Exploiting the Advantages of Differential Feeds for Compact Antennas

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Presentation Overview

1. Introduction – Differential vs. Single-Ended Interface
2. Quadrifilar Antenna Geometry and Free Space Radiation Characteristics
3. Radiation Characteristics - Integrated
4. Radiation Characteristics – Integrated/Hand and Body Effects
5. Conclusions

1. Differential vs. Single-Ended Interface

- Conventional antenna design employs differential feeds for antennas operating in open areas. The dipole antenna is a good example.
- When a ground plane is present, single ended operation is used. Examples are monopole and microstrip antennas.

Differential vs. Single-Ended

- However, there are several disadvantages to single-ended feeds:
  - The currents on the ground plane lead to:
    - Reduced isolation
    - Variable performance due to presence of human operator, including increased loss and detuning
    - Longer integration process

Differential vs. Single-Ended

Advantages of antennas with inherent balanced inputs:

- Low ground plane currents, providing:
  - Stable and better performance in the presence of components and an operator
  - Easier integration process
- Lower part count: no need for single-ended to differential conversion
- Can be driven directly by differential active devices at appropriate impedance level

Antenna Geometry Details

Differential Design:

- Diameter: 10 mm
- Height: 20 mm

Dielectric constant (er):~20

- LTCC Balun
- 0.9 dB Insertion Loss

Single-Ended Design:

- Diameter: 10 mm
- Height: ~20 mm

Dielectric constant (er):~40

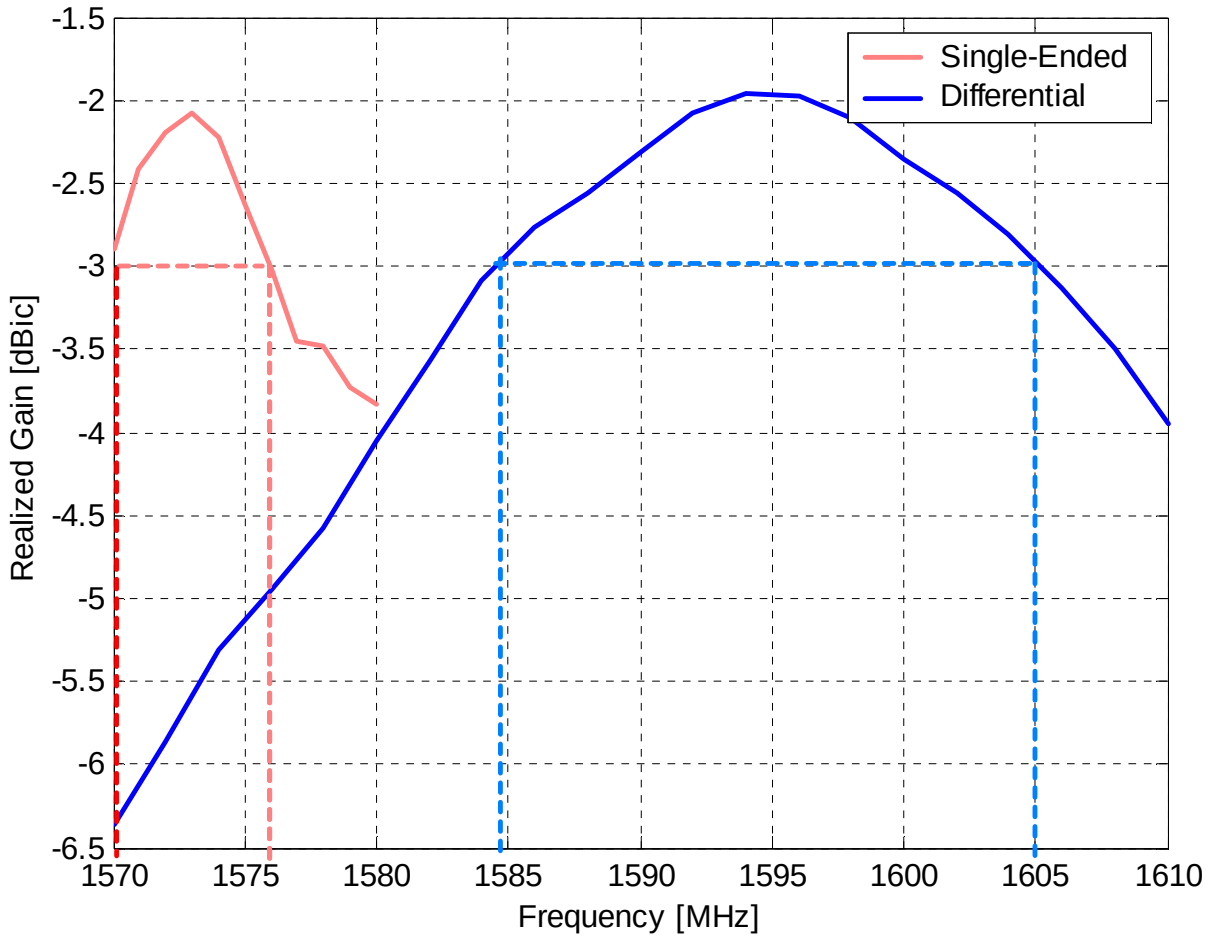
- Integrated Balun
- with coaxial feed

Differential

Single-Ended

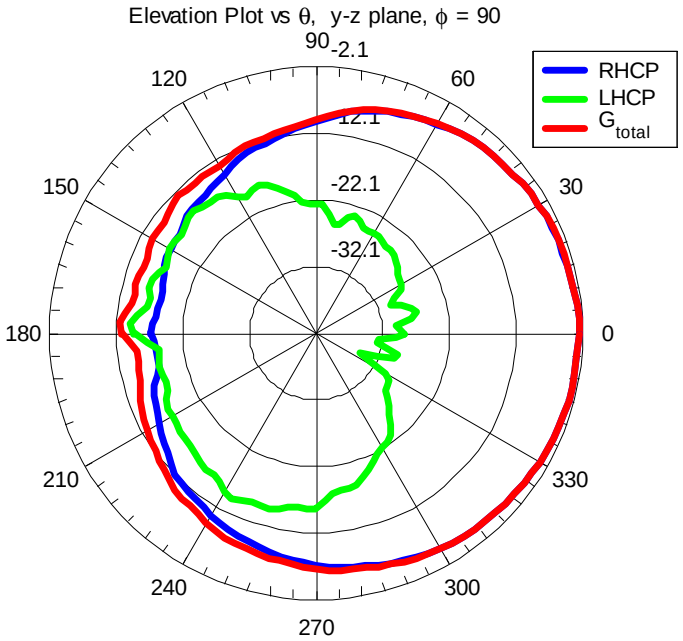
2. Realized Gain and Bandwidth

- 21MHz vs. 6 MHz Bandwidth
- Differential tested with 0.9 dB insertion loss LTCC Balun

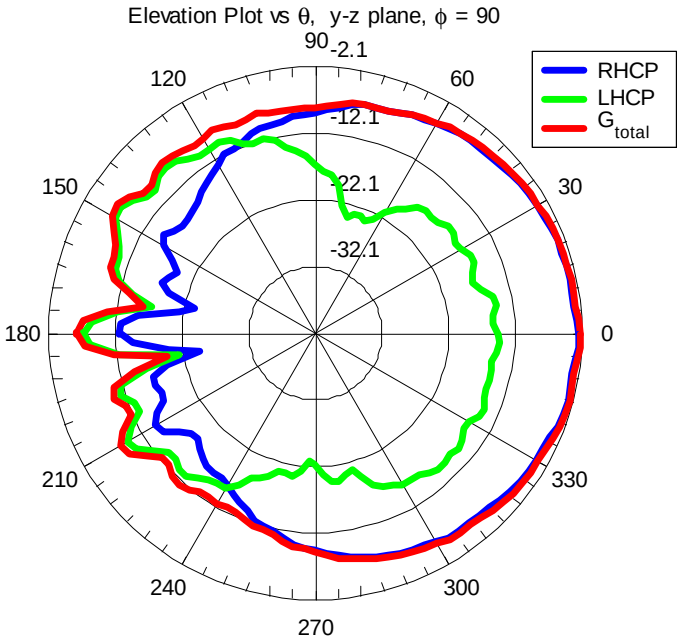


Elevation Pattern x-z plane

Differential

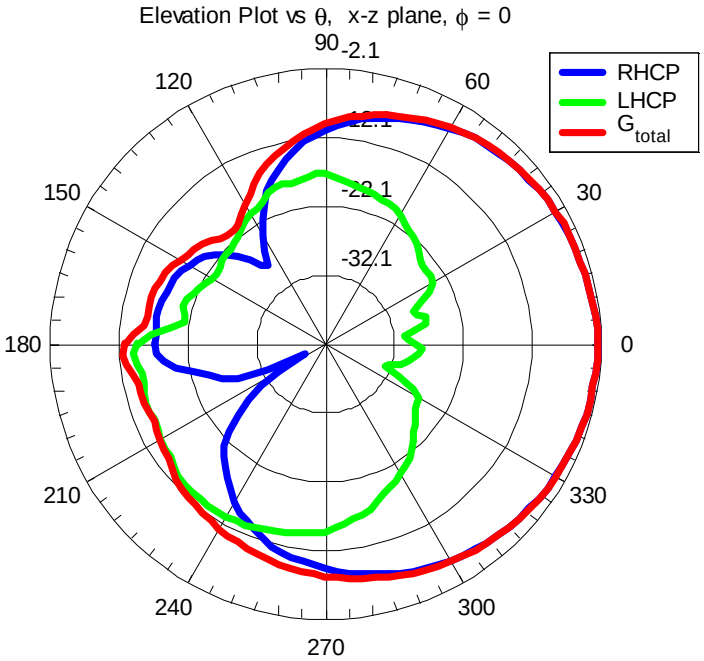


Single-Ended

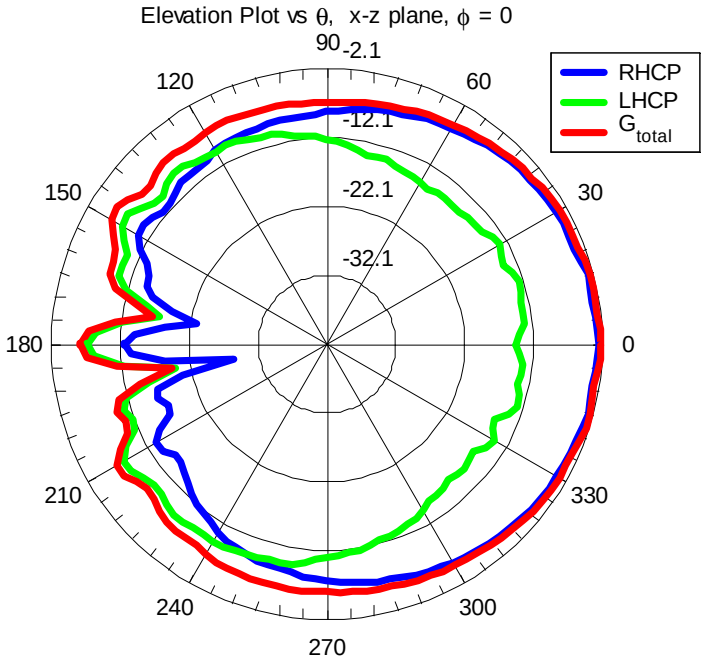


Elevation Pattern y-z plane

Differential

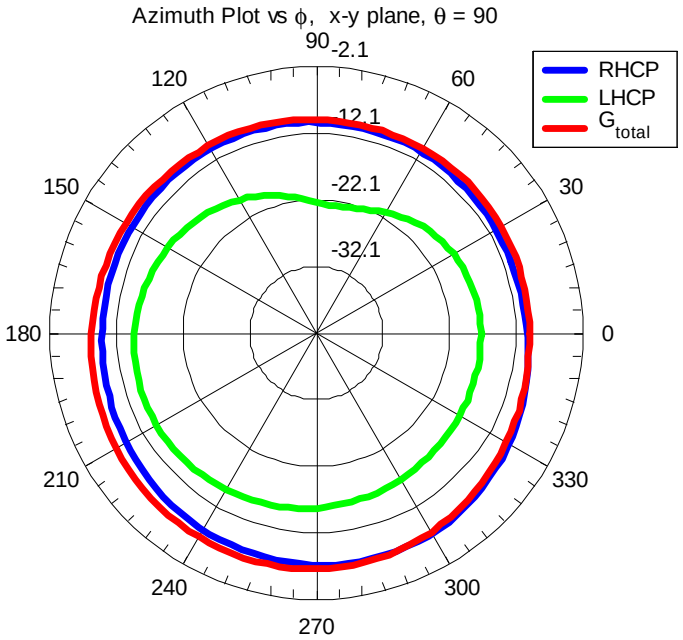


Single-Ended

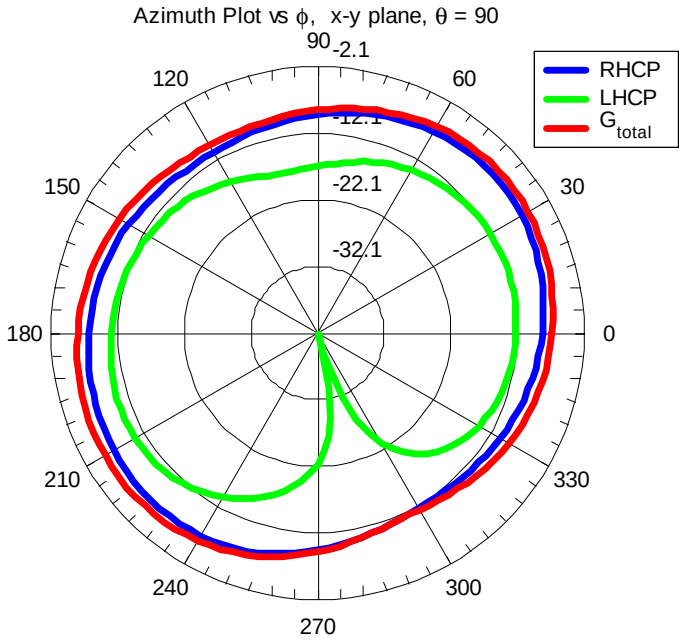


Azimuth Pattern x-y plane

Differential

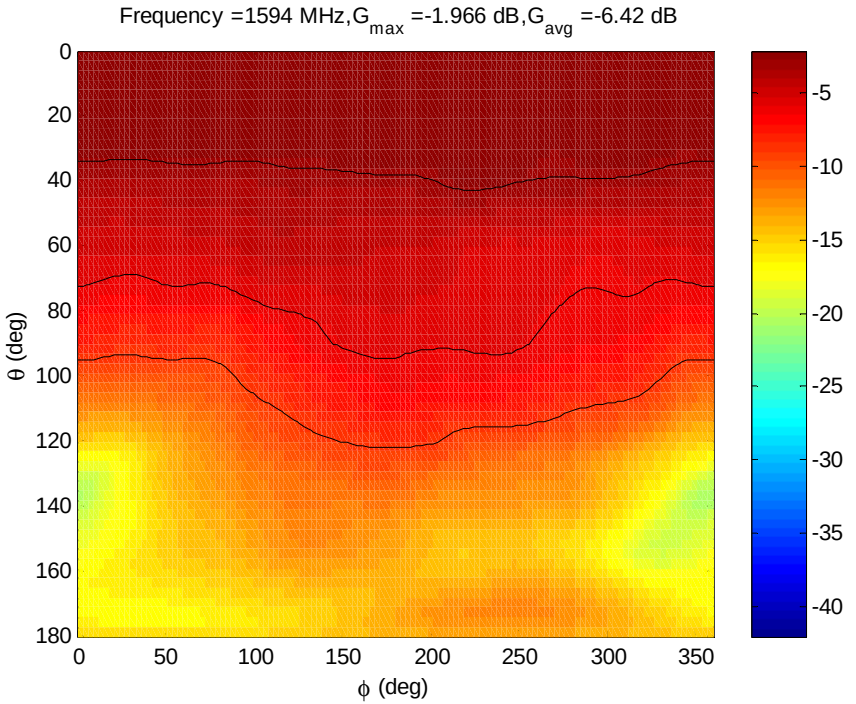


Single-Ended

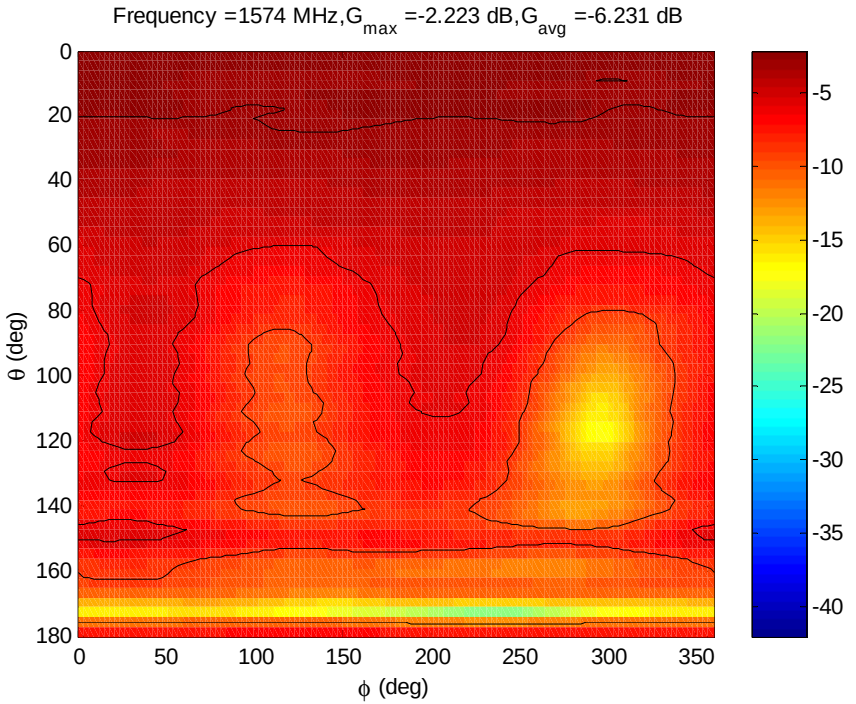


2-D Contour Plot

Differential

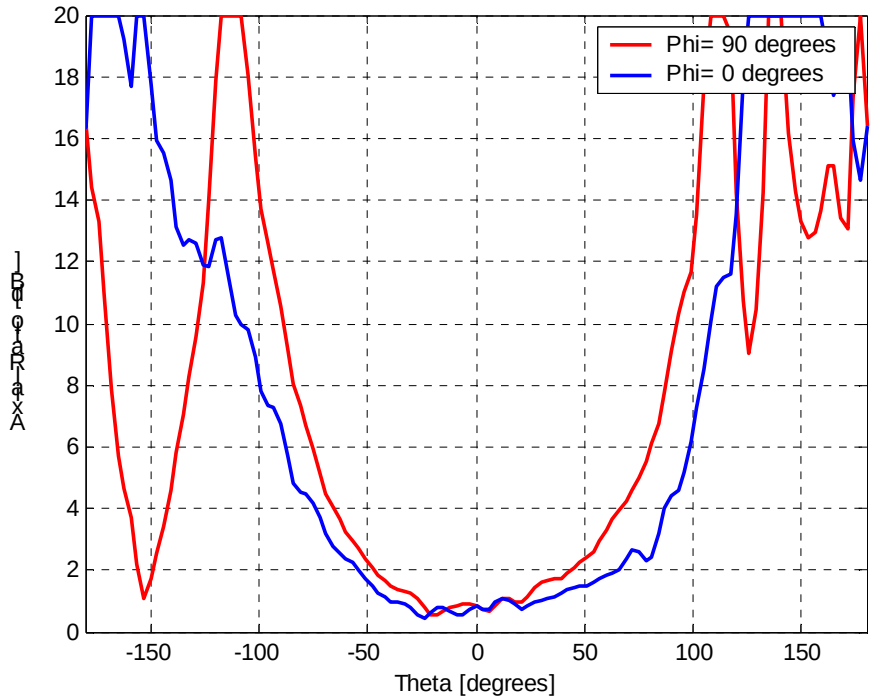


Single-Ended

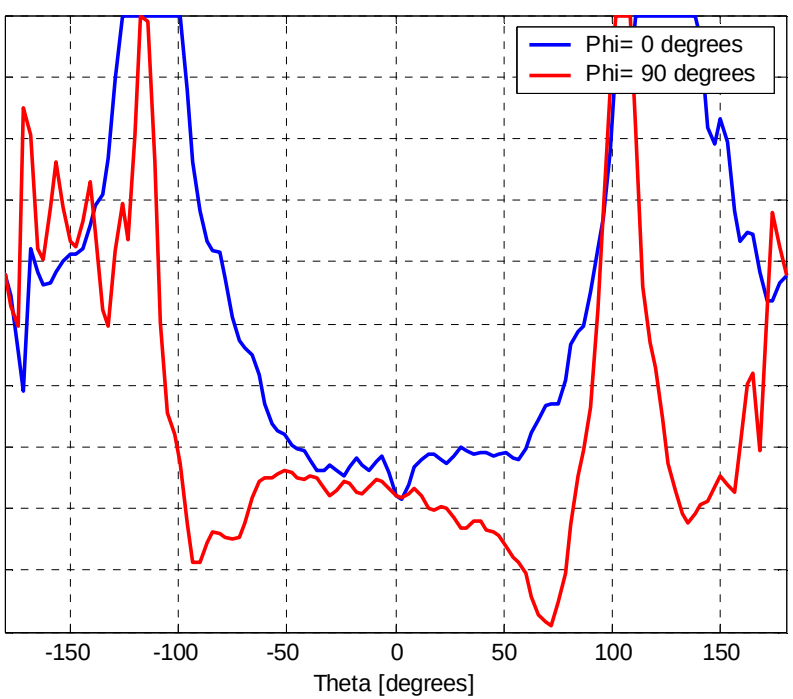


Axial Ratio vs. Theta

Differential

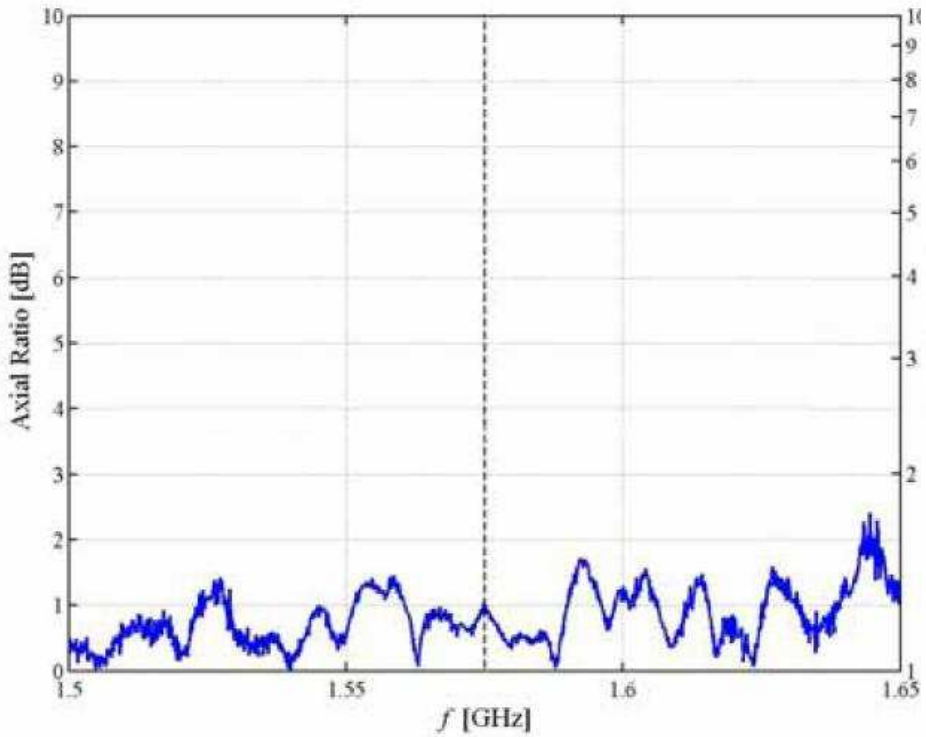


Single-Ended

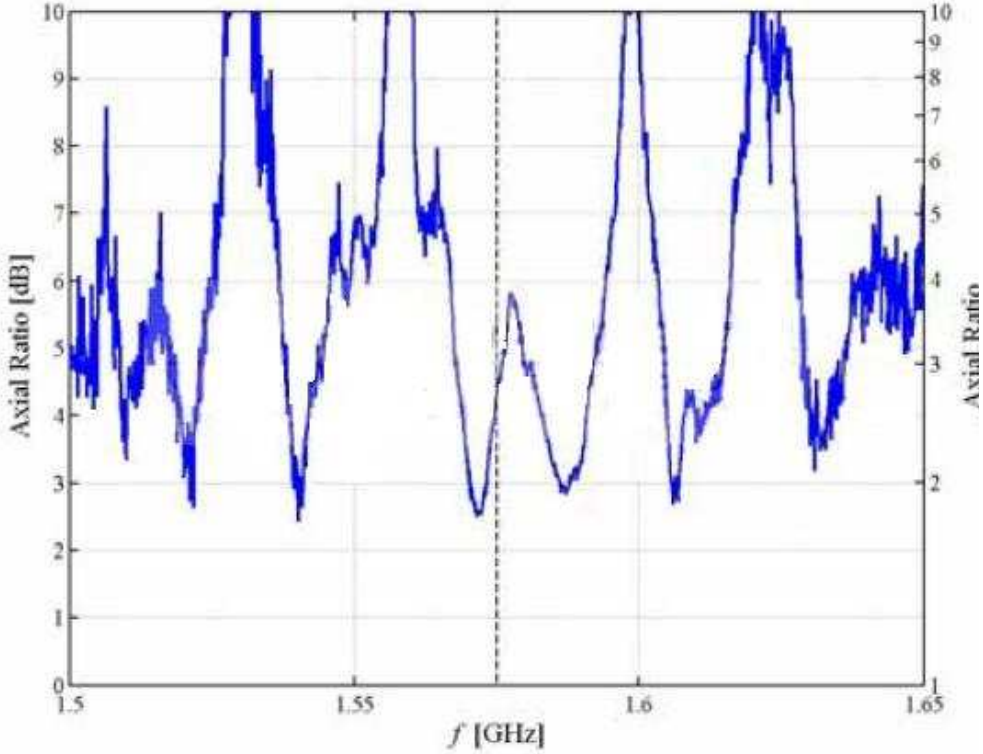


Axial Ratio vs. Frequency/ Axial Ratio Bandwidth

Differential

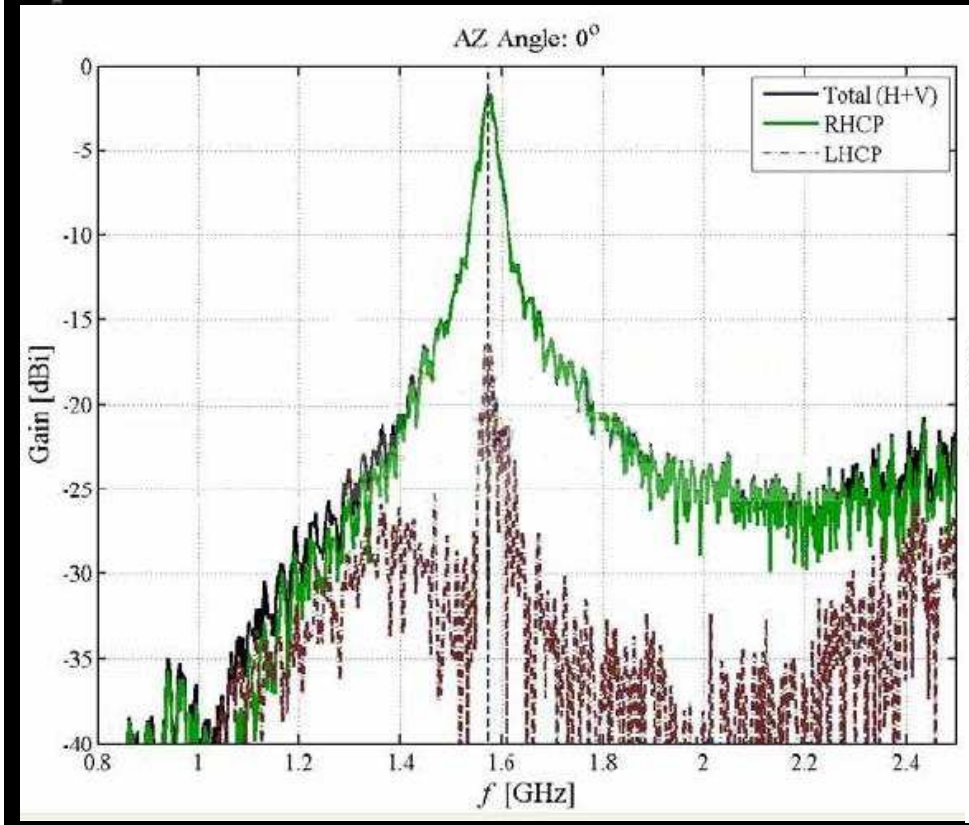


Single-Ended

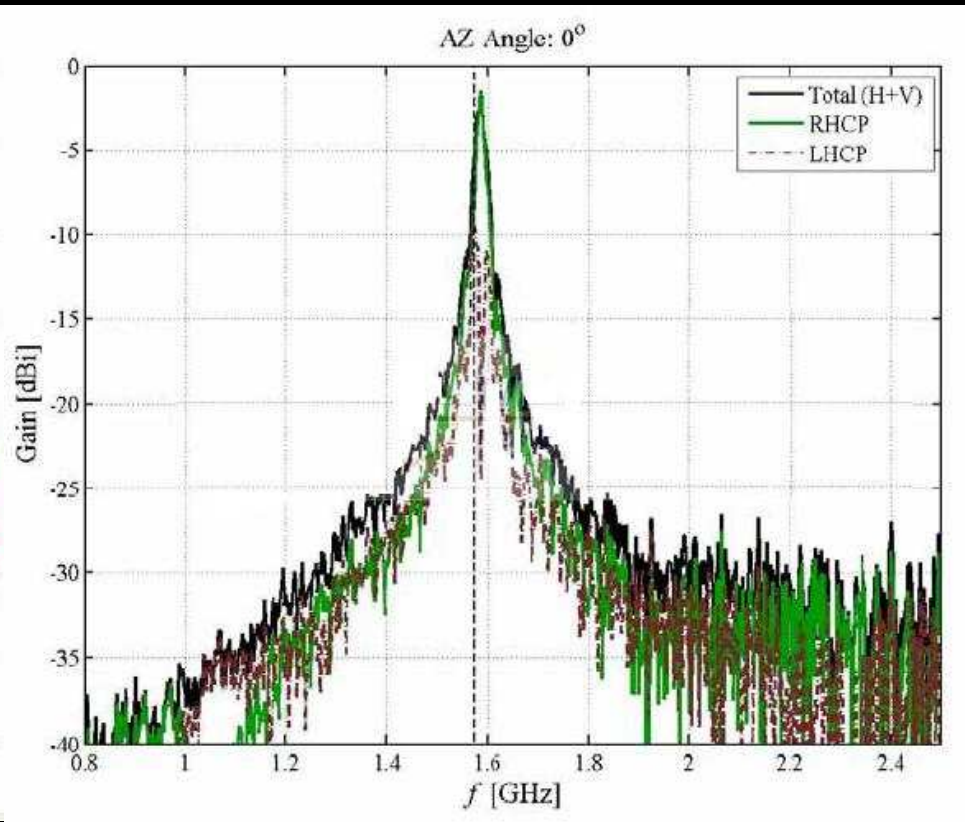


Antenna Filtering

Differential



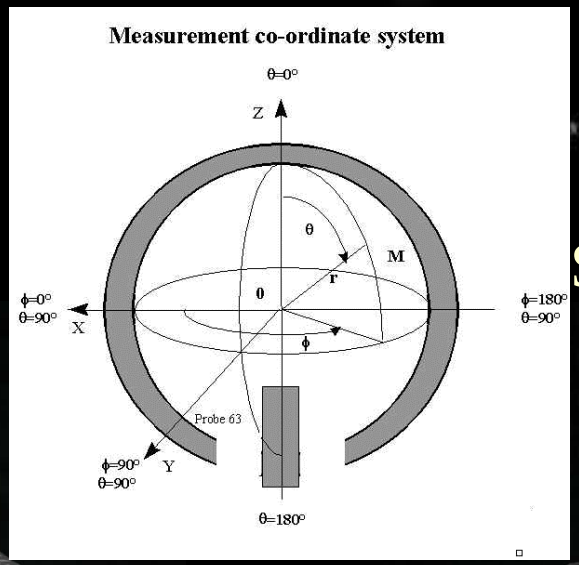
Single-Ended



Free Field Conclusions

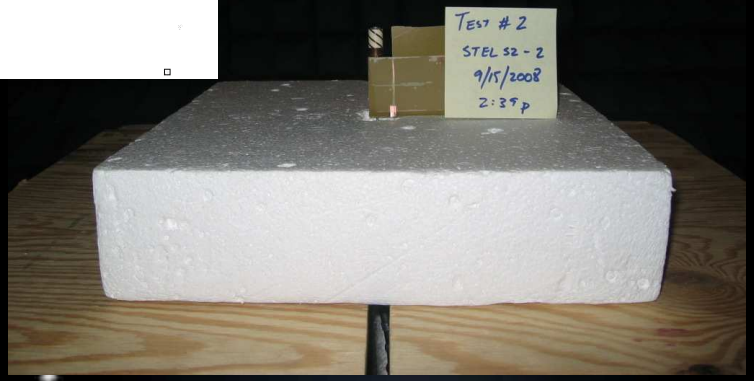
	Single-Ended	Differential with LTCC Balun
Realized Gain	-2.3	-2.0
Axial Ratio Bandwidth (-3dB) [MHz]	4 MHz	150 MHz
Axial Ratio	Greater than 4 dB	Less than 2 dB
RHCP vs. LHCP Rejection	10 dB	20 dB
Bandwidth (-1 dB) [MHz]	6	21

3. Radiation Characteristics Integrated



Differential

Single-Ended



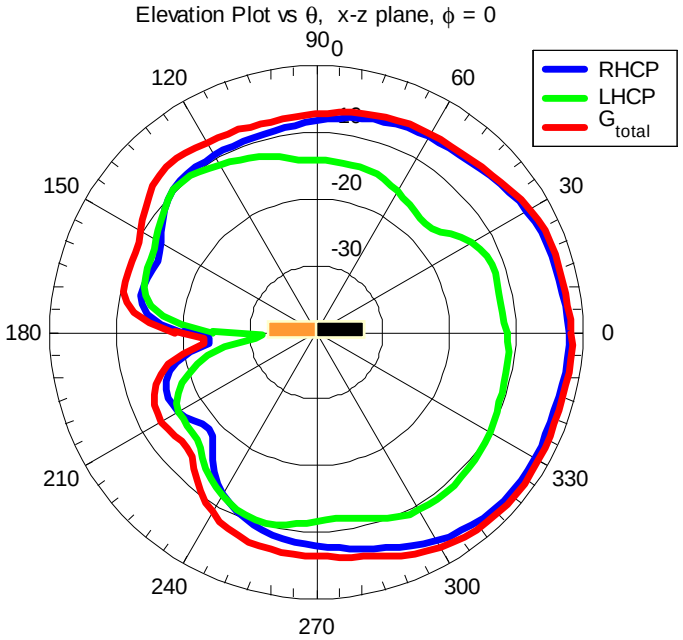
Test Board Dimensions:

Length: 120 mm

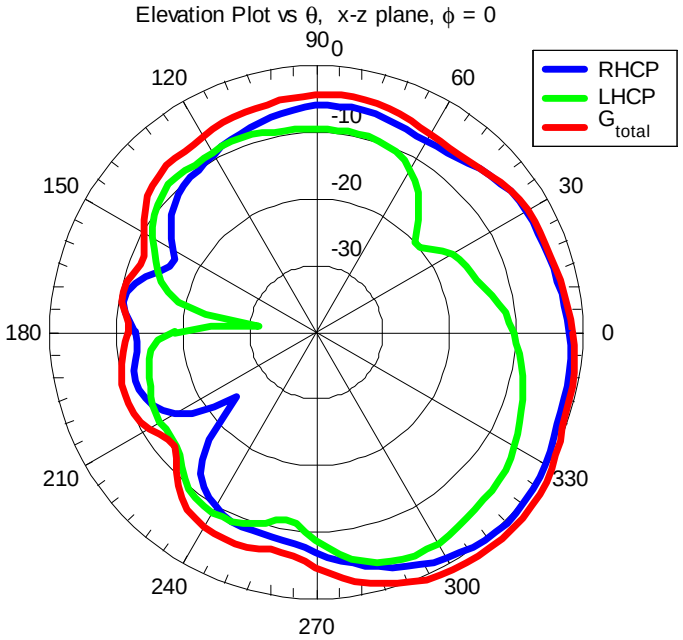
Height: 60 mm

Elevation Pattern x-z plane

Differential

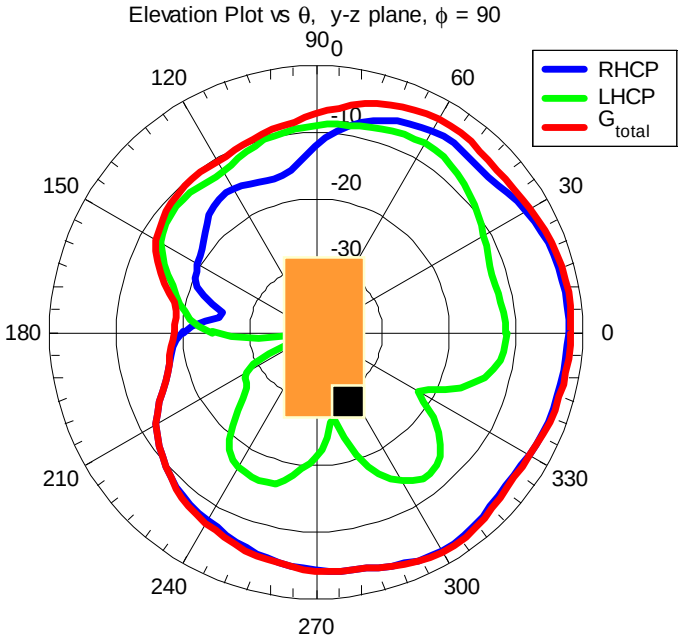


Single-Ended

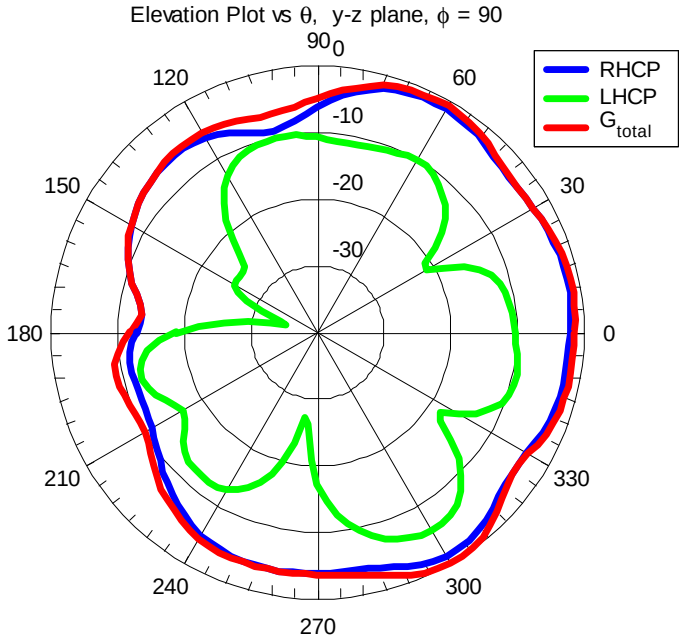


Elevation Pattern y-z plane

Differential

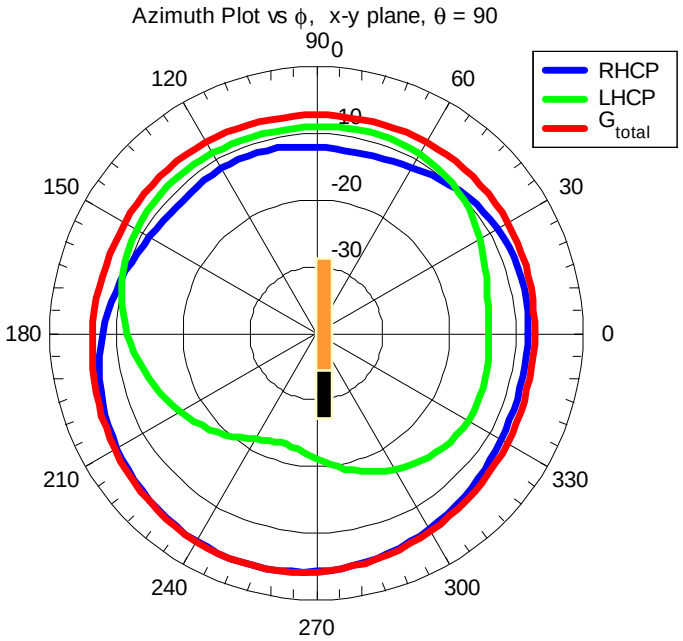


Single-Ended

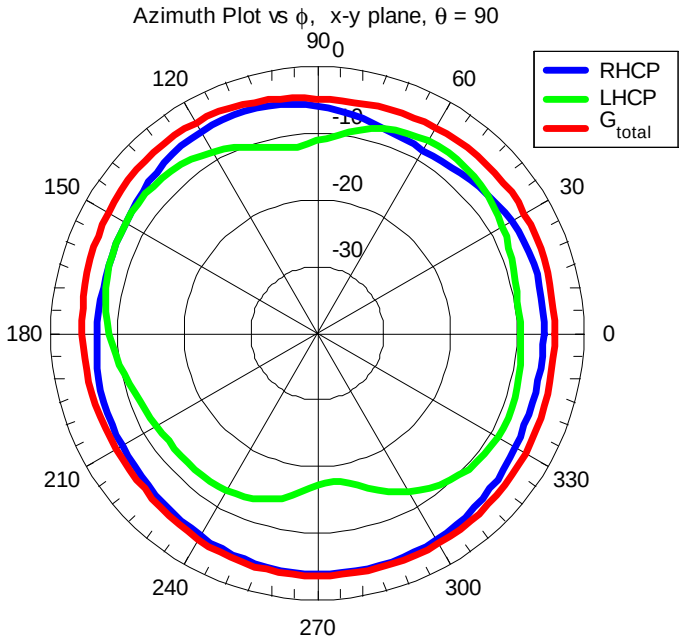


Azimuth Pattern x-y plane

Differential

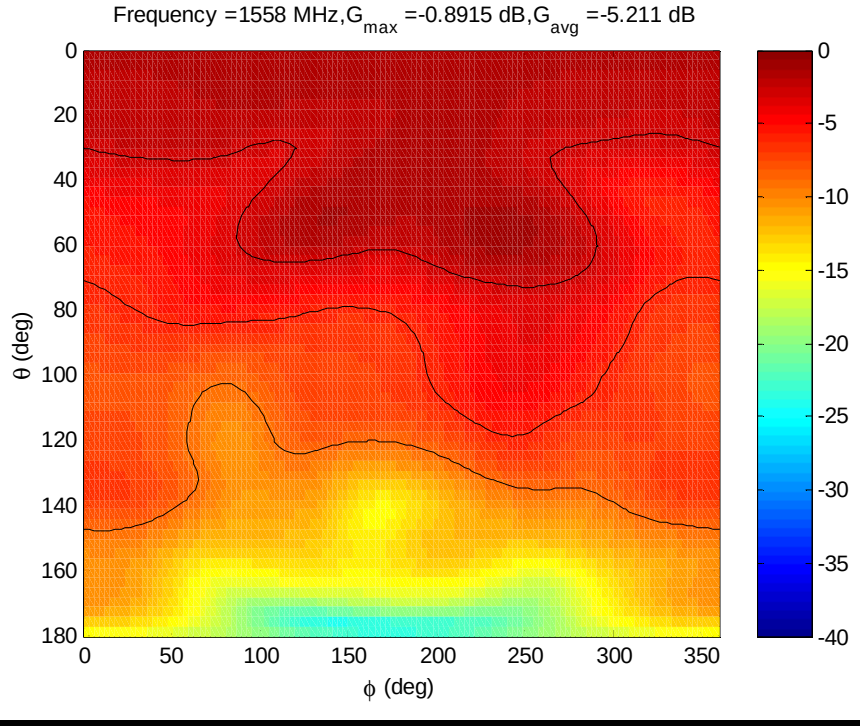


Single-Ended

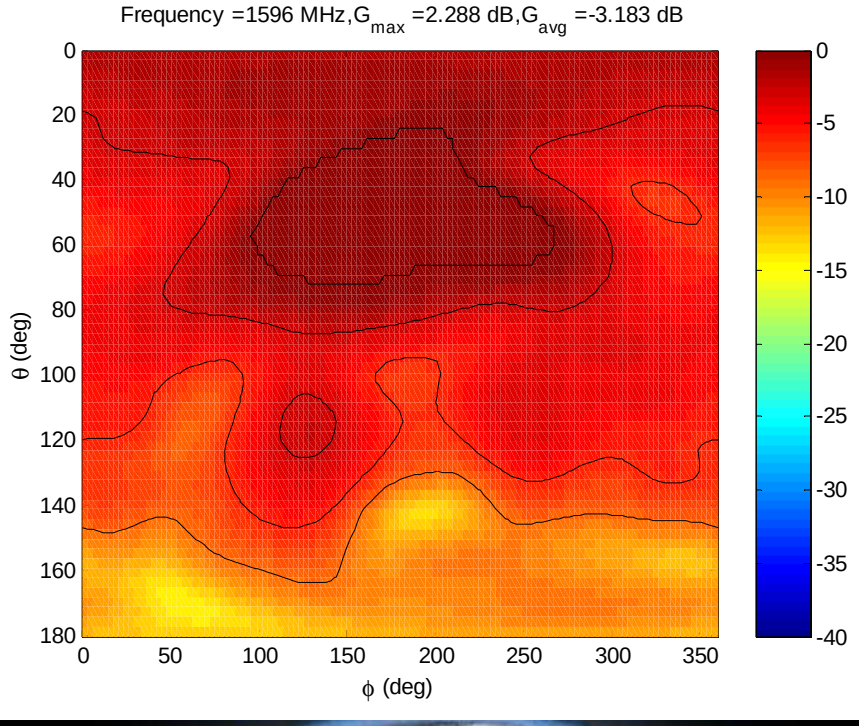


2-D Contour Plot

Differential

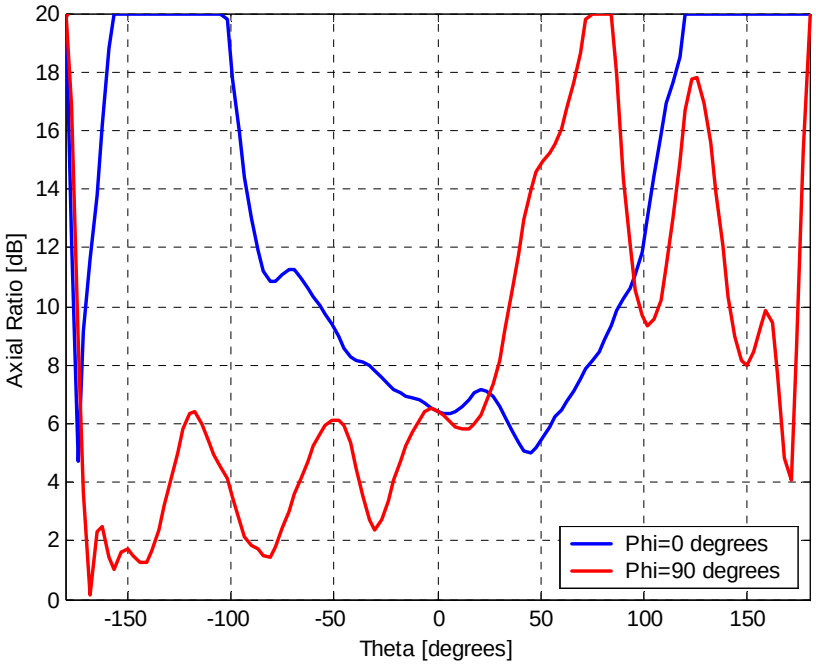


Single-Ended

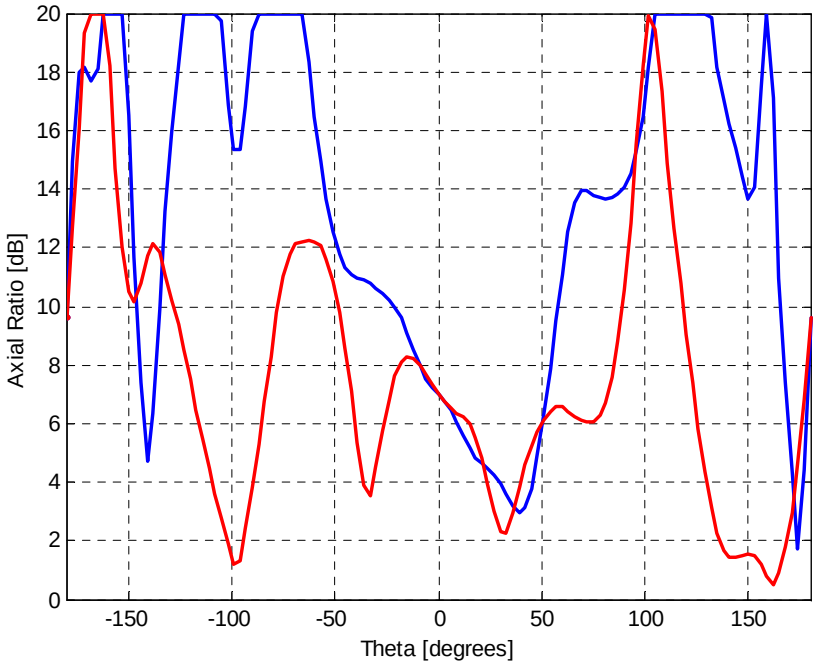


Axial Ratio vs. Theta

Differential



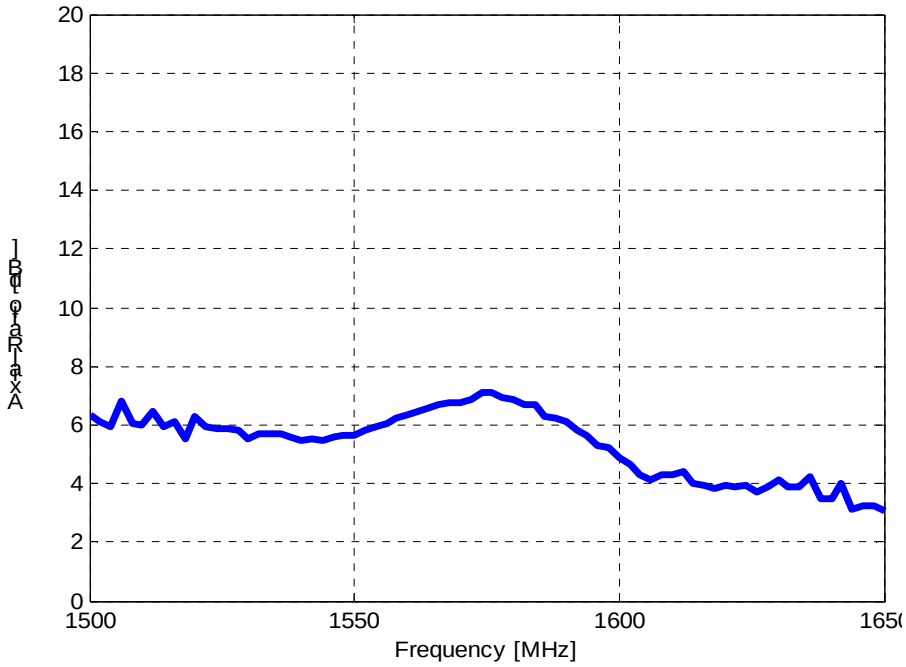
Single-Ended



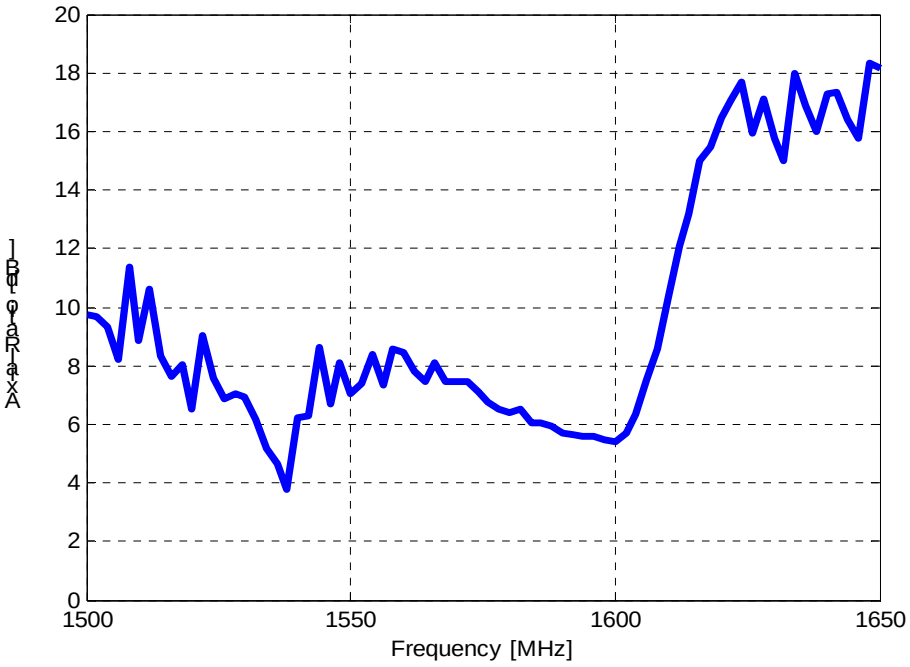
Axial Ratio vs. Frequency/ Axial Ratio Bandwidth

MAXTENA

Differential



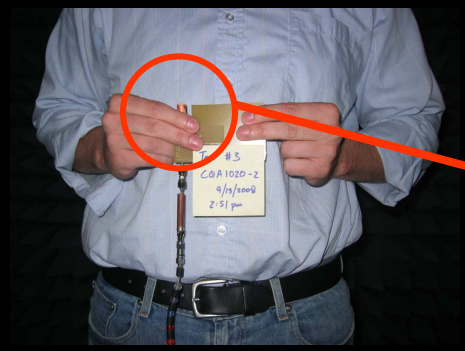
Single-Ended

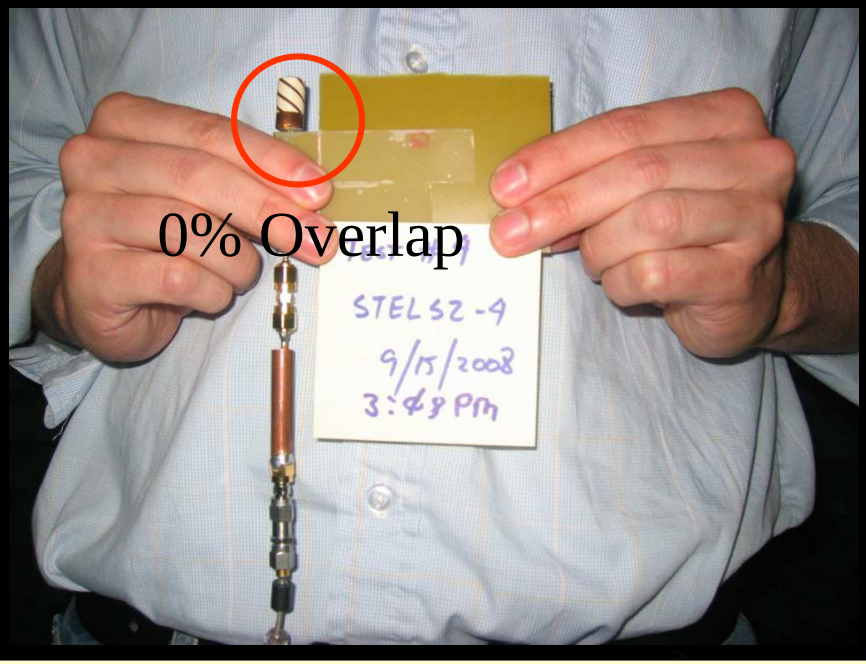


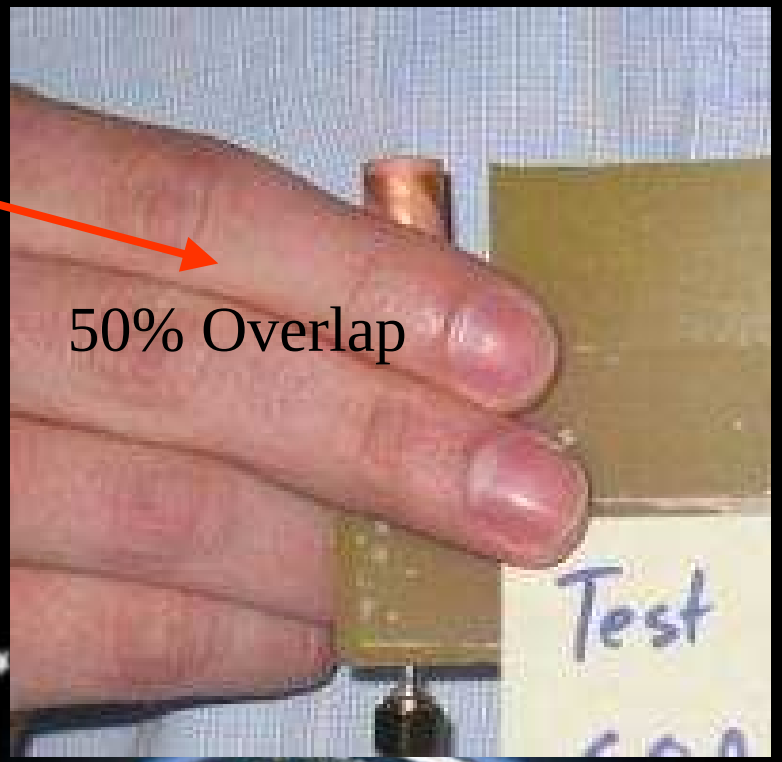
Integrated Conclusions

	Single-Ended	Differential with LTCC Balun
Realized Gain	2.3	-0.7
Efficiency Free Field [%]	49	31
Axial Ratio (<6 dB)	~30 MHz	~120 MHz
RHCP vs. LHCP Rejection	~5 dB	~10 dB
Bandwidth (-1 dB) [MHz]	16	24

4. Radiation Characteristics Integrated including Hand and Body

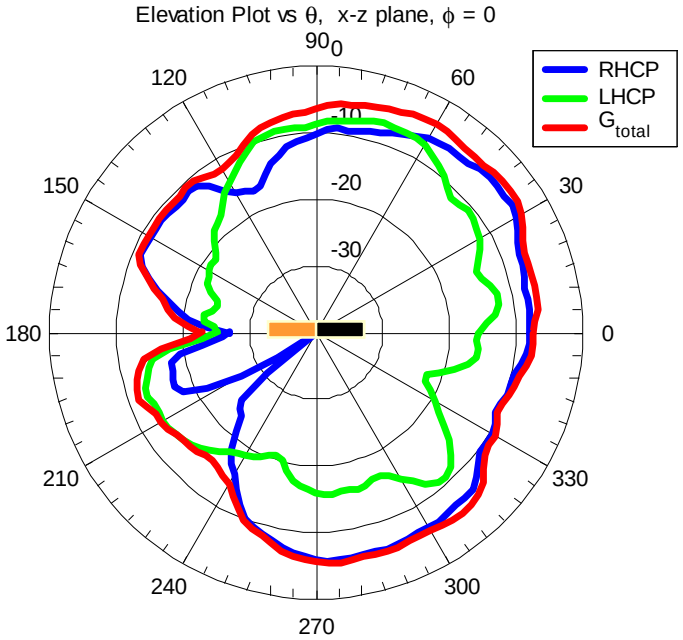




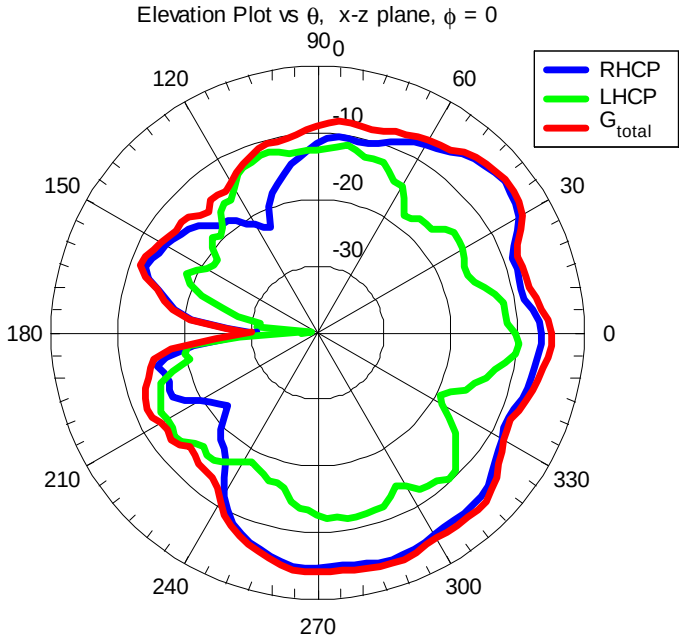


Elevation Pattern x-z plane

Differential

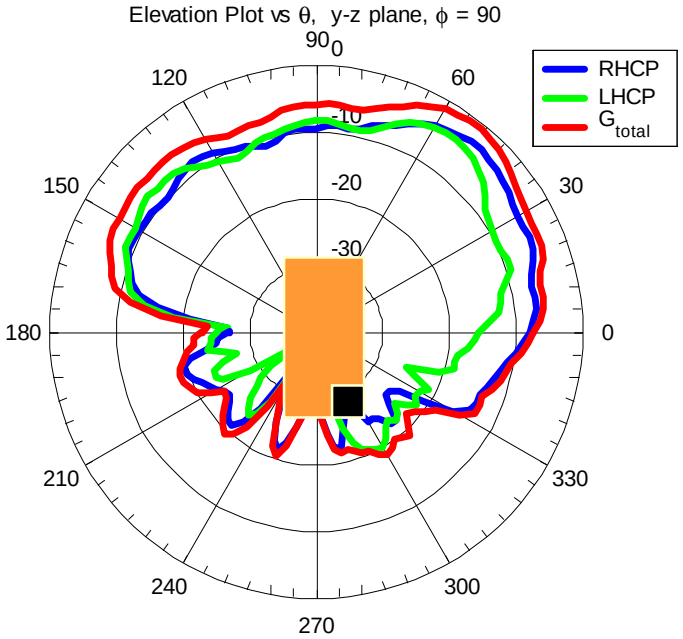


Single-Ended

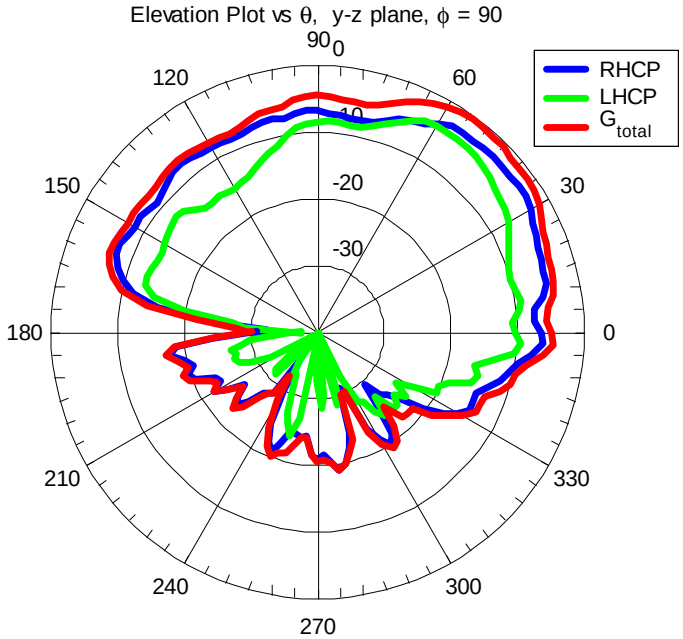


Elevation Pattern y-z plane

Differential

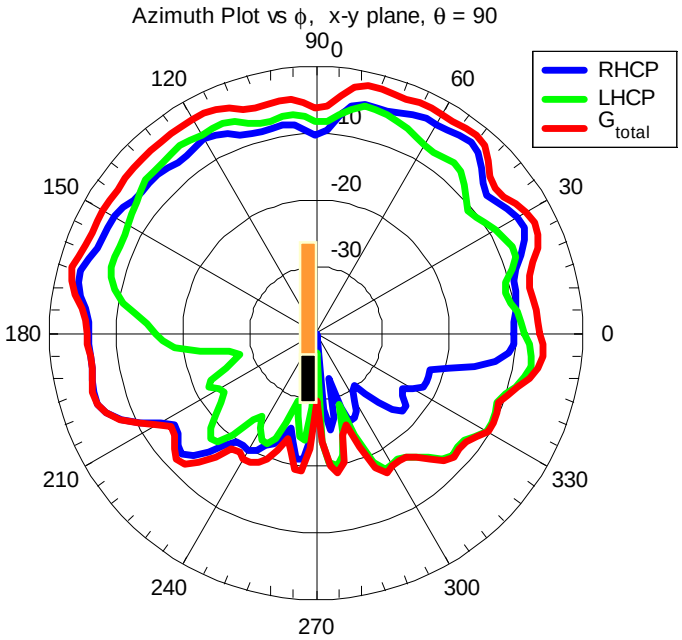


Single-Ended

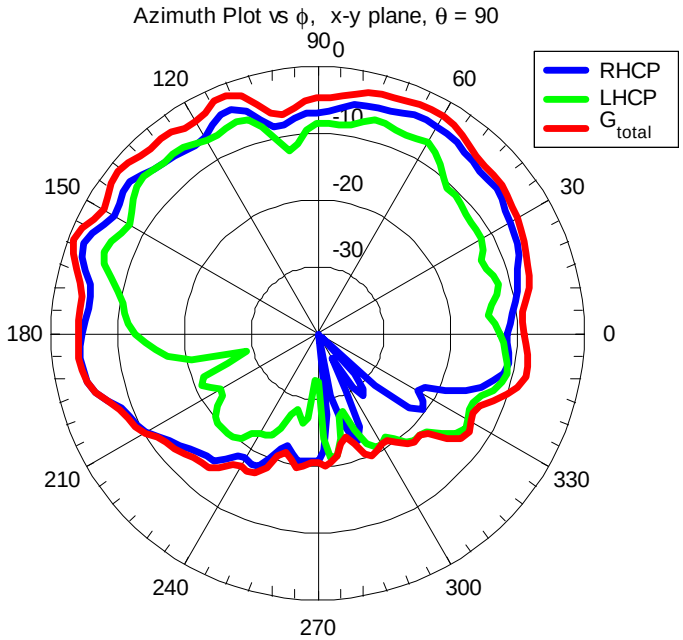


Azimuth Pattern x-y plane

Differential

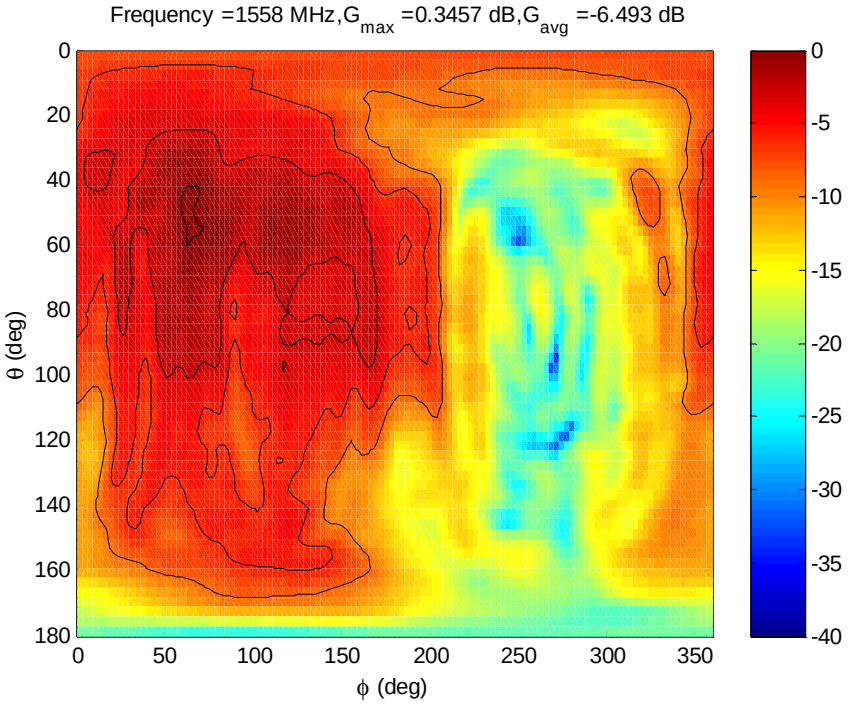


Single-Ended

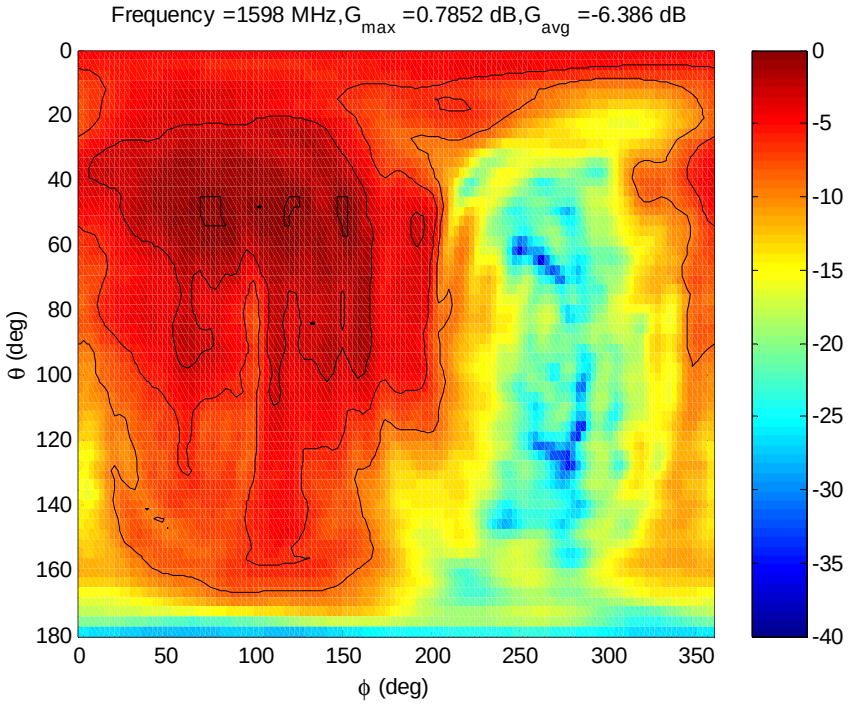


2-D Contour Plot

Differential

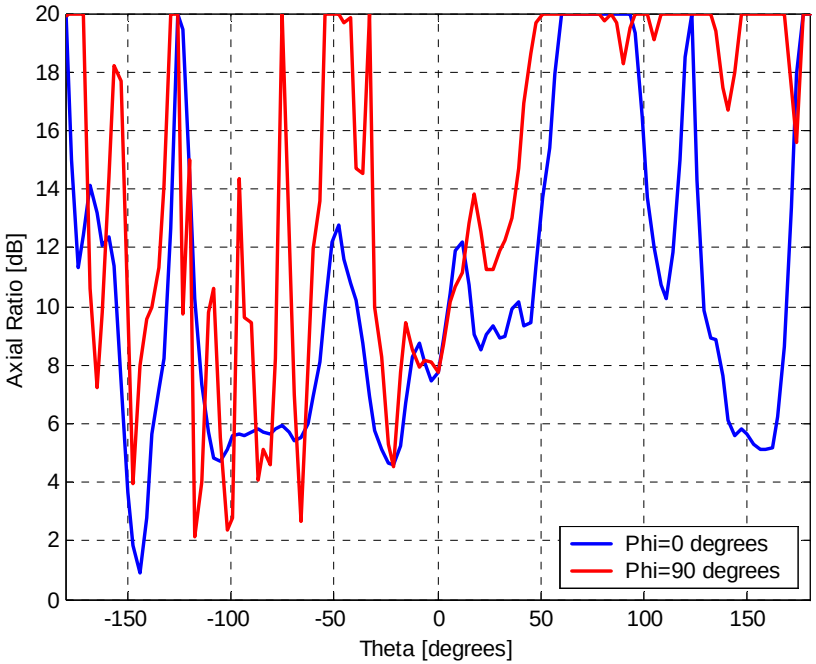


Single-Ended

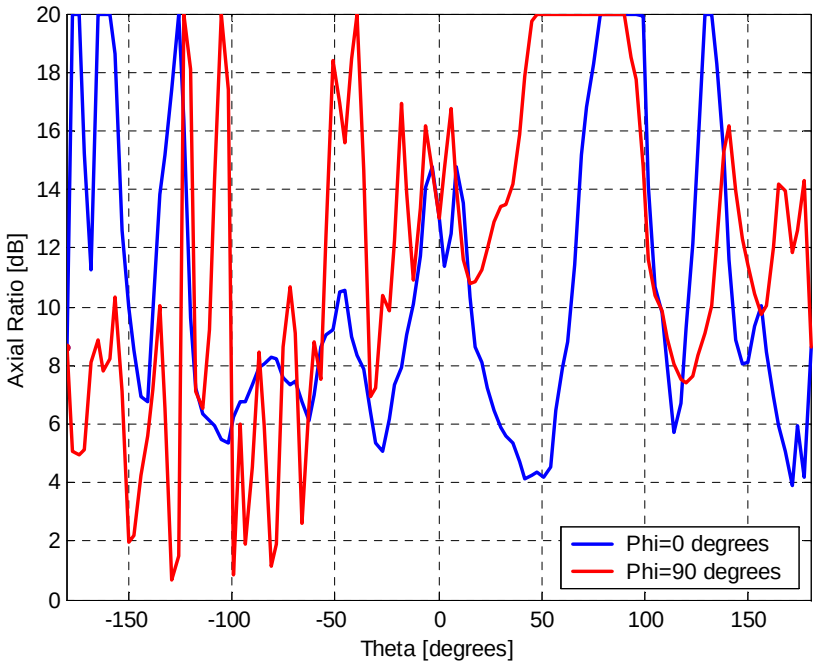


Axial Ratio vs. Theta

Differential

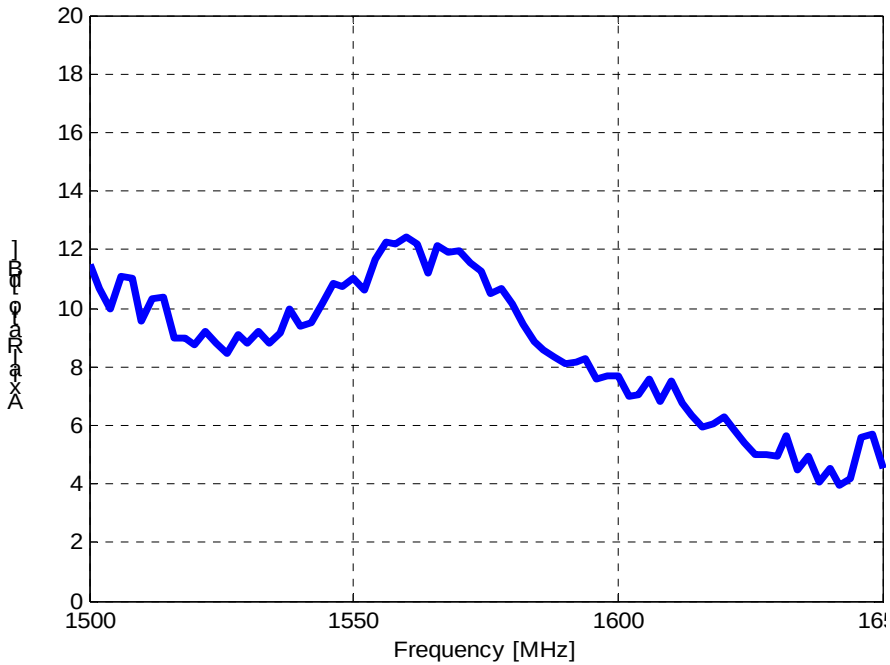


Single-Ended

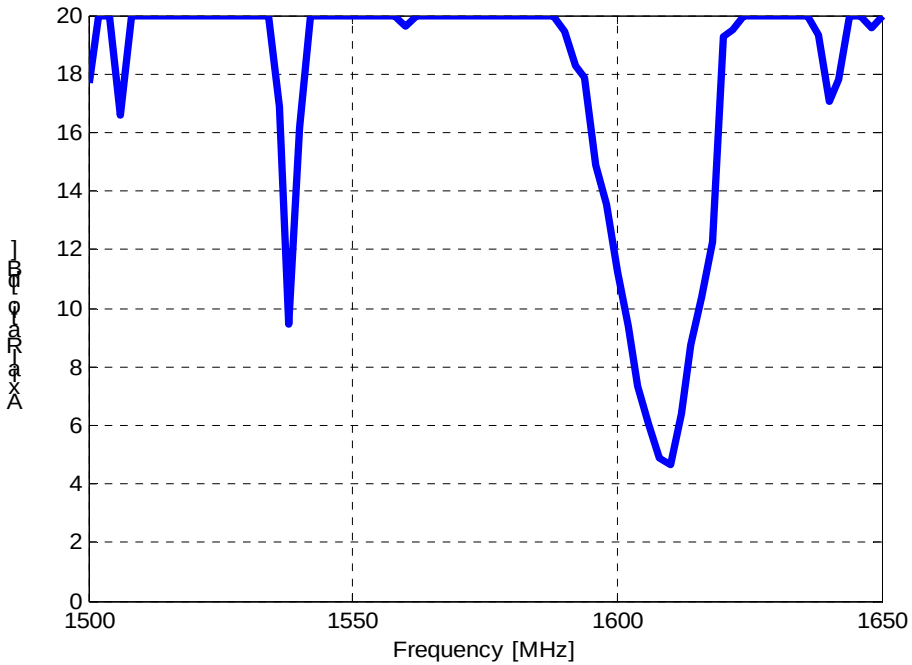


Axial Ratio vs. Frequency/ Axial Ratio Bandwidth

Differential



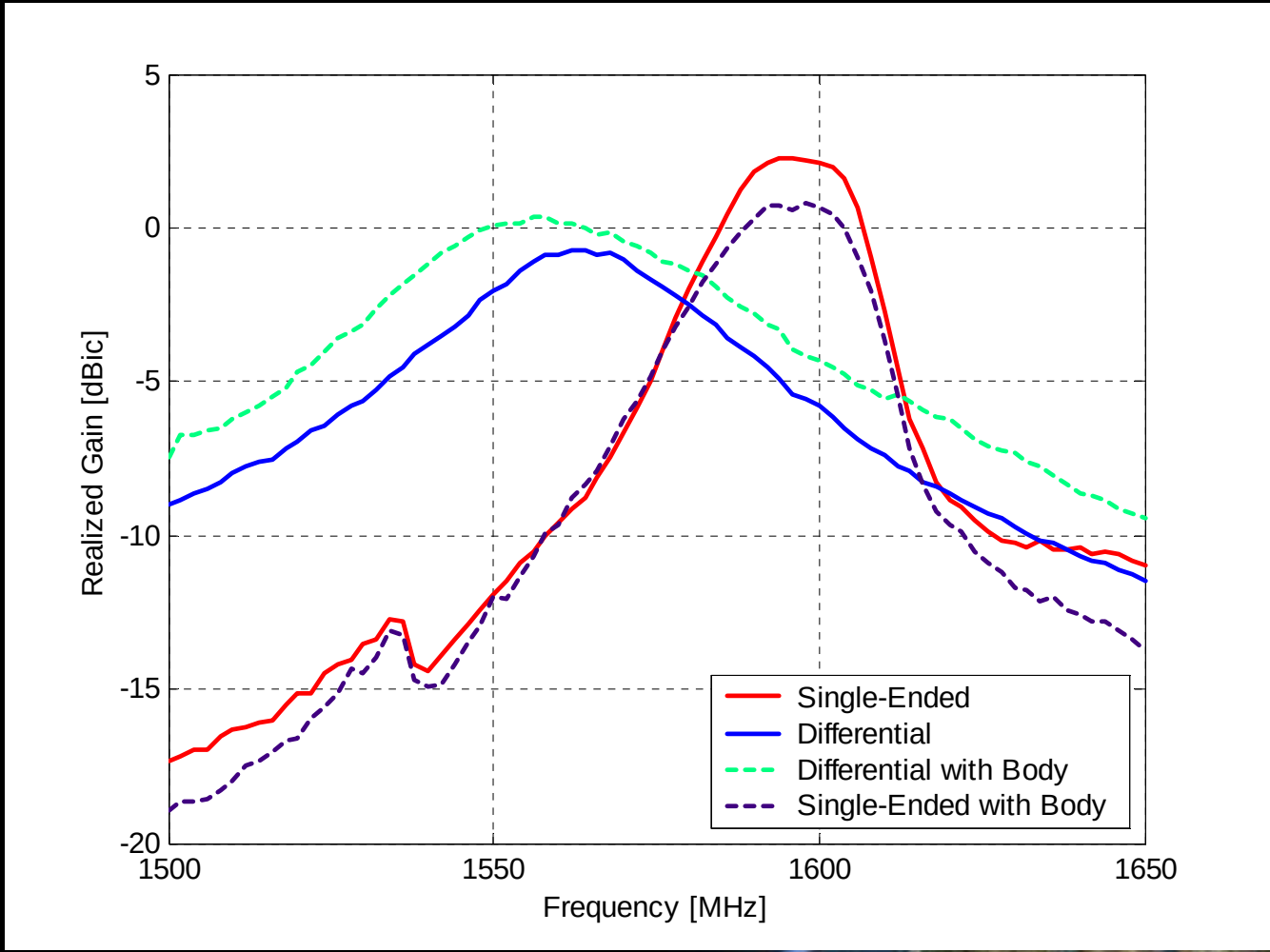
Single-Ended



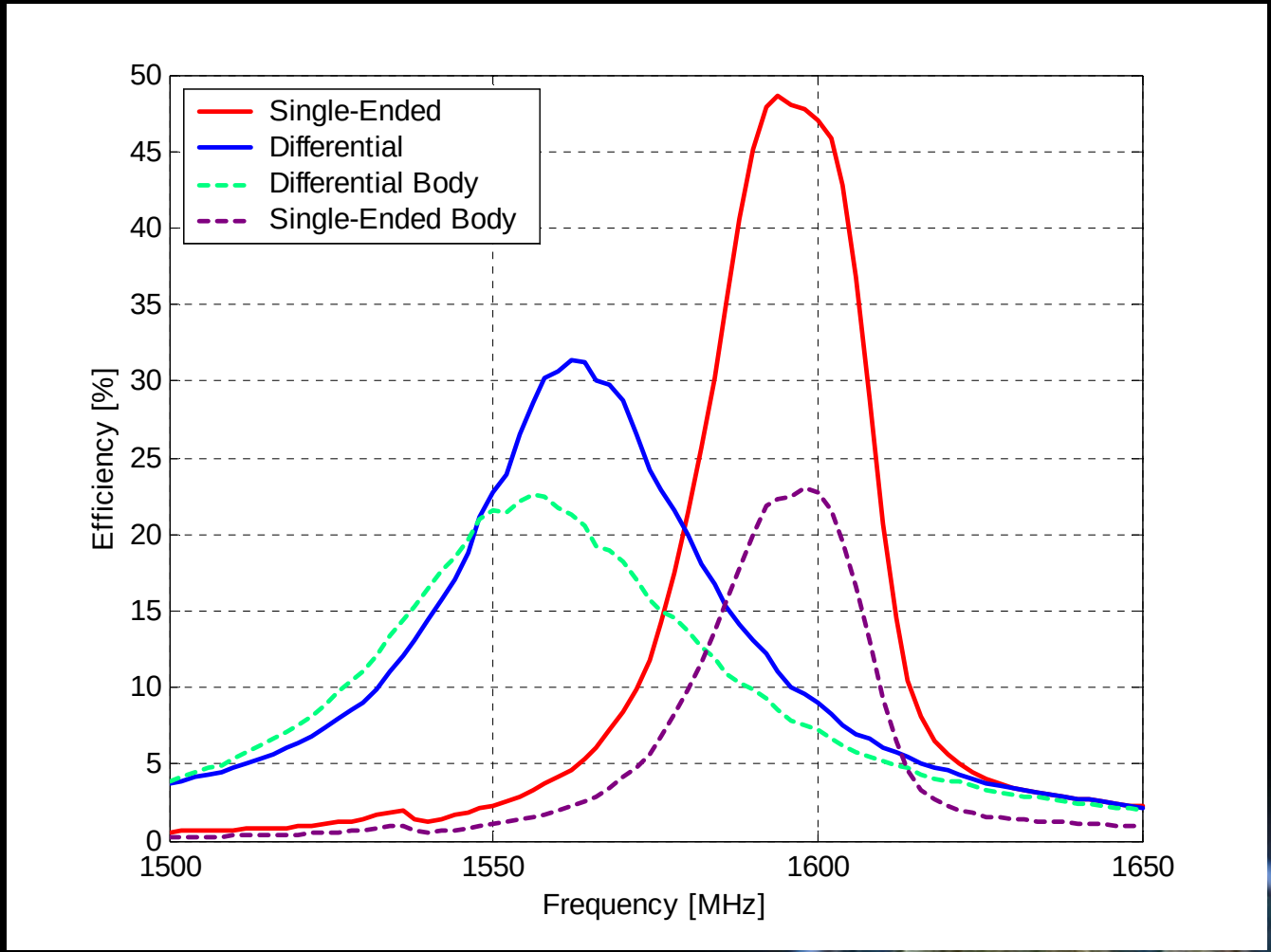
Integrated-Hand and Body/ Conclusions

	Single-Ended	Differential with LTCC Balun
Realized Gain	0.8	0.4
Efficiency Free Field [%]	23	22
Bandwidth (-1 dB) [MHz]	16	32
Hand/Body Detuning Shift	2 MHz	6 MHz

5. Conclusions



5. Conclusions



5. Conclusions

- M1575CQA with 50% hand overlap performs the same as the single ended antenna with 0% hand overlap.
- Differential interface antenna shows higher human body immunity.
- This direct evaluation concludes that the differential interface antenna has higher gain, better human body immunity and outstanding performance compared to single ended antennas.