The Compact Quadrifilar Antenna (CQA) for Handheld GPS and Satellite Radio Reception

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Outline

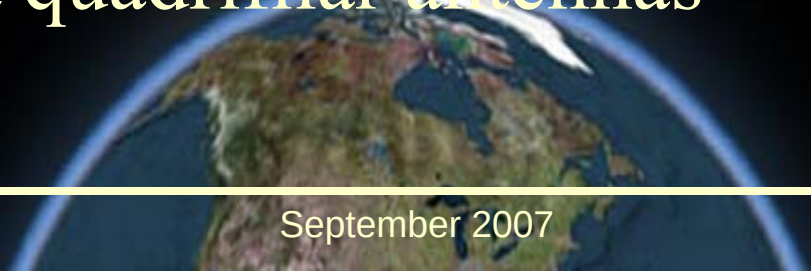
- Maxtena Overview
- Maxtena Technology and IP
- Why Differential?
- Antenna Geometry
- Phase Shifter
- Antenna Impedance and Tuning
- Differential GPS Antenna Performance
- Conclusions

Maxtena Overview

- Maxtena is a start-up company (founded in 2006)
- Focused on advance differential material technology
- GPS and cellular market
- Initial Product: GPS quadrifilar antenna using advance material differential technology

Maxtena Technology and IP

- Patent pending (Filed in 2006)
- New approach in antenna design using differential interface and advance materials
- Improved radiation characteristics
- More bandwidth!/Differential Feeding!/More Efficiency!/Smaller Size!
- Maxtena IP provides a unique platform for smaller and more efficient quadrifilar antennas



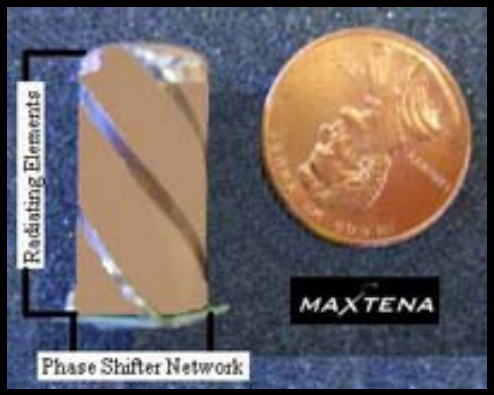
Why Differential?

RadioMax ™ differential architecture with advance materials improves performance and integration capability

- Lower System BOM
- Smaller Size
- Minimizing Hand Detuning Effects
- Differential RFIC

Differential GPS Antenna – M1575CQA

- Frequency: 1575.42 MHz ±10MHz
- Polarization: RHCP
- Efficiency: 38% (differential) -1.3 dBic
- Beamwidth: 140° (both axis)
- Axial Ratio: 0.2 dB (max)
- Front to back ratio: 12 dB
- VSWR: 1.3:1 (typical)
- Impedance: 100Ω (differential)
- Dimensions: 10mm diam. x 20mm length



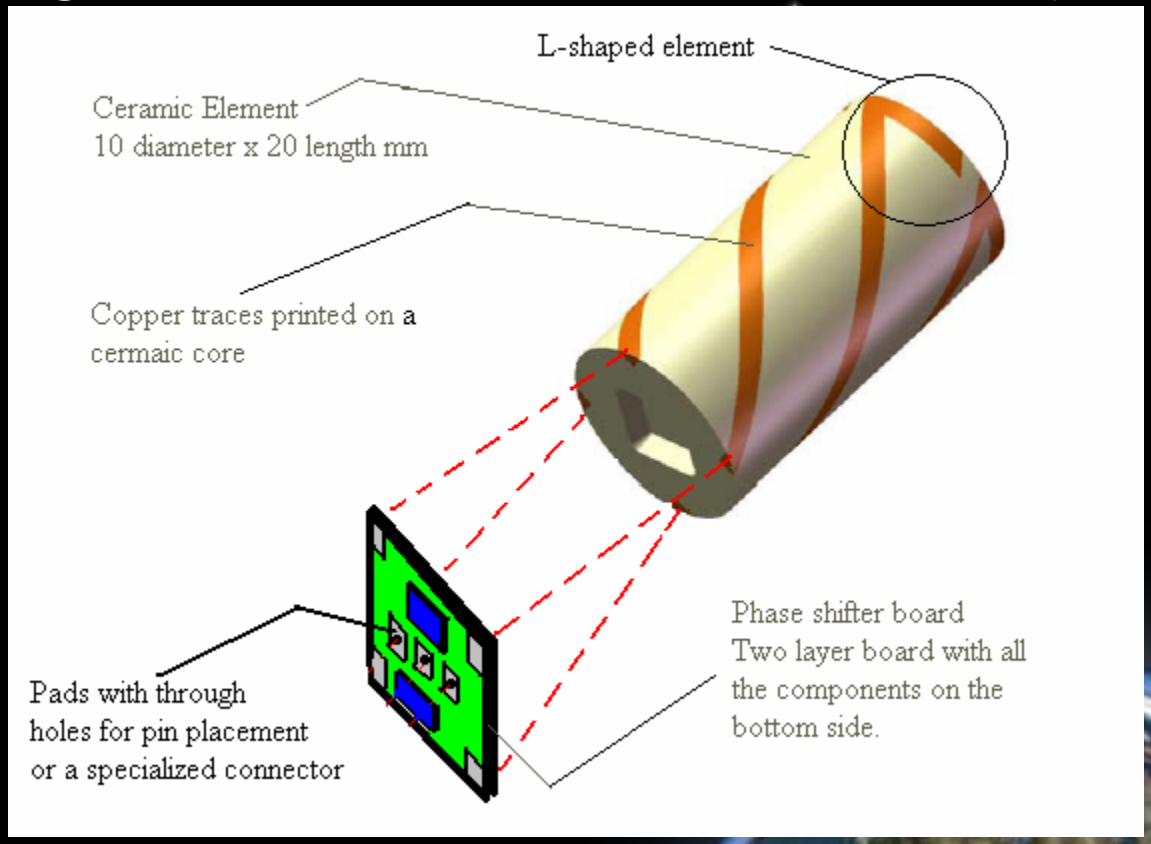
Differential GPS Antenna – M1575CQA

- Maxtena GPS quadrifilar antenna technology
  - Separate balun and symmetric antenna windings
  - Phase shifter board drives quadrature ➔ simplifies antenna tuning
  - Excellent isolation between the ports, excellent amplitude and phase stability ➔ better Circular Polarization
  - Differential interface reduces part count ➔ more gain and efficiency

- Conventional GPS quadrifilar antenna technology
  - Integrated balun
  - Asymmetric (quadrature) antenna windings
  - Lower efficiency and gain
  - Lower Circular Polarization purity
  - Single-ended design

M1575CQA Geometry

- L-shaped terminations and independent phase shifter board (single-ended or differential interface)

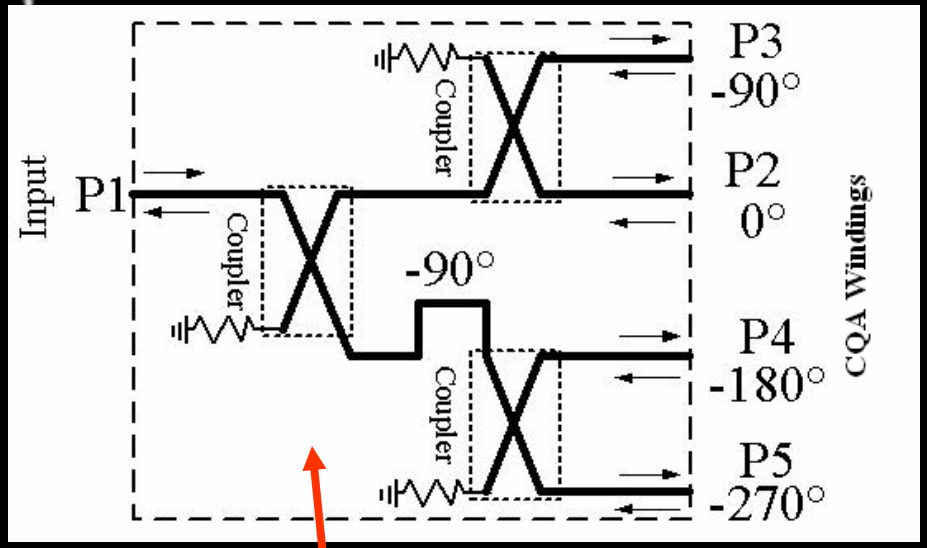


M1575CQA Phase Shifter

- Balun and two hybrid couplers using LTCC technology
- Three hybrid couplers using LTCC technology
- Able to achieve better than 20 dB isolation between the ports
- Phase balance +/- 3 degrees
- Amplitude balance +/- 0.5 dB

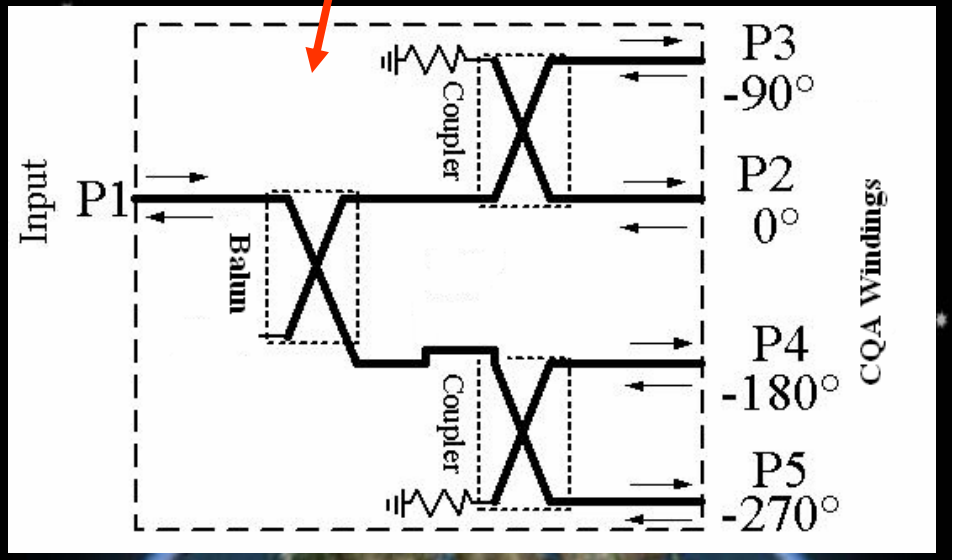
M1575CQA Phase Shifter

- Typical Phase Shifter Topologies



Using three LTCC hybrid couplers

Using LTCC Balun and two hybrid couplers



M1575CQA Impedance and Tuning

- General scattering matrix of a 4-port antenna system:

$$S_A = \begin{bmatrix} s_{11} & s_{21} & s_{31} & s_{21} \\ s_{21} & s_{11} & s_{21} & s_{31} \\ s_{31} & s_{21} & s_{11} & s_{21} \\ s_{21} & s_{31} & s_{21} & s_{11} \end{bmatrix} \text{ and } a_A = S_A b_A .$$

- Ideal scattering matrix of a hybrid is:

$$S_H = \begin{bmatrix} 0 & 0.5 & -j0.5 & -0.5 & j0.5 \\ 0.5 & 0 & 0 & 0 & 0 \\ -j0.5 & 0 & 0 & 0 & 0 \\ -0.5 & 0 & 0 & 0 & 0 \\ j0.5 & 0 & 0 & 0 & 0 \end{bmatrix}$$

M1575CQA Impedance and Tuning

- Reflection coefficient is the following:

$$\Gamma = s_{11} - s_{31}$$

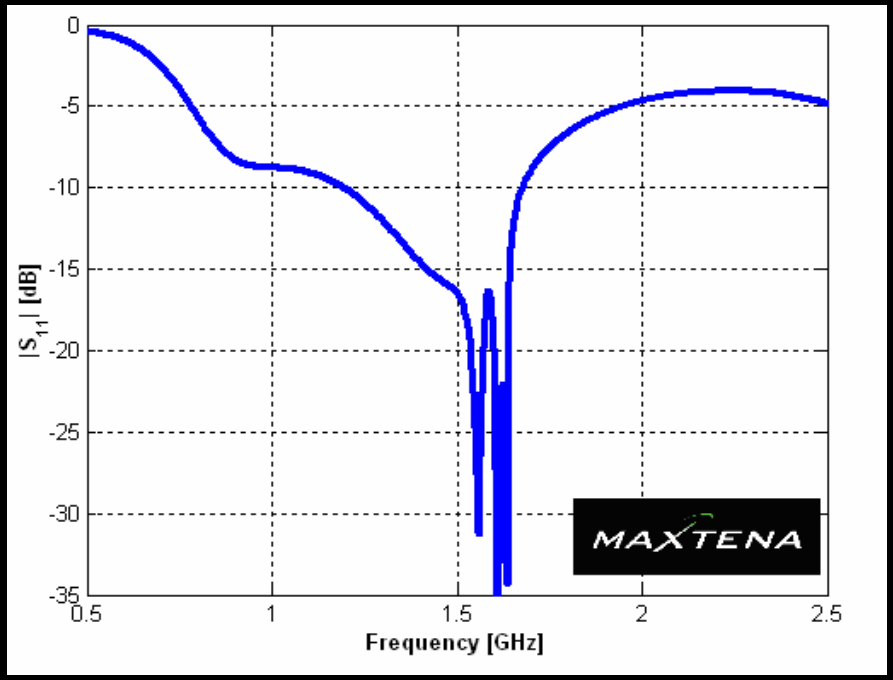
- Parasitic impedance of the phase shifter board contributes to the antenna impedance
- Proper modeling required for optimal efficiency

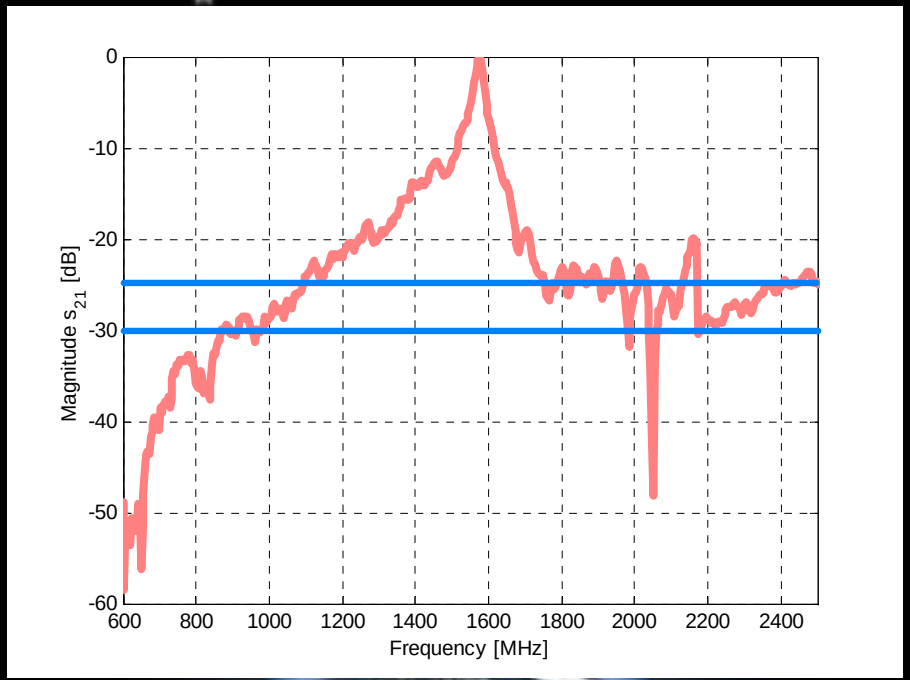
M1575CQA Impedance and Tuning

- Antenna geometry (diameter, pitch angle, and height) optimized for specific desired impedance
- Impedance control through one stage matching required to match to desired phase shifter input impedance
- Maxtena developed a proprietary five-port tuning method
- The method simplifies tuning of the whole antenna system in one step process

M1575CQA Performance

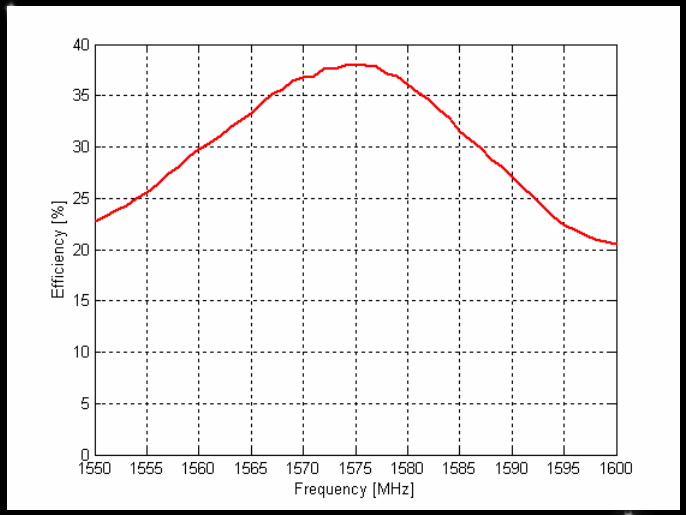
- M1575CQA Return Loss and Filtering

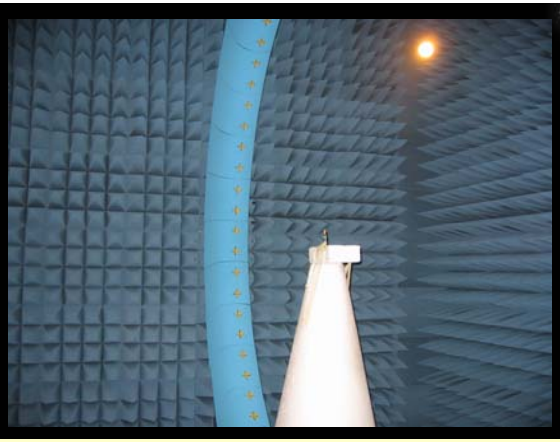


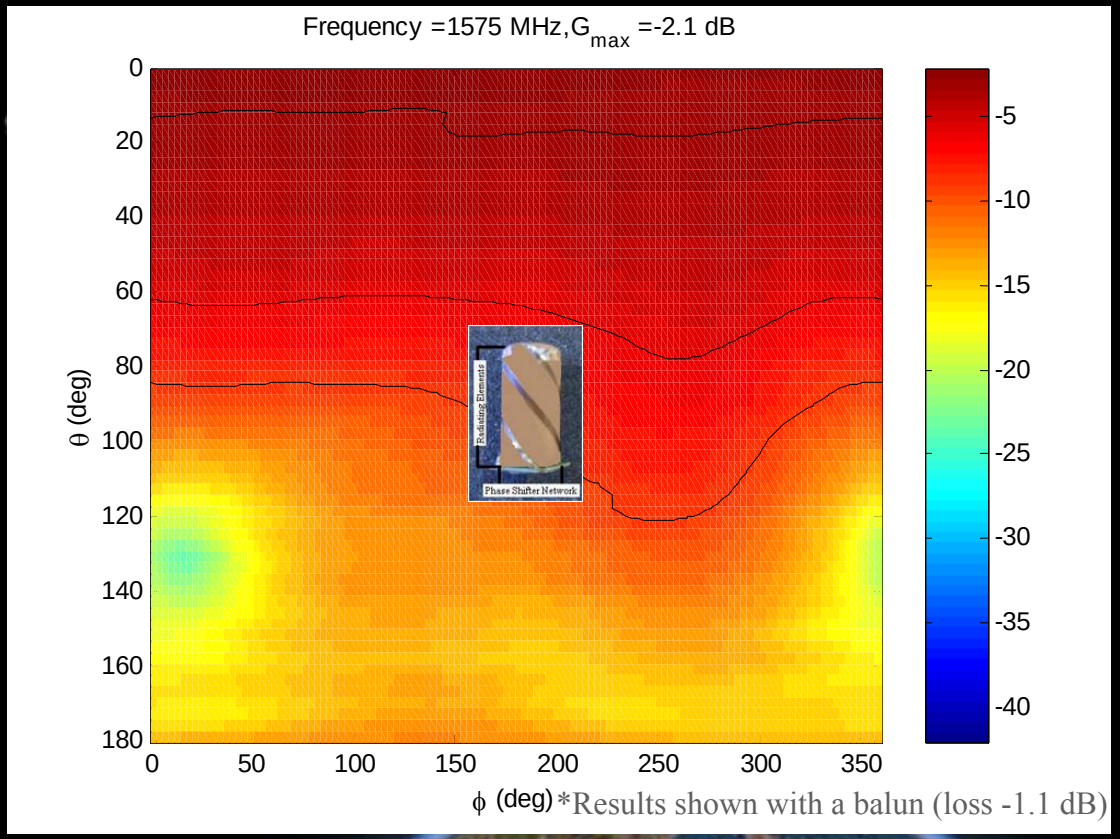


M1575CQA Performance

- Contour Plot – Very Good Upper Hemisphere Symmetry



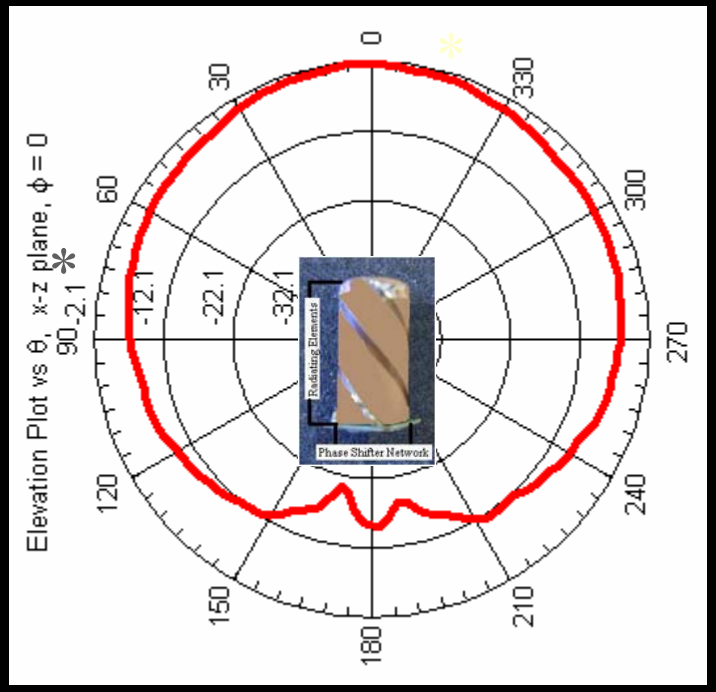


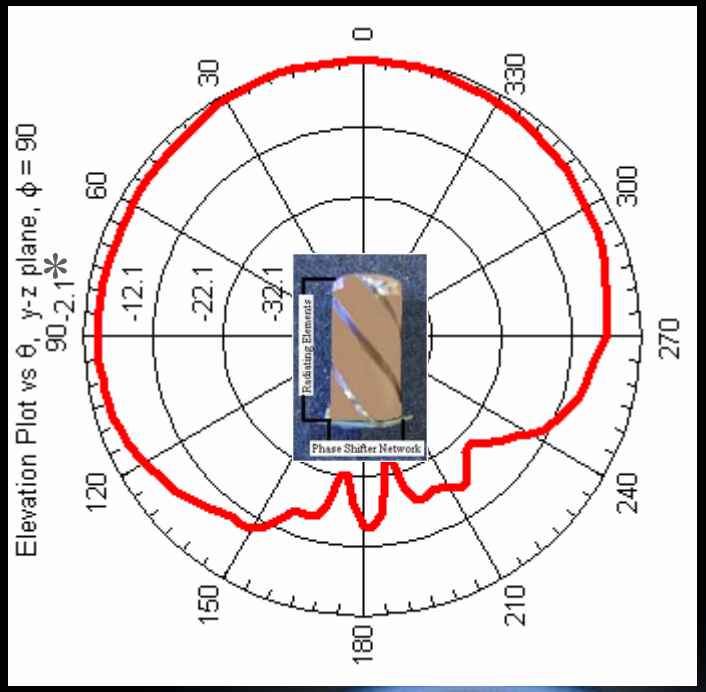


*Results shown with a balun (loss -1.1 dB)

M1575CQA Performance

- Elevation Patterns





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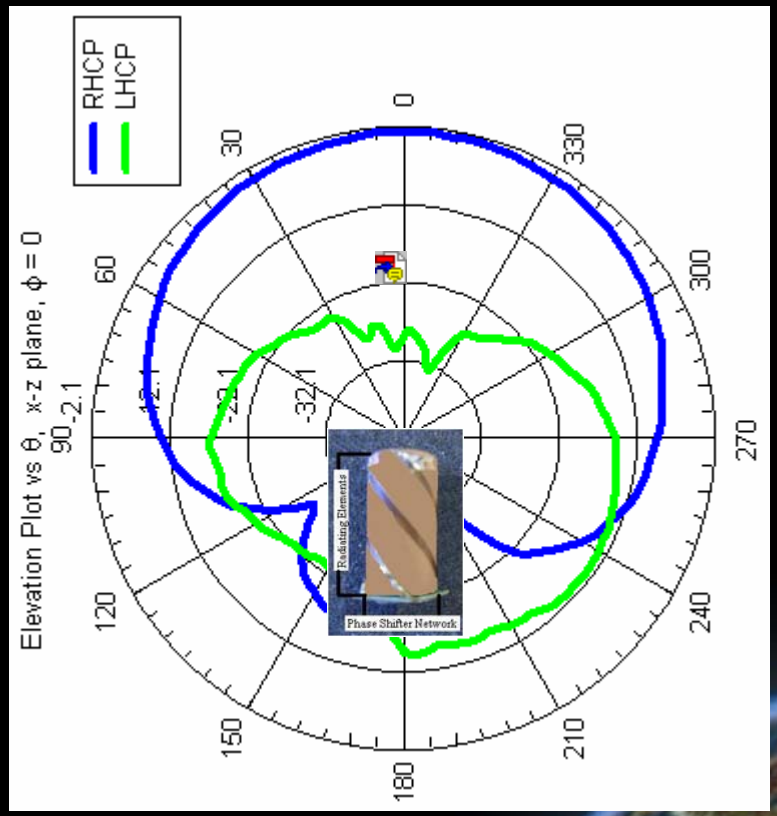
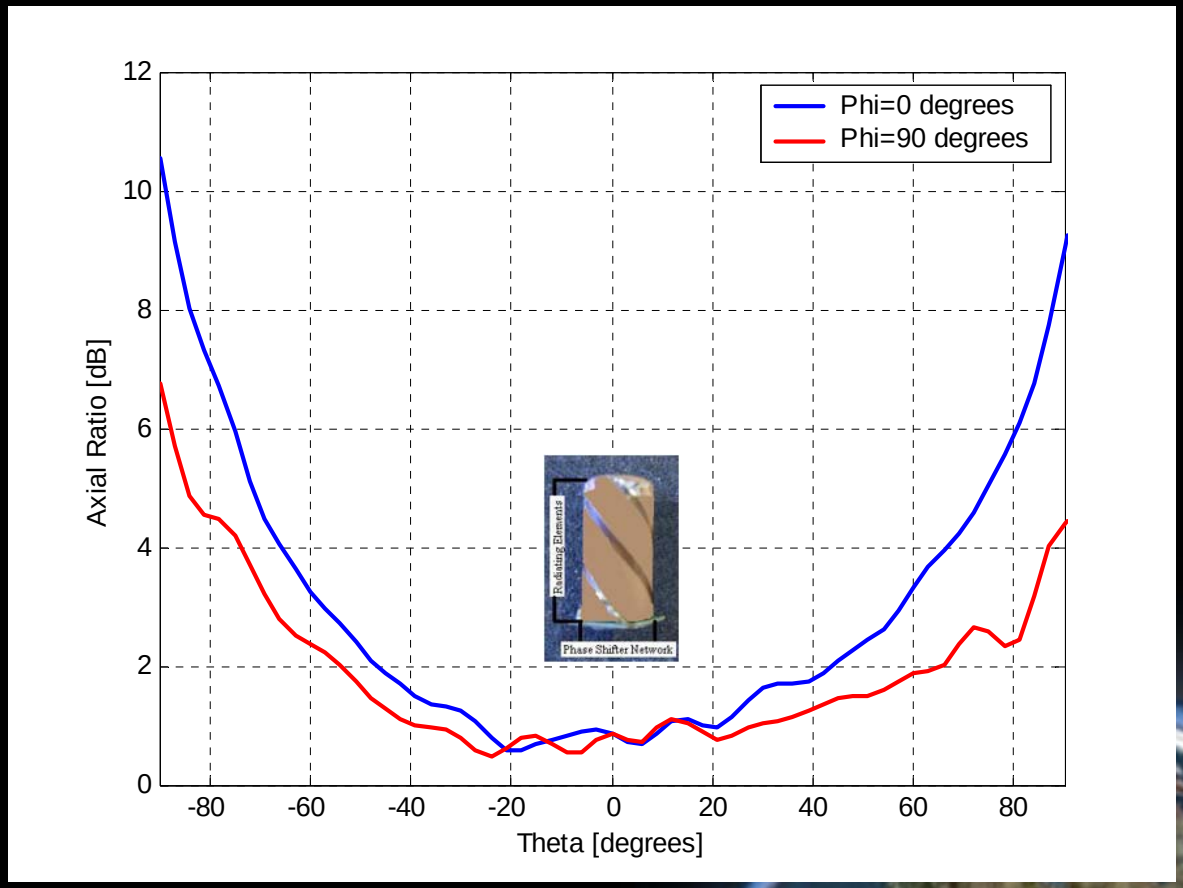
M1575CQA Performance

- RHCP vs. LHCP Rejection



M1575CQA Performance

- Axial Ratio



Conclusions

- Advance Differential Material Technology
- Differential Interface
- Reduced BOM
- Increased Efficiency and Bandwidth
- Minimizing Hand Detuning Effects
- 7 mm design possible
- Technology applicable to cellular market for quad and penta-band antenna designs

Conclusions

Questions?

Comments?