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INTRODUCTION

The HPV-1 is a valuable, race proven, distributorless ignition system (DIS). A complete stand-alone system, the HPV-1 brings state-of-the-art ignition technology to today's performance and racing vehicles. All this is offered in one easy-to-install, fully adjustable package.

GENERAL DESCRIPTION

The patented* HPV-1 Ignition System represents a major breakthrough in engine control technology. The ignition is a single package that contains everything needed to develop the hottest spark possible. Then, through the controls on the front panel, accurate spark timing is now under the control of the user. Thousands have been sold since 1986, proving the HPV-1's performance time after time on the street and the track.

The HPV-1 ignition fires two cylinders simultaneously before every TDC, one while on its compression stroke, the other on its exhaust. This keeps the plugs cleaner during idle and low power running. The HPV-1 ignition also has much longer spark duration than other, more dated, ignition technologies, such as capacitive discharge (CD) ignitions or magnetos. This results in better combustion and produces more torque and horsepower. The high resolution, 60-minus-2 tooth crankshaft position sensor virtually eliminates spark scatter and timing variation. The advance is easily adjusted at different RPMs using three controls on the unit. Included in this comprehensive package is a built-in adjustable Rev limiter used to prevent engine damaging over revs.

The only task that could represent a slight hurdle during installation involves mounting the crankshaft position sensor. Every HPV includes your choice of either a 60 tooth crankshaft pickup wheel or a 120 tooth camshaft/distributor wheel. A magnetic sensor detects the teeth on this steel wheel. Electromotive makes ready-to-install trigger wheels and sensor brackets for some of the most popular engines. However, if the engine you plan to use is not covered by these kits, the trigger wheel must be fitted and a sensor bracket must be fabricated.

UNPACKING

Always carefully inspect all units and determine if any damage occurred in shipping. If damage is evident, contact the shipper for instructions as to the recovery of such damages.

TECHNICAL ASSISTANCE

Technical Assistance is available by telephone, facsimile or email. Call between 8:30 am and 4:30 PM Eastern time. Before calling, make sure you have read the manual completely and checked all the basics. Please make sure that your problem is not something simple that is covered in the manual.

Telephone: (703) 331 - 0100

Fax: (703) 331 - 0161

email: tecinfo@electromotive-inc.com

* Patent RE 34,183

THEORY OF OPERATION

THE ADVANTAGES OF DIRECT FIRE IGNITION

The HPV-1 offers benefits not available with any other ignition:

- Makes more power by burning the fuel and air mixture more completely.
- 100% spark energy (120 millijoules) up to 9600 RPM.
- Long, 2,000 microsecond (average) spark duration - 60° duration at 10,000 RPM!
- Simple and easy timing adjustments.
- No power draining magnetos or distributors to drive.
- Digital timing controls let you monitor the timing advance with a voltmeter.
- Options include:
 - high speed rev limiter
 - dual rev limiter for staging at the drag strip or valet mode
 - remote timing advance control

HOW DIRECT FIRE IGNITIONS WORKS

The term "Direct Fire" describes the firing of plugs directly from the coils and not through a distributor cap and rotor. This is accomplished by using multiple coils that have two sparkplug wire terminals on each coil. These terminals connect directly to the sparkplugs, allowing one cylinder to fire on compression while its companion cylinder fires simultaneously on exhaust. Open spark gaps in the rotor and cap are eliminated, making wear and moisture problems a thing of the past.

Another important feature, and the one that sets HPV-1 apart from C-D systems and makes it the ignition of choice, is the ability to charge ignition coils to 8.5 amps in less than 3.5 milliseconds. Furthermore, the use of multiple coils allows up to 180° of charging time on four and eight cylinder engines, and 120° on six cylinder engines. This is four times as much dwell time as single coil systems have to work with, and translates to full spark energy to 9600 RPM. Unlike multiple spark C-D systems that may only put out one very short spark at high speeds, the HPV-1 puts out a full, long burning spark at your highest and most critical engine speeds. Long burn times assure effective burning of even lean fuel mixtures.

The heart of the HPV-1 is a digital chip called the HREIC, patent number RE 34,183, which takes the electric pulses from the crankshaft sensor, identifies the two missing teeth and then keeps track of the remaining 58 teeth. The HREIC's hard wired logic determines engine speed and computes the spark advance from your knob settings. Setting the timing advance curve is a simple task that anyone can understand.

In addition to synchronizing and firing the plugs at the correct advance angle, the HREIC also computes the exact dwell to produce 8.5 amps of coil current. If it fails to hit exactly 8.5 amps when the plug fires, the HREIC starts the next charging cycle a little sooner or later, assuring that next time around it will be exactly 8.5 amps. This corrects any errors that are caused by battery voltage or coil temperature changes and insures maximum spark energy.



HIGH RESOLUTION SINGLE-CRANKSHAFT-SENSOR DECODING

Some OEM direct ignition systems use both a crankshaft and a camshaft sensor assembly, making the system more complicated and more expensive than it needs to be. Other systems use low resolution, four to ten tooth trigger wheels on either the crankshaft or camshaft; these are not enough teeth to assure that the coils are firing without timing errors. The HPV-1 solves these problems with a single, high resolution, 60-minus-2 tooth crank trigger wheel. This affords resolution unheard of in any other electronic ignition available today, offering spark accuracy of $\frac{1}{4}$ degree of crankshaft rotation. This accuracy makes the system ideal for the most demanding engines.

INSTALLATION

HPV-1 ignitions have been fitted to virtually every type of engine made. Applications range from stationary industrial engines to experimental aircraft to all kinds of street and track cars. Given the wide range of applications, the installation guide below is general in nature. For some specific applications, Electromotive supplies complete bolt-on kits. These are covered after the general information.

TRIGGER WHEEL INSTALLATION

The trigger wheel and magnetic sensor must be installed properly since they identify the crankshaft position down to the nearest $\frac{1}{4}$ degree. There are two styles of trigger wheels available. The crankshaft wheel (60-2 tooth) is the recommended approach, as it minimizes spark scatter from gear lash and cam twist. This wheel has 58 teeth spaced at 6 degree intervals. The camshaft trigger wheel (120-4 tooth), designed to operate on half-speed shafts, mounts in place of the distributor rotor or on the end of a camshaft. When installing the trigger wheel, make sure that the trailing edge of the 11th tooth after the two missing teeth passes the magnetic sensor at TDC of #1 cylinder. Follow the appropriate instructions below.

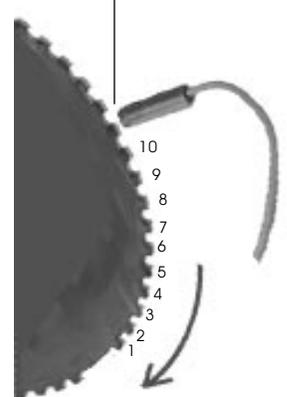
Crankshaft Trigger Wheel

Crankshaft trigger wheels are available in $2\frac{1}{2}$ ", $3\frac{1}{2}$ ", 5", 6", $7\frac{1}{4}$ " and $8\frac{1}{4}$ " diameters; all are 0.125" thick. These wheels are typically mounted between the harmonic balancer and the first pulley. This may require the assistance of a machine shop. To choose the proper wheel size, find a suitable location on an accessible part of the crankshaft and note the diameter of the largest part of the hub, vibration damper or pulley. The trigger wheel must be spaced at least $\frac{1}{2}$ " away from other steel rotating parts as other steel parts will cause interference with the sensor signal.

It is important that the trigger wheel be mounted so as to be perfectly concentric with the crankshaft. One approach is to machine a shallow cut on the front or back face of the damper, and open up the hole on the inside of the trigger wheel to match. Then the wheel may be pinned or bolted in the proper location. Holes may also be drilled through the wheel to allow it to be mounted between the damper and pulley. Remember that placing the trigger wheel behind the pulley will space the pulley(s) out 0.125", causing a slight offset on the belt.

The trigger wheel should show no more than .003" out-of-round. If necessary, the entire damper/trigger wheel assembly may be put on a lathe and trued.

Align sensor with the trailing edge of the 11th tooth



Sensor Alignment

Camshaft/Distributor Trigger Wheel

Although crankshaft mounting is preferred, it might sometimes be easier to mount the trigger wheel to the end of a cam or in the original distributor. For these applications, where the wheel will be turning at half-crankshaft speed, a 120-4 tooth wheel is provided. These may be ordered in 2¾" or 3¼" diameters. Installation on the cam is similar to the procedure discussed above for crankshaft mounting. Inside the distributor, an adaptor might be made to attach the trigger wheel to the distributor shaft. Even an old rotor might serve as a starting point for such an installation.

Remember that these are general suggestions only. If you are not sure how to proceed, Electromotive can often direct you to a Value Added Dealer for assistance.

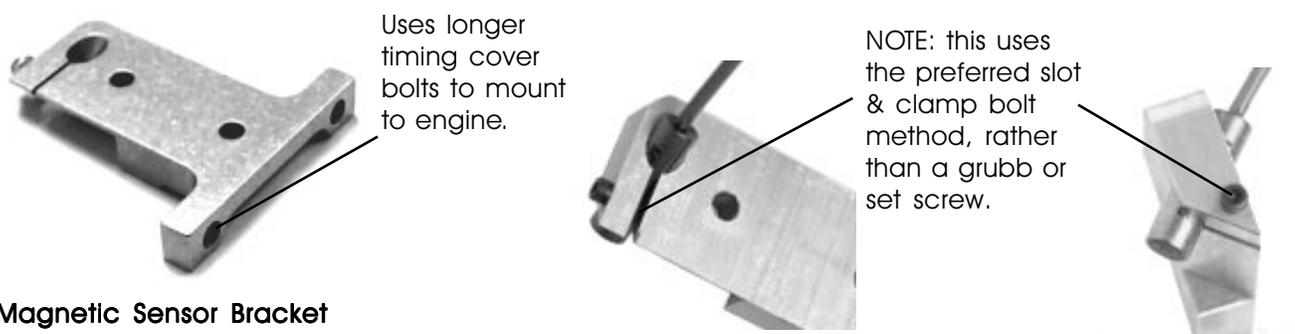
MAGNETIC SENSOR

Test fit the trigger wheel to the crankshaft and design a sturdy aluminum bracket to hold the magnetic sensor. The tip of the sensor should align to the center of the wheel's edge. The sensor must also line up with the trailing edge of the 11th tooth after the two missing teeth when the engine is at TDC. Once the wheel is in place, accurately align the magnetic sensor to the eleven tooth with the proper air gap.

The bracket can be installed anywhere as long as the magnetic sensor aligns with the 11th tooth when the engine is at TDC. This bracket must be nonmagnetic (not made of steel) and should be stout enough not to vibrate at high engine speeds.

Secure the sensor in the bracket with a clamping arrangement. Set screws often crush part of the sensor, leading to premature failures. When drilling the hole for the sensor, start with a small pilot hole. Make sure your alignment is correct before drilling the hole to final size. For the final hole, use a drill bit just under the size of the sensor, 3/8" or .375", then do a final pass with a .375" bit at slow speed to keep from having too large a hole.

Below are several views of a bracket for the Small Block Chevy. Made out of a ½" piece of aluminum stock, these pictures show one way to create a simple but sturdy bracket.



Magnetic Sensor Bracket

Note On Hard-Starting Radical Camshaft Engines

If your engine is equipped with a radical camshaft that has early intake valve openings, long duration and high lift, you may experience hard starting. To remedy this situation, advance the base timing by substituting the 12th or 13th tooth in the above instructions. If the 12th tooth is used, you must subtract 6 degrees from your spark timing table in the HPV-1. The 13th tooth requires 12 degrees to be subtracted from the advance curve. From the 11th tooth, every tooth represents 6 degrees.

Sensor-To-Trigger Wheel Air Gap

Trigger Wheel Size	Air Gap	Allowable Out-of-round
2½"	.009" - .010"	.001"
3½"	.011" - .012"	.001"
5"	.018" - .021"	.002"
6"	.024" - .028"	.002"
7¼"	.029" - .031"	.003"
8¼"	.035" - .038"	.003"

Trigger Wheel and Sensor Specifications

BOLT ON TRIGGER WHEEL AND BRACKET KITS

Electromotive offers several kits for popular engines that make the installation of the HPV-1 a simple bolt-on. Below are step-by-step instructions for installation of these kits.

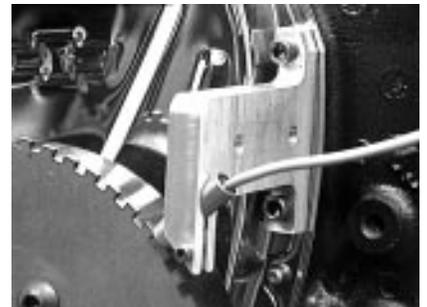
SMALL BLOCK CHEVY AND FORD

Electromotive supplies bolt-on kits for Small Block Chevy and Ford engines in three configurations:

- for Chevy engines using any balancer under 7" in diameter
- for Chevy engines equipped with the GM 8", 1969 and later, high performance balancer
- for Ford 289-302 and 351C engines with the 4 bolt balancer

7" And Smaller Balancers

1. Set the engine to TDC as per manufacturer specifications and instructions. Remove the crankshaft pulley and timing tab. Clean the front of the balancer thoroughly.
2. Install the sensor bracket at the two timing cover bolts used to hold the timing tab. These are the bolt holes directly above the timing cover alignment pin on the timing tab (driver's) side of the block. The timing tab may be reinstalled with the Electromotive sensor bracket. Use the ¼-20 X ¾" bolts provided.
3. The 7¼" trigger wheel mounts between the balancer and the pulley, with the "F" (at the two missing teeth) facing forward. The wheel centers itself on the pulley. If the lip of the pulley does not extend



Small Block Chevy

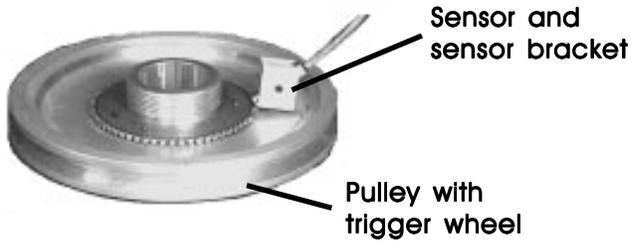
beyond the trigger wheel enough to center the pulley/trigger wheel assembly on the balancer, use the supplied aluminum stepped bushing to center the assembly. Install the trigger wheel and pulley on the crankshaft but **DO NOT TIGHTEN** at this time.

4. Install the sensor in the sensor bracket. Verify that the trailing edge of the eleventh tooth is aligned with the center of the sensor. Note that there is some adjustment provided by the holes in the trigger wheel for radial alignment. Also check that the sensor is centered above the trigger wheel in the front/back plane. If necessary, shim out the bracket with washers or lightly sand it down to move it in. Once the alignment is correct, tighten the three bolts which hold down the pulley and trigger wheel. Torque the bolts to manufacturer's specifications.
5. Set the sensor gap to .029" - .031" and tighten the sensor hold down screw.
6. Check for run-out in the trigger wheel by measuring the air gap at three points around the wheel. There should be no more than .003" variation from the smallest gap to the largest gap.

GM 8" Balancer

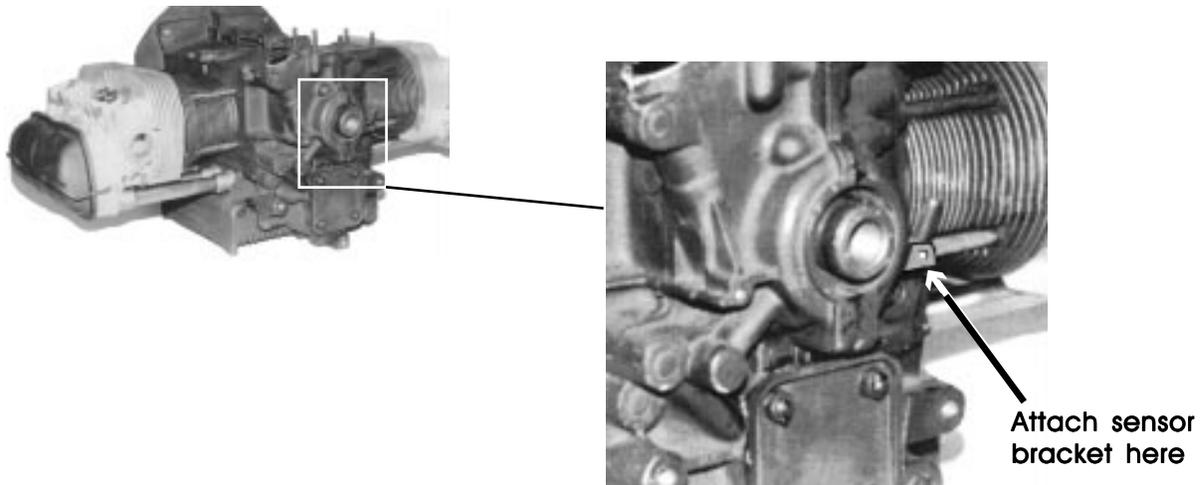
1. Set the engine to TDC as per manufacturer specifications and instructions. Remove the crankshaft pulley and timing tab. Clean the front of the balancer thoroughly. Trim back the rubber separator as necessary to allow the trigger wheel to sit flush on the balancer.
2. Install the sensor bracket at the two timing cover bolts used to hold the timing tab. These are the bolt holes directly above the timing cover alignment pin on the timing tab (driver's) side of the block. The timing tab may be reinstalled with the Electromotive sensor bracket. Use the 1/4-20 X 3/4" bolts provided.
3. With the engine at TDC (top dead center), the twelve holes on the balancer resemble the numerals on a clock. With the "F" (located under the gap at the two missing teeth) facing forward, align the trigger wheel so that the holes are aligned with the holes in the balancer at the two, six and ten o'clock positions. The eleventh tooth after (counterclockwise) the missing two teeth should be aligned directly with the sensor bracket where the sensor will be. Mark the three holes and remove the trigger wheel.
4. Tap the holes to 3/8-24. Install the trigger wheel with the button-head Allen bolts provided. **DO NOT TIGHTEN** at this time.
5. Install the sensor in the sensor bracket. Verify that the trailing edge of the eleventh tooth is aligned with the center of the sensor. Note that there is some adjustment provided by the holes in the trigger wheel for radial alignment. Also check that the sensor is centered above the trigger wheel in the front/back plane. If necessary, shim out the bracket with washers or lightly sand it down to move it in. Once the alignment is correct, tighten the three button-head Allen bolts which hold down the trigger wheel. Torque the bolts to 25 ft./lbs.
6. Set the sensor gap to .035" - .038" and tighten the sensor hold down screw.
7. Check for run-out in the trigger wheel by measuring the air gap at three points around the wheel. There should be no more than .003" variation from the smallest gap to the largest gap.

TRIGGER WHEEL AND BRACKET FOR THE VOLKSWAGEN TYPE 1



Electromotive has designed a clean and easy-to-install trigger wheel and sensor for the VW Type 1 engine. Follow the directions below, and you will enjoy an ignition system that offers more than just promises to increase your VW's performance.

1. Remove the crankshaft pulley. Clean the front of the engine thoroughly.
2. Locate the 6 mm Phillips head machine screw to the right of the engine seal - it holds the sheet metal to the engine block (see figure). Remove this screw and trim the sheet metal to fit the sensor bracket.
3. Install the sensor bracket using the 6 mm cap screw provided. Insert the magnetic sensor into the bracket. **DO NOT TIGHTEN EITHER AT THIS TIME.**
4. Slide the new pulley fitted with the trigger wheel onto the crankshaft in order to align the sensor and bracket assembly. Align the sensor and bracket relative to the trigger wheel. The sensor should be aligned exactly at the trailing edge of the 11th tooth after the two missing teeth. Also check that the sensor is centered over the edge of the wheel. Now remove the pulley again and tighten the bracket.
5. Install and tighten the new lower pulley and gap the magnetic sensor to between 0.011 and 0.012 inches. Tighten the set screw for the magnetic sensor. Do not overtighten - it will damage the inside of the sensor causing it to fail.



MOUNTING THE HPV-1

1. The mounting surface should be able to hold the HPV-1 without stressing or bending the baseplate.
2. Keep the HPV-1 away from road debris and direct water spray.
3. The unit should never be submersed in mud or water.
4. Keep the HPV-1 away from high temperatures. Do not mount too close to the exhaust or a turbocharger.
5. Keep vibration and heat to a minimum for best durability.
6. Maintain easy access for changing calibrations.
7. Use 1/4" bolts to secure the HPV-1 and use thread lock or self-locking nuts to keep secure.

WIRING THE HPV-1

POWER AND GROUND CONNECTIONS

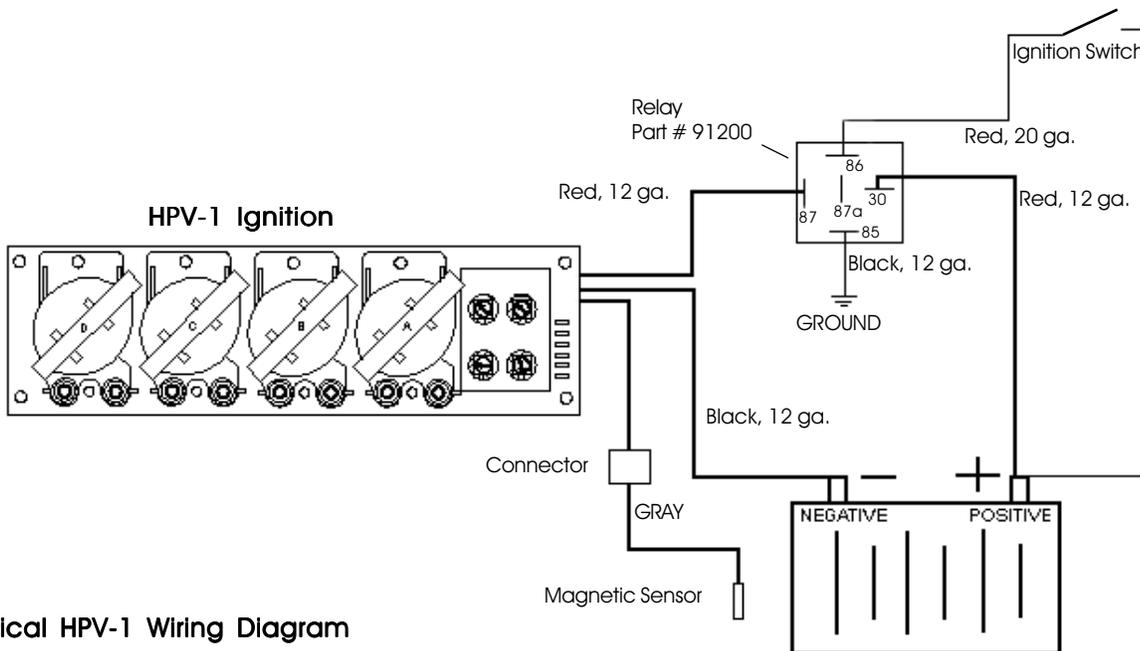
Wiring is critical when working with modern engine controls. All power and ground connections should be made in such a fashion as to minimize voltage drops and signal interference from high-power devices. With ignition coils firing up to 16 amps of current next to sensors that are measuring millivolts, it is of great importance to guard against undesirable feedback and voltage drops.

CRITICAL Remove any series (ballast) resistors from the circuit. They are not needed and will cause the system to malfunction. Do not attach anything else to the HPV power supply circuit.

Other problems originate with inadequate 12 volt power leads. These can cause voltage drops when the coils turn on. All 12 volt wiring must be 16 gauge on 4 and 6 cylinder applications, and 12 gauge on 8 cylinder applications. Use switches rated for 20 amps, minimum. It is best to run separate power leads directly from the battery through a high quality, high current relay. Avoid putting the fuel pump or any other load on the same circuit as the HPV-1. A relay is always recommended, and must be used with any switched power source.

If you don't use an alternator, use a 16 volt battery - 12 volt batteries do not stay at 12 volts when the engine has run for a while. Low voltage will cause loss of power at the top end of your performance curve. Be careful with standard batteries, as vibration may cause the plates to dislodge and produce an erratic power supply. Such a problem would show up as a high-load and/or high-speed miss.

In some applications with dual batteries it is not recommended to use diodes in the connection between the batteries, especially in the ground circuits. If electrical noise still tends to misfire the HPV-1, a large (220 μ F, 20 volt or higher) capacitor is recommended across the HPV-1's red and black power leads. Try to install the capacitor as close to the HPV-1 as possible.



Typical HPV-1 Wiring Diagram

To Fuse Or Not To Fuse?

It is generally not required to fuse the HPV-1's +12 red wire. Since fuses add series resistance they are a source for voltage loss. Fuses in a race car may serve as another source of failure, but if desired use these values for sizing fuses:

4 or 6 cylinder - 8 amp 8 cylinder - 15 amp

Fusible links also may provide protection and are less prone to failure.

Grounds, Grounds, Grounds!

Five grounds should always be present:

- battery to engine block
- battery to chassis
- engine block to chassis
- HPV-1 (chassis) to engine block
- Black wire from the HPV-1 to the battery (preferred) or engine

Ground the HPV-1's large black wire to the battery. If this is not convenient, you may use a common point on the engine block to ground the HPV. Use this same point to ground the engine to the chassis, and, if applicable, the battery. If a ground has to be extended use a minimum of 12 gauge wire. An additional ground wire between a coil screw (use the screw that has a ground tab under it) and the engine block ground is recommended. At least 16 gauge wire should be used.

NOTE: Always make sure the screws holding down the coils are tight.

Do not use the HPV-1 terminal marked "GND"; severe damage could result. This ground is only for the 5V internal supply which is used with the HPV's accessories.

Special Note On Dyno Installations

If your HPV-1 is installed on an engine dyno, attach an additional ground wire between the engine stand (chassis) and a good electrical ground like a water pipe. In many engine dynamometer situations a battery eliminator replaces the alternator. In this case, use at least a 25 amp D.C. regulated power supply set at 13.8 volts output. These are available through most ham radio or hobby electronics outlets. If a dual plug per cylinder HPV-1 is used, or if other devices are being powered, a 35 amp power supply will be needed. Attaching a battery in parallel to the 13.8 volt power supply at the engine will also help, especially if an electric fuel pump is also in use. A battery and battery charger will work, provided that the battery is in good condition and the charger is not set too high. Never use just a battery charger, as unfiltered D.C. may damage the HPV-1. Long wires to the control panel and back to the engine must be avoided. Take caution to locate the starter ground wire correctly to avoid sending starter current through the HPV-1 chassis.

MAGNETIC SENSOR

The magnetic crank angle sensor sends small AC voltage signals to the HPV-1 for engine position and speed references. Be sure to secure its cable and connector to keep it from breaking or fraying the wires inside. Keep the sensor wire away from high current and high voltage sources, such as the spark plug wires or the alternator.

SPARK PLUGS

Since the HPV-1 puts out significantly more spark energy than most other ignitions, it is not necessary to run a hot sparkplug. Typically, a colder heat range plug is required. Plug gap should be set from .025" to .032". If the engine has a high compression ratio (over 12:1) or runs high boost (over 14 psi) it may be necessary to reduce the plug gap. Use the following as a guide:

High Power 75 to 115 HP per Cylinder	0.025"
Over 115 HP per cylinder, or compression ratios over 12:1	0.022"
Alcohol High Compression	0.025"
High Performance Street	0.030"
Stock Street	0.032"

Large gaps are often recommended as a way of increasing the contact between the spark and the air/fuel mixture to promote maximum combustion. The HPV-1's accomplishes this in a much better fashion through its extremely long duration spark.

SPARK PLUG WIRES

Use 8 mm or larger RFI and EMI suppression wire with late model GM boots. We recommend using a CARBON CORE suppression wire with 3K to 5K ohms resistance per foot. Resistive spark plug boots also may help misfiring problems. **SOLID CORE PLUG WIRES CAN NOT BE USED.** If you are not certain as to the effectiveness of the suppression qualities of a particular wire, do not use them. Periodically check the plug end boots for carbon tracking. This can be done by looking at the plugs running in a dark area and spraying the spark plug wires with a spray bottle of water. Replacement of plug wires on an annual basis is recommended.

FIRING ORDER

The HPV-1 uses one coil to fire two spark plugs simultaneously every revolution, once on a cylinder's compression stroke and once on its exhaust stroke. This requires cylinders to be paired to the coils. You must know your engine's firing order before continuing.

The coils fire in the following sequence from TDC of number one cylinder:

4 cylinder: Coil A @ TDC, B @ BDC	(A,B)
6 cylinder: Coil A @ TDC, B @ 120° ATDC, C @ 240° ATDC	(A,B,C)
8 cylinder: Coil A @ TDC, C @ 90° ATDC, B @ BDC, D @ 270° ATDC	(A,C,B,D)

This sequence repeats itself every engine rotation. Begin placing the plug wire on the coils in the above

sequence per the firing order of your engine. Start with the #1 cylinder on coil A, the next cylinder in the firing order on coil B, etc. When you reach the cylinder which is at TDC the same time that #1 is at TDC, you should have gone through all the coils and be back on coil A. A chart has been included to help you with some popular firing orders:

Engine:	Firing Order	Coil	A	B	C	D
8 Cylinder						
Most GM, Chrysler and AMC	1-8-4-3-6-5-7-2	1&6	4&7	5&8	2&3	
Ford 302,355,429,460,390	1-5-4-2-6-3-7-8	1&6	4&7	3&5	2&8	
Ford 351,400	1-3-7-2-6-5-4-8	1&6	4&7	3&5	2&8	
Cadillac 368,425,472,500	1-5-6-3-4-2-7-8	1&4	6&7	2&5	3&8	
Mercedes-Benz	1-5-4-8-6-3-7-2	1&6	4&7	3&5	2&8	
6 Cylinder						
Buick 3.0,3.8	1-6-5-4-3-2	1&4	3&6	2&5		
Chevy 2.8	1-2-3-4-5-6	1&4	2&5	3&6		
Ford 2.8	1-4-2-5-3-6	1&5	3&4	2&6		
Porsche 911	1-6-2-4-3-5	1&4	3&6	2&5		
4 Cylinder						
Most	1-3-4-2	1&4	2&3			
VW Air Cooled	1-4-3-2	1&3	2&4			
Dual Plug 4 cylinder	1-3-4-2	1&4	2&3	1&4	2&3	

If your engines firing order is not to be found in this chart, use this example to help in determining which cylinders go to the coils:

BMW 6 cylinder firing order	1	5	3	6	2	4		
HPV-1 6 cylinder coil order	A	B	C	A	B	C		
MERCEDES BENZ V-8	1	5	4	8	6	3	7	2
HPV-1 8 cylinder coil order	A	C	B	D	A	C	B	D

Generic Wiring Guide

4 cylinder:

Firing order _____
 Coil A B A B

6 cylinder:

Firing order _____
 Coil A B C A B C

8 cylinder:

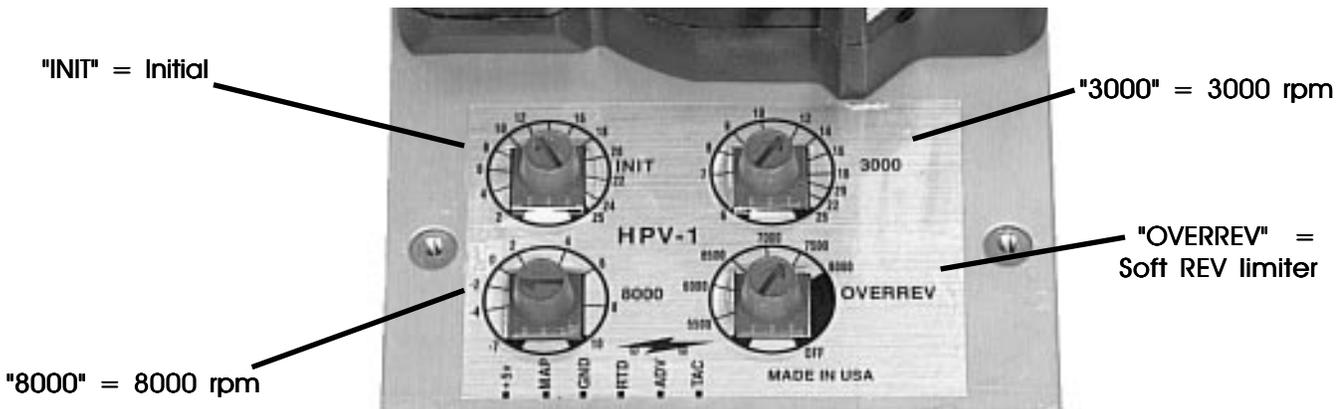
Firing order _____
 Coil A C B D A C B D

OPERATION & CALIBRATION

CONTROLS

The HPV-1 has four knobs which must be set by the user. The knobs, located under the protective cover on the front of the unit, are labeled:

- INIT initial advance used for idle control
- 3000 additional advance at 3000 RPM
- 8000 advance added or subtracted from 3000 to 8000 RPM
- OVERREV rpm limiter



DEFINITION OF SPARK ADVANCE CURVES

The actual spark advance is determined with the following equation:

$$\text{Mechanical Advance} + \text{Spark Curve} = \text{Actual Timing}$$

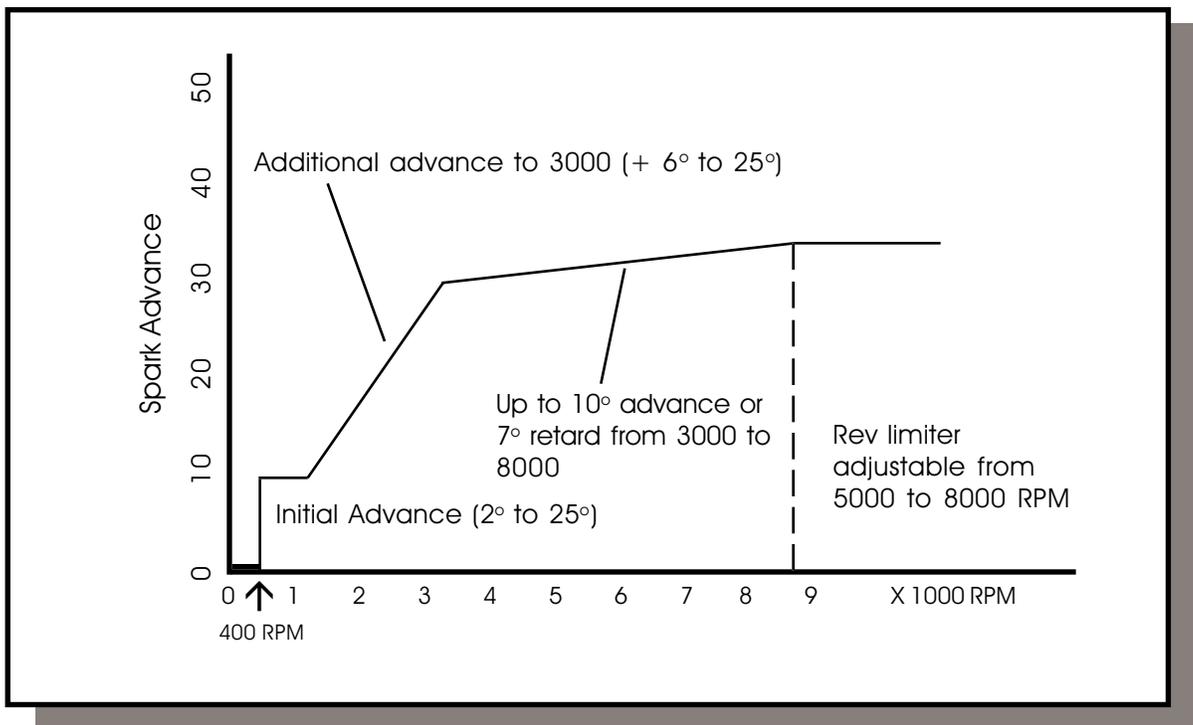
The advance from cranking to 400 RPM equals the mechanical advance set by the location of the sensor and trigger wheel. At 400 RPM control jumps to the amount set on the INIT knob. The advance remains at Initial to 1000 RPM where it begins to climb in a linear fashion an additional amount as set on the 3000 knob. At 3000 RPM, the advance curve changes slope and advances (or retards) up or down a further amount as selected on the 8000 knob. Above 8000 RPM, the advance does not change.

SELECTING AN ADVANCE CURVE FOR YOUR ENGINE

Before setting the advance curve for your engine, you should have some basic information to start with:

- Mechanical advance at the sensor
- Target idle timing (from a stock or comparable engine)
- Recommended maximum advance (from your engine builder or other source)

This information will give you a place to start from; real world testing will allow you to refine your curve for maximum performance.



HPV Advance Curve

MEASURING THE MECHANICAL TIMING

It is important to either compensate for or eliminate any mechanical error built into the crank trigger assembly. The trailing edge of the 11th tooth after the two missing teeth should be directly under the center of the magnetic sensor when the engine is at TDC, cylinder #1. Before starting on the knob settings, find the mechanical timing by placing a jumper wire between the spade terminals marked "RTD" and "+ 5V". Start the engine and attach your timing light to one of the sparkplug wires connected to COIL A. Observe the engine timing; ideally it should be zero. If you have provisions for adjustments to your crank trigger assembly, adjust the sensor until there is zero advance. If you do not have the ability or provisions to eliminate any mechanical timing, or if you have intentionally built in some advance to help the engine start, write down the amount of timing displayed by the timing light. **A timing light with built-in advance measurements may only be used to verify "0" (no advance) due to the double pulse of the Electromotive ignition.**

The Mechanical Timing Is: _____ Date: _____ Measured By: _____

SETTING THE ADVANCE

"INIT" - Initial Advance

The initial advance represents the ignition timing from 400 rpm to 1000 rpm, and is adjustable from 2 through 25 degrees. This is where most engines idle, and each engine type seems to prefer something different. Make your adjustments taking into consideration any mechanical advance or retard that may be built into your crank trigger assembly. If you are starting with a stock idle setting, make sure you have the actual advance the engine idles at. Don't confuse this with the timing specification from a service manual - you are usually instructed to disconnect a vacuum line or an electrical connector to put the timing into some default mode. If possible, check a stock motor with a timing light when everything is hooked up.

"3000" - 3000 RPM Advance

This represents the additional spark advance added to the initial setting when the engine reaches 3000 rpm. This value is added linearly from 1000 rpm to 3000 rpm. At 2000 rpm, 1/2 of this setting is added to the INIT timing (see chart). The range of this adjustment is 6 to 25 degrees.

"8000" - 8000 RPM Advance or Retard

At 8000 rpm you have the ability to add up to 10 degrees or subtract up to 7 degrees of timing from the advance you have selected at 3000 rpm. This value is added or subtracted in a linear fashion from 3000 rpm to its full amount at 8000 rpm, so if you would select -6 degrees, it would subtract 3 degrees (half the total timing change) from your timing curve at 5500 rpm (half the RPM span.) If you had selected +10 degrees, it would add 5 degrees of timing at 5500 rpm.

WARNING: DUE TO VARIATIONS IN PRINTING AND ASSEMBLY THE DISPLAYED TIMING VALUES MAY VARY FROM ACTUAL TIMING. USE A VOLTMETER OR TIMING LIGHT TO VERIFY YOUR SELECTIONS.

"OVERREV" - Rev Limiter

Built into every HPV-1 is a "soft" rev limiter that will take your timing to 0 degrees (or whatever the mechanical timing of the crank-trigger assembly is) when the rpm you have selected is reached. The operating range of this limiter is 5000 rpm to 8000 rpm and will be disabled if you dial into the black area beyond 8000. The black area is also where you would set the rev limiter if you were using one of Electromotive's optional high speed or dual rev limiters.

NOTE: USING ANY TOOTH OTHER THAN THE 11TH ON THE CRANK-TRIGGER ASSEMBLY AT TDC WILL NOT ALLOW THE HPV-1 TO ZERO THE TIMING WHEN THE REV LIMITER IS ENGAGED.

Suggested starting calibrations:

Gas Race Engine: 0° Mechanical, 12° "INIT", 21° "3000", -2° "8000"

Street Stock: 0° Mechanical, 12° "INIT", 24° "3000", -2° "8000"

CAUTION: THESE ARE SUGGESTIONS, ONLY! YOUR ENGINE MAY REQUIRE MORE OR LESS TIMING. IF YOU ARE RUNNING A HIGH COMPRESSION OR A BOOSTED ENGINE, START WITH LESS TIMING. ALWAYS START WITH THE TIMING LOW (RETARDED) AND WORK UP (ADVANCED). LISTEN CAREFULLY FOR DETONATION OR SPARK KNOCK. TOO MUCH TIMING ADVANCE WILL DAMAGE YOUR ENGINE!

IMPORTANT PRECAUTIONS AND CHECK LIST

BEFORE YOU START THE ENGINE

After you have set a calibration for your engine, review the check list below before starting the engine for the first time:

- ___ the protective cover over the control knobs has been reinstalled
- ___ sparkplug wires are of the correct type and are attached in the correct firing order
- ___ all ground connections are in place
- ___ the HPV-1 has a good +12V supply and all series (ballast) resistors have been removed
- ___ the battery is in good condition, fully charged and reading over 12 volts
- ___ the crank trigger wheel is running true and timed correctly
- ___ the magnetic sensor is gapped properly and its cable connector is connected
- ___ all bolts and screws have been torqued and locked down

MEASURING IGNITION ADVANCE WITH A VOLTMETER

Ignition advance can be read with a digital voltmeter while the engine is running. Using the connectors on the front panel of the HPV, attach the - lead of the voltmeter to the "GND" tab and the + to the "ADV" tab. Select the lowest D.C. voltage scale possible on your meter that will measure 0.6 Volts D.C. The advance can be read directly from the voltmeter by multiplying the reading by 100 (i.e., .01 volts = 1 Degree .3 volts = 30 Degrees).

OTHER PRECAUTIONS

1. Do not let the sparkplug wires touch the block or head. The power of this ignition can burn through most sparkplug wire insulation. Use a quality wire, 8 mm or larger in diameter, with two piece spring loaded contacts. Use a wire loom kit with wire separators.
2. Never run the system without the sparkplug wires on the coils and sparkplugs. The spark has enough energy to be dangerous. This could also result in damage to the HPV-1.
3. It is very important to remove any series (ballast) resistance in both the +12 volt power (red) and the ground (black) wires. All connections must be clean and tight.
4. A fully charged battery is necessary for full performance and correct operation of the system. During cranking, the battery voltage should not fall below 8 volts. If the battery is old, replace it. Make sure the starter is turning the engine fast enough for the crank trigger assembly to fire the coils.
5. Do not operate the HPV-1 continuously at more than 18 volts. Double battery jump starts can damage the HPV-1. Do not disconnect the alternator while the engine is running. This may cause high voltage spikes and destroy the unit.

OPTIONS INSTALLATION

HIGH SPEED REV LIMITER

This option will allow you to bring in a rev limiter over the HPV-1's normal 8000 rpm peak. Install this device close to the HPV-1 and use the supplied wires to connect it as follows:

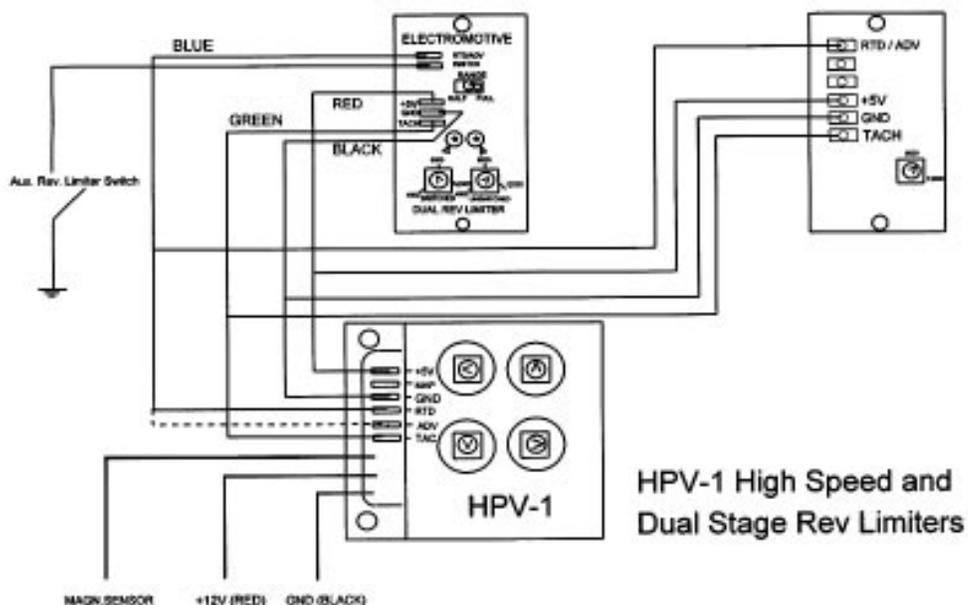
WIRE	REV LIMITER	HPV-1
Red Wire	+5v	+5v
Black Wire	GND	GND
Green Wire	TAC	TAC
Blue Wire	ADV/RTD	ADV or RTD

To select soft rev limiting, which brings the timing to it's electronic 0, attach the blue wire to the RTD terminal on the HPV-1. To cut the coils off (hard rev limiting) attach the blue wire to the ADV terminal. Set your rev limiter by turning the knob to the desired rpm.

If you are using a tachometer, splice it into the green wire between the HPV-1 and rev limiter. Do not run high voltage "C-" leads to the TACH input of the rev limiter. This will destroy it.

Calibration

Turn the adjustment knob to the approximate desired RPM. Rev the engine to the desired rev limiting RPM. Listen for the engine power to fall off if it is in the zero timing mode. If the rev limiter is set for coil cut off a distinct engine bucking will occur. Adjust the knob and repeat as necessary to get it dialed in.



Note: Each rev limiter is calibrated for a 4, 6 or 8 cyl engine as noted at the end of the serial number on the side of the limiter. Eight cylinder rev limiters only cut coils C and D while A and B remain running in the coil cut off mode.

DUAL REV LIMITER

The Dual Rev Limiter is set up exactly like the High Speed Rev Limiter as noted above, except for the addition of an external SPST switch that takes the "SWITCH" terminal to chassis ground to engage the auxiliary rev limiter. A switch allows you to temporarily divide the rev limit speed in half. This feature allows you to set your rev limiters at safer engine rpm's. Turn it back to "full" in order to take it out of half mode.

TACH AMPLIFIER

Older tachometers work on a high voltage signal from the C- lead of the coil. Most modern tachometers are designed to run on a 12 volt square wave, which is the signal the HPV puts out. The Tach Amplifier boosts the HPV's 12 volt signal to spikes of over 175 volts to allow compatibility with older style tachometers. In many cases, new tachometers or new internal components may be preferable to using the amplifier. When installing the amplifier, locate it as close to the tachometer as possible and follow these wiring instructions:

RED	KEY POWER (12V)
BLACK	GROUND
GREEN	TACHOMETER
WHITE	HPV-1 "TAC"



Note: The amplifier may cause noise in your car's radio.

REMOTE ADVANCE CONTROL

The Remote Advance allows changes to the overall timing curve without direct access to the HPV-1.

Wire the leads as follows:

Red wire	+5v terminal
Black Wire	GND terminal
Green Wire	MAP terminal



Timing Adjustments

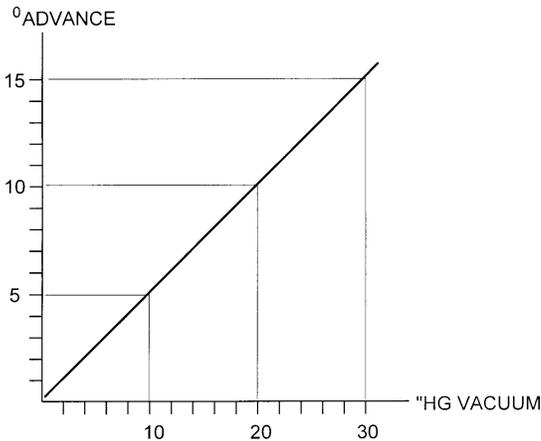
Inputs to the HPV only allow timing to be advanced, not retarded. The Remote Advance allows a total range of 14°. To use the Remote Advance for both advance and retard, as it is labeled, you must set the remote to 0 and retard the INIT knob 7°. This allows a range of +7° to -7° of adjustment. Use a voltmeter to verify that you are back at your original timing.

OPTIONS

VACUUM ADVANCE UNIT

Now available for HPV-1 users with normally aspirated engines, is a Vacuum Sensor that hooks up directly to the HPV-1's +5, GND and MAP terminals, to give 15° of advance when the manifold makes 30" of vacuum. This is additional advance and is added over and above the knob selected timing anytime vacuum is present on the intake manifold. No timing is added at wide open throttle (no vacuum on manifold). See graph below for advance vs. manifold vacuum.

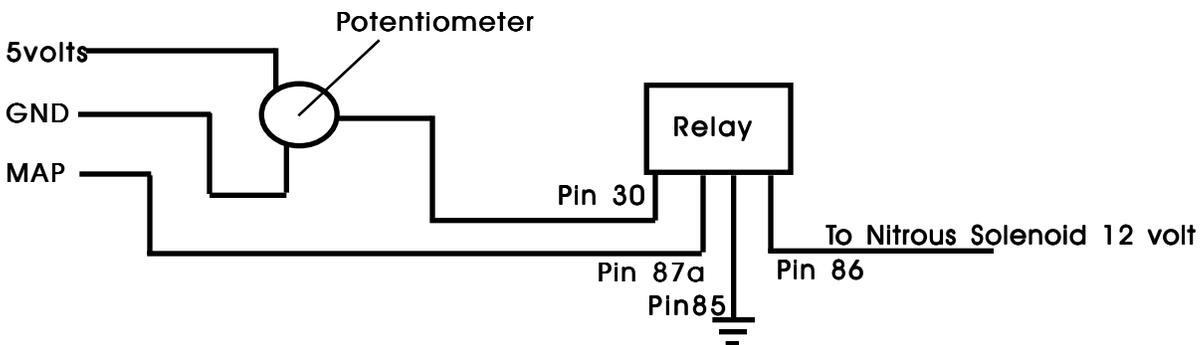
Care must be taken when setting the timing up with this unit, you will have to re-adjust the knob settings of the controller to compensate for this feature.



Caution: Do not confuse this Vacuum Sensor with a more common MAP sensor which works in oposite direction. The Vacuum sensor uses a grey connector where a MAP sensor uses a green or orange/yellow connector.

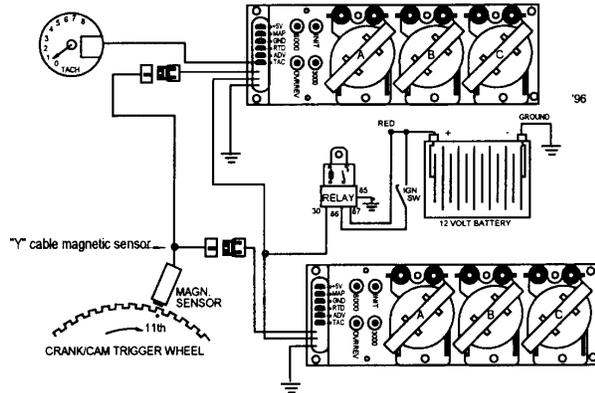
NITROUS OXIDE TIMING COMPENSATION

When using an HPV-1 on an engine with nitrous, you will want to retard the ignition timing when spraying. This can be done by setting the advance curve of the HPV-1 to reflect the timing values for when the engine is on the bottle, and then using a potentiometer and a relay to add in the additional timing when the engine is being run without nitrous oxide. The drawing below shows how to hook up a relay equipped with a normally closed terminal (pin 87a) so that when the nitrous solenoid is powered with 12 volts, then the voltage from the potentiometer, going to the MAP terminal is interrupted, and the HPV-1 goes back to the knob only timing. The voltage from the potentiometer dictates the additional advance linear from 0° at 0volts to 15° at 5 volts.



SPECIAL NOTES ON DUAL PLUG, ODD FIRE, 12 CYLINDER AND 2 STROKE ENGINES

dual plug 6 cylinder

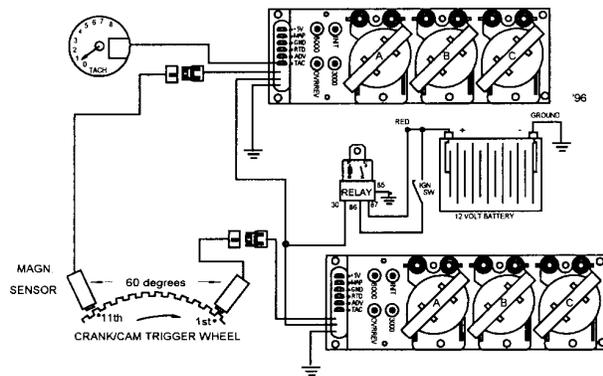
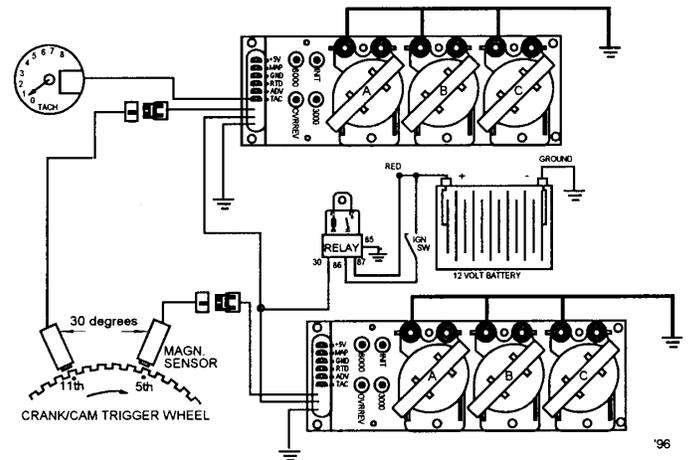


DUAL PLUG ENGINES

Two HPV-1s can be applied to an engine equipped with two spark plugs per cylinder. Using a "Y" cable magnetic sensor, the same TDC and RPM inputs are supplied to both ignitions from the same trigger wheel. The spark angles of the top or bottom plugs can be adjusted at independent angles, as is often done on rotary engines, or at the same time.

ODD-FIRE ENGINES

The HPV-1 ignition triggers the coils at even intervals. An odd-fire 6 cylinder engine must be treated as two 3 cylinder engines to use the HPV ignition. Use two HPV-1 6 Cylinder units sensing a common trigger wheel with two sensors spaced 30 degrees apart. A special grounding harness shorts one of each coil's towers to ground, creating 6 single tower coils.



12 CYLINDER ENGINES

The HPV-1 can be configured to handle a 12 cylinder engine if the engine is viewed as two 6 cylinder engines on a common crankshaft. Using two 6 cylinder HPV-1s and a single crankshaft trigger wheel, the respective sensors are placed the same distance, in degrees, from each other as the two banks are separated. On a 60° V-12, the sensors would be placed 60° apart. One unit handles the left bank and the other the right.

TWO CYCLE ENGINES

Two cycle engines can be handled with one HPV-1 for 1 through 4 cylinder applications. A 4 cylinder HPV-1 would be used for a 2 cylinder 2 cycle engine since its coils fire every 180 degrees, and a 6 cylinder HPV-1 for a 3 cylinder since it fires a coil every 120 degrees. A normal 60 - 2 wheel would be used on the crankshaft. Since only 2 tower ignition coils are available, one of the two towers must be shorted to engine block ground to complete the spark circuit. If dual plug heads are available, both plugs may be fired from the same coil but the combined air gap cannot exceed .060". Special note: Since most 2 cycle engines have magneto-type flywheels it is absolutely necessary that all residual magnetism be removed from the crankshaft. Remove the permanent magnets and demagnetize the flywheel and crankshaft before installing the system.

TROUBLESHOOTING GUIDE

This Troubleshooting guide was written to help you diagnose any problems you might have with your HPV-1. Please make sure that all of the instructions have been followed accurately and verified. We can not foresee every possible problem so we must assume that the engine is in proper mechanical order.

ENGINE CRANKS BUT WON'T START OR FIRE

Check: Supply voltage.

With the ignition switch on, measure the voltages at the red and black wires that power and ground the HPV-1. Recheck while cranking.

Red Wire	Key on - 12.0 to 18.0 Volts; Cranking - no less than 10 Volts
Black Wire	0.0 Volts under all conditions

Check: Spark.

The preferred method: Attach an inductive timing light to any sparkplug wire and crank the engine to see if the timing light strobos. Also, look for the tach needle to jump while cranking. Alternatively, use a sparkplug style tester and check for spark at the plug end of the wire while cranking. CAUTION: This is an extremely powerful ignition and may be lethal! DO NOT handle the spark plug wires or coils while the engine is running! STAY AWAY from all connections when cranking!

Check: The magnetic sensor.

Inspect for physical damage caused by the trigger wheel. Check the air gap between the sensor tip and wheel. Try smaller air gaps. Replace the magnetic sensor if the resistance between the red and black wires going into the sensor is outside of the 600 to 800 OHM range. Make sure the bracket and nearby parts are not magnetic or magnetized.

ENGINE BACKFIRES DURING CRANKING

Check: Incorrect mechanical advance. Either too much (for most engines) or not enough mechanical timing for high overlapped valve engines. Verify mechanical advance and adjust as necessary.

ENGINE STARTS, BUT MISFIRES OR DIES AT HIGH RPM

Check: Sparkplug wires.

The plug wires must be connected and in the correct firing order. Also check for shorts or burnt-through insulation. Wires over a year old should be replaced with new wires. Sparkplug wires must have a resistance of 3000-5000 ohms-per-foot or greater. Replace wires as necessary.

Check: Spark at each plug.

With an inductive crank trigger timing light, check every sparkplug wire to see if it strobos

the light. Replace plugs and/or wires as necessary.

Check: Battery.

Check battery for age or obvious damage. Load test if possible. Check voltage under cranking and running conditions.

Check: The magnetic sensor and crank trigger wheel.

The sensor and trigger wheel must be installed accurately according the installation instructions. Check the mechanical timing, sensor-to-trigger wheel air gap and run-out, both radial and lateral. Look for damaged teeth on the wheel. Replace or machine as required to bring into spec. The sensor bracket must be sturdy enough to not vibrate at high speeds. Check the wiring of the magnetic sensor, including proximity to interference sources. Keep the sensor wire at least 4" from plug wires, alternator wires, or any other wires carrying high current.

Check: Calibration.

Too little or too much timing will cause running problems and potential engine damage. After measuring mechanical timing, use a voltmeter to verify advance reading. Dial back timing lights are not compatible with the extra spark of the HPV-1, so they will not show accurate timing information.

Note: One of the plug wires attached to a coil goes positive, the other goes negative. If your timing light does not flash correctly, change the pickup to the other wire on that coil. At a steady RPM the timing mark should be extremely stable.

Check: Coil hold down screws.

The screws holding the coil to the baseplate must be tight. They ground the coil to the chassis of the HPV-1. Also check for corrosion. Clean, tighten as required.

Check: Fuel mixture.

Adjust as necessary.

TERMS AND CONDITIONS

Direct Sales and Our Value Added Dealers

Electromotive products are sold either direct or through our Value Added Dealers (VADs). Electromotive works closely with a network of independent dealers throughout the world. These dealers supplement our products with their experience, installation and calibration skills for specific applications. Combined with their discounts and expert knowledge, it can often be more effective to purchase a system from a VAD instead of directly from Electromotive.

WARRANTY

1 Year limited warranty covers material and workmanship

All warranty claims must be pre-approved by the factory. Please call for return authorization and instructions. Customer is responsible for the return of dysfunctional units to Electromotive. All units in need of warranty repair should be sent "Attention: Service Department" to the address shown below. The service department will repair or replace units at their discretion. A service charge will be assessed on units with no trouble found or units found to be damaged due to customer misuse.

Repairs & Returns

An RMA number is required for all shipments to Electromotive. All units in need of repair should be sent to:

Electromotive, Inc.
Attention: Service Department
9131 Centreville Road
Manassas VA 20110-5208

Customer is responsible for all shipping charges. Include a short note outlining the problems encountered and how you can be contacted. Please be aware that a minimum service charge will be assessed for testing, even if no trouble is found. All returns require pre-approval by the factory and are subject to a 20% restocking charge.

Pricing Policies

All prices subject to change. Wholesale pricing will be extended to automotive businesses only. A copy of the business license and a commercial phone listing are required. Discounts are based on quantity purchases or repeated purchases over 12 months. No discounts on individual orders under \$250. No discounts on software licenses.