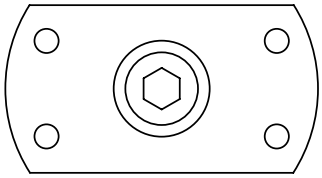
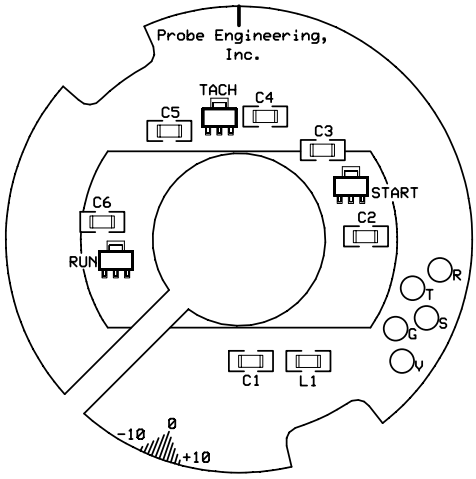
PROBE ENGINEERING, INC.

Installation Instructions

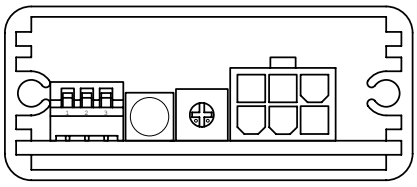
Model DX-65EL Ignition System



Trigger Rotor



Pickup Plate



Control Module

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The Model DX-65EL electronic ignition is designed for Yamaha XS650 twins from 1970 to 1982, and may be fitted to both early breaker-points engines and later transistorized ignition models.

The Model DX-65EL is a dual-fire ignition system that fires both spark plugs simultaneously once per crankshaft revolution, using a dual-tower coil. The "L"-suffix system is based on the earlier Model DX-65E product, but incorporates a user-adjustable rev-limiter circuit. When the rev limit is reached, each cylinder fires on every-other power stroke, cutting power in half and preventing engine over-speeding without accumulating excessive unburned fuel in the cylinders.

The system employs fully electronic spark timing advance-retard, and does not use the OEM mechanical advancer assembly. Once set, the spark timing remains fixed and stable.

The system will work with the 1980-and-later OEM coil, but for superior performance, an aftermarket coil between 3 ohms and 5 ohms primary resistance should be used. For competition applications, a 3-ohm coil will give hotter spark at sustained maximum RPM. For street applications, a 5-ohm coil will give excellent performance, and will make lower demands on the XS650's charging system.

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What should be in the kit:

The Model DX-65EL kit includes the following components:

- Control Module
- Pickup Plate (with shielded leads and 6-pin connector)
- Power Cable Harness (with 5-pin connector)
- Trigger Rotor
- 3/16" hex wrench (to tighten internal-expander screw of Trigger Rotor)
- M6 by 12mm pan head screws with rubber-faced flat washers (2 each)
- Self-adhesive Velcro for mounting the Control Module
- Spare white and orange wires (1-foot long each, for optional features)
- Pair of NGK BPR7ES spark plugs (the use of resistor-type plugs is required)

What else you will need:

In addition to the usual small hand tools required to get access to the engine's breaker-points assembly and to remove the fuel tank, side panels, etc., installation will require the following tools and supplies:

- Wire cutters/strippers
- Solderless crimp-type connectors, bullet connectors, or solder and shrink tubing
- Loctite® "blue" medium-strength thread-locking compound or equivalent
- Xenon-flash timing light

If you have a 1979 or earlier points-type ignition, you will also need the following tools:

- 1/4" NPT pipe tap (tapered pipe tap, available at most hardware stores)
- 1/4" pipe plug and/or pipe nipple (short length of pipe, threaded at each end)
- Gear puller (not absolutely necessary, but very handy – see steps #17 and #18)

Installation:

1. Remove the side panels (for general access).

2. Raise and/or remove the seat.

3. Disconnect the battery.

4. Remove the fuel tank.

5. Remove the alternator rotor cover on the left side of the engine.

6. Remove the chromed-steel breaker-points cover on the left side of the cylinder head. *Remove this cover even if you have a 1980-or-later engine without breaker points*.

For 1980-and-later engines, or if you've installed a hard-weld camshaft (a hard-weld cam will be returned to you without the internal bushings and seals), skip steps #7 through #18, and go directly to step #19.

7. Remove the chromed-steel centrifugal advancer cover on the right side of the cylinder head.

8. Remove the breaker points and their backing plate as a complete assembly from the housing.

9. Disconnect the breaker points from the ignition coils.

10. Disconnect the condensers (condensers should not be used with the solid-state ignition).

11. Disconnect and remove the 2 ignition coils and their spark plug leads.

12. Remove the nut securing the breaker-points cam to the left end of the advancer shaft (the advancer shaft runs through the hollow center of the camshaft).

13. Remove the breaker-points cam from the left end of the advancer shaft (it pulls straight off the shaft).

14. Remove the nut on the right end of the advancer shaft that connects the shaft to the advancer mechanism.

15. Remove the advancer shaft and the advancer collar (the collar connects the shaft to the flying weights).

16. Remove the 2 "e-rings" retaining the flying weights on their respective pivots on the advancer mechanism, and remove the weights and springs. You can leave the rest of the advancer back plate assembly in place; it will not hurt anything, and will give you a convenient "push" point for the following steps, if needed.

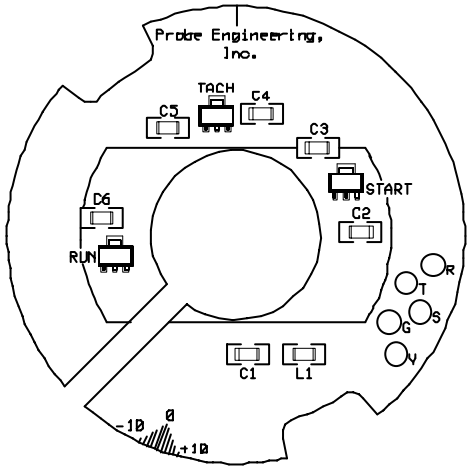
17. There are a seal and a bushing installed in each end of the hollow camshaft. The seal and bushing on the left side of the camshaft must be removed to install the Trigger Rotor. To remove the seal, thread the 1/4" NPT (National Pipe Thread) tap partway into it. You can use a tap handle for this if you have one handy; if not, an adjustable end wrench on the drive flats of the tap will work fine. Once the tap has a decent "bite," the seal will usually twist out of the end of the camshaft without much trouble if you simultaneously pull it toward you while twisting. If the seal doesn't twist out while tapping, there are two ways to deal with it. The first method is to thread a 1/4" pipe plug into the seal, and press the seal and plug out from the right side of the engine, using the advancer shaft you just removed as a "pusher." A conventional gear puller tool pulling against the advancer backplate and pushing on the shaft makes this easy. The second method is to thread a 1/4" pipe nipple into the seal, and pull it out from the left side.

18. To remove the (inboard) bushing from the left side of the camshaft, again use the 1/4" NPT tap to cut threads into the bushing***. Be careful not to tap so far into the bushing that you begin cutting threads in the internal shoulder of the camshaft material that backs up the bushing***. The bushing is usually a little tighter in the bore than the seal is, and will often have to be pulled out (using the pipe nipple) or pushed out (using the advancer rod and gear puller combination).

For 1980-and-later engines, resume here:

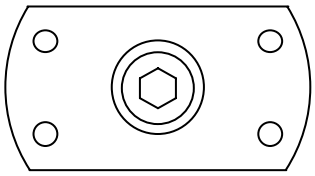
19. Using brake cleaner, electric parts cleaner, acetone, or some other non-residue solvent, clean and degrease the internal bore of the camshaft on the left side.

20. Locate the Pickup Plate in the kit. It looks like this (wires are not shown, for clarity):



21. Using the screws and washer supplied in the kit, install the pickup plate into the points-plate relief the left points housing. Position the plate so that the mounting screws are roughly centered in the two clearance spaces on the plate O.D. (to allow final timing adjustment either way), and lightly tighten the screws. The yellow line just above the words "Probe Engineering, Inc." at the top of the pickup plate will be at the 12:00 position.

22. Locate the Trigger Rotor in the kit. From the front, it looks like this:



23. Using a 3/16" hex wrench, loosen the internal-expander screw inside the trigger rotor a couple of turns, then slip the rotor into the freshly cleaned left-side bore of the camshaft until the rotor bottoms on its shoulder. Spin the rotor inside the camshaft a few turns to ensure that it doesn't foul the pickup plate's wires (or anything else). Don't tighten the internal-expander screw yet.

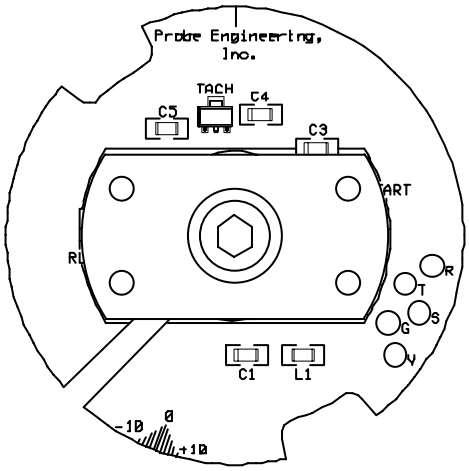
24. Remove the sparkplugs from the engine, so that you will not be fighting against compression in the next steps (you will still be fighting valve spring pressure, which is trouble enough).

25. Take a look inside the alternator housing. At about the 5:00 position on the stator housing casting are a letter "F" and a letter "T." Near each letter are the corresponding timing marks (lines). The letters will either be cast into the stator housing (early points-type engines) or stamped into a metal tag attached to the housing (1980-and-later engines). To the immediate right of the letter "T" is the line that denotes the Top Dead Center (TDC) position of the crankshaft. (If you've been setting valve clearances yourself, you already know about this mark – it's where you position the crank to adjust valve lash.) In the next step, you will be setting the alternator rotor pointer to the "T" mark.

26. Using a 17mm socket or box-end wrench on the alternator-rotor bolt head, turn the engine in the "running" direction (counterclockwise), and carefully align the timing mark on the alternator rotor with the "T" indicator mark on stator housing.

27. Remove the trigger rotor from the camshaft, and smear a few of drops of medium-strength blue Loctite (or equivalent thread-locking compound) around the inside diameter of the camshaft bore, where the rotor engages it. Reinstall the rotor.

28. The outline of the rotor is printed in yellow silkscreen ink on the face of the pickup plate. Align the rotor so that it matches the printed outline, hold it firmly in place, and tighten the internal-expander screw inside the rotor using a 3/16" hex wrench (an adjustable end-wrench is useful for holding the rotor across the flats while tightening the screw). The assembly should now look like this:



29. Check to make sure the alternator rotor mark is still aligned with the "T" mark on the stator housing. If the crankshaft position moved while you were tightening the rotor's expander screw, loosen the rotor and repeat steps #26 and #28 until everything looks right.

30. If you have a pre-1980 machine, you will have to mount a new dual-tower coil to replace the two original single-tower coils. A dual-tower coil can usually be mounted near the original coil mounting plate(s) beneath the lower frame backbone tube, under the fuel tank. A high-performance coil with a primary resistance as low as 3 ohms may be used. "Accel" brand 3-ohm dual-tower coils and "Dyna" brand 5-ohm and 3-ohm dual-tower coils have been extensively tested with this system, and have given excellent results.

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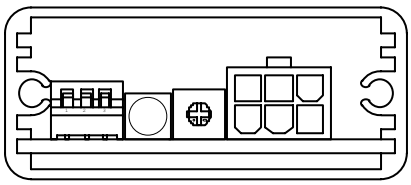
IMPORTANT NOTE: Ignition coils intended for capacitive-discharge ignition (CDI) systems generally have less than 1 ohm primary resistance, and are incompatible with the Model DX-65EL system. The wrong type coil will cause irreversible damage to the Power Module. Many inexpensive multimeters can't measure accurately down to a few ohms, so be especially careful to know what coil resistance you have.

31. Cut and fit the new high-tension leads from the coil towers to the spark plugs. The plug leads must be resistor-core suppression-type or spiral-core suppression-type plug wire. Solid-core wire may be used only if new resistor-type spark plug caps are installed (5k ohms resistance; NGK type LB-05F is a good choice).

32. If you have a 1980-or later-bike, you will already have a dual-tower ignition coil, and will not have to replace it. If your coil is in questionable condition, or if you want to use a higher-performance ignition coil (the stock dual-tower coil is decent, but not great), see the recommendations above.

33. Locate the Control Module in the kit. It looks like this:



34. There is a 6-pin connector toward the right side of the module, a three-position DIP switch toward the left side, and a red LED and blue potentiometer between the two. There is also a 5-pin connector (not shown in the line drawing) at the end of a short wire bundle coming out the module.

35. Find a place where you'd like to mount the control module. The module's potentiometer can be used to make small trim adjustments to the idle-speed spark advance, which is independent of the full-advance timing. It is preset for your bike at the factory, and will usually not require adjustment unless you elect to run significantly more or less full-advance timing than Yamaha's original specifications. If the blue potentiometer is accessible when the module is in place, it will make this adjustment easier.

36. The control module is delivered with Velcro fastening material. The "loop" side is attached to the module; the "hook" side has an aggressive "peel-and-stick" adhesive, for attaching to a clean, flat surface on the bike. The module dissipates

low power, and will get barely warm to the touch during operation. It does not require aggressive airflow, but should not be mounted in a sealed volume with no airflow at all.

37. Route the pickup plate assembly's wire bundle to the location of the control module. The pickup plate wires are insulated using high-temperature Teflon, and have a tinned-copper braided shield surrounding them; the wires can be routed pretty much anywhere (except to an exhaust pipe!) without major temperature concerns. However, the wires must be kept well away from the spark-plug leads, so that the electronics won't get confused or damaged by spark-energy "pickup" from the high-voltage coil leads.

38. The sensor assembly's wire bundle has a 6-pin plug that matches the module's 6-pin connector housing. Plug them together; they are keyed, so that they only fit one way. The retaining latch that will "click" when the connectors are fully mated.

39. There is a 5-pin connector on the Power Cable Harness. On the connector's rear surface (where the wires enter), molded-in numbers show each wire's position, 1 through 5. The wires in each position are as follows. You only have to deal with the three wires shown in **boldface** type:

♦ **Position 1:**	**Heavy-gauge red wire – goes to switched +12 volts**
♦ **Position 2:**	**Heavy-gauge green wire – goes to chassis ground**
♦ **Position 3:**	**Heavy-gauge yellow wire – goes to ignition coil**
♦ Position 4:	Open position – for optional kill switch connection
♦ Position 5**:**	Open position – for optional tachometer output

40. The green wire (connector position 2) goes to a good chassis ground. The chassis ground must be free of paint and be clean, bright metal. **The battery box on the XS650 is NOT a good chassis ground** – it's isolated from the chassis by the four vibration-isolation rubber mounts at its top. The ground wire is 12" long as supplied, to ensure that it is grounded close to the module location.

41. The red wire (connector position 1) goes to a switched source of +12 volts from the battery. You can pick this up from the wire supplying +12 volts to the ignition coil's primary terminal. Dual-tower coils are generally not marked for positive (+) and negative (-) primary terminals (since it does not matter).

42. The yellow wire (connector position 3) goes to one primary terminal of the ignition coil (the other primary terminal of the coil is connected to +12 volts).

Again, terminal polarity is generally not marked on a dual-tower coil, and it does not make any difference.

43. Figure 1 shows how the power wiring should look when you're done. The pickup plate and its wires are left out of the diagram for clarity – only the wires that the installer is responsible for connecting are shown. If you are unfamiliar with wiring diagrams, wires that have a "dot" at their intersection are electrically connected to one another, while a "jog" signifies that they are not connected.

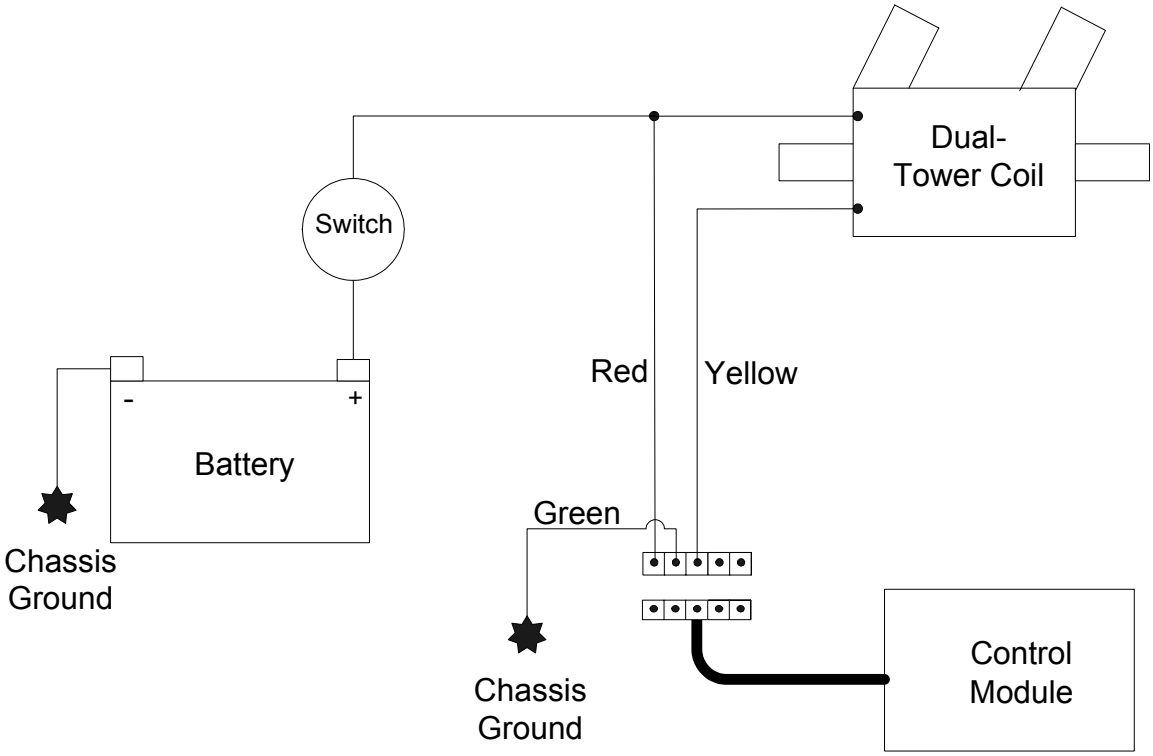


Figure 1

44. Plug the 5-pin connector into the control module's matching connector. It's keyed, so it only goes one way, and it will be obvious. Make sure the connector is completely seated– the latch will engage with a "click" when the connector is fully home.

45. Take a deep breath, clear your head, and double-check your wiring.

46. Install the BPR7ES plugs included in the kit into the engine and connect the plug caps.

47. Reconnect the battery.

48. Reinstall the fuel tank, open the petcock (if you have non-vacuum-operated petcocks), and set the choke(s) as required.

49. Turn the ignition switch on.

50. Start the engine.

51. Warm up the engine a little bit so that you can take the choke off, and so that the engine will idle when you need it to.

52. Connect a xenon-flash type timing light (the bright kind) to the left-hand cylinder's plug wire, and connect the timing light to the bike's battery.

53. ***For 1979-and-earlier engines****:* With the timing light pointed at the alternator timing marks, rev the engine up to about 3,500 RPM (about 500 RPM above the speed at which the timing reaches full advance). The timing is correct when the timing light "freezes" the alternator-rotor timing mark so that it aligns with the full-advance mark on the alternator housing. If the full-advance timing is correct, go to step #58. If the timing is not correct, go to step #55.

54. ***For 1980-and-later engines:*** With the engine idling at 1,200 RPM, shine the timing light on the alternator timing marks. The timing is correct when the timing light "freezes" the alternator rotor mark aligned with the "F" timing mark on the stator housing. After checking the idle timing, rev the engine to about 3,500 RPM to verify that the ignition timing advances as the revs increase (note that the 1980-and-later alternator housings do <u>not</u> have full-advance timing marks). If the timing is correct, go to step #59. If the timing is not correct, go to step #55.

55. If the timing is not correct, shut off the engine. Use a marking pen or a scribe, make a mark on the points housing in line with the central zero ("0") line of the timing-adjust marks silkscreened onto the pickup plate at about the 7:00 position.

56. Loosen the two pickup plate retaining screws, and rotate the plate in the housing to adjust the timing. Turning the plate counterclockwise *retards* the timing; turning it clockwise *advances* the timing. Each timing-adjust mark space on the pickup plate represents a timing change of two degrees at the crankshaft. After you've readjusted the timing, lightly tighten the pickup plate retaining screws.

57. Restart the engine and recheck the timing. Repeat the adjustment steps as necessary until the timing is correct. If you run up against the end of the pickup plate retainer screw clearance before the timing is correct, mark the position of the trigger rotor, loosen the internal expander screw, slightly reposition the rotor in the end of the cam, and retighten the internal expander screw. If you were unable to retard the timing enough, reposition the rotor slightly clockwise inside the end of the cam. If you were unable to fully advance the timing, reposition the rotor slightly counterclockwise.

58. For early (pre-1980) engines that have both full-advance and idle-advance marks on the alternator housing, you can now check and adjust the idle-speed spark timing. The blue potentiometer on the control module controls the idle-speed timing. Turn the screw clockwise to increase the idle delay and retard the idle timing; turn it counterclockwise to advance the idle timing. The idle timing is correct when the timing light "freezes" the timing indicator mark on the alternator rotor somewhere between the two "F" timing marks on the stator housing.

59. When the timing is correctly set, turn off the ignition switch, tighten the two pickup plate screws, and close the petcocks (if you don't have vacuum-operated petcocks). Reinstall the alternator rotor cover, seat, side covers, the points-housing and advancer-housing covers, and any other covers or bodywork you removed.

Appendix 1; setting the rev limiter

The three toggles of the module's DIP switch allow the user to set the rev limiter to one of eight combinational settings. In ascending order, these are:

Rev Limit	Switch 1	Switch 2	Switch 3
RPM	Position	Position	Position
7,500	Down	Down	Down
7,750	Down	Down	Up
8,000	Down	Up	Down
8,250	Down	Up	Up
8,500	Up	Down	Down
8,750	Up	Down	Up
9,000	Up	Up	Down
None (limiter off)	Up	Up	Up

The as-delivered DIP switch setting is with all three toggles in the "down" position, with the rev limit set to 7,500 RPM (the Yamaha factory redline figure for a stock XS650).

The toggles are numbered from one to three (from left to right); the numbers are visible on the switch housing.

When the engine reaches the set rev limit, each cylinder fires on every other power stroke (that is, every four crankshaft rotations, instead of every two crankshaft rotations, as is normal for a four-stroke engine). The resulting "stutter" sound and feel will alert the rider that the rev limit has been reached, at the same time reducing engine power by half to prevent over-revving. As soon as engine speed is reduced below the limit, normal ignition firing resumes.

Setting all three toggles to the "up" position disables the rev limiter and allows unrestricted engine RPM.

Appendix 2; kill switch and tachometer options

As noted in the wiring table earlier in this document, there are tachometer and kill switch options available. If you've completed the basic ignition system installation, you've already dealt with the three wires that came pre-installed in the 5-pin power cable harness connector. The two remaining connector positions are associated with the tachometer and kill switch options. Their numbers are:

- Position 4: Kill switch
- Position 5: Tachometer output

The DX-65EL installation kit includes one white and one orange wire that can be inserted into the 5-pin connector housing to make the kill switch and tachometer connections.

The terminals are preinstalled onto the ends of the wires; these may be inserted into the connector housing from the back (where the molded-in numbers are, and where the existing red, green, and yellow wires are sticking out). The terminals "snap" into place and are then permanently retained; you can feel and hear them "click" when they go all the way home. The simplest way to see how the terminals must be oriented for insertion (they only go one way) is to use one of the other wires already installed in the connector as a guide.

The first option is the Kill Switch; this one's easy. If you install the kit's accessory white wire in connector position 4, and short the other end of the wire to chassis ground, the plugs will stop sparking for as long as the electrical connection is made. The kill function does NOT disable the ignition's control module or tachometer output; they continue to operate (the module alone draws only about 85 milliamperes). The kill function shuts off the coil current, so that there can be no spark. When the kill wire is disconnected from ground, normal operation resumes.

The second option is the "digital" tachometer output signal (orange wire, connector position 5). The digital tachometer output is configured to give one signal pulse per crankshaft revolution, swinging between 12V and zero volts with a 50% duty-cycle square wave; this is a common Japanese bike electronic-tachometer format for 4-cylinder bikes.

Electronic tachometers will generally have either three or four wires. The three-wire versions have the following connections:

- +12V
- Ground
- Signal Input

Four-wire tachometers have an additional dedicated lead for the internal backlight. Color coding for these wires varies from manufacturer to manufacturer, so you will have to determine which is which according to your tachometer's documentation.

Other details and notes:

- The DX-65EL system has an auto-shutoff feature that turns off the coil current if the engine is not started within 30 seconds of the key switch being turned on (or if the engine has been stopped or stalled). This prevents draining the battery or damaging the coil and/or module if the system is accidentally left energized. Once "timed out," the module will automatically resume normal operation when crank rotation is detected; you don't have to cycle the power to re-boot the system.

- Recheck ignition timing after each periodic cam chain adjustment. Since the ignition is driven from the end of the cam, a stretched chain will retard the ignition.

For questions and/or assistance, contact:
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