



Product Documentation



Installation & Operating Guide

Guide Applicable to E-MAG Ignition Models E-113 and P-113 Ignitions on Lycoming 4 Cylinder Engines

(NOTE: There are minor variations within the 113 series, so this manual may not fully apply to all ignitions.)

Experimental Aircraft Only

E-Mag ignitions are not (currently) certified and are not approved for installation on certified aircraft.

Warranty

Your E-MAG electronic ignition is warranted for one (1) year from the date of purchase. Any unit returned must first receive a return authorization number prior to shipping (postage paid). E-MAG will repair or replace ignition modules within the warranty period that, in E-MAG's sole opinion, have not been subjected to abuse or any attempted field repairs. This warranty is limited to the purchase price of E-MAG hardware and does not cover the engine or other engine components that may be affected by defects or failure of the system.

Caution

The aircraft operator has the SOLE responsibility of determining how to appropriately and safely control engine operation. Nothing stated by E-MAG, its employees, owners, agents or affiliates should be construed as overriding or invalidating the engine manufacturer's instructions (including lean operation warnings).

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2014 Greg Street
Azle, Texas 76020
Phone (817) 444 5310

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Using This Manual

Your ignition is designed to make installation as straightforward and as simple as possible. To further assist you, this manual includes a variety of comments and tips.

Note: The term “E-MAG” shall apply to both E model and P model ignitions, unless specifically stated otherwise. P models have a built-in backup alternator and E models do not.

Installation

Overview

Installing your E-MAG ignition will require you to:

1. Install the drive gear on your ignition.
2. Attach three (four if you use the tack) leads to the Control Plug.
3. Spark plugs and the spark plug harness
4. MAP (manifold pressure) sensor tube
5. Install your E-MAG ignition on the engine, set the timing, and select the maximum timing advance.

CAUTION: Do NOT strike or apply significant inward force to the ignition shaft. Doing so could damage or misalign the position sensor.

Operating the ignition without all connections – 1) power, 2) ground, 3) p-lead, 4) plug wires with plugs (and all plugs grounded) can result in damage to the ignition and/or cause an electrical shock to the installer.

Please resist the temptation to do a quick (incomplete) hook up so you can watch the ignition spark or make the LED light up.

Firing the ignition without all connections could damage the unit, and void your warranty.

Drive Gear

E-MAG ignitions are indexed to the engine through a drive gear. The drive gear from a non-impulse magneto can be recovered and, if in good condition, be reinstalled on your E-MAG. The gear from an impulse magneto is different, and cannot be reused.



1. To recover the drive gear from an existing magneto:
2. Remove the cotter key, castle nut, and washers. A strap wrench is helpful while removing (or re-installing) the castle nut from the ignition shaft.
3. Remove the drive gear from the magneto shaft. A gear puller will be necessary to remove the gear without damaging the gear, or the magneto. NEVER strike the magneto, the gear, or the shaft in order to remove or install the gear.
4. Install the drive gear on the E-MAG shaft using the woodruff key, washer, castle nut, and cotter key provided. Additional washers can be used to align the hole for the cotter key with the castle nut when tightened. Make certain the cotter key ends lay flat and do not extend past the open face of the gear. The back wall of the accessory case will be close to the face of the drive gear, and you don't want any protrusions that could make contact and wear against the back.

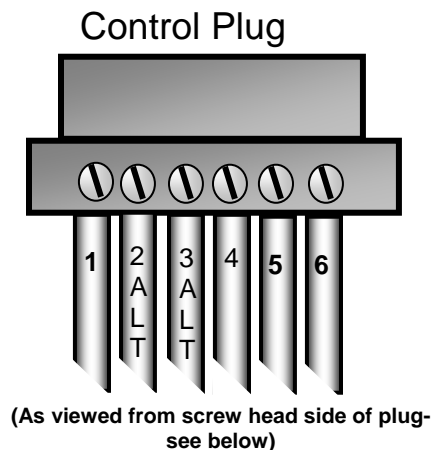


**Woodruff Key
installed in shaft**

E-MAG Control Leads

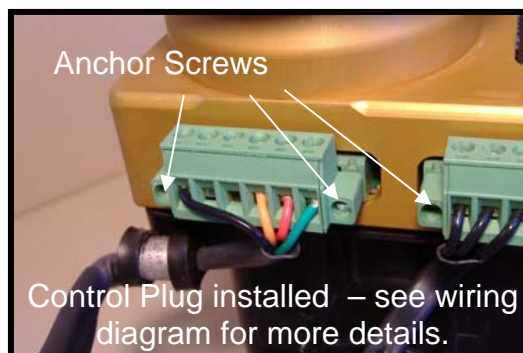
Control Wiring – Control leads are connected to the ignition via a Control Plug that captures each lead with a screw cage mechanism. The plug is then attached to the ignition and secured with anchor screws on either side. A wiring diagram is included at the end of this manual. The numbering system for the plug terminals is 1 thru 6 as viewed looking at the cage screw heads with wires oriented below (see fig).

Use the cushioned anchor strap to provide a mechanical strain relief for the wires (apply thread locking compound to the coil bolt holding the anchor strap). The wire/plug assignments are as follows:



Note: If you are replacing a Shower of Sparks type ignition with an E-MAG, you need to remove the vibrator and related hardware.

1. “1” connects directly to a nearby engine case ground using 18 gauge wire. Note: You cannot rely on the ignition’s mechanical attachment to the engine to provide ground. Aluminum anodizing acts as an electrical insulator, so the clamp connection to the anodized flange will not serve as a reliable ground.
2. “2” Control Alternate
3. “3” Control Alternate
4. “4” connects to your ignition ON/OFF (ground) p-lead switch using 20 gauge wire or larger.



Note 1: If you are replacing a magneto, your old P-Lead can serve this purpose, and may already be wired to a suitable switch.

Note 2: Non-starting magnetos require a mechanism to prevent them from firing during start-up. Keyed ignition switches have a jumper on the back that serves this purpose. When installing an E-MAG in place of a non-starting magneto that was controlled by such a switch, make sure you remove this jumper. You do NOT want a start-up block on any circuit controlling your E-MAG(s).

5. "5" connects to your main 12 volt aircraft buss through a dedicated circuit breaker (not provided) using 18 gauge wire. E-MAGs should use a 5-amp breaker, and P-MAGs should use a 3-amp switchable breaker. The switch is needed to test the P-MAG internal alternator during ground run up – see Operating Notes.

Note 1: Whenever the aircraft buss is powered up, the ignition is "awake". It draws a small amount of current even when not firing the plugs. Use the main buss switch (or breakers if necessary) to power down the ignitions when not in use

6. "6" is a courtesy (optional) connection to provide a digital tack signal – two pulses per revolution.

Note 1: Collect your tack signal from only one, not both, ignitions. This applies to dual E-MAG ignitions as well as split systems (E-MAG in tandem with a magneto or other EI).

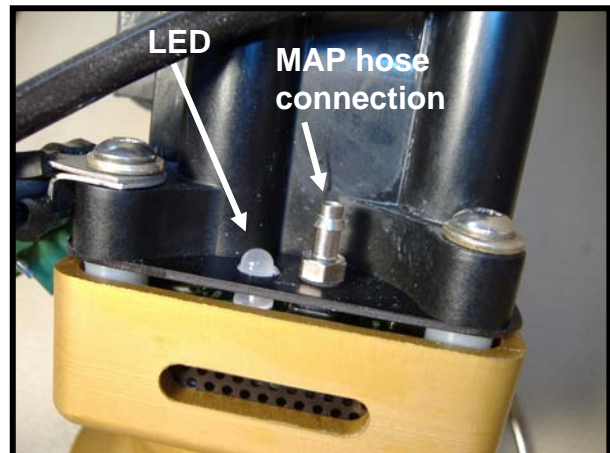
Note 2: Unlike a magneto, your E-MAG will generate a tack signal even when it is disabled by the p-lead ignition switch, so you won't lose tack when you switch the E-MAG OFF during a preflight ignition check.

Note 3: E-MAG's tack output is a courtesy feature that is unrelated to the ignition's primary purpose. Due to the variety of instrument options available, our ability to support and troubleshoot tack interface issues is limited. See wiring diagram for details of tach signal provided as well as the section on EICAD below.

MAP Sensor

Connect one end of the sensor hose to the MAP nipple on the back of the ignition case next to the coil base, and secure with nylon clamp. Route the line to a convenient connection point (connecting hardware not included) where you can tee into the line going to your manifold pressure gauge.

Note 1: The MAP sensor is a fail-safe input; i.e. if the tube comes loose or fails in-flight, timing will retard to an operable, but much less efficient range.



Spark Plugs & Harness

Post Assignments – The plug wire assignments are as follows:

1. Cylinders 1 and 2 connect to the coil pair nearest the LED indicator
2. Cylinders 3 and 4 connect to the coil pair furthest from the LED indicator.

Note 1: It does not matter which cylinder is connected to which post within a given pair. They are completely interchangeable, which can be convenient to help fine tune the wire lengths.

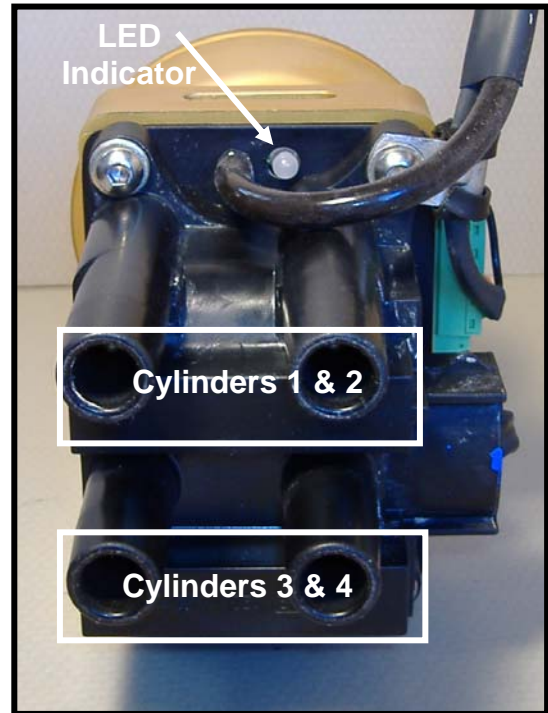
Aircraft Plugs - One advantage of electronic ignition is the ability to fire across a wider spark plug gap (0.030" to 0.035" in the case of E-MAG). Some aircraft plug styles are difficult/impossible to adjust this wide. Plug styles similar to REM37BY have an extended electrode arm that is easier to adjust. Caution: You will need to support the base of the arm when adjusting plug gap, as it can break off where it attaches to the rim.

Auto Plugs - There are a number of auto spark plug styles and temperature ranges available through automotive outlets. E-MAG has NOT undertaken studies to compare the relative durability/suitability of different plugs. We do offer a standard "starter" plug for convenience. Customers need to monitor plug condition and evaluate/adjust as necessary. We offer the following list of plug alternatives that are reported (BY OTHERS) to work in most installations.

1. NGK BR8ES 2.5mm Center Electrode (our standard "set-up" plug)
2. NGK BR8EV Gold Palladium Center Electrode

Auto Spark Plug Adapters - Plug adapters permit the use of 14mm automotive type plugs with a $\frac{3}{4}$ " reach. [Not suitable with engines that use long-reach (13/16") aircraft plugs.] First, install adapters with the supplied gasket on the spark plugs finger tight. Then, insert in engine and tighten to 15 ft/lb (standard plug torque).

Note 1: If you install and torque the adapters separately, stresses will be focused at the adapter neck and can cause it to fail during installation.



E-MAG Aircraft Lead Kit – E-MAG’s aircraft plug leads have traditional “cigarette and spring” threaded fittings pre-installed on one end of our auto style wires. The hex cap end attaches to standard 5/8” x 24 spark plugs. There is currently no harness option for 3/4” x 20 plugs.



The ignition end connects to the coil and is trimmed, and fitted in the same manner as our standard Auto Lead Kit – see below.

Note 1: Aircraft kits use our premium low-noise auto wire (not shielded). To date, we've had no (zero) reports of noise problems from customers using this wire. Even so, builders have the option, if needed, of adding a shield over the leads and grounding them at the spark plug end.



E-MAG Auto Lead Kit – E-MAG’s auto style harness is provided as an assembly kit. It gives the builder greater control over length and makes for a cleaner more custom installation.



Note 1: Auto leads should be kept separated when installed. Do NOT bundle them together as is common with shielded aircraft wires, as this can cause them to be inductively coupled. Wire looms can be purchased at auto parts stores, but a simple separator can be fabricated out of tie-wraps and 1/4” segments of left over MAP sensor hose – see photo.

Auto Lead Fabrication

- 1) Plan your route and lay out one lead at a time, starting with the longest leads first. Cut leads with about three extra inches. It will be easier to make your first terminal connections at your workbench, so mark the cut leads so you know where they belong when you return.
- 2) Install COIL end boots and terminals (only) on each lead – see “Crimping Terminals” below. Your kit includes 2 extra terminals with each set so don’t panic if you make a “practice piece”.
- 3) Connect all four leads to the coil and secure along the wire route. You might even install the wire separators (if you plan to use them) so you can more accurately determine the correct length. Cut the plug wire end where it meets the plug tip. Install the spark plug boots and terminals.



Note 1: Now that you've had some practice with crimping terminals, it may be more convenient to install the plug terminals with the wires on the engine. You can mark the terminals so they are oriented in the right direction when crimping. This might avoid having to twist the head when connecting them to the plug.

4) Crimping Terminals

Identification: The shorter steel terminals and rounded boots are for the spark plugs. The longer brass terminals and flat-backed boots are for the coil end.

- a) First, run the wire through the boot so it's a couple of inches from the end. This will give you room to work with the wire and terminal. A light coating of silicone spray (not included) is needed to lubricate the wire as you work it through the boot.

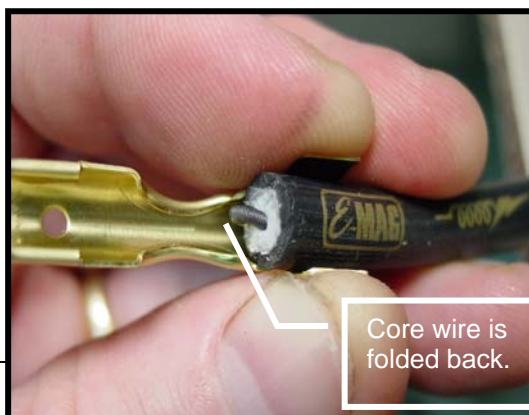
Note 1: It is best to push the boot down the wire (rather than pulling) to avoid straining the wire core.

Note2: You can push on the heel of the boot and straighten the opening so it is aligned with the wire as you push it through.

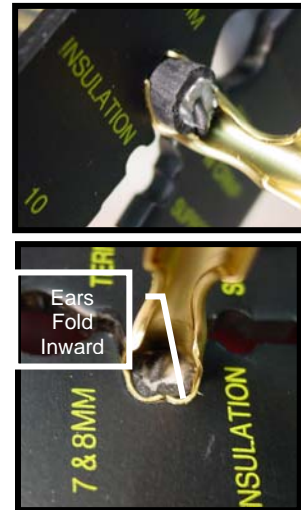
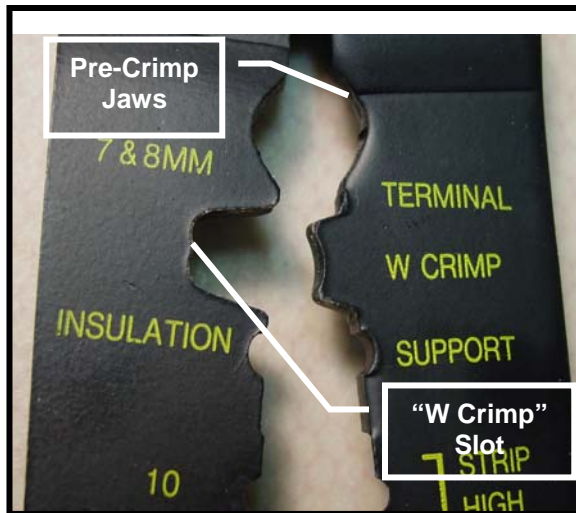
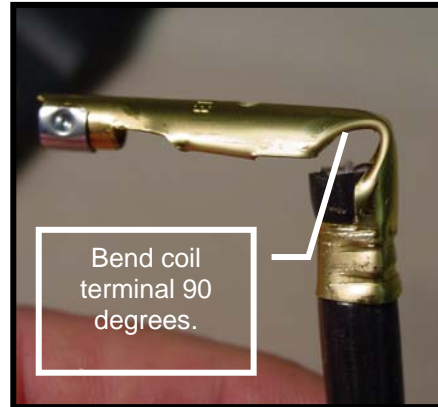
- b) Use a razor blade to trim 1" of shielding from the end of the wire. The wire has a black outer jacket, a white insulating layer, and a center spiral wound (wire) core. Gently cut the outer (black) shield and avoid cutting anywhere near the center core. The white layer separates easily so you can twist the outer jacket in order to complete the separation.

Note 1: The center core can easily be nicked by the crimp tool (if used) or a blade. When you are finished crimping the terminals, a simple ohm test will help you spot a nicked wire. Measured resistance should be approximately 180 ohms per foot of wire. A nicked center wire might read several times that.

- c) Free the terminals from their strips with wire cutters.
- d) Fold the wire core back against the shield and position in the crook of the terminal ears, and "Pre-Crimp" the terminal. Pre-Crimping will snug the ears against the wire shield (for positioning) and point the tips of the ears inward just enough so they fit in the "W Crimp" slot on the tool.



- e) "Final Crimp" the terminal using the "W Crimp" slot on the Crimp Tool. The ears feed into the side that has the "W" point. This way the ears will roll back toward each other and imbed themselves in the shield as the Final Crimp is formed.
- f) Push (not pull) the terminal to position it inside the boot. The longer coil terminals will need to be bent 90 degrees (at the narrow section) before positioning in the boot.



Installation and Timing

Note 1: If replacing an impulse magneto, you need to remove the magneto impulse spacer. Impulse magnetos are traditionally installed on the left side. The spacer is a roughly 1" spacer located between the magneto and the engine case. The studs that hold the spacer to the case will be too long for use with the E-MAG. You'll need to replace the long studs with shorter ones, or simply use suitable length bolts (not provided).

Note 2: These Installation and Timing procedures are strictly limited to E-MAG (meaning both E-MAG and P-MAG models) ignitions ONLY. If you are installing dual E-MAGs, pull the breaker AND the coil plug (see photo below) from BOTH ignitions. Reconnect them ONLY as instructed and only for the ignition you are working with. If you have a companion ignition by another manufacturer, BE ADVISED you need to

follow all safety and handling guidelines appropriate for that system – SEPARATE AND APPART from the instructions provided here for your E-MAG.

Confirm all connections to the ignition as follows, but do not install the ignition in the engine until instructed to do so:

- Control leads (12 volt, ground, ON/OFF P-lead), 1 (optional) tack lead, and possibly a jumper between terminals #2 and #3 (see below) all of which attach to the (6) position Control Plug. Insert this plug into the receptacle and secure with the anchor screws on each end.
- 3 lead coil plug should be **DISCONNECTED** so the plugs cannot fire during these setup procedures. **Note: While in Setup Mode** (see below), the ignition is configured so the plugs will not fire. Disconnecting the coil primary plug is simply added insurance to make sure the spark plugs can't fire while you are installing and setting the timing.
- MAP Sensor tube.
- Spark Plug Leads - with spark plugs installed in the engine (or plugs grounded to engine case).

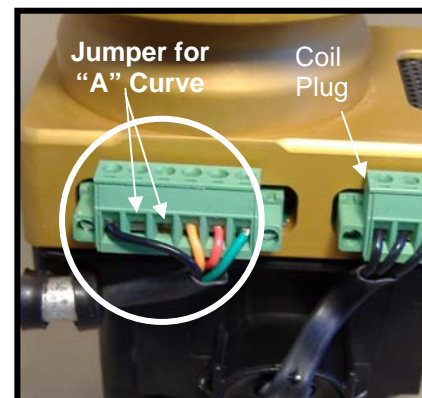
Variable Timing Limit:

The ignition will use engine rpm and manifold pressure to calculate firing angle over a range of operating conditions. There are two preprogrammed curves that can be called up by the operator by using a jumper between terminals #2 and #3. The "B" curve will allow timing to advance as much as 39 degrees. The "A" curve will allow timing to advance as much as 34 degrees. **We recommend starting with A curve.**

- **A Curve** advances (up to 34 degrees) - **WITH** jumper.
- **B Curve** advance (up to 39 degrees) - **NO** jumper.

Note 1: E-MAG has NOT tested the myriad of fuel and engine configurations, and cannot prescribe which setting is appropriate for a given situation. For most builders, **we recommend starting in the low advance "A" setting.** If temps are not within your desired range, or if you are 1) if installing on a fresh engine that may tend to run hot anyway, 2) running high-compression pistons, or 3) testing with auto fuel, you can use the following supplemental controls:

- Use expanded controls available with EICAD (see below)
- Test with (near) standard magneto timing. With the ignition indexed at TDC and using the "A" curve, you can disconnect the MAP tube from



the ignition(s). In this configuration, the maximum advance will be near standard mag timing (26 degrees).

Set Ignition Timing: Beginning with firmware version 16, ignitions can set timing using “Quick-Set” as follows:

Note 1: Series 113 ignitions with firmware version 15 or lower will set timing with the steps described in “Alternate Method” - below.

Install the ignition(s) in the accessory case at any attitude that is convenient. You won't need to move them again so secure them for operation. Remove the MAP sensor tube connection where it attaches to your aircraft system (not at the ignition itself).

1. Rotate your prop to the engine **TDC** (or TC) timing mark. By approaching this mark with the prop moving in the direction of normal engine rotation you can minimize play in the gears.

Note 1: Be wary of old magneto timing habits. Magnetos are timed using the 25 degree (or other) BTDC marks. You will use the **TDC** mark ONLY.

Note 2: It does not matter whether the engine is on the compression or exhaust stroke for a particular cylinder.

Note 3: On **some** engines, “TC” is stamped on the ring gear, which aligns with a reference alignment hole on the starter. On **others**, the ring gear mark is lined up with the engine case seam. Consult you engine manual on how to locate TDC.

2. Setup Mode is entered by turning 12 volt buss power ON, while the p-lead switch is OFF (grounded). In Setup Mode the LED indicator (located at the base of the coil) will light continuous RED.
3. Blow into the MAP sensor tube for a period at least one second. The ignition will acknowledge the signal by causing the LED to switch from solid RED to blinking RED. Blow into the MAP sensor tube a second time, (again for at least one second) and after a moment, the LED will blink GREEN indicating the ignition timing has been set. Then simply power cycle (12 volt power OFF then ON) to enable operation, at which time the LED will be solid GREEN (assuming the engine is still at TDC).
Reconnect the MAP sensor tube to its operating location.

Note 1: Units with firmware version 21 (and after) – After the first “blow” (blinking RED LED) the ignition clears all previously stored index data, and the second “blow” inserts the current position as the new stored index. If you want to access the position sensor's native index, you can simply power cycle (12 volt OFF/ON) after the first blow (when you see blinking RED LED).

Note 2: Prior to firmware version 20, the LED will be solid GREEN after the second “blow”.

Note 3: If you are setting timing on two ignitions and the MAP sensor tubes are teed together, you can set timing on both ignitions in exactly the same way in exactly the same amount of time.

Note 4: The pressure required to activate Quick-Set is set rather high (minimum 0.5 psi) to minimize the chance that it could be triggered inadvertently. This 0.5 psi is similar to the pressure needed to sound a trumpet. As an additional precaution, we require pressurization for a duration of one second before the instruction is accepted.

Alternate Timing Method

1. Setup Mode is entered by turning 12 volt buss power ON, while the p-lead switch is OFF (grounded). In Setup Mode the LED indicator (located at the base of the coil) will light continuous RED. Turn the drive gear with your fingers slowly until you see the LED turn GREEN. You will be looking for a single (very precise) point in the ignition’s rotation, so turn the gear slowly. The GREEN LED signals the ignition’s internal crank angle sensor is at the ignition index.

Note 1: If you turn the ignition switch ON, the ignition will leave Setup Mode and go into run mode. In run mode the **plugs will fire if the coil plug is connected and the ignition sensor sees the firing position**. In order to reenter Setup Mode you must turn the ignition switch OFF and turn 12 volt power OFF. You can then apply 12 volt power WHILE the p-lead switch is OFF (grounded), per the instructions above.

2. Rotate your prop to the engine TDC (or TC) timing mark. By approaching this mark with the prop moving in the direction of normal engine rotation you can minimize play in the gears.

Note 1: Be wary of old magneto timing habits. Magnetos are timed using the 25 degree (or other) BTDC marks. You will use the **TDC** mark ONLY.

Note 2: It does not matter whether the engine is on the compression or exhaust stroke for a particular cylinder.

Note 3: On **some** engines, “TC” is stamped on the ring gear, which aligns with a reference alignment hole on the starter. On **others**, a ring gear mark is lined up with the engine case seem. Consult your engine manual on how to locate TDC.

3. Without moving the drive gear, position the gasket on the E-MAG flange and install the ignition in the engine accessory case. You will engage the ignition drive gear with a gear inside the accessory case. Don't worry if you bump the gear and lose your LED light at this point, but try to avoid moving the gear very far off the index (GREEN) position.

Note 1: It is critical that the ignition flange face and the flange seating area of the accessory case be thoroughly cleaned of ANY old gasket material or other residue. Even a small amount of buildup under one edge can result in the ignition being skewed, and the ignition gear engagement being too tight or too loose. For that reason, gasket sealing materials, if used at all, must be evenly and equally distributed around the flange face.

4. After the ignition is positioned in the case, install your mounting clips, washer and nut (or bolt as the case may be). Tighten only finger tight at this time.
5. Reacquire the GREEN LED indicator by slowly rotating the ignition. If you don't have sufficient adjustment range to reacquire the GREEN LED, you can remove the ignition, rotate the gear a distance equal to one tooth width, and reinsert the ignition. This should put the index (GREEN) position within your adjustment range.
6. Once the GREEN LED is reacquired, secure the position by tightening the mounting clips.
7. When finished setting the timing for both ignitions (and only then) you can then reconnect the coil plug to the ignition.

Confirm Plug Wiring:

Before running the ignition, it's a good practice to confirm you have plug wires correctly assigned at the coil with the following ("pull-thru") test:

1. Remove all the spark plugs and reconnect them to the plug leads.
2. Rest each plug on the engine case, or any convenient location, so long as the plug is grounded to the engine.
3. Rotate the prop by hand and confirm the plugs fire as follows:
 - a. The PAIR closest to the prop will fire at TDC. Note 1: RMSD, if active, will delay firing for three TDC index counts – see below.
 - b. The PAIR furthest from the prop fires 180 degrees later, provided you do not stop or reverse direction (continuous rotation).

Diagnostic Indications:

The two-color LED used for setting timing has other uses. In run mode (12 volt power ON and p-lead ungrounded) the LED is normally off, but will light YELLOW (red and green illuminated simultaneously) if the position sensor detects it is out of position relative to the sensor magnet. This can happen if the ignition shaft has shifted inward. Such might be the result of an impact during shipping or installation. This is easily corrected by removing the ignition and prying the shaft outward with a couple of screw drivers, using the bottom of the drive gear as your grip for the shaft.

Blast Tube Cooling:

E-MAGs are designed for a high-heat environment, but even so there are practical thermal limitations. Air blast (cooling) tubes are a common and inexpensive way to limit the ignition operating temperatures. As such, we recommend installing blast tube cooling as an added safeguard. Blast tubes should be directed at the narrow (round) portion of the nose section, and not at the rectangular electronics case itself.

Run Mode Starting Delay – for engines using composite sumps:

Note: The factory default for ignitions with firmware version 03.06 (and later) has Run Mode Start Delay DISABLED. See EICAD below for instructions on how to enable Run Mode Start Delay.

Series 113 ignitions can be programmed with a Run Mode Starting Delay ("RMSD"). RMSD is a ONE-TIME firing delay that will suspend plug firing until the ignition sees three (or other number as configured by operator using EICAD) passes of the TDC index. At start up, RMSD can help ventilate the intake and exhaust chambers and minimize the accumulation of fuel vapor left over from a prior run (a hot start), or other causes. At the time of this writing, this only known to be an issue for those using composite oil sumps.

Normal RMSD Operation - RMSD will engage when the following start up sequence is followed. The ignition must be powered "ON" WHILE the key (or other p-lead switch) is in the OFF position. Only then should the operator turn ON (unground) the p-lead switch and start the engine. When this sequence is followed RMSD will provide a (ONE TIME) three revolution delay before allowing the plugs to fire. After the RMSD delay routine has been executed, the plugs will fire every revolution. If the engine fails to start on the first attempt and if the operator wants to re-enable RMSD the unit must be powered OFF and then ON with the sequence described above.

Bypassing RMSD - For a given startup, RMSD can be bypassed (plugs fire on the first index pass) simply by powering "ON" WHILE the key (or other p-lead switch) is in the ON position. This will assist with hand prop starting, if ever needed. See EICAD (below) for instruction on how to bypass RMSD all the time.

Background - Wasted spark systems avoid the weight, mechanical complexity, and high altitude issues associated with traditional magneto distributors. All EI systems that don't have a distributor, use wasted spark. In these system, plugs are fired in pairs at A) the charged cylinder that's ready to ignite, as well as B) the opposing cylinder during its exhaust stroke. This second spark is not intended to ignite, hence the name "wasted spark". At startup, E-MAGs will fire plugs slightly after TDC, at which time the "wasted" side will be in a period of valve overlap. [Valve overlap is when the intake and exhaust valves are open at the same time.] When starting an engine where vapor has accumulated in the "wasted" cylinder, this vapor can be ignited by the wasted side spark. Vapor accumulation might be due to a) improper shut down, b) over priming, c) a hot start, or d) other reasons. In the test cell instances where this was observed, the event itself was rather unremarkable. It was heard as a hard "puff" prior to engine start. However, the intake manifold channeled this "puff" to the oil sump, which was later measured as a 15 to 20 psi pulse. This pulse cracked the composite oil sump that was on the engine being tested. An identical replacement sump did the same thing during a second hot start. When replaced with a standard aluminum sump, the problem did not recur on any subsequent (hot or cold) starts.

NOTE: RMSD is a new feature designed to assist with clearing unburned fuel from the "wasted" side. We CANNOT guarantee that it will, in all cases, prevent ignition on the wasted side if conditions are right, in which case a composite sump, if used, could be damaged.

E-MAG Interactive Control and Display ("EICAD")

We are mindful that part of E-MAG's appeal is its simplicity. The factory default settings, together with the setup options above will satisfy the majority of installations. So for most builders, EICAD (pronounced "i-kad") is PURELY OPTIONAL. Even so, your ignition is EICAD capable, if and when you decide to use it.

Series 113 ignitions can use EICAD to access an expanded set of configuration and operating controls. EICAD is made up of three parts. The first part is the communication hardware already built into all series 113 ignitions. The second part is the operating code installed in the ignition. EICAD requires firmware versions 03.07 or later. The third part is a program running on a PC computer (or other device) to communicate with the ignition. A downloadable PC based program (free to E-MAG owners) will fill this third requirement.

EICAD will allow builders to adjust:

Tach Output - Tach output can be set to either one or two pulses per revolution to match your digital tach instrument. Factory default is two pulses per revolution. Builders with Model 113 R3 or later can use EICAD to switch between a 5 volt and a 12 volt tack pulse. Some instruments are designed to get a signal from a magneto p-

lead (higher voltage) while others are designed to use a probe in the side of the magneto (lower voltage). The factory default is for a 12 volt pulse.

Programmable RMSD - Run Mode Start Delay (RMSD) is a feature needed by relatively few installations (those with composite oil sumps), and is described in more detail above. EICAD lets builders set the number of delay revolutions. **IMPORTANT: The factory default setting for RMSD is for no (ZERO) delay cycles. If you use a composite sump, and you want RMSD to be active, you need to change this setting.** Early testing indicates that using “3” as the setting for RMSD can be helpful.

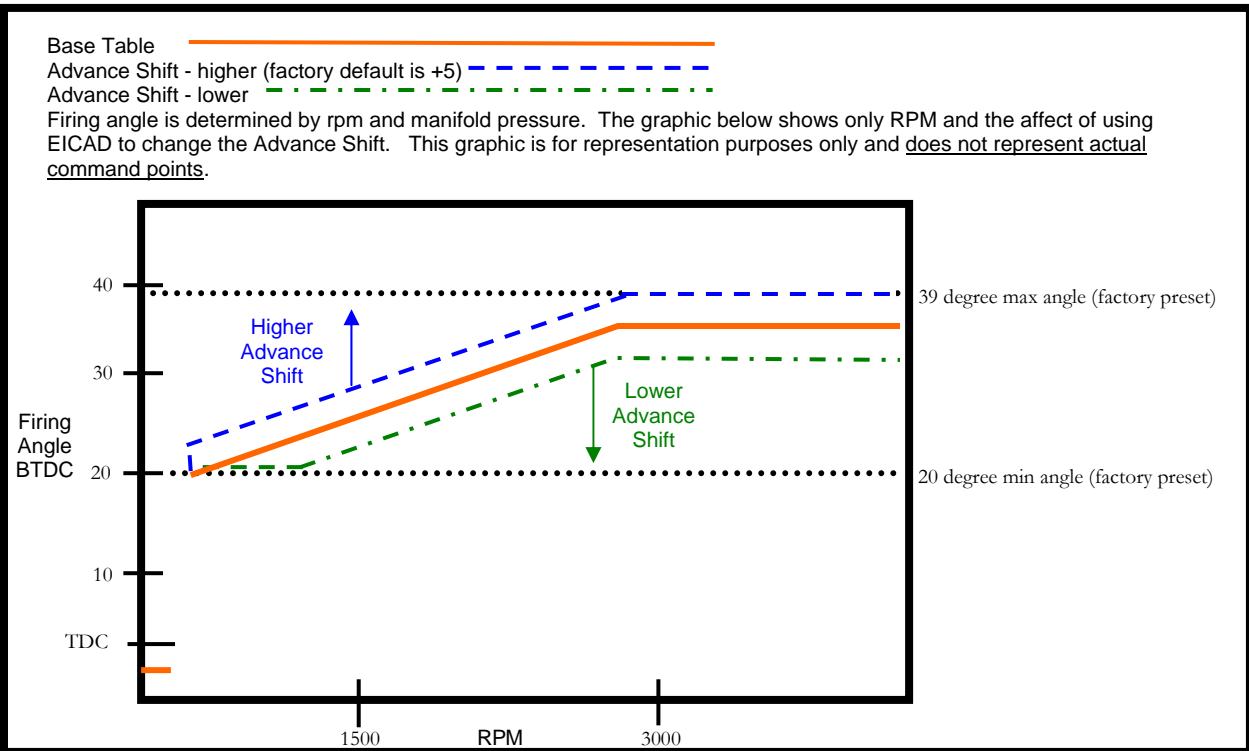
Advance Shift- Programmable Advance Shift simply expands the range of settings beyond the two “A” and “B” factory preset positions (within limits). We expect most customers will find the A and B curves meet their needs, but EICAD may be of interest for customers wanting to fine-tune the advance because they are experimenting with high-compression engines, alternate (auto) fuels, or who simply want more precise control over engine temperatures.

A Closer Look: Series 113 ignitions use a Base Table to determine ignition timing. The Base Table uses rpm and manifold pressure to assign a firing angle. The ignition also has provision for applying an “Advance Shift” to the Base Table. When told to do so, the ignition will shift (advance or retard within preset limits) the Base Table firing angle by the value stored in the Advance Shift.

- The “A” curve (referenced elsewhere in this manual) is the Base Table itself. Placing a jumper between terminals #2 and #3 of the control plug tells the ignition (at power up) to look at the Base Table alone for firing angle.
- The “B” curve is the Base Table with the Advance Shift applied. The factory default Advance Shift is “+5”. Removing the jumper tells the ignition (at power up) to apply the Advance Shift value to the Base Table.

Using EICAD, you can replace the factory default Advance Shift (+5) with a figure anywhere between (-12) to (+12) degrees. There are, however, factory min/max limits (not adjustable by the customer) set at 20 and 39 degrees respectively. This keeps the firing angle inside the range of settings that are 1) called out by some engine (magneto) installations as a minimum, and 2) no more than our factory default (39 degree max) curve – see chart below. After EICAD stores an Advance Shift value, the PC (lap top) can be removed.

Note: Operators should exercise caution when making changes to ignition timing. We strongly recommend small incremental changes, and monitoring the engine closely with each change. We can offer **no assurance** that the timing settings in this range will be appropriate for all engines.



Note 1: We are working on a small cockpit mountable control that should eliminate the PC altogether.

Operating Notes

Starting - To start the engine, simply turn ON 12 volt power to the ignition (presumably your main power switch), turn ON the ignition p-lead (ground) switch (open), and then start the engine. Start mode is automatically sensed by the E-MAG and provides multiple strikes to each cylinder.

Engines with composite oil sumps should review RMSD instructions and cautions above.

Starting routine for fuel injected engines (suggested by E-MAG customers):

- a) Master ON.
- b) Open throttle ¼"
- c) Mixture

(1) Cold Engine:

1. Mixture full rich.

2. Boost pump ON until pressure rises then OFF.
3. Return mixture to lean.

(2) Hot Engine:

1. Leave mixture lean.
 2. No boost.
- d) Crank until first fire (typically 3 to 4 blades).
- e) Feed in mixture gradually.

Engine Management – The stronger plug spark and variable timing of electronic ignition will change how the engine behaves. We increase efficiency by burning more fuel inside the cylinder with less unburned (or still burning) fuel exiting the exhaust. So it's common to see EGT (exhaust gas temperature) drop slightly and CHT (cylinder head temperatures) raise slightly, compared to operation with magnetos. Note: If CHT raises more than you like, you can reduce the timing advance (see **“Variable Timing Limits”**) but you might also want to check:

1. Engine Baffling - Additional power will generate additional heat. Baffling that might have been adequate or marginal when using magnetos may need to be improved when using electronic ignition.
2. Instrumentation - Double check instrument calibration. Some believe the ring type (under the spark plug) CHT sensors tend to read on the high side.

If you use “lean to rough” to help identify your mixture setting, know that electronic ignitions can change how “lean rough” is felt, if you feel it at all.

Electrical System Condition - E-MAG's power dip (kick-back) protection guards against severe voltage drops that occur when the starter is first engaged. However, in the event of a compromised electrical system (low battery, long cable runs, corroded terminals, cold engine, etc) buss voltage may not rebound as the starter speeds up (as is normal). A properly designed and functioning electrical system is essential for the system to work properly. If buss voltage stays below safe levels, the power dip safety circuit will do what it is supposed to do – not allow the ignition to fire. Note: Your starter is likely the largest load on the electrical buss. In emergency situations, hand prop starting will avoid the starter motor induced voltage drop. Do not attempt a hand prop start unless you are well versed in this procedure. See Emergency Prop Starting below.

Stopping the engine - CAUTION: P models (self-powering) are similar to magnetos in that the ignition kill switch (or mixture control) is the only way to stop the ignition once the engine is started.

Powering Down - With all E-MAG models, use your main power switch or breaker(s) to power down the ignitions. The ignition OFF switch (p-lead) only tells the E-MAG to

stop generating spark. It does NOT cut power to the ignition. If you leave the craft with your E-MAG(s) powered ON, they will draw down your battery over time.

P- Model (self-powering) Alternator Check: - You can check the internal alternator operation on the P model during run-up (900+ rpm) by switching to the P model ignition and cutting 12 volt power (not the p-lead switch) at the breaker (or other switch). If the built-in alternator is working, the engine will continue to run. If it is not working, the engine will quit. [See Note 1 under minimum operating speed.](#)

P- Model (self powering) Minimum Operating Speed – After installation you should perform a ground test to verify the P-MAG's low speed limit (where the P-MAG alternator is turning too slow to support the ignition). Your ground idle speed will be lower than your in-flight idle speed. Ideally, the minimum P-model cutout speed is well under the in-flight idle speed. If this is not the case with your installation, take note so you can stay above the P-model cutout speed if ever flying under the units emergency power. Do the test during a **ground** run-up, by simply switching to your P- model ignition (or if running dual Ps switch to them one at a time) with the engine at roughly 1300 rpm. Then cut the 12 volt power (not your p-lead switch) to the ignition and slowly lower the engine rpm until it quits. Make note of the speed the engine quits and compare it to your in-flight engine idle speed.

[Note 1: When performing this test, allow the engine to come to a stop and let the ignition fully power down. Reapplying 12 volt power \(or activating the other ignition\) at the last moment to keep the engine running may not restore the ignition to full operation, and is unlike the power failure events the p-model is designed to defend against.](#)

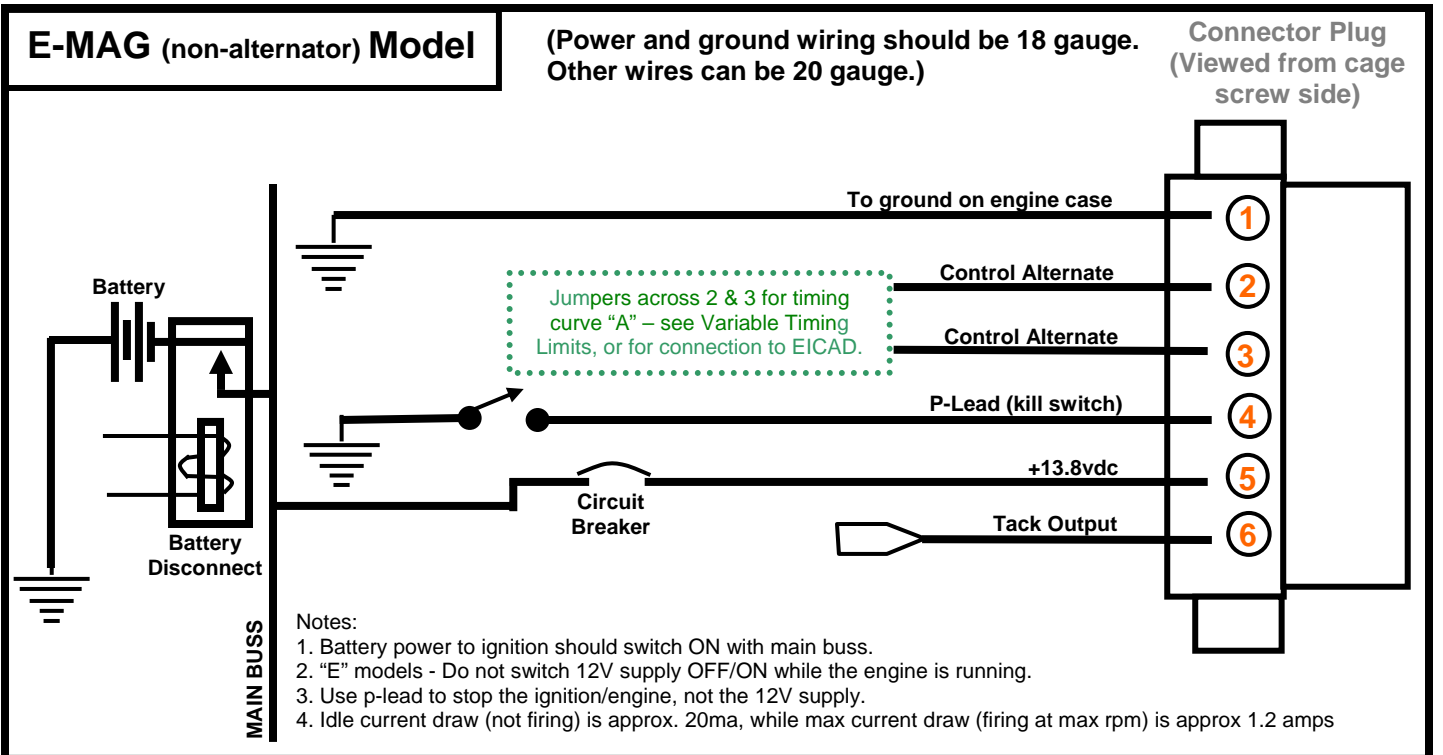
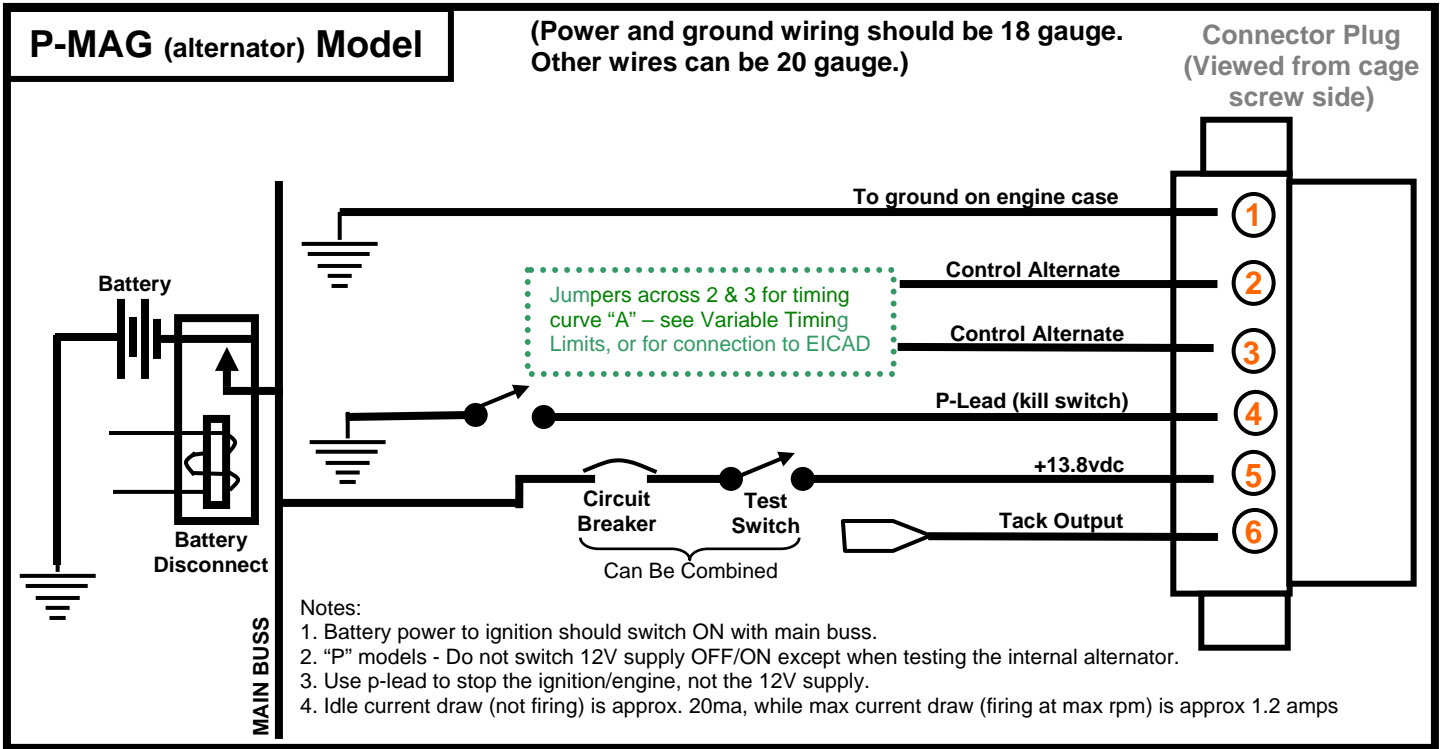
Emergency Power - The P model (self powered) alternator power output is proportional to engine rpm. The ignition will automatically switch to its internal power when the voltage from the aircraft drops to below roughly 12 volts. Should it ever be called upon in an emergency (aircraft power failure), the P-MAG internal alternator will take over automatically. There is no need for operator action of any kind.

Emergency Prop Starting – Both the E-models and P-models need outside electrical power to start. You cannot prop-start the engine with either ignition if the battery is missing, or totally dead. However, a low battery that barely “bumps” the starter motor, or can only “click” the solenoid will likely have enough energy to power the ignition for prop starting. **Caution: Do not attempt a prop start unless you are trained and are comfortable with the procedure. The following is NOT a thorough or complete guide on how to safely prop start an engine.**

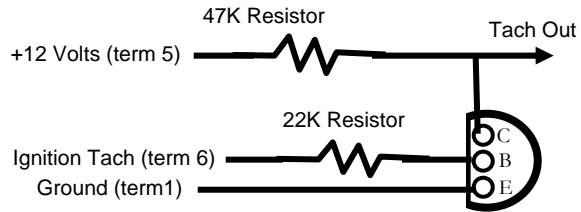
At start-up the E-MAG's first fire will occur at TDC (cylinders 1 and 2 - every other compression stroke). So if you begin at a random position, you have a 50/50 chance of being set for firing on any given attempt. However, if you have a visible reference on the flywheel that correlates the cylinder compression you feel to cylinders 1 & 2 (as opposed to cylinders 3 & 4 located 180 degrees opposite) you'll know you are properly positioned to fire.

IMPORTANT: Keep the ignition switches OFF any time you are positioning the prop by hand. Then (and only then) 1) turn the ignition switches ON, 2) cycle the 12 volt power switch(s) to bypass RMSD (see above), and 3) you are now ready to prop-start the engine.

Wiring Diagrams



Early 113 ignitions only produced a 5 volt tach pulse. The circuit shown below will increase that signal to 12 volts, if needed. Series 113 R3 or later can use EICAD to select either tack voltage.



Transistor NPN 2N4123 (RS 276-1617) "RS" =Radio Shack
Resistor 1/4 or 1/8 watt 22K (RS 271-1339)
Resistor 1/4 or 1/8 watt 47K (RS 271-1342)

Note: Tack signal is NOT a primary ignition function. It is a courtesy signal we are happy to provide. Due to the variety of instruments available, we can provide only limited tack signal trouble shooting and/or customer support.

