E-MAG Electronic Ignition

Product Documentation

Troubleshooting Tips

LC114 V4

Applicable to E-MAG 4 Cylinder Ignitions

(NOTE: Ignition models and firmware sets vary. Not all suggestions are applicable to all models. 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.

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Troubleshooting

The following troubleshooting suggestions are predicated on the operator already knowing and using proper safety precautions. Proceed with caution.

Note: Strategies are not listed in any particular order.

Strategies to Verify Overall Ignition Operation

Pull-Thru Test

A good starting point for troubleshooting is the Pull-Thru test. It will confirm a number of operating requirements at once:

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

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, making sure the plug metal case is grounded to the engine.
3. Unground the p-lead and then rotate the prop by hand to confirm the plugs fire as follows:
4. The PAIR of plugs:
    - [Lycoming Only] Closest to the prop will fire at TDC.
    - [Continental Only] Furthest from the prop will fire at TDC.
5. The other PAIR of plugs will fire 180 degrees later. Note: Certain firmware versions will cause the second pair (at slow "Pull-Thru" speeds) to spark at positions well before or well after 180 degrees. The firing position will be correct when the engine is turning at normal speeds. Just make sure the second pair fires and use the first pair to verify they fire at TDC.

If you don't see firing in this pattern, you will have some clues as to where to start looking.

1. Plugs that don't fire in correct pairs – check for plug leads not connected to proper coil terminals.
2. Individual plugs not firing – check plugs or plug leads (see ohm check below).
3. Plugs don't fire at TDC – Timing is not set correctly.

4. Plugs don't fire at all

    a. Is the LED lit Red or Green? If so, you are still in set-up mode, so the p-lead is still grounded (check switch or possible short to ground).

    b. Is the LED Yellow? – Indicates sensor magnet is out of alignment – see LED Signals below.

    c. Is the 3 pin (coil) plug attached and are the wires securely connected?

Most Frequent Installation Errors:

1. Plug leads connect to incorrect coil posts.
2. Plug lead assembly damages (nicks) the center conductor core. See Ohm Check below.
3. Getting the control plug terminal numbering system backwards. (Hint – Terminal #1 is the ground wire and is the one closest to the LED and MAP connection).
4. Setting timing with the 25 degree mark on flywheel instead of the TDC mark.
5. Not having a proper ground connection.
6. Impacting the nose (inward) when installing the drive gear (or other handling).
7. Not installing blast tube cooling or not orienting it to the proper area on the ignition.

Most Frequent Operating Errors:

Hard starting or pop/stumble at startup – then smoothes out. Results from starting too rich or over priming. Fuel injected engines in particular are prone to this problem. [Excerpt from E-MAG Operating Manual]

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

1. Master ON.
2. Open throttle ¼"
3. Mixture
    a. Cold Engine:
        i. Mixture full rich.
        ii. Boost pump ON until pressure rises then OFF.
        iii. Return mixture to lean.
    b. Hot Engine:
        i. Leave mixture lean.
        ii. No boost.
4. Crank until first fire (typically 3 to 4 blades).
5. Feed in mixture gradually.

Strategies to Isolate a Symptom

Isolate the ignition - If you suspect unusual ignition behavior:

1. Try switching (p-lead) OFF one ignition and then the other to see if you can associate the symptom with a single ignition. If the condition appears with both ignitions independently, the problem may not be with the ignition(s) at all.

2. Swap ignitions left to right to see if the symptom follows the ignition. If the symptom persists (on the same side), the issue may be with the plugs, plug wires, fuel supply, or the cylinders themselves.

3.

Isolate accessory hardware

1. Try swapping the harness left to right to see if the symptom follows the harness.

2. Try swapping the plugs (or installing new plugs) to see if the symptom follows the plugs.

Isolate the cylinder

Roughness can be caused by a cylinder (or cylinders) intermittent firing or not firing at all.   With both ignitions operating, the intermittent ignition can be masked by the plug firing from the other ignition. Operating briefly on the suspect/rough ignition (only) can reveal a great deal about the source of the problem.

Look for EGT temperature drops between the cylinders. EGT is a faster indicator than CHT. Even an occasional miss can be spotted as a very brief flicker or momentary dip in EGT. In order to see it, you'll need to have your eyes glued to EGT while the roughness is present. Noting which cylinder(s) exhibit a temperature drop/flicker is the **key data** reference (see below).

Wasted spark systems fire plugs IN PAIRS (front pair and then the rear pair). If you can associate a symptom (cold cylinder or EGT dips) with a single (1) cylinder , the cause is not likely to be inside the ignition box itself. It may be in the plug wire, the plug, the cylinder, or fuel to that cylinder – i.e. downstream from the ignition head.

Alternatively, if you detect a pattern that affects two (opposing/paired) cylinders simultaneously (cylinders 1 & 2, or 3 & 4), then the issue is likely to be the ignition control head or the ignition coil.

Ignition Coil: Make sure that none of the coil wires on the three pin plug located on the side of the ignition is loose. If that checks OK you can disconnect the connector plug and measure the resistance (ohms – not continuity) across the three terminals as follows:

Outer pins to center (measure each separately)	0.6 to 0.7 ohms typical
Outer pins to each other	1.2 to 1.4 ohms typical

Remove the spark plug wires and measure resistance between the terminals (within each bank).

Terminal to terminal (measure each bank separately)	9,000 ohms typical

Isolate by pattern of occurrence

Does the condition appear?

1. All the time?

2. At hot/cold starts?

3. At particular engine speeds?

4. At particular power settings?

5. At high altitude and not at low altitude or vice versa? A nicked spark plug wire may not present a problem initially. Over time, however, it can erode back, and may first appears as roughness at higher altitudes - and then smooth out at lower altitudes. See Ohm Check below.

6. Is this a new or long term symptom?

7. Have you made any other changes to your wiring/fuel/controls/baffling around the time the issue first appeared?

Plug Lead – Ohm Check

You can verify that your plug leads are assembled correctly by a simple ohm check. Each lead should produce approximately 180 ohms of resistance per running foot of plug wire (in the range of 300 to 600 ohms - shortest to longest leads.

1. Disconnect the leads from the ignition and the spark plugs.

2. Connect an ohmmeter to the terminals on each end. Read the ohms reading while you alternately exercise each plug ends (twist, bend, and tug) to see if the reading jumps significantly (to several times the normal reading). If it does, you likely have a nicked conductor core.

3. To repair a terminal, simply snip off the bad end (assuming you have an inch or so to spare) and replace with a new terminal. Our wire kits ship with two extra terminals in every set, so you should have the hardware on hand. When trimming the insulation for the new end, take care to stay clear of the center core. See instructions in the current manual regarding wire assembly.

Lead Check (for aviation style plugs)

At the aviation plug end, the conductor core is pinched between the spirals of a spring that, in turn, contact with the spark plug. We've seen a couple of examples of this spring (pinch) acting like a wire stripper and pulling the spiral wound conductor core off of its fiber center.

What Can the System Tell You?

LED Signals

1. (Series 113 and after): A FLASHING OR STEADY YELLOW LED (not to be confused with flicker in #5 below) – Indicates the position sensor is too close or too far away from the sensor chip. If the nose of the ignition is pressed or bumped sharply (inward) the shaft can shift and cause such a misalignment. Proper alignment can sometimes be restored by removing the ignition and using two flat blade screw drivers to pry outward against the heel of the drive gear.

You might detect (feel or hear) a small outward shift in the position of the shaft. The expected movement is rather small - 0.030" or less.

a. Up to and including firmware version 26 - A YELLOW LED (solid) will appear in run mode ONLY, and will not intervene with regard to engine timing or operation.

b. Beginning with Firmware version 27 – A YELLOW LED (flashing) will appear in both setup mode as well as run mode at power-up, and will intervene (prohibit) further operation until proper alignment is restored. If the condition is detected later while the engine is running, the LED will light (solid) Yellow but will not prohibit operation. The yellow LED will remain lit until the unit is (12 volt) powered OFF.

c. Firmware versions 25 and before – predates the sensor magnet position alert feature.

2. No LED at power up - Indicates the power or ground is not connected, or the p-lead is ON (not grounded). TIP: (not applicable to earlier units) When first (12 volt) powered ON, the ignition will signal a brief color burst (1/2 a second) of RED and GREEN to confirm it has powered up (verifying you at least have 12 volt power and ground). If the p-lead was open (ON) the LED will then go dark. If the p-lead was closed (OFF) the LED will light up, indicating you are in setup mode.

3. After setting timing the LED stays green when you move the prop - Indicates the magneto impulse spacer is still in place and the drive gear is not engaging the accessory drive gear.

4. After timing the ignition, the LED turns green at a position other than the flywheel TDC mark. The ignition is not holding timing – call E-MAG.

5. After setting timing and resetting 12 volt power (your confirmation step when setting timing), the LED should be solid GREEN. However, if the engine happens to be positioned on the (very narrow) boundary between RED and GREEN, the LED will flicker rapidly between RED and GREEN (the combination sometimes looking amber or yellow). It's not a problem. Your timing set was successful. Simply nudge the prop very slightly and you will see a solid RED or solid GREEN, depending on the direction.

Summary of LED Signals

The following is a sequential summary of the LED signals.

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.

EICAD Information (version 4) (Series 114 Ignitions)

1. Current ignition (circuit board) temperature.
2. Maximum recorded (circuit board) temperature.
    a. Properly installed blast tube cooling should keep the maximum temperatures in the 175 to 185 degree (F) range. If you see temps above 190, check your cooling tubes and/or your accessory case air flow. Higher temps run the risk of thermal shutdown.
3. Spark Plug Alerts – Series 114 units have components that report the ignition coil discharge rate.
    a. A rapid discharge rate indicates a spark plug or plug lead is fouled (shorted).
    b. A slow discharge rate indicates a spark plug or plug lead is open (broken).

Strategies for Dealing with High Engine Temps:

1. Double check engine timing.
2. Set the ignition for less advance.
    a. Temporarily - Put the control plug jumper IN and remove the MAP tube. This will reduce your max advance to roughly 26 degrees (similar to most magnetos). This is easy to do in the field, and is just as easy to undo if you don't see results.
    b. Use EICAD to:
        i. Move the Advance Shift downward (Note: Advance Shift is ignored when you have the control plug jumper IN).
        ii. Move the Max Advance ceiling down.
3. Improve engine baffling.
4. Improve accessory compartment exit air path. Exit air is just as important as inlet air.
5. Carbureted engines – make sure you have properly sized jets.

Common tach errors:

1. Failure to configure ignition for 5 vs 12 volts
2. Failure to configure ignition for correct pulse per rev.
3. Instruments that are designed to pick up a signal from the magneto p-lead are looking for a much stronger pulse (hundreds of volts) than our tach signal will generate.

Ignition Temperatures / Blast Tube Cooling

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 (well above 200F) can experience thermal shut down. Temperature issues can be mitigated by the addition (or improvement) of blast tube cooling, and 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). Otherwise, readings can be made with thermal reactive labels or with a thermal probe secured in a manner to measure ignition case temperature. Current production units have a thermal sticker on the end of the ignition case. When new the dot (circular window in the center of the sticker) is off-white or ash color. They are rated for 200(F) degrees at which point they will turn grey or grey/black.

A frequent cause of inhibited blast tube cooling 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’ve had several reports of improvement after improving exit air.