A Planar Multi-Beam Antenna Array

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The planar multi-beam antenna array may be integrated into the distributed directional antenna system for On-The-Move (OTM) applications on ground vehicles and other mobile platforms. This paper describes a low profile, low cost C-Band Multi-Beam Antenna Array that may be used for a distributed directional antenna system. The designed planar multi-beam antenna array consists of a 4 X 8 Right Hand Circularly Polarized (RHCP) micro-strip patch element array panel and an 8 X 8 Butler Matrix feed Board. The minimum level of the cross polarization of the antenna array has been obtained due to the innovative designs of the RHCP patch and its sub-array. The prototype was fabricated and measured to verify the far field gain, radiation patterns, and the scan performance. Tested results demonstrated that a single planar multi-beam antenna array panel can cover a scan range from -45 degree to +45 degree with its eight discrete antenna beams.

The designed planar multi-beam antenna array prototype is made of eight microstrip patch sub-arrays. The separation distance between the two adjacent sub-arrays is 0.66 wavelength. The microstrip patch antenna sub-array is designed and fabricated with four single RHCP microstrip patch antenna elements offset 90 degrees from one another on the front side. On the backside of the Printed Circuit Board (PCB), there is a microstrip corporate feed line to combine all the four elements and interfaced with a SMA connector. Each antenna element in the sub-array consists of an air spaced probe feed patch with the separation of about 0.75 wavelength. The 8 X 8 Butler Matrix is fabricated on one layer of the PCB, which consists of the fixed phase shifters and the 90-degree hybrids. The eight output ports of the Butler Matrix will be connected to the eight antenna sub-arrays. While the eight input ports will be connected to the inputs of the RF feeds. The fixed phase shifters and the 90-degree hybrids are designed with 50-Ohm microstrip lines.

The antenna prototype has been fabricated and measured for the C-Band frequency range. The measured multi-beams scan at +/-5, +/-16, +/-27, and +/-40 degrees. These eight discrete beams will cover the +/-45 degree sector for a single planar panel. The measured and simulated -5 and +27 degree scan antenna gain patterns are shown in Figure 1 at the C-Band center frequency. The measured gain patterns are for the RHCP gains including the 8 X 8 Butler Matrix and the other losses, which match well with the simulated results. The Butler Matrix and the other losses are not included in the simulated gain patterns.

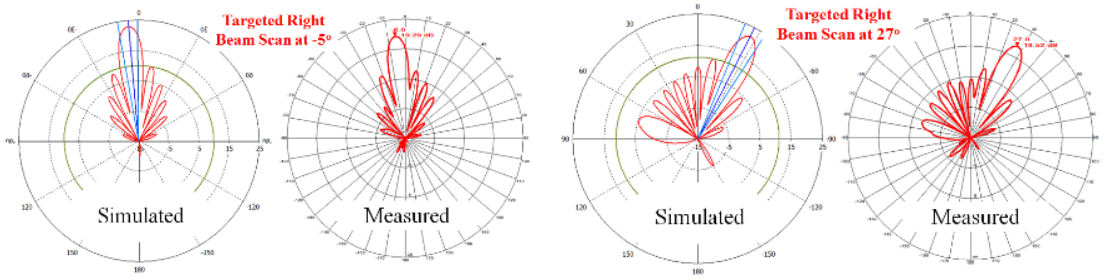

Figure 1. Simulated and Measured Antenna Gain Patterns Scan at -5° (Left) and +27° (Right)