

# Department of the Navy SBIR/STTR Transition Program

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NAVSEA #16-587

Topic # N141-034

Monolithic Microwave Integrated Circuit (MMIC) Compatible Phase Shifters for Phased-Array Radars

Nuvotronics, Inc.

## WHO

**SYSCOM:** NAVSEA

**Sponsoring Program:** PEO IWS  
2.0, Above Water Sensors

**Transition Target:** Future X-Band Radar

**TPOC:**  
(812)854-5265

**Other transition opportunities:**  
AEGIS (Q4CY18) and AMDR (Q4CY18) in addition to POM16-13 Integrated Air & Missile Defense of Ships and Littoral Forces, POM16-14 Controlled, Distributed, Offboard EW, POM16-15 Integrated, Non-Kinetic Strike, and POM16-16 Protection Against Asymmetric Threats

**Notes:** Nuvotronics has revolutionized microelectronics hardware through advanced manufacturing platforms like its PolyStrata® architecture. The company also develops high-power/low-loss phase shifter technology using reliable solid-state gallium nitride (GaN) HEMT devices.



<http://www.navy.mil/management/photodb/photos/160728-N-MX772-072.JPG>

## WHAT

**Operational Need and Improvement:** Modern active electronically scanned phased array radars provide outstanding capability and performance, but they are very expensive because of the need for Radio Frequency (RF) power amplifiers at each antenna element (RF amplifiers are a primary cost driver in modern radar). The Navy is pursuing a sub-array architecture which mitigates this restriction by splitting the power from a single, highly efficient, solid-state power amplifier to multiple antenna elements, thereby reducing cost. However, sharing amplifiers among multiple antenna elements requires a phase shifter for each. This imposes power handling challenges and places significant insertion loss requirements on the phase shifter.

**Specifications Required:** The Navy is seeking to develop MMIC-compatible phase shifters meeting military system reliability requirements that will support a 4-channel phase shifter network composed of a single RF input divided into 4 independent phase-shifted output channels. The phase shifters will be capable of output power levels >5W peak/channel, >2W average/channel, switching delay of less than 1msec, phase resolution greater than 3 bits (4-bits would be desirable), and <1 dB total insertion loss between the input and the output of each phase shifter channel. The proposed phase shifters should target S, C and X Band solid state radar applications.

**Technology Developed:** Our approach exploits a state-of-the-art MMIC process and utilizes a mix of proprietary and well-known architectures for flat phase states, high power handling and low loss over wide bandwidths. Used in passive phased arrays, Nuvotronics phase shifters provide cost savings compared to active phased arrays, or can be used in T/R modules to enable new active phased array architectures. Very high power solid-state power amplifiers can also benefit from the technology for phase aligning constituent amplifiers. For systems requiring up to 30% bandwidth from L-band to K-band with a maximum power/element up to 10 watts, the company has developed a four-bit X-band PIN diode phase shifter demonstrator.

**Warfighter Value:** Up to 80% reduction in active circuits compared to AESA will result in substantial cost savings to Navy and other defense agencies.

## WHEN

**Contract Number:** N00024-16-C-4035 **Ending on:** March 6, 2018

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Test four-bit PIN diode phase shifter breadboard	Low	1.5 dB loss for four bits	4	September 2016
Test GaN HEMT phase shifter iteration 1	Med	1.2 dB loss for four bits	5	February 2017
Test GaN HEMT phase shifter iteration 2	Med	1 dB loss for four bits	5	February 2018
Build and test a subarray (if option is awarded)	Low	Produce antenna scan patterns	6	February 2019

## HOW

**Projected Business Model:** Nuvotronics, Inc. a leading innovator in radio frequency (RF) hardware and defense technology, has a 40,000 square-foot manufacturing facility in Durham, N.C. The space integrates research, development, design and 15,000 square feet of cleanroom operations for a 8-inch wafer fabrication line, assembly and test for its proprietary PolyStrata® architecture. The company plans to grow its product areas in miniaturized next-generation phased arrays, solid state power amplifiers (Ka, E, V, W, and G-Band), and advanced microwave and millimeter wave passives such as baluns, filters, diplexers, and time delay units. The company's unique precision 3D micro-scale manufacturing has wide market applications.

Nuvotronics is prepared for module level manufacturing of this device, supplying to DoD Prime Contractors. Nuvotronics is also open to a licensing model of the phase shifter element given the right economic factors and licensing partner.

**Company Objectives:** Nuvotronics has a strong history in transitioning SBIR related work into products for our customers. The company's mission is to be the leading supplier of microfabricated RF components and subsystems to aerospace, defense, and commercial customers. We are prepared to transition this technology into phased arrays and can support component analysis to determine performance and cost benefit for current and future phased arrays.

**Potential Commercial Applications:** This technology also applies to various other radar applications such as Federal Aviation Administration (FAA) radars, law enforcement radar, Coast Guard radars, and commercial ship radars. The technology might also be applied to microwave and millimeter wave imaging systems.

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