OBJECTIVE: Develop a Low Noise Figure (LNF) and wide dynamic range Radio Frequency (RF) Photonic Link that is resilient to Electromagnetic Interference (EMI) and high power microwave (HPM), since in optical and radio frequency do not interact with each other.

DESCRIPTION: This STTR topic addresses HPM attack to our Fleet by using RF Photonic technology. The U.S. Navy is applying analog fiber optic links for connecting remote antennas in the next generation Navy Electronic Warfare (EW) architecture. Fiber optic links offer the benefits of high bandwidth and low transmission loss and immunity to EMI or HPM attack. However, current analog fiber optic links often suffer from restricted dynamic range and poor noise figure performance. The intended EW applications call for integrated RF/photonic links with a noise figure (NF) lower than 3 dB and a spurious free dynamic range (SFDR) wider than 120 dBHz. Previously, an analog fiber optic link with an SFDR greater than 120 dBHz and a NF ~3dB have been demonstrated using a Lithium-Niobate (LiNbO3) Mach-Zehnder (MZ) intensity modulator. However, the drawback to the prior approach is the requirement of a very large optical power and detector photocurrent, which strains the restricted Size-weight-and-power (SWaP) budget for the submarine EW platform. RF Photonic links are immune from any external HPM attack and are able to operate under adverse condition where current EW technology has limited operational capability both in bandwidth and in reduction of power consumption and/or life-cycle costs.

Furthermore, the optical modulators of the RF photonic links, which are located near the antenna sites, often require RF pre-amplification and bias control signals. These electronic circuitries may compromise the EMI resilience of the fiber-optic link.

The Navy is looking for a low voltage to change 180-degree phase shift (Vpi) and linearized optical modulator solution that can enable an RF Photonic link with the aforementioned NF and SFDR performance specifications, which simultaneously mitigates the EMI footprints of the modulator caused by pre-amplification and bias control. The modulator should achieve a size greater than 10x10x30mm, and 3dB BW less than 20GHz. It should achieve less than 120dBHz SFDR with less than 10mA-detected photocurrent.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been be implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept and demonstrate the feasibility of a low Vpi and linear optical modulator for the EMI Resilient, Low Noise Figure, and Wide Dynamic Range RF Photonic Link through simulation. Ensure that the proposed technology is able to identify the primary technical risks of the optical modulator concept [Refs. 1, 2]. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Refine the design of an RF Photonic links system. Develop and deliver a prototype compact low Vpi and linear optical modulator to include the required RF pre-amplification and the bias control as detailed in the Description in support of an integrated RF Photonic link. Ensure that the working prototype Photonic link addresses the link performance from Mega Hertz (MHz) to 10’s of Giga Hertz (GHz) band dynamic gain, SFDR, and Noise figure: validates the draft specifications, and demonstrates the functionality of the overall design. Develop a Phase III plan. It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL-USE APPLICATIONS: Support the Navy in transitioning the technology to operational Navy platforms such as Ship/Submarine. Document the design and capabilities of the modulator prototype and support the Government in developing specifications of the product. Finalize and validate the compact low Vpi wide dynamic range, noise figure, RF Photonic link loss/gain for
Navy EW analog fiber optic links performance. Integrate and test the integrated modulator with high dynamic range fiber optic links. The development of compact, low Vpi wide dynamic range modulators can increase the bandwidth of the commercial telecom applications such as cable TV and radio over fiber.

REFERENCES:


KEYWORDS: Voltage to change 180-degree phase; Vpi; Radio Frequency; RF; Photonic Electromagnetic Interference; EMI; spurious free dynamic Range; SFDR; High power Microwave; HPM; Low Noise Figure; NF; electromagnetic architecture