REMCOM®

Electromagnetic Simulation Software

Impedance Tuner Matching

Overview of XFdtd's schematic editor

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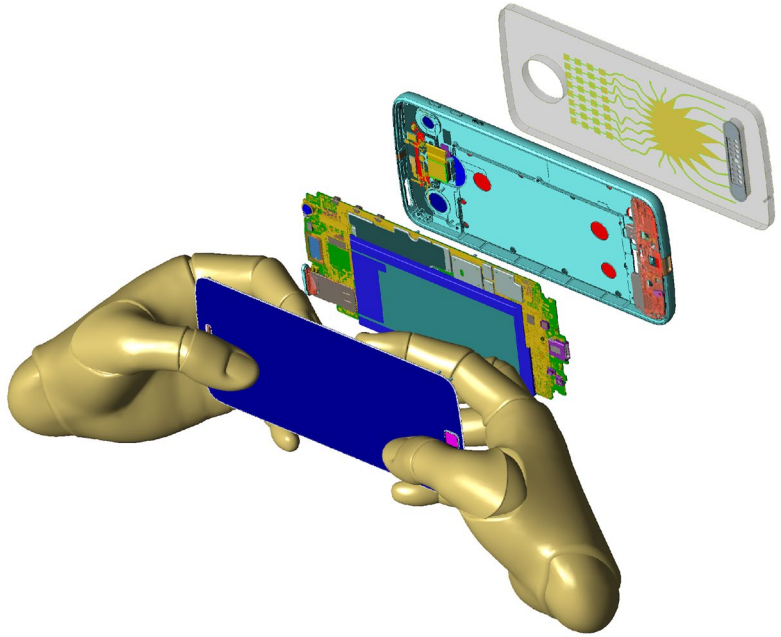
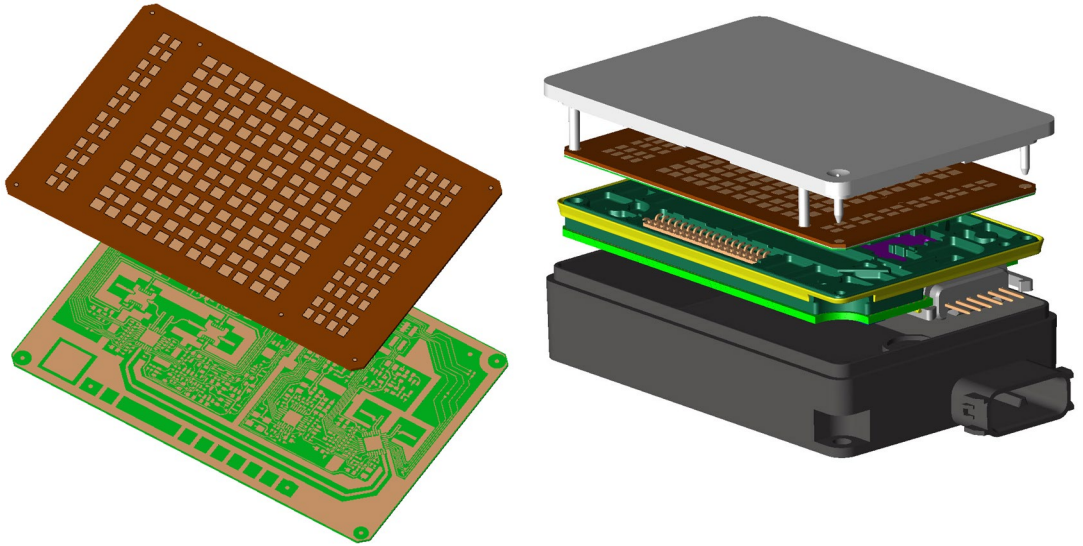
XFdtd Full-Wave Simulation





Cellular Phone

- 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

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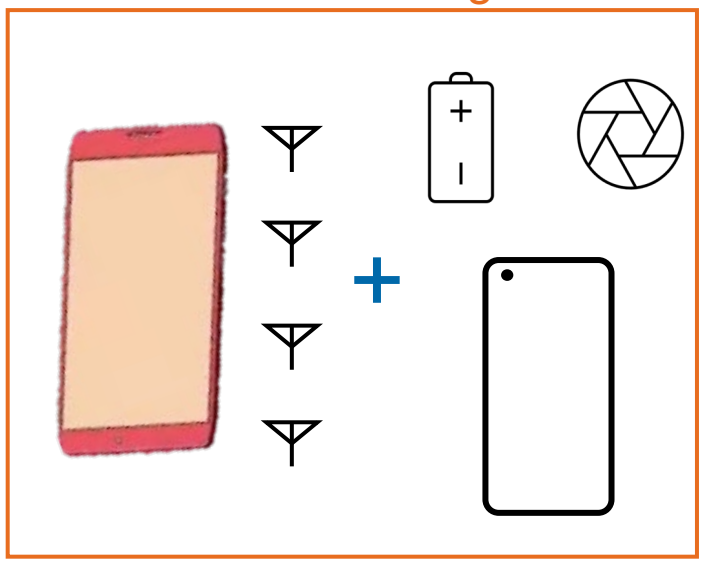
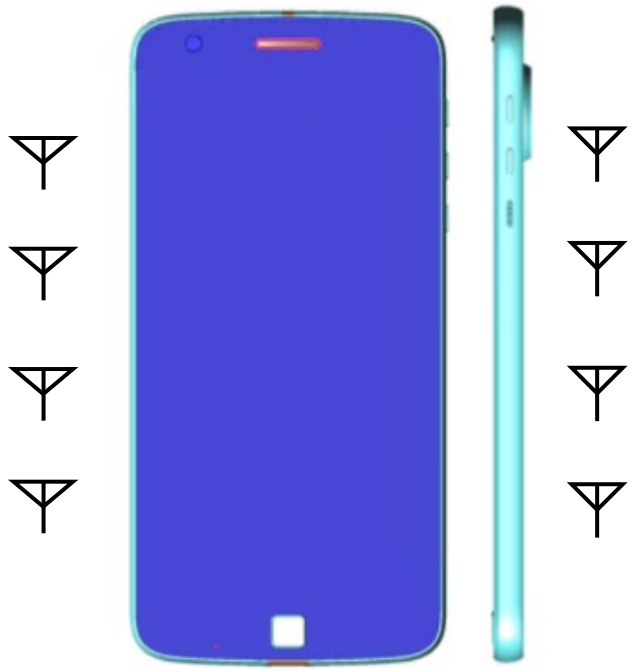
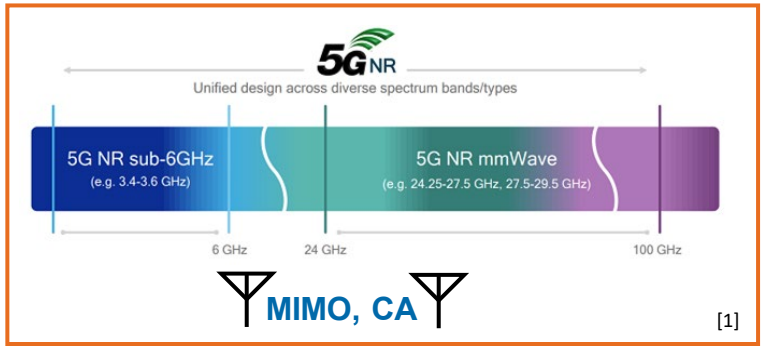
Optimizations in the Schematic Editor

Industrial Design



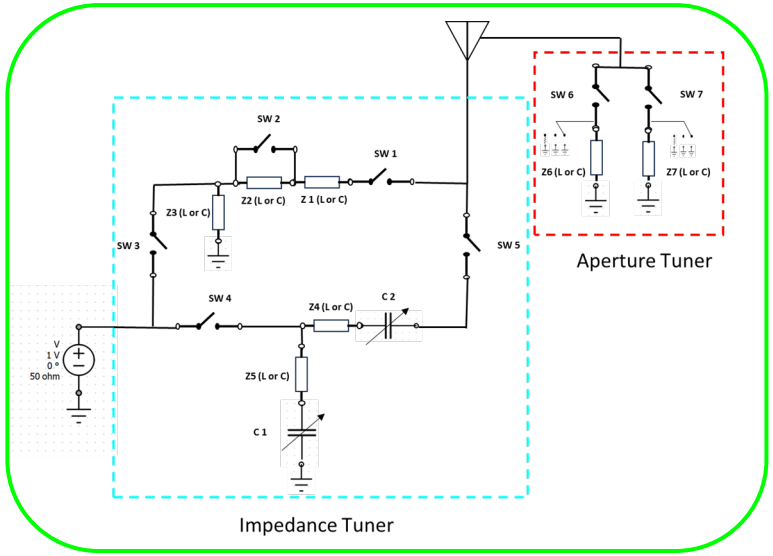


Bands & Standards



[1]

Impedance and Aperture Tuner



Additional Bands + Modern Industrial Designs + Device States = Necessitates the need for tuners

*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/

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What's New in XFdtd?

- Incorporated particle swarm optimizer directly into our schematic editor allowing us to optimize fixed component types and values as well as the tune codes associated with specific goals and operating modes.

- The optimizer can optimize on a variety of antenna/RF metrics such as return loss, isolation between ports, and system efficiency.

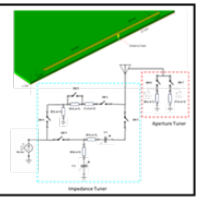
Example Project Summary

- Simple DILA Antenna Structure
- Employ impedance and aperture tuners implemented as subcircuits in the overall matching circuit for the antenna
- Using new optimizations we'll get a matching circuit allowing for different cellular bands of operation
- The operating modes in our example will be different cellular frequency bands

Workflow for Matching Network of DILA Antenna

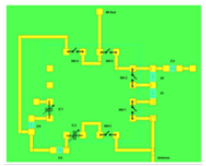
Step 0

Determine Antenna and Circuit Topology



Step 1

Use the Circuit Topology To Guide the Layout

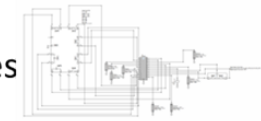


Step 2

XFDTD Simulation of the Antenna and PCB Layout

Step 3

Employ SE to Construct Schematic which includes XF Data, Impedance and Aperture Tuners, and Fixed Components

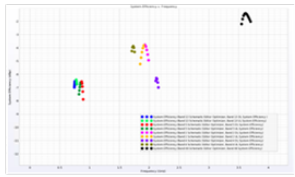


Step 4

Use SEO to Optimize The Types and Values of Fixed Components and the Tune Codes of the Tuners

Step 5

Review The Optimized Results !



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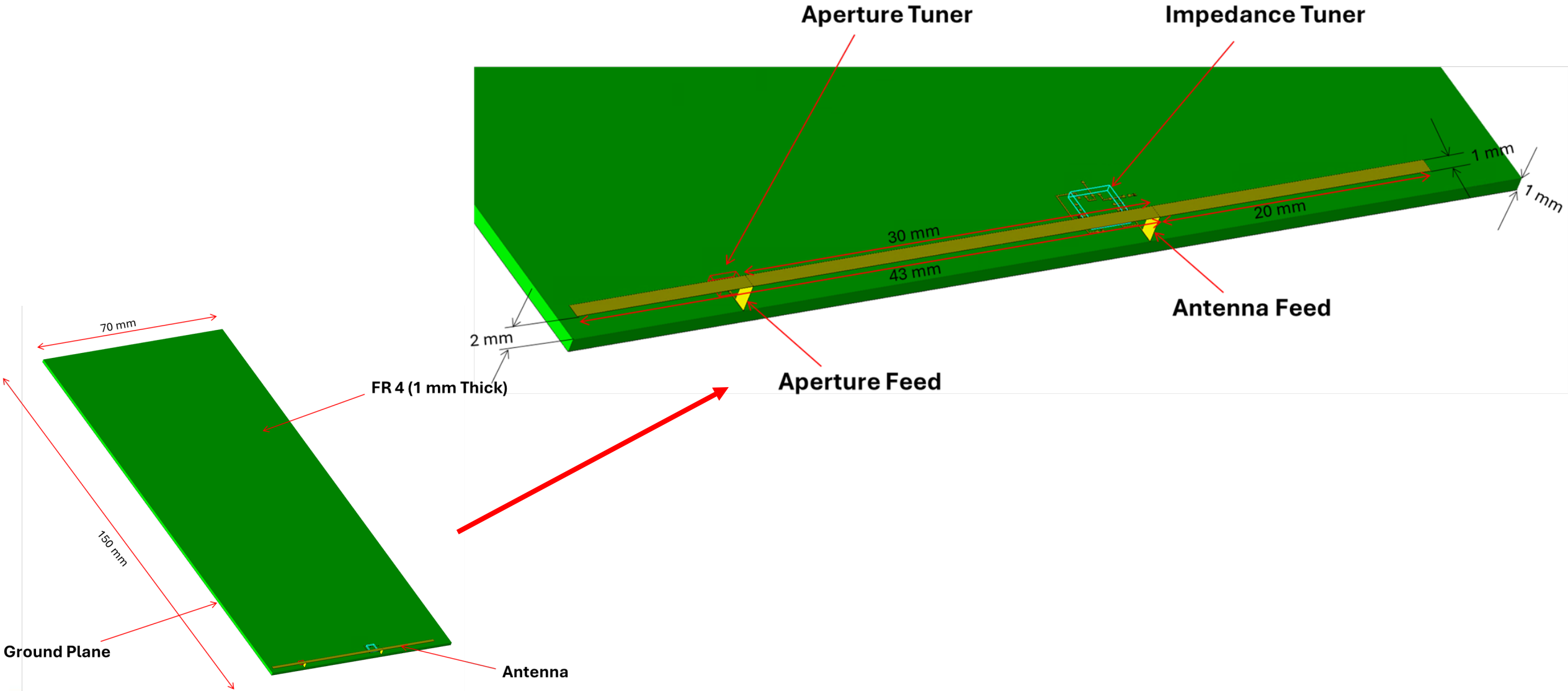
Device and Antenna with Tuners

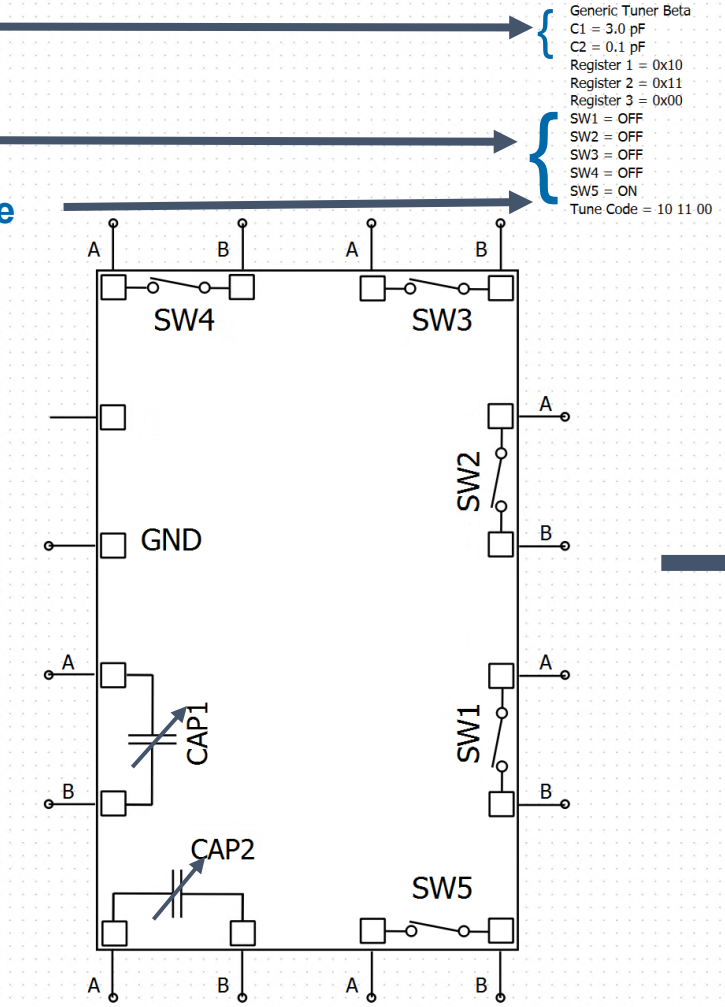


Impedance Tuner Subcircuit

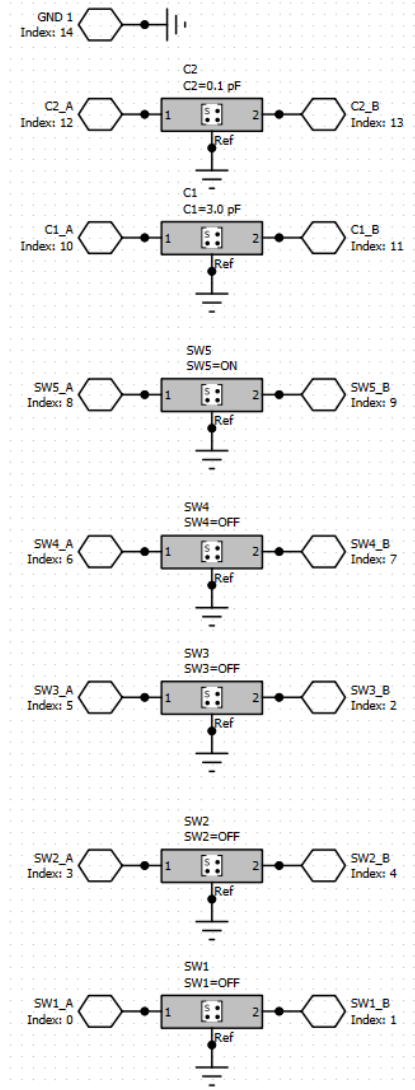
Tunable Capacitor Configuration

Switch Configuration

Tune Code

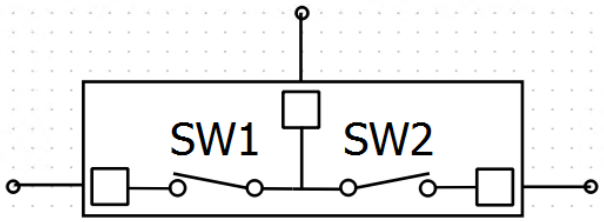


Impedance Tuner Subcircuit

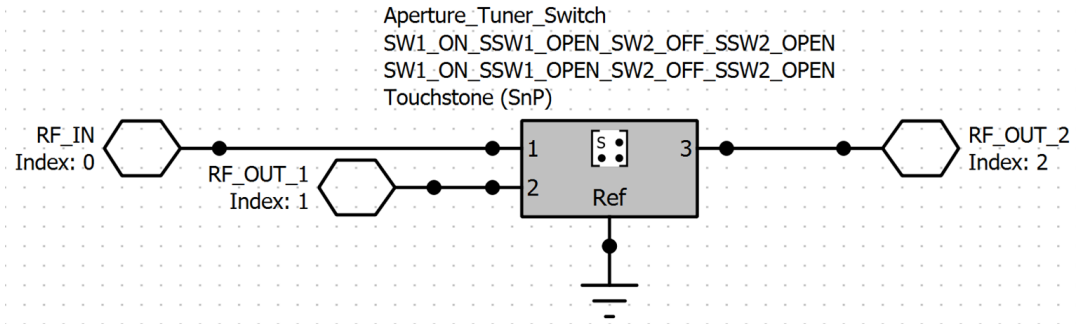


Lower Level of the Subcircuit Containing the Underlying S-Parameter Data (Measured or Simulated)

Aperture Tuner Subcircuit



Generic Aperture Tuner Switch
Aperture_Tuner_Switch = SW1_ON_SSW1_OPEN_SW2_OFF_SSW2_OPEN
Register Aperture Tuner Switch = 0x0D

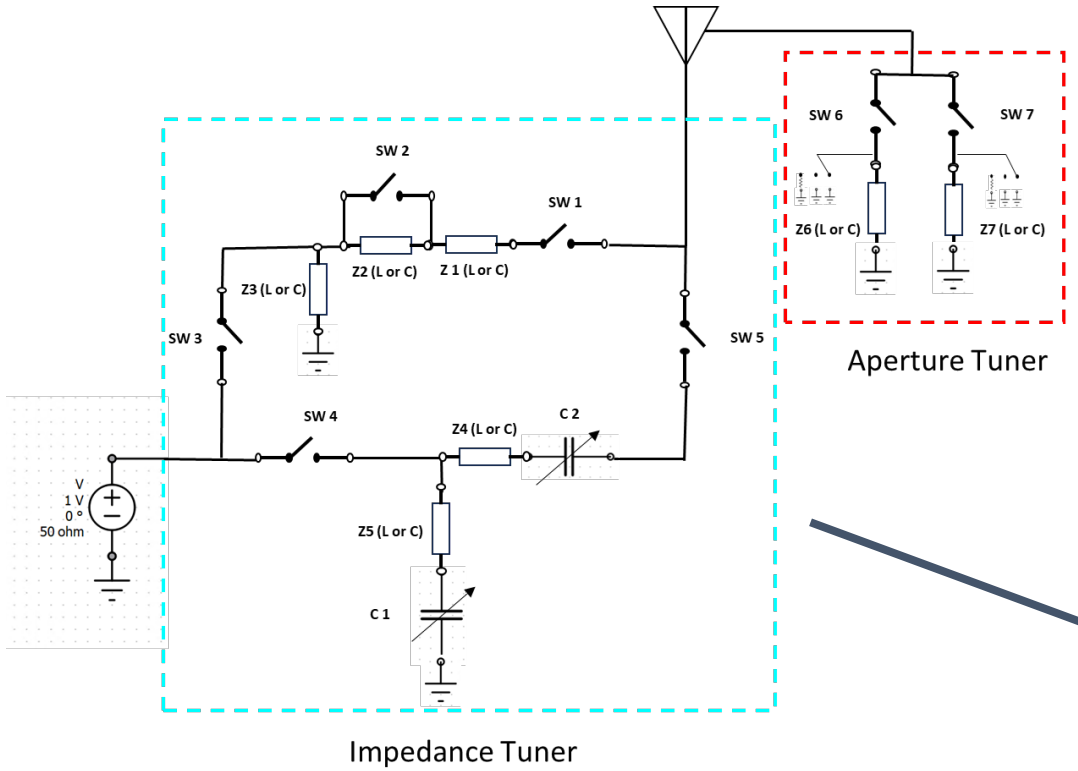


Aperture Tuner Subcircuit

Lower Level of the Subcircuit Containing the Underlying 3 Port S-Parameter Data

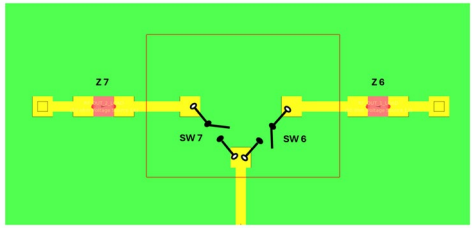
Step 1 Layout

Step 1 Layout in XFdtd

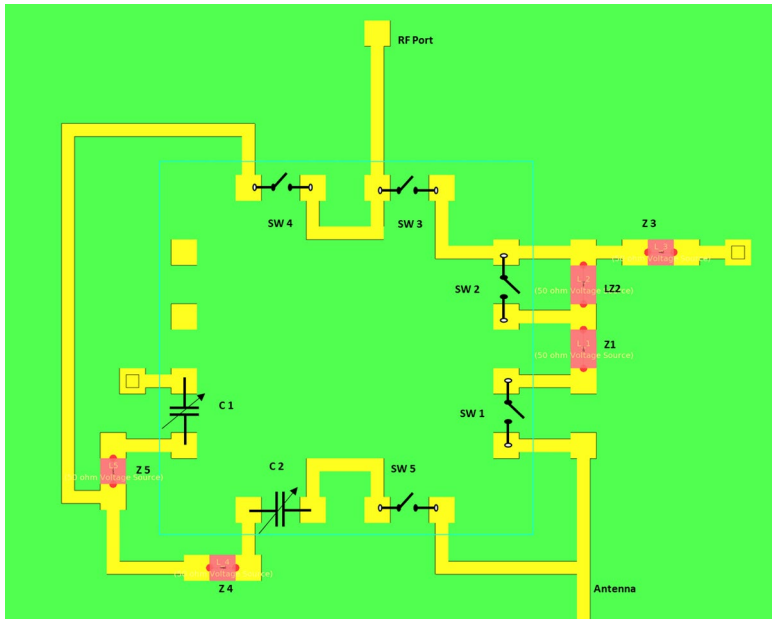


Aperture Tuner

Impedance Tuner



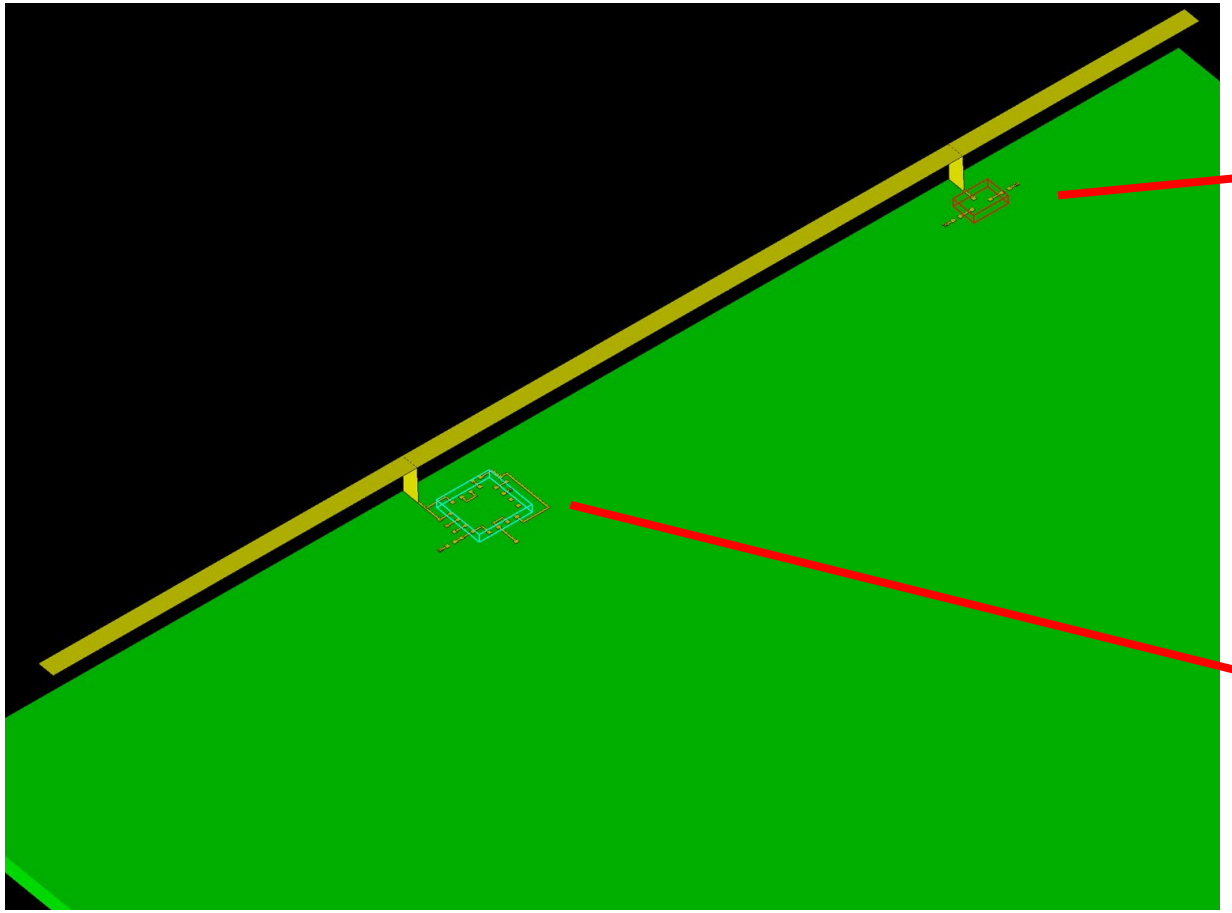
Aperture Tuner Layout



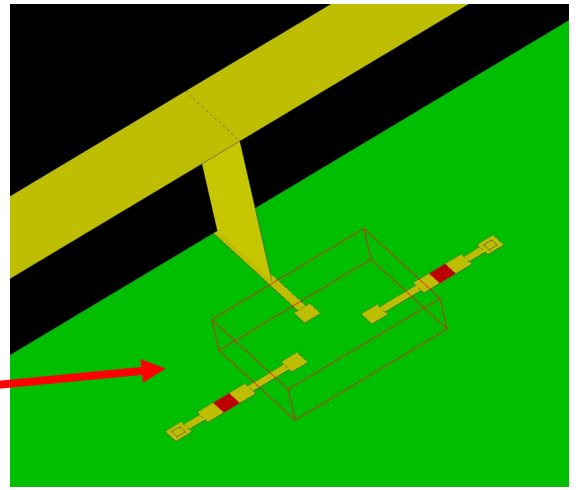
Impedance Tuner Layout

Step 1 Matching Network Layout Details and Antenna

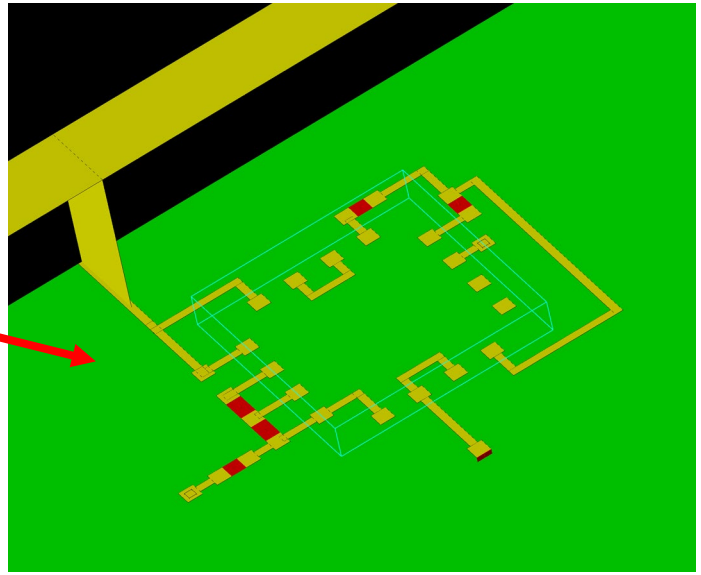
Pads and transmission lines connect all matching network components



Aperture Tuner Layout

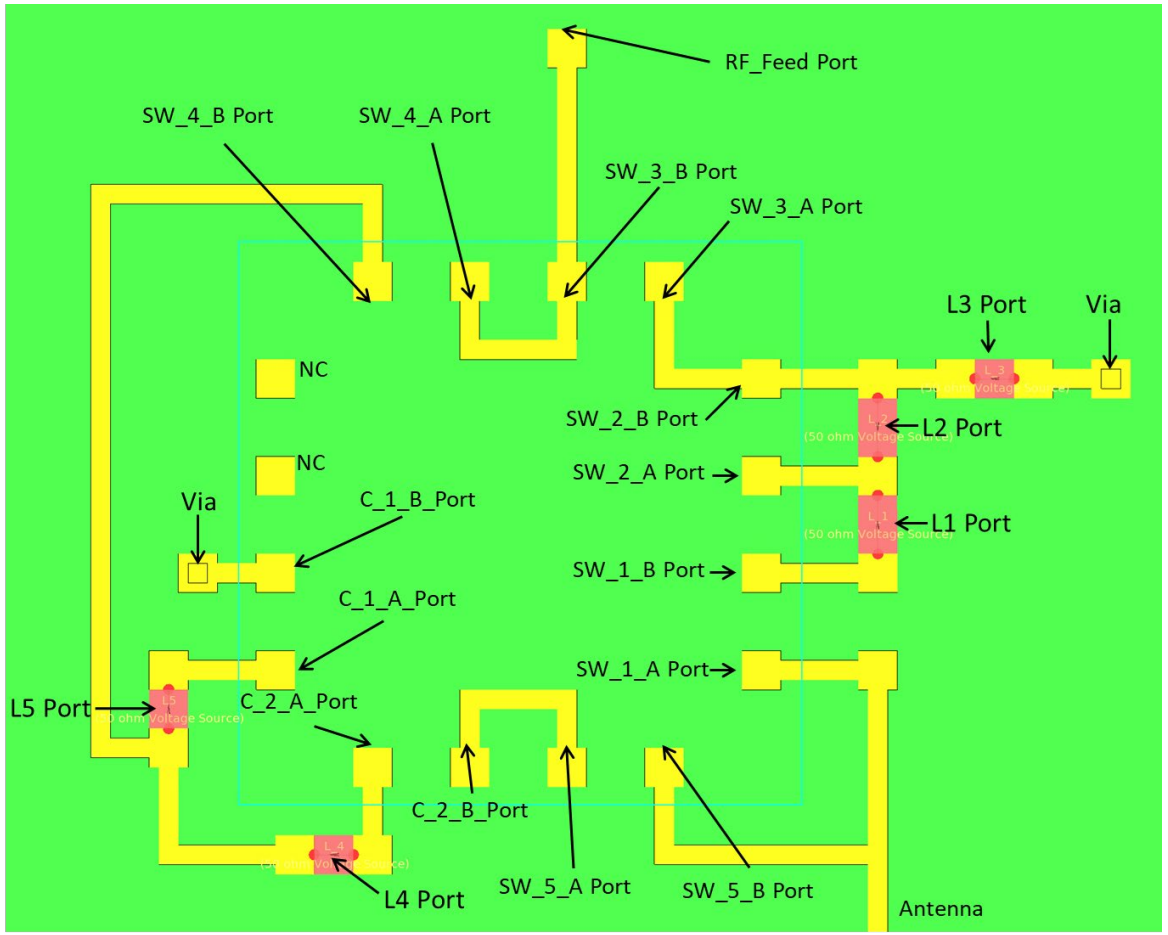


Impedance Tuner Layout

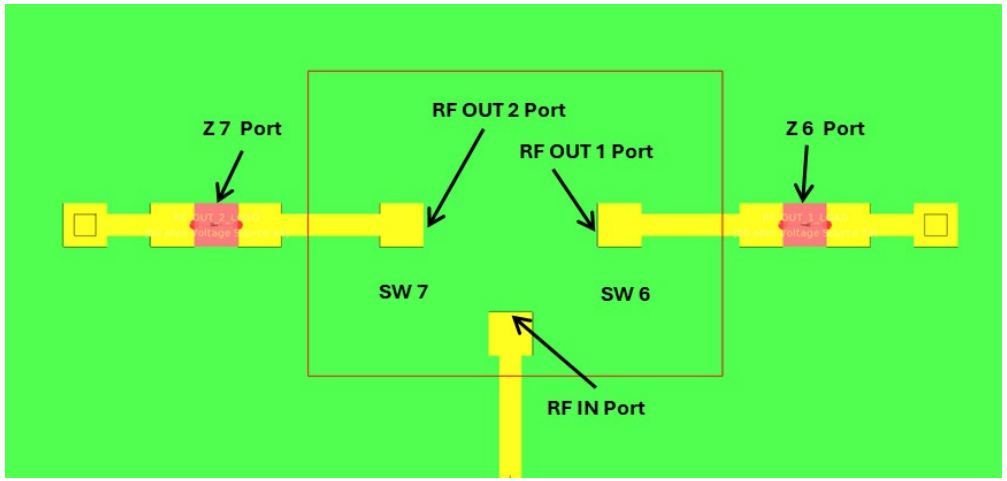


Step 2 XFdtd Simulation

Step 2 Port Details of the Impedance Tuner Layout



Port Details of the Impedance Tuner Layout



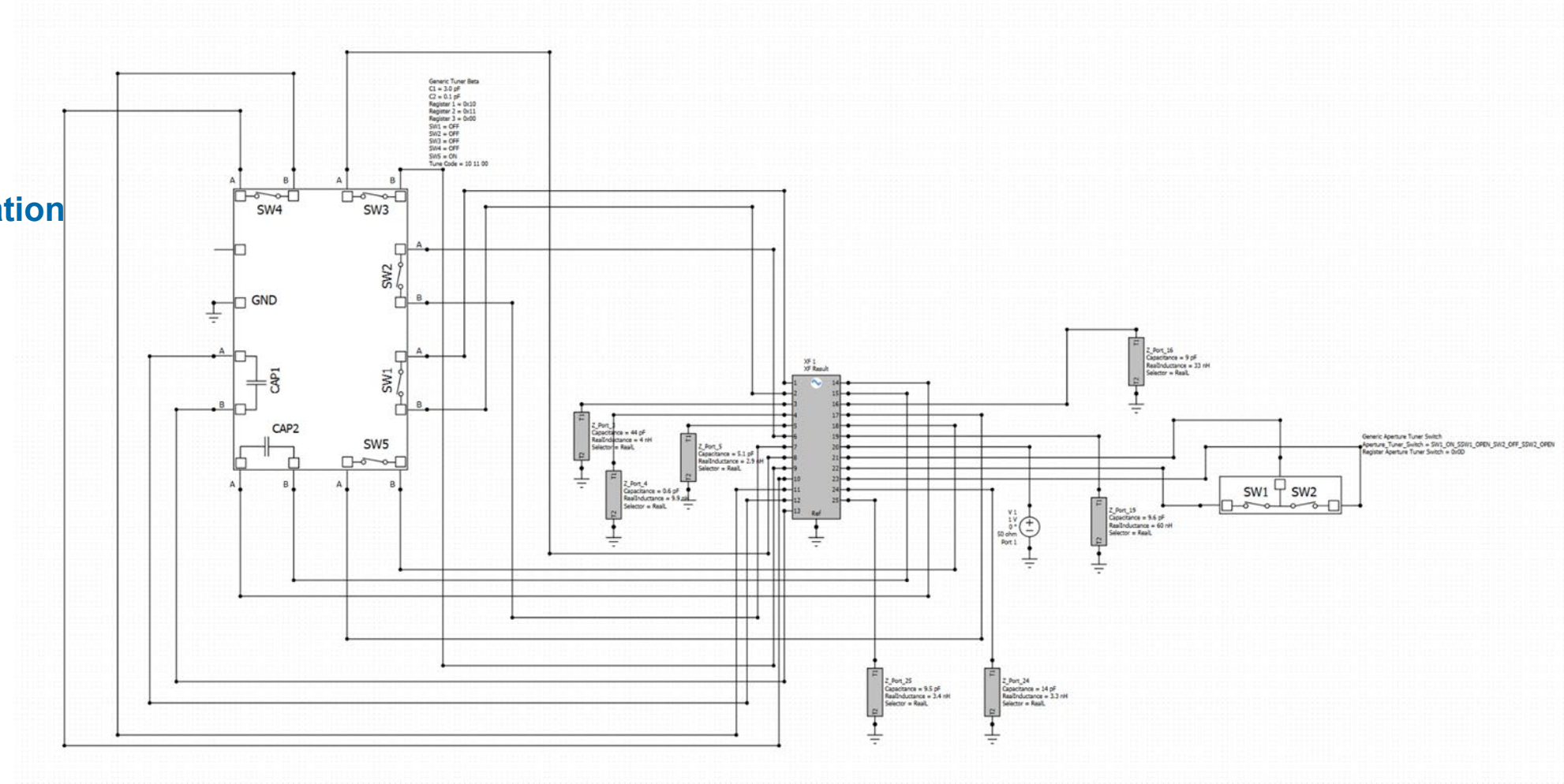
Port Details of the Aperture Tuner Layout

Step 3 Schematic Editor

Step 3 Schematic Editor

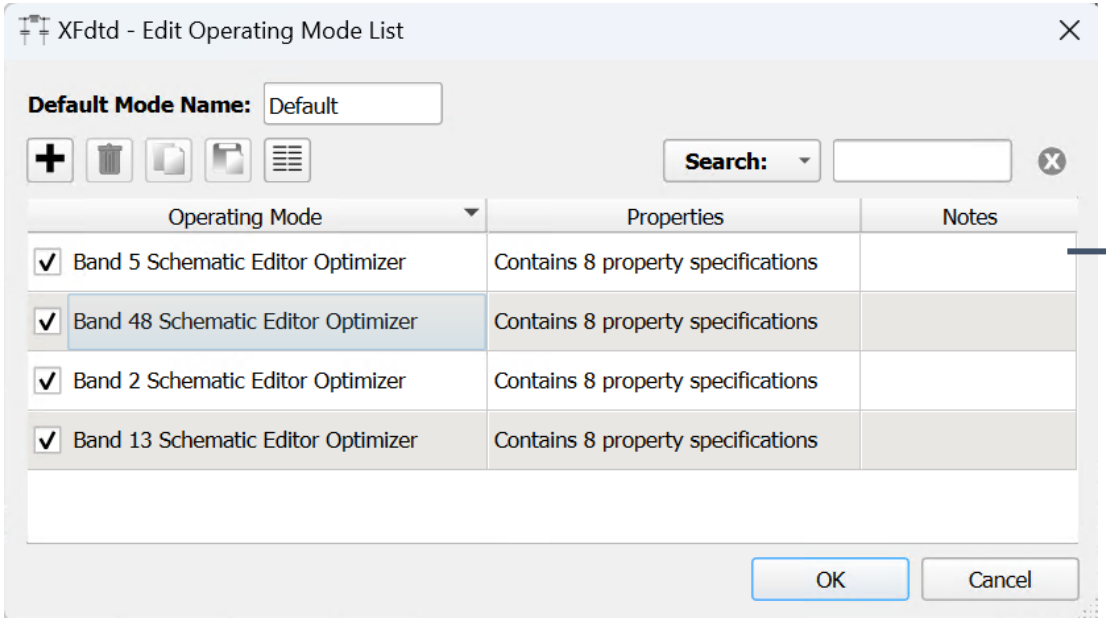
Schematic Includes:

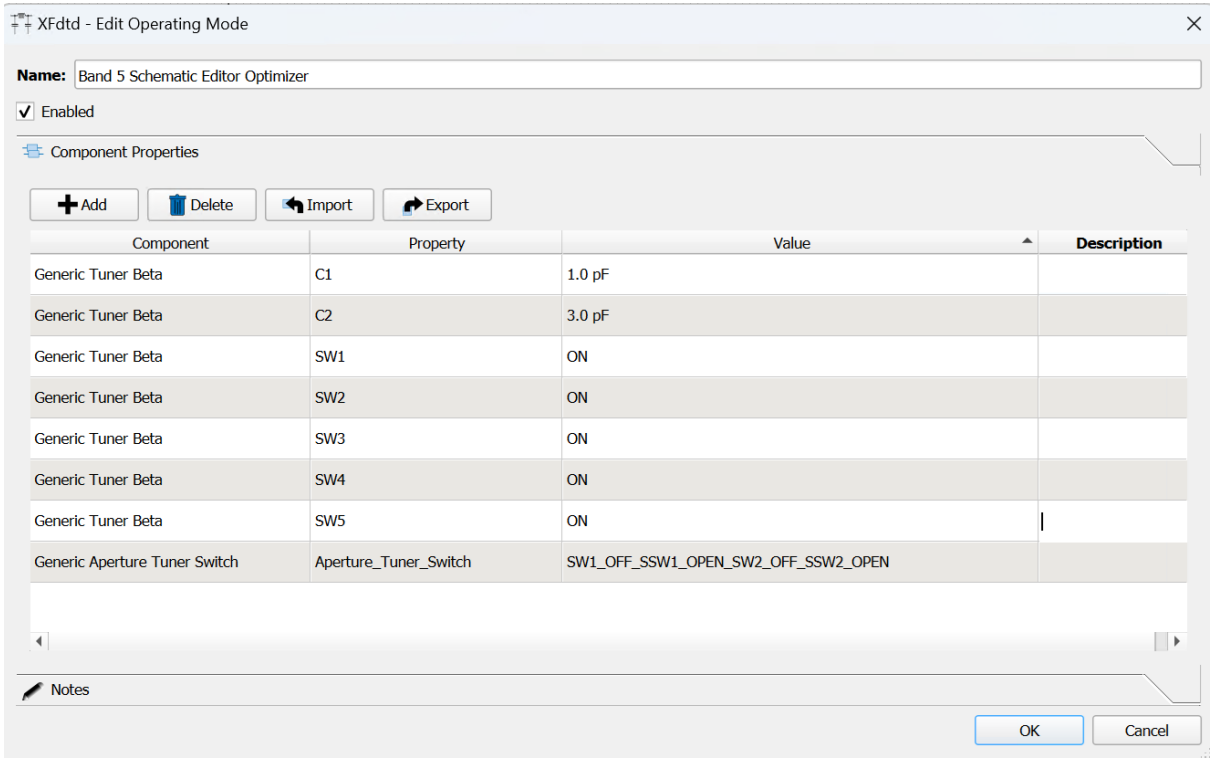
- **25-port FDTD Simulation**
- **Impedance Tuner**
- **Aperture Tuner**
- **7 Fixed L or C Components**



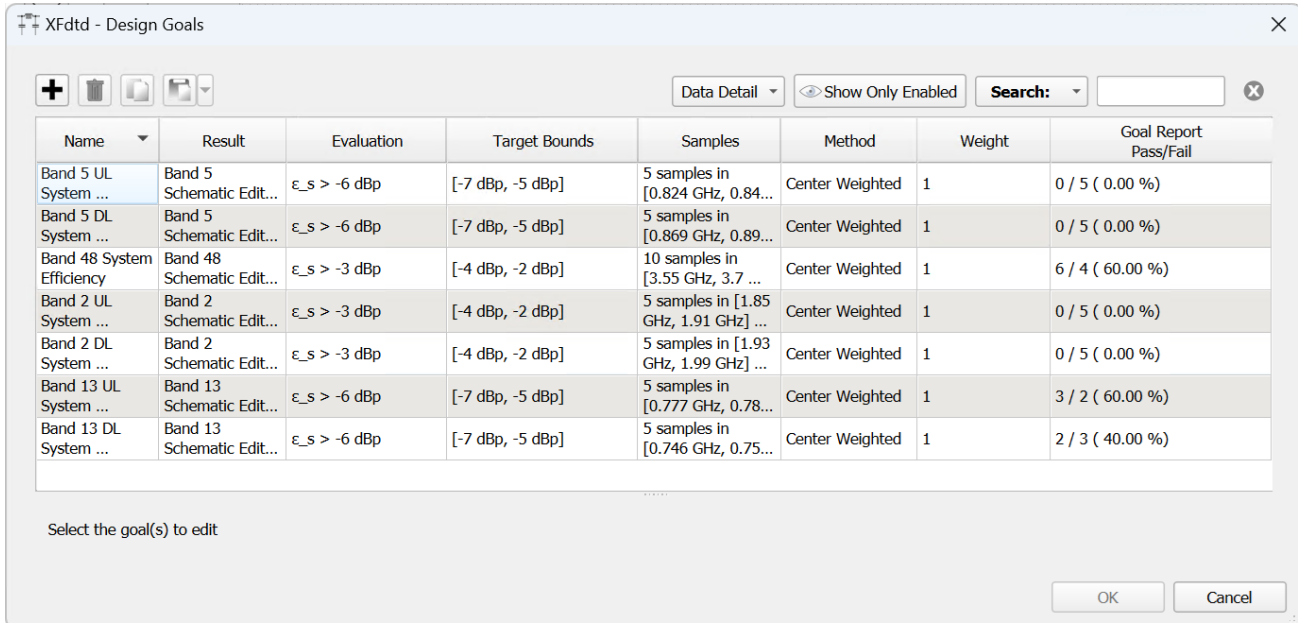
Step 4 Schematic Editor Optimizer

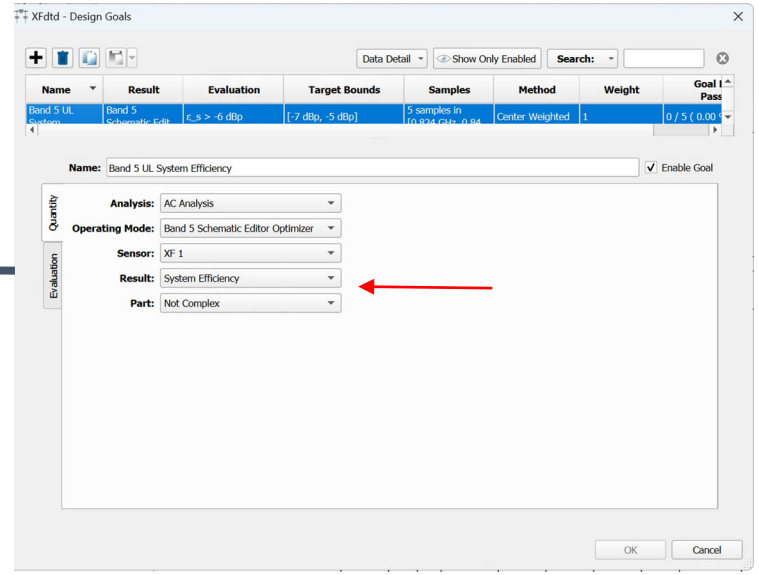
Step 4 Define Operating Modes

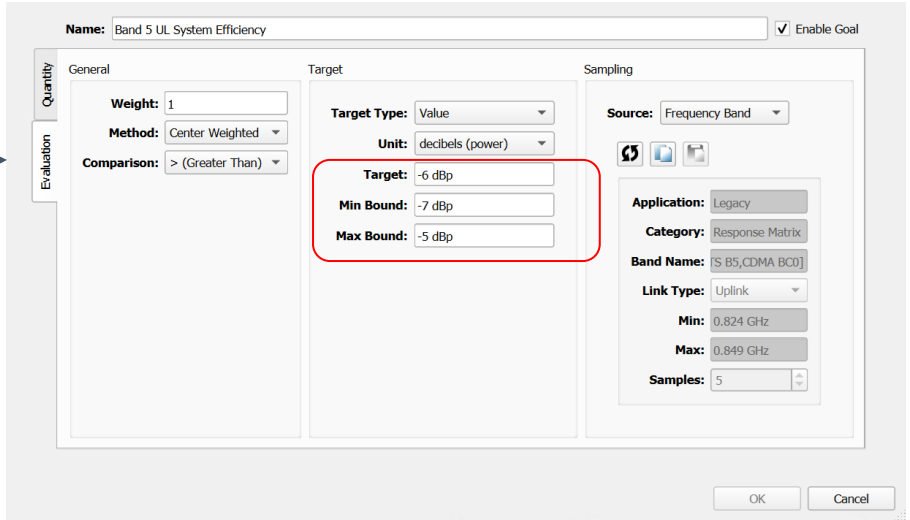




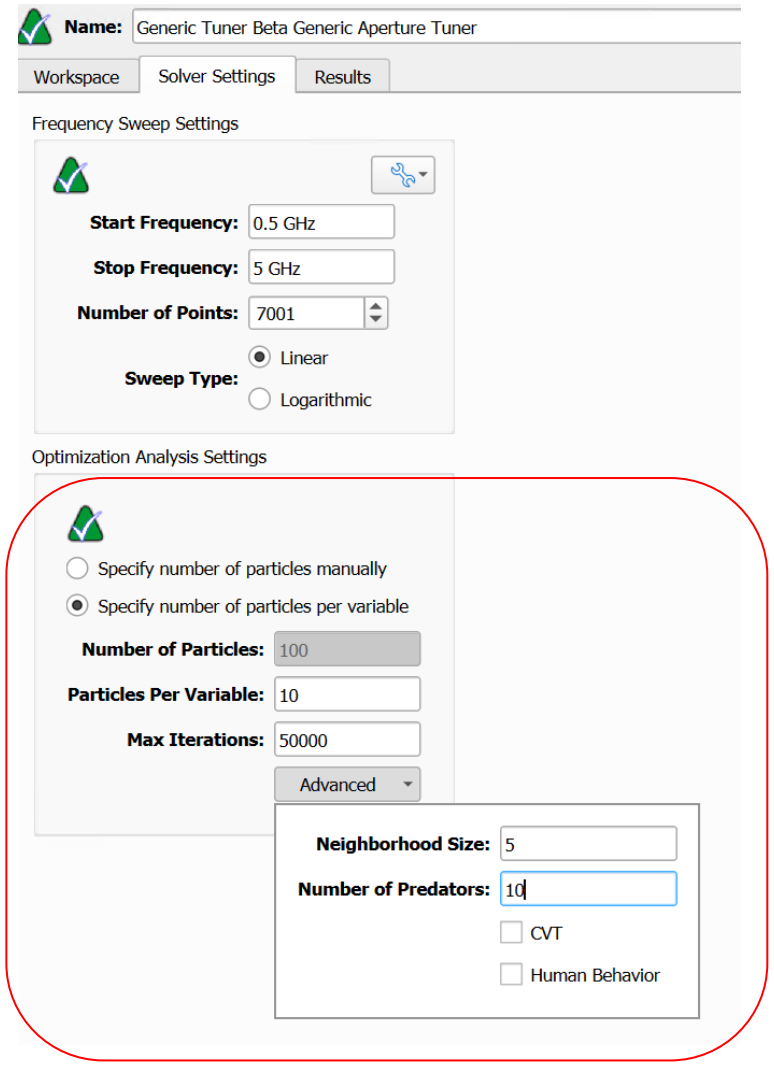
Step 4 Configure Goals on Operating Modes





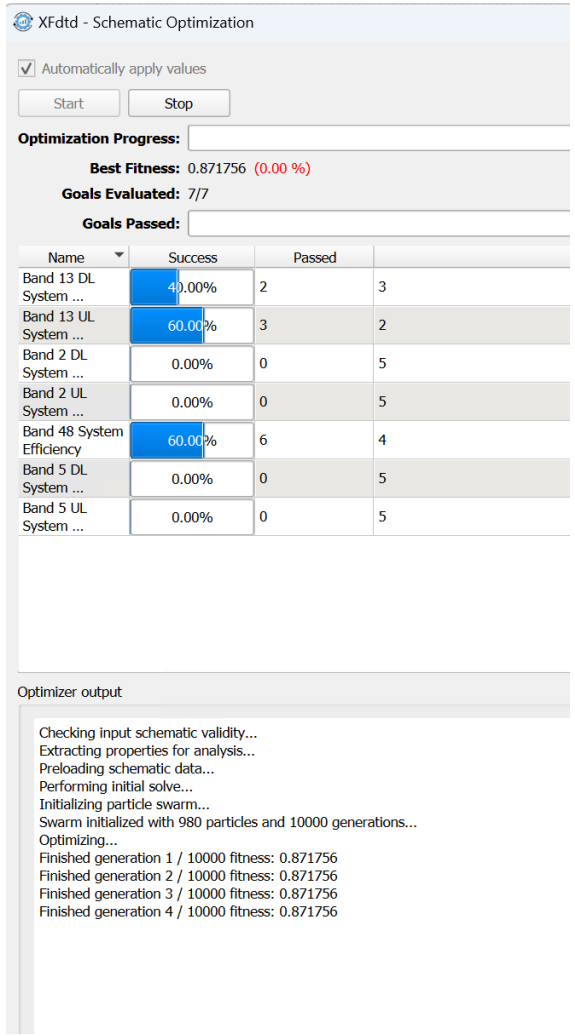


Step 4 Configure Particle Swarm Optimizer



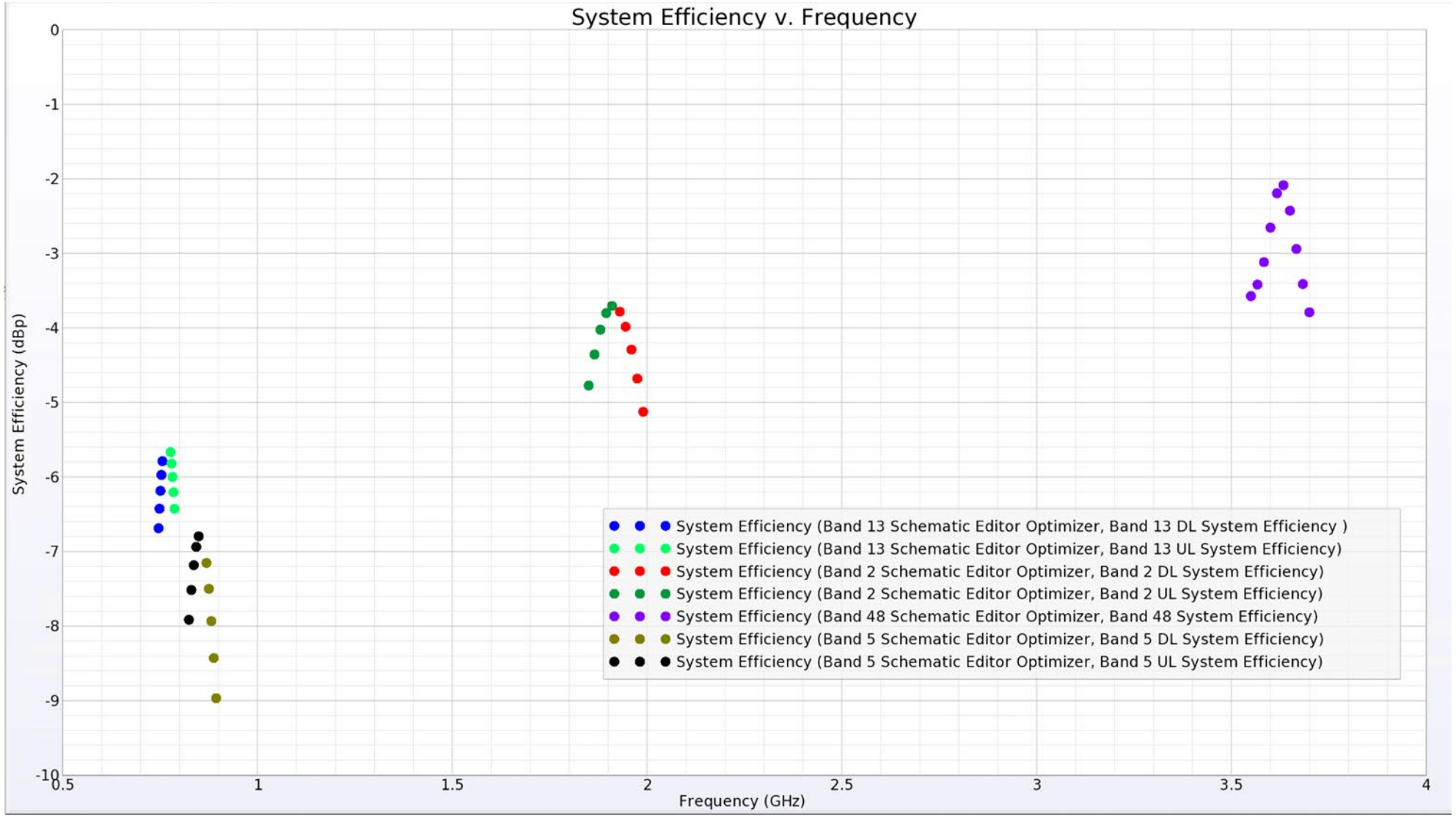
Details of the Particle Swarm Optimizer

PSO Execution

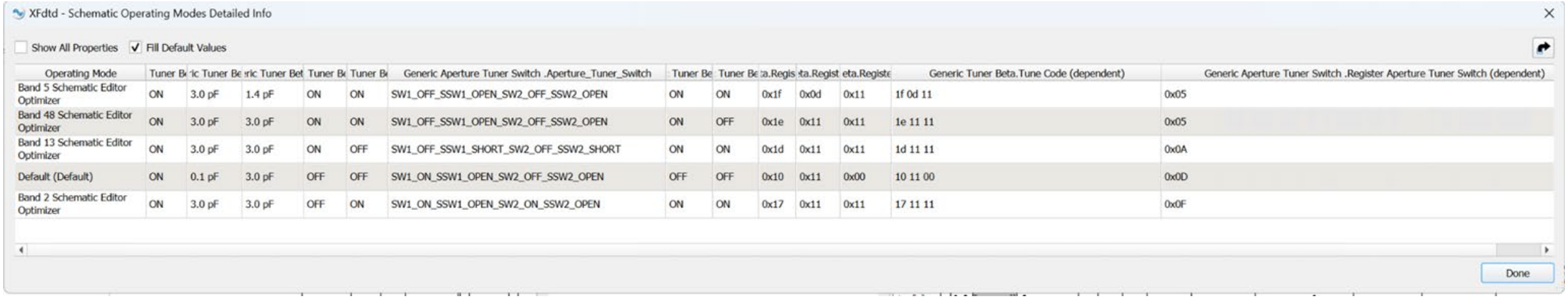


Step 5 Review Results

Step 5 Optimized System Efficiency Results



Step 5 Tune Codes and Fixed Component Values



Operating Mode	Tuner B	ic Tuner Be	ric Tuner Bet	Tuner B	Tuner B	Generic Aperture Tuner Switch .Aperture_Tuner_Switch	Tuner Be	Tuner Be	a.Regis	ta.Regist	eta.Registe	Generic Tuner Beta.Tune Code (dependent)	Generic Aperture Tuner Switch .Register Aperture Tuner Switch (dependent)
Band 5 Schematic Editor Optimizer	ON	3.0 pF	1.4 pF	ON	ON	SW1_OFF_SSW1_OPEN_SW2_OFF_SSW2_OPEN	ON	ON	0x1f	0x0d	0x11	1f 0d 11	0x05
Band 48 Schematic Editor Optimizer	ON	3.0 pF	3.0 pF	ON	ON	SW1_OFF_SSW1_OPEN_SW2_OFF_SSW2_OPEN	ON	OFF	0x1e	0x11	0x11	1e 11 11	0x05
Band 13 Schematic Editor Optimizer	ON	3.0 pF	3.0 pF	ON	OFF	SW1_OFF_SSW1_SHORT_SW2_OFF_SSW2_SHORT	ON	ON	0x1d	0x11	0x11	1d 11 11	0x0A
Default (Default)	ON	0.1 pF	3.0 pF	OFF	OFF	SW1_ON_SSW1_OPEN_SW2_OFF_SSW2_OPEN	OFF	OFF	0x10	0x11	0x00	10 11 00	0x0D
Band 2 Schematic Editor Optimizer	ON	3.0 pF	3.0 pF	OFF	ON	SW1_ON_SSW1_OPEN_SW2_ON_SSW2_OPEN	ON	ON	0x17	0x11	0x11	17 11 11	0x0F

Push Schematic to XF Simulation

- As long as the simulation is set up properly, we only have to run one XF simulation.
- We can push the schematic back onto our previously run XF simulation to determine quantities such as envelope correlation coefficients, far field patterns, near field results such as SAR.
- By use of the superposition principle these data can be determined from the previously run XF simulation.
- Allows users to quickly post process the full-wave results in the presence of the circuit.

Contact

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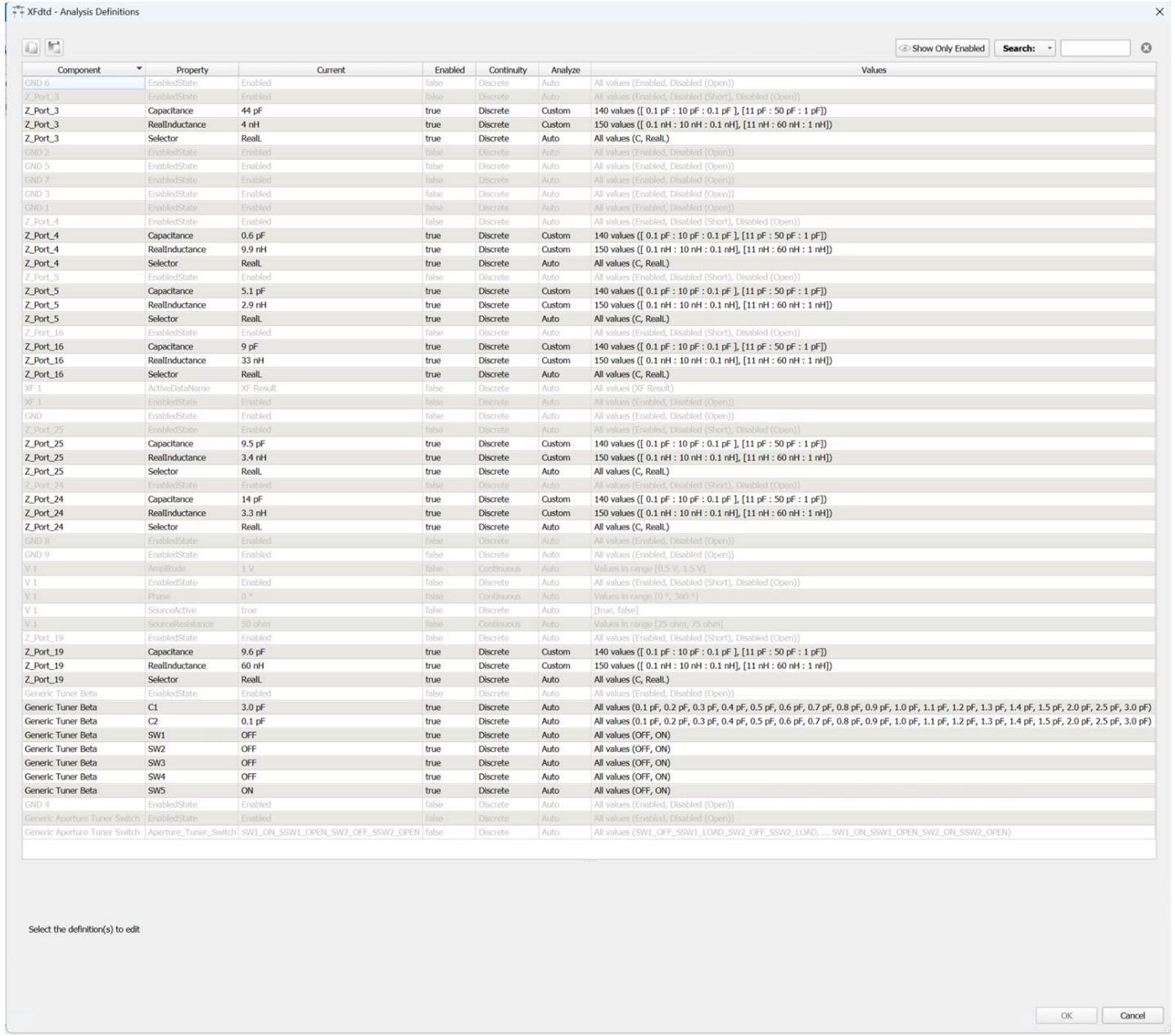
Backup Slides

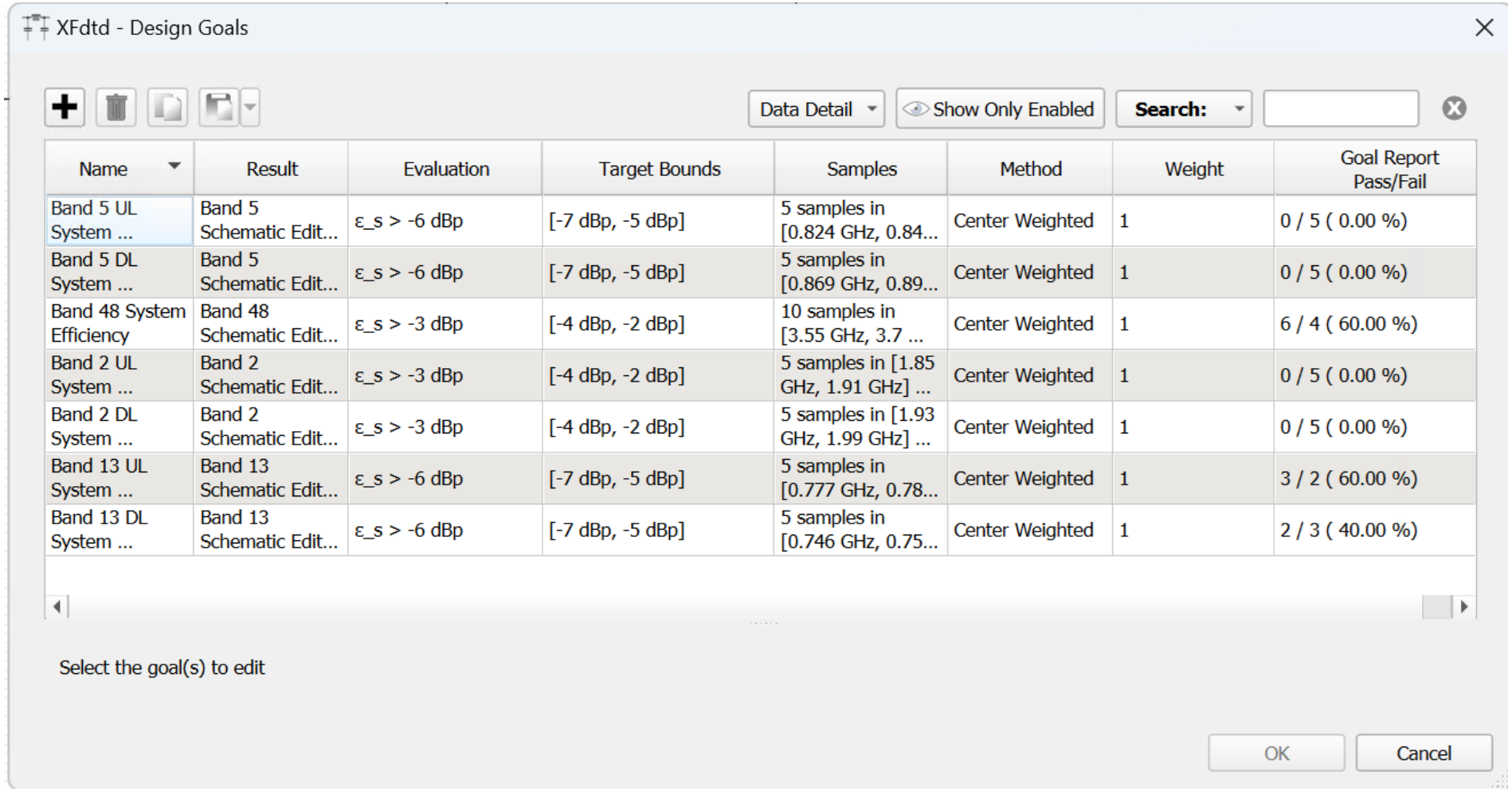
LC Definitions

Allowable component values



Design Goals

List of design goals



Optimized Fixed Components