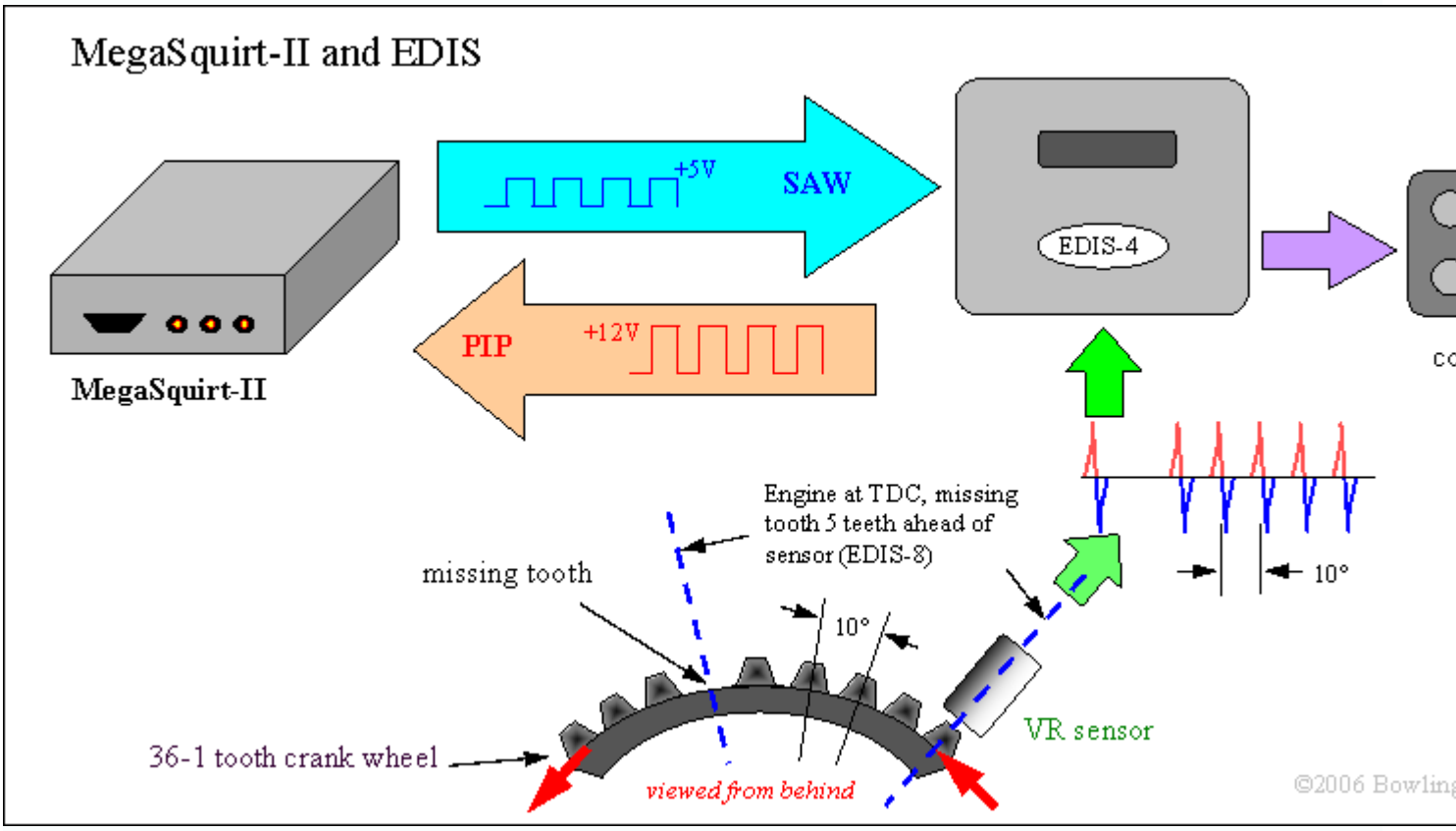
EDIS Ignition Control with MegaSquirt-II

The Ford EDIS System

Ford's **E**lectronic **D**istributorless **I**gnition **S**ystem (EDIS) is an ignition system that does NOT require a cam position signal. It can function with just a variable reluctor crank position sensor and a 36-1 tooth wheel (36-1 means *'36 teeth minus one'*, and refers to 36 evenly spaced teeth, one of which has been removed). *(For a custom 36-1 wheel for a small block Chevrolet, see: www.megamanual.com/ms2/36-1.htm)*

Because it doesn't need a camshaft position sensor, EDIS is a particularly easy way to replace distributor ignitions when retrofitting older engines with a modern computer programmable ignition.

To understand the inner workings of the EDIS module, read US patent numbers 4,661,778, 4,922,874, and 5,014,676 at www.uspto.gov. However, to use the EDIS on your engine, you don't need to know it's internal workings.



The EDIS system is made up of:

- EDIS module,
- crank wheel,
- crank variable reluctor sensor (VRS), and

- one or more coil pack(s).

This section deals with the operation of the Ford EDIS Electronic Ignition Module. There is a lot of information on the modules on the web, but much of it is incorrect or incomplete. The information here was derived from direct testing on the bench as well as sources like the DIY-EFI list. Additional detailed information provided by John DeArmond, James Murray (MSnEDIS), Perry Edwards, and a few other key sources were very helpful in figuring out proper module operation.

You can get complete EDIS setups, including the crank wheel, sensor, modules, spark plug wires and harnesses, from Boost Engineering. The EDIS-8 & EDIS-6 modules are also available from a number of manufacturers for about $180. The EDIS-4 module can be found for around $100. Here are some part numbers:

	EDIS-4	***EDIS-6***	***EDIS-8***
AC Delco	19017159, F1945	19017168	19017160, F1946
Autotune	PT6909	PT6910, PT6912, PT7088, PT7095	PT7089, PT7092, PT7093
BWD	CBE114	CBE115, CBE116, CBE52, CBE59	CBE53, CBE56, CBE57
GP Sorenson	EL162	EL375, EL378	EL174
Motorcraft	DY630, F0CF12A359AB, F0CF12A359AC, F1CZ12A297A, F1CZ12A297B, F1CZ12K072A, F1CZ12K072B	90GB12K072AB, DY629, DY657, DY680, DY682, DY689, DY724, DY727, F07F12K072BA, F0TZ12K072B, F0TZ12K072BA, F1TZ12K072B, F1TZ12K072BA, F4SZ12K072B, F4ZF12K072AC,F4ZF12K072BB, F4ZF12K072BC, F4ZZ12K072A, F4ZZ12K072B	DY644, DY687, DY726, DY755A, DY887, F1AF12K072AC, F1AF12K072AD, F1AZ12K072A, F3LF12K072AA, F3LY12K072A, F4SZ12K072A, F5SF12K072AA, F5SZ12126AA, F5SZ12K072AA
NAPA-Echlin	TP500, TP515	TP504, TP507, TP513	TP508
Niehoff	FF424A	FF420, FF424C, FF424F, FF425E	FF421, FF425A, FF426A
Standard	LX239	LX254, LX256	LX243
Wells	F140, F157	F142, F158, F159, F169	F143, F144

If you go to a salvage yard for EDIS modules, they are usually located in the engine compartment on the driver's side inner fender. The modules have a EDIS-4 (or EDIS-6 or EDIS-8, depending on number of cylinders) sticker on them. Try to take the connector as well, as well as the ignition coil pack(s) and connectors. You can also obtain used units from the salvage web at www.car-part.com.

The EDIS can be found on:

- **EDIS-4**, 1990 to 1993 1.9L 4 cylinder engines,
- **EDIS-6**, 1990 to 1995 4.0L 6 cylinder engines, and
- **EDIS-8**, on 1990 to 1997 4.6L V8 engines.

The EDIS 4 and 8 cylinder coil packs are available from Accel under number 140018 ($54.95 each from Summit Racing)

The EDIS system handles the complete task of crank/ignition synchronization as well as current control for the wasted-spark coils. It sends just one signal (PIP) to MegaSquirt-II™, and receives just one signal (SAW) back. The desired amount of ignition advance is generated by MegaSquirt-II™. The interface between the EDIS and MegaSquirt-II™ is extremely simple. There is one output signal (PIP) and one input signal (SAW) from the EDIS module MegaSquirt-II™.

On all engines, the complementary coils are connected to the cylinders that are 360° (i.e., ½ of a 720° engine 'cycle') apart in the firing order. For example, the firing order for HO 5.0L and 351 engines is 1-3-7-2-6-5-4-8. Connect cylinders 1 and 6 to the same coil, 3 and 5 to another coil, 7 and 4 to another coil, and 2 and 8 to the remaining coil. Note that the coils are packages in two groups of two coils (each of which fires 2 cylinders) in V8 applications.

The operation the EDIS system is very simple. The crankshaft is fitted with a 36-tooth wheel, with one tooth missing. The missing tooth indicates the exact position of the crankshaft to the EDIS. The EDIS system is a wasted-spark setup (i.e. two spark plugs fire which are separated by 360 "cycle-degrees" of a 4-cycle engine), so there is no synchronization with the camshaft. This means that one cylinder has its spark plug firing during the valve overlap period near top dead center, but because the pressures are so low and the charge is diluted by the exhaust gases, no ignition occurs. This spark is 'wasted' on a cylinder that isn't firing, and EDIS is referred to as a 'wasted spark' ignition system.

Near the crank wheel is a **V**ariable-**R**eluctance (VR) sensor - this sensor produces a bipolar signal. The VR sensor is pointed at the center of the crank wheel, with a 0.030 to 0.060 inch gap (0.75 mm to 1.5 mm) to the crank wheel teeth.

Number of Cylinders	*Specific_Angle*
4	90°
6	60°
8	50°
10	26°

The VR sensor and 36-1 crank trigger wheel must be set in the correct relationship to each other. With the engine at TDC for cylinder #1, this relationship is:

- **EDIS-4**: missing tooth is exactly nine teeth (90°) ahead of the VR sensor,
- **EDIS-6**: missing tooth is exactly six teeth (60°) ahead of the VR sensor,
- **EDIS-8**: missing tooth is exactly five teeth (50°) ahead of the VR sensor.

Note that you have a choice where to place the sensor, IF you can shift the wheel. It is a good idea to build the VR sensor bracket so that you have a degree of radial adjustment (closer/farther from the wheel) and angular adjustment (closer/further from TDC). Also, bear in mind that most automotive engines rotate

clockwise when viewed from the front, ***except*** many Honda engines.

With the above configuration, the EDIS module will fire the ignition at 10° BTDC, ***unless*** the module receives a **Spark Angle Word** (SAW) command. The 10° advance is constant, regardless of RPM. This functions as a **limp-home mode**; if the module doesn't receive SAW commands from MegaSquirt-II, it will generate a usable (but not optimal) 10° BTDC of ignition advance.

To test the VR sensor alignment, run the EDIS in limp home mode. This can be done by disconnecting the SAW/PIP plug, or disconnecting MegaSquirt-II (or its power).

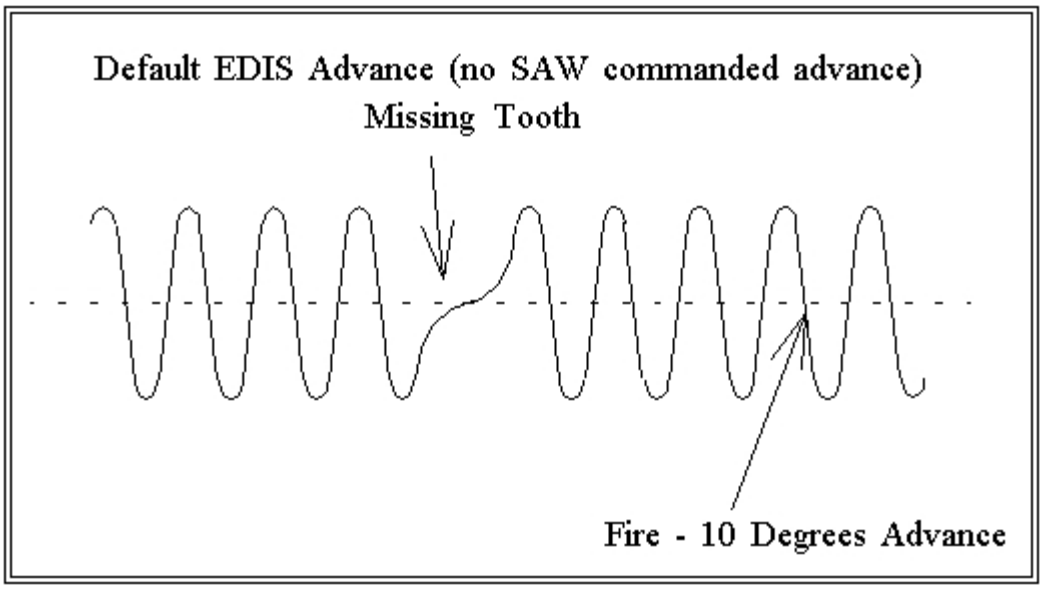
Start your engine and check that the timing is exactly 10° BTDC with a timing light on cylinder #1. If the timing isn't 10° BTDC, adjust the position of your VR sensor until the timing is as close to 10° BTDC as you can get it. Don't forget to reconnect the SAW/PIP plug when you are done, or you will have NO timing advance and your engine will run poorly and inefficiently.

The VR sensor signal polarity is such that when the tooth tip is exactly centered on the VR sensor, the VR output is at zero volts falling from a positive to a negative polarity - i.e. a zero-crossing with a negative slope. The VR signal is fed directly into the EDIS module, to indicate the crankshaft's position. The EDIS module handles **all** VR signal processing. In fact, the EDIS module has a built-in VR signal hysteresis - when the VR signal is passing from negative to positive polarity (next tooth is approaching), the signal must reach +0.5 volts before the EDIS module will "arm".

It then will "trigger" when the signal passes through zero on a positive to negative transition, which occurs when the VR sensor tip is aligned with the crank wheel tooth.

Using the VR signal and the 'missing tooth' wheel, the EDIS module can synchronize with the engine crankshaft.

Here is a picture of the (simulated) VR signal generated from the crank wheel, and the EDIS-8 firing point for coil #1:



When the EDIS module receives proper a VR signal, it generates a 12-volt square-wave signal with a period linked to the next cylinder to fire. In other words, when this signal (Ford calls it the **PIP**, for **P**rofile **I**gnition **P**ick-up) goes from +12V to ground, one of the ignition coils is firing. This signal follows the ignition coils, not the VR sensor (as indicated on some incorrect documentation floating around).

For an EDIS-8 module, there will be four complete cycles of the PIP waveform for every 360 degrees crankshaft, or thirty-five VR signal cycles (not 36 because of the missing tooth). An EDIS-6 will yield three PIP cycles per every 360-degrees crank, and an EDIS-4 gives two.

For example, with an EDIS-8, we have 9 VR sensor cycles (or 8 if the 'missing tooth is in that sector) for every 90° of engine rotation, and this corresponds to the period between coil firings (on two cylinders, one of which is wasted). So during this period, the coil has started low, gone to 12 volts to charged the coil, then gone low (grounded) to fire the plugs. The duration of the PIP signal is based on the desired coil dwell period, and is calculated internally by the EDIS module.

The spark advance is controlled by the **Spark Angle Word** (**SAW**) line on the EDIS module. The SAW is a pulse width of a specific duration that tells the EDIS system when to fire the spark plugs. It is calculated as follows:

$$\mathbf{SAW = ZTDC - (ST \times T \times {}^{2.sup.x}/_{CMI})}$$

where:

- **SAW** is the calculated pulse width (in microseconds);
- **ZTDC** is the pulse width offset corresponding to the SAW pulse width for a spark advance of 0° TDC;
- **ST** is spark advance in degrees, and is negative for spark angles after top dead center (ATDC);
- **T** is the pulse accumulator clock period (in microseconds);
- **2.sup.x** is the number of steps between position signals for a desired spark resolution and x is a whole number; and
- **CMI** is the engine crank marker interval, i.e., the number of degrees of crankshaft rotation between signals from the position sensor.

A top dead center offset value is selected as 1536 microseconds (i.e., ZTDC=1536). A clock period of four microseconds (4µsec) is used in the pulse accumulator, corresponding to a clock frequency of 250 KHz. The crank marker interval is 10° and a desired resolution within the 10° intervals is chosen as 64 discrete steps, i.e., x=6. The formula for determining SAW pulse width is thus:

SAW = 1536 - (25.6 × (desired spark advance in degrees)) (in µsec)
Range: 64 - 1792 µsec (57½° BTDC to 10° ATDC)
Resolution: 4 µsec ($^{5}/_{32}$ of a degree)

For example, for 36° of advance, we want MegaSquirt-II to send a SAW of:

SAW = 1536 - (25.6 × 36°) (in µsec)
= 1536 - (922) (µsec)
= **614 µsec**

The width of the SAW word in degrees is related to the desired advance by the above equation. At first glance, it looks odd, but it does make sense (depending on the hardware generating the width). With a microcontroller timer peripheral, most timers use a counter 16-bits in length, and they have a mode known output-compare, which is used to make an output toggle when the counter reaches a comparison value. Using a 16-bit timer incrementing at a 1 microsecond rate, and a 16-bit comparison register to toggle the output, one can easily generate the required period. In fact, the numbers are quite easy to use - see the following table for example SAW advance widths and corresponding 16-bit timer compare values:

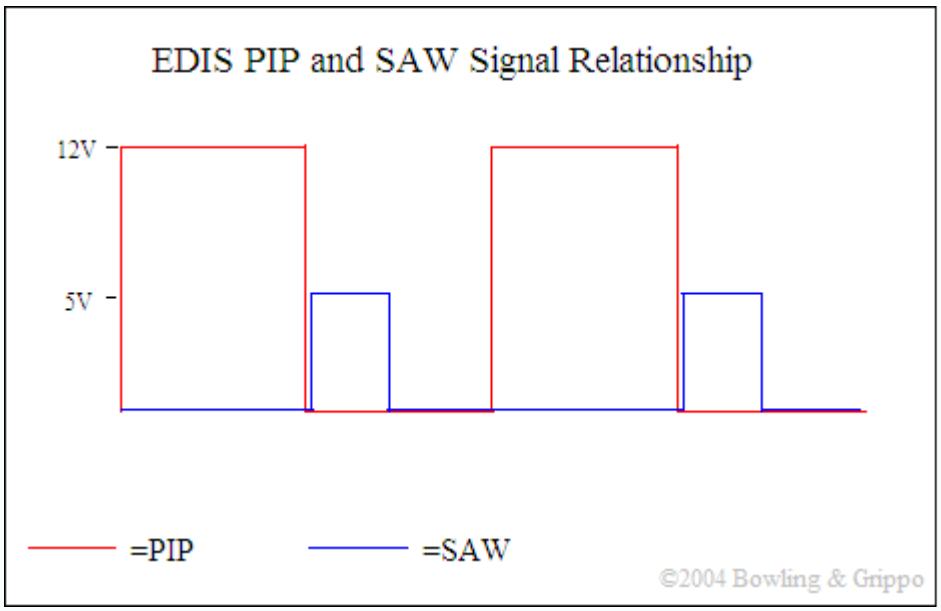
Advance Degrees	SAW Pulse Width (µsec)	High-order 8-bits	Low-order 8-bits
10°	1280	0x05	0x00
20°	1024	0x04	0x00
25°	896	0x03	0x80
30°	768	0x03	0x00
40°	512	0x02	0x00
50°	256	0x01	0x00
55°	128	0x00	0x80

The numbers now make a little more sense. The high-order of the 16-bit timer drives every 10 degrees, and the lower 8-bits drives the advance values in-between. This makes generation of advance widths very easy with a microcontroller. The Ford engineers knew what they were doing!

The PIP signal is used as a reference to synchronize the generation of the SAW pulse by MegaSquirt-II™. The SAW signal is generated by MegaSquirt-II and is an input to the EDIS module. This signal is a +5V positive square wave pulse, and the width of this pulse determines the advance that the EDIS module will use for subsequent ignition events, up to a half second or so. If the SAW signal is lost for much longer than this, the 'limp-home' mode is enabled, and advance is set at 10° BTDC. So the SAW signal does not have to be sent on every PIP cycle - the EDIS module will remember the last SAW commanded advance and "remember" it for subsequent ignition advance values until a new pulse is received or until 'limp-home' mode is enabled.

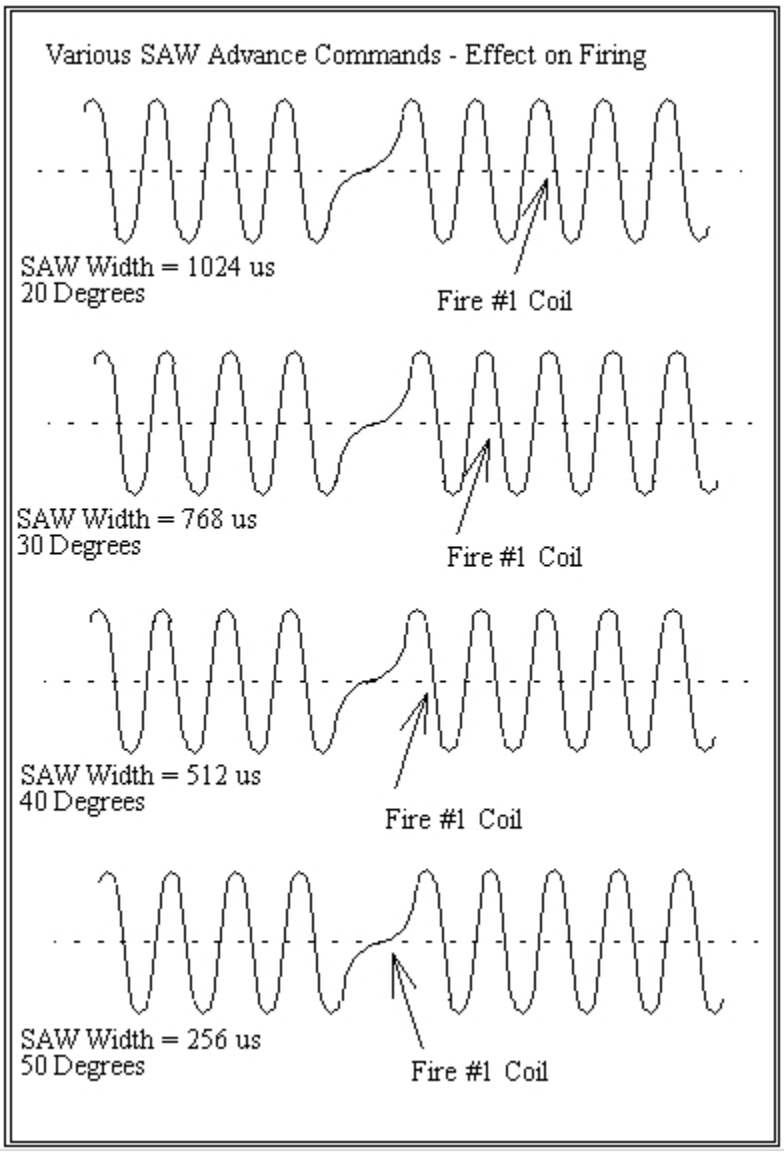
Note that the SAW pulse must be synchronized with the PIP negative going pulse (i.e, when the PIP drops to zero). It cannot be applied asynchronously to the PIP signal, otherwise incorrect advance commands will be interpreted by the EDIS module. SAW should be initiated a short period after the **falling edge** of the PIP signal.

Here is the proper relationship between the two signals:



Note that there is some uncertainty over the exact timing relationship between the two signals for some EDIS modules.

The range of the spark advance word is from 59° (60° would be a pulse width of zero, and the previous SAW would be used) down to 0°. How does one measure this? Using a two-channel scope and monitoring the VR waveform and coil #1 output from the EDIS module, it is easy to see the relationship:



A significant part of the whole EDIS module is the multiple-coil drivers. First thing is that the EDIS module has the actual ignition coil driver built-in - the driver is not part of the Ford wasted-spark coil pack. The coil packs are just standard ignition coils, and could in theory be substituted with other coil-only packs. The EDIS-8 module has four coil drive channels - EDIS 6 has three, and the EDIS-4 has two. The EDIS module handles the dwell time automatically, depending on commanded advance and RPM - another feature which makes the EDIS one of the easiest to use DIY setups.

The EDIS ignition system is rugged. The module mounts under-hood and will survive engine-bay temperatures, water, freezing, etc. And with only two wires going back to the MegaSquirt-II box (PIP and SAW), wiring is extremely easy.

Installing the Ford EDIS System

Note that the PIP signal from the EDIS module to MegaSquirt® is like a Hall sensor signal (positive only square wave). As a result, you use the Hall input circuit, On a V3 board, jumper D1 and D2 (or install jumpers in their place when assembling).

The SAW signal from MegaSquirt-II to the module comes out on pin #**17** of the 40 pin socket (labeled **IGN**), and is connected to the **5**th hole of the **JP1** socket (pin **8** of the MC9S12C64) on V2.2 boards (JS10 on V3.0 boards). The PIP signal goes to MegaSquirt-II via the DB37 pin **24**. This is connected to pin **14** of the 40 pin

socket (IRQ), and pin #**1** of the MC9S12C64 processor.

To install EDIS with MegaSquirt-II, you connect:

V2.2 main board:

- the 5th hole of JP1 to the SAW pin (#3) on the EDIS module (which you can jumper to an unused DB37 pin, if you want),
- the PIP pin (#1 on the EDIS module) to DB37 pin #24,
- Make sure D8 (the 'John' Zener diode) is jumpered.

V3.0 main board:

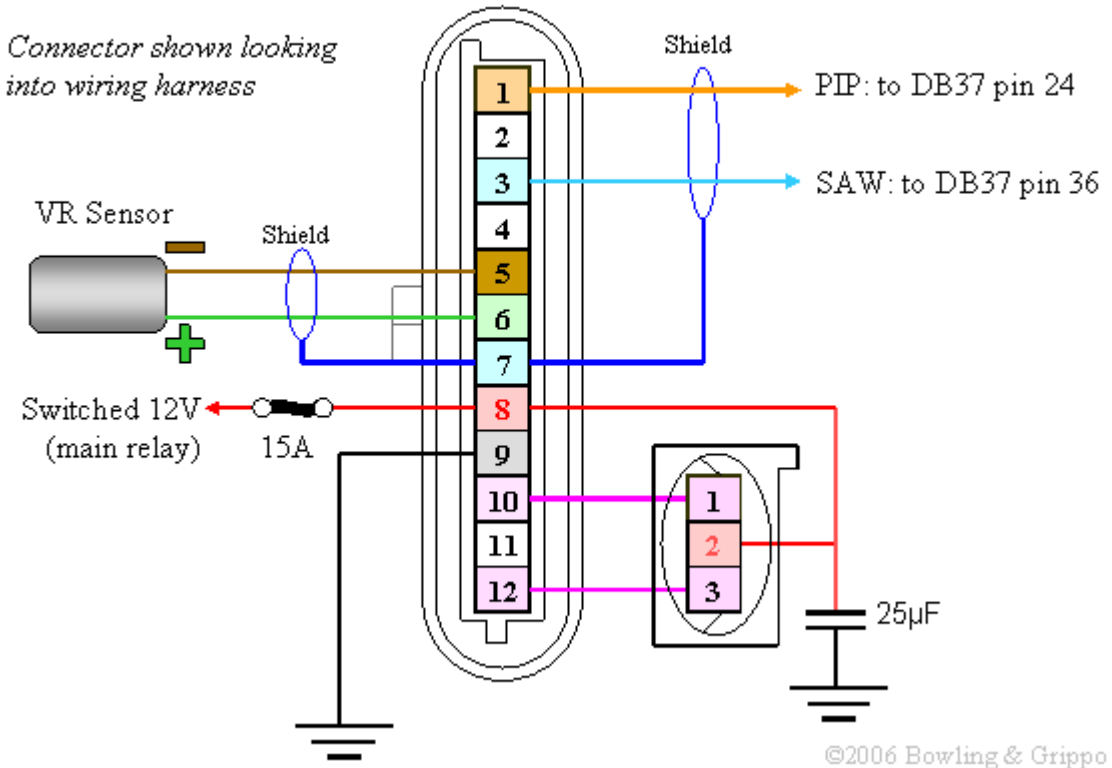
- DB37 pin #**36** to the **SAW** pin (#3) on the ignition module
- DB37 pin #**24** to the **PIP** pin (#1) on the ignition module
- On the V3.0 main board:
    - use the 'Hall sensor circuit' (step #50.a in the assembly guide) - jumper D1 and D2,
    - jumper **OPTOIN** to **TACHSELECT** on the bottom side of the PCB, near the DB37 connector, opposite the heat sink,
    - jumper **TSEL** to **OPTOOUT** on the bottom side of the PCB, near the center.
- jumper **JS10** to **IGN** (this uses the processor port for the SAW signal directly),
- jumper **XG1** to **XG2** on the bottom side of the PCB, near the 40 pin socket,

If you are using the relay board with a v3 main board:

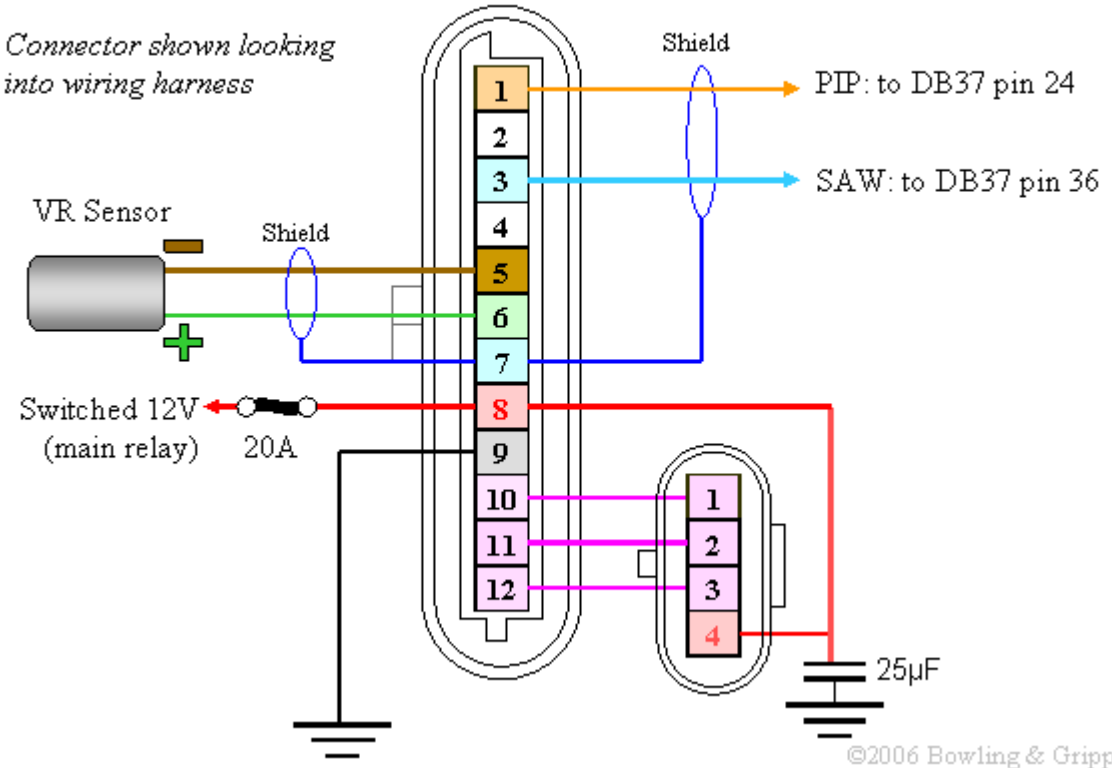
- the **SAW** signal connects to the **S5** terminal (#11 on the 20 position terminal strip) on the relay board, it comes from DB37 pin 36 (make sure you have a wire connecting pin 36 to pin 36 in the MegaSquirt/relay board connecting cable),
- the **PIP** signal connects to the **Tach** terminal (#15 on the 20 position terminal strip) on the relay board, it goes to DB37 pin 24.

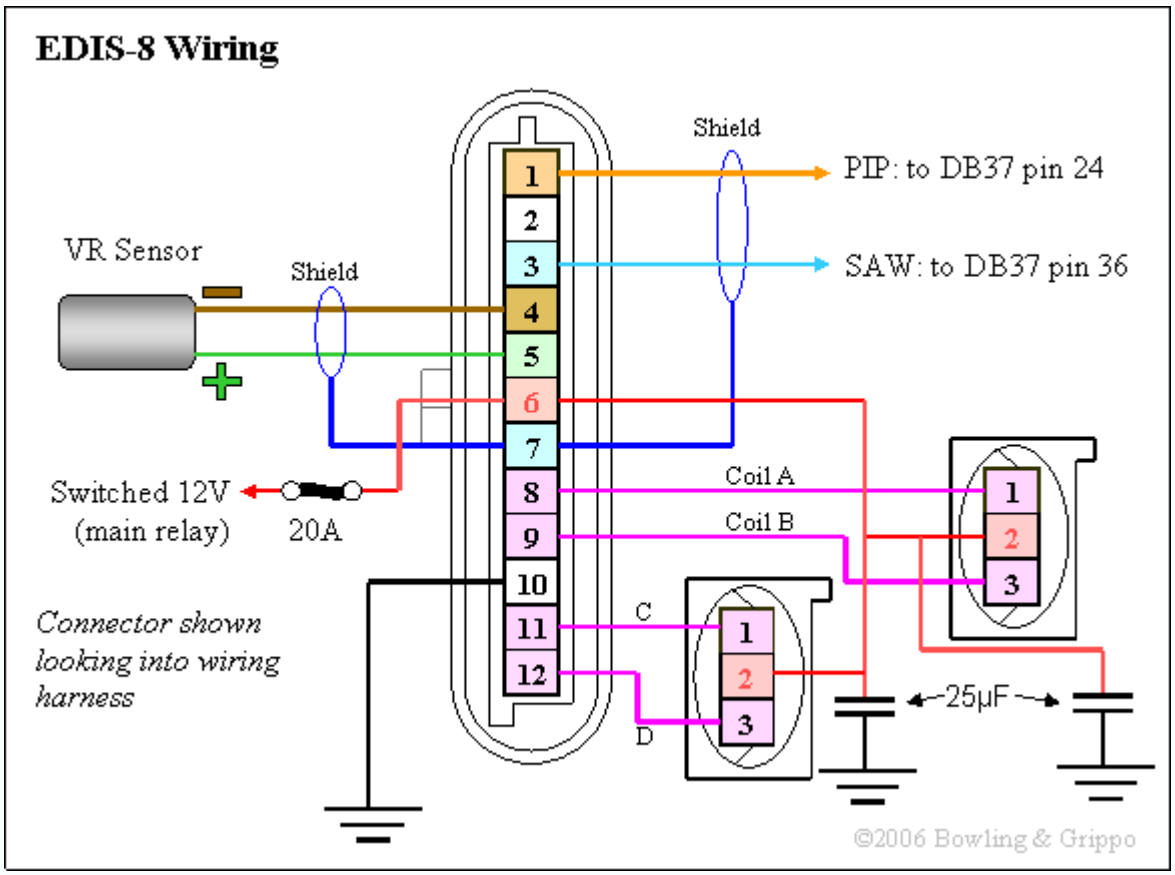
Here are the EDIS pin-outs for the EDIS4, EDIS-6 and EDIS-8:

EDIS-4 Wiring



EDIS-6 Wiring





Note that the EDIS-4 and EDIS-8 key are similar, but swapped from end to end. Do not attempt to connect them, you will ruin the module, wiring, and/or coil packs. In all case the clip is the most useful guide to the pin numbering. Pin #1 is usually marked on the connector.

Spark Plug Wiring

There are a number of principles to wiring the spark plug leads to the coils, and a number of '*gotchas*'.

- A single coil (two towers vertical when the connector is at the bottom) should fire cylinders that are 360° apart in the firing order. For example, if your firing order is 18436572, then 1&6, 8&5, 4&7, and 3&2 should be connected to the same coils (they are called 'complimentary cylinders).
- Do not confuse the firing order with the coil terminal numbering.
- Coil A fires 'first' (i.e., correct for cylinder #1), so it should be connected to cylinder #1 (and the complimentary cylinder). It doesn't matter which terminal on a coil goes to which of the two complimentary cylinders (since they both fire, the one on the exhaust stroke using vary little spark energy because of the ionized exhaust gases).
- **4 cylinder (EDIS4):**
  - On a four cylinder engine, with a firing order of 1342, that means the coil should be connected so that 1&4 are on coil A (left side when connector is at bottom), and 2&3 are connected to coil B (right side). Other firing orders are connected differently. Basically, you connect #1 and the third cylinder in the firing order to coil A, and the second and fourth cylinders in the firing order to coil B.
  - On EDIS4, coil A is connected to pin 10 of the EDIS module, coil B is connected to pin 12 of the EDIS module. If these are connected the wrong way around, the coils will fire in a different order, and the spark plug wires will need to be rearranged.
- **6 cylinder (EDIS6):**
  - On a 6 cylinder engine, the coils in a 6 terminal pack fire ACB (with ABC left to right with the

connector on the bottom). Coil A fires first and should be connected to cylinder #1 and its complimentary cylinder. The coil C should be connected to the cylinder that fires after #1, and its complimentary cylinder. The remaining two cylinders should be connected to coil B.
    - For example, with a 6 cylinder having a firing order of 123456 (GM 60° V6), you would connect coil A to 1&4, coil C to 2&5, coil B to 3&6.
    - On EDIS6, coil A is connected to pin 10 of the EDIS module, coil B is connected to pin 11 of the EDIS module, and coil C is connected to pin 12 of the EDIS module. If these are connected the other way around, the coils will fire in a different order, and the spark plug wires will need to be rearranged.
- **8 cylinder (EDIS8):**
    - On an eight cylinder engine, the coils fire ABCD (actually ABCDABCDABCD...). So coil A is connected to cylinder #1 and its complimentary cylinder, coil B is connected to the cylinder that fires after cylinder #1 (& its compliment), coil C connects to the next cylinder (...), and coil D connects to the next cylinder, and it's compliment. That's all of them.
    - On EDIS8, there are two coil packages, with two coil in each package. Coil A is connected to pin 8 of the EDIS module, coil B is connected to pin 9 of the EDIS module. Coil C is connected to pin 11 of the EDIS module, coil D is connected to pin 12 of the EDIS module. You will need this info to figure out which coil pack is A/B and which is C/D. Coils A and C are on the right side of their respective coil packs, with the connector at the bottom, B and D are on the left.
    - For example, if your V8 firing order is 18436572 (Chevy V8), then 1&6 should be connected to coil A, 8&5 to coil B, 4&7 to coil C, and 3&2 to coil D. Again, it doesn't matter which of the complimentary cylinders is connected to which of the terminal on the same coil.
- Cylinders may be numbered in different ways, depending on the manufacturer. Inline four cylinders are generally 1234 from 'front' to 'back', with the front being the opposite end from the transmission. V and flat engines might be numbered with even numbers in one bank and odd on the other, or they might be numbered down one bank then the other. ALWAYS check in a service manual to be sure.
- Given the number of potential problems (firing order, cylinder numbering, module to coil wiring), the best advice is from James Murray http://megasquirt.sourceforge.net/extra/edis-hardware.html, *"One method is to test on the starter (plugs out.) First mark your crank pulley with where each plug should fire and then strobe each coil tower in turn as you crank the engine to see which one fires. e.g. I was installing MSnEDIS onto a small block Chevy which has 18436572 firing order, so I marked 1 at TDC, 8 at 90 ATDC i.e. a quarter turn anti-clockwise, then 4 at 180 ATDC, then 3 at 270 ATDC. You can just chalk the numbers on roughly. When you have worked out which plug is which connect up the wiring and off you go. Remember that the coil fires a pair of towers, so in my example 1&6, 8&5, 4&7, 3&2 are the pairs."*

Note that most timing lights that let you set the timing with a dial and read the alignment of fixed TDC marks with the strobe will not work with EDIS. This is because these timing lights use the time between sparks to compute the engine speed and advance, but the EDIS wasted spark is giving sparks twice as often as the timing light expects for a given rpm. If you have a 'dial back' timing light, set the dial to zero and use a degreed damper or timing tape to view the advance.

Settings/MegaTune

In MegaTune, set:

- **Trigger offset** = **0°** (this will vary slightly, depending on the wheel/pickup configuration),
- **Ignition Input Capture** to '**Rising Edge**', ('Falling Edge' *for MicroSquirt® only if using the VR input circuit - not recommended*),
- **Cranking Trigger** to '**Calculated**',

- **Coil Charging Scheme** to '**EDIS**',
- **Spark Output** to '**Going High (Inverted)**', ('Going High (Inverted)' *for MicroSquirt*).
- **Trigger Wheel Teeth** to '**0**' (zero)

Set the **predictor algorithm** option to '**last interval**'.

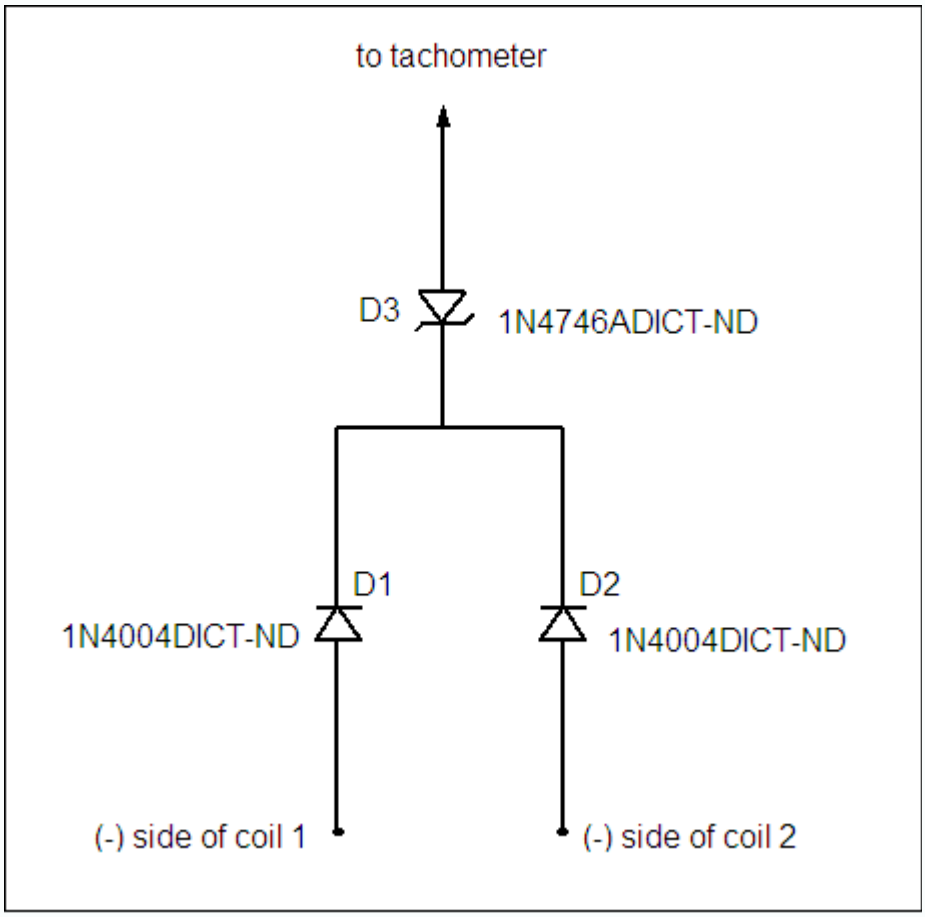
DO NOT set the missing tooth settings to 36-1 - set the Trigger Wheel Teeth to zero - the EDIS module takes care of the 36-1 wheel - MegaSquirt-II sees it as a regular distributor.

Tach Interface

For your dash tachometer, you have a few choices, :

- You may be able to use the IDM (*Ignition Diagnostic Monitor*) output to drive the tach. IDM a signals that the primary side of the ignition coil has fired. Simply wire the IDM output (pin 2 on all the EDIS modules) to the tach input, OR

- If your tachometer was previously driven by a single coil, and the IDM signal doesn't work, your tachometer will need input from two coils to indicate properly. The trick is that you need to tie all the coils together, without allowing them to ground each other. Below is a simple circuit (with Digi-Key part numbers) showing how to interface the EDIS system with your tach:



The schematic shows how to do this on a 4 cylinder (two coils). For a 6 cylinder, you would simply add another 1N4004 to the negative side of the third coil (connected to the single 1N4746 like the other two). For an eight cylinder, you would add two more 1N4004 diodes (one for each additional coil) in addition to those shown above. Be sure to get the bands pointing the right way.

If you are running EDIS on a Ford engine, you may also be interested in controlling the PWM Idle vale: IAC.htm#pwm

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