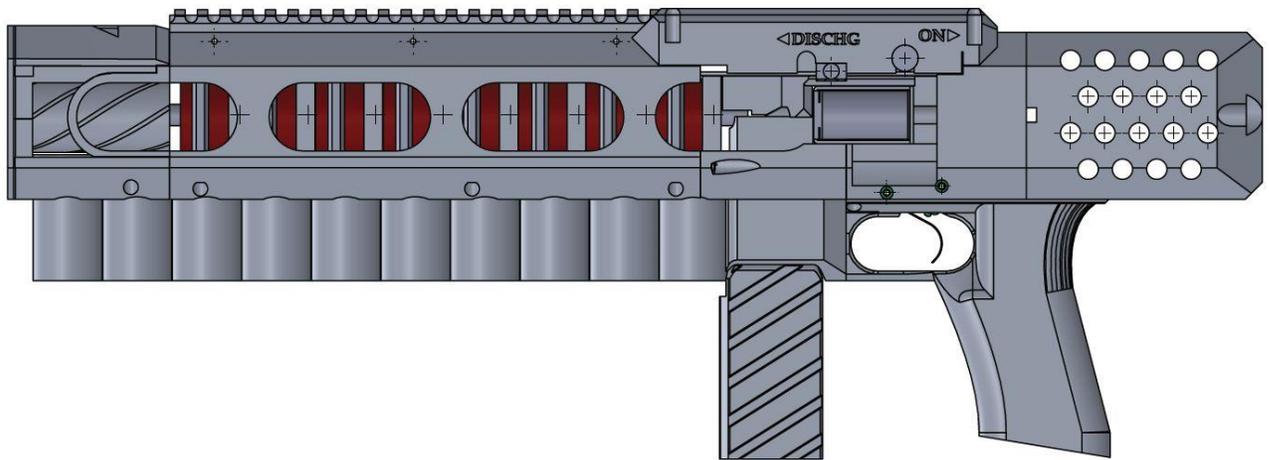


EMG-01 Beta 8 Stage IGBT Coilgun

User Manual



Arcflash Labs, LLC
8620 Belford Ave, Unit 603
Los Angeles CA 90045 - (424) 256-5087
www.arcflashlabs.com • admin@arcflashlabs.com

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Updated: 02/2021

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IT IS STRONGLY ADVISED TO READ THIS ENTIRE MANUAL

FAILURE TO ADHERE TO THESE PROCEDURES COULD RESULT IN IMMEDIATE AND CATASTROPHIC DAMAGE TO THE EMG-01B



- ALWAYS ENSURE THE POWER SWITCH IS SET TO THE DISCHARGE (FORWARD) POSITION BEFORE INSERTING THE FUSE OR BATTERY.
- NEVER INSERT THE FUSE OR BATTERY WITH THE SWITCH IN THE ON (REARWARD) POSITION.

1. Introduction

The Arcflash Labs EMG-01B (Electro-Magnetic Gun – 01 Beta) is an 8 stage low voltage capacitor augmented fully automatic coilgun.

It features 8 stages controlled by a nanosecond-precise microcontroller which allows for firing up to 8 rounds per second at >45m/s.

The EMG-01B 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-01B is shipped standard with the MG18 constant-pressure fed magazine which can hold up to 18 rounds single stacked and fire the entire magazine on full-auto mode. The EMG-01B is also backward compatible with the SG18 magazine of the SGP-35. The gun is also shipped standard with a 6S Lithium Polymer battery (charger sold separately) which can provide power for over 100 shots before needing to recharge.

As a beta 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-01B 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-01B is dropped or exposed to water: discontinue use immediately and return the gun to its manufacturer for repairs.

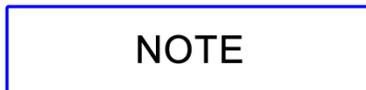
The following terminology is used throughout this manual for the purpose of denoting important and safety critical information:



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

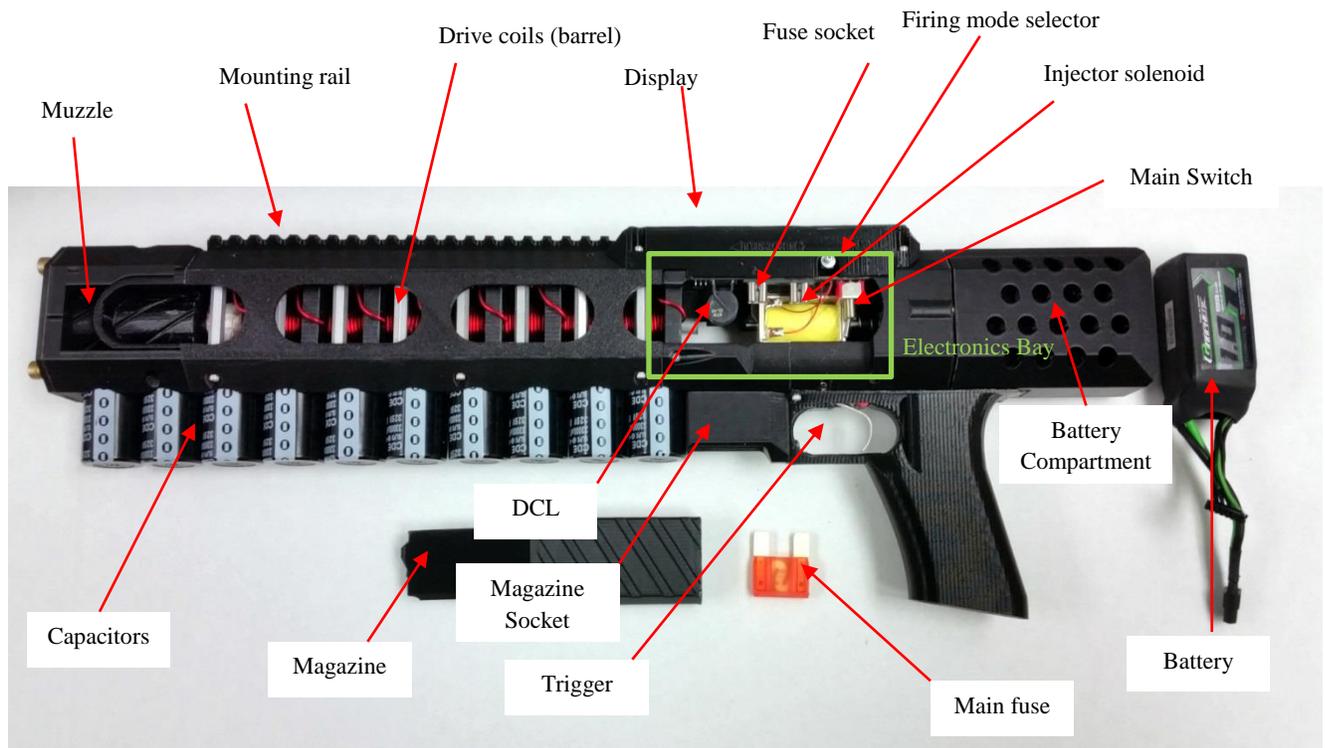


An operation, procedure, or practice which if not strictly observed, could result in damage to the device and/or voiding of the device's warranty.



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



- 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 Mangetic Armatures or 0.25x0.75" steel dowel pins could result in fire or explosion.

The EMG-01B 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. While most of the components experiencing transient high voltage spikes are protected from the user, it is advised that you should never touch any internal components 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.

2.2 Electronics Bay



- **Never stick any object or any part of your body into the Electronics Bay**
- **Do not touch the Discharge Current Limiter (DCL) after powering down the gun- it may become hot**
- **Do not stick any object or any part of your body in between the injector solenoid and the barrel**



- **Always take care to INSPECT THE ELECTRONICS BAY after removing the magazine. Loose rounds could cause a short which could damage the gun.**
- **Take care to protect the exposed components (DCL, firing mode switch and main switch) from excessive force. Never rest the gun in a position where these switches are stressed.**
- **Always store the gun in a safe place where the switches are protected. Damage to these components will result in permanent damage to the gun**

The “Electronics Bay” is a large cavity in the EMG-01B above the trigger and magazine socket housing a number of critical components. The most important of which components are: the injector solenoid, the Discharge Current Limiter (DCL), the fuse (and fuse socket), the main switch, and the firing mode selector.

It is important to keep this cavity clear of debris at all times and to protect all components in this area from water, dust and contamination. It is due to the fragility of the components in the Electronics Bay that this EMG-01 model is still considered a “Beta Testing” version as this area is still vulnerable to damage if care is not taken to protect it.

Projectiles are pushed out of the magazine by a pulsed solenoid, known as the injector. 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-01B.

The DCL is a large resistor which converts the stored energy in the capacitors to heat when the gun is powered off, and also converts the energy stored in the battery into capacitor charge when the gun is powered on. This allows the gun to be powered up and down quickly with a simple flick of the switch. The DCL may heat to over 100°C immediately after the gun is shut down or powered on, but quickly cools within the span of a few minutes.

2.3 Main fuse



- Inserting the fuse or battery with the power switch in the **CHARGE (rearward facing) position will cause high amperage flashover resulting in damage to the gun, shock and/or burns to the user.**



- **Always ensure the main switch is set to the DISCHARGE (FORWARD) position before removing the fuse.**



- *It is recommended to remove the battery rather than the fuse for long term storage of the EMG-01B, since it causes less stress on the main PCB mountings.*

- *Repeatedly removing and replacing the fuse is not recommended.*

The main fuse of the EMG-01B is a 40A automotive fuse which acts as a protection against certain types of over-current.

The EMG-01B uses a different startup procedure than the EMG-01A. It is of the utmost importance that the user never inserts the fuse or battery with the power switch set to the ON position. Doing so will place the entire switched load of the gun onto the fuse contacts which will superheat - resulting in damage to the fuse contact pads, the fuse itself, and possibly the user's fingers as well as the gun's switching electronics. It is for this reason that an additional warning to this effect is placed on page 1 of the manual. As with all electronic devices: make sure the power is switched off before inserting the fuse or battery.

2.4 Main switch



- **ALWAYS ENSURE THE POWER SWITCH IS SET TO THE DISCHARGE (FORWARD) POSITION BEFORE INSERTING THE FUSE OR BATTERY.**

- **NEVER INSERT THE FUSE OR BATTERY WITH THE SWITCH IN THE ON (REARWARD) POSITION.**

The main switch of the EMG-01B controls both the power electronics and the DCL. It has two modes: Discharge and ON.

When the switch is placed in the ON (REARWARD) position, the battery will be connected to the main electronics of the gun and the capacitors will be commanded to charge by the microcomputer. The microcontroller will immediately charge the capacitors through a second DCL configured as an inrush current limiter, until the capacitors are at full charge.

When the switch is placed in the DISCHARGE (FORWARD) position, the battery is disconnected from the main electronics and the capacitors are shorted across the DCL resistive load, discharging them quickly.

Actuating the main switch releases a large amount into the electronics bay through the dual DCL's. Shortly after turning the gun on or off, the user should take care to not touch the DCLs as they may become hot.

2.5 Display/Firing Mode Selector

The display shows the velocity of the prior shot, the battery percentage and also shows the current and available firing modes of the gun. There are four modes: SAFE, SINGLE, BURST, and AUTO.

To adjust the firing mode, simply press inward on the firing mode selector until the desired firing mode is selected.

In the SAFE mode, the gun will not fire and will display a warning should the user depress the trigger.

In the SINGLE mode, the gun will fire a single shot semi-automatically once per trigger pull.

In the BURST mode, the gun will fire three shots (at a rate of 8 rounds per second) in a burst while the user holds down the trigger. If the user releases the trigger mid-burst, subsequent shots will not fire.

In the AUTO mode, the gun will fire continuously as long as the user holds down the trigger.

2.6 Battery



- The EMG-01B contains a large 6S Lithium Polymer battery. Large lithium polymer batteries can catch fire or release gas if stored improperly. Always store in a cool , dry environment.



- Take care not to pinch the wires when closing the battery compartment.

The EMG-01B 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.

2.7 Magazine



- The EMG-01B uses a similar magazine retaining mechanism to the SGP-35. Inserting the magazine should be done in a fluid motion. There is no switch or button required to insert or remove the magazine, a ball detent retainer holds the magazine securely in place.
- If the magazine has trouble feeding rounds or the gun becomes jammed frequently, it is recommended to remove all armatures from the magazine, then depress the follower with a 1/8" steel rod or long screwdriver, then spray the cavity with WD-40 or light oil. Manually actuate the follower a few times to spread the oil throughout the magazine. Proper lubrication will improve armature feeding.

The EMG-01B uses a proprietary magazine design and retaining mechanism which was designed to accommodate an 18-round 3D-printed magazine (the MG18). The magazine uses a constant pressure spring to store up to 18 0.25x0.75" projectiles. The magazine socket on the EMG-01B is compatible with the SG18 magazines used in the SGP-34/35 accelerators.

Unfortunately it is not backward compatible with the MG-20 or MG-9-CS magazines used by the EMG-01A.

2.8 Capacitors



- **The EMG-01B contains 10 large 33mF capacitors capable of storing up to 100J of combined energy.**

The EMG-01B contains a large bank of electrolytic capacitors (330,000 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 require approximately 6 seconds to charge during power-up and 4 seconds to discharge during power-down. To power down the gun we recommend the following procedure: 1) set the microcontroller to "SAFE", 2) switch the Main Switch to the DISCHARGE (FORWARD) position, 3) remove the magazine from the gun, verify that there is no round still remaining in the barrel, and 4) wait for ALL LEDs to extinguish before removing the battery.

The breach illumination indicates the state of charge on the capacitors. If the breach end of the barrel is illuminated red, the capacitors are charged.

3. Operation

3.1 Startup

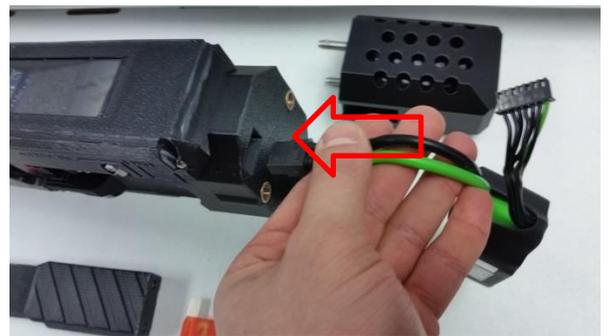


- ALWAYS ENSURE THE POWER SWITCH IS SET TO THE DISCHARGE (FORWARD) POSITION BEFORE INSERTING THE FUSE OR BATTERY.
- NEVER INSERT THE FUSE OR BATTERY WITH THE SWITCH IN THE ON (REARWARD) POSITION.
- It is unsafe to power up the gun with a magazine inserted

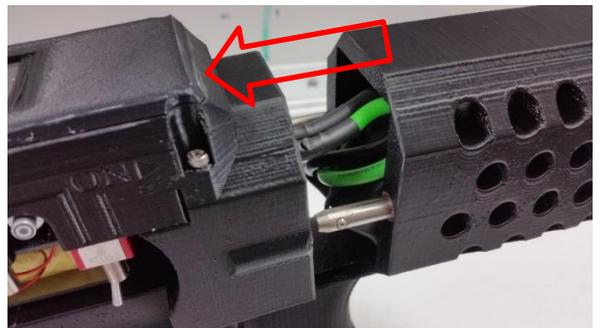


- Always check that there is nothing inside the electronics bay before powering up. Any rounds or debris inside the bay could result in damage to the gun.

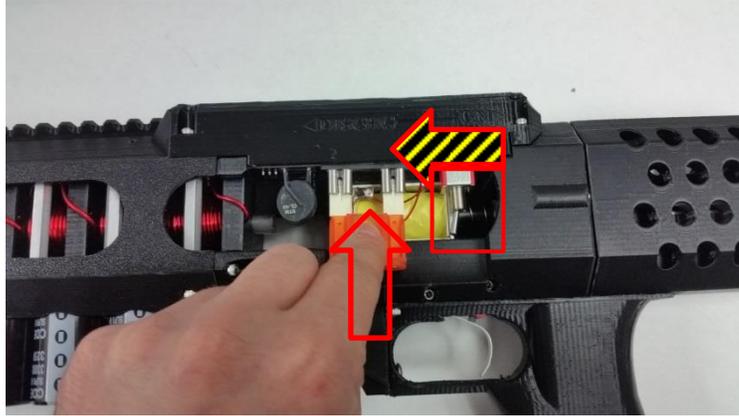
1. Ensure battery is charged to its nominal voltage of 25.2V
2. Open battery compartment by holding the handle and gently sliding the battery compartment rearward. Do not exert upward force.
3. Remove the compartment and connect battery XT-60 connector to the socket in the gun.



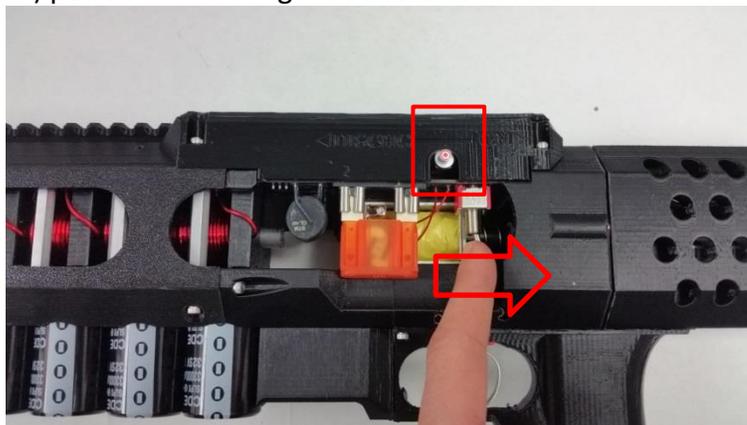
4. Stuff the battery, connector and excess wires into the battery compartment. Ensure wires clear pinch points and close the compartment by sliding the battery section forward onto the rail mount. Slide the battery enclosure forward on the bottom rail until the detent pins insert partially into their sockets. Gently press or carefully slap the compartment closed.
ENSURE THAT THE WIRES ARE NOT PINCHED BEFORE CLOSING THE COMPARTMENT



5. Gently insert the fuse into its socket. Before inserting the fuse, make sure that the main switch is in the forward (discharge) position. **Do not exert excessive pressure on the fuse socket as this may damage the main control board.**



6. Once the fuse has been inserted and the battery is installed, flip the Main Switch to its rearward (ON) position. The firing mode selector button should illuminate.



7. Once the fuse is inserted and the Main Switch is set to the (ON) position, the primary computer should begin to boot up and capacitors will begin to charge. Within a second, the breach should illuminate red, and the main menu should appear on screen.



8. Once the capacitors have charged, press the firing mode selector button to switch the gun to the desired firing mode.



3.2 Inserting a magazine

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-01B. The active round in the magazine itself acts as the chambered round.
2. Begin by inserting the magazine partially into the slide as shown below.



3. Insert the magazine fully into the gun.



3.3 Shutdown

1. Flip the Main Switch to the DISCHARGE (FORWARD) position.



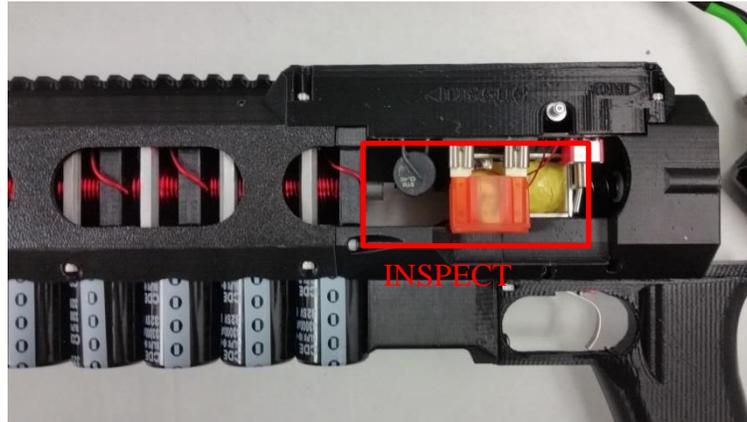
2. Remove the magazine from the gun.



3. Place the gun on a safe, stable surface and point the gun in a safe direction, then hold the handle with one hand and remove the battery enclosure with the other. Do not lift up on the battery enclosure, slide straight out.



4. Inspect the electronics bay to verify that there is no round still remaining in the barrel or electronics bay.



4. Software

The software in this device is not intended to be user-serviceable. In fact, tampering with the EMG-01B 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.

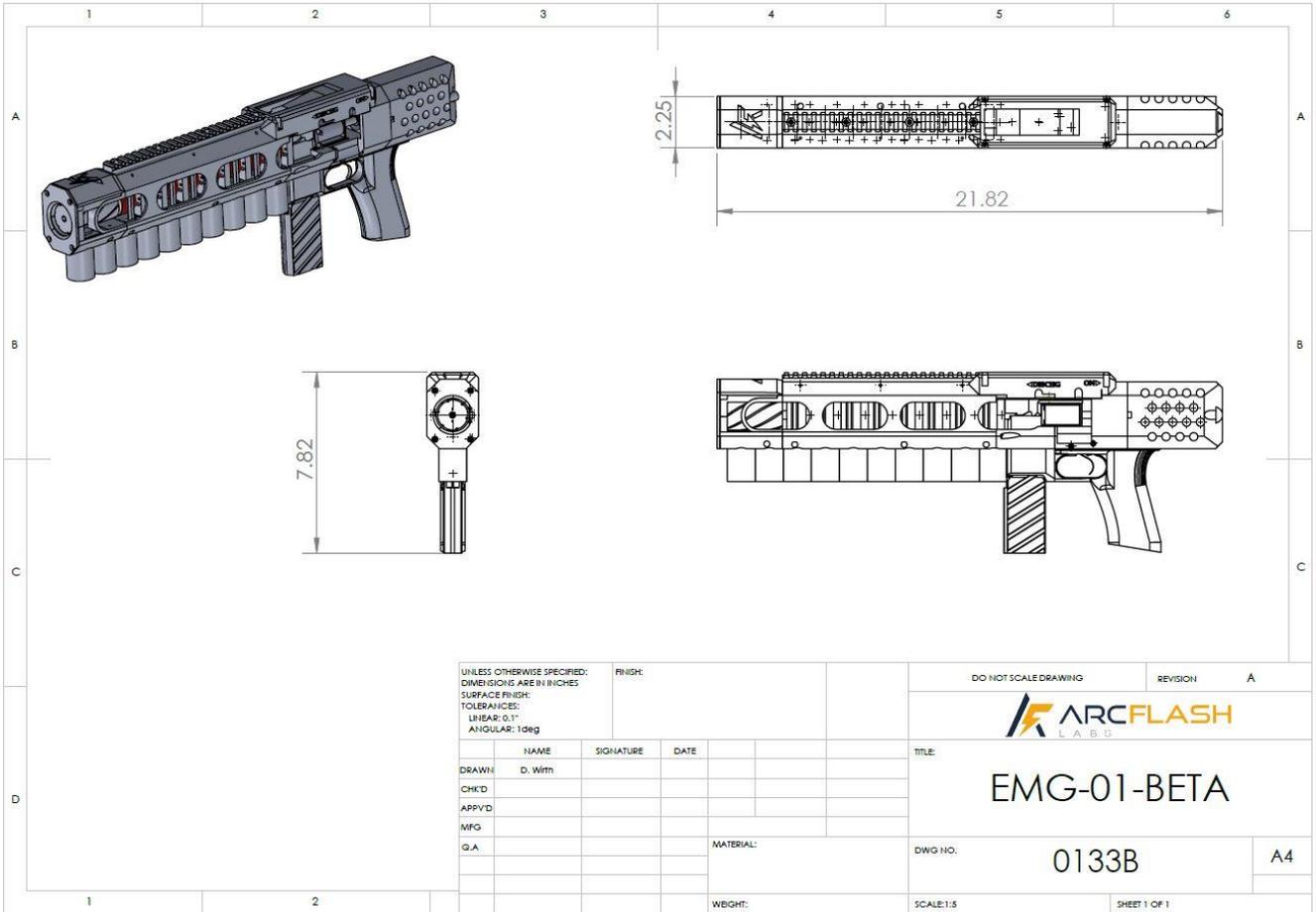
5. Hardware Specifications

Accelerator Specifications

Primary power source	1x 6S LiPo – 25.2V
Power supply	Proprietary (2,000W)
Capacitors	10x 33mF LV electrolytic
Switches	8x IGBT
Projectile	0.25x0.75" carbon steel, 4.6g
Capacity	18 rounds (standard)
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	22.0" x 8.0" x 2.25"
Overall Weight (unloaded, no battery)	4.8 lbs



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