FrankenCIS
Microsquirt Manual supplement

REANIMOTION ENGINEERING

A SUBSIDIARY OF REANIMOTION INTERNATIONAL

FrankenCIS

Printed: August 2018

Publisher

Reanimotion Engineering Pty Ltd

Managing Editor

Steve

Table of Contents

Part I

1 Introduction

FrankenCIS is a software and hardware project to allow the MegaSquirt family of engine controllers to replace the Bosch WUR or control the DPR/EHA valve on later systems.
In its simplest implementation - mimicking the WUR by a temperature to bar map and closed loop pressure control. With optional interceptor like +- control of fuel mixture using the full mapping abilities of the MegaSquirt family.

More advanced implementations - the sky is the limit really, Spark and Idle control, Full fuel mapping, Closed loop wideband O2 control, Boost enrichment and or pressure control, and so on.

This document should be used in conjunction with the Microsquirt Hardware Manual available from MSExtra.com (http://www.msextra.com/manuals/ms2manuals/)

How are we doing it?

We have created a new firmware or operating system based on the MS2extra code and MegaSquirt hardware which retains all the relevant EFI tuning, spark control and accessory features, but when switched into one of the K-Jet / CIS modes completely changes the way it interacts with the fuel side of the system.

- K-Jetronic basic - controls an electronic WUR block by targeting a control pressure map referencing Time/Temperature. MS2Extra firmware has been modified to change a "Squirt per Rev" to mapped fuel pressure control on Injector1. The target pressure is taken from a new map representing the WUR basic bar/temp curve and then modified by percentage according to changes in the remaining tuning options. The standard style EFI Load and RPM referenced fuel demand map is them mixed in on top to provide an enhanced version of the manifold pressure adjustment available in the standard mechanical WUR.

- K-Jetronic Lambda - as above with the addition of a second map table controlling the Frequency Valve or equivalent. in this mode we also split the additional EFI style tuning features between the WUR and FV where appropriate.

- KE-Jetronic - completely different to the first two, No WUR, No Frequency Valve, static control pressure and complete control of the differential pressure between the top and bottom chambers of the Fuel Distributor. This option requires a small interface module between the DPR (sometimes called EHA) and the MicroSquirt to convert the injector control signals.

THIS PRODUCT MAY BE USED SOLELY ON VEHICLES USED IN SANCTIONED COMPETITION WHICH MAY NEVER BE USED UPON A PUBLIC ROAD OR HIGHWAY, UNLESS PERMITTED BY SPECIFIC REGULATORY EXEMPTION (VISIT THE “EMISSIONS” PAGE AT HTTP://WWW.SEMASAN.COM/EMISSIONS FOR STATE BY STATE DETAILS.

IT IS THE RESPONSIBILITY OF THE INSTALLER AND/OR USER OF THIS PRODUCT TO ENSURE THAT IT IS USED IN COMPLIANCE WITH ALL APPLICABLE LAWS AND REGULATIONS. IF THIS PRODUCT WAS PURCHASED IN ERROR, DO NOT INSTALL AND/OR USE IT. THE PURCHASER MUST ARRANGE

TO RETURN THE PRODUCT(S) FOR A FULL REFUND.

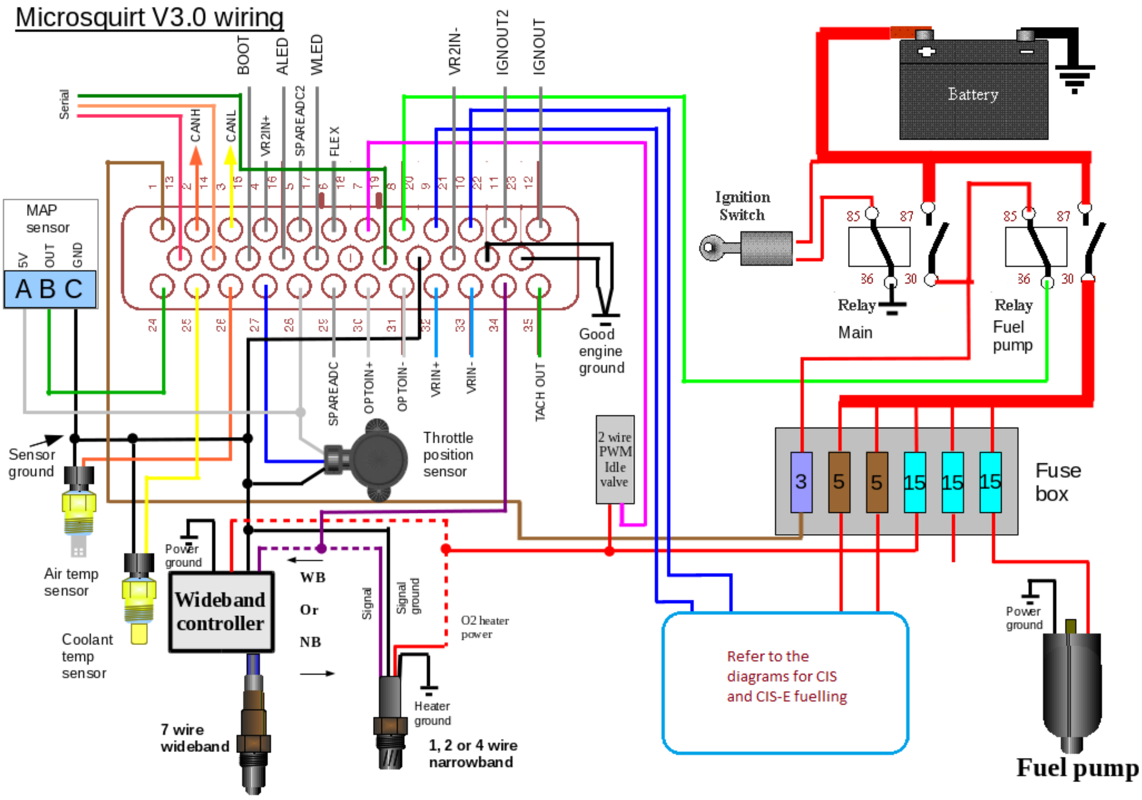
THIS POLICY ONLY APPLIES TO INSTALLERS AND/OR USERS WHO ARE LOCATED IN THE UNITED STATES, HOWEVER CUSTOMERS WHO RESIDE IN OTHER COUNTRIES SHOULD ACT IN ACCORDANCE WITH THEIR LOCAL LAWS AND REGULATIONS.

WARNING:
This installation is not for the tuning novice! Use this system with EXTREME caution! FrankenCIS allows for total flexibility in engine tuning. Misuse or improper tuning of this product can destroy your engine! If you are not well versed in engine dynamics and the tuning of engine management systems DO NOT attempt the installation. Refer the installation to an FrankenCIS-trained tuning shop or call +61 7 3256 5600 for technical assistance.

NOTE: All supplied FrankenCIS calibrations, Wizards and other tuning information are offered as potential starting points only. IT IS THE RESPONSIBILITY OF THE ENGINE TUNER TO ULTIMATELY CONFIRM IF THE CALIBRATION IS SAFE FOR ITS INTENDED USE. FrankenCIS holds no responsibility for any engine damage that results from the misuse or mistuning of this product!

Part II

2 Wiring



General system wiring overview above. Individual installations may vary.

Fuelling and Spare ADC connections to the control pressure sensor will depend on the version of CIS and FrankenCIS components installed.
The throttle position sensor can be ignored or added if required for CIS and would normally be connected to the Air Plate Potentiometer in CIS-E installations.
Spark and Idle control outputs are optional etc.

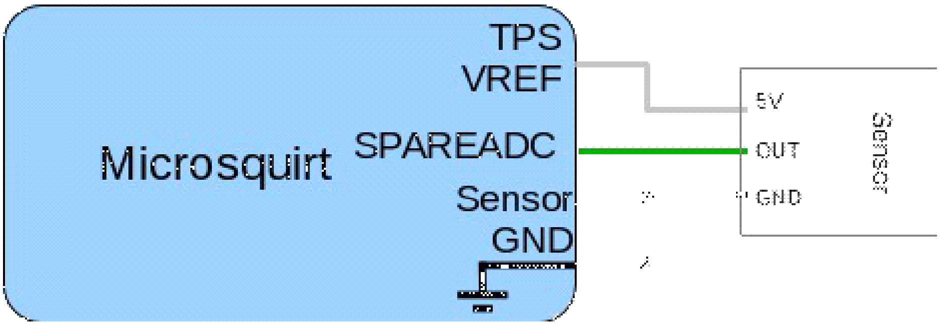
Pin#	Name	Color	In/Out	Function	Max current
1	+12V In	Red	In	Main power feed	< 1A
2	CANH	Blue/Yellow	Comms	CAN communications	-
3	CANL	Blue/Red	Comms	CAN communications	-
4	VR2+	VR2	In	'Cam' tach in	-
5	SPAREADC2 (MAF)	Pink/Black	In	Spare analogue input	-
6	FLEX	Purple/White	In	Flex / spare input	-
7	FIDLE	Green	Out	Idle valve output	3A
8	FP (pump)	Purple	Out	Fuel pump relay output	3A

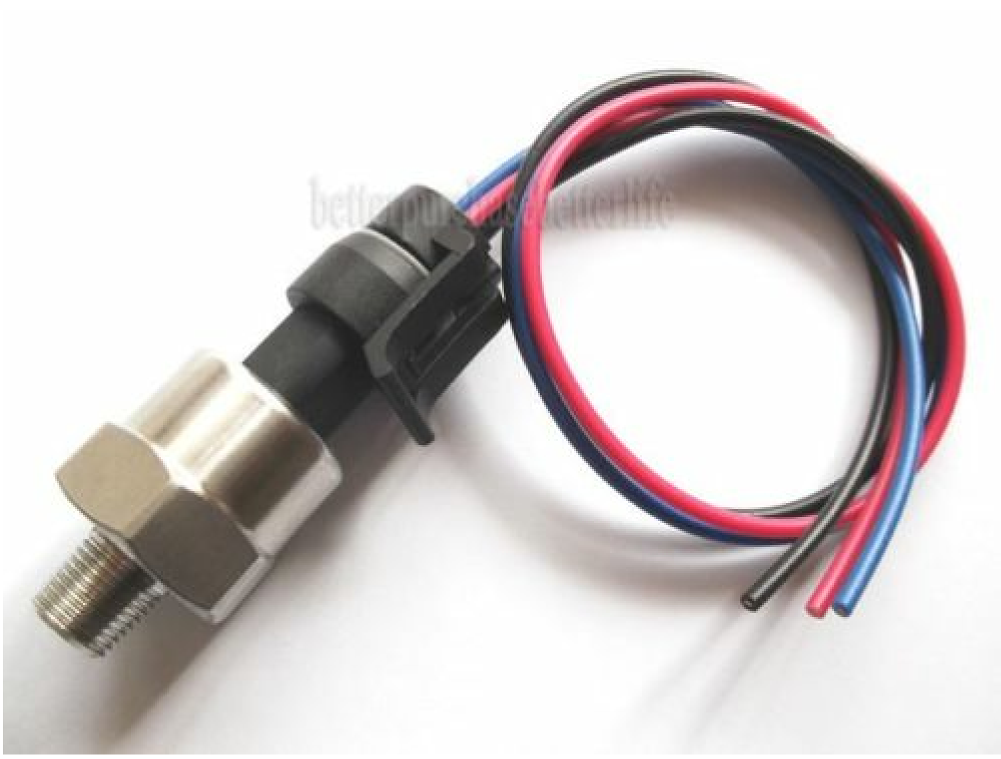
9	FUEL A	Thick Green	Out	FrankenCIS or DPR 5	5A
10	FUEL B	Thick Blue	Out	Frequency Valve or DPR 2	5A
11	SPK B (IGN2)	Thick White/Red	Out	Spark B logic output	0.02A
12	SPK A (IGN 1)	Thick White	Out	Spark A logic output	0.02A
13	RX	-	Comms	RS232 communications	-
14	TX	-	Comms	RS232 communications	-
15	BOOT LOAD	Purple/Black	In	Bootloader enable input	-
16	ALED	Yellow/Black	Out	Spare relay output	3A
17	WLED	Yellow/White	Out	Spare relay output	3A
18	Sensor Ground	-	GND	Not installed	-
19	Serial Ground	-	GND	Serial Ground	-
20	Sensor Ground	White/Black	GND	Sensor Ground	-
21	VR2-	VR2	In	'Cam' tach in	-
22	POWER GROUND	Thick Black	GND	POWER GROUND	-
23	POWER GROUND	Thick Black	GND	POWER GROUND	-
24	MAP	Green/Red	In	MAP sensor input	-
25	CLT	Yellow	In	CLT sensor input	-
26	MAT	Orange	In	MAT sensor input	-
27	TPS	Blue	In	TP Sensor input	-
28	TPS VREF (5V)	Gray	Out	5V supply for TPS	0.1A
29	CONTROL PRESSURE	Orange/Green	In	Control Pressure Sensor	-
30	OPTO+	Grey/Red	In	Coil negative tach in	-
31	OPTO-	Grey/Black	In	Coil negative tach in	-
32	VR1+	VR1	In	'Crank' tach in	-
33	VR1-	VR1	In	'Crank' tach in	-
34	O2	Pink	In	Oxygen/lambda sensor in	-
35	TACHO	Green/Yellow	Out	Tacho / rev counter out	0.3A

2.1 3.4.9 Spare ADC / Control Pressure

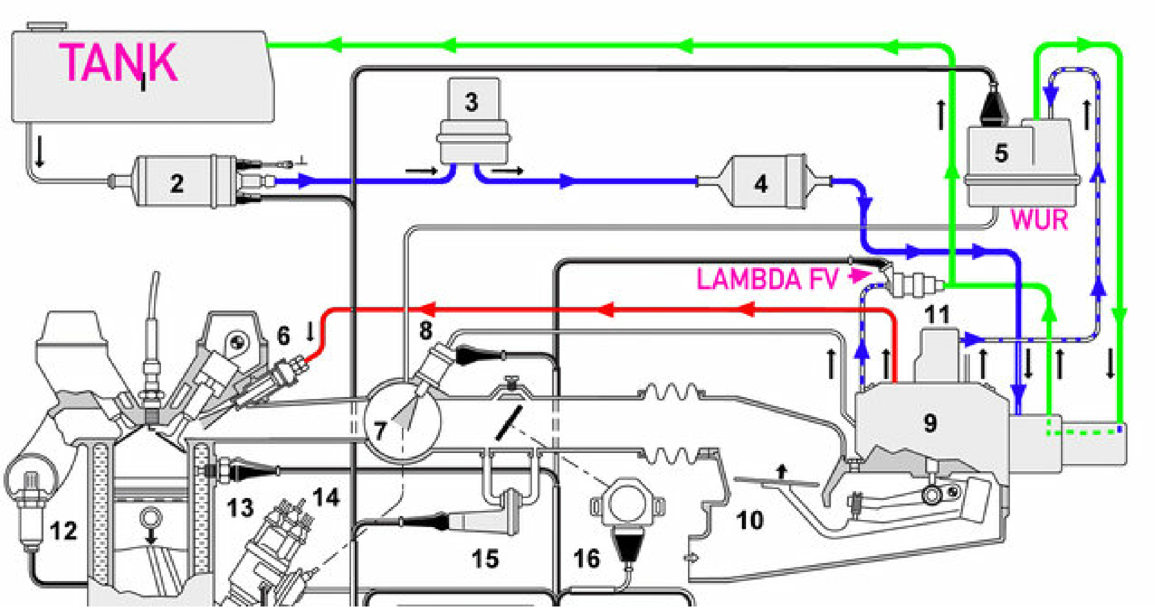
Spare ADC is Pin 29 - Orange / Green on the MicroSquirt

The SPAREADC input is used for Control Pressure Measurement for CIS installations and can also be utilized as a lower chamber pressure monitor in CIS-E installs
Fitted either in line or directly to the FrankenCIS metering block, the fuel pressure sensor in the control pressure circuit provides actual Control Pressure in kPa and is used in the Target Pressure feedback loop calculations within the MicroSquirt.

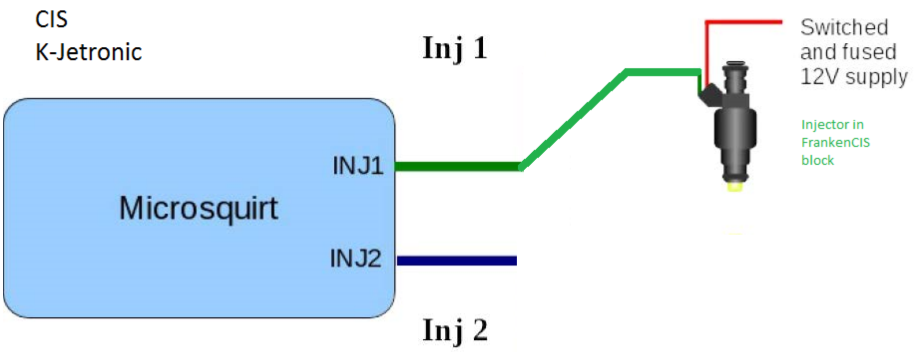

TPS
VREF
Microsquirt
SPAREADC
Sensor
GND
5V
OUT
GND
Sensor

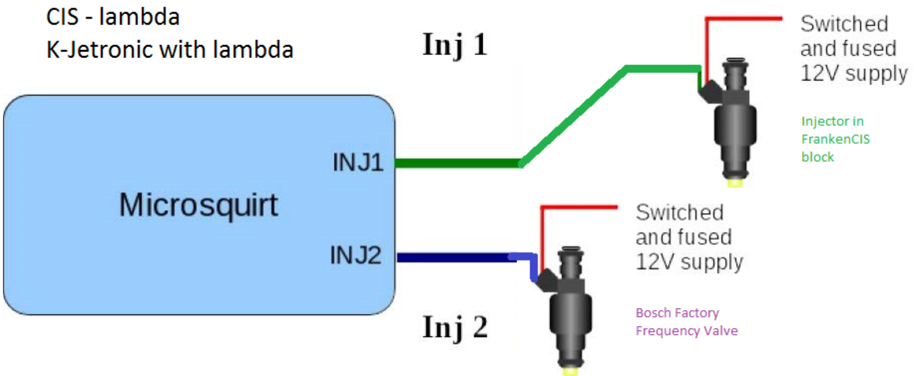


2.2 4 Fuel System - CIS

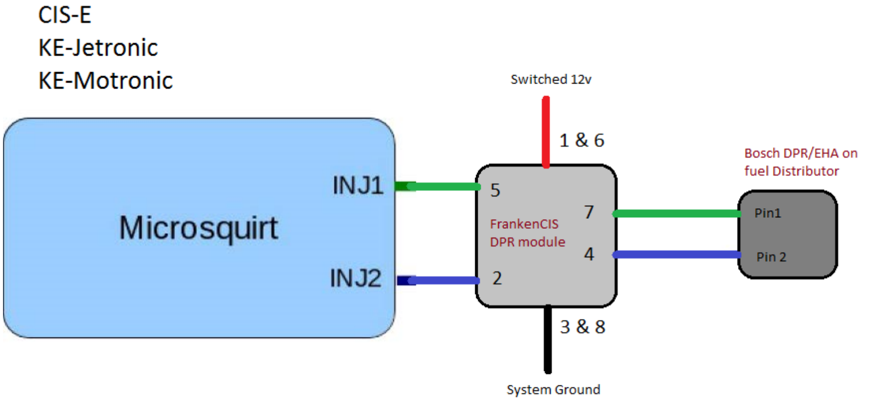


FrankenCIS replaces the Bosch Warm Up Regulator at 5, and optionally controls the Frequency Valve at 11

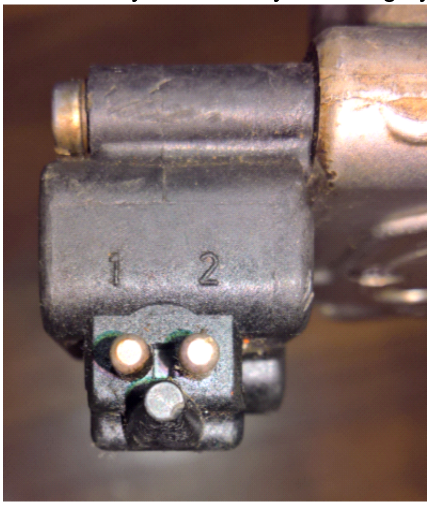




2.3 4 Fuel System - CIS-E



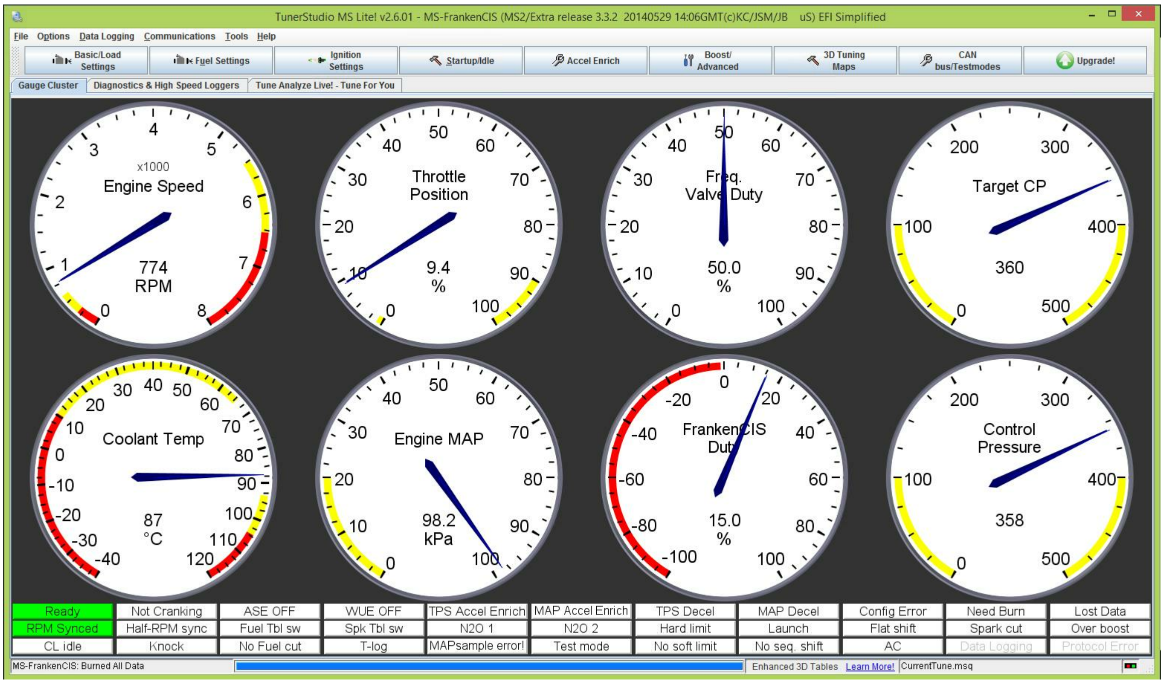
Please note: the pin numbers on the Bosch DPR/EHA harness plug for Mercedes vehicles are wrong.
Make sure you confirm your wiring by verifying the numbers on the actual DPR/EHA as shown



Part III

3 System Setup and Tuning

After loading the project and connecting to the microsquirt as per the main manual, the screen should look similar to the following



Under Engine and Sequential settings, the Injector Port Type must be set to correctly match the FrankenCIS system installed, and the number of cylinders should match the target motor.
The remaining settings should reflect the installation configuration with a couple of exceptions

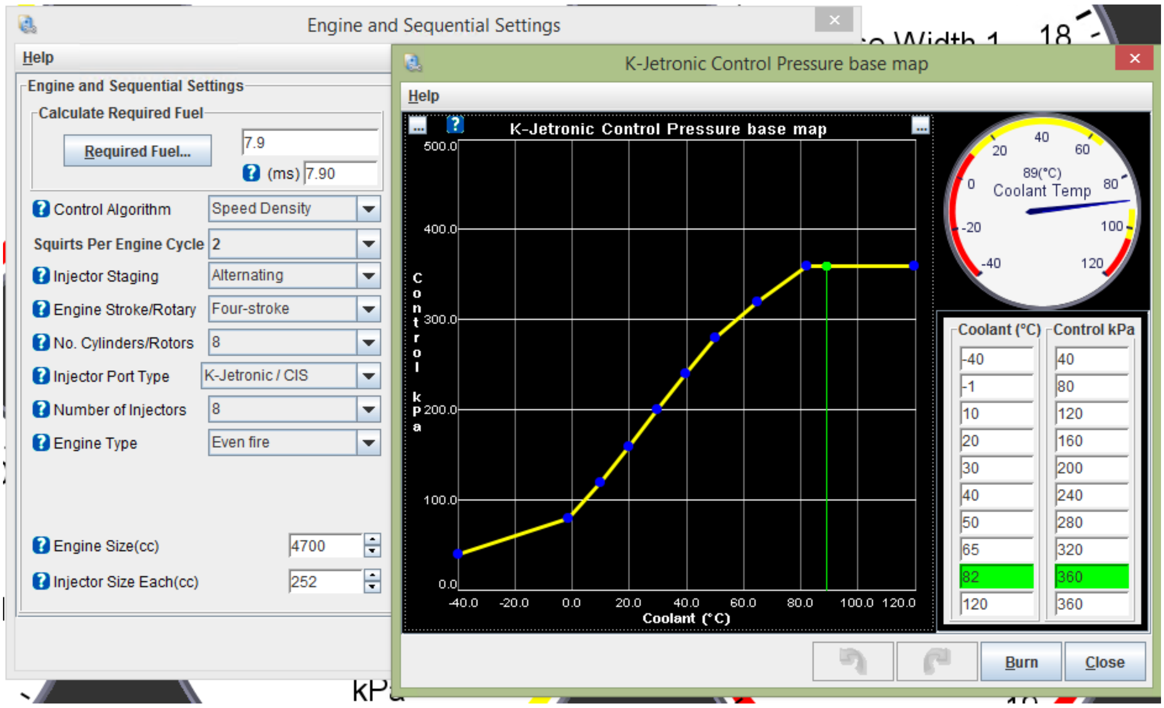
Squirts per engine cycle is now irrelevant but should be left at 2 or 'constant' if available
Injector size is also no longer a real value but should be close to the estimated fuel flow per injector if known otherwise 252 is a good number

If doing an install with the FrankenCIS eWUR then refer to the CIS with WUR section

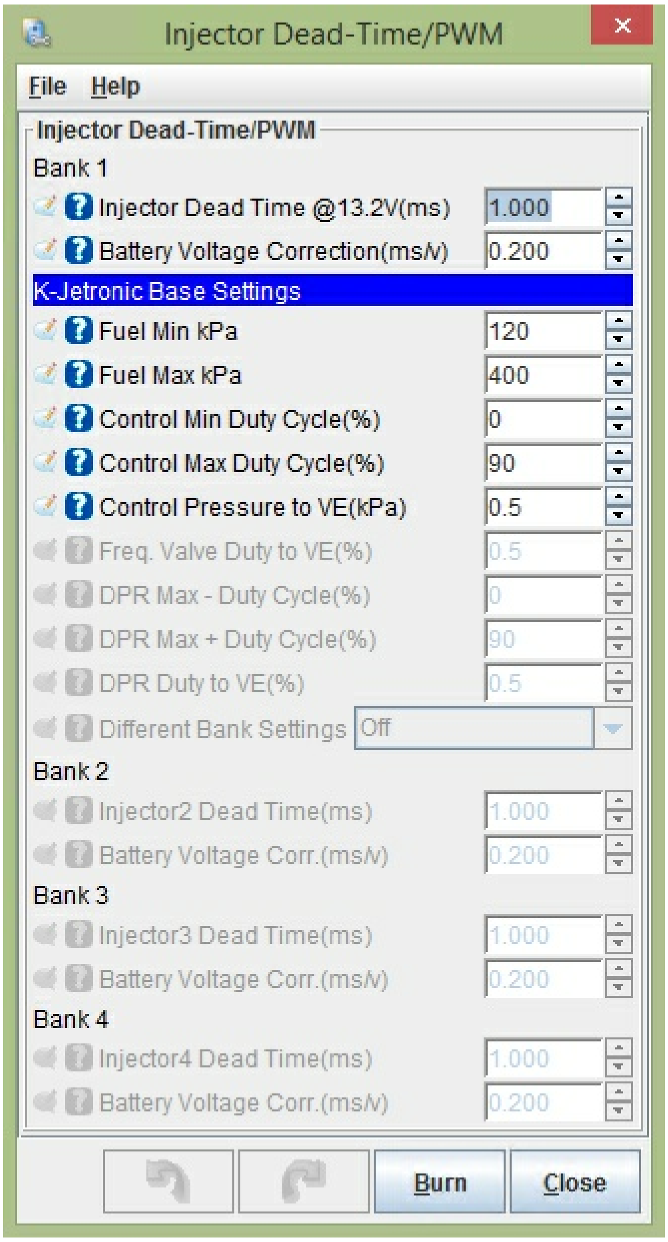
If doing an install with the FrankenCIS DPR Interface then refer to the CIS-E section

Throughout the system click or mouse over the blue question mark for an explanation of the setting

3.1 - CIS with WUR



Injector Dead Time PWM contains some FrankenCIS specific settings for range and resolution

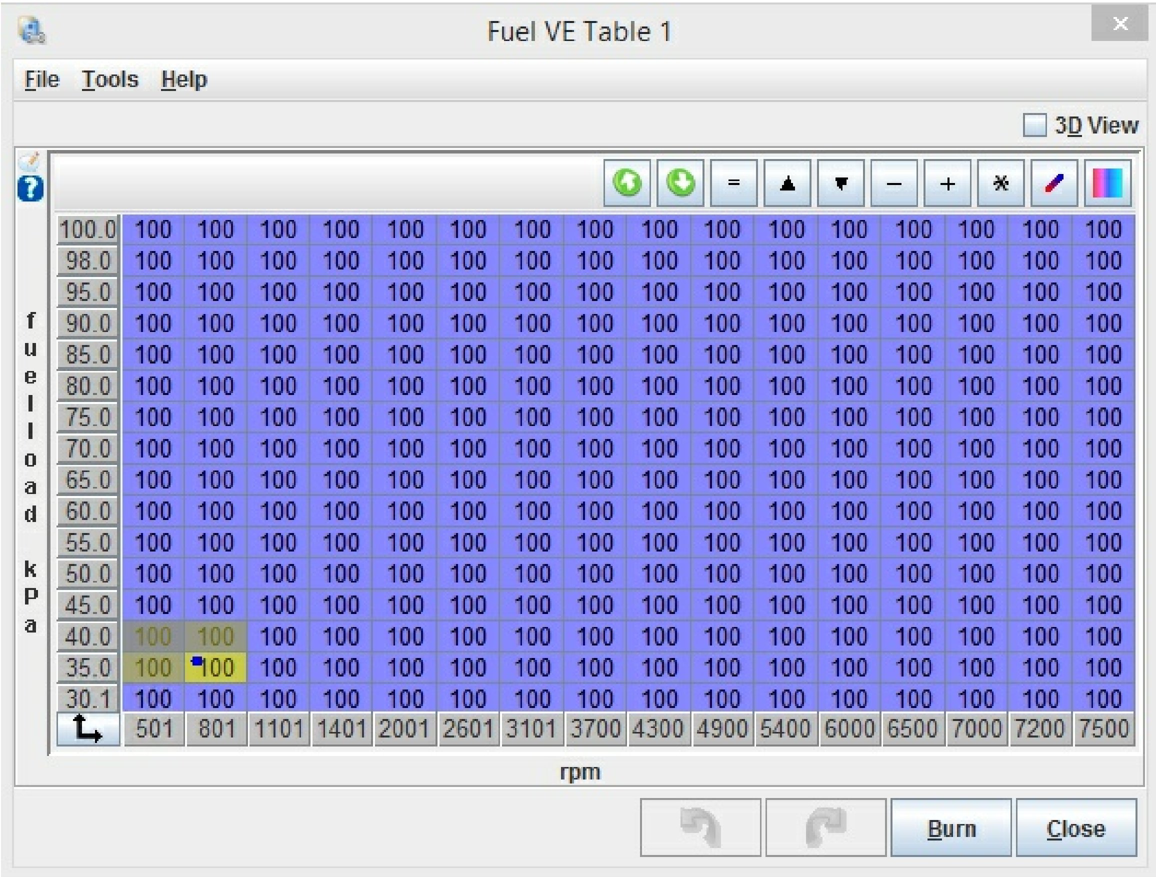


The starting point for the settings above can be adjusted to suit your installation

The kPa to VE factor. how many kPA to 1 point (0.1%) of VE.

The system converts a desired VE change to target kPA change using this multiplier

VE tables are the main point of adjustment for the running fuel trim and should begin as a flat 100 across all cells



	501	801	1101	1401	2001	2601	3101	3700	4300	4900	5400	6000	6500	7000	7200	7500
100.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
98.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
95.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
90.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
85.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
80.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
75.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
70.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
65.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
60.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
55.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
50.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
45.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
40.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
35.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
30.1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

If set to the Lambda version and Inj2 is properly connected the the factory Frequency Valve then a second VE table is available by turning on Dual Table Use in General Settings
This gives individual control of both systems

VE Table 1 has control of the eWUR
and a mid point of 100 in the table

VE Table 2 has control of the Frequency Valve
and by default with Freq valve to VE(%) set to 1.0
ranges between 0-200 with 100 being the unadjusted mid point in the cells and 50% duty at the valve

optionally with Freq valve to VE(%) set to 2.0
ranges between 0-100 with 50 being the unadjusted mid point in the cells

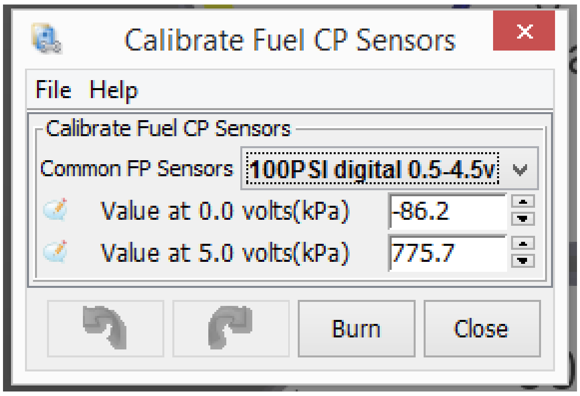
Basically the frequency valve has a range of Zero to 100% and normal operation is at 50% with lower being lean and higher being rich

With our standard table setup we have a value of 100 in the cells as normal so 101 to 200 tunes a richer mixture and below 100 leans it out
This is with "Freq valve Duty to VE%" set to 1.0 or a 1:1 ratio as we are actually controlling the valve in half percent steps

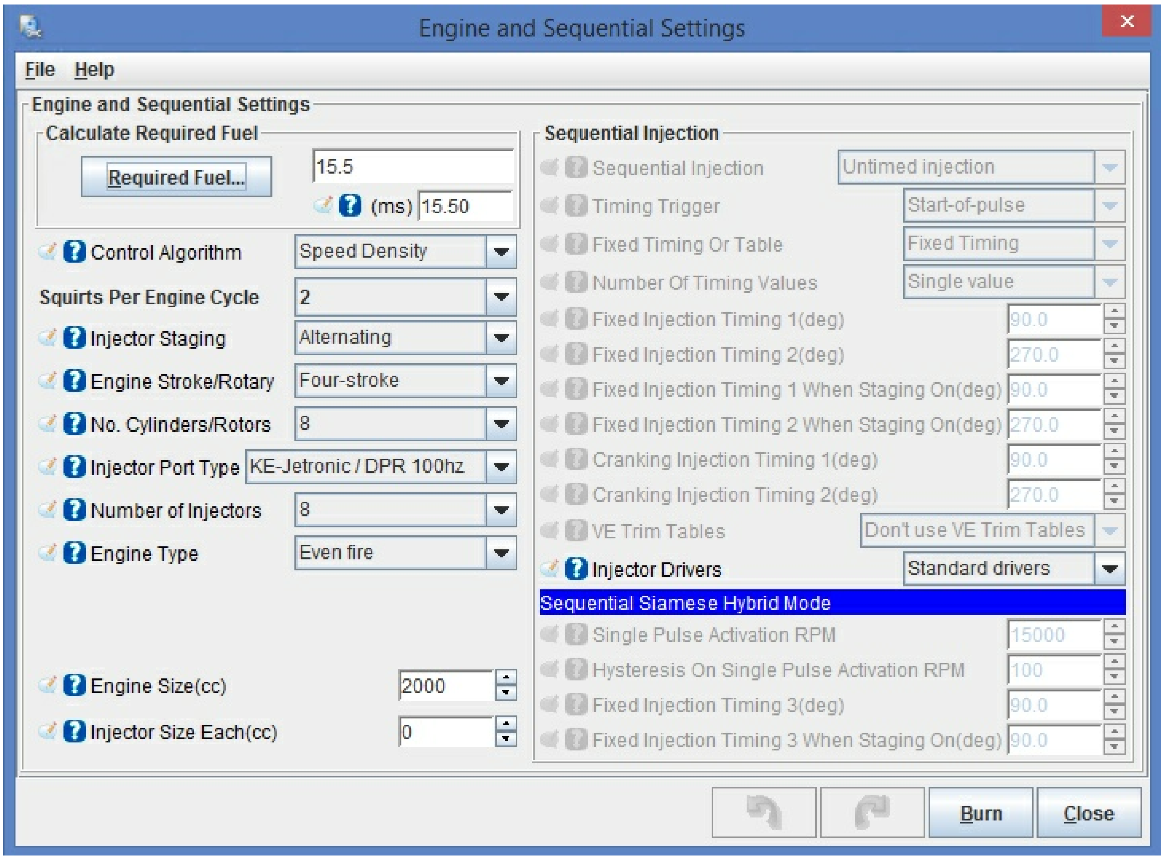
If we change the setting to 2.0 it then means the table values are directly proportional to the Frequency Valve values so Zero is off , 100 is fully open and 50 = 50% or half way
this is now in 1% steps so we lose a bit of resolution, but someone may prefer this option

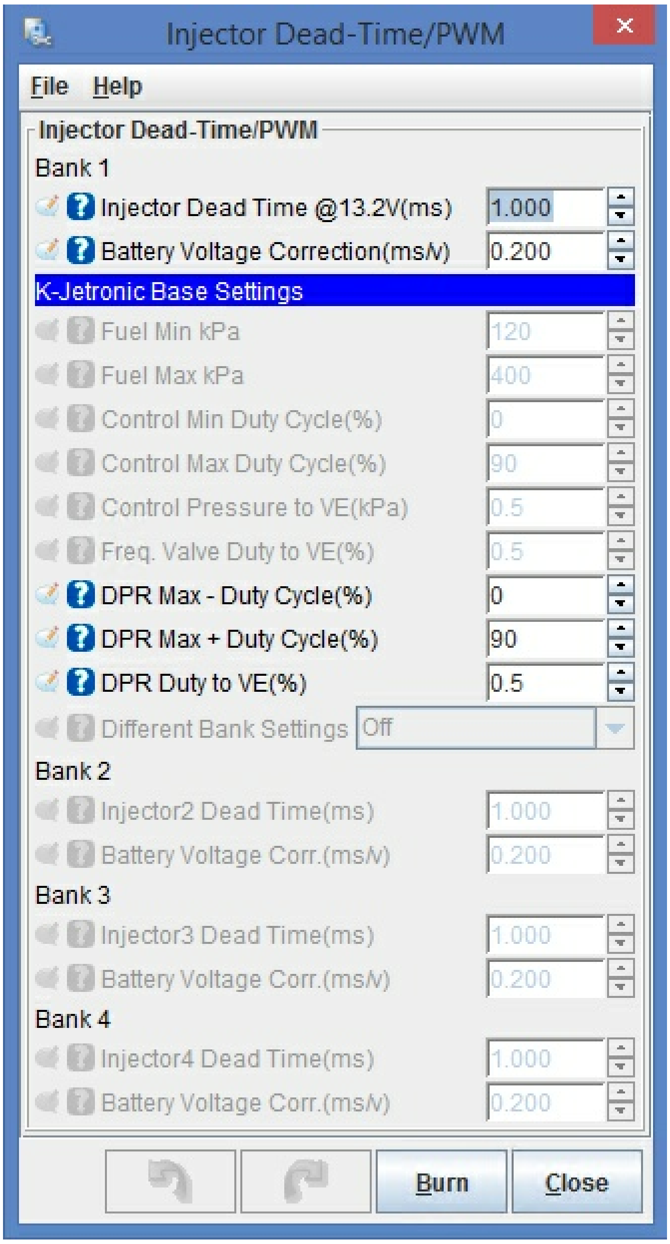
The recommendation is to have it at 1.0 so Table 1 which controls the WUR and Table 2 which controls the Frequency valve are both operating the same with 100 as the center or normal fuel delivery.

don't forget to calibrate the Control Pressure sensor via the tools menu



3.2 - CIS-E


Engine and Sequential Settings
File
Help
Engine and Sequential Settings
Calculate Required Fuel
Required Fuel...
15.5
(ms) 15.50
Control Algorithm
Speed Density
Squirts Per Engine Cycle
2
Injector Staging
Alternating
Engine Stroke/Rotary
Four-stroke
No. Cylinders/Rotors
8
Injector Port Type
KE-Jetronic / DPR 100hz
Number of Injectors
8
Engine Type
Even fire
Engine Size(cc)
2000
Injector Size Each(cc)
0
Sequential Injection
Sequential Injection
Untimed injection
Timing Trigger
Start-of-pulse
Fixed Timing Or Table
Fixed Timing
Number Of Timing Values
Single value
Fixed Injection Timing 1(deg)
90.0
Fixed Injection Timing 2(deg)
270.0
Fixed Injection Timing 1 When Staging On(deg)
90.0
Fixed Injection Timing 2 When Staging On(deg)
270.0
Cranking Injection Timing 1(deg)
90.0
Cranking Injection Timing 2(deg)
270.0
VE Trim Tables
Don't use VE Trim Tables
Injector Drivers
Standard drivers
Sequential Siamese Hybrid Mode
Single Pulse Activation RPM
15000
Hysteresis On Single Pulse Activation RPM
100
Fixed Injection Timing 3(deg)
90.0
Fixed Injection Timing 3 When Staging On(deg)
90.0
Burn
Close

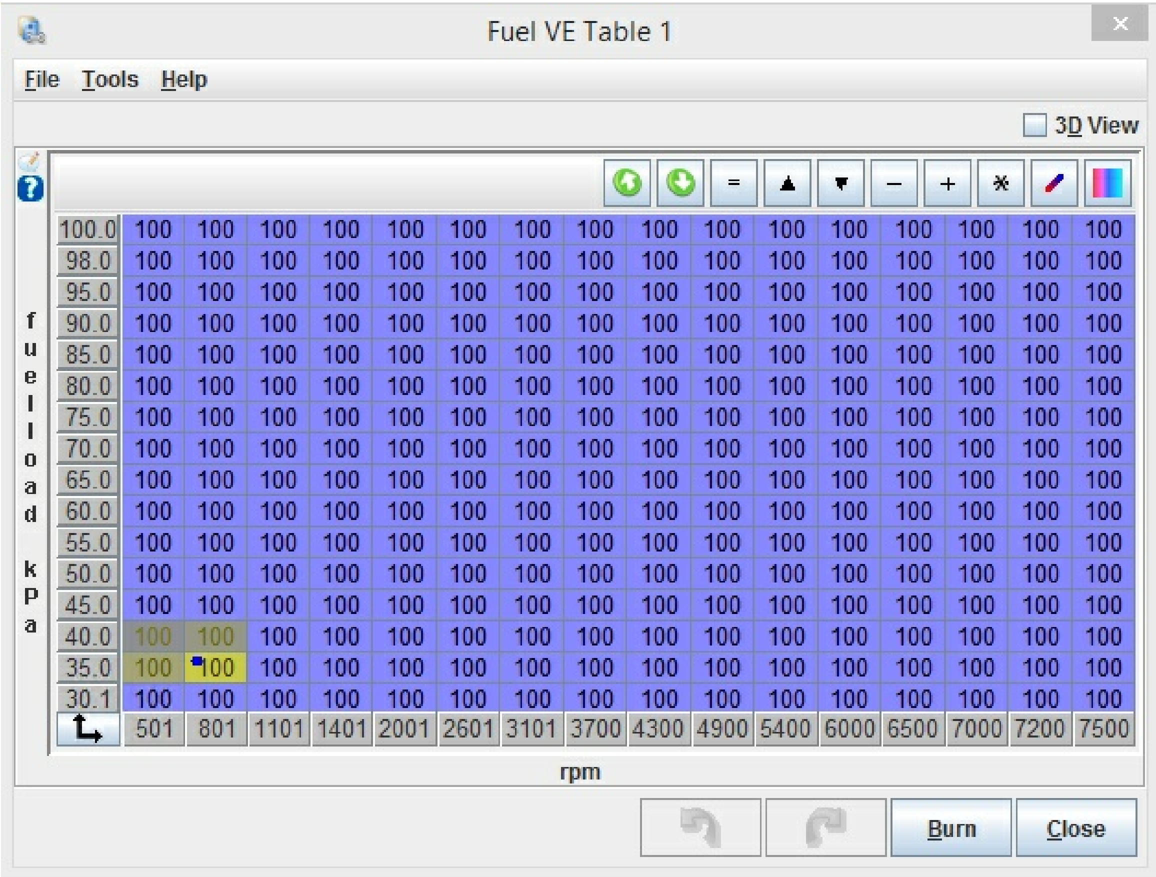


The starting point for the settings above can be adjusted to suit your installation

The Duty to VE factor. PWM duty cycle to 1 point (0.1%) of VE.

The system converts a desired VE table and EGO change to target PWM Duty change using this multiplier

VE tables are the main point of adjustment for the running fuel trim and should begin as a flat 100 across all cells



fuel load kpa \ rpm	501	801	1101	1401	2001	2601	3101	3700	4300	4900	5400	6000	6500	7000	7200	7500
100.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
98.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
95.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
90.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
85.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
80.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
75.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
70.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
65.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
60.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
55.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
50.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
45.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
40.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
35.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
30.1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

The CIS-E systems have two main variants and the center point or tuning offset for the DPR/EHA varies depending on the system.

the early KE generally has a light grey DPR or EHA valve and is usually set to operate positive duty cycle bias requiring a current of around 20ma at idle which might be 120 or so in the map depending on the ration chosen in the settings.

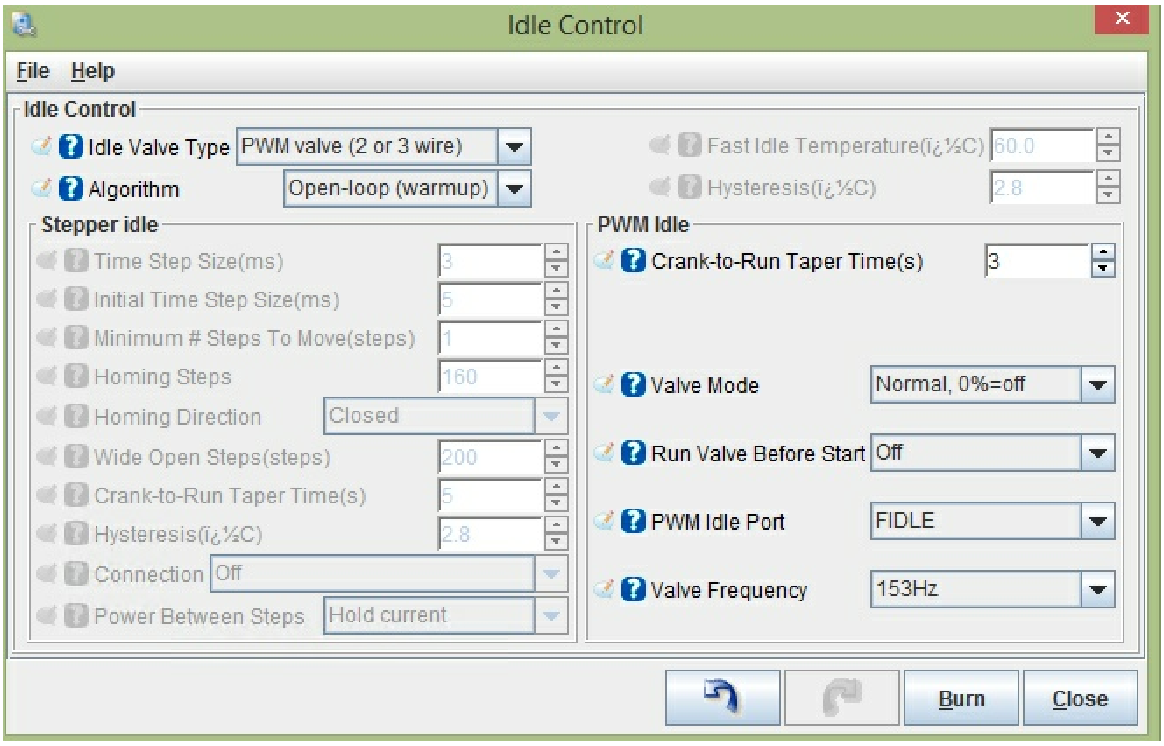
the later KE3 or KE-Motronic is usually a black DPR/EHA and is usually happy with a centre point of 0-6ma which would be 100 in the maps

This gives individual control of both systems, but means startup values will vary by install depending on the system in place and whether or not the DPR has been previously adjusted manually via the little trim screw

If you chose - either type of DPR can be manually adjusted to provide a slightly positive bias around 100 in the maps so an electrical control failure will provide the same "Limp Home" capabilities as the late CIS-E

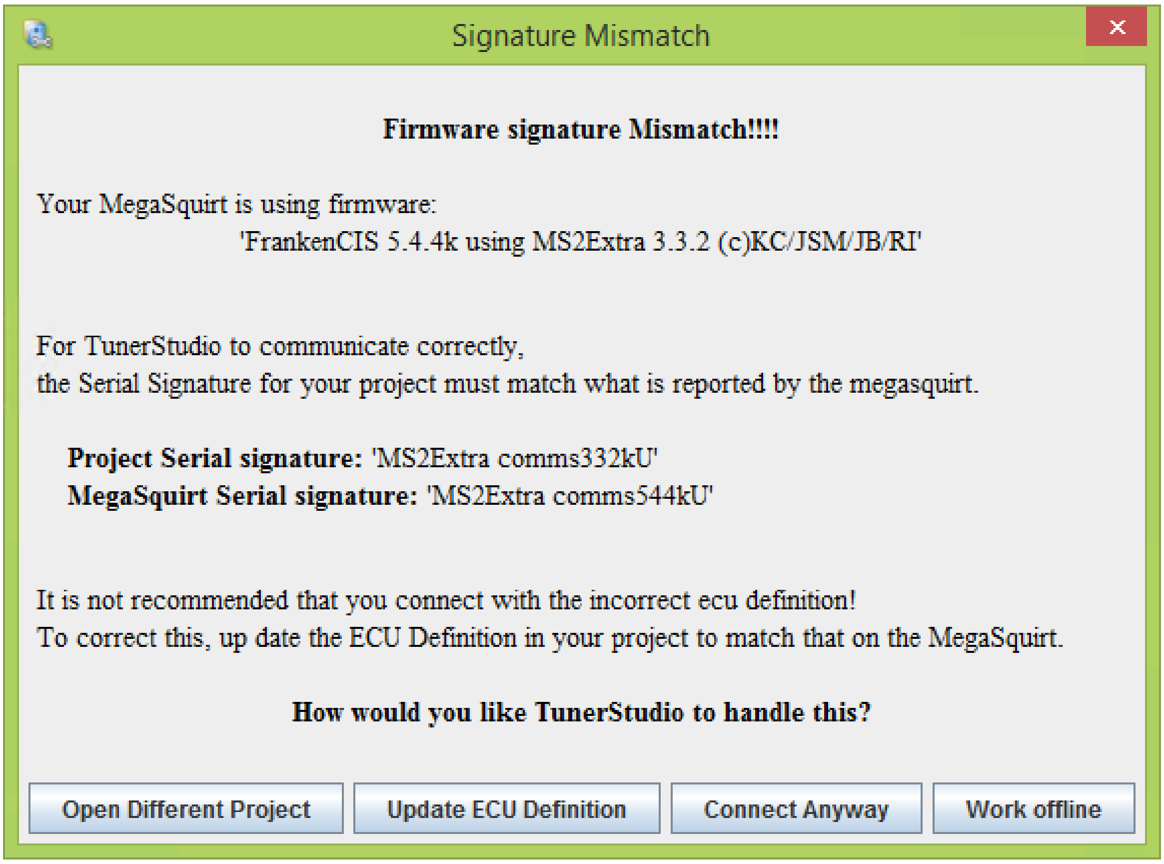
3.3 Idle Valve

The factory rotary Idle valve seems to be happy with the following settings
make sure it is fitted with the flyback diode as mentioned in the main manual
1n4001 as recommended


Idle Control
File Help
Idle Control
Idle Valve Type
PWM valve (2 or 3 wire)
Algorithm
Open-loop (warmup)
Fast Idle Temperature(ï¿½C)
60.0
Hysteresis(ï¿½C)
2.8
Stepper idle
Time Step Size(ms)
3
Initial Time Step Size(ms)
5
Minimum # Steps To Move(steps)
1
Homing Steps
160
Homing Direction
Closed
Wide Open Steps(steps)
200
Crank-to-Run Taper Time(s)
5
Hysteresis(ï¿½C)
2.8
Connection
Off
Power Between Steps
Hold current
PWM Idle
Crank-to-Run Taper Time(s)
3
Valve Mode
Normal, 0%=off
Run Valve Before Start
Off
PWM Idle Port
FIDLE
Valve Frequency
153Hz
Burn
Close

3.4 Firmware

When updating firmware the following dialog will show on connection to the system



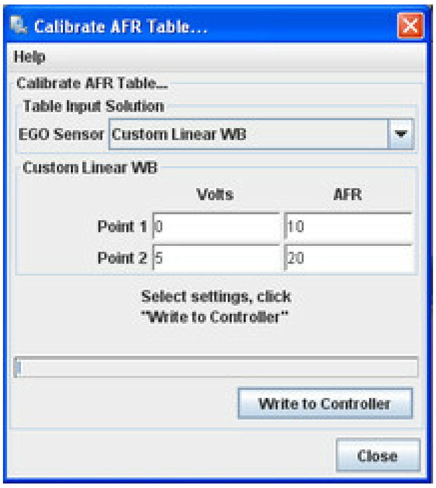
Select Update ECU Definition, it will then allow you to browse and select the appropriate .ini file for your ECU

e.g. microsquirt.ini

3.5 Spartan2 Wideband Setup

Install and wire up spartan 2 according to the user manual

In Tuner Studio, tools->Calibrate AFR Table->EGO Sensor select "Custom Linear WB", enter the values shown in the picture below and write changes to MegaSquirt.

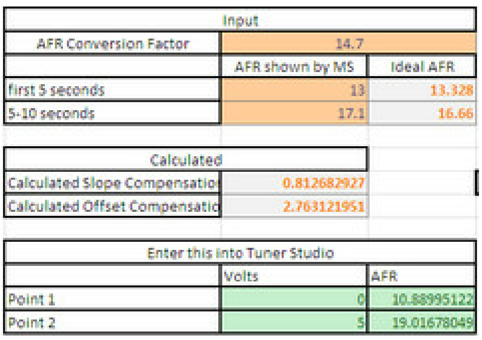


Later on we will change the Custom Linear WB settings to account for offset and linear errors.

During powerup Spartan 2's Output Squencer will be triggered, the output sequencer will output 2 distinct calibration voltages on the Linear Output, 1.666 volts for the first 5 seconds then 3.333 volts the next 5 seconds, after 10 seconds has passed then the Linear Output will function normally. When a wideband controller is first powered up, it will take about 30 seconds to 1 minute for the Wideband Oxygen Sensor to heat up, while the sensor is heating up the Wideband sensor is unable to read the AFR of the exhaust gas composition, only when the sensor is heated up will the AFR of the exhaust gas composition be correct. Spartan 2's Output sequencer takes advantage of this heatup time when the AFR data is not correct to output calibration voltages that we will use to generate new

Tuner Studio settings to compensate for offset and linear errors.
While Tuner Studio is running and is actively displaying AFR data, cycle power to Spartan 2 and write down the 2 AFRs shown by tuner studio during the first 5 seconds and then during the next 5-10 seconds. For this example lets use 13 AFR and 17.1 AFR. Now if there were no offset or iinear errors present the first 5 seconds AFR should be 13.328 AFR and the 5-10 seconds AFR should be 16.666 AFR.

Now download and open this Microsoft excel worksheet here



Input		
AFR Conversion Factor	14.7	
	AFR shown by MS	Ideal AFR
first 5 seconds	13	13.328
5-10 seconds	17.1	16.66

Calculated	
Calculated Slope Compensatio	0.812682927
Calculated Offset Compensatio	2.763121951

Enter this into Tuner Studio		
	Volts	AFR
Point 1	0	10.88995122
Point 2	5	19.01678049

Assuming that the first 5 seconds AFR shown by Tuner Studio is 13 AFR and the 5-10 seconds AFR shown by tuner studio is 17.1 AFR, you would enter 13 and 17.1 into the excel worksheet like the above picture, of course instead of 13 AFR and 17.1 AFR you would enter the AFR shown by your Tuner studio. Once those two AFRs are entered, the settings in the green box will be calculated to compensate for offset and linear errors, this calculated setting you will enter into Tuner

Studio and you MegaSquirt will be able to read AFRs from Spartan 2 with an accuracy of 1/10th of an AFR.

In Tuner Studio, tools->Calibrate AFR Table->EGO Sensor select "Custom Linear WB", enter the values shown in green excel worksheet and write changes to MegaSquirt. In my example where the frist 5 seconds AFR is 13 AFR and the 5-10 AFR is 17.1 AFR, my calculated new tuner studio settings is 10.89 AFR @ 0 volts and 19.02 AFR @ 5 volts.

Now if everything was done correctly then now your Megasquirt will be able to read AFR with 1/10th AFR accuracy. Cycle power to Spartan 2 again and now the first 5 seconds AFR should be between 13.3 +/- 0.1 AFR and the 5-10 seconds AFR should be 16.7 AFR +/- 0.1 AFR. Because Megasquirt uses only up to the first decimal place to represent AFR, the best you can do is +/- 0.1 AFR accuracy.

**** IMPORTANT ****

Once setup and before any tuning is performed - it is mandatory that the results of the sensor are verified against a known reference

The Dyno AFR sensor should be sufficient

Part IV

4 Reference Install Parts List

MicroSquirt (tm)	
FrankenCIS (tm) Metering Block #1 or #2	
Injector	Delphi FJ10409 Fuel Injector (Single) For Dodge Chrysler Eagle 1993-1997
Control Pressure sensor	100psi Digital 1/8NPT
Pressure Damper if using FrankenCIS #2	Toyota 23270-62010
Gasket for above damper	Toyota 23232-41081
MAP sensor	Denso
IAT sensor	BOSCH 0280130085 , PORSCHE 99360611400 , VW 058905379
Engine Temp sensor	Bosch
WBo2	Innovate LC2 or 14point7 Spartan

(to suit a particular application the last four sensors above can be substituted with anything compatible with MegaSquirt)

Back Cover