Product Documentation

Installation & Operating Guide

LC114.28

Guide Applicable to E-MAG Ignition Models E-114 and P-114 for Lycoming 4 Cylinder and Continental O-200 Engines

(NOTE: Variations may be introduced from time to time. This manual may or may not fully document all such changes. E-MAG reserves the right to make changes without notice.)

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.

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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 will supplement the installation steps with a variety of comments and tips that are shown in blue.

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. E models have not been in production for several years.

Certain segments of this manual are applicable to the Continental O-200 or the Lycoming ignitions only. Such segments will be identified with the bracketed notation "[Continental]" or "[Lycoming]" as appropriate. The "Lycoming" reference applies to Lycoming as well as other "Lycoming-like" engines.

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 output) leads to the Control Plug.
3. Install spark plugs and spark plug harness.
4. Install MAP (manifold pressure) sensor tube.
5. Install your E-MAG ignition on the engine, set the timing, and select the timing advance range.

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 and plugs [*IMPORTANT***] with each plug grounded to the**

engine case, 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 spark plugs connected (and properly grounded) can damage the unit, and void your warranty.

Tools you may need.

Strap wrench (for tightening/loosening drive gear castle nut)
Gear puller (for removing gears from magnetos or E-MAGs as needed)
Needle nose pliers (shaping cotter pin on castle nut)

Drive Gear

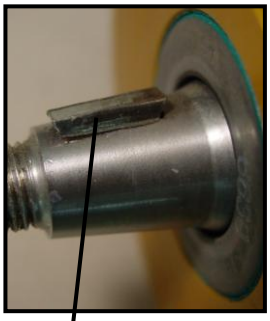
[Lycoming] E-MAG ignitions are indexed to the engine through a drive gear. The drive gear from a non-impulse magneto can be recovered and, if in good condition, reinstalled on your E-MAG. The gear from an impulse magneto is a different style, and cannot be reused. **At one time, E-MAG manufactured drive gears that were intended for E-MAG ignitions only. Those (non-certified) gears should not be used on traditional magnetos or other equipment.**

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(s), castle nut, and 5/64" cotter pin provided. Two washers are included – use one or both as needed. Torque to 120-150 in/lbs. Make certain the cotter pin ends are secure and lay flat. The back wall of the accessory case will be close to the end of the shaft.



Woodruff Key installed in shaft

[Continental] E-MAG ignitions are indexed to the engine through a drive gear. Recover the impulse gear from your magnetos and reinstalled on your E-MAG using E-MAG's Gear Adapter (sold separately).

1. To recover the drive gear from an existing magneto:

   a. Remove the cotter key, castle nut, and washers. A strap wrench is helpful while removing (or re-installing) the castle nut on the ignition shaft. NEVER strike the magneto, the gear, or the shaft in order to remove or install the gear.

      i. Position the Gear Adapter, drive gear, and the **washer provided with your kit** on the shaft. Tighten the castle nut and secure with the provided 5/64" cotter pin. Make certain the cotter pin ends are secure and lay flat. The back wall of the accessory case will be close to the end of the shaft.

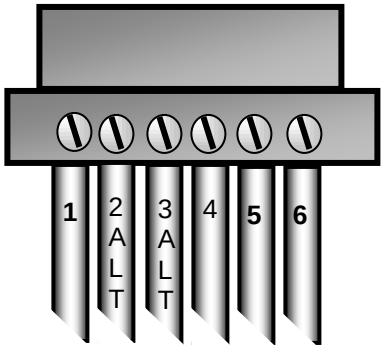
   Note 1: If you use a washer that is different (smaller) than the one provided, the gear may not be properly retained.

E-MAG Control Leads

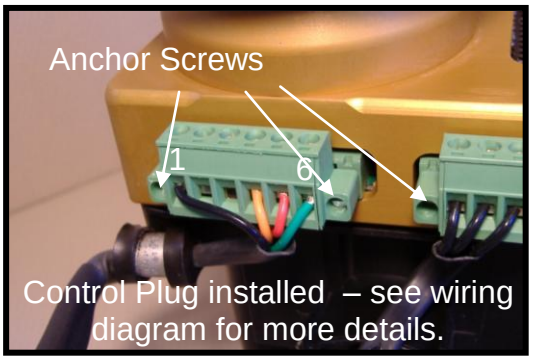
Control Wiring

Control leads are connected to the ignition via a Control Plug that captures each lead with a screw cage mechanism. The (removable) plug is then attached to the ignition and secured with anchor screws on each side of the plug. 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).

Control Plug



(As viewed from screw head side of plug- see below)



Control Plug installed – see wiring diagram for more details.

Use the cushioned anchor strap to provide a mechanical strain relief for the control wires (apply thread locking compound to the coil bolt holding the 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 be a reliable ground.

2. "2" Control Alternate

3. "3" Control Alternate

4. "4" is your ignition ON/OFF (p-lead) control that operates by connecting pin #4 (via the cockpit kill switch) to ground. Use 20 gauge wire or larger.

Note 1: If you are replacing a magneto, your old P-Lead can be used, and may already be wired to a suitable switch. Magneto p-lead wire is typically shielded (not needed with our system), so keep it clear of all connections and terminals.

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 bus, routed through a dedicated 3 amp switchable circuit breaker (not provided) using 18 gauge wire. If using a fuse (instead of breaker), use a slow-blow type. The switch function is needed to test the (P model) internal alternator during ground run up – see Operating Notes.

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

Note 2: DO NOT power the ignition ON if/when you have a battery charger connected to the bus. Some chargers are designed to pulse the battery with high voltage that can damage electronics.

6. ”6” is a courtesy (optional) connection to provide a digital tack signal – two pulses per revolution (reconfigurable to 1ppr using EICAD). The default tach voltage is 12 volts, although some ignitions were produced with a 5 volt signal. See notes on the Wiring Diagram at the end of this manual for switching tach voltage signal, if needed. Adding a ground wire (pin #1 to the EFIS or tach instrument) will help assure a clean signal.

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

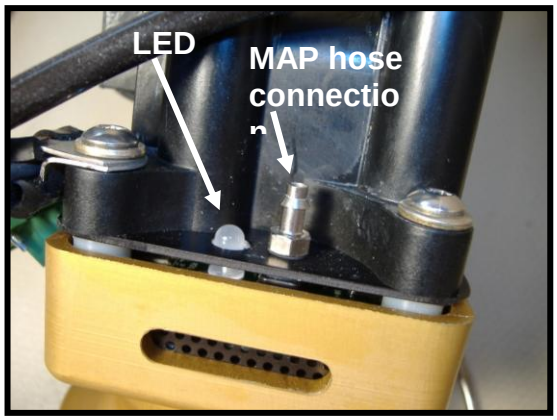
Note 2: Unlike a magneto, your E-MAG will generate a tack signal even when it is disabled by the p-lead ignition switch, so you won’t loose tack when you p-lead the E-MAG OFF during a preflight ignition check.

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.

If you use a volt meter to test continuity of your control plug circuits, do NOT insert your probe into the Control Plug (female) terminal openings. Instead, you can test the circuit with a probe on the screw head that clamps the control wires. Testing with the probe inserted in the terminal opening can pry open the contacts and prevent (or weaken) the connection when the Control Plug is reattached to the ignition (male) header.

Alternate Wiring - Other E-MAG control wiring schemes have been proposed from time to time. Please understand that our ongoing testing, maintenance, and support is based on our recommended configuration only.

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, or:

[Lycoming] Connect to:

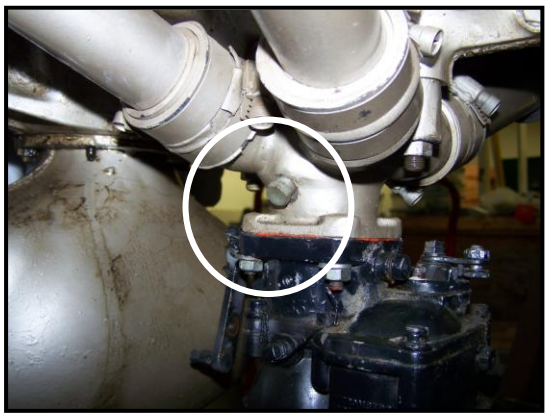
1. Manifold fitting near the induction intake, or

2. Primer port on cylinder #3 or #4. Make sure to use a short length of high-temp material before transitioning to the silicone tube provided.

[Continental] Connect to:

1. Manifold fitting near the intake, or

2. Primer port on cylinder #1 (if present). Make sure to use a short length of high-temp material before transitioning to the silicone tube provided.



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 less efficient range.

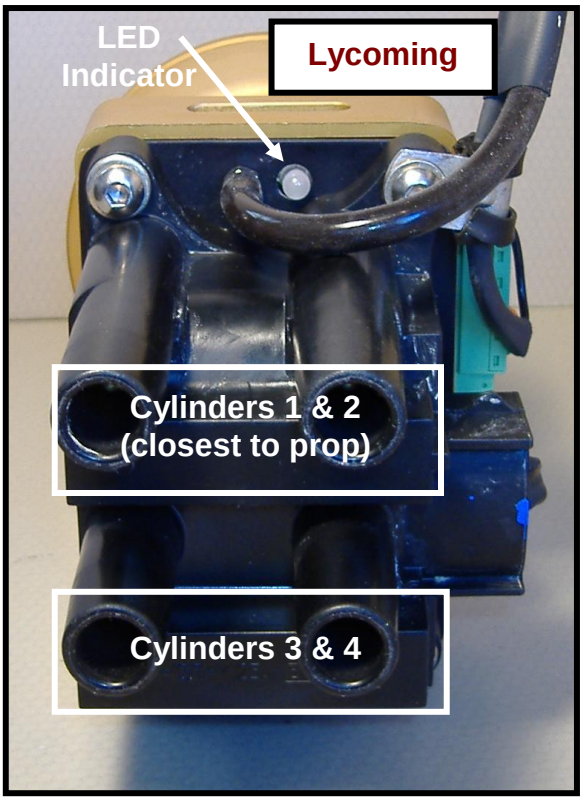
Spark Plugs & Harness

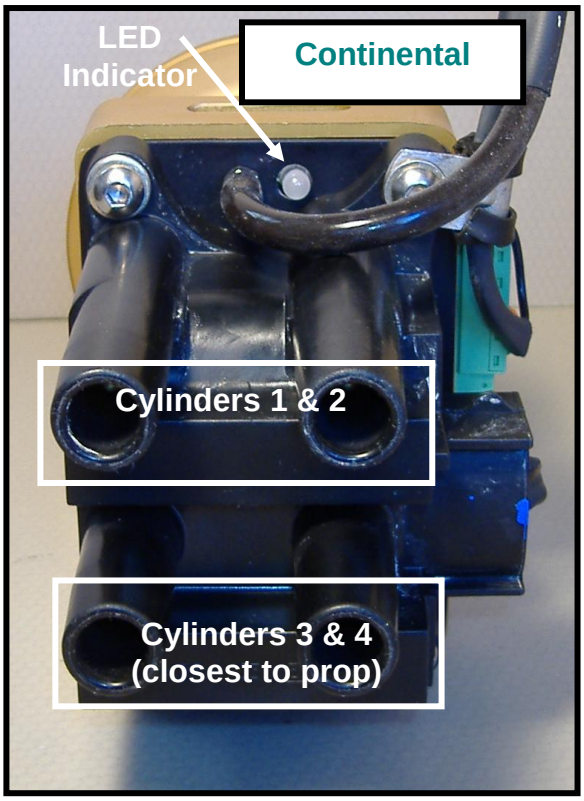
Post Assignments – The plug wire assignments are as follows:

[Lycoming]

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.





[Continental]

1. Cylinders 1 and 2 connect to the coil pair nearest the MAP tube
2. Cylinders 3 and 4 connect to the coil pair furthest from the MAP tube.

Note 1: It does not matter which cylinder is connected to which post within a given pair.

There is a label on the back of the coil to help identify the correct plug wire assignments.

Aircraft Plug Notes - 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 or “fine wire” plugs have an 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 Plug Notes - 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. 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. Set plug gaps 0.030” to 0.035”.

1. NGK BR8ES 2.5mm Center Electrode (NGK stock #3961 has solid/permanent terminal post, NGK stock #5422 has a screw on post)
2. NGK BR8EIX Iridium Electrode
3. Denso IKH27 for long-reach heads with LR adapters only.

Auto Spark Plug Adapters - Plug adapters permit the use of 14mm automotive type plugs. Use short reach (SR) adapters if your aviation plug callout is "M" type (for example RE**M**XXXX). Use long reach adapters (LR) if your aviation plug callout is "B" type (RE**B**XXXX). **First**, install adapters with the supplied gasket on the spark plugs finger tight. **Then,** insert the combined assembly (plug with adapter) in the engine and tighten to 18 ft/lb (standard auto plug torque) through the spark plug ONLY. Do not torque the adapter itself.

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 Auto Lead Kits – Auto plug lead kits come as a pre-terminated set. If you decide you want to shorten one or more leads, a crimping tool and terminals can be purchased separately.

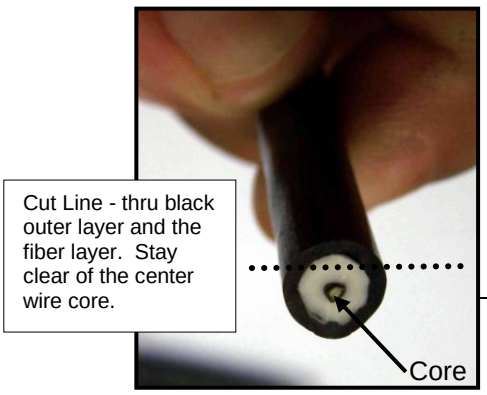
E-MAG Aircraft Lead Kits – DISCONTINUED

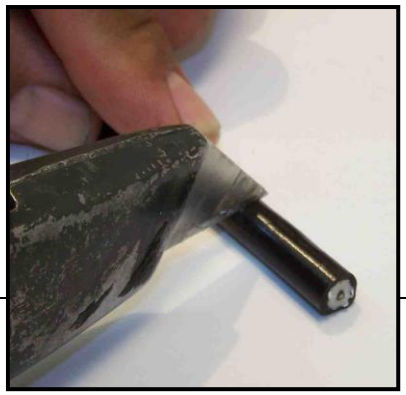
Note: Leads should be kept separated. Do NOT bundle them together as is common with shielded aircraft wires, as this can cause them to be inductively coupled. Wire looms can be purchased at auto parts stores, but a simple separator can be fabricated out of tie-wraps and ¼" segments of left over MAP sensor hose – see photo.

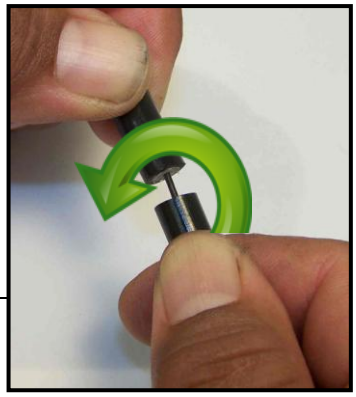
Lead Fabrication (for trimming auto style leads – only needed if shortening a lead).

1) Trimming

a) The black/red outer jacket and the white inner layers are separated by a reinforcing fiber weave. The conductive core is a spiral wound filament (avoid when trimming). Use a razor blade to trim the outer layers 3/4" from







the end for crimped terminals (1/4" for aircraft plug end fittings). **Gently** cut thru the outer (black) shield and fiber layer (all the way around). Avoid cutting anywhere near the center core. The white inner layer separates easily as you twist the trimmed end. Twisting counter-clockwise will help to avoid unraveling the spiral core.

Note 1: The center core can easily be nicked by a stripping tool (if used) or a blade. When finished, a simple ohm test will help you spot a nicked wire. See Ohm Check later in this section.

2) Crimping

Identification: The shorter steel terminals and rounded boots are for auto spark plugs. The longer brass terminals and flat-backed boots are for the coil end (both aircraft and auto harnesses).

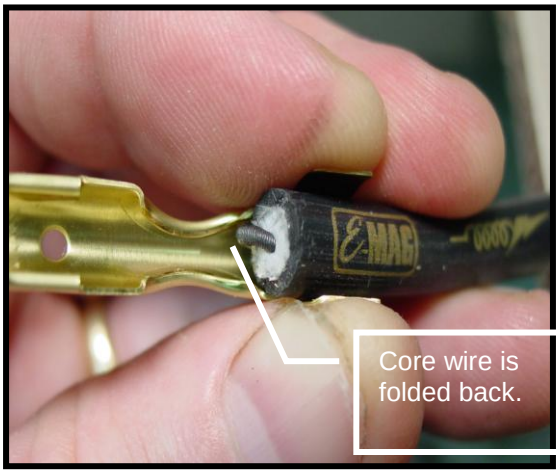
a) First, run the wire through the boot so you have a couple of inches from the end. This will give you room to work the wire and terminal. A light coating of **SILICONE SPRAY** (not included) is **required** to lubricate the wire as you work it through the boot. (oil, WD-40, spit, and Chap Stick won't work)

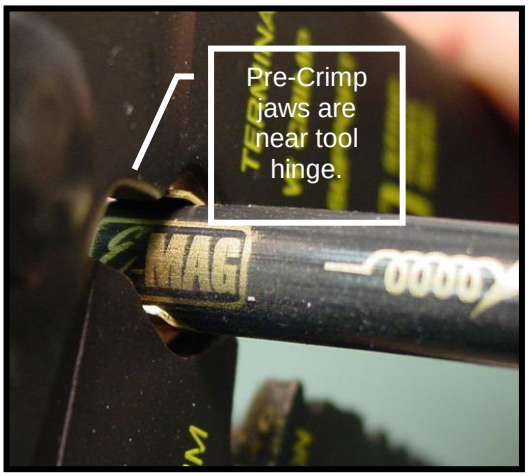
Note 1: It is best to push the boot down the wire (rather than pulling) to avoid straining the wire core.

Note 2: You can push on the heel of the boot to straighten the passage as you push the wire through.

Free the terminals from their strips with wire cutters.

b) 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

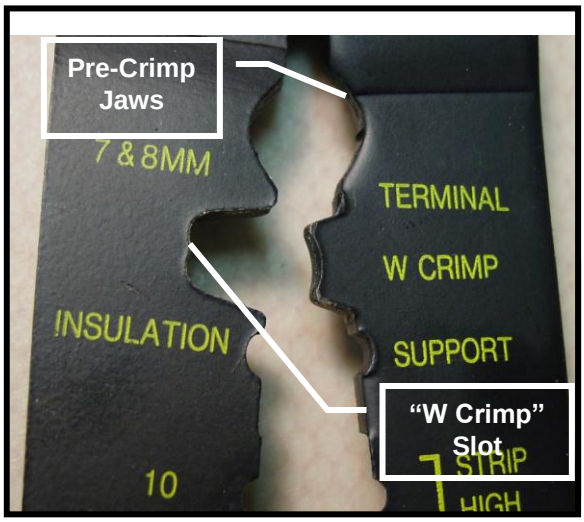


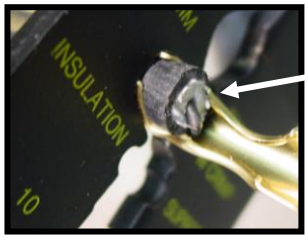


ears against the wire shield (for positioning) and point the tips of the ears inward just enough so they fit in the "W Crimp" slot on the tool.

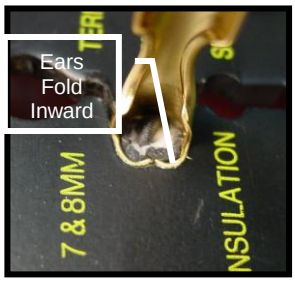
c) “Final Crimp” the terminal using the “W Crimp” slot on the Crimp Tool. The ears feed into the side that has the “W” point. This way the ears will roll back toward each other and imbed themselves in the shield as the Final Crimp is formed.

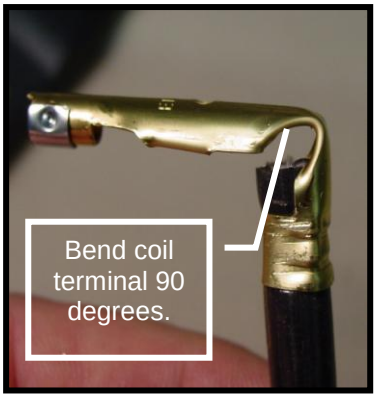
d) Push (not pull) the terminal to position it inside the boot. The longer coil terminals will need to be bent 90 degrees (at the narrow section) before positioning in the boot.





Position with 1/4” to 1/8” extending past ears





Ohm Check

You can verify the finished leads are assembled correctly by a simple ohm check. Each lead should produce approximately 180 ohms of resistance per foot of plug wire. Disconnect the leads from the ignition and the spark plugs, so you can touch an ohmmeter probe to the terminals on each end. Watch the ohmmeter output while you exercise each end vigorously (twist/bend/tug) to see if the reading jumps significantly (several times the normal range). If it does, you likely have a nicked or degraded conductor core. To repair a crimped terminal end, simply snip off the bad end (assuming you have an inch or so to spare) and replace with a new terminal. To repair a connection on an aviation plug fitting, simply re-position the contact spring lance.

Installation and Timing

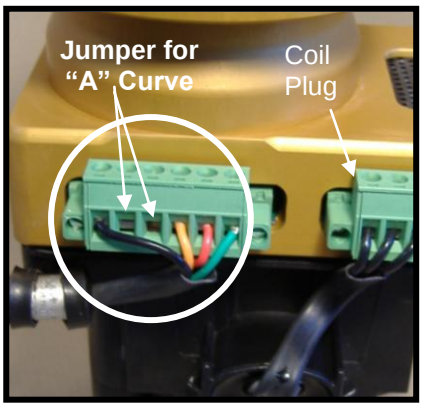
Note 1: [Lycoming Only] If replacing an impulse magneto, you need to remove the magneto impulse spacer. Impulse magnetos are traditionally installed on the left side. The spacer is a roughly 1" section located between the magneto and the engine case. The studs that hold the spacer to the case will be 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: WHICH SIDE? If installing only one E-MAG (keeping one magneto) some prefer to replace the non-impulse magneto in order to 1) avoid having to remove the longer studs on the impulse side, and 2) avoid having to purchase a drive gear (non-impulse drive gears can be reused), and 3) retain the ability to start on either ignition. Others prefer the opposite, i.e. replace the impulse magneto and eliminate the more mechanically complex unit (believing it to be more prone to failure).

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:

- Control leads (12 volt, ground, ON/OFF P-lead, optional tack lead, optional jumper between #2 and #3 -- see below) are all attached to the six position Control Plug. After wiring, insert the Control Plug into the receptacle on the side of the ignition and secure with anchor screws on each side of the plug. Use strain relief Adel clamp provided.
- 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 (hands on the prop?).
- MAP Sensor tube.
- Spark Plug Leads - with spark plugs installed in the engine (or plugs grounded to engine case).



Variable Timing Range:

The ignition will use engine rpm and manifold pressure to calculate firing angles over a range of operating conditions. When setting timing (below), the advance range can be shifted by the following means. These can be used individually or in combination (where effects will be **cumulative**):

1. JUMPERS between terminals #2 and #3 of the control plug.
    a. Jumper OUT: With no jumper, the "B" curve will allow timing to advance, typically, up to 39 degrees (with default factory Advance Shift setting)*. New equipment ships with Jumper OUT.
    b. Jumper IN: Installing a jumper between #2 and #3 enable the "A" curve, which allows timing to advance, typically, as much as 34 degrees - a less aggressive advance range.
2. CLOCKING: Set timing with the engine positioned slightly after TDC (1-6 degrees). Greater offsets will produce greater retard (less aggressive advance).
3. * Use extended controls, EICAD (described elsewhere) or other means, to change the internally stored Advance Shift value. The factory default value is 4.2, and can be move up/down as needed to apply more/less aggressive advance - when Jumper is OUT. This is typically not our recommended method for basic adjustments.

E-MAG has NOT tested the myriad of fuel, compression, and engine configurations, and cannot prescribe which setting is appropriate for all situations.

- For most engines with recommended magneto timing of 25 degrees, operators might start with JUMPER IN, and timed at TDC.
- For engines with recommended magneto timing of 20 degrees, operators might start with both 1) JUMPER IN, and 2) CLOCK (time) the ignition 5 degrees after TDC.
- **Different fuels, compression ratios, and other conditions may require further adjustment. IN ALL CASES, operators are responsible for determining proper settings.**

Note 1: The ignition looks at the jumper state at power-up only. You **cannot** route these jumper terminals to a switch and go back and forth between curves while the engine is running. EICAD does allow you to change timing (Advance Shift) while the engine is running.

Note 2: Jumper shifts the operating advance range - not the startup firing position.

Set Ignition Timing:

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. Temporarily 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 "TC" (or 1-6 degrees after) timing target (see all notes for this section). 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. Here, you will time at TDC or slightly after (never before).

   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 PROP SIDE of the ring gear, which aligns with a reference alignment hole on the starter. On **others**, the ring gear mark is on the ENGINE SIDE and lines up with the top side engine case seam. Consult you engine manual on how to locate TDC. See also: Lycoming Service Instructions 1437 (http://www.lycoming.com/support/publications/service-instructions/pdfs/SI1437.pdf).

   Note 4: Startup Firing
   - Units with firmware V40 (and after) have an automatic 4 degree starting lag to make certain (start) firing occurs well after TDC.
   - Prior to firmware V40, start firing occurs where the ignition is timed. These units can implement a starting lag by CLOCKING the engine 2-3 degrees AFTER TDC. This will shift startup firing, and will also shift the operating range (in the less aggressive direction).

   Background: Low-mass props can decelerate rapidly as the starter motor pulls thru each compression stroke (TDC being the top of each compression stroke). If the prop slows enough, it's effectively become stationary when it reaches TDC. In these conditions, combustion can send the prop backwards. Delaying startup firing is a simple hedge against this risk.

2. Setup Mode is entered by turning 12 volt bus power ON, <u>WHILE</u> the p-lead switch is OFF (grounded). If the LED is not lit up, you are not in Setup Mode.

3. Blow into the MAP sensor tube (see note below for duration and pressure). After the **first** blow, the ignition will acknowledge by switching the LED to from solid RED to blinking RED.

4. Blow into the MAP sensor tube a **second** time, and the LED will blink GREEN indicating the ignition timing has been set.

5. Power cycle (12 volt power OFF then ON) to enable operation and, provided the prop has not moved, verify you still see a green LED. Reconnect the MAP sensor tube to its operating location.

Note 1: 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 2: The "blow" 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.

Note 3: 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 distributed around the flange face.

Note 4: After step 5 above. Occasionally, the LED will flicker (rapidly) between yellow/red/green, indicating the engine is sitting right on the edge between TDC/Green and NOT-TDC/Red. There is no problem, your timing set was successful. Verify by rocking the prop (slowly) back and forth, and you'll see a distinct red then green then red as you pass over TDC.

Confirm Wiring ("Pull-Thru" test):

Before running the ignition, it's a good practice to 1) confirm you have plug wires correctly assigned at the coil and 2) confirm operation of both ignition circuits with the following ("Pull-Thru") test:

1. Remove all the spark plugs from the engine and reconnect them to the plug leads.

2. Rest each plug on the engine case, or any convenient location such that [*** IMPORTANT***] **each plug is grounded to the engine case**.

3. Unground the p-lead and then rotate the prop by hand to confirm the plugs fire as follows:

    a. The PAIR of plugs:

        1. [Lycoming] Closest to the prop will fire at TDC.

        2. [Continental] Furthest from the prop will fire at TDC.

Note 1: RMSD, if active, will delay firing for "X" number of TDC index counts – see below.

b. The other PAIR of plugs will fire 180 degrees later.

This "pull-thru" test also verifies a number of operating elements, so it is a handy tool for troubleshooting. It verifies:

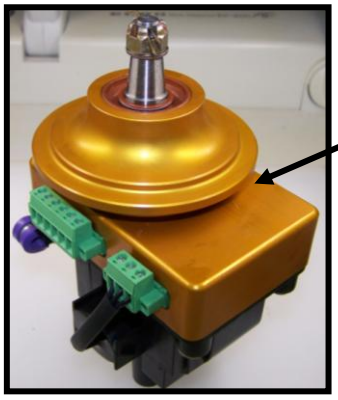
1. Plug wire assignments.
2. Both ignition firing circuits.
3. Ignition timing.
4. Plug wires and the plugs themselves.
5. Drive gear engagement.
6. 12 volt and ground connection.
7. P-lead wiring and p-lead switch.

Blast Tube Cooling (mandatory):

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 reduce the ignition operating temperatures. We consider them mandatory. Blast tubes should be directed at:

[Lycoming] The narrow (round) portion of the nose section, and not at the rectangular electronics case itself.

[Continental] The flat case section that is opposite the connector plug or opposite the MAP/LED end, which ever is more convenient.



Continental Blast Tube

Note 1: Late series 113 ignitions (and after) have a feature that records the maximum temperature seen at the ignition circuit board. The large majority of ignitions we've serviced in our shop have a recorded "Max Temp" in the range of 175 to 185 degrees (F). This is within our recommended limit of 190 (the same limit specified for some, if not all, magnetos). This shop reading will not tell us when the Max Temp was recorded (heat soak after shut-down, early break-in procedures, etc.), so we don't know if the reading reflects the current operating environment. **Also please note: Our temperature signal has NOT been calibrated, and serves as a general temperature indicator ONLY.**

Ignitions operating at exceptionally high temperatures can experience thermal shut down. Such instances can be aided by the addition of (or improvements to) blast

tube cooling, as is required by the current manual. Experience has also shown the mere presence of blast-tubes does not guarantee they are operable and/or effective. So we encourage builders (soon after installation) to **verify the ignitions are operating within acceptable temperature limits**. E-MAG's built-in temperature signal can be displayed by one or more of the free configuration and control programs that are available on our web site (see our "Downloads" page at www.emagair.com). Other, more accurate, readings can be made with thermal reactive labels or with a thermal probe secured in a manner to measure ignition case temperature.

The most frequent cause of inhibited blast tube cooling (we suspect) relates to exit air restrictions. Blast tube air "blasts" because of the pressure differential across the baffle partition. If accessory side exit-air is restricted, pressure on the back side can rise, and the pressure differential is reduced. We don't claim to be authorities in this area, but we have enough reports from customers who were able to significantly reduce ignition temperatures (as well as oil temperatures and accessory case temps overall) by improving exit-air flow, that we are confident this is, at a minimum, one of the primary causes.

Run Mode Starting Delay – for engines using composite sumps:
Note: The factory default has Run Mode Start Delay <u>DISABLED</u>. See EICAD below for instructions on how to enable Run Mode Start Delay.

Series 114 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 "X" number 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.

After the RMSD (one time) 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 in order to reset the RMSD delay.

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 feature that assists 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 114 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 114 ignitions. The second part is the operating code installed in the ignition. 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 allows 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 – 12 volts. Series 114 ignitions change the tach voltage from 12 volts to 5 volts by installing the diode, provided in your kit, between the tach output (terminal #6) and ground (terminal #1) on the Control Plug (see wiring diagram). Alternatively, the diode can be installed on the instrument end of the tach lead.

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.

Advance Shift- Programmable Advance Shift simply expands the range of settings beyond the two “A” and “B” factory preset positions. 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 114 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) the Base Table firing angles by the value (shown in degrees) stored in the EICAD Advance Shift window.

- 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 assignments.

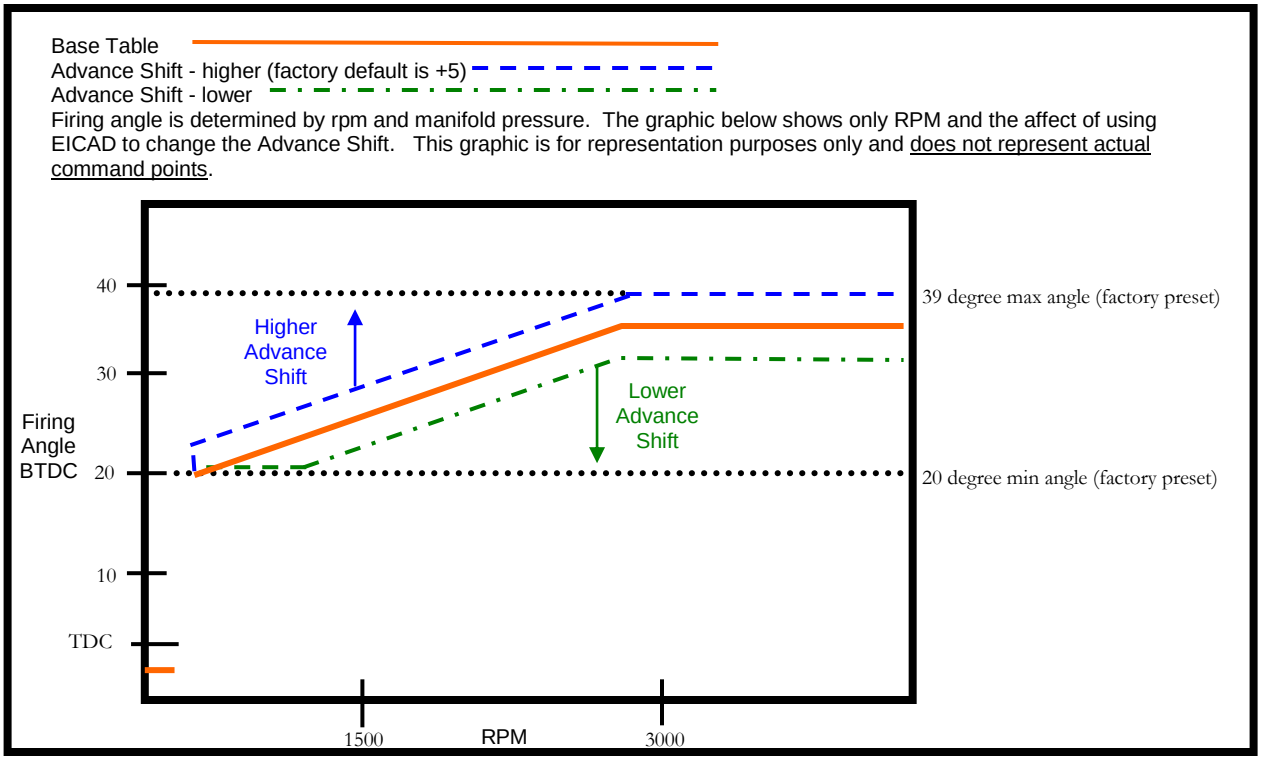
- The "B" curve is the Base Table with the Advance Shift applied. The factory default Advance Shift is "+5". Removing the jumper tells the ignition (at power up) to apply the Advance Shift value to the Base Table.

The ignition looks at the jumper state at power-up only, so putting the jumper on a switch will not allow you to move back and forth between tables dynamically (while the engine is running). EICAD, on the other hand, will allow you to change the Advance Shift value dynamically..

EICAD lets you replace the factory default Advance Shift (+4.2) with a figure anywhere between (-12) to (+12) degrees (shifts in 1.4 degree increments). This will change your "B" curve only. You can also change the ignitions maximum advance limit (see EICAD "Max Advance"). After EICAD stores an Advance Shift value, the PC (lap top) can be removed. In order to use the new setting you enable the "B" curve by simply not installing the (terminals 2 and3) jumper.

Note 1: 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 range of timing settings will be appropriate for your engine. It is quite possible that some settings may be harmful.

Note 2: Small cockpit devices are now on the market that will allow communication to the ignition. They eliminate the PC altogether.



Operating Notes

Starting - To start the engine:

1. First - turn ON bus power to the ignition (presumably your main power switch),

2. Then turn ON the ignition p-lead switch (un-ground). [Emphasis added for units with firmware lower than V40]

3. Then start the engine. Start mode is automatically sensed by the E-MAG and provides multiple strikes to each cylinder.

E models (without internal alternator) should avoid powering ON the ignition while the p-lead is in run-mode (ungrounded) and with the engine running. E models (if powered down on a running engine) should first turn p-lead OFF, then restore 12 volt power, then turn p-lead back ON. Not a critical requirement – it's just better practice.

Fuel Injected Engines

A starting routine for fuel injected engines (suggested by E-MAG customers) is as follows:

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. E-MAGs improve 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 find your desired mixture setting, you need to 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) bus 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 bus 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 bus. In emergency situations, hand (prop) starting will avoid the starter motor induced voltage drop. Do not attempt a 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 - Don't power down (remove 12 volt power) your E-MAGs until the engine has come to a stop. The ignitions log valuable data at the conclusion of each flight. The ignitions know the flight is over is by looking for engine speed to drop below 200 rpm. If you cut off 12 volt power before the ignition sees this speed, this

valuable data log will be lost. P Model ignitions are not exempted as the internal alternator will be unable to support the ignition somewhere below 900 rpm (see ”P-Model Minimum Operating Speed” below).

With all E-MAG models, use your main power switch or breaker(s) to power down the ignitions. Turning the ignition switch (p-lead) switch to OFF 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 a ground run-up (900+ rpm) by switching to the P model ignition and cutting bus power (not the p-lead switch) at the breaker. If the built-in alternator is working, the engine will continue to run. If it is not working, the engine will quit. See Note under minimum operating speed below.

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 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 bus 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 bus 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’s internal alternator power output rises in proportion with engine rpm. Unlike previous versions, Series 114 ignitions will transition off of aircraft power (and onto internal power) as the internal power rises. Somewhere around 1200 to 1500 rpm P-model ignitions should be operating totally on internal power. At this point, internal power is the ignition’s primary power supply and the aircraft power is the backup. Transitions to and from the aircraft power supply are managed automatically by the ignition. There is no need for operator action of any kind. If you loose external power, your P-model ignition is capable of providing emergency power down to 900 rpm, and sometimes less.

Emergency Prop Starting – Both the E-models and P-models need outside electrical power to start. You cannot prop-start the engine with either type 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. After startup, P-model ignitions can then power themselves. **Caution: Do not attempt a prop start unless you are trained and are comfortable with the procedure.**

At start-up, series 114 ignitions will fire at the TDC mark and at the 180 degree flywheel marks. **CAUTION: E-MAGs will fire plugs as you pull thru the TDC/180 degree landmarks <u>REGARDLESS OF SPEED OR DIRECTION OF ROTATION</u>.**

IMPORTANT: Keep the bus power and p-lead switches OFF any time you are positioning the prop by hand. Then (and only then) 1) turn the switches ON.

Cleaning - NEVER spray engine cleaner or degreasing agents on the ignition body. The ignition case is not sealed - by design. Rain (blast tube spray) will not harm the ignition, but solvents sprayed or washed into the ignition case can collect and leave a corrosive residue that will degrade the circuit board and electronics. Such damage will not covered under the ignition warranty.

Maintenance:

Annual or 100 Hr. Inspection (whichever comes first):

1. Check E-MAG web site for most recent Service Notes (www.emagair.com page “Service Notes”) and verify equipment is current with all updates.

2. Ignitions come with a (one-time trigger) thermal sticker that will trip (turn from light ash color to gray or gray/black) if case temperatures exceed 200 degrees (F). If tripped, review blast cooling and/or other ventilation issues that affect ignition cooling. Keep ignition temperatures below 200 degrees.

3. Ohm check plug wires (see “Ohm Check” above), and examine spark plugs for signs of unusual wear or build-up. Gap plugs per instructions above. Replace auto style plugs with new ones after 100 to 125 hours. When re-installing auto style plugs with auto plug adapters, review plug/adapter installation guidelines above.

4. Remove ignition and examine shaft and drive gear condition. Note: Ignition disassembly is not necessary (and if done may void your warranty). Look for excessive play (lateral and axial). Shaft rotation should be free, with no catching, flat spots, or grinding. The shaft on “P” models (with internal alternator) will have a push-pull rippling effect as the shaft turns and the permanent magnets pass the rotor poles. This is normal and expected. If a P model ignition does not have this magnetic ripple, the unit requires additional (shop) service.

5. Replace older 1/16” cotter pins with larger 5/64” cotter pin. Inspect and secure the ends to prevent movement. The smaller pins have been in service for

some time, but we've have occasional reports of pins coming loose and/or breaking.

6. Examine control plug and coil plug connections. Tighten to 4-5 inch pounds. Verify there are no stray wire strands. Verify all control wires use the Adel clamp strain relief.

7. Reinstall the ignition, and verify proper operation. Review Setting Ignition Timing instructions above. For P models, re-verify minimum operating speeds when running on internal power (see Minimum Operating Speed test above.)

Additional LED Signaling

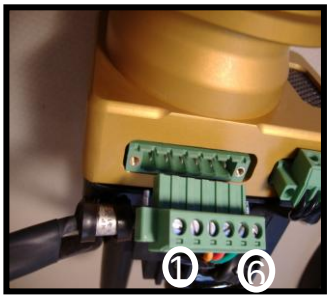
(Applies to all 114 series and most 113 series programs)

Beyond the RED and GREEN LED signals described in the manual for setting timing, other LED signals are as follows:

1. Sensor Magnet Range Check - Every time the ignition powers up, the ignition first performs a self-test to verify the sensor magnet is within an acceptable range. If the Range Check passes, the ignition proceeds with initialization (no LED signal). If the Range Check fails, it will proceed no further and will signal an alert with a pulsing (approx 1 every quarter sec) YELLOW LED. From the operators perspective it will appear as a non-operative ignition. The flashing YELLOW will continue until the infraction clears or the unit is powered OFF. No record of the alert remains after power OFF.
2. Successful Start UP – Next, the ignition will signal a successful start up with an LED color burst. The color burst will occur immediately after power up and will appear as a quick pulse of RED and a quick pulse of GREEN – any overlap of the two may appear as YELLOW. At this point the ignition is active and ready for service. The color burst is very brief. To see it you'll need to be staring at the LED when you power up.
3. If the p-lead was grounded PRIOR to power up and REMAINS grounded, the ignition will light the LED steady RED or steady GREEN (after the step 2 color burst). The color will depend on engine position relative to the ignition index. If the p-lead was not grounded, the LED will go dark after the color burst. Setting timing and the rules for setup mode are discussed in more detail in the manual.
4. Should the ignition later detect a sensor magnet position infraction, after a successful start up, it will NOT interrupt ignition operation. It will continue to fire plugs and perform all operational tasks. But it will signal the infraction by lighting the LED steady YELLOW (no pulsing). The yellow signal will remain until the condition clears or the ignition is powered OFF.

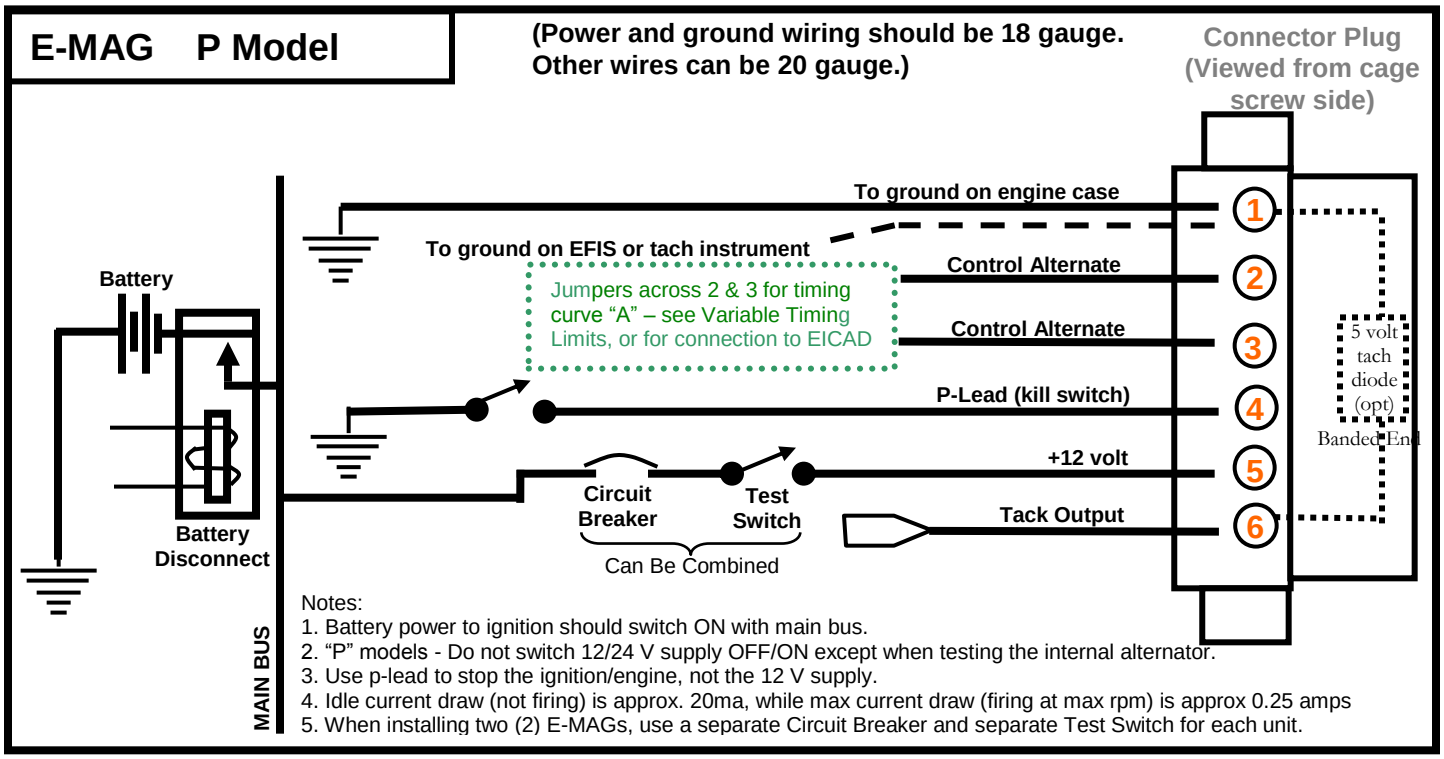
No record of the infraction remains after power OFF. The next time the ignition is powered ON the process starts over again with step 1.

Wiring Diagrams



Tach Voltage - For E and P models as needed.

Switch 12 v tach signal to 5 v by installing diode (provided) - see “P-MAG” diagram example below.



Troubleshooting

We maintain a Troubleshooting Tips guide that is accessible on our web site - see the Downloads page. By posting it there, we will be able to keep it more up to date.

We also describe a number of suggestions and features not covered in the manual on our web site. Go to www.emagair.com. Look for:

Tips & Tricks

Brown Bag Confessions