A MULTIFUNCTIONAL MMW ELECTRONIC SCANNING ANTENNA CONCEPT FOR FUTURE COMBAT SYSTEMS (FCS)

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ABSTRACT

A discussion of the on-going effort to develop a multifunctional mmW Electrically Scanned Antenna (ESA) concept by the Army Research Lab is presented. The antenna has matured to the point where many of the sub-array component parts have been identified, fabricated, and tested. The antenna supports both radar and communications through a multi-beam dual aperture configuration. This system has been explicitly developed to address the Multi-Function Radio Frequency (RF) concept and meet many of the needs for a Future Combat Systems (FCS) by alleviating the need for multiple antennas. Included in the architecture are a Rotman Lens (for azimuthal beamforming), Ferro-electric true-time delay elements (for elevation beamforming), distributed MMIC amplifiers (for power and low-noise requirements), and separate aperture-fed patch antenna arrays (one for transmitting and one for receiving). The low profile of this unique design is suitable for non-obtrusive insertion on a variety of platforms

1. ARRAY ANTENNA

Aperture coupled patch antennas are use as the radiating element. Because of the frequency range of interest (36.5 – 39.5 GHz), many challenging issues arose due to the compact nature of the elements. One very important problem addressed was construction of a feed architecture such that both vertical and horizontal polarization were supportable. The array architecture was developed to allow expansion in both the elevation and azimuthal planes (thus, narrowing the beams).

2. ROTMAN LENS

We have fabricated and tested a Rotman lens that will serve as the azimuthal beamformer for our ESA, Figure 1. This lens is a simplified version of a Rotman Lens developed for ARL by the University of Georgia. Magic Tee junctions have been removed to simplify the manufacturing design with little loss in performance. Further improvements include an incorporated phase compensation network. The ESA is re-configurable to support beam-spoiling applications. To control beam select ability, two concepts for MxN beam switching networks are being developed. One is a traditional pin diode approach capable of high-speed actuation while the other concept uses light actuated silicon tabs that can handle high power applications.

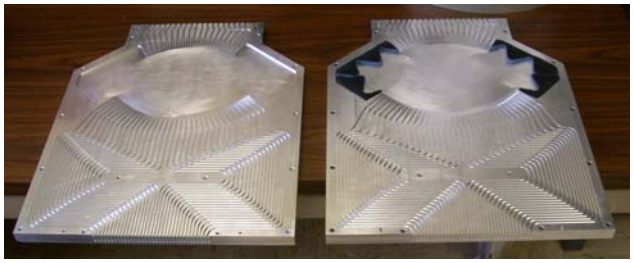

Figure 1 – Rotman Lens beamformer.

3. FERROELECTRIC SCANNING

We look forward to integrating true-time delay Ferro-Electric scanning devices into our design to address elevation scanning. The feed architecture is not trivial and has required a considerable amount of development – aperture coupling is our leading candidate. Because many devices will be needed in each ESA, we are looking for a manufacturing technique that will allow multiple components to be made. This requirement for the delay devices can only be met by a thick film technology; we have identified tape casting as the most suitable technology for accomplishing this need.

4. LNA'S AND POWER AMPLIFIER ASSEMBLIES

We are implementing an architecture that has separate transmit and receive arrays. As such, we have developed a modular package, which is amenable for insertion into either transmit or receive. This package was developed with ease of replacement in mind should an individual amplifier fail, Figure 2. Measured results for

the LNA's and Power Amplifiers will be presented. A specially developed waveguide-to-microstrip transition (using a Yagi-like radiator) has been developed to couple energy to and from the Rotman lens.

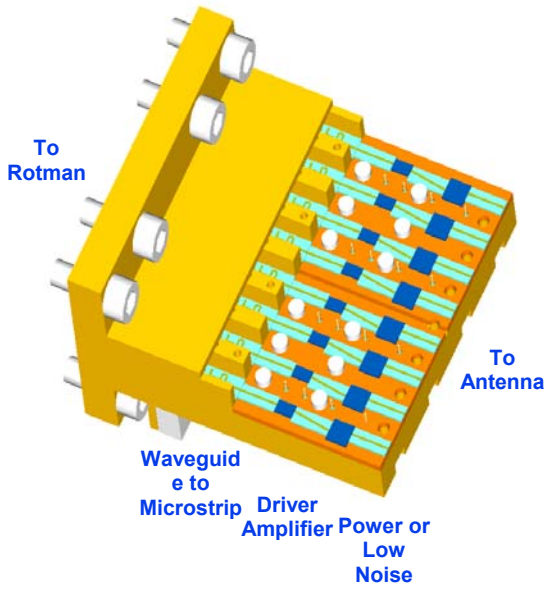

Figure 2 – The LNA and Power Amplifier Assembly.

5. CONCLUSION

A viable ESA architecture for FCS multifunction RF sensor requirements has been developed. Component parts such as the antenna array, amplifiers, and the Rotman lens are performing as desired and are ready for insertion into a working prototype. The ferroelectric delay lines still requires a high level of engineering effort to ensure proper impedance matching and a uniform phase progression between the apertures. Multifunction field demonstrations of the ESA will occur early next year.

6. REFERENCES

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