

Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-4388-18

Topic # N161-066  
Robust SiC MOSFET based Power Modules  
GeneSiC Semiconductor, Inc.

WHO

**SYSCOM:** ONR  
**Sponsoring Program:** PEO Ships: PMS 320 Electric Ships Office  
**Transition Target:** Navy medium voltage electric ship platforms.  
**TPOC:**  
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**Other transition opportunities:** Air and Missile Defense Radar (AMDR) Laser Power Supplies  
**Notes:** High frequency 6.5kV SiC MOSFETs such as the one pictured are expected to transform future Navy electric ship power conversion, distribution and energy storage systems.



High frequency 6.5kV SiC MOSFET - Copyright 2018, GeneSiC Semiconductor, Inc.

WHAT

**Operational Need and Improvement:** Components being developed in this program offer significant system level benefits by significantly enhances military capability through unprecedented increases in electrical efficiency throughout the naval electrical power systems. This fundamental component technology is a key enabler for many high voltage power conversion technologies onboard future ships. Presently, many power conversion systems are not even being designed for manufacture because of the <1 kHz operating frequencies and poor high temperature performance of Silicon power devices prevents their realization. The widespread use of these critical components will usher in new electronics hardware capability with high power ratings and noisy operating conditions  
**Specifications Required:** SiC power modules with low on-resistance, high voltage (6.5kV) high current (100 A), higher switching speeds (up to 20 kHz) and high temperature (200C) are being developed in this program.  
**Technology Developed:** This project is focused on developing Silicon Carbide (SiC) based Metal Oxide Semiconductor Field Effect Transistors (MOSFETs), and power modules that use these MOSFETs. The near-ideal, temperature independent switching characteristics of SiC MOSFETs allows the realization of SiC power modules with significantly enhanced capability as compared to existing technologies  
**Warfighter Value:** GeneSiC's high frequency, medium voltage SiC MOSFETs can significantly improve future Navy electric ship power conversion, distribution and energy storage systems. Power supplies for directed energy weapons and power conversion systems can be made compact, lightweight and more efficient.

WHEN

**Contract Number:** N68335-17-C-0549 **Ending on:** September 6, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Design and Fabrication of 6.5kV MOSFETs	N/A	Mask Plates, Wafer specs, and Fabrication equipment/outline ready	4	1st QTR FY18
Fabrication of 6.5kV MOSFET on 100mm platform	Med	Demonstrate 6.5kV and 350mOhm through measured data	5	4th QTR FY18
Fabrication of 6.5kV MOSFETs on 150mm platform	High	Demonstrate SiC MOSFET chips that meet the specs using 150mm foundry platform	6	1st QTR FY19
Complete detailed On-state, high temperature, and switching measurements	High	Demonstrate High Temperature as well as high frequency operation of SiC MOSFETs capable of operating at 6.5kV/40 mOhm ratings	6	1st QTR FY19
Demonstrate Phase Leg Module	High	Using multiple 6.5kV/40 mOhm SiC MOSFETs, demonstrate a Phase Leg Module capable of rated voltage, current, frequency and temperatures	7	4th QTR FY19

HOW

**Projected Business Model:** GeneSiC is a SiC device component supplier. This program enables the company to extend the offerings of its products to 6.5kV ratings. GeneSiC is an ongoing profitable firm with a diversified revenue sources – commodity Silicon rectifier products; High Temperature Specialized SiC products and solutions; Commercial SiC products and R&D services. The company intends to use its extensive distribution and sales representatives to expand its reach to higher value markets using by offering 6.5kV SiC MOSFETs, which have not yet been commercialized.  
**Company Objectives:** GeneSiC's mission is to become the market leader in high quality, high value added Silicon Carbide based semiconductor devices. The company strives to offer industry-leading device technology, and pursue high volume opportunities. GeneSiC's strategy is towards capitalizing on its core competency in device and process design to develop a significant market and intellectual property on superior SiC based devices. This includes development of rectifiers and MOSFETs, SJTs and Thyristor devices. The company is focused on sampling to, and achieving some volume traction with market leaders in each of the industry segments relevant towards SiC power devices. Progressive vertical integration of critical manufacturing and services will be performed in order to attain an industry leadership position.  
**Potential Commercial Applications:** These devices will be critical to the ongoing research into rotating and linear machines, in which the capability to deliver and extract electrical energy efficiently at very high mechanical speeds is critical for success. For airborne and space-borne systems, HV devices will have a significant impact on applications in free electron laser, active electronic warfare, decoys and seekers. A compact and efficient power supply is expected to give a substantial advantage to the Air Force's next generation radars. Another potential application for these devices is missile guidance systems

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