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Small Business Innovation Research(SBIR) Program - Proposal Cover Sheet

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SBIR Phase I Proposal

Proposal Number:	**F244-0007-0317**
Proposal Title:	**270VDC input power capability for Common Munitions Tester**

Agency Information

Agency Name:	**USAF**
Command:	**AFMC**
Topic Number:	**AF244-0007**

Firm Information

Firm Name:	**Syrnatec Inc.**
Address:	**549 Cedar Street, Newington, CT 06457-8736**
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UEI:	**WWGQNYQZ2C73**
DUNS:	**062691952**
CAGE:	**8FDJ7**
SBA SBC Identification Number:	**001656301**

Firm Certificate

OFFEROR CERTIFIES THAT:

1. It has no more than 500 employees, including the employees of its affiliates.	**YES**
2. Number of employees including all affiliates (average for preceding 12 months)	**03**
3. The business concern meets the ownership and control requirements set forth in 13 C.F.R. Section 121.702.	**YES**
4. Verify that your firm has registered in the SBAS Company Registry at www.sbir.gov by providing the SBC Control ID# and uploading the registration confirmation PDF:	**SBC_001656301**

Supporting Documentation:

- SBC_001656301_UPDATED.pdf

5. It has more than 50% owned by a single Venture Capital Owned Company (VCOC), hedge fund, or private equity firm	**NO**
6. It has more than 50% owned by multiple business concerns that are VOCs, hedge funds, or private equity firms?	**NO**
7. The birth certificates, naturalization papers, or passports show that any individuals it relies upon to meet the eligibility requirements are U.S. citizens or permanent resident aliens in the United States.	**YES**
8. Is 50% or more of your firm owned or managed by a corporate entity?	**NO**
9. Is your firm affiliated as set forth in 13 CFR Section 121.103?	**NO**
10. It has met the performance benchmarks as listed by the SBA on their website as eligible to participate	**YES**
11. Firms PI, CO, or owner, a faculty member or student of an institution of higher education	**NO**
12. The offeror qualifies as a: [ ] Socially and economically disadvantaged SBC [**X**] Women-owned SBC [ ] HUBZone-owned SBC [ ] Veteran-owned SBC [ ] Service Disabled Veteran-owned SBC [ ] None Listed	
13. Race of the offeror: [ ] American Indian or Alaska Native [ ] Native Hawaiian or Other Pacific Islander [**X**] Asian [ ] White [ ] Black or African American [ ] Do not wish to Provide	
14. Ethnicity of the offeror:	**NON-HISPANIC**
15. It is a corporation that has some unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have not been exhausted or have not lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability:	**FALSE**
16. Firm been convicted of a fraud-related crime involving SBIR and/or STTR funds or found civilly liable for a fraud-related violation involving federal funds:	**NO**
17. Firms Principal Investigator (PI) or Corporate Official (CO), or owner been convicted of a fraud-related crime involving SBIR and/or STTR funds or found civilly liable for a fraud-related violation involving federal funds:	**NO**

Signature:

Printed Name	**Signature**	**Title**	**Business Name**	**Date**
Nishita Mirchandani	Nishita Mirchandani	Corporate Official (CO)	Nishita Mirchandani	05/23/2020

Audit Information

Summary:

Has your Firm ever had a DCAA review?**NO**

VOL I - Proposal Summary

Summary:

Proposed Base Duration (in months):	**6**

Technical Abstract:

Syrnatec proposes the development and integration of a high-efficiency, Ga_2O_3-based DC-DC converter specifically designed for the Common Munitions Built-In Test/Reprogramming Equipment (CMBRE). Engineered to deliver a stable 270 VDC output with 96-99% efficiency, this converter leverages the wide bandgap properties of Gallium Oxide, enabling operation at high power densities (up to 2 kW/kg) while maintaining thermal stability in elevated temperatures (up to 150°C). This solution addresses the critical need for precise and reliable power in CMBRE applications, supporting advanced munitions testing and diagnostics on key platforms such as the F-35 and B-21.

The converter integrates CNT (carbon nanotube) and graphene-infused silicone rubber cables to enhance thermal dissipation and EMI shielding, ensuring efficient performance even during high-frequency switching operations. Advanced simulations using LTspice, COMSOL Multiphysics, and ANSYS HFSS will be conducted to validate the converter's electrical, thermal, and EMI characteristics. Following these simulations, rigorous laboratory testing will confirm power stability, efficiency, and durability under military-simulated field conditions.

This Ga_2O_3-based converter offers significant advancements over traditional silicon and SiC-based solutions, providing higher power density, enhanced thermal resilience, and radiation resistance suitable for demanding defense environments. The scalable, modular design supports adaptability across various power requirements, making it applicable to a wide range of DoD platforms, including field power systems, UAVs, and radar operations. Syrnatec's Ga_2O_3 DC-DC converter is set to redefine military power systems with a high-performance, compact, and reliable solution for mission-critical defense applications.

Anticipated Benefits/Potential Commercial Applications of the Research or Development:

DoD Applications:

F-35 Lightning II: Powers advanced avionics and electronic warfare systems, delivering stable 270 VDC with excellent thermal management.

MQ-9 Reaper UAV: Provides efficient power for targeting and navigation systems, enhancing mission duration and reducing

weight.
Mobile Command Centers: Supports satellite communication and radar equipment with compact power systems, enabling consistent field performance on platforms like the Army's Deployable Communication System (DCS).
Non-DoD Applications:
Telecom Towers (e.g., Verizon and AT&T Infrastructure): Provides stable power to remote towers, reducing operational costs and maintenance needs.
EV Charging Stations (e.g., Tesla Supercharger Network): Efficiently manages high voltage requirements, reducing energy loss and cutting down on charging time.
Renewable Energy Systems (e.g., Solar Farms): Optimizes DC power conversion in solar and wind installations, ensuring efficient energy transfer and storage.
Commercial Aviation (e.g., Airbus E-Fan Program): Supports electrified propulsion, improving power efficiency and promoting sustainable aviation solutions.

Attention:

Disclaimer: For any purpose other than to evaluate the proposal, this data except proposal cover sheets shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. This restriction does not apply to routine handling of proposals for administrative purposes by Government support contractors. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

Addition:

Enter the page numbers separated by a space of the pages in the proposal that are considered proprietary:

List a maximum of 8 Key Words or phrases, separated by commas, that describe the Project:

Ga_2O_3 DC-DC Converter, High-Efficiency Power Conversion, Common Munitions Built-In Test Equipment (CMBRE), Wide Bandgap Semiconductor, Carbon Nanotube (CNT) Cables, EMI Shielding, Military Power Systems, Thermal Management in Electronics.

VOL I - Proposal Certification

Summary:

1. At a minimum, two thirds of the work in Phase I will be carried out by your small business as defined by [13 C.F.R Section 701-705](). The numbers for this certification are derived from the budget template. To update these numbers, review and revise your budget data. If the minimum percentage of work numbers are not met, then a letter of explanation or written approval from the funding officer is required.	**YES**

Please note that some components will not accept any deviation from the Percentage of Work (POW) minimum requirements. Please check your component instructions regarding the POW requirements.	
Firm POW	**100%**
Subcontractor POW	**0%**
2. Is primary employment of the principal investigator with your firm as defined by 13 C.F.R Section 701-705?	**YES**
3. During the performance of the contract, the research/research and development will be performed in the United States.	**YES**
4. During the performance of the contract, the research/research and development will be performed at the offerors facilities by the offerors employees except as otherwise indicated in the technical proposal.	**YES**
5. Do you plan to use Federal facilities, laboratories, or equipment?	**NO**
6. The offeror understands and shall comply with export control regulations.	**YES**
7. There will be ITAR/EAR data in this work and/or deliverables.	**NO**
8. Has a proposal for essentially equivalent work been submitted to other US government agencies or DoD components?	**NO**
9. Has a contract been awarded for any of the proposals listed above?	**NO**
10. Firm will notify the Federal agency immediately if all or a portion of the work authorized and funded under this proposal is subsequently funded by another Federal agency.	**YES**
11. Are you submitting assertions in accordance with DFARS 252.227-7017 Identification and assertions use, release, or disclosure restriction?	**NO**
12. Are you proposing research that utilizes human/animal subjects or a recombinant DNA as described in DoDI 3216.01, 32 C.F.R. Section 219, and National Institutes of Health Guidelines for Research Involving Recombinant DNA of the solicitation:	**NO**
13. In accordance with Federal Acquisition Regulation 4.2105, at the time of proposal submission, the required certification template, "Contractor Certification Regarding Provision of Prohibited Video Surveillance and Telecommunications Services and Equipment" will be completed, signed by an authorized company official, and included in Volume V: Supporting Documents of this proposal. NOTE: Failure to complete and submit the required certifications as a part of the proposal submission process may be cause for rejection of the proposal submission without evaluation.	**YES**
14. Are teaming partners or subcontractors proposed?	**NO**
15. Are you proposing to use foreign nationals as defined in 22 CFR 120.16 for work under the proposed effort?	**NO**
16. What percentage of the principal investigators total time will be on the project?	**25%**
17. Is the principal investigator socially/economically disadvantaged?	**NO**
18. Does your firm allow for the release of its contact information to Economic Development Organizations?	**YES**

VOL I - Contact Information

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(1) Table of Contents:

Table of Contents

(2) Glossary:

SDB = Small Diameter Bomb
Ga_2O_3 = Gallium Oxide
OFP = Operational Flight Program
CNT = Carbon Nanotube
CMBRE = Common Munitions Built-in-Test (BIT) Reprogramming Equipment
EMI = Electromagnetic Interference
TAU = Test Adapter Unit

(3) Milestone Identification:

Sr. No	Task	Deliverable	1 M = 1 Month					
			M1	M2	M3	M4	M5	M6
1	Kickoff							
2	Task 1: Requirements Analysis and Interface Compatibility for CubeSat Integration	A detailed Requirements Analysis Report with CubeSat-specific integration needs, outlining environmental resilience, power, and thermal requirements essential for the Ga_2O_3 converter's effective performance in CubeSat applications.						
3	Task 2: Design and Testing of Ga_2O_3 DC-DC Converter for CMBRE Integration	A comprehensive Design Optimization Report detailing design configurations, power stability, thermal management, and EMI mitigation strategies. Performance Testing Results showcasing efficiency, power stability, and EMI shielding under test conditions. A Stress Test Analysis confirming durability and compliance with CMBRE specifications for long-term military use.						
4	Deliverable							

(4) Identification and Significance of the Problem or Opportunity:

Identification of the Problem: The current state-of-the-art CMBRE system operates on a base power supply of 115 VAC and relies on external AC-DC converters to adapt this power for testing munitions and airframe systems, such as the BRU-61B/A bomb rack. This setup, while functional, introduces several inefficiencies due to the conversion process. Each stage of AC-DC conversion creates inherent voltage fluctuations and electrical noise, which not only degrade the quality of the power supplied but also impact the

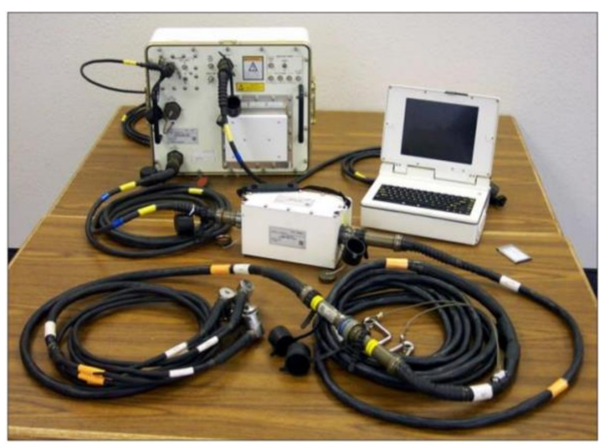


Figure 1: The Currently Used CMBRE

accuracy of fault isolation and testing processes. Voltage irregularities and interference are especially detrimental during critical tasks such as loading the Operational Flight Program (OFP) data, where precise and clean power delivery is crucial to maintain data integrity and ensure that operational configurations are accurately loaded onto the system. The external converters, by design, are susceptible to noise generation, which directly affects the quality and consistency of the diagnostic power supplied, leading to potential diagnostic inaccuracies and inconsistencies. Furthermore, the reliance on external AC-DC converters adds significant logistical complexity to the CMBRE system. These converters, often bulky and challenging to maneuver, increase the overall weight and footprint of the testing setup. In practical field environments, this bulk creates substantial drawbacks, as the converters are not only cumbersome to transport but also require additional setup time and space, complicating deployment in fast-paced or constrained settings. The need to manage additional equipment hinders the system's adaptability and mobility, making it less suitable for rapid or remote deployments where logistical efficiency is paramount. Moreover, these bulky converters are susceptible to physical wear over time, which introduces another layer of maintenance and reliability concerns, especially when deployed in harsh or high-demand environments.

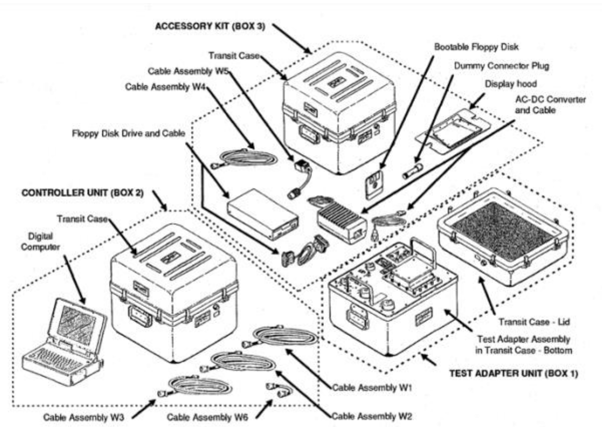
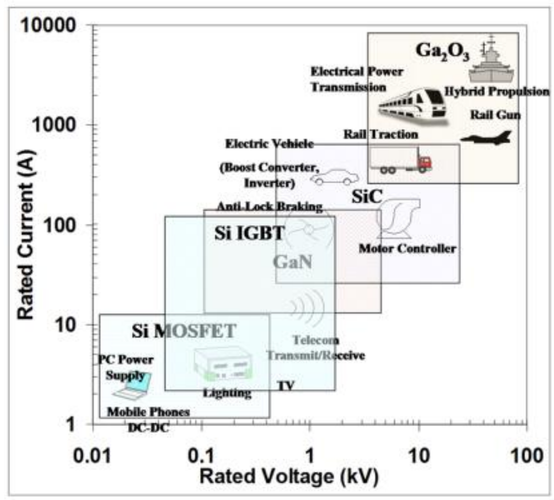


Figure 2: CMBRE and Its Accessories



The design limitations of the current CMBRE also reflect in its lower efficiency and thermal management capabilities. The AC-DC conversion process typically yields around 85% efficiency, with energy losses that manifest as additional heat generation. In field applications where sustained power output is necessary, this heat build-up can strain the system, affecting its overall stability and risking overheating under prolonged use. The current system's limited capacity to dissipate this excess heat impacts its reliability and longevity, especially during high-temperature operations where effective thermal regulation is critical. As a result, not only does this lead to increased power consumption, but it also necessitates regular maintenance cycles to address thermal degradation, a factor that impacts operational readiness and the long-term reliability of the system in rigorous military environments.

<u>*Significance of the Opportunity:*</u>

Syrnatec introduces a groundbreaking solution with our high-performance Ga_2O_3 DC-DC converter, designed to deliver direct 270 VDC output without the need for traditional AC-DC conversion stages. This converter utilizes Gallium Oxide (Ga_2O_3), a wide-bandgap semiconductor with a bandgap of 4.8 eV, compared to silicon's 1.1 eV, allowing the system to operate efficiently across extreme voltage

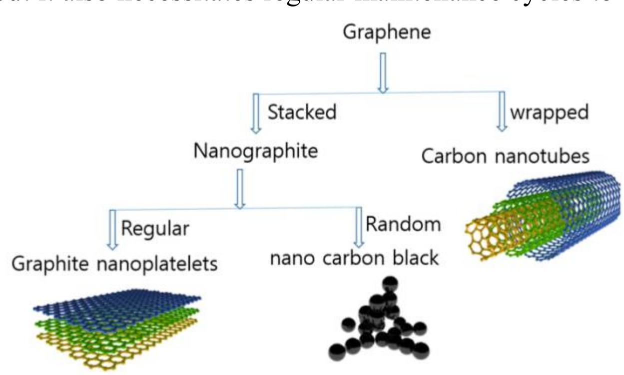


Figure 3: Flowchart of Graphene used in CNT

and thermal ranges—up to 650 VDC and between 70°C to 150°C. The unique properties of Ga_2O_3 enable this converter to provide high-density, ripple-free power, which is critical for military applications requiring compact, resilient designs. By operating at a high frequency of 1 MHz, the converter minimizes the size of passive components such as inductors and capacitors, achieving a power density of up to 2 kW/kg, reducing overall size and weight and integrating smoothly into existing CMBRE infrastructure without external converters. This direct high-voltage output meets military specifications for power delivery, providing stable and precise power essential for advanced diagnostics, fault isolation, and Operational Flight Program (OFP) data loading on munitions systems like the BRU-61B/A bomb rack. Our innovation delivers a stable, 270 VDC ripple-free output, overcoming the voltage fluctuations and noise commonly introduced by AC-DC conversions in traditional systems. This direct DC configuration allows for 96-99% efficiency, minimizing energy loss and reducing heat output, a substantial improvement over the 85% efficiency typically achieved by legacy systems. The elimination of intermediate conversion stages significantly reduces electrical noise, which can interfere with sensitive diagnostics and data transmission. With stable, high-quality power aligned to onboard conditions, the converter enhances the reliability of pre-flight testing and ensures accurate fault isolation, a key requirement for the performance of munitions systems in critical operations.

To complement the converter, Syrnatec employs advanced CNT (carbon nanotube) and ene-infused silicone rubber cables, chosen for their exceptional electrical conductivity and thermal management properties. The conductivity of these cables is up to 1,000 times higher than copper, allowing high current transmission at minimal resistance, crucial for a stable and efficient 270 VDC output. This high-current capacity ensures consistent power over long distances without signal degradation. The thermal conductivity of CNT and graphene is approximately five times greater than conventional materials, providing rapid heat dissipation and supporting the system's stability in extended operations. This advanced thermal management is essential for military applications, where sustained reliability is a priority. By effectively mitigating heat buildup, the cabling system contributes to a longer operational lifespan for the CMBRE, minimizing maintenance demands and ensuring consistent performance in various operational settings.

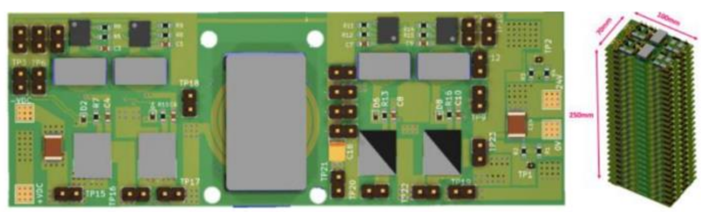


Figure 4: Our Proposed DC-DC Circuit

Our cables also enhance the system with exceptional electromagnetic interference (EMI) shielding, a critical requirement in military environments where high-noise conditions can compromise data integrity. Graphene's EMI shielding capability protects against signal interference during crucial OFP data loading and testing procedures, preventing data corruption and ensuring high diagnostic accuracy. This shielding property resolves a primary limitation of traditional systems, where AC-DC conversion-induced noise can affect testing reliability. Syrnatec's EMI-protected cabling assures data integrity, which is essential in high-stakes testing environments, providing an extra layer of protection for mission-critical tasks.

The combination of Ga_2O_3 converter technology and CNT and graphene-infused cabling results in an exceptionally durable and resilient system. Unlike conventional silicon-based systems, which endure for approximately three years in harsh environments, the Ga_2O_3 converter is engineered for over nine years of reliable operation under demanding electrical and thermal conditions. This extended operational lifespan not only reduces the

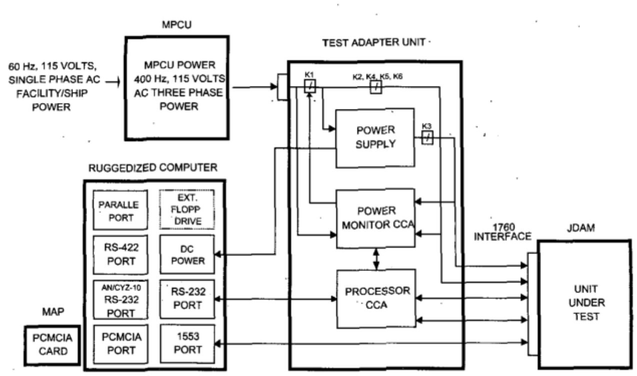


Figure 5: Block Diagram for CMBRE which Include Test Adapter Unit (TAU)

frequency of replacement and maintenance cycles but also enhances overall system reliability, a crucial factor for continuous military readiness. The durability and thermal resilience of the Ga_2O_3 technology allow the CMBRE to maintain high efficiency and performance without degradation, meeting the USAF's long-term needs in challenging operational environments.

Syrnatec's innovative design introduces a compact, field-ready solution optimized for efficient deployment in diverse settings. The high frequency switching capability allows a lightweight design that integrates directly into the CMBRE Test Adapter Unit (TAU) without requiring modifications or additional equipment. This low-weight, compact form factor simplifies logistical demands, reducing setup time and enhancing portability, especially valuable for field operations where weight and mobility are essential. By enabling direct 270 VDC testing power in a streamlined, plug-and-play design, the Syrnatec solution addresses the operational limitations of the current CMBRE system, offering military personnel a reliable, deployable, and accurate high-voltage testing capability.

Table 1: Current State of Art Vs Syrnatec Proposed Technology

Feature	Current CMBRE System	Proposed Syrnatec Technology	Improvement
Power Output	115 VAC, requiring external AC-DC converters	Direct 270 VDC output (no conversion required)	Eliminates need for external converters, reducing power conversion steps
Voltage Stability	Voltage fluctuations common due to AC-DC conversion	Stable, ripple-free DC output at 270 VDC	Provides consistent voltage, improving diagnostic accuracy
Electrical Noise	High noise from AC-DC conversion	Minimal noise with direct DC output; high EMI shielding from CNT/graphene cables	Enhances data integrity, reduces interference in OFP loading
Power Density	~1 kW/kg (low density due to bulky converters)	2 kW/kg achievable with Ga2O3 (1 MHz switching frequency reduces component size)	Reduces size, weight, and logistical footprint
Efficiency	~85% efficiency (due to multiple conversion steps)	96-99% efficiency with direct Ga2O3 conversion	Improves energy efficiency, reducing heat and energy waste
Thermal Management	Limited heat dissipation; higher risk of overheating	5x thermal conductivity with CNT/graphene cables	Maintains reliability during prolonged field testing
Durability (Operational Lifespan)	~3 years in harsh conditions	Up to 9 years (3x improvement) with Ga2O3 materials	Enhances lifespan, reducing replacement frequency and maintenance needs
EMI Shielding	Limited EMI shielding; high risk of data interference	Superior EMI shielding with graphene-infused cables	Protects critical OFP data and sensitive diagnostics from interference
Logistics Footprint	Requires bulky external converters; difficult to transport	Compact, integrated solution fitting directly into CMBRE	Simplifies transport and setup in field environments
Field Deployment	Heavy and complex setup, not optimized for mobile use	Lightweight and field-ready design with direct plug-and-play compatibility	Increases deployability and usability in remote or austere settings

Scenario:

- **F-35 Lightning II Preflight and Armament Validation:** The F-35 requires precise, high-voltage testing of mission-critical armament systems like the BRU-61B/A bomb rack to ensure reliability and functionality without additional hardware or power conversion needs.
  Our Solution: Syrnatec's Ga2O3 DC-DC converter, delivering direct 270 VDC output, integrates seamlessly into the F-35's CMBRE system, enabling preflight testing of armament without bulky external converters. Our high-efficiency Ga2O3 converter, with a bandgap of 4.8 eV, operates efficiently under high temperature (70°C-150°C) and voltage (up to 650 VDC), providing a ripple-free and stable power source. The CNT and graphene-infused cables ensure minimal resistance and I^2R losses, maintaining consistent power with superior EMI shielding for reliable data transmission. This solution replicates the F-35's onboard power conditions precisely, ensuring accurate fault isolation in the BRU-61B/A bomb rack, optimizing preflight testing without increasing the logistics footprint.
- **Small Diameter Bomb (SDB) Deployment Readiness on F-15EX Eagle II:** The F-15EX relies on rapid, accurate testing of SDB systems to ensure deployment readiness, especially under field conditions where bulky equipment hinders efficiency.
  Our Solution: By providing direct, 270 VDC output, our Ga2O3 DC-DC converter streamlines testing by eliminating intermediate AC-DC conversions, ensuring a smooth, consistent power source for the SDB's BRU-61B/A rack. The 1 MHz switching capability of the Ga2O3 converter reduces component size, enabling a lightweight and compact form factor that integrates directly into the CMBRE. The CNT and graphene-enhanced cables support efficient, high-current transmission with reduced heat generation, thanks to their high thermal conductivity, allowing consistent testing across extended periods. This high-density, low-loss power setup optimizes SDB readiness by ensuring high diagnostic accuracy and minimizing setup time, essential for rapid F-15EX deployment.
- **B-21 Raider Long-Range Strike Testing and Maintenance:** The B-21 requires a stealth-compatible, compact testing solution to validate long-range munitions systems under precise power conditions, without compromising its low observability profile.
  Our Solution: Syrnatec's Ga2O3 DC-DC converter, capable of delivering direct 270 VDC, integrates within the CMBRE for the B-21 Raider, matching onboard power conditions without additional power conversion. Ga2O3's wide bandgap enables operation in extreme environments, preserving efficiency and durability over years of high-stress use. The 1 MHz frequency of the converter minimizes passive components like capacitors and inductors, ensuring a compact, low-weight form that avoids interfering with the Raider's stealth profile. The CNT and graphene-infused cables enhance EMI shielding, protecting munitions data from interference and enabling stealth-aligned diagnostic accuracy. This provides the B-21 with reliable, field-ready testing that upholds stealth capabilities while meeting high-performance standards for long-range mission equipment.
- **MQ-9 Reaper UAS Remote Armament Testing:** The MQ-9 Reaper needs a lightweight, field-compatible high-voltage testing solution for armament diagnostics in remote deployments with limited logistics support.
  Our Solution: Syrnatec's Ga2O3 DC-DC converter delivers direct 270 VDC without requiring intermediate AC-DC conversion, providing consistent power for MQ-9 Reaper munitions testing in remote environments. The high thermal resilience and energy efficiency of the Ga2O3 converter allow it to handle extreme temperature and voltage ranges, ensuring reliable performance even under field conditions. Our lightweight design integrates easily with CMBRE, reducing setup time and logistical complexity. The CNT and graphene-infused cables maintain high-current capacity while minimizing heat and EMI, ensuring stable power for critical diagnostics in isolated areas. This compact solution enables rapid, effective testing with minimal footprint, supporting the MQ-9's flexibility and readiness in austere environments.
- **AC-130J Ghostrider Close Air Support (CAS) Pre-Mission Armament Verification:** The AC-130J requires fast, accurate pre-mission verification of munitions under operational voltage conditions to ensure rapid deployment readiness in high-stakes CAS missions.

Our Solution: Our Ga2O3 DC-DC converter, integrated into the AC-130J's CMBRE, provides a direct 270 VDC output that matches in-flight power conditions for pre-mission armament testing without external converters. The high switching frequency of 1 MHz allows smaller passive components, maintaining a compact footprint that supports the AC-130J's mobility. The CNT and graphene-infused cables ensure high electrical conductivity and superior EMI shielding, preventing interference in critical data transfers. This setup provides the AC-130J with rapid, field-compatible diagnostics, enabling CAS operations with reliable armament readiness and minimizing logistical drag, ensuring swift mission deployment when speed and accuracy are paramount.

(5) Phase I Technical Objectives:

Technical Objective 1: Deliver Direct, High-Voltage 270 VDC Output with Enhanced Stability: Provide a stable, ripple-free 270 VDC power source to the CMBRE, eliminating intermediate AC-DC conversion stages to ensure consistent diagnostic accuracy and reliable fault isolation for munitions systems.

Risk: Potential Incompatibility with Existing CMBRE Interface

Mitigation: Conduct thorough compatibility testing with the CMBRE's Test Adapter Unit (TAU) to confirm seamless integration. Develop adapter modules if necessary to ensure that the direct 270 VDC output aligns with current interface requirements without modification.

Technical Objective 2: Achieve High-Efficiency and High-Density Power Conversion with Ga_2O_3 Technology: Utilize Ga_2O_3's wide bandgap properties to achieve 96-99% power conversion efficiency and up to 2 kW/kg power density at 1 MHz, reducing the overall system size and heat generation, suitable for compact and efficient field operations.

Risk: Efficiency Degradation Under High Operational Stress

Mitigation: Utilize Ga_2O_3's high thermal and electrical tolerance and establish efficiency benchmarks across a range of environmental conditions. Implement monitoring systems to automatically adjust power output in real-time to sustain efficiency.

Technical Objective 3: Integrate Advanced Thermal and EMI Management with CNT and Graphene Cables: Employ CNT and graphene-infused cables to enhance thermal dissipation and provide high EMI shielding, ensuring system stability under prolonged use, preventing data interference, and maintaining data integrity during OFP loading in high-noise environments.

Risk: Heat Accumulation from High Current in Conductive Cables

Mitigation: Optimize cable length and layout to distribute current effectively, minimizing I^2R losses. Conduct temperature cycle testing to verify thermal resilience and integrate cooling mechanisms, if necessary, in high-power scenarios.

(6) Work Plan:

Scope: The major requirements and specifications for this Phase I effort include a comprehensive analysis of CubeSat integration needs for a Ga_2O_3 DC-DC converter, focusing on power, thermal, and environmental constraints. This will involve evaluating interface requirements, conducting design optimization for CMBRE compatibility, and ensuring durability through thermal management and radiation hardening strategies. The effort will also extend to the design and testing phase, with emphasis on achieving high power conversion efficiency, stable power output, and EMI shielding.

Task 1: Requirements Analysis and Interface Compatibility for CubeSat Integration

Objective: Define CubeSat power, thermal, and environmental requirements to ensure compatibility with the Ga_2O_3 DC-DC converter. Assess integration constraints and necessary design adjustments to meet CubeSat's operational standards. Establish foundational parameters for effective design and testing phases.

Subtask 1.1: Power and Environmental Constraints Definition for CubeSat:

In this subtask, the focus will be on a comprehensive analysis of the CubeSat's operational power needs and the environmental conditions it faces in space. This analysis will ensure that the Ga_2O_3 DC-DC converter is tailored to meet these stringent requirements while maintaining high efficiency and power density. The first step involves gathering and studying data from existing space-qualified power systems and CubeSat mission specifications. This data will provide insight into the typical power loads, voltage ranges, and current demands that CubeSats encounter in low Earth orbit (LEO) and other space environments.

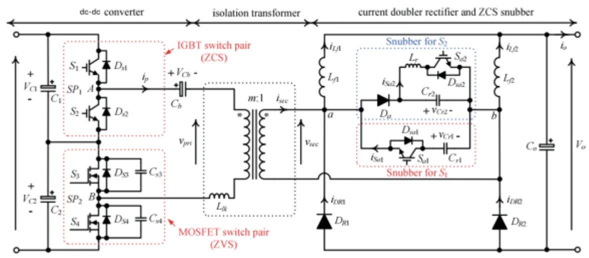


Figure 6: The Proposed DC-DC Circuit

Using advanced circuit simulation tools such as **LTspice** and **PSIM**, detailed models of the Ga_2O_3 DC-DC converter will be developed to simulate its behavior under varying power conditions. These simulations will help analyze the converter's response to load fluctuations, power surges, and steady-state operations, providing a comprehensive understanding of its performance under real-world CubeSat scenarios. Additionally, the analysis will include an evaluation of the power density, with a target of achieving up to 2 kW/kg, ensuring the system delivers sufficient power within the CubeSat's limited space and weight constraints.

The subtask will also integrate insights from isolated power converter topologies, such as forward and flyback DC-DC converters, which are known for their ability to handle high-voltage and high-current operations while offering built-in isolation. This aspect is critical for CubeSats that operate in environments prone to Single Event Effects (SEE), where high-energy particles can induce transient disturbances in electronic systems. By simulating the Ga_2O_3 DC-DC converter using these topologies, the study will determine its capability to maintain stable operations during such events, thereby protecting the CubeSat's payloads and mission-critical electronics from potential disruptions.

Environmental constraints such as temperature extremes and radiation exposure will be assessed using **COMSOL Multiphysics** and **ANSYS Fluent** to simulate the thermal behavior and radiation resilience of the Ga_2O_3 converter. Space environments often expose CubeSats to temperature fluctuations that can range from -150°C in the shadow of the Earth to over 150°C when exposed to direct sunlight. The simulations will help identify potential thermal hotspots and ensure that the converter can efficiently manage heat dissipation using integrated materials like CNT and graphene for enhanced thermal conductivity. Additionally, Ga_2O_3's inherent wide bandgap properties will be analyzed for their capability to withstand high-voltage conditions (up to 650 VDC) and maintain operational stability at elevated temperatures (up to 150°C).

Radiation tolerance is another critical aspect of this analysis. CubeSats in LEO and beyond encounter high levels of ionizing radiation that can lead to Single Event Burnout (SEB) or gate rupture in semiconductor devices. The subtask will include simulations using **SPEOS by ANSYS** to assess the Ga_2O_3 converter's resilience to these effects, leveraging its molecular structure that provides inherent resistance to radiation-induced damage. The results will be used to ensure the converter's components are robust enough to maintain consistent operation without degradation during long-duration space missions.

By the end of Subtask, the analysis will yield a thorough understanding of the CubeSat's power and environmental requirements, confirm the Ga_2O_3 DC-DC converter's ability to meet these demands, and establish key design parameters. These results will inform subsequent tasks focused on interface design and integration, thermal management, and radiation hardening. This subtask will lay the foundation for optimizing the converter for CubeSat applications, ensuring reliable performance in the harsh conditions of space.

Success Criteria: Achieving a comprehensive analysis that verifies the Ga_2O_3 DC-DC converter's ability to meet CubeSat power demands and endure operational temperature and radiation conditions without performance issues.

Subtask 1.2: Interface Requirements and Ga_2O_3 Integration Alignment:

This Subtask focuses on defining the electrical and mechanical interface requirements for integrating the Ga_2O_3 DC-DC converter into CubeSat platforms. This subtask will ensure that the design is compatible with the unique constraints of CubeSats, including limited physical space, onboard power distribution specifications, and the need for high resilience under space conditions. The goal is to align the Ga_2O_3 converter's architecture with CubeSat standards while maintaining high-voltage and temperature tolerance (up to 650 VDC and 150°C).

Electrical Interface Analysis:

The first step in this subtask involves a detailed analysis of the CubeSat's existing power delivery architecture, including input and output voltage requirements, current loads, and power bus configurations. This analysis will be conducted using **Altium Designer** to create detailed circuit schematics and ensure that the Ga_2O_3 converter's electrical configuration aligns with CubeSat standards. Special attention will be paid to the matching of voltage levels, current limits, and connection types to facilitate seamless integration. The electrical interface design will also involve optimizing the control circuitry to support the high-frequency (1 MHz) capabilities of the Ga_2O_3 converter, which is essential for maintaining efficiency and reducing the size of passive components.

Physical and Mechanical Integration:

CubeSats are highly compact, with strict limits on size and weight, typically following the standard CubeSat form factors (e.g., 1U, 3U, 6U). To address these constraints, **SolidWorks** or **Autodesk Fusion 360** will be employed to create 3D models of the Ga_2O_3 DC-DC converter and simulate its placement within the CubeSat framework. The mechanical design will ensure that the converter fits within the available space without interfering with other critical components. This modeling process will involve assessing component placement for optimal heat distribution and structural support, ensuring that the converter's integration does not compromise the CubeSat's mechanical integrity or interfere with payload functions.

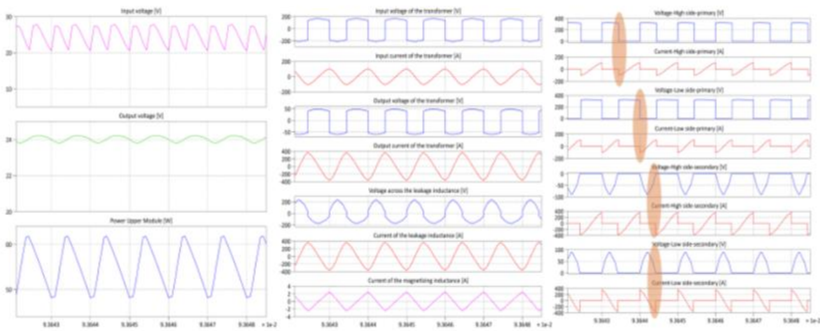


Figure 7: Fully Zero Voltage Switching.

EMI Considerations:

High frequency switching in power converters can generate electromagnetic interference (EMI), which poses a significant challenge in small satellite applications where sensitive communication and control systems coexist in a compact space. **COMSOL Multiphysics** and **ANSYS Electronics Desktop** will be used to model and simulate the electromagnetic behavior of the Ga_2O_3 converter. The objective is to identify potential sources of EMI and implement shielding techniques to mitigate these effects. The integration plan will specify the use of CNT and graphene composites, known for their superior EMI shielding properties, to encase critical sections of the converter. This shielding will prevent high-frequency noise from affecting CubeSat communication and sensor systems, ensuring reliable operation across the entire satellite.

Thermal Interface Specifications:

Due to the high-power density of the Ga_2O_3 converter, effective thermal management is crucial. The subtask will include defining thermal interface materials and configurations that align with CubeSat's cooling capabilities. Thermal simulations conducted in **ANSYS Workbench** will help identify the best placement for heat sinks or conductive paths within the CubeSat structure. CNT and graphene-infused silicone rubber will be assessed for use as thermal interface materials due to their excellent heat transfer properties. These materials will aid in spreading and dissipating heat efficiently, preventing localized hotspots and maintaining the converter's performance across varying operational loads.

Mechanical and Electrical Adjustments:

If the Ga_2O_3 converter's original design requires modifications to fit CubeSat constraints, this subtask will outline specific changes to be made. These adjustments may include miniaturizing certain components or redesigning the layout to optimize space utilization. For electrical adjustments, the control logic may be refined to accommodate the CubeSat's onboard power management system, ensuring seamless integration without overloading or undersupplying other subsystems.

Success Criteria: Developing detailed electrical and mechanical interface specifications that ensure seamless integration of the Ga_2O_3 converter within CubeSat systems while maintaining EMI compliance and proper physical fit.

Subtask 1.3: Initial Specification of Thermal Management and Radiation Hardening:

This Subtask focuses on developing initial specifications for managing the thermal profile and enhancing the radiation tolerance of the Ga_2O_3 DC-DC converter to ensure its sustained performance in CubeSat operations. This task is essential as CubeSats are often deployed in extreme environments where efficient thermal management and radiation resilience are critical for long-term functionality. The specifications will guide the selection and integration of advanced materials and design features to bolster the converter's reliability under space conditions.

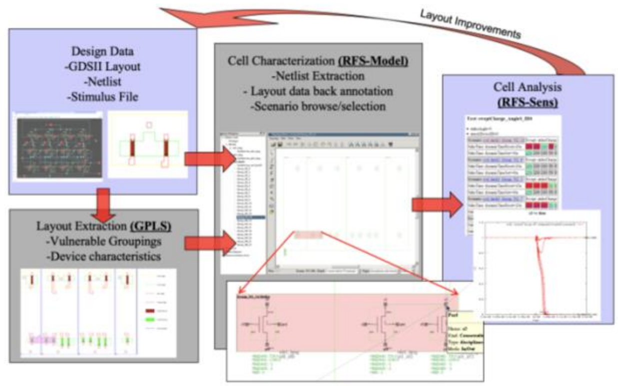


Figure 8: Modeling and simulation approach.

Thermal Management Strategy: Given the high-power density and efficiency goals (up to 2 kW/kg) of the Ga_2O_3 DC-DC converter, effective thermal management is vital to prevent overheating and maintain consistent operation. The subtask will involve using **COMSOL Multiphysics** and **ANSYS Workbench** for detailed thermal simulations. These tools will model the heat distribution across the converter and predict temperature gradients under various operational loads. The simulations will help identify potential hotspots and determine the most effective thermal paths for heat dissipation.

The thermal management plan will integrate materials known for their superior thermal conductivity, specifically CNT (carbon nanotube) and graphene-based composites, which exhibit thermal conductivities up to five times higher than conventional materials. These materials will be considered for use in thermal interface layers and as additives in silicone rubber for flexible, high-efficiency heat transfer solutions. By incorporating CNT and graphene, the converter will benefit from improved heat spread and dissipation, allowing it to maintain optimal temperatures during continuous high-power operation. These materials will also be evaluated using **ANSYS Electronics Desktop** to confirm their behavior in conjunction with the Ga_2O_3 semiconductor.

The specification will outline the use of thermal interface materials (TIMs) strategically placed between the converter and the CubeSat's structural elements to maximize heat transfer. It will also propose configurations for potential passive cooling solutions, such as heat sinks or thermal straps, made with CNT-infused composites to enhance conduction while maintaining a lightweight profile essential for CubeSats.

Radiation Hardening Approach: The space environment presents significant radiation challenges, including exposure to high-energy particles that can lead to Single Event Effects (SEE) such as Single Event Burnout (SEB) and Single Event Gate Rupture (SEGR). To address this, the subtask will develop specifications for radiation-hardening techniques to ensure the Ga_2O_3 DC-DC converter maintains integrity during missions in Low Earth Orbit (LEO) and higher radiation exposure zones.

The Ga_2O_3 material itself provides inherent advantages due to its wide bandgap properties, which contribute to higher breakdown voltage and superior resistance to radiation-induced damage compared to traditional silicon-based semiconductors. This subtask will involve simulations using **SPEOS by ANSYS** and **RadHard software** to model the effects of space radiation on the Ga_2O_3 converter and validate its tolerance under ionizing conditions.

Radiation-hardening strategies will include specifying the use of redundant Ga_2O_3 MOSFETs in critical circuit paths to provide fail-safe operation in case of transient radiation-induced failures. Shielding techniques using graphene-based materials will be explored, as graphene's atomic structure offers significant protection against radiation penetration while being lightweight and structurally adaptable. The combination of inherent material resilience and added shielding will help mitigate risks of SEB and SEGR, ensuring the converter’s long-term operational stability.

Comprehensive Specifications Development: The subtask will also produce initial specifications for the integration of CNT and graphene as part of the converter’s radiation shielding. These specifications will define how these materials can be applied—either as coatings, embedded layers, or structural components—to enhance overall radiation hardness without adding significant weight or volume. The use of **MATLAB** for algorithmic modeling will provide additional analysis on heat transfer and degradation rates under simulated space radiation conditions, further refining the thermal and radiation specifications.

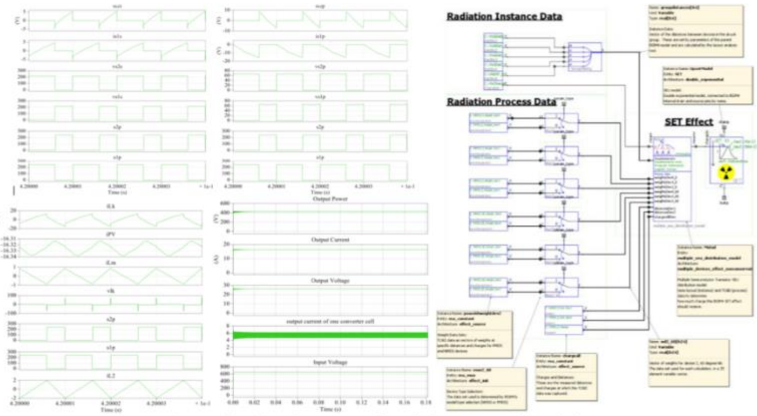


Figure 9: Simulation results of the proposed module

Success Criteria: Producing robust thermal and radiation management specifications utilizing CNT and graphene composites that ensure converter stability in space conditions and resistance to SEB and SEGR.

Deliverable:

- A detailed Requirements Analysis Report with CubeSat-specific integration needs, outlining environmental resilience, power, and thermal requirements essential for the Ga_2O_3 converter’s effective performance in CubeSat applications.

Task 2: Design and Testing of Ga_2O_3 DC-DC Converter for CMBRE Integration

Objective: To design and conduct rigorous testing on the Ga_2O_3 DC-DC converter using CNT- and graphene-infused silicone rubber cables. This phase emphasizes validating critical metrics, including power stability, efficiency, thermal dissipation, and electromagnetic interference (EMI) shielding.

Subtask 2.1: Design Optimization of Ga_2O_3 Converter for Power and Thermal Performance

Subtask 2.1 aims to refine the design of the Ga_2O_3 DC-DC converter to achieve maximum power conversion efficiency, stable voltage output, and optimized thermal performance, aligning with the stringent requirements of CMBRE (Common Munitions Built-In Test/Reprogramming Equipment) integration. This task involves a multi-faceted approach that utilizes advanced simulation tools, material integration, and design optimization techniques to ensure the converter meets or exceeds the performance targets of 96-99% efficiency and a stable 270 VDC output.

High-Efficiency Design Focus: The primary objective of this subtask is to fine-tune the Ga_2O_3 DC-DC converter's architecture to ensure it operates at peak efficiency. This will involve using **SPICE-based simulators** such as **LTspice** and **PSIM** to conduct detailed circuit simulations under various load conditions, assessing how the converter performs across different voltage and current ranges. These simulations will help identify areas where component configurations can be improved to minimize power losses and maximize energy transfer.

To achieve the high switching frequency required (1 MHz), the design will leverage Ga_2O_3’s wide bandgap properties, which enable efficient operation at high voltages and temperatures while maintaining minimal heat generation. This characteristic is essential for reducing the size of passive components like inductors and capacitors, thereby achieving a compact design with high power density (targeting up to 2 kW/kg). The circuit layout will be optimized using **Altium Designer** to ensure the minimal parasitic inductance and capacitance that can impact switching performance.

Thermal Performance Optimization: Thermal management is a critical consideration due to the high power density of the Ga_2O_3 converter. Advanced thermal simulation tools like **COMSOL Multiphysics**

and **ANSYS Workbench** will be employed to model the converter's thermal profile and predict temperature distributions under continuous operation and peak loads. These simulations will help pinpoint potential thermal hotspots and inform the placement of heat-dissipating elements to ensure even temperature distribution.

Integration of CNT and Graphene-Infused Cables: A significant aspect of this optimization subtask is the integration of CNT (carbon nanotube) and graphene-infused silicone rubber cables, which provide superior thermal conductivity and minimal resistive losses. These cables will be modeled using **ANSYS Electronics Desktop** to evaluate their thermal behavior and electrical conductivity when used in conjunction with the Ga_2O_3 converter. The incorporation of these materials is designed to enhance heat dissipation and maintain power transmission efficiency, which is particularly important for sustained high-power operations. The use of CNT and graphene ensures that the converter remains within safe operating temperatures and does not experience performance degradation due to thermal buildup.

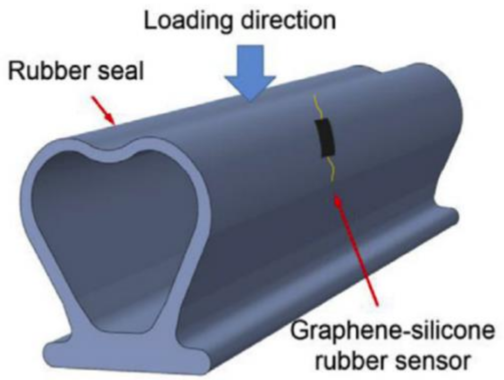


Figure 10: Sensor for monitoring on a rubber seal

Component Configuration and Control Circuitry Refinement: To maintain stable power output at 270 VDC, the Ga_2O_3 DC-DC converter's control circuitry will be refined to support precise regulation and minimal output fluctuations. This refinement will involve designing feedback and control loops using **MATLAB/Simulink**, allowing for advanced control algorithms that ensure fast response times and stable performance even under fluctuating load conditions. The high-frequency operation of the converter will necessitate careful selection of Ga_2O_3 MOSFETs and diodes, optimized for rapid switching and low on-resistance, to maintain high efficiency while minimizing switching losses.

Iterative Testing and Design Adjustments: The optimization process will be iterative, with continuous testing and validation to refine the converter's performance. Prototyping tools and **LabVIEW**-integrated test benches will be used to conduct preliminary bench tests, simulating the operating conditions that the converter will face in CMBRE applications. These tests will focus on evaluating power efficiency, thermal stability, and voltage consistency. Data collected during these tests will guide design adjustments, such as reconfiguring component layouts or modifying cooling paths, to further enhance the converter's performance.

Success Criteria: Finalizing the converter design to achieve 96-99% efficiency, stable 270 VDC output, and effective thermal management as validated through simulation results.

Subtask 2.2: Laboratory Testing for Power Stability, Efficiency, and Thermal Dissipation

This Subtask involves a series of comprehensive laboratory tests designed to validate the Ga_2O_3 DC-DC converter's performance in terms of power stability, efficiency, and thermal dissipation. This phase is critical to ensuring that the optimized converter design meets the stringent operational requirements for CMBRE integration. The objective is to verify that the converter delivers reliable power output, maintains high efficiency under varying load conditions, and effectively dissipates heat to prevent performance degradation during prolonged use.

Power Stability Testing: To confirm power stability, the converter will be subjected to a range of operational voltage and current loads using **high-power electronic load testers** and precision **power supplies**. The aim is to ensure that the converter can maintain a consistent 270 VDC output without significant voltage ripple or fluctuation, even under transient and dynamic load changes. Testing will be controlled and monitored using **NI LabVIEW** to automate the process, collect data, and log power performance metrics in real-time. The test setup will include oscilloscopes and high-precision multimeters for voltage and current measurements, ensuring that output stability meets the targeted specifications. This is particularly important for CMBRE applications where precise, stable power is necessary for accurate diagnostic and testing operations.

Efficiency Testing Under High-Load Conditions: The converter's efficiency will be tested by running it under various load conditions that simulate actual field operations. The testing will involve gradually increasing the load from low to high power levels to evaluate the converter's ability to sustain its targeted efficiency range of 96-99%. **Power analyzers** equipped with advanced measurement capabilities will be used to calculate the efficiency by comparing input and output power. These tests will help identify any inefficiencies or power losses that may arise under maximum load and will provide insights into potential areas for further refinement.

Efficiency testing will also incorporate **data acquisition systems (DAQ)** synchronized with LabVIEW to capture real-time performance data, allowing for precise adjustments and validation of the converter's power regulation mechanisms. The results will confirm whether the Ga_2O_3 converter can maintain high efficiency during extended operations, an essential characteristic for minimizing heat generation and ensuring the converter's long-term reliability in the field.

Thermal Dissipation Evaluation: Thermal management is a crucial part of the converter's performance validation, especially given the high-power density required for military applications. The thermal dissipation evaluation will be conducted using **infrared (IR) thermal cameras** and **thermal sensors** to monitor the temperature distribution across the converter during continuous high-power operation. The integration of CNT and graphene-infused silicone rubber cables will be tested to assess their effectiveness in conducting and dissipating heat.

COMSOL Multiphysics will be used to simulate the thermal behavior of the converter in parallel with real-time testing to compare modeled data with observed temperature profiles. This will ensure that the thermal management strategies developed during the design phase are effective in practice. The converter will be placed in an environmental chamber capable of simulating various ambient conditions to test its performance under temperature extremes, as it would experience in field operations.

Load Cycling and Sustained Operation Testing: To simulate real-world usage, the converter will be subjected to load cycling, where it switches between different power levels to test how well it handles changes in load over time. Sustained operation testing will involve running the converter at high load continuously for an extended period to evaluate thermal buildup and verify that the integrated thermal management components, including the CNT and graphene-enhanced cables, function as intended.

Data Analysis and Iterative Improvements: Data gathered during these tests will be analyzed using **MATLAB** to create detailed plots of power stability, efficiency trends, and temperature changes. Any anomalies or deviations from expected performance metrics will be investigated, and the findings will inform iterative design adjustments. These adjustments may include minor modifications to the control circuitry, thermal interface materials, or component placement to further optimize the converter's performance.

Success Criteria: Demonstrating that the Ga_2O_3 converter maintains consistent power stability, achieves efficiency targets under various load conditions, and operates within safe temperature ranges during sustained testing.

Subtask 2.3: Electromagnetic Interference (EMI) and Stress Testing

In this Subtask it is designed to ensure that the Ga_2O_3 DC-DC converter meets stringent military standards for electromagnetic compatibility and long-term durability under simulated field conditions. This subtask involves executing a series of detailed EMI tests and mechanical stress evaluations to verify that the converter can operate without interference and withstand the mechanical and thermal stresses typical of military and space applications. The objective is to validate the converter's shielding effectiveness, structural integrity, and reliability under high-frequency switching and environmental challenges.

Electromagnetic Interference (EMI) Testing: EMI testing is critical to confirm that the Ga_2O_3 DC-DC converter does not emit or suffer from interference that could disrupt other sensitive equipment, particularly in the high-noise environments typical of CMBRE operations. This testing will be conducted using specialized **EMI/EMC test chambers** equipped with advanced spectrum analyzers, such as those provided by **Keysight Technologies**. These analyzers will measure both conducted and radiated emissions from the converter to ensure compliance with military EMI standards (e.g., MIL-STD-461).

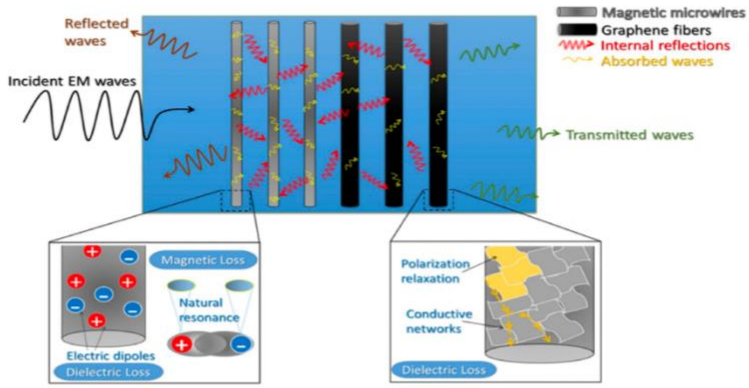


Figure 11: Mechanism of electromagnetic wave propagation from the specimen investigated

The integration of CNT (carbon nanotube) and graphene-infused silicone rubber cables will be a focal point of these tests, as these materials are chosen for their superior electromagnetic shielding properties. Simulations using **ANSYS HFSS (High-Frequency Structure Simulator)** will model the electromagnetic field behavior and predict areas of potential interference. The results will guide adjustments to shielding strategies if necessary, ensuring that the converter's design prevents emissions from affecting surrounding systems and remains immune to external EMI.

EMI Shielding Effectiveness Evaluation: Testing will involve placing the converter in high-noise environments to assess how well the CNT and graphene-based shielding performs in preventing signal interference during high-frequency switching operations. The shielding effectiveness will be measured in decibels (dB) to confirm that it meets the required attenuation levels for military applications. Additional EMI suppression techniques, such as the use of ferrite beads and grounding strategies, will be tested and optimized as part of the process.

Stress Testing for Mechanical and Environmental Durability: Stress testing will assess the mechanical resilience of the Ga_2O_3 DC-DC converter to simulate the physical and environmental challenges encountered during launch, operation, and prolonged use in military settings. **Environmental chambers** capable of simulating temperature extremes and rapid thermal cycling will be used to replicate the high-heat and rapid temperature changes experienced during field deployment. This ensures that the thermal management strategies, including the CNT and graphene-enhanced cables, maintain their efficacy under variable thermal loads.

Vibration and Shock Testing: The converter will be subjected to vibration and shock testing using **electrodynamic shakers** to simulate the mechanical stresses of launch and deployment. This testing ensures that all components of the converter, including the power module and integrated materials, maintain structural integrity and continue functioning as designed. The converter's ability to withstand vibration at frequencies that match those encountered during flight and transport will be assessed. Data from accelerometers placed on the converter will be captured and analyzed using **LabVIEW** or similar data acquisition software to ensure that all performance metrics remain within acceptable ranges.

Thermal Cycling and Electrical Stress Testing: Thermal cycling tests will involve subjecting the converter to repeated cycles of heating and cooling, reflecting real-world conditions such as rapid temperature transitions during orbital transitions or field use. Electrical stress testing will push the converter to operate at and beyond its rated voltage and current limits to verify that Ga_2O_3's inherent properties effectively prevent breakdowns, such as Single Event Burnout (SEB) and Single Event Gate Rupture (SEGR). **SPEOS by ANSYS** and **MATLAB** will be used to simulate the effects of these stresses on the converter's electrical components, verifying their durability and ensuring that the design meets the targeted lifespan of at least nine years under operational conditions.

Iterative Refinement and Analysis: Based on the findings from the EMI and stress tests, any observed deficiencies will be documented, and iterative design improvements will be proposed. If required, adjustments to the shielding, mechanical reinforcements, or thermal strategies will be made to optimize the converter for better performance. The test data will be analyzed to confirm compliance with military-grade durability standards, ensuring that the converter can reliably perform under extreme conditions without degradation.

Success Criteria: Ensuring the converter passes EMI compliance tests and endures stress simulations, maintaining operational integrity and supporting a projected nine-year lifespan under simulated field conditions.

Deliverables:

- **Design Optimization Report** documenting finalized design configurations, power stability parameters, thermal management strategies, and EMI mitigation techniques.
- **Performance Testing Results** detailing efficiency metrics, power stability, and EMI shielding effectiveness across tested conditions.
- **Stress Test Analysis** to validate durability and reliability, supporting the converter's resilience in military testing environments and its long-term operability under CMBRE specifications.

(7) Deliverables:

Task	Deliverable	Description
Requirements Analysis and Compatibility	Requirements Analysis Report	A comprehensive report detailing CubeSat's power, thermal, and environmental requirements to ensure compatibility with the Ga_2O_3 DC-DC converter.
Interface Requirements Definition	Interface Compatibility Specifications	A document outlining necessary electrical and mechanical interface adjustments for integration within CubeSat's limited space and power systems.
Thermal and Radiation Suitability Assessment	Thermal and Radiation Management Plan	Specifications for thermal dissipation and radiation hardening techniques, utilizing CNT and graphene materials to meet CubeSat's high-radiation, space-constrained environment.
Initial Design Adaptation	Preliminary Integration Design Outline	An outline of the initial design adaptations for the Ga_2O_3 converter, addressing size, power stability, and resilience requirements for CubeSat integration.

(8) Related Work:

Syrnatec, Inc., a women-owned, ITAR-compliant small business with expertise in satellite power systems, has developed a novel, low-SWaP, high-efficiency Electrical Power System (EPS) for deep space missions. Our EPS features a radiation-hardened Ga_2O_3-based DC-DC converter, tailored to meet the demanding power requirements of LEO and GEO satellite missions. To maximize solar energy capture, we integrate high-efficiency $(3AP)PbI_4$ perovskite solar cells with a 24.8% power conversion rate alongside high-density Li-metal batteries, enhancing energy storage and system resilience.

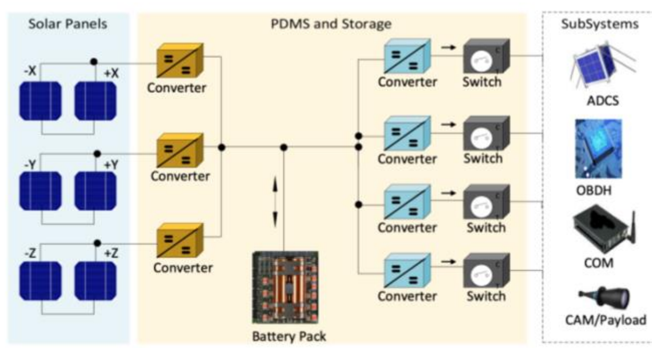


Figure 12: Syrnatec EPS System

Our EPS also includes a Maximum Power Point Tracking (MPPT) algorithm using Fuzzy Logic Control (FLC) for real-time voltage adjustments, which maintains optimal power output despite fluctuations in solar irradiance and temperature. This intelligent MPPT approach ensures robust, stable power tracking and increased efficiency, positioning Syrnatec's EPS as a durable and high-performing solution for long-duration satellite power applications.

(9) Commercialization Potential:

9.1 Commercial Potential

Quantitative Market Analysis Major electrical power telecommunication systems and next generation vehicles will need efficient power conversion system for their various loads operating on field. Proposed

DC-DC converter will meet this requirement. Syrnatec will also approach DLA users, Prime contractors with this product. System with modified cooling mechanism (air-cooled) will also be developed to reduce product cost and meet commercial market demand (identified applications include Uninterrupted power supply for Data centers, telecom infrastructure, Electric, hybrid and autonomous vehicles are few of the examples. WBG based automotive Power converter markets was estimated at US$ 4.9 billion in 2022 and may expand to US$ 6.4 billion by 2027 growing at 5.1 % CAGR. Market is majorly driven by E-Vehicles and Autonomous vehicles. There is significant interest in exploring WBG based power converters for Defense applications as well. Present Manufacturers of of SiC and GaN components include Vicor Corp, Wolfspeed, Infineon, ST Microelectronics, GeneSiC. Hi reliability SiC/ GaN based Power converters are supported by vendors like SynGE Aviation, Raytheon, etc. These are majorly custom designed system. Having a standard COTS model for the product will add leverage to Syrnatec offerings.

9.2 Description of Product(s) and/or System Application(s)

Syrnatec proposes to develop a 10 kW wide-bandgap (WBG) DC-DC converter, employing a parallel-cascaded 10 kW design. The system will be scalable to allow adjustments in power ratings, making it adaptable for various operational requirements.

Figure 13: CAGR for DC-DC

DoD Applications:

The 10 kW WBG DC-DC converter will be highly relevant for U.S. Department of Defense (DoD) initiatives, particularly those involving advanced power systems for military operations. Specific U.S. Air Force platforms that could benefit include tactical aircraft and UAVs, where efficient power conversion is crucial for avionics and propulsion systems. For example, the converter could support the F-35 Lightning II by delivering reliable power for onboard radar and electronic warfare systems, optimizing the power-to-weight ratio for better performance. Similarly, it could enhance the B-21 Raider's advanced electrical systems for long-range missions. This converter also suits ground-based military applications, such as mobile command centers and deployable communication units, providing scalable, high-efficiency power essential for field operations and radar installations.

Non-DoD Applications:

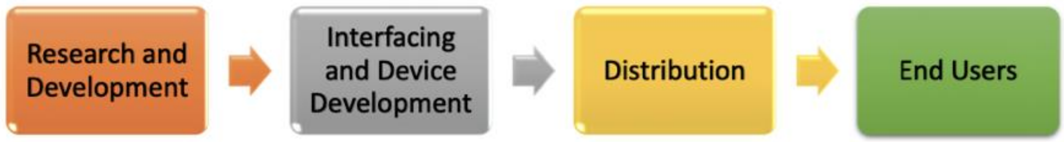
In commercial and industrial sectors, the 10 kW WBG DC-DC converter can serve multiple purposes where robust, high-power systems are needed. For example, it can be integrated into the power management systems of off-highway and mining vehicles, allowing for reliable and efficient operation in harsh conditions. Construction vehicles that rely on heavy-duty electrical systems could benefit from the converter's power efficiency, enabling better performance and reduced downtime. In the telecommunications industry, the converter could be utilized to provide consistent power to remote infrastructure sites, ensuring reliable data transmission and operation. It is also suitable for EV charging stations, where high-power, efficient energy conversion is needed to reduce charging times and enhance the overall energy management system. Renewable energy conversion, such as integrating solar panels into grid systems, can use this converter to improve power throughput and storage efficiency. Additionally, in the aviation industry, electrified propulsion systems on commercial aircraft could implement the 10 kW WBG converter to support sustainable flight technology, reducing fuel consumption and emissions.

(9.3) Business Model(s)/Procurement Mechanism(s)

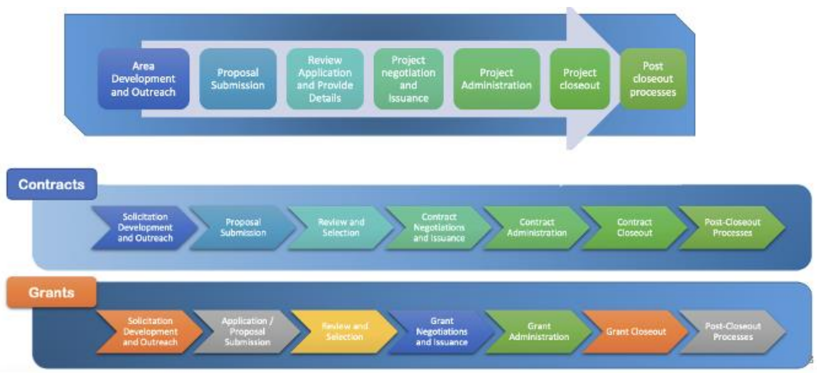
Syrnatec will develop, prototype, demonstrate and commercialize these converters in the US and International customers. Syrnatec's relationship with suppliers of WBG raw materials supplier Novel Crystal ensures availability of the components for long term contracts and mass production is performed in house in Connecticut. Integration of the PCB will be done by Syrnatec. Functional, electrical and lot qualification tests will be carried out at Syrnatec's facility or at DLA certified laboratories. Syrnatec's business model includes business certifications such as AS9100 and product certifications such as MIL-

STD-883; Syrnatec's team has extensive experience, and have obtained all the necessary manufacturing certifications.

(9.4) Marketing Expertise:



Syrnatec Inc. is an ITAR-compliant, HUBZone, minority woman-owned small business. The management has 30+ years of experience in Semiconductor domain servicing global defense, avionics and Space customer globally. Syrnatec has strong marketing team familiar with commercialization process of hi-end electronics, mechanical and optical products. Marketing teams are in strategic locations in Asia, EU and the US to efficiently carry out Commercialization activity. Syrnatec also has design team with more than 100,000 manhours of experience in design and fabrication of hi-reliability Semiconductor, Microwave, and optical products.



We have already formed key strategic alliances to accelerate commercialization efforts, working closely with partners like TechSolutions Consulting and Dawnbreaker Inc. to identify and engage potential customers within the U.S. and European markets.

(9.5) Competition and Advantages of Syrnatec's Technique

Competition:

Current solutions in the market for high-power DC-DC converters primarily come from companies leveraging silicon (Si) or silicon carbide (SiC) technology. Key players include large power electronics manufacturers such as Infineon Technologies, Texas Instruments, and Vicor Corporation. While these solutions provide reliable power conversion, they often come with limitations in efficiency and power density when subjected to high-voltage and high-temperature operations. Silicon-based converters generally suffer from lower thermal tolerance and reduced efficiency in demanding conditions, while SiC-based converters offer improvements but still face limitations in power density and long-term thermal management.

Why Our Solution is Better: Syrnatec's approach using wide-bandgap (WBG) Ga_2O_3 (Gallium Oxide) technology offers significant advantages over existing Si and SiC-based converters. Here's why our technique outperforms current solutions:

- **Higher Power Density**: Ga_2O_3 technology supports power densities up to 2 kW/kg, surpassing the limits of silicon and even SiC converters. This allows for compact, lightweight designs, which are particularly beneficial for applications in both DoD platforms like UAVs and tactical aircraft, and non-DoD sectors such as construction and mining vehicles where space and weight are critical.
- **Superior Thermal Performance**: The wide bandgap (4.8 eV) of Ga_2O_3 provides excellent thermal stability, enabling operation at higher temperatures (up to 150°C) without efficiency losses. This is a key advantage for military applications like the F-35 and B-21 Raider, where sustained performance under extreme conditions is necessary. Competitors using SiC technology still face challenges when

exposed to continuous high thermal loads, whereas Ga_2O_3's properties inherently support better heat dissipation.

- **Enhanced Efficiency**: Our Ga_2O_3 DC-DC converter achieves 96-99% efficiency, surpassing the typical performance metrics of silicon-based systems and even many SiC implementations. This high efficiency translates into lower energy losses and reduced operational costs, which is valuable for applications requiring constant high power, such as telecom infrastructure and renewable energy systems.
- **Scalability and Adaptability**: The modular design of Syrnatec's 10 kW converter, which can be cascaded in parallel to scale power ratings, offers greater flexibility than many current market solutions. This makes it an ideal fit for applications ranging from high-power military systems to commercial aviation and renewable energy sectors that need adaptable power solutions.
- **Innovative Material Integration**: The incorporation of CNT and graphene-infused silicone rubber cables in our converter design enhances both electrical conductivity and thermal management. These materials outperform traditional copper in conductivity and provide superior heat dissipation, giving our converters an edge over conventional designs. This innovation ensures that our converters maintain efficiency and reliability even during prolonged, high-power operation—critical for the DoD's mobile command centers and non-DoD applications like electric vehicle (EV) charging stations and heavy-duty industrial vehicles.

(10) Relationship with Future R/R&D Efforts:

The successful completion of Phase I will provide a comprehensive analysis and preliminary design that confirms the feasibility of integrating a Ga_2O_3 DC-DC converter within the CMBRE system. This phase will yield detailed specifications and interface requirements addressing critical aspects such as power stability, thermal management, and EMI shielding. These results will serve as the foundation for Phase II, transitioning from analysis to practical development and testing of the integrated solution. The anticipated outcome is a reliable, high-efficiency power system capable of meeting stringent USAF operational standards, setting the stage for broader application across other military platforms. Phase II will build upon the findings of Phase I by refining the design, developing prototypes, and conducting rigorous testing to validate system performance under real-world conditions. This phase may involve the delivery of a CMBRE system for modification as GFE or access to one for developmental testing and design validation. For instance, Phase II will illustrate how the Ga_2O_3 DC-DC converter can maintain high power efficiency and compactness, facilitating quick and efficient diagnostics for advanced airframes, such as the F-35, and reducing logistical burdens in field operations. Additionally, testing will showcase its adaptability and resilience, essential for diverse mission scenarios. Beyond munitions testing, Phase II holds broader significance for future research and Air Force applications. For example, the Ga_2O_3 DC-DC converter's high-power density and thermal management capabilities can be leveraged for use in airborne radar systems, which require stable and high-quality power for continuous operation and precise detection capabilities. Implementing this technology in radar systems could enhance their reliability and performance during extended missions, ensuring consistent data flow and operational accuracy. Further research stemming from Phase II could explore integrating this advanced power technology into UAVs, where low weight and high-power density are critical for maximizing mission range and endurance. For example, employing the Ga_2O_3-based system in UAVs could support extended flight durations and power-intensive payloads like advanced sensor arrays and communication equipment. This approach could also be applied to mobile ground units that require reliable power for sensor platforms and real-time data analysis. The successful implementation in these platforms would demonstrate the versatility and strategic value of Ga_2O_3-based power systems, positioning them as key enablers for advanced Air Force operations across multiple mission profiles.

D. Key Personnel:

1. Mr. Yash Mirchandani (Principal Investigator):

Mr. Yash Mirchandani brings over a decade of experience in operations, product development, and technical sales, particularly in leading the development and manufacturing of aerospace and defense technologies. His expertise includes working with governmental agencies across the US, Europe, and Asia, with significant contributions to flight safety hardware and space-grade microelectronics. Mr. Mirchandani has extensive knowledge in managing projects that integrate novel technologies with critical military systems. This background is highly relevant for overseeing the adaptation of the Ga_2O_3 DC-DC converter for CMBRE (Common Munitions Built-In Test/Reprogramming Equipment), where precise power control and reliability are paramount. His strong network within the defense and aerospace markets, including partnerships with major OEMs like GE Aviation, will be instrumental in aligning the project with current military standards and operational needs.
Academic Background: Holds a B.S. in Mechanical Engineering, an M.S. in Space Systems Engineering, and is a certified Quality Representative trained in AS13001 and AS9100.
2. Dr. David Barnhart (Aerospace and Systems Integration Expert):
Dr. David Barnhart is a seasoned professional in space system integration and engineering, holding roles as a Research Professor at USC and Director/Co-Founder of the USC Space Engineering Research Center (SERC). His extensive experience with advanced aerospace projects, including his tenure as a senior project manager at DARPA, has involved pioneering cellular spacecraft morphologies and modular system architectures. This expertise will be critical for the system-level integration of the Ga_2O_3 DC-DC converter within the CMBRE framework, ensuring that the converter's design supports military-grade operational standards for munitions testing and diagnostics. Dr. Barnhart's background includes enhancing NASA's SPHERES program and working on defense-focused projects such as Phoenix and SeeMe, underscoring his ability to translate complex technology into reliable field applications. His contributions will guide the integration, testing, and refinement phases of the CMBRE-compatible power system, leveraging his deep knowledge of both traditional aerospace engineering and innovative, modular power solutions.
Academic Background: Holds a B.S. in Aerospace Engineering from Boston University and an M.Eng. from Virginia Tech, with over 60 research publications and numerous keynote presentations at global aerospace and defense conferences.
3. Dr. Pedram Chavoshipour Heris (Simulation and Modeling Expert):
Dr. Chavoshipour Heris specializes in power electronic converters, having earned his B.S. degree in power electronic engineering and an M.S. from the University of Tehran. His research covers the analysis, modeling, design, and control of power electronic systems, with expertise in coupled-inductor-based and modular converters, as well as photovoltaic systems. His deep understanding of power conversion modeling will support the optimization of the Ga_2O_3 DC-DC converter for both DoD applications, such as military aircraft power systems, and non-DoD uses, including telecom infrastructure and EV charging stations.
Academic Background: Ph.D. in Power Electronics from University of Arkansas at Fayetteville, AR
4. Dr. Uttam Singisetti (Wide Bandgap Power Electronics Expert):
Dr. Singisetti is an Associate Professor in Electrical Engineering at the University at Buffalo, SUNY, with extensive experience in developing wide-bandgap semiconductor devices. His career includes roles at UCSB, where he worked on high-frequency GaN devices, and at Intel's Component Research Lab, where he modeled advanced transistor technologies. He has coauthored over 100 publications and his research interests include III-N electronic devices and next-generation wide bandgap power devices, positioning him to drive the technical development of the Ga_2O_3-based DC-DC converter. His expertise will ensure the converter's high efficiency and thermal performance, making it ideal for U.S. Air Force platforms and beyond.
Academic Background: Holds an M.S. from Arizona State University, and a Ph.D. in Electrical Engineering from UCSB.

E. Facilities/Equipment:
Syrnatec has equipped its facility with state-of-the-art tools, equipment, and software aligned specifically for the development, testing, and validation of advanced power systems. The facility includes advanced circuit simulation software, such as SPICE-based simulators, for in-depth circuit analysis to model the

Ga_2O_3 DC-DC converter's performance under varying loads and conditions. Thermal analysis is conducted using tools like COMSOL Multiphysics, which allows for the simulation and optimization of thermal profiles, especially crucial when integrated with CNT and graphene-infused cables for superior heat dissipation. EMI analysis software is also employed to model and mitigate electromagnetic interference during high-frequency switching, ensuring stringent shielding requirements are met.The facility features high-power test benches for comprehensive power stability and efficiency testing, capable of delivering outputs up to 270 VDC at high load conditions and validating adherence to efficiency targets of 96-99%. Environmental simulation chambers replicate space-like conditions, including temperature extremes and radiation exposure, essential for assessing the resilience and performance of the Ga_2O_3 converter in simulated CubeSat and CMBRE operational scenarios. Additionally, EMI/EMC test chambers provide detailed evaluations of the shielding capabilities of CNT and graphene-enhanced cables to prevent interference during operation. For thermal and structural testing, thermal cycling chambers ensure that the Ga_2O_3 converter and cables maintain performance under rapid temperature variations, while thermal imaging systems provide real-time monitoring of heat distribution and identification of thermal hotspots during high-power tests. Reliability and durability testing infrastructure includes vibration test equipment to simulate mechanical stresses encountered during CubeSat launches and operations, ensuring structural integrity. Electrical stress testing machines assess the durability of Ga_2O_3 MOSFETs and related components, targeting an operational lifespan of at least nine years. The integration of advanced materials is supported by precision soldering and assembly equipment, essential for combining CNT and graphene-infused silicone rubber cables with the Ga_2O_3 DC-DC converter to achieve low resistive losses and optimal thermal performance. Material characterization tools analyze the conductivity and thermal properties of these nanomaterials to confirm their suitability for high-power applications. The facility is also equipped with sophisticated software for data collection and analysis, including data acquisition systems (DAQ) for monitoring voltage, current, temperature, and power efficiency throughout testing. Custom control software automates test sequences, supports metric collection, and facilitates iterative design improvements. Software tools such as LabVIEW are used for data acquisition and management, while SPICE-based simulators, COMSOL Multiphysics, ANSYS for system modeling, and custom embedded firmware for CMBRE control functions ensure comprehensive and accurate analysis.

Syrnatec's Facility

Computer Lab

Testing Lab

F. Consultants/Subcontractors:

N/A

G. Prior, Current, or Pending Support of Similar Proposals or Awards:

Syrnatec Inc. has been awarded the following awards:

- **DARPA** Topic-: Extreme Photon Imaging Capability – Hard X-ray (EPIC-HXR) **SBIR 2022** Contract no. W912CG22P0003 (Phase 1)
- **NASA** Topic-: Radiation Tolerant High-Voltage, High-Power Electronics (Phase 1) **SBIR 2021** Contract no. 80NSSC21C0335 (Phase 1)
- **NASA** Topic-: Radiation Hardened High Power "GBID" Ga2O3 Based Isolated DC-DC Converter **SBIR 2022** Contract no. 80NSSC22PB209 (Phase 1)
- **NASA** Topic-: Radiation Hardened High Power "GBID" Ga2O3 Based Isolated DC-DC Converter **SBIR 2022** Contract no. 80NSSC23CA156 (Phase 2)
- **NASA Topic-:** Z8.13 (Z8.13-2523) (80NSSC23PB601)- Autonomous Space Traffic Management Technologies for Small Spacecraft Swarms and Constellations - Contract no. **SBIR 2023** - 80NSSC23PB601 (phase 1)
- **US Space Force** Topic-: SF233-0003 - Revolutionary SmallSat Power Enhancement – **SBIR 2023** Contract No. FA24012490035 – (Phase 1)

DSIP Defense SBIR/STTR Innovation Portal
Cost Volume

SBIR Phase I Proposal

Proposal Number	F244-0007-0317
Topic Number	AF244-0007
Proposal Title	270VDC input power capability for Common Munitions Tester
Date Submitted	11/06/2024 10:32:19 AM

Firm Information

Firm Name	Syrnatec Inc.
Mail Address	549 Cedar Street, Newington, Connecticut, 06457
Website Address	https://syrnatec.com/
UEI	WWGQNYQZ2C73
Duns	062691952
Cage	8FDJ7

Total Dollar Amount for this Proposal	$139,067.58
Base Year	$139,065.50
Year 2	$2.08
Technical and Business Assistance(TABA)- Base	$0.00
TABA- Year 2	$0.00

Base Year Summary

Total Direct Labor (TDL)	$117,058.50
Total Direct Material Costs (TDM)	$0.00
Total Direct Supplies Costs (TDS)	$0.00
Total Direct Equipment Costs (TDE)	$0.00
Total Direct Travel Costs (TDT)	$0.00
Total Other Direct Costs (TODC)	$0.00
G&A (rate 10%) x Base (TDL+TOH)	$11,705.85
Total Firm Costs	$128,764.35
Subcontractor Costs	
Total Subcontractor Costs (TSC)	$0.00
Cost Sharing	-$0.00
Profit Rate (8%)	$10,301.15
Total Estimated Cost	$139,065.50
TABA	$0.00

Year 2 Summary

Total Direct Labor (TDL)	$1.76
Total Direct Material Costs (TDM)	$0.00

Total Direct Supplies Costs (TDS)	$0.00
Total Direct Equipment Costs (TDE)	$0.00
Total Direct Travel Costs (TDT)	$0.00
Total Other Direct Costs (TODC)	$0.00
G&A (rate 10%) x Base (TDL+TOH)	$0.18
Total Firm Costs	$1.94
Subcontractor Costs	
Total Subcontractor Costs (TSC)	$0.00
Cost Sharing	-$0.00
Profit Rate (8%)	$0.15
Total Estimated Cost	$2.08
TABA	$0.00

Base Year

Direct Labor Costs

Category / Individual-TR	Rate/Hour	Estimated Hours	Fringe Rate (%)	Fringe Cost	Cost
Mechanical Engineer/ Principal Investigator (Yash Mirchandani)	$110.00	170	30	$5610.00	$24,310.00
Aerospace Engineer/ Aerospace & Aviation Expert (Dr. David Barnhart)	$80.00	210	30	$5040.00	$21,840.00
Electronics Engineer/ Simulation Expert (Dr. Pedram Chavoshipour Heris)	$60.00	260	30	$4680.00	$20,280.00
Materials Engineer/ Power Electronics Expert (Dr. Uttam Singisetti)	$60.00	260	30	$4680.00	$20,280.00

Subtotal Direct Labor (DL)	$86,710.00
Labor Overhead (rate 35%) x (DL)	$30,348.50
Total Direct Labor (TDL)	**$117,058.50**

G&A (rate 10%) x Base (TDL+TOH)	$11,705.85
Cost Sharing	-$0.00
Profit Rate (8%)	$10,301.15
Total Estimated Cost	$139,065.50
TABA	$0.00

Year 2

Direct Labor Costs

Category / Individual-TR	Rate/Hour	Estimated	Fringe Rate	Fringe Cost	Cost

		Hours	(%)		
Mechanical Engineer/ Principal Investigator (Yash Mirchandani)	$1.00	1	30	$0.30	$1.30

Subtotal Direct Labor (DL)	$1.30
Labor Overhead (rate 35%) x (DL)	$0.46
Total Direct Labor (TDL)	**$1.76**

G&A (rate 10%) x Base (TDL+TOH)	$0.18
Cost Sharing	-$0.00
Profit Rate (8%)	$0.15
Total Estimated Cost	$2.08
TABA	$0.00

Explanatory Material Relating to the Cost Volume

The Official From the Firm that is responsible for the cost breakdown

Name: Nishita Mirchandani

Phone: (860) 594-5248

Phone: nishita@syrnatec.com

Title: Proposal Owner

If the Defence Contracting Audit Agency has performed a review of your projects within the past 12 months, please provide: No

Select the Type of Payment Desired: Partial payments

Cost Volume Details

Direct Labor

Base

Category	Description	Education	Yrs Experience	Hours	Rate	Fringe Rate	Total
Mechanical Engineer	Principal Investigator	Master's Degree	10	170	$110.00	30	$24,310.00
Aerospace Engineer	Aerospace & Aviation Expert	PhD	10	210	$80.00	30	$21,840.00
Electronics Engineer	Simulation Expert	PhD	8	260	$60.00	30	$20,280.00
Materials Engineer	Power Electronics Expert	PhD	10	260	$60.00	30	$20,280.00

Are the labor rates detailed below fully loaded? **YES**

Please explain any costs that apply.
Fringe Benefits includes Federal Unemployment Tax Allowance, State Unemployment Tax, Workmen's Compensation Insurance, Employee Benefits such as Health and welfare including life, accident and health

Provide any additional information and cost support data related to the nature of the direct labor detailed above.
Principal Investigators, and Other Engineers will be compensated at Industry-standard rates. https://www.bls.gov/oes/current/oes_ct.htm#19-0000

Direct Labor Cost ($): $86,710.00

Year2

Category	Description	Education	Yrs Experience	Hours	Rate	Fringe Rate	Total
Mechanical Engineer	Principal Investigator	PhD	10	1	$1.00	30	$1.30

Are the labor rates detailed below fully loaded? **YES**

Please explain any costs that apply.
Fringe Benefits includes Federal Unemployment Tax Allowance, State Unemployment Tax, Workmen's Compensation Insurance, Employee Benefits such as Health and welfare including life, accident and health

Provide any additional information and cost support data related to the nature of the direct labor detailed above.
Principal Investigators, and Other Engineers will be compensated at Industry-standard rates. https://www.bls.gov/oes/current/oes_ct.htm#19-0000

Direct Labor Cost ($):	$1.30
Sum of all Direct Labor Costs is($):	$86,711.30

Overhead
Base

Labor Cost Overhead Rate (%)	**35**
Overhead Comments:	
Overhead Cost ($):	**$30,348.50**

Year2

Labor Cost Overhead Rate (%)	**35**
Overhead Comments:	
Overhead Cost ($):	**$0.46**
Sum of all Overhead Costs is ($):	**$30,348.96**

General and Administration Cost
Base

G&A Rate (%):	**10**
Apply G&A Rate to Overhead Costs?	**YES**
Apply G&A Rate to Direct Labor Costs?	**YES**
Please specify the different cost sources below from which your company's General and Administrative costs are calculated.	
G&A Cost ($):	**$11,705.85**

Year2

G&A Rate (%):	**10**

Apply G&A Rate to Overhead Costs?	**YES**
Apply G&A Rate to Direct Labor Costs?	**YES**
Please specify the different cost sources below from which your company's General and Administrative costs are calculated.	
G&A Cost ($):	**$0.18**
Sum of all G&A Costs is ($):	**$11,706.03**

Profit Rate/Cost Sharing

Base

Cost Sharing ($):	**-**
Cost Sharing Explanation:	
Profit Rate (%):	**8**
Profit Explanation:	
Total Profit Cost ($):	**$10,301.30**

Year2

Cost Sharing ($):	**-**
Cost Sharing Explanation:	
Profit Rate (%):	**8**
Profit Explanation:	
Total Profit Cost ($):	**$10,301.30**
Total Proposed Amount ($):	**$139,067.58**

CERTIFICATE OF COMPLETION

THIS CERTIFICATE IS PRESENTED TO

Nishita Mirchandani, Syrnatec Inc.

FOR SUCCESSFULLY COMPLETING FRAUD, WASTE AND ABUSE TRAINING AND MEETING ALL REQUIREMENTS SET FORTH BY THE OFFICE OF SMALL BUSINESS PROGRAMS

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

Nov 05, 2024
COMPLETION DATE

Nov 05, 2025
EXPIRATION DATE