

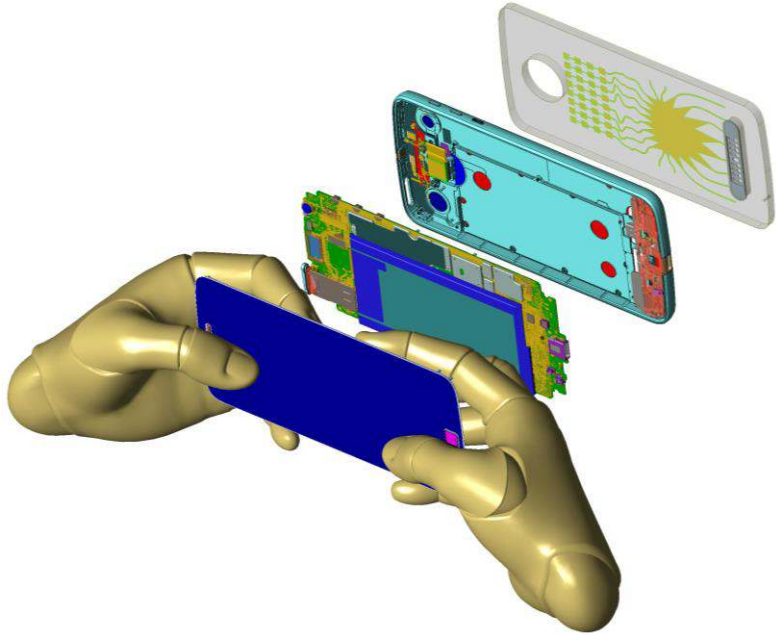


Electromagnetic Simulation Software

XFtd's Schematic Editor for Matching Network and Corporate Feed Network Analysis

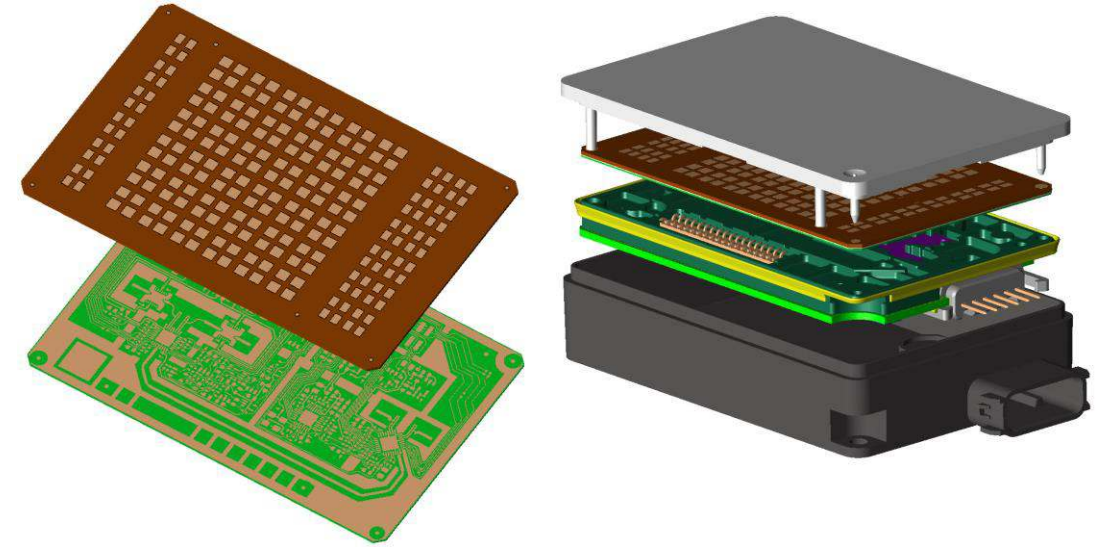


Full-Wave Simulation



Smartphone

- LTE antennas w/ carrier aggregation
- Diversity, WiFi, BlueTooth, GPS antennas
- 5G FR2 in mmWave bands
- Compliance testing for human exposure (SAR)

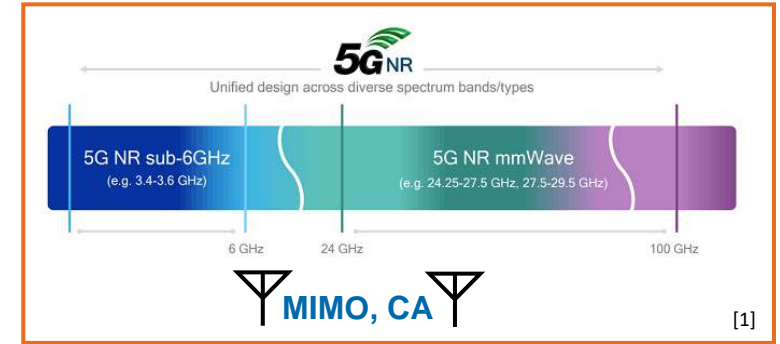
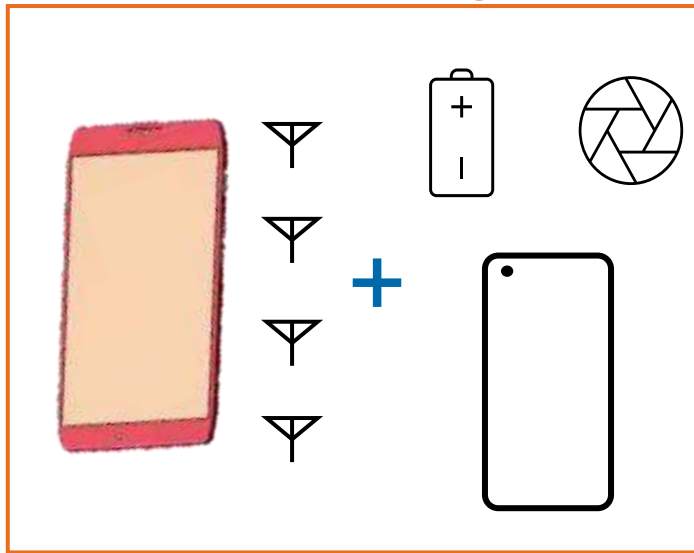


Automotive Radar

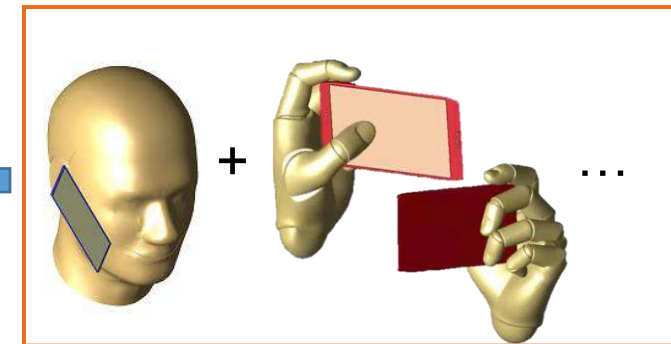
- 24-81 GHz bands
- Antenna, feeding network, LO design and coupling
- Radome, mounting bracket, fascia attenuation analysis

Introduction to Schematic Editor

Industrial Design



Bands & Standards



Use cases

Reduced Area + Additional Antennas + Antenna loading = Tougher Challenge to Antenna Engineers

*Motorola Mobility provided the 3-D CAD model of the phone, which was then modified for demonstration purposes to include an external floating antenna

[1] <https://www.rfpage.com/what-are-5g-frequency-bands/>

Frequency-Domain Circuit Solver

❑ Schematic Editor

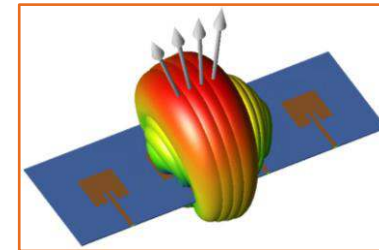
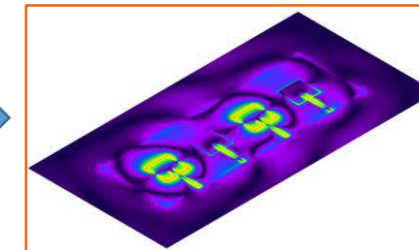
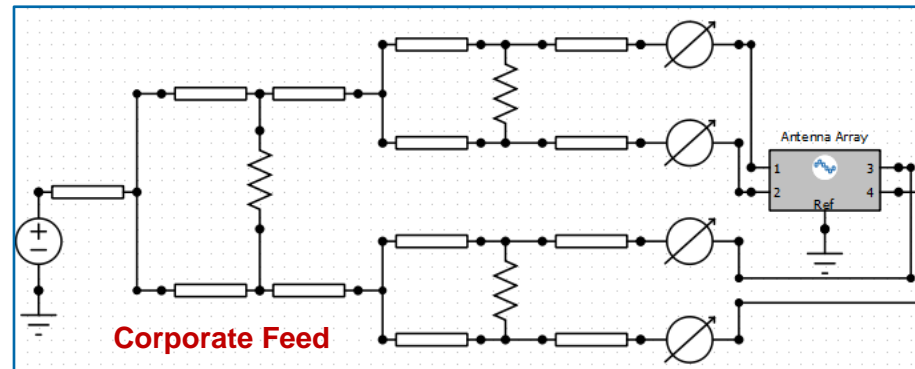
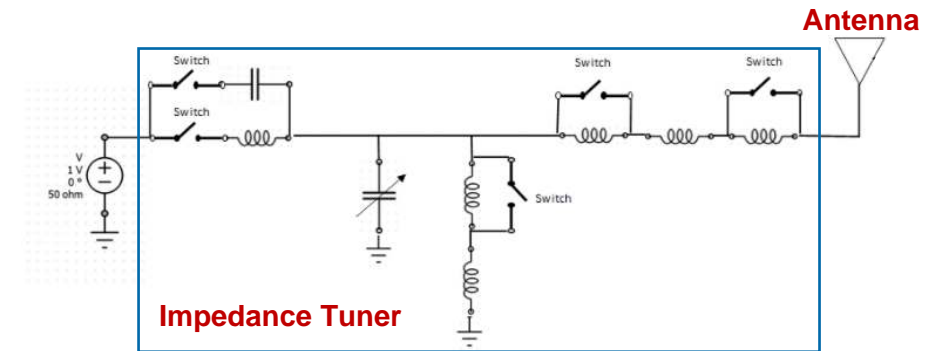
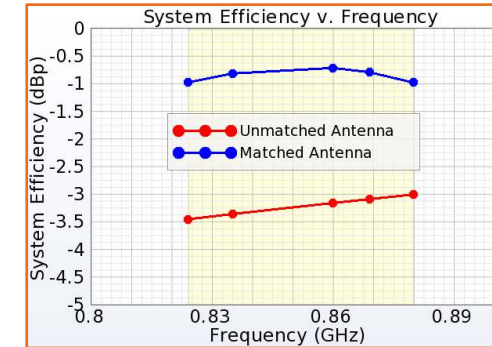
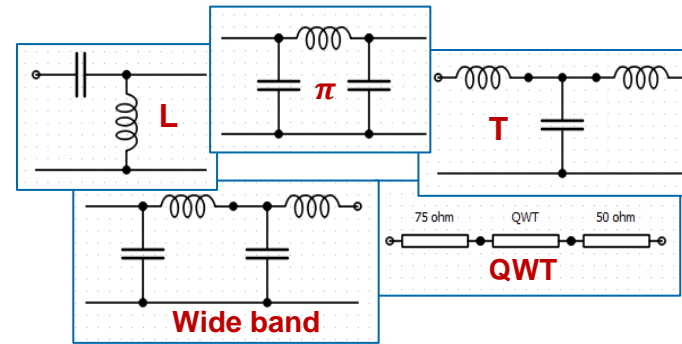
- Matching networks & passive devices

❑ Operating modes

- Multistate and multiport devices
- Corporate feed networks

❑ Apply schematic to FDTD Simulation

- Near-field results
- Far-field results
- System efficiency



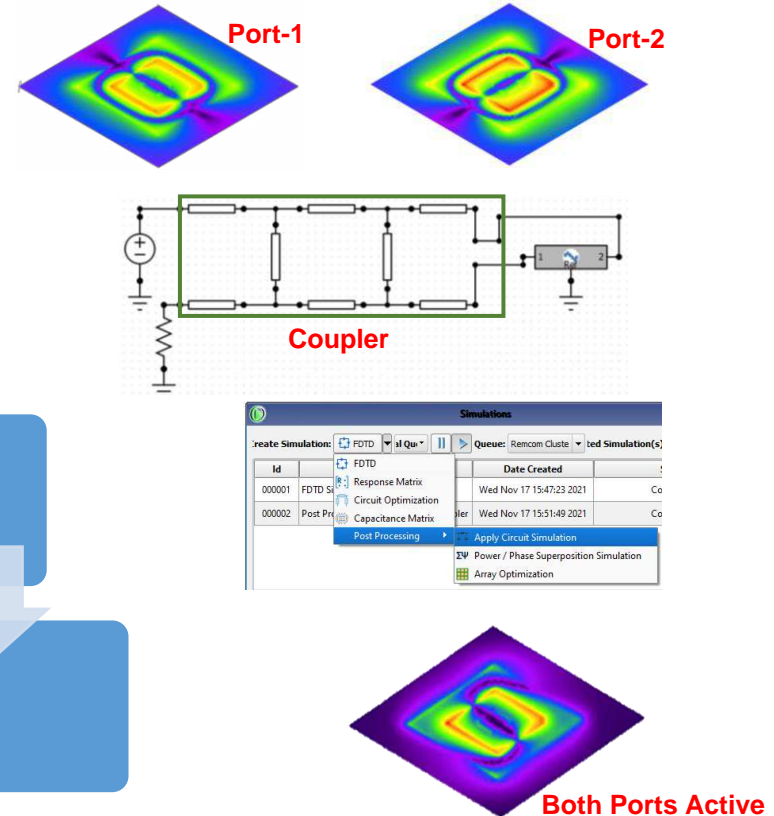
Workflow

Perform FDTD Simulation

Design & Simulate Circuits in
Schematic Editor

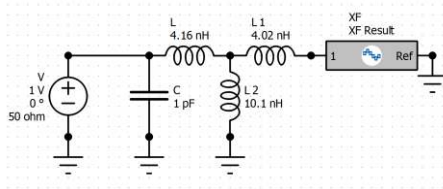
Apply Circuit Simulation
Results to FDTD Simulation

View Full-wave Results

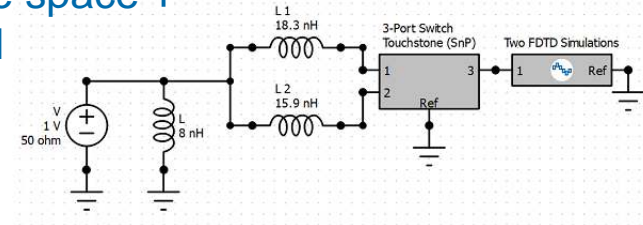


Schematics in XF

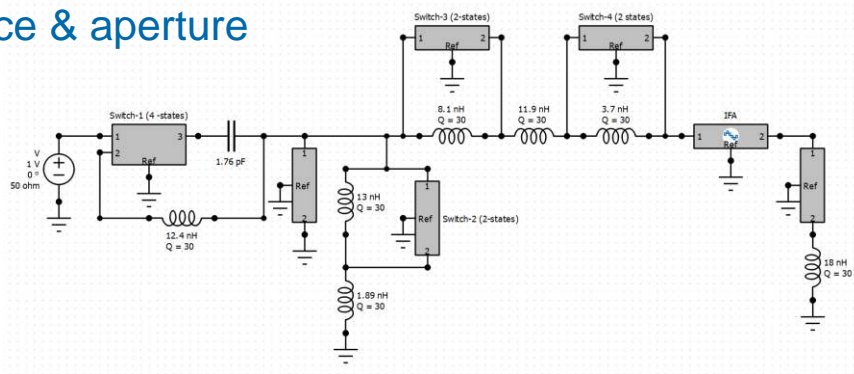
Simple match



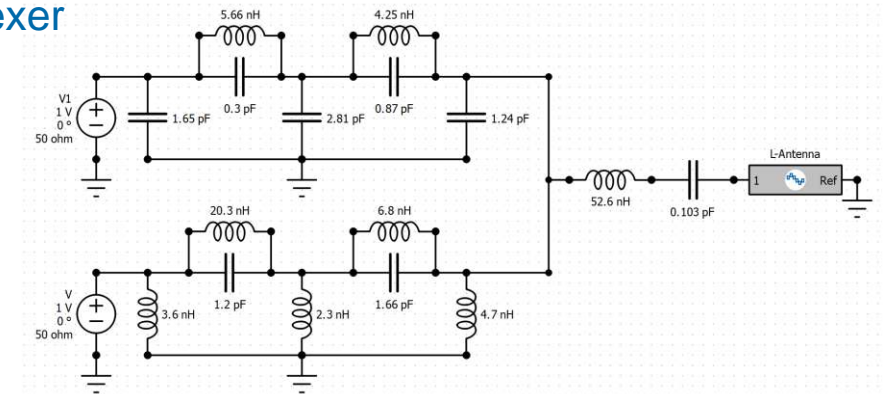
Phone in free space + against head



Impedance & aperture tuners

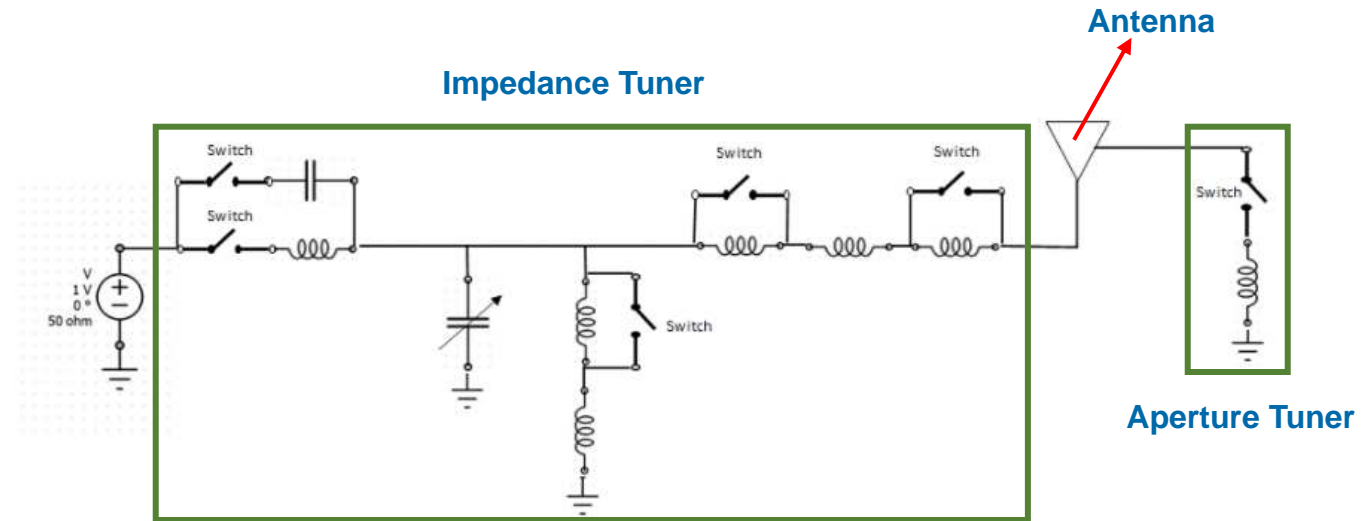
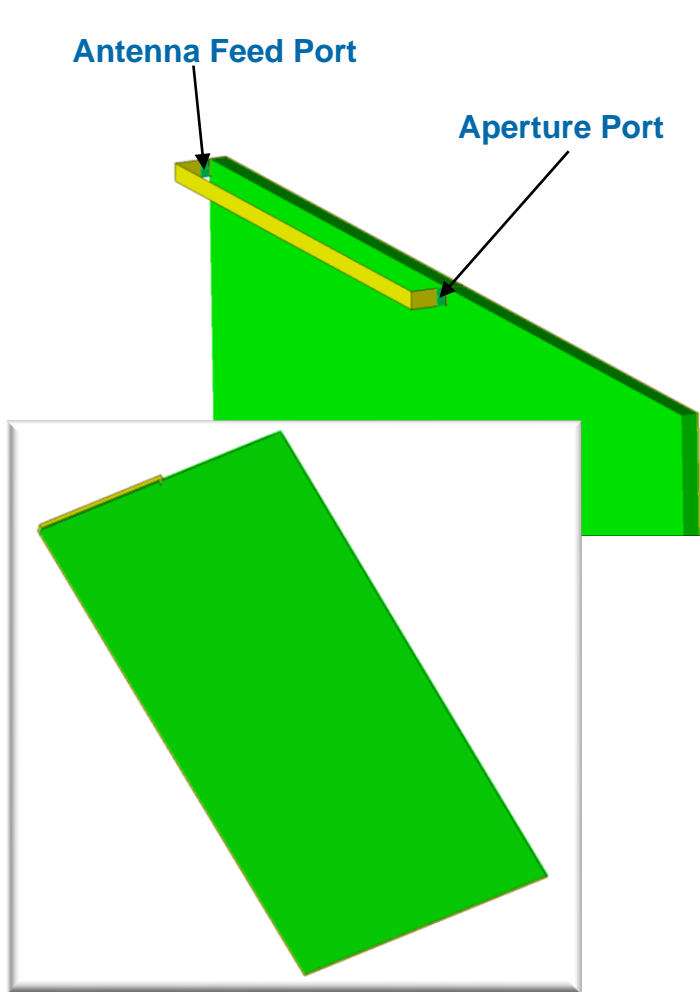


Diplexer



Schematics can be applied to the FDTD simulation so all full-wave results can be analyzed.

Aperture and Impedance Tuners with Operating Modes



LTE Bands	Transmit (GHz)	Receive (GHz)
13	0.777 – 0.787	0.746 - 0.756
5	0.824 – 0.849	0.869 – 0.894
2	1.85 – 1.91	1.93 -1.99
4	1.71 -1.755	2.11 -2.155

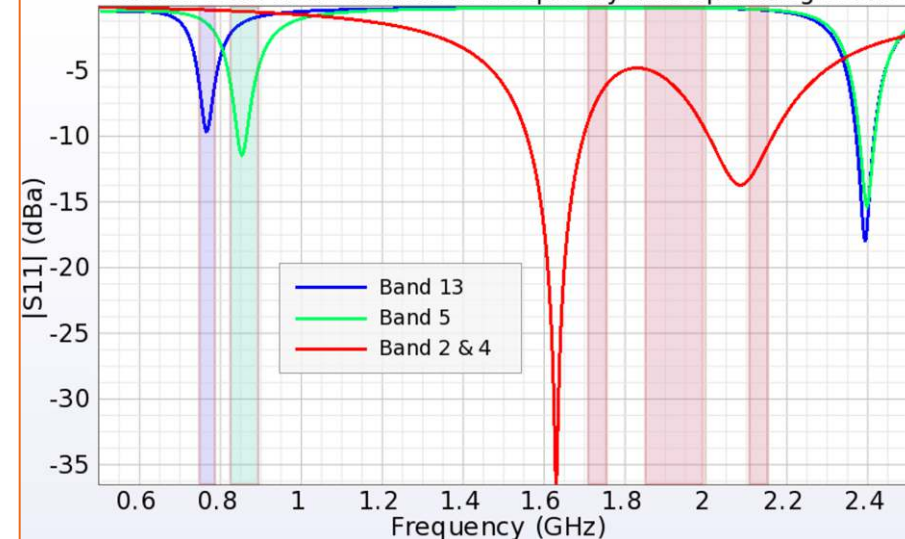
Aperture and Impedance Tuners with Operating Modes

Impedance Tuner

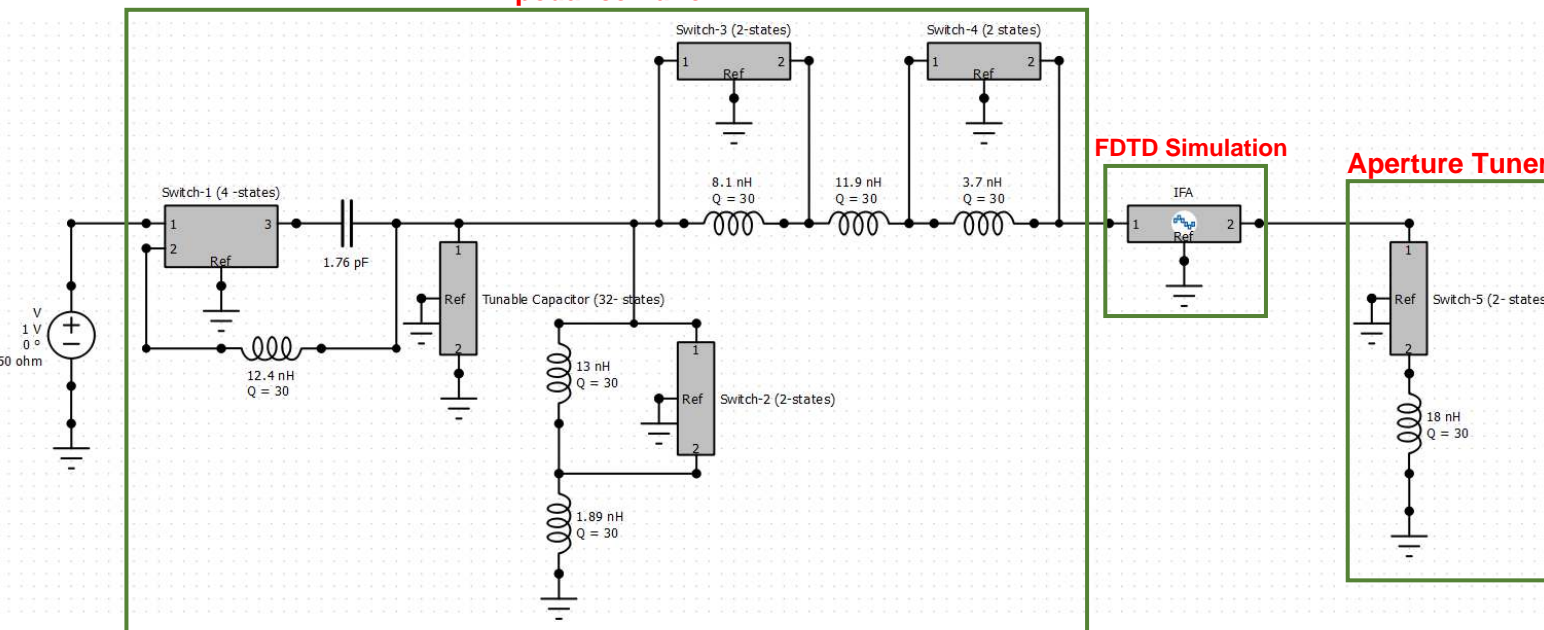
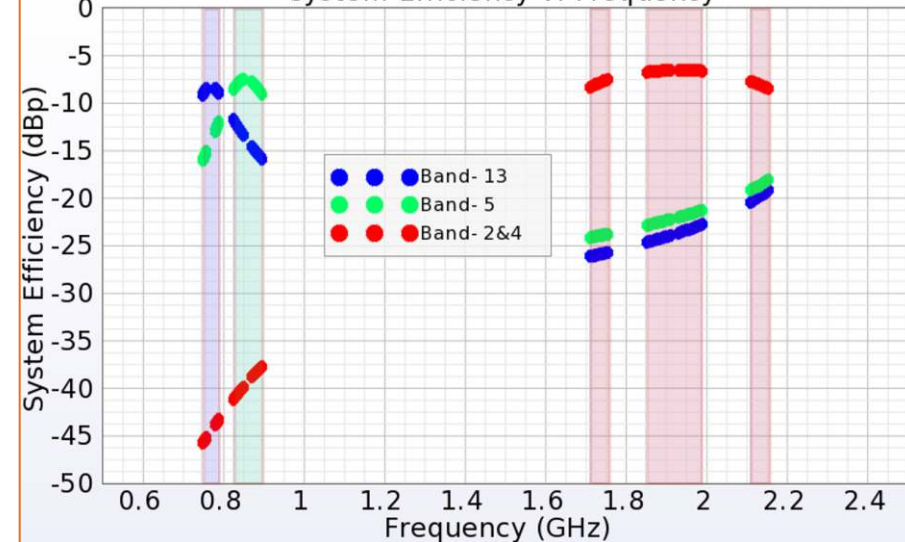
FDTD Simulation

Aperture Tuner

Return Loss as a Function of Frequency and Operating Mode



System Efficiency v. Frequency



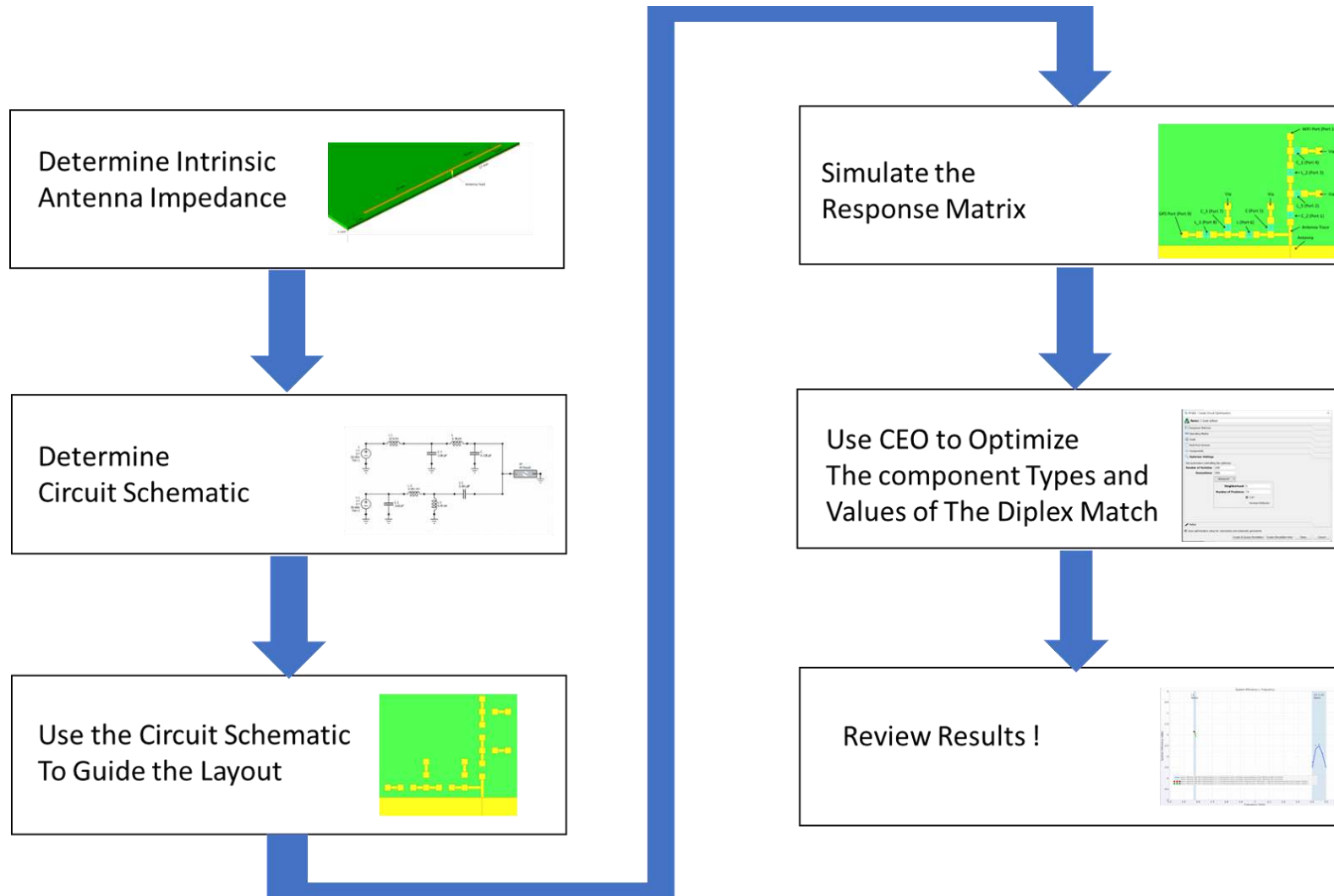
XFDTD - Schematic Operating Modes Detailed Info

☐ All Properties ☒ Default Values

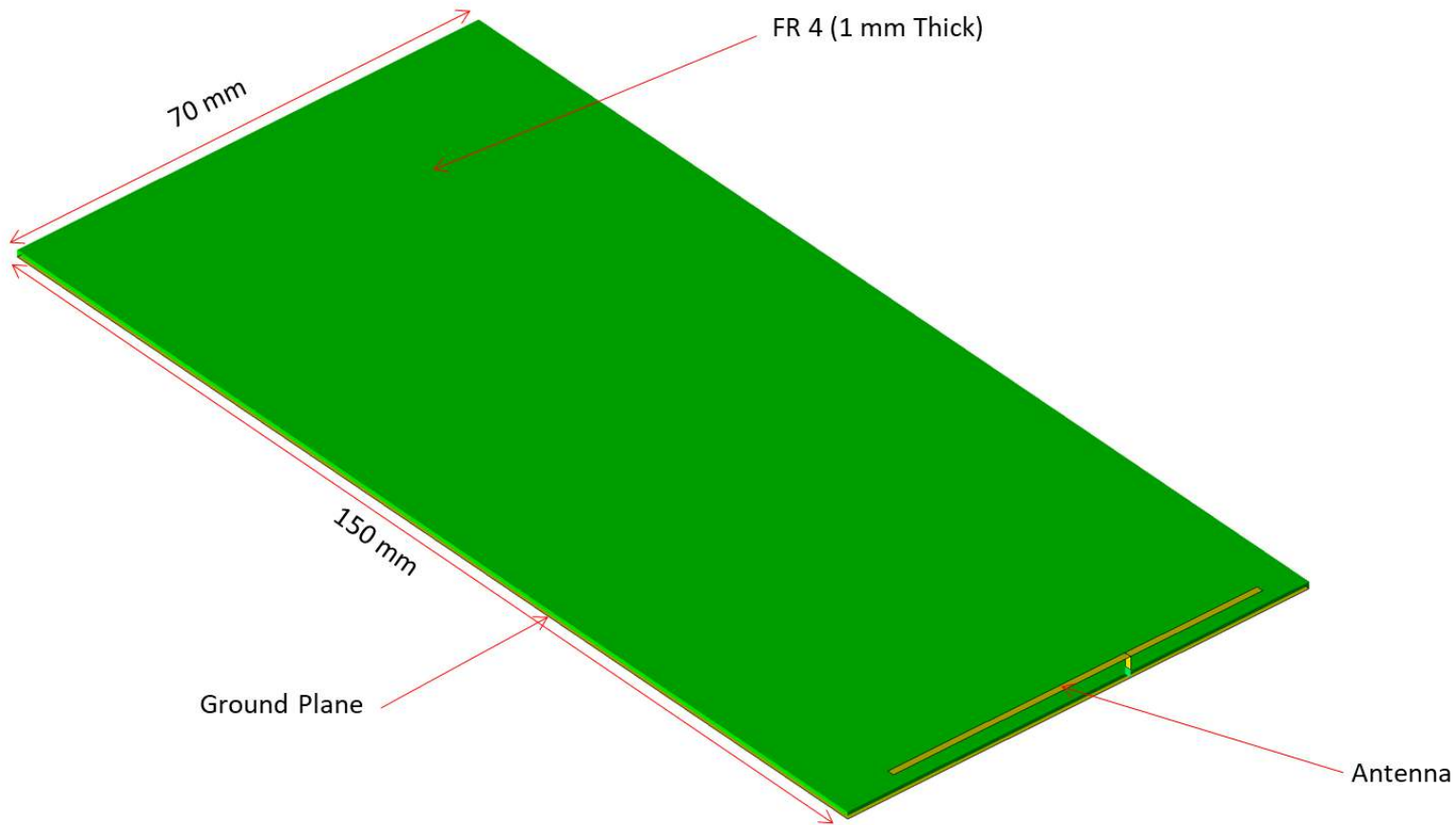
Operating Mode	Switch-1 (4 states).ActiveDataName	Switch-2 (2 states).ActiveDataName	Switch-3 (2 states).ActiveDataName	Switch-4 (2 states).ActiveDataName	Switch-5 (2 states).ActiveDataName	Tunable Capacitor (32 states).ActiveDataName
Band-13	SW1_ON_SW2_OFF	SW1_OFF	SW1_OFF	SW1_OFF	SW1_OFF	Tunable Cap 0.4pF
Band-5	SW1_ON_SW2_OFF	SW1_OFF	SW1_ON	SW1_OFF	SW1_OFF	Tunable Cap 0.4pF
Default	SW1_OFF_SW2_ON	SW1_ON	SW1_ON	SW1_ON	SW1_ON	Tunable Cap 3.0pF
Band-2&4	SW1_OFF_SW2_ON	SW1_ON	SW1_ON	SW1_ON	SW1_ON	Tunable Cap 3.0pF

Done

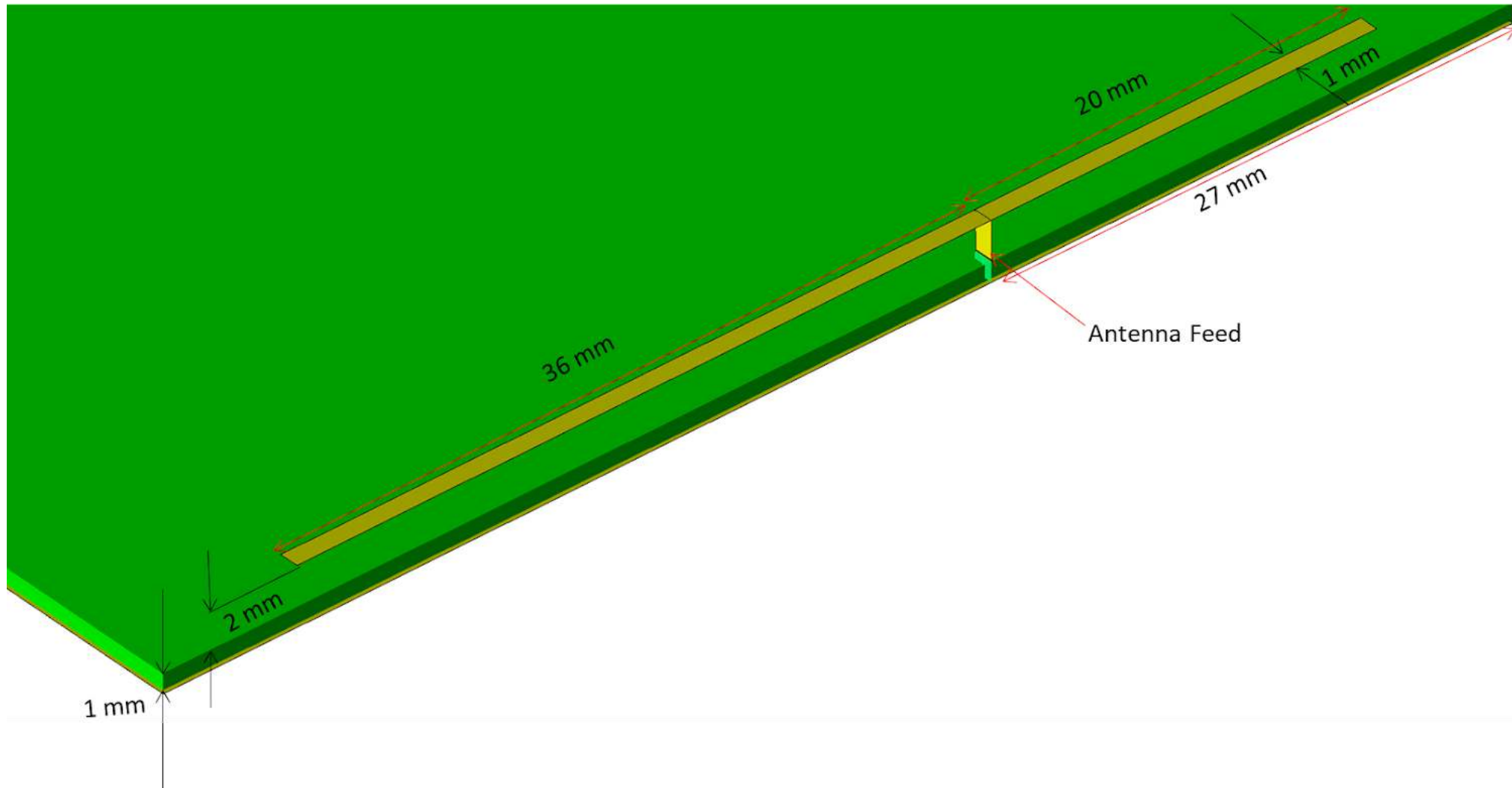
Matched Diplex Workflow



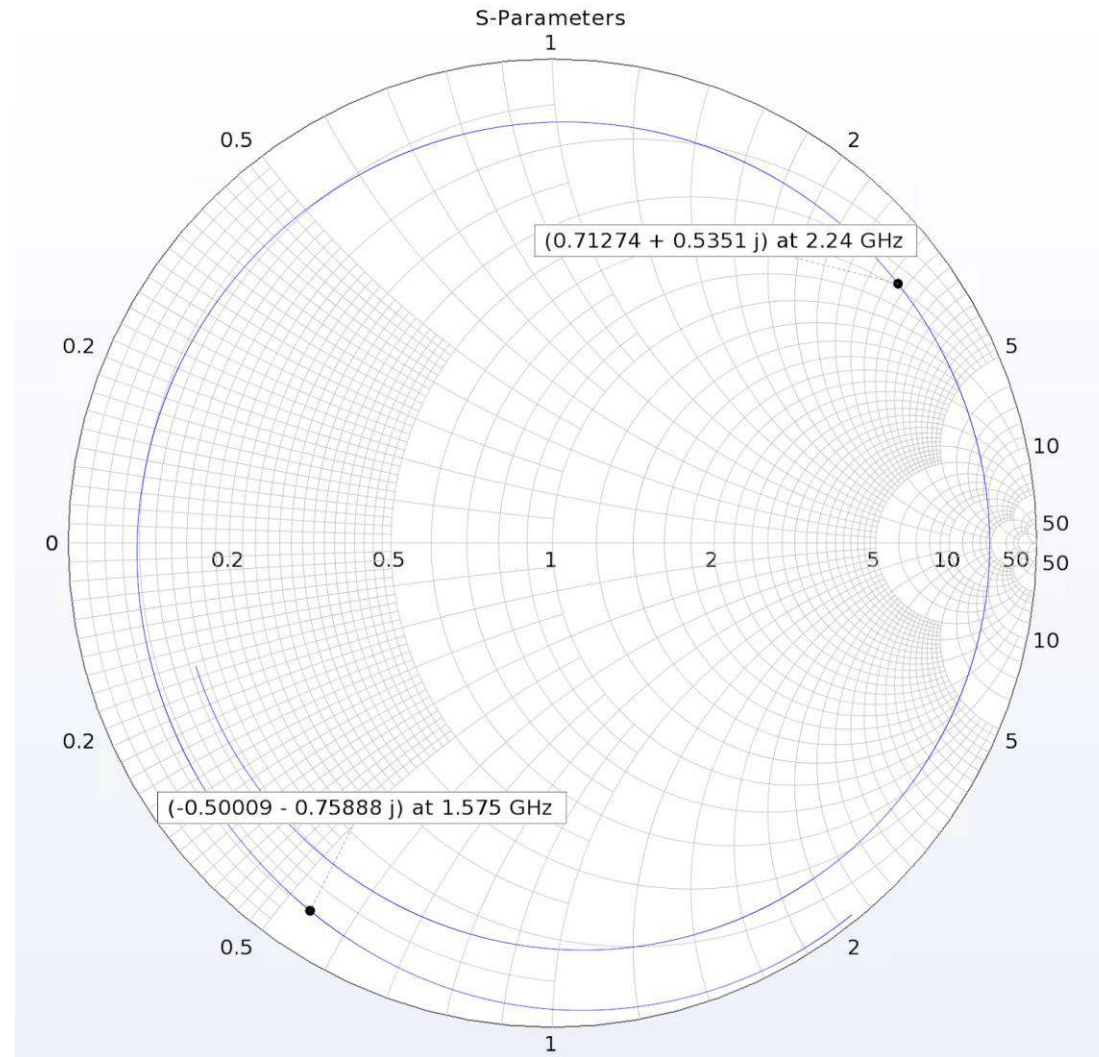
Antenna Layout



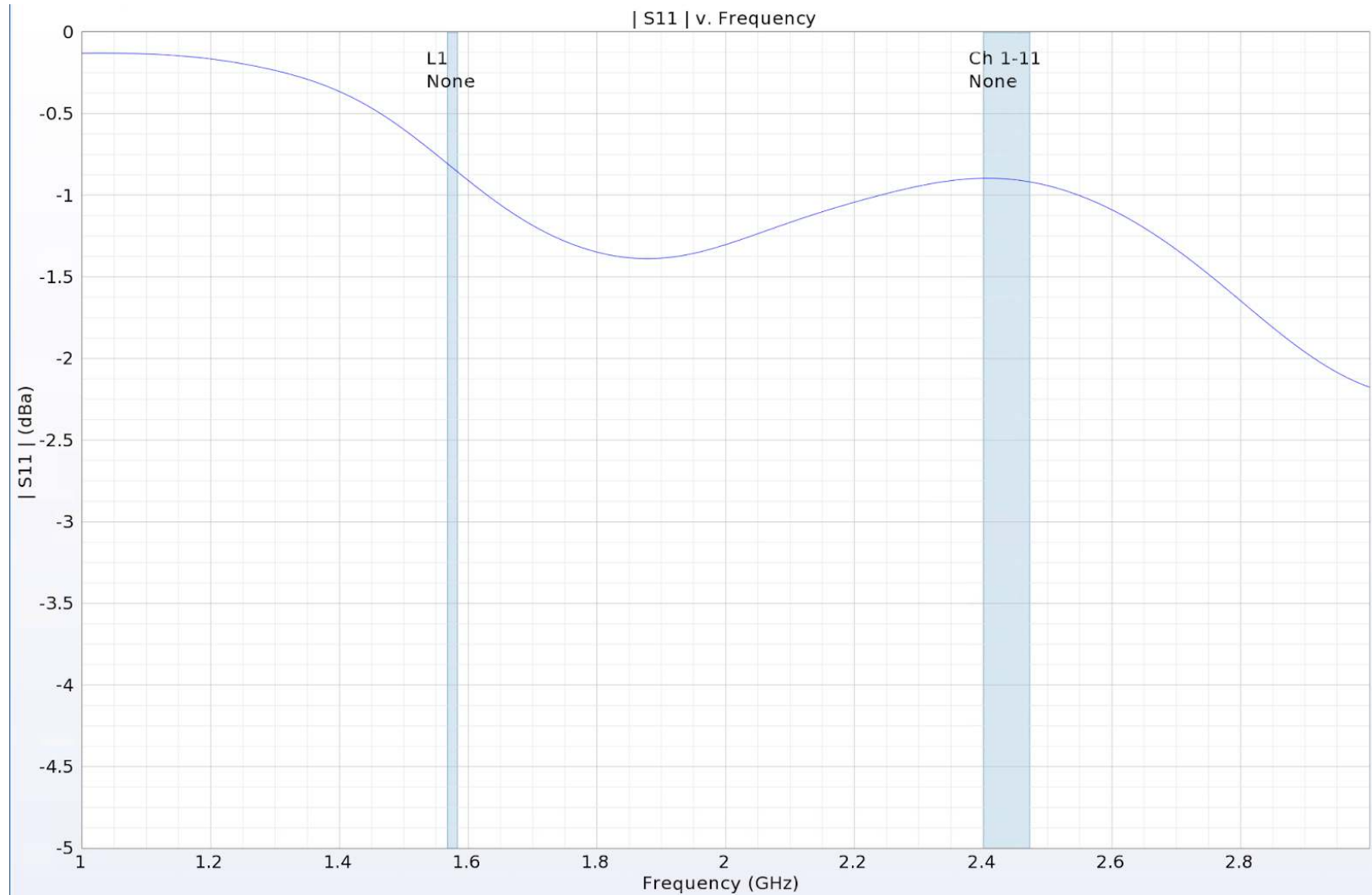
Antenna Layout



Intrinsic Impedance of the DILA



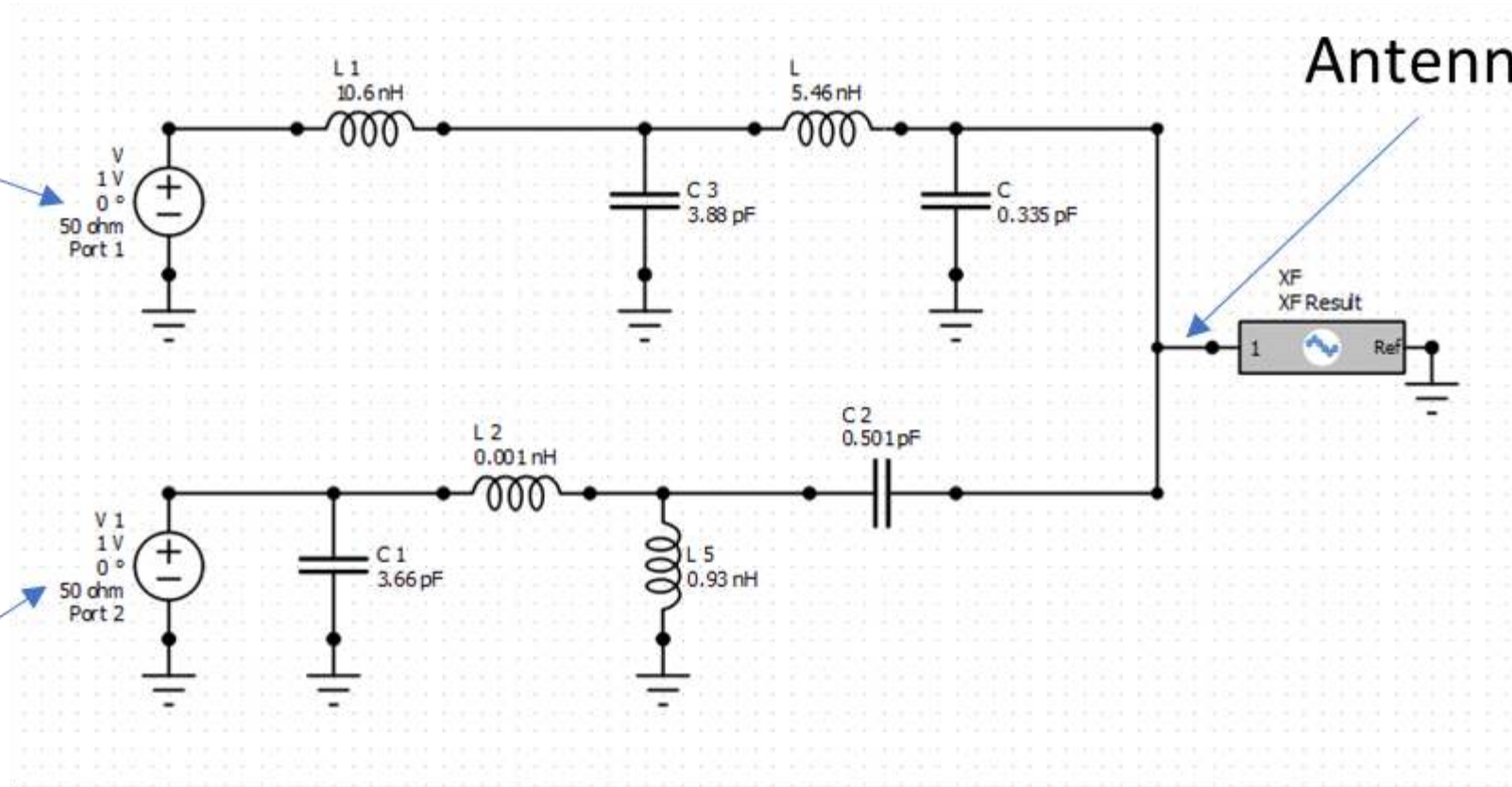
DILA Return Loss



GPS/WIFI Diplex Circuit

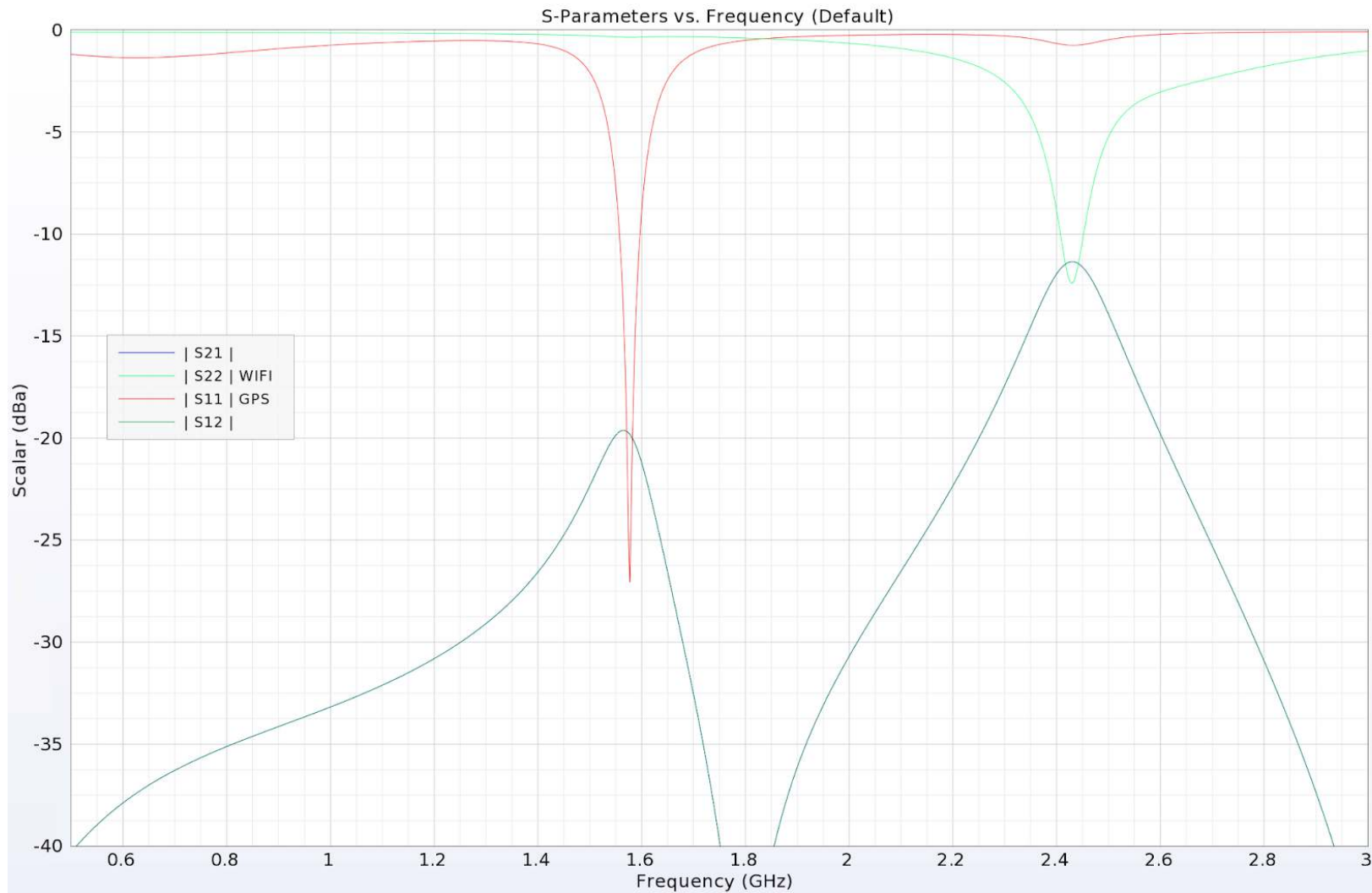
GPS Port

Antenna Port

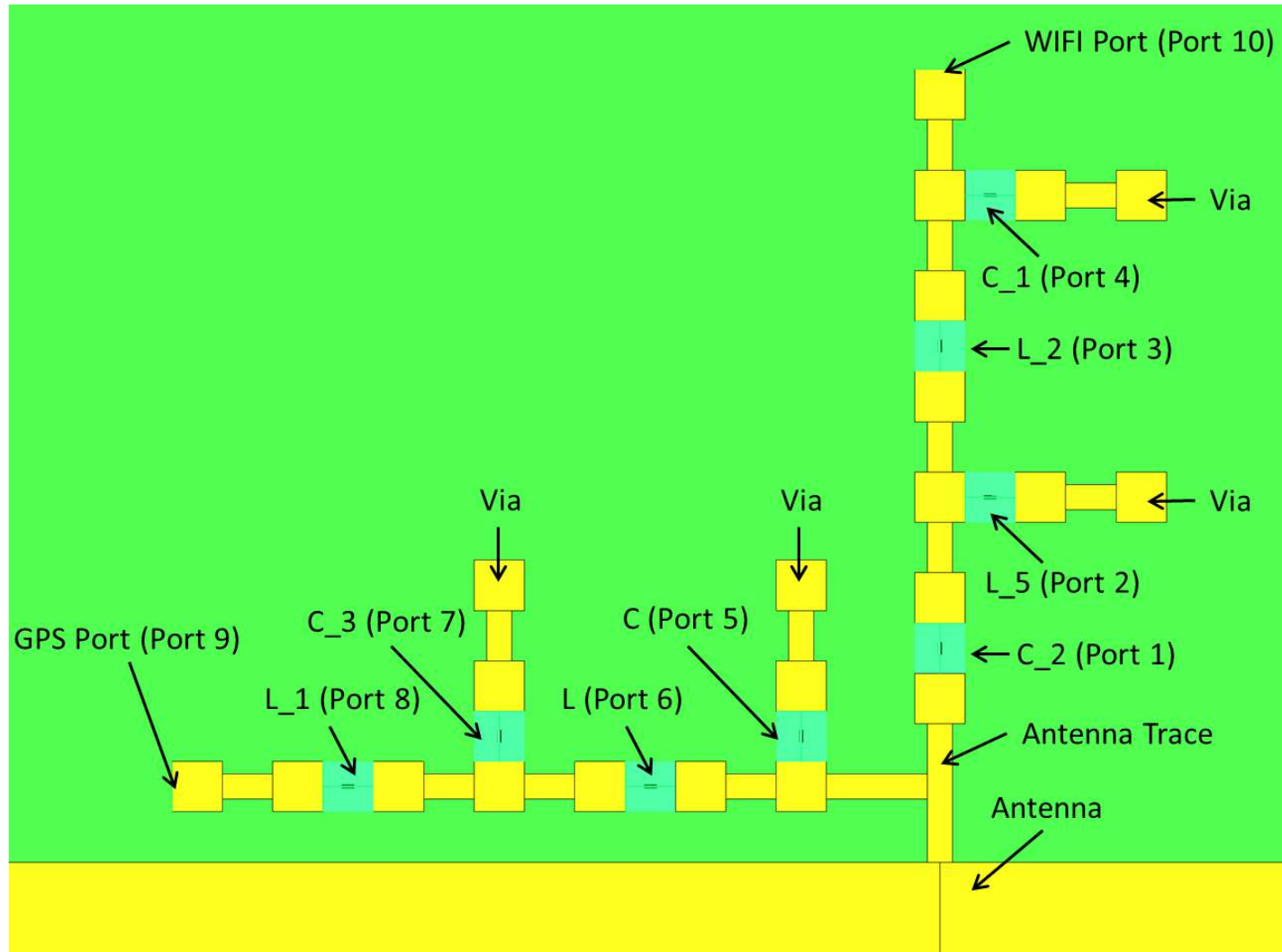


WIFI Port


S-Parameters of Diplex Circuit



Physical Layout with CEO



CEO Component Types and Values

 **Optimized Circuit Output for GPS_WIFI_Diplexed_Match_v3 : 000015 : 1**

File

Circuit Optimization Component Value Results for:

Run Details

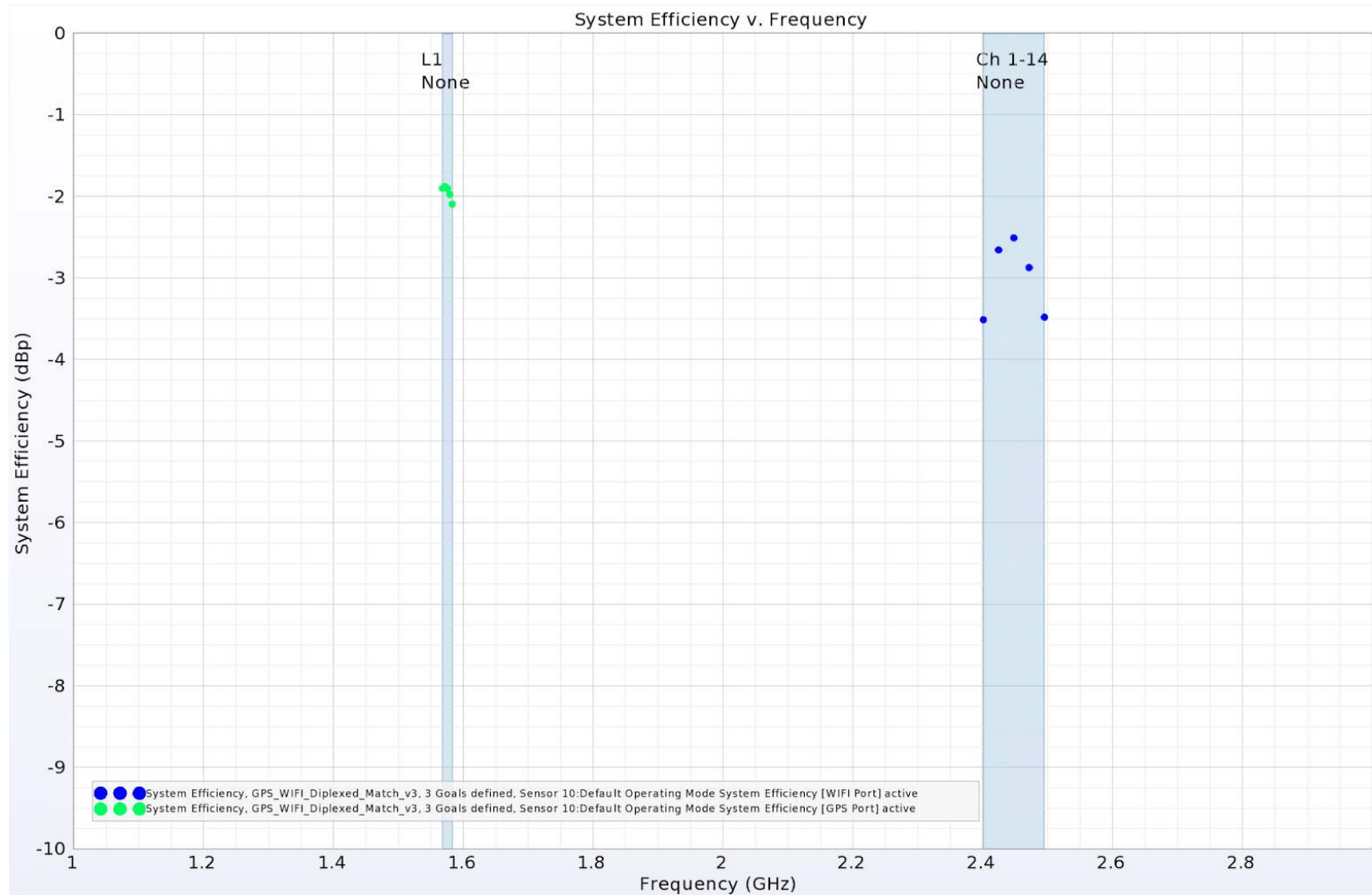
Project Name: GPS_WIFI_Diplexed_Match_v3
Simulation: 3 Goals defined
Run Number: 1
Operating Mode: Default Operating Mode

Name	Device	Arrangement	Resistor	Capacitor	Inductor	Additional Variables
C_2	C	Series	0.2 ohm	0.6 pF	--	--
L_5	C	Series	0.2 ohm	80 pF	--	--
L_2	C	Series	0.2 ohm	9.1 pF	--	--
C_1	C	Series	0.2 ohm	2.4 pF	--	--
C	L	Series	0.2 ohm	--	47 nH	--
L	L	Series	0.2 ohm	--	3.8 nH	--
C_3	C	Series	0.2 ohm	4.1 pF	--	--
L_1	L	Series	0.2 ohm	--	3.5 nH	--
GPS Port	--	--	50 ohm	--	--	--
WIFI Port	--	--	50 ohm	--	--	--

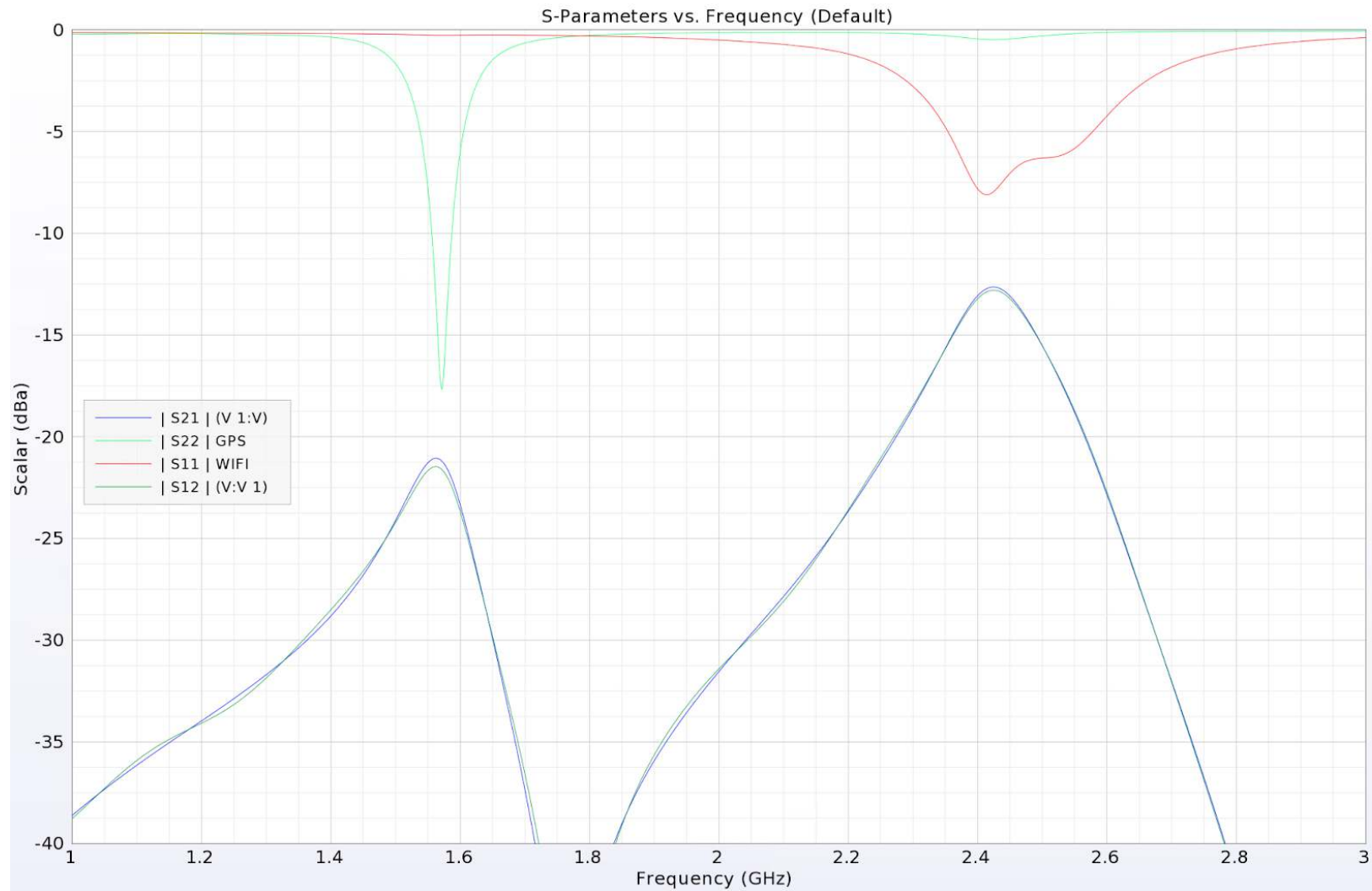
Apply Component Values to Project

Create a Schematic

CEO System Efficiency



S-Parameter of the GPS/WIFI Diplex Match



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