

# Department of the Navy SBIR/STTR Transition Program

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Topic # N142-123

High Speed and High Voltage Capacitors for Naval HPRF Directed Energy

Applications

Ballistic Devices Inc

## WHO

**SYSCOM:** ONR

**Sponsoring Program:** NAVAIR PMA 242 (Direct and Time Sensitive Strike)

**Transition Target:** High Power Radio Frequency (HPRF) Directed Energy (DE) Applications. Potentially Small (Group 1, Group 2) UAV/RPA (Unmanned Aerial Vehicle/Remotely Piloted Aircraft)

**TPOC:**

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**Other transition opportunities:**

Potentially AN/SPY-6 Air and Missile

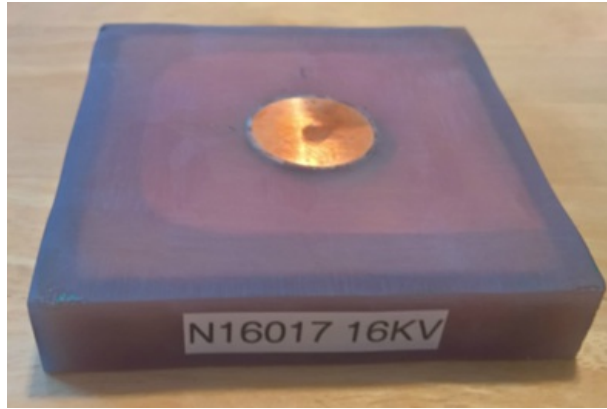
Defense Radar (AMDR), Surface

Electronic Warfare Improvement

Program (SEWIP) Block III; USN

Enterprise Air Surveillance Radar (EASR) – the next generation radar for aircraft carriers and amphibious warfare ships; DOD Prime contractors. Additionally, the academic research community and fusion research laboratories have expressed interest in these components.

**Notes:** Initial program work will be accomplished under Code 35, Division 351 – Aerospace Science Research – working with NAWCAD and PMA 242. Shown above is a 16kV 117nF capacitor for HPRF applications.



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## WHAT

**Operational Need and Improvement:** Capacitors currently available have a breakdown voltage more than an order of magnitude too low for applications that require small size, weight and power (SWaP), temperature stable dielectrics, low equivalent series resistance and the ability to repetitively charge and discharge in less than 400ns. With lower voltage capacitors, very large banks with the devices connected in series and parallel must be assembled - frequently requiring hundreds of capacitors. The Navy seeks to develop and transition a reliable, compact single device solution for high voltages and large capacitance values.

**Specifications Required:** Capacitors that can store high energies are an integral part of pulsed power systems used for HPRF applications. The technology should significantly increase energy storage density without compromising performance parameters such as internal impedance, voltage rating, leakage current, temperature stability, and reliability when compared to existing capacitors of similar ratings and application, be able to handle the mechanical and thermal stress of repetitively charging and discharging in less than 400ns, be capable of operating in a maritime or airborne environment across a temperature range of -20 °C to > 70 °C, and pass MIL-STD shock and vibration environmental testing.

**Technology Developed:** Ballistic Devices Inc. has developed a novel capacitor manufacturing technology to produce high energy density, thermally stable, very low loss components. This technology allows components to be produced with voltage ratings from as 8kV to 80kV in approximately 4kV increments. Specifically designed to support pulsed power applications such as resonance and DC block and pulse shaping, they are ideally suited for use in HPRF DE applications and for incorporation as technology upgrades for use in Navy systems such as AN/SPY-6, SEWIP Block 3, and future EASR and AMDR-X radars.

**Warfighter Value:** Incorporation of Ballistic Devices' higher energy density, thermally stable capacitors will significantly increase the performance of legacy and envisioned DE systems. These components will enable development of systems with higher power in a more compact form and enable pulse shaping, DC block, and resonance applications while reducing SWaP-C.

## WHEN

**Contract Number:** N68335-16-C-0050 **Ending on:** March 10, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstrate capacitor core high voltage capabilities	N/A	Core components successfully transmit 60MW of pulsed power	TRL 3	2nd QTR FY15
Demonstrate temperature stability of encased 80kV components	N/A	Components measured to be C0G	TRL 4	2nd QTR FY17
Demonstration of a fabrication line for 12kV, 16kV, and 80kV components	N/A	Produce components suitable for evaluation on a production line	TRL 5	1st QTR FY19
Demonstrate/validate component reliability	Med	Successfully demonstrate: reliability in high temp. environment, extended operating life, 85/85 and pulsed power stress testing	TRL 6	2nd QTR FY20

## HOW

**Projected Business Model:** Ballistic Devices Inc is currently producing components at a rate of approximately 100 units per month with the ability to scale up to 500 units per month within a 6 month timeframe. It is our intention to produce up to 10,000 units per year internally. If larger volumes are needed rapidly, we will either license the manufacturing method to another supplier, or use 3rd party volume manufacturers to meet the required demand.

**Company Objectives:** We expect to have our components to pass reliability qualification by Q1 2020, at which time we expect to have direct sales to commercial and DOD prime contractors. We will engage with DOD primes who have existing directed energy programs and encourage the incorporation of our components. To enable broad adoption, it is our intent to contact large scale component distributors to encourage commercial use. Currently we are partnering with small businesses who use these types of capacitors and using their feedback to further the development of these components.

**Potential Commercial Applications:** The initial commercial applications for these components is mostly in the pulsed power space. Power systems for fusion research and particle accelerators are a niche market. Additionally, we also intend to pursue the high voltage electron microscopy space. The use of electronic component distributors will help facilitate contact to other markets.

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