



Simulating Electronic Cable Crosstalk and Emissions

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Agenda

- Tools Overview
- Circular Cable
- Flat Cable
- Connectors
- Combining Cable and Connector
- Cable “On Platform”
- Discussion

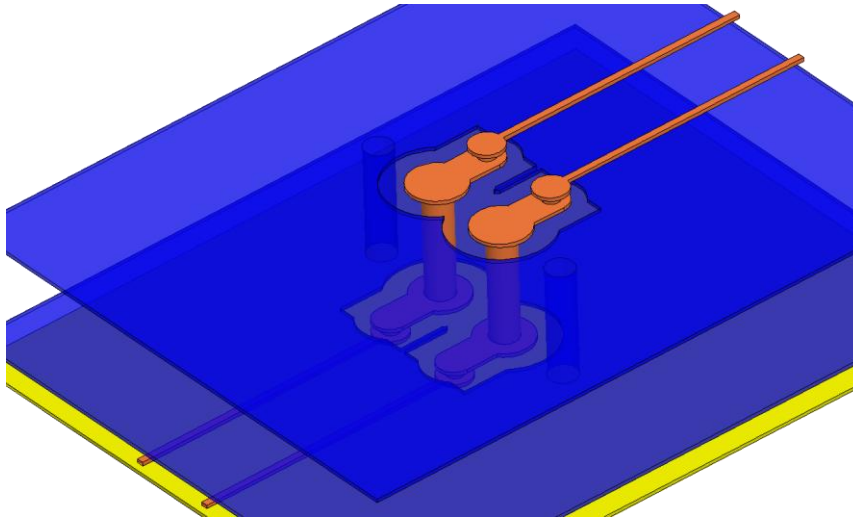
Why Simulate Cables and Connectors?

- Cables and connectors are present in virtually all electronics assemblies
- Cable and connector effects on signals may need to be accounted for
- As frequencies and clock speeds get higher, cable and connection effects can not be ignored
- Cables/connectors can be a source of EMC/EMI problems
- Use of simulation can aid in identifying/eliminating possible issues in the virtual space, prior to physical build/prototyping

Relevant ANSYS Tools

ANSYS Q3D/Q2D Extractor

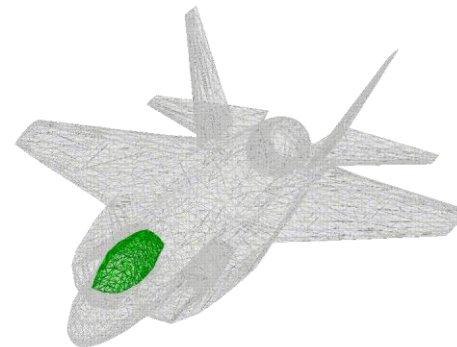
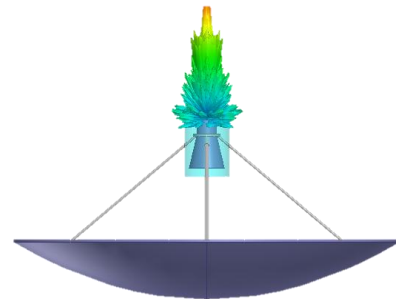
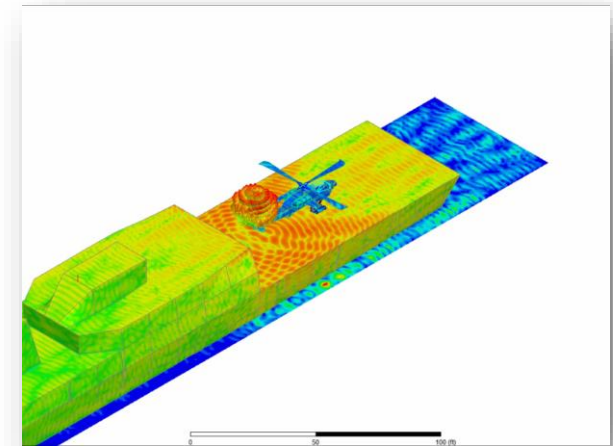
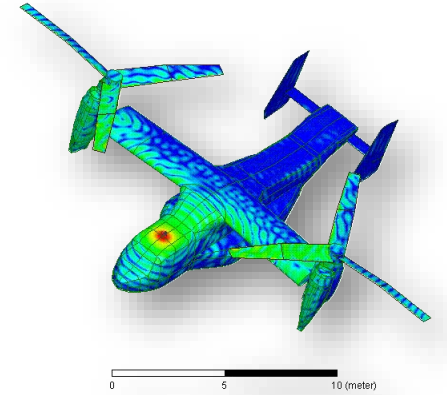
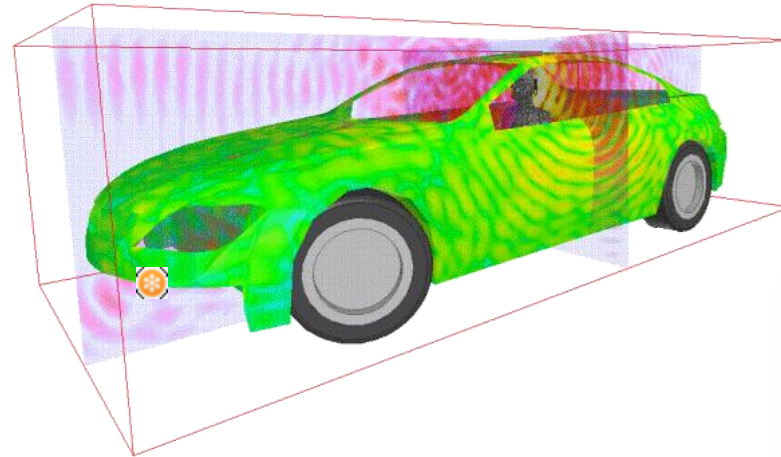
- **Quasi-static extraction tool**
- **Solves**
 - 3D Arbitrary structures
 - 2D uniform cross-section
 - Cables
 - Wires
 - Transmission lines



- **Uses**
 - Finite Element solver
 - Electrostatic solver
 - Separate DC and AC solvers
 - Resistance & Inductance Solvers
 - Capacitance and Conductance solvers
- **Applications**
 - RLCG parameter extraction of
 - Connectors (Q3D)
 - Bus Bars (Q3D)
 - Package lead frames (Q3D)
 - Transmission lines calc. (2D)
 - Cable characterization (2D)
 - Circuit model (2D & Q3D)

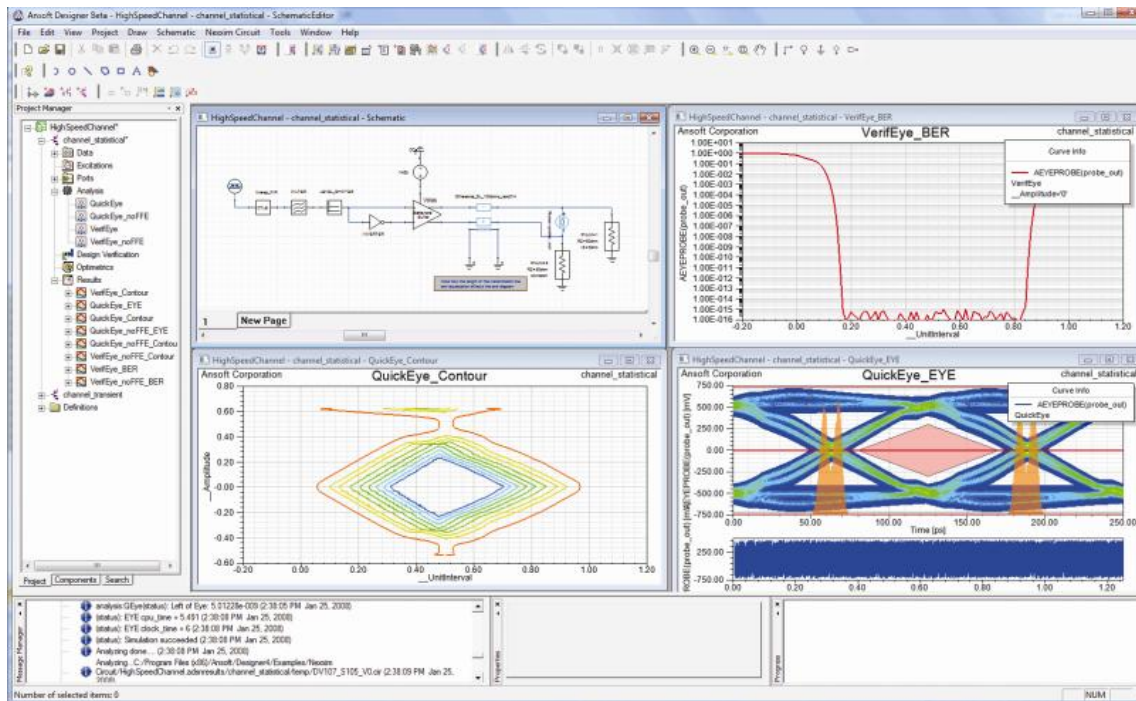
ANSYS HFSS: 3D & Boundary Element

- High Frequency Structure Simulator
- Full-wave frequency domain 3D electromagnetic field solver
- Multiple Solver Technologies
 - 3D FEM, Frequency Domain
 - Integral Equation/Boundary Element
 - Hybrid FEBI
 - 3D FEM Transient, Time Domain
- Finite element method with adaptive mesh refinement
 - Provides an **Automatic, Accurate** and **Efficient** solution
 - Removes requirement for manual meshing expertise



ANSYS HF Circuit

- Integrated, multi-purpose system, circuit simulation tool
- Used in concert with Siwave, HFSS, and Q3D
- Solves
 - System level simulations
 - Circuit level simulation



- **Uses**

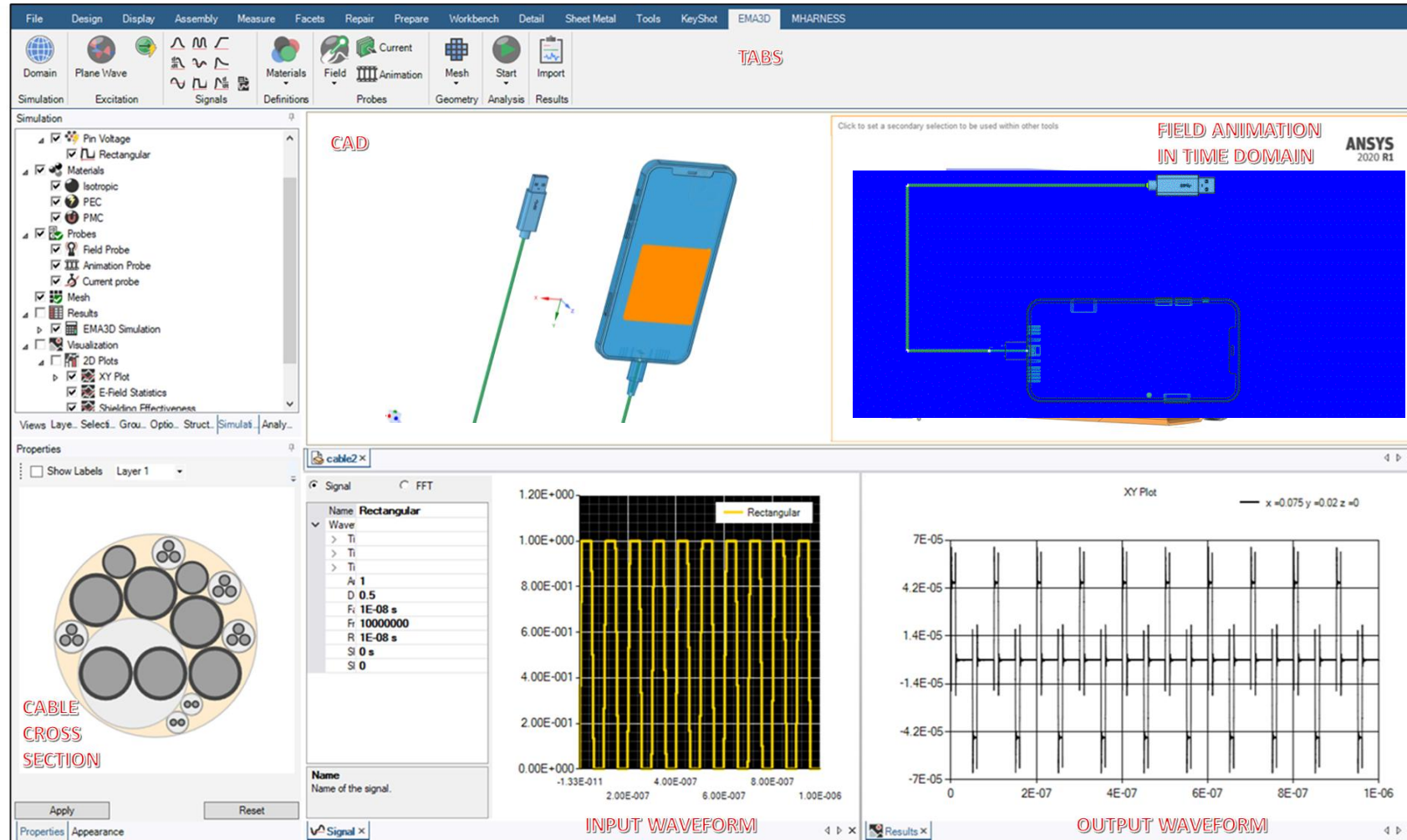
- Time domain solvers
- Frequency domain solver
- Method of Moment solver
- Solver on Demand
 - HFSS
 - Siwave
 - Hspice
- Dynamic Links
- Design Hierarchy

- **Applications**

- Orchestrates communication between various ANSYS EM tools
- System level simulation
- RF and μ wave circuit designs
- Spice circuit designs
- Signal Integrity
- Power Integrity
- Antenna Arrays
- RF IC simulation
- EMI/EMC

ANSYS EMC Plus

FDTD Cable Harness Solution

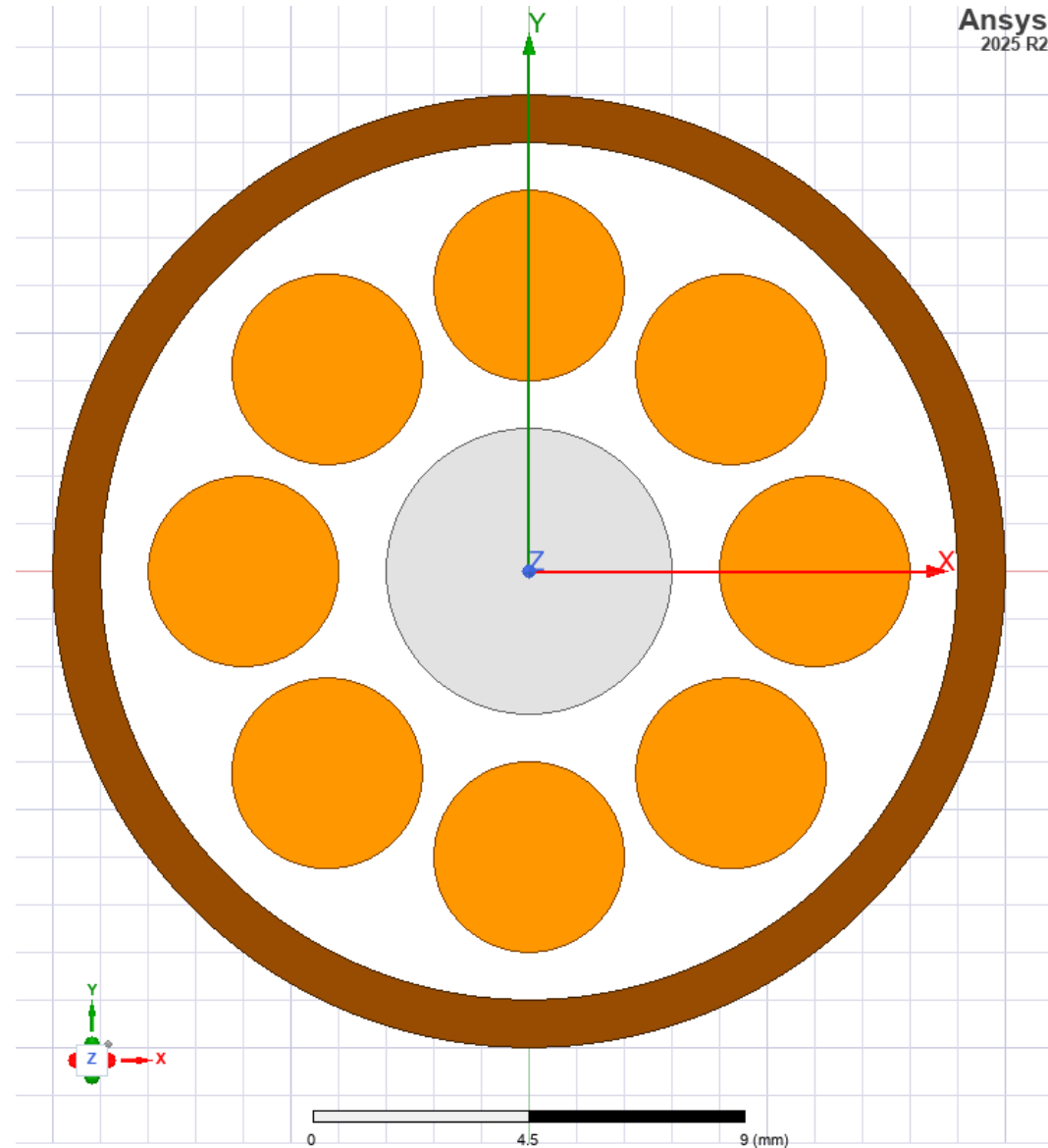




Examples

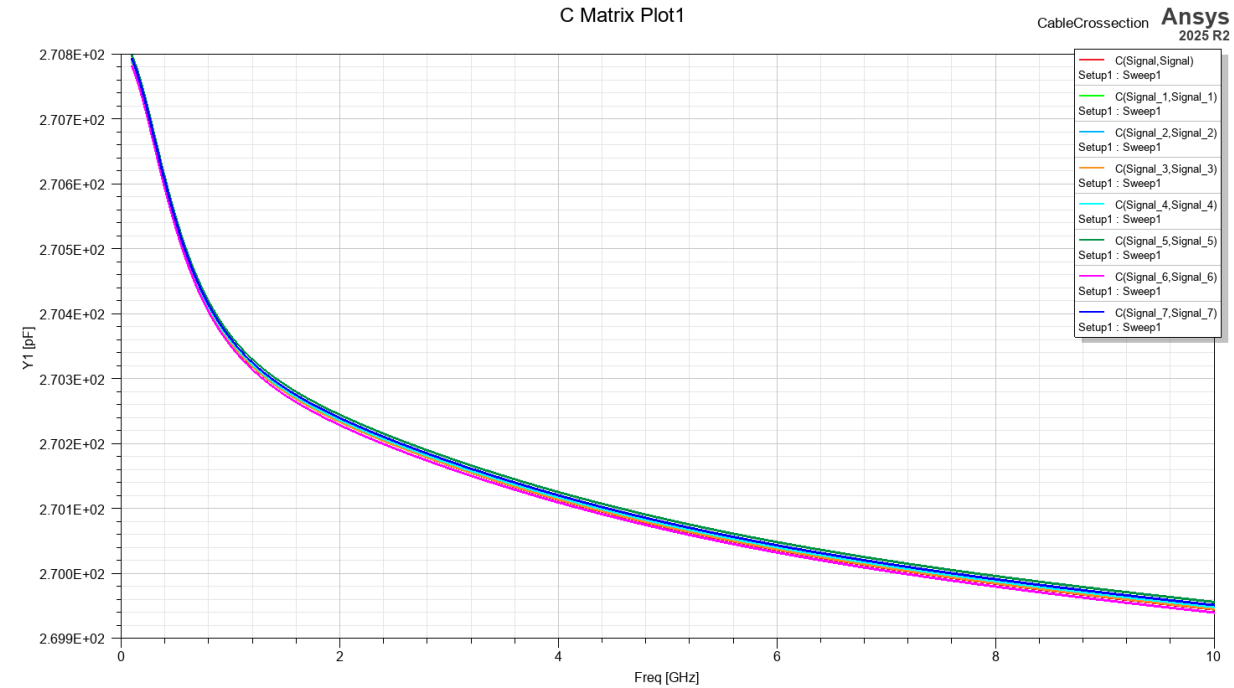
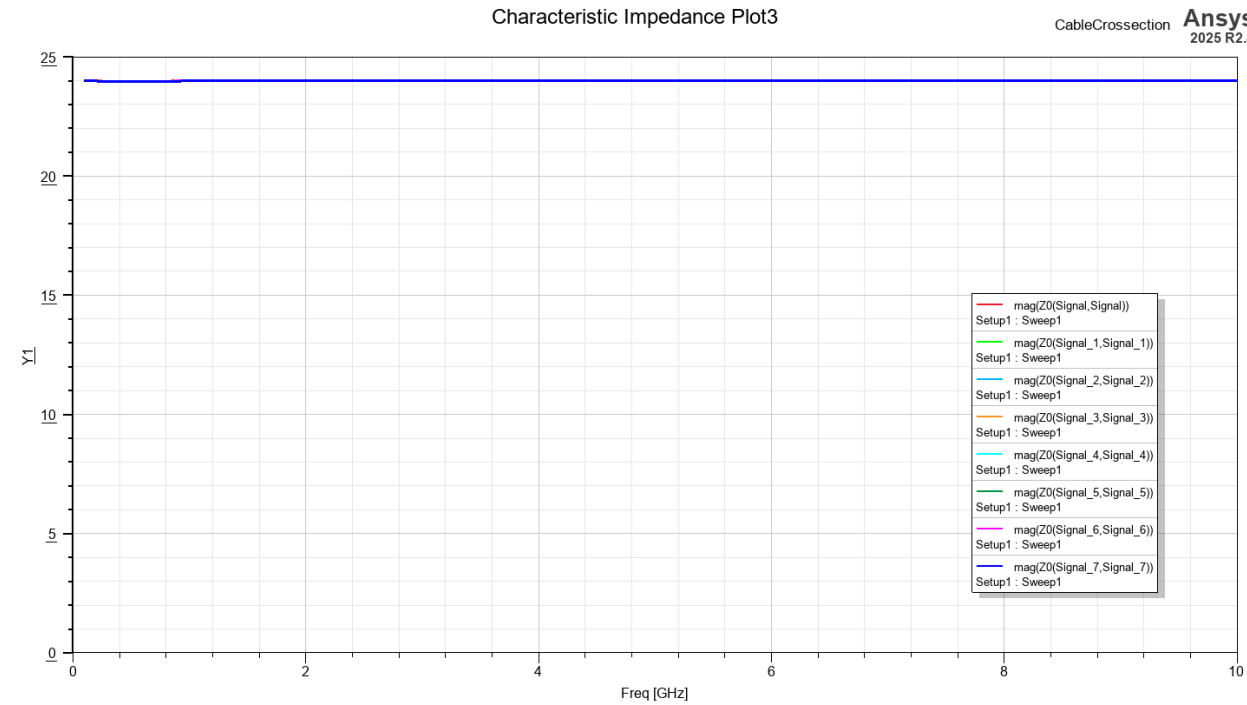
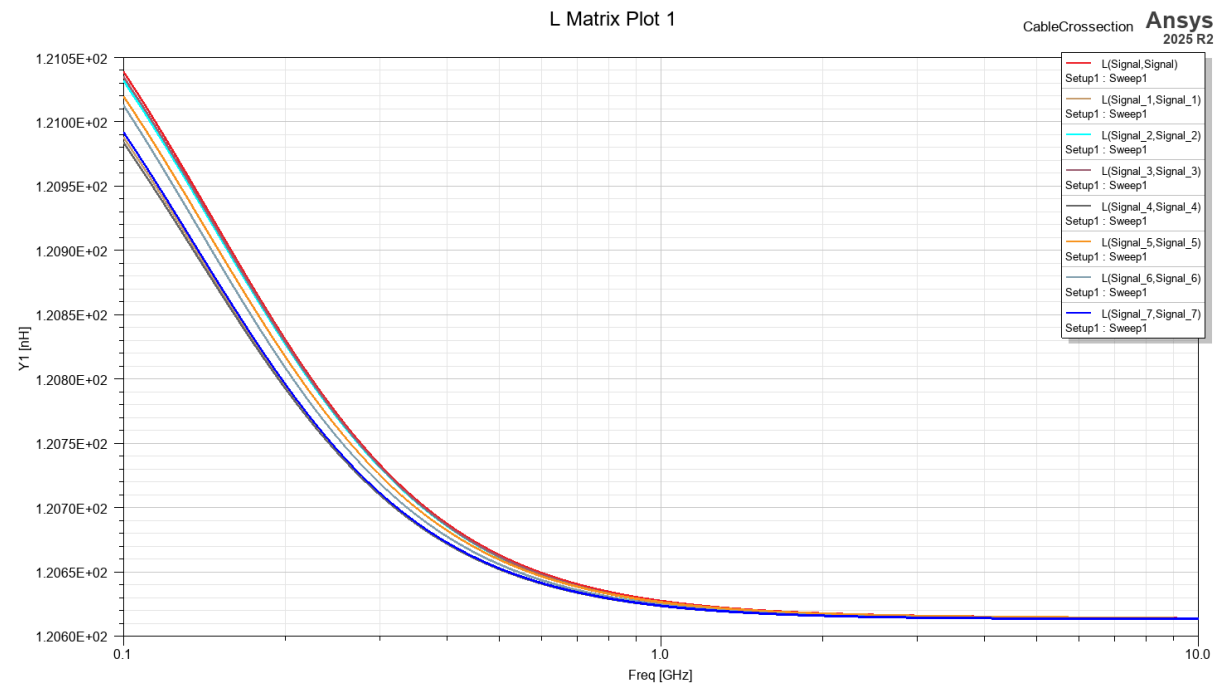
Cable Simulation

- Cross-Sectional Representation
- Parameter extraction using Q2D
 - Copper signal conductors
 - Copper shield/reference
 - Dielectric Core (diel const. 3.44)
 - Dielectric Insulator (diel const. 2.25)
- Simulate up to 10GHz

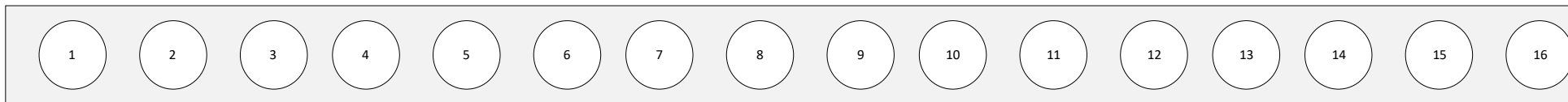


Cable Simulation

- Characteristic Impedance, Z_0
- L, C

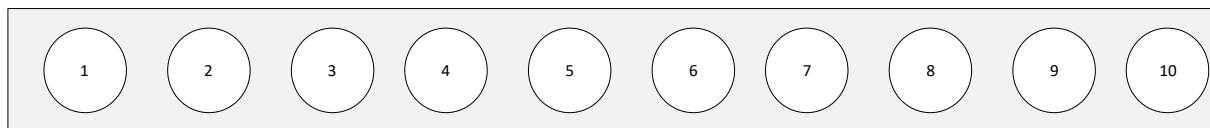


Flat Cable

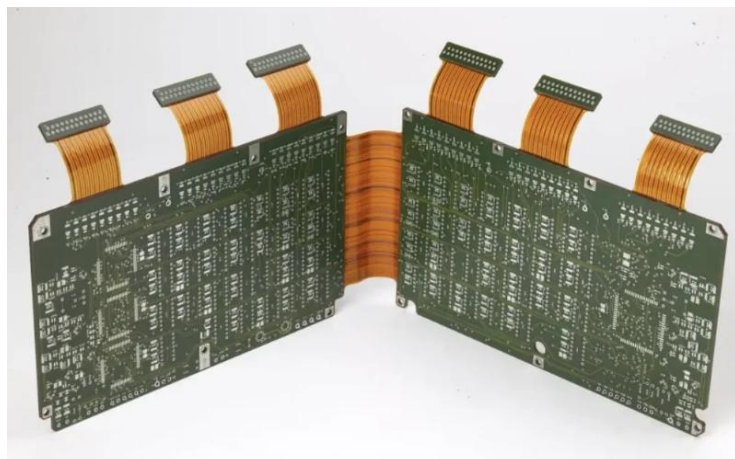


Victim

Aggressor

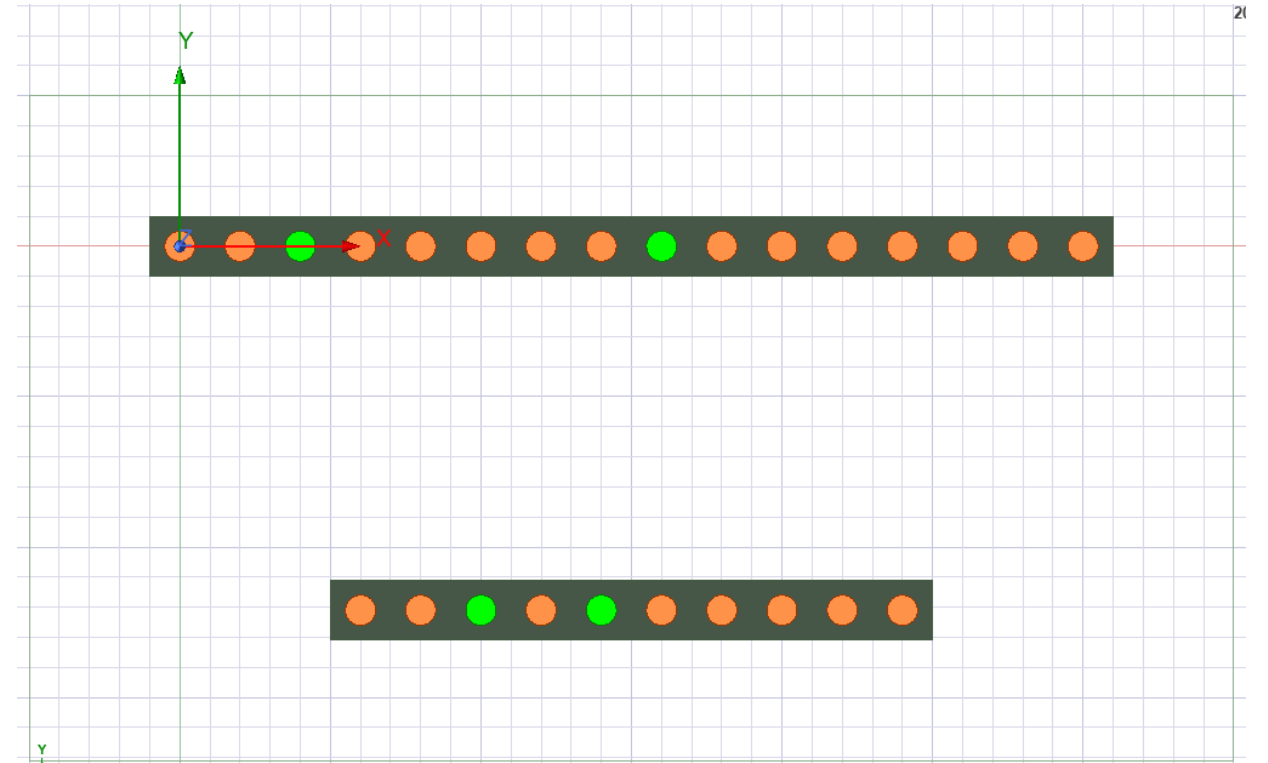
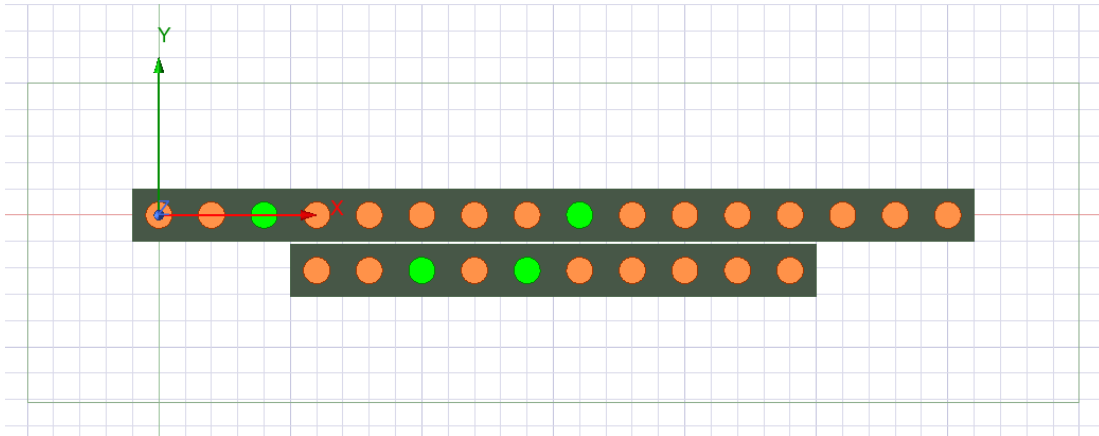


- 16pin cable only has two return paths for the 14 other signals



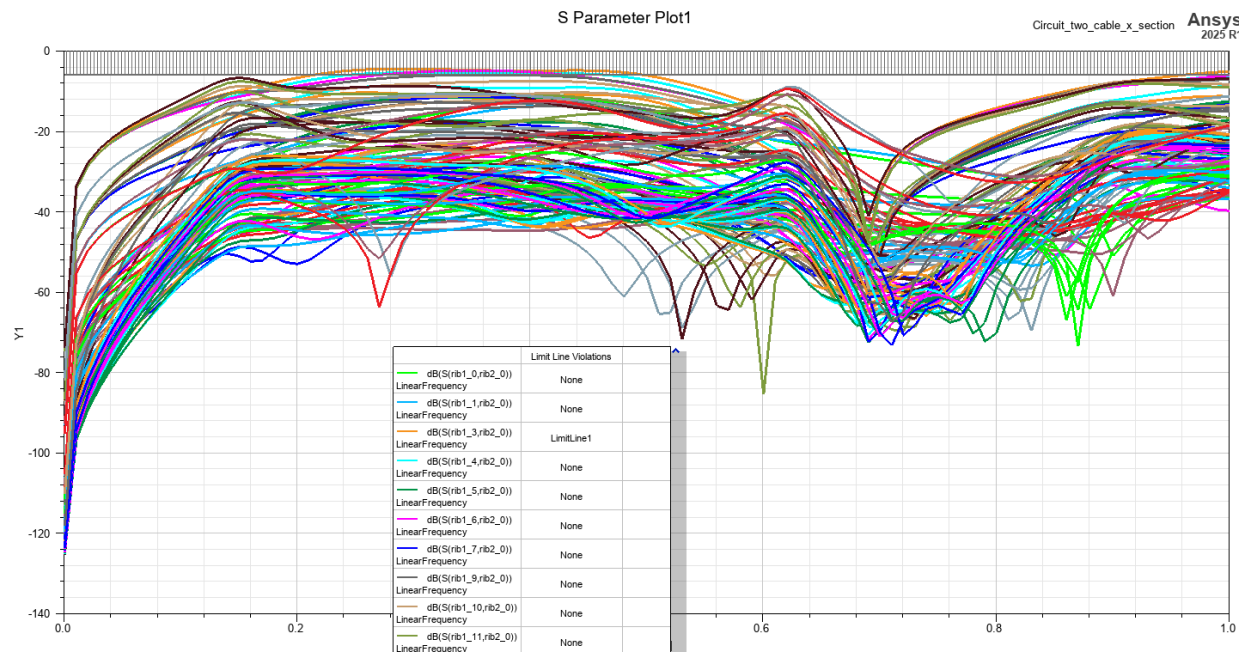
Q2D Characterization of Ribbon Cables

- Used Q2D, performed simplest characterization of cable coupling
 - Calculated “coupling coefficients” (S_{mn} , $m \neq n$)
 - S-parameters from 16-pin cable “input” to 10-pin cable “output”
 - Essentially the transfer function from input of one cable to the output of other cable for all combinations of signal carrying conductors
 - Two configurations:
 - Cables laying on top of each other
 - 10mm separation between the cables

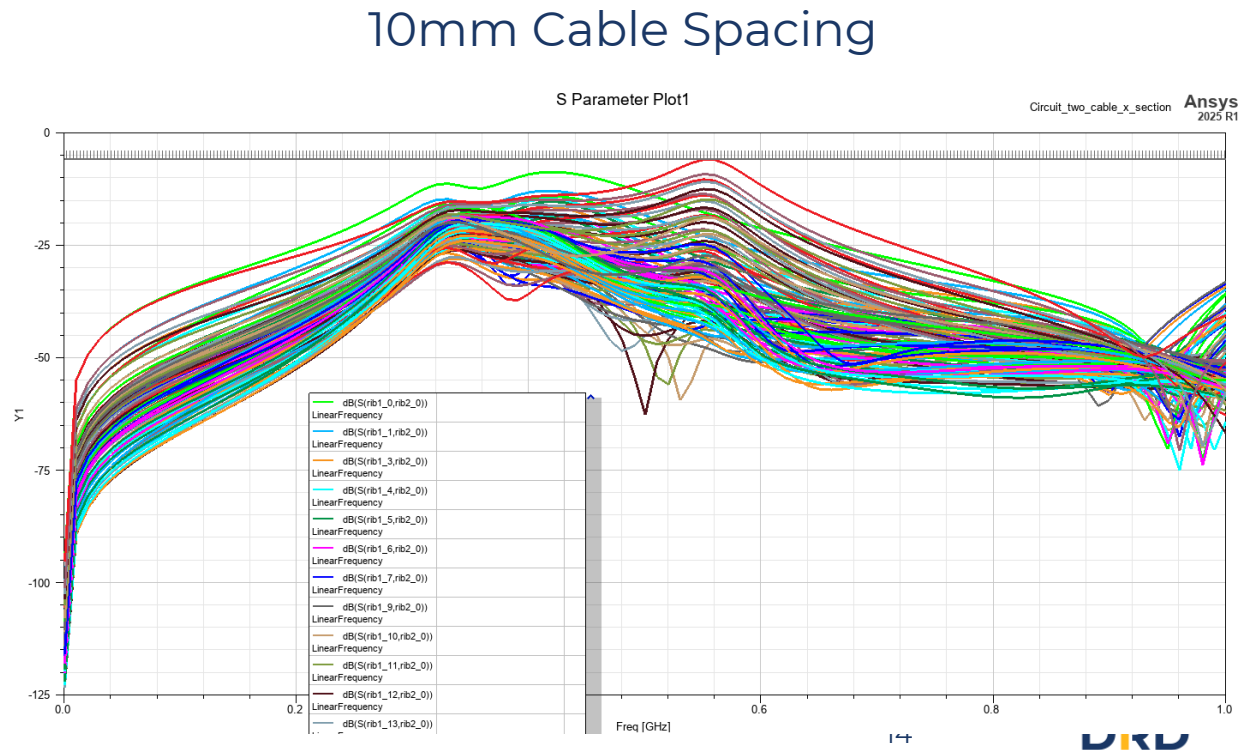


Q2D Characterization of Ribbon Cable

- Generalized spectral behavior
 - Unity power excitation over entire bank 0GHz-1GHz
- Only have issues if there is noise/excitation at an indicated resonance
- Limit line is at -6dB

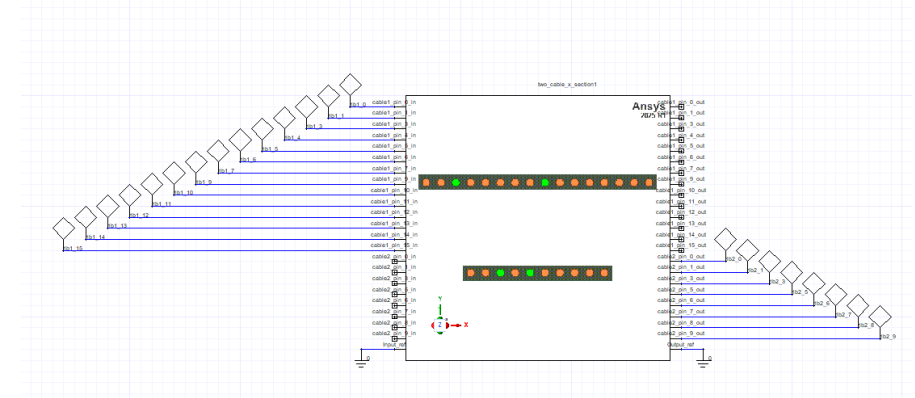


No Cable Spacing



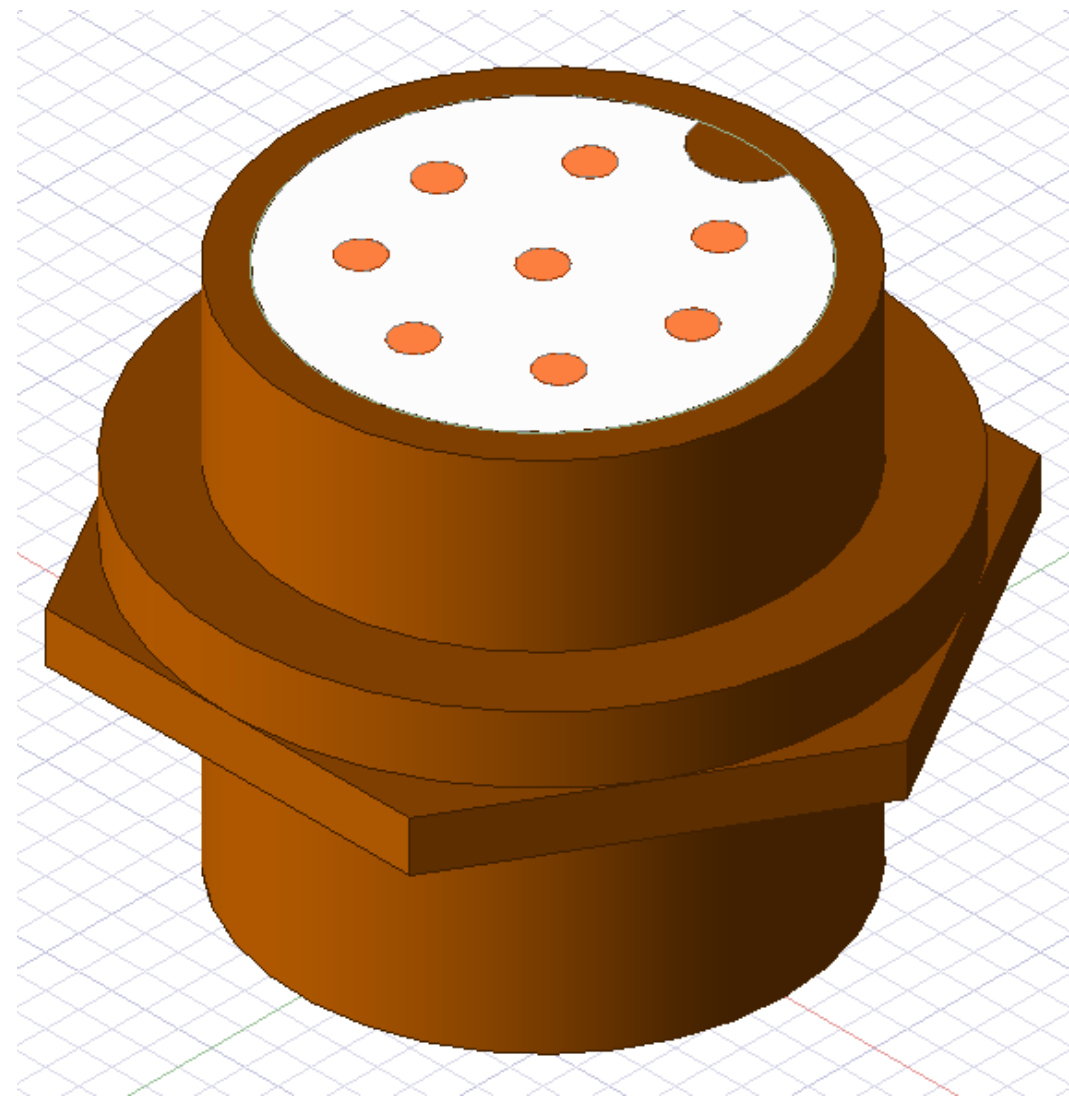
Full System Simulation

- Ultimately, have *.sNp models for:
 - Boards (SIwave)
 - Connectors (Q3D/HFSS)
 - Cables (Q2D/HFSS)
 - Cable Terminations (Circuit block set)
- Perform SI analysis and observe cross-talk/noise
- Each component is a block in HF Circuit tool



8 Pin Connector

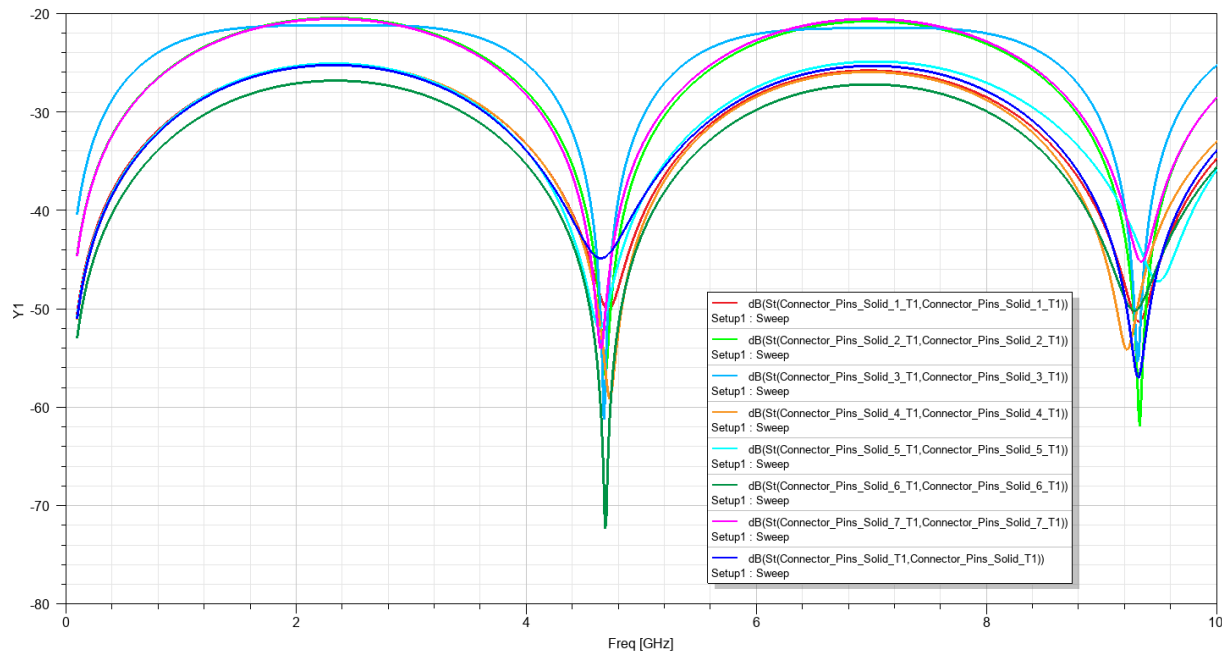
- S-parameter extraction with ANSYS HFSS
 - Aluminum body (reference)
 - Copper pins (signal)
 - Polyamide (dielectric)
- Simulate up to 10GHz



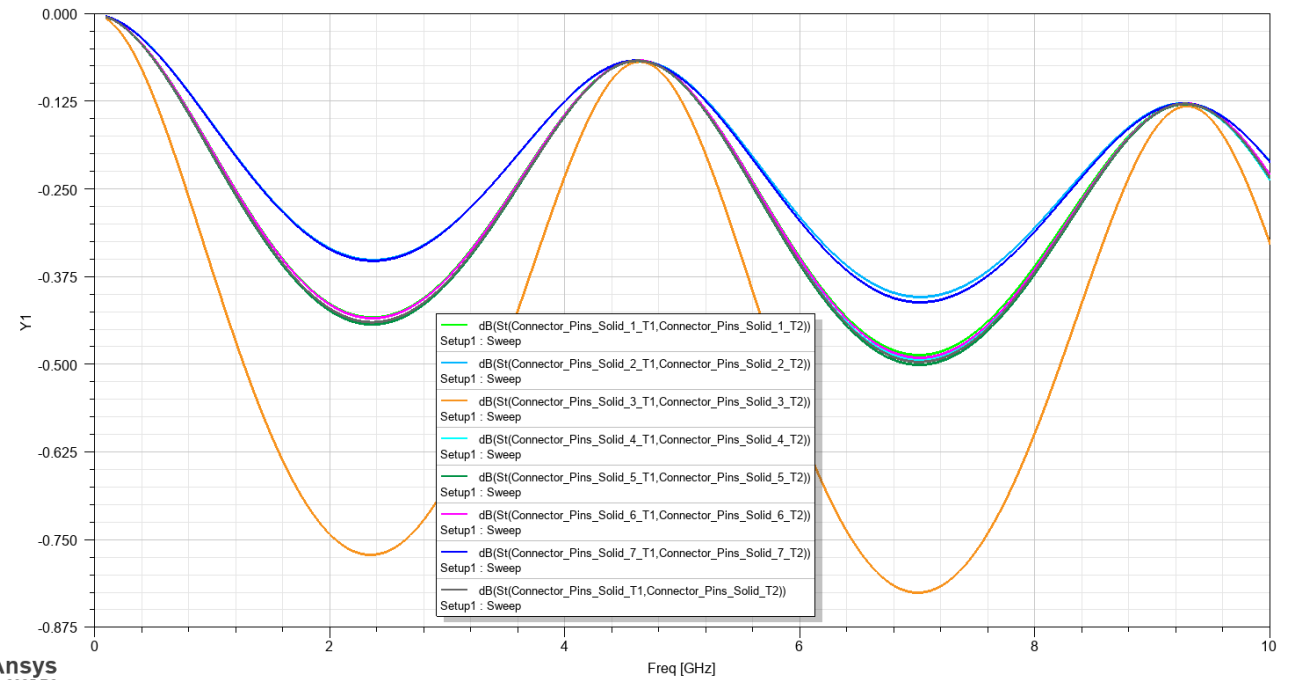
8 Pin Connector

- Insertion and Return Loss of Signal Pins

Terminal S Parameter, Return Loss

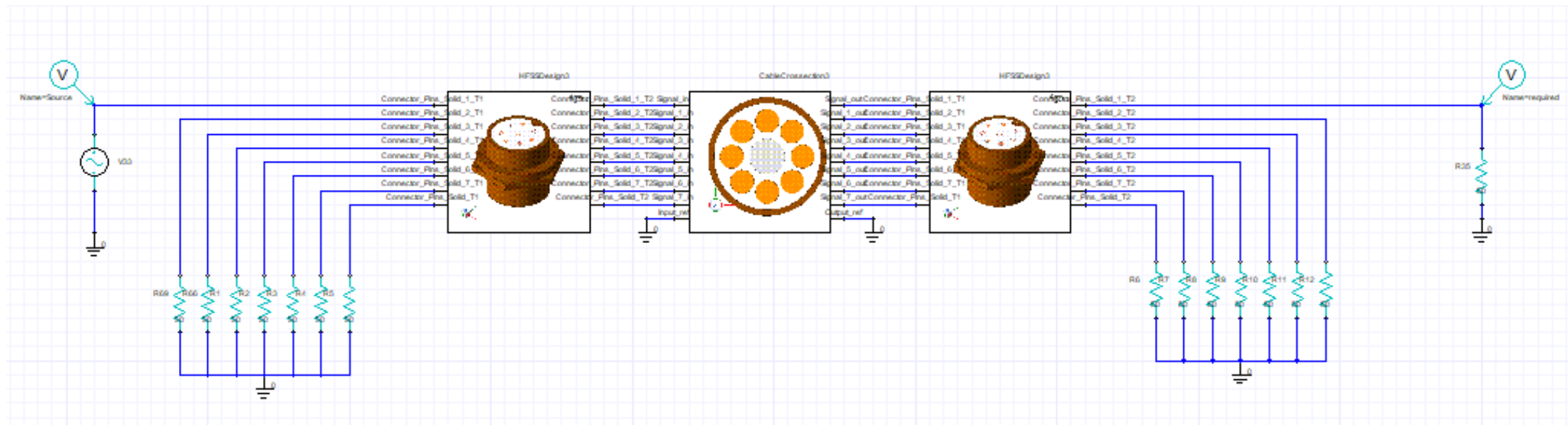


Terminal S Parameter, Insertion Loss



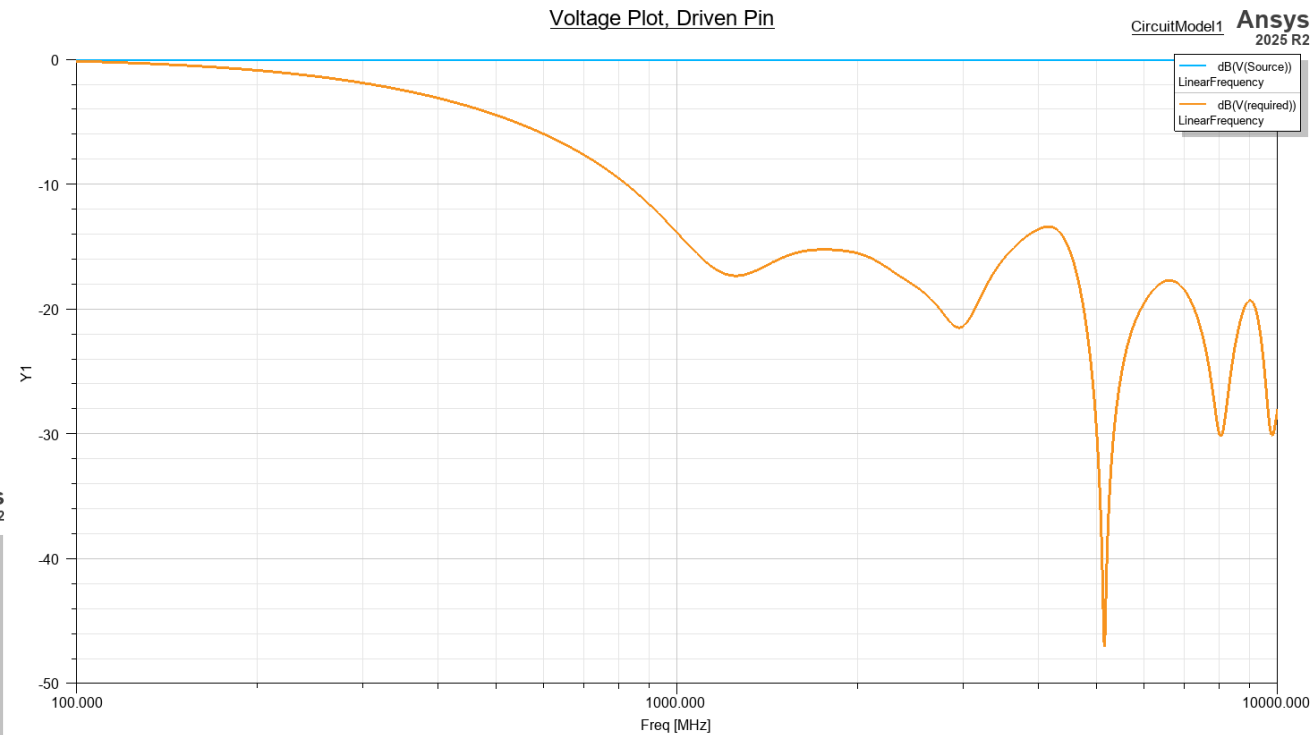
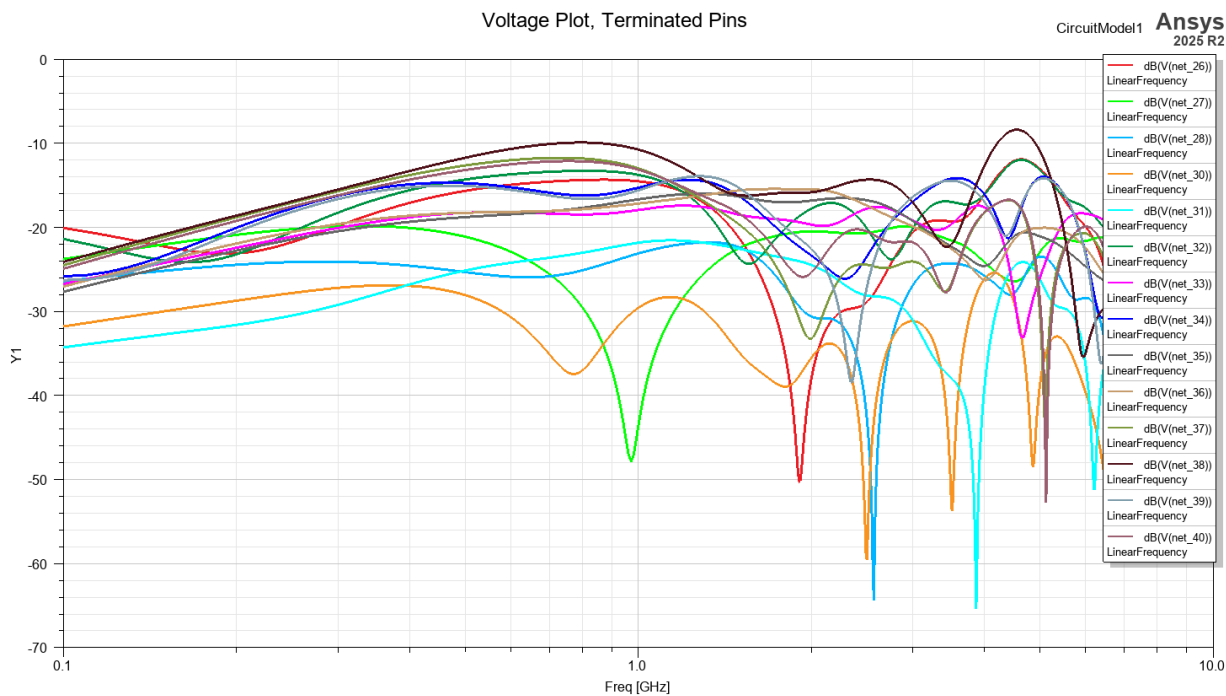
Cable and Connector

- Use HF Circuit to include both cable and connector effects
 - 10m long cable
- Linear Voltage Frequency Sweep



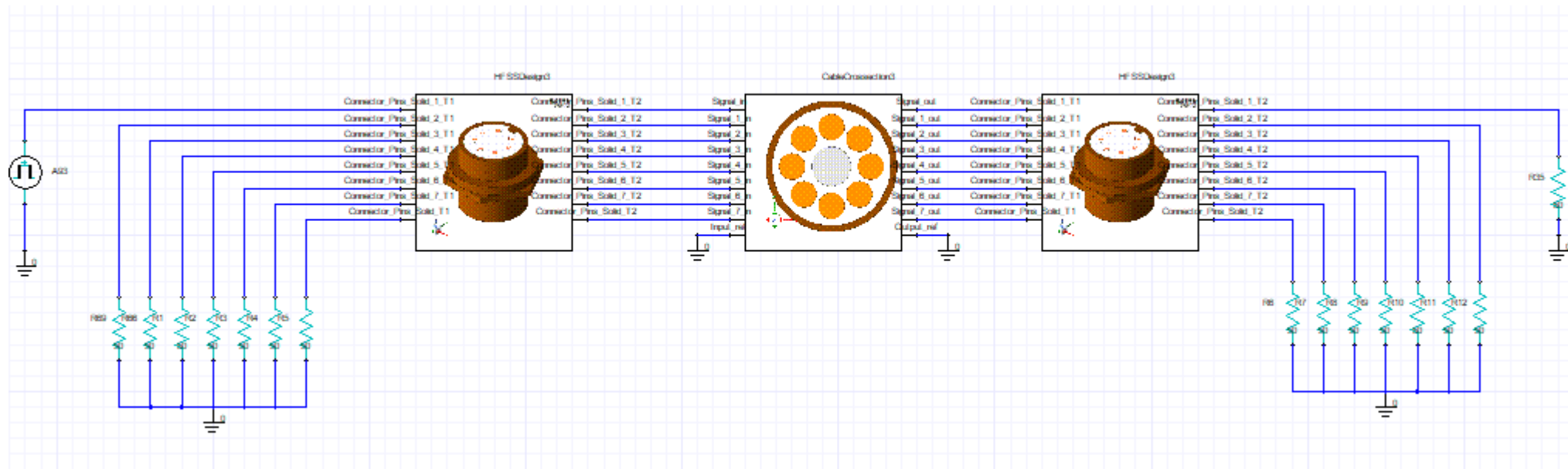
Cable and Connector

- Linear Voltage Sweep
- Driven Pin, 0.1GHz-10GHz
- Terminated Pins, 0.1GHz-10GHz

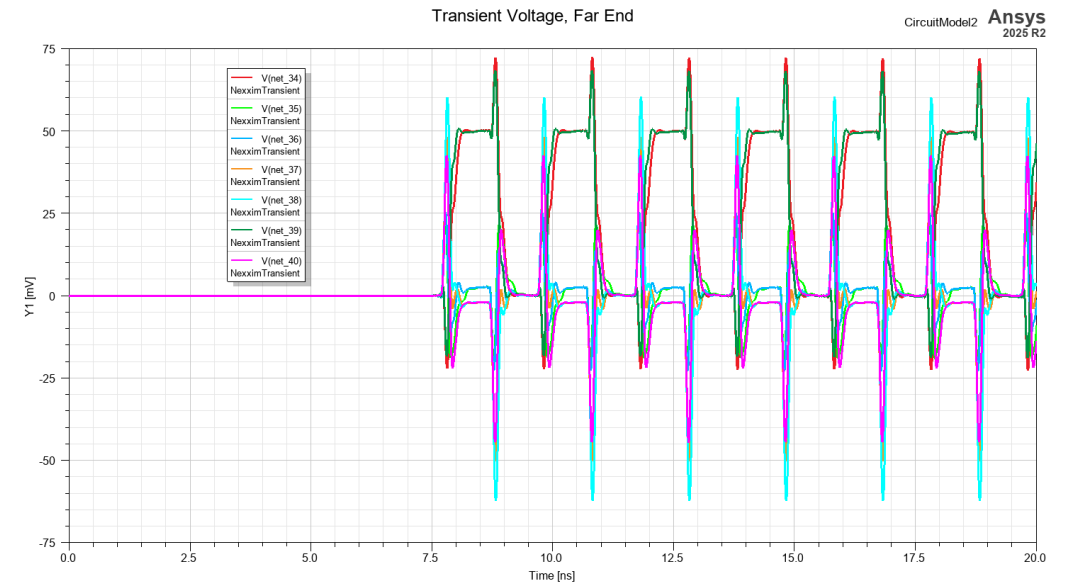
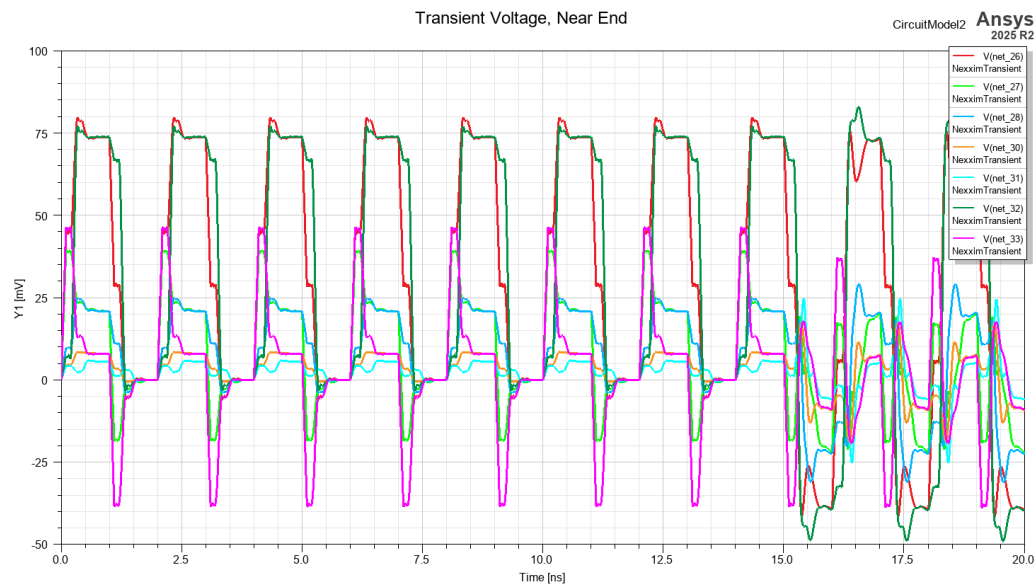
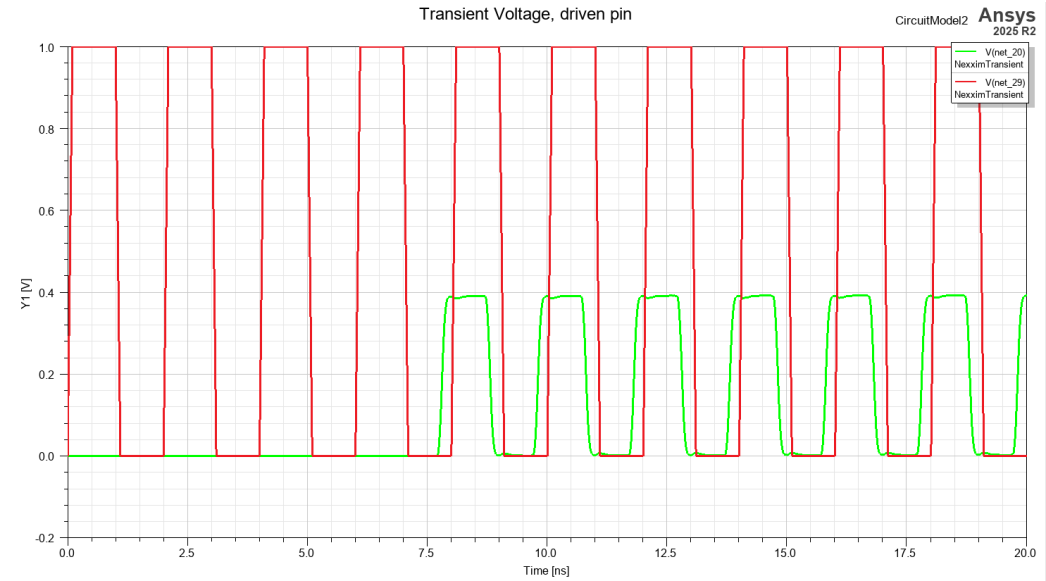


Cable and Connector

- Time Domain step excitation
 - 1.5m long cable
 - 500MHz Clock

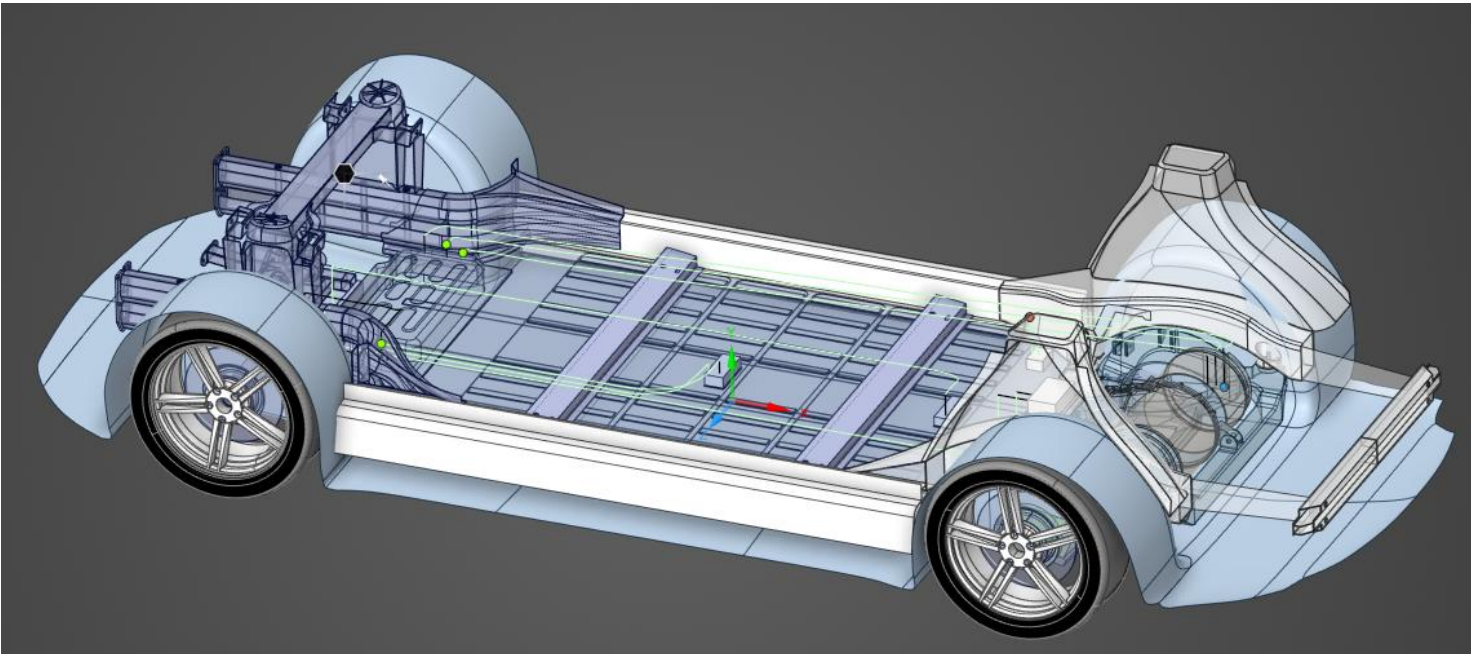
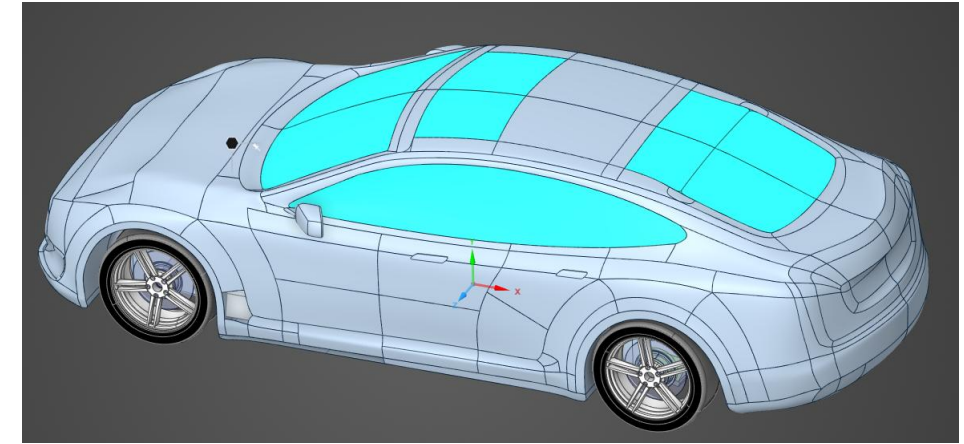


Cable and Connector



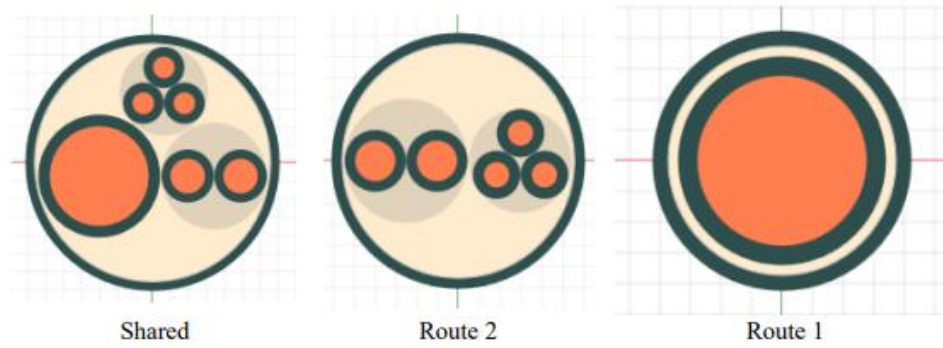
Cables on Platform

- Cable Harnesses in a Car
- Trapezoidal voltage steps are applied to specific conductors in various cables



Cables on Platform

- ANSYS EMC+ used for this type of simulation
- Cable routes have different cross-sectional definitions along the runs

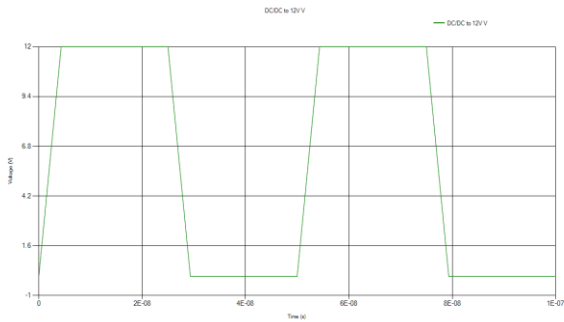


- Entire platform is included in the simulation

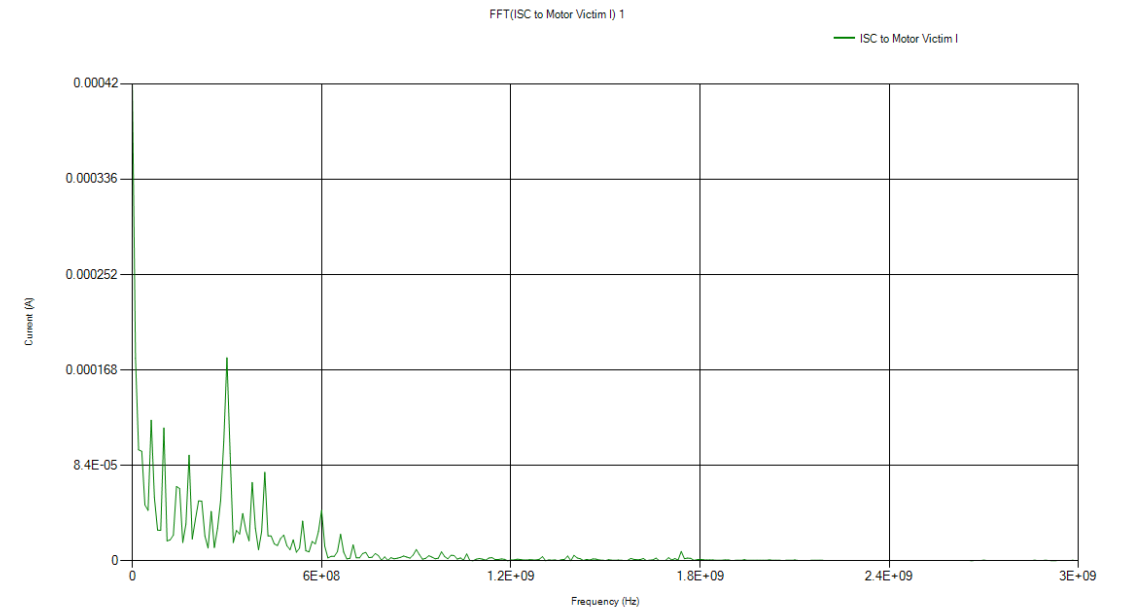
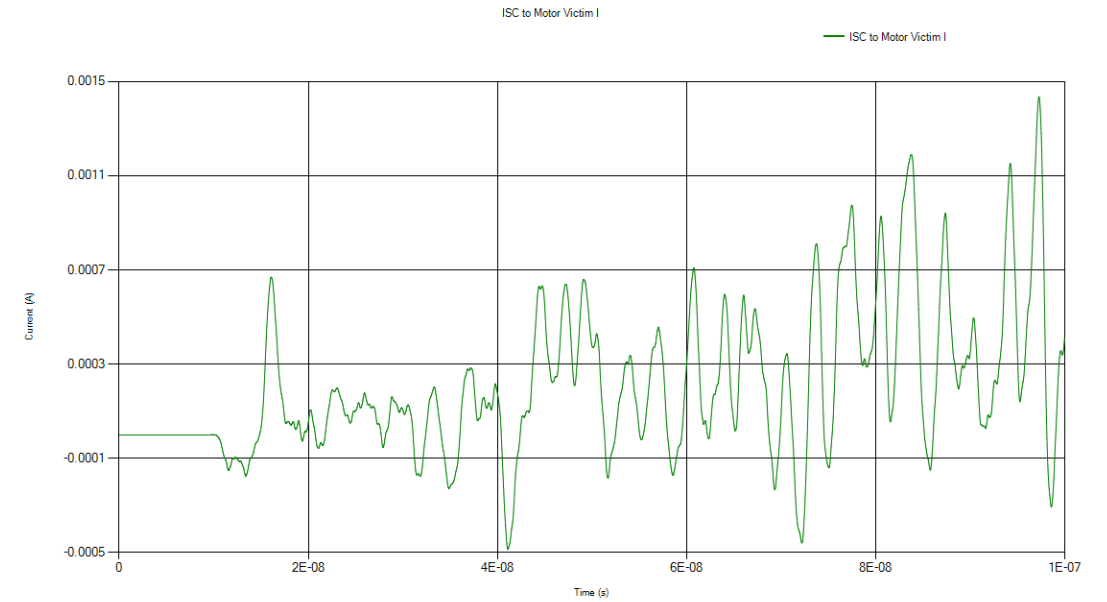
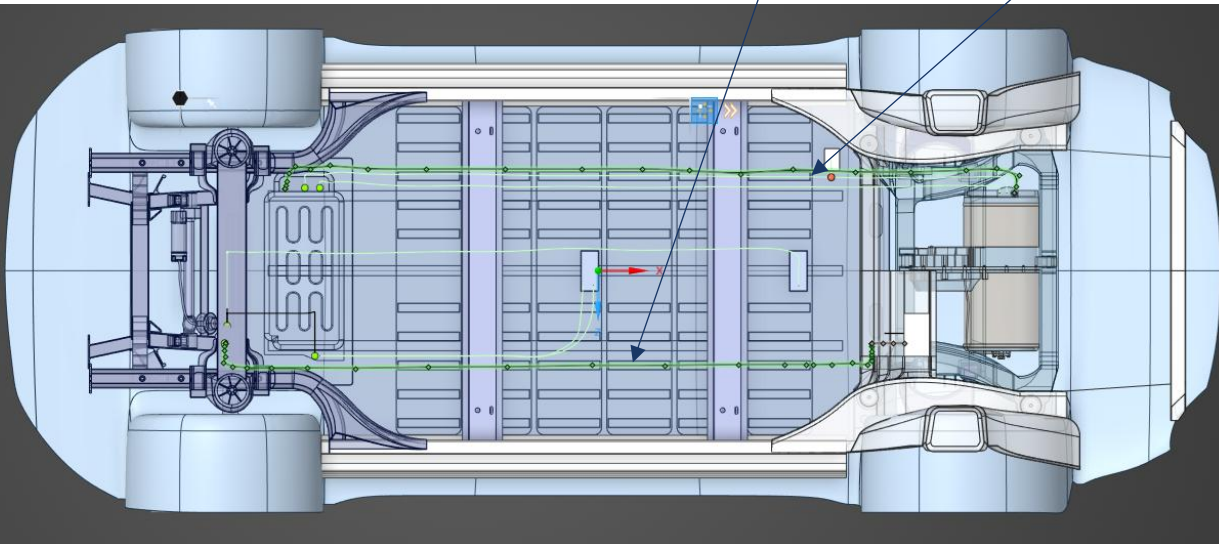


Cables on Platform

- Example of “source” to “victim” prediction

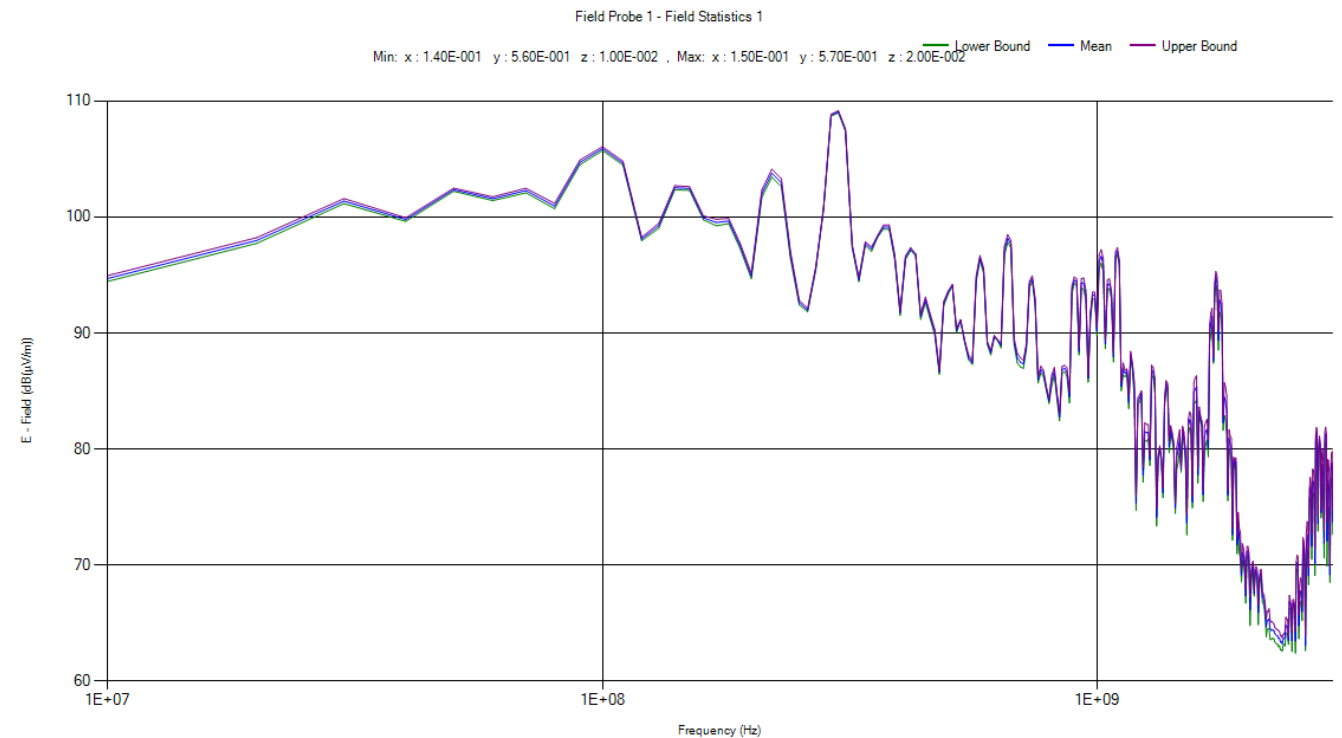
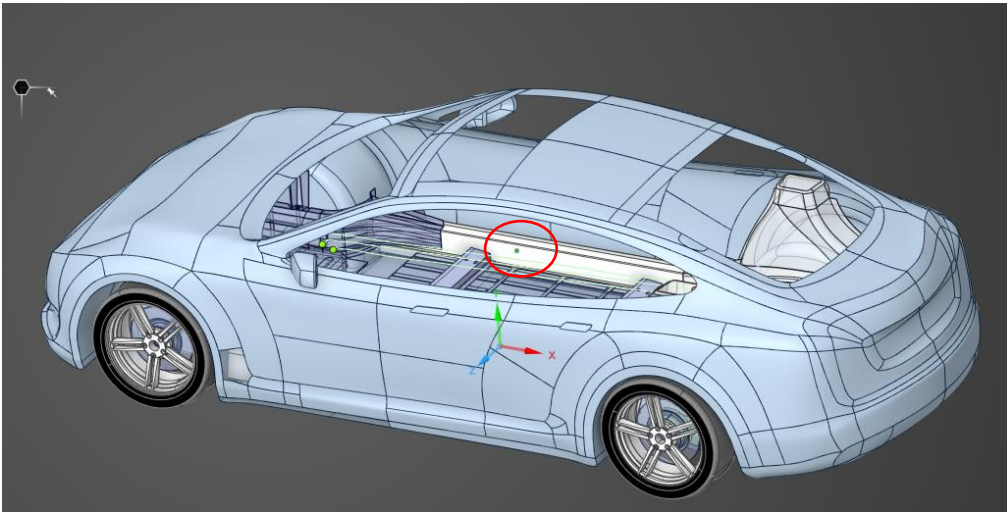


aggressor victim



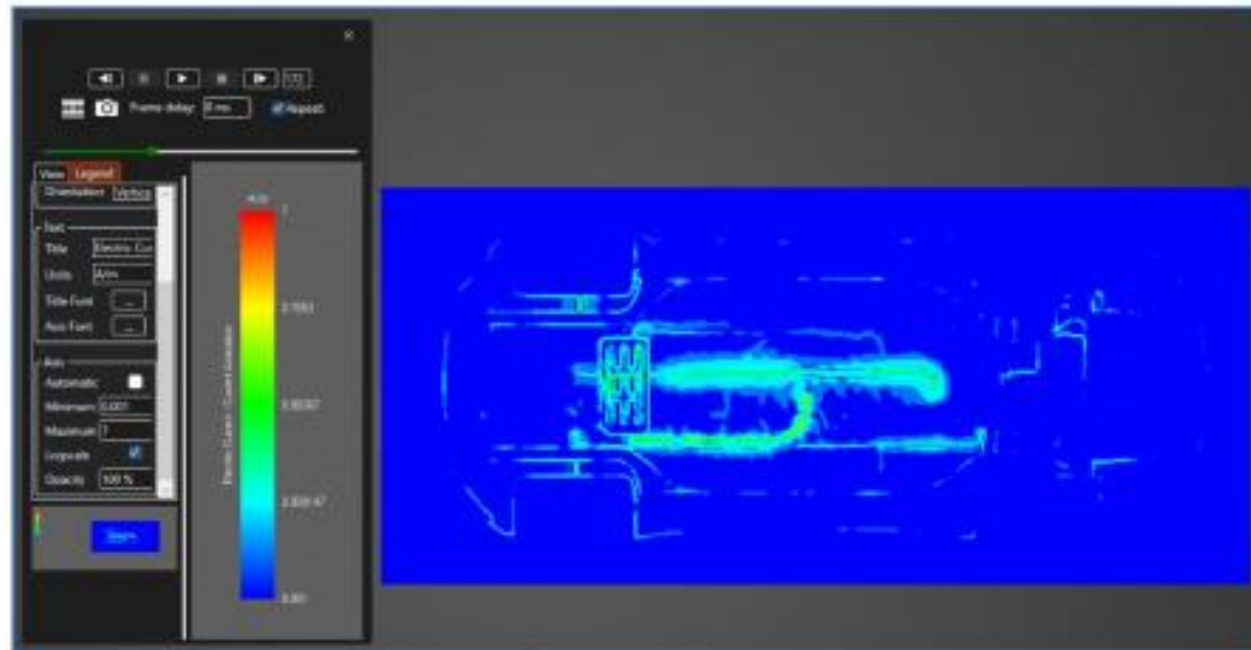
Cables on Platform

- A field probe is placed at the center of the passenger compartment



Cables on Platform

- Many ways to post-process information



Discussion

- Questions?
- Comments?
- For more information, please contact your DRD Account Manager
- Reach out to ***support@drd.com***
- Thank You!