Department of the Navy SBIR/STTR Transition Program

Statement A: Approved for public release, distribution is unlimited. (30 November 2015)

Topic # N123-161

DYNAMIC TUNER FOR NARROW-BAND VLF SUBMARINE COMMUNICATION TRANSMITTING SYSTEM

Diversified Technologies, Inc.

WHO

SYSCOM: SPAWAR

Sponsoring Program: Undersea Integration Program Office (PMW 770)

Transition Target: Fixed Submarine Broadcast System (FSBS)

TPOC:

Other transition opportunities: High Power Switches, Power Conversion, High Voltage Solid-State Circuit Breakers, RF-Signals, Submarine Communication

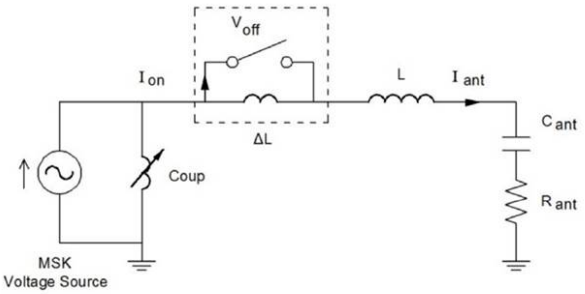

Figure 1. Dynamic tuning circuit. The incremental tuning inductor ΔL is shunted by a solid-state switch.

WHAT

Operational Need and Improvement: The U.S. Navy's Very Low Frequency/Low Frequency (VLF/LF) Submarine Broadcast is vital to America's strategic defense, providing reliable means to command submarines at depth, as well as other fleet assets, using high power radio stations all over the globe. The six major VLF stations would benefit from enhanced transmission efficiency and radiated-power with the customary 200 baud Minimum Shift Keying (MSK) modulation with its 100 Hz frequency shifts.

Specifications Required: Electronic, dynamic tuning of a resonant VLF antenna is a low-loss energy-conversion process applied to the electromagnetic energy stored in the antenna and its tuning inductors. This stored energy is converted back and forth between the MARK and SPACE frequencies by causing a small change in the antenna tuning inductance, causing the antenna resonance to track exactly the instantaneous frequency of the MSK signal. Full center-frequency CW power and efficiency are thus made available on MSK, independent of antenna bandwidth.

Technology Developed: Diversified Technologies, Inc's (DTI) technical solution is this nearly-ideal solid-state switch. Comprised of many transistors operated in a series-parallel array, the switch is capable of switching at the voltage and current required by the individual transmitters (order kV, kA) without significantly sacrificing the intrinsic speed and performance of the devices. This technology is a logical and optimized extension of equipment DTI has built for other applications.

Warfighter Value: DTI's switching technology offers a modern, reliable, and modular solution to this need. Depending on the particular site profile, DTI's switch will increase efficiency by up to 50%, greatly reducing operating and maintenance costs. The switch will also open new frequencies to use, granting a flexibility not currently available to the sites. Finally, as a modular solution, the cost of implementation will be greatly reduced in comparison to fully custom designs.

WHEN

Contract Number: N66001-14-C-5212 **Ending on:** December 23, 2016

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Design 2 kV, 1.2 kA AC Switch	N/A	Design of dynamic tuning switch provides capability of dynamically tuning the antenna of a VLF transmitting station, allowing the Navy to operate existing VLF stations at lower frequencies	3	January 2015
Fabricate Low Power Module	N/A	Assembly of low power module, expected performance of 1 kV / 600 A at 55 kHz and extensible to high power switch, complete	4	June 2015
Test Low Power Module	Low	Low power module tested to 150 V, 150 A at 55 kHz, limited by in-house power	5	September 2015
Fabricate and Test Full	Med	Full switch tested to 1 kV, 600 A at Dixon Naval Radio Transmitter Facility	6	December 2016

HOW

Projected Business Model: DTI plans to fabricate internally and install in concert with the Navy and relevant contractors.

Company Objectives: The primary market for the specific technology developed in this SBIR is the Navy's VLF transmitter network. These systems alone represent a multi-million dollar opportunity for this technology. Beyond this specific application, the underlying technologies developed in this SBIR address all of DTI's high voltage switching markets. Developing and fielding solutions to the demanding VLF systems will make our other, more traditional components more reliable and capable.

Potential Commercial Applications: DTI's development of a next-generation dynamic tuning system for VLF transmitters will feed several initiatives in the future. First, it represents a significant expansion of DTI's existing RF power portfolio, both in functionality and frequency band. Once DTI has provided a functional dynamic tuner, we will be uniquely positioned in the marketplace as the only provider of such a tuner. The robustness and extreme reliability of this tuner has potential to drive our other RF offerings into even more extreme environments and requirements space, which will benefit a range of military, industrial, and high energy physics customers--all of whom would benefit from more reliable, novel switch and tuner technologies.

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