Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-3252-17

Topic # N151-065
Extreme Temperature, Low Loss Custom Power Switch
Mainstream Engineering Corporation

WHO

SYSCOM: ONR

Sponsoring Program: targeting…….

Transition Target: targeting…….

TPOC:
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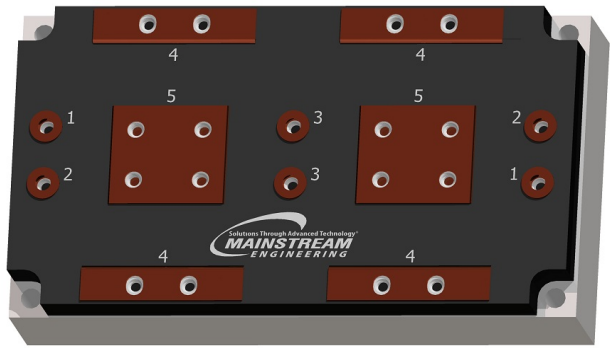
Other transition opportunities:

Notes: Mainstream Engineering's power switch, shown to the right, is currently configured to operate in -55 deg C to 100 deg C ambient temperatures. The switch's design though can be tailored to lower or higher temperature extremes by using alternative component packaging, within the power switch, without requiring the switch to be redesigned.



Power Conversion Module (PCM)
Size, Weight, Power, and Cost (SWaP-C)
Thermal Management System (TMS)
Integrated Fight Through Power (IFTP)
Line Replaceable Units (LRUs)

WHAT

Operational Need and Improvement: The Navy and U.S. Marine Corps are looking for improvements to semiconductor switch modules that will enable electric energy conversion in harsh environments such as the arctic, desert, and or cryogenic systems. In addition, Navy vehicles will also require overall improvements to power conversion SWaP-C in order to reduce life cycle costs, fuel consumption, and system volume while increasing power density and efficiency. Overall improvements to power conversion SWaP-C through are limited 1st by the semiconductor switch technology, the temperature range over which the switch can operate, and the speed / frequency it can be switched at.

Specifications Required: ONR has specified that the power electronic switch is to withstand ambient thermal variations of -225 deg C to 150 deg C and switch at 200 kHz. In addition, when incorporated into a 200 kW – 300 kW PCM, the system as a whole is required to operate with an efficiency of 98% and overall power density of 6 MW/m^3, which includes the TMS.

Technology Developed: Mainstream Engineering has developed a GaN based power switch rated for 1.3 kV and 240A peak with switching frequencies in excess of 200 kHz. The switch implements a multilevel topology to reduce EMI and incorporates a wirebondless design to improve reliability. Switch thermal extremes are handled through integrated cooling and novel packaging geometry that also allows for integrated gate drive electronics.

Warfighter Value: Mainstream Engineering's power switch will decrease waste electrical power by 3% - 6%, which equates to 6 kW – 19 kW for 200kW and 600kW systems at full load. In addition, the required space claim will be 2x – 3x smaller than current IFTP and energy storage LRUs and 9% lighter due to higher switching frequencies.

WHEN

Contract Number: N68335-16-C-0279 **Ending on:** August 7, 2018

Milestone	Risk Level	Measure of Success	Ending TRL	Date
End of Phase I: Feasibility of cryogenic power conversion system	N/A	Electrical performance at -225 deg C	TRL 3	January 2016
Phase II base: Module testing in a 100 kW three phase inverter	Med	Thermal and Electrical performance, Thermal cycling performance	TRL 6	August 2018
Phase II Option 1. PCM design and miniaturization	Low	Power Density	TRL 3	May 2019

HOW

Projected Business Model: The GaN power switch will be manufactured at Mainstream Engineering, with lead times on low volume orders of 10 – 11 weeks. The Switch will be sold as a standalone component for integration with a Prime's system / subsystem. In addition, the GaN power switch will also be used in Mainstream Engineering's power conversion product line and sold as part of a complete power conversion subsystem for commercial and military applications.

Company Objectives: Mainstream Engineering plans to further develop the power switch packaging technology to work with alternative semiconductor solutions beyond GaN. In addition, Mainstream is looking to establish transition/commercialization partnerships with prime contractors such as DRS, L3, GE, LMCO, and Northrop Grumman for the GaN power switch module.

Potential Commercial Applications: Commercial applications for the power switch include power distribution in space and under sea oil and gas drilling where extreme temperature environments are present. Wind turbines are another application area that would benefit from reductions in power conversion system size and weight with the multi-level switch capable of handling typical wind turbine voltages.

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