Coil Gun Electrical Product Design Requirements (PRD)

# High Level Overview

The goal is to create a modular multi-stage coil gun that accelerates a projectile through discharging high voltage capacitors through coils. The product must be battery powered and be controlled through a central MCU. The product should have a display indicating battery voltage level, capacitor voltage level, and status indicators. The user should have control over the charging and discharging of capacitors, as well as inputs over safety/deadmans switch active and projectile firing.

## High Level Parts Requirements

Firing Mechanism: High voltage capacitors, coils, electrical switch

Control: Microcontroller, Deadman’s switch, firing trigger, LCD screen, Battery Charge Indicator, Capacitor charge indicator, Not-safe LED, Speed sensor, Number of stages sensor

Power: Battery, buck voltage regulator, capacitor charging boost converter, Power-ON LED

Safety: ESD and EMI protection, EMC. RFID verification before access.

# Low Level Parts Requirements

Battery: LiPo, should take a 3s (11.1V nominal) for a range between 9V-12.6V. Set voltage range to 7-15V for flexibility. Will require a connector to board. Ideally high capacity.

RFID Tag + Reader: should be on the same frequency and power requirements, passive tags. COTS RFID module.

Buck Voltage Regulator: step down to MCU voltages, should take input of 7-15V and output 3.3V.

Boost converter: Step up 11V to 125V and further multiples. Output current irrelevant, charging time can take as long as required. Should have current limiting resistor in place as well. Should have a separate switch to enable.

Capacitors: High voltage rating, aiming for 400V+. High capacitance, aiming for 100uF < C < 1000uF

Microcontroller: Familiarity, ease of use. Requires debugger to flash firmware – STLink with SWD vs USB 2.0? Requires at least 2 ADC channels and an SPI, Timers for each stage.

USB: USB2.0, USBC connector

Deadman’s Switch: any basic switch, no specific requirements. Should not latch.

Electrical Firing switch: Required to be 400V compatible, ideally IGBT or high voltage FET/BJT. Fast response time.

Firing trigger: Any basic button, no specific requirements. Should not latch.

LCD Screen: minimize number of connection wires, use communication protocol. SPI preferred.

Coils: Easily modifiable, set length beforehand to plan wire routing.

Analog Components – Resistors, capacitors, op-amps, inductors, etc.

Connectors – Based on application, ideally all identical.

# Low Level Parts Selection

Battery:

Battery Connector:

Buck Converter:

Boost Converter:

Capacitors:

Capacitor Connector:

Coil Connector:

Microcontroller:

Deadman’s Switch:

Fire Switch:

Fire Trigger:

LCD Screen:

USB: