Multi-level Photonic Modules for Millimeter Wave Phased Array Antennas

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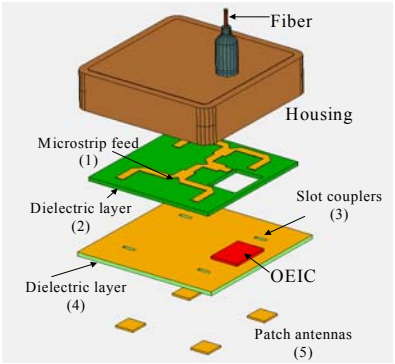
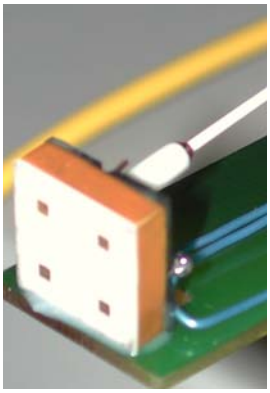
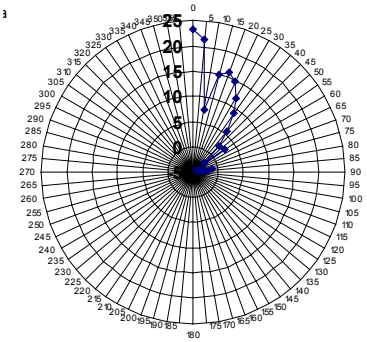
Photonics for phased array antennas are being considered for military communication systems. For these systems to be cost effective the integration of photonics and millimeter wave components into a single module that can operate up to Q/V-Band is required. As the operating frequency of phased array systems approaches 20 GHz, the antenna size and spacing approaches the size of the MMIC circuit itself. Because of this, single layer planar techniques cannot be implemented due to the large module footprint. The most advantageous way to maintain a footprint compatible with Ka band and higher frequency systems is to reduce the size of the module using a multilevel approach. We have developed a module design and assembly process that includes optical components, millimeter wave components, optical fiber interfaces and an integrated planar antenna to form a module capable of meeting military requirements at 40 GHz. The planar antenna is part of the module package eliminating the need to attach or secure an additional antenna component on the phased array antenna.

We successfully developed a multi-level photonic module for a phased array antenna operating at millimeter wave frequencies. The module comprises of photonic and millimeter wave circuits integrated with planar antenna sub-array that forms a complete transmitter element. The module performance matched the simulation demonstrating a 7.5 dBm EIRP at 40 GHz. We believe that this was the first attempt to develop low cost, high volume products using commercially available batch processing of photonic and millimeter wave components into a single multi-level package for phased array antennas.







(a) (b) (c)

The multi-level module concept (a); the completed millimeter wave photonic module (b); the measured antenna pattern at 40 GHz using the optical input.