Vi-PEC.com

versatile intelligent performance engine control

Installation & Configuration Manual

i44 and i88

Made in New Zealand

Product Warranty Statement

ELECTRONZ LTD – LIMITED LIFETIME WARRANTY

All Engine Control Units (ECUs) manufactured or distributed by Electronz Ltd are subject to the following LIMITED LIFETIME WARRANTIES, and no others.

Electronz Ltd warrants only to the original purchaser of the ECU, for the lifetime of the ECU, (subject to the limitations set out below), that the ECU shall be free from defects of materials and workmanship in the manufacturing process. This warranty ceases to apply and does not apply to ECUs that have not been manufactured or distributed by Electronz Ltd for a period of greater than one year.

An ECU claimed to be defective must be returned to the place of purchase. Electronz Ltd, at its sole option, may replace the defective ECU with a comparable new ECU or repair the defective ECU.

This limited lifetime warranty is not transferrable and does not apply to any ECU not properly installed or properly used by the purchaser or end user, or to any ECU damaged or impaired by external forces. The above warranties are the full extent of the warranties available on the ECU. Electronz Ltd has no liability to the original purchaser or any other person for any loss, injury or damage to persons or property resulting from the use of the ECU or any failure of or defect in the ECU whether by general, special, direct, indirect, incidental, consequential, exemplary, punitive, or any other damages of any kind or nature whatsoever. Electronz Ltd specifically disclaims and disavows all other warranties, express or implied, including, without limitation, all warranties of fitness for a particular purpose, warranties of description, warranties of merchantability, trade usage or warranties of trade usage.

For off-road use only, not intended for highway vehicles. This ECU contains a user-configurable software programme, which is updated by Electronz Ltd from time to time. The user must ensure the current correct version of this programme is downloaded from the website of Electronz Ltd and installed in the ECU prior to use. This limited lifetime warranty does not apply where the ECU has been installed with the incorrect version of the software programme. The user is solely responsible for the setup and testing of all user-configurable features.

Electronz Ltd License Agreement

The software programme in this ECU is licensed not sold. Electronz Ltd grants the user a license for the programme only in the country where the programme was acquired. No other rights are granted under this license and the programme may only be used on one machine at a time. If the programme is transferred a copy of this license and all other documentation must be transferred at the same time. The license may be terminated by the user at any time. Electronz Ltd may terminate the licence if the user fails to comply with the terms and conditions of this license. In either event the copy of the programme must be destroyed.

Table of Contents

1 Introduction

Thank you for purchasing your Vi-PEC Wire-In Engine Control Unit (ECU). Vi-PEC i-Series ECUs are an advanced, fully programmable microprocessor controlled Engine Management System.

The i-Series software platform boasts an impressive list of features giving a new level of user adjustment. This flexibility allows the tuner to have complete control over the engine management system. i-Series software employs high resolution fuel and ignition tables with configurable load and RPM centres. Coupled with up five dimensional fuel and ignition mapping, barometric pressure compensation and intake air temperature correction this gives an unprecedented level of tuning accuracy. i-Series ECUs are in field upgradeable, no need to return the ECU for software updates.

All Vi-PEC i-Series Wire-In Engine Management Systems are designed with flexibility and ease of installation in mind. Vi-PECWire-In systems are deigned to be wired to either existing wiring or preferably as a complete re-wire. In some cases header boards can be purchased to allow wiring of the i-Series ECU to factory ECU headers. Contact your nearest Vi-PEC dealer for more information on these.

Vi-PEC Engine Management Systems are designed with the final result in mind. Not only do they boast an impressive range of performance features, but are designed with a focus on safety, reliability and drive-ability. However, the ultimate success of your engine management upgrade is determined by how well the system is installed and tuned.

Installing and tuning any after-market engine management system is not to be taken lightly. i-Series ECUs give the tuner the control & flexibility that only top after-market engine management systems in the world can provide. While every effort has been made to keep i-Series ECUs as user friendly as possible, it should be recognised that added features bring added complexity.

The complete set-up of your ECU can be divided into two equally important tasks.

1. This manual covers the wiring and installation of your i-Series ECU. While it is not strictly essential that this work is performed by an automotive electrician, the knowledge and tools available to these professionals makes it highly recommended. Regardless of who does the installation, it is of utmost importance that clean and robust connections are made throughout the installation. A significant majority of after market engine management failures are due to poor wiring practices. Note that use of complex features such as Variable Valve Timing, Electronic Throttle Control and ECU Hold Power require advanced wiring practice.
2. Once the i-Series ECU has been installed it will need to be tuned using a laptop computer with iVTS software. Information on the configuration and tuning of the i-Series ECU is detailed in the online help section of iVTS . i-Series ECUs are shipped pre-loaded with a base configuration that should be close enough to get most engines running after a few application specific adjustments have been made. While hearing the engine running on the new ECU for the first time is always a satisfying feeling, it is important to realise that the job is not complete. The amount of tuning performed and the experience of the tuner are the two most important factors in determining how happy you will be with your engine management system.

1.1 Support Options

Should any issues arise during installation, the following options exist for technical support:

1. Contact your nearest Vi-PEC dealer. A Vi-PEC dealer list is available on our website: www.vi-pec.com
2. Technical Support Email: support@vi-pec.com
3. Online Discussion Forum: Available from the Vi-PEC website.

The majority of questions received by the technical support team are clearly answered in the manuals. To speed up your technical inquiry please consult the manuals to make sure that your question has not already been answered.

2 Choosing a Configuration

As all i-Series inputs/outputs are configurable, the required connections will be highly dependent on the application. Read this section carefully to ensure the correct functions are chosen.

The first step in installing a i-Series ECU is to decide what function each of the configurable inputs and outputs will provide.

The i-Series ECUs have the following input / output pins:

IO	i44	i88
Injection Drives	4 x Peak & Hold	8 x Peak & Hold
Ignition Drives	4	8
Auxiliary Outputs	8	10
Digital Inputs	3 or 4*	10
Analog Voltage Inputs	3 or 4* + Internal MAP	11
Temperature Inputs	2	4
Knock Sensor Inputs	1	2
Regulated Outputs	+8V & +5V	+8V & +5V
Trigger Inputs	2	2

*** i44 shares one header pin for DI4 and An Volt 2 and one header pin for DI3 and Knock**

2.1 Injector Outputs

2.2 Ignition Outputs

i-Series ECUs offer up to eight independent ignition drives which can be used in a wide range of configurations from a basic distributor set-up through to more complex multi-coil arrangements. Unused ignition channels can be used for additional auxiliary outputs (simple switching functions only). Direct spark, wasted spark and distributed ignition configurations are supported.

i-Series Ignition Specifications:

- Ignition Drive High 20mA @ 5V
- Ignition Drive Low 2A over current protected
- Open Collector (not fly-wheeled) in auxiliary output mode.

2.3 Auxiliary Outputs

i-Series Wire in ECUs have up to ten general purpose auxiliary outputs. On some i-Series ECUs unused ignition and injection channels can also be used as auxiliary outputs, check the Injector Outputs and Ignition Outputs pages for more information. Auxiliary outputs are general-purpose outputs that may be used to perform a wide range of functions. However, the following limitations apply:

- A Three Terminal ISC Solenoid must be wired to Aux 1 and Aux 2.
- An ISC Stepper Motor must be wired to Aux 5, Aux 6, Aux 7 and Aux 8.
- Variable Valve Timing (VVT) solenoids must be wired to Aux 1 to 4.
- Aux 5 to 8 can not be Pulse Width Modulated (PWM) above 300Hz. Note that PWM frequencies above 300 Hz may be required to drive a tachometer for a V8 above 4500 RPM.
- Aux 5 to 10 can be used to high side drive (supply 12V to) solenoids.
- An electronic throttle motor must only be wired directly to Aux 9 (+) and Aux 10 (-).

Auxiliary outputs supply an earth to switch loads such as a solenoid, relay, bulb or LED. All auxiliary outputs may be used as a conditional switch that becomes activated at a certain value (e.g. Honda VTEC), or for more complex control operations such as as idle speed control and electronic boost control.

Loads may be connected directly to the auxiliary output without using a relay provided they do not draw more than 2A of current. Essentially this means that a directly connected load should have a resistance exceeding 7Ω. Refer to the section on wiring auxiliary outputs.

Some of the functions that may be performed by auxiliary outputs include:

- Fuel Pump Relay Switching (highly recommended for safety reasons)
- Engine Coolant Fan Relay Switching
- Electronic boost control using a boost control solenoid (uses PWM)
- Variable valve timing solenoid (e.g. VTEC)
- Warning / Check Engine Light
- Purge Control
- EGR Control
- Any function requiring an output activated by temperature, manifold pressure (MAP), RPM, gear position, digital input state etc.
- Water Injection / nitrous oxide control (uses PWM)
- Inter-cooler Water Spray
- Air Conditioning Clutch / Fan
- General Purpose PWM
- Idle Speed Control solenoids or stepper motors
- Direct Electronic Throttle Control (%BIG_ECU%> only)

i-Series Auxiliary Output Specifications:

- 1.5k Ohm Internal Pull-up Resister
- Auxiliary Drive Low 2A over-current protected
- Open Collector (fly-wheeled) in auxiliary output mode.
- Aux 5 to 8 High Side Drive (ISC Stepper Mode) 0.5 A.
- Aux 9 and 10 (i88 only) Push-Pull drive 4/4 A.

2.4 Analog/Temperature Inputs

i-Series ECUs have plentiful analog voltage and temperature channels. The difference between volt and temperature channels is temperature channels have an internal pull-up resister.

All analog volt channels are created equal and can be wired to any type of analog input (there is no restrictions as to what must be wired to each channel).

Analog Volt Inputs may be configured to accept an analog signal between 0-5V. Applications include:

- Narrow-band O2 (0-1V output)
- Wide-band O2 (via external wide-band controller)
- 0-5V Voltage (e.g. Boost Adjust)
- Pressure (from 0-5V transducer)

Temperature channels are designed to be used only with PTC or NTC thermistor sensors. Almost all factory temperature sensors fit this category. Do not wire the output of a 0-5V temperature sensor (e.g. a pyro. module) to these channels, instead use an Analog Voltage Input.

Analog Channel Specifications:

- Measurable Input Range 0-5V DC
- Input impedance 2.2M Ohm DC (4.7k Ohm AC).
- Maximum Input Voltage +/- 50 V
- Temperature Channel Pull-up Resister 1k Ohm to 5V

2.5 Digital Inputs

Digital Inputs are inputs that recognise either a high (+V) or low (GND) signal. Digital inputs are typically set-up to monitor the position of manual switches or connected to sensors that output a signal of variable frequency.

The following Digital Input Limitations Apply:

- Only Digital Inputs 1 to 6 can be used for frequency input (e.g. speed).
- Only Digital Inputs 1 to 4 can be used for Variable Valve Timing (VVT) cam position input.

i-Series ECUs have up to 10 Digital Inputs that can be configured for sensors/ switches such as:

- Vehicle Speed Sensor
- Antilag Switch
- Clutch Switch (for launch control and flat shifting)
- High / Low Boost Switch
- Water Spray Switch
- Dual Fuel / Ignition Map Switch
- Nitrous Oxide Switch
- Anti-theft Switch
- AC Request Switch

Digital Inputs have a software selectable pull-up resister that can be enabled when measuring from ground switching devices (such as hall effect sensors).

Digital Input Specifications:

- Low Level Input < 1V
- High Level Input > 2 V
- Digital Input Pull-up Resister (if enabled) 4k7 Ohm to 12V
- Maximum input voltage +/- 50 V

2.6 Trigger Inputs

Trigger inputs are required from crank/cam angle sensor(s) (CAS) for the i-Series ECU to calculate the current engine speed and position.

i-Series ECUs use on board digital trigger decoding to to determine engine position from the given signals. Set-up of the trigger inputs is performed using iVTS Tuning Software. Contact your nearest Vi-PEC dealer for advice on wiring and set-up of trigger inputs if unsure.

Trigger 1 is used to determine crankshaft position. Trigger 2 is used to determine the engines position in the firing order. In all cases Trigger 1 will need to be used. In many cases Trigger 2 must also be used.

Engines with Variable Valve Timing may also require Digital Inputs be wired to cam shaft position sensors.

Refer to the Trigger Wiring section for more information about trigger requirements for different ignition/injection set-ups.

2.7 Summary

After reading this chapter you should be able to complete a list outlining the basic configuration that will be used. It is important to write such a list as you will need to set up each output in iVTS later on. An example of such a list is shown below. A blank table to be filled out by the installer is given in the following chapter.

Configuration: 6 Cylinder, direct spark, sequential injection, turbocharged, variable valve timing	
Trigger 1	Crank Angle Sensor
Trigger 2	Cam Angle Sensor
Analog Volt 1	MAP Sensor (Vi-PEC 4 Bar)
Analog Volt 2	Throttle Position (TPS)
Analog Volt 3	After market Wide-band O2 Controller
Analog Volt 4	Factory Narrow Band O2 (0-1V)
Analog Volt 5 to 8	N/C
Analog Temp Input 1	Engine Coolant Temperature
Analog Temp Input 2	Inlet Air Temperature
Analog Temp Input 3	Fuel Temperature
Analog Temp Input 4	N/C
+5V Out	TPS and MAP sensor power
+8V Out	Cam/Crank angle sensor power supply
Ignition 1	Igniter Channel 1 (Cylinder 1)
Ignition 2	Igniter Channel 2 (Cylinder 2)

Configuration: 6 Cylinder, direct spark, sequential injection, turbocharged, variable valve timing	
Ignition 3	Igniter Channel 3 (Cylinder 3)
Ignition 4	Igniter Channel 4 (Cylinder 4)
Ignition 5	Igniter Channel 5 (Cylinder 5)
Ignition 6	Igniter Channel 6 (Cylinder 6)
Ignition 7	Fuel Pump Relay
Ignition 8	A/C Clutch Relay
Injection 1	Injector 1 (Cylinder 1)
Injection 2	Injector 2 (Cylinder 2)
Injection 3	Injector 3 (Cylinder 3)
Injection 4	Injector 4 (Cylinder 4)
Injection 5	Injector 5 (Cylinder 5)
Injection 6	Injector 6 (Cylinder 6)
Injection 7	Fuel Pump Speed Control 1
Injection 8	Fuel Pump Speed Control 2
Auxiliary Output 1	Idle Speed Control Solenoid (Close)
Auxiliary Output 2	Idle Speed Control Solenoid (Open)
Auxiliary Output 3	Tachometer
Auxiliary Output 4	Variable Valve Timing Solenoid
Auxiliary Output 5	Inter-cooler Water Spray
Auxiliary Output 6	Shift Light
Auxiliary Output 7	A/C Fan Relay
Auxiliary Output 8	Boost Control Solenoid
Digital Input 1	Vehicle Speed
Digital Input 2	Variable Valve Timing Cam Position Sensor
Digital Input 3	A/C Request Switch
Digital Input 4	I/C Spray Switch
Digital Input 5	Start Position Switch
Digital Input 6	Power Steer Switch
Digital Inputs 7 to 10	N/C

Example of usage of inputs and outputs

2.8 Installer IO Table

Fill out the following table to assist in installation. It will come in useful when configuring inputs and outputs in iVTS Tuning Software. It is important to note that not all ECU types have all of these inputs/outputs available.

Installer I/O Table		
Function	***Connection***	***Example***
Trigger 1	Crank Angle Sensor	Reluctor, Proximity, Optical or Hall
Trigger 2		
Analog Temp Input 1		NTC Thermistor sensors Only
Analog Temp Input 2		
Analog Temp Input 3		
Analog Temp Input 4		
Analog Volt 1		0-5V Input from sensor or external controller
Analog Volt 2	(Shared with DI4 on i44)	
Analog Volt 3		
Analog Volt 4		
Analog Volt 5	(Internal MAP on i44)	
Analog Volt 6		
Analog Volt 7		
Analog Volt 8		
Analog Volt 9		
Analog Volt 10		
Analog Volt 11		
+5V Out	TPS and MAP sensor power	+5V Power OUT
+8V Out		
Ignition 1		Use spare Ignition channels for switching type Auxiliary Outputs
Ignition 2		
Ignition 3		
Ignition 4		
Ignition 5		
Ignition 6		
Ignition 7		
Ignition 8		
Injection 1		Wire Inj 1 to cyl 1, 2 to 2, 3to 3 etc... Use spare Injection channels for switching type
Injection 2		
Injection 3		
Injection 4		
Injection 5		

Installer I/O Table		
Injection 6		Auxiliary Outputs
Injection 7		
Injection 8		
Auxiliary Output 1		High Frequency PWM or VVT Control. 3W-ISC Solenoid must be wired to Aux1 & Aux2.
Auxiliary Output 2		
Auxiliary Output 3		
Auxiliary Output 4		
Auxiliary Output 5		PWM less than 300 Hz or GP switching. ISC Stepper. High side driven loads.
Auxiliary Output 6		
Auxiliary Output 7		
Auxiliary Output 8		
Auxiliary Output 9	(E-throttle Motor +)	E Throttle Motor or GP Output.
Auxiliary Output 10	(E-throttle Motor -)	
Knock 1		Knock Sensors Only
Knock 2		
Digital Input 1		Frequency Input, Switch Input or VVT Position
Digital Input 2		
Digital Input 3		
Digital Input 4	(Shared with An Volt 2 on i44)	
Digital Input 5		Frequency Input or Switch Input
Digital Input 6		
Digital Input 7		Switch Input Only
Digital Input 8		
Digital Input 9		
Digital Input 10		

Installer IO Table

3 Component Installation Locations

The i-Series Engine Management System and associated components may be installed in a variety of locations but it is important to choose component locations in accordance with the following guidelines.

3.1 ECU Location

The following items should be taken into account when choosing a location for the ECU:

1. The i-Series ECU requires environmental protection for both physical and electrical factors that may affect its performance. Normally this requires the device to be fitted inside the vehicle cabin. This position avoids the high temperatures associated with the engine bay and reduces the chances of the ECU getting wet. This position also offers some physical separation between the ECU and ignition components that may cause interference.

2. The main exception to this rule is where the engine is somewhat distant from the driving position, such as a boat. In these cases the ECU should be mounted in close proximity to the engine but NOT directly on, or next to, the engine (e.g. mounted just outside the engine compartment). The idea here is to minimise the length of wiring between the engine and the ECU while maintaining some physical distance to prevent heat and interference. It is preferable to have short main wiring and a longer tuning cable.

3. If water immersion or spray is likely (particularly for marine applications), additional protection may be necessary. A sealed plastic container may be employed here.

4. Allow sufficient space at both ends of ECU for the main wiring harness and tuning cables to be connected.

5. A mounting bracket is provided. Install the bracket on a flat surface and clip the ECU into this bracket firmly. Use only the mounting bracket provided and DO NOT drill holes in the case, as this will probably cause internal damage.

6. It is recommended that the ECU is rubber mounted in order to isolate the ECU from vibration.

7. For motorsport applications, the ECU should be located in a position that minimises the risk of physical damage in the event of the vehicle being involved in a crash. ECUs used for speedway applications should be mounted securely within the cockpit area, protected from the elements, isolated from vibration and utilise an additional retention strap for protection from high impacts.

3.2 Ignition Component Placement

All components of the ignition system have the potential to radiate large amounts of interference (electromagnetic radiation) that can wreak havoc on sensitive electronic devices. Therefore it is essential that the ignition components are carefully placed and that full suppression techniques are used. See the ignition wiring section for further details.

IMPORTANT

Never mount the igniter onto or next to the ECU

Always mount igniter(s) in the engine bay as close to the ignition coil(s) as possible. This helps to minimize the length of high current wiring between the igniter(s) and coil(s). Avoid areas of high temperature such as exhausts, turbochargers and radiators since the igniter itself will generate heat at high power. If vibration levels will be excessively high, some form of soft or rubber mounting is advisable to prevent component and wiring fatigue. Preferably igniters should be mounted on the chassis rather than the engine to reduce vibration.

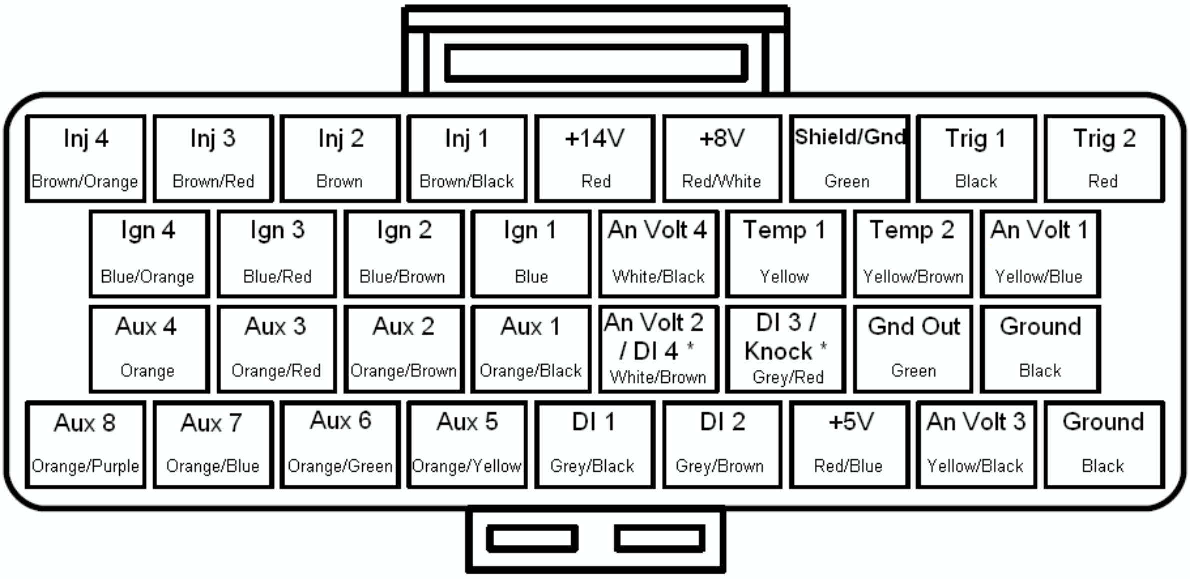
3.3 MAP Sensor Location

A Manifold Absolute Pressure (MAP) sensor is required for almost all applications. i44 ECUs have an internal MAP sensor but can also be wired using an external MAP sensor. i88 ECUs require the installation of an external MAP sensor. The MAP Sensor should be installed in a location near the engine, but away from excessive heat, vibration and moisture. It is not recommended to mount the MAP sensor directly on the engine. Refer to Input Wiring section for more information on plumbing and wiring the MAP sensor.

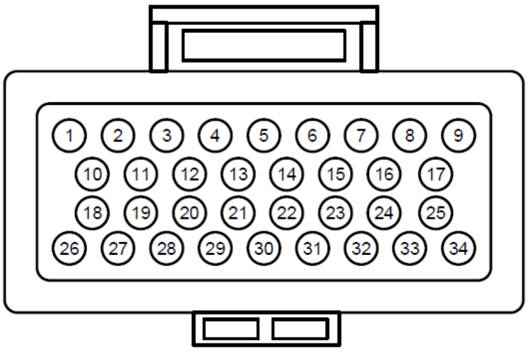
Ideally the MAP sensor should be mounted higher than the inlet manifold so that moisture will not condense in the MAP sensor hose.

4 i44 Header Pinout

Viewed looking into ECU header (or wire side of loom connector)

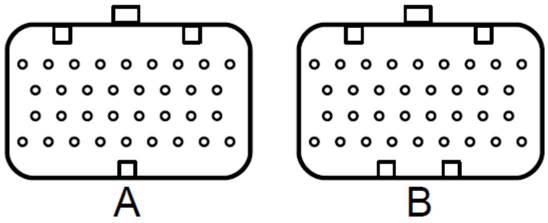


*** Pin 22 can be used as either An Volt 2 or DI 4. Pin 23 can be used as either Knock or DI 3.**

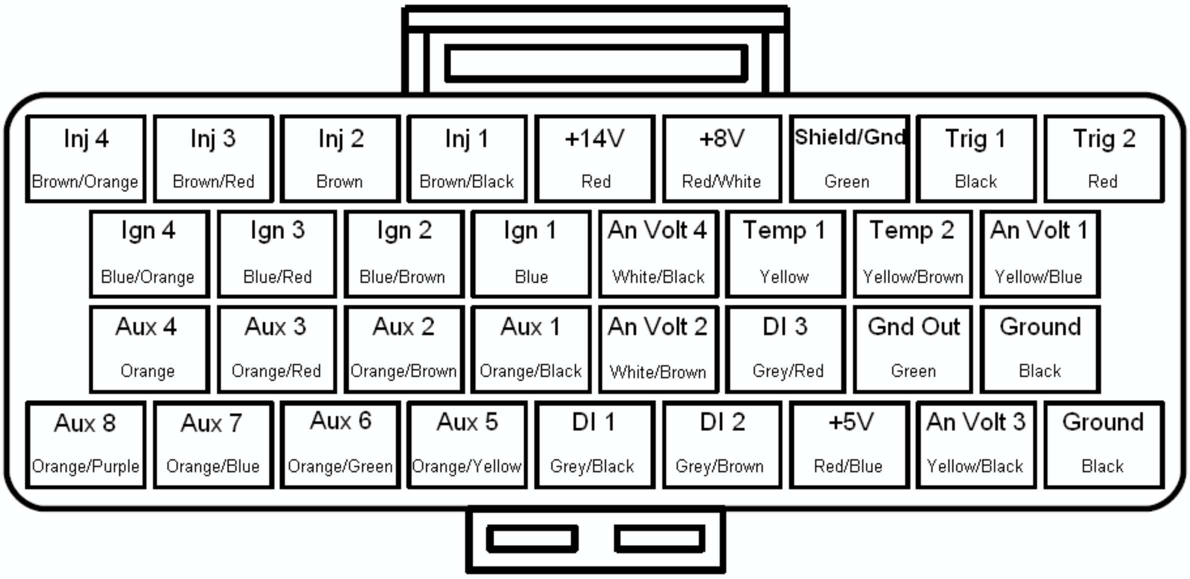


5 i88 Header Pinout

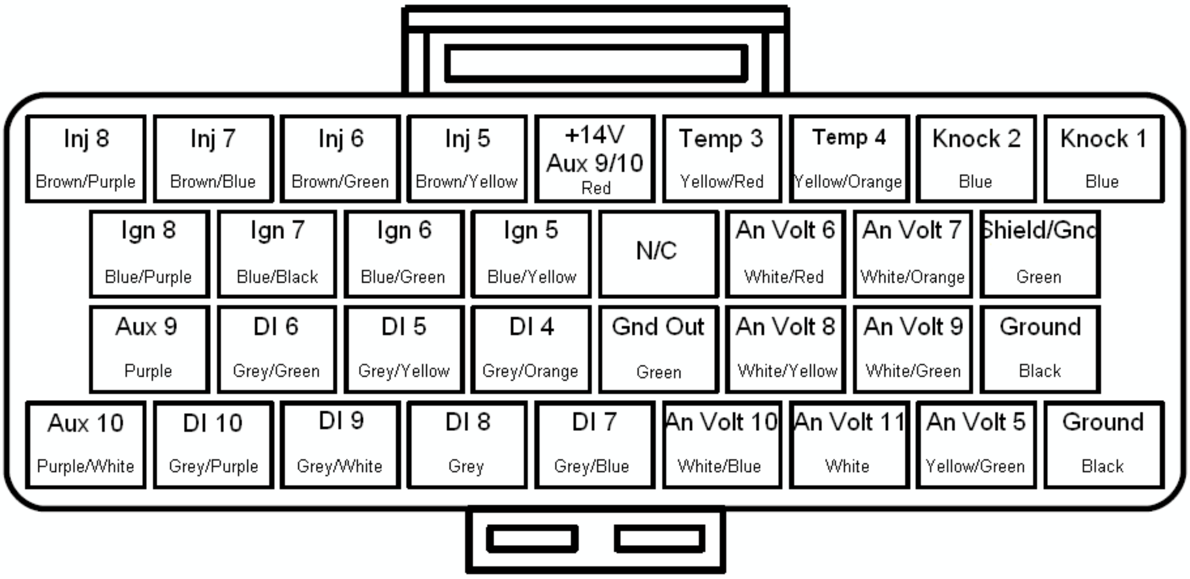
Viewed looking into ECU header (or wire side of loom connector)

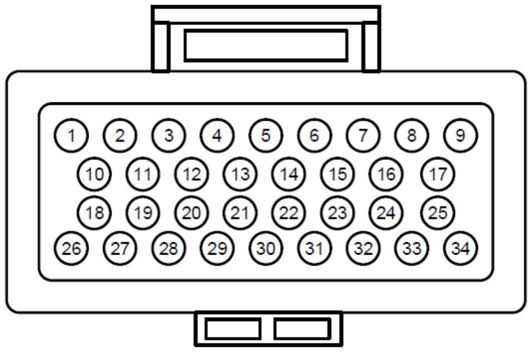


A



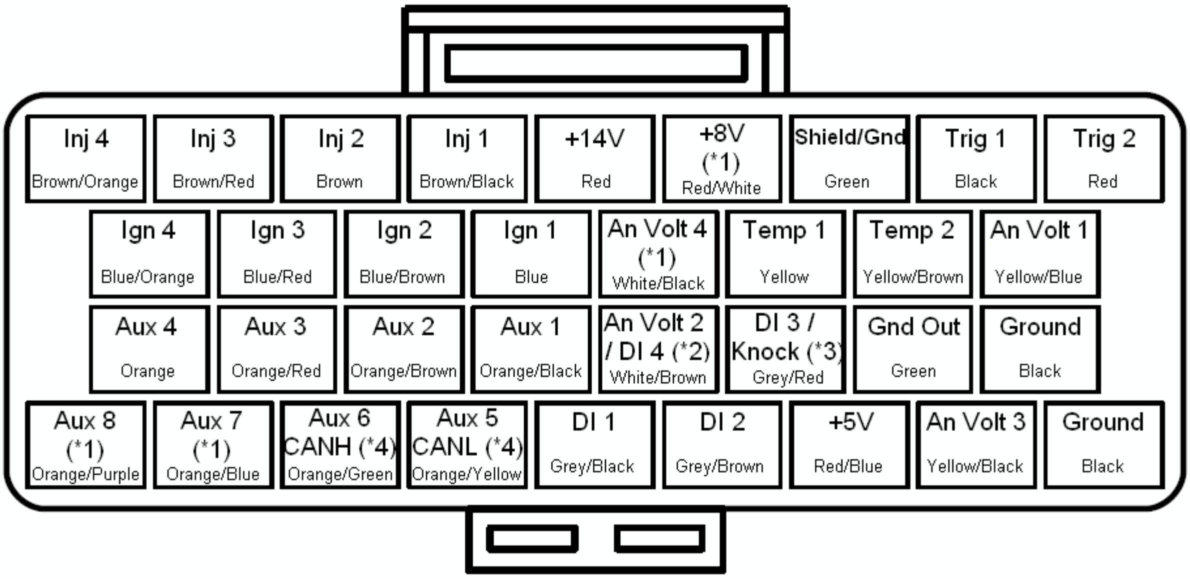
B




1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17
18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34

6 ECU A Loom Compatibility

All Vi-PEC i-Series Wire In ECUs use the same "A" connector for the wiring loom. i88 ECUs have an additional "B" connector. The ECUs are designed to maximise compatibility and provide an option and easy upgrade path. The pinout of the A connector across all ECUs is almost identical. This allows ECUs to be swapped for testing purposes or for an upgrade without changing wiring. The diagram below shows a comparison of the A connector pinout. While it should not cause any problems to plug in and out different ECU types it is up the the installer to confirm that all IO is matched and will be left in a safe state after the ECU swap.



*1 – i88 and i44 Only

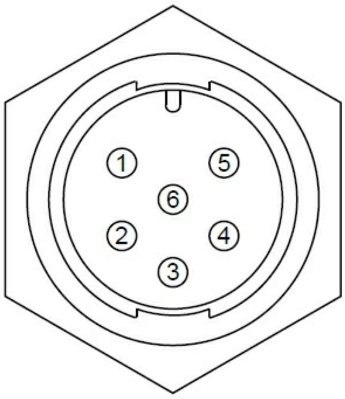
*2 – An Volt 2 on i88, DI4 or An Volt 2 on i44

*3 – DI3 on i88, DI3 or Knock on i44.

*4 – Aux on i44 and i88

7 Communications Port Pinout

Vi-PEC i-Series i88 and i44 wire-in ECUs have a communication port on the front plate of the ECU directly below the tuning port. The following is the pin information for the communication port.



Looking into ECU connector

Pin	Colour	Function
1	Brown	Ground
2	Blue	NC
3	White	CAN H
4	Green	CAN L
5	Yellow	ECU RS232 TX
6	Gray	ECU RS232 RX

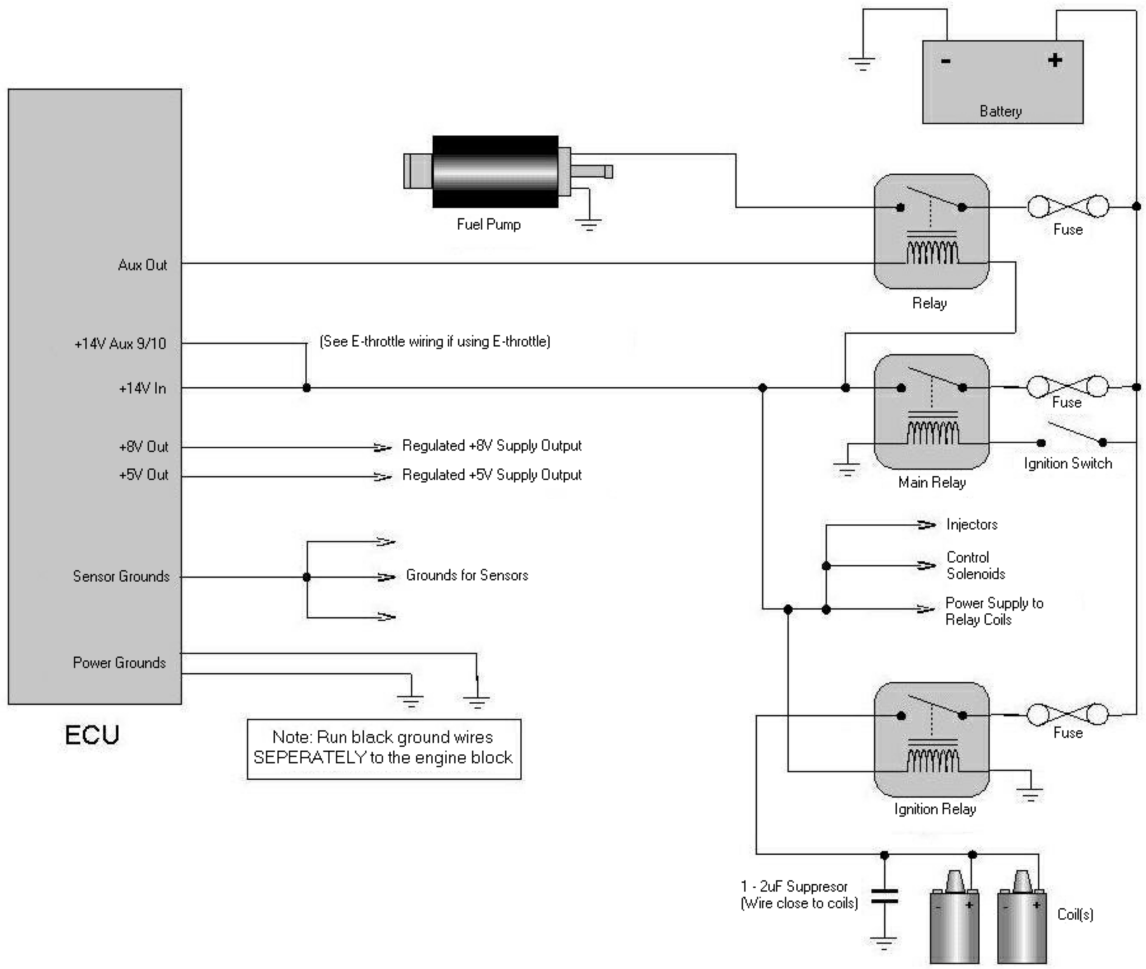
8 Power and Ground Wiring

Correct wiring of the power supplies is a very important part of the installation process. The following sections describe wiring of power supplies to the ECU and also power supplies from the ECU.

8.1 Power Supplies

The following diagram shows the recommended wiring arrangement for the power supplies. The following key points are worthy of noting:

- The switch labelled 'ignition switch' is usually the key. The wire that is used to turn on the main relay should be energised when the key is in the 'ON' position. Do not use a source that provides power when the key is in the ACC position as these are typically disconnected while the starter motor is being cranked.
- Each relay uses it's own fuse. Ideally the fuses should be located as close to the battery as possible to minimise the length of unfused wiring.
- When the main relay is turned off all other relays will turn off. However, the high current supplied by the other relays is NOT drawn through the main relay.



Power and Ground Wiring

8.2 +14V In

i44 ECUs have one red wire that supplies power to the ECUs internal supplies.

i88 ECUs have two red power wires. The power wire in connector A is used to power the ECUs internal supplies. The red +14V Aux 9/10 power wire in connector B is used to power the Aux 9 and Aux 10 drivers. For non electronic throttle control applications both red wires should be connected to a relay that provides power when the key is in the 'ON' position. BOTH +12V In wires must be connected at all times.

Although the ECU does not draw a large amount of current, the voltage applied to the '+14V In' wire must remain above 7 Volts at all times. This is especially important while the starter motor is being cranked. A significant drop in voltage will result in the ECU undergoing a reset that will stop the engine from running. As a result, it is important that the battery is in good condition and suitable for the application. Also, make sure that all wiring to the battery and associated terminals are clean and free from corrosion.

8.3 +14V Aux9/10

Note: this applies to i88 ECUs only.

The +14V Aux 9/10 wire provides an external power supply to the Aux 9 and Aux 10 driver circuitry. This allows external disconnection of the supply to these drivers as a safety measure when electronic throttle control is used. If electronic throttle control is not being used connect this wire to the same power supply as the ECUs +14V In wire. If wiring with electronic throttle control, refer to the Electronic Throttle Control section of this manual.

This wire MUST be powered in order for the ECUs self diagnostics and the Aux 9 and 10 drivers to function properly.

8.4 Power Ground

These wires supply the high current earth for the output drives. Since these wire will carry substantial currents, ensure they are well terminated to a clean earth point on the engine block. It is also essential that there is a good clean connection between the engine block and battery negative terminal.

IMPORTANT!

The Power Grounds MUST be run as SEPARATE wires. DO NOT be tempted to join them together at the ECU and run as a single wire. Also beware of poor earth points around the engine. Some manifolds and other attaching parts may be rubber mounted and therefore have poor earth bonding. A good rule of thumb is to use the engine BLOCK or HEAD rather than attaching parts.

8.5 Sensor Ground

These wires are used to supply a ground reference for the sensors used by the i-Series ECU. As such, it is ESSENTIAL that these wires are used for all sensors that require a ground (e.g. throttle position sensor, coolant temperature sensor, etc.). Failure to do this may result in unstable sensor readings causing erratic ECU operation. Do NOT be tempted to ground sensors to the engine block unless it is absolutely necessary (e.g. single wire sensor).

IMPORTANT!

Do NOT connect any green Sensor Ground Wires to the engine block or other grounded point. This will cause current from other devices to flow in the sensor ground wires and may result in unstable sensor readings. Most sensors are isolated from ground so this is usually not a problem. Pay particular attention to this point when connecting external controllers.

8.6 +5V Out

This wire supplies a regulated and over current protected +5V to be used by sensors that operate from a 5V supply. The most common example is a throttle position sensor (TPS) and some manifold absolute pressure (MAP) sensors. Do NOT connect this wire to +12 volts or any other +5V supply.

8.7 +8V Out

Note: This does not apply to the i-Series i88 based plug-in ECUs.

This wire supplies a regulated +8V to be used for the Crank Angle Sensor (CAS) if optical or hall sensors are being used. **Do not use this wire to supply power for other devices.** Care must be taken as some optical and hall sensors are designed to use a 5V supply and may be damaged if supplied with 8V. If a 5V supply is required then the '+5V Out' may be used.

8.8 ECU Hold Power Wiring

This wiring method is only used when an Idle Speed Control (ISC) Stepper motor is wired. This wiring method allows the ECU and engine management system to remain powered after the key has been switched off. This allows the ISC stepper motor to be reset to the appropriate position for the next start up. The ECU will shut down the system when reset is complete.

The other alternative is to reset the stepper motor at key-on, which can cause excessive over-rev on start up or extended cranking periods.

This wiring method is shown in the following diagram.

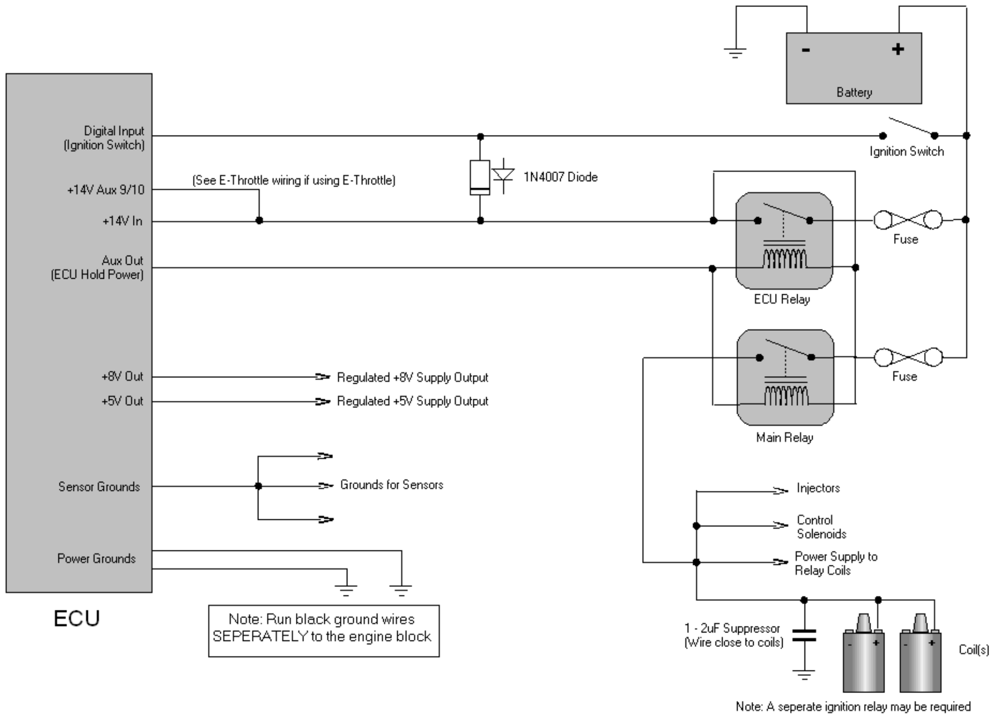
How it works:

1. The ignition switch is turned on, powering the ECU through the external diode.
2. The ECU powers up and switches the ECU and Main Relays on.
3. All systems are powered through the relays now and run as normal.
4. When the ignition switch is turned off, the ECU senses this through its Digital Input.
5. The ECU resets the stepper motor to its default position, then shuts off the ECU and Main relays when it is ready causing the system to power down.

The following items must be set-up in iVTS Tuning Software when using this wiring. This should be done on the bench before installing the ECU to prevent damage to the diode as it will be powering the system until ECU hold power is set up.

- The appropriate Digital Input must be configured as 'Ignition Switch'.
- The appropriate Auxiliary Output (or Ignition or Injection channel) must be configured as 'ECU Hold Power'.
- The ISC Control 'Stepper Reset' function should be set to 'Key OFF'.

The correct operation of this wiring system can be tested by listening for a pause of a few seconds between switching the key off and the ECU and Main relays switching off. The ISC stepper motor may also be heard operating during this period.



ECU Hold Power Wiring

9 Input Signal Wiring

The following sections describe wiring of the various types of sensors used as inputs to the i-Series ECU.

9.1 Trigger Inputs

Trigger inputs are required for the i-Series ECU to calculate engine speed as well as engine position. In all but the most basic applications both Trigger 1 and Trigger 2 must be used. These must be connected to crankshaft or camshaft position sensors to provide the required information.

- Trigger 1 is used to determine crankshaft position.
- Trigger 2 is used to determine the engines position in the firing order (cam position). Often called the sync signal.
- Digital Inputs may be required for Variable Valve Timing camshaft position sensors (Refer to Digital Inputs Wiring for more information).

In applications using direct spark or sequential injection, Trigger 2 must always be driven from a sensor on the camshaft a sensor using a trigger wheel that performs one revolution for each 720 degree engine cycle.

The Trigger 1 and Trigger 2 cables each include two wires surrounded by a braided shield. These have the following functions.

Trigger 1 Cable (Black)

Black	Trigger 1 signal input
White	Sensor Ground

Trigger 2 Cable (Grey)

Red	Trigger 2 signal input
White	Sensor Ground

The braided shield in both cables MUST not be grounded at the sensor end. If the sensor has its own shielded wire connection, make sure this does not connect directly to the engine block.

There are a large number of triggering variants used by different engine manufacturers. The important differences are the type of sensors used, the number of pulses sent from the sensors during an engine cycle and the timing of the pulses in relation to the engine cycle. There are two main types of sensors that are commonly used. It is important that the sensor type is known, as the wiring for each type is completely different.

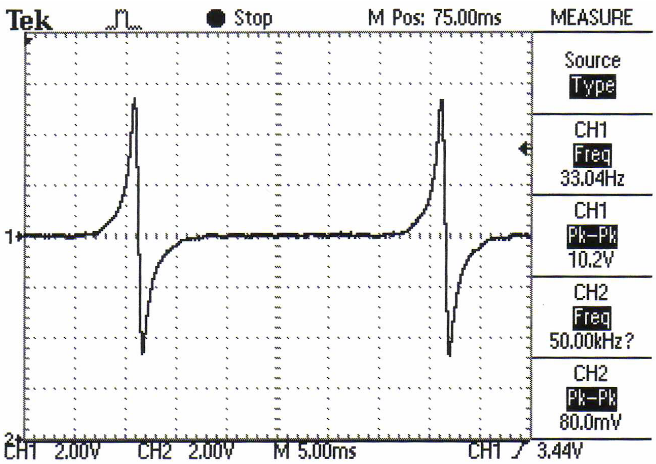
9.1.1 Reluctor/Magnetic Sensors

Reluctor/Magnetic sensors have a toothed trigger wheel that passes across the face of the sensor. The movement of the teeth past the sensor generates a voltage in the sensors winding. These sensors usually have only two wires as the sensor itself generates a voltage. One wire is the sensor ground while the other is the signal output. Some reluctor sensors have a second ground to sheild their enclosure and therefore have three wires. These sensors are often identified by sharp tooth profiles.

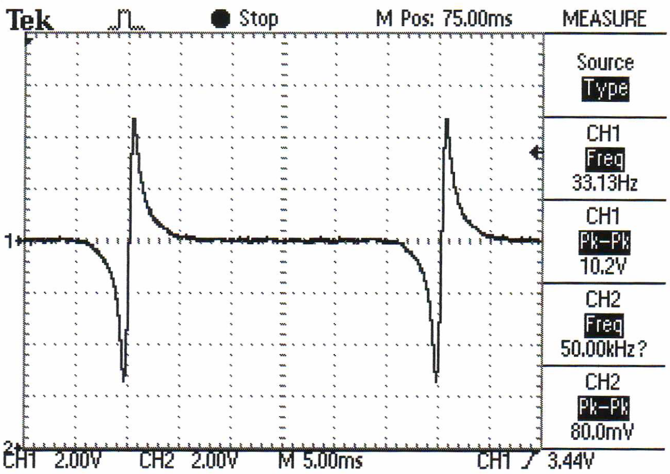
IMPORTANT!

The polarity of the reluctor sensors two wires is very important and must be correct. Wiring of sensors incorrectly could result in erratic running and possibly engine damage

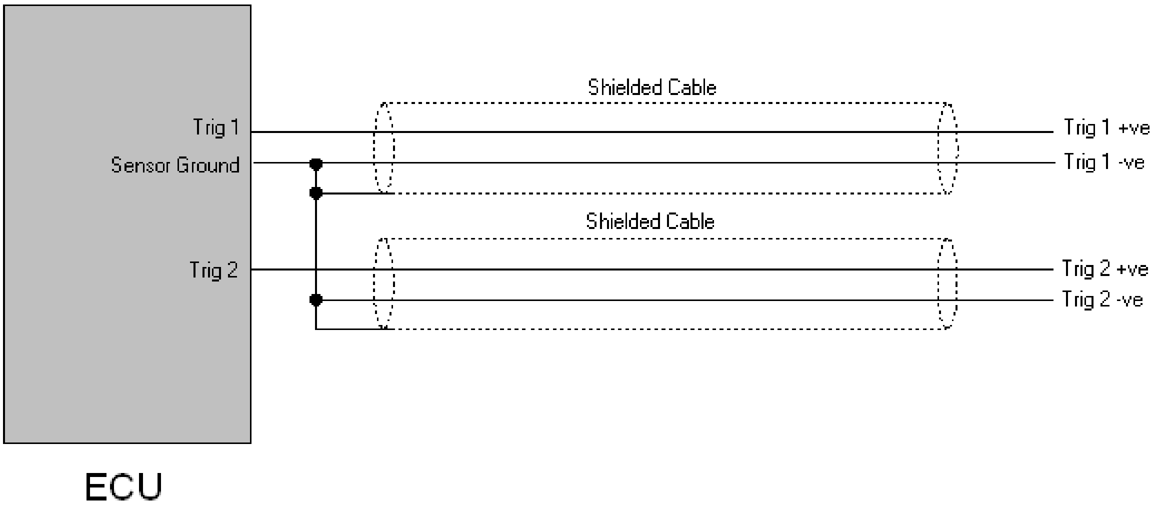
Reluctor sensors MUST be wired so that the ECU sees a positive voltage as the tooth approaches the sensor and a negative voltage as the tooth leaves the sensor. An oscilloscope is usually required to determine correct reluctor polarity.



Correct Reluctor Polarity



INCORRECT Reluctor Polarity



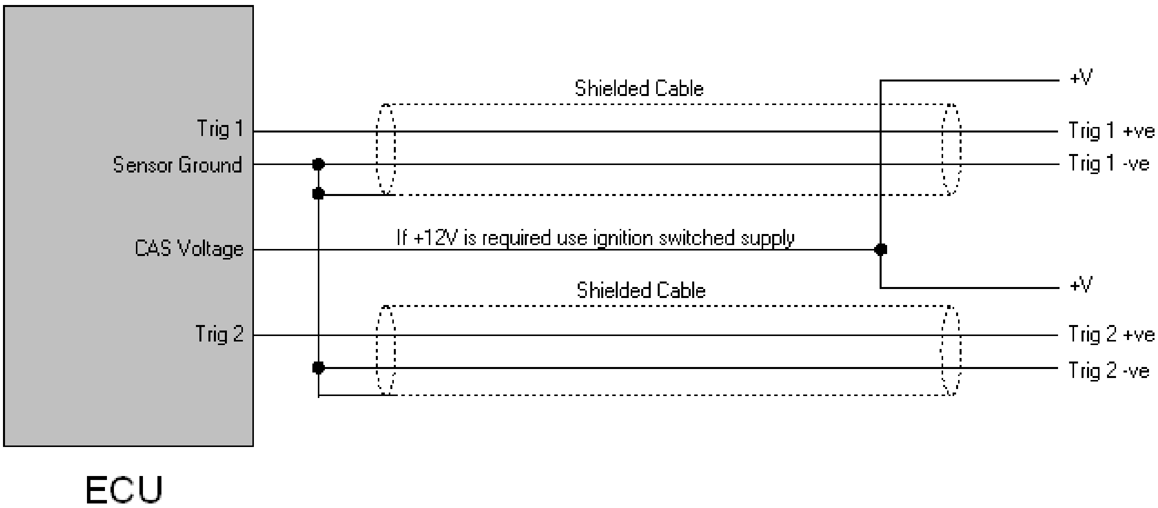
Reluctor Sensor Wiring

9.1.2 Hall/Optical/Proximity Sensors

Optical, Hall effect and Proximity sensors typically use a trigger wheel with slots or tabs cut out to generate pulses. These sensors require a power supply and typically have three wires.

The +8V Supply offers a regulated 8V for optical or hall sensors. These wires are not used for reluctor sensors. Note: many hall sensors will not tolerate 12V and require a 5V or 8V regulated supply.

Most optical or hall sensors will require the 'Trigger Pull-up Resistors' to be turned on, this is done in the 'Trigger 1' and 'Trigger 2' menus in iVTS.



Hall/Optical/Proximity Sensor Wiring

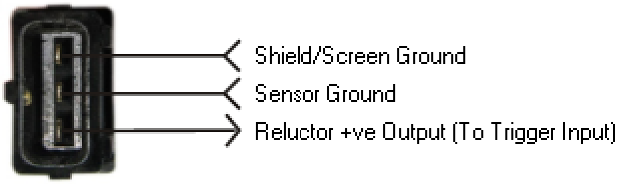
Note: Honeywell GT101 Hall sensors are **not** suitable for a trigger sensor.

9.1.3 Specific Trigger Applications

Enter topic text here.

9.1.3.1 Audi Quattro 5 Cylinder

5 Cylinder Audi Quattro Crank Angle Sensor



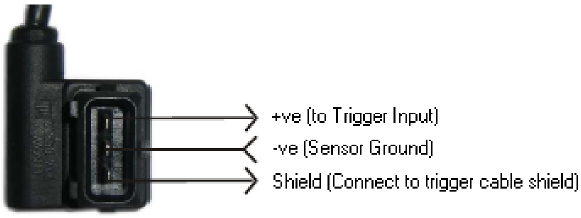
5 Cylinder Audi Quattro Crank Angle Sensor Wiring

Note: Connect sensor shield to braided part of trigger cable.

9.1.3.2 BMW M50

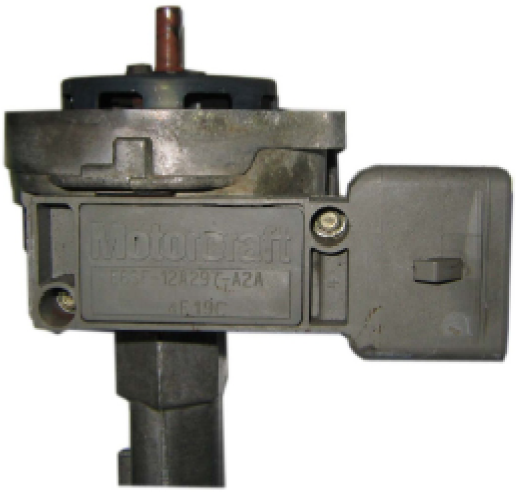
BMW M50 Cam Angle Sensor

BMW M50 Crank Angle Sensor

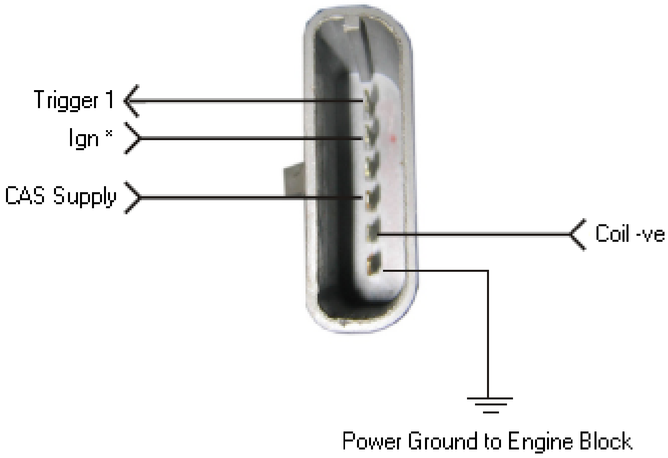


BMW M50 Cam/Crank Angle Sensor Pinout

9.1.3.3 Ford Motorcraft

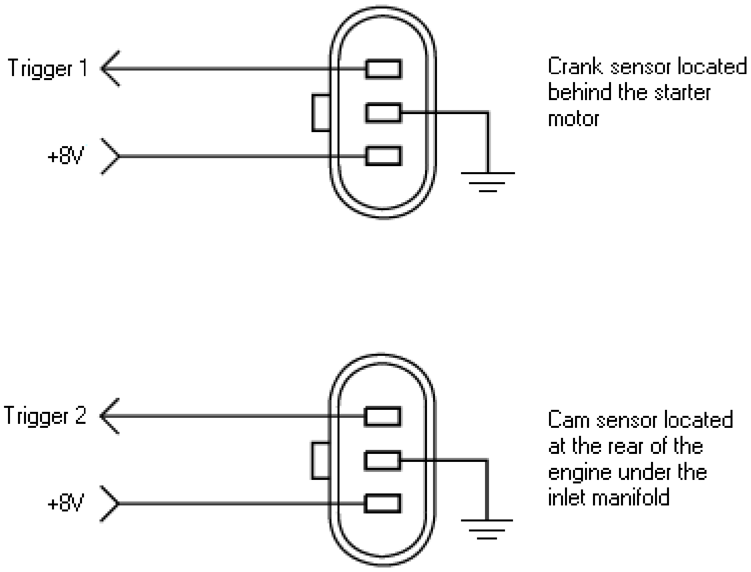


Ford Motorcraft Distributor



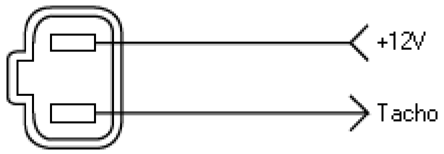
Ford Motorcraft Distributor Wiring

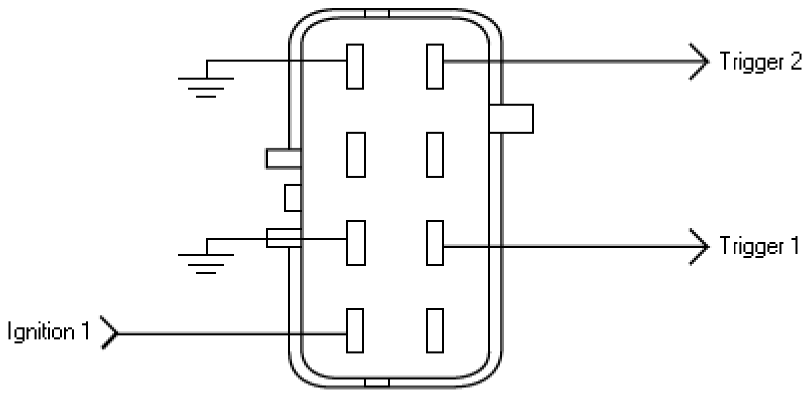
9.1.3.4 GM LS1



LS1 Crank and Cam Sensor wiring

9.1.3.5 Honda 24 Tooth

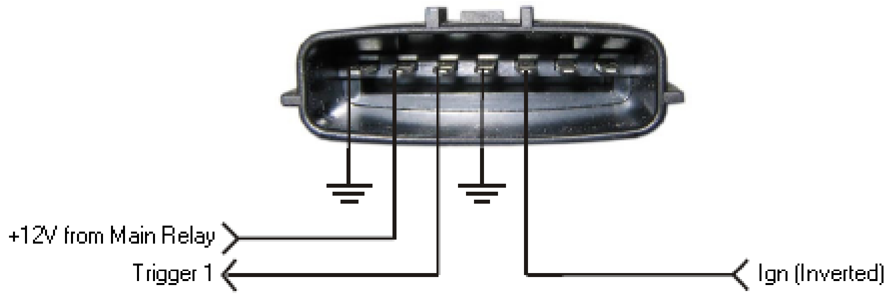




Honda 24 Tooth (Distributor) Trigger Wiring. As found on Honda H22A Engine.

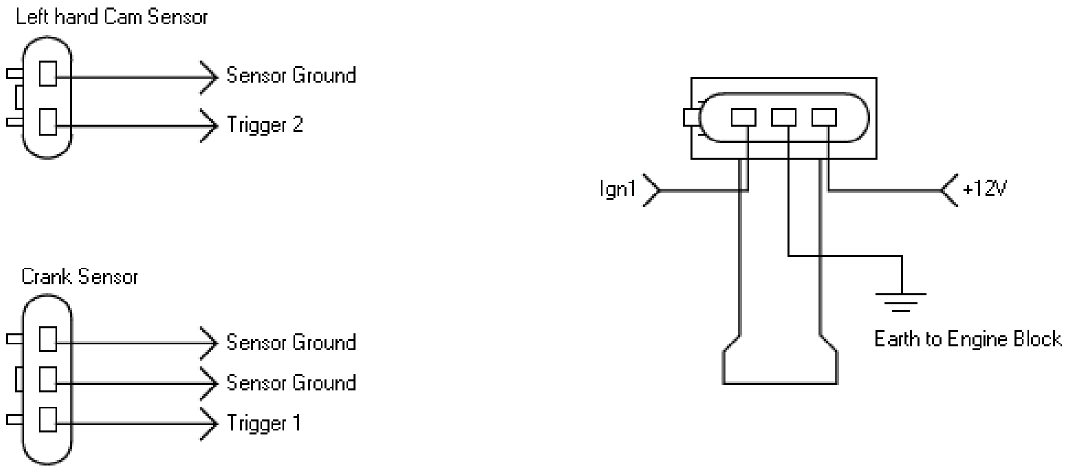
9.1.3.6 Honda Civic EK

Honda Civic EK 1600 Crank Angle Sensor



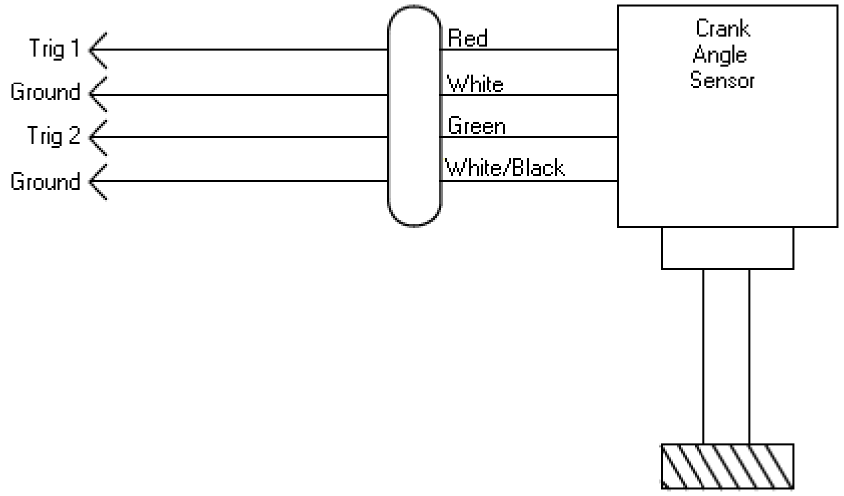
Honda Civic EK 1600 Crank Angle Sensor Wiring

9.1.3.7 Honda S2000



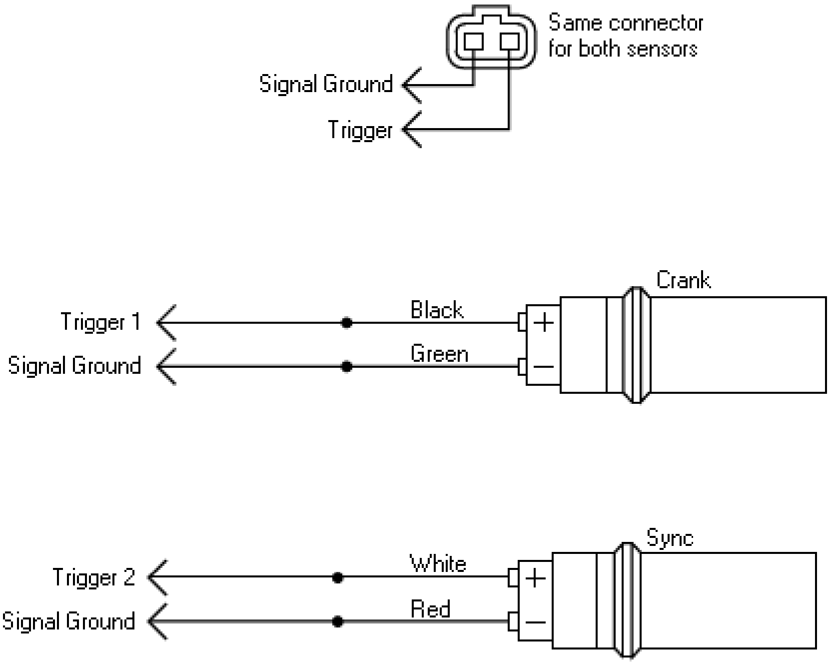
Honda S2000 Triggers and Ignition

9.1.3.8 Mazda 13B Series 4 & 5



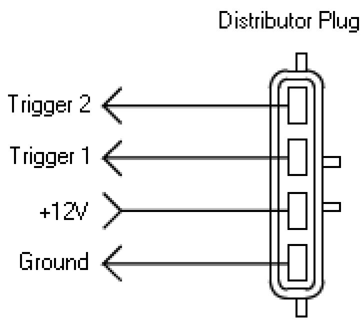
Mazda 13B (Series 4 & 5) Crank Angle Sensor Wiring

9.1.3.9 Mazda 13B Series 6, 7 & 8



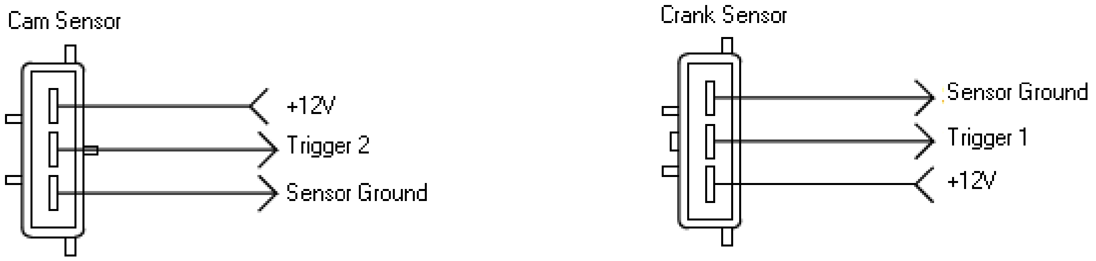
Mazda 13B Series 6, 7 & 8 Trigger Wiring

9.1.3.10 Mazda 323 (Distributor)



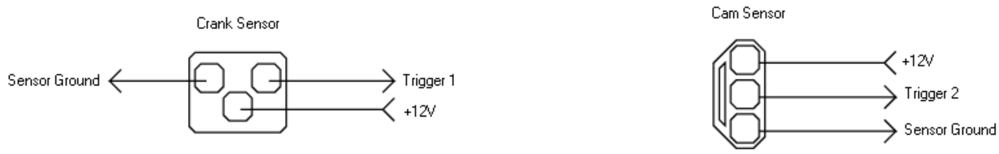
Mazda 323 (Distributor) Wiring

9.1.3.11 Mazda MX5



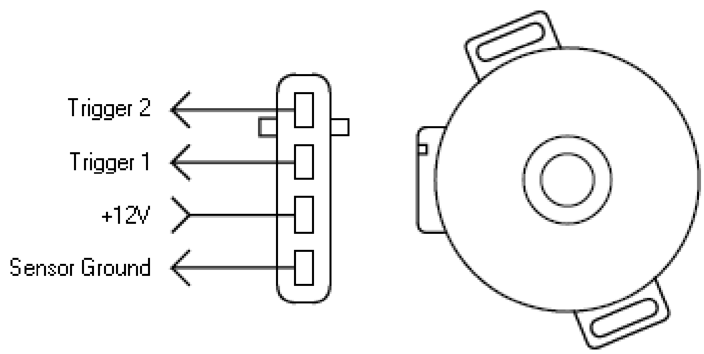
Mazda MX5 Trigger Wiring

9.1.3.12 Mitsubishi FTO/GTO



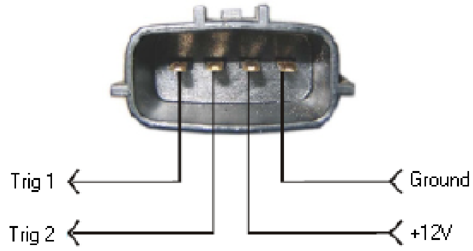
Mitsubishi FTO/GTO Trigger Wiring

9.1.3.13 Mitsubishi VR4 4G63

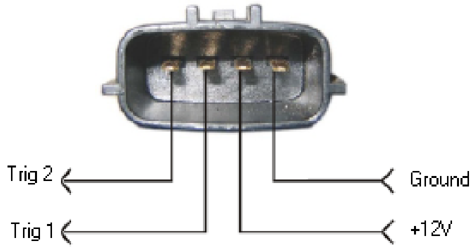


Mitsubishi VR4 4G63 Trigger Wiring

9.1.3.14 Nissan ECCS

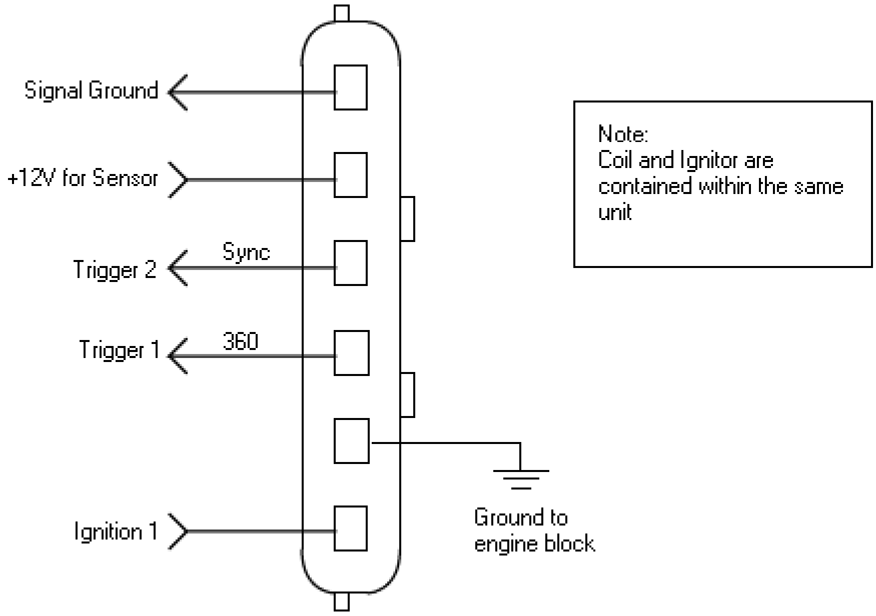


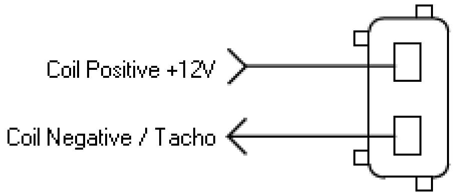
G1 + G2



G3, G4 and G4+

9.1.3.15 Nissan SR20DE Distributor

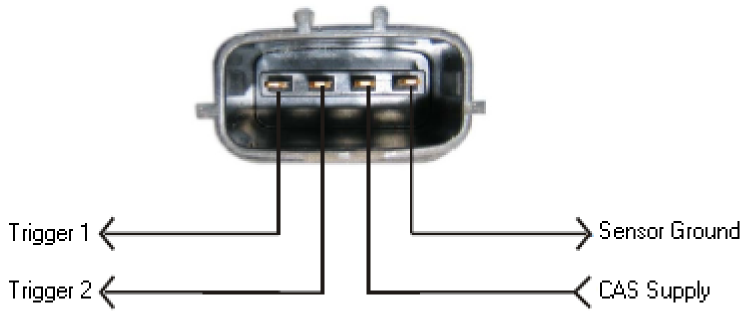




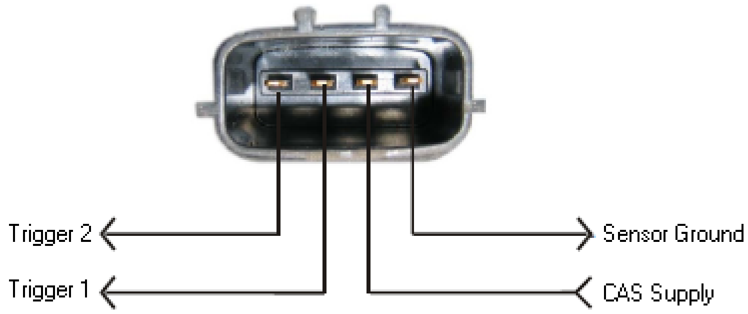
Nissan SR20DE (Distributor) Trigger Wiring

9.1.3.16 Nissan VH41

Nissan VH41 Crank Angle Sensor



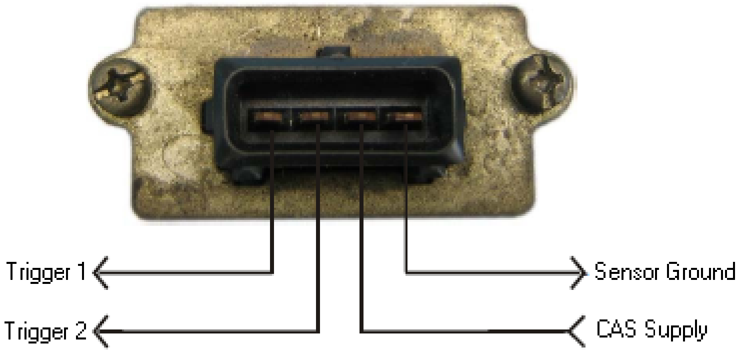
Nissan VH41 Crank Angle Sensor Wiring (G1 & G2 ECUs)



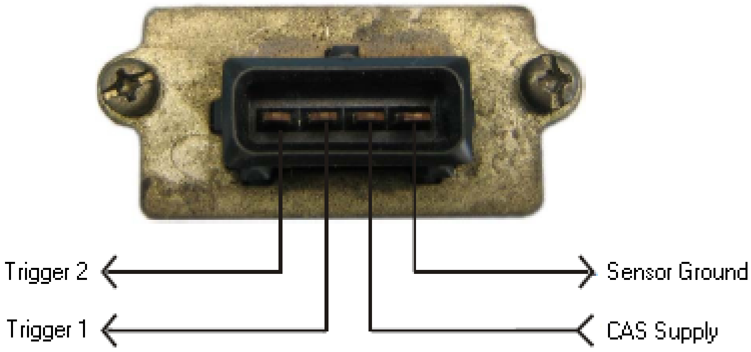
Nissan VH41 Crank Angle Sensor Wiring (G3, G4 and G4+ ECUs)

9.1.3.17 Nissan VH45

Nissan VH45 Crank Angle Sensor

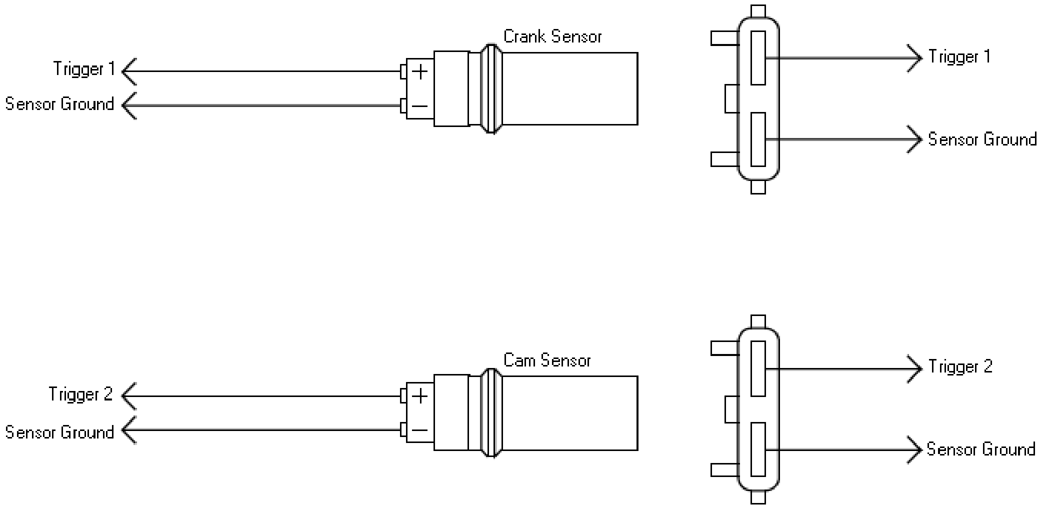


Nissan VH45 Crank Angle Sensor Wiring (G1 & G2 ECUs)



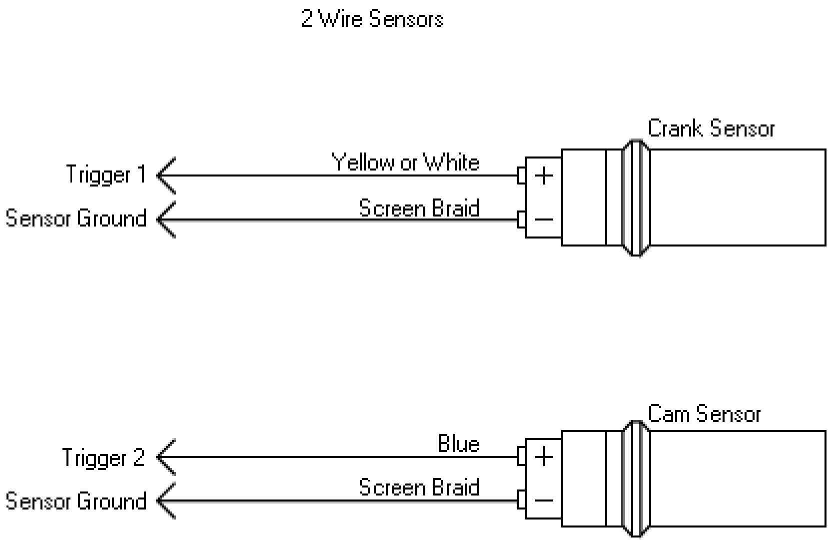
Nissan VH45 Crank Angle Sensor Wiring (G3, G4 & G4+ ECUs)

9.1.3.18 Nissan VQ30

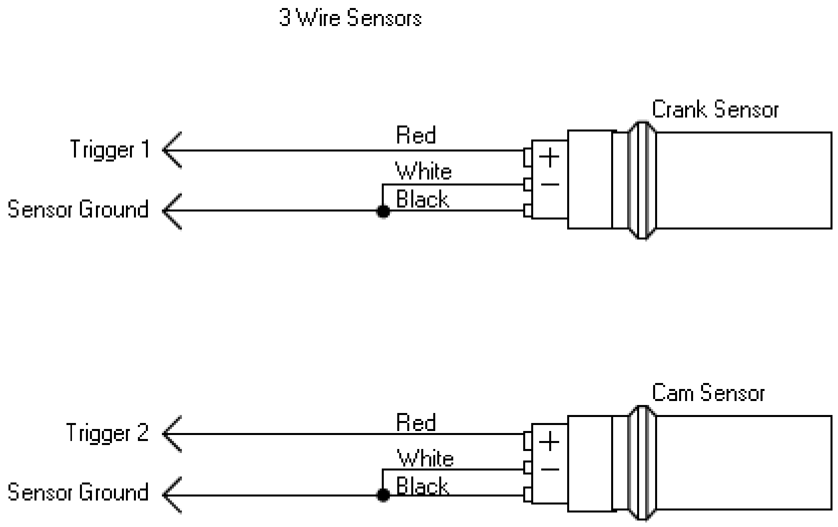


Nissan VQ30 Trigger Wiring

9.1.3.19 Subaru EJ

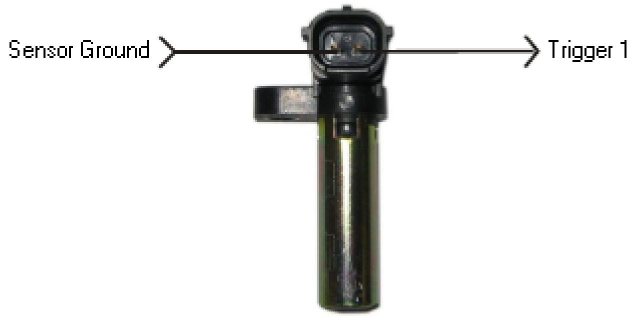


Subaru EJ 2 Terminal Trigger Wiring



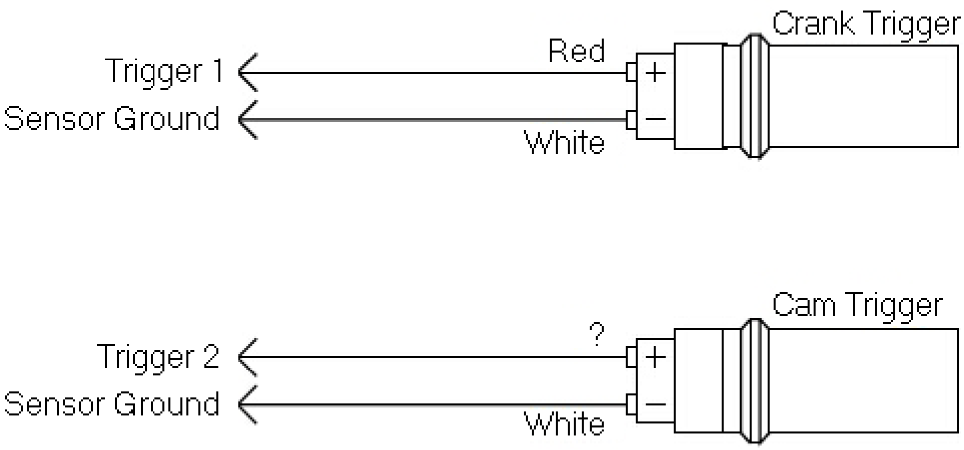
Subaru EJ 3 Terminal Trigger Wiring

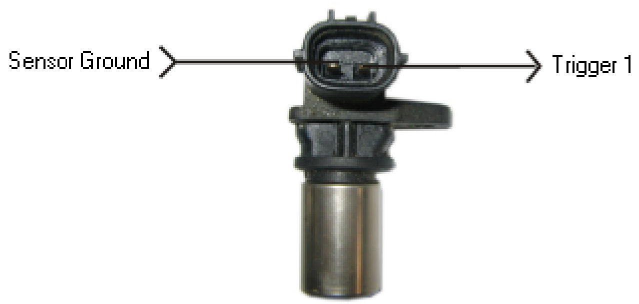
9.1.3.20 Subaru EZ30R



Subaru EZ30R (H6) Crank Angle Sensor Wiring

9.1.3.21 Toyota 1UZ-FE

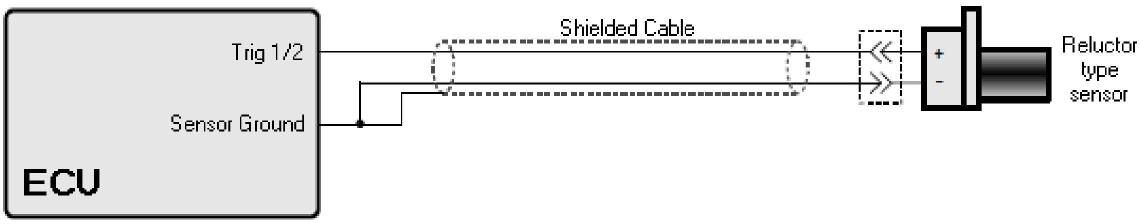




Toyota 1UZFE Crank Angle Sensor Wiring

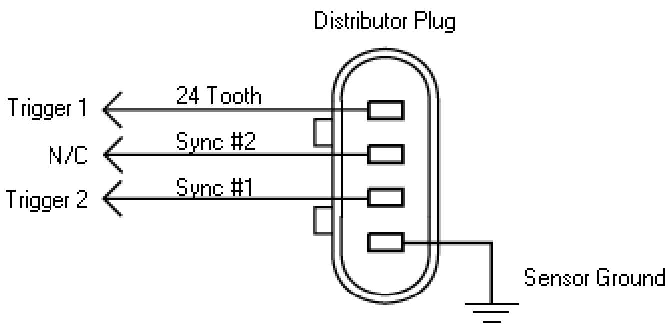
9.1.3.22 Toyota 1ZZ-FE

1ZZ Crank Angle Sensor Polarity



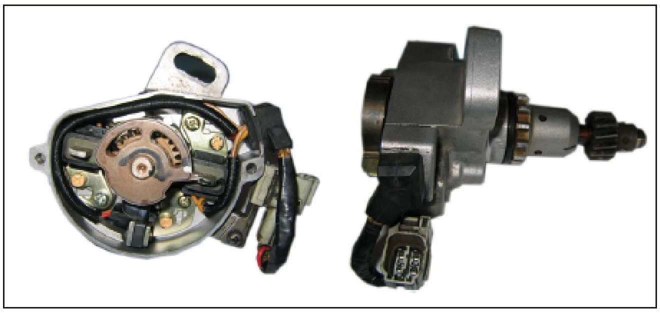
Toyota 1ZZ Crank and Cam Angle Sensor Wiring

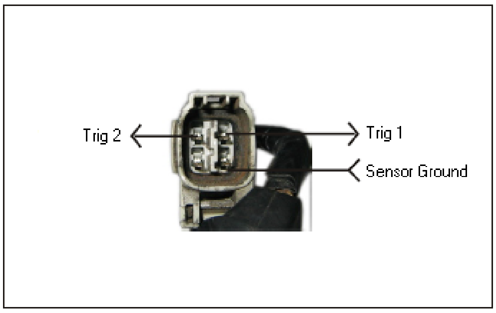
9.1.3.23 Toyota 24 Tooth



Toyota 24 Tooth Distributor Wiring

9.1.3.24 Toyota 4AGZE





9.2 Analog Inputs

Analog Inputs are divided into Temperature Inputs (An Temp) and Analog Voltage Inputs (An Volt).

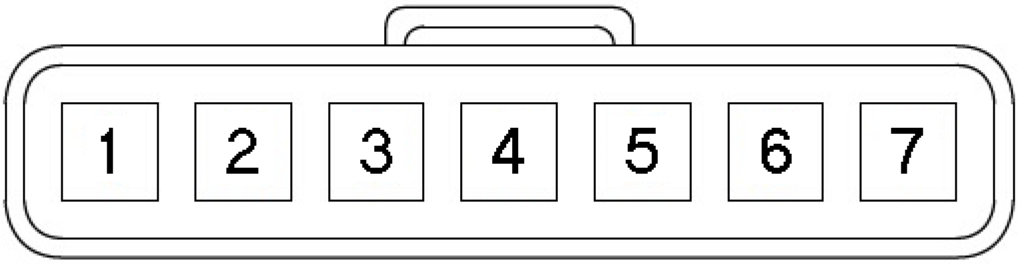
The primary difference between An Temp and An Volt channels is that An Temp inputs have an internal pull up resistor fitted that makes them only suitable for use with thermistor type (NTC or PTC) temperature sensors.

Both An Temp and An Volt inputs are capable of measuring signals over a 0-5V range. Signal voltages outside that range will not damage the inputs, but will not be measured.

9.2.1 Air Flow Meter Sensors

9.2.1.1 Specific Air Flow Meter Applications

9.2.1.1.1 Mitsubishi EVO IV-VIII AFM

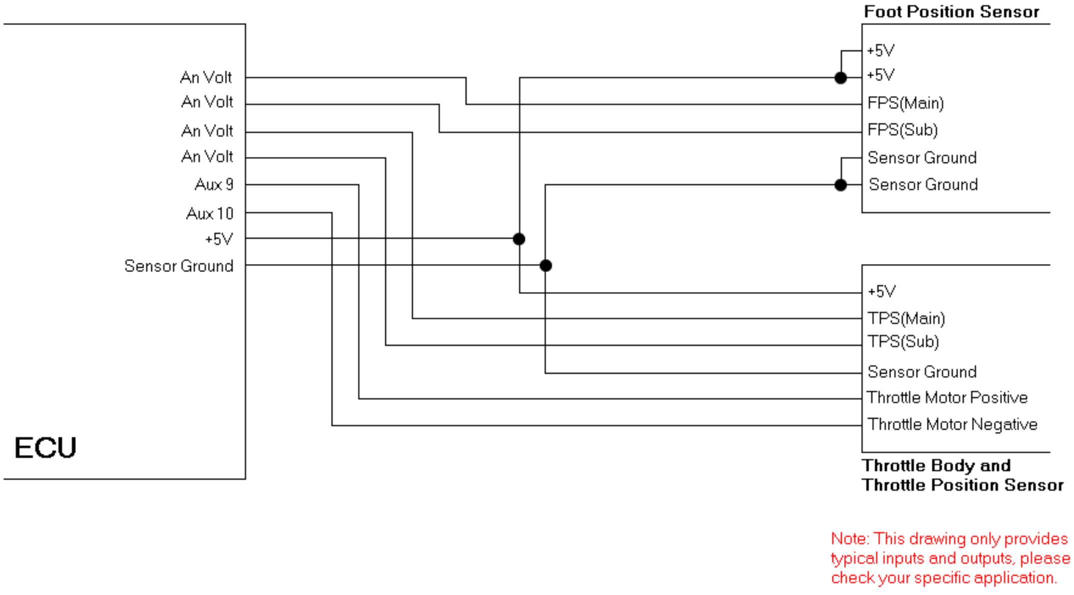


Looking into Air Flow Meter

1	+5V
2	Baro
3	AFM Signal
4	+12V
5	Sensor Ground
6	Ambient Temp

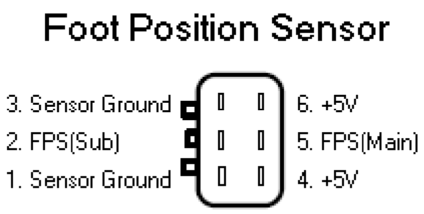
9.2.2 Foot Position Sensors

9.2.2.1 Generic FPS Wiring



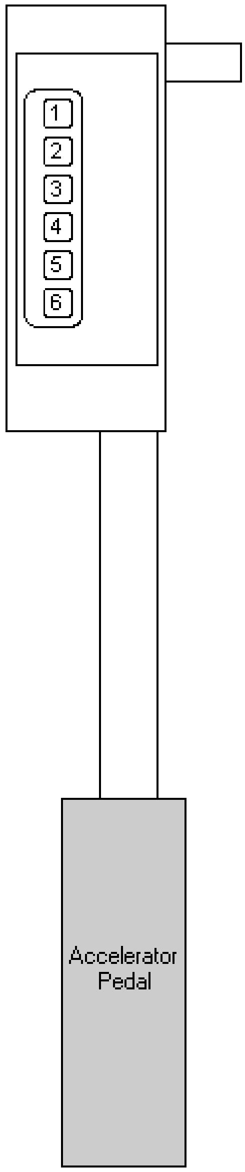
9.2.2.2 Specific FPS Applications

9.2.2.2.1 Nissan VQ35 FPS



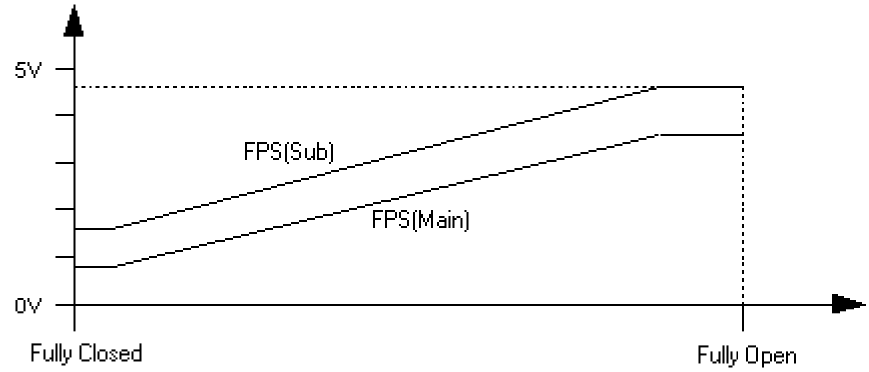
Nissan VQ35 Foot Position Sensor Wiring (Looking into FPS)

9.2.2.2.2 Suzuki Swift FPS



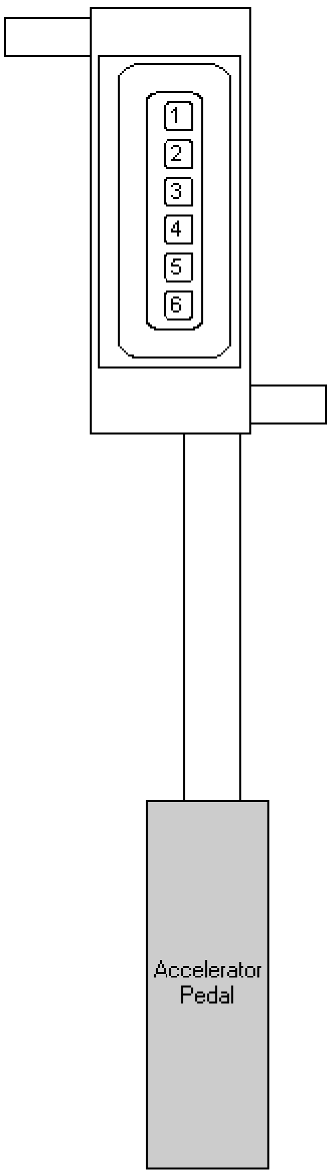
Pin #	Description
1	FPS(Main)
2	Sensor Ground (Main)
3	+5V (Main)
4	FPS(Sub)
5	Sensor Ground (Sub)
6	+5V (Sub)

Suzuki Swift Foot Position Sensor Wiring



Suzuki Swift Pedal Position vs Output Voltage

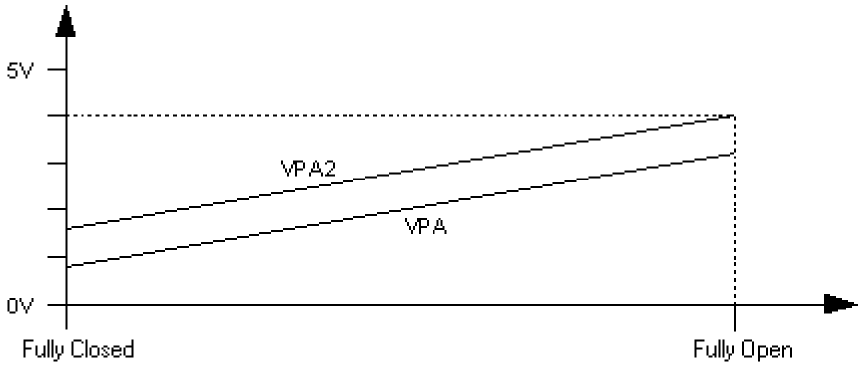
9.2.2.2.3 Toyota 3UR-FE FPS



Pin #	Toyota Naming	Description

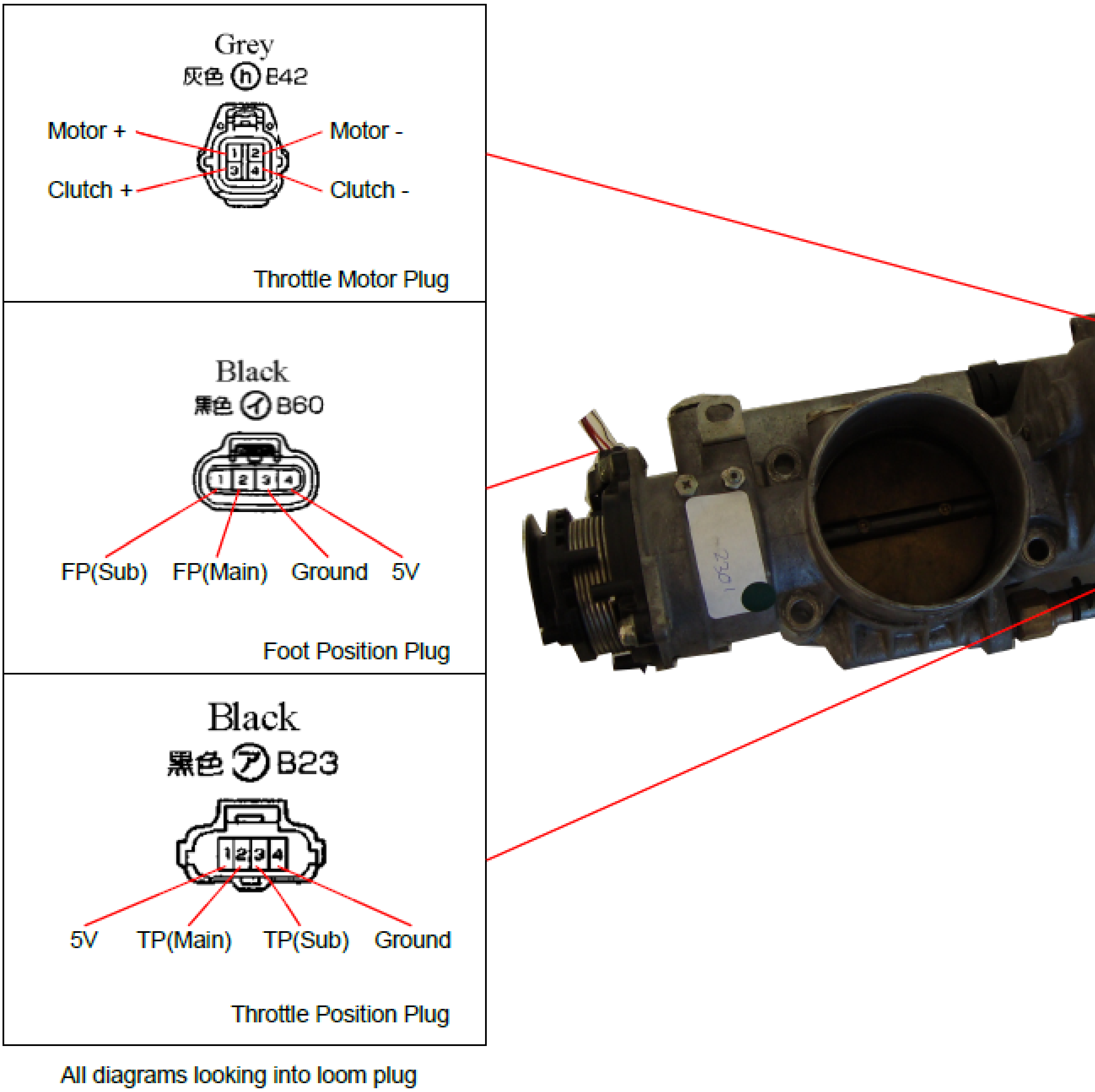
1	VPA	FPS(Main)
2	EPA	Sensor Ground (Main)
3	VCPA	+5V (Main)
4	VPA2	FPS(Sub)
5	EPA2	Sensor Ground (Sub)
6	VCPA2	+5V (Sub)

Toyota 3UR-FE FPS Wiring



Toyota 3UR-FE FPS Pedal Position vs Output Voltage

9.2.2.2.4 Toyota Clutched E-Throttle FPS



Toyota Clutched E-Throttle FPS Wiring

9.2.3 MAP Sensors

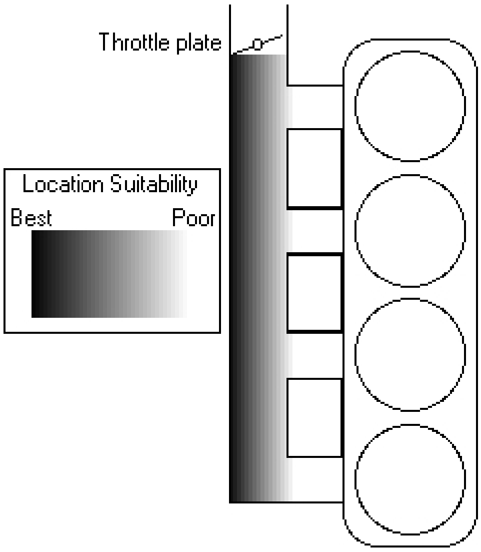
9.2.3.1 Generic MAP Wiring

A MAP sensor will be required in all cases except for naturally aspirated engines with very aggressive camshaft profiles. The MAP fluctuations caused by large amounts of overlap result in a very unstable MAP reading especially at idle. Also note that multi-butterfly engines often give a poor vacuum signal. In these cases, it is best to use the throttle position (rather than MAP) to indicate the engine load. In all cases where forced induction is used, a MAP sensor is required.

i-Series i44 ECUs have an internal MAP sensor. If a higher pressure is required than that of the internal MAP sensor, an external MAP sensor can be wired to an Analog Volt input. To use the internal MAP sensor connect the MAP pressure hose to the barbed fitting on the ECU's end plate.

i-Series i88 ECUs require the wiring and mounting of an external MAP sensor (if a MAP sensor is to be used).

The MAP sensor must be connected to the inlet manifold via a suitable length of 3mm (minimum size) vacuum hose. The take off point must be between the engine and throttle plate so that the MAP sensor registers vacuum (as well as pressure on turbo applications). The take off point must be from a common chamber that is connected to all cylinders rather than off a single intake runner. The fuel pressure regulator's pressure signal is usually a good take-off point. However, do not be tempted to share the MAP sensor vacuum hose with other devices such as a boost gauge or in particular a blow off valve.

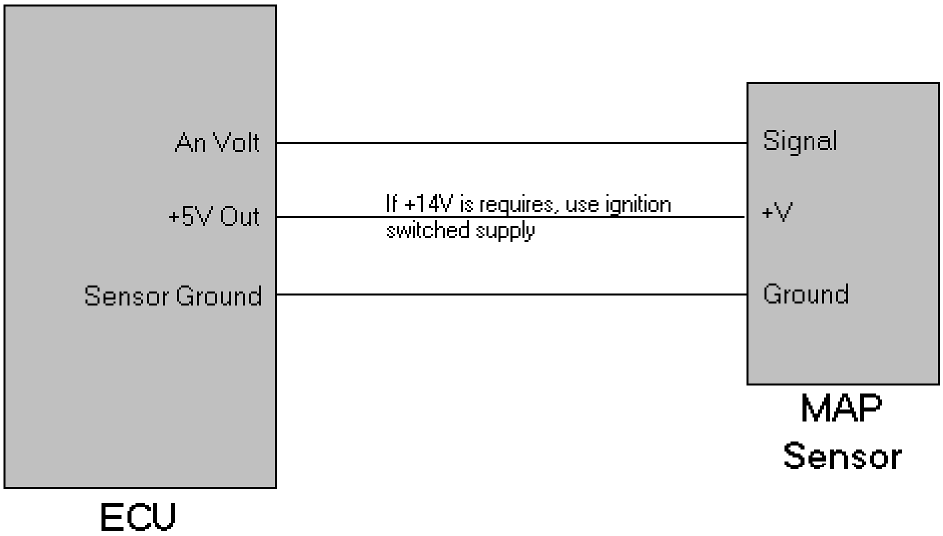


Suitable manifold take off points for MAP sensor hose

Ideally the MAP sensor should be mounted higher than the inlet manifold so that moisture will not condense in the MAP sensor.

Wiring of a MAP sensor requires the connection of three wires:

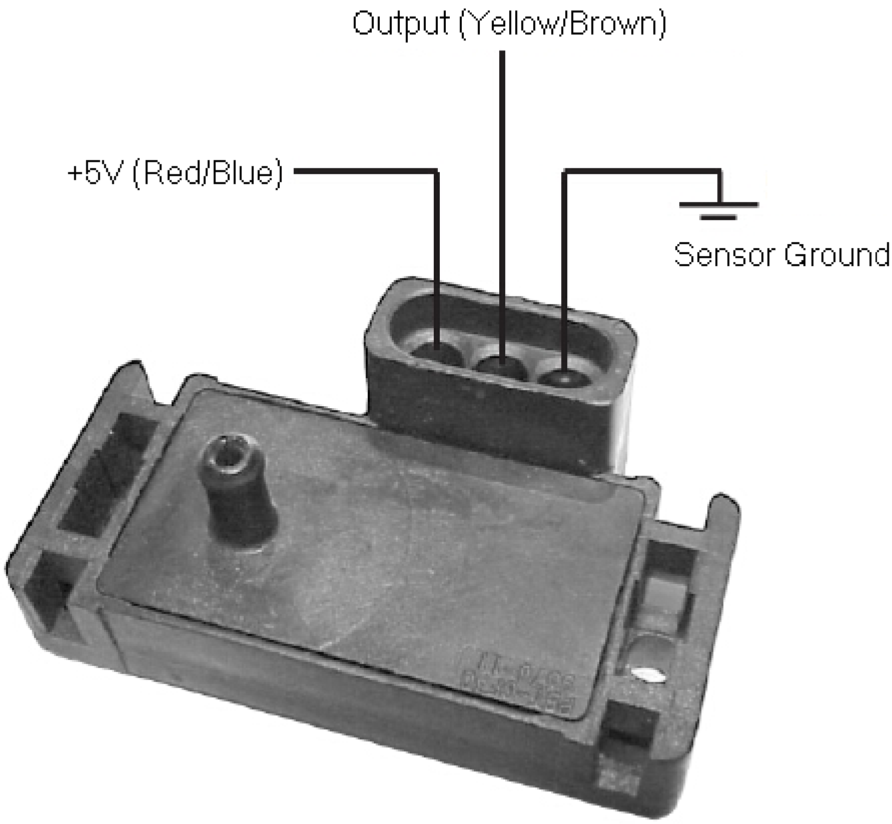
1. Signal - The MAP signal must be wired to an Analog Volt input. Configure this input as MAP sensor and select the appropriate calibration in iVTS.
2. Power - The ECUs +5V Out can power +5V MAP sensors otherwise power the sensor as per manufacturers specifications.
3. Ground - The MAP sensor MUST be grounded back at the ECU using a green Sensor Ground wire, not the engine block.



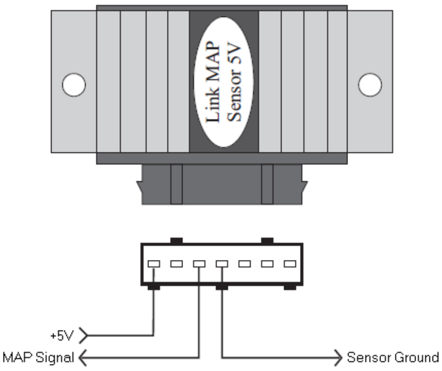
MAP Sensor Wiring

9.2.3.2 Specific MAP Applications

9.2.3.2.1 Delco MAP Sensor

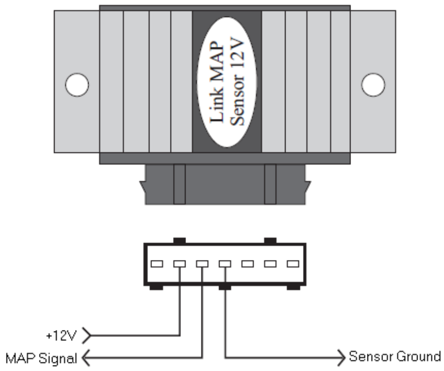


9.2.3.2.2 Link MAP Sensors



5 Volt Link MAP Sensor Wiring

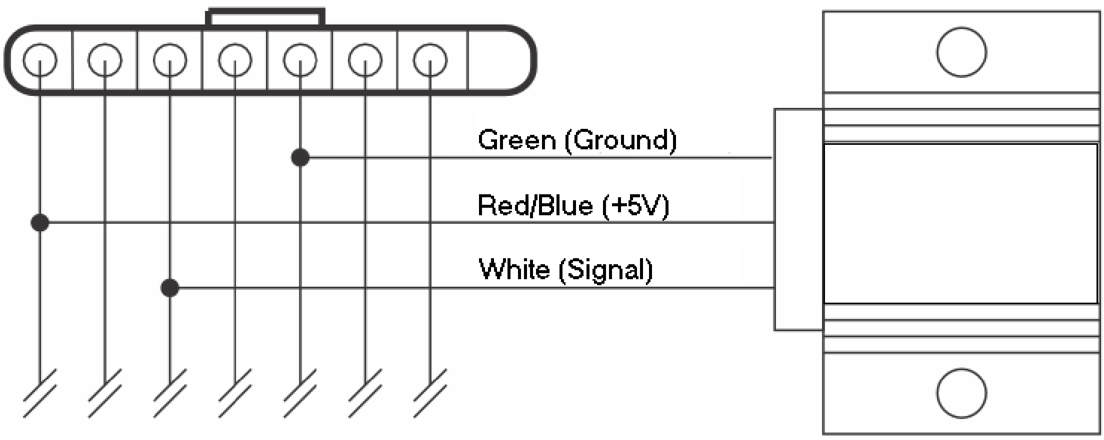
Note: Only use a +12V OR +5V supply. NEVER wire both at the same time.



12 Volt Link MAP Sensor Wiring

MAP Loom Wire Colours	
MAP Signal	White
Sensor Ground	Green
+12V	Red
+5V	Red/Blue

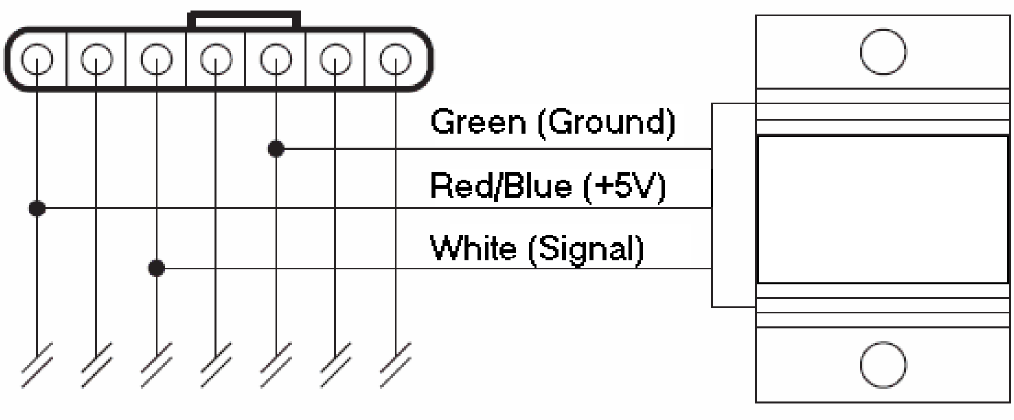
9.2.3.2.3 Mitsubishi EVO 1-3 MAP to AFM Wiring



Looking into back (wire side) of the Air flow Meter Connector

Mitsubishi Lander Evolution 1 to 3 Manifold
Air Pressure to Air Flow Meter Wiring

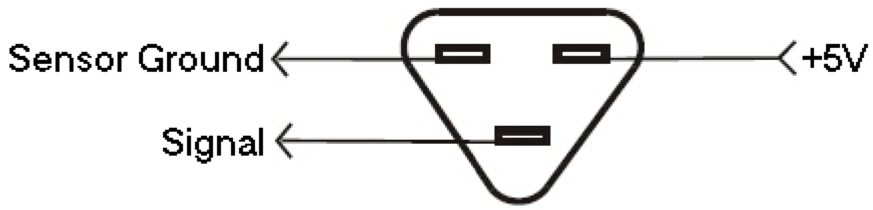
9.2.3.2.4 Mitsubishi EVO V MAP to AFM Wiring



Looking into back (wire side) of the Air Flow Meter Connector

9.2.3.2.5 Subaru MAP GC8

Wire Colours (1993 GC8 WRX)		
	Sensor	Loom
Sig	White	Yellow/Black
+5V	Pink	Yellow/Green
Gnd	Green	Red/Green



Looking into MAP Sensor Connector (Male Terminals)

9.2.4 Oxygen Sensors

9.2.4.1 Narrow Band Oxygen Sensor

A narrow-band exhaust gas oxygen (EGO) sensor is very accurate at air/fuel ratios near 14.7:1 (for petrol). At richer or leaner are/fuel ratios there is a very small output signal change for large changes in air/fuel ratio. This makes the narrow-band sensor very good at detecting either a lean or rich condition, but not very useful for detecting how lean or rich. For this reason, a narrow-band sensor is not recommended for tuning purposes. However a narrow band sensor is suitable for running Closed Loop Lambda (CLL). CLL allows the ECU to self tune at cruise to improve economy and emissions.

There are many variations of EGO sensors although most are identical in terms of the output signal. The principal differences are mostly physical involving lead tolerance, heated or unheated, mounting methods, and whether or not a signal ground wire is supplied.

Lead Tolerance

The lead additives used in most high-octane fuel (aviation gas or race gas) will reduced the lifespan of the sensor considerably. Some probes are shielded and are more tolerant than others.

Heating

Many probes incorporate an electrical heating element, which is powered by the vehicles 12 Volt supply. These heaters allow the probe to be mounted in cooler portions of the exhaust system and significantly improve the probe performance at idle and during warm up phases of operation. This is because the probe temperature must exceed 300ºC before accurate readings are possible.

An Auxiliary Output can be used to control the heating of the oxygen sensor if required. To do this, ground the sensors heater wire through any of the ECUs auxiliary channels.

Mounting

Most probes have an M18 x 1.5 metric thread designed to screw into a mating boss. Some variants use a bolted flange arrangement, but these are relatively uncommon.

Almost all EFI engines will have a probe installed as original equipment in the exhaust manifold or turbo housing.

If the vehicle does not have a factory fitted EGO sensor, it will be necessary to manufacture a sensor mount according to engine type and layout.

The ideal mounting position of the sensor in the exhaust can vary depending on the application. Most of the time the preferred position is in the exhaust manifold collector on a naturally aspirated engine or after the turbocharger on a turbocharged engine. However, a location further down the exhaust is acceptable provided the probe is adequately heated. Note that it is also possible to get an EGO sensor too hot which also causes an inaccurate reading. Therefore in applications with particularly high exhaust gas temperatures (e.g. turbo engines, rotary engines) it may be necessary to either use an unheated sensor or move a heated sensor further down the exhaust.

Caution: EGO sensors use ceramic material internally and are susceptible to impact damage. Handle probes carefully to avoid impacts at all times.

Narrow Band Oxygen Sensor Wiring

Typically narrow-band EGO sensors can be recognised as having one, two, three or four wires. These have the following functions.

- Single Wire Sensor - The wire is the signal output and should be connected directly to an Analog Voltage Input.
- Two Wire Sensor - One wire for the signal output (to Analog Voltage Input). The other is the signal ground (Signal Ground (green)).
- Three Wire Sensor (Heated) - One wire for the signal output (to Analog Voltage Input). Two wires for the heater. One of the heater wires should be connected to an ignition switched 12V supply. The other heater wire can be connected to a convenient ground (or controlled using an auxiliary output). Heater polarity is not important.

- Four Wire Sensor (Heated) - As for three wire sensor, but with an extra wire for the signal ground which must be connected to Sensor Ground (green).

Recommended Narrow Band Oxygen Sensor

The recommended narrow-band EGO sensor is a Bosch 3-wire lead-tolerant unit with Part Number 0 258 003 070. As with other Bosch 3 wire sensors, the wire colours are:

2 white wires	=	heater (18 watts)
1 black wire	=	output signal

9.2.4.2 Wide Band Oxygen Sensor

Wideband exhaust gas oxygen (EGO) sensors are able to accurately measure air/fuel ratios over a very wide range from very lean to very rich. This makes these devices very suitable for tuning purposes.

A wideband sensor can be used to run Closed Loop Lambda (CLL) for improved economy and emission. A wideband sensor is a necessity if Quick Tune (refer to the iVTS online help) is going to be used to tune the engine.

Any Analog Volt channel may be used to accept the signal from a wide-band EGO sensor controller. Note that i-Series ECUs cannot accept the signal directly from a wide-band sensor. A wide-band controller works as an interface between a wide-band O2 sensor and the ECU. The controller should connect directly to the sensor and output a voltage between 0 and 5V.

The sensor calibration (the voltages that correspond to given air/fuel ratios) must be known and this information must be entered into the ECU via iVTS .

The recommended Wideband Oxygen Sensor controller is the Innovate LC-1 Wide-Band controller

9.2.5 Pressure Sensors

9.2.5.1 Generic Pressure Sensor Wiring

Any Analog Volt channel may be used for inputs from additional general purpose (GP) pressure sensors. The only restriction is that the sensor must have a 0-5V output. The sensor calibration (the voltages that correspond to given pressures/temperatures) must be known and this information must be entered into the ECU via iVTS.

GP Pressure Sensor Wiring:

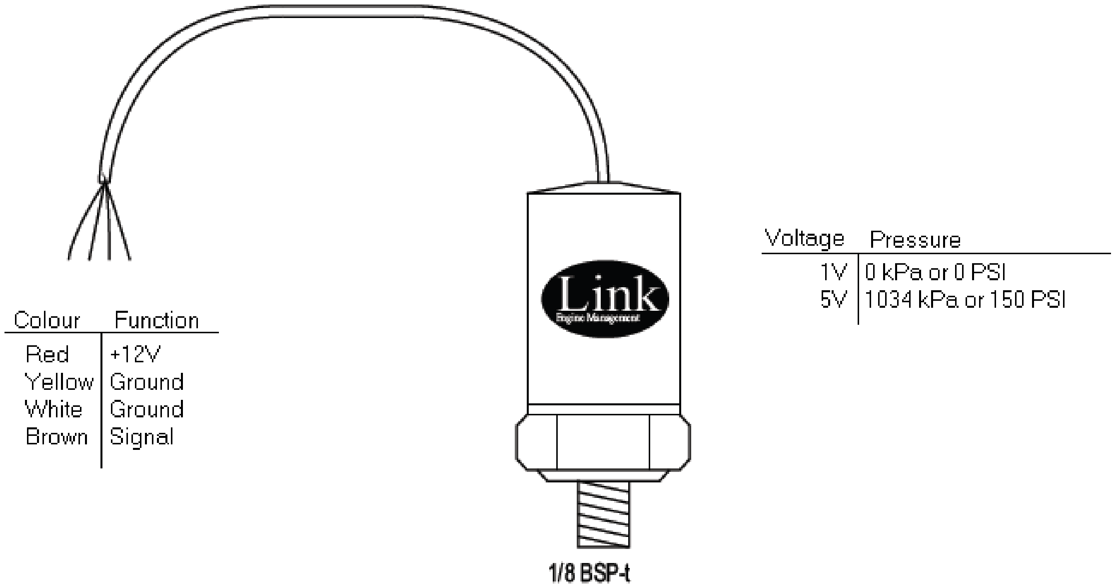
- Signal – Analog Volt Channel
- Power – As per sensor manufacturers specification (can use ECUs +5V out if required)
- Ground – Ground to ECUs Sensor Ground.

CAUTION!

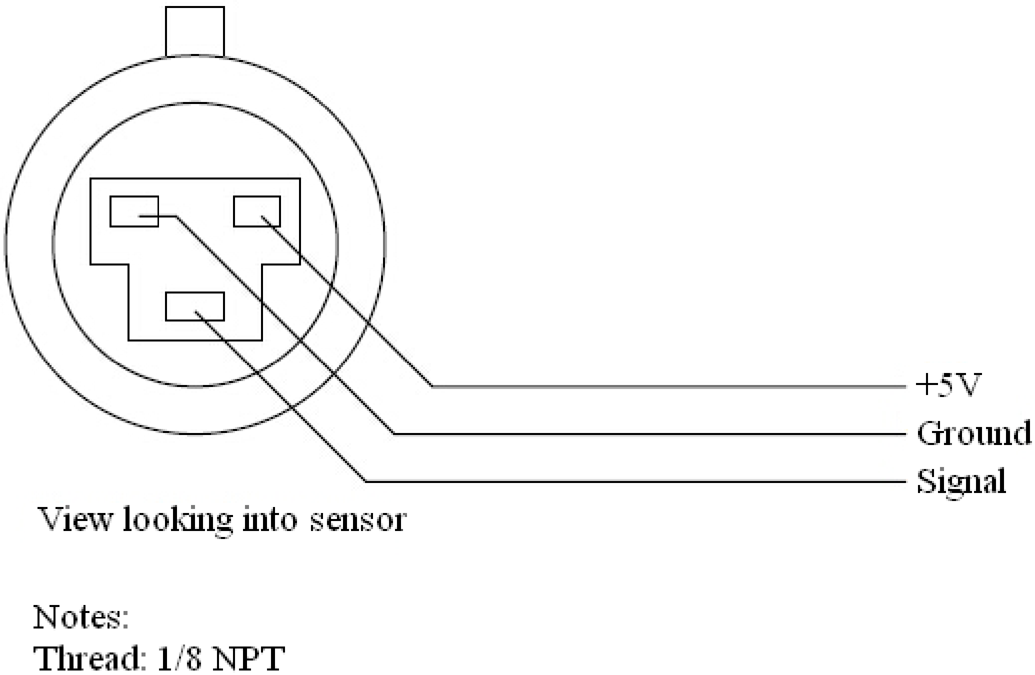
Do not use a sensor designed to measure air pressure to measure fuel, oil or water pressures. Consult the sensor manufacturers specifications.

9.2.5.2 Specific Pressure Sensor Applications

9.2.5.2.1 Link 10 Bar Pressure Sensor Wiring



9.2.5.2.2 TI 150psi Pressure Sensor



9.2.6 Temperature Sensors

9.2.6.1 Engine Coolant Temperature Sensor

Engine coolant temperature is required primarily for fuel enrichment during cold starting and during the warm-up period that follows. This sensor should always be mounted on the engine side of the thermostat.

i-Series ECUs can measure the temperature using a thermistor (NTC or PTC) sensor or a sensor with a 0-5V output. Any sensor calibration is permitted.

Thermistor sensors have a resistance that changes with temperature and are commonly used in automotive applications. When wiring thermistor sensors the polarity is NOT important. **An Analog Temp wire should be connected to one terminal on the sensor while the other terminal must be connected to the Sensor Ground (green) wire.**

When using a sensor that produces a 0-5V output or in piggy back application where a factory ECU is already providing the temperature sensor pull-up resister, connect the ECT signal to an Analog Volt channel.

i-Series ECUs are compatible with any NTC or PTC thermistor sensor. The recommended sensor is a Bosch 0 280 130 026 sensor. A number of pre-calibrated sensor options are also provided in iVTS Tuning Software. Note that most factory sensors will use the Standard Bosch NTC calibration. In order to use a sensor with a different calibration you will need to know how the sensor's resistance changes with temperature and enter this information into the ECU via iVTS Tuning Software.

9.2.6.2 Intake Air Temperature Sensor

Using an inlet air temperature sensor allows fuel and ignition corrections to be made for changes in the temperature of the air entering the engine. The air temperature sensor must be set-up to most accurately measure the temperature of the air entering the engines combustion chambers. On a naturally aspirated engine this normally means any position between the air filter and inlet manifold. However, on a turbocharged/supercharged engine the sensor must be placed **AFTER** turbocharger and any inter-cooler.

On most applications (both naturally aspirated and turbocharged) the recommended mounting position is in the inlet pipe just before the throttle plate. The sensor may also be placed in a section of the inlet manifold that is subject to high airflow. However, in some applications the inlet manifold may get very hot and heat soak the sensor causing a reading that is not representative of the air entering the combustion chambers.

It is very important on a turbocharged/supercharged engine that the air temperature sensor can react fast enough to track the rapidly changing temperature. For this reason, an open element sensor is required. The recommended sensor is a Bosch 0 280 130 085. On naturally aspirated engines this sensor may be substituted for a 0 280 130 039, which is cheaper and easier to fit.

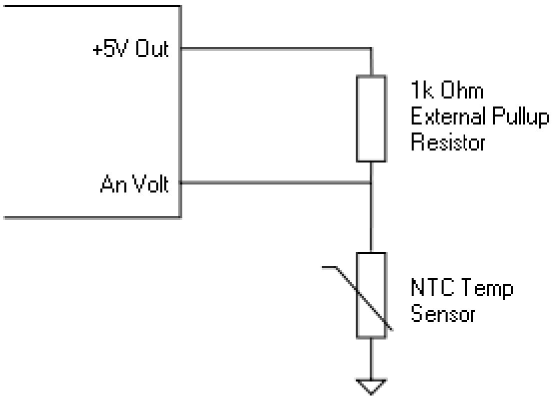
i-Series ECUs are designed to measure the temperature using a thermistor sensor. These sensors have a resistance that changes with temperature and are commonly used in automotive applications. When wiring thermistor sensors the polarity is NOT important. **The Inlet Temperature Sensor must be connected to the Sensor Ground (green) wire and an Analog Temp wire.**

i-Series ECUs are compatible with any NTC or PTC thermistor sensors. The default calibration is for either of the Bosch sensors listed above. In order to use a sensor with a different calibration you will need to know how the sensor's resistance changes with temperature and enter this information into the ECU via iVTS Tuning Software. Note that most commonly used sensors calibrations are available by selecting them in iVTS Tuning Software.

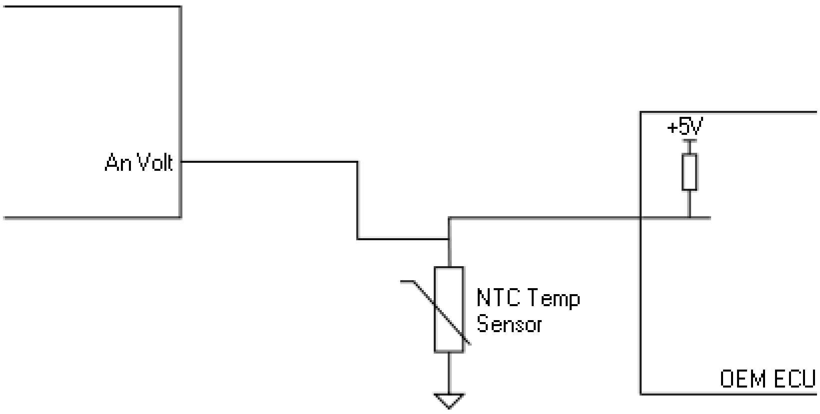
9.2.6.3 Using voltage channels with NTC sensors

Volt channels can be also be used to read the temperature from a Negative Temperature Co-efficient (NTC) temperature sensor. An external 1K pull-up resistor must be connected the ECUs voltage input pin and 5V.

The exception to this when wiring a temperature sensor in a piggyback situation. The OEM engine management system's internal pullup resistor will be utilized, in this case the sensor would be wired as you would for a standard temperature input.



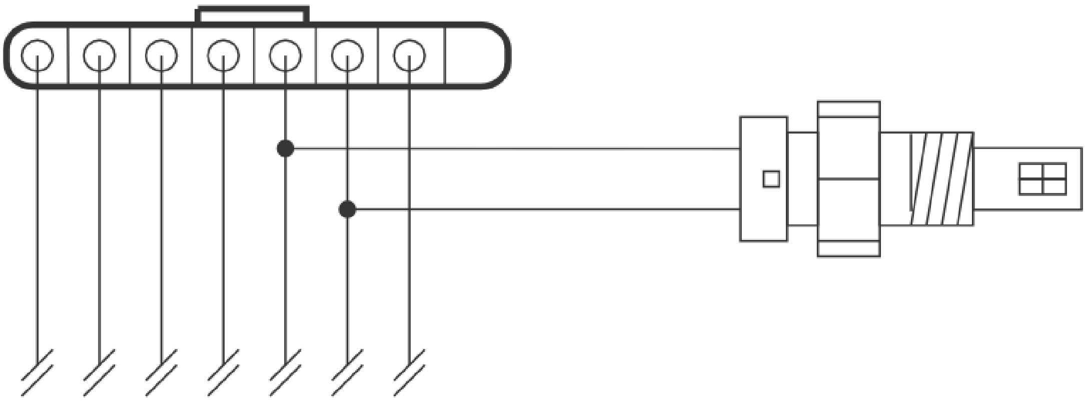
Wiring a NTC temp sensor with an external pullup resistor.



Wiring a NTC temp sensor in a piggyback situation.

9.2.6.4 Specific Temperature Sensor Applications

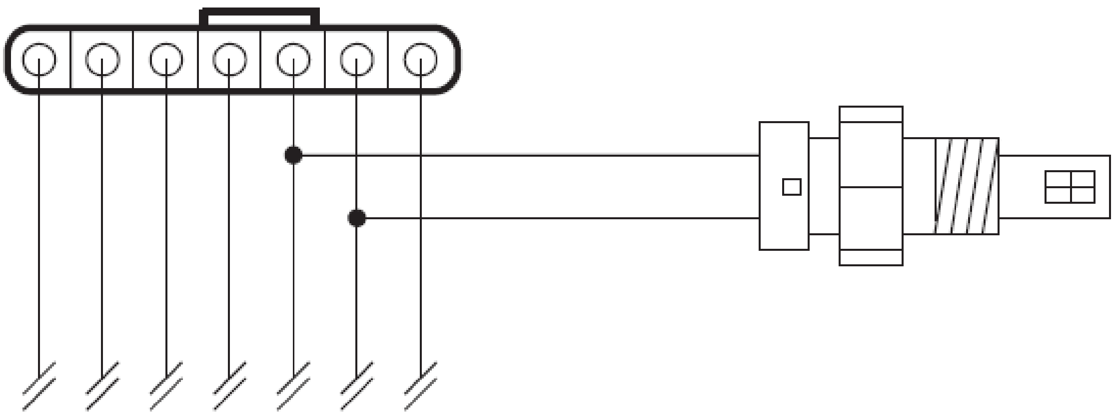
9.2.6.4.1 Mitsubishi EVO 1-3 IAT to AFM Wiring



Looking into back (wire side) of the Air Flow Meter Connector

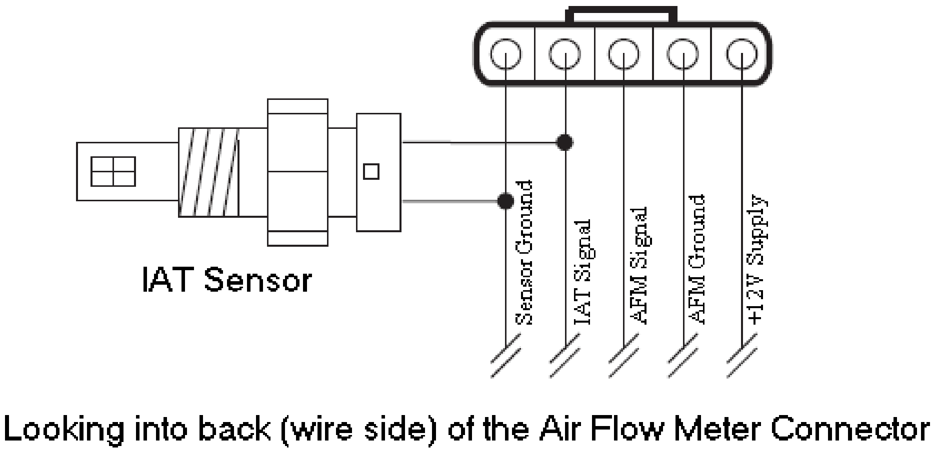
Mitsubishi Lancer Evolution 1 to 3 Intake Air
Temperature (IAT) to Air Flow Meter (AFM)

9.2.6.4.2 Mitsubishi EVO V IAT to AFM Wiring



Looking into back (wire side) of the Air Flow Meter Connector

9.2.6.4.3 Subaru WRX 7-9 IAT to AFM Wiring



9.2.7 Throttle Position Sensors

9.2.7.1 Generic TPS Wiring

A Throttle Position Sensor (TPS) is connected directly to the end of the throttle shaft to measure the current angle of throttle opening. Even if the throttle position sensor is not required for load sensing, it is still highly recommended to use one. Throttle position is used for a number of other functions including:

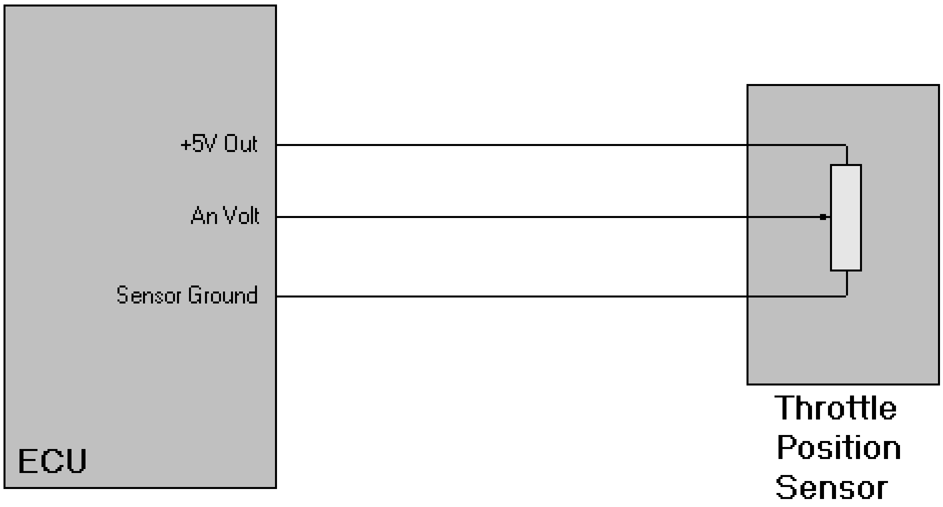
- Acceleration enrichment (much better than using MAP)
- Overrun fuel cuts
- Idle Speed Control
- Boost Control (in some cases)
- Anti-Lag

IMPORTANT!

The throttle position sensor must be a potentiometer (variable resistance) and operate over the entire range of throttle movement. Partial range sensors and idle/full-throttle switches are not suitable and may not be used with i-Series ECUs.

Ensure the TPS mounting position allows the throttle to move through its full range of motion. The TPS should be adjusted so that it is not reaching the end of its movement at either closed throttle or full throttle. An ideal output voltage range is 0.5 to 4.5 volts. Note: that the ECU will interpret a 0V or 5V signal on the TPS channel to be an error condition.

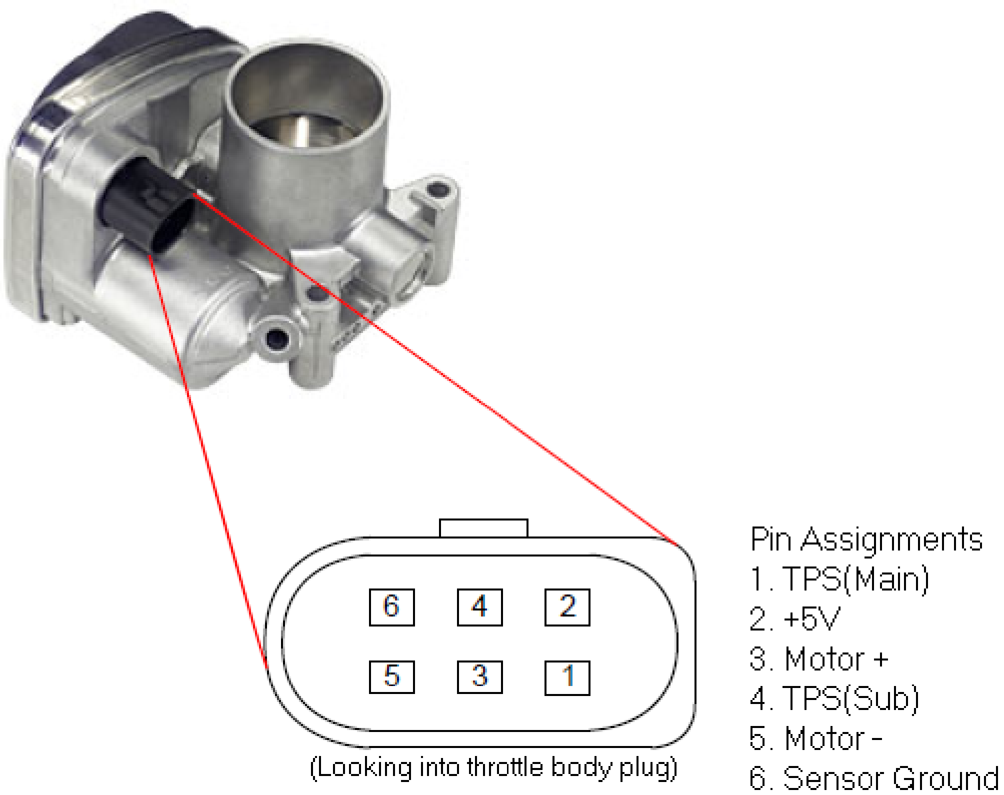
A typical TPS has 3 terminals. To wire either the factory TPS or a custom fitted sensor, an ohmmeter is required. Two of the terminals will show a fixed resistance as the TPS is moved. Connect these terminals to the +5V Out wire (Red/Blue) and Sensor Ground wire (Green). The orientation of the +5V and ground does not matter. The result is that the TPS output will either increase or decrease in voltage with throttle position. The ECU will automatically detect this so either option is acceptable. The third terminal must show a variable resistance between it and the ground terminal as the throttle position is changed. This is the TPS output and should be connected to any Analog Volt input.



TPS Wiring

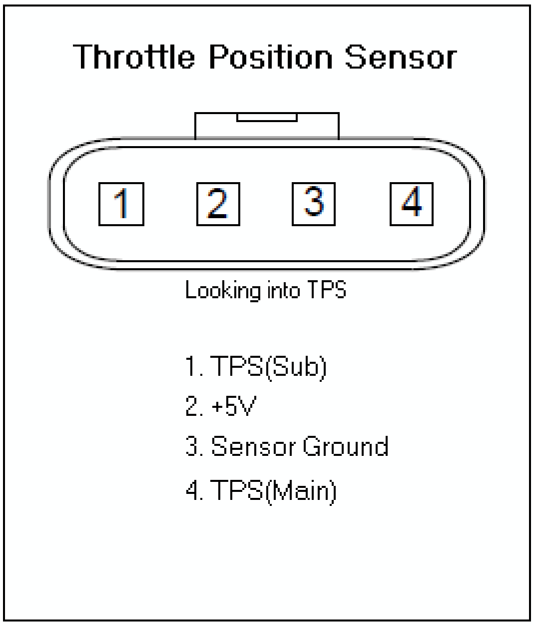
9.2.7.2 Specific TPS Applications

9.2.7.2.1 BMW M52 (VDO) TPS



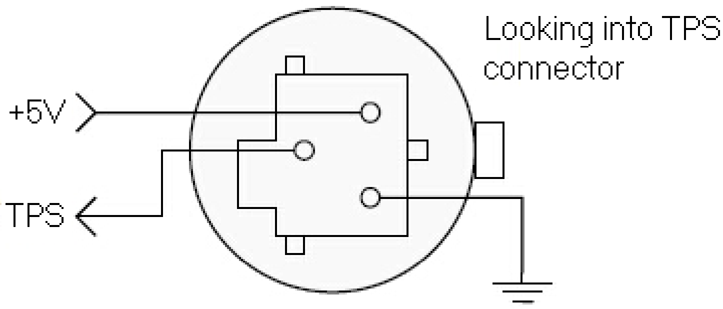
BMW M52 (VDO) Throttle Position Sensor Wiring

9.2.7.2.2 Ford Falcon BA TPS

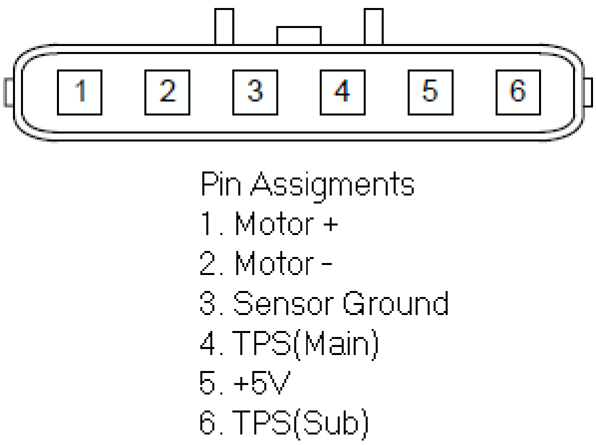


Ford Falcon BA Throttle Position Sensor Wiring

9.2.7.2.3 GM LS1 TPS

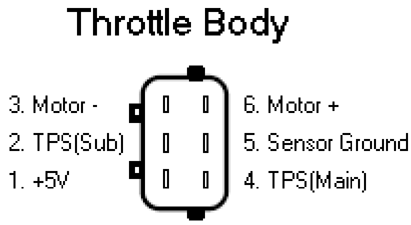


9.2.7.2.4 Mitsubishi EVO X TPS



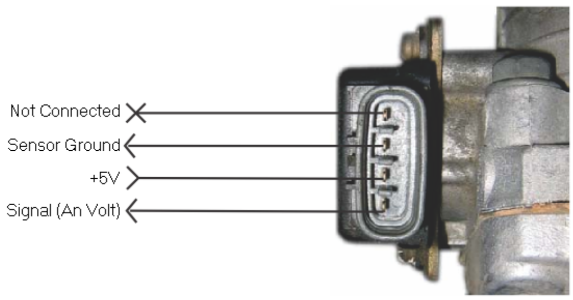
Mitsubishi EVO X Throttle Position Sensor Wiring

9.2.7.2.5 Nissan VQ35 TPS



Nissan VQ35 Throttle Position Sensor Wiring (Looking into Throttle Body Connector)

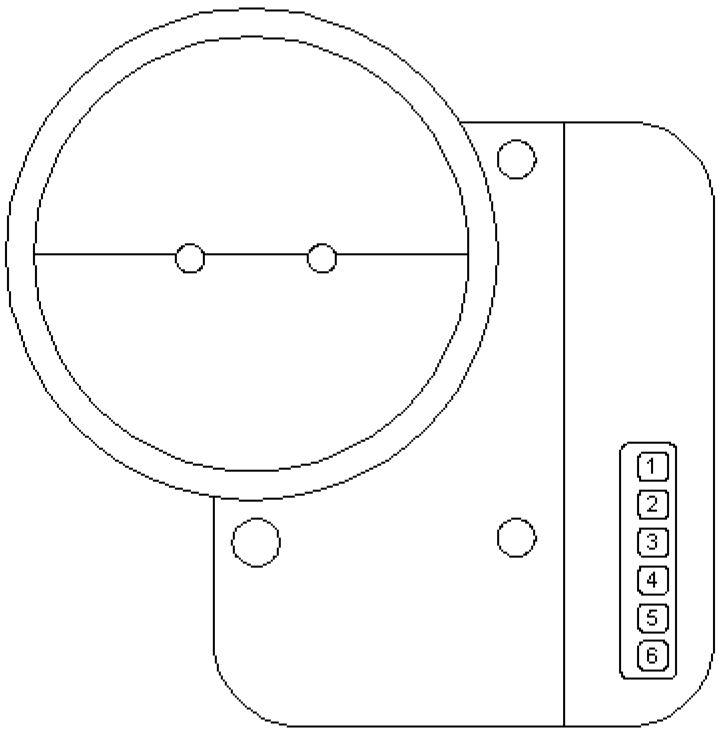
9.2.7.2.6 Subaru WRX GC8 TPS



Note: Pinout taken from 1993 GC8 WRX.

Note: Spare wire on TPS is idle switch. This can be connected to a Digital Input on ECU if required.

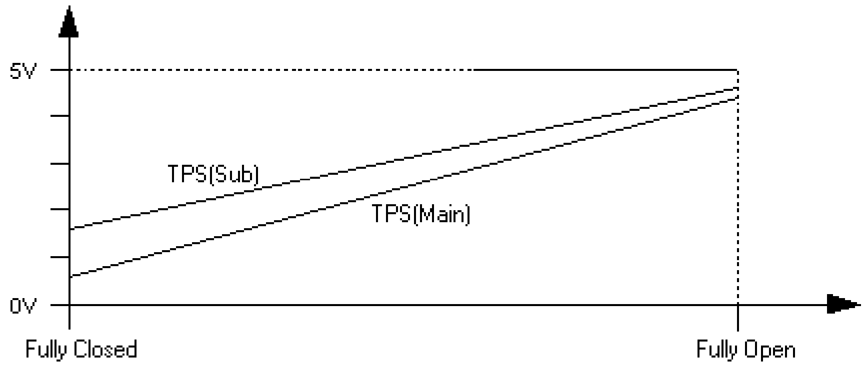
9.2.7.2.7 Suzuki Swift TPS



Pin #	Description

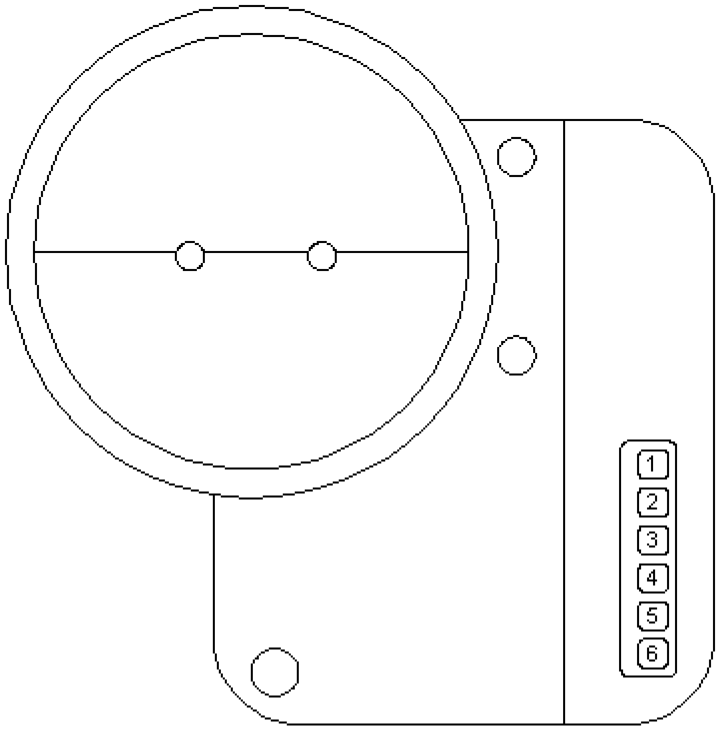
1	TPS(Main)
2	+5V
3	TPS(Sub)
4	Sensor Ground
5	Motor -
6	Motor +

Suzuki Swift Throttle Position Sensor Wiring



Suzuki Swift Throttle Position vs Output Voltage

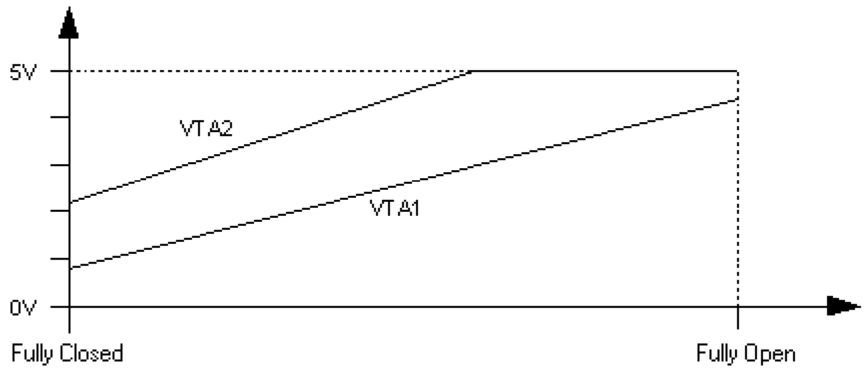
9.2.7.2.8 Toyota 3UR-FE TPS



Pin #	Toyota Naming	Description
1	VTA1	TPS(Main)

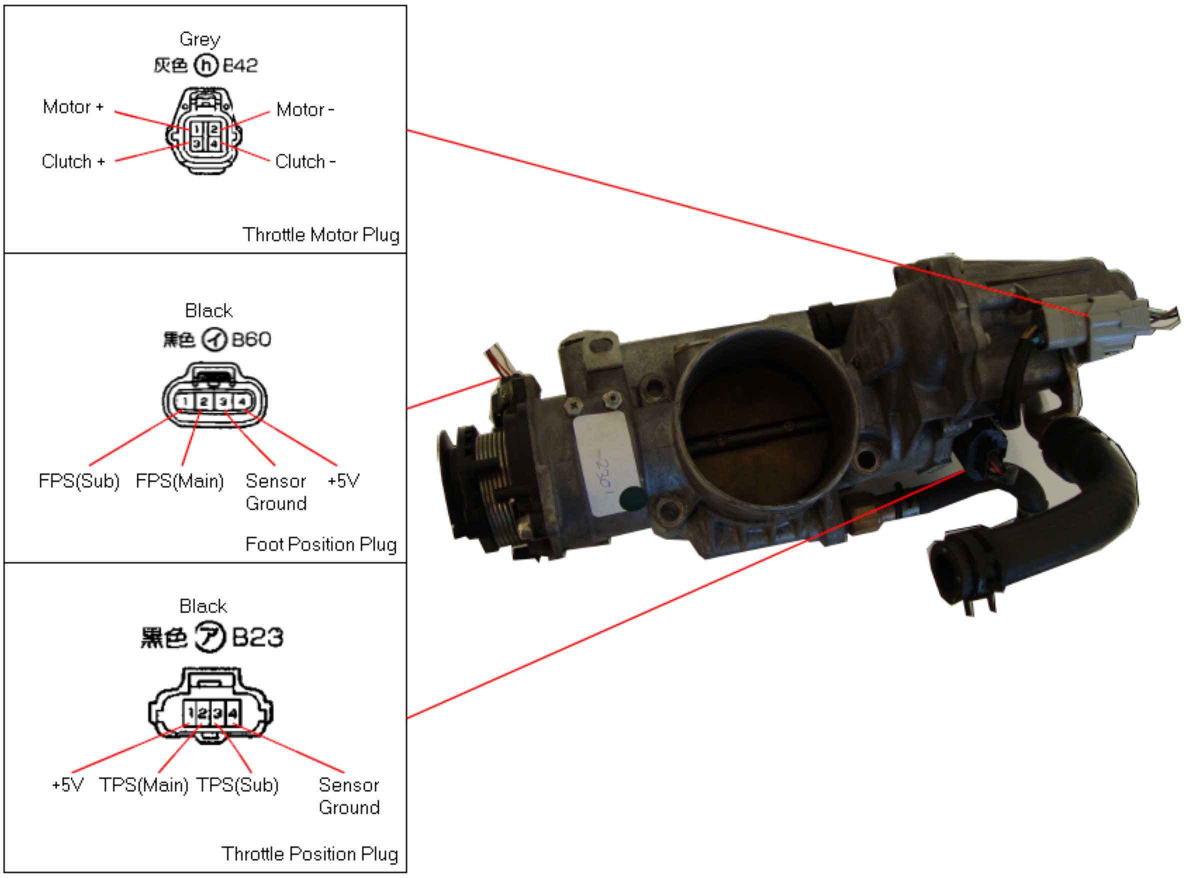
2	VC	+5V
3	VTA2	TPS(Sub)
4	E2	Sensor Ground
5		Motor -
6		Motor +

Toyota 3UR-FE Throttle Position Sensor Wiring



Toyota 3UR-FE E-Throttle Position vs Output Voltage

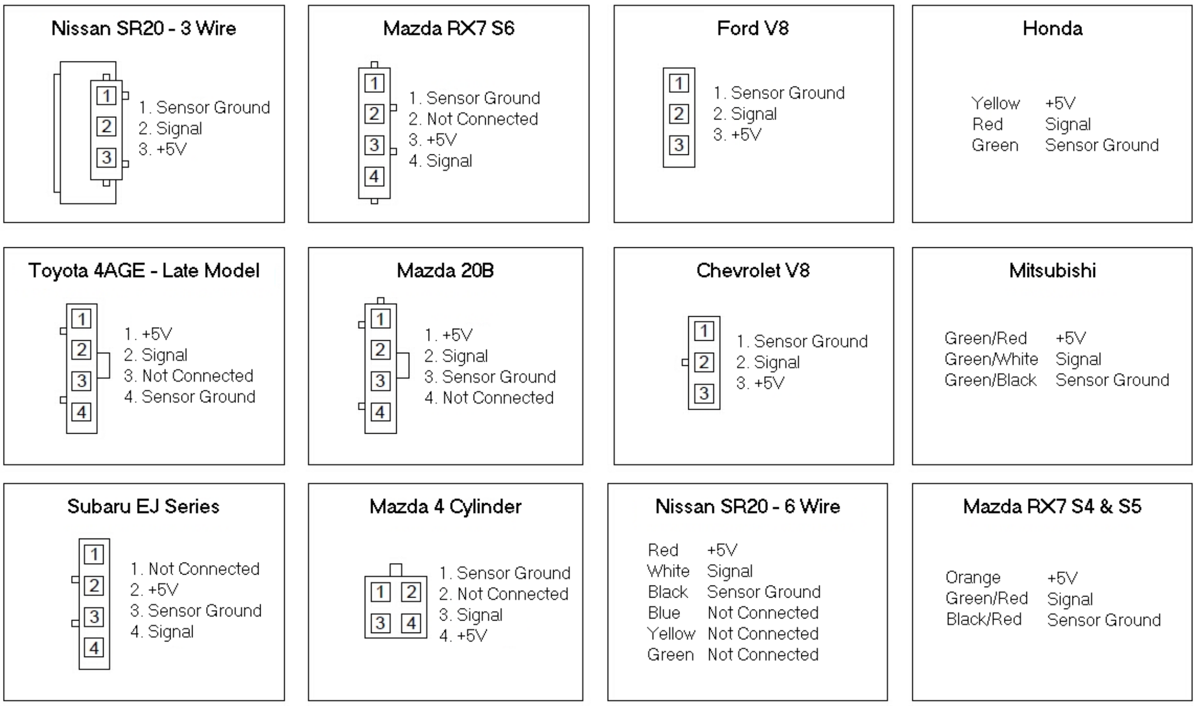
9.2.7.2.9 Toyota Clutched E-Throttle TPS



Diagrams are looking into wiring loom plugs

Toyota Clutched E-Throttle Throttle Position Sensor Wiring

9.2.7.2.10 Various TPS Pinouts



9.3 Digital Input Wiring

Digital inputs may be connected to switches, controllers or sensors to control various functions including launch control (clutch switch), anti-lag, high/low boost, water spray, dual fuel/ignition maps, nitrous oxide, air conditioning request and variable valve timing.

- Digital Input Allocation Chart
- Switches and Controllers
- Vehicle Speed Input
- VVT Cam Position Input
- Ethanol Content Sensors
- GT101 Speed Sensor

Digital Input Allocation Chart

Some Digital Input channels are only able to work with certain functions. The chart below details which functions can work on which digital input channels. Use this chart when planning an ECU install.

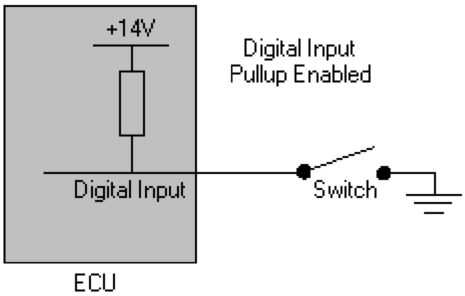
	Digital Input									
Function	1	2	3	4	5	6	7	8	9	10
Digital Knock	Max 500 Hz									

Frequency	
Gear Cut	
GM Siemens Ethanol Sensor	
GP Speed	
LF Wheel Speed	
LR Wheel Speed	
RF Wheel Speed	
RR Wheel Speed	
MAF Meter	
Turbo RPM	
VVT Cam Position	Max 500 Hz
All other Digital Input Functions	

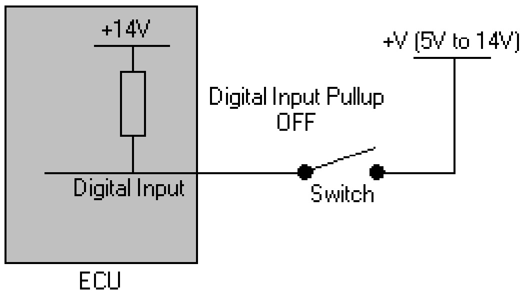
Digital Input Functionality - Firmware version 5.0.4.1862

Switches and Controllers

The diagrams below show the two methods of wiring Digital Inputs to a switch. When wiring other devices such as controllers it will be necessary to determine if these devices are active low or active high. If a switch or controller drives low then the Digital Inputs 'Pull-up Resister' will need to be enabled in iVTS Tuning Software.



Wiring of a Drive Low Switch to a Digital Input



Wiring of a Drive High Switch to a Digital Input

Vehicle Speed Input

Speed signals should only be connected to Digital Inputs 1 to 6.

Vehicle Speed may be calculated using the output from a digital speedometer drive or in some cases from the speedometer assembly itself. This may be connected directly to a Digital Input. Some sensors will require that the Digital Inputs 'Pull-up Resister' is enabled in iVTS Tuning Software.

VVT Cam Position Input

Continuously Variable Valve Timing (CVVT, VVT, VVTi, AVCS) Cam Position digital inputs can only be connected to Digital Inputs 1 to 4.

Reluctor or Optical/Hall sensors can be used to measure camshaft position on engines equipped with VVT systems. VVT position sensors should be wired to digital Inputs in the same manner as Trigger Sensors. This includes the use of Sensor ground and shielded cables. Shielded cable for Digital Input wiring is not included in the standard loom but can be purchased from your Vi-PEC dealer. Not using shielded cable can result in cam shaft position measurement errors.

For engine specific information on the wiring of triggers and VVT position sensors refer to your Vi-PEC dealer or www.vi-pec.com.

Although not absolutely necessary, it is recommended to ease configuration that cam position signals are wired to the same number Digital Input channel as the corresponding solenoid control Auxiliary Output (refer following table). For compatibility, the following use of Digital Inputs and Auxiliary outputs is recommended for VVT wiring. Note that in practice any Digital Input/Auxiliary Output combination can be used.

Cam Shaft	Digital Input	Auxiliary Output
Inlet or Inlet LH	DI 1	Aux 1
Inlet RH	DI 2	Aux 2
Exhaust or Exhaust LH	DI 3	Aux 3
Exhaust RH	DI 4	Aux 4

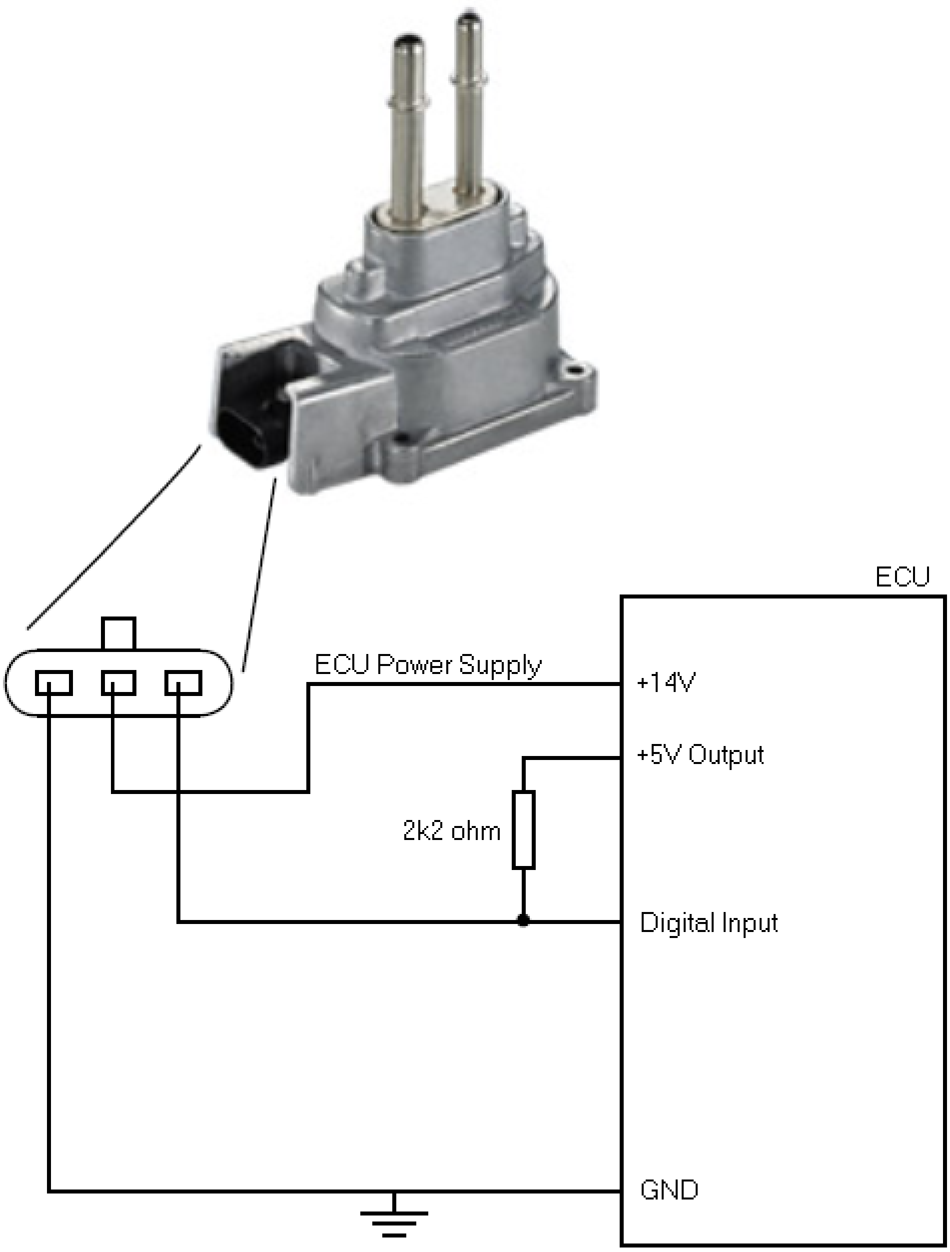
In cases where the same camshaft position signal is used to measure camshaft timing as well as provide sync (firing order position) information, this sensor will usually be wired to Trigger 2.

9.3.1 Ethanol Content Sensor Wiring

Two types of ethanol content sensor are supported, the GM/Siemens ethanol sensor and the Continental ethanol content sensor. Both sensor types require the Digital Input channel to be set to 'GM Siemens Ethanol Sensor'.

The Siemens ethanol content sensor can be wired as follows:

Siemens Ethanol Content Sensor

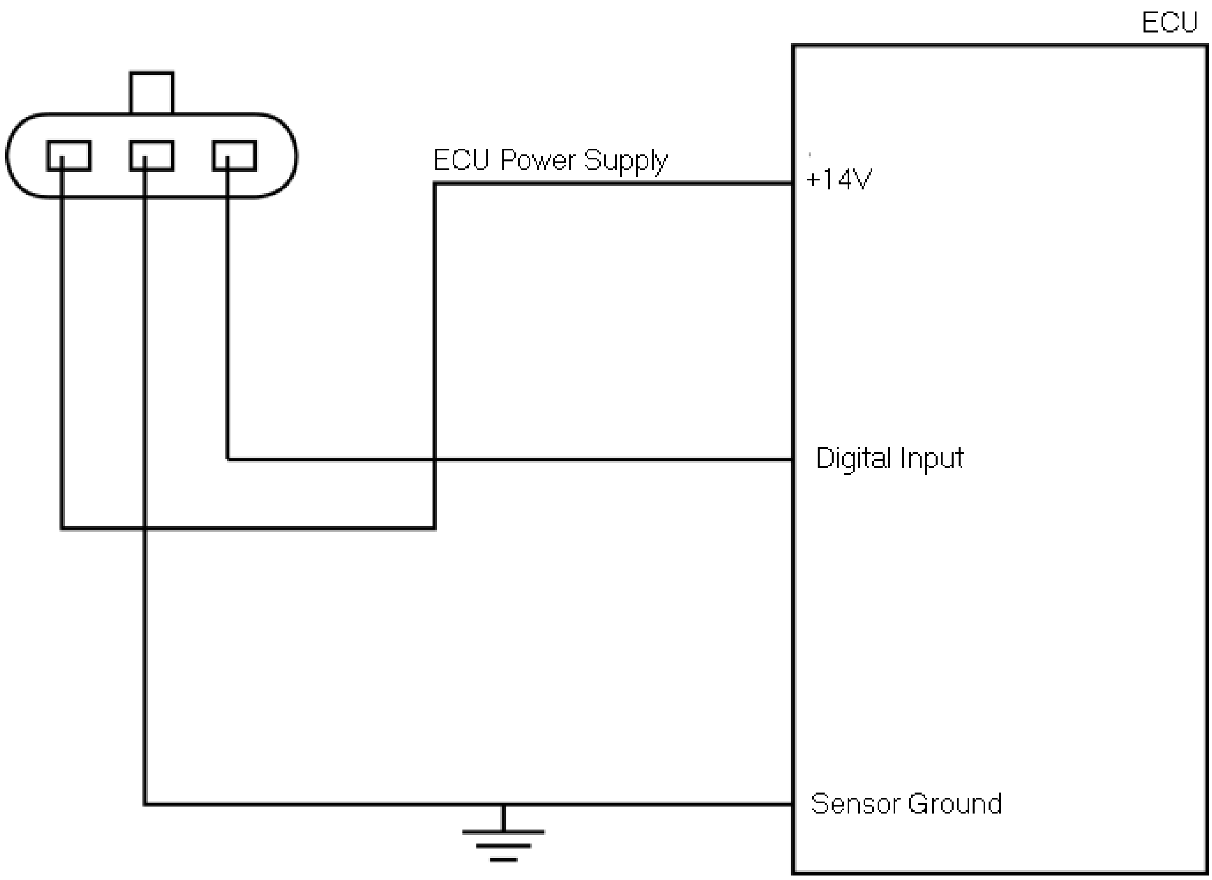


Note: Pullup resistor inside ECU must be set to OFF

The Continental Ethanol sensor has a part number of A2C53344228.

The Continental ethanol sensor can be wired as follows:

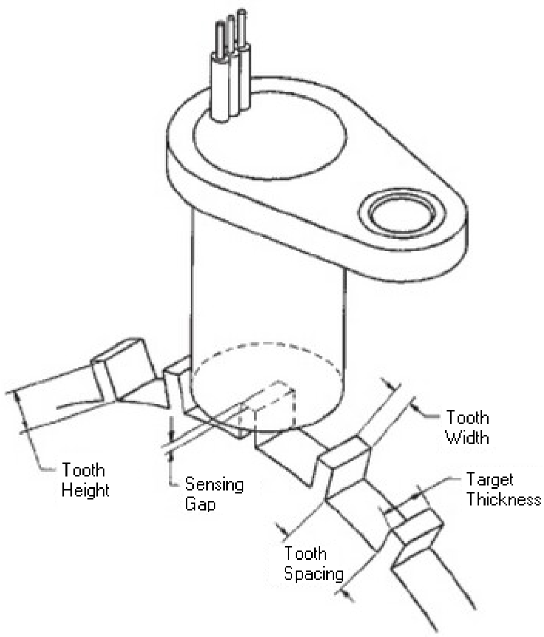
Continental Ethanol Content Sensor



For the Continental Ethanol sensor set the ECUs internal pullup resistor to ON.

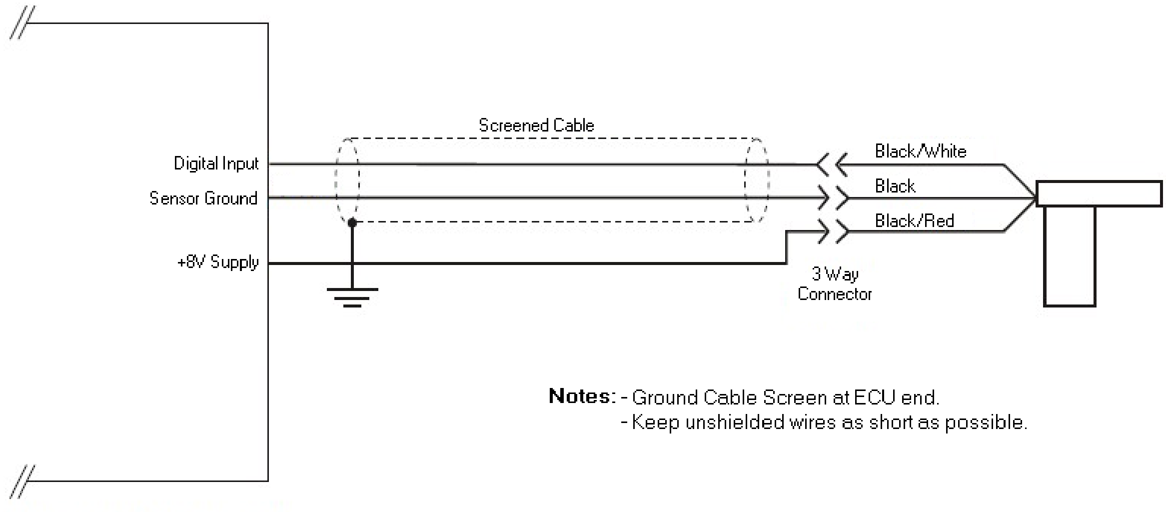
9.3.2 GT101 Speed sensor

GT101 Hall Effect Sensor



Sensor Tooth Dimensions

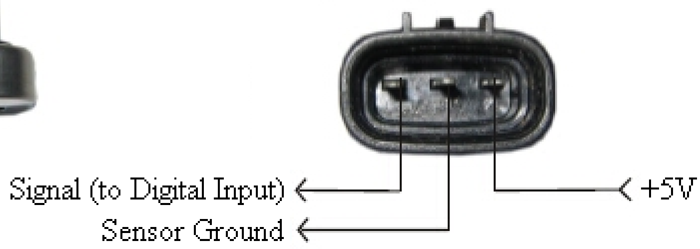
Tooth Height	5.0 mm (minimum)
Tooth Width	2.5 mm (minimum)
Tooth Spacing	10.0 mm (minimum)
Target Thickness	6.5 mm (minimum)
Air Gap	1.0 to 2.0 mm



Note: The GT101 sensor should **not** be used as a crank sensor. They are useful for other speed functions where the tooth count and rotation speed are low.

9.3.3 Toyota Speed Sensor


Toyota Speed Sensor



Toyota Speed Sensor Pinout

9.4 Knock Inputs

Vi-PEC ECUs can accept a variety of knock inputs depending on the ECU model.

The table below outlines which knock inputs each Vi-PECi-Series ECU accepts.

i-Series ECU Model / Knock Input	Internal	Digital
I44	√	√
I88	√	√
Plug-in (I88 topboard)	√	√

The ECU pins labelled *Knock 1* and *Knock 2* can be wired directly to a single or two terminal knock sensor.

Single terminal knock sensors earth through the engine block - these require single core shielded cable and are connected as shown:

Two terminal knock sensors earth through a wire back to the ECU - these require twin core shielded cable and are connected as shown:

10 Output Wiring

The following sections describe wiring of output devices to i-Series ECUs.

10.1 Auxiliary Output Wiring

i-Series ECUs have up to 16 auxiliary outputs. Unused ignition and injection channels can also be used as auxiliary outputs. Auxiliary outputs are general-purpose outputs that may be used to perform a wide range of functions. Certain Auxiliary Output channels can only be used with certain Functions, the table below is useful when planning which Function to allocate to each Auxiliary Output channel.

	Auxiliary Output																Auxiliary Output - Fuel								Auxiliary Output - Ign							
Function	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Boost Solenoid	■	■	■	■	■	■	■	■									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
ISC Solenoid	■	■	■	■	■	■	■	■									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Shift Light (PWM)	Max 4000 Hz	■	■	■	Max 300 Hz	■	■	■									Max 300 Hz	■	■	■	■	■	■	■	Max 300 Hz	■	■	■	■	■	■	■
Tacho	■	■	■	■	■	■	■	■									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Test(PWM)	■	■	■	■	■	■	■	■									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
GP PWM	■	■	■	■	■	■	■	■																								
Chassis Power Relay	■	■	■	■	■	■	■	■																								
Exhaust Power Valve	■	■	■	■	■	■	■	■																								
Ethrottle Signal 1	■	■	■	■																												
VVT Cam Solenoid	Max 4000 Hz	■	■	■																												
CL Stepper Ctrl					■	■	■	■																								
ISC Stepper					■	■	■	■																								
Rotary Oil Pump					■	■	■	■																								
Ethrottle Signal 2					■	■	■	■	■																							
Ethrottle (+)									■																							
Ethrottle (-)										■																						
ISC Sol. Slave	■																															
Knock Window	■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Speedo Out	■	■	■	■	■	■	■	■													■	■	■	■					■	■	■	■
TGV Open							■																									
TGV Closed								■																								
All other Auxiliary Output Functions	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Auxiliary Output Functionality - Firmware version 5.0.4.1862

The following conditions also apply.

- All Auxiliary, Ignition and Injection outputs can switch a load by supplying a ground for it.
- Aux 5 to 8 can be used as high side drives (ie they can supply power to a load).

Auxiliary Outputs are normally used to supply a GROUND to actuate solenoids, relays, LEDs or lights. The amount of current flow is entirely dependant on the internal resistance of the device connected to a drive. The load must not draw more than 2 Amps. This means that a directly connected load should have a resistance exceeding 7Ω. If the resistance is lower than this a relay should be used. DO NOT connect +12V directly to any auxiliary output.

The following list shows only some of the devices that can be controlled by Auxiliary Outputs

- Idle Speed control (ISC) Solenoids and Stepper Motors
- Boost Control Solenoid
- Fuel Pump Relay
- Fuel Pump Speed controller
- Engine Fan Relay
- A/C Clutch Relay
- A/C Fan Relay
- Inter-cooler Spray Pump Relay
- Tachometer
- Check Engine Light
- Purge and EGR Solenoids
- Variable Valve Timing Solenoids
- Speedometer
- Oxygen Sensor Heater
- Water Injection
- Nitrous Oxide Injection
- Electronic Throttle Control
- General Purpose Switching
- General Purpose Pulse Width Modulation (PWM)

i-Series Auxiliary Output Specifications:

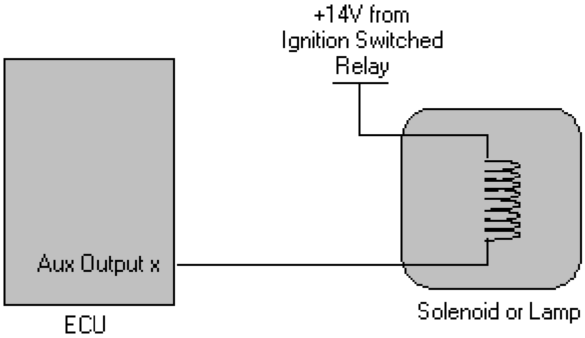
- 1.5k Ohm Internal Pull-up Resister
- Auxiliary Drive Low 2A over-current protected
- Open Collector (fly-wheeled) in auxiliary output mode.
- Aux 5 to 8 High Side Drive (ISC Stepper Mode) 0.5 A.
- Aux 9 and 10 (i88 only) Push-Pull drive 4/4 A.

10.1.1 Low Side Driving (Switching To Ground)

On a typical two-terminal solenoid, the Auxiliary Output should be connected to one terminal to supply a ground, while the other terminal should be connected to an ignition switched (key ON) 12V source. A warning/shift light may also be wired the same way. This configuration is shown below.

WARNING!

Solenoids and relays wired to auxiliary outputs must take their switching coil power supply from a switched (through a relay) source. Do NOT use a +12V hot supply (direct from the battery). Doing so may result in the ECU staying powered up when the key is switched off.

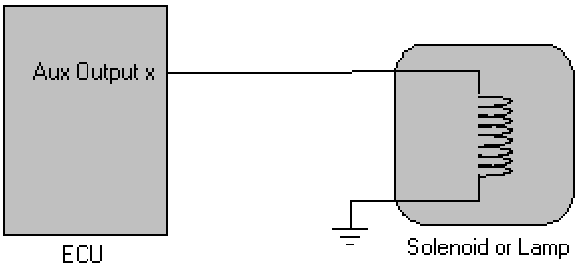


Low Side Driving a Solenoid

10.1.2 High Side Driving (Switching Power Supply)

Some single terminal solenoids are grounded through the engine block (e.g. most Honda VTEC solenoids). Therefore power must be applied to the terminal on the solenoid to turn it on. Auxiliary Outputs 5 to 8 can be used to supply power to a solenoid. If Auxiliary Outputs 5 to 8 are already used then it will be necessary to wire a relay to control the solenoids power supply.

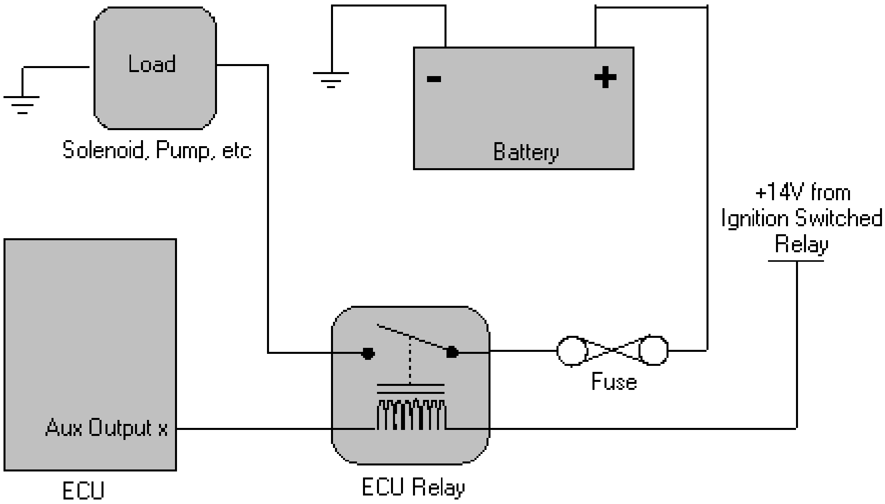
Aux 5 to 8 high side drivers can supply up to 0.5 Amps. this means the solenoid must have a resistance greater than 30 Ohms.



High Side Driving a Solenoid

10.1.3 Switching Through a Relay

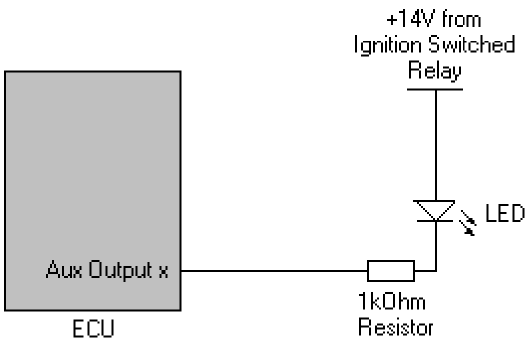
To switch any large load through a relay, the wiring shown below should be used. Examples of such loads include fuel pumps, engine coolant fans and air conditioning compressor clutches. DO NOT wire high current devices directly to the ECU.



Switching Loads Using a Relay

10.1.4 Switching an LED

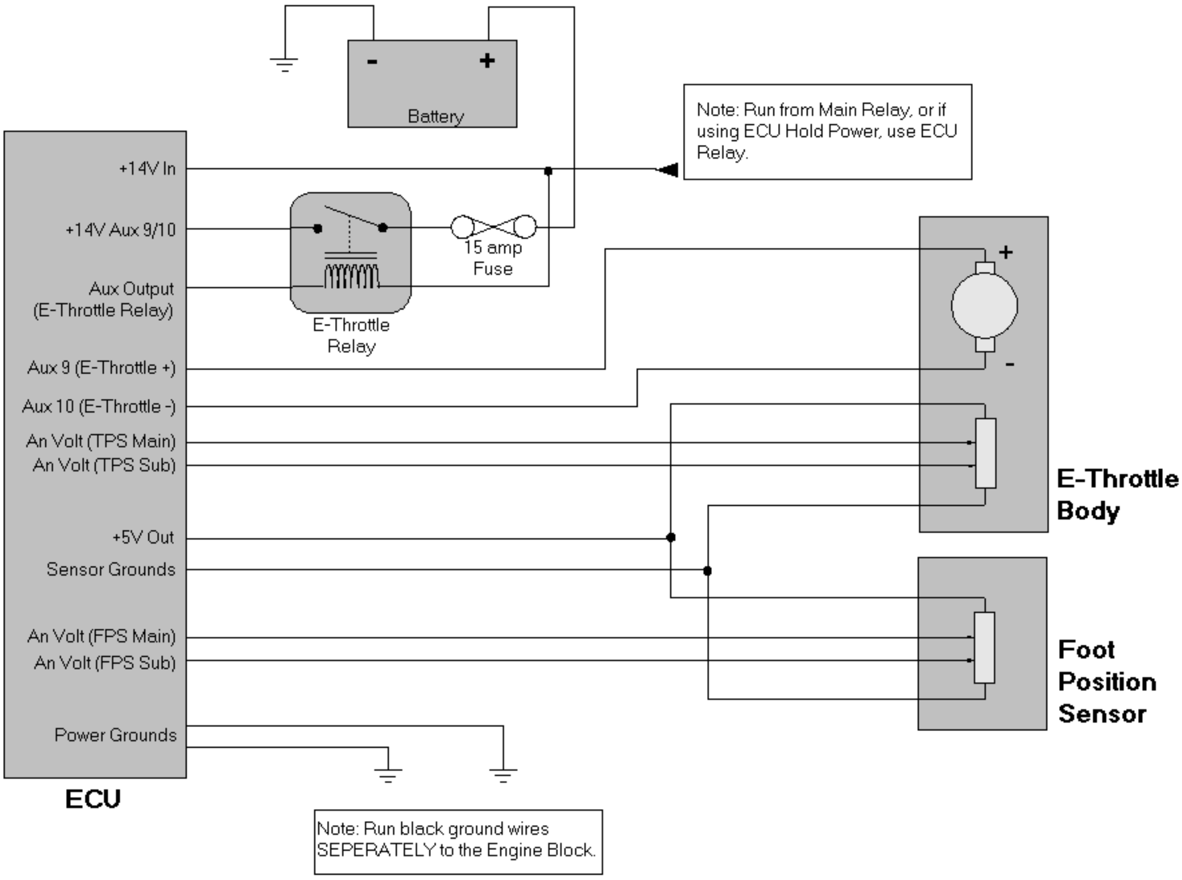
Auxiliary outputs may be connected to a high intensity LED to provide a shift, or warning light. However, a 1kΩ (1000Ω) current limiting resistor is required to be placed in series with the LED. Failure to install the resistor will result in permanent failure of the LED. A bulb may also be used instead of an LED (and it does not require a resistor).



Connection of an LED to an Auxiliary Output

10.2 E-Throttle

10.2.1 Generic Internal E-Throttle Wiring



10.2.2 External Electronic Throttle Control Module

The external electronic throttle control module can be wired as in output interface for ECUs that do not support electronic throttle control internally.

The module requires three auxiliary outputs from the ECU. Signals '1' and '2' control the output drive signals from the module and 'Enable' signal disconnects power from the internal electronic throttle drive.

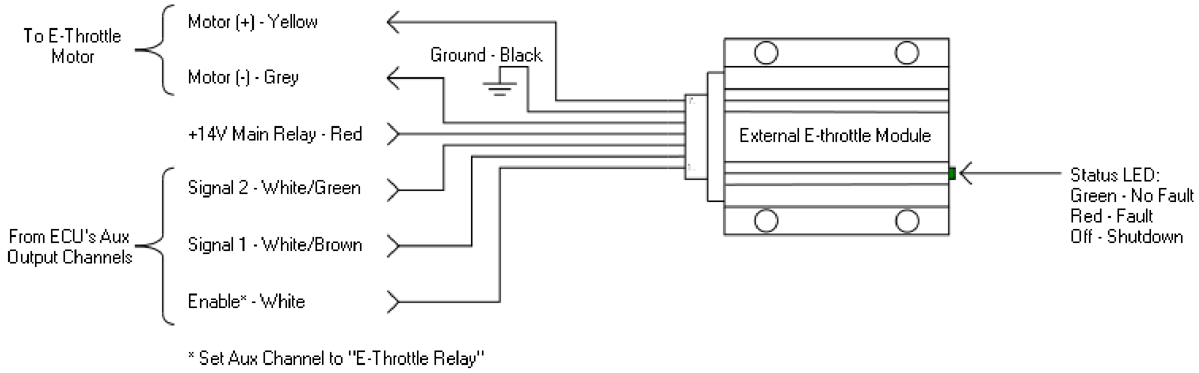
- Signal 1 must be connected to any of the following auxiliary channels: 1, 2, 3 or 4. The function must be set to 'E-Throttle Signal 1'.
- Signal 2 must be connected to any of the following auxiliary channels: 5, 6, 7 or 8. The function must be set to 'E-Throttle Signal 2'.
- Enable must be connected to any auxiliary, auxiliary fuel or auxiliary ignition channel. The function must be set to 'E-Throttle Relay'.

The power for the device needs to come from the main relay. Power should ONLY be present at key on.

WARNING

DO NOT POWER THE DEVICE OFF +12V DIRECTLY FROM THE BATTERY. POWER

MUST BE SUPPLIED VIA THE MAIN RELAY



External EThrottle Wiring Example

An LED on the end of the case provides information on it's current state:

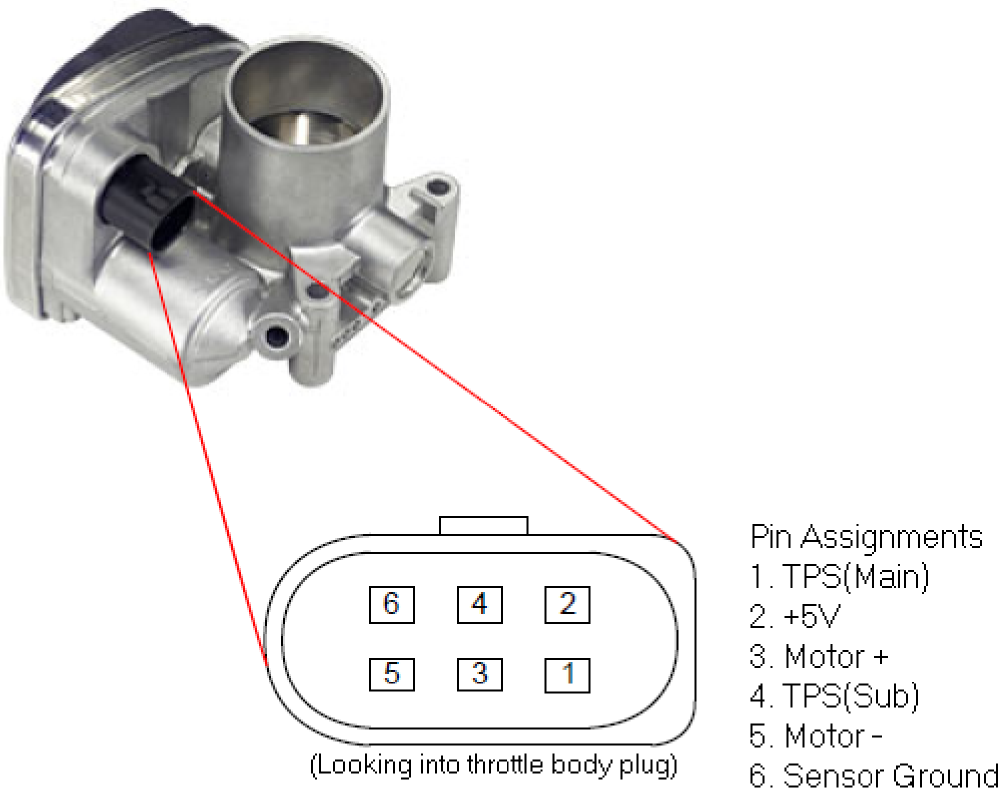
- A green LED indicates the device is powered and enabled.
- A red LED indicates that there is a fault. A fault condition can occur from an output short circuit, excessive current draw or if the device goes over its rated temperate.
- If the LED is off the device is either not powered or not enabled.

For information regarding the wiring of the E-Throttle inputs see the Electronic Throttle Control section of this manual.

10.2.3 Specific E-Throttle Applications

Enter topic text here.

10.2.3.1 VDO Electronic Throttle



BMW M52 (VDO) E-Throttle Wiring

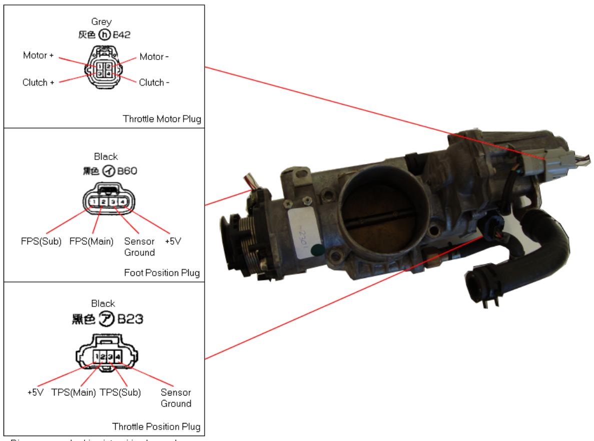
E-throttle Setup Notes

While every effort is taken to ensure correctness, no responsibility will be taken for the consequences of any inaccuracies or omissions.

VDO Part Number	408 238 424 002
Vehicle Make	BMW
Vehicle Model	M52
P Gain	8.00
I Gain	0.102
D Gain	30.00
Deadband %	0.2
Max DC	90
Min DC	-90
Frequency (Hz)	500
TP(sub) 100%	100%
TP(Main) closed (V)	4.52 V

TP(Main) open (V)	0.29 V
TP(Sub) closed (V)	0.48 V
TP(Sub) open (V)	4.70 V
TPS(Main) error high (V)	4.70 V
TPS(Main) error low (V)	0.15 V
TPS(Main) error (%)	5.00 V
TPS(Sub) error high (V)	4.85 V
TPS(Sub) error low (V)	0.30 V
TPS(Sub) error (%)	5.00 V

10.2.3.2 Toyota Clutched Electronic Throttle

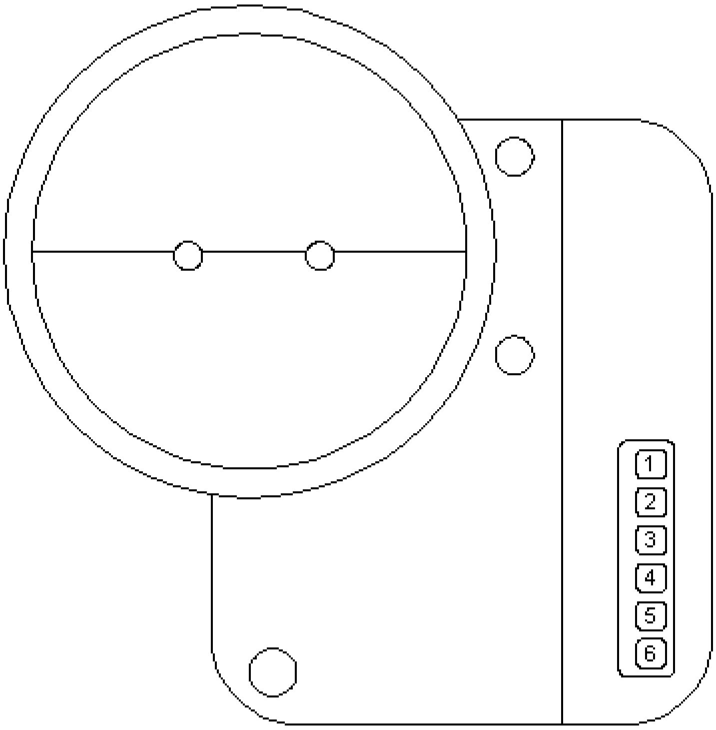


Diagrams are looking into wiring loom plugs

Setup Notes	
Part Number	
Vehicle Make	Toyota
Engine Models	3S-GTE, 1UZ-FE
P Gain	8.00
I Gain	0.121
D Gain	60.00
Deadband %	0.2
Max DC	95
Min DC	-95
Frequency (Hz)	500
TP(sub) 100%	68.5%
TP(Main) closed (V)	0.29 V
TP(Main) open (V)	3.92 V
TP(Sub) closed (V)	1.93 V
TP(Sub) open (V)	4.99 V
FP(Main) closed (V)	0.55 V
FP(Main) open (V)	4.26 V
FP(Sub) closed (V)	2.30 V
FP(Sub) open (V)	4.99 V
Connect the negative of the clutch to a native auxiliary channel (not aux-fuel or aux-ign). The clutch positive must not be hot fed. Set the	

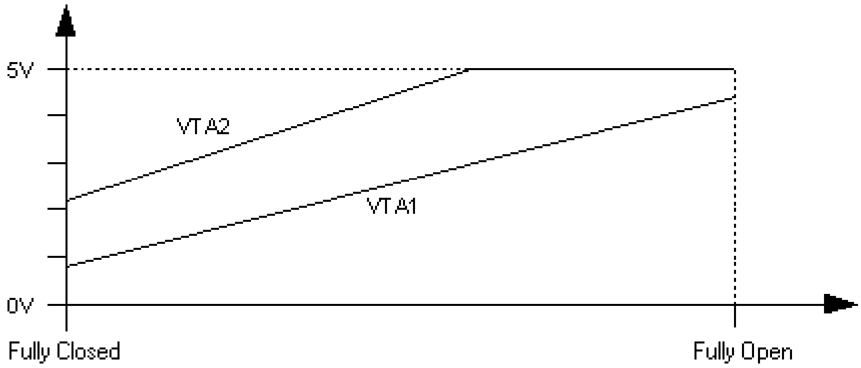
function to 'Test PWM' with a frequency of 250 Hz.

10.2.3.3 Toyota 3UR-FE



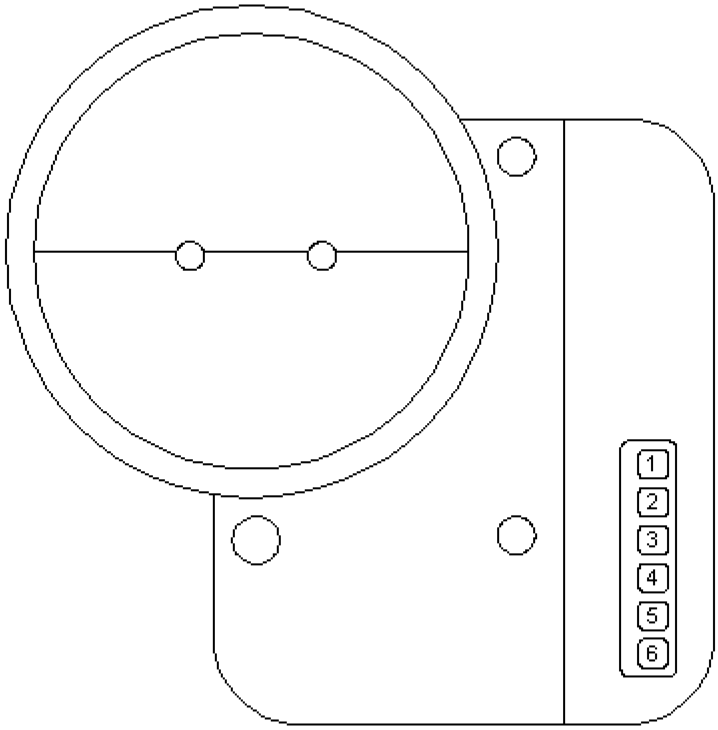
Toyota 3UR-FE E-Throttle Wiring

Pin #	Toyota Naming	Description
1	VTA1	TPS(Main)
2	VC	+5V
3	VTA2	TPS(Sub)
4	E2	Sensor Ground
5		Motor -
6		Motor +



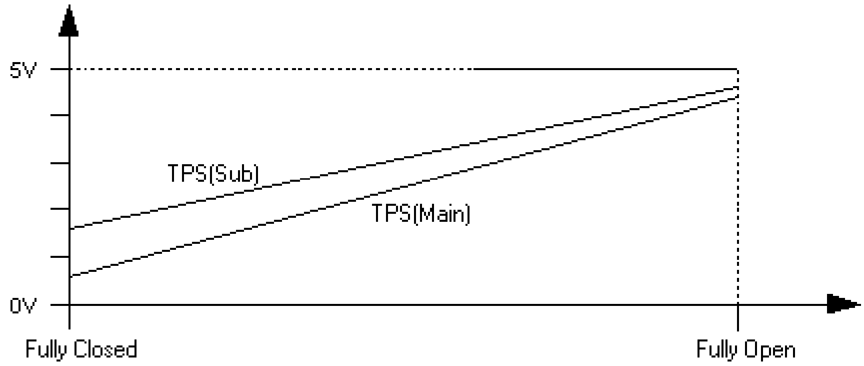
Toyota 3UR-FE E-Throttle Position vs Output Voltage

10.2.3.4 Suzuki Swift



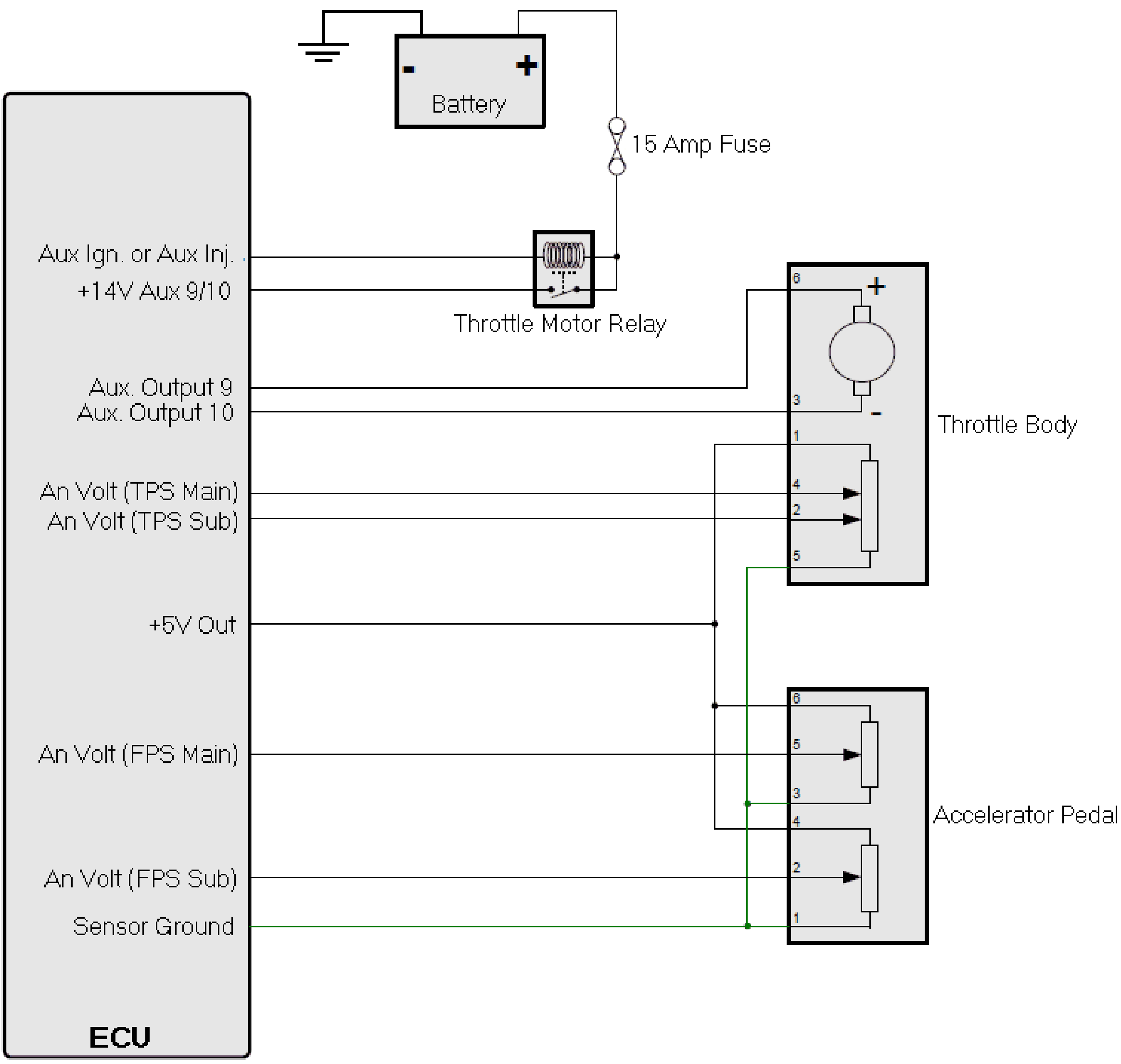
Suzuki Swift E-Throttle Wiring

Pin #	Description
1	TPS(Main)
2	+5V
3	TPS(Sub)
4	Sensor Ground
5	Motor -
6	Motor +



Suzuki Swift Throttle Position vs Output Voltage

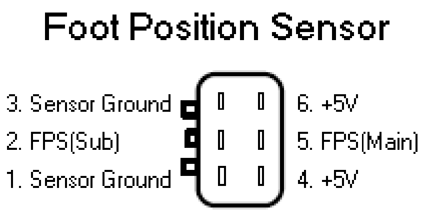
10.2.3.5 Nissan VQ35



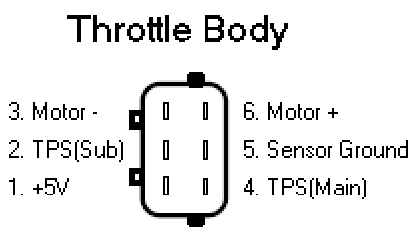
Notes:

- Motor + refers to the pin that has battery voltage applied to it to open the throttle.
- It is recommended to use shielded cables for TPS and FPS sensors.
- To prevent back feeding, the throttle motor relay must be controlled from a non flywheeled output such as a spare Ignition or Injection channel.

Nissan VQ35 E-throttle Wiring diagram

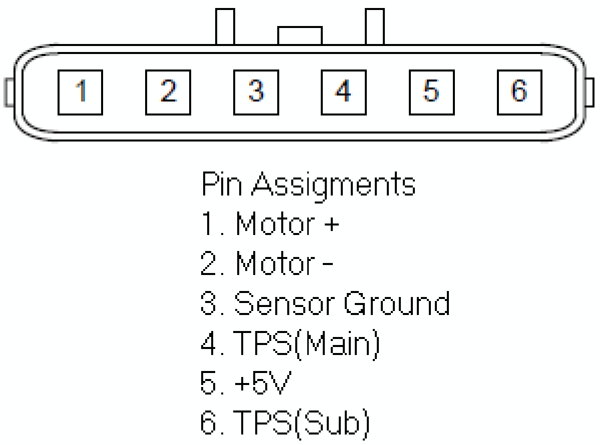


Nissan VQ35 FPS Pinout (looking into FPS)



Nissan VQ35 TPS Pinout (looking into Throttle Body Connector)

10.2.3.6 Mitsubishi EVO X



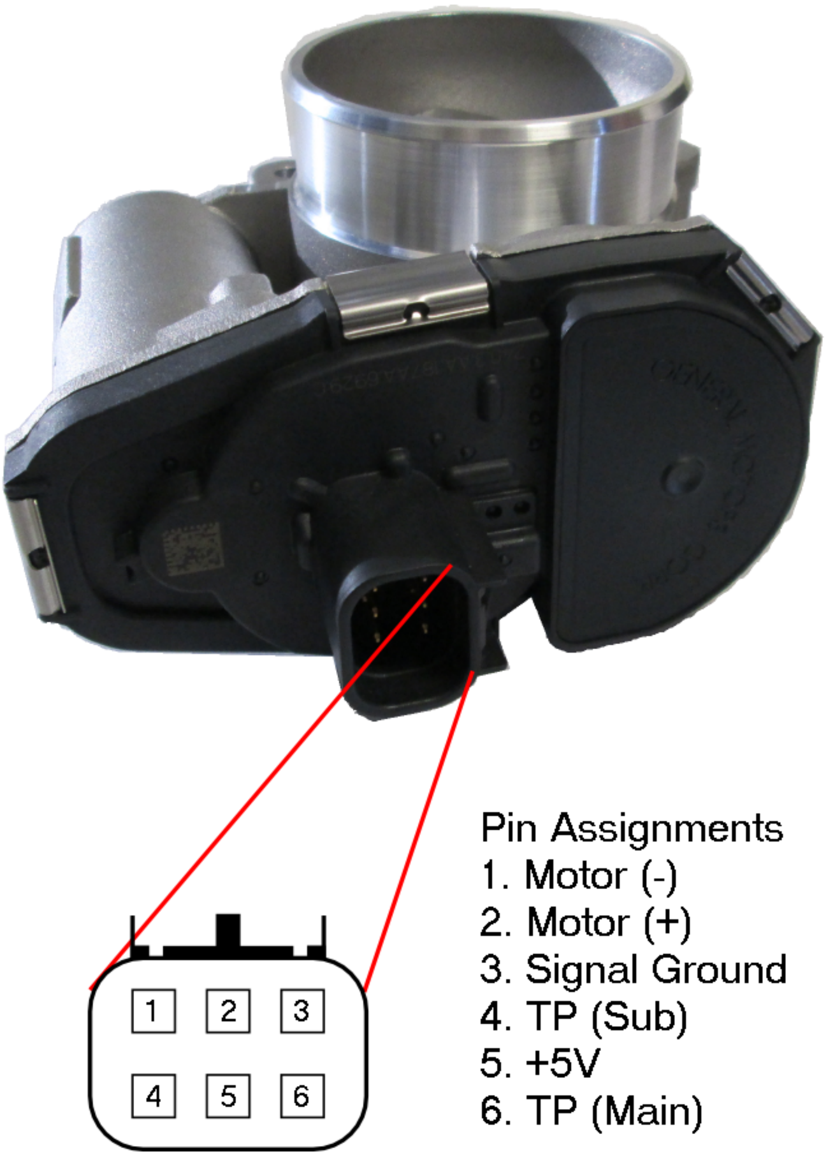
Mitsubishi EVO X E-Throttle Wiring

E-throttle Setup Notes

While every effort is taken to ensure correctness, no responsibility will be taken for the consequences of any inaccuracies or omissions.

Part Number	
Vehicle Make	Mitsubishi Lancer
Vehicle Model	EVO X
P Gain	8.00
I Gain	0.142
D Gain	35.00
Deadband %	0.2
Max DC	90
Min DC	-90
Frequency (Hz)	500
TP(sub) 100%	100%
TP(Main) closed (V)	0.53 V
TP(Main) open (V)	4.42 V
TP(Sub) closed (V)	4.47 V
TP(Sub) open (V)	0.52 V
TPS(Main) error high (V)	4.70 V
TPS(Main) error low (V)	0.30 V
TPS(Main) error (%)	5.00
TPS(Sub) error high (V)	4.70 V
TPS(Sub) error low (V)	0.30 V
TPS(Sub) error (%)	5.00

10.2.3.7 GM Throttle body



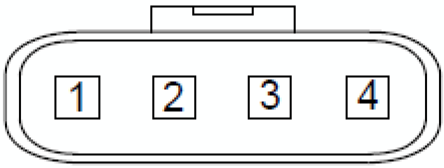
GM throttle body settings	
Frequency	500 Hz
Deadband	0.1%
Proportional Gain	7.00
Integral Gain	0.051
Derivative Gain	35.00
Max Clamp	90.0% DC
Min Clamp	-90.0 % DC

10.2.3.8 Ford BA Falcon Electronic Throttle Wiring

E-throttle Setup Notes

While every effort is taken to ensure correctness, no responsibility will be taken for the consequences of any inaccuracies or omissions.

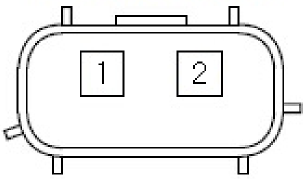
Throttle Position Sensor



Looking into TPS

1. TPS(Sub)
2. +5V
3. Sensor Ground
4. TPS(Main)

Throttle Motor



Looking into throttle motor

1. Motor (+)
2. Motor (-)

Setup Notes

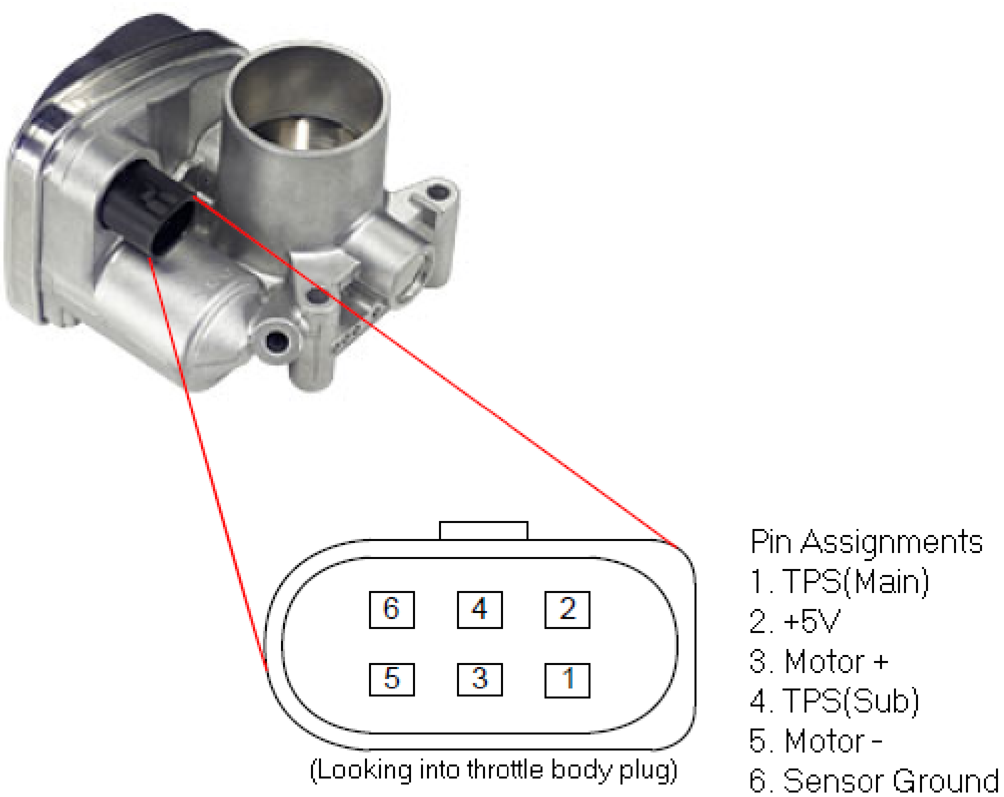
Part Number:
Vehicle Make: Ford
Vehicle Model: BA Falcon

P Gain: 7.00
I Gain: 0.148
D Gain: 35.00
Deadband %: 0.2
Maximum Duty Cycle: 90%
Minimum Duty Cycle: -90%
Frequency (Hz): 500
TP(sub) 100%: 67%

TP(Main) closed (V): 3.80
TP(Main) open (V): 1.65
TP(Sub) closed (V): 1.38
TP(Sub) open (V): 3.84

TPS(Main) error high (V): 4.10
TPS(Main) error low (V): 1.30
TPS(Main) error value (%): 5.0
TPS(Sub) error high (V): 4.10
TPS(Sub) error low (V): 1.00
TPS(Sub) error value (%): 5.0

10.2.3.9 BMW M52 (VDO)



BMW M52 (VDO) E-Throttle Wiring

E-throttle Setup Notes

While every effort is taken to ensure correctness, no responsibility will be taken for the consequences of any inaccuracies or omissions.

VDO Part Number	408 238 424 002
Vehicle Make	BMW
Vehicle Model	M52
P Gain	8.00
I Gain	0.102
D Gain	30.00
Deadband %	0.2
Max DC	90
Min DC	-90
Frequency (Hz)	500
TP(sub) 100%	100%
TP(Main) closed (V)	4.52 V

TP(Main) open (V)	0.29 V
TP(Sub) closed (V)	0.48 V
TP(Sub) open (V)	4.70 V
TPS(Main) error high (V)	4.70 V
TPS(Main) error low (V)	0.15 V
TPS(Main) error (%)	5.00 V
TPS(Sub) error high (V)	4.85 V
TPS(Sub) error low (V)	0.30 V
TPS(Sub) error (%)	5.00 V

10.3 Fuel Injector Drives

Note: For information on wiring Injection Outputs as additional Auxiliary Outputs, refer to the section on wiring Auxiliary Outputs.

The injector drives on a i-Series ECUs work by supplying an EARTH to turn the injectors on. A switched (key ON) 12V must be supplied to the other terminal of the injector. The polarity of the injector is not important. Note that injectors should be powered from the same supply as the ECU. This ensures the ECU has accurate measurement of injector voltage for calculating injector dead time.

WARNING!

DO NOT connect +12V directly to any of the injector drives

Injectors are commonly available as either high impedance or low impedance. To determine injector impedance: With the injector unplugged, use an ohmmeter to measure the resistance across the two terminals of the injector;

- If the injector resistance is greater than 6 Ω then the injectors are high impedance and no ballast resistors are required,
- If the injector resistance is less than 6 Ω then ballast resistors will be required.

i-Series Injection Specifications:

i-Series i88

- Max Peak Current = 4 A
- Max Hold Current = 1 A
- Max Saturated Injection or Auxiliary Output Current = 5 A
- Open Collector (not fly-wheeled) in auxiliary output mode.

i-Series i44

- Max Peak Current = 4 A
- Max Hold Current = 1 A
- Max Saturated Injection or Auxiliary Output Current = 5 A

- Open Collector (not fly-wheeled) in auxiliary output mode.

10.3.1 Injection Mode

i-Series ECUs have up to eight independent injector drives. This means that for most engines sequential injection can be used. Depending on the number of Injection Drives, the following Injection Modes may available:

- Single Point Group
- Sequential
- Multi Point Group
- Sequential/Staged
- Group/Staged

Single-Point Group Injection

A single injector (sometimes two) is used to supply fuel for all cylinders. Normally this injector is placed just before or just after the throttle body. In this mode the injector(s) are fired once per TDC. The injector should be driven by Injector Drive 1. If two injectors are used then the second injector should be driven by Injector Drive 2.

Multi-Point Group Injection

This mode should be used if each cylinder has its own injector, but there are too many cylinders or insufficient triggering to use sequential injection. In this mode the injectors are fired in two out-of-phase groups with each group firing once for every 360 or 720 degrees of crankshaft rotation (depending on the Injection Rate setting). Wire each injector to its own drive or pair injectors if there are not enough drives.

Sequential Injection

This mode should be used if each cylinder has it's own injector providing the following criteria are met:

1. There must be one Injector Drive for each cylinder.
2. There must be sufficient triggering for the ECU to calculate the current engine position in the 720 degree engine cycle. This means that a second trigger sensor is required for synchronisation and this must use an appropriate trigger wheel driven off of the camshaft (or driven at half the crankshaft's angular speed).

In this mode each injector must be correctly wired to its own injector drive so that the injector can be fired. The timing at which the injectors fire is configurable within iVTS Tuning Software.

The firing order of the engine is NOT important at the wiring stage as the firing order will be entered into the ECU via iVTS Tuning Software. Wire each cylinder to its corresponding injector drive number (wire cylinder 1 injector to injector drive 1, 2 to 2, 3 to 3 etc...).

Set the 'Injection Mode' to 'Sequential' when using this configuration.

Staged Injection

This mode allows the use of staged injection where the engine uses primary injectors that operate at all times and secondary injectors that only operate at high load/rpm. This arrangement is useful in applications with very high fuel delivery requirements that would normally require extremely large injectors. Very large injectors make tuning difficult at low loads (idle and low power operation). With staged injection one smaller set of injectors operates at low load giving more precise control. At higher loads both sets of injectors become active to supply the required fuelling needs.

Group Fire Staged Injection

This mode must be used for staged injection if the criteria required for sequential injection are not met. In this mode the number of injection drives used can be specified using the 'Active Drives' setting. Irrespective of the number of injection drives used, wire the primary injectors to odd numbered Injector Drives (Inj1, Inj3, Inj5, Inj7), wire the secondary injectors to even numbered Injector Drives (Inj2, Inj4, Inj6, Inj8). In this mode all primary injector drives are fired at the same time (group fire) and all secondary injector drives are fired at the same time (group fire). Set the 'Injection Mode' to 'Group/Staged' when using this configuration.

Sequential Staged Injection

This mode can be used to provide full sequential injection on both the primary and secondary injectors. This mode requires that the engine have sufficient triggering to calculate crankshaft position and the position in the firing order (i.e. a sync signal is required).

Cylinders/ Rotors	Primary	Secondary	Spare Inj Drives
2	Inj 1 = Pri 1 Inj 2 = Pri 2	Inj 3 = Sec 1 Inj 4 = Sec 2	Inj 5-8 Spare
3	Inj 1 = Pri 1 Inj 2 = Pri 2 Inj 3 = Pri 3	Inj 4 = Sec 1 Inj 5 = Sec 2 Inj 6 = Sec 3	Inj 7-8 Spare
4	Inj 1 = Pri 1 Inj 2 = Pri 2 Inj 3 = Pri 3 Inj 4 = Pri 4	Inj 5 = Sec 1 Inj 6 = Sec 2 Inj 7 = Sec 3 Inj 8 = Sec 4	None
5	Inj 1 = Pri 1 Inj 2 = Pri 2 Inj 3 = Pri 3 Inj 4 = Pri 4 Inj 5 = Pri 5	Inj 7 = Sec Group 1 Inj 8 = Sec Group 2	Inj 6 Spare
6	Inj 1 = Pri 1 Inj 2 = Pri 2 Inj 3 = Pri 3 Inj 4 = Pri 4 Inj 5 = Pri 5 Inj 6 = Pri 6	Inj 7 = Sec Group 1 Inj 8 = Sec Group 2	None

Full primary and secondary sequential injection can only be achieved on engines with four cylinders or less. Wire injectors as shown in the preceding table. On engines with 5 or 6 cylinders the primary injectors will be fired sequentially and secondary injectors fired in group mode. Engines with 8 or more cylinders must use Group Staged Injection.

Set the 'Injection Mode' to 'Sequential/Staged' when using this configuration.

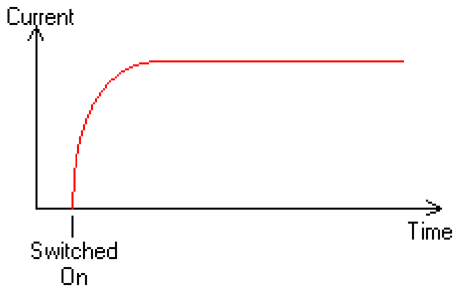
10.3.2 Fuel Injector Wiring and Setup Tech Note

Injector Impedance

The injector impedance measured in ohms(Ω) defines the maximum current that will be drawn with an applied voltage. The maximum current can be simply calculated using the following formula:

Maximum Injection Current = Battery Voltage / Injector Impedance

The term 'Impedance' is used rather than 'Resistance' when talking about fuel injectors. This is due to the inductive properties of the fuel injector. The inductive properties of the fuel injector cause the current to increase in a 'damped' fashion towards it's maximum current.



Example

A 12Ω fuel injector is wired to an injection channel, the battery voltage is 13.5V. How much current will the injector draw?

Using the above equation -

Max Injection Current = Battery Voltage / Injector Impedance

= 14V / 12Ω

= 1.17 A

Example

A 3Ω fuel injector is wired to an injection channel, the battery voltage is 14V. How much current will the injector draw?

Max Injection Current = Battery Voltage / Injector Impedance

= 14V / 3Ω

= 4.67 A (very high)

Measuring Injector Impedance

Measuring injector impedance is simple, all you need is a multimeter.

1. Set the multimeter to its resistance setting with the lowest range possible (e.g. 0Ω – 100Ω).
2. Measure the resistance of the multimeter leads by connecting the two together, note down this number.
3. Connect the two leads of the multimeter to the two terminals of the injectors. (Make sure the injector terminals are clean). Note the measured resistance.

4. Subtract the lead resistance from the measured resistance. (e.g. 2.01Ω – 0.01Ω = 2.00Ω) This number is the injector impedance.

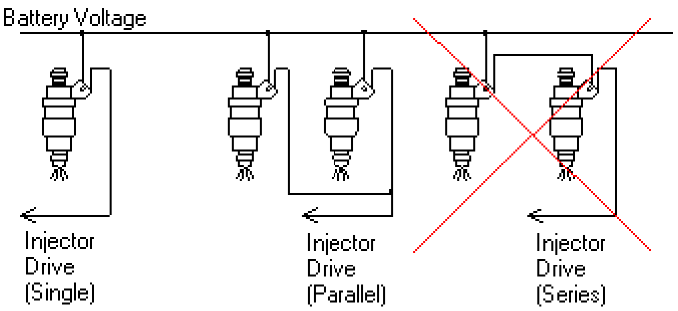
Note, it is good practice to measure all of the injectors. This checks the condition of the solenoid inside the fuel injector. If an injector has been overheated, the measured impedance is generally lower.

High vs. Low Impedance Injectors

Injectors can be classified as either 'high' or 'low' impedance. As a general rule, 6Ω or greater is considered a high impedance injector, and less than 6Ω is considered low impedance. Low impedance injectors will draw higher current.

Injector Wiring

Injectors can be wired either individually or in groups to an injection drive. When wiring injectors in groups, they MUST be connected in a parallel arrangement. Never wire fuel injectors in series.



It is important to consider drive current when wiring injectors. Drive current is the amount of current flowing into any individual injection channel on the ECU.

- When wiring one injector per injection channel, drive current is exactly equal to injector current.
- When wiring multiple injectors per injection channel, drive current equals the sum of the injector currents on that channel.

It is important that the injectors are supplied from the same voltage supply that is used by the ECU. This allows the ECU to accurately measure the injector voltage for dead time correction as well as flywheeling the current when operating in peak and hold mode.

Example

Three 12Ω fuel injectors are wired to an injection channel, the battery voltage is 13.5V.

How much current will each injector draw?

Max Injection Current = Battery Voltage / Injector Impedance

= 13.5V / 12Ω

= 1.125 A

How much current will flow into the injection channel (drive current)?

Drive Current = Injector 1 Current + Injector 2 Current + Injector 3 Current + …

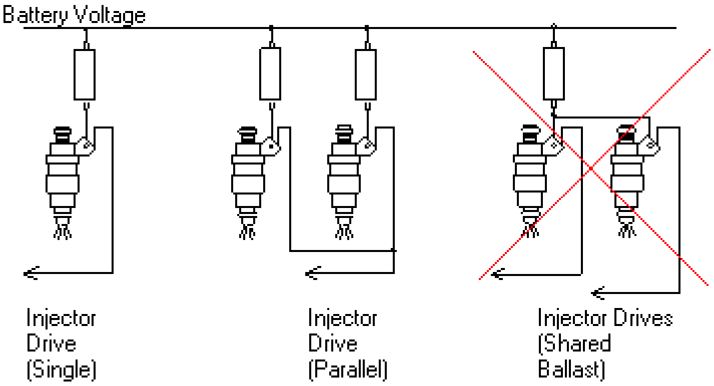
= 1.125 + 1.125 + 1.125

= 3.375 A

Ballast Resistors

Ballast resistors provide a way of limiting the current through a low impedance fuel injector.

A ballast resistor is always wired in series with a fuel injector. Each fuel injector requires it's own ballast resistor. You can not share a ballast resistor over multiple injectors, this will cause varying injection current depending on how many drives are turned on.



Calculating injection current through fuel injectors wired with ballast resistors can be done simply by adding the ballast resistor resistance (Ω) to the injector impedance (Ω). The new impedance can then be used in the previously discussed equations.

Effective Injector Impedance = Injector Impedance + Ballast Resistance

Maximum Injection Current = Battery Voltage / Effective Injector Impedance

Example

Two 2Ω fuel injectors are wired to an injection channel each with a 4.7Ω ballast resistor, the battery voltage is 12V.

What is the effective impedance of each fuel injector?

Effective Injector Impedance = Injector Impedance + Ballast Resistance

= 2Ω + 4.7Ω

= 6.7Ω

How much current will each injector draw?

Max Injection Current = Battery Voltage / Effective Injector Impedance

= 12V / 6.7Ω

= 1.79 A

How much current will flow into the injection channel (drive current)?

Drive Current = Injector 1 Current + Injector 2 Current + Injector 3 Current + …

= 1.79 + 1.79

= 3.58A

When selecting a ballast resistor, it is important to select a value that will limit the current enough not to damage the ECU, but supply enough current to open the injector.

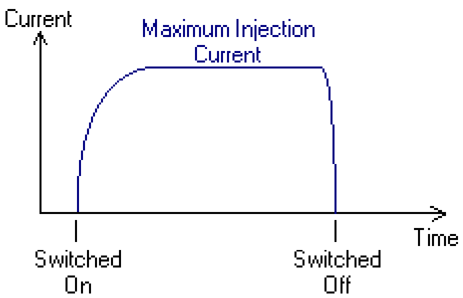
The alternative to using a ballast resistor is to use a peak and hold control mode, this will be explained further in a following section.

Injection Control Modes

There are two main ways of controlling fuel injectors: saturated control and peak and hold control. Saturated mode is typically suited to driving high impedance injectors and peak and hold mode is suited for driving low impedance injectors.

Saturated Control

Saturated control is the most simple form of injector control. Basically the injector drive is turned hard on the entire duration of the injection event. This means the maximum current is held for most of the injection period (less the turn-on and turn-off current transitions).



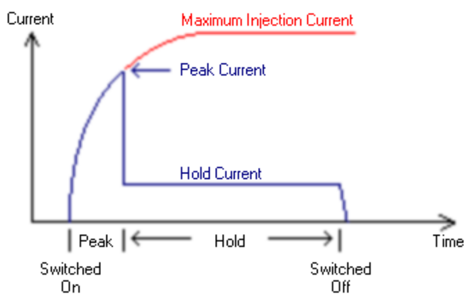
It is critical to not exceed the rated saturated injection current for the ECUs injector drives.

Peak and Hold Control

Peak and hold injector control is a two stage system for driving low impedance injectors. Peak and hold provides the advantages of fast opening times (dead time) compared with ballast resistors and low power consumption when holding the injectors open.

During the peak stage, the injector drive turns hard on and the current rises towards the maximum injection current. The ECU detects when the current reaches the defined 'Peak Current', at this point the control switches to hold mode.

Once in the hold stage, the ECU is acting as an ultra efficient ballast resistor limiting the current through the injector.



You can see from the above image, the maximum current is higher than that of the peak current. If this wasn't the case, the current would never reach its peak value and switch over to hold mode.

When setting the peak and hold currents, it is important to consider this. Careful reading of the fuel injector specification sheet will provide minimum opening currents and impedance for calculating the maximum current.

Typically the hold current will be one quarter of the peak current. The following table shows typical peak and hold settings.

Effective Impedance (Ω)	Peak Current (A)	Hold Current (A)
2	4	1
4	2	0.5

Safety Features

When a Vi-PEC ECU equipped with peak and hold injection detects that the peak current (8A in saturated mode) has been reached in 40uS, the injector drive will go into safe mode, effectively shutting the drive down.

It is possible to trigger safe mode either by a direct battery short or when wiring a combination of injectors to a drive resulting in a very low impedance.

The second safety feature is a peak time out. The peak mode will only remain active for a maximum time of 4ms, at this point it will switch to hold mode. This is a safety feature only, for correct operation the transition from peak mode to hold mode must be made by the current exceeding the set peak current.

Summary

In summary:

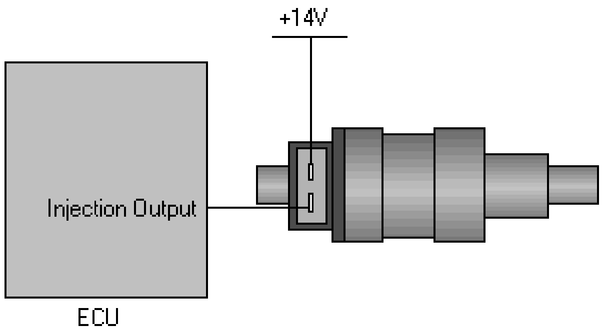
- The saturated injection mode is used for controlling high impedance injectors (greater than 6Ω).

- The peak and hold injection mode is used for controlling low impedance injectors.
- Peak and hold injection provides the advantage of faster opening times with less injector and circuitry heating.
- Injectors must never be wired in series.
- If ballast resistors are required, they must be wired per injector.

10.3.3 High Impedance Injectors

All i-Series ECUs can drive up to two high impedance injectors off each Injector Drive. It is recommended to wire a single injector to each injector drive. On engines with more cylinders than the ECU has Injection Drives injectors should be paired.

Wiring for high impedance injectors is shown below.



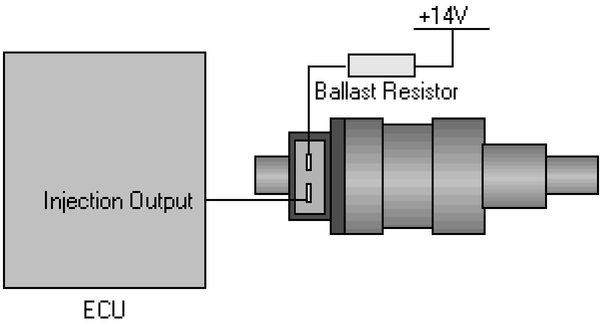
High Impedance Injector Wiring

10.3.4 Low Impedance Injectors

i88 and i44 ECUs can drive low impedance injectors directly the same as wiring high impedance injectors. When driving low impedance injectors directly it is essential that before running the engine the correct Injection Mode (Peak and Hold) and Peak and Hold Currents are configured using iVTS Tuning Software.

Wiring Ballast Resistors

It is recommended to wire a single injector to each injector drive. On engines with more than eight cylinders injectors must be paired.



Injector wiring for injectors with ballast resistors

Ballast Resistor Selection

If the injector impedance is LESS THAN 2 Ohms, use 2R2 (2.2 Ohm) ballast.

If the injector impedance is between 2 and 6 Ohms, use 4R7 (4.7 Ohm) ballast.

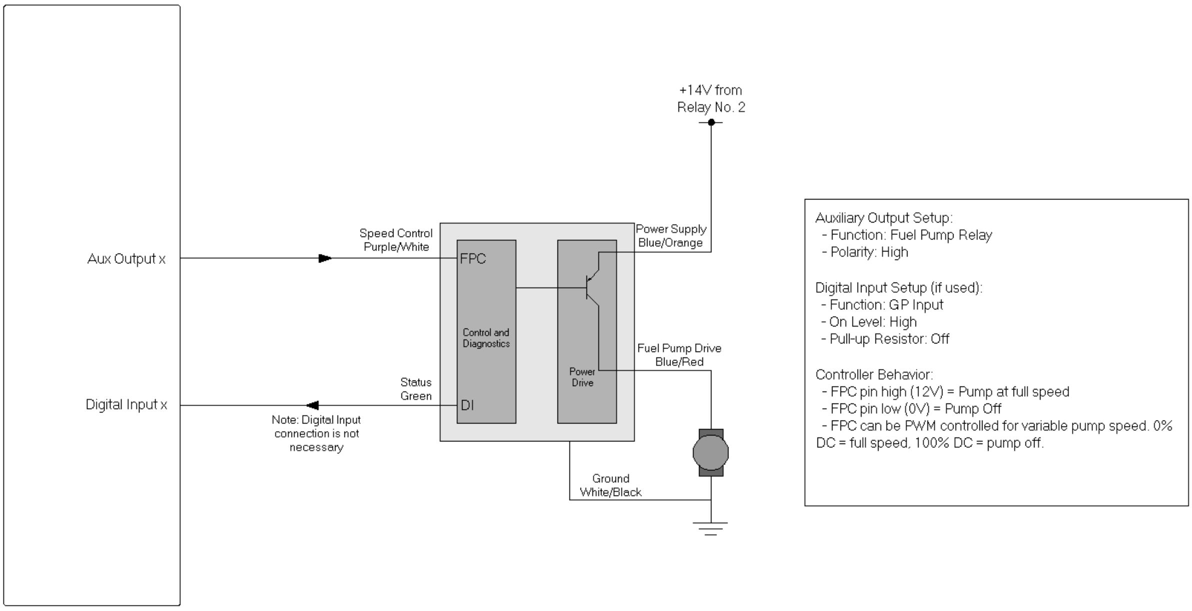
If the injector impedance is greater than 6 Ohms, use no ballast.

It should be noted that injector ballast resistors get quite hot at high injector duty cycles. Therefore these should be mounted on a heat sink and this should be bolted to the chassis. Typically ballast resistors should be mounted in the engine bay.

Do not use common 0.25W or 1.0W resistors, as these will burn out almost immediately. 50W resistors should be used. These are relatively uncommon at hobbyist shops, but are readily available from your Vi-PEC dealer in groups of 2, 4, 6 or 8 resistors on a heat sink.

10.4 Fuel Pump Control

10.4.1 Toyota 1JZ-GE Fuel Pump Control



10.5 Idle Speed Control

Idle Speed Control (ISC) is required to provide an acceptable idle speed when the engine is cold or when loads (AC etc.) are applied. Without idle speed control, an engine will idle too slowly when cold. Often the cold idle speed will be so low that the engine stalls. Likewise, extra load loads will decrease the idle speed and may cause the idle to stall or become unstable. The ISC system regulates the engine idle speed by adjusting the amount of air which is bypassed around the throttle. This air may be bypassed using either a solenoid or stepper motor.

i-Series ECUs employ a sophisticated closed loop idle speed control system that provides factory like idle speed control. This system can be used to provide idle speed control using either a 2 or 3 terminal ISC Solenoid or a 4 or 6 terminal ISC Stepper Motor. While a solenoid and stepper motor operate very differently they both achieve the effect of bypassing air around the throttle plate to increase the idle speed.

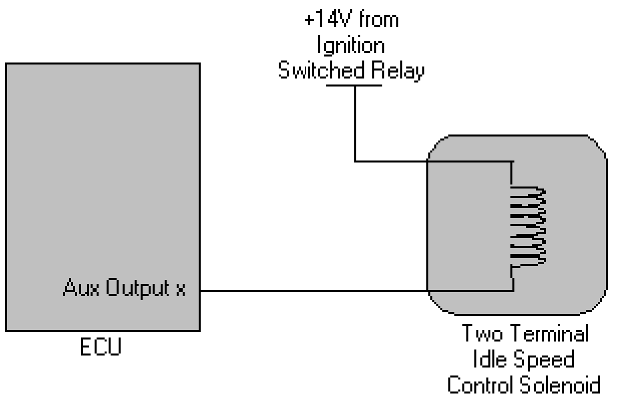
Some engines use a non-electronic system to control idle speed as the engine warms up. This system contains a bimetallic strip, which is heated by the engine coolant and/or electrically. As the engine warms up, the amount of bypassed air is reduced and the idle is returned to its normal level. The ECU does not control this type of device. It is intended ONLY as an idle up when the engine is cold.

10.5.1 Two Terminal ISC Solenoid

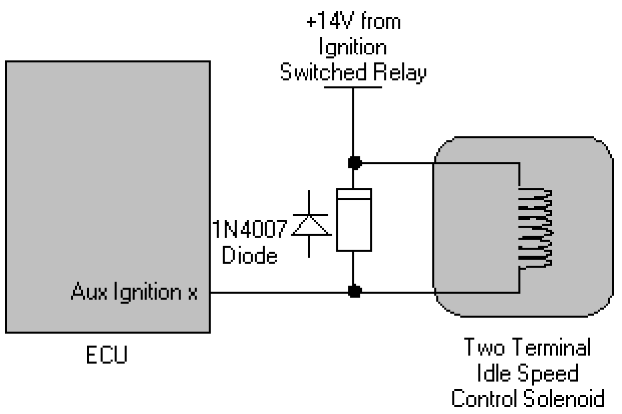
A two terminal ISC solenoid may be wired to Auxiliary Channels 1 to 8. Injection channels can not be used for ISC control. Ignition Channels 1 to 8 can also be used to control a two terminal ISC Solenoid however an external fly-wheeling diode must be wired.

Two terminal ISC solenoids need only one auxiliary output (or ignition channel) to open the solenoid. A spring is used to automatically close the solenoid. Connect one terminal to the engine managements power supply and connect the remaining terminal to an Auxiliary/ Ignition Output Output. The orientation of the wires does not matter.

An ISC solenoid must be wired to a switched power supply. Note that some Nissan ISC solenoids are powered directly from the battery. This wiring must be changed,



Wiring for two-terminal ISC solenoid on Auxiliary Output



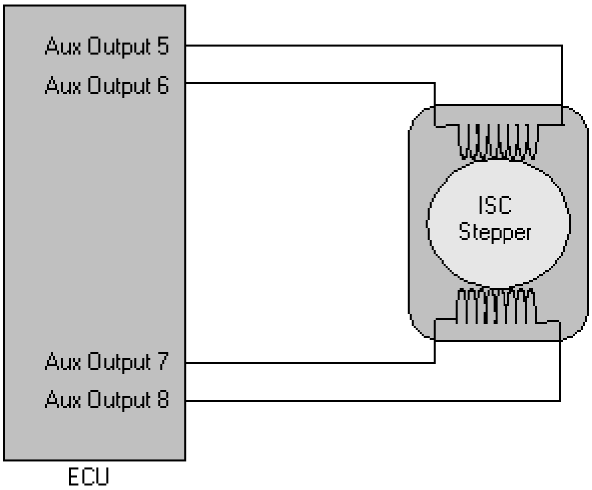
Wiring for two-terminal ISC solenoid on Ignition Output

10.5.2 Four Terminal ISC Stepper Motor

An ISC Stepper Motor must be wired to Aux 5, Aux 6, Aux 7 and Aux 8.

When using an ISC Stepper, the ECUs power supply should be wired for ECU Hold Power as shown in Figure 6.2. This will allow the ECUs Hold Power function to be taken advantage of. Using ECU Hold Power allows the ECU to reset the stepper motor after key off. This avoids extended cranking periods caused by resetting the stepper at key on.

The diagram below shows a schematic of a four-terminal stepper motor. Note that there are two coils. Use an ohmmeter to pair the terminals with a common coil. Aux 5 and 6 must be connected to the terminals for one coil, while Aux 7 and 8 must be connected to the terminals for the other coil. If it is found that the stepper motor runs in the opposite direction to that expected, reverse the wiring to Aux 5 and Aux 6.



Four-terminal ISC Stepper Motor

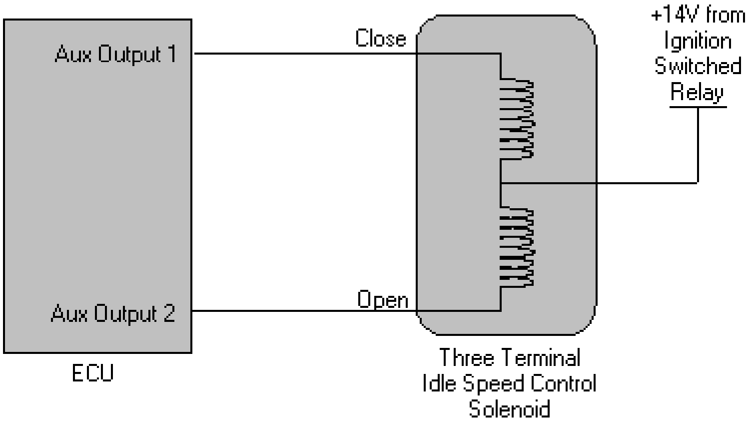
Note: Stepper motors with a winding resistance of less than 20 ohms are not recommended, because of the higher current draw, these stepper motors are at risk of over heating and open or short circuiting windings. The vast majority of stepper motors have winding resistances higher than 20 ohms.

10.5.3 Three Terminal ISC Solenoid

A Three Terminal ISC Solenoid must be wired to Aux 1 and Aux 2. Aux 1 is ISC Close, Aux 2 is ISC Open.

Three terminal ISC solenoids needs one Auxiliary Output to open the solenoid and another Auxiliary Output to close it.

Use an ohmmeter to find the common terminal (usually the centre). Figure 8.14 shows the schematic. Next measure the resistance between the common and remaining two terminals. This should be greater than 10 ohms. Apply +12V to the common terminal of the solenoid. Ground one of the other terminals. If this terminal causes the valve to open, connect it to an Auxiliary Output 2 and note that this output should be configured as 'ISC Solenoid'. If the valve closes, connect the terminal to Auxiliary Output 1 and note that this output should be configured as 'ISC Solenoid Slave'.



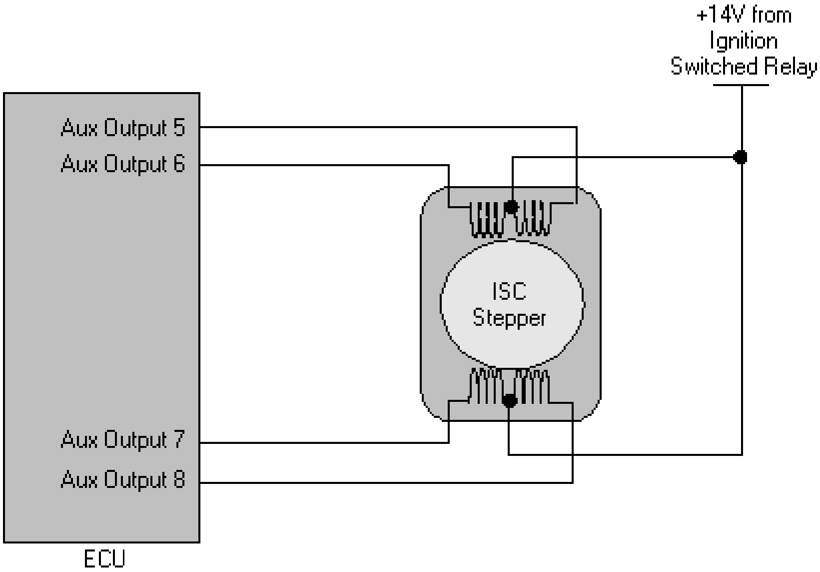
Three terminal ISC Solenoid Wiring

10.5.4 Six Terminal ISC Stepper Motor

An ISC Stepper Motor must be wired to Aux 5, Aux 6, Aux 7 and Aux 8.

When using an ISC Stepper, the ECUs power supply should be wired for ECU Hold Power. This will allow the ECUs Hold Power function to be taken advantage of. Using ECU Hold Power allows the ECU to reset the stepper motor after key off. This avoids extended cranking periods caused by resetting the stepper at key on.

The diagram below shows a schematic of a six-terminal stepper motor. These are similar to a four-terminal Stepper Motor, but each coil has a centre-tap that must be connected to 12V. Like the four-terminal version, Aux 5 and 6 must be connected to the terminals for one coil, while Aux 7 and 8 must be connected to the terminals for the other coil. If it is found that the stepper motor runs in the opposite direction to that expected, reverse the wiring to Aux 5 and Aux 6 channels.

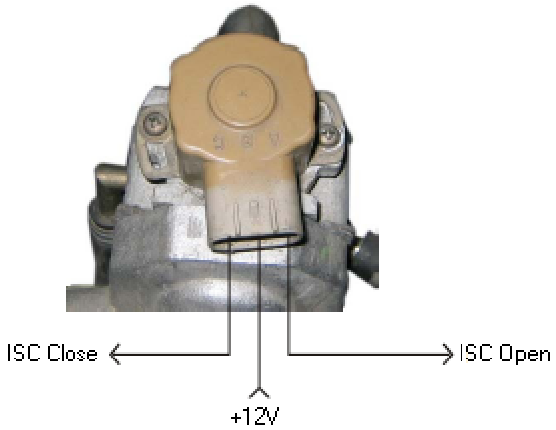


Six-terminal ISC Stepper Motor

Note: Stepper motors with a winding resistance of less than 20 ohms are not recommended, because of the higher current draw, these stepper motors are at risk of over heating and open or short circuiting windings. The vast majority of stepper motors have winding resistances higher than 20 ohms.

10.5.5 Specific Idle Applications

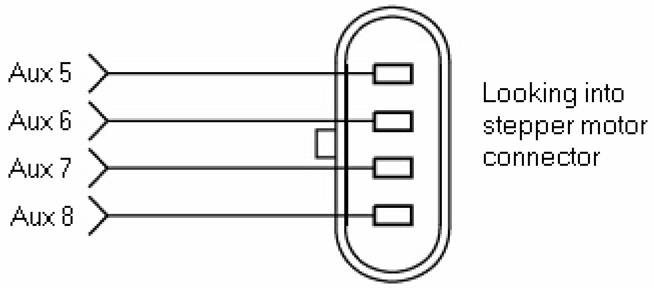
10.5.5.1 Subaru Idle Control Valve EJ20T



Wire Colours (1993 GC8 WRX)	
ISCO	Black
+12V	Yellow/Red
ISCC	White

Note: Pinout and wire colours taken from GC8 WRX

10.5.5.2 LS1 Idle Stepper



10.6 Ignition Drives

Note: For information on wiring Ignition Outputs as additional Auxiliary Outputs, refer to the section on wiring Auxiliary Outputs.

i-Series ECUs have up to 8 independent ignition drives which can be used in a wide range of configurations from a basic distributor set-up through to more complex multi-coil arrangements. i-Series ECUs support the ignition configurations shown in table below.

Number of Cylinders	Distributor	Wasted Spark (1 Dual Post Coil per two Cylinders)	Direct Spark (1 Coil per Cylinder)
2	✓	✓	✓

Number of Cylinders	Distributor	Wasted Spark (1 Dual Post Coil per two Cylinders)	Direct Spark (1 Coil per Cylinder)
3	✓	✓	✓
4	✓	✓	✓
5	✓	✓	✓ *
6	✓	✓	✓ *
8	✓	✓	✓ *
10	✓	✓ *	×
12	✓	✓ *	×

Number of Rotors	Leading Wasted	Leading Direct
2	✓	✓
3	X	✓*
4	X	✓*

Available Ignition Combinations (* i88 ECU Only)

10.6.1 Coil Requirements

The coil required for a particular application will depend largely on the method used to drive the coil and the spark energy requirements. Consult the igniter manufacturer for a recommended coil for use with a particular igniter.

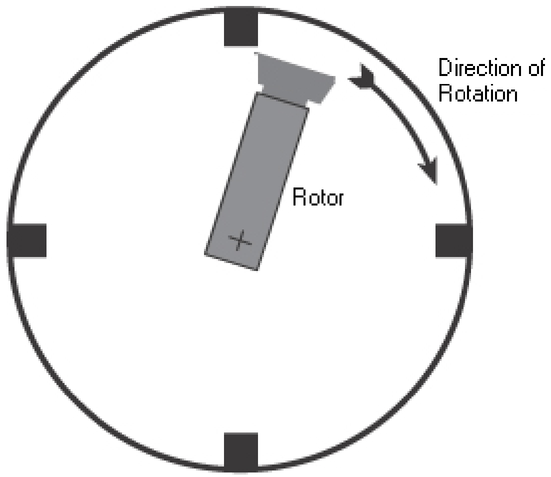
The required Dwell Time will be entirely dependent on the coils inductance. Dwell time should be correctly set to avoid damage to coils and igniters and also ensure adequate spark energy. It is not true that increased dwell time will always result in increased spark energy.

Use only coils designed for high-energy transistor/inductive ignition systems. The coils primary resistance should typically be between 0.4 Ω and 1.0 Ω. This applies to both single and dual post coils in distributed and multi coil applications.

10.6.2 Distributor Ignition

A distributor rotates at half the crankshaft speed and routes the high voltage generated by the coil to the intended spark plug via a rotor and HT wiring. A distributed engine requires one ignition drive and a single channel igniter. Use Ignition Drive 1 to switch the igniter.

Because the rotor will only point to each post on the distributor cap for a short amount of time, the rotor timing dictates the range of ignition advance angles that may be used without misfiring or unnecessarily losing spark energy. A wider tip on the rotor will also allow a wider range of timing values to be used. The tip of rotor should be just leaving the post when the crankshaft is positioned at the minimum timing that will be used (typically at about 10 degrees BTDC). The point where the leading tip of the rotor arrives at the post is the most advanced timing that should be used.



Correct Rotor Timing

10.6.3 Igniter Requirements

An igniter acts as an interface between the ECU and the ignition coil(s). The Igniter is used to drive the coil(s) by supplying a ground for the coils negative terminal.

The igniter is basically a solid-state switch, which may also limit the coil current to a predetermined value. This limiting feature eliminates coil ballast resistors and provides protection of the coils if the dwell time (time the coil is charged for) is set too long. Over voltage clamping is incorporated to prevent damage to the igniter should a high-tension lead become disconnected or similar.

Each one of the ignition drives may be used to switch a separate channel on an igniter. Each channel on the igniter is used to switch an ignition coil. The following examples show the requirements for some common ignition configurations:

Example - 4 cylinder engine with direct spark

- Four ignition drives must be used
- A four channel igniter (or 2 x 2 channel igniter's) must be used
- Four Single Post Coils must be used

Example - 4 cylinder engine with wasted spark

- Only two ignition drives are used (Ign. 1 and Ign. 2)
- One two channel igniter must be used
- Two Dual Post Coils must be used

Example - Engine with single distributor ignition

- Only one ignition drive is used (Ign. 1)
- A single channel igniter must be used
- One Single Post Coil must be used

Conventional igniters begin to charge the coil when their input is high. Spark occurs when the input goes low. This is known as a Rising 'Dwell Edge'. Some factory igniters (eg some Ford and Honda), MSD ignitions and some other units work in the opposite sense. The coil begins to charge when the input signal goes low while spark occurs on the transition from low to high. In these cases, a Falling 'Dwell Edge' must be selected in iVTS Tuning Software.

Always mount igniter(s) in the engine bay as close to the ignition coil(s) as possible. This helps to minimize the length of high current wiring between the igniter(s) and coil(s).

WARNING!

NEVER mount the igniter(s) on or near to the i-Series ECU

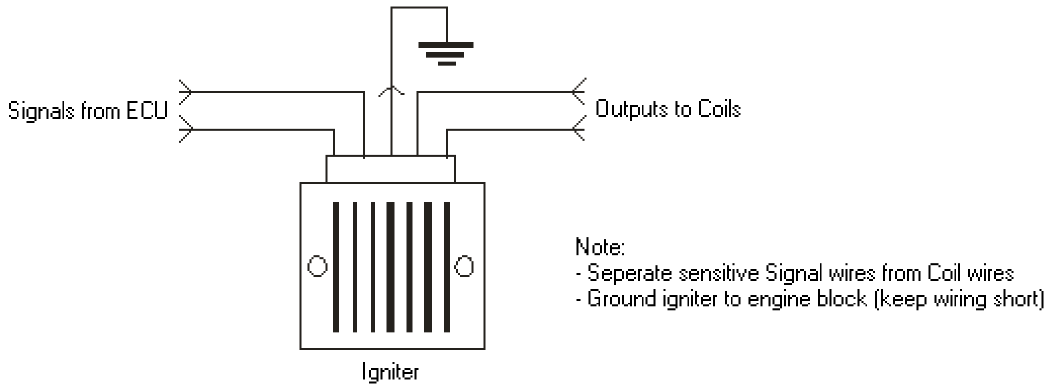
Avoid areas of high temperature such as exhausts, turbo chargers and radiators since the igniter itself will generate heat at high power. If vibration levels will be excessively high, some form of soft or rubber mounting is advisable to prevent component and wiring fatigue.

High current ignition wiring should NOT be run along side other ECU wiring. Separate high current ignition wiring into its own loom running directly to the coils.

10.6.4 Ignition System Wiring

The following guidelines should be considered when wiring ignition systems:

- Unsuppressed H.T. leads act as aerials and radiate very powerful interference signals. **ALL applications must use suppressed HT leads**, preferably resistance type rather than spiral wound or inductive. Typically these vary from 1000 ohms to 5000 ohms depending on lead length. NEVER use plain wire leads.
- It is recommended that applications also employ a suppressor capacitor (0.5 - 3uF) connected directly between the ignition coil(s) POSITIVE terminal and ground. Most points condensers are suitable. Multiple coils can share a single suppressor. 'V' and boxer engines with multiple coils should have a suppressor on each bank.
- Isolate the ignition system as much as possible from other sensitive devices, especially the ECU. Do not run non-ignition related wiring close to igniters, coils or HT leads wherever possible. Maintain maximum distance from radio transmitters and coaxial cables etc.
- Always use resistor spark plugs. These can be checked by measuring the resistance between the top of the spark plug and the centre electrode. On a resistor plug the resistance will be several thousand ohms.
- If insufficient ignition energy is causing a high-power misfire (especially on turbo/super charged engines), it may be necessary to reduce the spark plug gap. Gaps as small as 0.5mm (.020') may be necessary. This also reduces the amount of radiated electrical noise due to the lower firing voltage.
- Keep the input wiring to the igniter (from the ECU) separate from the output wiring of the igniter (to the coils) as shown below.



Separation of igniter input and output wiring

10.6.5 Multi-Coil Direct Spark Ignition

Direct spark uses an ignition coil per cylinder, firing each cylinder once per engine cycle (2 crankshaft revolutions). If multi-coil operation is required for an odd number of cylinders, the only option is to use an ignition coil per cylinder.

i88 ECUs have eight ignition drives allowing up to eight individual coils to be controlled. Therefore, this ECU may only be used on engines with eight cylinders or less with direct spark ignition.

i44 ECUs have four ignition drives allowing up to four individual coils to be controlled. Therefore, this ECU may only be used on engines with four cylinders or less with direct spark ignition.

Engines using direct spark ignition must have a way for the ECU to calculate the current order in the firing sequence. Because an engine may be at one of two possible positions in the firing sequence given a crankshaft position, a trigger wheel rotating at crankshaft speed is not sufficient for direct spark ignition. Therefore a second sensor mounted on the camshaft (or driven at camshaft speed) is required to send a sync pulse. If an engine does not have an appropriate sensor then either one will need to be fabricated or another ignition mode must be used.

Some factory set-ups using direct spark have a coil and igniter in one package, mounted on top of the spark plug. These are normally three terminal devices requiring 12 volts, ground, and the signal from an Ignition Drive.

When using a non-factory arrangement the coils should be positioned so they minimise the length of the HT Leads. This will help reduce the noise generated when the spark plugs are fired.

Each ignition drive **MUST** be connected via an igniter channel to a coil (remember some coils have the igniter built in).

Example - 4 cylinder engine with direct spark

- Four ignition drives must be used
- A four channel igniter (or 2 dual channel igniters) must be used
- Four Single Post Coils must be used
- Drive the igniter for cylinder one from Ign 1, cylinder 2 from Ign 2, cylinder 3 from Ign 3 and cylinder 4 from Ign 4.

When wiring an ignition system using direct spark, the firing order of the engine is not important as it will be entered into the ECU via iVTS.

Ignition Drive 1 must be wired to cylinder 1 coil, Ignition Drive 2 to cylinder 2, 3 to 3, etc.

10.6.6 Multi-Coil Wasted Spark Ignition

Wasted spark will fire two cylinders simultaneously, using a common dual post coil. When a dual post coil is fired, two cylinders receive a spark. One cylinder is fired conventionally on the compression stroke while the other cylinder has its piston in the same position but on the exhaust stroke. One crankshaft rotation later, these two cylinders are two working stokes further ahead and the spark plugs fire again, but now with reversed roles. The result is that each coil will be fired twice per engine cycle hence the term “wasted spark”. This set-up can ONLY be used on engines with an even number of cylinders.

Dual Post Coils

One dual post coil (with a primary resistance between 0.4 and 1.0 ohms) is required per 2 cylinders. Figure 8.8 shows a typical coil. The coils should be positioned so they minimise the length of the HT Leads. This will help reduce the electrical noise generated when the spark plugs are fired.

Dual Post Coil

The main concern when using dual post coils is the generation of electrical interference. This can interfere with ECU operation and cause unwanted static on car radios. The ignition suppression techniques outlined earlier are particularly important. All wasted spark systems should use 'Resistive Spark Plugs' if the engine does not currently use them.

One igniter channel is required for each dual post coil.

Single Post Coils

It is possible to run an engine that has a single coil per cylinder in wasted spark configuration. This is often done when there is not enough ignition drives to control each coil individually. In this case two coils are fired at the same time.

Each coil must be wired to a single igniter channel. It will be necessary to split the wiring from the each ECU ignition output to go to the input of two igniter channels.

IMPORTANT!

When running a wasted spark arrangement with a single coil per cylinder, each coil must be wired to an individual ignition channel. DO NOT wire the output of one igniter channel to two coils. This will result in very low spark energy and erratic engine running.

Wasted Spark Ignition Wiring

To ensure each ignition drive is matched to the correct cylinder, the firing sequence will need to be determined. Note this option is only possible when the engine has an even number of cylinders. When using a wasted spark arrangement, an ignition drive will fire cylinder pairs that are 360° apart in the firing order.

- Ignition Drive 1 always needs to be connected to cylinder number 1 and its corresponding cylinder (360° apart in the firing order).
- Ignition Drive 2 should be connected to the next cylinder in the firing order and its corresponding cylinder (360° apart in the firing order).
- If more cylinders exist (6, 8, 10 & 12 cylinder engines) then the pattern should be

continued. For example Ignition Drive 3 fires the third cylinder in the firing order and its corresponding cylinder.

Use the following table to determine coil ignition wiring for wasted spark applications. Write the engines firing order in the column on the left.

Write Firing Order Below	Number of Cylinders			
	2	4	6	8
1	Ign 1	Ign 1	Ign 1	Ign 1
	Ign 2	Ign 2	Ign 2	Ign 2
		Ign 1	Ign 3	Ign 3
		Ign 2	Ign 1	Ign 4
			Ign 2	Ign 1
			Ign 3	Ign 2
				Ign 3
				Ign 4

Wasted spark Ignition Wiring

Example - Wasted spark set-up for a 4 cylinder engine with 1-3-4-2 firing order.

- Ignition Drive 1 fires cylinders 1 and 4
- Ignition Drive 2 fires cylinders 2 and 3

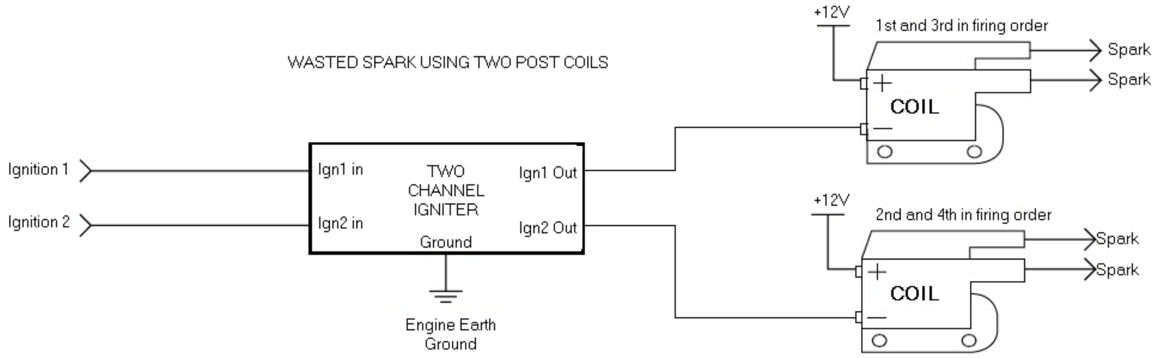
Example - Wasted spark set-up for a 6 cylinder engine with 1-5-3-6-2-4 firing order.

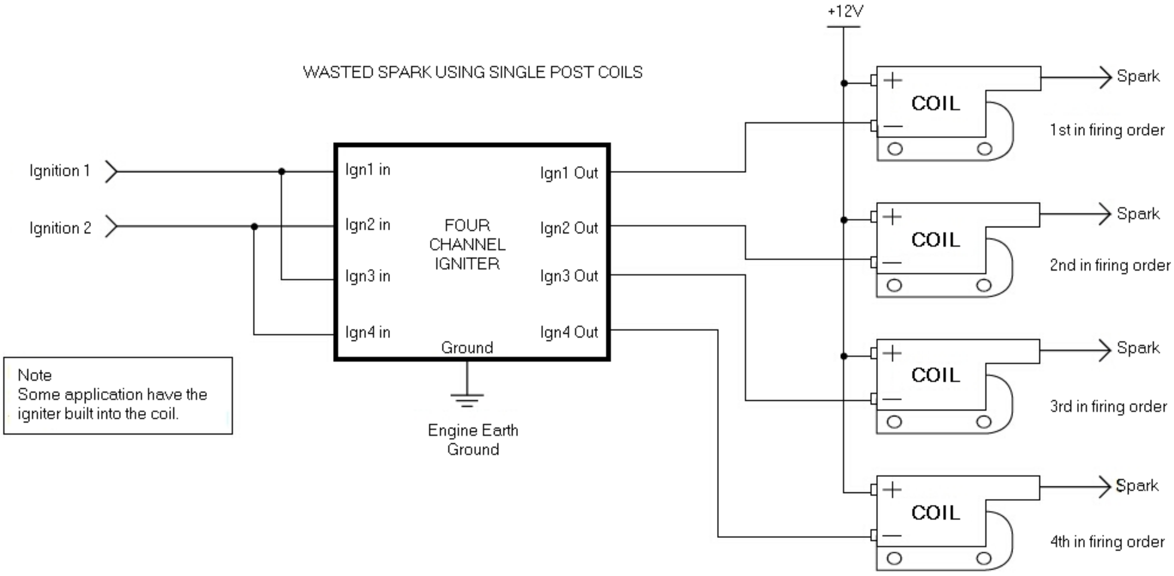
- Ignition Drive 1 fires cylinders 1 and 6
- Ignition Drive 2 fires cylinders 5 and 2
- Ignition Drive 3 fires cylinders 3 and 4

10.6.7 Ignition Wiring Examples

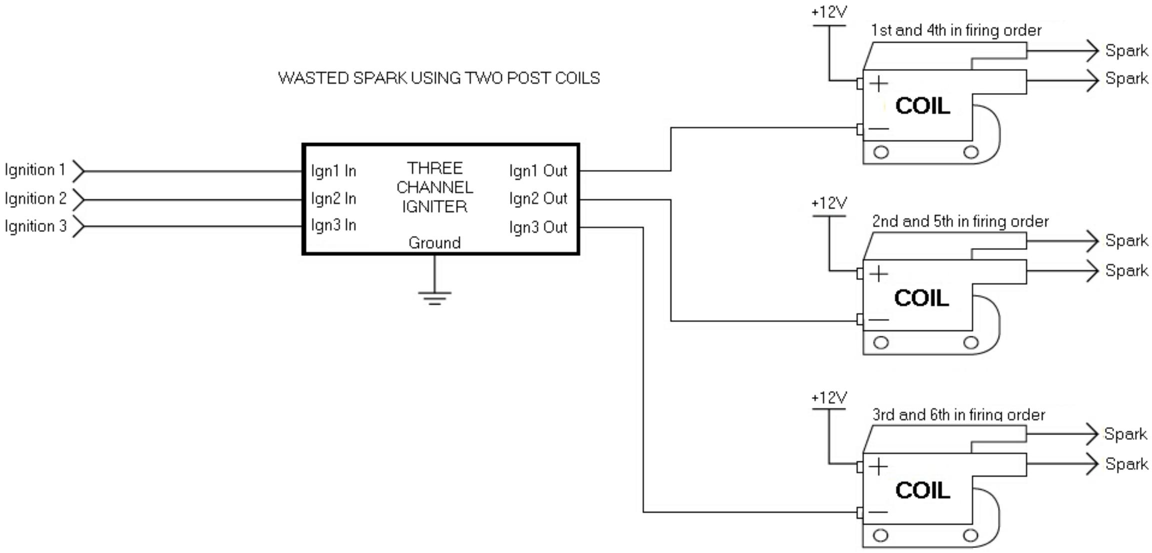
10.6.7.1 Wasted Spark

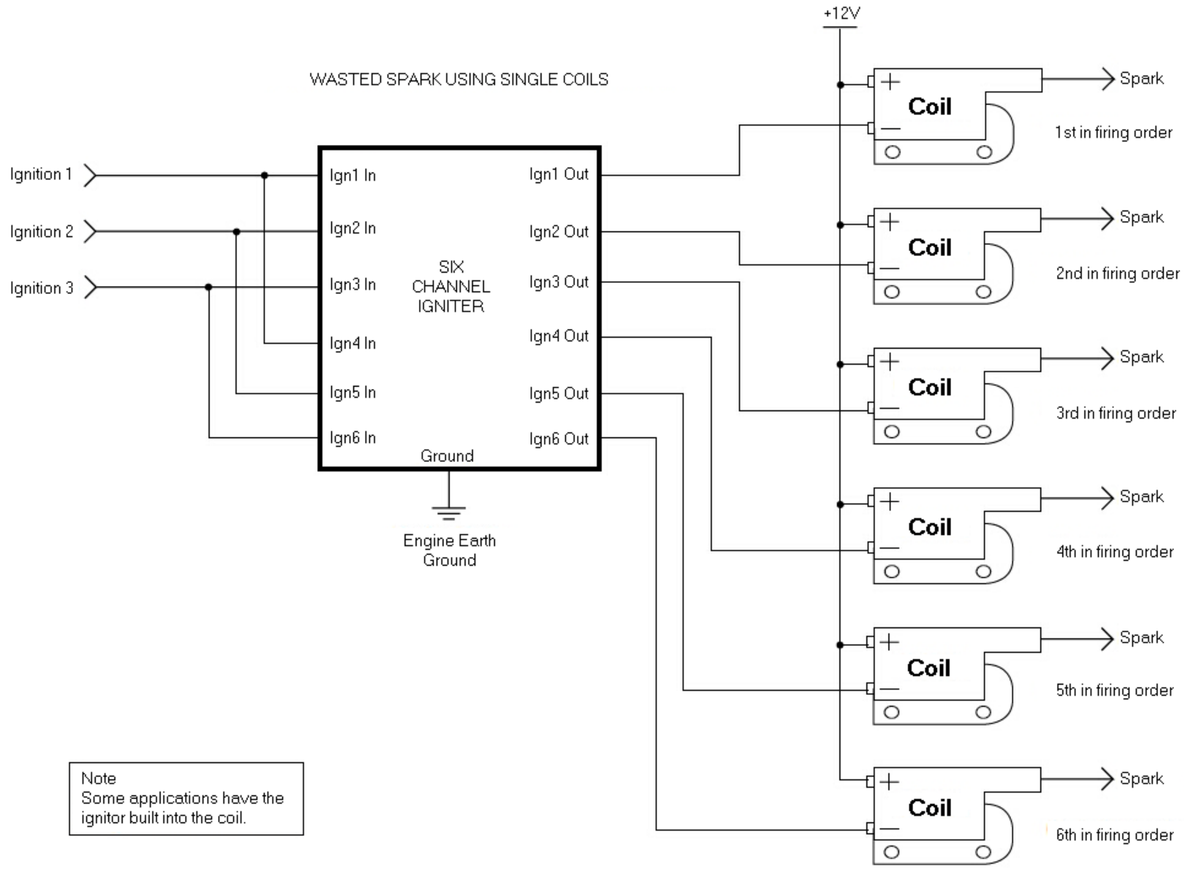
10.6.7.1.1 4 Cyl Wasted Spark



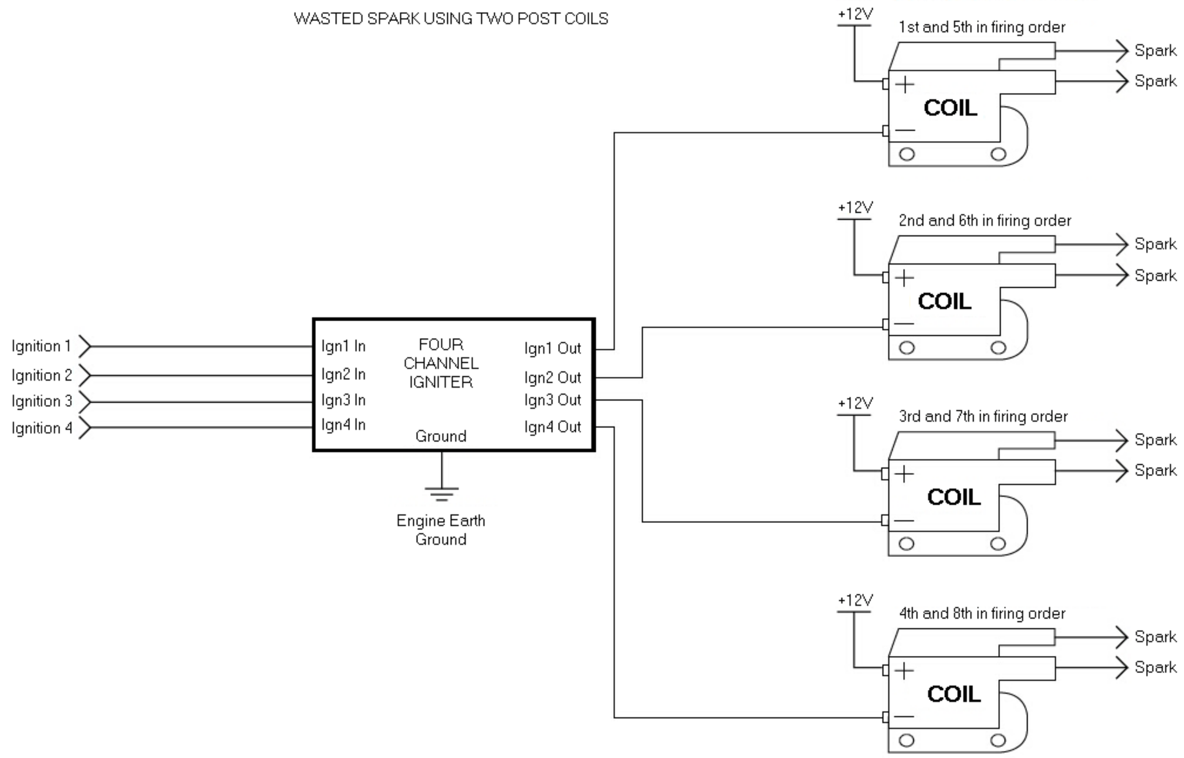


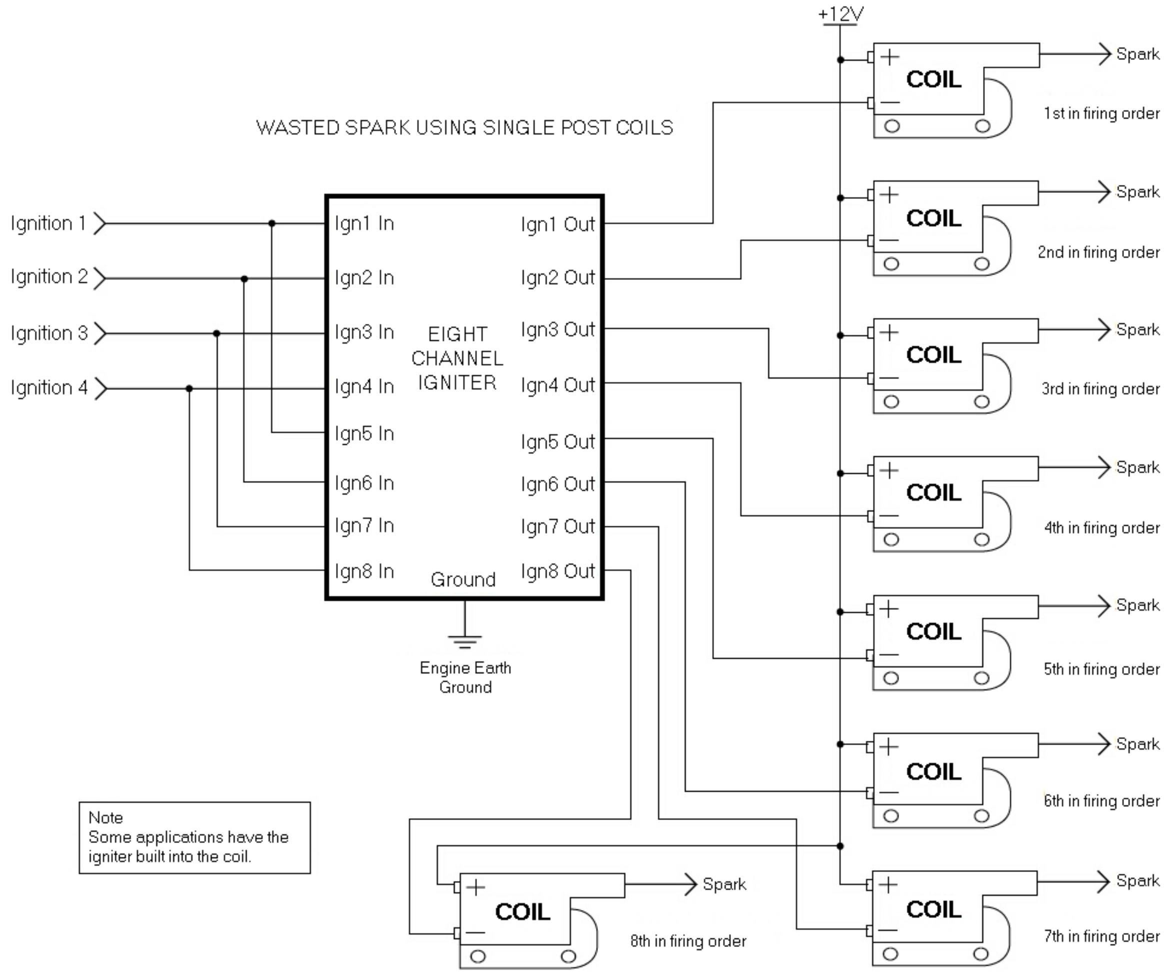
10.6.7.1.2 6 Cyl Wasted Spark



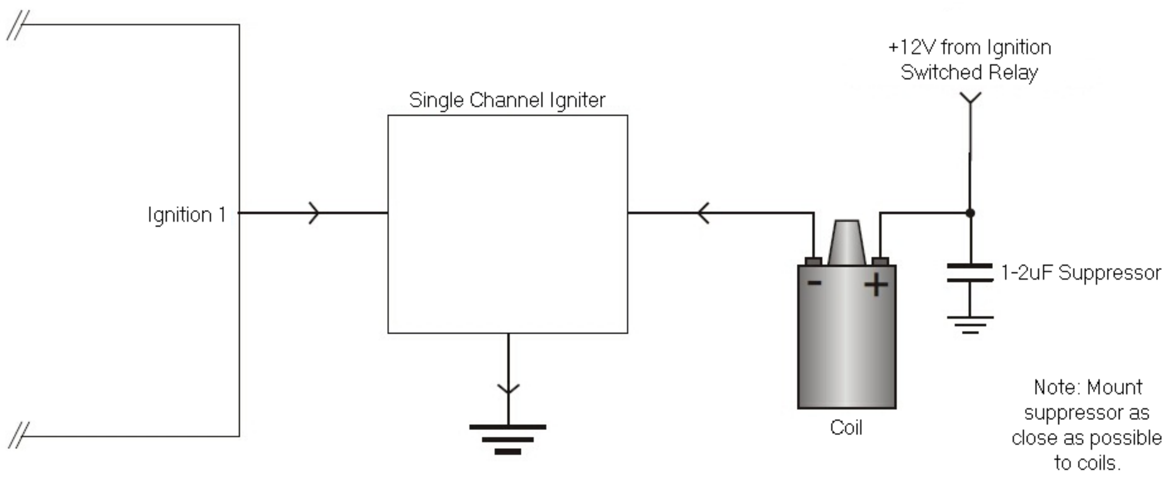


10.6.7.1.3 8 Cyl Wasted Spark

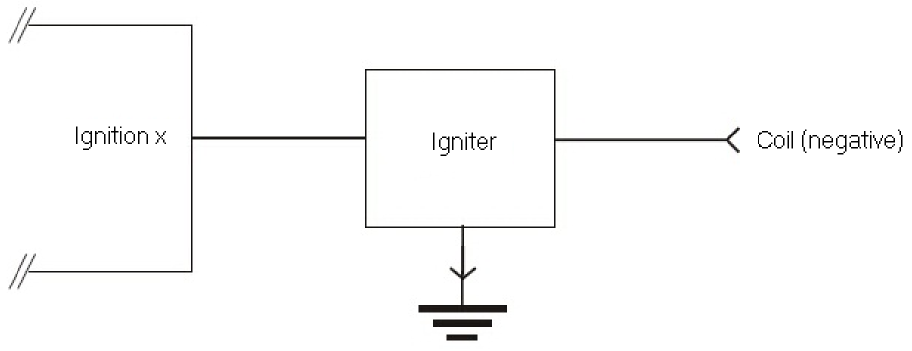


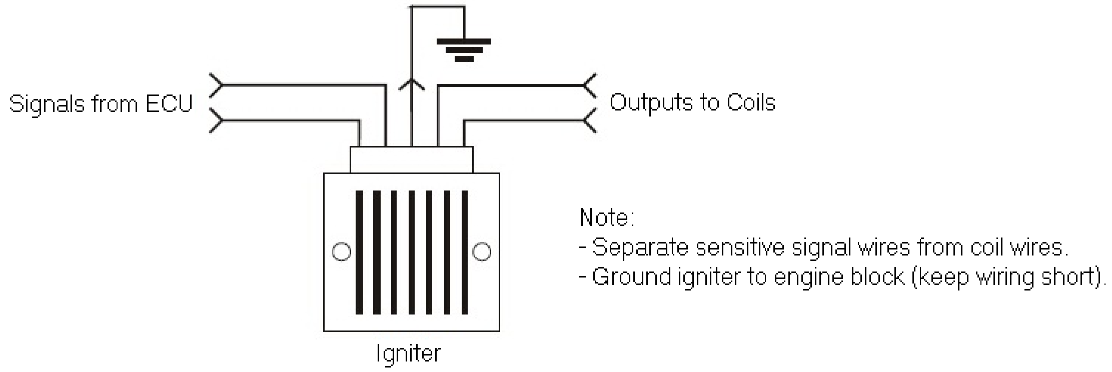


10.6.7.2 Distributor Ignition



10.6.7.3 General Ignition Wiring



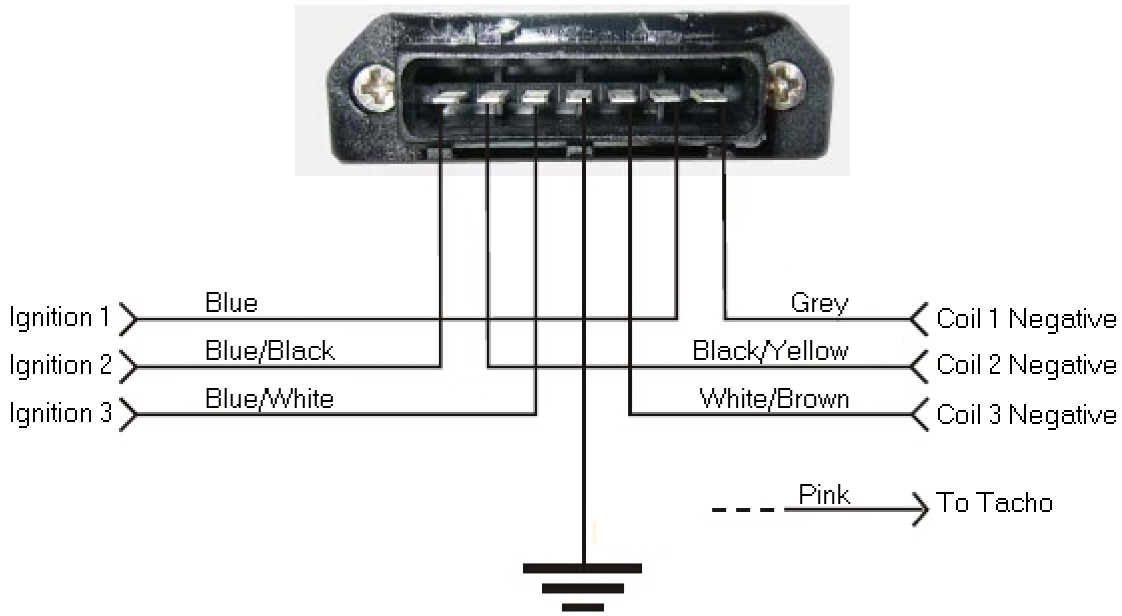


10.6.8 Specific Ignition Applications

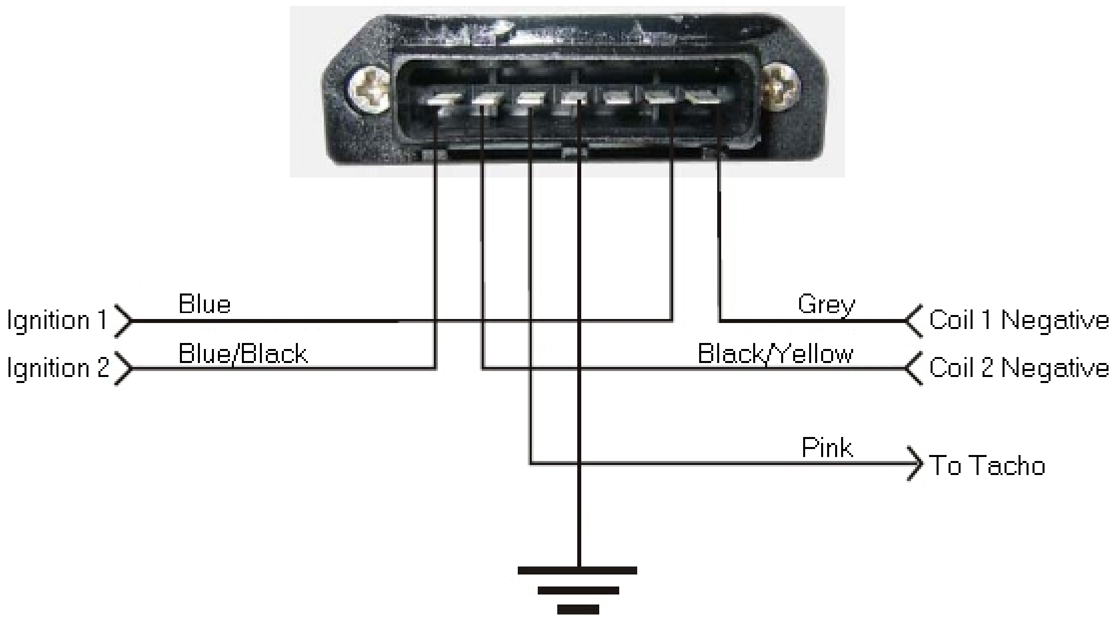
10.6.8.1 Vi-PEC Igniters

3 Channel:

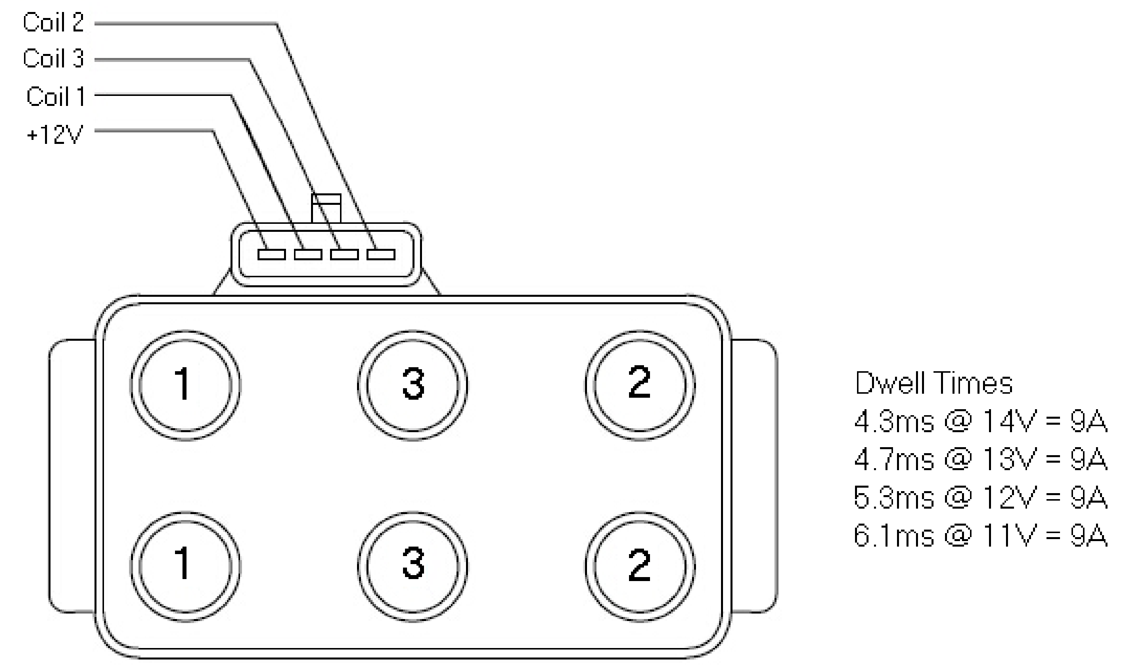
3 Channel (early, no longer manufactured):



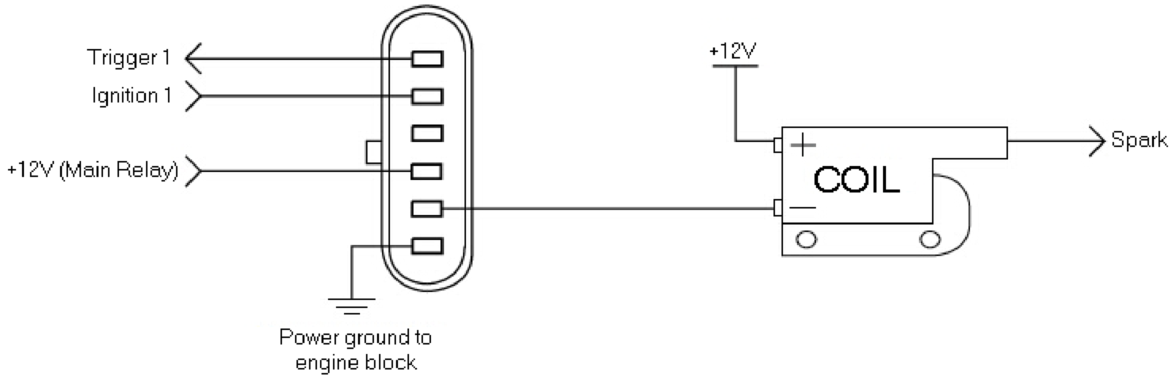
2 Channel (early, no longer manufactured):



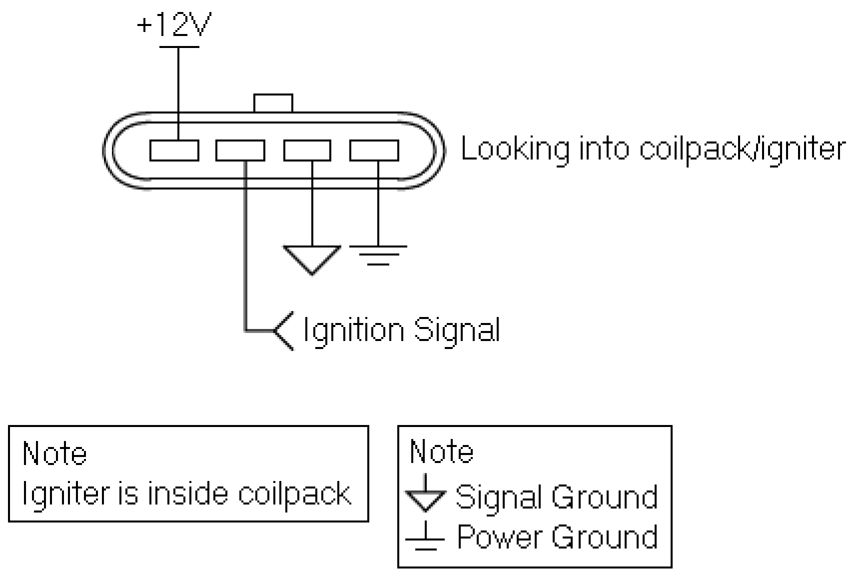
10.6.8.2 Ford Motorcraft 6Cyl Wasted Spark



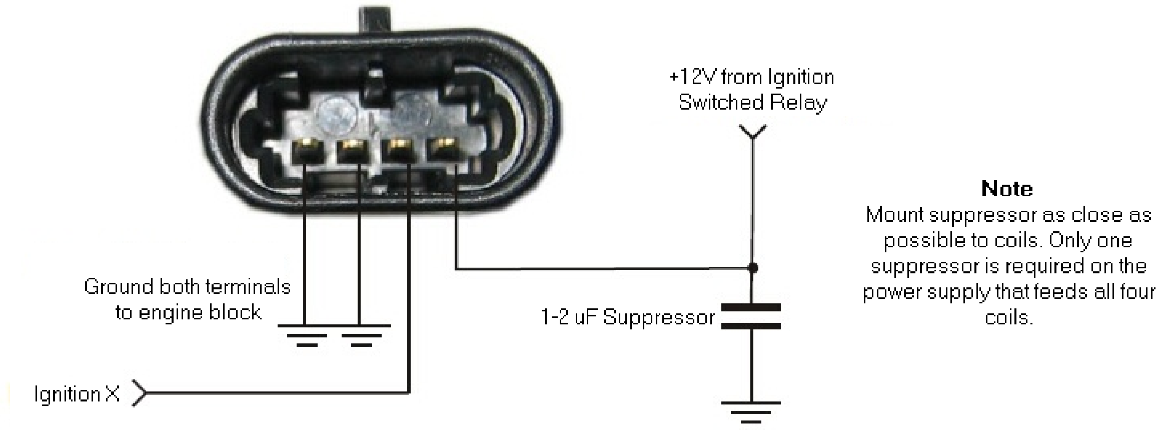
10.6.8.3 Ford Motorcraft Distributed



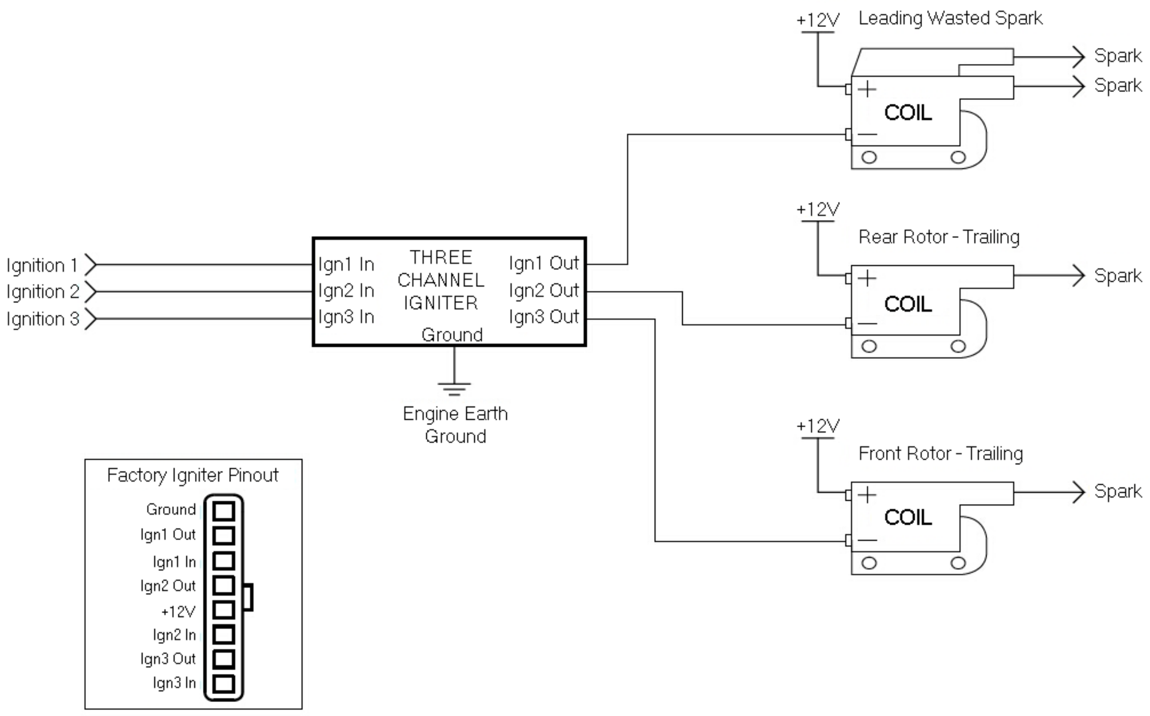
10.6.8.4 LS1 Coil Wiring



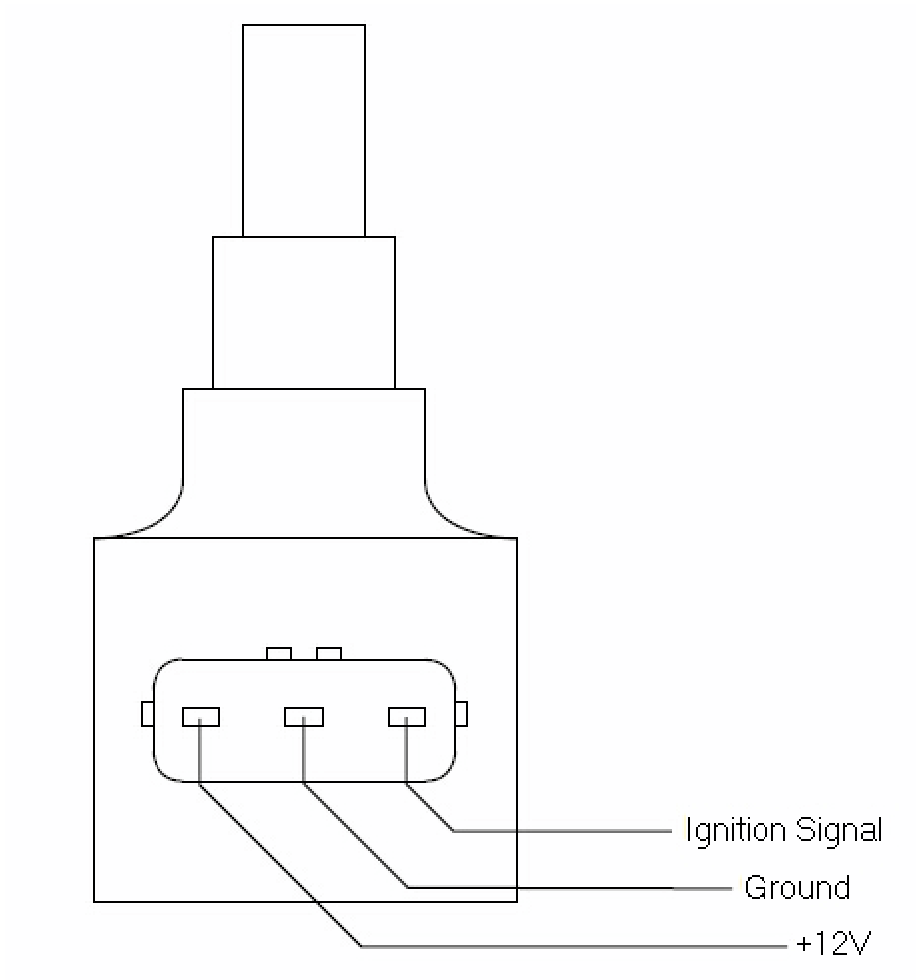
10.6.8.5 LS2 LS7 Coil Wiring



10.6.8.6 Mazda 13B Ignition Wiring

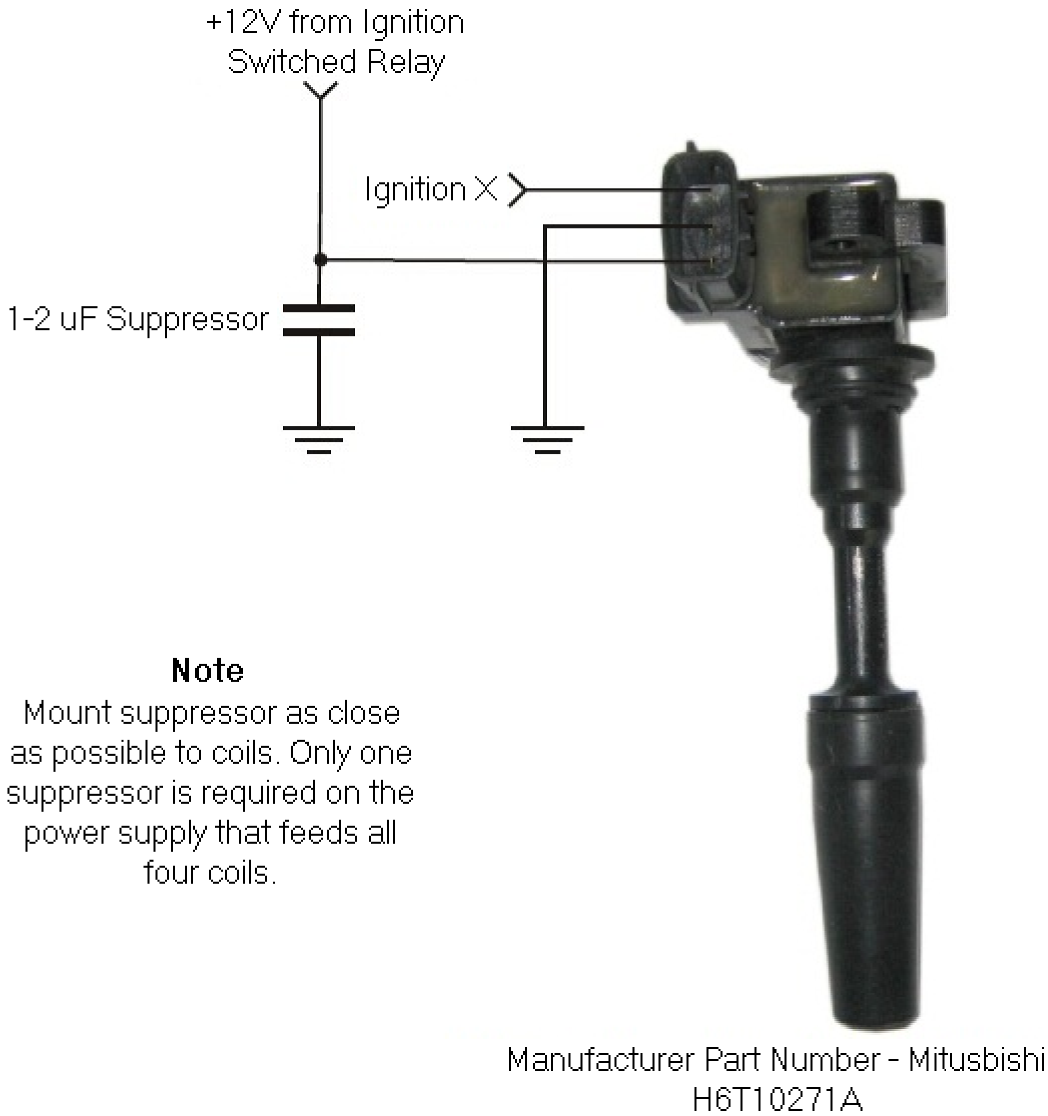


10.6.8.7 Mazda RX8 Coil Wiring

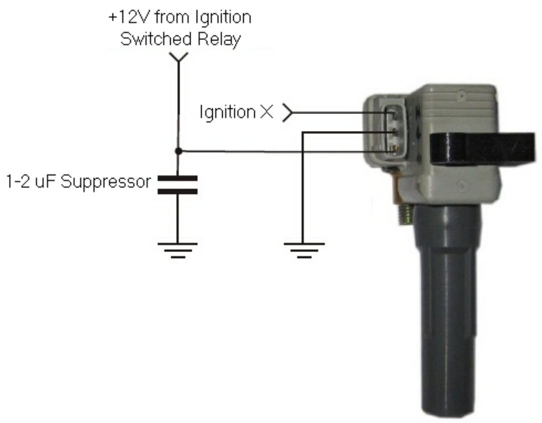


10.6.8.8 Nissan VH41 VH45 Igniter

10.6.8.9 Nissan VQ30 Coil Wiring

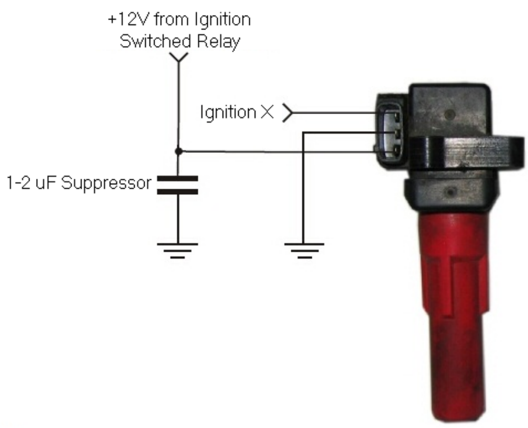


10.6.8.10 Subaru Internal Igniter Coils



Manufacturer Part Number - Diamond Fk0186 12V

Use 5 ms Dwell Time

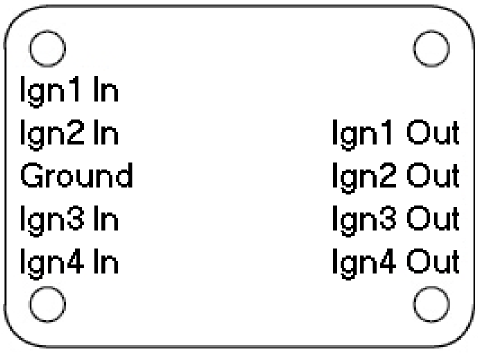


Manufacturer Part Number - Diamond Fk0140 12V

Use 3 ms Dwell Time

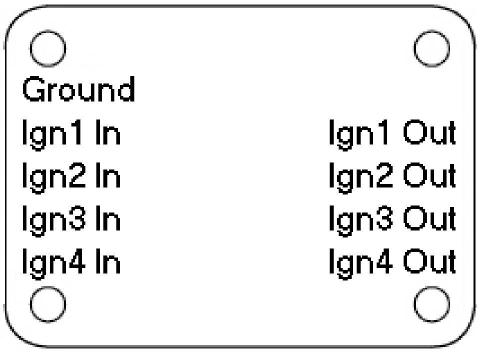
10.6.8.11 Subaru V1 V2 Igniters

60 x 80 Small Igniter
No Cooling Fins



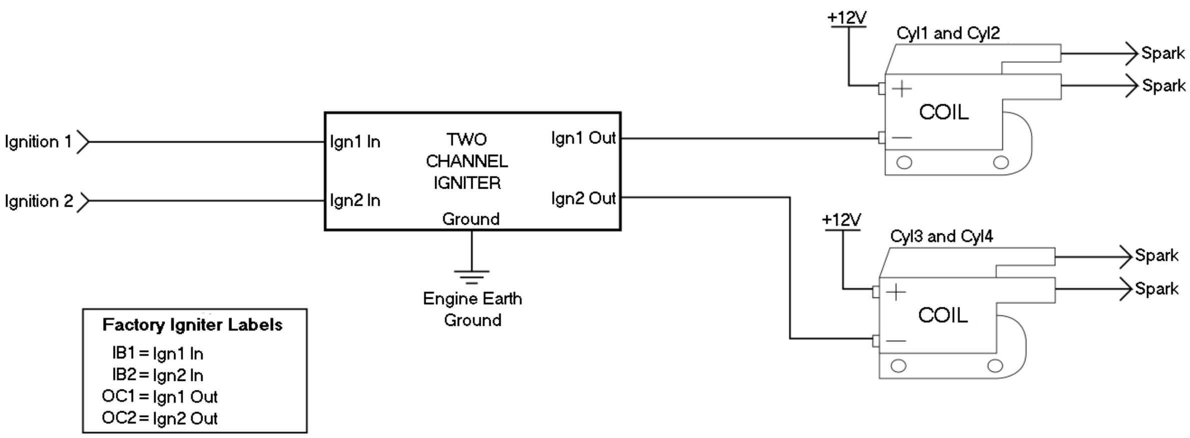
Actual Connection Locations

Igniter
With Cooling Fins

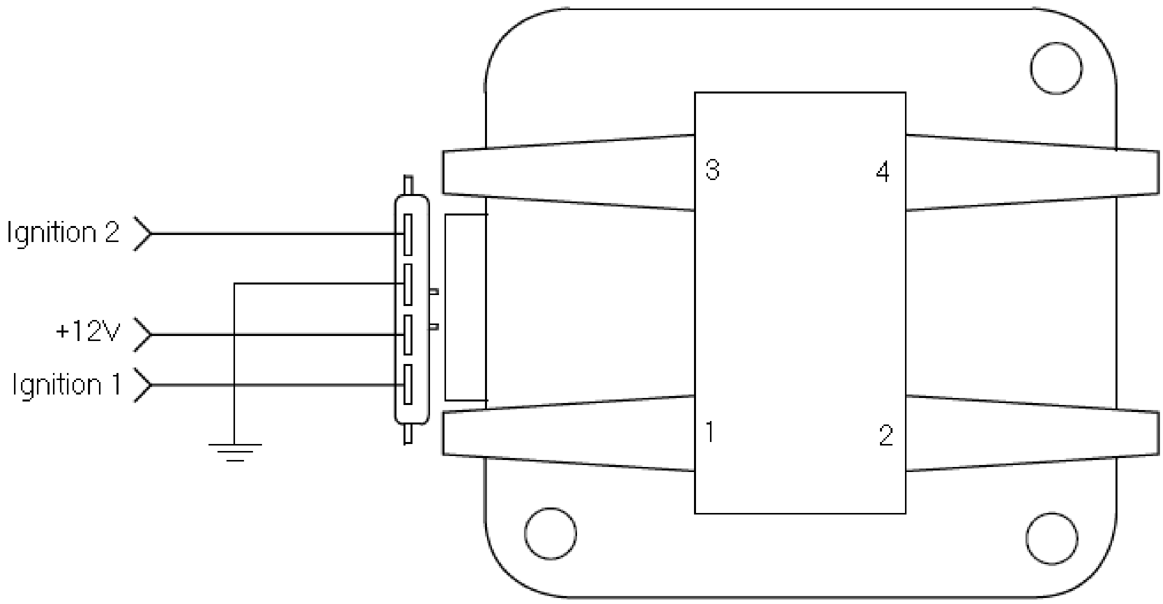


Actual Connection Locations

10.6.8.12 Subaru V3 V4 Coil Wiring



10.6.8.13 Subaru V5 V6 Coil Wiring

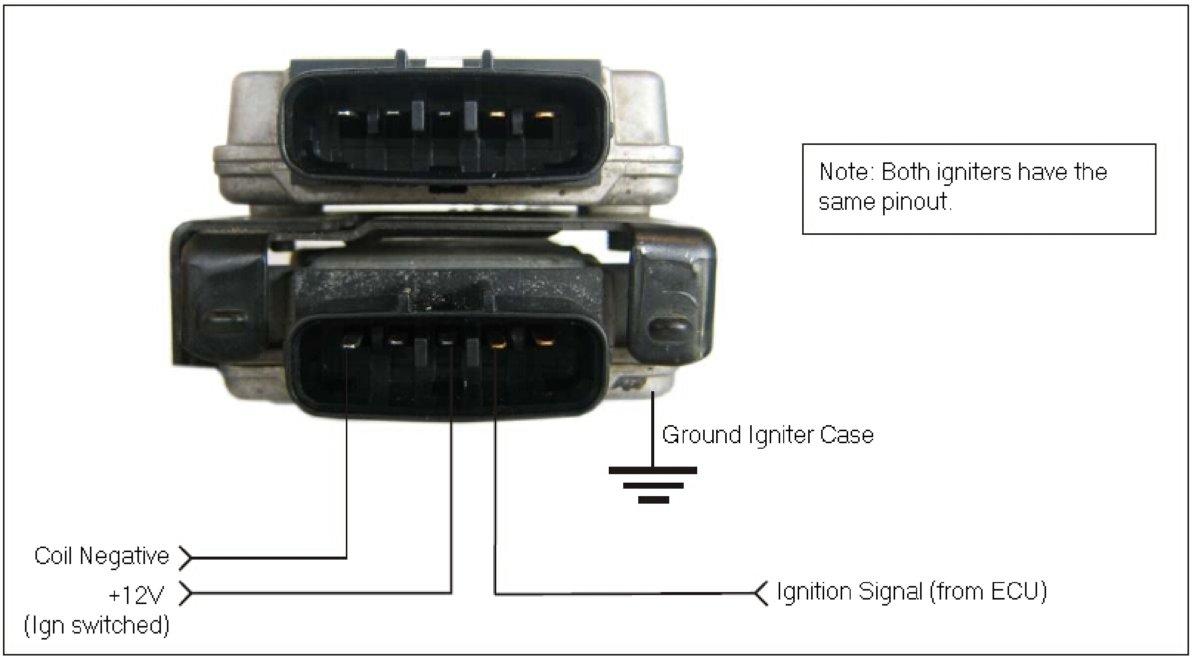


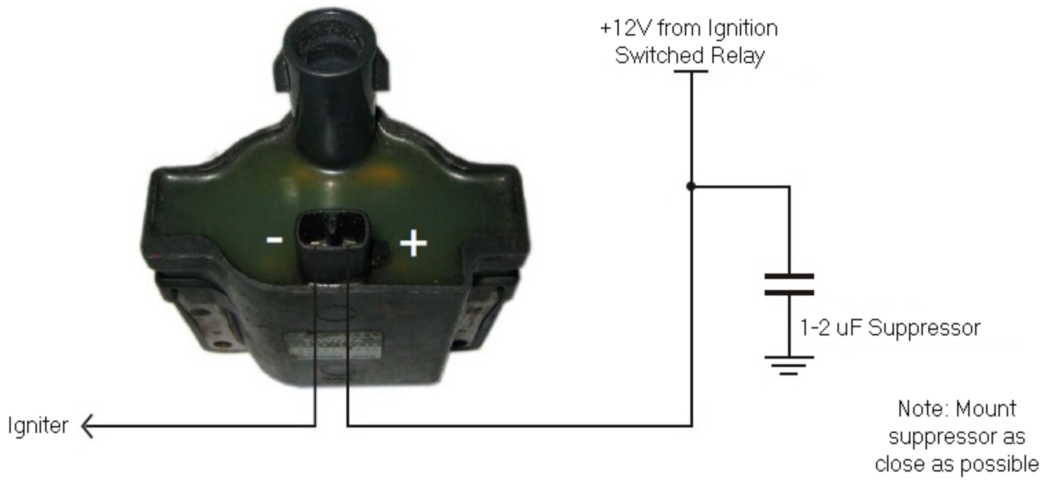
The Subaru WRX V5-V6 ignition coil pack operates in a wasted spark ignition mode.

Ignition 1 activates coil outputs 1 and 2.

Ignition 2 activates coil outputs 3 and 4.

10.6.8.14 Toyota 1UZFE Ignition





10.7 Variable Valve Timing (VVT) Solenoids

10.7.1 Generic VVT Wiring

Continuously Variable Valve timing (CVVT, VVT, VVTi, AVCS, VANOS) Cam Position solenoids can only be connected to Auxiliary Outputs 1 to 4.

It is recommended to ease configuration that cam position control solenoids are wired to the same number Auxiliary Output channel as the corresponding cam position Digital Input (refer following example).

Although not absolutely necessary, it is recommended to ease configuration that cam position signals are wired to the same number Digital Input channel as the corresponding solenoid control Auxiliary Output (refer following table).

For compatibility, the following use of Digital Inputs and Auxiliary outputs is recommended for VVT wiring. Note that in practice any Digital Input/Auxiliary Output combination can be used.

Cam Shaft	Digital Input	Auxiliary Output
Inlet or Inlet LH	DI 1	Aux 1
Inlet RH	DI 2	Aux 2
Exhaust or Exhaust LH	DI 3	Aux 3
Exhaust RH	DI 4	Aux 4

Solenoids MUST be wired directly to an auxiliary output channel DO NOT wire continuously variable valve timing solenoids through a relay as high frequency switching is used.

Some factory systems use 12V switching to control VVT solenoids. These solenoids must be rewired to be ground switching.

10.7.2 Specific VVT Applications

10.7.2.1 BMW VANOS Solenoids

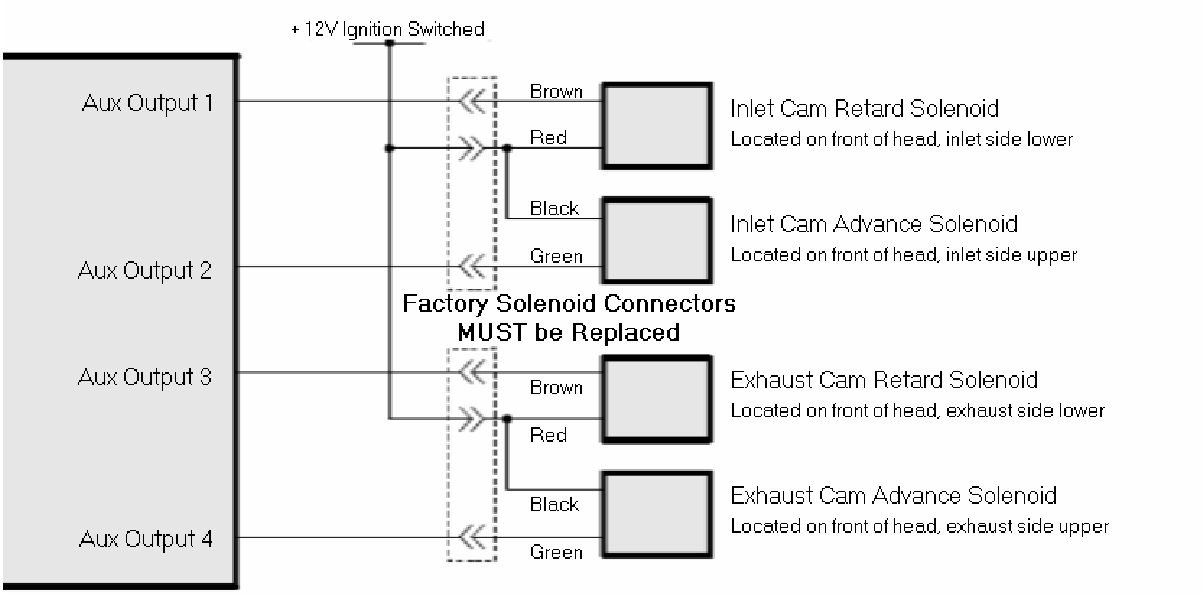
BMW Vanos

The BMW Vanos system uses a non-conventional advance and retard solenoids. The wiring for this is different to a standard VVT system.

Solenoid	Auxiliary Output
Inlet Camshaft Retard Solenoid	Aux 1
Inlet Camshaft Advance Solenoid	Aux 2
Exhaust Camshaft Retard Solenoid	Aux 3
Exhaust Camshaft Advance Solenoid	Aux 4

A modification to the vehicle must be made before the system will operate correctly.

BMW S50 - The connectors on the solenoids contain diodes that need to be removed. The best option is to replace the connector with an general purpose aftermarket connector. The following shows the correct wiring method.



BMW S50 VANOS Wiring

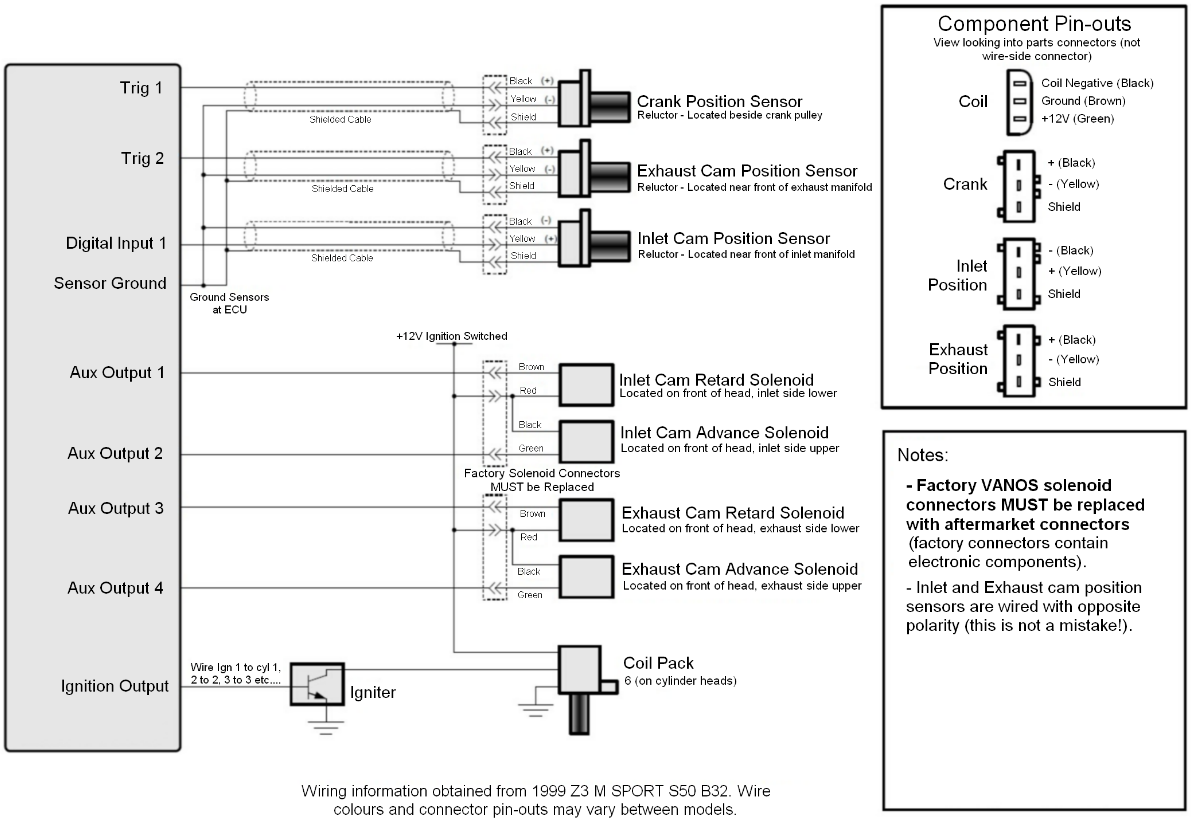
BMW S54 - The VANOS module contains diodes that need to be removed. The following diagram shows the location of these diodes.

BMW S50 VANOS Diode Removal

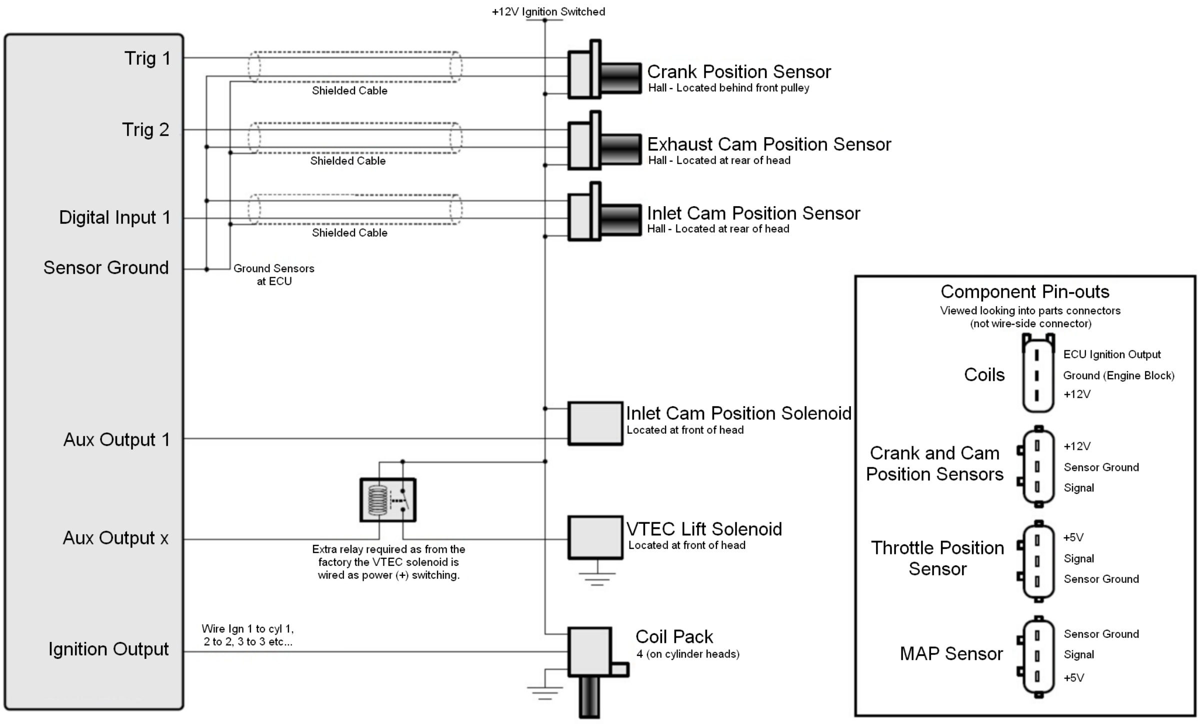
The diodes can be carefully removed by heating up one end with a soldering iron and prying up this end. The other end can then be heated and the diode will fall away. Remove all four diodes.

Pins 2 and 5 on the connector must be changed to be supplied with '12V key on' rather than ground as wired by the OEM. An additional relay may be required.

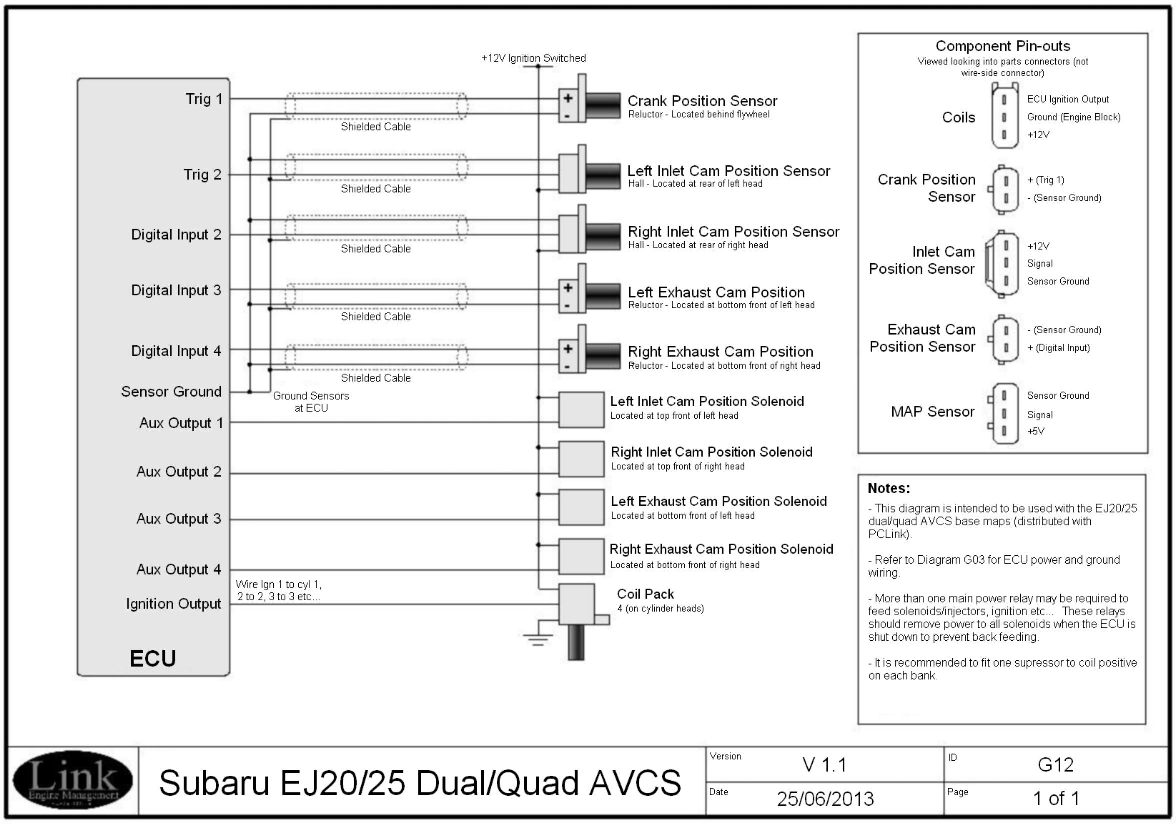
10.7.2.2 BMW Z3 Dual VANOS S50_B32



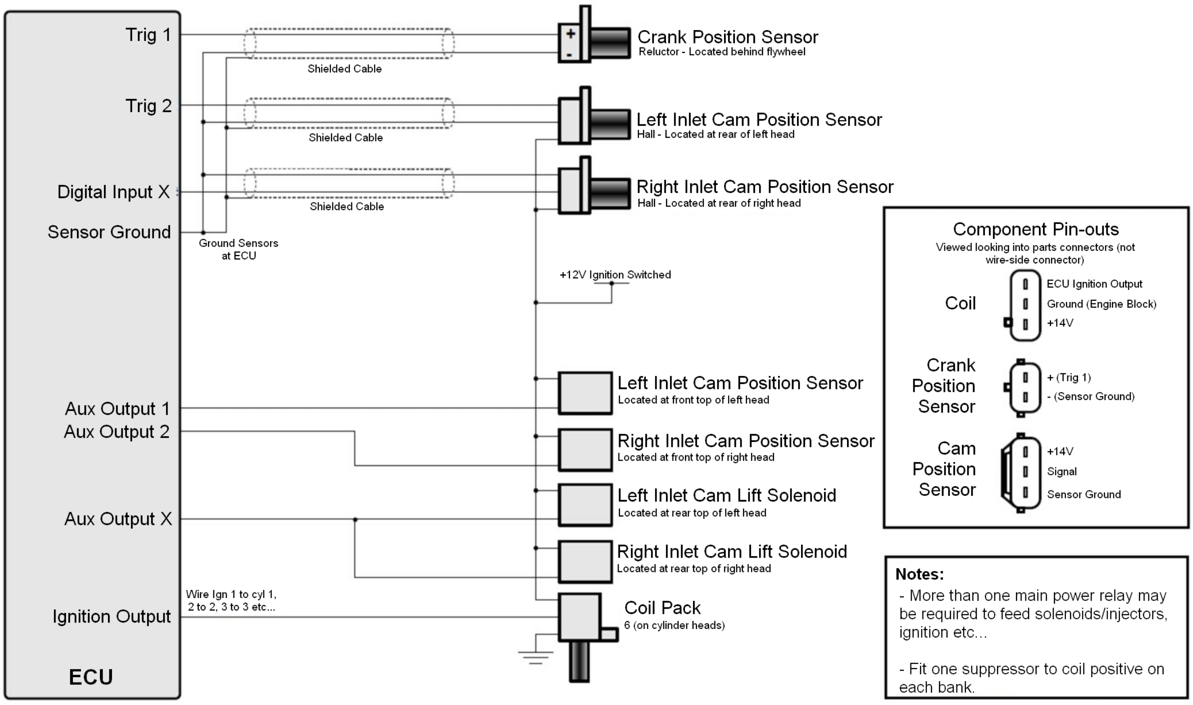
10.7.2.3 Honda K20A VTEC Wiring



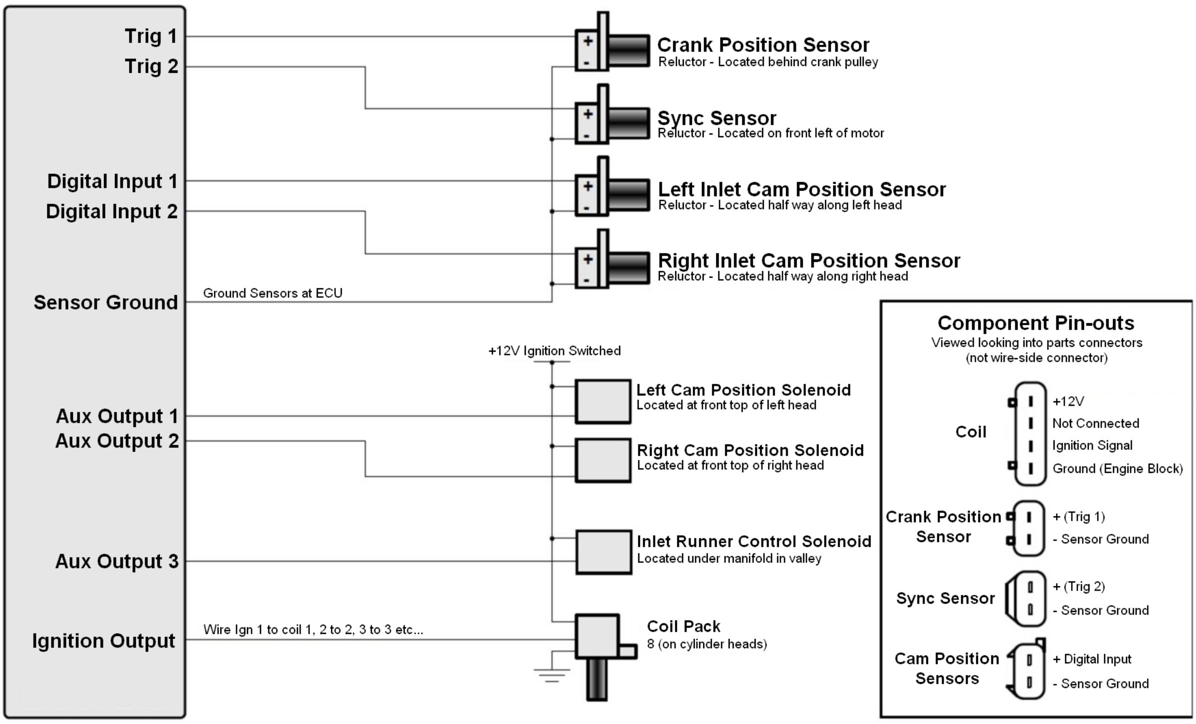
10.7.2.4 Subaru EJ Dual/Quad AVCS



10.7.2.5 Subaru EZ30 AVCS Wiring

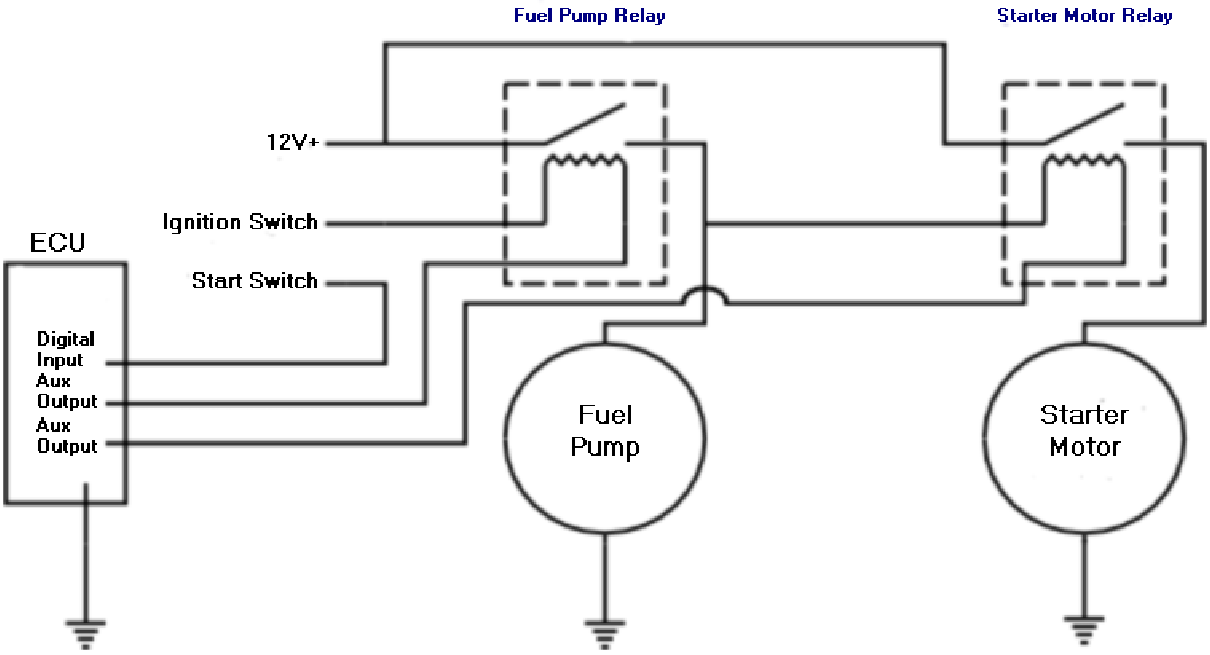


10.7.2.6 Toyota 2UZFE VVT Wiring



10.8 Starter Motor Wiring

When the ECU is controlling the starter motor relay it is recommended to wire the one of the activation pins (85 or 86) through the output of the fuel pump relay.



When wired this way the starter motor relay is only capable of turning on if the fuel pump relay is already on. This provides an additional level of safety should the starter motor control wiring become shorted.

10.9 Tachometer

An auxiliary output configured as 'Tacho' produces a 0-12V pulse to drive a low-level tachometer. There will be one output pulse for each time a cylinder reaches TDC. Connect an Auxiliary Output directly to a low-level tachometer.

i-Series ECUs will NOT drive a high-level tachometer. High-level tachometers must be triggered by a coil's negative terminal. Using a high-level tachometer on a multi-coil engine presents some problems, as each coil is not firing as often as a distributor engine's coil would. In this case the preferred solution is to modify the high-level tachometer to accept a low-level signal.

11 Rotary Engine Wiring

This section outlines wiring of i-Series ECUs to Rotary engines. Wiring of Injection, Ignition and Metering Oil Pump control is covered. This applies to two, three and four rotor engines.

11.1 Rotary Injection Wiring

Wire Injectors as shown in the table below:

Rotors	Primary	Secondary	Spare Inj
2	Inj 1 = Pri 1 Inj 2 = Pri 2	Inj 3 = Sec 1 Inj 4 = Sec 2	Inj 5-8 Spare
3	Inj 1 = Pri 1 Inj 2 = Pri 2 Inj 3 = Pri 3	Inj 4 = Sec 1 Inj 5 = Sec 2 Inj 6 = Sec 3	Inj 7-8 Spare
4	Inj 1 = Pri 1 Inj 2 = Pri 2 Inj 3 = Pri 3 Inj 4 = Pri 4	Inj 5 = Sec 1 Inj 6 = Sec 2 Inj 7 = Sec 3 Inj 8 = Sec 4	None

Rotary Injection Wiring

Notes:

- A i88 ECU is required for sequential injection on 3 and 4 rotor engines.
- Injection mode should be set to Sequential/Staged.
- Ensure injector staging adjustments and primary and secondary injector dead times are is setup correctly for the injector types fitted.
- ECUs without peak and hold injection must be wired with ballast resistors if low impedance injectors are used.
- When wiring low impedance injectors directly to a peak and hold ECU, make sure Injector Driver Mode is set to Peak and Hold and the correct peak and hold currents have been set.
- Spare Injection drives can be used as additional auxiliary outputs if required.

11.2 Rotary Ignition Wiring

Wire Ignition as shown in the following table:

Rotors	Ignition Mode	Leading	Trailing	Spare Ign
2	Leading Wasted	Ign 1 = L1 & L2	Ign 2 = T2 Ign 3 = T1	Ign 4
2	Leading Direct	Ign 1 = L1 Ign 2 = L2	Ign 3 = T1 Ign 4 = T2	Ign 5-8 Spare
3	Leading Direct	Ign 1 = L1 Ign 2 = L2 Ign 3 = L3	Ign 4 = T1 Ign 5 = T2 Ign 6 = T3	Ign 7-8 Spare
4	Leading Direct	Ign 1 = L1 Ign 2 = L2 Ign 3 = L3 Ign 4 = L4	Ign 5 = T1 Ign 6 = T2 Ign 7 = T3 Ign 8 = T4	None

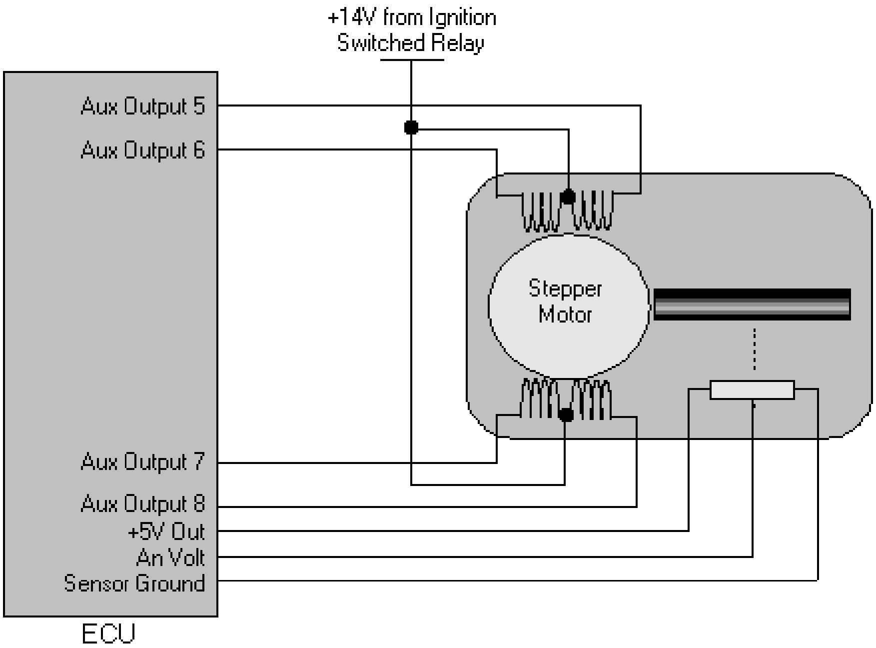
Rotary Ignition Wiring

Notes:

- A i88 ECU is required for direct spark ignition on 3 and 4 rotor engines.
- Ensure the Ignition Mode is set to Rotary – Leading Direct or Rotary – Leading Wasted. Do not use the generic Direct Spark or Wasted Spark modes.
- Igniters must be wired. Do not wire coils directly to the ECU.
- Spare Ignition drives can be used as additional auxiliary outputs if required.

11.3 Metering Oil Pump Wiring

Rotary engines Metering Oil Pumps can be controlled directly from i-Series ECUs. This involves wiring the pumps stepper motor and position feedback to the ECU.



Metering Oil Pump Control Wiring

Notes for wiring the stepper motor:

- The centre tap of both windings should be wired to the same power supply as the ECU to ensure correct flywheeling and to prevent backfeeding.
- One common pair of windings must be wired to Auxiliary Outputs 5 and 6. The other pair must be wired to Auxiliary Ouputs 7 and 8.
- Auxiliary Outputs 5-8 must be set to “Rotary Oil Pump”.
- Use the Stepper Calibration function (found under Aux 8) to test if the stepper is wired correctly. Setting Stepper Calibration to Fully Closed should cause the motor to close the valve (so no oil enters the engine). Likewise, setting Stepper Calibration to Fully Open should cause the motor to completely open the valve. Once finished tested, set Stepper Calibration to Off.
- If the motor rotates in the wrong direction swap the wiring of Aux 7 and Aux 8.

Notes for wiring the motor position feedback:

- Any Analog Volt input can be used for the feedback position signal.
- The sensor should be wired to the ECU's sensor ground (which is grounded at the ECU) not directly to the engine.
- When wired correctly the position signal should have approximately 0.9V with the valve

fully closed and 4.4V with the valve fully open (note that if this is opposite it can be compensated for using the analog inputs calibration).

Instructions for configuring and calibrating the ECU for Metering Oil Pump Control can be found in the iVTS Tuning Software online help (search Metering Oil Pump). These must be followed exactly to ensure accurate oil metering. This MUST be done before attempting to start the engine.

Your nearest Vi-PEC dealer can provide you with a factory metering oil pump control calibration table if required.

Motor	Position Sensor
PICTURE - motor pinout 1 – Black – Aux 7 2 – Red/White – Power Supply 3 – Yellow – Aux 8 4 – Blue – Aux 5 5 – Red – Power Supply 6 – White – Aux 6	Blue = +5V Yellow = Position Signal Black = Sensor Ground

Series 6 RX7 Metering Oil Pump Pinout

12 PC Tuning

i-Series ECUs require PC/laptop tuning using the iVTS Tuning Software application running on a Windows based computer. iVTS Tuning Software may be downloaded from www.vi-pec.com. Note that when new versions of iVTS Tuning Software are released they are posted on the website and may be downloaded at no cost. Also note that i-Series ECUs must be used with the correct version of iVTS Tuning Software.

IMPORTANT!

The i-Series ECU has on board USB.

BEFORE connecting the ECU to your laptop, the USB drivers must be installed. Failure to install the drivers on your laptop first may result in windows assigning incorrect drivers. These drivers will not work with the i-Series ECU and are difficult to uninstall.

12.1 Installing USB Drivers

Before connecting the ECU to your laptop or PC, the ECU USB drivers must be installed. These drivers are installed as part of iVTS installation as described in the following section. Should internet download not be practical, a copy of the drivers on CD can be obtained from your nearest Vi-PEC Dealer.

12.2 Installing iVTS Tuning Software

Due to the frequent updates iVTS Tuning Software is no longer shipped with each ECU. You will be required to download the latest version of iVTS Tuning Software from:

www.vi-pec.com

Should access to an Internet connection be impractical, the latest version of iVTS Tuning Software can be requested from your nearest Vi-PEC dealer on CD.

Installing from the web

1. Go to the above website and navigate to the downloads and software updates section.
2. Download the latest version of iVTS Tuning Software. When prompted to run or save the file, select save. It is recommended to save this file on the desktop.
3. Double click the saved file and follow on screen instructions.
4. When prompted to install USB drivers, select yes. This may take some time.
5. When installed, open iVTS Tuning Software by double clicking on the icon that has been placed on the desktop.

Installing from a CD

1. Insert the iVTS Tuning Software disk into you computer's CD ROM.
2. Open 'My Computer'
3. Double click your CD ROM drive.
4. Double click the file labelled iVTS Tuning SoftwareSetup.exe (or similar name).
5. Follow the on screen instructions.
6. When prompted to install USB drivers, select yes. This may take some time.
7. When installed, open iVTS Tuning Software by double clicking on the icon that has been placed on the desktop.

12.3 Communicating With Your ECU

After iVTS Tuning Software installation, you will be able to connect the i-Series ECU to the laptop to perform set-up and tuning work.

1. Connect the ECU to your laptop using a Vi-PEC i-Series ECU USB Cable. If not supplied with the ECU, these can be purchased from a Vi-PEC dealer. No other adapter or cabling is required. Connect the cable to the connector labelled USB.
2. If this is the first time you have connected a i-Series USB ECU to you laptop follow the driver installation instructions that appear. When prompted if you wan to install drivers select 'Continue Anyway'.
3. Start iVTS Tuning Software by double clicking on the iVTS Tuning Software icon on the windows desktop.
4. Switch the key to the ON position. This will provide power to the ECU.
5. In iVTS Tuning Software, under the 'Options' menu, select 'Connection'. The connection options dialogue will open. Select the correct COM Port number from the drop down list or select auto for automatic com port detection.
6. iVTS Tuning Software offers both mouse and keyboard control. To establish a connection between the PC and ECU using the mouse, click the ‘L’ icon located near the top centre of the iVTS Tuning Software screen. Alternatively, using the keyboard, press and hold the Ctrl, Shift and L keys. The same process can be used to disconnect. If a successful connection is established, iVTS Tuning Software will download settings from the ECU, otherwise you will be warned that an error has occurred.
7. Make sure the connection shows “ONLINE” in the top right corner of iVTS Tuning Software. The logo should also be spinning in the top right corner.
8. To permanently STORE any changes made to the ECU click on the 'S' icon near the top centre of the screen or press F4. If this is not done before turning the ECUs power off all changes made will be lost.

13 First Time Setup

This section of the manual details a generic procedure for first time set-up of the i-Series ECU. These procedures also provide a good means of becoming familiar with both the i-Series ECU and iVTS Tuning Software. It is recommended that these procedures are followed for every set-up, no matter how experienced you are!

13.1 Pre-start Checks

To avoid potential engine damage and wasted time, the adjustments presented in the following sections must be made before attempting to start the engine.

For further help on any of the settings discussed below, consult the online Help in iVTS Tuning Software. Online help can be invoked by pressing F1, or right clicking any item and selecting ‘What’s this?’.

Pre-set-up Checks

Before attempting to configure the ECU, ensure the following tasks have been completed:

1. Ensure the ECU and all associated components are connected and correctly wired/ installed.
2. Fully charge the vehicle’s battery, as the engine will be required to be cranked during the set-up procedure.
3. Check all oil and water levels are correct.

Connecting to iVTS Tuning Software

Use the following procedure to establish a connection between your Vi-PEC ECU and iVTS Tuning Software tuning software.

1. Make sure your laptop battery is fully charged or plugged in to mains power.
2. Connect the ECU to your laptop and connect to iVTS as described in the 'Communicating with your ECU' section of this manual.

13.2 Initial Setup

After all checks described in previous sections have been performed, the ECU is ready to be configured for a particular application. The following set-up procedure should be used on all installations as a minimum:

Configuration and Fueling Set-up

If the ECU is to be used to control fuel injection, all of the following steps must be performed. If the ECU will not be controlling fuel injection, then only steps 1 and 2 are required.

1. If you have a .pcl file containing a base configuration, this is the time to load it into the ECU. To do this, select ‘Open’ form the ‘File’ menu. Select the required .pcl file and then select ‘Ok’. When prompted if you want to load the file into the ECU, select ‘Yes’.
2. Click on the ‘Configuration’ heading in the ECU Settings function tree (top left of iVTS Tuning Software screen):

   a. Select the correct engine type

   b. Select the correct number of cylinders/rotors.
   c. Enter the engines firing order.
3. Click on Fuel > Fuel Setup > Fuel Main:
   a. Select the desired Injection Mode (e.g. Sequential or Group).
   b. Select Injector Control method (e.g. Saturated or Peak and Hold) (Peak and Hold ECUs only). Also set the correct injector peak and hold currents.
   c. Select 'Fuel Table1' from under the 'Fuel' heading. Right click on the table, select 'Axis Setup'. Set the Y Axis (Load) to the appropriate option (e.g. MGP or TPS).
4. Click on ‘Accel Enrichment’:
   a. Turn Accel Mode OFF for first time set-ups.
5. Click on Fuel Corrections > IAT Fuel Correction:
   a. If air temperature correction is to be used and an air temperature sensor is fitted, set the ‘IAT Mode’ to ON. Then select and fill in the IAT Fuel Trim Table.
   b. Turn OFF air temp correction (under ‘IAT Mode’) if air temperature correction is not going to be used
6. Click on Fuel > Fuel Setup > Injector Setup:
   a. Select '2D Table' or '3D Table'. Fill in the dead-time table with the information from your injector data-sheet.
7. Click on ‘Overrun Fuel Cut’:
   a. Set ‘Fuel cut Mode’ to OFF.
8. Click on Fuel Corrections > Dual Fuel Table:
   a. Set Table 2 Mode' to OFF.
9. Click on Fuel Corrections > 4D Fuel Table:
   a. Set ‘4D Fuel Mode’ to OFF.
10. Click on Fuel Setup > Injector Test:
   a. Turn each injection channel on one by one and check that the correct cylinders injector clicks. Fix any problems now if the injectors do not operate.
11. Perform a Store to permanently save changes to the ECU by pressing F4.

Ignition Set-up

If the ECU is to be used to control ignition, all of the following steps must be performed. If the ECU will not be controlling ignition, then only the first step is required.

1. Click on Ignition > Ignition Set-up > Ignition Main:
   a. Select the correct type of ‘Ignition Mode’ for the application. Set to 'OFF' if ignition is not controlled by the ECU.

   b. Set ‘Maximum Advance’ to a suitable value.
   c. Enter appropriate values for coil dwell time in the ‘Ignition Dwell Time’ table.
2. Click on Ignition Corrections > ECT Ign Trim:
   a. Set CT Trim Mode to OFF (for now).
3. Click on ‘IAT Ign Trim’:
   a. Set IAT Trim Mode to OFF (for now).
4. Click on Individual Cyl Ign Trim > Individual Cyl Ign Trim:
   a. Set ‘Indiv Ign Mode’ to OFF (for now).
5. Click on Ignition Corrections > Dual Ign Table:
   a. Set Table 2 Mode to OFF (for now).
6. Click on ‘4D Ign Table':
   a. Set ‘4D Ign Mode’ to OFF (for now).
7. Click on Ignition Setup > Ignition Test:
   a. Turn each ignition channels test function on one by one.
   b. Check for a quiet clicking sound from each coil or alternately connect a spark gap and check for spark on the correct cylinders.
   c. Correct any problems before continuing.
8. Perform a Store to permanently save changes to the ECU by pressing F4.

Limits Set-up

At this stage it is not necessary to precisely set all limits. However, it is essential to ensure they are set to values that will not interfere with tuning procedures. It is advisable to err on the conservative side when setting limit values.

1. Click on Limits > RPM Limit > RPM Limit:
   a. Select the desired ‘RPM Limit Mode’
   b. Select the RPM Limit Table, enter the required RPM limiting value for each engine temperature in the ‘RPM Limit Table’.
2. Click on Limits > MAP Limit > MAP Limit:
   a. Select the desired ‘MAP Limit Mode’
   b. Select the MAP Limit Table, enter the required MAP limiting value for each engine temperature in the ‘MAP Limit Table’.
3. Click on Limits > Speed Limit:
   a. Set the Speed Limit’ to a high enough value to ensure it is not invoked during tuning. Note that this limit will only be effective if a vehicle speed sensor is correctly wired and configured.
4. Perform a Store to permanently save changes to the ECU by pressing F4.

Auxiliary Output Set-up

This section configures the ECU’s Auxiliary Output drivers for the devices they have been wired to. Preparing a configuration table as shown in Section 2.7 of this manual will greatly simplify set-up of Auxiliary Outputs. Note that one auxiliary channel should always be wired and configured for the fuel pump relay drive.

1. Click on Auxiliary Outputs then select the first Auxiliary Output that requires configuration:
   a. Select the required ‘Function’ for the Auxiliary Output channel.
   b. Configure the channel as required. Refer to iVTS Tuning Software’s online help for more information on adjustments.
2. Configure each additional Auxiliary Output channel. Ensure unused channels have their ‘Function’ set to 'OFF'. Note that the ‘Test On’ and 'Test PWM' functions can be used to test wiring of auxiliary output devices.
3. Configure any Ignition and Injection channels used for auxiliary output functions in the same manner.
4. Perform a Store to permanently save changes to the ECU by pressing F4.

Digital Input Set-up

This section configures the ECU's Digital Input channels for the devices they have been wired to. Preparing a configuration table as shown in Section 2.7 will greatly simplify set-up of Digital Inputs.

1. Click on ‘Digital Inputs’ then select the first Digital Input that requires configuration:
   a. Select the required ‘Function’ for the Digital Input channel.
   b. Configure the channel as required. Refer to iVTS Tuning Software’s online help for more information on adjustments.
   c. Confirm the operation of the Digital Input by opening the Digital Inputs tab of the runtime values (Press F12).
2. Configure each additional Digital Input channel. Ensure unused channels have their ‘Function’ set to ‘OFF’.
3. Perform a Store to permanently save changes to the ECU by pressing F4.

Analog Input Set-up

This section configures the ECU’s Analog Input channels for the devices they have been wired to. Preparing a configuration table as shown in Section 2.7 will greatly simplify set-up of Analog Inputs. Essential inputs are configured in this section. All steps must be performed on all applications.

1. Click on ‘Analog Inputs'.
2. Select the Analog Channel that is wired to the MAP

sensor.

a. Set the function to ‘MAP Sensor’.

b. Select the correct “MAP Sensor Type’.

c. Ensure the MAP runtime value reads reasonably close to the barometric pressure reading (BAP).

d. Perform a MAP Sensor Calibration. Do this by selecting ‘MAP Sensor Calibration’ from the Options menu and following on screen instructions.

3. Select the Analog Channel that is wired to the TPS sensor:

   a. Set the function to TPS (main).

   b. Perform a TPS Calibration. Do this by selecting ‘TPS Setup' from the Options menu and following on screen instructions.

4. Set up all other connected Analog Volt channels as required.
5. Set unused channels to OFF.
6. Click on the An Temp channel wired to the engine coolant temperature (ECT sensor).

   a. Set the channels function to 'Engine Coolant Temp'.

   b. Select ‘Sensor Type’. If a custom type sensor is to be used then the resistance vs. temperature values should be entered now in a spare Calibration Table.

   c. Confirm correct reading of the sensor by opening the Analog Inputs tab runtime values (lower area of iVTS Tuning Software screen).

7. Repeat the previous step for all Analog Temperature channels.
8. Perform a Store to permanently save changes to the ECU by pressing F4.

Trigger Set-up

Trigger set-up requires entering information regarding the way in which engine speed and position is measured. Consult the iVTS Tuning Software online help for further information on functions.

WARNING!

These are probably the most critical set-up values. Do not attempt to start the engine unless you are 100% confident that these values are correct.

If trigger information is unknown, consult your nearest Vi-PEC dealer for further assistance.

1. Click on ‘Triggers’ then ‘Trigger Set-up’:

   a. Configure triggers as required.

2. Click on ‘Trigger1’:

   a. Select correct trigger type and set-up completely.
3. Click on ‘Trigger2’:
   a. Select correct trigger type and set-up completely.
4. Perform a Store to permanently save changes to the ECU by pressing F4.

Additional Set-up

It is important that all features not required for initial tuning are either disabled or correctly set-up. It is recommended that features be initially disabled to ensure they do not complicate tuning.

1. Click on ‘Motorsport’ then ‘Antilag’:
   a. Set ‘Antilag Mode’ to OFF.
2. Click on ‘Launch Control’:
   a. Set ‘Launch Control Mode’ to OFF..
3. Click on 'Gear Cut Control’:
   a. Set 'Gear Cut Control Mode’ to OFF.
4. Click on Boost Control > Boost Set-up:
   a. Configure Boost Control as described in the iVTS Tuning Software online help.
5. Click on 'Multiple Boost Tables':
   a. Set 'Active Tables' to 1 Table.
6. Perform a Store to permanently save changes to the ECU by pressing F4.

13.3 Trigger Calibration

The following instructions assume that all pre-start set-up instructions given in previous sections have been completed. Only after all pre-start checks have been made should an attempt be made to crank the engine. The following steps must be performed before an attempt is made to start the engine to ensure the ECU is calibrated to precisely measure engine position.

1. Connect the ECU to iVTS Tuning Software.
2. Select 'Fuel', then 'Fuel Set-up':
   a. Set ‘Injection Mode’ to OFF. This will prevent the engine from trying to start while the triggers are calibrated.
   b. Perform a Store (press F4) to make sure fuelling is not re-enabled if power to the ECU is lost.
3. Click on ‘Triggers’ then ‘Calibrate Triggers’.
4. Perform the correct trigger calibration procedure as described in the iVTS Tuning Software online help (Press F1).

Note that trigger calibration must be performed again once the engine is running. Due to the acceleration and deceleration of the crankshaft at low speeds, an inaccurate measurement of engine timing is usually made. Also it is often harder to see timing marks with a timing light at slow engine speeds. Trigger calibration should be checked again at between 2000-4000 RPM where engine speed is stable and a more consistent timing reading can be obtained.

13.4 First Time Startup

After performing all set-up instructions given in previous sections, including trigger calibration, the engine is now ready to be started. The following procedure should be used for first time start-up:

1. Turn the ignition key OFF then ON. The fuel pump should prime momentarily upon power up.
2. Connect the ECU to iVTS Tuning Software.
3. Click on each of the runtime value tabs (located about two thirds of the way down the screen) and check that all values are as expected. Where possible operate sensors (e.g. TPS) to ensure correct readings are displayed. The following values should be checked:
    a. TPS – spans from 0 to 100% when throttle is pressed. If not, perform a TPS Calibration.
    b. MAP – should read approx 101 kPa (at sea level) with the engine not running. If not, check the MAP Sensor Type setting and perform a MAP Calibration.
    c. ECT – should read current engine temperature.
    d. IAT – should read current intake air temperature.
    e. Digital Inputs – Operate switches connected to any digital inputs while watching the runtime value to ensure they operate as expected.
4. Rectify any faults found in Step 3.
5. Click on the ‘Fuel’ heading, then ‘Fuel Set-up’:
    a. Locate the ‘Master’ setting. This will need to be adjusted during or just after start-up.
6. Crank the engine until it starts. Some throttle may be required for first time start-up due to imperfect tuning. If necessary adjust the Master setting to enrich/lean the engine (increase to enrich).
7. If the engine fails to start after several attempts, do not crank it endlessly. Stop and determine the problem before continuing.
8. Check the Trigger Error Counter (found under the Triggers runtime values tab). If this value increases during cranking/running then there is a trigger setup fault. It is not unusual for this number to count one or two on the first engine revolution.
9. Once the engine starts, adjust the ‘Master’ setting to achieve best possible running.
10. The engine should now be allowed to fully warm up. It may be necessary to readjust ‘Master’ several times to maintain smooth running. Don’t

forget to keep an eye on engine temperature.

11. Once the engine is warmed up and running well, perform another trigger calibration (known “as setting the base timing”).
12. Perform a Store by pressing F4.

13.5 Essential Tuning Adjustments

It is assumed that at this stage all set-up procedures described in previous sections have been completed and the engine is running. The following steps detail correct set-up procedures for some of the more critical ECU parameters (note that MAP Sensor Calibration should have already been completed by now):

MAP Sensor Calibration

At key on and engine not running the Manifold Absolute Pressure (MAP) Sensor should always match the Barometric Absolute Pressure (BAP) Sensor. As well as providing altitude correction, the BAP sensor also allows the MAP sensor to be calibrated prior to tuning.

i-Series ECUs use an on-board barometric sensor that is calibrated prior to dispatch. This ensures that all iVTS Tuning Software programs (PCL Files) give a consistent state of tune throughout the ECU range. This allows a PCL file to be transferred between i-Series based ECUs giving an equivalent state of tune providing all factors affecting VE are equal.

Without the ability to calibrate all the available types of MAP Sensors to the BAP Sensor there would be significant affects on the accuracy of the resulting tune, especially when tuning with Manifold Gauge Pressure (MGP) as a load index.

To calibrate the MAP sensor, select the 'MAP Sensor Calibration' item in the iVTS Tuning Software 'Options' menu and follow on screen instructions.

Injector Voltage (Dead time) Correction

There is always a delay between the injector being energised and the injector actually opening. Likewise, there is a small delay between the injector being de-energised and the injector closing. The opening time is considerably longer than the closing time, however the overall result is that less fuel will flow for a given pulse width than would be expected with an 'ideal injector'. To compensate for this the injector pulse widths are increased to compensate for this 'dead-time'. The dead-time for a given injector is a function of the battery voltage, differential fuel pressure and the type of injector driver (saturated or peak and hold). A typical dead-time at 3 Bar differential fuel pressure and 14 volts is just under 1ms (ms = millisecond = 1 thousandth of a second).

In applications with a linear 1:1 fuel pressure regulator (i.e. not a rising rate regulator), the differential fuel pressure (difference between manifold pressure and fuel pressure) will be constant. Therefore the only variable that is changing will be the battery voltage (this changes with electrical load and sometimes engine speed). Without correction, the changes in dead time will cause the engine to run lean when the voltage drops. If the Injector Voltage Correction is properly set-up then changes in the battery voltage will not affect the air/fuel ratio.

The injector dead-time table allows the dead- time for different battery voltages to be entered. The values represent the dead-time in milliseconds. These should increase with falling system voltage.

Injector dead time for a particular set of injectors can be determined using a flow bench or on a running engine.

To determine the injector dead-time using a flow bench, the injectors need to be operated at the intended operating pressure (normally three bar) and at a constant duty cycle as well as a set voltage. Vary the supply voltage to the injector and measure minimum pulse width at which the injectors will flow for a particular voltage. This is the required dead-time for that injector at that tested voltage.

To determine injector dead time on a running engine, with the engine fully warmed and operating at stable air/fuel ratios (a very precise AFR meter is required – a narrow band O2 sensor will not suffice), electrical drain needs to be applied to the system; the preferred method is disconnecting the alternator main fuse. Battery load testers are also useful here too.

Watching the air fuel ratios change while the battery voltage drops, the dead-time table can be trimmed to maintain the same stable air/fuel ratio. Injector Dead-Time can be viewed as a row graph. A smooth curve needs to be maintained at all times.

NOTE: any change to the fuel pressure or injectors will require a recalibration of the injector dead-times.

Master

Master should be set so that the numbers in the middle of the fuel table end up around a value of 50. This is to allow sufficient span of the numbers in the main fuel table.

14 Communication Wiring

This section contains detailed information about wiring communications wires to provide robust and reliable signals.

- CAN Bus wiring
- ECU to OBD-II Port Wiring

14.1 CAN Bus Wiring

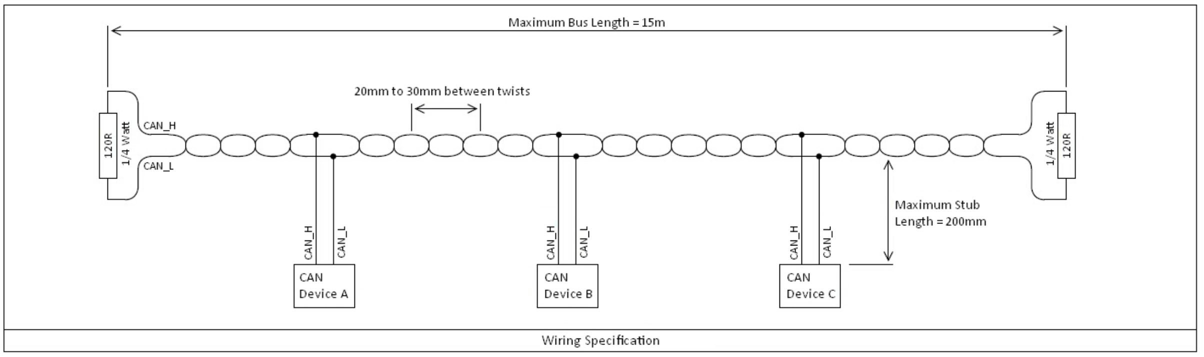
A CAN bus consists of a main bus (trunk) with devices individually joined to the bus.

Each end of the bus must be terminated with a 120R resistor (1/4 Watt minimum).

The trunk (main bus) must be a total length of less than 15m.

The two wires of the bus must be twisted together with a rate between 33 and 50 twists per meter. (20mm to 30mm between twists)

Each device needs to be connected into the main bus. The length of the wire used to connect to the bus must be less than 200mm.



Wiring Specification

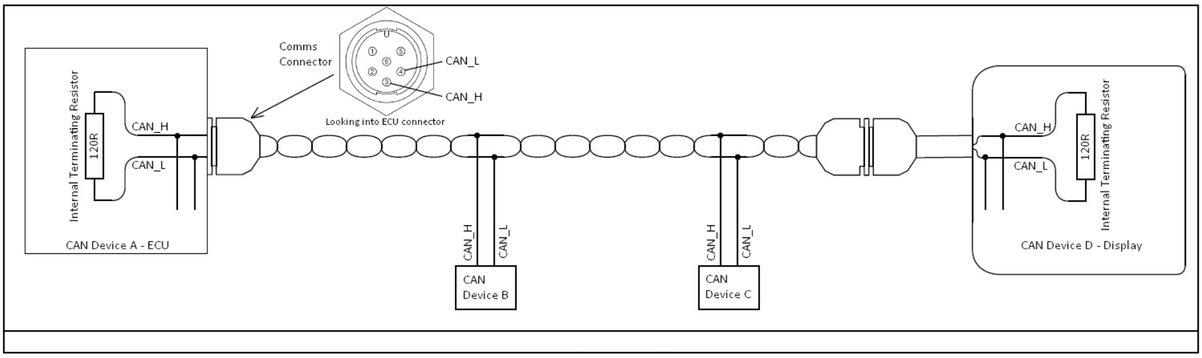
To simplify the installation, the following devices contain terminating resistors:

- Vi-PEC i-SeriesECUs.
- Vi-PEC Display. Note that the terminating resister is in the connector of the displays power supply cable.

This means that these devices can **only** be used at the **end** of the bus. If you want to connect these devices to the middle of the bus, please contact your local Vi-PEC distributor to arrange the removal of the internal resistor.

Example

The following is an example using devices to terminate the bus.

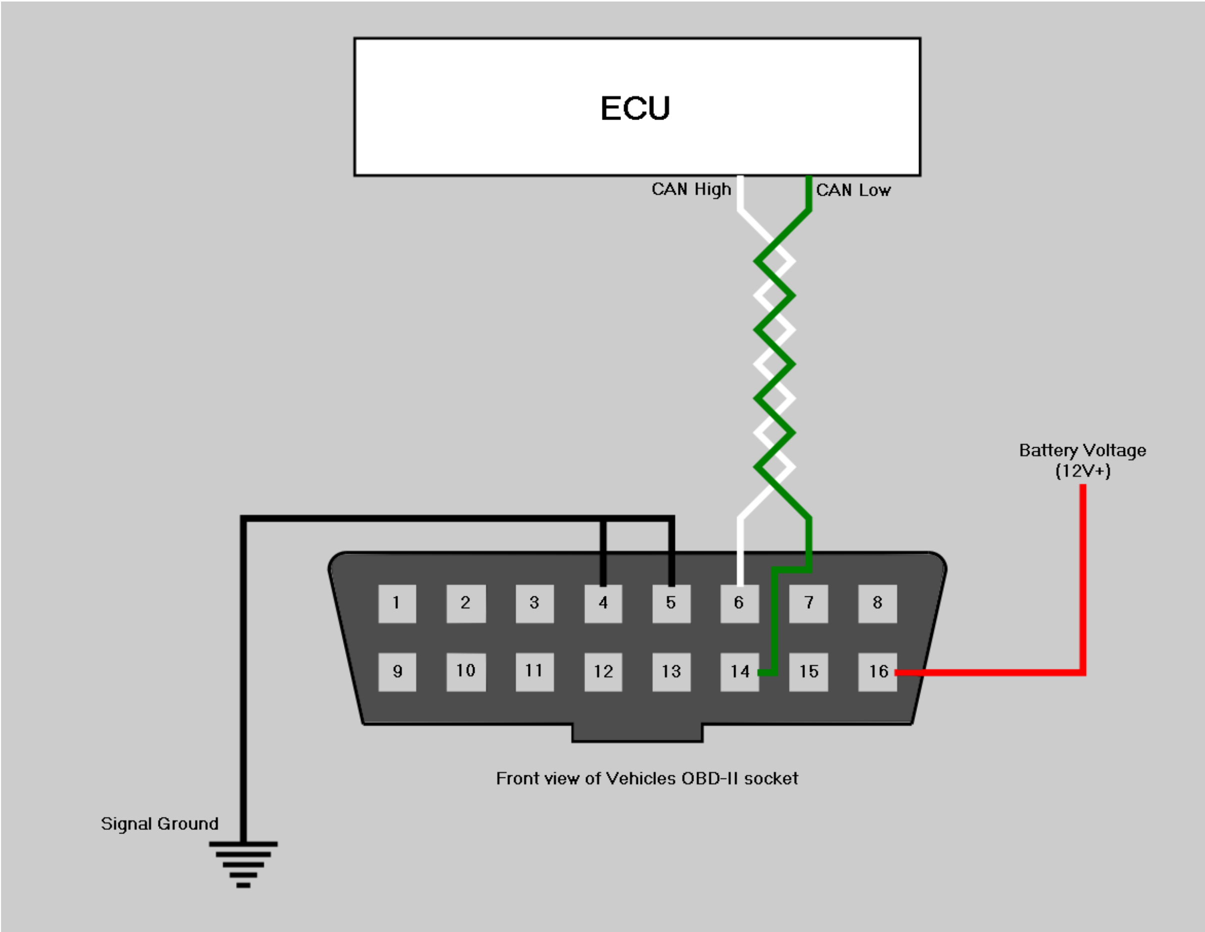


Hints

- Run the trunk as close as possible to all devices. It is important to minimise the length of the connection from the device to the bus.

14.2 ECU to OBD-II Port Wiring

Vi-PEC i-Series ECUs are capable of transmitting live data and fault codes to the vehicles OBD-II port. The ECUs data is transmitted to the ODB-II port over the ECUs CAN bus. The diagram below details the required connections.



OBD-II Pin Connections

Pin	Function	Notes
4	Chassis GND	Connect to ECU Signal GND
5	Signal GND	Connect to ECU Signal GND
6	CAN High	Connect to ECU CAN High
14	CAN Low	Connect to ECU Low
16	Battery Voltage (+)	Connect to a fused Battery Voltage (12V+) supply

Install Notes

- Depending on the Vi-PEC i-Series ECU you have the ECU may have one or two CAN bus connections, either CAN bus is suitable for OBD-II communication.
- Depending on the Vi-PEC i-Series ECU you have the CAN bus connections will be on a separate communication port, or may require a 'CANPCB' wiring connector.
- Refer to the CAN Bus Wiring topic for guidelines on the CAN High and CAN Low wiring.

- Refer to the CAN Bus Wiring topic for guidance on wiring multiple CAN devices to the same CAN bus.
- If permanently installing a device to the OBD-II port, an ignition switched power supply to pin 16 is preferable, as this will prevent the device draining the vehicles battery.
- Once the wiring for the OBD-II port is complete refer to OBD (On Board Diagnostics) for setup information.

vi-pec.com