

# Low Cost Phase Shifters for Phased Arrays

## PROBLEM / OBJECTIVE

Phased array antennas provide a significant increase in capability over the directional antenna designs currently envisioned for Warfighter Information Network-Tactical (WIN-T) and Future Combat Systems (FCS). Phased array antennas utilize beam steering that allows all energy to be focused on the intended recipient, thereby increasing signal strength and throughput. Beam steering can be instantaneous and executed without the mechanical and inertial problems of a rotating array. The ferroelectric and Micro Electro-Mechanical Systems (MEMS) phase shifters has reduced the size, weight, and power (SWAP) consumption of today's phased array antennas to enable the enhanced antenna capabilities to be less noticeable through conformal vehicle integration. The Army Science Board recognized the benefits of phased array antennas in their "Advance Antenna Study" and recommended to Army leadership that this technology be developed and integrated into futures force programs. As a result, this project was approved by the ASTWG as an MTO. The system performance enhancements offered by phased array antennas will enable transition of on-the-move SATCOM communications platforms to WIN-T Increments 2 & 3, as well as to Tactical Missile Seekers.

## ACCOMPLISHMENTS / PAYOFF

### **Process Improvement:**

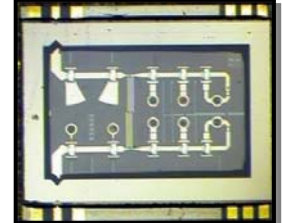
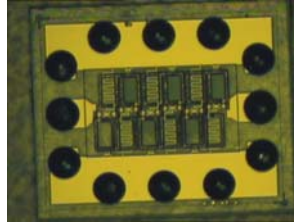
Processes were developed which allow economical mass production of ferroelectric and MEMS phase shifters. In the ferroelectric process, ferroelectric material is sputtered on a sapphire substrate and processed in a MMIC foundry. In the MEMS process, alumina substrates are used for the deposition of MEMS devices in a fully automated MMIC foundry.

### **Implementation and Technology Transfer:**

This project has transitioned the ferroelectric and MEMS phase shifters to PM WIN-T for use in phased array antennas to be fabricated as a part of Increment 3. Final development of the phased arrays for WIN-T is being accomplished under the ALPS ATO-D. Transition for seekers is to the Advanced Missile Technology and Extended Area Protection & Survivability ATO-Ds for the development of seeker technology for NLOS-M and other missile systems.

### **Expected Benefits:**

Projecting out 10 years, the Net Present Value of cost avoidance is expected to reach \$134M for the Army. Through this ManTech effort, the cost of both ferroelectric and MEMS phase shifters has been decreased from more than \$50 per phase shifter to less than \$10.



Ferroelectric and MEMS Phase Shifters

The development of this technology will also provide the Services with an expanded industrial base. Previously there were no volume production facilities for either ferroelectric or MEMS phase shifters. There is now volume production of ferroelectric phase shifters utilizing two foundries and a fully automated volume production facility for MEMS phase shifters. Production rates exceed that required by a factor greater than 10. The unexpected low losses of the MEMS phase shifters has allowed for the design of semi-passive and passive phased arrays for both communications and seeker applications, lowering costs by up to a factor of four.

## TIME LINE / MILESTONE

Start Date: August 2004  
End Date: September 2008

## FUNDING

Army ManTech: \$13.4M  
CERDEC: \$0.30M

## PARTICIPANTS

US Army CERDEC  
US Army Research Laboratory  
US Army AMRDEC  
Agile RF, Inc.  
Raytheon Space & Airborne Systems