

# Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2018-0516

Topic # N161-031

Efficient, Low-Loss Combiner Technology for Affordable Transmit and Receive Module

Manufacturing

Nuvotronics

## WHO

**SYSCOM:** NAVSEA

**Sponsoring Program:** PEO IWS 2.0, Air and Missile Defense Radar (AMDR)

**Transition Target:** Not limited to a specific program but targeting high power PAs for EW, wideband high power combiners for traditional and future frequency bands, radar T/R modules, etc.

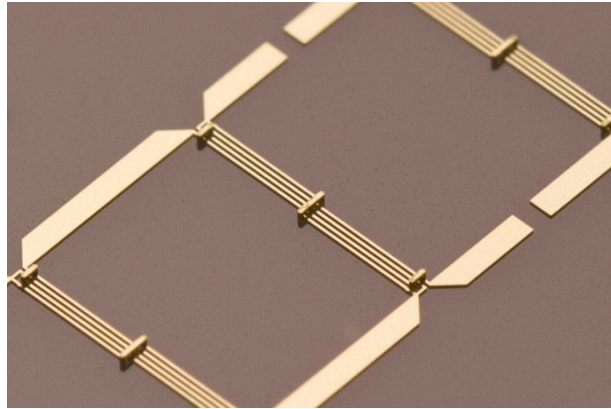
**TPOC:**

(812)854-6385

**Other transition opportunities:**

SEWIP Block II EW system, E-2D Advanced Hawkeye, AN/ALQ-99 jamming, EA-6B and EA-18G EW aircraft, AN/ASQ-239 electronics warfare suite for F35 Joint Strike Fighter, and AOEW as a future program opportunity.

**Notes:** We streamlined our exclusive PolyStrata microfabrication process to batch-manufacture affordable 3D couplers using plated copper on low cost large-format substrates. Couplers developed during this program are fully compatible with automated module assembly, require no critical wire-bond geometries, and are held to micron tolerances that improve repeatability.



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## WHAT

**Operational Need and Improvement:** Future Navy radar and electronic warfare (EW) systems will be based on radio frequency (RF) transmit and receive (T/R) module architectures where dozens (perhaps hundreds) of T/R modules are packed tightly behind the array face. Typically, each individual T/R module contains two or more monolithic microwave integrated circuit (MMIC) high-power amplifiers (HPAs). Within the T/R module, the HPA outputs are combined with a power combiner to supply a required output power, which is determined by system performance and cost trade-offs. For T/R module designs that combine multiple HPA outputs, the power combiner is integral to the design.

**Specifications Required:** The proposed couplers must be compatible with existing GaN-based T/R module technology, enabling transition of the technology to near-future Navy systems in the form of technology updates without requiring fundamental system architecture changes while future designs also benefit. It must have reliable life expectancies comparable to the combiner technology they will replace (a T/R module service life of at least 15 years). Finally, it must be compatible with existing automated assembly processes standard to the industry (e.g. pick-and-place assembly) so that it may be easily inserted into the manufacturing process. As a guideline, a 50% increase in combiner cost over that of current thick film on ceramic technology is acceptable.

**Technology Developed:** Nuvotronics has developed an improved manufacturing method for RF power combiners with improved efficiency performance, cost-competitive with existing COTS technologies from S-band through millimeter-wave frequencies. Our couplers offer significantly higher power performance compared to existing COTS parts as well. The technology has broad applications in Navy radar, electronic warfare and communications systems that require solid-state power-combined amplifiers with power levels to hundreds of watts.

**Warfighter Value:** This topic serves to increase mission capability by enhancing basic sensor (radar and EW system) performance such as detection range. A secondary benefit is increased system efficiency, which translates into reduced cooling load and, as a result, decreased operating cost. The Navy is making a huge investment in T/R module based phased array systems that incorporate hundreds of modules in each array face. Extracting the maximum power possible from each T/R module optimizes system performance and produces the greatest return on investment in the system.

## WHEN

**Contract Number:** N00178-17-C-7001 **Ending on:** December 31, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Fabricate prototype couplers	Med	Verify low loss	4	March 2017
Temperature cycle prototype couplers	Med	Verify no delamination	5	June 2017
Fabricate and test four-way combiner combined with thick-film process	Med	Verify test articles	4	September 2018
Design and test wideband microstrip coupler	High	Verify low loss	4	September 2018
Verify four-way combiner in SSPA module	Med	Show improved power and efficiency over baseline design	6	May 2019

## HOW

**Projected Business Model:** Nuvotronics, Inc., a leading innovator in radio frequency (RF) hardware and defense technology, has 80,000 square feet of space, including a 17,000 sq. ft. 8-inch wafer cleanroom, assembly and test line in Durham, NC. Certified to AS9100D, Nuvotronics integrates research, development, design and manufacturing to provide solutions that take advantage of its proprietary PolyStrata architecture.

The company is currently executing successfully on long term plans to grow its product line in miniaturized next-generation phased arrays, solid state power amplifiers (Ka, E, V, W and G bands) and advanced passive microwave and millimeter wave devices such as couplers, baluns, filters, diplexers and time delay units. The company's unique precision 3D micro-scale manufacturing has wide market applications.

**Company Objectives:** Nuvotronics seeks suitable defense prime transition partners interested in incorporating this efficient combiner technology into one of the target transition programs or a similar suitable application. Creative new ideas for insertion from interested partners are also enthusiastically encouraged.

**Potential Commercial Applications:** Having experienced success with launching Polystrata technology solutions in the traditional space and in the terrestrial signal intercept market with a variety of functions including beamforming and sub-octave pre-selector modules, Nuvotronics is focused on expanding into other markets which can benefit from the size, weight and mechanical precision advantages of our technology. These markets cover both defense and commercial applications and include electronic warfare, radars and sensors, new space, 5G cellular backhaul and automotive radar.

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