OBJECTIVE: Develop a high-powered Radio Frequency (RF) linear power amplifier that enables efficient, linear operation with multiple simultaneous signals across a wide instantaneous bandwidth capable of operating in an active antenna array.

DESCRIPTION: Current Navy directional, tactical communication networks operate in a one beam at a time fashion with each message exchange assigned separate time slots. This limits network performance and spectral usage. The next generation of communication networks will use multiple simultaneous beams to leverage the spatial dimension in order to establish multiple communication links simultaneously in different directions. To achieve the major networking advantages of multi-beam operation (discussed below) enabled by digital array communications technology, power amplifiers will need to be developed that do not generate unacceptably high levels of interfering nonlinear effects when multiple communications signals are transmitted through them simultaneously. Current state-of-the-art amplifier designs are challenged to achieve acceptable levels of linearity performance without significant reductions in RF power, bandwidth, and power-added efficiency. Due to the reduced link ranges and allocated bandwidths of commercial communications, there is little investment to meet the metrics required for Navy operation.

Linearity together with power, bandwidth, and efficiency enables multichannel Transmit (Tx) capability. This, in turn, yields increased network throughput and decreased latency. High linearity also enables new, modern waveforms that further improve throughput. Improved throughput is needed to support the increasing network sizes; the growing emphasis on joint, cooperative, and net-centric technologies; as well as the proliferation of Unmanned Aerial Vehicles (UAVs) and other persistent surveillance platforms with their high throughput requirements. The resulting increased throughput will enable the flow of more data and growth in new mission areas such as Ballistic Missile Defense and Electronic Warfare. The decreased latency will enable new and compressed kill chains against advancing threats as well as larger networks. The Navy needs a technology that provides simultaneous, multichannel Tx operation. This will enable the warfighter to expand and refine the battlespace through improved and expanded network functionality.

A solution is needed in the area of high-powered RF linear power amplifier. Advanced techniques such as those described in [Refs. 1-3] will be needed to attain the targeted performance metrics. Current commercially available power amplifiers do not meet the combined power, bandwidth, linearity, and efficiency performance needed for military, multichannel operations.

The prototype amplifier solution must demonstrate the following performance metrics: (1) The amplifier will transmit M-ary Continuous Phase Frequency Shift Keying (CPFSK) and Orthogonal Frequency Division Multiplexing modulations and up to 4 simultaneous signals located in C-band (4 GHz to 8 GHz). The instantaneous bandwidth of these signals will be relatively narrow compared to the operational bandwidth of all C-band. 8 is a stretch goal for the number of simultaneous signals. (2) The peak power output by the power amplifier should be selectable from 36 dBm to 46 dBm in 2 dB steps. (3) The goal for the Error Vector Magnitude (EVM) is 2% or less. (4) The output third order intercept should be more than 55 dBm. (5) The goal for the power-added efficiency is 55% or more. (6) The goal for the power gain is 45 dB with 0.5 dB of gain flatness over the operational bandwidth. The power amplifier will need to fit on
a board that is 7 inches by 1.75 inches and occupy less than roughly 30% of the area (approximately 4 square inches). All performance metrics should be met while operating with an output Voltage Standing Wave Ratio (VSWR) between 1:1 and 2:1 in the architecture.

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: Define and develop a concept for a high-efficiency wideband linear power amplifier. Demonstrate the concept can feasibly meet the Navy requirements as provided in the Description. Establish feasibility by a combination of initial analysis and modeling and if possible, through demonstration on existing hardware. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype in Phase II. Develop a Phase II plan that includes prototype testing, evaluation, and demonstration.

PHASE II: Develop and deliver a prototype power amplifier that demonstrates the performance parameters outlined in the Description. Validate the prototype through comparison of model predictions to measured performance. 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 Navy use. Further refine the prototype for evaluation to determine its effectiveness and reliability in an operationally relevant environment. Support the Navy in the system integration and qualification testing for the technology through platform integration and test events to transition the technology into PEO IWS 6 applications for simultaneous communications links to improve and expand tactical network functionality.

High-powered RF linear power amplifiers will have direct application to private sector industries that involve directional communications between many small nodes over large areas. These applications include transportation, air traffic control, and communication industries.

REFERENCES:


KEYWORDS: Linear Power Amplifier; Power Added Efficiency; High-powered Radio Frequency; RF; Multibeam Operation; Digital Array Communications; Spatial Dimension