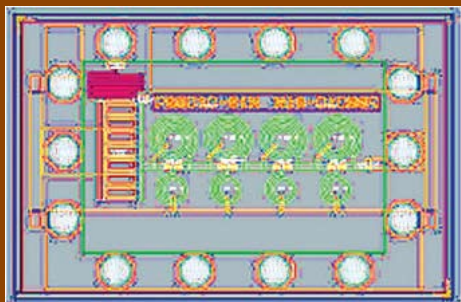


## Affordable Phase Shifters for Phased Array Antennas

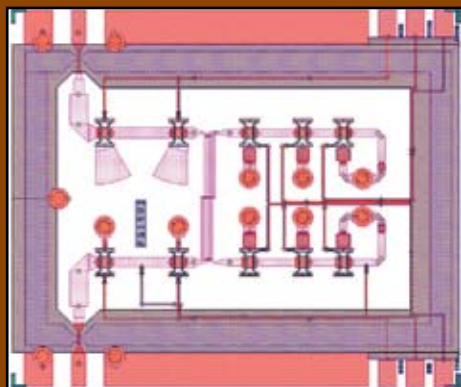
Provide production sources for low cost Ferroelectric and Micro Electro-Mechanical Systems (MEMS) phase shifters for Phased Array antennas and tactical Seekers.

### OBJECTIVE / SOLUTION

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 shifter will further reduce 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 future force programs. As a result, this project was approved by the ASTWG as an ATO-M. The system performance enhancements offered by phased array antennas are applicable to both SATCOM and Unmanned Aerial Vehicle (UAV) communications platforms that are present in the WIN-T and FCS architectures, as well as Tactical Missile Seekers.



Ferroelectric Phase Shifter



Micro Electro-Mechanical System (MEMS) Phase Shifter

### ACHIEVEMENTS

Contract was awarded to Agile Materials & Technologies in August 2004. During FY05, the performance of the initial phase shifters exceeded expectations. Low loss was achieved. Excellent uniformity, both chip to chip and wafer to wafer was achieved. There was little variation of loss or phase shift from -30 to +125 degrees Celsius. New processing changes have resulted in a 10:1 reduction in leakage currents in the second set of samples. Lower application voltages for the phase shifters will result from additional processing changes for the third set of samples. These enhancements will result in increased reliability. The phase shifter has been redesigned to incorporate an internal bias connection, eliminating the requirement for external biasing. Simulation and actual measurements of the second samples showed good agreement and we have achieved >50% of program metrics goals in only 14 months.

During FY06 the yield of Ferroelectric Phase Shifters increased to >80. An Ion mill was installed at Agile to allow for internal control of the milling process to increase yield and reduce cost. Solder bumps were replaced by gold stud bumps with no effect on performance, thereby increasing yield. Phase shifter loss was reduced. Phase shifter cost was reduced to near the program goal. The MEMS Phase Shifter contract was awarded to Raytheon 17 March 06. Initial 15 GHz and 30 GHz MEMS Phase Shifters were designed, complete with a hermetic seal. Modeling and simulation shows expected losses of <2dB. Initial delivery is expected in early November. The reliability test station is currently being designed and fabricated.

### BENEFITS

- Increased capability over directional antenna.
- Increased signal strength and throughput.
- Uses electronic beam steering to eliminate mechanical and inertial problems of rotating arrays.
- Reduces size, weight, and power (SWAP) consumption.
- Defeats jamming threats by nulling out the jamming signal while steering the beam to another user.

### STATUS

- First delivery of MEMS Phase Shifters November 2006.
- Fourth shipment of Ferroelectric Phase Shifters December 2006.

### WEAPON SYSTEMS / SECONDARY ITEMS IMPACTED

- Warfighter Information Network-Tactical (WIN-T)
- Future Combat Systems (FCS)
- Non-Line-of-Sight Launch System (NLOS-LS)
- Surface Launched Advanced Medium Range Air to Air Missile (SLAMRAAM).