Microsquirt Hardware Manual

Megasquirt-2 Product Range

MS2/Extra 3.3.x

Dated: 2015-03-14

Hardware manual covering specific wiring and configuration of your Microsquirt ECU.

This version of the documentation applies to:

- MicroSquirt V3 as shown above running firmware MS2/Extra 3.3.x

Does not apply to other Megasquirt products or other firmware versions.

Table of Chapters

Contents

1 Introduction

The Microsquirt is a compact ECU based on Megasquirt-2 technology. This manual covers Microsquirt specific installation details and should be used in conjunction with the general Setting up and TunerStudio reference manuals.

1.1 Emissions and disclaimer

All parts are sold for OFF ROAD RACE-ONLY ground-vehicle use only, or vehicles that pre-date any federal and state emissions control requirements. Aftermarket EFI/EMS systems are not for sale or use on pollution controlled vehicles. Alteration of emission related components constitutes tampering under the US EPA guidelines and can lead to substantial fines and penalties. Your country/state/district may also have specific rules restricting your tampering with your vehicle's emissions system.

Race parts are inherently dangerous and may cause injury or damage if improperly modified or altered before use. The publishers of this manual will not be held liable for and will not pay you for any injuries or damage caused by misuse, modification, redesign, or alternation of any of our products. The publishers of this manual will not be held in any way responsible for any incidental or consequential damages including direct or indirect labor, towing, lodging, garage, repair, medical, or legal expense in any way attributable to the use of any item in our catalog or to the delay or inconvenience caused by the necessity of replacing or repairing any such item.

1.2 Required tools

Tuning laptop

Stroboscopic timing light

Multi-meter (volts, ohms)

Screwdrivers

Wire cutters

Terminal crimpers

Soldering iron and solder

Heat-shrink tubing

Fire extinguisher

Although not essential, the following are highly recommended:

Oscilloscope or scope-meter or soundcard scope

Test light

Power probe

1.3 How to use this manual

Customers new to EFI are advised to read all of sections 1-5 as these cover some fundamental concepts and give an overview of how to connect up the various EFI components.

More experienced customers can likely skim through sections 1-5.

Section 3.3 is the external wiring diagram, you should print that out.

Section 6 covers the many different tach trigger input schemes (wheel decoders) that exist to support numerous OEM trigger wheel patterns. Find the section that is appropriate for your engine and read that one.

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

This symbol indicates an “Information” note.

This symbol indicates a “Caution” note.

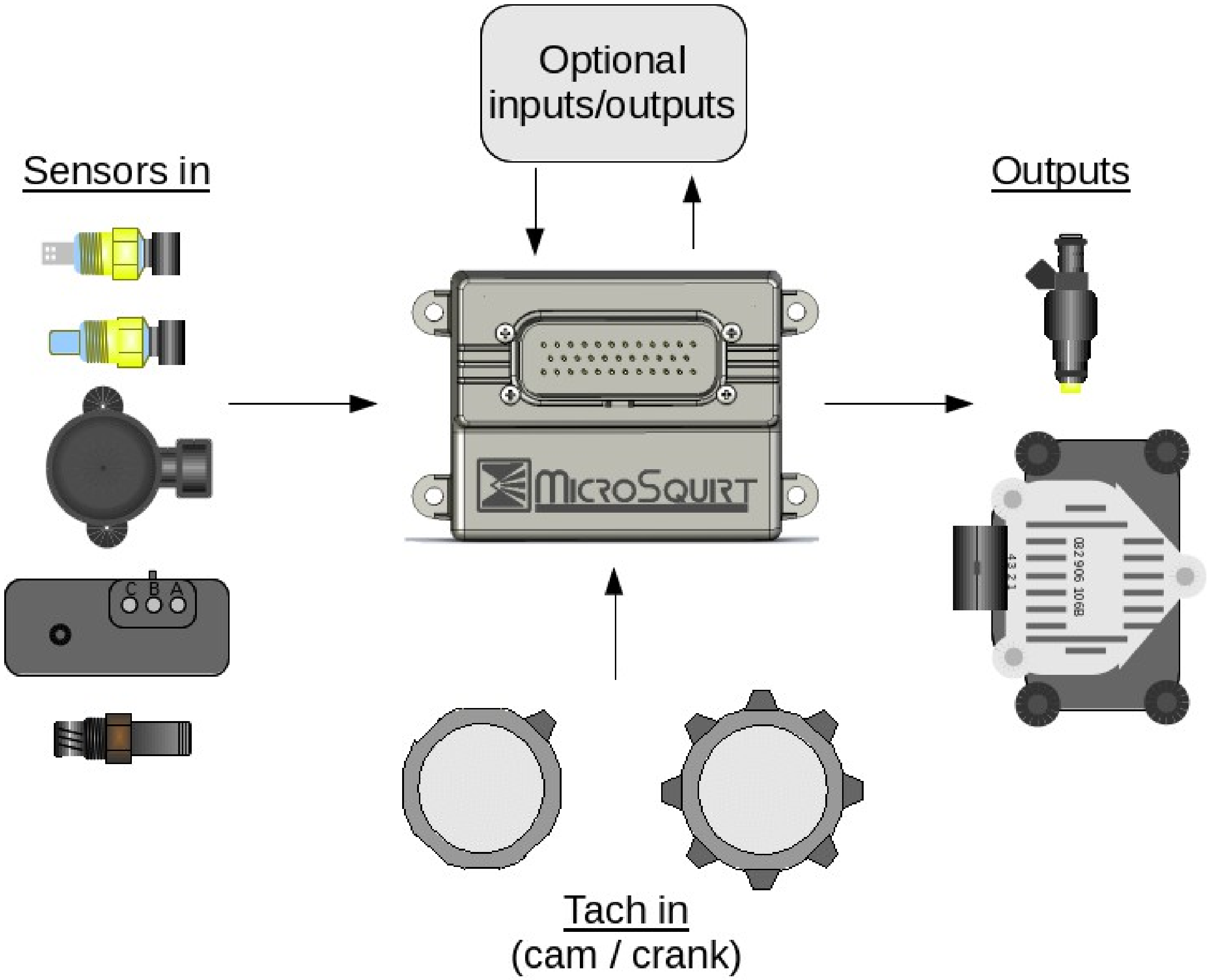
This symbol indicates a “Warning” note.

Installing or tuning your Microsquirt incorrectly can potentially cause damage to your engine, the Microsquirt or external hardware. Warning notes indicate specific areas where you need to exercise extreme care.

Do not rely on these warnings as your only criteria for taking care !

For additional help and support, visit the website **www.msextra.com**

2 Microsquirt System Hardware



2.1 Overview

The Microsquirt engine control unit (ECU) receives signals from the various input sensors and then controls the fuel and spark outputs to run the engine.

For engines that already have fuel injection installed, you will likely be able to re-use many of the existing sensors and output hardware.

For engines that do not have existing fuel injection, review the available options in this manual and select the most suitable components to complete your install.

2.2 Microsquirt Installation

The Microsquirt is designed to be splash resistant and uses automotive grade electronic components internally. However, it is not designed to be installed in the engine compartment. Typically it will be installed under the dash in a car or under the seat on a bike - but away from direct engine temperatures. The temperature must not exceed 185°F (85°C.)

The dimensions of the mounting hole pattern are 4.20" by 2.14" (107 x 54mm). The hole diameters are 0.20" (5mm.)

If full water resistance is desired, the case can be dismantled and sealed with a silicone sealant. The wiring plug (AMPSEAL) is an automotive grade sealed connector.

2.3 Wiring Harness and fuses

The Microsquirt can be supplied with a 30 inch or 8 foot "pigtail" wiring harness to form the basis of your own wiring.

For certain installs a "drop-on" wiring harness may be available (e.g. LS1 engine.)

2.4 Crank / Cam Inputs

The Crank and Cam sensors provide the Microsquirt with engine position information which is critical for ignition timing. Fuel-only installs will often take a signal from an existing inductive ignition coil.

2.5 Sensor Inputs

The sensor inputs provide the ECU with information about current engine operating conditions and are used to calculate the fuel and spark outputs.

The primary inputs are MAP sensor, MAT sensor, CLT sensor, TPS and O2 input.

2.6 Outputs

Based on the crank/cam and sensor inputs the Microsquirt calculates the required fuel and spark outputs.

2.7 Tuning interface

The Microsquirt uses an RS232 interface for tuning. This is provided as a 2.5mm jack socket in the wiring harness and uses an adapter cable to a standard DB9 serial connector. Your computer will likely require a USB-serial adapter also - adapter cables based on the FTDI chipset are recommended. Some customers have reported unreliability with Prolific based cables.

Microsquirt also has CAN communications for connection to add-on modules or dashes.

3 Wiring

A main step in your Microsquirt installation is connecting up the wiring. Be sure to follow the guidance here to avoid common mistakes that will often lead to problems.

3.1 Best Practices

3.1.1 Wire and connector choice

For many first-time users, it may be tempting to re-use old connectors and wiring. While this may sometimes be cost-effective, beware of false economy. Using fresh connectors and suitable automotive grade wiring can save many a headache. Be particularly aware of using wire or components that are not temperature rated high enough, engines get HOT and the insulation on sub-standard wires can melt or degrade leading to erratic connections or short circuits. All components must be rated for 105°C / 220°F as a minimum.

There are many suppliers dedicated to supplying the required items to construct wiring harnesses.

3.1.2 Soldering or crimping

This is mainly down to personal choice, some installers prefer a soldered joint, others swear that crimped connections are superior. The key task is to make a reliable connection.

In your wiring harness you will need to ensure that all joints are effective both electrically and mechanically. Always test by tugging on the wires to ensure that they are not loose. Use heat-shrink tubing over connections to insulate them and prevent shorts.

With the correct crimpers, uninsulated crimp terminals with a slide on cover will usually give a more professional and reliable connection than pre-insulated type crimp connectors.

Don't even think about using scotch blocks - they are bad enough for installing a radio or trailer plug!

3.1.3 Re-pinning AMPSEAL

Optionally, to create the smallest wiring harness possible, the AMPSEAL connector may be carefully dismantled and unused spare wires removed. Generally it is advised to leave spare wires in place with the ends taped up.

Removing wires from the AMPSEAL connector will make it non-sealed, so this should not be done when the sealing is required.

3.1.4 Fusing

It is required that the system be fused - as shown in the general wiring diagram. Remember that an automotive battery is capable of supplying hundreds of amps into a short circuit which can easily melt wires or start a fire. Appropriate fuses can help reduce this risk and save component damage.

If there is a risk of the connections becoming damp then it can be worth applying petroleum jelly (e.g. Vaseline) to the connections to slow the corrosion.

3.1.5 Making the harness

When building the wiring harness, it is strongly advised to run all cables first before attaching ends. Neaten up the cable runs and wrap or otherwise attach in place. Only once all the lengths are known and everything is in place should ends be crimped. It also helps to make the wiring in one direction. i.e. work inwards towards the ECU or outwards towards the accessories - not both.

3.1.6 Four-pin relay pin-out note

Be aware that there are two incompatible "standards" for four-pin automotive relays. Mixing them up will usually cause a short-circuit in your wiring harness. The type where pin 85 is opposite 86 is preferred as this is the same as 5-pin relays.

It is highly recommended to use relay-bases, these are easier to mount, look tidier and there is no problem of mixing up the wires if a relay is unplugged.

3.1.7 Relay and accessory power routing

Any relays, solenoids or lamps operated by the Microsquirt must only be powered when the Microsquirt is on. Typically it is easiest to take their power from the "fuel pump relay" so they are only powered when the engine is running. Miswiring accessories can cause power to backfeed into the Microsquirt causing unexpected behaviour such as running-on.

3.2 Grounding (Earthing) Schemes

Implementing a correct grounding scheme is critical to a successful Microsquirt install.

Connecting sensors to the wrong ground, using corroded ground points or dubious original wiring are sure-fire ways to give you a headache.

There are two key rules:

1. All sensors must ground at the Microsquirt

2. Ground the Microsquirt at the engine block/head using both available ground wires.

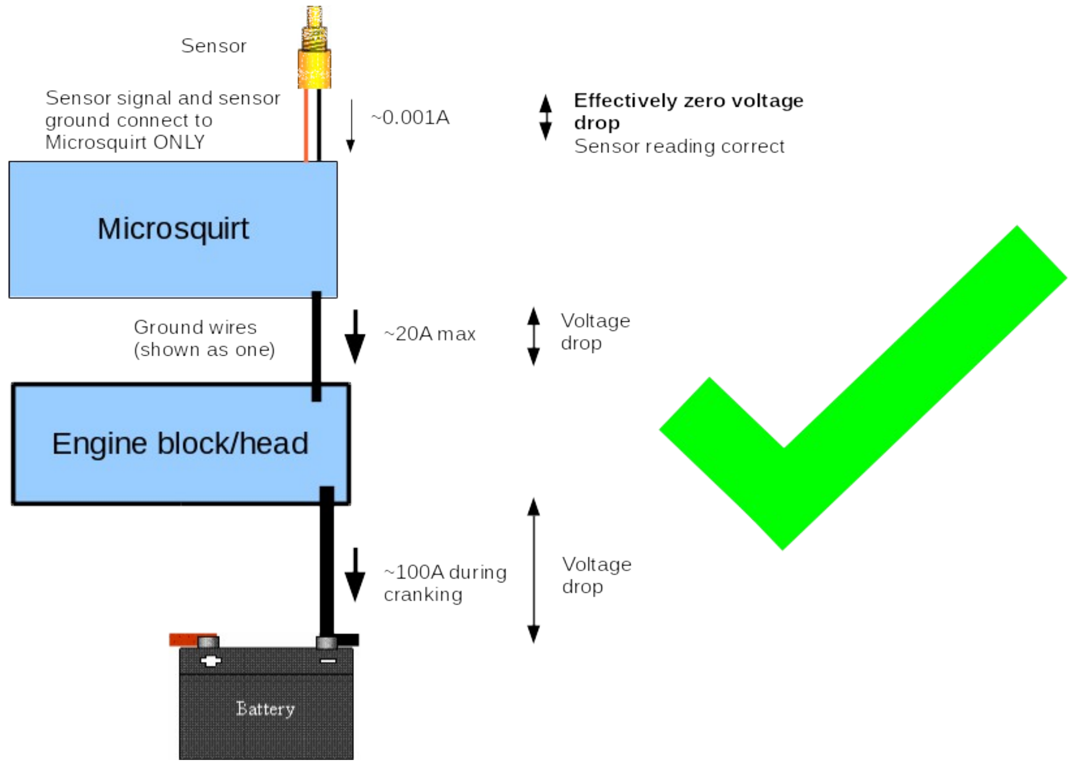
Reasoning:

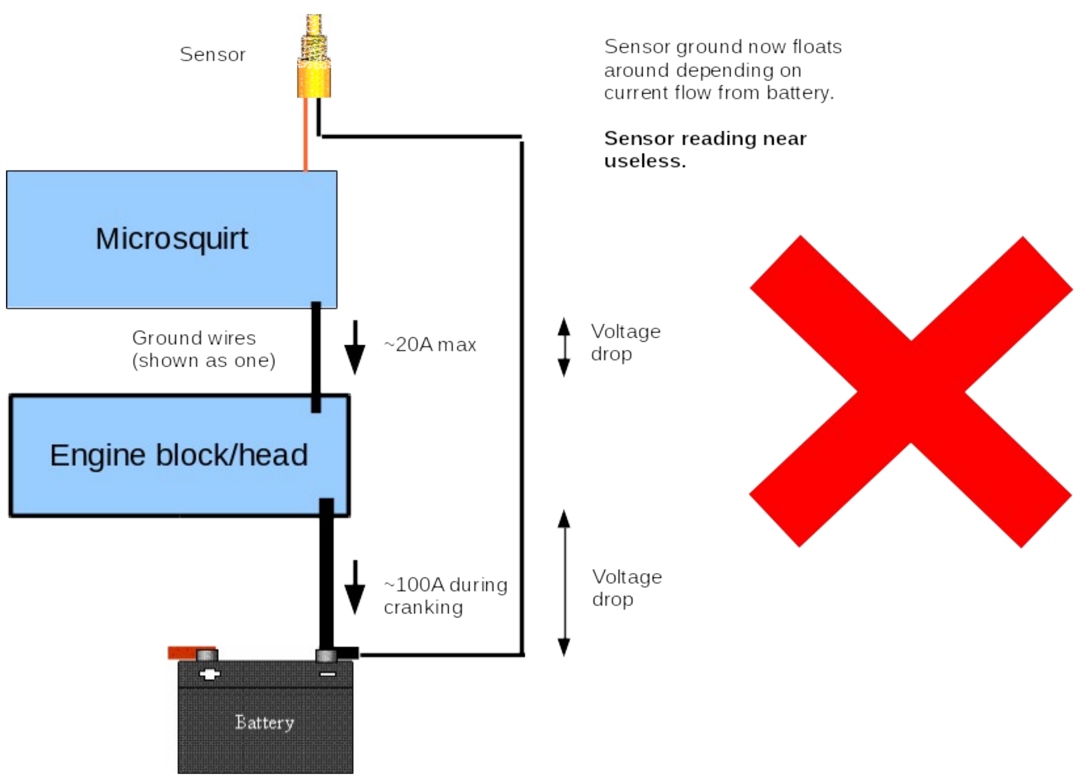
When a current flows through a wire there is always a voltage drop, the bigger the current, the bigger the drop (this is ohm's law.) During cranking there is a very large current flowing through the ground strap from battery to engine and perhaps a few volts may be dropped across it. Even during running, a number of amps will flow through the Microsquirt grounds to the engine.

The sensors (coolant, air temp, throttle position, wideband, tach input) all use low current, low voltage signals. The Microsquirt measures the voltage from the sensor and converts it into a temperature, position etc. reading. If that sensor is grounded to anything other than the Microsquirt itself, then that input voltage will be altered by any external voltage drops. For a sensitive measurement such as AFR (lambda) this can be a real problem. All good wideband controllers offer a high-current ground (connects to engine) and a sensor/signal ground (connects to Microsquirt.)

Tach input (e.g. crank, cam sensors) will be even worse - they can show false or missed teeth and cause sync-loss due to the ground voltage difference.

The following two diagrams illustrate good and bad wiring schemes showing where the troublesome voltage drops are created and how that would cause sensor readings to be garbage.



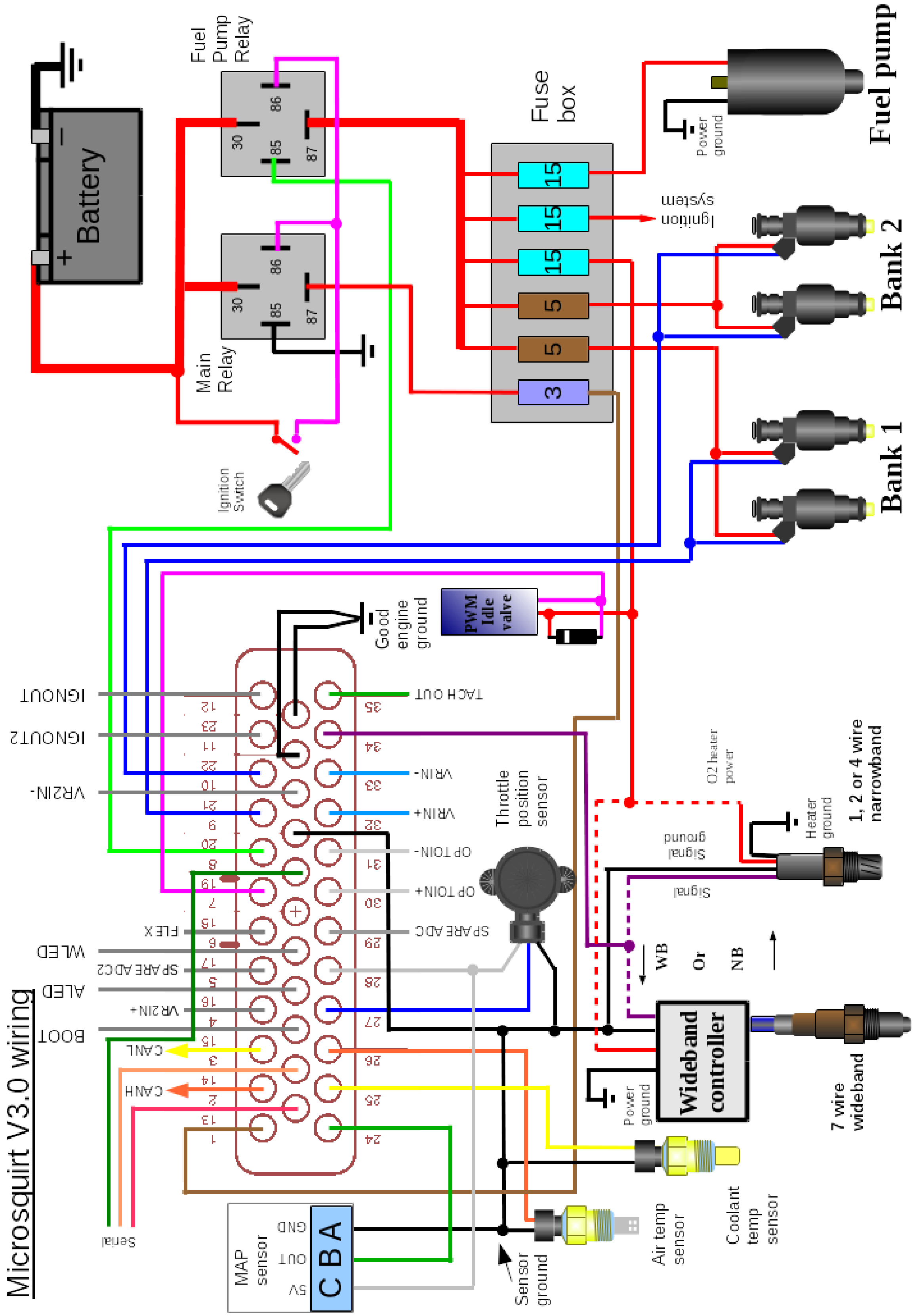


If re-using or splicing into OEM wiring, do not assume that their wiring is OK. Always follow the above principles.

As a check, with the Microsquirt connector unplugged, ensure that the sensor grounds have no continuity to engine/body ground. Your sensor readings will be junk if they do have continuity - the sensors must ground at the Microsquirt **only**.

3.3 Core Wiring Diagram

Refer to diagram on next page.


Microsquirt V3.0 wiring
Battery
Fuel Pump Relay
Main Relay
Ignition Switch
Fuse box
Fuel pump
Power ground
Ignition system
Bank 2
Bank 1
PWM Idle valve
Good engine ground
Throttle position sensor
O2 heater power
Heater ground
Signal ground
Signal
1, 2 or 4 wire narrowband
WB
Or
NB
Wideband controller
7 wire wideband
Power ground
Coolant temp sensor
Air temp sensor
Sensor ground
MAP sensor
C B A
GND
OUT
5V
IGNOUT
IGNOUT2
VR2IN-
WLED
ALED
BOOT
FLEX
SPARE ADC2
VR2IN+
CANL
CANH
Serial
TACH OUT
VRIN-
VRIN+
OPTOIN-
OPTOIN+
SPARE ADC

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	INJ 1	Thick Green	Out	Injector bank 1 output	5A
10	INJ 2	Thick Blue	Out	Injector bank 2 output	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	SPAREADC	Orange/Green	In	Spare analogue input	-
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

3.4 Relay Board

The 'Relay Board' is an optional add-on for 'traditional' Megasquirts and is not well suited to the Microsquirt. Customers are advised to build a harness with their own relays and fuses instead.

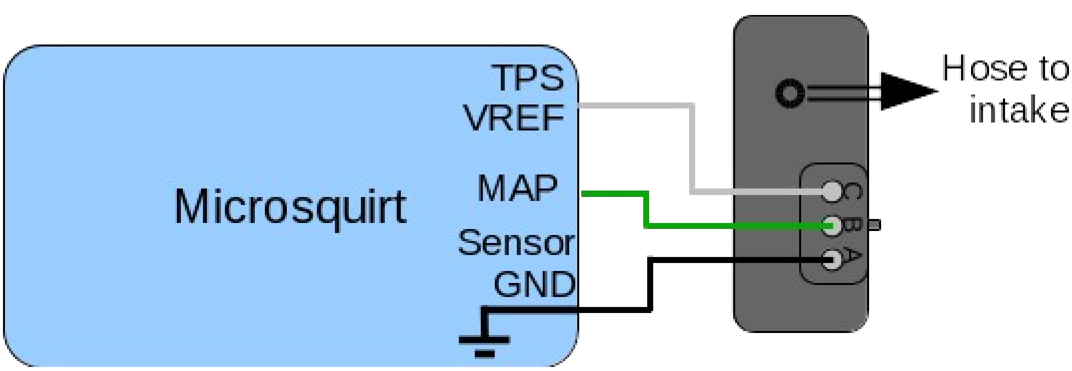
3.5 Inputs

3.5.1 Crank and Cam Tach inputs

These sensors provide the Microsquirt with engine position information and are used to schedule fuel and spark. See chapter 5 for more information.

3.5.2 MAP (Manifold Absolute Pressure) sensor

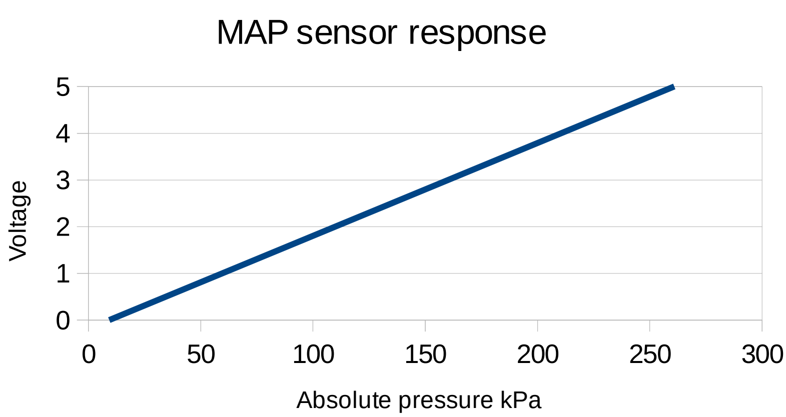
This sensor measures air pressure on absolute scale where zero is a complete vacuum and sea-level ambient pressure is around 101kPa. This sensor is the primary input for the "Speed-Density" fuel algorithm. Alpha-N users do not require a MAP sensor.



The sensor has three wires, 5V supply (TPSVREF), Ground (sensor ground return) and signal. It sends a 0-5V signal back to the Microsquirt.

The pressure barb is connected to a full-vacuum source at the intake manifold. When tapping into any existing vacuum ports on a throttle body be sure to select one that gives full vacuum when the throttle is closed. (i.e. not a "ported vacuum" source that would connect to a distributor.)

The GM sensors are designed to be installed on the engine, Northstar and LS1 style sensors clip directly into the top of the plastic intake.

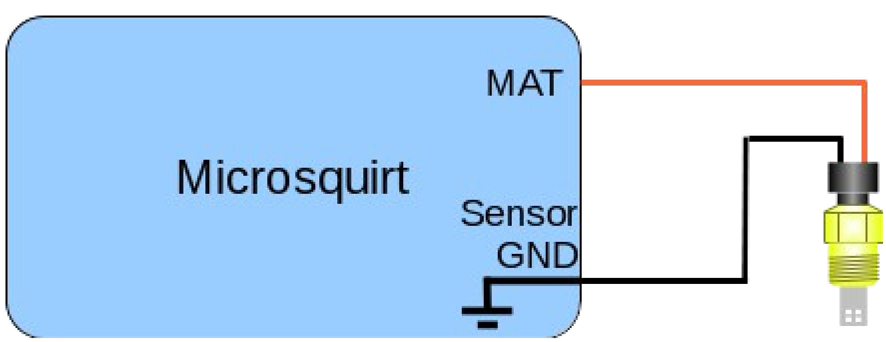


Optionally a second sensor may be installed to measure barometric pressure. This works in the same way but typically a 1-bar sensor is used. The pressure feed port is left open to the atmosphere and will help the engine respond to changes in ambient pressure or elevation.

3.5.3 IAT/MAT (Intake/Manifold Air Temperature) sensor

This external sensor measures the temperature of the air entering the engine. This is used to calculate air density and is a key factor in the Speed-Density fuel calculation.

The temperature sensor is a variable resistor (a thermistor). Higher temperatures give a lower resistance, the response is non-linear.

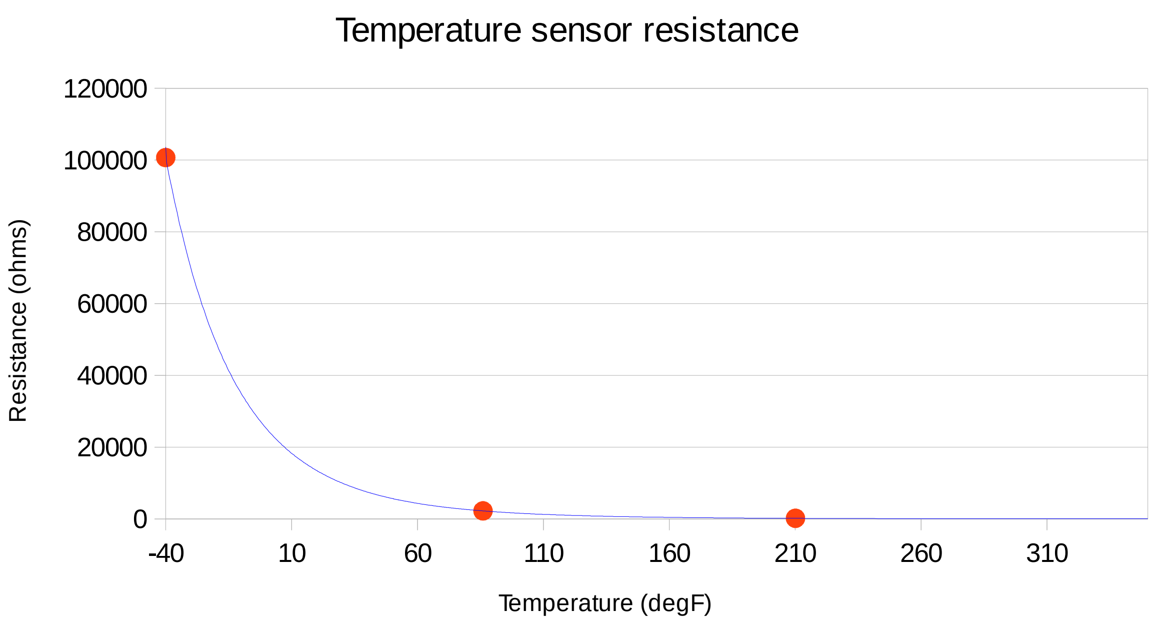


Any install not using a MAT should connect the MAT input to sensor ground to prevent the reading "floating".

A good sensor will have two wires, one wire connects to sensor ground, the other to the MAT input on the ECU.

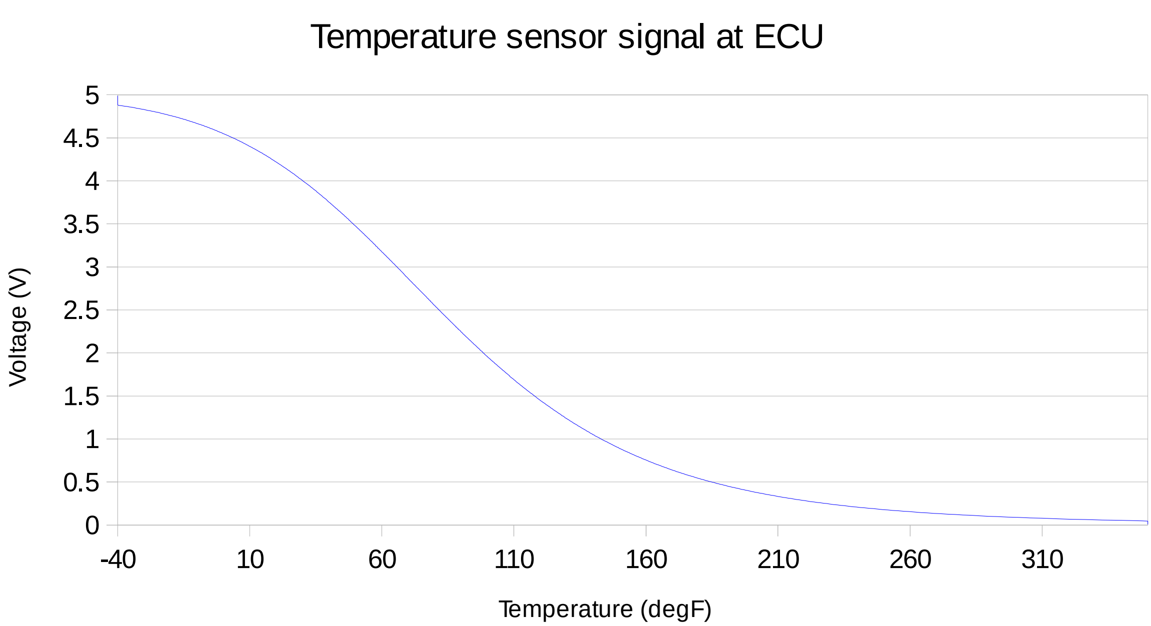
One-wire sensors are not recommended.

The sensor may either be an "open-element" or "closed-element" type sensor. "Open-element" sensor have a thermistor directly exposed to the air-stream - this type of sensor is required for turbo-charged application where the air temperature can change quickly. The "closed-element" type sensor is identical to a coolant temperature sensor and has an encapsulated thermistor - these respond too slowly for turbo-charged application.



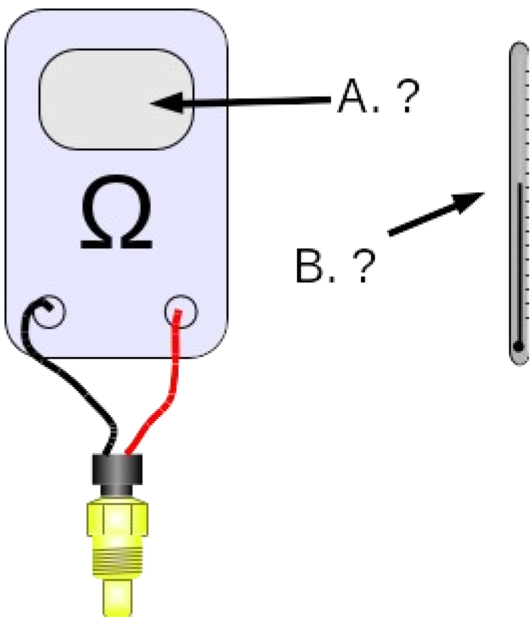
The red dots are the three standard calibration points for GM sensors.

The ECU uses a circuit to convert the resistance into a voltage that it measures.



3.5.3.1 Sensor calibration

TunerStudio includes many predefined calibration curves to select from, but for other "unknown" sensors the three calibration points can be determined.



The manual calibration process requires the use of a multimeter set to measure resistance and ideally a thermometer. Without a thermometer your calibration will be fairly close but not perfect.

1. Set the meter to ohms and connect the meter to the two terminals on the MAT or CLT sensor.
2. Allow the sensor to reach room temperature.
3. Take the resistance reading.
4. Measure room temperature using a thermometer (typically 20°C / 68°F)
5. Place the end of the sensor in a mixture of ice melting in water and allow it to stabilise.
6. Take the resistance reading.
7. Measure the ice/water temperature using a thermometer (typically 0°C / 32°F)
8. Place the end of the sensor in a pan of boiling water and allow it to stabilise.
9. Take the resistance reading.
10. Measure the boiling water temperature using a thermometer (typically 100°C / 212°F)

You now have the three calibration points for TunerStudio.

For a GM sensors these should be close to:

Where	°C	°F	Ohms
Ice/water	0	32	9441

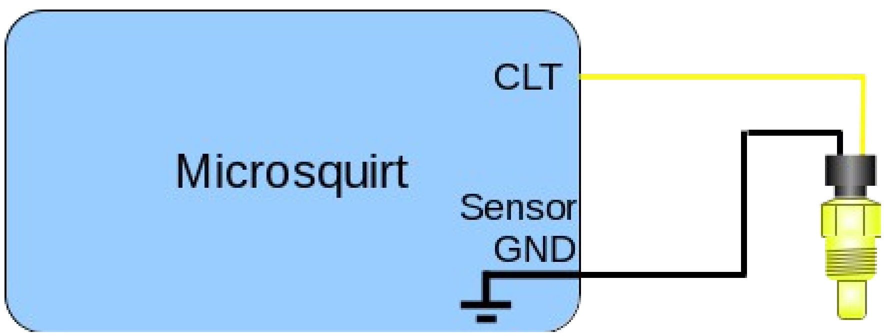
Room temp.	20	68	3518
Boiling water	100	212	172

Note that the default calibration data in TunerStudio goes down to -40° but that's rather difficult to measure in the normal workshop.

3.5.4 CLT (Coolant Temperature) sensor

This external sensor measures the temperature of the engine coolant (or cylinder head for air-cooled engines.) It is primarily used to provide additional fuel during engine warm-up.

The coolant temperature is a thermistor and works in the same way as the air temperature sensor.

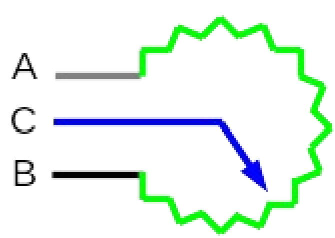


Any install not using a CLT should connect the CLT input to sensor ground to prevent the reading "floating".

A good sensor will have two wires, one wire connects to sensor ground, the other to the CLT input on the ECU.

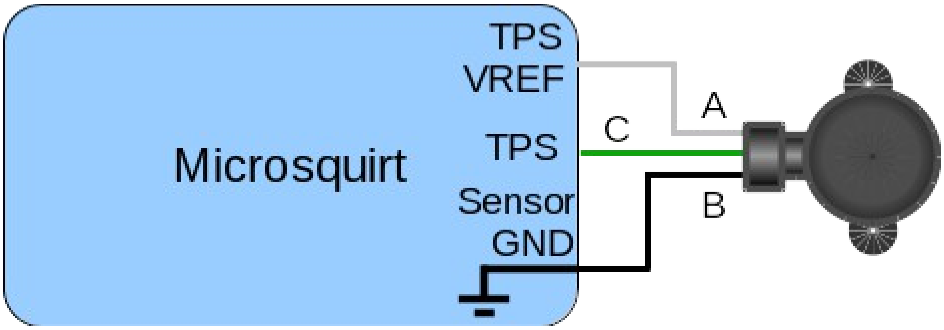
One-wire sensors are not recommended.

3.5.5 TPS (Throttle Position Sensor)



This external sensor measures the position of the throttle plate. It is a variable resistor (potentiometer) and sends a 0-5V signal back to the Microsquirt. The sensor has three wires, 5V supply (TPSVREF), Ground (sensor ground return) and signal. The Microsquirt converts the signal to a 0-100% scale using your calibration numbers. 0% corresponds to fully closed, 100% to fully open.

Switch-type throttle position sensors are not recommended.



Any install not using a TPS should connect the TPS input to sensor ground to prevent the reading "floating".

3.5.6 O2 (Oxygen) Sensor / Lambda Sensor


1-wire Narrowband

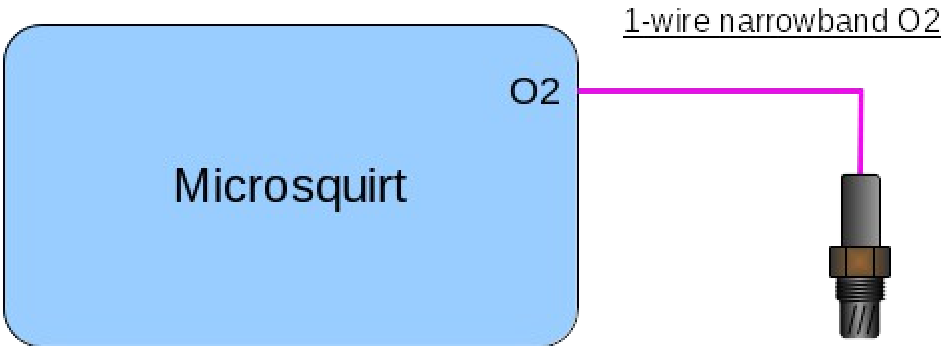

4-wire Narrowband


Wideband

The O2 / oxygen sensor / lambda sensor input gives feedback on the air:fuel ratio (mixture) of the engine and is screwed into a threaded bung which is welded into the exhaust system. Ensure that there are no air leaks or the readings will be inaccurate.

Narrowband sensors are cheap and very accurate for reading "stoichiometric" mixtures (e.g. 14.7 AFR or 1.000 lambda.) They are widely used by OEMs where the 3-way catalysts require these mixtures for correct operation. They do not give accurate readings under rich or lean conditions.

1-wire narrowband sensors rely on exhaust heat to bring them up to operating temperature and are typically mounted close to the exhaust ports or the "collector" of a cast exhaust manifold.



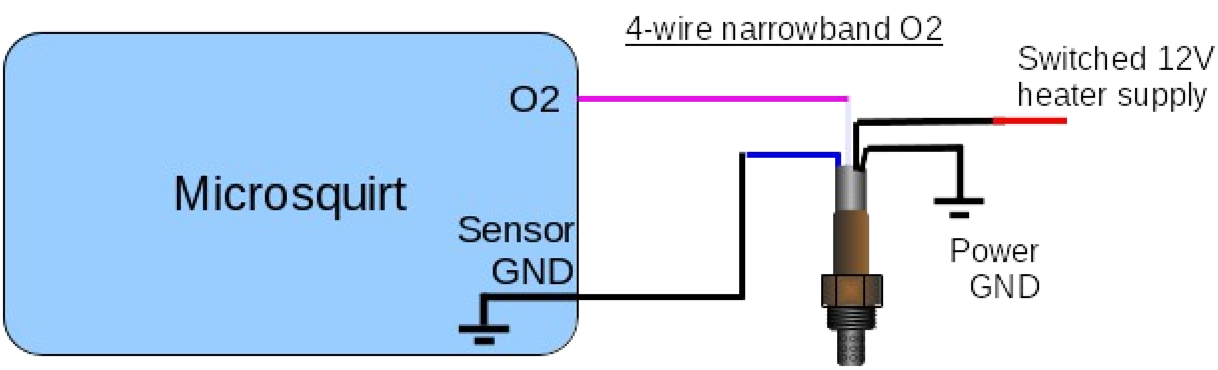
4-wire narrowband sensors include a heater and a signal ground. These can be mounted further away from the exhaust port as they are self heating. Preferable to a 1-wire.

Typical wiring

Blacks = heater power and ground

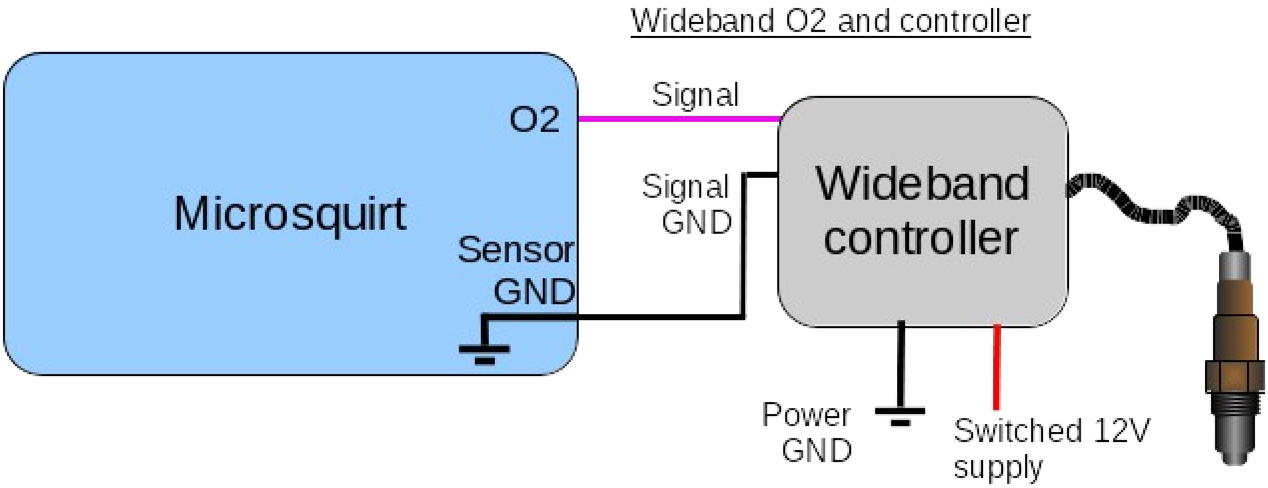
Blue = signal ground

White = O2 signal



Wideband sensors require an external controller for use with the Microsquirt. Widebands are more expensive than narrowband sensors but give readings over a far wider range of exhaust mixtures. When used with a Microsquirt they give you the ability to tune your engine in the rich (power) and lean (cruise) regions. Strongly recommended.

The better controllers offer a signal ground which should be connected to the Microsquirt sensor ground. Other models require grounding to the engine block only. Consult the directions that came with your wideband controller.



3.5.7 MAF (Mass Air Flow) Sensor

Ford Lightning 6 pin MAF

Nissan Infiniti Q45 MAF

The MAF Sensor measures the actual mass air-flow into the engine. This can be used for a more accurate fuelling calculation- other fuelling algorithms estimate the mass air flow based on MAP, TPS, RPM, MAT.

MS2/Extra supports voltage MAFs only. Frequency MAFs (such as LS1) are not supported.

The sensors have at least three wires, 12V supply, Ground (sensor ground return) and signal to the Microsquirt.

The following diagrams show the MAF signal connected to "SPAREADC2/MAF" but you can wire to "MAP" or "SPAREADC" if desired so long as the input port setting in TunerStudio is set to match.

Ford 4 pin MAF

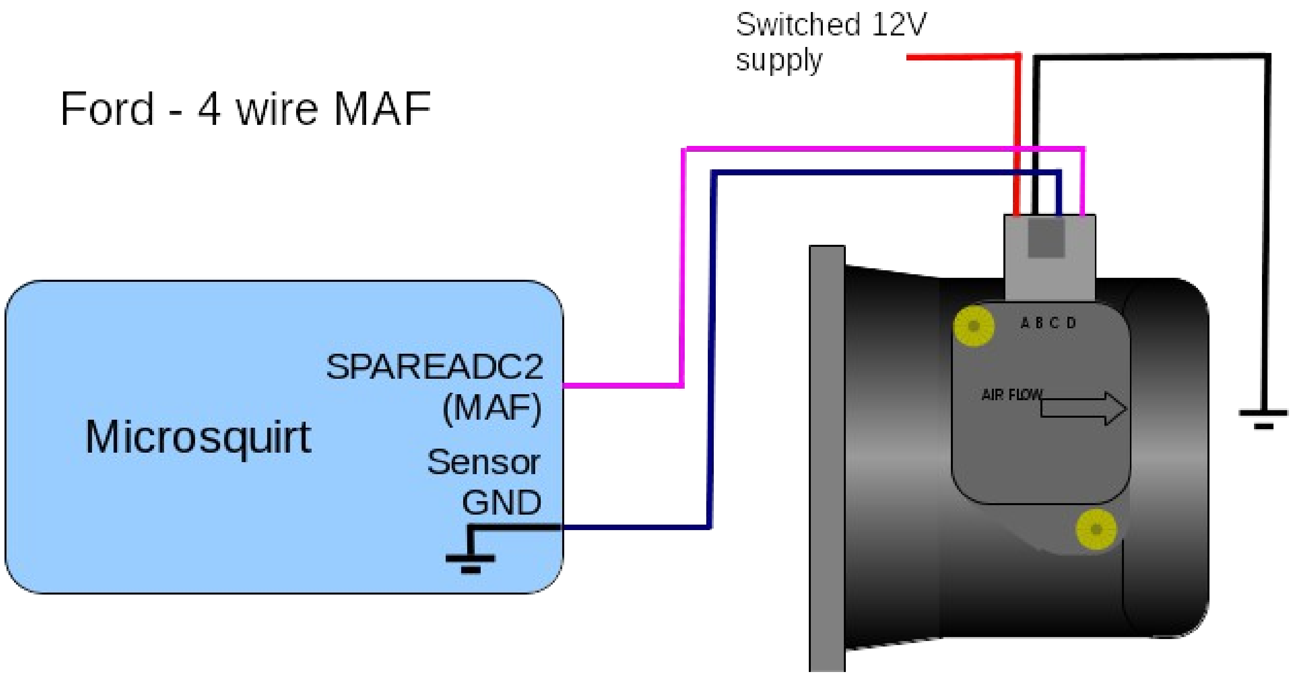
This earlier style MAF has an oval connector.

A = Switched 12 volts supply

B = Power Ground

C = MAF signal ground

D = MAF output signal



Ford 6 pin MAF

This MAF also includes an intake air temperature sensor, so an additional MAT is not required.

E = IAT sensor signal ground

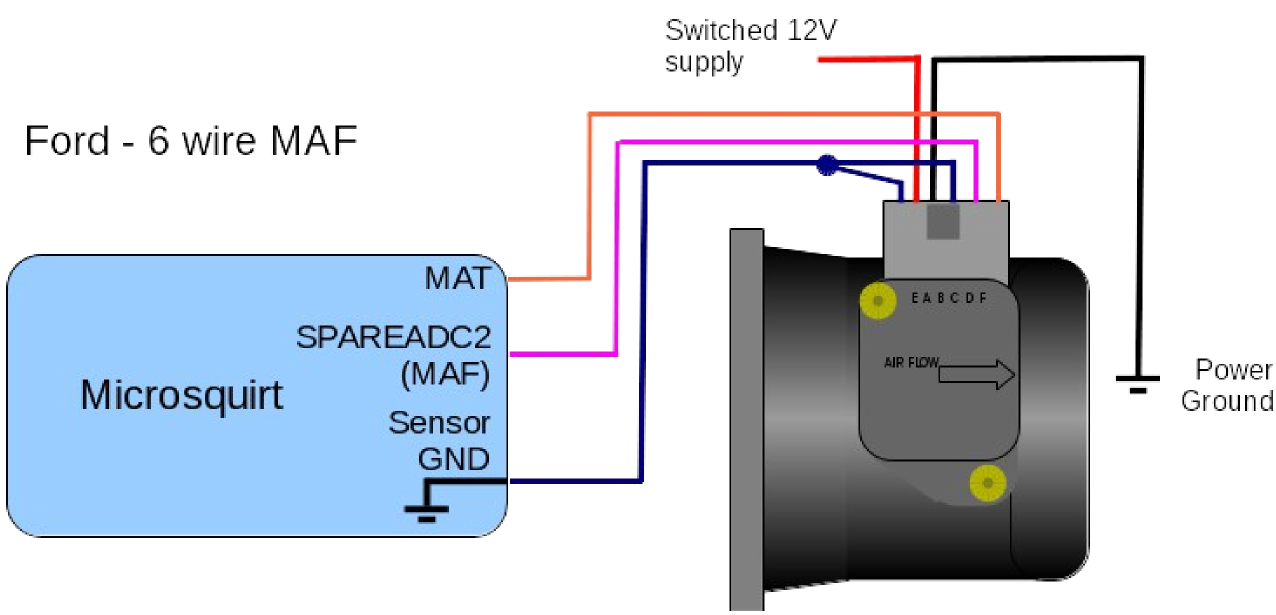
A = Switched 12 volts supply

B = Power Ground

C = MAF signal ground

D = MAF output signal

F = IAT sensor signal

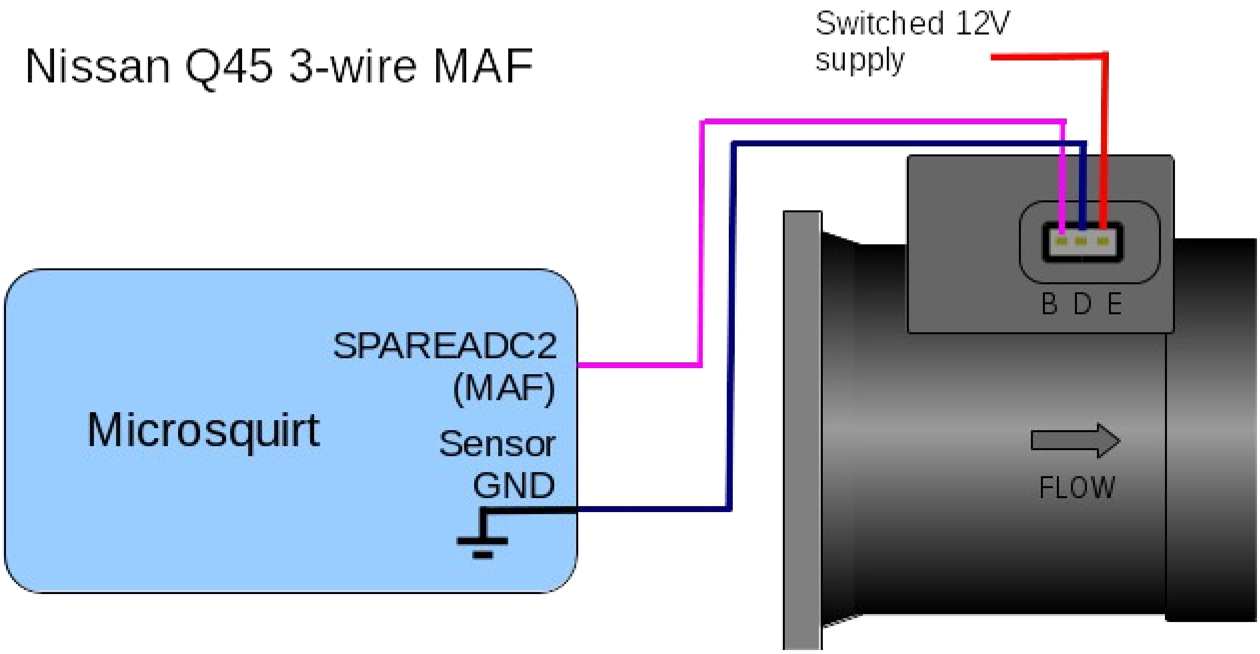


Nissan Infiniti Q45 90mm MAF

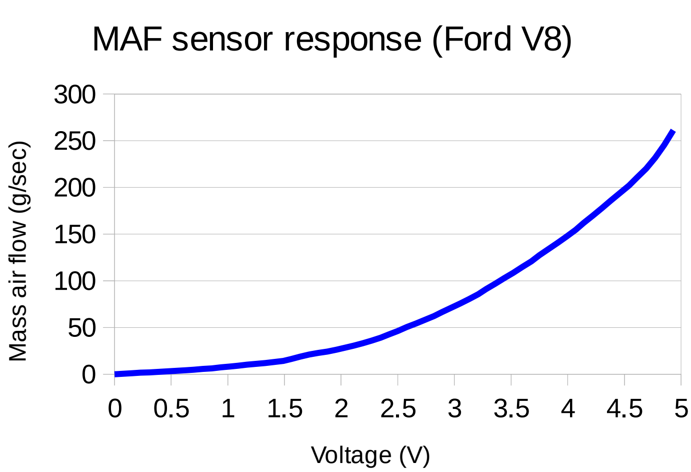
B = MAF output signal (White)

D = Ground (Black)

E = Switched 12 volts (Black/white)



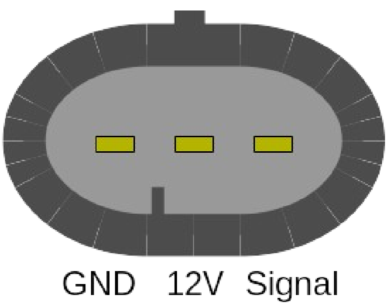
The flow response of MAF sensors is non-linear and uses a calibration tuning curve in the Microsquirt to convert the input signal into a grammes/second flow rate number.



3.5.8 Flex / Switch input

The Flex fuel (or fuel composition) sensor detects the percentage of ethanol within the fuel passing through it. This can be used by the Microsquirt to automatically adjust fuel and spark to allow for the change in fuel. Higher ethanol blends require more pulsewidth and additional spark advance.

The GM sensor (shown) uses barbed pipes, the Ford sensor uses screw in fittings.



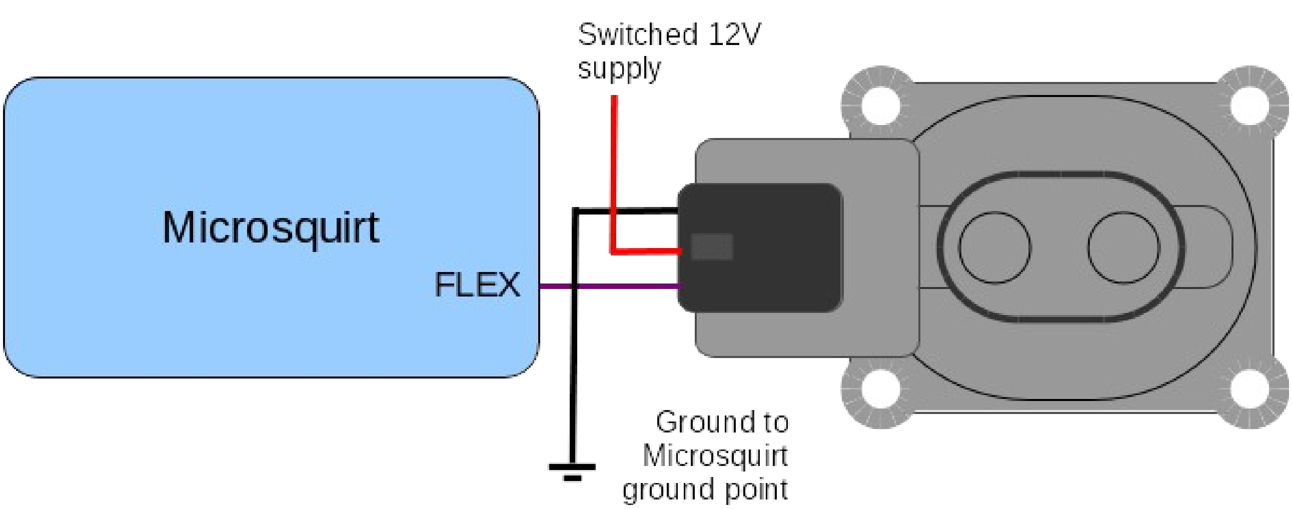
Looking into sensor connector from left.

Ground (GM = white, Ford = Black)

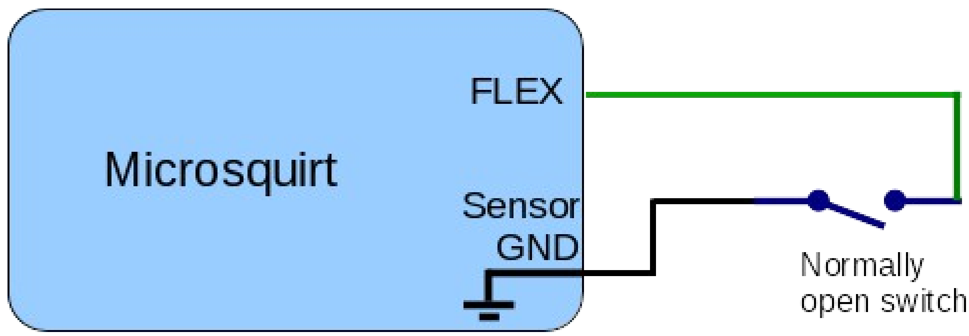
+12 Volt supply (GM/Ford = pink)

Output signal, (GM = purple, Ford = white)

GM and Ford appear to use the same sensor but the letters on the connector may be different.



When not being used for Flex Fuel, the "Flex" input wire may be used as a ground-switch input.

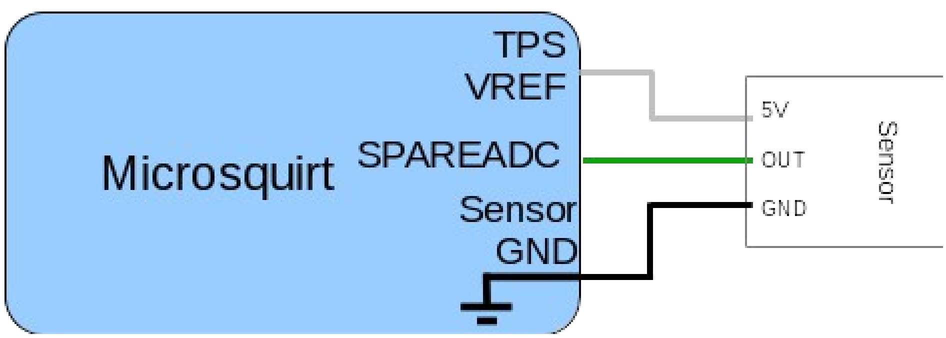


3.5.9 Spare ADC / Switch input

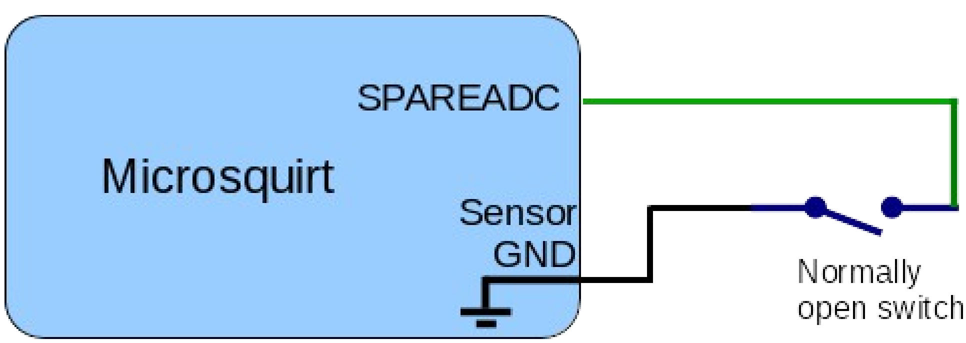
The SPAREADC and SPAREADC2 inputs can be used as 0-5V analogue, switch inputs or as outputs to the stepper-idle add-on.

Analogue options: MAF, 2nd O2 sensor, Baro sensor, misc sensor.

When used for a misc 0-5V analogue sensor input, SPAREADC is datalogged as ADC6 on a scale of 0-1023 points and SPAREADC2 is datalogged as ADC7. See the TunerStudio manual for more detail.



Switch input options: Launch input, nitrous input, shift cut input



See the specific feature for information on how to configure the inputs.

3.5.10 BOOTLOAD input

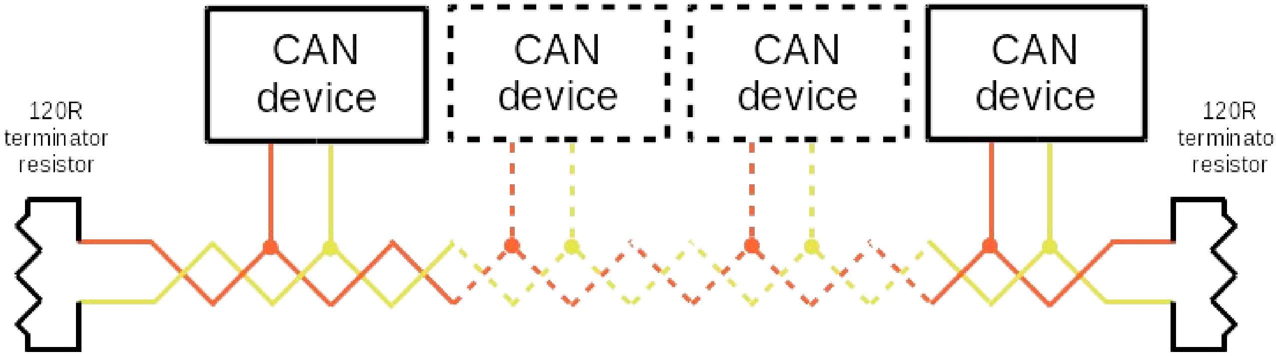
The bootload wire is used to force the Microsquirt into "bootloader" monitor mode. This is only typically needed when loading the firmware for the first time. It can optionally be used if the firmware has become corrupted (e.g. an ignition spike got into the wiring harness) and the normal firmware loading will not function.

It is connected to ground when required. At all other times it must be taped up and kept away from any high voltage noise sources. Do not ever apply a voltage to this wire.

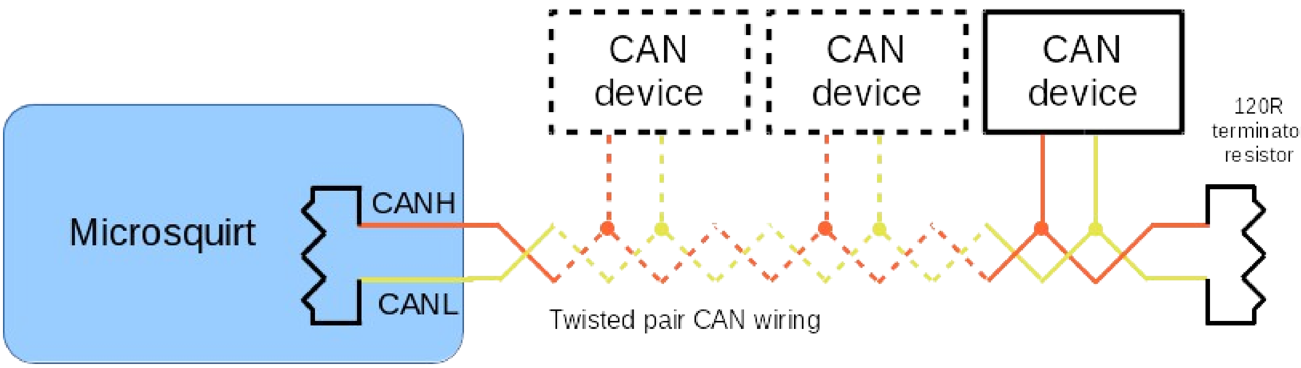
3.5.11 CAN comms

The CANH/L wires are used to connect to add-on units such as transmission control, CANEGT interfaces, data capture or compatible dashboards.

In general, CAN forms a bus network with a 120R terminator at each end and devices wired as short 'drops' off the network.



The Microsquirt includes a terminating resistor internally, so no additional resistor is required at that end.

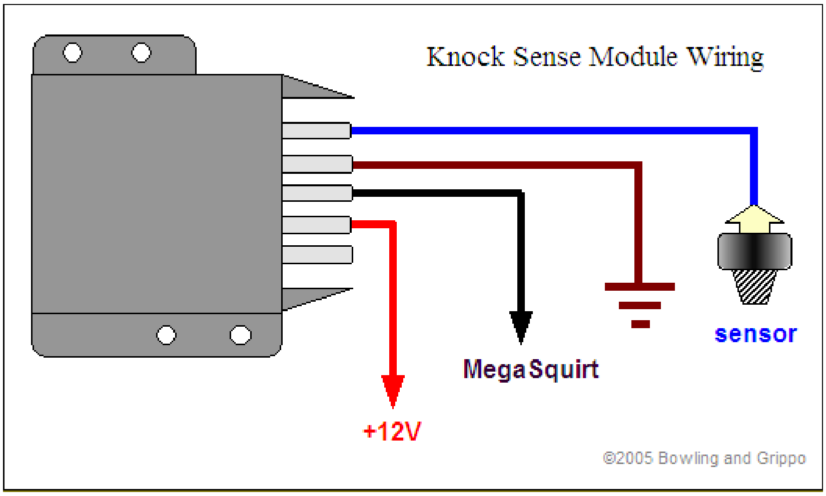


3.5.12 Knock sensor

Microsquirt supports knock sensing with an external interface to the knock sensor. Do not connect a sensor directly to the Microsquirt - it will not work.

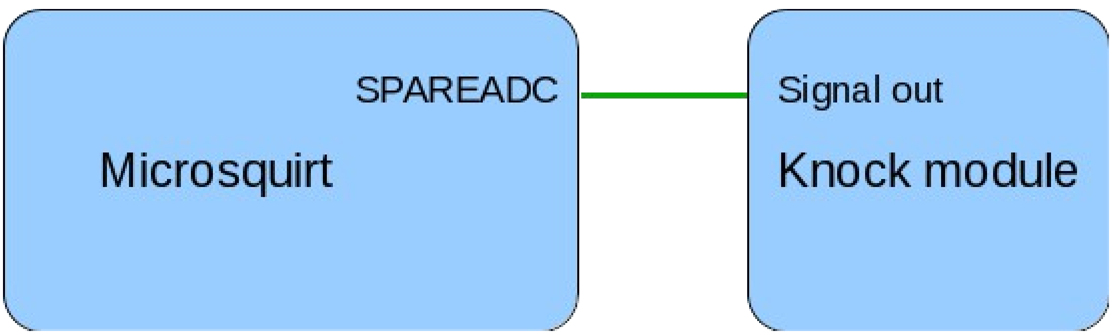
Two configurations are available - on/off or analogue.

The **on/off mode** can be used with a GM ESC module (16022621, 16052401)



The connection to the Microsquirt is on SPAREADC or SPAREADC2.

In the **analogue mode**, 0-5V signal is fed into SPAREADC or SPAREADC2.



3.6 Outputs

3.6.1 Fuel Injector outputs

The Microsquirt has two injector outputs. These can supply up to 5A maximum each. Typically this allows for four high-z (14 ohm) injectors per channel.

Fuel injectors are covered in more detail in section 4.

3.6.2 Ignition outputs

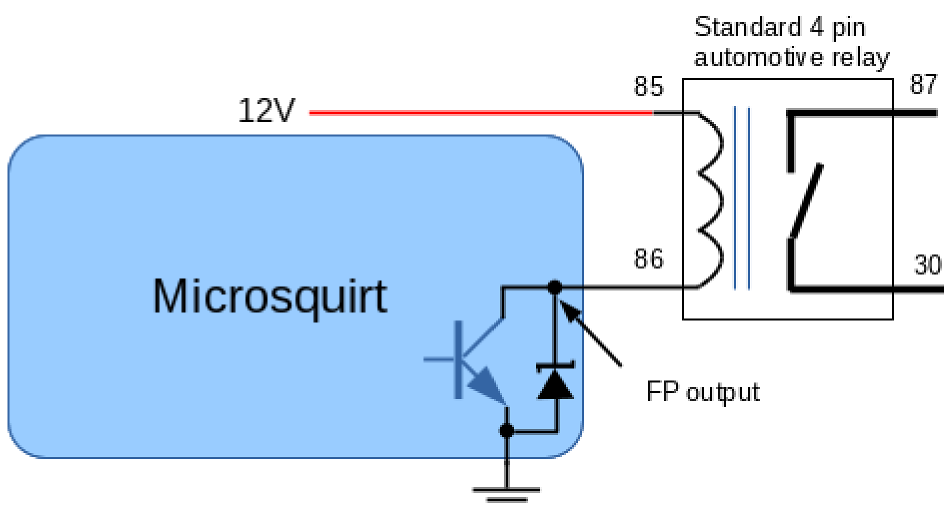
The Microsquirt as standard provides two logic ignition channels IGNOUT1 (SPKA) and IGNOUT2 (SPKB). Optionally the WLED and ALED outputs can be re-purposed to give a total of four output channels.

Alternatively, WLED may be used to drive a CDI box "white wire" connection.

Ignition outputs and the ignition system are covered in more detail in section 5.

3.6.3 Fuel pump output

The Fuel Pump output is low current low-side output used to drive a relay that switches the high current fuel pump. The coils and injectors should also take power from this relay so that when the engine is shutdown or stalls these are positively disconnected from power.

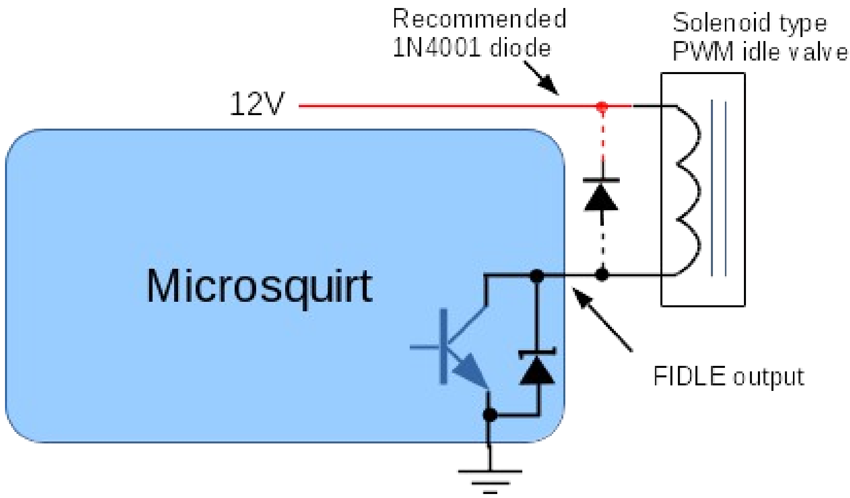


3.6.4 Idle valve

An idle valve is used to allow additional air into the engine, bypassing the throttle plate. This works similarly to the part of the choke mechanism on a carburettor and raises idle speed during warmup. Additionally it can be used for "closed-loop idle" to maintain a steady idle RPM under varying engine loads (lights on vs. off etc.)

As standard, the Microsquirt supports 2-wire PWM idle valves or on/off type valves only. Stepper idle motors require an add-on. Servo type idle valves are not currently supported.

2-wire PWM idle valve

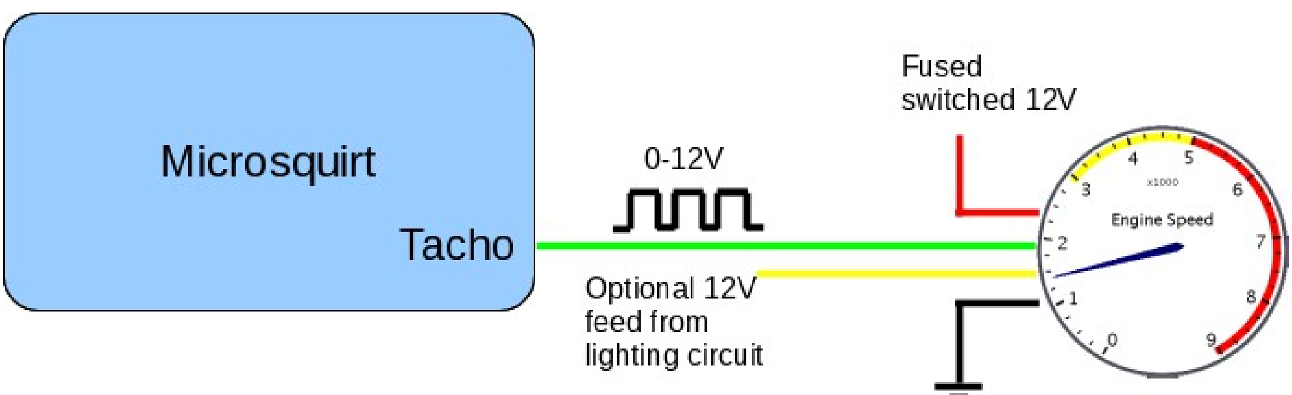


The 12V supply for the idle valve must be a fused switched supply - ideally from the fuel pump relay. It must never be supplied power when the Microsquirt is off.

Many PWM idle valves will benefit from the addition of a 1N4001 diode in the wiring harness across the idle valve connections. Connect the banded end to the 12V side. (The diode changes the way the valve responds to the PWM signal and makes it more controllable.)

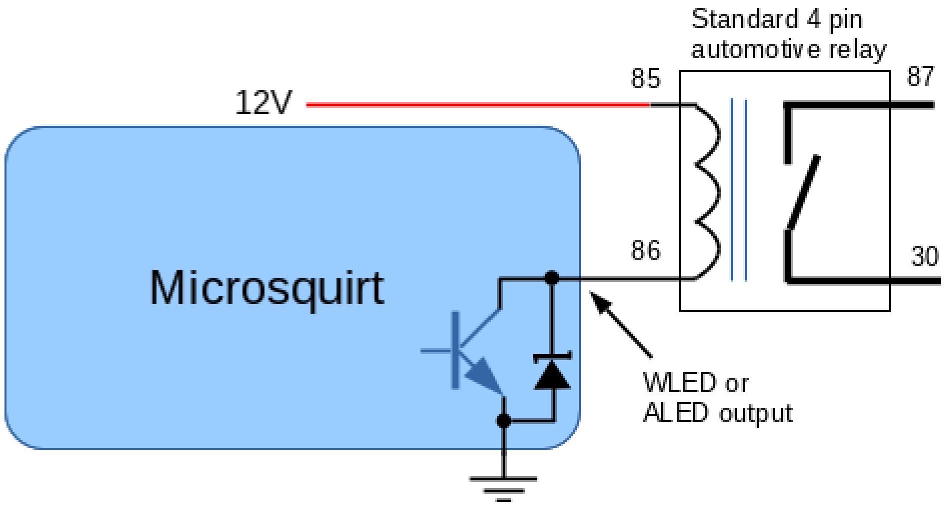
3.6.5 Tacho output

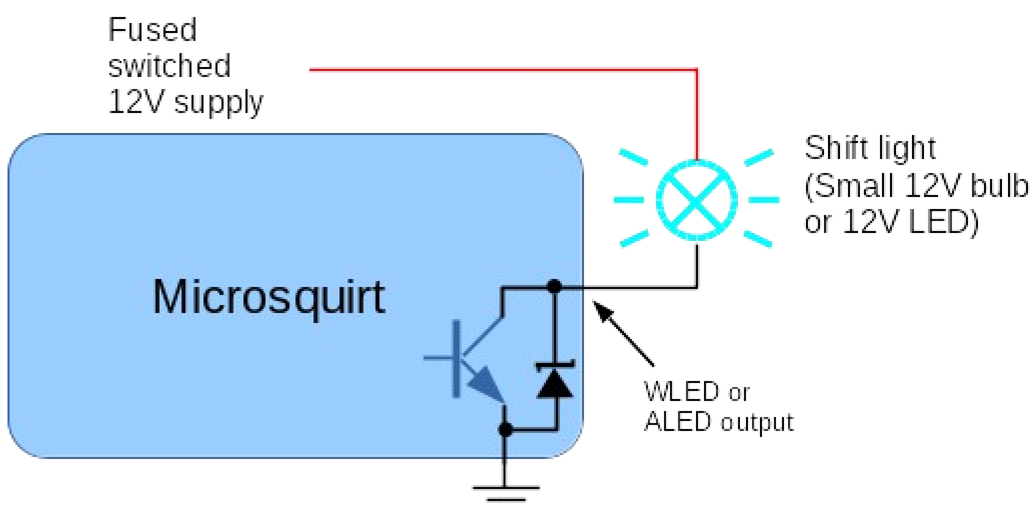
The Tacho output typically provides a 0-12V pulsed signal that is suitable for driving an aftermarket tachometer (rev counter.) This must be enabled in the software.

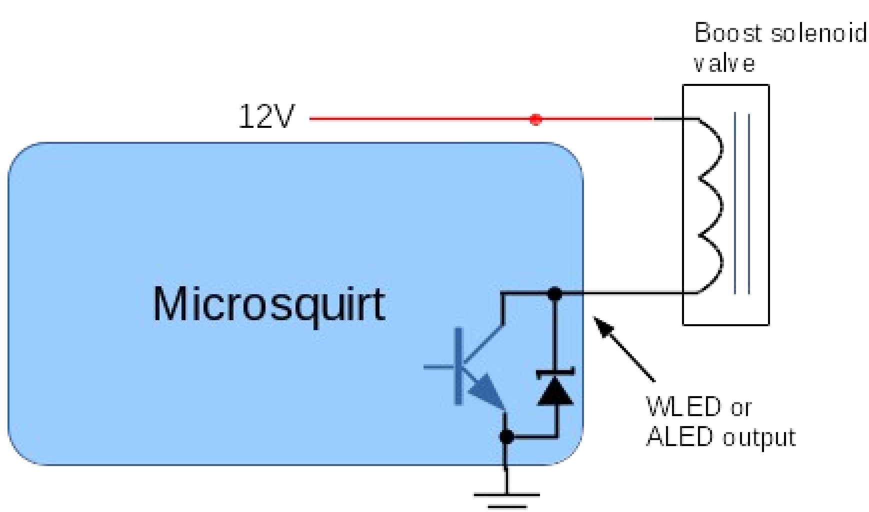


3.6.6 WLED/ALED outputs

The WLED and ALED outputs are general purpose outputs suitable for driving solenoids and relays. They can also be re-purposed as ignition channels C and D (see chapter 5.)







3.7 Inputs and Outputs Summary

The following chart lists all of the inputs and outputs on the MS2 and their typical uses. This may help you plan your wiring for optional features.

Pin	Analog in?	Digital in?	Digital out?	Prog. output	Typical use	Optional usage / notes
SPAREADC	✔	✔	✔		EGO2	Analog in, digi in, digi output.
SPAREADC2	✔	✔	✔		Baro	Analog in, digi in, digi output.
Tacho			✔	✔	Tacho	Digital outputs only
WLED			✔	✔	Spk C	Digital outputs only
ALED			✔	✔	Spk B	Digital outputs only
FIDLE			✔	✔	PWM idle	Digital outputs only
Flex		✔			Launch	Digital inputs only
IGN	Primarily SpkA output.					
IGN2	Always SpkB output.					
MAP	Usually MAP analog input. Can be used for MAF analog input.					
MAT	Always MAT analog input.					
CLT	Always CLT analog input.					
TPS	Always TPS analog input.					
O2	Always O2 (lamba) analog input.					
INJ1	Always Injector bank 1 output.					
INJ2	Always Injector bank 2 output.					
VR1+/-, Opto	Always primary tach (RPM) input.					
VR2+/-	Always secondary tach (RPM) input i.e. cam signal.					
CANH/L	Always CANH/L signals.					

3.7.1 Pin vs. feature table

This is the list of I/O pins with available functions.

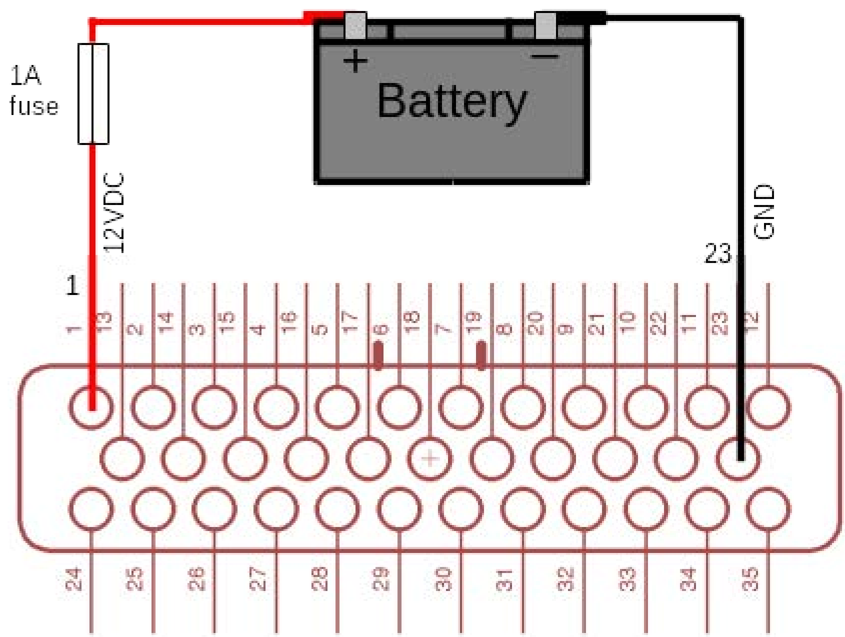
ALED	Spark D				Seq. Shift OUT		Prog Output	AC Idle - Out		Tach Out
FIDLE	PWM Idle	Boost Control		Nitrous OUT-1	Seq. Shift OUT		Prog Output	AC Idle - Out	*Step Idle **	Tach Out
FLEX	Flex Fuel	Table Switch	Launch	Nitrous IN		Seq. Shift IN		AC Idle - In		
IGN	Spark A				Seq. Shift OUT			AC Idle - Out		Tach Out
IGN2	Spark B									
SpareADC	EGO2	Const Baro	Launch	Nitrous IN		Seq. Shift IN	Knock	AC Idle - In	*Step Idle **	
SpareADC2	EGO2	Const Baro	Launch	Nitrous IN		Seq. Shift IN	Knock	~~AC Idle - In~~	*Step Idle **	
TACHOUT					Seq. Shift OUT		Prog Output	AC Idle - Out		Tach Out
WLED	Spark C		Spark A	Nitrous OUT-2	Seq. Shift OUT		Prog Output	AC Idle - Out	*Step Idle **	Tach Out

3.8 Bench test wiring

Before installing on your engine, it can be useful to install the Microsquirt on the bench to become familiar with the tuning software.

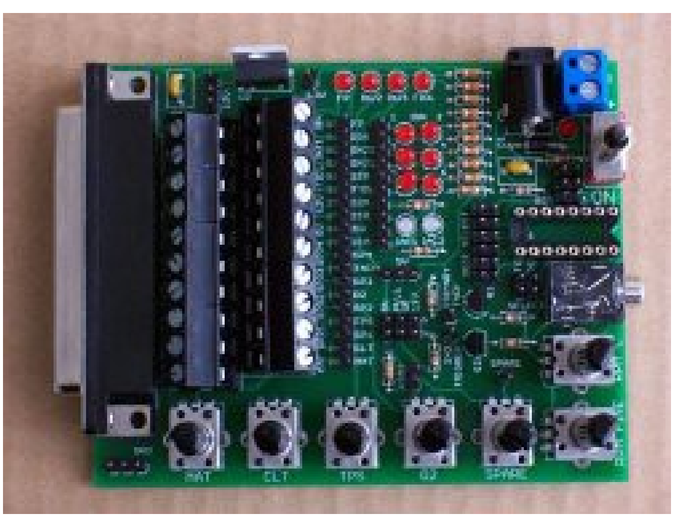
3.8.1 Minimal connection

The bare minimum for testing is a fused 12V supply, ground and the serial connection to your tuning computer.



3.8.2 JimStim connection

For more extensive testing, the JimStim can be used. This has screw terminals to connect your Microsquirt wiring pigtail and can simulate many of the engine sensors.



4 Fuel System

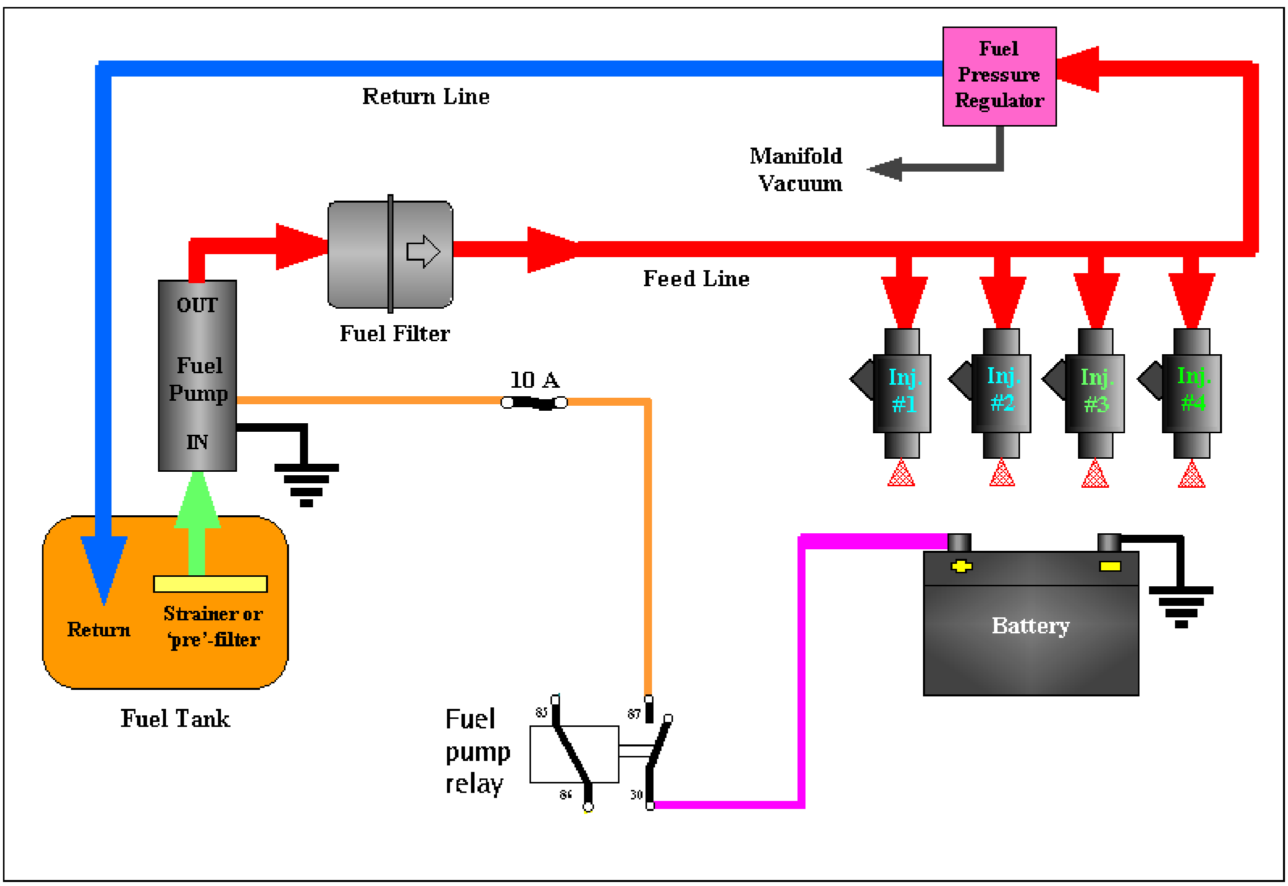
Fuel is extremely flammable and fuel systems run at high pressures. Be sure to have a fire extinguisher to hand in case of mishap and take appropriate caution when working on fuel systems.

4.1 Introduction

The fuel system install comprises electrical and plumbing work.

The Microsquirt has two injector outputs. These can supply up to 5A maximum each. Up to four high-z (14 ohm) injectors are allowed per channel. Low-z (2.5 ohm) injectors require series injector resistors or a peak and hold controller.

The following shows a typical EFI fuel system.



A high pressure pump is connected to the fuel tank and feeds fuel to the fuel rails(s) these provide fuel directly to the top of the injectors. The fuel rail(s) are connected to an intake manifold pressure referenced pressure regulator. The regulator maintains the rail pressure a set pressure above the intake under all conditions. Excess fuel is returned to the fuel tank through the return line.

Key elements

- Fuel pump
- Fuel hose/pipe and fittings
- Injectors

- Injector mounting
- Fuel rails
- Pressure regulator

4.1.1 Existing EFI Vehicle

Most vehicles with EFI already fitted are readily adaptable to use Megasquirt for control. Typically all of the fuel system components will be readily suitable.

However, if like many users you are increasing the power of your engine, you will need to consider whether your injectors are large enough and whether your fuel pump has adequate flow. In particular note that all fuel pumps flow less fuel as the pressure increases - so if you are boosting your engine you will be needing more fuel under the conditions when your pump can supply less!

Some recent engines use ECU controlled fuel pumps or dead-head systems with no regulator. At this time, these are not easily controlled and you are advised to convert to a conventional system with a vacuum referenced bypass regulator and return line.

4.1.2 Retro-fit EFI Vehicle

When installing EFI on a previously carburetted vehicle or a new build you have to source all the required fuel system components. There are many choices open to the retro-fit market. Be aware that a high horsepower install will often spend more on the fuel system than the ECU.

4.2 Single Fuel pump

You will need a high pressure pump with enough volume at your operating pressure to feed you engine under maximum load. Typical pressures needed in the neighborhood of ~45 psi for port fuel injection, ~10-20 psi for TBI injection. A port injection pump will work with TBI, but not vice-versa.

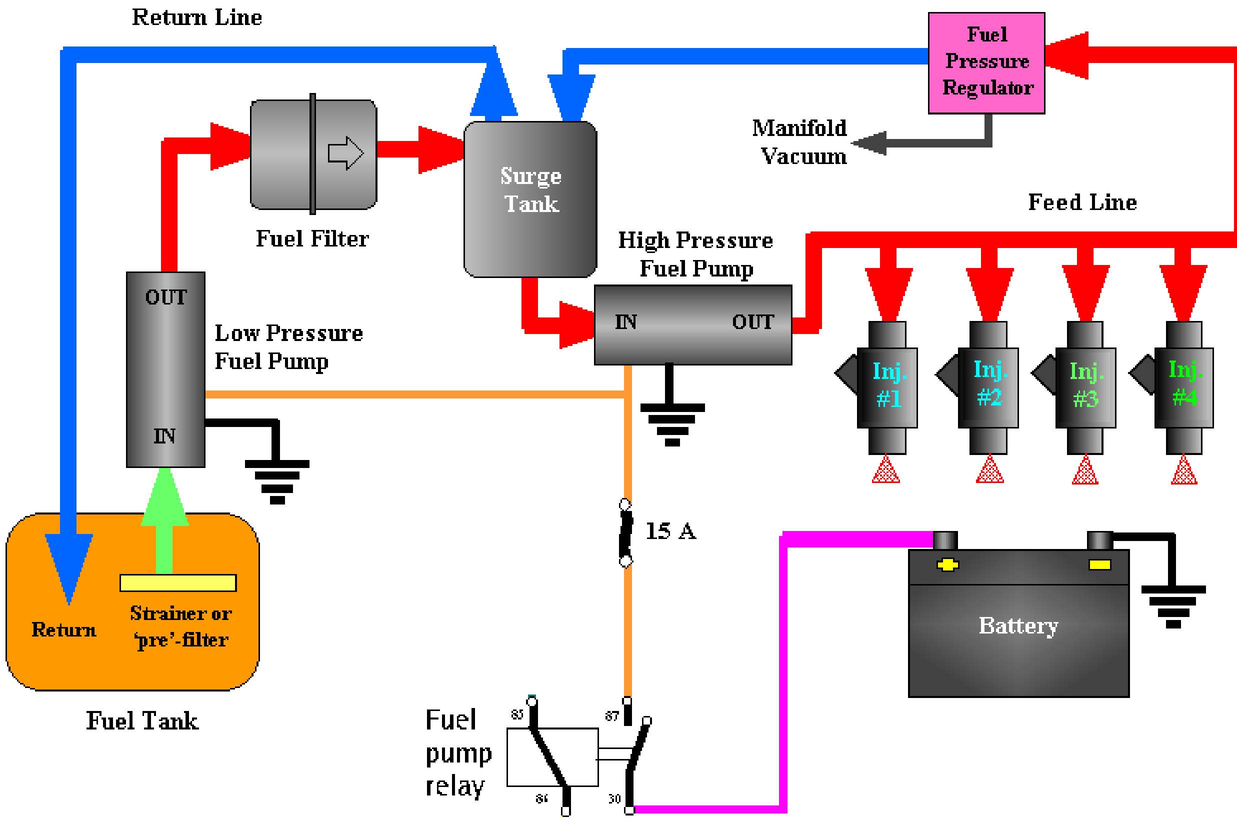
A standard EFI install uses a single high pressure pump connected as per the diagram in 4.1 above. Depending on your target power output, many OEM style pumps may be suitable. Surprisingly, some of the Bosch inline EFI pumps installed on 100hp cars are actually rated to 450hp fuel capacity. OEM style pumps are a usually a good choice as they are designed for trouble free operation for tens of thousands of miles.

OEMs sometimes place the pump inside the fuel tank. In an EFI retrofit it is generally easier to use an external fuel pump.

If an OEM style pump does not offer sufficient output, there are plenty of aftermarket high volume EFI pumps on the market.

4.3 Low pressure / high pressure - twin pump

For a basic retrofit, you may find that a low pressure/high pressure system is a simpler way to avoid tank modifications for the fuel pickup, although a fuel return to the tank is still required.



The low pressure side can be your existing electric fuel pump. You need to add the surge/swirl tank and high pressure side. For the tank return you may already have an return or evap canister connection or could connect into the filler neck, ensuring that fuel returns to the tank and cannot leak out of the vehicle.
Surge/swirl tank can be purchased or you can make your own. Use thick wall TIGed aluminium or brazed steel. Ensure it is totally leak free.

4.4 Wiring the Fuel Pump

To activate the fuel pump, the Microsquirt provides a ground for the fuel pump relay circuit -see the main wiring diagram.
Ordinarily, at power on, the Microsquirt will run the fuel pump for 2 seconds, then when you start cranking the fuel pump is enabled again. If you stop cranking before the engine starts or you stall, the pump is turned off.

An inertial safety shut off switch is a good safety feature – it is used to kill power to the pump if there is significant impact to vehicle.

4.5 Fuel Line

Steel tubing or Cunifer (Bundy tubing) is recommended, but you MUST have short sections of flexible line in the feed and return lines between the engine and frame to allow for engine movement. The return line should have minimal restriction. For reference, GM systems typically have 3/8" feed lines and 5/16" return lines.

You may be able to use your original fuel line as a return line, plumbing a new 3/8" (10mm) line for fuel supply. You can run the return line into the tank, or reroute it to a fitting or nipple you install in the fuel tank filler neck/tube assembly (in which case you may be able to use the original pick-up for your supply line). If you run a new pick-up into the tank, it will need a filter.

You may have to fabricate fuel lines for your system. Tubing is available in steel, cunifer (bundy), stainless steel, and aluminum for this purpose. Do not use plain copper as it can fatigue fail with dangerous leaks resulting. The size is generally given as the outside diameter of the tubing. Unless you have a very unusual combination (or very high horsepower, well over 500+), you should be able to use 3/8" tubing for both the supply and return lines.

Buy a good tubing bender (there are numerous styles in various price ranges) so that you don't kink or collapse the tubing while bending it.

Most fittings and adapters in the USA automotive aftermarket are based on a 37° sealing angle (SAE J514 37° -formerly known as JIC). These are also often referred to simply as AN fittings. Male and female 37° fittings will mate together for a leak-proof connection. Be aware that 45° fittings (commonly available in the USA) are not interchangeable with 37° fittings.

Abrasion (the rubbing of the hose against some other component) is the number one cause of hose failure. A leaking fuel hose can start a very dangerous fire in your car, so make sure hose assemblies are routed properly to reduce the chance of any abrasion damage. Use a support every 12 to 18 inches (30 to 45 cm) to secure the hose. For chafe protection, be sure to install a grommet at any point a hose passes through a panel or bulkhead.

Besides steel or aluminum tubing fuel line, you can also use one of the steel or nylon braided hoses from various suppliers. Generally these use the same AN 'dash' sizing system, and can use appropriate fittings to connect to 37° flare, NPT thread, or other systems.

Note that if you are using a factory fuel rail, you may be able to find an aftermarket adapter to mate your OEM fuel fitting to an AN hose.

IMPORTANT: Keep the fuel lines out of passenger compartment and routed safely away from moving or hot parts to avoid damage/excessive heat. For flexible rubber hose use the SAE 30R9 EFI hose which is rated at 250 psi. EFI hose clamps are also recommended rather than gear clamps. Check with someone who knows if you are not sure about your installation. Nobody needs a 50 psi gasoline fed fire to ruin their day!

4.6 Fuel filter

Use a fuel injection fuel filter rated for the pressure at which your system operates. DO NOT use a universal carburettor filter - the higher pressure of fuel injection systems may cause it to burst! Position the filter downstream of the pump so that a clogged fuel filter will not over heat the fuel-cooled pump.
However, if you fuel pickup does not include a strainer, it is wise to install a coarser filter ahead of the pump. When using original old steel fuel tanks, pieces of rust can dislodge and jam the fuel pump.

4.7 Fuel Pressure Regulator

The vacuum referenced fuel pressure regulator is essential. It provides constant pressure differential between fuel at injector nozzle and manifold air pressure [port EFI] or atmospheric pressure [TBI]. This makes the injected fuel quantity solely a function of the injector open time. Without the vacuum/boost reference connection you would need an excessively small pulsewidth under cruise/idle and an enlarged pulsewidth under wide open throttle or boost. Make sure the regulator is connected to a full vacuum source, not ported-vacuum. Check it has vacuum with the engine idling and the throttle shut.

If you have an adjustable fuel pressure regulator (FPR), set the pressure with the fuel pump running, but the engine not running - that's your base fuel pressure (it is referenced to atmospheric pressure).

The regulator is typically at the far end of the fuel rail (after the injectors) which recirculates all of the fuel, keeping it cool and free from air pockets. However, it can be installed anywhere after the fuel pump, but you may experience fuel heating and air pockets.

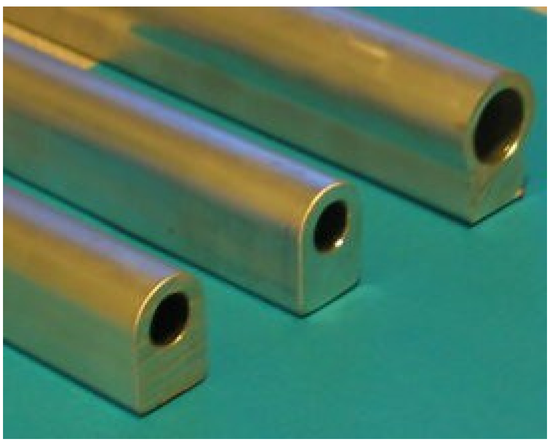
If you are using an aftermarket fuel pressure regulator, it is a good idea to also install a pressure gauge, since most of these are adjustable. For TBI, use a 0-30 psi gauge. For port injection use a 0-60 psi or 0-100 psi gauge. Most of these gauges will mount directly on a fuel fitting using a 1/8" NPT thread.

4.8 Injector installation

Many "high performance" vendors offer ready made EFI intake manifolds for engines that did not originally come fitted with EFI. Or you can choose to modify your existing intake by welding, glueing or screwing in injector bungs. Many aftermarket vendors offer suitable injector bungs.

4.9 Fuel Rails

Most injector systems will use one or more fuel rails. These serve two functions: they supply fuel to a multiple number of injectors (4 on a 4 cylinder, for example), and they physically locate the tops of the injectors. Most OEM rails can be made to work with standard engine configurations, but if you are doing a custom conversion you may have to fabricate fuel rails. Many place supply blank aluminum fuel rail extrusions in whatever length you need.



4.10 Fuel Injectors

4.10.1 Injector Size

It is important that your injectors are correctly sized for your engine size and power requirements.
Too small and you will run out of fuel at high power and rpms, with likely engine damage from going lean. Too large and you will encounter tuning difficulties for idle and cruise conditions.

You can use the following chart to select injectors based on the total horsepower of your engine and the total number of injectors:

Injectors Rating Required in cc/min (lbs/hr)

	Number of Injectors					
Horsepower	1	2	4	5	6	8
100	620 (59)	305 (29)	158 (15)	126 (12)	105 (10)	-
150	924 (88)	462 (44)	231 (22)	189 (18)	158 (15)	116 (11)
200	-	620 (59)	305 (29)	252 (24)	210 (20)	158 (15)
250	-	777 (74)	389 (37)	305 (29)	263 (25)	189 (18)
300	-	924 (88)	462 (44)	368 (35)	305 (29)	231 (22)
350	-	-	524 (51)	431 (41)	357 (34)	273 (26)
400	-	-	620 (59)	494 (47)	410 (39)	305 (29)
500	-	-	777 (74)	620 (59)	515 (49)	389 (37)
600	-	-	924 (88)	746 (71)	620 (59)	462 (44)
800	-	-	1239 (118)	987 (94)	819 (78)	620 (59)
1000	-	-	1544 (147)	1240 (118)	1030 (98)	777 (74)
1500	-	-	-	-	1575 (150)	1187 (113)
2000	-	-	-	-	-	1554 (148)

Based on 0.50 BSFC and 85% duty cycle
Turbo/supercharged engines should add 10% to listed minimum injector size

Injectors are usually rated in either lbs/hour or cc/min. The accepted conversion factor between these depends somewhat on fuel density, which changes with formulation (i.e., by season), but the generally used conversion for gasoline is:

1 lb/hr ~ 10.5 cc/min

Another way to select injectors is to take them from an engine that makes nearly the same power as your engine will [assuming the same number of injectors].

If your regulator is adjustable (many aftermarket ones are), you can also adjust the fuel pressure to achieve different flow rates. Changing the fuel pressure doesn't affect the flow rate as much as you might assume, since it is based on the square root of the pressure ratio. The formula is:

$$\text{new flow rate} = \text{old flow rate} \times \sqrt{(\text{new pressure} \div \text{old pressure})}$$

So for example, if you had 30 lb/hr injectors rated at 43.5 psi, and you went to 50 psi, you would get:

$$\text{flow rate} = 30 * \sqrt{(50/43.5)} = 32 \text{ lb/hr}$$

Do not run more than 70 psi fuel pressure, or the injectors may not open/close properly.

However, do not install injectors with a much larger flow capacity than you need. Very large injectors will create idle pulse width issues that will make tuning very difficult.

4.10.2 Injector Impedance and wiring

Injectors can typically be categorised as either high impedance (hi-z, high-ohm, saturated) or low impedance (low-z, low-ohm, peak and hold.) It is important to know which type your injectors are. Both types can be used with Megasquirt although high impedance tend to be easier to use.

New injectors will specify which type they are or list the ohms. If you are unsure, measure them with your meter on the ohms setting.

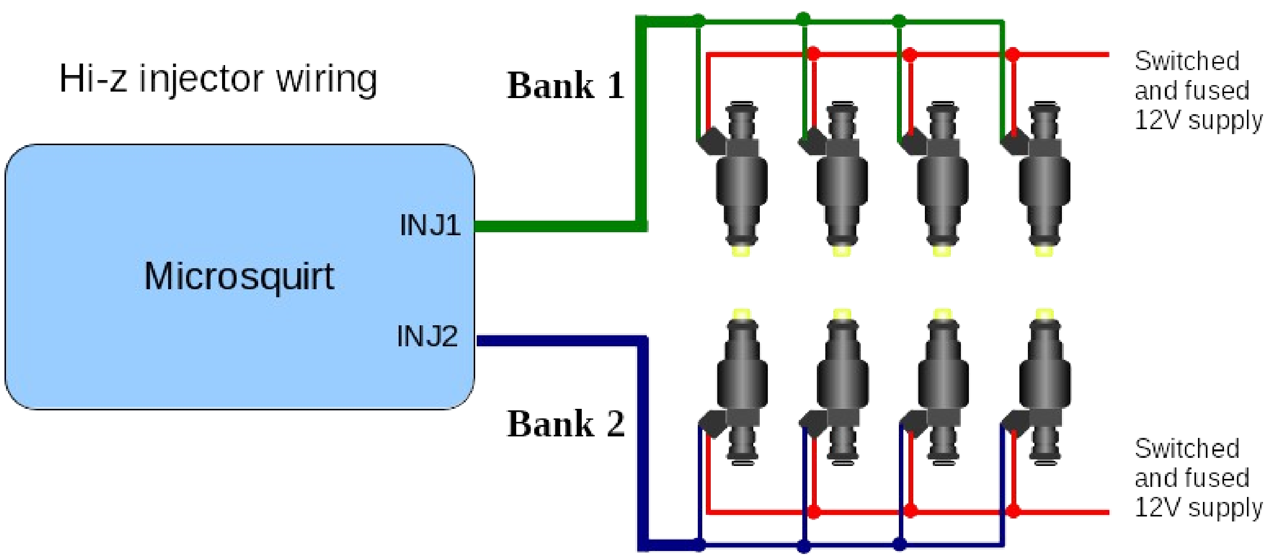
- High impedance injectors are typically 12-16 Ohms.
- Low impedance injectors are often 2.5 Ohms or less.

Do not simply connect and hope.

4.10.2.1 High impedance injectors (12-16 Ohms)

These injectors can be directly connected to the Microsquirt. No need for injector resistors and Injector PWM should be turned off.

Up to 4 injectors per channel may be connected.



4.10.2.2 Low impedance injectors (less than 3 Ohms)

These injectors can be used, with a few connection options.

- Injector resistors
- External peak-and-hold adapter

4.10.2.3 Low impedance injectors - Injector PWM

Injector PWM is not available on Microsquirt.

4.10.2.4 Low impedance injectors - Injector Resistors

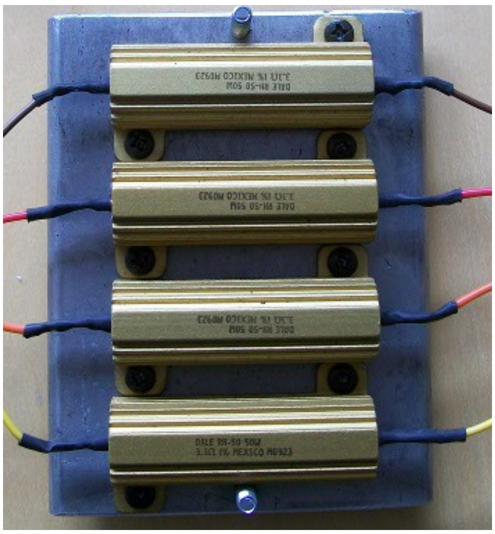
This method has been used by many OEMs as a simple approach to driving low-z injectors. The installer has the option of installing a power resistor (typically with a 20 to 25 watt rating) in series with each injector (in effect converting them to high impedance.)

The series resistors will slow down the opening of the injector slightly, so it is suggested that the resistance of the resistors be kept to a minimum but staying within the 5A limit of each injector channel. One resistor must be used for each injector - do not try to share resistors.

For typical 2.5ohm low impedance injectors, the following resistances can be used

Number of injectors per channel	Resistor value
1	3.3 ohm
2	4.7 ohm
4	10 ohms

The resistors should be mounted to a suitable heatsink (e.g. a thick piece of aluminium plate) as they will get hot in operation.



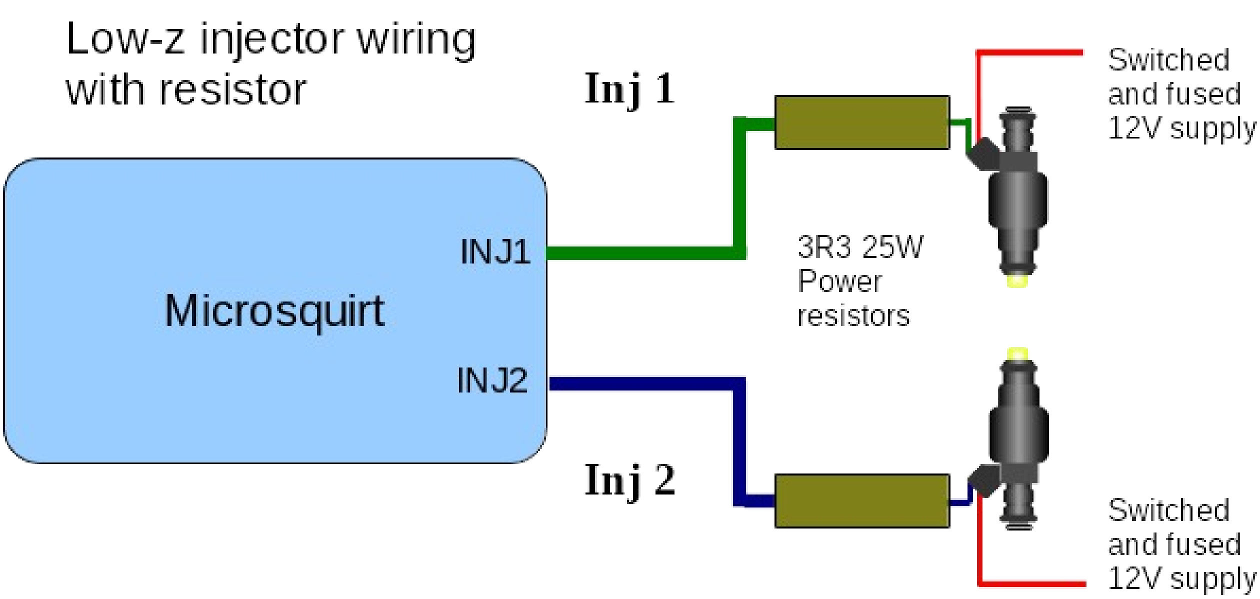
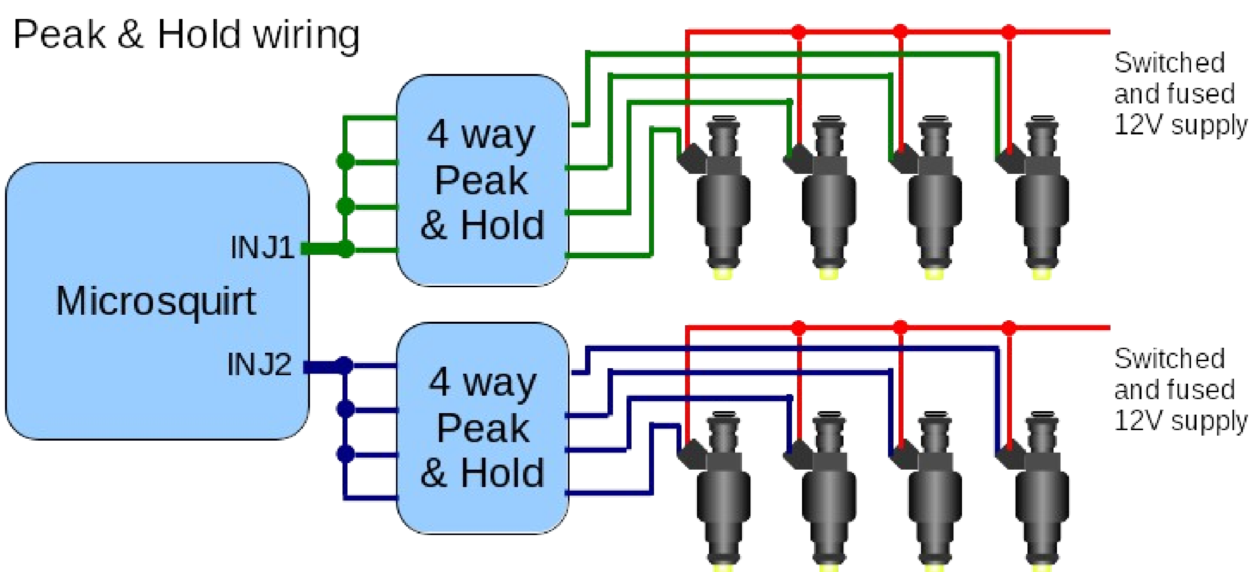


Diagram showing one injector per channel and 3.3 ohm series resistors.

4.10.2.5 Low impedance injectors - Peak and hold

Aftermarket peak and hold controllers are available, these take the low-side injector output from the Microsquirt and provide the required peak and hold drive for the injectors. Typically this is a peak to 4A and then a hold at 1A.

Refer to supplier's documentation for exact wiring - the following diagram is representative only.



4.10.3 Staged injection

Staged injection is a method that allows for two sets of injectors to give a better dynamic range of fuelling - more precise control at idle, but still flowing enough fuel at full load. Typically, at low load, idle or cruise only the smaller primary injectors are in operation. At higher fuel demands, the secondary injectors are enabled.

When using "Staged Injection" the primary injectors are connected to INJ 1 and the secondary injectors are connected to INJ 2.

See the TunerStudio reference manual for configuration details.

4.10.4 Sequential injection 'mod'

The Microsquirt has two injector outputs. There is no option for more.

5 Ignition System - fundamentals

The ignition system comprises both the crank and cam tach inputs and the ignition outputs to drive coils. There are many different combinations possible, this chapter will describe some of the possibilities.

Note: A tach input is required on ALL installs including fuel-only.

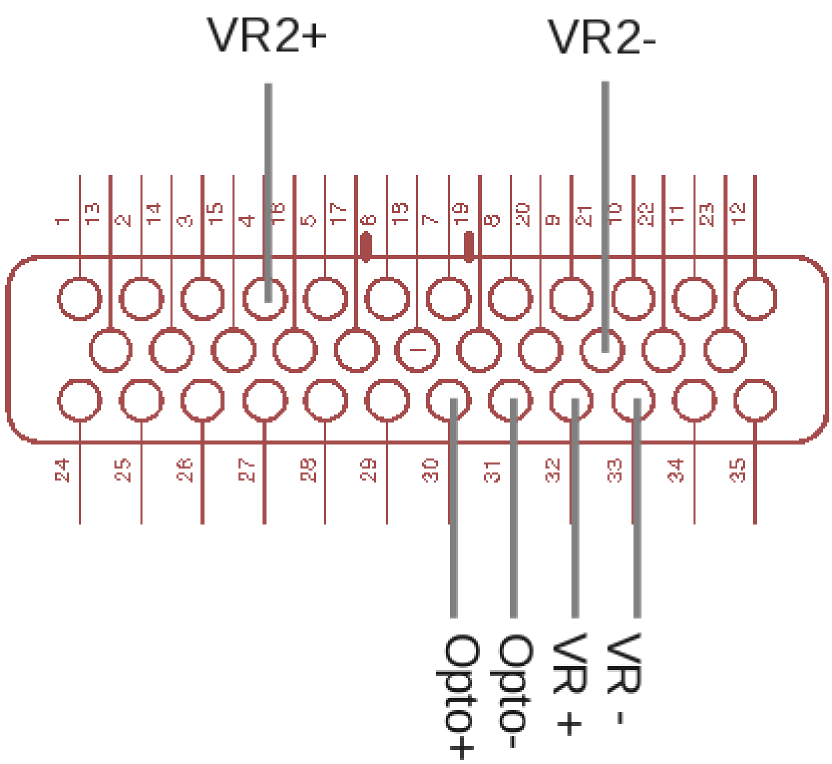
5.1 Safety Notes

Ignition systems produce dangerous voltages in excess of 30,000V. Take care to avoid shock.

5.2 Crank and Cam tach inputs

The tach input is one of the most important signals going into the Microsquirt and correct system operation is not possible until the tach input is correctly installed and configured. ***Until the Microsquirt reads the correct RPM, nothing else will work.***

Even if you are starting with fuel injection only (not controlling ignition) you must still provide the Microsquirt with a tach input - see coil negative triggering in section 5.2.1



Opto+/- are the inputs for coil-negative triggering on a fuel only install, do not use them if you are controlling ignition.

VR+/- are the inputs from the crank sensor (VR, Hall, Opto, etc.)

VR2+/- are the inputs from the cam sensor (VR, Hall, Opto, etc.)

The following sections describe sensors in general and will refer to VR+/- which is used for the primary (or only) tach input. For the second / cam sensor, be sure to connect to VR2+/-

There are many different options for tach input and this is probably one of the largest areas of difficulty with any after-market EFI install. The firmware contains software decoders to suit many stock installs using original sensors. If your engine is supported, then this is the recommended approach.

Two key pieces of information you need to know are:

- Sensor type(s)
- Trigger wheel pattern

The sensor types fall into a few basic families of sensors and the right way to use the sensor depends more on the type rather than the particular vehicle or manufacturer. There are also a few "special" systems in use from the eighties that combine a sensor input with an ignition driver output in one module. These will be discussed later - Ford TFI, Ford EDIS, GM HEI, GM DIS.

If you are considering an after-market, non-OEM sensor you must ENSURE that it has a suitable temperature rating. Typically engines run at around 100°C/212°F so a minimum of 105°C rating is required, 125°C desired. Do not consider using 85°C rated parts around the engine as they will degrade and cause you trouble. Be aware of heat radiated from exhaust components - these can overheat sensors and cause failure.

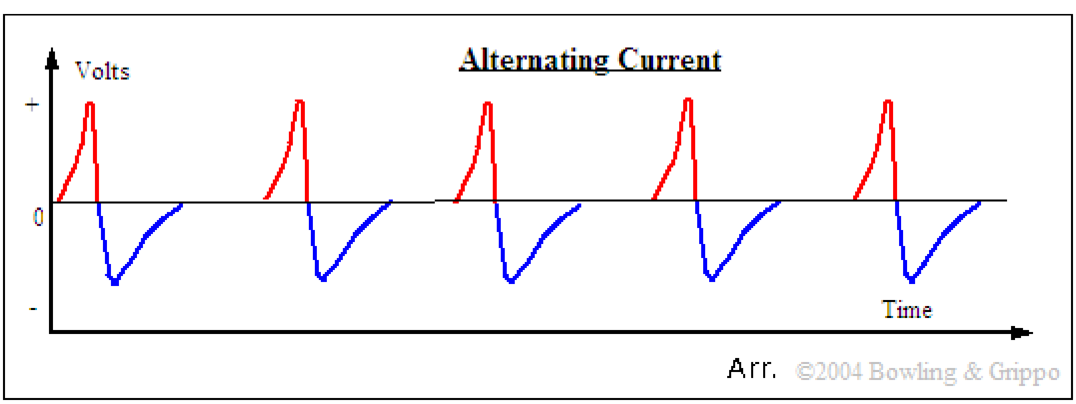
5.2.1 Coil Negative Input

For fuel-only installs it is possible to obtain a tach in trigger from the negative terminal of a single coil. See section 6.1

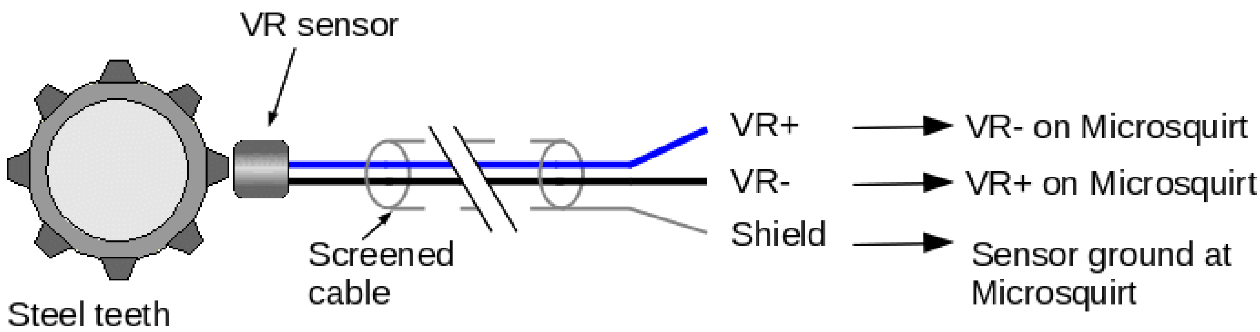
5.2.2 VR (magnetic) sensor input

The VR sensor is a very commonly used sensor. Usually it is seen as a two wire sensor although some manufacturers install a screen on the cable, so yours may have three wires. In CAS (crank angle sensor) units a multiplug may be used to combine multiple sensors. The sensor itself generates an AC voltage when a piece of steel (the trigger) moves past it. Non-ferrous trigger wheels will not work. The voltage varies from less than a volt during cranking to tens of volts at higher revs.

Typically it is suggested that the magnetic tip of the sensor is around the same size as the teeth on the wheel.

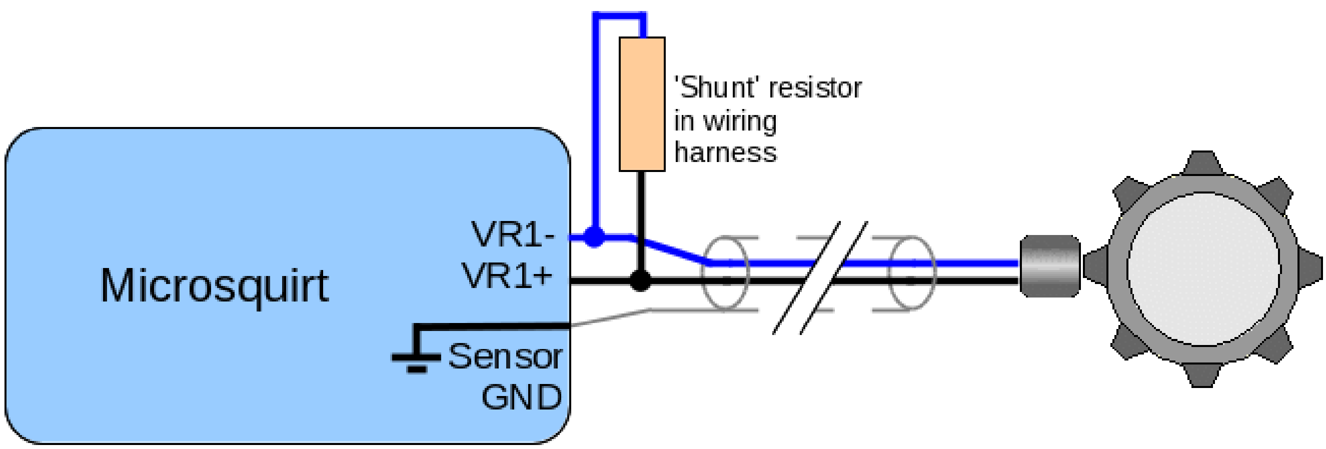


In order to use a VR sensor a "conditioner" circuit is required to convert the AC voltage into a DC square wave signal while retaining the timing information. The Microsquirt has this conditioner built in. The two signal wires from the VR sensor are connected to the VR+/- inputs at the Microsquirt. Ideally use a screened twisted pair cable and connect the screen to sensor ground at the Microsquirt end only.



Some installs may find it necessary to install a "shunt" resistor between VR+ and VR- to reduce the signal voltage at higher RPMs. A 1/4W resistor is sufficient and values in the range of 1k to 10k.

10k is recommended for 60-2 wheels.



The VR cam input is unlikely to need a shunt as the camshaft rotates at half speed. However, if it is found necessary, apply an additional shunt resistor in the wiring harness berween VR2+ and VR2-.

Alternatively, inside the case there are "solder-bridge" pads.

To apply a shunt to the VR1 input, bridge SB2 with solder.

To apply a shunt to the VR2 input, bridge SB3 with solder.

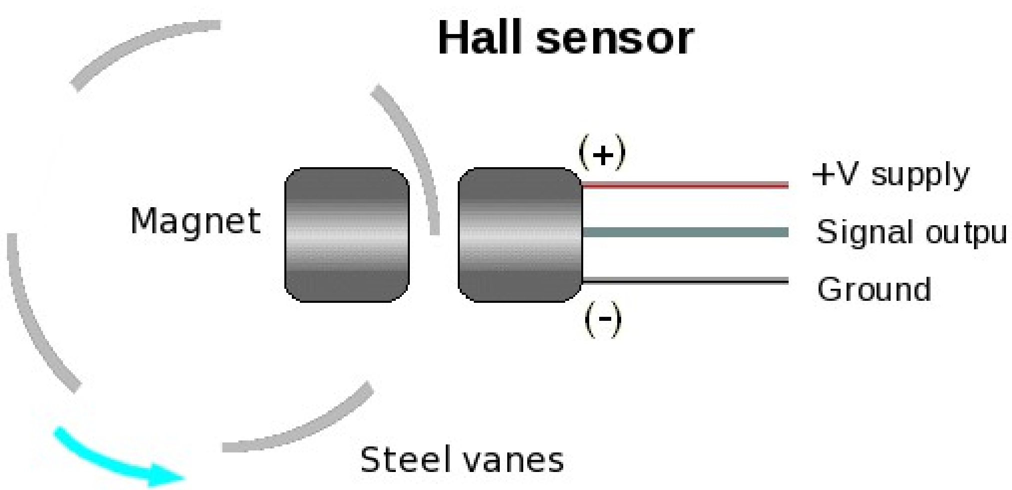
5.2.3 Hall sensor input

The Hall sensor is another commonly used category of sensor. These are almost exclusively a three wire sensor. In CAS (crank angle sensor) units a multi-plug may be used to combine multiple sensors. The sensor itself acts like a switch to ground in the presence of a magnetic field. Hall sensors are commonly seen in distributors where vanes or shutters mask off the magnetic field causing the sensor to rapidly switch on or off at the edge of the vane. Another way that a hall sensor can be used is with a "flying magnet" installed on a rotating part of the engine (crank, cam sprocket etc.). As the magnet passes the hall sensor, the output switches to ground.

The most common OEM arrangement for a hall sensor is within a distributor. The vanes in the distributor rotate and block or unblock a magnet.

With no vane between the magnet and sensor - the output is grounded.

With a vane between the magnet and sensor - the output is inactive.

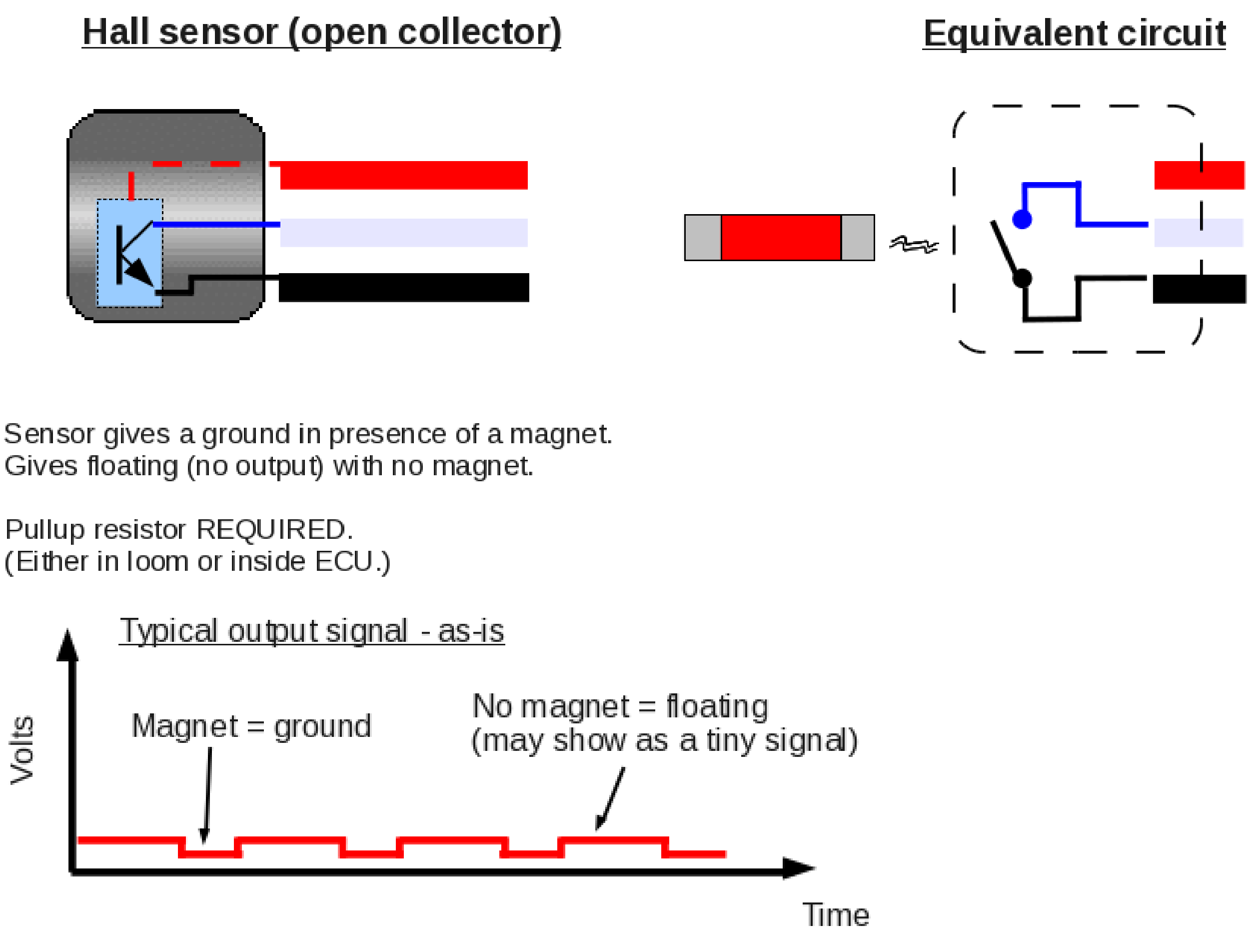


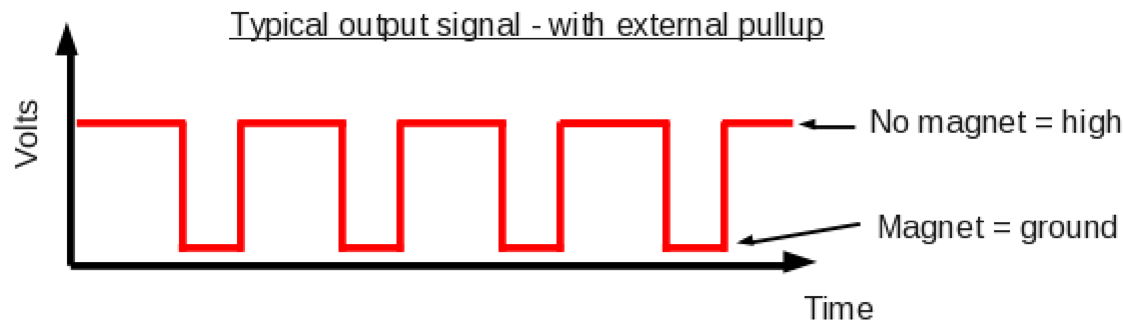
Above: diagrammatic representation.

Below: OEM dizzy modified to make single-tooth cam trigger.

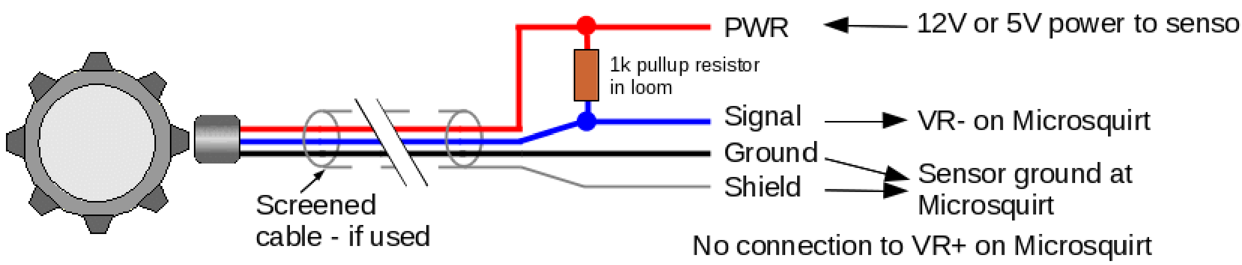
There are two main categories of hall sensor

- open-collector (needs a pull-up resistor)
- built-in pull-up resistor (covered in section 5.2.4)



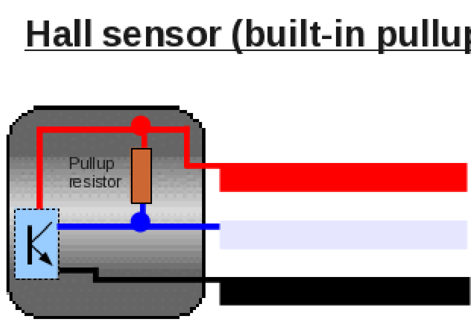


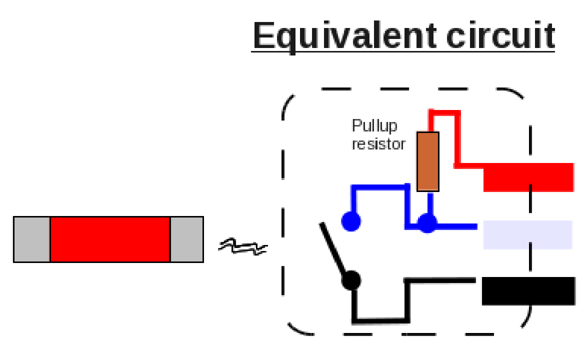
The hall sensor requires a supply voltage which is usually 12V from a fused 12V supply or 5V from the TPSREF output of the Microsquirt. The sensor is then grounded at the Microsquirt sensor ground and the signal wire connects to the VR- tach input. A pull-up resistor is required in the wiring harness.



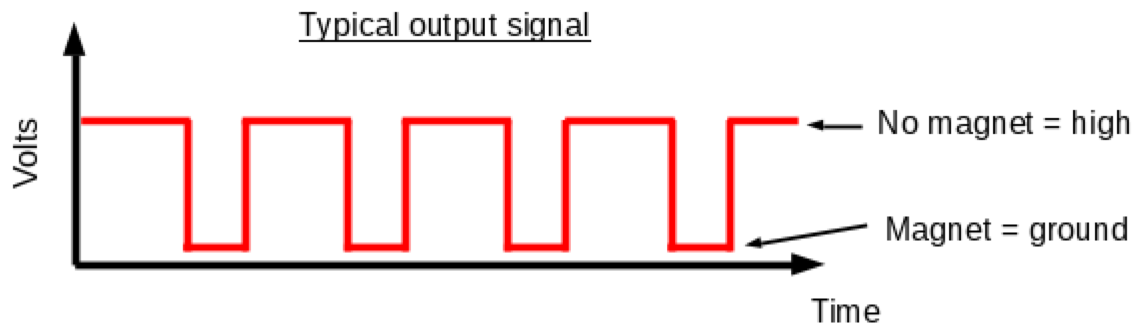
5.2.4 Hall sensor input (built-in pull-up)

These sensors operate similarly to the hall sensors in section 5.2.3 but include the pull-up resistor internally so they give a 0V or 5V signal.

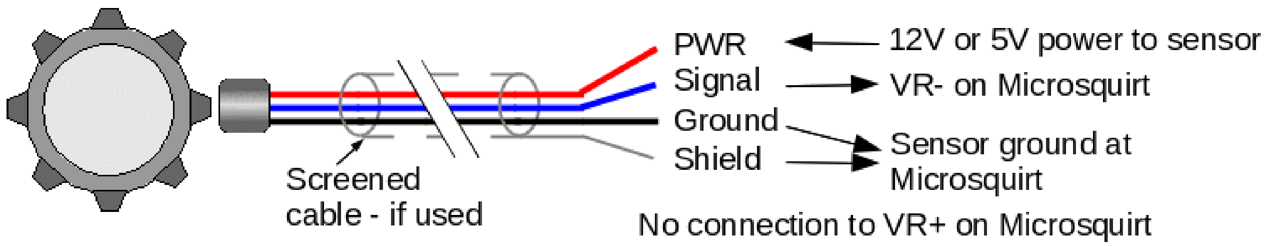




Sensor gives a ground in presence of a magnet.
Gives positive voltage with no magnet.



The hall sensor requires a supply voltage which is usually 12V from a fused 12V supply or 5V from the TPSREF output of the Microsquirt. The sensor is then grounded at the Microsquirt sensor ground and the signal wire connects to the VR- tach input.



5.2.5 Gear-tooth sensor input

The gear-tooth sensor is a variant of the hall sensor - the key difference is that it has a magnet built into it and switches when close to steel, no external magnets are required. This makes them very easy to use. These are almost exclusively a three wire sensor. In CAS (crank angle sensor) units a multi-plug may be used to combine multiple sensors. The sensor itself acts like a switch to ground when close to steel.

Just like hall sensors, the gear-tooth sensor may be open-collector or have a built-in pull-up. Refer to sections 5.2.3 and 5.2.4 for more detail.

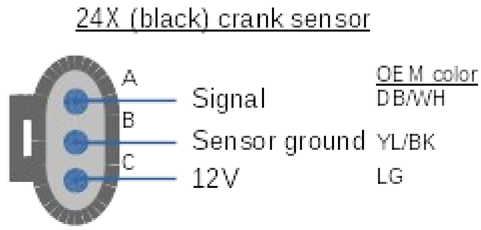
The image above shows the Honeywell 1GT101DC gear-tooth sensor, this works well for single tooth or half-moon cam wheels, but is not suitable for missing-tooth wheel installs.

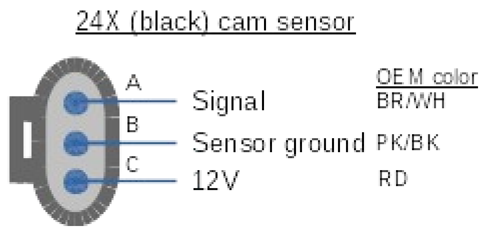
5.2.6 GM LS 24X crank/cam sensors

The sensors used on the LS family of GM engines are designed to read the crank and cam triggers specific to those engines. The 24X crank pattern uses a pair of adjacent toothed wheels and requires the specific GM sensor.

The 24X style black sensors use a 12V supply and operate like a hall sensor with a built-in pull-up - putting out a 0-5V logic signal as the teeth pass.

See section 5.2.4 for generic wiring.



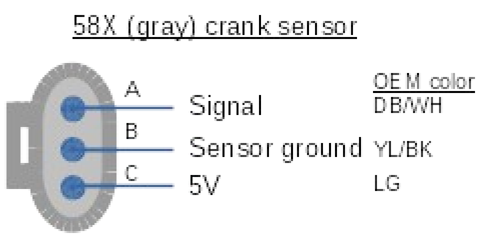


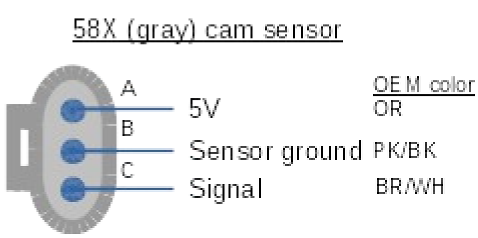
5.2.7 GM LS 58X crank/cam sensors

The sensors used on the LS family of GM engines are designed to read the crank and cam triggers specific to those engines. The 58X crank pattern uses a conventional single crank wheel.

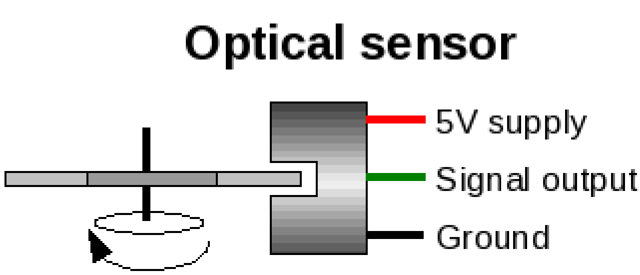
The 58X style gray sensors use a 5V supply from TPSVREF and operate like an open-collector hall sensor as they require a pull-up resistor.

See section 5.2.3 for generic wiring.





5.2.8 Optical sensor



The optical sensor is another commonly used category of sensor. These are almost exclusively a three wire sensor. In CAS (crank angle sensor) units a multi-plug may be used to combine multiple sensors. The sensor itself acts like a switch to ground when light shines through the trigger disc. Optical sensors are commonly seen in distributors where vanes or shutters block the light causing the sensor to rapidly switch off and back on when light is present again. A pull-up resistor is almost certainly required.

See section 5.2.3 for wiring.

Note: One OEM application for optical sensors is the Mitsubishi/Nissan/Optispark CAS. Megasquirt-2 does not support the 360 slit "hi-res" tach input from these CASes, see the specific manual section for configuration details.

5.2.9 Distributor points input

NOTE: re-phasing a distributor can be quite awkward - installing a trigger-wheel for tach input is strongly recommended instead.

It is possible to convert a points distributor to give a tach input to Microsquirt and have control of your timing. In this case the points now only provide a tach signal and the Microsquirt is used to control the coil. Most conventional points distributors have a mechanical advance (weights) and a vacuum canister. In the original system these change the timing depending on engine RPM and load. Now that Microsquirt will be controlling the timing you will need to lock out these mechanisms in your distributor and likely change the phasing.

Set the engine to approx 10BTDC. Rotate the distributor so that the point are just opening when the engine rotates forwards.

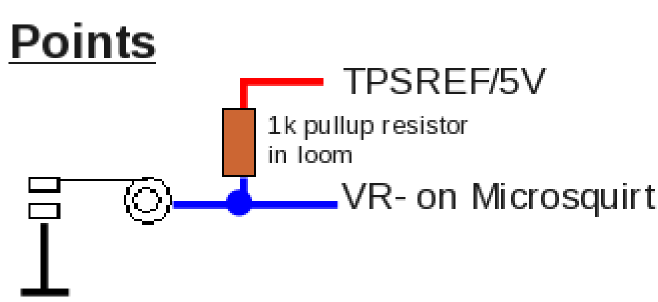
Now set the engine to approx 25BTDC - the rotor arm needs to be pointing directly to a tower on the distributor cap.

You will likely need to make mechanical changes (cutting, bolting, welding) inside the distributor to achieve this.

With incorrect rotor arm phasing you will very likely end up with cross-firing to the wrong cylinder.

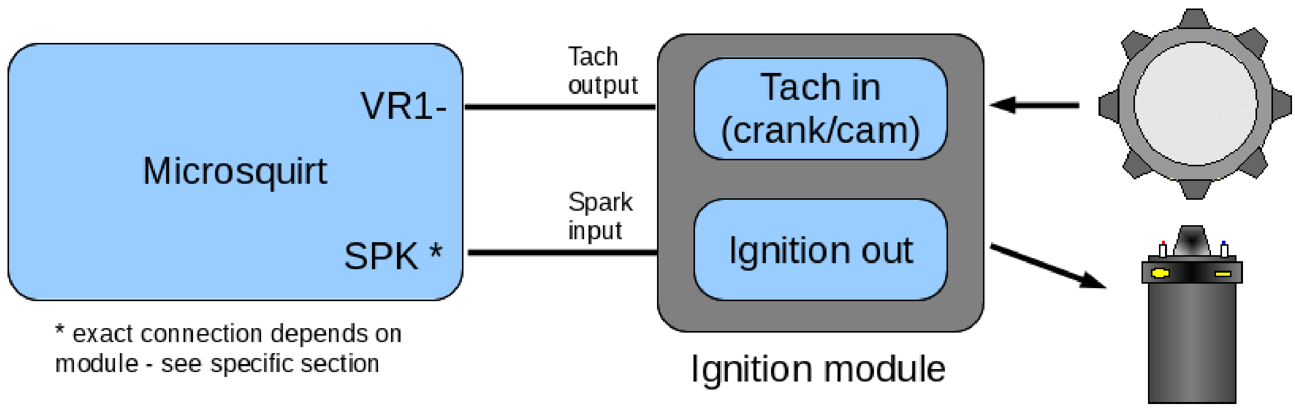
The low-tension side of the coil must be disconnected from the distributor and is now controlled by the Microsquirt (see ignition outputs section.)

The points are grounded within the distributor and the points terminal is connected to the Microsquirt tach input.



5.2.10 Combined Ignition module (TFI, EDIS, HEI, GMDIS)

Some ignition modules, particularly from the 1980s combine the tach input and coil driving ignition output within one module. All of them supply a simple square wave digital signal to the Microsquirt and should be connected to the VR1- input.



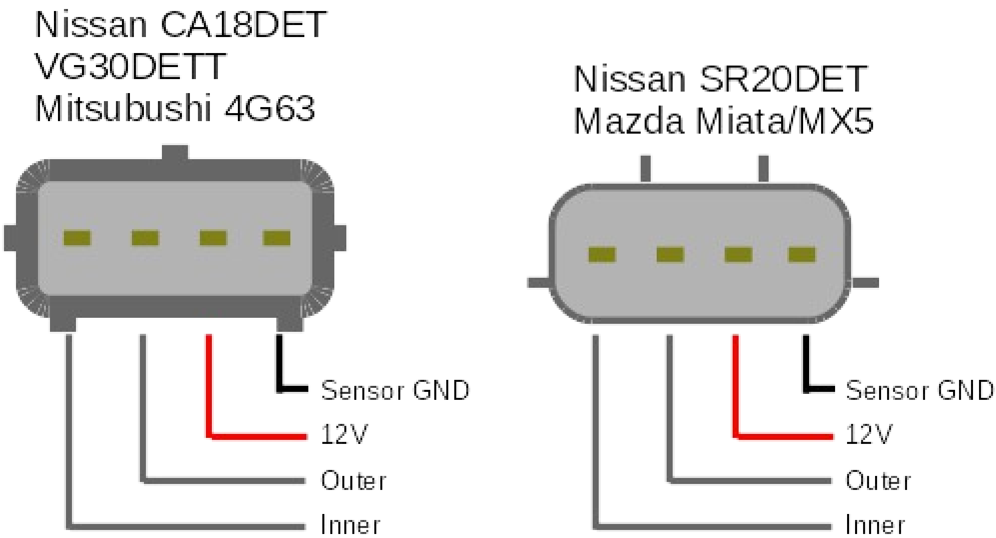
It is important to be aware that while Ford EDIS and GM DIS both have special toothed wheels, the module handles all the decoding and presents a signal to the Microsquirt that looks like a distributor input. With these two modules, the Microsquirt does not know or care how many teeth are actually on the wheel, so do not use the "toothed wheel" setting. This also means that normally you cannot use sequential fuel with these systems as no engine position information is available to the Microsquirt.

Full configuration details for these specific installs are covered in the section 6.

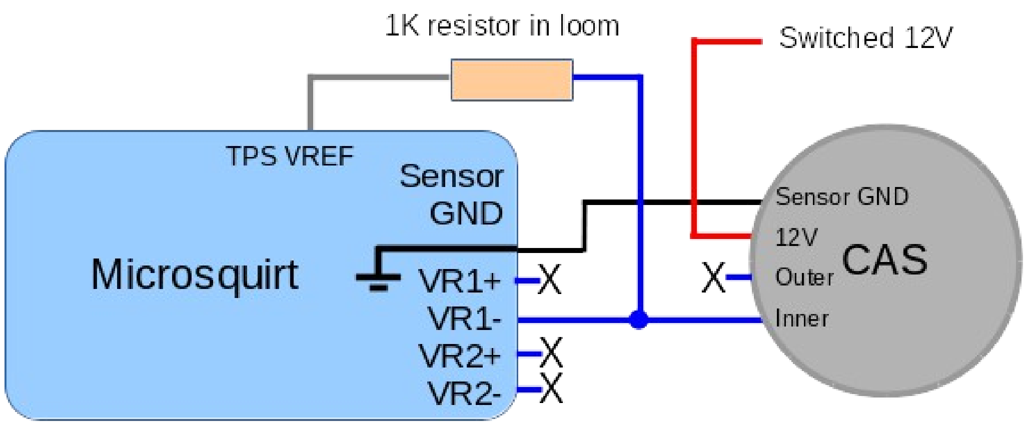
5.2.11 Nissan CAS

The Mitsubishi CASes used on many Nissans and GM LT1 Optispark use a dual optical pickup and a trigger disc with a high-resolution series of 360 outer slits and a low-resolution series of inner slots - one per cylinder.

The Megasquirt-2 code does not support the high-resolution outer signal. The low-resolution inner signal can be used with a single coil and distributor in "Basic Trigger" mode.



With the stock trigger disc, the high-resolution outer track is not used. The low-resolution inner track is connected to the VR1- input.



Typical settings:

Spark mode = Basic Trigger

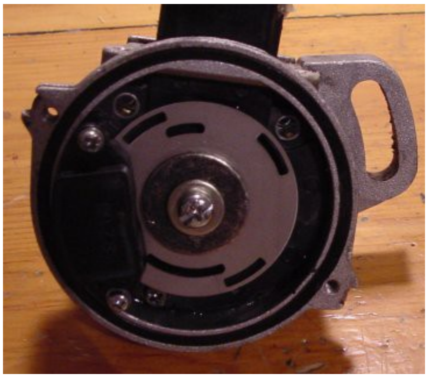
Trigger angle/offset = Start at 10 deg - adjust while strobing timing.

Ignition input capture = ????

Number of coils = Single coil

5.2.12 4G63 / 6G72

Some other hall or optical CASes such as 4G63 (Miata) and 6G72 can be supported by special decoders for the trigger pattern.



See sections 6.15 for 6G72 and 6.18 for 4G63

5.2.13 Mitsubishi CAS with aftermarket disc

As an alternative to the 360 slot CAS or low resolution 4G63, 6G72 patterns, many companies offer replacement trigger discs with standard patterns. When this kind of replacement trigger disc is installed the "Toothed Wheel" mode needs to be used - see section 6.9

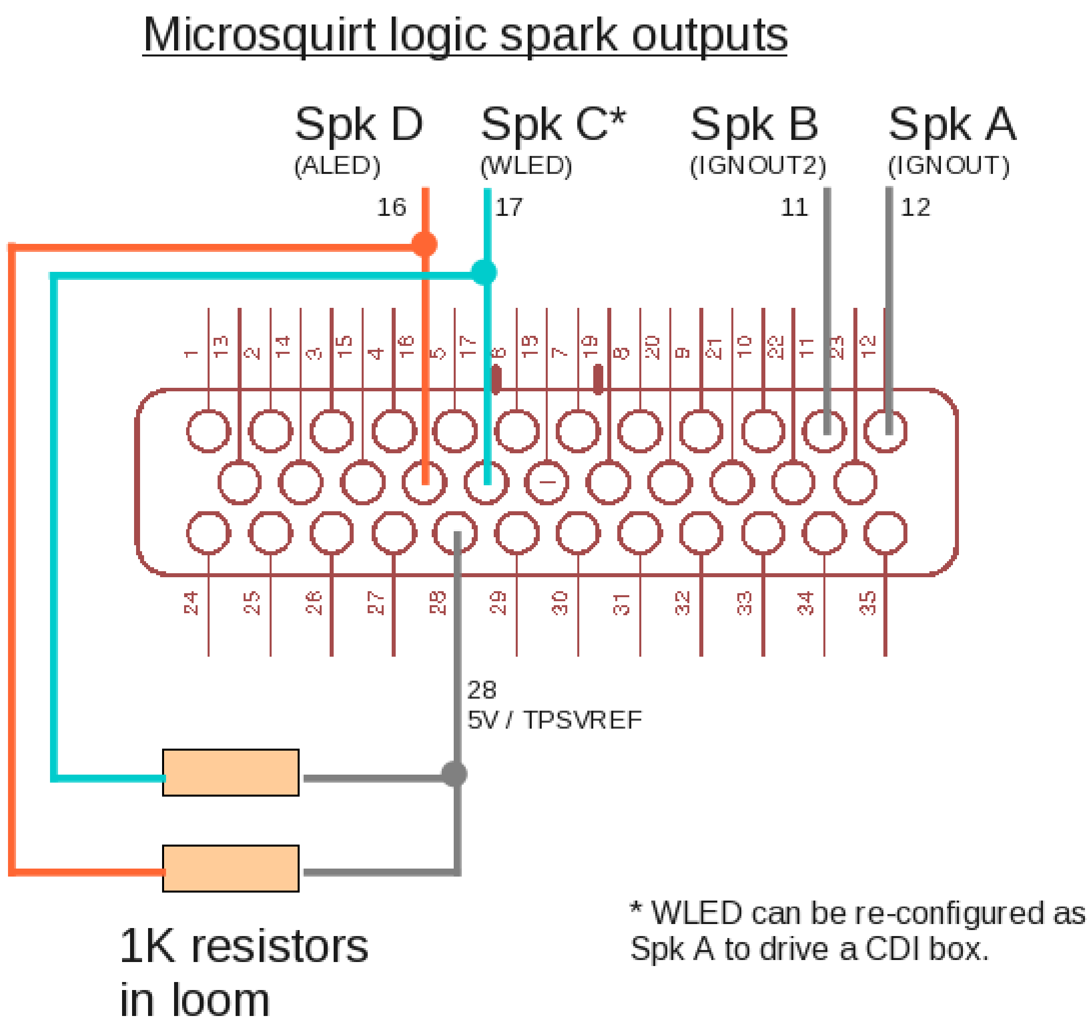
5.3 Ignition outputs

The Microsquirt as standard provides two logic ignition channels. Optionally the WLED and ALED outputs can be re-purposed to give a total of four channels.

The logic outputs are suitable for connection to logic coils or ignition amplifier modules. *Do not directly connect high-current coils.*

For 99% of applications with a logic coil or an ignitor, set the Spark Output to Going High. This is a critical setting! Setting it incorrectly could result in melted coils.

It is strongly advised that ignition coils are powered from the fuel-pump relay. This ensures that the coils can only be powered when the engine is running.



On regular ignition installs, the ignition outputs must be connected in firing order sequence.

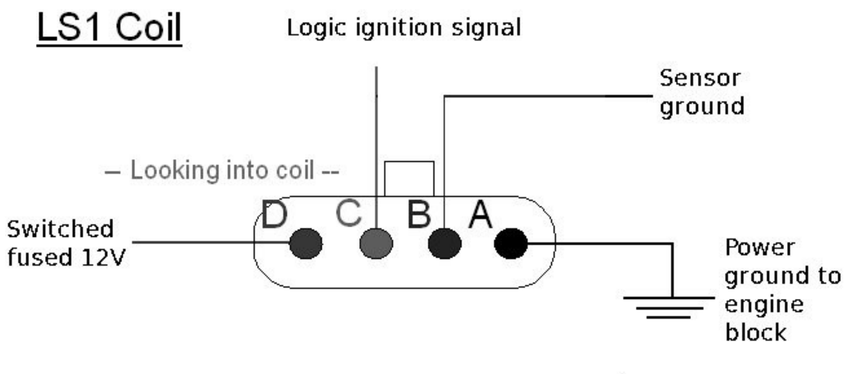
e.g. a 4-cyl engine with coil-on-plug and a 1-3-4-2 firing order would connect A=1, B=3, C=4, D=2

Rotary engines are wired differently - refer to the specific section.

5.3.1 Logic coils

These coils can directly accept the 0-5V logic level signal from the Microsquirt. The contain an ignition driver and a coil within the package.

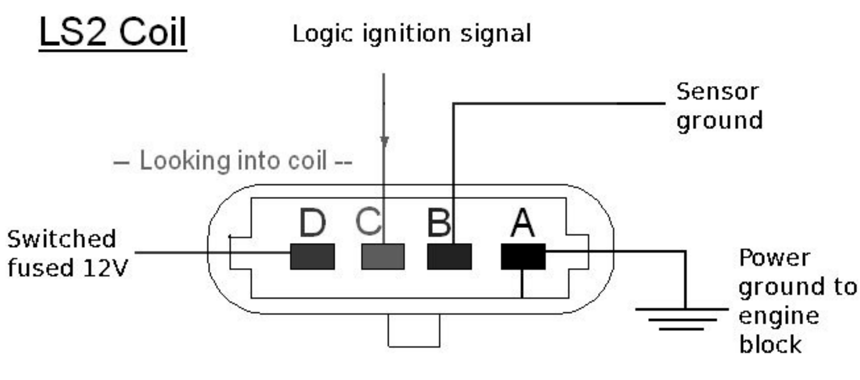
LS1 (left), LS2 middle), Truck (right) coils



A dwell figure of 3.5ms is advised for LS1 coils.(was 4.5)

Note that some coils have a built-in over-dwell protection feature. If given too much dwell the coil will automatically spark. This can give a dangerous advanced spark. Be sure to strobe your timing at high revs to ensure this is not happening.

Set the Spark Output to Going High

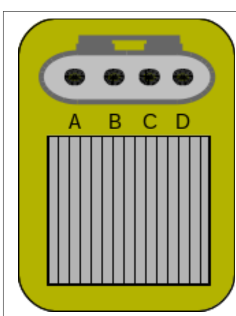


A dwell figure of 3.5ms is advised for LS2 coils. (was 4.5)

Note that some coils have a built-in over-dwell protection feature. If given too much dwell the coil will automatically spark. This can give a dangerous advanced spark. Be sure to strobe your timing at high revs to ensure this is not happening.

Set the Spark Output to Going High

D585 truck coil

	**Pin-out** A = Power ground to engine block B = Signal ground (connect to sensor ground) C = Spark input signal D = 12V supply Common colors: A = black B = brown C = varies per coil

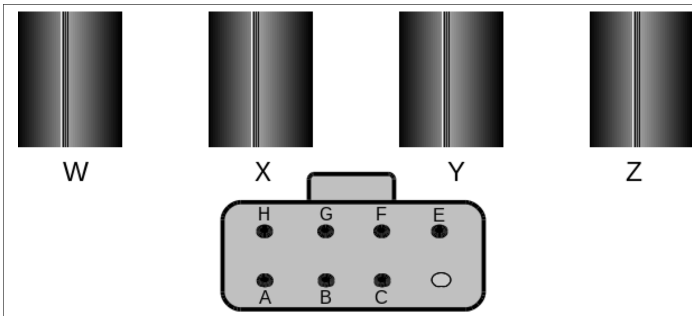
	D = pink

A dwell figure of 3.5ms is advised for truck coils.

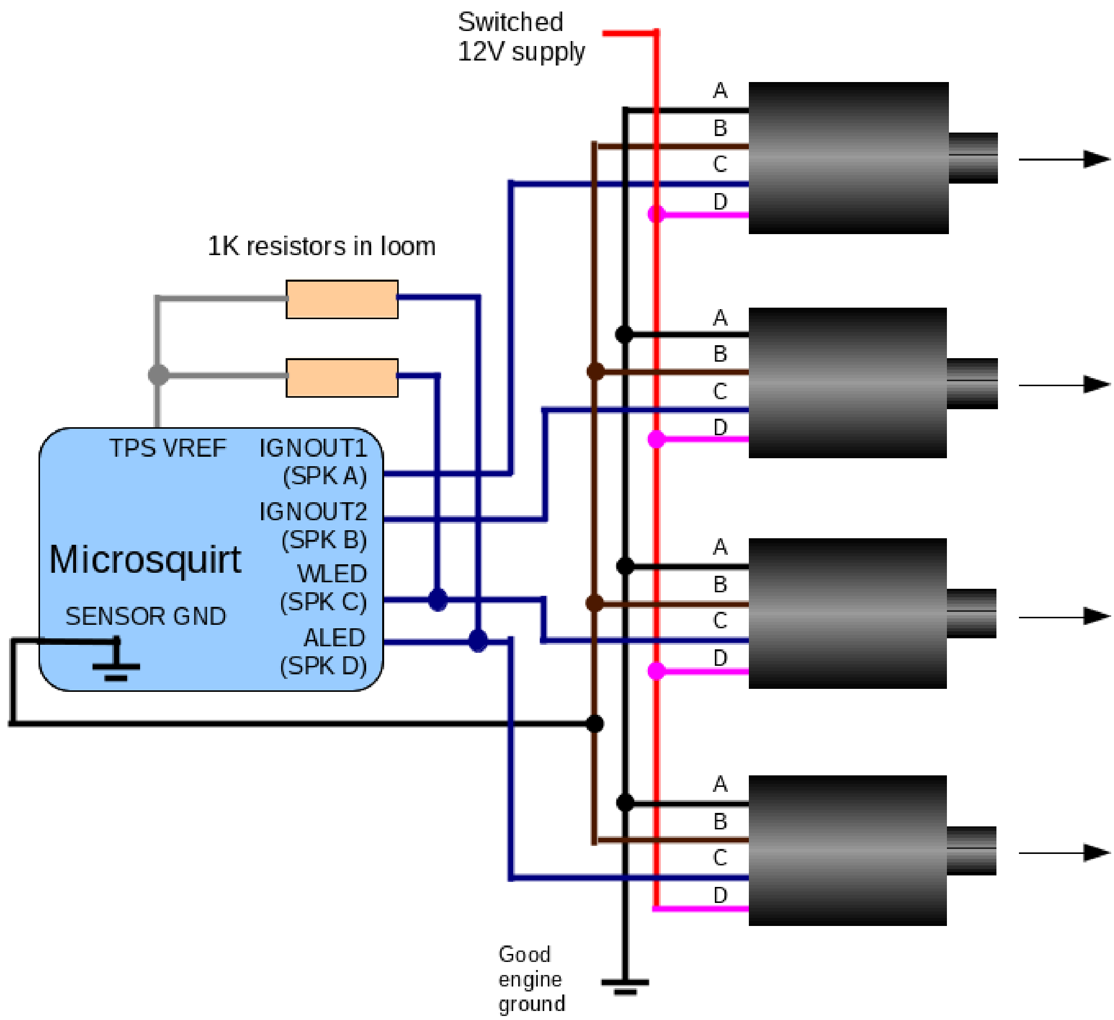
Note that some coils have a built-in over-dwell protection feature. If given too much dwell the coil will automatically spark. This can give a dangerous advanced spark. Be sure to strobe your timing at high revs to ensure this is not happening.

Set the Spark Output to Going High

LS coilpack multi-plug

	**Pin-out and typical colors** A = black = power ground B = red = signal coil W C = green = signal coil X E = brown = signal ground F = light blue = signal coil Y G = purple = signal coil Z H = pink = 12V supply

General layout for 4-cyl coil-on-plug using LS coils



IGN1A logic coil

A - Ignition signal from Megasquirt

B - Logic ground, connect to Megasquirt sensor ground

C - Spark wire ground, connect to cylinder head

D - Power ground, connect to battery negative

E - 12 volt power (switched and fused)

Set the Spark Output to Going High.

This is a high energy aftermarket logic coil available from DIYautotune.com.

0 004- 402 001 - single logic coil

Pin-out

1 = Power Ground (Brown)

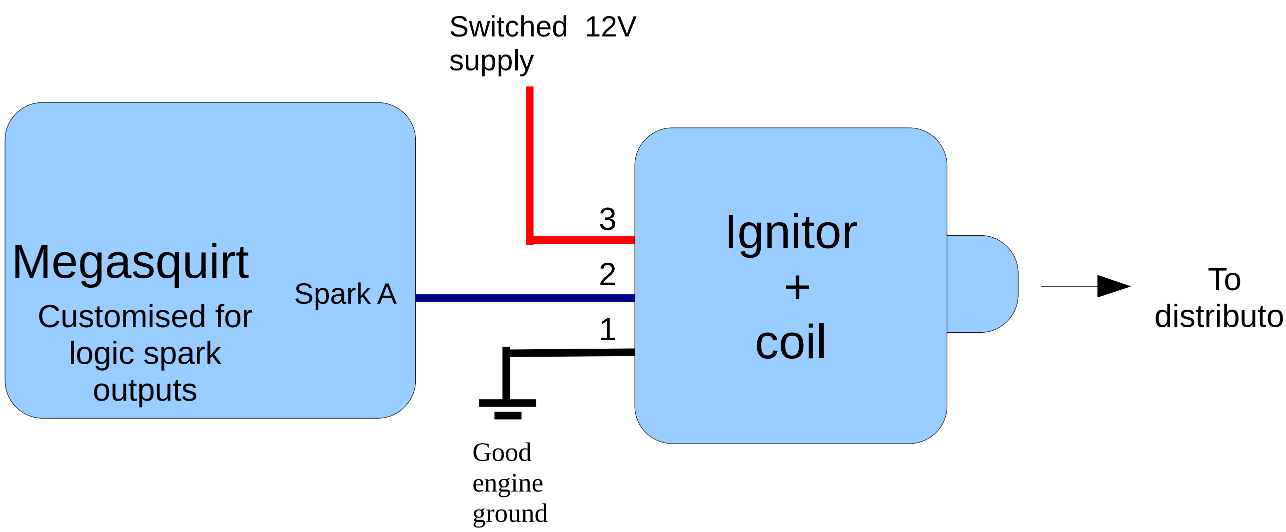
2 = Spark input signal 1 (Black/Red)

3 = 12V supply (Black)

Set the Spark Output to Going High.

Fitted to many VAG vehicles including 2.0 litre mk3 Golfs 1993-1999. Designed to be used as a single coil with a distributor.

Intermotor 12916



032 905 106B - 4 tower wasted spark logic coil

Pin-out

1 = Spark input signal 1

2 = 12V supply

3 = Spark input signal 2

4 = Power Ground

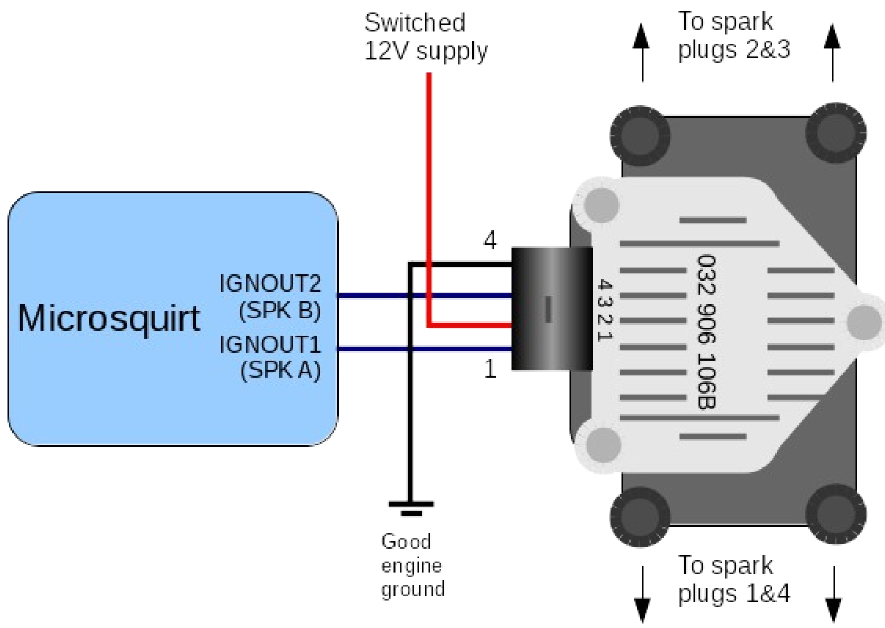
Set the Spark Output to Going High

The connector is 1J0 973 724

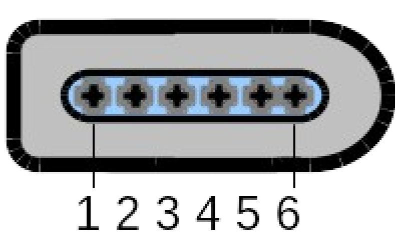
Probably the simplest way to get ignition on a 4 cylinder engine with the Microsquirt. This cost effective OEM logic wasted coil is a direct connection to the Microsquirt as it has a built-in ignitor.

Fitted to many VAG vehicles including 1.6 litre mk4 Golfs.

Intermotor 12919



06A905097 - 4 way logic coil



4 way logic coil from VW Golf / Jetta, Skoda Octavia

Uses part numbers 0040102029, 06A905097, 06A905104, ZSE029

The connector is a polarised Bosch Kompact 6 way. 1J0973726 - 6 Way Sealed Female Connector. The contacts are 2.8 mm

Set the Spark Output to Going High

Pin-out

1 = Power Ground

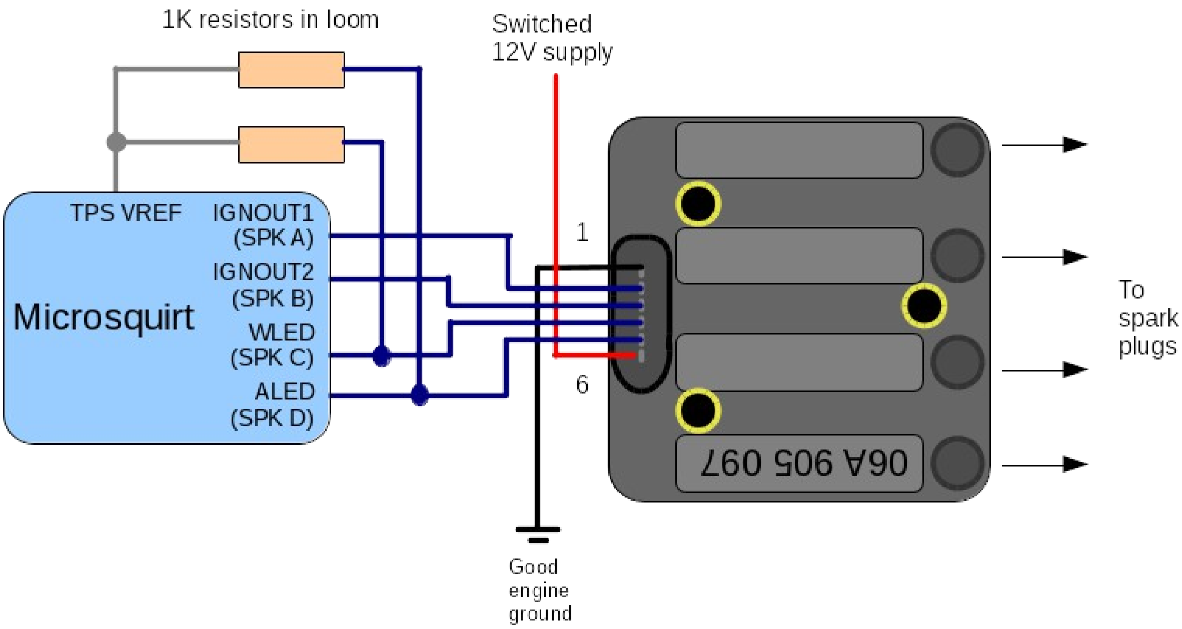
2 = Spark input signal 1

3 = Spark input signal 2

4 = Spark input signal 3

5 = Spark input signal 4

6 = 12V supply



06B 905 115 - 4 wire logic COP

VAG P/N 06B 905 115 COPs: used on VW 1.8t and may other VAG cars.

Pin 1: Connects to Pin 1 on all other coils and then to +12v ignition feed (or fuel pump relay)

Pin 2: Signal ground (connect to engine block)

Pin 3: Spark Signal from Microsquirt

Pin 4: Power ground (connect to engine block)

Earlier than 2001 coils, PN - 06B 905 115, 06B 905 115 rev B and E.

These have an input resistance of ~1k and should work OK with the Microsquirt outputs.

Cranking dwell = 4.0ms Running dwell= 3.0ms

Set the Spark Output to Going High

Later than 2001 coils, PN 06B 905 115 rev L and R have a low input resistance and are not suitable for use with the Microsquirt.

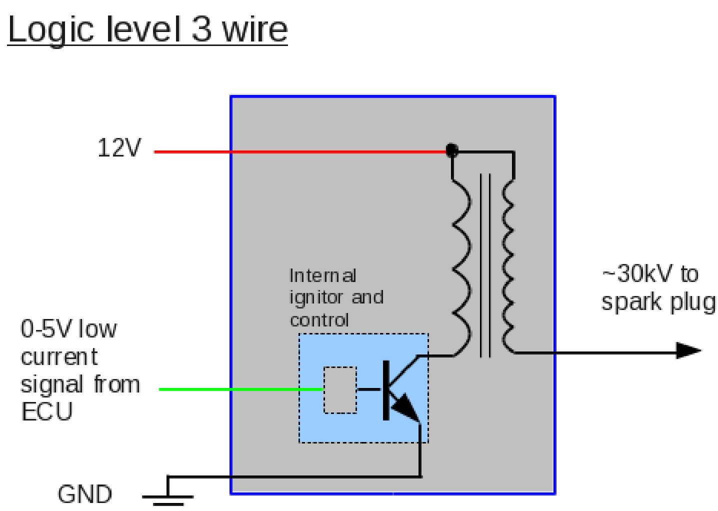
Aside from these specific examples, there are many generic 3, 4, 5 wire COPs that can be used with the

Microsquirt.

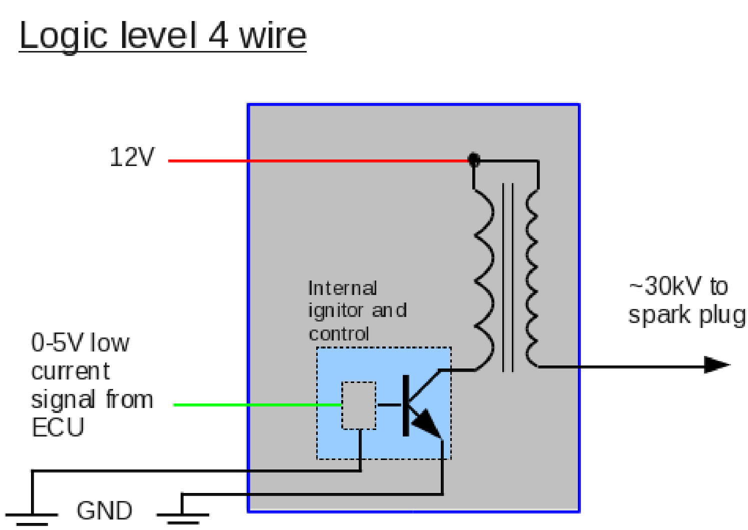
Before using an "unknown" coil it is necessary to check the resistance to ground on the input.

Using a multimeter set to resistance, check between the Spark Signal Input and Signal Ground.

If you have a reading of say ~1k then the Microsquirt outputs can be used directly.



3-wire COPs are ambiguous, many are high-current (needing an ignitor), some may be logic level with a built in driver. Perform a resistance check on the signal input to confirm. High current will have an input resistance to 12V of a few ohms only.

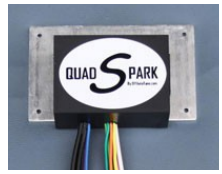


COPs with 4 or 5 wires have a built in amplifier (ignitor) so they can typically be connected directly to the logic spark output from the Microsquirt.

5.3.2 Amplifiers (ignitor, power transistor, ignition module)

An ignition amplifier module takes the 5V logic signal from the Microsquirt and drives a high-current ignition coil.

There are many different modules available on the market with 1, 2, 4 ignition channels.

Bosch style 1, 2, 4 channel ignitors and Quadspark 4 channel ignitor.

Bosch 0 227 100 124

Cross references Intermotor 15015.

This single channel module can be used to drive a single high-current coil. Dwell is controlled by the Microsquirt.

Set the Spark Output to Going High

Pin-out

1 = Coil negative output

2 = Power Ground

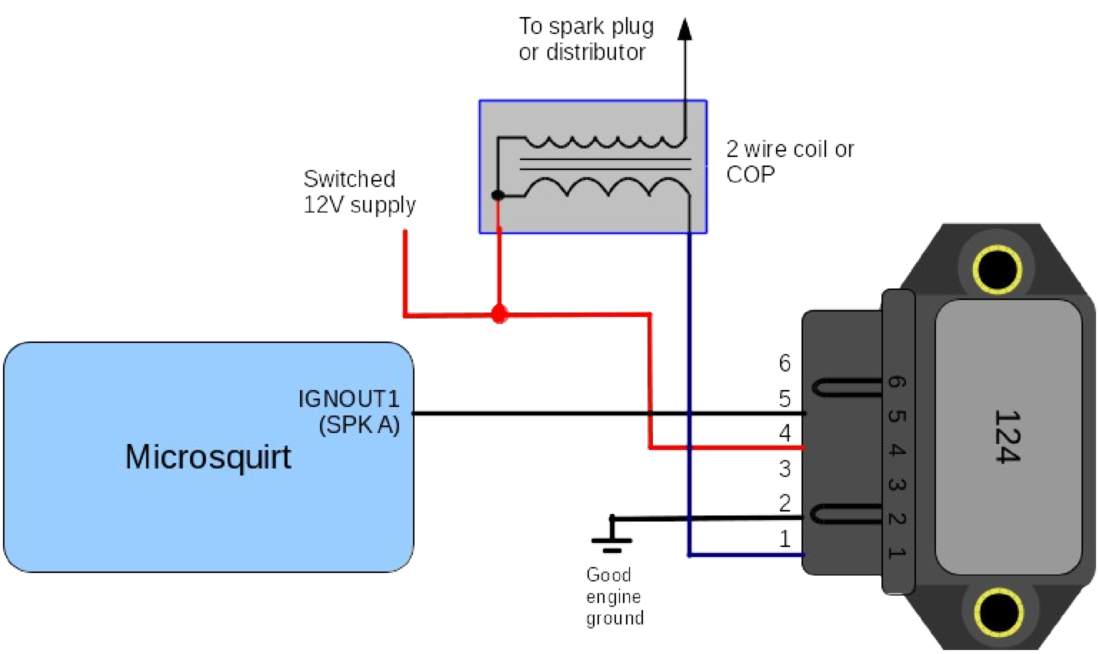
3 = Input screen (if used)

4 = 12V supply

5 = Spark input signal

6 = NC

(7 = NC)



Bosch 0 2227 100 137

This is very similar to the 124 but the spark input signal is on pin 6.

Bosch 0 227 100 200

Cross references Intermotor 15867.

This dual channel module can be used to drive a high-current wasted spark coil-pack for full spark control on a four-cylinder engine, or a pair of COPs on a two-cylinder engine. Dwell is controlled by the Microsquirt.

Set the Spark Output to Going High

Pin-out

1 = Coil negative output 1

2 = Spark input signal 1

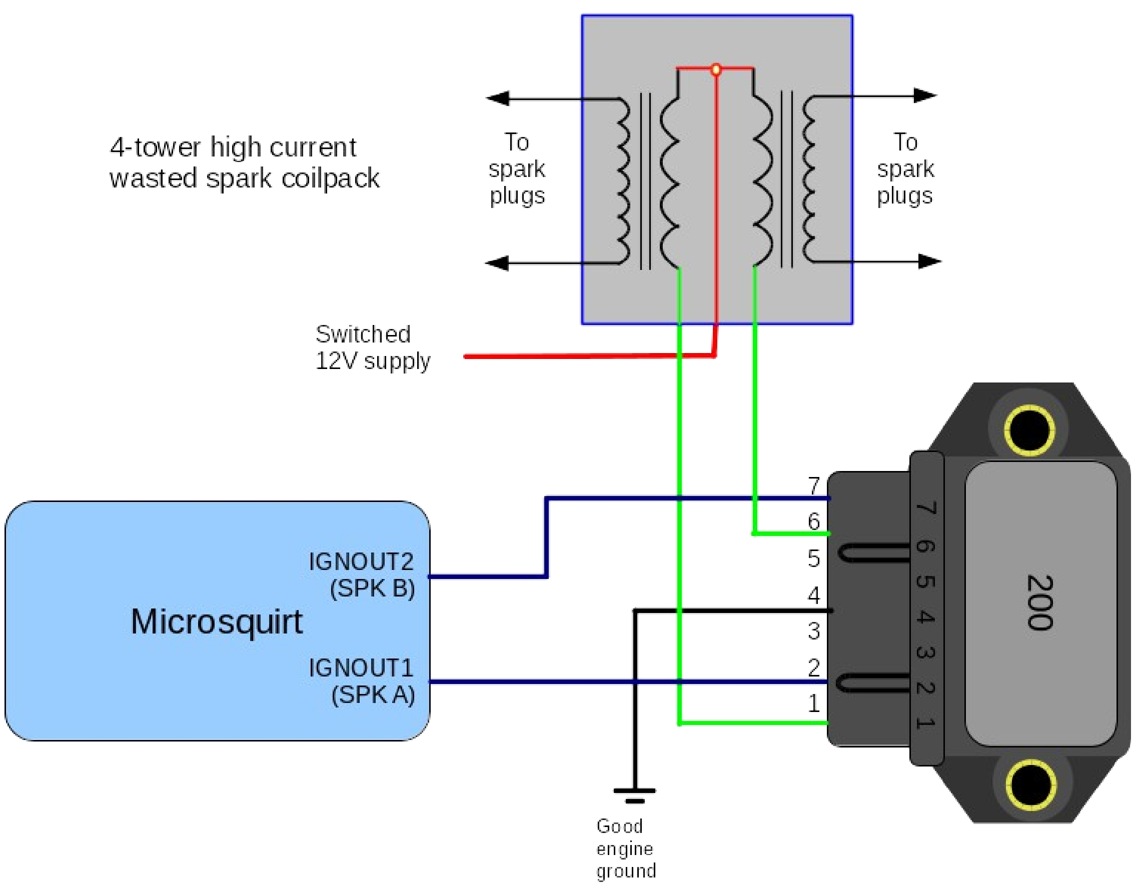
3 = NC

4 = Power Ground

5 = NC

6 = Coil negative output 2

7 = Spark input signal 2



Bosch 0 227 100 211

Cross references Intermotor 15857. Typically used on VW Golf 1.8t yr 2000.

This four channel module is typically used to drive four COPs on a four-cylinder engine, it could also be used to drive a pair of high-current wasted spark coil-packs for full spark control on an eight cylinder engine. Dwell is controlled by the Microsquirt.

Set the Spark Output to Going High

Pin-out (5 pin)

1 = Spark input signal 1

2 = Spark input signal 2

3 = Power Ground

4 = Spark input signal 3

5 = Spark input signal 4

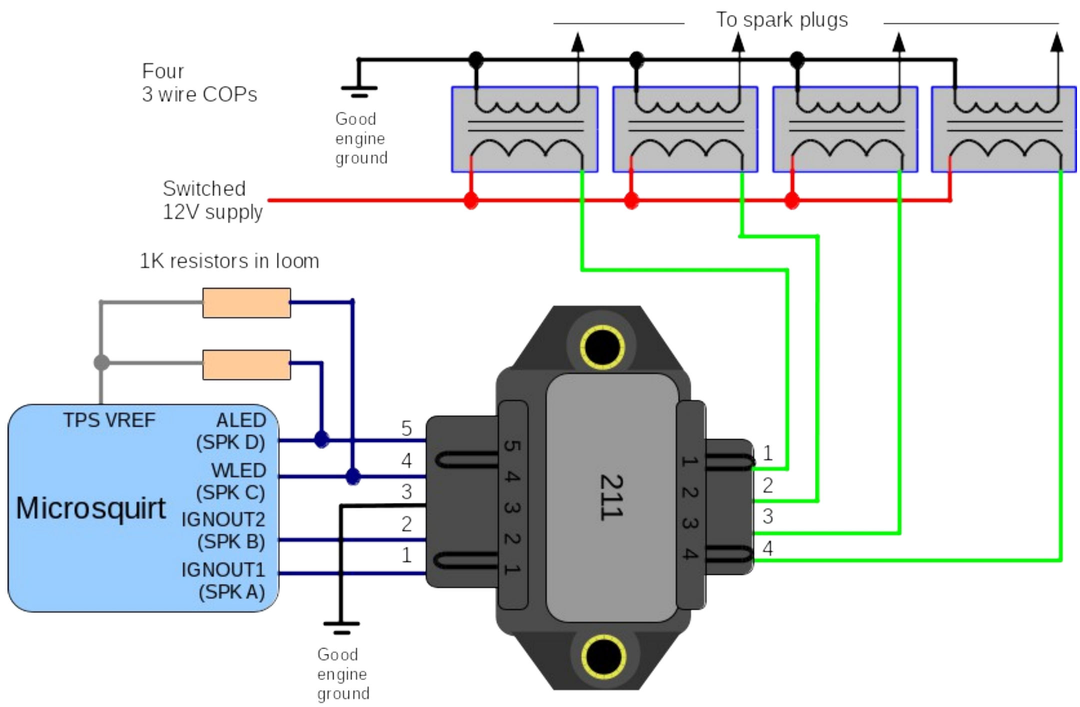
Pin-out (4 pin)

1 = Coil negative output 4

2 = Coil negative output 3

3 = Coil negative output 2

4 = Coil negative output 1



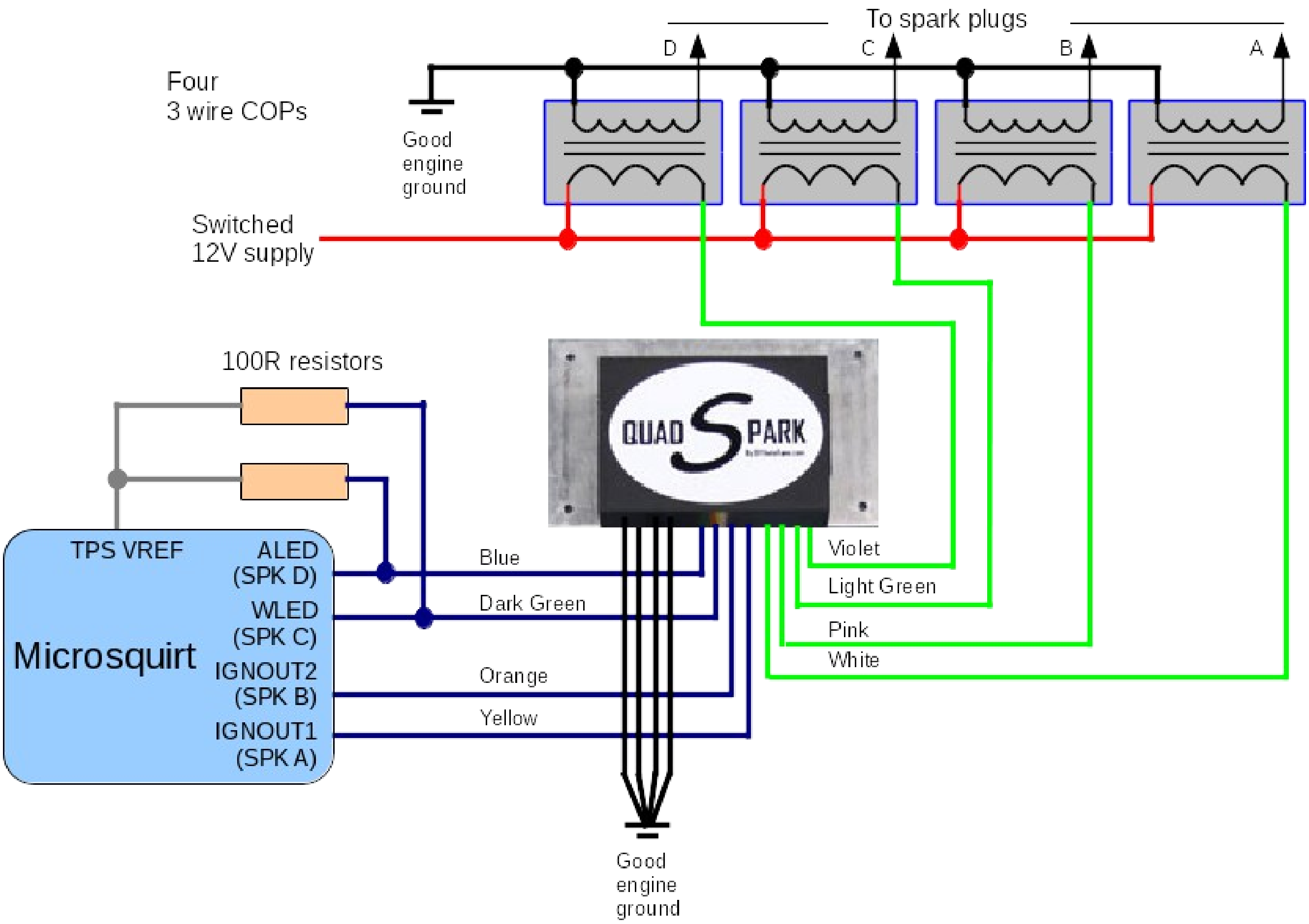
Quadspark

This aftermarket four channel module operates similarly to the Bosch 211, but is typically more cost effective.

Set the Spark Output to Going High

Pin-out	Thickness	Function
Yellow	20 gauge	Spark Input A (from Microsquirt)
White	16 gauge	Spark Output A (to coil negative)
Orange	20 gauge	Spark Input B (from Microsquirt)
Pink	16 gauge	Spark Output B (to coil negative)
Dark green	20 gauge	Spark Input C (from Microsquirt)
Light Green	16 gauge	Spark Output C (to coil negative)
Blue	20 gauge	Spark Input D (from Microsquirt)
Violet	16 gauge	Spark Output D (to coil negative)
Black	4 x 14 gauge	Ground (to engine block or cylinder head)

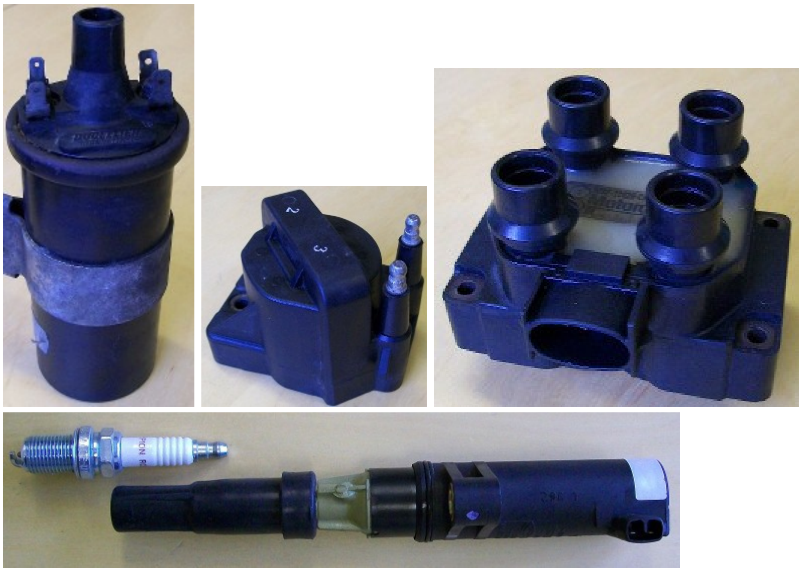
Note! To correctly operate the Quadspark, the two pullup resistors for Spk C, Spk D need to be 100 Ohms.



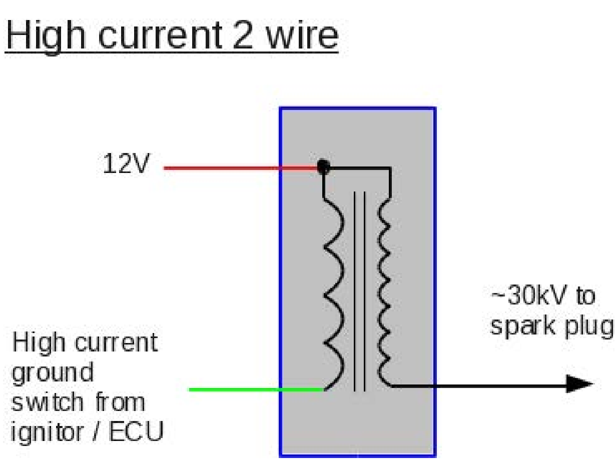
The diagram shows connection to COPs, but the module can also be used to drive high current coilpacks (Ford, Chrysler etc.)

5.3.3 High current coils

This type of coil requires an amplifier as per section 5.3.2



Shown are conventional single coil, GM wasted spark coil, Ford wasted spark coil-pack, Renault 2-wire COP. All of these coils are high current coils and require an ignition amplifier module (ignitor) to connect to the Microsquirt.



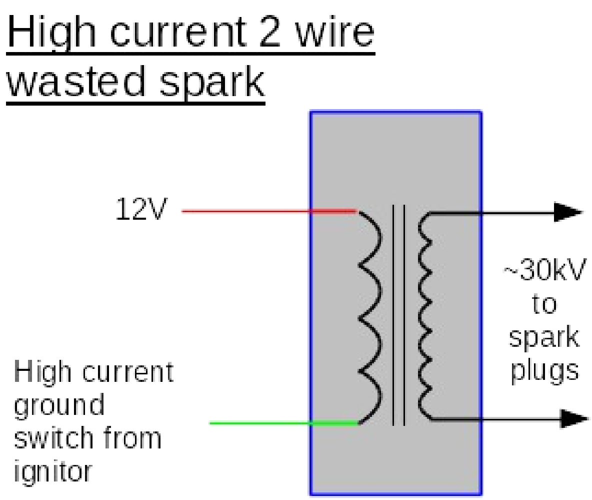
Conventional coils and

'dumb' 2-wire COPs.

The connections are :

- switched/fused 12V supply
- output from ignitor.
  The resistance measured between the inputs will be a few ohms only.

Requires an ignitor.

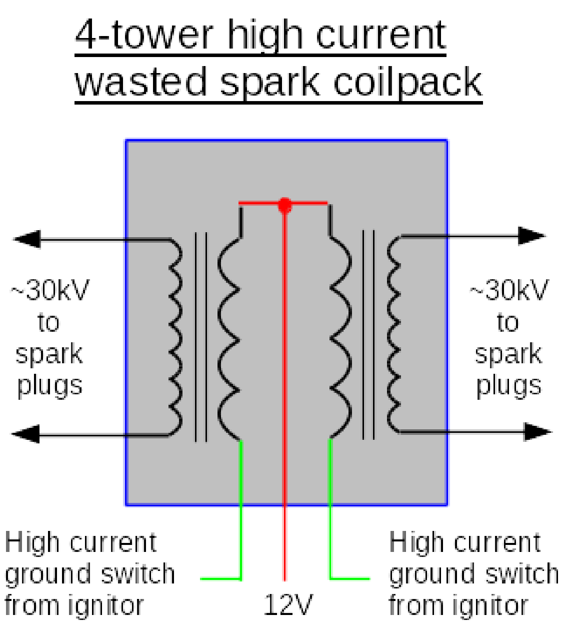


2 wire wasted spark coils - like the GM coil.

The connections are :

- switched/fused 12V supply
- output from ignitor.
  The resistance measured between the inputs will be a few ohms only.

Requires an ignitor.



4-tower wasted spark coil-pack such as Ford (EDIS style) Neon, VW and others.

The connections are :

- switched/fused 12V supply
- output from ignitor (left and right)
  The resistance measured between 12V and the primary wires will be a few ohms only.

Requires an ignitor.

5.3.4 CDI modules (e.g. MSD, Crane etc.)

Typical CDI units provide a "white wire" trigger input that can be connected to the Microsquirt for ignition control. Follow the manufacturers installation instructions for the other wiring. Ensure that no other trigger inputs are connected (e.g. green, violet.)

The following Ignition settings are required:

Set the Spark Output to "Going High"

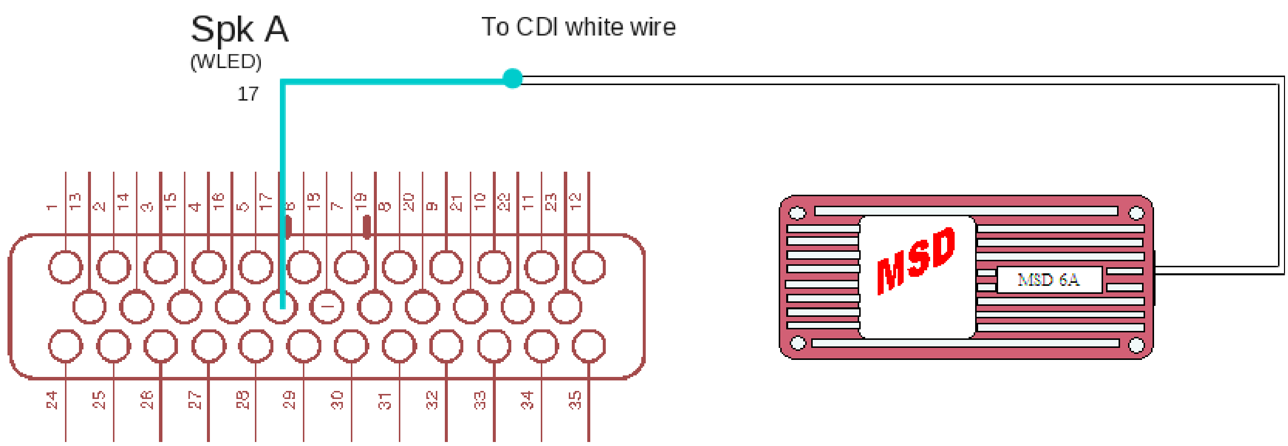
Number of coils to "Single Coil"

Dwell to "Standard Dwell"

Spark A Output pin as "WLED"

MSD is a well known brand and we will cover their wiring scheme here. Other manufacturers use similar wiring colours, but check the supplied diagrams.

Microsquirt output for CDI box



- tach signal is a yellow wire - do not connect this to MicroSquirt.
- spark control signal is a white wire - connect this to the Microsquirt.
- ground is a heavy black wire
- permanent 12V power is a heavy red wire
- switched 12 volts is a thin red wire
- the coil positive (+) wire is orange
- the coil negative (-) wire is thin black
- the unused VR signal wires are green and violet.

With the MSD ignition box, we use the white 'points' input wire. Do not connect anything to the green and violet wires. The MSD box is only being used to fire the coil. The Microsquirt must receive its tach input from a crank or distributor pick-up.

5.3.5 Mazda Rotary ignition wiring

Early Mazda rotary engines used a distributor and conventional coils, these are not covered here.

Later engines used EFI and distributorless ignition with a number of specific multiple coil setups. In the tuning software, ensure that the engine stroke is set to "Rotary."

There are three main modes of the Megasquirt-2 rotary ignition support

- FC mode - uses a wasted spark coilpack for leading plugs and individual trailing coils.

  External ignitors are used. One for the leading coil and a combination ignitor for the trailing coils.
- FD mode - uses a wasted spark coilpack for leading plugs and individual trailing coils

  External ignitors are used. One for the leading coil and one each for the trailing coils.
- RX8 mode - uses one logic coil per plug (four in total)

Mode ->	FC	FD	RX8
Number of coils	Wasted Spark	Wasted Spark	Coil on Plug
Output mode	FC	FD	FD
Spark A	Leading (IGt-L)	Leading	Front Leading
Spark B	Trailing Select (IGs-T)	Front Trailing	Front Trailing
Spark C*	Trailing Trigger (IGt-T)	Rear Trailing	Rear Trailing
Spark D*	(not used)	(not used)	Rear Leading

* pullup resistor required in wiring harness as per diagram in 5.3

The leading coil feeds the upper spark plugs, and trailing the lower plugs. The front (crank pulley end) rotor is considered rotor 1.

Be aware that the output naming in "Output Test Mode Inj/Spk" is slightly different - coil A,B are the leading coils, coil C,D are the trailing coils. Note that this only applies to test mode, physical coil wiring must follow the above table.

Be sure to use the output test mode to confirm coil wiring before attempting a first start.

RX8 logic coils

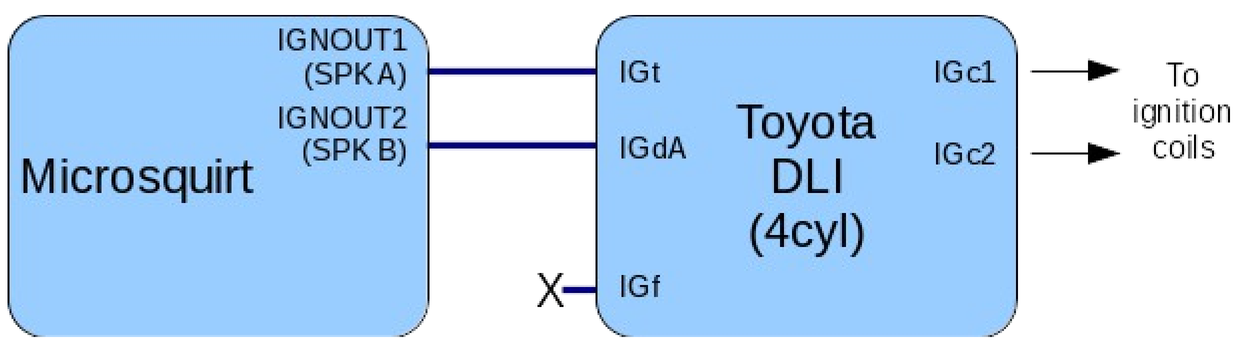
Pin A = logic signal in

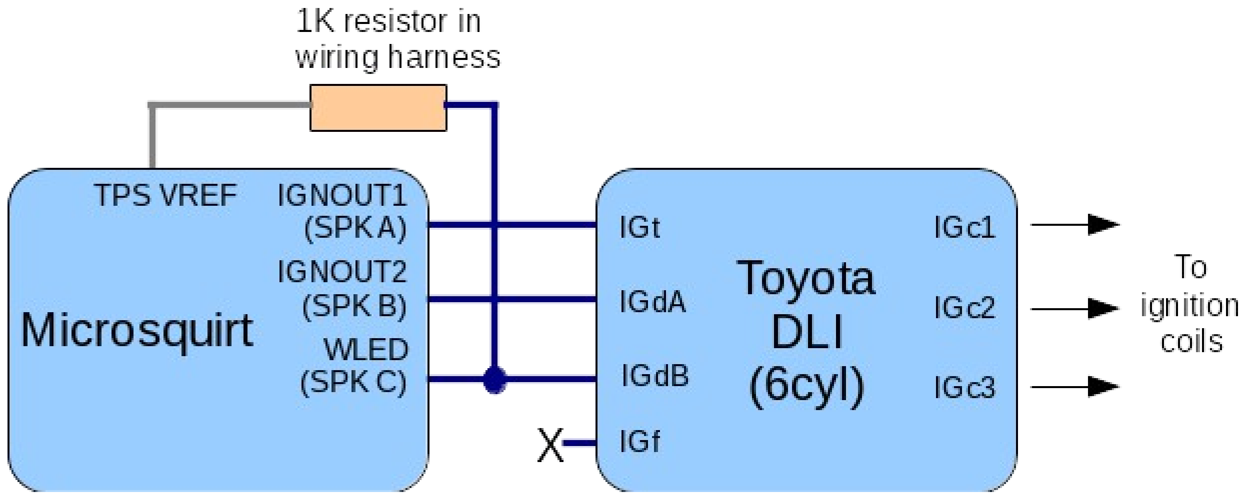
Pin B = power ground

Pin C = 12V supply

5.3.6 Toyota DLI ignition wiring

Some Toyotas use a system named "DLI" that connects between the ECU and the wasted spark coils. This uses a multiplexed signalling system. In the software settings ensure that "Toyota DLI" is selected.




1K resistor in
wiring harness
TPS VREF
IGNOUT1
(SPK A)
IGNOUT2
(SPK B)
WLED
(SPK C)
Microsquirt
X
IGt
IGdA
IGdB
IGf
Toyota
DLI
(6cyl)
IGc1
IGc2
IGc3
To
ignition
coils

6 Ignition system - specific operating modes

The Megasquirt range supports many different tach input and output schemes including many OEM specific configurations.

For installations on engines without a supported tach input, a 36-1 trigger wheel on the crankshaft is the suggested setup.

Here are all of the 'spark modes' supported by the Megasquirt-2 product range and whether they support wasted spark (W/S) and COP/seq (coil-on-plug or sequential fuel) or not on a 4-stroke engine. 2-stroke engines only need a missing tooth wheel on the crankshaft for sequential fuel and spark.

Note that even if your trigger input could support COP/sequential, your ECU may not have enough outputs.

Spark Mode	Cam input needed ?	W/S ?	COP /seq ?	Applications
Fuel only	N	N	N	Various for fuel only (no spark control)
EDIS	N	Y	N	Early to mid 1990s Fords 4,6,8cyl
Basic trigger (distributor)	N	N	N	Widespread - HEI7, GMDIS, TFI, distributor
Trigger Return	N	N	N	Typically 1980s VW hall distributors
Toothed wheel "Missing tooth wheel" on crank "Missing tooth wheel" on cam "Missing tooth wheel" on crank + single tooth on cam "Dual wheel" non missing on crank + single tooth on cam (36-1, 60-2, 4-1, 24/1, 24/2, 6-1 etc.)	Varies	Varies	Varies	Ford, Bosch ECUs, very widespread. e.g. Ford, BMW, Vauxhall/Opel, many Japanese vehicles using Nippondenso CAS, GM LS2 **This is the most common selection covering thousands of installs.** See detail pages for all variations
Neon/420A	N	Y	If cam used	420A Neons
36-2+2	N	Y	If cam used	"Next Generation" Crank Chryslers
36-2-2-2	N	Y	If cam used	Some Subaru and Mazda RX8
Miata 99-00	Y	Y	Y	1999-2005 Miata with 4 tooth crank trigger and 1,2 cam trigger. VVT not supported on Megasquirt-2
Subaru 6/7	Y	Y	Y	Subarus flat fours
6G72	Y	Y	Y	
IAW Weber*	Y	Y	Y	Fiat / Cosworth engines with 4 tooth crank trigger and uneven distributor trigger.
CAS 4/1*	Y	Y	Y	
4G63	Y	Y	Y	Mitsubishi, Mazda Miata (MX5)
Twin trigger*	(Y)	Y	N	Bike engine with one reluctor and two trigger coils. Typically 4 cylinder wasted-spark.

Spark Mode	Cam input needed ?	W/S ?	COP /seq ?	Applications
Chrysler 2.2/2.5*	Y	Y	Y	Distributor pickup. YMMV
Renix 44-2-2	N	N	N	Renault 4cyl, also V6 with 66-2-2-2
Suzuki Swift*	N	N	N	Distributor trigger wheel
Suzuki Vitara 2.0*	N	Y	N	Suzuki Vitara 2.0
Daihatsu 3cyl*	N	N	N	3+1 cam trigger
Daihatsu 4cyl*	N	N	N	4+1 cam trigger
VTR1000*	N	Y	N	12-3 on crank
Rover#1*	N	?	N	Rover K Series 36-1-1
Rover#2*	N	?	N	Rover K Series 36-1-1-1-1
Rover#3*	N	?	N	Rover K Series 36-2-2
GM7X*	N	Y	N	Direct from sensor bypassing GMDIS modules.
QR25DE*	Y	Y	Y	Nissan
Honda RC51*	Y	Y	Y	Also other versiants
LS1	N	Y	N	GM LS1, LM7 etc. with 24X crank
YZF1000*	?	?	?	
HD 32-2*	N	N	Y	Harley 45deg V-twin. Can use MAP sensor for phase detection or use a cam sensor.
Miata 36-2*	N	Y	N	Flyin' Miata custom 36-2 wheel fitted to 99-05 engine.

* indicates a configuration that has received less usage in the field and may be less well proven. Proceed with caution or discuss with your supplier before using.

Running excessive timing under load will almost always cause severe engine damage such as broken pistons.

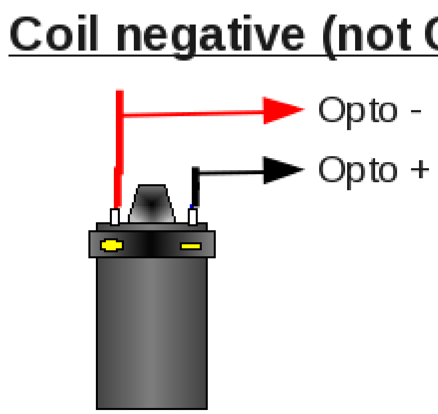
It is essential that timing is confirmed with a timing-light on EVERY install.

NOTE! The tach input polarities provided in section 6 are for reference only and subject to review.

6.1 Coil negative for fuel only

For fuel-only installs it is possible to obtain a tach in trigger from the negative terminal of a single coil. Note that this won't work well on a wasted spark setup and must never be connected to a CDI type coil with a high primary voltage.

Coil negative input CANNOT be used for installs using the Microsquirt to control ignition.



Typical Settings

Spark mode = "Fuel only"

6.2 Distributor pickup

The distributor is the traditional method of timing spark and distributing the high-tension spark voltage to individual spark plugs. Typically this used a set of breaker points, a condensor and a single ignition coil. Most distributors feature mechanical and vacuum advance systems to match spark timing somewhere close to optimal for different operating conditions. Later systems were "breakerless" and replaced the high-maintenance points with VR, hall or optical sensors. When combined with OEM fuel injection systems, the distributor may be "locked" in that there is no advance mechanism - the timing is controlled by the computer. Some OEM systems retain a distributor only for the high-tension spark distribution and use a trigger-wheel arrangement for tach input.

The first step in an install is to identify what kind of system is already fitted to your engine. Usually this is relatively straight forward to establish.

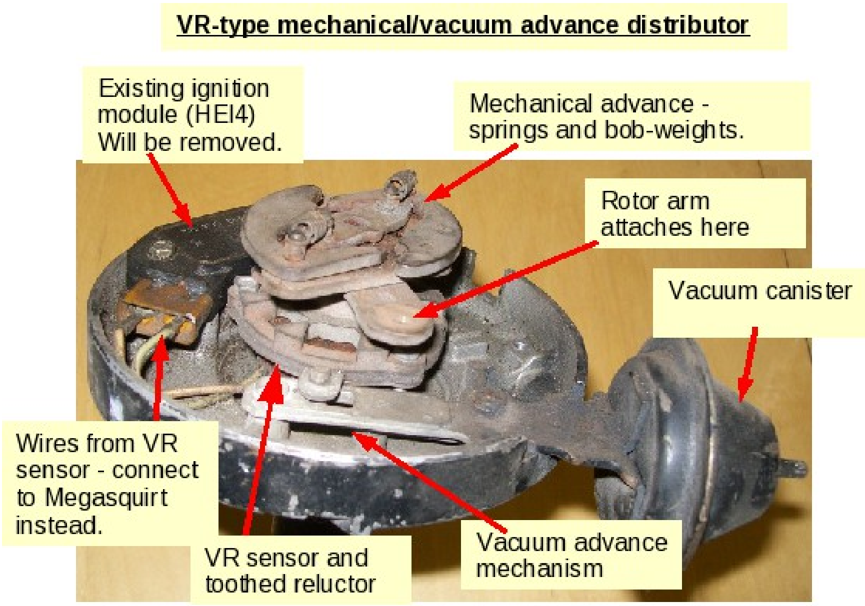
Note that Ford TFI, GMHEI7, GMHEI8 are special cases using a locked distributor and are covered in their own subsections.

6.2.1 Traditional vac/mech distributor

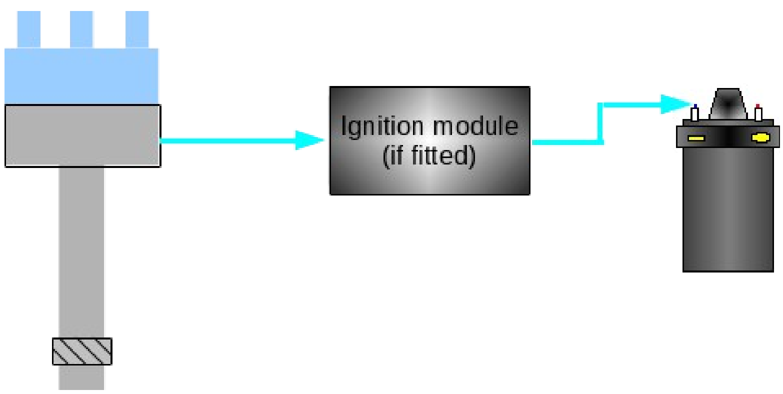
For distributor triggering you need one pulse per spark event. e.g. a normal distributor on a typical 4 stroke, 4 cylinder engine will have four lobes/teeth/vanes/slots in the distributor.

This applies to points, optical, VR, hall.

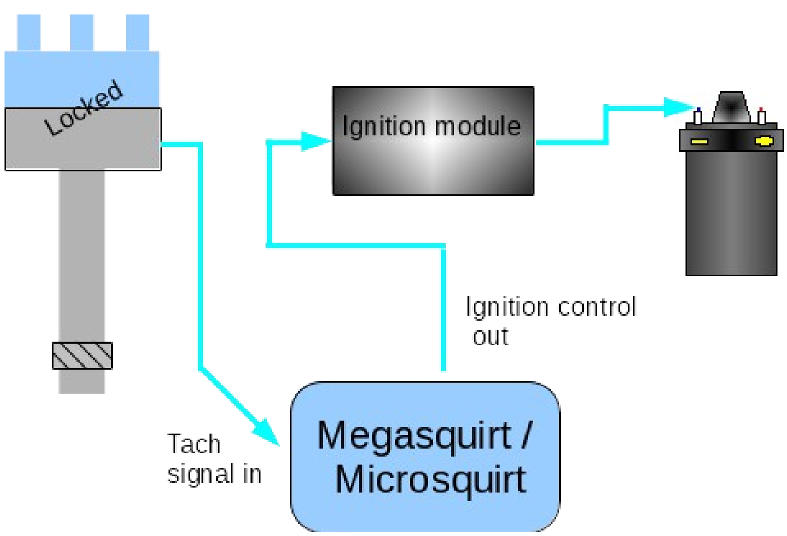
See section 5.2 for wiring details on the tach input.



Shown above is a "large cap" General Motors HEI4 distributor, typical on mid 1970s V8s.



Typical original arrangement



Typical arrangement with ECU ignition timing control and locked distributor

6.2.1.1 Input phasing

A typical distributor includes advance mechanisms which were originally used to control the timing. These are not used when using computer control and must be locked out to give a "locked" distributor.

Correctly modifying an old distributor to give a reliable tach input may well be more difficult than adding a crank trigger wheel and will never be as accurate. You are advised to consider installing a crank trigger wheel (e.g. 36-1) and sensor instead.

Early distributors such as points, HEI4, Duraspark etc, all have advance mechanisms built in. The HEI4 distributor shown above illustrates these mechanisms and is typical of pre-computer distributors. Similar distributors can be converted to computer control-

Remove ignition module (if present)

Connect pickup sensor (VR, hall, opto, points) to ECU.

Remove and weld up mechanical advance mechanism.

Remove vacuum canister.

Use remnants of vacuum advance mechanism to achieve correct input:output phasing.

You may be able to set the rotor output phasing FIRST and then rotate the baseplate to achieve the correct input phasing.

Later engines may feature a distributor in conjunction with computer controlled timing - usually these distributor are "locked" from the factory and should already have good input and output phasing. (e.g. Ford TFI, GM HEI7/8, Bosch hall effect.) Align as per the factory manuals and determine how it is phased before you modify anything!

The crank angle at which the tach input triggers is of importance and needs to be configured in the Megasquirt. For best spark control there are some optimal and some disallowed crank angles.

A typical engine will have an operating advance range of say 10-50 BTDC timing (depending on engine type.) The trigger must not happen during this range of angles.

It can be really helpful to install timing tape on your crank pulley or temporarily mark on a range of angles.

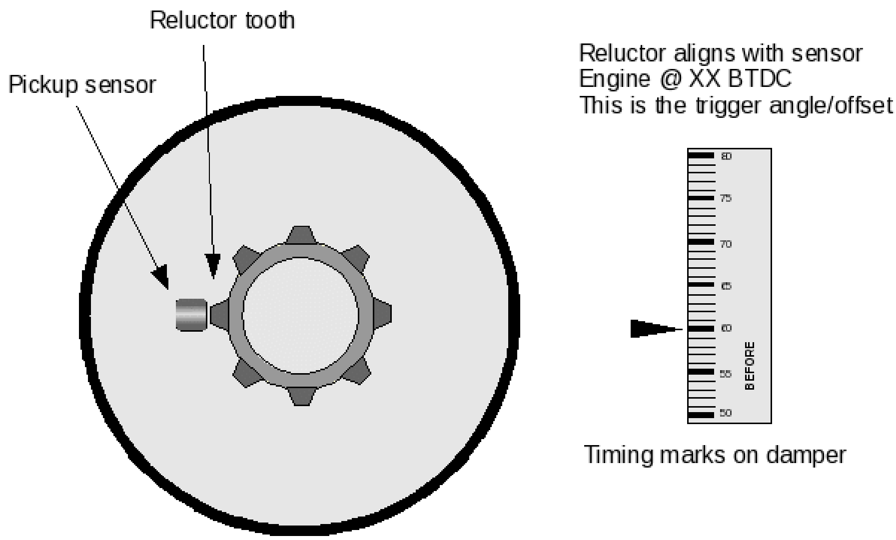
For best accuracy at high revs or during transients, aim for the trigger to align at 60-90 BTDC. This also allows a full range of timing (including ATDC timing should you need it for boosted conditions.) This range of trigger angle is preferred for new installs.

For slightly better starting, but not quite such good running accuracy, aim for a trigger ~10BTDC or your desired cranking advance. This is the typical trigger angle for TFI and HEI7/8. You cannot retard timing later than the trigger angle. e.g. 9BTDC and lower are not possible with a 10 BTDC trigger angle.

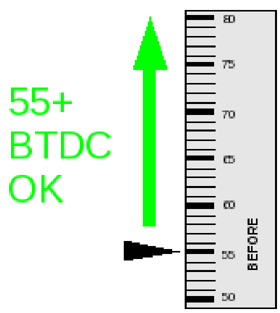
The VR sensor input presents a simple pulse as the reluctor passes the sensor, this gives a timing position easily identified by eye. Use "Basic Trigger"

Rotate the engine to 60 BTDC (or 10 BTDC if chosen) and then align the distributor so the reluctor aligns with the centre of the sensor.

VR type distributor pickup



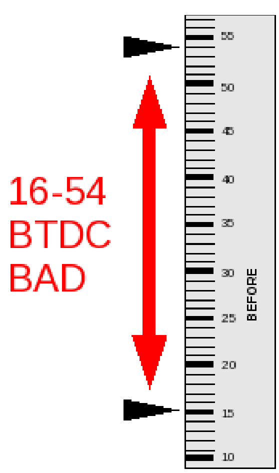
Be aware of the allowable values for "trigger angle". Do not use angles in the disallowed range or you will have unreliable or unexpected operation.



Timing marks on damper

Allowed high angles

Timing allowed in normal range (up to 5 degrees less than trigger angle.) Retarded ATDC timing possible.



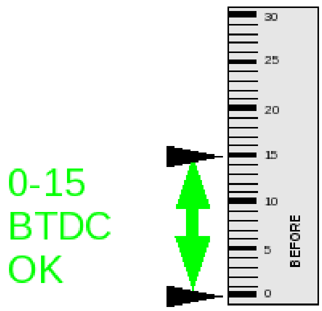
Timing marks on damper

Disallowed angles.

Do not use a trigger angle between 16 and 54 degrees.

Timing will not work correctly.

Distributor must be moved or re-phased.



Timing marks on damper

Allowed low angles

Timing allowed in normal range (greater than trigger angle.) Retarded ATDC timing not possible.

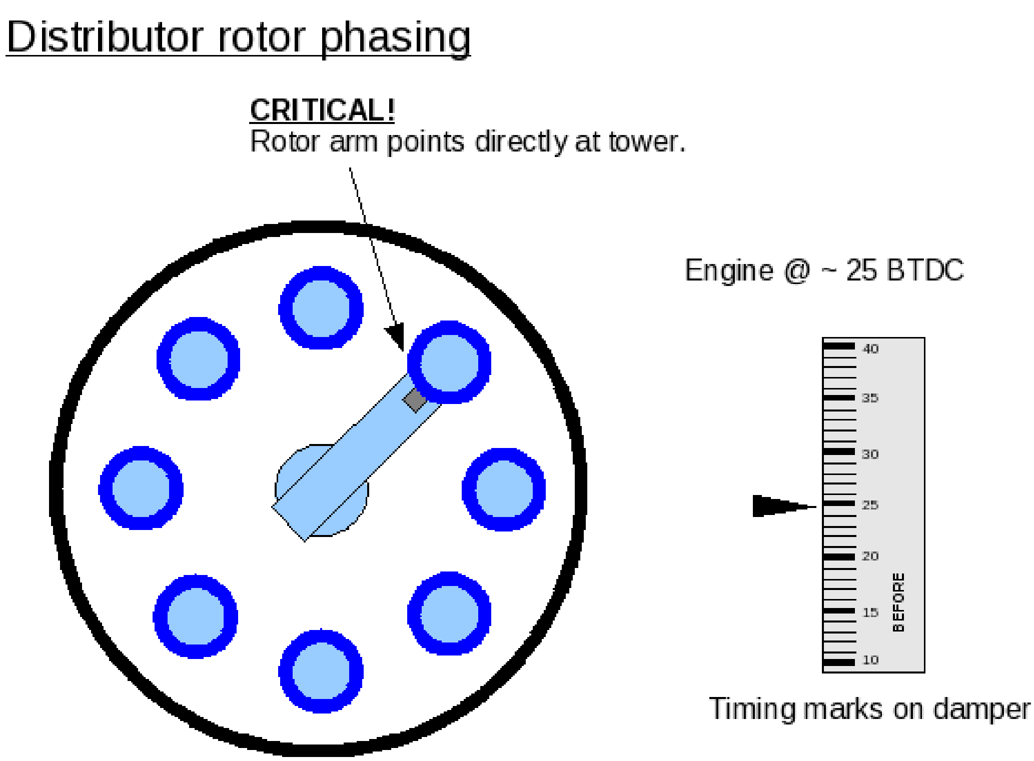
Once the tach input is setup it is important to confirm the output phasing is correct.

6.2.2 Rotor / Output phasing - all distributor installs

Rotor phasing is CRITICAL.
Without it you will get cross firing and the engine will run extremely badly.

Rotate your engine to ~25 BTDC.

The rotor arm MUST point towards a tower on the distributor.



When using the distributor for the tach input as well, beware of just rotating the distributor - that would change the input phasing that you already set - you may need to make a physical modification to rotate the rotor arm. (e.g. weld up the locating slot and cut a new one.) If you moved the distributor, go back and re-set the input phasing.

This potential conflict between input and output phasing is why a crank trigger is strongly recommended.

If you are crank triggering and the distributor is only used for the spark distribution then you can simply rotate the dizzy to achieve the required rotor phasing. In this case it is not necessary to 'lock' the distributor, you can unhook the vacuum canister and leave the mechanical advance operational.

6.2.3 Distributor with hall/optical 'trigger return'

The purpose of the "Trigger Return" mode is to have accurate cranking timing as well as accurate running timing. It achieves this by using the signal from both edges of a vane/slot. One edge is used for the timing calculations during running and will typically pass the sensor at 55BTDC or more. The other edge is used for cranking timing and must pass the sensor at the desired cranking advance angle e.g. 10BTDC

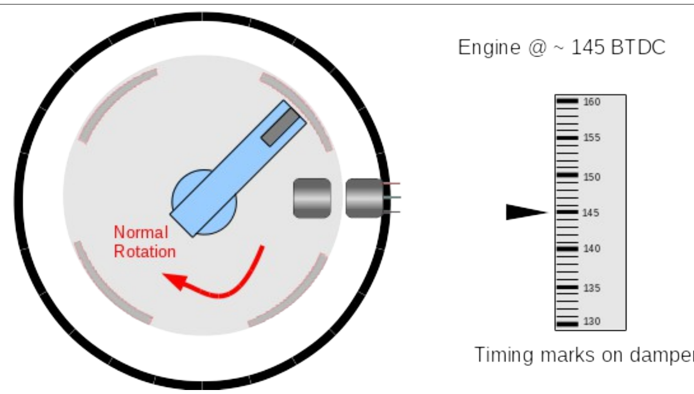
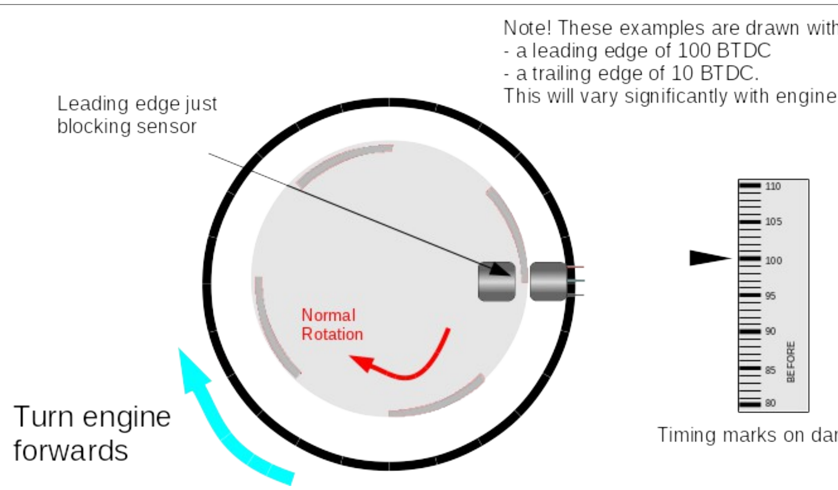
This scheme was commonly used by VW during the 1980s with a locked hall-effect distributor.

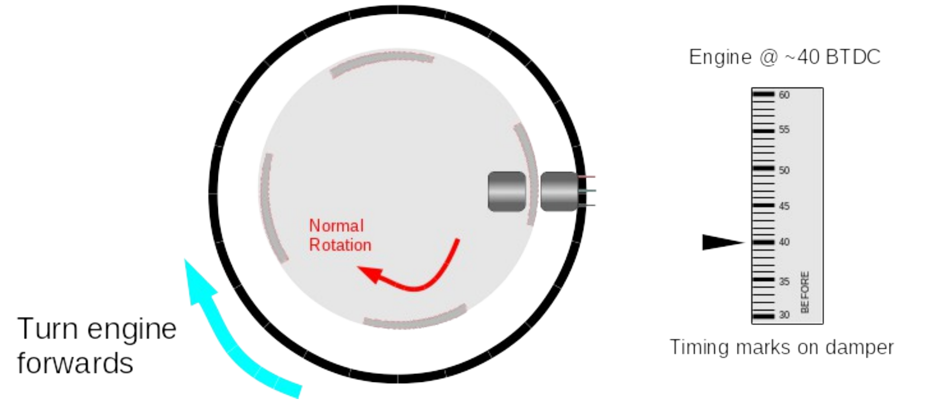
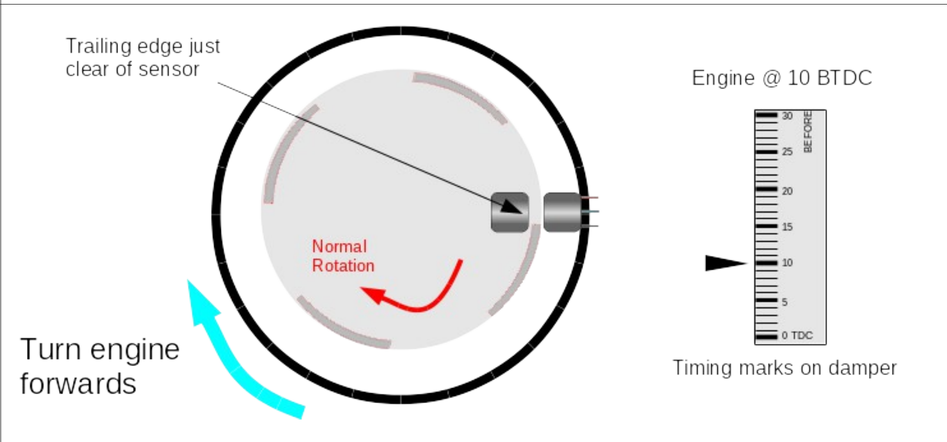
'Trigger return' may only be used if the slots/shutters/vanes in the distributor are evenly spaced and equal sized.

Do not try to use 'trigger return' with many Nissan optical pickups or with signature-PIP TFI as these have uneven slots/vanes.

See section 5.2 for wiring details on the tach input.

Configuring trigger return requires knowing the crank angle that each vane edge passes the sensor. You can check this visually or by wiring up the system and using a multimeter to measure the output from the sensor.

A. Hall/opto distributor showing inactive trigger.	
B. Engine rotated forwards until edge at sensor. The crank angle here is the "Trigger Angle"	

C. Engine turned forwards some more.	
D. Engine turned forwards some more. This is the Return angle and needs to match your setting for cranking advance. This needs to be ~10BTDC. Rotate your distributor if needed, then repeat steps B,C,D.	

The output phasing on an OEM trigger-return type distributor installed in the normal position should not require adjustment.

6.2.4 Distributor with basic crank trigger

Installing a "flying magnet" crank trigger gives more accurate ignition control than using a distributor based pickup as it eliminates timing chain and cam-gear slop. It also eliminates the hassle of re-phasing the distributor.

For best timing accuracy, it is recommended that the flying magnet passes the pickup sensor when the engine is around 60BTDC.

See section 5.2 for wiring details on the tach input.

Typical Settings

Spark mode = "Basic Trigger"

Trigger angle/offset = 60 BTDC (adjust as required)

Ignition capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = depends

Spark A output pin = depends

Dwell type = depends

Dwell duty = depends

6.2.5 Distributor with crank trigger wheel

This is the preferred method to use with a distributor.

Using a trigger wheel (e.g. 36-1) on the crank is the most best way to obtain accurate ignition control. The ECU uses every tooth on the wheel to determine engine position. It eliminates timing chain and cam-gear slop. It also eliminates the hassle of re-phasing the distributor.

The distributor and single coil can be retained, but you have the option of a future upgrade path to wasted-spark or perhaps coil-on-plug ignition.

The setup and configuration of the crank trigger wheel is covered in the Toothed wheel section 6.9.

6.3 Ford TFI

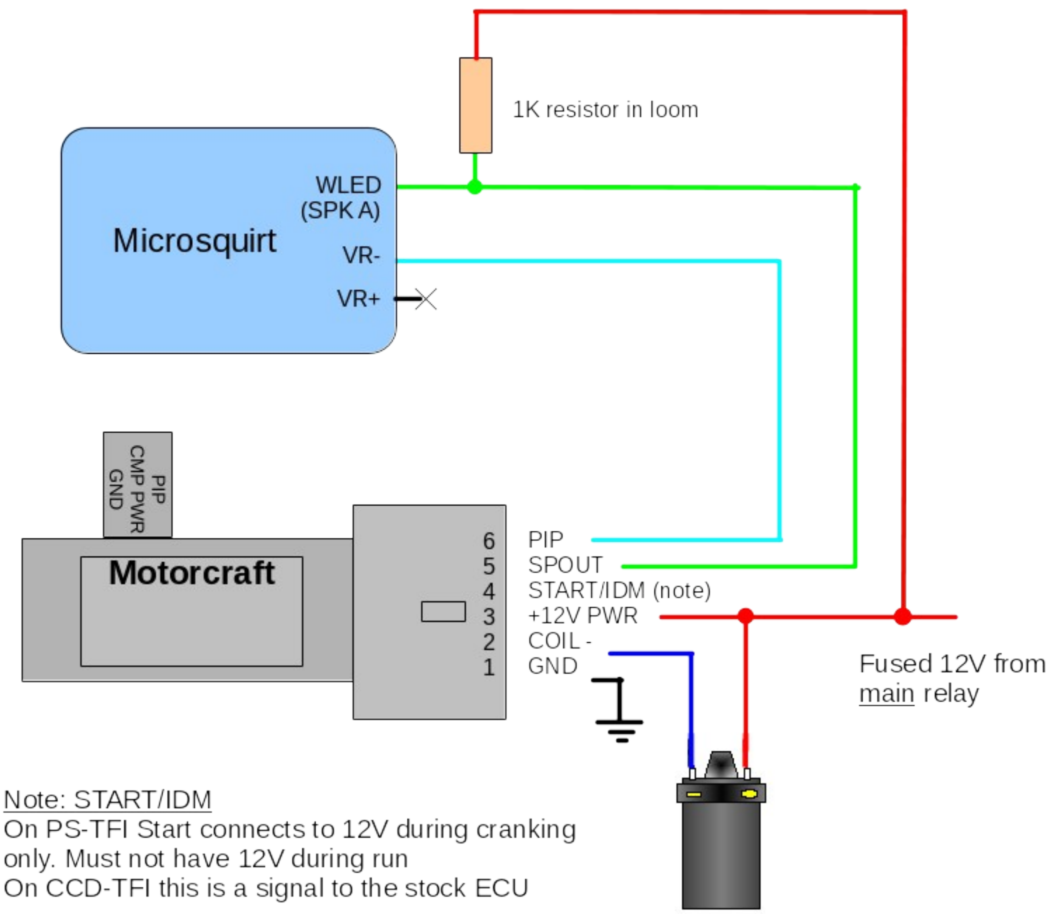
Ford's TFI module was used throughout the 1980s and into the 1990s on many millions of vehicles in two main mounting positions - 'distributor mount' and 'remote mount'. There are also two electrical versions: "Push Start" and "Computer Controlled Dwell". Checking the wiring on pin4 is likely best. The wiring of the modules is largely the same, just the distributor mount connects directly to a 3 wire hall sensor in the distributor. In most installations you do not need to concern yourself with that as only the 'PIP' and 'SPOUT' connections are of interest. The other connections should be left stock.

Push-Start (PS) vs. Computer Controlled Dwell (CCD)
The module described mainly here is the 'PS' type that uses a 12V start signal, it is claimed to be grey in colour. 50% dwell duty should be used.
The 'CCD' type is claimed to be black in colour and pin 4 runs as a diagnostic signal to the original ECU. These modules need standard dwell control e.g. 3ms instead of a fixed duty. Other wiring should be the same.

Base Timing and phasing
"Base Timing" on the distributor (with computer control 'SPOUT' disconnected) is around 10BTDC. This is the number you should use as your initial Trigger Offset. As these distributors were designed for ECU control, the rotor arm phasing should already be correct.

Signature PIP
Note that there is a TFI variant with "Signature PIP" that in the original install allows for cylinder identification and sequential fuel. This signature is not used in Megasquirt-2.

These distributors should be configured as "Basic Trigger".



Typical Settings

Spark mode = "Basic Trigger"

Trigger angle/offset = 10 BTDC as a starting point, fine tune with a timing light.

Ignition capture = "Falling edge"

Spark output = "Going High"

Spark A output pin = "WLED"

Dwell type = "Fixed duty"

Dwell duty = "50%"

6.4 GM HEI7

The original "High Energy Ignition" (HEI) distributors used the 4 pin module from the early 1970s is fine in the breakerless distributor as designed, but is not suitable for computer timing control. The later 7 and 8 pin modules and corresponding distributors are designed for computer control and should be an easy swap onto earlier engines - not only are those modules intended for computer control, but their distributors are already locked-out so no modifications are required. HEI7/8 uses three control wires to/from the Megasquirt.

The 'Ref' signal from the module to the Megasquirt gives rpm and engine position information.

The 'Est' signal from Megasquirt to the module controls the advance when running.

The 'Bypass' signal from Megasquirt to the module allows the module to benefically control its own advance during cranking. Once the engine has been running for more than 5 seconds, the Megasquirt takes control of timing.

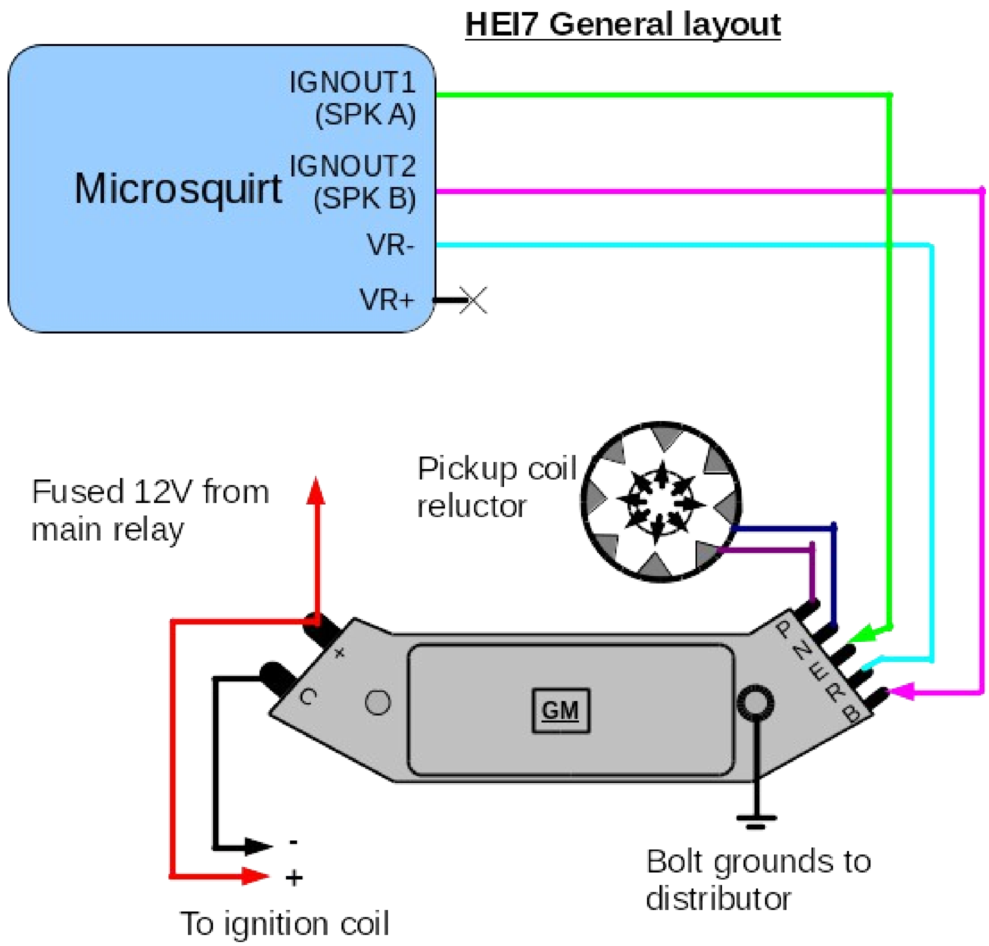
P = Positive from VR sensor

N = Negative from VR sensor

E = Electronic spark timing (EST) from Microsquirt IGNOUT1

R = Reference (REF) to Microsquirt VR-

B = Bypass from Microsquirt IGNOUT2



Typical Settings

Spark mode = "Basic Trigger"

Ignition capture = "Rising Edge"

Spark output = "Going High"

Spark A output pin = "IGN1"

Dwell type = "Standard Dwell"

Nominal Dwell = "3.0"

GM/HEI options = "GM bypass"

6.5 GM HEI8

This works the same as HEI7, but the module is packaged differently.

P = Positive from VR sensor

N = Negative from VR sensor

G = Ground to Microsquirt Sensor ground

B = Bypass from Microsquirt IGNOUT2

R = Reference (REF) to Microsquirt VR-

E = Electronic spark timing (EST) from Microsquirt IGNOUT1

Typical Settings

Spark mode = "Basic Trigger"

Ignition capture = "Rising Edge"

Spark output = "Going High"

Spark A output pin = "IGN1"

Dwell type = "Standard Dwell"

Nominal Dwell = "3.0"

GM/HEI options = "GM bypass"

6.6 Dual Sync Distributor

A dual-sync distributor is an aftermarket locked distributor that provides a clean trigger signal for an ECU. The signal can be used for sequential fuel in some situations.

As Microsquirt has only two fuel channels, it is simplest to ignore the "reference" signal from the distributor and configure as a regular distributor using "Basic Trigger."

Setting the rotor arm phasing is important as shown in 6.2.1.2.

Alternative: It is possible to use both signals from the dual-sync distributor and control a distributorless ignition system (wasted spark or wasted-COP.) In this case use the "Dual wheel" option in the Trigger Wheel system. Setting the rotor arm phasing is important as shown in 6.2.1.2, then determine the tooth#1 angle from the Trigger Wheel page.

6.7 Ford EDIS

Ford's Electronic Distributorless Ignition System (EDIS) is an ignition system that does not require a cam position signal. It requires a variable reluctor (VR) sensor and a 36-1 tooth crank wheel (36-1 means '36 teeth minus one', and refers to 36 evenly spaced teeth, one of which has been removed), it will not work with other pattern wheels or hall sensors.

EDIS is a particularly easy way to install programmable ignition control on an older engine with a distributor. The EDIS modules are very reliable and the system works well. The EDIS module itself handles all the decoding of the toothed wheel and sends one pulse per cylinder to the ECU.

It is strongly advised to use Ford VR sensors and Ford coilpacks with the EDIS modules. They were designed to work together and do.

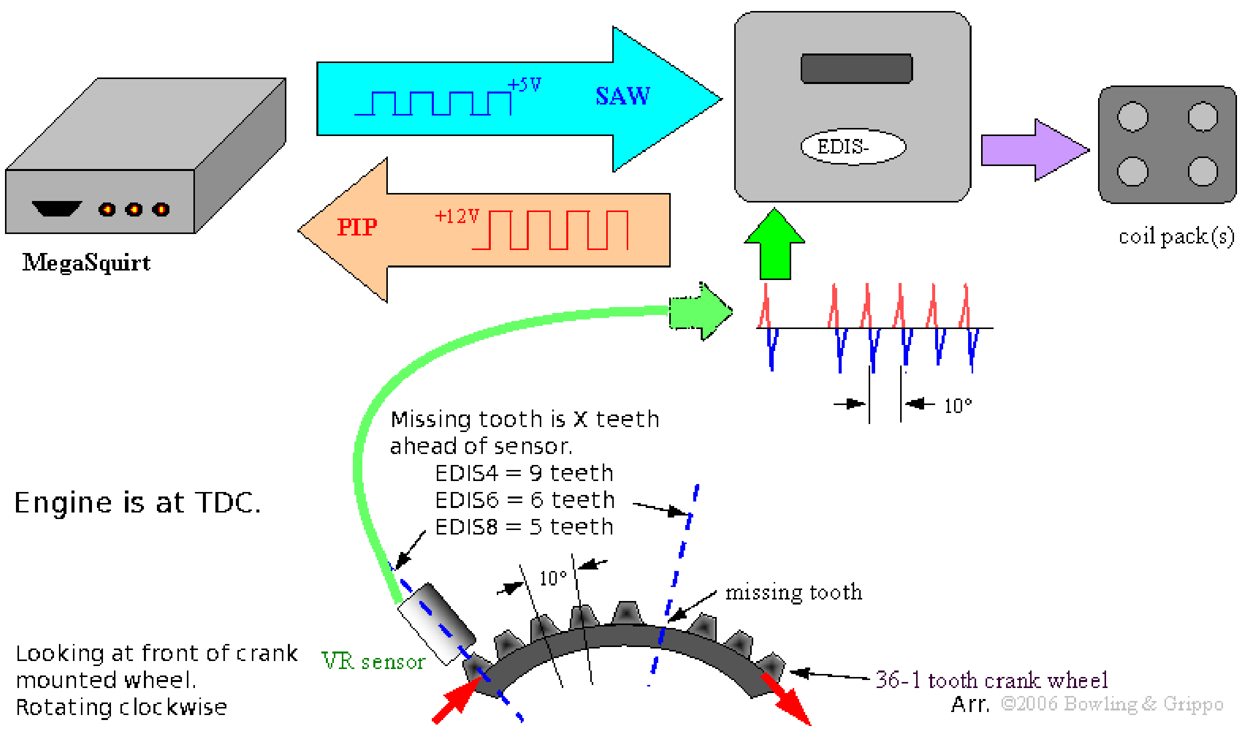
Note! If your engine already has a different supported trigger wheel setup, consider utilising that before retro-fitting EDIS.

6.7.1 System components

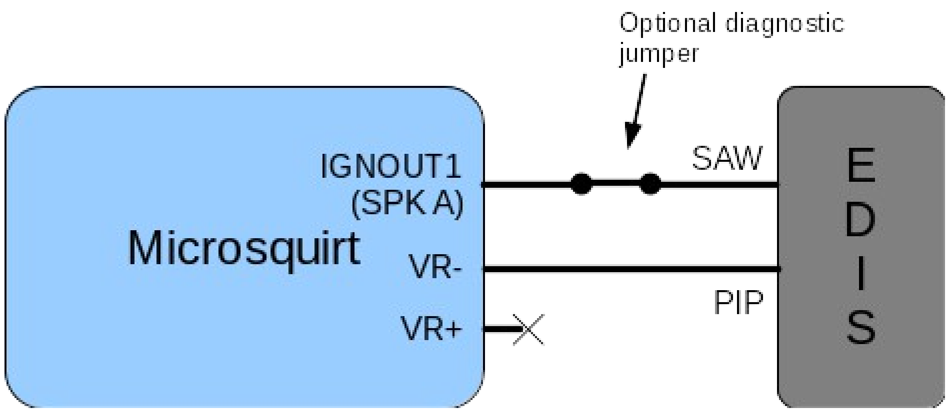
The EDIS system is made up of:

- EDIS module,
- crank wheel,
- crank variable reluctor (VR) sensor and
- one or more coil pack(s).

See appendix B for a junk-yard hunters guide to finding EDIS.



6.7.2 ECU wiring



Typical Settings

Spark mode = "EDIS"

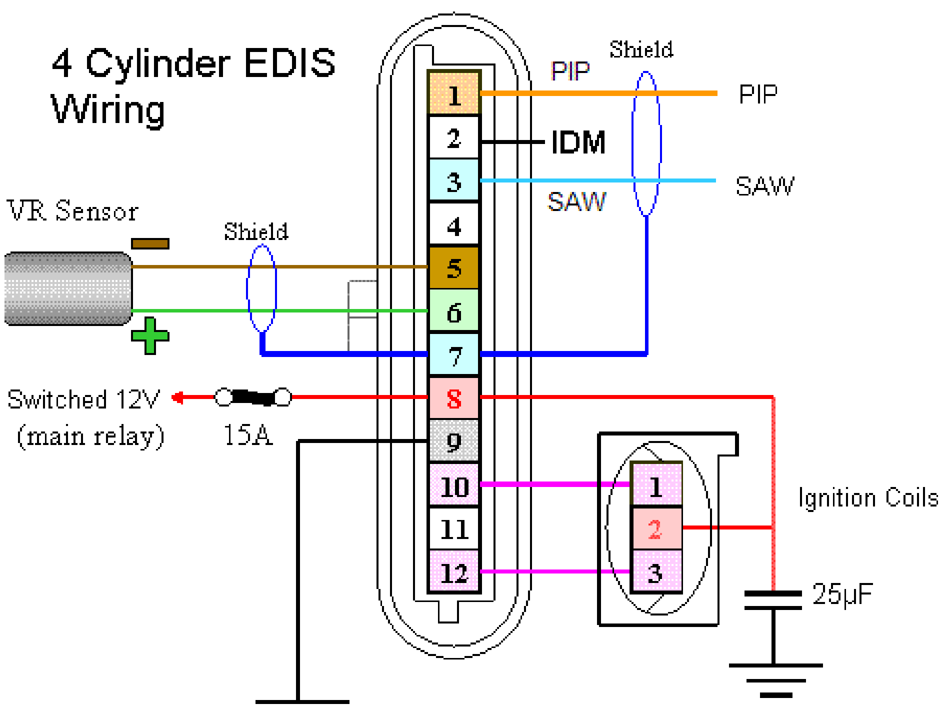
Ignition capture = "Rising Edge"

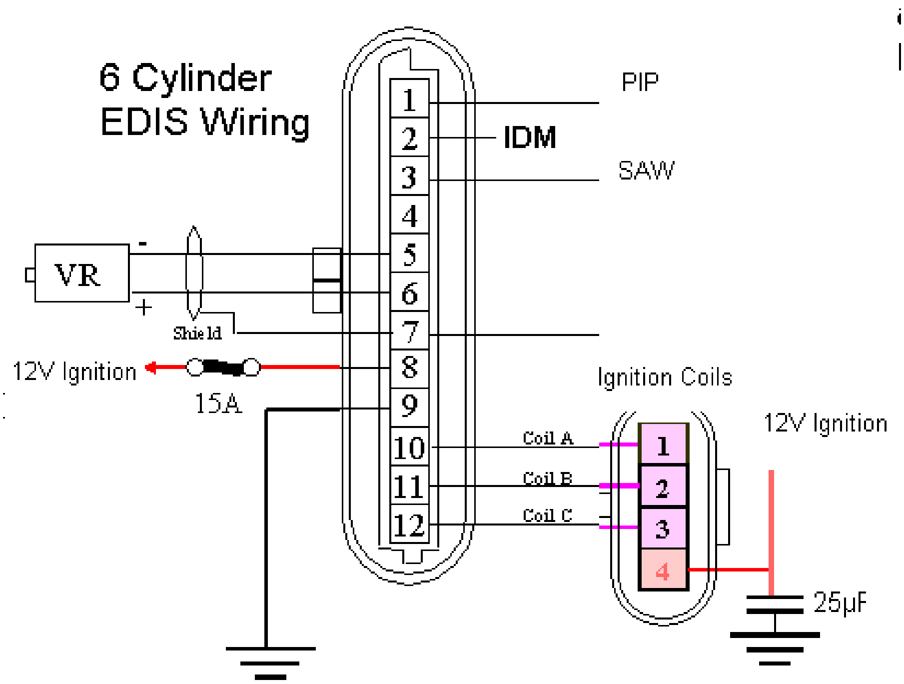
Spark output = "Going High"

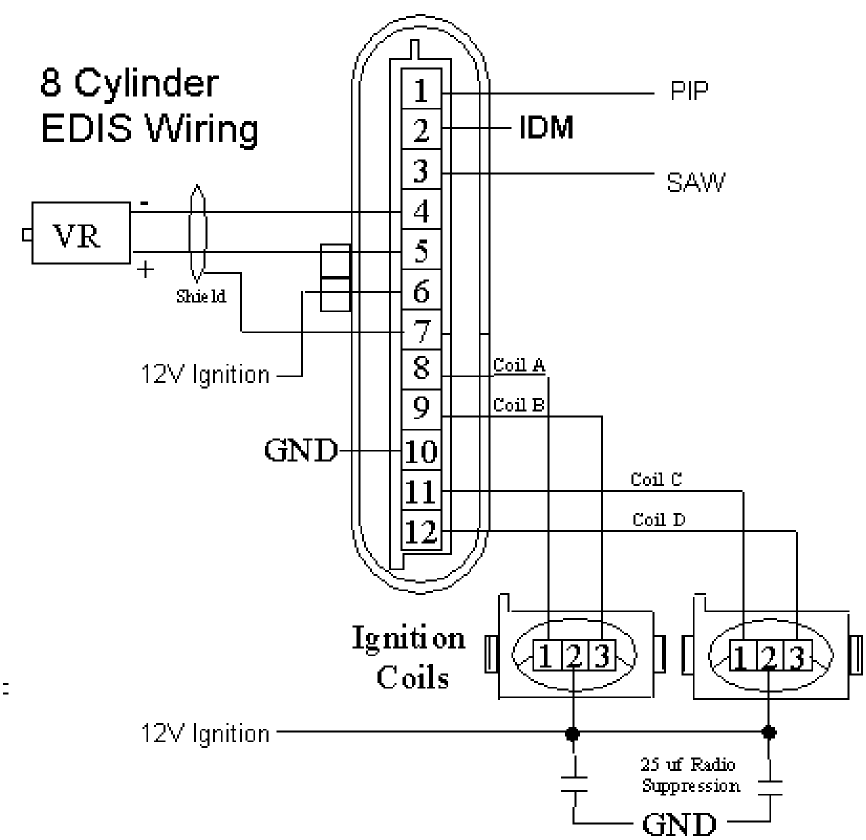
Spark A output pin = "IGN1"

6.7.3 Module wiring

The EDIS system comes in three varieties : EDIS4, EDIS6, EDIS8 which are suited to even-fire 4, 6, 8 cylinder engines. The specific wiring of the module varies slightly between the variants.







6.7.4 36-1 trigger wheel and VR sensor

The relationship of the VR sensor and the missing tooth is critical. The EDIS module expects and requires a specific phasing.

On engines originally equipped with EDIS this will already be set. Later Ford engines also maintain the same phasing even though the EDIS function is now built into the ECU.

Note that while the relationship of the VR sensor and the missing tooth is critical, the actual placement of the VR sensor on your engine is not. i.e. the VR sensor could be at 12 o'clock, 3 o'clock, 6 o'clock, 9 o'clock - it really does not matter - so long as the wheel is phased to match.

See the diagrams below EDIS4, EDIS6, EDIS8. The main diagrams show clockwise engine rotation as that is the most common, there is an anti-clockwise example afterwards.

For each module type there are two phasing diagrams shown.

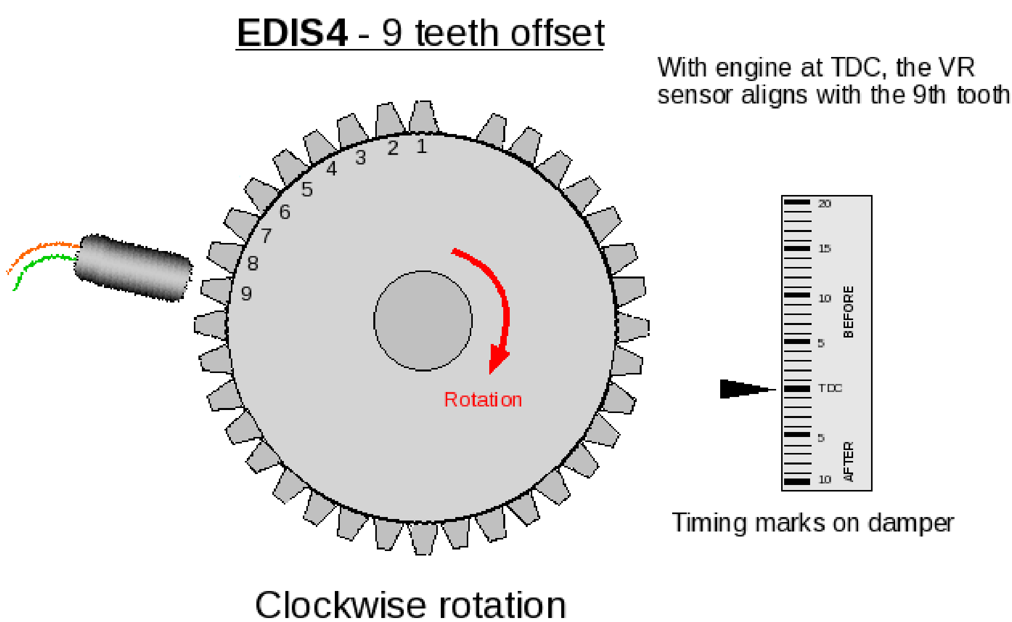
Both methods achieve the same result.

- method a - engine is set to TDC and teeth counted
- method b - engine is set to angle X BTDC and missing tooth aligned with sensor

Use method 'a' if you can. Alternatively, some installers may find method b easier to understand.

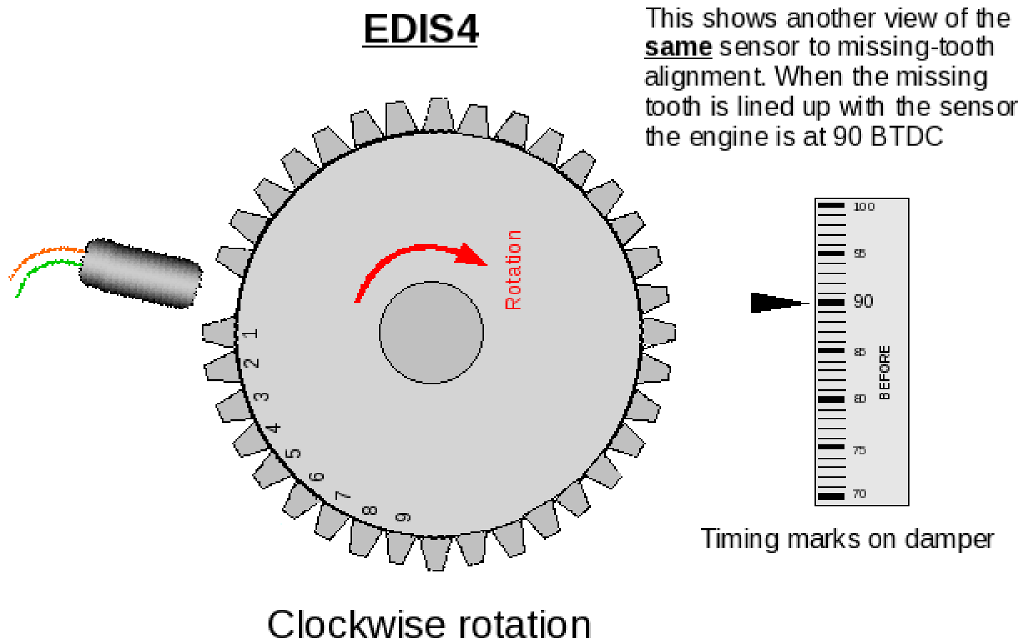
6.7.4.1 EDIS4 - Clockwise rotation (normal) - method a

Set your engine at TDC, then put the missing tooth 9 teeth earlier (more clockwise) than the sensor. This will put the centre of a tooth central to the sensor.



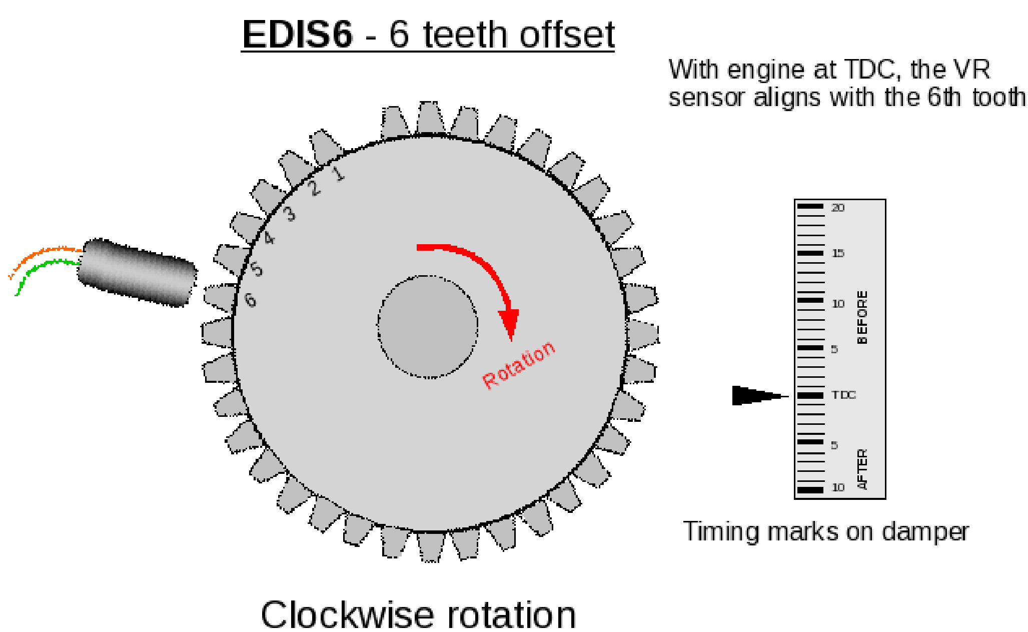
6.7.4.2 EDIS4 - Clockwise rotation (normal) - method b

Turn your engine to 90 BTDC. Mount the VR sensor wherever is convenient and mount trigger disc so that the centre of the sensor aligns with the centre of the missing tooth.



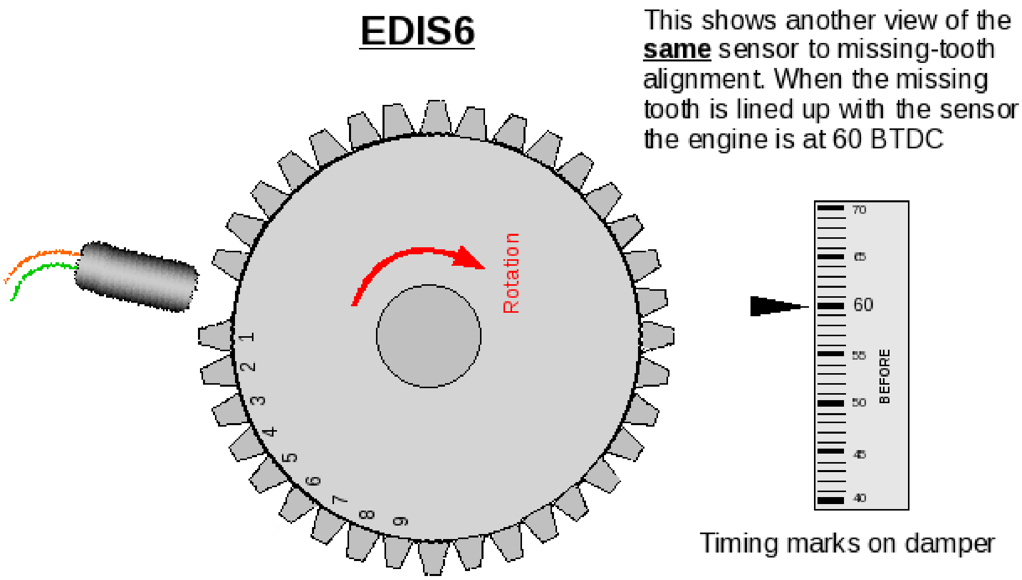
6.7.4.3 EDIS6 - Clockwise rotation (normal) - method a

Set your engine at TDC, then put the missing tooth 6 teeth earlier (more clockwise) than the sensor. This will put the centre of a tooth central to the sensor.



6.7.4.4 EDIS6 - Clockwise rotation (normal) - method b

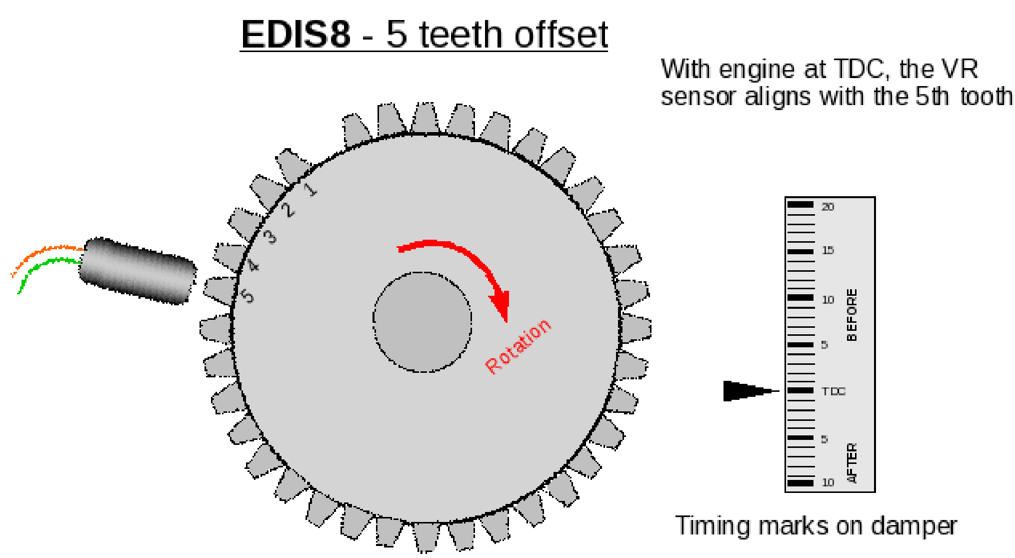
A different way of looking at the SAME phasing.
Turn your engine to 60 BTDC. Mount the VR sensor wherever is convenient and mount trigger disc so that the centre of the sensor aligns with the centre of the missing tooth.



Clockwise rotation

6.7.4.5 EDIS8 - Clockwise rotation (normal) - method a

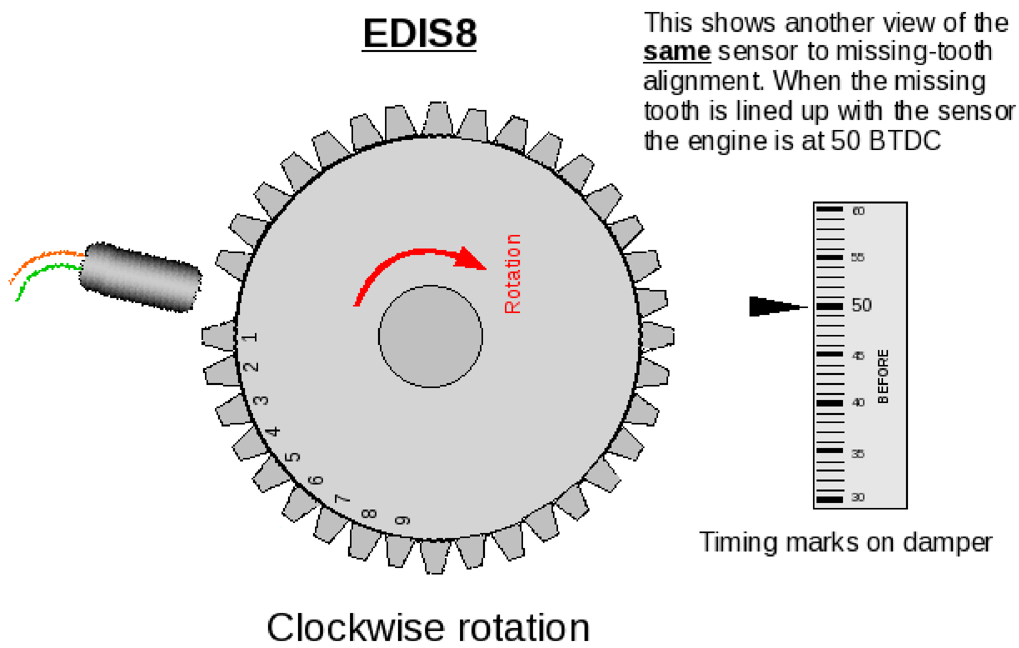
Set your engine at TDC, then put the missing tooth 5 teeth earlier (more clockwise) than the sensor. This will put the centre of a tooth central to the sensor.



Clockwise rotation

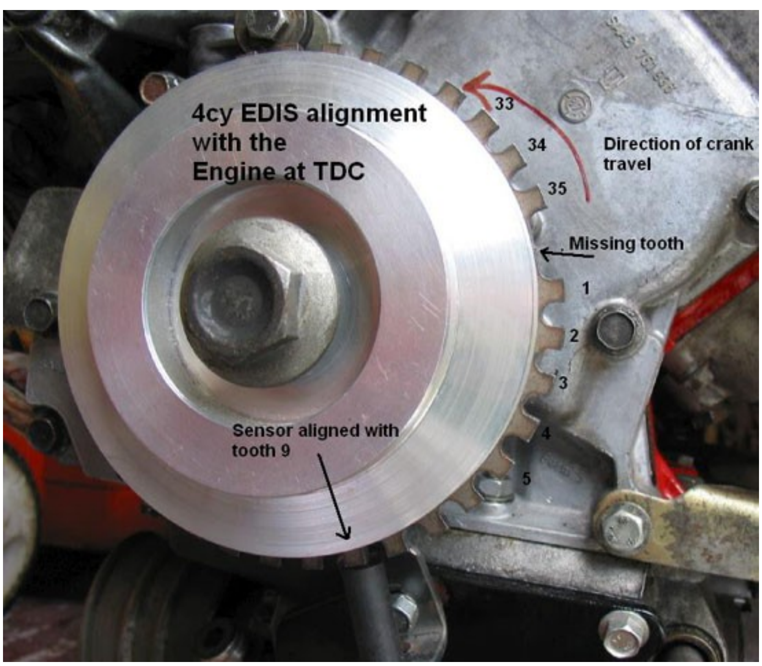
6.7.4.6 EDIS8 - Clockwise rotation (normal) - method b

Turn your engine to 50 BTDC. Mount the VR sensor wherever is convenient and mount trigger disc so that the centre of the sensor aligns with the centre of the missing tooth.



6.7.4.7 EDIS4 anti-clockwise

Anti-clockwise rotation.
The same applies, but directions are reversed.



6.7.5 Checking the timing

As with all installs, it is important to confirm the timing is correct. To test this it is best to first run the EDIS in limp home mode. This can be achieved by disconnecting the SAW plug/socket or switching off/unplugging the ECU. Fit your strobe onto no.1 plug lead as normal (you may need to try the other tower of the pair).

A dumb strobe is advised, or use a strobe that is compatible with wasted-spark or 2-stroke.

Ensure EDIS still has power and crank your engine, check that the timing is exactly 10deg. If not, adjust your sensor until it is. It is safe to idle the engine with the SAW lead disconnected, timing should be rock solid at 10BTDC. Don't forget to reconnect the plug when done!

Now that you have confirmed that the EDIS is correctly running at 10BTDC base timing, you need to check that ECU is correctly commanding timing on the EDIS.
Start the engine and then on the Ignition settings menu on your tuning computer, select "Fixed Timing" and enter 15 BTDC, check that you strobe 15 BTDC on the crank.

When done, return the setting to "Use table" and Burn.

6.8 GM DIS (for reference only)

As far as the ECU is concerned, GMDIS works similarly to HEI7. Even though the module is controlling wasted spark ignition, the ECU does not receive any cylinder identification or phase information.

This wiring need confirming.

P = Positive from VR sensor

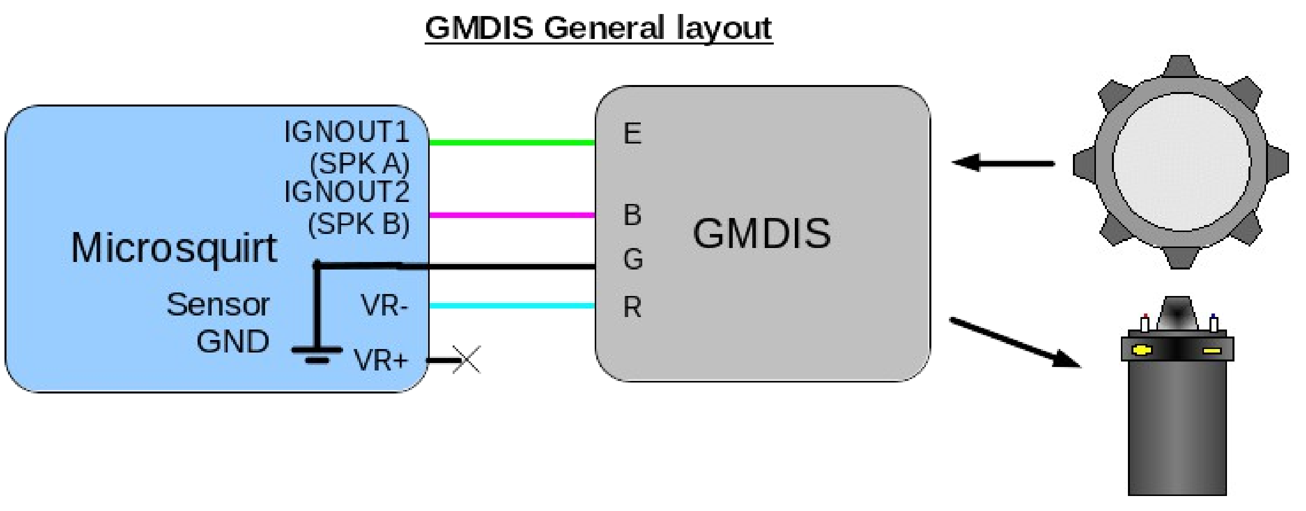
N = Negative from VR sensor

G = Ground to Microsquirt Sensor ground

B = Bypass from Microsquirt IGNOUT2

R = Reference (REF) to Microsquirt VR-

E = Electronic spark timing (EST) from Microsquirt IGNOUT1



These settings need confirming.

Ignition capture = "Falling" (check!)

Spark output = "Going High" (check!)

Spark A output pin = "IGN1"

Dwell type = "Standard Dwell"

Nominal Dwell = "3.0"

GM/HEI options = "GM bypass"

6.9 Toothed Wheel

The Toothed Wheel mode is designed to support most combinations of regular missing tooth wheels with or without a cam signal. It is the most commonly used "spark mode" for tach input.

Various spark outputs (single coil, wasted spark, coil-on-plug) are supported by Toothed Wheel, the table in section 6.9.1 shows possible options. See section 5.3 for ignitor, coil and wiring examples.

Other irregular OEM specific wheel patterns (e.g. 420A, 4G63, LS1) have their own spark modes which are covered in later sections.

6.9.1 Wheel combinations

The table below lists all of the valid combinations for trigger wheel. However some of the modes will rarely be used. The most common are:

36-1 on crank - many Fords

36-1 on crank plus single tooth cam sensor - same

60-2 on crank - many vehicles with Bosch ECU, BMW, VW, Audi, Volvo, Vauxhall, Opel, Peugeot etc.

60-2 on crank plus single tooth cam sensor - same

24 tooth on cam - many Japanese originated vehicles use the Nippondenso 24 tooth CAS with differing numbers of 2nd trigger teeth and sensors.

Note - this table is for four-stroke piston engines. Two stroke or rotaries only need 360 degrees of information for full sequential and COP.

Commonly used modes have detailed sections on how to set them up. Unusual modes are not documented in detail at this time.

Physical wheels		**Supports**							**Settings**		
Main wheel	**Secondary wheel**	**Single coil**	**Wasted spark**	**Wasted-COP**	**COP**	**Batch/ bank fire**	**Semi-seq**	**Seq.**	**Trigger wheel arrangement**	**Main wheel speed**	**2nd trig every rotation of**
Missing tooth on crank	None	Y	Y	Y	N	Y	Y	N	Single wheel with missing tooth	Crank	n/a
Missing tooth on cam	None	Y	Y	Y	Y	Y	Y	Y	Single wheel with missing tooth	Cam	n/a
Missing tooth on crank	Single tooth on cam	Y	Y	Y	Y	Y	Y	Y	Dual wheel with missing tooth	Crank	n/a
Missing tooth on crank	LS2 4X, VW 2 wide/narrow or half-moon on cam	Y	Y	Y	Y	Y	Y	Y	Dual wheel with missing tooth	Crank	n/a
Non-missing tooth on crank	Single tooth on crank	Y	Y	Y	N	Y	Y	N	Dual wheel	Crank	Crank
Non-missing tooth on crank	Single tooth on cam	Y	Y	Y	Y	Y	Y	Y	Dual wheel	Crank	Cam
Non-missing tooth on crank	Cam wheel with tooth per cylinder	Y	N	N	N	Y	N	N	Dual wheel	Crank	Every Cylinder

Non-missing tooth on cam	Single tooth on cam	Y	Y	Y	Y	Y	Y	Y	Dual wheel	Cam	Cam
Non-missing tooth on cam	Single tooth on crank or two opposite teeth on cam	Y	Y	Y	N	Y	Y	N	Dual wheel	Cam	Crank
Non-missing tooth on cam	Cam wheel with tooth per cylinder	Y	N	N	N	Y	N	N	Dual wheel	Cam	Every Cylinder

For initial setup and determining tooth#1 angle on uncommon setups having timing marks or tape on your crank pulley/damper covering the full 360 degrees will be greatly helpful. Speed shops sell timing tape for a variety of damper diameters. If your engine has no timing marks you do need to add them. Just guessing at timing is a great way to damage an engine.

It is essential that ignition timing is confirmed with a timing-light on EVERY install.

Running excessive timing under load will almost always cause severe engine damage. Ignore this warning at your peril !

6.9.2 Terminology notes

Missing tooth - This is a regular wheel with a group of "missing" teeth e.g. 12-1, 36-1, 36-2, 60-2

on crank - the wheel is rotating at crank speed, normally directly attached to the crank pulley or flywheel

on cam - the wheel is rotating at camshaft or distributor speed

Single coil - a single coil and distributor

Wasted spark - double ended coils (or a pair of coils) that fire twice per cycle

Wasted-COP - a single coil per cylinder, but firing twice per cycle

COP - a single coil per cylinder that fires once per cycle

Batch/bank fire - groups of injector fired at once, not timed to a specific cylinder event

Semi-sequential - injectors fired twice per cycle timed to cylinder events

Sequential - each injector fires once per engine cycle timed to a specific cylinder event

6.9.3 Wheel naming

There does not appear to be universal agreement on the way to name wheels, however in the Megasquirt world, they will be named like the following examples.

36-1. This means a single wheel with place for 36 teeth and a single tooth omitted. i.e. 35 teeth at 10 (360/36) degree spacing.

36-2. This means a single wheel with place for 36 teeth and a two adjacent tooth omitted. i.e. 34 teeth at 10 (360/36) degree spacing.

36-1-1. This means a single wheel with place for 36 teeth and a two non-adjacent single tooth omitted. This type of wheel is not supported by "toothed wheel" - it is supported as Rover#1

36-2-2-2. This means a single wheel with place for 36 teeth and a three sets of double missing teeth. This type of wheel is not supported by "toothed wheel" - it is supported as 36-2-2-2 with the specific OEM pattern built into the decoder.

24/1. This means 24 teeth (non-missing) on one wheel and a single tooth on a second wheel.

36-1/1. This means a one 36-1 wheel and a single tooth on a second wheel.

3+1. This means one wheel with 3 equally spaced teeth and an additional tooth to indicate sync. (Supported somewhat as Daihatsu 3cyl)

Spark Mode - set to "Toothed Wheel"

Trigger Angle/Offset - always zero

Angle between main and return - n/a

Oddfire small angle - for oddfire engines this specifies the smallest of the crank angles between ignition events

GM HEI/DIS options - n/a

420A/NGC alternate cam - n/a

Use cam signal if available - n/a

Oddfire phasing - usually "Alternate" but for Vmax use "Paired"

Skip pulses - number of input pulses at startup that are ignored before decoding begins. Safe to leave at 3.

Ignition Input Capture - see ignition page

Spark output - see ignition page

Number of coils - see ignition page

Spark hardware in use - see ignition page

Cam input - see ignition page

Trigger wheel arrangement - see table above for correct settings

Trigger wheel 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 - the number of missing teeth. Common are 1 for 36-1, or 2 for 60-2 or 36-2

Tooth #1 angle - definition depends on whether main wheel is missing or non-missing type. See sections below.

Main wheel speed - Does the main wheel rotate at crankshaft speed or camshaft (distributor) speed.

Second trigger active on - Like ignition input capture above, specifies which voltage level is considered "active"

Level for phase 1 - only applies in "Poll level" mode. See Dual+Missing section.

and every rotation of - how often are second trigger input pulses received. See Dual Wheel section

All of the settings on the right hand side of the page are general and will be covered in the Ignition manual.

There are two main categories of install - Retrofit and Existing.

6.9.4 Retrofit install

If you have an engine that did not originally come equipped with a trigger wheel (e.g. a distributor based, pre-EFI engine) then you have to mount a wheel and sensor and set the phasing correctly.

Suggestion for a typical car engine

Install a 36-1 wheel on the crank for accurate wasted spark ignition and batch-fire fuel.

For installs requiring COP or sequential fuel, install a 36-1 wheel on the crank and a 50/50 cam tooth with gear-tooth hall sensor.

60-2 works great on most engines too, but is not advised for very high rpms.

For very high revving engines (such as motorcycle engines) due to the number of teeth per second, 36-1, 24-1 or 12-1 are preferred.

While the code can cope with any sensor/tooth phasing, during cranking the rpms vary up and down greatly as the engine rotates. It is desirable to place the missing tooth such that it passes the sensor when the engine speed is somewhat stable or it may be impossible for the ECU to "see" the missing tooth. The OEMs have found that certain tooth#1 angles work well and it is worth following their lead.

It is **suggested** to align your wheel and sensor to arrive at the following tooth #1 angles.

4 cylinders ~90-120 deg

6 cylinders ~50 deg

8 cylinders ~40 deg

Take a look at Appendix B pages for places to source used trigger wheels, sensors and coilpacks. Note that you do NOT need the EDIS module, so later ('internal-EDIS') cars are useful donors too.

Mounting the wheel is quite critical in that it MUST be mounted so it rotates without moving up, down, left or right as the sensor needs to see all of the teeth with a gap of 0.75 - 1.0mm.

The tooth size needs to be matched to the sensor. Make sure that the sensor is designed to operate with the tooth size on your wheel. If using an OEM part, then stick to the sizes that they used.

Very long single teeth, as used on some bike flywheels are not readily supported - consider retrofitting a toothed wheel instead.

Having mounted the wheel and sensor, you can proceed for an existing install.

6.9.5 Existing install

In this cases where you are fitting Megasquirt to an engine already fitted with a trigger wheel, your main task is to wire up the sensor(s), determine the tooth #1 angle and wire up your coil(s). It should not normally be necessary to modify the trigger wheels.

6.9.6 Missing tooth crank wheel

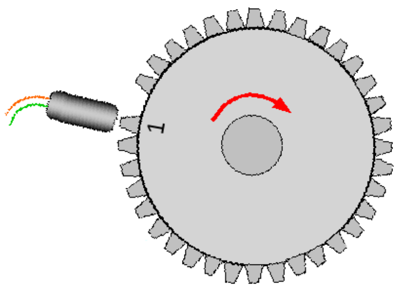
This is a very common configuration for wasted spark with the most typical wheels being 36-1 (Ford) and 60-2 (Bosch.) Note that the missing teeth are in a single group - if your wheel has multiple groups then you need a special wheel decoder. Many custom decoders already exist e.g. 36-2-2-2 and the one matching your wheel must be used instead of this generic "toothed wheel" mode.

The software benefits from a reasonable number of teeth (hence 36 or 60) for best ignition timing accuracy. Low tooth count wheels such as 4-1 are not advised.

What is Tooth #1

With the engine rotating in the normal direction...

Tooth #1 is the first tooth to pass the sensor after the missing tooth gap.

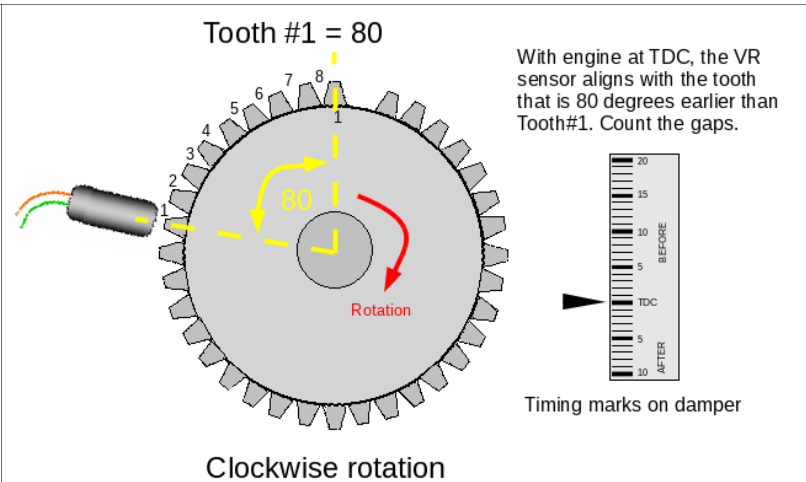


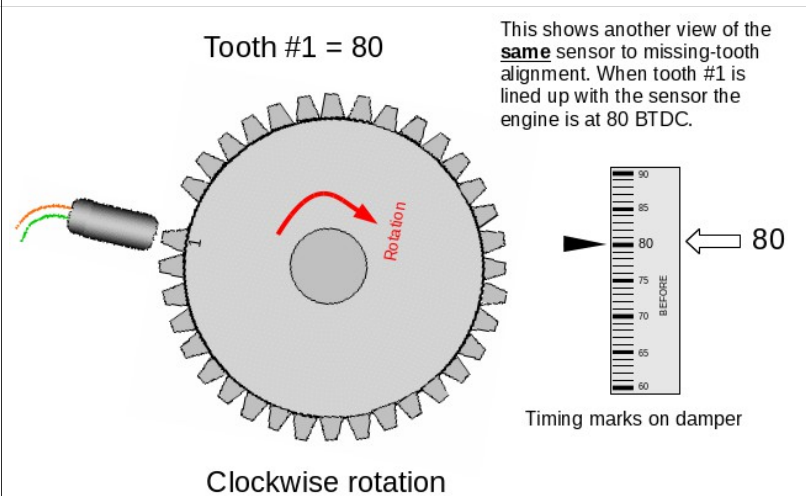
We use the term "tooth#1" as it is consistent across wheels with one, two, three or four missing teeth in the group.

Once the software knows the tooth#1 angle it automatically calculates other needed information internally.

The following table shows examples, in this case the tooth#1 angle happens to be 80 degrees.

<table>
<tr>
<td>Clockwise rotation (normal) - method a
Set your engine at TDC, then count the number of GAPS to tooth#1 in the direction of rotation (clockwise here) and multiply by the angular size of the tooth.
e.g. 8 teeth * 10 deg/tooth = 80 deg

36-1 wheels are 10 deg per tooth
60-2 wheels are 6 deg per tooth
24-2 wheels are 15 deg per tooth</td>
<td>
</td>
</tr>
<tr>
<td>Clockwise rotation (normal) - method b
A different way of looking at the SAME phasing.
Turn your engine so that tooth #1 aligns with the sensor.

Read off the tooth#1 angle from timing marks/tape on the crank pulley.</td>
<td>
</td>
</tr>
</table>

Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Single wheel with missing tooth

Trigger wheel teeth = number of teeth including missing teeth (e.g. 36, 60 etc.)

Missing teeth = number of missing teeth (e.g. 1, 2)

Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Crank wheel

Common combinations:

Ford 4 cyl = 36-1, 80deg tooth #1

Ford 6 cyl = 36-1, 50deg tooth #1

Ford 8 cyl = 36-1, 40deg tooth #1

Bosch 4 cyl (Peugeot, Vauxhall) = 60-2, 114 deg tooth #1

6.9.7 Missing tooth cam wheel

This arrangement is not commonly used by OEMs but does support full sequential with a single wheel and sensor. Cam triggering is less accurate than crank triggering due to timing belt or chain stretch.

The software benefits from a reasonable number of teeth (hence 36 or 60) for best ignition timing accuracy. Low tooth count wheels such as 8-1 are not advised.

The previous section on missing tooth crank wheel generally applies when the wheel is mounted to the cam, but remember that one rotation of the cam is 720 crank degrees. The settings are in crank degrees. So a tooth#1 that is 8 gaps earlier than the sensor on a 36-1 wheel would give a 160deg tooth#1 angle (8 * 10 * 2 [for cam])

Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Single wheel with missing tooth

Trigger wheel teeth = number of teeth including missing teeth (e.g. 36, 60 etc.)

Missing teeth = number of missing teeth (e.g. 1, 2)

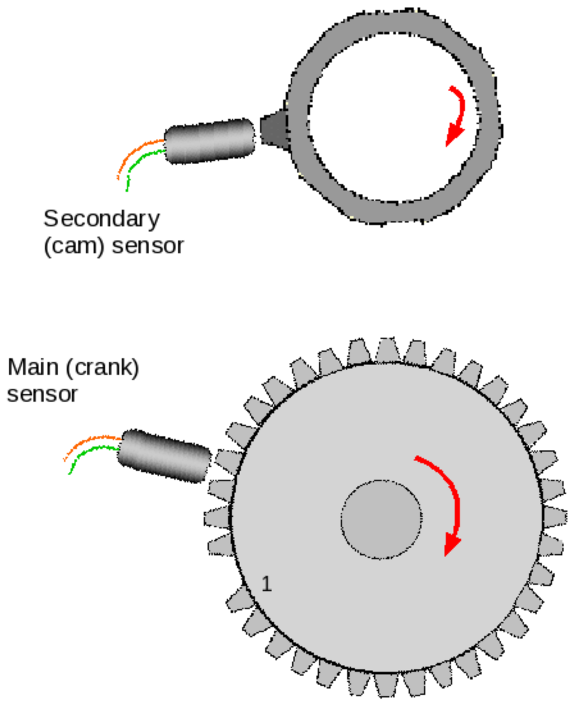
Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Cam wheel

6.9.8 Missing tooth crank wheel and single tooth cam wheel

This is a very common arrangement that supports full sequential and coil on plug.

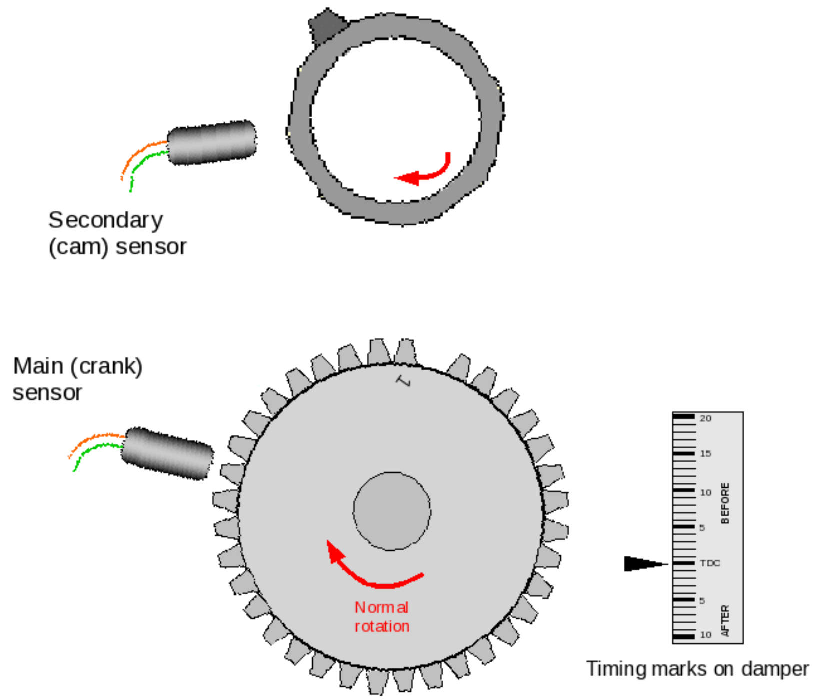
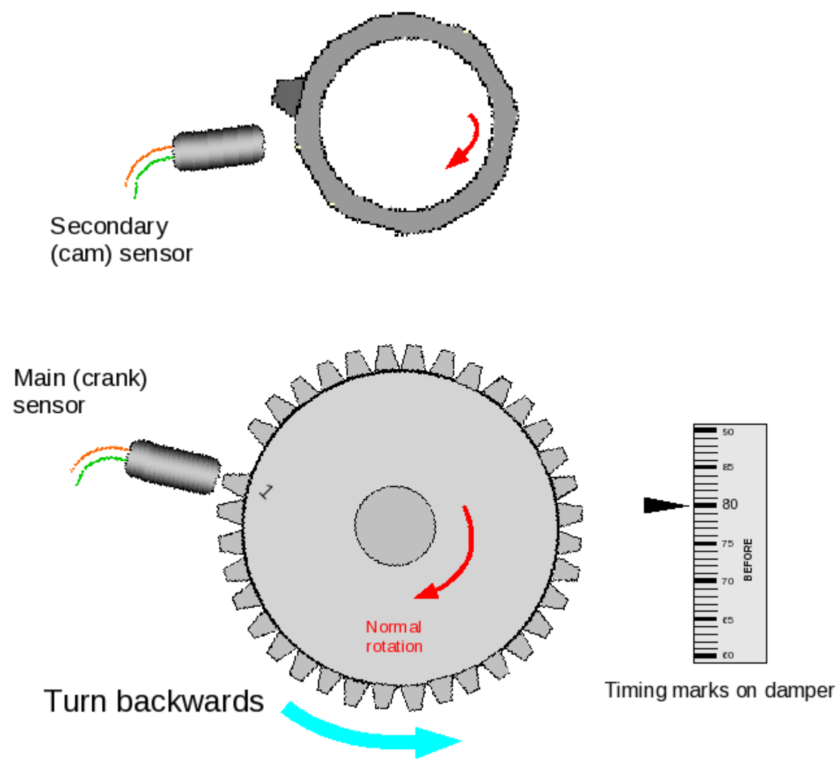
(For 50/50 half-moon or 4-window wide/narrow or other polled cam wheels see section 6.9.9)

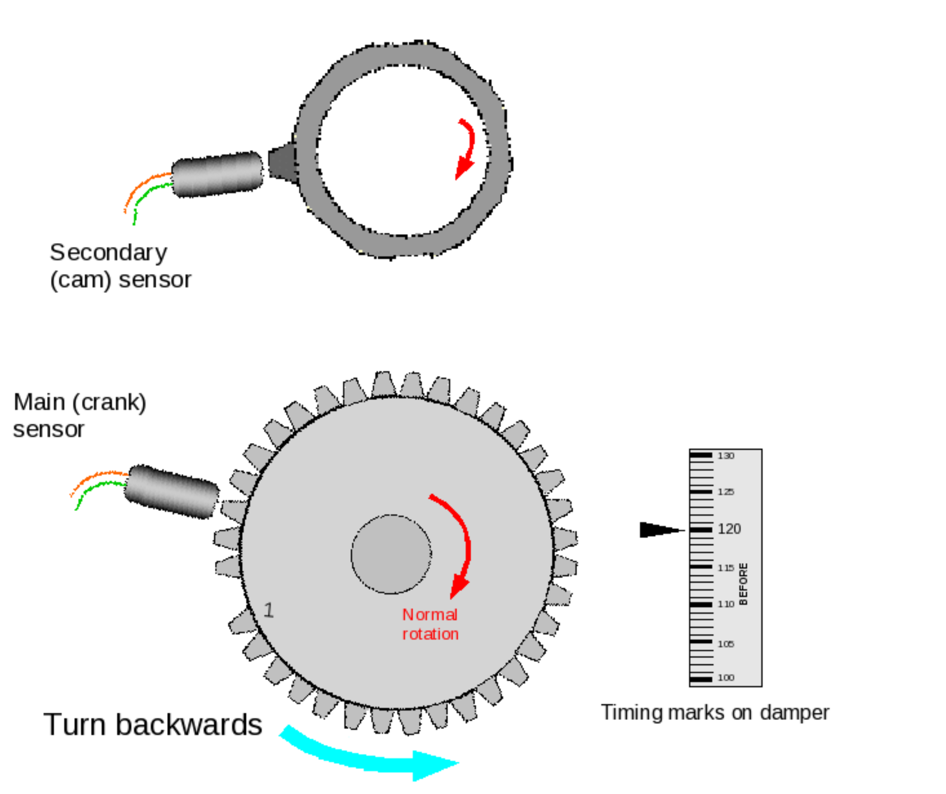


The definition of tooth#1 is the same as the basic missing tooth crank wheel and should be phased in the same way. Ensure you also read the section above. The cam input tells the code which engine cycle/phase it is on. From the crank wheel alone the code knows when cylinder one is at TDC, but it cannot distinguish TDC compression or TDC exhaust. The cam sensor adds this information which is why it needs to be one pulse only per engine cycle.

The cam signal is a single pulse usually generated by a narrow tooth, vane or window. During setup, you will need to use the composite logger in TunerStudio to verify the phasing between the crank and cam signals is acceptable.

To confirm correct cam sensor phasing proceed as follows. (Note that some engines should not be rotated backwards, use tape or pen marks on the pulleys or sprockets to remember positions and rotate forwards only.)

First, set your engine at TDC compression #1	
Now rotate the engine backwards to tooth#1 The angle read off the damper is the tooth#1 angle	

Now rotate the engine backwards some more - this is the best place for the cam tooth to pass the sensor.	

Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Dual wheel with missing tooth

Trigger wheel teeth = number of teeth including missing teeth (e.g. 36, 60 etc.)

Missing teeth = number of missing teeth (e.g. 1, 2)

Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Crank wheel

Second trigger active on = Rising edge (confirm with composite logger)

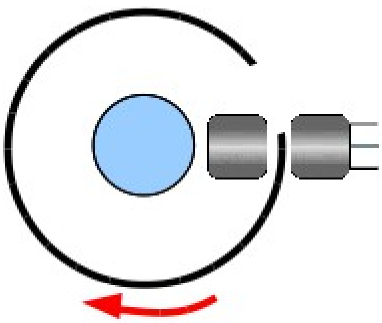
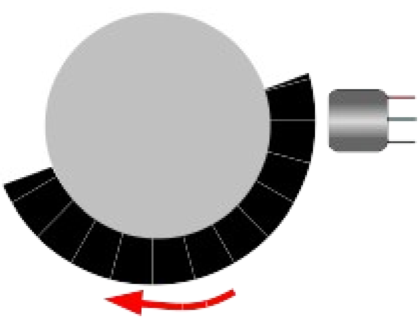
6.9.9 Missing tooth crank wheel and polled cam wheel

This is a fairly common arrangement that supports full sequential and coil on plug. Here a missing tooth wheel is used on the crank in the common way and a hall-effect or gear-tooth sensor is used on the cam with a long tooth or window or vane. This gives you the ability to have full sequential, but the engine syncs up as fast as a regular missing tooth crank wheel.

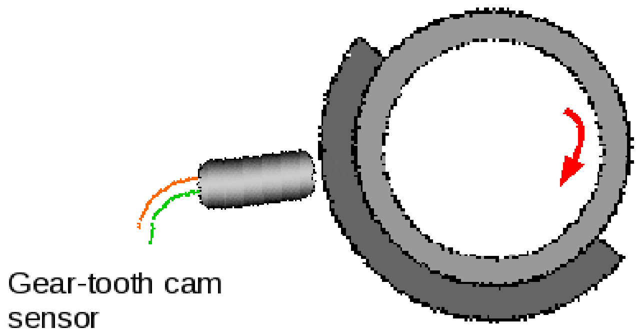
Different OEM implementations exist - some engines use a 50/50 cam pattern, Vauxhall red-top engines use a window in the distributor rotor that spans the missing tooth region. Many newer engines with Bosch ECUs utilise a 4 tooth wide/narrow cam trigger, this is used on some VW, GM LS2, LS4 and some Mercedes. As far as the code is concerned these are equivalent because it only 'looks at' (polls) the cam just after the missing tooth to determine engine phase.

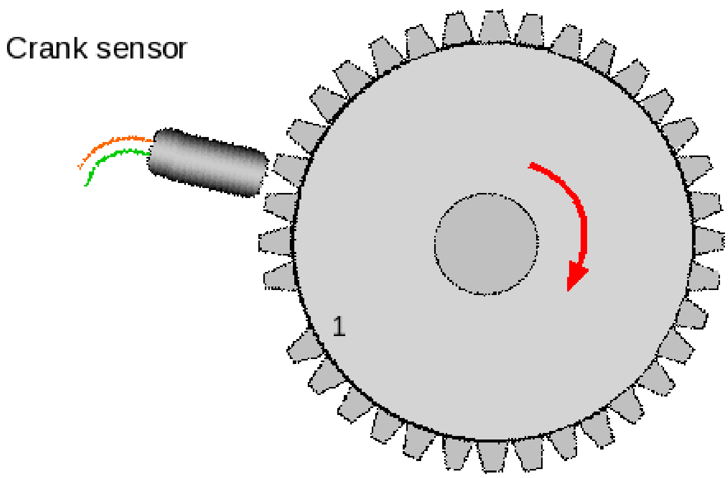
The wide/narrow type is used for VVT control on some engines, this is not supported with Megasquirt-2.

Typical polled cam triggers:

 	4 tooth wide/narrow type e.g. GM LS2 4X / VW / Mercedes
	Vane cup with single window e.g. 1 window Bosch dizzy in Vauxhall red-top.
	Half-moon type

General arrangement





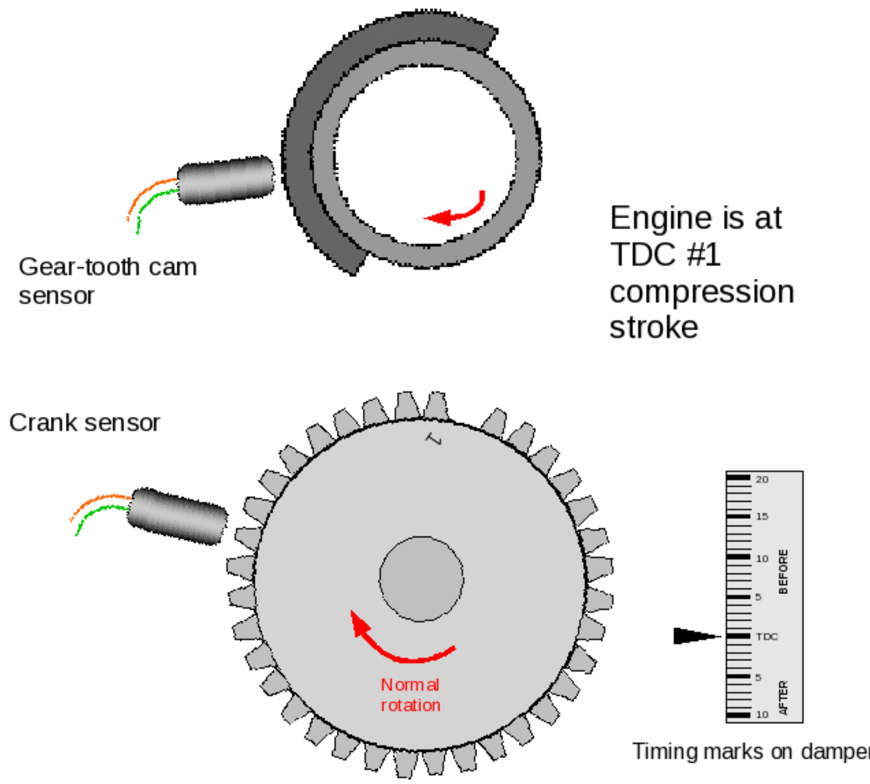
The definition of tooth#1 is the same as the basic missing tooth crank wheel and should be phased in the same way. The cam input tells the code which engine cycle/phase it is on. From the crank wheel alone the code knows when cylinder one is at TDC, but it cannot distinguish TDC compression or TDC exhaust. The cam sensor adds this information.

At close to tooth#1 the code examines the voltage level on the input to determine which phase it is on - the 'tooth' should be normally start at least 20 crank degrees before tooth#1 and continue for another 20 crank degrees afterwards. (The level is actually polled at tooth#2.)

The additional teeth on the long/short cam wheel do not matter.

To confirm correct cam sensor phasing proceed as follows.

First, set your engine at TDC compression #1

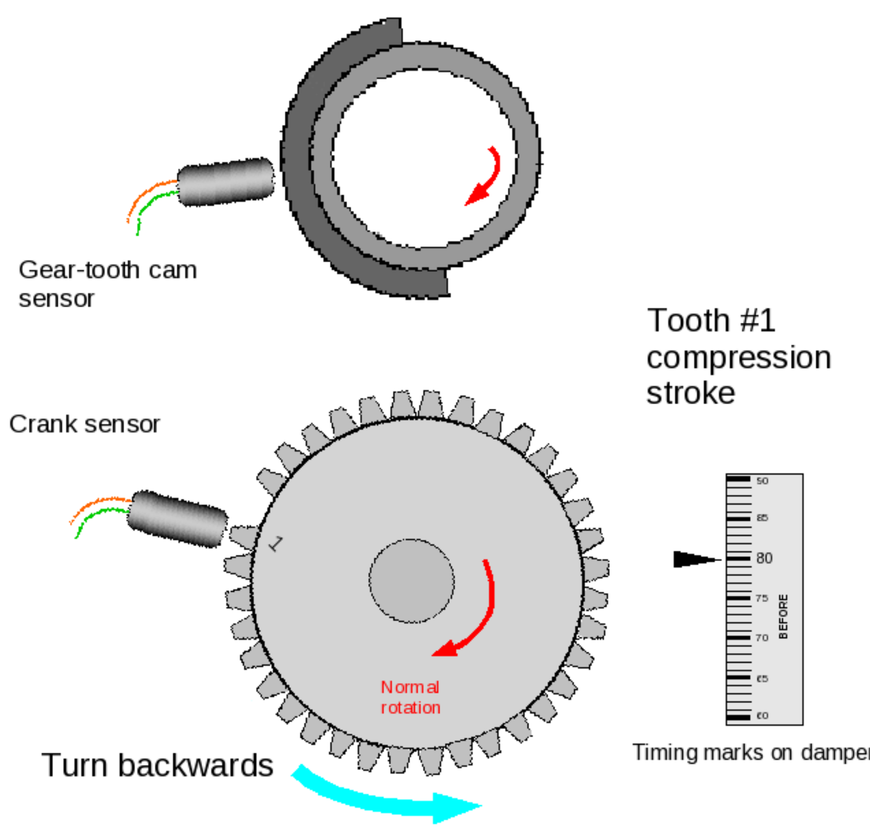


Now rotate the engine backwards to tooth#1

The cam sensor should be roughly in the middle of window/tooth/vane

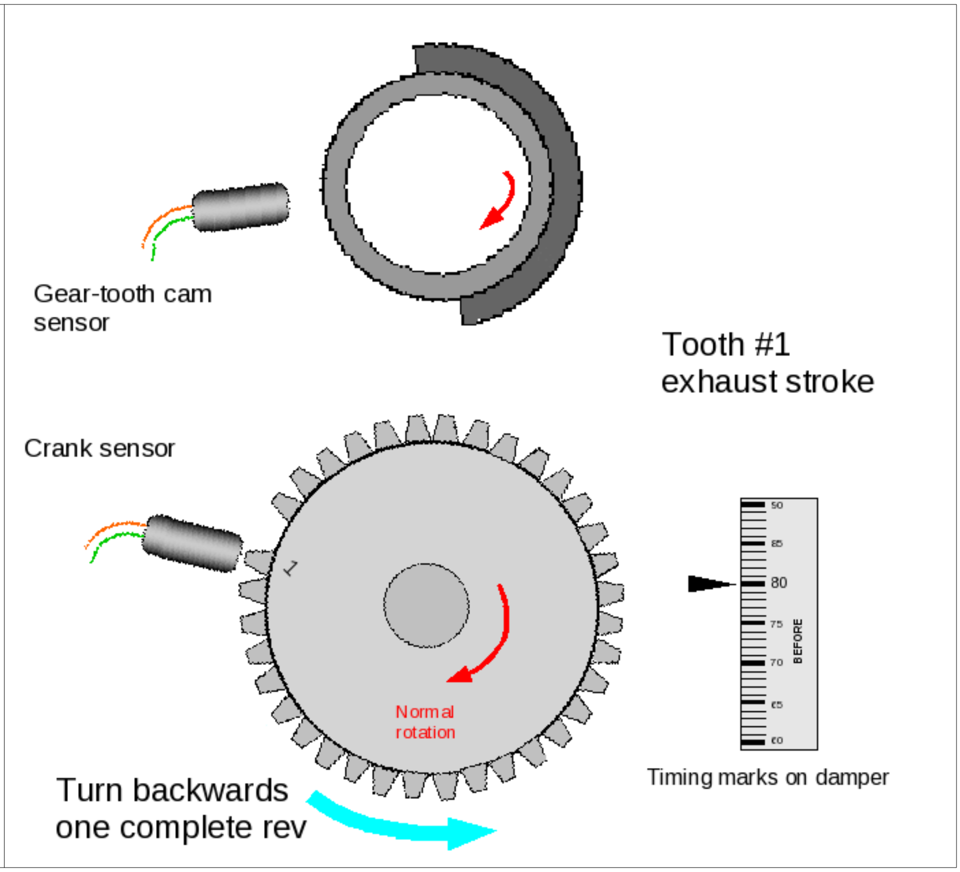
With the cam sensor powered and connected to the Microsquirt measure the output voltage.

A voltage of ~0V here requires the HIGH setting and a voltage of ~5V here requires the LOW setting.
???? Check ????



Now rotate the engine backwards a full revolution.

The cam sensor will be opposite that previous window/tooth/vane. (If there was a window before it must be a vane now and vice-versa.)



Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Dual wheel with missing tooth

Trigger wheel teeth = number of teeth including missing teeth (e.g. 36, 60 etc.)

Missing teeth = number of missing teeth (e.g. 1, 2)

Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Crank wheel

Second trigger active on = Poll level

Level for phase one = as determined above

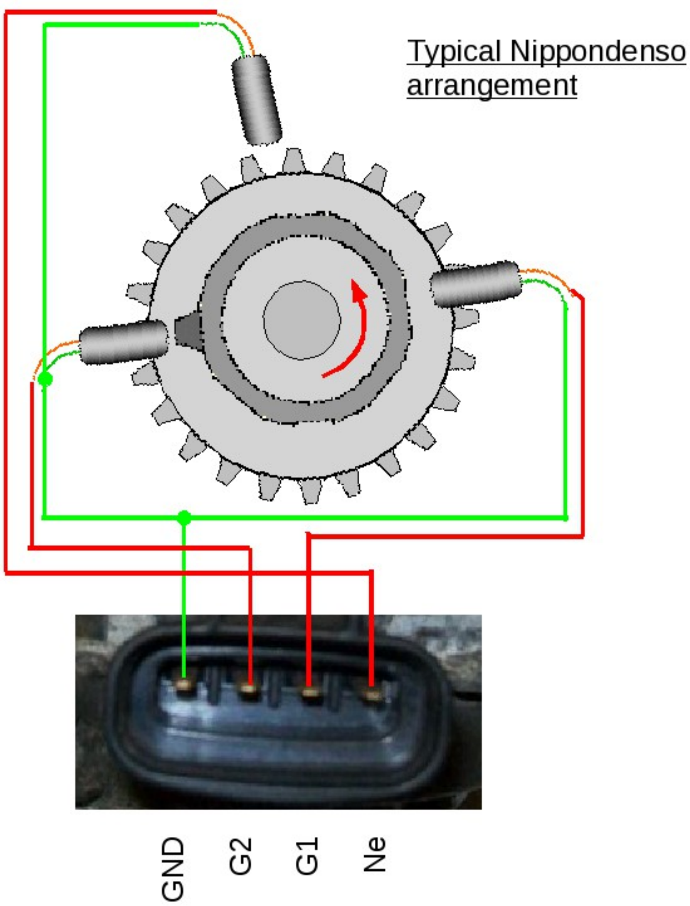
6.9.10 Nippondenso CAS

The Nippondenso CAS (crank angle sensor) comes in a number of versions which all use a 24 tooth main wheel and a second wheel with one, two, three or four teeth. There is a single sensor (called Ne) pointing at the 24 tooth wheel and one (G1) or two (G1 and G2) sensors pointing at the second wheel.

This style of CAS is very common on Toyota and Mazda engine from the 1980s and 1990s.

The number of teeth on the second wheel determines whether it can be used (without modification) for single coil distributor, wasted spark or coil-on-plug (COP) and sequential.

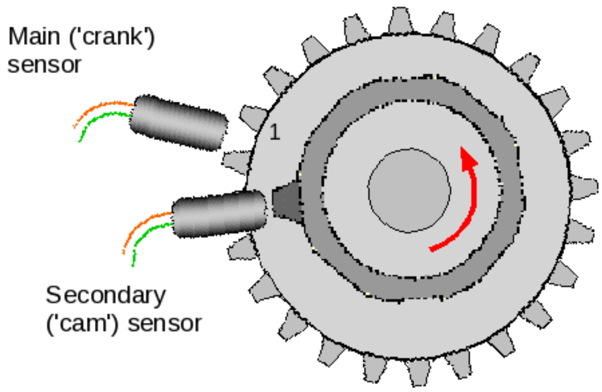
The version with a single tooth and two pickup sensors is intended for sequential. The two sensors are used by the OEM to allow the engine to synchronise within one engine revolution. Presently we only support using one of the 'G' sensors.


Typical Nippondenso arrangement
GND
G2
G1
Ne

CAS connection	Microsquirt connection
NE- / GND	VR1+ and VR2+
Ne	VR1-
G1 or G2	VR2-
Other G	not used

6.9.11 NipponDenso CAS with single G tooth

With the single tooth every 720 degrees this setup gives enough engine information for full sequential fuel and spark.

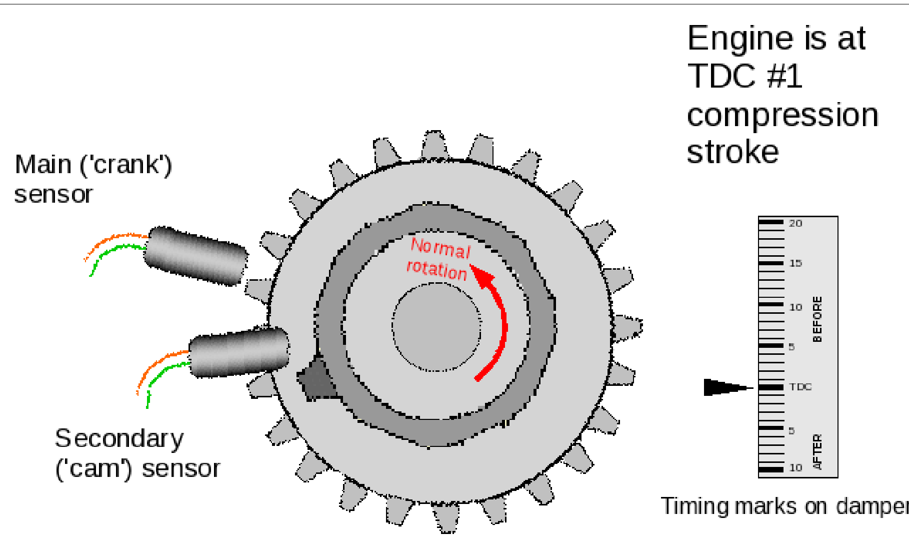


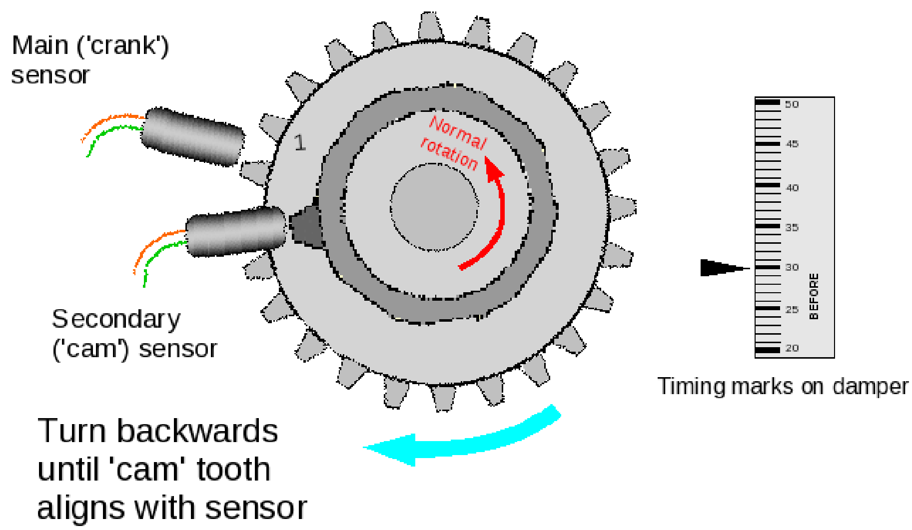
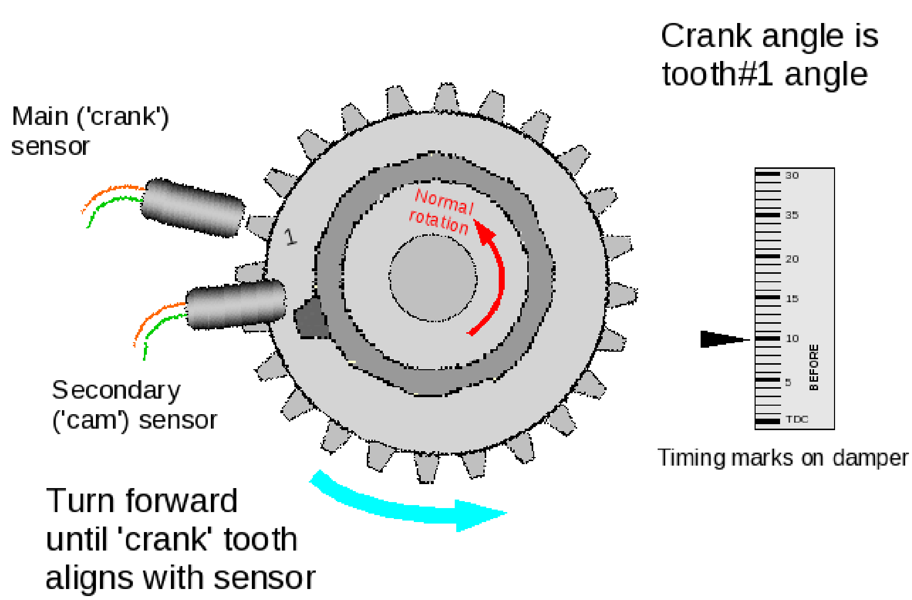
What is Tooth #1

With the engine rotating in the normal direction...

Tooth #1 is the first tooth to pass the main sensor after the single tooth has passed the second sensor.

Make sure these do not happen at the same time - in the diagram you can see that the main sensor is over a gap when the secondary sensor is aligned with its tooth.

First, set your engine at TDC compression #1	

Now rotate the engine backwards until the 'cam' sensor and tooth line up. If you rotated more than one turn, then add 360 to your tooth#1 angle.	
Now rotate the engine forwards until the next 'crank' tooth aligns with its sensor. The crank angle now is the tooth#1 angle. (Note that angles shown in diagram are examples only)	

Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Dual wheel

Trigger wheel teeth = number of teeth

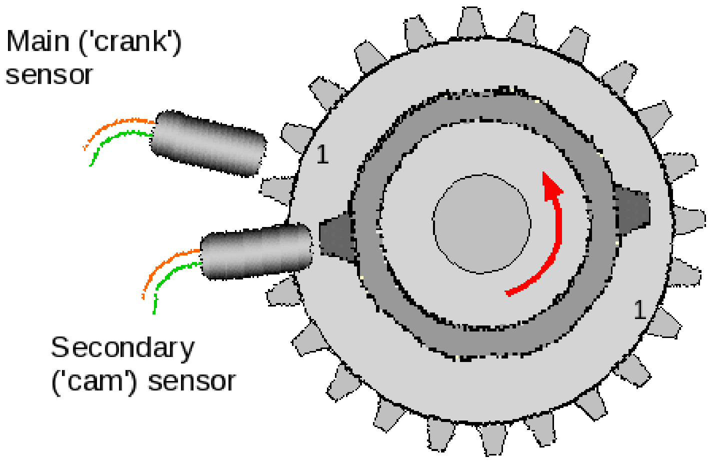
Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Cam wheel

Second trigger active on = Rising (verify with composite logger)

and every rotation of = Cam

6.9.12 NipponDenso CAS with two G teeth



With the cam tooth every 360 degrees this setup gives enough engine information for semi-sequential fuel and wasted spark. (On a rotary such as the RX7, or a two-stroke engine, full sequential fuel and spark is possible as the engine cycle spans 360 degrees.)

What is Tooth #1

With the engine rotating in the normal direction...

Tooth #1 is the first tooth to pass the main sensor after either cam tooth has passed the second sensor.

Make sure these do not happen at the same time - in the diagram you can see that the main sensor is over a gap when the secondary sensor is aligned with its tooth.

Use the instructions in the previous single cam tooth section to determine your tooth#1 angle. It will always be between 0 and 360 degrees.

Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Dual wheel

Trigger wheel teeth = number of teeth

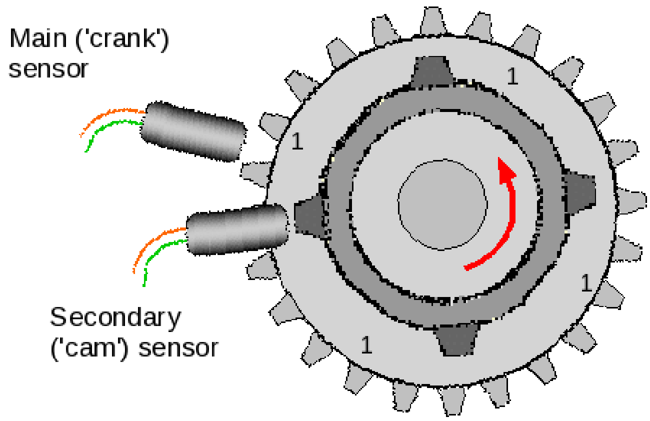
Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Cam wheel

Second trigger active on = Rising (verify with composite logger)

and every rotation of = Crank

6.9.13 NipponDenso CAS with three or four G teeth



This version is used on three and four cylinder engines with one G tooth per cylinder.

There is only enough position information to run a distributor and untimed injection.

It is not strictly necessary to use both Ne and G wheels. Using both will give you the improved timing accuracy from the 'every-tooth' wheel decoder system, but for simpler installs it is possible to use the 'G' input only and configure as "Basic Trigger" instead. Timing will not be as accurate though.

What is Tooth #1

With the engine rotating in the normal direction...

Tooth #1 is the first tooth to pass the main sensor after either cam tooth has passed the second sensor.

Make sure these do not happen at the same time - in the diagram you can see that the main sensor is over a gap when the secondary sensor is aligned with its tooth.

Use the instructions in the previous single cam tooth section to determine your tooth#1 angle. It will always be between 0 and 360 degrees.

Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Dual wheel

Trigger wheel teeth = number of teeth

Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Cam wheel

Second trigger active on = Rising (verify with composite logger)

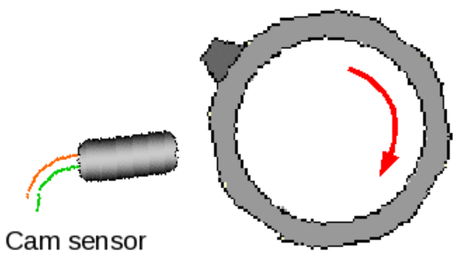
and every rotation of = Every cylinder

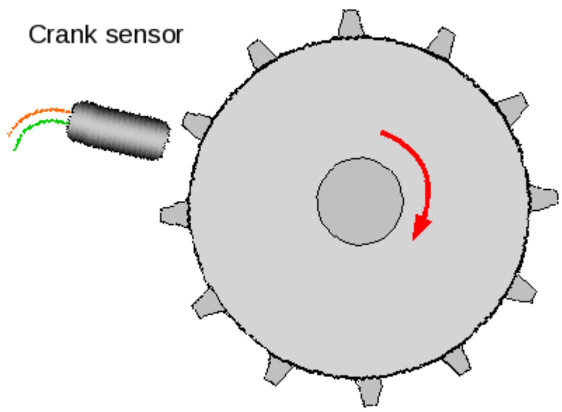
6.9.14 Non-missing tooth crank wheel with one cam tooth

This arrangement is not commonly used by OEMs but could be used to extend a simple 'distributor' crank trigger to support sequential. It can also be useful on bike engines with very uneven cranking RPMs that struggle to detect the gap in a missing tooth wheel.

Generally Microsquirt benefits from many crank teeth to improve ignition timing accuracy. However, with this wheel arrangement, you need to beware of trying to use too many teeth on the crank as there is a risk of the trigger inputs overlapping as the cam belt or chain stretches. If this overlap occurs, it will cause sync-loss as the cam tooth moves from being seen "before" to "after" a crank tooth or vice-versa.

12 crank teeth is the suggested maximum.





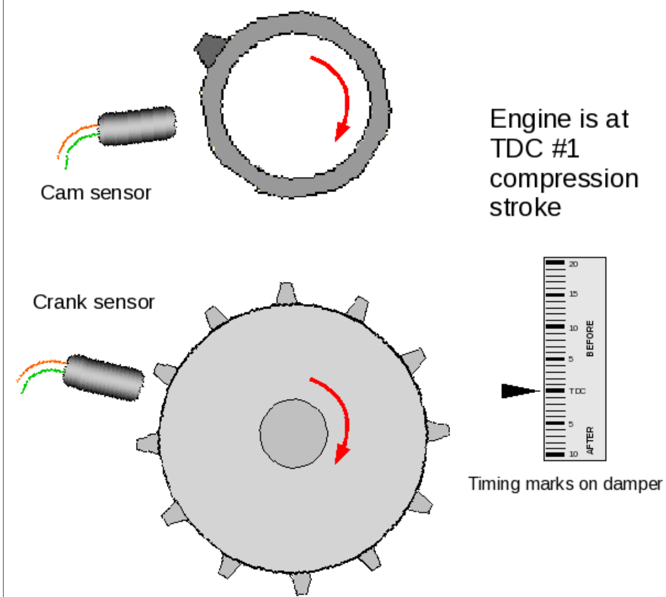
<u>What is Tooth #1</u>

With the engine rotating in the normal direction...

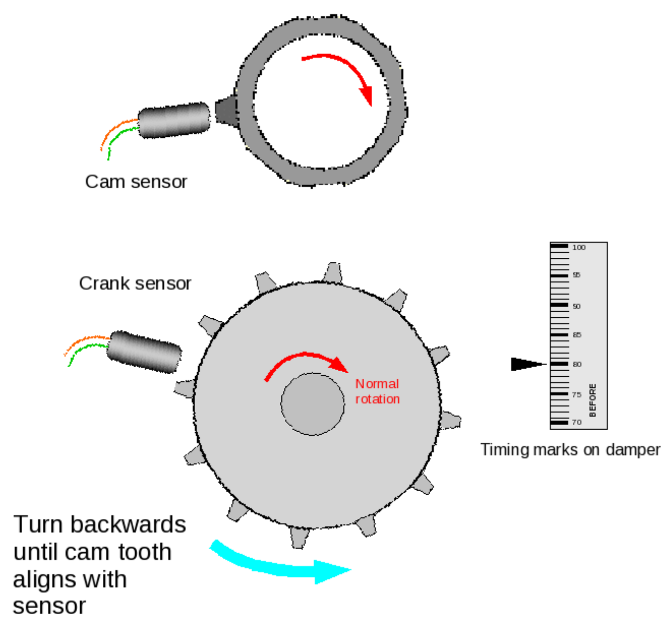
Tooth #1 is the first tooth to pass the main sensor after the cam tooth has passed the second sensor.

Make sure these do not happen at the same time - in the diagrams below you can see that the main sensor is over a gap when the secondary sensor is aligned with its tooth.

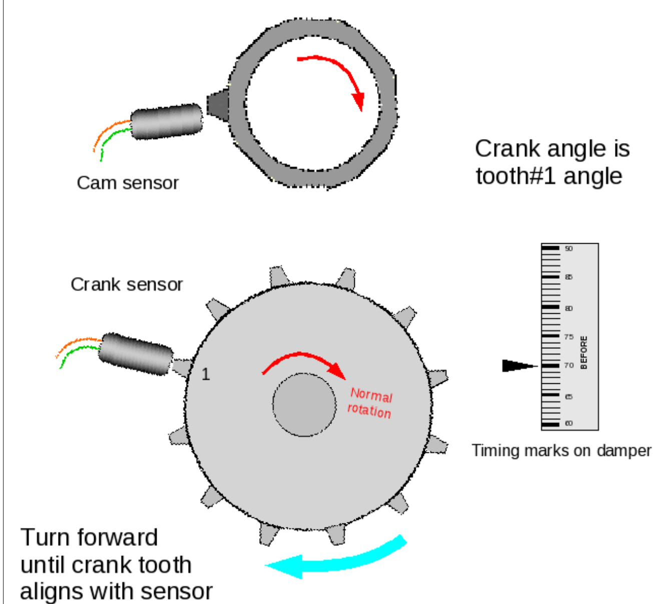
First, set your engine at TDC compression #1



Now rotate the engine backwards until the cam sensor and tooth line up.
If you rotated more than one turn, then add 360 to your tooth#1 angle.



Now rotate the engine forwards until the next crank tooth aligns with its sensor. The crank angle now is the tooth#1 angle. (Note that angles shown in diagram are examples only)



Typical settings:

Spark mode = Toothed wheel

Trigger angle/offset = 0 (not used in toothed wheel mode)

Trigger wheel arrangement = Dual wheel

Trigger wheel teeth = number of teeth

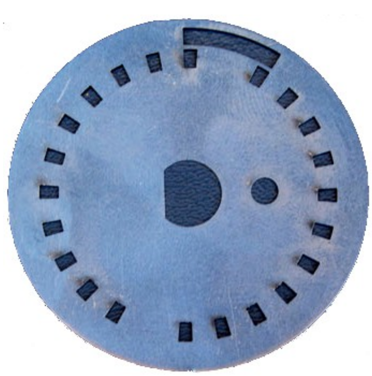
Tooth #1 angle = tooth #1 angle as determined above

Main wheel speed = Crank wheel

Second trigger active on = Rising (verify with composite logger)

and every rotation of = Cam

6.9.15 Mitsubishi CAS with aftermarket disc - single coil / wasted spark



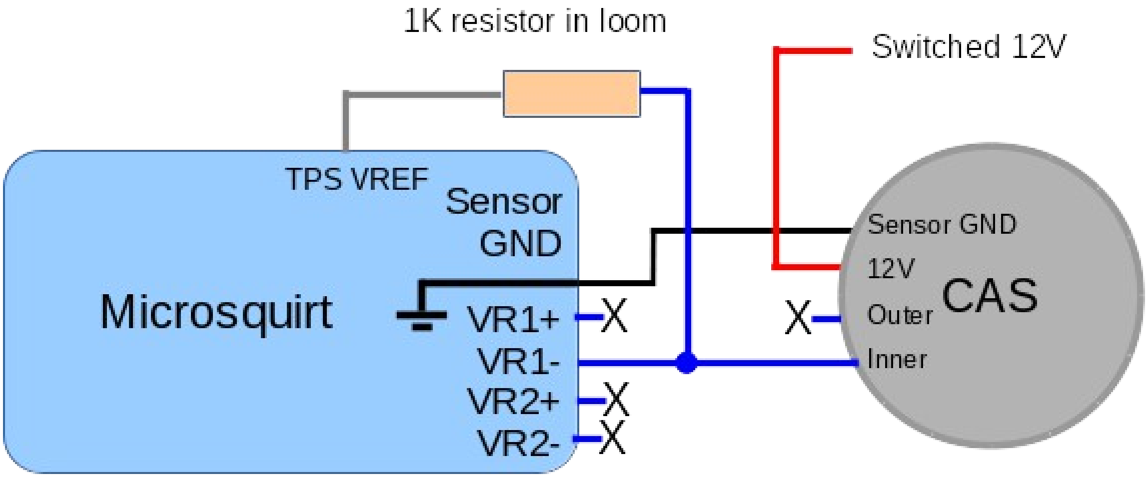
This replacement trigger disc is equivalent to a 12-1 wheel at crank speed with a single pulse on the cam.

The inner signal alone is good enough to run a single coil or distributor.

The addition of the outer single slot signal allows for coil-on-plug or sequential fuel.

Other variants exist.

For single-coil or wasted spark, only the inner track is required. A 1k pull-up resistor needs to be installed in the wiring harness.



Typical settings:

Spark mode = Toothed Wheel

Trigger Angle/Offset = 0 (not used)

Ignition input capture = ????

Spark Output = Depends on coils / ignitors

Number of coils = Wasted Spark

Trigger wheel arrangement = Single wheel with missing tooth

Trigger wheel teeth = 12

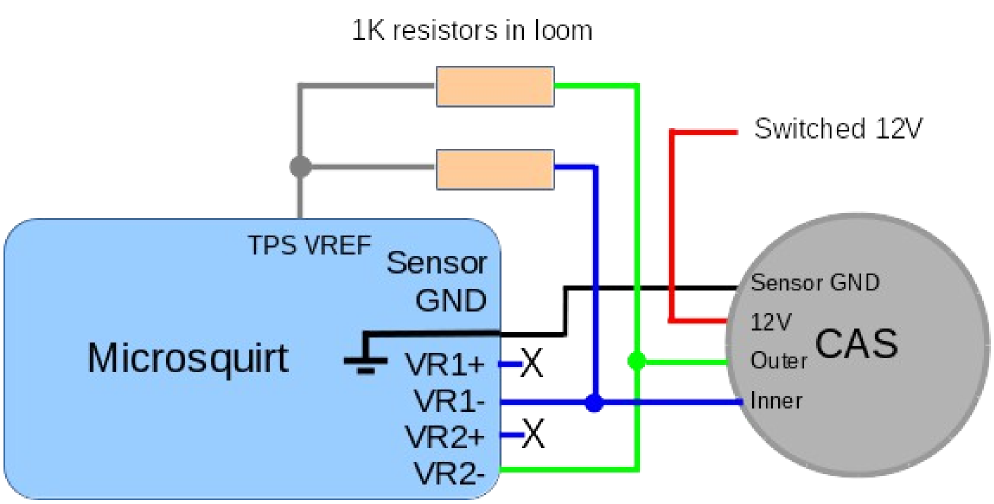
Missing teeth = 1

Tooth #1 angle = 345 (confirm with strobe)

Wheel speed = Crank wheel

6.9.16 Mitsubishi CAS with aftermarket disc - coil-on-plug

With the same replacement as shown in 6.9.10, both sensor outputs can be wired to allow coil-on-plug.



Typical settings:

Spark mode = Toothed Wheel

Trigger Angle/Offset = 0 (not used)

Ignition input capture = ????

Spark Output = Depends on coils / ignitors

Number of coils = Coil on plug

Trigger wheel arrangement = Dual wheel with missing tooth

Trigger wheel teeth = 12

Missing teeth = 1

Tooth #1 angle = 345 (confirm with strobe)

Wheel speed = Crank wheel

Second trigger active on = poll level

Level for phase 1 = ???

6.9.17 Other wheel arrangements

The examples shown here are not an exhaustive list of all the combinations that are possible, for other arrangements of crank and cam wheels you will need to apply the general principles to your install.

6.9.18 Example: Ford Zetec

The Ford Zetec is a popular four-cylinder four-stroke used on many Ford from the mid nineties onwards. As standard these engines use a 36-1 crank wheel and a VR sensor. A high-current coilpack is used and requires an ignitor.

Megasquirt-2 only needs the crank signal to run wasted-spark and batch fire fuel, this is the recommended configuration.

(Connecting and configuring the cam signal would allow coil-on-plug ignition with suitable coils.)

The following diagram shows the recommended wiring using a 2 channel ignition module to drive the standard Ford coilpack.

Alternative #1: substitute a 2 channel ignitor of your choice.

Alternative #2: use a logic wasted spark coil pack such as the VW item (032 905 106B) shown in section: 5.3.1 instead of the ignitor and stock coilpack.

Typical settings:

Spark mode = Toothed Wheel

Trigger Angle/Offset = 0 (not used)

Ignition input capture = Rising (confirm with tooth logger)

Spark Output = Going High

Number of coils = Wasted Spark

Trigger wheel arrangement = Single wheel with missing tooth

Trigger wheel teeth = 36

Missing teeth = 1

Tooth #1 angle = 90 (tweak with strobe)

Wheel speed = Crank wheel

6.10 Neon/420A

The "Neon/420A" mode supports the following vehicles when equipped with a 2.0 or 2.4 4-cylinder Chrysler engine. Also known as "1st gen Neon".

"NS" body models:

1996-2000 Chrysler Town and Country

1996-2000 Dodge Caravan/Grand Caravan

1996-2000 Plymouth Voyager/Grand Voyager

"JA" body models:

1995-02 Chrysler Cirrus

1995-02 Dodge Stratus

1996-2000 Plymouth Breeze

"JX" body models:

1996-02 Chrysler Sebring Convertible

"PL" body models:

1995-02 Dodge Neon

1995-2001 Plymouth Neon

"PT" body models:

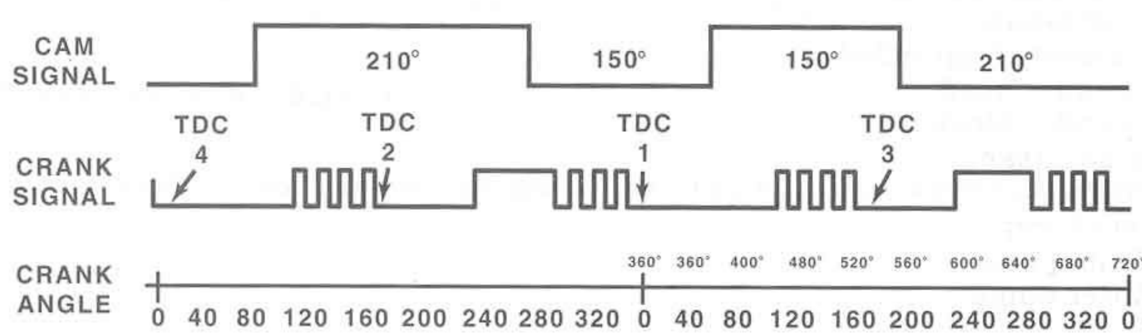
01-02 Chrysler PT Cruiser

"FJ" body models:

1995-02 Chrysler Sebring Coupe

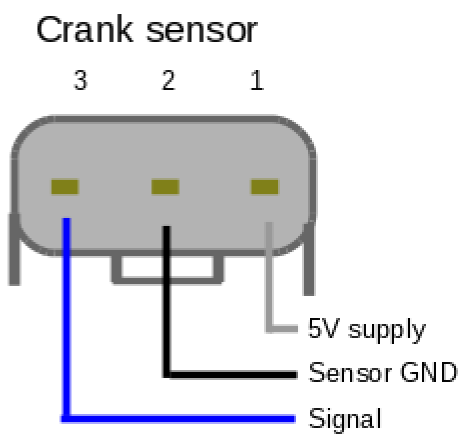
1995-2000 Dodge Avenger

The crank and cam signal pattern looks as follows:



Megasquirt-2 only needs the crank signal to run wasted-spark and batch fire fuel, this is the recommended configuration.

(Connecting and configuring the cam signal would allow coil-on-plug ignition with suitable coils.)



The following diagram shows the recommended wiring using a 2 channel ignition module to drive the standard 420A coilpack.

Alternative #1: substitute a 2 channel ignitor of your choice.

Alternative #2: use a logic wasted spark coil pack such as the VW item (032 905 106B) shown in section: 5.3.1 instead of the ignitor and stock coilpack.

Typical settings:

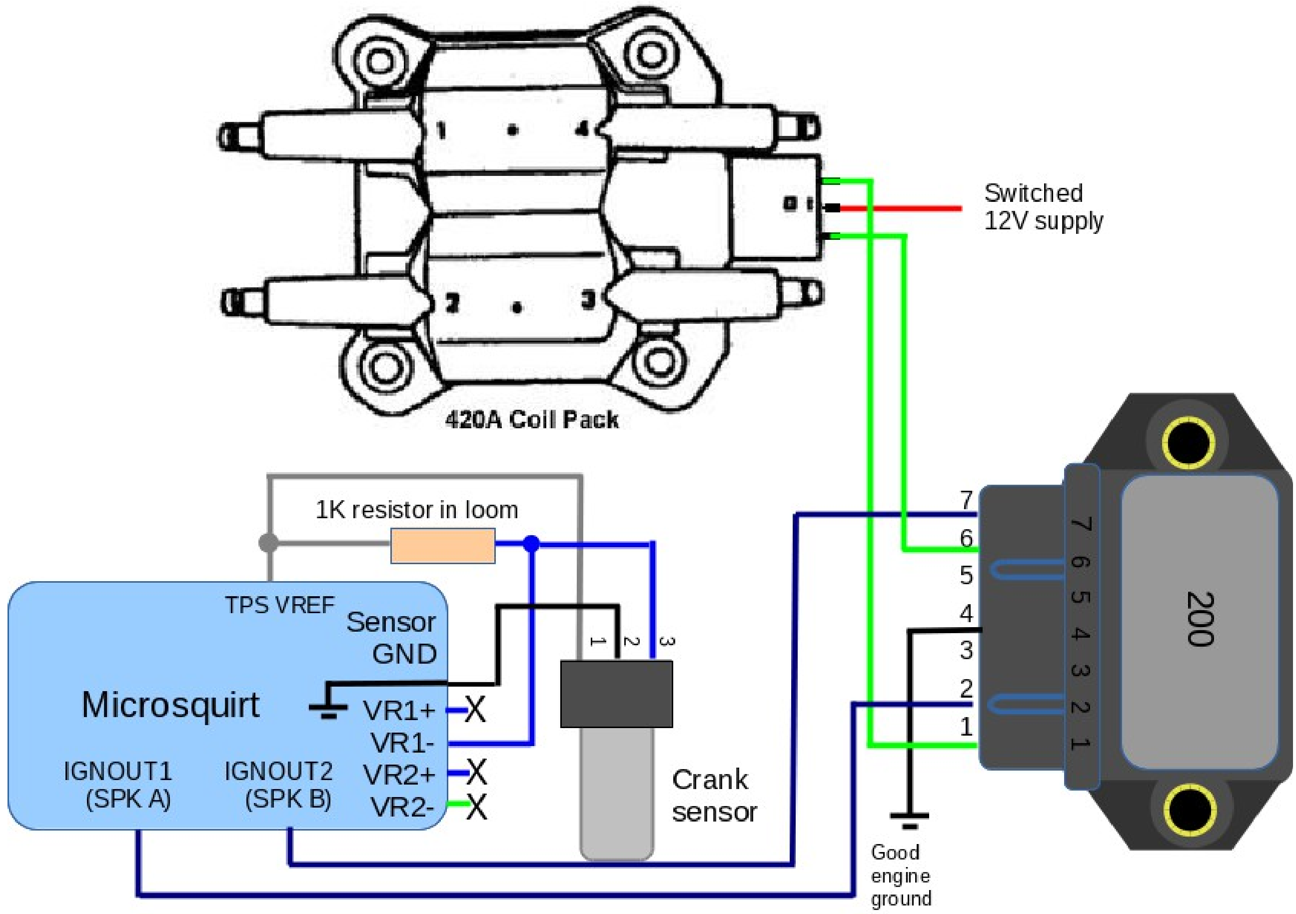
Spark mode = 420A

Trigger Angle/Offset = 0 (tweak if required)

Ignition input capture = Rising edge

Spark Output = Going High

Number of coils = Wasted Spark

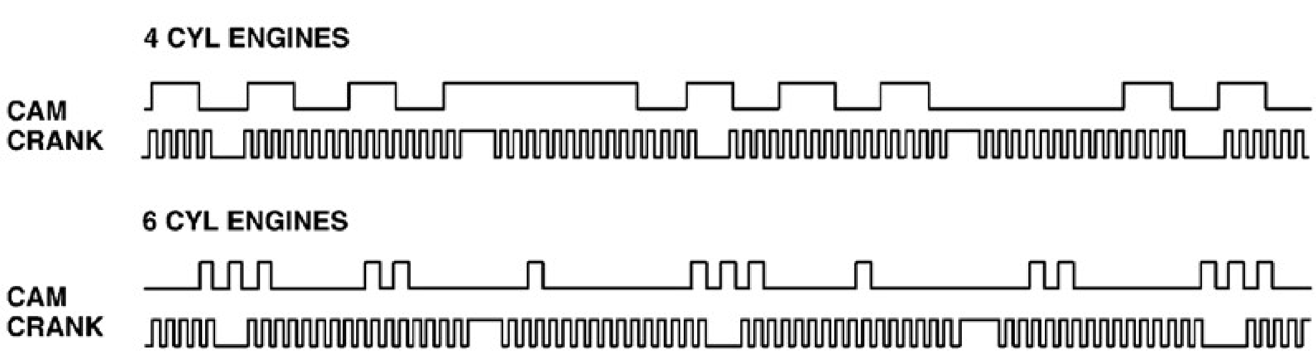


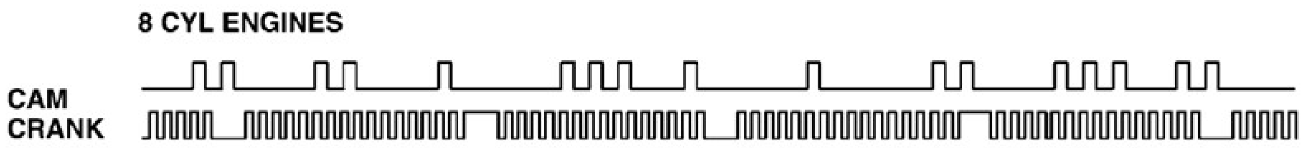
Injectors are wired up using the general diagram in section 4.9.2.1. Connect injectors 1 & 4 to bank 1 and injectors 2 & 3 to bank 2.

6.11 36-2+2 (NGC)

This ignition mode supports Chrysler's "next gen crank" pattern which was an attempt to consolidate the multitude of crank and cam patterns in use across Chrysler engines. It consists of 36 evenly space slots in a crank wheel, with a -1 (or -2) and +1 (or +2) pattern. The cam patterns vary across 4, 6, 8 cylinder variants.

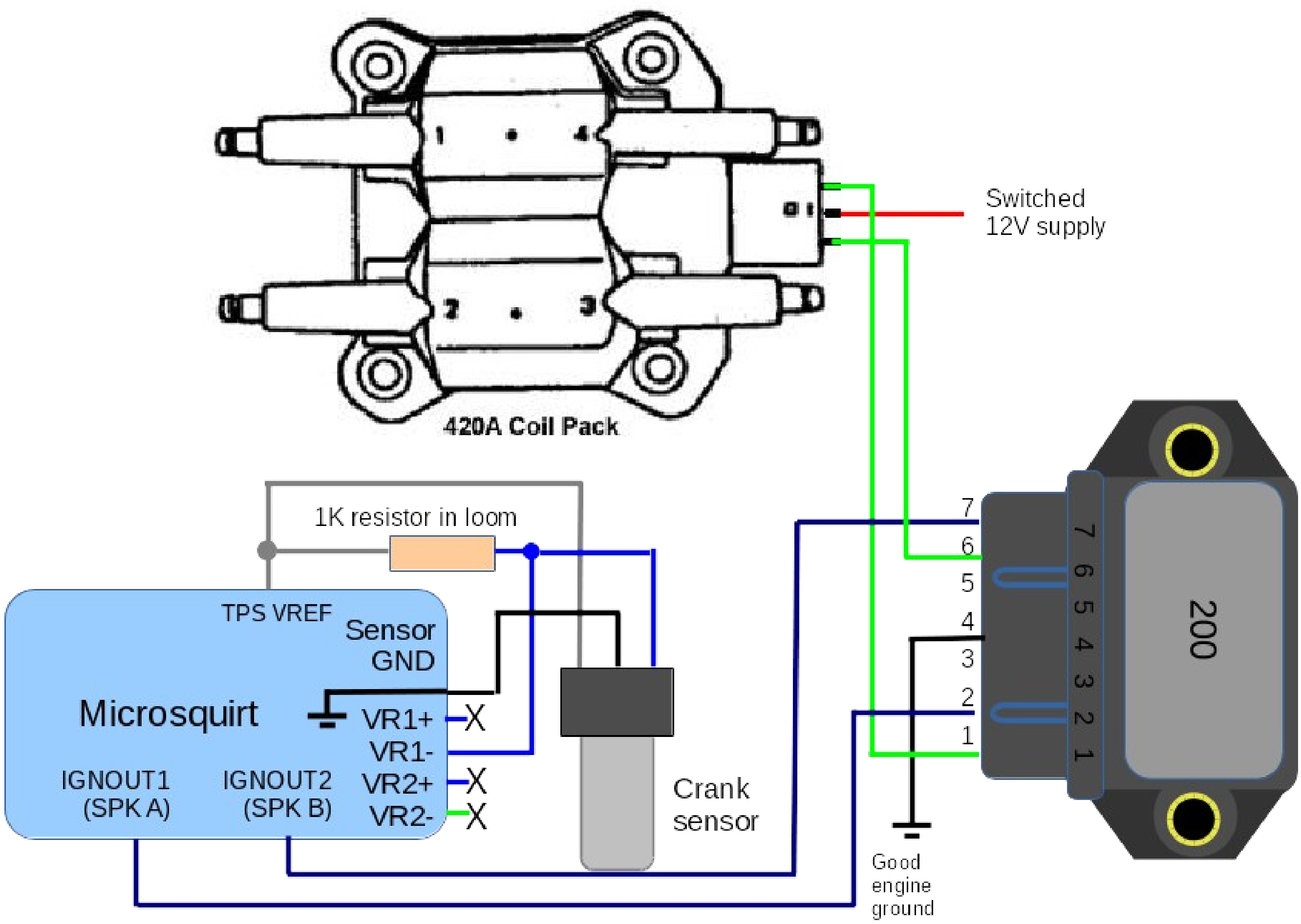
NGC patterns came into use around 2002.





Microsquirt only needs the crank signal to run wasted-spark and batch fire fuel, this is the recommended configuration. A pull-up resistor is required in the wiring harness for the crank signal.

Four cylinder example :



Typical settings:

Spark mode = 36-2+2

Trigger Angle/Offset = 0 (tweak if required)

Ignition input capture = Rising Edge

Spark Output = Going High

Number of coils = Wasted Spark

Injectors are wired up using the general diagram in section 4.9.2.1. Connect injectors 1 & 4 to bank 1 and 2 & 3 to bank 2.

Alternative #1: substitute a 2 channel ignitor of your choice.

Alternative #2: use a logic wasted spark coil pack such as the VW item (032 905 106B) shown in section: 5.3.1 instead of the ignitor and stock coilpack.

Six and eight cylinder variants are wired up similarly, following the general ignitor and coil wiring diagrams in section 5.3.

6.12 36-2-2-2

The 36-2-2-2 mode is designed for use with 4-cyl Subarus and Mazda RX8 engines with stock trigger wheels and sensor positions.

As standard, these engines use VR type crank sensors.

See the generic instructions in section 5.2 and 5.2.2

Mazda RX8 engines

RX8 engines use rotary specific coils - see section 5.3.4 for wiring.

Typical settings:

Spark mode = 36-2-2-2

Trigger Angle/Offset = 0 (tweak if required)

Ignition input capture = Falling Edge (typically)

Spark Output = Going High

Number of coils = Coil on Plug

Subaru 4cyl engines

Typically, the cam sensor is not used and "wasted spark" or "wasted COP" should be used.

Typically a high current wasted spark coil pack is used, these will require an ignitor.

Typical settings:

Spark mode = 36-2-2-2

Trigger Angle/Offset = 0 (tweak if required)

Ignition input capture = Falling Edge (typically)

Spark Output = Going High

Number of coils = Wasted Spark

6.13 Miata 99-05

The 99-05 Miata uses a low resolution crank trigger for primary timing and teeth on camshaft to detect phase. Both crank and cam inputs need to be connected.

See the generic instructions in section 5.2 and 5.2.2

Most engines of this era run coil-on-plug ignition using logic coils which can be connected directly to the Microsquirt.

See the generic instructions in section 5.3.1 for wiring four coils. Be sure to include the pull-up resistors to 5V TPSVREF.

Improved timing accuracy can be obtained by upgrading to a regular toothed wheel on the crank shaft, such as the Flyin-Miata 36-2 wheel. (See also section 6.37)

Typical settings:

Spark mode = Miata 99-00

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Rising Edge (Set according to whichever edge gives the most stable signal. If timing advances with RPM, try flipping it.)

Spark output = Going High

Number of coils = Wasted Spark

6.14 Subaru 6/7

This mode is designed for the EJ series engines with the unique "6/7" trigger - there are six unevenly spaced teeth on the crank wheel and seven teeth in total on the cam sprocket for cylinder identification. Both crank and cam inputs need to be connected..

VR sensors are used which can be directly connected, although some experimentation may be required with resistor "shunts" as the signals have been troublesome for some.

See the generic instructions in section 5.2 and 5.2.2

Some/most engines use a wasted spark coil pack. These are believed to be high current and will require an ignitor.

Typical settings:

Spark mode = Subaru 6/7

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going High

Number of coils = Wasted Spark

6.15 6G72

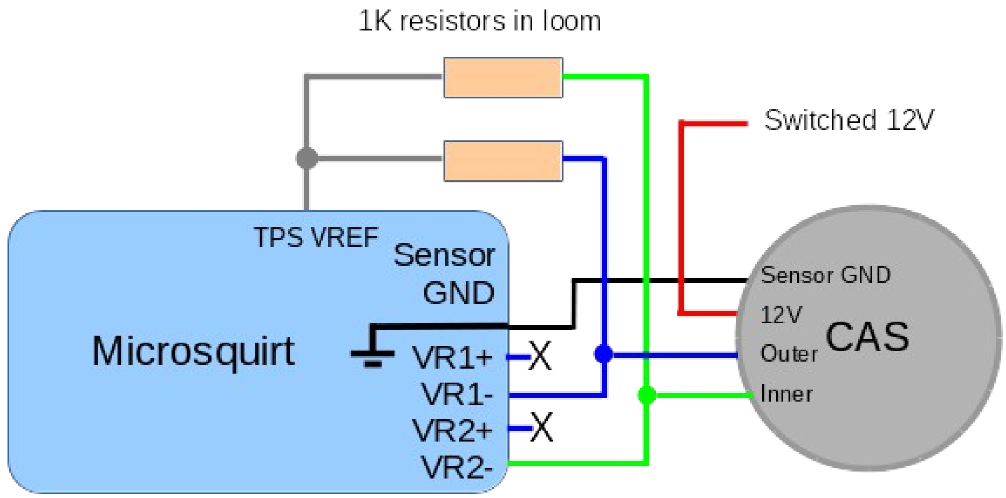
Known applications include:

- Mitsubishi 3000GT
- Mitsubishi Galant V6
- Some other Mitsubishi and Chrysler V6 models


1991-1992 6G72 use an optical CAS.

Electrically, the two signals on these CAS are connected the same as a hall sensor and require a pair of pull-up resistors in the wiring harness.

The outer track is considered to be the 'crank' signal and the inner track is the 'cam'.



Later 6G72 use two independent sensors on crank and cam, but the signal pattern to the ECU is the same. 1k pull-up resistors to TPSVREF are required.

Connect crank sensor to VR1-

Connect cam sensor to VR2-

Typical settings:

Spark mode = 6G72

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Rising edge

Spark output = Going High

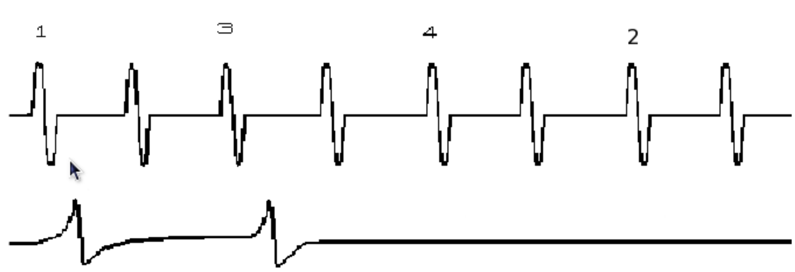
Number of coils = Wasted Spark

6.16 IAW Weber

Known applications include:

- Ford Sierra Cosworth
- Some Fiat and Lancia applications

This application uses a four tooth crank trigger with a VR sensor and a two tooth cam trigger with a Hall effect or VR sensor, depending on the year.



Models with a hall effect cam sensor should connect to VR2- and will require a pull-up resistor in the harness.

Typical settings:

Spark mode = IAW Weber

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Falling edge

Spark output = Going High

Number of coils = Depends on application

Some applications use a single high current coil, others use coil-on-plug. External ignitors are likely required.

6.17 Mitsubishi CAS 4/1

Known applications include:

- Mitsubishi 4G91
- Mazda Protege and 323 with optical distributor

This consists of a Mitsubishi optical CAS. Electrically, the two signals on this CAS are connected the same as a hall sensor and require a pair of pull-up resistors in the wiring harness.

Typical settings:

Spark mode = CAS 4/1

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Falling edge

Spark output = Going High

Number of coils = Depends on application

You will need to set the “Angle between main and return” parameter to the distance between edges of the optical sensor.

Note that if you are not able to get a stable signal off both edges, you should instead use "Toothed

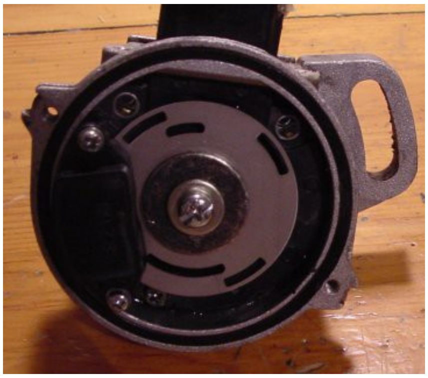
Wheel", mode with "Dual wheel" and 4 teeth at cam speed set.

6.18 Mitsubishi 4G63 (and Miata)

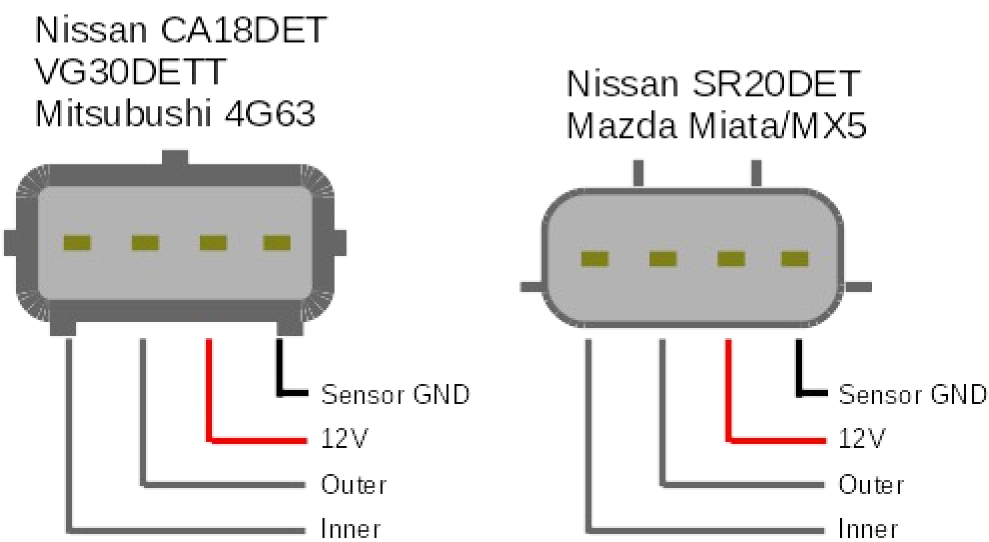
Known applications include:

- Mitsubishi 4G63 with distributorless ignition, as used in Eclipse, Galant VR4, and Lancer Evolution
- 1990-1997 Mazda MX5 Miata

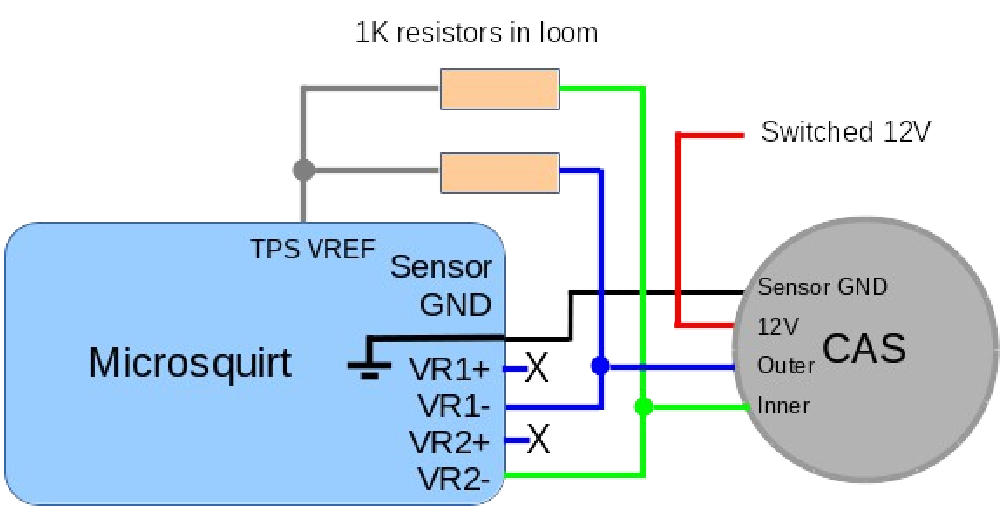
The 2G 4G63 and pre-1999 Miata (MX5) use a Mitsubishi optical CAS.


4G63 2G CAS

Electrically, the two signals on these CAS are connected the same as a hall sensor and require a pair of pull-up resistors in the wiring harness.



The outer track is considered to be the 'crank' signal and the inner track is the 'cam'.



Later 4G63 use two independent hall sensors with a two tooth crank trigger and a two tooth cam trigger, but the signal pattern to the ECU is the same. 1k resistors to TPSVREF are required.

Connect crank sensor to VR1-

Connect cam sensor to VR2-

Typical settings:

Spark mode = 4G63

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Rising edge

Spark output = Going High

Number of coils = Wasted Spark

Most Miata/MX5 of this era use a logic wasted spark coilpack which can be directly connected to the Microsquirt.

6.19 Twin trigger

The twin-trigger mode is designed primarily for 4-cylinder bike engines using a pickup similar to the photo. There is a single tooth and two pickup coils. This allows for wasted-spark ignition.

Supported combinations include:

- Crank wheel. 4 cylinder, 4 stroke engines with wasted spark ignition, non sequential fuel.
- Crank wheel. 2 cylinder, 4 stroke engines with in wasted spark ignition, non sequential fuel.
- Cam wheel. 2 cylinder, 4 stroke engines with in coil-on-plug ignition, non sequential fuel.

This mode can be used on both even fire and odd fire engines.

If possible this setup should be replaced with a regular toothed wheel (e.g. 12-1) for more accurate timing control.

Typical settings:

Spark mode = Twin trigger

Trigger angle/offset = typically around 10deg (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Wasted Spark or Coil-on-plug

6.20 Chrysler 2.2/2.5

This setup is unique to Chrysler 2.2 and 2.5 engines from the 1980s and early 1990s, equipped with multiport injection. (The TBI versions of this engine used Basic Trigger mode instead.) It uses a four tooth cam trigger with a “window” in the middle of one tooth and two hall sensors.

Only one hall sensor is used by Microsquirt. It needs to be connected to VR1- with a pull-up resistor in the wiring harness.

Typical settings:

Spark mode = Chrysler 2.2/2.5

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil

6.21 Renix 44-2-2 (66-2-2-2)

Known applications include:

- 1987-1990 Jeep Cherokee 4.0
- Many 1980s era Renault products

This trigger mode came in a four cylinder variation which used 44 base teeth with two gaps 180 degrees apart, and a six cylinder version with 66 base teeth and three gaps 120 degrees apart.

Typically Renault installs utilise a crank sensor only and output to a single coil and distributor.

Wasted spark or coil-on-plug require a single tooth on the cam and a cam sensor. The cam pulse needs to occur before the missing tooth region that precedes TDC#1 firing.

Typical settings:

Spark mode = Renix 44-2-2

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil

6.22 Suzuki Swift

Known applications include:

- Suzuki Swift engines with a distributor with a VR sensor and 12 irregularly spaced teeth.

An external ignitor will be required.

Typical settings:

Spark mode = Suzuki swift

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with

RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil

6.23 Suzuki Vitara 2.0

Known applications include:

- Vitara 2.0

This variant uses an uneven crank wheel with eleven teeth.

6.24 Daihatsu 3cyl

Known applications include:

- Some 3 cylinder Daihatsu

This mode is considered experimental. The Daihatsu three cylinder version has 3 equally spaced

teeth in a distributor with a fourth tooth adjacent to one of the teeth (3+1) and a VR sensor.

An external ignitor will be required.

Typical settings:

Spark mode = Daihatsu 3cyl

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil

6.25 Daihatsu 4cyl

Known applications include:

- Some 4 cylinder Daihatsu

This mode is considered experimental. The Daihatsu four cylinder version has 4 equally spaced

teeth in a distributor with a fourth tooth adjacent to one of the teeth (4+1) and a VR sensor.

An external ignitor will be required.

Typical settings:

Spark mode = Daihatsu 4cyl

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil

6.26 VTR1000

Known applications include:

- Some Honda V-twin motorcycles

It uses a 12-3 crank trigger with a VR sensor and no cam sensor.

Typical settings:

Spark mode = VTR1000

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Wasted spark

Must also set 2 cylinders and Odd-fire.

6.27 Rover#1

Known applications include:

- Rover K-series engines

The crank trigger wheel has 36 base teeth and two one tooth gaps, 180 degrees apart. This only allows a single coil and batch fire injection. Cam input is not supported.

Typical settings:

Spark mode = Rover#1

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil

6.28 Rover#2

Known applications include:

- Rover K-series engines

The crank trigger wheel with 36 base teeth and four one tooth gaps. This only allows a single coil or wasted spark ignition and batch fire or semi-sequential injection. Cam input is not supported.

Typical settings:

Spark mode = Rover#2

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil or Wasted Spark

6.29 Rover#3

Known applications include:

- Rover K-series engines

Similar to Rover #2, but the gaps are two teeth wide and positioned differently. As with Rover #2, supports wasted spark and semi-sequential injection, but does not support cam input.

Typical settings:

Spark mode = Rover#3

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Single coil or Wasted Spark

6.30 GM7X

Known applications include:

- Some GM four and six cylinder engines with distributorless ignitions.

GM refers to the crank wheel in their internal documentation as a 7X trigger wheel. It has six equally spaced teeth and a seventh tooth for cylinder identification.

Typical settings:

Spark mode = GM7X

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Number of coils = Wasted Spark

6.31 QR25DE

Known applications include:

- Nissan QR25DE and some other Nissan four cylinders.

Requires crank and cam sensors to be connected.

6.32 Honda RC51

Known applications include:

- Honda RC51, RC46, FSC600 and many CBR variants
- AP1 Honda S2000

This one uses a 12 tooth crank trigger and 3 tooth cam trigger, with VR sensors on both.

RC51 is 2 cyl odd-fire.

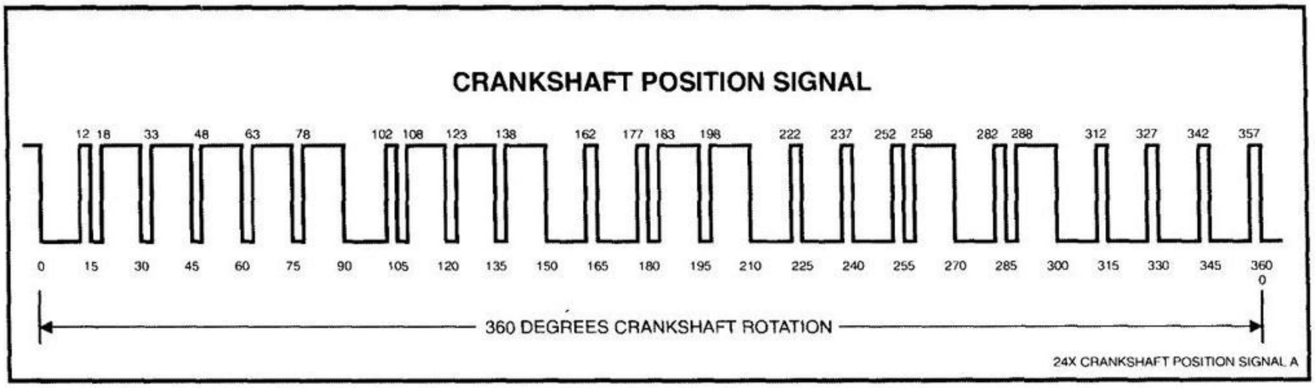
FSC600 is 2 cyl even-fire.

RC46 is 4 cyl odd-fire.

6.33 GM LS1 (24X)

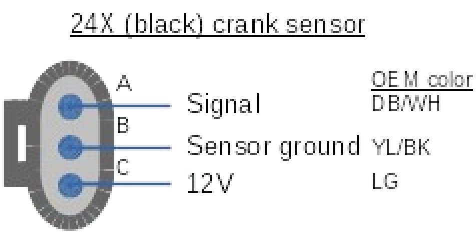
Known applications include:

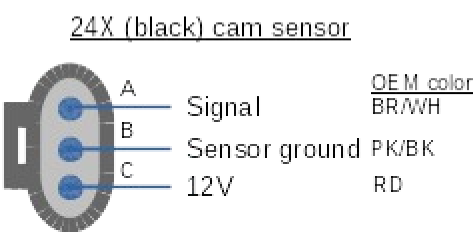
- Chevrolet V8s of LS1 family using a 24X crank pattern. (Typically Gen 3.)



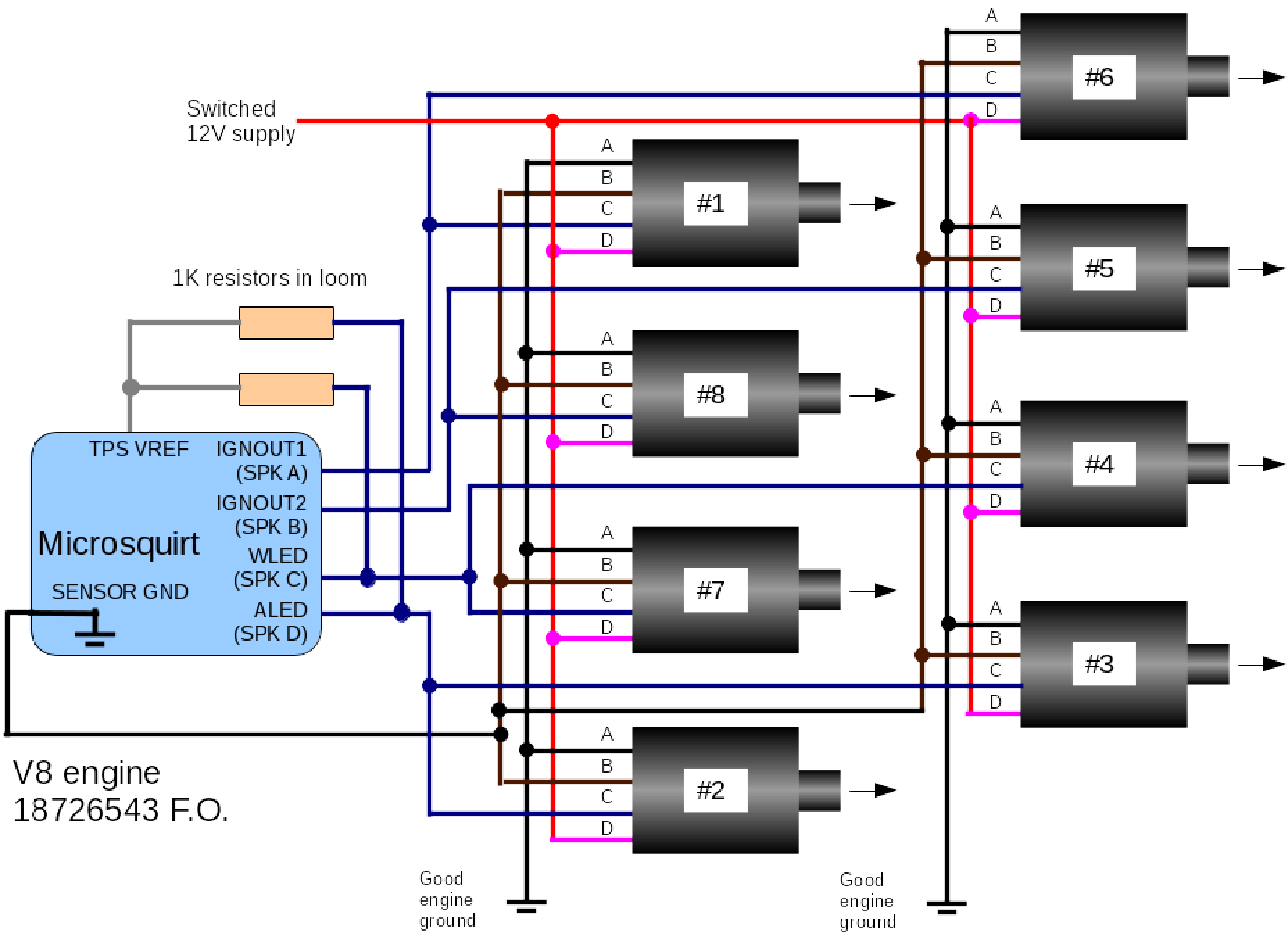
Crankshaft Position Sensor Signal

Only the crank sensor is used with Microsquirt.





The coils are wired in pairs SpkA = 1&6, SpkB = 8&5, SpkC = 7&4, SpkD = 2&3



Typical settings:

Spark mode = LS1

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Rising edge

Spark output = Going high

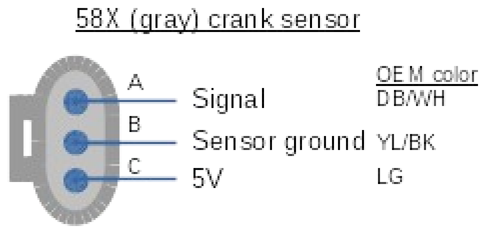
Number of coils = Wasted spark

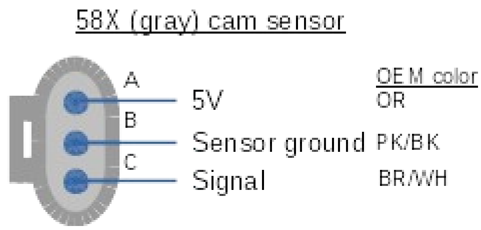
6.34 GM LS2 (58X)

Known applications include:

- Chevrolet V8s of LS2 family using a 58X crank pattern. (Typically Gen 4.)

Only the crank sensor is used with Microsquirt.





The coils are wired in pairs SpkA = 1&6, SpkB = 8&5, SpkC = 7&4, SpkD = 2&3. Coil wiring is shown in section 6.33

Typical settings:

Spark mode = Toothed wheel

Ignition input capture: Rising edge

Spark output: Going High

Number of coils = Wasted Spark

Trigger wheel arrangement = Single wheel

Trigger wheel teeth = 60

Missing teeth = 2

Tooth #1 angle = 15 (adjust with strobe)

Main wheel speed = Crank wheel

6.35 YZF1000

Known applications include:

- Yamaha YZF1000 / Thunderace
- Yamaha FZR1000
- Yamaha FZR750
- Yamaha FZ700

Typical settings:

Spark mode = YZF1000

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Falling edge

Spark output = Going high

6.36 HD 32-2

Known applications include:

- Harley Davidson with 32-2 crank trigger

A VR sensor is used on the crank trigger. As standard there is no cam sensor. Phase detection is possible using the MAP sensor.

Typical settings:

Spark mode = HD 32-2

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Cam sensor = MAP

The front cylinder is considered cyl#1 and therefore connects to SpkA. Sequential fuel is allowed with the two injector outputs.

6.37 Miata 36-2

Known applications include:

- Mazda Miata (MX5) 99-05 fitted with aftermarket 36-2 crank trigger

Typical settings:

Spark mode = Miata 36-2

Trigger angle/offset = 0 (adjust with strobe)

Ignition input capture = Set according to whichever edge gives the most stable signal. (If timing advances with RPM, try flipping it.)

Spark output = Going high

Both crank and cam sensors are VR type and need to be connected.

7 Throttles

The major influence on engine speed on a spark-ignition (gasoline) engine is air-flow. (Contrast a compression-ignition (diesel) engine where there is no throttling and fuel flow governs engine speed.)

For normal running the main throttle plates control the air-flow. At idle an idle valve can be used to provide controlled flow, or a throttle stop screw can be used on the main throttles to allow a low flow during "closed" throttle conditions.

Throttles need to be appropriately sized for the engine displacement and RPM range. Too small and the engine will "run out of steam" at higher RPMs. Too large and tiny throttle movement will allow a large airflow giving jerky low-load operation.

There are a wide range of throttles available. Most factory EFI installs use a single throttle plate. Many aftermarket companies offer USA style 4 barrel carburettor replacement throttle-bodies. Another option that is particularly common on 4-cylinder engines is to fit bike throttle bodies.

Independent throttle body installs free up the most power from the engine, but will need to be balanced (equal airflow for each throttle) and the MAP signal will be weak - consider using "ITB mode" or "Alpha-N."

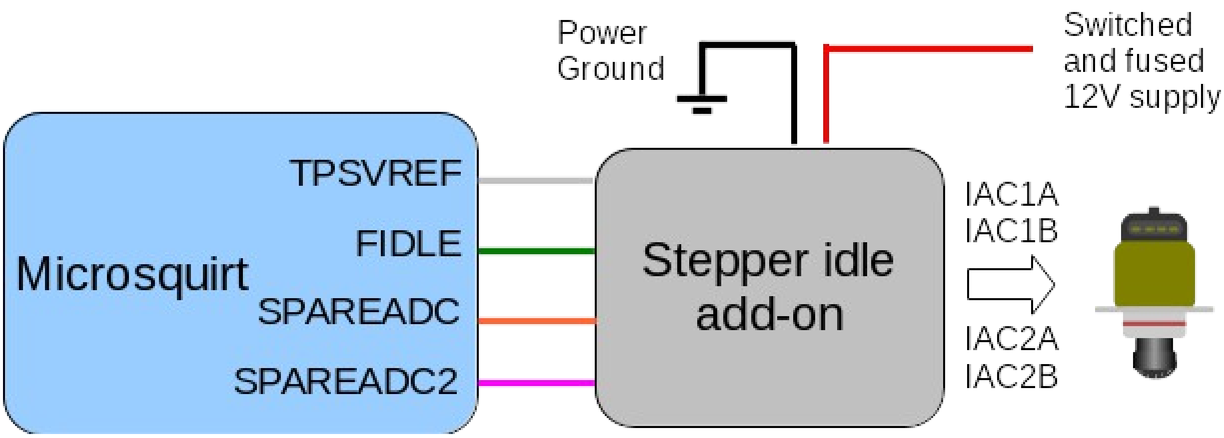
All throttles will need to be fitted with a TPS if not already included.

Example 4150 style 4-barrel EFI throttle body.

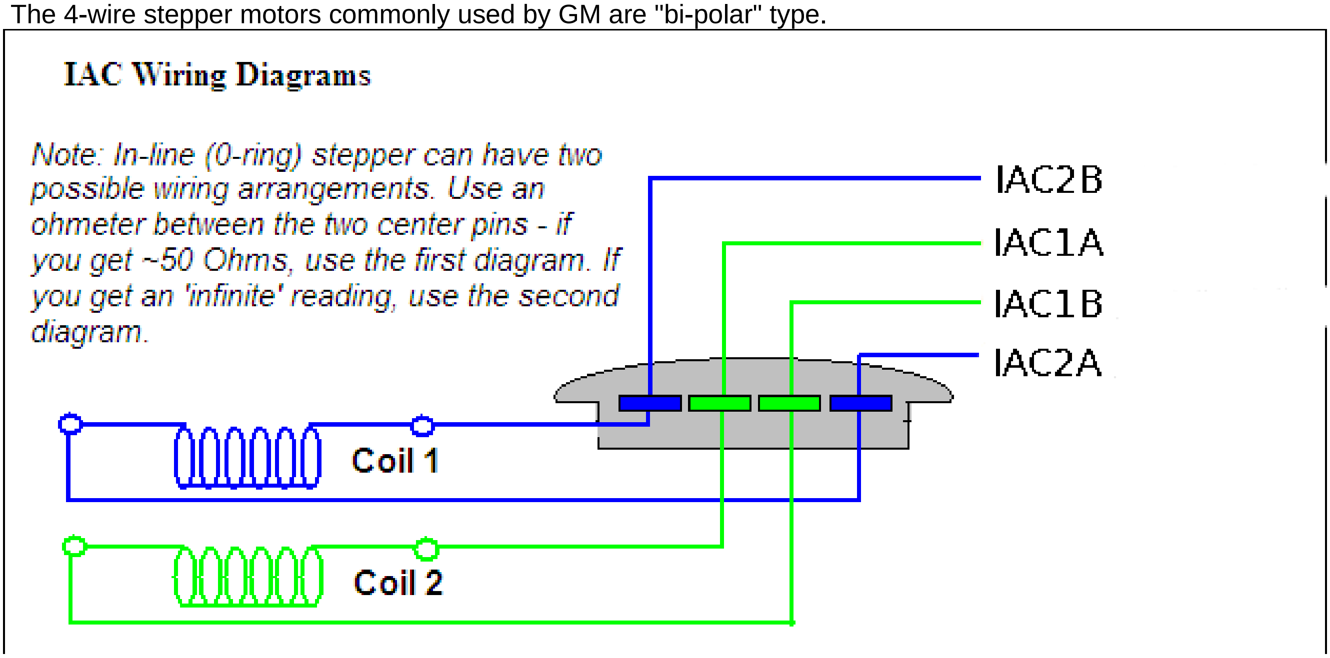
8 Optional Hardware

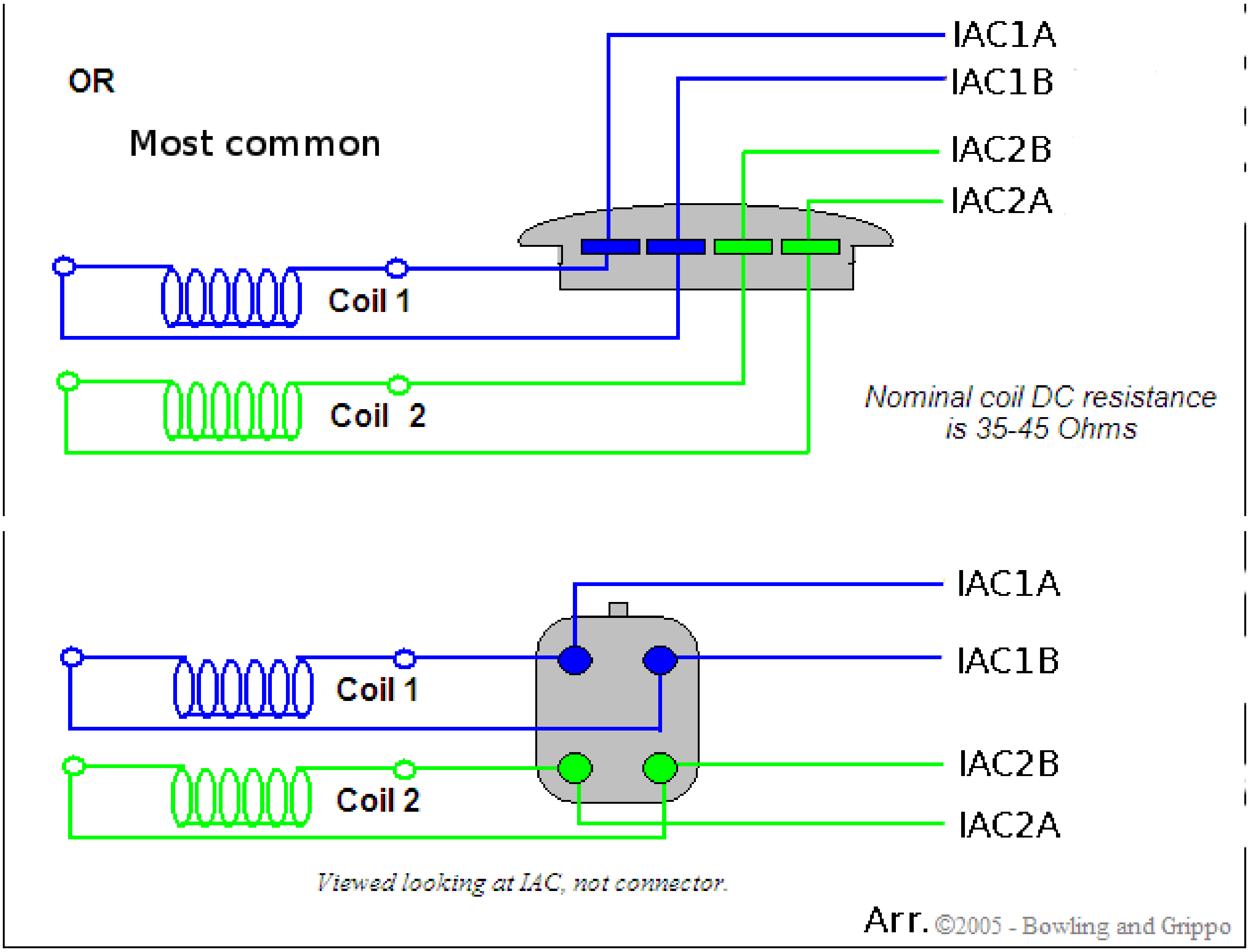
8.1 Stepper idle driver

4-wire stepper idle valves are common on many GM vehicles. An add-on board (available from EFI Source) is required for the Microsquirt to connect to them.



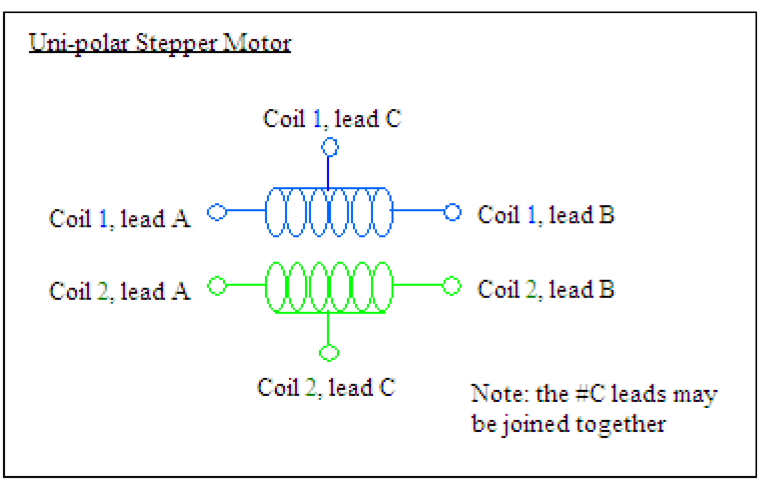
The 4-wire stepper motors commonly used by GM are "bi-polar" type.





Other manufacturers use 5- or 6-wire steppers which are uni-polar.

These are usually wired as shown in the schematic below, with a center tap on each of two windings. In use, the center taps of the windings are typically wired to the 12V supply, and the two ends of each winding are alternately grounded to reverse the direction of the field provided by that winding.



8.2 Expansion boards

The Microsquirt is designed as a compact ECU with enough inputs and outputs to control an engine. If additional inputs and outputs are desired, an add-on expansion board may be used.

The Microsquirt has CAN communications that allow the simple 2-wire connection.

Example expansion boards are:

- CANEGT - allows K-type thermocouples for per-cylinder exhaust gas temperature monitoring
- GPIO/ trans - allows control of electronically shifted automatic transmissions
- IO-Expander - DIY assembled product for additional analogue input, relay outputs, GPS, accelerometer, thermocouple.
- Dashes / loggers - many vendors dashboards are compatible with the Megasquirt-2 data stream.

For specific product features and configuration details, please refer to your supplier's documentation.

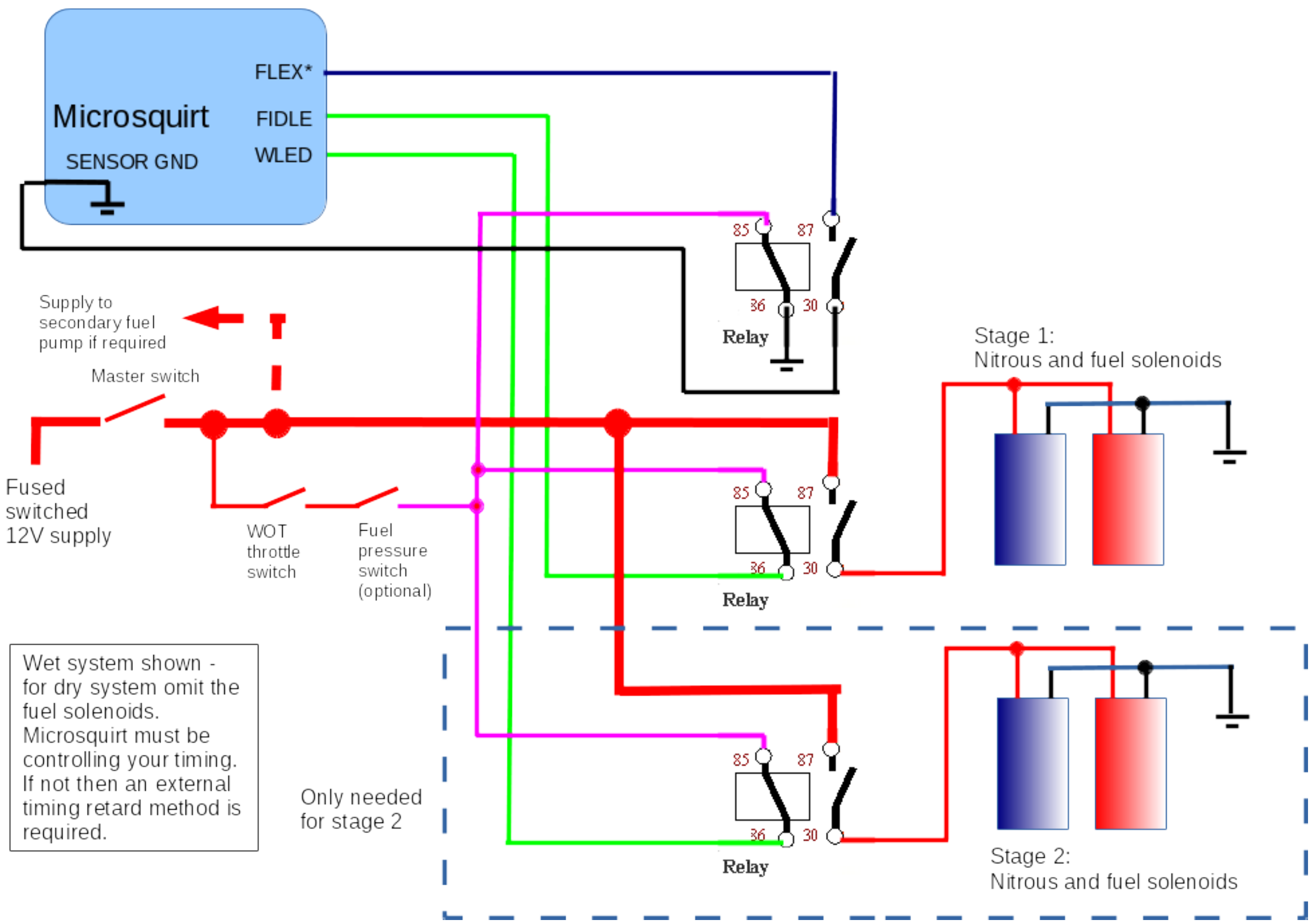
9 Example wiring

9.1 Nitrous

The following layout shows typical wiring for a wet nitrous system. It is drawn using "FLEX" as the ground-switched input. The stage1 output is always on FIDLE, so that cannot be used for idle control.

Optionally, SPAREADC or SPAREADC2 may be used instead with the appropriate software setting.

Optionally a double pole switch can be used as the master switch. Use one set of terminals for the +12V supply and the second set for the ground input and then omit the top relay



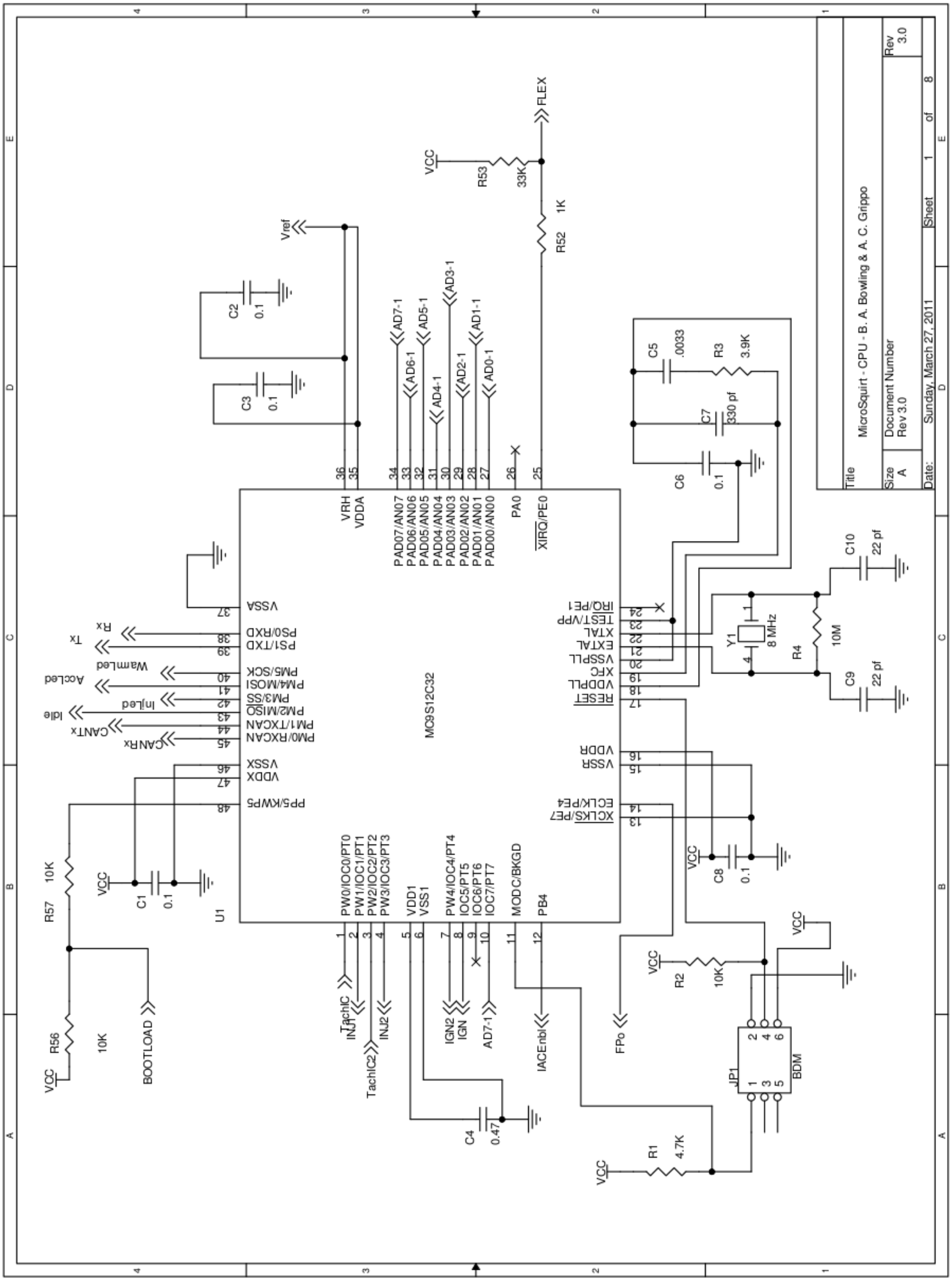
10 Further information

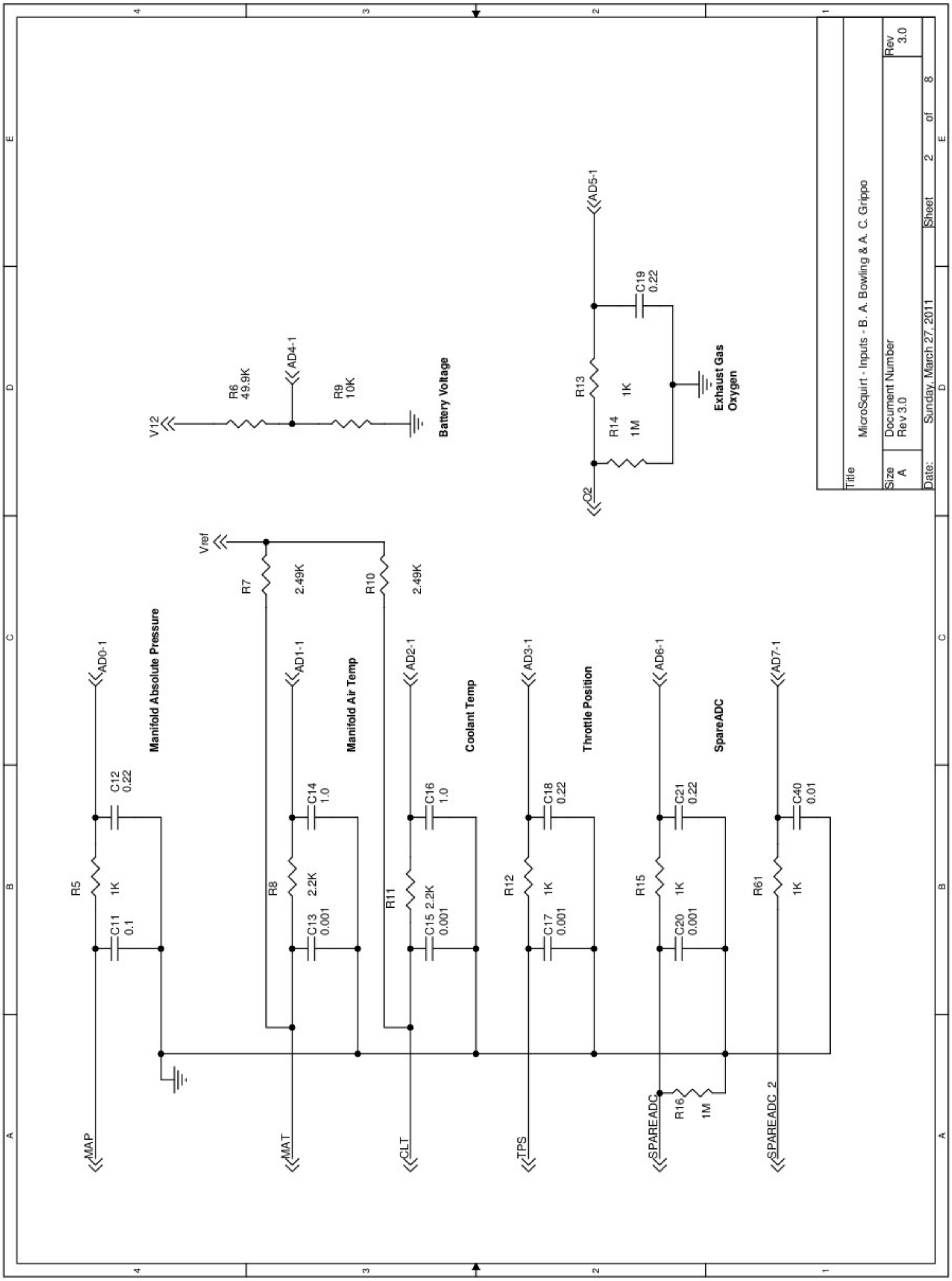
For additional information or to join the community forums for Megasquirt, please visit:

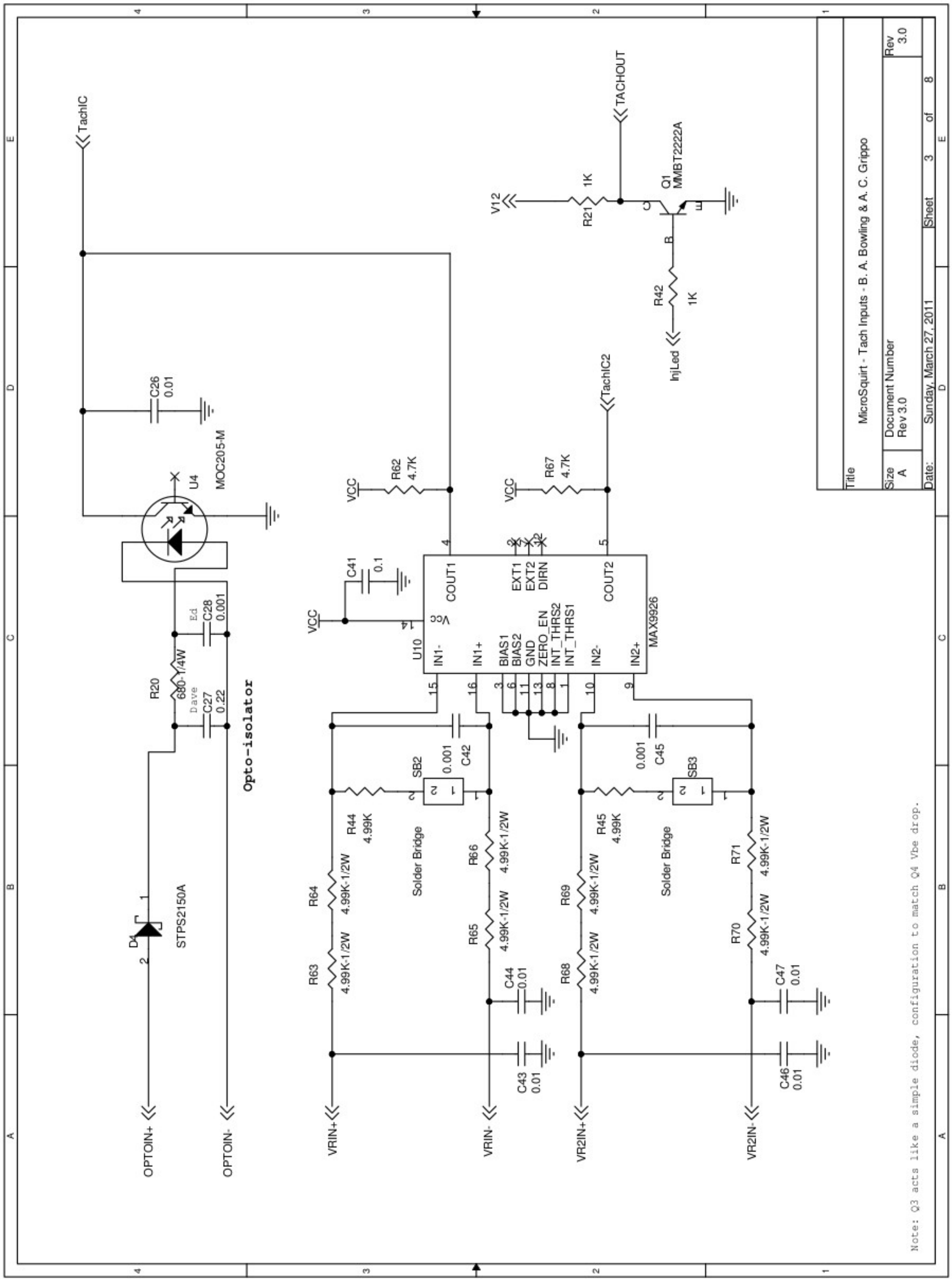
www.msextra.com

11 Appendix A Schematics

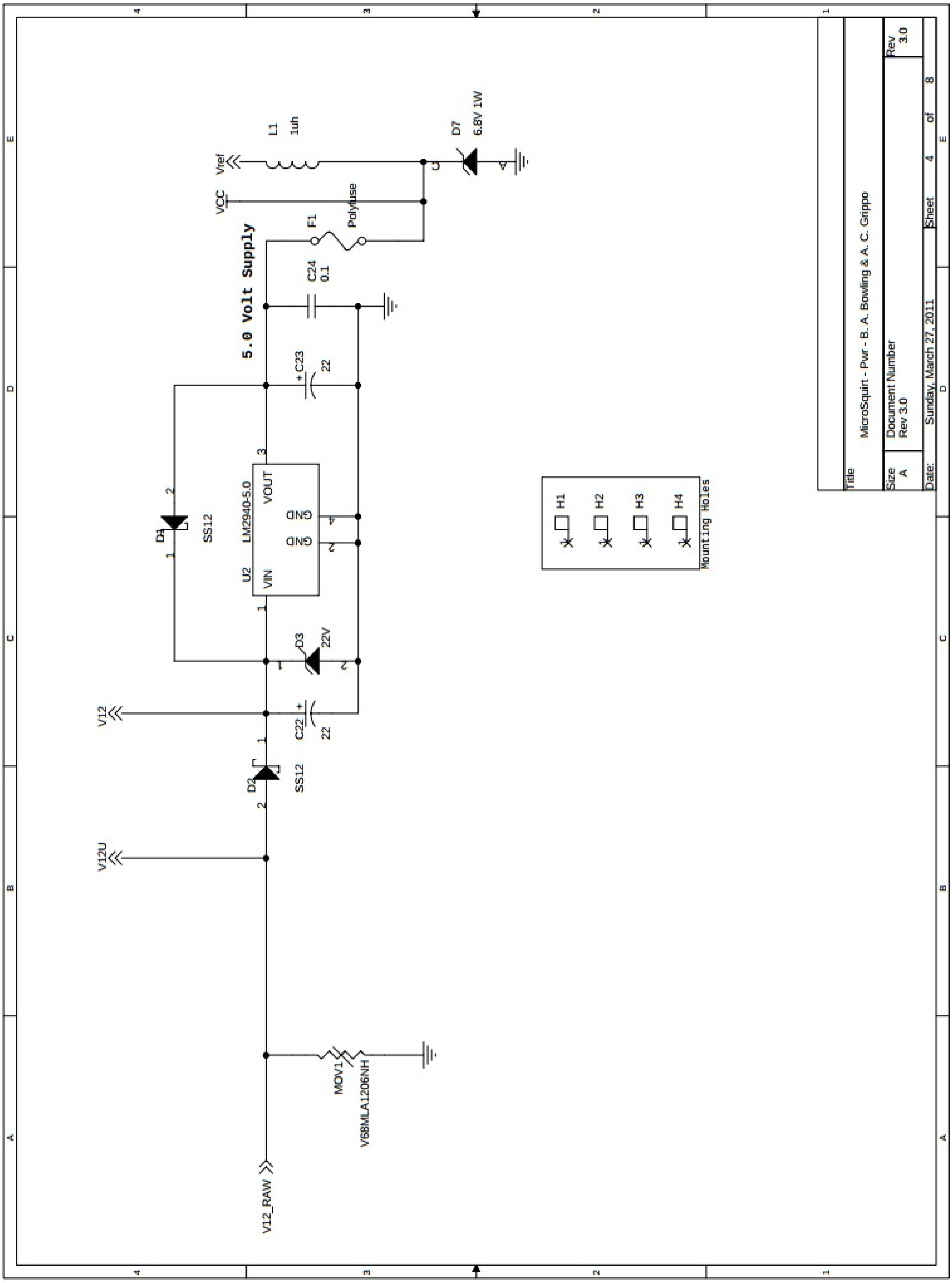
The copyrighted Microsquirt schematics are provided for repair, interfacing and education purposes only.


MicroSquirt - CPU - B. A. Bowling & A. C. Grippo
Document Number
Rev 3.0
Size
A
Rev
3.0
Date: Sunday, March 27, 2011
Sheet 1 of 8
MC9S12C32


MicroSquirt - Inputs - B. A. Bowling & A. C. Grippo
Title
Size A
Document Number Rev 3.0
Rev 3.0
Date: Sunday, March 27, 2011
Sheet 2 of 8
Manifold Absolute Pressure
Manifold Air Temp
Coolant Temp
Throttle Position
SpareADC
Battery Voltage
Exhaust Gas Oxygen
AD0-1
AD1-1
AD2-1
AD3-1
AD4-1
AD5-1
AD6-1
AD7-1
MAP
MAT
CLT
TPS
SPAREADC
SPAREADC_2
O2
V12
Vref
R5 1K
R6 49.9K
R7 2.49K
R8 2.2K
R9 10K
R10 2.49K
R11 2.2K
R12 1K
R13 1K
R14 1M
R15 1K
R16 1M
R61 1K
C11 0.1
C12 0.22
C13 0.001
C14 1.0
C15 0.001
C16 1.0
C17 0.001
C18 0.22
C19 0.22
C20 0.001
C21 0.22
C40 0.01



TachIC
C26
0.01
U4
MOC205-M
R20
680-1/4W
C28
0.001
C27
0.22
Opto-isolator
D1
STPS2150A
OPTOIN+
OPTOIN-
VCC
R62
4.7K
C41
0.1
U10
MAX9926
COUT1
EXT1
EXT2
DIRN
COUT2
IN1-
IN1+
BIAS1
BIAS2
GND
ZERO_EN
INT_THRS2
INT_THRS1
IN2-
IN2+
R67
4.7K
TachIC2
C42
0.001
SB2
Solder Bridge
R44
4.99K
R64
4.99K-1/2W
R63
4.99K-1/2W
R66
4.99K-1/2W
R65
4.99K-1/2W
C44
0.01
C43
0.01
VRIN+
VRIN-
C45
0.001
SB3
R45
4.99K
R69
4.99K-1/2W
R68
4.99K-1/2W
R71
4.99K-1/2W
R70
4.99K-1/2W
C47
0.01
C46
0.01
VR2IN+
VR2IN-
V12
R21
1K
Q1
MMBT2222A
TACHOUT
R42
1K
InjLed
Title
MicroSquirt - Tach Inputs - B. A. Bowling & A. C. Grippo
Size
A
Document Number
Rev 3.0
Rev
3.0
Date:
Sunday, March 27, 2011
Sheet
3
of
8
Note: Q3 acts like a simple diode, configuration to match Q4 Vbe drop.



5.0 Volt Supply
Vref
L1
1uh
VCC
D7
6.8V 1W
F1
Polyfuse
C24
0.1
C23
22
U2
LM2940-5.0
VIN
VOUT
GND
GND
D1
SS12
D3
22V
V12
C22
22
D2
SS12
V12U
MOV1
V68MLA1206NH
V12_RAW
H1
H2
H3
H4
Mounting Holes
Title
MicroSquirt - Pwr - B. A. Bowling & A. C. Grippo
Size
A
Document Number
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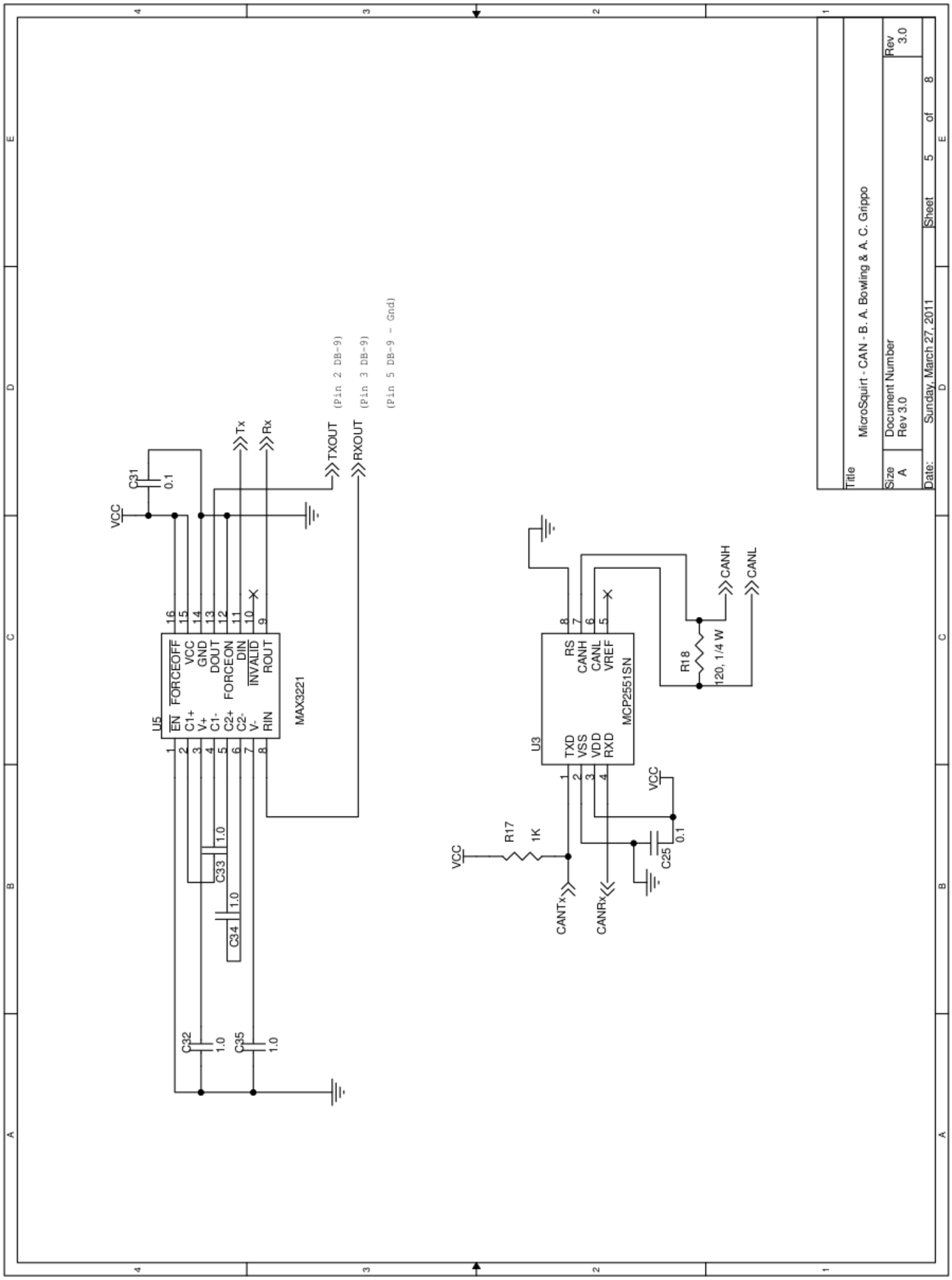
Title
MicroSquirt - CAN - B. A. Bowling & A. C. Grippo
Size
A
Document Number
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Date: Sunday, March 27, 2011
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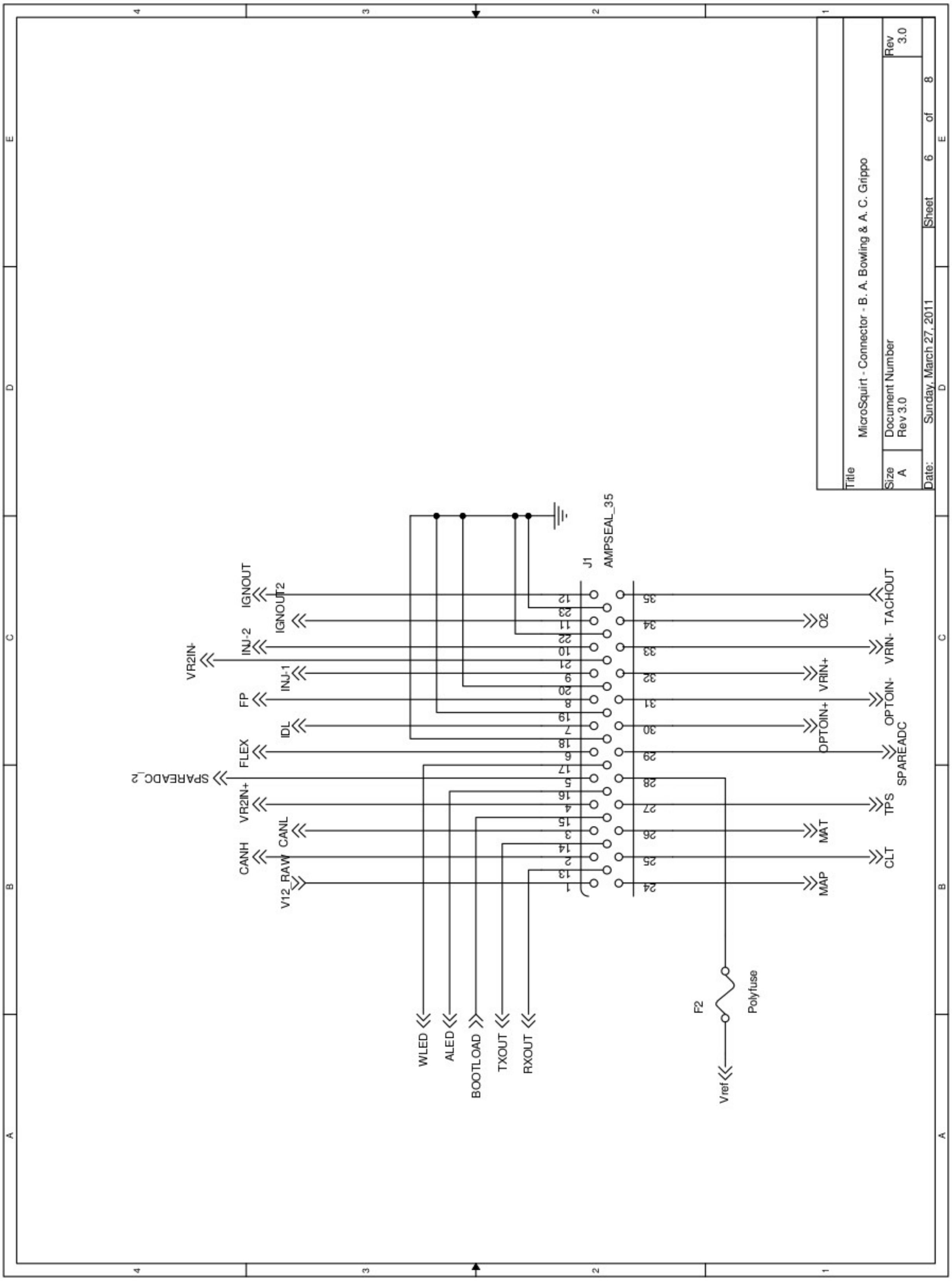
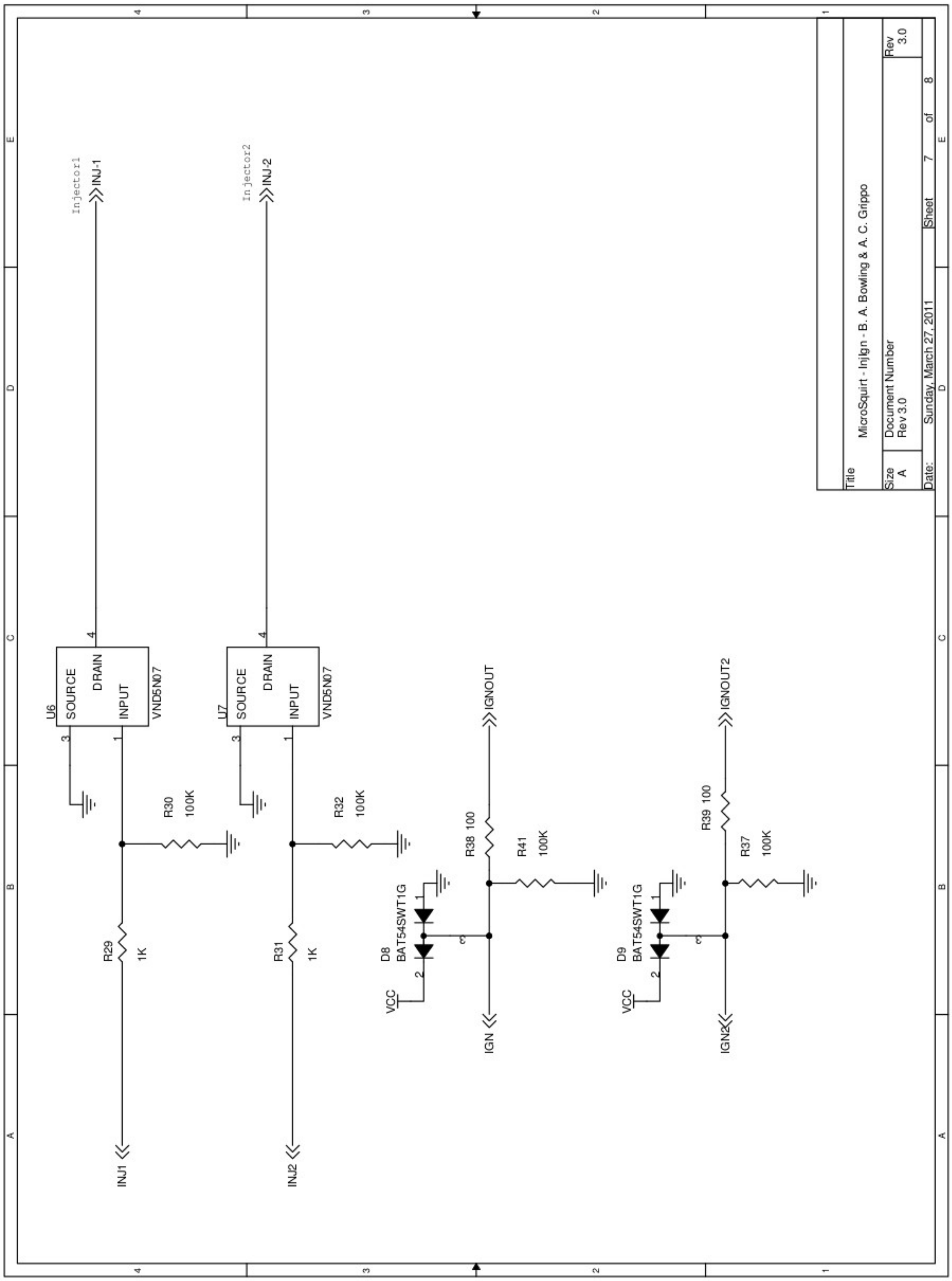
U5
MAX3221
EN
C1+
V+
C1-
C2+
C2-
V-
RIN
FORCEOFF
VCC
GND
DOUT
FORCEON
DIN
INVALID
ROUT
U3
MCP2551SN
TXD
VSS
VDD
RXD
RS
CANH
CANL
VREF
VCC
C31 0.1
C32 1.0
C33 1.0
C34 1.0
C35 1.0
C25 0.1
R17 1K
R18 120, 1/4 W
Tx
Rx
TXOUT
RXOUT
(Pin 2 DB-9)
(Pin 3 DB-9)
(Pin 5 DB-9 - Gnd)
CANTx
CANRx
CANH
CANL


Title
MicroSquirt - Connector - B. A. Bowling & A. C. Grippo
Size
A
Document Number
Rev 3.0
Rev
3.0
Date: Sunday, March 27, 2011
Sheet 6 of 8
J1
AMPSEAL_35
IGNOUT
IGNOUT2
INJ-2
VR2IN-
INJ-1
FP
IDL
FLEX
SPAREADC_2
VR2IN+
CANL
CANH
V12_RAW
TACHOUT
O2
VRIN-
VRIN+
OPTOIN-
OPTOIN+
SPAREADC
TPS
MAT
CLT
MAP
WLED
ALED
BOOTLOAD
TXOUT
RXOUT
F2
Polyfuse
Vref


Injector1
INJ-1
Injector2
INJ-2
U6
SOURCE
DRAIN
INPUT
VND5N07
U7
SOURCE
DRAIN
INPUT
VND5N07
R30
100K
R32
100K
R29
1K
R31
1K
INJ1
INJ2
IGNOUT
IGNOUT2
R38 100
R41
100K
R39 100
R37
100K
D8
BAT54SWT1G
D9
BAT54SWT1G
VCC
VCC
IGN
IGN2
Title
MicroSquirt - InjIgn - B. A. Bowling & A. C. Grippo
Size
A
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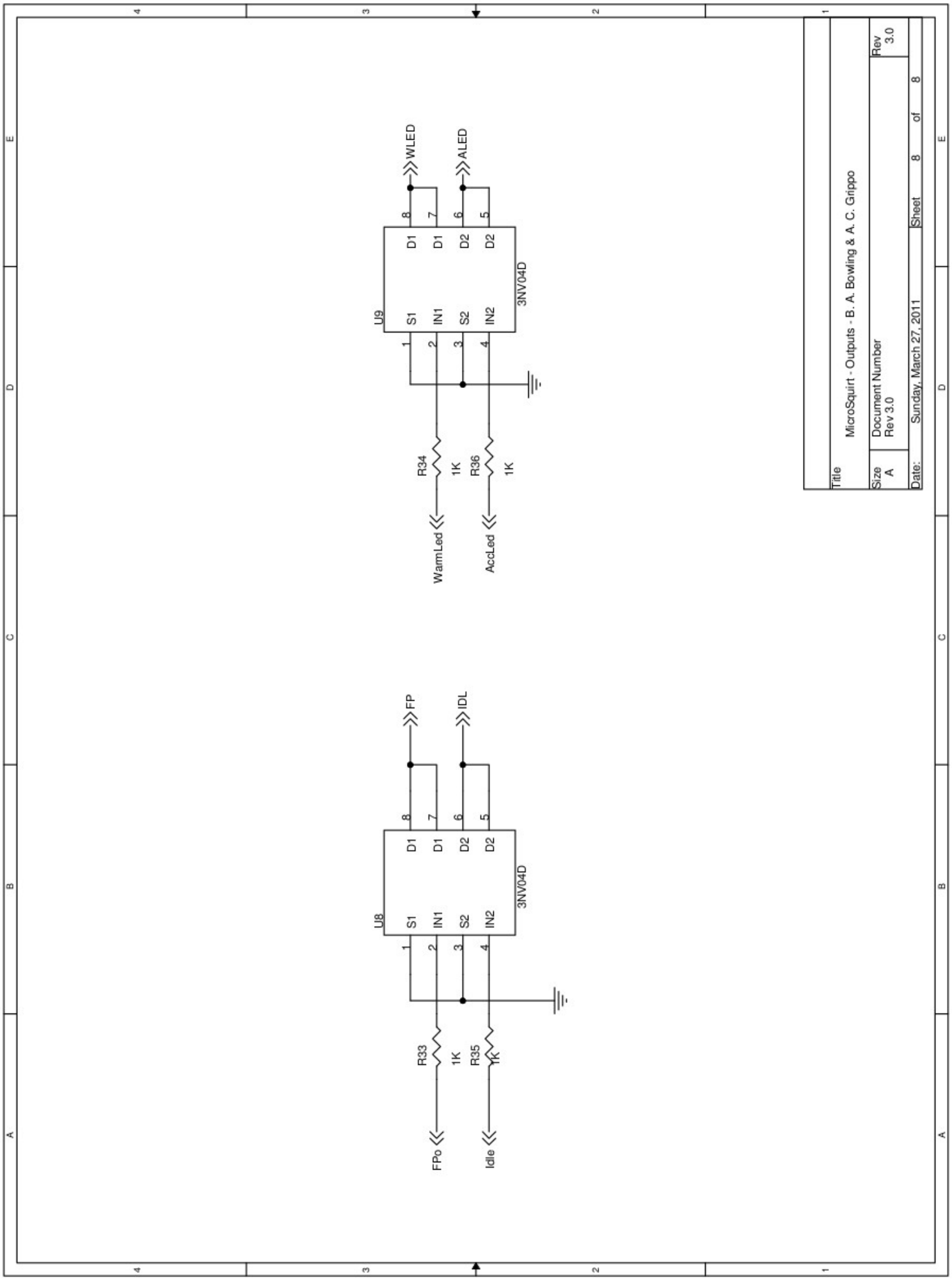
WLED
ALED
U9
3NV04D
S1 IN1 S2 IN2
D1 D1 D2 D2
R34 1K
R36 1K
WarmLed
AccLed
FP
IDL
U8
3NV04D
R33 1K
R35 1K
FPo
Idle
Title
MicroSquirt - Outputs - B. A. Bowling & A. C. Grippo
Size A
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12 Appendix B: Junkyard guide to finding EDIS

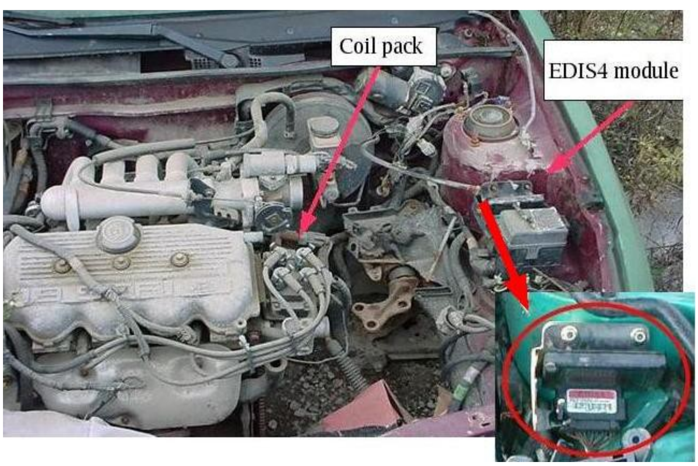
12.1 North America - EDIS4

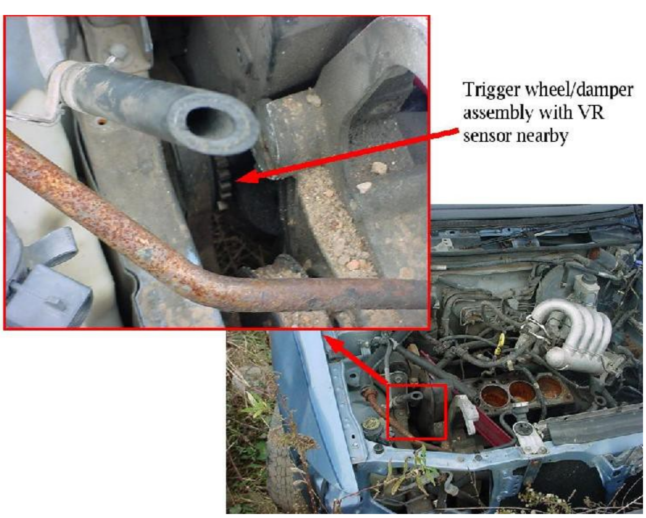
Early to mid 1990s Ford Escort/ Mercury Tracer with base 1.9L SOHC engine were fitted with the EDIS4 system. You can tell the engine because it has a tubular aluminium (NOT cast) inlet manifold.

The EDIS4 module is mounted just behind the fuse box on the drivers side of the engine bay, it has a label on the plug that says EDIS4. The bolts are 10mm AF. You are advised to remove the fuse box first for easier access. Cut off as much as the harness as you can.

Looking toward the passenger side end of the engine, the VR sensor is above and to the left of the end of the crankshaft. The easiest way to access the sensor is to remove the front wheel (if it's not already removed), lie on your back, and reach up from the bottom to access the sensor mounting bolts. The bolts are either small metric or star bit. Once it's off, the cable is most easily cut from the top.

The crank pulley bolt is 19mm. You will need to stop engine from turning, various methods have been suggested. 1) remove the head, put some rocks into the bore and refit the head. 2) remove a spark plug and put a long bar down the hole 3) remove a plug from cylinder with piston at BTDC and coil in some rope, remove rope when finished.





12.2 Europe - EDIS4

1989-1993 Fiesta XR2i 1.6

1990-1992 Fiesta RS turbo

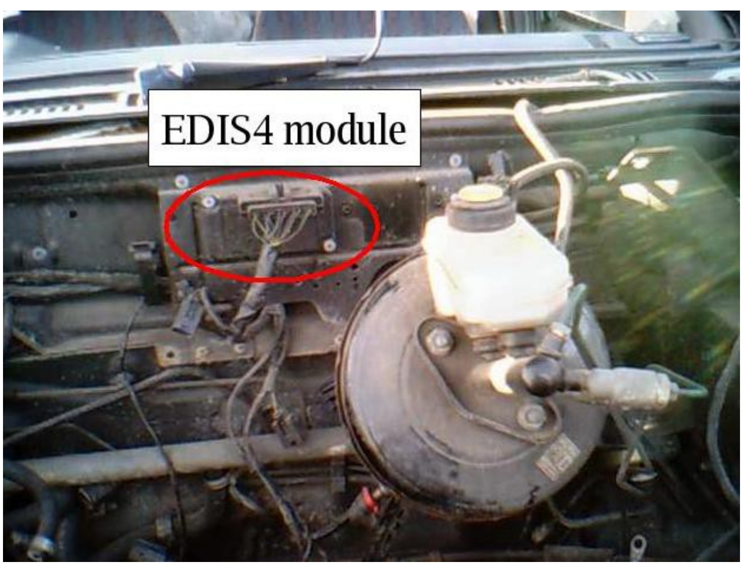
1989-1994 Escort 1.6i

1990-1994 Orion 1.6i

Modules are all in the engine bay and typically located in the middle of the bulkhead or the right hand side as you face the car.

Known part numbers are: 89FB-12K072-AC, 91AB-12K072-AA

Orion CVH MPI

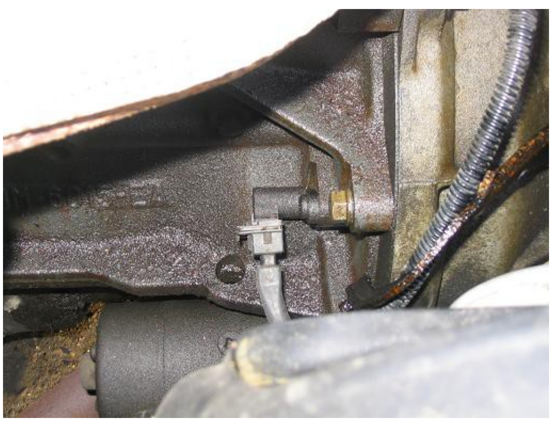


Fiesta / crossflow Escort

Mondeo with 1800/2000 engine.

Location of the VR sensor varies. On the small CVH engines it pokes through the rear flange of the engine towards the flywheel. 1.8CVH Sierra has one on the front. 2.0DOHC Sierra/ Granada is in the block at the left side way below the inlet manifold. Duratec V6 (Mondeo) is mounted near the front, it also has a cam sensor that works too.

The mounting bolts are either small metric or star bit.


Escort / Fiesta location on engine flange above starter.

Do not confuse with the ESC II hybrid module which has a vacuum tube and comes on the carb model cars.

There is also an aluminium one to avoid as well.

12.3 Europe - EDIS6

up to 1995ish Mondeo V6 automatic

Ford/Cosworth Granada Scorpio 24v V6

Module located rear left of engine bay as you face the car.

Known part numbers are: 90GB-12K072-AB

12.4 Europe - EDIS8

Chances of finding one of these in a scrapyard are very low! Not known to have been installed on any European built vehicles. Your best bet is either to import a module from the USA or buy new. I would suggest buying the other bits locally.

For connectors try one off another car if all the wires are in use or one off an ESC module. The number of wires used in the connector varies so check they are all there!

There is a possibility of using 2 EDIS4 modules to drive a V8. But now that the MS ECU can directly drive 4 coils (V8 in wasted spark) this is no longer necassary.

12.5 Europe - 36-1 trigger disc

The 1.8CVH Sierra has a useful disc pressed onto the back of the crank pulley

All of the other CVH installs have the trigger teeth cut into the flywheel and so are useless.

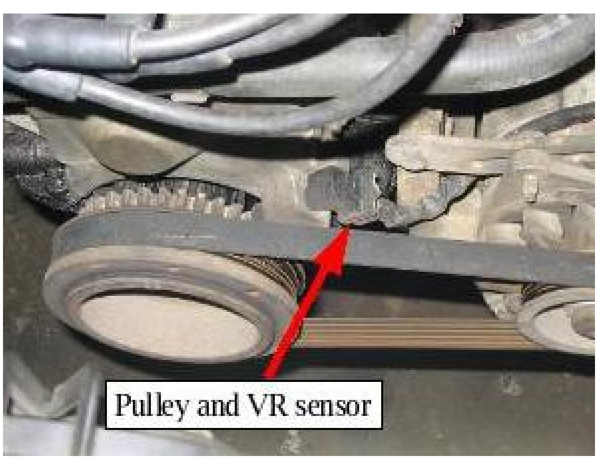
For a scrap yard trigger disc, remove from 1.8CVH Sierra. You will need to stop engine from turning, various methods have been suggested.

1) remove the head, put some old bolts or other junk into the bore and refit the head.

2) remove a spark plug and put a long bar down the hole

3) remove a plug from cylinder with piston at BTDC and coil in some rope, remove rope when finished

4) Jam something into the flywheel teeth



If you are after a pressed steel disc, try part no. 1078767 from Ford, this came on the 16v DOHC Granada engines. Alternatively many retailers sell universal 36-1 trigger wheels.

12.6 Europe - VR sensor

Usually it is easiest to get from the same vehicle as the EDIS module so the wiring harness wiring colours match.

Or any vehicle with a trigger disc will yield one, so CVH Fiesta/Escort/Orion or Fiesta with Valencia (crossflow) engine with ESCII hybrid, DOHC Sierra/Granada, Mondeo.

12.7 World - Coilpack(s)

Fords from the EDIS era and beyond use suitable coilpacks.

13 Revision history

2014-07-22	Revision history started.
2014-07-23	Added Quadspark wiring diagram.
2014-08-01	Added missing 4th page of schematic.
2014-08-05	Correct typo "trigger wheel" -> "toothed wheel". Added chapter index.
	Add VR solder bridge details and shut resistor diagram.
2014-08-11	Flip 4G63 tach-in. Add note about tach-in polarity for ref.
2014-11-27	Enable auto-numbering. Fix missing EDIS wiring diagram. Update main wiring diagram.
	Add new CAN wiring diagram. Add 4-wire O2 sensor pic. Update TFI, HEI, 420A,
	36-2+2, Miata 99-05, 6G72, 4G63, LS1 input polarities per DIYA.
2015-02-02	Fix EDIS diags. Pin usage table. Relay board note.
2015-03-14	Correct MAP sensor pinout.