

Enabling Technologies for Mobile Communications

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Air Force Mission Oriented Investigation and
Experimentation (MOIE)

The logo for the MITRE Technology Program, featuring a stylized graphic of stacked blocks in yellow, orange, and blue to the left of the text.

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Problem

- **The Armed Forces are moving to Network Centric Warfare, requiring seamless air to air, space and ground connectivity**
- **The physical layer to support this is currently not adequate or affordable for airborne platforms**
- **New and emerging technologies need to be applied to the development and implementation of electronically scanned arrays (ESAs) for airborne communications**

Background

Installation Constraints

- Proliferation of apertures on aircraft
 - Limited space for antennas
- High installation complexity and costs
- Need for multiple simultaneous connections

Advantages of Phased Arrays

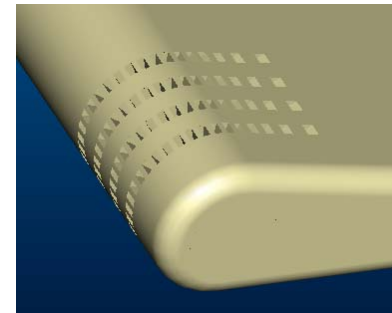
- Conformal profile
- Rapid beam pointing
- Adaptive beam shaping
- Multiple simultaneous beams
- Graceful degradation
- Simplified installation



**Airborne Command Post
EHF Antenna: 30" High**



**Planar Array
2" to 6" High**



**Conformal Array on Wing
Leading Edge**

Wideband Antennas for Airborne Platforms

Objective

- **Address significant technical problems associated with transmit phased arrays for wideband airborne communications**
 - **Solid state power amplifier performance**
 - **Array heat dissipation due to low amplifier efficiency**
 - **Antenna location on aircraft wings**
 - **Beam forming on a vibrating surface**

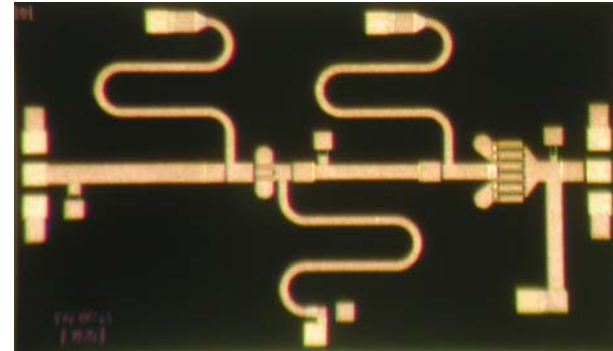
Activities

- Design, fabricate and test high efficiency Ku and Ka-band solid state power amplifiers for use in phased arrays
- Develop real-time sensor network for array beam forming and control when located on a vibrating, curved aircraft wing
- Analyze potential configurations for dual and multi-band arrays

Highlight

Ku-band High Efficiency Solid State Power Amplifier For a Phased Array

Parameter	Goal	Measurement
Efficiency	50%	50%
Gain	20 dB	21.3 dB
Output Pwr	1.2 Watts	0.6 Watts
Frequency	14-15 GHz	14 – 14.5 GHz
Bandwidth	1 GHz	500 MHz



Measured Amplifier Performance

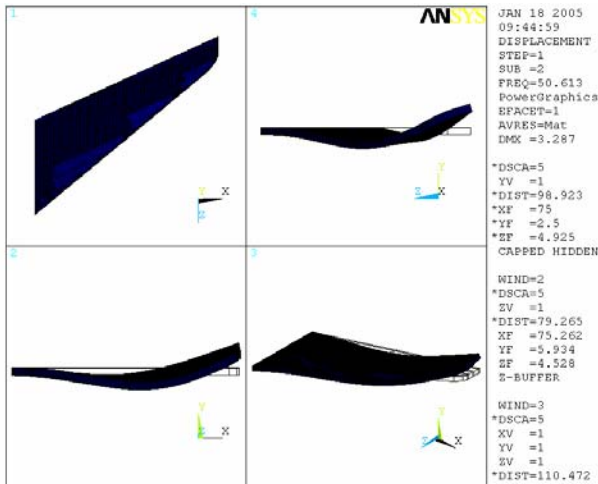
Ku-band Solid State Power Amplifier IC

- Typical Ku-band power amplifiers have 30-35% DC to RF conversion efficiency
- Higher efficiency can be obtained at the expense of power and bandwidth
- Higher efficiency is the key to thermal management in a transmit phased array

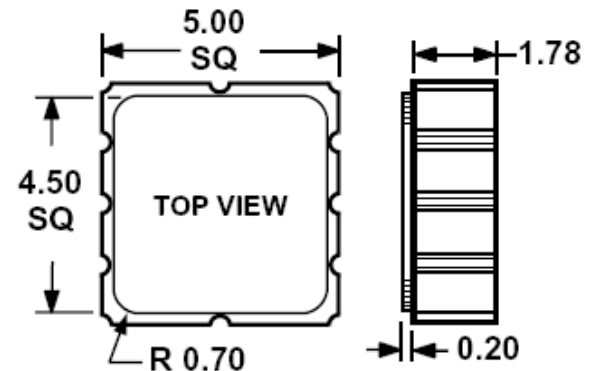
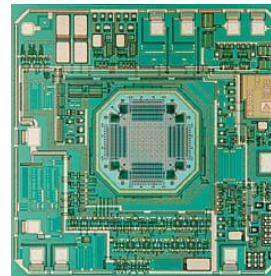
Highlight

Location of Phased Arrays on Aircraft Wings

- Electronic correction of beam errors due to wing displacements
 - MEMS sensors to determine real-time wing displacements
 - Finite Element Analysis used to calculate wing vibration modes
 - Analyze impact of wing dynamics on beam control



**F-16 Wing Plate Bending
Mode at 50.6 Hz**



**Analog Devices MEMS
Accelerometer and Tilt Sensor**

Impacts

- **Solutions to problems for transmit phased arrays for airborne communications**
 - Location of antennas on wings
 - Reduce prime power and thermal problems
- **Support connectivity for airborne platforms, bringing them into the Global Grid network**
 - For all platforms in C2 constellation

Future Plans

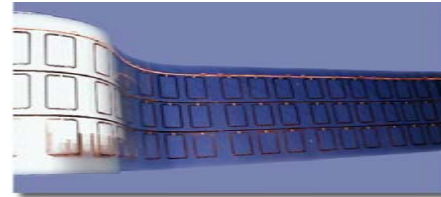
Technology Transfer

- High efficiency SSPAs
- Phased array architecture with thermal management
- Beam forming techniques on vibrating, curved wings



Prototype Ku-band Array

Conformal Array Development



- Driven by limited real estate and complex fuselage
- Test sensor network for array beam forming and control on vibrating, curved wings
- Investigate flexible arrays
- Continue Ku-band phased array development