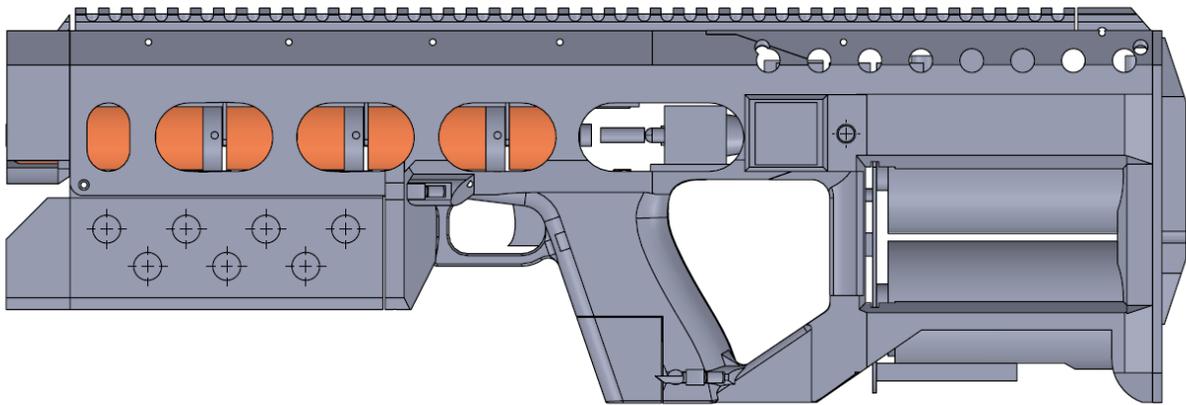


EMG-01 Alpha 8 Stage IGBT Coilgun

User Manual



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1. Introduction

The Arcflash Labs EMG-01A (Electro-Magnetic Gun – 01 Alpha) is an 8 stage, IGBT switched, low voltage capacitor augmented fully automatic coilgun.

It features 8 IGBT stages, each with an independent infrared optical gate. The fire control and sequencing of the coils is aided by microcontroller which provides nanosecond-precise timing signals to the IGBT gates and allows for firing up to 4 rounds per second at >45m/s.

The EMG-01A is configured to ONLY fire 0.25x0.75” steel projectiles (dowel pins). Arcflash Labs recommends the use of 2575 Magnetic Armatures (sold separately) but any 0.25x0.75” steel dowel pin should work.

The EMG-01A is shipped standard with a 6 round coil spring magazine which can hold up to 9 rounds single stacked, and fire up to 6 rounds on full-auto. The gun is also shipped standard with a 1500mAh 6S Lithium Polymer battery (charger sold separately) which can provide power for over 100 shots before needing to recharge.

As an alpha tester of the EMG-01, you are privileged to join an exclusive community of electromagnetic gun developers and enthusiasts around the globe. Until now, only a handful of individuals have ever seen an electromagnetic gun, let alone fired one. Congratulations on being selected to own a piece of history.

1.1 Terminology and Safety

The list below and throughout this manual is a summary of the major hazards associated with the device, but is NOT ALL INCLUSIVE. There are many other hazards associated with the device which are not laid out in this manual. We recommend wearing high voltage, flame retardant gloves at all times when using the device as well as goggles and thick clothing. Never use the device indoors or around flammable materials and always have a fire extinguisher on standby.

The EMG-01A is NOT WATER RESISTANT AND NOT IMPACT SAFE. Exposure to water or dropping from distances greater than 1 foot may cause irreversible damage to the gun, fire, explosion, electrical shock or venting of toxic gas from the battery or capacitors. If the EMG-01A is dropped or exposed to water: discontinue use immediately and return the gun to its manufacturer for repairs.

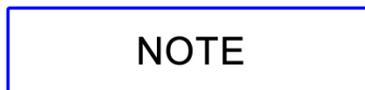
The following terminology is used throughout this manual for the purpose of denoting important and safety critical information:



An operation, procedure, or practice which if not correctly followed could result in personal injury or loss of life.

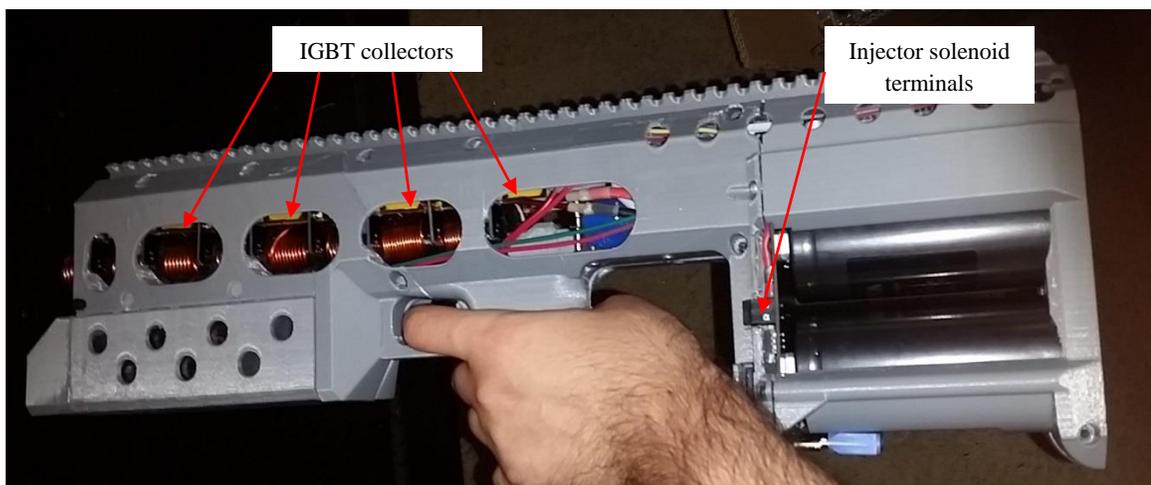
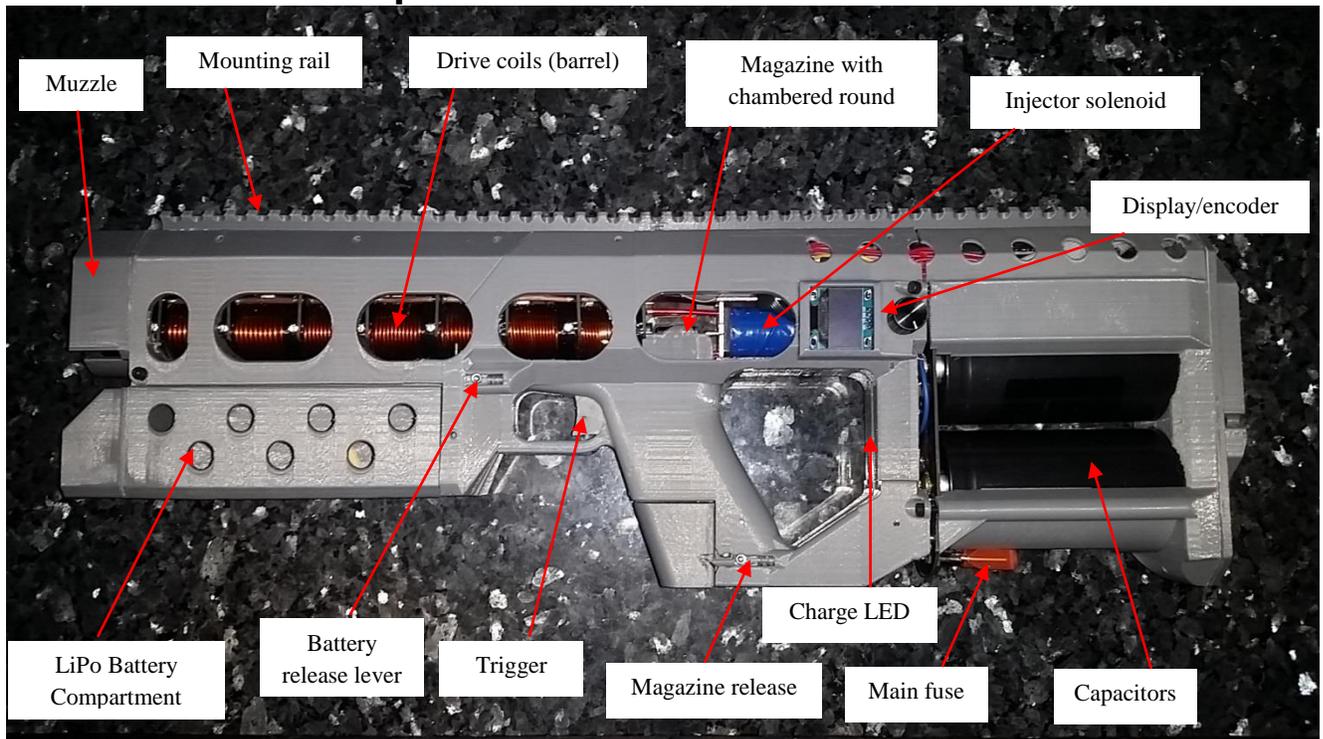


An operation, procedure, or practice which if not strictly observed, could result in damage to the device and/or voiding of the device's warranty.



A recommended procedure, suggested practice, or point of additional information which may facilitate the ease of use for the operator, or point out a feature of particular importance which is useful to know, but not safety-critical.

2. Overview of components



2.1 Barrel



- Severe shock hazard: never touch the IGBT collectors or internal wiring of the gun, especially when it is powered on.
- Muzzle energy is sufficient to break bones, cause serious injury or even death. It goes without saying: never point the gun at anyone or anything you do not intend to destroy.
- Never fire projectiles longer than 0.75" – firing projectiles other than Arcflash 2575 Magnetic Armatures or 0.25x0.75" steel dowel pins could result in fire or explosion.



- Never cover the end of the barrel or point the gun at any object closer than 1" from the end of the barrel. Covering the end of the barrel could result in a jam which may result in a serious fire or explosion of the IGBTs and/or driver coils.

The EMG-01A is a fully automatic electromagnetic gun – its core component is a sequence of optically gated, IGBT switched driver solenoids. As a projectile passes through the barrel, it triggers optical gates which send signals back to the microcontroller. The microcontroller quickly interprets these signals and directs the coils to turn on in a precise sequence. This accelerates the projectile down the barrel and out of the gun with an exit velocity of roughly 45m/s.

While its muzzle energy is comparable to most bb-guns (around 5 joules or 3.7 ft/lbs), it should be treated the same way as a firearm: with the utmost respect. While the muzzle energy is roughly the same as a bb-gun, the projectile mass is far higher. Hazards from accidental discharge include broken bones and severe injuries – in short, never point the device at anything you don't want to destroy. Treat it as loaded at all times.

The device operates on low voltage (25V), but carries extremely high amperage (300A+) during a shot, which is immediately converted to high voltage (300V+) in the driver coils and is discharged through freewheel diodes at the top of the driver coil stages. Never touch any metal parts of the gun during a shot, especially those near the barrel. 300V is more than enough to cause serious electrical shock, personal injury or death. The high voltage components (IGBT collector pads) are covered in amber high voltage Kapton tape for your protection and for the protection of the microcontroller from high voltage spikes. **NEVER REMOVE THIS ORANGE TAPE FROM THE IGBT COLLECTOR PADS.** If it falls off for any reason, discontinue use of the device and send the device back to Arcflash Labs, LLC for repairs if the tape falls off for any reason. It is a simple repair. Firing the device with no tape on the pads will almost certainly lead to severe shock and/or irreversible damage to the gun.

2.2 Injector



- Never stick any object or any part of your body in between the injector and the breech.

Projectiles are pushed out of the magazine by a small captive solenoid, known as the injector. This solenoid is a very low power device. For comparison: the injector operates on roughly 1 ampere while a single driver coils draws roughly 300 amps. This injector has a spring loaded mechanism which allows it to return to its home position. It is this spring return mechanism which sets the maximum rate of fire of the gun. 8 rounds per second is the maximum safe rate of fire of the injector, and hence the maximum rate of fire of the EMG-01A.

2.3 Display/encoder

The display shows the velocity of the prior shot and also allows for the user to select various firing modes as well as the number of active driver stages. The display also allows the user to set the gun on safe and displays a warning when the gun is set to safe.

2.4 Main fuse



- *The Main Fuse may be used as a power switch. It is always recommended to remove the fuse before powering down the gun in preparation for storage.*
- *Small sparks may be observed when you first connect the main fuse after a long period of inactivity. This is normal.*
- *Always insert the main fuse in one fluid motion. If the fuse breaks electrical contact during startup, remove it, wait for the capacitors to fully discharge, and try again. Multiple fuse connections during startup may result in problems with the encoder or secondary microcontroller.*

The main fuse of the EMG-01A is a 40A automotive fuse which acts as a protection against certain types of over-current and also serves as the primary power switch of the EMG-01A. It may be used as the means to power up the gun rather than removing the battery. It is recommended to leave the battery in place and remove the main fuse rather than removing the battery after each use.

2.5 Battery



- The EMG-01A contains a large 6S Lithium Polymer battery. Never leave a charged battery unattended and always store in a cool , dry environment.



- **Take care not to pinch the wires when closing the battery compartment.**
- **Always pull back the release lever before closing the battery compartment. “Slamming” the battery compartment closed without depressing the release lever will damage the retaining mechanism and will shorten the lifespan of the gun.**

The EMG-01A contains a Lithium Polymer battery. As with any device containing a large lithium battery, it presents a number of hazards including shock, fire, explosion or venting of toxic gas. Always store the gun and battery in a cool, dry environment indoors, away from any flammable materials.

2.6 Trigger



- Do not exert excessive pressure on the trigger. It is a fragile component.

The trigger of the EMG-01A is connected to a small microswitch internally and is actuated by a small spring. The trigger only has roughly 0.25" of travel length and the spring return is very fragile. If excessive pressure is exerted on the trigger, the spring return could detach. If this occurs, discontinue use of the gun and immediately return to the manufacturer for repairs. If further pressure is exerted on the trigger, damage to the microswitch could result.

2.7 Magazine



- Always pull back the release lever before inserting a magazine. "Slamming" a magazine into the gun without depressing the release lever will damage the retaining mechanism and will shorten the lifespan of the gun.

The EMG-01A uses a proprietary magazine design which was designed to accommodate a 9-round 3D-printed conformal magazine (the MG9-CS). The magazine uses a steel coil spring to store up to 9 0.25x0.75" projectiles. However, the injector solenoid on the EMG-01A is only capable of firing 6 out of the 9 rounds fully auto. This is due to the high spring pressure in the magazine and the limitations of captive solenoid injectors.

An upgraded 20-round magazine and an upgraded high force injector are currently in development and at least one of the two components should be available by the time the EMG-01B is released.

2.8 Capacitors



- The EMG-01A contains two large 180mF capacitors capable of storing up to 100J of combined energy.

The EMG-01A contains two very large electrolytic capacitors (360,000 uF total capacitance) – at the time of construction these are the highest density electrolytic capacitors in production. They are capable of delivering up to 300A burst current at 25V and storing over 100J of energy.

The capacitors remain charged for approximately **ONE MINUTE** after disconnecting all power from the gun. During this time, the gun will still be fully functional and pressing the trigger will still fire a round. To power down the gun we recommend the following procedure: 1) set the microcontroller to "SAFE", 2) remove the Main Fuse from its socket – this immediately removes the battery from the circuit, 3) remove the magazine from the gun, verify that there is no round still remaining in the barrel, and 4) wait for ALL LEDs (especially the blue LED near the handle) to extinguish before removing the battery.

The blue LED near the handle indicates the state of charge on the capacitors. If the blue LED is active, the capacitors are charged.

3. Operation

3.1 Startup



- It is unsafe to power up the gun with a magazine inserted.
- Always check that there is nothing inside the barrel before powering up. Any rounds or debris inside the barrel during startup could result in a misfire or explosion of the IGBTs.

1. Ensure battery is charged to its nominal voltage of 25.2V
2. Open battery compartment and connect battery XT-60 connectors



3. Stuff connector and wires into the battery compartment gently, ensure wires clear pinch points and close the compartment, depressing the battery released lever before fully closing the compartment.

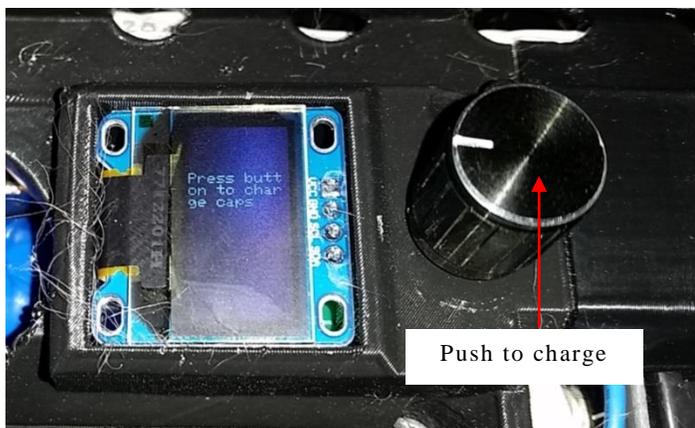




4. Insert fuse at an angle as shown below. Connect one terminal, then rotate to connect the other terminal. Once both terminals are connected, do not remove the fuse – press in firmly until the fuse is fully seated in its terminals. If you accidentally disconnect the fuse during insertion, let the system fully power down before re-inserting.



5. Once the fuse is inserted, the primary computer should begin to boot up. Wait for the message that says “press button to charge caps”. When you are prepared to use the gun, press down on the rotary dial to energize the system. For safety: make sure there is no magazine inserted.



6. The blue LED near the handle should illuminate, indicating that the capacitors are charged and the system is energized.



7. The computer should enter its normal operating mode, showing a display that looks similar to the picture below. When the EMG-01A boots up, it will always boot in safe mode. Pressing the trigger will not fire the gun when the safety is on, but the coils are still energized and if a round is manually pushed into the barrel it may still fire.



8. To turn the safety off, simply use the rotary encoder dial to select a different firing mode ("SINGLE", "BURST", or "AUTO").
9. Pressing the trigger will now fire the gun in the operating mode you have selected.
 - a. SINGLE: Fires only one round per trigger-press.

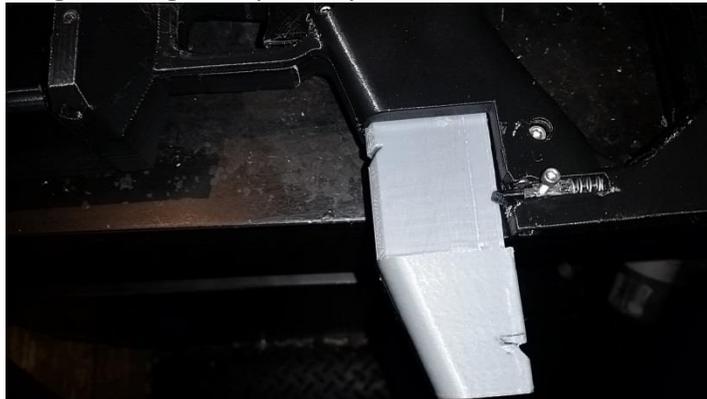
- b. BURST: Fires up to three rounds per trigger-press. If the user releases the trigger before the end of the three round burst, the rest of the burst will not fire.
- c. AUTO: Fully automatic operation. Fires rounds continuously until the trigger is released.

3.2 Inserting a magazine

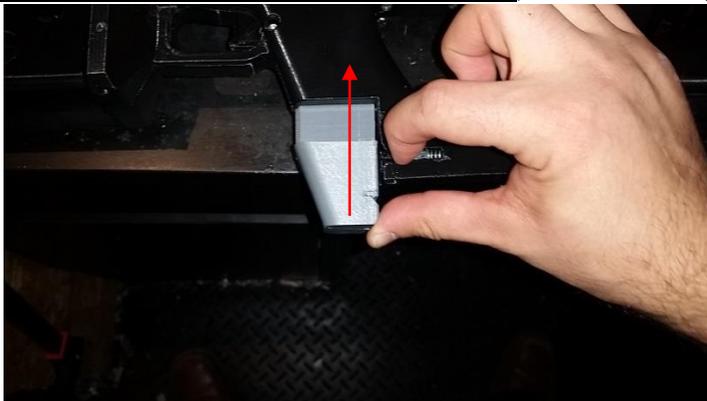


- Always pull back the release lever before inserting a magazine. “Slamming” a magazine into the gun without depressing the release lever will damage the retaining mechanism and will shorten the lifespan of the gun.

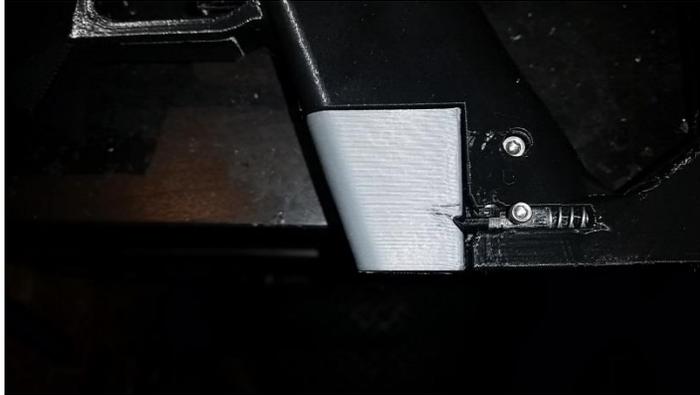
1. Always ensure the gun is powered up and pointed in a safe direction before inserting a magazine. There is no slide or chamber on the EMG-01A. The active round in the magazine itself acts as the chambered round. Once the magazine is inserted and the charge LED is illuminated, the gun is live.
2. Begin by inserting the magazine partially into the slide as shown below.



3. **WHILE DEPRESSING THE MAGAZINE RELEASE LEVER**, insert the magazine fully into the gun.



4. Ensure the magazine is well seated and the latch is fully engaged with the notch on the magazine.



3.3 Changing power level

1. One of the most interesting properties of electromagnetic guns is the ability to change the muzzle velocity on the fly. The EMG-01A integrates this feature on the main menu. Simply select the option: "P:*****" and press down on the button to select the power level. By default, the gun is set on maximum power at startup.



2. Use the encoder dial to select the desired power level: 1-8.



3. Press the encoder button a second time to lock in the desired power level.

3.4 Shutdown

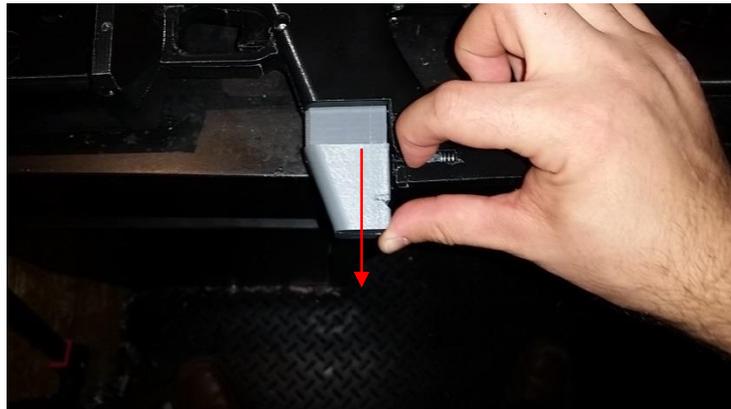
1. Select "SAFE" on the display using the encoder dial and press down on the button.



2. Remove the Main Fuse from its socket – this immediately removes the battery from the circuit.



3. Remove the magazine from the gun and verify that there is no round still remaining in the barrel.



4. Wait for ALL LEDs (especially the blue LED near the handle) to extinguish before storing the unit



4. Software

The software in this device is not intended to be user-serviceable. In fact, tampering with the EMG-01A software is expressly discouraged and will immediately void any express or implied warranties. Any attempt to modify the software may render the gun unusable or unsafe. Arcflash Labs, LLC assumes absolutely no responsibility for units which have had their software modified by the end user.

5. Hardware Specifications

Accelerator Specifications

Primary power source	1x 6S LiPo – 25.2V, 1500mAh
Power supply	1.5kW (battery direct drive)
Capacitors	2x 180mF/25V electrolytic
Switches	8x IGBT/opto triggered
Projectile	0.25x0.75" carbon steel, 4.6g
Capacity	9 rounds (standard) 20+ (extended)
Rate of fire	8.0 rounds/sec
Muzzle velocity	45 m/s
Muzzle energy	4.65J
Efficiency	6.5%

Physical Dimensions

Barrel length	10.0"
Bore	0.25"
Physical Dimensions	20.5" x 6.8" x 3.9"
Overall Weight (unloaded, no battery)	2.5 kg

