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VoltFist: Smart High-Voltage Defense Prosthesic

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***Abstract*—This research paper details the design and development of a compact Electromagnetic Pulse (EMP) generator capable of emitting high-intensity electromagnetic fields. The device is powered by a 3.7V lithium-ion battery and incorporates a step-up transformer that boosts the voltage to approximately 40kV, along with a capacitor to ensure a steady voltage supply. The primary aim of the study is to evaluate the generator's efficiency and performance under varying operational conditions. By effectively stepping up the input voltage, the system generates powerful electromagnetic pulses essential for various applications. Experimental results confirm the generator's capability to produce strong EMPs, highlighting its potential use in research, electronic testing, and defense-related scenarios. Overall, the study demonstrates the feasibility and practical value of the proposed EMP generator design.**

Keywords— Electromagnetic Pulse (EMP) generator, step-up transformer, lithium-ion battery, capacitor, efficiency, high voltage, electromagnetic fields.

I. INTRODUCTION

An electromagnetic pulse (EMP) refers to a rapid release of electromagnetic energy that can interfere with or damage electrical and electronic devices. It creates a surge of energy that spreads outward at the speed of light, potentially causing significant voltage spikes in nearby electronic circuits. These voltage surges can harm or disable sensitive components. The extent of the damage caused by an EMP depends on various factors, including the intensity of the pulse, the distance from the affected devices, and the level of shielding protecting the electronics.

This project aims to develop a compact, cost-effective EMP generator using widely accessible components. The design incorporates the following key elements:

- Power Supply: A lithium-ion battery with a 3.7V output, selected for its affordability and availability. It is recognized for its compact and high energy density, which serves as the power supply.
- Voltage Boosting: A step-up transformer that converts the low 3.7V from the battery to a much higher voltage of 40kV, necessary for producing powerful electromagnetic pulses.
- Energy Storage: A capacitor that stores the electrical energy before it is rapidly released.

The safety circuit consists of several key components working together to ensure reliable operation. A 5V relay acts as an electromechanical switch, enabling the control of high-power circuits with low-power signals. The MOSFET 2N7000 functions as a switch or amplifier to regulate current flow effectively. A 555 timer is used to generate precise time delays or oscillations, providing accurate triggering or timing within the circuit. The comparator plays a crucial role by comparing input voltages and delivering binary outputs for decision-making processes. Additionally, a potentiometer allows for adjustable resistance, enabling fine-tuning of voltage or current for optimal circuit performance.

This explores how EMPs are generated, focusing on how different electrical components work together to improve the strength and efficiency of the pulses. By building and testing the EMP generator, the aim is to better understand how it operates and identify its potential uses. The pulses produced can be used in controlled environments to test how electronic systems react to electromagnetic interference, helping to create more durable and reliable technologies.

The project aims to develop a compact and portable EMP generator designed to provide a non-lethal means of defence for women in vulnerable situations. By emitting electromagnetic pulses, the device temporarily disables electronic devices or attackers' equipment, ensuring personal safety without harm. The goal is to offer a reliable safety tool for women in high-risk areas, such as isolated or poorly lit spaces, where they may face heightened threats. The project also seeks to empower women with a technological solution that enhances their control over personal security, enabling them to defend themselves effectively in dangerous situations. Rigorous testing will be conducted to evaluate the generator's performance, safety, and reliability in real-world scenarios. Additionally, the focus is on promoting non-lethal defence solutions that can temporarily disable an aggressor's electronic tools, providing an alternative to physical confrontation.

II. LITREATURE SURVEY

[1] The paper titled "*Equivalent Circuit Modeling and Experimental Validation of a Double Exponential Pulse Generator for HEMP Conductive Immunity Testing"* proposes an equivalent circuit model for a double exponential pulse generator, used as a noise source in high-altitude electromagnetic pulse (HEMP) conductive disturbance immunity tests. A design methodology is presented, linking the circuit model to source pulse requirements under low-impedance conditions. The model and methodology are experimentally validated using printed circuit board test circuits.

[2] "*Design and Validation of an Equivalent Circuit Model for Double-Exponential Pulse Generators in HEMP Immunity Testing per IEC 61000-4-24"* This paper proposes an equivalent circuit model for a double-exponential pulse generator as a time-domain noise source for high-altitude electromagnetic pulse (HEMP) immunity testing. The relationship between the circuit model and source pulse requirements from test standards is analyzed, leading to a design methodology for extracting circuit components that meet source impedance and waveform criteria. The model is designed for various test modes and validated through simulation-based testing per IEC 61000-4-24, demonstrating its effectiveness.

[3] "*Design and Implementation of a Scaled-Down EMP Generator for Safe Experimental Analysis of Electromagnetic Effects on Electronics"* this paper details the design and implementation of a scaled-down electromagnetic pulse (EMP) generator for research purposes. It demonstrates EMP effects on electronics while ensuring safety with limited range and voltage. The project faced challenges, including component failures, but was completed successfully within reduced specifications. Testing showed partial alignment with theoretical predictions, highlighting the need for further research into EMP effects and protective measures for electronics.

[4] *Development of Advanced EMP Generators for Evaluating Semiconductor Material Resilience and Protective Elements in High-Intensity Electromagnetic Environments,* Recent advancements in energy storage devices focus on ensuring electromagnetic stability, enabling them to maintain performance under electromagnetic pulse (EMP) exposure. EMPs can induce overvoltage pulses in circuits, with parameters like amplitude and duration varying based on pulse origin and proximity. High-energy EMP generators are crucial for studying the effects of EMPs on semiconductor thin-film materials and developing protective elements for electronic equipment. A new set of EMP generators has been created to evaluate protection elements across a wide range of EMP intensities. These generators, combined with an advanced design, provide precise and powerful EMP exposure. The system includes visual indicators for operating modes and high-voltage generation, ensuring safety and ease of use. The control and power supply systems meet design standards and support research on EMP interactions with semiconductor materials.

[5] "*Design and Testing of a Scaled-Down EMP Generator for Safe Demonstration of Electromagnetic Effects"* this document discusses the design, construction, and testing of an Electromagnetic Pulse (EMP) generator, with a focus on demonstrating the EMP phenomenon at a scaled-down level. The project aimed to create a pulse capable of damaging nearby electronics by rapidly heating semiconductor materials, but it was limited to a safe range of two feet and a maximum voltage of 1000 volts to prevent damage to lab equipment or injuries. The document provides an overview of the theoretical and practical aspects of EMP generation. It references established principles of electromagnetic fields and circuit theory, drawing on foundational works such as Physics for Scientists and Engineers by Serway and Beichner, and the textbook Principles and Applications of Electromagnetic Fields by Plonsey and Collin.

III. OBJECTIVES

This project focuses on the development of a compact and portable Electromagnetic Pulse (EMP) generator designed as a non-lethal personal defence tool specifically for women. The device emits electromagnetic pulses capable of temporarily disrupting electronic devices or equipment that an aggressor may rely on, providing a secure and non-harmful method of self-protection. It is particularly suited for use in high-risk environments, such as poorly lit or isolated areas, empowering women to enhance their personal safety with confidence.

The initiative represents an innovative approach to personal security by leveraging technology to offer an effective alternative to physical self-defence. The development process will involve thorough testing to ensure the device's safety, reliability, and effectiveness under real-world conditions. By focusing on temporary electronic disruption rather than physical harm, the project prioritizes user safety while addressing the growing need for discreet and non-lethal defence solutions.

IV. METHODOLOGY

A. Components

Lithium-Ion Battery (3.7V)

Chosen for its affordability, compact size, and high energy density, the lithium-ion battery serves as the primary power source for the EMP generator.

Step-Up Transformer

This component boosts the battery's 3.7V output to approximately 40kV, a critical requirement for generating high-intensity electromagnetic pulses.

Capacitor

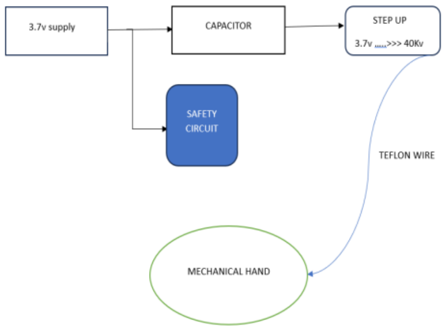
Used to store and release energy efficiently, supporting a consistent voltage supply during pulse generation.

Safety Circuit

Implemented to ensure user safety by providing electrical isolation from high-voltage pulses. The safety circuit includes the following elements:

- 5V Relay: An electromechanical switch that enables control of high-voltage circuits using low-power signals.
- MOSFET (2N7000): Functions as an electronic switch or amplifier, allowing efficient control of current flow.
- 555 Timer IC: Provides precise timing and pulse generation for controlled triggering of circuit events.
- Comparator: Evaluates voltage levels and outputs binary signals for logic-based decisions within the safety system.
- Potentiometer: Adjustable resistor used to fine-tune voltage or current levels in the circuit for optimal performance.

B. Block Diagram



C. Working

a) Power Source and Voltage Management: The device is powered by a 3.7V lithium-ion battery with NMC (Nickel Manganese Cobalt Oxide) chemistry, capable of delivering a maximum discharge current of 40A. To ensure a consistent voltage supply, the output from the battery is routed through a capacitor. This capacitor stabilizes the voltage before it is directed to a step-up transformer

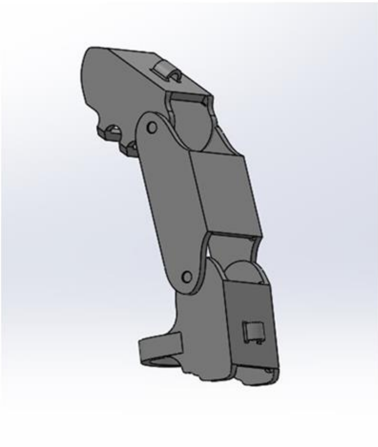
b) Voltage Transformation and Insulation: The transformer amplifies the stabilized 3.7V input to a high voltage of 40kV. Due to the high voltage involved, Teflon-insulated wires are utilized for transmission, as they offer superior insulation properties and significantly reduce the risk of insulation failure. Additionally, the wires are coated with heat-shrink tubing rated UL94V-0, a fire-retardant material capable of withstanding temperatures up to 125°C, further enhancing safety and durability.

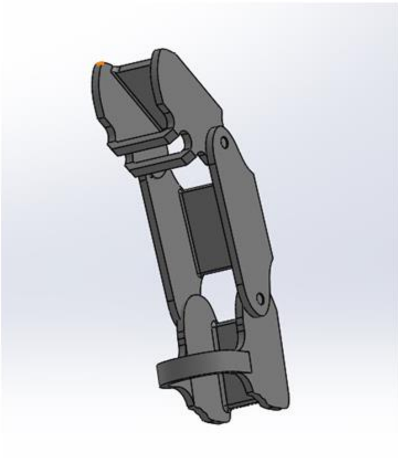
c) Mechanism of Electromagnetic Pulse Discharge: The high-voltage output is channeled to the fingers of a prosthetic mechanical hand. The prosthetic hand is 3D-printed using PLA (Polylactic Acid), which serves as an insulating material to ensure that no electrical contact occurs between the wearer and the device's positive terminal. When the fingers of the mechanical hand come into contact with an attacker's body, the circuit is completed, triggering the release of the electromagnetic pulse.

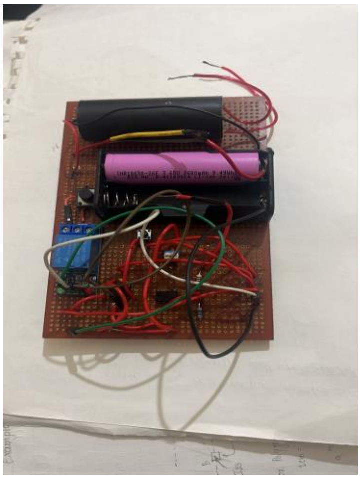
d) Safety Features: The circuit incorporates a voltage monitoring system to ensure safe operation. It continuously compares the voltage difference between the attacker’s body and the device's positive terminal. If a decrease in the voltage difference is detected, indicating potential safety risks, the circuit immediately disconnects to prevent unintended discharge or harm to the user.

This design prioritizes both functionality and safety, ensuring effective delivery of electromagnetic pulses while protecting the wearer from electrical exposure

V. RESULTS







PCB circuit connection

VI. CONCLUSION

The research and simulation of the electromagnetic pulse (EMP) generator have successfully demonstrated the feasibility and effectiveness of using a capacitor, a step-up transformer, a lithium-ion battery, and a safety circuit which provides isolation for the person who wears it.

The step-up transformer efficiently amplified the initial battery voltage from 3.7V to a high voltage of 400kV, enabling the generation of potent electromagnetic pulses. The resulting peak current of approximately 4,000 amperes and peak voltage of around 40,000 volts validate the capability of the designed EMP generator to produce the desired high-intensity pulses. Additionally, the rapid decrease in EMP field strength with distance underscores the localized nature of the generated EMP, which is beneficial for controlled applications.

This study highlights the importance of precise component selection and circuit design in achieving effective EMP generation. The results indicate that the EMP generator has potential applications in testing the resilience of electronic devices against EMP effects and developing defense mechanisms against EMP attacks

VII. FUTURE SCOPE

Future work can focus on refining circuit parameters and experimenting with alternative coil designs to improve the efficiency and effectiveness of the EMP generator. Emphasis should also be placed on developing practical applications while ensuring comprehensive safety measures for secure usage. This project lays a foundation for further advancements in EMP technology, offering opportunities for its integration into diverse fields and expanding its practical applications.

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