Solid-State High-Efficiency Radar Transmit Module

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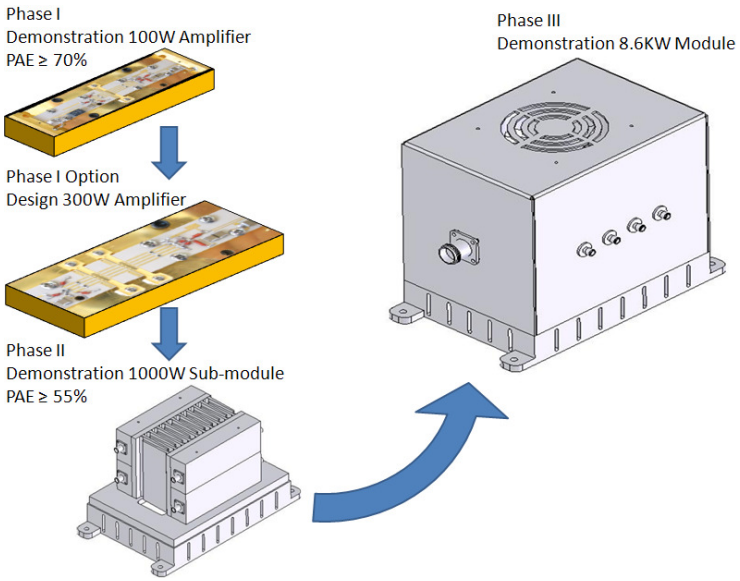


PROBLEM STATEMENT

Current radar transmitters that operate at very high power levels are considered to have low efficiencies (on the order of 20-30 percent). To generate a given output, airframes equipped with low efficiency radar transmitters require greater (e.g. larger) power supplies coupled with higher capacity (e.g. larger) cooling systems. In nearly all cases, larger power supplies and larger cooling systems equal increased weight. The impact of weight is especially acute in high-altitude, long-endurance unmanned air systems (UASs), where propulsion and power generation are principal cost drivers. Increased weight results in decreased performance.

Auriga will design and manufacture a high-efficiency, high-power amplifier (PA) module at Ultra High Frequency (UHF) frequency (406-450 MHz). The PA module will function as a "building block" and be combined to create a sub-system for an UAS. The current development effort is targeting a building block of 400 watts (W) output power at only 3 lbs with dimensions of 6 x 4 x 1.5 inches or 36 cubic inches. The system should be capable of 30 dB of gain so that the input RF power is no more than 500 mW. It is anticipated that a number of these building blocks can be combined to provide any power output desired while saving weight compared to existing systems.

WHO CAN BENEFIT?

Auriga believes this technology, with slight modifications to the specifications (frequency and power), will benefit various radar programs as a replacement of

current traveling wave tube amplifiers (TWTAs) with output power up to a few kilowatts. This high power technology can also benefit communication programs such as JTRS mounted warfighter programs. Deeper discussions with MUOS, GMR, JCREW, AMF and Next Generation Jammer (NGJ) program members are being explored, as all could benefit from the combining of PA sub-modules to meet higher power requirements while limiting power consumption needs of the their host vehicles.

BASELINE TECHNOLOGY

The flight capability of UASs is limited by many factors, including the power consumption of the on-board radar. Low efficiency of operation requires additional weight, more prime power and heat removal management. These impacts are exacerbated by the reduced size and increased altitudes associated with high-altitude, long-endurance missions, where propulsion and power generation are principal cost drivers.

TWTAs, although less expensive to purchase than solid-state, high-power amplifiers, are more costly to operate due to energy requirements to power the amplifiers and the cooling system required to maintain required TWTA performance levels – adding weight to the overall radar system. TWTA weaknesses are compounded when the technology is implemented in an uncontrolled environment where the system may be jostled (such as those experienced by UAS), causing failures and necessary maintenance. TWTA's short operating life compared to solid-state technologies is also a determining factor in the life time cost of the system.

TWTAs are currently used in larger UAS radar systems that require high-power. TWTAs perform well, yet are fairly fragile and require frequent replacement (typically less 2,000 hours), especially when compared to a solid-state alternative.

TECHNOLOGY DESCRIPTION

Features	Advantages	Benefits
Lightweight	Offers better payload distribution	Reduction in cost to operate
High-efficiency	Requires less power to operate	UAS may fly longer
High-power	Radar range increased	Better detection of enemy
More stable	Less frequent replacement	Lower cost, less downtime
Longer life	Less frequent replacement	Less downtime
Compact size	Offers more space for other critical components	System design flexibility

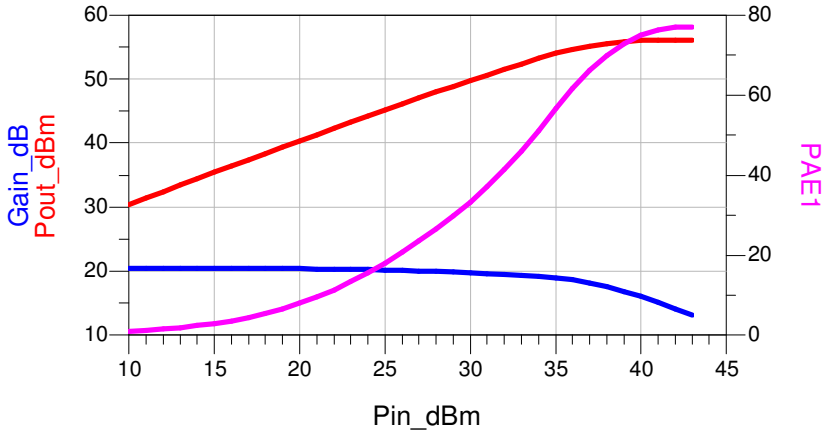
The PA module will utilize Gallium Nitride High Electron Mobility Transistors (GaN HEMT) which have demonstrated superior performance compared to existing technology such as Gallium Arsenide pseudomorphic High Electron Mobility Transistors (GaAs pHEMT) or Silicon laterally diffused metal oxide semiconductor (Si LDMOS). GaN HEMTs can withstand much higher voltages

due to higher breakdown voltage (up to 200V) and have better thermal conductivity because of the use of silicon carbide (SiC) as the substrate. The system interface is much easier with the higher bias voltage and higher power density. The PA module is being designed for a 28 V supply, a typical system voltage. The pulse bias circuit is incorporated in each module, making it easy for power distribution design when multiple modules are combined. The PA module will have standard connectors and a form factor suitable for easy integration to target radar systems.

CURRENT STATE OF DEVELOPMENT

A 400W prototype will be demonstrated in December 2009. The projected performance based on simulations at 428 MHz, VDS = 28 V, and Pin = 40 dBm is:

- Power-added-efficiency (PAE): 75 %
- Output power: 56.0 dBm (400 W)
- Gain: 16 dB



Milestone progress during this program is listed below. By the end of Phase 2, the 400 W modules will be combined to achieve 800 W and will be tested for TRL 6. To achieve TRL 6, Auriga will need an insertion system identified and testing conditions specified by June 2010.

Milestone	TRL	Measure of Success	TRL Date
80W prototype	3	Pout=80W, PAE=58%	11/5/2007
400W prototype	4	Pout>390W, PAE>70%	12/30/2009
400W module demo	5	Pout>390W, PAE>70%, Gain>40dB	2/24/2010
800W module demo	6	Pout>800W,PAE>70%, Gain>40dB	12/30/2010

REFERENCES

Omar, Mohammed Emmett
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ABOUT THE COMPANY

Auriga Measurement Systems, LLC, located in Lowell, Massachusetts, is a recognized international leader in modeling, measurement and design of RF, microwave and millimeter-wave technologies. For more than 30 years, members of the Auriga Modeling and Design teams have been pushing the limit of RF measurement science. Auriga has the experience to help companies achieve never-before-seen MMIC designs and non-linear models with unparalleled performance. Supplementing customers' design and modeling resources or delivering turnkey solutions, Auriga is a "sure fire" asset to getting products to market faster, more efficiently and with higher confidence for success.