

Topic: N171-074

Physical Optics Corporation

Tunable, Rapid, Electronically Controlled X-band (T-REX) Notch Filter

To address the Navy need for fast, affordable, and reliable tunable notch filters at X-band frequencies, Physical Optics Corporation (POC) proposed to develop a new Tunable, Rapid, Electronically Controlled X-band (T-REX) notch filter, based on a resonating RF structure utilizing ferroelectric-based capacitors for ultrafast-frequency tuning. The innovation in the resonating RF structure provides a large tunable range by using tunable capacitors to quickly (<50 ns) change the impedance to shift the operational frequency. As a result, the initial T-REX Phase I prototype filters offer notch attenuation >-40dB within the 8.8 GHz to 12 GHz range, minimal passband insertion loss (<0.3 dB), and a notch bandwidth from 800 MHz to 1200 MHz with low reflected power (<10%), which directly addressed the Navy need for low-cost electronic warfare and military communications systems that suppress interference. In Phase II, POC will further optimize the T-REX filter design. POC will develop a fully functional prototype, covering the entire frequency range (from 8 GHz to 12 GHz) for demonstration and evaluation at a Navy facility, to reach technology readiness level (TRL)-6/-7.

Technology Category Alignment:

RF Components for sensing, transmission and communication

Electronic Warfare (EW)

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SYSCOM: NAVSEA

Contract: N68335-19-C-0209

 Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-19-C-0209

Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2019-0588

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Physical Optics Corporation

WHO

SYSCOM: NAVSEA

Sponsoring Program:

Transition Target: SEWIP block II

TPOC:

(812)854-4804

Other transition opportunities:

Radio Frequency (RF) system manufacturers will be potential customers of the T-REX filter, i.e., U.S. Navy electronic warfare (EW) and military communications systems. Other potential customers for T-REX include cell phone companies, vessel traffic control equipment and satellite communication (SATCOM) manufacturers and wireless network developers. At other frequencies, a modified version of T-REX may be of utility to cellular telephone companies. The T-REX filter will be useful anywhere for wireless data transmission that requires improved filter performance. Dual use players include Netgear, Loral Space and Communications, and Paragon Towers, Inc.

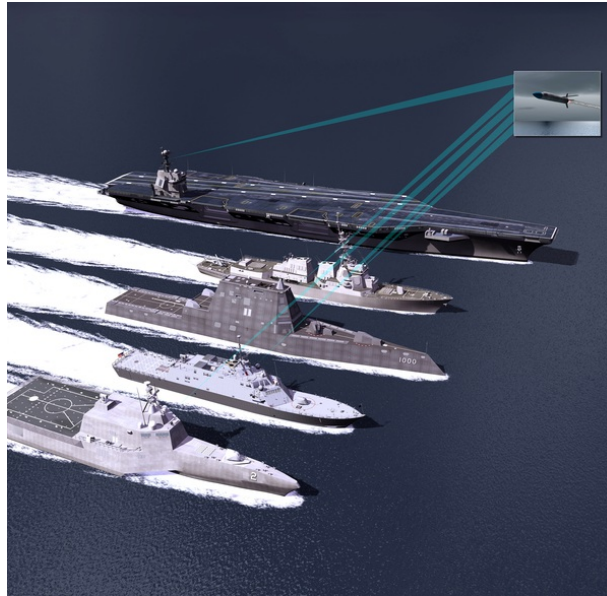


Photo Courtesy U.S. Navy (<http://mil-embedded.com/articles/u-modernization-effort-centers-cots/>)

WHAT

Operational Need and Improvement: Many current dual use solutions incorporate microwave filters including cavity, lumped element, ceramic, and microstrip. Cavity filters have very low insertion losses and high isolation (>50 dB); however, they're large with slow tuning speeds. Lumped element filters usually have very low Q factors and do not provide sharp enough skirt performance to meet the current attenuation, bandwidth, and insertion loss requirements. Ceramic filters are small but have high insertion loss and are not tunable. Standard microstrip filters generally have very high insertion losses at high frequencies. Therefore, no current technology completely addresses the U.S. Navy's needs.

Specifications Required: Low-SWaP (size, weight and power), fast, agile, affordable, and reliable tunable notch filters at X-band (8-12 GHz) for EW and military communications systems that suppress interference. Other figures of merit and functionality are: stop-band attenuation is >40 dB, pass-band attenuation should be <0.3 dB, fast tuning speed <1 μ s, and per-unit cost of under \$2000.

Technology Developed: Physical Optics Corporation (POC) is developing T-REX, a new notch filter, based on a resonating RF structure using ferroelectric-based capacitors for ultrafast-frequency tuning. The innovation in the resonating RF structure provides a large tunable range by using voltage-variable barium strontium titanate (BST) capacitors to quickly (<1 microsecond) change the impedance to shift the operational frequency. T-REX filters offer notch attenuation >40dB location within the 8 GHz to 12 GHz range, minimal passband insertion loss (<0.3 dB), and a notch bandwidth from 80 MHz to 1200 MHz with low reflected power (<10%) which directly addresses the U.S. Navy need for low-cost EW and military communications systems that suppress interference.

Warfighter Value: T-REX addresses U.S. Navy requirements for fast, affordable, and reliable tunable notch filters at X-band and higher frequencies for EW and military communications systems that suppress interference. T-REX can be used in a broad range of civilian commercial applications including transmission tower relays, civilian communication systems, and possibly FM radio tuners and transmitters for better isolation between nearby radio transmissions. It can be used in base stations to enhance the signal coverage in a particular area while minimizing interference to other areas. Furthermore, it can be mounted on trains and other vehicles for wideband communication such as WiMax, digital TV, and SATCOM; also T-REX can have advantages in maintaining contact with First Responders.

WHEN

Contract Number: N68335-19-C-0209 **Ending on:** July 22, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
T-REX design optimization completed	Low	simulation result fulfill navy's requirements	3	September 2019
First-generation T-REX prototype development completed	Med	measured result fulfill navy's requirements	4	November 2019
ICD for the T-REX prototype completed	Low	the filter has the right interfaces and SWa-P match Navy's requirement	5	November 2019
T-REX prototype laboratory demonstration completed	Med	measured result fulfill navy's requirements	5	February 2020

HOW

Projected Business Model: POC plans to manufacture the filter in-house. The estimate for the first year after Phase II completion is based on two key considerations: our manufacturing capability and our presence in the military market. As of today, POC can produce sixty T-REX units per year, capable of generating a revenue of \$400K in low-rate initial production (LRIP). With available expansion space in our manufacturing facilities scheduled for 2020, we can accommodate up to 100 T-REX units per year in full-rate production (FRP) to reach a target of \$20M within three years after completing Phase II.

Company Objectives: POC has a long and successful history of commercializing technologies developed from SBIR projects. Our company has already introduced to the market 100 products, launched seven spin-off companies, and provided the technology base for two new ventures. Furthermore, POC has licensed to industry 62 technologies derived from SBIR projects. Currently 38% of POC's business including affiliates is related to SBIR-derived products. POC products are already in use at 71 DoD/DOE sites including aircraft flight data recorders and data transfer systems, displays on aircraft and tanks, video surveillance equipment at nuclear facilities, multimedia links at the Pentagon and U.S. intelligence/NATO centers, data networks on 28 Navy capital ships, and a variety of components integrated by prime contractors. POC received two contracts with total value of \$20.6 million from the Navy T-45 platform for production of aircraft data recorders. This was followed by over \$14 million in contracts from V-22 and MH-60 platforms.

Potential Commercial Applications: Due to its outstanding features, RF system manufacturers will be potential customers of the T-REX filter. The first approach will be to meet needs of the primary sponsor of this project (Navy) for EW and military communications systems that suppress interference. Beyond this, potential customers for T-REX include cell phone companies, vessel traffic control equipment and SATCOM manufacturers, as well as wireless network developers. At other frequencies, a modified version of T-REX may be of utility to cellular telephone companies. Essentially, the T-REX filter will be useful anywhere for wireless data transmission that requires improved filter performance. Some of the major players include Netgear, Loral Space and Communications, and Paragon Towers, Inc.

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