

# Transition

An example of a U.S. Air Force supported Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) technology that has transitioned into an Air Force, other DoD agency, or commercial industry system or subsystem.

**Topic Number:**

AF093-146

**Topic Title:**

Broadband, Ultra-linear, Extremely High Frequency (EHF) Traveling Wave Tube Amplifier

**Contract Number:**

FA8650-11-C-1022

**SBIR Company Name & Location:**

Linearizer Technology Inc., Hamilton, New Jersey

**Technical Project Office:**

AFRL Sensors Directorate, Wright-Patterson AFB, Ohio

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Figure 1: Military satellite communication systems require highly efficient linear transmitters to minimize distortion and improve signal quality. (Courtesy photo)

## New Jersey Small Business Develops Linear Efficient Transmitter

Airmen conducting surveillance of adversarial activities in today's war on terror require more than just voice communication. Images, video and other data elements are critical if the warfighter is to accomplish their mission. Modern communications systems use complex modulation schemes, such as Quadrature Amplitude Modulation (QAM), to increase the information that can be transmitted in a given channel. Power amplifiers made for these modulations must be highly linear in order to minimize distortion that degrades adjacent channel signals and signal transmission quality.

To achieve the required level of linearity, it is common practice to operate power amplifiers at a reduced power level, or what is known as "high output power backoff." However, there are consequences to this approach such as low efficiency, unnecessary heat generation and higher costs. At millimeter-wave or extremely high frequencies (EHF), these factors can make a communication system impractical to implement, particularly for applications that are sensitive to power consumption, such as satellite communications (Fig. 1) and avionic/mobile communication platforms.

## Air Force Requirement

Bandwidth efficient modulations such as 16QAM allow transmission of three or four times more data in the same amount of bandwidth used by a standard modulation. However, they require increased linearity from the power amplifier. Power amplifiers that provide both linearity and optimum efficiency are essential for the transmission of high data-rate, bandwidth efficient signals.

To support this critical mission, the Air Force needs advanced, compact, linear and efficient linearized traveling wave tube amplifiers (TWTA). Linearizers are electronic circuits that improve the non-linear behavior of amplifiers to increase efficiency and maximum output power. The TWTA are a new technology that supports future generations of bandwidth efficient military satellite communications.

## SBIR Technology

Working with the Air Force under a Small Business Innovation Research (SBIR) award, Linearizer Technology, Inc., (LTI) developed and demonstrated a compact EHF linear, high-power transmitter with reduced size, weight, power (SWAP) and cost, compared with other current technology.

The linearizer microwave power module-transmitter (LMPM-T) includes a miniature TWT-based microwave power module produced by L-3 Electro Dynamics Division and an X- to Q-band linearizer block up-converter (L-BUC) produced by LTI. It is designed for the transmission of QAM and other bandwidth-efficient complex digital modulations. The company fabricated and tested a prototype LMPM-T that delivered a linear power output greater than 50 watts, with an overall efficiency greater than 20 percent.



Figure 2: Complete X- to-Q-Band Transmitter (LMPM-T) with >50 W linear power is shown above. (Courtesy photo)

## Transition Impact

The resultant linearity of this transmitter improves upon current satellite communication specifications and provides an efficiency increase that is two to three times greater than present millimeter-wave power amplifiers.

This technology also has value for both space-borne and ground-based systems. The resulting MPM-T will be valuable in all Q-band/EHF communication systems where bandwidth efficiency and power consumption is of concern. Portable, mobile and airborne communications systems will be prime candidates for integration of this technology.

“The integration with a linearized block up-converter resulted in the demonstration of a fully functional, low SWAP, efficient millimeter-wave MPM communications transmitter, which could be used for low-cost EHF MILSATCOM terminals, as well as high data-rate communications systems,” said Rick Worley, Air Force program manager for the SBIR effort. “These types of communication transmitters are urgently needed to address the ever-increasing demand for high data-rate transmission.”

## Company Impact

Since completing the SBIR Phase II contract, LTI has experienced a significant increase in the sale of its Q-band technology developed as part of this effort and anticipates additional contracts in the near future.

“We are very excited by the business that the technology developed as part of the Air Force SBIR program is bringing to our company”, said Dr. Allen Katz, LTI president. “The linear EHF microwave power module developed, as part of this project represents a major advance in millimeter wave power amplifier technology.”

While the prototype developed under the SBIR program focused on military satellite communications using EHF band, the technology is intended for dual-use applications in that it can also be applied to Ka-band, where a strong and growing need exists for an efficient, linear, wideband communications transmitter covering both the commercial and military Ka communication bands.

To learn more about this company and its products visit its website at [www.lintech.com](http://www.lintech.com).



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# SBIR/STTR

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