XDi200

DIRECT IGNITION SYSTEM

ELECTROMOTIVE

ENGINE CONTROLS

XDI200

Product Installation Manual
& User's Guide

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1 Terms and Conditions

1.1 ELECTROMOTIVE, INC. PRODUCT WARRANTY

Products manufactured by Electromotive (XDi Ignitions and TEC ECUs) are built to last. Many of our products have been in service for multiple decades. Products sold, but not manufactured, by Electromotive are warranted as described under **Other Products and Parts We Sell**.
Should your product not be functioning properly during the warranty period, please first check **Tech Support** information available at www.electromotive-inc.com under the **Support** tab. You may find that the issue is due to something other than unit malfunction.
Our warranty period is 1 year as of January 1, 2017.

New Product Warranty:
With a **1 year limited warranty**, Electromotive offers, by far, one of the best warranties in the business on all new XDi and TEC units, for the original purchaser only, from the original purchase date. We warrant our products to free of defects in materials and workmanship during the warranty period. The replacement product will, in turn, be warranted for **1** year from the date of replacement. Electromotive will pay for standard shipping to return the repaired/replacement unit to the customer, if a defect covered under warranty is found.
Note: At Electromotive's discretion, products that show evidence of tampering, abuse, accident damage, or other unusual wear and tear conditions may not be eligible for warranty coverage. See details under **Warranty Exclusions**.

If You Need Warranty Service:
Notify us at support@electromotive-inc.com or 703/ 331-0100 M-F 8:30 to 5:00 EST. Then, send (1) a note with a summary of the issues you are experiencing, (2) a copy of your sales receipt, and (3) the XDi or TEC unit. Ship to: Electromotive Repairs, 9131 Centreville Road, Manassas, VA 20110**. You must include the purchase receipt and it must clearly show name of the seller, date of purchase and purchase amount.**
Our policy is to provide a new or factory refurbished replacement unit rather than repair units under warranty, at our discretion. If the issue is something very minor, we may opt to repair rather than replace. Replacement products may include remanufactured or refurbished products or components.
If your product is shown to be in complete working order when we receive it, you may be charged a small fee for handling and return shipping.

Out-of-Warranty Product Repair
Should your product be out of warranty, we offer factory diagnosis and repair services. There is a small fee for diagnosis and estimation of repair costs. Check with us for the current diagnosis fee. You will have options including (1) repair, (2) (if available) purchasing a refurbished unit, or (3) trading your old unit for a discount off a new unit. We strive to keep our repair times to within 5 business days, plus shipping days.

Other Products And Parts We Sell:
We make every attempt to source products that live up to our quality standards. In the rare occasion that one of these products/parts fails within 90 days of purchase, return it to us along with a copy of your sales receipt and we will replace it if, at our discretion, the malfunction is not due to the same exclusions listed under **Warranty Exclusions**.

Warranty Exclusions:
Any product, on which the serial number has been defaced, modified or removed or doesn't appear in the Electromotive serial number registry.
Damage, deterioration, or malfunction deemed to be from:
Accident, misuse, neglect, fire, water, lightning, or other acts of nature, unauthorized product modification, tampering, or failure to follow instructions supplied with the product/available for download from www.electromotive-inc.com
Repair or attempted repair by anyone not authorized by Electromotive.
Any damage due to shipment.
Removal or installation of the product.
Causes external to the product such as electric power fluctuations or failure
Use of supplies or parts not meeting Electromotive specifications.
Any other cause, which does not relate to a product defect.

Limitation of Implied Warranties:
There are no warranties, expressed or implied, which extend beyond the description contained herein including the implied warranty or merchantability and fitness for a particular purpose.

Exclusion of Damages:
Electromotive's liability is limited to the cost of repair or replacement of the product.
Electromotive shall not be liable for:
Any costs for removal, installation, tuning or set up of the unit before or after the malfunction.
Damage to other property caused by any defects in the product.
Damages based upon inconvenience, loss of use of the product, loss of time, loss of profits, loss of business opportunity, loss of goodwill, interference with business relationships, or other commercial loss, even if advised of their possibility of such damages.
Any other damages, whether incidental, consequential or otherwise
Any claim against the customer by another part.
Certain shipping charges.

2 Forward

The **XDI200 Distributorless Ignition** system is the latest ignition system in the expanded line of ultra-high resolution engine management systems from the company that revolutionized engine management over twenty years ago. The **XDI200** can be configured to control the ignition of virtually any 1, 2, 3, 4, 6, 8 or 12 cylinder engine, as well as 1 or 2-rotor rotary engines, and dual plug 4 or 6 cylinders. The heart of the XDI systems has always been a high-resolution ignition, which offers incredibly precise ignition timing even at the highest acceleration rates. The **XDI200** continues this tradition; only what was once done with an analog ignition circuit is now done with a high-speed microprocessor. Direct Fire Units (DFU's) with twin-tower coils are available from Electromotive in 2- and 3-coil versions. Single tower coils are available as well. These DFU's are completely weather proof, and feature sealed electrical connectors. Additionally, the DFU's are impedance matched for optimum performance with our **XDI200.**

There are Nine dedicated, user-definable, general-purpose inputs / outputs (GP I/O's) included with the **XDI200** to make your high-tech engine setup a snap. The GP I/O's can be used to control anything from wastegates for turbo setups to simple electric radiator or intercooler fans. The possibilities are nearly limitless.

One of the GPI's has a frequency-based input capability, which can process data from wheel a speed sensor or similar device. The other GPI's are analog inputs only, and do not feature frequency-based capabilities. These channels can perform timing trims, and many other functions.

Besides the GP I/O's, several functions are built-in to the **XDI200** that are quite useful on most applications. The following outputs are standard on the **XDI200**:

Tachometer (configurable to drive most modern tachs)
Check Engine Light
Fuel Pump Relay Ground (activated at appropriate times by the **XDI200**
Idle Speed Motor control (stepper motor style or 2-wire style)

The **XDI200** uses the following inputs to perform engine management:

Crank Trigger
Cam Trigger (optional)
Manifold Air Pressure
Coolant Temperature Sensor
Manifold Air Temperature Sensor
Throttle Position Sensor
Knock Sensor (optional)
Exhaust Gas Oxygen Sensor (O_2 sensor)

2.1 Improvements of the XDI200 over the TECgt

The XDI200 has the added features of:

1. Water resistant case and connector system
2. 6 high current ignition coil drivers to operate 12 cylinder or dual plug 6 cylinder engines.
3. 6 separate ignition coil logic outputs to operate up to 12 Driver On Coil (DOC) coils.
4. User selected fixed coil dwell time or standard coil current control.
5. General Purpose Inputs(GPI) separated from General Purpose Outputs(GPO)
6. On board USB port for direct connection to Laptop PCs.
7. Retained RS232 Serial port like older TECs with same functionality
8. New Second Oxygen sensor input
9. New Third temperature sensor input
10. High power Tach signal driver
11. Two range knock sensor sensitivity
12. Added 2 more GPO outputs
13. Dedicated road speed frequency input
14. Future Twin Variable Valve Timing cam input and output control

2.2 Fundamentals of the System

The goal behind Electromotive's Total Engine Control product line is to provide complete, high-resolution control of all functions of the modern engine, and to do so with a user-friendly interface. Consequently, the **XDI200** is designed to easily control a huge number of complex engine management functions through the hands of a user who is new at the game.

Engine Speed & Position = Crank Sensor…

What separates our engine management systems from those of our competitors is the fact that our products are all designed around an ultra high-resolution ignition. For this reason, we use a 60(-2) tooth crank trigger wheel to give the computer an extremely accurate engine position input. This is also the reason that we do not support any other types of trigger inputs. Take, for instance, the flying magnet trigger input used by some manufacturers: 8 cylinder engines have 4 magnets mounted to the crank trigger wheel. Our 60(-2) tooth trigger has *15 TIMES MORE RESOLUTION!* From a magnetic sensor aimed at the trigger wheel, the **XDI200** receives its input for engine speed and position.

Engine Load = MAP Sensor…

As nice as the 60(-2) tooth trigger wheel is for determining engine speed and position, more is necessary to perform ignition and fuel control; namely a load input. While many OEM's use Mass Airflow (MAF) sensors to determine the airflow (and thus the load) of an engine, Electromotive systems are designed around Manifold Air Pressure (MAP) sensors as the load-determining device. MAP sensors simply plug into the intake manifold of the engine (after the throttle), and are inherently easier to install than MAF sensors since they are not sensitive to vacuum leaks or engine airflow requirements. A 1-Bar MAP sensor is designed for naturally aspirated engines. A 2-Bar sensor is used for turbo/supercharged engines with up to 15psi (about 200kPa absolute) manifold boost. A 3-Bar sensor is good for up to 30psi (300kPa), while a 4-Bar is good for up to 45psi (400kPa). Choose the appropriate sensor for the application, and you are done.

Ignition Advance Control…

Once the MAP sensor and crank sensor are installed, the **XDI200** has inputs for RPM and load. Under steady-state conditions on a fully warmed-up engine, these are the only necessary inputs for the **XDI200** to control the fuel and ignition curves. Control of the ignition advance curve is quite simple: there is a table of RPM vs. MAP in which the desired ignition advance angle is entered for every point. The table can be made in any size from 8x8 to 16x16 data points. Between each data point, there is a 256 point interpolation occurring. This keeps the advance curve from "stepping" from point-to-point. Additionally, it means that the engine can be tuned with only a few input numbers; some other systems on the market rely on the tedious input of hundreds of numbers to obtain an ignition advance curve that is still not as smooth between data points as ours.

Compensations…

Having a warmed-up engine running under steady-state conditions is all well and good, but in the real world, we must deal with cold weather starting, engine accelerations and decelerations, etc. For these scenarios, engines need fuel and spark *compensations*. The coolant temperature sensor (CLT) provides an input for the **XDI200** to measure the engine temperature. Since cold engines need more fuel than hot engines, tables are provided in the software to allow fuel flow increases as a function of engine temperature. Other parameters related to the coolant temperature are cold starting (cranking) enrichments and throttle movement enrichments when cold

Additional Features…

Once all the necessary input sensors are in place, and the software is tuned, the engine will run quite well. However, to further refine the control of the engine, a few additional features are included. The idle air control motor (IAC) is used to meter air into the engine at idle. This helps maintain a smooth idle, regardless of operating conditions. It can also be used to increase the idle for cold temperatures, or air conditioner activation. A fuel pump output is also included, which allows the user to turn on the fuel pump relay for a set amount of time when the ignition is turned on. This primes the fuel system, and powers the fuel pump once the engine is cranked and running. A tachometer output is included, which will drive most modern tachometers, and a check engine output is included to keep track of failed engine sensors. A host of other engine input and output options are included as well, and are outlined in other areas of this manual.

3 Installing the Hardware

3.1 Pre-Installation Checklist

To perform a complete **XDI200** installation, the following items are required:

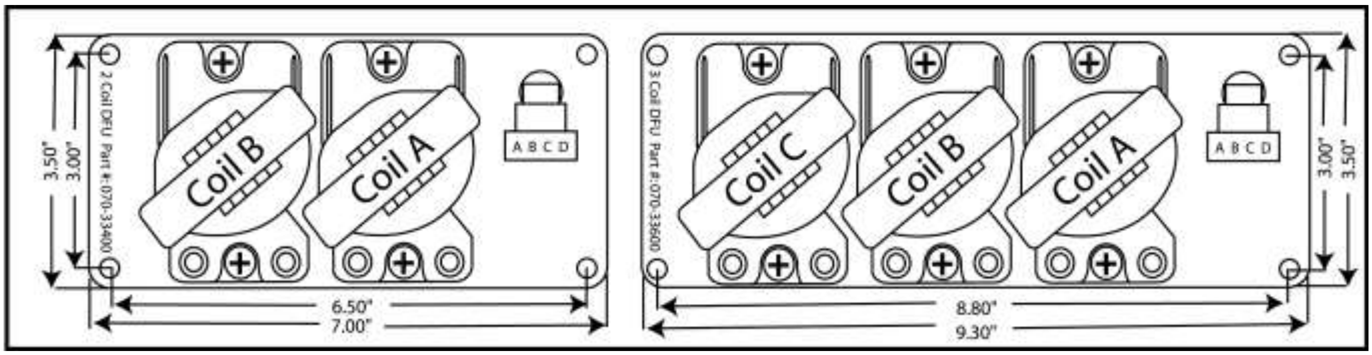
1. **XDI200** Computer
2. DFU(s) or Driver on Coil Ignition Coils.
3. Resistor Core Spark Plug Wires (see notes on Spark Plug Wires)
4. **XDI200** Wiring Harness w/ Power Harness
5. Windows-based PC-type Computer (see notes on Computer Requirements)
6. Serial Connector Cable (DB9) for PC or USB Cable
7. Crank Position Sensor (Magnetic Sensor)
8. 60 (-2) Tooth Crank Trigger Wheel or 120 (-4) Tooth Cam Trigger Wheel
9. Coolant Temperature Sensor (CLT) (OPTIONAL)
10. Manifold Air Temperature Sensor (MAT) (OPTIONAL)
11. Manifold Air Pressure Sensor (MAP) (OPTIONAL)
12. Throttle Position Sensor (TPS) (OPTIONAL)
13. Exhaust Gas Oxygen Sensor (EGO) (OPTIONAL)
14. Idle Air Control Motor (IAC) (OPTIONAL)
15. Knock Sensor (KNK) (OPTIONAL)
16. Wire Terminal Crimping Tool (available from Electromotive)
17. Shrink Tubing
18. Assorted Wire Crimp Terminals
19. Drill
20. ¼" Bolts for DFU(s) & **XDI200** ECU
21. Soldering Gun

3.2 Mounting the Main Computer and DFU

For utmost reliability, install the **XDI200** computer where temperatures will not exceed 150ºF (65ºC). The **XDI200** computer should be installed in the passenger compartment of the vehicle where it will not be exposed to the elements. A good location is in the kick panel of a vehicle originally equipped with a factory ECU. As a second choice, the **XDI200** may be mounted in an area that is partially exposed to the elements. It must not be mounted above or close to any exhaust or oil piping. A well vented area is recommended, particularly in engines utilizing most of the ignition channels and operating at sustained high speeds. It should be noted that the **XDI200** might get hot under prolonged high-rpm operation. As long as air is moving around the ECU, there is no risk of damage to the **XDI200**; just be careful not to burn yourself on the unit! Secure the **XDI200** ECU with four ¼" socket head cap screws. If the wiring harness goes through the firewall, a suitable grommet must be used to avoid chafing.

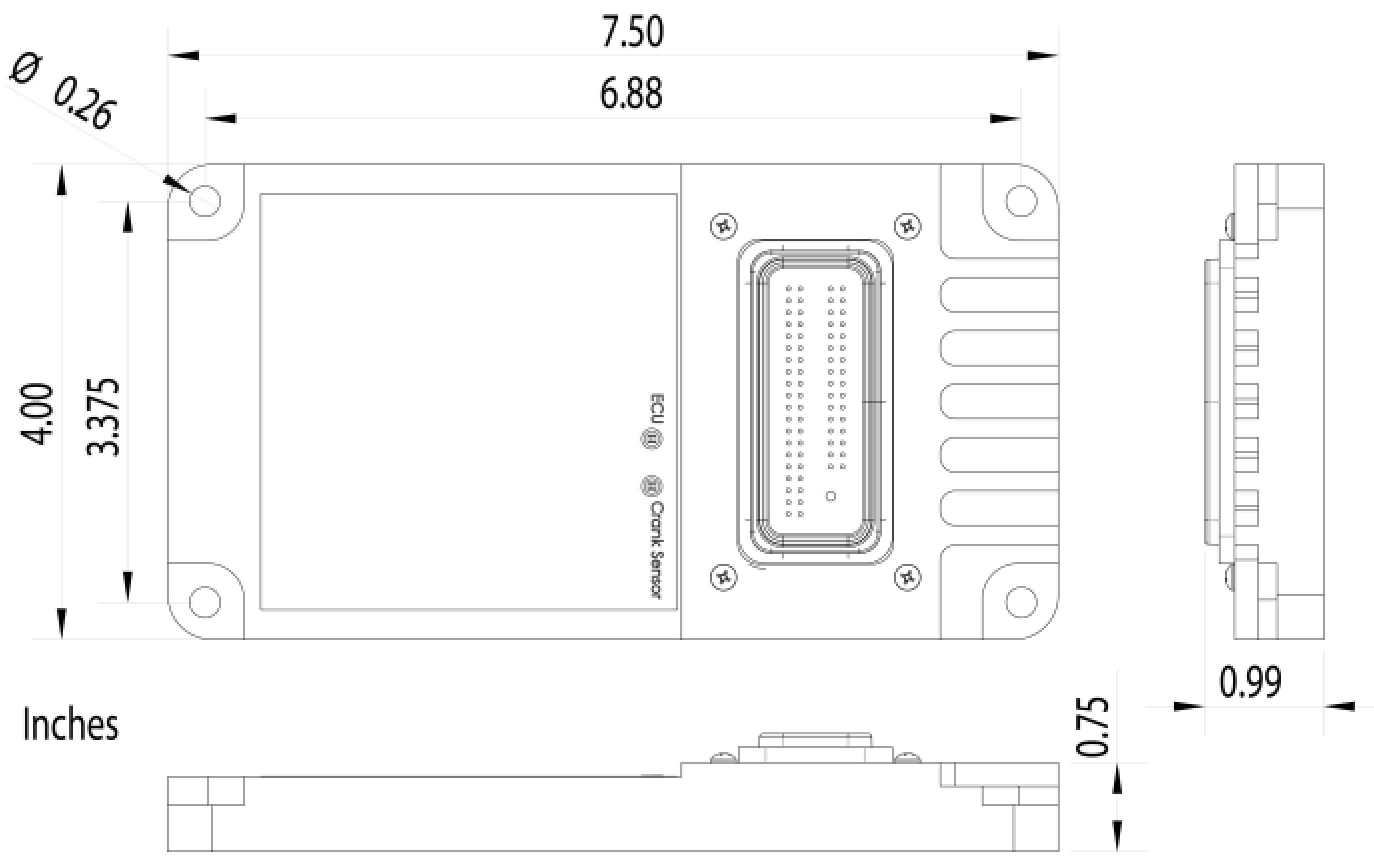
The DFU(s) can be placed nearly anywhere under the hood of the vehicle where the temperatures are below 250ºF (120ºC). Since they are entirely sealed, exposure to the elements is not an issue. The DFU Ground Wire MUST be installed to vehicle ground.

It is recommended that the ECU and DFU be separated by at least six inches for the purpose of reducing electrical noise in the ECU.



2-Coil DFU Dimensions **3-Coil DFU Dimensions**

Figure 1. Electromotive Direct Fire Units



Mounting bolt pattern is 3.375" x 6.88"

Figure 2. XDI200 ECU

3.3 Trigger Wheel and Sensor Installation

The foundation of the **XDI200** ultra-high resolution ignition is the 60(-2) tooth trigger wheel. The trigger wheel is designed to give uncompromising timing accuracy at the highest engine acceleration rates. As such, Electromotive does not support other triggering systems, particularly those of the “flying magnet” variety. These systems can lead to vastly inaccurate spark timing, and can contribute to engine damage. For most applications, the 60(-2) tooth trigger wheel is mounted on the crankshaft damper or pulley. Some applications may warrant the use of a camshaft- or distributor-mounted trigger wheel. With this setup, a 120(-4) tooth trigger wheel is necessary, since the camshaft turns at half the speed of the crank.

3.3.1 Crankshaft Trigger Installation for 60(-2) Tooth Wheel

For a crankshaft-mounted trigger wheel setup, an appropriate place must be found to mount the wheel and trigger. Typically, the easiest place to mount a trigger wheel is on the harmonic damper or pulley. If it is mounted on a damper, it should be mounted on the inner hub rather than the outer dampening ring. The damper/pulley should be keyed to the crankshaft so that it cannot spin on the crankshaft, as this would cause an ignition timing error. When using a damper that has bolt-on pulleys, the trigger wheel can usually be mounted between the pulleys and the damper. However, the accessory pulleys will need to be shimmed out by 1/8” (the thickness of the trigger wheel). A variety of application-specific trigger wheels are available. See **Appendix II** for a listing of applications. Universal trigger wheels are also available in a variety of sizes, and are listed in **Appendix II** as well. Electromotive can custom-make trigger wheels in nearly any configuration for a one-time tooling fee.

To choose the proper size trigger wheel, find the diameter of the pulley or damper on which the wheel is to be mounted. The trigger wheel diameter should be about ½” larger than this diameter. It should also be noted that the trigger wheel should be at least ¼” from any moving magnetic pieces, such as bolts or other fasteners, to avoid interference and false triggering. It is important that the trigger wheel be perfectly concentric with the crankshaft centerline. To achieve concentricity, a shallow cut can be machined in the front or rear face of the damper to create a centering ledge, and a hole can be created in the trigger wheel to match the ledge diameter. The trigger wheel can then be drilled to bolt it to the damper.

See **Table 1** below to determine the tolerances that must be maintained when mounting the trigger wheel. These tolerances may require the use of a lathe to true the trigger wheel with the crankshaft centerline, which can be accomplished by putting the entire damper/trigger wheel assembly on the lathe. Note that the maximum out-of-round is the distance between the lowest and highest teeth and the crank sensor. That is, if a feeler gauge is used between the sensor and the wheel to measure the out-of-round, the reading between the lowest and highest teeth should not exceed the guidelines in the table.

3.3.2 Hall Effect or Magnetic Crank Sensors

The XDI200 can accept either a magnetic sensor or a Hall Effect sensor. Magnetic sensors can be used for all wheel diameters however, it is recommended to use a magnetic sensors when the Trigger wheel is less than 4 inches in diameter . Hall Effect sensors should not be used for trigger wheels less than 4 inches. Hall effect sensors are preferred because they have better noise rejection. However Hall Effect sensors require adding a +12V power lead to it. Electromotive can supply both Magnetic and Hall Effect sensors.

Table 1: Crank Trigger Specifications

Trigger Wheel Size	Air Gap	Maximum Out-of-Round
2.5"	0.025" max	0.002"
3.5"	0.035" max	0.003"
5"	0.050" max	0.005"
6"	0.060" max	0.006"
7.25"	0.070" max	0.007"
8.25"	0.080" max	0.008"

3.3.3 Crank Sensor Installation

When installing the crank sensor, an appropriate bracket must be made to aim the sensor at the trigger wheel. A good starting point for a magnetic sensor bracket is Electromotive part number 210-72003, which is our universal sensor bracket (**See Figure 3**). If this part is not used as a starting point, a custom bracket can easily be made. **The most important things to remember when fabricating a bracket are that it should be bolted directly to the engine block, away from rotating steel or magnetic pieces, and should be nonferrous (not attracted to magnets).** This will keep the sensor and trigger wheel vibrating together so the gap between the two always stays the same. Variations in sensor gap may cause erratic timing or false triggering of the ignition. (This is the reason for not mounting the trigger wheel to the outer ring of a harmonic damper.) As such, any custom magnetic sensor bracket should be very rigid. The sensor can be secured with either a set screw or a clamping arrangement, as long as the 1/2" sensor is utilized (part number 250-72218). If the smaller 3/8" sensor is used, a clamping arrangement should be employed rather than a setscrew, as the setscrews may crush the sensor. Hall effects sensors are only available in ½" diameter. See **Table 2** for the appropriate magnetic sensor/trigger wheel combinations.

Figure 3. Universal Crank Sensor Bracket

Once a sensor and trigger wheel are installed, they must be aligned such that the **XDI200** computer knows where to locate Top Dead Center of the #1 cylinder (referred to as TDC #1). **Correct alignment necessitates that the center of the sensor must be aligned with the trailing edge of the 11th tooth after the two missing teeth when the engine is at TDC #1 (see the drawing at the end of this section).** Aligning the magnetic sensor with anything other than the 11th tooth will cause an ignition timing retard or advance, depending on the direction of the misalignment. Each tooth represents six degrees, so if the sensor is aligned with the trailing edge of the 12th tooth, the timing will be advanced by six degrees. Conversely, if the sensor is aligned with the trailing edge of the 10th tooth, the timing will be retarded by six degrees. In the event that the sensor is not aligned correctly, the WinTec software can be made to compensate by manipulating the Tooth Offset Parameter, as outlined in **the tuning section** of this manual.

IMPORTANT NOTE :

Make sure that the Mag. Sensor harness is NOT routed near battery cables or other high current leads or devices such as cooling fans, starter or alternator. Locating close to coil wires or other power leads should be avoided.

Table 2: Magnetic crank sensor selection. Note: use a clamping arrangement for securing 3/8" sensors, rather than a setscrew. The ½" sensors can be secured with any clamping method.

	3/8" Diameter Chisel Point Sensor PN: 250-72212	1/2" Diameter Flat Tip Sensor PN: 255-72218	½" Diameter Flat Tip Hall Effect Sensor
All 120 (-4) Tooth	X		
2-3/8" & 2-1/2" 60 (-2) Tooth	X		
3-1/2" 60 (-2) Tooth (below 6000rpm)	X	X	
3-1/2" 60 (-2) Tooth (Above 6000rpm)	X	X	
Greater than 3-1/2" 60 (-2) Tooth wheels	X	X	X
1 tooth Cam Wheel			X

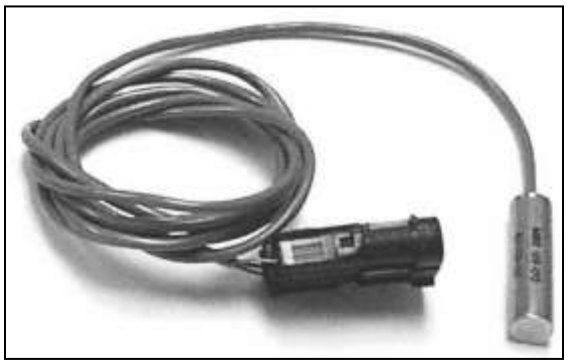


Figure 4. Electromotive ½" (12.7mm) crank sensor

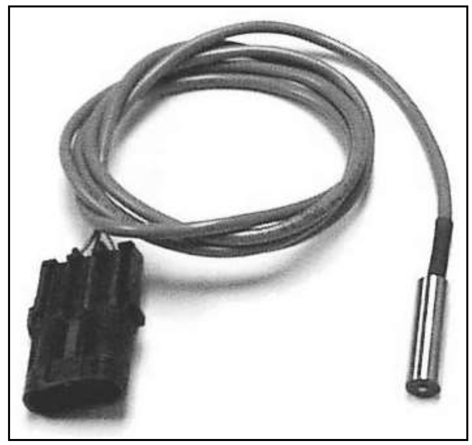


Figure 5. Electromotive 3/8" (9.53mm)

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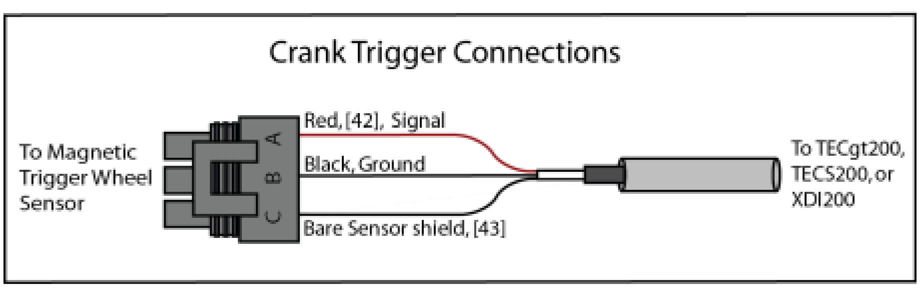
3.3.4 Wiring a Magnetic Trigger Sensor

The magnetic sensor has three wires. The red wire is the signal from the sensor, the black wire is the signal ground, and the bare wire is the shield. The harness has provisions for both a crank and a cam sensor. **The crank sensor cable must be used for *all* 60 (-2) or 120 (-4) tooth trigger wheel inputs.** It is not recommended to use a magnetic sensor on the cam trigger wheel.



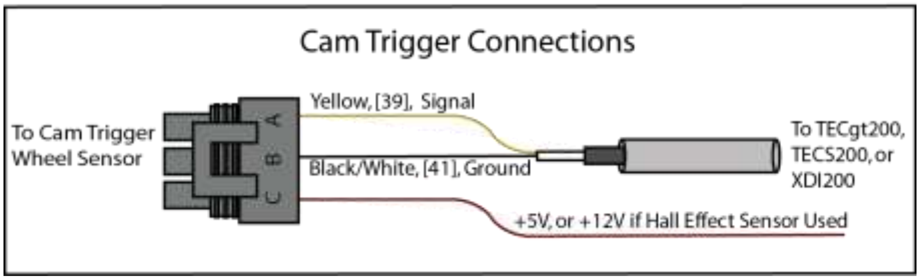
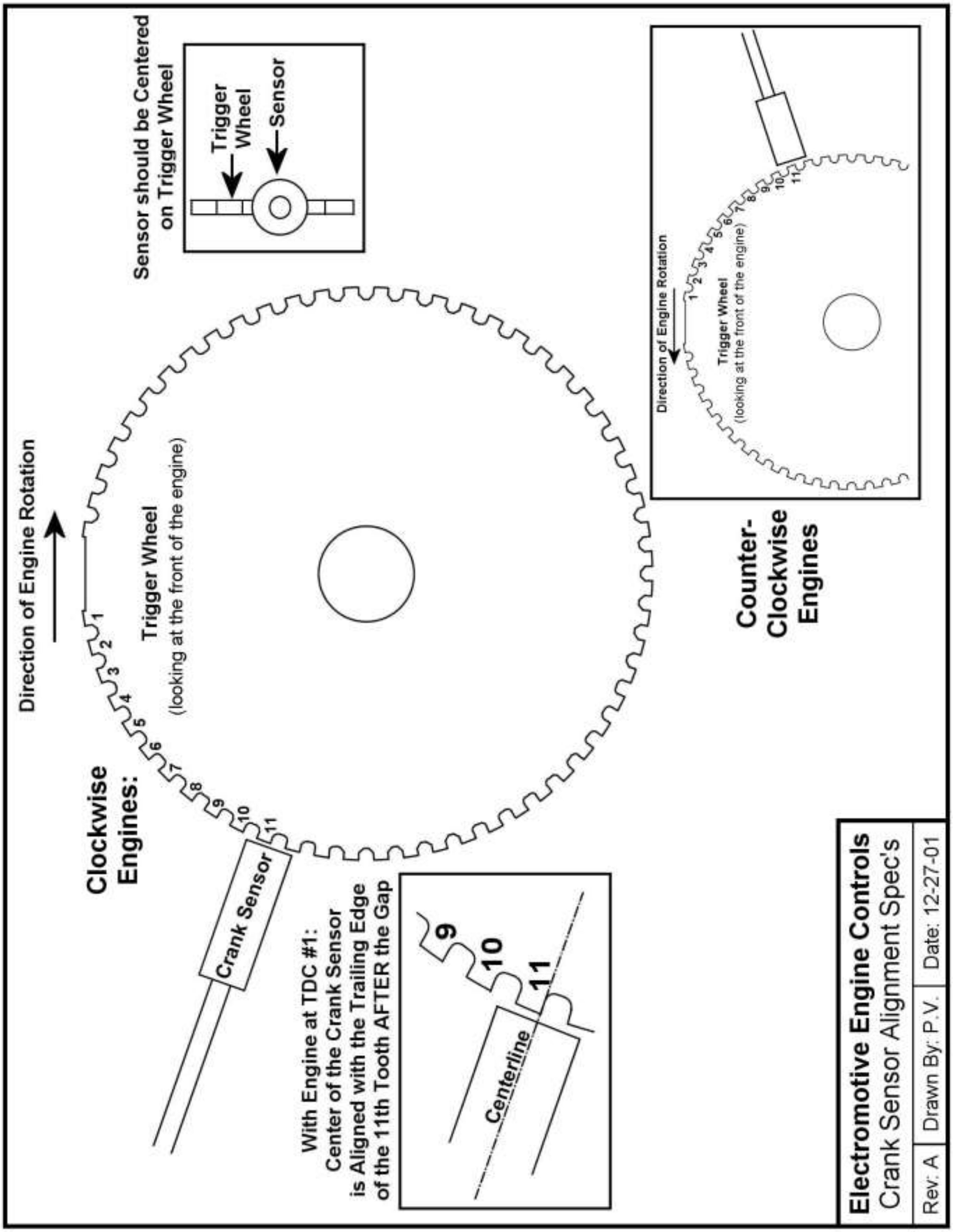


Figure 6: Wiring layout for crank and cam sensors. Note that the Cam Sensor is only used when full cylinder to cylinder timing trim is needed. The wiring is the same if a Hall Effect sensor is used on the crankshaft wheel.

3.3.5 Verifying Trigger Wheel Timing

The most important step in the trigger wheel installation process is to check the ignition advance with a timing light. A timing indicator (pointer) should be attached to the engine block, and it should point at a line on the crankshaft pulley or trigger wheel when the engine is at TDC #1. When running the engine, verify that the timing value read by the timing light corresponds to the timing value in the software's engine monitor screen.

Use of a good-quality inductive timing light is recommended. DO NOT use a timing light that goes between the spark plug and spark plug wire with a clamp probe. Dial-Back inductive timing lights can be used, but will need to be dialed to DOUBLE the actual desired timing value due to the waste-spark firing of the DFU coils. They are fooled into thinking that the timing is twice as advanced as it actually is.


Direction of Engine Rotation
Clockwise Engines:
Trigger Wheel
(looking at the front of the engine)
1
2
3
4
5
6
7
8
9
10
11
Crank Sensor
With Engine at TDC #1:
Center of the Crank Sensor
is Aligned with the Trailing Edge
of the 11th Tooth AFTER the Gap
9
10
11
Centerline
Sensor should be Centered
on Trigger Wheel
Trigger
Wheel
Sensor
Counter-
Clockwise
Engines
Direction of Engine Rotation
Trigger Wheel
(looking at the front of the engine)
Electromotive Engine Controls
Crank Sensor Alignment Spec's
Rev: A
Drawn By: P.V.
Date: 12-27-01

3.3.6 Camshaft- & Distributor-Mounted Trigger Setups

While crankshaft mounted triggers are preferred, it is sometimes easier to install a camshaft- or distributor-mounted trigger wheel. For these cases in which the trigger wheel is spinning at **half the engine speed**, a 120(-4) tooth trigger wheel is necessary. This wheel has two sets of two missing teeth, spaced 180 degrees apart. As such, the input to the **XDI200** is identical to that of the crank-mounted 60(-2) tooth trigger wheel. Electromotive offers 120 (-4) tooth wheels in 3.25" and 2.75" diameters.

It is often easy to use an old distributor rotor to serve as the mount for a 120(-4) tooth trigger wheel. A simple nonferrous bracket would need to be fabricated to hold the sensor. The 3/8" chisel point sensor (PN: 250-72219) must be used on 120(-4) trigger wheels. As such, the bracket for the sensor should use a clamping arrangement rather than a setscrew to hold the magnetic sensor. **Just like the crank-mounted trigger, the distributor/cam-mounted triggers require the sensor to be aligned with the trailing edge of the 11th tooth after the two missing teeth when the engine is at TDC #1.** The same tolerances that apply to the crankshaft-mounted trigger wheels (**Table 1**) apply to the camshaft-mounted trigger wheels as well.

A Note on Engines with High-Overlap Camshafts:

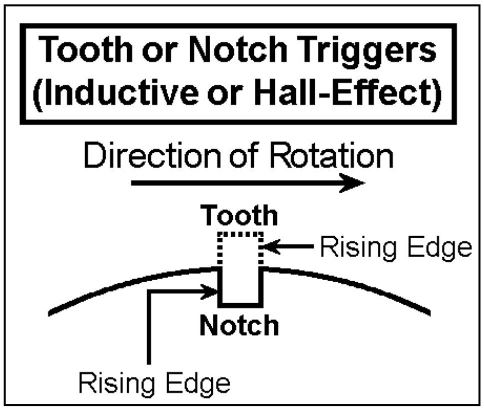
If your engine is equipped with a camshaft that has early intake valve openings or very long duration, you may experience backfiring through the throttle during starting. This is caused by the intake valves beginning to open on the exhaust stroke. Since the spark plugs fire on both the compression and the exhaust strokes, the spark on the exhaust stroke may cause unburned fuel in the intake manifold to ignite, resulting in a backfire.

To remedy this situation, advance the "mechanical" timing by manipulating the **DFU "A" Trigger Wheel TDC** Parameter. If your crank sensor is aligned with the 11th tooth of the trigger wheel at TDC #1, setting the Tooth Offset to a number LOWER than 11 will **add** mechanical advance. If the number "10" was set for the Tooth Offset, the mechanical timing would be ADVANCED by 6 degrees (6 degrees per tooth). This would require that you subtract 6 degrees from the values in your ignition advance table in WinTec to obtain your desired advance value. That is, the timing table will have to read 30 degrees in order for the engine to operate at 36 degrees advance. See **the Tuning Guide Section** for more details.

3.3.7 Individual Cylinder trim application – <u>Cam Synchronization</u>

When individual cylinder advance angle trimming is desired, a once-per-engine-cycle synchronization, or "sync," pulse must be received by the ECU. Typically, the sync pulse is generated by the installation of a 1-notch (or 1-tooth) trigger wheel onto the camshaft. A Hall effect sensor is used as a triggering method. With this method, the tooth must pass by the magnetic sensor between 180º and 6º before TDC Compression (<u>not</u> exhaust) of the number one cylinder. See **Figure 11** for installation details.

The XDI200 will only trigger off a <u>rising voltage</u> during the synchronization period (between 180º and 6º BTDC compression). A rising edge occurs when the metal on the cam trigger wheel becomes closer to the sensor. See **Figures 8 and 9** for representative examples and different cam trigger wheel designs, and their rising edge location.



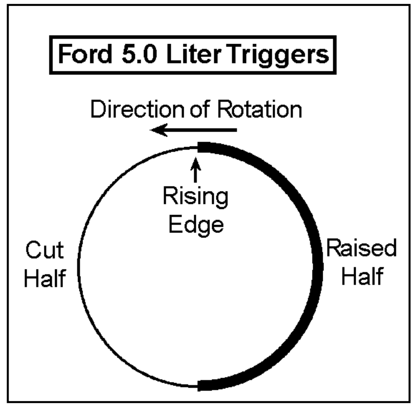


Figure 8. Tooth/Notch Triggers

Figure 9. Ford "Half-Moon" Trigger

Due to high noise sensitivity of magnetic sensors, it is required to use a Hall Effect sensor are with the **XDI200's** sync pulse requirement. This would include most Hall effect, flying magnet sensors. As long as the sensor outputs a rising voltage to the **XDI200** between 180º and 6º before TDC compression for the number one cylinder, it should work perfectly.

Terminal 39 on the ECU is used for cam sync inputs (as shown in **Figure 6**). If using a Hall effect or other sensor type that is powered by +5Volts, be sure that the output signal from the sensor is going into terminal 39. Keep in mind that when adapting an OEM cam trigger setup to a **XDI200**, the wheel may need to be rotated to place the rising edge in the appropriate degree window for the **XDI200**.

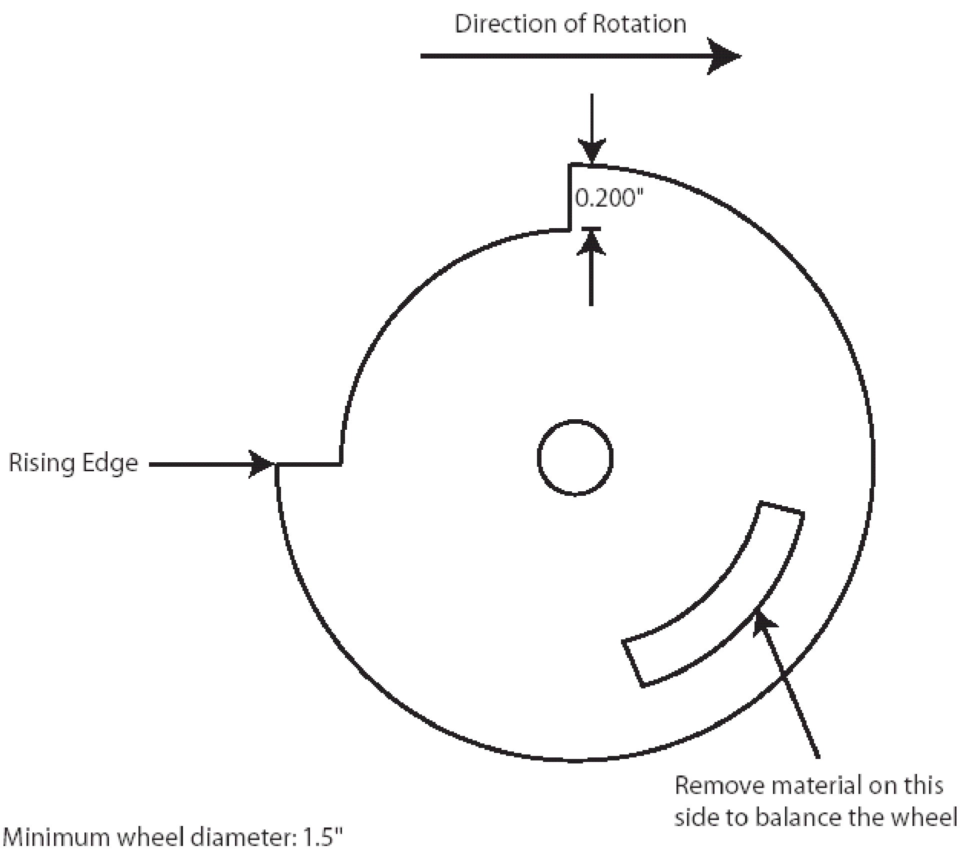


Figure 11: Proper cam trigger installation. This cam trigger occurs approx. 90º BTDC Compression on the #1 cylinder (as measured at the crank). Note the 87 degree (as measured on the cam wheel) "window" in which the rising edge must occur.

3.3.8 TDC Tooth Setup Software Adjustment Parameters

So, you took a lot of time to install your trigger wheel, and now you realize that you didn't get the trailing edge of the 11th tooth to align with the center of the magnetic sensor with the engine at TDC #1. What to do?

The WinTec4 software features a TDC setup parameter that allows users to manipulate the TDC point for the trigger wheel. There are two adjustable parameters:

Change DFU "A" Trigger Wheel TDC
Change DFU "B" Trigger Wheel TDC

For all but the odd-fire applications, the adjustment is only present for the DFU "A" TDC. The default setting for DFU "A" TDC is 11, signifying TDC alignments with the 11th tooth. If you are aligned with the 13th tooth at TDC, change this number to 13. Several late-model Bosch-equipped applications use our 60 (-2) tooth trigger wheel, but come from the factory with a different TDC tooth alignment. Typically, these setups are referenced to the 14th tooth for TDC, but you MUST confirm this on your application, since Bosch used a few different offsets through the years.

Odd-Fire applications have the ability to move the TDC reference for the second DFU (using the parameter "DFU "B" Trigger Wheel TDC"). This allows the user to define the odd-fire ignition split that is present on the engine. Refer to the Tuning Guide Section to determine the proper settings for this value.

Some applications may require more "mechanical timing" to compensate for large, high-overlap cams. Assuming the crank sensor is aligned with the 11th tooth at TDC, this can be done by entering a value for the "Change DFU "A" Trigger Wheel TDC" that is LESS than 11. Each tooth less than 11 represents 6 degrees of advance that is added to the Ignition Advance Table.

Some applications may require less "mechanical timing" (some rotary users may wish to do this). Assuming the crank sensor is aligned with the 11th tooth at TDC, this can be done by entering a value for the "Change DFU "A" Trigger Wheel TDC" that is MORE than 11. Each tooth more that 11 represents 6 degrees of retard that is subtracted from the Ignition Advance Table.

If an odd-fire engine has the trigger wheel installed incorrectly, and the DFU "A" TDC parameter is changed to compensate for the error, the "DFU "B" Trigger Wheel TDC" parameter needs to be manipulated in the same amount. As an example, if the TDC for DFU "A" is at 11 and is moved to 10, the TDC for DFU "B" would need to be moved from 16 to 15.

The following pages outline the various situations that can be addressed through the TDC software parameters.

Situation A
Problem:
Incorrect trigger wheel alignment results in undesired mechanical timing.
Solution:
With the engine at TDC #1, find the trigger wheel tooth that is aligned with the crank sensor. Enter the number of this tooth into the TDC Tooth Alignment Parameter. The timing will be shifted to make the Ignition Advance Table accurate.
Method:
The software will automatically RETARD the timing when a number GREATER THAN 11 is entered into the TDC Tooth Alignment Parameter. The timing will be automatically ADVANCED when a number LESS THAN 11 is entered.

Situation B
Problem:
The engine needs less mechanical advance, and the crank sensor is aligned with the 11^{th} tooth.
Solution:
Enter in the number "12" to the TDC Tooth Alignment Parameter. The timing values will be automatically RETARDED by 6 degrees. The Ignition Advance Table values will now be incorrect (the displayed values will be 6 degrees higher than the actual advance).

Situation C
Problem:
The engine needs more mechanical advance, and the crank sensor is aligned with the 12^{th} tooth instead of the 11^{th}.
Solution:
Enter in the number "11" to the TDC Tooth Alignment Parameter. The timing values will be automatically ADVANCED by 6 degrees. The Ignition Advance Table values will now be incorrect (the displayed values will be 6 degrees lower than the actual advance).
Note:
In the past, aligning the sensor with the 12^{th} tooth would advance the mechanical timing by 6 degrees.

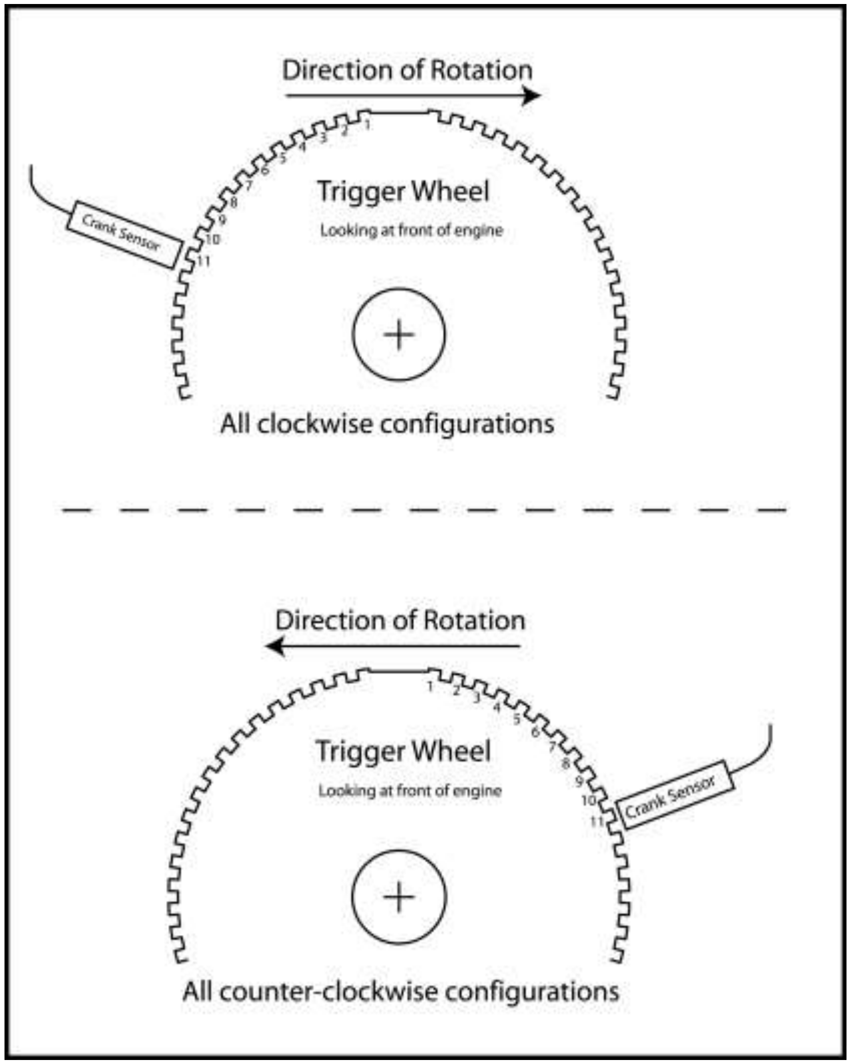


Figure 13 - TDC tooth for two possible scenarios.

In a normal scenario, not considering software manipulation, aligning the magnetic sensor with anything other than the 11th tooth will cause an ignition timing retard or advance, depending on the direction of the misalignment. Each tooth represents six degrees, so if the sensor is aligned with the trailing edge of the 12th tooth, the timing will be advanced by six degrees. Conversely, if the sensor is aligned with the trailing edge of the 10th tooth, the timing will be retarded by six degrees. If some ignition advance is required for easier starting (high compression/radical cam timing engines, for example), aligning the sensor with the 12th or 13th tooth will yield 6° or 12° (respectively) of advance during cranking. Also check that the sensor is centered over the edge of the wheel.

4 Wiring the System

4.1 Introduction

The task of installing a **XDI200** wiring harness may seem a bit intimidating at first. However, by dividing the wiring installation into a few small jobs, it can be accomplished by most installers in a reasonable amount of time.

WARNING: Always disconnect the battery when doing ANY electrical work on a vehicle. Use common sense when working around electrical systems, particularly the **XDI200** DFU coils. The voltage output of the coils can be well over 40,000 Volts at a given instant.

4.1.1 Suggestions on Crimp Terminals…

When crimping terminals to the sensor wires, care must be taken to ensure that a proper crimp is made. Improper crimps can lead to terminal failure and wire fatigue. To crimp properly, we recommend using a high-quality ratcheting crimp tool (such a tool is available from Electromotive). In the absence of a good crimp tool, the terminals can be soldered. Care should be taken to make absolutely certain that the solder penetrates the terminal and gets to the wire.

There are two main crimp styles used with the **XDI200** sensors: Metri-Pack and Weather-Pack. Metri-Pack terminals have two crimp areas. One area crimps to the bare (stripped) wire and provides the electrical connection, and the other area crimps to the un-stripped wire housing to provide a strain relief. Metri-Pack connectors are pull-to-seat.

Weather-Pack terminals also have two crimp areas, but instead of one area acting as a strain relief, it is used to hold the connector seal in place. Therefore, when crimping a Weather-Pack terminal, always insert the cable seal before crimping. Weather-pack connectors are push-to-seat.

Note : Soldered terminals will not tolerate much flexing. They may break if too much movement is allowed.

The main XDI200 connector is a Molex 123 type connector.
Please go to this internet link and down load this document:

http://www.molex.com/pdm_docs/as/AS-34566-001.pdf

It has important information on handling the XDI200's new Molex connector.

4.2 Wiring ECU & Main Power

The two red/white (red with white tracer) wires on pins 33 and 53 are the switched ignition power. For redundancy, both red/white wires must be connected to the same switched +12V circuit. The ground wire is 12awg and on pin 73. The reason for the larger/thicker size of the ground wire is that the ECU is mainly in charge of switching the GROUNDS, not the +12 Volt power. As an example, coil outputs are all pull-to-grounds. The XDI200 does not use constant +12 Volt power.

Both red/white 18awg wires, [33] and [53], must be connected to the ignition switch. The black 12awg wire, [73] of the connector is connected to full time battery negative. See **Figure 15** for a wiring diagram.

If you are using the **XDI200** Power Harness, refer to the next section on installing the Switched +12 Volt Input into the Power Harness.

4.2.1 Power Harness Installation

Electromotive's Power Harness (PN 070-40000) for the **XDI200** is capable of supplying the +12Volt high-amperage power required to run the DFU's, EGO sensor heater and fuel pump. Included in the harness is a fuse block with four fuses (ignition, DFU's, and Fuel Pump are fused) and two relays to switch the power. Our custom harnesses are all built with the power harness pre-installed, so wiring them is even more straightforward. **Figure 15** gives an example of a typical Power Harness installation.

There are three breakouts in the Power Harness:

- **ECU Connections**
- **Power Inputs**
- **Power Outputs (w/ switched voltage input)**

ECU Connections

The **XDI200** Connections are color-matched to the **XDI200** harness.

- Light Green 20awg Wire: Connects to [57] (Fuel Pump Relay Ground)
- Yellow (from power harness) 20awg Wire: Connects to Switched +12v input

Power Inputs

The Power Inputs are color coded in standard fashion:

- Two Red/White 18ga Wire in parallel, pin [33] and [53]: connect to (Switched +12V input)
- Black 12awg Wire, pin [73]: Connect to Vehicle Battery - minus

Power Outputs (w/ switched voltage input)

The power outputs provide power for the DFU's, EGO sensor heater, and Fuel Pump. The switched voltage input is used to turn on the **XDI200** ECU, and should be wired to a +12Volt source that is activated with the ignition key.

Purple/White Stripe 16awg: Used for fuel pump if needed
Red/White Stripe: DFU Power (pin "D" on DFU's)
Green 16awg: Fuel Pump Positive and EGO Sensor Heater Positive
Yellow 18awg: Switched +12 Volt Input (for **XDI200** turn-on request)

The Wiring Diagrams in the DFU wiring section of this manual show the terminals on which the power should be brought in. Any reference to fusing the power source in these sections is unnecessary when using the Power Harness, since the connections are already fused.

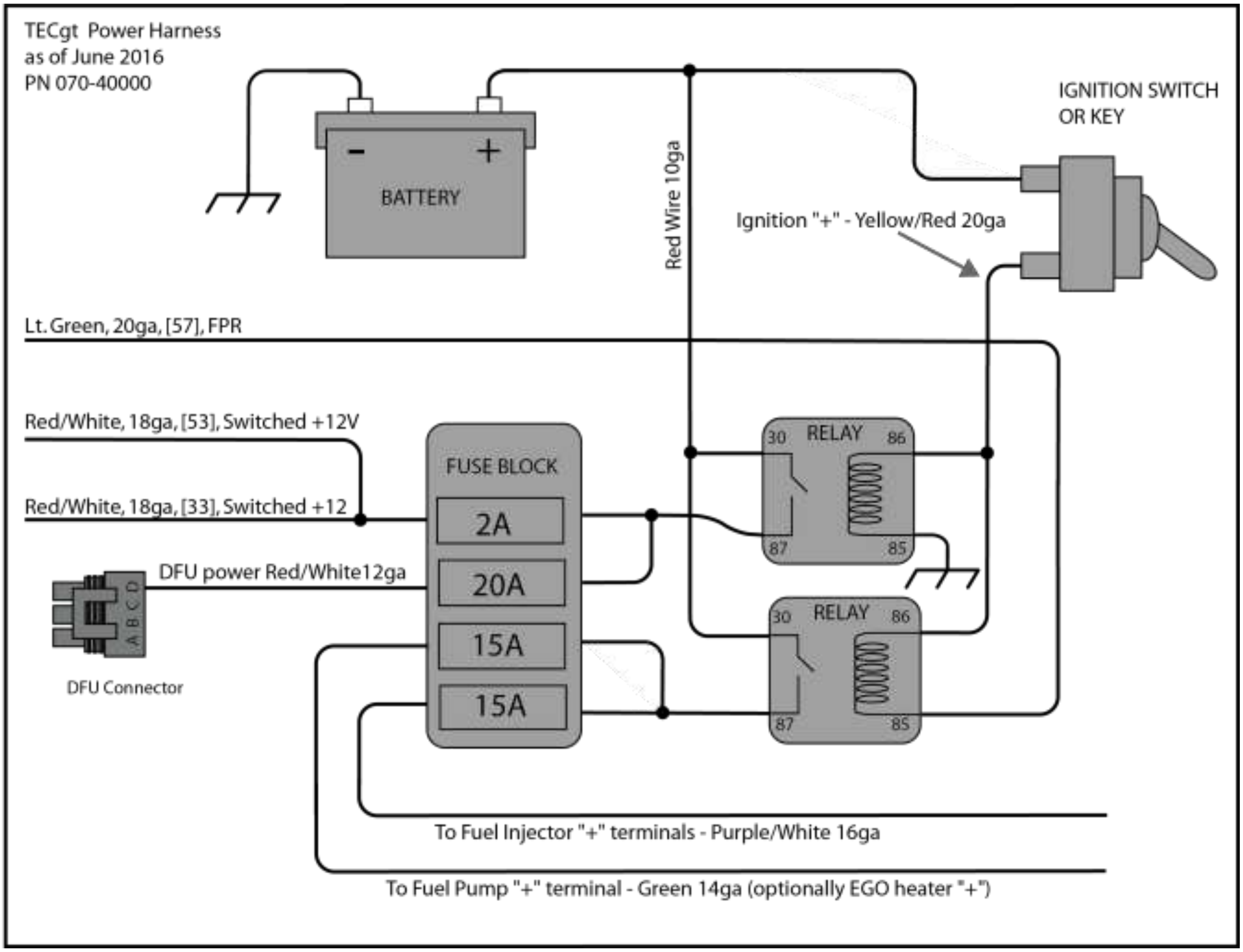


Figure 15. XDI200 Power Harness (PN: 070-40000).

4.3 Wiring Ignition Coil Primary Sides

4.3.1 Introduction

The XDI200 has the ability to operate either the older style standard ignition coils or more recent Driver on Coil (DOC) coils. If DOC coils are selected, the customer must set a fixed dwell time in the calibration. Failure to select DOC and set a dwell time will cause damage to the DOC coils. Use the section directly below to wire Electromotive's standard DFU's. Jump to the next section for instructions on wiring DOC logic driven coils.

4.3.2 Standard Direct Fire Units, DFU's

DFU's are made by Electromotive in two variants: 2-coil and 3-coil. Each coil drives two spark plugs in waste-spark ignition setups. Eight cylinder engines will use two 2-coil DFU's. 2-rotor engines will use 4 single tower coil units. Two cycle applications will use single tower coils as well.

The DFU's are driven by a 12-volt charging system housed in the **XDI200** ECU. For the Electromotive DFU wiring requirements, refer to **Figures 25** below.

4.3.3 Wiring Standard DFU's Coils

The DFU connectors use pull-to-seat terminals. DO NOT crimp the terminals onto the wires until you have fed the wires through the connector!

Before wiring the DFU's, you must select the right configuration below. Each standard Electromotive DFU has a 4 pin connector on it.

- **2-Coil DFU's (Part Number 070-33400)**

The 2-coil DFU's utilize three of the four terminals in their yellow connector. Here is the pin out:

Terminal A	Ground Pulse for Coil A
Terminal B	Ground Pulse for Coil B
Terminal C	Unused
Terminal D	Full-Time +12 Volt Source (9 amps)

On a standard inline 4-cylinder four-stroke application, this DFU will be used. On 8 cylinder or dual-plug 4-cylinders, two of these DFU's will be used.

- **3-Coil DFU's (Part Number 070-33600)**

The 3-coil DFU's utilize all four of the terminals in the yellow connector. Here is the pin out:

Terminal A	Ground Pulse for Coil A
Terminal B	Ground Pulse for Coil B
Terminal C	Ground Pulse for Coil C
Terminal D	Full-Time 12 Volt Source (9 amps)

On a standard 6-cylinder even-fire application, this DFU will be used.

- The **XDI200** harness has two cables for the DFUs. Both cables have three 16awg wires with a shield.
- 6 or 4 cylinder engines with single spark plugs use only the first cable, 8, 12 and Dual plug engines use both cables

- **4- Coil DFU's (Part Number 070-33400)**

The 4-coil DFU is actually two 2-coil DFU's. When this part number is specified, two 070-33400 DFU's will be used. The first DFU should be wired in the same manner as part number 070-33400.

The first step in wiring the DFU's is to install the ground wire. The DFU's come from our factory with a ground wire pre-installed on a tapped, un-anodized hole. This wire MUST be connected to chassis/battery ground. **FAILURE TO DO SO MAY RESULT IN SEVERE ELECTRICAL SHOCK TO THE USER!!** Electrical shock will occur if the DFU is not grounded, and someone touches it while touching chassis ground (with the engine running). If desired, the ground wire may be relocated elsewhere on the DFU chassis. However, you will need to scrape off the anodization from the chassis at the point of contact, since the anodizing acts as an electrical insulator. Also, loose coil screws may cause an electrical shock as well, since they must be grounded to the case at all times. **Always make sure that both the coil screws and the ground wire are securely fastened.**

After the DFU has been grounded, the rest of the wiring may begin. The DFU's come shipped with the appropriate connectors. Terminal D on all DFU's should be connected to a **FUSED 12 VOLT SOURCE** that can pull **9 AMPS** of current. In the wiring harness, the outputs for Coils A, B, and C are routed in the same shielded-cable housing. On an 8 cylinder, the outputs for DFU 2 (A2, B2) are routed in a separate shielded-cable housing. These are all 9amp pull-to-ground outputs; that is, they create a ground path every time a coil charges. When the coils fire, the outputs "float," with no connection to ground or power. If the wires need to be spliced or lengthened, 16awg wire should be used. See **Figure 25** for details on the coil outputs in the wiring harness. The XDI200 has both standard DFU coil outputs and logic outputs. When using the Standard DFU outputs showed below, remove or tape off the DOC wires [5,6,7 and 10,11,12].

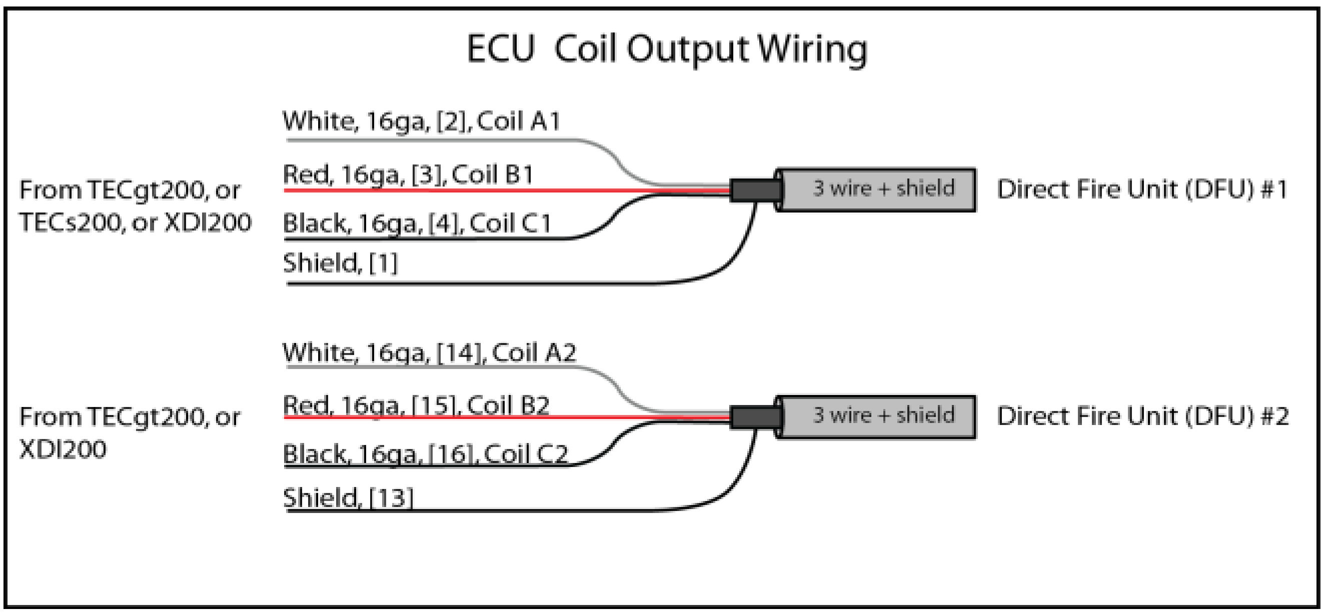


Figure 25: ECU Coil Output Wires (note: shield wire is connected inside the **XDI200** unit, not connected at the coils).

WARNING:

The DFU chassis **MUST** be grounded. A ground wire must be connected to battery negative, or to a good chassis ground. **FAILURE TO GROUND THE DFU'S MAY RESULT IN SEVERE ELECTRICAL SHOCK!** Also, poorly grounded DFU's may result in poor engine performance, and can cause engine damage!! Use the drilled and tapped hole next to the yellow connector for the ground wire. If desired, the unit may instead be grounded at one of the four bolt holes. However, **you will need to scrape off the anodizing under the bolt head**. The anodizing is an electrical insulator, so unless it is scraped down to bare aluminum, it will not provide a good connection to ground. If more than one DFU is used on a vehicle, each one will require its own ground wire.

Additionally, make sure that the **coil screws** are fully tightened at all times!!

4.3.4 Spark Plug Wiring High Voltage Side

The coils fire in a specific order for each engine configuration. The proper coil must be connected to the correct cylinder in the firing order.

Coil Notation

The following notation is used when referring to coils. A letter and a number are combined to identify a coil. The letter refers to the coil location on the DFU. The coil located closest to the connector is Coil A. The coil next to it is Coil B. If the DFU contains three coils, the last coil is Coil C. The number identifies the DFU that the coils are on. In an engine configuration using only one DFU, the number following the letter is 1. Coil notation is shown in Figure 26.

Note: Each coil has two towers for spark plug wires. The towers are identical and should be thought of as the same coil. For example, if the engine setup guide refers to cylinder 1 connected to Coil A1 and cylinder 6 connected to Coil A1, you can connect your spark plug wires for the respective cylinders to EITHER tower.

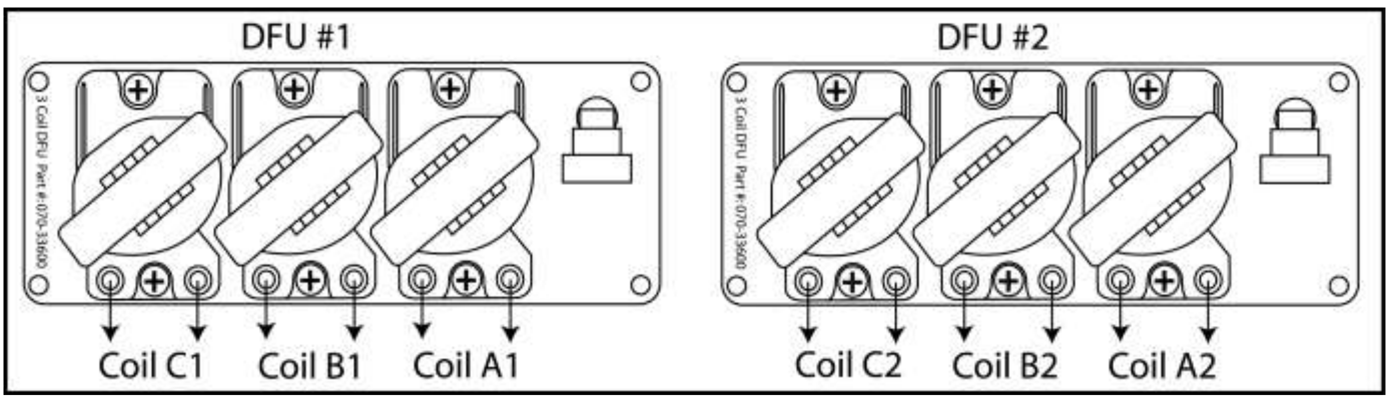


Figure 26 : Coil notation

Figure 26 shows a configuration using two 3-coil DFU's. If you are using 2-coil DFU's the numbering is the same except there is not C1 and C2. If your application requires only one DFU, then A2, B2, and C2 will not be needed.

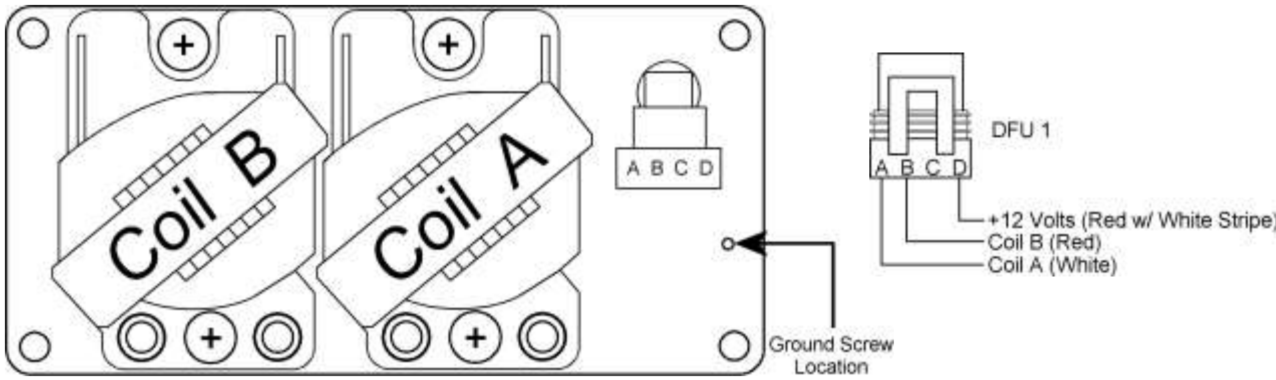
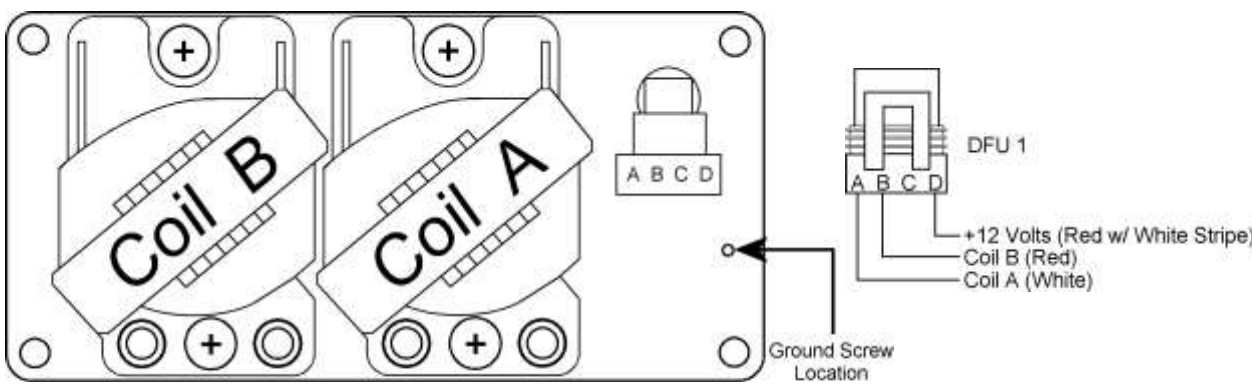
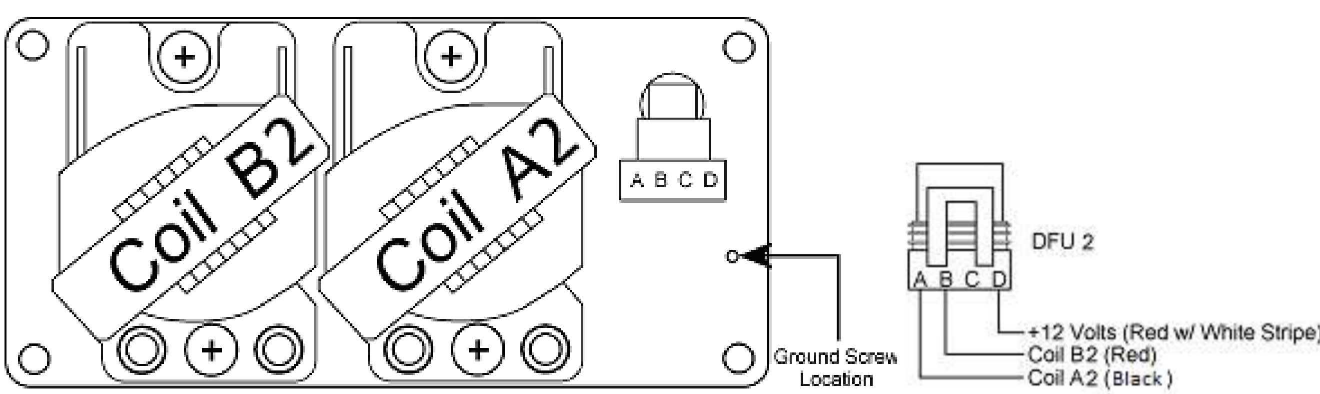


Figure 27. 4-Cyl DFU Setup



1st DFU



2nd DFU

Figure 28: 8-Cyl and 4-cyl Dual Plug DFU Setup. **Note that the 2nd DFU coils will not be labeled C and D from Electromotive**. When the 2nd DFU is wired as shown, the coil labeled "A" will fire coil output "A2." The coil labeled "B" will fire coil output "B2."

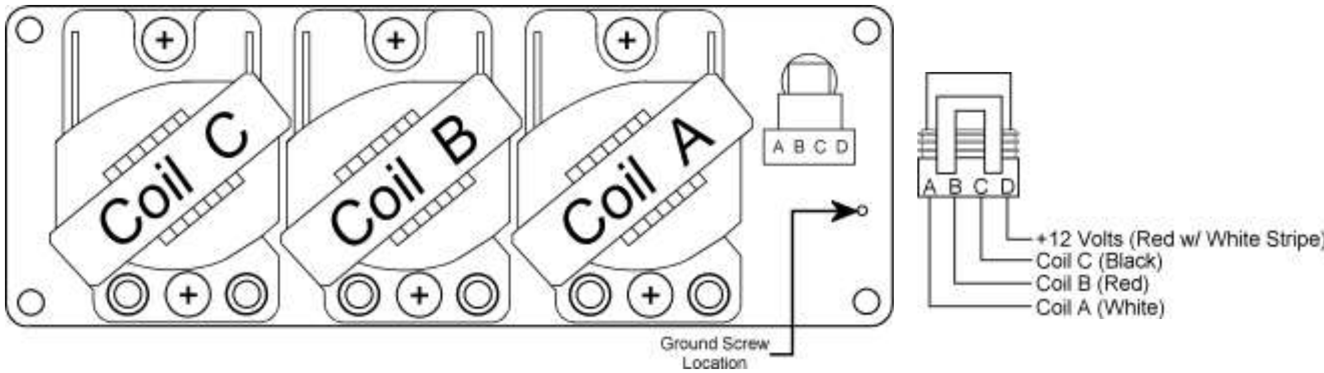
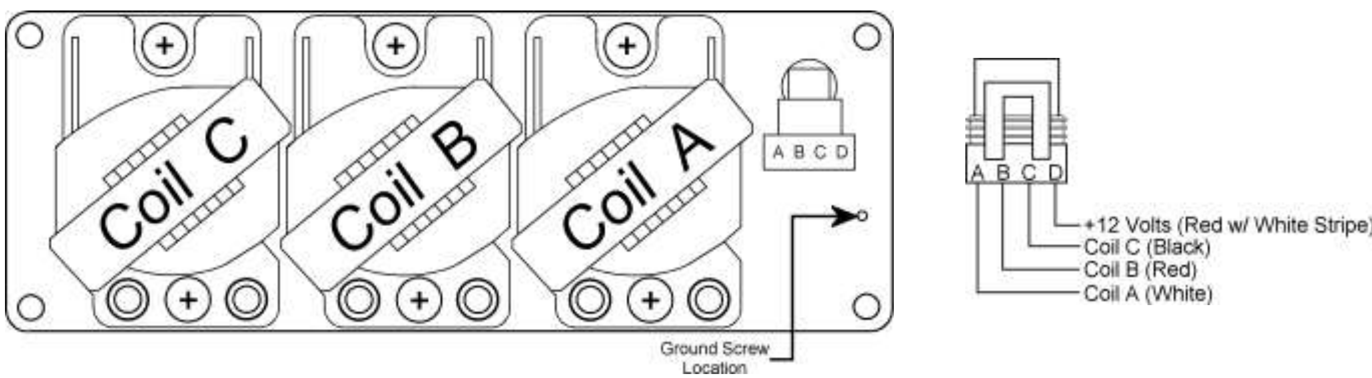
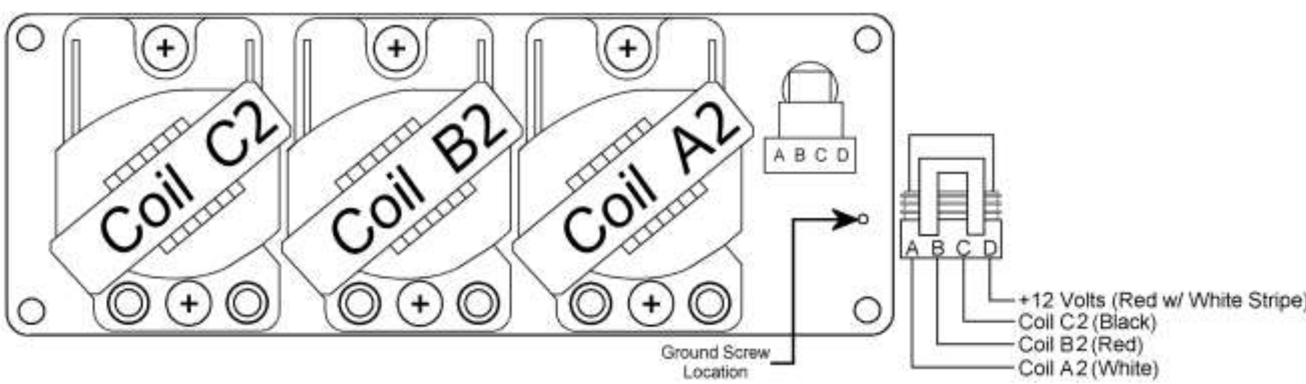


Figure 29: 6-Cyl DFU Setup



1st DFU



2nd DFU

Figure 30: (*The above picture is from a twin-plug 6 Cyl.*), if running a V8 the first DFU will have coils A1, B1 the second DFU will have coils A2, B2.

4.4 Ignition Firing Order

For the engine to run correctly, the coils must be connected to the appropriate cylinders. Since the Electromotive DFU's utilize waste-spark coils, it is necessary to know the firing order of an engine to determine which cylinders should be paired together.

- When a 1, 2, or 4-cylinder engine is chosen in the software setup, coil channels A and B will be fired alternately, every 180º of crankshaft rotation. The firing goes: **A** – 180 º – **B** – 180 º – **A** – 180 º – **B** – etc…

- When a 3, or 6-cylinder engine is chosen in the setup, coils A, B, and C will fire every 120º of crankshaft rotation. The firing goes:
  A – 120 º – **B** – 120 º – **C** – 120 º – **A** – 120 º – **B** – 120 º – **C** – etc…

- When an 8-cylinder engine is chosen, DFU #1 Coils A1, B1 and DFU #2 Coils A2, B2 will fire every 90º of crankshaft rotation. However, on the 8-cylinder setup, the coils fire A1-A2-B1-B2 instead of A1-B1-A2-B2. The firing goes:

  A1 - 90º – A2 - 90º – B1 - 90º – B2 - 90º – **A1 -** 90º – B1 - 90º – A2 - 90º – B2 **–** etc…

Note: To clarify these seemingly complex firing patterns, write your firing order into the appropriate engine setups found below and wire them accordingly.

4.4.1 Common Engine Sparkplug Wiring

4.4.1.1 Chevy V8

Firing Order: 1-8-4-3-6-5-7-2

Coil Firing Order:	**A1**	**A2**	**B1**	**B2**	**A1**	**A2**	**B1**	**B2**
Engine Firing Order:	**1**	**8**	**4**	**3**	**6**	**5**	**7**	**2**

As can be seen, Coil A1 will be used for cylinders 1&6, Coil B1 for cylinders 4&7, Coil A2 for cylinders 5&8, and Coil B2 for cylinders 2&3.

4.4.1.2 Honda 4-cylinder

Firing Order: 1-3-4-2

Coil Firing Order:	**A1**	**B1**	**A1**	**B1**
Engine Firing Order:	**1**	**3**	**4**	**2**

Cylinders 1&4 are paired to Coil A1. Cylinders 2&3 are paired to Coil B1.

4.4.1.3 Mazda 2-Rotor Rotary

Spark Plug Setup: Leading & Trailing Plugs on Both Rotors

Coil Firing Order:	**A1**	**A2**	**B1**	**B2**
1st or 2nd Rotor:	**1st rotor**	**1st rotor**	**2nd rotor**	**2nd rotor**
Leading or Trailing:	**Leading**	**Trailing**	**Leading**	**Trailing**

Note: In the software, the timing split between the leading and trailing spark plugs can be set for different engine speeds.

4.4.1.4 4-cylinder 2-stroke

Firing Order 1-2-3-4

Coil Firing Order:	**A1**	**A2**	**B1**	**B2**
Engine Firing Order:	**1**	**2**	**3**	**4**

4.4.1.5 Coil-Per-Plug Applications

The following engines utilize a coil-per-plug ignition setup:

4-strokes: 1-cyl, 2-cyl 180°, 3-cyl (all), 4-cyl odd fire
Rotaries: ALL
2-strokes: ALL

For these applications, it will be necessary to use our single tower coils, as shown in **Figure 36.**

4.5 Coil Firing Schemes

The **XDI200** software is able to run a multitude of different engine configurations. To determine the proper wiring of coils for a given engine, it is necessary to understand the points at which the coils are fired as functions of engine position. The following pages outline the different ignition firing patterns that are available on the **XDI200**. It will be necessary to know the firing order for your engine before using the engine configuration tables (some common firing orders are given in the following section). Once this is known, simply wire the vehicle's coils to reflect the data in the tables.

4.5.1 Coil Firing Patterns for EVEN-FIRE Engines

1 Cylinder	<<< 1st revolution	2nd revolution >>>	
Crank Degrees	0°	360°	
Coil Channels	A	A	(1 Coil, coil-per-plug)
Injector Channels ( ) = staged			
	1 (2)		Full Sequential
	1 (2)	1 (2)	Phase Sequential
Firing Order			

2 Cylinder	<<< 1st revolution	2nd revolution >>>	
Crank Degrees	0°	360°	
Coil Channels	A	A	(coil-per-plug)
Injector Channels ( ) = staged			
	1 (3)	2 (4)	Full Sequential
	1 (2)	1 (2)	Phase Sequential
Firing Order			

3 Cylinder	<<< 1st revolution			2nd revolution >>>			
Crank Degrees	0°	120°	240°	360°	480°	600°	
Coil Channels	A	B	C	A	B	C	(coil-per-plug)
Injector Channels ( ) = staged	1 (4)		2 (5)		3 (6)		Full Sequential
	1 (4)	2 (5)	3 (6)	1 (4)	2 (5)	3 (6)	Phase Sequential
Firing Order							

4 Cylinder					
Crank Degrees	0°	120°	240°	360°	
Coil Channels	A	B	A	B	(Coil-per-plug)
Injector Channels ( ) = staged					
	1 (5)	2	3 (6)	4	Full Sequential
	1 (3,5)	2 (4,6)	1 (3,5)	2 (4,6)	Phase Seq.
Firing Order					

4 Cylinder dual plug

	<<< 1st revolution		2nd revolution >>>		
Crank Degrees	0°	180°	360°	540°	
Coil Channels	A1	B1	A1	B1	(DFU-1 4 cyl.)
	A2	B2	A2	B2	(DFU-2 4 cyl.)
Injector Channels () = staged					
	1 (5)	2	3 (6)	4	Full Sequential
	1 (3,5)	2 (4,6)	1 (3,5)	2 (4,6)	Phase Seq.
Firing Order					

6 Cylinder

	<<< 1st revolution			2nd revolution >>>			
Crank Degrees	0°	120°	240°	360°	480°	600°	
Coil Channels	A	B	C	A	B	C	(3 Coils)
Injector Channels () = staged							
	1 (4)	2 (5)	3 (6)	1 (4)	2 (5)	3 (6)	Phase Sequential
Firing Order							

8 Cylinder

	<<< 1st revolution				2nd revolution >>>				
Crank Degrees	0°	90°	180°	270°	360°	450°	540°	630°	
Coil Channels	A1	A2	B1	B2	A1	A2	B1	B2	(2) two Coil DFU's
Injector Channels () = staged									
	1 (5)	2 (6)	3	4	1 (5)	2 (6)	3	4	Phase Sequential
Firing Order									

4.5.2 Coil Firing Patterns for ROTARY Engines

1 rotor

Coil Channels	A1 - leading	(coil-per-plug)
	Rotary Split Table	- equal tooth offsets
	A2 - trailing	(coil-per-plug)
Injector Channels () = staged	1 (2)	Full Sequential

2 rotor

Crank Degrees	0°	180°	
Coil Channels	A1 - leading	B1 - leading	(coil-per-plug)
	Rotary Split Table	Rotary Split Table	- equal tooth offsets
	A2 - trailing	B2 - trailing	(coil-per-plug)
Injector Channels () = staged	1 (3)	2 (4)	Full Sequential
Firing Order			

NOTES : Coil Channel A1 = 1st DFU - Coil A
Coil Channel B1 = 1st DFU - Coil B
Coil Channel A2 = 2nd DFU - Coil A
Coil Channel B2 = 2nd DFU - Coil B

4.5.3 Coil Firing Patterns for 2-CYCLE Engines

1 Cylinder

Coil Channels	A	(Coil-per-plug)
Injector Channels () = staged		
	1 (2)	Full Sequential

3 Cylinder

Crank Degrees	0°	120°	240°	
Coil Channels	A	B	C	(Coil-per-plug)
Injector Channels () = staged				
	1 (4)	2 (5)	3 (6)	Full Sequential
Firing Order				

2 Cylinder			
Crank Degrees	0°	120°	
Coil Channels	A	B	(Coil-per-plug)
Injector Channels () = staged			
	1 (3)	2 (4)	Full Sequential
Firing Order			

4 Cylinder					
Crank Degrees	0°	120°	240°	360°	
Coil Channels	A	B	C	A	(Coil-per-plug)
Injector Channels () = staged					
	1 (5)	2	3 (6)	4	Full Sequential
	1 (3,5)	2 (4,6)	1 (3,5)	2 (4,6)	Phase Seq.
Firing Order					

4.5.4 Coil Firing Patterns for ODD-FIRE Engines

2 Cylinder Odd Fire
(Default : Tooth Offset A = 11, B = 18 for Harley Davidson)
<<< 1st revolution | 2nd revolution >>>

Crank Degrees	0°	Tooth Offset	360°	360°+ Tooth Offset	
Coil Channels	A1	A2	A1	A2	coil-per-plug
Injector Channels () = staged	1 (3)		2 (4)		Full Sequential
	1 (2)		1 (2)		Phase Sequential
TDC Event Order (Not the Firing Order)					

NOTE : Harley-Davidson MUST have 3 degrees in the Timing Split Table !

4 Cylinder Odd Fire (Default : Tooth Offset A,B = 11)
<<< 1st revolution | 2nd revolution >>>

Crank Degrees	0°	Tooth Offset	180°	180°+ Tooth Offset	360°	360°+ Tooth Offset	540°	540°+ Tooth Offset	
Coil Channels	A1	A2	B1	B2	A1	A2	B1	B2	coil-per-plug
Injector Channels () = staged	1 (5)		2		3 (6)		4		Full Sequential
	1 (3)		2 (4)		1 (3)		2 (4)		Phase Sequential
TDC Event Order (Not the Firing Order)									

4.5.5 Examples of Typical Engine Setups

Example : 2 rotor

Coil Channels	A1 - leading	B1 - leading	(coil-per-plug)
	Rotary Split Table	Rotary Split Table	- equal tooth offsets
	A2 - trailing	B2 - trailing	(coil-per-plug)
Injector Channels () = staged	1 (3)	2 (4)	Full Sequential
Firing Order	1	2	

Rotor 1 : Leading = Coil A1 Rotor 2 : Leading = Coil B1
Rotor 1 : Trailing = Coil A2 Rotor 2 : Trailing = Coil B2

Rotor 1 : Injector 1 = Primary, Injector Channel 3 = Staged
Rotor 2 : Injector 2 = Primary, Injector Channel 4 = Staged

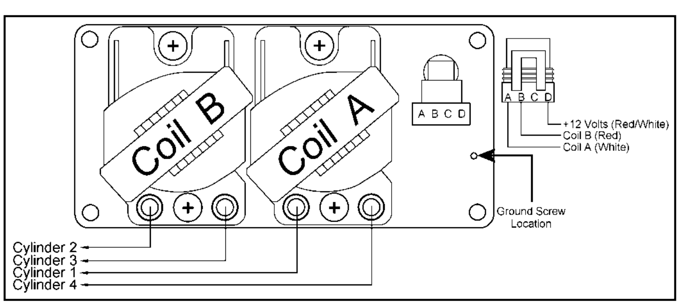


Figure 32. Typical In-Line 4-cylinder DFU wiring. Firing Order 1-3-4-2 depicted here.

Example : 6 Cylinder

	<<< 1st revolution			2nd revolution >>>			
Crank Degrees	0°	120°	240°	360°	480°	600°	
Coil Channels	A1	B1	C1	A1	B1	C1	1 DFU w/ 3 Coils
Injector Channels () = staged	1	2	3	4	5	6	Full Sequential
	1 (4)	2 (5)	3 (6)	1 (4)	2 (5)	3 (6)	Phase Sequential
Firing Order	1	5	3	6	2	4	

Coil A1 = Cylinders 1 and 6
Coil B1 = Cylinders 5 and 2
Coil C1 = Cylinders 3 and 4

	phase sequential	full sequential
Injector Channel 1 :	Cylinders 1 & 6	Cylinder 1
Injector Channel 2 :	Cylinders 5 & 2	Cylinder 5
Injector Channel 3 :	Cylinders 3 & 4	Cylinder 3
Injector Channel 4 :	unused	Cylinder 6
Injector Channel 5 :	unused	Cylinder 2
Injector Channel 6 :	unused	Cylinder 4

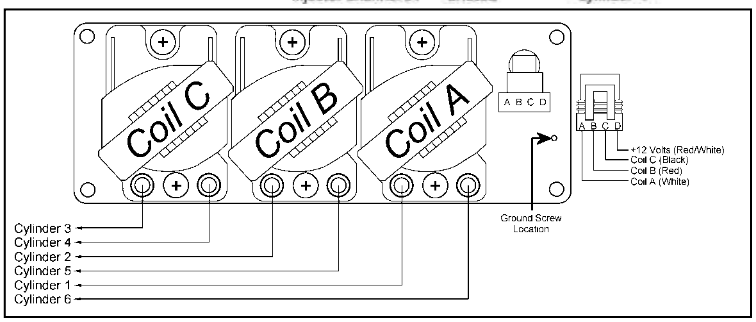


Figure 33. Typical In-Line 6-cylinder DFU wiring.
Firing Order 1-5-3-6-2-4 depicted here.

8 Cylinder

8 Cylinder	<<< 1st revolution				2nd revolution >>>				
Crank Degrees	0°	90°	180°	270°	360°	450°	540°	630°	
Coil Channels	A1	A2	B1	B2	A1	A2	B1	B2	(2) two Coil DFU's
Injector Channels () = staged									
	1 (5)	2 (6)	3	4	1 (5)	2 (6)	3	4	Phase Sequential
Firing Order	1	8	4	3	6	5	7	2	

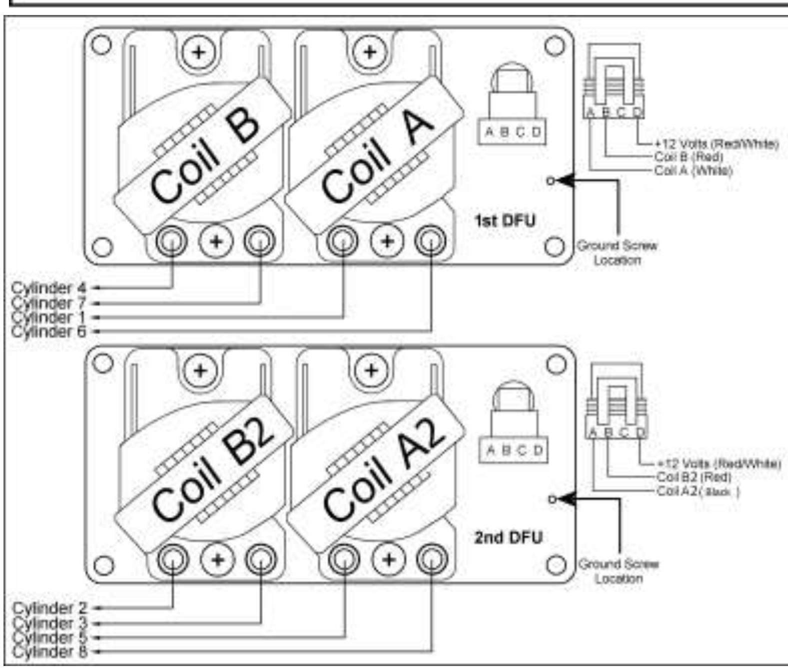


Figure 35. Typical GM 8-cylinder DFU wiring. Firing Order 1-8-4-3-6-5-7-2 depicted here. Remember, 8-cylinder setups fire the coil channels in the order of A^1-A^2-B^1-B^2.

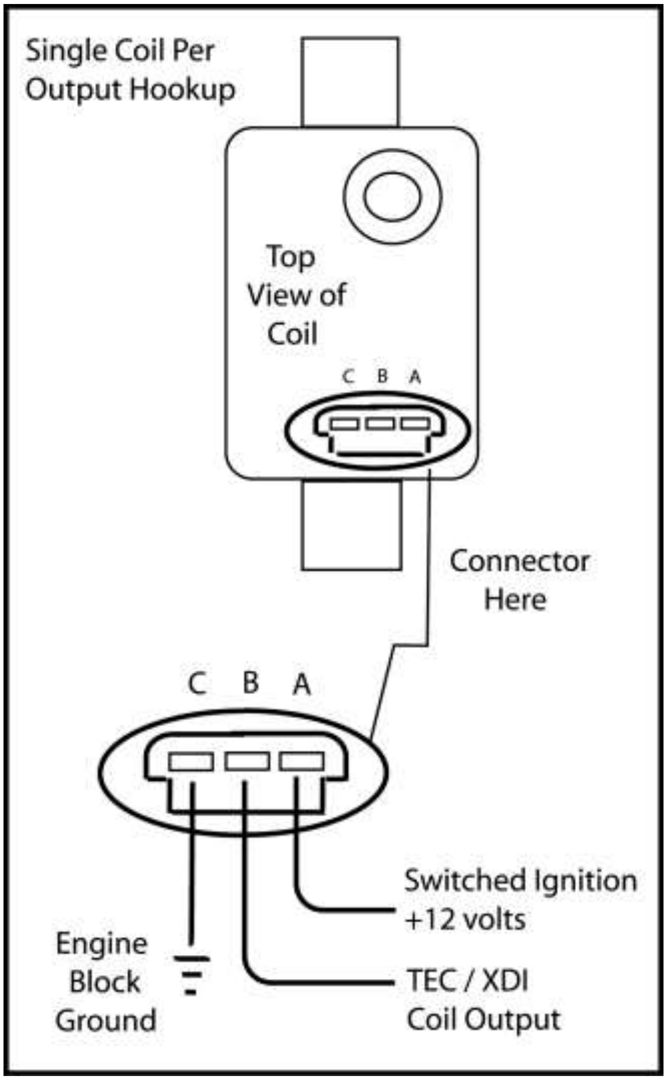


Figure 36. 2-Rotor (Mazda 12A and 13B) coil setup. 4 of these coils will be required for leading and trailing plugs.

Leading plugs will go to **XDI200** connector pin [2] (white wire) = first rotor, leading. **XDI200** pin [3] (red wire) = second rotor, leading.

Trailing plugs will go to **XDI200** pin [14] (white wire) = first rotor, trailing. **XDI200** pin [15] (red wire) = second rotor, trailing.

4.5.6 Common Firing Orders

→ Remember, coils are fired in the following sequence:

- 4 cylinder: A-B-A-B
- 6 cylinder: A-B-C-A-B-C
- 8 cylinder: A1-A2-B1-B2-A1-A2-B1-B2

The following Firing Orders apply to <u>Even-Fire</u> Engines ONLY!

8 cylinder - *2 DFU's*	**Firing Order**	**DFU 1 coil A**	**DFU 2 coil A**	**DFU 1 coil B**	**DFU 2 coil B**
Most GM, Chrysler, & AMC V8's:	1-8-4-3-6-5-7-2	1&6	8&5	4&7	3&2
Chevrolet LS1 V8:	1-8-7-2-6-5-4-3	1&6	8&5	7&4	2&3
Ford 5.0L, 351W/M/C, 400 V8's:	1-3-7-2-6-5-4-8	1&6	3&5	7&4	2&8
Ford other V8's:	1-5-4-2-6-3-7-8	1&6	5&3	4&7	2&8
Ford 4.6/5.4 Liter V8:	1-3-7-2-6-5-4-8	1&6	3&5	7&4	2&8
Cadillac 368, 425, 472, 500:	1-5-6-3-4-2-7-8	1&4	5&2	6&7	3&8
Cadillac Northstar:	1-2-7-3-4-5-6-8	1&4	2&5	7&6	3&8
Audi 4.2 V8, & Mercedes Benz:	1-5-4-8-6-3-7-2	1&6	5&3	4&7	8&2

6 cylinder - *3 coil DFU*	**Firing Order**	**Coil A**	**Coil B**	**Coil C**
Buick 3.0 & 3.8 (60º V6):	1-6-5-4-3-2	1&4	6&3	5&2
Chevrolet 2.8 (60º V6):	1-2-3-4-5-6	1&4	2&5	3&6
Chevrolet 4.3 (90º V6):	1-6-5-4-3-2	1&4	6&3	5&2
Ford 2.8 (60º V6):	1-4-2-5-3-6	1&5	4&3	2&6
Chrysler Slant 6:	1-5-3-6-2-4	1&6	5&2	3&4
Porsche Flat 6:	1-6-2-4-3-5	1&4	6&3	2&5
Datsun Inline 6 (L6):	1-5-3-6-2-4	1&6	5&2	3&4
Nissan 3.0 V6 (60º V6):	1-2-3-4-5-6	1&4	2&5	3&6
VW VR6 (15º V6):	1-5-3-6-2-4	1&6	5&2	3&4

6 cylinder - *2 - 3 coil DFU's*	**Firing Order**				
		A1	**B1**	**C1**	
Porsche Flat 6:	1-6-2-4-3-5	1&4	6&3	2&5	Uppers
		A2	**B2**	**C2**	
		1&4	6&3	2&5	Lowers

4 cylinder -	**Firing Order**	**Coil A**	**Coil B**
Most Inline 4-cyl Engines:	1-3-4-2	1&4	3&2
VW Flat 4 (air-cooled):	1-4-3-2	1&3	4&2
Dual Plug 4-cyl:	1-3-4-2	1&4	3&2

4.5.7 How to find the TDC Event Order :

1. Turn the engine to TDC #1.
2. Rotate the engine in its normal direction of rotation.
3. Record the order in which the cylinders have TDC's. It does not matter that the TDC events are mixed between compression and exhaust during this process.

4.5.8 TDC Tooth for DFU "2" needed for an Odd-Fire Engine:

1. Turn the engine to TDC #1.
2. Measure the crankshaft degrees between TDC #1 and the next TDC event for the engine.
3. Take this Degree Number (**DN**) and divide it by 6. If the result has a decimal, round UP to the nearest Whole Number (**WN**).
4. Add WN to the number 11 to give you the necessary value for the **TDC Tooth for DFU "2"** parameter.
5. Perform the following subtraction: DN – WN = **X**.
6. Enter **X** into the **Rotary Ignition Split** table for all RPM points.

4.5.9 Harley-Davidson Applications

The unique sound of the Harley-Davidson V-Twin is the result of an odd (uneven) firing pattern between the two cylinders. To run this engine, select **2-cylinder Odd-Fire** for the engine setup. Since this is a 45^{o} V-Twin with one connecting rod lobe, the TDC events occur in the following fashion for one complete engine cycle:

TDC A – 45^{o} – **TDC B** – 315^{o} – **TDC A** – 45^{o} – **TDC B**

- For the TDC Setup,
  Set the DFU #1 Trigger Wheel TDC to the 11th tooth.
  Set the DFU #2 Trigger Wheel TDC to the 18th tooth.

- In the **Dual Plug Timing Split**, set the values to 3 degrees for all RPM's.

- Wire DFU #1 - **Coil A1** output to **pin A** of a 4-cylinder DFU. This will fire cylinder A's spark plug.

- Wire DFU #2 - **Coil A2** output to **pin B** (not pin C!) of a 4-cylinder DFU. This will fire cylinder B's spark plug.

4.5.10 Rotary Engines

For rotary engines, the coil firing occurs on both the leading and trailing spark plugs. Using the **Dual Plug Timing Split Table**, simply enter the desired split (in degrees) between the leading and trailing spark plugs. For a 2-rotor engine, 4 single tower coils will be needed. References to DFU #1 in the software will correspond to the 2 primary spark plug coils (coil outputs A1 and B1), and will fire the **leading spark plugs** on rotors 1 and 2, respectively.

References to DFU #2 in the software will correspond to the 2 secondary spark plug coils (coil outputs A2 and B2), and will fire the **trailing spark plugs** on rotors 1 and 2, respectively. Typically, rotaries work well with about 7-15 degrees of split between the leading and trailing ignition under light load. Under full load, the engines generally make best power with closer to zero degrees of split. A rotary will run on just the leading or trailing ignition, but a power loss will occur. Keep this in mind when trying to diagnose ignition wiring problems.

Rotor 1

Leading: Coil Channel A1
Trailing: Coil Channel A2
Coil Channel A1 and A2 are split by the value in the Dual Plug Timing Split.

Rotor 2

Leading: Coil Channel B1
Trailing: Coil Channel B2
Coil Channel B1 and B2 are split by the value in the Dual Plug Timing Split.

4.5.11 Dual Plug Engines

4 & 6 cylinder only

For dual plug engines, there are two spark plugs per cylinder. Although it may seem that you should connect both towers of one coil to the two spark plugs of one cylinder, this is NOT the case. Doing so would require one coil to fire two spark plugs that are on the compression stroke, which would have a very negative effect on spark energy. Instead, the coils must be wired so that each cylinder will have two coils for its two spark plugs. Refer to the example of the 6-cylinder Porsche Dual Plug engine to see how the wiring should be done.

Since most dual plug cylinder heads have a hemispherical design, the spark for both plugs on an individual cylinder should occur at the same instant for optimum flame-front propagation. However, with non-hemispherical dual plug heads, it may be desired to experiment with staggering the spark timing from one plug to the next. To do this, the Dual Plug Timing Split Table can be used. The values entered into this table represent the timing split (in degrees) between the two spark plugs on a particular cylinder. When this is done, the flame front will begin at different areas of the cylinder at different times, resulting in an uneven flame propagation. Consequently, it is recommended that most dual plug applications NOT use the Dual Plug Timing Split.

4.6 Spark Plug Wire Selection

The **XDI200** outputs an extremely high-energy charge for the ignition coils. Resistor (carbon) core wires work best with this charging method, since they absorb electrical noise generated by the coil firing events. Use 8mm or larger RFI and EMI suppression wire with GM boots. We recommend using a carbon core-style suppression wire with a resistance of 3,000 to 5,000 ohms per foot. **SOLID CORE WIRES SHOULD NEVER BE USED**. Do not be misled by spark plug wire manufacturers claiming to give you a “power increase” from their wire. The bottom line is that with our charging method, different spark plug wires simply do not make a difference in terms of spark energy. However, there is a huge difference in noise generated by different spark plug wire types (solid core wires generate a very high amount of noise with our system).

Quoted from Magnecor’s Website:

“What is not generally understood (or is ignored) is that the potential 45,000 plus volts (with alternating current characteristics) from the ignition coil does not flow through the entire the length of fine wire used for a spiral conductor like the 1 volt DC voltage from a test ohmmeter, but flows in a magnetic field surrounding the outermost surface of the spiral windings (skin effect). The same skin effect applies equally to the same pulsating flow of current passing through carbon and solid metal conductors. A spiral conductor with a low electrical resistance measured by a 1 volt DC ohmmeter indicates, in reality, nothing other than less of the expensive fine wire is used for the conductor windings!

Electrical devices, including spark plugs, use only the electrical energy necessary to perform the function for which such devices are designed. Spark plug wires are nothing more than conductors, and whereas a bad ignition wire's inefficient conductor can reduce the flow of electricity to the spark plug, an ignition wire that reportedly generates an "increase" in spark energy will have no effect on the spark jumping across the spark plug gap, since the energy consumed at the spark plug gap won't be any more than what is needed to jump the gap. For a more obvious example of this, a 25watt light bulb won't use any more energy or produce any more light if it's screwed into a socket wired for a 1000watt bulb."

Due to the extremely high energy in the **XDI200** coil charging circuit, spark plug wires may wear out faster than with a standard ignition. As such, it is recommended that the wires be checked periodically for carbon tracking caused by a breakdown of the internal conductor element. Looking at the plug wires in a dark area and wetting them with a spray bottle of water will reveal carbon tracking. Pay close attention to the exposed section of the spark plug (where the rubber boot ends) during the test. To maximize spark plug wire life, keep the lengths as short as possible (i.e. mount the DFU as close to the engine as possible). Replacement of the wires on an annual basis is recommended for high-rpm/high-horsepower applications.

For an extremely high-quality wire with excellent noise suppression, we recommend the Magnecor brand. Specifically, their "Electrosports 80" 8mm wire is very good with our system. Custom wire lengths and ends are available from them so you will not need to crimp the wires yourself. They can be reached at (248)669-6688 or on the web at: www.magnecor.com . Taylor Pro-Wire Silicon Resistor wires also work well.

4.7 Spark Plug Selection

As was previously stated, spark plugs are generally more important to spark quality than spark plug wires. Most spark plugs exhibit failure when exposed to a large load. Failure usually consists of either intermittent sparking or arc-over. Arc-over is when the spark occurs between the spark plug wire and the engine block, instead of at the plug tip. Arc-over is exacerbated by the use of low-quality wires, or wires that have cuts in the insulation.

The load at which a spark plug fails is different for all spark plugs. With the **XDI200's** charging circuit, the more load you put on an engine, then more voltage will be applied to the plug. This is a beneficial situation: for a high compression engine, the voltage at the plug will be inherently higher (since there is more load). The detriment is that spark plugs and wires are only rated to a certain voltage (30-40,000 volts is typical), and can begin to "blow out" at around 40,000 volts. If that voltage is exceeded by a large amount for a long enough length of time, the spark plugs will either blow out, break down or arc to somewhere other than the electrode (often through the insulator directly to the engine block).

The solution is to run smaller plug gaps on high-compression engines. This is perfectly acceptable with our ignition charging method, since the high load of the cylinder pressure will allow the voltage to be quite high at the electrode, but the small gap will keep the plug from seeing an over-voltage situation. Use the recommendations below as a guideline for spark plug gaps:

- Stock Street Engine — 0.045"-0.060" (1.1mm-1.5mm)
- High Performance Street — 0.030"-0.035" (.75mm-.9mm)
- Alcohol High Compression — 0.025" (0.65mm)
- High Power 75 -115 HP per Cylinder — 0.025" (0.65mm)
- Over 115 HP per Cylinder — 0.022" (0.55mm)

- Over 12:1 CR or Over 14psi Boost 0.022” (0.55mm)

Use of resistor plugs is highly recommended for optimum noise suppression. If using anything other than a resistor spark plug wire, a resistor plug MUST be used. The bottom line is this: the **XDI200** system uses an *inductive* (long duration charge at battery voltage) charging method for the coils, which is completely different than the *capacitive* (short duration charge at higher-than-battery voltage) charging method used by several other aftermarket manufacturers. What may work well for these systems may not work well for ours. Following our recommendations about spark plug and wire selections will yield excellent results.

4.8 Driver on Coil Logic Driven Coils

If you select Driver on Coil logic driven coils you will not use the shielded wires found on pins [1,2,3,4 and 13,14,15,16]. Remove or tape these wires off. The DOC logic level outputs are very sensitive to miss wiring. Be careful not to short these wires to ground or +12V. Internal damage will happen if you do. The DOC logic outputs are +5 volt logic and cannot drive coils directly. It is allowed to connect up to two DOC coils to each logic output.

DOC coils either are 3 or 4 wire devices.

	Connect To:	3 wire DOC	4 wire DOC
Power +12 V	DFU Power +12V Switched	+12V	+12V
Signal	Pin 5, 6, 7, 10, 11 or 12	Signal	Signal
Power Ground	Engine Block Ground	Ground	Power Ground
Reference Ground	Pin 17 or 18 Black/White	Not Present	Reference Ground

The wiring of the logic signals simply follows the plug wiring as noted in the standard DFU wiring above. Where a coil spark plug wire connection is indicated substitute the DOC logic output for that cylinders DOC coil. One DOC logic output is wired to two DOC coils.

SIGNAL CONNECTION EXAMPLES: VERIFY THE FIRING ORDER

		4 Cylinder	6 Cylinder and Dual Plug	8 Cylinder
	Firing Order:	1-3-4-2	1-6-2-4-3-5	1-8-4-3-6-5-7-2
Standard Coil	***DOC Pin / Wire Color to signal pin***	***Connect to Coils***	***Connect to Coils***	***Connect to Coils***
A1	5 Black/Gray	1 and 4	1 and 4	1 and 6
B1	6 Black/Red	2 and 3	3 and 6	4 and 7
C1	7 Black/Green	Not Used	2 and 5	Not Used
A2	10 Black/Blue	Not Used	1 and 4 (dual plug)	5 and 8
B2	11 Black/Pink	Not Used	3 and 6 (dual plug)	2 and 3
C2	12 Black/Orange	Not Used	2 and 5 (dual plug)	Not Used

When using the DOC logic outputs, tape up or remove the unused standard coil outputs.

WARNING: Before starting the engine when DOC coils are used, change the engine configuration setting to DOC coil and set a fixed dwell time. If you do not know the exact dwell time to use for the coil you have, start with 1.8 mSec. Failure to make this calibration change may cause extreme damage to the coils.

5 Wiring Sensors & Other Inputs

The **XDI200** harness has provisions to connect all of the engine devices described in this section. Refer to this section to wire your sensors appropriately.

- The following sensors use pull-to-seat connectors (feed the wire through the connector before crimping the terminal!):
  Coolant Temperature
  Manifold Air Temperature
  Some Throttle Position Sensors
  Idle Air Control Motor

- The following sensors use push-to-seat connectors (crimp the terminal to the wire before inserting into the connector!):
  Crank Sensor
  Cam Sensor (if used)
  MAP sensor (1-Bar sensors use green connector. 2-& 3-Bar use orange connector)
  Some Throttle Position Sensors
  EGO Sensor
  Knock Sensor

5.1 The Manifold Air Pressure (MAP) Sensor

The MAP sensor determines the operating load of the engine. To do so, it measures the intake manifold absolute pressure. Since the intake manifold pressure has a direct effect on the amount of air that the cylinders can ingest, the use of a MAP sensor as a load-determining device is well justified.

MAP sensors are available from Electromotive in three varieties: 1-, 2-, and 3-Bar. A 1-Bar sensor would be used on a naturally aspirated engine, a 2-Bar sensor would be used on a boosted engine (up to 15psi), and a 3-Bar sensor would be used on a boosted engine (up to 30psi).

The output of a MAP sensor is a 0 to +5 Volt signal. When the intake manifold pressure is low (high vacuum), the sensor reading is low (approaching 0 Volts). This would occur during part-throttle cruising or decelerating (engine braking). When the intake manifold pressure is high (low vacuum), the sensor reading is high (approaching +5 Volts). This would occur during full throttle operation.

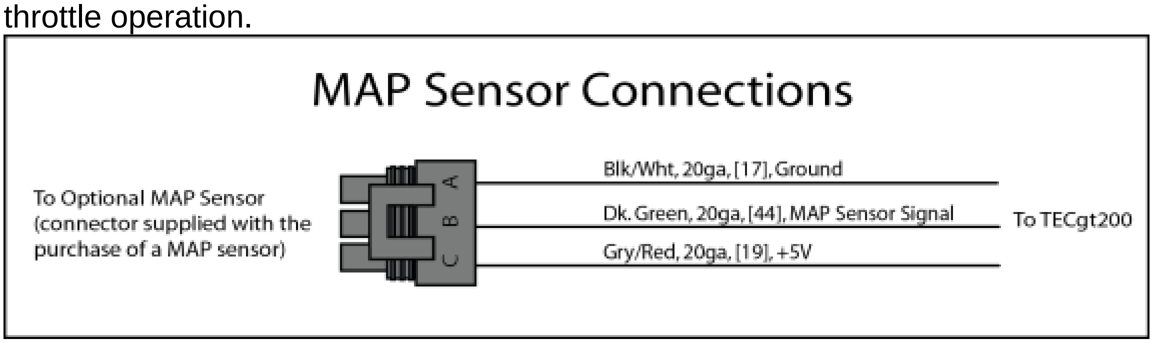


Figure 40: MAP sensor wiring.

5.1.1 MAP Sensor Data

To check that the MAP sensor is working correctly, and to check for the MAP sensor Bar number (1-, 2-, or 3-Bar), it is necessary to know the output voltage from the sensor as a function of pressure. With the **XDI200** turned on, but the engine NOT running, the MAP sensors will output the voltage for atmospheric pressure (since manifold pressure is equal to the atmospheric pressure when the engine in not running). At standard atmospheric conditions (101.3 kPa), the output voltages should be:

1-Bar: approximately 4.80 Volts
2-Bar: approximately 2.30 Volts
3-Bar: approximately 1.55 Volts

Note that the output voltage should be measured between pin "B" (output) and pin "A" (ground). If the sensor does not output a voltage near the above numbers, the sensor is likely defective. Refer to **Figure G.1.1** for MAP sensor wiring instructions. Refer to **Figures G.1.2 through 4** for MAP sensor voltage as a function of manifold pressure for the three MAP sensors.

Since the **XDI200** does NOT know whether the MAP voltage is from a 1-, 2-, or 3-Bar MAP sensor (that is, it only knows the voltage), it is necessary to enter the MAP sensor that is being used into the software. See **Table 7** for a numerical breakdown of the MAP sensor voltage and corresponding load percentage.

Table 7: MAP sensor load percentage, voltage, and kPa relationship.

MAP volts	% Load	1 bar kPa	2 bar kPa	3 bar kPa
5	100	104.8	208	316
4	80	86	168	252
3	60	67	128	190
2	40	48	88	127
1	20	29	48	64
0	0	10.3	8	1.1

Table 8: MAP sensor voltage & kPa relationship.

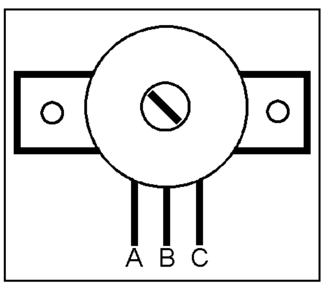
Load Percentage	MAP Voltage	1-Bar kPa	2-Bar kPa	3-Bar kPa
0%	0.00	10	8.8	3.6
5	0.25	15	18	17
10	0.50	20	28	33
15	0.75	24	38	48
20	1.00	29	48	64
25	1.25	34	58	80
30	1.50	39	68	96
35	1.75	43	78	111
40	2.00	48	88	127
45	2.25	53	98	143
50	2.50	58	108	159
55	2.75	62	118	174
60	3.00	67	128	190
65	3.25	72	138	206
70	3.50	77	148	222

75	3.75	81	158	237
80	4.00	86	168	253
85	4.25	91	178	269
90	4.50	96	188	285
95	4.75	100	198	300
100	5.00	105	208	315

5.2 Throttle Position Sensor

The throttle position sensor (TPS) functions as a multi-purpose input to the **XDI200**. The TPS is optional and is only used for activating the Idle air motor and for data logging purposes. TPS's that are compatible with the **XDI200** must be of the potentiometer (rheostat) variety. A potentiometer has three connections: +5Volt, Ground, and Output Signal. As the throttle is moved, the TPS output should transition smoothly from a low voltage (approaching 0V) at idle to a high voltage (approaching 5V) at full throttle. Switch-type TPS's will NOT work with a **XDI200** since they do not output a smooth voltage transition from closed to opened throttle.

The throttle position sensor should have a resistance of roughly 10kΩ measured across the +5V and Ground terminals. To determine the pin out of an unknown TPS, follow the instructions below (you will need an ohmmeter):



TPS

1. With the TPS in the **closed throttle** position, measure the resistance of the following three positions referenced to **Figure G.2.1**: A-B, A-C, and B-C.
2. With the TPS in the **opened throttle** position, measure the same three resistances. Two of the readings will have changed from Step 1, and one of the readings will be the same.
3. The +5V and Ground terminals are from the terminal pair whose resistance stayed the same between steps 1 and 2. The **Ground** terminal is from the pair whose resistance *increased* from Step 1 to Step 2.

Example: **Step 1.** Closed Throttle: A-B : ~500Ω B-C : ~9500Ω A-C : ~9500Ω

Step 2. Opened Throttle : A-B : ~9500Ω B-C : ~500Ω A-C : ~9500Ω

Step 3: Process of Elimination

- A-C resistance stayed the same in steps 1 & 2. Therefore, either "A" or "C" is the Ground connection.
- A-B resistance increased from ~500Ω to ~9500Ω from Step 1 to Step 2. Therefore, "A" or "B" is the ground connection.
- **"A" must be the Ground** connection since "B" cannot be the ground connection as a result of Step 1.
- **"C" must be the +5 Volt** connection, since "A" is not.
- **"B" must then be the Output Signal**.

Another way to look at the TPS's electrical functionality is to realize that it simply creates an output that is either biased to Ground or to +5 Volts. At closed throttle, the output should be biased to ground, and at full throttle, the output should be biased to +5 Volts. See **Figure 41** for an electrical schematic of a typical potentiometer. Please note that the TPS must use a (roughly) 10kΩ potentiometer! Failure to do so will result in improper impedance matching for the **XDI200**, and a false sensor reading will result. Fortunately, most TPS's are of the 10kΩ variety.

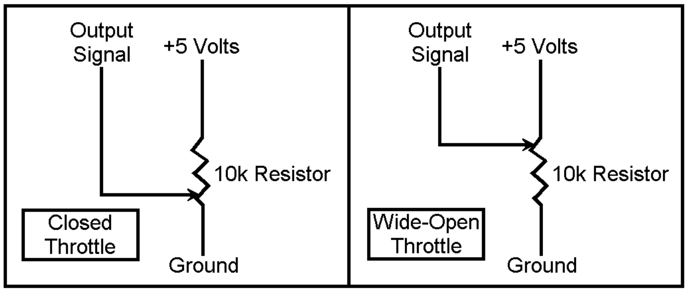


Figure 41 Potentiometer functionality for closed and open throttle conditions.

5.3 TPS Wiring

Many different TPS's have been used by OEM's in the past few decades. The most common types are driven directly on the throttle shaft by either a dowel pin going through the shaft of a "D" shaped throttle shaft. Various TPS styles are available from Electromotive, as outlined in **Figures 42 to 45**.

Arm-Style TPS
PN 310-71310

Fig. 42

GM Dowel-Pin Style
PN 310-71320

Fig. 43

"D" Shaft TPS
PN 310-71340

Fig. 44

Ford Dowel-Pin Style
PN 310-71330

Fig. 45

The TPS connects to three wires from the **XDI200** harness: +5 Volt, Ground, and TPS Signal. See **Figure 46** for proper wiring instructions.

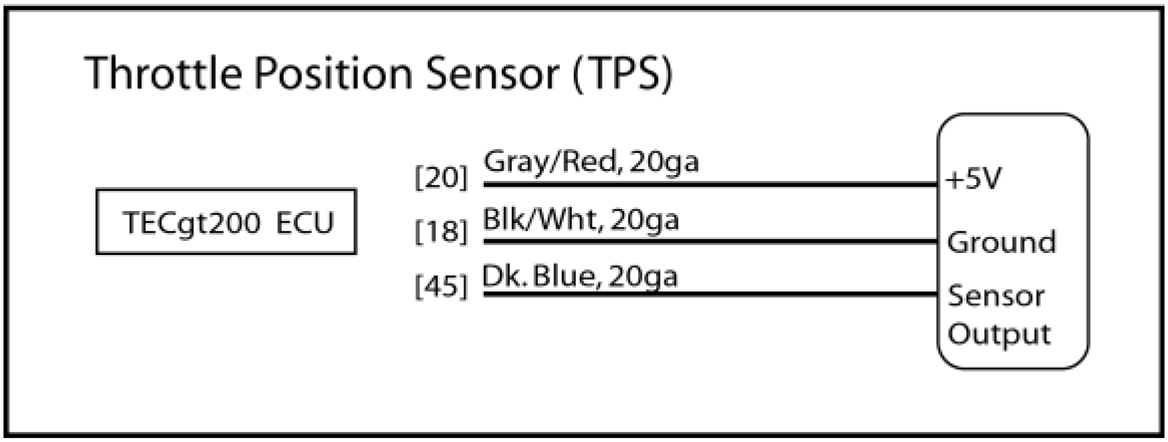


Figure 46: Proper throttle position sensor wiring

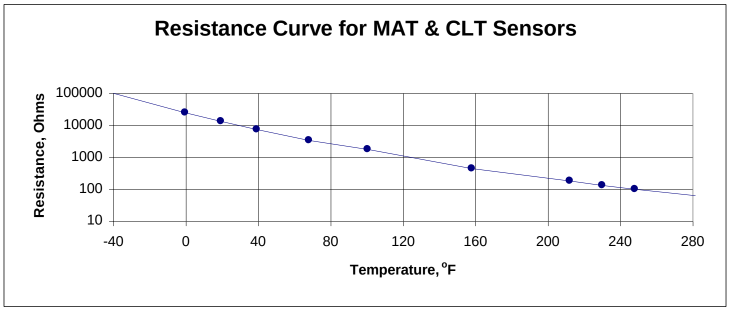
5.4 Coolant Temperature Sensor

The **XDI200** is compatible with negative temperature coefficient (NTC) thermistor-type coolant temperature sensors. This type of sensor has two terminals, and the resistance between the two terminals changes as a function of temperature (see **Figure 50**). The coolant (CLT) sensor provides variable advance timing as a function of engine temperature.

The **XDI200** is set up to use the GM-style coolant temperature sensors. These sensors are sold by Electromotive under part number 305-71210. They are threaded for a 3/8" NPT hole.

Liquid-cooled engines should have the CLT sensor installed somewhere in the coolant passages. Ideally, it should be installed toward the outlet of the engine (or the entry of the radiator) so that the highest temperature reading will be seen.

For **air-cooled** engines, there are a few options for obtaining a usable engine temperature. The first option is to use the factory cylinder temperature sensor, which is often found on air-cooled Porsche applications. The second option is to use the engine oil temperature instead of the coolant temperature. Beware of choosing this method, since air cooled engines often have a very large oil capacity that takes much longer to heat up than the cylinders themselves. A third option would be to use a *manifold air temperature* sensor in a sheet metal “stove” on one of the cylinders.



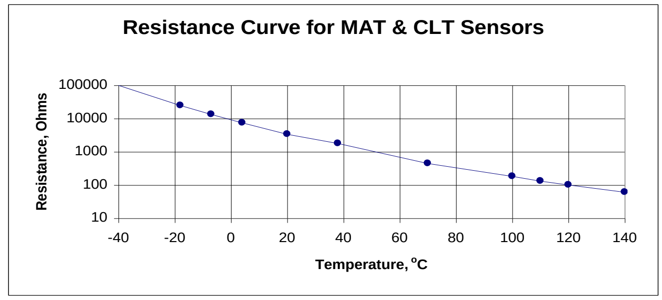


Figure 50. Sensor resistance vs. temperature for CLT and MAT sensor.

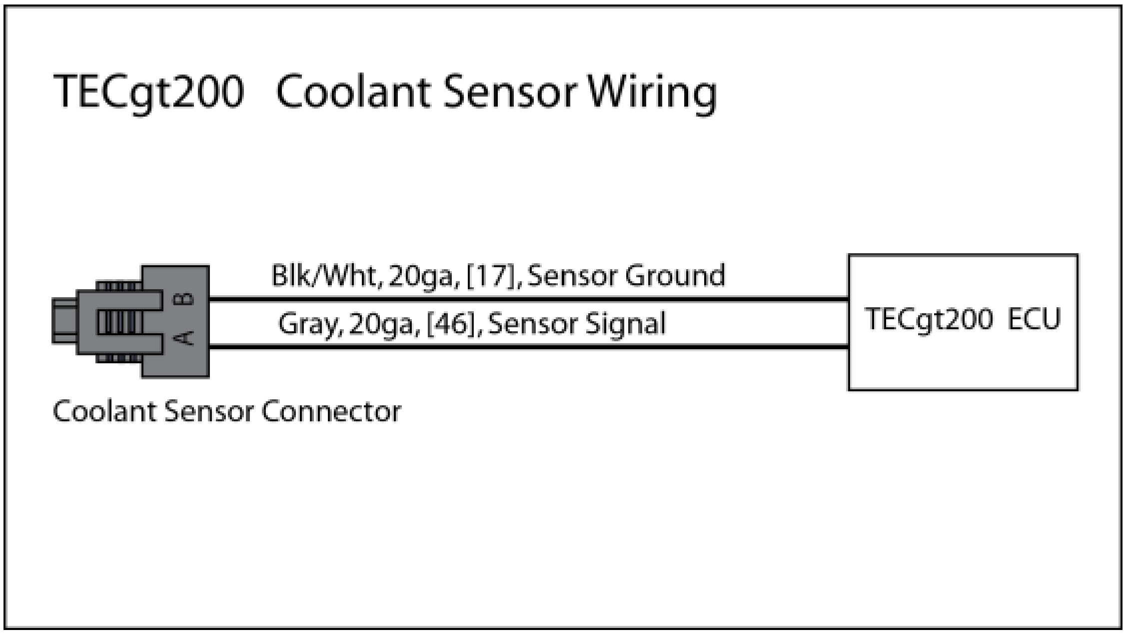


Fig. 51. Coolant temperature sensor wiring.

Wiring the Coolant temperature sensor is straightforward. See **Figure 51** for details. Since the sensor is just a resistor, wires “A” and “B” can be switched with no adverse results.

To test for faulty coolant temperature sensors, simply measure the resistance across terminals A and B with an ohmmeter. Match the resistance of the sensor to the operating temperature using **Table 5**. As a guideline, use the following specs:

Cold engine (70F, 20C):   ~3300Ω
Hot Engine (180F, 80C):   ~350

Table 5. CLT and MAT sensor resistance

Temp, ºC	Temp, ºF	Resistance, ohms
-40	-40	100700
-18	0	25000
-7	19	13500
4	39	7500
20	68	3400
38	100	1800
70	158	450
100	212	185
110	230	133
120	248	102
140	284	62

5.5 Manifold Air Temperature Sensor

Like the Coolant Temperature Sensor, the Manifold Air Temperature (MAT) Sensor is an NTC thermistor. The MAT input is used for data logging purposes.

The **XDI200** is set up to use the GM-style MAT sensors. These sensors are sold by Electromotive under part number 305-71220. They are threaded for a 3/8" NPT hole. Wiring the MAT sensor is very easy. See **Figure 52** for details.

Install the MAT sensor in an area that is representative of the air temperature entering the engine. If it is mounted directly in the intake manifold (particularly in aluminum and iron manifolds), it may be getting a slightly warmer reading than the actual air temperature due to the conduction of heat through the manifold and the radiation of heat onto the sensor tip. It is sometimes better to install the sensor upstream a bit, particularly if the air intake (or filter box) is made of a material that does not conduct heat very well (like plastic). This will give the MAT sensor a more appropriate reading for intake air temperature.

The MAT sensor resistance curve is identical to that of the CLT sensor. See **Figure 50 and Table 5** for details. The sensor resistance test can be done the same way as well:

70ºF (20ºC): ~3300Ω
180ºF (80ºC): ~350Ω

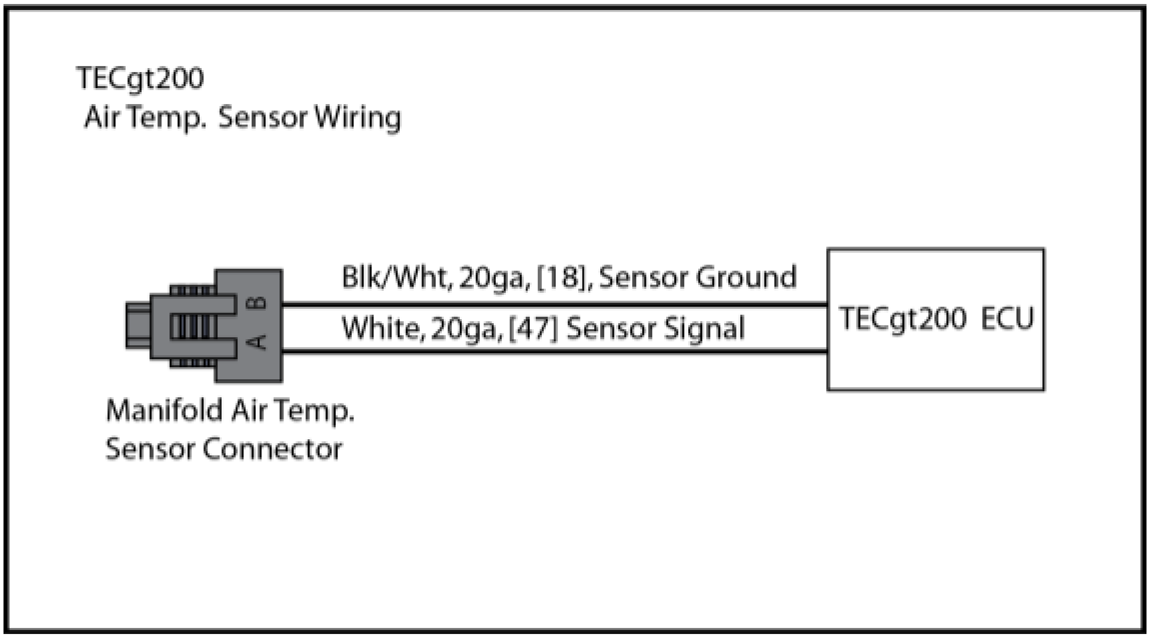


Figure 52. Manifold air temperature sensor wiring.

5.6 The Exhaust Gas Oxygen Sensor

The Exhaust Gas Oxygen (EGO) sensor is designed to measure the oxygen content of the combustion products. In measuring this value, an estimate of an engine's air-to-fuel ratio (AFR) can be made. **The EGO sensor** is used for data logging purposes only.

5.6.1 Mounting the EGO Sensor

The EGO sensor should be mounted in the exhaust stream close to the engine. It should not be mounted in the header pipe for only one cylinder. Instead, it should be mounted after the collector. Failure to mount the EGO sensor close to the engine will result in poor performance due to under-heating the sensor. The EGO sensor needs plenty of heat to operate properly. Mild steel threaded bungs for the EGO sensor are available from Electromotive under PN 315-72111.

When installing the sensor, take care not to run the wires on the exhaust. This will obviously melt the wires once exhaust temperatures rise.

5.6.2 Wiring the EGO Sensor

Virtually all 4-wire EGO sensors on the market are compatible with the **XDI200**. Most universal EGO sensors available from the auto parts store have a color code as follows:

Black: EGO +
Gray: EGO –
White: Heater + or –
White: Heater – or +

- Note that the heater polarity is not important, it only needs opposite voltages on the two wires. **DO NOT ATTEMPT TO RUN THE EGO HEATER WITH THE +5V LINE IN THE XDI200 HARNESS!!**

Electromotive's EGO sensors also follow this color code, and are mated to a 4-position female weather-pack connector in the following pin out:

Gray: Pin D   Black : Pin C   White : Pin B   White : Pin A

The heater circuitry allows the EGO sensor to warm up quickly. It also keeps the EGO as warm as possible during idling conditions, where unheated EGO sensors (1-wire style) often cool down significantly. The positive wire for the heater can be spliced to the Fuel Pump output on the **XDI200** Power Harness (PN 070-40000). This is the 16awg light green wire. This is NOT the same as the Fuel Pump Relay Ground output of the **XDI200**, which is a 20awg light green wire from pin [57].

If the Power Harness for the **XDI200** is not being used for the EGO heater element, the EGO heater should be wired to a switched voltage source. If it is wired to a full-time voltage source, it will drain the battery in short order! See **Figure 56** for proper wiring.

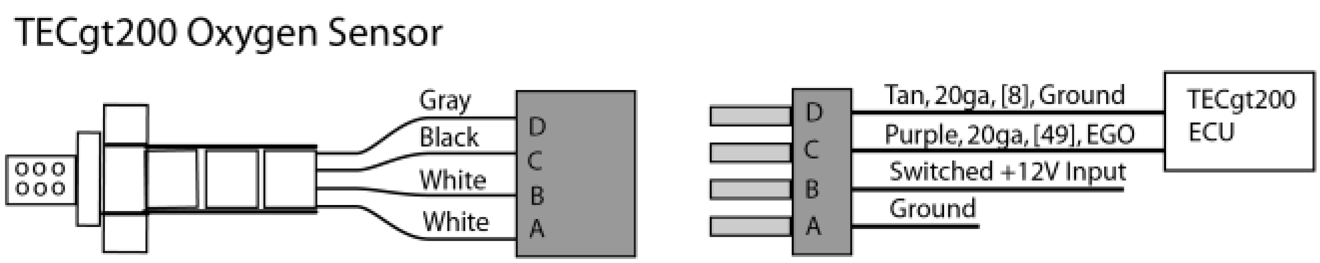


Figure 56. Wiring details for Electromotive's EGO sensor (PN 315-72120).

5.6.3 EGO Functionality

When using an EGO sensor, it must be realized that AFR's that are not near the stoichiometric value are not accurate. The stoichiometric value is the AFR that results in complete combustion with no excess fuel (gas, alcohol, etc.) or excess air (oxygen). In simple terms, the stoichiometric value is AFR at which the incoming mixture is neither **lean** nor **rich**. Read the section on Oxygen Sensor Corrections for more information.

The reason for inaccuracies when away from the stoichiometric AFR is simple: EGO sensors are only designed to provide a **switch-point** at the stoichiometric AFR. The voltage goes from a low reading (approaching 0 volts) when lean to a high reading (approaching 1 volt) when rich. Note that the **XDI200** software multiplies the EGO input voltage by a factor of 5 when displayed on the engine monitor and datalog screens. Thus, the maximum value that could be obtained for a rich mixture would be 5volts, not 1volt. Instead of being a straight line between lean and rich, the curve is like the one depicted in **Figure 98**. Additionally, the EGO curve changes with exhaust gas temperature, thus nullifying calibration data made at a particular exhaust temperature when used at a different temperature.

Along with these negatives comes a positive: an EGO sensor is typically good at providing a stoichiometric measurement when at idle or part-throttle cruising.

5.6.4 About One-Wire EGO Sensors

One Wire EGO sensors were used a number of years ago on early fuel-injected vehicles (and some carbureted engines). These EGO's output the same voltage curve as any standard 4-wire sensor, but do not have a built-in heater or ground reference. Wire the sensor as follows:

- Connect the wire from the EGO sensor to the EGO+ line on the **XDI200** (this is the Purple 20awg wire in the **XDI200** Harness – Pin [49]).
- Connect the EGO- line on the **XDI200** (this is the tan 20awg wire going to Pin [8]) to the Sensor Ground line (this is black w/ white stripe 18awg wire going to ground).

One-wire sensors are typically not as accurate as 4-wire sensors, since they have no built-in heater element. Instead they must rely on exhaust system heat entirely. Unless the EGO sensor is mounted very close to the engine in a cast iron manifold, 1-wire sensors should not be used.

5.7 Wideband O2 Sensor

5.7.1 Wideband EGO Information and Installation Instructions

The **XDI200** supports an input from most wideband sensor controllers. The wideband controller must have an analog 5-volt output signal. A typical configuration is shown in Figure 57.

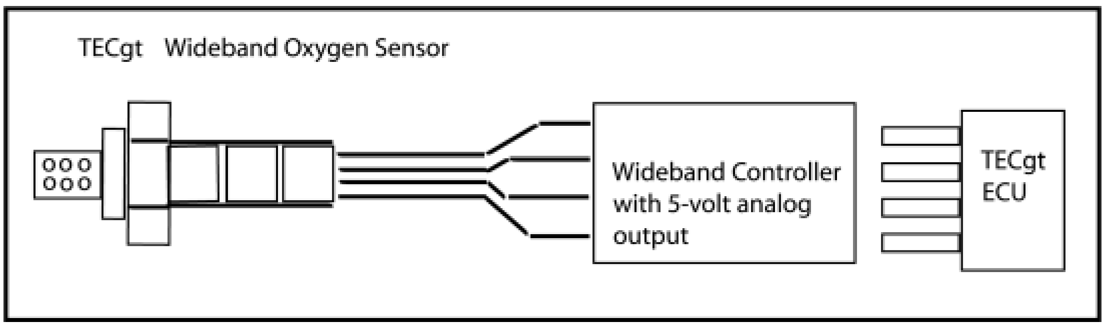


Figure 57- Typical Wideband Configuration

The installation of the oxygen sensor and controller should follow the wideband controller manufacturer's instructions.

- The analog 5-volt output signal connects to pin [49], O2 sensor (+) (purple wire) on the **XDI200**.
- The wideband signal ground is connected to pin [8] (tan wire).

*Note: Some wideband control units have a sensor ground and a ground for the heater. Other units have only one ground. You should connect the sensor ground to G32. If there is only one ground or the controller manufacturer recommends grounding the unit directly to the battery, follow the manufacturer's installation instructions.

To select the wideband input for a calibration file, click the "EGO/Wideband Air/Fuel Ratio Table" button from the Calibration Screen. (Note: this should be performed in No Connection Mode, the bin file should then be saved and downloaded to the **XDI200**). Then click "Calibrate EGO Sensor". Click "Load WIDEBAND EGO Sensor Table, this effectively performs two operations. The first is it configures the **XDI200** to use the analog voltage on pin [49] as the EGO voltage.

The second is that it loads the default wideband sensor values. Since there are so many different controllers, the default values will probably not exactly match the data provided by your controller's manufacturer. Therefore, it is essential that you use the manufacturer's data to adjust the voltages and AFR's in the boxes provided. Lastly, return to the Calibration Screen, save your bin file, and download it to the **XDI200.   You are now ready to use the wideband EGO input.**

5.8 Secondary EGO sensor input

A second EGO sensor input is available. Connect this to pin 50, Purple/Tan wire. Use pin 17 or 18 Black/White for the reference ground. This sensor input is used just for data logging and does not control any outputs.

5.8.1 EGO FAQ's and Troubleshooting Tips:

1. *"How do I know the **XDI200** is using the wideband sensor?"*

There are several indications that you are using the wideband option for your EGO input. The label for EGO voltage on the digital monitor screen (the monitor screen at the bottom of the window) will change from "EGO Sensor" to "Wideband Sensor". On the analog monitor screen, the label under the AFR bar will change from "EGO Sensor" to "Wideband Sensor".

2. *"The **XDI200** AFR changes, but it doesn't match my controller's display unit."*

The analog voltage from the wideband controller can be read on the analog monitor screen in the box labeled "WBS". The **XDI200** uses this voltage, and the corresponding values you entered in the calibration to determine the AFR. For example, if the manufacturer states 2 volts is an AFR of 12.6, and the **XDI200** WBS is displaying 2 volts but the **XDI200** AFR reads 13.6, then you entered the calibration values incorrectly. Repeat the procedure detailed above to correct the calibration file. If the **XDI200** is displaying the AFR you would expect for the corresponding voltage, but your controller display unit does not match accordingly, then you should contact the wideband controller's manufacturer with this discrepancy.

5.9 Knock Sensor

To compensate for poor fuel quality and other adverse engine operating conditions, the **XDI200** has the ability to retard timing based on detonation. To perform this task, it uses a knock sensor to sense when the engine is experiencing spark knock.

The knock sensor circuitry in the **XDI200** is designed to sense **detonation**, not pre-ignition. Pre-ignition occurs when the air/fuel mixture in the cylinder is ignited before the spark plug fires. This is generally the result of a hot spot in the cylinder. When pre-ignition occurs, peak cylinder pressure occurs after the piston has reached top dead center (TDC) of its compression stroke, but too early to produce optimum power. Optimum engine power generally occurs when the peak cylinder pressure is between 10 and 15 degrees after TDC compression. Thus, pre-ignition causes the cylinder pressure to peak before the ideal 10-15 degrees after TDC compression, and in extreme cases, the peak cylinder pressure may occur *before* TDC.

Detonation is often referred to as “pinging” or “spark knock.” On many engines, the human ear can easily hear the sound made by detonation, since it occurs in the audible range (typically around 5000 cycles/sec). The knock sensor can hear the onset of pre-ignition as well, but better than our ears.

Detonation is defined as a pressure shock wave that develops in a cylinder as a result of a slow-burning flame front. Typically, detonation is caused by ignition timing that is too advanced, poor fuel quality (low octane), or poor combustion chamber design. Engines with large combustion chambers and poor air-swirl characteristics are especially prone to detonation. During detonation, the spark plug initiates the flame front, but the flame front moves so slowly that there is time to compress and heat the unburned mixture to the point of *spontaneous ignition*. This results in a pressure shock wave that is akin to beating the upward-moving cylinder with a downward-moving hammer! It also results in a noise resonance through the engine block, just as a noise would resonate through the block if you hit the piston with a hammer. Piston, ring, and rod bearing damage is typical when an engine is detonating too much.

To obtain an accurate reading, the knock sensor must be screwed into the engine block. A plugged hole in a coolant passage is an ideal location, since the knock sensor is threaded for a 1/4" NPT hole. The knock sensor is essentially a microphone that is designed to be very sensitive to the frequency of detonation.

When the **XDI200** senses detonation from the knock sensor, it will begin to retard the timing on all subsequent spark events. Once knock has dropped a sufficient amount, the timing will then begin to increase to the desired advance setting. When the **XDI200** starts to increase the advance, it will <u>not</u> add any more timing than what is set in the Ignition Advance table.

Since engines are more likely to experience detonation at lower RPM’s with medium or high loads, it is advisable to turn the knock sensor on for these conditions. On the other hand, since engines are less likely to experience detonation at higher RPM’s (since the flame front is moving too fast for detonation to occur), AND most engines will increase their mechanical noises that can false-trigger the knock sensor (like valves hitting their seats), it is advisable to turn the knock control off at high RPM’s. Mechanical noise can be identified by datalogging a light-load, high-RPM driving situation. If no detonation is heard during the drive, but the datalog indicates that there was knock in the upper rpm/light load area, mechanical noise may be false triggering the knock sensor.

Rotary engines are generally unable to use the knock parameter as effectively as a piston engine, since real detonation in a rotary will typically only occur one time…then the apex seals will be broken! It is still worth using the knock sensor on a rotary, but do not place all of your faith in it. Just keep in mind that ignition timing should always be VERY conservative with a rotary engine.

The **XDI200** uses any 1-wire *FREQUENCY-BASED* knock sensor input. Electromotive stocks a GM 1-wire knock sensor under PN 305-71410. See **Figure 58** for wiring details.

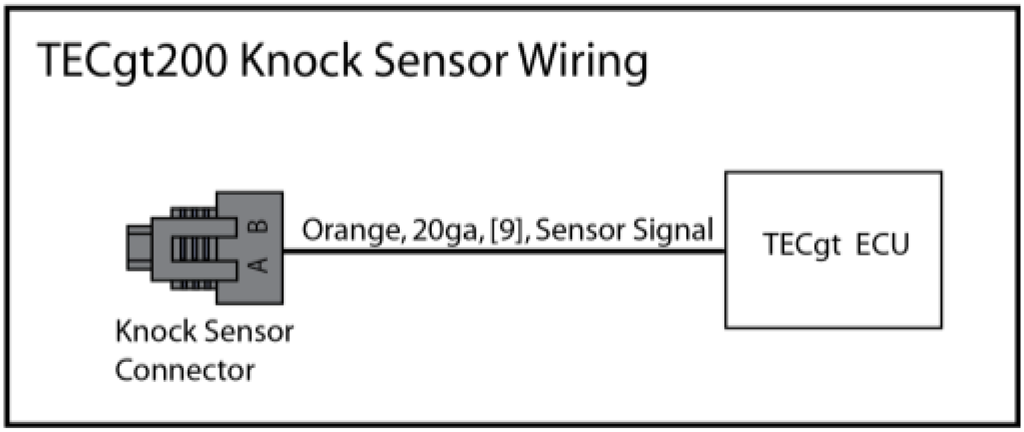


Figure 58. Knock sensor wiring.

5.10 Auxillary Temperature Sensor Input

A third temperature sensor input is available on pin 48 Orange/White. It is connected just like a coolant temperature sensor. Connect the signal to pin 48 and connect the reference to pin 17 or 18.

This sensor input is just used for data logging and does not control any outputs.

5.11 General Purpose Inputs (GPI's)

The General Purpose Inputs (GPI's) are configurable for many different input functions. These are dedicated GPI **input only** channels. Most are analog voltage inputs except "Speed" which is a frequency input.

An analog input is defined as a 0-5 volt signal. TPS, MAP, and EGO sensors are good examples of analog voltage sensors. A speed input is defined as a frequency signal. When using a magnetic sensor as a speed sensor, its output will be an AC sine wave. When using a Hall effect sensor, the output will be a 0-5 volt square wave.

One of the most useful functions of the GPI is trimming. Using a simple potentiometer referenced to +5 volts and ground, it is possible to configure the inputs to trim the fuel and spark curves based on the potentiometer knob position. These functions are quite easily configured in the WinTEC software.

GPI Wiring Table:

GPI Input	Pin Color	Function
2	22 Orange/Red	Analog Voltage 0-5 VDC
3	23 Orange/Green	Analog Voltage 0-5 VDC
4	24 Orange/Blue	Analog Voltage 0-5 VDC
5	25 Orange/Purple	Analog Voltage 0-5 VDC
6	26 Orange/Pink	Analog Voltage 0-5 VDC
7	27 Orange/Tan	Analog Voltage 0-5 VDC
8	28 Orange/Yellow	Analog Voltage 0-5 VDC
9	29 Orange/Gray	Analog Voltage 0-5 VDC
Speed	34 Orange/Black	Road Speed Pulses
EG RTD	48 Orange/White	Resistive Temperature Sensor
EGO Sec.	50 Purple/Tan	Analog Voltage 0-5 VDC

5.11.1 Available General Purpose Input (GPI) Functons

Ignition Advance Trim: Trims the ignition advance angle by a set amount through the use of a potentiometer. See **Figure 60** for wiring diagram.

GPO Trim #1 and **#2 :** These functions allow the user to add or subtract up to 50 percent Duty Cycle from the values established in the GPO table specified by the trim number. GPO Trim #1 only effects table 1, GPO Trim #2 only effects table 2. See **Figure 60** for wiring diagram.

A/C Idle Speed Increase: On **XDI200** installations with an idle air control motor, this feature allows the idle speed to be increased when the air conditioner is turned on. See **Figures 61 and 62** for recommended wiring.

Valet Switch: When a speed input is used, the valet switch allows the user to set a speed limit on the vehicle. The rev limiter will be activated when the desired speed is reached. See **Figure 64** for wiring diagram.

Nitrous Retard: Provides a set amount of ignition timing retard when nitrous is activated. When used with the Electromotive 4-stage timing retard module, the NOS Retard should be set to –30º (consult the 4-Stage Nitrous Retard Instructions for wiring). When used with a potentiometer, the timing will be retarded linearly from 0 to 30 degrees when a 0 to +5 volt signal is placed on a GP I/O input (channels 2-9). See **Figure 63** for wiring diagram.

Speed Input: The speed input is on pin 34 Orange/Black. The speed input allows the input of a frequency-based signal. Many late-model vehicles use electric speedometers that use either Hall effect or reluctor triggering mechanisms. These are both compatible with the **XDI200** speed input. Depending on the location of the speed input trigger wheel, you must configure the software to calibrate the speed input signal to the actual vehicle speed. See **Figure 65** for typical sensor wiring.

Timed Advance: When voltage (either 12v or 5v) is applied to the chosen GP I/O channel this function allows the user to add or subtract up to 30 degrees of timing for up to 2 secs. in .05 sec. increments. Timing will ramp up (advance) in the time specified (up to 2 seconds in .05 sec. increments) or down (retard) when the channel is switched on. Switching the channel off will ramp the timing back to the values in the Ignition Advance Table, the ramp back will happen in the specified time programmed by the user within the software.

Datalog Enable: Allows the use of on board data logging function. Options are RPM to begin data logging and Frequency (5, 10, 20 Hz) sampling rate. Wires the same as any input that is switched, such as the Valet Rev Limiter.

Voltage Input: No options, it just gives you a recordable voltage from 0 – 5 volts.

Timed Ignition Cut: option for shifting requires minimum RPM and minimum MAP value, amount of time for ignition cut in milliseconds, amount of time before ignition can be cut again. Finally, there is an option to pull to 12v (activate high) or pull to 0v (activate low). Additionally, the line must be released before the channel can be activated again.

5.11.2 Wiring the GPI's

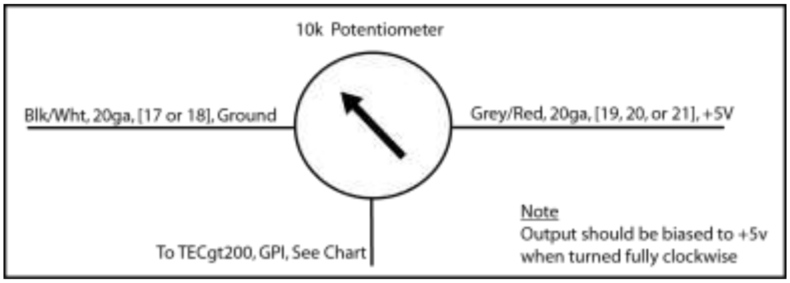


Figure 60:
Potentiometer wiring for Fuel, Ignition and GP I/O Trim Inputs

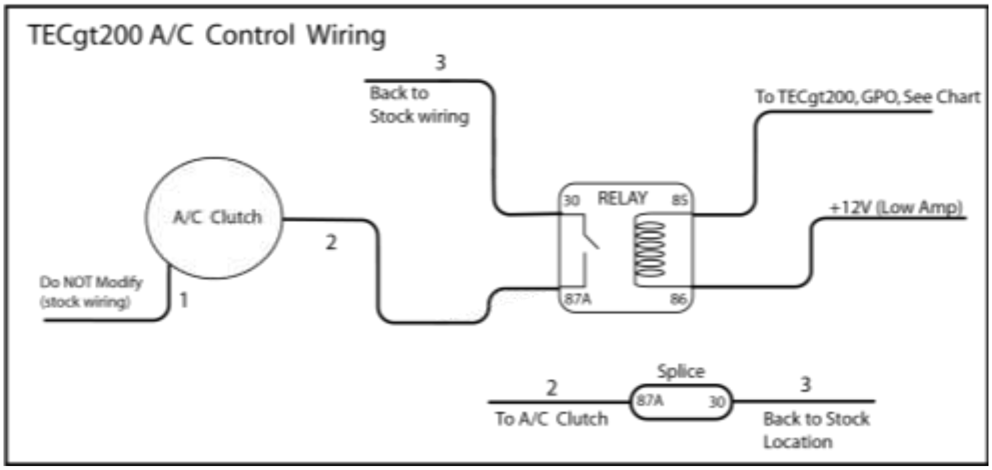


Figure 61:
Air conditioner idle speed increase wiring.

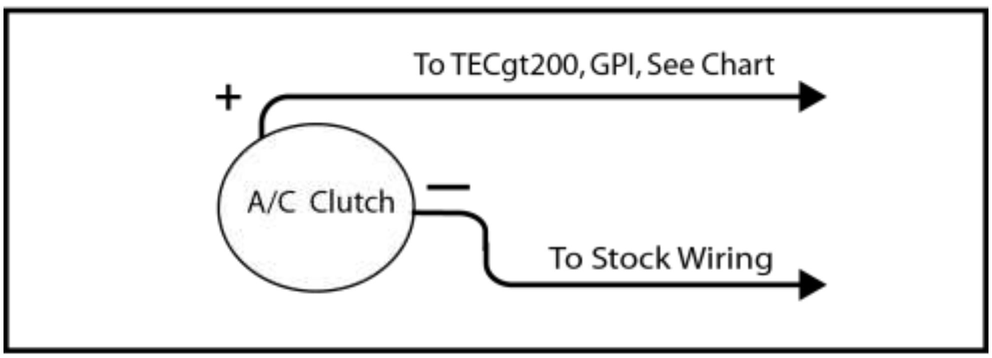


Figure 62:
Alternate air conditioner idle speed increase wiring. Note that the A/C clutch solenoid polarity MUST be known for this method.

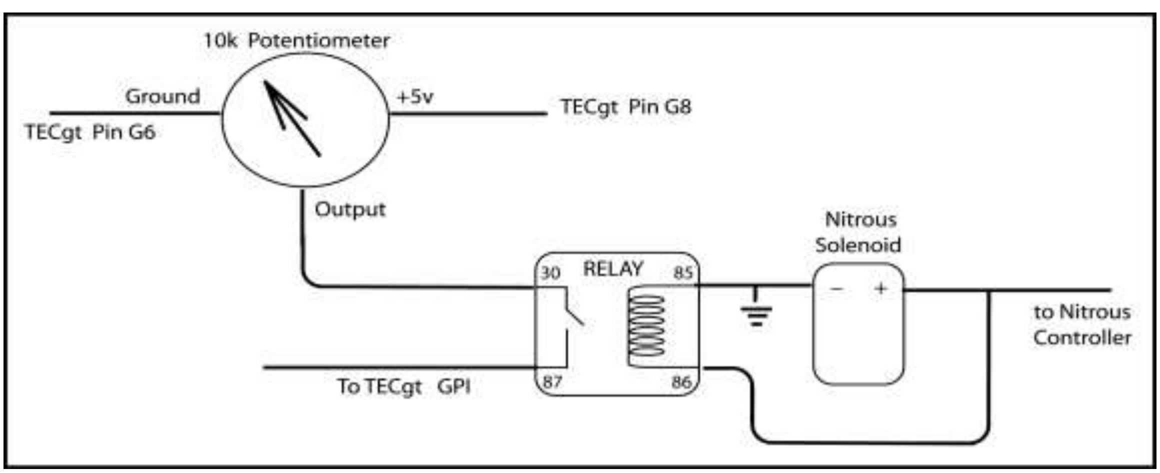


Figure 63:
Nitrous timing retard wiring.

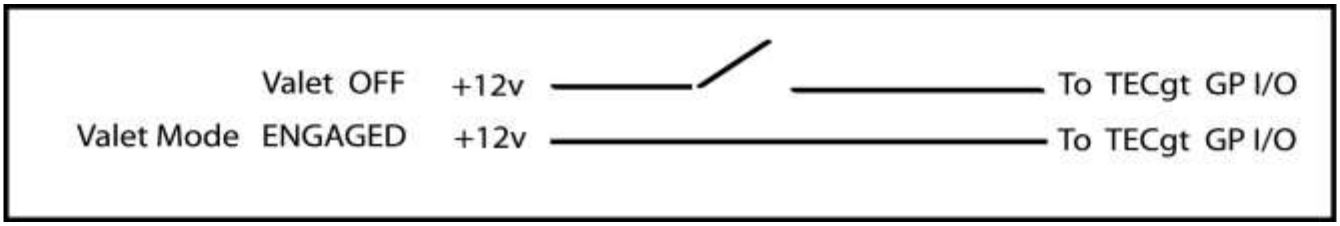


Figure 64: Valet mode on/off wiring.

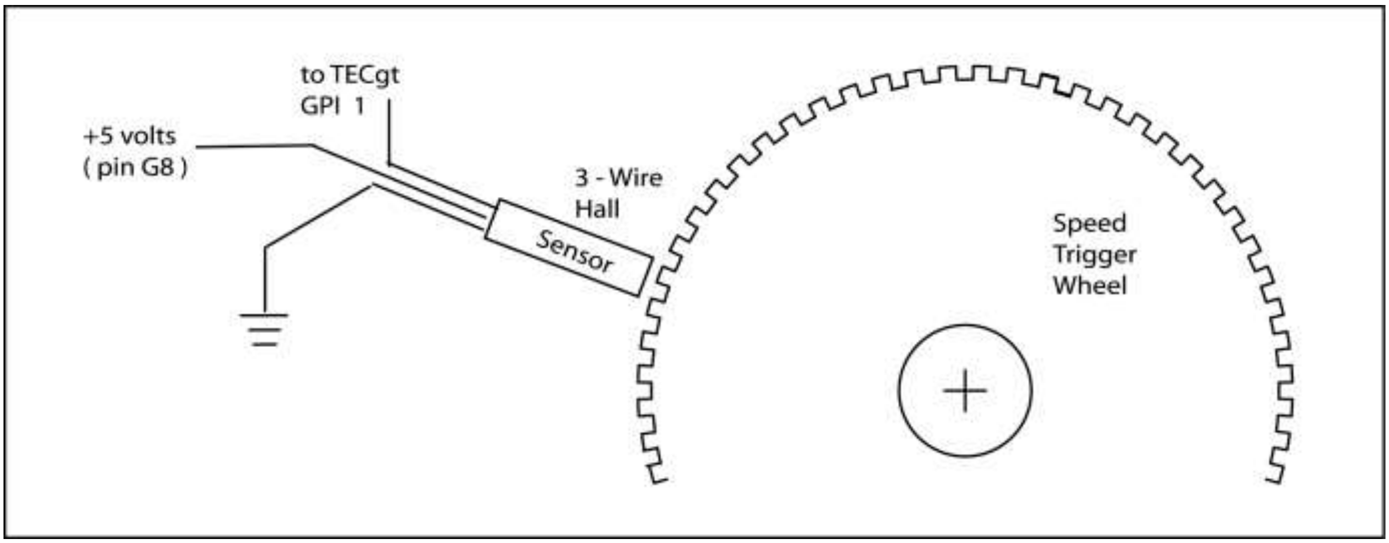


Figure 65: Typical speed sensor wiring

6 Wiring Outputs

6.1 Idle Air Control Motor

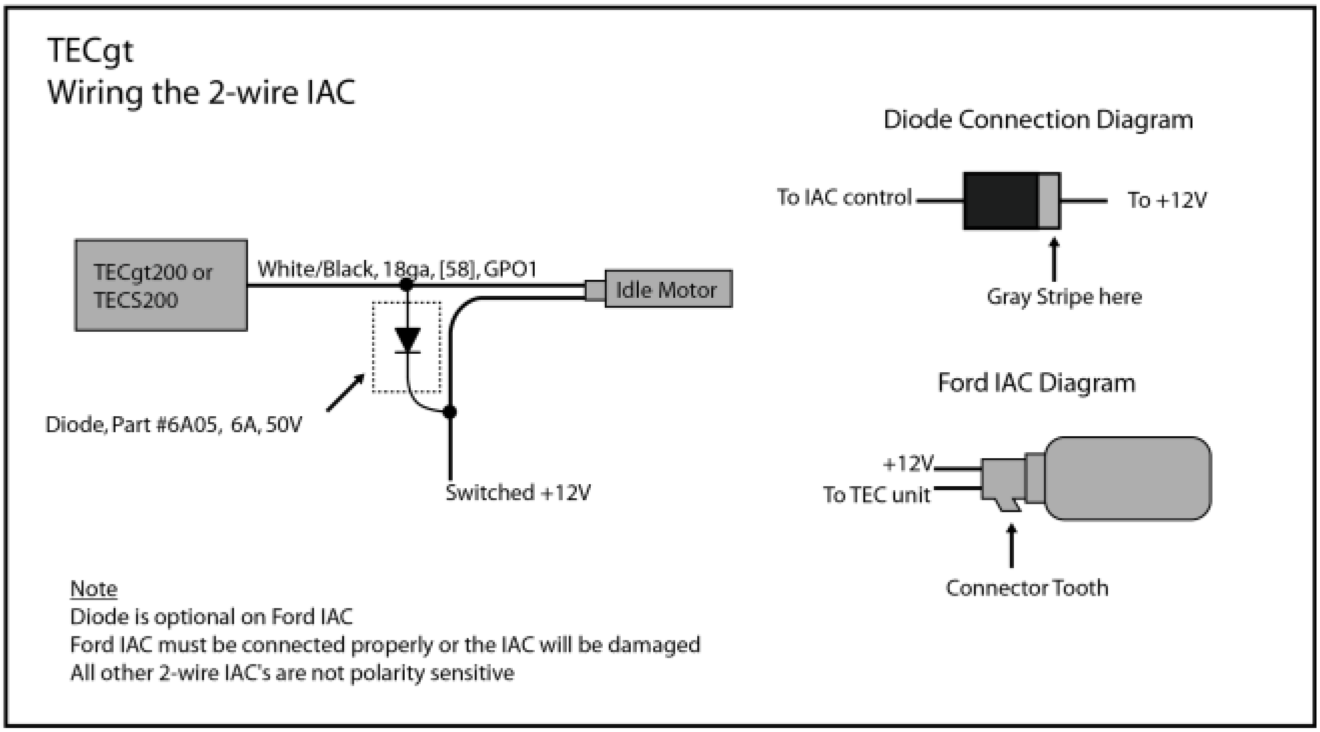


Figure 68 – Wiring the 2-wire IAC

The Idle Air Control (IAC) Motor is responsible for maintaining a smooth engine idle. Using the WinTec software, the IAC motor can be made to increase idle speeds during cold engine operation or air conditioner turn-on. The IAC motor control built into the **XDI200** can be used with four-wire stepper motor-style IAC's. The stepper motor allows the pintle of the IAC motor to move in and out very quickly to allow varying amounts of air into the intake manifold. This way, even with the throttle closed, the IAC motor can supply additional air to the engine. See **Figure 69** for an IAC motor plumbing diagram. See **Figure 68 or 71** for IAC wiring instructions. The **Tuning Guide section Idle Air Control Motor** covers the tuning of the IAC Parameters.

The idle speed control motor must be able to supply enough air to the engine so that is can have an effect on engine speed. Therefore, be sure to use at least a 1/4" hole for the air bypass passages.

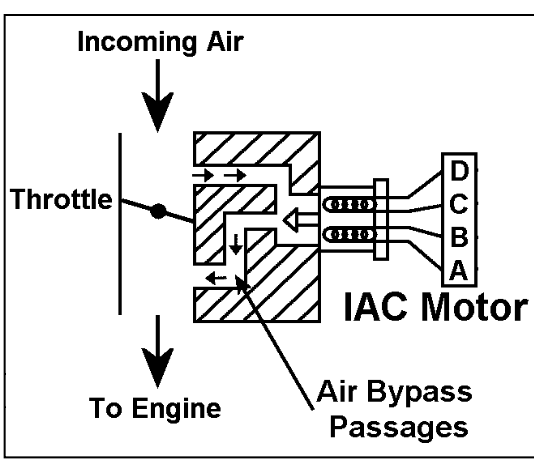


Figure 69: IAC motor plumbing **Figure 70:** IAC motor housing

For individual throttle applications, it will be necessary to use a balance tube to bring all the throttles to the IAC motor. This will allow each cylinder to be filled equally by the bypass air. A minimum of 1/2" inner diameter plumbing should be used for the balance tube to allow for adequate cylinder-to-cylinder consistency.

Electromotive offers a universal IAC Motor Housing for retrofitting an IAC motor onto an engine. The housing is designed around the Ford/Mazda bolt pattern, and as such, it fits many applications. It is also available in "universal" format with the addition of brass hose barbs. (universal PN: 325-81112, Ford PN: 325-81114) This allows the installation of rubber hose onto the housing. One hose can then be run to the intake plenum with the other hose going to filtered air.

With all Idle Air Control Motor setups, always make sure that the engine is receiving filtered air from the air bypass passages.
The IAC will not be activated unless the TPS voltage is <u>BELOW</u> the "TPS Closed Throttle Voltage" value. As an example, if the TPS voltage is 1.5 volts when the throttle is fully closed, the IAC motor will not be activated unless the "TPS Closed Throttle Voltage" setting is GREATER THAN 1.5 volts.

6.1.1 Wiring a 2-wire IAC:

A 2-wire IAC should be wired as shown in Figure 68. The diode shown is required on all idle motors except some Ford motors. If the Ford IAC you are using had a diode across it in the original wiring harness, it is recommended that you use the original diode. If you never had an original harness, a diode should be used just to be safe. The Radioshack part will work in this case. Care must be taken to be certain that the polarity on the Ford motor is also correct. For those of you outside the U.S., Malpin carries diodes of similar spec to the Radioshack part.

6.1.2 Wiring a 3-wire IAC:

The 3-wire IAC requires the use of the 2-wire to 3-wire IAC adapter. The wiring is as follows: switched +12v source to the center lead of the IAC, pins C and D from the 3-wire IAC adapter will go to the outer leads of the IAC motor. If the IAC motor appears to be working backwards, reverse the wires to the two outer leads of the IAC motor. Switched +12v must also be connected to the IAC adapter pin B. The case of the adapter ***<u>MUST</u>*** be grounded. Pin A from the IAC adapter connects to the signal wire from the **XDI200** unit. This setup does not require any diodes.

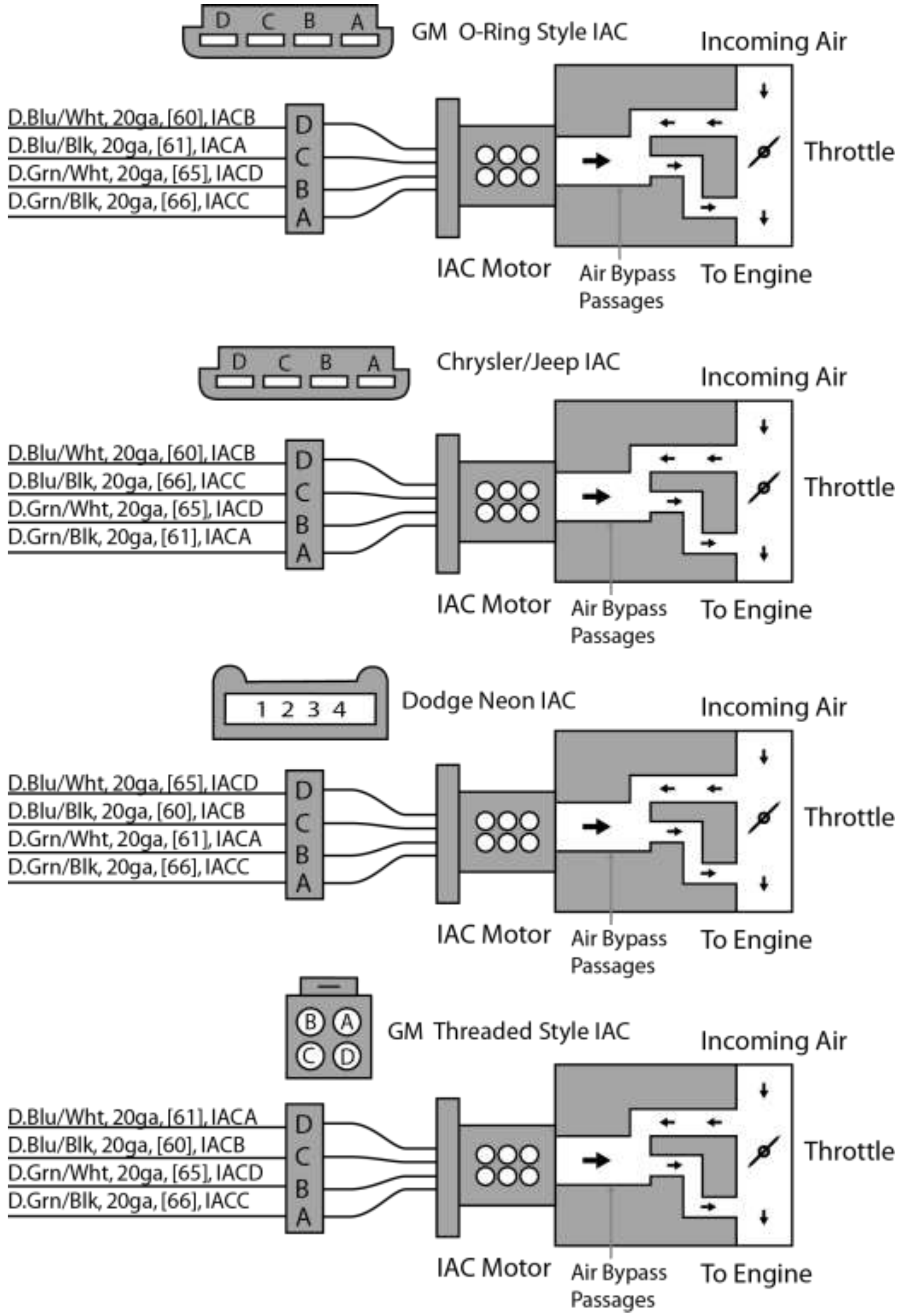


Fig 71: Common 4-wire idle air control motor wiring.

6.2 Tachometer Output

The tachometer output on the **XDI200** is a +12 Volt square wave. Each time a coil fires, a "tach pulse" is generated. Therefore, the output from the tachometer signal is ground, then +12 Volts for 30 degrees of crankshaft rotation starting at each TDC/spark event. A 4-cylinder will output 2 tach pulses per revolution, a 6-cylinder will output 3 tach pulses per revolution, an 8-cylinder will output 4 tach pulses per revolution. For applications that have a tachometer configured for a different number of cylinders than the engine (i.e. a 6-cylinder car that was converted to an 8-cylinder), there is the option of changing the tach output type in the software.

This type of signal is compatible with most new-style tachometers. However, some older tachometers trigger off the high-voltage signal from the ignition coil (C-). These types of coils require the use of a tachometer amplifier, since they are designed to trigger off of a 120 Volt signal. Tachometer amplifiers (PN: 150-15210) are available from Electromotive to suit these applications.

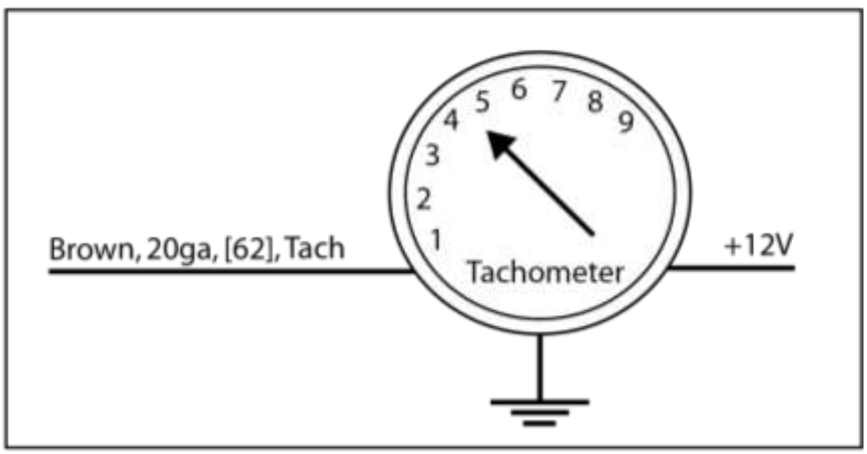


Figure 76: Typical tachometer wiring.

6.3 Fuel Pump Relay Output

The fuel pump output is designed to provide activation of the fuel pump relay on a vehicle. It is NOT designed to power the fuel pump directly. See **Figure 77** for wiring instructions.

The software allows the user to define the amount of time that the fuel pump primes the system when the **XDI200** is first turned on. This ensures adequate fuel rail pressure on start-up.

When the **XDI200** is first turned on, the fuel pump will run for the amount of time defined in the software. If the engine is not cranked during or after this time, the fuel pump will turn off. Once the engine is cranked, the fuel pump will turn back on. Essentially, the fuel pump should always be running when the engine is rotating.

CAUTION:

Do NOT connect the fuel pump relay output directly to the fuel pump. This will cause an excessive amount of current to be drawn through the circuit, and may result in damage to your **XDI200**.

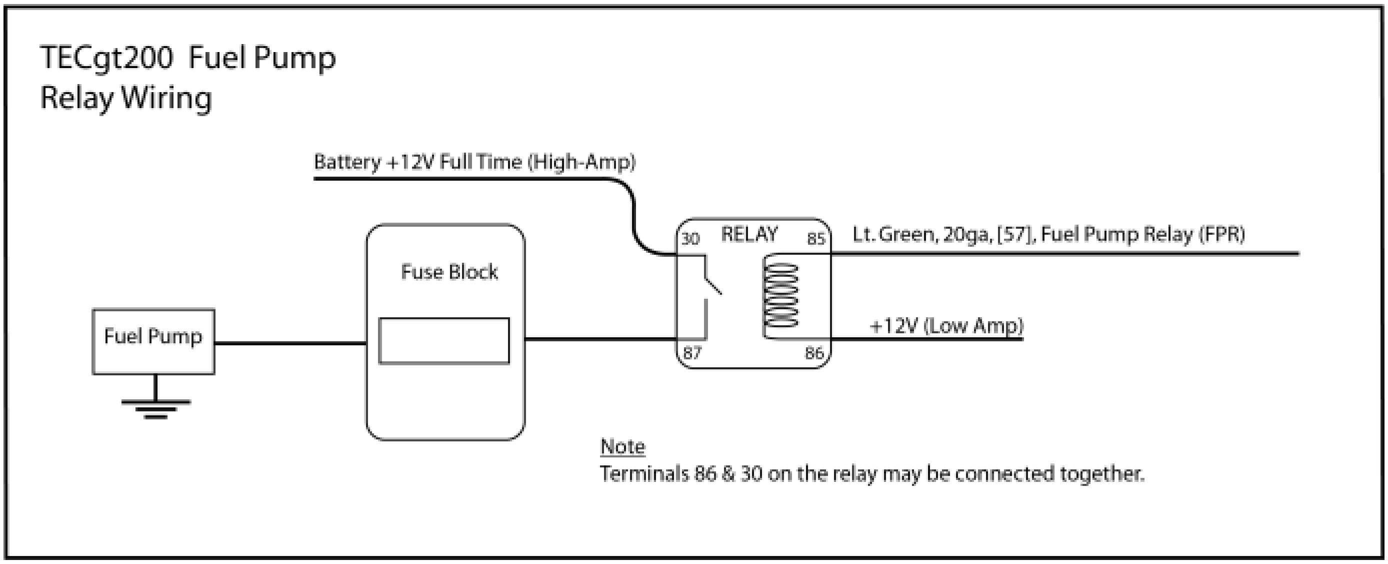


Figure 77: Fuel pump relay wiring.

6.4 General Purpose Output (GPO) functions :

Some of the most versatile functions of the **XDI200** computer are its GPO's. These outputs can control virtually any electronics device that is associated with engine operation. Take for example a simple electric radiator fan. Instead of retrofitting a thermo-switch mounted somewhere near the radiator's air stream to turn the fan on and off, you can simply use one channel of the **XDI200's** GPO functions. To accomplish this task, you would first select the **Radiator Fan** option from the GPO menu. Then, you would input the temperature at which the fan should turn on, and the temperature at which it should turn off. The temperature readings are all obtained from the Coolant Temperature Sensor (CLT), so they are much more accurate and reliable than an external thermo-switch. The output of the GPO is a pull-to-ground, so you would run the appropriate GPO wire for the channel you defined as "Radiator Fan" to a standard 4-position automotive relay (pin 85 on the relay). The opposite side of the relay (pin 86) would be wired to +12 volts, and the relay would be switching the power (or the ground) to the fan with pins 30 and 87.

A few facts that must be remembered when using a channel for a GPO function :

- All the GPO's, regardless of their function, are pull-to-ground outputs when they are activated. That is, they create a connection to ground when turned on.

- A MAXIMUM of 1 amp may be drawn from each GPO circuit.

- It is HIGHLY recommended to use a relay on the output of the GPO channels, regardless of amperage draw. Only the FULL TABLE functions require NO RELAY or the use of a solid state relay. A standard relay will not switch on and off fast enough when using frequency based functions

6.4.1 Outputs

GPO Output	Pin Color	Function
GPO 1	58 White/Black	Pull Down to Gnd. 1 amp
GPO 3 / IACA	61 D.Blue/Black	Push-Pull 1 amp
GPO 4 / IACB	60 D.Blue/White	Push-Pull 1 amp
GPO 5 / IACC	66 D.Green/Black	Push-Pull 1 amp
GPO 6 / IACD	65 D.Green/White	Push-Pull 1 amp
GPO 8	64 White/Blue	Pull Down to Gnd. 1 amp
GPO 9	63 White/Purple	Pull Down to Gnd. 1 amp
C.E.	59 Pink	Check Engine Lamp Pull Down
Data Log Stat	56 White/Orange	Date Log Status Lamp Pull Down
FPR	57 Lt. Green	Fuel Pump Relay Pull Down

NOTE: When a 4 wire IAC motor is used, GPOs 3-6 are unavailable.

6.4.2 Available GPO Functions

Radiator Fan: See previous paragraph for functionality. See **Figure 80** for wiring diagram.

Shift Light: Turns on a shift light (or any other rpm-activated object) at a user-definable RPM. See **Figure 81** for wiring diagram.

Torque Converter Control: Use this GPO to control a lock-up torque converter. You are able to define the MAP and Speed points at which the torque converter clutch is activated. Since there is a multitude of different lock-up transmissions, an electrical schematic is not included for this feature. Consult the shop manual for your application to find the wire that engages the torque converter lock-up. Use a GPO channel to activate the proper wire. A relay should always be used for this function.

Duty Cycle Table: This GPO uses a 16 x 16 table of MAP reading vs. RPM to allow the input of a duty cycle at each MAP/RPM point. Numbers are interpolated between cells to create a smooth curve. The possibilities of this GPO are extensive. Typically, it is used to control an rpm/load-dependent solenoid such as a turbo waste gate. You can select table 1 or 2.

A/C Control: This feature turns the air conditioner clutch off when the engine is above specific RPM and MAP values. See **Figure 82** for wiring diagram.

Auxiliary Fuel Pump: This GPO turns on an auxiliary fuel pump at a desired RPM and MAP value. See **Figure 83** for wiring diagram.

The **Intake Runner** and **Nitrous Controls** function in the same manner as the **Auxiliary Fuel Pump Control**. That is, they activate as a function of RPM and MAP value. Note that the Nitrous Control should not be used to turn on the nitrous directly. Instead, it should be thought of as a nitrous enable. This essentially replaces the wide-open-throttle switch. Use **Figure 83** for similar wiring.

Custom (and) / Custom (or): Custom (and) uses both ranges RPM and MAP values. It requires RPM below which GPO comes on and MAP minimum turn on value. Custom (or) functions only inside either RPM or MAP values set OR both.

6.4.3 Wiring the GPO's:

This section covers the wiring that is necessary to use the various GP I/O controls. With one exception (A/C turn-off), the relays depicted in the schematics are all simple automotive 4-position relays. The air conditioner turn-off request needs a 5-position relay. 4-position and 5-position relays are generally rated at 30 or 40 amps, which should be more than adequate for most applications. High quality relays and relay sockets are available from Electromotive under part numbers 340-91200 and 340-91201, respectively. Part number 340-91200 is a 5-position relay, so it can be used for all applications depicted below.

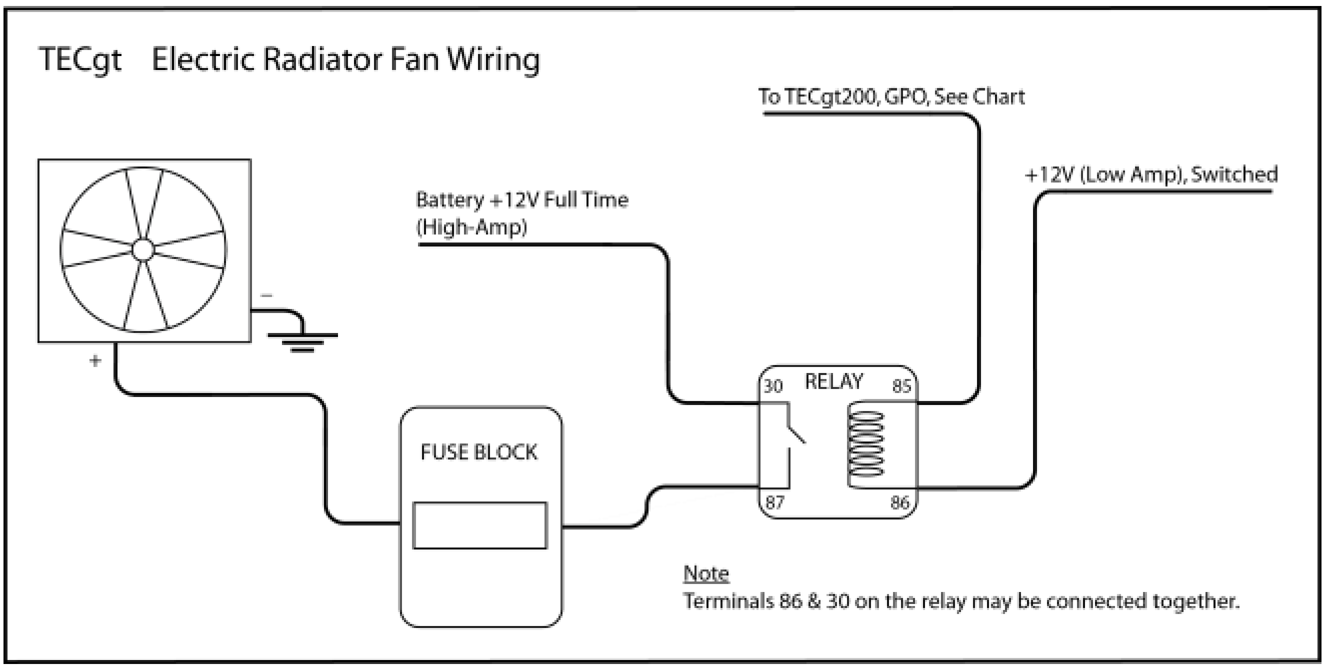


Figure 80: Electric radiator fan wiring.

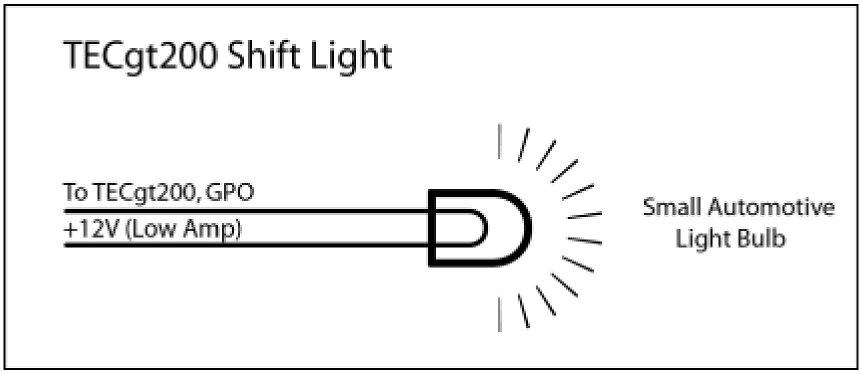


Figure 81: Shift light wiring.

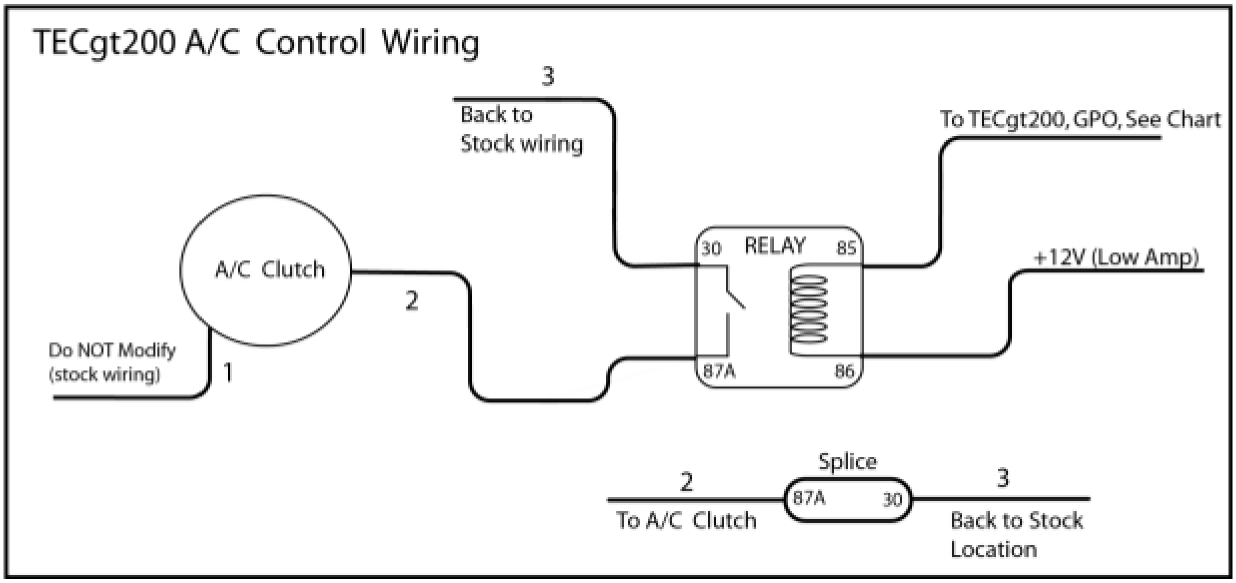


Figure 82: Air conditioner control wiring. Note that the relay simply splices into either of the two wires on the A/C clutch with terminals 30 and 87a. When activated, the A/C control will break the (normally-closed) connection between 30 and 87a by grounding pin 85.

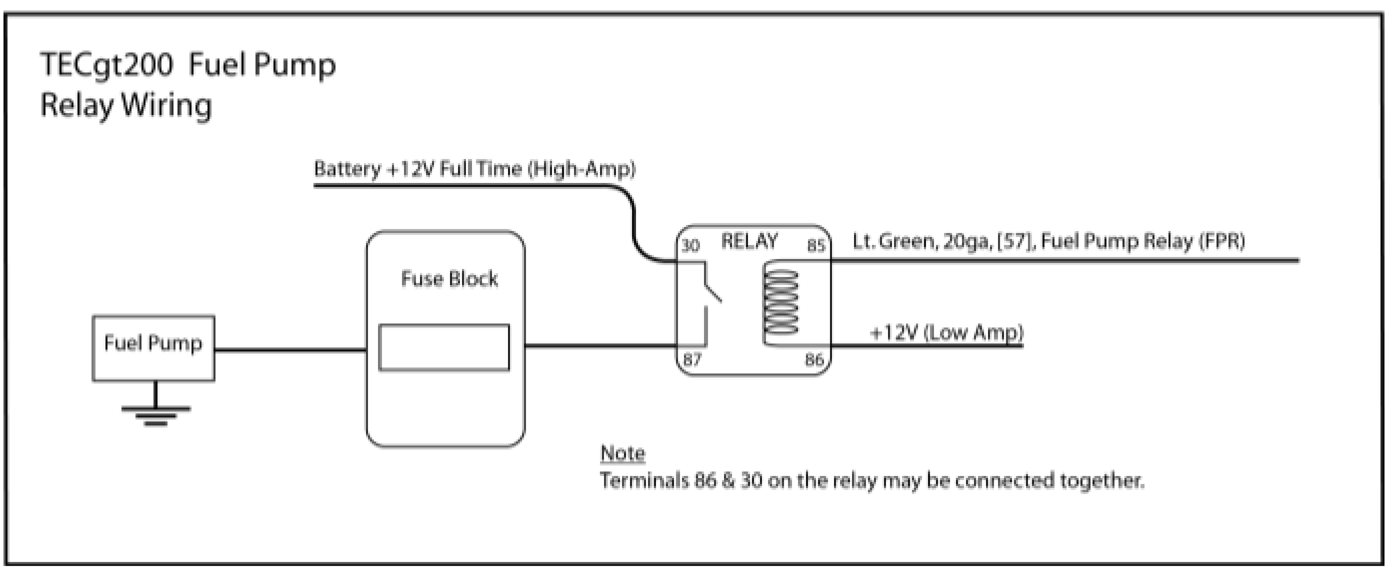


Figure 83: Auxiliary fuel pump wiring.

7 Communications Ports on the XDI200

The XDI200 has 3 serial communications ports built into it. You must connect to one of them to program the XDI200.

7.1.1 PC communications, USB port

The built in USB port allows you to directly connect the XDI200 to your laptop computer without an adapter. Use the connector built into the wire harness to plug directly into your laptop. When plugging the USB jack into your computer, you should hear the “beep-beep” that tells you that Windows has found the USB equipped XDI200 and that the driver is loading automatically from Windows. You may have to have your computer connected to the internet to complete this task. Use Electromotive’s Wintecc4 to begin the calibration process. When opening Wintec4, make sure that Wintec4 discovers your USB connection and its on the correct port number.

Note on finding the USB port:
If Wintec4 cannot find the USB port it is because the PC has assigned the new USB connection to a number higher than 12. To correct this, go to your computer control panel and select hardware device manager. Then look at Ports, If the USB port number shows a number higher than 12, select that port and then select advanced. Change the port number to one that is less than 12. Close that and go to Wintec4 control options and change the communications to that new port number.

7.1.2 PC communications, RS232 Serial port

The XDI200 also has the old style RS232 serial port that some PC computers still have. The XDI200 functions will work identically for either USB or RS232. Do not use both ports at the same time. Make sure the Wintec4 software finds the right port number, usually 1 or 2.

7.1.3 CAN bus serial port

XDI200 has a built in CAN bus port to transmit engine data to other computers on your car. Your supplier of the other computers should have already contacted Electromotive on the details of the data stream. Remember to turn the CAN bus data on in the calibration set up if you need it.

Serial Port	Pin Color	Function
RS 232	30 Brown in 7 conductor cable	Ground
RS 232	31 Orange in 7 conductor cable	RXD
RS 232	32 Blue in 7 conductor cable	TXD
USB	35 Black & Shield in 7 cond. cable	USB Gnd
USB	36 Red in 7 conductor cable	USB PC 5V
USB	37 White in 7 conductor	USB D-
USB	38 Green in 7 conductor	USB D+
CAN	51 Yellow/Pink	CAN High
CAN	52 Green/Pink	CAN Low

Table. Summary of Serial Communications Ports

8 Tuning Guide

8.1 Introduction

This section focuses on the tuning of a **XDI200** equipped engine. The tuning procedures outlined here are based on an engine that has been wired correctly, has proper carburation, and has gone through the Tuning Wizard with the engine parameters to establish a base program. Failure to meet any of these criteria will make the tuning procedure difficult. Refer to section D.4 for terminology used in this section.

8.2 Adjusting the Timing Advance

Perhaps the most important step in tuning an engine is establishing the required ignition advance. An engine with too much timing will detonate, regardless of how much fuel is thrown at it. An engine with too little timing will perform poorly, and overheat the exhaust in short order. We are looking for the happy medium here. Keep in mind that the timing settings are solely dependent on the crank trigger installation angle. If the crank sensor is aligned with the 13th tooth of the trigger wheel when the engine is at TDC #1, the engine timing will be mechanically advanced by two teeth (12 degrees). When this occurs, the timing values in the Ignition Advance Table will be 12 degrees LESS THAN the actual engine timing. If the crank sensor is aligned with the 10th tooth at TDC#1, the timing will be mechanically retarded by one tooth (6 degrees). When this happens, the timing values in the Ignition Advance Table will be 6 degrees MORE than the actual engine timing. **Always confirm your timing values in the software with a timing light!** Remember that dial-type timing lights will not read correctly with the **XDI200** due to the waste-spark. To avoid potential engine damage, it is best to check engine timing with a timing light when first starting the tuning process.

As a guideline, most piston engines, regardless of compression ratio, will require anywhere from 8-20 degrees of advance when the engine is idling. Rotary engines require little or no timing at idle (some even idle with negative advance!), so an ignition advance of zero may work best at low engine speeds. Less timing makes the combustion process occur later, and thus makes the exhaust temperatures higher. It also usually makes an engine idle somewhat rough. If your exhaust manifold is glowing red at idle, you know one thing: there is not enough timing. NO_x emissions will typically be low with too little timing. More timing makes the combustion process occur sooner, and will decrease exhaust temperature. It also makes an engine idle smoother. NO_x emissions will rise with too much timing.

With increasing RPM, the timing needs to be advanced for optimum power. This is a result of the available time for combustion decreasing with increasing RPM. The peak cylinder pressure needs to occur between 10 and 15 degrees after TDC compression for optimum power production, so the timing must be tuned to allow this to happen. As a rule of thumb, engines with slow-burning (large) combustion chambers, and/or low dynamic compression (low volumetric efficiency) typically need more timing advance, since the flame front moves slowly. Engines with fast-burning (usually small) combustion chambers and/or high dynamic compression ratios need less timing for optimum power, since the flame front moves faster.

Peak timing usually should occur by 3000 rpm on most engines. Load-dependent timing should always be used, especially on turbo/supercharged engines. With increasing load (i.e. full-throttle or full-boost), less timing is needed. With decreasing load (i.e. cruising), increased timing is needed.

Rotary engines (particularly the turbocharged rotaries) do not give the tuner a margin of error when it comes to ignition timing. They will detonate ONE TIME only, and will then be broken. The apex seals cannot stand up to the huge shockwave generated by detonation. Tune these engines extremely conservatively!! Start with the least amount of timing possible and the most amount of fuel possible. A huge power-to-weight advantage is present on the rotary turbo engines, but it will only come to a tuner who is cautious and patient.

8.3 Getting the Engine to Idle

Hopefully by now your engine is up and running. Most likely, the idle mixture needs some attention, as does the throttle stop screw**. It is recommended to keep the IAC motor OFF during this preliminary part of the tuning process** (incorrect values in the IAC settings will cause an engine to surge at idle, making tuning difficult, at best). Simply unplugging the IAC motor will do (you don't have to turn the IAC feature off in the software). Make sure the IAC motor is fully extended so that no bypass air is entering the engine. If you are unable to keep the engine running without your foot on the gas pedal, turn the throttle stop screw a few turns to open the throttle. This should keep the engine running.

If the engine is running rough, it is a result of too much fuel. Black smoke will most likely be leaving the tail pipe. If this is the case, decrease the idle fuel mixture.
quality smoothes out.

Timing also plays a big role in idle quality. Most piston engines idle well with at least 10 degrees of advance at idle. Rotary engines require less timing at idle (try zero degrees). Also check that the spark plug wires are all connected to the *appropriate* cylinders. Check the wiring section if you are unsure on this one.

8.4 Tuning the Idle Air Control Motor

Once an engine is running, and the parameters from have been tuned, the **"Tuning the Idle Air Control Motor Section**" can be turned on. The IAC motor has a few settings to establish the proper idle speed without oscillation. Also the IAC motor has the ability to provide increased air to the engine during cranking, without opening the throttle. **The IAC motor will only work if the TPS voltage is below that which is defined in the "TPS Parameters" section.** So if the TPS voltage is 1.5 volts at idle, the "TPS Voltage at Closed Throttle" will need to be set to 1.55 volts in the software in order for the IAC function to turn on.

To begin tuning the IAC motor parameters, turn the engine OFF. Define your desired idle speed as a function of coolant temperature. This is the target speed that the IAC motor will attempt to reach.

Start the engine, and watch the idle speed and coolant temperature. If the engine is idling higher than the desired idle speed setting, the throttle plate is opened too far or there is a vacuum leak on the engine. Try spraying carburetor cleaner around the intake manifold sealing surfaces to check for vacuum leaks, if the throttle plate is fully closed. If the engine is idling lower than the desired idle speed setting, then the IAC motor is not able to supply the engine with enough air on its own. When this occurs, open the throttle plate slightly.

Once the throttle plate is adjusted correctly, the IAC motor should be holding the engine's idle RPM. However, the IAC motor may be causing an RPM oscillation. If this is the case, look to the rest of the IAC parameters.

Along with the IAC motor settings, the "Idle Advance" feature can increase the ignition advance when an engine falls below the desired idle speed, and decrease the ignition advance when the engine rises above the desired idle speed. This can help achieve the desired idle RPM, even on applications not using the IAC motor.

8.4.1 Configuring the New Electromotive Idle Speed Control

For information on wiring the 2-wire IAC, refer to the drawings at the end of this section.

- Go to the idle speed window and enter the following values:
  Error Sensitivity (+): 70 (when RPM is below target)
  Error Sensitivity (-): 70 (when RPM is above target)
  Rate-of-Change Sensitivity (+): 1 (when RPM is increasing)
  Rate-of-Change Sensitivity (-): 220 (when RPM is decreasing)
- Click on the Min/Max Dutycycle button and enter values according to which idle motor you are using.
  Ford: Min = 1, Max = 255, Allow shutdown should be checked
  Honda: Min = 50, Max = 188, Allow shutdown should be checked
  Bosch (should be most German cars): Min = 100, Max = 255, Allow shutdown should be checked
  Mazda: Min = 60, Max = 155, Allow shutdown should not be checked
  Electromotive Stepper: Min = 50, Max = 185, Allow shutdown does not effect this motor
- Pick your idle targets as discussed in Section B.8
- Make sure to pick the control motor type (2- or 4-wire).
- If you are using a 3-wire motor, you must have a 3-wire converter box. Select the 2-wire setting and connect your motor using the 2-wire to 3-wire converter.
- Reset position sets the position that the idle motor will be in after the RPMs drop below the Decel limit. A good starting point for this value is 8.

8.4.2 Idle Speed primer

This idle is a bit complex and can be a bit tough to familiarize yourself without having seen such a system before. However, the process should not be terribly difficult to get through.

The Error Sensitivities define the sensitivity to the difference between the current RPM and the desired RPM. In order to prevent stalling, the rate at which the engine slows down must also be monitored so that the RPMs can be caught to prevent stalling. This is done with the Rate-of-Change Sensitivities. A large value should generally be used with falling RPM and a smaller value should be used with the rising gain. The Error Sensitivities and the Rate-Of-Change values are calculated separately and then added together. This allows the case where the RPM may be higher than the target RPM, but because it is falling rapidly, the idle motor will actually begin to open, to prevent idle droop or a stall. Below are some graphic examples of how these parts work.

8.4.3 Getting the IAC Started

Attempt to start the engine. If the engine starts hard, try reducing the maximum duty cycle until the startup revs are under control. Unfortunately, this trick does not work with the 4-wire IAC. If the engine starts too hard with the 4-wire, try increasing the Positive rate-of change to help arrest high startup revs.

After starting the engine the first time, chances are that it will not hold idle. In some cases, the idle will be stable, or nearly stable. But most of the time, the engine will oscillate and possibly die. Increase the minimum duty cycle until the engine runs without stalling. Once you have done this, you can adjust the minimum duty cycle back down until the desired idle speed is achieved. Generally you will want the engine to idle with an IAC reading of 1-2%. If you decreased the maximum duty cycle very much to stop hard starts, you may consider adjusting your throttle plate instead of increasing the minimum duty cycle.

Once the idle minimum and maximum is set, rev the engine to various RPMs to make sure that the engine returns smoothly to the correct idle speed. Adjust the Reset position until it does. Adjust the falling sensitivity until the idle settles above the target and the arrow indicators for the IAC flicker back and forth. Reduce the falling rate sensitivity until the idle drops. Adjustments to this value should be made in increments of 1 or 2. Adjusting more than that can very quickly cause the RPMs to oscillate.

Once the idle is stable and revs return smoothly to the target idle speed, the car should then be drivable. Little if any adjustments should be required to finalize the idle settings.

8.4.4 Error Sensitivity

Error Sensitivity controls how rapidly the idle motor will move in reaction to the error of RPM at any given time. The picture below shows how the **XDI200** unit finds error.

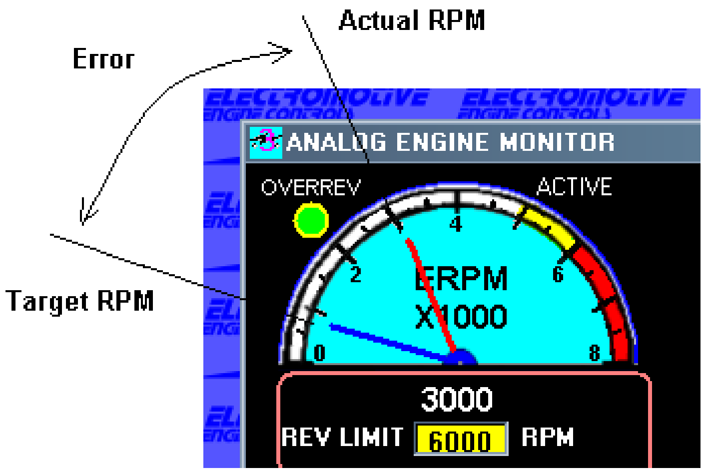


Figure 90

8.4.5 RPM Rate-of-Change Sensitivity

Rate-of-Change sensitivity controls how rapidly the idle motor moves in reaction to the RPM changing. For example, if the RPM is dropping slowly as in example A in Figure 2, the Rate-of-Change sensitivity will result in very little reaction. If the RPM is dropping rapidly as in example B in Figure 2, the reaction will be larger. The Rate-of-Change calculation will always work against the direction of motion. This is the adjustment that will prevent the engine from stalling when the throttle is closing. It can be thought of as an adjustable dashpot.

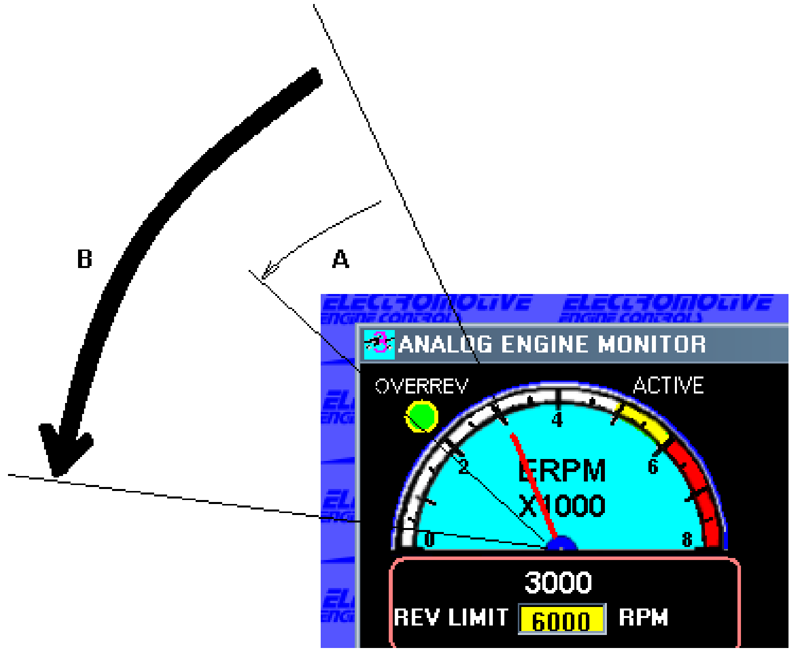


Figure 91

8.5 Tuning Tips:

In most cases, the default values given in the initial setup will be relatively close to the setting your car will need. The settings you will need depend heavily on the size of your engine and the size of the idle motor. For example, if you have a 302 V-8 and are using the Electromotive stepper idle motor, larger sensitivity values will usually be needed because the idle motor must make larger changes to get the engine to respond. In a case where the factory Idle motor is being used, the starting settings given above will likely work well because the idle motor is properly sized for the engine. Regardless of engine/idle motor combination, the default configuration should be close.

8.5.1 Other tips:

If your engine starts and maintains idle, but the idle drops too low when lifting off the gas and then rises slowly to the target RPM, a likely solution is to increase the Reset position. This will help to slow the rate that the RPM drops when lifting off the gas. You could also try a slight increase in falling rate sensitivity.

If the engine keeps shooting past the rpm target in both directions without stopping (RPM is oscillating), try reducing both proportional gains. These values should both generally be the same.

If the engine revs very high when starting (hard start), try decreasing the maximum duty cycle value. This will reduce the amount that the idle motor can open thus reducing how high the engine can rev on startup.

If when revving the engine, the engine rpm oscillates a little bit around the decel rpm while falling, reducing the reset value should help to prevent this. If the engine falls below the idle target and almost stalls, a larger reset value will help.

Fuel Pump Turn-On Time

- **Set Constant for the Fuel Pump Turn-On Time:** This feature is used to turn the fuel pump on when the ignition is turned on. The fuel pump will run for the specified number of seconds, or until engine cranking occurs. Use this value to prime your fuel system.

8.5.2 Absolute vs. Gage Pressure

A MAP sensor is an absolute sensor. This means that its readings are referenced to a full vacuum. As such, the lowest reading attainable on a MAP sensor would be a full vacuum. (In practice, however, most MAP sensors only go down to about 10kPa. Gauge pressure is referenced to ambient atmospheric pressure. When we say that an engine is running 15psi (103kPa) of boost, it means that the intake manifold is seeing 15psi of positive pressure. Since standard atmospheric pressure is approximately 14.7psi (101.3kPa), the absolute manifold pressure for this engine would be 29.7psi (205kPa or about 2 Bar). Thus, a 2-Bar sensor is necessary for this engine. Refer to the formula below if you are confused about the difference between gauge and absolute pressure.

Ambient (atmospheric) Pressure + Gauge Pressure = Absolute Pressure

- When discussing <u>absolute</u> pressure, there is no distinction made between vacuum and pressure.

- When discussing <u>gauge</u> or <u>relative</u> pressure, vacuum readings will be negative values and boost readings will be positive. Alternatively, in the US measurement system, vacuum readings can be expressed in inches of Mercury and boost can be expressed in pounds per square inch.

8.5.3 Units of Measurement

In the US, units of vacuum are typically measured in inches of mercury (in-Hg). Units of pressure are typically measured in pounds per square inch (psi). Since there is a distinction made between vacuum and pressure readings, these units are generally not used for absolute measurements.

In most other countries, the metric system in used for pressure measurements. In this system, the kilopascal (kPa) is the standard unit of measurement. The distinction must be made to whether the measurement is in absolute kPa or gauge kPa. Typically, this is done by writing “kPa, abs” for the former, and “kPa, gauge” for the latter. For the purposes of this section, we will treat all kPa reading as *absolute* readings. **Table 11** gives conversion data for US and metric units. Remember:

Ambient (atmospheric) Pressure + Gauge Pressure = Absolute Pressure

- **1psi = 6.895 kPa**
- **1 in-Hg = 3.377 kPa**
- **1 Bar = 101.3kPa, abs = 0psi, gauge**
- **2 Bar = 202.6kPa, abs = 14.7psi, gauge**
- **3 Bar = 303.9kPa, abs = 29.4psi, gauge**

Table 11: US to metric unit conversion data.

kPa Absolute	in-Hg/psig Gauge
0	29.9 in-Hg
10	27.0 in-Hg
20	24.0 in-Hg
30	21.1 in-Hg
40	18.1 in-Hg
50	15.2 in-Hg
60	12.2 in-Hg
70	9.28 in-Hg
80	6.31 in-Hg
90	3.35 in-Hg
100	0.39 in-Hg
110	1.26 psi
120	2.71 psi
130	4.16 psi
140	5.61 psi
150	7.06 psi
160	8.51 psi

kPa Absolute	in-Hg/psig Gauge
170	10.0 psi
180	11.4 psi
190	12.9 psi
200	14.3 psi
210	15.8 psi
220	17.2 psi
230	18.6 psi
240	20.1 psi
250	21.6 psi
260	23.0 psi
270	24.4 psi
280	25.9 psi
290	27.4 psi
300	28.8 psi
310	30.3 psi
320	31.7 psi
330	33.2 psi

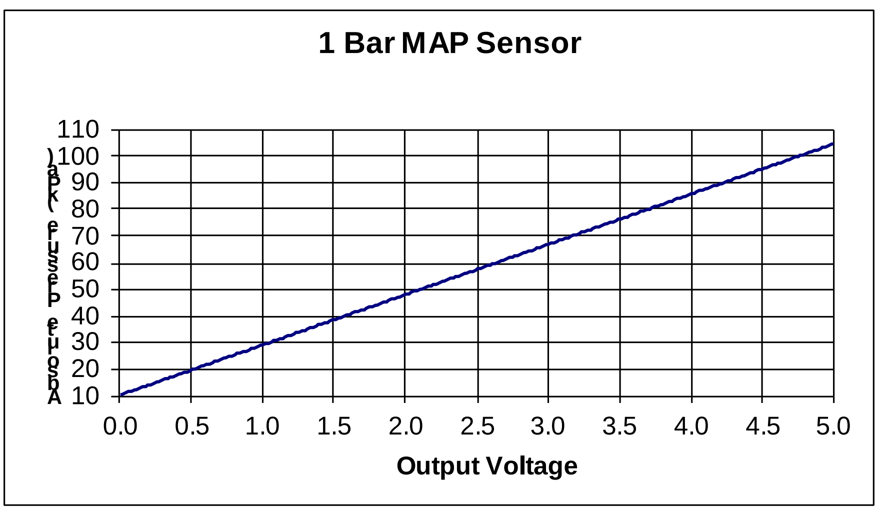


Figure 106: 1-Bar MAP sensor output voltage.

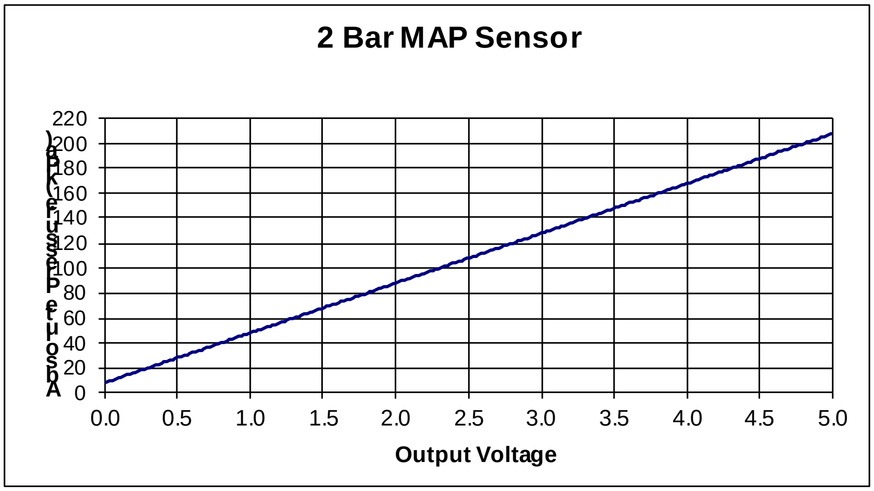


Figure 107: 2-Bar MAP sensor output voltage.

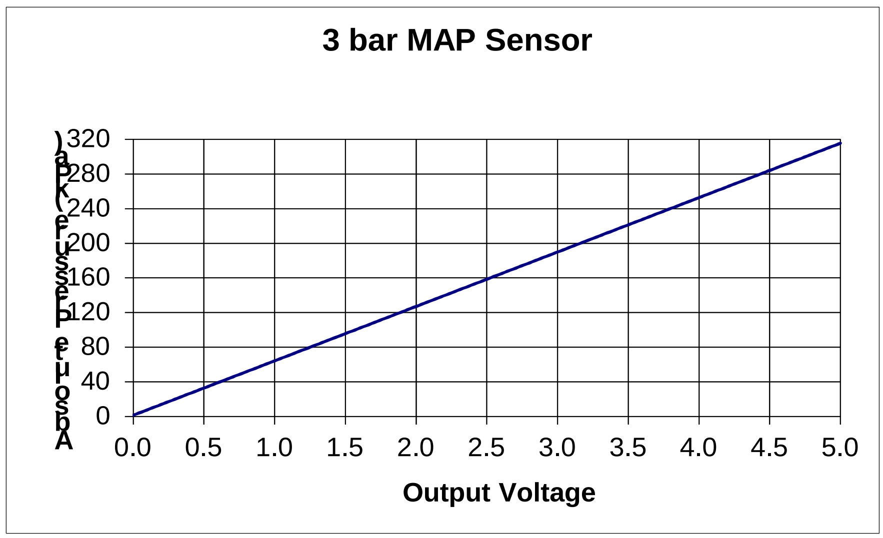


Figure 108: 3-Bar MAP sensor output voltage.

9 Diagnostics

The **XDI200** has two provisions for diagnostics: an output wire for a “check engine” light and an LED on the ECU. The two outputs perform different tasks that are outlined below.

9.1 Trouble Codes from the LED’s Mounted on the XDI200

The LED’s mounted on the **XDI200** are used to alert the user’s attention to electrical and crank trigger problems. They are also used to show the mode (in terms of the rpm range) in which the **XDI200** is operating. Here are the readings from the LED’s :

- **Turn ignition key on (but do not start engine):**
  Upper LED goes steady green :

Good, the processors are getting power.

Upper LED does not turn on at all :

Either the **XDI200** is not receiving +12V power from pin (A), or the ECU has an issue.

- **Engine cranking (below 400 rpm):**

  Lower LED changes color from red to green every other revolution:

  Good, the crank sensor is working correctly

  Lower LED does not change colors:

  The crank sensor is not functioning properly (signal is not being picked up).

- **Engine running (over 400 rpm):**

  Lower LED is steady green:

  Good, the crank trigger is functioning properly.

  Lower LED flashes red every so often:

  The **XDI200** is getting a bad signal from the crank trigger. The engine most likely misfires whenever the light flashes red.

- **Engine is Hitting Rev Limiter:**

  Lower LED changes color turns orange:

  The first or second stage of the rev limiter is occurring.

  Lower LED turns red:

  The third (and final) rev limiter stage is occurring.

Note:

If a misfire occurs during normal engine operation, but the lower LED on the **XDI200** was not observed to momentarily flash red, the crank sensor may be at fault. To test for errors in this situation, turn the engine off without removing power from the **XDI200** ECU by hitting the letter "K" from the engine monitor screen when using a laptop). If the lower LED is flashing red after the engine is shut off, there was a crank sensor problem at some point during the run.

9.2 Trouble Codes from the Check Engine Output

The trouble codes from the check engine output are related to the engine sensors. If the check engine output wire is connected to a light bulb, it will display a sequence of flashes depending on the problem. The diagnostic codes are arranged such that there are two digits for each code. The check engine light will give long duration flashes for the first digit of the code and short duration flashes for the second digit. Here are the diagnostic codes(asterisked items are not available with the first software release):

- 12: Crank Trigger Error
- 13: Cam Trigger Error
- 14: ECU Internal Failure*
- 21: Throttle Position Sensor High
- 22: Throttle Position Sensor Low
- 23: Manifold Air Pressure Sensor High
- 24: Manifold Air Pressure Sensor Low
- 25: Coolant Temperature Sensor High
- 26: Coolant Temperature Sensor Low
- 31: Manifold Air Temperature Sensor High
- 32: Manifold Air Temperature Sensor Low

- 33: High Battery Voltage
- 34: Low Battery Voltage
- 35: Knock too Long
- 37: Exhaust Gas Oxygen Sensor Lean too Long
- 38: Exhaust Gas Oxygen Sensor Rich too Long*
- 41: GP I/O 6 Input High*
- 42: GP I/O 6 Input Low*
- 43: GP I/O 7 Input High*
- 44: GP I/O 7 Input Low*
- 45: GP I/O 8 Input High*
- 46: GP I/O 8 Input Low*
- 47: GP I/O 9 Input High*
- 48: GP I/O 9 Input Low*
- 51: GPO 1 Failure
- 52: GP I/O 3 Failure
- 53: GP I/O 4 Failure
- 54: GP I/O 5 Failure
- 61: Idle Speed Motor Driver Thermal Shutdown
- 62: Idle Speed Motor Driver Short to Battery or Open Load
- 63: Idle Speed Motor Driver Short to Ground

9.3 Trouble Code Descriptions

Code 12 – Crank Trigger Error: This code will register when the ECU has detected a problem with the crank trigger signal. If any of the failure scenarios have been detected in the section above on the crank sensor LED diagnostic, this code will be displayed

Code 13 – Cam Trigger Error: The ECU is not getting an appropriate signal from the cam sensor. A broken cam trigger wheel or a bad cam sensor could cause this error. This code will only be displayed on sequential applications.

Code 14 – ECU Internal Failure: This code is displayed when there has been a substantial failure inside the ECU. Call Technical support for further information.

Codes 21 & 22 – TPS High/Low: See above description.

Codes 23 & 24 – Manifold Air Pressure High/Low: These codes are set when the MAP sensor has gone outside its specified range. This can be useful for a boosted application to trigger a check engine signal when an over-boost situation has occurred. Alternately, it can be used to detect a short in the wires. When this code is displayed, the **XDI200** will be using the MAP Failure Default value for MAP calculations. As such, there will be no load input to the **XDI200's** ECU, and the computer will enter into a "limp-home" mode.

Codes 25 & 26 – Coolant Temperature Sensor High/Low: Once again, these codes are set when the coolant temperature reading is outside its specified range. Use this light to warn of coolant temperatures that are too high. When this code is displayed, the **XDI200** will be using the CLT Failure Default value for coolant-based calculations. As such, there will be no engine temperature input to the **XDI200's** ECU.

Codes 31 & 32 – Manifold Air Temperature Sensor High/Low: Works identically to codes 25 & 26, except for the MAT sensor.

Code 33 – Battery Voltage too High: The battery voltage has exceeded 17 Volts. This can be caused by a bad voltage regulator on the alternator.

Code 34 – Battery Voltage too Low: The battery voltage has gone below 7.5 Volts. Check the state of charge on the battery. Also check all power connections.

Code 35 – Knock too Long: The ECU has recorded a level of engine spark knock (from the knock sensor) for a duration that exceeds what was established in the software. This code is indicative of either poor fuel quality, or extreme engine temperatures leading to spark knock. Some tuning will be required for the knock sensor trouble codes, since all engines make noises that will trigger the knock sensor, but which are not caused by spark knock.

Code 37 – EGO Lean too Long: This code is set when the oxygen sensor reading is lean for a prolonged period of time. Make sure the sensor has not come unplugged.

Code 38 – EGO Rich too Long: This code is set when the oxygen sensor reading is rich for a prolonged period of time. Make sure the sensor is not shorted to +12 Volts.

Codes 41&42, 43&44, 45&46, 47&48 all function like Codes 23&24, except they are for the Analog to Digital Inputs.

Codes 51-54 – GP I/O 1-9 Failure: These codes are set when the GP I/O input/outputs have been shorted to voltage or have been over-drawn (too much current). Make sure that the total circuit draw for GP I/O's 1-9 is less than 10 amps (1 amp per channel).

Code 55 – Fuel Pump Output Failure: The fuel pump output has seen an over-current situation, or is shorted to power.

Code 56 – Check Engine Output Failure: The check engine output has seen an over-current situation, or is shorted to power. The code can only be seen with a laptop, since the check engine light is likely at fault.

Code 58 – Tachometer Output Failure: The tachometer output has seen an over-current situation, or is shorted to power or ground.

Code 61 – Idle Speed Control Thermal Shutdown: The driver for the idle speed motor has been overheated. The can be caused by incorrect IAC motor wiring, or from a broken motor.

Code 62 – Idle Speed Control Short to Battery or Open Load: This code is set when the IAC driver has been shorted to voltage, or the motor has been unplugged.

Code 63 – Idle Speed Control Short to Ground: The IAC driver has been shorted to ground.

9.3.1 Using the Trouble Codes

The trouble codes are displayed for a sensor when the maximum or minimum value for a sensor has been exceeded. Since the maximum and minimum points are user-definable in the

WinTec software, a failure code does not necessarily indicate a failed sensor (i.e. the failure parameters may be set incorrectly).

As an example, let's look at the Throttle Position Sensor Parameters. Before the parameters can be entered into the software, it is necessary to know the TPS voltage at both fully closed and wide open throttle. This can be observed in the monitor screen by opening and closing the throttle (without the engine running). If the closed throttle voltage was 1.0 volt and the wide open throttle voltage was 4.6 volts, the TPS parameters should be set as follows:

TPS Fully Closed Throttle Voltage:	1.1 Volts
TPS Wide Open Throttle Voltage:	4.5 Volts
TPS High Voltage Failure (0-5V):	4.8 Volts
TPS Low Voltage Failure (0-5 V):	0.8 Volts
TPS Failure Default Value (0-5V):	1.5 Volts

As can be seen, the **Fully Closed Throttle Voltage** setting is actually a bit above the actual closed throttle voltage (1.1V > 1.0V). This is done because the Idle Speed Control will only start working when the TPS reading is below the **Fully Closed Throttle Voltage** setting. The **Low Voltage Failure** setting is made a few tenths of a volt lower than the actual closed throttle voltage (1.0V > 0.8V). This is done to display code 22 for throttle position sensors that have either rotated in their mount or have failed completely by outputting a lower-than-expected voltage. Likewise, the **High Voltage Failure** setting is made a few tenths of a volt higher than the observed wide open throttle voltage. This will allow code 21 to be displayed in the event of a high voltage failure. The **Failure Default Value** is the voltage that the **XDI200** will use for its TPS-based calculations when the TPS sensor has failed. Since this is a fixed value, there will be no TPS-based acceleration enrichments when the TPS has failed. However, the Failure Default Value is useful for applications using the TPS-MAP Blend feature because it defines a fixed amount of TPS to blend with the MAP sensor during a TPS failure.

9.3.2 Wiring the Check Engine Light

The check engine light output gives a pull-to-ground for a light bulb. Pin on the **XDI200's** gray connector is the pink wire for the check engine light. The circuit should not be allowed to flow more than 0.25 Amps, which dictates that a light bulb of 3 Watts or less should be used. See **Figure 110** for wiring instructions.

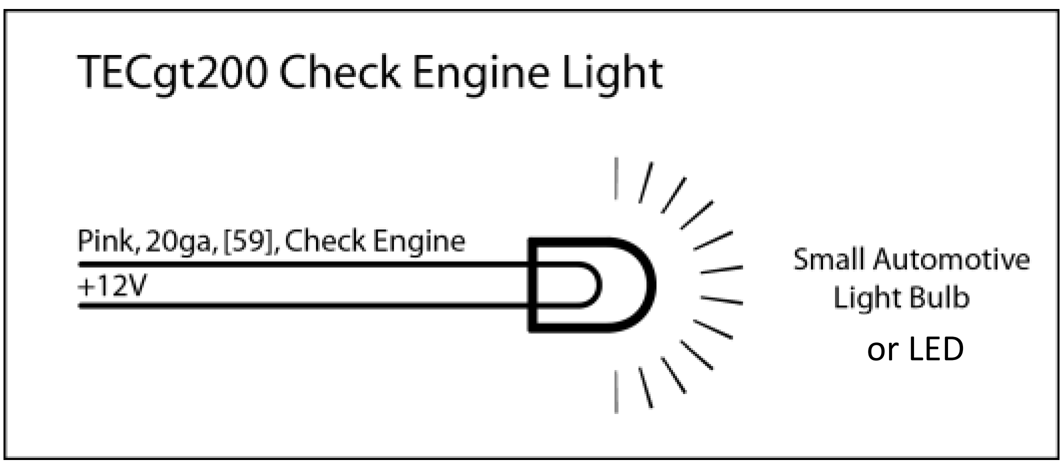


Figure 110: Wiring diagram for the check engine output.

9.4 Tuning the Knock Control

Once an engine is tuned well enough to drive, the Knock Control feature can be used. The Knock Control retards timing based on detonation occurrence. When the detonation level detected by the KNK sensor exceeds the value defined in the Knock Threshold setting, the **XDI200** will begin to retard the timing. More specifically, the timing will be retarded in increments defined by the Rate of Advance Retard. Each time a coil fires, the timing will be retarded by this amount until the knock level has dropped below the Knock Threshold. If the knock level drops below the Knock Threshold, the **XDI200** will add back ignition advance in increments defined by the Rate of Advance Increase parameter. If the knock level does not drop below the Knock Threshold, the **XDI200** will stop retarding the ignition timing when the Maximum Retard Allowed parameter is met. It is important to realize that the **XDI200** will NEVER add ignition timing over and above the value set in the Ignition Advance Table when the Knock Control is adding advance back to the engine.

9.5 Using the Ignition Advance Trims

The Ignition Advance Trim feature allows timing to be adjusted based on coil output channels. When in phase-sequential operation, the coils can be trimmed in waste-spark pairs. When in full-sequential operation, the coils can be trimmed on an individual cylinder basis.

When the Ignition Advance trim is used, a set amount of timing can be added to or subtracted from the Ignition Advance curve. Certain engines have the tendency to detonate on certain cylinders more than others. To counteract this issue, the Ignition Advance Trim can be used to remove timing from the problematic cylinders.

Timing can be adjusted by + or – 15^{o}.

10 Data logging with the XDI200

There is a huge amount of data moving between the engine sensors and ECU when using the **XDI200** system. The data logging feature of the system allows users to view all of this data in graphical format, thereby simplifying tuning and troubleshooting by a huge amount. Data logging is available in two modes : **On-Board** Data logging (OBD) and **PC-Based** Data logging (PCD). As their name imply, OBD stores sensor information inside the **XDI200's** ECU, while PCD stores sensor information on the hard drive of a laptop.

10.1 PC-Based Data logging

PCD requires the use of a laptop computer to record sensor data. The volume of recorded data is only limited by hard drive space. Since the data is recorded in a simple text file, only a small amount of disk space is needed for a lot of data logging.

To engage the PCD function, simply click on the "Create Data log File" button in the WinTec software. The speed at which the data logging occurs can be defined, as can the length of the data recording. To view the data, click the "View Data log File" button in the software. The data can be displayed on either a single graph with all the sensors, or individual graphs for each sensor.

10.2 On-Board Data logging

On Board Datalogging, OBD does not require that a laptop be present to record data. Instead, the OBD function is engaged by a switch to +5 or +12 volts on a GPI channel. Using the Data Log Status Light line (pin [56]), an OBD status light can be wired to tell the user what mode of data logging is occurring. Consult **Wiring Sensors and Inputs** to wire the GPi and Data Log Status Light to configure the data logging. When wired appropriately, the status light will display the following codes : **Light is Off :** No OBD is occurring. **Light is Flashing :** The OBD function is active, and data is being recorded. **Light is On :** The OBD memory is full.

When the OBD memory is full, turn the GPI switch off. View the data log file with the Wintec software by selecting the GPI channel and double click on "Retrieve Data Log from Unit". If you do not wish to view a particular OBD file, simply turn the GPI switch back on, and the previous file will be erased. This is an important fact : whenever the GPI switch is turned off, the data will remain in the Tec's memory, even if the engine is shut off. When the switch is turned back on, the previous data will ALWAYS be erased.

There is the option to engage the OBD function only above a specified RPM point. When this is chosen, the OBD will be engaged when that RPM is reached, and will remain on until the switch is turned off, or the memory is full.

Typically, the RPM activation point is used for drag race applications in the following scenario : In the software, set the RPM point to be about 200 RPM above the staging RPM. Do the burnout and stage the car. Turn on the OBD feature. Make the run and turn the OBD off after crossing the finish line. Download the data to the laptop when you are ready to view it. The memory will be erased the next time the OBD switch is turned on.

The OBD has a much higher sampling rate then the PCD. The sampling rate can be defined in the software. Faster sampling rates allow less time to be viewed in a data log file. Conversely, slower sampling rates allow more time to be viewed in a data log file.

OBD total data logging time is limited by the memory space available in the Tec. When the data logging is operating at the highest frequency (20 samples-per-second), about 109 seconds of data can be stored in the memory.

11 Rev Limiters

Several different rev limiters are built into the **XDI200** system. These rev limiters can be engaged in a few different manners, and can be used for a variety of functions.

11.1 Valet Mode Rev Limiter

The Valet Mode rev Limiter is engaged when the Valet Switch is turned on. See **Section Wiring General Purpose Inputs** for details on wiring the valet switch. Use a standard GPI input pin, a dash mounted switch and configure the function in Wintec. The Valet Mode Rev Limiter is activated by either RPM or Vehicle Speed. When the RPM or speed threshold is crossed, the Valet Mode Rev Limiter will be engaged.

The Valet Mode Rev Limiter can also be used as a staging rev limiter in drag racing applications.

11.2 Secondary Rev Limiter :

The Secondary Rev Limiter is activated when the MAT line (White 20awg, Pin 47) is connected to ground. When activated, it will engage the same type of rev limiter as the Primary

Rev Limiter (so if the Three-Stage Rev Limiter is chosen for the Primary Rev Limiter, the Secondary Rev Limiter will also be a Three-Stage).

The Secondary Rev Limiter is most often used in drag racing applications as a staging rev limiter. A relay can be connected to the Trans-Brake on an automatic car, and when the brake is released, the relay will break the connection between the MAT line and ground.

The MAT reading will obviously drop to zero volts, which corresponds to a temperature of 150C. It is recommended that the Low Voltage Failure for the MAT be set slightly higher than zero volts to counteract this effect. This will cause the MAT reading to go to the Failure Default Value.

The easiest way to wire the Secondary Rev Limiter is to use a standard 4-position relay. Using the relay, Pins 30 and 87 will short to each other when 86 goes to +12 volts :

Relay Pin 30 : MAT Sensor Signal (White 20awg, **[47]**) from the connector AND from the **XDI200**.

Relay Pin 87 : Sensor Ground (Black/White 18awg, **[17]**) from the MAT Connector AND from the **XDI200.**

Relay Pin 85 : Vehicle Ground

Relay Pin 86 : Switch to +12 Volts to activate Secondary Rev Limiter.

11.3 Primary Rev Limiter :

The Electromotive rev limiter is very flexible. For ignition control, the timing can be dropped to 0 degrees on rev limit, or our 3-stage coil cut can be used. The options are described below.

11.4 Zero degree advance

This is the simplest rev limiter. When the rev limit is reached, timing is simply dropped to zero degrees. This item is unlikely to do the job by itself in any but the lowest power applications.

11.5 3-stage coil cut

The 3-stage coil cut uses three steps to limit RPMs. When the rev limit is reached, timing will drop to 12 degrees ATDC. This step by itself will cause a significant drop in power. However many high powered, boosted engines will continue to climb quite rapidly. After a specified number of RPM, the coil current is cut in half. This will cause the engine to misfire and further reduce the RPM increase. If the engine continues to climb, after the second specified number of RPM, the ignition is cut completely. This rev limiter alone will prevent over revving, but in the case of high powered drag engines coupled to an automatic transmission or supercharged applications, this can be quite violent. This is best used alone in naturally aspirated and turbo charged engines with a manual transmission.

11.6 Full coil cut

Full coil cut rev limiter turns all coils off at the rev limit speed.

12 Troubleshooting

Troubleshooting an engine management system is actually a fairly straightforward process. When viewed in simple terms, an engine that is in good mechanical condition, but will not run properly, can only need one of these things:

- Make sure there is adequate fuel pressure at all times.
- Make sure the crank trigger is installed properly.
- Make sure the wiring is correct.
- Make sure the DFUs are GROUNDED and that the coil screws are TIGHT.
- Make sure that the engine sensors are reading correctly.
- Make sure that the fuel injectors are firing, and are not clogged.
- Check the fuses and relays if a power loss occurs.

12.1.1 Air, Fuel, and Spark

As a result, troubleshooting an engine problem can be divided into these three parameters. With laptop software that allows the tuning of the engine as well as the diagnosis of potential engine sensor problems, troubleshooting an electronically controlled engine is fairly simple.

12.2 Starting Problems

12.2.1 Air-Related Starting Problems

- A small amount of air must enter the engine cranking in order for the engine to start.
    - Open the throttle a small amount during cranking. If the engine starts, manipulate the IAC motor settings as outlined in the **Tuning Guide Section sub section idle air control.** for proper start-up parameters.
    - If the engine does not start with a small amount of throttle opening, look to either fuel or spark-related problems.

12.2.2 Fuel-Related Starting Problems

Note: When diagnosing a fuel system problem, a fuel pressure gauge will be needed.

- With the ignition key switched on, the fuel pump should run for a few seconds. The fuel pressure should then increase to the rating of the fuel pressure regulator (typically 43psi).
    - If the pressure does not rise to this pressure, there is either air in the line, or the fuel pump or regulator is malfunctioning.
        - Air can be relieved from the fuel line by running the fuel pump for a minute or two.
    - If the pressure stays at 43psi but the engine will not start, look to the fuel injectors.
- If the fuel system passes the above test procedure, look to the engine tuning calibration file.
    - Too much of a starting enrichment will flood the engine. A flooded engine will have spark plugs that are wet with fuel.
    - Too little starting enrichment will keep an engine from starting and running properly.
    - A coolant temperature enrichment that is too low or too high will cause an engine to have cold starting problems.

12.2.3 Spark-Related Starting Problems

- The crank sensor is the first thing to check when an engine will not start.
    - Crank the engine. The LED on the **XDI200** ECU should flash red-green-red-green in a fairly steady fashion. If the light is not functioning in this manner during cranking, and there is no RPM reading when viewed on a laptop, there is likely a trigger problem.
    - IF the Crank indicator is solid green then…

        - Check the crank sensor alignment and air gap with the trigger wheel.
        - Check the crank sensor resistance (should be between 600 and 700 ohms across the red and black wires).
    - If the Crank indicator is solid red then…
        - check that all teeth are intact not damaged
        - The run out (out of round) of the sensor wheel is not excessive.
        - No other electrical interference is present such as DC motors or spark plug wires are near the sensor or wheel.
        - That the steel wheel and pulleys are not magnetized
    - If the LED is functioning normally, check for spark at the coils. Remove the two spark plug wires from the coils, and watch for a spark between the coil towers during cranking. BE EXTREMELY CAREFUL NOT TO TOUCH THE SPARK!! It will really be painful, and can be deadly to people with pacemakers!
        - If there is no spark, check the wiring to the DFU and to the **XDI200**. Pin D on the DFU should have +12volts with the ignition key on.
        - If the wiring is good, and the coils are still not firing, look to the software. Make sure the appropriate calibration file is loaded.
        - If there is spark across the coil towers, but the engine will not run, check the plugs and plug wires. Also be sure that the coils are firing the appropriate cylinders (see **Wiring section, sub section coil firing patterns**. An engine will not run (or will run very rough) if the plug wires are not going to the appropriate cylinders.
- If the engine backfires through the throttle, check that "mechanical timing" has not been added or subtracted with an improper trigger wheel installation.

12.3 Idling Problems

Sections on Idle speed control in the Tuning Guide above should be consulted to determine problems with idling that are tuning-related before any troubleshooting is undertaken.

12.3.1 Air-Related Idling Problems

- If using an IAC motor, and the engine is surging at idle, turn the IAC control OFF.
    - If the engine idles nicely, it is likely an IAC tuning problem.
    - If the engine still surges, it is likely an air-fuel mixture problem.
- If using an IAC motor and the engine runs rough at idle, it is likely an air-fuel mixture problem.
- If the IAC motor does not seem to be functioning at all, check the TPS closed throttle voltage. This value must be ABOVE the actual TPS reading at closed throttle in order for the IAC motor to be engaged.
- If the engine idles too high, either the IAC motor is not functioning, the RPM value set in the calibration file is too high, or the throttle plate is opened too far.
- To check for proper IAC functioning, the pintle should retract fully when the ignition key is first turned on, if using a 4-wire IAC motor. The motor should then move out by the specified amount in the IAC motor settings.

12.3.2 Fuel-Related Idling Problems

- Check for stuck injectors and fuel pressure problems if the idling characteristics cannot be improved through tuning

12.3.3 Spark-Related Idling Problems

- Check for wiring problems before attempting to correct an idling problem. If the plug wires are run correctly, and the DFUs are powered correctly, check the ignition advance table.
- Engines typically need at least 10º of timing to idle smoothly. Check the Timing Advance Table at the idle MAP/RPM points.
- Check the trigger wheel installation to make sure that "mechanical" timing has not been (unknowingly) added or subtracted.

12.4 Low-, Medium-, and High-Load Problems

12.4.1 Air-Related Load Problems

To function properly, the only air-related load problems arise from improperly sized throttles. Make sure that a throttle can flow enough air for an engine. Stock throttles on heavily modified engines will typically cause upper-rpm performance problems.

12.4.2 Fuel-Related Load Problems

- Fuel problems when an engine is under load can cause engine damage quickly. The first check for the fuel system is to look at the fuel pressure.
  - If the fuel pressure is dropping with load, there is a problem. Either the fuel pump cannot keep up with the engine's fuel needs, or the fuel pressure regulator is not functioning properly. Fuel pressure should increase by 1psi with every 1psi of boost on turbo- or supercharged engines (unless a rising rate regulator is installed).
  - If the fuel pressure is good, the injectors may be undersized. .
  - If the injectors are sized appropriately and the fuel pressure is adequate, it is likely a tuning issue.
- Undesired EGO sensor corrections can contribute to fuel problems under load. .

12.4.3 Spark-Related Load Problems

- Problems related to spark when under load can be traced to three factors: Tuning, Secondary Ignition Failure, and Improper Wiring. Make sure the DFU's are wired correctly before proceeding.
  - Tuning issues sometimes seem like spark-related problems. An engine that is detonating has too much timing in the Ignition Advance Table, or is not receiving enough fuel. An engine that is not performing well may have too little timing, or too much timing.
    - Try adding timing until detonation is detected, then back off a bit. Rotary engines do not make a loud pinging sound, so **do not** attempt to run a rotary into detonation.
  - Secondary Ignition failure is often blamed for ignition problems under load. The secondary ignition includes the spark plugs and spark plug wires. **See the Wiring Section** above for the proper selection of spark plugs and wires.
    - Make sure the coil screws are very tight! Also, the DFU's must be grounded for proper operation.
    - If misfiring occurs under load, loose coil screws or ungrounded DFUs are often the culprit.

13 Appendix I. ECU Specifications

13.1 OUTPUTS

13.1.1 Coil Outputs

- 6 x 8 amp direct-fire coil drivers
- Feedback charging loop for ideal cylinder-to-cylinder consistency
- No "ignition modules" or "CD" boxes needed
- 6 parallel Logic output for DOC coils, with user set fixed dwell time.

13.1.2 Idle Air Control (IAC) Motor

- Provides control of 4-wire stepper motor IAC's
- 2-wire IAC motor control
- Adjustable idle speed increase for cold starts
- Adjusts idle speed in response to engine load (i.e. A/C activation)

13.1.3 General Purpose s (GPO's)

- 1 amp max per GPO channel
- 7 channels of pull down outputs
- 4 channels are push-pull for 4 wire IAC's

13.1.4 Fuel Pump Control

- Low current pull-to-ground output for activation of fuel pump relay
- Configurable for fuel system priming

13.1.5 Tachometer Output

- Drives modern 0-12 volt tachometers
- High side amplifier to drive multiple triggered tachometers and other devices.

13.1.6 Check Engine Light Output

- Pull-to-ground output for instrument panel light (1 amp max current draw)

13.1.7 ECU Diagnostic Check engine Lamp

- Warns of crank trigger problems
- Multi-code diagnostics

13.2 INPUTS

13.2.1 General Purpose Inputs (GPI's)

- 8 channels 0-5 Volt analog inputs
- 1 Resistive temperature device.
- 1 Secondary EGO channel 0-5 Volts
- 1 Road Speed pulse input

13.2.2 Engine Sensor Inputs

- Crank Sensor
  - 2-wire magnetic or Hall sensor (compatible w/ some OEM's)
  - Uses Electromotive-spec 60(-2) tooth crank trigger
  - Ultra-high resolution engine position input
- Cam Sensor
  - Hall effect sensor necessary for full-sequential applications
  - Once-per-cam-revolution pulse
- Manifold Air Pressure (MAP) Sensor

- 1 Bar: 0-104kPa absolute
  30”Hg – 0”Hg (naturally aspirated)
- 2 Bar: 0-206kPa absolute (up to 1 Bar Boost)
  30”Hg – 15psi (up to 15 psi Boost)
- 3 Bar: 0-313kPa absolute (up to 2 Bar Boost)
  30”Hg – 30psi (up to 30psi Boost)

- Throttle Position Sensor (TPS)
  - Uses throttle shaft-mounted rotary potentiometer
  - Compatible with most OEM 3-wire setups
- Coolant Temperature Sensor (CLT)
  - Uses NTC thermistor coolant sensor (2-wire)
- Manifold Air Temperature Sensor (MAT)
  - Uses NTC thermistor manifold temperature sensor (2-wire)
- Knock Sensor (KNK)
  - Provides ability to detect pre-ignition
  - Compatible with piezo-style knock sensors (1-wire)
- Oxygen Sensor (EGO)
  - Compatible with 1-, 3-, and 4-wire oxygen sensors
  - Wide Band converter modules (0-5v output)

13.2.3 Angle Based Timing Control

- Ultra-high resolution triggering
- Engine position known to within 1/8º

13.2.4 Feedback Charging Control

- Monitors each coil firing event
- Coil current monitoring
  - Consistent dwell adjustment
  - Full coil charging without overcharging

13.3 Tuning Features

13.3.1 Ignition Timing Map

- 16 x 16 user definable tables of RPM vs. MAP for ignition advance angle
- 65535-point interpolation between data points
- 1º adjustment increments
- +/-1/4º spark timing accuracy, worst case

13.3.2 Rev Limiters

- Progressive “soft” rev limiter (3 stages)
- 1000-20000rpm capability for primary rev limiter
- 1500-12000rpm capability for auxiliary rev limiter

13.3.3 On-Fly Tuning

- Glitch-free, real-time tuning while engine is running
- Full control of all fuel, ignition, and input/output parameters

13.3.4 Compensation Features

- Ignition
  - Coolant temperature-based advance adjustments
  - Manifold air temperature-based advance adjustments
  - Smooth idle advance control (integrated w/ IAC settings)
  - Paired-cylinder timing trims (each coil has timing trim)
  - Individual-cylinder timing trims for full-sequential setups

- Ignition timing offsets for odd-fire applications
- RPM-based timing split for rotary application

13.4 Supported Engine Configurations

13.4.1 4-Stroke

- 1-, 2-, 3-, 4-, 6-, 8- 12- cylinder even-fire engines.
- 2-, 4- 6- cylinder odd-fire engines.
- 2-, 4- 6-cylinder dual-plug engines.
- Waste-spark ignition control for all applications

13.4.2 2-Stroke

- 1-, 2-, 3-, 4- cylinder engines.
- Coil-per-plug for all applications

13.4.3 Rotary

- 1-, 2- 3-rotor engines.
- Coil-per-plug for all applications

13.5 Data logging Features

13.5.1 Laptop Data logging

- Records to hard drive on laptop
- Sampling rate is approximately 50 samples-per-second
- Total data logging time is limited only by hard drive space

13.6 Physical Dimensions

Length:	7.5”
Width:	4.0”
Height:	1.0” (add for connector)
Weight:	1.55 lbs
Bolt Hole Pattern:	6.88” x 3.375” (1/4” – 6mm bolts)

13.7 Environmental Considerations

One Sealed 73-Pin Molex MX123 Connector for Inputs & Outputs
Sealed Printed Circuit Board. Water resistant case, under hood mountable.

13.8 PC Requirements

Computer

- IBM-Compatible PC
- Pentium-1 233 or better
- 1024 x 768 monitor resolution (256 colors)
- 64 Mb of ram
- 10 MB of free hard drive space

Communications

- RS-232 9- or 25-pin D connector
- COM 1-99 (software selectable)
- USB Optional, use either or RS232 or USB but not both
- CAN Bus Data Output

14 Appendix II. Trigger Wheel Availability

Universal 60(-2) Tooth <u>Crank</u> Trigger Wheels – All Have 1” Center Hole (unless noted)

8.25” Outer Diameter	PN 230-72682
7.25” Outer Diameter	PN 230-72672
6” Outer Diameter	PN 230-72660
5” Outer Diameter	PN 230-72650
3.5” Outer Diameter	PN 230-72635
2.5” OD, 1.5” Center Hole	PN 230-72625
2.375” OD, 0.25” center Hole	PN 230-72624

Universal 120(-4) Tooth Wheels <u>Cam</u> Trigger Wheels

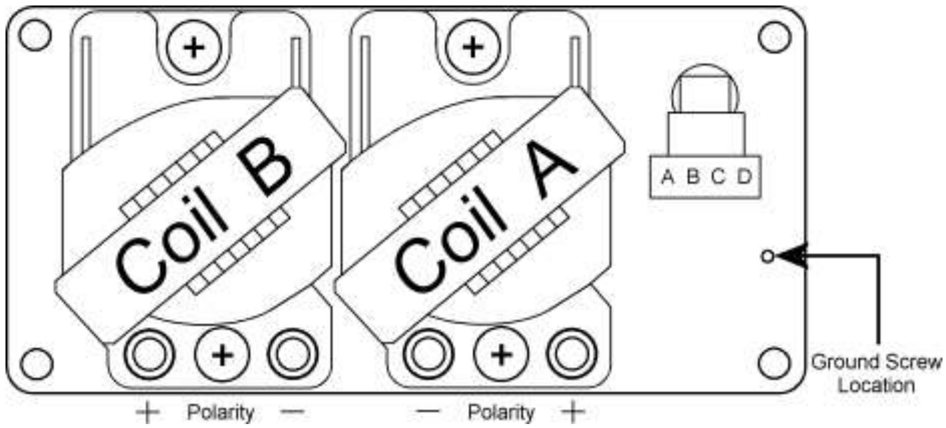
2.75” Outer Diameter	PN 230-72128
3.25” Outer Diameter	PN 230-72133

Custom Bolt-On Trigger Wheel Kits – All custom kits include everything necessary to install a trigger setup. Kits with a 220- Part Number reuse the stock sensor and mount in the stock location. Kits with 205- designations use the 3/8” sensors, while 200- kits use the ½” sensors.

Chevrolet Small Block – 8” Damper	PN 200-72808
Chevrolet Small Block – All Other Dampers	PN 200-72707
Chevrolet LT1	PN 205-72828
Chevrolet Big Block – all Dampers	PN 200-72820
Ford Small Block – 351W Based Engines	PN 200-72819
Ford 4.6L & 5.4L SOHC and DOHC	PN 220-72500
Toyota Supra 3.0L 2JZ-GE & GTE (1993-1998) (includes current Lexus IS300)	PN 220-72301
Eclipse/Talon 2.0L (1st Generation only)	PN 200-73002
Honda ‘B’ Series DOHC VTEC (No P/S or A/C)	PN 200-72410
Dodge Neon (1st generation SOHC & DOHC)	PN 200-73001
VW Type 1	PN 200-72401
Jeep 4.2 Liter	PN 205-72780
2nd Generation MR2 Turbo & NA	Coming Soon

Please note that most common engines have trigger kits made by our various dealers. Porsche, Mazda, Toyota, Acura/Honda and Subaru applications are currently covered extensively.

15 Appendix III. Secondary Coil Polarity for Redundant Ignition Applications



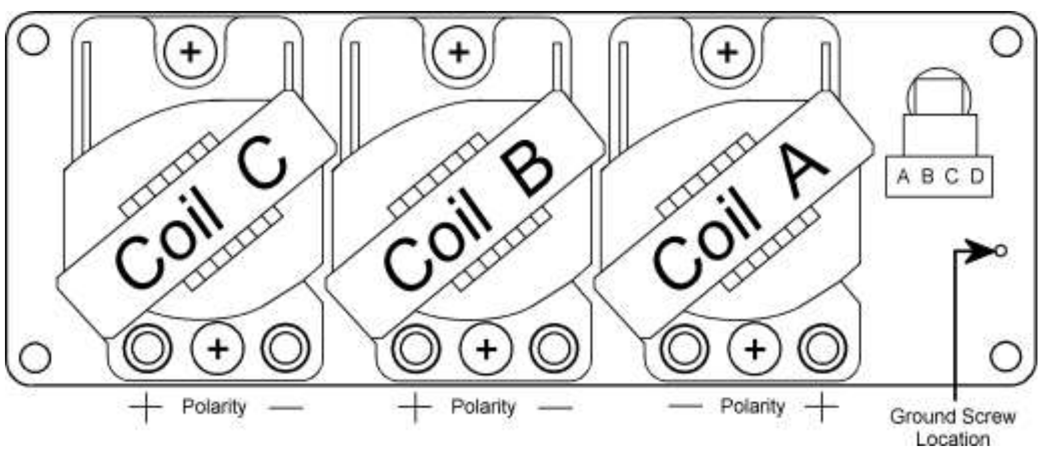


Figure 120: DFU Secondary Voltage Polarity – for Redundant Ignition Applications.

16 Software & Firmware Support

The **XDI200** is designed to be fully upgradeable with respect to its software and firmware. The software is the operating system that is used to tune the engine. The firmware is the embedded code that is installed in the **XDI200's** processors. Small changes in functionality can be covered with software changes. Larger changes in functionality, particularly the addition of new features, generally require a firmware upgrade.

Both software and firmware upgrades are available for a nominal fee on our website. To perform the upgrade (that is, to purchase software and firmware upgrades), you will need to know your unit's serial number. **Software and Firmware upgrades that are purchased with a serial number that does not match your unit's serial number WILL NOT WORK on your unit.**

16.1.1 Software Coding Information

Electromotive calls its **XDI200** Windows software "WinTec 4.X.Y." The "4.X.Y" portion of the WinTec name is the code that is used to tell what the version of software is made for.

- The "4" means simply the software version 4 platform.
- The "X" digit states the FIRMWARE version on which the software will function.
- The "Y" digit states the latest build SOFTWARE version.

The software version is displayed when the WinTec software is opened on a computer. Software versions are compatible with the firmware version for which they are designed. For example,

- A 4.0.3 software version is compatible with a 4.0.0 firmware version.
- A 4.1.2 software version is compatible with a 4.1.0 firmware version.
- A 4.1.0 software version WILL NOT run with a 4.0.0 firmware version.

Always use the PC SOFTWARE version for which the FIRMWARE is designed. The "X" digit of the PC software must always match the "X" digit of the Firmware!

16.1.2 Firmware Coding Information

The Firmware version is displayed in the Engine Monitor Screen. The firmware code is "4.X.0.T3" The "X" digit must match the "X" digit of the software version (see above). This is the firmware version. Firmware for the **XDI200** starts with "WXD07". The next two digits XX are the release version, release changes, new feature additions or some other major change will be signified in this number. The last 3 digits are the build number. Build number YYY indicates bug fixes from one release level to the next. Example : where firmware file number "WXD07xxyyy" XX is the release number, YYY is the build number.

16.1.3 Software Upgrade Procedure

As was previously stated, the firmware and software versions are completely upgradeable through a simple software download from the Electromotive website. Software upgrades are simple, and can be accomplished with the following steps.

1. Download the software from the Electromotive website onto a PC.
2. Install the new WinTec software onto the PC that you will use for tuning your engine.
3. Open the NEW WinTec software version on the PC, and open the OLD calibration file (the *.bin file) into the NEW WinTec software.

4. The main values from your old *.bin file should be transferred directly. However, for safety, ALWAYS make sure that the old *.bin values are the same as the new values.
5. Save the bin file in the new WinTec software version (give it a new name).
6. Download the new file into your **XDI200** ECU as you normally would.

Following this step-by-step procedure should keep everything straightforward during the upgrade process.

16.1.4 Firmware Upgrade Procedure

Care must be taken when installing different firmware versions on your **XDI200** ECU. Follow the steps outlined below:

1. Download the Firmware upgrade from the Electromotive website.
2. Install the firmware upgrade on the PC that you will use to tune the engine.
3. Connect the **XDI200** to the PC's serial or USB port and power it ON.
4. Startup the WinTec software, it should show in the System console that the unit was found and display the firmware version.
5. Turn-OFF power to the TEC unit.
6. Turn on power to TEC but do not run engine
7. Go to Tools > Options > Firmware Upgrade. Find and select the new .em3 file and download
8. Once the upgrade is complete, cycle the power to the TEC. If the firmware upgrade was successful, both LED's will go GREEN. If the firmware upgrade failed, the ECCL LED will stay RED and the crank will stay off. If this occurs, start the procedure over at step 5.
9. The firmware is now upgraded, you can begin/continue tuning.

17 Appendix IV. ECU Connector Pin Out List

Pin	EMI Color	Gauge	Function	Alternate Color	Assigned Function
1	Bare (A)	16 TST	Coil Shield		
2	White(A)	16 TST	Coil A1		
3	Red(A)	16 TST	Coil B1		
4	Black(A)	16 TST	Coil C1		
5	Blk/Gray	20TXL	DoC A1		
6	Blk/Red	20TXL	DoC B1		
7	Blk/Grn	20TXL	DoC C1		
8	Tan	20TXL	Ground		
9	Orange	20TXL	Knock		
10	Blk/Blue	20TXL	DoC A2		
11	Blk/Pink	20TXL	DoC B2		
12	Blk/Org	20TXL	DoC C2		
13	Bare (B)	16 TST	Coil Shield		
14	White(B)	16 TST	Coil A2		
15	Red(B)	16 TST	Coil B2		
16	Black(B)	16 TST	Coil C2		
17	Blk/Wht	20TXL	Ground		
18	Blk/Wht	20TXL	Ground		
19	Gray/Red	20TXL	5V Ref		
20	Gray/Red	20TXL	5V Ref		
21	Gray/Red	20TXL	5V Ref		
22	Org/Red	20TXL	GPI2		
23	Org/Grn	20TXL	GPI3		
24	Org/Blue	20TXL	GPI4		
25	Org/Ppl	20TXL	GPI5		
26	Org/Pink	20TXL	GPI6		
27	Org/Tan	20TXL	GPI7		
28	Org/Yel	20TXL	GPI8		
29	Org/Gray	20TXL	GPI9		
30	Brown	7cond	Ground		
31	Orange	7cond	RXD		
32	Blue	7cond	TXD		
33	Red/Wht	18TXL	12 volt in		
34	Org/Blk	20TXL	Speed In		
35	Black/Shield	7cond	USB GND		
36	Red	7cond	USB PC5V		
37	White	7cond	USB D-		
38	Green	7cond	USB D+		
39	Yel	20TXL	CAM in		

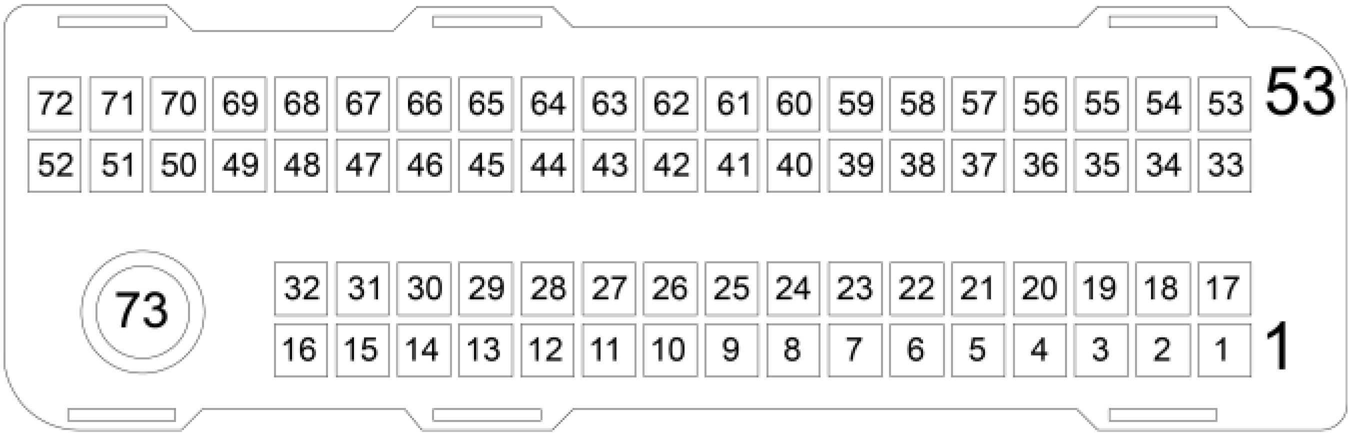
40	Yel/Ppl		CAM 2		
41	Black/Wht	20TXL	Ground		
42	Red	24 TSP	Crank Sensor in		
43	Blk/Shld	24 TSP	Ground		
44	Green	20TXL	MAP		
45	Blue	20TXL	TPS		
46	Gray	20TXL	CLT		
47	White	20TXL	MAT		
48	Org/Wht		EG RTD		
49	Purple	20TXL	EGO Std		
50	Ppl/Tan		EGO W.B.		
51	Yel/Pink	20TXL	CAN H		
52	Grn/Pink	20TXL	CAN L		
53	Red/Wht	18TXL	12 volt in		
54					
55					
56	Wht/Org		Data log stat		
57	L.Grn	20TXL	FPR		
58	White/Blk	20TXL	GPO1		
59	Pink	20TXL	CE		
60	D.Blu/Wht	20	IACB / GPO4		
61	D.Blu/Blk	20	IACA / GPO3		
62	Brown	20TXL	Tach		
63	Wht/Ppl	20TXL	GPO9		
64	Wht/Blu	20TXL	GPO8		
65	D.Grn/Wht	20	IACD / GPO6		
66	D.Grn/Blk	20	IACC / GPO5		
67					
68					
69					
70					
71					
72					
73	Black	12TXL	Main Gnd		

18 Appendix V. ECU Connector Drawing

Please go to this internet link and down load this document:

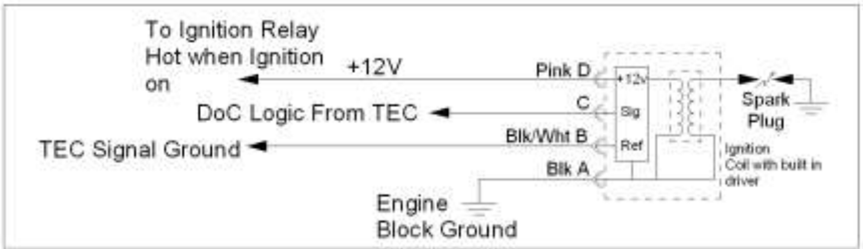
http://www.molex.com/pdm_docs/as/AS-34566-001.pdf

It has important information on handling the XDI200's new Molex connector.

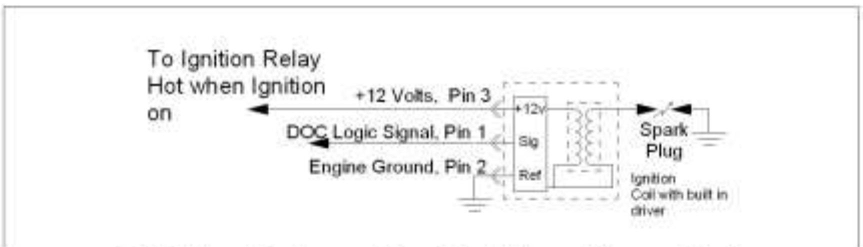


Molex 73 Circuit MX123
Wire Side Shown

19 Appendix VII. Driver on Coil Schematic



4 Wire Driver On Coil Ignition Coil
(Example shown is GM LS coil)



3 Wire Driver On Coil Ignition Coil
(Example shown is Hitachi, Honda coil)

		Wire Color	4 Cylinder	6 Cylinder	8 Cylinder
TECgt200 Pin	Function	Firing Order	1,3,4,2	1,5,3,6,2,4	1,8,4,3,6,5,7,2
17	ECU Ground	Blk/Wht			
5	DoC A1	Blk/Gray	1 & 4	1 & 6	1 & 6
6	DoC B1	Blk/Red	2 & 3	5 & 2	4 & 7
7	DoC C1	Blk/Grn		3 & 4	
17	ECU Ground	Blk/Wht			
10	DoC A2	Blk/Blue			5 & 8
11	DoC B2	Blk/Pink			2 & 3
12	DoC C2	Blk/Org			

Wiring of TECgt200 Driver on Coil Logic outputs to Cylinder Coils

20 Glossary of Terms

Advance: As applied to ignition timing, advancing the timing refers to firing the spark plug comparatively sooner.

ATDC (After Top Dead Center): When a piston is moving downward, after TDC.

Bar: A Bar is a measurement of pressure. One Bar equals 101.3kPa or 14.7psi. Standard atmospheric pressure is 1-Bar absolute, or 0-Bar relative (gauge). An engine running 1-Bar of turbo boost is actually running 2-Bar absolute, so it requires a 2-Bar MAP sensor.

Boost: When a pressure that is greater than the ambient atmospheric pressure is forced into the intake manifold. Turbo- and superchargers create boost.

BTDC (Before Top Dead Center): When a piston is moving upward, but has not yet reached TDC.

Cam Sensor: A device used to provide a once-per-engine cycle pulse to the **XDI200**. This establishes the stage of engine operation that is occurring for a given TDC.

Coolant Temperature Sensor: A device that measures the coolant temperature of an engine.

Crank Sensor: A device that can "read" a crank trigger wheel, and output a voltage signal that can be used by an engine management system.

Crank Trigger: A device used to measure the crankshaft position and speed, typically composed of a crank trigger wheel and a crank sensor.

Detonation: When the air-fuel mixture is ignited by the spark plug, then a high cylinder temperature "spontaneously" ignites another portion of the unburned mixture. A knocking sound is produced when detonation occurs, and knock sensors are designed to hear this knocking. Engine damage can be caused by detonation.

DFU: Direct Fire Unit. Electromotive coil packs are referred to as DFUs.

Duty Cycle: The percentage of time that a pulse width modulated output is turned on. A duty cycle of 100% indicates a fully turned-on modulation output.

ECU: Electronic Control Unit. A device that is used to process several inputs for the control of several outputs.

Exhaust Gas Oxygen (EGO) Sensor: A device that compares the oxygen content of the exhaust gases with the oxygen content of the ambient atmosphere. An air-fuel ratio approximation can be made with an EGO sensor.

General Purpose Inputs (GPI): Input channels that the **XDI200** can use to process data from sensors that are not related to the core engine management sensors. Switches and vehicle speed sensors can be run to the GPIs.

General Purpose Outputs (GPO): Output channels from the **XDI200** that can be used to trigger external devices such as thermo fans, torque converters, etc.

Horsepower (HP): A measurement of the rate at which an engine can perform work. One HP = 550 lb-ft per second.

Idle Air Control (IAC) Motor: A device that is used to meter air into an engine at idle. Air from the outside of the intake manifold is regulated into the intake plenum by the IAC motor.

Ignition Timing: The amount of degrees before Top Dead Center that a spark plug fires.

Knock Sensor: A device used to measure detonation.

Knocking: see ‘Detonation’

Load: The amount of work that an engine must provide at a given instant. Load is measured by using the MAP sensor to estimate the cylinder pressure on **XDI200** systems. Higher loads result in higher MAP readings.

Manifold Air Pressure (MAP) Sensor: A device that measures the absolute pressure of the intake charge for an engine.

Manifold Air Temperature Enrichment: An inlet air temperature-based enrichment that is used to add fuel when the incoming air is cold, and therefore denser than usual.

Manifold Air Temperature (MAT) Sensor: A device that measures the temperature of the incoming air charge for an engine.

Millisecond (ms): A length of time equal to one one-thousandth of a second.
1 millisecond = 0.001 second

Pinging: See ‘Detonation’.

Retard: As applied to ignition timing, retarding the timing refers to firing the spark plug comparatively later.

Rich Mixture: An air-fuel mixture that carries more fuel than the stoichiometric air-fuel ratio.

Spark Knock: See ‘Detonation’

TDC (Top Dead Center): On piston engines, when a piston is at its highest point (closest to the cylinder head), and the combustion chamber is at its smallest volume, it is at TDC. TDC#1 refers to the case when the #1 cylinder is on TDC. On rotary engines, TDC occurs when the combustion chamber volume is smallest.

Throttle Position Sensor (TPS): A device used to measure the position of the throttle.

Torque (TQ): A measurement of the work that an engine can perform, typically expressed in pound-feet (lb-ft).

Trigger Wheel: A device attached to the crankshaft that provides a moving reference of speed and position of an engine's crankshaft.