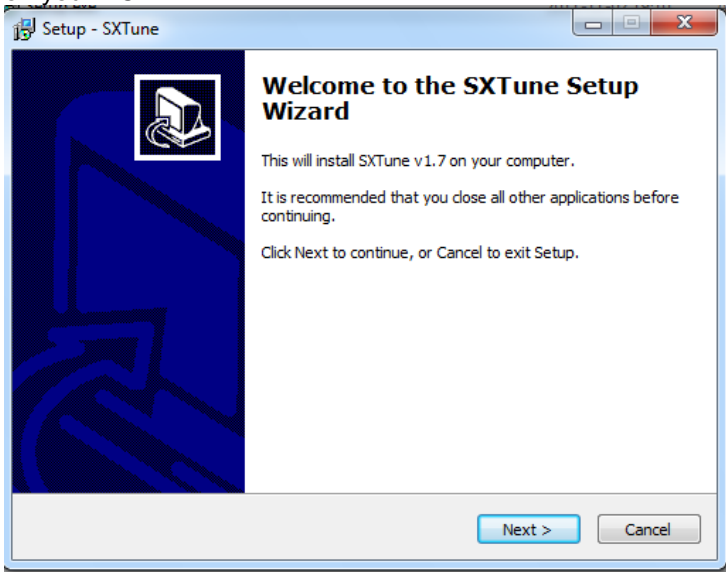
This manual is intended as a quick start guide and overview of the basic features of Typhoon and Tornado ECUs. SC ECUs are used in a variety of applications, as such requirements and functionality is often specific to these applications.

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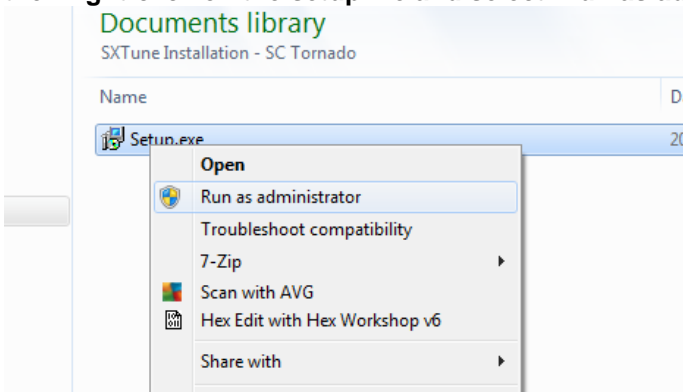
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Software Installation

To install the SXTune Calibration and Configuration tool on your PC please double click the setup file and follow the on-screen prompts. SXTune will then be installed onto your PC. If you have been supplied with or have downloaded a map for your ECU please copy this to the folder 'My Documents\SXTune Calibrations' on your PC.



N.B. You must be logged into your PC as an administrator to install SXTune. If you are not logged on as an administrator on your PC the installer will give the error message 'Access Denied'. You can then right-click on the setup file and select 'Run as administrator' to avoid this.

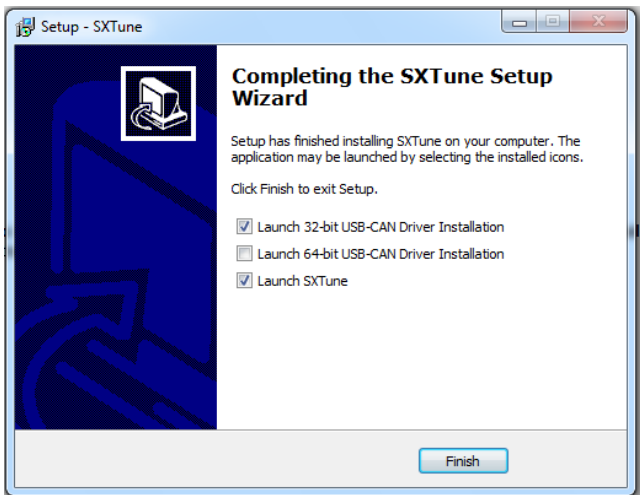


SXTune is suitable only for use with Microsoft Windows* XP, Windows Vista* and Windows 7* operating systems both 32 and 64 bit.

Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

USB-CAN Interface Dongle Installation

The SC USB-CAN interface dongle uses a CDC Windows driver; this is installed as part of the installation of SXTune. At the end of the SXTune installation process you will be given the option to install either the 32 bit or 64 bit driver software, make sure that the box is ticked for the version of Windows that you have. If you do not know which version then tick both boxes and the installer will attempt to install both versions, the incorrect version will simply fail to install and this will not cause a problem.



N.B. You MUST install the USB-CAN interface drivers onto your PC before plugging in the USB-CAN interface. If the drivers are not installed, SXTune will show the error message 'CAN Interface Not Found' when trying to connect. The USB-CAN drivers should be installed as part of the SXTune installation, but they can also be downloaded separately from the SC website: www.twinkam.co.uk.

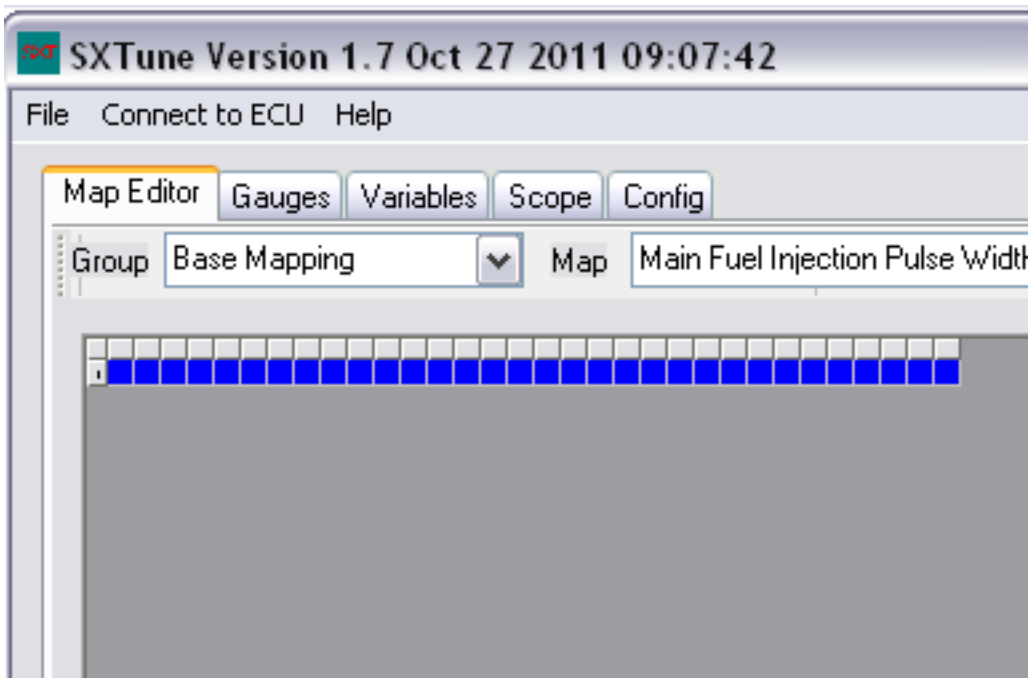
Quick Start Guide

When the wiring harness is installed and ECU powered please operate the ignition switch and ensure the ECU has power. If you are using the ECU to control the fuel pump this will be signified by a two or three second fuel pump prime when the ECU first powers up.

N.B. You MUST install the USB-CAN interface drivers onto your PC before plugging in the USB-CAN interface. If the drivers are not installed, SXTune will show the error message 'CAN Interface Not Found' when trying to connect. The USB-CAN drivers should be installed as part of the SXTune installation, but they can also be downloaded separately from the SC website: www.twinkam.co.uk.

Connect the USB-CAN interface dongle to your PC and the DB9 connector to the DB9 connector on your engine loom.

Within SXTune click 'Connect to ECU'



SXTune will now search the COM ports on your PC for the USB-CAN interface and then attempt to connect to the ECU.

ECU Hardware Installation

Before any configuration or calibration can be carried out the ECU must be installed on the car. Due to the vast number of differences between engine installations and specific car models it is impossible to provide detailed instructions for every model. The below is a best practice guide and assumes you are using a supplied wiring loom, either a SC Generic wiring loom or a custom loom for your application. Wherever possible we would recommend the ECU and wiring loom are professionally installed.

ECU Mounting

Typhoon and Tornado are housed in an extruded aluminium enclosure which is IP65 rated and as such suitable for engine bay mounting. The ECU is usually secured with 3M dual lock or a similar fastening medium to a flat surface such as a bulkhead, floor or similar. The ECU should not be mounted in areas of high ambient temperature e.g. near turbo chargers or exhaust manifolds.

Wiring Loom Installation

A loom supplied by SC will usually be supplied with a fuse/relay box, a 6, 13 or 16 pin expansion connector and a DB9 CAN comms breakout. The fuse/relay box should be secured to a suitable surface via the supplied mounting hole in the bracket. The DB9 CAN comms connector and expansion connector can remain loose on the loom but best practice is always to retain any loose connectors or cables to avoid undue wear and possible damage.

The loom should be run in a similar manner or the OEM loom. If the engine is being loomed from scratch then the loom should be run away from areas of high ambient temperature e.g. it should not be run near/over turbo chargers or exhaust manifolds. The loom should be retained with cable ties or cable mounts to avoid excessive flexing and if the loom is run near any rotating components such as pulleys or pumps it should be well secured to avoid damage and failure from contact with rotating components.

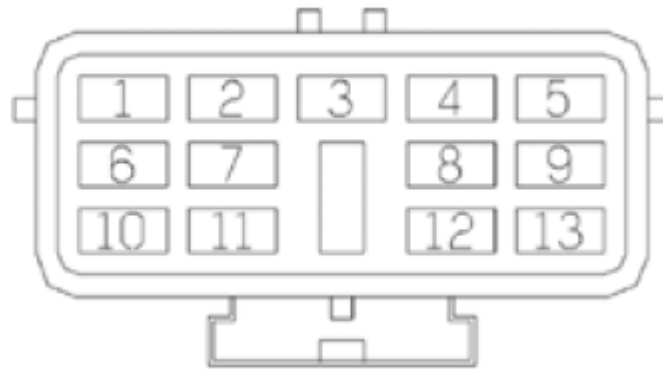
A loom supplied by SC will require three connections to the car/existing wiring loom. These are:

- +12V (usually red) – main permanent power for ECU/Loom
- Ground (usually black) – main ground for ECU/Loom
- +12V Ignition Switched (usually white) – key on/ignition on signal for ECU

Automotive spec looms have these connections terminated with self locking spade terminals to allow quick connection.

N.B. The main permanent and ignition switched power MUST NOT be connected together. The permanent power must remain live for at least 5 seconds after the ignition switched has been turned off for the ECU to save any changes. The permanent power must also be on before the ignition switched power is turned on to allow the programming procedure to work correctly.

In addition to the above basic connections SC supplied automotive looms also have the following inputs/outputs available usually via a 13 pin AMP expansion connector:

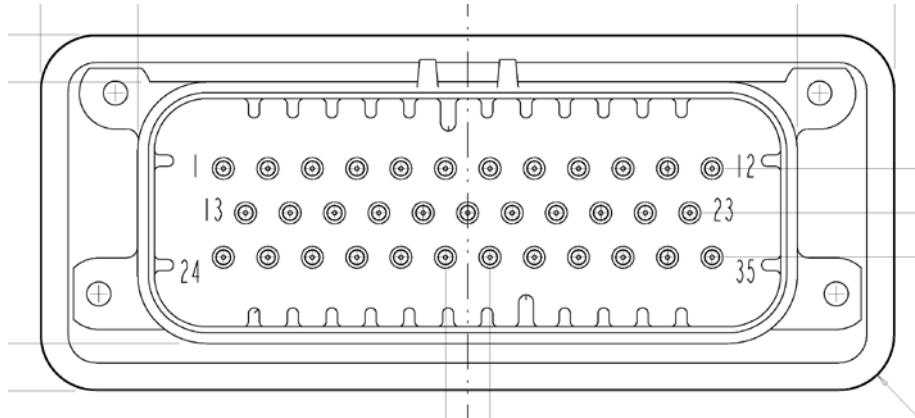


The pin out for this connector is as follows:

Pin Number	Name
1	+12V Ignition Feed
2	Ground
3	Lambda Sensor Signal Input
4	Linear 1 Analogue Input
5	Fuel Pump Output (Positive Supply to Pump)
6	Relay 1 Switched Output
7	PWM 1 Output
8	PWM 2 Output
9	Auxiliary 1 Output
10	Auxiliary 2 Output
11	Cam 2 Input
12	Reference Voltage Output
13	Manifold Pressure Sensor Input

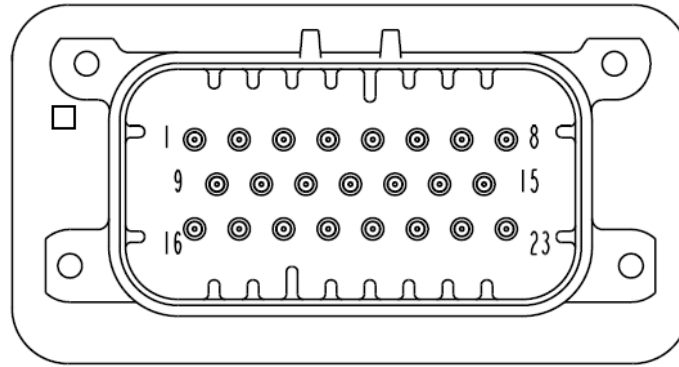
Tacho supply, coolant gauge supply etc. can be configured in the configuration/calibration software for output on PWM or Aux output connections on the expansion connector allowing standard dash display/dash packs to be driven from the ECU.

For trouble shooting purposes a pin-out of the 35 Pin Typhoon and Tornado connector is shown below:



Pin	Name	Description	Notes
1	VBATT	Battery Voltage Direct	Direct Battery Power 6-15V
2	VKEY	Ignition Key Input	Switched Ignition Feed
3	GROUND	Power Ground	
4	INJ1	Injector 1	5A Protected Output
5	INJ2	Injector 2	5A Protected Output
6	INJ3	Injector 3	5A Protected Output
7	INJ4	Injector 4	5A Protected Output
8	DIG_GND	Crank/Cam Sensor Ground	Digital Ground
9	CRANK	Crank Sensor	Hall effect or Variable Reluctance input
10	CAM1	Inlet Camshaft Sensor Bank 1	Hall effect or Variable Reluctance input
11	TCOOL	Coolant Temp Input	0-5V Analog Input
12	TAIR	Air Temp Input	0-5V Analog Input
13	IGN1	Power or TTL Ignition Coil 1	Hardware selected output type
14	IGN2	Power or TTL Ignition Coil 2	Hardware selected output type
15	IGN3	Power or TTL Ignition Coil 3	Hardware selected output type
16	IGN4	Power or TTL Ignition Coil 4	Hardware selected output type
17	LINEAR1	Analogue Input 1	User Configurable 0-5V Analog Input
18	CAM2	Inlet Camshaft Sensor Bank 2	Hall effect or Variable Reluctance input
19	NTC_GND1	Temp Sensors Ground	Analog Ground
20	LAMBDA1	Lambda Sensor Bank 1	0-5V Analog Input
21	CANH	CAN High	To PC comms DB9
22	CANL	CAN Low	To PC comms DB9
23	PROG	Program Enable	To PC comms DB9
24	RELAY1	Relay Output	User Programmable Relay Function
25	RELAY2	Fuel Pump Relay Output	Relay Output (Fuel Pump & O2 Heater Relay)
26	PWM1	Pulse Width Modulated Output 1	User Configurable Output Function, 5A Protected Output
27	PWM2	Pulse Width Modulated Output 2	User Configurable Output Function, 5A Protected Output
28	AUX1	Auxiliary Output 1	5A Protected Output
29	AUX2	Auxiliary Output 2	5A Protected Output
30	LINEAR_GND1	TPS & MAP Ground	Analog Ground
31	NTC_1	NTC Sensor Input 1	Temperature Sensor Input
32	TPS1	Throttle Position Sensor Input 1	0-5V Analog Input
33	MAP	Manifold Pressure Sensor Input	0-5V Analog Input
34	VREF1	TPS & MAP Reference Voltage	5V Reference
35	GROUND	Power Ground	

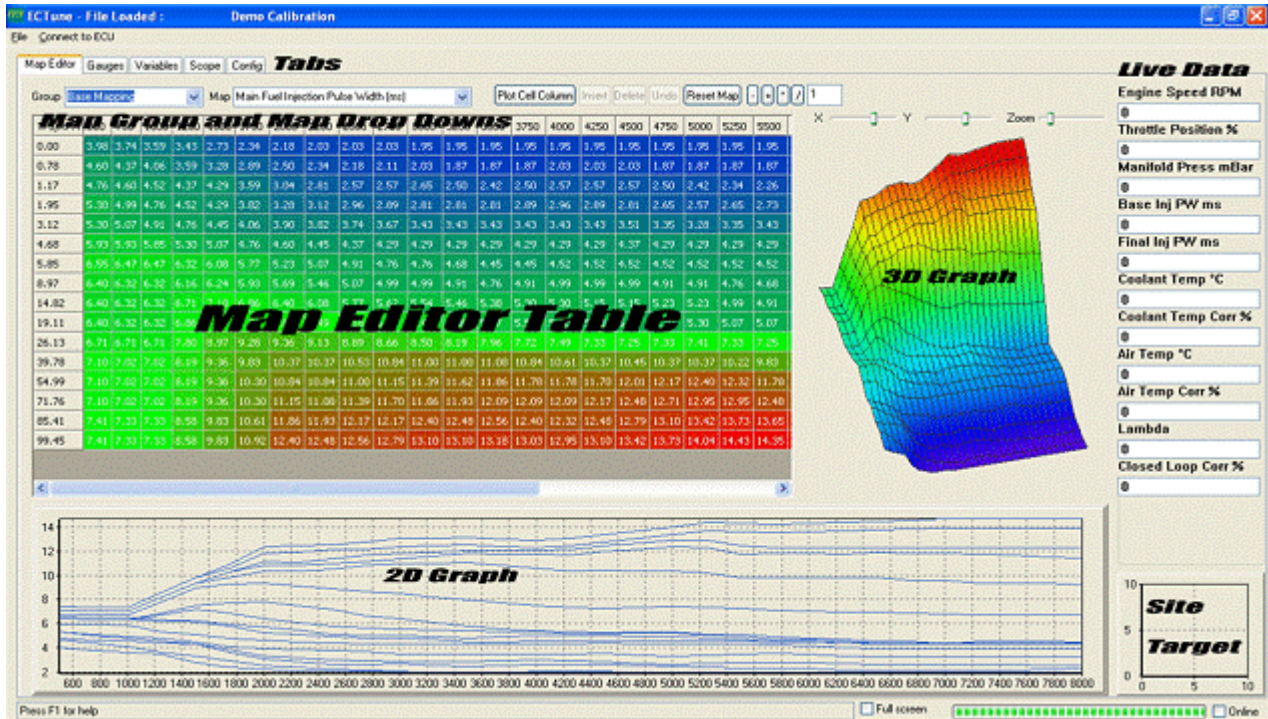
The pin-out of the 23-way connector on Tornado is shown below:



Pin	Name	Description	Notes
1	IGN5/INJ7	Power or TTL Ignition Coil 5	Hardware selected output type
2	IGN6/INJ8	Power or TTL Ignition Coil 6	Hardware selected output type
3	AUX3	Auxiliary Output 3	User Configurable Output Function, 5A Protected Output
4	AUX4	Auxiliary Output 4	User Configurable Output Function, 5A Protected Output
5	HBRIDGE+	DC Motor Positive	5A DC Motor Control
6	HBRIDGE-	DC Motor Negative	5A DC Motor Control
7	FANS1	Cooling Fan Relay 1 Output	5A Protected Output
8	FANS2	Cooling Fan Relay 2 Output	5A Protected Output
9	PWM3	Pulse Width Modulated Output 3	User Configurable Output Function, 5A Protected Output
10	PWM4	Pulse Width Modulated Output 4	5A High Speed Output (shared with H-Bridge)
11	WSPEED1	Wheel Speed Input Left Rear	Hall Effect Input
12	WSPEED2	Wheel Speed Input Right Rear	Hall Effect Input
13	WSPEED3	Wheel Speed Input Left Front	Hall Effect Input
14	WSPEED4	Wheel Speed Input Right Front	Hall Effect Input
15	LAMBDA2	Lambda Sensor Bank 2	0-5V Analog Input
16	TPS2	Analogue Input	0-5V Analog Input
17	PPS1	Analogue Input	0-5V Analog Input
18	PPS2	Analogue Input	0-5V Analog Input
19	LINEAR5	Analogue Input 5	0-5V Analog Input
20	NTC_2	NTC Sensor Input 2	0-5V Temperature Sensor Analog Input
21	NTC_3	NTC Sensor Input 3	0-5V Temperature Sensor Analog Input
22	SENS_GND2	Analog Ground	Sensor Ground
23	VREF2	Voltage Reference	5V Reference

Map Editor

The Map Editor provides access to the maps used for calibration of the ECU. Specific maps are organised into groups selected by the right hand drop down and individual maps are accessed via the left hand drop down. A 3D graph of the map is shown to the right of the main map editor table and a 2D representation of rows/columns is shown under the main map editor table.



Map Editor ToolBar



The Map Editor Toolbar provides access to the cell operations listed below:

Interpolate Cells



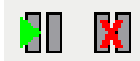
The interpolate function automatically fills in cell values into the map in either rows or columns with linear interpolated values between the first and last cells.

Breakpoint Editing



Breakpoint editing mode for the X and Y axes is enabled by clicking the appropriate icon showing the axis to edit. To return to the main map editor click the breakpoint icon with no axes.

Insert/Delete Breakpoints



Inserting and deleting breakpoints is only enabled in breakpoint editing mode. To insert a new breakpoint select the point for insertion in the map and click the 'Insert Breakpoint' icon. The map will be fully recalculated to insert a new breakpoint with linear interpolated values in the new cells. To delete a breakpoint, select the breakpoint to be deleted and click the 'Delete Breakpoint' icon. By modifying breakpoints in this way, changes will not affect the existing calibration.

Undo and Reset



The last change made to a map can be undone by clicking the 'Undo' icon. The whole current map can be reset to the state at ECU power-up by clicking the 'Reset' icon.

Mathematic Operators



The maths operators – add, subtract, multiply and divide are available for the currently selected cell or group of cells. For example, to multiply the currently selected cells by 1.2 (increase by 20%), enter 1.2 into the maths box and click the '*' icon.

Change 2D Plot Type



This icon changes the 2D plot through the following sequence: 'Plot all rows', 'Plot current row only', 'Plot all columns', 'Plot current column' allowing all aspects of the map to be viewed as a 2D slice.

Clear Bold Text in Cells



Cells that have been modified in the current map are highlighted in bold text. To clear all the bold text, click this icon.

Lock Trace Cell



To force the focus cell to be the current trace cell, tick this box. This avoids needing to press the space bar to make the focus cell jump to the current trace cell. This function will stop the user from selecting other cells or groups of cells for editing; only the current trace cell can be edited. To return to normal editing mode un-tick the 'Lock Trace Cell' box.

Keyboard Functions

Within the map editor tab changes are made either by typing a value into the load site or using PgUp and PgDwn keys to increase or decrease the values. Load sites are selected with the mouse, arrow keys (if the focus is set on the table) or by pressing the space bar which will select the current active load site.

A full break down of keyboard commands used in the Map Editor tab is provided below:

Function Keys:

- F1 – Help
- F2 – Move Forwards Between Maps within a Group i.e. between main fuel map and main ignition map
- F3 – Move Backwards Between Maps within a Group
- F5 – Refresh (reload) Current Map
- F8 – Edit Y Axis Break Points
- F9 – Edit X Axis Break Points
- F10 – Open File Menu
- F11 – Return to map editing from breakpoint editing

Shortcut Keys:

- CTRL + S – Save Current Map To File
- CTRL + L – Load Current Map From File
- CTRL + Q – "Quick Fuel" Function (See Quick Fuel Section Below)
- CTRL + PgUp – Coarse Adjust Value Up
- CTRL + PgDwn – Coarse Adjust Value Down
- SPACE – Jump to Current Trace Cell

Editing Keys:

- PgUp – Fine adjust value up
- PgDwn – Fine adjust value down.

Quick Fuel:

Quick fuel is a method for rapidly setting fuelling whilst the engine is in steady state. Quick Fuel is only available if the ECU has a wideband Lambda Sensor connected, closed loop fuelling is turned on and the target lambda table is calibrated.

To use Quick Fuel hold the engine on a load site, ensure the target is as close to centre as possible. Wait until the closed loop compensation has stabilised at a value and press CTRL+Q. When CTRL+Q is pressed SXTune will adjust the current load site injector pulse width based on the current value + or – the amount of closed loop lambda adjustment. When Quick Fuel has been activated on a load site the closed loop fuel correction should now read zero.

Quick Fuel is intended as a tool to help rapid calibration of low load and engine speed load sites. Its use should be limited at high engine speeds and care should be taken when using Quick Fuel to validate that the entered value is sensible and correct. It is always recommended that a Dyno lambda sensor or similar is used as well as an on-vehicle lambda sensor to validate the on-car reading.

Gauges

The gauges page shows live data in a graphical form for quick reference when setting up or calibrating an engine.



There are seven preset gauge pages:

- 1 – General
- 2 – Fuelling
- 3 – Ignition
- 4 – Boost Control
- 5 – General Gauges (provides additional information over 1: General Gauges)
- 6 – Electronic Throttle
- 7 – Traction Control

Switching between gauges and text

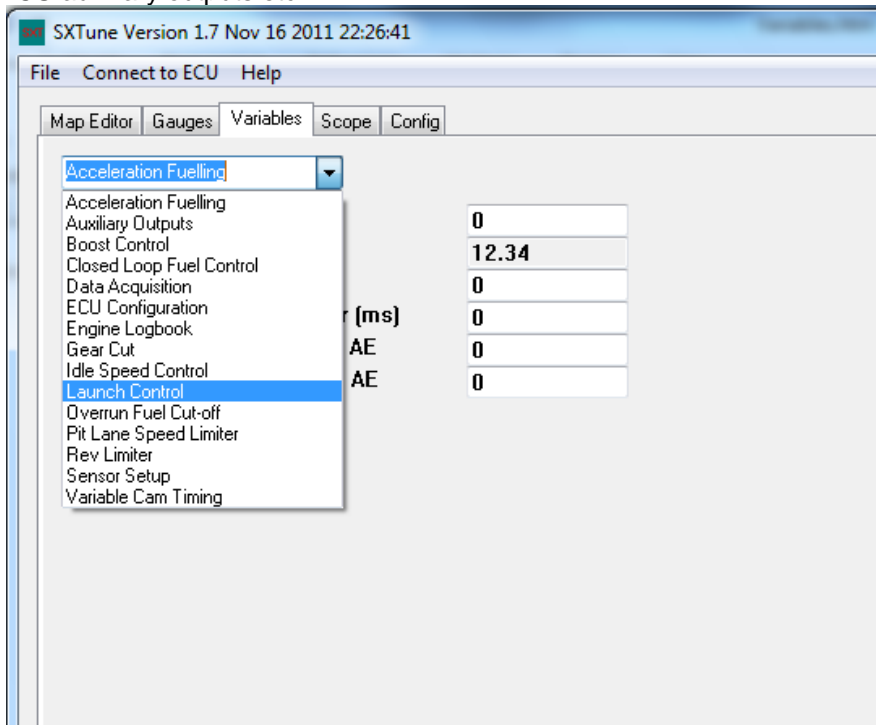
Pressing the 'Enter' or 'Return' key when the gauges tab is active will toggle between large font text and graphical gauges.

Data Logging Function

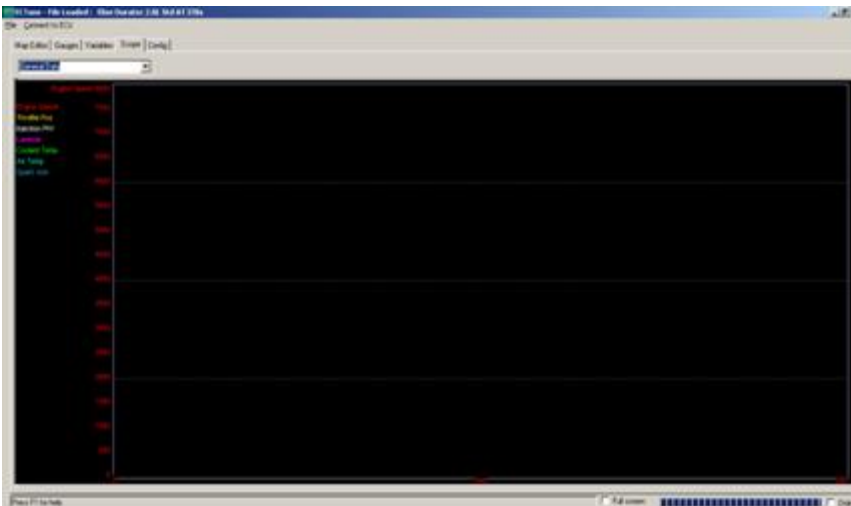
The gauges page also provides a data logging function for recording, playing back or exporting as a .csv data shown on the gauges. This function is controlled via six buttons on the lower left of the screen which provide functionality for playback, recording, fast forwarding, rewinding, stopping and pausing the data logging. To export the data as a .CSV file (which can be imported directly into MS Excel) right click on a gauge and select the "Save Data To CSV" option or click 'Record' in the File Menu.

Variables

This tab provides access to single values “variables” such as sensor configurations, over run fuel cut off, ECU auxiliary outputs etc.



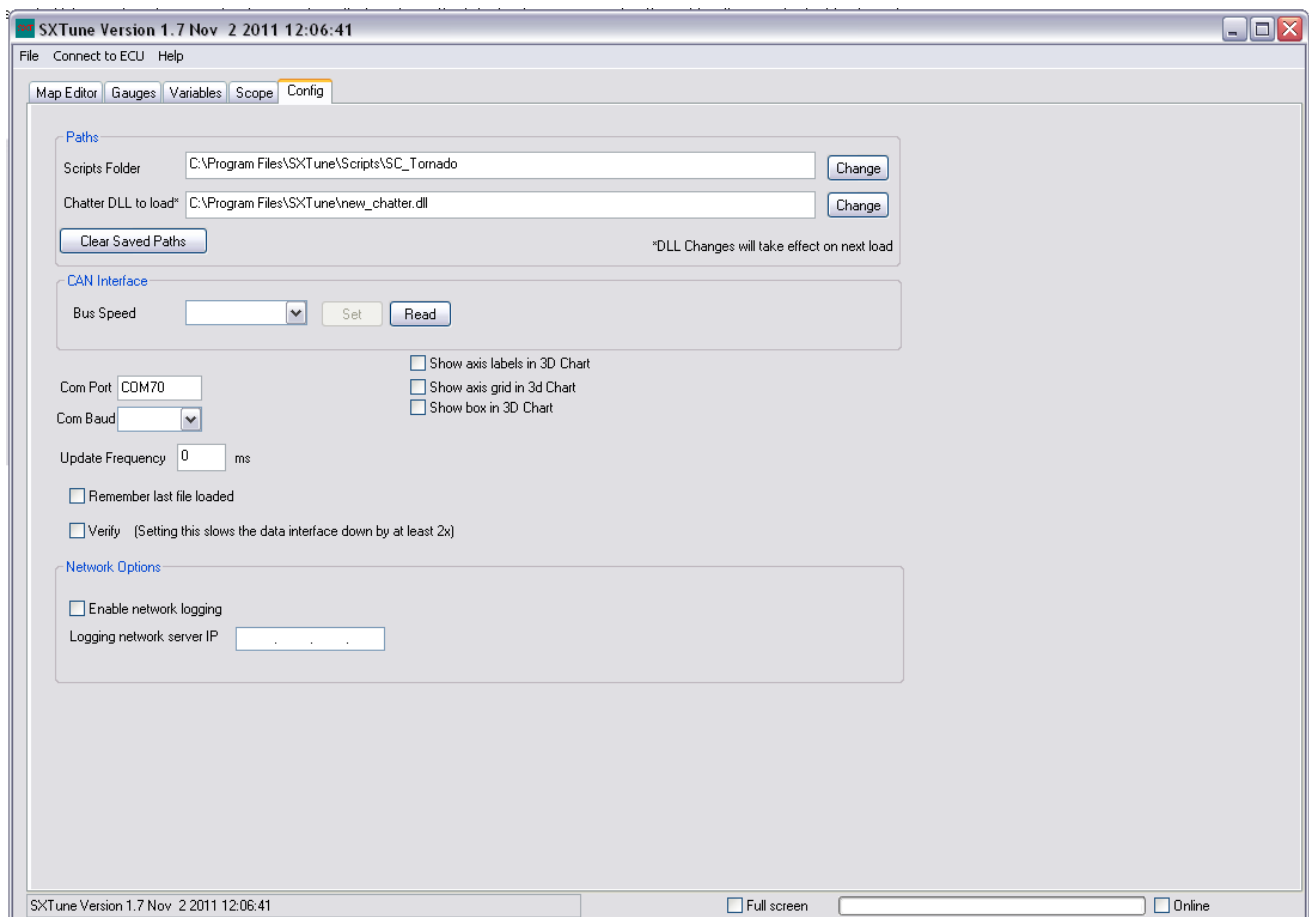
Scope



The scope provides a graphical time based view of a variety of parameters. The scope has four built in channel groups which are:

- Boost Control – contains channels for Engine Speed, Throttle Position, Base Boost Duty Cycle, Final Boost Duty Cycle, Manifold Pressure, Target Boost Pressure and Spark Advance.
- Fuel Closed Loop Control – contains channels for Engine Speed, Throttle Position, Lambda, Closed Loop % and Manifold Pressure.
- General Data – contains channels for Engine Speed, Throttle Position, Injection PW, Lambda, Coolant Temp, Air Temp and Spark Advance.
- Idle Control – contains channels for Engine Speed, Throttle Position, Base Idle DC %, Final Idle DC %, Coolant Temp, Air Temp and Spark Advance.

Config Page



The 'Config' tab contains configuration details for SXTune. This page is set on installation and no item should need changing unless instructed to do so.

Paths

The paths section contains the paths to the location of the scripts folder and the communications DLL that SXTune requires to operate. By changing the scripts folder SXTune can be instructed to communicate and display alternative maps for different ECUs, i.e. SC Tornado or Hurricane CRD.

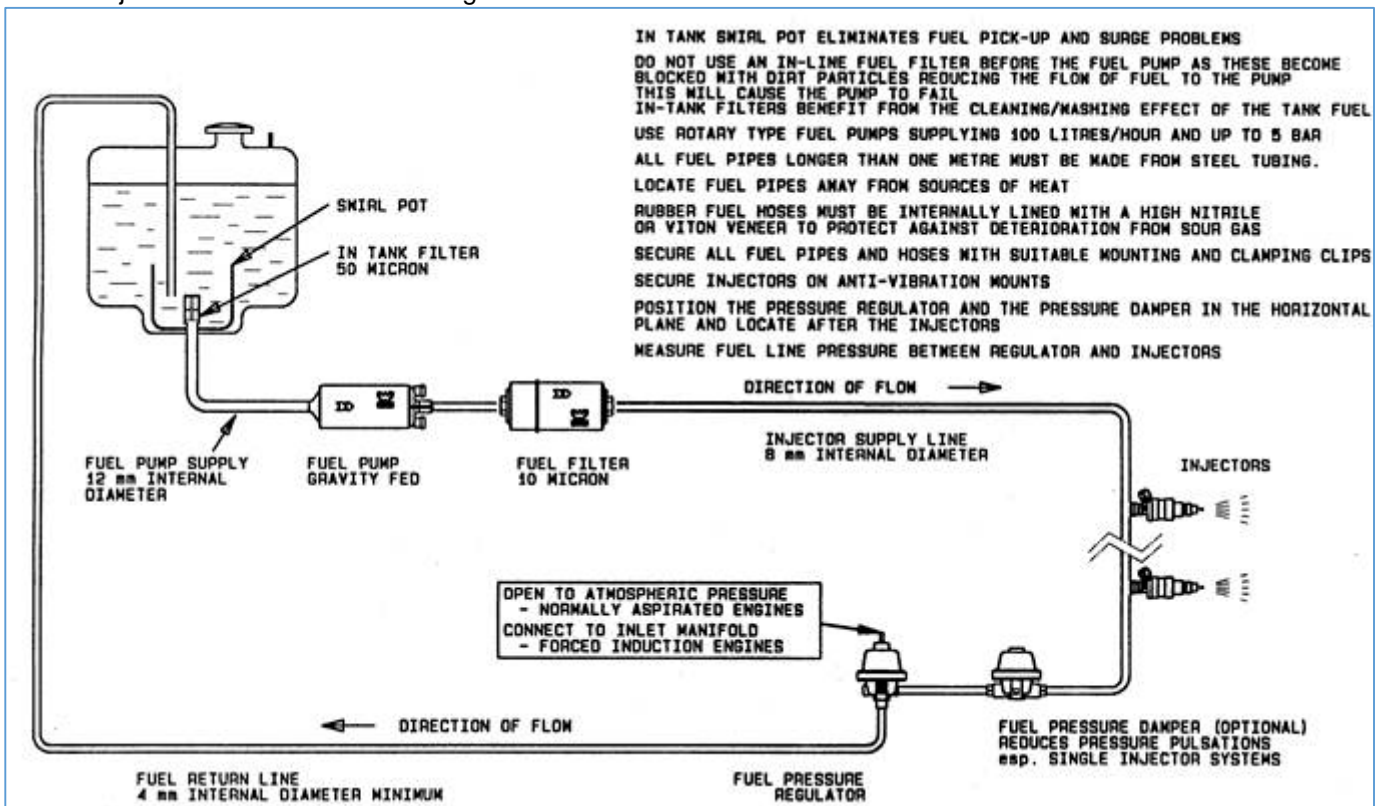
CAN Interface

Here you can change the bus speed of the USB-CAN interface between 250kb, 500kb and 1Mb/s speeds.

N.B. Changing the CAN interface bus speed to an incorrect value will cause loss of communications between SXTune and the ECU.

Fuel Supply

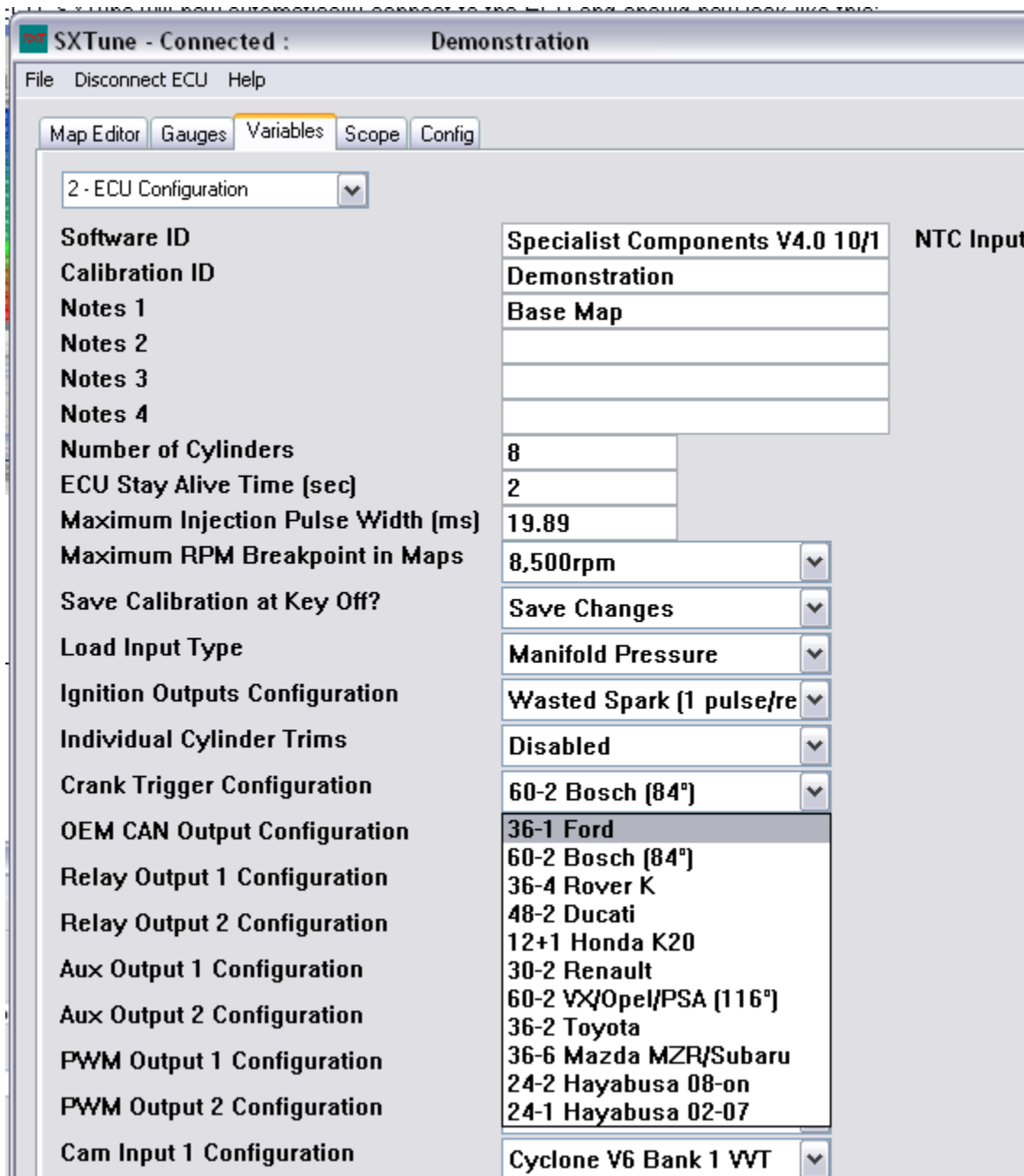
- In-tank filter 50 micron, pre pump, not in-line type.
- Diameter 12.0mm I.D. fuel line to pump.
- Fuel injection hose, nitrile or viton lined. (sour gas)
- Rotary type pump 100 litres/hour up to 6 bar.
- Injector filter 10 microns.
- Injector supply - diameter 8.0mm I.D.
- Fuel pressure regulator follows after injectors.
- Fuel line return to tank min 6.0mm I.D. (Min.)
- In-tank - swirl pot - resolves fuel surge problems and eliminates fuel vapours.
- Do not run pump dry (seizes rollers).
- Dirt particles main cause of pump failure.
- Fuel pressure damper reduces pressure pulsations, especially large single injector installations.
- Pump is ECU controlled.
- Always secure hoses with clips.
- Avoid long fuel supply runs with rubber hose, use steel pipes, locate away from sources of heat, eg. exhaust systems.
- Injectors - anti vibration mounting.



ECU Configuration

There are some essential base settings which must be entered before first engine start-up. These are:

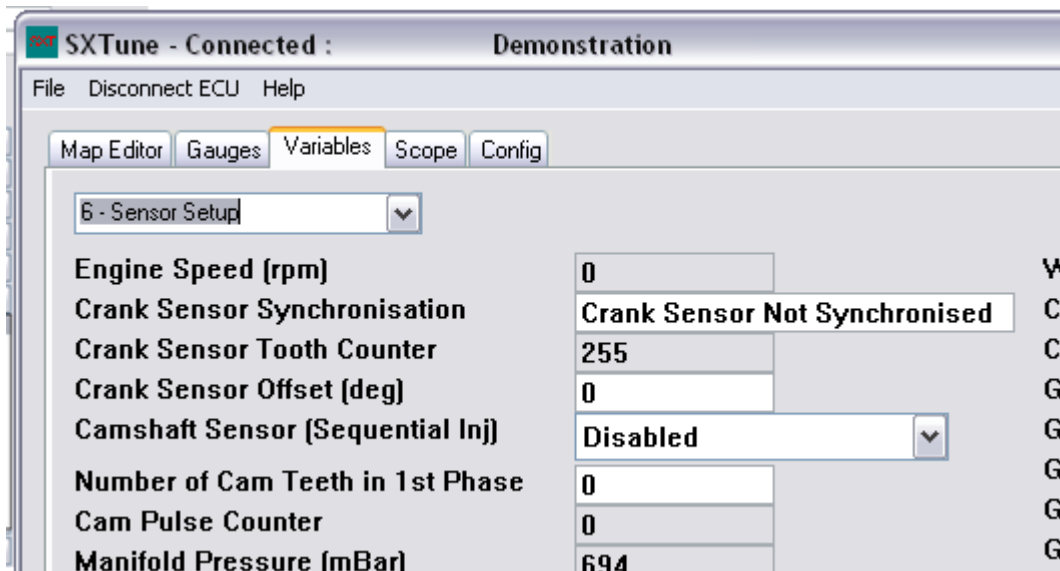
Crankshaft Trigger Calibration:



The crankshaft and camshaft trigger pattern selection is located in 'Variables' tab option '2 – ECU Configuration'. Select the correct crank pattern from the drop down list 'Crank Trigger Configuration'. Many original equipment crankshaft trigger wheels can be selected included the most common aftermarket trigger wheels of '36-1' and '60-2'. The crankshaft sensor offset is built into the ECU firmware so you do not need to enter this position into the calibration. The offset for '36-1' trigger wheels is 90 degrees, whereas '60-2' is available in the most common 84 degree offset and also the 116 degree offset used by some Vauxhall/Opel and Peugeot/Citroen engines.

Most crankshaft trigger wheels can be added to the ECU as long as there is at least one missing or additional tooth in the pattern. For further information please contact Specialist Components.

To check that the crankshaft trigger is working correctly use the Crank Synchronisation in 'Variables' tab option '6 – Sensor Setup'



Set the 'Camshaft Sensor' drop down to 'Disabled' then crank the engine over with the ignition coil and fuel pump relay disconnected. You will see the 'Crank Tooth Counter' increment as each crank tooth passes the sensor. When the ECU sees the correct number of teeth followed by either the correct number of additional tooth/teeth or missing tooth/teeth then the Synchronisation will switch from 'Not Synchronised' to 'Crank Sensor Synchronised OK'.

If there is a problem with the crank trigger, the status will remain at 'Not Synchronised' and the tooth counter will rotate from 0-255. If the tooth counter does not count at all then there is no signal from the crankshaft position sensor.

Troubleshooting:

Tooth Counter does not count when engine is turning

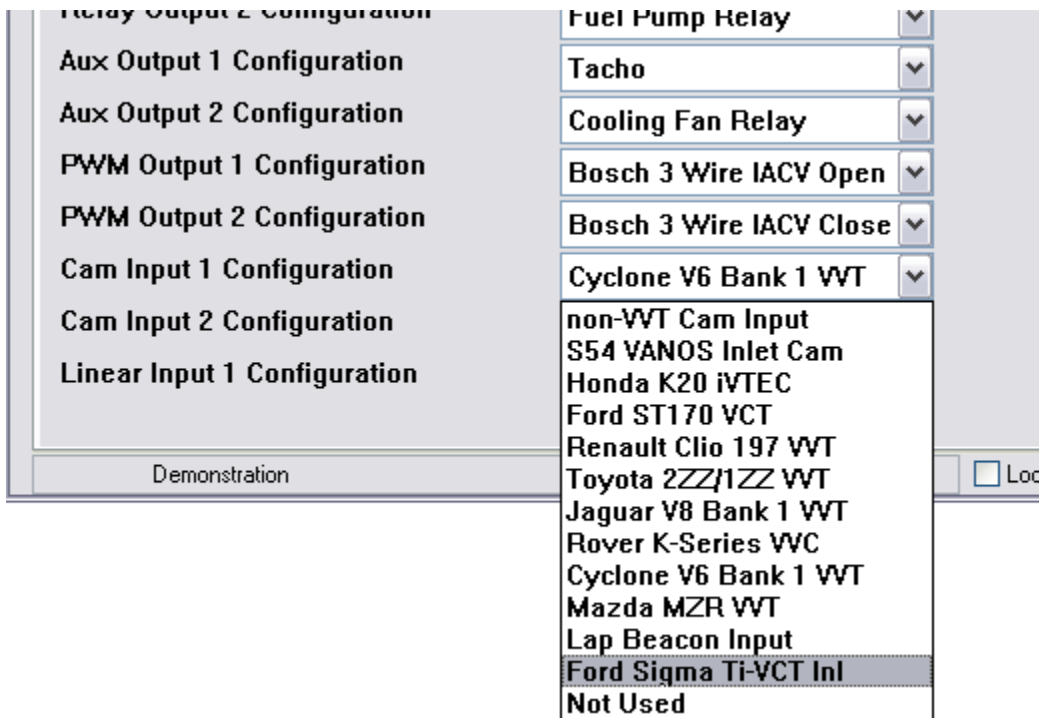
- Crank sensor wired incorrectly
- Gap between trigger wheel and sensor too large
- Wrong type of crank sensor used (VR or Hall Effect)
- Wrong trigger wheel material (must be ferromagnetic)
- ECU will not synchronise
- VR Crank sensor wiring reversed (signal must cross zero from high to low)
- Wrong trigger pattern selected, does not match wheel
- Trigger wheel teeth wrong shape
- Trigger wheel not centred on crankshaft (gap changing as wheel rotates)
- Engine turning too slowly

Crank Sensor Offset

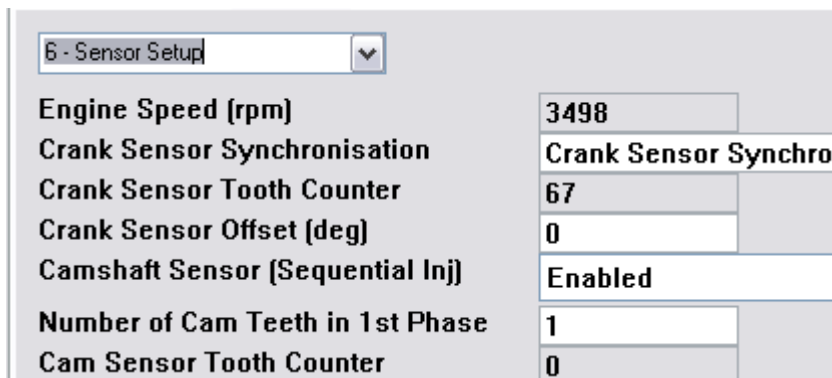
The purpose of the crank sensor offset is to accommodate any small discrepancies in position of the crank sensor. For example, in a Ford 36-1 application the offset for TDC#1 should be 90degrees after the missing tooth. If the trigger wheel is mounted out of position, advanced by 5 degrees, then entering 5 degrees in the Crank Sensor Offset will correct for this discrepancy. The range of this offset is -30 degrees to +30 degrees.

This offset should be set by using an ignition timing strobe, ensuring that the final spark advance value matches that read by the strobe. **N.B.** If using a wasted spark ignition system, strobe timing lights will read double the actual spark advance, so 50 degrees read by the strobe is actually 25 degrees!

Camshaft Trigger Calibration:



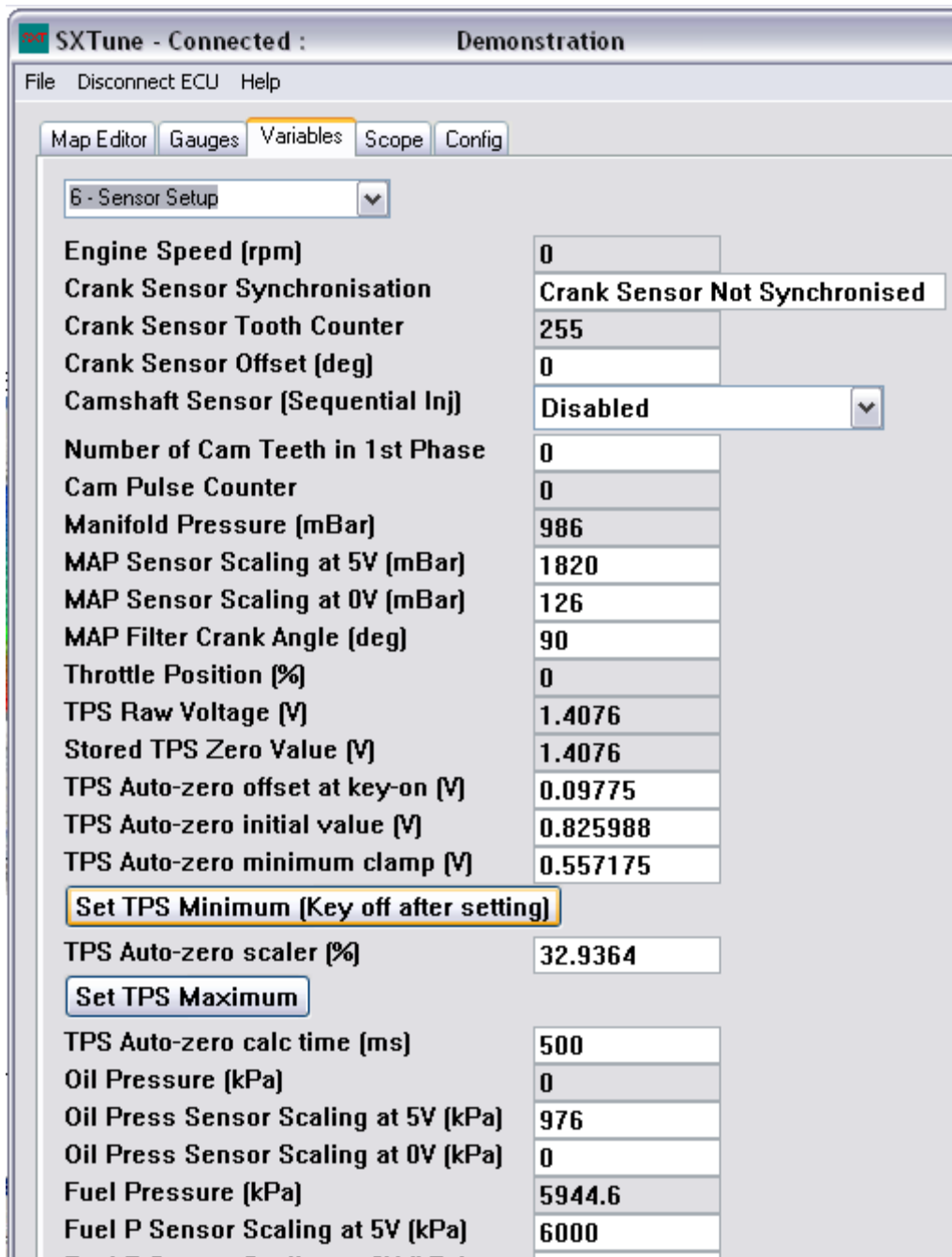
Trigger patterns for both Cam Inputs 1 & 2 can be selected in 'Variables' tab option '2 – ECU Configuration'. A wide range of original equipment camshaft triggers can be accommodated to enable variable valve timing control. For a conventional non varying camshaft input select the option 'non-VVT Cam Input'. Then enter the number of cam teeth pulses in the first phase (Cylinder #1 firing) into 'Variables' option '6 – Sensor Setup'.



Enable the camshaft trigger by selecting 'Enabled' in the Camshaft Sensor drop down. This will also enable sequential injection. If this option is disabled, the ECU will still inject once pulse per cycle, but this could either be in either phase.

The camshaft input can be checked by monitoring the 'Cam Sensor Tooth Counter' box which will count the cam shaft sensor pulses, this value is reset to zero each time the crankshaft rotates once. Therefore, for a camshaft with 1 tooth in phase 1 and 2 teeth in phase 2, the tooth counter box will oscillate between 1 and 2 when the engine is turning.

Throttle Position Sensor Calibration:



To calibrate the throttle position sensor click the 'Variables' tab and select option 6 "Sensor Setup" from the drop down.

The aim is for the value 'Throttle Position %' to read 0 at idle position and 99.45 at wide open throttle. To achieve this:

- At idle position click the button "Set TPS Minimum (Key off after setting)" and then switch off the ignition for 10 seconds and back on again.
- Hold the throttle at wide open, and then click the button "Set TPS Maximum".

After this procedure has been completed, validate that the throttle position % goes smoothly from 0 at idle to 99.45 at wide open throttle. If it does not, repeat the procedure and then look at the troubleshooting guide below.

Troubleshooting:

- TPS Voltage Reads Backwards – The throttle position sensor is wired incorrectly. Please check the wiring
- TPS is sticky or jumps about – This is most likely a failing throttle position sensor and may need replacement.
- TPS reads 99.45 regardless – The ECU is not receiving a throttle position sensor signal. 99.45% is the default failed value.

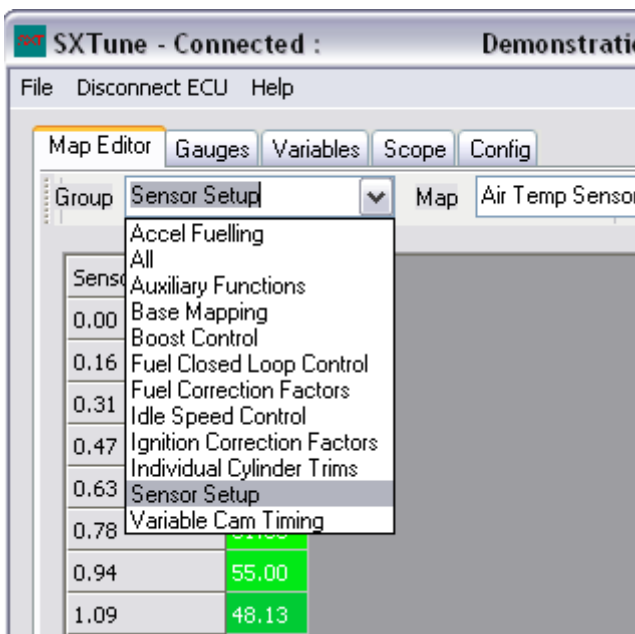
The ECU features a sophisticated auto-zero algorithm which will automatically learn the 0 position each time the ignition is switched on. If the throttle position sensor is moved, or replaced after the throttle position sensor has been calibrated then it should not be necessary to repeat this procedure as the auto-zero will 'learn' the new setting. **N.B.** This feature requires that the throttle stop is not moved, as it will automatically learn this as the new 0 position and if throttle position is the primary load input, this will change the air-fuel ratio throughout the map. If you do not wish to use the auto-zero feature then set the 'TPS Auto-zero offset at key-on' value to 0 which will disable this feature.

Inlet Air Temperature and Engine Coolant Temperature Sensor Scaling:

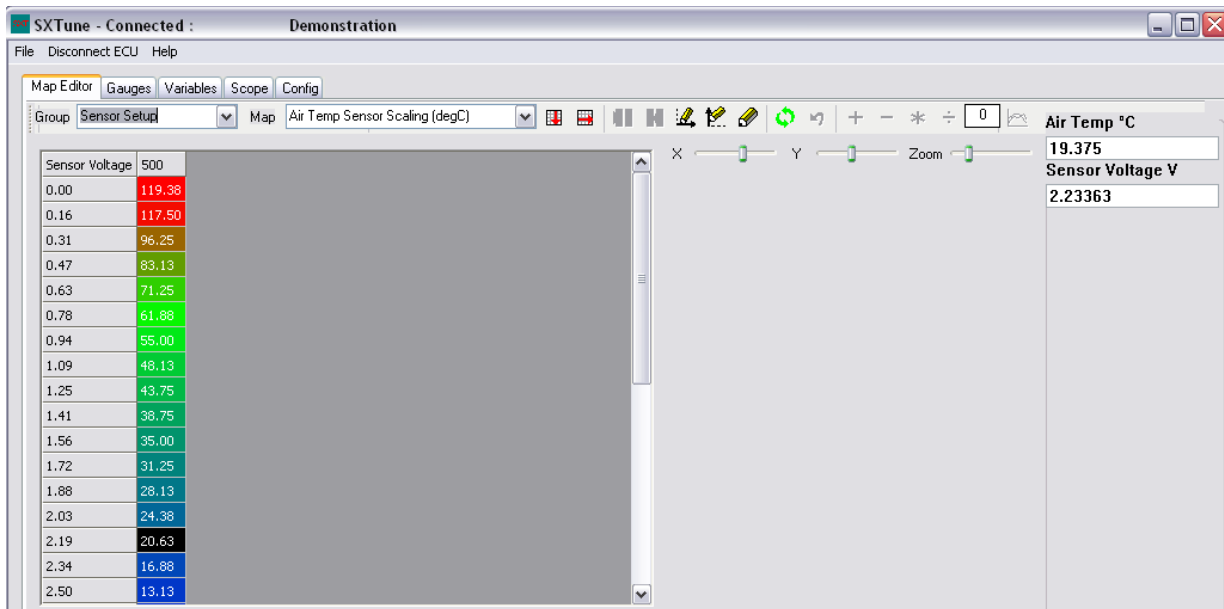
Inlet air temperature and coolant temperature sensors require scaling in order to present accurate temperature readings. SC maintains a library of sensor calibrations for most popular sensors and will e-mail sensor calibrations as required. Most base calibrations supplied contain sensor calibrations correct for the application. A quick method to check if the sensors are correctly scaled and operating correctly is to ensure both air temp and coolant temp read very similar values with the engine off and coolant at ambient temperature and that the readings the sensors provide compare with the current ambient temperature.

If you wish to calibrate a new sensor please follow the below guide:

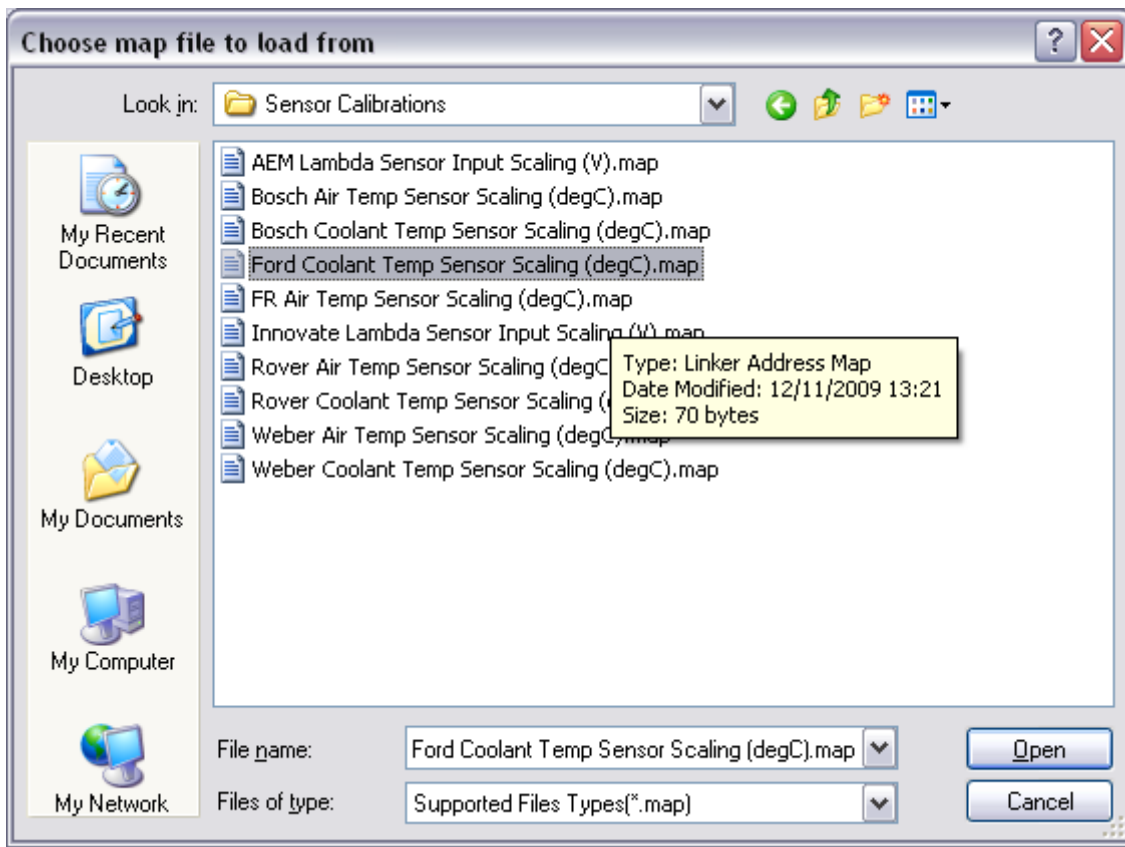
- On the 'Map Editor' tab select "Sensor Setup" from the "Group" drop down.



- Select the sensor which requires calibration from the "Map" Dropdown:



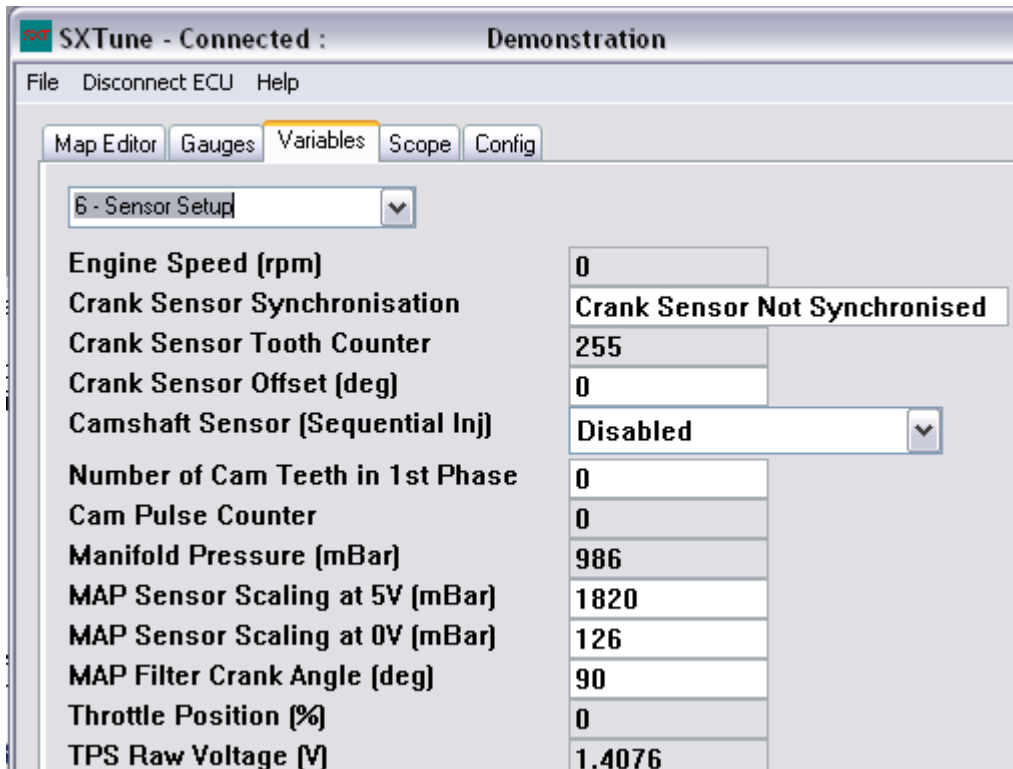
- To load a supplied sensor calibration press CTRL + S and select the sensor calibration file.



- To calibrate a sensor from scratch you will need to enter the temperature which corresponds to the voltage.
- Live temperature and voltage are shown on the right hand side of the map editor screen allowing you to calibrate a sensor by heating the sensor (for example in a kettle) with a mechanical gauge or thermometer present to validate what the temperature at each voltage breakpoint is. The current active breakpoint is highlighted by the 'trace cell' in black.
- Wherever possible we would recommend you save time by using a sensor with a known calibration.

MAP Sensor Calibration:

For engine packages which use manifold air pressure (MAP) as the primary load input (for example turbo charged engines) it is necessary to scale the MAP sensor to ensure correct operation. MAP sensors are linear and as such, the ECU only needs to know the pressure (in millibars) at 0V and 5V. To calibrate the MAP sensor in SXTune click the 'Variables' tab and select option 6 "Sensor Setup" from the drop down.



- In MAP sensor scaling at 5V enter the pressure in mBar that the MAP sensor will read at 5V
- In MAP sensors scaling at 0V enter the pressure in mBar that the MAP sensor will read at 0V
- MAP filter crank angle (deg) is designed to average the MAP sensor input over a number of crank degrees to filter out pulses in the inlet tract at the expense of response time. You can increase this value to 360 degrees when mapping to get a very stable signal, however reduce it to 45deg after mapping to improve the transient response.

MAP sensor scalings are available from the manufacture usually in the form of a graph. Only Linear output MAP sensors are supported.

List of ECU Configuration Variables:

- Software ID – None user editable field containing the current ECU firmware version
- Calibration ID – User Editable Field to set an ID for the Calibration
- Notes 1 – User Editable field for additional notes relating to engine or calibration.
- Notes 2 – User Editable field for additional notes relating to engine or calibration.
- Notes 3 – User Editable field for additional notes relating to engine or calibration.
- Notes 4 – User Editable field for additional notes relating to engine or calibration.
- Number of Cylinders – The number of cylinders of the engine
- ECU Stay Alive Time – The time which the ECU will stay alive after key off
- Max Injections Pulse Width – The maximum injector pulse width that can be entered into the fuel map in milliseconds. This sets the resolution of the injection pulse width and should be set for the injectors being used. Changing this value will change all the values in the base fuel map and can be used for injector resizing. For example: the current injector size is 300cc/min and the max pulse width is set to 20ms. If 400cc injectors were to be used, then the max pulse width should be changed to $(300/400 * 20) = 15\text{ms}$ to keep the fuelling the same.

- Maximum RPM Breakpoint in maps – This setting allows a choice of four maximum engine speed breakpoints. Changing this setting will affect all the fuel and ignition maps and the rev limiter.
- Save Calibration At Key Off – Controls if the ECU saves changes at power off. If this setting is set to 'discard changes' then all changes made will be lost at key off.
- Load Input Type – Controls the primary method for detecting engine load, either Throttle Position or Manifold Air Pressure
- Ignition Outputs Configuration – Sets a choice of wasted spark ignition which triggers one pulse per revolution and direct ignition to trigger the ignition coil once per cycle for coil on plug (COP) applications.
- Individual Cylinder Trims – Enables and disables the individual cylinder trim maps for ignition and fuelling.
- Crank Trigger Configuration – Selects the crank trigger pattern to be used for engine position detection.
- OEM CAN Output Configuration – Selects from a choice of OEM CAN outputs, used to communicate with a range of OEM dashboards and ABS systems.
- 4 Cylinder Staged Injection – Enables staged injection for 4 cylinder engines (Tornado only). Uses outputs IGN5 and IGN6 to control injectors for cylinders 1&4 and 2&3 respectively. A fuel flow rate ratio variable is available to compensate for staged injectors with differing flow rates to the standard injectors. The amount of fuel distribution between the standard and staged injectors is controlled by a separate map.
- Various User Configurable Inputs and Outputs – A wide range of choices for uses of the user configured inputs and outputs is available. N.B. For 6 cylinder engines Aux Outputs 1 and 2 must be selected as Injectors 5 & 6.

Engine First Start-up

Once the above sensor setup has been complete and validated engine start-up can be attempted. Every application is different and the below is intended as a rough guide to first engine start-up.

- Unplug coil pack and injectors from wiring loom.
- Ignition on – if fuel pump is under ECU control ensure fuel pump primes
- Connect to ECU via SXTune software to enable live data display.
- Turn engine on started and ensure the ECU sees a cranking signal, if engine RPM is present then a stable crank signal is present.
- Turn ignition off
- Reconnect coil pack and injectors.
- Turn ignition on – crank engine. The engine should start. If idle speed and cold start is yet to be calibrated it may require throttle application to avoid stalling.
- Run the engine up to operating temperature checking that all sensors read correctly with the engine running, that the battery is charging and that the engine runs cleanly.
- Check the ignition timing with a strobe light. Adjust the 'Crank Sensor Offset' variable in 'Sensor Setup' so that the ignition timing is correct.

At this point the ECU is ready to be calibrated

SEQUENCE OF OPERATIONS TO MAKING A CALIBRATION

Before using the system on an engine to make a calibration, it is necessary to set the user variables. This is important as incorrect selection of hardware or ranges may mean having to re-calibrate.

ECU Configuration

Work through the entire ECU Configuration Variables page ensuring that all the parameters are set correctly for the engine to be calibrated.

Throttle Position Calibration

Set the minimum and maximum TPS values so that TPS reads 0% when throttle is closed and 99.45% when fully open.

Maximum Engine Speed Breakpoints

Select a suitable maximum RPM breakpoint, the maximum RPM breakpoint should be higher than the required maximum RPM.

RPM and Load Breakpoints

Use 'breakpoint editing' to move the breakpoints to the values you require for your application.

Maximum Injection Time Breakpoint

This is dependent on the type of injector selected and the pressure used in the fuel system. The lower this value, the better the resolution of fueling increments.

It may be necessary to run the engine at power to find out what exactly the maximum required value is going to be. Set the value accordingly before a full hot calibration is made.

The maximum physical value is limited by the value of maximum RPM, and is found:-

$$\frac{60}{\text{MAXRPM}} = \text{Maximum possible injection time (ms) per revolution.}$$

Rev Limiter Type Selection

Select the control method for the revolution limiter, either fuel cut or ignition cut.

Injector Selection

Each type of injector has a different fuel flow rate and battery correction curve. Injectors cannot be changed after a full calibration without a complete re-calibration.

Manifold Pressure Sensor Selection

Set the calibration of the pressure sensor that will give the range of inlet air pressure you require to correct for. Note: A manifold pressure sensor is optional.

Cranking Enrichment Table

If you require a number of engine cranks without the engine firing, i.e. (to build up oil pressure) this can be achieved with the cranking enrichment table.

Decide on the number of cranks required and set to 'ZERO' all the values below it. Do not set the whole table to 'ZERO' as the engine will not receive any fuel.

GENERAL

Ensure that all fuelling and ignition correction calibration tables have correction values stored. This will allow you to map the base calibration values without having to make adjustments for any changes in operating conditions.

Hot Idle

When the engine is hot, balance the throttle bodies and set your idle speed and C.O. or Lambda. Check your idle breakpoints are in the right area, re-adjust if necessary. Check maximum electrical loads do not stall the engine.

Hot Calibration

Complete a full hot calibration and check that you have all the breakpoints in right areas to accommodate the engine fueling and ignition requirements.

Hot Transients

After completing the hot calibration set all hot transients (acceleration fuelling).

Cold Start

Allow the engine to cool completely before making the cold start calibration. While doing the cold start find the new values for the acceleration fuelling. Check maximum electrical loads do not stall the engine.

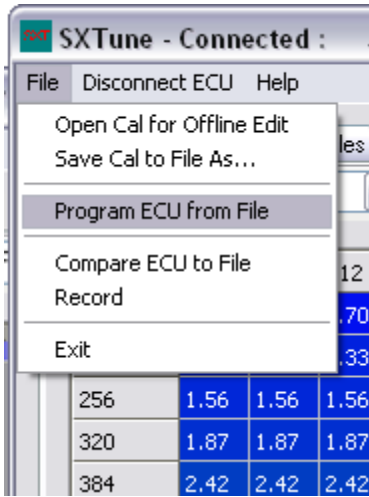
Programming a Calibration File (map) into the ECU

N.B. All ECUs from SC are supplied with a base map pre-loaded for your engine. Do not upload a new map unless you are absolutely certain that you need to do so!

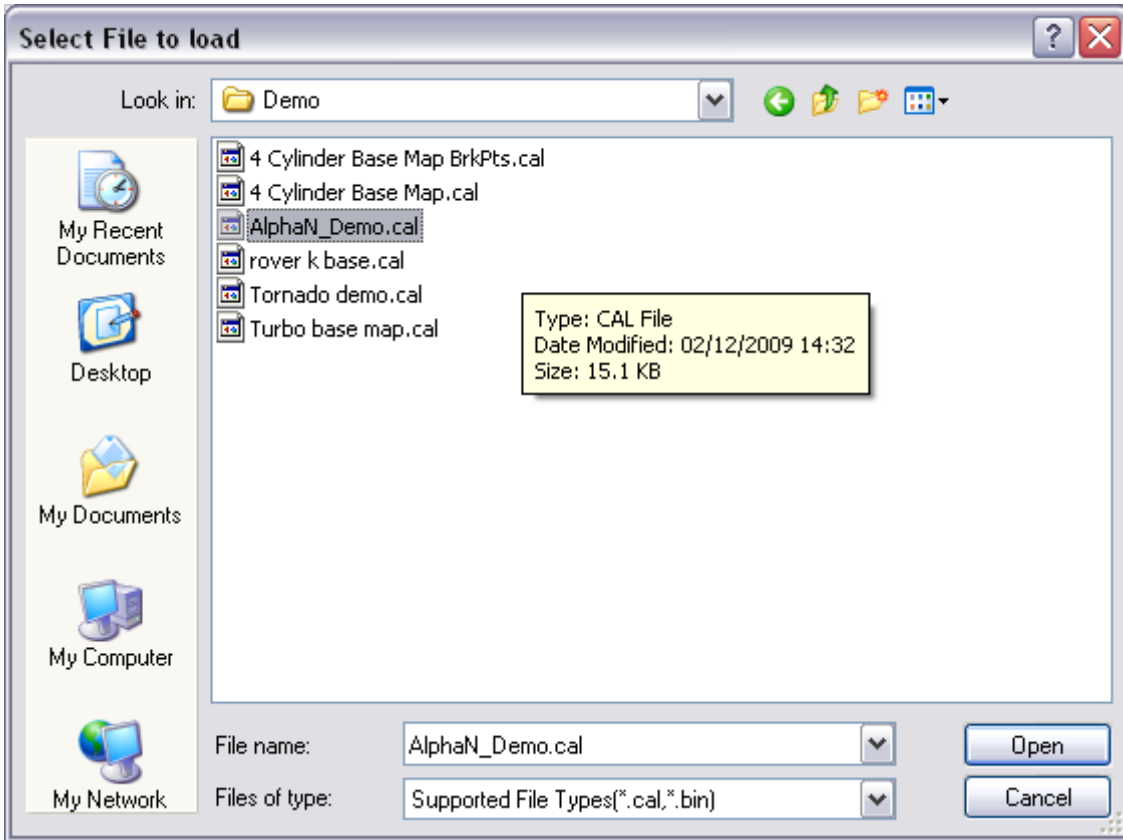
To load a new calibration file into the ECU from disk, follow the steps below:

1: Switch Ignition On and click 'Connect to ECU'

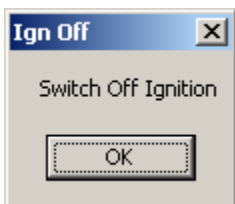
2: Click File, Program ECU from File



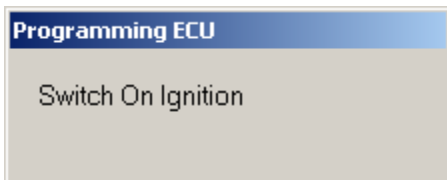
3: Select the calibration file you wish to program into the ECU



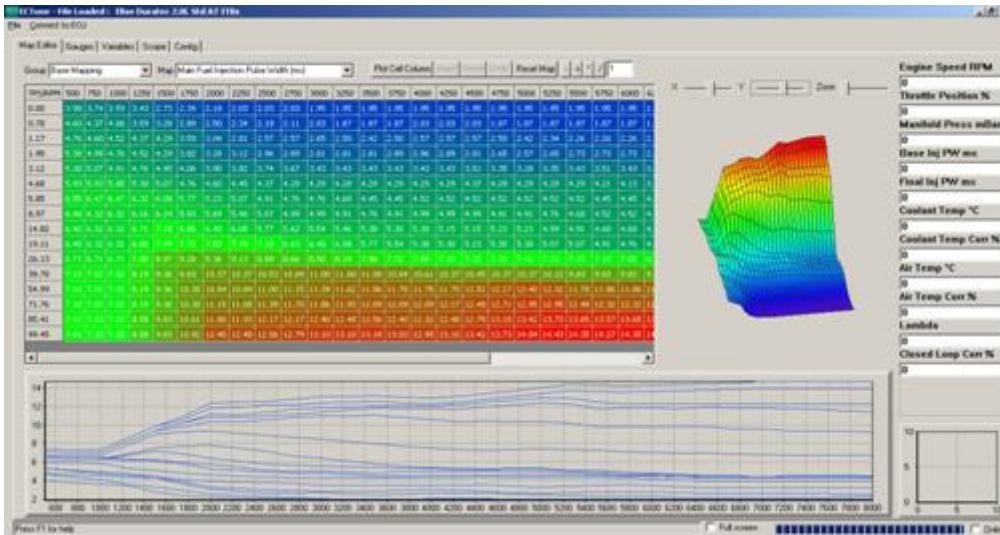
4: SXTune will now prompt you to turn off the ignition, turn off the ignition and click OK:



5: SXTune will now wait for the ECU to shutdown then, only when prompted, turn on the ignition:



6: SXTune will now upload the calibration to the ECU. SXTune will now automatically connect to the ECU and should now look like this:



Sensor Setup

This Sensor Setup page contains the variables related to setup of sensor inputs and scaling

The screenshot shows the 'Sensor Setup' page in SXTune. The page is titled 'SXTune - File Loaded: SC Typhoon Demo AlphaN Base Map' and has a menu bar with 'File', 'Connect to ECU', and 'Help'. The 'Sensor Setup' page is divided into two columns of parameters, each with a text input field and a value field. The parameters are:

- Engine Speed (rpm):** 12.34
- Crank Sensor Synchronisation:** 12.34
- Crank Sensor Tooth Counter:** 12.34
- Crank Sensor Offset (deg):** 0
- Camshaft Sensor (Sequential Inj):** Enabled
- Number of Cam Teeth in 1st Phase:** 10
- Cam Sensor Tooth Counter:** 12.34
- Manifold Pressure (mBar):** 12.34
- MAP Sensor Scaling at 5V (mBar):** 1196
- MAP Sensor Scaling at 0V (mBar):** 35
- MAP Filter Crank Angle (deg):** 45
- Throttle Position (%):** 12.34
- TPS Raw Voltage [V]:** 12.34
- Stored TPS Zero Value [V]:** 0
- TPS Auto-zero offset at key-on [V]:** 0.09775
- TPS Auto-zero initial value [V]:** 0.9775
- TPS Auto-zero minimum clamp [V]:** 0
- Set TPS Minimum (Key off after setting):** [Button]
- TPS Auto-zero scaler (%):** 39.21
- Set TPS Maximum:** [Button]
- TPS Auto-zero calc time (ms):** 500
- Oil Pressure (kPa):** 12.34
- Oil Press Sensor Scaling at 5V (kPa):** 976
- Oil Press Sensor Scaling at 0V (kPa):** 126
- Fuel Pressure (kPa):** 12.34
- Fuel P Sensor Scaling at 5V (kPa):** 12500
- Fuel P Sensor Scaling at 0V (kPa):** -1250
- Wheel Speed (km/h):** 12.34
- Number of Wheel Speed Sensor Teeth:** 12
- Wheel Circumference (mm):** 321250
- Current Gear Ratio:** 12.34
- Current Gear:** 12.34
- Gear 1 Ratio High:** 255
- Gear 1 Ratio Low:** 108
- Gear 2 Ratio High:** 71
- Gear 2 Ratio Low:** 62
- Gear 3 Ratio High:** 51
- Gear 3 Ratio Low:** 46
- Gear 4 Ratio High:** 39
- Gear 4 Ratio Low:** 35
- Gear 5 Ratio High:** 32
- Gear 5 Ratio Low:** 29
- Gear 6 Ratio High:** 2000
- Gear 6 Ratio Low:** 100
- Air Temp Filter Coefficient:** 0.0392157
- Coolant Temp Filter Coefficient:** 0.0156863
- Oil Temp Filter Coefficient:** 0.0392157
- Lambda Filter Coefficient:** 0.0627451

Crank Synchronisation Section

- Engine Speed (rpm) – The current engine speed, useful to monitor if the crank sensor input is working correctly
- Crank Sensor Synchronisation – Shows in simple text whether the crank sensor is correctly synchronised or not
- Crank Sensor Tooth Counter – This non-editable value increments whenever a tooth passes the crank sensor which is useful in diagnosing crank sensor issues. If the crank sensor tooth counter

increments when the engine is cranking but the Crank Sensor doesn't synchronise then check that the polarity of the sensor is correct (if VR) and the correct crank trigger pattern is selected.

- Crank Sensor Offset – the degree amount the crank sensor TDC reference is offset by to take into account differences in trigger wheels or the use of custom crank trigger wheels. Maximum value is 32 degrees (retard direction), the minimum value is -32 degrees (advance direction).
- Camshaft Sensor – enable/disabled drop down to enable/disable the use of a camshaft sensor for 720degree engine sync and therefore sequential injection. If this is set to disable, the ECU still injects once per engine cycle but the firing order will start at the first TDC, not necessarily TDC cylinder 1.
- Cam Pulse Counter – None user editable field showing cam pulse count

Manifold Pressure Sensor Section

- Manifold Pressure – None user editable field showing current manifold pressure in mBar
- MAP Sensor Scaling at 5V – The MAP sensor measured absolute manifold pressure at 5V output in mBar
- MAP Sensor Scaling at 0V – The MAP sensor measured absolute manifold pressure at 0V output in mBar

Throttle Position Sensor Section

- Throttle Position – None user editable field showing current throttle position in %
- TPS Raw Voltage – None user editable field showing current raw throttle position sensor output voltage
- TPS Zero Value – None user editable field showing TPS zero value in volts.
- TPS Auto-Zero Scaler (%) – the scaler applied to the TPS sensor output to provide 0 – 99.45% range.
- TPS Auto-Zero Offset At Key On – The offset applied at key on to the Auto-Zero strategy. Should be 0.09775V unless otherwise stated.
- TPS Auto-Zero Initial Value – Initial zero value in volts for the throttle position sensor output.
- TPS Auto-Zero minimum clamp – the minimum clamp applied to the throttle position sensor output.
- TPS Auto-Zero Calc Time – the time in milliseconds during which auto zero will be calculated. Should be 500ms unless otherwise stated.

Pressure Sensor Scaling Section

- Oil Pressure – None user-editable field showing current oil pressure in kPa.
- Oil Pressure Sensor Scaling at 5V – The oil pressure sensor measured pressure at 5V output in kPa
- Oil Pressure Sensor Scaling at 0V – The oil pressure sensor measured pressure at 0V output in kPa
- Fuel Pressure – None user-editable field showing current oil pressure in kPa.
- Fuel Pressure Sensor Scaling at 5V – The oil pressure sensor measured pressure at 5V output in kPa
- Fuel Pressure Sensor Scaling at 0V – The oil pressure sensor measured pressure at 0V output in kPa

Wheel Speed Input Scaling Section

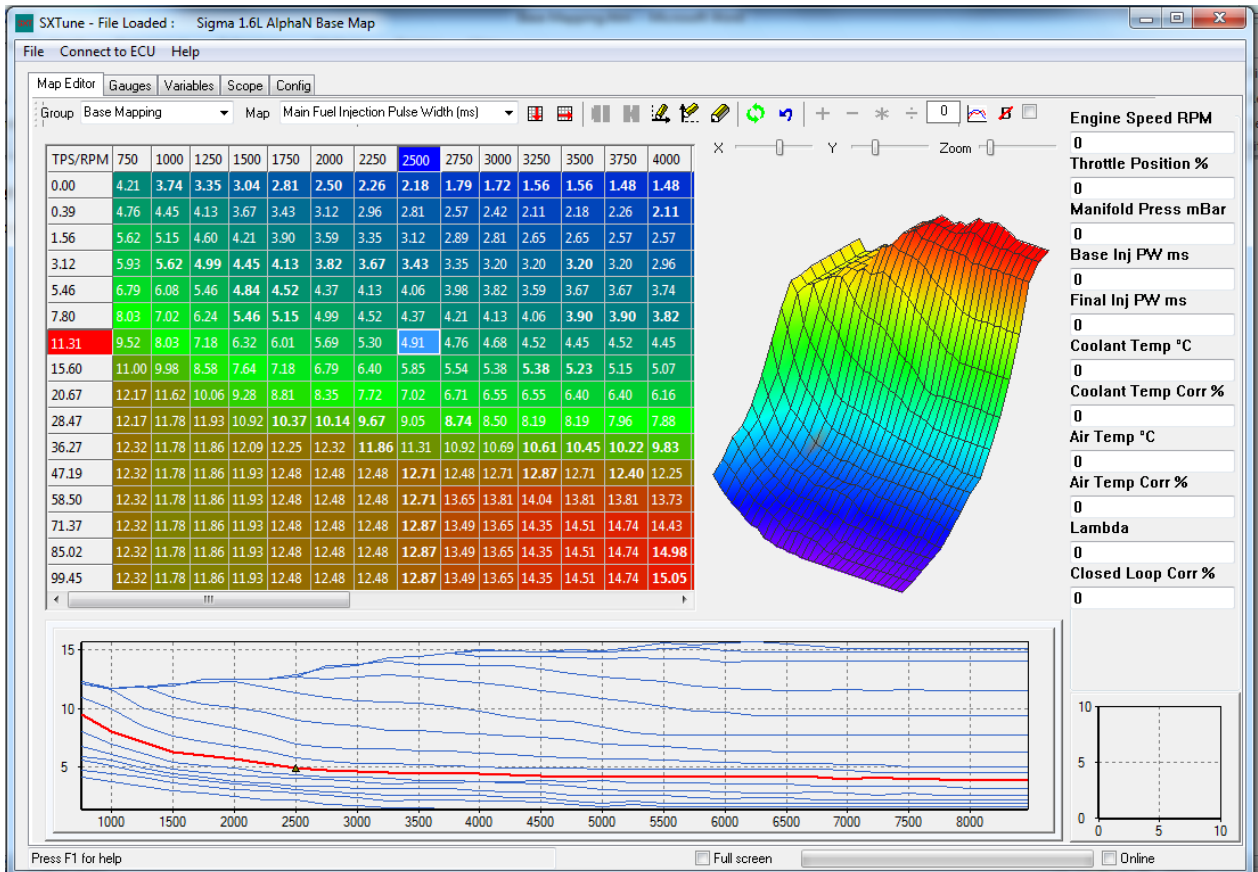
- Wheel Speed – None user editable field showing wheel speed in KMH
- Number of wheel speed sensor teeth – The number of teeth present on the wheel speed sensor.
- Wheel Circumference – the wheel circumference including tyre in mm
- Current Gear Ratio – None user-editable field showing the current gear ration as N/V (Engine speed (rpm) / Vehicle Speed (kmh))
- Current Gear – None user-editable field showing the current calculated gear position
- Gear Ratio 1-6 High/Low – The values of the N/V low and high thresholds to calculate current gear. E.g. if Current Gear Ratio is less than Gear 2 Ratio High and greater than Gear 2 Ratio Low then the ECU will calculate the current gear as 2.

Filter Coefficients

- These are the first order low-pass filter coefficients for the temperature and lambda sensor inputs. Do not change unless instructed to do so.

- **Base Mapping**

The base mapping group contains the maps required for primary fuel and ignition control. These are the two maps that will be used primarily when mapping an engine on a dynamometer.



The load axis of the fuel and ignition maps will be either throttle position (TPS) or manifold pressure (MAP) depending on the primary load selection in ECU Configuration.

- The load axis breakpoints can be edited by pressing F8 and the engine speed breakpoints can be edited by F9, to return to the map press F11.
- When the engine is running, the closest breakpoint to the current load and speed will be indicated by the 'Trace Cell' which is highlighted in black.
- The proximity to the nearest breakpoint is indicated by a visual representation, the 'breakpoint proximity control' in the bottom right hand corner.
- To edit the current trace cell, press the space bar and the 'Focus Cell' (the cell currently being edited) will jump to the trace cell.
- Values can be entered directly by typing in a number, incremented or decremented with Page Up and Page Down or a maths function can be applied using the maths toolbar at the top right hand corner.
- Cells that have been edited are highlighted with bold text which is cleared when either the map is changed or the clear bold text icon is clicked.
- To switch quickly between fuel and ignition maps using the keyboard, press F2 or F3.

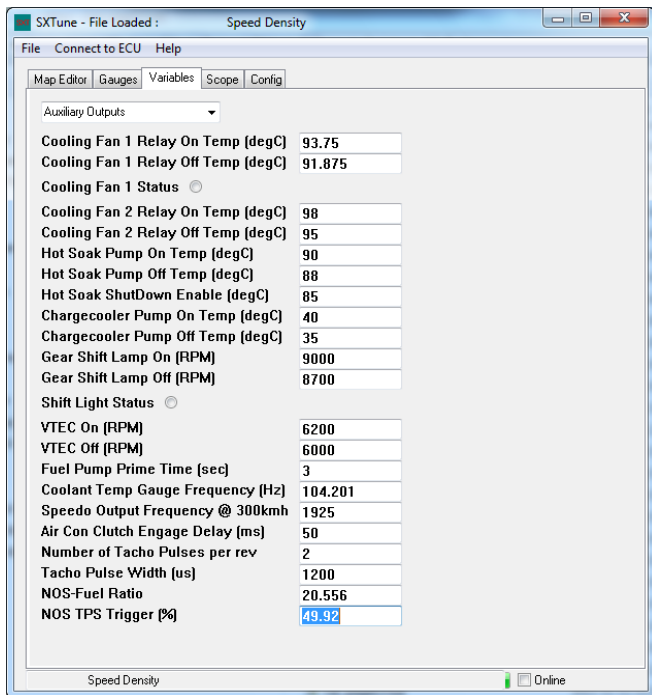
Quick Fuel:

Quick fuel is a method for rapidly setting fuelling whilst the engine is in steady state. Quick Fuel is only available if the ECU has a wideband Lambda Sensor connected, closed loop fuelling is turned on and the target lambda table is calibrated.

To use Quick Fuel hold the engine on a load site, ensure the target is as close to centre as possible. Wait until the closed loop compensation has stabilised at a value and press CTRL+Q. When CTRL+Q is pressed SXTune will adjust the current load site injector pulse width based on the current value + or – the amount of closed loop lambda adjustment. When Quick Fuel has been activated on a load site the closed loop fuel correction should now read zero.

Quick Fuel is intended as a tool to help rapid calibration of low load and engine speed load sites. Its use should be limited at high engine speeds and care should be taken when using Quick Fuel to validate that the entered value is sensible and correct. It is always recommended that a Dyno lambda sensor or similar is used as well as an on-vehicle lambda sensor to validate the on-car reading.

Auxiliary Outputs

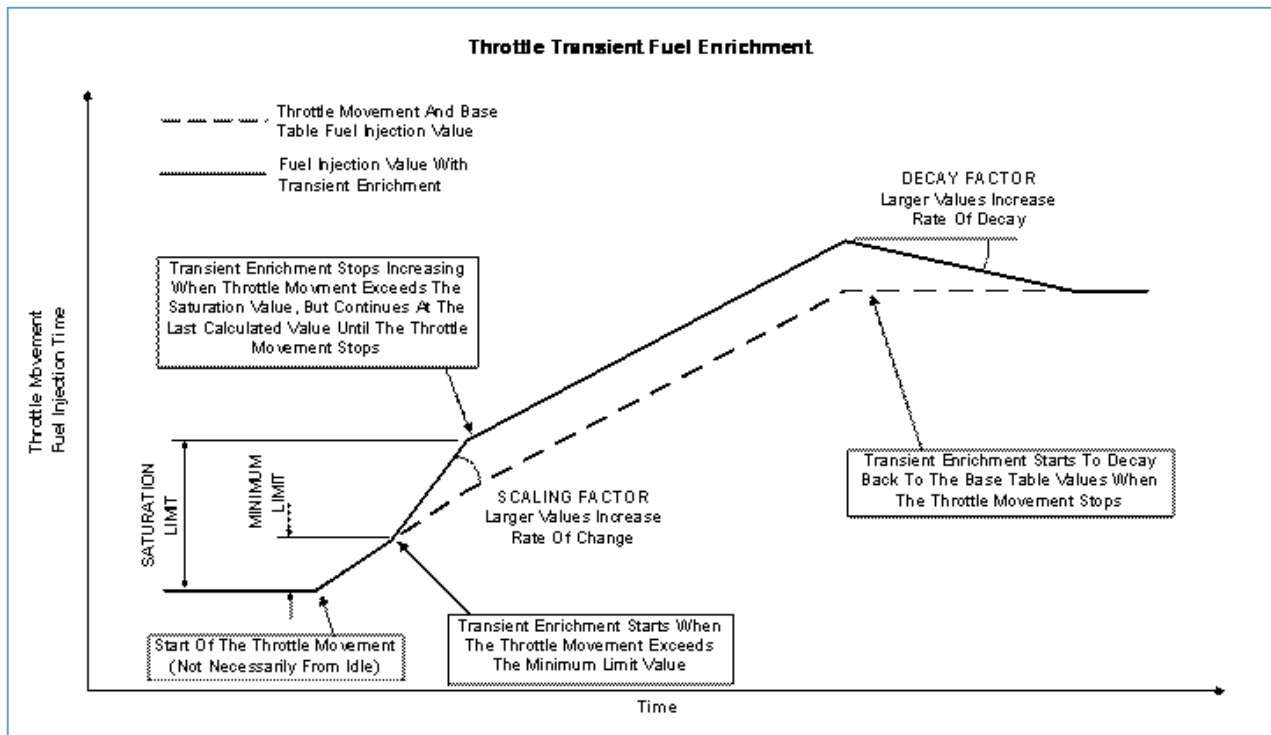


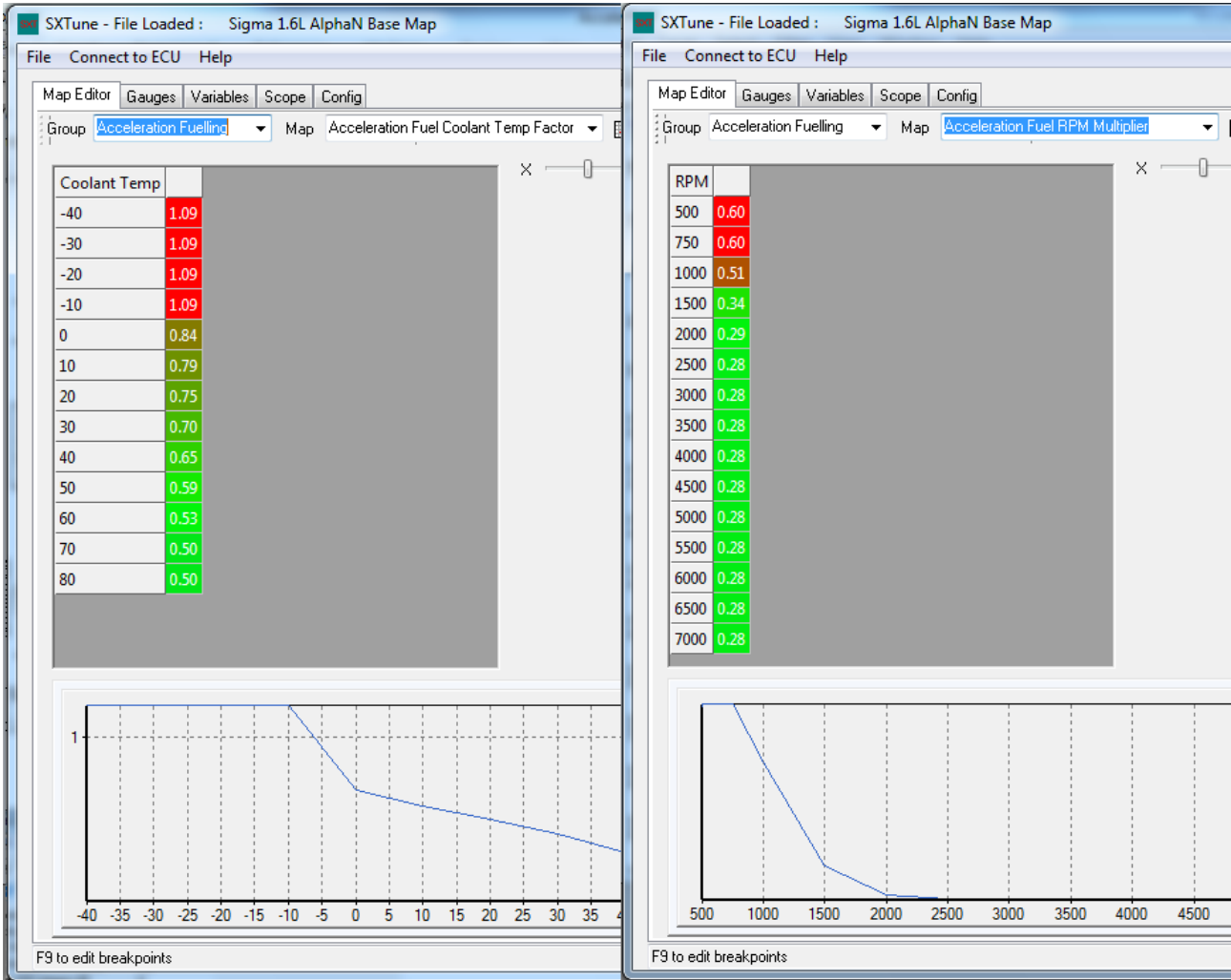
The Auxiliary Outputs Variables page lists the values related to auxiliary outputs

- Cooling Fan 1 Relay On Temp – The coolant temperature at which the cooling fan relay 1 is turned on
- Cooling Fan 1 Relay Off Temp – The coolant temperature at which the cooling fan relay 1 is turned off
- Cooling Fan 2 Relay On Temp – The coolant temperature at which the cooling fan relay 2 is turned on (Tornado 2 Only)
- Cooling Fan 2 Relay Off Temp – The coolant temperature at which the cooling fan relay 2 is turned off (Tornado 2 Only)
- Hot Soak Pump On – The coolant temperature at which the hot soak is turned on (Tornado 2 Only)
- Hot Soak Pump Off – The coolant temperature at which the hot soak is turned off (Tornado 2 Only)
- Hot Soak ShutDown Enable – The coolant temperature at which the hot soak strategy is enabled at engine off (Tornado 2 Only)
- Gear Shift Lamp On – The engine speed at which the gearshift lamp is turned on
- Gear Shift Lamp Off – The engine speed at which the gearshift lamp is turned off
- VTEC On – The engine speed at which the VTEC output is turned on
- VTEC Off – The engine speed at which the VTEC output is turned off
- Fuel Pump Prime Time – The time in seconds for which the fuel pump relay will run for at key on/ignition on.
- Coolant Temp Gauge Frequency – The frequency of the coolant temp gauge output (used for driving OEM temperature gauges)
- Speedo Temp Gauge Frequency @300kmh – The frequency of the speedometer output at 300km/h, used to scale the speedometer output
- Air Con Clutch Engage Delay (ms) – The delay time between air con request input becoming active and the A/C compressor relay activating
- Number of Tacho Pulses Per Rev – The number of pulses which will be sent via the Tacho output per engine revolution
- Tach Pulse Width (us) – The width in microseconds of each pulse sent via the Tacho output. If 0 is entered, a default value of 1200us will be used

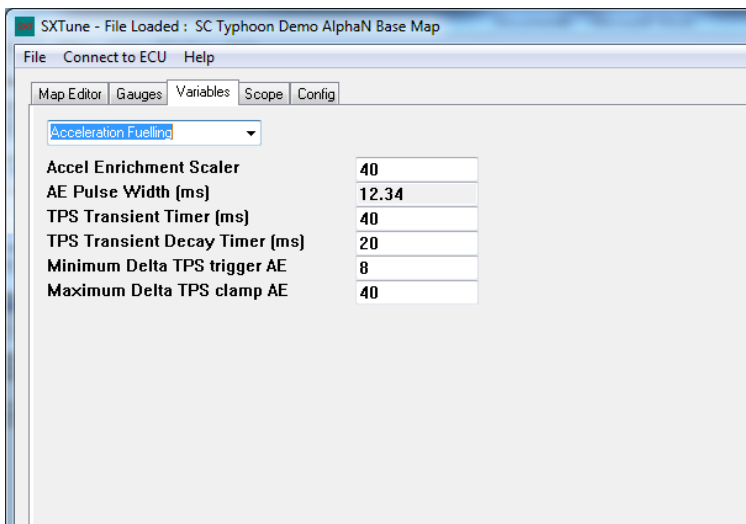
Acceleration Fuelling

Acceleration fuelling is calculated by measuring a change in throttle angle (delta TPS) and using this term multiplied by a global scaling factor and coolant temperature and engine speed compensations to generate an injection pulse width term that is added to the final injection pulse width. The diagram below shows the operation of the transient fuelling enrichment.





The acceleration fuelling value is multiplied by the 'Acceleration Fuel Coolant Temp Factor' map which is a function of coolant temperature as cold engines require more acceleration enrichment. The value is also multiplied by the 'Acceleration Fuel RPM Multiplier' map which allows the acceleration enrichment to be varied with engine speed, typically less enrichment is required at higher engine speeds.



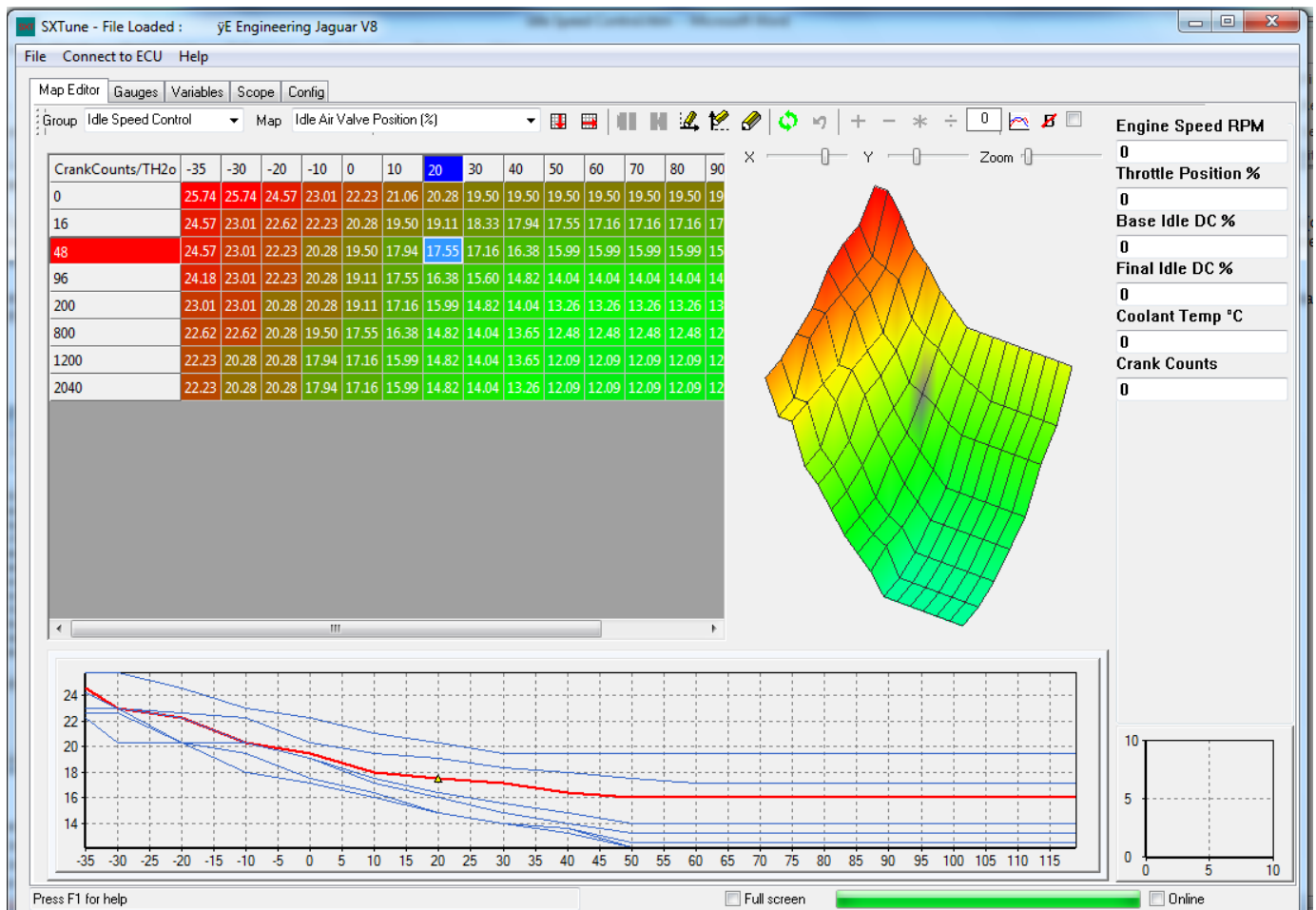
The acceleration fuelling variables page contains the variables listed below:

- Accel Enrichment Scaler – the global scaler for acceleration fuelling
- AE Pulse Width – None user editable field showing current acceleration enrichment injection pulse width (added to the final injection pulse width)
- TPS Transient Time – Timer (in milliseconds) over which the delta TPS value is calculated (see strategy illustration)
- TPS Transient decay timer – Timer (in milliseconds) which determines rate of acceleration enrichment term decay
- Minimum Delta TPS trigger AE – The minimum limit to enable acceleration fuelling calculation
- Maximum Delta TPS clamper AE – The maximum saturation limit of the acceleration enrichment calculation

Idle Speed Control

Tornado and Typhoon feature comprehensive idle speed control strategies. Closed loop idle speed control is provided by a proportional spark advance term and a proportional-integral idle air valve (or throttle position for electronic throttle control) controller. Typically engines react quickly to spark advance changes and more slowly to air quantity changes. The proportional spark advance controller therefore gives a fast reacting load compensation with limited range and the air valve control complements this with larger amplitude but slower control.

Idle speed control is invoked when the TPS (PPS for electronic throttle) is less than the enable threshold percentage in the Idle Speed Control variables page and the engine speed is less than the total of the Idle Control Offset to Target added to the current Target Idle Speed. To disable idle speed control, set the Idle Control TPS Enable Threshold to Zero.



N.B. For electronic throttle applications Idle Air Valve duty cycle is translated directly into a throttle position value by dividing the final duty cycle by 4. This percentage value is added directly to the target TPS % for idle speed air control. For clarity, from this point onwards this guide will refer only to Idle Air Valve position.

Base Air Valve Position

The base air valve position is calculated from a map 'Idle Air Valve Position %' as a function of Coolant Temperature and Crankshaft Revolutions since engine start. Higher values of idle air valve duty cycle will bypass more air into the engine to give a higher idle speed or to compensate for added friction in the engine from cold oils and clearances. This value acts as the open loop 'feed forward' valve position for closed loop idle speed control and is the starting value for all idle air valve calculations. This map should be set so that the hot stabilised idle valve position produces sufficient air to maintain the target idle speed.

Closed Loop Control

Integral and proportional gain maps set the gains of the proportional-integral (PI) controller as a function of the error between target idle speed and actual idle speed. The integrator base time is set in the Idle Speed Control variables page.

Load Rejection Compensations

Various feed-forward correction maps are provided to compensate for the additional loads of cooling fans and air conditioning compressors on the engine at idle. These should be calibrated such that the engine speed does not deviate by target when these loads are switched in and out.

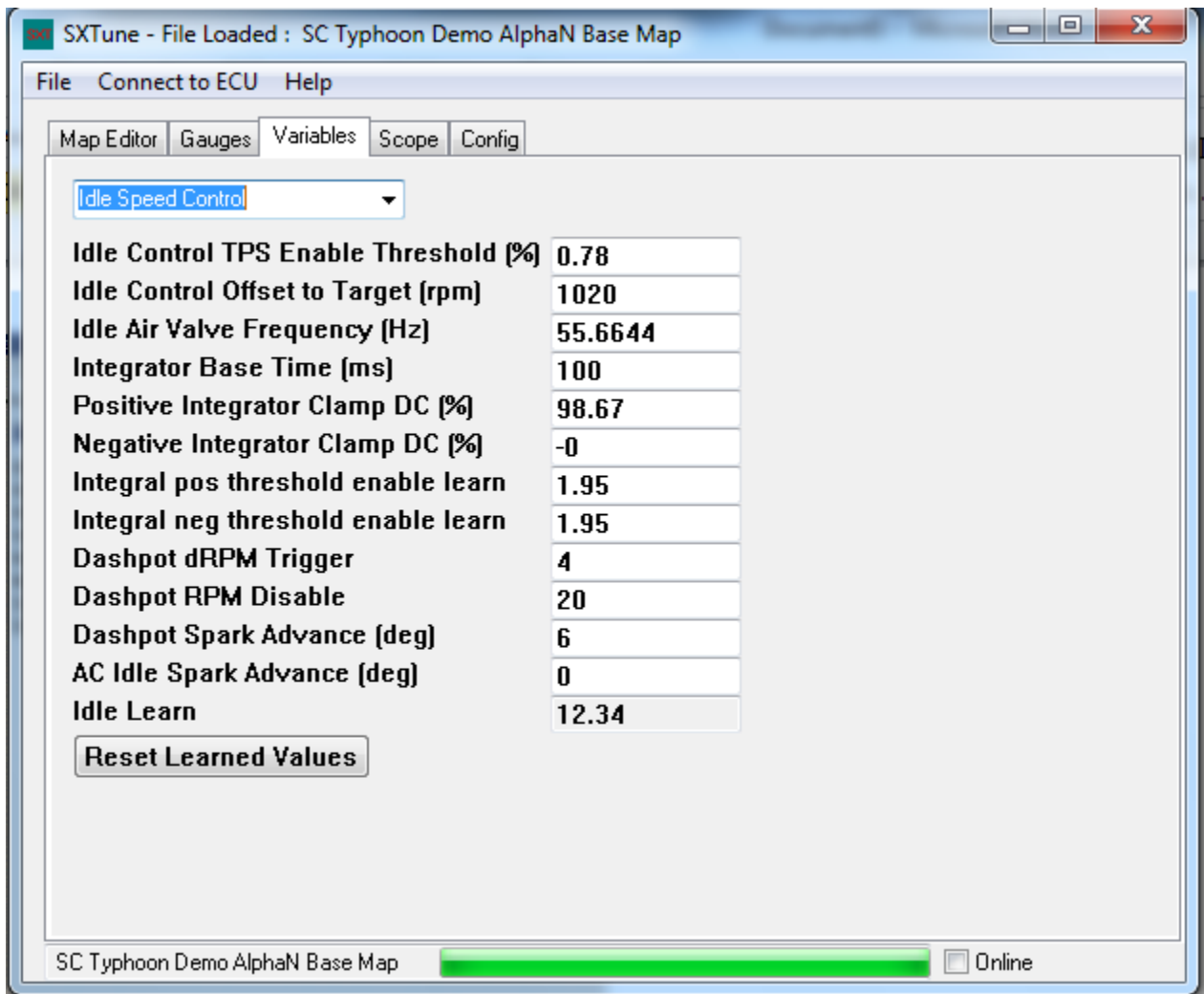
Dashpot

A 'Dashpot' function is included to correct for integrator wind-up causing engine stalls when returning to idle. When the engine speed is higher than target idle speed, the closed loop idle controller will reduce the idle valve duty cycle in an attempt to lower the engine speed. However if the engine speed is falling too quickly, for example when closing the throttle or exiting overrun cut-off, the engine speed may drop below the target idle speed and the engine can stall before the closed loop control can correct the error.

Dashpot is triggered by rate of change of engine speed. If the engine speed is falling faster than the 'Dashpot dRPM Trigger' value then Dashpot strategy is invoked. When dashpot is triggered, both proportional and integral values are set to zero, a fixed Spark Advance value is used and the Dashpot map values are added to the final air valve duty cycle. The aim of the strategy is to slow the rate of change of engine speed such that the engine returns gracefully to idle speed without undershoot or engine stall. The dashpot strategy is cancelled when the engine speed is less than Target Idle Speed plus Dashpot RPM Disable value. At this point the closed loop idle speed control strategy starts again.

Idle Learn

The ECU can adapt to variations between engines and idle valve actuators etc by means of an Idle Learn strategy. The Idle Learn value increments when the integrator is greater than the positive threshold enable learn value and decrements when the integrator is less than the negative threshold enable learn. This learn value is always added to the final idle air valve duty cycle and is stored in the ECU at key-off.

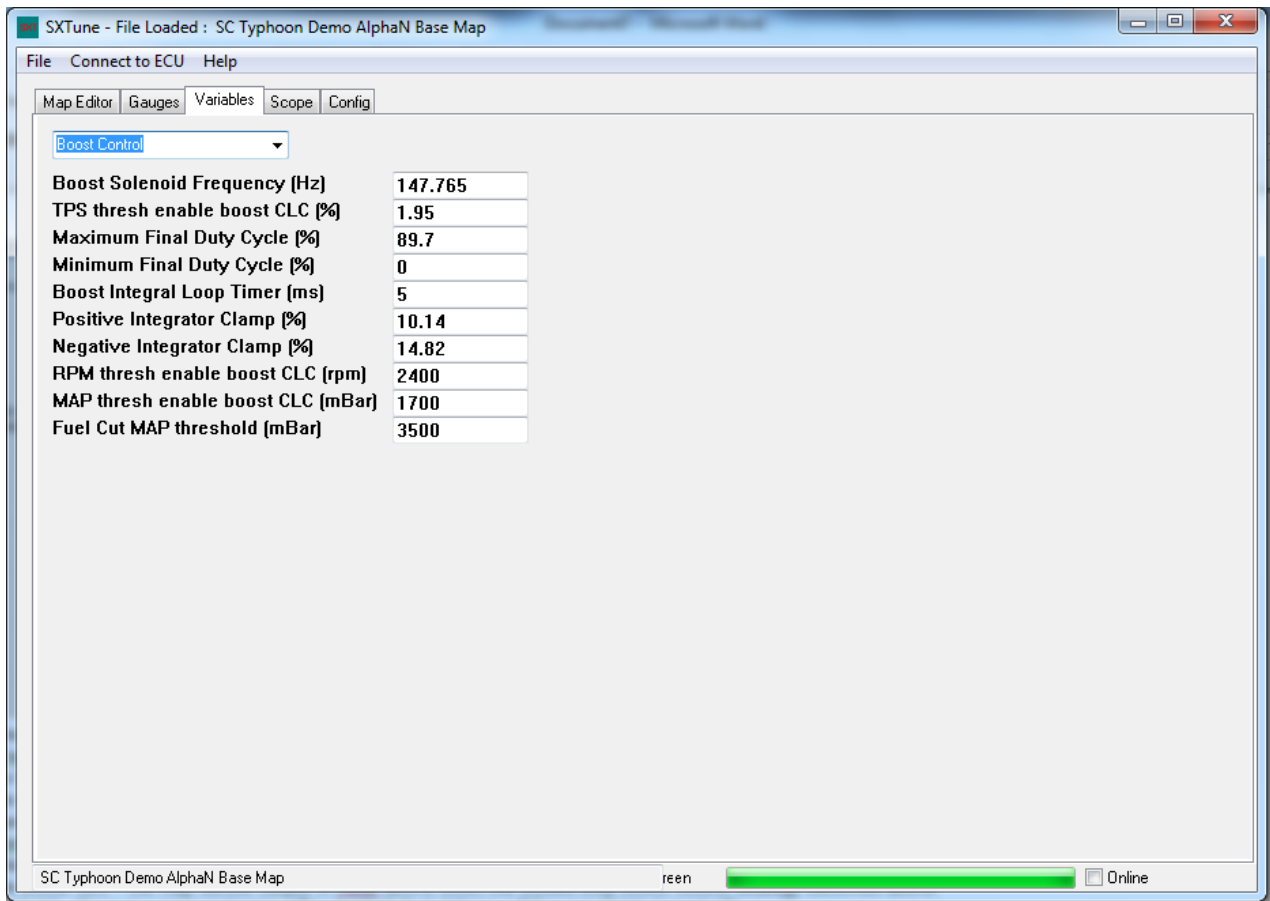


This 'Idle Speed Control' variables page contains the variables relating to idle speed control and is broken down into:

- Idle Control TPS Enable Threshold (%) – The throttle position below which the idle control strategy becomes active
- Idle Control Offset to Target (rpm) – The engine speed below which the idle control strategy becomes active as an offset to the target idle speed
- Idle Air Valve Frequency – Control frequency for the idle air valve in Hz
- Integrator Base Time – The time base in milliseconds for the idle speed PI controller integral term
- Positive Integrator Clamp DC (%) – The maximum positive value allowed for the idle speed PI controller integral term
- Negative Integrator Clamp DC (%) – The maximum negative value allowed for the idle speed PI controller integral term
- Integral pos threshold enable learn – The idle speed PI controller integral term above which the idle learn value will increment
- Integral neg threshold enable learn – The idle speed PI controller integral term below which the idle learn value will decrement
- Dashpot dRPM Trigger – The delta engine speed above which Dashpot will be triggered
- Dashpot RPM Disable – The engine speed above target idle speed at which dashpot will be disabled
- Dashpot Spark Advance (deg) – The fixed spark advance value used when dashpot is enabled
- AC Idle Spark Advance (deg) – The Spark Advance offset value added to the idle spark advance when the AC clutch relay is enabled
- Idle Learn – The learned idle air valve percentage value
- Reset Learned Values – Resets the idle learned value to zero

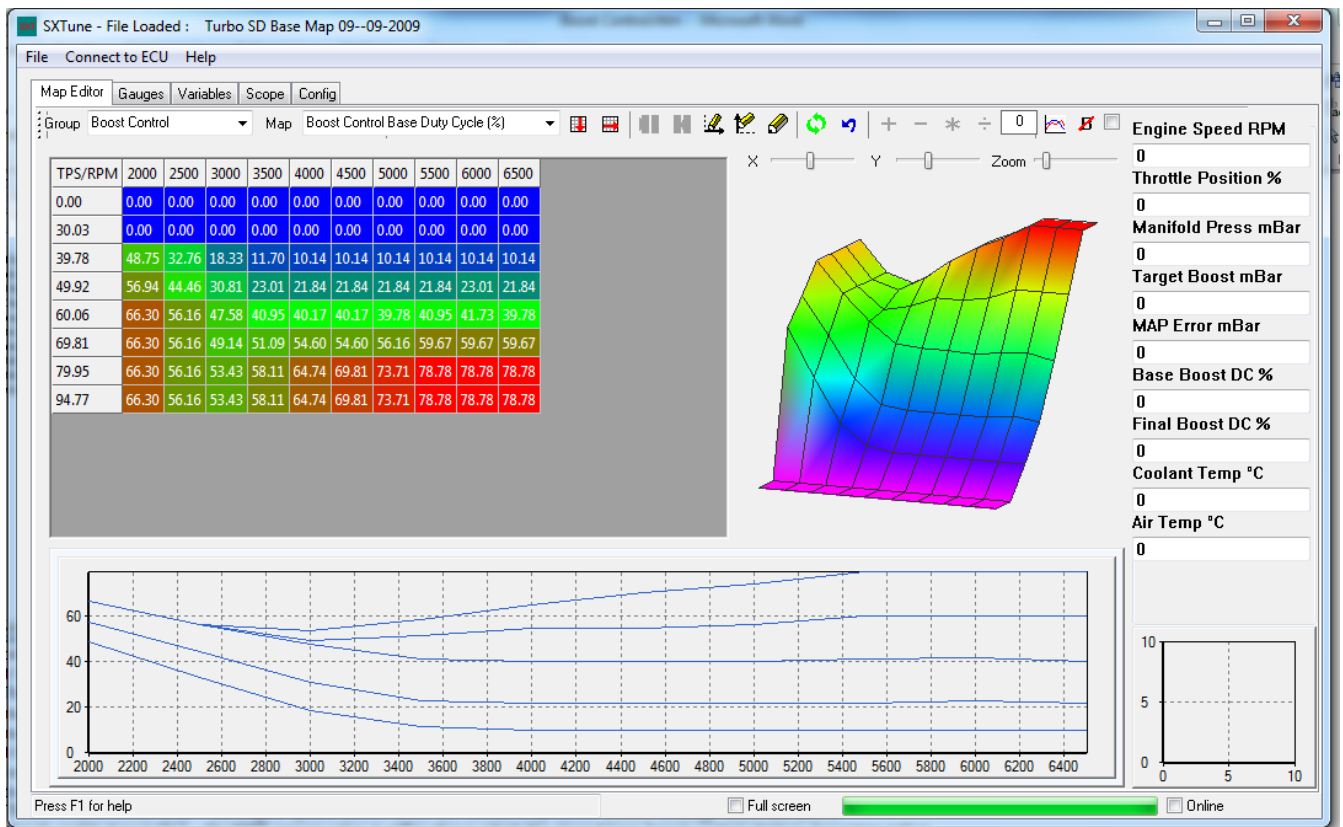
Boost Control

Boost control is achieved by means of a bleed valve in the turbocharger wastegate controlled by a Pulse Width Modulated (PWM) signal from one of the ECU PWM outputs as selected in ECU configuration.

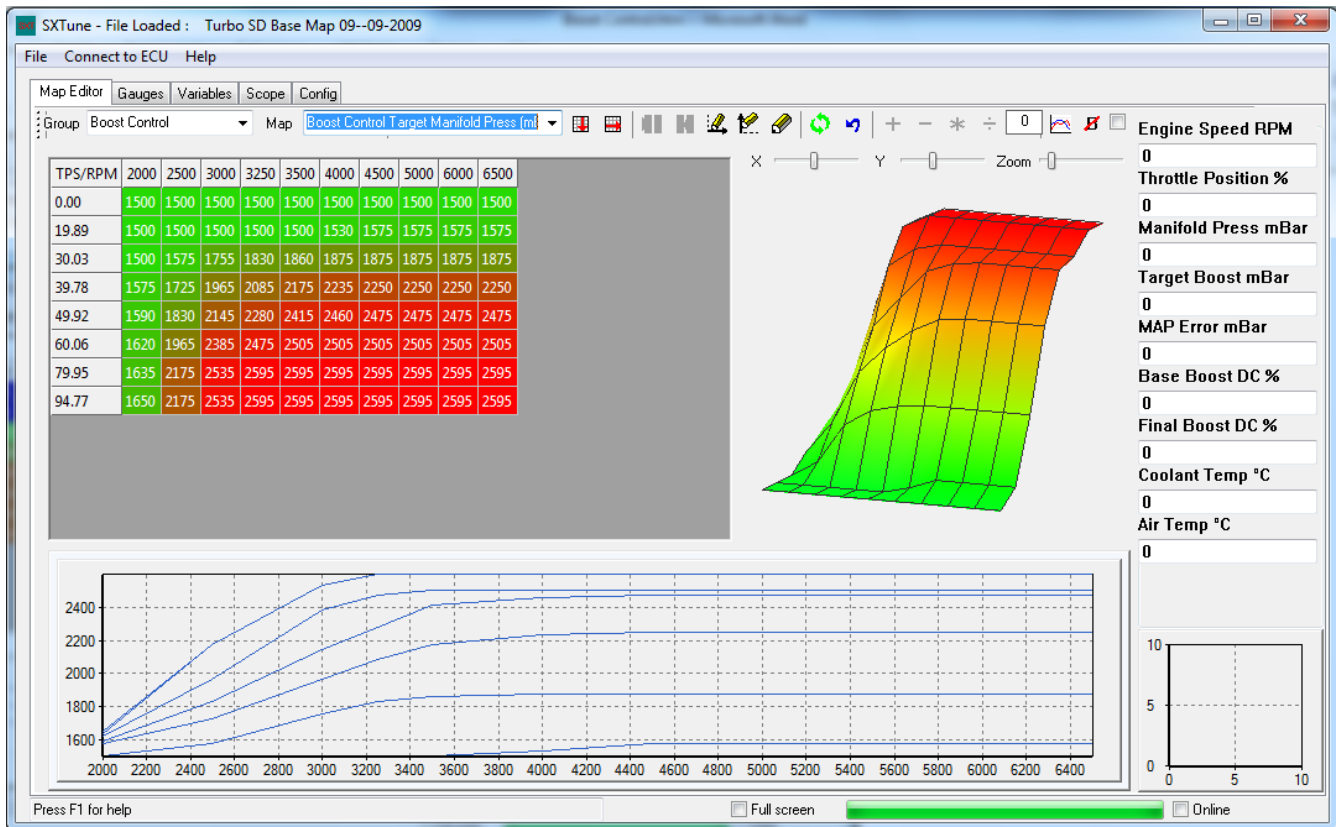


This Boost Control page displays values relating to the closed loop boost control strategy and is broken down into:

- Boost Solenoid Frequency – The piloting frequency at which the boost control solenoid will be driven in Hz.
- TPS Thresh enable boost CLC – the throttle position percentage above which the closed loop boost control strategy becomes active (set to 99.45 to disable closed loop boost control)
- Maximum Final Duty Cycle – The maximum boost control solenoid duty cycle percentage
- Minimum Final Duty Cycle – The minimum boost control solenoid duty cycle percentage
- Boost Integral Loop Timer (ms) – The time base for the boost PI controller integral term
- Positive Integrator Clamp (%) – The maximum positive value of the boost PI controller integral term
- Negative Integrator Clamp (%) – The maximum negative value of the boost PI controller integral term
- RPM Thresh enable boost CLC – the engine speed above which the closed loop boost control strategy becomes active.
- MAP thresh enable boost CLC – the MAP sensor value in mBar above which the closed loop boost control strategy becomes active.
- Fuel Cut MAP Threshold – the map sensor output in mBar at which fuel delivery will be completely turned off (for engine protection purposes).



The open loop boost control term is calculated by a map as a function of throttle position and engine speed. This should be calibrated to achieve the target boost level before closed loop boost control is enabled. The target manifold pressure in mBar is calculated from a map also as a function of throttle position and speed.

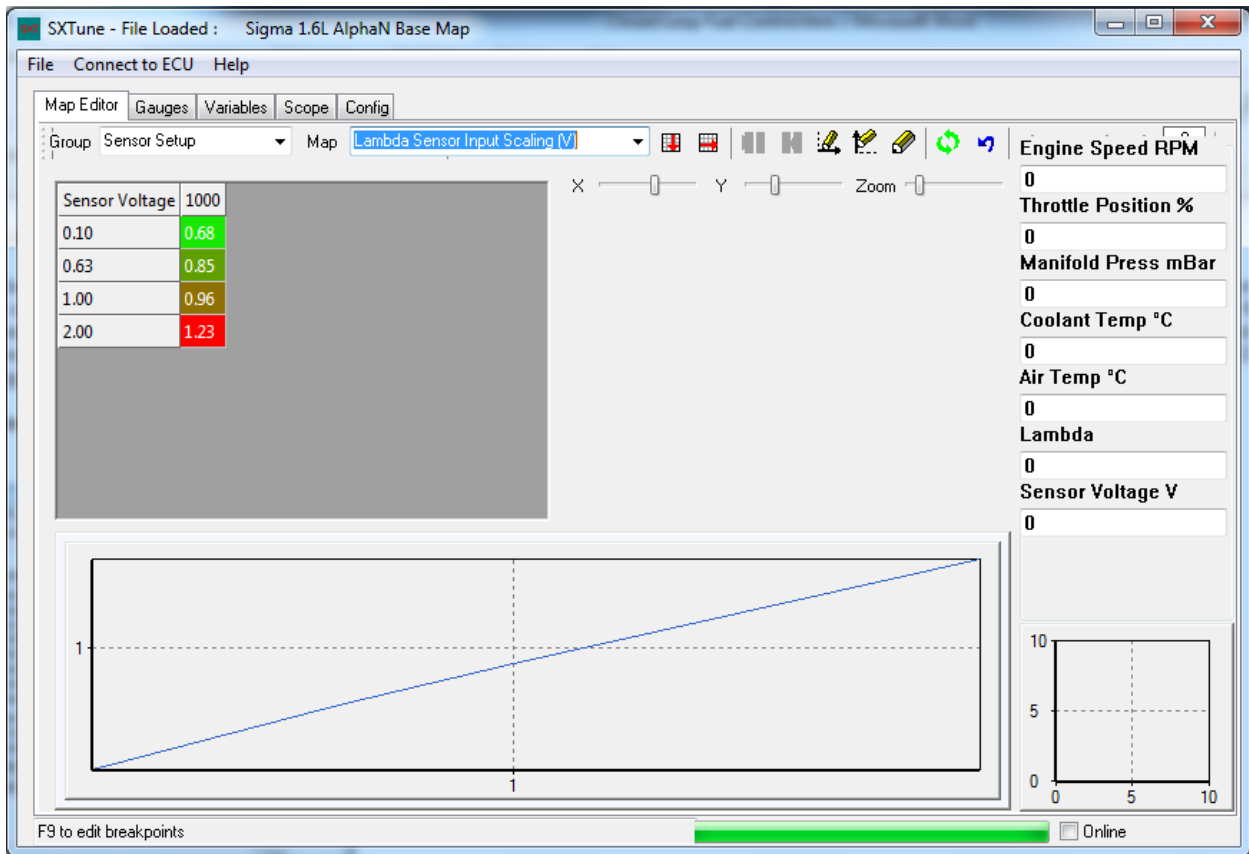


This forms the set point of the proportional-integral closed loop boost controller. The integral and proportional gain terms are set by maps as a function of the error between the target MAP (set point) and the actual measured MAP.

Closed Loop Fuel Control

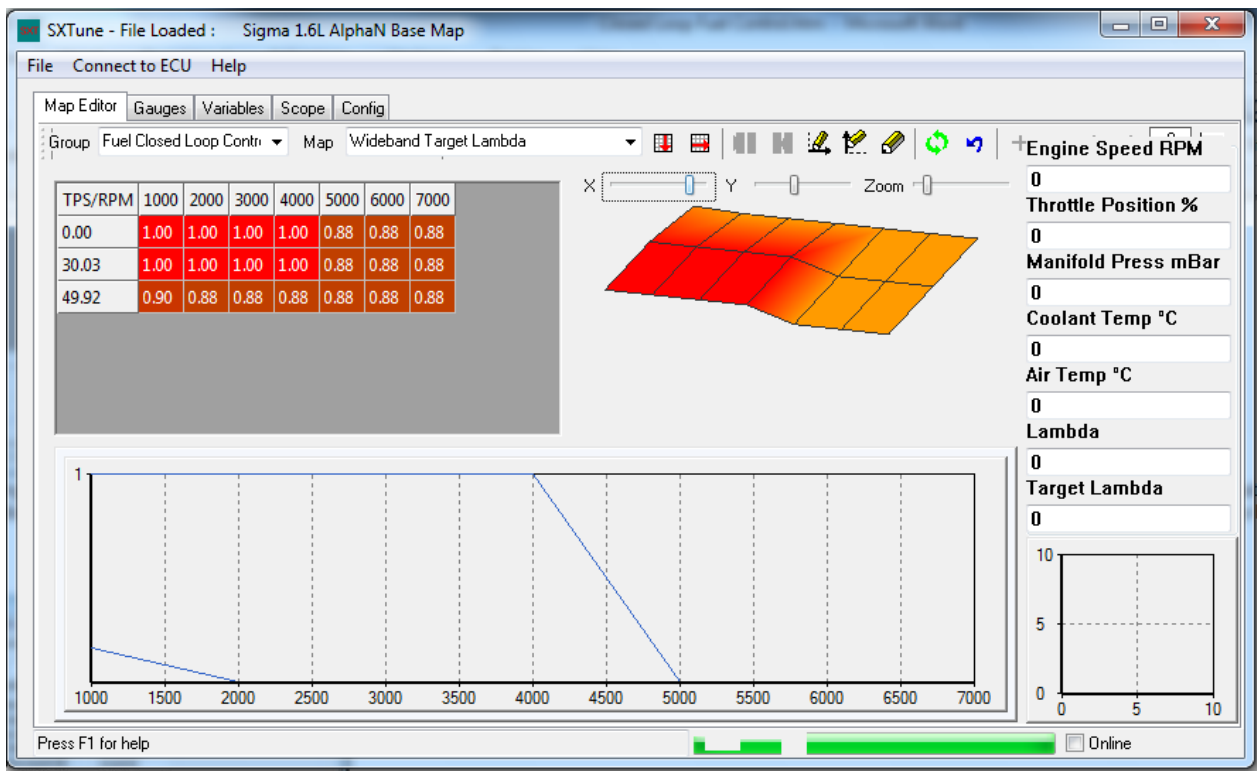
Closed loop fuelling control is provided by using either a narrowband lambda sensor connected directly to the ECU lambda input or by using a wideband sensor connected via an external wideband sensor controller with a 0-5V analogue output. Narrowband sensor control can only be used to target exhaust lambda of 1.00 (AFR 14:7 with petrol/gasoline), normally for exhaust emissions reduction using a three-way catalytic converter. Wideband sensor control can be used to target any air-fuel ratio and also for tuning. SC recommends that wideband control is not left turned on permanently, but only used as a tuning tool. Wideband sensors and controllers are not generally reliable enough to use for long periods of time and a faulty sensor could give incorrect feedback into the ECU and cause the engine to run dangerously lean, resulting in engine failure. Once the engine has been correctly calibrated there is no need to continue using wideband lambda sensor control.

Wideband Sensor Control



Before enabling wideband sensor control the sensor input voltage scaling must be entered. In the Map Editor, Group - 'Sensor Setup', Map - 'Lambda Sensor Input Scaling (V)' the output voltage of the chosen wideband lambda controller vs lambda can be entered. This is a variable breakpoint map, voltage breakpoints can be entered using F9, to return to the map press F11.

The Closed Loop Control Start Time is located in the 'Closed Loop Fuel Control' Group and is a map with axis of start-up coolant temperature. Lambda sensors are heated and require longer to achieve working temperature when switched on from low temperatures. Engines need to run richer when cold, so closed loop fuel control may not be appropriate at low coolant temperatures. This map allows the desired closed loop control start times to be set.

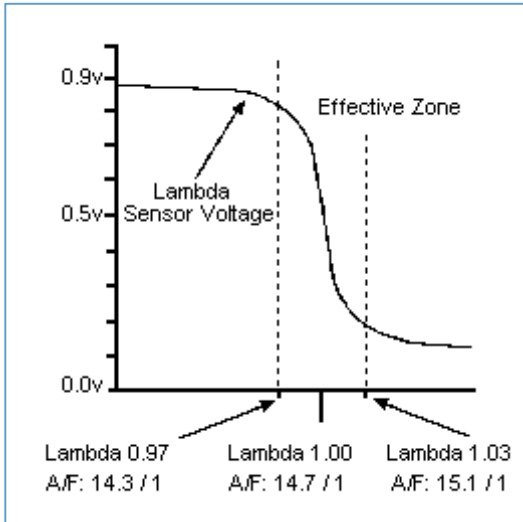


The Wideband Target Lambda map is located in the 'Fuel Closed Loop Control' Group and should be calibrated to the desired lambda for the engine. Typically a normally aspirated engine will run at Lambda 1.00 at part load, low speed and 0.85-0.88 at full load to achieve maximum power. Turbocharged engines will need to run richer than this to reduce exhaust gas temperatures.

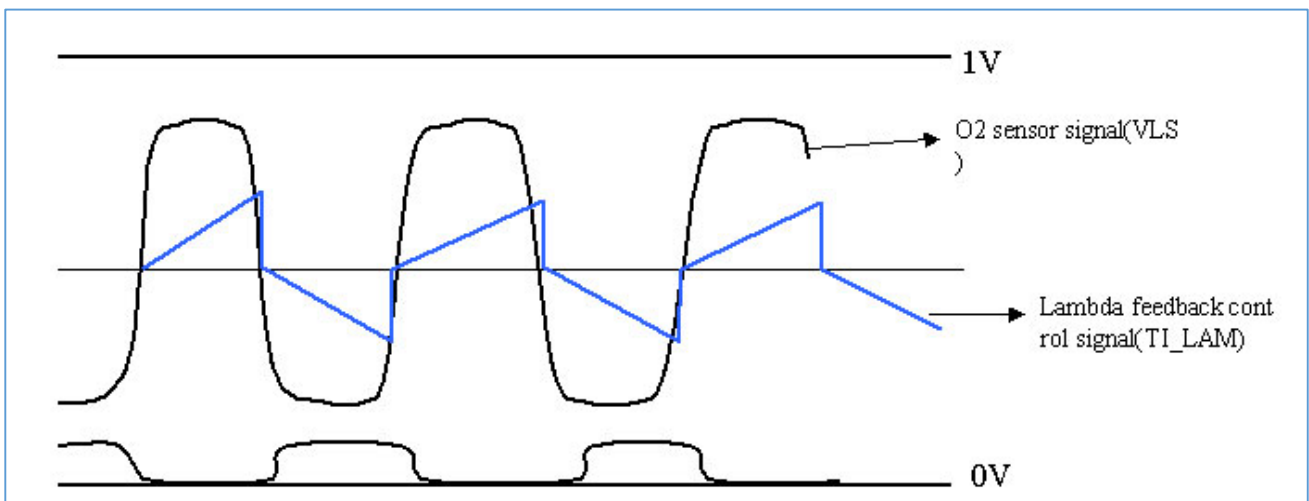
Target lambda is achieved via a proportional-integral controller. The proportional term is calculated from the 'Wideband Lambda Proportional Gain' map (note that this is different from that used by the narrowband control). The integral gain is taken from two maps depending on whether the Lambda is lean or rich of target 'Lambda Integral Step Lean to Rich' and 'Lambda Integral Step Rich to Lean'.

Narrowband Sensor Control

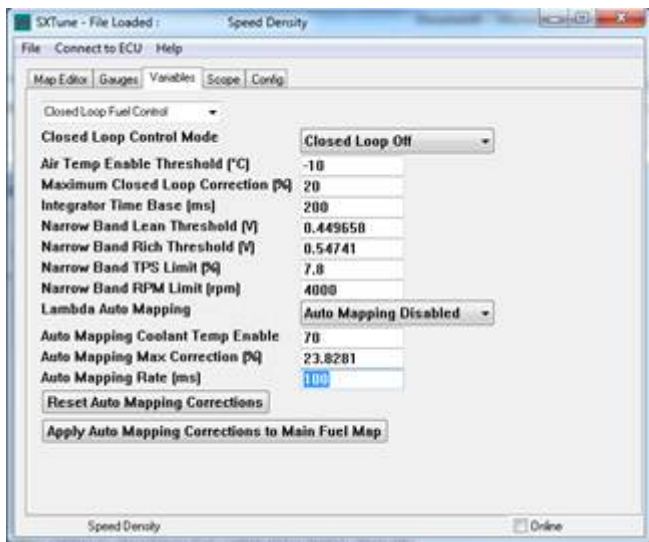
Narrowband lambda sensor control is used to optimise exhaust gas emissions. Narrowband (Zirconia type) lambda sensors are only accurate at lambda 1.00, the stoichiometric air-fuel ratio, so it is not possible to translate the sensor voltage into actual lambda. The sensor output produces less than 0.5V when the air-fuel ratio is leaner than lambda 1.00 and greater than 0.5V when the air-fuel ratio is richer than lambda 1.00. Thus the closed loop control strategy for narrowband sensor operates in a different mode to wideband control, using this binary feedback for the control loop. The sensor voltages determining rich and lean are set in the Closed Loop Control Variables page.



To promote the thermal reaction in a catalytic converter it is necessary to cycle the fuelling slightly rich and lean of Lambda 1.00. The resultant differences in oxygen content of the exhaust allow the catalyst to alternate between "oxidizing" CO and HC and "reducing" NO_x.



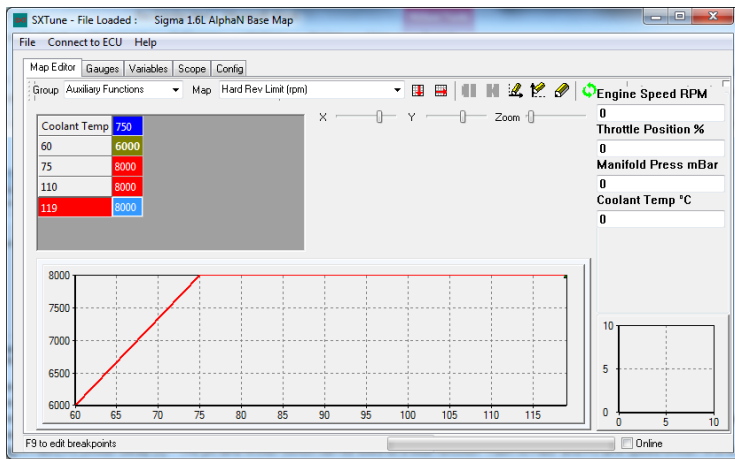
The proportional and integral step sizes are set by four maps as a function of throttle position and engine speed. The scope page is a useful tool in monitoring the closed loop control loop and determining the correct operation of the system. Ultimately the system performance can be measured by an exhaust gas analyser; the system should be optimised as a compromise between engine performance and tailpipe emissions.



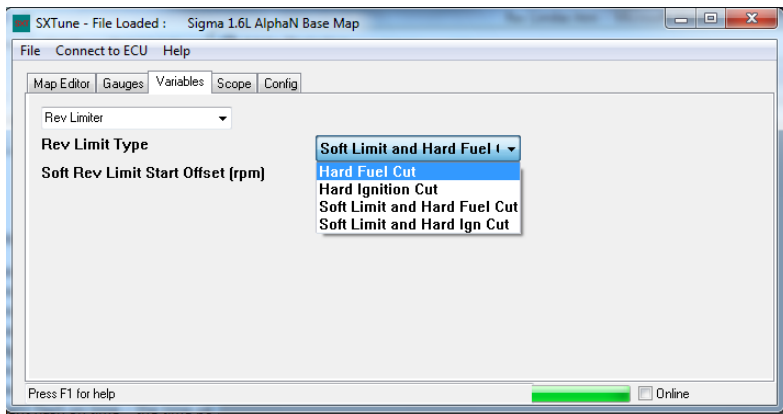
This Closed Loop Fuel Control variables page contains the following values:

- Closed Loop Control Mode – Selects the closed loop fuel control strategy to be employed. Selectable options are Closed Loop Off, Narrowband Control and Wideband Control.
- Air Temp Enable Threshold – The inlet air temp below which closed loop fuel control will become inactive.
- Maximum Closed Loop Correction – The percentage amount of correction the closed loop control strategy is allowed to modify the final injector pulse width by.
- Integrator Time Base – Controls the time base for the fuel closed loop PI controller integrator term.
- Narrow Band Lean Threshold – The voltage a narrowband lambda sensor shows as it swings to lean, anything below this voltage is considered lean.
- Narrow Band Rich Threshold – The voltage a narrowband lambda sensor shorts as it swings to rich, anything above this voltage is considered rich.
- Narrow Band TPS Limit % – the throttle position above which narrow band closed loop fuelling strategy becomes inactive.
- Narrow Band RPM Limit (rpm) - the engine speed above which narrow band closed loop fuelling strategy becomes inactive.
- Lambda Auto Mapping – Enables or disables the lambda auto mapping strategy
 - Auto Mapping Coolant Temp Enable – The coolant temperature above which auto mapping is enabled
 - Auto Mapping Correction (%) – The maximum correction percentage values clamp for the 'Auto Mapping Corrections (%)' map.
 - Auto Mapping Rate (ms) – The rate in milliseconds at which the auto mapping strategy is allowed to increment the correction percentage
 - Reset Auto Mapping Corrections – Resets the 'Auto Mapping Corrections (%)' map values to zero
 - Apply Auto Mapping Corrections to Main Fuel Map – Multiplies the base injection pulse width map by all the values in the 'Auto Mapping Corrections (%)' map and then resets the map to zero

Rev Limiter

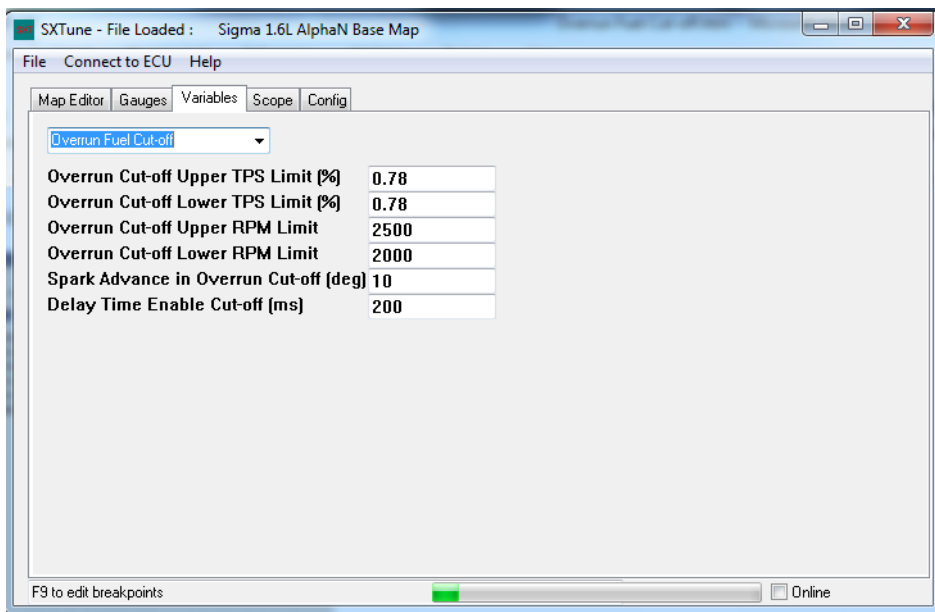


Rev limiting (over-speed protection) is implemented by a user selectable range of hard and soft cuts. The primary hard rev limit is set by a Map 'Hard Rev Limit (rpm)' under the Group 'Auxiliary Functions'. This map is a function of coolant temperature, enabling a reduced rev limit to be set when the engine is too hot or too cold providing increased engine protection.



The rev limiter type is set by a drop-down box in the 'Rev Limiter' Variables page. There are options of hard fuel or ignition cuts, where either the fuel injection or ignition is completely switched off when the engine speeds exceeds the value obtained from the 'Hard Rev Limit' map. Also available is a soft limit which progressively reduces the engine torque as the hard limit is approached, giving a much smoother rev limiting effect. The start of the soft limiter is set by the value 'Soft Rev Limit Start Offset (rpm)' as an offset to the hard cut value. For example, if the hard cut is set to 8000rpm and the soft rev limit offset to 250rpm, the ECU will begin to reduce the engine torque at 7750rpm, increasing to a 50% reduction in torque at 7875rpm and culminating in a complete cut at 8000rpm.

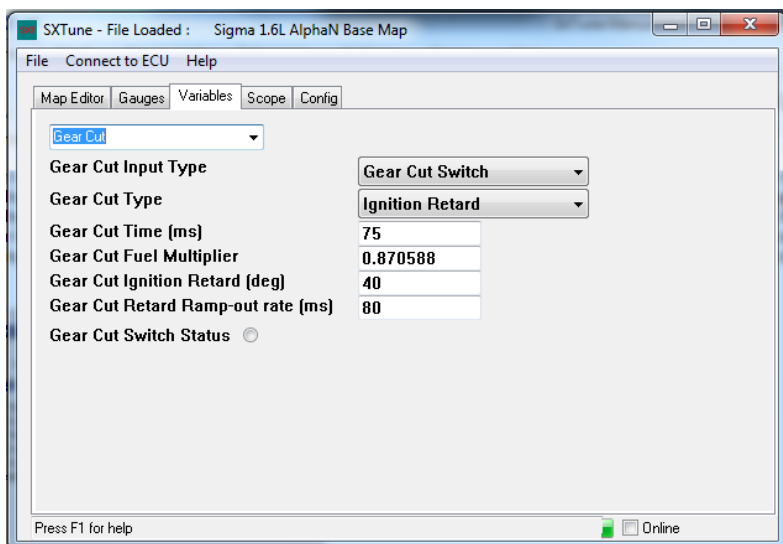
Overrun Fuel Cut-Off



This page contains variables relating to the over-run fuel cut off strategy and is broken down into:

- Overrun Cut-off upper TPS Limit % - The upper TPS limit above which overrun fuel cut-off will become disabled
- Overrun Cut-off lower TPS Limit % - The lower TPS limit below which overrun fuel cut-off will become enabled
- Overrun Cut-off upper RPM Limit - The upper RPM limit above which overrun fuel cut-off will become enabled
- Overrun Cut-off lower RPM Limit - The lower RPM limit below which overrun fuel cut-off will become disabled
- Spark Advance in Overrun Cut-off – The spark advance in degrees which will be applied when the engine is under over-run conditions.
- Delay Time Enable Cut Off – The delay time between meeting conditions to activate overrun fuel cut off and overrun fuel cut off becoming active.

Gear Shift Cut

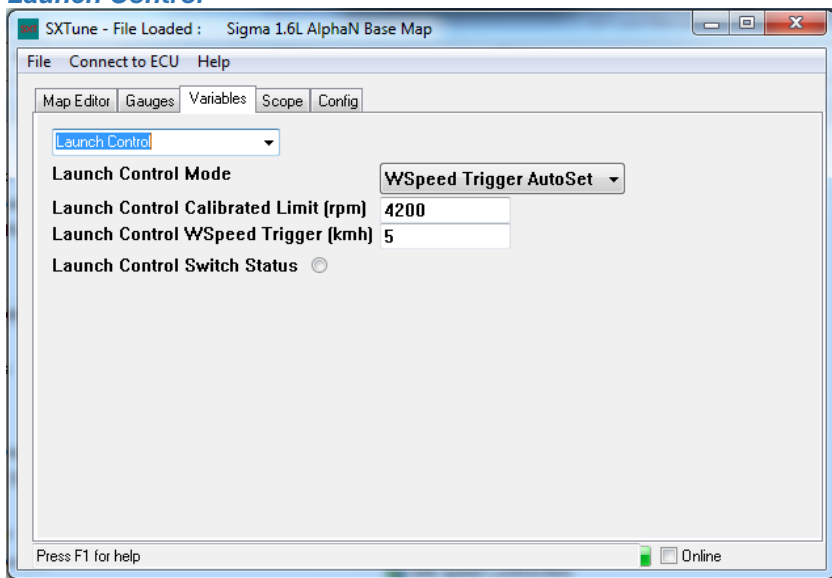


This page contains variables relating to the Gear Shift Cut Function:

- Gear Cut Input Type – drop down box to select the gear cut input from either a Gear Control Unit (GCU e.g. Geartronics) or from a switch mounted on the gear lever

- Gear Cut Type – drop down box to select the type of gear cut: either a complete ignition cut or ignition retard
- Gear Cut Time (ms) – if Gear Cut Input Type is selected as Gear Control Unit this is the maximum time-out of the gear cut, else if a switch is used this the cut time
- Gear Cut Fuel Multiplier – the final injection pulse width is multiplied by this amount during the shift. Used to reduce unburnt fuel burning in the exhaust after the shift
- Gear Cut Ignition Retard – the negative spark advance offset applied to the final spark advance value during the shift
- Gear Cut Retard Ramp-out Rate – the time in milliseconds that the Gear Cut Ignition Retard is ramped out after the shift

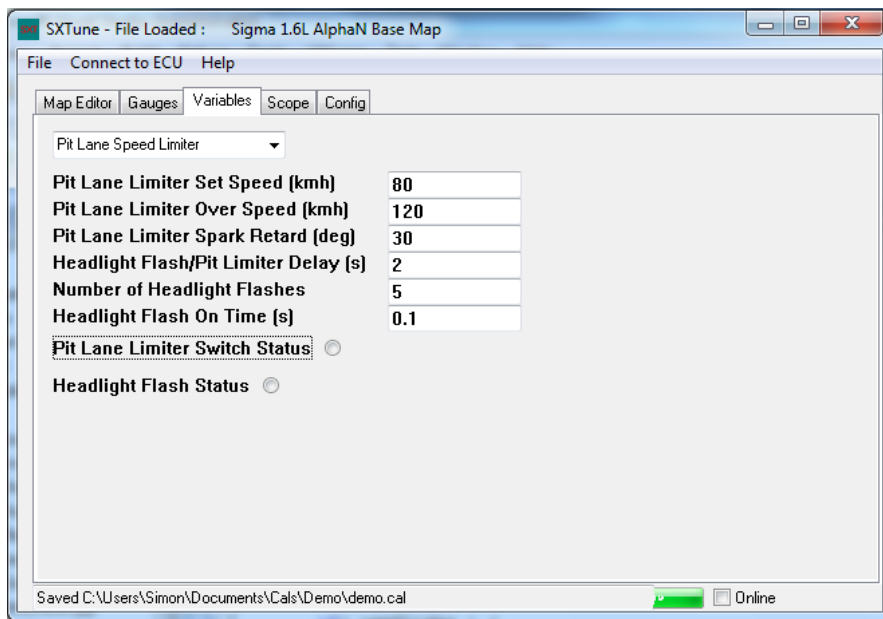
Launch Control



Typhoon and Tornado feature a launch control strategy to optimise acceleration from a standing start. This function operates by holding a set engine speed regardless of throttle position when stationary, this limiter is cancelled when the vehicle starts to move allowing the engine speed to increase.

- Launch Control Mode – drop down box to select from the launch control options:
 - WSpeed Trigger AutoSet – this mode uses the launch control input to set the launch engine speed. When the button is pressed the launch control strategy latches the current engine speed as the launch set engine speed. The speed limiter is cancelled either by pressing the button again, or by the wheel speed input exceeding the Launch Control WSpeed Trigger value.
 - Switch Trigger AutoSet - this mode uses the launch control input to set the launch engine speed. When the button is pressed the launch control strategy latches the current engine speed as the launch set engine speed. The speed limiter is cancelled only by pressing the button again.
 - Switch Trigger Cal Limit – this mode uses the Launch Control Calibrated Limit to set the launch engine speed. When the button is pressed the launch control strategy holds the calibrated engine speed as the launch set engine speed. The speed limiter is cancelled only by releasing the button.
- Launch Control Calibrated Limit – the launch engine speed value used in Launch Control Mode 'Switch Trigger Cal Limit'
- Launch Control WSpeed Trigger – the wheel speed value used to cancel launch control in Launch Control Mode 'WSpeed Trigger AutoSet'

Pit Lane Speed Limiter

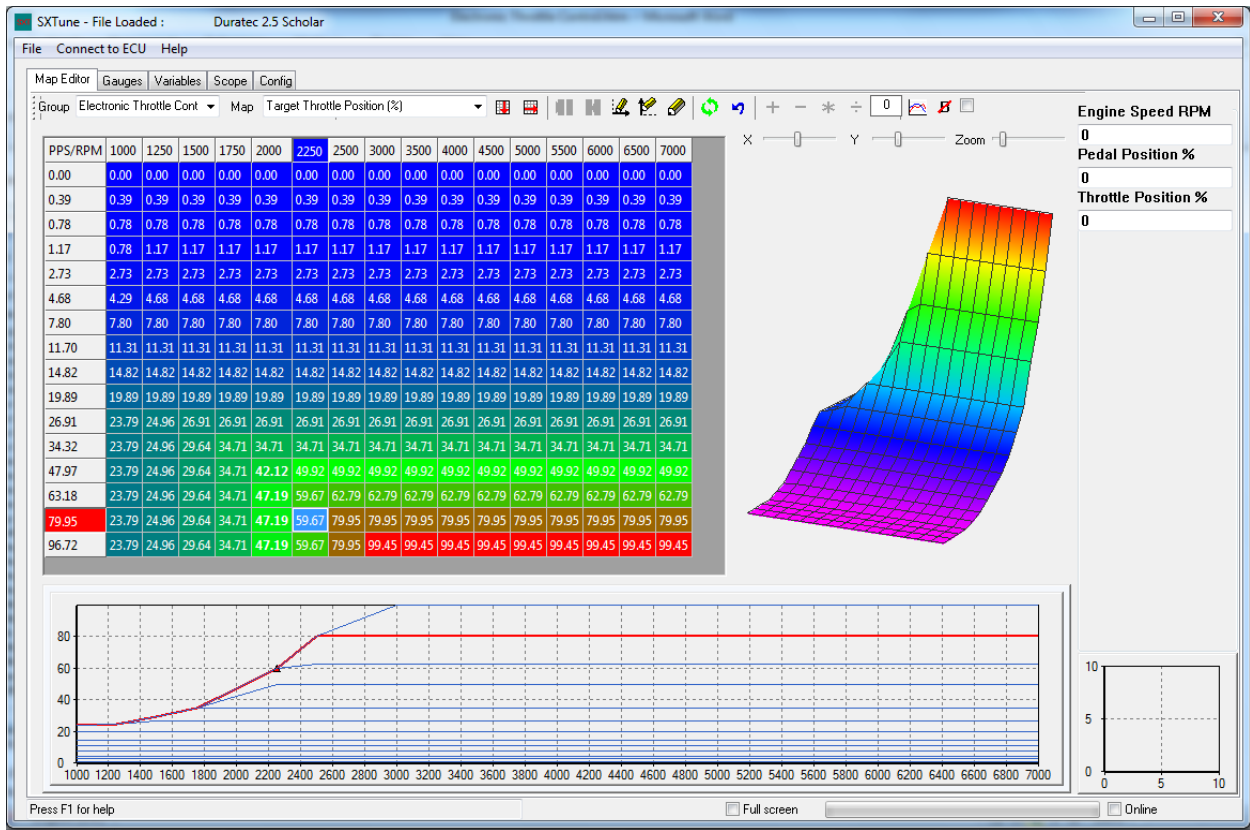


The Pit Lane Speed Limiter is used to control the maximum vehicle speed to a set value when the ECU pit lane speed limiter switch is enabled. The values required to calibrate the pit lane speed limiter function are in the 'Pit Lane Speed Limiter' variables page.

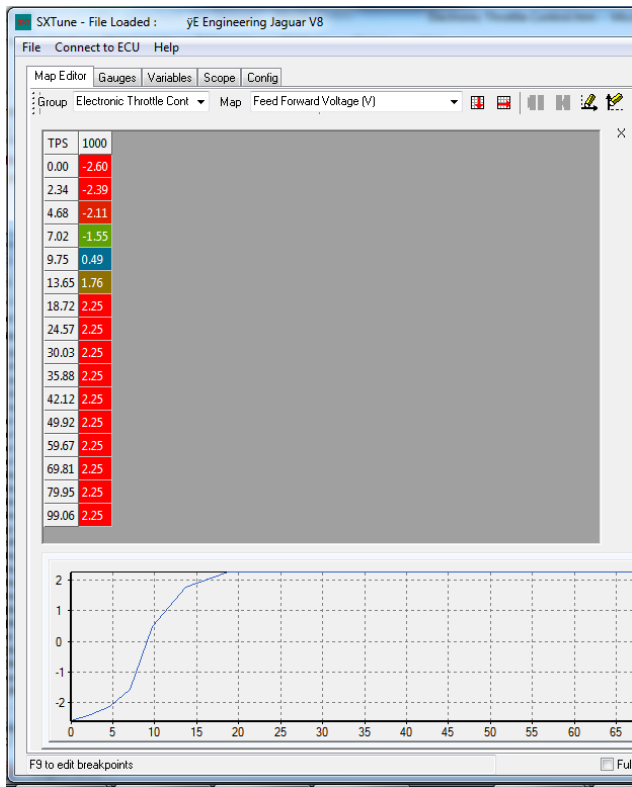
- Pit Lane Limiter Set Speed (kmh) – value in kmh of the desired pit lane speed limit
- Pit Lane Limiter Over Speed (kmh) – value in kmh above which the pit lane speed limit will be disabled
- Pit Lane Limiter Spark Retard (deg) – negative offset applied to the final spark advance value when the pit lane limiter is active. The value is ramped in automatically when the set speed is approached. This function is used to reduce the torque oscillations caused by the engagement of the limiter.
- Headlight Flash/Pit Limiter Delay (s) – The pit lane limiter switch can be used as a dual function 'Flash to Pass' and Pit lane speed limiter. A brief press of the button will invoke the headlight flasher function, while holding down the button for longer than this value will invoke the pit lane speed limiter.
- Number of headlight flashes – the number of flashes of the headlight flasher function
- Headlight flash on time – the time period of the headlight flasher function

Electronic Throttle Control (Tornado Only)

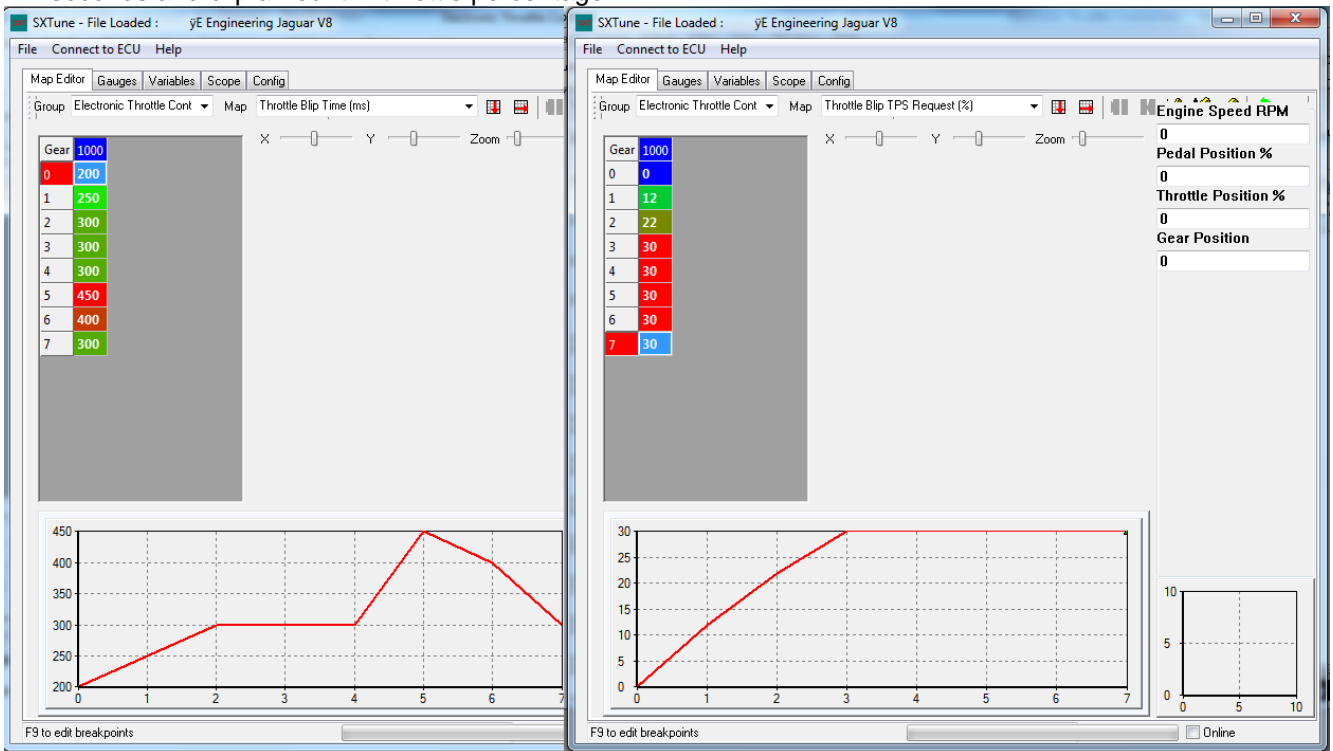
Tornado features a comprehensive electronic throttle control function for DC motor electronic throttle bodies. Target throttle position is set by a map as a function of pedal position (which is calculated as the lowest of the available pedal position sensors) and engine speed. This map enables the throttle profile to be set and also to limit the maximum throttle opening as a function of engine speed, for example to increase air velocity at low engine speeds.



A feed-forward voltage term for the PID controller is calculated from a map as a function of throttle position. The purpose of this feed forward term is to compensate for the springs in the throttle body. Typically electronic throttle bodies are sprung to a limp home position at around 6% of opening, with an opening spring and a closing spring to hold this position when no power is applied to the motor. By applying a compensating voltage to the motor, the effect of the springs can be minimised and the PID control is improved.



A downshift throttle blipper function is calibrated using two maps as a function of gear position: blip time in milliseconds and blip amount in throttle percentage



The Electronic Throttle Control variables page contains the following values:

- Pedal Position Sensors Config – drop down to select the configuration of the pedal position sensors
- Throttle Position Sensors Config – drop down to select the configuration of the throttle position sensors
- Throttle Body Drive Frequency – the piloting frequency of the H-bridge output PWM
- Throttle Body Proportional Term – the proportional gain term of the electronic throttle PID (proportional-integral-derivative) controller
- Throttle Body Integral Term – the integral gain term of the electronic throttle PID (proportional-integral-derivative) controller
- Throttle Body Derivative Term – the derivative gain term of the electronic throttle PID (proportional-integral-derivative) controller
- Throttle Body Integral Saturation – the maximum integral clamp term of the electronic throttle PID (proportional-integral-derivative) controller (limits integrator wind-up)
- Pedal Position Sensor 1 min – the minimum pedal position sensor 1 voltage
- Pedal Position Sensor 1 max – the maximum pedal position sensor 1 voltage
- Pedal Position Sensor 2 min – the minimum pedal position sensor 2 voltage (if using only one pedal position sensor, use the same value as for pedal position sensor 1)
- Pedal Position Sensor 2 max – the maximum pedal position sensor 2 voltage (if using only one pedal position sensor, use the same value as for pedal position sensor 1)
- Throttle Position Sensor 1 min – the minimum throttle position sensor 1 voltage
- Throttle Position Sensor 1 max – the maximum throttle position sensor 1 voltage
- Throttle Position Sensor 2 min – the minimum throttle position sensor 2 voltage (if using only one throttle position sensor, use the same value as for throttle position sensor 1)
- Throttle Position Sensor 2 max – the maximum throttle position sensor 2 voltage (if using only one throttle position sensor, use the same value as for throttle position sensor 1)
- TPS/PPS Diags Error Threshold (V) – the maximum allowed error voltage for the pedal and throttle position sensor
- PPS Filter Coefficient – first order filter coefficient for pedal position. Smaller numbers increase the level of filtering
- Diagnostic issues are indicated by the radio buttons

SXTune - File Loaded : Sigma 1.6L AlphaN Base Map

File Connect to ECU Help

Map Editor Gauges Variables Scope Config

Electronic Throttle Control

Pedal Position Sensors Config

Throttle Position Sensors Config

Throttle Body Drive Frequency (Hz) 500

Throttle Body Proportional Term 500

Throttle Body Integral Term 400

Throttle Body Derivative Term 300

Throttle Body Integral Saturation 120

Pedal Position Sensor 1 min [V] 0.4

Pedal Position Sensor 1 max [V] 4.4

Pedal Position Sensor 2 min [V] 0.5

Pedal Position Sensor 2 max [V] 3.8

Throttle Position Sensor 1 min [V] 0.0146625

Throttle Position Sensor 1 max [V] 3.96

Throttle Position Sensor 2 min [V] 2.19938

Throttle Position Sensor 2 max [V] 4.18

TPS/PPS Diags Error Threshold [V] 0.05

PPS Filter Coefficient 5

TPS1 Raw Voltage [V] 12.34

TPS2 Raw Voltage [V] 12.34

PPS1 Raw Voltage [V] 12.34

PPS2 Raw Voltage [V] 12.34

PPS1 scaled [%] 12.34

PPS2 scaled [%] 12.34

PPS scaled [%] 12.34

TPS1 scaled [%] 12.34

TPS2 scaled [%] 12.34

TPS Drive Request [%] 12.34

TPS 1 filtered [%] 12.34

Twin Track Pot Opp Dir

Twin Track Pot Same Dir

PPS1 Fault Voltage Too Low

PPS1 Fault Voltage Too High

PPS2 Fault Voltage Too Low

PPS2 Fault Voltage Too High

TPS1 Fault Voltage Too Low

TPS1 Fault Voltage Too High

TPS2 Fault Voltage Too Low

TPS2 Fault Voltage Too High

ETB Fault Position Error

ETB Fault Motor Over Current

PPS1/2 Fault Correlation Error

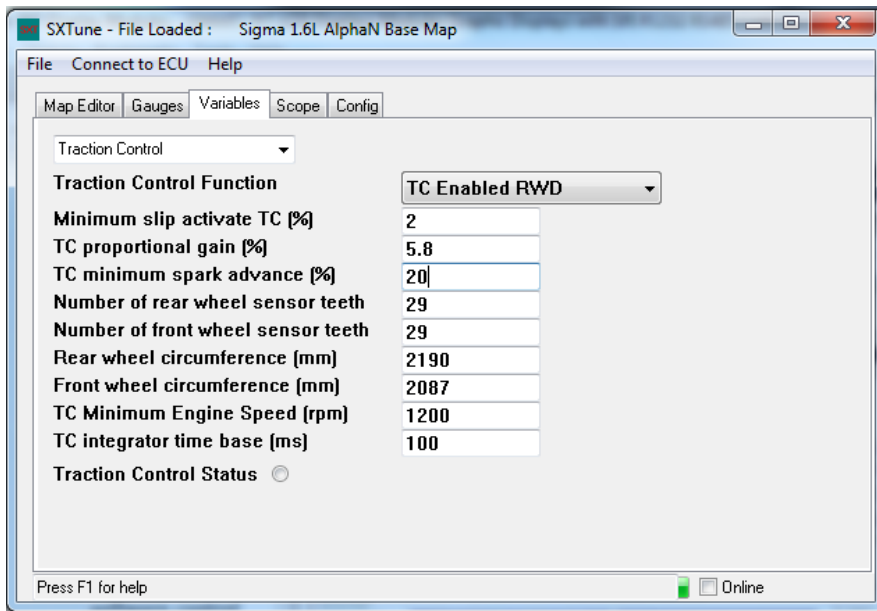
TPS1/2 Fault Correlation Error

Press F1 for help

Full screen Online

Traction Control (Tornado Only)

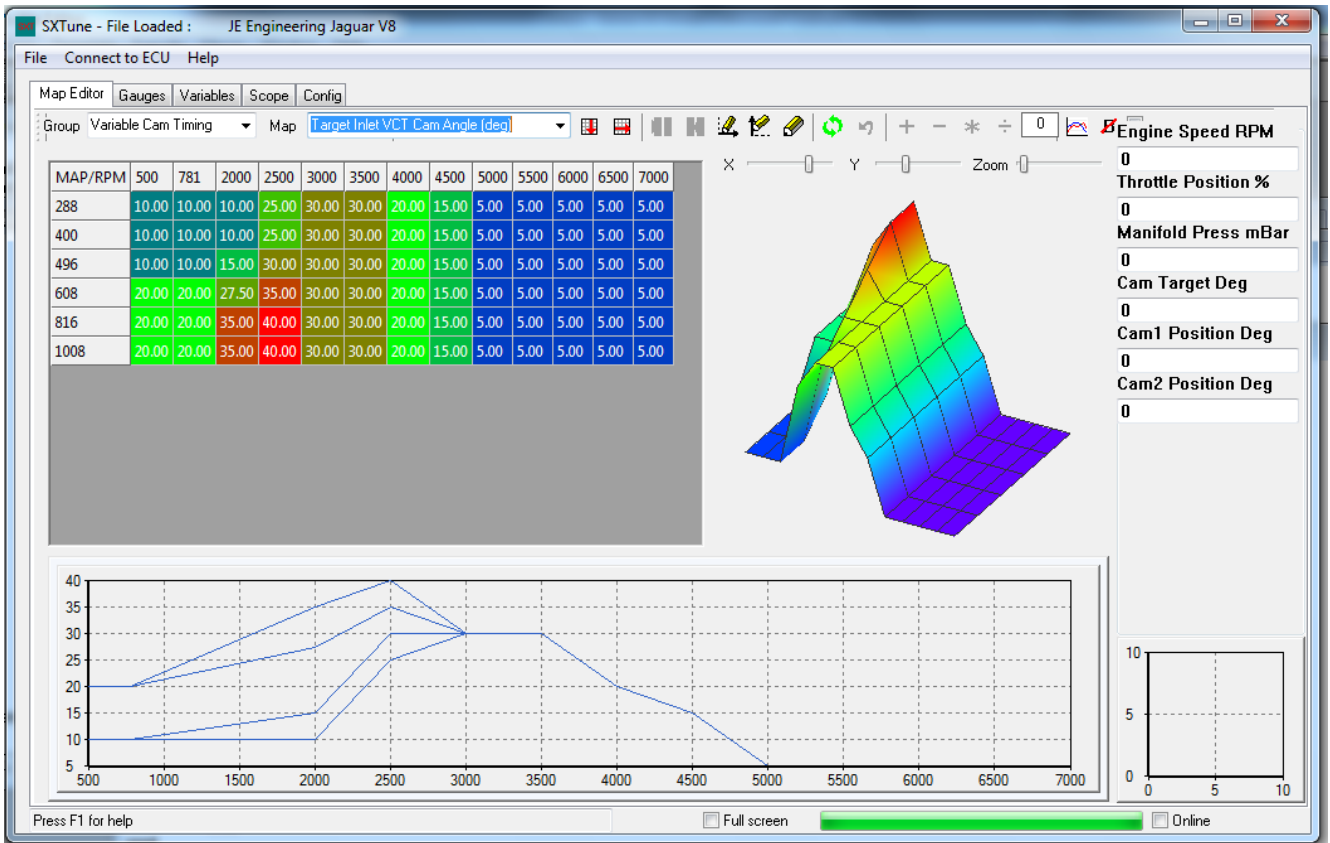
Tornado features a traction control strategy that reduces engine torque in response to measured wheel slip between the driven and undriven wheels. The highest of the rear axle and front axle speeds is calculated and then compared to determine the percentage wheel slip. A proportional-integral controller uses the wheel slip value to determine a reduction in engine torque which achieved using a combination of spark advance reduction and missing individual injection events. The target wheel slip level is set by a driver adjustable potentiometer connected to Linear Input 5 (which must be selected as 'TC Target Slip %' in ECU Configuration). The current target percentage slip level can be viewed on the Gauges page 'Traction Control'.



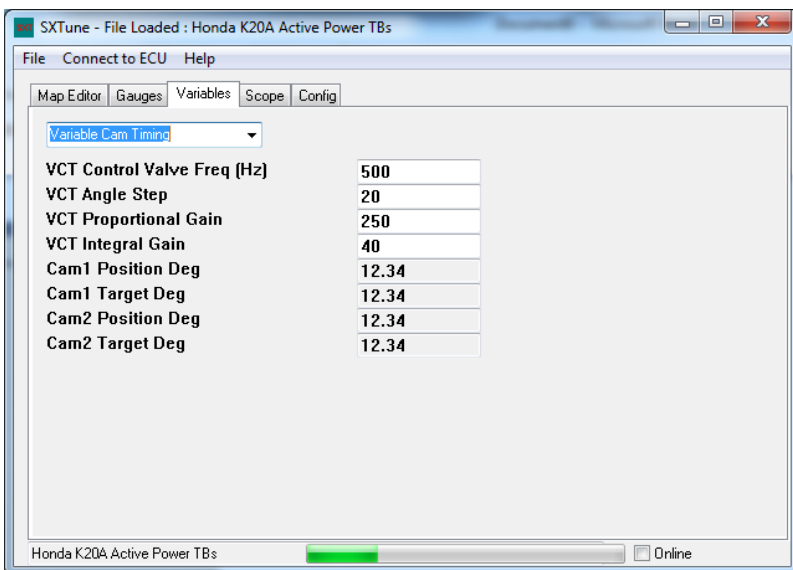
The Traction Control variables page contains the following functions:

- Traction Control Function – drop down box to select the traction control function as either rear wheel drive (RWD) or front wheel drive (FWD)
- Minimum slip activate TC % - the minimum slip percentage between the driven and undriven wheels to enable traction control
- TC proportional gain (%) – the proportional gain term of the TC PI (proportional-integral) controller
- TC minimum spark advance (%) – the TC PI controller generates a percentage of the final spark advance term. This value clamps the minimum spark advance percentage.
- Number of rear wheel sensor teeth – the number of trigger teeth on the rear wheel trigger wheels
- Number of front wheel sensor teeth – the number of trigger teeth on the front wheel trigger wheels
- Rear wheel circumference (mm) – the rolling circumference of the rear wheels in millimetres
- Front wheel circumference (mm) – the rolling circumference of the front wheels in millimetres
- TC Minimum Engine Speed (rpm) – engine speed value below which TC will be disabled
- TC Integrator time base (ms) – the integral time base of the TC PI (proportional-integral) controller

Variable Cam Timing



Typhoon and Tornado feature dual variable camshaft timing control. This can be used as either inlet and exhaust camshaft control on an inline engine or dual inlet camshaft control on a vee engine. Target camshaft position is calculated from a map of load (TPS or MAP) and engine speed. Closed loop control is achieved by means of a proportional-integral controller, the gains of which can be set in the 'Variable Cam Timing' variables page.



This page contains variables relating to the variable valve timing control strategy. It is broken down into:

- VCT Control Frequency – Sets the piloting frequency in Hz for the variable cam timing oil control valve
- VCT Angle Step – Sets the set point increment filter for the VCT PI controller. Larger values reduce the amount of filtering
- VCT Proportional Gain – Sets the proportional gain of the VCT PI controller

- VCT Integral Gain – Sets the integral gain of the VCT PI controller

Engine Log Book

Throttle Position 0-1.5% (hours)	12.34	Manifold Pressure 150-200kPa (hours)	12.34
Throttle Position 1.5-15% (hours)	12.34	Manifold Pressure 200-250kPa (hours)	12.34
Throttle Position 15-25% (hours)	12.34	Manifold Pressure 250-300kPa (hours)	12.34
Throttle Position 25-35% (hours)	12.34	Coolant Temp 105-110°C (hours)	12.34
Throttle Position 35-50% (hours)	12.34	Coolant Temp 110-115°C (hours)	12.34
Throttle Position 50-65% (hours)	12.34	Coolant Temp 115-120°C (hours)	12.34
Throttle Position 65-80% (hours)	12.34	Coolant Temp >120°C (hours)	12.34
Throttle Position 80-100% (hours)	12.34	Oil Temperature 140-145°C (hours)	12.34
Engine Speed 1000-2000rpm (hours)	12.34	Oil Temperature 145-150°C (hours)	12.34
Engine Speed 2000-3000rpm (hours)	12.34	Oil Temperature 150-155°C (hours)	12.34
Engine Speed 3000-4000rpm (hours)	12.34	Oil Temperature >155°C (hours)	12.34
Engine Speed 4000-5000rpm (hours)	12.34	Maximum Engine Speed 1 (rpm)	12.34
Engine Speed 5000-6000rpm (hours)	12.34	Maximum Engine Speed 2 (rpm)	12.34
Engine Speed 6000-7000rpm (hours)	12.34	Maximum Engine Speed 3 (rpm)	12.34
Engine Speed 7000-8000rpm (hours)	12.34	Maximum Engine Speed 4 (rpm)	12.34
Engine Speed 8000-9000rpm (hours)	12.34	Maximum Engine Speed 5 (rpm)	12.34
Vehicle Speed 0-30km/h (hours)	12.34	Total Engine Life (hours)	12.34
Vehicle Speed 30-60km/h (hours)	12.34		
Vehicle Speed 60-90km/h (hours)	12.34		
Vehicle Speed 90-120km/h (hours)	12.34		
Vehicle Speed 120-150km/h (hours)	12.34		
Vehicle Speed 150-180km/h (hours)	12.34		
Vehicle Speed 180-210km/h (hours)	12.34		
Vehicle Speed 210-240km/h (hours)	12.34		
Manifold Pressure 0-25kPa (hours)	12.34		
Manifold Pressure 25-50kPa (hours)	12.34		
Manifold Pressure 50-75kPa (hours)	12.34		
Manifold Pressure 75-100kPa (hours)	12.34		
Manifold Pressure 100-150kPa (hours)	12.34		

The engine log book provides min/max and time spent at/above values for a variety of parameters. It also stores the 5 highest engine speeds attained to allow quick identification of engine over rev. It can be reset at any time by clicking the 'Reset Logbook' button.

Map Functions

Listed below is a breakdown of the Groups and Maps within each Group is listed below along with a brief explanation of the function of each Map.

Acceleration Fuelling: The acceleration fuelling group contains the maps which control acceleration fuelling

- Acceleration Fuel Coolant Temp Factor: This map allows the amount of fuel injected under acceleration conditions to be varied by coolant temperature. The map values are multipliers applied to the transient fuelling calculation
- Acceleration Fuel Decay Factor: This map allows the decay factor of the additional fuel delivered under acceleration conditions to be varied by RPM.
- Acceleration Fuel RPM Multiplier: This map allows the amount of fuel injected under acceleration conditions to be varied by engine RPM. The map values are multipliers applied to the base fuel map.

Alternate Maps: (Tornado 2 Only) Alternate maps are available to be selected via an external switch (when enabled in ECU configuration) for the following functions

- Boost Control Base Duty Cycle (%)
- Boost Control Target Manifold Pressure (mBar)
- Fuel Injection Pulse Width (ms)
- Spark Advance (deg)
- Target Throttle Position (%)

Auxiliary Functions: The Auxiliary functions group contains the maps which control auxiliary functions such as coolant gauge drive and rev limiter.

- Coolant Temp Gauge DC (%) – controls the PWM output % relative to engine temperature. This map is used for calibrating a PWM/Aux Output used to drive an OEM coolant temperature gauge.
- Rev Limiter (rpm) – controls the engine RPM limiter relative to engine temperature.

Base Mapping: The base mapping group contains the main fuel and ignition maps

- Main Fuel Injection Pulse Width (ms): This map allows the amount of injected fuel to be varied to suit engine requirements. All values are in milliseconds. The map is a function of engine speed and either throttle position or manifold pressure
- Main Spark Advance (deg): This map allows the amount of ignition advanced to be varied to suit the engine requirements. All values are in degrees before top dead centre. The map is a function of engine speed and either throttle position or manifold pressure
- Staged Injection Percentage Split (%) (**Tornado 2 Only**): This map controls the split of fuelling between the lower and upper injectors. The values are in percentage of upper injectors, therefore 0% is all the fuel delivered by the lower injectors and 100% is all the fuel delivered by the upper injectors

Boost Control: The boost control group contains the maps required for the closed loop boost control system.

- Boost Control Base Duty Cycle (%) – controls the base duty cycle of the boost control valve relative to engine RPM and throttle position
- Boost Control Target Manifold Press (mBar) – sets the target inlet manifold pressure relative to engine RPM and throttle position
- Boost Valve Integral Gain (%) – controls the integral gain of the PI closed loop boost controller applied to the boost control valve relative to the difference between the actual manifold pressure and the target manifold pressure
- Boost Valve Proportional Gain (%) - controls the proportional gain of the PI closed loop boost controller applied to the boost control valve relative to the difference between the actual manifold pressure and the target manifold pressure
- Gear Based Boost DC Offset (%) – modifies the base duty cycle of the boost control valve as a function of gear position
- Gear Based Boost Target Offset (mbar) – modified the target boost pressure as a function of gear position

Electronic Throttle Control (Tornado Only): The electronic throttle control group contains the maps for the electronic throttle (drive-by-wire) system.

- Feed Forward Voltage (V) – sets the open loop voltage applied to the throttle motor as a function of throttle position. It is used to compensate for the spring forces on the throttle.
- Target Throttle Position (%) – sets the target throttle position as a function of accelerator pedal position and engine speed.
- Throttle Blip Time (ms) – enables a throttle blip for downshift rev matching, this map sets the time for the throttle blip in ms as a function of gear position
- Throttle Blip TPS Request (%) – sets the amount of throttle blip for downshift rev matching as a function of gear position

Fuel Closed Loop Control: This group contains the maps related to closed loop fuel control strategies.

- Auto Mapping Corrections (%) (**Typhoon 2/Tornado 2 Only**) – This map is filled in by the ECU automatically as part of the lambda auto mapping strategy. The map breakpoints are copied automatically from the main fuel injection pulse width map. If auto mapping is enabled, as the fuel closed loop control 'learns' the required fuelling correction for each breakpoint, the cells are automatically filled in by the ECU with the required correction values.
- Lambda Integral/Proportional Steps Lean to Rich and Rich to Lean – These 4 maps set the step sizes for the narrowband lambda PI control strategy. Only change these values if you are an experienced user looking to improve emissions and catalyst efficiency.
- Closed Loop Control Start Time (sec) – control the time after engine start-up that closed loop fuel control will become active relative to coolant temperature.
- Lambda Proportional Gain (%) – controls the proportional gain applied to the closed loop fuel control strategy based on the difference between the current lambda and the target lambda value. This map applies to wideband lambda fuelling control only.
- Wideband Target Lambda – sets the target lambda based on throttle position and engine speed

Fuel Correction Factors: This group contains the maps related to fuel correction factors such as Inlet Air Temperature and Barometric correction factors:

- Cranking Fuel Injection Multiplier – controls the multiplier applied to the base fuel map under cranking conditions. The axes are coolant temperature and number of crank revolutions since engine start.
- Air Temp Multiplier – controls the multiplier applied to the base fuel map based on current inlet air temperature. This map is used to compensate for changes in air density due to temperature changes.
- Injector Dead Time Correction (ms) – controls the time added to the base fuel map injector pulse width to take into account injector latency under differing battery/vehicle voltages.
- Coolant Temp Multiplier - controls the multiplier applied to the base fuel map based on current engine coolant temperature for cold starting compensation.
- Initial Prime Pulse Width (ms) – controls the length of time the injectors will fire for when the first crank tooth passes the sensor, dependant on engine coolant temperature. Used to wet the inlet manifold and reduce start time.
- Fuel Injection Timing (deg BTDC) – controls the degrees before top dead centre at which the injectors will be fired.
- Baro Correction Multiplier – controls the multiplier applied to the base fuel map dependant on barometric pressure. Used for altitude compensation and only applied when Throttle Position is selected as the primary load input.
- Fuel Pressure Multiplier – controls the multiplier applied to the base fuel map dependant on fuel pressure (only enabled when fuel pressure sensor is selected as an optional input in 'ECU Configuration')
- MAP Connection Multiplier - controls the multiplier applied to the base fuel map dependant on manifold air pressure. This map can be useful when calibrating turbocharged or supercharged engines with individual throttle bodies and aggressive camshaft profiles. If a stable MAP signal is not possible then the engine can use throttle position as the primary load input while using the MAP correction factor as a 'boost correction' to increase the fuelling under boost conditions.

Idle Speed Control: This group contains the maps related to idle speed control.

- Idle Air Valve Dashpot (%) - this map controls the amount of idle air valve opening in response to the difference between actual engine speed and target idle speed
- Idle Air Valve AC Offset (%) – adds an offset to the idle air valve duty cycle to compensate for the load of an air conditioning compressor.
- Idle Air Valve Cooling Fan 1/2 Offset (%) – adds an offset to the idle air valve duty cycle to compensate for the electrical load of cooling fans.
- Idle Air Valve Integral Gain (%) - controls the integral gain applied to the idle control valve PI closed loop controller relative to the difference between the actual RPM is from target RPM.
- Idle Air Valve Position (%) - controls the base idle air valve position (duty cycle) based on crank counts and engine coolant temperature.
- Idle Air Valve Proportional Gain (%) - controls the proportional gain applied to the idle control valve PI closed loop controller relative to the difference between the actual RPM is from target RPM.
- Idle Control Base Spark Advance (deg) – controls the idle speed base spark advance dependant on engine coolant temperature. This value is the base spark advanced under idle conditions (the base map value is NOT used)
- Idle Control Proportional Spark Advance (deg) – Controls the amount of spark advanced added/subtracted based on the difference between the actual RPM is from target RPM.
- Target Idle Speed (rpm) – Sets the desired target idle speed based on engine coolant temperature.

Ignition Correction Factors: This group contains maps related to ignition corrections factors:

- Cranking Spark Advance (deg) – This map controls the amount of spark advance applied under cranking conditions based on engine coolant temperature.
- Ignition Coil Dwell (ms) – Sets the ignition coil dwell (on time) based on engine speed and battery voltage. This map should be set for the ignition coil being used. It is important that the correct amount of dwell is applied to the ignition coil. Too little dwell can cause incomplete combustion or misfiring. Too much dwell can damage the coil and/or the ECU.

- Spark Advance Air Temp Offset (deg) – Controls the amount of spark advanced added/subtracted under differing inlet air temperature conditions.

Individual Cylinder Trims: This group contains 8 maps of injection trims and 8 maps of ignition trims:

- Cylinder X Fuel Multiplier – These maps enable modification of the fuelling delivered to each cylinder as a function of throttle position and engine speed. Only enabled if 'Individual Cylinder Trims' is switched on in 'ECU Configuration'
- Cylinder X Spark Advance Offset – These maps enable modification of the ignition delivered to each cylinder as a function of throttle position and engine speed. Only enabled if 'Individual Cylinder Trims' is switched on in 'ECU Configuration'

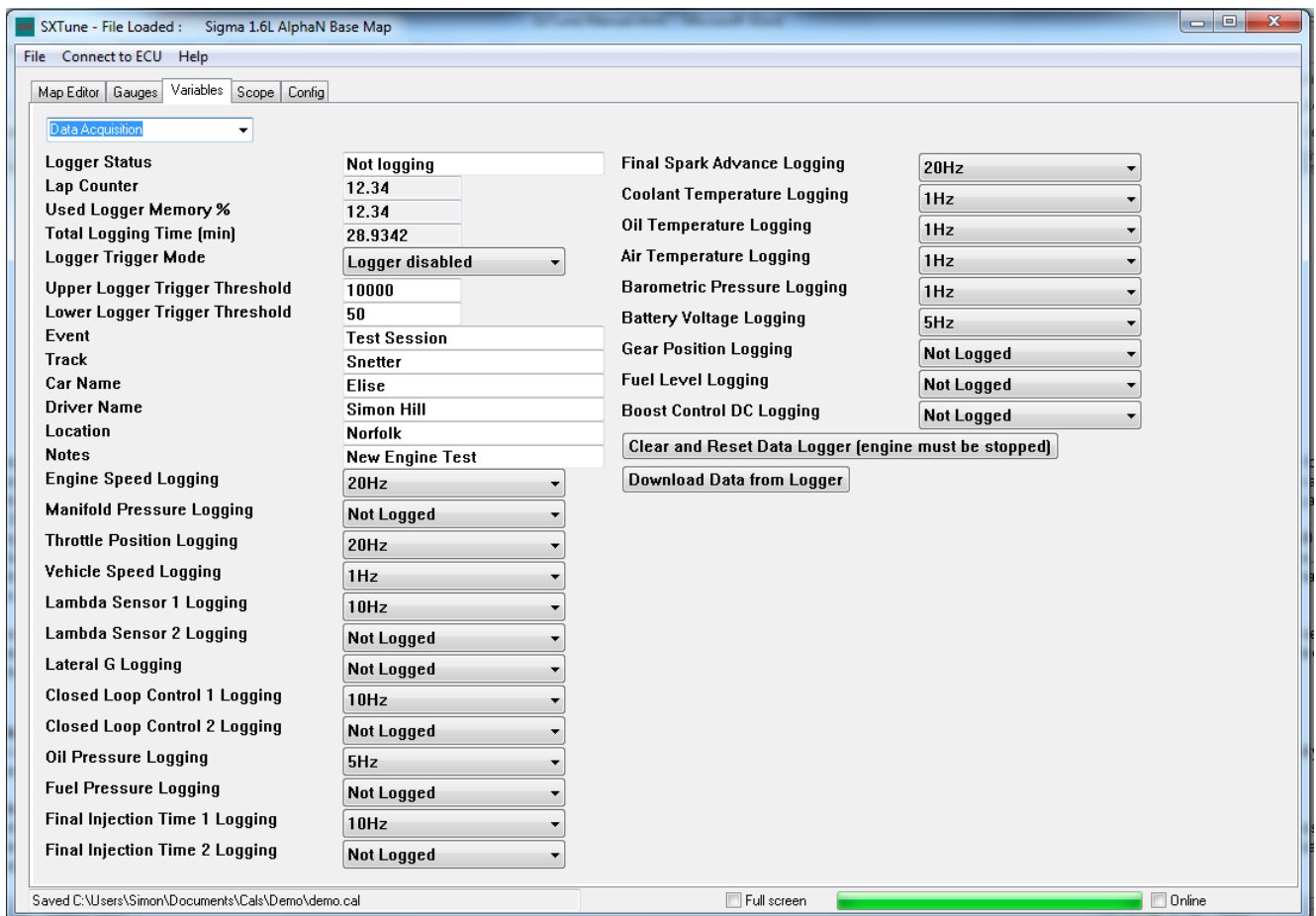
Sensor Setup: This group contains the maps related to sensor setup e.g. Inlet Air Temperature, Coolant Temperature etc.

- Air Temp Sensor Scaling (degC) – This map controls the calibration of the inlet air temperature sensor.
- Coolant Temp Sensor Scaling (degC) – This map controls the calibration of the coolant temperature sensor
- Lambda Sensor Input Scaling (V) – Controls the scaling of the wideband lambda sensor input voltage.
- Oil Temp Sensor Scaling (degC) – Controls the scaling of the oil temperature sensor.

Variable Cam Timing: This group contains the maps related to VVT inlet and exhaust cam position.

- Target Exhaust VCT Cam Angle (deg) – Controls the desired phasing of the exhaust cam based on engine speed and throttle position or manifold pressure.
- Target Inlet VCT Cam Angle (deg) - Controls the desired phasing of the inlet cam based on engine speed and throttle position or manifold pressure

Data Acquisition



Tornado 2 and Typhoon 2 are supplied with an internal data acquisition system that can log channels up to 100Hz. Data is stored in the ECU and downloaded after each session to be viewed in the SXLogView data analysis program. It is configured and controlled directly from the 'Data Acquisition' variables page, as described below:

- Logger Status – text display showing the current logger status, i.e. if the logger is currently logging data or not.
- Lap Counter – numeric display showing the current lap number
- Used Logger Memory % - numeric display showing the percentage of logging memory that has been used
- Total Logging Time (min) – numeric display of the total amount of logging time available calculated from the currently selected number of channels and logging frequencies
- Logger Trigger Mode – drop down box to select the logger trigger type: logger disabled, engine speed triggered or vehicle speed triggered
- Upper Logger Trigger Threshold – value below which logging is enabled
- Lower Logger Trigger Threshold – value above which logging is enabled
- Event, Track, Car Name, Driver Name, Location, Notes – user editable text boxes which will be written into the data file
- Channel frequency selection – 24 drop down boxes to select the logging frequency of each channel. Any channel can be disabled by selecting 'Not Logged' **apart from 'Vehicle Speed' which must be logged**. If vehicle speed is not required select '1Hz' to minimise the amount of logger memory used.
- Clear and Reset Data – button to clear the logger's memory and reset the data logger. Can only be used when the engine is not running, pressing the button when the engine is running will have no effect.
- Download Data from Logger – button to download the data from the logger, process the data and save it to disk. **N.B.** the download of a full data logger may take up to one minute, please allow time

for this procedure to complete. The data file generated is automatically saved in the correct location with a filename created from the current date and time.

Troubleshooting

SC Engine Management Systems are fully electronic control systems and as such it is necessary that certain 'minimum' operating requirements are complied with so that the system can function correctly.

Power Supply

It is essential that the management system is supplied with a good source of electric power at all times. A minimum working voltage should be no less than 9 Volts, this is especially so during cold start cranking.

A typical four cylinder, twin coil ignition system and running the fuel pump will be drawing approximately 10 amps of electric current. In all instances, it is vital that an alternator/generator is used to re-charge and maintain good the system battery. Poor battery condition will inevitably cause poor performance and the possibility of a complete system failure.

System Ground

SC wiring harnesses are fitted with a main battery earth ring tag. Ensure that the main system earth is grounded on the engine and that any additional earth ring tags are securely grounded to the vehicle chassis with a sound return path back to the battery negative terminal.

Electrical Interference and Noise

The electronic control unit relies upon good, clean and accurate information supplied to it in the form of electrical signals from the engine sensors. To maintain the integrity of the data signals, the wiring harness needs to be carefully routed away from all sources of electrical noise, (i.e., away from ignition leads, the alternator, electric motors etc).

Ensure that the routing of the harness, especially the RPM and cam phase (if fitted) signal cables, do not run parallel to and near the high tension ignition leads.

Note: Resistive ignition leads should always be used (1000 ohms per metre).

Engine Management System Sensors

These devices present information on the engine status to the ECU. A system failure or poor running may be due to one of the engine sensors not functioning correctly, here is a check list of the engine sensors and details of how to test them.

1. Engine Speed Sensor

Generally located on the crankshaft pulley, this device sends a signal to the ECU each time a tooth from a trigger disc passes the magnetic pick-up of the sensor. The air gap between a tooth and the sensor is typically 1.0 +/- 0.2 mm. The internal resistance of this sensor - 650 +/- 100 ohms.

2. Cam Phase Sensor (if fitted)

This sensor operates in the same manner as the engine speed sensor. Typically the air gap is 0.3 - 0.4 mm. Internal resistance of this sensor - 650 +/- 100 ohms.

3. Throttle Position Sensor

Ensure that the sensor is fitted correctly and moves smoothly through its range. Monitor the voltage from the sensor in 'Variables', 'Sensor Setup'. The voltage must increase as the throttle opens, if this is reversed swap the 5V VREF and Ground wires on the sensor.

4. Air and Coolant Temperature Sensors

As the air or coolant temperature changes so accordingly the internal resistance of that sensor changes. Test, with the sensor disconnected from the wiring harness by measuring the resistance across the sensor terminals.

Typical readings from temperature sensors:-

Air temperature Sensor	3000 Ohms at 25 degrees Celsius
Coolant Temperature Sensor	3000 Ohms at 25 degrees Celsius

An open or closed circuit indicates a faulty temperature sensor.

6. Air Pressure Sensor (optional)

To test, measure the potential difference across connector pin 1 and pin 2 with the connector fitted to the sensor and the ignition switched on. Typical readings at standard atmospheric pressure at sea level - 1013mBar

Diagnostic Routines

The following diagnostic routines serve as useful indications in the event of a system failure and help to advise corrective action.

If the engine fails to start:

Check that you have fuel and a charged battery. The engine must rotate at a minimum of 150rpm during cranking with greater than 9V at the ECU for the engine to start successfully.

To check the ECU is functioning correctly:

When turning on the ignition, the fuel pump runs for a few seconds.

If not, check the following:

The systems fuses are sound, the main relay - 15 amp fuse and the pump relay 10 amp fuse.

That you have 12 volts ignition switched at the white wire and the system 12 volt connection to battery (red wire).

All the system grounds (black wires) are secured to the engine or chassis and have a good ground return path to the battery negative terminal.

Check the 35 way ECU connector and terminals are fitted correctly, i.e. secured and latched into the ECU connector and socket.

N.B.: Do not disconnect the ECU with the ignition switched on as this may cause damage to the ECU electronics

Other Possible Causes of Poor Performance

Connectors and Terminals

Inspect all connectors for pins that may have been pushed out into the back of the connector. Also check that the wires have not become separated from the pins. Ensure that all connectors and terminals are securely fitted to their appropriate devices.

Wiring Harness

Examine the wiring harness along its route for signs of chaffing, especially where the harness passes through bulkheads and where it makes contact with components, at corners and other possible sharp edges.

Throttle Bodies

Air flow through throttle bores on multi throttle installations should be balanced with a syncrometer at both idle and out of idle conditions.

CANBus

Controller Area Network (CAN or CAN-bus) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host. Typhoon and Tornado use industry standard CAN 2.0B at speeds of 1Mb, 500kb and 250kb for communication with dash displays, data loggers and PC's via the USB-CAN interface.

The CAN Data Export for Typhoon and Tornado is shown below. Please note this data export is common across Typhoon and Tornado. The data export is required for configuration of dash displays, data loggers and other devices you wish to share data with via the CANBus.

CODE	Name	Description	Unit	Data Type	Position	Update Frequency (Hz)	Engineering Scaling
300	RPM	Engine Speed	rpm	unsigned short	Byte0-0x00, Byte1-0x00	50	1rpm/bit
	TPB	Throttle Position	%	unsigned char	Byte2		0-0%, 255=100%
	Max. Used			unsigned char	Byte3		
	MAP	Manifold Air Pressure	mmHg	signed short	Byte4-0x00, Byte5-0x00		1mmHg/bit
301	Max. Used			unsigned short	Byte6-0x00, Byte7-0x00		
	dThrot	Delta Throttle Position		signed short	Byte0-0x00, Byte1-0x00	50	
	Max. Used			unsigned short	Byte2-0x00, Byte3-0x00		
AC	Acceleration G-sensors	u/s	unsigned short	Byte4-0x00, Byte5-0x00	1 u/s/bit		
302	DC	Deceleration G-sensors	u/s	unsigned short	Byte6-0x00, Byte7-0x00		1 u/s/bit
	MMH	Wheel Speed	kph	unsigned short	Byte0-0x00, Byte1-0x00	50	0.1kph/bit
	DCSusable	Usable Duty Cycle	%	unsigned short	Byte2-0x00, Byte3-0x00		0-0%, 255=100%
	IdleCua	Final Idle Duty Cycle	%	unsigned short	Byte4-0x00, Byte5-0x00		0-0%, 255=100%
Max. Used			unsigned short	Byte6-0x00, Byte7-0x00			
303	INOT Angle	Inte. Case Position Angle	deg	signed short	Byte0-0x00, Byte1-0x00	50	0.25 deg/bit
	GNOT Angle	Extens. Case Position Angle	deg	signed short	Byte2-0x00, Byte3-0x00		0.25 deg/bit
	NOT Angle Target	Target Inte. Case Position	deg	unsigned char	Byte4		0.25 deg/bit
	ENOT Angle Target	Target Extens. Case Position	deg	unsigned char	Byte5		0.25 deg/bit
	DRW_TPB1	Driveby wire pressure TPB	%	signed short	Byte6-0x00, Byte7-0x00		0-0%, 1023=10.0%
304	DirectPW	Direct Injection Pulse Width	u/s	unsigned short	Byte0-0x00, Byte1-0x00	35	1 u/s/bit
	RunPW	Final Injection Pulse Width	u/s	unsigned short	Byte2-0x00, Byte3-0x00		1 u/s/bit
	BAJ adv	Base Spark Advance	deg	signed short	Byte4-0x00, Byte5-0x00		0.25 deg/bit
	BAOL	Final Spark Advance	deg	signed short	Byte6-0x00, Byte7-0x00		0.25 deg/bit
305	Lambda	Actual Measure Lambda		unsigned char	Byte0	35	0+0.00, 255=2.00
	TargetLambda	Target Lambda		unsigned char	Byte1		0+0.00, 255=2.00
	HPFuelLearn	Fuel Learn Value	%	signed short	Byte2-0x00, Byte3-0x00		0.00%/bit
	OLC	Closed Loop Control Value	%	signed short	Byte4-0x00, Byte5-0x00		0.00%/bit
	TPBWReq	Driveby wire target TPB	%	signed short	Byte6-0x00, Byte7-0x00		0-0%, 1023=10.0%
306	Gear	Gear Position		unsigned char	Byte0	35	
	DirectClosed	Direct closed Duty Cycle	%	unsigned char	Byte1		0-0%, 255=100%
	DirectCua	Final Direct Duty Cycle	%	unsigned short	Byte2-0x00, Byte3-0x00		0-0%, 255=100%
	OILP	Oil Pressure	MPa	unsigned short	Byte4-0x00, Byte5-0x00		0.00MPa/bit
	FuelP	Fuel Pressure	MPa	unsigned short	Byte6-0x00, Byte7-0x00		0.00MPa/bit
307	Servo	Servo Air Pressure	mmHg	unsigned short	Byte0-0x00, Byte1-0x00	35	1 mmHg/bit
	Proport	Proportional Servo Control Time		unsigned short	Byte2-0x00, Byte3-0x00		
	Integrat	Integral Servo Control Time		unsigned short	Byte4-0x00, Byte5-0x00		
	TargetProport	Target Proport. Pressure	mmHg	unsigned short	Byte6-0x00, Byte7-0x00		1 mmHg/bit
308	VBatt	Battery Voltage	V	unsigned short	Byte0-0x00, Byte1-0x00	50	0-0V, 1023=16V
	DIVBatt	Injector Battery Voltage Correction	u/s	unsigned short	Byte2-0x00, Byte3-0x00		1 u/s/bit
	Phase	Injector Timing Phase	deg	unsigned char	Byte4		0.25 deg/bit
	CompCorr	Compens. Touch Counter		unsigned char	Byte5		
309	Devail	Oil Drail Time	u/s	unsigned short	Byte6-0x00, Byte7-0x00		1 u/s/bit
	Throt	Raw Throttle Position Voltage	V	unsigned short	Byte0-0x00, Byte1-0x00	50	0+0V, 1023=5V
	PPB1	Raw Pedal Position 1 Voltage	V	unsigned short	Byte2-0x00, Byte3-0x00		0+0V, 1023=5V
	PPB2	Raw Pedal Position 2 Voltage	V	unsigned short	Byte4-0x00, Byte5-0x00		0+0V, 1023=5V
	TPB1	Raw Throttle Position 1 Voltage	V	unsigned short	Byte6-0x00, Byte7-0x00		0+0V, 1023=5V
TPB2	Raw Throttle Position 2 Voltage	V	unsigned short	Byte0-0x00, Byte1-0x00	0+0V, 1023=5V		
30A	TPBPPBFail	Throttle/Pedal Fault Code		unsigned char	Byte2	50	
	PPB	Booted Pedal Position	%	unsigned char	Byte3		0-0%, 255=100%
	PPB1	Booted Pedal Position 1	%	unsigned char	Byte4		0-0%, 255=100%
	PPB2	Booted Pedal Position 2	%	unsigned char	Byte5		0-0%, 255=100%
	TPB1	Booted Throttle Position 1	%	unsigned char	Byte6		0-0%, 255=100%
	TPB2	Booted Throttle Position 2	%	unsigned char	Byte7		0-0%, 255=100%
30B	THC0	Coolers Temp sensor	deg C	unsigned char	Byte0	50	0-10 deg C, 255=150 deg C
	TC01	Oil Temp sensor	deg C	unsigned char	Byte1		0-10 deg C, 255=150 deg C
	HPFuelCnk	Crank Fuel Correction	%	unsigned char	Byte2		0-0% 2.05=+0.00%
	TAIR	Air Temperature	deg C	unsigned char	Byte3		0-10 deg C, 255=150 deg C
	THC01	Raw Coolers Temp Sensor Voltage	V	unsigned short	Byte4-0x00, Byte5-0x00		0+0V, 1023=5V
	TC01	Raw Oil Temp Sensor Voltage	V	unsigned short	Byte6-0x00, Byte7-0x00		0+0V, 1023=5V
30C	ERunTimer	Engine Run Timer	s	unsigned short	Byte0-0x00, Byte1-0x00	50	0.00s/bit
	TAIR	Raw Air Temp Sensor Voltage	V	unsigned short	Byte2-0x00, Byte3-0x00		0+0V, 1023=5V
	Lambda1	Raw Lambda Sensor Voltage	V	unsigned short	Byte4-0x00, Byte5-0x00		0+0V, 1023=5V
	HPFuelTHC0	Coolers Temp Fuel Correction	%	unsigned char	Byte6		0-0% 2.05=+0.00%
	HPFuelTAIR	Air Temp Fuel Correction	%	unsigned char	Byte7		0-0% 2.05=+0.00%
30D	CnkCnk	Crank Rotation Counter		unsigned short	Byte0-0x00, Byte1-0x00	50	1 rev/bit
	HPFuelServo	Servo Pressure Fuel Correction	%	unsigned char	Byte2		0-0% 2.05=+0.00%
	Max. Used			unsigned char	Byte3		
	CAT Air	Air Temp Spark Advance Correction	deg	signed short	Byte4-0x00, Byte5-0x00		0.25 deg/bit
	RPM Targetable	Target Idle Speed	rpm	unsigned short	Byte6-0x00, Byte7-0x00		1rpm/bit