E-MAG Electronic Ignition

Product Documentation

Series 200T-6X

Installation and Operating Guide

Lycoming & Continental 6 Cylinder Engines
(Experimental Version)

V 200-6X .024

Changes: Corrections and supplements may be made at any time (see version number on cover page – bottom right). Refer to E-MAG's web page "Downloads" for the most recent version.

Experimental Aircraft Only: Series 200T-6X ignitions are not certified and are not approved for installation on certificated aircraft.

Warranty: E-MAG electronic ignitions are warranted for one (1) year from the date of purchase. 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 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. Do not attempt to open or separate the ignition case sections. Doing so will void your ignition warranty.

CAUTION: The aircraft operator has the SOLE responsibility of determining how to appropriately and safely configure and control engine and ignition operation. Nothing stated by E-MAG in this manual, its employees, owners, agents, representatives, or affiliates should be construed as overriding or invalidating the engine manufacturer's instructions. E-MAG has NOT performed testing on the wide variety of engines in popular use and cannot offer specific advice as to proper/suitable ignition configuration.

Notwithstanding engine manufacturer approval of certain engines to burn auto/alternative fuels, such endorsements almost certainly presume operation with fixed magneto timing – and not variable firing electronic ignition. Operators are SOLELY RESPONSIBILITY for independently verifying proper engine behavior with standard and/or alternative fuels including the ignition setup AS CONFIGURED BY THE OPERATOR.

2014 Greg Street, Suite 112, Azle, TX 76020
Phone (817) 444- 5310

Using This Manual:

Your ignition is designed with several installation conveniences. To further assist, this manual will supplement the installation sequence with comments, tips, and background information that will be shown in *blue* text. Always use best aviation practices when installing this ignition.

Some segments are specific to Continental or Lycoming engines. Such segments will be identified with the bracketed notation "[Continental]" or "[Lycoming]" and colored as shown. The "Lycoming" reference applies to Lycoming and Lycoming-like engines. Please note:

Lycoming is a registered trademark of Avco Corporation
Continental is a registered trademark of Continental Motors Group

Exercise care when handling the ignitions, engine, and propeller. There is a significant risk of burn, electrical shock, injury, or even death. This manual may offer safety suggestions, but it is NOT to be considered a complete list of the potential hazards, NOR is it presented as a complete set of safety precautions that should be followed.

RISK OF EQUIPMENT DAMAGE: [***IMPORTANT***] Firing the ignition without all high voltage loops in place, risks damaging the coils and/or electrical shock to the handler. Equipment damage may not be immediately evident. Loops include the circuit from a given coil tower, to plug wire, to plug, to engine block, to companion plug, to companion plug wire, to companion coil tower. Each pair of cylinders (1&2, 3&4, 5&6) constitutes a separate loop.

Ignition Manual Changes:

ID	Date	Principal Changes (minor alterations not listed)
V 200-6X.022	4/2/18	Initial publication.
V 200-6X.023	5/21/18	SafT Switch descr (DPST).
V 200-6X.024	8/17/18	Added LRX plug adapter. Added mounting clamp discussion. Altered instruction for changing DIR. Added pictures and numerous other changes.
		When equipment is being serviced or installed always check for newest version of the manual. Disregard previous versions.

Overview:

Series 200T-6X ignitions provide
1) High-energy spark.
2) Variable and fixed firing capability.
3) Redundant operating power – an internal alternator as well as a connection to the aircraft power bus.
4) Backup fire control circuit – a full featured modern logic circuit as well as a simple stand-by firing circuit – operated by a single cockpit SafT switch.
5) Single module. All elements (electronics, position, power, coils) are housed in a single assembly.

Installing your E-MAG ignition will require
1) Attaching three (four if you use the tack) wire connections from the ignition Control Plug.
2) Installing spark plugs, plug adapters, and a trim-to-fit harness.
3) Installing a manifold pressure tube connection.
4) Blast tube cooling.
5) Installing your E-MAG ignition on the engine.
6) Setup position references.
7) Test, tune, and monitor to ensure proper operation.

What's included
200T-6X (Lycoming or Continental version) ignition set includes:
1) 1 ignition module.
2) 1 Standard Control Plug connector kit (solder connections w strain relief clamp)
   a) Circular plug - 6 pin female.
   b) 2" of 1/8" heat shrink tubing.
   a) 3" of 3/8" heat shrink tubing.
3) MAP connections (1/8" barb fitting, 10-32 female, and 1/8" NPT female):
   a) 1/8" hose barb can be used with the 1/8" ID tubing provided, or it can be removed to access:
   b) 10-32 female thread fitting, that can be removed to access:
   c) 1/8" NPT female thread in the ignition case.
   d) 36" silicone MAP tube (1/8"ID x 1/4" OD).
   e) 3 each, nylon tube clamps for ¼" OD MAP tube.
4) Ignition gasket.
5) SafT Switch kit – controls 1 or 2 200T ignitions. One switch is provided with a dual capability.

Auto Plug Adapter set includes
1) 6 auto plug adapters (specify "LR" long-reach, [certain Continentals] "LRX" extended long-reach, or "SR" short-reach adapters when ordering).
2) 6 copper gaskets.

Trim-to-fit harness set includes
1) 26' of custom E-MAG low noise plug wire.
2) 6 coil boots.
3) 6 plug boots.
4) 8 coil terminals (two extras).
5) 8 plug terminals (two extras).
6) 1 crimp tool.

Optional Parts **specify when ordering**

1) Circular control plug with pre-wired pig-tail – 72" wire bundle installed, and epoxy potted on shorter (1.5" vs. 2") circular connector (in lieu of Standard Control Plug connector above). This assembly eliminates soldering wires to the standard connector. We suggest the standard connector if you already have imbedded wiring to the ignition(s).
2) Mounting Studs – [Lycoming] Shorter (1-5/8", # 31C-13) studs will be needed to replace the longer ones you will remove along with your old impulse spacers.
3) Mounting Clamps – 200T-6X have a 0.19" thick flange that requires compatible clamps.
   a) If replacing thick flange magnetos, such as the 0.31" thick flanges on some Continental/Bendix styles, your old clamps will not work.
   b) Some Continental/Bendix style clamps (#535847) have a shallow reach and will not provide suitable contact surface. Continental clamp #630535 has a longer reach.

Installation supplies and tools needed

1) Silicone spray – used when fabricating trim-to-fit harness.
2) Ohm meter - recommended (but not required) to test spark plug wires after assembly.
3) Solder iron and rosin core solder for control wires (not needed if ordering pre-wired Control Plug).

Other hardware and fittings NOT included

1) Fittings to attach the manifold pressure tube to the engine.
2) P-lead switch to control the ignition ON/OFF function (you can re-use an existing switch).
3) Fuse or breaker for bus protection and/or power test switch.
4) Blast Tube cooling (new or re-use existing).
5) Spark Plugs – readily available at auto parts outlets. Recommendations listed later in the manual.
6) Spark plug wire supports and separators.
7) Ignition mounting clamps. You will re-use existing or off the shelf mounting clamps. Thick flange (0.31") mounting clamps will not fit.

Control Wiring:

1) Standard circular plug connector (PT06A-10-6S-SR or similar). This is a solder style plug with strain relief clamp for installation with pre-existing (20 AWG) wire.
2) Optional circular plug connector with pig tail – circular connector (PT06P-10-6S or similar) with 72" of wire soldered and potted – see color references below and wiring schematic at the end of the manual.

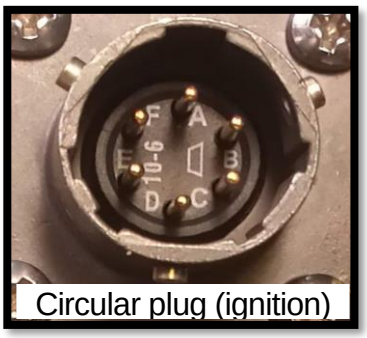
Pin "A" on circular plug **(Pig-Tail red wire)** - connects to your 14 or 28-volt aircraft bus. Route thru a power test switch and suitable circuit protection. Possibilities are:

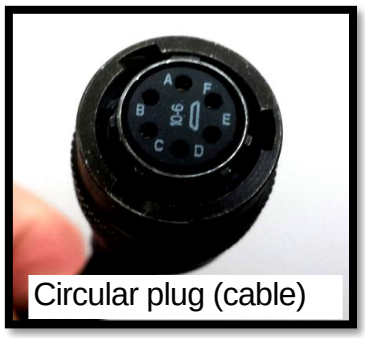
1) A separate 5-amp fuse and separate power test switch.
2) A 5-amp switchable circuit breaker, which can satisfy both circuit protection and power test duties.

Pin "B" (Pig-Tail black wire) - connects to the cockpit panel ground.
Pins "C" and "D" (Pig-Tail white and green 22AWG) – stow for future use.
Pin "E" (Pig-Tail yellow wire) - connects to your cockpit kill switch (ignition ON/OFF). To turn ignition OFF, ground the p-lead with the switch. To turn ignition ON, un-ground the p-lead Kill Switch (*).
Pin "F" (Pig-Tail blue wire) – provides a 3 pulse/rev, 12-volt tach pulse. Tach signal is present even when the ignition is p-leaded OFF.

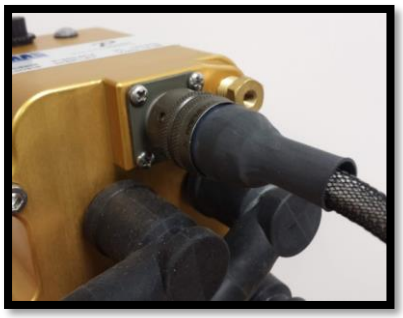
(*) SafT Switch: Series 200T-6X ignitions will use a secondary cockpit switch to enable Safe Mode or Norm Mode operation. A bias signal sent over the existing kill wire (pin E) is all that's needed. The bias signal is produced by a 1K ohm resistor that connects the kill lead to ground by way of the included SafT Switch - detailed later in the manual.

Note 1: Shower or vibrator type starting aids are ***not compatible*** *and may damage your E-MAG – remove or isolate before installation.*


Circular plug (ignition)


Circular plug (cable)

Note 2: E-MAG p-lead wire does not make radio noise and therefore does not require shielding. If replacing a magneto, your existing shielded p-lead wire can be re-used. If doing so, the outer shield needs to be trimmed clean and kept well clear of all other terminations.



Note 3: All E-MAGs are "starting ignitions". In a dual installation, or if replacing a non-starting magneto, revise your starting procedures, and/or remove any key switch starting blocks (remove the jumper on the back of the key switch) to your E-MAGs.

Note 4: Whenever the aircraft bus is powered ON, the ignition is "awake". It draws a small amount of current (approx. 40 milliamps) even when not firing plugs. Use the master bus switch (or breakers if necessary) to power down the ignitions when not in use.

Note 5: DO NOT power the ignition ON if/when you have a ground battery charger connected to the bus.

Note 6: Collect your tack signal from only one, not both, ignitions unless your instrument has provisions for two (separate) tach inputs. Unlike a magneto, your E-MAG will produce a tack signal even when kill switch is turned to OFF.

Note 7: E-MAG's tach 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 interface issues is limited. We will post the most common suggestions/remedies in our Trouble Shooting Guide (download from web site).

Our recommended wiring schematic is shown at the end of this manual. Other wiring schemes may be proposed by others from time to time. Please understand our ongoing testing, maintenance, revisions, and support is based on our recommended configuration only. **We DO NOT TEST OR SUPPORT** alternative wiring schemes. If used, our ability to provide knowledgeable or timely support may be limited.

Manifold Pressure (MAP):

Series 200T-6X ignitions come with 3' of 1/8" ID x 1/4" OD silicone tubing for your manifold pressure

connection. The ignition comes with a 1/8" barbed nipple located next to the Control Plug header. This fitting can be removed to reveal a 1/8" NPT in the ignition case if you prefer different fittings and materials. Route the MAP tube to a convenient connection point on the engine, or a MAP header if used. The MAP input sensor has both electronic and mechanical filters built-in.


1/8" Barb for MAP

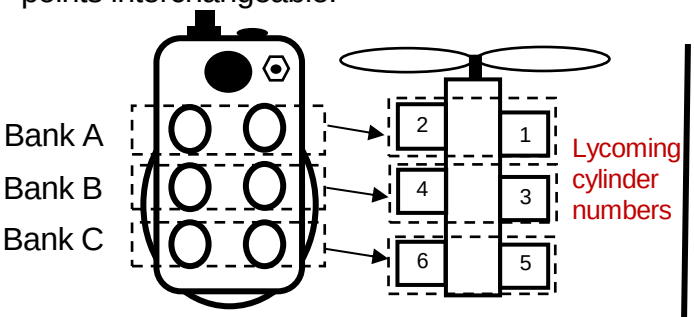
With **normally aspirated** engines, the MAP tube is a fail-safe input. Meaning if the MAP plumbing comes loose or fails, plug firing in NORM Mode will retard to a very flyable, but slightly less efficient, firing position. If installing two ignitions, run a single MAP tube to the accessory area, and then tee the line to each ignition. If you have a manifold pressure gauge, tee into that existing line for your pressure source.

With **turbo normalized or boosted** engines, the MAP tubing is NOT considered fail-safe. A MAP plumbing failure can, in certain conditions, call for more ignition advance than is necessary, appropriate, or safe. Excess advance can result in loss of power, overheating, and/or damage to the engine. For this reason:

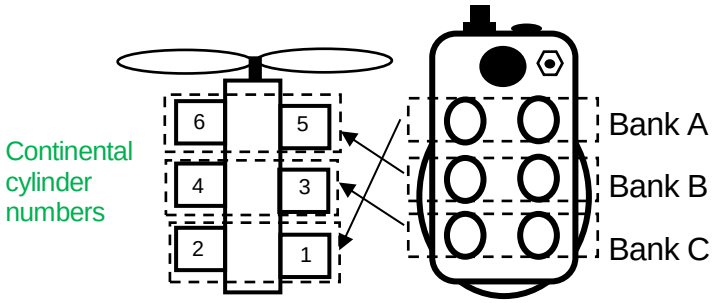
1) The MAP plumbing for two ignitions should not share a common feed. Using separate MAP plumbing for each ignition will minimize the effect of a MAP plumbing failure on either side.
2) The cockpit **SafT Switch** is a simple and effective override that will bypass the MAP input (plumbing failures) and set the ignition for Safe Mode firing (where MAP input is not a factor) – see SafT Switch later in this manual.

[Lycoming] cylinders have a primer port that can be used to access manifold pressure. Use a standard 1/8" pipe fitting and a short length (3 or more inches) of metal primer tubing (not provided) at the cylinder before transitioning to the MAP tubing.
[Continental] *Connect MAP tube to the fitting near your induction air control.*

Coil to Cylinder assignments
As with any wasted-spark ignition, E-MAGs fire spark plugs in pairs. Cylinders 1&2, 3&4, 5&6 are paired with plug leads connected to both ends of a double ended coil "Bank", making the two coil attachment points interchangeable.



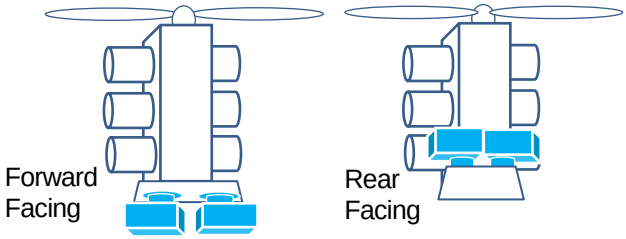
[Lycoming] (540) engines will typically route Banks A, B, & C as shown.
1) Right and Left rotating engines route the same.
2) Geared engines – may or may not require swapping Banks B and C. Verify correct firing order with Pull-Thru test (described later in this manual).



[Continental] engines always route Bank A to cylinders 1&2.
Banks B & C will vary:
1) Most forward-facing ignitions (470s and 360s) route Banks B & C as shown. Right and Left rotating engines route the same.
2) Most rear facing ignitions (470s, 520s, 550s), will swap Banks B & C. Right and Left rotating engines route the same.
3) Geared engines may or may not require swapping Banks B & C. Verify with Pull-Thru test (described later in this manual).

Note1 : Due to the variety of applications in different engines, some changes or re-assignment of leads may be necessary. The Pull-Thru test [highly recommended] is the best way to verify plug firing conforms to the engine manual.

Note2: Forward-facing refers to installations where the ignition drive points toward the prop. Rear-facing refers to installations where the ignition drive points away from the prop.



Auto Plugs and Adapters

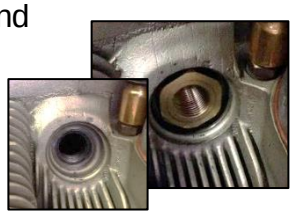
Aircraft engines are typically tapped for 18mm thread spark plugs. To use 14mm automotive style plugs, we offer Auto Plug Adapters. There are numerous plug styles and temperature ranges available through automotive outlets. E-MAG has NOT undertaken studies to compare the relative durability or suitability of different plugs. Customers need to monitor plug condition and evaluate and adjust as necessary. We offer the following list of plug and plug adapter alternatives that have history of good service. Set plug gaps at 0.030" to 0.035".

Long vs. Short Reach Cylinders


SR LR LRX

Cylinders come in two plug thread depths that can be identified as follows.

1) [Lycoming] Long Reach (LR) engines can be identified by yellow paint applied to the fins near the spark plug hole.
2) LR/SR engines can also be identified by the aircraft spark plug call-out for your engine. If it has the letter "M" - as in RE**M**XXXX, you will need SR plugs and adapters. If it has the letter "B" as in RE**B**XXX, you will need LR or LRX plugs and adapters.
3) The thread lengths of our plug adapters are as follows:
   a) Short Reach ("SR") external threaded section is approx. 1/2".
   b) Long Reach ("LR" and "LRX") external threaded section is approx. 3/4".



Note: [Continental] LRX is an LR adapter with the hex head extended ¼" to facilitate socket attachment (removal only) on Continental 550s (maybe others) where the plug hole is recessed – see pic.

Spark Plugs - See Appendix for specific spark plug recommendations.
IMPORTANT: Remember to **FIRST** install spark plug in the adapter (fully seated and finger tight). **THEN,** insert the combined plug/adapter assembly in the engine and tighten to **18 ft/lb** (standard auto plug torque) through the spark plug ONLY. **Do NOT torque the adapter itself.** If you torque the adapters directly, stress will be focused underneath the adapter head and it can fail during installation. Such failures are not covered under warranty. Use anti-seize (sparingly) on the outer/engine side of adapters.

Trim-To-Fit Harness

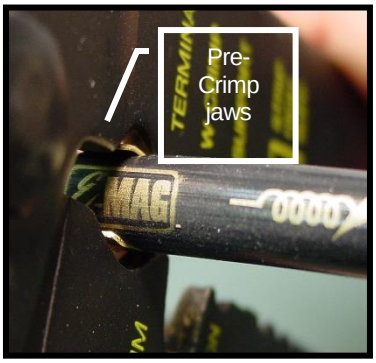
All lead kits use our custom low-noise plug wire that is not shielded. We have no (zero) reports of noise problems from customers using this wire (properly installed and in good condition). If you do hear spark noise, something is not installed or functioning properly. Plug "clicking" noise over the radio is a useful maintenance signal. Something is loose or worn and arcing - which causes radio clicking noise. Leads should be kept separated. Do NOT bundle them together which 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

Criss-Cross vs. Up-Down

It's relatively immaterial whether you route plug leads in the traditional magneto criss-cross fashion (one ignition wired to alternating upper and lower plugs) or one ignition firing all the upper plugs and the other ignition firing all the lower plugs

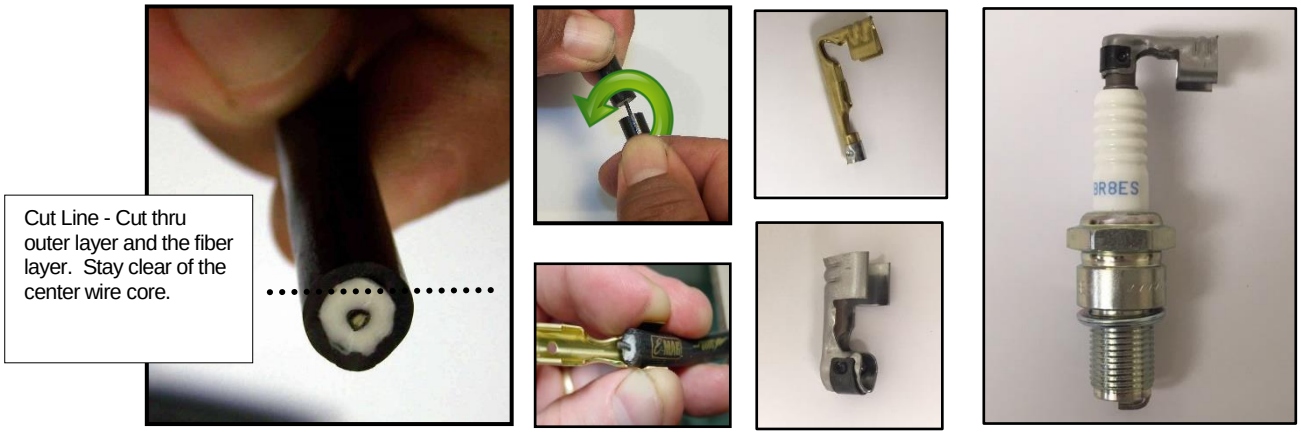
Lead Fabrication



Trimming

The red (or black) outer jacket and the white inner layers are separated by a reinforcing fiber weave. The conductive element is a spiral wound filament around a Kevlar core (avoid when trimming). Use a razor blade to trim the OUTERMOST red and fiber layers ONLY 3/4" from the end, all the way around the wire. Avoid cutting anywhere near the center core. The white insulation layer separates easily as you twist the trimmed outer jacket. Twisting the cut end counter-clockwise will help to avoid unwinding the spiral core.

Note 1: The center core is easily nicked and weakened by contact with a Stripping tool or a blade. DO NOT use the wire stripping station on the crimp tool.



Terminals and Boots

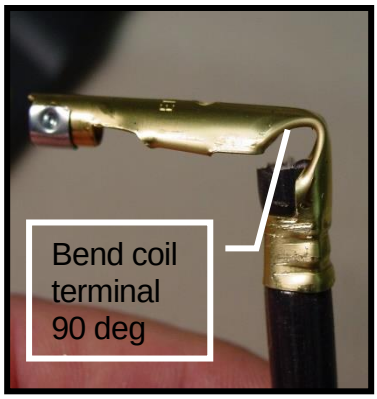
The silver terminals and rounded boots are for the spark plug connection. The longer brass terminals and flat-backed boots are for the coil connection.

Coil ends - First, run the wire through the boot so you have a couple of inches extended. This will give you room to work the wire and terminal. A light coating of S**ILICONE SPRAY** (not included) is required to lubricate the wire as you work it through the boot.

Plug ends – You can crimp the terminal to the wire and then insert the assembly into the boot with silicone spray lubrication.

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 coil boot to straighten the passage as you push the wire through. Free the terminals from their strips with wire cutters. The terminals are NOT finger friendly. They will easily cut if not handled carefully.



Pre-Crimp - Fold the ¾" of exposed wire core back against the lead and position it in the crook between the terminal ears. Then finger pinch the terminal ears to 1) provide a preliminary snug fit, and 2) reduce the spread between the ears so they fit in the "W Crimp" station of the crimping tool.

Position so you have at least 1/8" of plug wire past the ears.
Final Crimp - Crimp the terminal using the W Crimp Station on the Tool. Position the ears so they feed toward the side with the "W" point. The ears will roll back toward each other and imbed themselves in the outer jacket as the Final Crimp is formed. Push (not pull) the terminal to final position inside the boot. Coil terminals will need to be bent 90 degrees (at the narrow section) before positioning in the boot.
Resistance Check - Verify the finished leads are assembled correctly with a simple ohm check. Each lead should produce roughly 180 ohms of resistance per foot of plug wire. To check, disconnect the leads at both ends so you can make (firm) ohmmeter contact with the terminals on each end. Watch the ohmmeter display while you exercise each end vigorously (twist/bend/tug) to see if the reading jumps significantly (several times the normal range). 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.

Note 1: Resistance checks are also recommended at annual inspection. It tests the condition of the conductive components, but it does not check the electrical insulation, which is another way that wires can fail. A visual inspection of plug wire is recommended, especially in areas of possible chafing.

Installation:

Note 1: SAFETY: These installation procedures are strictly limited to E-MAG ignitions ONLY. If you are using 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. This guide will NOT include all safety precautions. Standard safety practices should be followed.

[Lycoming] If present, remove the original magneto spacer and replace the mounting studs with shorter ones (# 31C12).

Harness and Plugs
The terminals on both ends of the plug wire are secured by a spring steel outer band with a detent. Verify that you feel and/or hear the steel band detent **snap-lock** as the terminals slip over the connecting post:
1) **Coil Terminals** - The coil terminal post inside the tower (see cutaway photo) has 3 grooves. As you push the circular terminal onto the post, you will feel and/or hear a series of clicks as the terminal detent snaps over these grooves.
2) **Plug Terminals**: Spark plugs have an hourglass shaped cap. You will feel and/or hear a click as the terminal snaps over the plug cap.

In either case, **if you don't feel and/or hear the terminal snap,** remove and inspect for irregularities or damage. If needed, replacement terminals can be provided by E-MAG. Our trim-to-fit harness kits come with two extra coil and plug terminals per set.

If not properly installed the leads can come loose, which risks interrupting ignition operation, and can damage the ignition coil. NEVER operate the ignition (fire plugs) without ALL high voltage loops (coil to wires to plugs to engine to plug to wire to coil) secured in place.

Note1: After plug wires are connected, verify the boot sleeve is fully inserted over the plug and coil towers and is relaxed, i.e. not "compressed" such that it's left pushing the boot away from the terminal.

Note 2: When removing the wires from either end, pull the boot/terminal straight off the post. If you use the 90-degree boot to lever/pry/bend the terminal off the post, you risk distorting and weakening the terminal spring retention clip.

Terminology:

We will avoid the term "timing", as its traditional meaning with mechanical magnetos does not always apply.

- *A traditional mechanical magneto that is "timed" at 25 degrees … fires at 25 degrees. This is not always the case with E-MAGs.*
- *A traditional magneto is timed by changing the ignitions physical (clamped) orientation. When changing your maximum advance or TC positions, you will not change the ignitions physical orientation.*

Instead, we'll use the following terms that better describe your E-MAG installation:

1) **Setup** - Procedures that index the ignition and engine to a set of Setup Reference positions.
2) **Setup References**
   a) **TC** – The ignitions stored position for top-dead-center - should match engine TC (ref. manufacturers flywheel, flange, or other markings).
   b) **MIN** - A mechanically stored (rotate/clamp) ignition position that will:
      i) Match the engine manufacturers recommended (magneto) firing angle - typically 20 to 25 degrees before TC.
      ii) Mark the low advance (high power) end of the Normal Mode firing range.
      iii) Mark the fixed firing position in Safe Mode.

      MIN is the primary anchor position for other Setup References. If MIN moved, check and adjust TC and MAX as appropriate.
   c) **MAX** – Marks the high advance (cruise power) end of the Normal Mode firing range. The factory default setting for MAX will be 5 degrees ahead of MIN.
   d) **DIR** – Setup will confirm the ignition is configured to operate in the required direction (DIR).
3) **Configuration Button** ("Button") is located beneath a black plastic screw cap on the end face of the ignition. Button commands will depend on the LED color.
   a) When the LED is GREEN:
      i) A quick-press will adjust the ignition TC to match the current engine position.
      ii) A four-sec. press/hold starts the process for changing the ignition's operating direction – see Setup Step 5.
   b) When the LED is BLUE, a quick-press will adjust the MAX position - see Check/Change Setup References and Tuning MAX.
4) **SafT Switch** – Safe Mode or Normal Mode is selected by a single cockpit SafT Switch (DPST) that controls both left and right (200T) ignitions. Safe Mode is enabled by the SafT Switch applying a 1K bias resistance to each kill circuit. For starting, SafT Switch must be set to NORM.
   a) **Safe Mode** - SafT Switch "SAFE" will fire plugs at the mechanically stored MIN firing position. Safe Mode uses a simple trigger circuit that bypasses processor-based position and variable fire control logic.
   b) **Normal Mode** - SafT Switch "NORM" allows RPM and MAP inputs, together with processor-based logic, to vary the firing position in a range between the

MIN and MAX boundaries.

5) **Power Test Switch** - A cockpit interrupt switch between bus power and the ignition that is used to test the E-MAG internal alternator. A switchable circuit breaker or separate test switch can perform this function.
6) **Kill Switch** (p-lead switch) - The traditional cockpit ignition ON/OFF (Left/Right) test switch is unchanged. The SafT Switch does not interfere or alter Kill Switch operation. The Kill Switch OFF position connects the E-MAG kill wire (p-lead) to ground. The ON position un-grounds the kill wire.

Note: All other connections from previous installations (shower of sparks etc.) must be reomoved.

LED Signals:

1) **RED LED indicates CAUTION**. When ignition is powered ON and kill switch is ON the unit is capable of firing plugs ("HOT").
   a) Steady RED indicates Normal Mode HOT.
   b) Flashing RED indicates Safe Mode HOT.
2) Other LED colors are enabled by turning kill switch to OFF (ground p-lead). Plug firing is blocked when displaying other colors.
   a) **BLUE** zone appears over a small portion of the rotational range.
   b) **GREEN** zone appears over the remainder of the rotational range.
   c) Position points
      i) **WHITE** signals MAX - a point inside the BLUE zone that marks the upper end of the variable firing range.
      ii) **YELLOW** signals ignition TC which should match engine TC. Start-up firing will be 4 degrees after ignition TC.
      iii) **BLUE-TO-GREEN** transition points ("B/G"). You will find two B/G transition points, one at each-end of the BLUE zone. Installation will focus on the B/G trailing-edge - closest to TC.

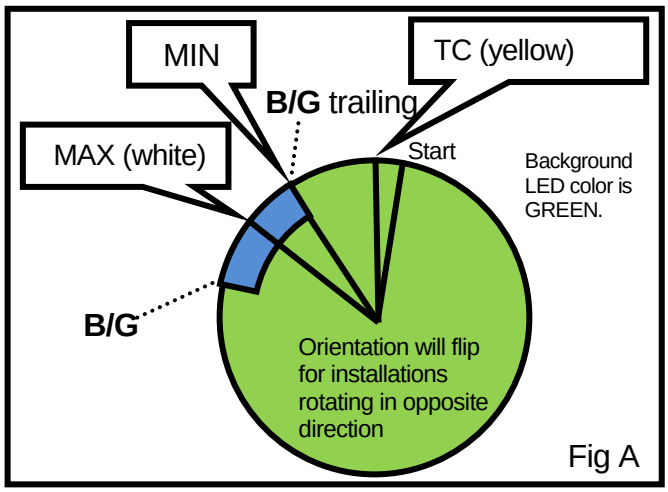


Fig A

TC (top center) References:
[Lycoming]: On Lycoming (direct drive) engines, "TC" may be stamped on the PROP SIDE of the flywheel, which will align with a hole in the face of the starter mounting case. You may also find a mark on the ENGINE SIDE of the flywheel that lines with the upper engine case seam. ALWAYS consult your engine documentation for the procedure to locate TC.

[Continental]: On Continental (direct drive) engines, "TC" may be marked on the prop flange and/or found underneath an inspection plug near the alternator. ALWAYS consult your engine documentation for the procedure to locate TC.

Setup:

1) Before installing the ignitions:
   a) Move prop in the direction of normal travel and note the movement (direction) of the ignition drive in the accessory case. Step 4 will ask you to rotate the ignition **body opposite** the direction of the ignition drive. For future reference, mark this direction (arrow ⇦ or ⇨ signifying the correct/opposite body rotation) on the engine case close to the ignitions.
   b) Pre-position prop (engine) to the manufacturer recommended magneto firing mark – typically 20 to 25 degrees BTDC. *It does not matter which cylinder (#1 or #2) is in compression.*
2) Verify bus power is OFF and Kill Switch is OFF (grounded). Connect the circular Control Plug. Turn bus power ON and verify LED is NOT RED.
3) Turn ignition **rotor** by hand to locate the BLUE LED zone. Orient ignition body so rotor lugs align with rubber cushions in the ignition drive – insert in the engine, along with the ignition gasket provided. Secure with mounting clamps finger-tight.
4) Very slowly rotate the ignition body **opposite** the ignition drive (ref. arrow ⇦ or ⇨) and watch for the LED to turn from **Blue** to **Green** - Stop. Tighten ignition mounting clamps.
5) Move prop/engine to TC.
   a) If LED turns YELLOW at TC - you're done.
   b) If LED stays GREEN, press the Button and the LED will turn YELLOW – you're done.
   c) If you can't find a YELLOW LED in the TC vicinity and the Button press does not produce it, you need to re-set ignition direction (DIR) as follows:
      i) Press/hold the Button for four seconds and the GREEN LED will start flashing GREEN.
      ii) Release the Button and rotate the engine 360 degrees in the normal direction of travel returning back at the TC vicinity.
      iii) The LED will return to steady GREEN.

   Repeat Step 5 *a)* and *b)*.
6) Connect plugs and plug wires - basic installation is complete.

Review all settings – see Check/Change Setup References and Tuning MAX below.

*Note 1: Make sure Kill Switch stays OFF (grounded) until Setup is complete **and** all plug, plug-wire, and coil connections are in place. Operating the ignition (firing plugs) without high-voltage circuits risks damaging the coil.*

*Note 2: Step 4 is straight forward but **strict** in two respects:*
1) *Color sequence: Blue-to-Green (B/G) is the color signal (not Green-to-Blue).*
2) *Direction specific: B/G appears while ignition is rotating per arrow mark (step 1a). If you overshoot and need to repeat, back up well into the Blue zone before resuming movement (per arrow) toward your B/G target.*

Note 3: In Step 5 you'll move the prop from B/G to TC, a short 20 to 25-degree movement. Don't go the long way around (340ish degrees) to reach TC.

Note 4: Re-Install Short-Cut: If re-installing on the same engine where previous TC, MAX, and DIR settings are retained (i.e. after routine maintenance) Steps 1 and 5 can be skipped. Always review settings after re-installing.

Note 5: Changing the ignition's DIR (if needed) will restore factory default TC and MAX (+5) settings consistent with the new direction reference.

Check/Change Setup References:

Kill Switch OFF, Power ON, and verify LEDs are NOT RED (i.e. engine is safe to handle)**.**
Note: Resolution within 1 degree is adequate for inspection purpose.

1) **CHECK MIN** by slowly sweeping the prop over the manufacturer's recommended (magneto) firing position. When passing this mark **in the normal direction of rotation**, you should see the LED switch from BLUE to GREEN (not GREEN to BLUE). If MIN position adjustment is needed, repeat Setup Steps 1(b) thru 5.
2) **CHECK** ignition **TC** by moving the engine (prop) to TC. The LED will turn YELLOW at the ignitions stored TC position. If LED is not YELLOW (LED stays GREEN), quick-press the Button. The new TC position will be stored, and the LED will turn YELLOW. If the LED does not turn YELLOW, change ignition rotation (DIR) by repeating Setup Step 5.
3) **CHECK MAX** by slowly sweeping the prop inside the BLUE LED zone. MAX is signaled when the BLUE LED turns WHITE. The default MAX setting will be 5 degrees ahead of MIN – a conservative value. Change MAX by moving engine to your preferred MAX (BLUE zone) position and quick-press the Button. The LED will turn WHITE, indicating the ignition is sitting at the new MAX position.

Check Plug Assignments (Pull-Thru Test)

The Pull-Thru test will confirm 1) plug wire assignments, 2) basic operation of firing circuits, 3) correct DIR setting, and 4) correct TC setting. All four are validated as follows:

1. Remove all spark plugs from the engine and reconnect them to the plug leads.
2. *IMPORTANT* Rest each plug on the engine case or convenient location such that the metal case of each plug is grounded to the engine block. *Alternatively, the plug metal cases can be wired to the engine block or bundled directly to each other.*
3. Turn bus power ON, Kill Switch ON, and SafT Switch to NORM. LED will be steady (not flashing) RED. Rotate the prop by hand, in the normal direction of travel and confirm all plug pairs fire in proper sequence. Any deviation from this pattern indicates a wiring or setup error. *See Note 4 below.*

   Both plugs for cylinders 1&2 (Bank A) fire 4 degrees **after** TC.
   Both plugs for Bank (B or C) fire 120 degrees later – see Note 4.
   Both plugs for Bank (C or B) fire 240 degrees later – see Note 4.

Note 1: SafT Switch must be set to NORM. Safe Mode will not fire plugs at (hand) pull-thru speeds.

Note 2: Plugs will not fire when the engine is moved in the wrong direction. To correct, change ignition direction (DIR) setting - Setup Step 5.

Note 3: Multi-Strike. At cranking speeds, the ignition uses a (5) rapid strike sequence for each bank. This means the Pull-Thu Test will not produce the familiar single spark "click". Instead, you'll hear the plugs "buzz" – the sound of a multi-strike sequence.

Note 4 – plug wiring overview:

1) *Both Lycoming and Continental, Bank A **always** connects to cylinders 1&2.*
2) *Banks B and C – only choice is (B to 3&4, C to 5&6) or vice-versa. Confirm Bank firing is consistent with the firing order in your engine manual. Due to Bank firing (plug pairs vs. single plug firing) you will be confirming one plug in the firing Bank, matches the traditional single plug firing order in the manual.*

Tuning MAX:

Orientation:

- *Operating the ignition in Normal Mode (SafT Switch "NORM") can improve engine efficiency by enabling automatic adjustments of the plug firing position. The range and slope of the adjustment reach is determined by the MAX setting. MAX will be either the default (+5 degrees) at Setup, or a different MAX position as determined by the operator. The default +5 is a modest setting. Tuning MAX can, and likely will, improve efficiency but it' is not required for basic operation, especially in Safe Mode where variable firing is not a factor.*
- *Engine and installation conditions vary widely. Operators need to confirm the suitability of their MAX setting, including the factory default. The effects of a given MAX setting will be most evident, and useful for tuning purposes, in cruise conditions where spark advance is greatest (RPM above 2400 and MAP 22" or below).*
- Operators need to be mindful of the engine manufacturer's temperature recommendations and red-lines. It should also be understood that improving efficiency (extracting more energy from a given amount of fuel) means a certain amount of additional heat will be generated. Tuning MAX changes the range of firing positions and this will affect CHTs, most notably in cruise. *As a relatively new feature, published engine manufacturer guidelines for tuning MAX (specifically) may be ambiguous or non-existent.*
- As a **GENERAL FRAMEWORK,** MAX adjustments can be guided by CHTs at cruise power settings – keeping in mind the limitations of CHT reporting. Ignition advance is a significant, but not the only factor influencing CHTs. Baffling, mixture, prop, cylinder beak-in, air temperature, air density, humidity, fuel type, induction boost, and more can affect CHT. Every installation should be considered unique – assume nothing.

Establish a base-line

An initial period of operation in Safe Mode (SafT Switch to "SAFE") will establish an operating baseline with plug firing at the manufacturers recommended position. Temperature issues encountered in Safe

Mode, if any, suggests a need for correction outside the ignition area – baffling, fuel, etc. These should be addressed before enabling Normal Mode.

Tuning Actions (affecting Normal Mode only)
1) Extending the firing range (set MAX further away from TC) will incrementally increase cruise CHTs.
2) Reducing the firing range (set MAX closer to TC) will incrementally decrease cruise CHTs.

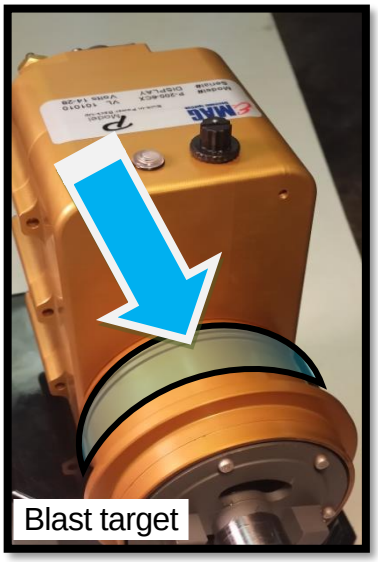
Begin Normal Mode operations (SafT Switch to "NORM") with a conservative, factory default or less, MAX setting. You can then **test with gradual 2-degree MAX extensions**. STOP extending MAX at the **lowest** setting where:
1) Cruise CHTs stabilize at your target temperature:
   a) Above the level experienced in Safe Mode cruise.
   b) Below the manufacturer recommended temps for take-off and climb (maximum power).
2) You start to see (cruise) efficiency gains flatten.

SafT Switch
When you enable Normal Mode (SafT Switch to "NORM") to test MAX settings, you always have the option of returning the SafT Switch to "SAFE" and restore your Safe Mode operating baseline. This is a new and significant safety tool. We encourage operators to become familiar and comfortable with its use. The SafT Switch can be operated at any time, except during start-up where SafT Switch must be set to Normal Mode ("NORM").

Note: Alternative (auto) Fuels: CAUTION - Notwithstanding engine manufacturer approval of some engines to burn auto/alternative fuels, such approvals almost certainly presume operation with fixed magneto firing - not variable firing electronic ignition. Operators need to independently validate proper engine behavior with different fuels and different ignition settings. In general, auto fuel burns faster than avgas and is, in effect, a timing change. An offsetting adjustment (lower advance) will be needed for Normal Mode operation, and perhaps Safe Mode as well, if experimenting with auto fuels.

Prior to First Start:

Check Blast Tube Cooling
E-MAGs are designed for a high-heat environment, but there are still thermal limitations and benefits to keeping the equipment as cool as possible. Blast tube cooling is a simple way to reduce operating temperatures, and we consider them mandatory (not applicable to forward facing installations on the cold side of the deck). Blast tubes should be directed at the round neck, immediately behind the mounting flange. The mere presence of blast-tubes does not guarantee they are operable and/or effective. After initial operations, operators can verify the ignitions are within temperature guidelines (under 200F during flight). Thermal reactive labels (included) or a thermal probe can verify ignition case temperatures at the forward section of the electronics (box shaped) compartment.


Blast target

Electrical System Condition
E-MAG's power dip protection helps guard against severe voltage drops that occur when the starter motor is 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 ignition to work properly. If bus voltage stays below safe levels, a built-in power dip safety circuit will not allow the ignition to fire (per design). The starter is the largest load on the electrical bus. In emergency situations, hand (prop) starting will avoid the starter motor induced voltage drop.

Operating Notes:

SafT Switch
The SafT Switch does NOT replace or interfere with your existing ignition ON/OFF test (kill) switch. It's a simple in-flight control that switches between Safe Mode (ON) and Normal Mode (ON). As an ON/ON switch, it's a fast/simple/low-stress alternative to the traditional (ON/OFF) ignition test routine. Remember, when starting SafT Switch must be set to NORM.

Engine Management
The high energy spark and variable firing of an electronic ignition will change engine behavior in significant ways.

Starting
1) Turn ON bus power to the ignition (presumably your main power switch).
2) Verify **SafT Switch is set to NORM**. The ignition will not fire plugs when cranking in SAFE mode.
3) Turn ON the ignition Kill Switch (un-ground kill wire).
4) Start the engine.
   a) Priming is not recommended (and should not be needed).
   b) Start with minimal (barely cracked) throttle and mixture settings. Increase these positions as little as necessary to find a starting position that works for your engine.

During start-up the ignition uses a multi-strike (5) rapid fire sequence, and boosts spark energy by roughly 70% (subject to available aircraft power).

Note: Wasted Side Firing - As with any wasted spark system Series 200 fires plugs in pairs. On any given cycle, one cylinder (within the pair) is in the "firing" position. At that moment, the companion cylinder is between the intake and exhaust strokes (with both valves open). If fuel vapor is present in the companion cylinder (due to priming, excess throttle/mixture, or any other reason) the wasted side gas can ignite. This is called a "wasted side firing". It's sometimes mistaken as a backfire or a kick-back, which is different. Wasted side firing is easily remedied by adjusting your starting procedure to eliminate excess fuel. We recommend starting with minimal throttle and mixture settings, no priming, fuel boost pump (if present) only long enough to see pressure rise. For hot-starts, forego boost pump altogether. Modify these settings as needed, but as little as possible to achieve quick and consistent starts.

Ignition Checks
Your ignition checklist will be extended to include two significant features in your E-MAG (internal alternator power and SafT Switch) that are not present in other systems. During your Left/Right ignition checks:

1) **Internal alternator ground-checks** - Each ignition has an internal alternator that operates in parallel with power from the aircraft bus. The ignition automatically transitions between aircraft power and internal power as needed. Aircraft power is needed for start and low RPM. Above idle, the ignition will automatically transition between internal and external power as needed.
   a) **Basic Alternator Check** (pre-flight ramp check) – typically 1700 rpm.
      i) Momentarily cut bus 12/24-volt power to the one running (left or right) ignition and verify the engine continues to operate smoothly – evidence the internal alternator is working.
      ii) Repeat with the other ignition.
   b) **Internal Alternator Cut-Out Speed Check** (new installs and annual inspections) marks the internal alternator low speed boundary. Alternator power output is tied to rpm. As a flight criterion you want to verify the ignition is capable of self-powering below your in-flight idle, typically in the range of 1100 rpm. Ground idle speeds will be much lower, making this test feasible.
      i) Operating on one ignition, lower engine speed to 1100 rpm. Cut bus power to the ignition.
      ii) Very slowly lower the engine rpm until the engine quits (note cut-out speed). A log-book entry will be helpful in tracking trends over time.
      iii) Repeat cut-out check on the other ignition.

      Note 1: When performing Cut-Out test, allow the engine to come to a stop and let the ignition fully power down. Re-applying 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 ignition is designed to defend against.

2) ***SafT Switch (SAFE/NORM) check.*** *NORM will be your typical SafT Switch operating mode and is required during start-up. As a means of ground testing each mode, add the following to your pre-flight Left/Right run-up routine (1700 rpm):*
   a) Operating on one ignition, turn SafT Switch from NORM to SAFE for 2-3 seconds and then back to NORM. The engine should run smoothly in both positions. The plug firing position may change with SafT switch transitions, so a slight shift in rpm might be expected.
   b) Repeat SafT Switch check on the other side.

Emergency Prop Starting
A low battery that barely "bumps" the starter motor, or can only "click" the solenoid, will have enough energy to power the ignition for prop starting. However, if the battery is totally dead, the low speed of a prop-start will not be fast enough for the internal alternator to power the ignition. In such cases, a 9-volt flashlight battery can provide temporary current (only needed on one ignition) for prop starting. For **details see web site Tips and Tricks download. Caution: Do not attempt a prop start unless you are trained and are comfortable with the procedure.**

Maintenance:

Condition Inspection (annual)
1) Confirm Setup Reference positions prior to removal. Note discrepancies (if any) from prior settings.

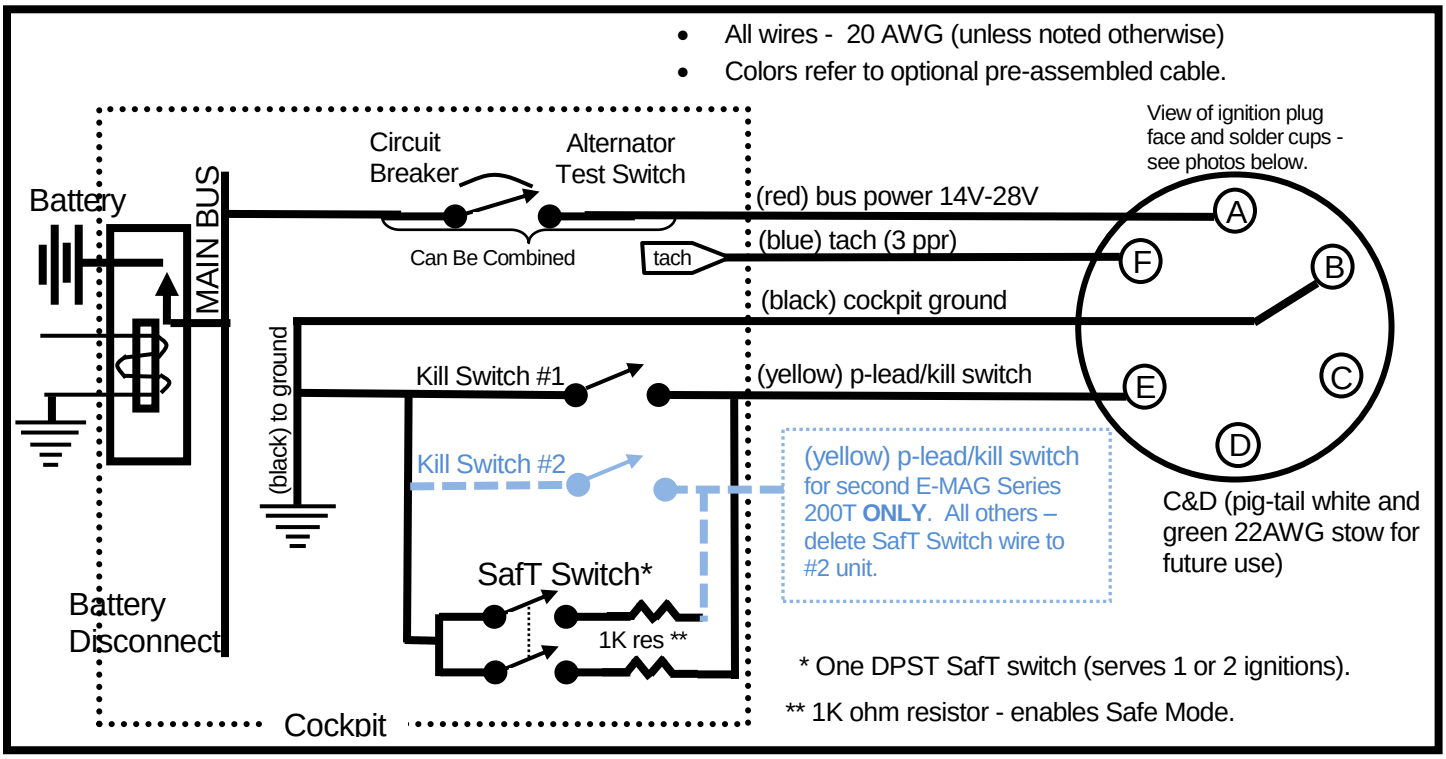
2) Check E-MAG web site for the most recent Manual (www.emagair.com/downloads), Service Notes (www.emagair.com/service-notes), and verify equipment is current with all updates.
3) Ignitions come with a thermal sticker that will trip (turn from a light egg shell white color to gray or gray/black) as case temperatures exceed 200 degrees (F). If tripped, review blast cooling and/or other cooling impediments. Operating temperatures should be kept below 200 degrees.
4) Resistance Check all plug wires and examine for evidence of wear or chafing.
5) Remove and inspect spark plugs for signs of unusual wear or build-up. Replace plugs at 125 hrs. Re-gap plugs per instructions. When re-installing auto style plugs with auto plug adapters, review plug/adapter installation guidelines.
6) Remove ignition and examine shaft for bearing play. Inspect drive cushions, which can get hard over time. Note: Ignition disassembly is not necessary (and if done may void your warranty). Look for excessive lateral play. Shaft rotation should be free, with no catching, flat spots, or grinding.
7) Reinstall the ignition. Check Setup Reference positions.
8) Verify proper operation including:
    a) Perform Ignition Checks on each ignition:
        i) Basic Alternator Check
        ii) Internal Alternator Minimum Cut-out Speed Check
        iii) SafT Switch Check

Troubleshooting:

E-MAG maintains a Troubleshooting Guide on our web site – see Downloads page.

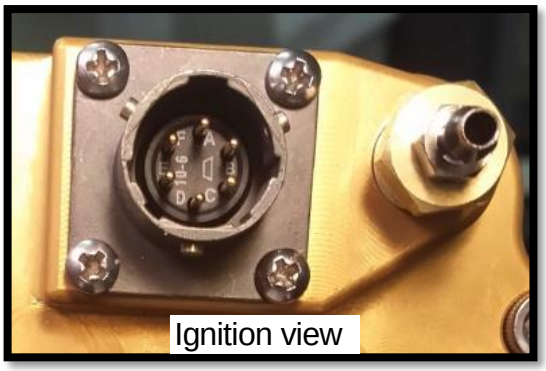
Installer Notes:

Wiring Diagram



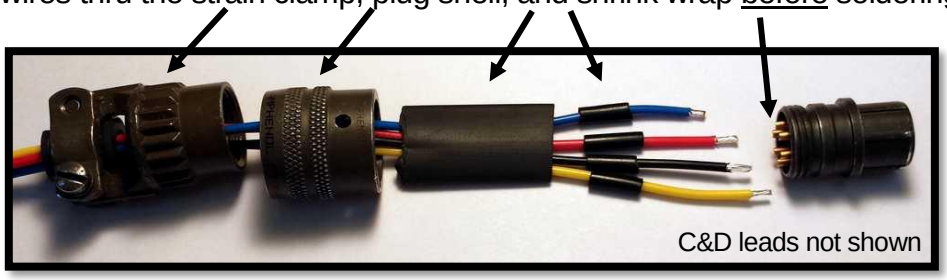

Control plug cable end


Optional potted pig-tail plug


Ignition view


Solder cup view

[left] Solder cup pins on back of standard control plug. Pin orientation matches the schematic above, and is marked on the inner face of the plug itself. When assembling the Std. connector, remember to pre-position wires thru the strain clamp, plug shell, and shrink wrap <u>before</u> soldering.


C&D leads not shown

Appendix – Spark Plugs and Adapters

Short Reach Plugs (uses SR plug adapter)

1) NGK Spark Plug BR8ES 2.5mm center electrode. Stock #3961 has a solid terminal tip. Stock #5422 has a screw on tip – if this type is used make sure the tip is well secured.
2) NGK Spark Plug BR8EIX iridium electrode with solid tip.

Long Reach Plugs (uses LR or LRX adapters)

1) Denso Spark Plug IKH01-27 (stock #5750) has an iridium electrode with a solid terminal tip. IKH27 (stock #5347) has an iridium electrode with a threaded tip – if this type is used make sure the tip is well secured.
   [Continental] The LRX adapter has an extended hex head for some Continental (550) engines that have a tight recess around the plug hole. The LRX extension provides socket access should you need to remove the adapter (**not** for tightening the adapter directly) – see below.

IMPORTANT: Remember to **FIRST** install spark plug in the adapter (fully seated and finger tight). **THEN,** insert the combined plug/adapter assembly in the engine and tighten to **18 ft/lb** (standard auto plug torque) through the spark plug ONLY. **Do NOT torque the adapter itself.** If you torque the adapters directly, stress will be focused underneath the adapter head and it can fail during installation. Such failures are not covered under warranty. Use anti-seize (sparingly) on the outer/engine side of adapters.

Operators need to monitor spark plug condition and adjust the plug temperature range as needed. The temperature rating is indicated by the NGK "8" or the Denso "27" reference in the part number. If selecting a different range, remember that lower numbers indicate hotter ratings, and higher numbers indicate cooler ratings.