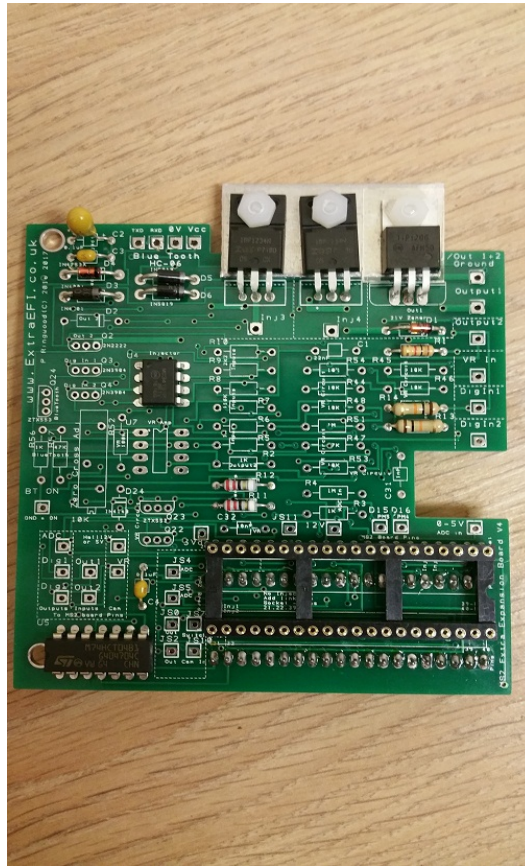# MS2X Card - Build Instructions

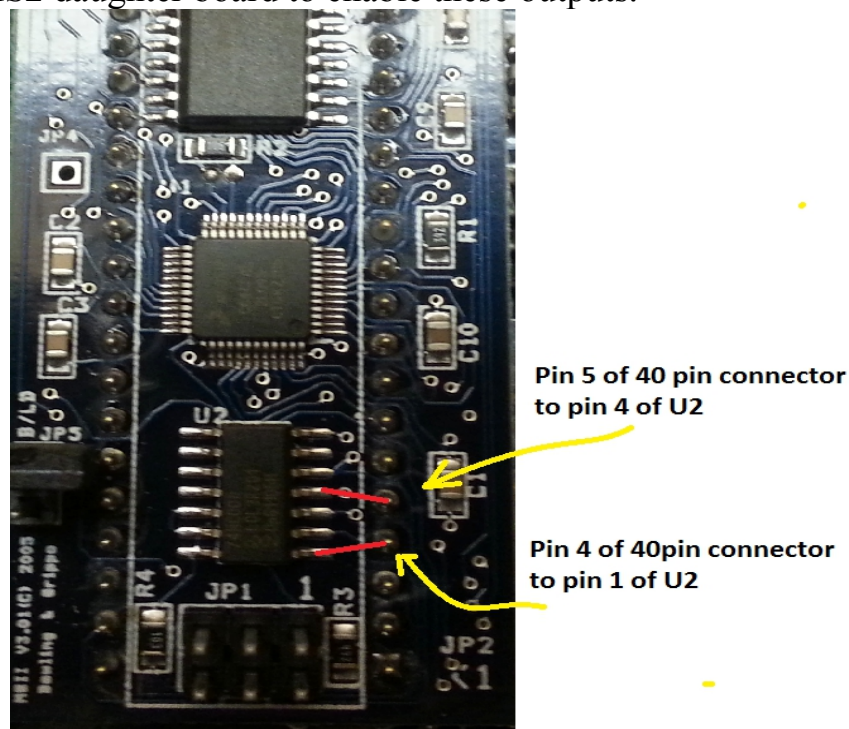This shows the board with 2 injector channels and the power output built.

The board can be used without the extra 2 injector drivers but it would then need a wired link to short out pin 21 to socket pin 21 and pin 22 socket pin 22 of the 40 pin connectors. This means the main board still runs at it did originally, i.e. 2 injector drivers with flyback for low impedance injectors. **The MS2X injector drivers must not be used!**
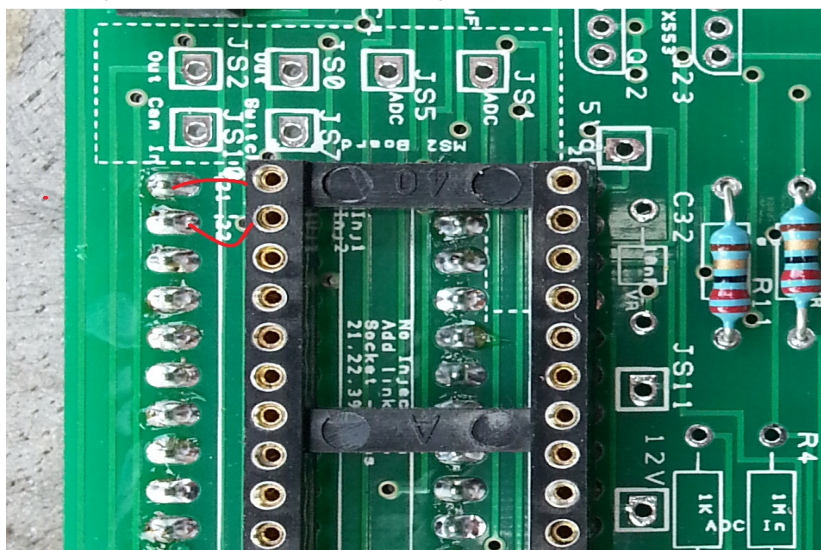
The MegaSquirt V3.0 main board needs a few mods to allow the MS2X card to fit above it:

1) Remove MOV1 from the top of the board and re-fit under the board into the same 2 holes. Lay it on its side, being careful not to short anything out where the legs of the component lay.

2) Ensure Q1 and Q5 (main board) are *Avalanch Rated* FETs, if in doubt, fit IRFIZ34N FETs, the same as the MS2X card uses.

3) Fit a link between S12c and JS9 (this feeds 12V to the MS2X card)

4) If using the main board VR trigger circuit, Remove R52 (top variable resistor) and fit a 100K resistor between the top and bottom holes of R52.

5a) If using MS2X Injector Drivers: Remove D5 and D7 (remember that you can only use High Impedance Injectors)

5b) If your NOT fitting extra Injector Drivers: Lower D5 and D7 to the main board (this keeps the flyback circuit active and gives room for the MS2X card)
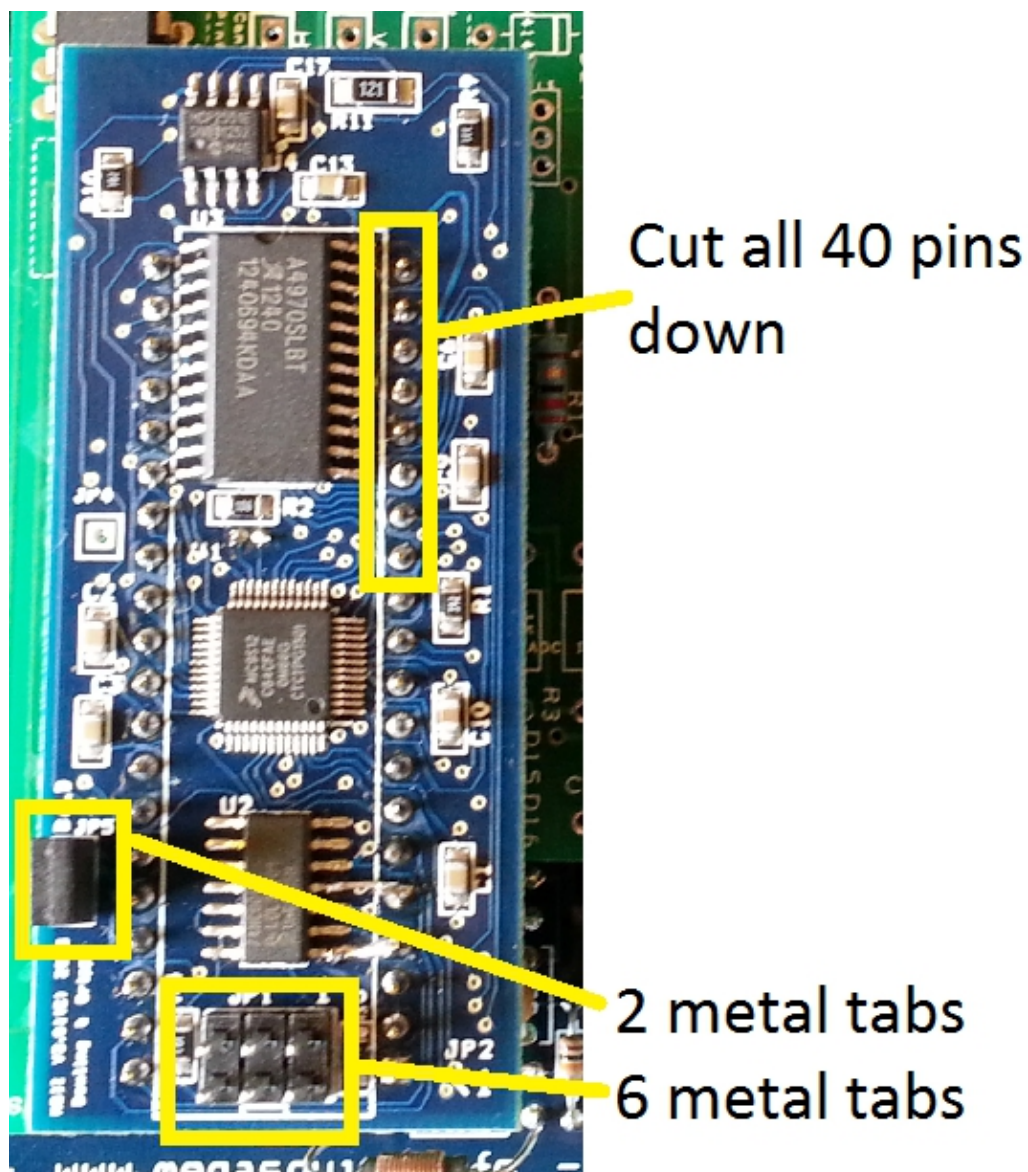
6) Cut down

If your going to be using any of the injector drivers on the MS2X card (more than the 2 on the main MS board) then you will need to add 2 links to the MS2 daughter board to enable these outputs.

Pin 5 of 40 pin connector to pin 4 of U2

Pin 4 of 40pin connector to pin 1 of U2

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The MS2 daughter board also needs some mods to fit back in the standard case and to run the new injector drivers:

All the metal links need cutting flush to the board. This needs to be done very carefully! It is very easy to damage the board, making it useless. I cut them with a good quality pair of side cutters, starting by cutting down to the plastic spacers. Then gently tease the plastic spacer up and off the stubs. Next cut the metal stubs down close to the board.
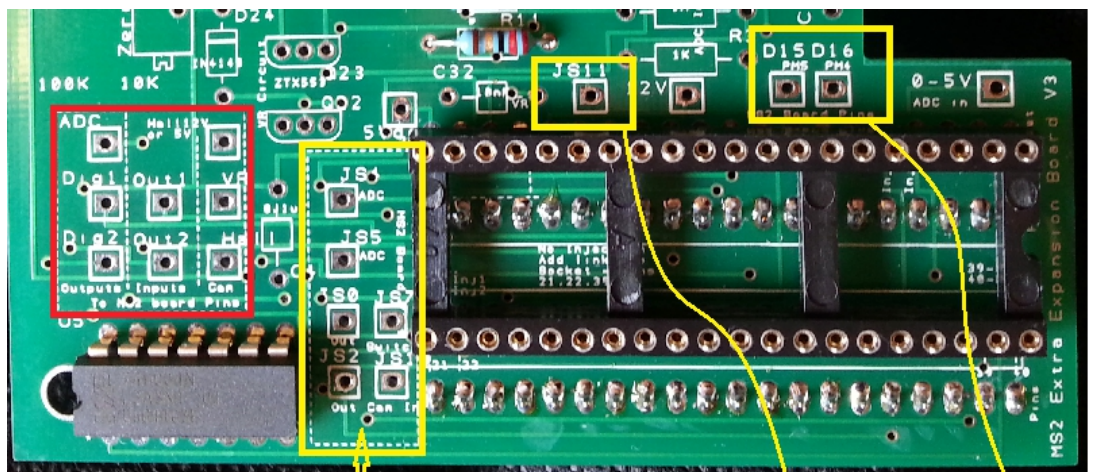
Then cut all 40 of the pins that stick up on top of the board.

Cut all 40 pins down

2 metal tabs
6 metal tabs
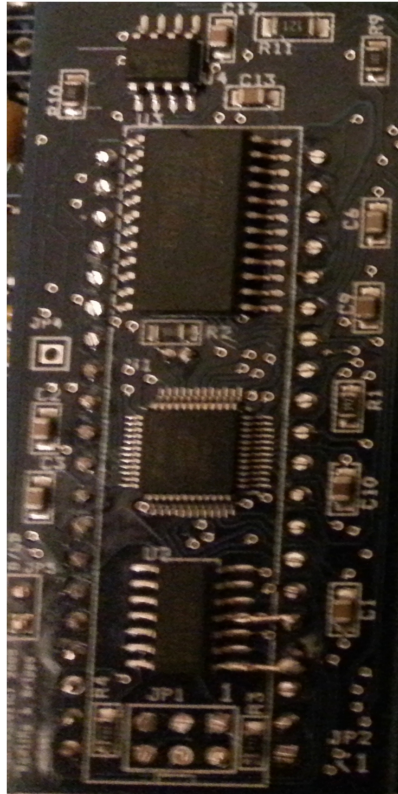
Above shows the cut down pins and the 2 links (used to enable the MS2X Injector drivers) on the MS2 daughter board.

The MS2 daughter board processor output pins are labelled on the MS2X card. You will need to wire links from the MS2X cards circuits (on next page) to the relevant processor pins (yellow on this page) :

JS4 (ADC In - Output - Input)

JS5 (ADC In - Output - Input)

JS0 (Output)   JS7 - (Input needs a link from pin10 to PE1)

JS2 (Output)   JS10 - (Cam input - Input - Output)

JS11 - (output)

D15 D16 - (Outputs, mainly used for spark drivers)
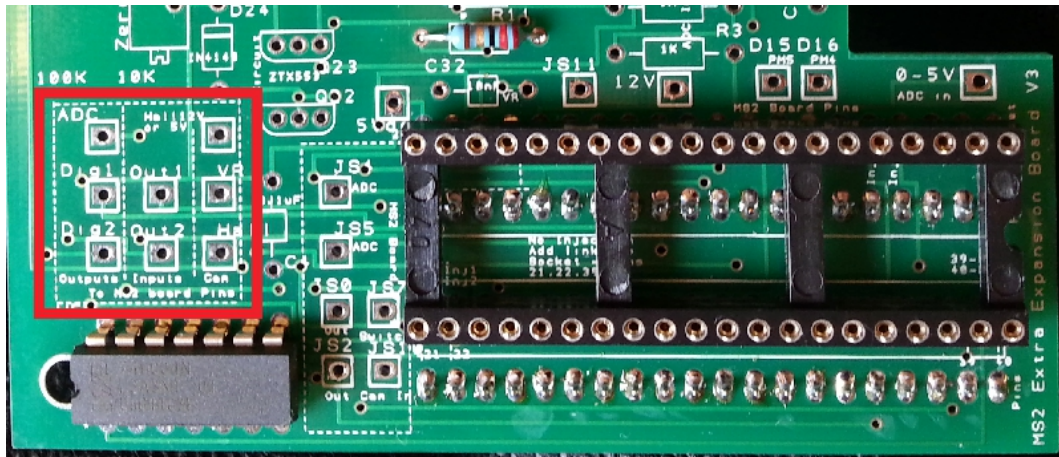
ADC - Analouge output from the 0-5V ADCin pad. Second Lambda, Fuel pressure, etc.

Dig 1 Dig 2 - Outputs from the Digital inputs 1 + 2. Launch control, switchable maps, etc

Out1 Out2 - Inputs to drive the on board Outputs
Output1 is capable of 3A, so can run Idle valve, etc.
Output2 is to drive a relay for a fan, solenoid, warning LED, etc.

Hall 12V or 5V - Link this to either 5V or 12V depending on the supply voltage your hall sensor uses (If using the Cam input)

VR - Output from the VR conditioner circuit. Link to JS10 if you want to use it as a cam signal

Hall - Output from the Hall sensor circuit. Link to JS10 if you want to use it as a cam signal

BLUETOOTH: Please note that whilst the bluetooth is enabled the normal RS232 port shouldn't be used as it will conflict with the bluetooth. This is why we have added the enable feature.
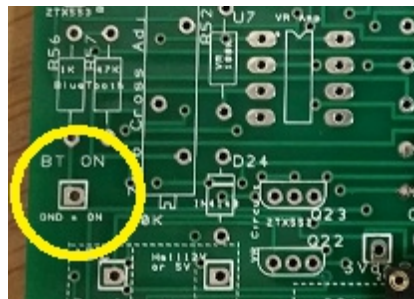
The bluetooth HC-06 module needs programming so it runs at 115200 Baud rate.

The BT ON pad needs to be switched to ground to enable the bluetooth power. This can be wired to an external switch or to a programmable output pad (e.g. D15, etc)

The example below shows LED15 set to enable the bluetooth 30 Seconds after the ECU is powered up. Note: Active Value = OFF

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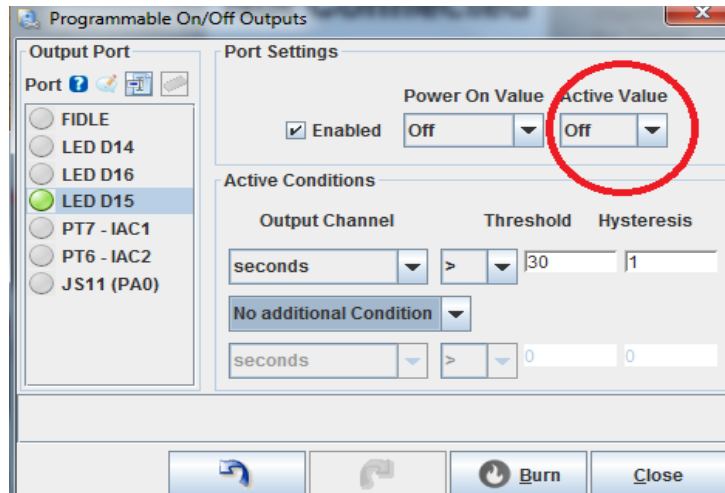
The MS2X card has 2 holes in it to hold it in place. These line up with Q11 and R37. Cut down the plastic screws for Q5, R36, Q9, Q3, Q1 so they don't foul the MS2X card when its in place. If using metal screws ensure they can't touch the MS2X card when its in place.
Once the MS2X card is finally in place, put a plastic nut on the screws that poke through the 2 holes of the MS2X card.

Lastly, the lid of the MS case will be very close to the top of the MS daughter board. I recommend you fit a thin sheet of plastic to the lid and hold it in place with some insulation tape, so it cant short out on the lid.

Software

When using the 2 injector drivers on the MS2X card the settings in Tuner Studio will need to be changed to allow these to be driven correctly. Failure to do so will result in issues with fueling.
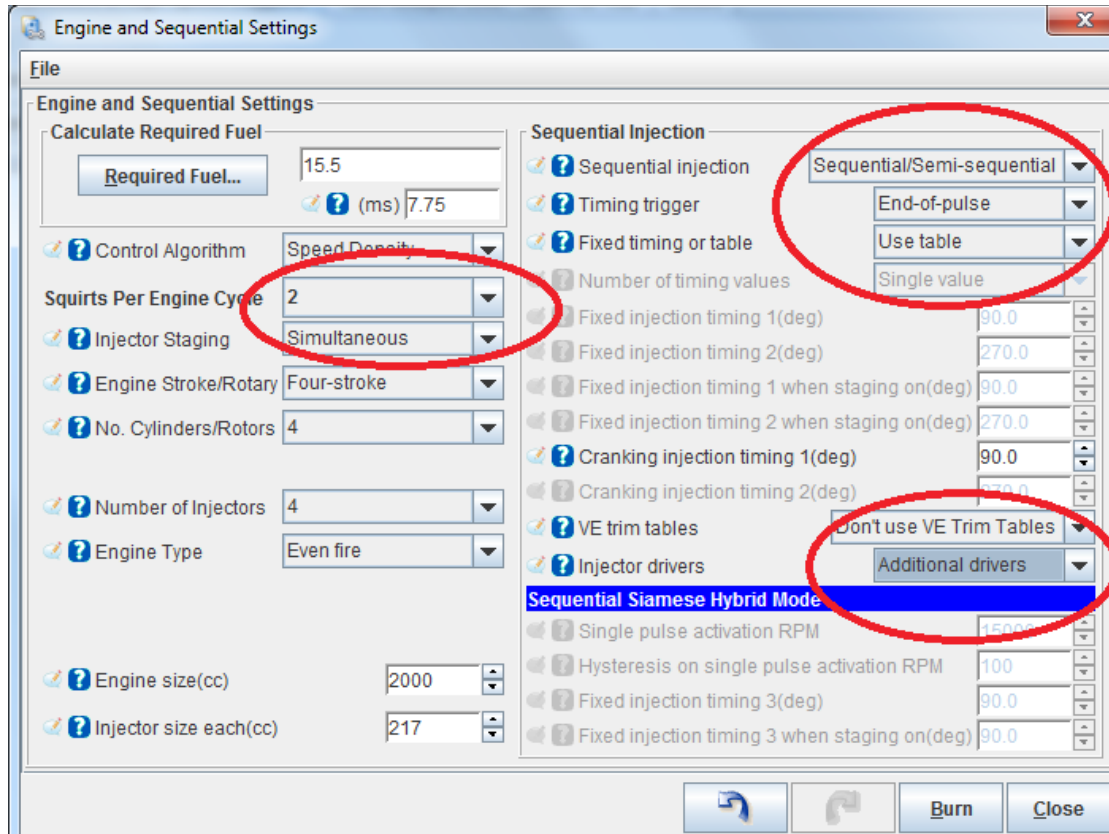
Start by Looking under **Basic Load Settings - Engine and Sequential Settings** (Note, don't get confused with Injector Sequence)

This brings up the following table:

Sequential Injection:
Here you can turn on the sequential function. **UnTimed** is OFF (normal function). It should be noted that Siamese mode, for Siamese ported engine like the British Leyland B series, and Staged Mode won't be discussed here as it is rather complex and a specialist subject

Timing Trigger:
This is when you want the fuel to be added in relationship to the angle you have set. Usually this is set to **End-of-Pulse** as that's easiest to work out with varying PW's, but you can have it so the fuel starts at a certain angle or that the fueling PW ends at the set angle (**Start-of-pulse**), or even so the PW is timed for being in the middle of the angle **(Mid-Pulse)**.

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Fixed timing or Table:
The fixed timing has no trim for engine speed or load, it simply uses the Fixed Injection Timing Angle for all conditions. If you select the table you can then adjust the angle with load and engine speed, much like the spark map, this is a 6x6 map. See below for the table.

Fixed Injection Timing:
This is the angle for fueling when not using the table. (Most applications will gain from using the table).

Cranking Injection Timing:
The angle that is used for crank fueling as some engines may benefit from firing fuel when the inlet valve is open during cranking.

VE Trim Tables:
This should be the final tuning stage if you have EGT and really know what your doing. It allows you to tune the fueling for each injector with it's own 16x16 trim table. The tables allow a +-12.4% adjustment from the main VE table. See the EGT Tuning Page for more on this.

Injector Drivers:
Standard Drivers means the 2 on board outputs, which are for Semi-Seq on a 4cy or Option 1 on a 6 or 8cy. See Below. **Additional Drivers** are if you are going fully sequential on a 4 cylinder or semi-sequential Option 2 on a 6 or 8cy, then you'll need an additional board with one or two Injector Banks for driving all of the injectors. See Below.

Table for the Fueling Angle when selected in the above settings:

This allows for adjustments to compensate for air speed and load.

Note: Do NOT jump too far in one go, limit the difference between sites to 100 at max to avoid stumbles.

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"Injection Timing Table1"

☐ 3D View

fuel load %	1000	1500	2000	2500	3000	4000
100.0	-330.0	-310.0	-290.0	-270.0	-250.0	-210.0
90.0	-330.0	-310.0	-290.0	-270.0	-250.0	-210.0
80.0	-330.0	-310.0	-290.0	-270.0	-250.0	-210.0
70.0	-330.0	-310.0	-290.0	-270.0	-250.0	-210.0
50.0	-330.0	-310.0	-290.0	-270.0	-250.0	-210.0
30.0	-330.0	-310.0	-290.0	-270.0	-250.0	-210.0

rpm

Burn   Close

General opinion is that the fuel needs to be delivered earlier as RPM increases, due to intake air and engine speed. A rule of thumb is 40deg for every increase of 1000rpm up to around 4000-5000rpm. At high RPM the PW's are usually so long that timing is no longer critical and air speed is also much higher, so any gains are minimal as rpm increases. In the above example the inlet valve opens at approx -340deg.

There are several methods of tuning the angle for the optimum setting, none of them will beat a rolling road tune. If you don't want to use a rolling road then several people tune at idle for the max AFR reading (richest point) where the theory is that this will be the angle that max mixture of the air/fuel occures. I have tried this method and couldn't really notice any change in AFR. Another method is to tune for the smoothest idle, I found -250 to -300 worked best for my RV8 on the EFI intake. I then adjusted the rest of the table so that every increase in 1000rpm the firing angle was +40 deg earlier up to 4000rpm. (+20deg / 500RPM)

Hardware Setup:

Semi-Sequential:
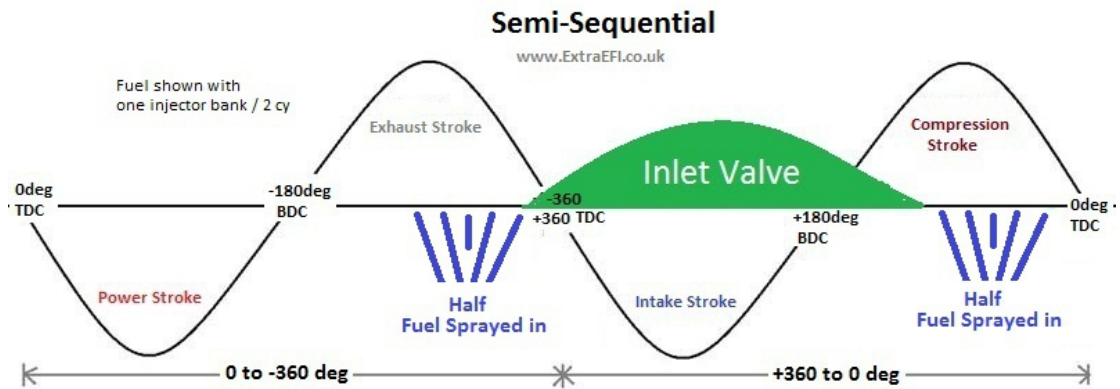
6 Cylinder Semi Seq:

Needs one injector driver adding to the MS2X card This then gives you three banks of injectors that can be fired in pairs at a specific crank angle during their stroke (once per crank rev/twice per engine cycle).

This means wiring the three Injection Bank outputs to pairs of cylinders. Firing order 1 - 5 - 3 - 6 - 2 - 4 would be wired Bank1 - 1+6, Bank2 - 5+2, Bank3 – 3+4

Note: You will need to set the Engine Constants for 2 squirts/engine cycle and Simultaneous Injection to keep the req_fuel correct.

8 Cylinder Semi Seq:

Needs two injector drivers adding to the MS2X card. This then gives you 4 banks that can fire the injectors in pairs at a specific angle during their stroke. (once per crank rev/twice per engine cycle)

This means wiring the four Injection Bank outputs to pairs of cylinders. Firing order 1,8,4,3,6,5,7,2 would be wired Bank1 - 1+6, Bank2 - 8+5, Bank3 - 4+7, Bank4 - 3+2

Note: You will need to set the Engine Constants for 2 squirts/engine cycle and Simultaneous Injection to keep the req_fuel correct.

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Fully Sequential:

(Cam sensor needed and only works for 4cy using MS2-Extra)

Needs 2 injector drivers adding to the MS2X card. This allows you to fire all of the required fuel for each independent cylinder at a specific time during the cycle of the piston. This means wiring each injector back to the MS ECU so that the controller can fire them singularly at a specified time witin the engine cycle.

Note: You will need to set the Engine Constants for 1 squirt/engine cycle and Simultaneous Injection to keep the req_fuel correct.

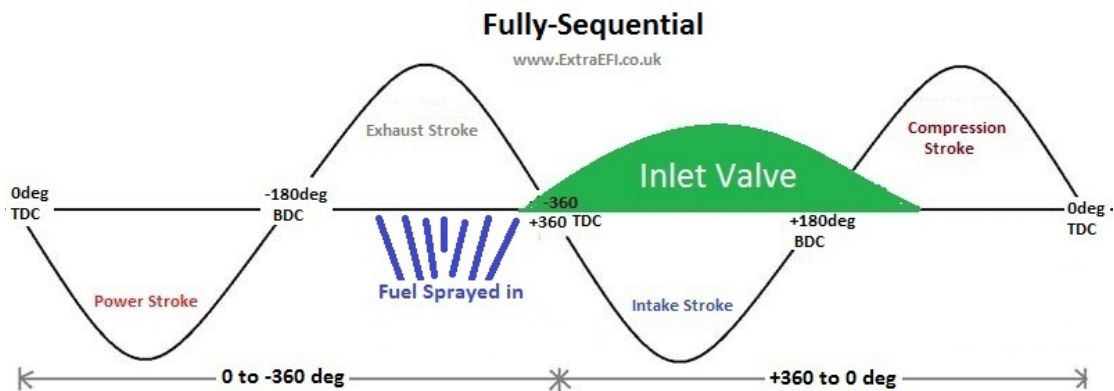| Ref	Name	Value	Output 1	Output 2	Injection C	Injection D	VR Input	ADC Input	Dig In 1	Dig 2 Input	Bluetooth
C1	Cap	0.22uF						X			
C2	Cap	4.7uF			X	X					
C3	Cap	0.1uF			X	X					
C4	Cap	100nF			X	X					
C31	Cap	0.001uF					X				
C32	Cap	0.01uF					X				
D1	22V Zener	1N4748A	X								
D2	Diode	1N4001		X							
D3	Diode	1N4001			X	X					
D4	36V Zener	1N4753A			X	X					
D5	Diode	1N5819			X						
D6	Diode	1N5819				X					
D24	Diode	1N4148					X				
Q1	Transistor	TIP122	X								
Q2	Transistor	2N2222A		X							
Q3	Transistor	2N3904							X		
Q4	Transistor	2N3904								X	
Q5	FET	IRFZ34N			X						
Q6	FET	IRFZ34N				X					
Q22	Transistor	ZTX553					X				
Q23	Transistor	ZTX553					X				
Q24	Transistor	ZTX553									
R1	Resistor	1K	X								
R2	Resistor	1K		X							
R3	Resistor	1K						X			
R4	Resistor	1M						X			
R5	Resistor	1K							X		
R6	Resistor	1K								X	
R7	Resistor	10K							X		
R8	Resistor	10K								X	
R9	Resistor	2k2	X								
R10	Resistor	2k2		X							
R11	Resistor	22R			X						
R12	Resistor	22R				X					
R13	Resistor	10K			X						
R14	Resistor	10K				X					
R44	Resistor	10K					X				
R45	Resistor	10K					X				
R46	Resistor	10K					X				
R47	Resistor	47K					X				
R48	Resistor	10K					X				
R52	Resistor	100K					X				
R53	Resistor	10K					X				
R54	Resistor	10K					X				
R55	Var Resistor	10K					X				
R56	Resistor	1K									X
R57	Resistor	47K									X
U1		40DIL	X	X	X	X	X	X	X	X	X
U4	Driver	IXDI404PI			X	X					
U5	Inverter	74HC04			X	X					
U7	Op Amp	LM2904					X				
U8		40DIL	X	X	X	X	X	X	X	X	X
	BlueTooth	HC-06									X