TunerStudio MS Lite Reference

Megasquirt-3 Product Range

MS3 1.3.x

Dated: 2015-06-16

MS3 Firmware Version: 1.3.4

Reference manual for using TunerStudio with your Megasquirt-3 ECU.

This version of the documentation applies to the Megasquirt-3 range of products which includes:

- MS3 using the V3.0 or V3.57 mainboards;
- MS3-Pro
- Products derived from the MS3-Pro Module, e.g.,MSPNP-Pro

Applies to firmware MS3 1.3.x

MS3-Pro customers may prefer to use the MS3-Pro manuals.

This version of the documentation ***DOES NOT*** apply to:

- Megasquirt-1;
- EMS Pro;
- Megasquirt-2;
- Microsquirt
- Microsquirt-module or any products using it.

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Table of Chapters

1 Introduction....10
2 File Menu....25
3 Options Menu....41
4 Data Logging Menu....45
5 Communications Menu....67
6 Tools Menu....71
7 Help Menu....78
8 Basic / Load Settings....79
9 Fuel Settings....109
10 Ignition Settings....136
11 Startup / Idle....156
12 Accel Enrich....175
13 Boost / VVT....187
14 Table Choices....207
15 Advanced Engine....217
16 3D Maps....248
17 CAN bus / Testmodes....255
18 Upgrade....279
19 Dashboard Gauge Cluster....280
20 Dashboard Indicators....295
21 Diagnostics & High Speed Loggers....301
22 Tune Analyze Live....306
23 Megasquirt Glossary of Terms....307
24 Revision history....314

Contents

1 Introduction....10
1.1 Overview....10
1.2 Prerequisites....10
1.3 How to Use This Guide....10
1.4 TunerStudio MS Lite Interface....11
1.4.1 Start Screen....11
1.4.2 Main Screen....12
1.4.3 Lite and Upgrade Versions of TunerStudio....13
1.5 Using the Software Interface....14
1.5.1 Data Input Screens....14
1.5.2 Curves....16
1.5.3 3D Tables....18
1.5.4 3D Tuning Maps....20
2 File Menu....25
2.1 Project....25
2.1.1 New Project....25
2.1.2 Open Project....32
2.1.3 Close Project....32
2.1.4 Export Project Archive....32
2.1.5 Import Project Archive....32
2.1.6 Project Properties....33
2.2 Tune Restore Point Dialog....37
2.3 Open Tune....37
2.4 Save Tune....38
2.5 Save Tune As....38
2.6 Gauge Cluster....39
2.6.1 Background....39
2.6.2 Antialiasing Enabled....39
2.6.3 Designer Mode....39
2.6.4 Gauge Demo....39
2.7 Work Offline....39
2.8 Exit....40
3 Options Menu....41
3.1 Language....41
3.2 Look and Feel....41
3.3 Navigation....41
3.3.1 Main Menu Style....41
3.3.2 Wrapping Main Menu....41
3.3.3 Toolbar Style....42
3.3.4 Navigation Options....42
3.4 View....42
3.4.1 Show Gauges on VE Analyze....42
3.4.2 Show Live Graphs on VE Analyze....42
3.4.3 Show Enable Condition in Menu Tooltips....42
3.5 Advanced....42
3.5.1 Report INI Warnings....42
3.5.2 Always Allow Multiple Instances....42
3.6 Preferences....43
3.6.1 Set Dialog Font Size....43
3.6.2 Perform Difference Report on Connect....43
3.6.3 Automatically Load and Save Current Tune....43
3.7 Performance....44
3.7.1 Gauge Float down on start....44

3.7.2 Modal Dialogs....44
3.7.3 Run in Lite Mode....44
4 Data Logging Menu....45
4.1 Start Logging....45
4.2 Stop....45
4.3 Logging Profiles....45
4.4 Automatic Logging....45
4.5 Import / Conversion....46
4.5.1 PalmLog Import Utility....46
4.5.2 Convert Binary Log (MS3, FRD)....46
4.6 View with MegaLogViewer....47
4.6.1 MegaLogViewer Datalog Fields....49
4.7 SDcard datalogging....63
4.8 Browse/Import SDcard....65
5 Communications Menu....67
5.1 Settings....67
5.2 Data Rate....67
5.3 Enable GPS Support....68
5.4 Mini Terminal....68
5.5 Debug Log Comm....69
5.6 Megasquirt Baud Rate....69
6 Tools Menu....71
6.1 Protocol Stats....71
6.2 TunerStudio Plug-ins....71
6.3 Calibrate TPS....71
6.4 Calibrate MAP / Baro....71
6.5 Calibrate Battery Voltage....73
6.6 Un/Lock calibrations....73
6.7 Calibrate Thermistor Tables....74
6.8 Calibrate AFR Table....75
6.9 Calibrate MAF Table....76
7 Help Menu....78
7.1 TunerStudio Help....78
7.2 Check for Update....78
7.3 Automatic Update Check....78
7.4 Enter Registration....78
7.5 About....78
7.6 Megasquirt 3 Info....78
8 Basic / Load Settings....79
8.1 Engine and Sequential Settings....79
8.1.1 Required Fuel Settings....79
8.1.2 Sequential Injection Settings....80
8.2 General Settings....81
8.2.1 Baro Sensor Settings....82
8.2.2 MAP Sensor Settings....83
8.2.3 General Sensor Settings....83
8.2.4 Load Parameters....84
8.3 Rev Limiter....85
8.3.1 Hard Rev Limit....85
8.3.2 Coolant Temp Limiter....86
8.3.3 Spark Retard....86
8.3.4 Spark Cut and Fuel Cut....86
8.4 Shift Light....87
8.5 Tacho Output....88
8.6 Fan Control....89
8.7 Torque Convertor Lockup....91
8.8 Alternator Control....93

8.9 Barometric Correction....95
8.10 MAP Sample Settings....96
8.11 ITB Load Settings....97
8.12 MAF Settings....98
8.13 MAF Flow Curve....99
8.14 MAF Correction Table (Old)....100
8.15 MAF/MAT Correction Table....101
8.16 MAT Air Density Table....102
8.17 MAT / CLT correction....102
8.18 Real-Time Display....103
8.19 Feature List Showing I/O Pins....105
8.20 I/O pins List Showing Usage....105
8.21 Expansion I/O pins List/Usage....106
8.22 Gauge and Settings Limits....107
9 Fuel Settings....109
9.1 Injector Dead-time / PWM....109
9.2 Injector Small Pulsewidths....110
9.3 Injector Timing Tables....111
9.4 Staged Injection....113
9.5 Fuel Sensor Settings (Flex)....115
9.6 Over-Run Fuel Cut....117
9.7 AFR/EGO Control....119
9.8 AFR Tables (1 and 2)....122
9.9 EGO Authority Table....122
9.10 EGO Delay Table....123
9.11 Narrowband EGO Targets....123
9.12 AFR Safety System....124
9.13 Fuel VE Tables (1 to 4)....126
9.14 Injector Trim Tables....127
9.15 Sequenced Batch Fire....128
9.16 Fuel Pump and Pressure....129
9.17 Temperature Adjustment....132
9.18 Pressure Adjustment....133
9.19 Fuel Pressure Safety....133
9.20 Fuel calculations Summary....135
10 Ignition Settings....136
10.1 Ignition Options / Wheel Decoder....136
10.2 Trigger Wizard....141
10.3 Dwell Battery Correction....141
10.4 Dwell vs RPM....142
10.5 Dwell Table....142
10.6 Cold Advance....143
10.7 MAT-Based Timing Retard....143
10.8 Noise Filtering....144
10.8.1 Primary Tach (crank)....145
10.8.2 Secondary Tach (cam)....145
10.9 Knock Sensor Settings....146
10.10 Knock Sensor Parameters....148
10.11 Knock Window Settings....150
10.12 Knock Coolant Scaling....151
10.13 Ignition Tables (1 to 4)....151
10.14 Rotary Settings....152
10.15 Rotary Split Table....153
10.16 Spark Trim Tables....153
10.17 Spark Calculations Summary....154
11 Startup / Idle....156
11.1 Cranking / Startup settings....156

11.2 Priming Pulse....157
11.3 Cranking Pulse %....157
11.4 Cranking Taper Curve....158
11.5 AfterStart Enrichment (ASE)....158
11.6 AfterStart Enrichment (ASE) Taper....159
11.7 Warmup Enrichment (WUE)....159
11.8 Priming Pulse 2....160
11.9 Cranking Pulse 2....160
11.10 AfterStart Enrichment (ASE) 2....160
11.11 AfterStart Enrichment (ASE) Taper 2....160
11.12 Warmup Enrichment (WUE) 2....160
11.13 Idle Control....160
11.13.1 Stepper idle....162
11.13.2 PWM idle....162
11.14 Idle Cranking Duty / Steps....163
11.15 Idle Warmup Duty / Steps....164
11.16 Closed-Loop Idle settings....165
11.16.1 Closed-Loop Idle Settings....165
11.16.2 Closed-Loop Idle PID Gains....166
11.16.3 Closed-Loop Idle PID Delays and Behavior....166
11.16.4 Closed Loop Idle PID activation Settings....167
11.17 Closed-Loop Idle Target RPM Curve....168
11.18 Closed-Loop Idle Initial Values....168
11.19 PWM Idle Voltage Compensation....169
11.20 Air Conditioning Idle-up....169
11.21 Idle Advance Settings....171
11.22 Idle RPM Timing Correction Curve....173
11.23 Idle VE Settings....173
12 Accel Enrich....175
12.1 Accel Enrich Settings....175
12.2 Time-Based Accel Enrichment....176
12.3 Accel-pump Accel Enrichment Settings....178
12.4 TPS WOT curve....179
12.5 EAE Adhere-to-walls Coefficient....180
12.6 EAE Sucked-from-walls Coefficient....180
12.7 EAE Adhere-to-walls RPM Correction....181
12.8 EAE Sucked-from-walls RPM Correction....181
12.9 EAE Adhere-to-walls CLT Correction....182
12.10 EAE Sucked-from-walls CLT Correction....182
12.11 EAE Adhere-to-walls Coefficient 2....182
12.12 EAE Sucked-from-walls Coefficient 2....183
12.13 EAE Adhere-to-walls RPM Correction 2....183
12.14 EAE Sucked-from-walls RPM Correction 2....183
12.15 EAE Adhere-to-walls CLT Correction 2....183
12.16 EAE Sucked-from-walls CLT Correction 2....183
12.17 Puddling Factors (accel)....183
12.18 Puddling Factors (decel)....184
12.19 Time Factors (accel)....184
12.20 Time Factors (decel)....185
12.21 X (Puddling) Temp. Corrections....186
12.22 Tau (time) Temp. Corrections....186
13 Boost / VVT....187
13.1 Boost Control Settings....187
13.1.1 Overboost Protection Settings....189
13.1.2 Boost Switching Settings....189
13.2 Boost Control Duty Table....191
13.3 Boost Control Target Table....192

13.4 Boost Control Initial Duty Table 1....192
13.5 Boost Delay (Timed From Launch)....193
13.6 Boost Control vs Speed....193
13.7 Boost Control Settings 2....194
13.8 Boost Control Duty Table 2....196
13.9 Boost Control Target Table 2....196
13.10 Boost Control Initial Duty Table 2....196
13.11 Turbo Anti-Lag (ALS)....196
13.12 Turbo Anti-Lag Tables....199
13.13 Turbo Anti-Lag Roving Idle....200
13.14 VVT Settings....201
13.14.1 VVT Settings....201
13.14.2 PID Parameters....203
13.14.3 Test....203
13.14.4 Cam Settings....203
13.15 VVT Intake Table....205
13.16 VVT Exhaust Table....205
13.17 VVT On/Off Table....206
14 Table Choices....207
14.1 Table Switch/Dual Fuel....207
14.1.1 Table Switching....207
14.1.2 Dual Fuel....209
14.2 Temperature Adjustment....211
14.3 Pressure Adjustment....212
14.4 Alt. Injector Dead-time/PWM 2....212
14.5 Alt. Injector Small Pulsewidths 2....212
14.5.1 Blend Curve 1....213
14.5.2 Blend Curve 2....213
14.5.3 Blend Curve 3....214
14.5.4 Blend Curve 4....214
14.5.5 Blend Curve 5....215
14.5.6 Blend Curve 6....215
14.5.7 Blend Curve 7....216
15 Advanced Engine....217
15.1 Speed and Gear Sensors....217
15.1.1 Vehicle Speed Sensor 1....217
15.1.2 Vehicle Speed Sensor 2....219
15.1.3 Vehicle Speed Sensor 3....219
15.1.4 Vehicle Speed Sensor 4....219
15.1.5 VSS output....219
15.1.6 VSSdot smoothing....220
15.1.7 Gear detection....220
15.1.8 Units....221
15.2 Shaft Speed Sensors....221
15.3 EGT/Thermocouple Settings....222
15.3.1 Configuration....222
15.3.2 Data Capture....223
15.3.3 Actions....223
15.4 Generic Sensor Inputs....223
15.5 Accelerometer Parameters....225
15.6 Traction Control....226
15.7 Traction Control - Perfect Run VSS....228
15.8 Traction Control - Perfect Run RPM....229
15.9 Traction Control - External Slip% input....230
15.10 Launch / 2-step / 3-step / T-brake....231
15.10.1 Launch Settings....231
15.10.2 Flat Shift Settings....232

15.10.3 Timed Retard....232
15.10.4 Transbrake, Throttle Stop....233
15.10.5 3-Step / Burnout Limiter....234
15.11 Timed Retard After Launch....234
15.12 Sequential Shift Cut....234
15.13 Nitrous System....236
15.13.1 General Settings....236
15.13.2 Nitrous System Stage 1....237
15.14 Water Injection....238
15.15 High Power Time Enrichment....240
15.16 Oil Pressure....241
15.17 Programmable On/Off Outputs....241
15.17.1 Output Port....242
15.17.2 Port Settings....242
15.17.3 Active Conditions....243
15.18 Generic PWM Outputs....243
15.19 Generic Closed-Loop....245
16 3D Maps....248
16.1 Fuel VE Tables [1 to 4]....248
16.2 AFR Tables [1 and 2]....249
16.3 Ignition Tables [1 to 4]....250
16.4 Rotary Split Table....251
16.5 Boost Control Duty Table....252
16.6 Boost Control Target Table....253
16.7 Injection Timing Tables [Primary and Secondary]....254
17 CAN bus / Testmodes....255
17.1 CAN Parameters....255
17.1.1 Digital Ports....256
17.1.2 PWM Outputs....257
17.1.3 CAN ADC Selection....257
17.2 CAN Broadcasting....258
17.3 CAN VSS, Gear, EGO, GPS....259
17.3.1 CAN VSS and gear selection....259
17.3.2 Innovate EGO Data Via CAN....260
17.3.3 GPS Data Via CAN....261
17.4 Real Time Clock....261
17.5 Check Engine Light....261
17.6 Limp Mode....265
17.7 Fallback MAP Table....267
17.8 Output Test Mode – Inj/Spk....268
17.8.1 Coil Testing....269
17.8.2 Injector Testing....270
17.8.3 PWM Settings....271
17.9 Output Test Mode – I/O....272
17.10 Output Test Mode – Idle Valve....272
17.11 Injector Sequential Testing....274
17.12 Inj/Spk Disabling Test Mode....275
17.12.1 Outputs Per Cylinder....275
17.13 Special Options....275
17.14 Long Term Trim Settings....276
17.15 Long Term Trim Table 1....278
18 Upgrade....279
19 Dashboard Gauge Cluster....280
19.1 TunerStudio gauges....281
19.2 AFR/EGO calculations....281
19.3 AFR/EGO inputs....281
19.4 CAN board inputs/outputs....282

19.5 Calculations 1....282
19.6 Calculations 2....284
19.7 Calculations 3....285
19.8 EGT Inputs....286
19.9 Generic Sensor Inputs....286
19.10 Outputs 1....287
19.11 Outputs 2....287
19.12 Outputs 3....288
19.13 Sensor inputs 1....288
19.14 Sensor inputs 2....290
19.15 Sensor Inputs 3....291
19.16 Sensor Inputs 4....291
19.17 VE Analyze Gauges....292
19.18 X-Code dev....292
19.19 Other Menu Items on the Gauge Pop-up Menu....294
20 Dashboard Indicators....295
20.1 Application Indicators....295
20.2 Predefined Indicators....295
20.3 Predefined Indicators with PORT_STATUS Deactivated (Default)....295
20.3.1 Predefined Indicators....295
20.3.2 Predefined Indicators 2....296
20.3.3 Predefined Indicators 3....297
20.4 Predefined Indicators with PORT_STATUS Activated....298
20.4.1 Predefined Indicators....298
20.4.2 Predefined Indicators 2....298
20.4.3 Predefined Indicators 3....299
20.4.4 Predefined Indicators 4....300
20.4.5 Predefined Indicators 5....301
20.5 Other Menu Items on the Indicator Pop-up Menu....301
21 Diagnostics & High Speed Loggers....301
21.1 Logger Type....302
21.2 Using the Loggers....304
21.3 Analyzing Data from the Loggers....305
22 Tune Analyze Live....306
23 Megasquirt Glossary of Terms....307
24 Revision history....314

1 Introduction

1.1 Overview

This guide aims to document the features of TunerStudio MS Lite, the tuning software that ships with the Megasquirt range of aftermarket ECUs (Electronic Control Units). This version of the documentation applies to the Megasquirt-3 range of products. The products in this range include:

- Megasquirt-3, often simply referred to as MS3;
- MS3-Pro;
- MS3-Gold
- Products derived from the MS3-Pro Module, e.g., MSPNP-Pro

In this guide Megasquirt will be used to refer to any of the above products unless a setting varies according to a specific Megasquirt-3 product. In this event the products will be named explicitly.

Megasquirt ECUs are designed to give enhanced flexibility in terms of engine control. They are designed for track, educational, and other off-road use. **Certain jurisdictions place environmental controls over the use of aftermarket ECUs. Please check your local legislative controls before using a Megasquirt with your engine.**

1.2 Prerequisites

In order to successfully use your Megasquirt with the software you will need the following:

- A Megasquirt connected to your engine using a viable sensor configuration;
- A PC running Windows or Linux, or an Apple running OS X;
- The appropriate Java Runtime Environment for your computer which can be downloaded free of charge from www.java.com;
- The latest versions of TunerStudio MS and MegaLogViewer MS which can be downloaded from http://www.tunerstudio.com/index.php/downloads;
- The latest firmware loaded onto your Megasquirt which can be downloaded from http://www.msextra.com/downloads.html;
- A good understanding of how your engine works and can be configured with your Megasquirt. If you need help community support is available at http://www.msextra.com.

1.3 How to Use This Guide

Depending on your engine, and your choice of configuration and sensors, you may not need to use all of the features included in TunerStudio, and so it is worth considering which sections are relevant to you. If you are setting up your Megasquirt for the first time you will find it helpful to use this document alongside the appropriate Hardware and Setting Up manuals for your product.

This guide includes a number of notes which are indicated as follows:

This symbol indicates an “Information” note.

This type of note is typically used to indicate how to enable an option within the software and other useful tips which are intended to make the software easier to use.

This symbol indicates a “Caution” note.

This type of note is typically used to indicate the order in which you should make changes in order to tune your Megasquirt most efficiently.

This symbol indicates a “Warning” note.

Configuring your Megasquirt incorrectly can potentially cause damage to your engine. In addition, working with some engine components such as ignition coils can be dangerous. Warning notes indicate specific areas where you need to exercise extreme caution.

Please do not rely on these warnings as your only criteria for taking care of yourself or your engine!!

1.4 TunerStudio MS Lite Interface

1.4.1 Start Screen

When you start the software you will initially see a splash screen from the developer (EFI Analytics) whilst the software loads, followed by a start screen similar to that shown below:

Although there are a number of options available to you from this screen, creating or opening a project is usually the next step. The top menu is discussed below in more detail, but it is worth noting that the number of options within this menu is reduced at this start screen.

The File Menu (1)

The File menu can be used to open or create a new project.

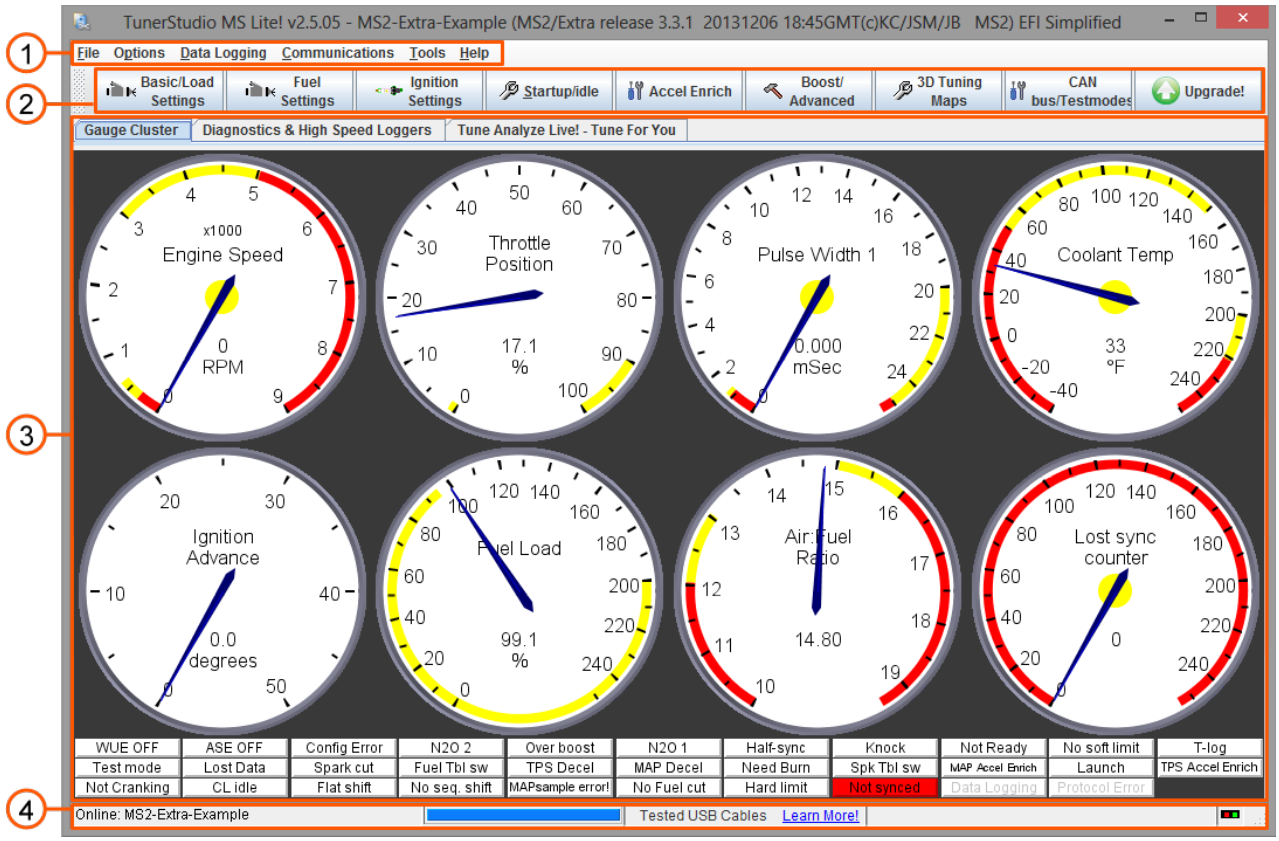
The File menu of this screen contains an Open Tune (.msq) option. This is only so that a tune can be viewed for analysis and diagnostics – you cannot connect to your Megasquirt or make changes to a tune that you open from this screen, you **must** create or open a project to do this.

Open Last Project (2)

The Open Last Project feature is a useful way to quickly access your most recent project. For more detailed information about opening or creating a project see Section 1.1 of this guide.

1.4.2 Main Screen

Once you have opened or created a project you will see the main TunerStudio screen as shown below:



Top Menu (1)

The Top Menu is documented in Sections 2. to 7. of this guide.

This menu is largely related to the software itself, specifically dealing with areas such as:

- How to create, open and backup projects and tune files;
- How to manage the behavior and appearance of the software;
- How to capture data from your Megasquirt for analysis;
- How to manage communications between your Megasquirt and TunerStudio;

- How to calibrate some of the main sensors that you will use with your Megasquirt;
- How to access TunerStudio's internal help file and obtain information about your version of TunerStudio.

Toolbar “Button” Menu (2)

The Toolbar Menu is documented in Sections 8. to 16. of this guide.

This menu contains the features through which almost all of the configuration and tuning of your Megasquirt is carried out.

Main Screen Tabs (3)

The Main Screen Tabs are documented in Sections 17. to 20. of this guide.

This area of the screen displays two sets of visual data according to the selected tab:

- The gauge cluster and associated indicator labels;
- Diagnostics and high speed loggers.

Status Bar (4)

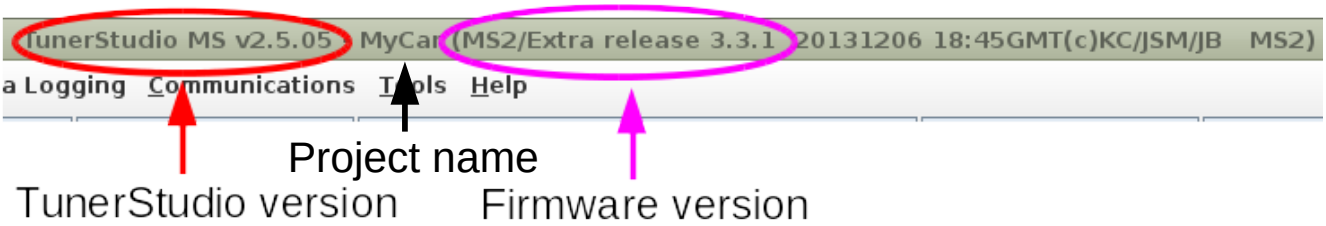
The Status Bar is not specifically documented in this guide, although it is referred to where appropriate.

The Status Bar is relatively simple and, from left to right, shows:

- The name of the current project;
- A progress bar which is used from time to time whilst the software carries out tasks;
- A link to the manufacturer's Internet Site;
- Optionally, the name of the current tune file (or CurrentTune.msq) – See Section 2.3. of this guide for more information about tune files;
- A communications indicator – the red and green boxes on the right hand side of the status bar indicate when information is being transferred between TunerStudio and your ECU.

Title Bar

The Title Bar shows the TunerStudio version, active Project name and Firmware version.



1.4.3 Lite and Upgrade Versions of TunerStudio

On the splash screen, the start screen, the status bar, and the last of the toolbar menu options you will see references to the Upgrade version of TunerStudio.

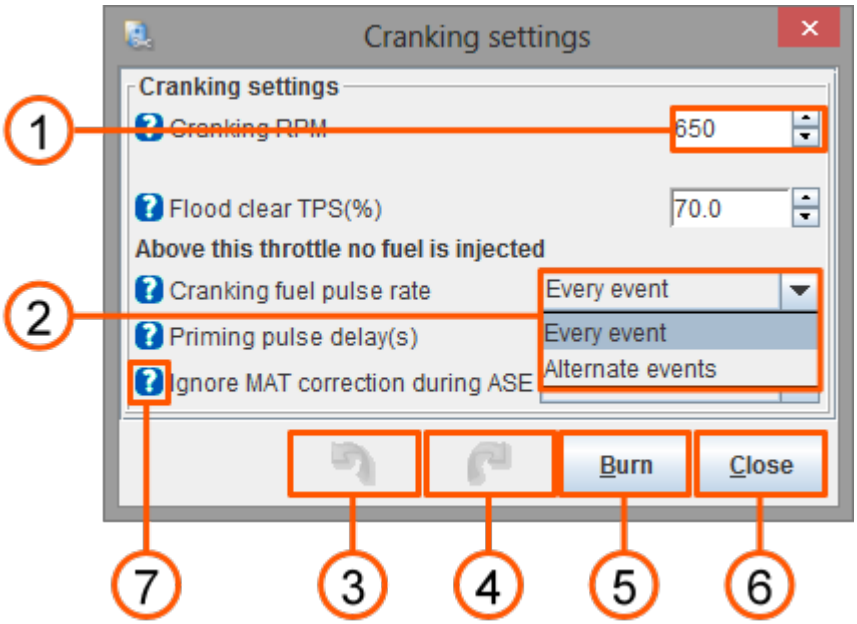
TunerStudio MS Lite is a fully functional tuning software product that comes inclusive with your Megasquirt ECU

purchase. TunerStudio MS Lite includes all of the features required to enable and configure all of the options and settings within your ECU. The Upgrade version also supports additional features that can be hard-wired into some ECUs, and additional functionality (such as GPS and auto tune support) which are not incorporated into your ECU or TunerStudio MS Lite as standard.

1.5 Using the Software Interface

1.5.1 Data Input Screens

Many of the screens within the software are comprised of text boxes, drop-down boxes and buttons. The following image (taken as an example from the Cranking/Startup settings screen within the Startup/idle Toolbar Menu) demonstrates how these can be used:



Text box (1)

Text boxes are designed to accept numeric entries, and so will only accept numbers and decimal points. Almost all of the text boxes include up and down buttons which allow you to make incremental values although it is often much quicker to simply type your chosen value into the box. When you have selected a text box you can also increase or decrease its value with the up and down buttons on your keyboard.

Drop-down box (2)

Drop-down boxes allow you to select one of many options. It is worth noting that when the value of a drop-down box is changed it can radically change the other options available in the software. Enabling or disabling a feature will often not only enable or disable other text and drop-down boxes on the screen that you are using, but may also enable or disable options in other areas of the software. Wherever possible, this guide aims to outline what changes you need to make in order to enable specific options and menu items.

Undo and Redo Buttons (3 and 4)

This concept will be familiar for many computer users. When enabled these buttons turn blue and allow you to repeatedly reverse or re-implement recent changes.

One quirk of the software is that the “undo” button will allow you to undo changes you have made on previous screens, not just the one that you are working with. For this reason be careful how you use this feature.

Burn Button (5)

When you make changes in TunerStudio they usually need to be written (or “burned”) to the flash memory within your Megasquirt before they take effect. The only exception to this is when you make changes to Fuel Tables, Ignition Tables (and their corresponding 3D Maps) where you can “live tune”. Even in this case the changes you make need to be burned to the Megasquirt's flash memory when you have finished live tuning before they become permanent.

Clicking “Burn” on any screen at any time will cause any changes you have made to be written to the flash memory in your Megasquirt.

You can burn changes as often as you like, although it is worth noting that the flash memory in your Megasquirt is only designed to withstand approximately 100,000 burn operations during its lifetime. Whilst you are extremely unlikely to exceed this number, it is always good practice to plan your changes carefully to enhance the life of your Megasquirt as well as to protect your engine.

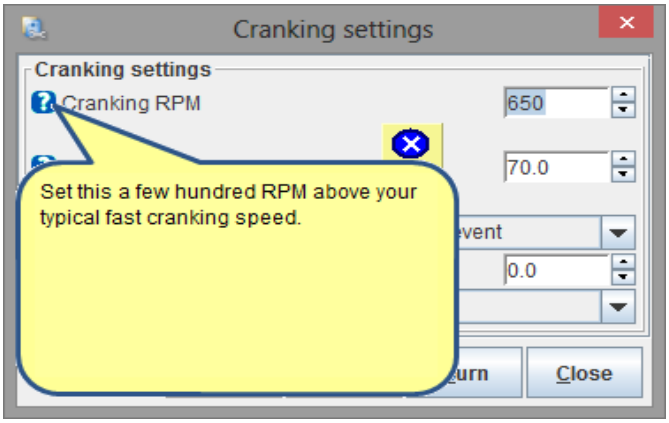
The burn process takes approximately 0.02 seconds. In Megasquirt-3 this takes place in parallel with normal operation and there is no interruption or "burn-stumble" as occurred with Megasquirt-2.

Close Button (6)

This button behaves like the close button in your operating system (the red cross in the above image which is taken from a Microsoft® Windows 8® screen capture). If you have not already clicked “burn” any changes that you have made will be burned automatically whenever a screen (or TunerStudio) is closed.

Tool-tips (7)

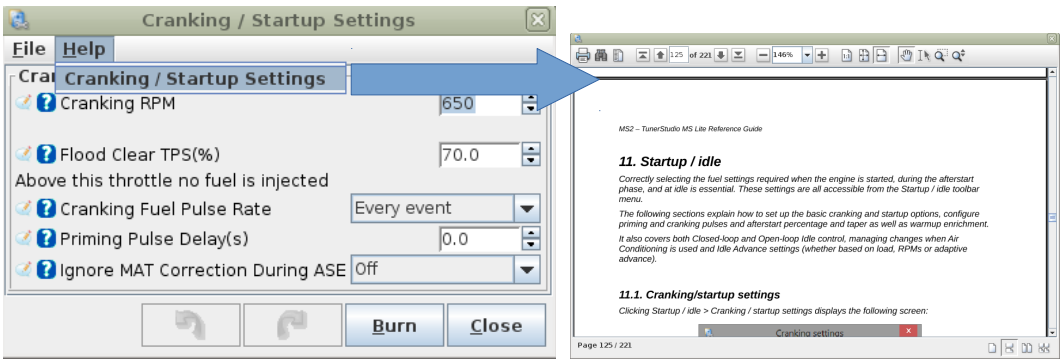
The blue question mark icons that appear throughout the toolbar menu screens provide pop-up information when clicked. Much of the content provided by these tool-tips is also included and expanded upon within this guide, although the tool-tips can be extremely helpful if you do not have this guide available. For example, clicking the blue tool-tip button for Cranking RPM will display the following:



Help (8)

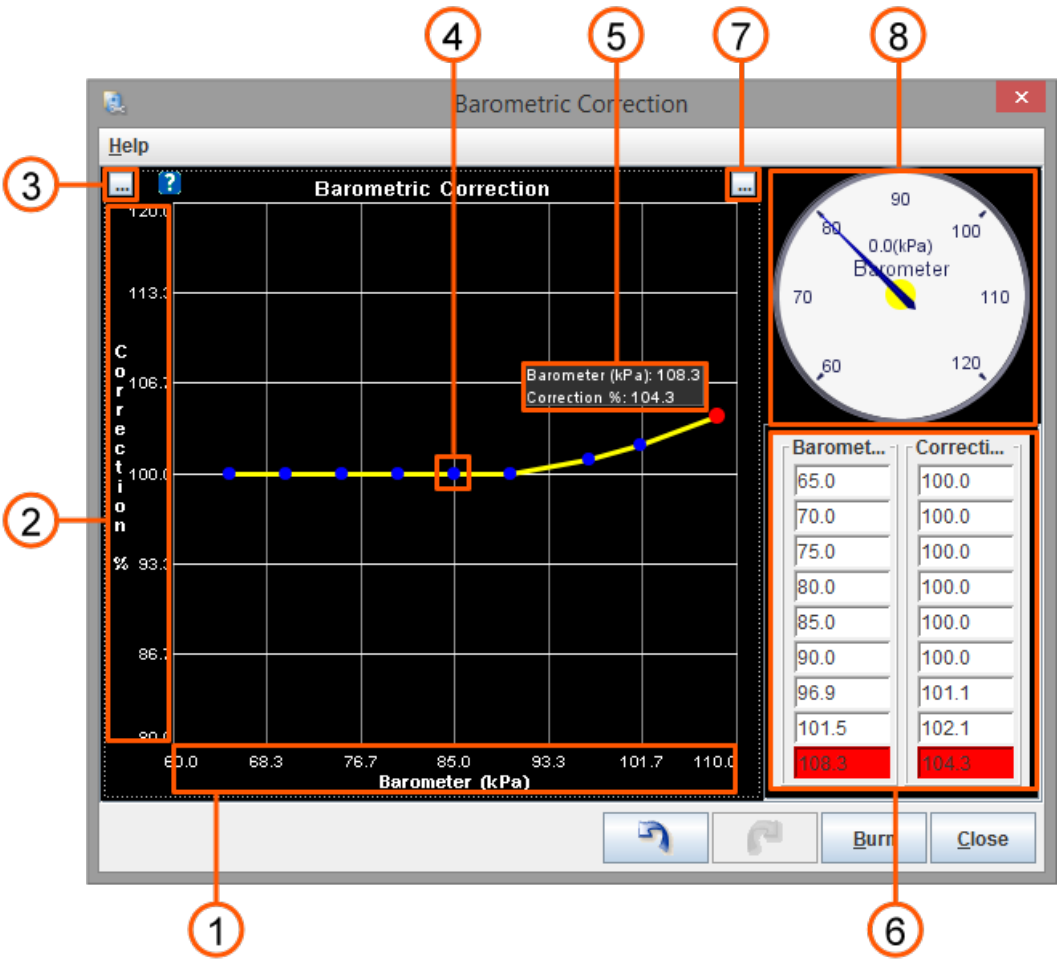
On most settings screens, you will also find a Help menu, clicking on this will open up this document at the appropriate page so you can read about all of the settings for that particular screen.

(You may need to be connected to the internet the first time you use this feature, so the PDF can be downloaded.)



1.5.2 Curves

Curves are a useful feature of TunerStudio as they allow you to make various adjustments depending on one or more states of your engine. The following image (taken as an example from the Barometric Correction screen within the Basic/Load Settings toolbar menu) demonstrates how these can be used:



X-Axis (1)

The X-Axis displays the main variable that is being used for manipulation (in this example barometric pressure) and units used (in this example kPa). It also displays a numerical range which increases from right to left (in this

example 60.0 to 110.0.)

Y-Axis (2)

The Y-Axis is usually used to show percentage correction (as in this example) although it can also be used for a second variable in some curves.

Options Menu Button (3)

The small button labeled “...” on the top left of the curve allows you to customize the ranges of the X and Y Axes. Clicking this button will display a pop-up menu from which you can set minimum and maximum settings for each axis. Optionally you can also ask TunerStudio to “Auto Scale” the maximum value for each axis by enabling the appropriate option from the pop-up menu.

Variable Points (4)

Each curve has a fixed number of points (in this example there are eight) which you can use to set a correction to the curve. Clicking and dragging any of these points up or down, or left to right, sets the adjustment that you want to make.

Selected Point Information Box (5)

When any point is selected (in this example the furthest from the left) it changes color and a box of the same color appears giving its precise location relative to the axes (in this example it shows Barometer (kPa): 107.3, and Correction %: 104.4.

Data Tables (6)

Rather than clicking and dragging the points on the curve you can enter your settings into the associated data table. When you have done this the appropriate point on the curve will move. If you click and drag a point on the curve its entry in the table is highlighted in red (in this example the eighth box down is highlighted and contains the same figures shown in the Selected Point Information Box.) TunerStudio refers to these as "text based arrays."

Often the data table for a curve is not visible by default although **all** curves do include a data table. The button labeled “8” (described below) can be used to display hidden data tables.

When you type an entry into a data table you will need to either use the “Enter” or “Tab” key on your keyboard to move out of that cell or click in another cell before the change will take effect. Unless you do this the point on the curve will not move and the change will not be saved or sent to your ECU when you burn or close the screen.

Show or Hide Data Tables (7)

This button can be used to either hide or display a data table. Some curves are quite small and have their data tables hidden by default. This button is especially useful when using these smaller curves as the table often obscures the curve, and so it can be useful to toggle between the curve the table.

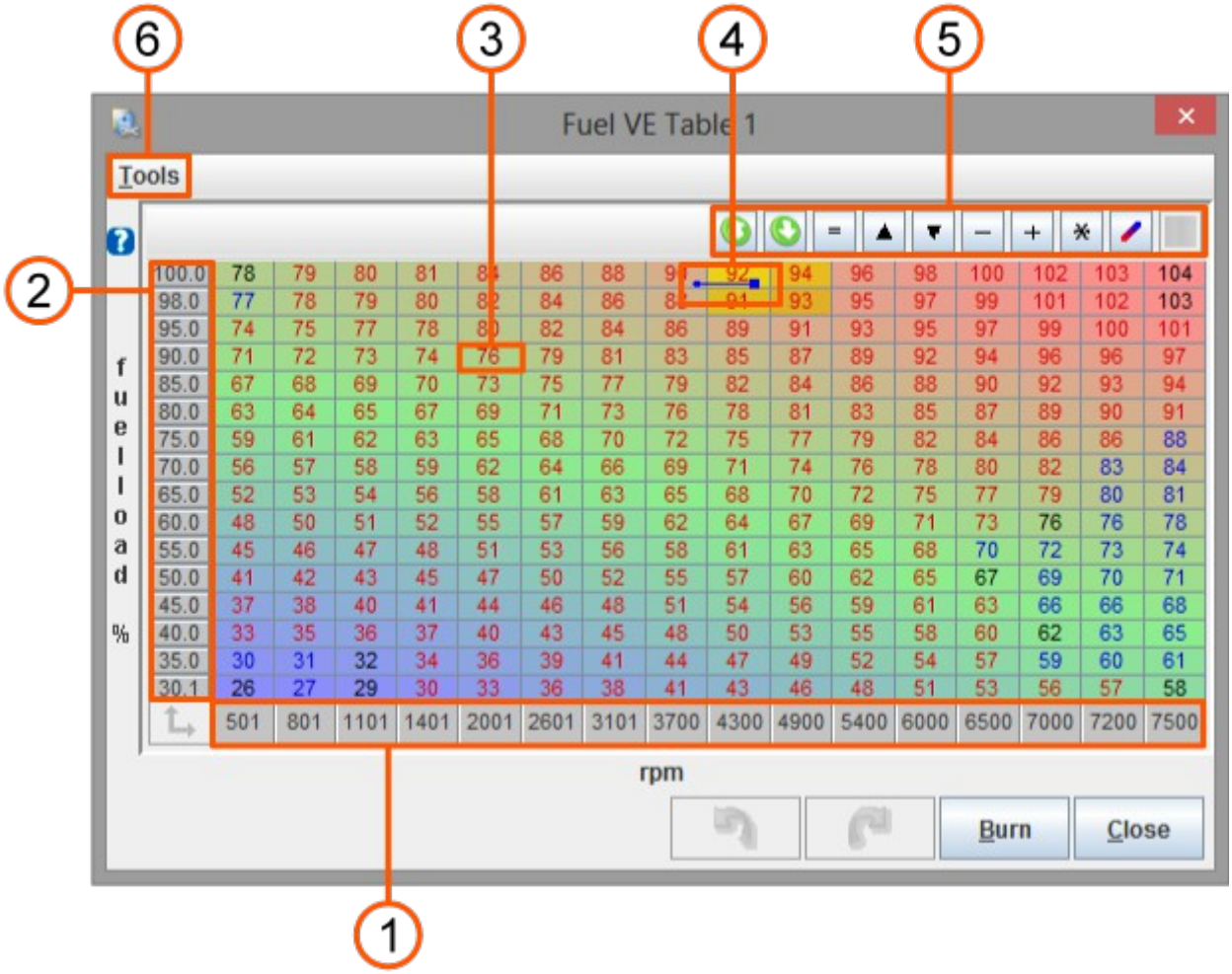
Gauge (8)

The appropriate gauge for the value that you are setting may appear next to some curves.

Not all curves in TunerStudio include a gauge. See Sections 2.6. and 17. for more information about gauges.

1.5.3 3D Tables

3D Tables are used for a range of tuning roles, although Fuel VE Tables and Ignition Tables are the most commonly used. The following image (taken as an example from the Fuel VE Table 1 screen within the Fuel Settings Toolbar Menu) demonstrates how these can be used:



X-Axis and Y-Axis Bin Values (1 and 2)

These values represent the thresholds for which values can be set within the table. In this example there are 16 bin values that can be set for rpm and for fuel load (%). These thresholds can be changed by clicking any of the gray buttons on either axis. When this is done you will see a box pop-up asking you to enter a new value for that bin.

It makes sense to make sure that you are happy with the bin values for each table before you begin to set any of its values.

Individual Cell Value (3)

In a 16 x 16 table there are a total of 256 different values that can be set (in this example the value that is set responds to volumetric efficiency.) These numbers can be entered individually, but there are also a number of ways to simplify this process using the Hot Keys and Buttons described below.

Hot Keys

Clicking on a single cell (or dragging to select a range of cells) and right clicking will display a useful pop-up menu. Most of the features of this menu can also be carried out using the buttons (5) and are described later in this section. This menu also lists the keyboard Hot Keys that can be used to manipulate the values in the table.

Current Running Point and History Trail (4)

If you are using your Megasquirt with your engine running, this screen will display a colored point to demonstrate its current position in the table. It will also display a history trail in the form of a trace line based on recent data from the engine's sensors to illustrate the changes in table position as your engine changes (for example, when RPM increases.)

You can change the number of “reads back” that are used to build the history trail. To do this, right click on your table and click on "History Trail Length" at the bottom of the pop-up menu. This will open a pop-up text box where you can enter the number of reads you want to see displayed.

Buttons (5)

These buttons allow you to carry out a range of tasks to manipulate the values in the table. Most can be used either for a single cell, or for a range of cells that you can select by clicking and dragging with your mouse.

Allows you to export the table to a file.

Allows you to import a table from a file.

Opens a pop-up text box and sets the value of the selected cells to the value that you enter.

Increases the values of the selected cells by one unit each time the button is clicked.

Decreases the values of the selected cells by one each time the button is clicked.

Opens a pop-up text box and reduces the value of the selected cells by the value that you enter.

Opens a pop-up text box and increases the value of the selected cells by the value that you enter.

Opens a pop-up text box and increases the value of the selected cells by multiplying the original values by the value that you enter (for example, entering 1.25 will increase the values of the selected cells by 25%). This can also be used for reducing values (for example, entering 0.8 will reduce the values of the selected cells by 20%)

Adjusts all of the selected cells to values interpolated by the cells in the four corners of the selection.

The standard Microsoft® Windows® copy (Ctrl + C) and paste (Ctrl + V) features are supported and will allow a selection of values to be copied into a second table or into a spreadsheet program such as Microsoft® Excel®.

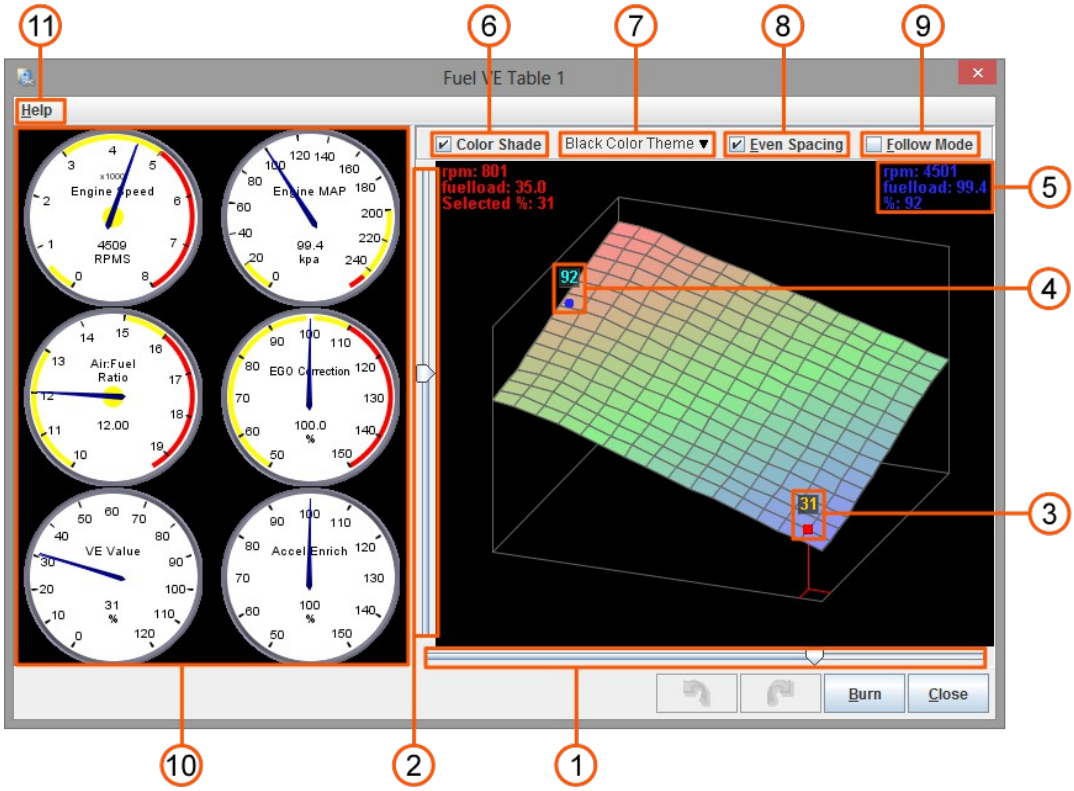
Tools (7)

This menu will display a Table Generator option on **some** 3D Table screens. This is an alternative method of creating values for your table which is only available in the optional Upgrade version of TunerStudio.

1.5.4 3D Tuning Maps

3D Tuning Maps allow a flexible visual rendering of the data held in a 3D Table. Whist numbers alone can be useful, it is sometimes extremely helpful to see a visual interpretation of these numbers to get a better feel for the tune that you are putting together.

Generally, whenever a 3D Table appears in TunerStudio there is a corresponding 3D Map available. The following screen depicts the corresponding 3D Map for the Fuel VE Table 1 used in the previous example:



Whilst 3D Maps can appear quite complex at first glance they are actually relatively simple. For each of the 256 points in the 3D table, a 3D map is created using the X and Y axis, with the height at each point reflecting the numerical value (often referred to as the Z axis). This allows you to get a feel for the gradients within your tune. Like 3D tables, lower numbers are shown in blue and higher numbers are shown in red with green representing mid-range values.

One of the major advantages of a 3D map over a table is that it can be rotated to allow views from different angles to give you a clear idea of the “shape” of your tune. Each map can be manipulated either by clicking and dragging it around, or by using the Yaw and Roll sliders.

Yaw Slider (1)

The Yaw Slider allows you to rotate the map along the horizontal plane – allowing it to be viewed from the front, back and sides.

Roll Slider (2)

The Roll Slider allows you to rotate the map through the vertical plane – allowing it to be viewed from above or below.

Using a combination of Yaw and Roll it is possible to view a map from **all** possible angles.

Selected Point (3)

All of the intersections between the lines represent a value of a cell in the corresponding 3D table. You can select any of these points by clicking on them. When you do this the selected point in the table will be highlighted by a colored marker. You can change the value for the selected point by dragging it up or down. Rotating the map by clicking and dragging or by using the Yaw and Roll sliders will give you a good feel for how your changes fit in with the other points in the map.

Tuning is a matter of personal preference (and there are many possible approaches) but when changing any value it is generally a good idea to maintain some smoothness throughout the map. Sharp upwards or downwards points will usually result in a poor running of the engine.

Active Engine Point (4)

If your Megasquirt-2 is connected and your engine running, the active position at which the engine is operating is reflected by a second colored marker. For most (but not all) of the maps RPM is used as the X-Axis and so you will be able to see this marker moving when you open and close the throttle. Making changes to the points in a map whilst varying RPM can be a useful way to live tune.

Current and Selected Point Information Boxes (5)

When a current point is displayed you will see a text area at the top right of the map giving detailed information about what is happening at that point (in this example it shows rpm: 4501; fuelload: 99.4; %:92.)

If you are working offline or your engine is not running no Current Point will be highlighted on the map and this text area will not be displayed.

When a point on the map is selected, you will see a text area on the top left of the map giving detailed information about what would happen at that selected point (in this example it shows rpm: 801; fuelload: 35.0; Selected %: 31.) A point on the map can be selected and the text area will be displayed even without your ECU connected.

Color Shade (6)

Clicking in the box next to Color Shade will toggle shading of the map on and off (it is “on” if there is a tick in the box). The choice of whether to use shading is a personal one, but most users find it easier to get a feel for the shape of the map with Color Shade on.

Color Theme (7)

This sets the background color for the map. Again it is a personal choice, but most users seem to prefer using a black background as it makes the shape of the shaded map appear very clearly.

Even Spacing (8)

Clicking in the box next to Even Spacing will toggle the spacing settings for the map. If Even Spacing is set as “on” the distance between lines on both axis is set to a fixed value regardless of the values associated with each axis. This makes it easier to select a point as they are never very close together.

If this option is set as “off” (no tick in the box) the spacing of the lines will reflect the values that you have set up for each axis.

Follow Mode (9)

If Follow Mode is set to off you can manually select and alter any point on the map. If it is switched on (and your Megasquirt-2 is connected and your engine running) the selected point will always reflect your engine position. For live tuning it is usually useful to have this setting set to on.

Map Gauge Cluster (10)

The Map Gauge Cluster will display an appropriate array of gauges to display your engine's behavior which may be useful during live tuning. Right-clicking on this gauge cluster will display a pop-up menu from which you can customize the cluster. This menu is very similar to the menu for TunerStudio's main gauge cluster which is documented in section 2.6.

Help (11)

Clicking this menu item will allow you to select the embedded “3D Table Usage” help file within TunerStudio. This provides further support for how to use these screens which can be used alongside this guide.

3D Map Hot Keys

There are a number of keyboard shortcuts that can be used to make changes to a 3D Map. These are briefly described as follows:

Up, Down, Left and Right Arrows – Allow you to move the selected point.
Increase & Decrease Z values:

- **Shift + (Up or Right) keys** – Increment selected point by 1;
- **Shift + (Down or Left) keys** – Decrement selected point by 1;
- **(> or . or q or + or =) keys** – Any of these will increment the selected point by 1;
- **(< or , or w or -) keys** – Any of these will decrement the selected point by 1;
- **CTRL + (Up or Right or > or . or q or + or =) keys** – Increment the selected point by a user defined value (the default increment is five);
- **CTRL + (Down or Left or < or , or w or -) keys** – Decrement the selected point by a user defined value (the default decrement is five).

G – Moves the selected point to the current active position.
F – Toggles Follow Mode on and off.
M – Increases the Yaw Angle of the table by 10 degrees.
K – Decreases the Yaw Angle of the table by 10 degrees.
N – Increases the Roll Angle of the table by 10 degrees.
J – Decreases the Roll Angle of the table by 10 degrees.
Z – Shows a top down view of table.

3D Map Menu Options

Right-clicking on the map itself will display a pop-up menu which allows you to further customize the appearance and behavior of the map. These are covered briefly below.

Smart Select Movement – When on (the default setting), the arrow keys will alter the selection direction so that the right key will always move to the next point on the right, left to the next point on the left, and so on relative to the position of the map as it is displayed. If this is set to off, the up and down keys will always along the Y axis, and the left and right keys will always move along the X axis regardless of the maps visual position.

Show Active Table Values – When on (the default setting) the values for the Z-axis (height) for both the selected and active points will be displayed on the grid.

Show Selected X & Y Values – This is off by default, but if set to on the selected X & Y values will be displayed along the appropriate axis.

Increment All Active Cells – This is off by default, but if set to on this only effects adjustments made using Follow Mode with your Megasquirt-2 connected and your engine running. In this scenario increments of Z values (height) will be applied to all table values that are currently active with a weight above the set value. This allows adjusting up to four map values (3D cells) at once if they are close enough to the active point. When set to off only the selected point will be adjusted.

Active Weight Threshold – This is only enabled if Increment All Active Cells is set to on. It allows for changing the weight used to determine what table values (3D cells) are adjusted. Valid values are 0% to 100% where 0% will allow up to four points to change, whilst 100% will only allow one point to move (assuming that value was matched perfectly by the engine outputs.)

Select Active Color – Allows you to change the color of the Active Point and Active text. By default the Active Point and text will be blue as described above.

Select Selected Color – Allows you to change the color of the Selected Point and Selected text. By default the Selected Point and text will be red as shown in the above example screen.

CTRL Increment By – As discussed in the Hot Keys section, when holding down the CTRL key whilst adjusting table values, you can increment or decrement values in steps greater than one (the default is five). This option allows you to change this multiple to a value other than five.

2 File Menu

The File Menu, the first item in the top menu, allows you to:

- Create, open and close Projects;
- Open, close and manage tune (.msq) files;
- Make changes to the gauge cluster;
- Choose whether to work online or offline;
- Exit TunerStudio.

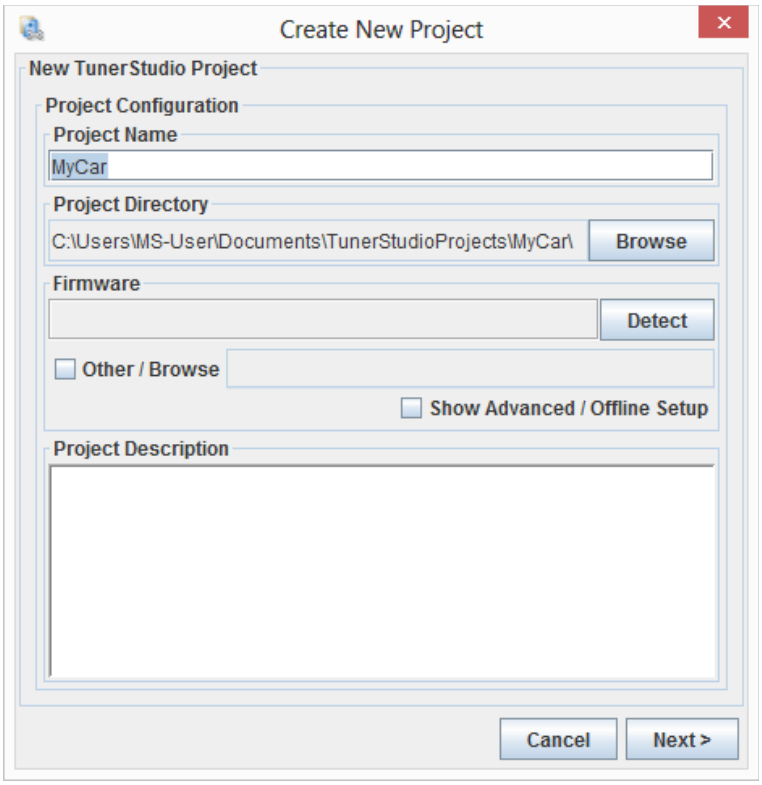
2.1 Project

TunerStudio requires a number of key files in order to work with (and allow you to change) the raw data held in your Megasquirt. Many of these key files are held within a project directory.

TunerStudio does have the ability to open an .msq file without opening a project (allowing you to review settings from that tune). To do this, TunerStudio uses a temporary project which will not enable communications. This means that you should **always** create or open a project if you intend to connect to and configure your Megasquirt with an .msq tune file.

2.1.1 New Project

You can create a new project either from the start screen or from the main screen. The only difference is that from the start screen you need to select File > New Project, whilst from the main screen you need to select File > Project > New Project. Either will display the first “Create New Project” screen as shown below:



Project Name

In the Project Name box you can give the project any name using characters allowed by your operating system. Unless you change it manually, the Project Folder will also assume this name.

Project Folder

The “Project Directory” entry does not normally need to be changed. Depending on your operating system your project will be created in:

1. Using Windows: Documents\TunerStudioProjects\ or My Documents\TunerStudioProjects\
2. Using Linux or OS X: [your directory path]/TunerStudioProjects/

Firmware

You need to ensure that you have the correct firmware for your Megasquirt associated with your project. Unless you want to test a development (beta) version it is recommended that you use the latest stable version of the firmware, which can be downloaded from http://www.msextra.com/downloads.html. This manual corresponds to the stable version of the firmware shown on the front page.

To use the latest version you may need to update your Megasquirt. Information about how to do this is available in the Setting Up manual.

If you do need to update your firmware make sure that during the update you select the appropriate version according to your Megasquirt. Different versions exist for MS3 (the standard Megasquirt-3) and MS3-Pro.

The firmware version can be changed after your project has been created (see Section 2.1.6.)

Firmware selection can be accomplished in three ways. The recommended approach is to use the “Detect” process which will automatically retrieve the firmware version from your ECU. This isn't always possible for various reasons – e.g., you may be having problems with your ECU connection or be using a beta version of the firmware. In these cases you can use one of the alternative methods to selecting your firmware. The various methods can be carried out as follows:

Detect

To use this option you must have your Megasquirt powered up and connected to your computer. If your Megasquirt is connected to your engine it is recommended that you use Key On Engine Off (KOEO), i.e., with power to the ECU but without the engine running. You can alternately power up your Megasquirt by any other appropriate power source. Once this is done click the "Detect" button. TunerStudio will attempt to identify the firmware on your controller and select the appropriate firmware file for your Controller.

When you click the Detect button a “Detect Device” screen will appear whilst TunerStudio will attempt to find your Megasquirt and its firmware version. If successful it will list your product, firmware version and Baud rate. Check that these are correct and then click “Accept” to continue. If the “Detect Device” screen reports “No controller found” check the power and computer connections and try again. If this still does not resolve the problem move on to the “Other / Browse” method described below to set the firmware up manually.

If your ECU is identified correctly, clicking “Accept” will load the necessary configuration file to match your firmware version and you can now move on to the Project Description described later in this section.

If your ECU is identified correctly but clicking “Accept” displays a message that reports “TunerStudio does not have a configuration to support the found hardware” then it is likely either that you are running an older version of TunerStudio, or you are running a beta version of the firmware. If you are running an older version of TunerStudio you should upgrade to the latest version. If you are using a beta version of the firmware you will need to use the “Other / Browse” method described below to set up your firmware configuration manually.

Other / Browse

This method is recommended only if you are not able to connect to your Megasquirt, or if you are using a beta version of the firmware.

The firmware on your Megasquirt may have been provided on a disk or downloaded as a .zip file from the msextra.com Internet site. If you have downloaded your firmware and haven't done so already extract the contents of the zip file to a directory of your choice. The configuration settings for TunerStudio are the ".ini" file within the firmware folder. Note that you need to have the Windows setting "Hide known extension types" disabled to correctly see this file.

Clicking in the box next to “Other / Browse” opens a screen which lets you browse to your firmware folder. From here you should be able to select the .ini file that you want to use. It is essential that you use the .ini file that is appropriate for your Megasquirt. There are four .ini files to choose from within each version of the firmware:

- ms3.ini – used for the MS3 and MS3-Gold.
- ms3pro.ini – used for the MS3-Pro ECU and ECUs based on the MS3-Pro module.

Select the file that is appropriate to your product. Now move on to the Project Description described later in this section.

Show Advanced / Offline Setup

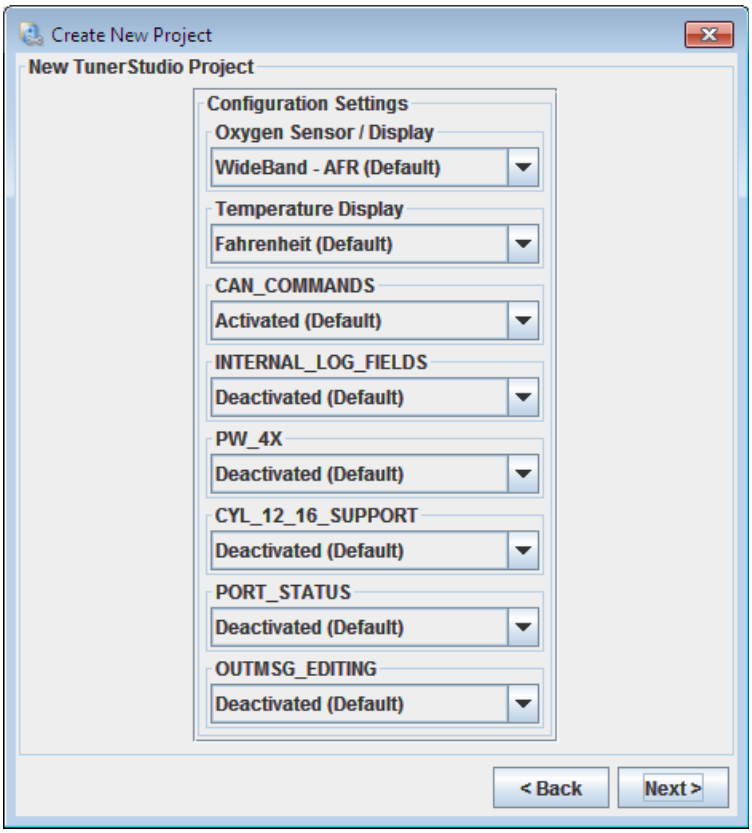
This is the most complex and least desirable method of selecting your firmware, and should only be used as a last resort by experienced Megasquirt users. To use this option you **must** know the firmware signature **which is rarely the same as the firmware version!**

Check the “Show Advanced / Offline Setup box to display the “ECU Definition” drop down box in place of the firmware label box. If you know the signature select it from this list. If you do not see the signature for your firmware (or have any doubts about which ECU definition you should use) **you are strongly advised** to establish a connection to your Megasquirt and use “Detect”, or to download an appropriate firmware version and use the “Other / Browse” method described above.

Project Description

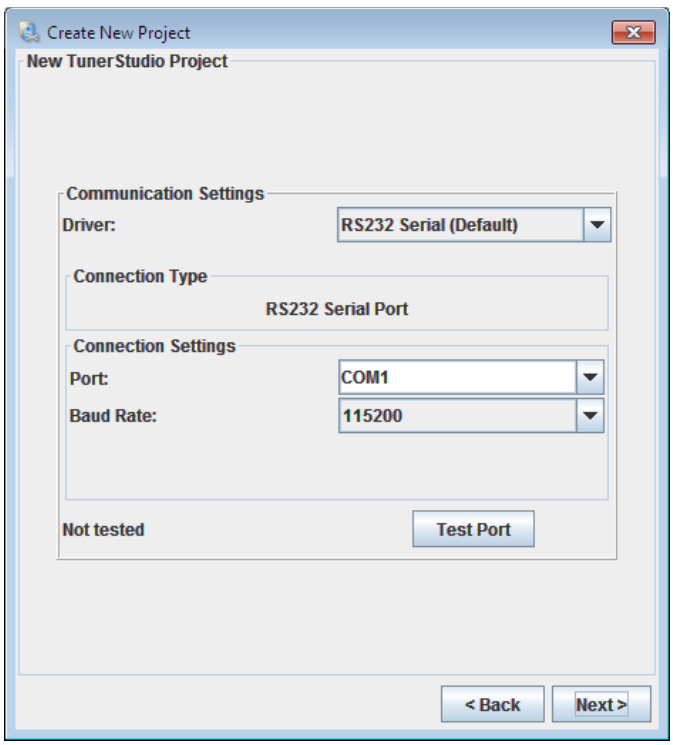
This is not a required option, but it can be useful if you use a large number of projects and are creating a project for a specific purpose. Enter any information that will help you to identify the project for your own use. This entry can be changed after you have created your project.

Once these settings are complete, clicking **“Next”** will take you to the second “Create New Project” screen as shown below:



Verify that what they are configured to match your set up. If you are unsure the default values are likely to work well. These settings can be changed after your project has been created.

Clicking **"Next"** will take you to the third "Create New Project" screen as shown below:



This screen allows you to select the driver type and connection settings to connect your Megasquirt to your computer.

Driver

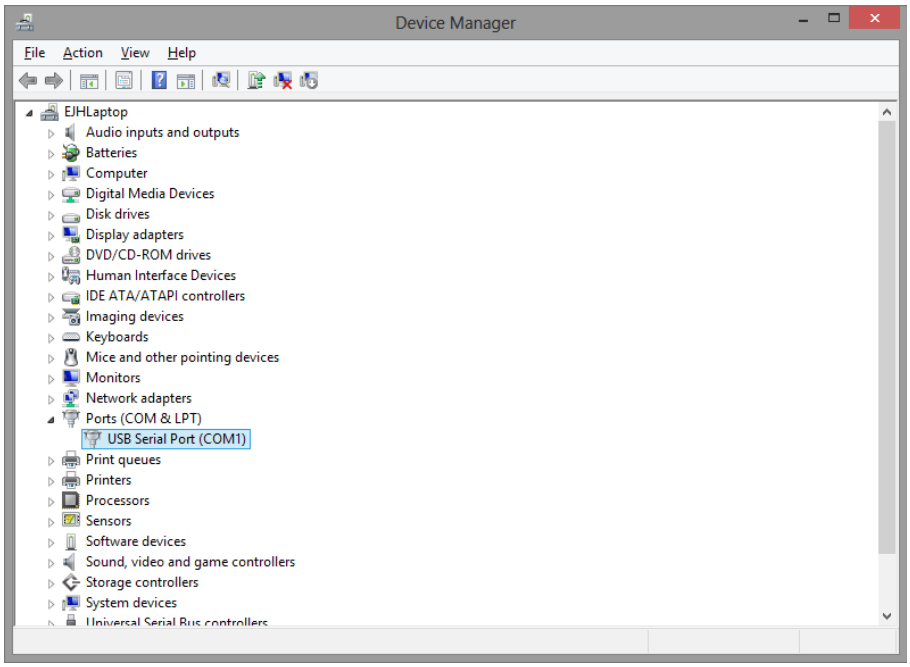
From the “Driver” drop down box, select the appropriate driver type that you use to connect to your Megasquirt. This setting is usually “RS232 (Default)”.

Port

From the “Port” drop down box, select the COM port that your your computer is using to connect to your Megasquirt-2. This is usually COM1, but if your computer has multiple connections to other serial devices it could be COM2, COM3, etc.

You can change the COM port that you use to connect to your ECU through Device Manager in Windows. Depending on the version of Windows that you are using, Device Manager can usually be accessed via the System settings in Control Panel. Alternately, typing “devmgmt.msc” in the Run option of the Start Menu or from a command prompt will open Device Manager in most versions of Windows.

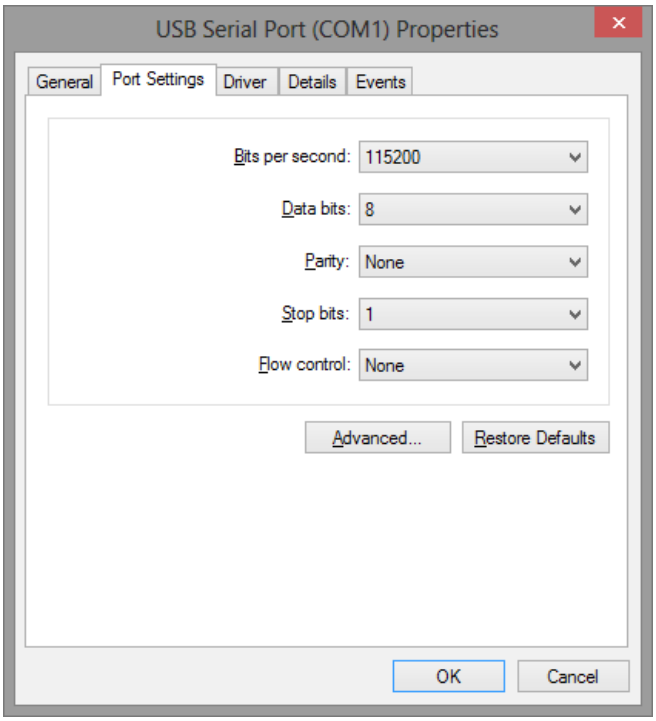
Expanding the Ports (COM and LPT) entry in Device Manager should display a screen similar to that shown below:



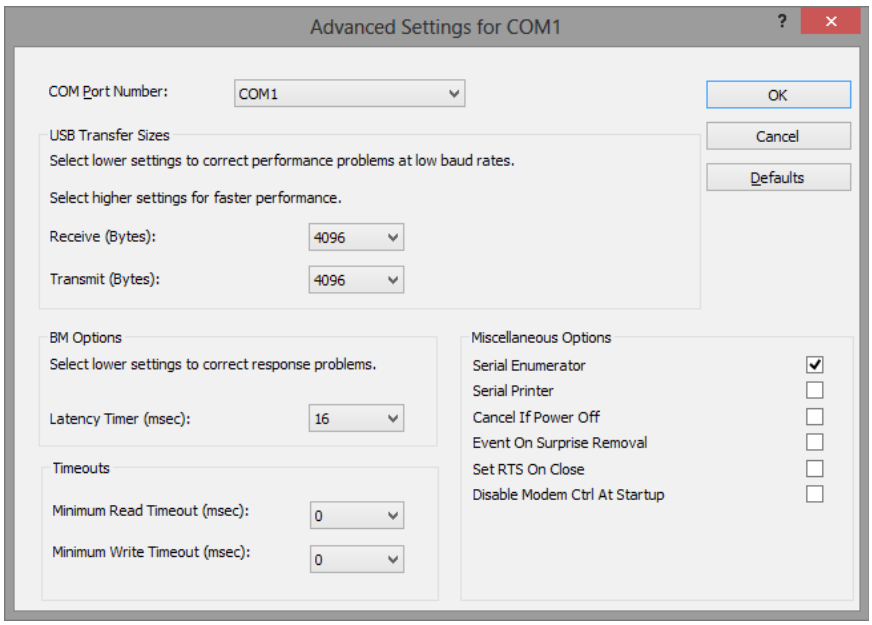
This image is taken from Windows 8.1. In other versions of Windows the screen may look slightly different.

Right clicking on the port to which your Megasquirt is connected, and clicking “Properties” will display the Properties screen for that port.

Clicking on the second tab (Port Settings) should display a screen similar to that shown below:



Clicking the “Advanced” button should show a screen similar to that shown below:



Using this screen you can change the COM Port Number for the port connected to your Megasquirt. If you want to use COM1 and another device is already using COM1, you will need to change the settings for that other device before setting up the port for your Megasquirt. The Latency Timer should be set to the minimum value (1).

To avoid conflicts, make sure that there is no other device using COM1 before you select this setting!

Baud Rate

All Megasquirt-3 products use a baud rate of 115200. If you do not set the baud rate to 115200 you will not get a successful response when attempting to connect to your product.

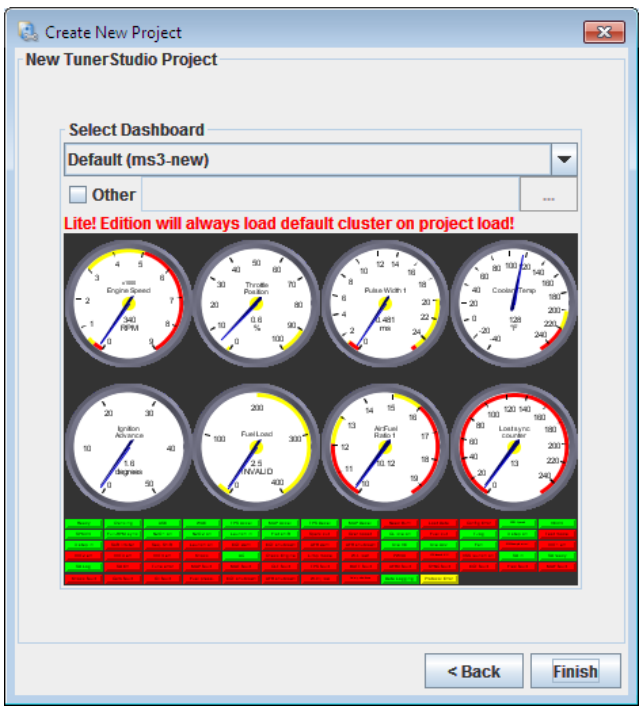
Although it is extremely unlikely that you would need to do it, it is **theoretically** possible to set your Megasquirt to connect at a lower baud rate (see Section 5.1.) although it is not generally recommennded.

Test Port

Once you have entered the above settings, make sure that your Megasquirt is connected to your computer and powered up and click “Test Port”. If the settings are correct you should be able to establish a connection. If not confirm that the product is powered up and connected, and recheck your settings.

It is strongly recommended that you create your project with your Megasquirt connected and powered up and using Detect and Test to be certain that your project is correctly configured. It is not, however, essential to complete this test in order to create a project. If you create a project without your Megasquirt connected you can run both Detect and Test later from the Communications Menu (see Section 5.1.)

Clicking **“Next”** will take you to the final “Create New Project” screen shown below:



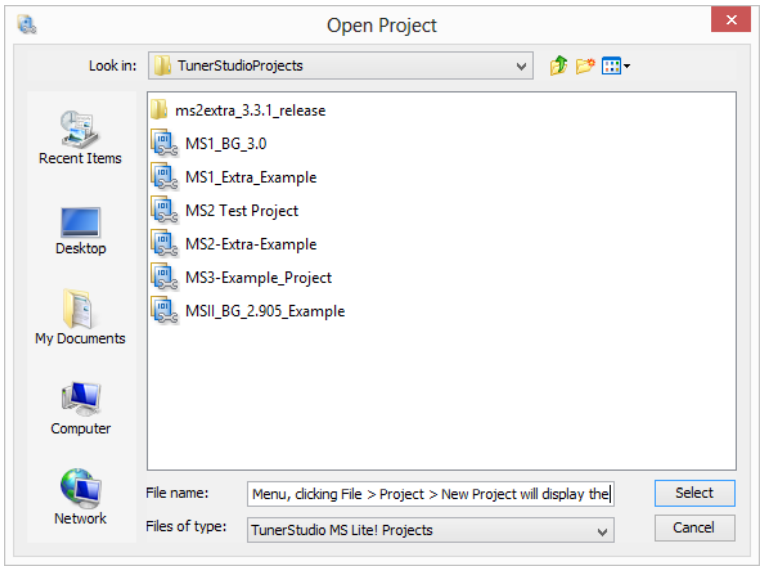
TunerStudio MS Lite will always load the Default dashboard whenever a project is opened.

For the above reason, this screen is only really useful if you are running the Upgrade version of TunerStudio and so it is recommended that you leave the dashboard set to “Default”.

Clicking “Finish” will complete the creation of your new project. Any current project will be closed and the new project will be opened and ready to use.

2.1.2 Open Project

You can open a project either from the start screen or from the main screen. The only difference is that from the start screen you need to select File > Open Project, whilst from the main screen you need to select File > Project > Open Project. Either will display the Open Project screen as shown below:



By default the “TunerStudioProjects” directory will be selected, although you can browse to another location if you have saved a project elsewhere. To open a project simply select it from the list and click “Select”. If you already have a project open and your tune is unsaved you will be prompted to save it before that project is closed. The project that you have selected will then be opened.

2.1.3 Close Project

As you might expect, clicking File > Project > Close Project will close the existing project. You will be prompted to save any changes to your tune file if any changes have been made. You will then be returned to the TunerStudio Start Screen.

2.1.4 Export Project Archive

This is a feature of the Upgrade version of TunerStudio and is documented for reference only.

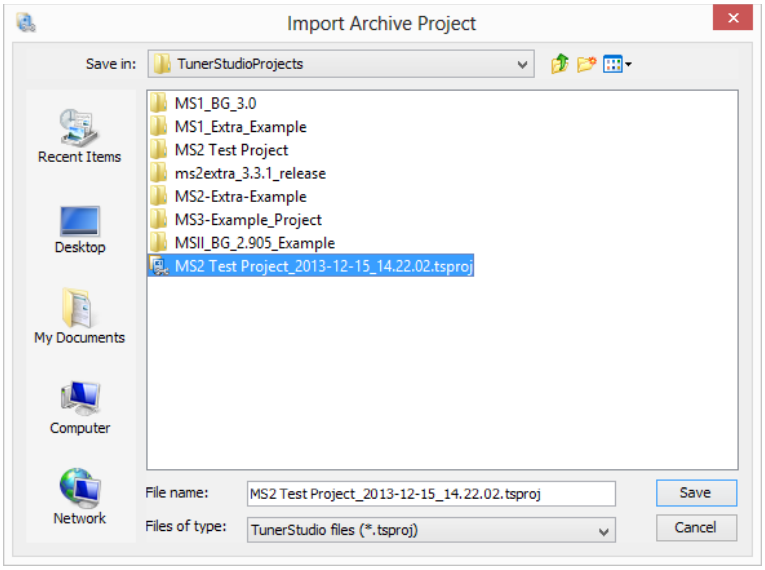
The Open Project screen lists projects rather than project files. In reality, each project is made up of a group of directories each containing a number of files required for the project.

In order to backup a project, or move it from one computer to another, the recommended method is to use the Export Project Archive feature.

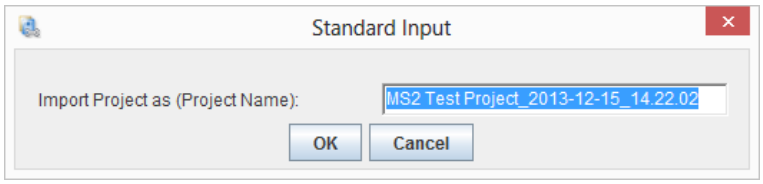
From the top menu, clicking File > Project > Export Project Archive will display a dialog which will allow you to save all of the attributes and settings associated with the project into a single TunerStudio file with the .tsproj file extension. The process of restoring a project from this file is covered in the next section.

2.1.5 Import Project Archive

You can import a project either from the start screen or from the main screen. The only difference is that from the start screen you need to select File > Import Project Archive, whilst from the main screen you need to select File > Project > Import Project Archive. Either will display the Import Project Archive screen as shown below:



Clicking on the .tsproj file that you want to restore and clicking save (to save it into a complete project folder structure) will prompt a second dialog as shown in the image below:



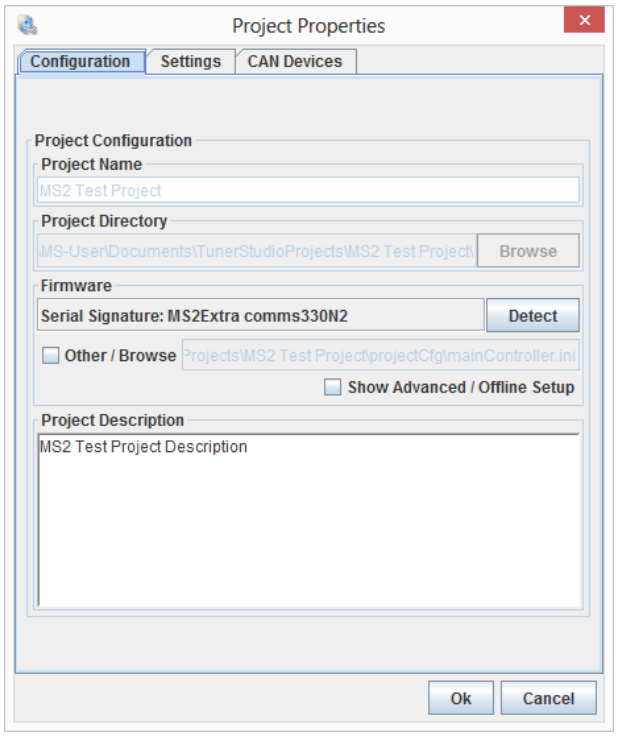
Be careful if you want to extract an archived project and you have another project with the same name. TunerStudio MS Lite will ask you if you want to overwrite any project with the same name, but it is good practice to make sure that any existing project with the same name is backed up.

Once you have selected the name for your project, and accepted that any other project of the same name will be overwritten, the project will be extracted. You will then be asked if you want to open the imported project.

2.1.6 Project Properties

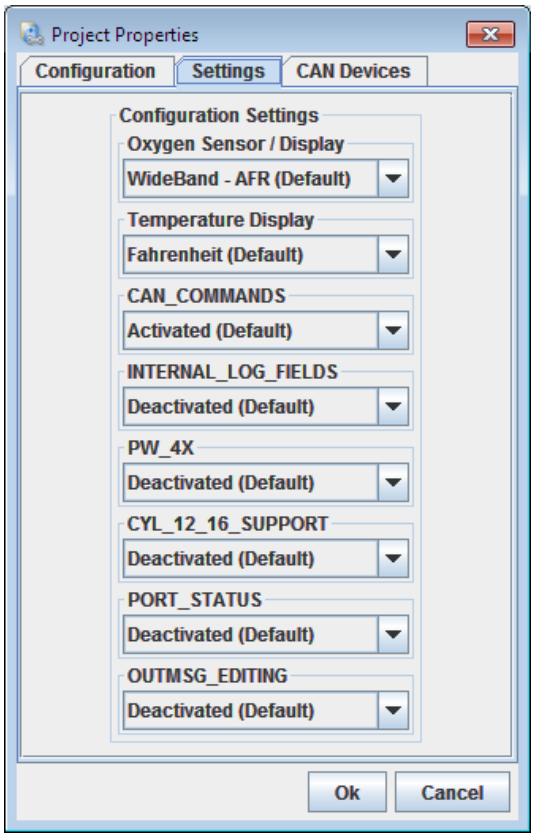
As discussed in Section 2.1.1 (New Project) it is possible to change a number of the settings for each project after it has been created.

From the top menu, clicking File > Project > Project Properties will display the Project Properties screen. This has three tabs. The first tab (configuration) is shown below:



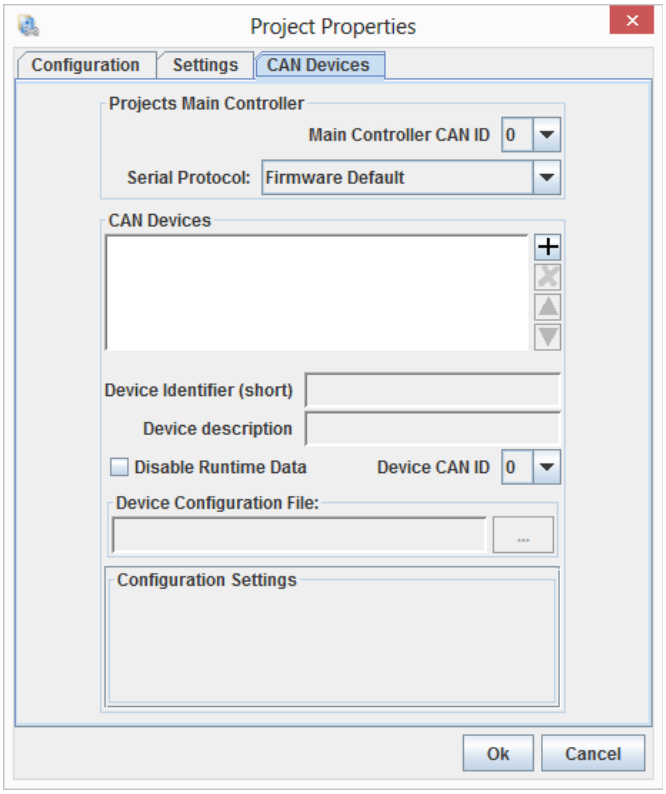
From this screen both the firmware version and the Project Description can be changed. If you were unable to use “Detect” to determine your firmware version from your Megasquiirt-2 product when you created your project you can do so now if you have your product connected and any connection issues resolved.

The second tab (Settings) is shown below.



As discussed in Section 2.1.1 the default settings should be expected to work with your Megasquirt, but they can be changed at any time as required.

The Third Tab (CAN Devices) is shown below:



CAN Devices are technical. You can skip the remainder of this section if you are not using an expansion board.

The CAN Devices tab has two main functions: Managing the “Project Main Controller” for the project; and managing “CAN Devices” (which are expansion boards.) The Main Controller will be (under almost all circumstances) your Megasquirt.

Main Controller CAN ID

Main Controller CAN ID is a setting that is almost always set to 0. This setting must match the corresponding setting within the CAN Parameters screen (see Section 15.1.)

Do not change this setting unless specifically directed to by your vendor.

Serial Protocol

The Serial Protocol setting is almost always set to “Firmware Default” and **should only** be changed by very experienced Megasquirt and TunerStudio users. For reference, the options for this setting are:

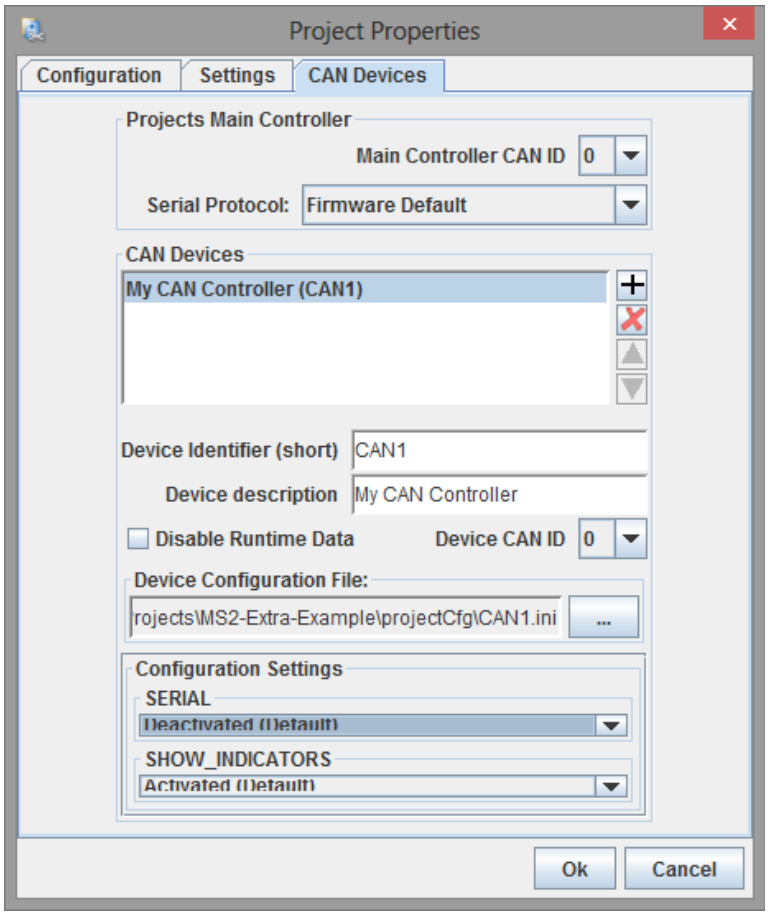
- *Firmware Default* – use the serial protocol that is specified in the firmware supplied 'ini' file.
- *Force – MS3 1.1+* - overrides the .ini (firmware) file and forces the CRC checked protocol. This protocol is used on MS2/Extra 3.3.x and MS3 1.2.x upwards.
- *Force – Standard MS2 and MS3 1.0* - overrides the .ini (firmware) file and forces the older non error-checked protocol. This protocol is used by older MS2 firmwares and some add-on devices.

CAN Devices

The CAN Devices section of this tab allows you to join expansion boards into your project. For example, if you have a JBperf IO-extender board connected to your Megasquirt, then you could use TunerStudio to collect additional sensor data from the IO-extender at the same time as collecting engine data from your Megasquirt. This is called “CAN pass-through” - TunerStudio is communicating with the expansion board with the data passing through the Megasquirt.

Note that the Megasquirt will not see this remote data itself – it is simply being sent through to TunerStudio. To configure your Megasquirt to use the data from an additional board use the CAN Parameters screen (again, see Section 15.1.)

An example of a CAN Device configuration is shown below:



Many of the settings in the CAN Devices section should be provided by the vendor of your expansion board. The general settings for the options for this sections are as follows:

+ – adds an additional CAN device (expansion board) to your project.

x – removes a CAN device from your project.

Up and Down Arrows – will move the selected CAN Device up and down the list.

Device Identifier (short)

This is an abbreviated name for the selected CAN device.

Device description

This is a longer name that you choose for the selected CAN device.

Disable Runtime data

This option determines whether TunerStudio collects live runtime data (sensor data) from the CAN device. This will almost always need to be enabled. Leaving the box blank will allow you to configure the remote device through the settings menus, but **will not** fetch live data.

Device CAN ID

This must be set to match the CAN ID set on the CAN device. Each device on the CAN network must use a different CAN ID.

Device configuration file

Use the button containing three dots [...] to Browse for the .ini file supplied by the CAN device vendor.

Configuration settings

Any settings specific to this CAN device can be configured here as required. These work in the same way as the Project Properties -> Settings for your Megasquirt.

2.2 Tune Restore Point Dialog

This is an optional feature of the Upgrade version of TunerStudio which allows a range of restore points to be established and quickly restored. With TunerStudio MS Lite, using Save Tune As (see Section 2.5.) is the recommended method of backing up your tune files. Open Tune (see Section 2.3.) is the recommended method of restoring a tune file with this version of the software.

2.3 Open Tune

A tune file (using the file extension .msq) contains all of the settings for a specific configuration for your Megasquirt. Depending on the various performance profiles you may require at different times you can save multiple tune files for each project.

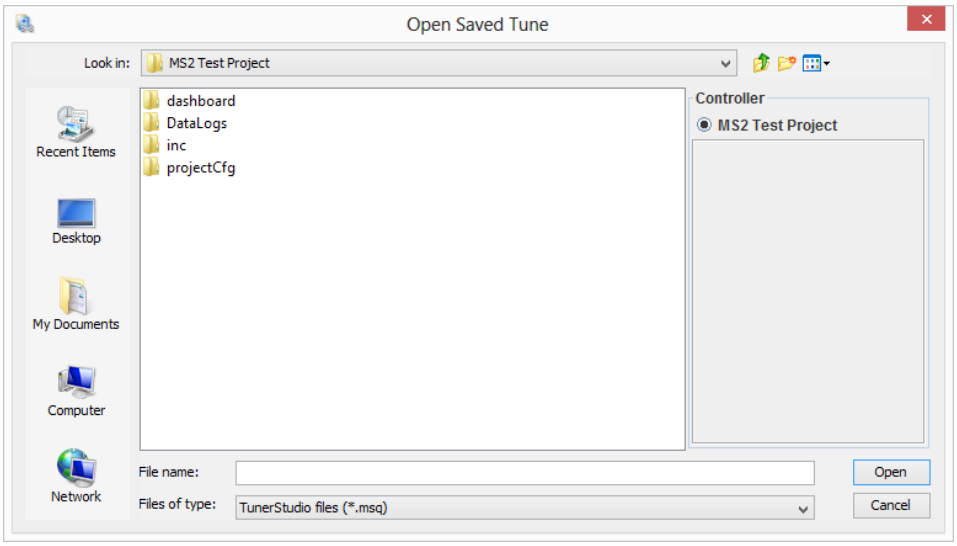
When TunerStudio connects to your Megasquirt it automatically fetches the current tuning settings and allows you to live tune online. You do not need to use Open Tune to do this.

Open Tune is used to open and view an existing saved tune. Optionally you can write this tuning data onto your Megasquirt.

Default tune files are included in the tune_files directory of the zip file for each firmware version. These can be used to start a tune offline.

TunerStudio will prompt you if you load a tune file which is incompatible with the firmware version that you are using, but in most cases you will be able to load in old settings. TunerStudio will report any problems it finds as warnings or errors. Each of these should be reviewed.

You can open a tune file by clicking File > Open Tune (msq). This will display the Open Tune screen as shown below:



Usually Tune files are saved and opened from the project directory, and so by default the directory for the current project is shown. Usually you will open Tune files from this directory to work with your current project. There are three possible exceptions to this:

- If you have downloaded and extracted a new version of the firmware you can browse to the tune_files directory within the firmware folder structure and open the default tune for your Megasquirt.
- From time to time you may have multiple projects using the same firmware and Megasquirt and it is perfectly acceptable to store and open tune files from a separate directory.
- As can be seen in Section 3.6. of this guide (Preferences) it is possible to choose from the Options Menu to automatically load and save the current tune. The advantages and disadvantages of this option are discussed in more detail in section 3.6, but if this option is selected there is usually only a need to use Open Tune in order to restore a backup of a tune file.

2.4 Save Tune

As discussed in the previous section, TunerStudio includes an option to automatically load and save the current tune. If you are using this option tunes will be saved automatically and you will not need to use Save Tune.

If you are not using this option, you will need to save your tune file manually. Clicking Menu > Save Tune will ensure that any changes you have made to your configuration are saved. When you close a project or exit TunerStudio you will be prompted to save any changes if you have not already done so.

2.5 Save Tune As

Save Tune As allows you to save your tune to an external file. This is a useful feature as means that you can backup a range of different tunes as you experiment with the configuration options.

Clicking Menu > Save Tune As will display the Save Tune As screen. From here you can choose a name and location for your tune file. For convenience it is usually recommended that you save each tune file in the directory of the project that you are using, although there is no reason that tune files cannot be stored in any folder or external disk.

It is STRONGLY recommended to use Save Tune As each time before you make configuration changes so you have a set of known working tunes. You should also use this to create a unique tune file (MSQ) before uploading to the support forum.

2.6 Gauge Cluster

The main gauge cluster is more fully documented in Section 17. Within the File > Gauge Cluster Menu there are four sub-Menu Options which are documented in Sections 2.6.1. to 2.6.4. below. You may notice that once you have clicked on one of the eight gauges in the gauge cluster of the main screen a number of additional items appear within the Gauge Cluster entry of the File Menu. This is largely for convenience in terms of making TunerStudio work on a wide range of operating systems. For details of these additional menu items please refer to Section 19.

2.6.1 Background

Selecting File > Menu > Gauge Cluster > Background displays four options as outlined below:

Set Background Color

This setting allows you to set the background color of the screen on which the gauges are displayed. This setting is not saved when you close your project or exit TunerStudio MS Lite.

Set Background Dither Color

This setting allows you to set the background dither color of the screen on which the gauges are displayed. This setting is not saved when you close your project or exit TunerStudio MS Lite.

Set Background Image

This setting allows you to set a background image to sit behind the gauges that are displayed. This setting is not saved when you close your project or exit TunerStudio MS Lite.

Image Position

If you have selected a background image that sits behind the gauges that are displayed, this option allows you to choose whether this image should be stretched to fill the screen, tiled to fill the screen or centered within the screen. Again, this setting is not saved when you close your project or exit TunerStudio MS Lite.

2.6.2 Antialiasing Enabled

This is an on/off option that allows you to choose whether the edges of the graphical gauges are smoothed or not. On most modern monitors and laptop screens this has a negligible effect.

2.6.3 Designer Mode

This is an Upgrade feature allowing the dash to be redesigned that is not available in TunerStudio MS Lite.

2.6.4 Gauge Demo

The gauge demo is intended to give an impression of the abilities of the gauge cluster. This option has two sub-Menu Options which start and stop the Gauge demonstration respectively.

2.7 Work Offline

This is an on/off option that allows you to make changes to your configuration without burning changes to your Megasquirt. This can be also be a useful feature if your Megasquirt experiences connection problem and goes offline, or is not available. Once you have finished working offline **it is essential that you disable this option** so that TunerStudio can again communicate with your Megasquirt.

When hibernating a laptop with TunerStudio still running, such as at the race track, it may be useful to select "Work Offline" before hibernating for a smoother experience after hibernation. Otherwise, some computers may not correctly find the serial device again on wake-up.

If you are working offline the dashboard will display an “Off Line” message across the screen. If you see this and your Megasquirt should be connected make sure that the Work Offline option is not enabled.

2.8 Exit

Selecting File > Exit completely closes TunerStudio. In the event that your tune requires saving you will be prompted to do so before the software exits. Closing TunerStudio using your operating system's toolbar (e.g., the red close button on the top right of Microsoft® Windows®) will have exactly the same effect as File > Exit.

If you are updating your Megasquirt's firmware using the ms3loader_win32 application you must exit TunerStudio before you begin the firmware update. It is not possible for a Megasquirt to negotiate with the firmware updater and TunerStudio at the same time without causing errors.

3 Options Menu

The Options Menu, the second item on the top menu, allows you to:

- Customize the language used by, and the appearance of, TunerStudio;
- Customize how TunerStudio works.

3.1 Language

Clicking Options > Language gives you a list of the languages that TunerStudio supports.

This guide, and most other Megasquirt guides, are only available in English at this time.

3.2 Look and Feel

Clicking Options > Look and Feel allows you to select from four options:

- Metal (Default)
- Nimbus
- CDE/Motif
- Windows

The choice of “Look and Feel” is entirely personal, and does not alter the layout or features of TunerStudio in any way.

The images in this guide are all taken using the “Metal” look and feel. Although the content will not be different, the screens in the software will appear differently to the images in this guide if any of the other “Look and Feel” options are used.

3.3 Navigation

The “Navigation” options allow you to make other changes to appearance and behavior of TunerStudio.

3.3.1 Main Menu Style

Options > Navigation > Main Menu Style is a selectable option that means that both the top menu items and the toolbar button menus are combined and displayed as a single main top menu.

This has an advantage in that more of the screen is available for the visual instrumentation – i.e., the gauge cluster and diagnostics and high speed loggers (see Sections 19. to 21.) This option also makes it easier to use TunerStudio solely using a keyboard. The disadvantage is that the top menu becomes crowded using anything other than a very high resolution monitor.

3.3.2 Wrapping Main Menu

Options > Navigation > Wrapping Main Menu is a selectable option that means that both the top menu items and the toolbar button menus are combined and displayed as a single main top menu, but the contents of that menu are able to take up multiple lines.

Again this has advantages in that more of the screen is available for the visual instrumentation and TunerStudio can be easily used without a mouse. The disadvantage that the top menu becomes crowded is reduced using this option.

3.3.3 Toolbar Style

Options > Navigation > Toolbar Style is a selectable option that allows both the top menu items and the toolbar button menus are displayed separately. Whilst the room for the visual instrumentation is slightly reduced this is generally considered to be the easiest combination to use and this is the default layout.

The images in this documentation are all taken with the Toolbar Style selected. Some of the content of the screens in the software will appear different to the images in this guide if a different layout is used.

3.3.4 Navigation Options

Options > Navigation Options > Show Disabled Menu is an on/off selection that determines if disabled menu items are displayed.

The images in this document are taken with Show Disabled Menu switched on.

3.4 View

The “View” options allow you to show and hide some components of TunerStudio.

3.4.1 Show Gauges on VE Analyze

VE Analyze (VEAL) is an auto-tune feature of the Upgrade version of TunerStudio. Changing this option within TunerStudio MS Lite has no effect. The VEAL feature, whilst useful, is not a required feature in order to successfully configure your ECU.

3.4.2 Show Live Graphs on VE Analyze

VE Analyze (VEAL) is an auto-tune feature of the Upgrade version of TunerStudio. Changing this option within TunerStudio MS Lite has no effect.

3.4.3 Show Enable Condition in Menu Tooltips

This option enables “tooltips” to be displayed when you hover the mouse over a disabled (grayed out) menu option. These tooltips can be extremely helpful as they indicate the changes you need to make in order to enable an option. This guide explains how to enable disabled options in more detail, but it is still strongly recommended that this feature is always enabled.

3.5 Advanced

The “Advanced” options provide two specific choices that you can make in terms of how you use the software.

3.5.1 Report INI Warnings

Options > Advanced > Report INI Warnings is an on/off option that determines whether the software prompts you if there are any errors within the firmware version that your project is using. This option is largely for the use of the firmware developers and therefore most users will prefer to leave it disabled.

3.5.2 Always Allow Multiple Instances

Options > Advanced > Always Allow Multiple Instances is an on/off option that determines whether you are able to **easily** run more than one copy (or “instances”) of the TunerStudio at the same time.

In general terms it is not a good idea to have more than one instance of the software attempting to connect to your Megasquirt at the same time, as this potentially allows conflicting information to be sent to your product.

For this reason it is **strongly recommended** that this option is always disabled.

There are times when it **may** be useful to have more than one instance of the software running at the same time – for example if you want to compare two tunes side by side whilst working offline. You are still able to do this with Always Allow Multiple Instances switched off although you will be prompted to confirm that you want to start a second instance of TunerStudio. If you choose to do this it is essential that no more than one of the instances is connected to your Megasquirt. You can use the “Work Offline” option (See Section 2.7.) to make sure that any other instances of the software are not connected to (and cannot cause conflict with) your Megasquirt.

3.6 Preferences

The “Preferences” options allow you to alter additional aspects of the behavior of the software.

3.6.1 Set Dialog Font Size

Options > Preferences > Set Dialog Font Size allows you to choose the font size used throughout most of the software. It will alter the font size throughout TunerStudio with the exception of the top menu which has a fixed font size.

All images in this guide use the default dialog font size of 12. Screens will vary slightly with a different font size selected.

3.6.2 Perform Difference Report on Connect

Perform Difference Report on Connect compares the current configuration of your ECU with the configuration of the current tune file on your tuning computer. This can be useful if you have recently updated your firmware, or you want to restore an older tune created with an earlier version of the firmware. It is recommended that this option is enabled.

3.6.3 Automatically Load and Save Current Tune

Options > Preferences > Automatically Load and Save Current Tune is an on/off option that gives you a choice of two very different ways of managing the tune file for your Megasquirt. **By default this option is enabled when you install TunerStudio**. Feedback suggests that most users prefer to work with this option disabled, and so that is generally recommended, although if you are used to working with this option enabled there is no reason to change.

Since the use of this option is a matter of personal preference, the advantages and disadvantages of having this option enabled are briefly discussed below.

Leaving Automatically Load and Save Current Tune Enabled (default setting)

With this option enabled a tune file called “CurrentTune.msq” is created in the main folder for each project that you create. Any changes you make to your tune are automatically saved to this CurrentTune.msq file, which is also automatically loaded whenever you open your project. This means that your tune file is constantly available and up to date.

The downside of this option is that it is more difficult to keep track of backups, and it is more complicated to switch between tunes (as each backup needs to be loaded into CurrentTune.msq.) If you only use one tune file for each project, and you do need to regularly backup and restore, enabling this option may work well for you.

Disabling Automatically Load and Save Current Tune

If you disable this option you will need to open and save your tune files manually. This means that you will need to open and save tune files more often, although your latest tune will always be loaded from your Megasquirt whenever it is connected.

Whilst there is a little more opening and closing of files with this option disabled, it does give you more control in terms of keeping track of changes, backups and the management of multiple tunes.

Backing up Tune Files

Regardless as to whether or not you have this option enabled, you are still **strongly recommended** to make regular backups of your tune file using the “Save Tune As” option (see Section 2.5.) It is also recommenced that you backup your tune to a flash drive, external disk or cloud storage on a regular basis.

3.7 Performance

The “Performance” options give you some choices in terms of how you want to use the software. These can effect the efficiency of TunerStudio and how it communicates with your Megasquirt.

3.7.1 Gauge Float down on start

Options > Performance > Gauge Float down on start is a simple on/off option that determines whether the gauges in the gauge cluster are animated when the software starts. This option can be disabled without altering any other behavior of TunerStudio.

3.7.2 Modal Dialogs

Options > Performance > Modal Dialogs is an on/off option that determines whether more than one of the screens displayed from the toolbar menus can be displayed at the same time. It is recommended that this option is disabled with Megasquirt-3.

3.7.3 Run in Lite Mode

Options > Performance > Run in Lite Mode is a feature of the Upgrade version which allows users to revert to the feature set of TunerStudio MS Lite. This option is not relevant to users of TunerStudio MS Lite and is disabled (grayed out) in this version of the software.

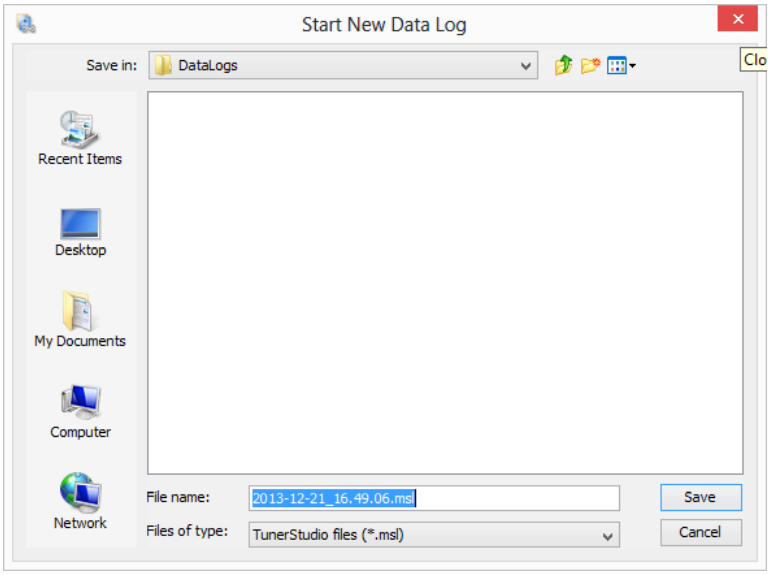
4 Data Logging Menu

The Data Logging Menu allows you to:

- Stop and Start logging data from your Megasquirt;
- View your saved log files using the accompanying MegaLogViewer software.

4.1 Start Logging

Clicking Data Logging > Start will display the Start New Data Log screen as shown below:



This will prompt you to save a new TunerStudio .msl file which will contain the data that is logged from your Megasquirt. By default this file will be saved in the DataLogs directory within the current project directory, although you can choose to browse and save it elsewhere if you prefer. As soon as you click “Save” the software will start to log data from your Megasquirt into this new file.

When data logging is running the “Data Logging” indicator label at the bottom of the gauge cluster will turn green.

4.2 Stop

Data Logging > Stop will cease data logging and the collated data file selected in the above section will be closed. Your data is now ready to be reviewed using MegaLogViewer.

At this stage the “Data Logging” indicator label at the bottom of the gauge cluster will return to its usual color.

4.3 Logging Profiles

Data Logging > Logging Profiles is a feature of the Upgrade version of the software which allows customization of the data collected. The standard format used for data logging will be sufficient to analyze the data collected from your Megasquirt.

4.4 Automatic Logging

Data Logging > Automatic Logging is also another Upgrade feature and is not documented in this guide.

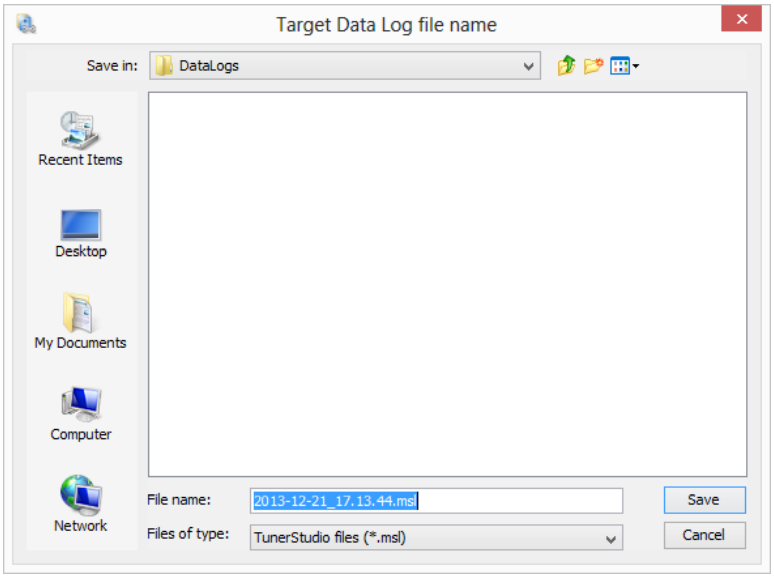
4.5 Import / Conversion

The “Import / Conversion” options allow data to be be imported from two other sources:

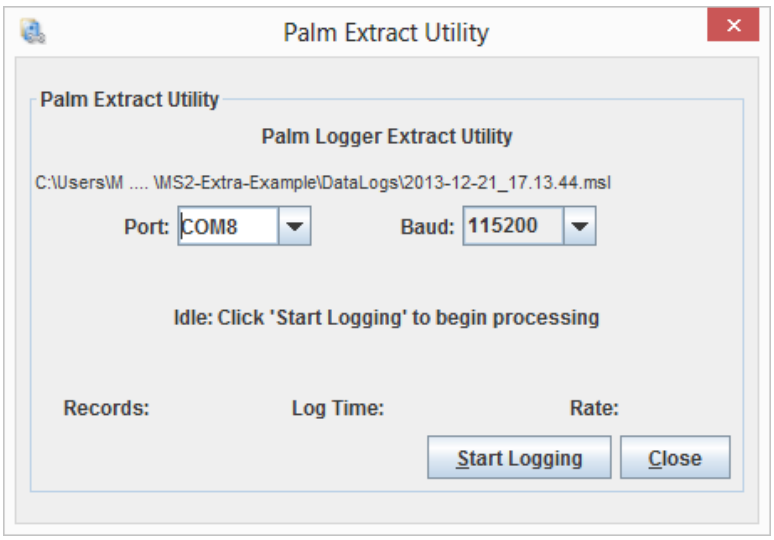
4.5.1 PalmLog Import Utility

This option allows data collected using propriety third party hardware and applications which save to the PalmLog format to be converted into a format that can be viewed with MegaLogViewer.

Clicking Data Logging > Import / Conversion > PalmLog Import Utility will display the Target Data Log screen as shown below:



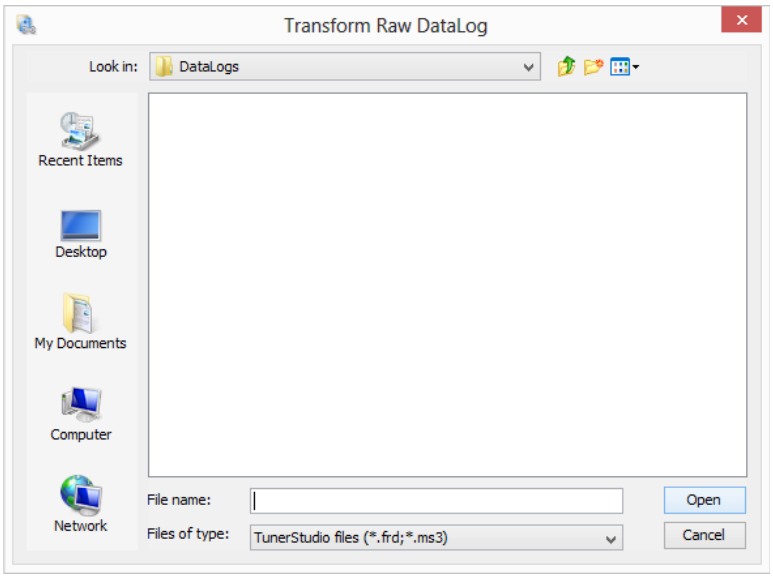
Once you have chosen the file that you want to save your data log to, the Palm Extract Utility screen will be displayed as shown below:



By following the options on this screen you will be able to produce a file that can be used viewed using MegaLogViewer.

4.5.2 Convert Binary Log (MS3, FRD)

Clicking Data Logging > Import / Conversion > Convert Binary Log (MS3, FRD) will display the Transform Raw DataLog screen as shown below:



MS3 datalogs are a binary logfile format that is written to the SDcard during SDcard datalogging. If the card is removed from the MS3 and inserted into your tuning computer, this option can be used to convert .MS3 logs into regular .MSL logs that can be viewed with MegaLogViewer. Contrast the log downloader in section 4.8.

FRD files **may possibly** be accessible using proprietary 3rd party hardware and applications.

Following the options on this screen should produce a file that can be used viewed using MegaLogViewer.

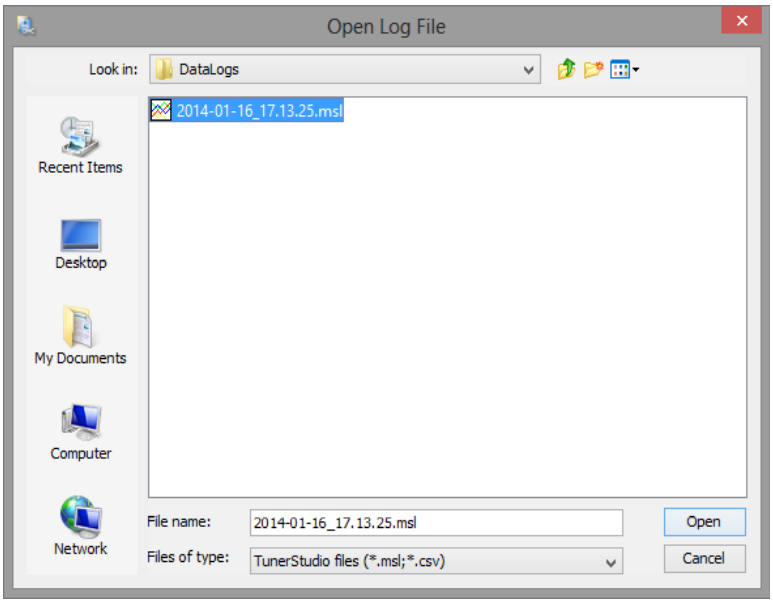
4.6 View with MegaLogViewer

MegaLogViewer is an analysis application which accompanies TunerStudio, and for which a license is included along with your Megasquirt. **MegaLogViewer needs to be installed for this option to work.**

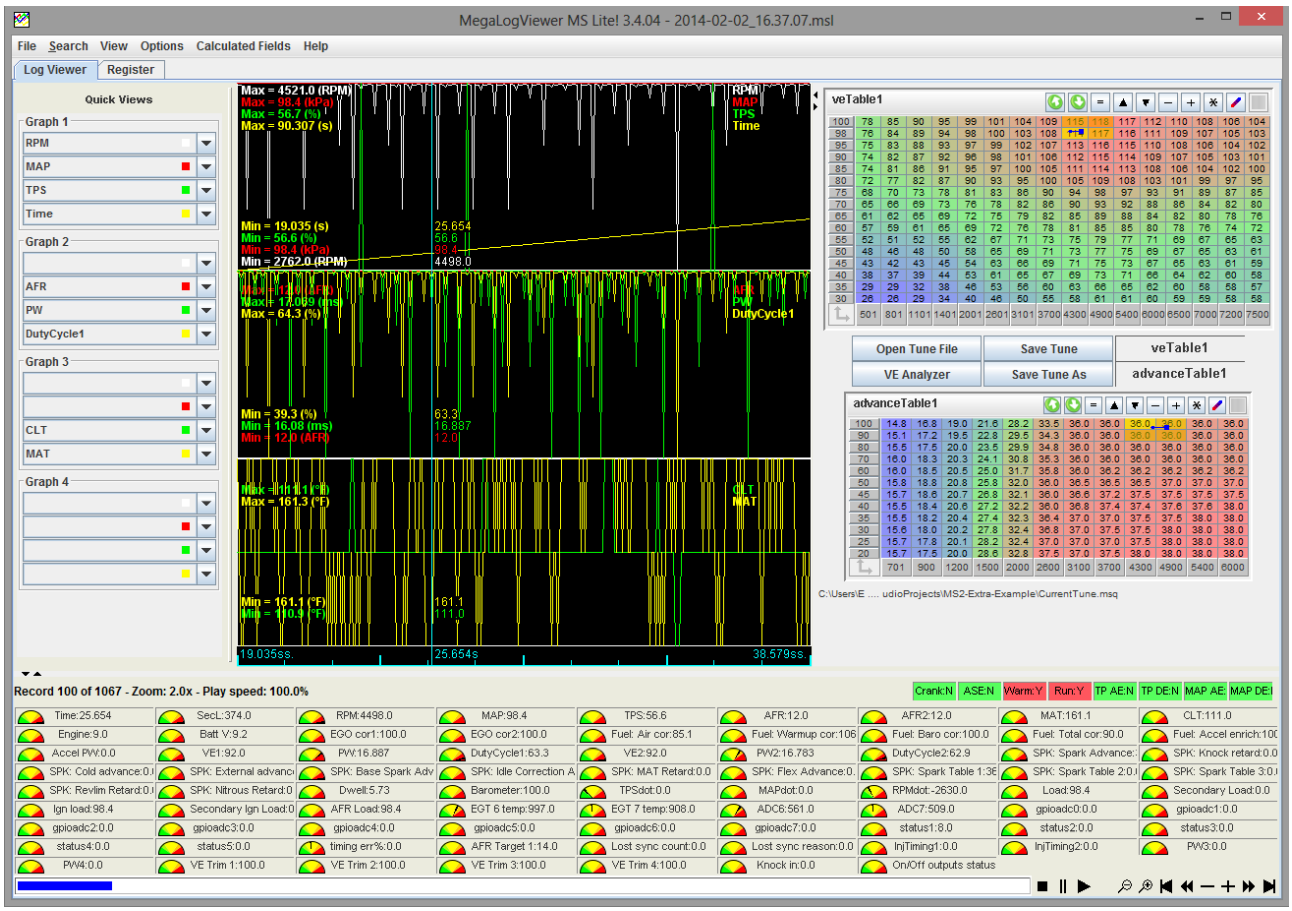
MegaLogViewer can be downloaded from: http://www.tunerstudio.com/index.php/downloads.

Complete documentation of MegaLogViewer falls outside the scope of this guide, although the key datalog fields that are relevant to your Megasquirt are documented in Section 4.6.1.

Clicking Data Logging > Import / Conversion > View with MegaLogViewer will display the Open Log File screen as shown below:



Selecting the data log file that you want to view and clicking “Open” will start MegaLogViewer with the data from your log file loaded in. A sample of the main MegaLogViewer screen is shown below:



From this screen you can review many of the sensor outputs and other readings from your Megasquirt. The “Quick View” graphs are especially useful and are easily customized using the options on the left hand side of the screen.

4.6.1 MegaLogViewer Datalog Fields

Below are listed all of the possible datalog fields for MegaLogViewer. Many fields are only visible if the relevant feature is enabled. e.g. EGT1 is only logged if EGT is enabled, VSS1 and fuel economy are only recorded if VSS is enabled etc. Some require additional hardware.

Accel X,Y,Z

The accelerometer X,Y,Z measured in SI units ms^{-2}.

AFR (1-8)

Air:fuel ratio reading from wideband EGO sensors 1-8.

AFR load

The “load” (e.g., MAP, TPS) used on the Y-axis of the AFR table.

AFR target 1

The current target value for AFR, looked up from the active AFR target table.

AFR target 1 error

The difference between actual and target AFR.

ALS added fuel

The fuel pulsewidth (time) adder due to the anti-lag system.

Alternator control duty

Output duty to control alternator.

Alternator control frequency

Output frequency to control alternator.

Alternator load

Measured load on the alternator.

Alternator target voltage

The voltage being targetted by the alternator control system.

Barometer

The barometer reading. This will show a current value if a dedicated baro sensor is installed, the initial MAP reading, or 100kPa if barometric correction is disabled.

Battery Voltage

The measured battery voltage (if this is radically different from your actual battery voltage, check for wiring faults.)

Battery Current

The measured battery current measured through the alternator control system.

Boost Duty1,2

The current duty cycle output to the boost solenoid1,2.

Boost psi

Boost in psi (derived from MAP and Barometer.)

Boost Target1,2

The target boost pressure 1,2 (in absolute kPa) for closed-loop mode.

CANpwmin0-3

Raw pulse period received over the CAN system from an expansion board.

CEL error code

This is the current error code. These are covered in more detail in the Megasquirt-3 Setting Up manual.

CEL status

This bitfield variable is a combination of binary bits about CEL faults. These are used to drive the CEL indicators:

128	64	32	16	8	4	2	1
EGT fault	RPM-sync fault	AFR fault	Battery fault	TPS fault	CLT fault	MAT fault	MAP fault

32768	16384	8192	4096	2048	1024	512	256
AFR shutdown	EGT shutdown	Fuel pressure fault	Oil fault	Cam fault	Knock fault	MAF fault	Flex fault

CEL status2

128	64	32	16	8	4	2	1
-	-	-	-	-	-	Safety shutdown	Water inj fluid low

Closed-loop idle target RPM

The target engine speed for closed-loop idle control.

Closed-loop idle RPM error

The difference between actual rpm and target rpm for closed-loop idle control.

CLT

The measured coolant temperature (CLT).

Duty Cycle 1

The calculated injector duty cycle on channel 1 (85% is a recommended maximum, above 100% is impossible.)

Duty Cycle 2

The calculated injector duty cycle on channel 2.

Dwell

The ignition dwell (charge) time on the main spark outputs.

E85 Fuel Correction

The percentage multiplier to fueling due to the flex fuel sensor.

EAE1

The percentage multiplier to fueling due to Enhanced Acceleration Enrichment channel 1.

EAE2

The percentage multiplier to fueling due to Enhanced Acceleration Enrichment channel 2.

EAE load

The “load” (e.g., MAP, TPS) used on the Y-axis of the EAE curves.

EGO cor 1-8

The percentage fuel correction from AFR1-8 when closed-loop EGO control is used (100% means no change.)

EgoV 1 Target

The current target value for EGO voltage (1,2), looked up from the active target table.

EgoV 1 Error

The difference between actual and target EGO voltage.

EGT 1-16

The reading from an external EGT sensor.

Engine

This bitfield variable is a combination of binary bits about engine status. These are used to drive the engine status indicators:

128	64	32	16	8	4	2	1
MAP decel enrichment	MAP accel enrichment	TPS decel enleanment	TPS accel enrichment	WUE active	ASE active	Cranking	Ready (active tach signal and pump running)

These values can be added together, e.g., 17 means Ready and TPS accel.

Ethanol Percentage

The calculated ethanol percentage in the fuel reported from the flex fuel sensor.

Fuel: Air cor

The percentage multiplier to fueling due to air density.

Fuel: Accel enrich

The current fuel pulsewidth percentage multiplier due to acceleration enrichment.

Fuel: Accel PW

The current fuel pulsewidth (time) adder due to acceleration enrichment.

Fuel: Baro cor

The percentage multiplier to fueling due to barometric correction.

Fuel: Total cor

The total fuel percentage multiplier obtained by multiplying the other factors. If this is outside of the range 80%-120% then there is likely something wrong with your tuning settings.

Fuel: Warmup cor

The percentage multiplier to fueling due to Warmup and Afterstart (this should be 100% on a warmed up engine.)

Fuel flow cc/min

Calculated averaged fuel flow. (Averaging period is set on Special Options - see Section 17.13.)

Fuel Pressure1_xxx

Primary differential fuel pressure in bar, kPa or bar. This is the differential fuel pressure above intake manifold pressure.

Fuel Pressure2_xxx

Secondary differential fuel pressure in bar, kPa or bar. This is the differential fuel pressure above intake manifold pressure.

Fuel pump control duty

The output duty cycle to control the fuel pump.

Fuel Temp1,2

Fuel temperature. 1 = primary fuel, 2 = secondary fuel

Fuel temperature cor

Correction to fuel due to fuel temperature.

Fuel pressure cor

Correction to fuel due to fuel pressure.

Gear

The current gear.

Generic Closed-Loop A,B duty

Output duty cycle from Generic Closed-Loop system.

GPS Altitude

Altitude in metres from external GPS.

GPS Course

The course/heading from external GPS.

GPS Latitude

Latitude degrees from external GPS. (Combination of degrees, minutes, seconds as one decimal number.)

GPS Lat. deg

Latitude degrees component from external GPS.

GPS Lat. min

Latitude minutes component from external GPS.

GPS Lat. sec

Latitude seconds component from external GPS.

GPS Longitude

Longitude degrees from external GPS. (Combination of degrees, minutes, seconds as one decimal number.)

GPS Lon. deg

Longitude degrees component from external GPS.

GPS Lon. min

Longitude minutes component from external GPS.

GPS Lon. sec

Longitude seconds component from external GPS.

GPS Lon. E/W

Longitude East/West indicator from external GPS.

GPS Speed

The speed from external GPS in your chosen speed units.

GPS Speed ms-1

The speed from external GPS in ms^{-1}.

Ign Load

The 'load' (e.g., MAP, TPS) used on the Y-axis of the ignition tables.

Injector Timing pri

The injection timing used for primary injector channels.

Injector Timing sec

The injection timing for secondary injector channels.

Knock cyl# 1-16

The signal value per-cylinder from the internal knock sensor interface.

Knock In

The signal value from an optional add-on knock sensor interface.

l/100km

Fuel economy in litres per 100 kilometres.

Lambda (1-8)

Lambda reading from wideband EGO sensors 1-8.

Lambda 1 Target

The current target value for Lambda (1,2), looked up from the active target table.

Lambda 1 Error

The difference between actual and target Lambda.

Launch retard timer

Timer for timed-retard after launch.

Launch timed retard

The retardation to the timing due to the timed-retard after launch.

Load

The primary '"load" for fuel calculations (this is equal to MAP on typical speed-density installs.)

Long term fuel trim cor

Fuel correction due to long term trim.

Lost sync counter

The count of "lost-sync" events. If the engine stalls the counter will increase by one. During startup it is acceptable to have a few lost syncs. If you see this counting up under other conditions there is a problem with your tach input.

Lost sync reason

A technical reason code for why the ECU lost synchronization with the tach input. Not particularly useful. The codes are listed in the Setting Up manual.

MAF

The air-flow in g/sec calculated from the MAF sensor.

MAFload

A calculated “load” value that works similarly to MAP in a speed-density system, (makes for better use of the

lookup tables.)

MAF_volts

The raw voltage input from a voltage MAF sensor.

MAF_freq

The raw frequency input from a frequency MAF sensor.

MAP

The measured MAP (on typical speed-density installs this should read close to 100kPa during key-on, engine-off and between 30kPa and 60kPa at idle.)

MAP accel

MAP acceleration component of accel-pump.

MAPdot

The rate of change of MAP (the increase in MAP per second.)

MAT

The measured intake manifold air temperature (MAT).

MPG(UK)

Fuel economy in miles per UK gallon (4.546 litres).

MPG(USA)

Fuel economy in miles per US gallon (3.8 liters.)

Nitrous 1,2 duty

The duty cycle to the nitrous solenoids in progressive mode.

Nitrous added fuel

The fuel pulsewidth (time) adder due to the nitrous system.

Nitrous timer

The delay timer for the nitrous system.

O2 (#1-8)

Input voltage from narrowband EGO sensors 1-8.

portXX

These datalog fields record the raw status of the input/output pins on the microcontroller within the Megasquirt ECU. The layout in this manual is:

128	Bit field value
PORTA7	CPU pin
Inj H	MS3 name
Inj H	MS3-Pro name

porta is PORTA

128	64	32	16	8	4	2	1
PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0
Inj H	Inj G	Inj F	Inj E	Inj D	Inj C	Inj B	Inj A
Inj H	Inj G	Inj F	Inj E	Inj D	Inj C	Inj B	Inj A

portb is PORTB

128	64	32	16	8	4	2	1
PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0
Spk H	Spk G	Spk F	Spk E	Spk D	Spk C	Spk B	Spk A
Spk H	Spk G	Spk F	Spk E	Spk D	Spk C	Spk B	Spk A

porteh is a combination of PORTE and PTH

128	64	32	16	8	4	2	1
PTH7	PTH6	-	PORTE4	-	PORTE2	PORTE1	PORTE0
Nitrous in	Tablesw. in		F.PUMP		FLEX	PE1	PE0/JS7
Digi Switch 12V in	Digital in 4	-	F.PUMP	-	Digi Switch in 1	-	-

portk is PORTK

128	64	32	16	8	4	2	1
PORTK7	PORTK6	PORTK5	PORTK4	PORTK3	PORTK2	PORTK1	PORTK0
PK7 (H1)	-	-	-	PK3 (H3)	Launch in	PK1 (H4)	Tacho out
-	-	-	-	(internal)	Digi Switch in 2	(internal)	Tach Out

portmj is a combination of PTM and PTJ

128	64	32	16	8	4	2	1
PTJ7	PTJ6*	PTM5	PTM4	PTM3	PTM2	PTJ1	PTJ0
JS11	(IAC EN)	D15	D16	D14	PM2(H2)	IAC2	IAC1
(Internal)	(IAC EN)	(Internal)	(Internal)	(Internal)	(Internal)	Stepper Out 2	Stepper Out 1

* 1.3.3 upwards

portt is PTP

128	64	32	16	8	4	2	1
PTP7	PTP6	PTP5	PTP4	PTP3	PTP2	PTP1	PTP0
FIDLE	VVT	Nitrous2	Nitrous1	Boost	Idle	(INJ2 PWM)	(INJ1 PWM)
PWM / Idle Out 1	PWM Out 3	High Curr. Out 2	High Curr. Out 1	High Curr. Out 3	PWM Out 2	-	-

portt is PTT

128	64	32	16	8	4	2	1
PTT7	PTT6	PTT5	PTT4	PTT3	PTT2	PTT1	PTT0
-	Datalog in	JS10	PT4	INJ 2	Cam in	INJ1	Crank in
-	Digi Freq In 3	Digi Freq In 2	Digi Freq In 1	Inj J	CMP	Inj I	CKP

PW1

The base fuel pulsewidth for injector channel 1. This is the actual electrical pulsewidth including deadtime, but not trim. See also SeqPW1.

PW2

The base fuel pulsewidth for injector channel 2. This is the actual electrical pulsewidth including deadtime, but not trim. Primarily for dual table or dual fuel.

PWM A-F duty

Output duty cycle from Generic PWM system.

PWM Idle Duty

The current duty cycle output to the idle valve.

RPM

The tachometer / rev counter (if this is dropping to zero or bouncing around, you probably have a problem with the tach-in signal.)

RPMdot

The rate of change of RPM (the increase in RPM per second.)

SDcard error

Error code for SDcard datalogging system - see the Setting Up manual for a list. Only relevant in "serial" datalogs.

SDcard file number

The current active datalog file number on the SDcard. Only relevant in "serial" datalogs.

SDcard phase

Technical code relating to SDcard datalogging system. Only relevant in "serial" datalogs.

SDcard status

Bitfield indicating current status of SDcard datalogging system. Only relevant in "serial" datalogs.

SecL

A built in clock that counts up seconds since the Megasquirt was last turned on. If this suddenly resets to zero, you probably have a power connection problem.

Secondary Ign Load

Like “Ign Load” but used for the secondary lookup table.

Secondary Load

Like “Load” but used for the secondary lookup table.

Sensor01-16

The reading from a sensor converted into your chosen units through the Generic Sensors system. You can also give the sensors a name of your choice which will then be used in the datalog.

Seq PW1-8

The base fuel pulsewidth for the injector on cyl#1. This is the actual output electrical pulsewidth including deadtime, all corrections and trim. (The "Firing Order" setting is used to determine which cylinder is which as the injectors always fire in the same order. A,B,C...)

SPK: 3-step Timing

The spark timing/advance taken from the 3-step system.

SPK: ALS Timing

The spark timing/advance taken from the anti-lag system.

SPK: Base Spark Advance

The spark timing/advance looked up from the ignition table before other adjustments are made.

SPK: CEL retard

The retardation to the timing due to check engine light and limp mode.

SPK: Cold advance

The advancement to the timing due to the cold advance curve.

SPK: External Advance

The external advancement to the timing, e.g., from a transmission controller.

SPK: Flex Advance

The advancement to the timing due to flex fuel.

SPK: Fuel cut retard

The retardation to the timing due to over-run fuel cut.

SPK: Idle Correction Advance

The advancement to the timing due to idle correction.

SPK: Knock Retard

The retardation to the timing due to knock control.

SPK: Launch Timing

The spark timing/advance taken from the launch (2-step) system.

SPK: Launch VSS Retard.

The retardation to the timing due to the speed based launch system.

SPK: MAT Retard

The retardation to the timing due to the MAT retard curve.

SPK: Nitrous Retard.

The retardation to the timing due to the nitrous system.

SPK: Revlim Retard

The retardation to the timing due to the rev limiter.

SPK: Spark Advance

The overall ignition advance.

SPK: Spark Table 1

The looked up spark advance from ignition table 1.

SPK: Spark Table 2

The looked up spark advance from ignition table 2.

SPK: Spark Table 3

The looked up spark advance from ignition table 3.

SPK: Spark Table 4

The looked up spark advance from ignition table 4.

SPK: Traction retard

The retardation to the timing due to traction control.

Shaft rpm 1,2

Shaft speed in RPM.

status1-8

These bitfield variables is a combination of binary bits about engine status. These are used to drive various status indicators.

status1

128	64	32	16	8	4	2	1
Full-RPM Synced	Spark Table-sw	Fuel Table-sw	(Synclatch)	RPM Synced	Config Error	Lost Data	Need Burn

status2

128	64	32	16	8	4	2	1
CL Idle	Over Boost	Spark Cut	Flat Shift	Launch	Launch In	N2O stage 2	N2O stage 1

status3

128	64	32	16	8	4	2	1
Launch On	Seq. Shift	Soft Limit	3-Step In	Test mode	3-Step	T Log	Fuel Cut

Status 4, 5

Typically only used by developers. The CEL system allows status5 to be used to record raw ADC counts or fluctuations of inputs.

status6

128	64	32	16	8	4	2	1
MAPsample error	Fan	Idle Advance	Idle VE	AFR Shutdown	AFR Warn	EGT Shutdown	EGT Warn

status7

128	64	32	16	8	4	2	1
Limp Mode	CEL	AC	Knock	VVT4 Error	VVT3 Error	VVT2 Error	VVT1 Error

status8

128	64	32	16	8	4	2	1
-	-	VSS Launch	VSS Launch Lock-out	PW4X Mode	Water Injection Low	Spark Disable Mode	Injectors Disable Mode

Stepper Idle position

The current stepper valve position (0 means fully closed.)

Time

TunerStudio maintains a time since it was started and records this is the datalog. The time is shown at the bottom of the graph area. When discussing datalogs, be sure to refer to this time (e.g., look at 145s in the log where...)

Timing err

A calculation of how accurately the position of the next tach tooth was predicted. Not very useful.

Total accel

Combination of TPS and MAP acceleration components of accel-pump.

TPS

The 0-100% throttle (pedal) position (check the calibration settings if you do not get 0-100%)

TPS accel

TPS acceleration component of accel-pump.

TPSADC

The raw ADC input of the throttle (pedal) position.

TPSdot

The rate of change of TPS (the increase in TPS per second.)

VE1,2

The looked up VE value for channel 1,2 (includes blends)

VSS1-4

Vehicle (wheel) speed sensor inputs in your chosen speed units.

VSS1-4 ms-1

Vehicle (wheel) speed sensor inputs in SI units ms^{-1}.

VSS1dot VSS2dot

The rate of change of VSS (acceleration) measured in SI units ms^{-2}.

VVT angle 1,2,3,4

The current relative angle of VVT cam 1,2,3,4

VVT duty 1,2,3,4

The solenoid output duty cycle for VVT cam 1,2,3,4

VVT target 1,2,3,4

The target angle of VVT cam 1,2,3,4

WallFuel1

The calculated fuel puddle volume on the intake port walls, channel 1.

WallFuel2

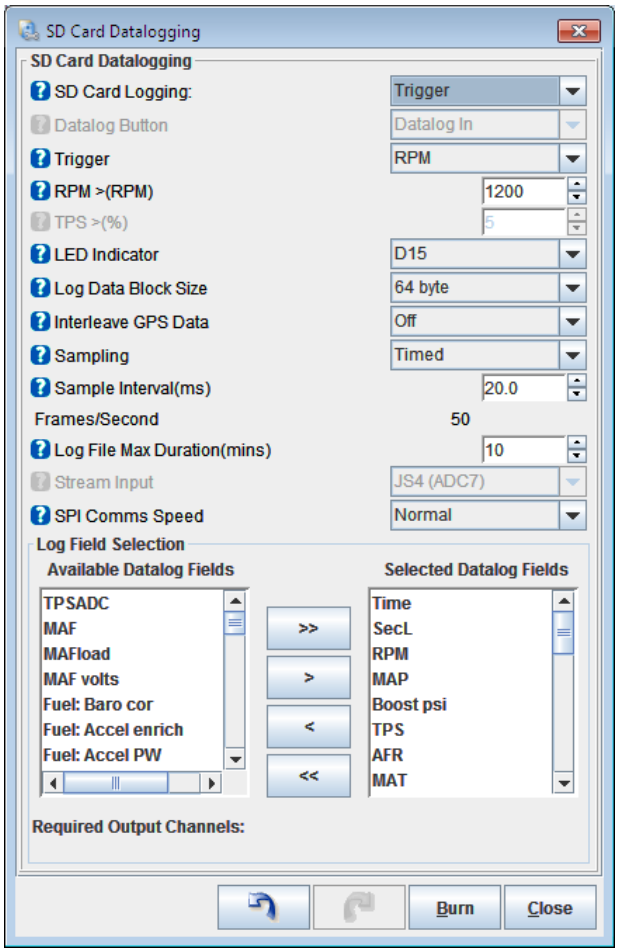
The calculated fuel puddle volume on the intake port walls, channel 2.

Water Duty

The duty cycle to the water injection solenoid.

4.7 SDcard datalogging

The Megasquirt-3 includes provision to datalog to an internal SDcard without the need for a laptop. The SDcard system records smaller blocks of data at a higher speed than regular 'serial' datalogs on a laptop. As a result of this, you are required to select which Datalog Fields you want recorded.



SD card logging

- Disabled - turns off the SDcard logging feature
- Always - basically it means always log. It is best not to insert the SD card while the Megasquirt is powered on and most certainly do not unplug the card while the power is on. Card damage can result.
- Button - logging is controlled by a push button
- Trigger - logging starts when a trigger condition is met

Datalog button

This selects the input pin used for the button if used.

RPM >

A log is started when RPMs exceed this trigger value.

TPS >

A log is started when TPS exceeds this trigger value.

LED indicator

This selects the output used for the optional LED indicator

Log data block size

- 64 byte is the most common setting
- 64 byte + stream allows the simultaneous recording of data and a 8kHz mono sound input. This could be used as a commentary during a datalog such as position on a racetrack or notable incidents in the log. Presently TunerStudio does not support extracting this audio data.

Interleave GPS data

When Megasquirt is configured to fetch GPS data internally (not a GPS module on your tuning computer) it can also record this data onto the SDcard. As the GPS data is far slower than the other datalog fields, it is slotted in between the other data.

Presently TunerStudio does not support extracting this GPS data.

Sampling

- Timed - a data sample is taken at predefined time interval - this is the most common option
- every tooth, every cycle - for special logging and at low engine speeds these options take a data sample at these events

Sample interval

How often to take a data sample.

3ms is the fastest supported, but many cards will only sustain 5ms before you start getting small gaps in the logs.

Frames/second

This shows how many data-points will be recorded per second at your chosen sample interval.

Log file max duration

How long each datalog should be.

The files are always created full size and fill up the allocated space during logging. If the log file is filled, a new file is started. If you turn off the power to the Megasquirt (which is safe to do during a log) the log will show full size however much data is actually in it. When the log file is extracted, the unused part of the allocated file will be ignored. (Note, it is impossible for the Megasquirt-3 to set the file length or otherwise "clean up" the log file in this case because there is no power and the processor is off !) A result of this is that all log files on the SD card will appear the same size.

Stream input

What input is used for a 0-5V audio signal for the stream logging option.

SPI comms speed

This setting is not used with Megasquirt-3 products manufacturer since 2013. Generally it should be set to "Normal" and only reduced in the rare cases of communication problems with the SDcard.

Log field selection

The field selector allows you to choose which data fields you want to log. Because of the compact datalog format, only 64 bytes are available total, so you need to pick the data that you find most critical.

To add a field, highlight it on the left and then click on > to move it to the right.

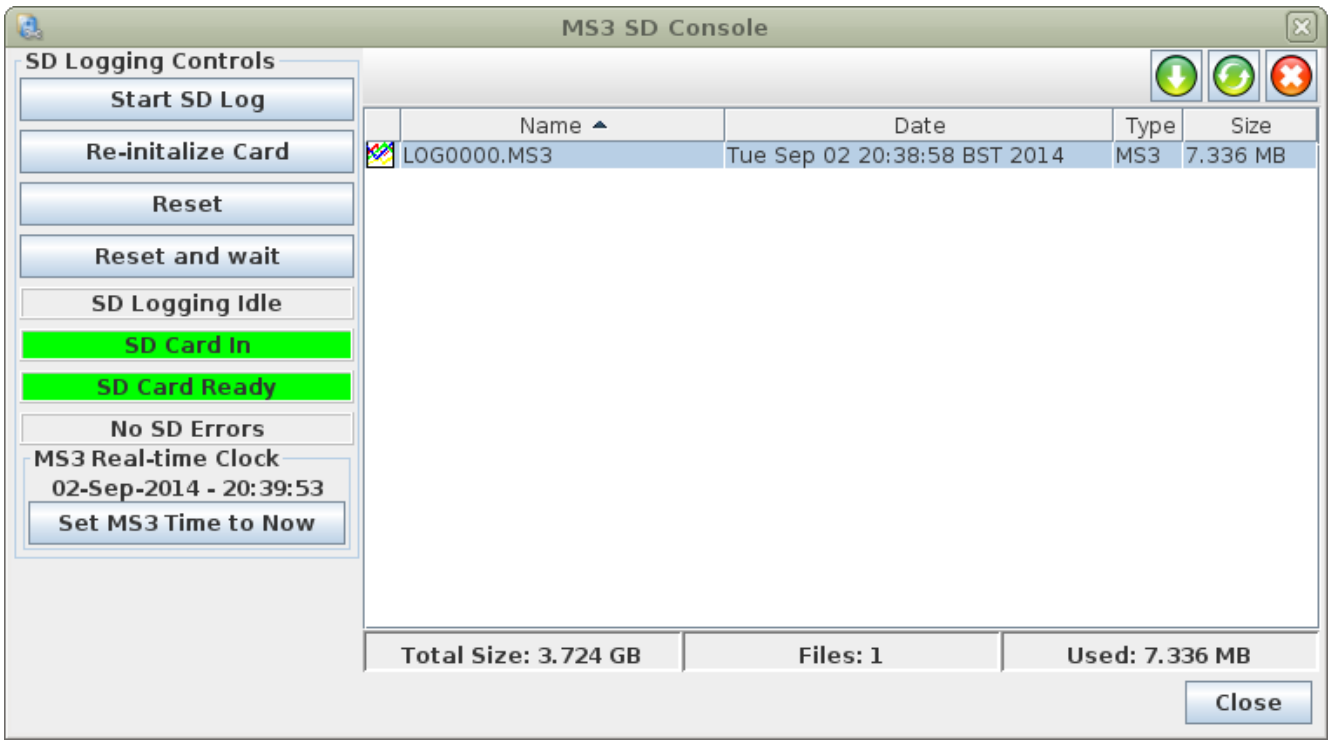
To remove a field, highlight it on the right and then click on < to move it to the left.

4.8 Browse/Import SDcard

This allows the SDcard datalogs to be read back from the SDcard while it is still attached to the Megasquirt. This is the only method to retrieve datalogs on the MS3-Pro.

It will only be accessible if SDcard datalogging is enabled and TunerStudio is online with the ECU.

The main workflow on this page will consist of highlighting a file or a number of files in the file pane and then clicking the Download button. The engine must be powered on, but with zero RPMs to download files.



Start SD log

Typically this is only used for testing. Ordinarily the options on the SDcard datalogging page should be used for starting and stopping datalogs.

Re-initialize Card

Typically this is only used for testing. This forces the card to be re-initialized.

Reset

Typically this is only used for testing. This forces the SDcard system to reset.

Reset and wait

If a log is currently in-progress this will stop the log and wait for further instruction such as downloading a log file.

Set MS3 Time to Now

For ECUs with a realtime clock this allows the time to be synchronized with your tuning computer.

Download select file(s).

Refresh file list.

Delete selected file(s).

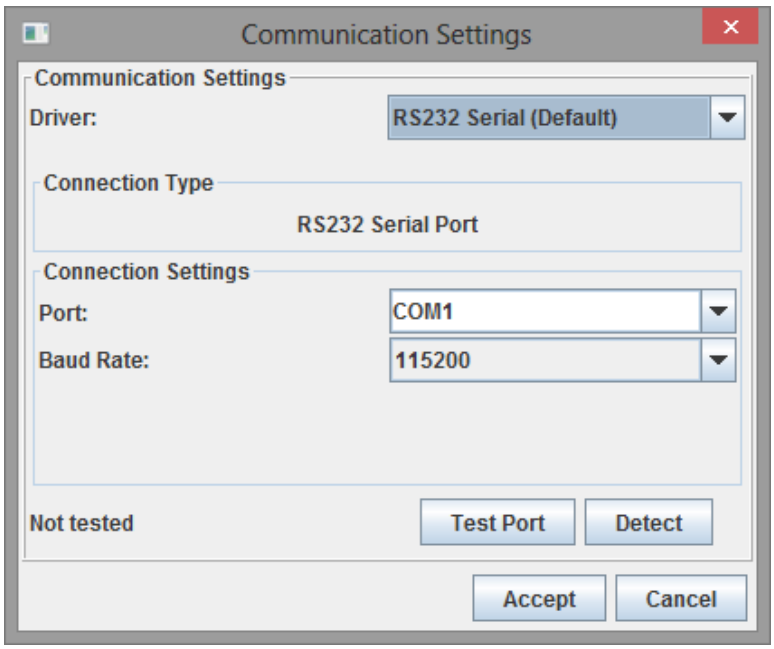
5 Communications Menu

The Communications Menu is used to set up and test communications between your computer and your Megasquirt. It will be useful if you are having problems connecting to your Megasquirt, or if you need to used an advanced setting.

Using many of the options within the communications menu will temporarily close the connection between your computer and your Megasquirt. This is normal and necessary for these options to work effectively. TunerStudio should reconnect to your Megasquirt again automatically after the communications screen you have been using has been closed. If this doesn't happen reopen the screen and carefully check any changes that you have made.

5.1 Settings

Clicking Communications > Settings will display the Communications Settings screen as shown below:



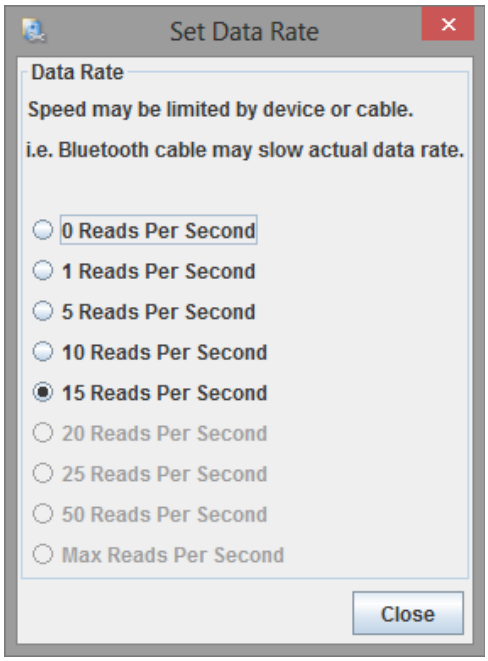
This screen is virtually identical to the third of the Create New Project screens (See Section 2.1.1.) Please refer to that section for most of the settings options shown on this screen.

The only real addition is the “Detect” button. This will scan your computer for Megasquirt products which can be helpful if you have changed the way that you are connecting to your Megasquirt and need to update the communications settings for your project. It is also helpful if you were having problems connecting to your Megasquirt whilst creating your project.

You may see two Megasquirt devices listed with JSSC and RXTX. RXTX will use the default legacy driver and is the correct device to use at this time. RXTX is an older communications technology that will probably be phased out in the future, but remains current at the time or writing.

5.2 Data Rate

Clicking Communications > Data Rate will display the Set Data Rate screen as shown below:



As a general rule 15 Reads Per Second is the preferred setting. If you connect using a slower connection type such as bluetooth your actual data rate **may** be lower.

5.3 Enable GPS Support

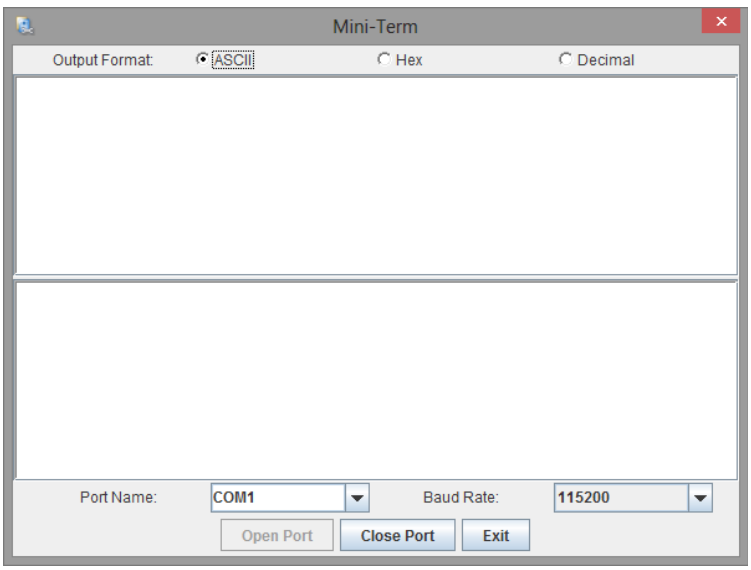
This menu refers to TunerStudio communicating directly to a GPS for logging onto a laptop. That GPS data cannot be used internally within the Megasquirt. The TunerStudio GPS support is only included in the Upgrade version of TunerStudio.

See also the CAN/GPS section of the manual.

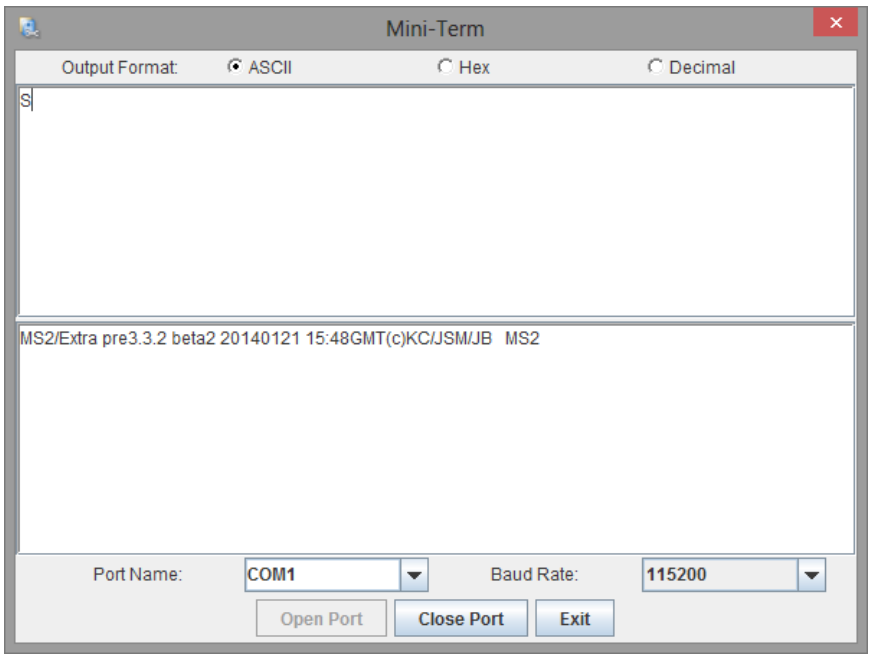
5.4 Mini Terminal

The Mini Terminal is a command line interface that can be used to interrogate your Megasquirt. Normally use of this terminal is restricted to diagnostics and support provided by Megasquirt technical experts.

Clicking Communications > Mini Terminal will display the Mini-Term screen as shown below:



As simple example of how Mini Terminal works is as follows: With your ECU connected and powered up, typing “S” into the top half of the screen should display the version of your Megasquirt and the firmware that it contains as shown below:



The other commands that can be used with Mini Terminal fall outside the scope of this guide.

5.5 Debug Log Comm

Your TunerStudioProjects file will contain a filed called “TunerStudioAppDebug.txt”. This is TunerStudio's internal log file which is created when the software is first installed and is updated whenever TunerStudio is used. This file is extremely useful for technical support in the event that you should experience problems with TunerStudio.

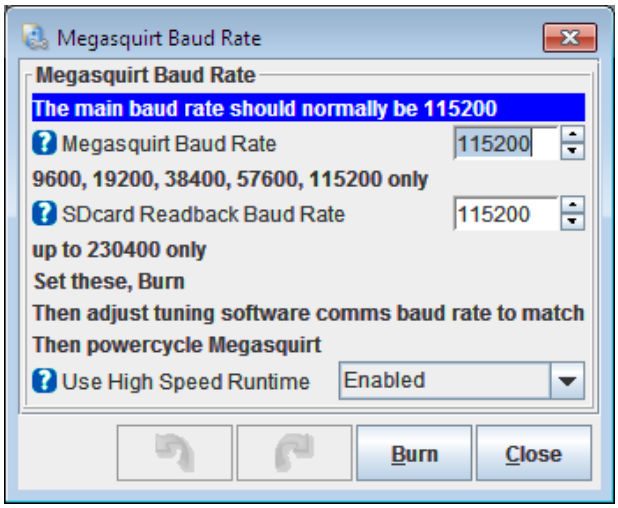
Occasionally it is useful for those providing TunerStudio support to obtain a more detailed log file to carry out troubleshooting. The Debug Log Comm option is an on/off setting which can be enabled or disabled by clicking Communications > Debug Log Comm. When enabled, this option instructs TunerStudio to write much more detailed information to the TunerStudioAppDebug.txt file.

Do not enable this option for any length of time or it will turn into a very large file very quickly. As a rule this option should only be enabled for a short period of time either at the request of a support technician, or for your own use if you have a good knowledge of the contents of the log file.

5.6 Megasquirt Baud Rate

Section 2.1.1. of this guide (New Project) details that for almost all Megasquirt-3 installations the baud rate should be set to 115200. The baud rate can theoretically be set to a lower level although this is generally not desirable and should only be done by advanced users under exceptional circumstances.

Clicking Communications > Megasquirt Baud Rate will display the Megasquirt baud rate screen as shown below:



Megasquirt Baud Rate

This sets the main serial communication speed that is used for all tuning and datalogging.

Generally it is advised that the main Megasquirt Baud Rate be left at 115200 unless you have a very good reason to change it.

To set your baud rate to a lower rate than 115200 **carefully** follow these five steps:

- Set the reduced baud rate using the above screen and click “Close”;
- Click Communications > Settings and display the Communications Settings screen;
- Under Baud Rate select **exactly the same value** you entered in the Megasquirt baud rate screen;
- Click “Accept”;
- Power off and then restart your ECU. It should now connect at the reduced rate.

These steps **must** be carried out in the order outlined above for the change to work correctly!

SDcard Readback Baud Rate

This sets the serial communication speed that is used when reading back SDcard datalogs. Many computers and serial driver combinations will support increased speeds. Useful options are 115200, 230400 and 460800. Use the highest speed that gives reliable operation. The higher the baud rate, the faster SDcard datalogs will download (see also section 4.8)

Use High Speed Runtime

There are two settings:

- On - enables a faster method of collecting realtime data from the ECU. Recommended.
- Off - use previous slower method for realtime data.

6 Tools Menu

The Tools Menu contains a range of options. Of these, the options you are most likely to use are the calibration options which are an important component of your Megasquirt configuration.

Megasquirt-3 uses internal calibration tables to convert the resistance/voltage from the input sensors into a real world number. It is necessary to setup this calibration so the inputs read correctly. The built-in calibrations for coolant temperature (CLT) and air temperature (MAT) are for GM sensors, so if you have GM sensors you are safe to leave these alone. All installs should set the calibration for the AFR (air fuel ratio) table that is used for the oxygen sensor (lambda sensor) whether narrowband or wideband.

6.1 Protocol Stats

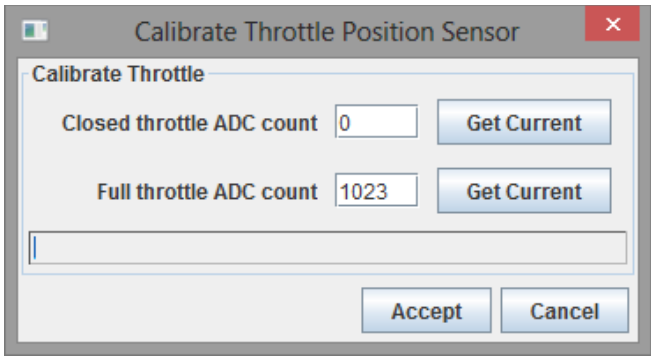
Protocol Stats are generally used by developers and for technical support. This feature lies beyond the scope of this guide.

6.2 TunerStudio Plug-ins

TunerStudio Plug-ins are additional modules which are created at community level and can be used to add additional features to TunerStudio. Plug-ins are only available within the Upgrade version of TunerStudio. Any documentation for Plug-ins should be provided by their developers.

6.3 Calibrate TPS

The Calibrate TPS option allows you to calibrate your throttle position sensor. Clicking Calibrate TPS will display the Calibrate Throttle Position Sensor screen as show below:



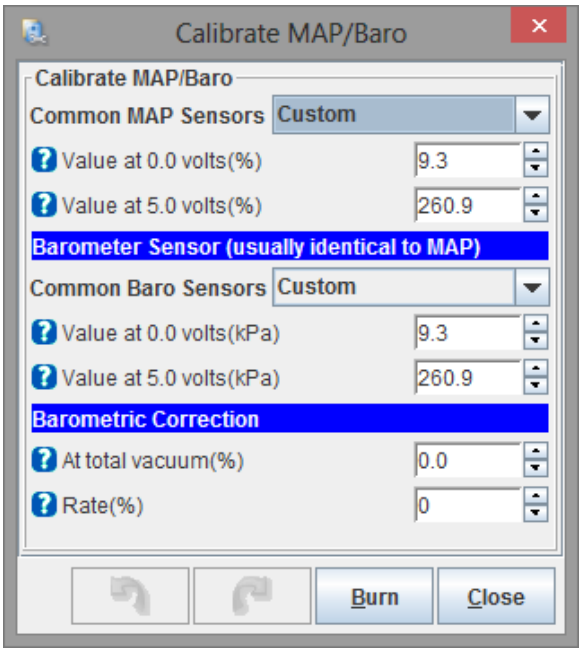
To calibrate the throttle position sensor do the following:

- Ensure that your Megasquirt is connected and the engine is not running (i.e., KOEO).
- Ensure that the throttle is closed;
- Click the “Get Current” button to the right of “Closed throttle ADC count”;
- Fully open the throttle;
- Click the “Get Current” button to the right of “Full throttle ADC count”;
- Click Accept and your throttle sensor will be calibrated.

6.4 Calibrate MAP / Baro

The Calibrate MAP / Baro option allows you to calibrate your MAP (Manifold Absolute Pressure) and Barometric Pressure sensors.

Clicking Tools > Calibrate MAP / Baro will display the Calibrate MAP/Baro screen as shown below:



The options for these settings are described below:

Common MAP Sensors

This gives a list of the commonly used MAP Sensors. If you are using one of these sensors select if from the drop down list, otherwise select “Custom”.

Value at 0.0 volts (%)

If you have selected one of the Common MAP Sensors this setting will be set automatically. If you are using a custom sensor enter the appropriate value for your sensor in this text box.

Value at 5.0 volts (%)

Again, if you have selected one of the Common MAP Sensors this setting will be set automatically. If you are using a Custom sensor enter the appropriate value for your sensor in this text box.

Common Baro Sensors

This gives a list of the commonly used Baro Sensors. If you are using one of these sensors select if from the drop down list, otherwise select “Custom”.

Value at 0.0 volts (%)

If you have selected one of the Common Baro Sensors this setting will be set automatically. If you are using a custom sensor enter the appropriate value for your sensor in this text box.

Value at 5.0 volts (%)

Again, if you have selected one of the Common Baro Sensors this setting will be set automatically. If you are using a custom sensor enter the appropriate value for your sensor in this text box.

Barometric Correction At total vacuum (%)

This setting related to the barometric correction to fuel at a total vacuum.

For new installs set this value to zero and the barometric correction curve to 100% across the board.

Imported settings from older code versions use a vacuum of 147 and have the curve at zero.

Barometric Correction Rate (%)

The rate of change of correction

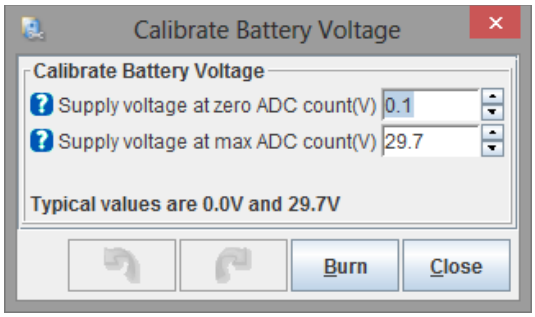
For new installs set this value to zero and the barometric correction curve to 100% across the board.

Imported settings from older code versions use a rate of -47 and have the curve at zero.

6.5 Calibrate Battery Voltage

It is not usually necessary to calibrate the battery voltage. **Do not alter these values from the defaults unless you have confirmed the actual voltage reading is inaccurate.**

Clicking Tools > Calibrate Battery Voltage will display the Calibrate Battery Voltage screen as shown below:

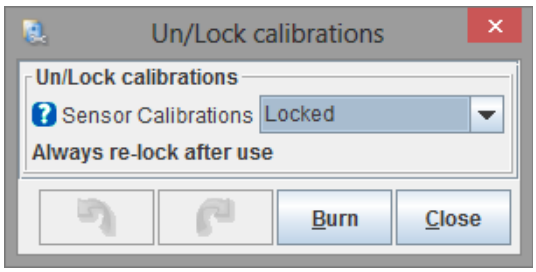


These settings can be used to correct battery voltage readings at (and between) zero and max.

6.6 Un/Lock calibrations

The calibration settings for Thermistor Tables, AFR Tables and MAF Tables can be locked or unlocked to prevent them from being changed accidentally.

Clicking Tools > Un/Lock calibrations will display the Un/Lock calibrations screen as shown below:

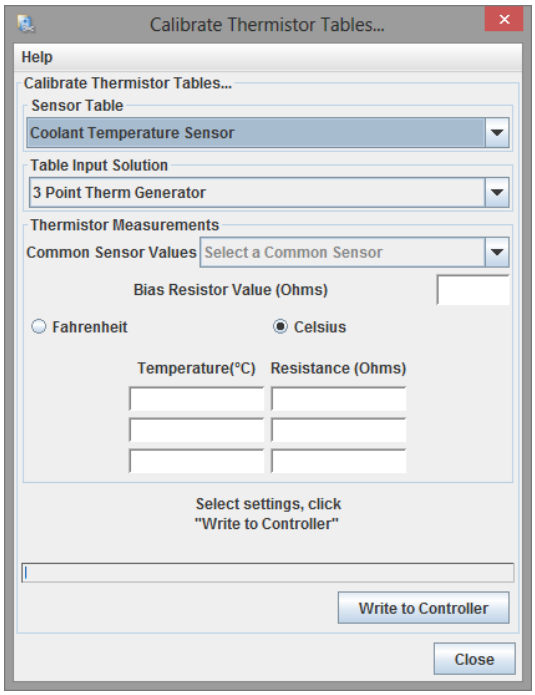


Selecting “Locked” or “Unlocked” will disable or enable the remaining calibration options.

If you unlock Sensor Calibrations **please ensure** that they are locked again once you have made your changes.

6.7 Calibrate Thermistor Tables

Clicking Tools > Calibrate Thermistor Tables will display the Calibrate Thermistor Tables screen as show below:



From this screen you can set the CLT (coolant temperature) calibration if needed. The options for these settings are described below:

Sensor Table

Select whether you are using a “Coolant Temperature Sensor” or an “Air Temperature Sensor”.

Table Input Solution

This value will normally be set to “3 Point Therm Generator”. It can also be set to “Custom Inc File”

If you select “Custom Inc File” for this setting the screen will update and you will be given the option to browse for your .inc file. To use this option you need to have an .inc file containing your thermistor settings on your hard disk. If you use this option then you will not need to use the other settings described in this section.

Common Sensor Values

From this option you can select your sensor type. You can select from a predefined list of common sensors using the drop down list, or leave this option unselected if you are using custom settings specific to an unlisted sensor.

Bias Resistor Value (Ohms)

If you have selected one of the common sensors this value should be set for you. If you are using a custom sensor you may need to set this value manually. If you are using a **MS3-Pro** or **MS3-Gold** these values should **always** be set to the default of 2490 ohms. If you are using an **MS3** the values will usually also be the default of 2490 ohms **unless** you or your vendor have changed the resistors on the mainboard. Your vendor should inform you if these resistors have been changed prior to shipping.

If necessary, these can be checked by inspecting the Megasquirt mainboard (V3.0 or V3.57 only.) R7 is the bias resistor for the coolant temperature sensor, R4 is the bias resistor for the air temperature sensor.

Temperature Settings (°C or °F)

Again, if you have selected one of the common sensors these values should be set for you. If you are using a custom sensor enter the three measured temperature and resistance value pairs.

If you are setting custom values then measure these accurately rather than estimating. For greatest accuracy the bias resistor should be close to the sensor resistance at a “warm” temperature.

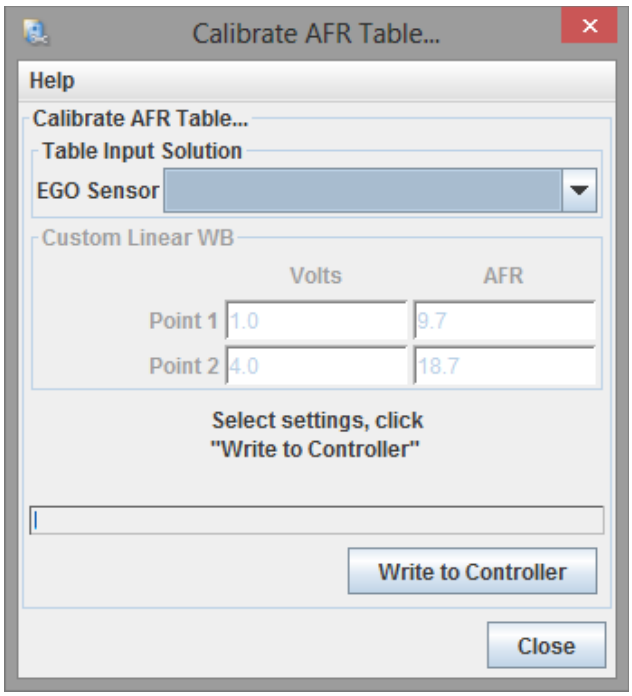
See the Setting Up manual for a method to measure the values.

Write to Controller

Once you have completed the settings in this screen click the “Write to controller” button to burn these settings to your Megasquirt.

6.8 Calibrate AFR Table

Clicking Tools > Calibrate AFR Table will display the Calibrate AFR Table screen as show below:



From this screen you can set the AFR (air fuel ratio) calibration if needed. The options for these settings are described below:

EGO Sensor

This option allows you to select an exhaust gas oxygen sensor. You can either select from the predefined list, select “Custom Linear WB” (wideband) or select “Custom Inc File”.

If you select “Custom Inc File” for this setting the screen will update and you will be given the option to browse for your .inc file. To use this option you need to have an .inc file containing your EGO sensor settings on your hard disk. If you use this option then you will not need to use the other settings described in this section.

Volts / AFR Values

If you have selected an EGO sensor from the predefined list these values will be set for you. If you have selected “Custom Linear WB” then you will need to enter the voltage/AFR pairs from your sensor or controller manual.

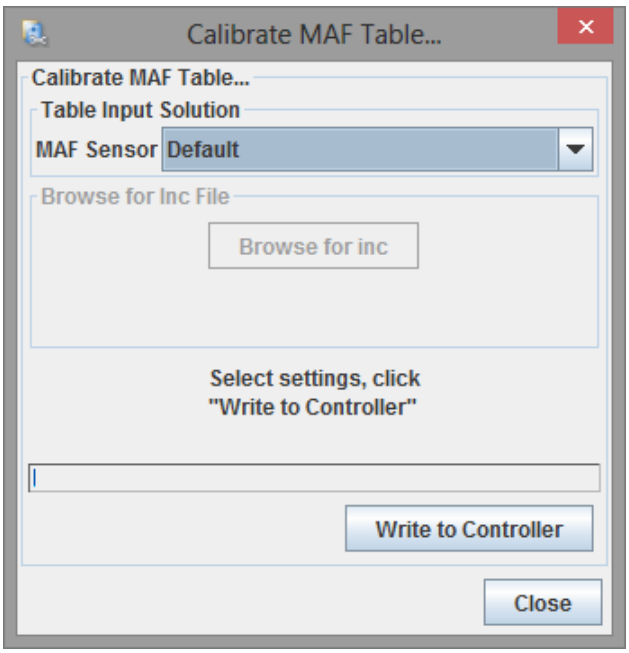
Write to Controller

Once you have completed the settings in this screen click the “Write to controller” button to burn these settings to your Megasquirt.

6.9 Calibrate MAF Table

This option is only enabled if you are using the old-style calibration for MAF Settings (See section 8.12.) This is perfectly acceptable for older configurations but is not recommended for new installs.

Clicking Tools > Calibrate MAF Table will display the Calibrate MAF Table screen as show below:



From this screen you can set the MAF (mass air flow) calibration if needed. The options for these settings are described below:

MAF Sensor

This option allows you to select an MAF sensor. You can either select from the predefined list, leave set as “Default” or select “Custom Inc File”.

If you select “Custom Inc File” for this setting the screen will update and you will be given the option to browse for your .inc file. To use this option you need to have an .inc file containing your MAF sensor settings on your hard disk.

Write to Controller

Once you have completed the settings in this screen click the “Write to controller” button to burn these settings to your Megasquirt.

7 Help Menu

7.1 TunerStudio Help

Clicking Help > TunerStudio Help will display the TunerStudio's own help file. This may provide further information in addition to the contents of this guide.

7.2 Check for Update

Clicking Help > Check for Update will check online to see if there is a more recent version of TunerStudio available. If you have Automatic Update Check (see Section 7.3. below) enabled you should not normally need to use this option.

7.3 Automatic Update Check

Clicking Help > Automatic Update Check toggles between enabling and disabling the automatic update check that takes place every time you run TunerStudio. It is **strongly recommended** that this option is enabled as it is good practice to always use the latest stable release of TunerStudio.

7.4 Enter Registration

Clicking Help > Enter Registration will prompt you to enter a registration code if you have purchased a license for the Upgrade version of TunerStudio. You do not need to enter a registration code to use TunerStudio MS Lite.

7.5 About

Clicking Help > About will display an information screen which includes the developer's Internet site and technical support contact email address, along with the version number of TunerStudio that you are using.

7.6 Megasquirt 3 Info

Clicking Help > Megasquirt 3 Info will display an information screen which includes a link to the MSExtra Internet site.

8 Basic / Load Settings

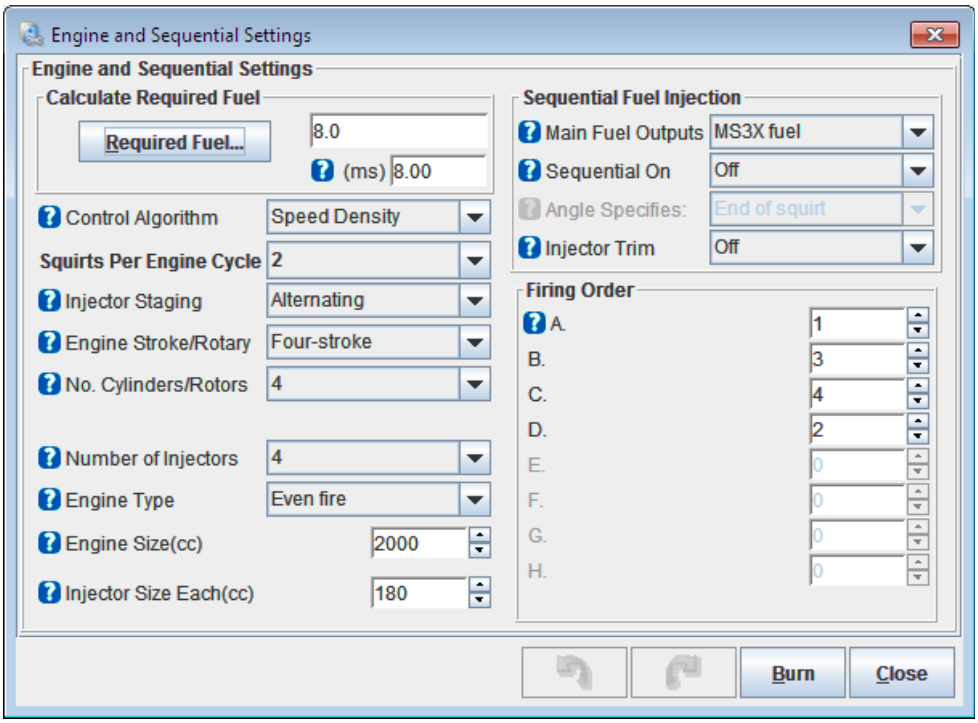
One of the essential roles of an aftermarket ECU such as a Megasquirt is to manage EFI (electronic fuel injection). Achieving the correct fuel mixture and ignition timing are vital in terms of optimizing EFI. This involves monitoring airflow into the engine and calculating optimal fuel requirement based on airflow.

There are a number of different methods to measure airflow into an engine, each based on different complex algorithms. To briefly summarize the options: Speed Density uses a MAP (manifold air pressure) sensor; Alpha-N uses a TPS (throttle position sensor); MAF (mass airflow) uses an actual airflow meter. All of these three methods have pros and cons and none is a 'magic bullet'. Some radical engines may need to use a combination of more than one sensor configurations. Most engines will achieve good results with Speed Density or MAF.

The following sections deal with how to use TunerStudio to enter the parameters that describe your engine, and to configure your choice of airflow sensors and algorithm.

8.1 Engine and Sequential Settings

Clicking Basic / Load Settings > Engine and Sequential Settings displays the following screen:



The options for these settings are described below:

8.1.1 Required Fuel Settings

The value for 'Required Fuel' (often referred to as ReqFuel) is calculated for you automatically using the your chosen algorithm. In order to do this it is essential that the settings for your engine are entered correctly. This section describes the settings that you need to complete before TunerStudio can calculate 'Required Fuel'.

Control Algorithm

The calculation method for fuel. The choices are:

- Speed Density (uses MAP sensor);
- Percent Baro (Speed-Density, but with barometric pressure difference included);

- Alpha-N (uses TPS);
- MAF (uses MAF);
- ITB (a mode specifically for Independent Throttle Bodies).

Squirts per Engine Cycle & Injector Staging

Sets injector staging in non-sequential modes. For sequential set 2 Squirts/Alternating or 1 Squirt/Simultaneous.

Engine Stroke / Rotary

Most engines are four stoke, although some (particularly on motor-cycles) are two stroke. The other (relatively rare) option is rotary.

No. Cylinders / Rotors

The number of cylinders or rotors in your engine.

Engine Type

Most engines are Even Fire. Typical odd-fire engines are V-twin, some V4, Vmax, some V6, V10.

Engine Size

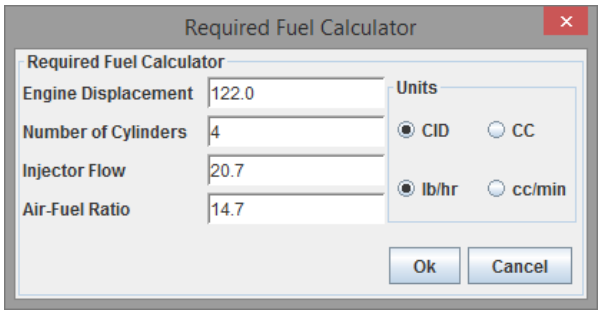
Engine size or displacement in cc. Ensure that you fill this in before using the Required Fuel calculator. To convert from cu.in to cc, multiply by 16.39.

Injector Size

The size of each of your main/primary injectors in cc/min. Typical conversion from lbs/hr is multiply by 10.5

Required Fuel Button

Once you have completed **all** of the appropriate entries for your engine, click the 'Required Fuel' button to calculate the required fuel for your configuration. This will display a pop-up screen similar to that shown below.



The entries will have been calculated for you by complex algorithms based on the values you have already entered. Click 'Ok' to accept these settings. **It is strongly recommended that you do not modify these values manually.**

8.1.2 Sequential Injection Settings

Main Fuel Outputs

This does not apply to MS3-Pro.

- Std fuel - Use the V3/V3.57 mainboard batch injector outputs.
- MS3X fuel - Use the MS3X expansion board's outputs to drive the fuel injectors.

Sequential Injection

There are four options that you can select from for this option:

- Untimed injection – batch fire injection non sequential;
- Sequential/Semi-sequential – injection is timed to specific crank angle, either once per rev (semi) or once per cycle (sequential);
- Semi-sequential Siamese – for siamese port engines;
- Sequential Siamese – for siamese port engines.

Sequential On

- Off - Use batch injection. On MS3X outputs or on MS3-Pro, the channels are divided into two groups, and all injectors in a group are squirted simultaneously.
- Semi-Sequential - Fire injectors in pair and allow the angle of injection to be specified, does not require a cam sensor. Injectors should be wired in the same manner they would be wired for fully sequential injection.
- Fully Sequential - Use fully sequential injection which typically requires a cam sensor. In this mode, outputs A-H are squirted in sequence, so care must be taken to use the correct wiring for the engine's firing order. For example, for a four cylinder engine with firing order 1-3-4-2, the following wiring should be used: Inj A = Cyl#1, Inj B = Cyl#3, Inj C = Cyl#4, Inj D = Cyl#2

Angle Specifies

- End of Squirt - The angle specified in the injector timing table specifies the angle of the end of each squirt. This is recommended for most engines.
- Middle of Squirt - The angle specified in the injector timing table specifies the angle of the middle of each squirt.
- Beginning of Squirt - The angle specified in the injector timing table specifies the angle of the beginning of each squirt.

Injector Trim

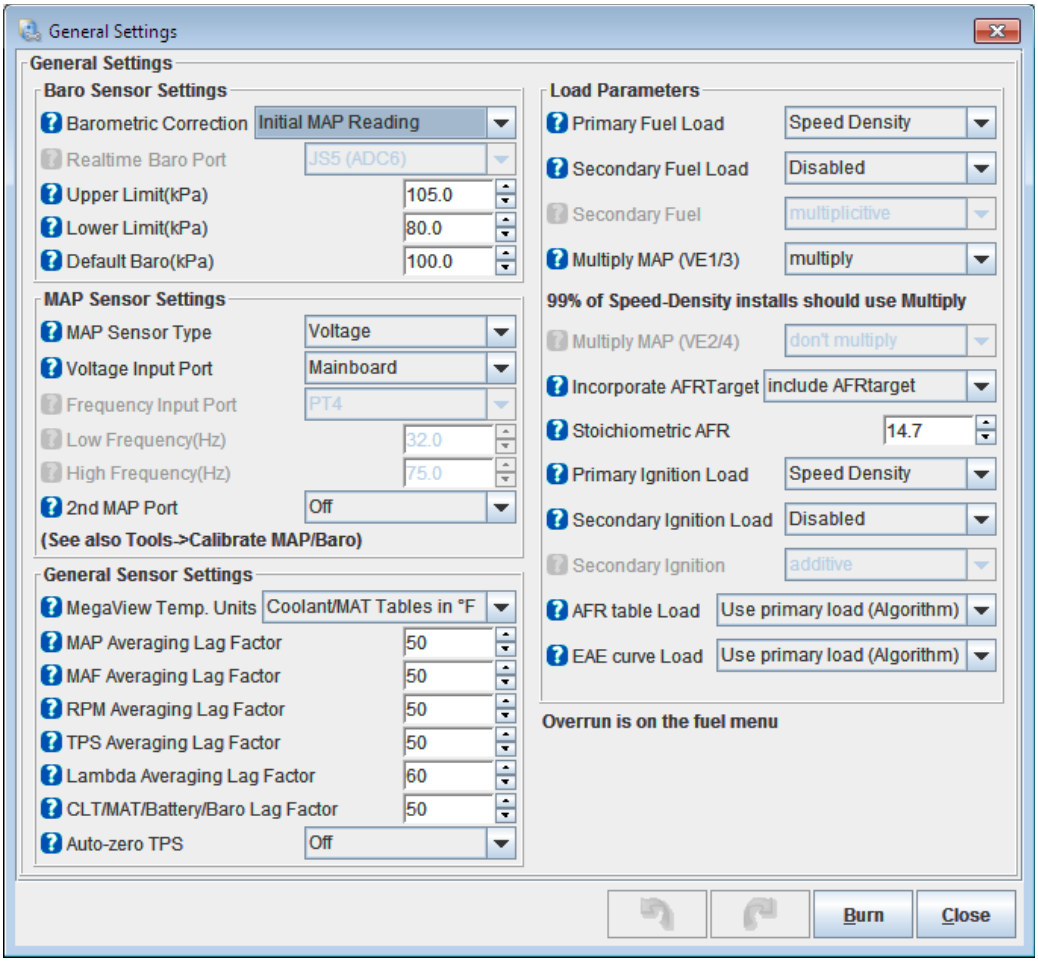
- Off - Per-injector fuel trim is disabled. All injectors will have the same pulse-width.
- On - Per-injector fuel trim is enabled. This allows the pulsewidth for each cylinder to be trimmed individually. Typically per-cylinder widebands or EGT are required to use this.

Firing order

The firing order should be set to the firing order that your engine uses. It does not affect the order in which the outputs are triggered. Instead it is used to associate an injector trim table with a particular physical output so that when injector trim is applied, it is applied to the correct cylinder. It is also used if closed-loop EGO is being done per-cylinder.

8.2 General Settings

Clicking Basic/Load Settings > General Settings will display the following screen:



From this screen you can set values for many of the settings you may need for your configuration, including barometric settings, MAP sensor settings, general sensor settings and secondary load parameters.

8.2.1 Baro Sensor Settings

These are settings that you may use if you want altitude to be taken into account in terms of determining your engine's performance.

Barometric Correction

Enables or disables fuel adjustment for barometer (altitude.) The options are as follows:

- Off – ignore baro;
- Initial MAP reading – take a sample from the MAP sensor at power-on;
- Two independent sensors – use a second dedicated barometer sensor.

Realtime Baro Port

The connection to an external or internal barometer sensor (used if you are using two independent sensors.)

Upper Limit (kPa)

Maximum barometer reading that the engine will see (typically 102kPa.) Limits faulty readings.

Lower Limit (kPa)

Lowest possible barometer reading that the engine will see (typically 68-80kPa.) Limits faulty readings.

Default Baro (kPa)

Fixed barometer reading for when barometric correction is disabled.

8.2.2 MAP Sensor Settings

For both MAP and baro sensors, see also the Calibrate MAP/Baro in section 6.4.

MAP Sensor Input Port

The connection to the MAP sensor which should be set to “Off” for installs **not using** MAP.

MAP sensor type

- Off - disables the MAP input - only relevant on pure Alpha-N or MAF installs.
- Voltage - A 0-5V analogue voltage used - by far the most common
- Frequency - a digital frequency input is used - rare

Voltage input port

Where the primary MAP sensor is wired (when voltage is selected.)

Frequency input port

Where the primary MAP sensor is wired (when frequency is selected.)

Low frequency

The frequency corresponding to the minimum pressure. The minimum pressure is set in the MAP calibration.

High frequency

The frequency corresponding to the maximum pressure. The maximum pressure is set in the MAP calibration.

2nd MAP port

Enables a secondary voltage MAP sensor and selects where it is wired.

8.2.3 General Sensor Settings

MegaView Temp. Units

Selects the temperature units displayed on the optional MegaView.

Averaging Lag Factors

Lag factors for a number of sensors can be smoothed with 100% representing no smoothing, and 10% representing a high degree of smoothing. This applies to:

- MAP Averaging Lag Factor;
- MAF Averaging Lag Factor;
- RPM Averaging Lag Factor;
- TPS Averaging Lag Factor;

- Lambda Averaging Lag Factor;
- CLT/MAT/Battery/Baro Averaging Lag Factor.

Auto-zero TPS

Automatically recalibrate TPS if negative TPS values are seen. This can be useful if the zero position on your TPS varies. (The temporary recalibration is not saved.) Recommended to disable this setting.

8.2.4 Load Parameters

Fuel over-run is covered in Section 9.6. of this guide

Primary Fuel Load

The calculation method for fuel. The choices are:

- Speed Density (uses MAP sensor);
- Percent Baro (Speed-Density but with barometric pressure difference included);
- Alpha-N (uses TPS);
- MAF (uses MAF);
- ITB (a mode specifically for Independent Throttle Bodies.)

Secondary Fuel Load

Enables a second modifier fuel table (VE2) – for **advanced** use only.

Secondary Fuel

Selects the modifier method for the secondary fuel load – **for advanced use only**.

Multiply MAP

Normal Speed-Density should enable 'Multiply MAP'. In rare circumstances, this can be disabled. %baro works the same. With Alpha-N, enabling multiply MAP gives 'Hybrid Alpha-N', disabling multiply MAP gives 'Pure Alpha-N'. MAF never multiplies in MAP.

This option should be used with caution – **99% of installations should use “Multiply”**.

Incorporate AFRTarget

Including the AFR target allows the VE table to be a “real” VE table and the desired AFR to be specified in the AFR table.

With AFR not included, the AFR table is for reference only and the VE table takes full control.

It is advised that this setting is set BEFORE you start tuning. Changing the setting will require a re-tune.

Stoichiometric AFR

The stoichiometric (chemically ideal) AFR for the fuel in use. For gasoline leave this as 14.7 and set the internal calibration on your wideband to match.

Primary Ignition Load

The load Y-axis for ignition table lookups.

Secondary Ignition Load

Enables a second modifier fuel table (Spk2) – **for advanced use only**.

AFR table Load

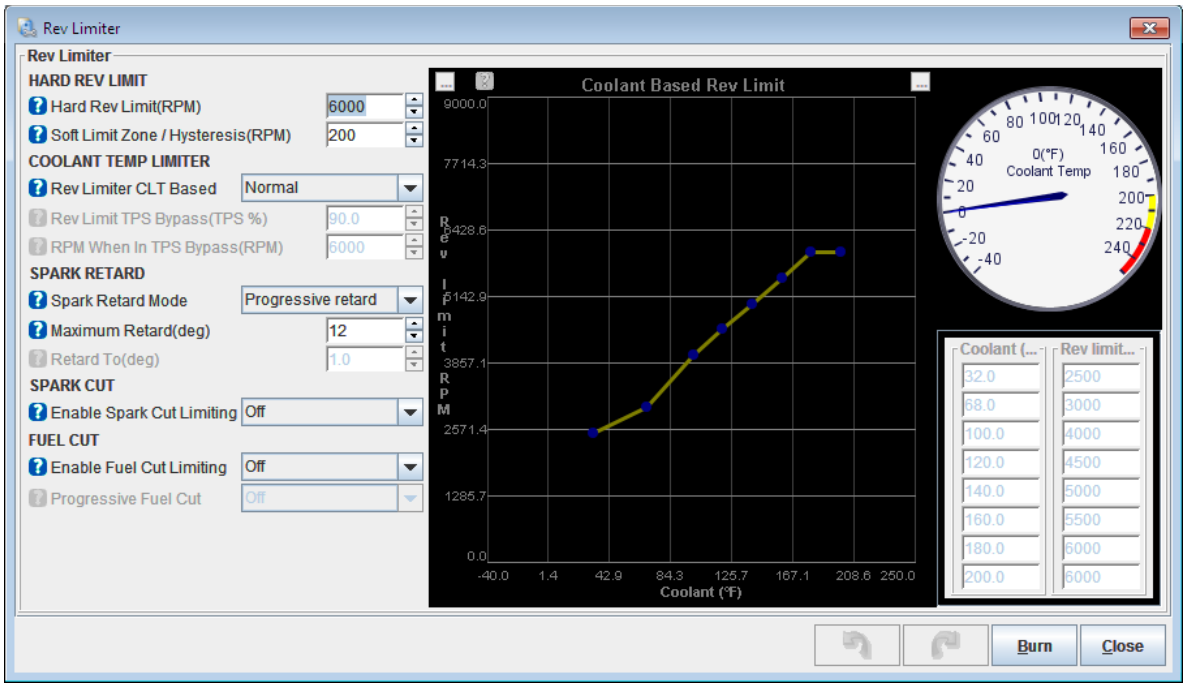
The load Y-axis for AFR table lookups.

EAE curve load

The load Y-axis for EAE curve lookups.

8.3 Rev Limiter

Clicking Basic/Load Settings > Rev Limiter will display the following screen:



From this screen you are able to control settings such as hard rev limit, coolant temperature limit, spark retard, spark cut and fuel cut.

8.3.1 Hard Rev Limit

Hard Rev Limit (RPM)

Specifies the rev limiter max RPM (you must also select a rev-limiter type below.)

After setting the Hard Rev Limit, you **MUST** also select a rev-limiter type below.

Soft Limit Zone

Sets an RPM deadband, soft limiters start this many RPM below the hard limit. If fuel cut is enabled, then the RPMs must fall by this much before fuel is re-enabled. A number of hundred RPM is suggested.

8.3.2 Coolant Temp Limiter

Rev Limiter CLT based

Enables optional coolant based rev limiter, so that the rev limit can be lowered when the engine is cold. The curve on the right hand of the screen (or the values for Coolant Temperature and Rev Limits) can be customized either by dragging the points on the curve or entering values into the table. This sets the hard limit at your chosen temperatures.

Rev Limit TPS Bypass (TPS %)

Above this TPS% the coolant curve is ignored. This should be set to a high percentage, so that only in an emergency when you really need full throttle on a cold engine can you override the cold limit. Or set to over 100% so that the limit in the curve is always used whatever the throttle position.

RPM When In TPS Bypass (RPM)

Rev limit when the TPS bypass limit has been passed. This is the full throttle hard rev limit and bypasses the coolant limit curve.

8.3.3 Spark Retard

Spark Retard Mode

There are four options for spark retardation to limit revs:

- Off – no spark retard used;
- Progressive retard – timing is progressively retarded above the set RPM;
- Fixed angle – above the soft RPM, the timing is immediately changed to this angle.

Maximum Retard (deg)

Maximum timing retard for progressive retard mode

Retard to (deg)

Timing value used in fixed angle mode.

8.3.4 Spark Cut and Fuel Cut

Enable Spark Cut Limiting

Enables spark-cut limiting (will not work with EDIS, TFI or GMDIS.)

If enabled this option can cause catalyst damage and is noisy in operation.

Enable Fuel Cut Limiting

Whether fuel-cut rev limiting is enabled.

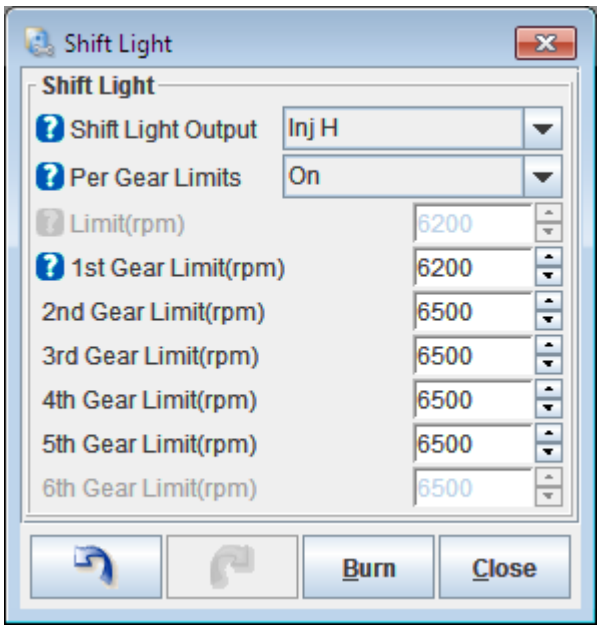
Progressive fuel cut

Enables a progressive non-rotational fuel cut that drops cylinders as revs rise between the lower and hard fuel cut limits. Requires Sequential/Semi-Sequential.

This option must not be used with staged or throttle-body injection.

8.4 Shift Light

Clicking Basic/Load Settings > Shift Light will display the following screen:



The options for these settings are described below:

Shift Light Output

Allows a specific output to be used to switch a shift light. (Do not also enable the same output in the generic on/off outputs.)

Per Gear Limit

Allows per-gear limits, can be useful to set a lower limit in lower gears to avoid overshooting.

Limit

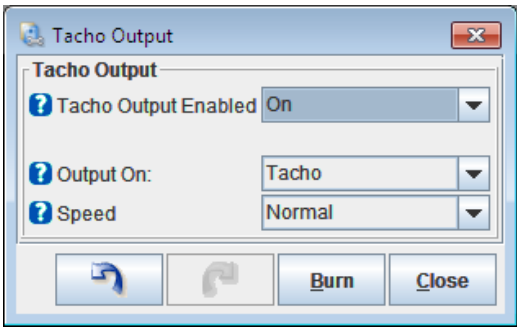
The shift light is enabled above this RPM.

1st, 2nd, 3rd, 4th, 5th, 6th Gear Limit

When per-gear limits are enabled, these limits are used.

8.5 Tacho Output

Clicking Basic/Load Settings > Tacho Output will display the following screen:



The options for these settings are described below:

Tacho Output Enabled

Enables the tacho output.

Output On

Selects the output pin.

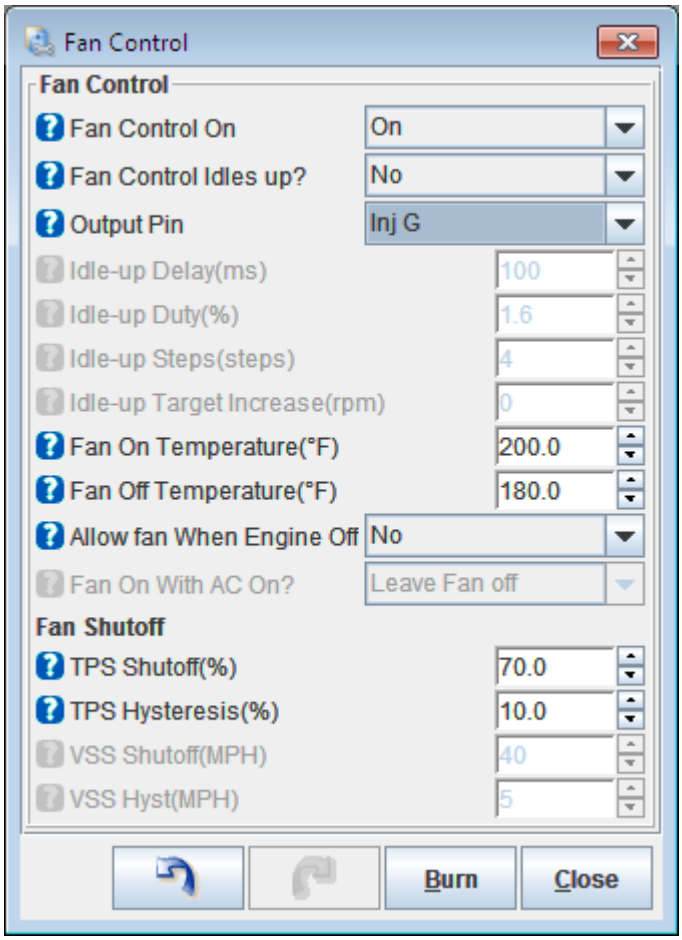
Speed

Can be set to one of two options:

- Normal – an output pulse is generated matching each cylinder event, i.e., 4 cylinder engines have 4 pulses per engine cycle;
- Half speed – output runs at half speed. This can enable a 4-cylinder tacho to be used on an 8-cylinder engine.

8.6 Fan Control

Clicking Basic/Load Settings > Fan Control will display the following screen:



The options for these settings are described below:

Fan Control On

Enables fan control

Fan Control Idles up?

Whether the fan activation should also raise the idle.

Output Pin

Selects the output pin for the fan relay.

Idle-up Delay

How long to wait after raising idle before turning on fan. (If fan control idles up is enabled.)

Idle-up Duty

PWM open-loop duty cycle to increase by before activating fan. (If fan control idles up is enabled and PWM idle control is enabled.)

Idle-up Steps

Additional Stepper-Idle steps to increase by before activating fan. (If fan control idles up is enabled and stepper idle control is enabled.)

Idle-up Target Increase

Target RPM to increase by. (If fan control idles up is enabled and closed-loop idle control enabled.)

Fan On Temperature

Turn fan on above this temperature.

Fan Off Temperature

Turn fan of below this temperature. (Must be lower than "on" temperature.)

Allow fan When Engine Off

Allows fan to run in key-on, engine-off situation.

Fan On With AC On

Whether the fan should be automatically turned on to help cool the A/C radiator.

TPS Shutoff

Disable fan above this TPS% (reduces load on engine when max power desired.) Set to over 100% to disable shutoff.

TPS Hysteresis

Deadband of TPS% for shutoff. Typically set to 5-10%.

VSS Shutoff

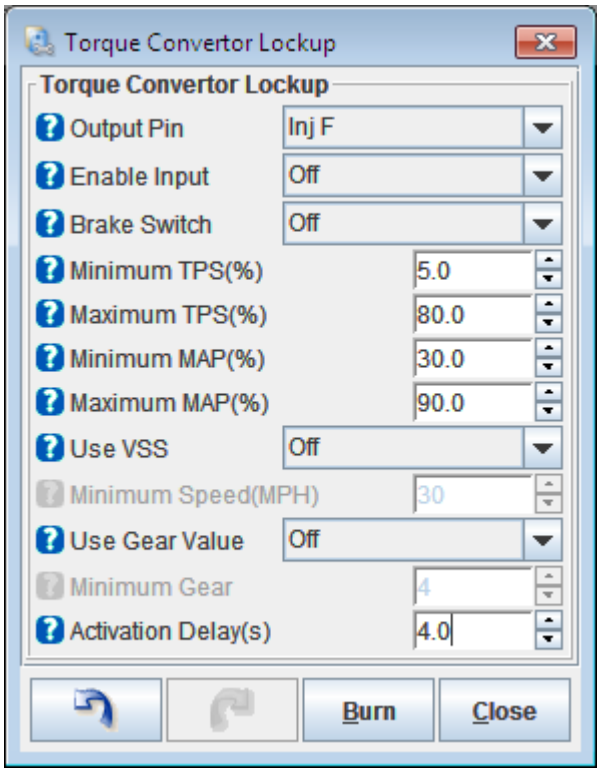
Disable fan above this vehicle speed (at high speeds airflow through radiator will be sufficient on its own.)

VSS Hyst

Deadband of VSS. Typically set to a 5-10 mph/kph.

8.7 Torque Convertor Lockup

Clicking Basic/Load Settings > Torque Convertor Lockup will display the following screen:



The options for these settings are described below:

Output Pin

Enables the Torque Convertor Lockup feature and selects the output port to connect to lockup solenoid.

Enable Input

Selects an optional input port for enable switch (could be used for 4th gear pressure switch.)

Brake Switch

Selects optional input port for brake light switch (brake light unlocks convertor.)

Minimum TPS

Minimum TPS to enable lockup.

Maximum TPS

Maximum TPS to enable lockup.

Minimum MAP

Minimum MAP to enable lockup.

Maximum MAP

Maximum MAP to enable lockup.

Use VSS

Optionally allow VSS1 or VSS2 speed input as criteria to enable lockup.

Minimum Speed

Sets minimum speed for lockup. (Requires VSS input in speed/gear sensors.)

Use Gear Value

Optionally allows gear number as criteria. (Requires gear to be enable in speed/gear sensors.)

Minimum Gear

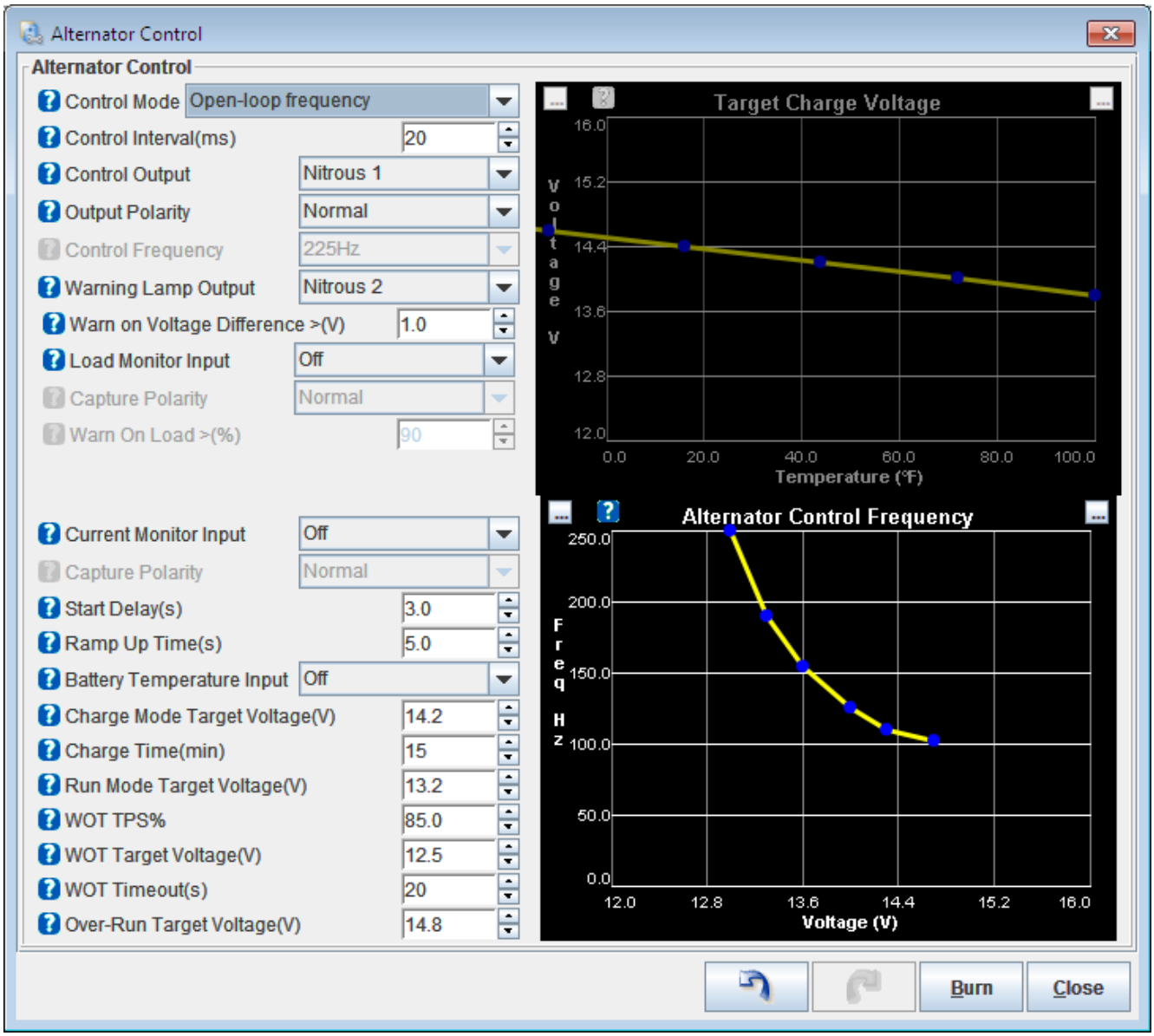
Minimum gear to enable lockup.

Activation Delay

Wait this long after conditions are met before locking up.

8.8 Alternator Control

Clicking Basic/Load Settings > Alternator Control will display the following screen:



The options for these settings are described below:

Control Mode

Control mode for alternator.

- Off = disabled
- On-Off = most basic control, typically on the 'L' lamp terminal
- Open-loop frequency = Frequency applied sets target voltage (Ford)
- Open-loop duty = Duty cycle applied sets target voltage (GM)
- Closed-loop field control = MS3 uses a closed-loop algorithm to control the alternator field to target a voltage (Chrysler)

- High-speed feedback field switching = MS3 monitors the voltage at 20kHz and switches the field on or off to match the monitored voltage to the target voltage. (99-05 Miata)

Control Interval

How often to run the control calculations.

Control Output

Output connection to the alternator.

Output Polarity

Whether a positive or negative active edge is used.

Control Frequency

Frequency used for control output signal.

Warning Lamp Output

Output for charge/warning light.

Warn on Voltage Difference

Light warning lamp if actual voltage is too far away from target.

Load Monitor Input

PWM digital input from alternator as load sense - often the 'F' terminal.

Capture Polarity

Whether a positive or negative capture edge is used.

Warn on Load

Light warning lamp if sensed load is above this limit.

Current Monitor Input

PWM digital input used for monitoring battery current. (Display only.)

Capture Polarity

Whether a positive or negative capture edge is used.

Start Delay

How long after start before alternator control is enabled. Allows engine to stabilise before alternator load is applied.

Ramp Up Time

Time to ramp up to target voltage. (Not available in on/off mode.)

Battery Temperature Input

If used, specifies a Generic Sensor that is configured for battery temperature. The temperature is then used to lookup a target charging voltage from the upper curve.

Charge Mode Target Voltage

Target voltage when in 'Charge' mode

Charge Time

How long after start is considered 'Charge' before transitioning to 'Run' mode.

Run Mode Target Voltage

Target voltage during 'Run' mode.

WOT TPS%

TPS% to trigger Wide Open Throttle (WOT) mode

WOT Target Voltage

Target voltage when in WOT mode, typically set lower than normal to free up some engine power.

WOT Timeout

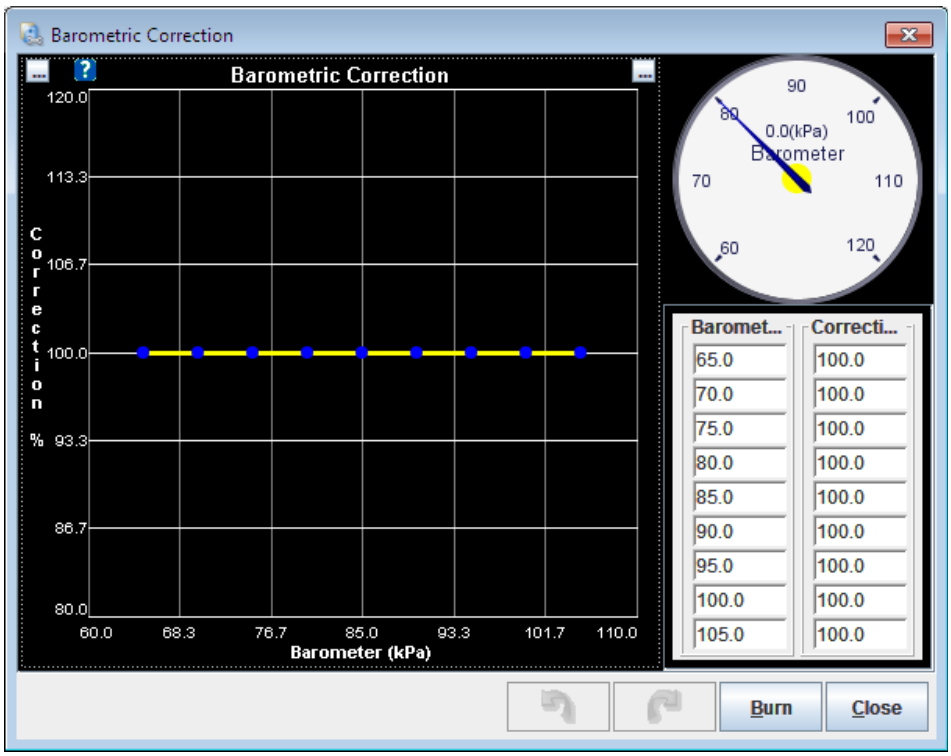
Timeout before WOT mode ends and target voltage returns to charge or run mode.

Over-Run Target Voltage

Target voltage when over-run fuel cut is active. Setting a slightly higher voltage here will give a minor 'regenerative braking' effect.

8.9 Barometric Correction

Clicking Basic/Load Settings > Barometric Correction will display the following screen:

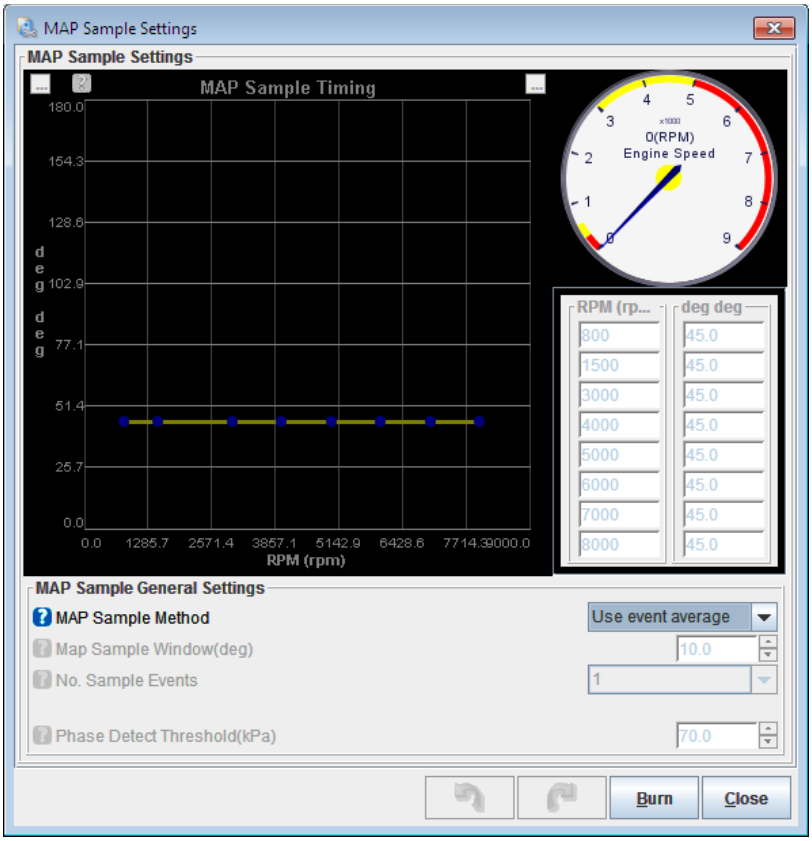


There are two ways that barometric correction may be used:

- The current way – on the MAP/Baro page the 'At total vacuum' and 'rate' numbers must be set to zero. This curve is then normally 100% at all points and adjusted up or down to alter fueling based on the barometer reading;
- The old way – the two numbers are set to 147 and -47 and the curve is normally 0% at all points.

8.10 MAP Sample Settings

Clicking Basic/Load Settings > MAP Sample Settings will display the following screen:



The options for these settings are described below:

MAP Sample Method

There are two settings for this option:

- “Use event average” is useful for most engines;
- “Use timed min” is intended for 1 cylinder or V twins with highly cyclic MAP signals.

MAP Sample Window (deg)

How many degrees to sample over.

No. Sample Events

How many ignition events to sample over. Typically set to 1 for large engines, or set to 2 for single or twin cylinder engines.

Phase Detect Threshold (kPa)

This setting is only enabled if all of the following settings are active – the last three of these settings are options within the Ignition Options / Wheel decoder screen, see section 10.1:

- You have a 1 or 2 cylinder engine;
- You are using “Toothed wheel” as spark mode;
- You have using “MAP sensor” for your Cam Input;
- You are using “Dual wheel with missing tooth” for your Trigger Wheel arrangement.

When using the MAP sensor to detect engine phase, this sets a pressure threshold that can identify the intake versus the exhaust phases. This will be highly engine dependent: 80kPa worked on a small 1 cylinder engine.

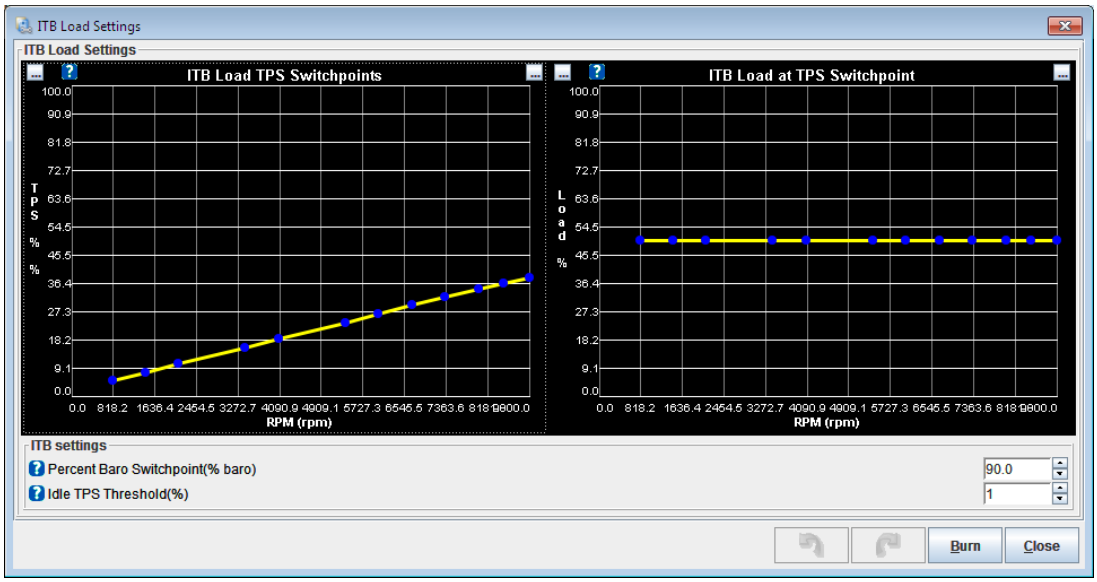
MAP sample timing

This curve sets the start of the sample window in degrees BTDC for each ignition event. The number must always be less than the number of degrees per event. (720 / num_cyls for a 4 stroke i.e. for 4cyl there are 180deg per event, for 8cyl there are 90deg.)

8.11 ITB Load Settings

The ITB Load Settings menu option is only enabled if ITB is selected as the control algorithm in Engine and Sequential Settings (see Section 8.1. of this guide.)

Clicking Basic/Load Settings > ITB Load Settings will display the following screen:



The left hand curve defines the TPS value where the MAP load reaches %Baro switchpoint. This curve will be different for each engine and should be set up using values obtained from log files from your engine. Setting this curve is an important part of ITB mode.

The right hand curve is used to allocate the bins on the VE table to either Speed-Density or Alpha-N tuning. The area of the VE table below the load value from the curve will be used for Speed-Density tuning and the area above the curve will be used for Alpha-N tuning. It is recommended that the "ITB load at TPS switchpoint" curve be set to 50% at all RPMs.

If either of these curves are changed then the VE table will need to be re-tuned.

%Baro switchpoint

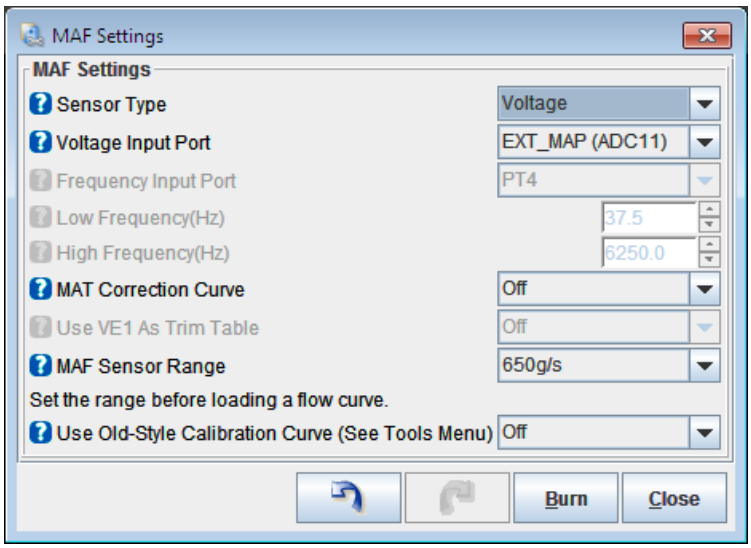
Above this MAP value, tuning switches from MAP based to TPS based. Default is 90% and works for most engines.

Idle TPS Threshold %

This setting defines the minimum TPS value required to allow the transition to Alpha-N tuning. This feature allows the fast idle MAP to exceed the %Baro switchpoint without entering Alpha-N mode. On engines with aggressive cams with higher overlap, it is possible for the fast idle MAP to exceed the %Baro switchpoint. When this happens, you do not want to enter Alpha-N mode tuning since the throttle is still reading fully closed. The Idle TPS Threshold % prevents you entering Alpha-N mode and you can use the warm up enrichment curve to compensate for any tuning errors caused by being stuck at the maximum Speed-Density bin while the MAP is greater than the %Baro switchpoint.

8.12 MAF Settings

Clicking Basic/Load Settings > MAF Settings will display the following screen:



The options for these settings are described below:

Sensor Type

Selects the MAF sensor type.

- Voltage - a 0-5V analogue input - most MAFs
- Frequency - some GM sensors on GM vehicles
- Off - disables the MAF input.

Voltage Input Port

Selects the analogue input pin where the MAF is connected.

Frequency Input Port

Selects the frequency input pin where the MAF is connected.

Low frequency

The frequency the MAF outputs to indicate least air flow.

High frequency

The frequency the MAF outputs to indicate greatest air flow.

MAT Correction Curve

Optionally enables a trim curve based on MAT sensor input.

Use VE1 As Trim Table

Optionally enables VE table 1 as a trim table. Fill the table with 100% to begin with.

MAF Sensor Range

Sets the range to match your MAF sensor. On gasoline, 650g/s ~800hp; 1300g/s ~1600hp; 1950g/s ~2400hp and 2600g/s ~3200hp. Use the lowest range suitable for better low-end precision.

Always set this range before loading a MAF calibration curve.

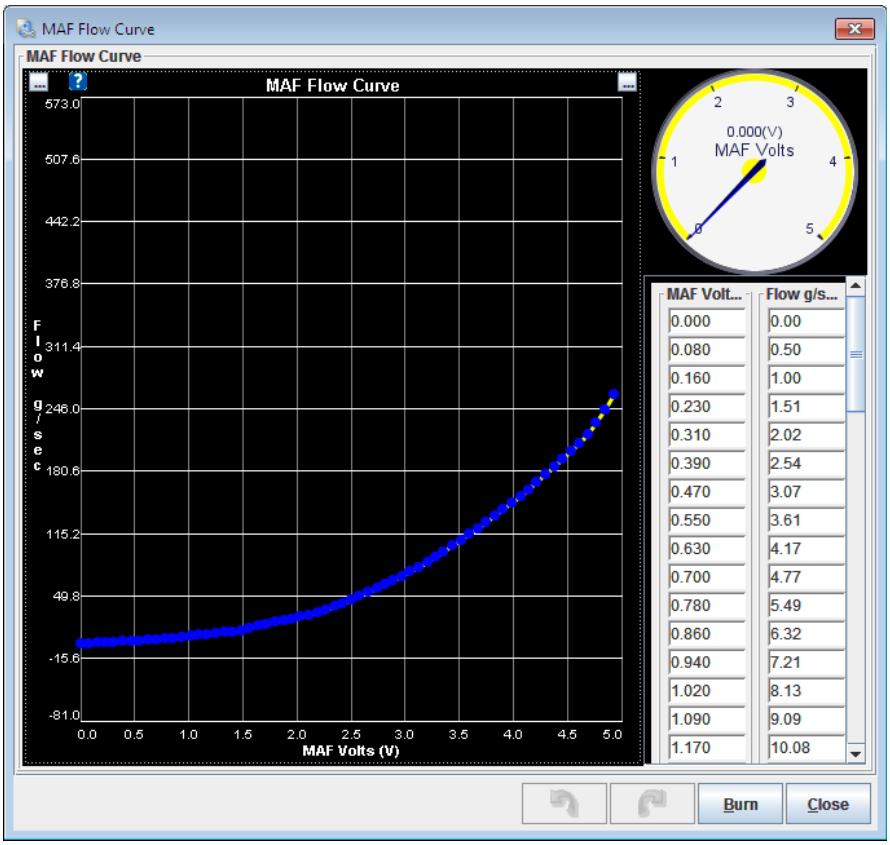
Use Old-Style Calibration Curve (See Tools Menu)

This option is **only** left in place to support legacy users using MAF in the 'old way' as per firmware version 1.1.x and earlier and **is not recommended for new installs**.

8.13 MAF Flow Curve

The MAF Flow Curve menu option is disabled if “Sensor Type” in the previous section is set to “Off”.

Clicking Basic / Load Settings > MAF Flow Curve will display the following screen:



This curve specifies grammes/sec versus frequency or voltage. Start out with the actual flow curve for your MAF sensor and then 'tweak' to tune it to your install.

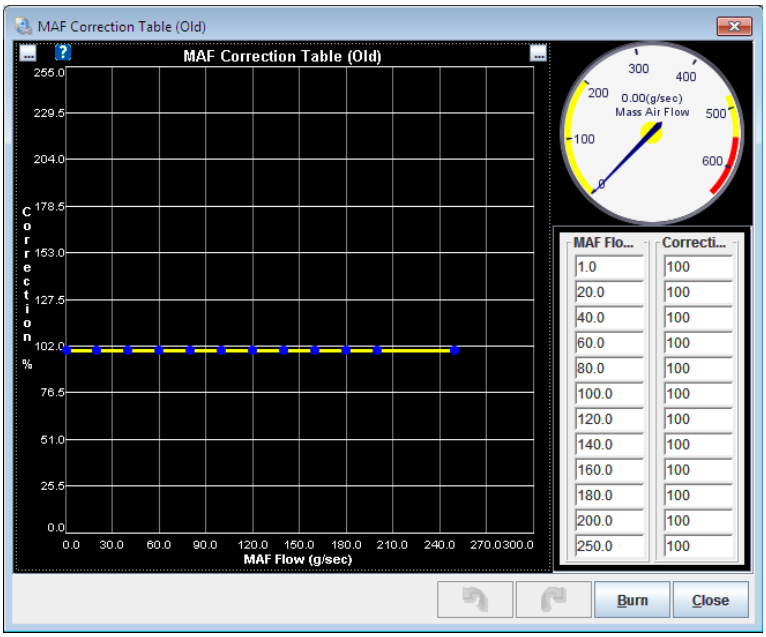
The Lite version of TunerStudio does not provide a method to load in the example flow curves provided in the tune_files directory of the firmware zip.

8.14 MAF Correction Table (Old)

The MAF Correction Table (Old) menu option is only enabled if “Use old-style calibration curve (see Tools menu)” is set as “on” using the MAF Settings dialog (see Section 8.12. MAF Options of this guide).

The MAF Correction Table (Old) is **only** left in place to support legacy users using MAF in the 'old way' and **is not recommended for new installs**.

Clicking Basic/Load Settings > MAF Correction Table (Old) will display the following screen:



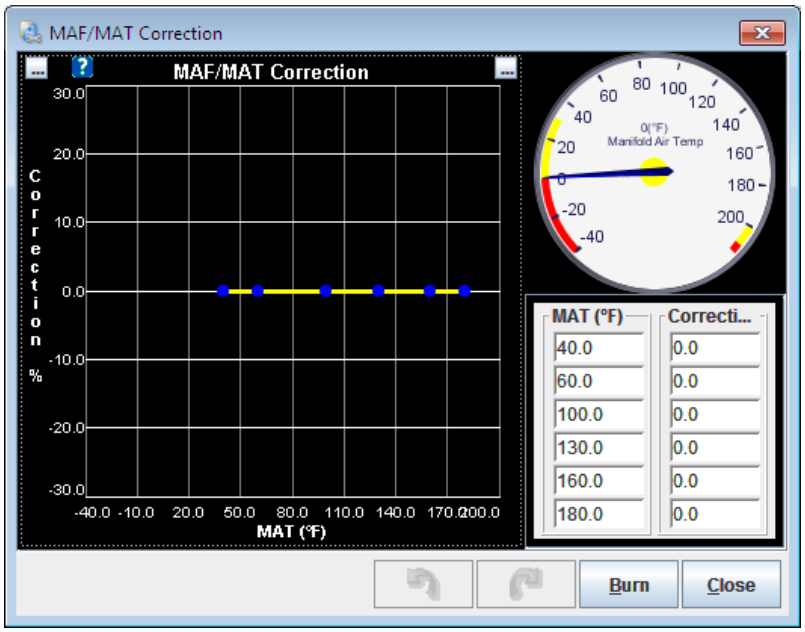
Specifies the adjustment on top of the MAF sensor calibration you loaded through Tools-Calibrate MAF table. Start out with the correction curve at 100% (no correction) and then 'tweak' to tune it to your install.

8.15 MAF/MAT Correction Table

To enable the MAF/MAT Correction Table menu option you must:

- Set a value for “Voltage input port” in MAF Settings to a value other than off (see Section 8.12.);
- Set “MAT Correction Curve” in MAF Settings to “On” (see Section 8.12);
- Use MAF as either the Primary or Secondary Fuel Load in General Settings (see Section 8.2.4.)

Clicking Basic/Load Settings > MAF/MAT Correction table will display the following screen:

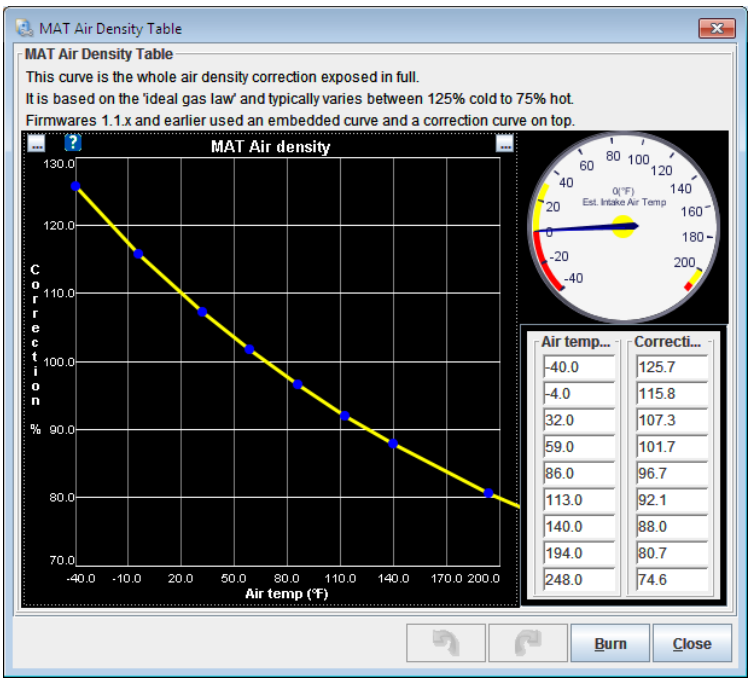


This curve allows for minor corrections to fueling based on manifold air temperature (MAT) when using MAF to control fueling. The default curve is 0% meaning no correction.

8.16 MAT Air Density Table

To enable the MAT Air Density Table menu option you must not use MAF as either Primary or Secondary Fuel Loads (see Section 8.2.4.)

Clicking Basic/Load Settings > MAT air density table will display the following screen:

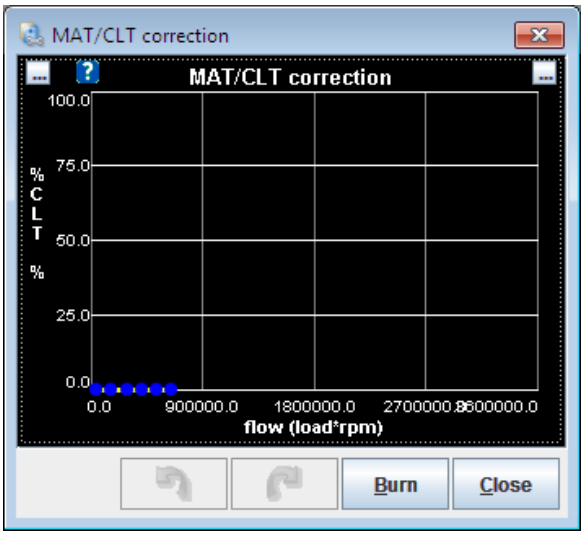


This curve is the whole air density correction exposed in full. It is based on the 'ideal gas law' and typically varies between 125% cold to 75% hot.

8.17 MAT / CLT correction

To enable the MAT / CLT correction menu option you must not use MAF as either Primary or Secondary Fuel Loads (see Section 8.2.4.)

Clicking Basic/Load Settings > MAT / CLT correction will display the following screen:



The curve is the %CLT blended into the MAT reading vs. airflow.

In theory, at zero airflow the air temperature in the intake manifold will reach the manifold (coolant) temperature. At infinite airflow, the air will be unaffected by the temperature of the manifold.

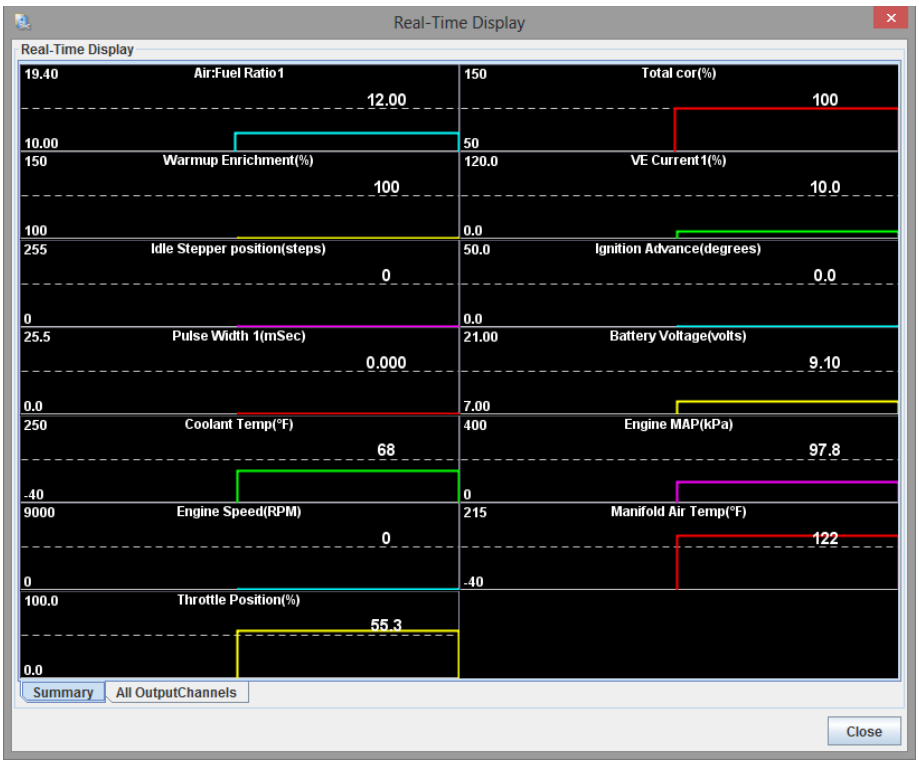
The curve is setup to give the 'best estimate' of intake air temperature as part of the speed-density fuel calculation.

It would be expected that some CLT should be blended in at low airflows, falling away rapidly to close to zero at higher airflows.

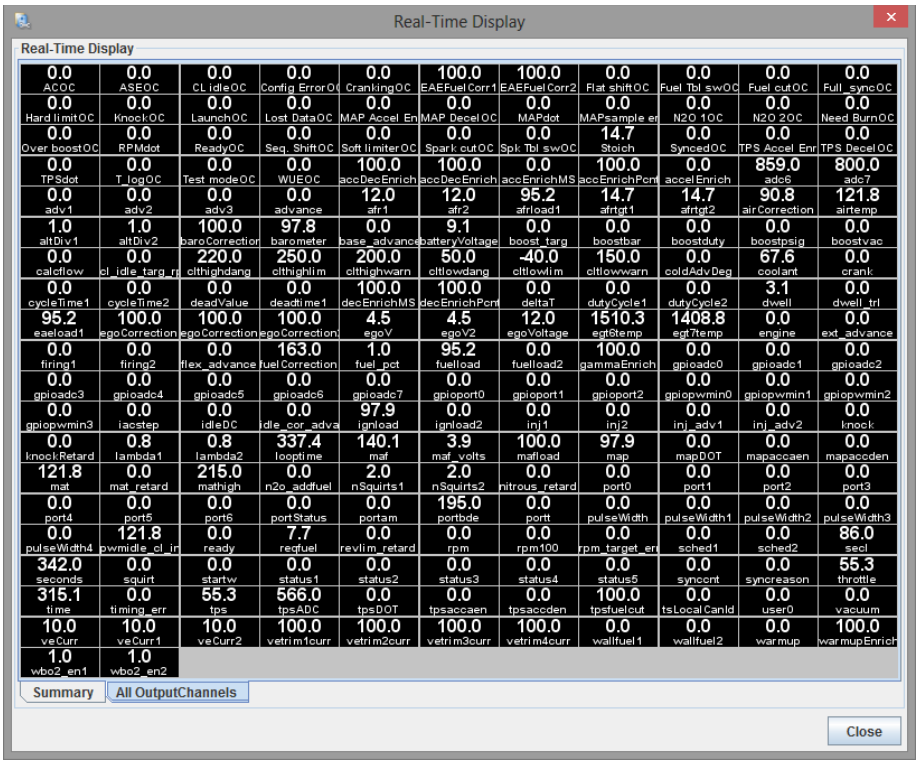
When first enabling this curve it will be necessary to adjust the VE values at low RPMs as they will be compensating for the air density change.

8.18 Real-Time Display

Clicking Basic/Load Settings > Real Time Display will display the following screen:

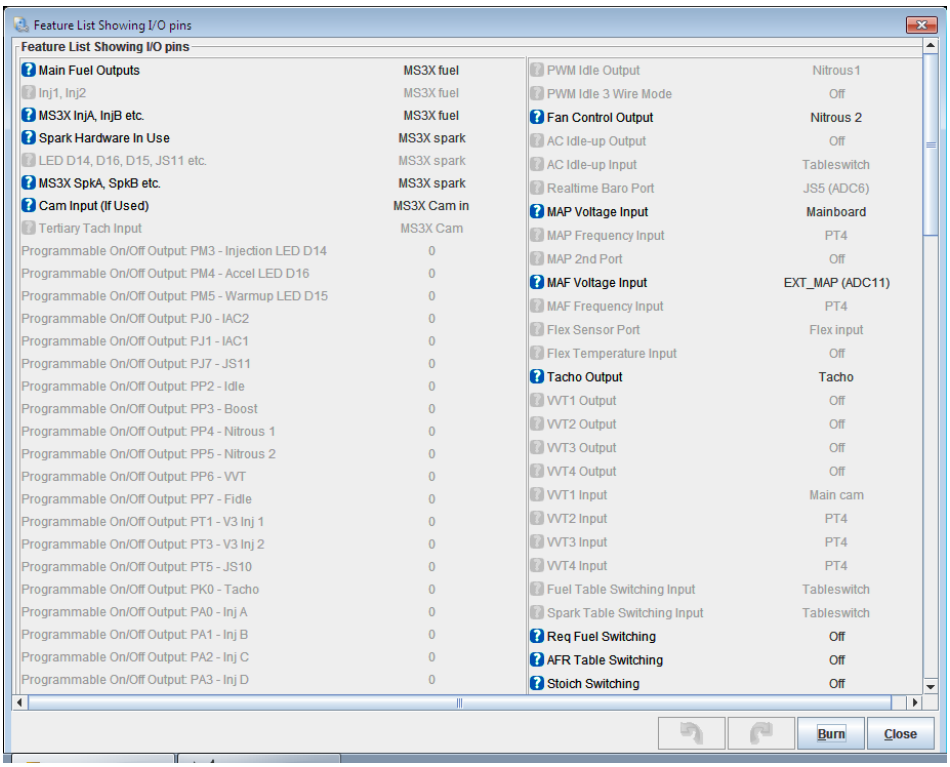


This screen shows real-time information for many of the key sensors for your Megasquirt. For further detail click the “All Output Channels” tab at at the bottom left to display a full list of variables, as shown below:



8.19 Feature List Showing I/O Pins

Clicking Basic/Load Settings > Feature List Showing I/O Pins will show a screen similar to that shown in the following image:



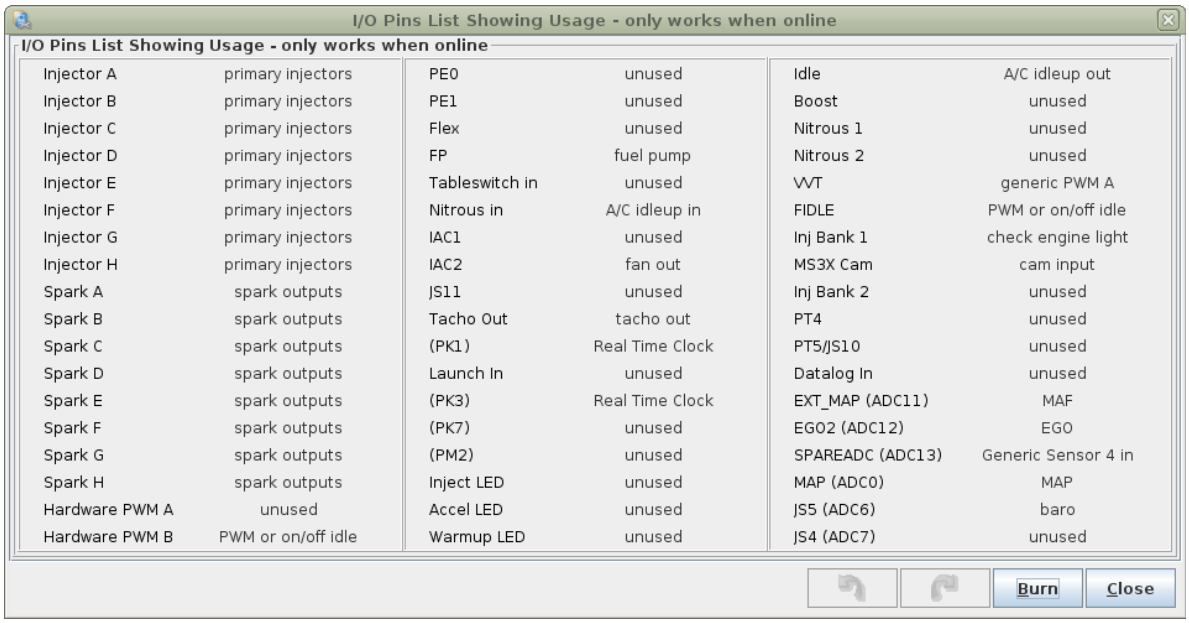
Depending on your engine and how you have configured your Megasquirt there are many different options which could be enabled with a wide variety of settings.

This screen is for information only and settings cannot be changed using this part of the software.

This screen is useful as it shows a summary of your configuration which can be useful for analysis and troubleshooting.

8.20 I/O pins List Showing Usage

Clicking Basic/Load Settings > I/O pins List Showing Usage will show a screen similar to that shown in the following image:



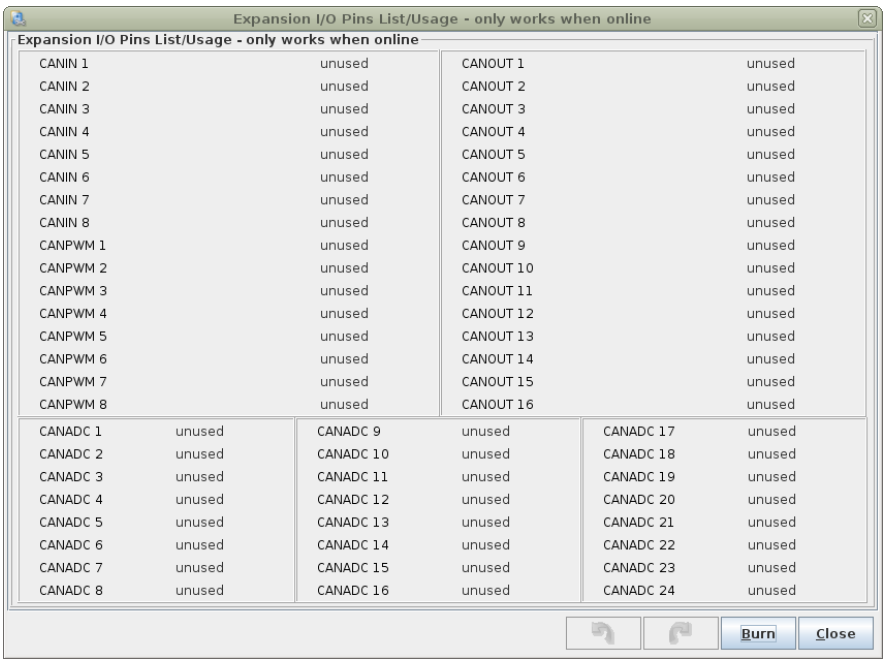
Depending on your engine and how you have configured your Megasquirt there are many different options which could be enabled with a wide variety of settings.

This screen is for information only and settings cannot be changed using this part of the software.

This screen is useful as it shows a summary of your configuration and which inputs or outputs are presently used and which are free.

8.21 Expansion I/O pins List/Usage

Clicking Basic/Load Settings > Expansion I/O pins List/Usage will show a screen similar to that shown in the following image:



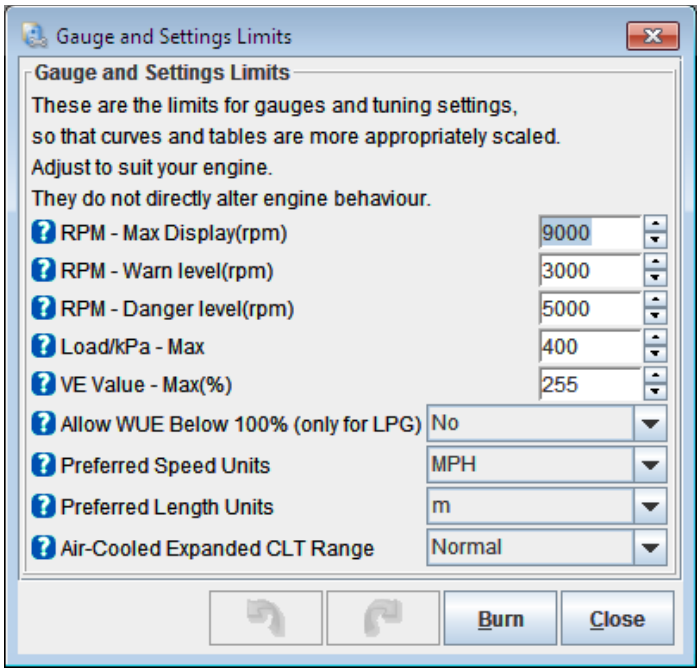
Depending on your engine and how you have configured your Megasquirt there are many different options which could be enabled with a wide variety of settings.

This screen is for information only and settings cannot be changed using this part of the software.

This screen is useful as it shows a summary of your configuration and which inputs or outputs are presently used and which are free.

8.22 Gauge and Settings Limits

Clicking Basic/Load Settings > Gauge and Settings Limits displays the following screen:



Changing these settings does not alter the behavior of your engine in any way, they ONLY change the limits which can be displayed on the screen and set the threshold limits for your tune.

This screen allows you to set the limits on the gauges within the main gauge cluster. The default settings are for automobiles, bike users will certainly need to change the limits available.

The options for these settings are outlined below:

RPM – Max (rpm)

The maximum for RPM on gauges, tables, curves and entry boxes. **Adjust to suit your engine.**

RPM – Warn Level (rpm)

The RPM 'warning' on gauges – displayed in yellow on the gauge.

RPM – Danger Level(rpm)

The RPM 'danger' on gauges – displayed in red on the gauge.

Load/kPa – Max

The maximum 'load' value, e.g., kPa on gauges, tables, curves and entry boxes.

VE Value max

The maximum for VE values.

Allow WUE Below 100% (only for LPG)

For most installs, setting warmup enrichment (WUE) to below 100% indicates a serious tuning mistake and the code will flag up a 'Configuration Error' to alert the user. In rare conditions such as using LPG (propane) for fuel, it can be valid. This setting disables the Config Error warning message.

Preferred Speed Units

Chooses the speed units - either Mile-per-hour or Kilometres-per-hour

Preferred Length Units

Chooses the size units - either metres or inches.

Air-cooled Expanded CLT Range

Allows gauges and curves to use an expanded coolant temperature range for air-cooled engines using the CLT sensor to measure oil or head temperature.

Once these settings have been changed it is necessary to close and restart TunerStudio for the changes to be reflected in the gauge cluster.

9 Fuel Settings

Ensuring that you have the correct fuel settings is essential in terms of achieving an effective tune for your Megasquirt.

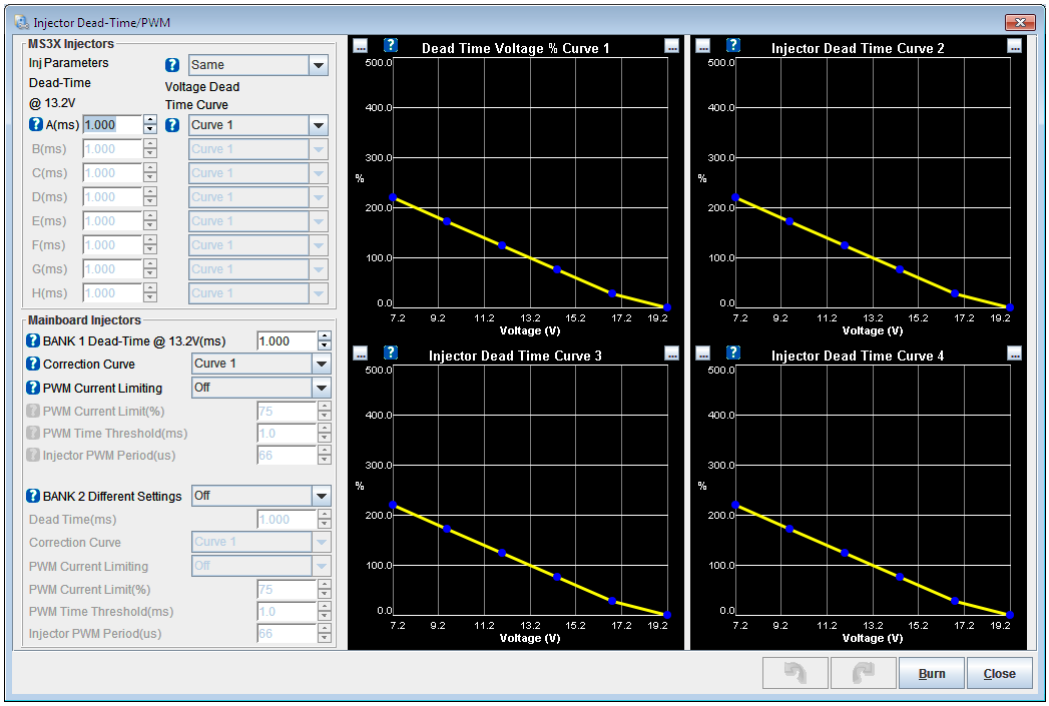
The Fuel Settings toolbar menu deals with the many options that are supported, including injection settings and timing, fuel sensor settings, automated fuel cut off, exhaust gas oxygen sensors, air fuel ratio tables, fuel volumetric efficiency tables and trim tables, and injector sequencing.

The following sections deal with these settings and options.

9.1 Injector Dead-time / PWM

The dead time (or offset) of an injector is effectively the portion of the pulsewidth when no fuel is injected, this is because the injector is an electro-mechanical valve and takes a measurable time to open and close. (Note that older documentation referred to this as just "opening time".)

Clicking Fuel Settings > Injector Dead-time / PWM displays the following screen:



There are three main areas on this page:

- The sequential (MS3X) injector settings
- The non-sequential mainboard injector settings (not MS3-Pro)
- The voltage correction curves. These allow fine tuning the battery voltage correction of the dead time.

The options for these settings are described below:

Inj Parameters

This selects whether the same or individual injector parameters should be set. Most installs with a single set of squential injectors should use "same". Installs using staged injection or dual fuel with two different types of injector connected can configure each injector.

- Same = one dead-time across all injectors. Recommended setting.
- Individual = the dead time for each injector is set individually.

Injector Dead Time @ 13.2V(ms)

This column of values sets the injector dead time per injector or for all injectors.

Typically settings:

- High impedance injectors - dead time = 0.8-1.0 ms
- Low impedance injectors with resistors - dead time = 0.8-0.9 ms
- Low impedance injectors with external peak/hold - dead time = 0.6-0.8 ms

Voltage Dead Time Curve

This column of values sets the voltage correction curve to use per injector or for all injectors.

Recommended - select Curve 1 and leave the curve alone.

Dead Time Voltage % Curves

These four curves allow the fine tuning of the dead-time voltage correction. You will typically need to determine this experimentally for your exact injectors with the Megasquirt.

The following settings only apply to the batch-fire mainboard injectors on a V3.0/V3.57 mainboard:

Bank 1 Injector Dead Time @ 13.2V(ms)

Injector dead time. Typically 0.7ms for low-z (~2.5ohm) and 0.9ms for high-z (~14ohm.)

Correction Curve

This column of values sets the voltage correction curve to use per injector or for all injectors.

PWM Current Limiting

Enables PWM (peak and hold) current limiting for low-z injectors.

PWM Current Limit (%)

This is the 'hold' percentage current. 30-50% is typical.

PWM Time Threshold (%)

The full-current 'peak' time at the beginning of each pulse and is typically set to 1-1.5ms.

Injector PWM Period (us)

The period/frequency during the hold phase. Safe to leave at 66us.

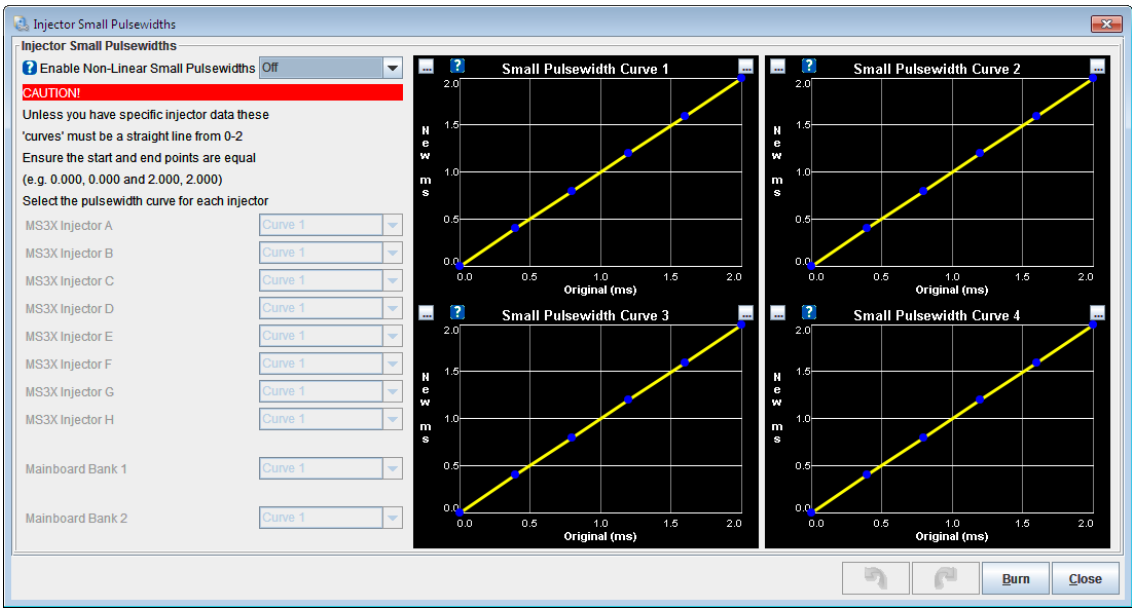
Different Bank Settings

Enables different settings for a second bank of injectors. Set to “Off” unless you have installed different injectors and are using Staged Injection.

9.2 Injector Small Pulsewidths

At most pulsewidths (say above 2ms) injectors behave in a linear manner, where 10% increase in effective pulsewidth gives a 10% increase in fuel flow. This linear behaviour is relied upon in the Megasquirt fuel calculations.
However, at small pulsewidths, injectors behave non-linearly. The Injector Small Pulsewidths feature allows the user to make a correction and make the non-linear region more linear in nature.

Clicking Fuel Settings > Injector Small Pulsewidths displays the following screen:



The options for these settings are outlined below:

Enable Non-Linear Small Pulsewidths

This enables or disables the feature. Unless you have calibration data for your injectors measured on your Megasquirt, this feature should be left turned off.

Curve selection

Each injector can be set to use one of the four small pulsewidth curves.

Small Pulsewidth Curves

The X-axis of the curve is the Megasquirt pulsewidth (before deadtime is applied) and the Y-axis is the required injector pulsewidth (before deadtime) that the injector needs to approximate linearity.

The start and end point pairs must be equal. e.g. 0.0ms, 0.0ms and 2.0ms,2.0ms

9.3 Injector Timing Tables

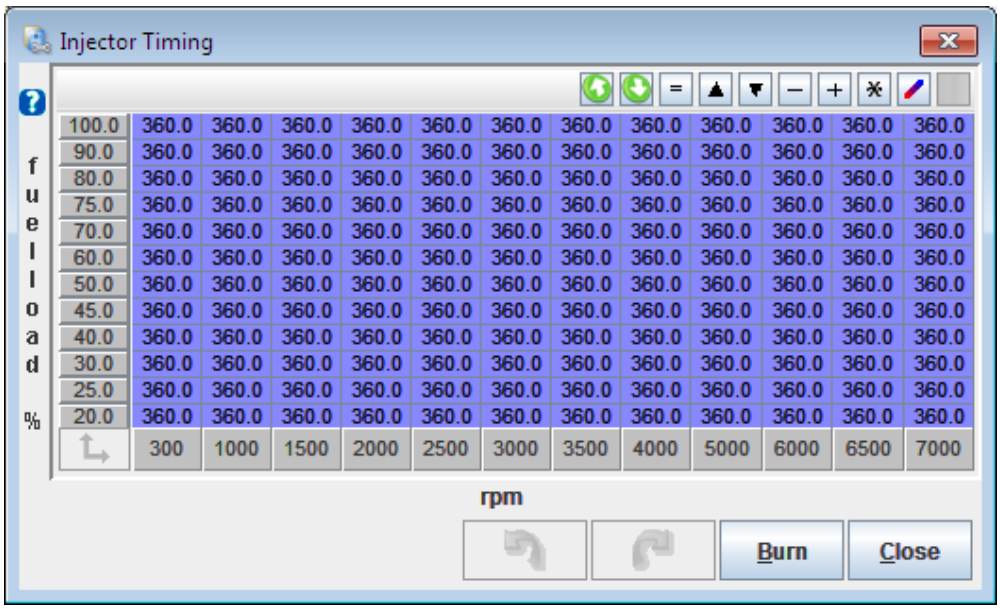
These tables allow you to set values for injection timing in degrees BTDC vs load/RPM. Conventional wisdom says that the injection event should finish just as the inlet valve is opening. This corresponds to around 360 BTDC as the timing is measured with respect to the spark event. Actual best timing can be determined by testing on a dyno or through road testing.

Injection Timing Table 1

The Injection Timing Table 1 menu option is only enabled if:

- The “Spark Mode” you have selected (see Section 10.1.) has a tach input that supports sequential ignition settings, i.e., **NOT** EDIS, EDIS Multispark, Basic trigger, Trigger return or some of the highly specific engine spark modes.
- AND “Sequential Injection” has been configured to “Sequential" or "Semi-sequential” (see section 8.1.2.)

Clicking Fuel Settings > Injection Timing Table 1 displays the following screen:



This is the main Injection Timing Table.

For details of how to use tables of this type see Section 1.5.3.

Secondary Injection Timing Table

The Injection Timing Table 2 menu option is only enabled if:

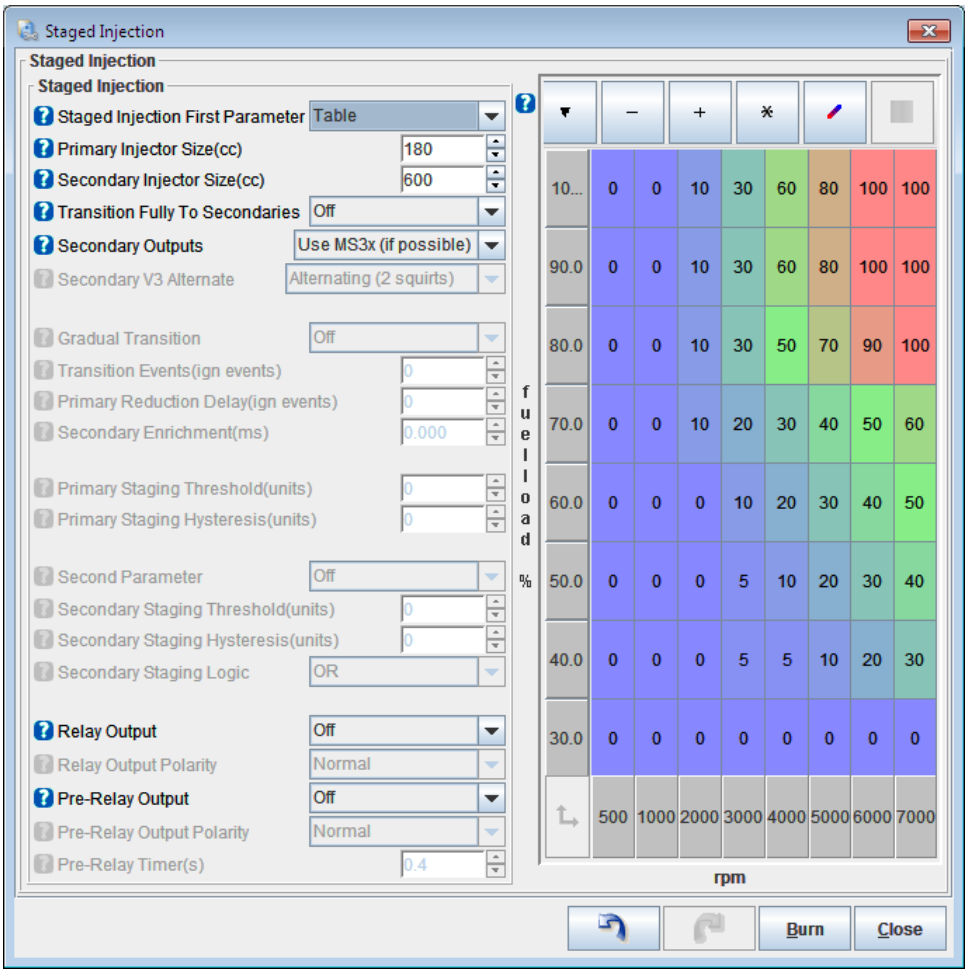
- The “Spark Mode” you have selected (see Section 10.1.) has a tach input that supports sequential ignition settings, i.e., **NOT** EDIS, EDIS Multispark, Basic trigger, Trigger return or some of the highly specific engine spark modes;
- AND “Staged Injection” has been enabled (see section 9.4.)

Clicking Fuel Settings > Secondary Injection Timing Table displays a screen almost identical to that shown above and which holds separate data.

This Secondary Injection Timing Table is used alongside the Injection Timing Table 1 for the Staged Injection outputs.

9.4 Staged Injection

Clicking Fuel Settings > Staged Injection displays the following screen:



The options for these settings are outlined below:

Staged Ignition First Parameter

This setting enables staged injection and sets the primary staging parameter which is used to determine when to engage the secondary injectors. When using Staged Injection, the "Table" option is recommended.

- Off - Staging disabled.
- RPM - Stage at a specific RPM.
- MAP - Stage at a specific MAP.
- TPS - Stage at a specific throttle position.
- Duty - Stage at a specific primary injector duty cycle.
- Table - Stage based on the table included in the dialog.

Primary Injector Size (cc)

The size of each of your main/primary injectors in cc/min (typical conversion from lbs/hr is multiply by 10.5)

Secondary injector size (cc)

Size of secondary injectors in cc/min.

Transition fully to secondaries

This setting is used to determine whether the fully staged state means that the primary and secondary pulse-widths are equal, or if the fully staged state means that primaries are shut down completely and staging transitions fully to the secondary injectors. The following settings are possible:

- Off - The fully staged state (100%) means the pulse-width on both the primaries and the secondaries is the same, and the pulsewidth is adjusted so that the total mass of fuel (grams) delivered by all injectors is equal to the theoretical mass of fuel that would be delivered by only the primary injectors if the secondaries were not engaged.
- On - The fully staged state means that the pulse-width on the primary injectors will be 0, and the full mass (grams) of fuel that would normally be delivered by the primaries will be delivered by the secondaries instead. If the secondaries are larger than the primaries, then the final pulse-width will end up smaller than the primary-only pulse-width.

- For either method, the total mass of fuel (grams) when between 0% staged and 100% staged will be maintained at the same amount as if all the fuel were being delivered by the primary injectors, and the secondaries were not engaged.

This way the commanded staging percent from the staging table can be adjusted without needing to readjust the VE table to maintain the proper amount of fuel being injected.

Secondary Outputs

This setting controls whether the MS3X outputs are used for secondaries or the mainboard "V3" board outputs are used. This option is only available with 4 or less cylinders. The following options are possible:

- Use MS3x (if possible) - Use the sequential (MS3X) outputs if it is possible to do so.
- Use V3 - Use the batch-fire board outputs.

Secondary V3 Alternate

This setting controls whether the secondaries (when using the V3 board outputs) alternate between injector channel 1 and injector channel 2, or inject simultaneously on injector channel 1 and injector channel 2. The following settings are available:

- Alternating (2 squirts) - Alternate between injector channel 1 and injector channel 2. Note that when in alternating mode, there are 2 squirts per cycle.
- Simultaneous (1 squirt) - Squirt fuel on injector channel 1 and injector channel 2 simultaneously. Note that when in simultaneous mode, there is 1 squirt per cycle.

Gradual Transition

Allows a gradual transition into staging instead of a hard switch point.

Transition Events (ign events)

How many ignition events it will take to go from no staging to fully staged.

Primary Reduction Delay (ign events)

Delays the reduction of the primary pulsewidth by a number of ignition events after the secondaries start coming online. (Useful if the secondaries are mounted further upstream.)

Secondary Enrichment (ms)

This setting is used to inject more fuel on the secondaries than the fully staged calculation determines. This is useful when there is a small lean spot just after staged injection fully engages.

Primary Staging Thresholds (units)

Used to determine when staged injection engages when using RPM, MAP, TPS, or Duty.

Primary Staging Hysteresis (units)

Used as a deadband to determine when staged injection shuts off.

Second Parameter

This setting is used to add a second method for determining when to stage.

Secondary Staging Threshold (units)

Used to determine when staged injection engages when using RPM, MAP, TPS, or Duty.

Secondary Staging Hysteresis (units)

Used as a deadband to determine when staged injection shuts off.

Secondary Staging Logic

Whether both parameters or either parameter will enable staging.

Relay Output

Use a relay output to enable secondary injectors (GM systems) where primary and secondary injectors are wired to the same injector output.

Relay Output Polarity

Allows output polarity sense to be swapped

Pre-Relay Output

Use a relay output earlier than secondary injectors (GM air-flaps).

Pre-Relay Output Polarity

Allows output polarity sense to be swapped.

Pre-Relay Timer

How long the pre-output is active before the staging transition begins.

Staging Table

The table-based method allows for smooth transitions in and out of staged mode.

The values in the table determine the percent staged, 0% means not staged at all, 100% means fully staged, and a percentage value between means that injection is partially staged.

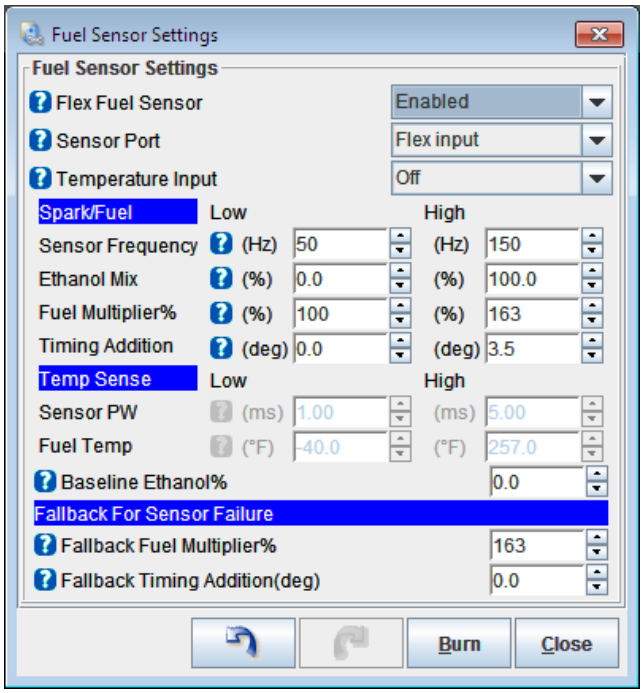
Typically you would set to 0% around idle and low load regions and 100% under full load and higher RPMs.

9.5 Fuel Sensor Settings (Flex)

The flex fuel system allows the use of E85 or other ethanol and petroleum blended fuel mixes to be used when

a fuel composition sensor is fitted.

Clicking Fuel Settings > Fuel Sensor Settings (Flex) displays the following screen:



The options for these settings are outlined below:

Flex Fuel Sensor

This enables or disables the Flex Fuel system.

Sensor Port

Selects where the flex sensor is connected.

Temperature Input

Selects whether an optional fuel temperature sensor is connected. This is fuel_temp1.

- Off - do not read fuel temperature
- Flex - use the temperature encoded in the flex sensor signal.
- Sensor01..08 - take a temperature reading from the Generic Sensors system.

Sensor Frequency

Low – The low frequency generated by the sensor (e.g., 50Hz for the GM sensor.)

High – The high frequency generated by the sensor (e.g., 150Hz for the GM sensor.)

Ethanol Mix

Low – The ethanol percentage corresponding to the low frequency.

High – The ethanol percentage corresponding to the high frequency.

Fuel Multiplier %

(100% means no change.)

Low – The fuel multiplier. The default of 100% for 0% ethanol gives 0% additional fuel.

High – The fuel multiplier. The default of 163% for 100% ethanol gives 63% additional fuel.

Timing Addition

Low – The timing addition in degrees at low frequency.

High – The timing addition in degrees at high frequency. (E85 burns more slowly than pure gasoline and will require more advance.)

Baseline Ethanol %

Ethanol percentage in regular fuel (assumes that the main fuel and spark tables are tuned for regular fuel.) Allows flex fuel system to be enabled without retuning base tables. Set to 0 for backwards compatibility.

Fallback Fuel Multiplier %

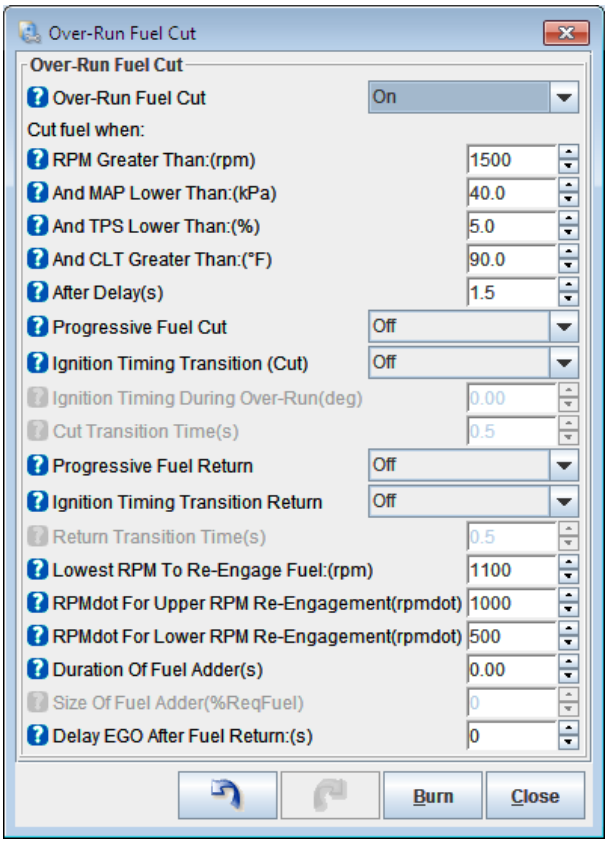
Multiplier to be used if the sensor sends an out of range frequency (faulty sensor or an error condition.)

Fallback Timing Addition (deg)

Timing to add under fault conditions (expected to be 0 or negative.)

9.6 Over-Run Fuel Cut

Clicking Fuel Settings > Over-run Fuel Cut displays the following screen:



The options for these settings are outlined below:

Over-Run Fuel Cut

Over-run fuel cut is a method to totally cut off fuel during over-run situations such as coasting down a hill in gear.

Be sure to set the parameters so that it is only triggered under true over-run conditions and not during regular driving.

RPM Greater Than (rpm)

Typically a number of hundred RPM above idle.

And kPa Lower Than (kPa)

Typically this will be below your idle kPa.

And TPS Lower Than (%)

This should be set close to zero such that over-run only enables when you really are off the throttle.

And Coolant Greater Than (°F/°C)

Set this to prevent over-run operation on a cold engine.

After Delay (s)

The delay prevents jerky on/off operation during transients.

Progressive Fuel Cut

Allows sequential injectors to be cut progressively for a smoother activation.

Do not use with staged injection.

Ignition Timing Transition (Cut)

Allows ignition timing transition during fuel cut to gradually reduce power for smoother activation.

Ignition Timing During Over-run

The ignition advance during overrun. Typically set to a low number or ATDC timing.

Cut Transition Time

Once main fuel cut delay timer has run, this sets a transition time from normal spark advance to the advance during overrun. The timer is also used for the progressive fuel cut.

Typically set a retarded timing for overrun with one second or so of time for smooth activation.

Progressive Fuel Return

Allows sequential injectors to be returned progressively for a smoother return. Does not make sense to use this with the accel-event option.

Do not use with staged injection.

Ignition Timing Transition Return

Allow ignition timing transition during fuel return to gradually increase power for a smoother transition.

Return Transition Time

This sets a transition time from overrun to normal conditions and is used with progressive spark return and

progressive fuel return.

If the throttle is applied above the threshold, the fuel and timing are immediately returned cancelling this timer.

Lowest RPM to re-engage fuel

Allows a deadband of RPM for smoother operation. Typically set this a few hundred RPM below your minimum RPM setting.

RPMdot For Upper RPM Re-Engagement

When revs are falling more quickly than this RPMdot value the initial RPM is used for fuel return.

In-between upper and lower RPMdot values, the return RPM is interpolated. This number must be larger than the 'lower' RPMdot setting.

Typically 1000.

RPMdot For Lower RPM Re-Engagement

When revs are falling more slowly than this RPMdot value the lower RPM is used for fuel return. This will happen when coasting down.

If revs are falling more quickly then any return transitions will be cancelled and the return RPM will be raised.

Set this so that clutch-in during fuel cut does not stall. Typically 500.

(The RPMdot shows negative in datalogs when revs are falling, so a setting of 500 means less negative than -500)

Duration of Fuel Adder

The length of time that additional fuel is added after over-run ends to avoid a lean-spike.

Size of Fuel Adder

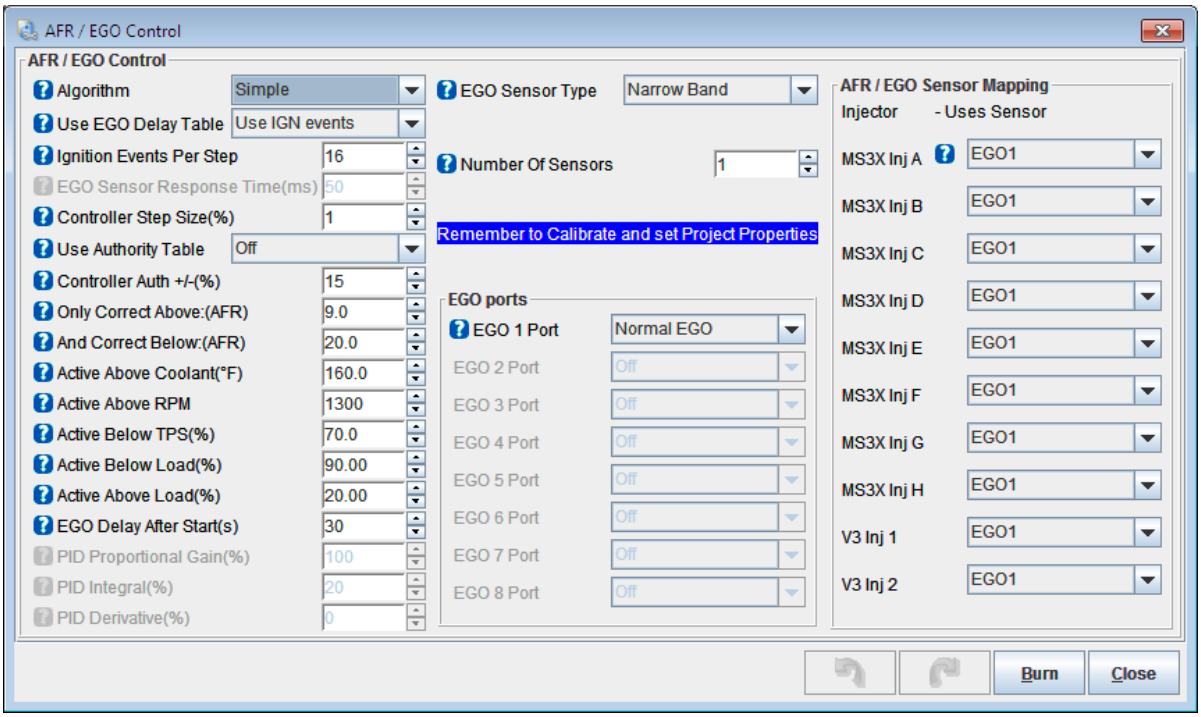
Fuel adder after over-run ends to avoid a lean-spike.

Delay EGO after fuel return (s)

Over-run will give a full-lean EGO reading and so closed-loop EGO should be disabled until a sensible reading is available. Set this long enough so that the EGO sensor is returning a true reading.

9.7 AFR/EGO Control

Clicking Fuel Settings > AFR/EGO Control displays the following screen:



The options for these settings are outlined below:

Algorithm

- Simple – This method of closed-loop EGO control is well-suited to use with a narrowband O2 sensor.
- PID – This closed-loop method incorporates a Proportional Integral Derivative control-loop which (when tuned properly) adjusts the amount of fuel being injected to quickly get to the target, and then maintains the target without any oscillation.
- No correction – no fuel changes are made in response to oxygen sensor readings.

Use EGO Delay Table

Specifies whether to use IGN events or delay table to determine how often EGO runs.

Ignition Events Per Step

The number of ignition events between each correction.

EGO Sensor Response Time

Static value representing O2 sensor response time which is added to the EGO delay table value.

Controller Step Size (%)

Controls how large each correction 'step' is.

Use Authority Table

Enables a table of EGO authority based on RPM/load. This allows greater control over when closed-loop EGO is operational and permits variable authority. An authority of zero means there will be no correction made. Normally the RPM and load axes should be set the same as the AFR tables.

Controller Auth +/- (%)

The maximum amount of adjustment performed by the closed-loop algorithm.

Only Correct Above

Only correct above this AFR. Used to ignore faulty sensor readings.

And Correct Below

Only correct below this AFR. Used to ignore faulty sensor readings.

Active Above Coolant (°F/°C)

Only make correction above this temperature.

Active Above RPM

Only make correction above this RPM.

Active Below TPS (%)

Only make correction below this throttle position.

Active Below Load (kPa)

Only make correction below this load.

Active Above Load (kPa)

Only make correction above this load.

EGO Delay After Start (sec)

Only make correction when engine has been running at least this long.

PID Proportional Gain (%)

Proportional term.

PID Integral (%)

Integral term.

PID Derivative (%)

Differential term.

EGO Sensor Type

- Disabled – No EGO sensor enabled;
- Narrowband – Enable narrowband sensor(s);
- Wideband – Enable wideband sensor(s).

Number of Sensors

Selects the number of oxygen sensors in use.

EGO Ports

For each EGO channel, selects where the sensor is connected.

AFR / EGO Sensor Mapping

Specifies which EGO sensor corresponds to each injector channel so that closed-loop corrections will alter the correct injectors.

e.g. on a V8 with one EGO sensor per bank, half of the injectors influence EGO1 and the other half influence EGO2.

9.8 AFR Tables (1 and 2)

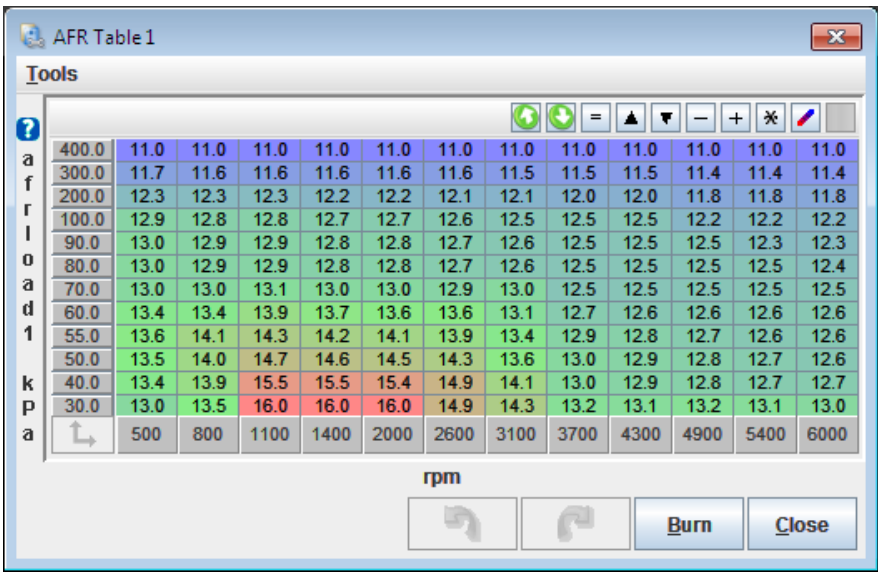
The AFR Tables allow you to set values for target AFR vs RPM/load.

When 'Incorporate AFR' is set to “off” (see Section 8.2.4.) this is a reference table only. When 'Incorporate AFR' is set to “on”, this table is included in the fuel calculation.

If you intend to use these tables please ensure that you set its values before you begin tuning.

AFR Table 1

Clicking Fuel Settings > AFR Table 1 displays the following screen:



For details of how to use tables of this type see Section 1.5.3.

AFR Table 2

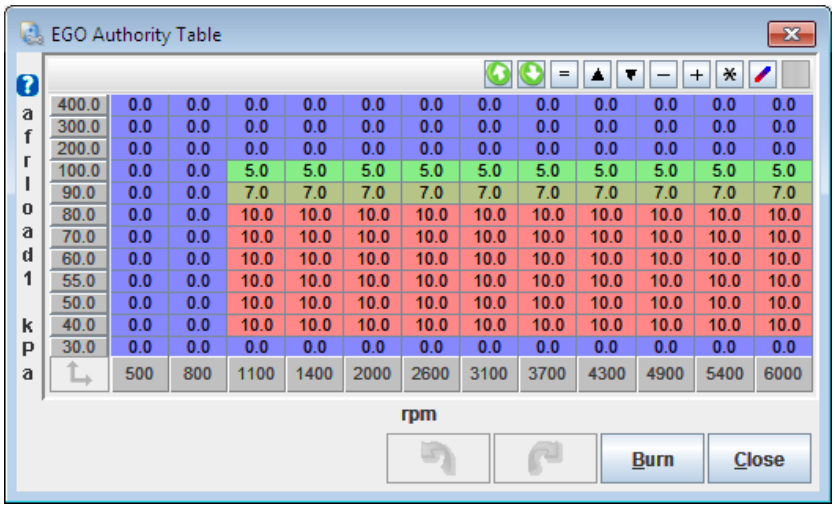
The AFR Table 2 menu option is only enabled if using Dual Fuel, AFR table switching, AFR table blending or through the Nitrous system.

Clicking Fuel Settings > AFR Table 2 displays a screen which looks almost identical to that shown above and which holds separate data.

9.9 EGO Authority Table

Specifies the EGO authority limit across the range of engine operation condition. Setting zero means there will be no change in fuel based on the lambda sensor i.e. open-loop mode.

Clicking Fuel Settings >EGO Authority Table displays the following screen:

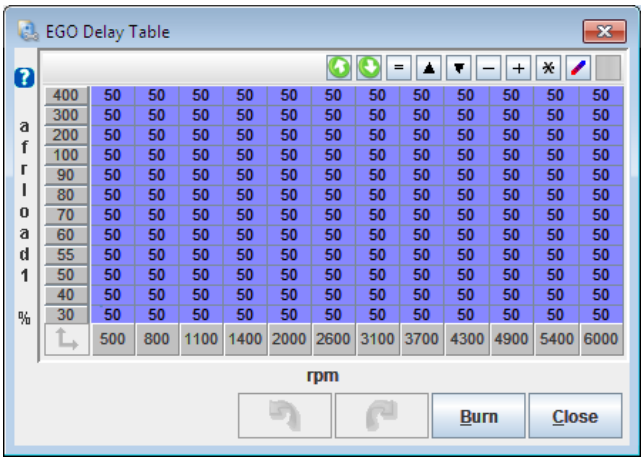


For details of how to use tables of this type see Section 1.5.3.

9.10 EGO Delay Table

Table which specifies the delay between runs of the EGO algorithm in ms to compensate for differing exhaust gas velocities.

Clicking Fuel Settings >EGO Delay Table displays the following screen:



For details of how to use tables of this type see Section 1.5.3.

9.11 Narrowband EGO Targets

The target narrowband lamba sensor voltage vs. load/RPM.

Clicking Fuel Settings >EGO Delay Table displays the following screen:

For details of how to use tables of this type see Section 1.5.3.

9.12 AFR Safety System

The "AFR Safety" System is designed to help you protect your engine from unwanted dangerous lean conditions. Typically this will be used for wide open throttle and/or boosted conditions. It only makes sense to use this feature with a wideband lambda sensor on an already well tuned engine.

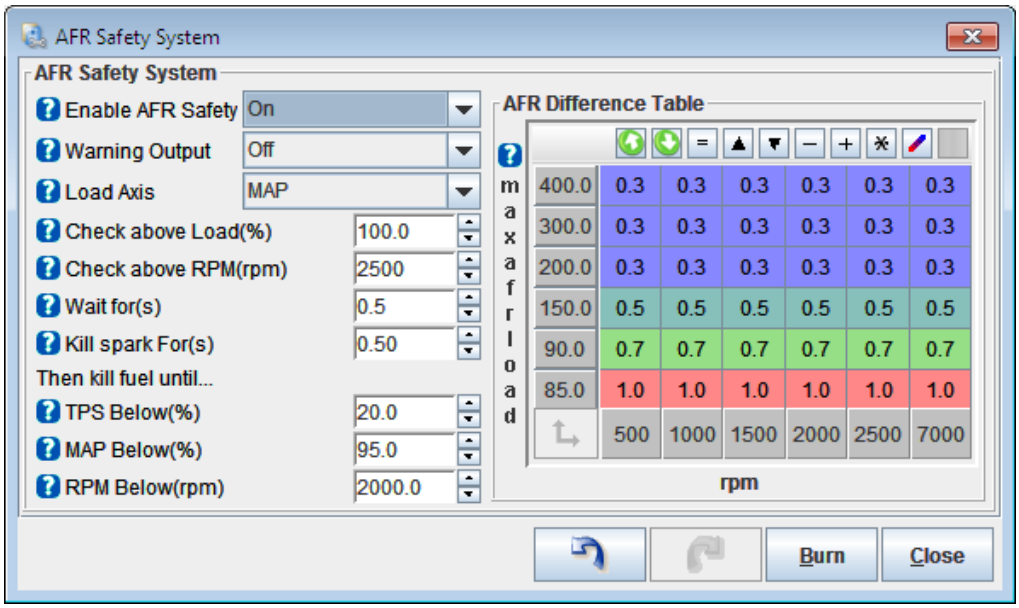
The system compares the wideband EGO input against your existing AFR target table and a safety limit difference table.

If the AFR is leaner then your different table allows beyond a time you specify, the engine will be shutdown as a protective measure until you get out of boost, off the throttle and down in revs.

This system will only work if configured correctly and will not protect your engine against bad tuning or knock! However, it is likely it would detect a failing fuel pump or regulator. A single faulty injector could easily go un-noticed with a single wideband reading the average AFR.

This shutdown mechanism is shared with the EGT over-temperature settings.

Clicking Fuel Settings > AFR Safety System displays the following screen:



The options for these settings are outlined below:

Enable AFR Safety

This enables or disables the system

Warning output

This can be used to turn on an output as soon as an over-lean condition is detected.

Load axis

Typically choose MAP if running speed-density or TPS if running Alpha-N

Check above load

The system only checks the AFR above this load.

Check above RPM

The system only checks the AFR above this RPM.

Wait for

This delay allows for a brief lean-spike without tripping the shutdown. Set as low as possible.

Kill spark for

Intially spark is cut for this time and then fuel as well.

TPS below, MAP below, RPM below

Normal engine operation resumes when all three conditions are met.

AFR Difference Table

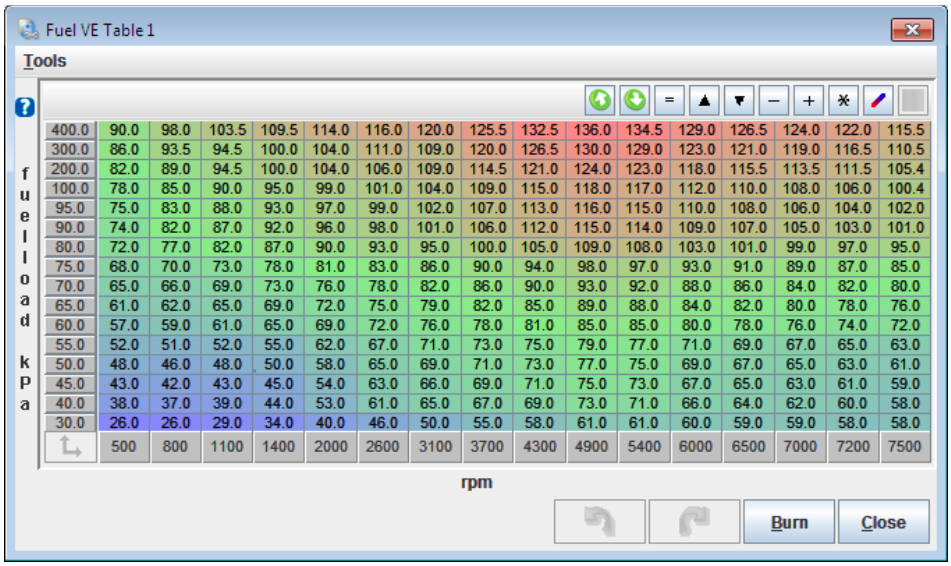
The table on the right is the "safety limit" difference table. This number is added to the current target AFR. If the actual AFR is leaner (larger), then the safety shutdown countdown begins.

9.13 Fuel VE Tables (1 to 4)

The three Fuel VE tables allow you to set values for volumetric efficiency (VE) at a range of points depending on rpm and fuelload. Larger VE values correspond to more fuel, smaller values correspond to less fuel.

Fuel VE Table 1

Clicking Fuel Settings > Fuel VE Table 1 displays the following screen:



This is the main fuel table [VE1].

In MAF mode, this table operates as a trim table and should initially be filled with 100% in all cells.

For details of how to use tables of this type see Section 1.5.3.

Fuel VE Table 2

This secondary Fuel VE table [VE2] is used as a blend table with VE1.

The Fuel VE Table 2 menu option is only enabled if a Secondary Fuel Load source has been selected (see Section 8.2.4.)

Clicking Fuel Settings > Fuel VE Table 2 displays a screen which looks almost identical to that shown above and which holds separate data.

Fuel VE Table 3

This Fuel VE table [VE3] can be used as:

- a dual fuel main table for the secondary fuel.
- a table-switched alternative to VE1.
- blend table with VE1.

Table Blending and Switching is covered in section 14.1 and in the Setting Up manual.

Again, The Fuel VE Table 3 menu option is only enabled if:

- “Dual Fuel” is enabled (see Section 14.1.2.)
- OR: fuel table-switching is enabled
- OR: a blend table is enabled to VE1

Clicking Fuel Settings > Fuel VE Table 3 displays a screen almost identical to that shown above and which holds separate data..

Fuel VE Table 4

This Fuel VE table [VE4] is used as a blend table with VE3.

Again, The Fuel VE Table 4 menu option is only enabled if:

- Fuel VE Table 3 is already active
- AND: A Secondary Fuel Load source or blend has been selected that enables Fuel VE Table 2.

Clicking Fuel Settings > Fuel VE Table 4 displays a screen almost identical to that shown above and which holds separate data..

9.14 Injector Trim Tables

The InjectorTrim Tables allow you to specify a percentage multiplier for adjustment on the basic fuel pulsewidth to allow for difference per cylinder.

- 0% means no adjustment
- Positive numbers mean to add fuel to that cylinder or channel
- Negative numbers mean to add fuel to that cylinder or channel

(Note that this is different to Megasquirt-2 where 100% means no adjustment.)

Injector Trim Tables apply per cylinders and use the Firing Order table (see section 8.1.2) to determine which injector is linked to each cylinder.

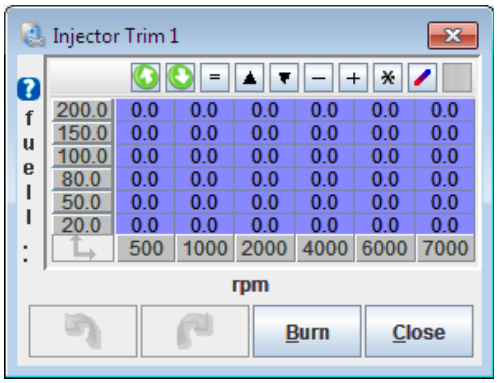
Injector Trim Tables are only enabled if:

- The “Spark Mode” you have selected (see Section 10.1.) has a tach input that supports sequential ignition settings, i.e., NOT EDIS, EDIS Multispark, Basic trigger, Trigger return or some of the highly specific engine spark modes.
- AND “Sequential Injection” has been configured to use “Sequential injection” (see section 8.1.2.)
- AND “Injector Trim” has been set to “On” (see section 8.1.2.)

Injector 1 Trim

This is used with the first of the batch-fire outputs on the V3.0 or V3.57 mainboard and applies for 1 or 2 cylinder engines running sequential fuel only.

Clicking Fuel Settings > Injector 1 Trim displays the following screen:



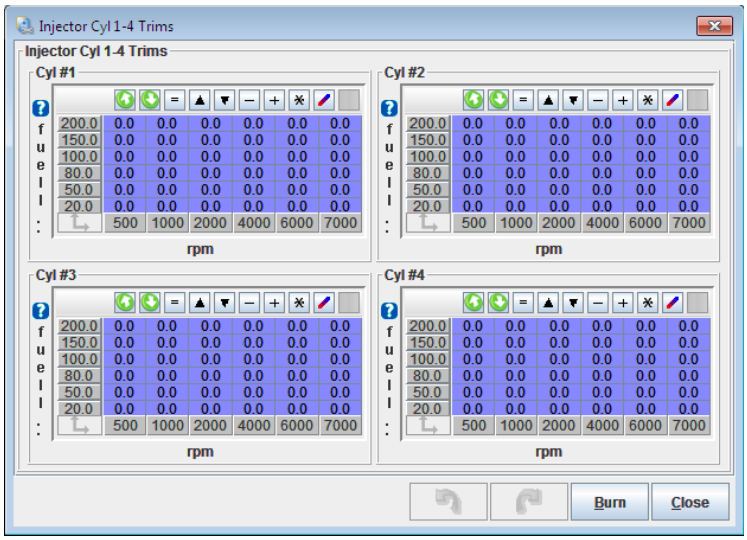
Injector 2 Trim

This operates in the same was as Injector 1 Trim.

Cyl 1-4 Trims

This applies to the normal sequential fuel outputs. As mentioned above, the Firing Order needs to be set first.

Clicking Fuel Settings > Cyl 1-4 Trims 1 displays the following screen:



Changes made to the trim table for Cyl#1 will apply to the injector linked to cylinder #1 only.

For details of how to use tables of this type see Section 1.5.3.

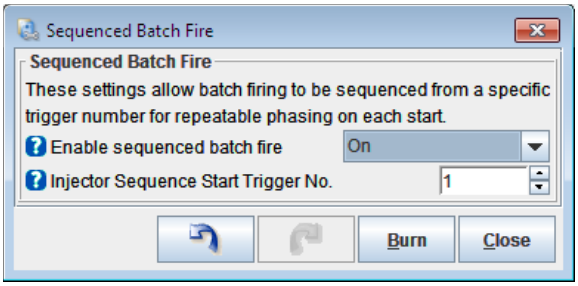
Cyl 5+Trims

The trim tables for cylinders 5 upwards operate in the same manner.

9.15 Sequenced Batch Fire

The Sequenced Batch Fire menu option is only enabled if “Sequential Injection” has been configured to use “Off” (see section 8.1.2.)

Clicking Fuel Settings > Sequenced Batch Fire displays the following screen:



The options for these settings are described below:

Enable Sequenced Batch Fire

Sequenced batch fire can be useful to give more repeatable engine operation without sequential fuel. On every startup the batch firing is aligned to the same ignition event (cylinder) when a suitable tach-in signal is available (such as a toothed wheel.) Without this feature the alignment is random.

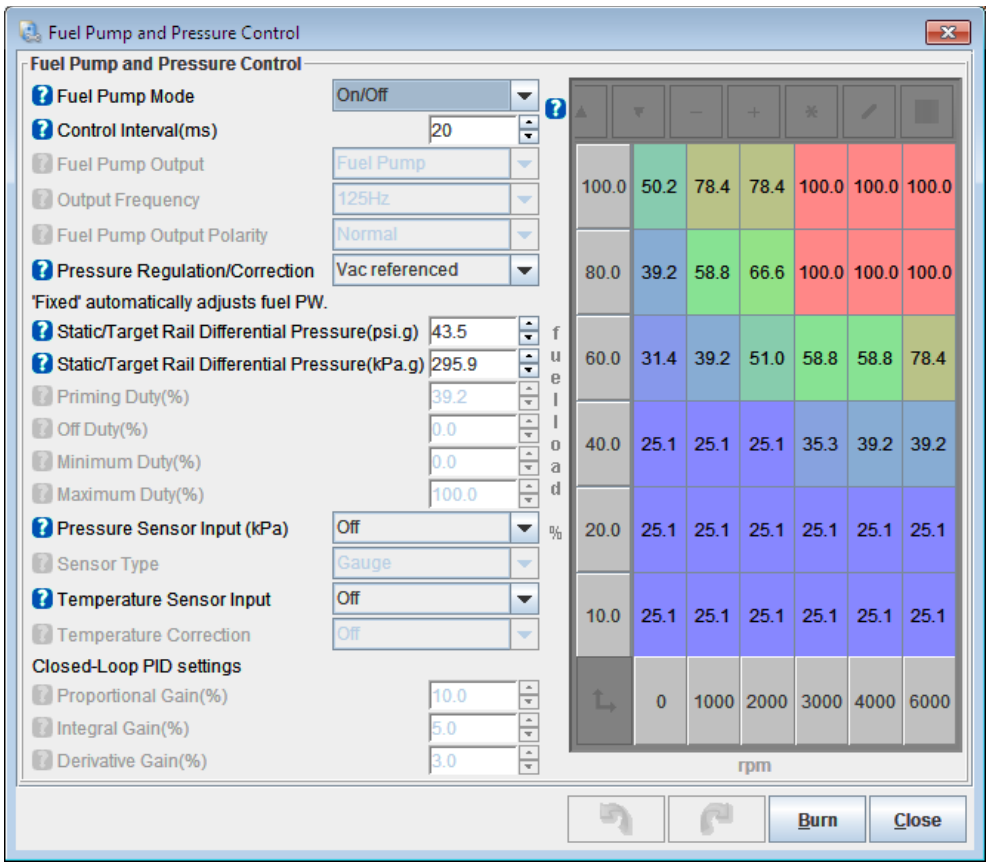
Injector Settings Start Trigger No.

Specifies the ignition 'trigger'. Typically try 0 or 1.

9.16 Fuel Pump and Pressure

This allows for control of the fuel pump and fuel pressure.

Clicking Fuel Settings > Fuel Pump and Pressure displays the following screen:



The options for these settings are described below:

Fuel Pump Mode

- On/Off is used for basic control where the Megasquirt controls the negative side of a relay.
- Open-Loop PWM provides a table based duty cycle for a fuel pump controller.
- Closed-Loop PWM monitors actual rail pressure and adjusts the duty cycle output to the pump controller to maintain a set differential pressure.

Control Interval

How often to run the control calculations

Fuel Pump Output

The output used to control the fuel pump (either to the relay or to a controller.)

Output Frequency

For PWM outputs, this sets the output frequency.

Fuel Pump Output Polarity

Allows the output signal to be inverted.

Set to 'Normal' for On/Off.

This setting is useful for PWM outputs and should be set to 'Invert' when using one of the mid-current ECU outputs as they invert the signal in hardware. The Spark or Digital outputs do not invert the signal and 'Normal' should be used. Note that the on/off fuel pump output is always electrically a low-side driver and connects to the negative side of the relay - changing this setting will have no impact on that. (i.e. the output will never become a 12V output.)

Pressure Regulation/Correction

By preference, fuel systems use a vacuum/boost referenced regulator that maintains line pressure Xbar above inlet pressure. Some GM fuel systems use a fixed fuel pressure referenced to ambient air pressure instead. The vac referenced systems give even injector flow across all inlet pressure conditions. The un-referenced systems give a varying flow and require a calculation within the ECU to compensate. Enabling 'Fixed' here turns on that automatic compensation.

Static/Target Rail Differential Pressure (psi.g)

The fuel rail pressure in PSI referenced to manifold pressure. Typically 43.5PSI for many installs.

Static/Target Rail Differential Pressure (kPa.g)

The fuel rail pressure in kPa referenced to manifold pressure. Typically 304kPa for many installs.

These two settings are in fact one setting just displaying in different units, they are linked together.

Priming Duty

The PWM duty cycle used during the priming pulse.

Off Duty

The PWM duty cycle used when the pump should be off. Set to 0 for most applications, or 75% for Ford FPDM modules.

Minimum Duty

The minimum PWM duty cycle to be used when running. Set to 0 for most applications, or 5% for Ford FPDM

modules.

Maximum Duty

The maximum PWM duty cycle to be used when running. Set to 100 for most applications, or 50% for Ford FPDM modules.

Pressure Sensor Input (kPa)

If used, specifies a Generic Sensor that is configured for fuel pressure in kPa.

Sensor Type

- 'Gauge' sensors are referenced to atmospheric pressure - with a vac referenced regulator, the reported pressure will drop under vacuum and increase under boost.
- 'Differential' sensors are referenced to manifold vacuum/boost - this pressure will typically remain static e.g. 43psi, 3bar.
- 'Absolute' sensors are referenced to true vaccum and will read about 14.7psi/1bar when there is no fuel pressure.

Temperature Sensor Input

If used, specifies a sensor input for fuel temperature.

Temperature Correction

Enables fuel correction based on fuel temperature.

Proportional Gain

Closed-loop Proportional term.

Integral Gain

Closed-loop Integral term.

Derivative Gain

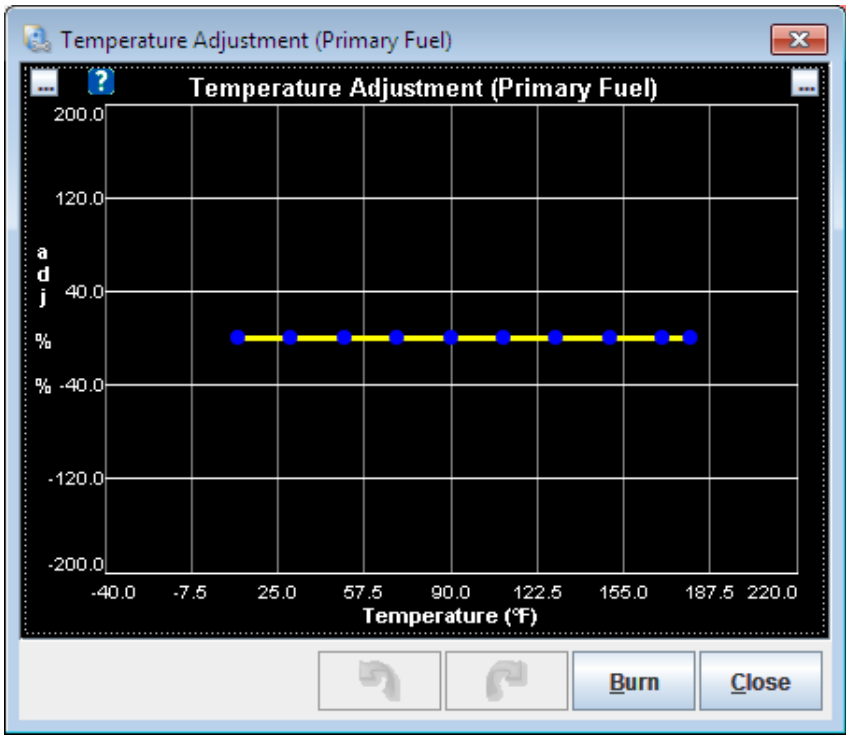
Closed-loop Differential term.

Open-loop PWM Table

The table specifies the PWM duty cycle each each load/RPM point.

9.17 Temperature Adjustment

Clicking Fuel Settings > Temperature Adjustment displays the following screen:

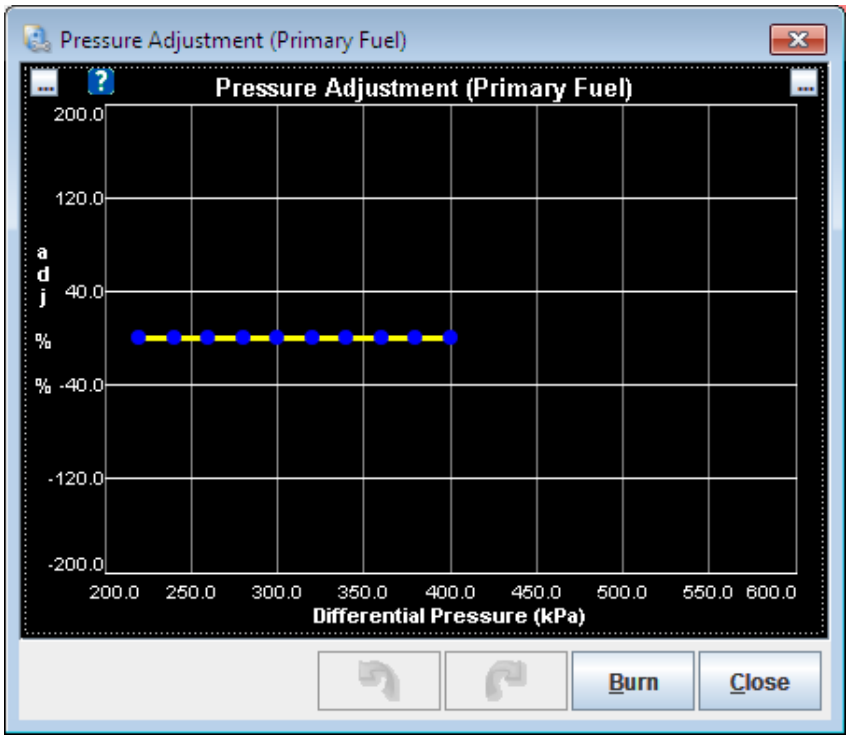


Specifies a percentage adjustment in fuelling based on fuel temperature. 0% means no adjustment.

The Temperature Adjustment is only enabled if a “Temperature Sensor Input” is enabled and "Temperature Correction" is set to "On" (see section 9.16)

9.18 Pressure Adjustment

Clicking Fuel Settings > Pressure Adjustment displays the following screen:



Specifies a percentage adjustment in fuelling based on fuel pressure. 0% means no adjustment.

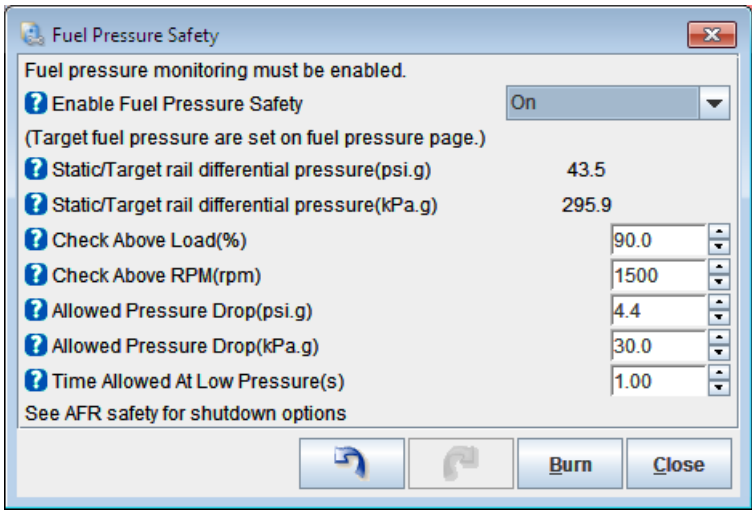
The pressure used for the lookup is always the pressure across the injector i.e. rail pressure - intake pressure.

The Pressure Adjustment is only enabled if “Fuel Pressure Regulation/Correction” has been configured to use “Custom Correction.” (see section 9.16)

9.19 Fuel Pressure Safety

The fuel pressure safety system links in to the AFR Safety engine shutdown mechanism (see Section 9.12) to protect the engine in the event of a fault with fuel pressure.

Clicking Fuel Settings > Fuel Calculations Summary will display the following screen:



The options for these settings are described below:

Enable Fuel Pressure Safety

Enables fuel pressure safety system.

If the measured fuel pressure drops too low for more than a set time, the engine is shutdown.

Static/Target Rail Differential Pressure (psi.g)

The fuel rail pressure in PSI referenced to manifold pressure. Typically 43.5PSI for many installs. Ths is set on the Fuel Pump and Pressure page.

Static/Target Rail Differential Pressure (kPa.g)

The fuel rail pressure in kPa referenced to manifold pressure. Typically 304kPa for many installs. Ths is set on the Fuel Pump and Pressure page.

Check Above Load

Only check for low pressure above this engine load (e.g. MAP, TPS, MAFload)

Check Above RPM

Only check for low pressure above this RPM.

Allowed Pressure Drop (psi.g)

Allowed drop in pressure below target.

Allowed Pressure Drop (kPa.g)

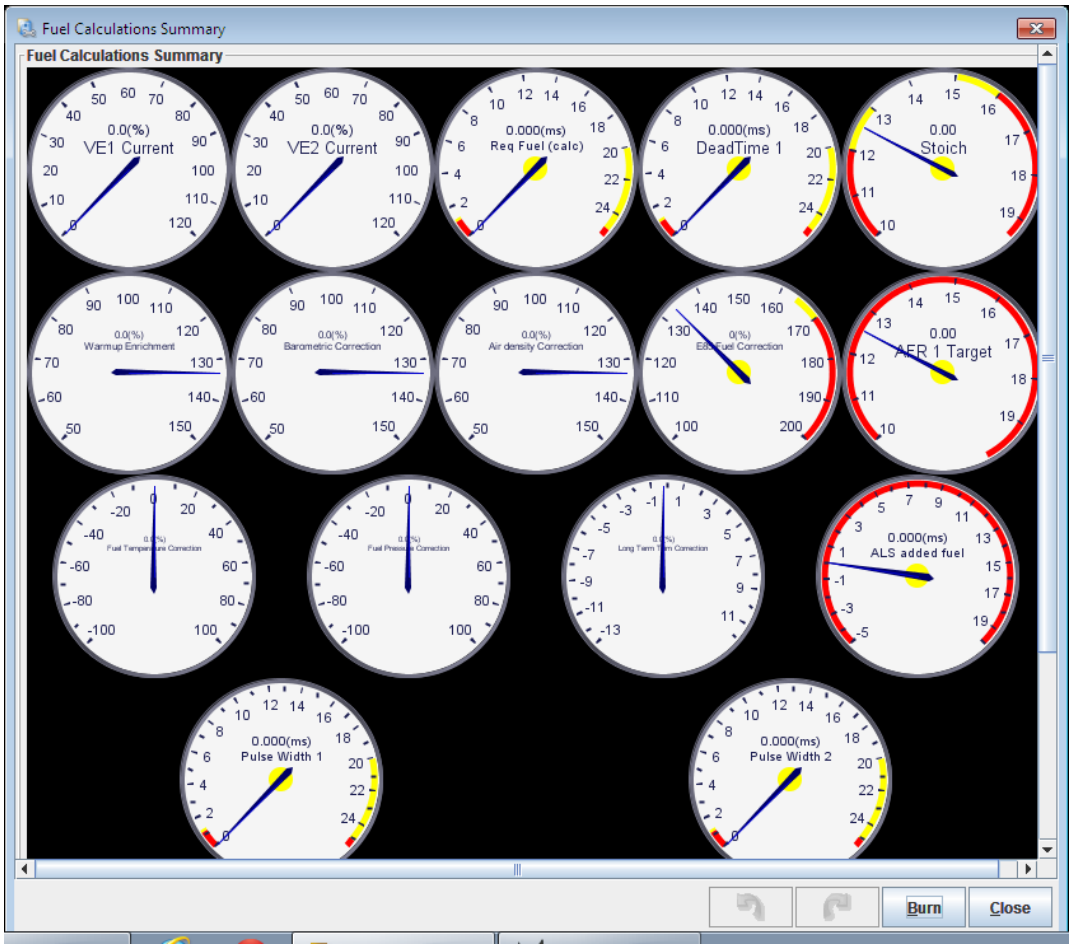
Allowed drop in pressure below target.

Time Allowed At Low Pressure

If fuel pressure stays too low for more than this time, the engine is shutdown using the AFR safety settings.

9.20 Fuel calculations Summary

Clicking Fuel Settings > Fuel Calculations Summary will display the following screen:



This screen offers a gauge cluster showing summary information of all the fuel related variables that are configured for your Megasquirt. This screen can be useful for analysis and troubleshooting.

10 Ignition Settings

There are many different ways to design an engine, and as a result there are a wide range of methods used by manufacturers to manage ignition settings.

Correctly setting up your ignition settings to ensure that your Megasquirt works well with your engine is one of the most critical areas of work when installing and configuring your Megasquirt. It is also an area where **it is very easy to damage your engine** if your configuration is poor, therefore take good care to plan your changes to ignition settings carefully. Seek support from the online forums at www.msextra.com if you are not certain which settings you should use.

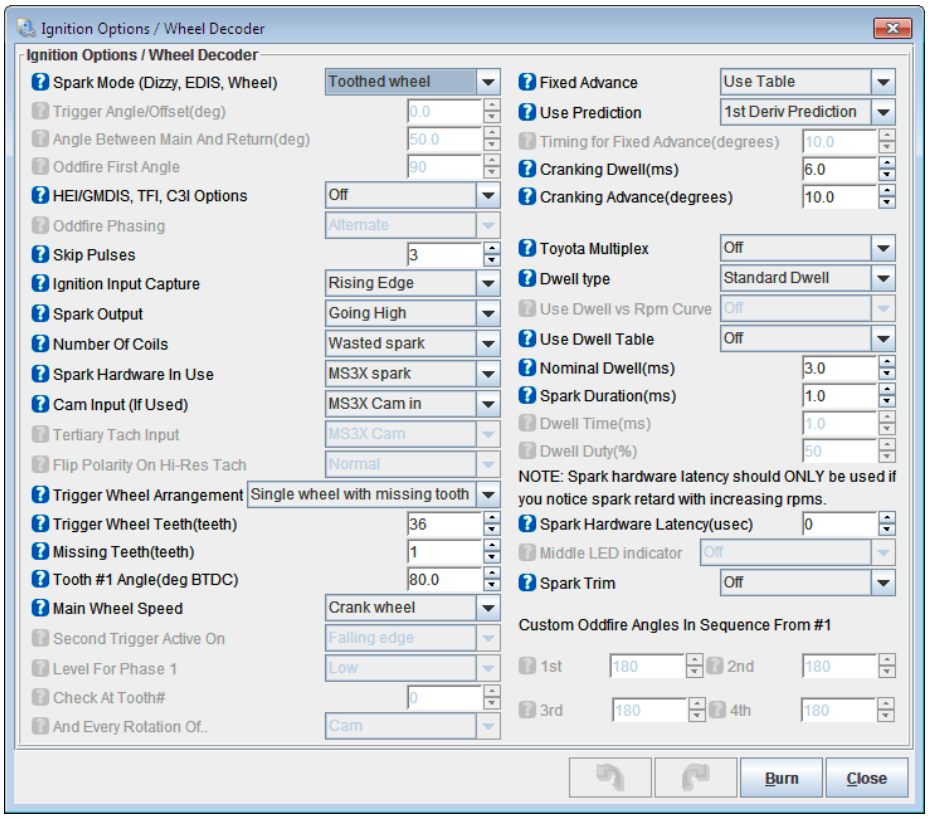
TunerStudio MS Lite supports a wide range of ignition settings and configurations which will allow you to configure your Megasquirt to work with your engine and to achieve an effective tune.

The settings and options to do this are contained within the Ignition Settings toolbar menu. These options include the fundamental settings such as spark mode, dwell battery correction, cold advance and manifold air temperature based timing retard. They also include noise filtering, knock sensor settings as well as ignition tables and settings for rotary engines.

The following sections deal with these settings and options.

10.1 Ignition Options / Wheel Decoder

Clicking Ignition Settings > Ignition Options / Wheel Decoder displays the following screen:



There are a significant number of different ways to configure the ignition options. The options for these settings are described below:

You will not need to set all of these options for your engine, disregard any options that are disabled according to your selection.

Spark Mode (Dizzy, EDIS, Wheel)

It is **absolutely essential** that you select the correct Spark Mode setting for your engine. If you have any doubt about which option to use **please ask for help before proceeding**.

Spark Mode sets the type of tach input pattern decoder to be used. These are covered in detail in the Hardware manual for your product.

Trigger Angle/Offset (deg)

In 'Basic Trigger' and 'Trigger Return' this specifies the engine angle BTDC that each trigger pulse is received.

In 'Toothed Wheel' this should always be set to zero – use tooth #1 angle instead.

In other modes this setting can be used to make a +/- 20 degree adjustment to the built-in reference angle.

Angle Between Main and Return (deg)

This is only used in CAS 4/1 mode and specifies the angular length of each tooth.

Oddfire First Angle

For oddfire engines this specifies the angle the engine must rotate from spark A output to spark B output.

HEI/GM DIS, TFI, C3I Options

GM HEI, Ford TFI and Buick C3I specific options.

With HEI7/8 and GM-DIS, this setting enables the 'bypass' output on spark B.

The C3I mode enables the 'bypass' and also quick-sync after the cam signal is received.

TFI Signature PIP mode is used with 'Basic Trigger' and allows the Megasquirt to use these distributors (where one vane is shorter than the others) for sequential fuel.

Oddfire Phasing

There are three settings for this option:

- Alternative – most oddfires such as Ford V4. Chevy V6, Viper V10;
- Paired – Yamaha Vmax;
- Custom – Set your own oddfire angles.

Skip Pulses

The number of tach input pulses at start-up that are ignored before ignition calculations and wheel decoding begins. The default value of 3 is suitable for most applications.

Ignition Input Capture

This must be matched to your tach input. If it is set incorrectly you can experience timing drift with rpms or mis-detection of missing teeth on a missing tooth wheel.

The tooth logger can be used to confirm polarity is correct.

Spark Output

Getting this setting right is **CRITICAL** or you will melt your ignition coils!

For 99% of installs using the sequential (MS3X) spark outputs, this should be set to 'Going high'

Number Of Coils

Specifies the type of ignition coils in use. TFI, HEI, EDIS, GMDIS must set to 'single coil'.

Spark Hardware in Use

Either MS3X or LEDs. The MS3X outputs are ready to use logic spark outputs. The 'LED' spark outputs will typically only be used on upgrades from MS2 or without the MS3X.

- JS10 spark - for compatability with MS2 installs (not on MS3-Pro)
- LEDs spark - for compatability with MS2 installs (not on MS3-Pro)
- MS3X spark - sequential logic spark outputs
- Tacho - can be used for TFI or CDI ignition boxes

Cam Input (If Used)

Selects the wiring of an electrical cam sensor or for 1 and 2 cylinder engines this optionally enables the MAP sensor input in place of a cam sensor. Used with 'Dual wheel with missing tooth' only.

Set the MAP sensor phase threshold on the General Settings screen (see Section 8.2.)

Tertiary Tach Input

Selects an input for the cam signal in "Flywheel Tri Tach" mode.

Flip Polarity on Hi-Res Tach

Allows the polarity to be changed on the high resolution tach input signal - Nissan CAS, Optispark only.

Trigger Wheel Arrangement

There are three settings for this option:

- Single wheel with missing tooth – typically a crank wheel such as 36-1 or 60-2;
- Dual wheel – two wheels without missing teeth e.g., Nippodenso 24/1 CAS;
- Dual wheel with missing tooth – typically a 36-1, 60-2 crank wheel **and** an additional cam wheel.

Trigger Wheel Teeth (teeth)

The number of effective teeth **counting the missing teeth as if they existed** – i.e., a 36-1 wheel has 35 physical teeth, but enter 36.

Missing Teeth (teeth)

The number of missing teeth. Common are 1 for 36-1, or 2 for 60-2 or 36-2. Other variations exist.

Tooth #1 Angle (deg BTDC)

Generally (with a missing tooth crank wheel) tooth #1 is the first tooth to pass the sensor after the missing tooth gap. With a non-missing tooth configuration determining tooth #1 is a little more complex and requires two sensors (on the crank and cam respectively.)

You should have determined tooth #1 and the correct angle during configuration. If you are not sure please refer to the Megasquirt-3 Setting Up and the appropriate Hardware Manual or ask on the forum at www.msextra.com.

Main Wheel Speed

Determines whether the main wheel speed used is based on the rotation at the Crank wheel or the Cam wheel.

Second Trigger Active On

Like ignition input capture above this specifies which voltage level is considered 'active'.

Level For Phase 1

In 'Poll level' mode this specifies which voltage level is used for each engine phase.

Check at Tooth

Which crank tooth number to poll the cam level at. Default is 0. For Rover 4.6 V8 try 17.

Changing the tooth no. may also change the phase.

And Every Rotation Of

Sets how often are the second trigger (e.g., cam) input pulses received.

Fixed Advance

There are two options for this setting:

- Fixed Advance – locks timing to the value set below. This is used for confirming timing with a strobe timing light during setup;
- Use table – normal operation where the spark advance table is used.

Use Prediction

There are two options for this setting:

- 1st Deriv. Prediction – engine acceleration / deceleration is allowed for in timing calculation (normal setting);
- No Prediction – no allowance.

Timing For Fixed Advanced (degrees)

The timing to lock to in 'Fixed' mode.

Cranking Dwell (ms)

Specifies the base coil dwell time during cranking before battery correction is applied.

Cranking Advance (degrees)

Specifies the ignition advance to be used while cranking. Typically 5-10 deg BTDC.

Toyota Multiplex

Enables specific multiplexed outputs for use with the Toyota ignition module such as used on the 7MGTE.

Dwell Type

There are four options for this setting:

- Standard Dwell – this is the setting to use for most installs;
- Fixed Duty – locks the spark output to a constant duty cycle instead of controlling dwell. e.g., Ford's 'Push Start' TFI modules, Bosch 'smart' ignition modules, or MSD and other CD boxes;
- Time After Spark – only intended for Saab Tri-Ionic DI cassettes;
- Charge at trigger – rarely used. Could be used with MSD type CDI boxes when running Basic Trigger only.

Use Dwell vs RPM Curve

For time-after-spark, the dwell can be varied with RPM.

Use Dwell Table

For 'standard dwell', a table of dwell values can be used. Normally a single dwell value is used.

Nominal Dwell (ms)

The base dwell time before battery voltage correction. Typical values are 3-4 ms.

Spark Duration (ms)

The time required for the spark to complete, typically in the order of 1 ms.

Dwell Time (ms)

The backwards dwell time for Time-After-Spark

Dwell Duty (%)

For fixed duty, this specifies the percentage duty cycle of the output signal.

Spark Hardware Latency

Should **only** be used if you notice spark retard with increasing rpms.

If you notice a slight retarding of ignition timing with rpm while strobing with fixed timing, you can enter a small number in here to remedy it.

Middle LED indicator

Only applies to MS3.

For Trigger Return mode only, the middle LED on the case can be used to echo the input signal from the distributor to help in setting up the base timing.

Spark Trim

Enables the adjustment of timing per individual cylinder.

Custom oddfire angles in sequence from #1

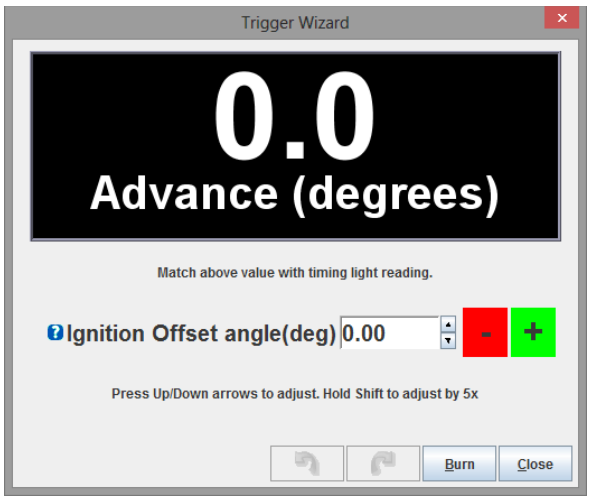
- 1st – Number of crank degrees engine rotates from spark A to spark B;
- 2nd – Number of crank degrees engine rotates from spark B to next cylinder;
- 3rd – Number of crank degrees engine rotates from spark C to next cylinder;

- 4th – Number of crank degrees engine rotates from spark D to next cylinder.

10.2 Trigger Wizard

The Trigger Wizard menu option is **not** enabled if “Fuel Only” or “Toothed Wheel” have been selected as the “Spark Mode” (see Section 10.1.)

Clicking Ignition Settings > Trigger Wizard displays the following screen:



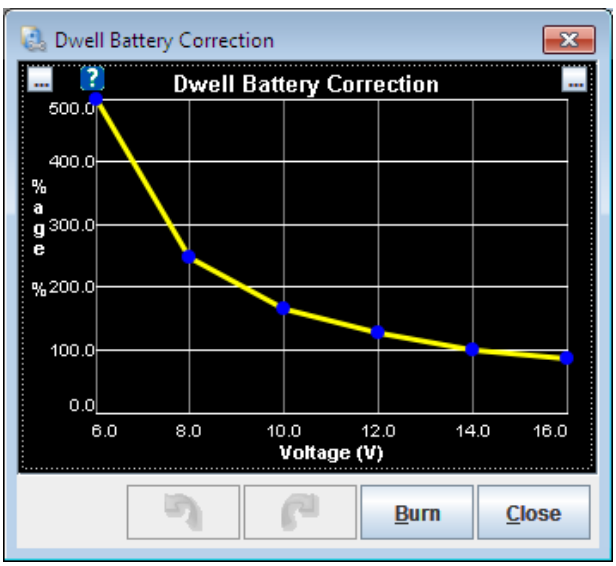
In 'Basic Trigger' and 'Trigger Return' this specifies the engine angle BTDC that each trigger pulse is received.

- In 'Toothed Wheel' this should always be set to zero – use tooth#1 angle instead.
- In other modes this setting can make a +/- 20 degree adjustment to the inbuilt reference angle.

10.3 Dwell Battery Correction

The Dwell Battery Correction menu option is not enabled if “Fuel Only” has been selected as the spark mode (see Section 10.1.)

Clicking Ignition Settings > Dwell Battery Correction displays the following screen:



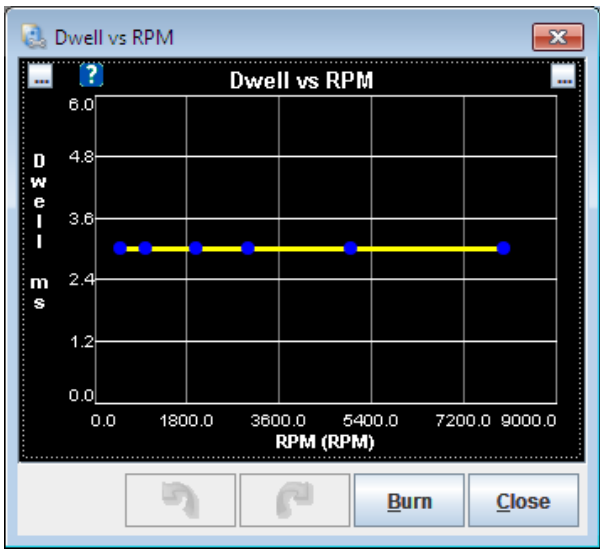
This curve specifies the percentage adjustment to the nominal dwell based on battery voltage.

Inductive coils require greater dwell (charge time) at lower voltages.

10.4 Dwell vs RPM

The Dwell vs RPM menu option is not enabled if “Fuel Only” has been selected as the “Spark Mode” (see Section 10.1.) It also requires "Dwell Type" to be set to "Time after spark" and "Use dwell vs RPM curve" to be enabled.

Clicking Ignition Settings > Dwell vs RPM displays the following screen:

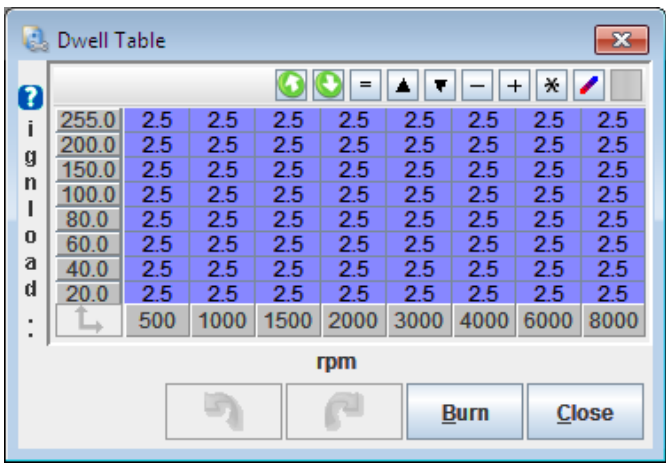


Consult Saab Tri-ionic information for optimum "dwell" times.

10.5 Dwell Table

The Dwell Table menu option is not enabled if “Fuel Only” has been selected as the “Spark Mode” (see Section 10.1.) It also requires "Dwell Type" to be set to "Standard dwell" and "Use Dwell Table" to be enabled.

Clicking Ignition Settings > Dwell Table displays the following screen:

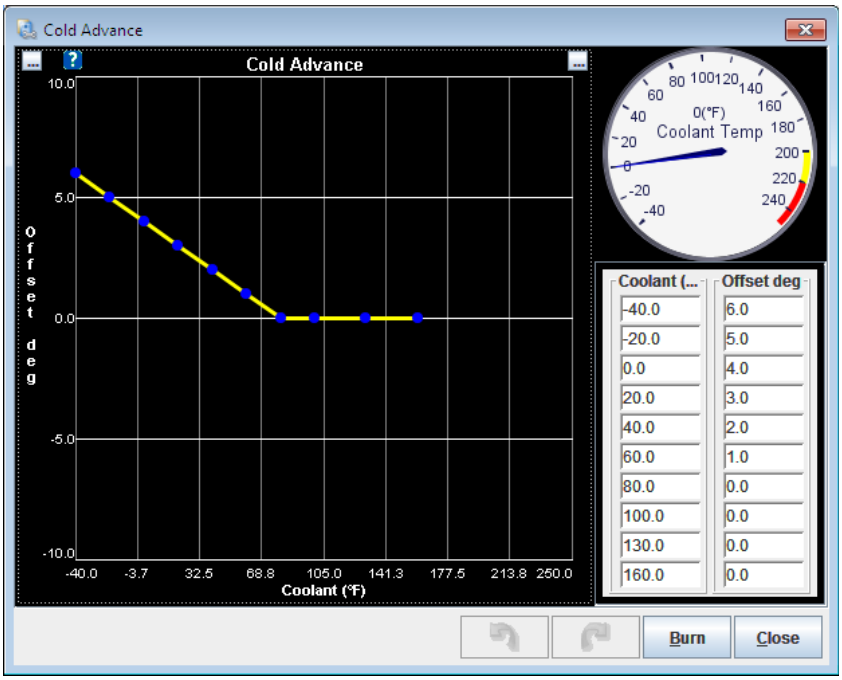


This allows for custom dwell settings at different load/RPM points.

10.6 Cold Advance

The Cold Advance menu option is not enabled if “Fuel Only” has been selected as the “Spark Mode” (see Section 10.1.)

Clicking Ignition Settings > Cold Advance displays the following screen:

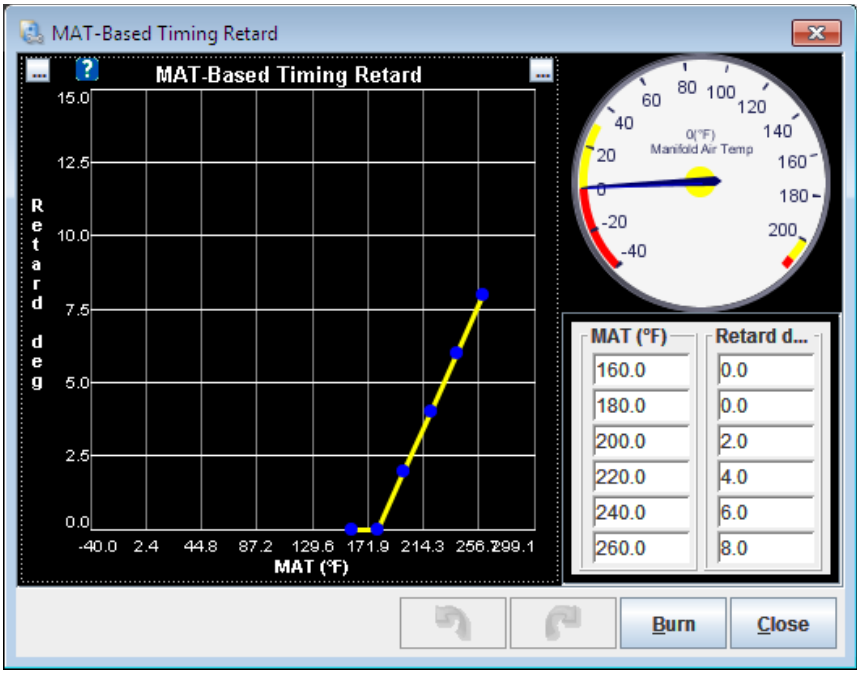


This curve optionally allows ignition timing to be advanced during warmup. Conversely, some engines may prefer retard during warmup (to pre-heat the catalytic convertor).

10.7 MAT-Based Timing Retard

The MAT-Based Timing Retard menu option is not enabled if “Fuel Only” has been selected as the spark mode (see Section 10.1.)

Clicking Ignition Settings > MAT-Based Timing Retard displays the following screen:

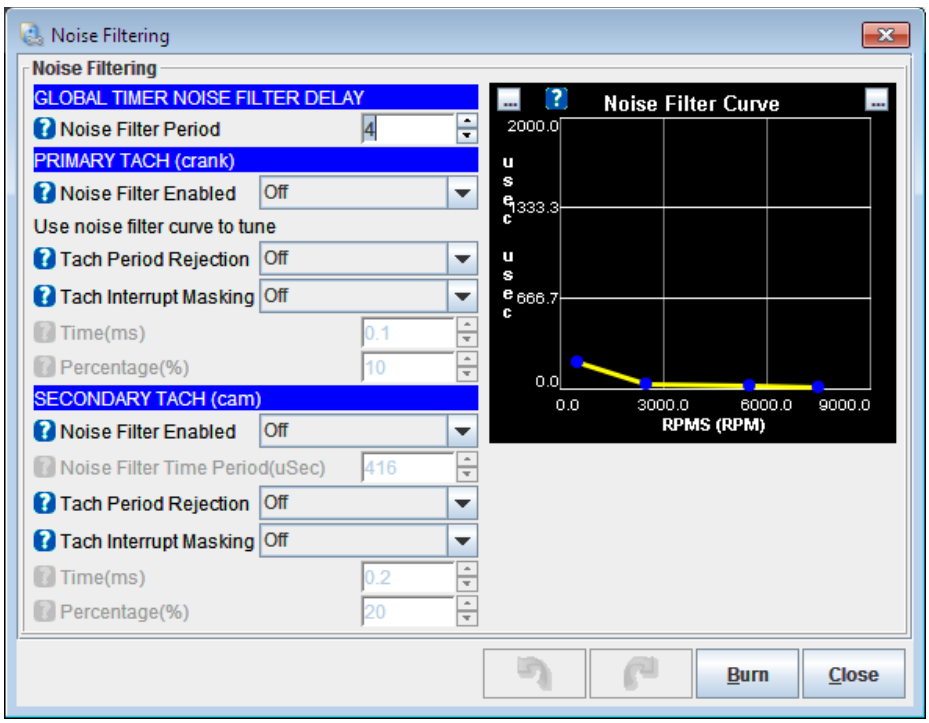


This curve allows ignition timing to be retarded based on intake temperature. This is primarily for forced induction installs where there is charge heating.

10.8 Noise Filtering

The Noise Filtering menu option is disabled if “EDIS” or “EDIS Multispark” have been selected as the “Spark Mode” (see Section 10.1.)

Clicking Ignition Settings > Noise Filtering displays the following screen:



The options for these settings are described below:

Noise Filter Period

Sets the CPU hardware based noise filter. Typically a small number or zero.

10.8.1 Primary Tach (crank)

Noise Filter Enabled

Use the noise filter curve on the right hand side of the screen to tune.

Enables noise filtering. Uses the curve to set the filter period. The filter measures the width of the tach-in pulse in order to reject short noise spikes and allow through valid wider tach-in pulses. Typically set to 1000us or more at low revs and 100us or more at high revs. Basic distributor setups can use far larger numbers.

Tach Period Rejection

Enables ignoring of bogus tach pulses, although they **will** still be recorded in the composite logger.

Tach Interrupt Masking

The tach input is disabled for a short period of time after a valid tach pulse to mask out any bogus tach pulses.

Time (ms)

This value must be set to less than the shortest ever valid time on your install.

The absolute time after a valid tach pulse when new pulses are ignored. The time value that you should use here depends greatly on the type of tach input you are using, e.g., a 60-2 wheel spinning at 10000rpm has a real tach pulse every 0.1ms. A distributor pickup on a 4-cylinder engine at 600rpm has a real tach pulse every 50ms.

Percentage (%)

This works as a percentage of the last valid tooth time. 30-50% are typical values.

10.8.2 Secondary Tach (cam)

Noise Filter Enabled

Enables a simple noise filter on the cam tach input.

Noise Filter Time Period (µs)

Equivalent to the time on the curve used for the crank input.

Tach Period Rejection

Enables ignoring of bogus tach pulses, although they will still be recorded in the composite logger.

Tach Interrupt Masking

The tach input is disabled for a short period of time after a valid tach pulse to mask out any bogus tach pulses.

Time (ms)

This value must be set to less than the shortest ever valid time on your install.

The absolute time after a valid tach pulse when new pulses are ignored. The time value here depends greatly on the type of tach input in use.

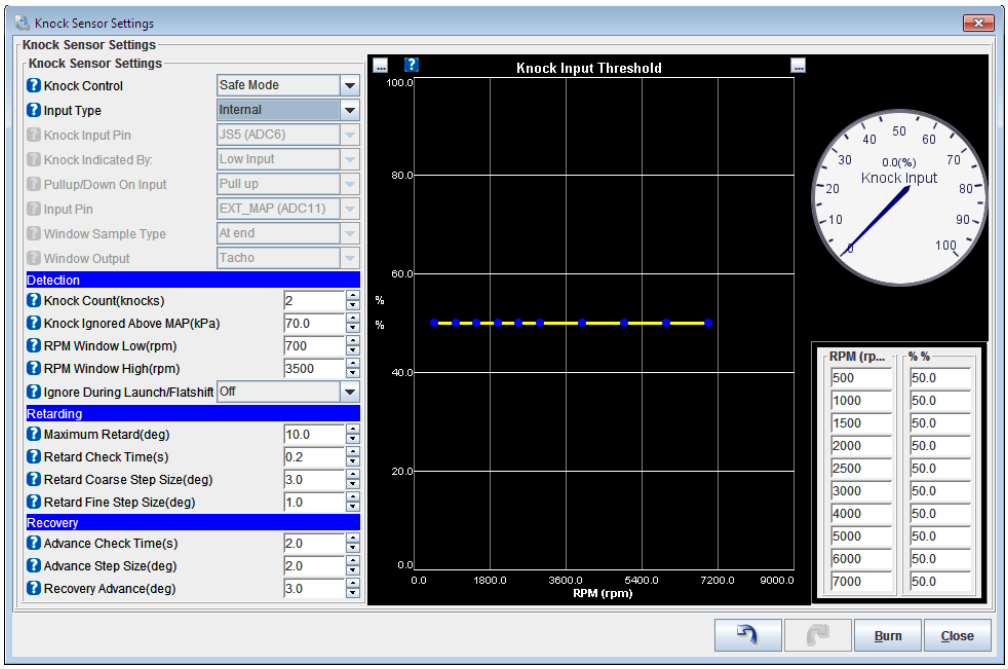
e.g., a 60-2 wheel spinning at 10000rpm has a real tach pulse every 0.1ms. A distributor pickup on a 4-cylinder engine at 600rpm has a real tach pulse every 50ms.

Percentage (%)

This works as a percentage of the last valid tooth time. 30-50% are typical values.

10.9 Knock Sensor Settings

Clicking Ignition Settings > Knock Sensor Settings displays the following screen:



The options for these settings are described below:

Knock Control

There are three options for this setting:

- Disabled: do not use knock feedback for ignition advance control;
- Safe Mode: use knock retard, but keep the advance below that which caused knock. This backs the advance one small step back and leaves it at that until TPS or MAP changes or knock comes back. This 'safe mode' scheme is recommended for a DIY set-up.
- Aggressive Mode: use knock retard, but keep advance at threshold of knock occurring. That is, the program advances (up to the timing table value) if it doesn't see knock, and retards if does see knock. The difference from safe mode is that the timing can be advanced all the way to the table value after knock, not just up to one step below knock. This may result in the knock returning, in which case the timing is retarded again, then advanced slowly, and so on.

Input Type

There are two options for this setting:

- On/Off: basic on/off 'knock' or 'no-knock' external input.
- Analogue: external analogue input proportional to knock signal level.
- Internal: internal knock module.

If set to Analogue or Internal, the knock input threshold can be set using the table on the right hand side of the screen. This sets an allowable knock level before retard is triggered. The numbers here are highly engine dependent.

Knock Input Pin

Selects where the on/off sensor/module is connected.

Knock Indicated By:

The logic input level, i.e., when set to 'low' then a zero volt signal means there is knock. This matches the GM module.

Pull Up / Down On Input

Determines whether or not an internal pull-up resistor should be applied.

Input Pin

Input for knock analogue signal.

Window Sample Type

Either read single analogue value at end knock window or peak detect.

Window Output

Optional digital output for knock window signal.

Knock Count (knocks)

Number of knock events detected before control is started.

RPM Window Low (rpm)

Knock control is implemented above this RPM.

RPM Window High (rpm)

Knock control is implemented below this RPM.

Ignore During Launch/Flatshift

Knock detection can be disabled when launch/flatshift are active to prevent false detection.

Maximum Retard (deg)

Maximum total retard when knock occurs.

Retard Check Time (seconds)

The time between knock retard corrections.

Retard Step Size (degrees)

How much to retard by on each correction step when knock is first detected. Make it large to quickly retard the timing and stop knock.

Advance Check Time (seconds)

The time between knock advance corrections (i.e., timing return to normal)

Advance Step Size (degrees)

How much to retard by on each correction step if knock restarts after it had stopped.

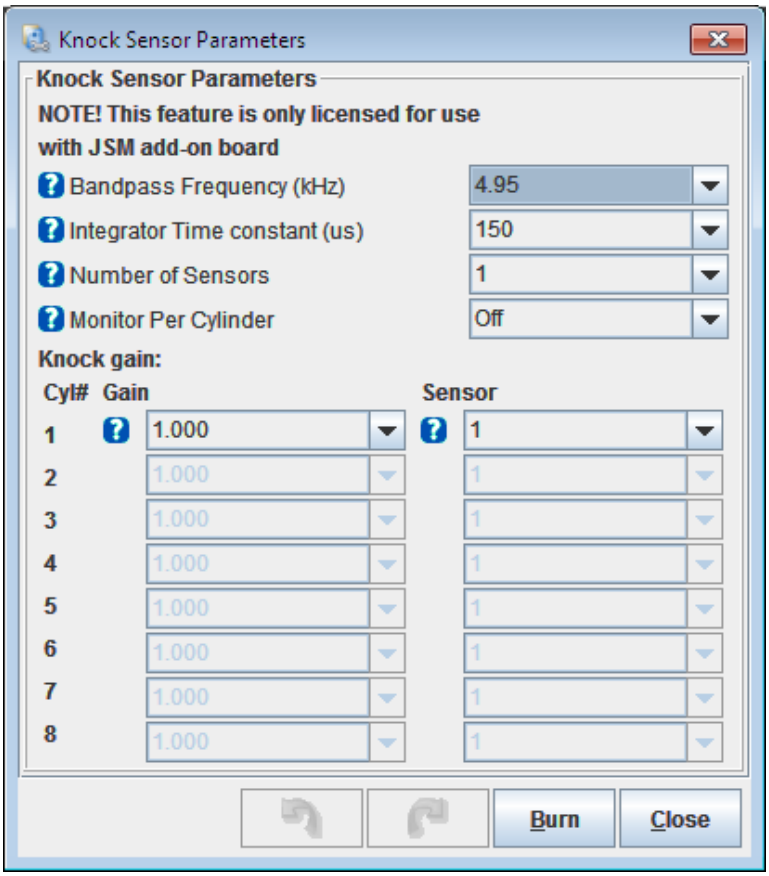
Recovery Advance (degrees)

If ignition table timing changes by this much then return to normal timing as the engine is clearly operating in different area.

10.10 Knock Sensor Parameters

This is only enabled if Knock Sensing is enabled and set to "Internal"

Clicking Ignition Settings > Knock Sensor Parameters will display the following screen:



The options for these settings are described below:

Bandpass Frequency

This should be adjusted to suit the resonant frequency of you engine.

Integrator Time Constant

How long the signal is sampled for.

Number of Sensors

How many knock sensors (1 or 2)

Monitor per Cylinder

Enables linking of knock signal to cylinder number. This only works if coil-on-plug or sequential fuel are enabled.

Gain

Compensate for sensor sensitivity and distance between cylinder and sensor.

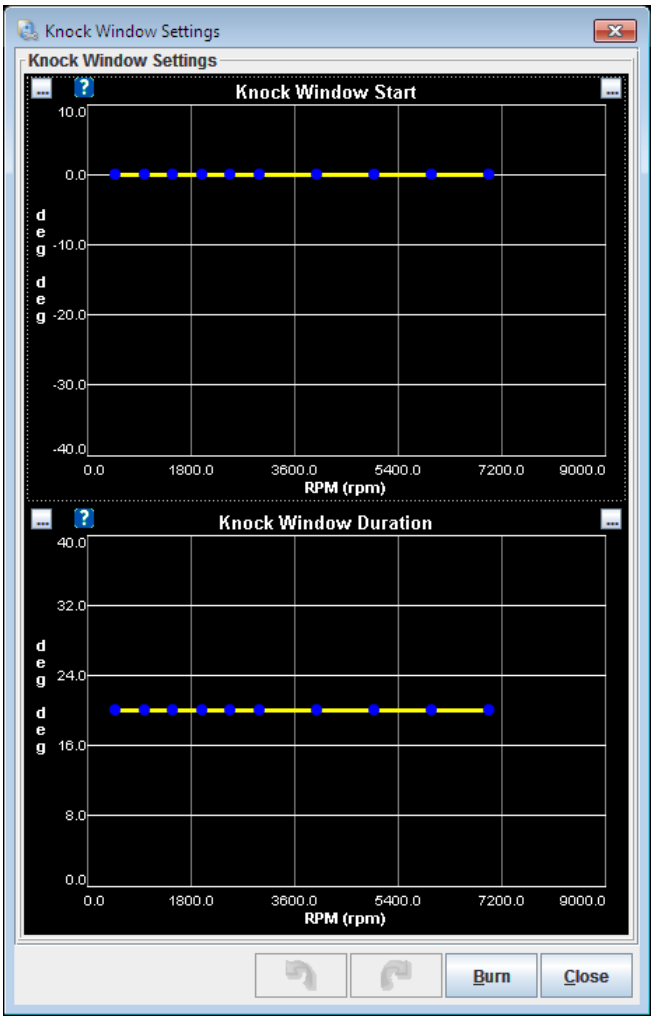
Sensor

Pick which sensor to use for each cylinder.

10.11 Knock Window Settings

This is only enabled if Knock Sensing is enabled.

Clicking Ignition Settings > Knock Window Settings will display the following screen:



Knock Window Start

Set the crank angle (for each cylinder) when the knock system starts 'listening' for knock.

Knock usually occurs in the time after TDC

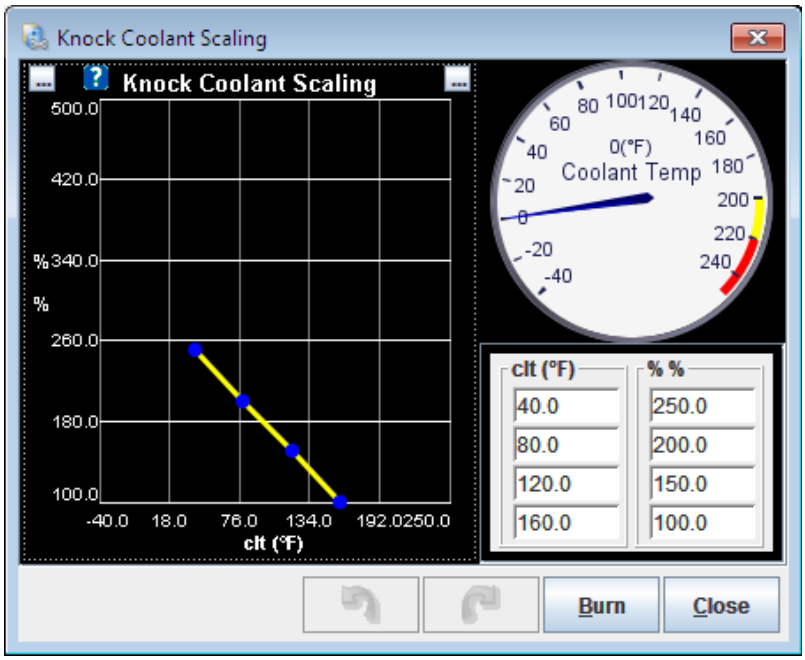
Knock Window Duration

Set the number of crank degrees that the knock system 'listens' for knock.

10.12 Knock Coolant Scaling

This is only enabled if Knock Sensing is enabled.

Clicking Ignition Settings > Knock Coolant Scaling will display the following screen:



Allows the threshold to be scaled up on a cold engine. Frequently a cold engine is noiser and may cause false alarms without a raised threshold.

10.13 Ignition Tables (1 to 4)

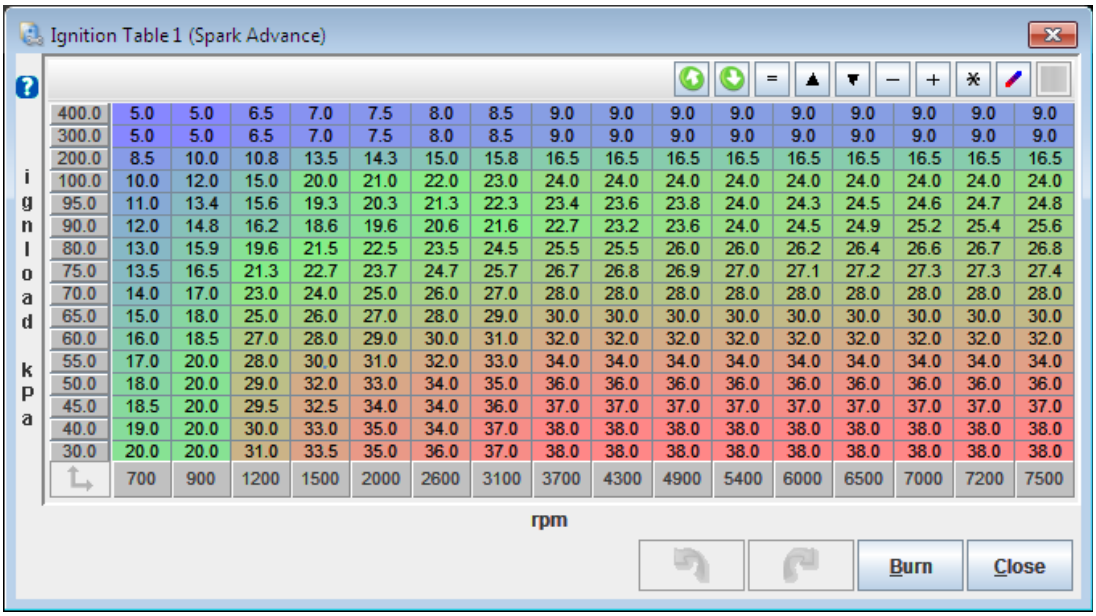
All of the Ignition Tables menu options will be disabled if “Spark Mode” is set to “Fuel Only” (see Section 10.1.)

To enable the Ignition Table 2 menu option configure a “Secondary Ignition Mode” in Basic/Load Settings > General Settings (see Section 8.2.4.)

To enable the Ignition Table 3 menu option enable “Spark Table Switching” in Table Choices->Table Switch/Dual Fuel (see Section 14.1.1.)

To enable the Ignition Table 4 menu option enable “Spark Table Switching” in Table Choices->Table Switch/Dual Fuel (see Section 14.1.1 and configure a “Secondary Ignition Mode” in Basic/Load Settings > General Settings (see Section 8.2.4.)

Clicking Ignition Settings > Ignition Table 1, 2, 3 or 4 will display a variation of the following screen:



Ignition Table 1

The main ignition table [Spark1]. Numbers are actual timing BTDC.

Ignition Table 2

The secondary ignition table [Spark2], can be used as a blend table with Spark1.

By default Ignition Table 2 will be filled with zero values and will require configuration.

Ignition Table 3

The alternate ignition table [Spark3]. Can be used as a switched table from Spark1. When Spark3 is active any secondary ignition table (Spark2) is ignored.

Ignition Table 4

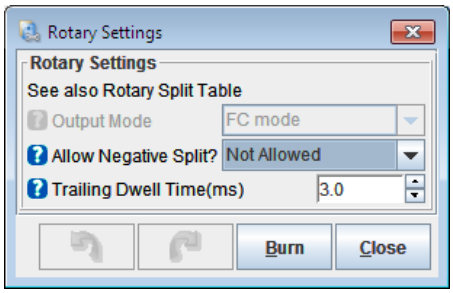
The ignition table [Spark4], can be used as a blend table with Spark3.

If you intend to use any of these three additional Ignition Tables please ensure that you set them before you begin tuning.

10.14 Rotary Settings

To enable the Rotary Settings menu option you need to set Engine Stroke/Rotary to “Rotary” in the Engine and Sequential Settings screen (see Section 8.1.)

Clicking Ignition Settings > Rotary Settings displays the following screen:



The options for these settings are described below:

Output Mode

There are two settings for this option:

- FC mode = combined trailing coil for two trailing plugs;
- FD mode = individual coils for each trailing plug.

This applies to the trailing coils. The leading coils are controlled by the main "Number of Coils" setting.

Allow Negative Split?

Split usually fires trailing coils after leading coils. If “negative split” is allowed, the split may be negative, causing the trailing coils to fire before the leading coils.

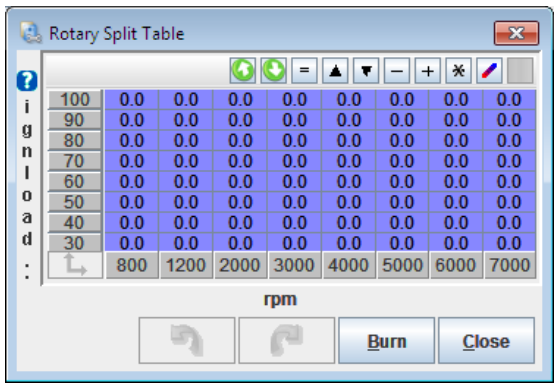
Trailing Dwell Time (ms)

Dwell time applied to trailing coil(s).

10.15 Rotary Split Table

To enable the Rotary Split Table menu option you need to set Engine Stroke/Rotary to “Rotary” in the Engine and Sequential Settings screen (see section 8.1.)

Clicking Ignition Settings > Rotary Split Table displays the following screen:



This table specifies the split (delay) in degrees between leading and trailing coils.

10.16 Spark Trim Tables

The Spark Trim Tables allow you to specify a timing adjustment in degrees per cylinder to allow for differences per cylinder.

- 0 means no adjustment

- Positive numbers mean to advance the timing in that cylinder
- Negative numbers mean to retard the timing in that cylinder

To enable the Spark Trim tables you need to enable Spark Trim, see section 10.1.

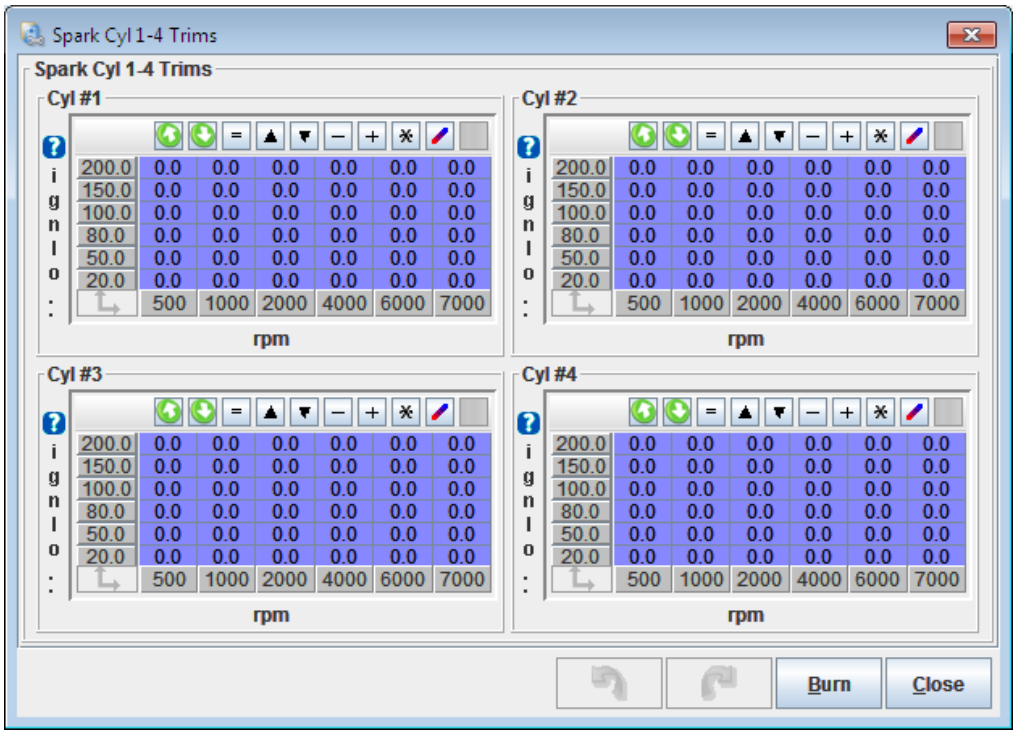
Spark Trim Tables apply per cylinders and use the Firing Order table (see section 8.1.2) to determine which spark output is linked to each cylinder.

Spark Trim requires crank and cam inputs that provide cylinder identification. i.e. you are running sequential fuel. Will not work with EDIS.

So long as the tach inputs are acceptable, spark Trim can be applied per cylinder even with wasted spark or single coil outputs.

Cyl 1-4 Trims

Clicking Ignition Settings > Cyl 1-4 Trims displays the following screen:

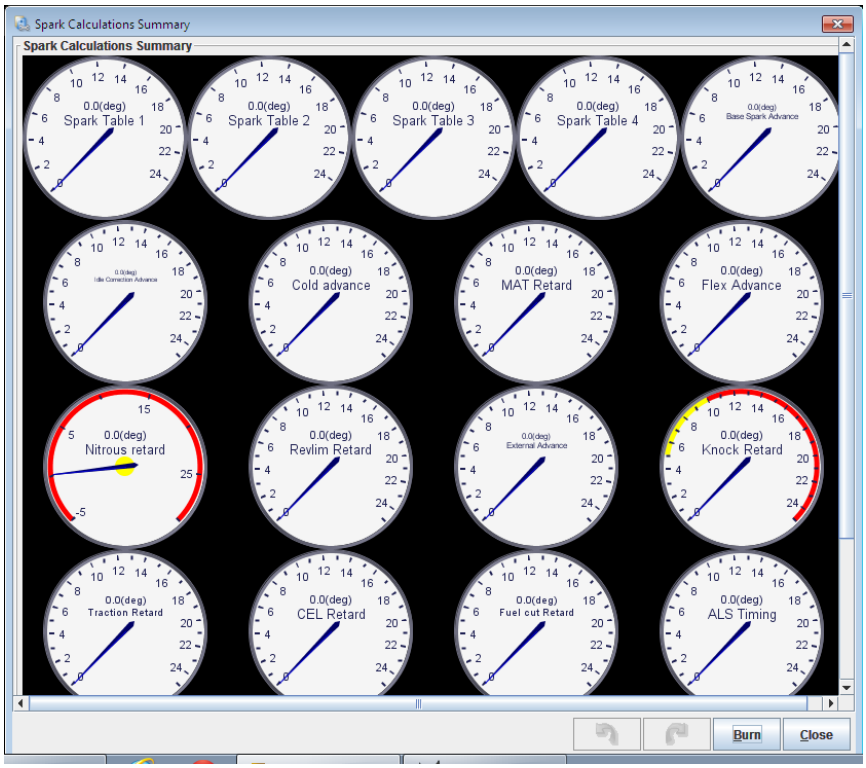


Cyl 5-8 Trims

These tables behave in the same way as Cyl1-4 Trims.

10.17 Spark Calculations Summary

Clicking Ignition Settings > Spark Calculations Summary displays the following screen:



This screen is for information purposes only and displays the spark advance at any given stage when the engine is running. This screen can be useful for analysis and troubleshooting.

11 Startup / Idle

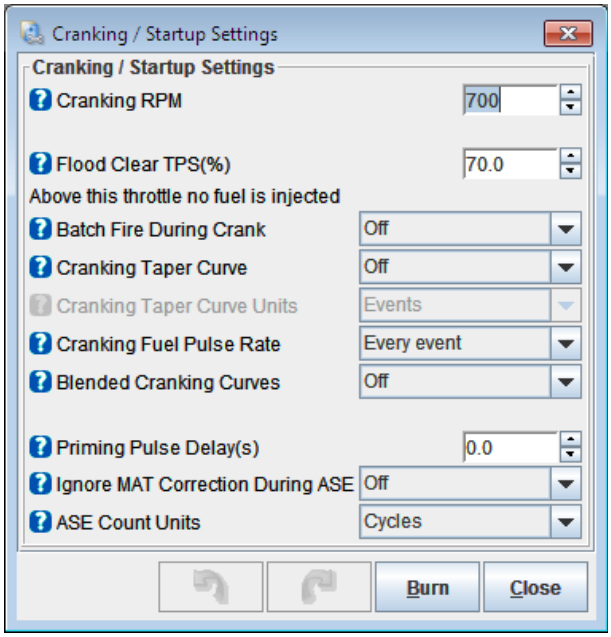
Correctly selecting the fuel settings required when the engine is started, during the afterstart phase, and at idle is essential. These settings are all accessible from the Startup / Idle toolbar menu.

The following sections explain how to set up the basic cranking and startup options, configure priming and cranking pulses, and afterstart percentage and taper as well as warmup enrichment.

It also covers both closed-loop and open-loop idle control, managing changes when air conditioning is used and idle advance settings (whether based on load, RPMs or adaptive advance).

11.1 Cranking / Startup settings

Clicking Startup / Idle > Cranking / Startup settings displays the following screen:



The options for these settings are described below:

Cranking RPM

Set this a few hundred RPM above your typical fast cranking speed.

Flood Clear TPS (%)

Above this throttle position no fuel will be injected during cranking to help clear a flood situation. It will also disable priming.

Batch Fire During Crank

Allows fuel to be fired on each tach event in a batch-fire mode on a sequential install. Can be useful in cold climates to allow large cranking fuel flow.

Cranking Taper Curve

Allows a taper curve on crank pulsewidth, either to reduce pulsewidth over time, or to allow an initial large shot of fuel.

Cranking Taper Curve Units

Selects units of ignition events or 0.1 seconds.

Cranking Fuel Pulse Rate

Engines with many cylinders such as V12s may find that the injecting fuel on every tach event gives difficult hot starting due to small pulsewidths.

This option allows the fuel to be injected on alternate events (with twice the pulsewidth.)

Blended Cranking Curves

Enables a blend curve between cranking curves.

Priming pulse delay(s)

Delays the priming pulses to allow a lazy fuel pump to build pressure.

Ignore MAT correction during ASE

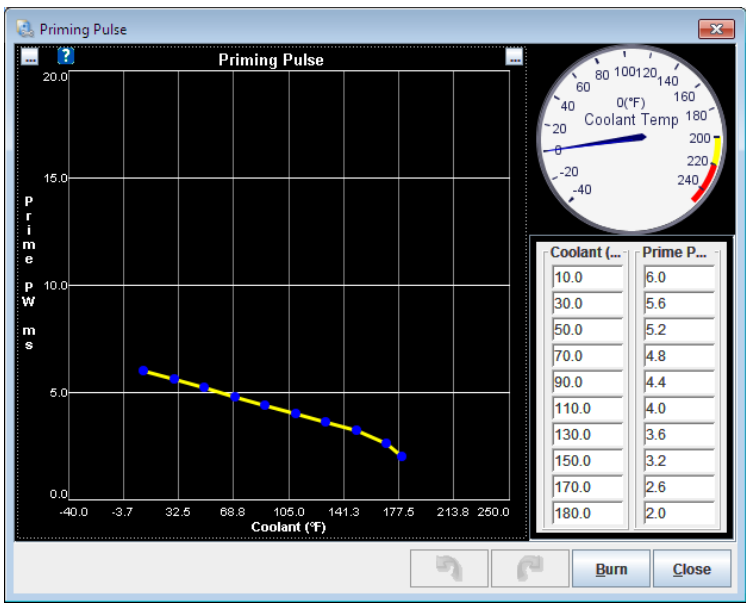
Can be used to help with perceived heat-soak issues.

ASE Count Units

Selects whether After Start Enrichment (ASE) uses Seconds or Ignition Events as the timer.

11.2 Priming Pulse

Clicking Startup/idle > Priming Pulse will display the following screen:

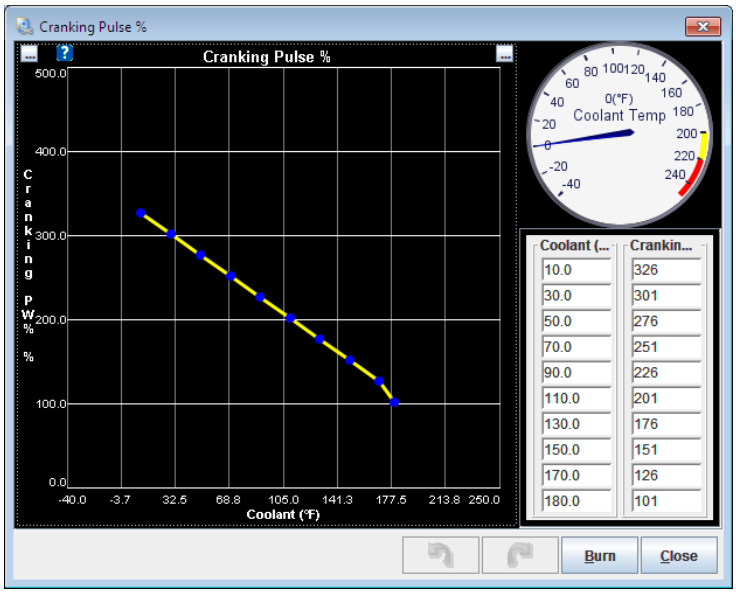


The priming pulse is used to wet the intake manifold walls and provide some initial starting fuel.

Setting the curve to all zeros will also disable fuel pump priming.

11.3 Cranking Pulse %

Clicking Startup / Idle > Cranking Pulse % will display the following screen:

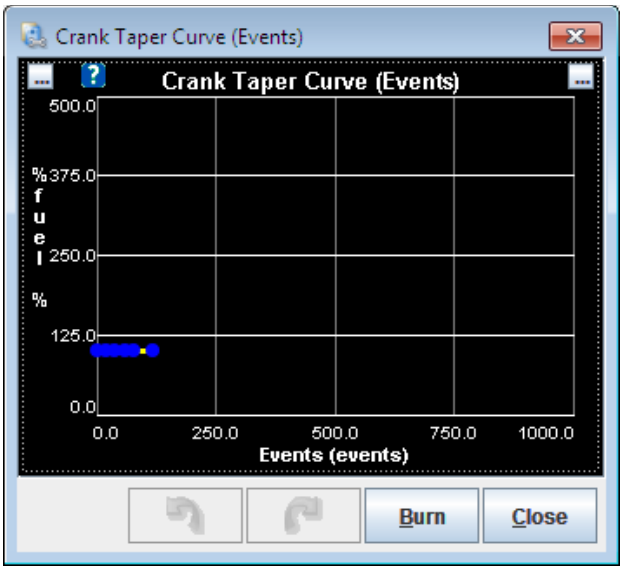


This percentage table controls the fuel injected when the engine is cranking. Most engines need 200-400% when cold and near 100% when hot.

This is a percentage of ReqFuel, so if you swap injectors this curve can be left alone.

11.4 Cranking Taper Curve

Clicking Startup / Idle > Cranking Taper Curve will display the following screen:

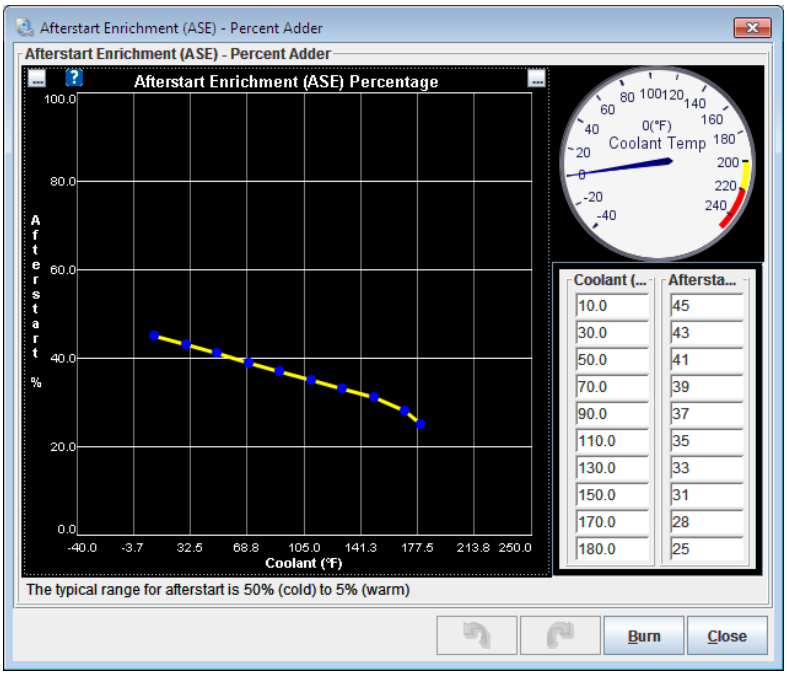


Allows cranking fuel to be tapered down during extended cranking to reduce flooding.

100% means normal cranking pulsewidth.

11.5 AfterStart Enrichment (ASE)

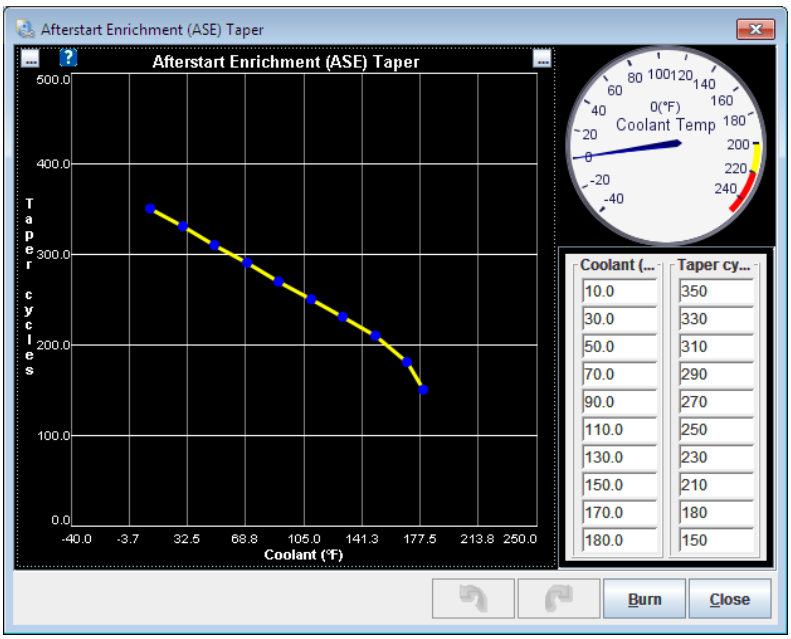
Clicking Startup / Idle > AfterStart Enrichment (ASE) displays the following screen:



Immediately after the engine has started it is normal to need additional fuel. This curve specifies how much fuel is added as a percentage – usually (5 to 50%)

11.6 AfterStart Enrichment (ASE) Taper

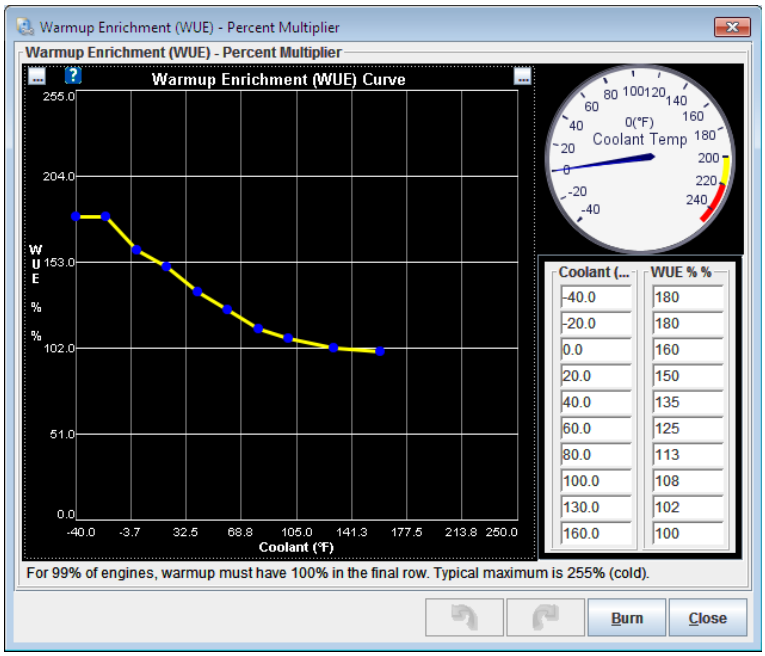
Clicking Startup > idle > Afterstart Enrichment (ASE) Taper displays the following screen:



Specifies how long (in engine cycles) to apply afterstart enrichment.

11.7 Warmup Enrichment (WUE)

Clicking Startup / Idle > Warmup Enrichment (WUE) displays the following screen:



Specifies the percentage multiplier for fuel during warmup. At cold temperatures 200-300% may be required.

At fully warm (the final row in the table or point on the curve) 100% **must** be specified.

The only except to this is engines running LPG may use values less than 100% if the "Allow WUE below 100%" setting is enabled as shown in section 8.22

11.8 Priming Pulse 2

This is the priming pulse curve used by the Dual Fuel system in section 14.1.2.

11.9 Cranking Pulse 2

This is the cranking pulse curve used by the Dual Fuel system in section 14.1.2.

11.10 AfterStart Enrichment (ASE) 2

This is the afterstart enrichment curve used by the Dual Fuel system in section 14.1.2.

11.11 AfterStart Enrichment (ASE) Taper 2

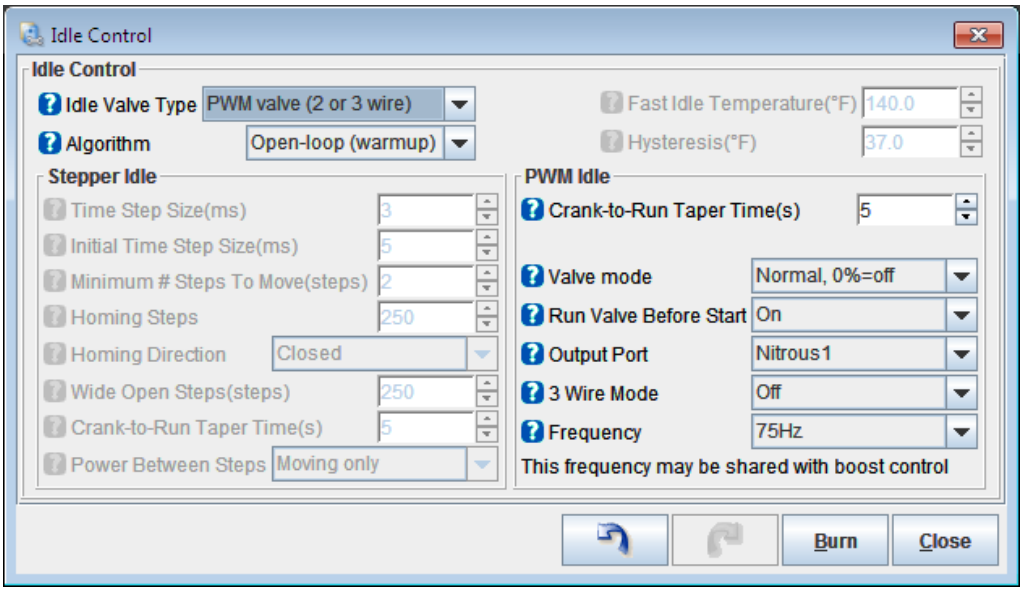
This is the after start enrichment taper curve used by the Dual Fuel system in section 14.1.2.

11.12 Warmup Enrichment (WUE) 2

This is the warmup enrichment curve used by the Dual Fuel system in section 14.1.2.

11.13 Idle Control

Clicking Startup / Idle > Idle Control displays the following screen:



The options for these settings are described below, and in Sections 11.13.1. and 11.13.2.

Idle Valve Type

Selects the method of idle control. There are four possible options for this setting:

- None – no idle control valve;
- On/Off valve – basic open or closed valve (rare);
- PWM valve (2,3 wire) – common from Ford or Bosch;
- Stepper valve (4,6 wire) – common with GM and Subaru.

Algorithm

This option only applies if “PMW valve” or “Stepper valve” are selected as the “Idle Valve Type”.

There are two possible options for this setting:

- “Open-Loop” controls the valve purely based on temperature;
- “Closed-Loop” adjusts the valve position to achieve a target RPM.

Fast Idle Temperature (°F/°C)

This option (also referred to as FIDLE Temperature) only applies if “On / Off valve” is selected as the “Idle Valve Type”.

Opens the idle valve below this temperature for fast-idle.

Hysteresis (°F/°C)

This option only applies if “On / Off valve” is selected as the “Idle Valve Type”.

Sets a deadband of coolant temperature so the valve doesn't jitter on and off if the coolant is right on the limit.

11.13.1 Stepper idle

This section only applies if “Stepper valve” is selected as the “Idle Valve Type”.

Time Step Size (ms)

Time between each stepper motor step. Increase this if the motor appears to behave intermittently.

Initial Time Step Size (ms)

The length of the first motor step. Typically set a little longer to improve reliability.

Minimum # Steps To Move (steps)

Minimum number of steps to move in one go.

Increase from the default of 1 if the valve moves unreliably.

Homing Steps

On startup the stepper motor will move this many steps to ensure it has reached the home position. Set the value to a number larger than the number of steps required for full travel. (This was formerly called “Start Value”)

Homing Direction

Whether to home the valve to the fully closed (recommended) or fully open position.

Wide Open Steps

Number of steps from closed to fully open. Homing steps must be set to a larger number.

Crank-To-Run Taper Time (s)

After the engine starts, the idle valve moves from the 'cranking position' to the 'run' position. This setting controls how long that transition takes.

Hysteresis (°F/°C)

Amount the coolant temperature must vary before the idle position is changed.

Power Between Steps

Stepper motor current control when not stepping. There are three possible options:

- Moving only – turns off power between steps, motor stays cooler but may be unreliable;
- Hold current – a holding current is applied between steps;
- Always on – full current is always applied. Reliable, but can cause excess heat in motor.

11.13.2 PWM idle

This section only applies if “PWM Valve” is selected as the “Idle Valve Type”.

Crank-To-Run Taper Time (s)

After the engine starts, the idle valve moves from the 'cranking position' to the 'run' position. This setting controls

how long that transition takes.

Valve Mode

Virtually all valves work with “Normal –0%” = “Off” corresponding to valve closed, although rarely this setting is inverted.

Run Valve Before Start

Determines whether the idle valve runs during Key-On-Engine-Off (KOEO). This can potentially help starting by giving additional air during the first few engine rotations.

Output Port

Output for PWM idle valve. Use FIDLE as default unless it is being used elsewhere in your configuration.

3 Wire Mode

Either "Off" or an output is selected. See the Hardware manual for wiring.

- Off - disables 3-wire mode and uses 2-wire mode.
- Output - the chosen 2nd output for the idle valve.

Valve Frequency

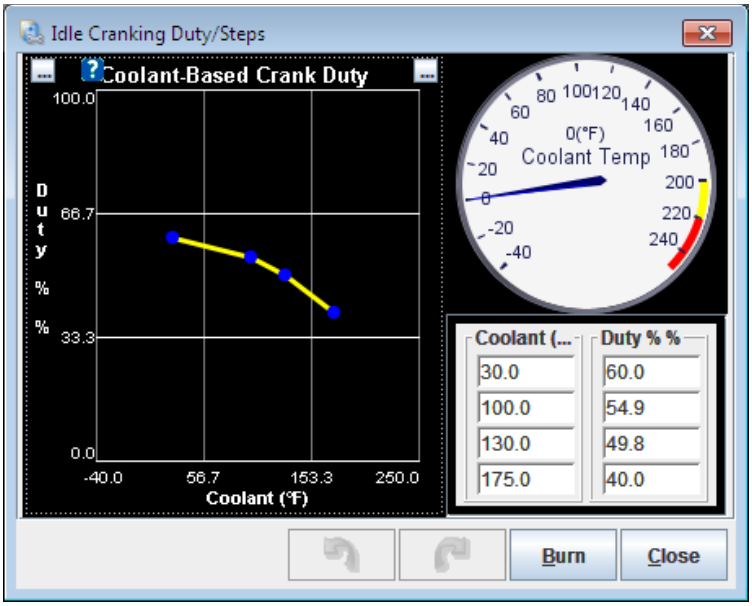
Frequency to operate at. This varies with valve type. Ford/Bosch valves typically operate 50-100Hz. Miata valves are closer to 300Hz.

Megasquirt-3 uses a hardware PWM channel for PWM idle so does not suffer any precision loss at higher frequencies.

11.14 Idle Cranking Duty / Steps

The Idle Cranking Duty / Steps menu option is only enabled if “Idle Valve Type” has been set to “PWM valve” or “Stepper valve” - see Section 11.13.

Clicking Startup / Idle > Idle Cranking Duty / Steps displays the following screen:



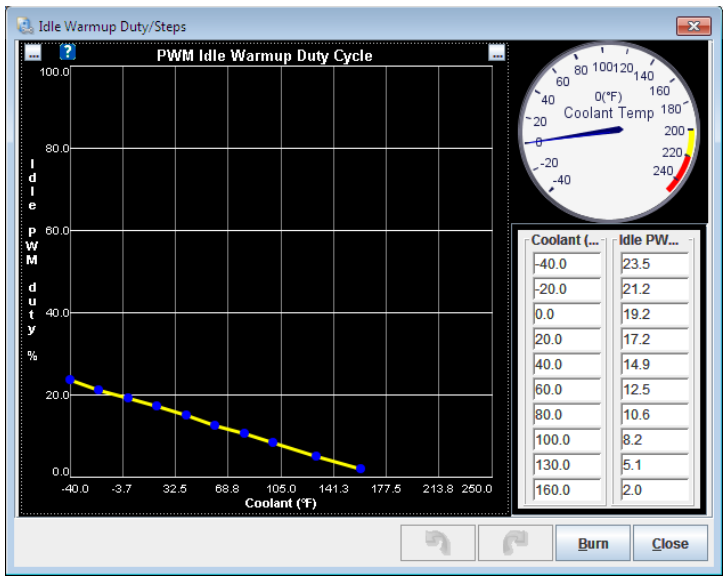
This curve sets the idle valve position during cranking. This should be set high enough so that the engine can start without touching the throttle when cold, but not so high that the engine revs up too far immediately after starting.

Large duties are more open. Typically zero is fully closed. (Some 2 wire Bosch valves have a closed position of about 35%)

11.15 Idle Warmup Duty / Steps

The Idle Warmup Duty / Steps menu option is only enabled if “Algorithm” has been set to “Open-loop (warmup)” - see Section 11.13.

Clicking Startup / Idle > Idle Warmup Duty / Steps displays the following screen:



This curve specifies the PWM Idle Duty vs. coolant temperature to be used during warmup.

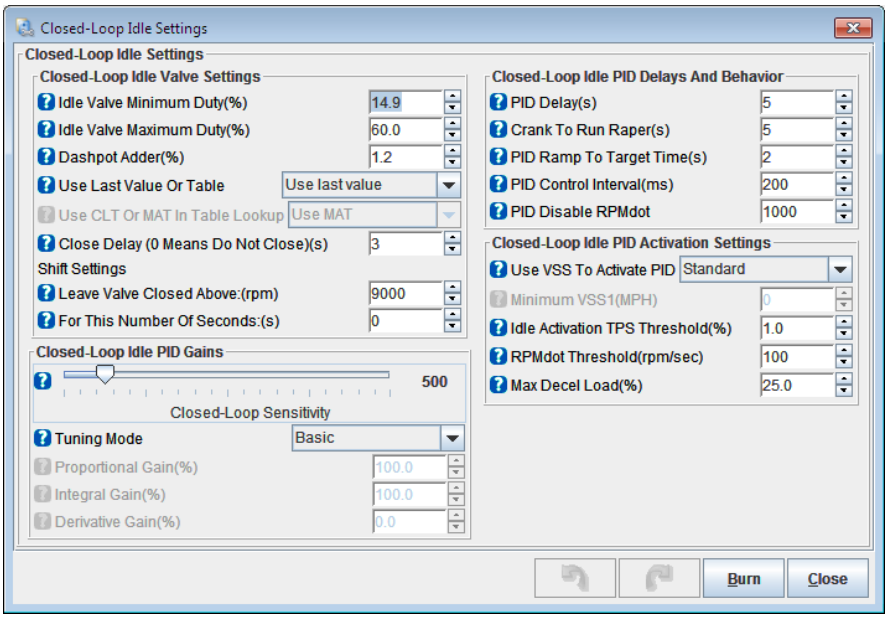
Large duties are more open. Typically zero is fully closed. (Some 2 wire Bosch valves have a closed position of about 35%)

The curve will start high at cold temperatures and descend towards zero at high temperatures.

11.16 Closed-Loop Idle settings

The Closed-Loop Idle settings option is only enabled if “Algorithm” has been set to “Closed-loop” - see Section 11.13.

Clicking Startup / Idle > Closed-Loop Idle Settings displays the following screen:



The options for these settings are described in Sections 11.16.1 to 11.16.4 below:

11.16.1 Closed-Loop Idle Settings

Idle Valve Minimum Duty (%)

The duty below which changes in duty no longer have an effect on RPM.

Idle Valve Maximum Duty (%)

The duty above which changes in duty no longer have an effect on RPM.

Dashpot Adder (%)

The amount to increase the idle valve duty / steps by when throttle is lifted. This should be set to a value that results in RPM being slightly above the target RPM.

Use Last Value Or Table

This setting controls whether the initial duty value used upon entering closed loop idle is taken from the last time in closed loop or taken from the initial value table.

Use CLT Or MAT In Table Lookup

This setting is used to set whether the initial values table y-axis lookup is done using CLT or MAT.

Close Delay – 0 Means Do Not Close (sec)

This setting controls the amount of time between pressing the throttle and closing the valve while driving. A value of 0 disables this setting.

The timer does not start until actual RPM is **200 RPM above** the target.

Leave Valve Closed Above: (rpm)

The RPM above which the idle valve will remain closed when shifting gears.

For This Number Of Seconds: (sec)

The longest amount of time that a shift takes. After this timer expires, the valve will follow normal dashpot behavior.

11.16.2 Closed-Loop Idle PID Gains

Closed Loop Sensitivity

Use this setting to tune how aggressively the idle speed controller tries to reach the target RPM. Adjust the slider up until the idle speed starts oscillating, then back down until it stops. Wait 5-10 seconds between each adjustment to give your Megasquirt a chance to settle.

Tuning Mode

If set to “Basic” then Proportional Gain, Integral Gain and Derivative Gain are not used to calculate overall Gain. If set to “Advanced” these three settings can be defined.

Proportional Gain

Proportional gain for closed loop idle PID loop. Reacts immediately to change in RPM.

Integral Gain

Integral gain for closed loop idle PID loop. Reacts to sustained difference between target RPM and actual RPM.

Derivative Gain

Derivative gain for closed loop idle PID loop. Reacts to rate of change of RPM.

11.16.3 Closed-Loop Idle PID Delays and Behavior

PID Delay (s)

Controls how long all conditions for entering closed-loop idle must be met for before entering closed-loop control.

Crank To Run Taper (s)

After the engine starts, the idle valve moves from the 'cranking position' to the 'run' position. This setting controls how long that transition takes.

PID Ramp To Target Time (s)

How long after entering closed loop idle it will take for actual RPM to match target RPM.

PID Control Intervals (ms)

Controls how often the closed loop idle algorithm runs.

PID Disable RPMdot

Use so that engaging clutch without throttle does not leave PID running. Avoids situations where PID stays running while not actually idling causing stalls once PID is entered again.

11.16.4 Closed Loop Idle PID activation Settings

Use VSS to activate PID

Controls whether the VSS activates closed-loop idle.

Minimum VSS

Closed-loop idle is disabled above this VSS.

Idle Activation TPS Threshold (%)

The TPS value below which the other factors for entering closed-loop idle are considered.

RPMdot Threshold (rpm/sec)

The value RPMdot must be below before closed-loop idle can be activated.

Max Decel Load (%)

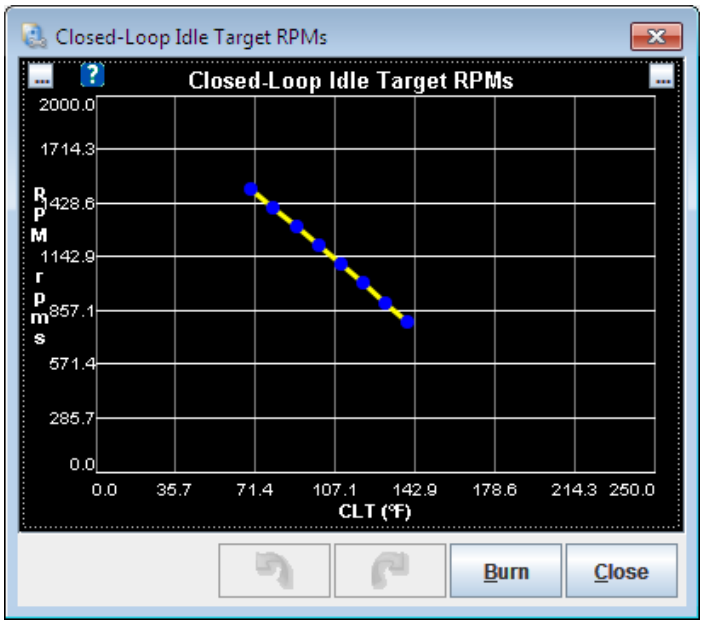
The value load must be above before closed-loop idle can be activated.

11.17 Closed-Loop Idle Target RPM Curve

The Closed-Loop Idle Target RPM Curve menu option is only enabled if:

- "Algorithm" has been set to "Closed-loop" (see Section 11.13.)
- OR "Idle Advance On" is set to "Adaptive" (see Section 11.21.)

Clicking Startup / Idle > Closed-Loop Idle Target RPM Curve displays the following screen:



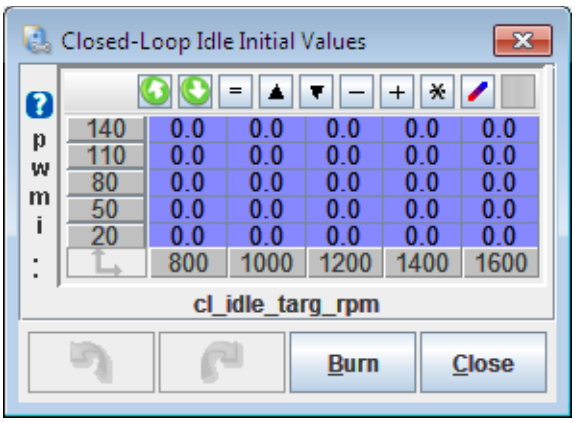
This curve displays the closed loop idle RPM target depending on coolant temperature. It is normal to set a high idle on a cold engine, tapering down as the engine warms up.

11.18 Closed-Loop Idle Initial Values

The Closed-Loop Idle Initial Values menu option is only enabled if:

- "Algorithm" has been set to "Closed-loop" - see Section 11.13;
- AND "Use Last Value Or Table" is set to "Use initial value table" - see Section 11.16.1.

Clicking Startup / Idle > Closed-Loop Idle Initial Values displays the following screen:

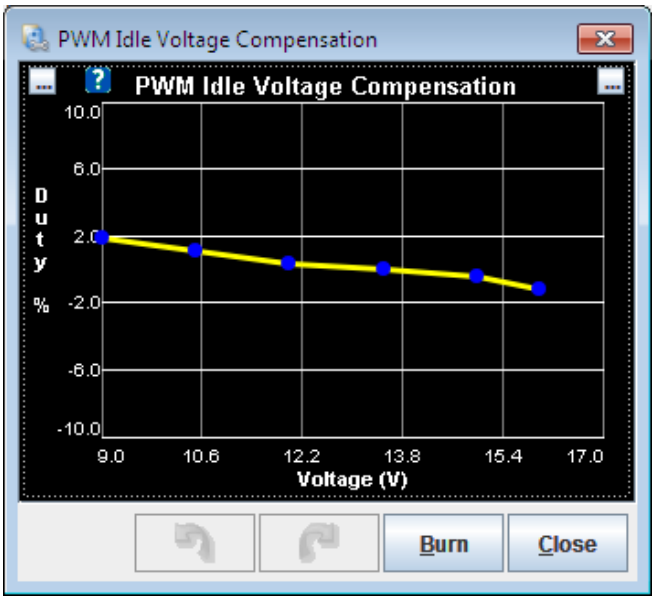


The best-guess idle valve position for RPM/load. This allows you to 'kick-start' the closed-loop idle by setting the valve to the most likely position.

11.19 PWM Idle Voltage Compensation

The PWM Idle Voltage Compensation menu option is only enabled if “Idle Valve Type” has been set to “PWM valve” (see Section 11.13.)

Clicking Startup / Idle > PWM Idle Voltage Compensation displays the following screen:

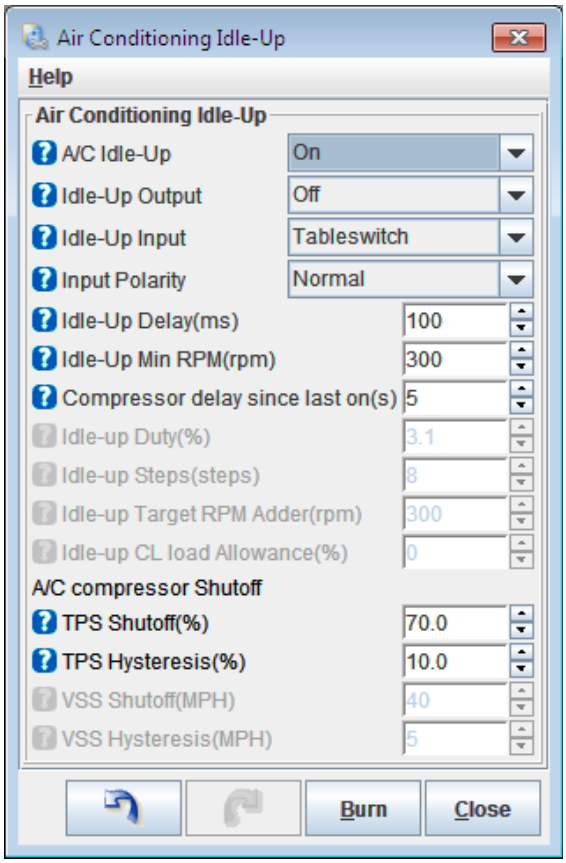


Some 2 wire PWM idle valves will operate differently depending on the system voltage. This allows a compensation to be applied to allow for that difference.

Typically at lower voltages the valve will need slightly more duty (positive number) and at higher voltages it will need less duty (negative number.)

11.20 Air Conditioning Idle-up

Clicking Startup / Idle > Air Conditioning Idle-up displays the following screen:



The options for these settings are described below:

A/C Idle-up

Enables feature.

Idle-up Output

Output to engage compressor.

Idle-up Input

Switch input.

Input Polarity

Typically the switch input expects a ground signal for 'on'. Setting this to "Inverted" means that the ground input means 'off' instead.

Idle-up Delay(ms)

Delay after switch is pressed before engaging compressor.

Idle-up Min RPM (rpm)

Lowest RPM that AC compressor can be turned on.

Compressor Delay Since Last On (s)

Sets a delay to prevent rapid cycling on/off.

Idle-up Duty Adder (%)

Only enabled if “Idle Valve Type” has been set to “PWM valve” (see Section 11.13.)

Additional PWM idle duty cycle to add when A/C is active.

Idle-up Steps Adder (steps)

Only enabled if “Idle Valve Type” has been set to “Stepper valve” (see Section 11.13.)

Additional idle steps to add when A/C is active.

Idle up target rpm adder (rpm)

Bump up RPM by this much when A/C is active.

Idle-up CL Load Allowance

When A/C is active the engine load will increase. Set this number so that the additional load doesn't kick you out of closed-loop idle.

TPS Shutoff

Disable A/C when TPS is above this. (Reduces load on engine when driver demands full power.)

TPS Hysteresis

Deadband in TPS to prevent A/C bouncing on/off.

VSS Shutoff

Only enabled if VSS is enabled (see Section 15.1.)

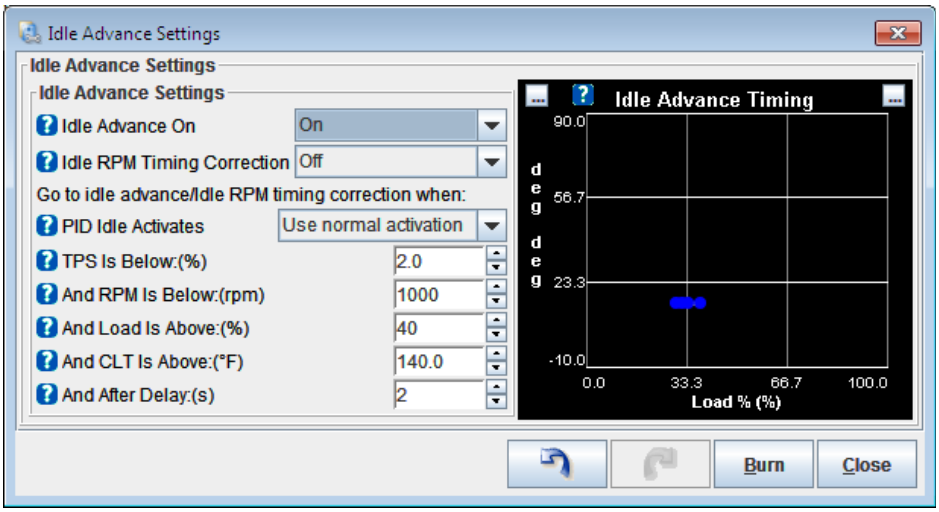
Disable A/C above this speed.

VSS Hysteresis

Deadband in VSS to prevent A/C bouncing on/off.

11.21 Idle Advance Settings

Clicking Startup / Idle > Idle Advance Settings displays the following screen:



The options for these settings are described below:

Idle Advance On

Enables / disables Idle-advance feature. The purpose of Idle-advance is to allow specific timing control when the engine is idling, particularly for stabilization.

Idle RPM Timing Correction

Enables additional advance curve linked to closed-loop idle target. This allows you to use timing control to assist with idle speed regulation.

PID Idle Activates

Either links idle-advance with closed-loop idle or allows idle advance to have its own conditions.

TPS is below:

Only activate below this TPS;

And RPM is below:

Only activate below this RPM;

And load is above:

Only activate above this load (helps code ignore over-run situations);

And CLT is above:

Only activate above this coolant temperature (typically idle-advance does not work too well during warmup);

And after delay:

After the conditions are met, wait this long before enabling idle-advance. **This helps reduce false activations**.

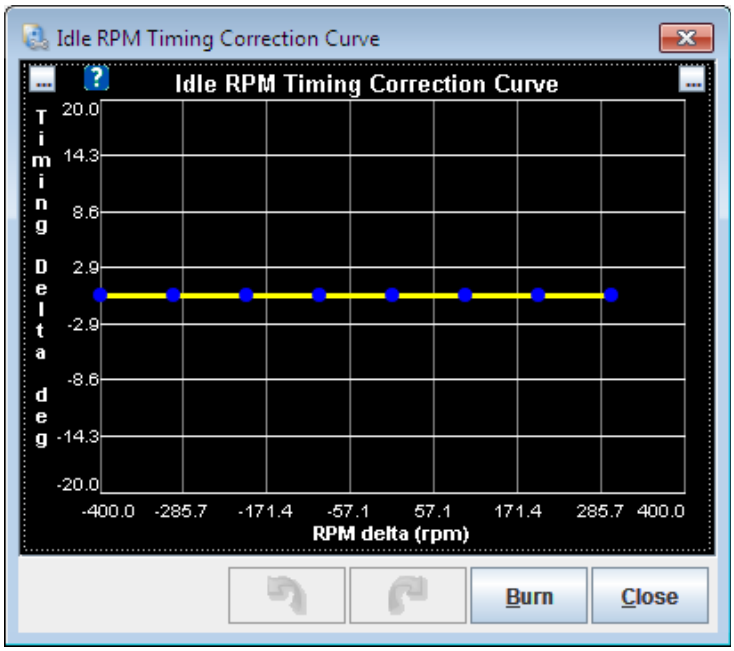
Idle Advance Timing

This curve sets the timing vs engine load when Idle-Advance is active. Typically the curve will ramp from low advance at low load to more advance at higher loads to help stablize idle.

11.22 Idle RPM Timing Correction Curve

The Idle RPMs Advance Timing menu option is only enabled if "Idle Advance On" is set to "On" and “Idle RPM Timing Correction” has been set to “On” (see Section 11.21.)

Clicking Startup / Idle > Idle RPM Timing Correction Curve displays the following screen:



Uses timing to assist closed-loop idle control.

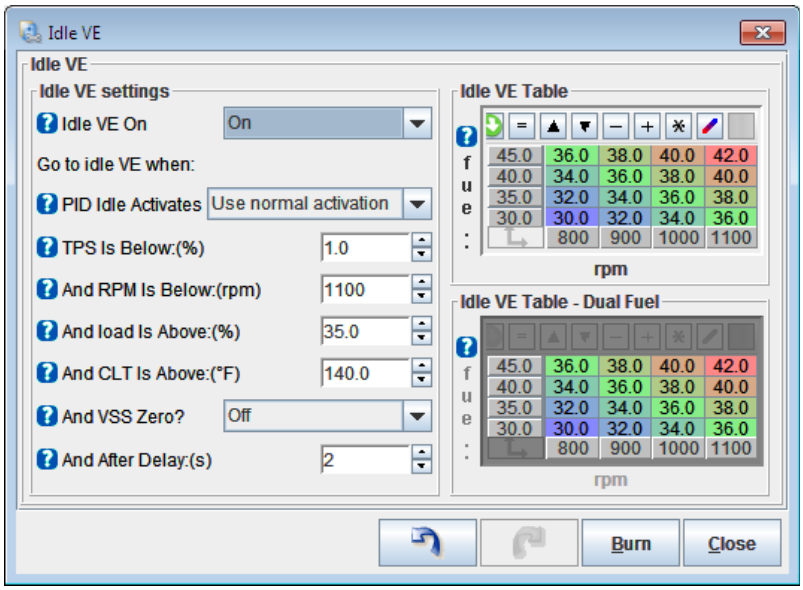
The X axis of the curve is RPMs +/- the target. i.e. if the target was 800, then -75 in the curve means 800-75 = 725RPM

The Y axis of the curve is timing +/-. i.e. + means add timing, - means subtract timing.

Typically, use positive (advanced) timing when RPMs are below target and negative (retarded) timing when RPMs are above target.

11.23 Idle VE Settings

Clicking Startup / Idle > Idle VE Settings displays the following screen:



The options for these settings are described below:

Idle VE On

Enables Idle-VE feature.

PID Idle Activates

Either links idle-advance with closed-loop idle or allows idle advance to have its own conditions.

TPS is Below

Only activate below this TPS.

And RPM is Below

Only activate below this RPM.

and load is Above

Only activate above this load. (Helps the ECU ignore over-run situations.)

And CLT is Above

Only activate above this coolant temperature. (Typically idle-VE does not work too well during warmup.)

and VSS Zero

Selects whether VSS1 must be zero before idle-VE is activated.

And After Delay

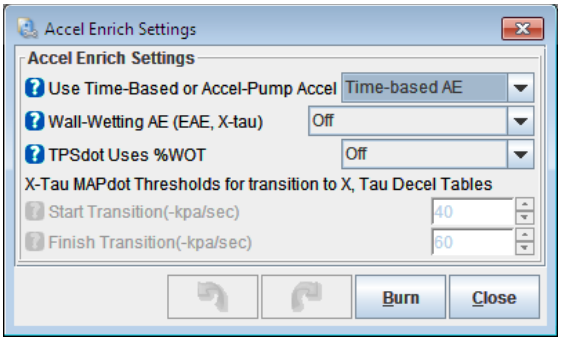
After the conditions are met, wait this long before enabling idle-advance. This helps reduce false activations.

12 Accel Enrich

The settings on the accel enrich menu are intended to improve engine performance during transients such as opening the throttle. There are a number of different methods available from simple to more scientific. At the most basic level, when you snap open the throttle, you will need a burst of additional fuel. Formerly this was provided by the acceleration pumper on a carburettor.

12.1 Accel Enrich Settings

Clicking Accel Enrich > Accel Enrich Settings displays the following screen:



The options for these settings are described below:

Use Time-Based or Accel-Pump Accel

Selects between time-based accel enrichment or pump-style enrichment.

- Time-based AE - traditional Megasquirt accel enrichment system
- Accel-pump AE - a system the works similarly to the carburettor accel-pump

Wall-wetting AE (EAE)

Enables a well-wetting transient system. These systems model the underlying physics. They can be more difficult to tune, but can provide superior response.

- Off - no additional
- EAE - one method of wall-wetting AE
- X-Tau - a different method of wall-wetting AE
- X-Tau with CLT correction - as above but adds a CLT factor also

TPSdot Uses %WOT

Enables a curve to model effective 100% TPS for a given RPM. This allows smaller throttle movements to be more responsive at lower RPMs and ignores changes in throttle above 'wide-open'.

Start Transition

X-Tau accel tables are used when MAPdot is positive or less negative than this start transition threshold. In-between a blend is used.

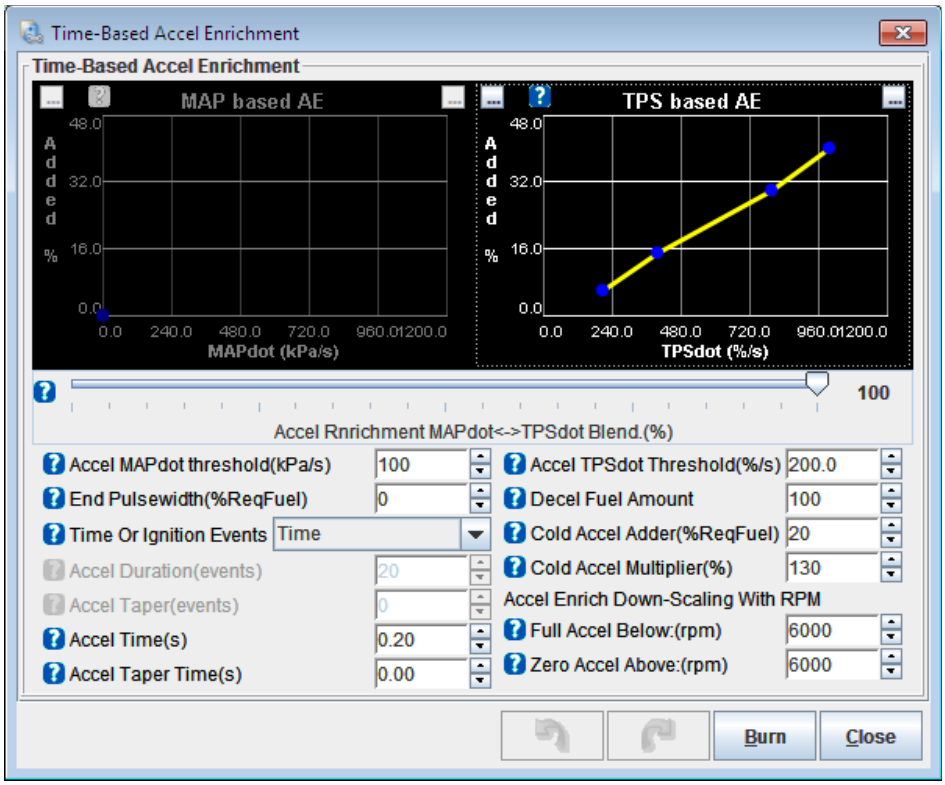
Finish Transition

X-Tau Decel tables are used when MAPdot is more negative than this finish transition threshold. In-between a blend is used.

12.2 Time-Based Accel Enrichment

This is the traditional Megasquirt accel enrichment where an extra shot of fuel is calculated based on the rate of throttle opening or rate of change of MAP or a blend of both.

Clicking Accel Enrich > Time-Based Accel Enrichment displays the following screen:



The options for these settings are described below:

Map Based AE Curve

The Map Based AE Curve is only enabled if the “Accel Enrichment MAPdot<->TPSdot Blend (%)” slider is set to a value less than 100% - see the third entry in this section.

This curve specifies a fuel pulsewidth percent adder based on rate of change of MAP (MAPdot).

This is part of the basic time based accel enrichment scheme. Larger changes in MAP require more fuel to be added. The number is a percentage of ReqFuel.

TPS Based AE Curve

This curve specifies a fuel pulsewidth percent adder based on rate of change of TPS (TPSdot).

This is part of the basic time based accel enrichment scheme. Larger changes in TPS require more fuel to be added. The number is a percentage of ReqFuel.

Accel Enrichment MAPdot<->TPSdot Blend (%)

This slider set a weight (0-100) to be given to TPSdot over MAPdot for accel enrichment.

Accel MAPdot Threshold (kPa/s)

Triggers enrichment above this MAPdot value.

End Pulsewidth (ms)

After main enrichment event, taper down to this amount of enrichment.

“0” is suggested for this setting.

Time or Ignition Events

Length of enrichment pulse is measured in ignition events or seconds.

Accel Duration (events)

Length of main enrichment pulse in ignition events.

Accel Taper Time (events)

Length of 'taper' events after main enrichment pulse

“0” is suggested for this setting.

Accel Time (s)

Length of main enrichment pulse.

Accel Taper Time (s)

Length of 'taper' time after main enrichment pulse

“0” is suggested for this setting.

Accel TPSdot threshold (%/s)

Trigger enrichment above this TPSdot value.

Decel Fuel Amount (ms)

Deceleration fuel cut amount in percent. 100% is no cut, 0% is complete cut of fuel.

100% is suggested for this setting.

Cold Accel Adder (ms)

At full cold (-40 ºC/ºF), add this amount to the enrichment.

Cold Accel Multiplier (ms)

At full cold (-40 ºC/ºF), multiply the enrichment by this percentage.

Full Accel Below: (rpm)

Below this RPM full enrichment is enabled.

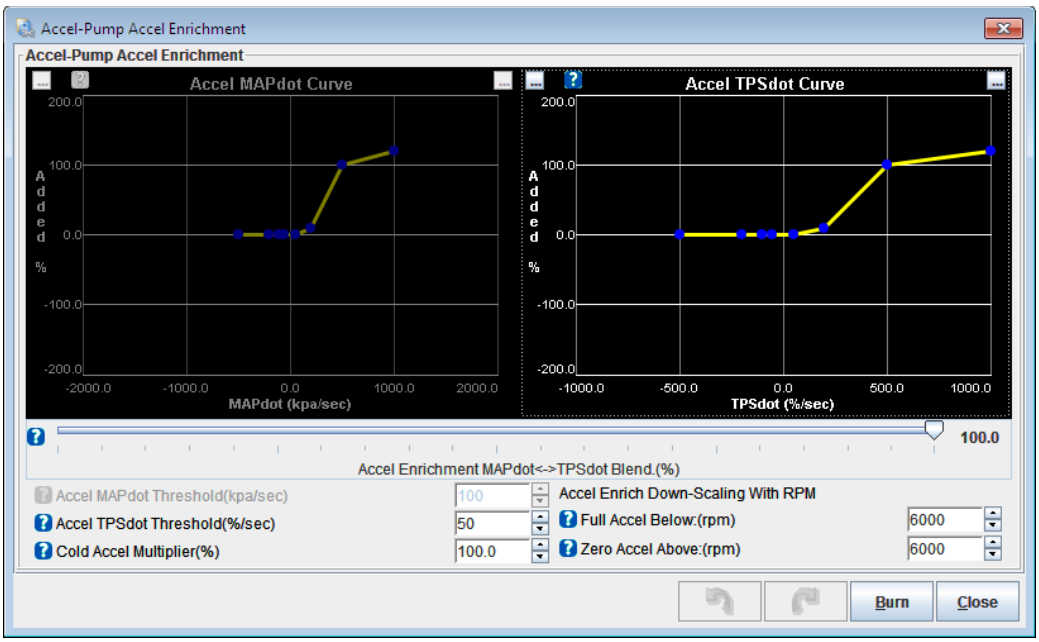
Zero Accel Above: (rpm)

Above this RPM, there is no enrichment. In between, the enrichment is on a sliding scale.

12.3 Accel-pump Accel Enrichment Settings

This is a transient enrichement system that works similarly to the carburettor accel-pump

Clicking Accel Enrich > Accel-pump Accel Enrichment Settings displays the following screen:



The options for these settings are described below:

Accel MAPdot Curve

The curve specifies a fuel pulsewidth percent adder based on rate of change of MAP (MAPdot)

This is part of the accel-pump based accel enrichment scheme. Larger changes in MAP require more fuel added.

The negative part of the curve is used for decel enleanment, or set to zero PW% for no enleanment.

Ensure that there is a 0 0 point in the curve so that when MAP is not changing, no additional fuel is added. The number is a percentage of ReqFuel.

The curve specifies a fuel pulsewidth percent adder based on rate of change of TPS (TPSdot)

This is part of the accel-pump based accel enrichment scheme. Larger changes in TPS require more fuel added.

The negative part of the curve is used for decel enleanment, or set to zero PW% for no enleanment.

Ensure that there is a 0 0 point in the curve so that when TPS is not changing, no additional fuel is added. The number is a percentage of ReqFuel.

Accel TPSdot Curve

The curve specifies a fuel pulsewidth percent adder based on rate of change of TPS (TPSdot)

This is part of the accel-pump based accel enrichment scheme. Larger changes in TPS require more fuel added.

The negative part of the curve is used for decel enleanment, or set to zero PW% for no enleanment.

Ensure that there is a 0 0 point in the curve so that when TPS is not changing, no additional fuel is added. The number is a percentage of ReqFuel.

Accel Enrichment MAPdot<->TPSdot Blend (%)

This slider set a weight (0-100) to be given to TPSdot over MAPdot for accel enrichment.

Accel MAPdot Threshold (kPa/s)

Triggers enrichment above this MAPdot value.

Accel TPSdot threshold (%/s)

Trigger enrichment above this TPSdot value.

Cold Accel Multiplier (ms)

At full cold (-40 ºC/ºF), multiply the enrichment by this percentage.

Full Accel Below: (rpm)

Below this RPM full enrichment is enabled.

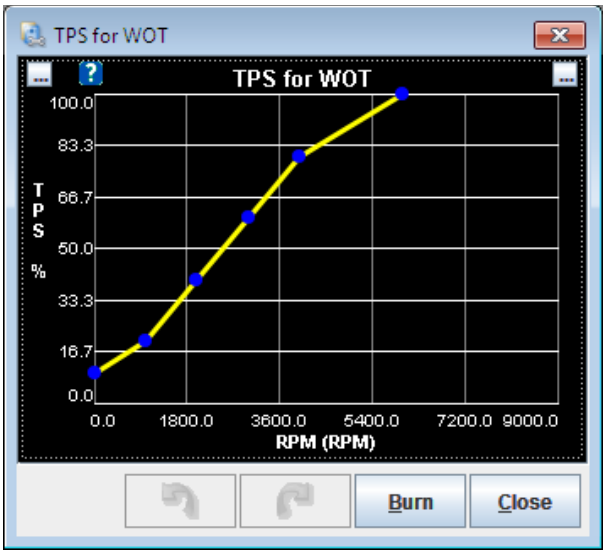
Zero Accel Above: (rpm)

Above this RPM, there is no enrichment. In between, the enrichment is on a sliding scale.

12.4 TPS WOT curve

The TPS WOT menu option is only enabled if the “TPSdot uses %WOT” setting is set to “On” see Section 12.1.

Clicking Accel Enrich > TPS WOT curve displays the following screen:



This curve sets the TPS% that is considered wide-open-throttle based on RPM.

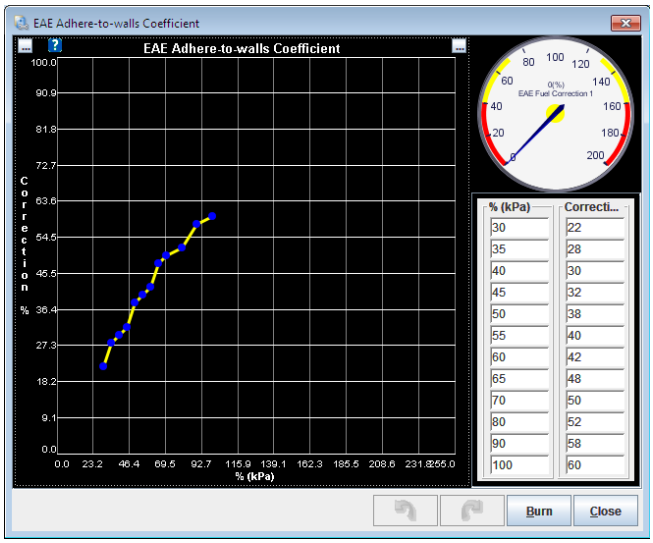
i.e., at low RPMs, partial throttle will flow the same air as full throttle. At maximum RPMs full throttle is required for full air flow.

When the throttle is at, or beyond, the new 'full throttle' it is considered to be 100% throttle. This has the effect of making TPS based accel enrichment more sensitive at lower throttle opening at lower RPMs and also prevents TPS accel enrichment if the throttle is already 'fully open.'

12.5 EAE Adhere-to-walls Coefficient

The EAE Adhere-to-walls Coefficient menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1.

Clicking Accel Enrich > EAE Adhere-to-walls Coefficient displays the following screen:

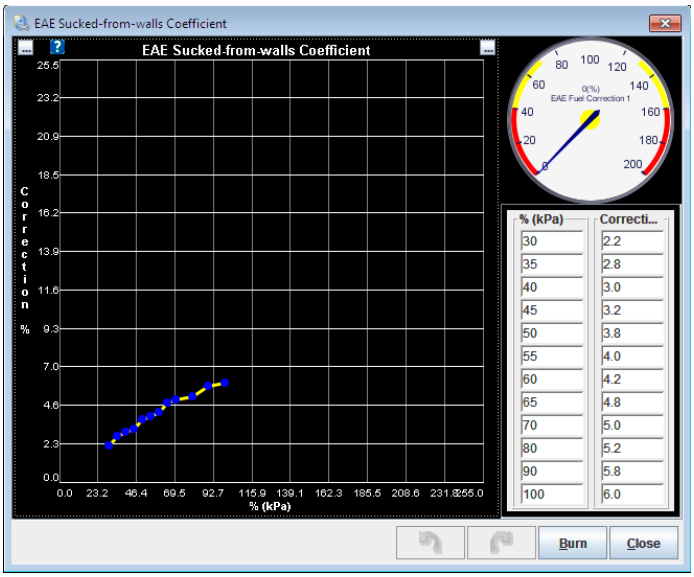


This curve determines how much fuel is being added to the port walls per injection event. It is a percentage (Y-axis) of each injection event based on load (X-axis).

12.6 EAE Sucked-from-walls Coefficient

The EAE Sucked-from-walls Coefficient menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1.

Clicking Accel Enrich > EAE Sucked-from-walls Coefficient displays the following screen:

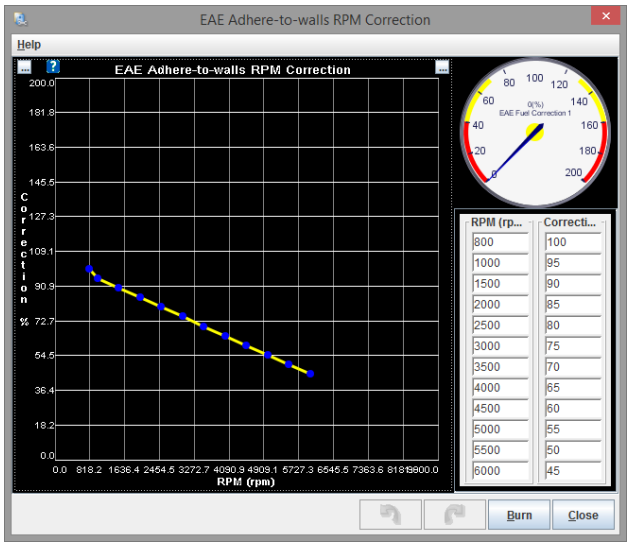


This curve determines how much fuel is being sucked from the walls on each intake (valve open) event. It is a percentage (Y-axis) of the total amount of fuel that has adhered to the walls based on load (X-axis), so therefore the percentages are much smaller (about 10x smaller) than the Adhere-to-walls coefficients.

12.7 EAE Adhere-to-walls RPM Correction

The EAE Adhere-to-walls RPM Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1.

Clicking Accel Enrich > EAE Adhere-to-walls RPM Correction displays the following screen:

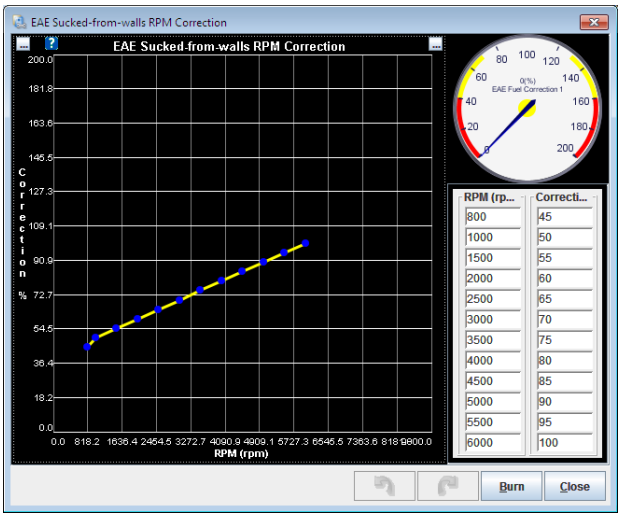


This curve modifies the EAE Adhere-to-walls curve. It allows the amount of correction specified by the EAE Adhere-to-walls curve to be increased or decreased based on RPM.

12.8 EAE Sucked-from-walls RPM Correction

The EAE Sucked-from-walls RPM Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1.

Clicking Accel Enrich > EAE Sucked-from-walls RPM Correction displays the following screen:

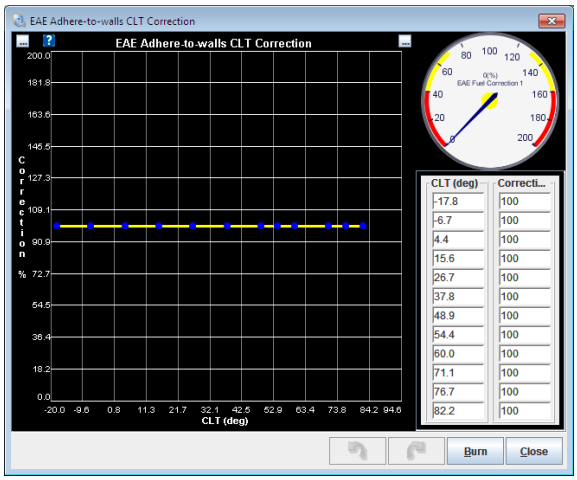


This curve modifies the EAE Sucked-from-walls curve. It allows the amount of correction specified by the EAE Sucked-from-walls curve to be increased or decreased based on RPM.

12.9 EAE Adhere-to-walls CLT Correction

The EAE Adhere-to-walls CLT Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1.

Clicking Accel Enrich > EAE Adhere-to-walls CLT Correction displays the following screen:

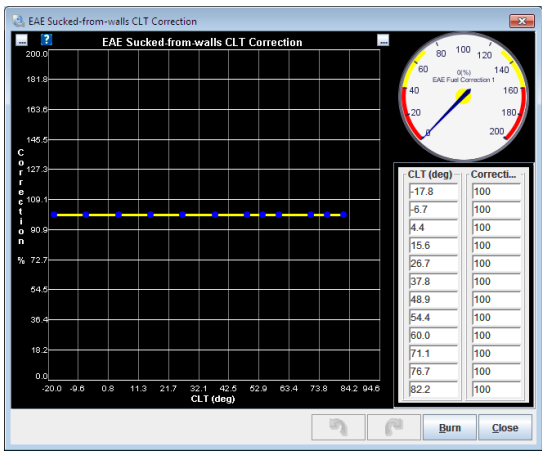


This curve modifies the EAE Adhere-to-walls curve. It allows the amount of correction specified by the EAE Adhere-to-walls curve to be increased or decreased based on coolant temperature.

12.10 EAE Sucked-from-walls CLT Correction

The EAE Sucked-from-walls CLT Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1.

Clicking Accel Enrich > EAE Sucked-from-walls CLT Correction displays the following screen:



This curve modifies the EAE Sucked-from-walls curve. It allows the amount of correction specified by the EAE Sucked-from-walls curve to be increased or decreased based on coolant temperature.

12.11 EAE Adhere-to-walls Coefficient 2

The EAE Adhere-to-walls Coefficient menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1 and Staging is enabled see Section 9.4.

This is for a second EAE channel for Staged Injection.

12.12 EAE Sucked-from-walls Coefficient 2

The EAE Sucked-from-walls Coefficient menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1 and Staging is enabled see Section 9.4.

This is for a second EAE channel for Staged Injection.

12.13 EAE Adhere-to-walls RPM Correction 2

The EAE Adhere-to-walls RPM Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1 and Staging is enabled see Section 9.4.

This is for a second EAE channel for Staged Injection.

12.14 EAE Sucked-from-walls RPM Correction 2

The EAE Sucked-from-walls RPM Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1 and Staging is enabled see Section 9.4.

This is for a second EAE channel for Staged Injection.

12.15 EAE Adhere-to-walls CLT Correction 2

The EAE Adhere-to-walls CLT Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1 and Staging is enabled see Section 9.4.

This is for a second EAE channel for Staged Injection.

12.16 EAE Sucked-from-walls CLT Correction 2

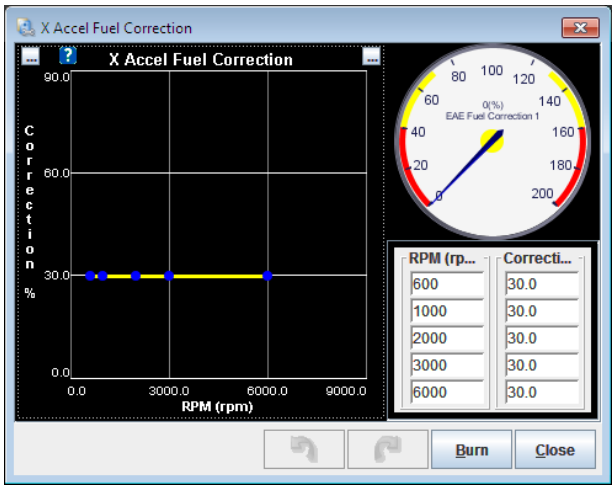
The EAE Sucked-from-walls CLT Correction menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “EAE” see Section 12.1 and Staging is enabled see Section 9.4.

This is for a second EAE channel for Staged Injection.

12.17 Puddling Factors (accel)

The Puddling Factors (accel) menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “X-Tau” see Section 12.1.

Clicking Accel Enrich > Puddling Factors (accel) displays the following screen:

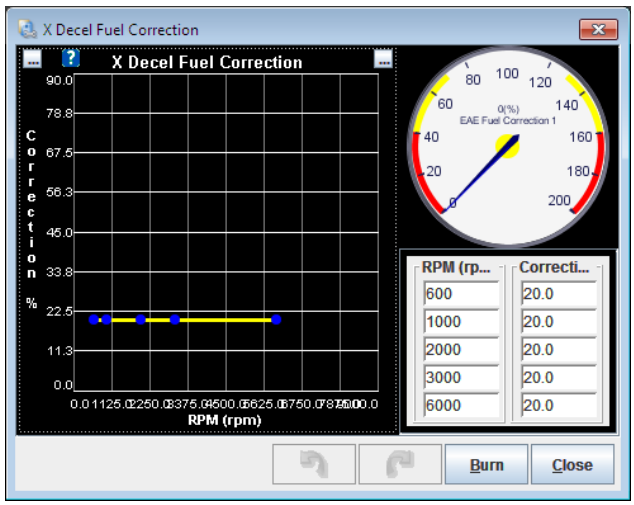


This is the percentage of the fuel (0-100%) that goes into the wall puddle while accelerating (fuel pulse width increasing), with the remainder of the squirt going directly into the cylinder to be burned.

12.18 Puddling Factors (decel)

The Puddling Factors (decel) menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “X-Tau” see Section 12.1.

Clicking Accel Enrich > Puddling Factors (decel) displays the following screen:

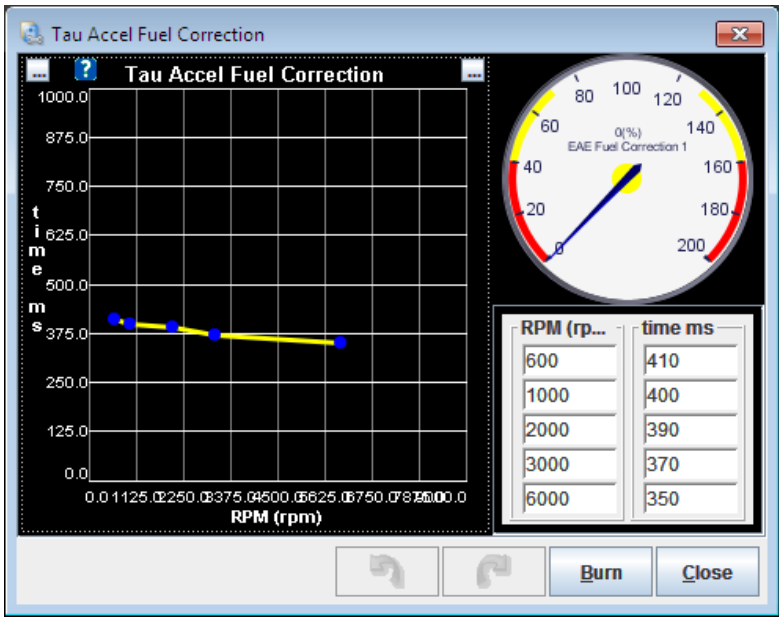


This is the percentage of fuel (0-100%) going into the wall puddle while decelerating (fuel pulse width decreasing.)

12.19 Time Factors (accel)

The Time Factors (accel) menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “X-Tau” see Section 12.1.

Clicking Accel Enrich > Time Factors (accel) displays the following screen:

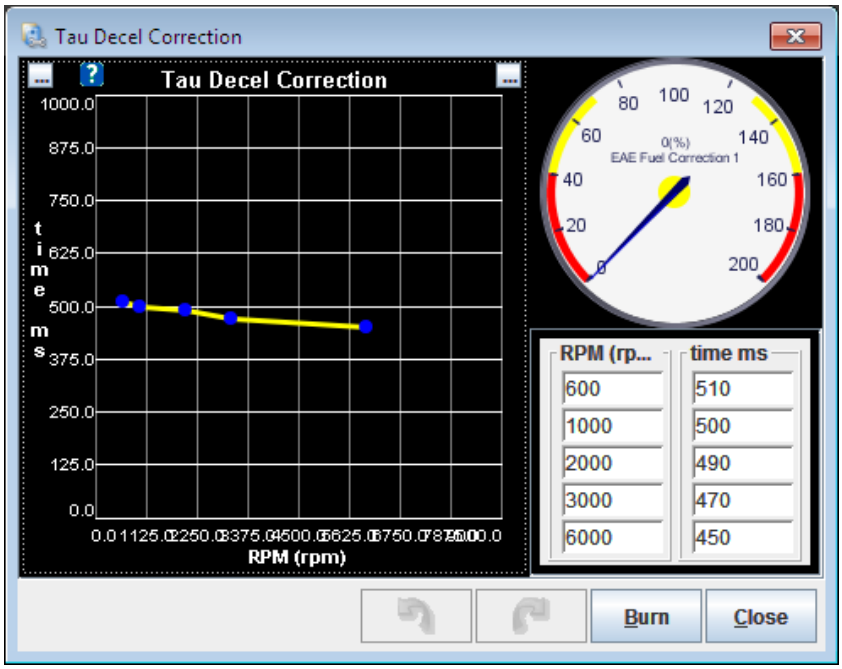


This is the time factor vs. RPM used during acceleration.

12.20 Time Factors (decel)

The Time Factors (decel) menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “X-Tau” see Section 12.1.

Clicking Accel Enrich > Puddling Factors (accel) displays the following screen:

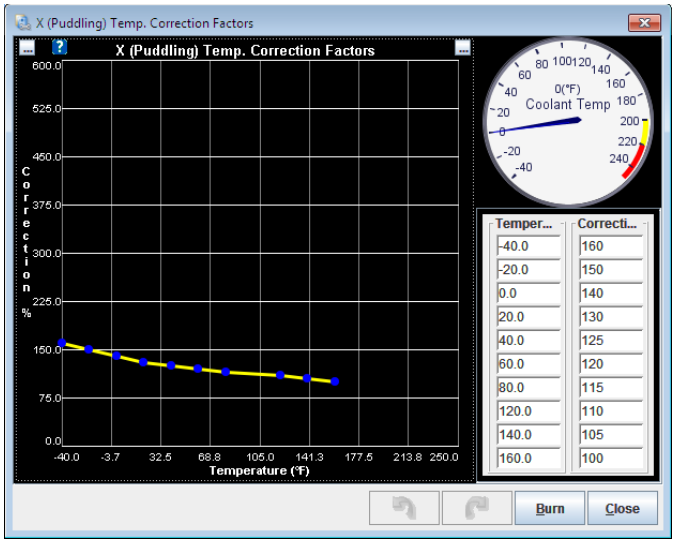


This is the time factor vs. RPM used during deceleration.

12.21 X (Puddling) Temp. Corrections

The X (Puddling) Temp. Corrections menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “X-Tau” see Section 12.1.

Clicking Accel Enrich > X (Puddling) Temp. Corrections displays the following screen:

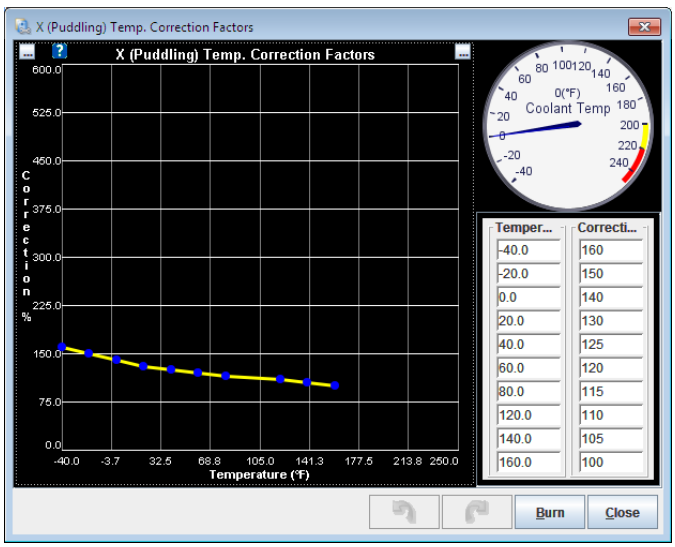


Coolant temperature (CLT) correction to the puddling factor X.

12.22 Tau (time) Temp. Corrections

The Tau (time) Temp. Corrections menu option is only enabled if the “Wall-Wetting AE (EAE, X-Tau)” setting is set to “X-Tau” see Section 12.1.

Clicking Accel Enrich > Tau (time) Temp. Corrections displays the following screen:



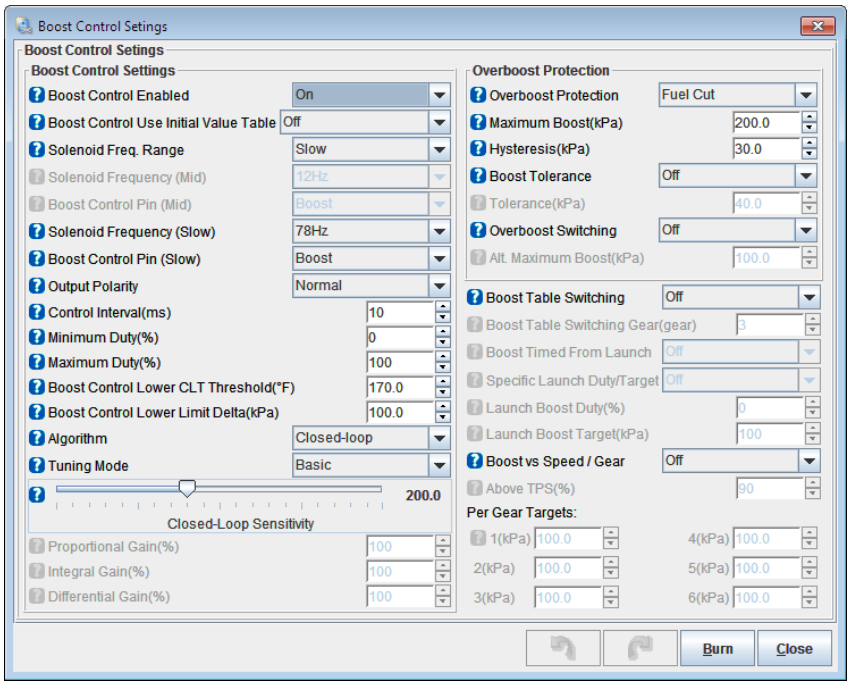
Coolant temperature (CLT) correction to the time factor Tau.

13 Boost / VVT

This chapter focuses on how to configure electronic boost control for use with a turbocharger, anti-lag and variable valve timing (VVT.)

13.1 Boost Control Settings

Clicking Boost/VVT > Boost Control Settings displays the following screen:



The options for these settings are described below:

Boost Control Enabled

Controls whether boost control is enabled.

Boost Control Use Initial Value Table

This setting will only be enabled if “Closed-loop” is selected below.

For use with closed-loop boost control. Controls whether the initial values table is used to set the initial duty before closed-loop is engaged.

Solenoid Freq. Range

Controls the frequency range allowed on the boost control output(s). Mid allows 12-1021 Hz. Slow allows 11.1-78Hz. Most solenoids will run successfully on the "slow" range. The "Mid" range of frequencies have to be shared with other outputs, so only use if necessary.

Solenoid Frequency (Mid)

Selects the frequency when using the mid range.

Boost Control Pin (Mid)

Output pin when using the mid range.

Solenoid Frequency (Slow)

Selects the frequency when using the slow range.

Boost Control Pin (Slow)

Output pin when using the slow range.

Output Polarity

Set this so that higher duty yields higher boost.

Control Interval (ms)

Controls how often the boost control algorithm runs. 50-100ms is recommended.

Minimum Duty (%)

(Closed loop) The duty below which changes in duty no longer cause changes in boost pressure.

Maximum Duty (%)

(Closed loop) The duty above which changes in duty no longer cause changes in boost pressure.

Boost Control Lower CLT Threshold

Coolant temperature must be above this value before boost control will work.

Boost Control Lower Limit Delta (kPa)

Boost pressure must be within this many kPa of the target boost before closed-loop control will activate.

Outside of this range the valve is held wide open (keeping the wastegate shut) for fastest spooling.

Algorithm

Controls whether open loop or closed loop control algorithm is used.

Many settings will only be enabled if “Algorithm” is set to “Closed-loop”.

Tuning Mode

Can be set to:

- Basic – uses fixed PID parameters (P = 100, I = 100, D = 100);
- Advanced – uses adjustable PID parameters for greater control (as described below).

Closed-loop Sensitivity

Use this setting to tune how aggressively the boost controller tries to reach the target boost. Adjust the slider up until the boost oscillates around the target, then back down until it stops.

Proportional Gain (%)

Proportional gain for closed-loop control. Proportional control causes immediate changes to output duty with changes in boost error.

Integral Gain (%)

Integral gain for closed-loop control. Integral control causes changes in duty with boost error over time. The longer boost is off target, the stronger the reaction due to the integral term.

Differential Gain (%)

Derivative gain for closed-loop control. Derivative control causes larger reactions in boost duty with faster rate of change of boost error. The faster error changes, the more duty will change to counteract.

13.1.1 Overboost Protection Settings

Overboost Protection

Selection can be fuel-cut, spark-cut, or both. “Fuel” cut only cuts fuel. “Spark” cut only cuts spark. “Both” cuts both fuel and spark.

Needs to be enabled when using Closed-Loop boost.

Maximum Boost (kPa)

Maximum desired boost before overboost protection cuts fuel / spark.

Hysteresis (kPa)

With overboost protection enabled, this determines how far pressure must drop before spark / fuel are re-enabled after boost has reached the maximum,.

Boost Tolerance

Trips the overboost protection if boost is a certain pressure above boost target. Allows overboost to track the boost target table.

Tolerance (kPa)

How far MAP can exceed the boost target before overboost cuts in.

Overboost Switching

Allows an input pin to toggle maximum boost to an alternate value.

Alt. Maximum Boost

The alternate maximum desired boost before overboost protection cuts fuel/spark.

13.1.2 Boost Switching Settings

Boost Table Switching

Allow boost tables to be switched or blended.

- Off - no table switching or blending
- Input pin - selects an input for table switching
- Blend - enables a blend table
- Gear - enables switching by gear (requires gear detection)

Boost Table Switching Gear

Selects which gear to switch tables on when gear-based boost table switching is enabled.

The Boost Table Switching Gear menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND Boost Table Switching is set to "Gear"

Boost Timed From Launch

Enables a table to ramp up boost after launch.

The Boost Timed From Launch menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND Launch Control is enabled (see section 15.10)

Specific Launch Duty/Target

Allow a specific target (closed-loop) or duty (open loop) to be specified when launch control is active.

The Specific Launch Duty/Target menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND Launch Control is enabled (see section 15.10)

Launch Boost Duty

Duty to use when launch is active.

The Launch Boost Duty menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND Boost Control is set to "Open-Loop"
- AND Launch Control is enabled (see section 15.10)

Launch Boost Target

Target boost (kPa) to use when launch is active.

The Launch Boost Target menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND Boost Control is set to "Closed-Loop"
- AND Launch Control is enabled (see section 15.10)

Boost vs Speed/Gear

Allows boost duty or target to be controlled based on vehicle speed or detected gear.

- Off - option is disabled
- VSS1 - use VSS1 to lookup boost from table
- VSS2 - use VSS2 to lookup boost from table
- Gear - use specific closed-loop target based on current gear (see below)

The Boost vs Speed/Gear menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND VSS is enabled on Speed and Gear Settings (see section 15.1)

Above TPS%

For safety, the TPS must be above this value for the VSS target boost to be used.

The Above TPS% menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND Boost vs Speed/Gear is enabled.

Per Gear Targets

These set closed-loop boost targets per gear when per-gear targets is enabled.

The Per Gear Targets menu options are only enabled if:

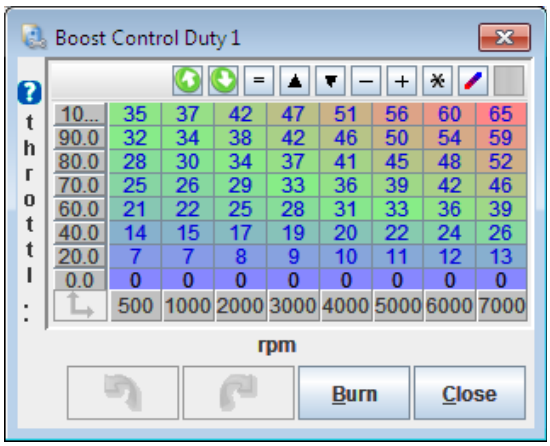
- “Boost Control Enabled” is set to “On”
- AND "Closed Loop" is enabled.
- AND Boost vs Speed/Gear is set to "Gear".

13.2 Boost Control Duty Table

The Boost Control Duty Table menu option is only enabled if:

- “Boost Control Enabled” is set to “On”
- AND Algorithm is set to “Open-loop” (see section 13.1. for these settings.)

Clicking Boost/VVT > Boost Control Duty Table will display the following screen:



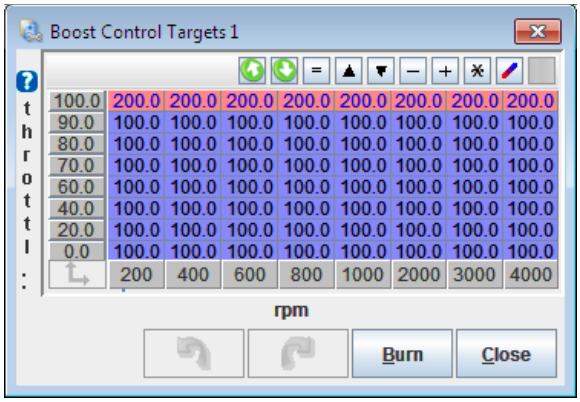
For Open-loop boost, this table sets the output duty cycle vs. TPS/RPM.

13.3 Boost Control Target Table

The Boost Control Target Table menu option is only enabled if:

- “Enable Boost Control” is set to “On”
- AND “Algorithm” is set to “Closed-loop” (see section 13.1. for these settings.)

Clicking Boost/VVT > Boost Control Target Table will display the following screen:



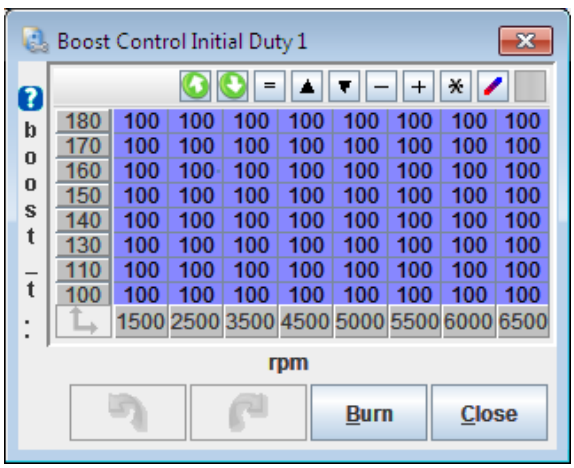
For Closed-loop boost, this table sets the target boost vs. TPS/RPM

13.4 Boost Control Initial Duty Table 1

The Boost Control Initial Duty Table menu option is only enabled if:

- “Enable Boost Control” is set to “On”
- AND “Boost Control Use Initial Value Table is set to “On”
- AND “Algorithm” is set to “Closed-loop” (see section 13.1. for these settings.)

Clicking Boost/VVT > Boost Control Initial Duty Table displays the following screen:



The best-estimate boost valve duty for target load vs. RPM. This allows you to 'kick-start' the closed-loop boost by setting the valve to the this position before engaging closed-loop PID control.

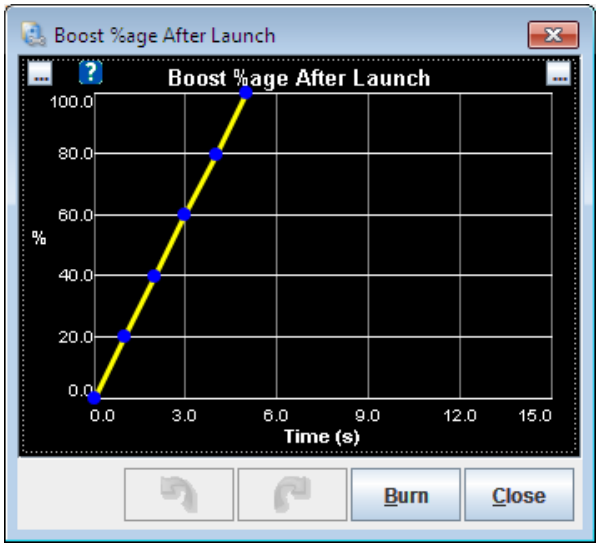
The table is determined by reviewing datalogs or taking a known open-loop table.

13.5 Boost Delay (Timed From Launch)

The Boost Delay (Timed From Launch) menu option is only enabled if:

- “Enable Boost Control” is set to “On”
- AND “Boost Timed From Launch" is set to “On” (see section 13.1. for these settings.)

Clicking Boost/VVT > Boost Delay (Timed From Launch) displays the following screen:



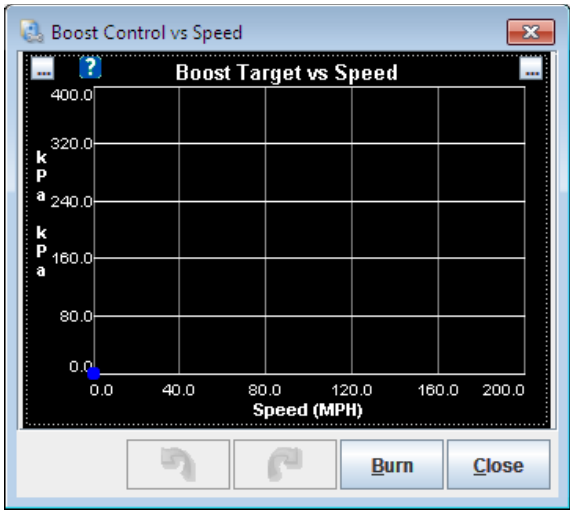
Allows boost to be feathered in (ramped up) after launching. 100% means use normal boost settings.

13.6 Boost Control vs Speed

The Boost Control vs Speed menu option is only enabled if:

- “Enable Boost Control” is set to “On”
- AND “Boost vs Speed/Gear" is set to “VSS1” or "VSS2" (see section 13.1. for these settings.)
- AND VSS is enabled (see section 15.1)

Clicking Boost/VVT > Boost Control vs Speed displays a screen similar to this:



For open-loop boost control, this specifies a solenoid duty based on the wheel speed on VSS1 or VSS2.

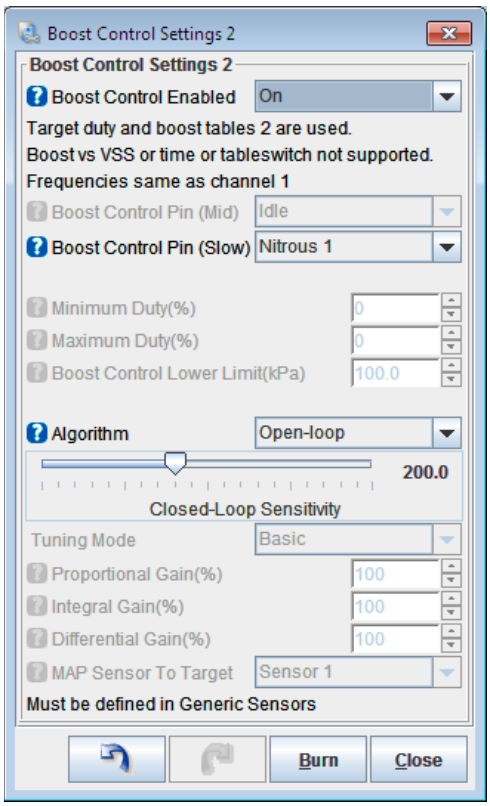
For closed-loop boost control, this specifies a target boost level based on the wheel speed on VSS1 or VSS2. This can be used to limit boost in lower gears to reduce the change of wheelspin or loss of control.

13.7 Boost Control Settings 2

The Boost Control Settings 2 menu option is only enabled if:

- "Enable Boost Control" is set to "On"

Clicking Boost/VVT > Boost Control Settings 2 displays the following screen:



The options for these settings are described below:

Boost Control Enabled

Controls whether the second channel of boost control is enabled.

Boost Control Pin (Mid)

Output pin when using the mid range.

Boost Control Pin (Slow)

Output pin when using the slow range.

Minimum Duty (%)

(Closed loop) The duty below which changes in duty no longer cause changes in boost pressure.

Maximum Duty (%)

(Closed loop) The duty above which changes in duty no longer cause changes in boost pressure.

Boost Control Lower Limit (kPa)

Boost pressure must be within this many kPa of the target boost before closed-loop control will activate.

Outside of this range the valve is held wide open (keeping the wastegate shut) for fastest spooling.

Algorithm

Controls whether open loop or closed loop control algorithm is used.

Many settings will only be enabled if “Algorithm” is set to “Closed-loop”.

In firmware version 1.3.x closed-loop is not fully implement on the second channel. Use open-loop only.

Tuning Mode

Can be set to:

- Basic – uses fixed PID parameters (P = 100, I = 100, D = 100);
- Advanced – uses adjustable PID parameters for greater control (as described below).

Closed-loop Sensitivity

Use this setting to tune how aggressively the boost controller tries to reach the target boost. Adjust the slider up until the boost oscillates around the target, then back down until it stops.

Proportional Gain (%)

Proportional gain for closed-loop control. Proportional control causes immediate changes to output duty with changes in boost error.

Integral Gain (%)

Integral gain for closed-loop control. Integral control causes changes in duty with boost error over time. The longer boost is off target, the stronger the reaction due to the integral term.

Differential Gain (%)

Derivative gain for closed-loop control. Derivative control causes larger reactions in boost duty with faster rate of

change of boost error. The faster error changes, the more duty will change to counteract.

MAP Sensor to Target

In a future code release this will specify the MAP sensor to use as the target for closed-loop.

13.8 Boost Control Duty Table 2

The Boost Control Duty Table menu option is only enabled if:

- "Boost Control Enabled" is set to "On"
- AND Algorithm is set to "Open-loop" (see section 13.1. for these settings.)
- AND Boost Control 2 is enabled (see section 13.7)

This works in the same way as the Boost Control Duty Table.

13.9 Boost Control Target Table 2

The Boost Control Target Table menu option is only enabled if:

- "Enable Boost Control" is set to "On"
- AND "Algorithm" is set to "Closed-loop" (see section 13.1. for these settings.)
- AND Boost Control 2 is enabled (see section 13.7)

This works in the same way as the Boost Control Target Table.

13.10 Boost Control Initial Duty Table 2

The Boost Control Initial Duty Table menu option is only enabled if:

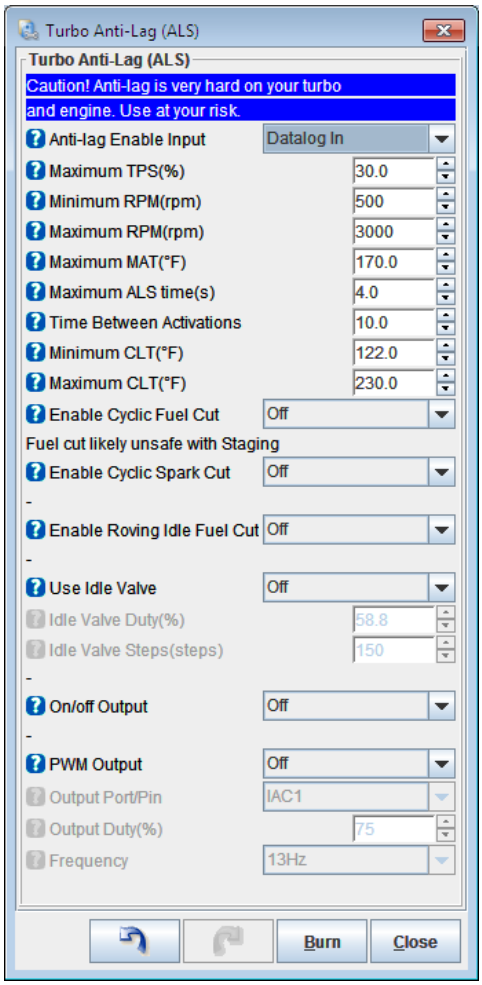
- "Enable Boost Control" is set to "On"
- AND "Boost Control Use Initial Value Table is set to "On"
- AND "Algorithm" is set to "Closed-loop" (see section 13.1. for these settings.)
- AND Boost Control 2 is enabled (see section 13.7)

This works in the same way as the Boost Control Initial Duty Table.

13.11 Turbo Anti-Lag (ALS)

Anti-lag is a combination of features you can use to keep the turbo spooled while shifting, beyond the basic flat shift rev limiter. The MS3 has several strategies it can use to dump extra fuel into the exhaust and increase exhaust gas temperatures under these conditions. This increase in exhaust temperature will shorten turbo life and possibly result in increased wear and tear on other parts of the exhaust system as well.

Clicking Boost/VVT > Turbo Anti-Lag (ALS) displays the following screen:



The options for these settings are described below:

Anti-Lag Enable Input

Enables the Anti-Lag system and selects the Enable input.

Maximum TPS

Disable ALS above this TPS%.

Minimum RPM

Disable ALS below this RPM.

Maximum RPM

Disable ALS above this RPM.

Maximum MAT

Disable ALS above this manifold temperature.

Maximum ALS time

Only allow ALS to be active for this long to reduce temperature build-up.

Time Between Activations

Enforce a minimum time between activations to reduce temperature build-up.

Minimum CLT

Disable ALS below this coolant temperature.

Maximum CLT

Disable ALS above this coolant temperature.

Enable Cyclic Fuel Cut

Whether cyclic fuel cut should be used. ONLY for use with sequential fuel.

Enable Cyclic Spark Cut

Whether cyclic spark cut should be used.

Enable Roving Idle Fuel Cut

Whether roving idle fuel cut should be used.

Use Idle Valve

Enables the idle valve in ALS mode.

Idle Valve Duty

What PWM valve duty should be used to give the extra air needed for ALS.

This is only enabled if a PWM idle valve is enabled.

Idle Valve Steps

What stepper valve steps should be used to give the extra air needed for ALS.

This is only enabled if a stepper idle valve is enabled.

On/Off Output

Enables an additional output in ALS mode for extra-air valve.

PWM Output

Enables an additional pulsed output in ALS mode.

Output Port/Pin

Selects the pulsed (PWM) output.

Output Duty

Duty cycle on pulsed output when ALS is active.

Frequency

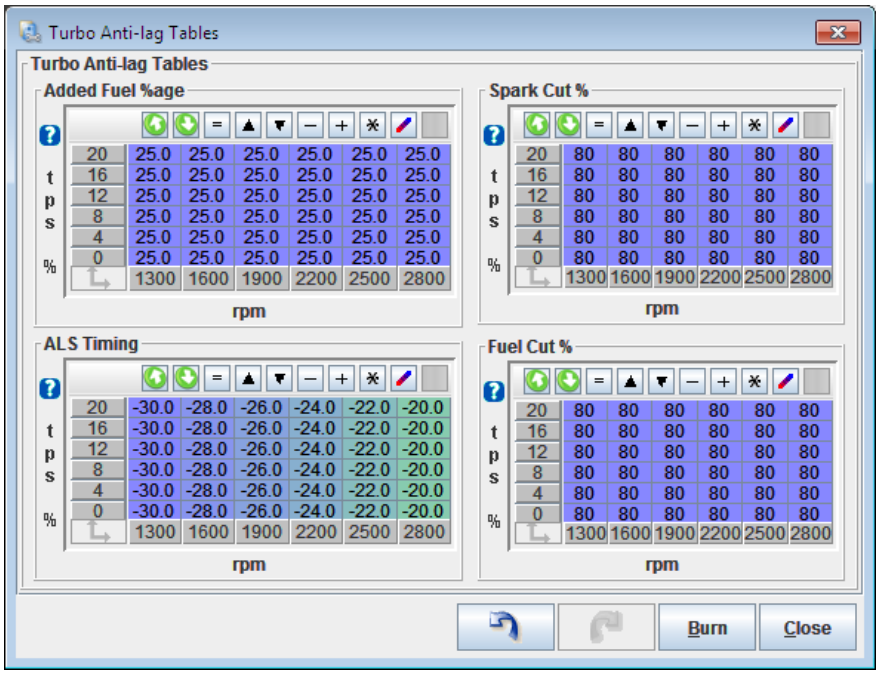
Frequency on pulsed output.

13.12 Turbo Anti-Lag Tables

The Turbo Anti-Lag Tables menu option is only enabled if:

- “Anti-Lag Enable Input” is enabled (see section 13.11)

Clicking Boost/VVT > Turbo Anti-Lag Tables displays the following screen:



Added Fuel %age

The percentage of fuel to be added vs. RPM/load when in anti-lag mode.

ALS Timing

The ignition advance vs. RPM/load when in anti-lag mode.

Typically this will be -20 to -50 for ATDC timing.

Spark Cut %

The Turbo Anti-Lag Tables menu option is only enabled if:

- “Anti-Lag Enable Input” is enabled
- AND "Enable Cyclic Spark Cut" is enabled (see section 13.11)

The spark-cut percentage vs. RPM/load when in anti-lag mode.

This drops sparks in a round-robin manner.

Fuel Cut %

The Turbo Anti-Lag Tables menu option is only enabled if:

- “Anti-Lag Enable Input” is enabled
- AND "Enable Cyclic Fuel Cut" is enabled (see section 13.11)

The fuel-cut percentage vs. RPM/load when in anti-lag mode.

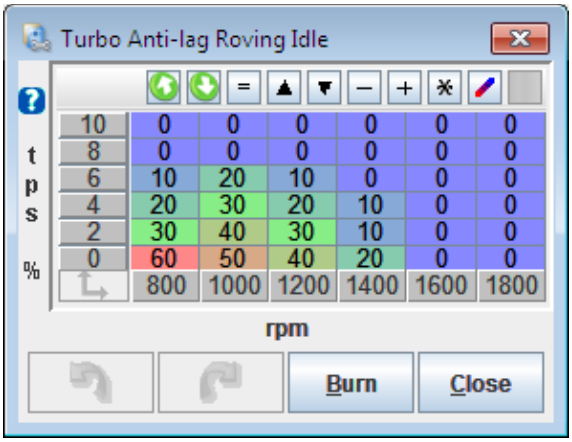
This must ONLY be used with sequential fuel as it cuts off injectors in a round-robin manner.

13.13 Turbo Anti-Lag Roving Idle

The Turbo Anti-Lag Roving Idle menu option is only enabled if:

- “Anti-Lag Enable Input” is enabled
- AND "Enable Roving Idle Fuel Cut" is "On" (see section 13.11)

Clicking Boost/VVT > Turbo Anti-Lag (ALS) displays the following screen:

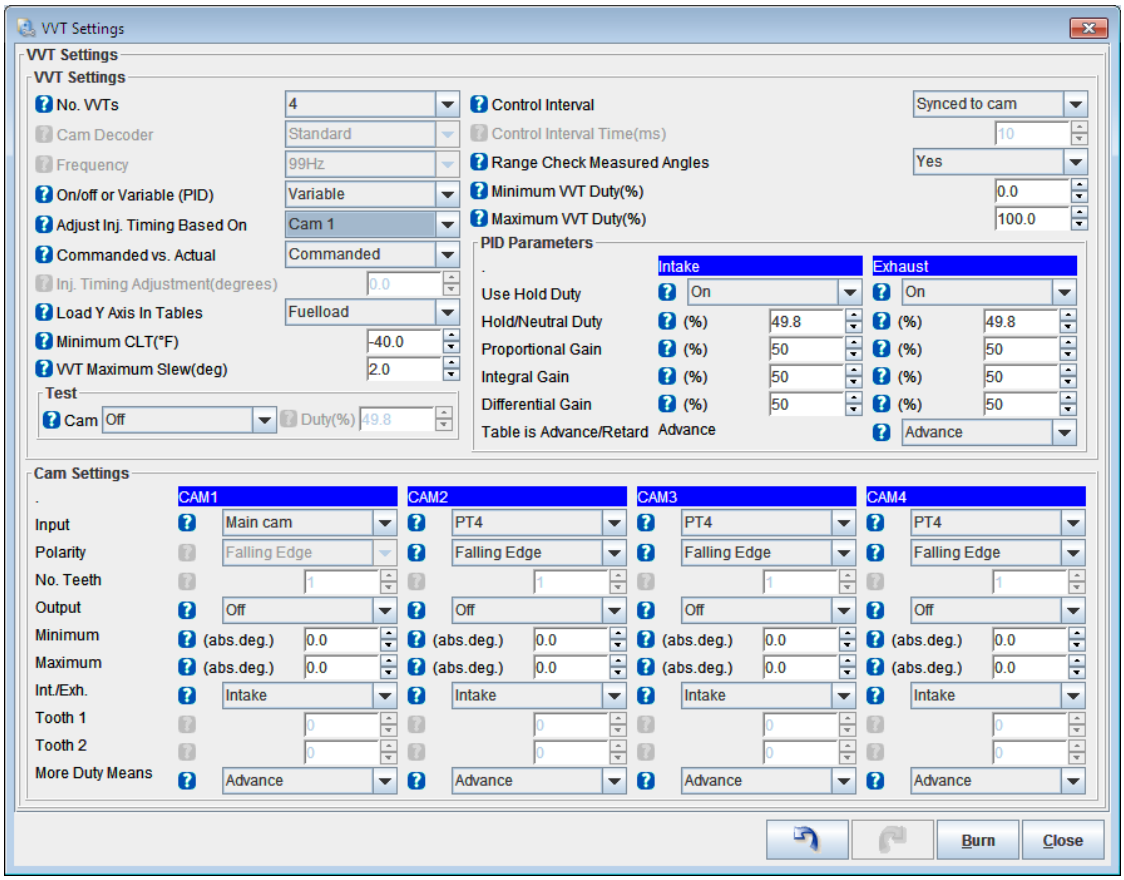


The fuel-cut percentage vs. RPM/load when in idling on an anti-lag vehicle mode.

This must ONLY be used with sequential fuel as it cuts off injectors in a round-robin manner.

13.14 VVT Settings

Clicking Boost/VVT > VVT Settings displays the following screen:



The options for these settings are described below:

13.14.1 VVT Settings

No. VVTs

Enables VVT control and selects number of cams to control.

Cam Decoder

The Cam Decoder menu option is only enabled if:

- VVT is enabled
- AND "Spark Mode" is set to "Toothed Wheel" (see section 10.1)

Frequency

The Frequency menu option is only enabled if:

- VVT is enabled
- AND an output is enabled.

VVT solenoid PWM frequency.

On/Off or Variable (PID)

Chooses between basic on/off mode or closed-loop variable position control.

Most settings on the VVT page are only available in Variable mode.

Adjust Inj. Timing Based On

Whether to adjust injection timing based on cam position and which cam.

Commanded vs. Actual

If injector timing is being adjusted, whether to adjust it based on target or actual current position.

Inj. Timing Adjustment

The Inj. Timing Adjustment menu option is only enabled if:

- VVT is enabled
- AND "On/Off" mode is enabled
- AND "Adjust Inj. Timing Based On" is enabled.

Angle to advance injector timing by when VVT is active on On/Off mode.

Load Y axis in Tables

The load unit used for the Y-axis on the lookup tables.

Minimum CLT

VVT only operates when coolant is above this temperature.

VVT Maximum Slew

The Inj. Timing Adjustment menu option is only enabled if:

- VVT is enabled
- AND "Variable" mode is enabled

Limits rate of change of VVT target to minimise overshoot caused by rapid target changes or low oil pressure at low rpms.

Default is 2.0deg per cam event.

Control Interval

How often to run the calculations.

- Synced to cam - the calculations are run as soon as new cam tooth passes the sensor. Recommended.
- Timed - user set interval for calculations

Control Interval Time

Specifies a fixed calculation interval.

Range Check Measured Angles

Whether error checking should be applied to the measured cam angles. Recommended.

Minimum VVT Duty

Minimum duty cycle for VVT solenoids.

Maximum VVT Duty

Maximum duty cycle for VVT solenoids.

13.14.2 PID Parameters

There are settings that apply to all intake cams and all exhaust cams.

Use Hold Duty

Some VVT systems will hold at a fixed position when a certain duty cycle is applied, enable this on those systems. Others have no specific hold-duty.

Hold/Neutral Duty

If enabled, this specifies the desired hold duty.

Proportional Gain

Proportional gain for closed-loop control. Proportional control causes immediate changes to output duty with changes in VVT position difference.

Integral Gain

Integral gain for closed-loop control. Integral control causes changes in duty with VVT position difference over time. The longer VVT is off target, the stronger the reaction due to the integral term.

Differential Gain

Derivative gain for closed-loop control. Derivative control causes larger reactions in duty with faster rate of change of VVT position difference. The faster the difference changes, the more duty will change to counteract.

Table is Advance/Retard

The Intake cam always uses a table of advances.

Whether the exhaust cam table is a table of advances (old method) or a table of retards (matches most exhaust VVTs.) Retard is recommended.

13.14.3 Test

Cam

Sets the cam (solenoid) to test

Duty

The output duty to the solenoid during testing.

13.14.4 Cam Settings

Input

Selects the input used for this particular cam sensor. Cam 1 is always tied to the main cam input defined in the Ignition Settings.

Polarity

The capture polarity for the cam. If reported cam angle changes unexpectedly with RPM while the cam is stationary, try swapping polarity.

No. Teeth

The number of teeth on the cam trigger wheel. For cam wheels with evenly spaced teeth this will usually be the actual number of teeth. Missing tooth or irregular cam wheels should use the "effective" number of teeth. e.g. a 4-1 cam wheel would specify 4 teeth as the 3 physical teeth are on a 90 degree pattern.

Output

The VVT control solenoid output.

Minimum

The minimum absolute angle from the cam sensor determined in test mode.

Maximum

The maximum absolute angle from the cam sensor determined in test mode.

Int./Exh.

Whether this is an intake or exhaust cam.

Tooth 1

Application specific, look for cam tooth after this crank tooth no.

Tooth 2

Application specific, look for cam tooth after this crank tooth no.

More Duty Means

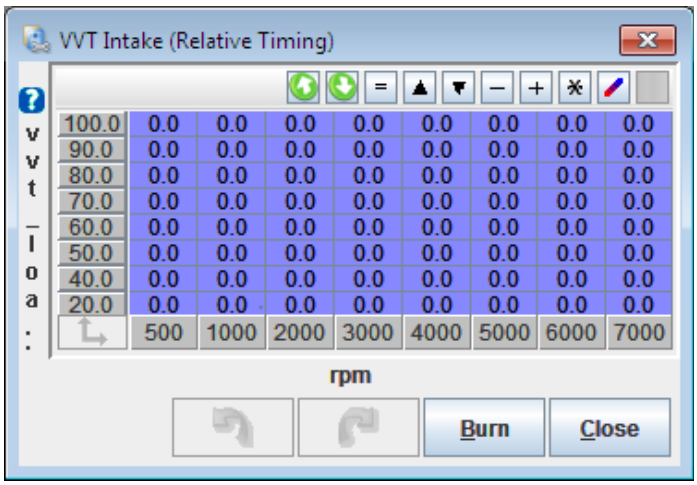
What direction the cam moves with output duty.

13.15 VVT Intake Table

The VVT Intake Table menu option is only enabled if:

- VVT is enabled
- AND "Variable" mode is enabled

Clicking Boost/VVT > VVT Intake Table displays the following screen:



Desired VVT (relative) timing vs RPM/load.

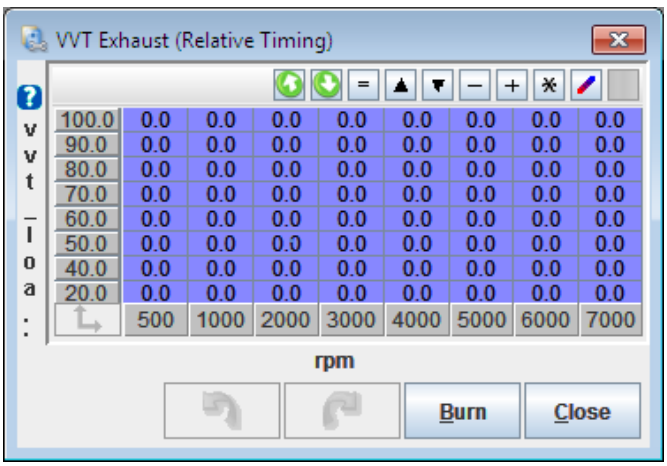
0 degrees means to leave the VVT intake cam at its "rest" retarded position. Positive numbers mean to advance the cam.

13.16 VVT Exhaust Table

The VVT Exhaust Table menu option is only enabled if:

- VVT is enabled
- AND "Variable" mode is enabled
- AND a cam is configured as an exhaust cam

Clicking Boost/VVT > VVT Exhaust Table displays the following screen:



Desired VVT (relative) timing vs RPM/load.

There are two ways that this table can operate depending on the setting "Table is Advance/Retard"

When using the recommended setting of "Retard", 0 degrees means to leave the exhaust cam in its rest position of fully advanced. Positive numbers then retard the cam.

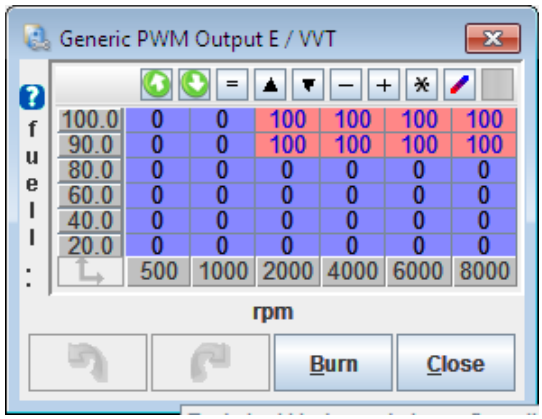
When using the compatability setting of "Advance", the table works backwards. 0 degrees means fully retarded and your maximum number will command the rest position of fully advanced.

13.17 VVT On/Off Table

The VVT On/Off Table menu option is only enabled if:

- VVT is enabled
- AND "On/Off" mode is enabled

Clicking Boost/VVT > VVT On/Off Table displays the following screen:



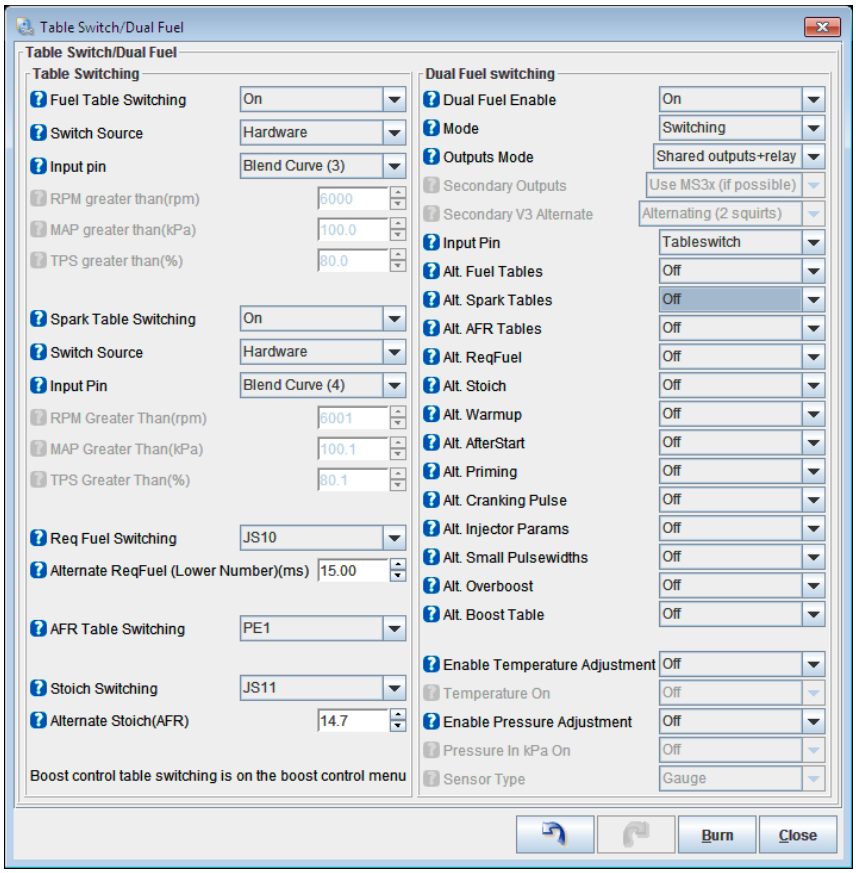
In place of the angle target table, an on/off table is used. In this table, set 100 for cells where VVT should be active and 0 for cell where it should be inactive. Do not use other values.

14 Table Choices

These menus give a number of selections for table-switching, blending and dual-fuel control. See also the Setting Up manual for more examples and background explanations.

14.1 Table Switch/Dual Fuel

Clicking Table Choices > Table Switching/Dual Fuel displays the following screen:



The options for these settings are described below:

14.1.1 Table Switching

Fuel Table Switching

Enables Fuel Table switching. Switches from using Fuel VE Table 1 (with optional modifier Fuel VE Table 2) to using Fuel VE Table 3 (with optional modifier Fuel VE Table 4.)

Switch Source

- Hardware - use a physical input switch, a remote switch or a blend cuve
- rpm - switch based on RPM
- kPa - switched based on MAP reading
- TPS - switch based on TPS reading

Depending on the selection you make here, one of the following four options will be enabled.

Switch Location

Enabled when “Switch Source” is set to “Hardware”. Selects where the switch is connected.

Expansion boards will need configuring through 'CAN parameters' (see Section 17.1.)

Blend curve (3) enables a blend curve instead of a switch function.

RPM Greater Than (rpm)

Enabled when “Switch Source” is set to “rpm”. Represents the rpm threshold for fuel switching.

MAPGreater Than (kPa)

Enabled when “Switch Source” is set to “kPa”. Represents the kPa threshold for fuel switching.

TPS Greater Than (%)

Enabled when “Switch Source” is set to “TPS”. Represents the TPS threshold for fuel switching.

Spark Table Switching

Enables Ignition Table switching. Switches from using Ignition Table 1 (with optional modifier Ignition Table 2) to using Ignition Table 3 (with optional modifier Ignition Table 4.)

Switch Source

- Hardware - use a physical input switch, a remote switch or a blend cuve
- rpm - switch based on RPM
- kPa - switched based on MAP reading
- TPS - switch based on TPS reading

Depending on the selection you make here, one of the following four options will be enabled.

Switch Location

Enabled when “Switch Source” is set to “Hardware”. Selects where the switch is connected.

Expansion boards will need configuring through 'CAN parameters' (see Section 17.1.)

Blend curve (4) enables a blend curve instead of a switch function.

RPM Greater Than (RPM)

Enabled when “Switch Source” is set to “rpm”. Represents the rpm threshold for spark switching.

MAP Greater Than (kPa)

Enabled when “Switch Source” is set to “kPa”. Represents the kPa threshold for spark switching.

TPS Greater Than (%)

Enabled when “Switch Source” is set to “TPS”. Represents the TPS threshold for spark switching.

Req Fuel Switching

Enables ReqFuel switch input.

Alternative ReqFuel (lower number)

ReqFuel to use when switched.

AFR Table Switching

Enables AFR table switch input or blend curve to switch from AFR 1 to AFR 2 as the AFR target table.

Stoich Switching

Enables Stoich switch input.

Alternate Stoich

Stoich to use when switched.

14.1.2 Dual Fuel

Dual Fuel Enable

Enables Dual Fuel support (e.g. LPG or secondary race fuel on a different system.)

Mode

- Switching - swaps from fuel 1 to fuel 2. e.g. gasoline vs. propane
- Dual Table - parallel fuel tables allowing simultaneous control of both fuels. e.g. mapped methanol under boost.

Most of the following settings are only applicable to "Switching" mode.

Outputs Mode

- Shared outputs - used when two sets of injectors share one set of control wires from the ECU and have a relay to switch +12V.
- Different outputs - where each main and secondary injectors are wired to different outputs.

Secondary Outputs

The Secondary Outputs menu option is only enabled if:

- "Dual Fuel Enable" is enabled
- AND "Different Output" mode is enabled

Whether the secondaries are connected to MS3X outputs or to the mainboard 'V3' batch fire outputs.

Secondary V3 Alternate

The Secondary Outputs menu option is only enabled if:

- "Dual Fuel Enable" is enabled
- AND "Different Output" mode is enabled
- AND "Secondary Outputs" is set to "Use V3"

Whether the batch fire outputs alternate during an engine cycle or fire once together.

Input Pin

Input for Dual Fuel switching.

Alt. Fuel Tables

Whether to switch fuel tables.

Alt. Spark Tables

Whether to switch spark tables.

Alt. AFR Tables

Whether to switch AFR tables.

Alt. ReqFuel

Whether to switch ReqFuel.

Alt. Stoich

Whether to switch Stoich.

Alt. Warmup

Whether to switch warmup curves.

Alt. AfterStart

Whether to switch afterstart curves.

Alt. Priming

Whether to switch priming curves.

Alt. Cranking Pulse

Whether to switch cranking pulse curves.

Alt. Injector Params

Whether to switch injector parameters.

Alt. Small Pulsewidths

Whether to switch small pulsewidth curves.

Alt. Overboost

Whether to switch overboost limits.

Alt. Boost Table

Whether to switch boost tables.

Enable Temperature Adjustment

Enable secondary fuel temperature adjustment.

Temperature On

Secondary fuel temperature input. (Configured through the Generic Sensors system.)

Enable Pressure Adjustment

Enable secondary fuel pressure adjustment.

Pressure In kPa On

Secondary fuel pressure input. (Configured through the Generic Sensors system.)

Sensor Type

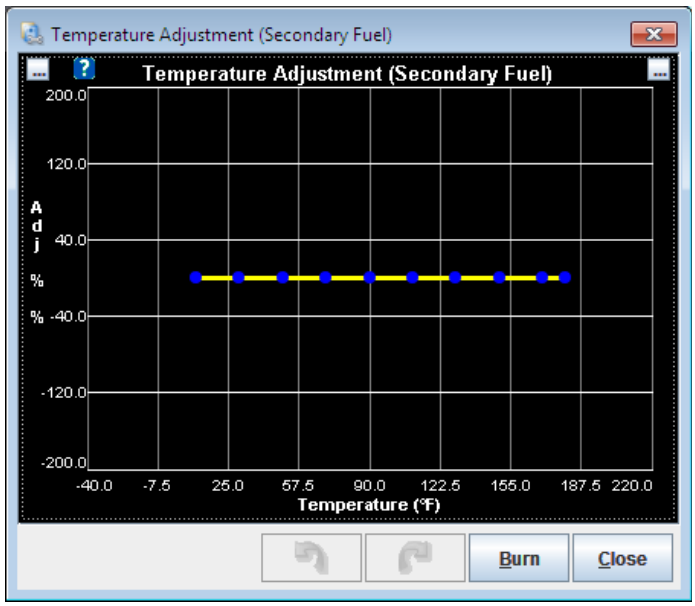
Sensor type: Gauge, Absolute, Differential.

14.2 Temperature Adjustment

The Temperature Adjustment menu option is only enabled if:

- "Dual Fuel Enable" is enabled
- AND "Enable Temperature Adjustment" is on.

Clicking Table Choices > Temperature Adjustment displays the following screen:



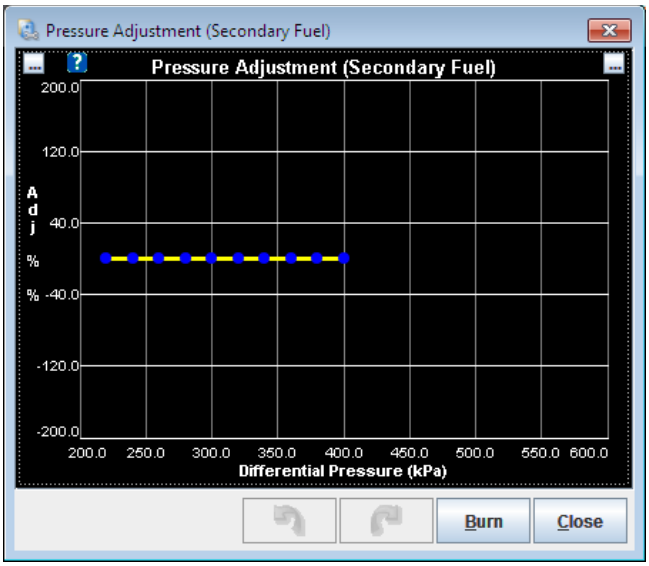
Specifies a percentage adjustment in fuelling based on fuel temperature. 0% means no adjustment.

14.3 Pressure Adjustment

The Pressure Adjustment menu option is only enabled if:

- "Dual Fuel Enable" is enabled
- AND "Enable Pressure Adjustment" is on.

Clicking Table Choices > Pressure Adjustment displays the following screen:



Specifies a percentage adjustment in fuelling based on fuel pressure. 0% means no adjustment.

14.4 Alt. Injector Dead-time/PWM 2

The Alt. Injector Dead-time/PWM 2 menu option is only enabled if:

- "Dual Fuel Enable" is enabled
- AND "Alt. Injector Params" is on.

This provides an alternate set of injector parameters for dual-fuel use when switching to a different set of injectors. See section 9.1.

14.5 Alt. Injector Small Pulsewidths 2

The Alt. Injector Small Pulsewidths 2 menu option is only enabled if:

- "Dual Fuel Enable" is enabled
- AND "Alt. Small Pulsewidths" is on.

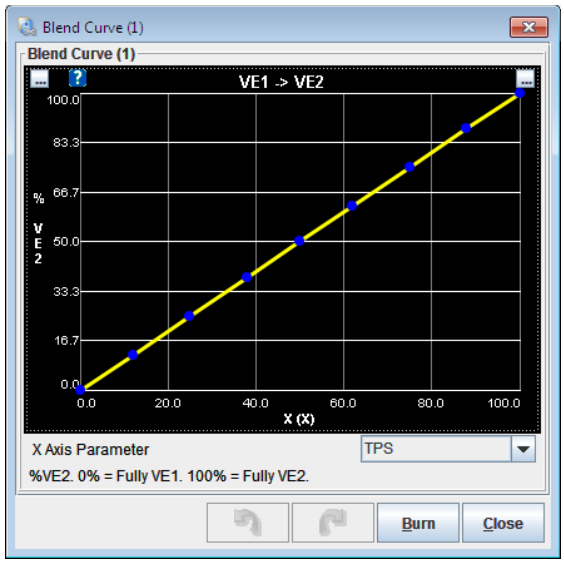
This provides an alternate set of injector small pulsewidth parameters for dual-fuel use when switching to a different set of injectors. See section 9.2.

14.5.1 Blend Curve 1

The Blend Curve 1 menu option is only enabled if:

- "Secondary Fuel Load" is enabled
- AND "Secondary Fuel" is set to "Blend Curve (1)". See Section 8.2.4.

Clicking Table Choices > Blend Curve 1 displays the following screen:



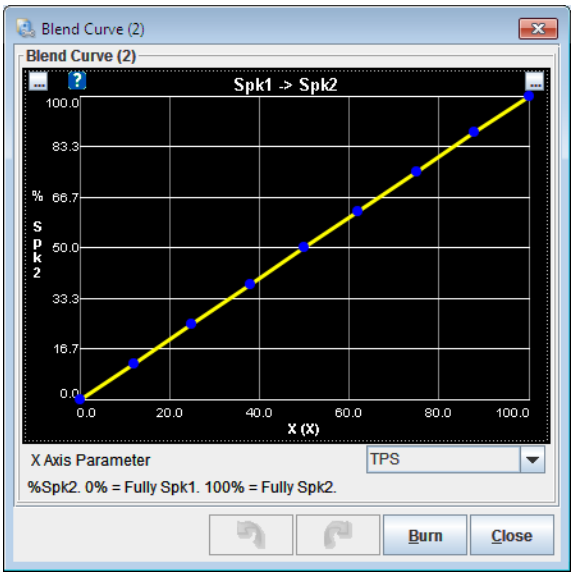
Sets a percentage blend from VE1 (0%) to VE2 (100%) based on the input X axis value.

14.5.2 Blend Curve 2

The Blend Curve 2 menu option is only enabled if:

- "Secondary Ignition Load" is enabled
- AND "Secondary Ignition" is set to "Blend Curve (2)". See Section 8.2.4.

Clicking Table Choices > Blend Curve 2 displays the following screen:



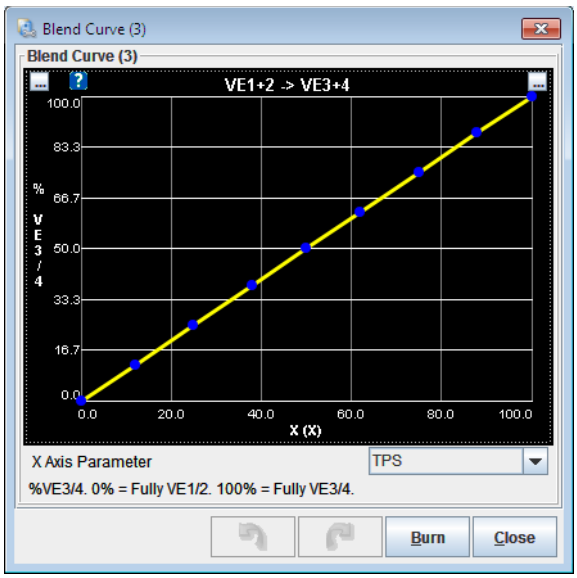
Sets a percentage blend from Spk1 (0%) to Spk2 (100%) based on the input X axis value.

14.5.3 Blend Curve 3

The Blend Curve 3 menu option is only enabled if:

- "Fuel Table Switching" is enabled
- AND "Switch Source" is set to "Hardware"
- AND "Input Pin" is set to "Blend Curve (3)". See Section 14.1.1.

Clicking Table Choices > Blend Curve 3 displays the following screen:



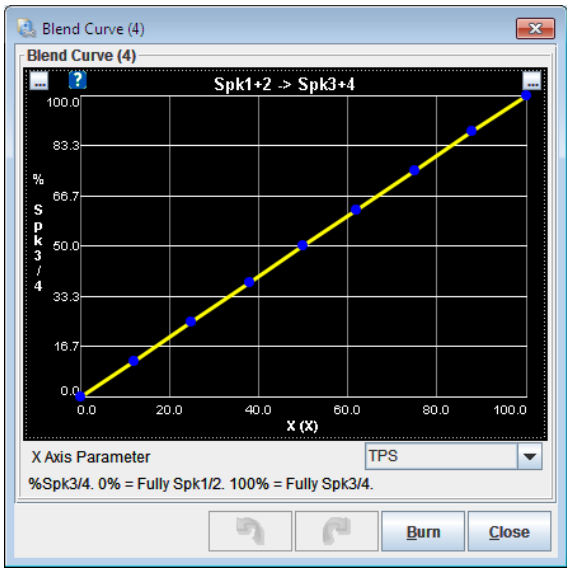
Sets a percentage blend from the combined VE1+2 (0%) to VE3+4 (100%) based on the input X axis value.

14.5.4 Blend Curve 4

The Blend Curve 4 menu option is only enabled if:

- "Spark Table Switching" is enabled
- AND "Switch Source" is set to "Hardware"
- AND "Input Pin" is set to "Blend Curve (4)". See Section 14.1.1.

Clicking Table Choices > Blend Curve 4 displays the following screen:



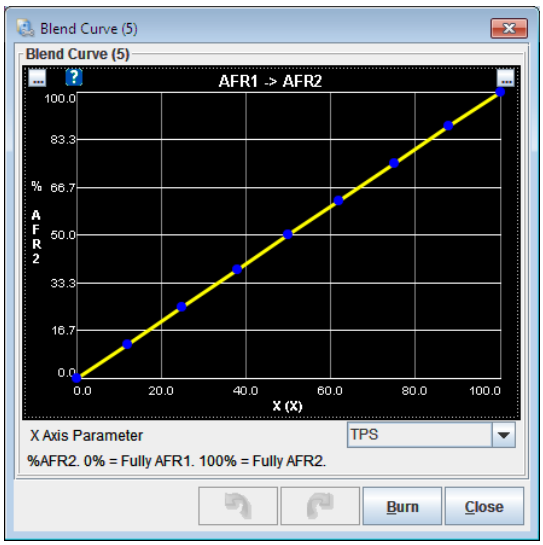
Sets a percentage blend from the combined Spk1+2 (0%) to Spk3+4 (100%) based on the input X axis value.

14.5.5 Blend Curve 5

The Blend Curve 5 menu option is only enabled if:

- "AFR Table Switching" is set to "Blend Curve (5)". See Section 14.1.1.

Clicking Table Choices > Blend Curve 5 displays the following screen:



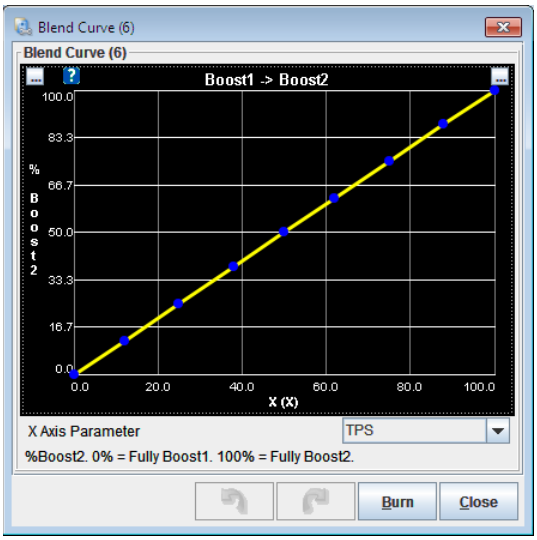
Sets a percentage blend from AFR1 (0%) to AFR2 (100%) based on the input X axis value.

14.5.6 Blend Curve 6

The Blend Curve 1 menu option is only enabled if:

- Boost Control is enabled
- AND Boost/VVT > Boost Control Settings > Boost Table Switching is set to "Blend Curve (1)". See Section 13.1.2.

Clicking Table Choices > Blend Curve 6 displays the following screen:



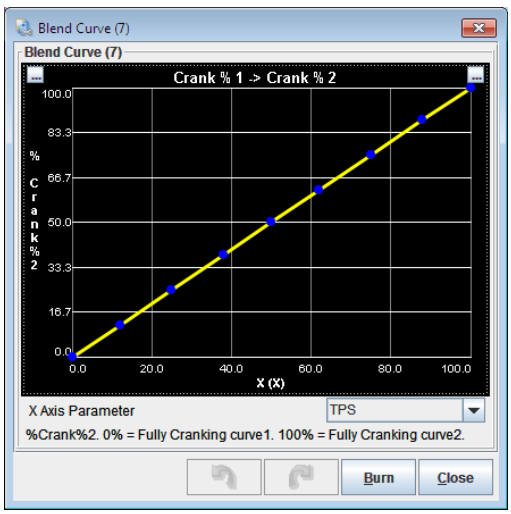
Sets a percentage blend from Boost1 (0%) to Boost2 (100%) based on the input X axis value.

14.5.7 Blend Curve 7

The Blend Curve 7 menu option is only enabled if:

- Startup/Idle > Cranking/Startup Settings > Blended Cranking Curves is set to "Blend Curve (7)". See Section 11.1.

Clicking Table Choices > Blend Curve 7 displays the following screen:



Sets a percentage blend from Cranking Pulse1 (0%) to Cranking Pulse2 (100%) based on the input X axis value.

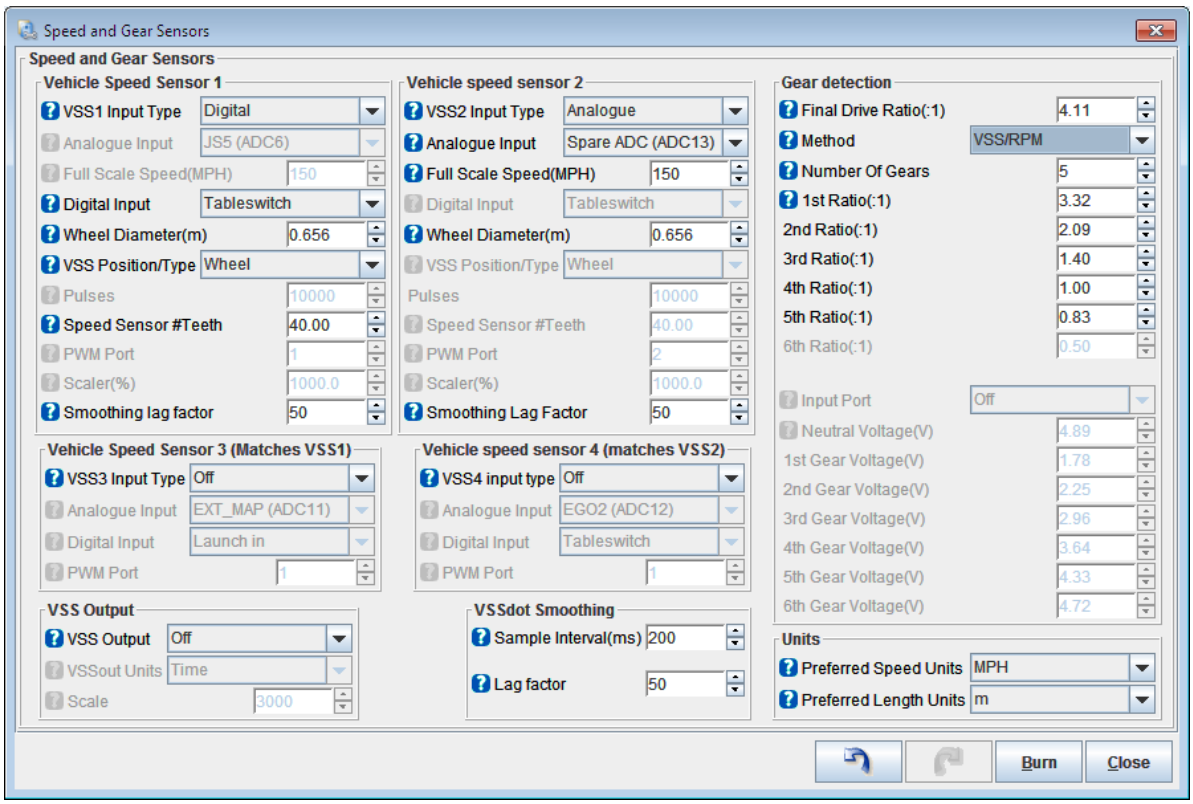
15 Advanced Engine

This menu covers some of the more complex and race related features.

15.1 Speed and Gear Sensors

The vehicle speed sensors (VSS) allow up to four wheel speeds to be monitored. The inputs read from either a wheel/axle mounted pickup or a pickup that is part of the transmission. The input can be magnetic (with suitable interface) or more directly a hall type input. This input is converted to a linear speed (ms^{-1}, mph or kph)
The VSS output feature provides a pulsed output in proportion to the VSS for driving a digital speedometer.
The gear detection calculates the current gear selected in the gearbox by a number of methods.

Clicking Advanced Engine > Speed and Gear Sensors displays the following screen:



The options for these settings are described below:

15.1.1 Vehicle Speed Sensor 1

VSS1 is a wheel on the driven axle.

VSS1 input type

Type of speed sensor connection.

- Off - VSS1 input disabled
- Digital - any pulse input or capture from an expansion board.
- Analogue - 0-5V input directly reporting speed (rare.)

Analogue Input

Input for analogue 0-5V speed sensor.

Full Scale Speed

Speed at 5V analogue input.

Digital Input

Selects digital pulse input or input via CAN from expansion board.

- Input - a pulse input directly connected
- CANVSS - capture actual speed number from an expansion board over CAN

  Configure the CANVSS offset/table/id through the CAN menus.
- Use CAN PWMin - capture pulse period from an expansion board over CAN

  Configure the CANPWM offset/table/id through the CAN menus.

Wheel diameter

Overall diameter of wheel and tire.

VSS Position/Type

Where the speed sensor is mounted

- **Wheel**: Directly on the wheel/hub. Select this when your sensor is picking up on a shaft spinning at the same speed as the wheels. Possibly the simplest option here is a gear tooth sensor (such as the Honeywell 1GT101DC) in close proximity to the back of the wheel studs, or a pre-existing ABS reluctor.
- **Driveline**: on the driveline/trans. Select this when your sensor is picking up on a shaft before the final drive gear. e.g. gearbox output shaft, propshaft. (This is most likely the setting to use for RWD transmission mounted sensors.)

  Many transmissions already offer a VSS output, if this is suitable, you may be able to just tap into this. Alternatively you could utilise a magnet on the output flange and a hall sensor.
- **Pulses per mile**: a sensor that provides a pulses-per-mile signal
- **Pulse per km**: a sensor that provides a pulses-per-mile signal

Pulses

Number of pulses per mile/km when pulses per mile or km is selected.

Speed Sensor #Teeth

Number of teeth on speed pickup reluctor.

PWM Port

CAN PWM port for capturing from expansion board.

Scaler%

Scaler to convert from one unit system to another.

Megasquirt uses 0.1 ms^{-2} internally, so to convert from 0.1 mph use 45.6%

Smoothing Lag Factor

Smoothing factor. 100% = no smoothing, 15% = maximum smoothing.

15.1.2 Vehicle Speed Sensor 2

VSS2 is a wheel on the undriven axle.

The same settings are used as Vehicle Speed Sensor 1

15.1.3 Vehicle Speed Sensor 3

VSS3 is a wheel on the same axle as VSS1. Many settings are shared with VSS1.

VSS3 Input Type

Off - VSS3 input disabled

On - uses same type as VSS1

Analogue Input

Input for analogue 0-5V speed sensor.

Digital Input

Selects digital pulse input or input via CAN from expansion board.

- Input - a pulse input directly connected
- CANVSS - capture actual speed number from an expansion board over CAN

  Configure the CANVSS offset/table/id through the CAN menus.
- Use CAN PWMin - capture pulse period from an expansion board over CAN

  Configure the CANPWM offset/table/id through the CAN menus.

PWM Port

CAN PWM port for capturing from expansion board.

15.1.4 Vehicle Speed Sensor 4

VSS4 is a wheel on the same axle as VSS2. Many settings are shared with VSS2.

The same settings are used as Vehicle Speed Sensor 3

15.1.5 VSS output

VSS output

The output is used to run a digital tacho. Specify the output port you are using.

VSS units

Type of output conversion.

- Time - The output time period is calculated as time factor / speed in ms-1
- Pulses per mile - scale to match what your speedo is expecting
- Pulses per km - scale to match what your speedo is expecting

Scale

The scaling factor or pulses per mile/km.

15.1.6 VSSdot smoothing

These settings control how the VSSdot (acceleration) calculation is performed. The lower the sample interval, the more respsonsive the calculation but the noisier it will be. Experimentation will be required to get the best settings for your application.

Calculating launch acceleration is particularly difficult to get right. Very low tooth counts and wheel speed collected via CAN will be the most difficult due to the low data rate and the communication delays.

Sample Interval

How often to calculate VSSdot (acceleration.)

Lag factor

Smoothing factor on VSSdot. 100% = no smoothing, 15% = maximum smoothing.

15.1.7 Gear detection

Configures a method to determine what gear your vehicle is in.

Final Drive Ratio

The final drive gear ratio.

Method

The gear detection supports three methods

- VSS/RPM - This calculates gear from engine rpm and wheel speed. It works well with a clutch, but might be difficult to get right with a loose convertor. You need to setup VSS1 input, final drive ratio, method, number of gears and the gear ratios.
- Analogue - Some bikes are fitted with a Gear Position Sensor. This 0-5V analogue input can be used directly to determine gear. You need to setup the method, specify an input port and the mean voltage for each gear.
- CAN gear# - If you are running a CAN equipped transmission controller, you might be able to directly fetch the gear from it. Setup the method here and configure the CAN settings on the CAN menus.

Number of Gears

How many gears you have.

1st Gear Ratio etc.

Ratio of each gear. Only used with VSS/RPM method.

Input Port

Analogue input for gear-position-sensor.

Gear Voltages

Nominal voltage in each position.

15.1.8 Units

The selections here determine the units used for inputing speed and length. (Programmers note, internally the units are always SI units metres and metres per second.)

Preferred Speed Units

Chooses the speed units - either Mile-per-hour or Kilometres-per-hour

Close the page and re-open after changing.

Preferred Length Units

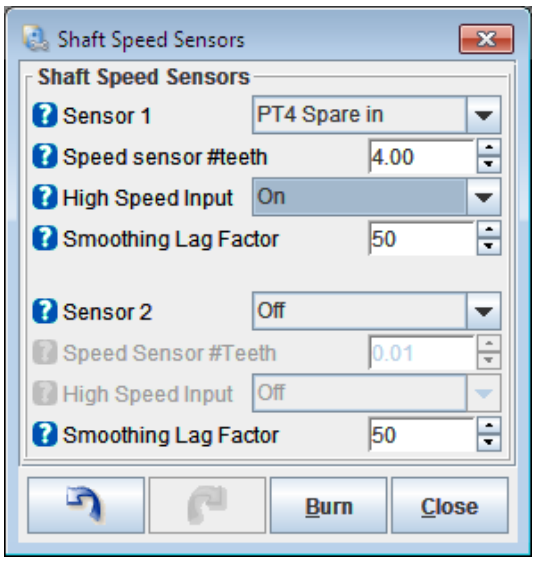
Chooses the size units - either metres or inches

Close the page and re-open after changing.

15.2 Shaft Speed Sensors

The shaft speed inputs work in a similar way to the vehicle speed but calculates to rpms. It could be used as gearbox input shaft speed to monitor convertor or clutch slip; or for turbo turbine speed.

Clicking Advanced Engine > Shaft Speed Sensors displays the following screen:



The options for these settings are described below:

Sensor 1

Selects digital pulse input.

Speed sensor #teeth

Number of pickup teeth on reluctor. Fractional teeth are allowed.

High Speed Input

Where possible, configures this as a high-speed input. Only applies to inputs that are internally connected to a timer. Very high speed inputs such as turbo speed sensors will need to use a high-speed input.

Smoothing Lag Factor

Smoothing factor. 100% = no smoothing, 15% = maximum smoothing.

Sensor 2

Selects digital pulse input.

Speed sensor #teeth

Number of pickup teeth on reluctor. Fractional teeth are allowed.

High Speed Input

Where possible, configures this as a high-speed input. Only applies to inputs that are internally connected to a timer. Very high speed inputs such as turbo speed sensors will need to use a high-speed input.

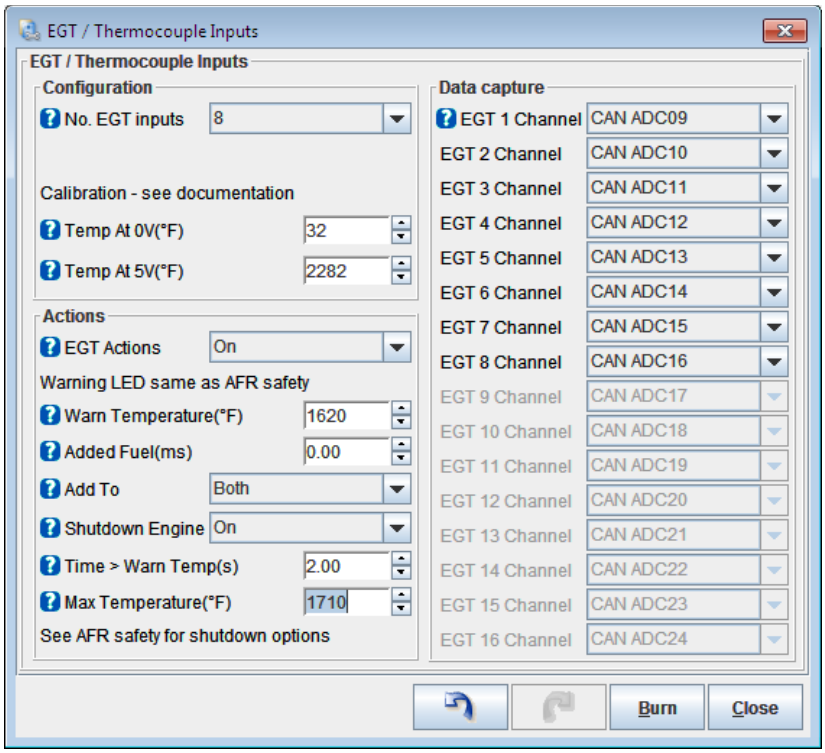
Smoothing Lag Factor

Smoothing factor. 100% = no smoothing, 15% = maximum smoothing.

15.3 EGT/Thermocouple Settings

The EGT system in Megasquirt-3 allows inputs from EGT sensors to be datalogged by serial or SDcard. It optionally allows the engine to be shutdown if EGT exceeds a set temperature. If an EGT probe is fitted to each exhaust port it can be used in conjunction with per-cylinder fuel trim to balance cylinders to account for air flow and injector flow differences. An interface circuit is required.

Clicking Advanced Engine > EGT/Thermocouple settings displays the following screen:



The options for these settings are described below:

15.3.1 Configuration

No. EGT inputs

Enables the system and specifies the number of channels you have connected.

Calibration

The calibration depends on the thermocouple amplifier in use. Consult the documentation that came with it.

A common calibration is 0V = 32°F/0°C, 5V= 2282°F/1500°C

Temp at 0V

The temperature indicated by a 0V input.

Temp at 5V

The temperature indicated by a 5V input.

15.3.2 Data Capture

Here you specify the local or remote analogue channels that the EGT inputs are connected to. For remote CAN inputs, see the CAN section for configuration.

15.3.3 Actions

These settings allow you to specify action if EGT gets too high.

EGT Actions

Enables the EGT warning and shutdown settings.

Warn temperature

Above this temperature the warning output selected on the AFR Safety system (section 9.12) is turned on.

Add fuel

Specifies a raw pulsewidth in milliseconds of additional fuel. This could be used to help protect the engine if EGT is too high.

Add to

Normally this is set to "Both". When using staged fuel outputs or dual table you may want to specify a particular channel.

Shutdown engine

Enables the engine shutdown feature.

Time > warn temp

If any of the EGT stays above the warn temperature for more that this time the engine is shutdown.

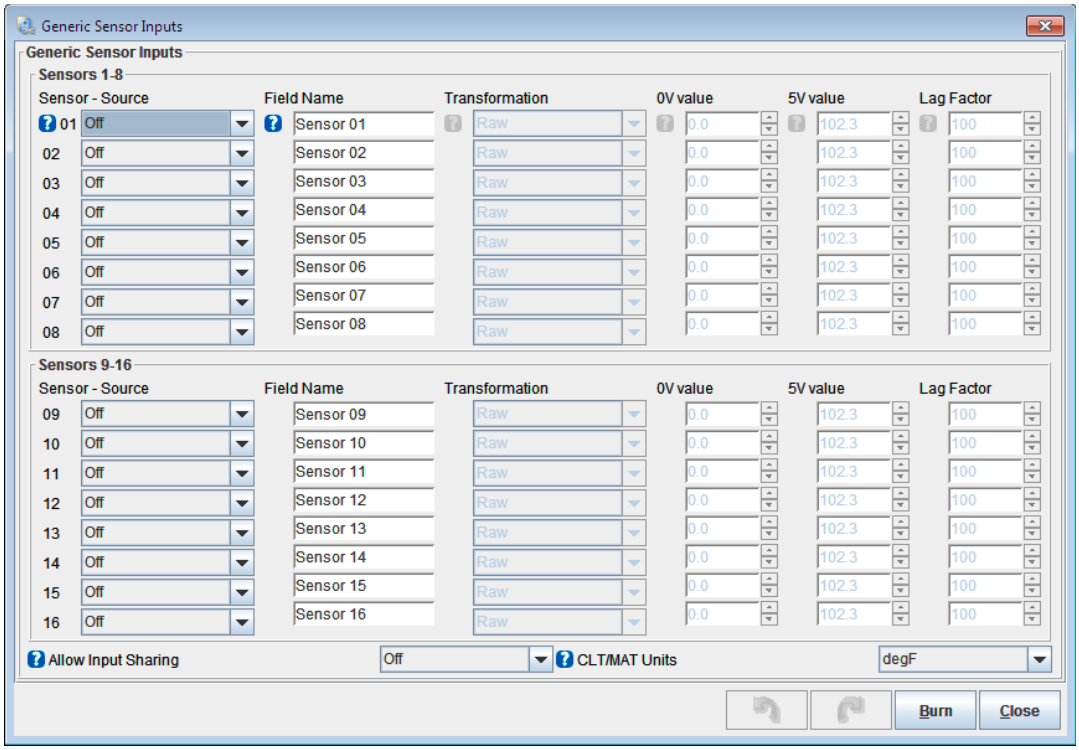
Max temperature

If any of the EGTs exceeds this temperature then the engine is shutdown immediately.

15.4 Generic Sensor Inputs

The Generic Sensors allows optional analogue inputs to be connected and easily recorded in datalogs or used as parameters in other features.

Clicking Advanced Engine > Generic Sensor Inputs displays the following screen:



The options for these settings are described below:

Each row in the main table applies to a sensor channel.

Source

The input port for a 0-5V analogue signal - either local or on a remote expansion board via CAN. CANADC inputs need to be configured in the CAN Parameters also, see section 17.1.

Field Name

Allows for a custom name for the input e.g. "Intercooler temp." This name will be used in dash gauges and datalogs.

Transformation

Type of transformation from raw input to useful numbers.

- Raw - raw 0-1023 ADC count
- Linear - useful for many ratiometric sensors with a linear scale.
- Same as MAP - if you have an identical pressure sensor as the main MAP sensor
- Same as CLT - if you have an identical temperature sensor and bias resistor as the main CLT sensor
- Same as MAT - if you have an identical temperature sensor and bias resistor as the main MAT sensor
- Same as EGO - if you have an identical EGO calibration as the main EGO sensor
- Same as MAF - if you have an identical Mass Air Flow sensor as the main MAF sensor calibration
- GM calibration - same transform as GM air/coolant thermistor sensors.

0V Value, 5V Value

These are only used with the Linear transformation.

- 0V value - specifies the number you want to see when 0V is applied
- 5V value - specifies the number you want to see when 5V is applied

Many sensors specify output at other voltages, e.g. some datasheets advise pressure at 0.5V and 4.5V. This needs to be converted to the 0V and 5V values using a calculator.

Take, 'A' = low voltage 'B' = high voltage 'C' = low pressure 'D' = high pressure

Calculate E = (D - C) / (B - A)

0V value = C - (E * A)

5V value = (E * 5) + 0V value

e.g. a Honeywell 100psi sensor specifies 0.5V = 0psi and 4.5V = 100psi, this calculates to -12.5 in the 0V box and 112.5 in the 5V box.

Lag Factor

Smoothing factor. 100% = no smoothing, 15% = maximum smoothing.

Allow Input Sharing

Normally each input can only be used by one feature. This setting allows inputs to be shared between generic sensors and other features. (Obviously you can still only connect one sensor to each input!)

CLT/MAT Units

Selects degF/degC for temperature units when using CLT/MAT calibrations.

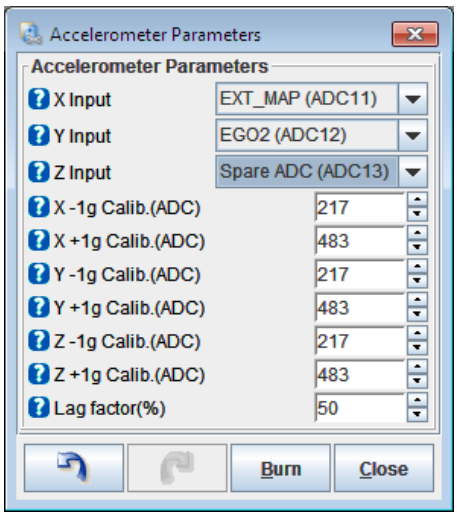
15.5 Accelerometer Parameters

This allows configuration of an optional external accelerometer, primarily for datalogging purposes.

The accelerometer is calibrated to +/-1g for convenience, but internally the code uses SI measurement units (ms^{-2}) so accelerometer acceleration can be compared to VSSdot measured acceleration.

The calibration procedure is covered in the Setting Up manual.

Clicking Advanced Engine > Accelerometer Parameters displays the following screen:



The options for these settings are described below:

X Input

Analogue 0-5V input for X-axis.

Y Input

Analogue 0-5V input for Y-axis.

Z Input

Analogue 0-5V input for Z-axis.

X -1g Calib.

Raw ADC input value when X is -1g.

X +1g Calib.

Raw ADC input value when X is +1g.

Y -1g Calib.

Raw ADC input value when Y is -1g.

Y +1g Calib.

Raw ADC input value when Y is +1g.

Z -1g Calib.

Raw ADC input value when Z is -1g.

Z +1g Calib.

Raw ADC input value when Z is +1g.

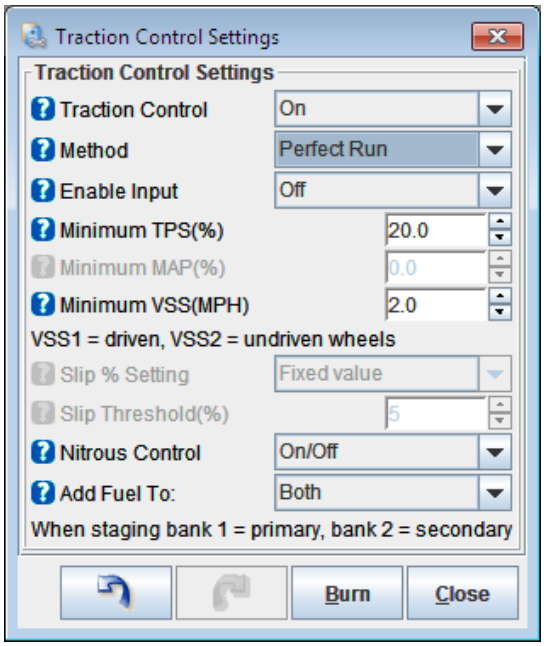
Lag Factor

Smoothing factor. 100% = no smoothing, 15% = maximum smoothing.

15.6 Traction Control

There are a number of different traction control strategies that may suit your vehicle and be permitted with your competition rules.

Clicking Advanced Engine > Traction Control displays the following screen:



The options for these settings are described below:

Traction Control

Enables the traction control system.

Method

Traction control method:

- Perfect Run - a drag race strategy for a single pass comparing actual VSS against best possible.
- VSS %slip - compares VSS1 to VSS2 and detects slip%.
- Perfect Run RPM - similar to Perfect Run but without VSS for classes where that is not allowed.
- Switch input - for use with an external slip detector.

Enable Input

Optional digital switch input

Minimum TPS

Only enable traction control above this TPS%

Minimum MAP

Only used in VSS %slip mode. Only enable traction control above this MAP

Minimum VSS

Only enable traction control above this VSS1

Slip % Setting

Whether to use a fixed slip% limit or an adjustable curve.

Slip Threshold

Fixed slip% limit.

Nitrous Control

Only on/off control is presently supported.

Add Fuel To:

Which bank of injectors to add fuel to.

Normally select 'Both'

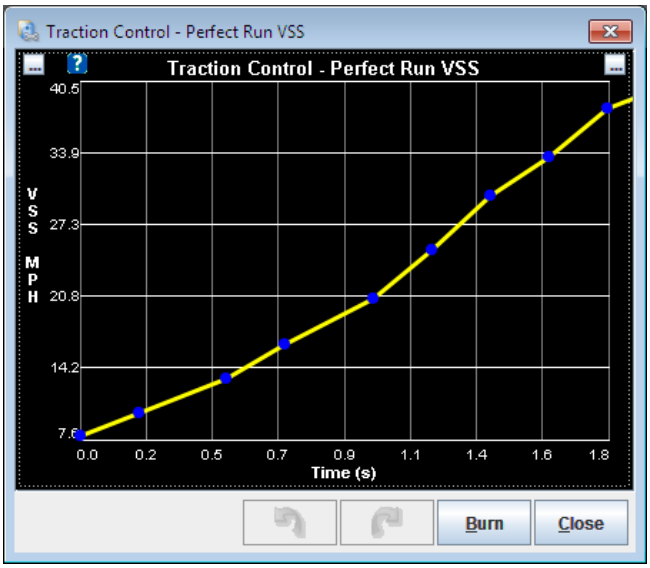
When staging bank 1 = primary, bank 2 = secondary

15.7 Traction Control - Perfect Run VSS

The Traction Control - Perfect Run VSS menu option is only enabled if:

- Advanced Engine > Traction Control > Traction Control is set to "On".
- AND Method is set to "Perfect Run" See Section 15.6.

Clicking Advanced Engine > Traction Control - Perfect Run VSS displays the following screen:



The perfect run traction control sets a curve of the 'best' speed (VSS) that you can run for each time-point after launch.

If your VSS is reporting a higher number than the curve, it is assumed to be wheelspin and the reactions come into force.

This traction control strategy is typically applied early in a run only.

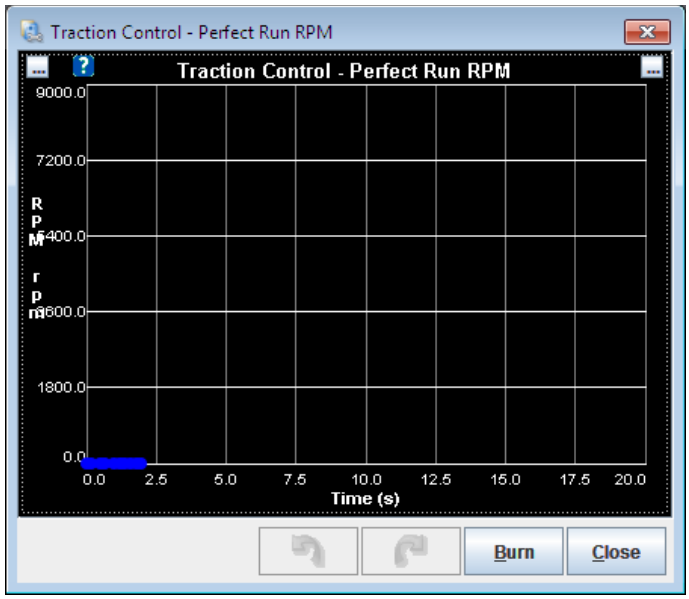
Note that VSS based traction control is outlawed in some race classes.

15.8 Traction Control - Perfect Run RPM

The Traction Control - Perfect Run VSS menu option is only enabled if:

- Advanced Engine > Traction Control > Traction Control is set to "On".
- AND Method is set to "Perfect Run RPM" See Section 15.6.

Clicking Advanced Engine > Traction Control - Perfect Run RPM displays the following screen:



The perfect run traction control sets a curve of the 'best' RPM that you can run for each time-point after launch.

If your RPM is higher than the curve, it is assumed to be wheelspin and the reactions come into force.

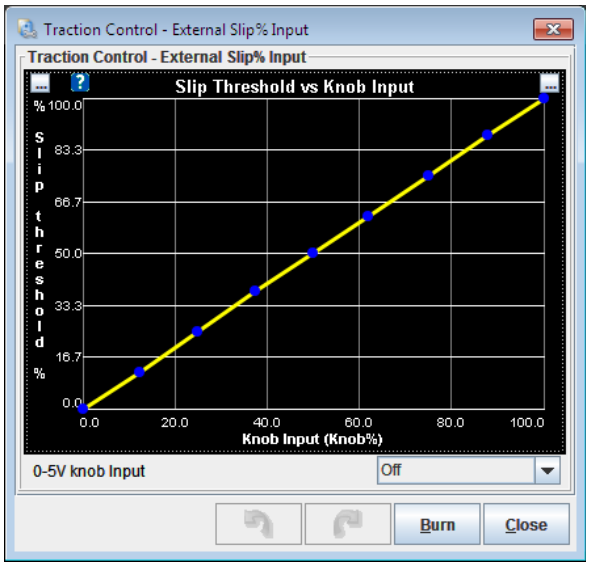
This traction control strategy only makes sense in first gear. Set the final row in the table to just earlier than the time when you expect to shift with an RPM higher than your maximum RPM.

15.9 Traction Control - External Slip% input

The Traction Control - External Slip% input menu option is only enabled if:

- Advanced Engine > Traction Control > Traction Control is set to "On".
- AND Method is set to "VSS %slip"
- AND Slip % Setting is set to "Adjustable" See Section 15.6.

Clicking Advanced Engine > Traction Control - External Slip % input displays the following screen:



0-5V knob input

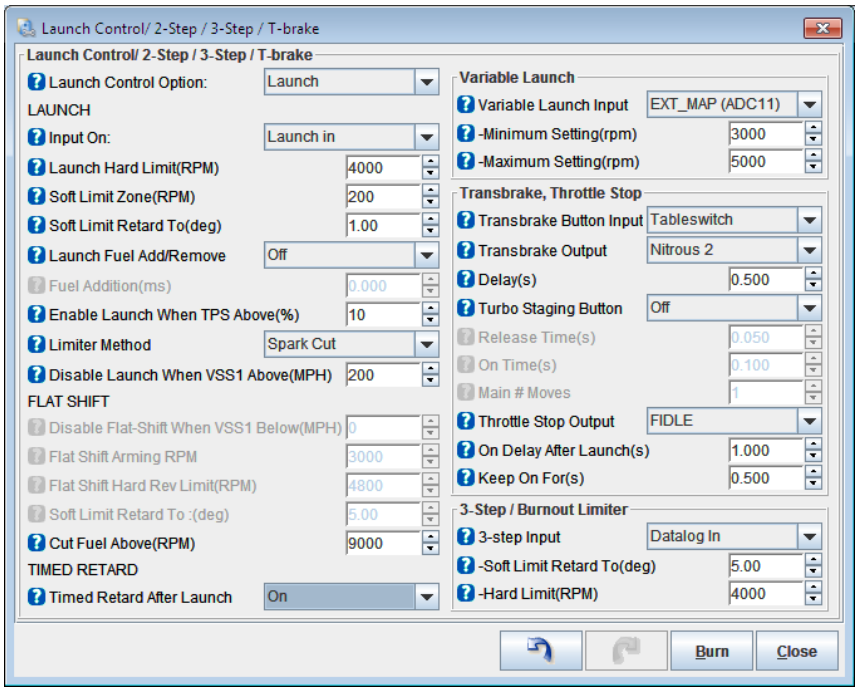
This enables a link to a Generic Sensor input to enable you to set the slip threshold. Configure the Generic Sensor to give 0-100 as the linear output.

Slip Threshold vs. Knob Input

This curve sets the desired slip threshold against the input knob position.

15.10 Launch / 2-step / 3-step / T-brake

Clicking Advanced Engine > Launch / 2-step / 3-step / T-brakel displays the following screen:



The options for these settings are described below:

15.10.1 Launch Settings

Launch Control Option

This option can be set to one of three options:

- Off – all of launch is turned off;
- Launch – launch only, no flat shift;
- Launch/flatshift – launch and flat shift.

Flat shift is used on manual gearboxes for full throttle shifts with a clutch switch to engage the limiter. For bike shifting, consider the Sequential Shift Cut instead, see section 15.12.

Input On

Input for launch switch.

Launch Hard Limit (rpm)

Above this rpm the hard limiter methods are used when the launch conditions are met.

Soft Limit Zone (rpm)

The soft limit is this many rpm below the hard limit (this is sometimes called the control range.)

200 rpm is typical.

Soft Limit Retard To (deg)

The absolute timing to retard to, i.e., 5 gives 5 BTDC timing.

Launch Fuel Add/Remove

Allows fuelling to be changed while the launch limiter is on.

Fuel Addition

The raw millisecond pulsewidth addition to make. Positive numbers add fuel, negative subtract it.

Enable Launch When TPS Above (%)

Launch is only active when the throttle is open a certain percentage. Most users can safely set this to a very low percentage.

Limiter Method

This option can be set to one of four settings:

- None – do not use;
- Spark cut – drop sparks, this is the most common limiter used but **will not** work with EDIS ignition;
- Fuel cut – cuts fuel;
- Spark and fuel – cuts both.

Disable Launch when VSS1 Above

Prevents launch from activating once you are rolling. Requires VSS to be enabled.

15.10.2 Flat Shift Settings

Disable Flat-Shift when VSS1 Below

Prevents flat-shift from activating at low speeds e.g. just after launch

Flat Shifting Arming RPM (RPM)

This rpm set point is used to differentiate between a flat shift and launch condition, typically set to a few thousand RPM above idle.

Flat shift hard to rev limit (RPM)

Above this rpm the hard limiter methods are used when the flat-shift conditions are met.

Soft Limit Retard To (deg)

The absolute timing to retard to, i.e., 5 gives 5 BTDC timing.

Cut Fuel Above

During the flat-shift up-shift and the revs are falling, the fuel is cut off until the revs have fallen below this set point to reduce exhaust explosions.

15.10.3 Timed Retard

Timed Retard After Launch

Enables feature to feed in timing after launch.

Variable Launch

Input for 0-5V analogue potentiometer used to vary launch RPM.

Minimum Setting

With a 0V(minimum) input, the launch hard limit is set to this RPM.

Maximum Setting

With a 5V (maximum) input, the launch hard limit is set to this RPM.

15.10.4 Transbrake, Throttle Stop

Transbrake Button Input

Switch input for transbrake button.

Transbrake Output

Output for transbrake solenoid.

Delay

Delay between button release and transbrake release.

Turbo Staging Button

Input for Turbo Staging control. (aka "bump box")

Release Time

How long to release trans-brake for on each move step. This should be set long enough to move the car a little without gaining any speed.

On Time

How long the trans-brake should be re-activated for between each step. This should be set long enough to fully grab again.

Main # Moves

How many moves (trans-brake release steps) on the first press of the button. Each subsequent press of the button gives a single move.

Throttle Stop Output

Output for throttle-stop solenoid.

On Delay After Launch

Delay after launch before solenoid is activated.

Keep On For

How long to keep solenoid on for.

15.10.5 3-Step / Burnout Limiter

3-step Input

Input for 3-step switch. Can be used as burnout limiter.

Soft Limit Retard To

The timing is retarded to this angle when the 3-step is on.

Hard Limits

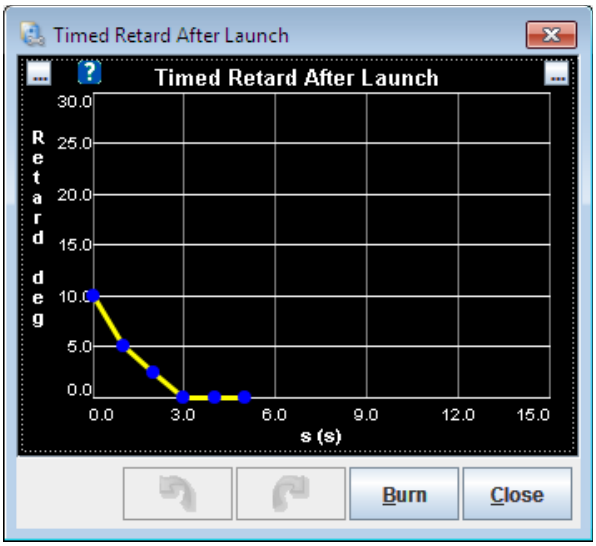
Sets the hard limit RPM when the 3-step is on.

15.11 Timed Retard After Launch

The Timed Retard After Launch input menu option is only enabled if:

- Advanced Engine > Launch / 2-step / 3-step / T-brake > Launch Control Option is enabled.
- AND Timed Retard After Launch is enabled. See Section 15.10.1.

Clicking Advanced Engine > Timed Retard After Launch displays the following screen:



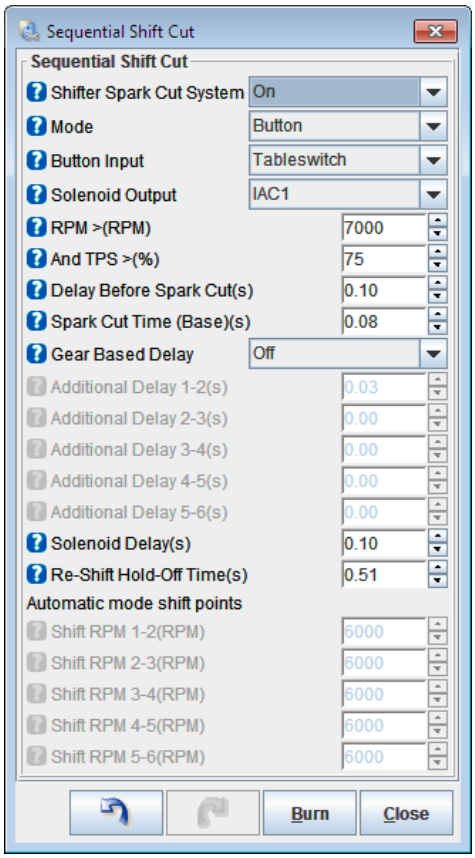
The curve sets the degrees of ignition subtracted from the normal timing (i.e. retarding it) against time after launch.

This can be used to launch at higher RPMs without blowing the tires away and then feeding the timing back in.

Be sure to end the curve with zero degrees of retard to use normal timing for the rest of the run.

15.12 Sequential Shift Cut

Clicking Advanced Engine > Sequential Shift Cut will display the following screen:



The options for these settings are described below:

Shifter Spark Cut System

Enables the sequential / bike shift cut system.

Mode

Whether the system operates from a push-button or automatically.

Button Input

Input used for the button.

Solenoid Output

Output to the shift solenoid.

RPM > (RPM)

Minimum RPM to allow shifting.

And TPS > (%)

Minimum throttle to allow shifting.

Delay Before Spark Cut (s)

The solenoid is activated immediately, then wait this long before cutting spark.

Spark Cut Times (s)

How long to cut spark for.

Gear Based Delay

Option to add additional spark cut time per gear.

Additional Delay

For each gear-shift specifies the additional delay to add to the basic "Delay before spark cut"

Solenoid Delay (s)

How long to keep the solenoid powered after the spark is returned.

Re-shift Hold-off Time (s)

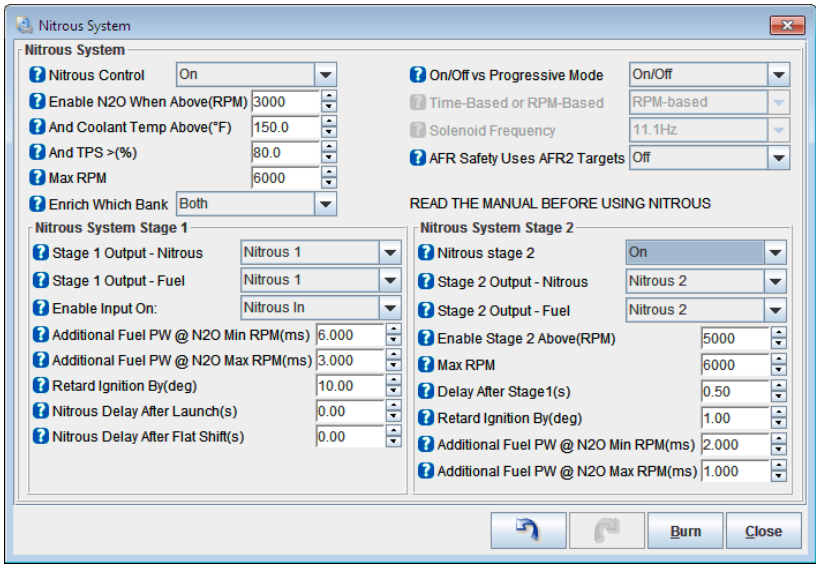
Ignore button for this long after shifting – to prevent a false shift.

Automatic shift mode points

RPM for each gear to initiate an up-shift.

15.13 Nitrous System

Clicking Advanced Engine > Nitrous System displays the following screen:



The options for these settings are described below:

15.13.1 General Settings

Nitrous Control

Enables the feature.

Turn N_20 On When Above (RPM)

The minimum RPM to enable nitrous.

And Coolant Temp Above (°F/°C)

The minimum coolant temperature to enable nitrous.

And TPS > (%)

The minimum throttle position to enable nitrous.

Max RPM

The maximum RPM to enable nitrous.

Enrich Which Bank

Set to “Both” for most installs. If using “Dual table” or “Staging” are in use it selects which injector bank receives any addition fuel pulsewidth.

On/Off vs Progressive

Selects between On/Off or Progressive control mode.

Time-based or RPM-based

Chooses between time or RPM as control factor.

Solenoid Frequency

Selects solenoid frequency. Typically around 13Hz.

AFR Safety uses AFR2 Targets

Allows optional AFR safety system to use alternate AFR targets when nitrous is active.

15.13.2 Nitrous System Stage 1

Stage 1 Output - Nitrous

Selects where the outputs are connected.

Expansion boards will need configuring through 'CAN parameters' (see Section 17.1.)

Stage 1 Output - Fuel

Selects where the outputs are connected.

Enable Input On

Input to use to enable the nitrous system.

Expansion boards will need configuring through 'CAN parameters' (see Section 17.1.)

Additional Fuel PW @ N_20 Min RPM (ms)

Fuel pulsewidth to add at the min RPM (tapers down between min and max.) Only for On/Off mode.

Additional Fuel PW @ N_20 MAX RPM (ms)

Fuel pulsewidth to add at the max RPM (tapers down between min and max.) Only for On/Off mode.

Retard Ignition By (deg)

Sets a fixed ignition retard when nitrous is active. Only for On/Off mode.

Nitrous Delay After Launch (s)

Sets a minimum time after launch control is released before nitrous can activate.

Nitrous Delay After Flat Shift (s)

Sets a minimum time after flat-shift is released before nitrous can activate.

Nitrous Stage 2

Enables the second stage.

The Nitrous Stage 2 options are only enabled if “Nitrous Stage 2” is enabled.

Stage 2 Output - Nitrous

Selects where the outputs are connected.

Expansion boards will need configuring through 'CAN parameters' (see Section 17.1.)

Stage 2 Output - Fuel

Selects where the outputs are connected.

Enable Stage 2 Above (RPM)

The activation RPM for stage 2.

Max RPM

The maximum RPM for stage 2.

Delay After Stage 1 (s)

Sets a minimum time delay after stage 1 activates before stage 2 can activate.

Retard Ignition By (deg)

Sets an additional ignition retard when stage 2 is active. Only for On/Off mode.

Additional Fuel PW @ N_20 Min RPM (ms)

Fuel pulsewidth to add at the min RPM (tapers down between min and max.) Only for On/Off mode.

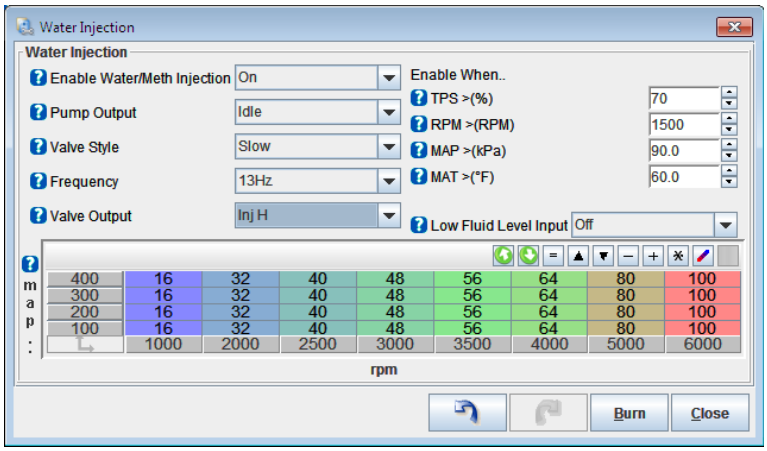
Additional Fuel PW @ N_20 Max RPM (ms)

Fuel pulsewidth to add at the max RPM (tapers down between min and max.) Only for On/Off mode.

15.14 Water Injection

Water injection is typically used with forced induction to reduce charge temperature and reduce detonation problems.

Clicking Advanced Engine > Programmable On/Off Outputs displays the following screen:



The options for these settings are described below:

Enable Water/Meth Injection

Enables the feature.

Pump Output

Output to pump relay.

Valve Style

- 'Off' - no valve output (used fixed nozzle)
- 'Slow' - slow speed valve output with chosen PWM duty cycle
- 'Fast' - valve switches at injector speed with chosen PWM duty cycle.

Frequency

Valve operating frequency.

Valve Output

Output for valve.

TPS >

Only enable above this TPS%.

RPM >

Only enable above this RPM.

MAP >

Only enable above this MAP.

MAT >

Only enable above this MAT.

Low Fluid Level Input

Allows a low fluid level sensor switch input.

The switch must be wired so that the input is grounded when the level is ok and no connection is made in low or fault conditions.

If fluid reserve is low when water injection is required, for safety the engine will be shutdown using the parameters in the AFR Safety System.

Duty Table

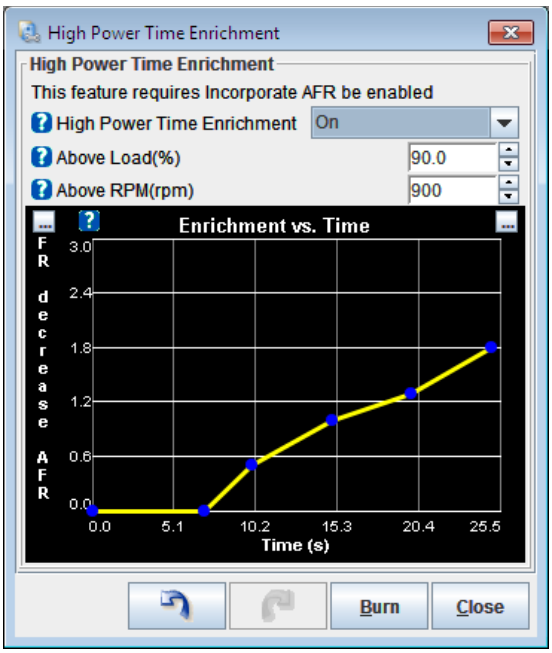
The duty cycle of the output vs RPM/load

15.15 High Power Time Enrichment

This feature will enrich the fuel mixture under prolonged high load to mitage internal engine temperatures.

This features requires that "Incorporate AFR" is enabled. See Section 8.2.4.

Clicking Advanced Engine >High Power Time Enrichment displays the following screen:



The options for these settings are described below:

High Power Time Enrichment

Allows richer mixture after prolonged high power operation to cool piston crown. The richer mixture is calculated by decreasing the AFR target using the number from the curve. The 'high power timer' counts up when above the load/rpm points and counts down below those points. The relevant enrichment is applied until the counter returns to zero.

Above Load

Only enable above this fuel-load.

Above RPM

Only enable above this RPM.

Enrichment vs Time

The curve specifies AFR decrease (richer) vs. time.

It is normal for the first row to be 0, 0.

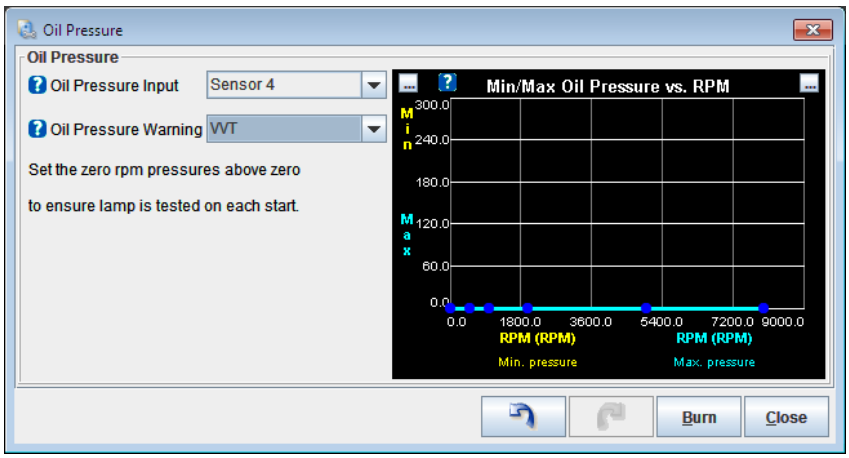
The second row typically specifies when the enrichment should begin. e.g. 7, 0. This means that there is no change from 0-7 seconds as both are set to a 0 decrease in AFR.

The third row onwards specify the richening.

15.16 Oil Pressure

The oil pressure system allows for monitoring of oil pressure and can also link into the Check Engine Light system. See section 17.5.

Clicking Advanced Engine > Oil Pressure displays the following screen:



The options for these settings are described below:

Oil Pressure Input

Sensor channel used for oil pressure input.

Oil Pressure Warning

Output for warning lamp.

Min/Max Oil Pressure vs RPM

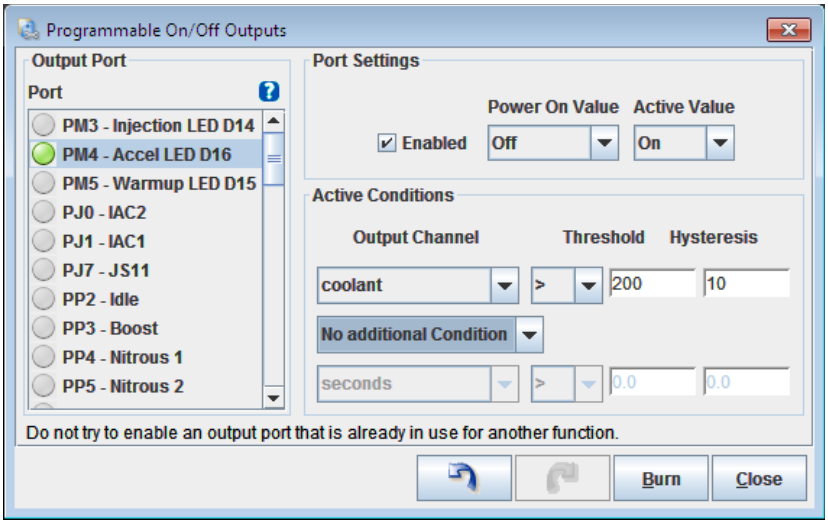
For each RPM setting, set the min and max oil pressures allowed at that RPM.

Outside of the limits the warning light will be illuminated.

It is suggested that the first row be 0 RPM. Set the Min and Max limits above 0 so that the oil warning light is tested on each start.

15.17 Programmable On/Off Outputs

Clicking Advanced Engine > Programmable On/Off Outputs displays the following screen:



This screen allows you to configure programmable outputs in addition to the outputs defined in other specific features. The options for these settings are outlined in Sections 15.17.1. to 15.17.3. below:

15.17.1 Output Port

On the left hand side of this screen is a list of ports that you can program to carry out different tasks.

This gives a list of the ports that can be programmed. The above image is a sample list of ports shown when connected to a Megasquirt. Your lists of ports may differ depending on your product, although they can be used in the same way.

When you click on any of the ports listed, the settings in the “Port Settings” and the “Active Conditions” sections on the right hand of the screen (documented in Sections 15.17.2. and 15.17.3. respectively) will apply to the port you have selected.

Be careful that you don't attempt to program a port that is already in use! The most obvious example is FIDLE, which can optionally be set as the PWM Idle port in the “Idle Control” screen (see Section 11.13.) If you are using FIDLE for this purpose you will encounter errors if you attempt to program it for a second role. Whilst this is the most obvious potential conflict, it is worth making sure that any port that you program is not being used for any other role.

15.17.2 Port Settings

These settings allow you to select whether a port is used and when it is used.

Enabled

Clicking the check box (so that it contains a tick) means that you are going to use the selected port. The gray bulb next to the port you are using in the Output Port list will change to green when this setting is checked.

Power On Value

This is a setting that determines if the output will be on or off when your Megasquit powers up. Please take the active conditions (see Section 15.17.3.) into account when deciding whether to set this to on or off.

Typically this value is set to “Off”.

Active Value

This is an on/off setting that determines if the output is triggered when the conditions for it to become active are

met.

Typically this value is set to “On”.

15.17.3 Active Conditions

These settings allow you to determine the conditions under which the output becomes active.

Output channel

This is a list of Megasquirt variables - much the same as the various gauges you can select in dashboard.

Operator

This 'logical operator' forms part of the equation. There are four options for this setting:

- > (is greater than);
- = (is equal to – this options is rarely useful);
- < (is less than);
- And (performs a bitwise AND operation – useful for setting outputs based on status bits.)

Threshold

The value at which the output channel is compared using the operator to establish whether the condition is considered to be “Active”.

Hysteresis

It is very common for a value to hover around the threshold which would cause the output to turn on and off rapidly. This setting helps to prevent that by creating a deadband below the threshold which prevents the output from being repeatedly activated during borderline conditions.

Additional condition

There are three options for this drop down box:

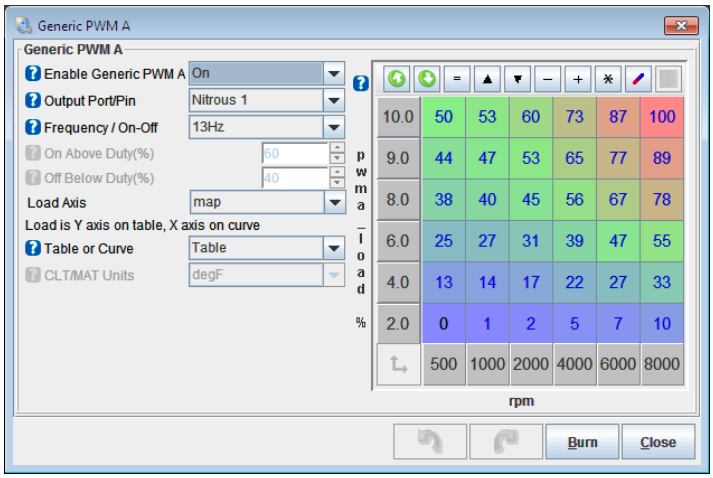
- No additional condition – only a single condition is used
- Or – output triggers if either condition 1 OR condition 2 is met
- And – output triggers only when condition 1 AND condition 2 are both met

If “Or” or “And” are selected then complete the second Output Channel, Operator, Threshold and Hysteresis using the procedures described above.

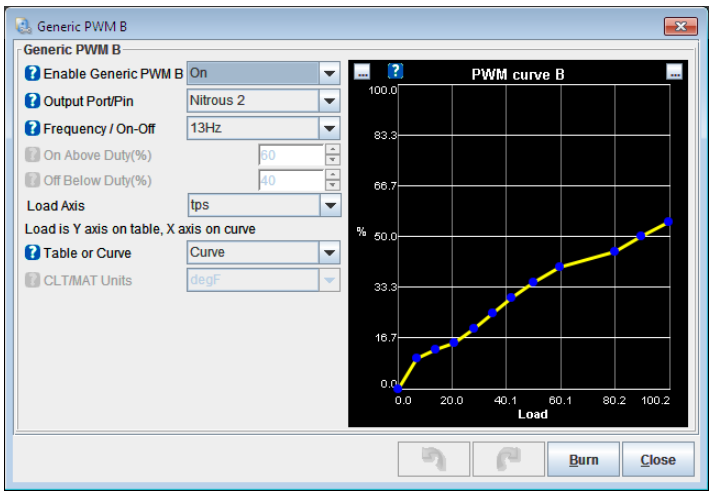
15.18 Generic PWM Outputs

The Generic PWM system allows up to six independent open-loop PWM (pulse width modulated) or on/off outputs. The duties are programmed through an 6x6 table of rpm vs. Y-axis. The output is typically used to drive a solenoid valve (PWM mode) or relay (on/off.) PWM is a method that pulses an output on and off, the on-time percentage (duty) is variable, this is often used for idle valves and allows a valve to "float" in-between closed and open for variable flow rates.

Clicking Advanced Engine > Generic PWM Output A displays the following screen (table mode):



Clicking Advanced Engine > Generic PWM Output B displays the following screen (curve mode):



The options for these settings are described below:

Enable Generic PWM

Enables Generic PWM feature. A table or curve is used to plot the desired output based on a lookup from the input variables.

Output Port/Pin

Output for relay/solenoid.

Frequency / On-Off

Selects:

- On-Off - output is turned on or off based on the table/curve.
- Variable frequency - output runs at the frequency set by the table/curve with 50% duty.
- xxHz - output runs at a fixed frequency with duty set by the table/curve.

On Above Duty

Output is on when the table/curve is above this number. On/Off mode only.

Off Below Duty

Output is off when the table/curve is below this number. On/Off mode only.

Load Axis

This selects the 'load' axis on the table or curve.

Table or Curve

Chooses between a 3D mapped table or a 2D curve.

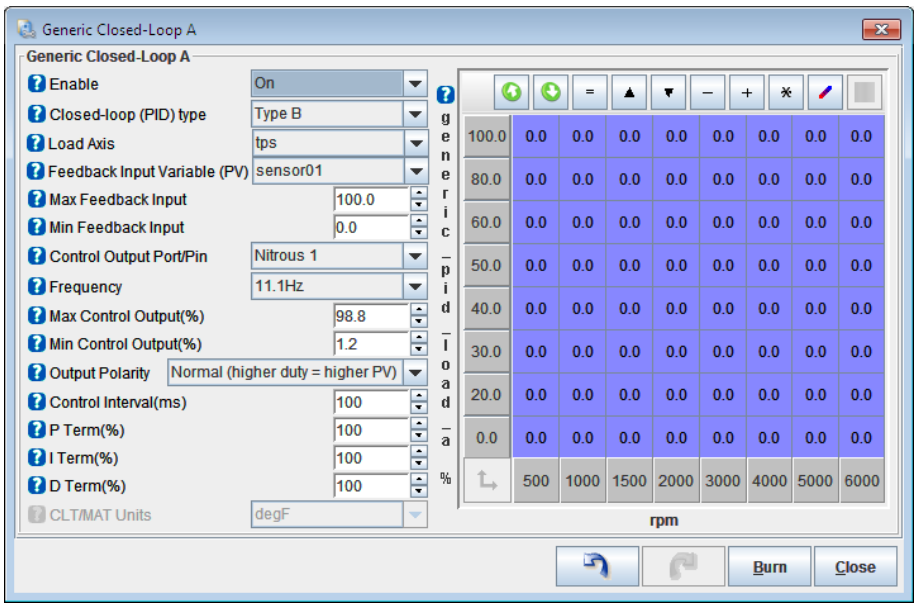
CLT/MAT Units

This display only field shows whether degC or degF are selected. It is set on the Generic Sensors page.

15.19 Generic Closed-Loop

The Generic Closed-Loop system allows up to two independent closed-loop PWM (pulse width modulated) outputs. A table is used to plot the desired value of the feedback value (PV) based on a lookup from the input variables. A closed-loop PID method adjusts the PWM output until the desired feedback value is achieved.

Clicking Advanced Engine > Generic Closed-Loop Output A displays the following screen:



The options for these settings are described below:

Enable

Generic Closed-Loop channel A on or off.

Closed-loop (PID) type

Type B (change in error affects P term) or

Type C (change in PV affects P term) PID

Load Axis

Variable used as the Y load axis in the lookup table

Feedback Input Variable (PV)

Variable used as feedback input (PV)

Max Feedback Input

Maximum value for feedback input (PV)

Min Feedback Input

Minimum value for feedback input (PV)

Control Output Port/Pin

Output pin.

This is the output to control the actuator (or whatever) that change the process.

e.g. opens or closes a valve.

Frequency

Frequency to use for PWM output

Max Control Duty

Maximum output duty

Min Control Duty

Minimum output duty

Output Polarity

Output polarity for control output, the options are

- Normal (higher duty = higher PV)
- Inverted (lower duty = higher PV)

Control Interval

Time in milliseconds between each run of the control loop

P term

Proportional gain.

I term

Integral gain.

D term

Derivative gain.

CLT/MAT units

This display only field shows whether degC or degF are selected. It is set on the Generic Sensors page.

Target Table

This is the target value which the closed-loop algorithm aims to match to the feedback input by controlling the

PWM output.

16 3D Maps

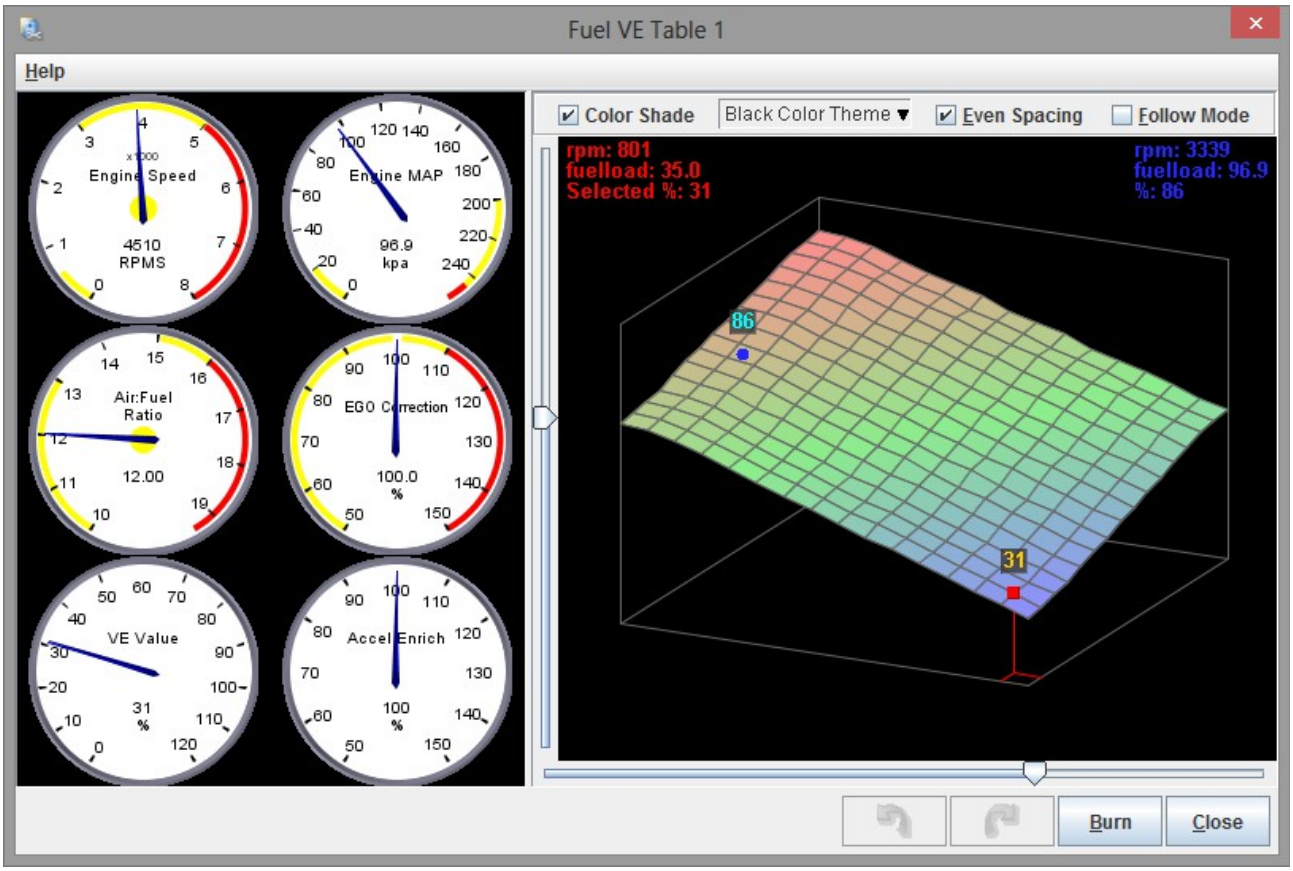
As described in Section 1.5.4 there are 3D Maps for many of the 3D Tables that are used throughout TunerStudio. That section outlines the purpose of these maps and how they can be used.

All of the maps are accessible from the 3D Maps toolbar menu. Sections 16.1. to 16.7. below outlines the type of maps available and refers back to the relevant sections that include the 3D Tables to which they correspond. You can make changes to either the 3D Table or the 3D Map at any time, **although it is strongly recommended that you do not change both simultaneously as it can be confusing.**.

16.1 Fuel VE Tables [1 to 4]

The three Fuel VE 3D Maps directly correspond to the three Fuel VE Tables which are documented in Section 9.13. That section of this guide outlines the options that are required to enable each of those tables. Those same options will enable the equivalent menu options in the 3D Maps toolbar menu.

Clicking 3D Maps > Fuel VE Table [1, 2, 3 or 4] will displays variant of the following screen:

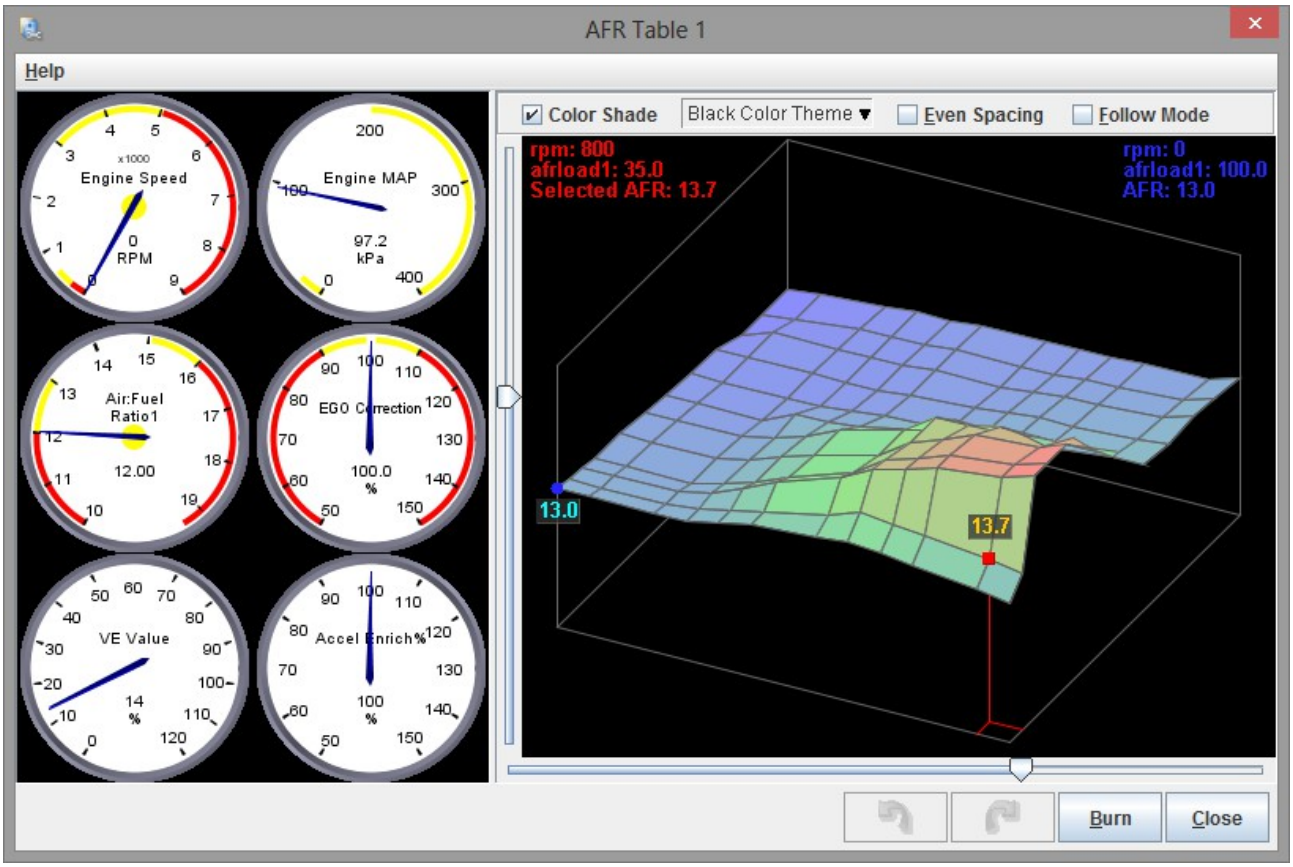


The screen will be a direct transformation of the numerical values in the matching Fuel VE Table. The X & Y axes represent rpm & fuelload respectively, and the height at each point reflects the percentage for the same point in the table.

You can use the methods described in Section 1.5.4 to view and make changes to these values.

16.2 AFR Tables [1 and 2]

The two AFR Maps directly correspond to the two AFR Tables which are documented in Section 9.8. That section of this guide outlines the options that are required to enable both of those tables. Those same options will enable the equivalent menu options in the 3D Maps toolbar menu.



Clicking 3D Maps > AFR Table [1 or 2] displays a variant of the following screen:

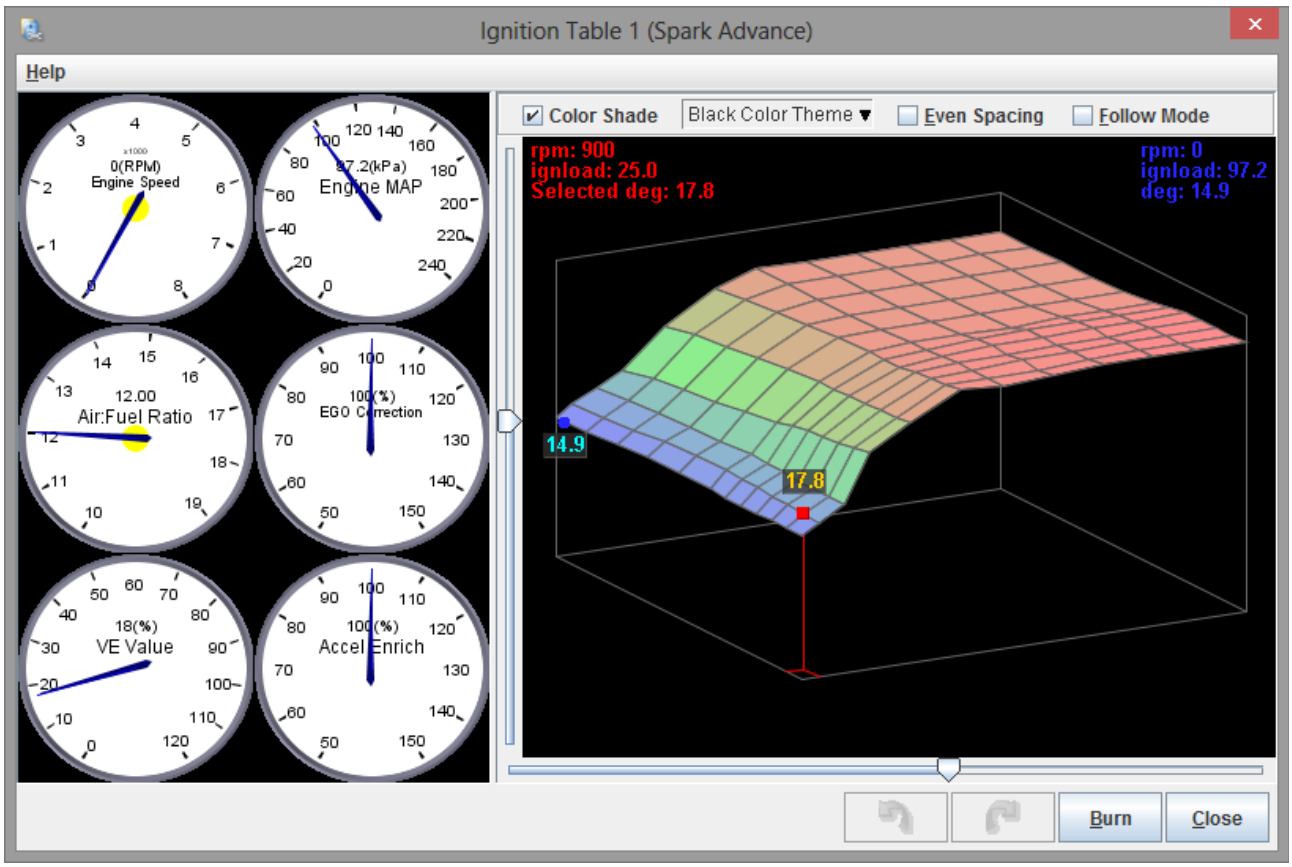
The screen will be a direct transformation of the numerical values in the matching AFR Table. The X & Y axes represent rpm & afr load respectively, and the height at each point reflects the AFR for the same point in the table.

You can use the methods described in Section 1.5.4 to view and make changes to these values.

16.3 Ignition Tables [1 to 4]

The three Ignition Maps directly correspond to the three Ignition Tables which are documented in Section 10.13. That section of this guide outlines the options that are required to enable each of those tables. Those same options will enable the equivalent menu options in the 3D Maps toolbar menu.

Clicking 3D Maps > Ignition Table [1, 2,3 or 4] displays a variant of the following screen:



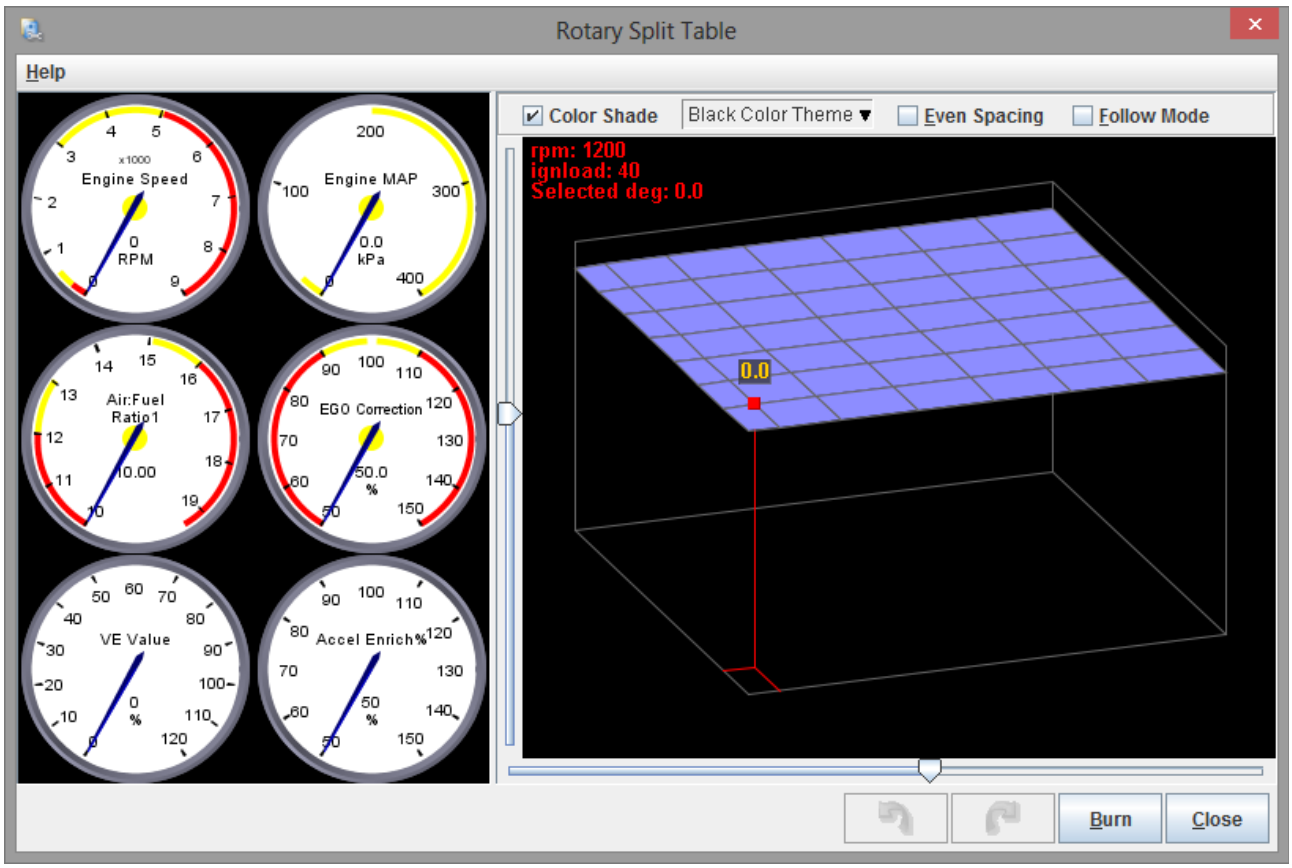
The screen will be a direct transformation of the numerical values in the matching Ignition Table. The X & Y axes represent rpm & ignition load respectively, and the height at each point reflects the degrees for the same point in the table.

You can use the methods described in Section 1.5.4 to view and make changes to these values.

16.4 Rotary Split Table

The Rotary Split Map directly corresponds to the Rotary Split Table which is documented in Section 10.15. That section of this guide outlines the options that are required to enable that tables. The same options will enable the Rotary Split Table menu option in the 3D Maps toolbar menu.

Clicking 3D Maps > Rotary Split Table displays the following screen:



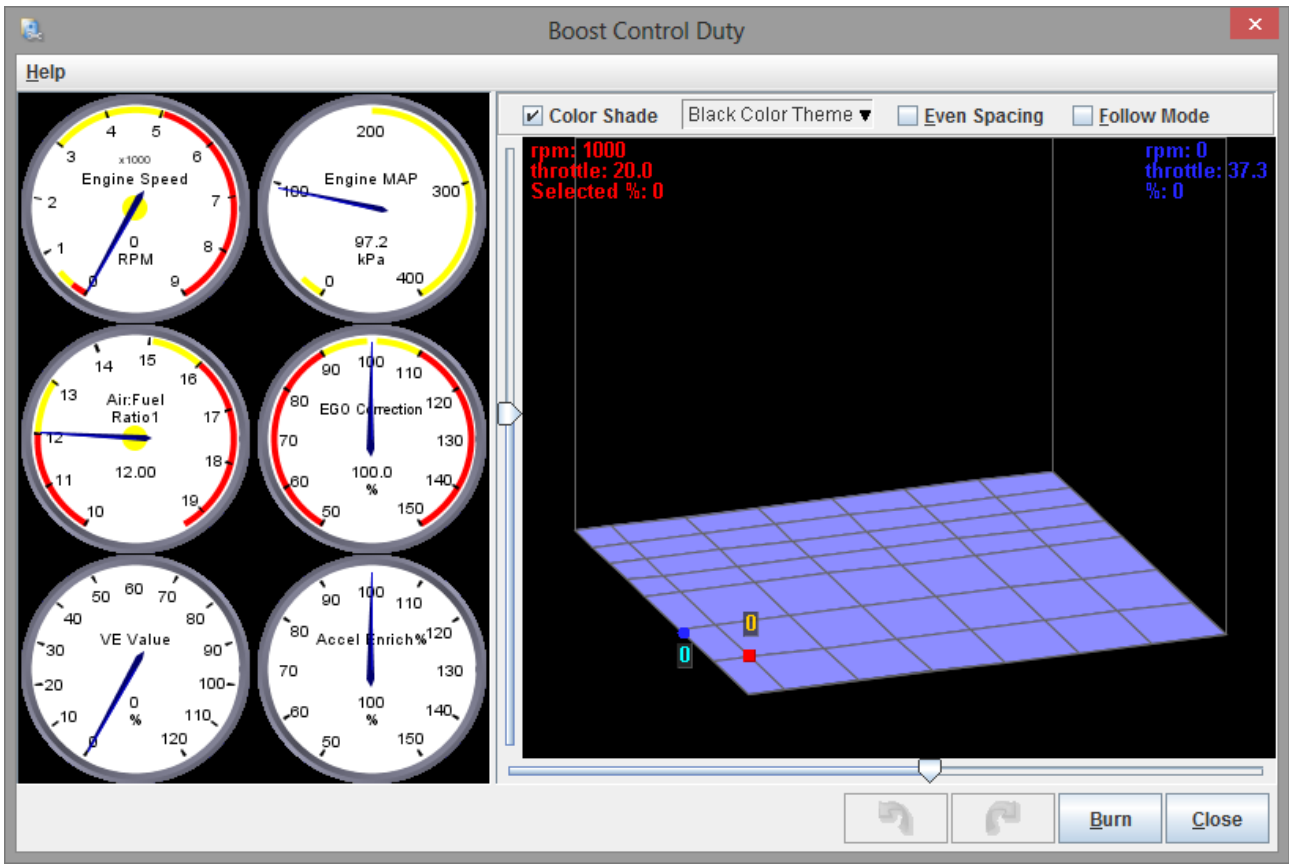
The screen will be a direct transformation of the numerical values in the Rotary Split Table. The X & Y axes represent rpm & ignition load respectively, and the height at each point reflects the degrees for the same point in the table.

You can use the methods described in Section 1.5.4 to view and make changes to these values.

16.5 Boost Control Duty Table

The Boost Control Duty Table Map directly corresponds to the Boost Control Duty Table which is documented in Section 13.2. That section of this guide outlines the options that are required to enable that table. The same options will enable the Boost Control Duty Table menu option in the 3D Maps toolbar menu.

Clicking 3D Maps > Boost Control Duty Table displays the following screen:



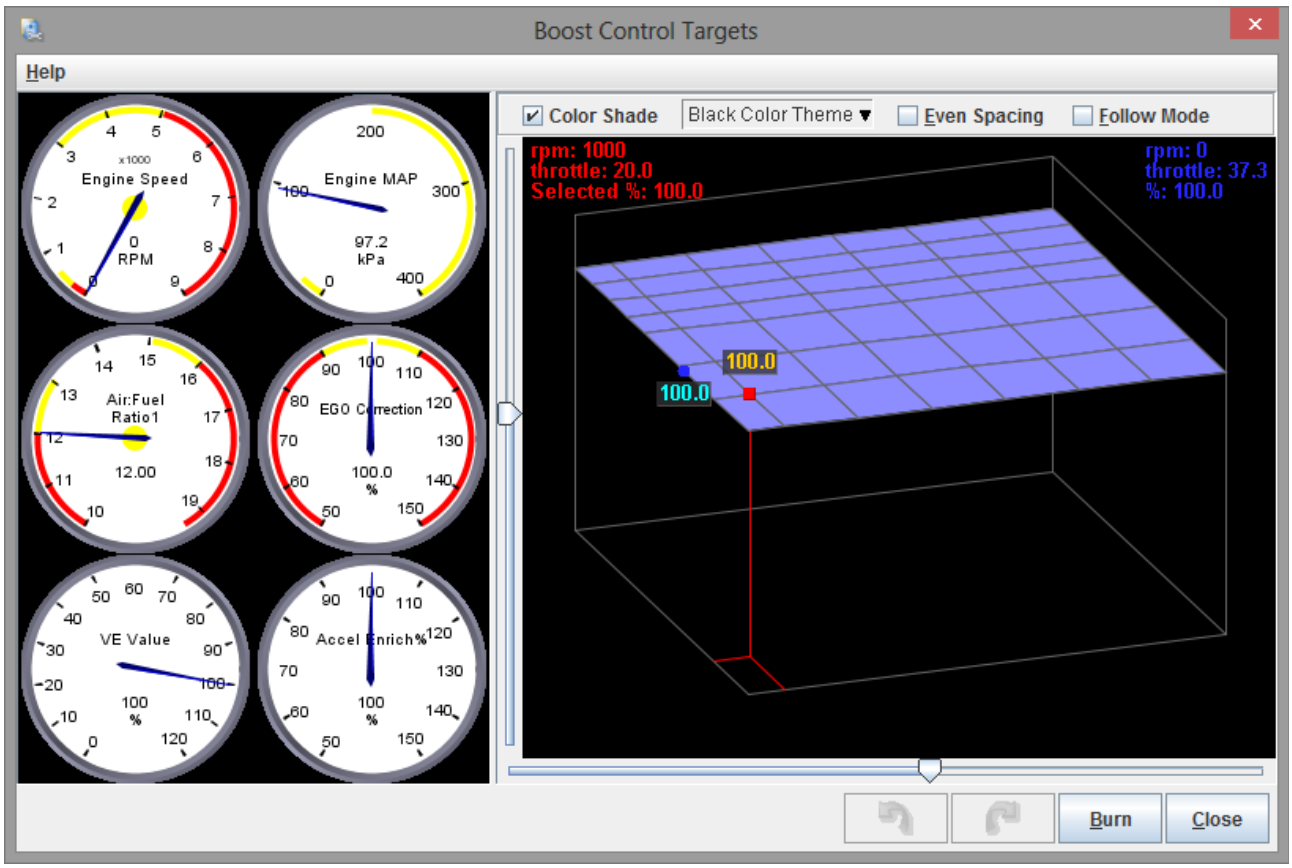
The screen will be a direct transformation of the numerical values in the Boost Control Duty Table. The X & Y axes represent rpm & throttle respectively, and the height at each point reflects the percentage for the same point in the table.

You can use the methods described in Section 1.5.4 to view and make changes to these values.

16.6 Boost Control Target Table

The Boost Control Target Table Map directly corresponds to the Boost Control Target Table which is documented in Section 13.3. That section of this guide outlines the options that are required to enable that table. The same options will enable the Boost Control Target Table menu option in the 3D Maps toolbar menu.

Clicking 3D Maps > Boost Control Target Table displays the following screen:



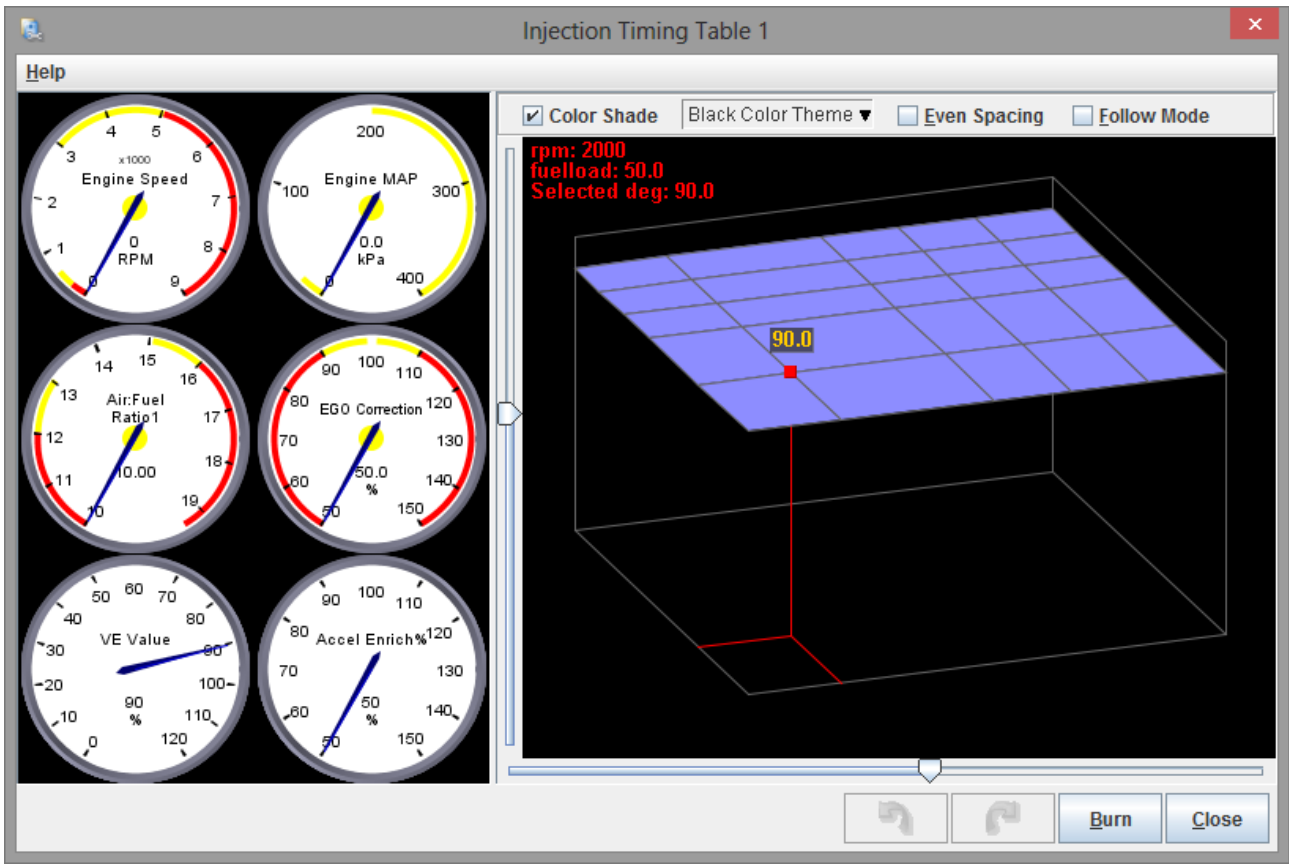
The screen will be a direct transformation of the numerical values in the Boost Control Target Table. The X & Y axes represent rpm & throttle respectively, and the height at each point reflects the percentage for the same point in the table.

You can use the methods described in Section 1.5.4 to view and make changes to these values.

16.7 Injection Timing Tables [Primary and Secondary]

The two Injection Timing 3D Maps directly correspond to the two Injection Timing Tables which are documented in Section 9.3. That section of this guide outlines the options that are required to enable each of those tables. Those same options will enable the equivalent menu options in the 3D Maps toolbar menu.

Clicking 3D Maps > Injection Timing Table [Primary or Secondary] displays a variant of the following screen:



The screen will be a direct transformation of the numerical values in the matching Injection Timing Table. The X & Y axes represent rpm & fuelload respectively, and the height at each point reflects the degrees for the same point in the table.

You can use the methods described in Section 1.5.4 to view and make changes to these values.

17 CAN bus / Testmodes

The feature set of the Megasquirt can be extended using external expansion boards which connect to the mainboard over a two wire "CAN" connection. The CAN connection is documented in the Hardware manual for your Megasquirt. CAN (Controller Area Network) bus settings configure the communication with the expansion board. Sections 17.1. onwards outline how this can be done.

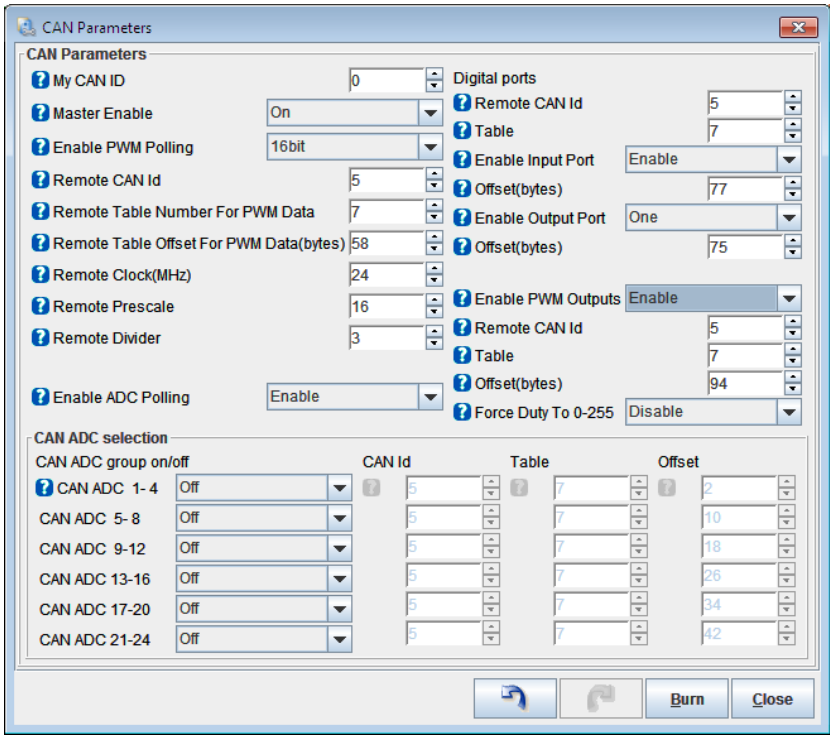
The majority of the CAN settings relate to the proprietary Megasquirt 29bit CAN header protocol. Standard 11bit broadcasting is covered in section 17.2. (For reference, greater support of standard 11bit CAN is available in firmware 1.4.x)

Sensor validation ("Check Engine Light") and Limp mode strategies are covered on this menu.

Megasquirt also includes a number of “test modes” to allow you to check your hardware. These allow you to confirm operation of some system components independant of the normal ECU operation. This is **highly recommended** before first starting the engine.These are outlined in sections 17.8. to 17.10. below.

17.1 CAN Parameters

Clicking CAN bus / Testmodes > CAN Parameters displays the following screen:



The options for these settings are described below:

My CAN ID

Set to 0 unless you specifically want to configure this as a secondary data capture ECU.

Master Enable

Enables fetching data from expansion board via CAN. Setting to "Off" still allows CAN-passthrough for tuning but turns off all other messages. This can be useful for performing a firmware upgrade on a remote expansion board.

Enable PWM Polling

Enables capturing PWM (pulse/frequency) from expansion board and selects either 16bit or 32bit data. Refer to your expansion board documentation for the appropriate setting.

If this setting **is not enabled** the next five settings will remain disabled.

Remote CAN ID

CAN ID of the expansion board used for PWM polling.

Remote Table Number For PWM Data

The table number on the expansion board for PWM data.

Remote Table Offset For PWM Data (bytes)

Data offset on the expansion board used for PWM data.

Remote PWM Clock Frequency (MHz)

Clock frequency on expansion board (see the documentation that came with the expansion board.)

Remote PWM Clock Prescale

Prescaler on expansion board (see the documentation that came with the expansion board.)

Remote PWM Clock Divider

Dividerer on expansion board (see the documentation that came with the expansion board.)

Enable ADC Polling

Enables analogue (ADC) polling from expansion board. See section 17.1.3.

17.1.1 Digital Ports

The next two settings are only enabled if an Input Port or Output Port is enabled.

Remote CAN ID

The CAN ID of expansion board used for ports polling.

Remote Table Number For Ports Data

The table number on the expansion board used for ports data.

Enable Input Port

Enables ports polling from expansion board.

Remote Table Offset For Ports Data (bytes)

Data offset on the expansion board used for input ports data.

Enable Output Port

Enables ports sending to expansion board.

Remote Table Offset For Ports Data (bytes)

Data offset on the expansion board used for output ports data.

17.1.2 PWM Outputs

A select number of features can use a PWM output on an expansion board, these settings configure the expansion board parameters.

Enable PWM Outputs

Enables sending PWM/pulsed outputs to expansion board.

Remote CAN ID

CAN ID of the expansion board used for PWM outputs.

Table

The table number on the expansion board for PWM outputs.

Offset

Data offset on the expansion board used for PWM outputs.

Force Duty to 0-255.

Forces PWM duty cycle to 0-255 range.

e.g. generic PWMs operate on a 0-100 scale, but your remote device might require a 0-255 scale.

17.1.3 CAN ADC Selection

These options **are only enabled** if

- “Master Enable” is set to “Enabled”
- AND Enable ADC Polling is set to "Enabled" (see above)

These selections allow the collection of remote analogue data which is then stored into the "CANADCxx" variable within the Megasquirt. This is then available for datalogging or use by an internal feature. This method ensures that most of the CAN data capture settings are held on one screen and other features can use a simpler interface.

CAN ADC 1-4

Enables capturing analogue inputs from expansion board and stores then in CANADC1-4.

The following three options **are only enabled** if this setting is enabled.

CAN Id

The CAN Id of the expansion board for capture to CAN ADC 1-4.

Table

The table number on the expansion board for capture to CAN ADC 1-4.

Offset

Data offset on the expansion board for capture to CAN ADC 1-4.

CAN ADC 5-8, 9-12, 13-16, 17-20, 21-24

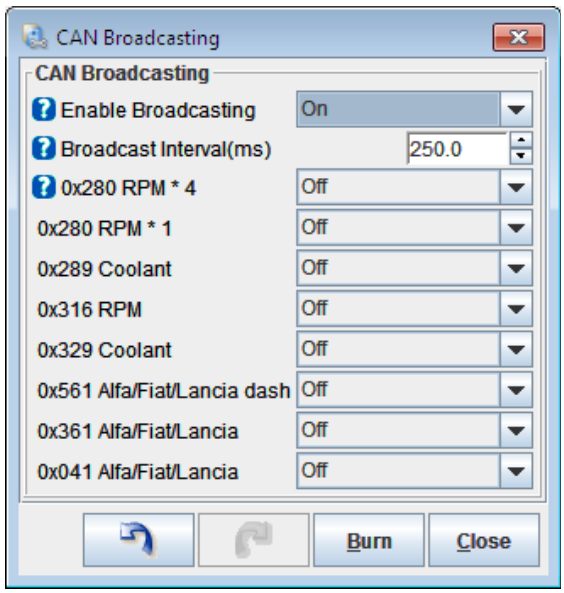
These settings work in exactly the same way as those for ADC 1-4.

17.2 CAN Broadcasting

The CAN bus / Testmodes > CAN Broadcasting menu option is only enabled if “Master Enable” is set to “Enable” in the CAN Parameters screen (see Section 17.1.)

This screen contains a selection of built-in broadcasts using standard 11bit headers to support specific customer requirements.

Clicking CAN bus / Testmodes > CAN Broadcasting displays the following screen:



The options for these settings are described below:

Enable Broadcasting

Enables broadcasting of parameters over CAN using standard 11bit headers.

Unless this setting **is enabled**, all other settings on the screen will be disabled.

Broadcast Interval (ms)

How frequently to broadcast.

Broadcast Messages

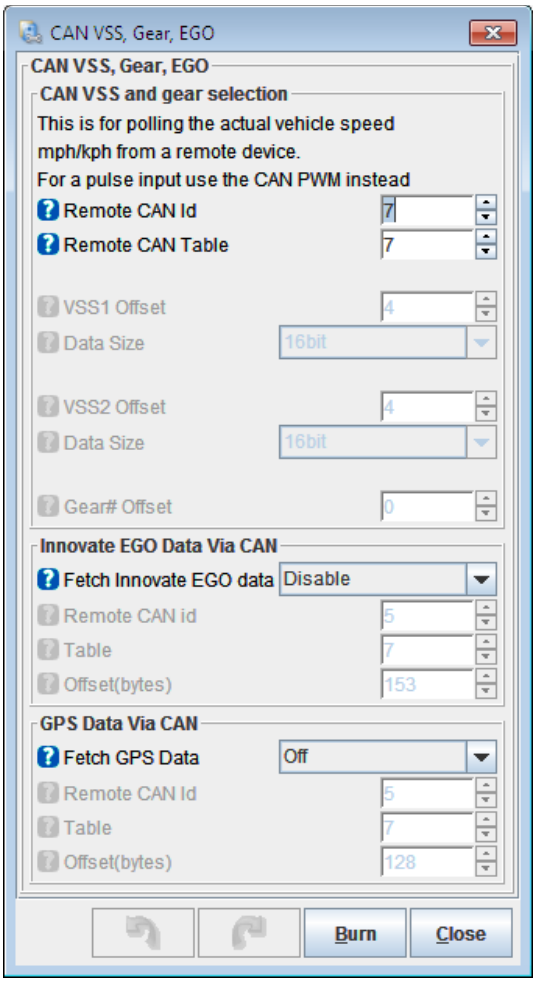
Specific messages can be enabled for broadcasting. Any appropriate selection can be set to “On”. These messages are listed as follows:

- 0x280 – rpm * 4;

- 0x280 – rpm * 1;
- 0x289 0 – coolant;
- 0x316 – rpm;
- 0x329 – coolant;
- 0x561 – Alfa / Fiat / Lancia Dash;
- 0x361 – Alfa / Fiat / Lancia;
- 0x041 – Alfa / Fiat / Lancia.

17.3 CAN VSS, Gear, EGO, GPS

Clicking CAN Bus / Testmodes > CAN VSS, Gear, EGO, GPS displays the following screen:



The options for these settings are described below:

17.3.1 CAN VSS and gear selection

These settings allow the fetching of a pre-calculated speed (VSS) from an expansion board. (Contrast CAN PWM capture where a pulse time is collected and converted into a speed within the Megasquirt.)

Remote CAN ID

CAN ID of the expansion board used for VSS and/or gear inputs.

Table

The table number on the expansion board used for VSS and/or gear inputs.

VSS1 Offset

These settings require

- "VSS1 Input Type" is set to "Digital"
- "Digital Input" is set to "CANVSS" (See Section 15.1.)

Data offset on the expansion board used for VSS1 gear inputs.

VSS1 Data Size

How the data is stored on the expansion board (8bit or 16bit). See your expansion board documentation.

VSS2 Offset

These settings require

- "VSS2 Input Type" is set to "Digital"
- "Digital Input" is set to "CANVSS" (See Section 15.1.)

Data offset on the expansion board used for VSS2 inputs.

VSS2 Data Size

How the data is stored on the expansion board (8bit or 16bit). See your expansion board documentation.

Gear # Offset

These settings require

- Gear Detection "Method" is set to "CAN Gear #" (See Section 15.1.)

Data offset on the expansion board used for 8bit gear number.

17.3.2 Innovate EGO Data Via CAN

This allows integration with an expansion board (such as those from JBperf) that natively support Innovate widebands.

Fetch Innovate EGO Data

Enables collecting EGO/AFR from innovate widebands on expansion board.

Remote CAN Id

The CAN Id of the expansion board. (Typically 5.)

Table

The table number on the expansion board. (Typically 7.)

Offset

Data offset on the expansion board. (Typically 153.)

17.3.3 GPS Data Via CAN

This allows integration with an expansion board (such as those from JBperf) that natively support GPS.

Fetch GPS Data

Enables collecting GPS on expansion board.

- Off - disables
- JBperf - fetches data in a format used on JBperf boards.

Remote CAN Id

The CAN Id of the expansion board. (Typically 5.)

Table

The table number on the expansion board. (Typically 7.)

Offset

Data offset on the expansion board. (Typically 128.)

17.4 Real Time Clock

This allows configuration of a real-time clock, either internally or on an expansion board.

Enable Real Time Clock

Enables collecting GPS on expansion board.

- Off - disables
- On-board - enables the (optional) internal clock. (Standard on MS3-Pro.)
- CAN - fetches clock data from an expansion board.

Trim +/-

Applies a trim to correct for slow/fast running clock.

Remote CAN Id

The CAN Id of the expansion board. (Typically 5.)

Table

The table number on the expansion board. (Typically 7.)

Offset

Data offset on the expansion board. (Typically 110.)

Set MS3 Time to Now

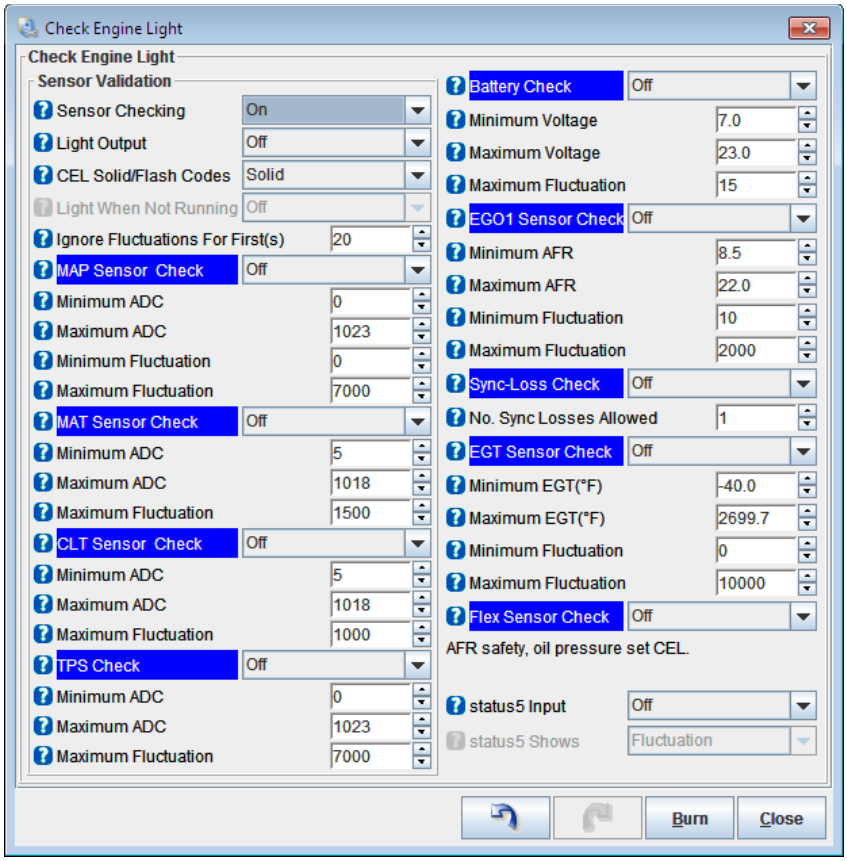
This button sends the time from your computer to the Megasquirt. The change will only show the next time you open the page.

17.5 Check Engine Light

The Check Engine Light system allows various sensor inputs to be range checked for correct operation and can

set a dash warning light or trigger a limp mode (limited operating strategy.)

Clicking CAN Bus / Testmodes > Check Engine Light displays the following screen:



The options for these settings are described below:

Sensor checking

Enables or disables this system

Light output

Selects an optional output for the Check Engine Light. Recommended.

CEL Solid/Flash Codes

Selects whether CEL lights up solidly or flashes codes to aid diagnostics.

Number of flashes and fault:

2=MAP 3=MAT 4=CLT 5=TPS 6=BATT 7=AFR0 8=SYNC 9=EGT 10=FLEX 11=MAF 12=KNOCK 13=CAM 14=OIL 15=FUELPRESS 16=EGTSHUT 17=AFRSHUT

Light When Not Running

Do you want the light on when the engine is off?

Ignore fluctuations for first

The number of seconds that sensor flucations are ignored after startup. This is to allow conditions to settle down and avoid false alarms.

MAP sensor check

Enable or disable checking of the MAP sensor input.

Minimum ADC

minimum valid ADC reading for the MAP sensor (try 5)

Maximum ADC

maximum valid ADC reading for the MAP sensor (try 1018)

Minimum Fluctuation

minimum fluctuation during smooth running

Maximum Fluctuation

maximum fluctuation during operation

(The minimum fluctuation setting is likely the most useful setting here as it can be used to detect a failed or 'stuck' sensor or if a hose fell off.)

MAT sensor check

Enable or disable checking of the MAT sensor input.

Minimum ADC

minimum valid ADC reading for the MAT sensor (try 5)

Maximum ADC

maximum valid ADC reading for the MAT sensor (try 1018)

Maximum Fluctuation

maximum fluctuation during operation

CLT sensor check

Enable or disable checking of the CLT sensor input.

Minimum ADC

minimum valid ADC reading for the CLT sensor (try 5)

Maximum ADC

maximum valid ADC reading for the CLT sensor (try 1018)

Maximum Fluctuation

maximum fluctuation during operation

(The CLT sensor should be smooth in operation, the max fluctuations can be used to detect a fault.)

TPS sensor check

Enable or disable checking of the TPS sensor input.

Minimum ADC

minimum valid ADC reading for the TPS sensor (try 10 below your 'closed' calibration)

Maximum ADC

maximum valid ADC reading for the TPS sensor (try 10 above your 'open' calibration)

Maximum Fluctuation

maximum fluctuation during operation

(The min/max limits will often detect a fault.)

Battery check

Enable or disable checking of the battery voltage input.

Minimum voltage

minimum acceptable voltage reading

Maximum voltage

maximum acceptable voltage reading

Maximum Fluctuation

maximum fluctuation during operation

(This can be used to warn of charging system faults or ground issues causing excessive voltage 'noise'.)

EGO1 sensor check

Enable or disable checking of the EGO1 sensor input.

Minimum ADC

minimum valid ADC reading for the EGO1 input

Maximum ADC

maximum valid ADC reading for the EGO1 input

Minimum Fluctuation

minimum fluctuation during smooth running

Maximum Fluctuation

maximum fluctuation during operation

(The fluctuation settings are key to detecting a failed sensor. Many wideband controllers will get 'stuck' if the sensor fails although appearing to show a valid AFR reading. Combined with closed-loop EGO or autotuning this can be troublesome without this detection scheme. Other controllers allow an 'out of range' voltage output - match the min/max ADC readings to capture this.)

Sync-loss check

Enable or disable checking of RPM sync-losses

No. sync losses allowed

how many recorded losses of tach-in synchronisation are allowed before setting the CEL.

(During normal operation you may see one or two sync-losses during startup. Beyond that there is a problem with your tach-in wiring or configuration.)

EGT sensor check

Enable or disable checking of the EGT sensor inputs.

Minimum EGT

minimum valid EGT while engine is running

Maximum EGT

maximum valid EGT while engine is running

Minimum Fluctuation

minimum fluctuation during smooth running

Maximum Fluctuation

maximum fluctuation during operation

(The temperatures are not checked immediately after startup, so the minimum temperature can be set to 200C to detect a dead cylinder or faulty sensor. The maximum will depend on your engine. N/A could be around 900C, boosted perhaps 1000C.)

Flex sensor check

Enable or disable checking of the Flex sensor input.

(An error condition will be triggered if the frequency on the flex input is outside of the set range.)

status5 input

Selects input for 'status5' value. Observe the dash gauge and examine datalogs to determine sensible min/max fluctuation limits and ADC counts for each sensor input in turn.

status5 shows

Sets gauge "status5" to record "fluctuations" number or raw ADC count for the chosen sensor input.

e.g. Set the status5 input to MAP, set to "fluctuations" and then enable "status5" on your dash or view in a datalog. Allow the engine to idle and observe the lowest number. You can then set the MAP minimum fluctuation to some value LOWER than this number. If the MAP input becomes too stable (e.g. the hose falls off) then the alarm will be raised.

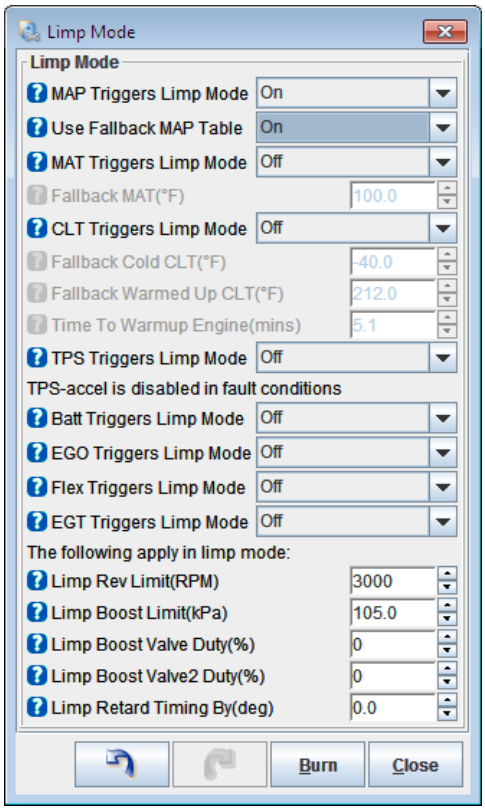
17.6 Limp Mode

This menu option will only be available if

- "Sensor Checking" is set to "On" (See Section 17.5.)

The Limp Mode allows a response to out of range sensors beyond the CEL warning light.

Clicking CAN Bus / Testmodes > Limp Mode displays the following screen:



The options for these settings are described below:

Settings for specific sensors will only be enabled if that sensor is being checked (See Section 17.5.)

MAP triggers limp mode

whether a MAP fault triggers limp mode

Use fallback MAP table

in the event of a MAP sensor failure, a fallback throttle based table can be used

MAT triggers limp mode

whether a MAT fault triggers limp mode

Fallback MAT

replacement MAT value

CLT triggers limp mode

whether a CLT fault triggers limp mode

Fallback cold CLT

replacement initial CLT value

Fallback warmed up CLT

replacement final CLT value

Time to warmup engine

time taken to blend from cold to warm value (simulating a warmup cycle)

TPS triggers limp mode

whether a TPS fault triggers limp mode. TPS based acceleration is disabled if TPS is faulty.

Batt triggers limp mode

whether an out of range battery voltage reading triggers limp mode

EGO triggers limp mode

whether an EGO fault triggers limp mode

Flex triggers limp mode

whether a Flex fault triggers limp mode

EGT triggers limp mode

whether an EGT fault triggers limp mode

Limp rev limit

the hard fuel cut rev limiter when in limp mode

Limp boost limit

the boost limt when in limp mode. Typically this will be no boost to prevent engine damage in unknown conditions.

Limp boost valve duty

forces boost valve1 to a set duty in limp mode.

Limp boost valve2 duty

forces boost valve2 to a set duty in limp mode.

Limp retard timing by

retards timing by the set amount in limp mode.

17.7 Fallback MAP Table

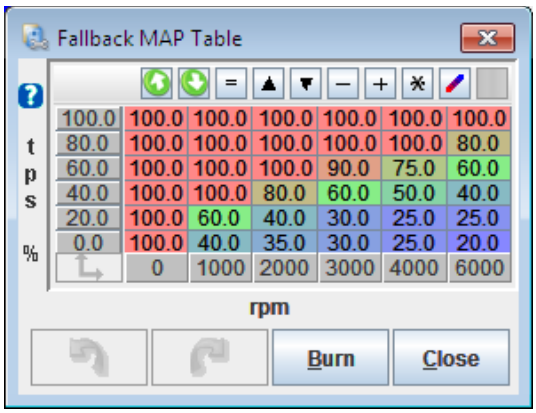
This menu option will only be available if

- "Sensor Checking" is set to "On"
- AND "MAP Sensor Check" is set to "On" (See Section 17.5.)
- AND "MAP Triggers Limp Mode" is set to "On"
- AND "Use Fallback MAP Table" is set to "On" (See Section 17.6.)

In the event of a MAP sensor failure, it is possible to use a 'synthesised' MAP value based on TPS/RPM. This will be less accurate than the real MAP reading, but the aim is to allow some driveability in the absence of a real

sensor reading before the root cause failure is fixed.

Clicking CAN Bus / Testmodes > Fallback MAP Table displays the following screen:

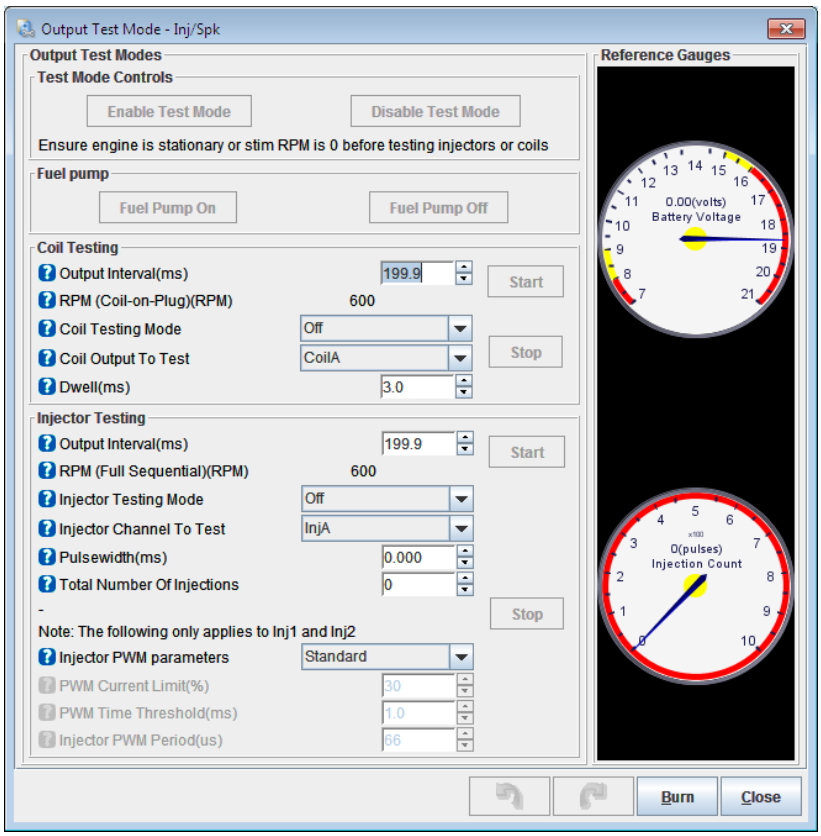


The initial vales for this table can be derived from datalogs comparing MAP, RPM, TPS while driving.

To test and tune this table, unhook the MAP hose and wait until 'Limp Mode' engages. Then this table will be operative and you can tune.

17.8 Output Test Mode – Inj/Spk

Clicking CAN Bus / Testmodes > Output Test Mode – Inj/Spk displays the following screen:



This test mode allows direct control and testing of the coils and injectors.

Used by accident this could cause flooding of the engine and potential damage, therefore a special initialisation method is required to enable it. Do not attempt to test injectors or coils on a running engine. Before testing injectors on a engine be sure to depressurise the fuel rail - this can be achieved by unplugging the fuel pump while the engine is idling. Unless you are flow testing injectors on a flow-bench, you **are strongly advised** to remove the fuel pump fuse during all of this testing.

Before using the test mode ensure that you have already configured the correct number of cylinders and type of injector and spark output etc, i.e., if you want to test 8 cylinder COP mode, you need to have correctly configured those settings beforehand.

First ensure that you are key-on, engine-off (or that RPM is set to zero on the stim if you are carrying out bench testing.) In this condition the 'Enable Test Mode' button will be available. Click the button to enable the test mode.

Fuel Pump

- Clicking “Fuel Pump On” will enable the fuel pump output and light the 'Ready' indicator on TunerStudio.
- Clicking “Fuel Pump Off” will disable the fuel pump output and turn off the 'Ready' indicator.

17.8.1 Coil Testing

The coil test mode is useful to confirm you have the coils wired correctly and to check dwell settings.

Exercise extreme caution during this test as ignition coils put out a potentially lethal voltage – typically 30,000V or more!

There are five settings to consider when carrying out coil testing:

Output Interval (ms)

How often to pulse the coil.

RPM (Coil On Plug) (RPM)

Approximate equivalent RPM (this cannot be set directly, but is a function of Output Interval.)

Coil Testing Mode

- Off - no coil testing
- One - test a single coil
- Sequence - test coils in sequence up to the selected coil output

Coil Output to test

Gives a list of available coils than can be tested.

Dwell (ms)

Dwell used during testing – no voltage correction is applied.

Follow the following steps to carry out coil testing:

- Choose the desired Output Interval;
- Set Coil Testing Mode to “One”;

- Choose which coil to test (e.g. CoilA);
- Choose your Dwell time in milliseconds (start low, e.g., 2.5ms);
- If your coils are powered via the fuel pump relay (recommended) set the fuel pump to “On”;
- Check the above settings, then click the “Start” button;
- When finished, click “Stop”.

If the coils get hot or your coil fuses pop, then you almost certainly have a basic settings mistake with output polarity. Turn off power **immediately** and review those settings.

17.8.2 Injector Testing

The coil test mode is useful to confirm you have the injectors wired correctly and to experiment with opening times, PWM settings or to measure flow rate if you have an injector test bench setup.

Using flammable liquids while testing is hazardous and can lead to serious fires. Non-flammable injector test liquid is available and you are **strongly recommended** to use it.

If your injectors are fitted to the engine you must not run the test mode with fuel pressure or you will fill your engine with fuel! Remove the fuse from your fuel pump and depressurise the line first.

There are six settings to consider when carrying out injection testing:

Output Interval (ms)

How often to pulse the injector.

RPM (Full Sequential) RPM

Approximate equivalent RPM (again, this cannot be set directly, but is a function of Output Interval.)

Injector Testing Mode

- Off - no injector testing
- One - test a single injector output
- Sequence - test injectors in sequence up to the selected coil output
- All - operate all injector outputs simultaneously

Injector Channel To Test

Gives a list of available injectors than can be tested (only applies if “One” or "Sequence" has been selected in Injector Testing Mode.

Pulsewidth (ms)

Pulsewidth used during testing – no dead-time is added and no voltage correction is applied.

Total Number Of Injections

Number of injection pulses in each test.

Follow the following steps to carry out injection testing:

- Choose the desired Output Interval (the estimated RPM equivalent will be displayed.);
- Set Injector Testing Mode to “One” or “All” (depending whether you want to test one ijnector alone or all injectors together;
- If you have selected “One” in step 2, choose which injector to test, e.g., “InjA”;
- Choose your Pulsewidth time in milliseconds;
- If your injectors are powered via the fuel pump relay (as is recommended) set the fuel pump to On;
- For functional testing, set the total number of injections to 65535 (the maximum) or for flow tesing use your chosen number;
- With valid settings entered the “Start” button should be active, if so click it.
- The number of injections gauge will count down and stop at zero.
- To stop testing sooner, click “Stop” at any time during the test.

17.8.3 PWM Settings

The PWM settings section allows you to test different PWM settings for the two injector bank outputs while in test mode. There are four settings that can be configured for this.

Injector PWM Parameters

Allows testing of different PWM current limiting parameters.

- Standard - use the PWM parameters configured in the main settings
- As Below - use custom settings in following fields.

PWM Current Limit (%)

The PWM duty cycle.

PWM Time Threshold (ms)

The full-current time at the beginning of each pulse.

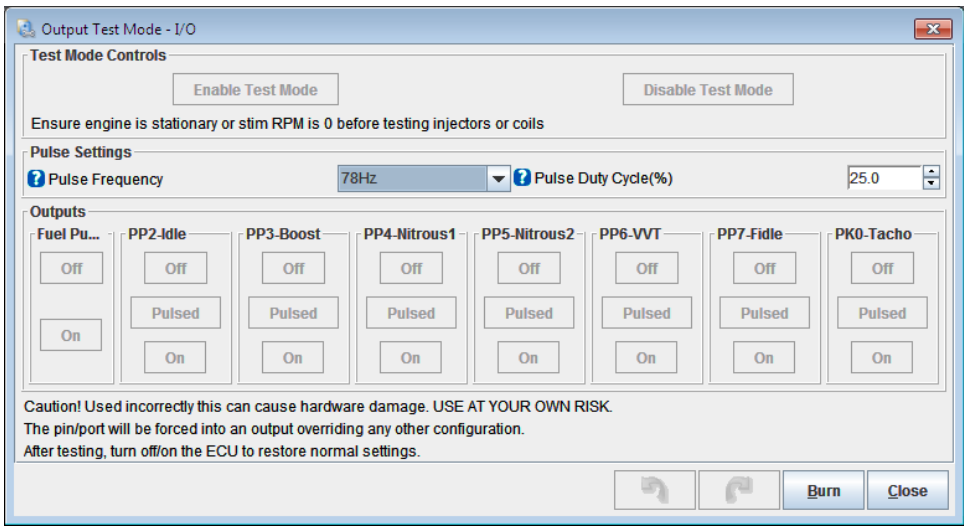
Injector PWM Period (µs)

The PWM period (or frequency.)

When you have finished using the test mode, close the test mode window and power off your Megasquirt product. If you disconnected your fuel pump you can reconnect it now.

17.9 Output Test Mode – I/O

Clicking CAN Bus / Testmodes > Output Test Mode – I/O displays the following screen:



This allows you to test some of the on/off and pulsed outputs in a controlled manner.

As with the other tests, be cautious – this mode allows you complete control over the outputs and it is important to take care not to cause any accidental damage.

First ensure that you are key-on, engine-off (or that RPM is set to zero on the stim if bench testing.) In this condition the 'Enable Test Mode' button will be available. Click the button to enable the test mode.

For each of the outputs you can select

- Off – turns the selected output off;
- On – turns the selected output on;
- Pulsed – pulses the output at the selected frequency and duty.

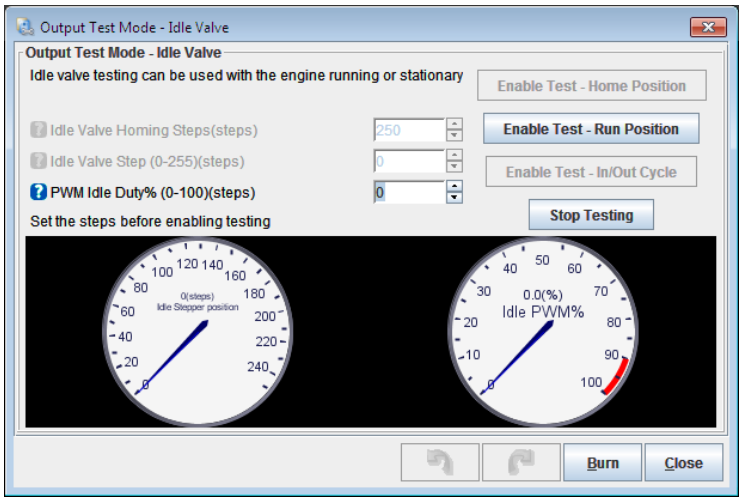
Remember that all of the power outputs from the Megasquirt are ground switching, so typically you will not be able to measure any voltage at the output with a meter. Use a small test lamp or test LED connected between 12V and the output.

When you have finished using the test mode, close the test mode window and power off your Megasquirt product.

17.10 Output Test Mode – Idle Valve

This Output Test Mode – Idle Value menu option will only be enabled if you have an appropriate setting selected for “Idle Valve Type” (see Section 11.13.)

Clicking CAN bus > Testmodes > Output Test Mode – Idle Valve displays the following screen:



The idle valve test mode can be used with the engine running or stationary. Note that with a PWM idle valve you may need to run a temporary fused 12V supply to the valve if you normally take power from the fuel pump relay and are testing with the engine off. You need to have enabled idle control before this is available.

There are three main settings for this screen:

Idle Valve Homing Steps

This only applies to stepper idle valves. This setting determines how many steps the motor should move during homing to ensure it has reached the home position. The number needs to be large enough to close the valve from any unknown starting position (this is because there is no position feedback – in non-automotive control applications there is often a feedback encoder.)

Idle Valve Step

The desired valve position, larger numbers should give a more open valve and higher rpm (for stepper motors.)

PWM idle duty%

The desired valve position, larger numbers should give a more open valve and higher rpm. (For PWM valves)

Some Bosch rotary PWM valves feature a failsafe mode so that zero flow is at, for example, 20% duty. Above that the valve operates as expected where more duty gives more airflow. Below this specific point is a failsafe mode that allows airflow even if there is no control signal. This is readily observed during test mode.

There are also three control buttons:

Enable Test – Home Position

For stepper idle valves this moves the valve through the number of homing steps back to the home position. (If it doesn't get all the way back to the stop, increase the number of homing steps.) The valve will move to the run position shortly afterwards.

Enable Test – Run Position

Enable test mode where the steps or duty setting controls the valve position.

Enable Test – In/Out Cycle

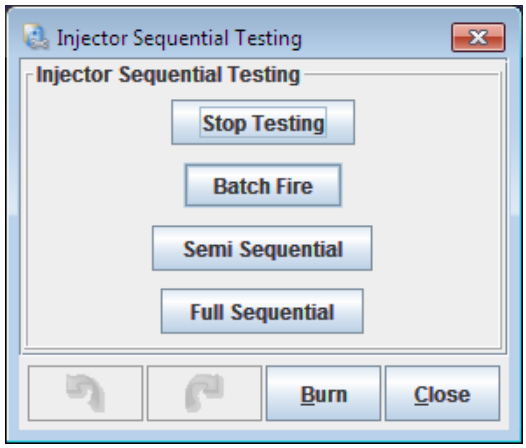
For stepper idle valves, this enables a test mode that continually opens and closes the valve.

Stop Testing

Disable test mode and allow normal idle control to operate.

17.11 Injector Sequential Testing

Clicking CAN bus > Testmodes > Injector Sequential Testing displays the following screen:



This allows on-the-fly switching between full sequential and other modes to test the effect on engine operation, not all options are appropriate for all engine configuration.

The buttons are described below:

Stop Testing

Disables the Injector Sequential Testing

Batch Fire

Switches to batch fire mode

Semi Sequential

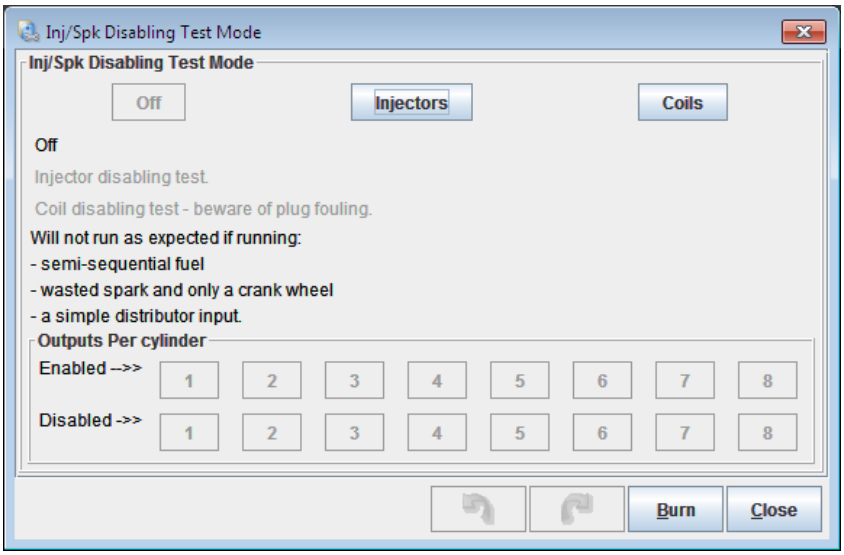
Switches to semi-sequential mode - only works if you are already configured for semi-sequential or full sequential.

Full Sequential

Switches to full sequential mode - only works if you are already configured for full sequential.

17.12 Inj/Spk Disabling Test Mode

Clicking CAN bus > Testmodes > Inj/Spk Disabling Test Mode displays the following screen:



This allows on-the-fly disabling of fuel and spark outputs - particularly for full sequential installations. Not all options are appropriate for all engine configuration.

This can be used to see what RPM drop there is when disabling a cylinder (to check for weak cylinders) and to confirm that injectors and coils or EGT sensors are wired to the correct cylinders.

The buttons are described below:

Off

Disables the test mode.

Injectors

Allow injectors to be disabled.

Coils

Allows coils to be disabled - beware of flooding.

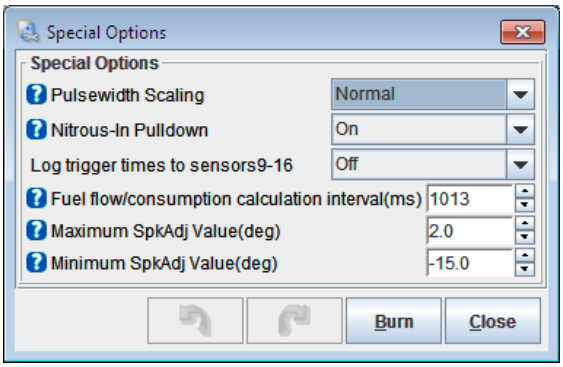
17.12.1 Outputs Per Cylinder

For each cylinder output, a button lights up in the Enabled or Disabled rows. Clicking on the button will disable or enable that output.

17.13 Special Options

These settings are rarely used special purpose settings.

Clicking CAN bus > Testmodes > Special Options displays the following screen:



The options for these settings are described below:

Pulsewidth Scaling

Only used on low-revving large engines for extra-long pulsewidths. MUST also set PW4X in Project Properties.

Nitrous-In Pulldown

Normally this should be on so that the input responds to a +12V signal. Ensure the JP8 is NOT installed on the MS3X card.

Log trigger times to sensors9-16

This enables an experimental feature to record engine trigger times to sensors9-16 to monitor per-cylinder effort. Only for developers.

Fuel flow/consumption calculation interval

How often to perform fuel consumption calculations. By default this is set to around 1000ms for 1 second updates to give a slowly changing averaged output.

Maximum SpkAdj Value

Sets a limit on the maximum adjustment a remote device (e.g. trans controller) can apply to the ignition timing.

This is a positive number, meaning advance.

Minimum SpkAdj Value

Sets a limit on the minimum adjustment a remote device (e.g. trans controller) can apply to the ignition timing.

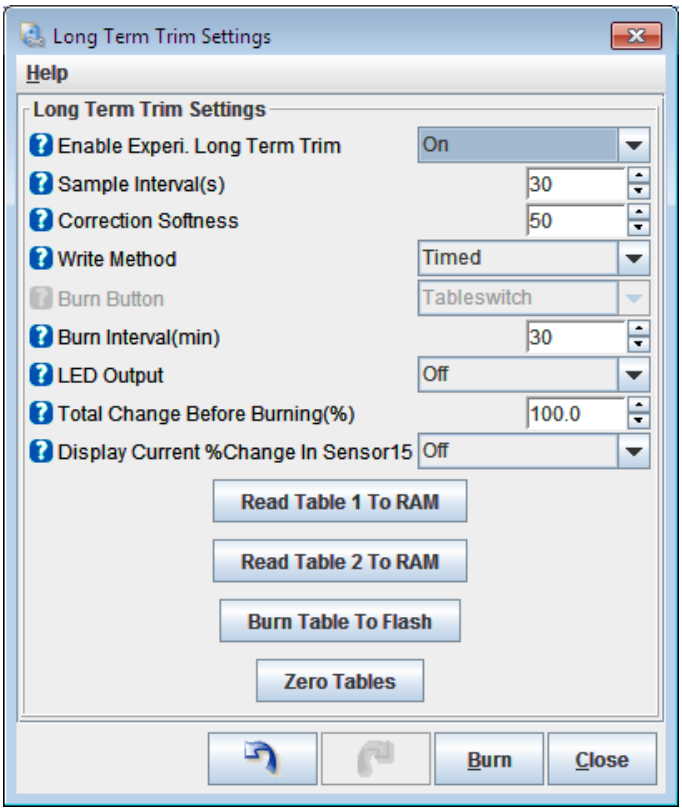
This is a negative number, meaning retard.

17.14 Long Term Trim Settings

Long-term fuel trim can be used to automatically make minor corrections to fuelling to allow for operating changes. It should only be used **after** the engine is fully tuned. It requires EGO control to be enabled and operational.

Due to an issue in TunerStudio 2.6, when Long Term Trim is used you need to disable "High Speed Runtime" on Communications->Megasquirt Baud Rate.

Clicking CAN bus > Testmodes > Long Term Trim Settings displays the following screen:



The options for these settings are described below:

Enable Experi. Long Term Trim

Enables the long-term fuel trim. This is intended to automatically make minor corrections in fuelling AFTER the engine is fully tuned. It requires EGO control to be enabled and operational.

Sample Interval

How often (in seconds) the code checks the current EGO correction.

Correction Softness

How softly the trim correction is applied. Larger numbers mean a softer/slower correction.

Write Method

- Timed - if needed, the trim table is automatically saved to flash
- Button - an external button is used to save the trim table to flash.

Burn Button

User operated button to burn trim table from RAM to flash so it is used at next power-on.

Burn Interval

Minimum time between automatic burns to flash.

LED Output

LED output is illuminated when RAM trim table exceeds change threshold. The user can then choose to Burn to flash.

Total Change Before Burning

If the sum of all changes exceeds this threshold than a burn to flash is requested - either automatically or by lighting the LED for user intervention. The purpose is to only make permanent changes if there was a widespread change.

Display Current %Change in Sensor15

Reports the total %change in 'sensor15' - mainly for testing.

Read Table 1 to RAM

This takes the saved table #1 and copies it to the working RAM area.

Read Table 2 to RAM

This takes the saved table #2 and copies it to the working RAM area.

Burn Table to Flash

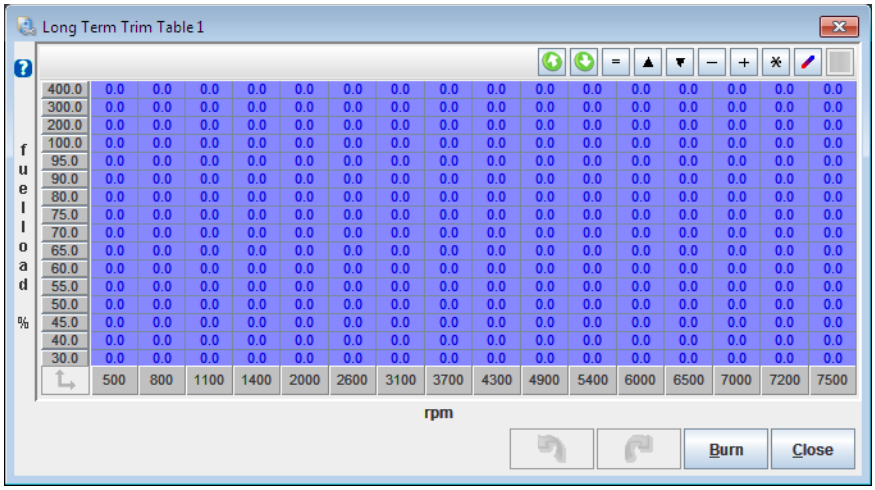
This saves the current working table into flash memory.

Zero Tables

This resets the working table and two saved tables to zero trim. It should be used after any fuel tuning.

17.15 Long Term Trim Table 1

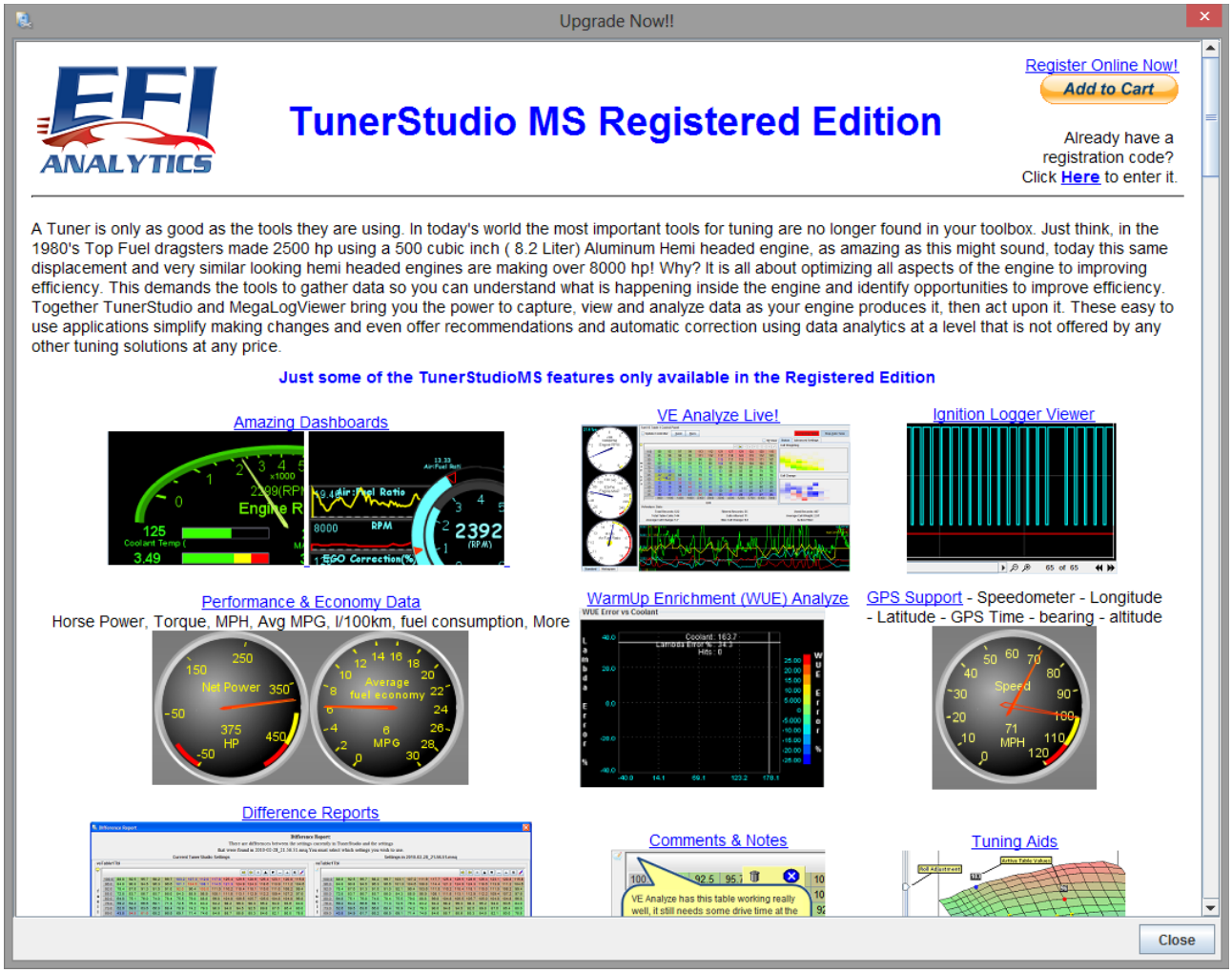
Clicking CAN bus > Testmodes > Long Term Trim Settings displays the following screen:



This read-only table shows the long-term-terim values the ECU has calculated based on lambda sensor feedback.

18 Upgrade

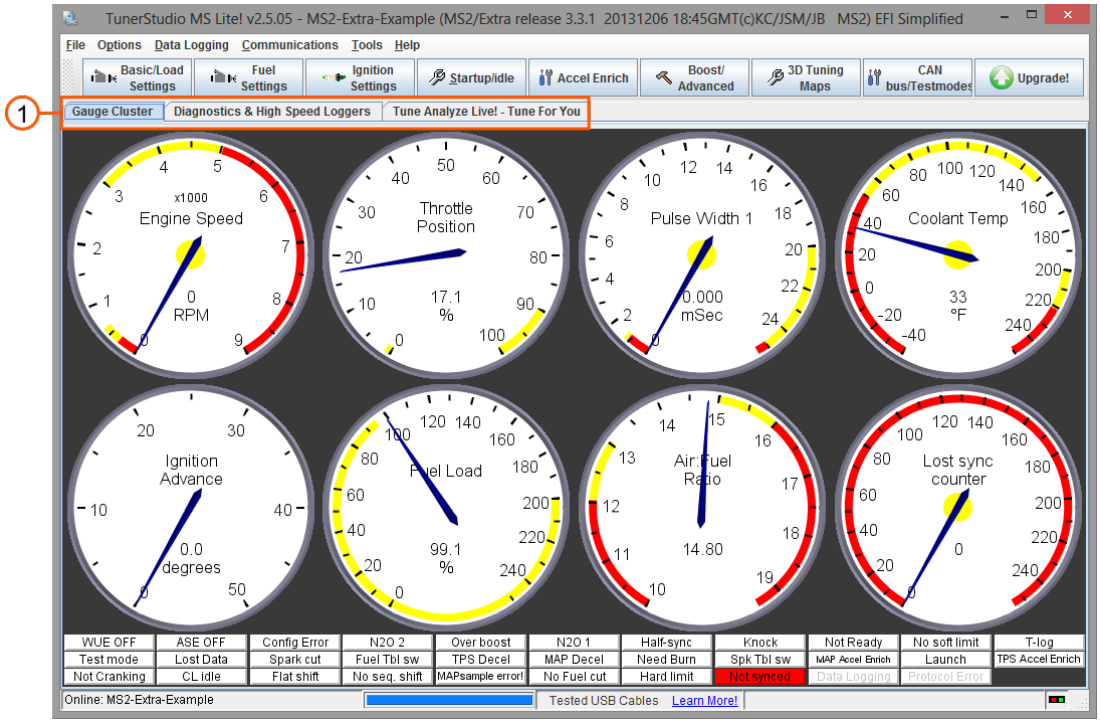
The Upgrade toolbar does not display a drop down menu, but will instead display a page of information screen about the Upgrade version of TunerStudio similar to that shown below:



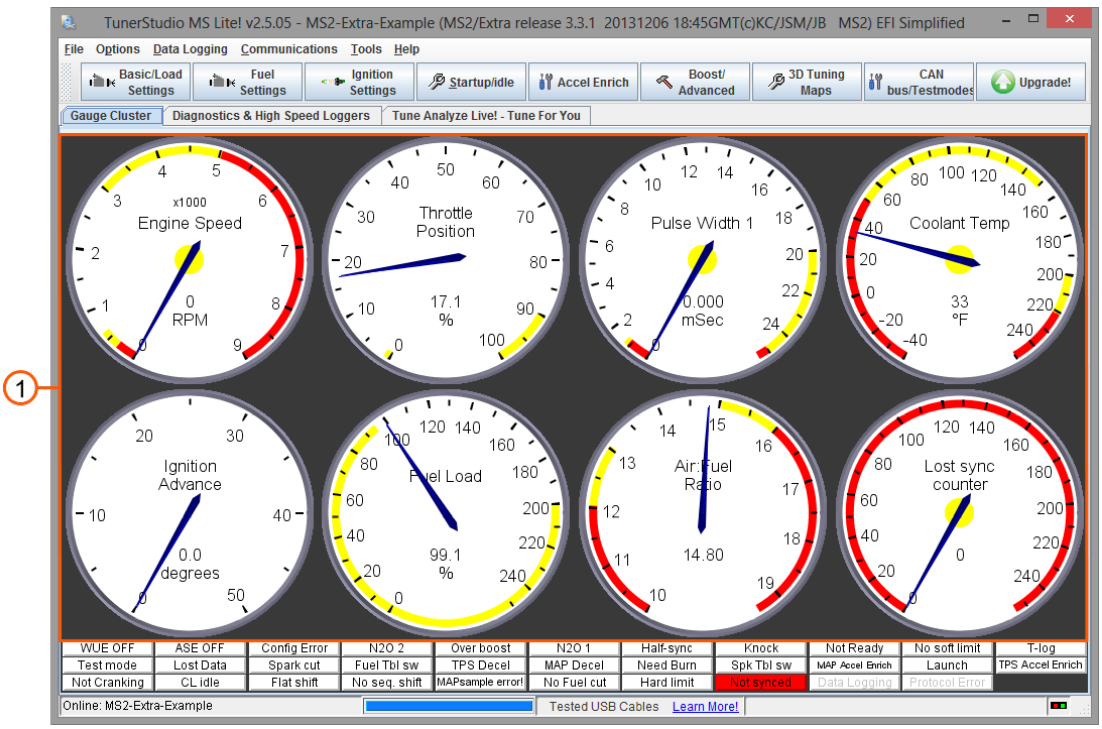
This screen includes information from the developer's Internet Site and is subject to change. It provides detailed information about the additional features included within the Upgrade version, and includes a link to purchase an upgrade license should you so wish.

19 Dashboard Gauge Cluster

In the main screen, there are three tabs “Gauge Cluster”, “Diagnostics & High Speed Loggers”, and “Tune Analyze Live – Tune For You”, labeled as (1) in the following image:



“Gauge Cluster” is the default tab which is displayed when you open TunerStudio. Using the default dash this gives you access to eight customizable gauges and a set of indicators. The gauges are labeled as (1) in the following image and are documented in this section. The dash indicators are documented in Section 20.



Right-clicking on any gauge in this gauge cluster will bring up a pop-up menu allowing you to swap the gauge for one of the alternatives as described in Sections 19.1. to 19.18. below:

19.1 TunerStudio gauges

These gauges are technical statistics for TunerStudio itself and will be rarely used.

Interrogation Progress

For developer use only.

Records Logged

The total number of datalog records recorded.

Runtime Data Rate

Shows how fast TunerStudio is communicating with the Megasquirt in frames per second.

(The data rate can be adjusted on the Communications menu.)

19.2 AFR/EGO calculations

AFR1 target

The current target value for AFR1, looked up from the AFR1 target table. Usually AFR1 target is used as the target AFR for all fuel channels.

AFR1 error

The difference between actual and target AFR1.

AFR2 target

The current target value for AFR2, looked up from the AFR2 target table. AFR2 Target is typically only of use in dual-fuel or custom blended table configurations.

AFR2 error

The difference between actual and target AFR2.

EGO Correction 1,2..

The percentage fuel correction from AFR1,2.. when closed-loop EGO control is used (100% means no change.)

Stoich

The value of the stoichiometric setting (typically 14.7 AFR for gasoline.)

19.3 AFR/EGO inputs

Air: Fuel Ratio1,2..

The current AFR reading from oxygen sensor 1,2.. Useful for wideband sensors. (Will only be available if Wideband - AFR is enabled in File > Project > Project Properties > Settings.)

Exhaust Gas Oxygen 1,2...

The current voltage reading from oxygen sensor 1. Useful for narrowband sensors.

Lambda 1,2..

The current lambda reading from oxygen sensor 1,2.. (Will only be available if Wideband - Lambda is enabled in File > Project > Project Properties > Settings.)

19.4 CAN board inputs/outputs

CAN PWMin0,1,2,3

Raw pulse period received over the CAN system from an expansion board.

CAN inputs 1-8

This bitfield variable is a combination of binary bits for CAN inputs 1-8.

128	64	32	16	8	4	2	1
CAN input 8	CAN input 7	CAN input 6	CAN input 5	CAN input 4	CAN input 3	CAN input 2	CAN input 1

CAN outputs 1-8

This bitfield variable is a combination of binary bits for CAN inputs 1-8.

128	64	32	16	8	4	2	1
CAN output 8	CAN output 7	CAN output 6	CAN output 5	CAN output 4	CAN output 3	CAN output 2	CAN output 1

CAN outputs 9-16

This bitfield variable is a combination of binary bits for CAN inputs 1-8.

128	64	32	16	8	4	2	1
CAN output 16	CAN output 15	CAN output 14	CAN output 13	CAN output 12	CAN output 11	CAN output 10	CAN output 9

19.5 Calculations 1

Calculations 1 consists of fuel related calculations.

Unless otherwise noted, **all multiplier values use 100% to mean no change**.

ALS added fuel

The fuel pulsewidth (time) adder due to the anti-lag system.

Accel Enrich PW

The current fuel pulsewidth adder due to acceleration enrichment.

Accel Enrich%

The current fuel pulsewidth percentage multiplier due to acceleration enrichment.

Air Density Correction

The percentage multiplier to fueling due to air density.

Barometric Correction

The percentage multiplier to fueling due to barometric correction.

DeadTime 1

The current injector deadtime value (allowing for battery voltage correction.)

E85 Fuel Correction

The percentage multiplier to fueling due to the flex fuel sensor.

EAE Fuel Correction 1

The percentage multiplier to fueling due to Enhanced Acceleration Enrichment channel 1.

EAE Fuel Correction 2

The percentage multiplier to fueling due to Enhanced Acceleration Enrichment channel 2.

Fuel Pressure Correction

Fueling correction due to pressure for currently active fuel system.

Fuel Temperature Correction

Fueling correction due to temperature for currently active fuel system.

Fuel on the walls 1

The calculated fuel puddle volume on the intake port walls, channel 1.

Fuel on the walls 2

The calculated fuel puddle volume on the intake port walls, channel 2.

Long Term Trim Correction

Fuel correction due to long term trim.

Nitrous Added Fuel

The fuel pulsewidth adder from the nitrous system.

Req Fuel (calc)

The current effective 'ReqFuel' value.

Total cor

The total fuel percentage multiplier obtained by multiplying the other factors. If this is outside of the range 80%-120% then there is **probably** something wrong with your tuning settings.

VE Current 1

The looked up VE value for channel 1.

VE Current 2

The looked up VE value for channel 2.

Warmup Enrichment

The percentage multiplier to fueling due to Warmup and Afterstart (this should be 100% on a warmed up engine.)

map_accel

MAP acceleration component of accel-pump.

total_accel

Combination of TPS and MAP acceleration components of accel-pump.

tps_accel

TPS acceleration component of accel-pump.

19.6 Calculations 2

Calculations 2 consists of spark/ignition related calculations.

3-step Timing

The spark timing/advance taken from the 3-step system.

ALS Timing

The spark timing/advance taken from the anti-lag system.

Base Spark Advance

The spark timing/advance looked up from the advance table before other adjustments are made.

CEL retard

The retardation to the timing due to check engine light and limp mode.

Cold advance

The advancement to the timing due to cold advance curve.

External Advance

The external advancement to the timing, e.g., from a transmission controller.

Flex Advance

The advancement to the timing due to flex fuel.

Fuel cut retard

The retardation to the timing due to over-run fuel cut.

Idle Correction Advance

The advancement to the timing due to idle correction.

Knock Retard

The retardation to the timing due to knock control.

Launch Timing

The spark timing/advance taken from the launch (2-step) system.

Launch VSS Retard.

The retardation to the timing due to the speed based launch system.

Launch timed retard

The retardation to the timing due to the timed-retard after launch.

Launch timer

Timer for timed-retard after launch.

MAT Retard

The retardation to the timing due to the MAT retard curve.

Nitrous Timer

The delay timer for the nitrous system.

Nitrous retard

The retardation to the timing due to the nitrous system.

Revlim Retard

The retardation to the timing due to the rev limiter.

Spark Table 1,2..

The looked up spark advance from ignition table 1,2..

Timing pred err

A calculation of how accurately the position of the next tach tooth was predicted (not often used).

Traction retard

The retardation to the timing due to traction control.

19.7 Calculations 3

Boost Target1,2

The target boost pressure for closed-loop mode channels 1,2.

CL idle target

The target engine speed for closed-loop idle control.

Clock

A built in clock that counts the seconds since the Megasquirt was last turned on. If this suddenly resets to zero,

you probably have a power connection problem.

Fuel economy - l/100km)

Fuel economy in litres per 100 kilometres.

Fuel economy - MPG(UK)

Fuel economy in miles per UK gallon (4.546 litres).

Fuel economy - MPG(USA)

Fuel economy in miles per US gallon (3.8 liters.)

Fuel flow cc/min

Calculated averaged fuel flow. (Averaging period is set on Special Options - see Section 17.13.)

Lost Sync Counter

The count of "lost-sync" events. If the engine stalls the counter will increase by one. During startup it is acceptable to have a few lost syncs. If you see this counting up under other conditions, there is a problem with your tach input.

Lost Sync Reason

A technical reason code for why the ECU lost synchronization with the tach input. Not particularly useful.

MAPdot

The rate of change of MAP (the increase in MAP per second.)

RPMdot

The rate of change of RPM (the increase in RPM per second.)

TPSdot

The rate of change of TPS (the increase in TPS per second.)

VSS1,2 Acceleration

The rate of change of VSS (VSS1dot) measured in SI units ms^{-2}. Same for VSS2.

VVT target 1,2,3,4

The target angle of VVT cam 1,2,3,4

19.8 EGT Inputs

EGT 01,02...

The reading from an external EGT sensor.

19.9 Generic Sensor Inputs

Sensor01-16

The reading from a sensor converted into your chosen units through the Generic Sensors system. You can also give the sensors a name of your choice which will then be used in the datalog and gauge name.

19.10 Outputs 1

Pulse Width 1

The base fuel pulsewidth for injector channel 1. This is the actual electrical pulsewidth including deadtime, but not trim. See also Pulse Width Seq 1,2.

Pulse Width 2

The base fuel pulsewidth for injector channel 2. This is the actual electrical pulsewidth including deadtime, but not trim. Primarily for dual table or dual fuel.

Pulse Width Seq 1,2..

The base fuel pulsewidth for the injector on cyl#1,2.. This is the actual output electrical pulsewidth including deadtime, all corrections and trim. (The "Firing Order" setting is used to determine which cylinder is which as the injectors always fire in the same order. A,B,C...)

Pulse Width V3 Inj1,2..

The base fuel pulsewidth for mainboard injector output 1,2.. This is the actual electrical pulsewidth including deadtime, but not trim.

19.11 Outputs 2

Boost Duty,2

The current duty cycle output to the boost solenoid. Channels 1,2.

Duty Cycle 1

The calculated injector duty cycle on channel 1 (85% is a recommended maximum, above 100% is impossible.) This is the base pulsewidth before any trim has been allowed for.

Duty Cycle 2

The calculated injector duty cycle on channel 2. Mainly for staged injection.

Dwell (Trailing)

The ignition dwell (charge) time on the rotary trailing outputs.

Dwell

The ignition dwell (charge) time on the main spark outputs.

Idle PWM%

The current duty cycle output to the idle valve.

Idle Stepper position

The current stepper valve position (0 means fully closed.)

Ignition Advance

The overall ignition advance.

Injection Timing (pri)

The injection timing used for primary injector channels.

Injection Timing (sec)

The injection timing used for secondary injector channels.

19.12 Outputs 3

Alternator Control Duty

Output duty to control alternator.

Alternator Control Frequency

Output frequency to control alternator.

Alternator Target Volts

The voltage being targetted by the alternator control system.

Fuel pump duty

The output duty cycle to control the fuel pump.

Generic Closed-Loop A,B duty

Output duty cycle from Generic Closed-Loop system.

Generic PWM A-F duty

Output duty cycle from Generic PWM system.

Nitrous 1,2 duty

The duty cycle to the nitrous solenoids in progressive mode.

VVT duty 1,2,3,4

The solenoid output duty cycle for VVT cam 1,2,3,4

Water Duty

The duty cycle to the water injection solenoid.

19.13 Sensor inputs 1

AFR load

The 'load' (e.g. MAP, TPS) used on the Y-axis of the AFR table.

Barometer

The barometer reading. This will show: a current value if a dedicated baro sensor is installed; the initial MAP reading; or 100kPa if barometric correction is disabled.

Battery Voltage

The measured battery voltage (if this is radically different from your actual battery voltage, check for wiring faults.)

Boost – boostbarGauge

The relative boost pressure in bar.

Boost – boostpsigGauge

The relative boost pressure in psig.

Coolant Temp

The measured coolant temperature (CLT.)

EAE load

The 'load' (e.g. MAP, TPS) used on the Y-axis of the EAE curves.

Engine MAP

The measured MAP (on typical speed-density installs this should read near 100kPa during key-on, engine-off and 30-60kPa at idle.)

Engine Speed

The tachometer / rev counter (if this is dropping to zero or bouncing around, you probably have a problem with the tach-in signal.)

Est. Intake Air Temp

A calculated estimate to the intake air temperature using a blend of measured air and coolant temperatures. See the MAT/CLT blending setting.

Fuel Load

The primary 'load' for fuel calculations (this is equal to MAP on typical speed-density installs.)

Ign Load

The 'load' (e.g. MAP, TPS) used on the Y axis of the ignition tables.

Knock Input

The signal value from an optional add-on knock sensor interface.

MAF Frequency

The raw frequency input from a frequency MAF sensor.

MAF Volts

The voltage from the MAF sensor.

MAFload

A calculated 'load' value that works similarly to MAP in a speed-density system (make for better use of the lookup tables.)

Manifold Air Temp

The measured intake manifold air temperature (MAT.)

Mass Air Flow

The airflow in g/sec calculated from the MAF sensor.

Secondary Fuel Load

Like 'Fuel Load' but used for the secondary lookup table.

Secondary Ign Load

Like 'Ign Load' but used for the secondary lookup table.

Throttle Position

The 0-100% throttle (pedal) position (check the calibration settings if you do not get 0-100%.)

Vac/Boost

Shows the MAP sensor in vacuum / boost imperial units.

19.14 Sensor inputs 2

Accel X,Y,Z

The accelerometer X,Y,Z measured in SI units ms^{-2}.

Alternator Load Duty

Measured load on the alternator.

Battery Current

The measured battery current measured through the alternator control system.

Ethanol Percentage

The calculated ethanol percentage in the fuel reported from the flex fuel sensor.

Fuel Pressure1_xxx

Primary differential fuel pressure in bar, kPa or bar. This is the differential fuel pressure above intake manifold pressure.

Fuel Pressure2_xxx

Secondary differential fuel pressure in bar, kPa or bar. This is the differential fuel pressure above intake manifold pressure.

Fuel Temp1,2

Fuel temperature. 1 = primary fuel, 2 = secondary fuel

Gear

The current gear.

Shaft Speed 1,2

Shaft speed in RPM.

Stream Level

The volume level of the audio stream being recorded to an SDcard datalog.

TPSADC

The raw ADC input of the throttle (pedal) position.

VSS1-4

Vehicle (wheel) speed sensor inputs in your chosen speed units.

19.15 Sensor Inputs 3

Knock cyl# 1-16

The signal value per-cylinder from the internal knock sensor interface.

VVT angle 1,2,3,4

The current relative angle of VVT cam 1,2,3,4

19.16 Sensor Inputs 4

GPS Altitude

Altitude in metres from external GPS.

GPS Course

The course/heading from external GPS.

GPS Latitude deg

Latitude degrees component from external GPS.

GPS Latitude min

Latitude minutes component from external GPS.

GPS Latitude sec

Latitude seconds component from external GPS.

GPS Latitude

Latitude degrees from external GPS. (Combination of degrees, minutes, seconds as one decimal number.)

GPS Longitude E/W

Longitude East/West indicator from external GPS.

GPS Longitude deg

Longitude degrees component from external GPS.

GPS Longitude min

Longitude minutes component from external GPS.

GPS Longitude sec

Longitude seconds component from external GPS.

GPS Longitude

Longitude degrees from external GPS. (Combination of degrees, minutes, seconds as one decimal number.)

GPS Speed

The speed from external GPS in your chosen speed units.

19.17 VE Analyze Gauges

The are not useful in the Lite version of TunerStudio.

19.18 X-Code dev

These gauges are typically only of use by developers.

-- 0 deadGauge

A gauge that does nothing.

Advance Bucket

This gauge is for historical purposes only.

CEL Error Code

Current Check Engine Light error code.

CEL status

This bitfield variable is a combination of binary bits about CEL faults. These are used to drive the CEL indicators:

128	64	32	16	8	4	2	1
EGT fault	RPM-sync fault	AFR fault	Battery fault	TPS fault	CLT fault	MAT fault	MAP fault

CEL status2

128	64	32	16	8	4	2	1
AFR shutdown	EGT shutdown	Fuel pressure fault	Oil fault	Cam fault	Knock fault	MAF fault	Flex fault

Injection Count

Used by injector test mode to show the number of remaining test squirts.

Mainloop time

How long each pass through the 'mainloop' of code is taking in microseconds.

SDcard error

Error code for SDcard datalogging system - see the Setting Up manual for a list.

SDcard file number

The current active datalog file number on the SDcard.

SDcard status

Bitfield indicating current status of SDcard datalogging system.

SDcard phase

Technical code relating to SDcard datalogging system.

status1-8

These bitfield variables is a combination of binary bits about engine status. These are used to drive various status indicators.

status1

128	64	32	16	8	4	2	1
Full-RPM Synced	Spark Table-sw	Fuel Table-sw	(Synclatch)	RPM Synced	Config Error	Lost Data	Need Burn

status2

128	64	32	16	8	4	2	1
CL Idle	Over Boost	Spark Cut	Flat Shift	Launch	Launch In	N2O stage 2	N2O stage 1

status3

128	64	32	16	8	4	2	1
Launch On	Seq. Shift	Soft Limit	3-Step In	Test mode	3-Step	T Log	Fuel Cut

Status 4, 5

Typically only used by developers. The CEL system allows status5 to be used to record raw ADC counts or fluctuations of inputs.

status6

128	64	32	16	8	4	2	1
MAPsample error	Fan	Idle Advance	Idle VE	AFR Shutdown	AFR Warn	EGT Shutdown	EGT Warn

status7

128	64	32	16	8	4	2	1
Limp Mode	CEL	AC	Knock	VVT4 Error	VVT3 Error	VVT2 Error	VVT1 Error

status8

128	64	32	16	8	4	2	1
-	-	VSS Launch	VSS Launch Lock-out	PW4X Mode	Water Injection Low	Spark Disable Mode	Injectors Disable Mode

VE Value

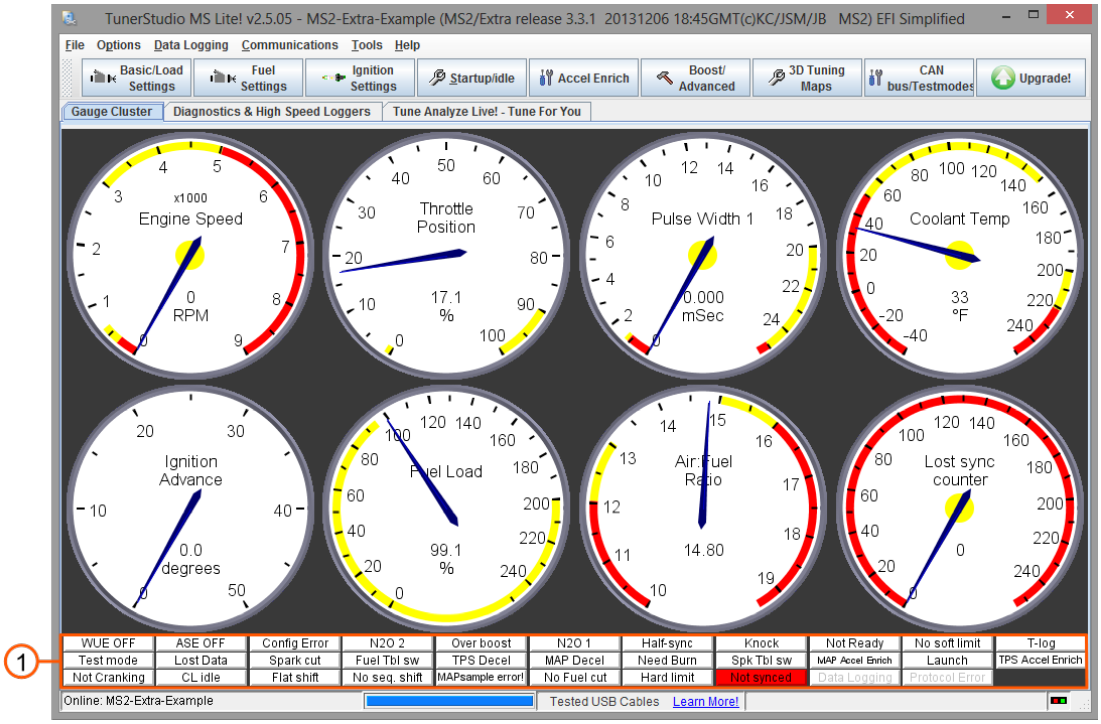
This gauge is for historical purposes only.

19.19 Other Menu Items on the Gauge Pop-up Menu

The “Background”, “Antialiasing Enabled”, “Designer Mode” and “Gauge Demo” menu options are replicated from the File > Gauge Cluster sub menu, which is documented in Section 2.6.

20 Dashboard Indicators

The Dashboard Indicators are located at the bottom of the default dash below the gauges and are labeled as (1) in the following image. The indicators are generally customizable and are used to indicate on/off events.



Right-clicking on any of these indicators will bring up a pop-up menu allowing you to swap the indicator for one of the alternatives as described in Sections 20.1. to 20.4. below:

20.1 Application Indicators

Datalogging – highlighted if data logging is active

Protocol Error – highlighted if there is a serial communication problem

20.2 Predefined Indicators

The list of alternative indicators will vary depending on whether you have activated “PORT_STATUS” in your Project Properties. Activating PORT_STATUS will add access to additional indicators and also changes the way the menus are laid out.

20.3 Predefined Indicators with PORT_STATUS Deactivated (Default)

Sections 20.3.1. and 20.3.3. list the options that will be offered to you if you right click on any of the indicators if PORT_STATUS for your project **has been left deactivated**.

20.3.1 Predefined Indicators

3 step in - whether 3-step input is active

3 step on - whether 3-step input is active

AC – determines whether air conditioning is active.

AFR Shutdown - if AFR shutdown is in-process

AFR warn - if warning of AFR shutdown is in-process

AFR0 fault - fault on AFR sensor

ASE / ASE OFF – determines whether running in After Start Enrichment mode.

BATT fault - fault on battery voltage

CL idle on – closed-loop idle control active.

CLT fault - fault on CLT sensor

Cam fault - fault on cam sensor

CEL AFR Shutdown - AFR shutdown is in-process

CEL EGT shutdown - EGT shutdown is in-process

CEL W.Inj low! - water injection system has low fluid

Check Engine - Check Engine Light system detected a fault

Config Error – if there is an error in your settings, in this case fix the settings.

Cranking / Not Cranking – currently cranking.

EGT fault - fault on EGT sensor

EGT shutdown - if EGT shutdown is in-process

EGT warn - if warning of EGT shutdown is in-process

Fan - fan output active

Flat shift – flat shift in effect.

Flex fault - fault on flex fuel sensor

Fuel Cut – fuel cut in effect.

20.3.2 Predefined Indicators 2

Fuel press - fault on fuel pressure

Full-RPM sync / Half RPM sync – whether the Megasquirt is fully synchronized to crank and cam signals enough to run coil-on-plug or sequential (this **might** show a cam fault.)

Idle Adv - idle advance is active

Idle VE - idle VE is active

Knock fault - knock occurring

Knock - the on/off knock input is active

Launch in – launch input active.

Launch on – launch control active.

Limp mode - limp mode is active

Lost Data – if something went wrong and data was not saved.

MAF fault - fault on MAF sensor

MAP Accel – currently in an accel enrichment event due to MAP.

MAP Decel – currently in an decel enleanment event due to MAP.

MAP fault - fault on MAP sensor

MAPsample error! – something is wrong with your MAP sample settings.

N2O 1 – nitrous stage 1 output.

N2O 2 – nitrous stage 2 output.

Need Burn – if unsaved data is waiting to be burned to flash memory.

Oil fault - fault with oil pressure

Over boost – boost limiter in effect.

PW4X - 4x pulsewidth mode is active

RPM Synced / Not RPM synced – whether the Megasquirt is synchronized to the crank and cam signals

Ready / Not Ready – shows when there is an active tach signal and pump is running.

SD Err - Error on SDcard

20.3.3 Predefined Indicators 3

SD Log - Logging active on SDcard

SD in - SDcard is inserted

SD ready - SDcard is initialised and ready to datalog

SPK3/4 – spark (ignition) table switching in effect. (Shows SPK1/2 when un-switched.)

SYNC fault - RPM sync faults detected

Safety Shutdown - AFR or EGT shutdown in effect

Seq. shift / No Seq. Shift – sequential shift control active.

Soft limiter / No soft limit – soft rev limiter in effect.

Spark cut – spark cut in effect.

T-log – tooth/trigger/composite log ready (TunerStudio internal use.)

TPS Accel – currently in an accel enrichment event due to TPS.

TPS Decel – currently in an decel enleanment event due to TPS.

TPS fault - fault on TPS

Test mode – spark / injector test mode is active.

Tune error - Total cor is less than 70%. Almost certainly there is a mistake in your tune.

VE3/4 - fuel table switching in effect. (Shows VE1/2 when un-switched.)

VSS launch L/O - Speed/VSS launch mode is locked out.

VSS launch on - Speed/VSS launch mode is active.

VVT1 err - error detected on VVT1 input (out of range angles.)

VVT2 err - error detected on VVT2 input (out of range angles.)

VVT3 err - error detected on VVT3 input (out of range angles.)

VVT4 err - error detected on VVT4 input (out of range angles.)

W.I. low! - water injection system has low fluid

WUE OFF / WUE – in WarmUp Enrichment mode.

20.4 Predefined Indicators with PORT_STATUS Activated

Sections 20.4.1 to 20.4.5 list the options that will be offered to you if you right click on any of the indicators if PORT_STATUS for your project **has been activated**.

20.4.1 Predefined Indicators

3 step in - whether 3-step input is active

3 step on - whether 3-step input is active

AC – determines whether air conditioning is active.

AFR Shutdown - if AFR shutdown is in-process

AFR warn - if warning of AFR shutdown is in-process

AFR0 fault - fault on AFR sensor

ASE / ASE OFF – determines whether running in After Start Enrichment mode.

BATT fault - fault on battery voltage

CL idle on – closed-loop idle control active.

CLT fault - fault on CLT sensor

Cam fault - fault on cam sensor

CEL AFR Shutdown - AFR shutdown is in-process

CEL EGT shutdown - EGT shutdown is in-process

CEL W.Inj low! - water injection system has low fluid

Check Engine - Check Engine Light system detected a fault

Config Error – if there is an error in your settings, in this case fix the settings.

Cranking / Not Cranking – currently cranking.

EGT fault - fault on EGT sensor

EGT shutdown - if EGT shutdown is in-process

EGT warn - if warning of EGT shutdown is in-process

Fan - fan output active

Flat shift – flat shift in effect.

Flex fault - fault on flex fuel sensor

Fuel Cut – fuel cut in effect.

20.4.2 Predefined Indicators 2

Fuel press - fault on fuel pressure

Full-RPM sync / Half RPM sync – whether the Megasquirt is fully synchronized to crank and cam signals enough to run coil-on-plug or sequential (this **might** show a cam fault.)

Idle Adv - idle advance is active

Idle VE - idle VE is active

Knock fault - knock occurring

Knock - the on/off knock input is active

Launch in – launch input active.

Launch on – launch control active.

Limp mode - limp mode is active

Lost Data – if something went wrong and data was not saved.

MAF fault - fault on MAF sensor

MAP Accel – currently in an accel enrichment event due to MAP.

MAP Decel – currently in an decel enleanment event due to MAP.

MAP fault - fault on MAP sensor

MAPsample error! – something is wrong with your MAP sample settings.

N2O 1 – nitrous stage 1 output.

N2O 2 – nitrous stage 2 output.

Need Burn – if unsaved data is waiting to be burned to flash memory.

Oil fault - fault with oil pressure

Over boost – boost limiter in effect.

PORTA indicators

128	64	32	16	8	4	2	1
PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0
Inj H	Inj G	Inj F	Inj E	Inj D	Inj C	Inj B	Inj A
Inj H	Inj G	Inj F	Inj E	Inj D	Inj C	Inj B	Inj A

20.4.3 Predefined Indicators 3

See above for remaining PORTA indicators.

PORTB indicators

128	64	32	16	8	4	2	1
PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0
Spk H	Spk G	Spk F	Spk E	Spk D	Spk C	Spk B	Spk A
Spk H	Spk G	Spk F	Spk E	Spk D	Spk C	Spk B	Spk A

PORTE, PORTH indicators

128	64	32	16	8	4	2	1
PTH7	PTH6	-	PORTE4	-	PORTE2	PORTE1	PORTE0
Nitrous in	Tablesw. in		F.PUMP		FLEX	PE1	PE0/JS7
Digi Switch 12V in	Digital in 4	-	F.PUMP	-	Digi Switch in 1	-	-

PORTJ, PORTM indicators (PTJ, PTM)

128	64	32	16	8	4	2	1
PTJ7	PTJ6*	PTM5	PTM4	PTM3	PTM2	PTJ1	PTJ0
JS11	(IAC EN)	D15	D16	D14	PM2(H2)	IAC2	IAC1
(Internal)	(IAC EN)	(Internal)	(Internal)	(Internal)	(Internal)	Stepper Out 2	Stepper Out 1

* 1.3.3 upwards

PORTK indicators

128	64	32	16	8	4	2	1
PORTK7	PORTK6	PORTK5	PORTK4	PORTK3	PORTK2	PORTK1	PORTK0
PK7 (H1)	-	-	-	PK3 (H3)	Launch in	PK1 (H4)	Tacho out
-	-	-	-	(internal)	Digi Switch in 2	(internal)	Tach Out

20.4.4 Predefined Indicators 4

See above for PORTM indicators.

PORTP indicators (PTP)

128	64	32	16	8	4	2	1
PTP7	PTP6	PTP5	PTP4	PTP3	PTP2	PTP1	PTP0
FIDLE	VVT	Nitrous2	Nitrous1	Boost	Idle	(INJ2 PWM)	(INJ1 PWM)
PWM / Idle Out 1	PWM Out 3	High Curr. Out 2	High Curr. Out 1	High Curr. Out 3	PWM Out 2	-	-

PORTT indicators (PTT)

128	64	32	16	8	4	2	1
PTT7	PTT6	PTT5	PTT4	PTT3	PTT2	PTT1	PTT0
-	Datalog in	JS10	PT4	INJ 2	Cam in	INJ1	Crank in
-	Digi Freq In 3	Digi Freq In 2	Digi Freq In 1	Inj J	CMP	Inj I	CKP

PW4X - 4x pulsewidth mode is active

RPM Synced / Not RPM synced – whether the Megasquirt is synchronized to the crank and cam signals

Ready / Not Ready – shows when there is an active tach signal and pump is running.

SD Err - Error on SDcard

SD Log - Logging active on SDcard

SD in - SDcard is inserted

SD ready - SDcard is initialised and ready to datalog

20.4.5 Predefined Indicators 5

SPK3/4 – spark (ignition) table switching in effect. (Shows SPK1/2 when un-switched.)

SYNC fault - RPM sync faults detected

Safety Shutdown - AFR or EGT shutdown in effect

Seq. shift / No Seq. Shift – sequential shift control active.

Soft limiter / No soft limit – soft rev limiter in effect.

Spark cut – spark cut in effect.

T-log – tooth/trigger/composite log ready (TunerStudio internal use.)

TPS Accel – currently in an accel enrichment event due to TPS.

TPS Decel – currently in an decel enleanment event due to TPS.

TPS fault - fault on TPS

Test mode – spark / injector test mode is active.

Tune error - Total cor is less than 70%. Almost certainly there is a mistake in your tune.

VE3/4 - fuel table switching in effect. (Shows VE1/2 when un-switched.)

VSS launch L/O - Speed/VSS launch mode is locked out.

VSS launch on - Speed/VSS launch mode is active.

VVT1 err - error detected on VVT1 input (out of range angles.)

VVT2 err - error detected on VVT2 input (out of range angles.)

VVT3 err - error detected on VVT3 input (out of range angles.)

VVT4 err - error detected on VVT4 input (out of range angles.)

W.I. low! - water injection system has low fluid

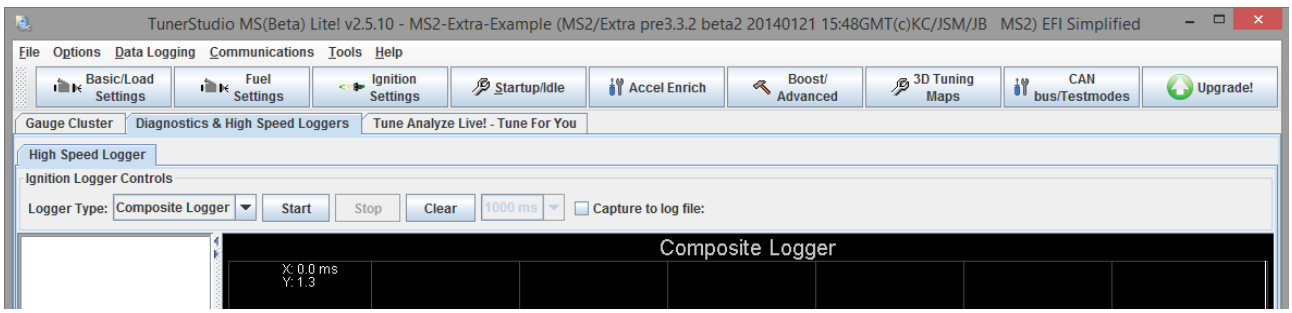
WUE OFF / WUE – in WarmUp Enrichment mode.

20.5 Other Menu Items on the Indicator Pop-up Menu

The “Background”, “Antialiasing Enabled”, “Designer Mode” and “Gauge Demo” menu options are replicated from the File > Gauge Cluster sub menu, which is documented in Section 2.6.

21 Diagnostics & High Speed Loggers

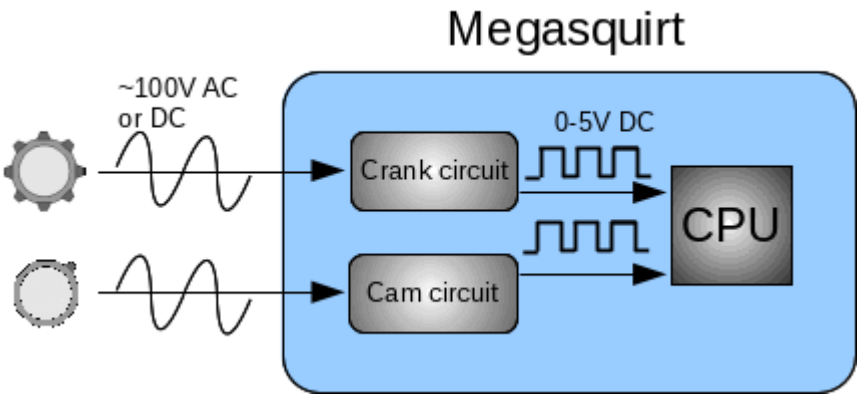
The diagnostics tab allows access to the high-speed ignition loggers built into the Megasquirt firmware. These should be used during initial installation to confirm that tach signals are present and clean. They can also be used later as fault finding tools. Selecting the Diagnostics & High Speed Loggers tab from the main screen will display a screen similar to that shown below:



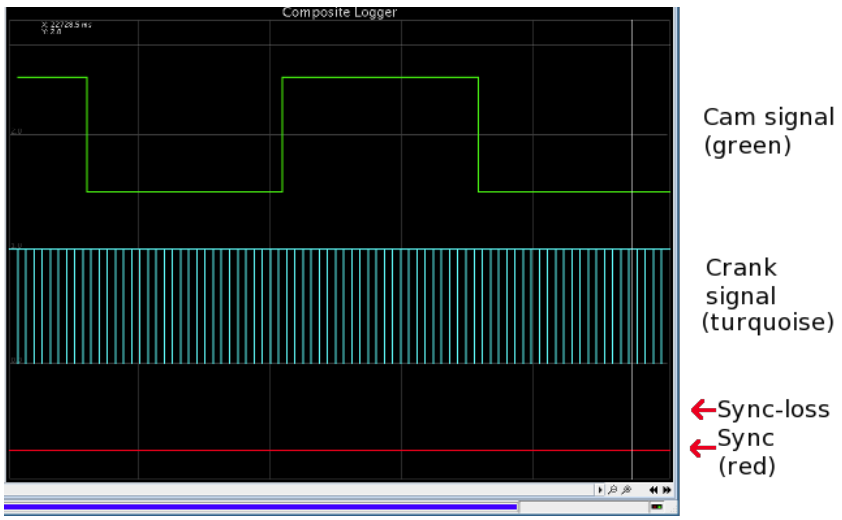
21.1 Logger Type

This selects which of the Megasquirt firmware supplied loggers to use. The tooth logger and composite logger are generally the most useful. Although your firmware may give you additional options, the four standard loggers are briefly described below.

For all of the loggers, you are seeing a decoded version of the input signal. The processor inside the Megasquirt only sees a 0-5V signal, the raw analogue signal is pre-processed by the tach-in circuits.



Composite Logger



This logger records both crank and cam signals in a format similar to an oscilloscope. The exact display will depend on a number of factors

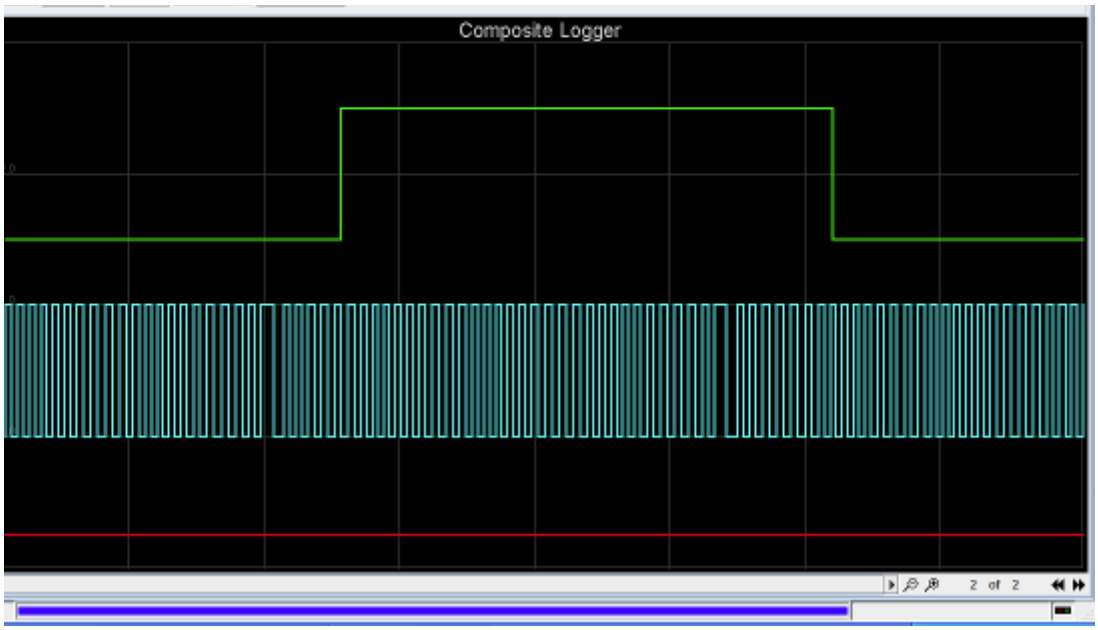
- ignition mode
- whether the cam signal is used
- noise filtering

Most ignition modes only listen for a single "edge" of the input signal and the composite logger will reflect that with a series of vertical lines for each input pulse. The cam signal will only display if the input is in use and enabled and there is a cam signal coming in.

Enabling the "noise filter" makes the ECU listen to both edges of the input signal and the display will look different for the same actual signal.

During initial setup or for test purposes the ignition mode "Log crank & cam" can be selected to put the Megasquirt into a diagnostics mode that will record the full digital signal on both crank and cam inputs. (The

engine will not run in this mode.)

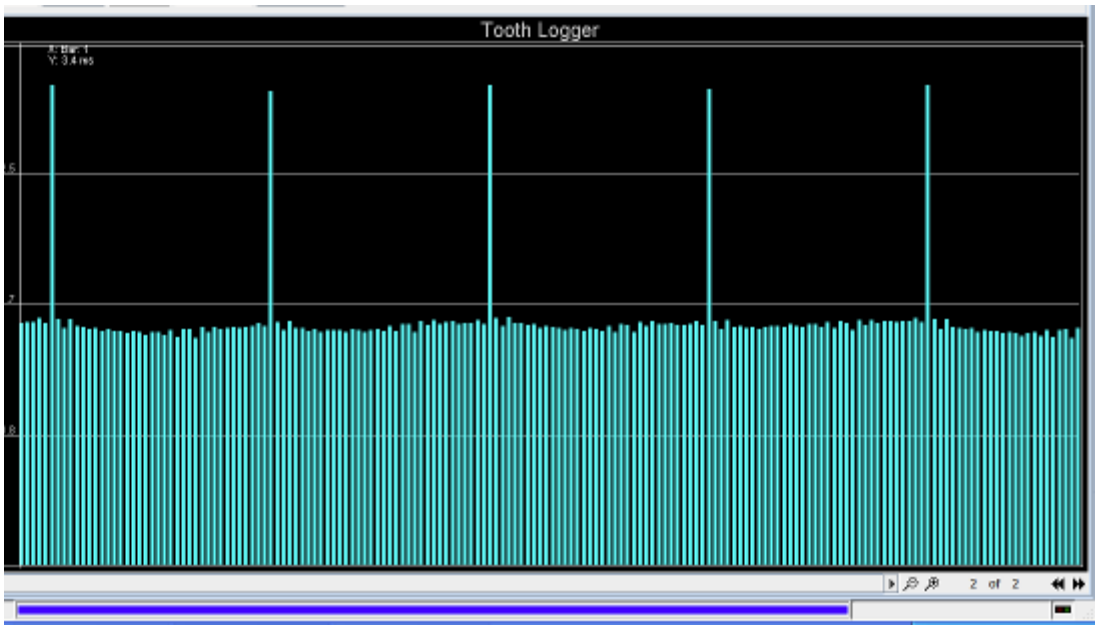


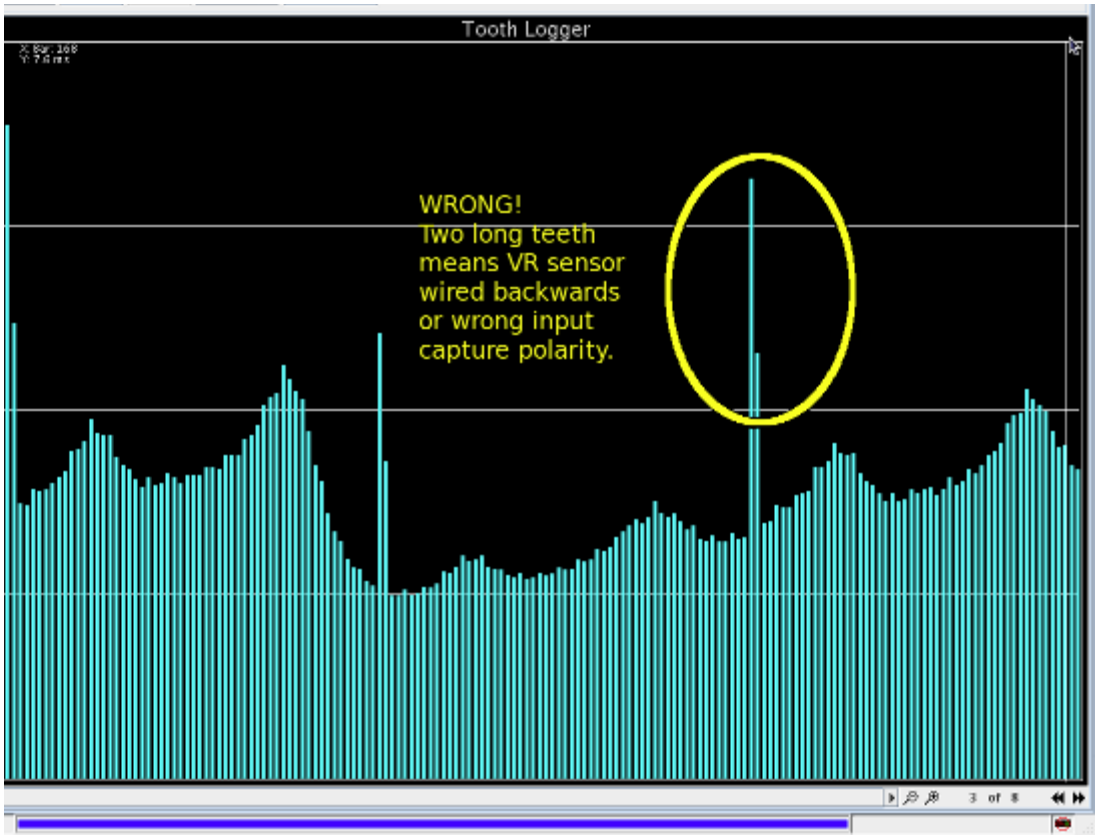
Sync Error Logger

This logger records a composite log up until a sync-loss occurs. The data shown is the crank and cam pattern that led up to the faulty signal causing sync-loss.

Tooth Logger

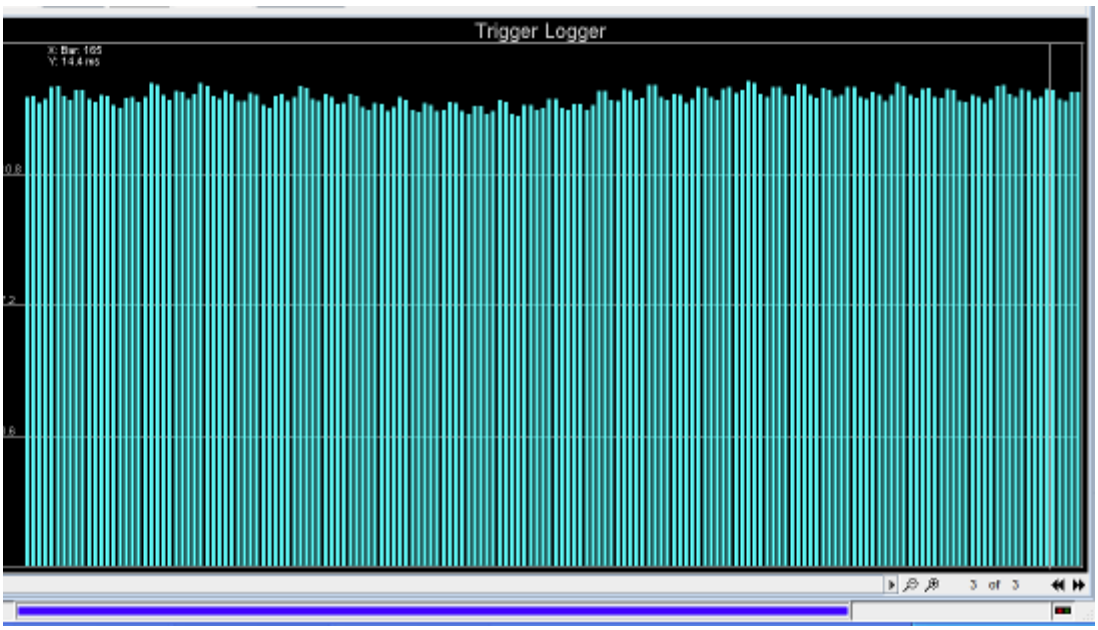
The tooth logger records just the crank pattern. It is useful for validating crank sensor polarity on missing-tooth wheels. (Correct polarity will show as a single long tooth, incorrect polarity will show as two fairly long teeth.)





Trigger Logger

The trigger logger records the internally decoded tach signal with one pulse per cylinder. This is not particularly useful for tracking down tach input problems. It will show up any uneven running of the engine.



21.2 Using the Loggers

Using the loggers is relatively straightforward. The options are described below:

Start

Starts capture of data from the Megasquirt.

Stop

Stops capture of data from the Megasquirt.

Clear

Clears the screen of any captured data.

Fetch interval

How often to collect data from the Megasquirt. This only applies to the Tooth and Trigger loggers.

During cranking when the engine is turning slowly, set the time to longer (e.g. 4000ms means 4 seconds) to enable a useful amount of data to be captured. You will need to wait at least this long before any data is displayed, so be patient.

Capture to Logfile

Enables the log to be recorded to a file on disk. The file can then be shared for support purposes.

Typical use of the logger:

Generally the following steps will enable you to capture data for analysis using one of the loggers.

- Turn on Megasquirt.
- Pick the Logger type
- Tick 'Capture to Logfile'
- Choose a filename or just press Enter.
- Click Start
- Crank the engine
- Wait for data to show
- Click Stop
- Untick “Capture to Logfile”.

21.3 Analyzing Data from the Loggers

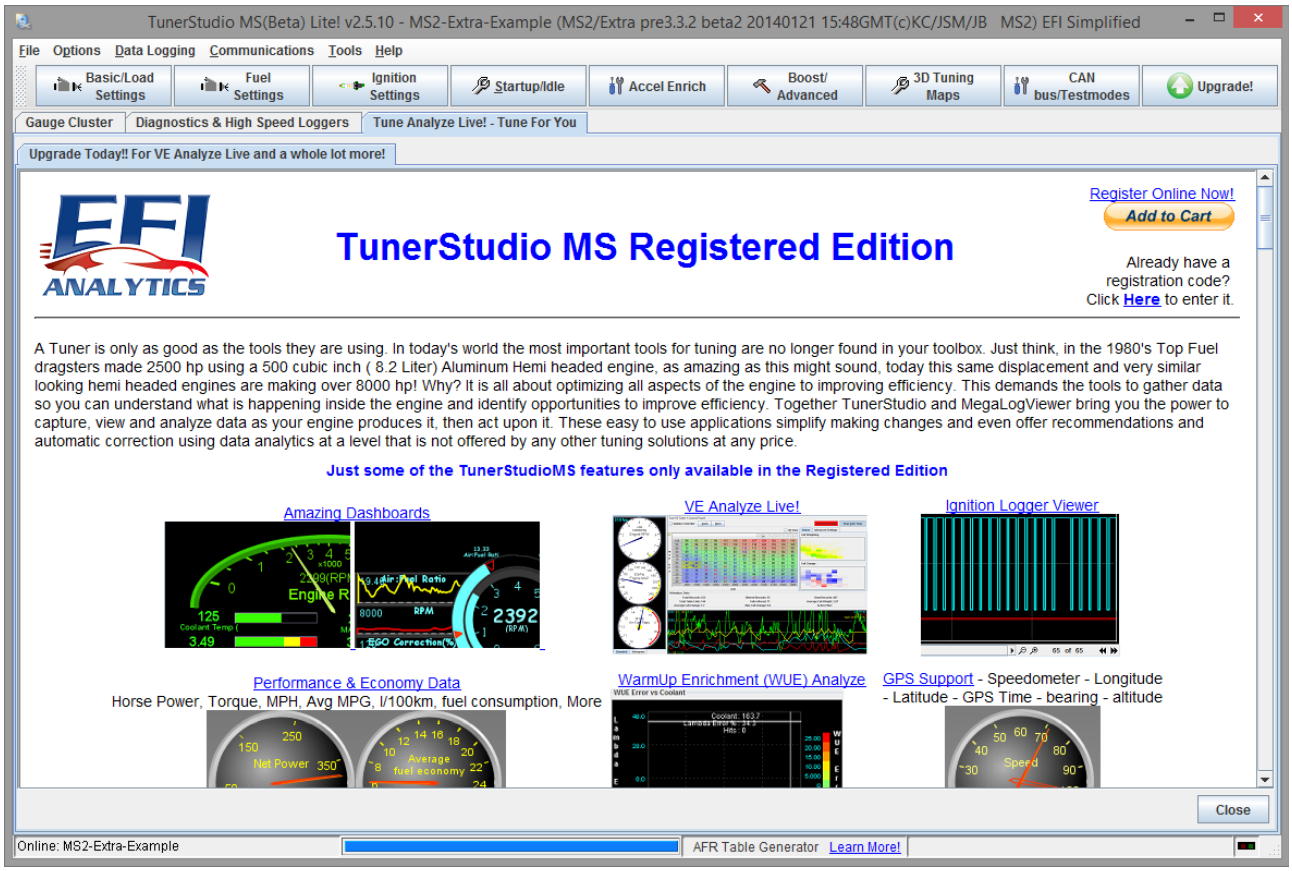
When the logger is running the data that is being collected will be displayed in the list on the left side of the screen. This screen can be re-sized using the left and right arrows on the top right of this list.

The log traces (the visual representation of the output) is displayed in the chart area on the right hand side of the screen.

Depending on your engine and your Megasquirt configuration the loggers can provide a wide range of outputs.

22 Tune Analyze Live

Tune Analyze Live is a feature of the Upgrade version of TunerStudio. Documentation of this feature lies outside the scope of this document. Clicking this option will display an upgrade screen as shown below from which it is possible to purchase a license to the upgrade version should you so wish.



23 Megasquirt Glossary of Terms

ADC – stands for "analog-to-digital converter". In this case, it is part of the conversion circuitry in the CPU that translates the varying voltage signal to a digital value that the CPU can understand and operate on. All of the sensors (TPS, MAP, CLT, MAT) send their signal to a particular ADC pin on the processor. The ADC result is used by the processor as a 'count'. MS-I has an eight bit ADC, so the counts can be from 0 to 255. MS2 and MS3 have a more precise 10-bit ADC, so the count can be from 0-1023. Both of these are mapped over a 0-5 Volt range (so the voltage into the ADC = ADC count * 5.0/1023 for MS2, for example); however, higher external voltage may be brought down to a 0-5 volt range with a voltage divider or boosted with an amplifier (such as for EGTs).

AE – Acceleration Enrichment, the enriched mixture provided when the throttle position sensor signal (TPSdot) or map sensor signal (MAPdot) changes at various rates.

AFM – Air Flow meter. Often a vane or flapper type device used to measure air-flow into an engine.

AFR – Air Fuel Ratio, the mass ratio of air to fuel in the combustion chamber. See lambda, NB- and WB-EGO sensors, below.

Alpha-N – Fuelling algorithm that uses throttle position as the primary load. Should not be used on turbocharged engines.

ASE – After Start Enrichment, the enriched mixture provided for a number of engine cycles when MegaSquirt detects that the engine has transitioned from cranking to running.

AMC – Automatic Mixture Control, a control system available in MS2/BG code to automatically tune fuel within the ECU using feedback from the oxygen sensor without use of a laptop. Should be used with great caution as a defective O2 sensor could cause a good VE table to be wiped out.

ATDC – After Top Dead Center, the crankshaft position with respect to the piston being at the top of its travel, meaning it has passed it's highest position and is descending.

Baro – Barometer - the ambient air pressure. At sea level this is around 100kPa. At high elevations it may be 80kPa. The fuelling needs to take account of this.

%baro – a fuelling algorithm where engine load = MAP/Baro and the speed-density system is used. This alters what values are looked up in the fuel VE table.

Barometric correction – a calculation that alters fuelling based on the ambient air pressure. Important at varying elevations. Of little importance in low-lying countries.

BIP373 – a robust ignition driver transistor from Bosch. Features over-currrent and over-temperature protection. Used in all good Megasquirt kits. Beware of lesser alternatives.

BTDC – Before Top Dead Center, the crankshaft position with respect to the piston being at the top of its travel, meaning it has NOT passed it's highest position and is rising. Most normal spark event occur BTDC.

CAN – (Controller Area Network) - a dedicated automotive networking system to allow different automotive processors to communicate and share inputs and calculated results. Used as a convenient way to extend the inputs and outputs of the Megasquirt ECU. (Not available on Megasquirt-1)

Carbon Monoxide (CO) – Poisonous gas produced during combustion process. In an automotive context, generally refers to regulated carbon monoxide (CO) tail pipe emissions.

CAS – Crank Angle Sensor. Often used to refer to combined crank and cam position sensors mounted where historically a distributor would have been.

Catalytic converter – a chemical device in the vehicle's exhaust system that can reduce the amount of regulated emissions emitted by converting Nox to N2 + 02, CO to CO2 and HC to CO2 + H20. Catalytic means the converter active substrate facilitates the reactions, but is not consumed (and thus has a long life with no replenishment requirements).

CID – Cubic Inch Displacement. The imperial measure of the swept volume of the pistons. 61.02 cubic inches = 1 litre.

Closed loop – refers to those times when an EFI computer is using feedback from a sensor to alter outputs

Closed loop boost – Megasquirt uses a PID to keep boost in line with a boost target table

Closed loop EGO – Megasquirt controls the EGO to the target table by varying the injected fuel amounts.

Closed loop idle – Megasquirt controls the idle rpm by opening or closing the idle valve as required.

CHT – Cylinder Head Temperature, used instead of coolant temperature (CLT) on air-cooled engines.

CKP – Crankshaft position sensor

CLT – Coolant Temperature sensor (aka. CTS). Usually the CLT sensor is an NTC (Negative Temperature Coefficient) thermistor, or a resistor whose resistance varies with temperature (NTC means the resistance goes down as the temperature goes up).

CMP – Camshaft position sensor

CNP – Coil Near Plug – See Coil on Plug

Coil On Plug – One ignition coil is installed per spark plug. Either directly on top of the plug e.g., a 'pencil' coil. Or in close proximity with a short plug-lead (actually coil near plug.) This setup can give maximum spark energy and can be the neatest install with least lost spark energy.

COP – Coil on Plug – See Coil on Plug

CPS – Possibly ambiguous Crankshaft or camshaft position sensor

CPU – Central Processing Unit, aka. "processor" or "microprocessor" the computational engine that performs the calculations to operate the injection and ignition functions in MegaSquirt®. It has a number of support circuits, like the power circuit, the clock circuit, the serial and CAN communications circuits, and various input and output conditioning circuits.

CTS – Coolant Temperature Sensor (aka. CLT). Usually the CTS is an NTC (Negative Temperature Coefficient) thermistor, or a resistor whose resistance varies with temperature (NTC means the resistance goes down as the temperature goes up.

Diode – A two lead electrical device that allows current to flow in only one direction (see also Zener diodes).

DIY – Do-It-Yourself.

DMM – (digital multi meter) electronic current/resistance/potential measuring tool. (Required tool for any Megasquirt install.) May also be referred to as DVM (digital volt meter.)

Dual table – A firmware feature allowing different injector outputs to have independent fuel tables. Can be used as an awkward method to achieve per-bank trim. More commonly used (with external relays) to map for regular fuel and LPG.

Duty Cycle – (DC)– A number indicating the amount of time that some signal is at full power. In the context of MegaSquirt EFI Controller, duty cycle is used to describe the amount of time that the injectors are on, and to describe the “hold” part of the peak and hold injector drivers (see Low Impedance Injectors, below).

ECU – (Electronic Control Unit) is the general term for a fuel injection controller, of which MegaSquirt is an example.

EDIS – Electronic Distributorless Ignition System is Ford's wasted-spark computer-controlled ignition module, which has a simple two wire hookup to MegaSquirt for full mapped ignition control.

EGO Sensor – Exhaust Gas Oxygen sensor, used to describe the sensor in the exhaust that measures the lean/rich state of the intake mixture. Used to control the fuel via a feedback algorithm called “closed loop”.

EGR – Exhaust Gas Recirculation. Used by OEMs for emissions purposes. Not supported by Megasquirt.

EGT – (Exhaust Gas Temperature) is the temperature of the exhaust gases, typically measured with a K-type thermocouple. Megasquirt does not have on-board hardware for a direct connection. An add-on board is required.

FET – (field effect transistor) - In MegaSquirt EFI Controller, the transistors used to control the activation of the

injectors.

FIdle – Fast Idle. A device used to control idle speed with additional air supplied by a vacuum solenoid. More commonly a fully variable PWM idle valve is used instead. This term is most frequently applied to a connection from the Megasquirt ECU that can be used to drive an on/off valve or a PWM valve.

Gamma – Used to indicate the change in a fuel amount from the calculated amount.

GammaE – A collection of all enrichments and minor corrections to fuel (see speed density.) Now renamed as 'totalcor'.

Gear tooth sensor – an "active", tooth presence sensor. It is based on the Hall effect. The Hall effect sensor consists of semiconductor material which will conduct current when the material is subject to a magnetic field. These types of sensors include a magnet within the sensor and will detect a steel tooth in close proximity. No external magnets are required. Very simple to use.

Gego – Gego is short for 'Gamma – Exhaust Gas Oxygen'. It is the change applied to the fuelling equation based on the EGO O2 sensor feedback. This feedback can (and is) done in a number of different ways, depending on the type of sensor, etc. The important thing is that this is a result of an external measurement, not a pure calculation, so it appears a bit mysteriously in the equation. Now renamed as 'egocor'.

Hall sensor – an "active", magnetic field presence sensor. It is based on the Hall effect. The Hall effect is the change of resistance in a semiconductor in a magnetic field. The Hall effect sensor consists of semiconductor material which will conduct current when the material is subject to a magnetic field. These types of sensors require a "flying magnet", wheel. Instead of teeth on the wheel, as in a variable reluctor sensor, you must have small magnet and a shutter wheel.

Hydrocarbon (HC): in an automotive context, generally refers to regulated unburned hydrocarbon tail pipe emissions.

HEI – , the distributor based electronically controlled ignition system from General Motors. There are a number of variants, identified by the module they use:

- 4-Pin module: non-computer controlled electronic ignition,
- 7-Pin module: computer controlled electronic ignition used in 'large cap' distributors,
- 8-Pin module: computer controlled electronic ignition used in 'small cap' distributors.

High Impedance Injectors – (a.k.a. hi-Z or high ohm) Fuel injectors designed to work with a simple switch in a 12 volt circuit, no special signal conditioning is required to drive them. The resistance of a high impedance injector is about 10-15 ohms.

Hz – (Hertz) the measurement of the frequency of a cyclical event, it represent the number of times per second the cycle is completed.

IAC – Idle Air Controller, though this term is sometimes used more generally, it usually refers to GM's 4 wire stepper motor controller for additional idle air (and hence engine speed) during warm-up and for idle regulation.

IAT sensor – Intake Air Temperature sensor, same as MAT, see below.

IGBT – Insulated Gate Bipolar Transistor a particular kind of transistor especially suitable for driving ignition coils. e.g., VB921, BIP373

Incorporate AFR – An MS2 and MS3 feature where the AFR target table is included in the fuelling equation. The Fuel VE table then becomes far closer to a true VE table. Enrichment or enleanment from stoichiometric comes from the AFR table. Ideally this setting should be turned on before any tuning and the AFR table set to your target AFRs. Then the VE table is tuned to achieve that AFR. Turning the setting on/off will require a complete re-tune.

Interpolate – The dictionary meaning is to insert an intermediate value into a series by estimating or calculating it from surrounding known values. On all tables and curves, when you are between points, the Megasquirt interpolates the intermediate values. Some older other brands were unable to do this and required monstrously large tables to overcome this limitation.

kPa (kiloPascals) – the measurement of air pressure used in MegaSquirt® computations. It ranges from 0 (vacuum) to 101.3 kPa (standard atmospheric pressure at sea level) to 250 kPa (21psi of boost) or higher.

Lambda – an alternative term to AFR where 1.0 is stoichiometric. Lambda numbering is fuel independent. 1.0 is always stoich.

Low Impedance Injectors – (a.k.a low-Z, low ohm) Fuel injectors that are designed to run at a much lower current than would be supplied by a direct 12 volt connection. They require a special signal that is initially at full current (4-6 amps, a.k.a. “peak current”) for about 1.0-1.5 ms, but then drops down to about 1 amp (“hold current”) for the rest of the opening pulse. The resistance of a low-impedance injector is typically 1-3 ohms. These may need a "peak and hold" board or a resistor pack.

LSU-4 – Bosch wide-band oxygen sensor.

MAF sensor – Mass Air Flow sensor. A sensor used to measure the mass of air flow through the intake tract (which must be sealed at the senor and downstream).

MAP sensor – Manifold Absolute Pressure sensor. Measure of the absolute pressure in the intake manifold (related to the engine vacuum), to determine the load on the engine and the consequent fueling requirements. The standard MAP sensor in MegaSquirt® is the MPX4250 (2.50 BAR, or 15 psi (vacuum) + 21 psig (boost)). A basis of the "speed density" fuelling algorithm.

MAPdot – rate of change of MAP value. (dMAP/dt) Used mainly to trigger Accel enrichment.

MAT Sensor – Manifold Air Temperature sensor, the same as IAT. The MAT circuit is identical to the CLT circuit, see CLT, above.

.MSL – file extension used by the MegaSquirt for storing datalogs (.XLS might also be used for datalogs with older versions of tuning software).

MPX4250AP – the standard internal MAP sensor used in MegaSquirt.

MS – MegaSquirt, used in this document to refer to the MegaSquirt® fuel injection controller or its embedded software. e.g., MS1 = Megasquirt-1, MS2 = Megasquirt-2, MS3 = Megasquirt-3

MS1/Extra – The most commonly used firmware on the Megasquirt-1 chip. Gives fuel and spark control. Used to be called Megasquirt'n'spark-extra or MSnS-extra. The original basic MS1 code was fuel only.

MS2/Extra – Firmware for the MS2 chip and Microsquirt with multiple spark outputs, many wheel decoders, closed loop idle, boost, nitrous, table switching and more

MS2/BG – More basic firmware for the MS2 chip and Microsquirt from Bowling and Grippo.

.MSQ – file extension used for saving MegaSquirt fuel injection controller user settings (aka. "parameters") on a tuning computer. Since approximately 2005, these have been readable XML format, so you can open these in Notepad or similar text editors. This format allows some exchange of tune data between different code versions.

NB-EGO Sensor – Narrow Band EGO sensor, gives a switch at the stoichiometric ratio (the chemically correct mixture of air and fuel), but unreliable for AFR other than stoichiometric.

Ohm's Law – A fundamental law of electricity, that states that the current flow (I) is equal to the voltage (V) divided by the resistance (R), or:

$$I = V/R$$

Oxides of Nitrogen (NOx) – in an automotive context, generally refers to regulated 'mono-nitrogen oxides' (NO and NO2) tail pipe emissions.

OEM – (original equipment manufacturer) - refers to parts produced for initial assembly of a new vehicle. (As opposed to after market parts.)

Open Loop – refers to those times when MegaSquirt works entirely from its calculations with no feedback from a sensor (compare Closed Loop.)

Open Loop Boost – there is no feedback from the map sensor – boost duty is controlled by the duty table only.

Open Loop EGO – there is no feedback from the oxygen sensor – fuelling is from the VE table only.

Open Loop Idle – there is no feedback loop with rpm – idle valve position is set only from the table.

PCB – (printed circuit board) – the fiberglass board that has the MegaSquirt component layout and circuits imprinted on it.

PID – (Proportional, Integral, Derivative) - a method of closed-loop feedback control

Pull-up Circuit – A very simple circuit consisting of a voltage supply and a current limiting resistor designed to prevent a signal from floating, it forces the signal to either be high (equal to the pull up voltage) or low (grounded).

P&H Injectors – Peak and hold injectors; see Low Impedance injectors.

PIP – Profile Ignition Pick-up is the term used for the signal sent from Ford's Electronic Distributorless Ignition System (EDIS) to the electronic control unit. The EDIS module decodes the 36-1 wheel and sends 2, 3 or 4 PIP pulses per engine revolution depending on EDIS4,6,8. The PIP signal into the ECU is a square wave switched at 12 volts. It provides information about both the engine speed and position.

PW – (Pulse Width) is the amount of time a signal is applied during each period. For example, is the amount of time (in milliseconds) an injector is pulled low (grounded) to inject fuel.

Pulse Width Modulation (PWM) – A signal with a fixed pulse width (frequency), which is turned on for part of the pulse. The percent of time that the signal is on is called its duty cycle. PWM is used to limit current to low impedance fuel injectors, as well as for solenoids such as idle valves, boost solenoids and VVT

Realtime baro – a dedicated second pressure sensor is used to monitor ambient pressure. Required if your vehicle will go on journeys at varying elevations.

Required Fuel – (Req_Fuel) The injector pulse width, in milliseconds, required to supply the fuel for a single injection event at stoichiometric combustion, 100% volumetric efficiency and standard temperature.

RPM – Revs Per Minute. The term used to describe engine speed.

SAW – Spark Advance Word is the 'returning' signal to a Ford EDIS ignition unit from the ECU that sets the amount of ignition advance requested. It is in the form of a 5 volt square wave.

Semi-sequential – Fuelling system where injection events are timed to each cylinder (like spark is) but occur twice per cycle. Offers some of the benefits of full sequential without needing a cam wheel input.

(Fully) Sequential – Fuelling system where injection events are timed to each cylinder (like spark is) and occur once per cycle. Do not confuse with direct injection. Sequential uses normal injectors of a normal size, but their timing can give slight power and/or economy increases

Stim (MegaStimulator) – the original stimulator is a small board which plugs into the connector of the MegaSquirt® controller. It simulates all the sensor the inputs the MegaSquirt® controller would normally see (but the rpm signal is only suitable for use with distributor or EDIS configurations) and provides power to the MegaSquirt® controller. The Stimulator also allows you to monitor the MegaSquirt® controller's injection pulses [actual], fuel pump relay operation, and fast idle solenoid output with four LEDs. The JimStim is an enhanced version that simulates many wheel patterns and has more LEDs for multiple spark outputs.

Speed Density – Fuel control algorithm that calculates fuelling based primarily on pressure, air temperature and volumetric efficiency.
PW = dead time + (ReqFuel * MAP * VE(rpm,map) * GammaE)
All the corrections are included within GammaE.

Stoichiometric – the chemically ideal air:fuel mixture. Expressed as 1.0 Lambda for all fuels or 14.7 for petroleum/gasoline.

SPOUT – Spark Out is the spark advance signal sent from MS-II™ to the Ford TFI module to set the timing advance.

Table blending – A firmware feature that allows the user to combine two tables, usually using different algorithms. e.g., one table could be a regular speed-density table and the other alpha-n. This could be useful on an individual throttle body install or as a way of extending the table size.

Table switching – A firmware feature that allows the user to swap to a different fuel, spark, etc table. Can be

used in conjunction with dual fuels or nitrous or as a way of extending the table size.

TBI – Throttle Body Injection is a form of injection is which the fuel is injected above the throttle(s). It was typically used on older engines since it can be a simpler system, but is also found on some very high output racing engines because the vaporization time is longer than with port injection.

TPI – Tuned Port Injection is General Motors bank-fire port fuel injection system. It was widely used on 305 and 350 cid V8 in the mid to late 1980's.

TPS – Throttle Position Sensor, a voltage divider that gives information to a MegaSquirt® controller about throttle opening, from which it computes rate of throttle opening for acceleration enrichment.

TPSdot – rate of change of TPS value. (dTPS/dt) Used mainly to trigger Accel enrichment.

Transistor – A solid-state (no moving parts) electronic device that uses a small voltage (on the base pin) to control a larger current (across the emitter and collector pins). There are two basic types of transistors, PNP and NPN. A PNP transistor allows current to flow if there is no signal on the base, and restricts the current as the base current increases. An NPN transistor allows current to flow in proportion to the signal on the base, and restricts the current as the base current decreases.

TS (TunerStudio MS) – The standard software for tuning MegaSquirt EFI controllers. (The previous, now obsolete, software was called Megatune.)

Volatile Organic Compounds (VOC) – in an automotive context, generally refers to organic components or precursors to smog formation. Organic compounds are all chemical compounds containing carbon-hydrogen (C-H) bonds of covalent character. The U.S. Environmental Protection Agency defines a VOC as any organic compound that participates in a photoreaction. An example of a VOC is PAN (peroxyacetyl nitrate), CH3COOONO2.

Voltage divider – A simple circuit that uses two resistors in series to reduce the output voltage Vo proportionally to the input voltage Vi. Two resistors, R1 and R2, are arranged in series, with one end connected to the external signal, and the other to ground. The signal is taken from between the two resistors. From Ohm's Law we can calculate that the total current will be I = Vi/(R1+R2). The same current flows in each resistor because they are in series. The voltage drop across each resistor is: V1 = I*R1 and V2 = I*R2 = Vo. V2 is output voltage Vo, which we can write as:

$$Vo = Vi* R2/(R1+R2)$$

V2.2 – The first mainstream circuit board used within Megasquirt. While still available for sale, it is largely obsolete.

V3.0 – The current circuit board used within Megasquirt (accurate Nov 2010). This superceded the V2.2 adding better support for low-z injectors and a circuit for VR conditioning.

V3.57 – A surface mount circuit board, largely the same as the V3.0 board.

VB921 – a particular IGBT designed for use with automotive ignition coils. Now superceded by BIP373.

VE – Volumetric Efficiency. The actual amount of air being pumped by the engine as compared to its theoretical maximum. A 2000 cc engine will theoretically move 2000 cc of air in one cycle at 100% efficiency. If the engine is actually running at 75% VE, then it will move 1500 cc of air on each cycle.

Vref – a 5 Volt supply used to power the TPS (and sometimes other external components needing a 5 Volt supply, like ignition modules or pull-ups).

VR sensor - Variable reluctor sensor – is an induction type sensor, it is "passive", i.e., it does not require a power source, and has a small magnet built in. Needs to use a conditioning circuit – as provided on the V3.0 and V3.57 mainboard. Cannot be used directly on the V2.2 mainboard.

Wasted-COP – a method where individual coils are fitted per spark plug, but the coils are fired in a 'wasted' manner twice per cycle. This is used during startup in some wheel modes and could also be used temporarily by a user before full coil-on-plug is installed.

Wasted Spark – A method of firing spark plugs in which one 'double-ended' coil simultaneously fires two coils on different cylinders. One of the cylinders is the intended 'target', and is near TDC on its compression stroke,

the other cylinder is offset by 360° in the firing order (of the 720° 4-stroke cycle), so it is near TDC on its exhaust stroke. The second spark is said to be 'wasted' because it does not ignite a mixture. On the other hand, the hot ionized exhaust gases require little energy to create a spark, so nearly all the energy goes to the 'target' cylinder. An example of a wasted spark system is Ford's EDIS. The advantage is that while a missing tooth crank wheel is required, no cam sync signal (and the corresponding wheel and sensor) are needed.

WB-EGO Sensor – Wide Band EGO sensor, can be used to derive real AFR data with mixtures from 10:1 to 20:1, i.e., anything you are likely to be interested in. Allows for lean or rich tuning.

WOT – Wide open throttle.

WUE – Warm Up Enrichment, the enriched mixture applied when the coolant temperature is low.

Zener diode – A diode that allows current to flow in one direction, unless the reverse voltage is higher than its rated avalanche voltage, in which case it will flow in the reverse direction. Often used to limit excessive voltage to certain circuits by shunting it either to ground or the power supply.

24 Revision history

2014-09-08	Revision history started. Minor edits.
2014-11-17	CEL status correction
2014-12-01	MS2->MS3 typo correction.
2015-01-30	Fix some typos. Gloassary from Setting Up. Add A/C idleup invert input.
2015-02-02	Minor staging typo.
2015-03-23	Staging notes.
2015-04-08	Add missing sections: Shift Light, Fan Control, Torque Convertor Lockup, Alternator control.
2015-06-16	More MS2 typo corrections.