# A Mast Mounted Directional Antenna

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*Abstract* – This paper describes the design of a small diameter C-Band Mast Mounted Directional Antenna (MMDA) intended for terrestrial communications. The MMDA is comprised of 16 Four-Element microstrip patch Sub-Arrays with fixed phase shift delay lines, RF switches, and a 4-Way power divider. As a result the antenna is able to generate sixteen discrete beams covering 360 degrees azimuthally. The prototype was fabricated and measured to verify the far field radiation performance. The tested Right Hand Circularly Polarized (RHCP) gain patterns matched well with the predicted results in both Elevation and Azimuth planes.

*Keywords – Mast Mounted, Directional Antenna, RHCP.*

## I. INTRODUCTION

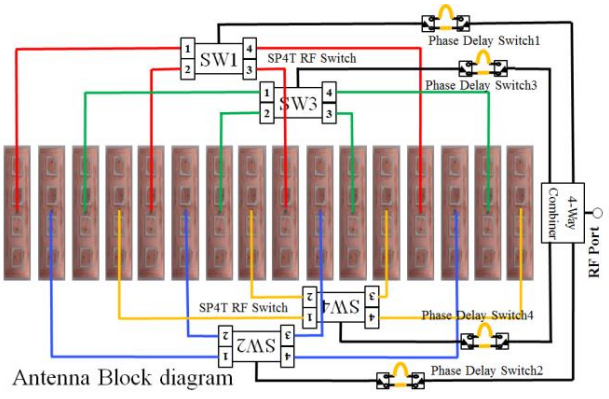
The RHCP antenna sub-array has four sequentially rotated microstrip patch antenna elements providing not only an ascetically low-profile but also a wide frequency bandwidth, high gain, and exceptional Cross-polar Discrimination (XPD) performance [1]. This study uses sixteen Four-Element Sub-Arrays organized in a circle to cover 360 degrees in the azimuth plane.

The beam-forming excitation technique used in this study is shown in Figure 1. In the azimuth plane, there are a total 16 beam states, each having a 22.5 degree 3dB Beam width. In the elevation plane, the fixed pencil RHCP beam is pointed at the horizon. The antenna is controlled using RF Switches, fixed delay lines, and a 4-Way power divider that excites four antenna sub arrays to form each of the 16 beam states.

## II. THE DESIGN AND RESULTS

### A. THE DESIGN

The front view of the fabricated prototype antenna is shown in Figure 1. The circular structural frame is populated with a total of 16 sub-arrays. Each sub-array consists of four Right Hand Circular Polarized (RHCP) patch elements offset 90 degrees from one another on the front side. On the backside of the Printed Circuit Board (PCB) is a microstrip corporate feed line. The air spaced elements element are then probe feed with a separation of about 0.75 wavelengths. To form a beam, the RF signal is initially divided evenly at the 4-Way power divider (combiner). The signal is then transmitted to four adjacent antenna sub-arrays through RF switches, 1, 2, 3, and 4. Only a single pole of the SP4T switches SW1, SW2, SW3, and SW4 can be selected at a time. The Red, Blue, Yellow, and Green colored lines represent different paths of the RF signal. The Phase Delayed Switch 1, Switch 2, Switch 3, and Switch 4 then select the fixed path based on the sub-array selection. For maximum radiation directivity, additional phase delays are added to the center two sub-array columns.

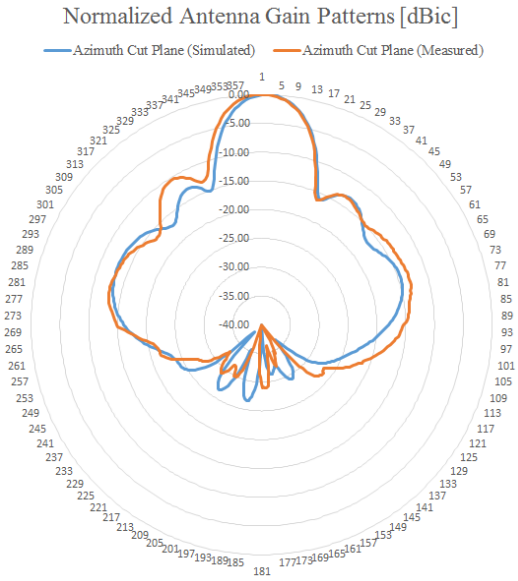



Antenna Block diagram

*Figure 1. Antenna Block Diagram and Prototype*

### *B. THE MEASURED RESULTS*

The antenna was measured in the C-Band frequency range. Simulation and measured results for the 16 azimuth cut gain patterns are similar with a 22.5 degree offset. The 16 beams envelop an area that covers 360 degree in azimuth plane. An overlay of the simulated and measured antenna gain patterns at the center frequency are shown in Figure 2, with the azimuth cut plane on the top and elevation cut plane on the bottom. Measured RHCP show a peak gain values of 17dBic, without the losses of the RF Switches and fixed delay lines.



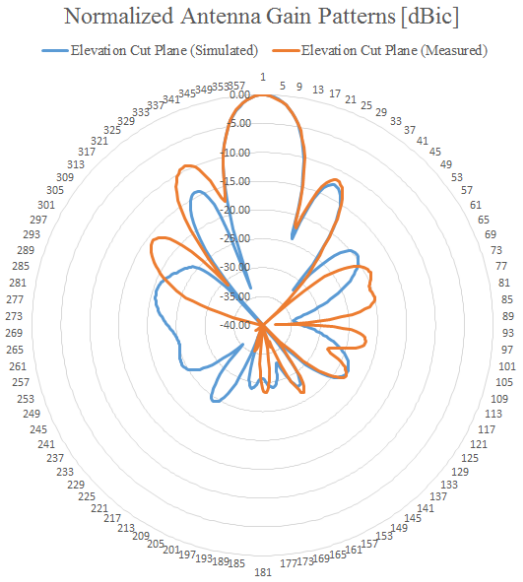




*Figure 2. Simulated and Measured Antenna Gain Patterns.*

## III. CONCLUSIONS

The mast mounted directional antenna offers a small diameter form factor while providing full 360 degree terrestrial communication. The efficient excitation technique gives the option of 16 distinct beams that all provide high peak gain patterns. A simplified switching architecture allows for reduced costs as compared to comparable systems currently being used.

## REFERENCES

[1] Constantine A. Balanis, Antenna Theory, John Wiley & Sons, Inc.