Department of the Navy SBIR/STTR Transition Program

DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited.

NAVAIR 2020-724

Topic # N182-101

Multicore Fiber Optic Package Optical Subassembly for Wideband Digital and Analog Photonic Links

Phase Sensitive Innovations, Inc.

WHO

SYSCOM: NAVAIR

Sponsoring Program: PEO (T), PMA 234

Transition Target: Airborne Electronic Attack Systems

TPOC:
(301)342-4122

Other transition opportunities: Potential applications of a balanced detection IMDD link includes: a) Millimeter wave wireless telecommunications; b) Long haul antenna remoting; c) Phased array antennas (AESA, SPY-1)

https://www.navair.navy.mil/product/ALQ-99-Tactical-Jamming-System

Notes: The wide applications of analog photonic links is limited by their cost and reliability concerns and mostly by their noise and linearity performances. The successful development of the balanced detection IMDD link will remove these limitations by substantial improvements on the link NF and linearity. High link output power and high linearity become indispensable backbone technology for tomorrows 5G communication and high frequency signal generation using photonic approaches.

WHAT

Operational Need and Improvement: Bulky, heavy, EMI-susceptible metal cables in today's war fighter not only raise SWaP concerns and also limit the system bandwidth due to high RF loss at elevated frequencies or over long distance. As a comparison, optical fibers are nearly lossless in transporting RF signals, very light and inherently immune to EMI. Replacing metal cables with RF photonic links can significantly improve the system SWaP and bandwidth but is currently limited by link NF. A broadband, low NF, high dynamic range RF photonic link is therefore highly demanded in tomorrow's avionic and marine platforms.

Specifications Required: The program objective is to develop two-core-, multicore-, fiber optic-based analog and digital links consisting of a DFB laser, a dual-output modulator and a balanced photo detector. The link specs include: 1) >100m two-core, multicore, single-mode fiber; 2) low optical insertion loss (~0.75dB), low return loss (~30dB) and low optical crosstalk (-40dB); 3) 10MHz – 45GHz link bandwidth; 4) >200mW input power for the dual-output modulator. Good path length matching over long distance and broad bandwidth as well as high laser relative intensity noise (RIN) rejection shall be demonstrated by developing and prototyping a high gain, low NF and high dynamic range balanced detection link. Thermal shock and temperature cycling studies are required to verify optical subassembly performance.

Technology Developed: Based on our industry leading low Vpi modulator and high-power photodiode technologies, PSI is developing a low-Vpi, high-extinction ratio dual-output modulator and a high-linearity balanced photodiode that can be integrated to a multicore fiber cable. Hermetic, ruggedized component packages and a plug & play link prototype will be delivered towards the end of the phase II effort.

Warfighter Value: The modern warfare environment has become a vast “information highway,” where communication, radar, surveillance and electronic support all compete for available bandwidth. Broadband connection between different subsystems enables today's warfighter for higher speed, better sensitivity, larger dynamic range, etc. In addition, fiber links significantly improve warfighter's payload by replacing the heavy, bulky metal cables and reduce warfighter's susceptibility to high-power microwave (HPM) attacks.

WHEN

Contract Number: N68335-20-C-0295 **Ending on:** March 15, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Develop dual-output MZM package	Med	Dual-output MZM with <4V half wave voltage and ~30dB extinction ratio	6	September 2021
Develop BPD package	Low	20GHz BPD with >0.5 A/W responsivity and >30dB CMRR	6	September 2021
Develop long MCF for link demo	Low	~100m MCF fiber with >35dB isolation between cores	4	June 2021
MCF-based BPD link demo	Low	20GHz broadband link with <20dB link NF using link prototype	4	March 2022
Ruggedized link prototype	Med	Ruggedize link prototype to meet relavent military specs	6	March 2023

HOW

Projected Business Model: PSI's goal is to integrate and transition this technology into government and prime contractor systems for upgrading current system’s bandwidth, NF, SWaP and reliability. Under several government fundings, PSI is building our own nanofab, packaging and characterization labs. We are planning to reach MRL 6 for component chip and package manufacturing in 2 years. PSI will also work with our existing prime customers to insert this technology into their systems.

Company Objectives: PSI is improving the dual-output modulator and balanced PD design and fabrication for improved bandwidth, efficiency and power balance and will acquire a long MCF sample to study their length matching properties in controlled environment for potential platform deployment. Integration of both the BPD and the dual-output MZM will focus on maintaining and improving the system balance and noise rejection capability. An MCF-based balanced detection IMDD link prototype using fully packaged components will be demonstrated in the phase II effort to meet the required link specs. PSI's goal is to integrate and transition this technology into government and prime contractor systems for upgrading current system’s bandwidth, NF, SWaP and reliability.

Potential Commercial Applications: There are tremendous market demands for high-performance RF photonic link in both DOD and commercial markets. Replacing heavy, low-bandwidth and expensive coaxial cables with light, broadband fibers is widely demanded for antenna remoting, high-speed communication and phased array in many avionic and 5G systems. Low NF RF photonic link is also the fundamental building block for essentially all analog photonic systems.

Contact: Peng Yao, Principal Investigator
yao@phasesensitiveinc.com (302) 286-5191