Abstract

- Increased path loss at mm-wave frequencies (5G) relative to 4G-LTE frequency bands motivates highly directional antennas to mitigate the loss in transmission.
- This research integrates a lens antenna into a mobile phone case to increase 5G wireless antenna performance for a compact, multi-functional electronic antenna packaging solution in the 28 GHz frequency band.

Antenna Simulation

- Fig 3. COMSOL™ simulated electric field strength at resonance (27 GHz) for a 200Ω edge-feed patch antenna on RT Duroid 5880.
- Fig 4. Simulated return loss for single element indicates resonance at 27.009 GHz. Bandwidth is 405 MHz.

Lens Design

- Fig 5. Layout of 4x1 antenna array for broadside radiation pattern.
- Fig 6. COMSOL™ simulated radiation pattern of 4x1 array at resonance (27 GHz) measured in dBi.
- The current lens design is a planar gradient index lens.
- In theory, it provides broadband, high-gain performance.
- The low-profile of this lens design is ideal for the packaging goals inside a mobile device case.
- The permittivity of the lens decreases from the center to the outer radius.
- \[ T = \frac{\sin \theta}{3 \sin^2 \theta} = \sqrt{\left(\frac{\epsilon_r - \tan^2 \theta}{\epsilon_{\text{eff}} \tan \theta + 1}\right)} \]

Additive Manufacturing

- 3-D printing permits infill variation to control material effective permittivity.
- Polyetherimide (PEI) filament is used for its high tensile strength and stable electrical properties over a wide range of temperatures and frequencies.
- PEI
  - Transition Temperature: 217 °C
  - Tensile Strength: 85 MPa
  - Dielectric Constant: 3.1
  - Dissipation Factor: 0.001

Future Work

- Fabricate antenna array and evaluate performance with anechoic chamber.
- Lens parameters calculated based on successful antenna array dimensions.
- Lens printed with Intamsys 3D printer.
- Integrated lens and antenna array performance improvement evaluated with anechoic chamber testing.

References