

# Innovation

**SBIR Topic Number:**  
AF063-010

**SBIR Title:**  
Efficient Lightweight,  
W-band Power Combiner

**Contract Number:**  
FA8650-08-C-1326

**SBIR Company Name:**  
QuinStar Technology, Inc.,  
Torrance, CA

**Technical Project Office:**  
AFRL Sensors Directorate,  
Wright-Patterson AFB, OH

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.



**The 10W SSPAM assembly employs an 8-way radial divider, 1.6W solid state power amplifier (SSPA), 8-way radial combiner, heat sink and fan.**

## Efficient Lightweight, E-band Power Combiner

- In order to handle large amounts of airborne intelligence, surveillance, and reconnaissance data, command and control information at high data rates, and large numbers of communication channels, future military communication satellites will require extremely wide bandwidth capabilities
- Compact high power, high efficiency amplifiers are needed in the E-Band (71-76 GHz) and (81-86 GHz) region for high speed 1-10 Gbps point-to-point data links for airborne, ground, unmanned aerial vehicle (UAV), and satellite applications
- During this Phase II SBIR program, QuinStar Technology, Inc., made multiple demonstrated advances in technology applications (e.g., 8-way and 16-way E-band radial line combiners, 10W E-band SSPA with radial combiner, 45W E-band solid state power amplifier design)
- The compact, high efficiency combiner and solid state power amplifier will enable the development of E-band high data rate (1-10 Gbps) data transmission systems for large numbers of communication channels (i.e., aircraft, UAV, and satellite)

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## Air Force Requirement

In order to handle an extremely large amount of airborne intelligence, surveillance, and reconnaissance (AISR) data, command and control information at high data rates, and large numbers of communication channels in support of many aircraft and unmanned aerial vehicles (UAVs), future military communication satellites will require extremely wide bandwidth capabilities. Millimeter-wave spectrum offers an ideal solution for such applications. It can easily provide wide bandwidth capacity required for high data rate and large channel numbers. Its short wavelength allows small, light-weight antennas to provide narrow beam widths and high antenna gains.

Compact high power, high efficiency amplifiers are needed in the E-Band (71-76 GHz) and (81-86 GHz) region for high speed 1-10 Gbps point-to-point data links for airborne, ground, UAV, and satellite applications.

## SBIR Technology

The objective of this SBIR program was to develop compact high efficiency, high power combiner technology in the 71 to 76 GHz band. The Phase II results achieved by QuinStar Technology, Inc., include the following demonstrated advances in technology:

- 8-way E-band radial line combiner with 0.15 dB insertion loss (96% efficiency)
- 16-way E-band radial line combiner with 0.375 dB insertion loss (92% efficiency)
- 4-way E-band septum combiner with 94% efficiency
- 3.7W 74 GHz gallium nitride (GaN) solid state power amplifier (SSPA) with 23.6% PAE, 19±2dB small signal gain from 72.5 to 77.5 GHz
- 10W 75 GHz GaN SSPAM with 16% power added efficiency (PAE)
- 45W E-band SSPA design
- 300 E-band transmitter feasibility

Typically, traveling-wave tube amplifiers (TWTA) are used to achieve high power in the millimeter wave regime. With the advancement of solid state power amplifiers and power combiner technology, compact high-efficient, high-power, solid-state millimeter wave sources are achievable. Power combiners can be grouped into three general types: waveguide, planar, and spatial/quasi-optical. When high power and low loss are the driving requirements for the E-band combiners, waveguide combiners provide the best probability of achieving the low insertion loss.

## Potential Application

Technology developed under this SBIR Phase II program is an enabling technology for high speed data links and the next generation of wideband military satellite communications (MILSATCOM) applications. The compact, high efficiency combiner and SSPA will enable the development of E-band high data rate (1-10 Gbps) data transmission systems for large numbers of communication channels (i.e., aircraft, UAV, and satellite).

## Company Impact

"This SBIR program provided an opportunity to develop capabilities to design and produce state-of-the-art millimeter-wave SSPAs for high data rate communication systems," states Dr. H. John Kuno, executive vice president of QuinStar.

"Founded in 1993, QuinStar is an ISO 9001:2008-certified millimeter-wave technology company which offers innovative product solutions. Our company has expertise with millimeter-wave products, microelectronic assembly, rapid prototyping and mass customization. We serve established, as well as emerging markets, and system applications in the commercial, scientific, and defense arenas."



# SBIR/STTR

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